State of California
The Resources Agency
Department of Fish and Wildlife
Inland Fisheries Division
Inland Deserts Region

# Upper & Lower Twin Lake General Fish Survey
Fall 2021

By:

Quinn Granfors
Environmental Scientist

## INTRODUCTION

A general fish survey was conducted on September 28/29, 2021, to gain information on the fisheries of Upper & Lower Twin Lake. This is the first fall survey conducted at these lakes. The majority of the lake's shorelines were sampled during this effort. In this report, data will describe dominant species, overall fish assemblage, and general statements about the fisheries of Upper & Lower Twin Lake. It will also serve as a beginning report which future surveys will be compared to, to evaluate trends in the areas of analysis and provide insight into the stocking regime within the lake.

## LOCATION

The Twin Lakes are located approximately 103 miles north of Bishop, CA within the Humboldt-Toiyabe National Forest at an elevation of 7,100 feet in the eastern Sierra Nevada Mountains (Figure 1). They are separated into Upper Twin Lake at 265 surface-acres at full pool and Lower Twin Lake at 275 surface acres at full pool.

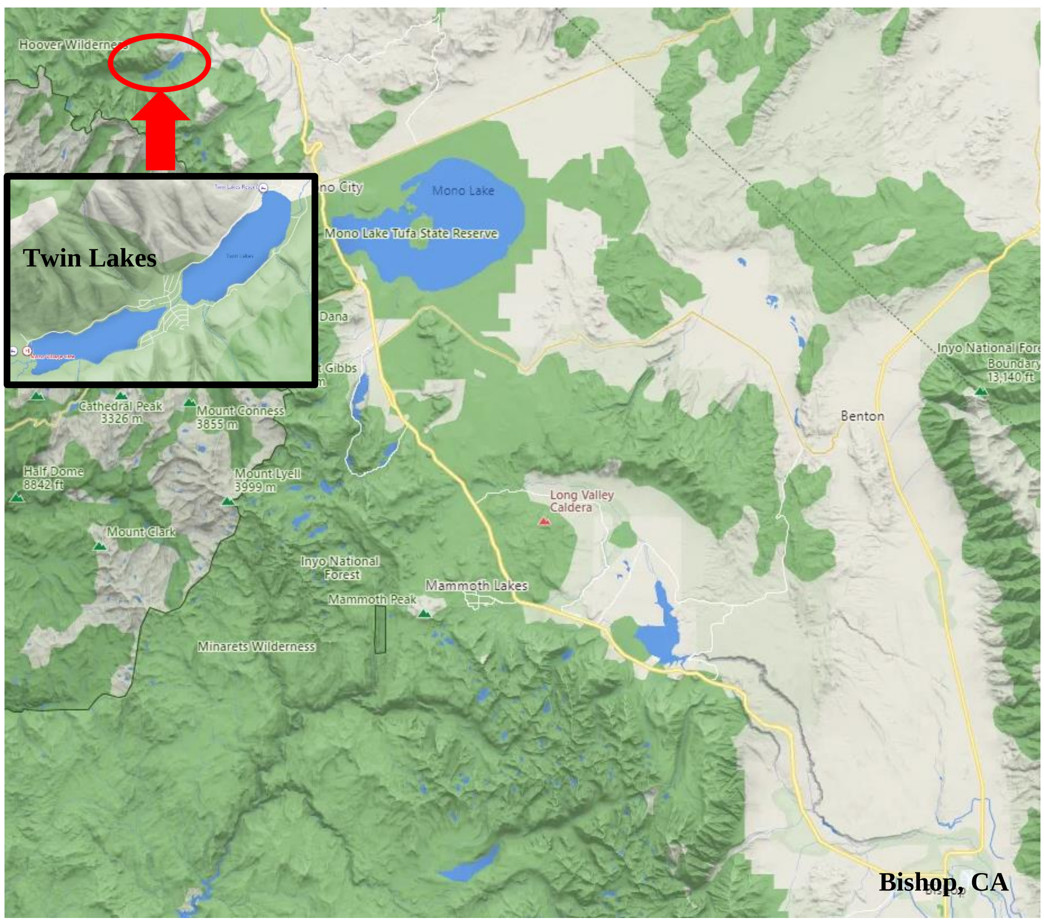


Figure 1. Topographic Map of Upper & Lower Twin Lake in relation to Bishop, California

**METHODS AND MATERIALS**

Both Twin Lakes are relatively small therefore much of each lake was sampled. Both lakes were sampled at night using a Smith-Root SR-18 electrofishing boat with one operator, two netters on the bow and two crew at the holding tank. Pulsed DC current (2-4 amps) was applied to the water to "stun" the fish. Fish that were observed under electronarcosis were dip netted and were placed into a holding tank inside the boat. The electrofishing time was recorded measuring generator seconds (electrofishing seconds) when the electrical field was applied to the water. Each transect was sampled in a "leapfrog" method wherein the bow of the boat was faced into shore with electricity applied, and the electrofishing boat moved forward into shallower depths while fish were netted. There were approximately 50-100 feet between leaps. An effort was made to capture all shocked fish that were visible; however, small sized fish and fish on the outer edge of the electrical field sometimes eluded capture. For each sampled area, fish were identified to species and up to 50 of each species was randomly selected, measured for total length (TL) in millimeters (mm) and weight in grams (g) with any additional fish being counted.

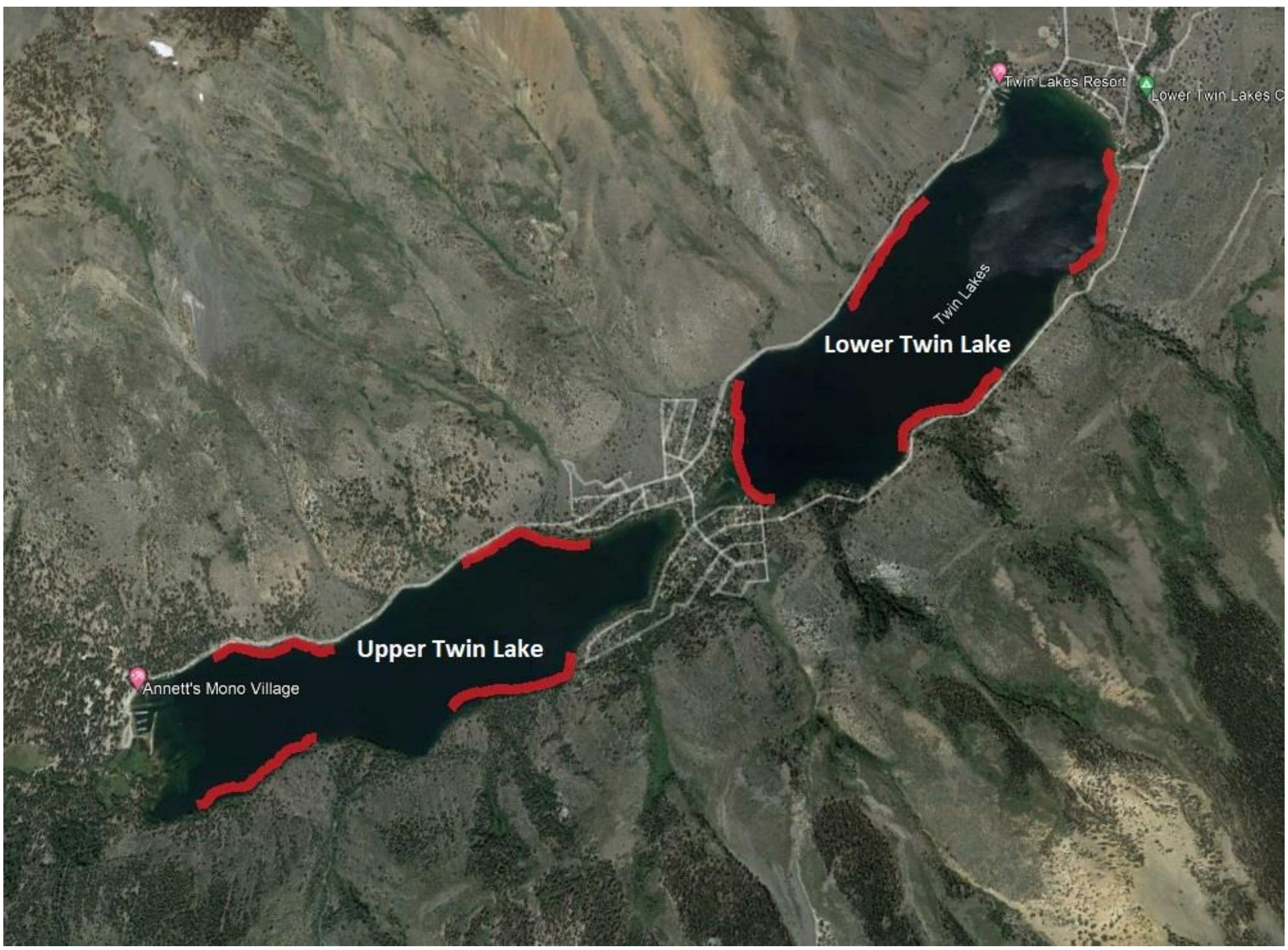


Figure 2. Transects sampled (red line) at Upper & Lower Twin Lake for
Fall General Fish Survey on 9/28 & 9/29/2021

## DATA ANALYSIS

Catch per unit effort (CPUE) was determined for all species combined and for individual species. The CPUE is reported as fish per minute of actual shock time. In addition, the mean length and weight for each species was determined. An analysis of relative abundance of each species and its percentage of the total catch was calculated. Several population indices were evaluated for selected species with sufficient sample sizes. These indices include length frequencies, weight-length relationships, relative weight (Wr) and proportional stock distribution (PSD) (Neumann et al. 2012).

## Relative Weight (Wr)

Relative Weights (Wr) are used to represent the overall condition of sportfish species. A fish's length is generally the primary determinant of its weight and increases in length will result in increases in weight. However, an increase in a fish's length is not always in direct proportion with an increase in its weight. Fish exhibit allometric growth, changing shape as they length increase. Relative weight represents a modification of the Relative Condition Factor (Kn) that compensates for fish that exhibit these allometric growth patterns. The Wr is based on the assumption that the slope and intercept of the weight-length relationship are the same as in the "ideal" equation used in its calculation (Cone 1989). To determine the Wr for species sampled the following equations were used:

$$Wr = (W/Ws) \times 100$$

Where:

Wr = the condition of an individual fish.

W = weight in grams

Ws = length-specific standard weight predicted by a length-weight regression for a species.

The equation to determine the Ws is:

$$\log10 (Ws) = a' + b * \log10 (L)$$

Where:

a' = intercept value

b = slope of the log10 (weight) – log10 (length) regression equation

L = maximum total length

The intercept & slope parameters for standard weight (Ws) equations are taken from the weight-length regression generated by the log10 scatter plot of the prior 10 years' data taken from DVL. Utilizing these Ws equations, fish of all lengths, regardless of species are in good condition with a Wr of about 100. Distance from 100 above or below, indicates fatter or poorer condition relative to the lake average over past years sampled.

**RESULTS AND DISCUSSION**

**Upper Twin Lake**

Six fish species representing 310 individual fish were collected and are summarized from most to least abundant species (Table 1). Cumulative CPUE for all species was 5.15 fish per minute, and a total electrofishing time was 60.22 generator minutes.

**Table 1. Species composition from Upper Twin Lake September 28, 2021.**

| Species | Scientific name | Number | Percent of Total | CPUE | Length Ranges (mm) |
|---|---|---|---|---|---|
| Brown Trout (BN) | *Salmo trutta* | 140 | 45.02 | 2.32 | 75-570 |
| Sucker (SKR) | *Catostomus sp.* | 88 | 28.39 | 1.46 | 75-318 |
| Tui Chub (TC) | *Siphateles bicolor* | 34 | 10.97 | 0.58 | 81-291 |
| Rainbow Trout (RT) | *Oncorhynchus mykiss* | 20 | 6.45 | 0.33 | 60-560 |
| Kokanee Salmon (KOK) | *Oncorhynchus nerka* | 14 | 4.52 | 0.23 | 270-305 |
| Mountain Whitefish (MTW) | *Prosopium williamsoni* | 14 | 4.52 | 0.23 | 125-384 |
| Total | | 310 | | | |
| Generator minutes: 60.22 | | | CPUE (Fish/ gen. min): 5.15 | | |

**Lower Twin Lake**

Six fish species representing 427 fish were collected and were arranged from most to least abundant species in Table 1. Cumulative CPUE for all species was 7.11 fish per minute, and a total electrofishing time was 60.03 generator minutes

**Table 2. Species composition from Lower Twin Lake September 29, 2021.**

| Species | Scientific name | Number | Percent of Total | CPUE | Length Ranges (mm) |
|---|---|---|---|---|---|
| Sucker (SKR) | *Catostomus sp.* | 180 | 42.15 | 3.00 | 78-260 |
| Tui Chub (TC) | *Siphateles bicolor* | 101 | 23.65 | 1.68 | 50-211 |
| Mountain Whitefish (MTW) | *Prosopium williamsoni* | 82 | 19.20 | 1.37 | 147-293 |
| Rainbow Trout (RT) | *Oncorhynchus mykiss* | 32 | 7.49 | 0.53 | 80-467 |
| Brown Trout (BN) | *Salmo trutta* | 28 | 6.56 | 0.47 | 157-845 |
| Kokanee Salmon (KOK) | *Oncorhynchus nerka* | 4 | 0.94 | 0.07 | 215-235 |
| Total | | 427 | | | |
| Generator minutes: 60.03 | | | CPUE (Fish/ gen. min): 7.11 | | |

Comparison of species composition shows the most abundant fish collected at Upper Twin Lake was the BN at 45% of total. SKR were most abundant in Lower Twin with 42% of the total. SKR and TC were prevalent in both Twin Lakes making up 39% of total in Upper Twin Lake and 66% of the total in Lower Twin Lake. KOK, RT and MTW collectively represent 15.47% of the total composition in Upper Twin Lake and 27.63% in Lower Twin Lake. Overall, species compositions are subject to biases if habitats are sampled unevenly since fish can have specific habitat preferences. Electrofishing is limited to water shallower than 10-12 ft of water making it more difficult to sample species that prefer open limnetic water. However, all species will utilize shallower water to feed and spawn during certain times of the year. This fall survey encompassed the seasonal timing of BN, KOK and MTW spawning aggregations where they will congregate in shallower water, especially near creek mouths (Moyle 2002). Their spawning activities likely increased their probability of being sampled in this survey relative to other times of the year.

**BROWN TROUT**

Brown Trout represented the majority of all fish sampled in the survey at Upper Twin Lake with a CPUE of 2.32 fish/ minute and representing 45% of the total catch. Lower Twin BN represented much less of the species composition at 6.56% of the total and CPUE of 0.47 fish/minute. Length frequency data collected, and number of BN sampled at both lakes is shown in Figure 3. The majority of the BN sampled in Upper Twin were between 150-299 mm. These fish are likely 2 to 3 years old, though the growth of BT is usually faster in lakes than in streams (Moyle 2002). Lower Twin Lake has a wide array of sizes with many much larger fish than Upper Twin. There were few fish smaller than 125 mm sampled during this survey at both lakes; however, it is likely more juveniles are residing in the streams above and below Upper & Lower Twin Lakes which migrate into the lake once they are larger.

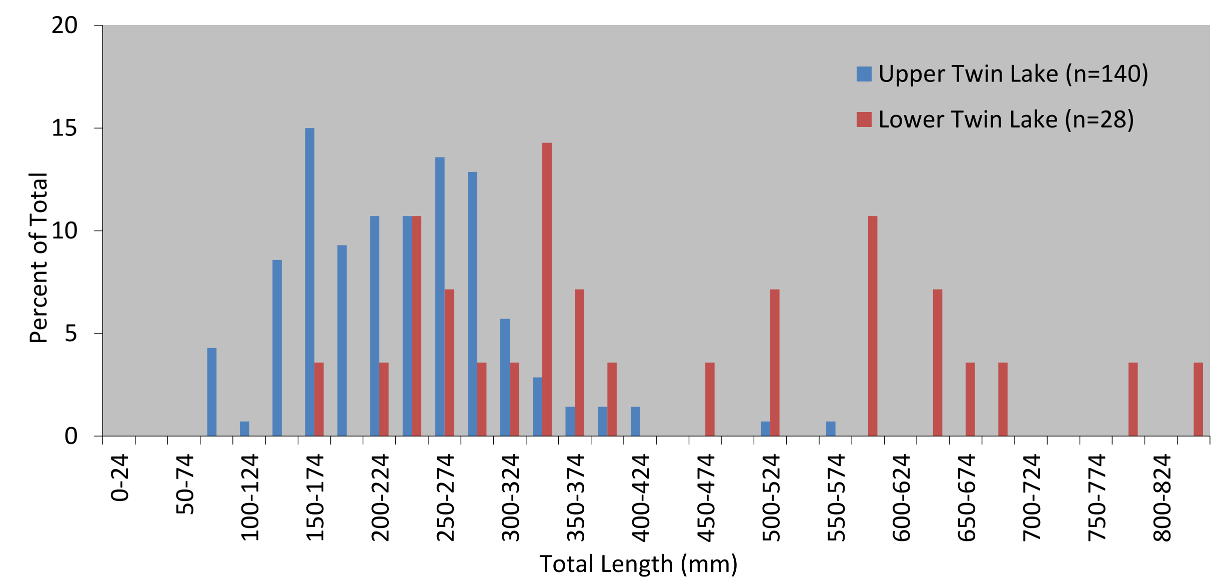

Figure 3: Total length frequency of brown trout sampled from Upper & Lower Twin Lake, fall 2021.

A length- weight scatter plot was created for BN greater than 150 mm (Figure 4) for estimation of weight of a total known length. The equation values from the untransformed length weight polynomial regression are shown with the $R^2$ (coefficient of determination) value. The high correlation coefficient ($R^2$) value of BN larger than 150mm shows the significant relationship between length and weight within Upper and Lower Twin Lake. However, their does appear to be greater variation in weight of BN larger than 400 mm between both lakes. Unfortunately, the larger capacity 50 lb. scale was not functional leaving the five BN larger than 3000 grams collected at Lower Twin Lake out this analysis. The slope equation likely would be much different with the inclusion of the missing data of the largest fish collected.

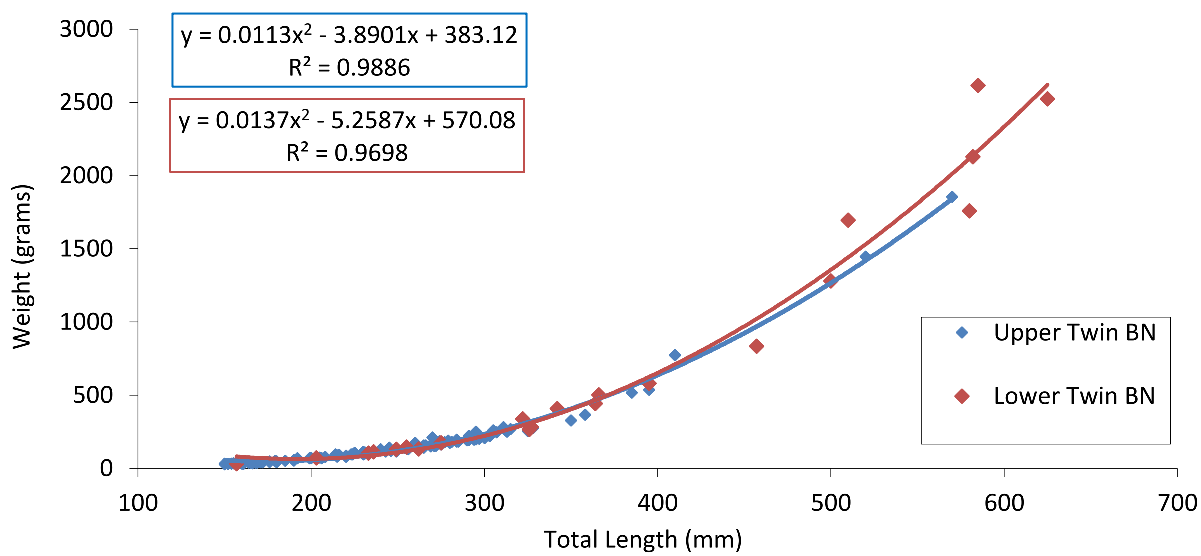

Figure 4: Length-weight scatter plot with corresponding polynomial regression lines for Brown Trout, captured from Upper & Lower Twin Lake, Fall 2021

Relative weight (Wr) data for BN collected during this sampling effort, using values found in Length, Weight, and Associated Indices (Neumann et al. 2012), is found in Table 3. The Wr values for each size class shows the BN relative condition with their proximity to 100 indicating good health. However, the reduced number of samples of some size classes makes their validity questionable. Overall, the Wr values are below 100 indicating the BN are in moderate condition with larger BN having slightly higher average Wr values.

Table 3. Relative weights (Wr) for Brown Trout collected at Upper & Lower Twin Lake, Fall 2021.

| Length Ranges | Upper Twin | | Lower Twin | |
|---|---|---|---|---|
| | Average Wr | sample size | Average Wr | sample size |
| 150-174 | 83 | 21 | 79 | 1 |
| 175-199 | 79 | 13 | --- | 0 |
| 200-224 | 79 | 15 | 81 | 1 |
| 225-249 | 79 | 15 | 77 | 3 |
| 250-274 | 76 | 19 | 73 | 2 |
| 275-299 | 73 | 18 | 75 | 1 |
| 300-324 | 74 | 8 | 87 | 1 |
| 325-349 | 66 | 4 | 74 | 4 |
| 350-374 | 66 | 2 | 82 | 2 |
| 375-399 | 74 | 2 | 78 | 1 |

| | | | | |
|---|---|---|---|---|
| 400-424 | 92 | 2 | --- | 0 |
| 425-449 | --- | 0 | --- | 0 |
| 450-474 | --- | 0 | 70 | 1 |
| 475-499 | --- | 0 | --- | 0 |
| 500-524 | 81 | 1 | 91 | 2 |
| 525-549 | --- | 0 | --- | 0 |
| 550-574 | 77 | 1 | --- | 0 |
| 575-599 | --- | 0 | 84 | 3 |
| 600-624 | --- | 0 | --- | 0 |
| 625-649 | --- | 0 | 78 | 1 |

Proportional stock distribution (PSD) values on BN between the two lakes are shown in Table 4. A balanced lentic population should be within the range of 30-70 with PSD-P between 10-40 and PSD-M between 0-10. Upper Twin appears to be out of balance on the low end, with an abundance of stock size BN and a low ratio of larger fish. Lower Twin appears to be out of balance on the high end with a very high ratio of larger fish. The difference in PSD values between the two lakes, relative to the number of BN collected in each, reinforces the importance of density dependency as a regulating factor for BN population structure and growth potential.

Table 4: Proportional stock distributions (PSD) of Brown Trout from Upper and Lower Twin Lakes Fall 2021

| | **Upper Twin** | **Lower Twin** |
|---|---|---|
| S = # stock size ≥ 200 mm | 87 | 27 |
| Q =# quality size ≥ 300 mm | 20 | 20 |
| P = # preferred size ≥ 400 mm | 4 | 12 |
| M = # memorable size ≥ 500 mm | 2 | 11 |
| T = # trophy size ≥ 600 mm | 0 | 6 |
| PSD = Q/S * 100 | 23 | 74 |
| PSD-P = P/S*100 | 5 | 44 |
| PSD-M = M/S*100 | 2 | 41 |
| PSD-T = T/S*100 | 0 | 22 |

Since little to no BN are stocked into the Twin Lakes, it appears they can sustain themselves sufficiently through natural recruitment in the adjoining streams, which is typical in the region. They are the top predator in the Twin Lake system and are regulated through density dependent processes, as evident through the length, weight, Wr and PSD analysis. BN are likely only limited by suitable habitat, water flow to spawn and food availability throughout the year. The abundance in variety of other fish species (TC, RT, KOK, SKR and MTW) and invertebrate (crayfish, aquatic insects, etc.) prey in the Twin Lake system, bodes well for BN larger than 400 mm (Leipzig and Deinstadt 1997). The abundance of prey options and low population size appears critical to sustaining the important trophy BN fishery in the Twin Lake system.

**RAINBOW TROUT**

This fall survey had 20 RT collected at Upper Twin Lake ranging in size from 60-560 mm and 32 RT from Lower Twin ranging in size from 80-467 mm (Table 1 & 2). Figure 5 presents total length frequency data for RT collected in this fall survey. The size range of RT sampled shows multiple year classes and stocked adults. The smaller fish are young-of-year through three years of age (Moyle 2002). The larger fish are stocked hatchery adults and are difficult to age given their artificial upbringing. Both Upper and Lower Twin Lake are stocked with RT throughout the summer for recreational purposes and the differing size classes are likely reflective of the size of fish stocked. However, the presence of young-of -year RT indicate spawning in the tributaries may contribute natural recruitment into both Twin Lakes.

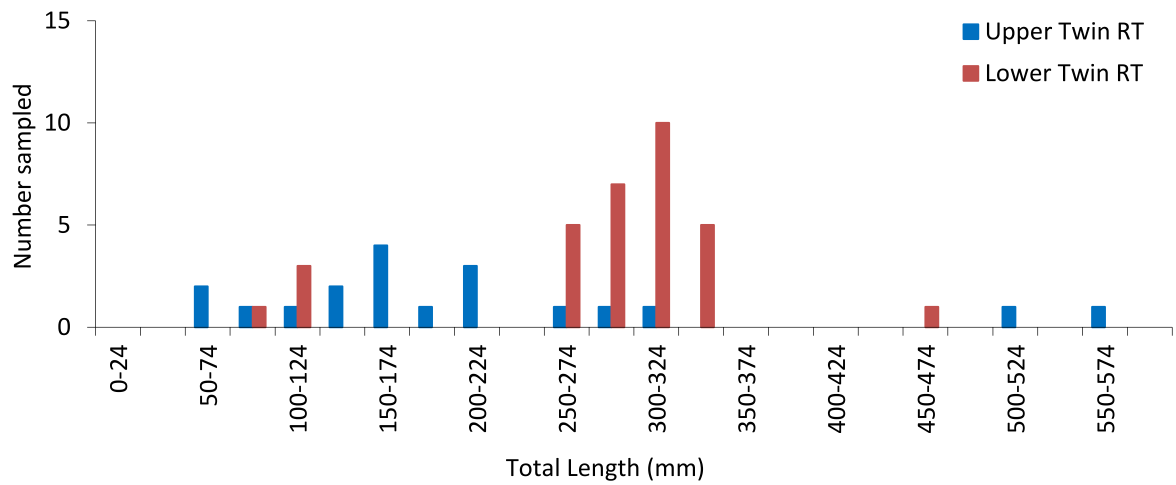


Figure 3: Total length frequency of rainbow trout from Upper & Lower Twin Lake, fall 2021.

The length- weight scatter plot was created for RT greater than 150 mm (Figure 4) for estimation of weight of a total known length. The equation values from the untransformed length-weight polynomial regression are shown with the $R^2$ (coefficient of determination) value. The high correlation coefficient ($R^2$) value of BN larger than 150mm shows the significant relationship between length and weight within Upper and Lower Twin Lake. However, their does appear to be greater variation in weight of RT between 250-350 mm between both lakes. The increased weight of these sized fish in Lower Twin is likely due their hatchery origin. Hatchery fish are fed an artificial diet on a regular basis and then stocked out to be caught by anglers making them much heavier at length relative to the more natural growth of RT spawned in the system or stocked a fingerling/sub-catchable as a put and grow stocking regime.

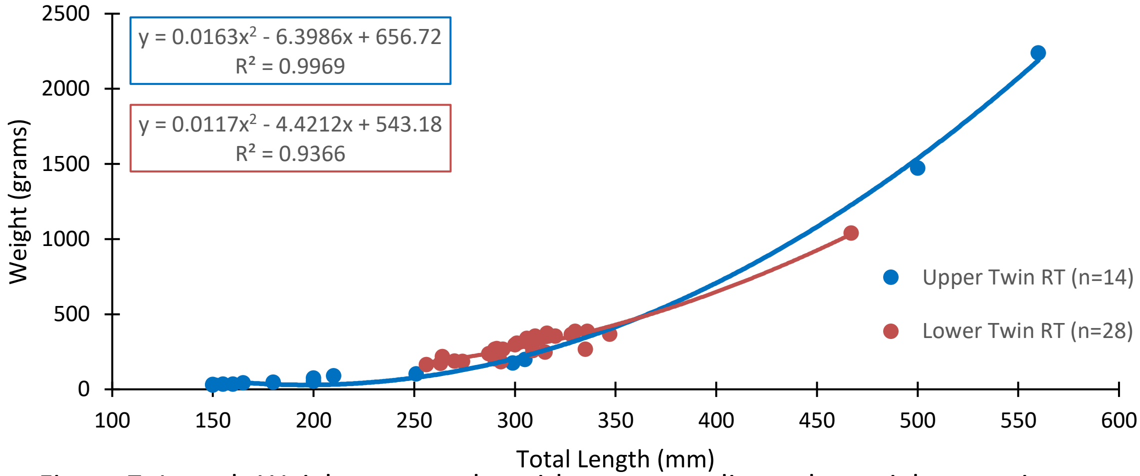

Figure 7: Length-Weight scatter plot with corresponding polynomial regression, lines for rainbow trout, caputured from Upper & Lower Twin Lake, Fall 2021

**MOUNTAIN WHITEFISH**

Mountain Whitefish represented 4.5% of the total number of fish collected in the Upper Twin survey and 19.2% of the fish collected in Lower Twin (Table 1 & 2). The MTW from Upper Twin ranged in size from 125-384 mm TL and 147-293 mm in Lower Twin (Figure 7). This species is bottom oriented with sub-terminal mouths used to feed upon aquatic insects and benthic invertebrates. This likely means they will compete with juvenile trout, SKR and TC that rely upon the same forage. Growth is variable depending upon habitat, food availability and temperature. Moyle (2002) noted that MTW from Upper Twin Lake grew to 110 mm in their first year, 150 mm in year three and up to 200 mm in year five. Larger individuals are likely 5-10 years old. Based upon these growth rates the MTW collected this survey ranged from 2-10 plus years old.

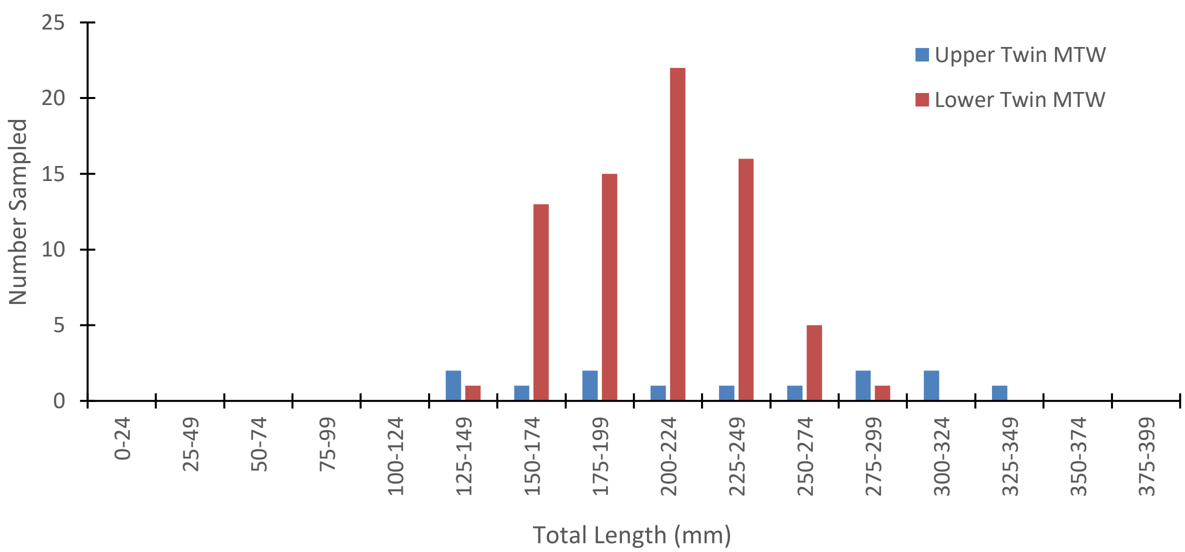

Figure 7: Length frequency of Mountain Whitefish sampled from Upper & Lower Twin Lakes, fall 2021

Length-weight correlations among both lakes can be found in Figure 8. It appears density dependent regulatory mechanisms are also impacting each population with the less dense Upper Twin MTW population exhibiting higher weights and greater length potential than the population in Lower Twin Lake. The high correlation coefficients ($R^2$) of both populations appear to show strong relationship between length and weight within Upper and Lower Twin Lake. Relative weight values ranged from 74-110 in Upper Twin and 63-94 in Lower Twin. It is likely the higher Wr values observed in Upper Twin can be attributed to a smaller population

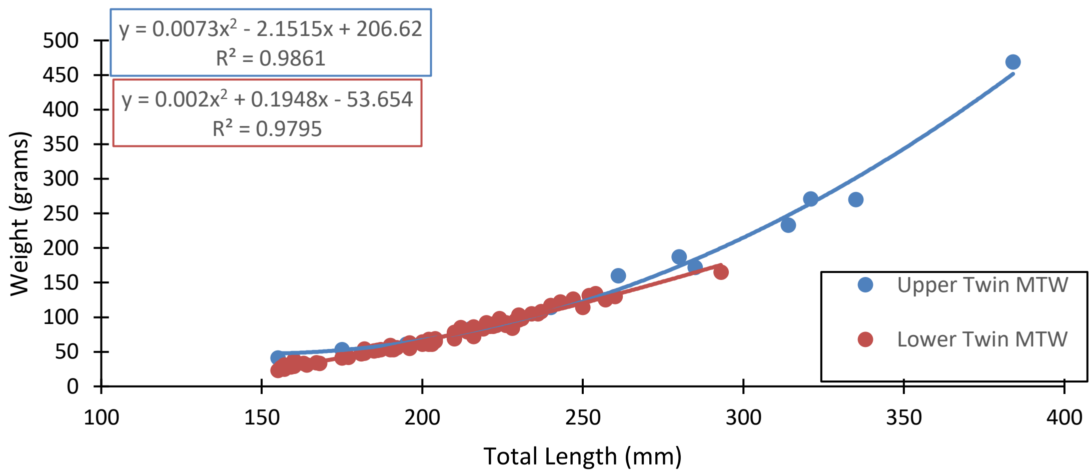


Figure 8: Length-Weight scatter plot with corresponding polynomial regression, lines for mountain whitefish, caputured from Upper & Lower Twin Lake Lake, Fall 2021

MTW were once numerous in California in the 19th century but remain common in their currently limited range. They are an undervalued gamefish, facing limitations to their range due to habitat fragmentation and competition with other Salmonids. Perhaps the abundant BN population in Upper Twin is helping regulate the MTW population through predation. The relatively reduced BN population within Lower Twin could be exerting less predatory actions upon the MTW, allowing for their greater numbers in the lake.

**KOKANEE SALMON**

Upper Twin Lake had 14 KOK sampled ranging in size from 270-305 mm. Lower Twin Lake had only four KOK sampled ranging in size from 215-235 mm during these surveys. All KOK sampled had high relative weight (Wr) values between 80-110 amongst both lakes. Figure 9 presents total length frequency data for all KOK collected. All KOK are likely 2–3-year-old fish preparing to spawn during the fall. The size and age of spawning KOK are determined by lake conditions that influence growth (i.e., food availability, light, and water temperature). KOK typically spawn in streams with gravel riffles not far upstream from the lake. However, lake spawning in beds of gravel close to shore in areas with alternative sources of water flow (i.e., wave action, groundwater, natural springs) can occur (Moyle 2002, Whitlock et al. 2014). Given the low surface flows of the adjacent streams typically observed during the fall spawning season and concurrent spawning of the much more aggressive and larger BN that occupy the same spawning streams, it is possible that shore spawning is an important mechanism for KOK persistence in the Twin Lake system.

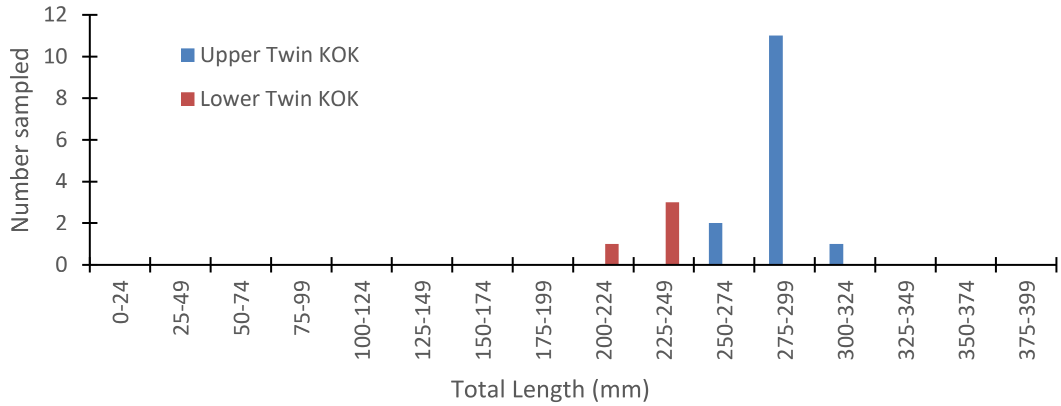


Figure 9: Length frequency of Kokanee Salmon sampled from Upper & Lower Twin Lake, fall 2021.

**SUCKER**

It is probable that both Tahoe Sucker (*Catostomus tahoensis*) and Mountain Sucker (*Catostomus platyrhynchus)* were sampled during this survey, with the majority being Tahoe Sucker based upon the sizes collected. Moyle (2002) indicates that Mountain Sucker rarely exceed 170 mm and occasionally reaching 230 mm in stream environments. These two species both exist in the watershed, however the Tahoe Sucker are more common on lacustrine environments. Sucker CPUE was 1.46 fish/minute at Upper Twin and 3.00 fish/minute at Lower Twin (Table 1). Figure 10 presents total length frequency data for SKR collected in this survey. The size range of SKR sampled this fall in Upper Twin was 75-318 mm with Lower Twin Size ranging between 78-260mm. Both sucker species are omnivorous feeding mostly upon benthic algae and diatoms but will also eat aquatic insects, invertebrates and detritus. They prefer habitat areas in the littoral zone with abundant aquatic macrophytes, logs and root wads. Suckers are known to be major prey item of larger trout.

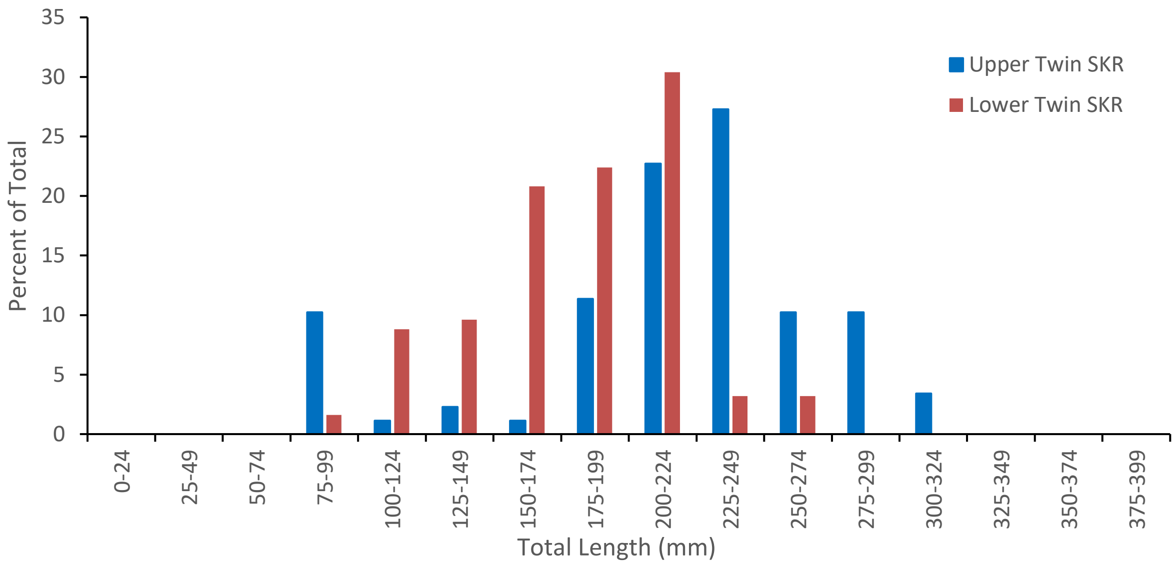

Figure 10: Length frequency of Sucker spp. sampled from Upper & Lower Twin Lake fall 2021

**LAHONTAN TUI CHUB**

Tui Chub were collected from both Twin Lakes with CPUE at Upper Twin being lower at 0.56 fish/minute (Table 1). Lower Twin Lake CPUE was 1.68 fish/minute (Table 2). Tui Chub represented significantly more of the species composition in Lower Twin Lake with 23.7% of the total fish captured. Tui Chub in Upper Twin only represented 11% of the total. Figure 11 presents total length frequency data for TC collected in these surveys. The size range of TC sampled at Upper Twin was 81-291 m whereas Lower twin lengths ranged from 50-211 mm. Cooper (1985) found that TC in California averaged 72 to 115 mm in total length in the first year of growth and 50 to 60 mm in each subsequent year. Therefore, most of the TC sampled are 1-4 years old. However, the adult size of TC can be highly variable and can reach 300 - 400mm or more in large lakes (Moyle, 2002).

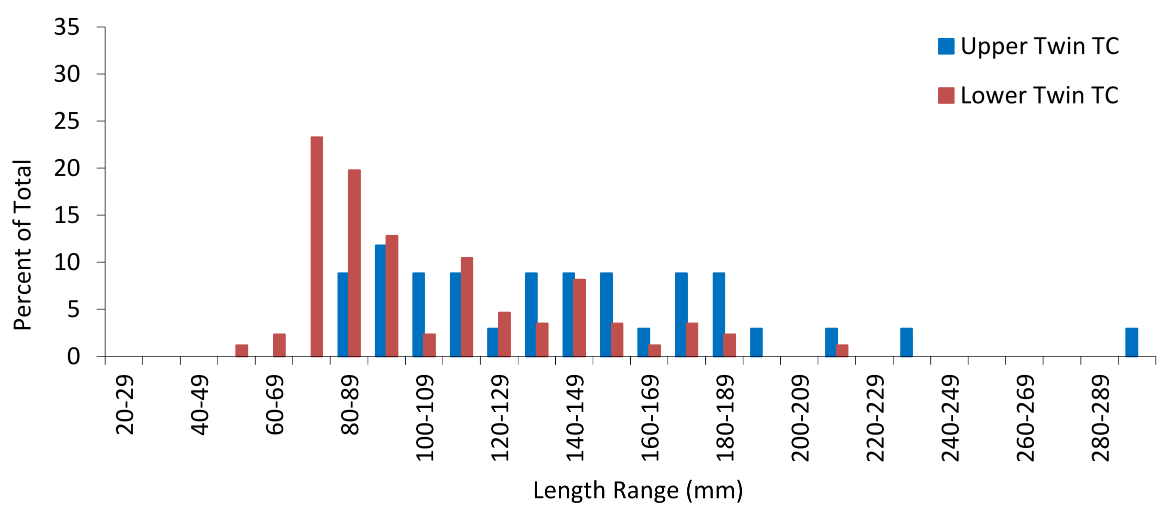

Figure 11: Length frequency of the total lengths of tui chub sampled from Upper & Lower Twin Lake, Fall 2021

## CONCLUSIONS

The fisheries within Upper and Lower Twin Lakes appears to be very different despite similar topography, habitat and species composition. Brown and rainbow trout appear to be the most abundant desirable sportfish with kokanee salmon persisting despite decades without being supplemented through stocking. All three sport-fisheries appear able to show contributions by naturally recruiting BN, RT, and KOK, evident by the smaller trout species and adult spawning KOK collected. Both lakes are typically supplemented by stocking of catchable adult RT to satisfy demand by anglers. The trophy BN fisheries of Upper and Lower Twin Lake appears to be heavily density dependent. Additional stocking of this species likely puts the population dynamics that create these magnificent trophy fish into peril. The 845 mm and likely 9 kg BN sampled this year is a fish of a lifetime. Conditions to create these rare fish should not by altered through augmented stocking. However, as trophy BN are rare and very difficult to catch, and the historically consistent augmentation of the RT population through stocking has not negatively affected the trophy BN fishery, the continuation of this practice should continue when available. The abundance and length frequencies of “non-sportfish” species (SKR, TC and MTW) adds to the dynamics of the fishery providing forage for sportfish and filling niches to keep the ecosystem healthy.

Given the information collected this year is merely a snapshot in time of what is occurring within these lakes, the infrequency of past surveys makes additional conclusions difficult. Future surveys should be executed to better understand the fishery trends in the Twin Lakes system.

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