Lower Granite Dam Data Shows Upstream Movement and Increasing Abundance of Walleye in the Snake River

INTRODUCTION

Walleye, (*Sander vitreus*), are fecund and effective predators whose range in North America has expanded drastically due to authorized and unauthorized introductions outside their native range (Hallock and Fletcher 1991). In the Pacific Northwest, Walleye have spread throughout the Columbia River Basin from invasions following an unauthorized introduction to Roosevelt Reservoir in 1960 (Hallock and Fletcher 1991). Walleye are opportunistic predators that key in on emigrating salmonids as a prey item when present. In the three lowest Columbia River reservoirs it is estimated that the yearly loss of salmonids from Walleye could be up to two million individuals (Beamesderfer and Nigro 1989; Temple 1998). A more recent report by Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), and the Pacific States Marine Fisheries Commission (PSMFC) sampled Walleye in Lower Snake River reservoirs in 2019; Ice Harbor (n=27), Lower Monumental (n=30), Little Goose (n=1), and Lower Granite (n=0; Hone et al. 2019). Diet analysis of these Walleye showed that salmonids comprised 36% of stomach contents in spring and 0% in summer (Hone et al. 2019). While this study sampled no Walleye ≥ 200mm in the Lower Granite Reservoir via electrofishing, data collected from Lower Granite Dam has shown increasing numbers of Walleye sampled from the adult fish ladder since 2016 (2016=2; 2017=11; 2018=49; 2019=20; D. Ogden, National Oceanic and Atmospheric Administration [NOAA], personal communication). No Walleye were sampled at Lower Granite Dam prior to 2016. This discrepancy suggests that electrofishing reservoirs is not effective at providing sufficient sampling of Walleye in the reservoirs and that information adult fish ladders at hydrosystem dams may be a more effective method of characterizing colonizing Walleye populations in the Snake River. Currently, the US Army Corps of Engineers does not record counts of Walleye passing through the fish ladder. Therefore, the trapping data is the best available information for Walleye movement and potential colonization into the Snake River basin upstream of Lower Granite Dam. The colonization of Walleye in the Snake River basin could have adverse effects on native and non-native species, especially when compounded by Smallmouth Bass (*Micropterus dolomieu*), a non-native piscivorous species that is already established in the Snake River basin. Monitoring upstream movements of Walleye at Lower Granite Dam and understanding demographic characteristics of colonizing individuals (e.g., age, sex) will provide needed information for fisheries biologists to prepare a management plan should Walleye become more prevalent in the Snake River basin.

METHODS

The adult trap at Lower Granite Dam is located on the fish ladder, and operates to systematically sample a proportion of all fish species moving through the ladder. The computerized system shunts fish from the ladder into the trapping facility where fish can be sampled. The trap rate can be changed throughout the year to fill research sampling and hatchery broodstock needs for various fishery programs. Trapping was suspended during the spring and summer of 2020 due to the COVID-19 pandemic but recommenced operations on July 1. Prior to August 18, trapping occurred five days a week from Monday through Friday and was shut off during the weekends. Because of this, the trap rate differs from the total sample rate goal. Starting August 18, the trap ran continually through the week and weekends so the trap rate was equal to the sample rate. Starting July 1, 2020, there were four different trap rate periods. From July 2, through July 31, the daily trap rate was 28.0% (sample rate = 20.0%). From August 1 through August 17, the daily trap rate was reduced to 25.0% (sample rate = 18.0%). From August 18 through

September 1, the daily trap rate was increased to 80% (sample rate = trap rate). From September 2 through November 12, the daily trap rate was reduced to 18.0% (sampling rate = trap rate). The trap seized operation on November 12, however, the ladder remained open for fish to pass.

When a Walleye was encountered at the adult trap, it was anesthetized using an Aqui-S solution, exsanguinated using a gill clip, and sampled. From each Walleye sampled, measurements of fork length (mm) and weight (g) were taken and otoliths, dorsal fin rays, stomachs, gonads, and fin tissue were removed for analyses (Table 1). Otoliths were collected for aging and potential future microchemistry analysis. Fin rays were taken as a second aging structure for an age structure comparison study. Aging and measurement of growth increments of hard structures will be completed in 2021. Stomachs were removed from sampled Walleye and stored in ethanol for diet analysis. Walleye gonads were evaluated as undeveloped, developing, fully developed, spawning, spent, or unknown in accordance with the Northwest Science & Technology "Identification of Sex, Maturity, and Gonad Condition of Walleye" field guide (Duffy et al. 2000). Tissue samples from fins will be used in genetic analysis to assist with Nampa Research's work on establishing a genetic sex marker for Walleye and to potentially evaluate Walleye population structure in the Snake River basin.

RESULTS

A total of 45 Walleye were encountered in 2020 from July 16, through October 24 at the Lower Granite Dam adult trap. Of the Walleye observed, 4.4% were observed during the first period (20.0% sample rate; n=2; Figure 1), no fish were observed during the second period (18.0% sample rate), 20.0% were observed during the third period (80% sample rate; n=9; Figure 1), and 53.3% were observed during the last period (18.0% sample rate; n=34; Figure 1). Based on sample rate data, an estimated 165 Walleye passed upstream of Lower Granite Dam unsampled from July to November.

A total of 45 fish were observed during the total sampling period at Lower Granite Dam. Females comprised 20.0% of the population (n=9) and males comprised 80.0% of the population (n=36). Mean fork length of all sampled Walleye was 43.2cm (range: 24.5cm -55.2cm; Figure 2). Mean fork length for females was 41.2cm (range = 33.0-50.0cm; Figure 2, Figure 3) and males was 43.7cm (range = 24.5-55.2cm; Figure 2 and 3). Mean weight for all sampled Walleye was 817.4g (range: 200.0-2041.0g; Figure 4, Figure 5). Mean weight of females was 760.6 (range 453.0-1480.0g; Figure 4 and 5) and males was 827.1g (range = 200.0-2041.0g; Figure 4 and 5).

Of the Walleye sampled at Lower Granite Dam, 40.0% showed underdeveloped gonads (n=18; Figure 6), 8.8% showed dormant gonads (n=4; Figure 6), 17.7% showed developing gonads (n=8; Figure 6), 31.1% showed fully developed gonads (n=14; Figure 6), and one fish was unknown. No Walleye gonads sampled at Lower Granite Dam from July 16 through October 24 showed signs of spawning or being spent.

DISCUSSION

Data gathered at Lower Granite Dam presents an important opportunity for fisheries biologists to characterize colonizing Walleye in the Snake River. Understanding the number of fish moving upstream of Lower Granite, their growth, their diet, and their sexual maturity will help biologists evaluate their threat to salmonid populations in the Snake River basin. Observed Walleye at Lower Granite Dam have has been trending upward since 2016, suggesting that Walleye will pose an increasing threat to upstream native fish populations. This will only compound the effects of other native and non-native predators such as Smallmouth Bass, Northern Pikeminnow (*Ptychocheilus oregonesis*), Cormorants (*Phalacrocorax*

auritus), that are established in the Snake River basin and known to have significant impacts on juvenile outmigrating salmonids.

Most of the Walleye sampled at Lower Granite Dam were observed at the adult trap during late summer and early fall while the sample trap rate was set to 80.0% and 18.0%. Walleye spawning migration occurs during late-winter early spring, while non-spawning migration timing, distance, and direction is highly variable among populations (Colby et al. 1979). Understanding the purpose and timing of Columbia River basin Walleye sampled at Lower Granite Dam during summer and fall would require further examination. Furthermore, no sampling occurred at Lower Granite from March 25th to July 1st due to COVID-19 closures. Obtaining data from full seasons in the future may help us better understand Walleye movement in the Snake River.

Males made up a large percentage of fish sampled at Lower Granite (80%). This may be explained by more exploratory movement patterns among males, resulting in more males ascending the ladder and therefore, being sampled. Furthermore, only 31.1% of sampled fish showed fully developed gonads. Male walleye have been shown to mature faster (2 to 4 years; as small as 270mm) than females (3 to 6 years; from 356-432mm; Hartman 2009). These age-at-maturity estimates are for Walleye with normal to fast growth rates in mid- to high-temperature river or lake environments. The low sexual maturity rate of Walleye at Lower Granite Dam is consistent with Walleye populations with the poorest growth rates (Colby et al. 1979). Growth curves from hard structures sampled from Walleye in 2020 will shed light on yearly growth rates.

Over the course of the 2020 field season, our methods evolved based on learned experiences. We found that the euthanasia technique proved important in successful extraction of otolith samples from Walleye. The presence of blood seemed to make otoliths difficult for technicians to locate. Using exsanguination as the euthanasia process increased successful otolith extraction rate, and will be carried into next year. Additionally, technicians reported issues with the hanging scale used on project. Multiple times the scale would hold on 100 grams. A log-transformed length-weight regression showed that these measurements were far outside expected weight and were excluded from the weight summary, weight-frequency histogram, and weight box plot in this summary. Additionally, fork length was used as the length metric for the 2020 field season, this metric is not commonly used for Walleye and will be supplemented in future field seasons with total length. Training and techniques will be refined for 2021 to ensure accurate weight and length readings for analysis.

Table 1. Number of samples collected from Walleye (*Sander vitreus*) at the Lower Granite Dam adult trap from July 16, 2020 to October 24, 2020.

Sex	Otolith	Gut content	Fin ray	Fin tissue
Male	32	36	36	34
Female	5	9	9	9
Total	37	45	45	43

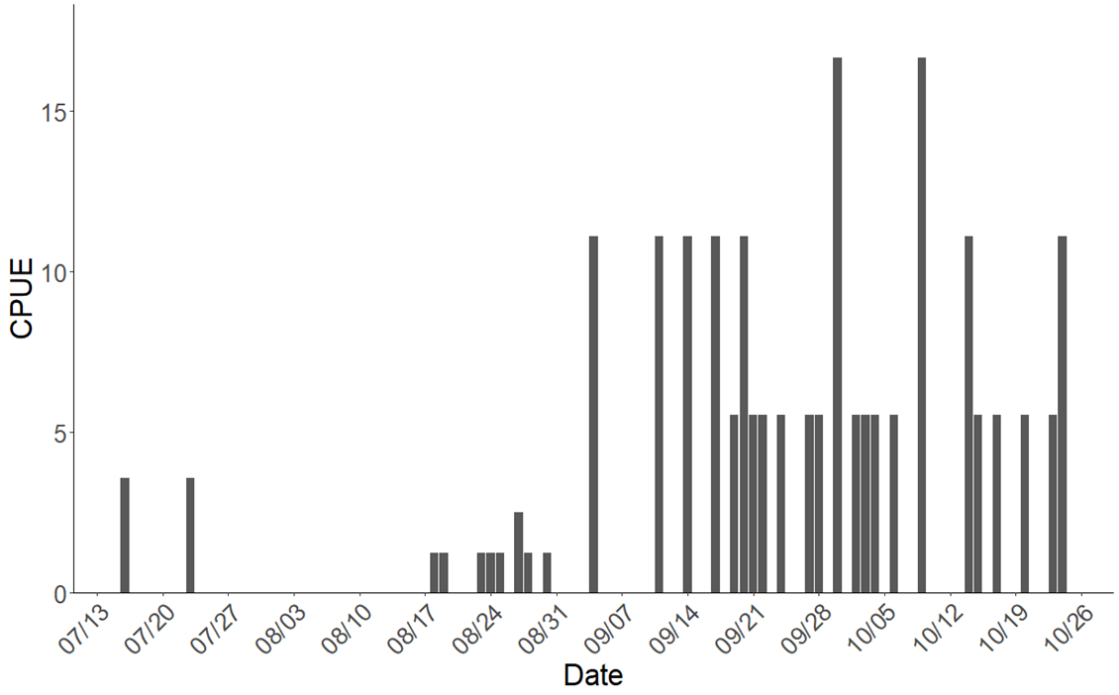

Figure 1. Number of Walleye (*Sander vitreus*) collected at Lower Granite Dam from 7/16/2020 to 10/24/2020 by sampling date and CPUE. CPUE was calculated using number of Walleye sampled and daily trap rate.

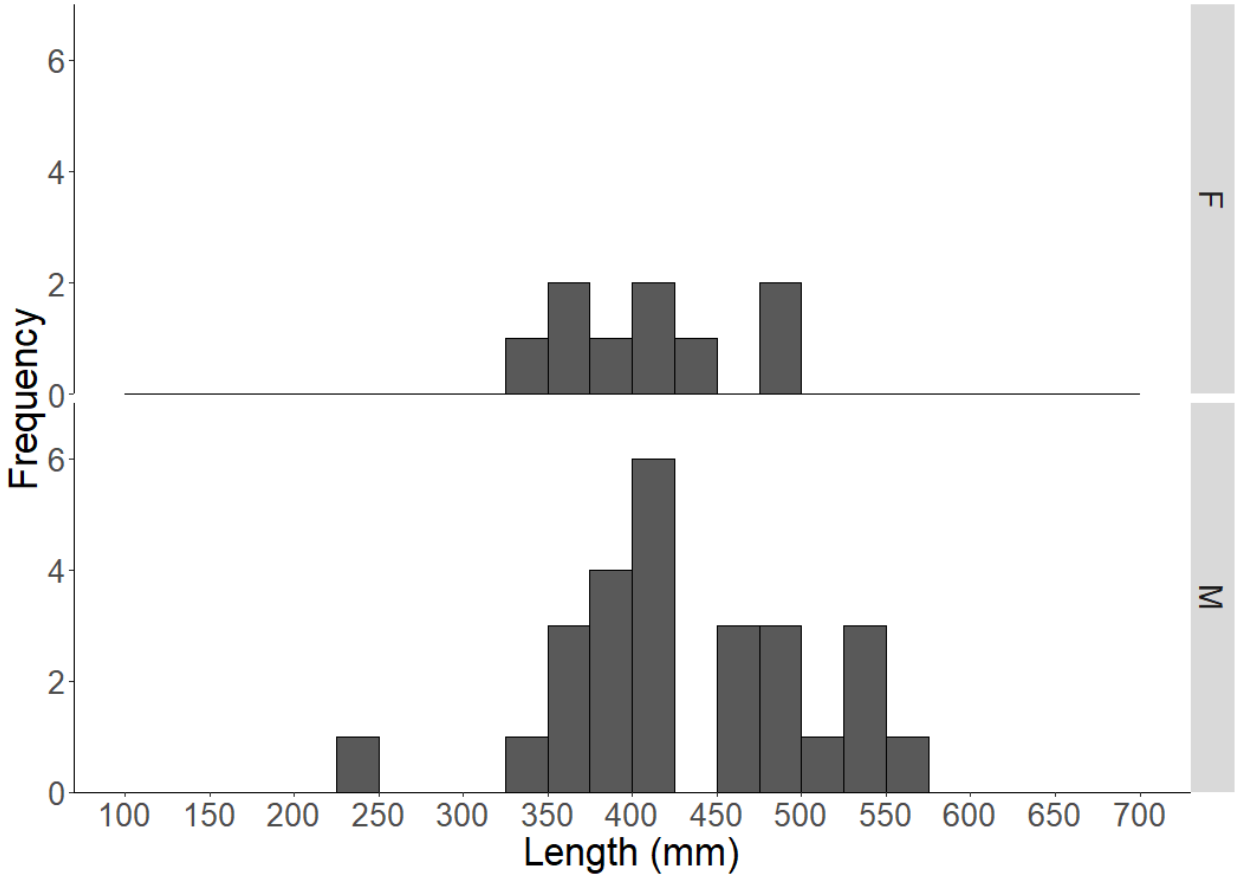

Figure 2. Length-frequency histogram of male (M) and female (F) Walleye (*Sander vitreus*) collected at Lower Granite Dam from 7/16/2020 to 10/24/2020.

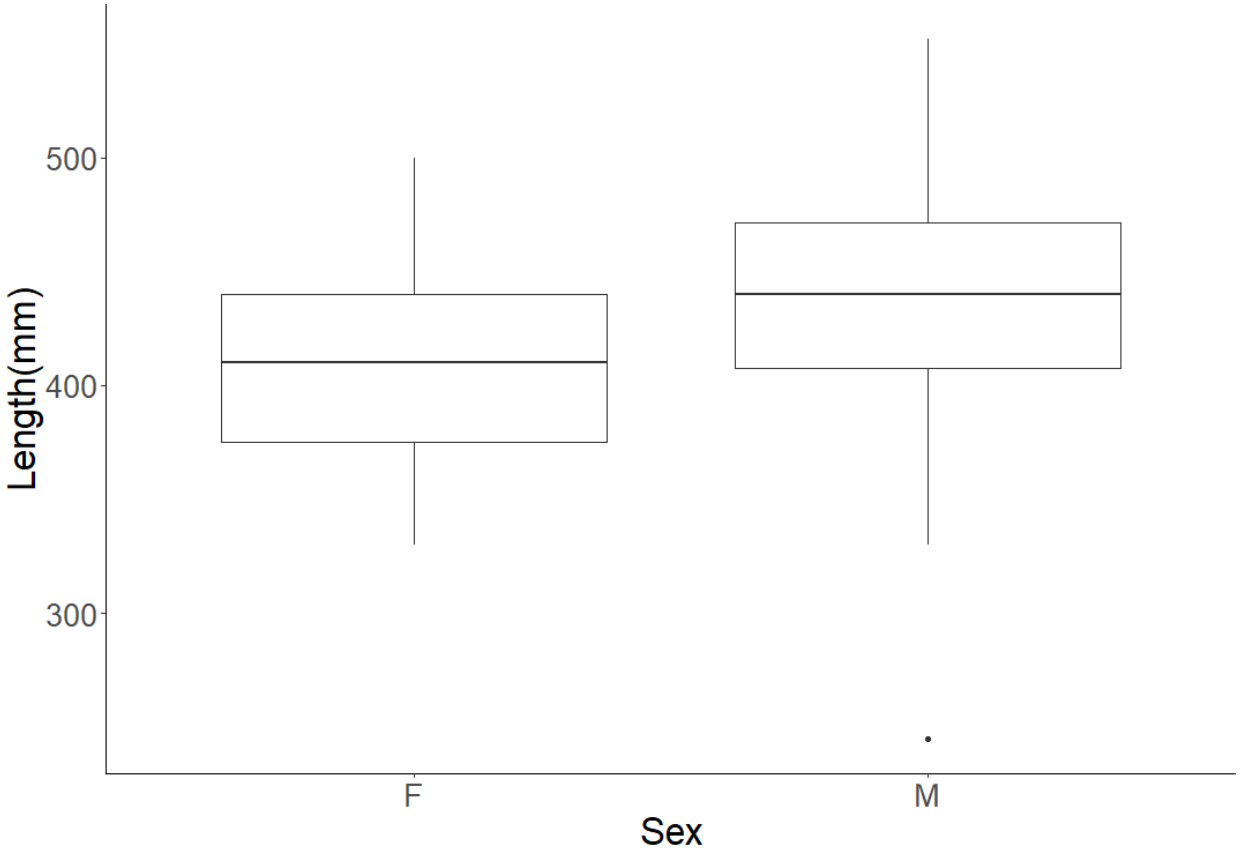

Figure 3: Box plot of length of male (M) and female (F) Walleye(*Sander vitreus*) collected at Lower Granite Dam from 7/16/2020 to 10/24/2020.

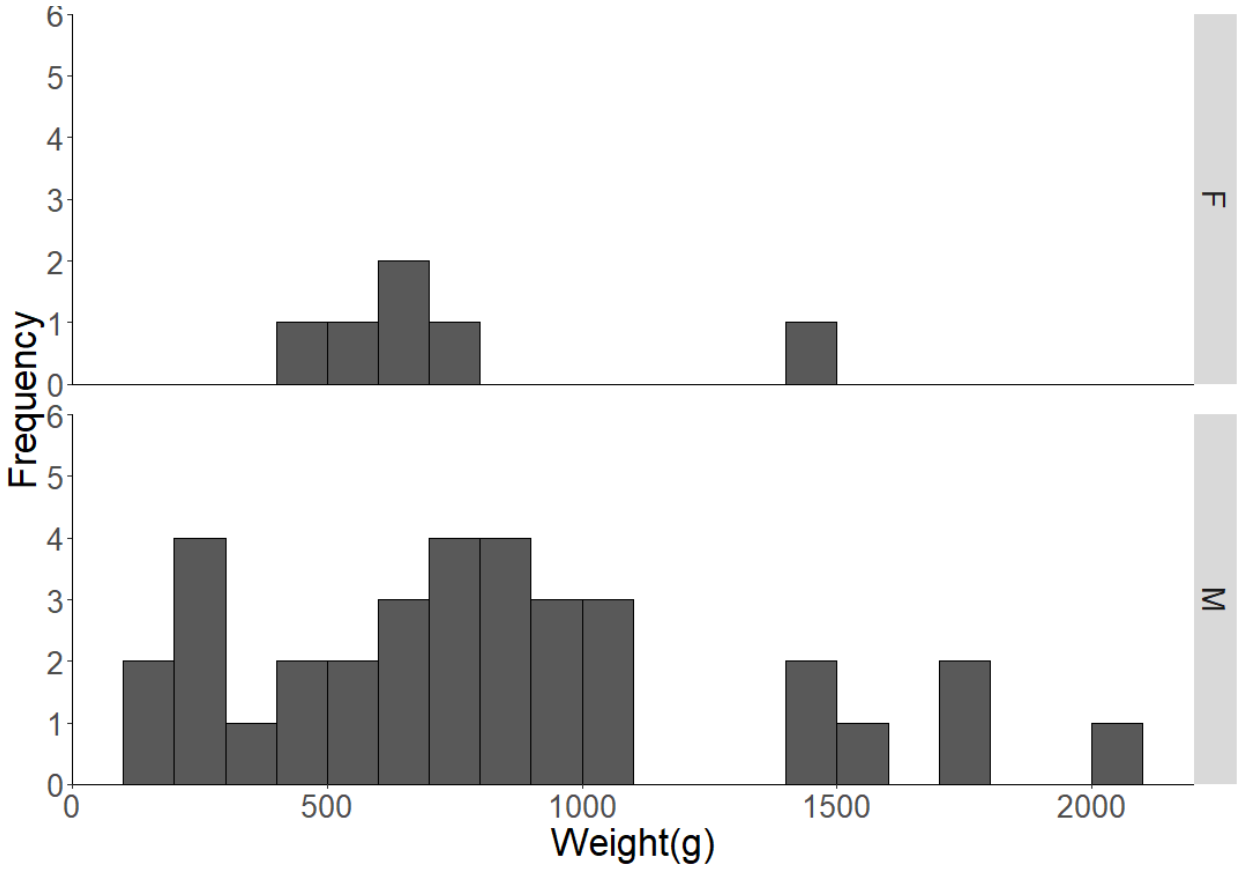

Figure 4. Weight-frequency histogram of male (M) and female (F) Walleye(*Sander vitreus*) collected at Lower Granite Dam from 7/16/2020 to 10/24/2020.

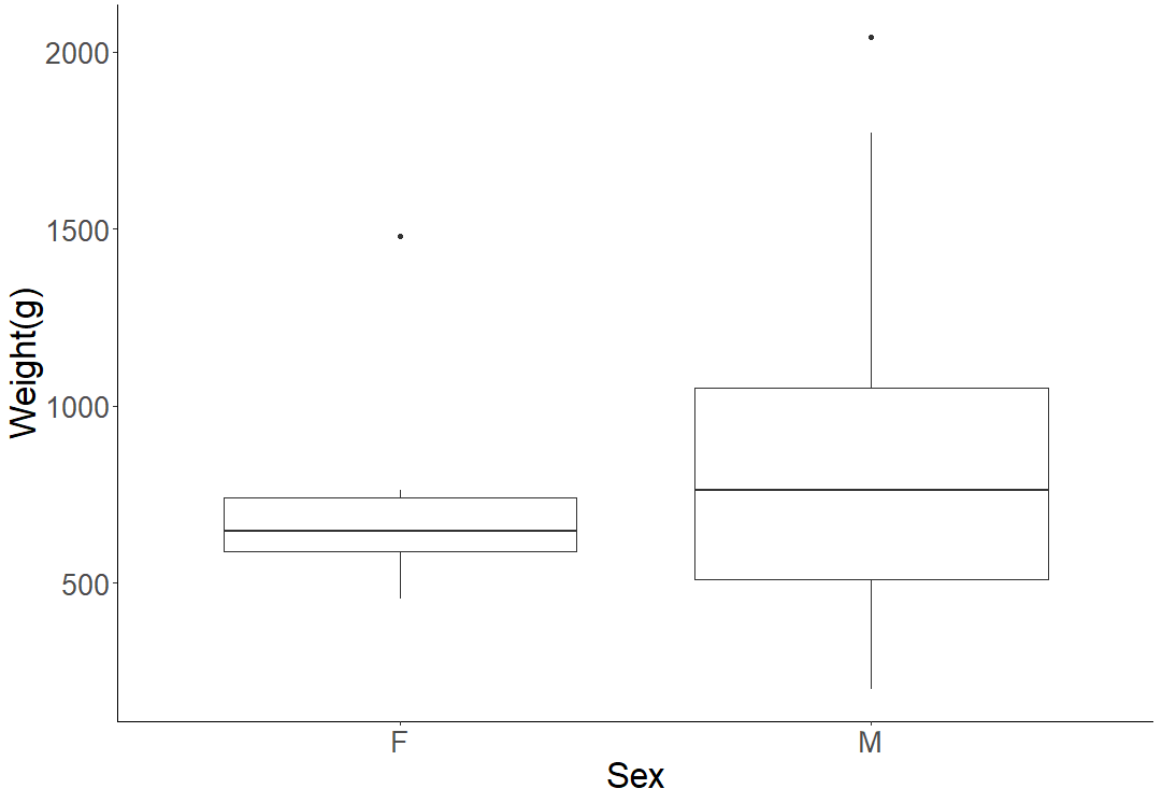

Figure 5. Box plot of weight of male (M) and female (F) Walleye (*Sander vitreus*) collected at Lower Granite Dam from 7/16/2020 to 10/24/2020.

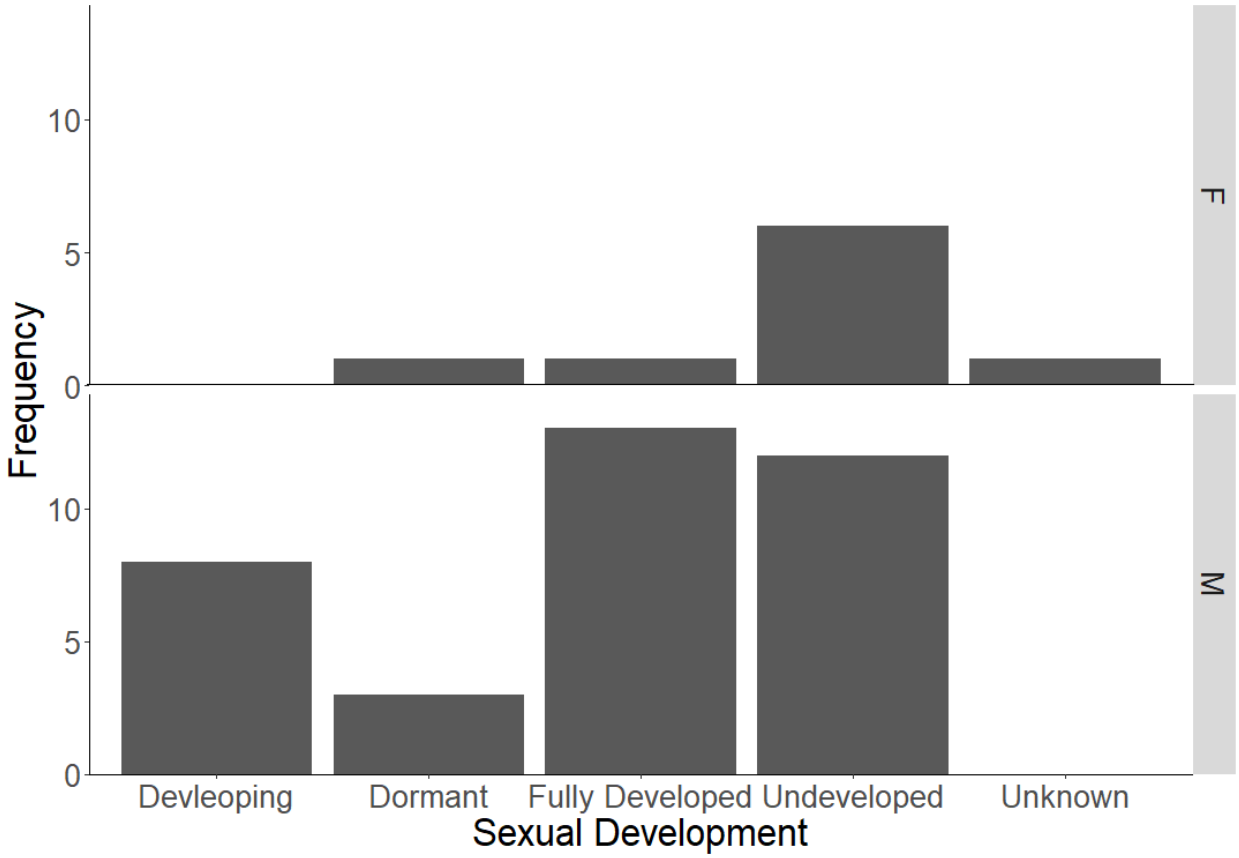

Figure 6. Sexual development of male (M) and female (F) Walleye (*Sander vitreus*) in accordance with *NWST Field Guide: Identification of Sex, Maturity, and Gonad Condition of Walleye* (2000) collected at Lower Granite Dam from 7/16/2020 to 10/24/2020.

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