State of California

Department of Fish and Wildlife

Clear Lake, Lake County, California

Fishery Report

Spring 2008, 2010, 2011 & 2012

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North Central Region

11/14/2018

Fish Evaluation Summary

Electrofishing surveys were conducted on Clear Lake during the following dates:

- June 16 – June 18; and July 1, 2008
- June 22 – June 23; and July 21, 2010
- June 28 – June 29, 2011
- June 27, 2012

Introduction

The objectives of these surveys were to determine:

- Fish species composition and relative species abundance
- Fish age class distribution
- Possible demographic trends occurring in the Clear Lake fishery

These annual surveys by California Department of Fish and Wildlife (CDFW) were conducted to help gather data on the Clear Lake fishery, including total lengths (TL, in millimeters, [mm]), weights (in grams, [g]), and relative numbers of species in the lake.

Methods and Materials

Transects on the shores of Clear Lake were sampled during June and/or July using multiple 18 ft. Smith-Root electrofishing boats. The boats ran parallel along the shore in a continuous manner with start and stop sites marked by GPS (Global Positioning System). Pulsed DC current was used to "stun" the fish. When an electrical field was applied to the water it was measured on a counter and this time was recorded as generator seconds for each transect. Thirty transects were sampled in 2008, 19 in 2010, 31 in 2011, and 28 in 2012. Time spent electrofishing each transect varied from site to site and year to year. Between 502 - 2100 generator seconds were used at each transect in 2008, 757 - 8568 seconds in 2010, 325 - 982 seconds in 2011, and 142 - 790 seconds in 2012.

An effort was made to capture all shocked fish, however small fish (< 25 mm TL) sometimes eluded capture as did those fish on the outer edge of the electrical field. All fish netted were placed in a livewell in the electrofishing boat. The crew consisted of two netters, one boat operator, and zero to multiple crewmembers processing fish from the livewell.

All fish collected were identified to species and the first 25 of each species at each transect had measurements recorded for total length (TL) in millimeters (mm). If a given species met its length threshold, weights in grams (g) was measured for the first 25 of each species (Table 15.1, Murphy et al. 1991). Minimum TL for each species were as follows: channel catfish (*Ictalurus punctatus* CC), 70 mm;

bluegill (*Lepomis macrochirus*, BG), tule perch (*Hysterocarpus traski*, TP), redear sunfish (*Lepomis microlophus*, RSF), and green sunfish (*Lepomis cyanellus*, GSF), 80 mm; goldfish (*Carassius auratus*, GF),

Sacramento sucker (*Catostomus occidentalis*, SKR-S), Clear Lake hitch (*Lavininia exilicauda chi*, HCH-C), and Sacramento blackfish (*Orthodon microlepidotus*, SBF), 90 mm; crappie (*Pomoxis* spp.), 100 mm; largemouth bass (*Micropterus salmoides* LMB), 150 mm. Minimum lengths were designated because weight measurements of small fish tend to be quite variable (low precision and accuracy), which can disturb calculations of length-weight relationships and relative weights. Weights were determined using a digital scale, or a Boga Grip™ scale for fish over seven pounds. All fish collected after the first 25 of a species per transect were tallied.

The mean length and weight for each species was determined and an analysis of population indices were evaluated for selected species when appropriate. These indices included catch per unit effort (CPUE; fish/shocking minute) length-weight (millimeters/grams) relationships, relative weight (Wr), and proportional/relative stock densities (PSD)/(RSD). Relative weights were gathered by collecting the lengths and weights on fish and entering them into fixed slope and intercept parameters for that specific species (Table 15.1, Murphy et al. 1991):

Catch Per Unit of Effort

CPUE was estimated for all species combined and for each individual species using the following equation:

$$CPUE = N/M$$

where:

N = total number of fish collected (or the total number collected of a given species) and

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

Proportional Stock Density

PSD is a numerical description of length-frequency data. The PSD is the percentage of a given species which are of a stock length and those which are also of a quality length. Length categories for various fish species are presented in Table 1. The following equation were used to calculate PSD:

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

When PSD is reported it should be rounded to the nearest whole number and should not include a percent symbol. If decimals are used they imply a level of accuracy, which is not supported by this analysis (Anderson & Neumann 1996).

Table 1. Length categories proposed for LMB, BCR, and BG from Table 15.2 of Willis et al. (1993). Measurements are minimum total lengths for each category.

Species	Stock (mm)	Quality (mm)	Preferred (mm)	Source
Bluegill	80	150	200	Gabelhouse (1984)
Black crappie	130	200	250	Gabelhouse (1984)
Largemouth bass	200	300	380	Gabelhouse (1984)

Relative Stock Density

Similar to PSD, RSD is a percentage of a given species of a minimum stock length as compared to those of a preferred, memorable, or trophy lengths. For this evaluation, the relative stock density of preferred lengths (RSD-P) were used and the preferred lengths can be found in Table 1. RSD-P was estimated using the following equation:

RSD-P = (number of fish ≥ minimum preferred length) / (number of fish ≥ minimum stock length) x 100

As with PSD, the RSD is rounded to the nearest whole number so as not to imply a greater accuracy than is supported by this analysis. What is considered a balanced population can be found on Table 2 with scales (Anderson 1985) (Gablehouse 1984), though the species listed are those that are only applicable to this study.

Table 2. Generally accepted PSD and RSD-P index ranges for balanced fish populations (from Willis et al. 1993).

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

Relative Weight

Relative Weights (Wr) are used to represent the overall condition of a species. A fish's length is generally the primary determinant of its weight, and increases in length will generally result in increases in weight. However, an increase in length is not always in direct proportion with an increase in weight. Scaling relationships between two morphological measurements, such as weight and length, are known as allometry (Shingleton 2010). Relative Weight represents a modification of the Relative Condition Factor (Kn) that compensates for fish that exhibit 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 at Clear Lake the following equations were used:

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

Where:

Wr = the condition of an individual fish.

W = weight (in g)

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

The equation to determine Ws is:

Log_{10} (Ws) = (Fixed intercept found in Table 3) + (Fixed slope found in Table 3) * log_{10} (TL)

where Ws = standard weight

TL = total length

The relative weight index ranges for determining the condition of selected species are: 110 and above: excellent, 90-109: good, 70-89: average, and 69 and below: poor (Ewing and Granfors, personal communication). Proportional and relative stock density values were gathered by collecting the lengths of fish and comparing them to fixed stock, quality, preferred, and memorable sizes for that specific species (Table 15.2 and 15.3, Anderson and Neumann 1996).

Table 3. Intercept (a') and slope (b) parameters for standard weight (Ws) equations that have been proposed and minimum total lengths (mm) recommended for application.

Species	a'	b	TL (mm)	Source
Bluegill	-5.374	3.316	80	Neuman and Murphy (1991)
Black Crappie	-5.618	3.345	100	Hillman (1982)
Largemouth bass	-5.316	3.294	150	Wege and Anderson (1978)

Weight-Length Linear Regression

Linear regression values for the length-weight relationship were determined for selected species. The linear regression line slope and intercept values enabled CDFW to estimate the weight of a fish if the TL was known. The regression equation was expressed as:

$$y = a + bx$$

Where:

y = estimated weight

a = intercept of the line

b = slope of the line

x = independent variable of TL

The intercept and slope values were generated using Microsoft Excel©. If the R^2 value was less than 0.8, no figure was made due to the unreliability of calculating a weight from a given TL and vice versa.

Results

2008

Table 4, as with all subsequent tables, summarizes the species composition, CPUE, mean TL, weight, and mean relative weight. A total of 779 fish were caught and sixteen species were identified, as well as one unspecified sculpin were collected during this survey (Table 4). LMB had the most representation as it comprised 52.8% of the total fish sampled. The overall CPUE for this survey was 2.00 fish per minute.

Table 4. Species composition from Clear Lake: June 16 – 18 and July 1, 2008.

	Species	Number	Percent	CPUE	Total Length (mm)	Weight (g)	Length Ranges	Relative Weight
1	Largemouth bass	411	52.8%	1.05	389.1	927.6	135 - 684	98
2	Brown bullhead	152	19.5%	0.39	367.1	798.8	285 - 410	NA
3	Bluegill	60	7.7%	0.15	101.7	71.5	29 -185	NA
4	Common carp	42	5.4%	0.11	702.7	4399.8	683 -729	NA
5	Channel catfish	20	2.6%	0.05	563.2	2257.1	540 - 700	NA
6	White catfish	18	2.3%	0.05	443.8	1435.5	314 - 610	NA
7	Clear Lake hitch	16	2.1%	0.04	304.4	257.1	215 - 355	NA
8	Sacramento blackfish	14	1.8%	0.04	348.1	646.1	170 - 515	NA
9	Inland silverside	13	1.7%	0.03	55.3	NA	29 - 105	NA
10	Black crappie	8	1.0%	0.02	275.6	441.8	130 - 350	NA
11	Redear sunfish	7	0.9%	0.02	246.6	533.3	138 - 280	NA
12	Goldfish	6	0.8%	0.02	NA	NA	NA	NA
13	White crappie	4	0.5%	0.01	332.5	687.3	282 - 353	NA
14	Green sunfish	3	0.4%	0.01	126.7	57	120 - 135	NA
15	Sacramento sucker	3	0.4%	0.01	116.3	185.0	45 - 250	NA
16	Sculpin	1	0.1%	0.00	65.0	NA	NA	NA
17	Tule perch	1	0.1%	0.00	149.0	NA	NA	NA
	Total	779						
	Generator minutes:	389.68						
	CPUE(Fish/gen. min)	2.00						
	Water Temperature	NA						

*Weights were only collected weights when the minimum TL for each species was as follows: green sunfish, 60 mm; redear sunfish, 70 mm; channel catfish, 130 mm; black crappie, 100 mm; Sacramento sucker, 100mm; largemouth and smallmouth bass, 150 mm; and rainbow trout, 120 mm.

Largemouth bass

LMB were the most numerous species collected in 2008, comprising 52.8% of the total fish sampled. LMB TL ranged from 135 – 684 mm (5.3 – 26.9 in; Table 4). The most common length class sampled was 375 mm (14.8 in; Figure 1).

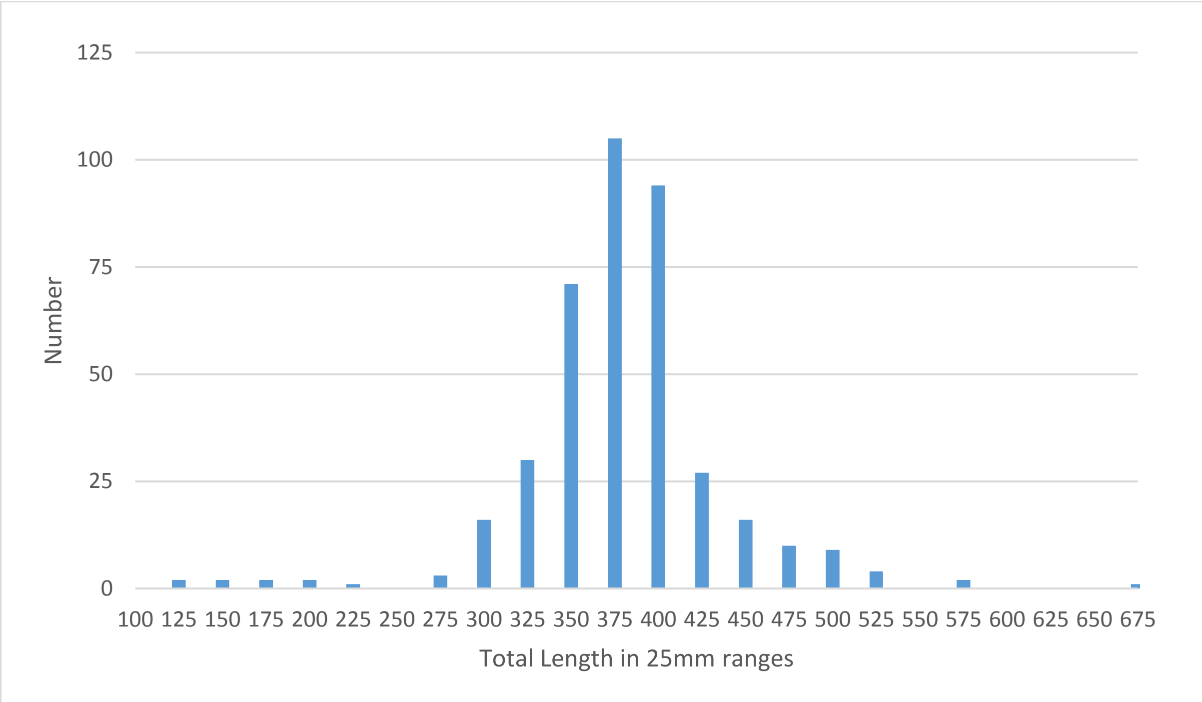

Figure 1. Length-frequency distribution for largemouth bass captured by electrofishing at Clear Lake Spring, 2008.

For LMB, the PSD was 98 and RSD-P was 63. A PSD of 98 indicated that the amount of stock-sized and quality-sized fish in the population was unbalanced, wherein quality-sized fish outnumbered stock-sized fish. The RSD-P also suggested there was an imbalance between stock and preferred-sized fish, with preferred sizes outside the high end of the balanced population range. LMB had a mean Wr of 98, indicating good body condition. A linear regression was performed with a R^2 of 0.808 (Figure 2), indicating that estimating total length from a given weight was reliable.

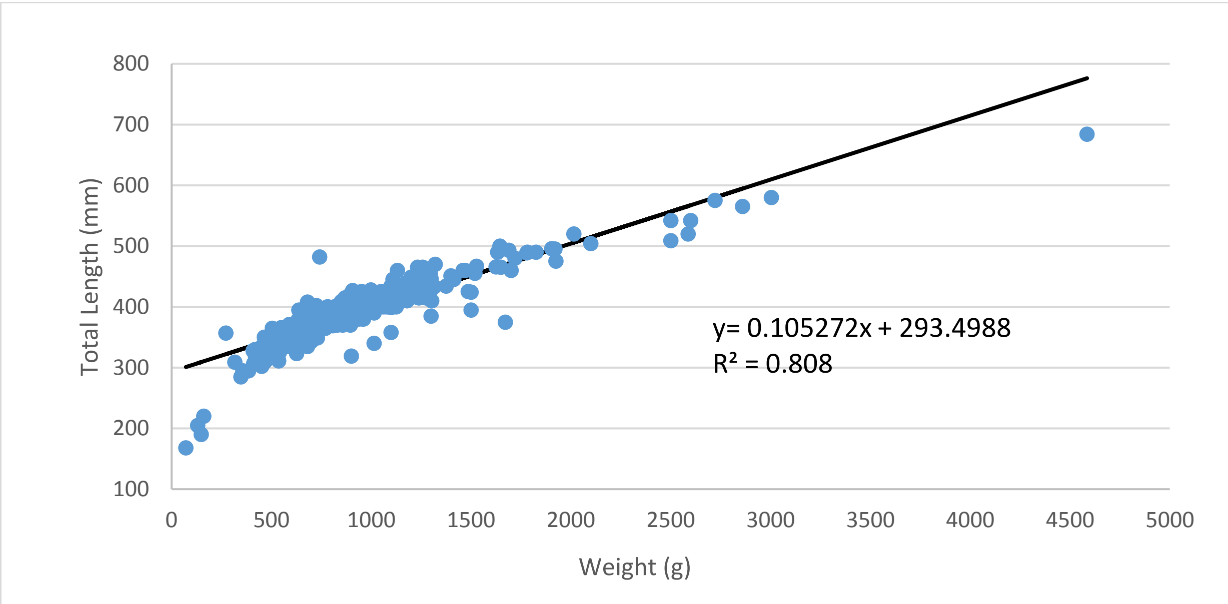

Figure 2. Total length-weight scatter plot with linear regression line for largemouth bass captured in Clear Lake, Spring 2008.

Bluegill

Bluegill TL ranged between 29 – 158 mm (1.1 – 6.2 in; Table 4). The length-frequency class with the greatest number of BG was 75 mm (3.0 in; Figure 3). The PSD of nine and RSD-P of zero indicated the BG were unbalanced, wherein there were relatively few quality and preferred-sized fish in comparison to stock-sized ones. Due to the lack of BG that met the minimum TL criterion for weighing, neither a relative weight nor a linear regression were created.

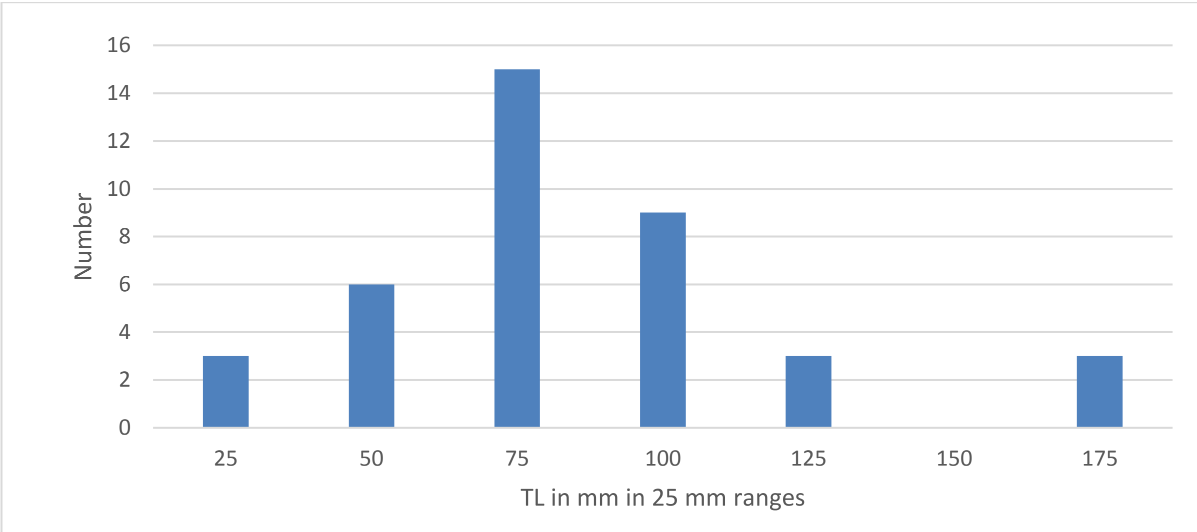

Figure 3. Length-frequency distribution for bluegill captured by electrofishing at Clear Lake, Spring, 2008.

2010

Due to inconsistent recording of electrofishing time, the total number of generator minutes and CPUE have been removed from these results. A total of 595 fish were collected with 14 species identified and one species of unidentified sculpin (Table 5).

Table 5. Species composition from Clear Lake, June 22 – 23 and July 21, 2010.
Mean Total Length (TL) was measured in millimeters (mm) and mean weight in grams (g).

	Species	Number	Percent	Total Length	Weight	Length Ranges	Relative Weight
1	Largemouth bass	290	48.7%	359.26	1043.92	35 - 560	106
2	Black crappie	119	20.0%	131.86	769.17	35 - 385	NA
3	Brown bullhead	42	7.1%	392.38	997.21	361-420	NA
4	Inland silverside	35	5.9%	70.11	NA	60 - 111	NA
5	Bluegill	34	5.7%	93.53	49.65	45 - 195	NA
6	Channel catfish	18	3.0%	559.22	2058.70	430 - 780	NA
7	Sacramento blackfish	15	2.5%	361.07	756.38	40 - 515	NA
8	Sacramento sucker	13	2.2%	165.83	79.80	50 - 285	NA
9	Sculpin	7	1.2%	77.50	12.00	55 - 100	NA
10	Goldfish	6	1.0%	NA	NA	NA	NA
11	Clear Lake hitch	5	0.8%	168.00	280.33	45-355	NA
12	Tule perch	5	0.8%	49.00	NA	40 - 70	NA
13	White catfish	3	0.5%	471.67	NA	445 - 500	NA
14	Green sunfish	2	0.3%	162.50	141.50	125 - 200	NA
15	Prickly sculpin	1	0.2%	40.00	NA	NA	NA
	Total	595					
	Water Temperature	70 – 79.3°F					

*Weights were only collected weights when the minimum total length for each species was as follows: green sunfish, 60 mm; bluegill, 80 mm; channel catfish, 130 mm; black crappie, 100 mm; Sacramento sucker, 100 mm; and largemouth bass; 150 mm.

Largemouth bass

LMB were the most numerous species collected, comprising 48.8% of all fish collected. LMB TL ranged between 35 – 560 mm (13.2 - 22.0 in) (Table 5). The most common length class sampled was 400 mm (15.7 in; Figure 4). PSD was 91 and RSD-P was 86. The mean relative weight of LMB was 106, indicating that LMB were in good condition. A linear regression was conducted, but based on an R^2 of 0.7782 the model was not reliable and no figure was made.

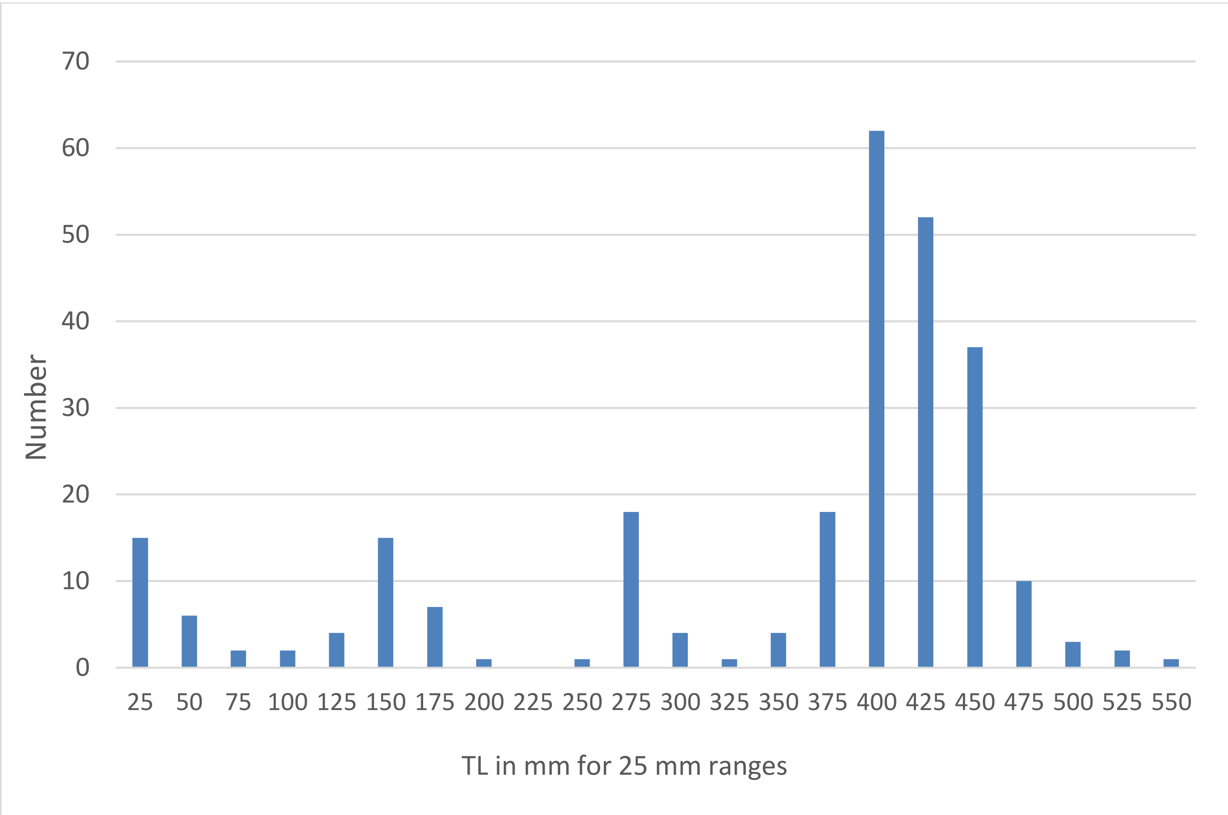

Figure 4. Length-frequency distribution for largemouth bass captured by electrofishing at Clear Lake, Spring 2010.

Black crappie

Black crappie ranged from 35 – 385 mm (1.4 - 15.2 in) in TL (Table 5). The most common length class sampled was 25 mm (1.0 in; Figure 5). Both the PSD and RSD-P were 100. These values demonstrated that the population was imbalanced, wherein there were a greater proportion of quality and preferred-sized fish than stock-sized ones. Due to the lack of BCR that met the minimum TL criterion for weighing, no relative weight or linear regression were calculated.

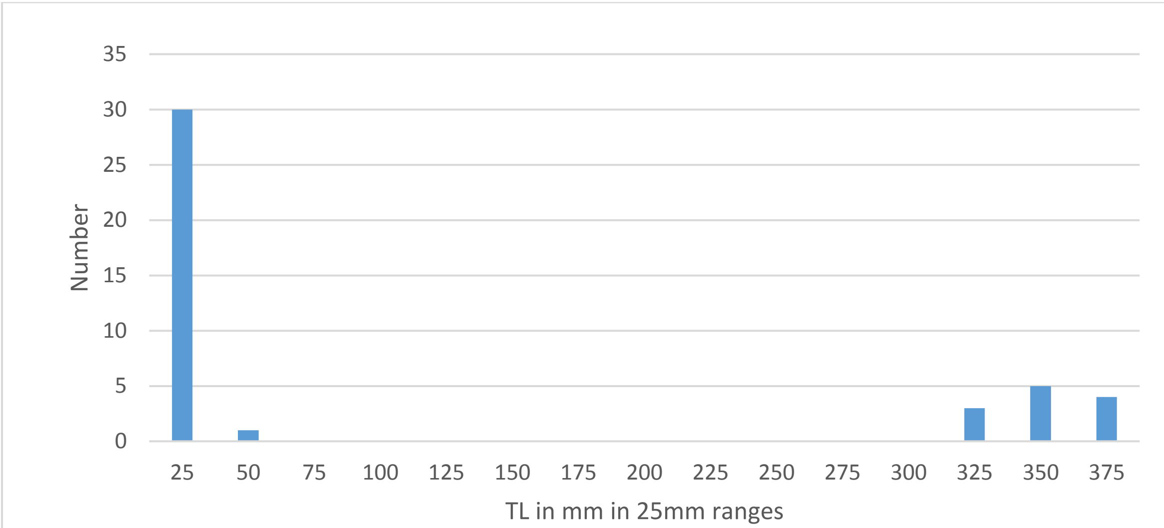

Figure 5. Length-frequency distribution for black crappie bass captured by electrofishing at Clear Lake, Spring, 2010.

Bluegill

Bluegill TL ranged from 45 – 195 mm (1.9 -7.7 in; Table 5). The most common length class sampled was 50 mm (2.0 in; Figure 6). PSD was 22 and RSD-P was zero. These values indicated that, while the population was balanced between the numbers of stock-sized and quality-sized BG, there was an imbalance between stock and preferred sized BG, since the preferred sizes were nonexistent. Due to the lack of BG that met the minimum TL criterion for weighing, no relative weight or linear regression were calculated.

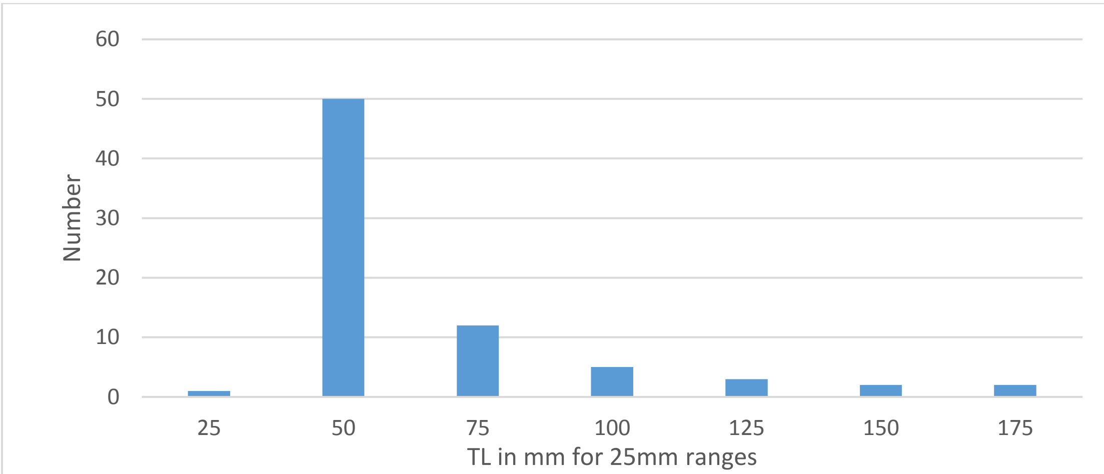

Figure 6. Length-frequency distribution for bluegill captured by electrofishing at Clear Lake, Spring, 2010.

2011

In June and July of 2011, a total of 559 fish in 370.05 generator minutes were collected. CPUE was 1.51 fish per minute for all of the fish sampled in Clear Lake (Table 6). Fourteen species were identified as well as a species of unspecified sculpin.

Table 6. Species composition from Clear Lake, June 28 – 29, 2011.

	Species	Number	Percent	CPUE	Total Length (mm)	Weight (g)	Length Ranges	Relative Weight
1	Largemouth bass	392	70.1%	0.701	415.47	1213.66	122 - 600	106
2	Bluegill	65	11.6%	0.116	140.50	97.10	70 - 205	143
3	Brown bullhead	48	8.6%	0.086	392.38	1053.96	312 - 470	NA
4	Channel catfish	9	1.6%	0.016	679.11	2175.00	540 - 900	NA
5	Clear Lake hitch	9	1.6%	0.016	154.22	42.11	120 - 255	NA
6	Sacramento blackfish	7	1.3%	0.013	390.86	715.71	254 - 485	NA
7	Golden shiner	6	1.1%	0.011	NA	NA	NA	NA
8	Black crappie	4	0.7%	0.007	315.00	553.25	100 - 470	NA
9	Prickly sculpin	4	0.7%	0.007	NA	NA	NA	NA
10	Sacramento sucker	4	0.7%	0.007	249.25	201.50	205 - 281	NA

Table 6 cont.

11	White catfish	4	0.7%	0.011	490.00	1703.33	450 - 510	NA
12	Goldfish	2	0.4%	0.004	397.50	1250.50	355 - 440	NA
13	Inland silverside	2	0.4%	0.004	90.00	5.00	NA	NA
14	Sculpin (General)	2	0.4%	0.004	72.50	14.00	35 -110	NA
15	Redear sunfish	1	0.2%	0.002	180.00	150.00	NA	NA
	Total	559						
	Generator Minutes:	370.05						
	CPUE	1.511						
	Water Temperature	73 – 79°F						

*Weights were only collected weights when the minimum total length for each species was as follows: green sunfish, 60 mm; bluegill, 80 mm; channel catfish, 130 mm; black crappie, 100 mm; Sacramento sucker, 100 mm; and largemouth bass; 150 mm.

Largemouth bass

LMB were the most numerous species collected in 2011, comprising 70.1% of all fish collected. LMB TL ranged from 122 – 600 mm (4.8 - 23.6 in; Table 6). The most common length class sampled was 425 mm (16.7 in; Figure 7). PSD was 91 and RSD-P was 89. Both values showed that the LMB population was unbalanced, wherein both quality and preferred length fish outnumbered stock-sized fish. The mean relative weight was 106, which indicated that LMB were in good condition. The R^2 value of 0.82 suggests that the linear regression model for estimating total length from a given weight was reliable (Figure 8).

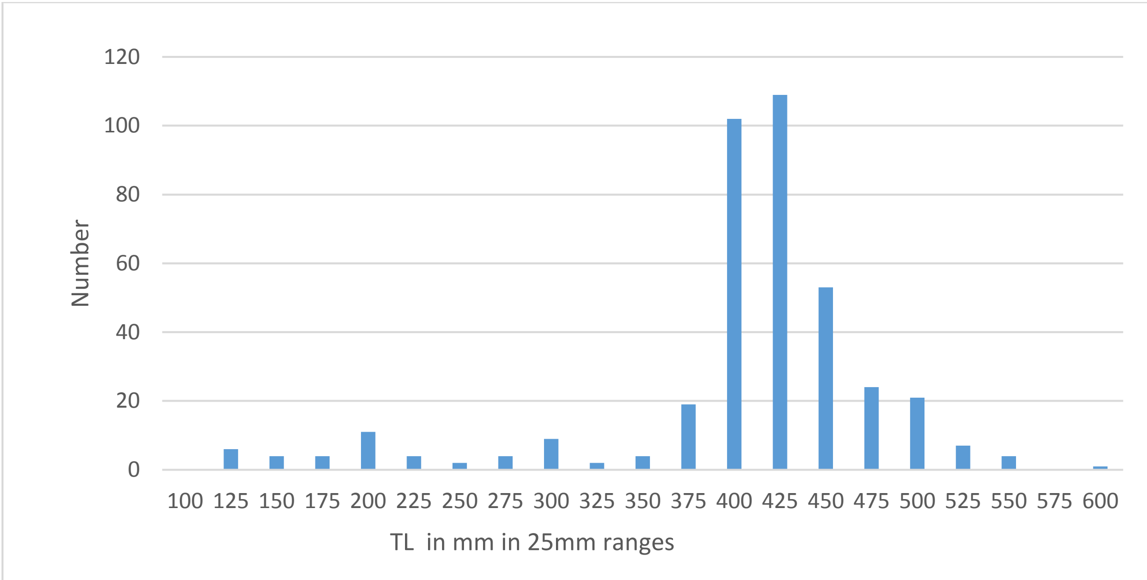

Figure 7. Length-frequency distribution for largemouth bass captured by electrofishing at Clear Lake, Spring 2011.

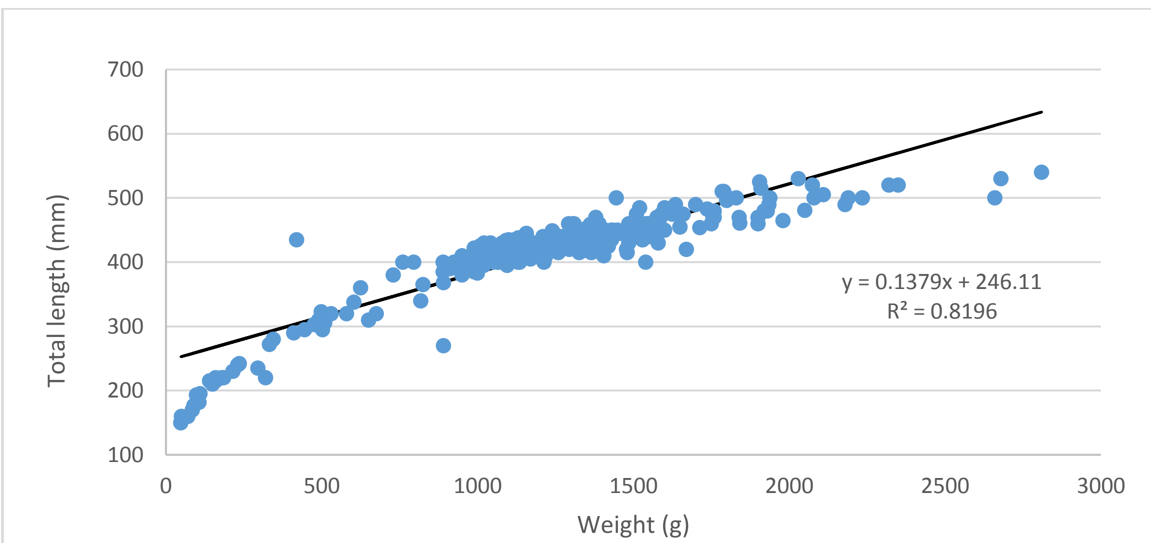

Figure 8. Total length-weight scatter plot with linear regression line for largemouth bass captured at Clear Lake, Spring 2011.

Bluegill

Bluegill TL ranged between 70 – 205 mm (2.8 - 8.1 in; Table 6). The most common length class sampled was 150 mm (5.9 in; Figure 9). The PSD was 49 and RSD-P was five. The PSD indicated that the population was balanced between the proportion of stock-sized and quality-sized fish. Conversely, the RSD-P indicated that there was an imbalance of stock to preferred-sized fish in population. This imbalance favored stock-sized fish. BG had a mean Wr of 143, indicating excellent body condition.

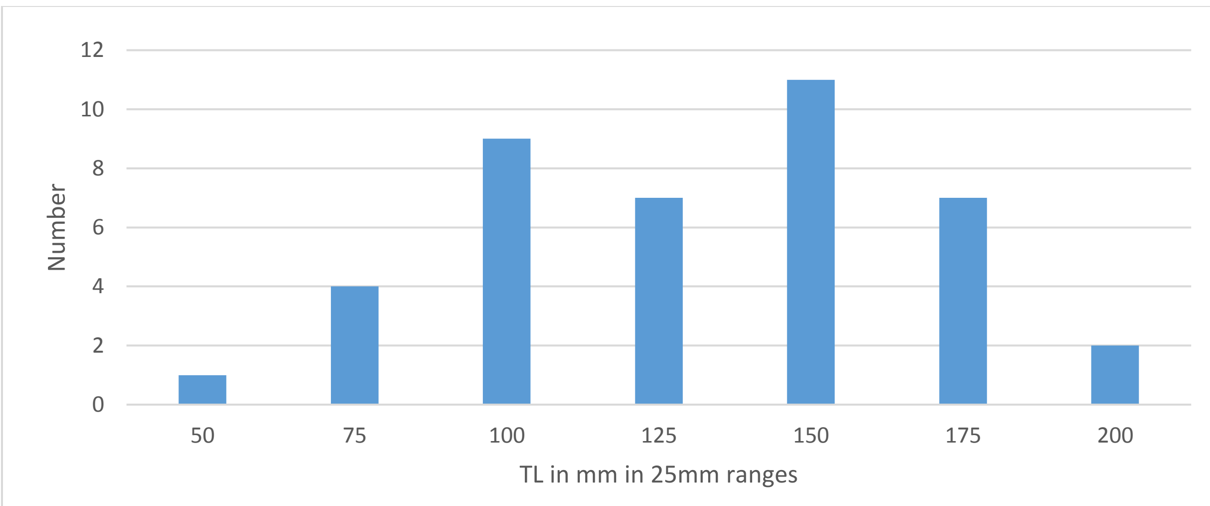

Figure 9. Length-frequency distribution for bluegill captured by electrofishing at Clear Lake, Spring, 2011.

2012

In June of 2012, a total of 838 fish were collected over 281 generator minutes (Table 7). Eighteen species were identified with LMB once again being the greatest single specie collected, representing 53.2% of the fish caught. The overall CPUE was 2.97 fish per minute.

Table 7. Species composition from Clear Lake, June 27, 2012

	Species	Number	Percent	CPUE	Total Length (mm)	Weight (g)	Length Ranges	Relative Weight
1	Largemouth bass	446	53.2%	1.582	284.26	1229.57	22 - 600	106
2	Bluegill	211	25.2%	0.748	90.59	60.64	25 - 235	120
3	Clear Lake hitch	45	5.4%	0.160	142.09	948.00	30 - 533	NA
4	Brown bullhead	35	4.2%	0.124	396.03	1025.73	345 - 430	NA
5	Sacramento sucker	21	2.5%	0.074	123.59	504.50	50 - 395	NA
6	Inland silverside	17	2.0%	0.060	77.35	2.00	65 - 93	NA
7	Channel catfish	15	1.8%	0.053	640.60	3744.93	348 - 765	NA
8	Black crappie	9	1.1%	0.032	261.11	354.33	110 - 375	NA
9	Goldfish	9	1.1%	0.032	230.83	637.75	45 - 352	NA
10	Sculpin	8	1.0%	0.028	45.00	NA	25 - 110	NA
11	Redear sunfish	7	0.8%	0.025	173.43	171.29	92 - 230	NA
12	Sacramento blackfish	6	0.7%	0.021	245.33	310.60	52 - 360	NA
13	White catfish	3	0.4%	0.011	572.00	2964.00	426 -680	NA
14	Green sunfish	2	0.2%	0.007	96.00	21.50	95 - 97	NA
15	Redear x Green sunfish hybrid	1	0.1%	0.004	170.00	143.00	NA	NA
16	Sacramento pikeminnow	1	0.1%	0.004	180.00	44.00	NA	NA
17	Tule perch	1	0.1%	0.004	45.00	NA	NA	NA
18	White crappie	1	0.1%	0.004	107.00	22.00	NA	NA
	Total	838						
	Generator minutes:	281.92						
	CPUE (Fish/ gen. min)	2.973						
	Water Temperature	70.7 – 75°F						

*Weights were only collected weights when the minimum total length for each species was as follows: green sunfish, 60 mm; bluegill, 80 mm; channel catfish, 130 mm; black crappie, 100 mm; Sacramento sucker, 100 mm; and largemouth bass; 150 mm.

Largemouth bass

LMB collected and measured ranged between 22 – 600 mm (0.9 - 23.6 in) (Table 7). The most common length class sampled was 50 mm (1.96 in; Figure 10). The PSD was 89 and RSD-P was 75. Based on these values, the population was imbalanced, wherein there were more quality and preferred-sized fish than stock-sized ones. LMB had a mean Wr of 105, indicating good body condition. A linear regression R^2 value of .80 indicated a reliable total length could be determined from a given weight (Figure 11).

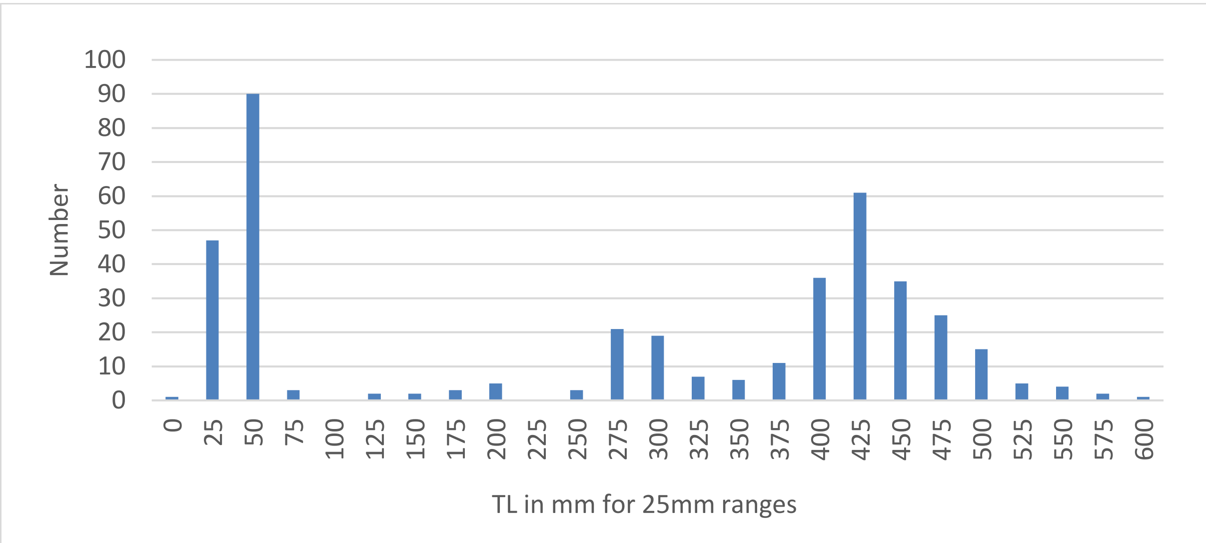

Figure 10. Length-frequency distribution for largemouth bass captured by electrofishing at Clear Lake, Spring, 2012.

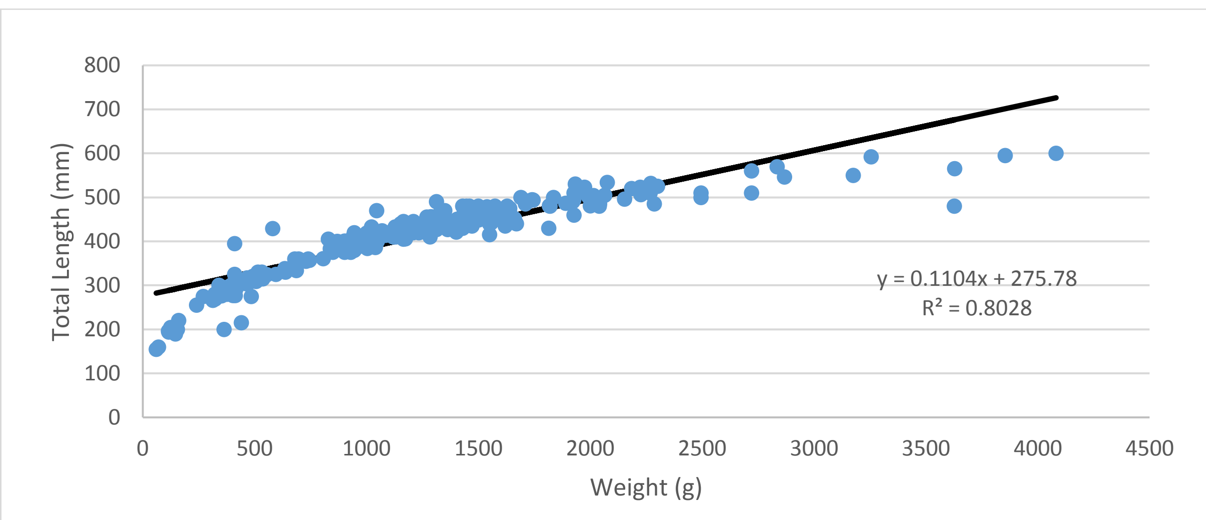

Figure 11. Total length-weight scatter plot with linear regression line for largemouth bass captured at Clear Lake, Spring, 2012.

Bluegill

BG collected and measured ranged from 25 – 235 mm (1.0 - 9.3 in). The most common length class sampled was 25 mm (1.0 in; Figure 12). PSD was 29 and the RSD-P was four. Although the PSD suggested a balanced population, the RSD-P indicated that preferred-sized fish were not in balance, wherein relatively few preferred-size and greater BG were collected compared to stock-size BG. BG had a mean Wr of 120, indicating excellent condition at the time of sampling. A linear regression R^2 value of 0.85 indicated a reliable total length could be determined from a given weight for BG in Clear Lake (Figure 13).

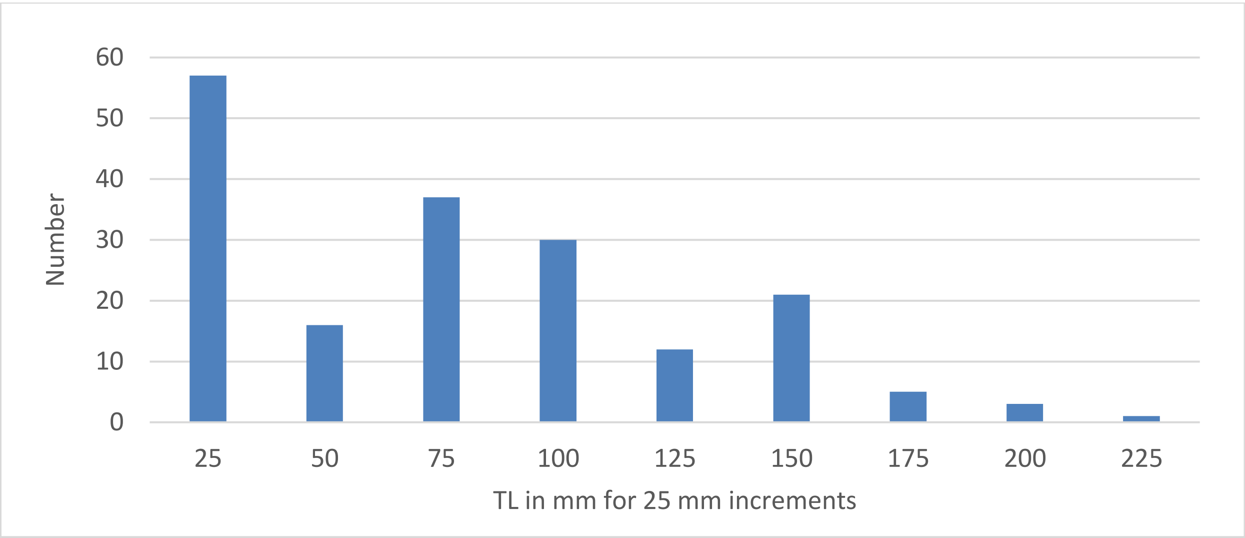

Figure 12. Length-frequency distribution for bluegill captured by electrofishing at Clear Lake, Spring, 2012.

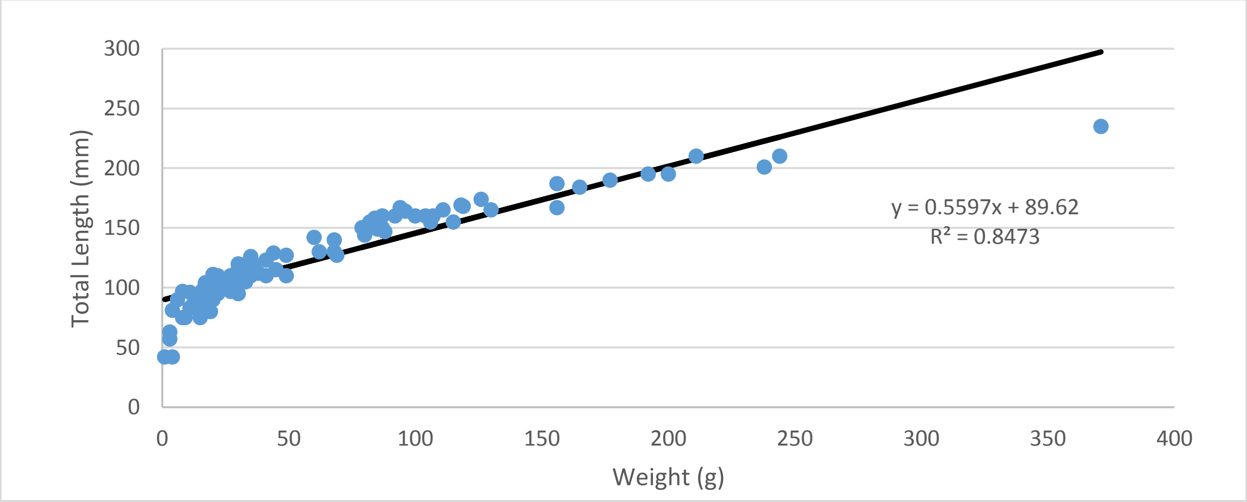

Figure 13. Total length-weight scatter plot with linear regression line for bluegill captured at Clear Lake, Spring, 2012.

Discussion

The 2008, 2011, and 2012 surveys showed CPUE fluctuating from 2.00 to 1.51, to 2.97, respectively. The decreased CPUE in 2011 may have been due to the drought. California experienced a drought from 2006-2009, which may have negatively affected the fish population. With a lower lake elevation, it is possible that the fishery experienced warmer water temperatures and less available shoreline vegetation used for rearing and protection.

In the three years' of surveys at Clear Lake, the LMB mean relative weights indicated the LMB in Clear Lake were in good condition. Throughout the surveys, LMB were by far the most common species collected. While LMB were numerous, the PSD and RSD-P values for all surveys were unbalanced, favoring quality and preferred-sized LMB over stock-sized individuals. There was a divergence in 2012, wherein the most frequently encountered size was the first-year age group: well below stock size (Moyle 2002). Nonetheless, the PSD and RSD-P showed that the population was still unbalanced. The most frequently encountered sizes in 2008 indicate that most LMB were in their third or fourth year (at least four years old in 2010, and four years old or older by 2011 and 2012; Moyle 2002).

Upon reaching 100 – 120 mm (3.9 – 4.7 in) standard length (the length measured from anterior most point of the snout to the posterior most point of the caudal peduncle), LMB will primarily feed on other fish, although preferred prey changes from year to year (Moyle 2002). Given changeable prey preference, and sampling that indicates most individuals were >100 mm (3.9 in; Figure 1, 4, 7, 10), Clear Lake's LMB may be a factor in the large fluctuations of other sampled fish species (Tables 4, 5, 6, and 7). A diverse diet may also explain how LMB have been able to sustain an imbalanced population of quality- and preferred-sized fish in Clear Lake (Ewing et. al 2016). An abundance of quality and preferred-size LMB stock is beneficial for the bass fishing economy on which the Clear Lake area depends. However, the large proportion of LMB (with flexible feeding and foraging behaviors; Moyle 2002), in combination with the presence of other non-native fish species, has a negative effect on the native fish populations. Non-native invasive fish species are increasingly recognized as a significant contributor to extinction threat in fresh waters (Cucherousset and Olden 2011).

When there were enough BG to assess, as in 2011 and 2012, mean Wr indicated BG in Clear Lake were in excellent condition. PSD of BG was only found imbalanced in spring of 2008, in which the proportion of stock-sized fish was greater than quality-sized fish. The PSD in 2010, 2011, and 2012 indicated that the BG population was balanced. The RSD-P in 2008 and 2010 were both zero because no BG of preferred size (200 mm or 7.9 in) were collected. In 2011, the RSD-P was considered balanced with preferred-sized BG, relative to the rest of the population. However, the RSD-P in 2012, returned to an imbalanced population, with more stock-sized BG relative to preferred-sized ones. It is unlikely that overfishing was the cause for fewer preferred-size BG in Clear Lake because fishing is considered to have little effect on BG populations (Moyle 2002). BG have high reproductive rates, in which anywhere from 2,000 to 18,000 larvae hatch from a single nest (Moyle 2002). Intraspecific competition would be a more likely factor behind the lower RSD-Ps values, since in some waters, severe intraspecific competition can stunt the growth of individual fish and result in large numbers of smaller fish in a population (Moyle 2002).

The majority of BCR sampled in 2010 had not reached maturity and were only a year old or less (Moyle 2002). Due to no stock and quality-sized BCR collected, the population was unbalanced with an abundance of preferred-sized fish. BCR were second in numbers collected in 2010, decreasing to eighth in 2011 and 2012 (Table 5, 6, and 7).   Due to the large populations of large – sized piscivorous fish in Clear Lake, it is likely that few smaller sized fish are able to grow to greater sizes.

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