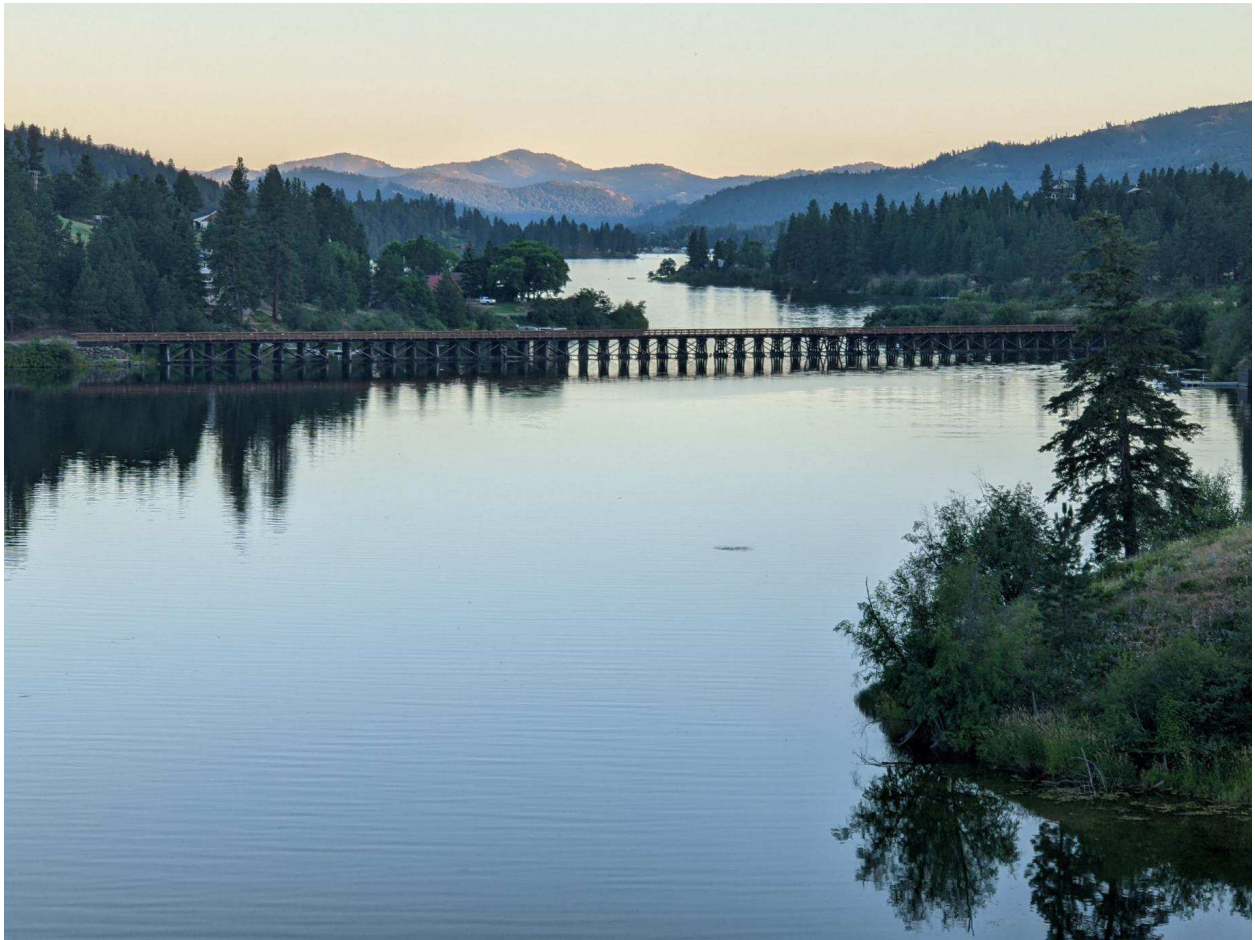


# A creel survey of Curlew Lake

10 years after the introduction of Yellow Perch



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**FISH &  
WILDLIFE**

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# A creel survey of Curlew Lake 10 years after the introduction of Yellow Perch

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# Abstract

Yellow Perch were first documented in Curlew Lake in spring 2011 while conducting trout stock assessment sampling. Initial low densities of Yellow Perch in Curlew Lake sampling in 2011 and 2012, and no prior detection of this species over the previous 13 years of sampling, indicated that these fish were the result of a recent illegal introduction. From 2014-2022, the rapid expansion of the Yellow Perch population combined with the average size (9-10 inches total length) generated considerable enthusiasm by anglers. Given the popularity of the Yellow Perch fishery, WDFW initiated a creel survey and a mark/recapture study at Curlew Lake in 2021 to better understand angler use and harvest. Specific objectives of the study were to estimate effort, catch, and harvest of Yellow Perch and Rainbow Trout during the spring/summer (May-August), fall (September-November), and winter (December-February) periods and estimate the exploitation (% harvested by anglers) of Yellow Perch.

During May-June, shore fishing effort exceeded boat fishing effort, peaking in June at 3,684 angler hours. Boat fishing effort peaked in July (4,763 angler hours) and steadily dropped as the summer progressed. Ice fishing effort peaked in January (4,545 hours) with similar levels of effort to boat anglers during the summer. Total estimated fishing effort across angler types for the entire creel season (May-February) was 40,682 angler hours. Catch and harvest of Yellow Perch was substantial over the course of the 9-month creel survey and similar across most months and time periods, with a summer peak in June and a winter peak in January. Total harvest from the summer and fall periods was 44,452 fish. Ice angler harvest peaked in January (14,317 fish) with a total of 31,464 fish harvested during the winter. Total Yellow Perch harvest for the entire survey (May-February) was estimated at 81,147 fish. The population size of Yellow Perch  $\geq 200$  mm (8 inches) total length was estimated at 154,345 fish. Total exploitation for the 9-month survey was estimated at 53%. Rainbow Trout comprised a much smaller component of overall effort, catch, and harvest than was expected, based on the popularity of the trout fishery as recently as 2011. The Rainbow Trout fishery was primarily driven by shore angling which peaked in May with 2,625 trout caught and 2,258 harvested. Boat angling for trout also peaked in May with 3,427 fish caught and only 787 harvested. Total harvest of Rainbow Trout for the 9-month period was only 9,448 fish.

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# Acknowledgements

We would first and foremost like to thank Sonya O'Brien for her tireless efforts collecting quality creel data from Curlew Lake. The success of this project is largely due to her dedicated work over nine months. We are also indebted to the staff at Curlew State Park, Tiffany's Resort, Fisherman's Cove, and Black Beach Resort for their assistance with outreach, distributing voluntary catch cards, and fostering an environment of cooperation among visitors to Curlew Lake. We could not have been successful without their support. We thank Brian Walker, Kenny Behen and Justin Spinelli for their assistance with logistics, data analysis and interpretation.

# Introduction

Curlew Lake is located in Ferry County, 7.7 kilometers (km) northeast of Republic, Washington (Figure 1). It has a surface area of 373 hectares (ha), and a mean depth of 13 meters (m) with a maximum depth of 40 m. The drainage area is 168 square kilometers (km<sup>2</sup>). Tributaries of Curlew Lake include Trout, Barrett, Mires, and Herron Creeks. Water exits the lake on the north end via Curlew Creek, which flows approximately 16 km before entering the Kettle River at the town of Curlew, Washington. Summer surface water temperatures in Curlew Lake commonly exceed 22° Celsius (72 degrees Fahrenheit). The lake typically freezes over between November and April.

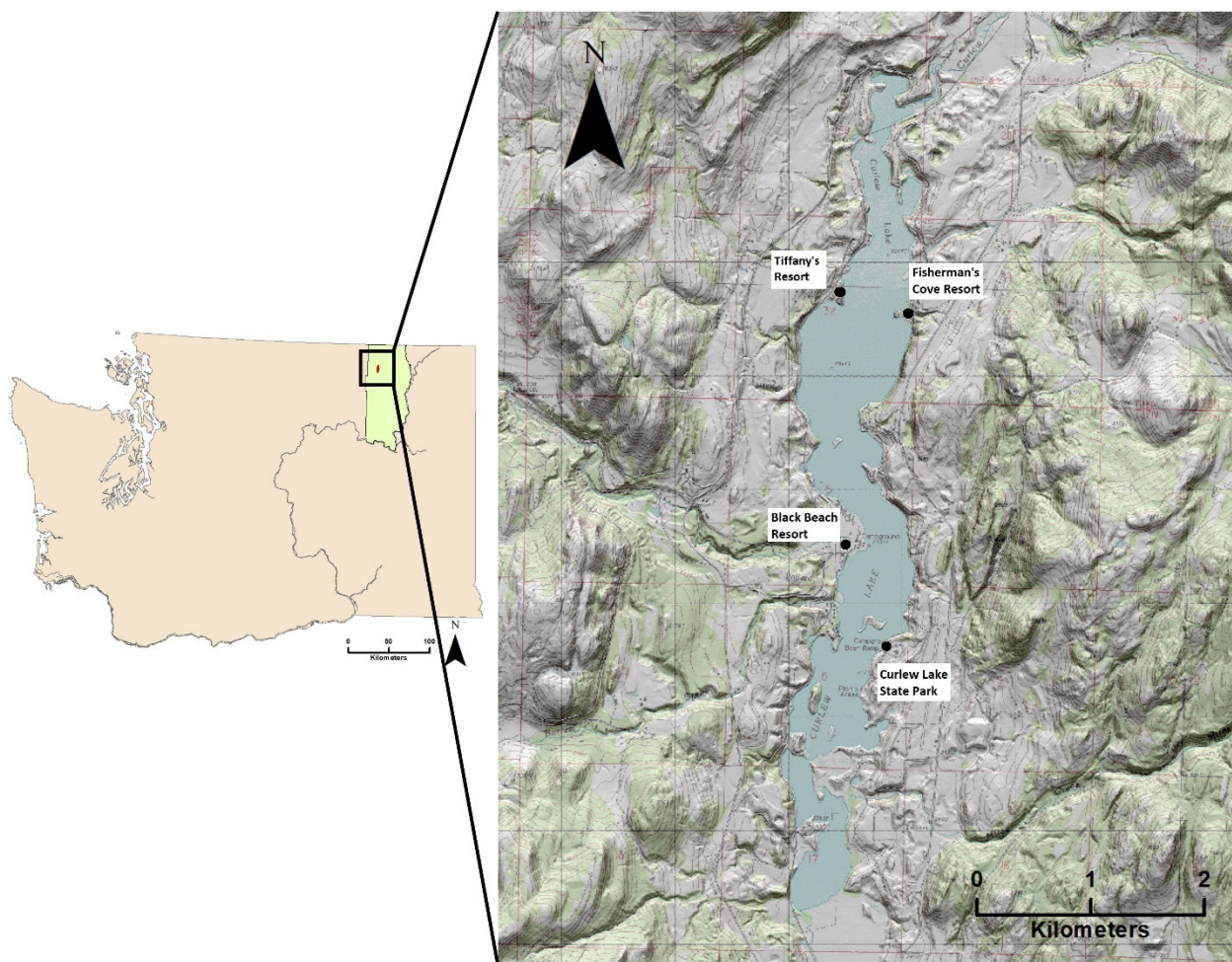


Figure 1. Location of Curlew Lake in Northeast Washington State.



Naturally reproducing species in Curlew Lake include Northern Pikeminnow *Ptychocheilus oregonensis*, Largemouth Bass *Micropterus salmoides*, and Smallmouth Bass *M. dolomieu*. The Washington Department of Fish and Wildlife (WDFW) stocks 180,000 to 200,000 Rainbow Trout *Oncorhynchus mykiss* in the lake annually to support a put-grow-and-take trout fishery. Since the 1950's, Rainbow Trout have driven most of the angler effort at Curlew Lake. Tiger Muskie *Esox masquinongy* X *E. lucius* were introduced into Curlew Lake in 1998 to control the Northern Pikeminnow population and create a unique sport fishery. Curlew Lake currently receives a maintenance stocking of 250 Tiger Muskie annually. Following the introduction of Tiger Muskie in 1998, WDFW began conducting standardized warmwater surveys (Bonar et al. 2000) annually to monitor changes in the fish community.

Yellow Perch were first documented in Curlew Lake in spring 2011 while conducting trout stock assessment sampling. Initial low densities of Yellow Perch in Curlew Lake sampling in 2011 and 2012, and no prior detection of this species over the previous 13 years, despite intensive sampling during that time frame, indicated that these fish were the result of a recent illegal introduction. WDFW continued to document the rapid growth of the population, and by 2019, catch of Yellow Perch had increased 500-fold (Figure 2).

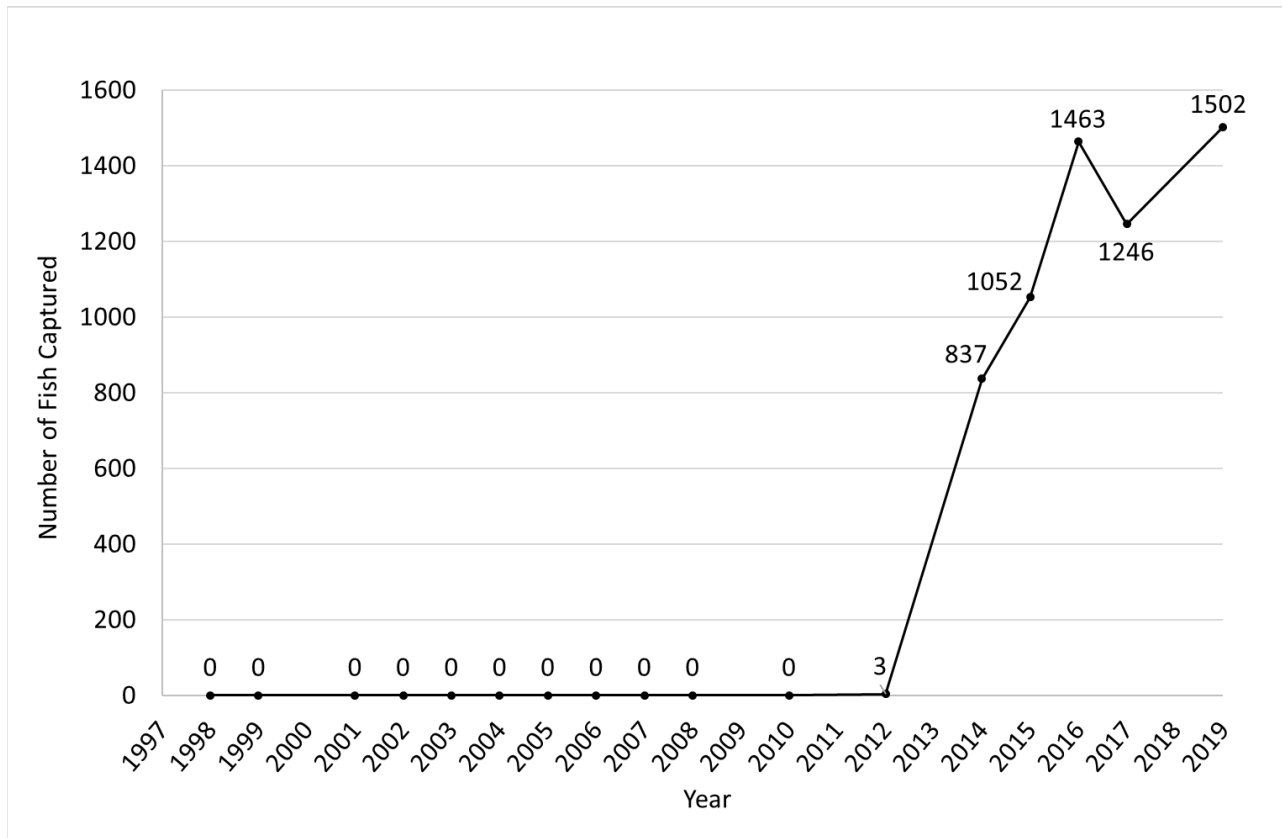


Figure 2. Total number of Yellow Perch caught in standard surveys of Curlew Lake since 1998. Sampling effort (i.e., the total number of electrofishing, gill net and fyke net sites) was consistent for all surveys from 2002-2019.

Following initial detection, WDFW documented high growth rates for Yellow Perch in 2015, with fish reaching a mean total length (TL) of 224 mm (8.8 inches) in just 2 years (Figure 3). By 2017-2019, growth had slowed to where the mean TL of age-2 fish was 188 mm (7.4 inches), with age-3 and age-4 fish reaching 248 mm (9.7 inches) and 279 mm (10.9 inches), respectively.

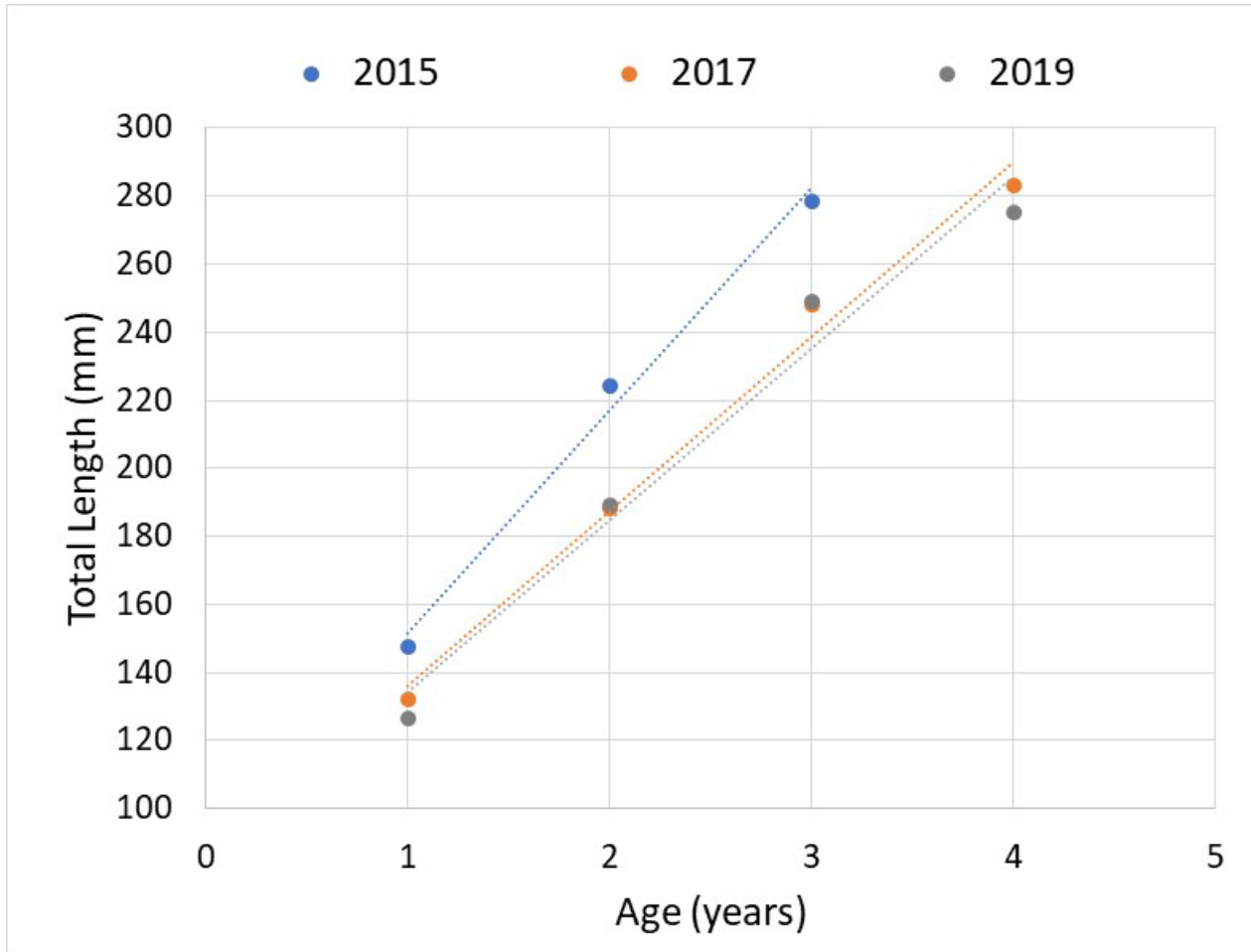


Figure 3. Mean length-at-age for Yellow Perch (n=344) collected from Curlew Lake in 2015, 2017 and 2019.

From 2014-2022, the rapid expansion of the Yellow Perch population combined with the average size (9-10 inches TL) has generated considerable enthusiasm by anglers. Boat anglers quickly began targeting Yellow Perch throughout the spring, summer, fall, and a popular winter ice-fishery developed. Within a few years, Curlew Lake became a destination Yellow Perch fishery that was widely discussed in the media.

All fish species in Curlew Lake are currently managed under statewide general rules. For Rainbow Trout, there is a 5 fish daily limit and no size restrictions. For Yellow Perch, there is no daily limit and no size restrictions.

Given the popularity of the Yellow Perch fishery, WDFW initiated work (creel survey and a mark/recapture study) at Curlew Lake in 2021 to better understand angler use and establish a baseline for future work. Specific objectives of the study were to: (1) estimate effort, catch, and harvest of Yellow Perch and Rainbow Trout during the spring/summer (May-August), fall (September-November), and winter (December-February) periods and (2) estimate the exploitation (% harvested by anglers) of Yellow Perch.

## Methods

### Creel Survey

We closely followed a protocol by Hahn et al. (2000) to conduct an access point creel survey at Curlew Lake from May 2022-February 2023. The survey was divided into three periods (spring/summer, fall, winter) to adapt methods for daylight length over the course of the fishing season and to draw comparisons between the ice fishery in the winter versus the boat/shore fishery during the spring/summer and fall.

We used a two-stage nonuniform probability sampling technique described by Malvestuto et al. (1978). The spring/summer survey (May-August) was divided into time blocks of 1 month and subdivided into weekday/weekend and AM/PM strata (secondary sampling units; SSUs). Sampling probabilities across SSUs were kept uniform since fishing effort was unknown prior to the survey. Creel shifts were six hours in duration and we opted to use AM/PM strata to provide better coverage of the fishing day (primary sampling unit; PSU). The AM creel shift extended from 08:00-14:00 and the PM creel shift from 14:00-20:00. Angler counts (boat and shore) were conducted from predetermined vantage points around the lake at the beginning, middle and end of each shift (08:00, 11:00, and 14:00 for AM; 14:00, 17:00, and 20:00 for PM).

The fall (September-November) and winter (December-February) surveys were divided into time blocks of 1 month and subdivided into weekday/weekend strata (SSUs). Sampling probabilities across SSUs were kept uniform. Creel shifts were 7 hours in duration and occurred from 09:00-16:00. Counts of boat and shore anglers were conducted from predetermined vantage points around the lake at the beginning, middle and end of each shift (09:00, 12:30, and 16:00).

During creel shifts, the creel clerk was stationed at one of the four primary access points to Curlew Lake: Curlew Lake State Park, Tiffany's Resort, Fisherman's Cove Resort, or Black Beach Resort (Figure 1). Initially, the creel clerk rotated through access points on each successive day to achieve even coverage. However, as the summer progressed, it became apparent that angler use was increasingly concentrated at Curlew State Park, especially during weekend days. Because we were reliant on obtaining completed trip data and most anglers were accessing the lake from the park, we chose to prioritize that location.

Creel interviews were conducted to obtain completed trip information across the entire fishery. Primary interview data collected included number of anglers in party, hours fished, species targeted, catch and

harvest. In addition, a subsample of harvested fish lengths was collected as time allowed (generally 5-10 fish lengths per party; collection of fish length data was always secondary to primary data collection).

Data were analyzed to produce estimates of angling effort (hours and trips) by angler type (boat, shore, ice) and species targeted, as well as catch and harvest by species, month, and season. Estimates were also produced for mean trip length and relative proportions of species targeted (Hahn et al. (2000).

## Yellow Perch Exploitation

From May 31-June 2, 2022, five WDFW staff and four volunteers captured 466 Yellow Perch >200 mm TL (8 inches) via angling from four locations in Curlew Lake (from north to south): North End (n=121), Tiffany's Point (n=21), Pine Point (n=173), and the south end near Curlew State Park (n=151). Each fish was measured for TL (mm), tagged with a Floy tag (FD-94 Anchor Tags, Floy Tag Inc., Seattle, WA; Figure 4), and immediately released at the site of capture. Tags were inserted into the white muscle tissue on the left side of the fish just below the dorsal fin, following Guy et al. (1996). We assumed a closed population (no immigration or emigration).



Figure 4. Yellow Perch tagged at Curlew Lake in May, 2022.

Throughout the creel survey, tag returns were reported in one of three ways: (1) in-person creel interviews, (2) voluntary trip reports, or (3) email. Voluntary trip reporting cards and signage directing anglers to report tagged fish were distributed to all three private resorts and Curlew Lake State Park.

Using the 466 tagged Yellow Perch as a surrogate for the population, we estimated exploitation (% harvested by anglers) during the spring/summer period (May-August) when most tags were reported. The angler reporting rate (percentage of anglers who reported a tagged fish upon capture) was unknown for this fishery, so we used a reporting rate (58%) estimated for the Yellow Perch fishery at Cascade Lake in Idaho (Meyer et al. 2012). The spring/summer period exploitation rate was estimated as follows:

$$\mu = (\text{number of tags reported} / \text{estimated \% reported}) / (\text{number of fish tagged})$$

The total harvest during the spring/summer period, estimated from the creel data, was then used to estimate the population size for Yellow Perch  $\geq 200$  mm TL as follows:

$$\hat{N} = \text{estimated harvest during the spring and summer period based on creel} \\ / \mu \text{ during the spring and summer period based on tag returns}$$

The population estimate was then used to produce an estimate of exploitation during the fall, winter, and the entire fishing season, as follows:

$$\mu = \text{number of fish harvested based on creel} / \text{population estimate based on tag returns}$$

# Results

## Creel Survey

Boat and shore angling effort varied considerably across the spring/summer and fall seasons (Figure 5). During May-June, shore fishing effort exceeded boat fishing effort, peaking in June at 3,684 angler hours and tapering off through the late summer and into fall. Boat effort peaked in July (4,763 angler hours) and steadily dropped as the summer progressed into fall. No anglers were observed during the month of November. Ice fishing effort peaked in January (4,545 hours) with similar levels of effort to boat anglers during the summer. Total estimated fishing effort across angler types for the entire creel season (May-February) was 40,682 angler hours.

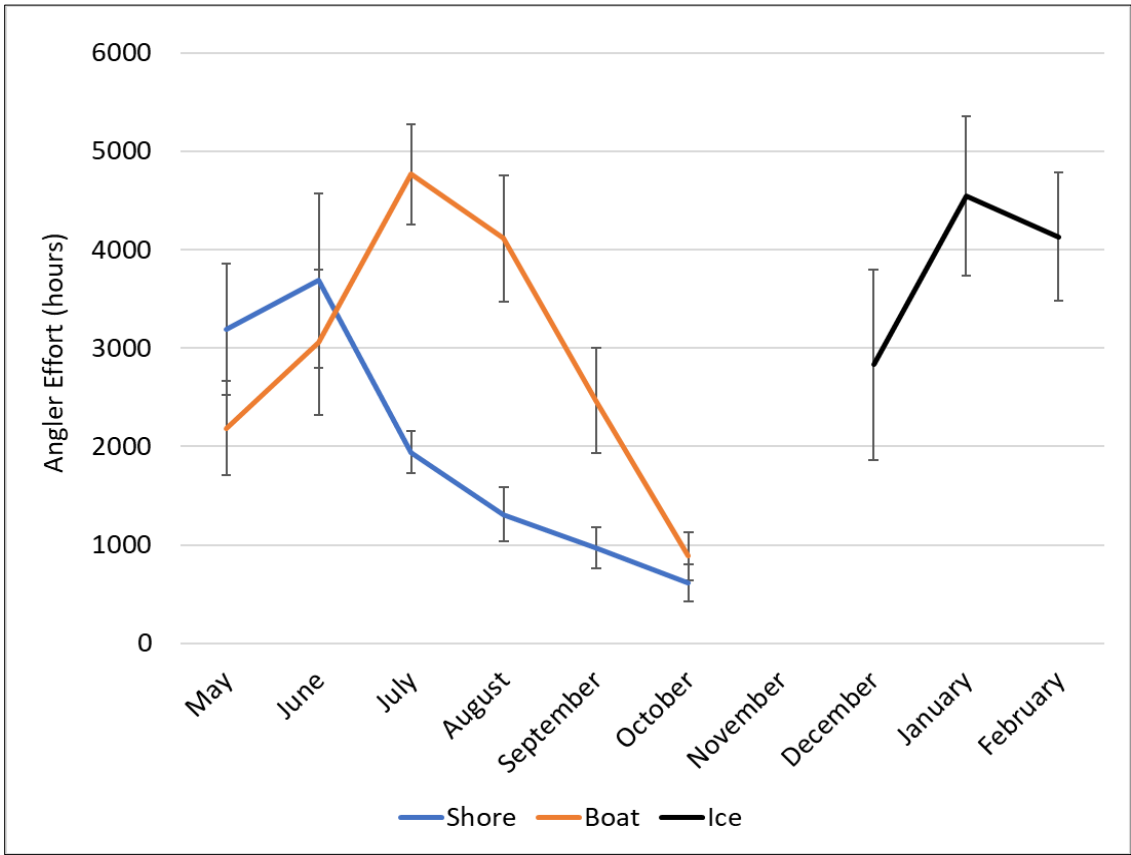


Figure 5. Estimated angler effort by month (including 80% confidence intervals), for boat, shore, and ice anglers at Curlew Lake, Washington during the 2022-2023 fishing season.

The relative proportion of anglers targeting different species varied between the month of May, the remainder of the summer and fall periods, and the winter period (Figure 6). During May, 50% of the anglers targeted Rainbow Trout, 41% targeted “any species,” and only 5% targeted Yellow Perch. During June-October, anglers targeting Yellow Perch represented 34-51% of total, with the remaining anglers split between “any species” and Rainbow Trout. During the winter, the ice fishery was dominated by anglers fishing for Yellow Perch (91-99%). Anglers targeting Largemouth Bass, Smallmouth Bass, and Kokanee were present in low numbers. Very few anglers targeted Tiger Muskie, so they were added to the “any species” category.

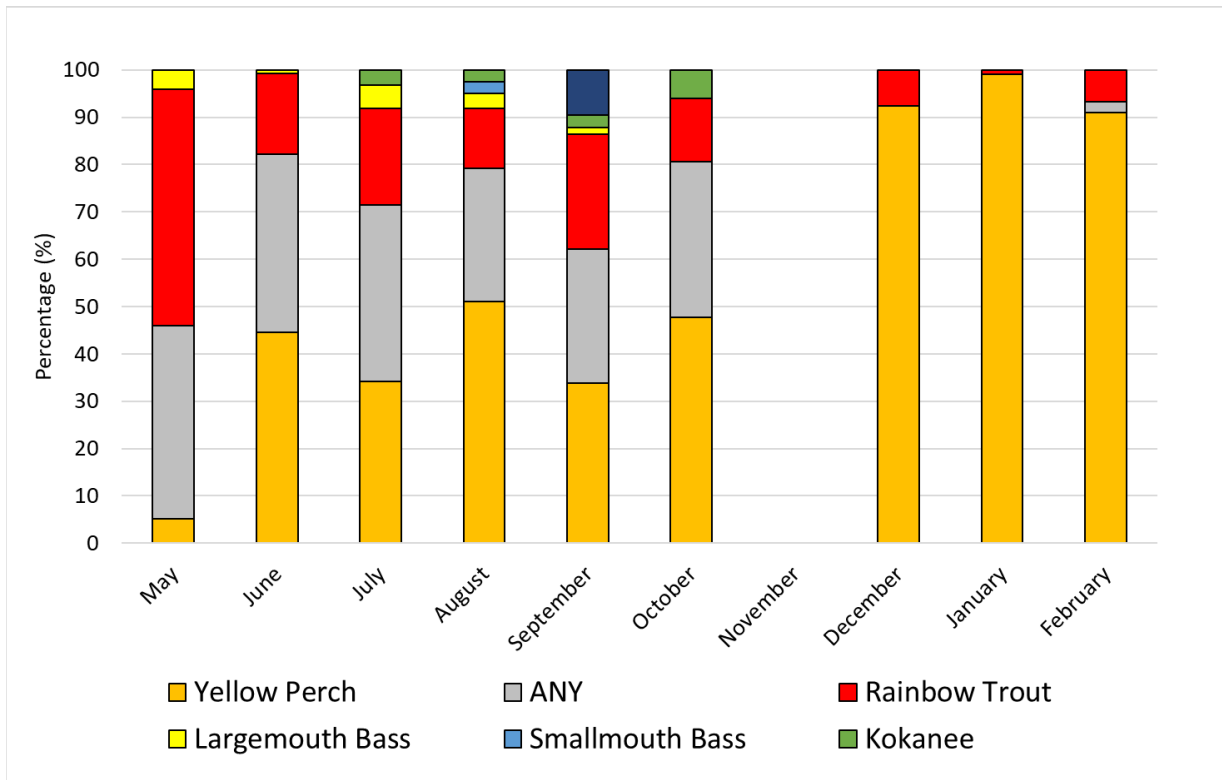


Figure 6. Relative proportion of species targeted by anglers, by month, at Curlew Lake, Washington from May 2022-February 2023.

Trip length varied considerably among angler types but was consistent across months within the spring/summer, fall and winter periods (Figure 7). Mean trip length for shore and boat anglers across the spring/summer and fall periods was 2.1 hours and 3.5 hours, respectively. During the winter period, mean trip length was 5 hours for ice anglers.

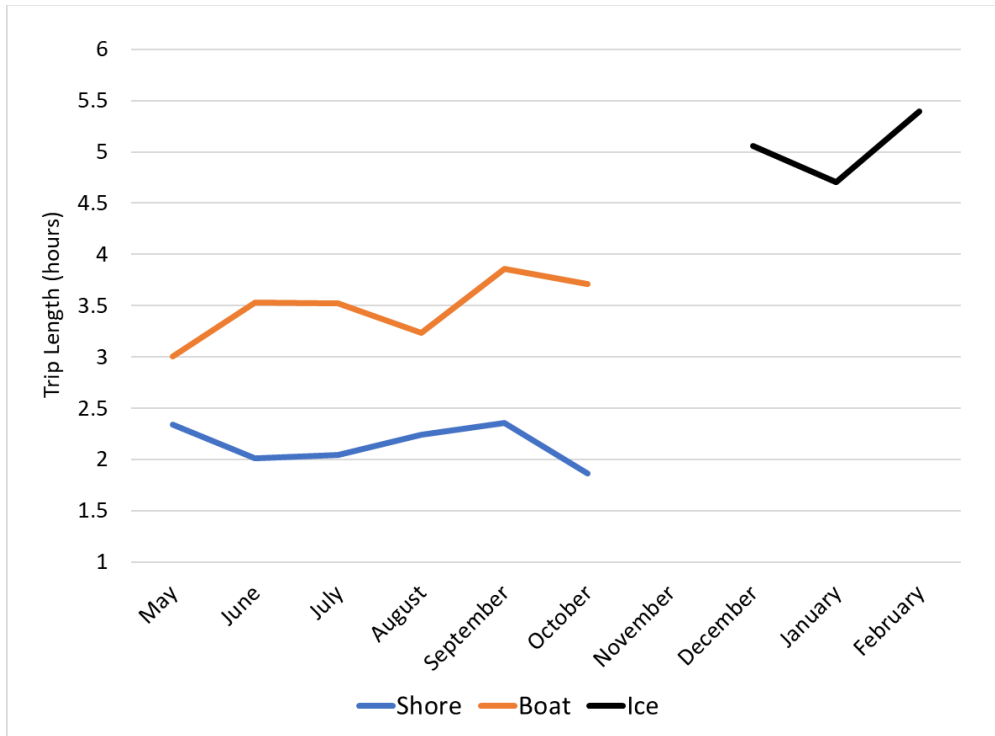


Figure 7. Average completed trip length by month, for shore, boat, and ice anglers at Curlew Lake, Washington from May 2022-February 2023.

Total catch of Yellow Perch (harvested + released) increased from May into June and remained high throughout the summer and fall (Figure 8) but peaked in January (21,427 fish) during the ice fishery. Total estimated catch of Yellow Perch for the entire survey period (May-February) was 117,920 fish.



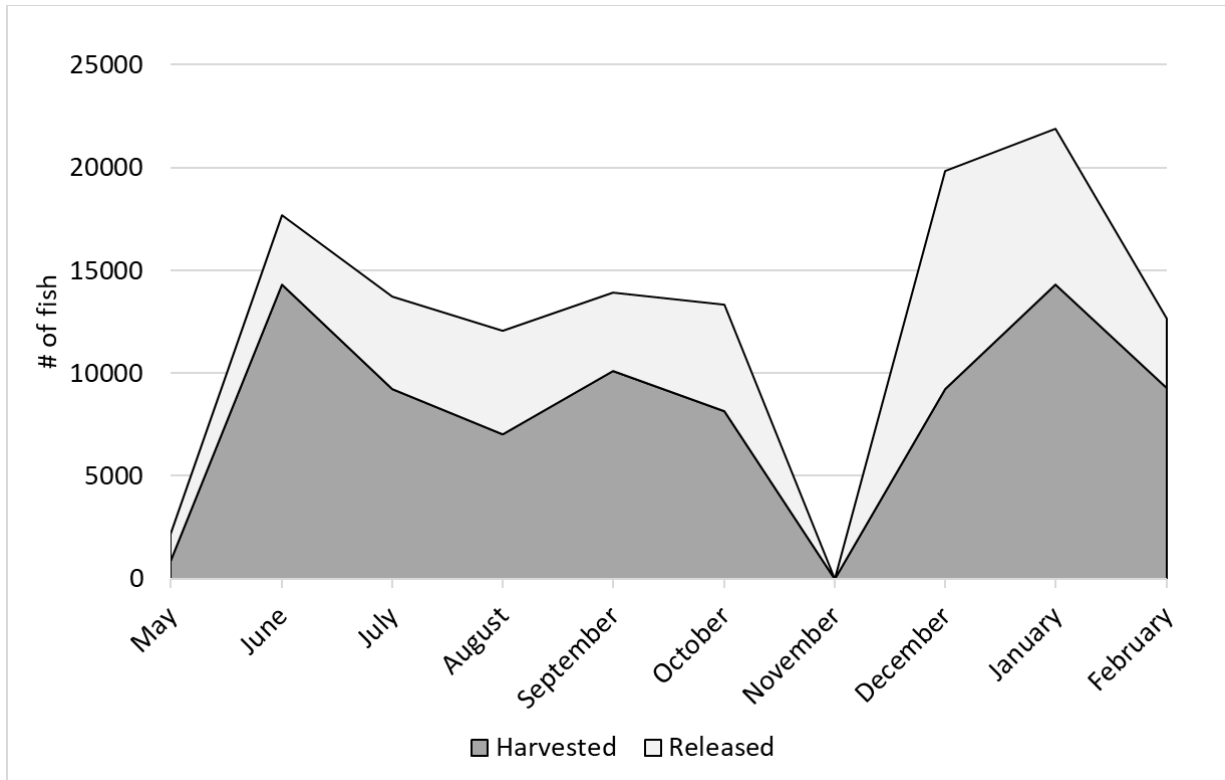


Figure 8. Estimated number of Yellow Perch harvested and released at Curlew Lake, Washington from May 2022-February 2023.

Boat anglers (June-October) and ice anglers (December-February) accounted for 93.6% of Yellow Perch harvested from Curlew Lake (Figure 9). Boat angler harvest peaked in June (12,009 fish) and remained high throughout the summer and fall (6,631-9,200 fish). Total harvest from the summer and fall periods was 44,452 fish. Ice angler harvest peaked in January (14,317 fish) with a total of 31,464 fish harvested during the winter. Total Yellow Perch harvest for the entire survey (May-February) was estimated at 81,147 fish.

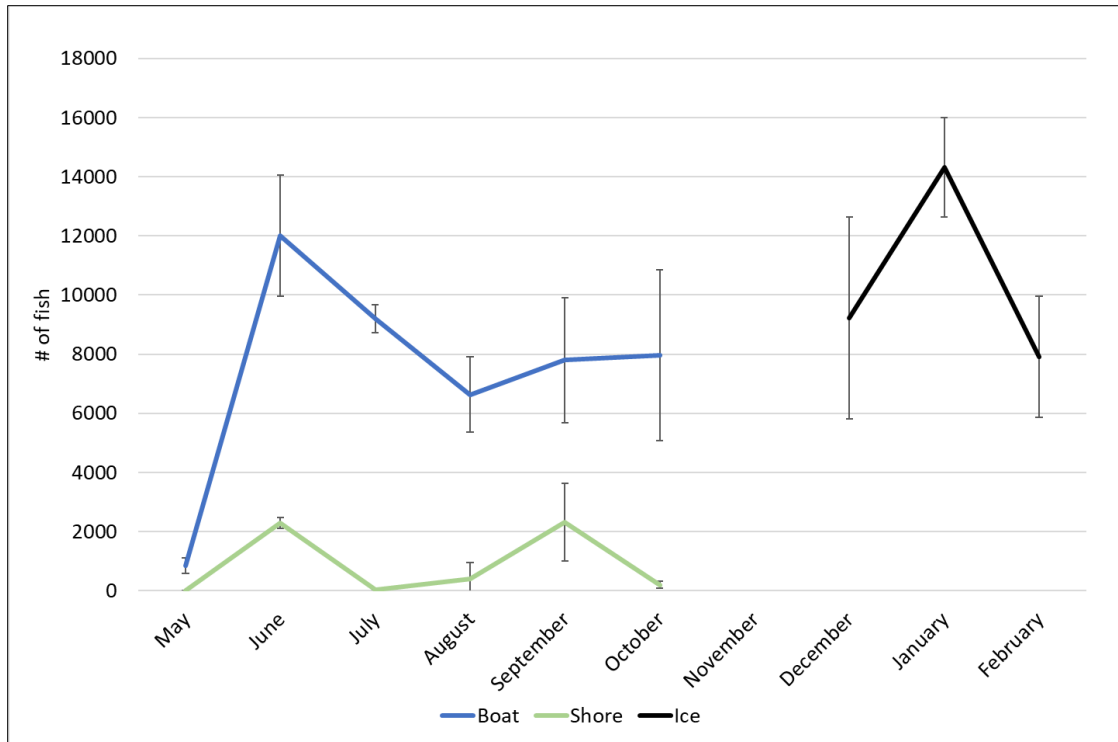


Figure 9. Monthly harvest estimates for Yellow Perch (including 80% confidence intervals), by angler type (boat, shore, and ice), at Curlew Lake, Washington from May 2022-February 2023.

Catch of Rainbow Trout (harvested + released) peaked in May (5,620 fish), declined throughout the summer, increased again in September (4,491 fish), and then declined through the remainder of the fall (Figure 10). During the winter, catch peaked in January (4,257 fish). During the summer and fall months, release rates (total released/total catch) varied from 20% in June to 75% in September. During May when catch was highest, release rate was 60%. During the winter period, release rates varied from 70% in February to 89% in January.

Shore anglers accounted for most of the Rainbow Trout harvested from Curlew Lake (Figure 11). Shore harvest was highest in May (2,258 fish) and declined throughout the summer. Total trout harvest from the entire survey (May-February) was 9,448 fish.

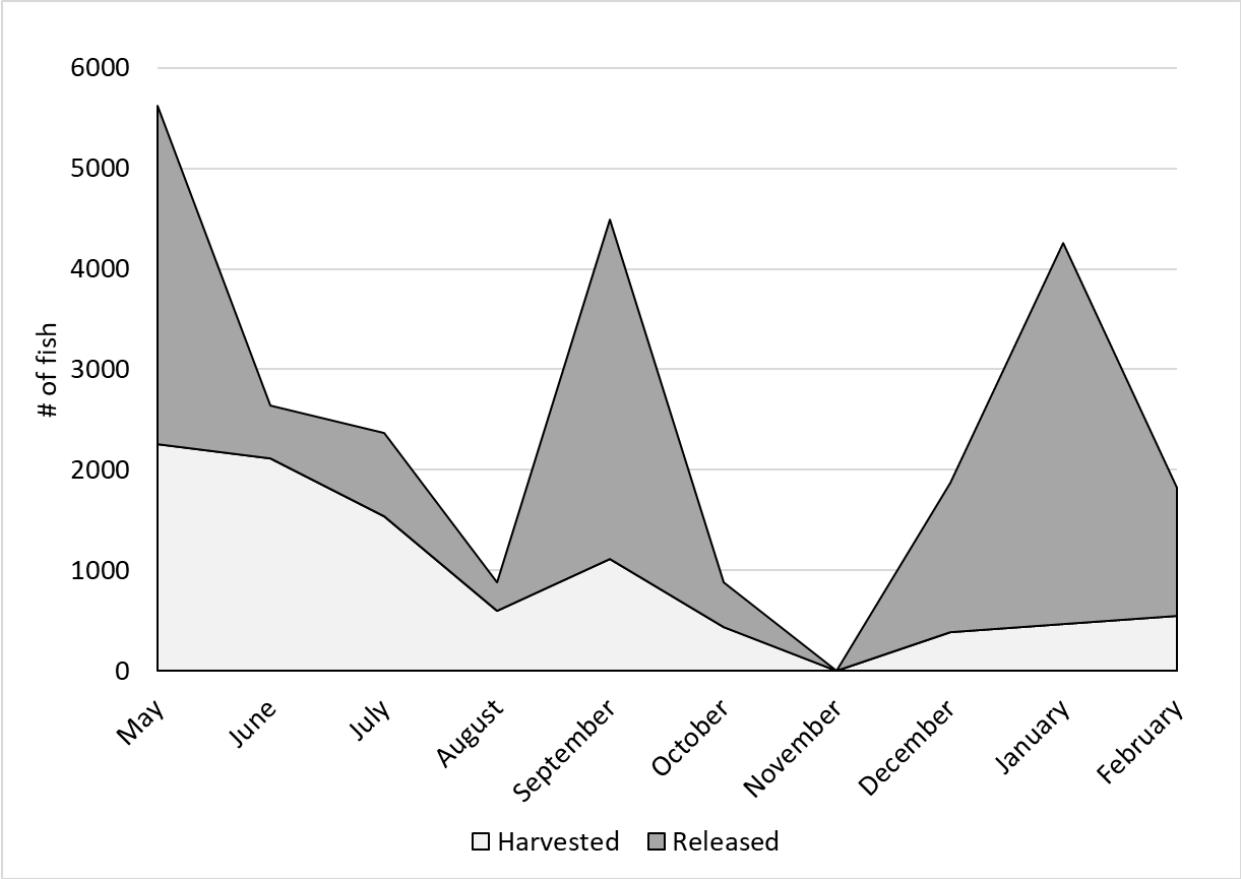


Figure 10. Estimated number of Rainbow Trout harvested and released at Curlew Lake, Washington from May 2022-February 2023.

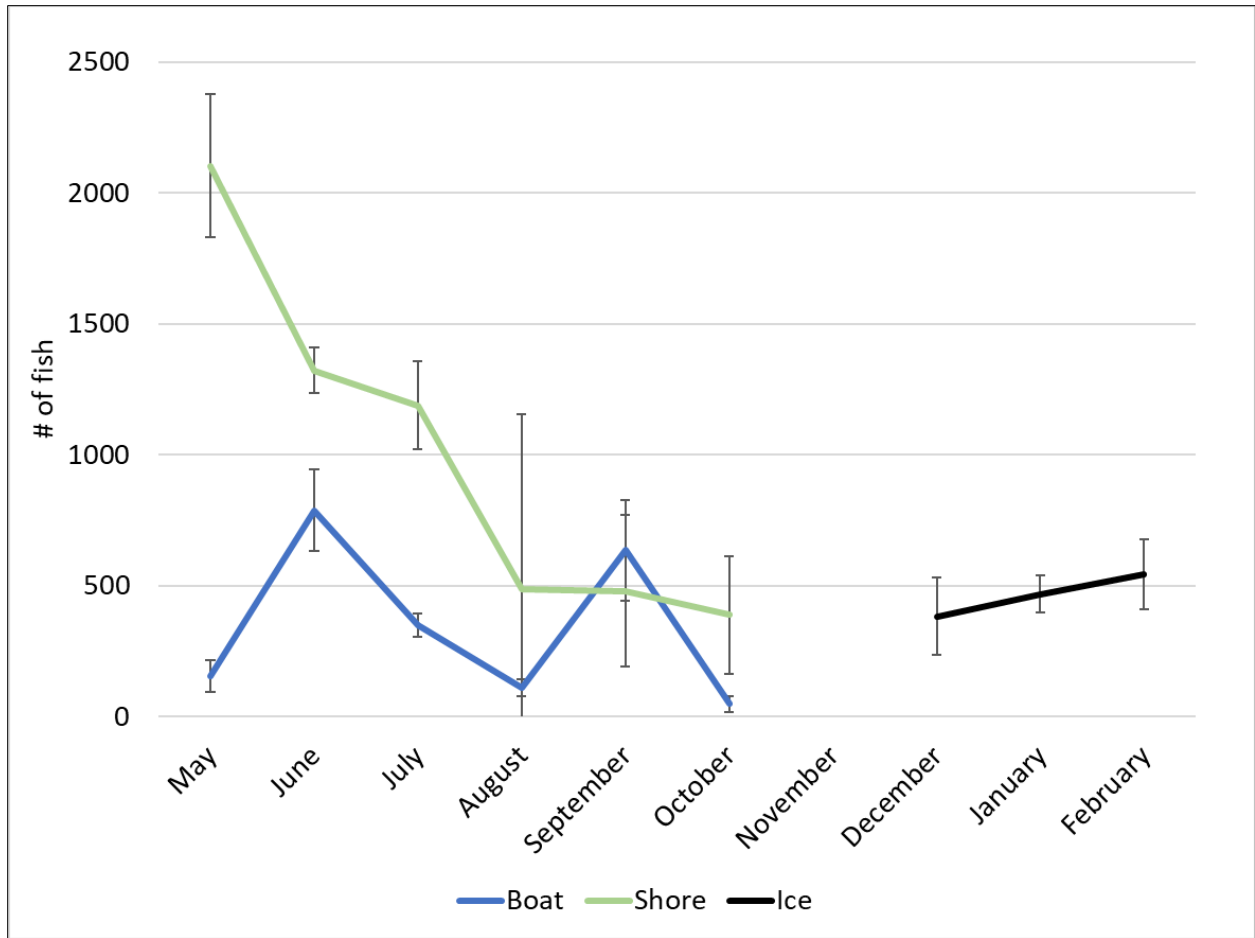


Figure 11. Monthly harvest estimates for Rainbow Trout (including 80% confidence intervals), by angler type (Boat, Shore, and Ice), at Curlew Lake, Washington from May 2022-February 2023.

The length distributions of Yellow Perch harvested from Curlew Lake are presented in both millimeters (10-mm TL bins; Figure 12) and inches (1-inch TL bins; Figure 13). The majority of fish harvested (63%) ranged from 230-280 mm (9-11 inches) TL, with the largest Yellow Perch measuring 356 mm (14 inches). The length distributions were consistent across time periods (spring/summer, fall, winter).

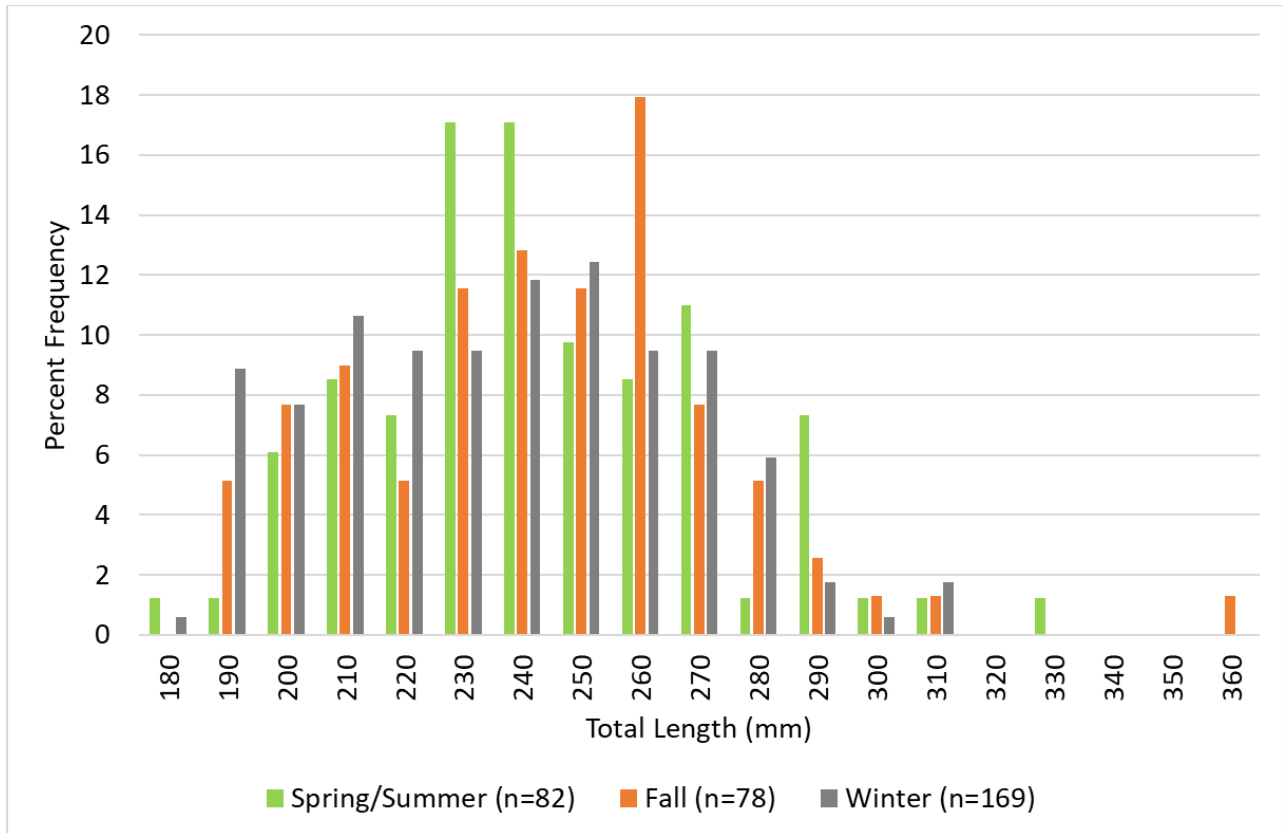


Figure 12. Percent frequency of harvested Yellow Perch by size class (10-mm TL bins) during the spring/summer (n=78), fall (n=82), and winter (n=169) at Curlew Lake, Washington from May 2022-February 2023.

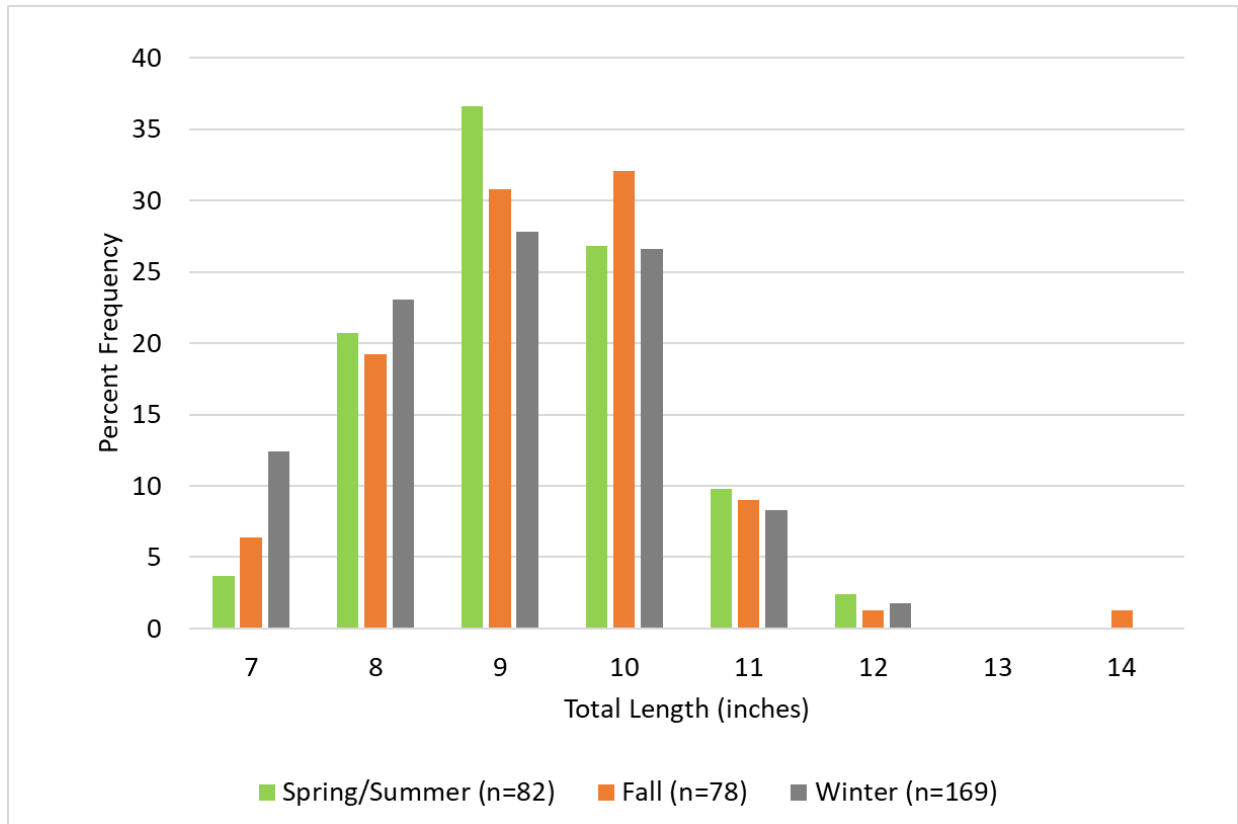


Figure 13. Percent frequency of harvested Yellow Perch by size class (1-inch TL bins) during the spring/summer (n=78), fall (n=82), and winter (n=169) at Curlew Lake, Washington from May 2022-February 2023.

Frequency of size classes for harvested Rainbow Trout from Curlew Lake are presented in both millimeters (10-mm TL bins; Figure 14) and inches (1-inch TL bins; Figure 15). The majority of fish harvested (75%) ranged from 254-356 mm (10-14 inches) TL, with the largest measuring 470 mm (18.5 inches). Most of the length data (71%) was collected during the spring/summer period when trout harvest was highest.

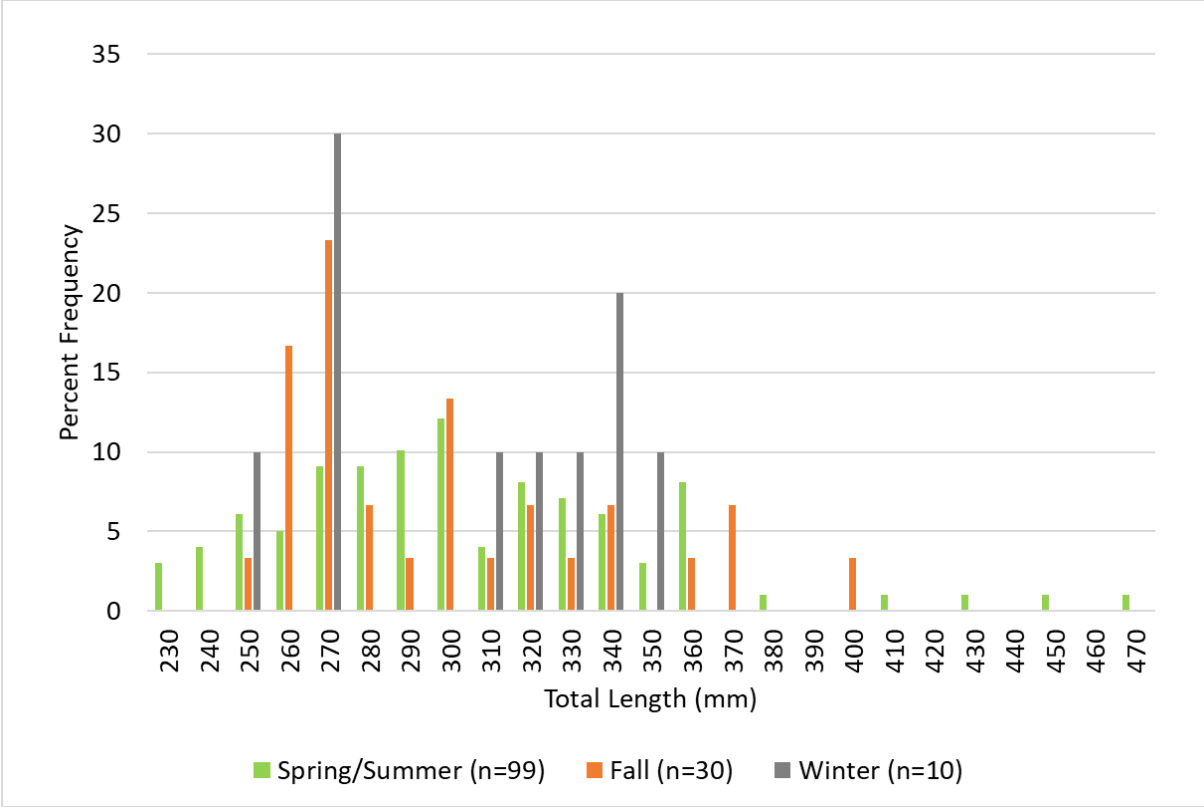


Figure 14. Percent frequency of harvested Rainbow Trout by size class (10-mm TL bins) during the spring/summer (n=99), fall (n=30) and winter (n=10) at Curlew Lake, Washington from May 2022-February 2023.

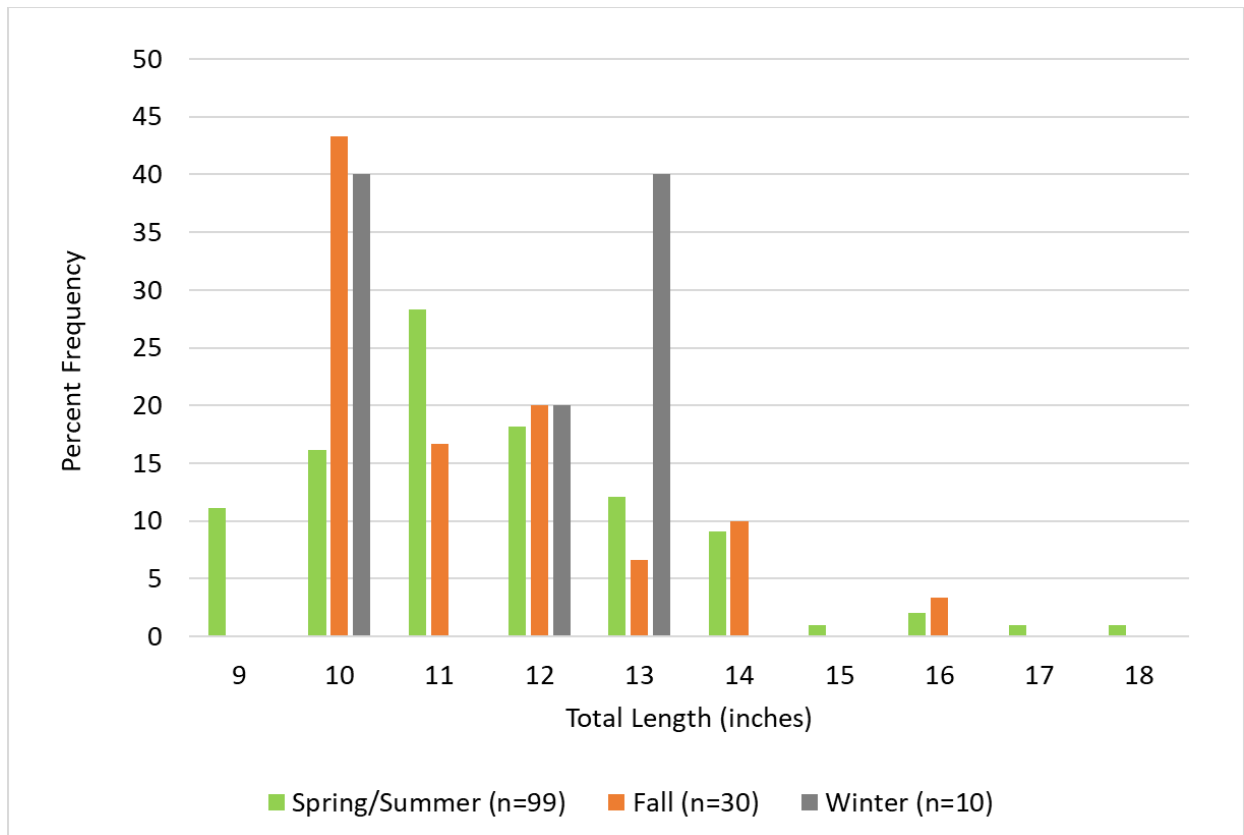


Figure 15. Percent frequency of harvested Rainbow Trout by size class (1-inch TL bins) during the spring/summer (n=99), fall (n=30) and winter (n=10) at Curlew Lake, Washington from May 2022-February 2023.

## Yellow Perch Exploitation

Over the course of the 9-month creel survey (May 2022-February 2023), a total of 78 tagged Yellow Perch were reported by anglers via voluntary catch cards (n=32), creel interviews (n=24), and email (n=22). The majority were reported during May-August (70%), so we used tag return data from these months to estimate exploitation and the population size. Using a reporting rate of 58% (Meyer et al. 2012), we estimate that 95 tagged Yellow Perch were harvested during May-August which represents 20% exploitation of the total number of fish tagged (n=466). The population size of Yellow Perch  $\geq$  200 mm (8 inches) TL was estimated at 154,345 fish. Total exploitation for the 9-month survey was estimated at 53% (Table 1).



Table 1. Expanded tag returns from Yellow Perch (>200 mm TL) harvested at Curlew Lake during May-August, adjusted for angler reporting rates ranging from 50-100%. Asterisk denotes the reporting rate (58%) adopted for this analysis.

Report%	Tag Returns	Total Tagged	POP EST.	Summer $\mu$	Fall $\mu$	Winter $\mu$	Total $\mu$
100	55	466	266111	0.12	0.07	0.12	0.30
90	61	466	239500	0.13	0.08	0.13	0.34
80	69	466	212889	0.15	0.09	0.15	0.38
70	79	466	186278	0.17	0.10	0.17	0.44
60	92	466	159667	0.20	0.11	0.20	0.51
<b>58*</b>	<b>95</b>	<b>466</b>	<b>154345</b>	<b>0.20</b>	<b>0.12</b>	<b>0.20</b>	<b>0.53</b>
50	110	466	133056	0.24	0.14	0.24	0.61

## Discussion

Catch and harvest of Yellow Perch was substantial over the course of the 9-month creel survey and similar across most months and time periods, with a summer peak in June and a winter peak in January. Exceptions (low catch and harvest) occurred during the months of May and November. May is a transition period for Yellow Perch following the spawn, and fishing is generally poor until late May/early June when fish move inshore to feed. November is the fall transition period when water temperatures drop quickly and fish transition to deeper water. In addition, snow storms and dense fog were recorded on November 4<sup>th</sup> and November 18<sup>th</sup>, followed by an early ice-up which precluded angler access by November 28<sup>th</sup> (ice was too thin to safely fish). Thus, no fishing was observed during the month of November. The months of March-April were not included in this survey due to budgetary constraints. By mid-March, the ice was no longer safe, and angling dropped off immediately. Enough ice to preclude launching a boat or fishing from shore persisted until around mid-April. Following ice-out in April, there were likely some shore and boat anglers, primarily targeting Rainbow Trout, which were not included in this survey. However, overall angling effort was low during that time (Tiffany’s Resort Staff personal communication 2023).

Fishing effort during the summer (May-August), including boat and shore anglers, comprised the majority (60%) of total fishing effort for the 9-month survey (40,682 hours). Fishing effort during the fall (September-October) and winter (December-February) accounted for 12% and 28% of total fishing effort, respectively. Due to shorter trip lengths recorded during the summer than the winter, the summer period accounted for 70% of the total fishing trips estimated for the 9-month survey (12,744 angler trips). Using net economic values for warmwater fishing in Washington (TCW Economics 2008), we estimate that Curlew Lake fisheries generate approximately \$546,335 in economic activity annually.

Estimates of angler exploitation from tag return data are highly influenced by the tag reporting rate (percentage of anglers who caught a tagged fish and actually reported it; Miranda et al. 2002). Since we

were unable to quantify the tag reporting rate during this study, we relied on the reporting rate provided by Meyer et al. (2012) for the Yellow Perch fishery at Lake Cascade in Idaho. However, we acknowledge that our reporting rate could have been higher due to the inclusion of creel interviews as a means of intercepting anglers combined with the distribution of signage and voluntary creel cards at the state park and private resorts. If the actual reporting rate was in the 60-80% range, our total estimated exploitation for the 9-month period declines from 53% to a range of 38-51%, which may be closer to reality. Regardless of the true reporting rate, we can confidently say this fishery is experiencing substantial Yellow Perch harvest (>30% exploitation).

Prior to the establishment of Yellow Perch in Curlew Lake (first detected in 2011), it was primarily known as a popular Rainbow Trout fishery. Over the course of this study, we documented a popular harvest fishery for Yellow Perch that spanned the summer, fall, and winter months. Apart from the month of May, when most anglers targeted Rainbow Trout, boat and shore anglers contacted during the creel survey indicated that they targeted Yellow Perch or were non-preferential, answering that they were targeting “any” fish species. Shore fishing effort dropped off in July as Yellow Perch moved offshore, while boat fishing effort peaked in July. Boat fishing for Yellow Perch remained excellent through September, then declined in October. The ice fishery angling effort during the winter period was nearly as high as the summer period, peaking in January. The vast majority of ice anglers (>90%) targeted Yellow Perch.

Rainbow Trout comprised a much smaller component of overall effort, catch, and harvest than was expected, based on the popularity of the trout fishery as recently as 2011. The Rainbow Trout fishery was primarily driven by shore angling which peaked in May with 2,625 trout caught and 2,258 harvested. Boat angling for trout also peaked in May with 3,427 fish caught and only 787 harvested. Total harvest of Rainbow Trout for the 9-month period was only 9,448 fish. The high release rate by boat anglers was unexpected and may be indicative of dissatisfaction with the size of trout caught. Although no creel data were collected during the years when Rainbow Trout comprised the primary fishery and available information is anecdotal, the mean size of Rainbow Trout has declined since Yellow Perch introduction. The majority of fish harvested (75%) ranged from 254-356 mm (10-14 inches) TL, with the largest measuring 470 mm (18.5 inches). However, during May and June, Rainbow Trout ranging from 200-225 mm (8-9 inches) TL were commonly caught and released by anglers, and many caught and released during the ice fishery were even smaller (likely fall fingerlings stocked in October).

Prior to the illegal introduction of Yellow Perch in Curlew Lake, the Rainbow Trout stocking rate was fairly static (225,000-235,000 fish annually from 2005-2010; approximately 225-235 trout/acre). Following rapid expansion of the Yellow Perch population and a recognition of declining trout growth, likely due to competition with Yellow Perch, Rainbow Trout stocking was reduced to 205,000 and 210,000 fish annually in 2013 and 2014, respectively, then reduced again to approximately 185,000 fish annually from 2015-2021. Currently, return of stocked trout to the creel is very low (estimated 5.1%), and a further reduction in the number of Rainbow Trout stocked annually is necessary to account for the effect of competition with Yellow Perch and allow for growth rates sufficient to produce trout of desirable size to anglers.

Given the propensity for Yellow Perch to overpopulate and experience slow growth in Washington lakes, managers were understandably concerned about illegal introduction of this species into Curlew Lake. Although Yellow Perch are widely distributed across the Washington State, they generally do not attract as much attention from anglers as experienced at Curlew Lake. However, most waters do not produce an equivalent harvest opportunity for this species (large numbers of quality-sized fish). Given the popularity of the Curlew Lake Yellow Perch fishery, a management paradigm shift from trout emphasis to a focus on maintenance of a high quality Yellow Perch fishery is warranted. Maintaining high growth rates for Yellow Perch are key to maintaining a population size structure desirable to anglers. Currently, data suggest that a combination of high levels of recruitment and harvest are resulting in a large population with fast-growing adults. Thus, we do not recommend any changes to the current fishing regulations for Yellow Perch (no daily limit or size restrictions).

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