HULT RESERVOIR FISH SPECIES COMPOSITION, SIZE AND RELATIVE ABUNDANCE 2017

Prepared for
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Table of Contents

List of Tables

List of Figures

Summary

The goal of this project was to provide information for the Bureau of Land Management (BLM) and Oregon Department of Fish and Wildlife (ODFW) regarding the current species composition, size, length frequencies and relative abundance of fish occupying Hult Reservoir, a small reservoir owned by BLM in the Siuslaw Basin on upper Lake Creek near the town of Horton, Oregon. Understanding the existing species composition, native fish habitat utilization, relative abundance of native and non-native fish and characterization of current fishing opportunities will allow the agencies to better promote, advertise, and enhance the fishery for the public through targeted management activities.

Specific objectives of this project were to: 1) collect information about the current fish species composition, size, and relative abundance of fish in the reservoir, particularly presence or absence of juvenile coho salmon, 2) provide a brief history of the site for reference, and 3) research and assimilate any previous data available for historical context.

We divided the reservoir into three zones (lower, middle and upper) of approximately equal size, then deployed miniature floating Oneida Lake Traps, deployed floating gill nets and boat electrofished in each zone during three seasons (summer, fall and winter) in 2017 to collect fish and determine species composition, length frequencies and relative abundance of fish in Hult Reservoir.

Seven species of fish were encountered in Hult Reservoir in 2017: largemouth bass *(Micropterus salmoides),* cutthroat trout *(Oncorhynchus clarkii),* tainbow trout/winter steelhead *(Oncorhynchus mykiss),* bluegill *(Lepomis macrochirus),* reticulate sculpin *(Cottus perplexus),* brown bullhead *(Ameiurus nebulosus)* and western brook lamprey (*Lampetra richardsoni*).

The most abundant fish observed were largemouth bass and bluegill in the summer and fall, and cutthroat in the winter. Cutthroat trout were much more prevalent in the fall and winter sampling than in the summer. Presumably, most cutthroat trout moved up into the tributaries to seek thermal refuge during the summer months and returned to the reservoir once the temperatures were more conducive to growth and survival. However, some of them likely moved downstream, were preyed upon, or perished from the high summer temperatures and low dissolved oxygen conditions in the reservoir in summer.

Under current conditions, high surface temperature (>20°C), bass predation, and hypoxic dissolved oxygen levels below four meters of depth show that reservoir conditions are inhospitable for juvenile salmonids in the summer.

Currently there are well established fisheries for both cutthroat trout (spring, fall, winter) and largemouth bass (summer) in the reservoir, and we talked to several anglers who target each of these species. Habitat segregation in the summer between the salmonids who move out of the reservoir and the warm-water fish that remain and spawn in the reservoir results in a diversified year-round angling opportunity.

There were no coho salmon (juvenile or adult) observed in Hult Reservoir in 2017, but adult coho salmon were observed spawning just downstream of the dam. This observation verifies that a proportion of the adult coho attempting to ascend the ladder at Lake Creek Falls are successful and continue migration upstream to the vicinity of Hult Reservoir. It may be possible to keep the current fishery in Hult Reservoir as it stands and still increase coho production in the system by improving adult passage at Lake Creek Falls, and possibly at Hult Dam.

Background / Introduction

The goal of this project was to provide information to the Bureau of Land Management (BLM) and Oregon Department of Fish and Wildlife (ODFW) biologists regarding the species composition, size and relative abundance of fish currently present in Hult Reservoir, a small reservoir owned by BLM on upper Lake Creek in the Siuslaw River Basin near the town of Horton, Oregon (Figure 1). Hult Reservoir is a remnant log pond from the former Hult Lumber Company, and is often referred to as Horton Lake, Hult Marsh, Hult Log Pond or Mill Pond by local residents. The average depth of the reservoir is 3 - 3.5 m with a max depth of 6.4 m near the water tower at the south end. The dam itself was built in 1948. Hult Dam is an 11.3 m high earthen structure with a spillway opening at 8.2 m on the west side, reported to be able to spill up to 1300 cubic ft/second if needed. The dam is capable of impounding 540 acre-feet of water (666,079 m^3).

According to the Eugene Register Guard (February 25, 1962), in 1933 Julius Hult and his two sons built the Horton Division of Hult Lumber Company in Horton, Oregon consisting of:

> . . . a sawmill, veneer plant, chippers machine shop, log ponds, and a forestry and logging department.
>
> From Horton, rough lumber was trucked to Junction City, veneer and chips to plywood and paper plants. The Horton plant, with the Junction City plants, contribute a payroll in excess of a million dollars annually to Lane County income.

Land ownership for the reservoir has changed several times; to American Can Company in 1967, Bohemia Lumber Company in 1972, Willamette Industries in 1992, and to BLM on August 23, 1994 in a land exchange with Willamette Industries (Carpenter 2017).

In 1973-74 the reservoir was drained and sinker-logs were removed, and in 1976 the Oregon Department of Fish and Wildlife (ODFW) stocked the reservoir with largemouth bass *(Micropterus salmoides)*, black crappie *(Pomoxis nigromaculatus)*, and bluegill *(Lepomis macrochirus)*. In 1989 ODFW stocked the reservoir with coho salmon fry (*Oncorhynchus kisutch*). In 1990 the reservoir was drained illegally, so in 1992 ODFW biologists sampled the reservoir with gill nets and boat electrofishing to determine whether any warm-water fish species were still present. In 1993 ODFW again stocked the reservoir with coho salmon fry.

Lake Creek is a tributary of the Siuslaw River (Figure 1). The Siuslaw River Basin is part of the Oregon Coast Coho Evolutionarily Significant Unit (ESU) and coho salmon in this unit are currently listed as "threatened" under the Federal Endangered Species Act (NMFS 2005). Although coho salmon are listed as threatened within the basin, they were not historically present in Lake Creek above Lake Creek Falls. Winter steelhead (*Oncorhynchus mykiss*) are also present in the Siuslaw system but are not listed in the ESA, and were not historically present above the falls. In an attempt to increase spawning and rearing habitat available for salmon and steelhead in the basin, BLM installed a fish ladder at Lake Creek Falls in the 1980's and submitted plans to place a fish ladder at Hult Dam. The plans were reviewed and approved by ODFW Fish Division and the Commission in 1987 and a fish ladder was constructed on the west side of the Hult Dam spillway in the early 1990's.

Based on lack of evidence of adult coho spawning above the dam it is believed the ladder design is not conducive for the upstream passage of adult coho salmon. The absence of juvenile coho in our reservoir sampling confirmed that coho do not successfully ascend the ladder as currently constructed.

In addition, a comprehensive dam evaluation was conducted in July 2012 where several potential failure points were identified. The evaluation presented potential risks for dam failure and flooding

hazards for downstream landowners. In 2016, the BLM implemented improvements to the dam infrastructure and the structural integrity of the dam as a short-term fix. Currently, BLM is preparing an Environmental Impact Statement (EIS) to help determine the ultimate fate of the dam (i.e. removal, partial removal, or fortifying the dam so it is structurally sound). Variables under consideration relevant to fisheries include: local recreational fishing opportunities, the potential for the reservoir as rearing habitat for ESA listed fish (coho salmon) and reconnecting the river for anadromous salmonid passage and resulting access to rearing and spawning habitat.

Prior to this work the fish species composition in the reservoir was unknown. Information discussed in this report provides BLM and ODFW with the current species composition, timing of native fish habitat utilization, relative abundance of native and non-native fish, and characterization of current fishing opportunities which will allow the agencies to improve, promote and manage the fishery in the reservoir.

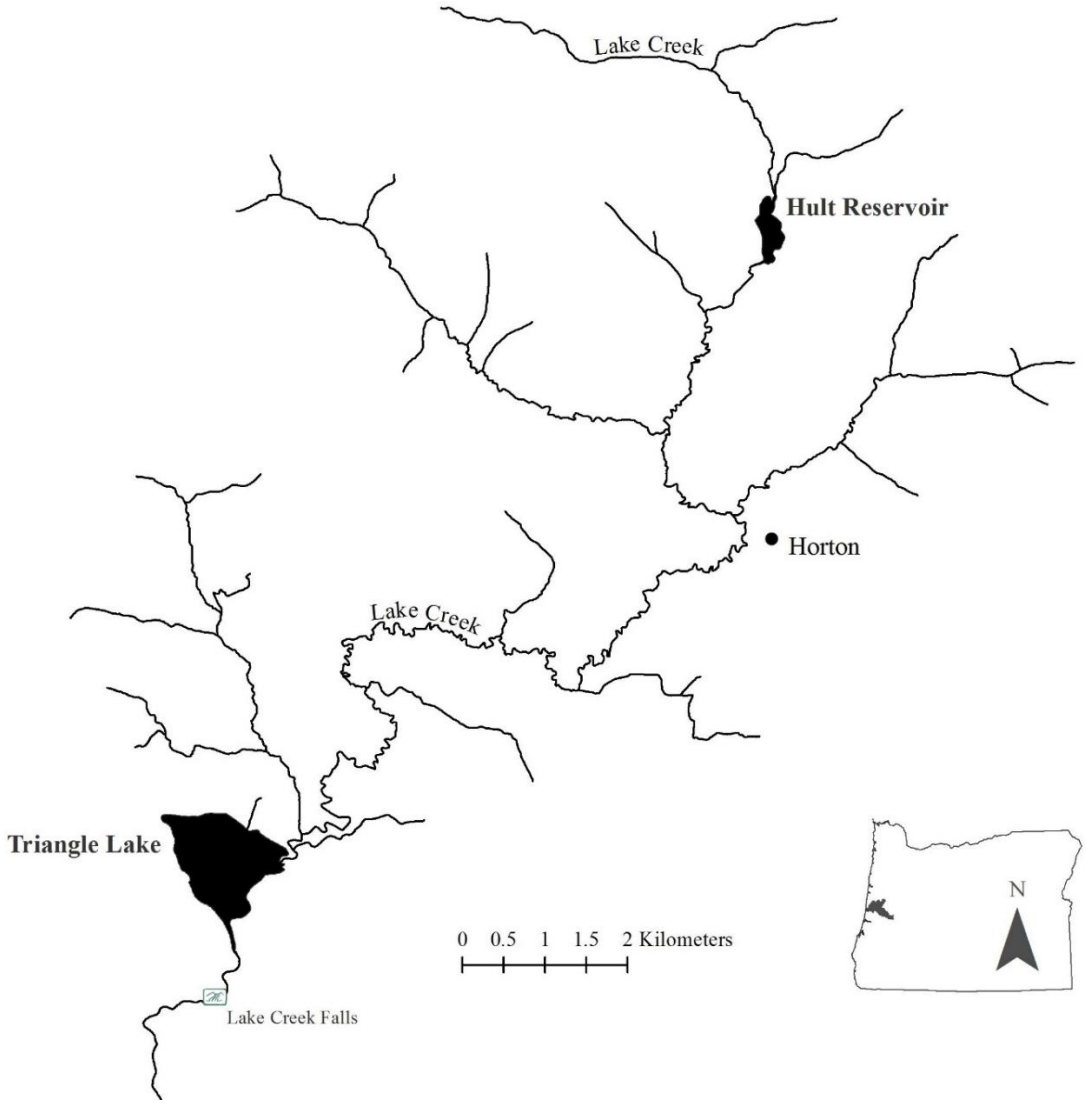

Figure 1. The Lake Creek Basin and key points of interest including Hult Reservoir. Stream layer displayed only includes Lake Creek and potential coho salmon distribution upstream of Triangle Lake (Bowers et al. 2014). Oregon inset (lower right) shows the location of the Siuslaw Basin.

Methods

Fish Capture – We divided the reservoir into three zones of approximately equal size (lower, middle and upper, Figure 2), then deployed miniature floating Oneida Lake Traps, floating gill nets and boat electrofished in each zone during three seasons (summer, fall and winter) in 2017 to determine species composition, length frequencies and relative abundance of fish in Hult Reservoir. Dividing the reservoir into zones, distributing the effort equally among them during each season, and using an active method in conjunction with the two passive methods of fish capture increased the likelihood of collecting a representative sample of species available from all size classes throughout the reservoir and throughout the year.

Boat electrofishing occurred in approximately 20 minute intervals in each reservoir zone during each season with the settings of 850-1000 V, 2-2.5 amps with a pulse width of 5 ms, and frequency of 120 DC. Electrofishing occurred in the daylight hours during the summer sampling to avoid disturbing campers at

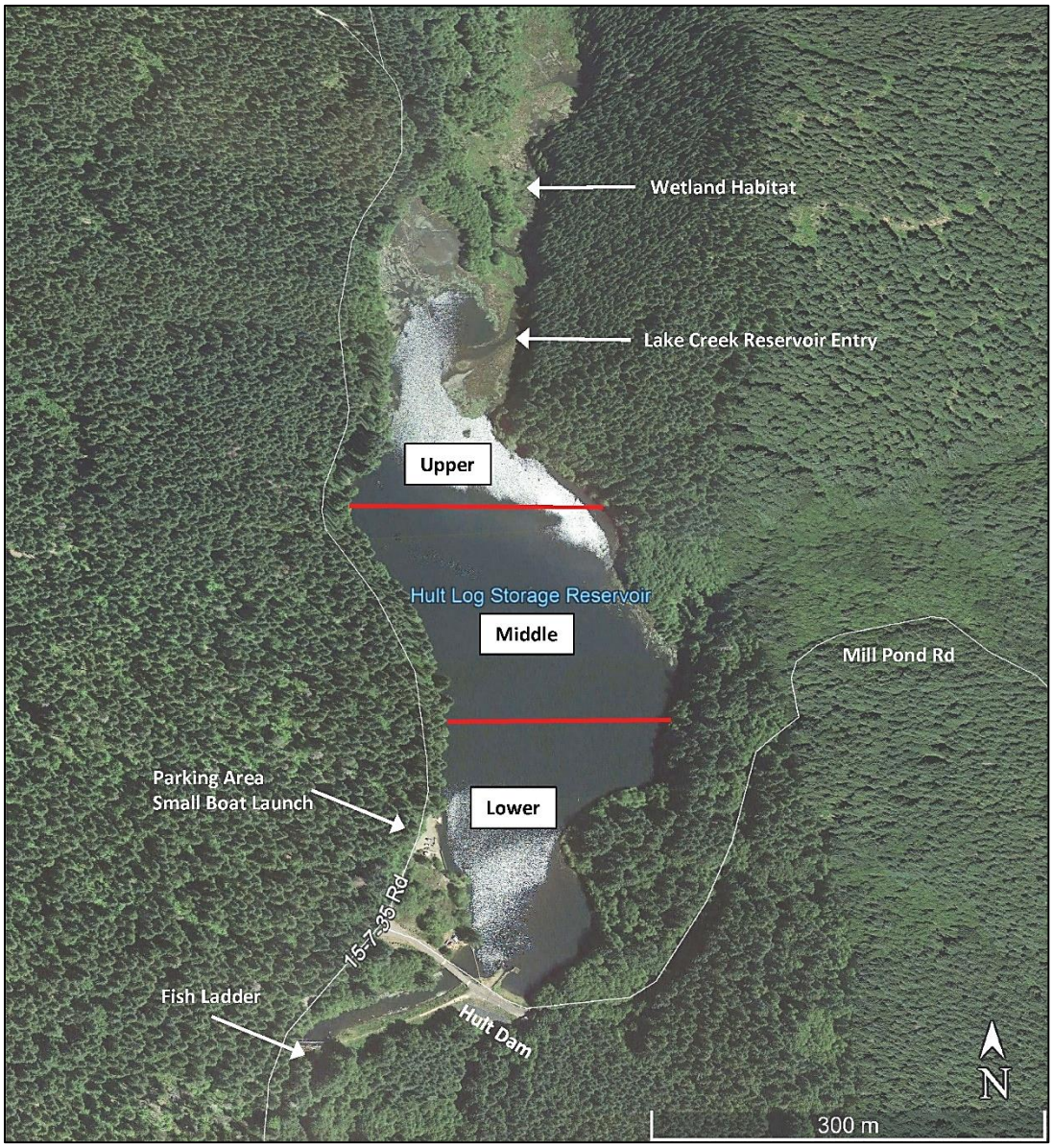

Figure 2. Hult Reservoir showing the boundary delineations for the upper, middle, and lower zones.

night. Electrofishing occurred at night during the fall and winter seasons. One floating experimental style gill net was set overnight in each reservoir zone each season, except during the summer sampling, where we attempted to avoid members of the public recreating on the reservoir by decreasing the duration of our net sets. The gill nets consisted of four 7.6 m x 3.0 m panels of increasing mesh size (square mesh size: 3.8 cm, 5.1 cm, 6.4 cm, and 7.6 cm). Gill nets were set perpendicular to shore and fished for approximately 24 h. One miniature floating Oneida Lake trap was placed in each reservoir zone each season and fished overnight (~24 hr). Trap nets consist of a 34 m long, 3.0-m deep lead line set perpendicular to shore leading back to a 0.64-cm delta mesh holding box (2.4 m x 2.4 m x 2.4; Figure 3).

Water Chemistry – Dissolved oxygen (saturation and mg/l) and temperature (°C) were measured with a YSI 550A handheld dissolved oxygen instrument manufactured by YSI Environmental.

Data Analysis – Young of the year fish (YOY, age-0) were counted separately as they primarily comprise a food base for the larger fish and only a small proportion of them will survive to contribute to the adult population. Using large numbers of young of the year fish in analyses would heavily bias the species ratios in the reservoir toward the species with high reproduction rates, and towards fish that spawn in the reservoir opposed to those that primarily use the reservoir as a migration corridor or only as adults (i.e. cutthroat, steelhead). Young of the year fish were identified using estimated age at size information assimilated from journal articles (Beamesderfer and North 1995: largemouth bass, Cargnelli and Gross 1996: bluegill), and no YOY cutthroat trout *(Oncorhynchus clarkii)* were encountered. River kilometers for potential spawning and rearing habitat available above Triangle Lake and Hult Reservoir were measured using a geographic information system (GIS) with ArcMap version 10.3 software in conjunction with the coho distribution layer provided by ODFW (Bowers et al. 2014).

Species Composition, Size, and Relative Abundance – All of the fish captured were identified to species, measured, and returned to the reservoir unless they were found dead in the gill nets, in which case the air-bladder was perforated and they were returned to the reservoir. All fish age-1 or older were counted and summarized by species for each season and the size range for combined sampling of all

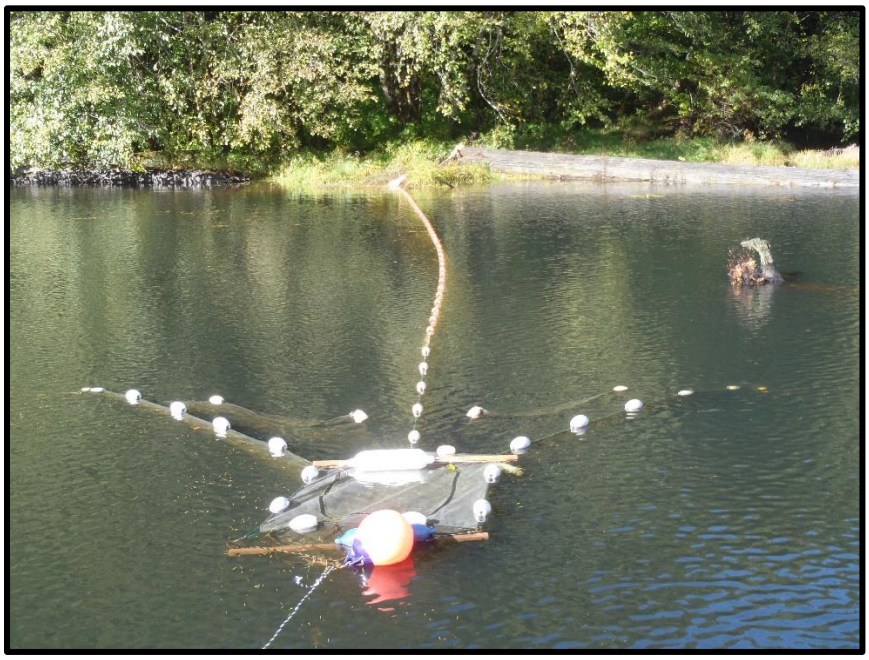

Figure 3. Miniature floating Oneida Lake Trap deployed in Hult Reservoir, October 2017.

seasons were recorded (Table 1). Cutthroat trout and largemouth bass were the primary focus for our size comparisons due to the interest in the fisheries for these species. Fork lengths were summarized by reservoir zones and season and we used Kruskal-Wallis one-way analysis of variance (ANOVA) on ranks to determine if there were size differences among reservoir zones within seasons (Figure 5). SigmaPlot version 12.5 software was used for all statistical analyses. Bluegill were excluded from the size analysis because of their relatively homogeneous and small size. Catch per unit effort (CPUE) for each collection method (boat e-fishing, gill nets, miniature floating Oneida Lake traps) during each season (summer, fall, winter) were summarized for the three fish species primarily targeted by anglers, cutthroat trout, largemouth bass and bluegill (Table 2).

Coho Salmon and the Oregon Plan – In 1998 the Oregon Department of Fish and Wildlife (ODFW) implemented the Oregon Plan for Salmon and Watersheds (State of Oregon 1997), which consists of three extensive monitoring projects designed to incorporate information from several perspectives of the salmon life cycle. Adult salmon returns are monitored by the Oregon Adult Salmonid Inventory and Sampling Project (OASIS), juvenile salmon rearing and migration are addressed by the Western Oregon Rearing Project (WORP) and habitat is surveyed and graded by the Aquatic Inventories Project (AQI) to help direct management decisions. Survey sites are selected by these projects using a Generalized Random Tessellation Stratified (GRTS) survey design (Firman and Jacobs 2001, Stevens 2002). To verify the current distribution of coho salmon within the Lake Creek Basin, we contacted biologists from these projects to gather additional information. In addition, we conducted our own impromptu spawning ground survey on December 6, 2017 prior to the winter sampling session in the reservoir to verify whether adult coho were spawning below the dam. The midpoint for the survey was the equestrian turnout (staging area for horses with a vault toilet) located 300 m downstream of Hult Dam. From the point where the trail goes down to Lake Creek we surveyed 50 m in each direction (upstream and downstream).

Historic Data – We queried the ODFW Hatchery Management Information System (HMIS) to determine which fish species had been released into the reservoir and when they were released to reconstruct the history of fish species in the reservoir. We also contacted the local fish biologists with ODFW to inquire about historical sampling information they may have regarding Hult Reservoir, searched the internet for newspaper articles and the BLM website for additional information.

Results

Current Species Composition 2017 – Seven species of fish were encountered in Hult Reservoir during our sampling expeditions conducted in three seasons in 2017: largemouth bass, cutthroat trout, rainbow trout/winter steelhead, bluegill, reticulate sculpin *(Cottus perplexus)*, brown bullhead *(Ameiurus nebulosus)* and western brook lamprey (*Lampetra richardsoni*) (Table 1).

We captured two largemouth bass in the fall sampling season that were 529 and 539 millimeters long [fork length (total length 22 inches, Figure 4)]. The estimated weight of these fish were 5.5 - 6.0 pounds using an online conversion tool (Texas Parks and Wildlife website; or Schneider et al. 2000). These bass were in very good condition with no external parasites or injuries, and considerably large for Oregon largemouth bass. The size range for all cutthroat trout sampled were 124-350 mm (fork length, 5-14 inches).

Electrofishing was the most effective method for sampling the reservoir. However, miniature floating Oneida Lake traps captured more young of the year fish than the other methods, and captured the most

western brook lamprey. Gill nets were only effective at capturing cutthroat trout. Most of the cutthroat captured in the winter season were in gill nets. Cutthroat trout captured in gill nets were larger than those encountered while electrofishing (Table 2). The ratio of salmonids compared to warm-water fish was 2.2% (2/91) in the summer, 13.2% (35/266) in the fall, and 36.7% (29/79) in the winter.

Table 1. Number and fork length range (mm) of species collected in Hult Reservoir during summer, fall, and winter of 2017. Fish were captured using miniature floating Oneida Lake traps, boat electrofishing and floating gill nets. Young of the year fish were not included in this total.

	Number captured			
Species	Summer	Fall	Winter	Fork length range (mm)
Largemouth bass *(Micropterus salmoides)*	45	86	22	71-539
Cutthroat trout *(Oncorhynchus clarkii)*	2	32	29	124-350
Rainbow trout/Winter steelhead *(Oncorhynchus mykiss)*	0	3	0	215-280
Bluegill *(Lepomis macrochirus)*	44	145	28	53-190
Reticulate sculpin *(Cottus perplexus)*	2	0	0	92-95
Brown bullhead *(Ameiurus nebulosus)*	2	0	0	233-262
Western brook lamprey (*Lampetra richardsoni*)	1	3	1	85-145

Figure 4. Largemouth bass 539 mm fork length captured in Hult Reservoir October 20, 2017.

Table 2. Summary statistics for cutthroat trout, largemouth bass, and bluegill captured using three methods (boat electrofisher, three floating gill nets, three miniature floating Oneida Lake traps) in Hult Reservoir during summer, fall, and winter of 2017. DAY or NIGHT refer to when electrofishing occurred. CPUE = catch per unit effort. YOY = Young of year. YOY not included in CPUE estimate.

			Collection Method			
Species	Season		E-Fish	Gill Net	Mini-Oneida	YOY
Cutthroat trout	Summer	number	2	0	0	0
		size range (mm)	205-252	---	---	
		effort DAY (h)	0.89	6.65	24.00	
		CPUE (fish/h)	**2.25**	---	---	
	Fall	number	25	7	0	0
		size range (mm)	180-305	300-340	---	
		effort NIGHT (h)	1.11	18.00	18.00	
		CPUE (fish/h)	**22.52**	**0.39**	---	
	Winter	number	8	21	0	0
		size range (mm)	181-295	124-350	---	
		effort NIGHT (h)	1.16	21	21	
		CPUE (fish/h)	**6.90**	**1.00**	---	
Largemouth bass	Summer	number	45	0	0	203
		size range (mm)	74-408	---	---	
		effort DAY (h)	0.89	6.65	24.00	
		CPUE (fish/h)	**50.56**	---	---	
	Fall	number	75	1	10	5
		size range (mm)	71-539	282	82-261	
		effort NIGHT (h)	1.11	18.00	18.00	
		CPUE (fish/h)	**67.57**	**0.06**	**0.56**	
	Winter	number	22	0	0	10
		size range (mm)	85-519	---	---	
		effort NIGHT (h)	1.16	21	21	
		CPUE (fish/h)	**18.97**	---	---	
Bluegill	Summer	number	35	0	9	2
		size range (mm)	53-168	---	98-143	
		effort DAY (h)	0.89	6.65	24.00	
		CPUE (fish/h)	**39.33**	---	**0.38**	
	Fall	number	141	0	4	7
		size range (mm)	70-190	---	62-115	
		effort NIGHT (h)	1.11	18.00	18.00	
		CPUE (fish/h)	**127.03**	---	**0.22**	
	Winter	number	20	1	7	5
		size range (mm)	75-175	99	95-154	
		effort NIGHT (h)	1.16	21	21	
		CPUE (fish/h)	**17.24**	**0.05**	**0.33**	

Two cutthroat trout were captured in the summer season, and these fish were pale and thin. There was no difference in size between reservoir zones for cutthroat captured in any of the three seasons that we sampled (P > 0.05 for all seasons, Figure 5). More cutthroat were captured in the upper zone of the reservoir in the fall (n=16), and in the lower zone during the winter (n=18). Cutthroat trout captured in the fall and winter were very colorful and appeared healthy. Overall, fewer largemouth bass were captured in the winter than any other season. More largemouth bass were captured in the upper zone of the reservoir in the summer and fall (n=25, 34 respectively) but more were captured in the lower zone in the winter (n=11). There was no difference in size between reservoir zones during the summer (P = 0.171) or winter (P = 0.216) sampling seasons, but the bass captured in the upper zone of the reservoir were larger than those captured in the lower zone in the fall (P = 0.034). There was no difference in size between the middle and upper zones, or the middle and lower zones (P > 0.05) in the fall.

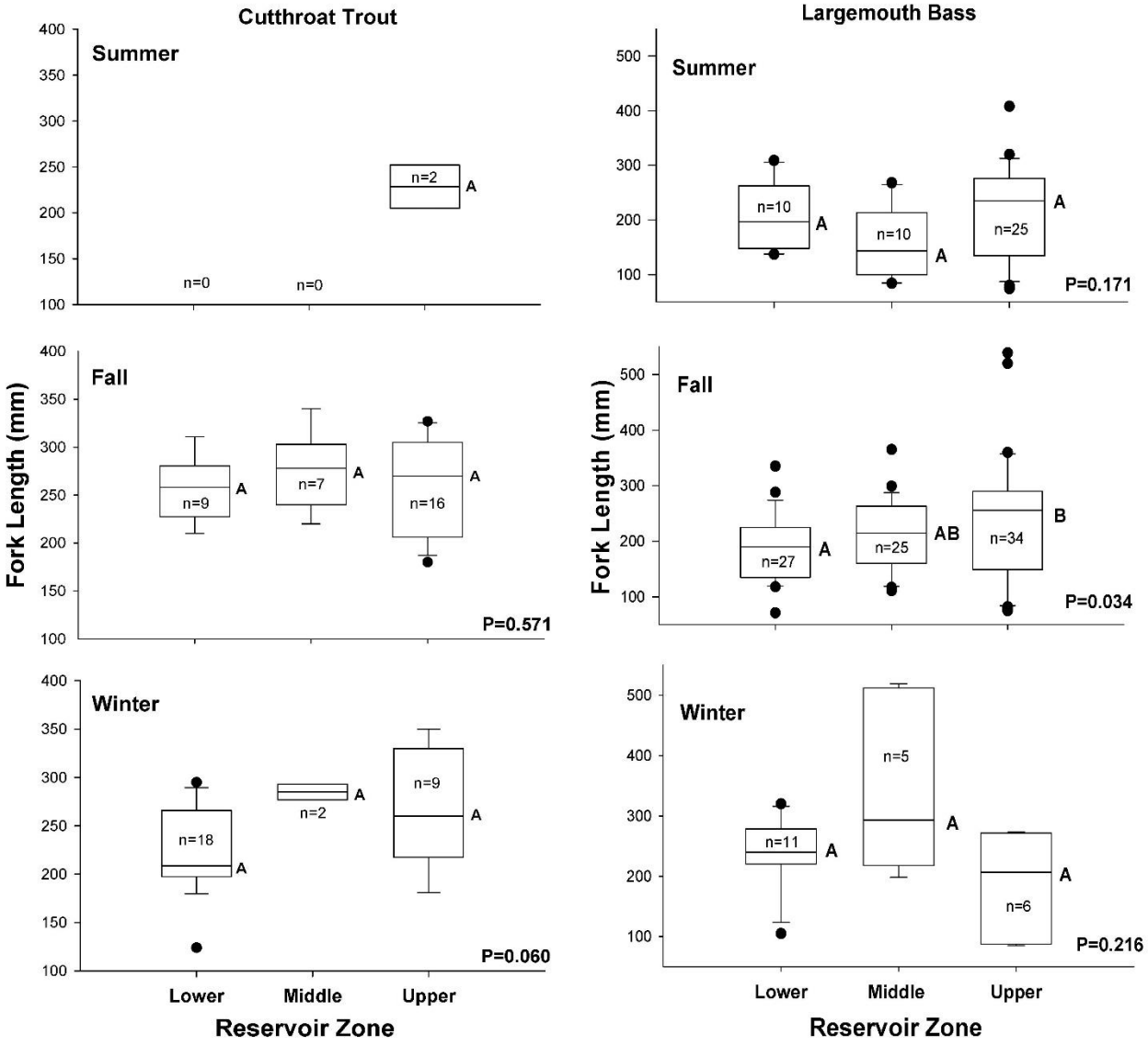

Figure 5. Cutthroat trout and largemouth bass fork lengths summarized by reservoir zones and season in Hult Reservoir, 2017. *P*-values are from Kruskal-Wallis one-way ANOVA on ranks. Within each plot, boxes with same letter are not significantly different.

Stream Kilometers of Potential Coho Habitat – We measured 96 kilometers (60 mi) of potential coho spawning and/or rearing habitat between Triangle Lake and Hult Reservoir upstream of Lake Creek Falls, and an additional 13 kilometers (8 mi) above Hult Reservoir.

Coho Salmon and the Oregon Plan – There has been little sampling conducted by the projects that comprise the ODFW Oregon Plan for Salmon and Watersheds Monitoring Program (OASIS, WORP, AQI) upstream of Hult Reservoir in the Lake Creek Basin. However, WORP and OASIS do include approximately six miles of Lake Creek and its tributaries upstream of Hult Reservoir into their coho sampling frame, which means that as of 2013 (when the frame was last revised) they considered this to be an area where they might potentially encounter coho salmon. The only time a survey site was selected upstream of the reservoir by WORP was in 1998 near Billy Tower Canyon on Lake Creek, and the only salmonids observed during snorkeling surveys were cutthroat trout (Ron Constable, *personal communication*). In 1998 and 1999 the OASIS project conducted steelhead spawning ground surveys above Hult Reservoir and adult steelhead were observed in both years. In contrast, in 2009 and 2012 coho spawning ground surveys were conducted upstream of Hult Reservoir but no adults were observed (Brianna Sounhein, *personal communication*). During our December 6, 2017 spawning ground survey conducted 300 m downstream of Hult Dam, we observed eleven coho salmon adults spawning and counted six redds in Lake Creek.

Water Chemistry – Dissolved oxygen (DO) and temperature data collected in Hult Reservoir during the three sampling seasons revealed that reservoir conditions are not conducive for salmonid survival during the summer. Hypoxic conditions (DO ≤2mg/l) were present in the reservoir below four meters of depth and temperatures were >20°C in the upper two meters of the water column in the summer. (Figures 6 and 7). By fall, DO and temperatures levels transitioned to conditions more favorable to salmonid rearing.

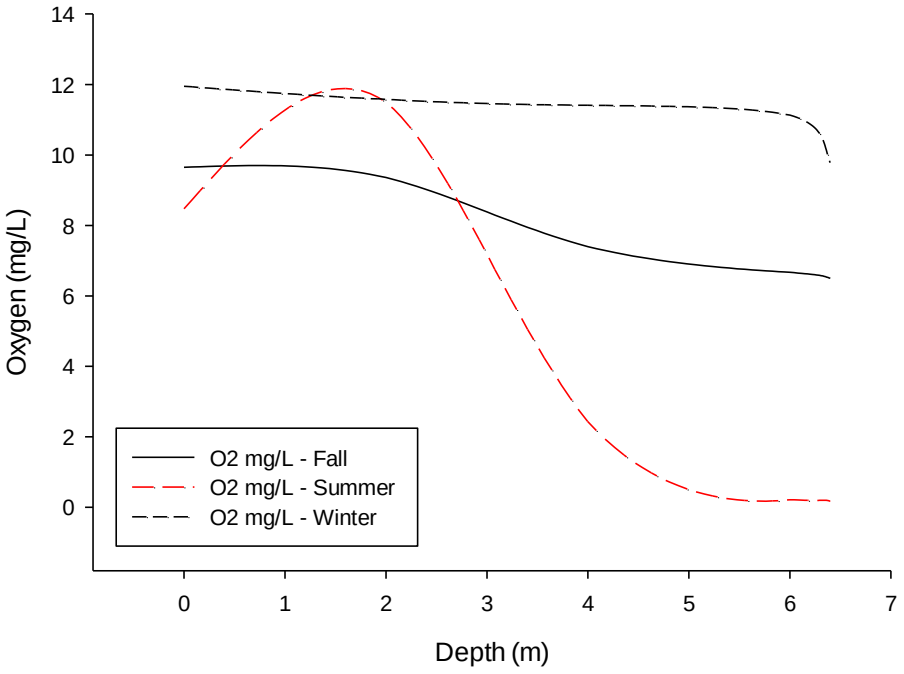

Figure 6. Dissolved oxygen levels (mg/L) at different depths of Hult Reservoir each season in 2017 measured at the deepest point near the dam.

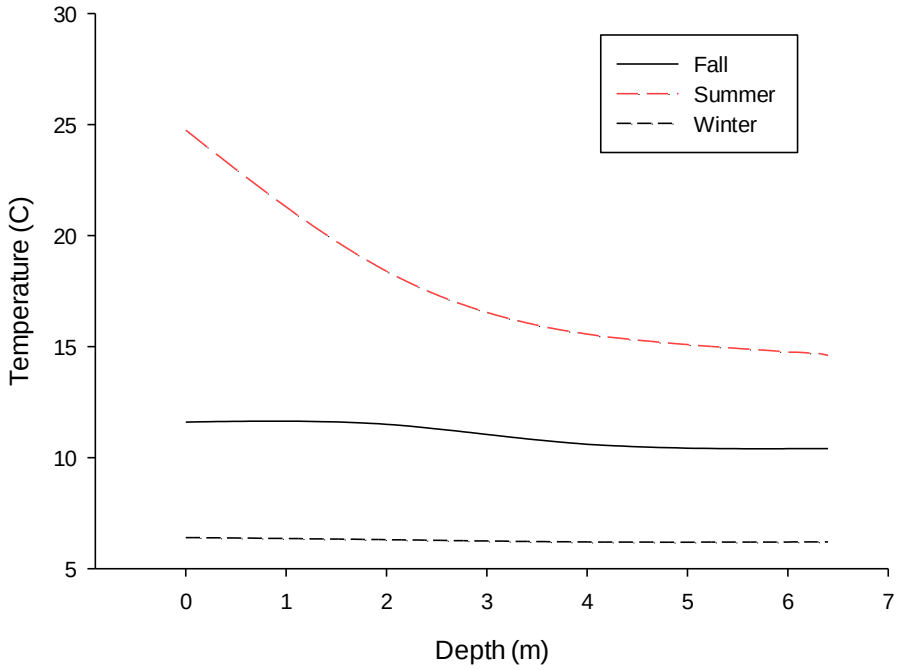

Figure 7. Temperature (°C) at different depths of Hult Reservoir each season in 2017 measured at the deepest point near the dam.

Historic Fish Information – In 1976 ODFW stocked black crappie, bluegill, and largemouth bass in Hult Reservoir, and in 1989 and 1993 coho salmon were released (Table 3).

In 1992 fish biologists with ODFW conducted boat electrofishing surveys in Hult Reservoir (Beidler 1992) to determine whether there were any warm-water fish species left after the reservoir was drained in 1990. Information for Table 4 was extracted from a draft of a memo sent from the ODFW Siuslaw District Fish Biologist to the ODFW Chief of Fisheries in 1992. The ratio of salmonids compared to warm-water fish species was 72.8% (99/136).

Table 3. Number and species of fish stocked into Hult Reservoir by ODFW.

Date	Species	Number	Total length range (mm)
02/18/76	black crappie	58	152 - 203
02/18/76	bluegill	500	76 - 152
02/18/76	largemouth bass	1,350	76
04/02/76	black crappie	395	102 - 178
04/02/76	bluegill	359	51 - 152
05/06/76	black crappie	163	76 - 178
05/06/76	bluegill	374	76 - 152
02/18/76	black crappie	58	152 - 203
06/20/89	coho salmon	12,717	Fry (<50 mm)
05/04/93	coho salmon	20,007	Fry (<50 mm)

Table 4. Beidler 1992 gill netting and boat electrofishing data from Hult Reservoir.

Capture Method	Date	Species	Number	Fork length range (mm)
Gill nets (x2)	04/08/92	coho smolts	38	145 - 173
	04/08/92	steelhead smolts	6	160 - 258
	04/08/92	cutthroat trout	3	204 (mean)
Boat e-fishing	04/14/92	coho smolts	11	No data
	04/14/92	steelhead smolts	8	No data
	04/14/92	cutthroat trout	33	No data
	04/14/92	bluegill	30	No data
	04/14/92	largemouth bass	7	No data

Discussion

Current Species Composition and Fishery – Seven species of fish were encountered in Hult Reservoir in 2017: largemouth bass, cutthroat trout, rainbow trout/winter steelhead, bluegill, reticulate sculpin, brown bullhead and western brook lamprey. The most abundant fish observed were largemouth bass and bluegill in summer and fall, and cutthroat trout in the winter. Cutthroat trout were much more prevalent in the fall and winter sampling than in the summer. Several studies show that mobile species like salmonids will move to seek out thermally suitable habitats (Baltz et al. 1987, Hodge et al. 2017). Presumably, cutthroat trout moved up into the tributaries to seek thermal refuge during the summer months and returned to the reservoir once the temperatures were more conducive to growth and survival.

There is currently an established fishery for both cutthroat trout (spring, fall, winter) and largemouth bass (summer) in Hult Reservoir, and we talked to several anglers who target each of these species. The quantity and quality of the fish that we sampled were indicative of a productive fishery for both species with cutthroat reaching 350 mm (14 in) and largemouth at 539 mm (nearly 22 in). A couple of the largemouth bass were considerably large for Oregon largemouth and would be considered highly desirable to anglers (5.5 – 6 lbs). Our results also revealed that reservoir conditions are inhospitable for salmonids in the summer, and that the habitat segregation in the summer between the salmonids which move out of the reservoir (or likely perish) and the warm-water fish that remain and spawn in the reservoir results in a diversified year-round angling opportunity.

Water Chemistry – Temperatures and dissolved oxygen data show that the reservoir is inhospitable for salmonids in the summer. Effects of hypoxia start to appear when dissolved oxygen is around 2.0 mg/L or less (e.g., Diaz 2001) often leading to suffocation. Different species of fish react to lower dissolved oxygen in different ways, and effects of hypoxia (reduced swimming speed, change in diet, restricted habitat) have been documented up to 6.0 mg/L in different marine and freshwater fish species (Pollock et al. 2007). The swimming performance of coho salmon is much more negatively impacted than that of largemouth bass by the same reduction of oxygen concentration (Dahlberg et al. 2011; Davis 1975). Hult Reservoir in the summer exhibits lower levels of dissolved oxygen than other times of the year, and hypoxic conditions below four meters (Figure 6).

A generally accepted lethal temperature for most anadromous salmonids in the Pacific Northwest is 26 °C. Hicks (2000) recommended not exceeding a temperature of 19 °C for juvenile steelhead and 20 °C for juvenile coho salmon to avoid direct mortality. Preferred rearing and optimal growth temperatures for steelhead are 14 – 16.5 °C and 11.4 – 15 °C for coho salmon (Richter and Kolmes 2005). Temperatures near the surface of Hult Reservoir approach the lethal thermal limit (Figure 7), so the only refuge for salmonids would be near the bottom of the reservoir in the deepest locations where the dissolved oxygen

readings are at or near the lethal limit. Under current conditions, this information suggests that draining the reservoir to remove warm-water species and planting rainbow trout to create a trout fishery in lieu of the warm-water fishery in the summer may not be a viable option.

Coho Salmon and the Oregon Plan – Overwinter rearing habitat during the first year of life is a limiting factor for the number of juvenile coho salmon that a watershed can support in most Oregon coastal streams (Rodgers et al. 2005). The Habitat Limiting Factors Model (HLFM; Nickelson et al. 1992a, Nickelson et al. 1992b, Nickelson 1998) for estimating carrying capacity of juvenile coho in Oregon heavily weights complex, large and deep expanses of habitat (i.e. beaver ponds, alcoves, deep pools containing large wood) as prime rearing habitat. In a comparison of winter rearing habitat among four coho salmon population units in 2007 (Nehalem, Siuslaw, Coquille, South Umpqua), the Nehalem and Siuslaw basins showed higher potential carrying capacities than the other two population units based on information from winter habitat surveys. It was estimated that the mean carrying capacity for a kilometer of wadeable stream (usually smaller tributaries, not the mainstem) in the Siuslaw Basin could support 1,704 juvenile coho (95%CI ± 630, Romer et al. 2008). There are approximately thirteen kilometers of quality spawning and in-stream rearing habitat located upstream of Hult Reservoir. Using the mean carrying capacity this equates to a potential carrying capacity for coho above the reservoir at 22,152 (range 13,962 – 30,342) without the inclusion of Hult Reservoir itself. The reservoir is 1 km long, and would be considered prime habitat for coho rearing, so that estimate would not be appropriate to estimate carrying capacity for the reservoir.

The idea that Hult Reservoir could provide a large overwinter rearing area for juvenile coho salmon has been proposed, but under current conditions coho would face some notable obstacles: 1) access to upstream habitat for adult coho spawning, 2) predation from largemouth bass in the reservoir, and 3) inhospitable summer conditions.

During the 100 m spawning ground survey conducted on December 6, 2017 below Hult Dam, we observed eleven coho salmon adults actively spawning and counted six redds in Lake Creek. We did not encounter any adult or juvenile coho in any of our sampling trips during any season within the reservoir. This suggests that the fish ladder at Hult Dam is not conducive for adult coho salmon upstream fish passage. Adult coho spawning below the dam verifies that a proportion of the coho attempting to ascend the ladder at Lake Creek Falls are successful and travel to the vicinity of Hult Reservoir.

Although we verified that adult coho are able to pass Lake Creek Falls, there is evidence that passage efficiency could be improved. According to preliminary results from an ODFW study conducted in 2015 where biologists Floy tagged adult coho near the bottom of the current fish ladder at Lake Creek Falls (those that presumably wanted to pass) and used video monitoring at the top of the falls to verify how many actually passed, approximately 25% of the coho salmon attempting to ascend the falls were successful (John Spangler, *personal communication*). There are ninety-six kilometers of potential spawning/rearing habitat for coho salmon upstream of Triangle Lake (just above Lake Creek Falls, Figure 2). The estimate for potential carrying capacity in this reach is 163,584 (range 103,104 - 224,064) juvenile coho, without including Triangle Lake itself. If access to the habitat upstream of Lake Creek Falls is a priority, the efficiency of adult passage at both the ladder at Lake Creek and at Hult Dam need to be further evaluated.

Historic Fish Information – The ratio of salmonids to warm-water fish species captured in Hult Reservoir was very different between seasons in 2017 and between the years 1992 and 2017. Following the drawdown of the reservoir in 1990, the remaining fish populations in the reservoir were likely not yet well re-established at the time sampling occurred as reported by Beidler in the spring of 1992. The ratio of salmonids to warm-water fish species captured in 1992 was 72.8% compared to the highest ratio of any

season sampled in 2017, which was 36.7% in the winter. In 2017 the ratio of salmonids to warm-water fish for each season were 2.2% in the summer, 13.2% in the fall, and 36.7% in the winter. The fish populations in the reservoir are now well established, and the comparative ratios of fish populations that we sampled are representative of conditions under current management structure. It would appear that the warm-water fish have been very successful in propagating and populating the reservoir in the past thirty years.

Largemouth bass are non-native, and known to prey heavily on juvenile coho in systems where the species overlap (Bonar et al. 2005). As discussed previously, largemouth bass were stocked in Hult Reservoir in 1967. Reimers (1989) noted an association with the reduction of coho salmon production in the Tenmile Lake system, another Oregon coastal stream, and the introduction of largemouth bass in 1971. He also suggested that production of smolts which was once prolific in the lakes, became limited to the tributaries in the system because of high predation rates in the lakes. It is likely that Hult Reservoir would result in a similar outcome under current conditions. However, we did notice a decrease in the abundance of bass during our winter sampling season for all gear types. We suspected the warm-water fish were still present but less accessible to our sampling gear due to decreased winter activity and movement to deeper water (Warden and Lorio 1975) which would render our passive capture methods less effective, and decrease the efficiency of electrofishing. Water temperatures during this period were < 6.5°C at all depths. Crawshaw (1984) found that activity for both largemouth bass and brown bullhead was relatively constant from 17 - 7°C but at lower temperatures there was a marked decrease in activity, and food consumption in bass was very low for temperatures < 8°C. This supports our hypothesis for decreased catch in the winter for warm-water species, but also suggests that if juvenile coho were present in the reservoir during the winter that predation from bass would be greatly diminished.

In 1992 several coho smolts were captured, but in 2017 we did not encounter any coho during our sampling. Sampling in 1992 occurred in the spring (April), and our sampling was conducted in summer, fall and winter. We have no information about the origin of the coho smolts that were sampled in 1992 and it is possible that they were they progeny from naturally spawning adults or hold-over fish from an undocumented fry release. This information is impossible to know, although the closest, documented fry release from ODFW was in June of 1989. The coho juveniles sampled in 1992 were clearly not part of the 1989 release, and were not likely progeny from any adults resulting from the 1989 release as they would not have been expected to return to the system until the fall of 1992.

Coho smolts collected in 1992 were unusually large with a mean length of 157 mm (range 145-173). The size of the coho collected in 1992 could be biased toward larger fish because of the sampling methods used. Both methods used at that time (boat electrofishing and gill nets) are known to be biased toward capturing larger fish, depending on protocols used for e-fishing and the mesh size of gill nets. It is also possible that young coho salmon were able to capitalize on the benefits of rearing in the reservoir and achieved a greater size, as has been documented in several other river systems with lakes (Reimers 1989, Bonar et al. 2005, Suring et al. 2015). Similarly, there is only one site monitored by the ODFW Life Cycle Monitoring Project (LCM) where coho smolts approached the size of those reported in Hult Reservoir in 1992, Mill Creek in the Yaquina River Basin (another Oregon mid-coastal stream). The Mill Creek trapping site is downstream of a small reservoir (surface area = 0.06 km^2 or 15 acres), and coho smolts from the Mill Creek site are noticeably larger than smolts from the other seven LCM sites spread throughout the Oregon Coast, and marine survival rates are higher (Suring et al. 2015). This information helps to bolster the idea that Hult Reservoir could be advantageous for overwintering coho juveniles in the Lake Creek sub-basin.

The fact that there were no coho salmon observed in Hult Reservoir in 2017 is not surprising. Based on the lack of current evidence of adult coho spawning above the dam, and the observation of coho spawning below the dam, it is probable that the ladder design is not conducive for the upstream passage of adult coho salmon. In addition, sampling occurred when most of the coho salmon smolts from the previous year would have emigrated toward the Pacific Ocean, and those that did not make it through the reservoir expeditiously in the spring were probably consumed by piscivorous predators in the reservoir (e.g. largemouth bass), or would have died due to high temperatures and low dissolved oxygen levels prior to our sampling in mid-July. The highest probability of our crew catching coho juveniles would have been in the winter when higher flows might have moved juvenile coho downstream and into the reservoir, and conditions would be more favorable for them to avoid predation (increased turbidity, colder temperatures, access to a larger reservoir due to increased water levels, they would have grown to a size where they could evade predators easier, lowered metabolism of predatory fish, etc.).

There are three potential life history patterns that could benefit coho production in the Lake Creek system under current conditions. 1) Adult coho observed spawning below Hult Dam contribute to coho production where juveniles do not have to contend with predatory largemouth bass in Hult Reservoir. 2) It is also possible that if adult coho spawned in the tributaries upstream of Hult Dam, their progeny could rear in the streams and then move downstream into the reservoir in October (as discussed above) to overwinter in the reservoir when largemouth bass are more sedentary. Then they could emigrate downstream of the dam the following spring before the water in the reservoir heats up. 3) Juveniles could also continue to rear in the streams until the following spring when they smolt, entering and passing directly through the reservoir quickly and still experience high survival rates through the reservoir. Increased flow and turbidity in the spring would decrease predation efficiency and provide downstream guidance flows for smolts to navigate through the reservoir quickly. Lower temperatures in the spring would also place the coho/bass habitat overlap in the reservoir at a time when the metabolism for the bass would be lower, making them less aggressive and more lethargic.

Therefore, it may be possible to keep the current fishery as it stands, and still increase coho production in the system by providing sufficient upstream access for adults. Juvenile coho would still have to contend with predation and competition from cutthroat trout in the tributaries upstream of the reservoir, and largemouth bass are present throughout the Lake Creek sub-basin. Largemouth bass and bluegill have been prevalent in Triangle Lake since at least 1970 (Skeesick 1970), and have been collected by ODFW biologists (2017) at locations just downstream of Lake Creek Falls, at the mouth of Deadwood Creek and in the mainstem Siuslaw River near the town of Mapleton (Brian Bangs, *personal communication*).

Current Public Use – This study was not designed to evaluate public fishing pressure or address the value of the reservoir to local recreation. However, during our sampling it was apparent that the reservoir is heavily used by the general public as we observed members of the public utilizing the reservoir during each of our sampling trips (summer, fall, winter). During the summer sampling period we observed many people in various crafts floating on the reservoir, angling from the bank and motorless watercraft, swimming and camping around the reservoir. In the fall, deer hunters were camped around the lake and several of them expressed their affinity for fishing in the reservoir. During all seasons, concerned citizens passing by stopped to talk to us about what we were doing to “their” fish (both cutthroat trout and largemouth bass) in the reservoir.

In this report we provide information about the species composition, size and relative abundance of fish occupying Hult Reservoir in 2017. We also assimilated additional information from several other sources to provide a more holistic view of Hult Reservoir. The purpose of this report was to supply

fisheries managers with current and pertinent information about the fish populations in Hult Reservoir. Understanding the existing species composition, native fish habitat utilization, relative abundance of native and non-native fish and characterization of current fishing opportunities will allow the agencies to better promote, advertise, and enhance the fishery for the public through targeted management activities.

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