

I. Project Title: **O&M of Highline Lake Fish Barrier Net**

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

Project/Grant Period: Start date (12/28/2011):
End date: (9/30/2016):
Reporting period end date: 11/14/15
Is this the final report? Yes _____ No X

III. Principal Investigator(s):

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IV. Abstract:

A spillway barrier net designed to control escapement of nonnative, warm-water fishes from Highline Reservoir (Highline Lake State Park, Colorado) was installed in August 1999. The net is made from Dyneema and is approximately 363 feet wide, 19 feet deep, weighs 1,400 pounds, with mesh openings no larger than a quarter inch. The net is designed to flex with current surge and changing water depth to prevent fish from escaping over or under it. The net was replaced for the second time on March 14, 2014, is currently 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 reservoir outlet gate operations, and sampling of the outlet stream below the lake to determine net performance.

Colorado River Action Plan: Main stem:

The Procedures for Stocking Nonnative Fish Species in the Upper Colorado River Basin (USFWS 1996) included specific reference to the need to screen the spillway at Highline Reservoir to control escapement of nonnative, warm-water fish species. This requirement prescribed that "Public and private waters that have a direct connection to rivers in the Upper Colorado River Basin (e.g., Elkhead Reservoir, Highline Reservoir and many ponds) will be equipped or managed with an anti-escapement device or practice acceptable to the Service (USFWS) and the State fish and wildlife agency." In addition, the Procedures, section IV.6, stated "The Upper Colorado River Basin Endangered Fish Recovery Program will pursue funding for equipping public reservoirs with anti-escapement devices" (USFWS 1996).

Funding from the UCRP became available in 1998 for installation of a fish screen at Highline Lake and the net was installed on 18 August 1999. The net reached the end of its life span after seven years of continuous operation and was replaced for the first time in March, 2006. The net was replaced for the second time in March, 2014. The replacement net was received in 2011 but installation was delayed due to lake conditions, and a major dredging project that occurred in the fall of 2013. Outlet testing in 2013 resulted in uncontrolled releases due to a stuck outlet gate, which was temporarily resolved by the use of a mobile external outlet plug. CPW purchased penstock sock nets to be used to prevent fish escapement in future annual outlet testing. Net installation was completed in early 2014 prior to refilling the Lake.

General Recovery Program Support Action Plan:

- III. Reduce negative impacts of nonnative fishes and sport fish management activities.
- III.A.2. Identify and implement viable control measures.
- III.A.2.c. Implement and evaluate the effectiveness of viable active control measures.
- III.B. Reduce negative impacts to endangered fish from sport fish management activities.
- III.C. Ensure public involvement occurs as appropriate.
- VI C. Plan and implement information and education and public involvement activities for all significant Recovery Program actions (e.g. presentations, public meetings, public involvement training, etc.).

Colorado River Action Plan: Mainstem

- III.B.1.a. Operate and maintain Highline Reservoir net.

VII. Accomplishment of FY 2015 Tasks and Deliverables, Discussion of Initial Findings and Shortcomings:

A. FY 2015 Tasks and Deliverables

Task 1. Maintain Protective Buoy Line.
Schedule: October – September, 2015
Deliverable: **Task Completed**

Task 2. Net Cleaning and Repair Operations.
Schedule: October – September, 2015
Deliverable: **Task Completed**

Task 3. Weekly visual survey.
Schedule: October – September, 2015
Deliverable: **Task Completed**

Task 4. Underwater Survey.
Schedule: October – September, 2015
Deliverable: **Task Completed**

Task 5. Fish sampling downstream of Highline Reservoir in outlet stream.
Schedule: Fall 2015
Deliverable: **Task Completed.** Annual report included.

B. Discussion of Initial Findings and Shortcomings: **N/A**

Study Area

The study area for this project is Highline Lake including the outlet downstream (Mack Wash) to the Colorado River.

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. The connecting cable, shackles, U bolts are in good working order.

Task 2. Net Cleaning and Repair Operations (in water): We performed 3 net cleanings in 2015: May 9, 2015, July 27, 2015, and October 7, 2015. The first cleaning this year took place a month later than in previous years since the net was in good shape at the end of last season and there was little algal presence at the start of the season. The second and third cleanings were moved back later as well due to the late first cleaning. The net was cleaned manually all 3 times by divers from United Underwater Contractors. As the net ages there will be an increase in algal buildup and we will move to 4 cleanings in 2016.

The highlights of the May 9, 2015 report were: 1) Cleaning was done on the net and it is just starting to show spots of heavy algae growth but overall the net is in good condition. 2) All hardware was inspected: anchoring cables are attached to the 4 manta bolts and the safety wire is in place and holding the shackles secure. 3) The net, thimbles, shackles, manta bolts and cable were completely inspected and all were in good condition. 4) Suspenders installed last year are holding up well but are showing signs of wear.

The highlights of the report submitted on July 27, 2015 were: 1) the net, lead line, thimbles, shackles, manta bolts and cable were completely inspected. All of the hardware is in good working condition. 2) All anchoring cables are attached to the 4 manta bolts and the safety wire is in place and holding the shackles secure. 3) The divers spent a lot of extra time cleaning to remove large hard spots that are starting to take hold and spread on the net. 4) The ¼" poly line spreading the top skirt are worn and stretching but are still holding up well to heavy boat traffic.

The highlights of the report submitted on October 7, 2015 were: 1) Most of the net cleaned up well and the ¼” poly line spreading the top skirt are worn out and need to be replaced. The net is just starting to show spots of heavy algae growth and some are becoming very difficult to remove. 2) The lead line, thimbles, shackles, manta bolts and cable were inspected and in good condition. 3) All anchoring cables are attached to the 4 manta bolts and the safety wire is in place and holding the shackles secure.

Task 3. Weekly visual survey: The net top line and floats along with the skirt were visually checked on a weekly basis with the Park Patrol Boat. On weekends the Patrol Boat would be deployed for several hours and when time permitted we would examine the net from the water surface. Due to issues with the PVC wearing on the old net, the skirt was tied with ¼” poly line from the skirt to the safety line which kept the skirt stretched out.

Task 4. Underwater Survey: United Underwater Contractors performed the inspections in accord with methodology and equipment used for previous inspections. Inspection reports are available at the park or on request.

Task 5. Implement and evaluate the effectiveness of viable active control measures: The reservoir outlet gates were not operated in 2015 due to the dredging and gate repair work performed in 2014. Sampling in Mack Wash cannot take place until irrigation flows into and out of the reservoir diminish, typically later than the due date for this annual report. The Appendix to this report contains a cumulative account of Mack Wash sampling, through the most recent year for which data are available. In 2015, CPW staff surveyed Mack Wash on November 18, after the end of the irrigation season. Species composition was very similar to that observed in previous years, with CPUE comparable or lower for most species, giving no indication of a change in the net’s effectiveness.

VIII. Additional noteworthy observations:

Gizzard shad were discovered in Highline Reservoir during standard annual sampling in October, 2015, and appeared to be very abundant. Possible sources include the Government Highline Canal, illegal introduction and/or illegal use of live fish as bait. No gizzard shad were collected in Mack Wash, suggesting that the net has been effective in preventing escapement from the reservoir.

The ¼-inch poly line suspenders installed in 2014 will need replacement in 2016, but given that they did not show signs of wear until the final inspection (October 7), should be okay until the first cleaning in 2016.

VIII. Recommendations:

- Due to the hard buildup of algae beginning on the net, and with past experience, we will begin 4 cleanings on the net in 2016.
- Park staff will monitor the net and debris being washed into the lake in the spring and will inform divers when the cleaning of the net will need to take place.

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

XI. FY 2014 Budget Status

- A. Funds Provided:
- B. Funds Expended: No USBR funds were expended in this fiscal year. \$3,000 was expended by CPW for three net cleanings (CPW covers annual O&M up to \$10,000) in FY15.
- C. Difference:
- D. Percent of the FY 2015 work completed, and projected costs to complete: 100%; \$3,000.00
- E. Recovery Program funds spent for publication charges: \$0.00

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

XIII. Signed: Alan C. Martinez 11/23/15
Principal Investigator Date

(Just put name and date here, since you will be submitting the report electronically)

APPENDIX: **Mack Wash fish sampling**

Background

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

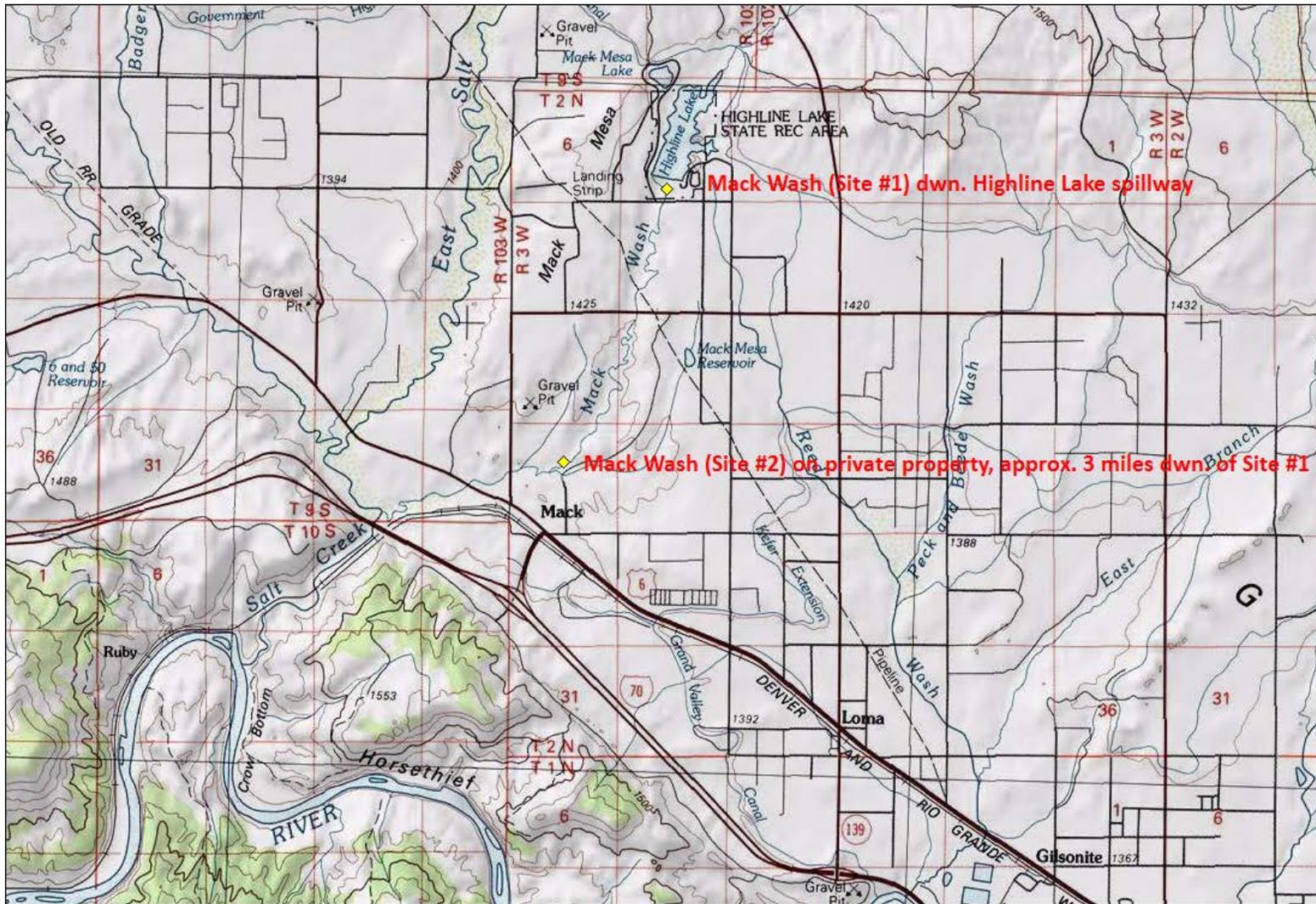
Fish can escape into Mack Wash from Highline Lake by moving over the spillway net and/or through the bottom release on the dam when no anti-escapement device is in place. Colorado Parks and Wildlife (CPW) biologists were concerned about fish escapement from Highline Lake into Mack Wash that may have occurred during canal surges and unintended lake bottom releases. 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 could not commence until water was no longer delivered downstream.

CPW biologists completed fish surveys at two sites in Mack Wash downstream of Highline Lake each November annually from 2011 to 2015. Additionally, CPW biologists also completed fish surveys within Highline Lake downstream of the spillway net and upstream of the spillway in March of 2012 and March of 2013. In March of 2014, the spillway net was replaced with a new net, and no sampling was completed in Highline Lake downstream of the spillway net and upstream of 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. A map of the Mack Wash fish survey sites follow, along with fish survey results from both Mack Wash (2011-2015) and Highline Lake (2012-2013).

Mack Wash

CPW biologists bank electrofished two sites on Mack Wash downstream of Highline Lake. 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 downstream of the spillway net. Non-native, non-salmonid fishes collected were lethally removed.

Mack Wash Fish Survey Sites



Mack Wash Fish Survey Results

Site #1-Just downstream of Highline Lake spillway

Total length of site surveyed in November 2011 = 0.11 mile

Total length of site surveyed in November 2012 = 0.14 mile

Total length of site surveyed in November 2013 = 0.14 mile

Total length of site surveyed in November 2014 = 0.12 mile

Total length of site surveyed in November 2015 = 0.14 mile

**Total # of Fish Collected; Total Length Size Range in Millimeters; Catch per Unit Effort (# fish/hour)
by Species and Year for Site #1
2011-2015**

Fish Species

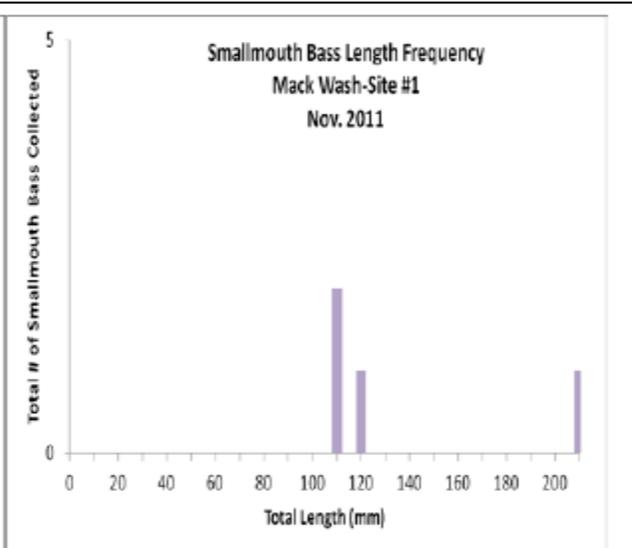
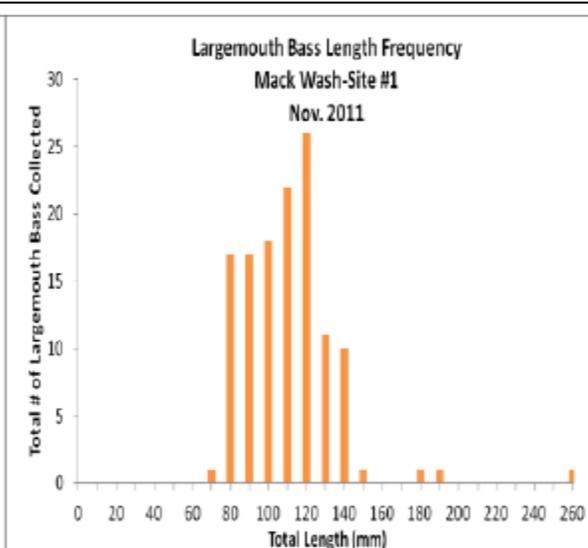
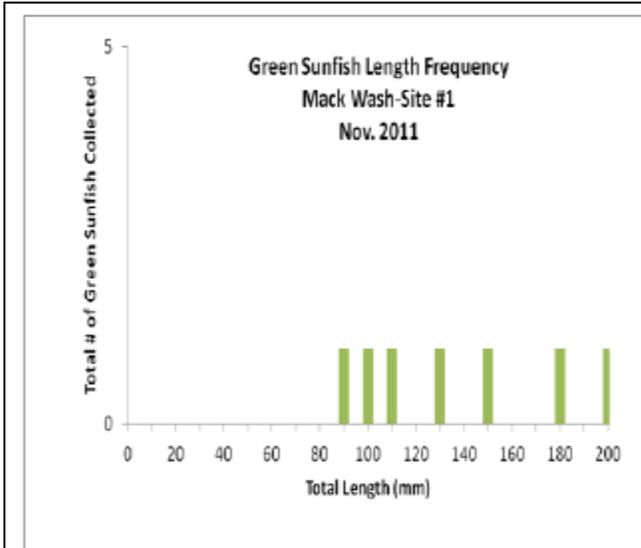
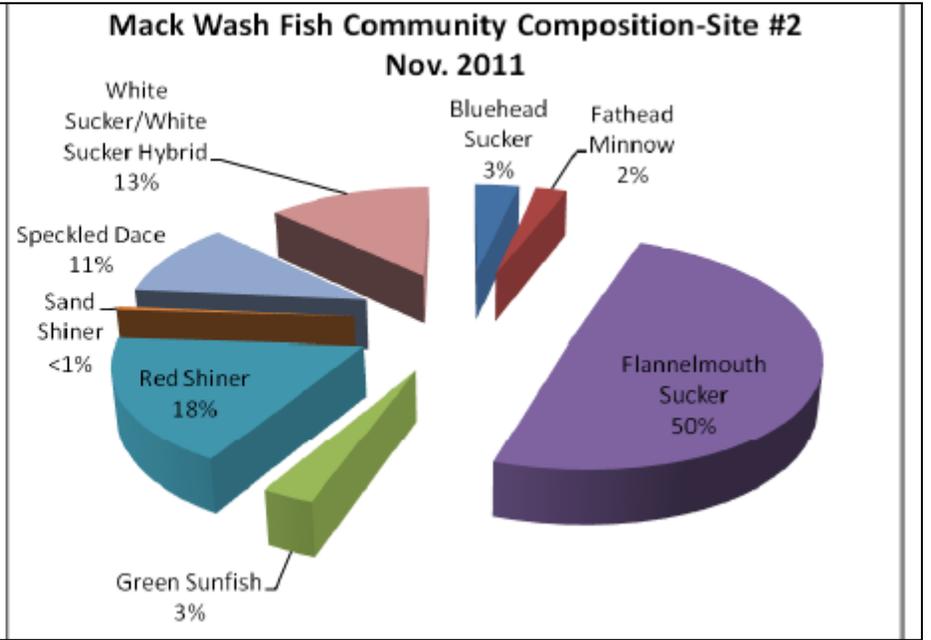
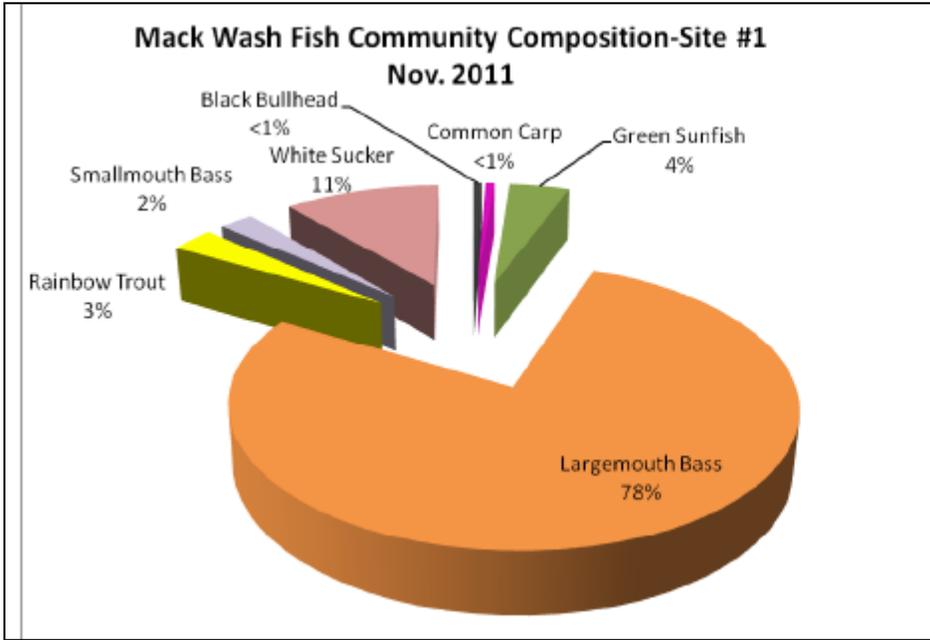
<u>Collected</u>	<u>2011</u>	<u>2012</u>	<u>2013</u>	<u>2014</u>	<u>2015</u>
Black Bullhead	1; 157; 1.6	0	1; 210; 1.3	1; 314; 1.0	1; 192; 1.4
Black Crappie	0	0	1; 69; 1.3	0	0
Channel Catfish	0	1; 522; 1.0	1; 293; 1.3	0	1; 429; 1.4
Common Carp	1; 193; 1.6	6; 466-625; 6.0	0	3; 462-515; 3.0	2; 511-512; 2.8
Green Sunfish	7; 84-192; 10.9	30; 74-195; 30.0	36; 37-179; 47.1	6; 132-177; 6.0	30; 55-183; 42.3
Largemouth Bass	126; 68-253; 196.9	261; 56-342; 261.0	32; 72-144; 41.8	86; 76-332; 86.0	64; 64-146; 90.1
Rainbow Trout	5; 305-358; 7.8	1; 309; 1.0	0	1; 317; 1.0	4; 238-311; 5.6
Smallmouth Bass	4; 107-207; 6.3	0	1; 92; 1.3	0	0
White Sucker/Hybrid	18; 202-380; 28.1	22; 173-268; 22.0	1; 369; 1.3	40; 126-197; 40	0
Yellow Perch	0	0	0	17; 76-206; 17	2; 164-189; 2.8
<u>Total Number of Fish Collected</u>	162	321	73	154	104

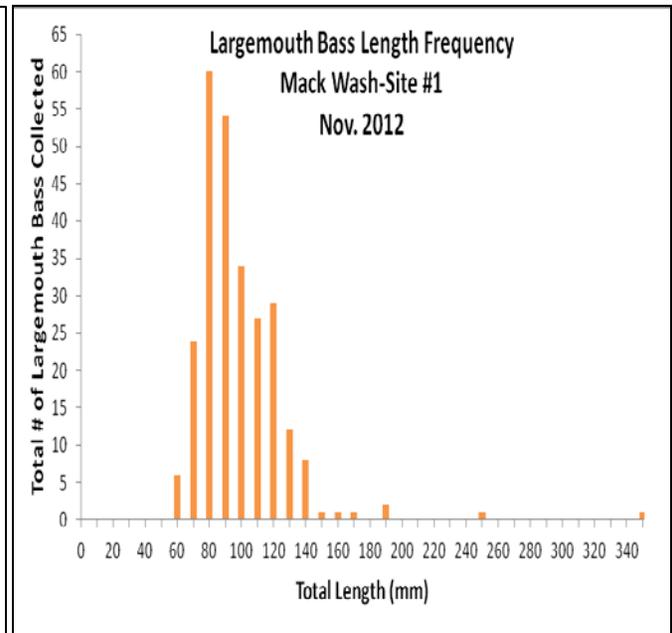
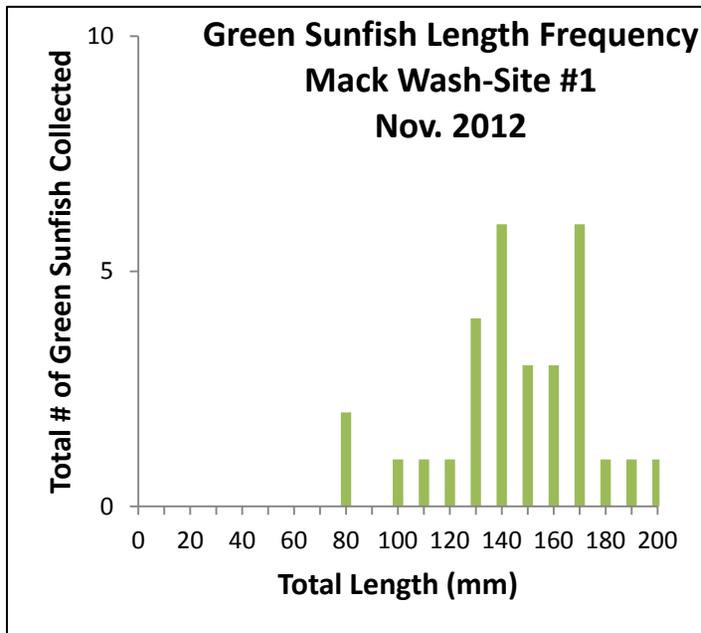
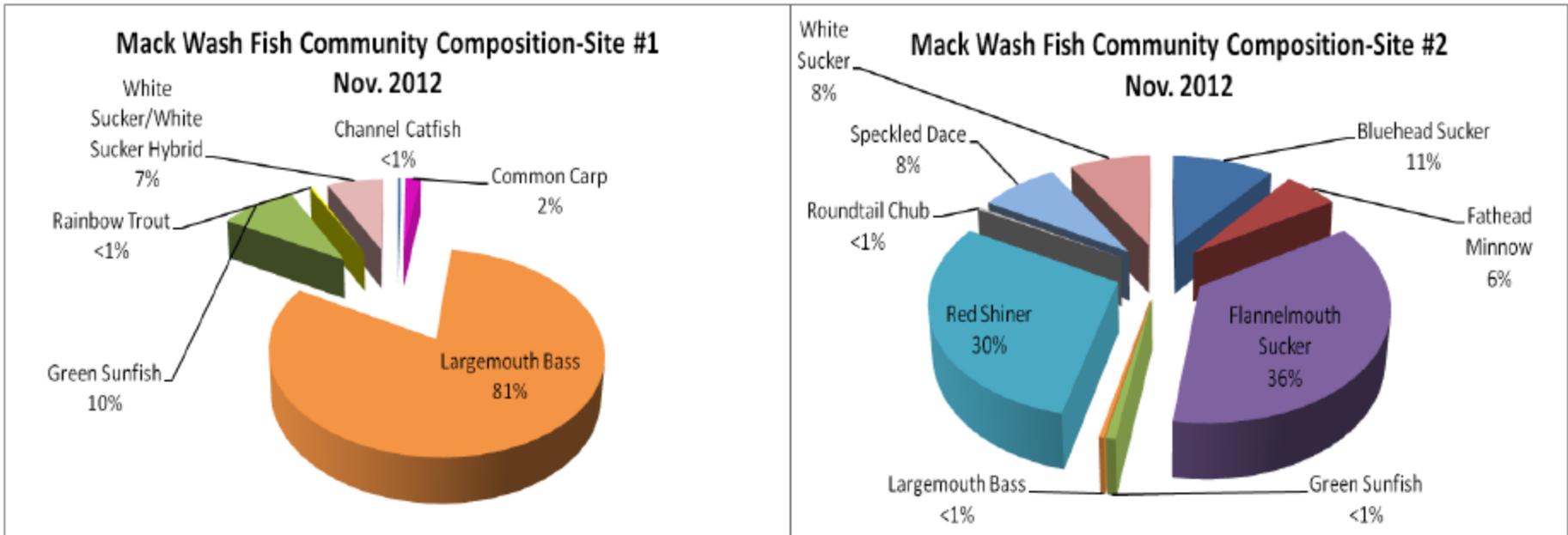
Site #2-Private property approximately 3 miles downstream of Site #1

Total length of site surveyed in November 2011 = 0.16 mile
 Total length of site surveyed in November 2012 = 0.18 mile
 Total length of site surveyed in November 2013 = 0.19 mile
 Total length of site surveyed in November 2014 = 0.17 mile
 Total length of site surveyed in November 2015 = 0.17 mile

**Total # of Fish Collected; Total Length Size Range in Millimeters; Catch per Unit Effort (# fish/hour)
 by Species and Year for Site #2
 2011-2015**

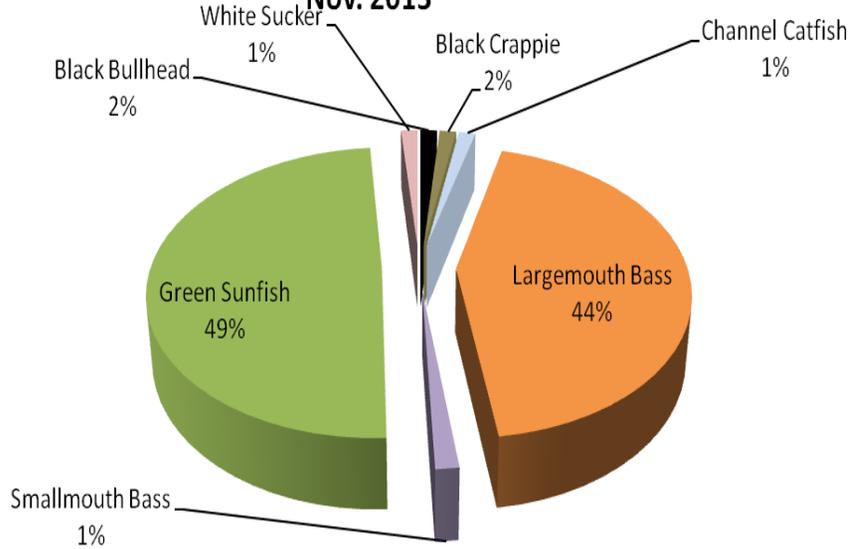
Fish Species Collected	2011	2012	2013	2014	2015
Bluehead Sucker	7; 63-95; 7.9	30; 56-216; 24.0	23; 72-195; 19.3	3; 99-218; 3.1	4; 91-121; 4.0
Fathead Minnow	5; 53-70; 5.7	15; 47-90; 12.0	6; 47-83; 5.0	6; 47-69; 6.1	1; 62; 1.0
Flannelmouth Sucker	101; 62-198; 114.8	104; 52-505; 83.2	45; 78-195; 37.8	23; 92-127; 23.5	30; 97-160; 30.3
Green Sunfish	6; 54-128; 6.8	2; 95-135; 1.6	1; 83; 0.8	26; 45-103; 26.5	19; 41-135; 19.2
Largemouth Bass	0	1; 129; 0.8	16; 67-176; 13.4	1; 83; 1.0	2; 105-119; 2.0
Red Shiner	36; 28-89; 40.9	84; 29-89; 67.2	453; 24-86; 380.7	177; 22-84; 180.6	65; 24-89; 65.7
Roundtail Chub	0	1; 84; 0.8	1; 74; 0.8	0	0
Sand Shiner	1; 44; 1.1	0	0	0	0
Speckled Dace	22; 58-88; 25.0	23; 53-99; 18.4	46; 44-91; 38.7	37; 55-98; 37.8	9; 47-98; 9.1
White Sucker/Hybrid	26; 59-259; 29.5	24; 42-230; 19.2	19; 67-214; 16.0	16; 51-238; 16.3	25; 59-241; 25.3
<u>Total Number of Fish Collected</u>	204	284	610	289	155





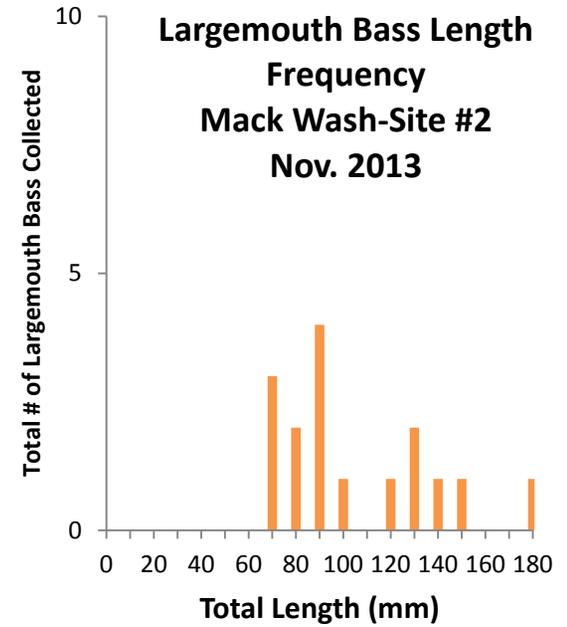
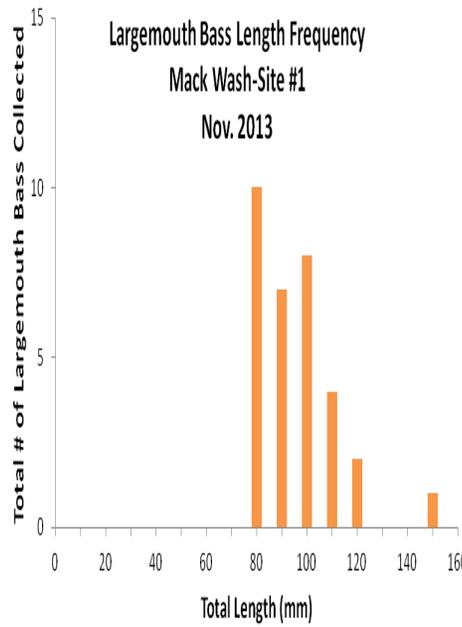
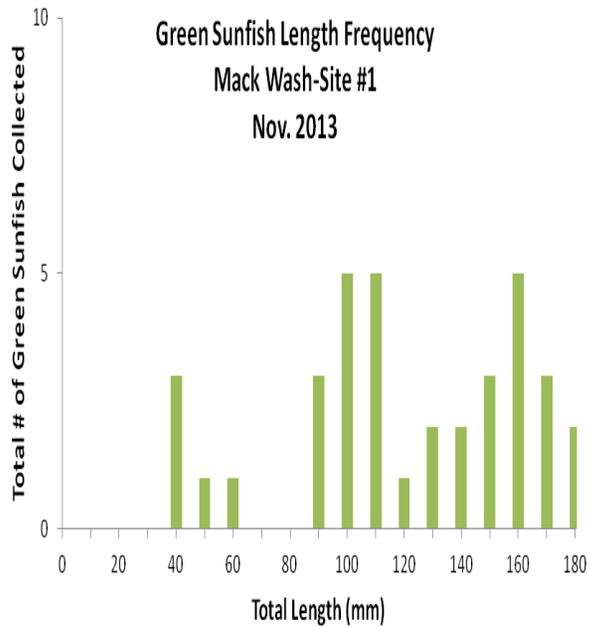
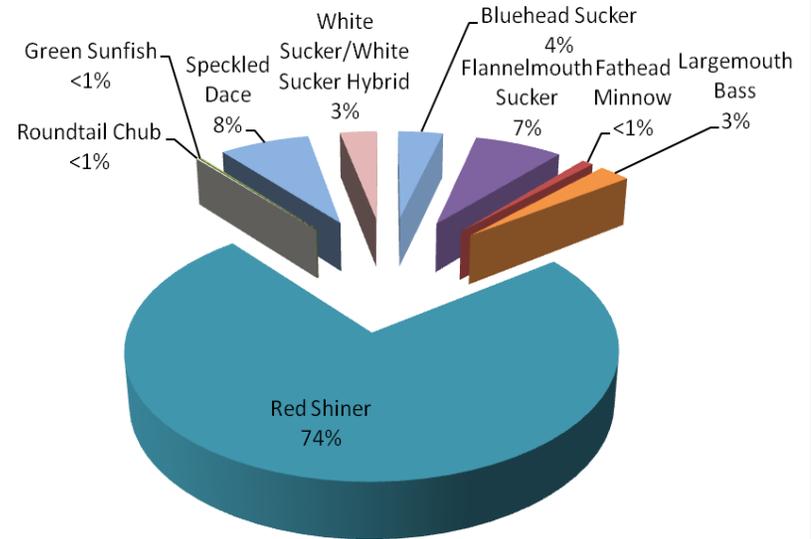
Mack Wash Fish Community Composition-Site #1

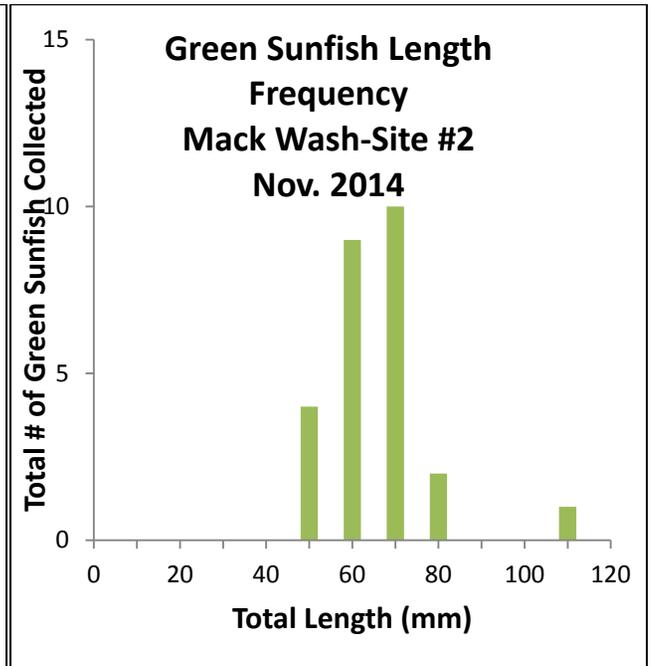
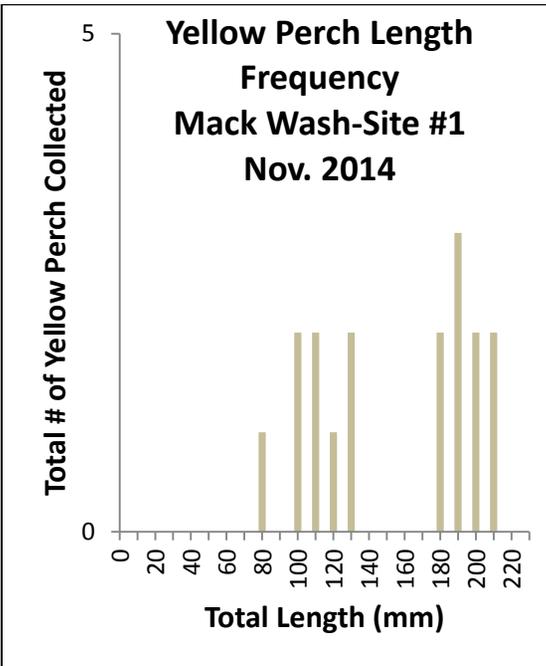
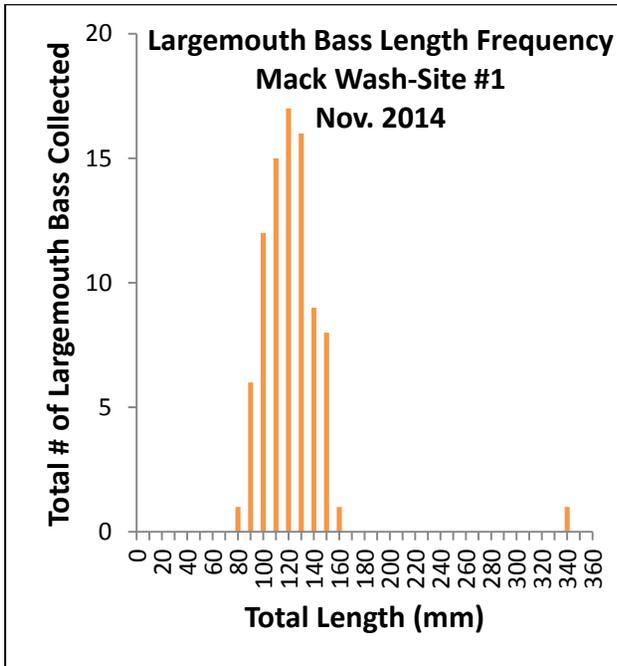
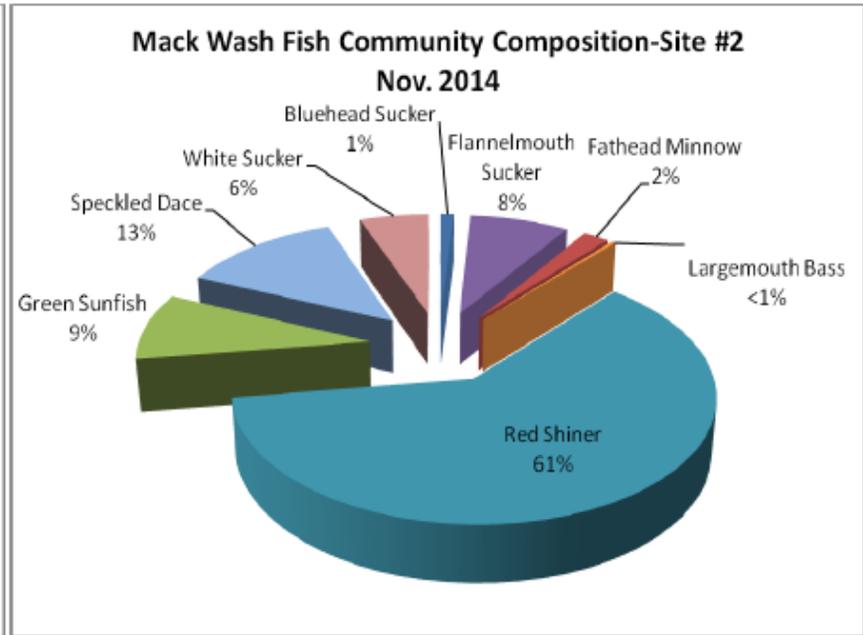
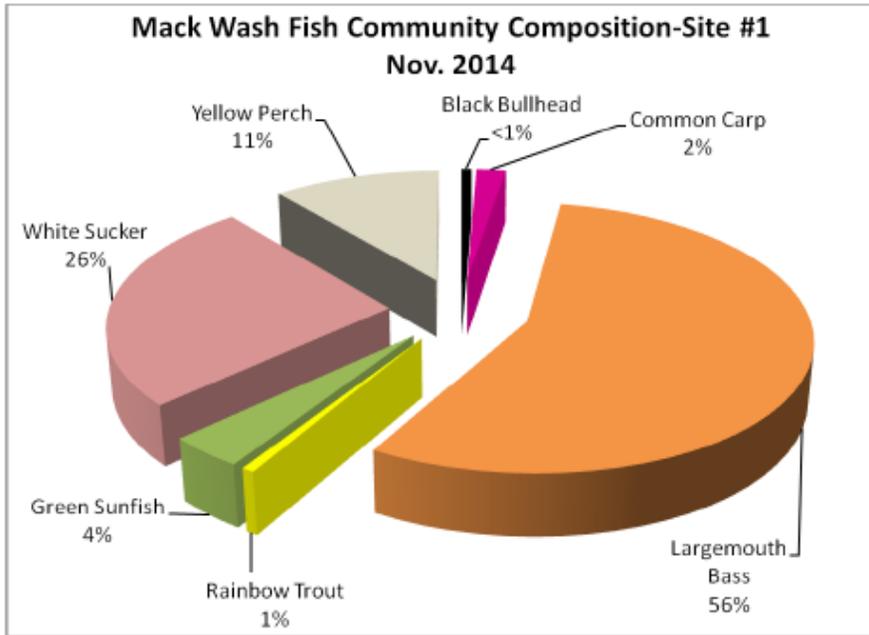
Nov. 2013

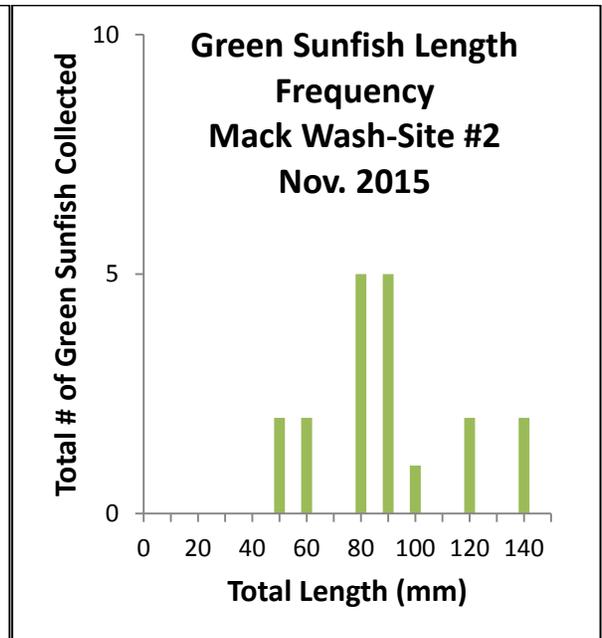
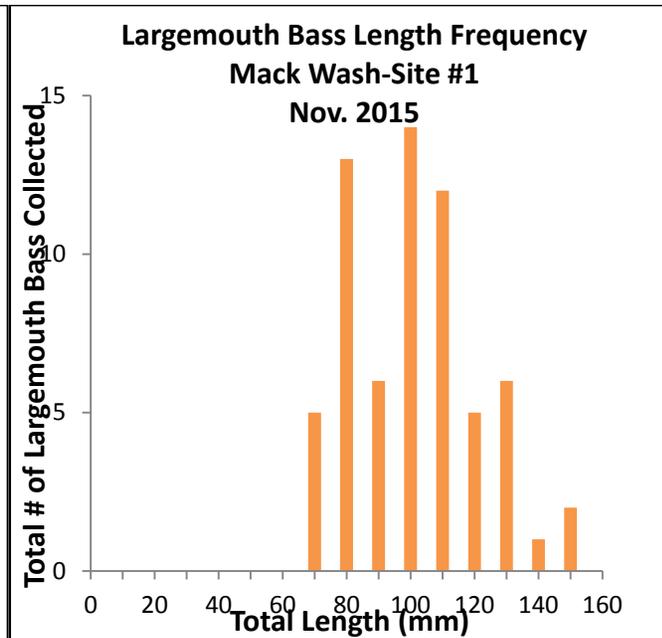
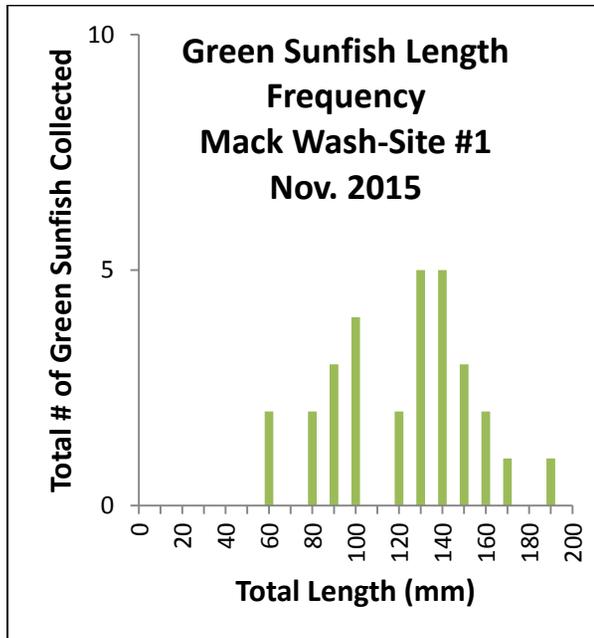
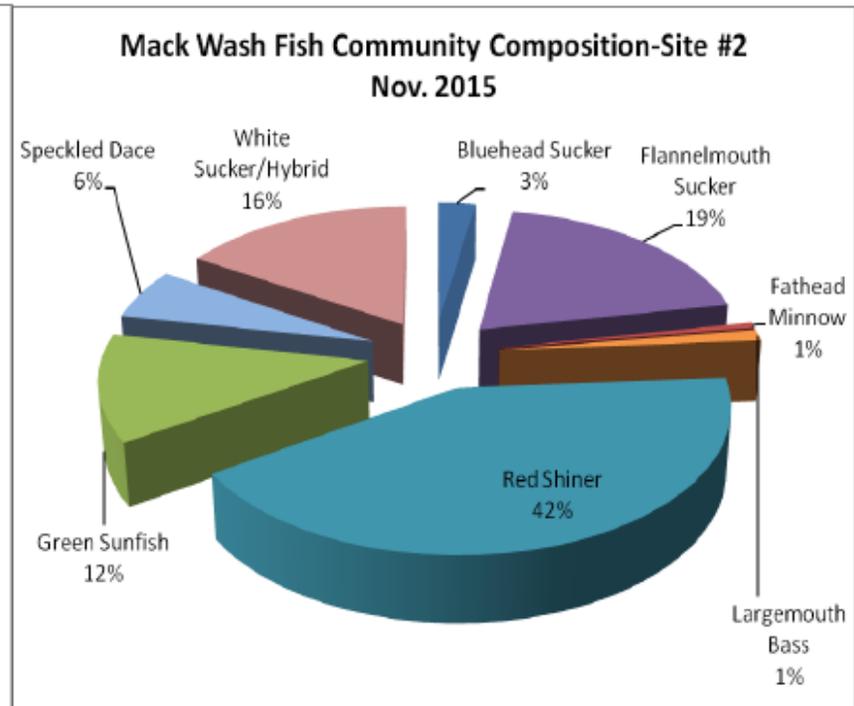
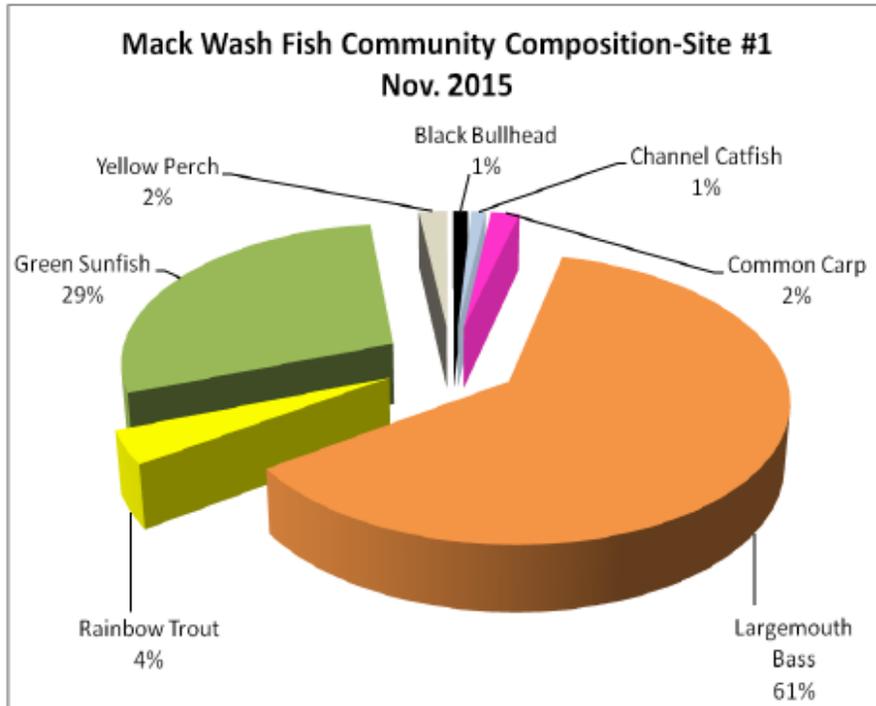


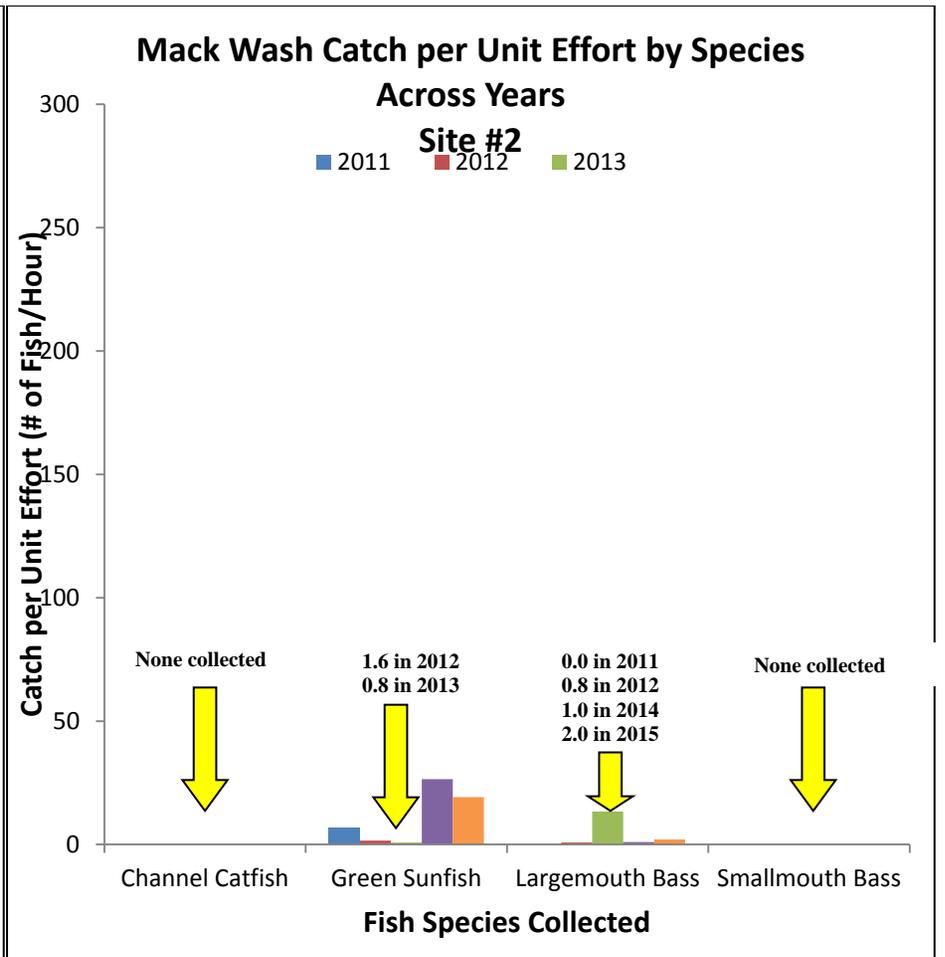
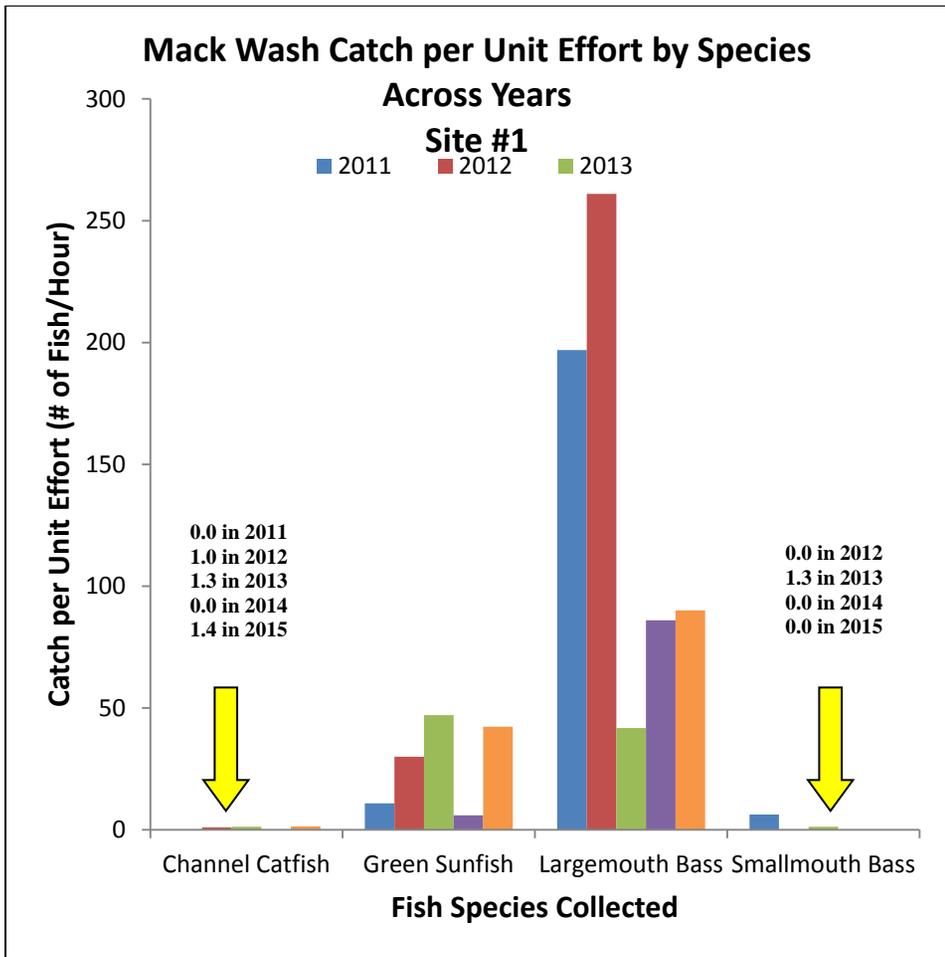
Mack Wash Fish Community Composition-Site #2

Nov. 2013









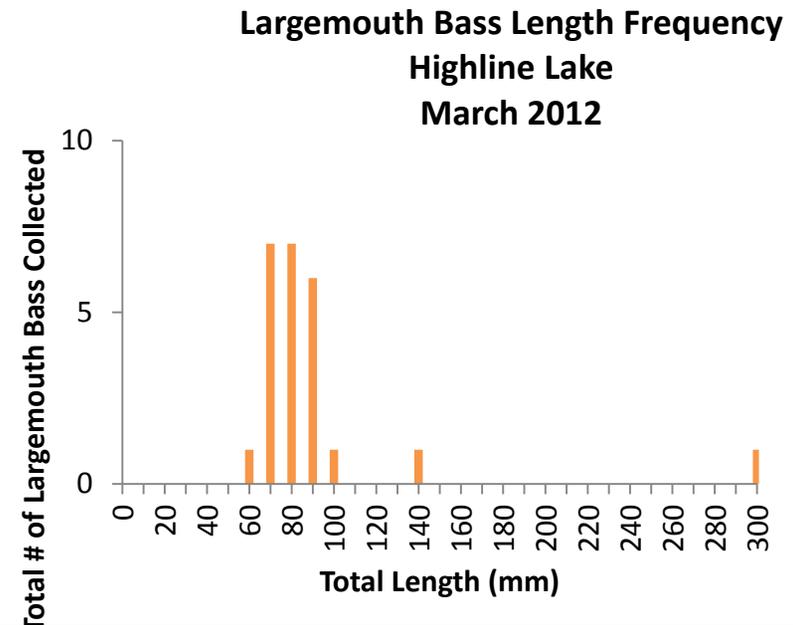
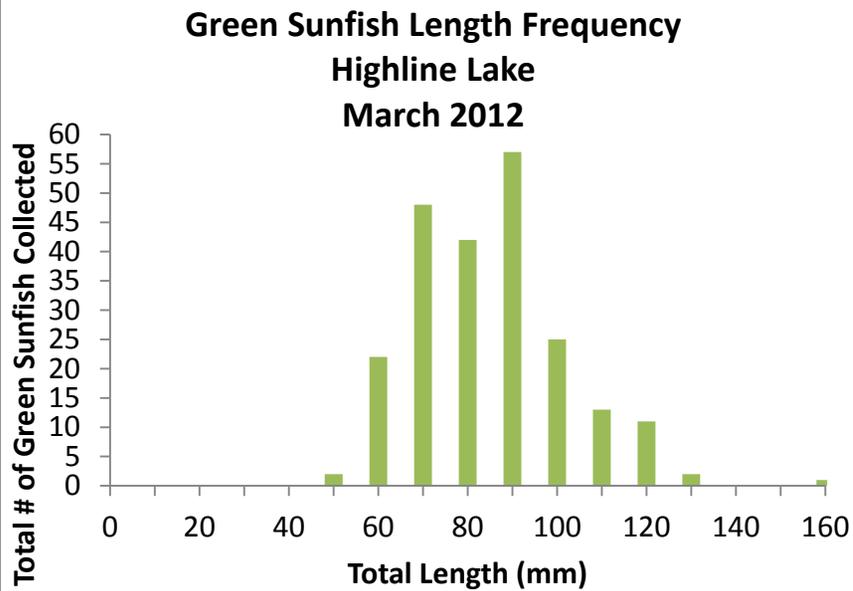
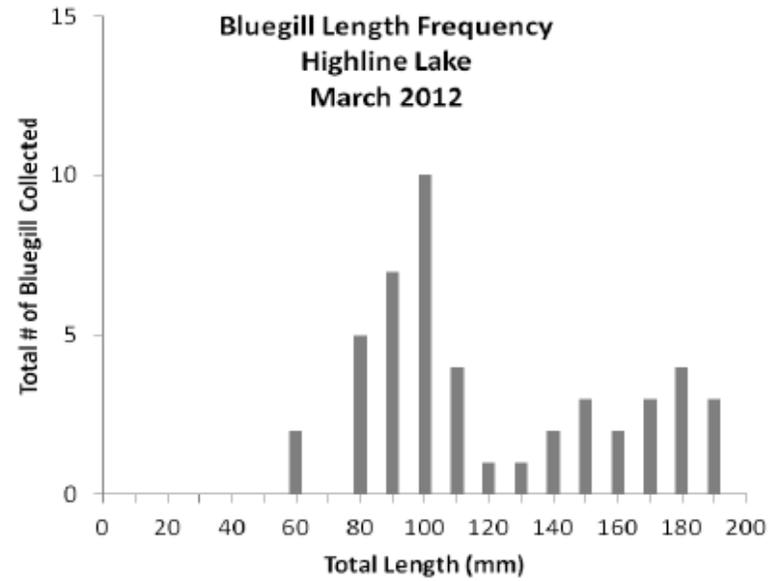
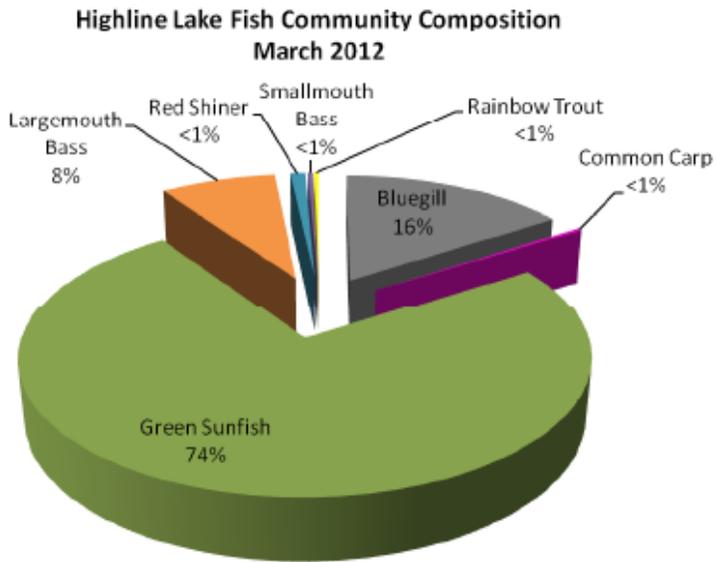
Highline Lake between spillway net and spillway

CPW biologists boat-electrofished Highline Lake on the evenings of March 20, 2012 and March 25, 2013 between the spillway net and the spillway. In addition, three experimental gill nets were also set the evening of March 20, 2012 in the same area and pulled the following morning. The objectives of the fish surveys were to determine fish species composition and relative abundance within the lake downstream of the spillway net. Surveying was completed prior to water being delivered downstream to water users. Fish collected were released back into Highline Lake upstream of the spillway net with the exception of one smallmouth bass which was lethally removed.

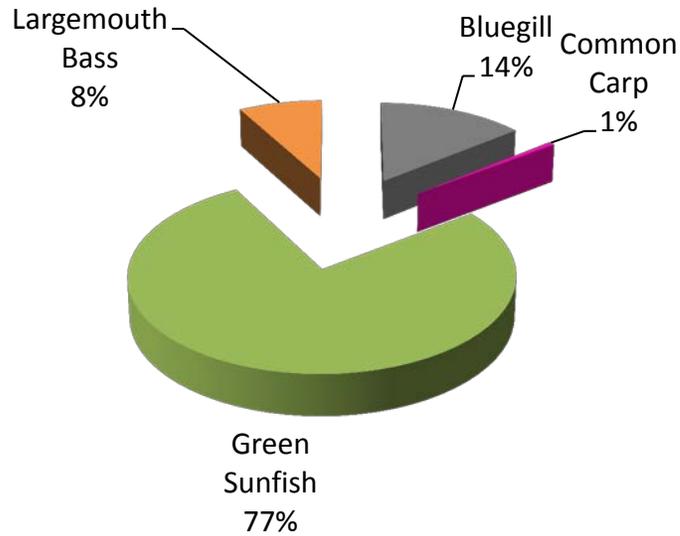
Highline Lake Fish Survey Results

2012					2013				
Collection Method	Fish Species Collected	Total # Fish Collected	Total Length Size Range in Millimeters (mm)	Catch per Unit Effort (# fish/hour)	Collection Method	Fish Species Collected	Total # Fish Collected	Total Length Size Range in Millimeters (mm)	Catch per Unit Effort (# fish/hour)
Electrofishing	Bluegill	47	57-188	74.6	Electrofishing	Bluegill	23	47-170	30.7
	Common Carp	1	483	1.6		Common Carp	1	502	1.3
	Green Sunfish	223	42-157	354.0		Green Sunfish	126	40-190	168.0
	Largemouth Bass	24	56-296	38.1		Largemouth Bass	13	67-123	17.3
	Red Shiner	3	58-71	4.8	Total Number of Fish Collected = 163				
	Smallmouth Bass	1	77	1.6					
Gill Nets	Rainbow Trout	1	284	0.02					

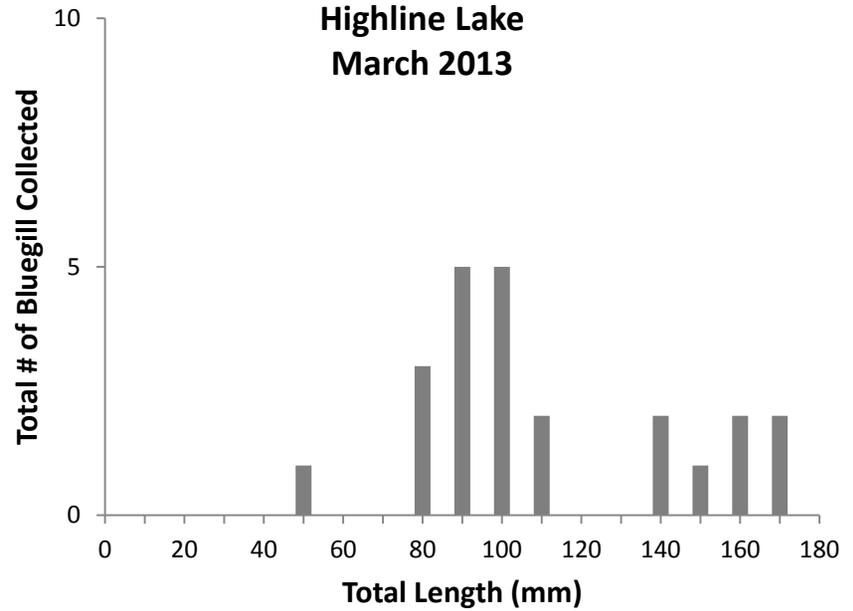
Total Number of Fish Collected = 300



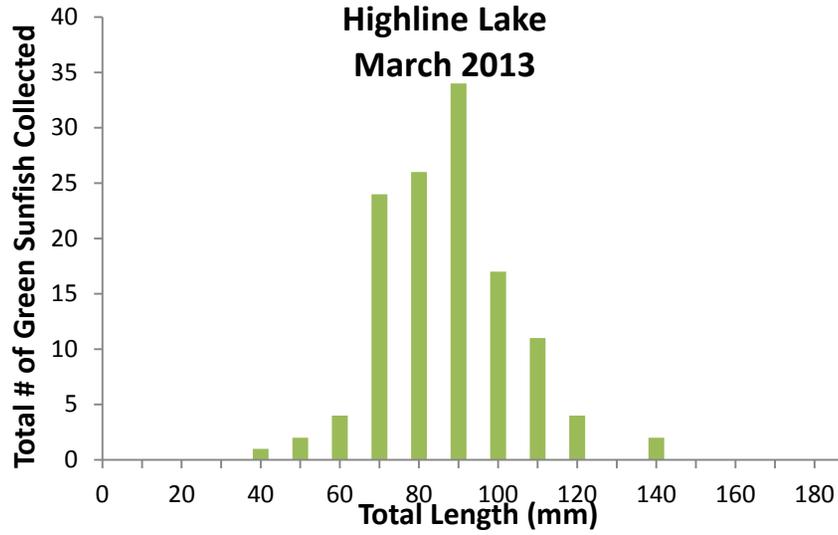
Highline Lake Fish Community Composition March 2013



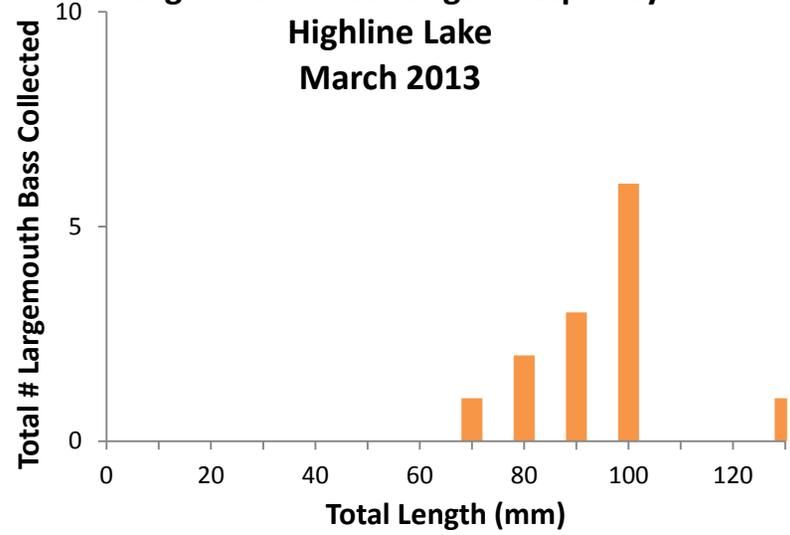
Bluegill Length Frequency Highline Lake March 2013



Green Sunfish Length Frequency Highline Lake March 2013



Largemouth Bass Length Frequency Highline Lake March 2013



Conclusions and 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. These events along with annual degradation of the spillway net likely influenced the results of CPW fish surveys within Highline Lake and Mack Wash, downstream of the spillway net. The majority of ictalurids and centrarchids collected within Mack Wash and which likely originated from Highline Lake were captured within the plunge pool at the base of the spillway downstream of Highline Lake (Site #1) from 2011-2013, and in 2015. The only exception occurred in 2014, when the density and catch rate of green sunfish were greater at Site #2, approximately three miles downstream of Highline Lake. Generally, fish appear to be confined to the spillway plunge pool in the fall when water is not being released from Highline Lake and delivered downstream. Depth of the plunge pool prohibits CPW biologists from accessing the head of the pool, allowing some fish to escape collection from year to year. Catch rate for ictalurids was the greatest in 2015 (1.4 fish/hour) when one channel catfish and one black bullhead were captured at Site #1. Green sunfish and largemouth bass densities and catch rates varied from year to year at this site, while smallmouth bass densities and catch rates have declined to 0 since 2013 when only 1 smallmouth bass was captured. One black crappie was collected from Site #1 in 2013, while yellow perch were first collected at this site in 2014. Red shiner have dominated the non-native fish community at Site #2 across all five years. Green sunfish density and catch rates were the greatest at this site in 2014 (26 fish; 26.5 fish/hour) and 2015 (19 fish; 19.2 fish/hour), while the same metrics for largemouth bass have declined since 2013 (16 fish; 13.4 fish/hour). Ictalurids and smallmouth bass were absent from Site #2 in all years sampled. Catch rates for all fish species collected between the Highline Lake spillway net and spillway declined from 2012 to 2013.

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 insure 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 net. The existing spillway net was replaced in March of 2014 after dredging activities within Highline Lake were completed;
- 3) re-adjustment of the poly-line from the skirt to safety cable appears to be holding the net in better position, keeping the skirt from washing over the 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
- 5) design and installation of a fish capture net on the downstream side of the outlet structure/bottom release to capture fish that have escaped from Highline Lake during operation of the outlet structure/bottom release

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.

ANNUAL PERFORMANCE PROGRESS REPORT (PPR)

BUREAU OF RECLAMATION AGREEMENT NUMBER: R12AP40001

UPPER COLORADO RIVER RECOVERY PROGRAM PROJECT NUMBER: C-20

Project Title: O&M of Highline Lake Fish Barrier Net

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Project/Grant Period: Start date (12/28/2011)
 End date: (09/30/2016)
 Reporting period end date (11/14/2015)
 Is this the final report? Yes X No

Performance: All tasks were accomplished and tailrace fish sampling results are included in this report. The outlet gates were not operated in 2015.