State of California
The Resources Agency
Department of Fish and Wildlife

Upper Blue Lake General Fish Survey
Lake County
Spring, 2022

By

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Upper Blue Lake on April 13, 2022 (Photo by S. Thomas).

Summary

To evaluate the fishery of Upper Blue Lake (Upper Blue), a general fish survey was conducted on April 13, 2022. For this survey, the entire shoreline was sampled with an electrofishing boat. Fish collected during the survey included Largemouth Bass (LMB) (*Micropterus salmoides)*, Rainbow Trout (RT) (*Oncorhynchus mykiss*), Sacramento Sucker (SKR) (*Catostomus occidentalis*), Black Crappie (BCR) (*Pomoxis nigromaculatus)*, and Goldfish (GF) (*Carassius auratus*). Other species that have been observed in Upper Blue in a previous general fish survey, but not encountered during this years' survey were Green Sunfish (GSF) (*Lepomis cyanellus*), Prickly Sculpin (PSC) (*Cottus asper)*, and Brown Bullhead (BB) (*Ameiurus nebulosus*) (Ewing 2014).

Results from the 2022 survey demonstrated that Upper Blue still had a diversity of fish species with indications of a recent spawn for LMB. However, the low number of fish collected made it difficult to assess the fishery. This spring's data along with past and future efforts will be used to monitor the status of this fishery.

Introduction

The objectives of this survey were to assess the following:

- **Fish species composition**
- **Fish age class distribution**
- **Body condition of each species**

Upper Blue is a natural lake in the Cache Creek watershed in northwestern Lake County, California, approximately seven miles west of Upper Lake, CA on Highway 20 (**Figure 1**). The drainage basin comprises the upper northwest section of the Cache Creek basin with water leaving the lake and eventually draining downstream into Clear Lake.

Upper Blue sits at an elevation of approximately 1,361 feet above mean sea level. At maximum pool, the lake occupies approximately 55 surface acres (Coulon 2009) and has 3,960 acre-feet of water storage (Brydon 1954). Upper Blue supports both a warmwater LMB, BG, BB, Tule Perch (TP) (*Hysterocarpus traski*), PSC, and

coldwater hatchery RT fishery.

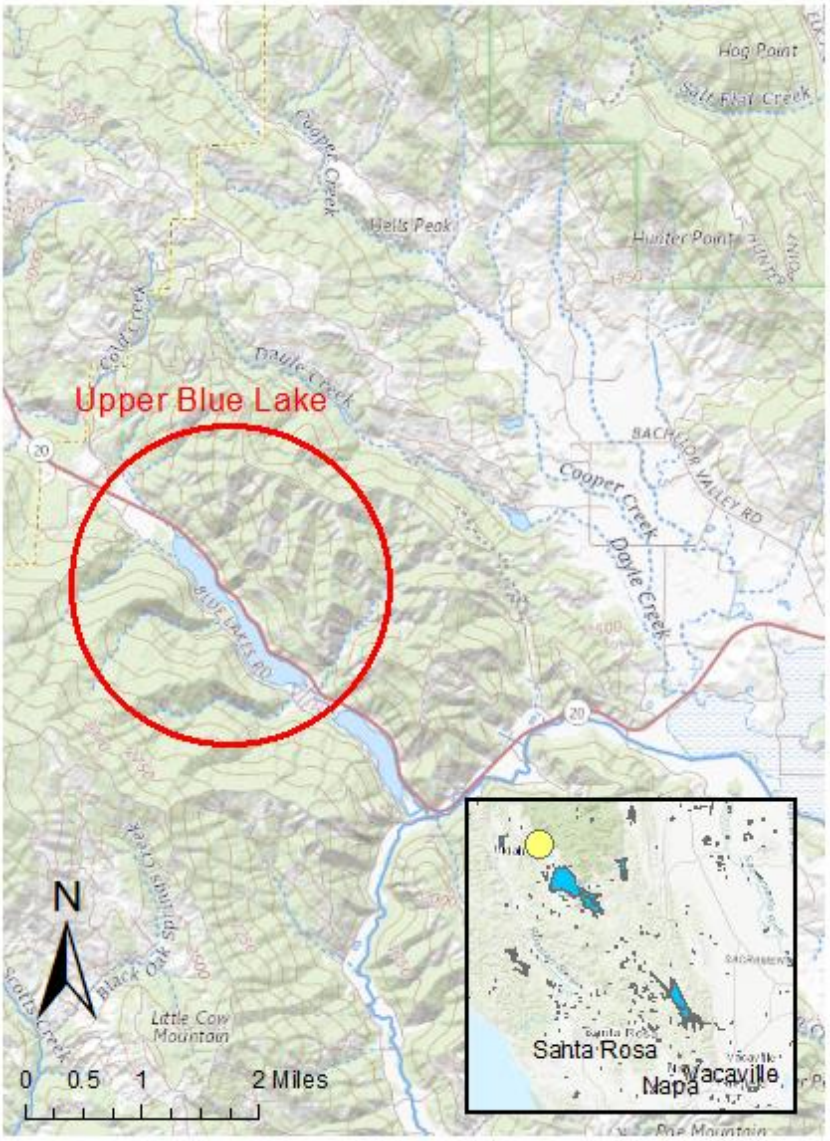

Figure 1. Upper Blue Lake, Lake County. Upper Blue Lake is also indicated by a yellow dot in the inset map in relation to Santa Rosa, Napa, and Vacaville.

Methods and Materials

The entire shoreline of Upper Blue Lake was sampled for 126 electrofishing minutes using an 18 ft. Smith-Root electrofishing boat. Upper Blue was surveyed from 11:06 until 13:50. Pulsed DC current (2-8 amps) was used to “stun” the fish. The boat ran parallel along the shore in a continuous manner. When an electrical field was applied to the water, it was measured on a counter and the time was recorded as

generator seconds. The crew consisted of two forward netters, one crewmember working the livewell, and one boat operator. Fish under galvanotaxis (involuntary movement toward an electrical field) were netted and placed in a holding tank. Netters tried to capture all shocked fish. However, small fish (< 25 mm) and fish on the outer edge of the electrical field sometimes eluded capture. The mean length and weight for each species was determined and an analysis of population indices were evaluated for species. These indices include catch per unit of effort (CPUE), plus proportional and relative stock densities (PSD and RSD) (Neumann et al. 2012). Fish were identified to species and had measurements recorded for total length (TL) in millimeters (mm) and weights in grams (g). Weights were determined using an AND© 6.6 lb. capacity digital scale. Weights were only collected when the minimum total length for LMB (150 mm), BCR (100 mm), and for RT (120 mm) were met.

Catch Per Unit of Effort

CPUE was defined as the number of fish collected per minute of shocking time. The data was used to estimate CPUE for all species combined and for individual species.

CPUE = N/M

where:

N = total number of collected or the total number of a species and

M = number of minutes that the electric field was active in the water

Relative Weight (Wr)

Relative Weights (Wr) are used to represent the overall condition of the species at Upper Blue. 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. These fish tend to change shape as they grow which is allometric growth. 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 &

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 at Upper Blue, the following equations were used:

Wr = (W/Ws) x 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 using the standard equations for that particular species found in Fisheries Techniques (Murphy and Willis 1996) when possible. In concept, a mean Wr of 100 for a broad range of size-groups may reflect ecological and physiological optimality for populations (Murphy and Willis 1996). Utilizing these Ws equations, fish of all lengths, regardless of species are in relatively good condition with a Wr of close to 100. The relative weight index ranges for determining the condition of selected species are: 110 and above as excellent, 90-110 as good, 70-89 as average, and 69 and below as poor.

If a minimum sample size of 30 of a given species is not collected or a minimum size is not met, no relative weights will be calculated.

Proportional Stock Density (PSD)

PSD is a numerical description of length-frequency data. The PSD is the percentage of stock length individuals that are of quality length. **Table 1** presents the length categories that have been proposed by Gablehouse (1984) for various fish species.

PSD = (number of fish ≥ minimum quality length) / (number of fish ≥ minimum stock length) x 100

According to R.O. Anderson and R. M. Neumann (1996) when PSD is reported it should be rounded to the nearest whole number and should not include a percent symbol. Reporting decimals may imply an accuracy not supported by the measure.

If a minimum size of any one individual wasn't met, or if there weren't enough individuals of a give size threshold (e.g., 20 or more "quality" size), no PSD was calculated.

Table 1. Proportional stock density length categories for selected species Gablehouse (1984). Measurements are minimum total lengths in millimeters (mm) for each category.

Species	Stock (mm)	Quality (mm)
Bluegill	80	150
Green Sunfish	80	150
Largemouth Bass	200	300

Relative Stock Density (RSD)

Similar to PSD, the RSD is the percentage of stock-size fish that are of preferred, memorable, or trophy lengths.

RSD-P = (number of fish ≥ minimum preferred length) / (number of fish ≥ minimum

stock length) x 100
RSD-M = (number of fish ≥ minimum memorable length) / (number of fish ≥ minimum stock length) x 100
RSD-T = (number of fish ≥ minimum trophy length) / (number of fish ≥ minimum stock length) x 100

For BG, Gablehouse (1984) found the preferred size is 200 mm and the memorable size is 250 mm. For LMB, Gablehouse (1984) found the preferred size is 380 mm and the memorable size is 510 mm.

As with PSD, the RSD should be rounded to the nearest whole number so as not to imply a greater accuracy than is supported by this analysis. According to Gablehouse (1984) a balanced population of LMB PSD should be 40 to 70, RSD-P 10 to 40, and RSD-M 0 to 10 (**Table 2**). Anderson (1985) identified balanced populations of BG as having a PSD of 20 to 60, with RSD-P of 5 to 20 and RSD-M of 0 to 10 (**Table 2**).

Table 2. Generally accepted proportional stock density (PSD) index ranges for balanced fish populations (from Willis et al. 1993).

Species	PSD	RSD-P	RSD-M	Source
Bluegill	20-60	5-20	0-10	Anderson (1985)
Crappie	30-60	>10		Gablehouse (1984)
Largemouth Bass	40-70	10-40	0-10	Gablehouse (1984)

Results

Table 3 summarizes the species composition, mean total length and weight, and length ranges of species collected in 2014 and 2022. In 2022, a total of 43 fish, representing five species were collected during the survey. LMB comprised 77% of the total fish sampled. SKR followed, comprising 14% of the total fish sampled. RT constituted 5% of the total catch. BCR and GF each made up 2%, respectively. The total CPUE for this survey effort was 0.34 fish/min.

Table 3. Species composition from Upper Blue Lake, June 12 and 13, 2014 and April 13, 2022. Mean Total Length (TL) was measured in millimeters (mm). Average Weight was in grams (g).

		2014			2022		
	Species	Number	Percent	CPUE	Number	Percent	CPUE
1	Largemouth Bass	342	0.91	2.65	33	0.77	0.26
2	Bluegill	12	0.03	0.09	NA	NA	NA
3	Common Carp	11	0.03	0.09	NA	NA	NA
4	Green Sunfish	9	0.02	0.07	NA	NA	NA
5	Brown Bullhead	1	0.00	0.01	NA	NA	NA
6	Prickly Sculpin	1	0.00	0.01	NA	NA	NA
7	Rainbow Trout	1	0.00	0.09	2	0.05	0.02
8	Sacramento Sucker	NA	NA	NA	6	0.14	0.05
9	Black Crappie	NA	NA	NA	1	0.02	0.01
10	Goldfish	NA	NA	NA	1	0.02	0.01
	Total	376			43		
	Generator minutes:	129			126		
	CPUE (Fish/ gen. min)	2.92			0.34		
	Water Temperature	72º F			54º F		

*Weights were only collected when the minimum total length for Bluegill and Green Sunfish was 80 mm, 150 mm for Largemouth Bass. No weights for Rainbow Trout were collected in 2014 to limit handling time and reduce the likelihood of harming the fish. No lengths and weights for Common Carp were taken due to the damage they do to Department equipment.

		2014			2022		
		(TL) (mm)	Weight (g)	Length Ranges	(TL) (mm)	Weight (g)	Length Ranges
1	Largemouth Bass	260.5	437.2	109 - 424	215.4	615.5	58 - 424

2	Bluegill	50.3	NA	35 - 65	NA	NA	NA
3	Common Carp	NA	NA	NA	NA	NA	NA
4	Green Sunfish	116.4	71.4	61 - 172	NA	NA	NA
5	Brown Bullhead	367.0	761	NA	NA	NA	NA
6	Prickly Sculpin	117.0	22	NA	NA	NA	NA
7	Rainbow Trout	210.0	NA	NA	331	335	262 - 400
8	Sacramento Sucker	NA	NA	NA	491	1605	420 - 458
9	Black Crappie	NA	NA	NA	294	419	NA
10	Goldfish	NA	NA	NA	304	525	NA

Largemouth Bass

In 2022, LMB total length ranged from 58 – 424 mm (2.3 – 16.7 in.). The length frequency distribution for LMB is presented in **Figure 2**. The length class with the highest frequency in 2022 was 100 mm (3.9 in.) compared to the 200 mm (7.9 in.) class in 2014 (Ewing 2014) and 400 mm (15.7 in) in 2009 (Thomas 2009). This indicates the 2022 modal length class are likely one to three-year old fish (Moyle 2002). The length frequency distribution shows a LMB population in which there is a fairly even distribution and range of size classes (**Figure 2**). In 2022, the mean total length for LMB was 215.4 mm (8.5 in.) compared to 260.5 mm (10.3 inches) in 2014. A comparison of LMB collected in the 2009 survey (Thomas 2009) and the 2014 survey indicate a gap in LMB collected from 250 – 324 mm (9.8 – 12.8 in.) (**Figure 2**). In 2022, more LMB were collected in the 250 – 324 mm (9.8 – 12.8 in.) length range than during 2009 and 2014.

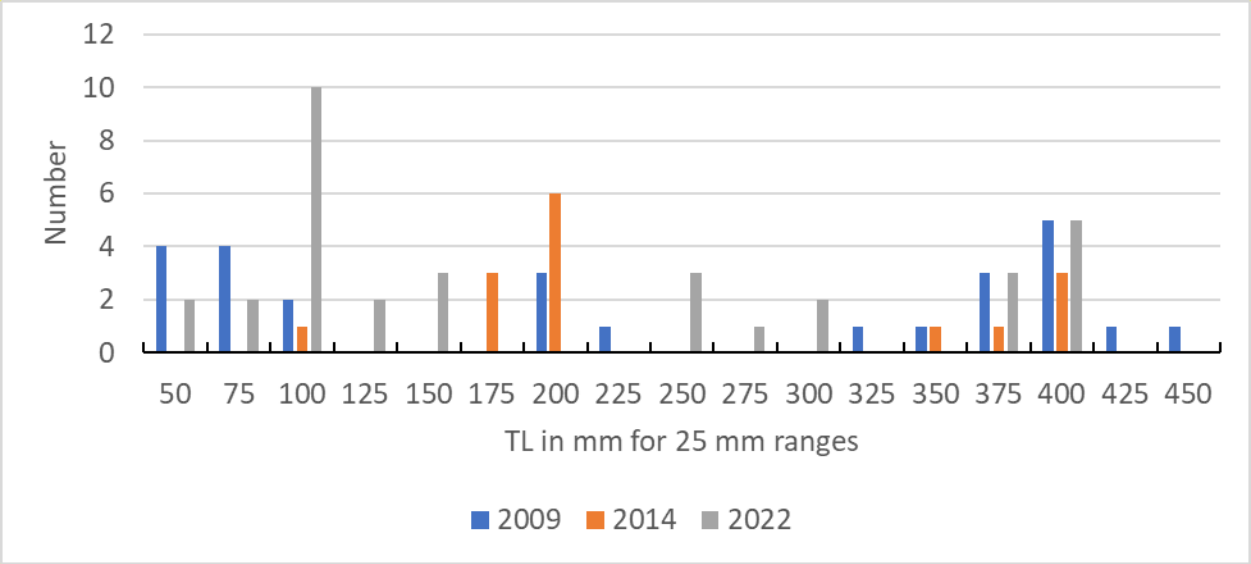

Figure 2. Length-frequency distributions for Largemouth Bass captured by electrofishing at Upper Blue Lake, Spring/Summer, 2009, 2014, and 2022.

Using the linear regression equation in **Figure 3**, a reliable estimated weight can be determined from the length of a LMB for both 2014 and 2022. Both the 2014 and 2022 slopes are similar, which suggests the LMB fishery has remained consistent between each year surveyed. Additionally, both the 2009 (Thomas 2009) and 2014 slopes were similar.

The high R^2 values of 0.93 in 2022 and 0.97 in 2014 indicates that estimating a weight from a given total length value for LMB is reliable (**Figure 3**).

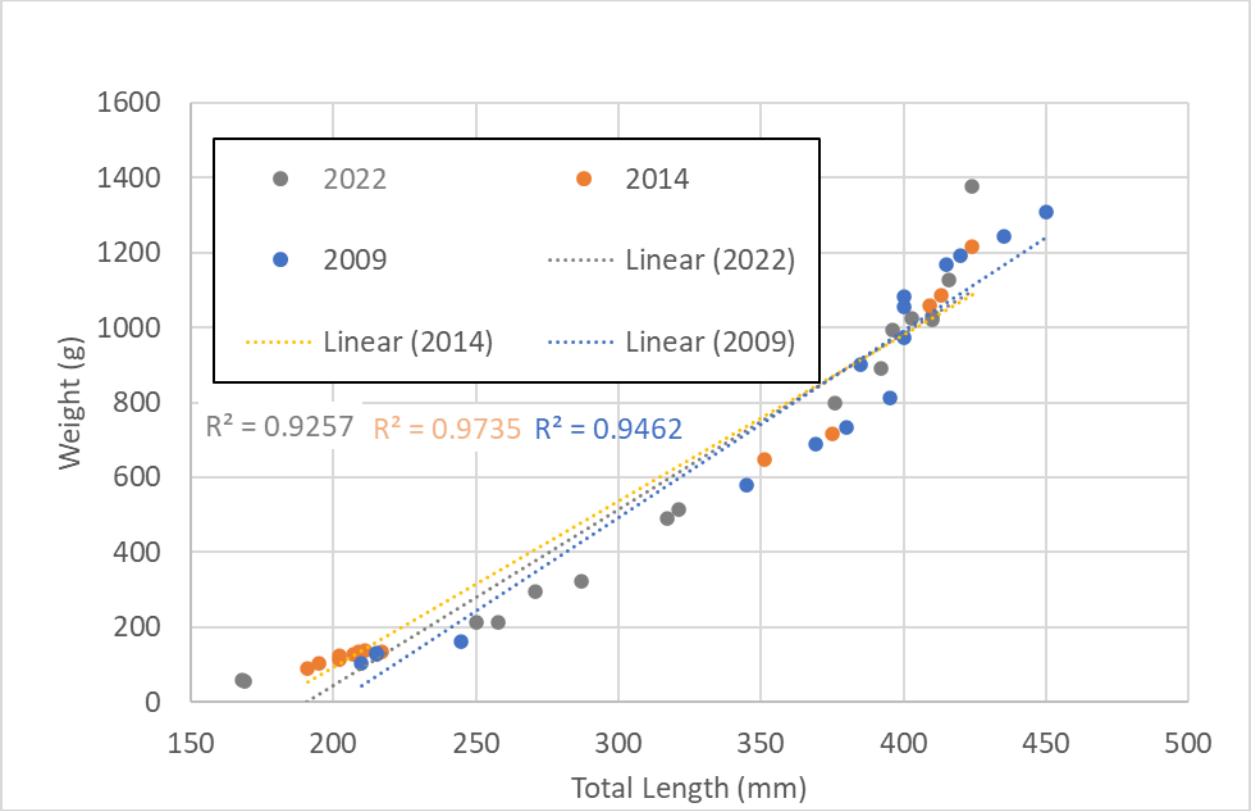

Figure 3. Total length-weight scatter plot with linear regression line for Largemouth Bass captured at Upper Blue Lake, Spring/Summer, 2014 and 2022.

No PSD, RSD-P, RSD-M, and relative weight values were calculated due to the lack of quality size and greater LMB collected.

Discussion

Most of the shoreline sampled was deep with surface temperatures that were cool. More fish were likely present at greater depths that the electrofishing boat could not sample. Due to the lack of suitable sample sizes for most species collected during this survey, no summaries were made, since the results would be unreliable, and possibly inaccurate. LMB recruitment appeared to be successful in 2022. More LMB would have likely been sampled during a late spring survey, when water temperatures increase. A fall survey can help determine the survivorship of these LMB over the summer.

Only one BCR was collected in 2022 and the only one collected in three spring/summer electrofishing survey years. The one BCR collected was 294 mm (11.6 in.). Although BCR are known to occur in Upper Blue, it is possible the species is limited

to a few, larger-sized fish. A fall survey may be able to identify young of the year BCR and a possible relationship between what is, and is not appearing in the spring surveys.

Upper Blue has a diverse species composition with ten species collected in the last two surveys. However, only five were collected in the 2022 spring survey. The next spring survey will attempt to sample Upper Blue in June, in hopes of collecting a higher species diversity and greater sample size of species that would be similar to 2014 effort.

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