The Summer Townet Survey

2022 Season Report

California Department of Fish and Wildlife

Bay Delta Region

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Contents

Introduction

The Summer Townet Survey (STN) is a long-term monitoring effort that samples for young pelagic fishes in the upper San Francisco Estuary (SFE), from San Pablo Bay upstream through the Sacramento-San Joaquin Delta (referred to as the Bay-Delta). This survey has been conducted consistently since 1959 and is one of the longest running estuarine fish sampling efforts in the United States. The study targets small fish (12-55 mm fork length (FL)) during June – August using a small trawl net with a fixed mouth size to determine the relative abundance and distribution of local fish populations to understand the annual recruitment success of fish populations that spawn in the spring and rear during the summertime. The area sampled, Suisun Bay and Delta, is an important nursery for many species of young fish. Originally designed to determine the annual spawning success of juvenile Striped Bass (*Morone saxatilis*), the study has evolved to inform on the state and federally listed endangered Delta Smelt (*Hypomesus transpacificus*) and other members of the pelagic community, including invertebrates and zooplankton. Environmental data is collected during sampling to understand relationships of fish catch with water temperature, turbidity, salinity, and other measures of habitat conditions (e.g., harmful algal blooms). This study has been of immense value to resource management in the SFE, having informed response of fish abundance and distribution relative to freshwater Delta outflow (Miller et al 2012), fish use of the low salinity zone (LSZ), decline of native fish and need for protection by State and Federal ESA listing (Tempel et al 2021), understanding recruitment of fish relative to loss by entrainment at water projects in the south Delta, and most recently actions taken to improve conditions for Delta Smelt and their habitat (Hammock et al 2019). Summer Townet currently provides fish, zooplankton, and water quality information used to understand summer-fall flow actions (STN Bibliography), modified operation of Suisun Marsh Salinity Control Gates, and tidal wetland restoration identified in the Delta Smelt Resiliency Strategy, federal biological opinion and CDFW issued incidental take permit (ITP).

Since 1959, STN has sampled 32 fixed locations from eastern San Pablo Bay to Rio Vista on the Sacramento River, and to Stockton on the San Joaquin River and a single station in the lower Napa River. Most stations are set in the channels of rivers, with additional locations in the shallow waters of Suisun, Grizzly, and Honker bays, to capture the movement of young fish as their distribution expanded throughout the season. These original 'index' stations are used to calculate relative abundance indices for Delta Smelt and Striped Bass. Presently, 40 stations (31 index and 9 non-index stations) are sampled every other week mid-June through early-August using a conical, fixed-frame net, which is pulled obliquely through the water column 2 to 3 times at each station. The repeated tows at each station provide a greater water volume sample relative to the larger water volumes that occur in various river sections and bays and improve detection of fish. At each station environmental variables are measured including water temperature (°C), water clarity (Secchi depth in cm & turbidity in NTU), and specific conductivity (µS/cm) to help explain trends in catch and annual recruitment.

Overview

The CDFW STN began the 2022 season with survey 1 on June 6th and completed the 6th and final survey on August 19th. Relative abundance indices for Delta Smelt and age-0 Striped Bass were calculated and reported in separate memos and can be accessed on the STN bibliography. The following seasonal report is meant as a supplement to the reported abundance indices, providing a summary of environmental trends, the abundance and spatial patterns for fish and invertebrate catch between June and August. Previous seasonal reports are accessible on the STN bibliography linked above.

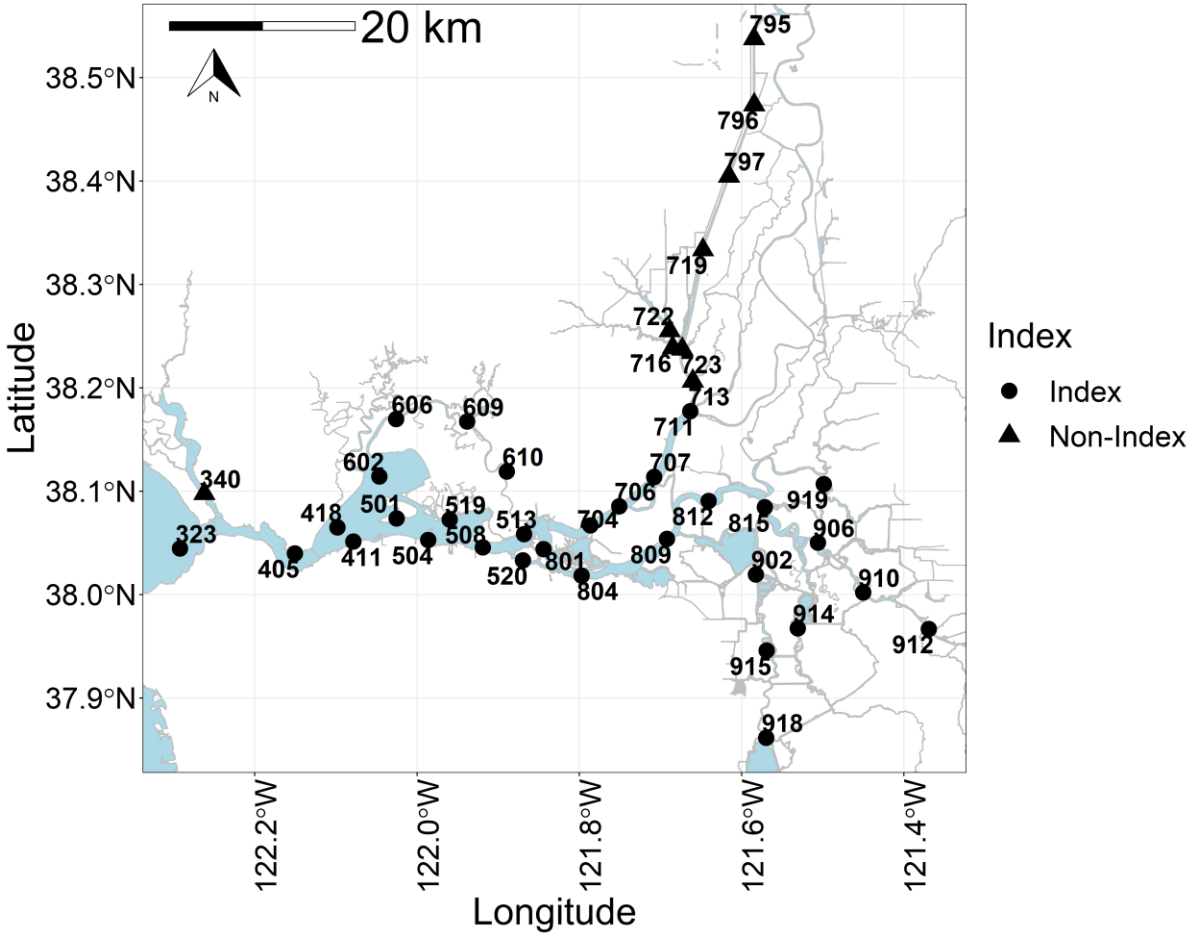


Figure 1. The Summer Townet Survey station map showing 31 index stations (circles) and 9 non-index stations (triangles).

Methods and Gear

The STN net samples 2-3 tows at each station for 10-minutes per tow, retrieved obliquely through the water column. Each index station receives 2 tows and a third tow if at least 1 fish was collected in one of the first 2 tows. In the North Delta non-index stations, a maximum of 2 tows is conducted to minimize the risk of Delta Smelt catch. The townet is an 18' 6" long cone (See Figure 2) with a 58" diameter opening at the mouth and a 12" diameter opening at the end of the cod end (narrow end). It consists of four major components: 1) the

collar, 2) the main body (½" stretched knotted mesh), 3) the fyke (½" knotless mesh) and 4) the cod-end (bobbinet with 8 holes per inch). A flowmeter (General Oceanics, model # 2030R, Figure 2 bottom) is suspended in the center of the net mouth during the tow. The flowmeter measures the distance traveled by the net (meters) through the water during the tow. This in turn allows us to calculate volume of water sampled, by applying the mouth area of the net (1.49 m2) and thus catch per unit effort (CPUE, generally reported as fish per 10,000 cubic meters).

Figure 2. The Summer Townet sled ready to be deployed. Note the meso-zooplankton (Clark-Bumpus) net mounted at the top of the D-ring and the flowmeter mounted in the center of the main fish net.

Following each tow, the fish net is emptied, and all fish and macro-invertebrates (caridean shrimp, crabs, and jellyfish spp.) are identified to species and enumerated. The first 50 individuals of each fish species have fork lengths recorded in millimeters. Any fish that cannot be identified in the field, such as larval fish less than 25 mm FL, are preserved in ethanol or 10% buffered formalin to be identified later within a CDFW laboratory.

A modified Clark-Bumpus (CB) net is mounted at the top of the fish net (see Figure 2) to collect meso-zooplankton, targeting zooplankton 0.5-3.0 mm long, including cladocerans, copepodids, and adult copepods. At each STN station, the CB sample is generally collected on the first concurrent fish net tow. Flowmeter counts for the CB net are recorded at the start

and end of each tow to determine distance traveled (m) so to calculate volume sampled (cubic meters). The CB sample is preserved using a concentrated, buffered formalin with rose-Bengal dye which is then diluted to a 10% buffered formalin solution using ambient field water. A bucket is used to collect a surface water sample to make water quality measurements (YSI Pro 30). Bottom water temperatures are measured using a Van Dorn to collect a small sample of water above the base of the water column.

Abiotic variables and a Microcystis *spp*. ranking metric are measured prior to sampling at each STN station (Appendix 1).

Routine Sampling

In 2022, STN successfully visited and sampled each index and non-index station in all 6 surveys. Most surveys were completed within 4 days using 1 or 2 research vessels (Survey 1, June 6-9; Survey 2, June 20-23; Survey 3, July 5-8; Survey 4, July 18-21; Survey 5, Aug 1-4; Survey 6, Aug 15-19). The summary of tows for each station are presented in Table 1.

Table 1. Tows per station by survey and total tows over the 2022 STN season.

Station Code	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6	Total
323	3	3	3	3	3	3	**18**
340	2	2	3	3	3	2	**15**
405	2	3	3	3	3	2	**16**
411	2	2	3	3	3	2	**15**
418	3	3	3	3	3	3	**18**
501	2	3	3	3	3	3	**17**
504	2	3	2	3	3	3	**16**
508	3	3	3	3	3	3	**18**
513	3	3	3	3	3	3	**18**
519	3	2	2	3	3	2	**15**
520	3	2	3	3	3	2	**16**
602	3	3	3	3	3	3	**18**
606	3	3	3	3	3	3	**18**
609	3	3	3	3	3	3	**18**
610	3	3	3	3	3	3	**18**
704	3	3	3	3	3	3	**18**

Station Code	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6	Total
706	3	3	3	3	3	3	**18**
707	3	3	3	3	3	3	**18**
711	2	3	2	2	3	2	**14**
713	2	2	2	2	2	2	**12**
716	2	2	2	2	2	2	**12**
719	2	2	2	2	2	2	**12**
722	2	2	2	2	2	2	**12**
723	2	2	2	2	2	2	**12**
795	2	2	2	2	2	2	**12**
796	2	2	2	2	2	2	**12**
797	2	2	2	2	2	2	**12**
801	3	3	3	3	3	3	**18**
804	3	3	3	3	2	3	**17**
809	3	3	3	3	2	3	**17**
812	2	3	2	2	2	2	**13**
815	2	3	2	3	2	3	**15**
902	2	3	2	3	2	2	**14**
906	2	2	2	2	2	2	**12**
910	3	2	2	2	2	3	**14**
912	3	3	2	2	2	2	**14**
914	3	2	2	3	2	2	**14**
915	2	3	2	3	2	3	**15**
918	3	3	2	3	2	2	**15**
919	3	2	2	2	2	2	**13**
Total	**101**	**104**	**99**	**106**	**100**	**99**	**609**

Non-Routine Sampling

In addition to the routine monitoring, STN conducted additional sampling (below), starting in survey 3 of 2022 (Table 2), for the Suisun Marsh Salinity Control Gate (SMSCG)

special study. STN conducted additional zooplankton tows using a mysid sled, as well as collected phytoplankton surface samples from the stations listed below.

Table 1. Additional sampling conducted for the Suisun Marsh Salinity Control Gate (SMSCG) study. A 0 indicates no sample collected and a 1 indicates that a sample was collected. The SMSCG column indicates if the station data is recorded with the STN database (0) or the SMSCG database (1).

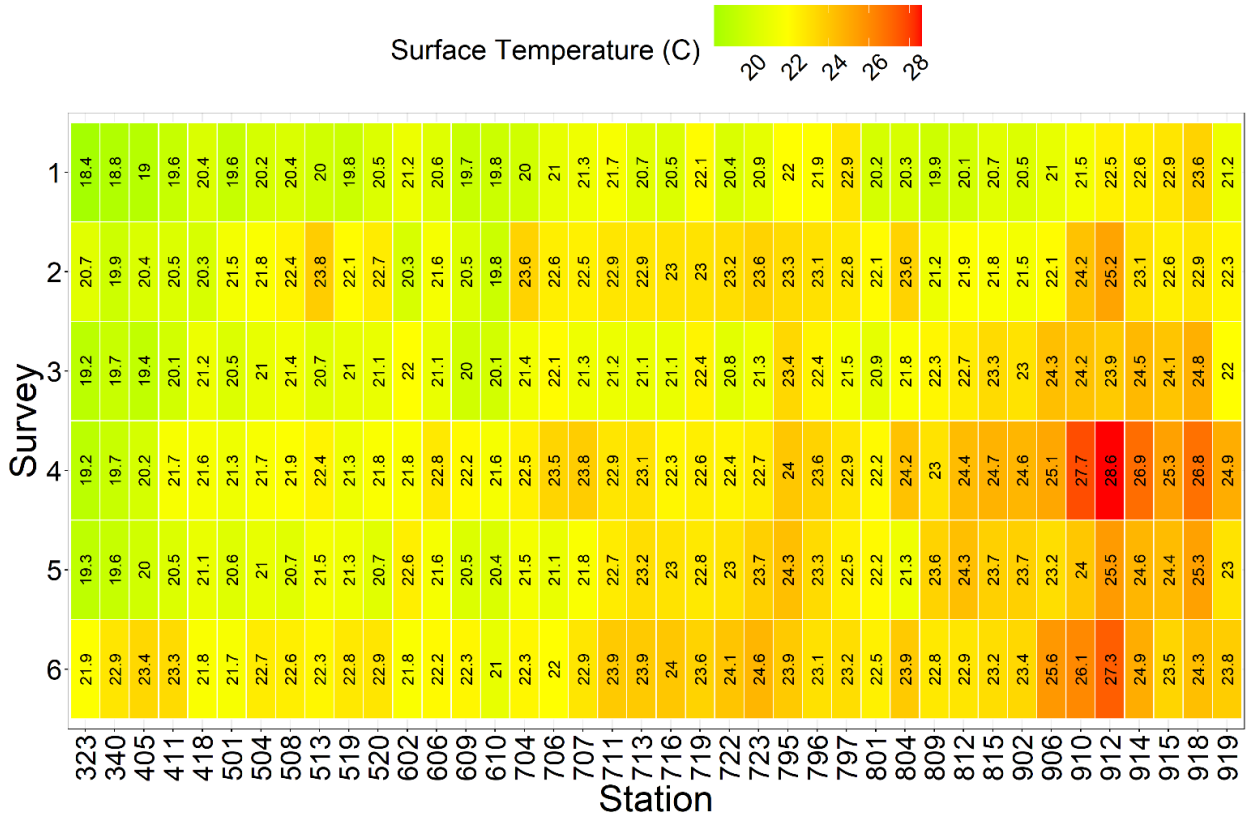
SURVEY	STATION	FISH (0, 1)	ZOOPLANKTON (0, 1)	PHYTOPLANKTON (0,1)	SMSCG (0, 1)
3	602	1	1	1	0
3	606	1	1	1	0
3	609	1	1	1	0
3	610	1	1	1	0
3	704	1	1	1	0
3	706	1	1	1	0
3	801	1	1	1	0
3	EMP NZS42[1]	0	1	0	1
3	FMWT 605[1]	0	1	1	1
3	Mont[1]	0	1	1	1
4	602	1	1	0	0
4	606	1	1	0	0
4	609	1	1	1	0
4	610	1	1	1	0
4	704	1	1	1	0
4	706	1	1	0	0
4	801	1	1	0	0
4	F605[1]	0	1	1	1
4	Mont[1]	0	1	1	1
5	602	1	1	1	0
5	606	1	1	1	0
5	609	1	1	1	0
5	610	1	1	1	0
5	704	1	1	1	0
5	706	1	1	1	0
5	801	1	1	1	0
5	EMP NZS42[1]	0	1	1	1
5	FMW T605[1]	0	1	1	1
5	Mont	0	1	1	1
6	602	1	1	0	0
6	606	1	1	0	0
6	609	1	1	1	0
6	610	1	1	1	0
6	704	1	1	1	0
6	706	1	1	1	0

6	801	1	1	1	0
6	EMP NZS42[1]	0	0	0	1
6	FMWT 605[1]	0	1	1	1
6	Mont[1]	0	1	1	1

[1]Indicates a station that is not a part of the regular STN sampling schedule.

Environmental Variables

The STN collects metrics for biotic and abiotic variables at each station. Summaries for temperature (°C), salinity (ppt), water clarity as Secchi depth (cm), turbidity (NTU), and Microcystis (1-5 qualitative rankings) are described below with corresponding figures.


Surface Temperature (C)
20
22
24
26
28
Survey
1
2
3
4
5
6
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919
Station

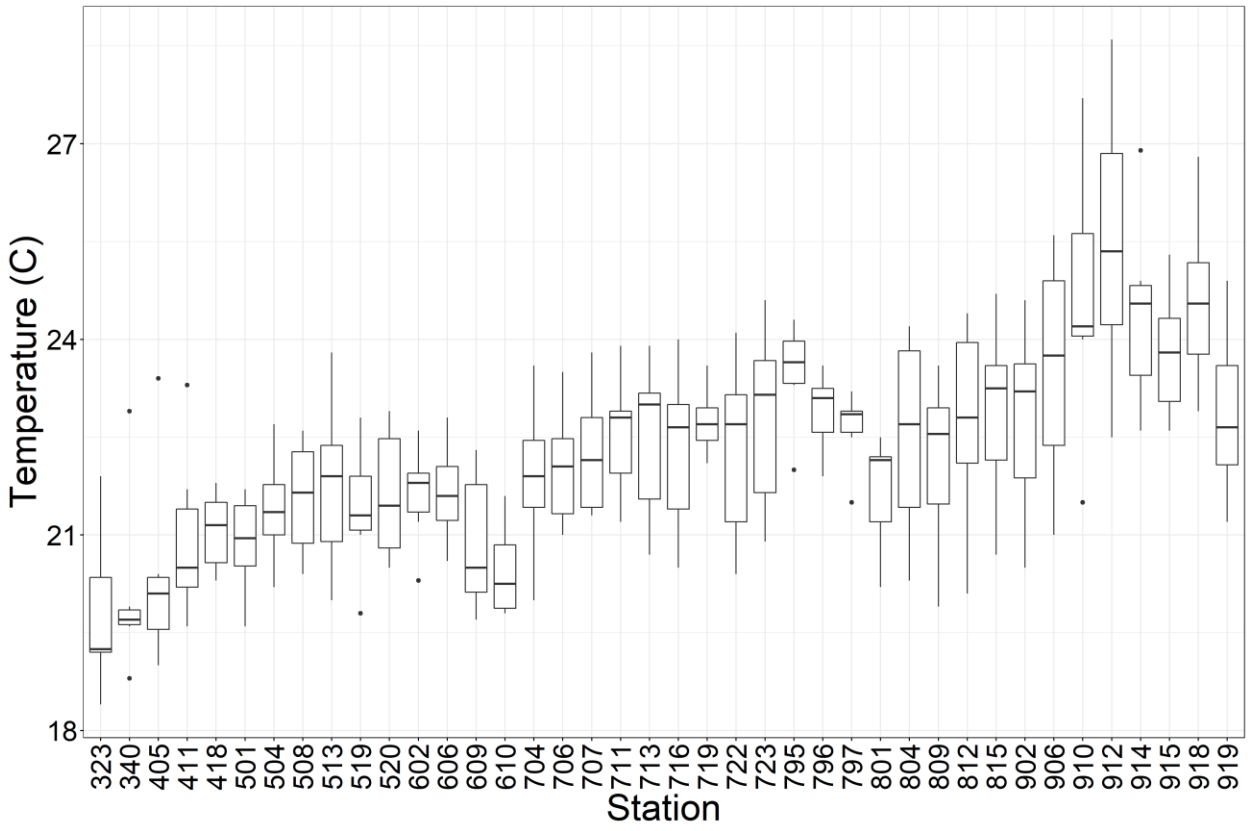

Temperature (C)
18
21
24
27
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919
Station

Figure 3. Surface temperature (C) at each STN station (index and non-index) by survey (top) and the distribution of temperature for each station across the season (bottom). Temperatures above 22 C are considered stressful (yellow) to Delta Smelt and have been linked to mortality above 25 C (red). Boxplots (bottom) show the median as a horizontal line, 1st and 3rd quartile by box, range by vertical line and outliers by point.

Temperatures (Figure 3) at the STN stations were cooler in June surveys (surveys 1-2) and warmest at the end of July and August (Surveys 4-6). Temperatures above 22 C are considered stressful to the native Delta Smelt and have been linked to mortality when above 25 C (Swanson et al 2000). In addition to temporal changes in temperature, stations furthest from San Pablo Bay were generally warmer than stations closer to the cooler ocean temperatures. This was particularly true of stations located in the South Delta (i.e., San Joaquin River and Old River) The warmest stations were 910 and 912, the eastern edge of the STN sampling range located just near Stockton, CA. Recorded temperatures across the season were likely influenced by the time of day and tide during the sampling event and these temporal factors were not considered in this comparison among stations.

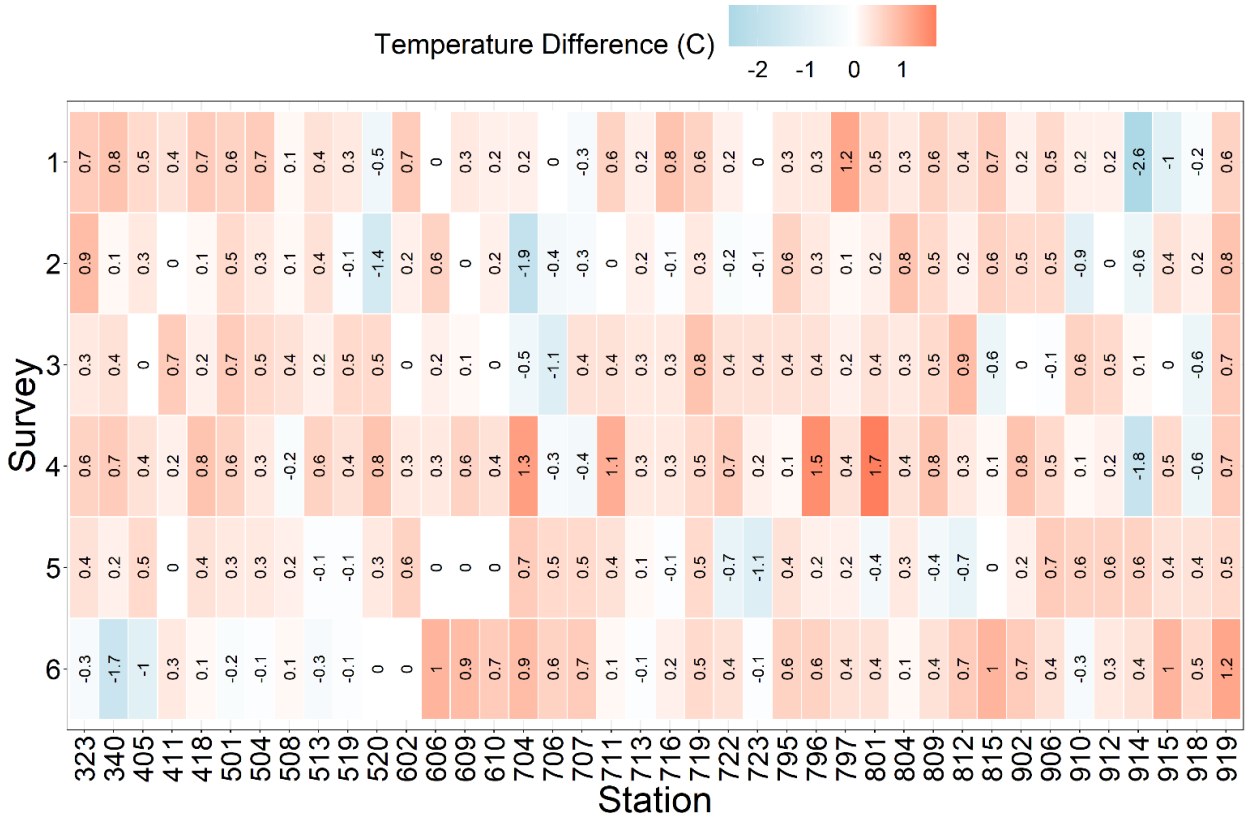
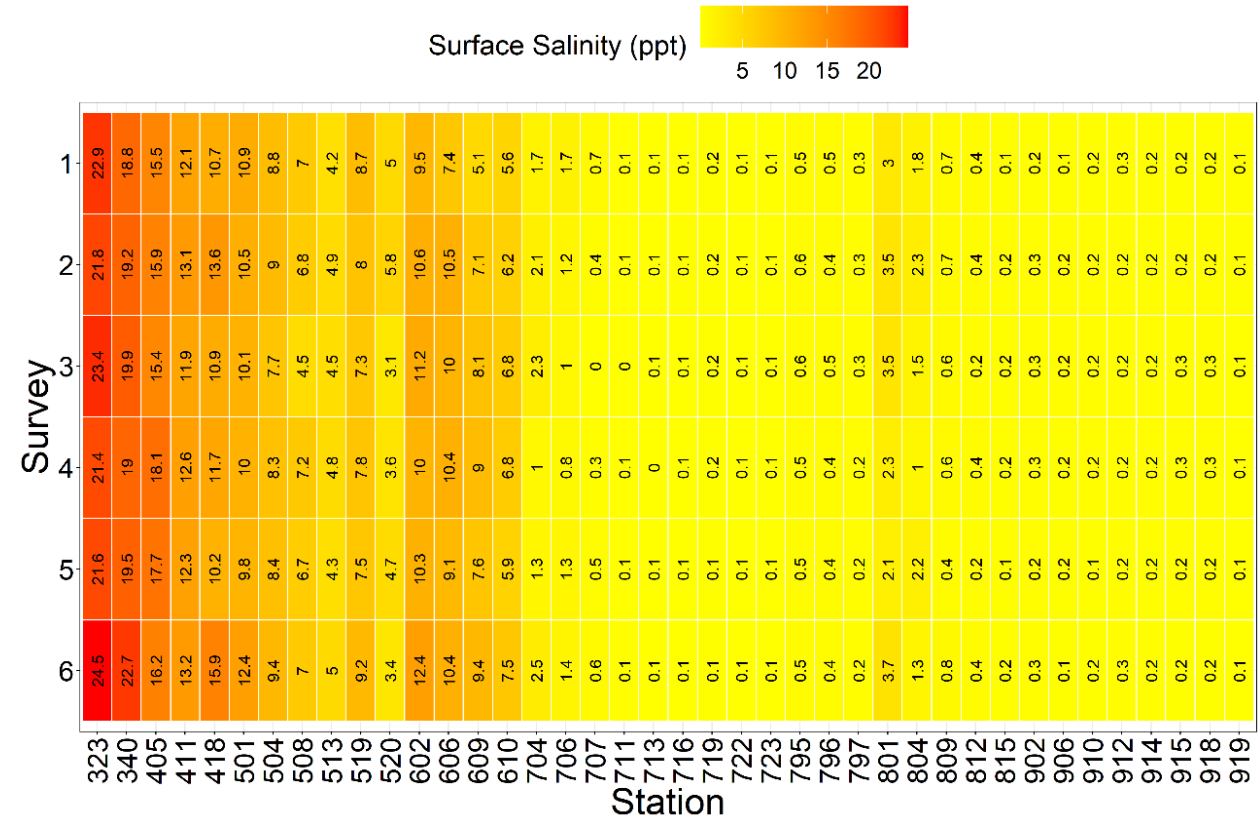


Figure 4. Temperature differences (C) between the surface and bottom at each STN station (index and non-index). Negative (blue) values are warmer bottom temperatures compared to

the surface, red colors indicate greater temperatures at the surface and clear tiles indicate little to no difference in temperature.

Values were generally similar between bottom and top water temperature readings (Figure 4). Warmer surface temperatures, over 1 C, were seen more frequently this year but did not reach the same extreme difference as (-5 C) compared to 2021.


Surface Salinity (ppt)
5
10
15
20
Survey
1
2
3
4
5
6
Station
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919
22.9 18.8 15.5 12.1 10.7 10.9 8.8 7 4.2 8.7 5 9.5 7.4 5.1 5.6 1.7 1.7 0.7 0.1 0.1 0.1 0.2 0.1 0.1 0.5 0.5 0.3 3 1.8 0.7 0.4 0.1 0.2 0.1 0.2 0.2 0.3 0.2 0.2 0.2 0.1
21.8 19.2 15.9 13.1 13.6 10.5 9 6.8 4.9 8 5.8 10.6 10.5 7.1 6.2 2.1 1.2 0.4 0.1 0.1 0.1 0.2 0.1 0.1 0.6 0.4 0.3 3.5 2.3 0.7 0.4 0.2 0.3 0.2 0.2 0.2 0.2 0.2 0.2 0.1
23.4 19.9 15.4 11.9 10.9 10.1 7.7 4.5 4.5 7.3 3.1 11.2 10 8.1 6.8 2.3 1 0 0 0.1 0.1 0.2 0.1 0.1 0.6 0.5 0.3 3.5 1.5 0.6 0.2 0.2 0.3 0.2 0.3 0.3 0.2 0.2 0.2 0.1
21.4 19 18.1 12.6 11.7 10 8.3 7.2 4.8 7.8 3.6 10 10.4 9 6.8 1 0.8 0.3 0.1 0 0.1 0.2 0.1 0.1 0.5 0.4 0.2 2.3 1 0.6 0.4 0.2 0.3 0.2 0.2 0.3 0.2 0.2 0.2 0.1
21.6 19.5 17.7 12.3 10.2 9.8 8.4 6.7 4.3 7.5 4.7 10.3 9.1 7.6 5.9 1.3 1.3 0.5 0.1 0.1 0.1 0.1 0.1 0.1 0.5 0.4 0.2 2.1 2.2 0.4 0.2 0.1 0.2 0.2 0.2 0.1 0.2 0.2 0.2 0.1
24.5 22.7 16.2 13.2 15.9 12.4 9.4 7 5 9.2 3.4 12.4 10.4 9.4 7.5 2.5 1.4 0.6 0.1 0.1 0.1 0.1 0.1 0.1 0.5 0.4 0.2 3.7 1.3 0.8 0.4 0.2 0.3 0.1 0.2 0.3 0.2 0.2 0.2 0.1

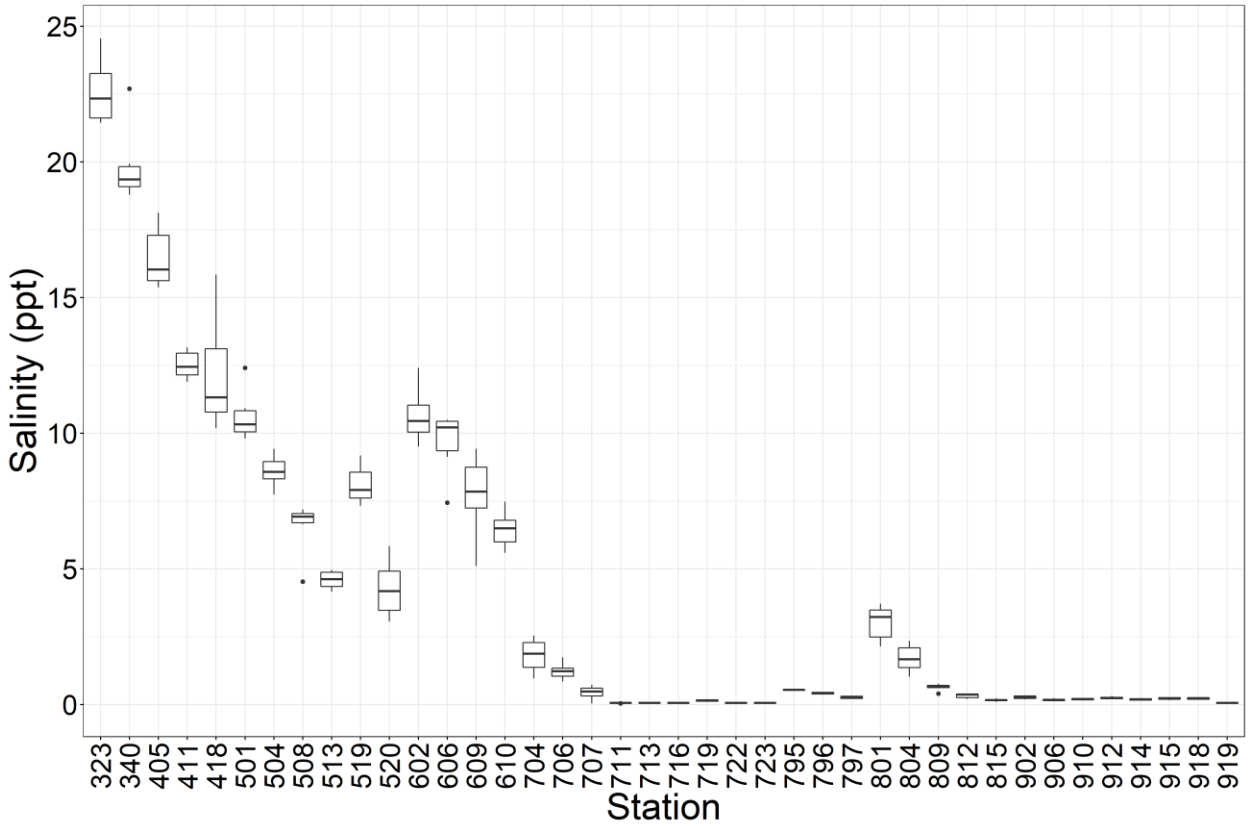

Salinity (ppt)
0
5
10
15
20
25
Station
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919

Figure 5. Top salinity (ppt) transformed from conductivity (µS/cm) measured at each STN station (index and non-index) in 2022. Red shading (top) indicates sea water transitioning to yellow as salinity decreases into freshwater ranges. The range (bottom) of salinity values at each station was greatest in western stations where tidal influence was greatest.

Salinity (Figure 5, above) in the Delta increased with proximity to San Pablo Bay. From Suisun Bay to the convergence of the San Joaquin and Sacramento River stations salinity was more variable, reflecting tidal influences in this region. Most stations did not have extreme differences in salinity between the surface and bottom zones of the water column (Figure 6, below) except in the western most region of the STN sampling range.

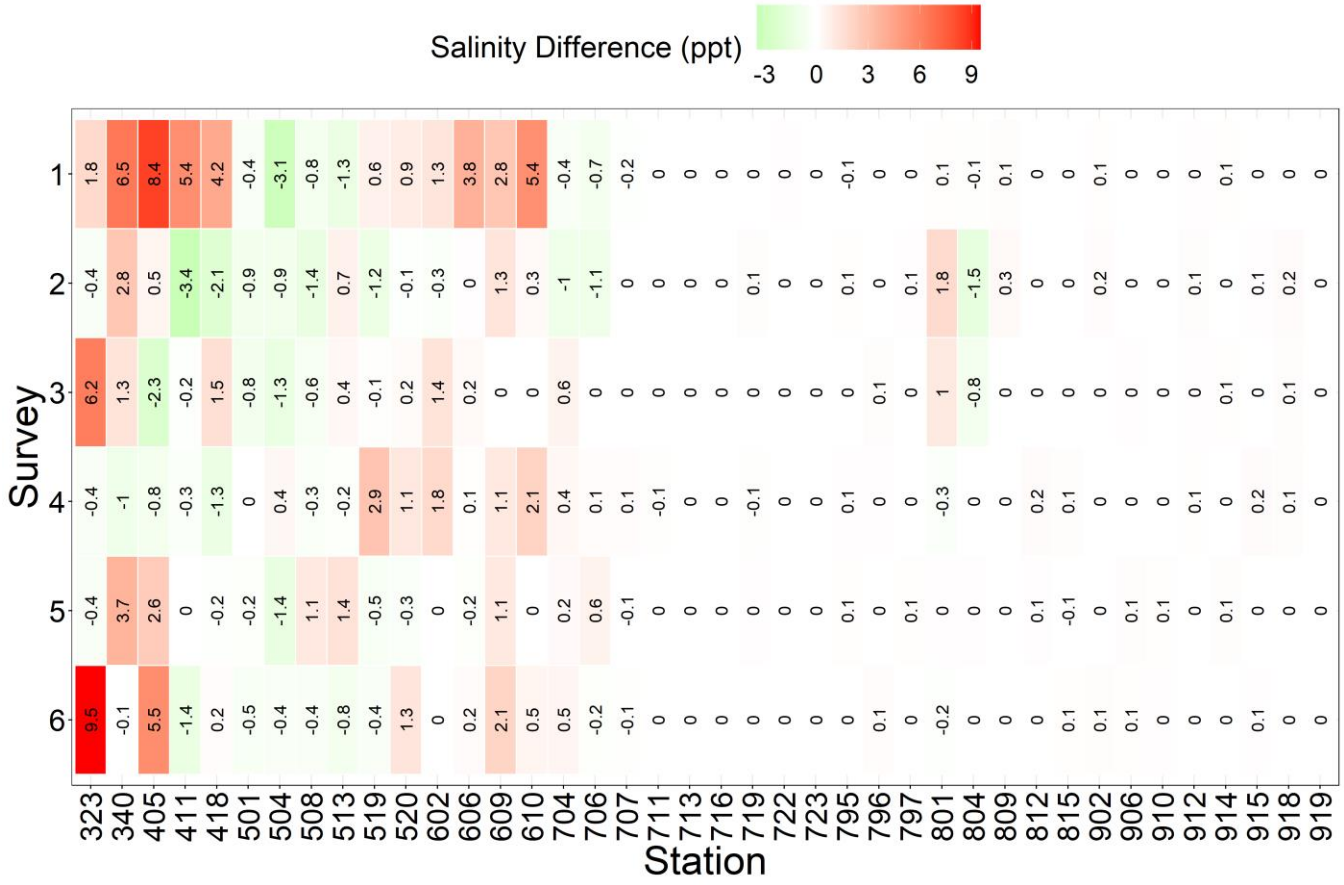
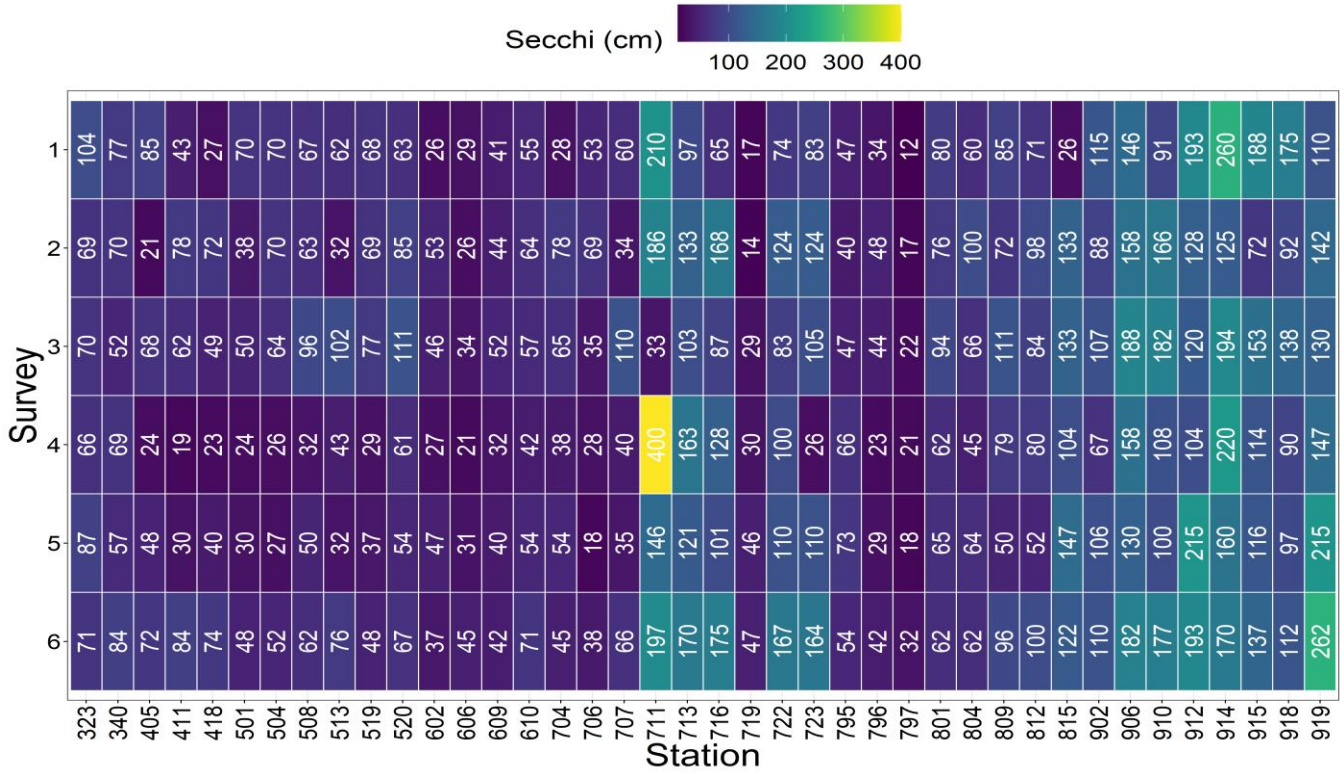


Figure 6. Salinity (ppt) differences within the water column between the surface and bottom. Negative (green) values indicate greater salinity lower in the water column while positive (red) values indicate greater salinity in the surface.


Secchi (cm)
100 200 300 400
Survey
1 2 3 4 5 6
Station
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919
1: 104 77 85 43 27 70 70 67 62 68 63 26 29 41 55 28 53 60 210 97 65 17 74 83 47 34 12 80 60 85 71 26 115 146 91 193 260 188 175 110
2: 69 70 21 78 72 38 70 63 32 69 85 53 26 44 64 78 69 34 186 133 168 14 124 124 40 48 17 76 100 72 98 133 88 158 166 128 125 72 92 142
3: 70 52 68 62 49 50 64 96 102 77 111 46 34 52 57 65 35 110 33 103 87 29 83 105 47 44 22 94 66 111 84 133 107 188 182 120 194 153 138 130
4: 66 69 24 19 23 24 26 32 43 29 61 27 21 32 42 38 28 40 400 163 128 30 100 26 66 23 21 62 45 79 80 104 67 158 108 104 220 114 90 147
5: 87 57 48 30 40 30 27 50 32 37 54 47 31 40 54 54 18 35 146 121 101 46 110 110 73 29 18 65 64 50 52 147 106 130 100 215 160 116 97 215
6: 71 84 72 84 74 48 52 62 76 48 67 37 45 42 71 45 38 66 197 170 175 47 167 164 54 42 32 62 62 96 100 122 110 182 177 193 170 137 112 262

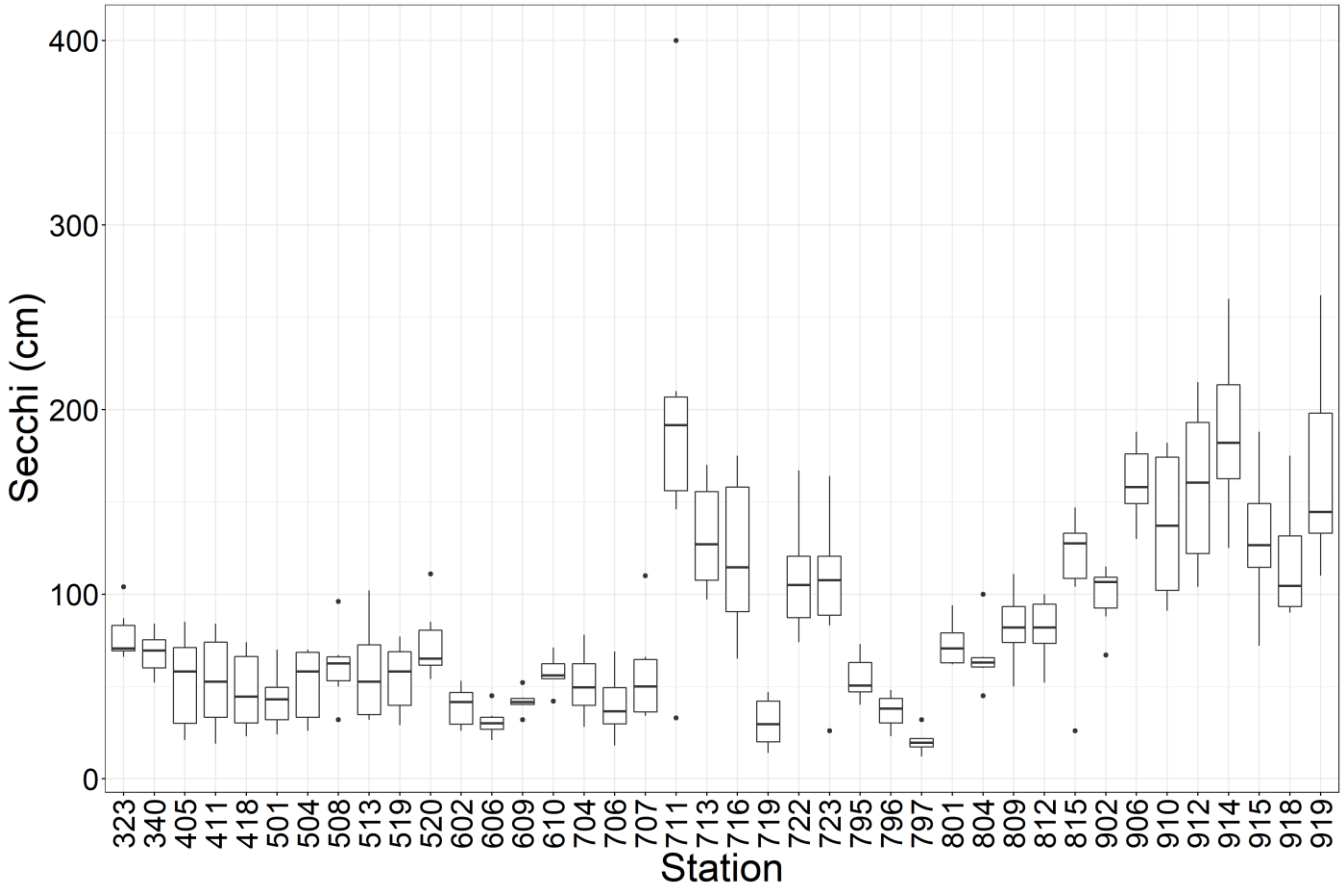

Secchi (cm)
0 100 200 300 400
Station
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919

Figure 7. Water clarity, measured in cm by Secchi disk, over all surveys at each station (top) and the distribution of Secchi readings over the whole season (bottom).

Secchi (Figure 7) and turbidity (Figure 8) values varied spatially but also across survey. Station 405 and the Sacramento River Deep Water Ship Channel (SDWSC) (719, 795-797) had the lowest secchi values and the highest turbidity readings. In addition, survey 4 had greater turbidity values than the other surveys.

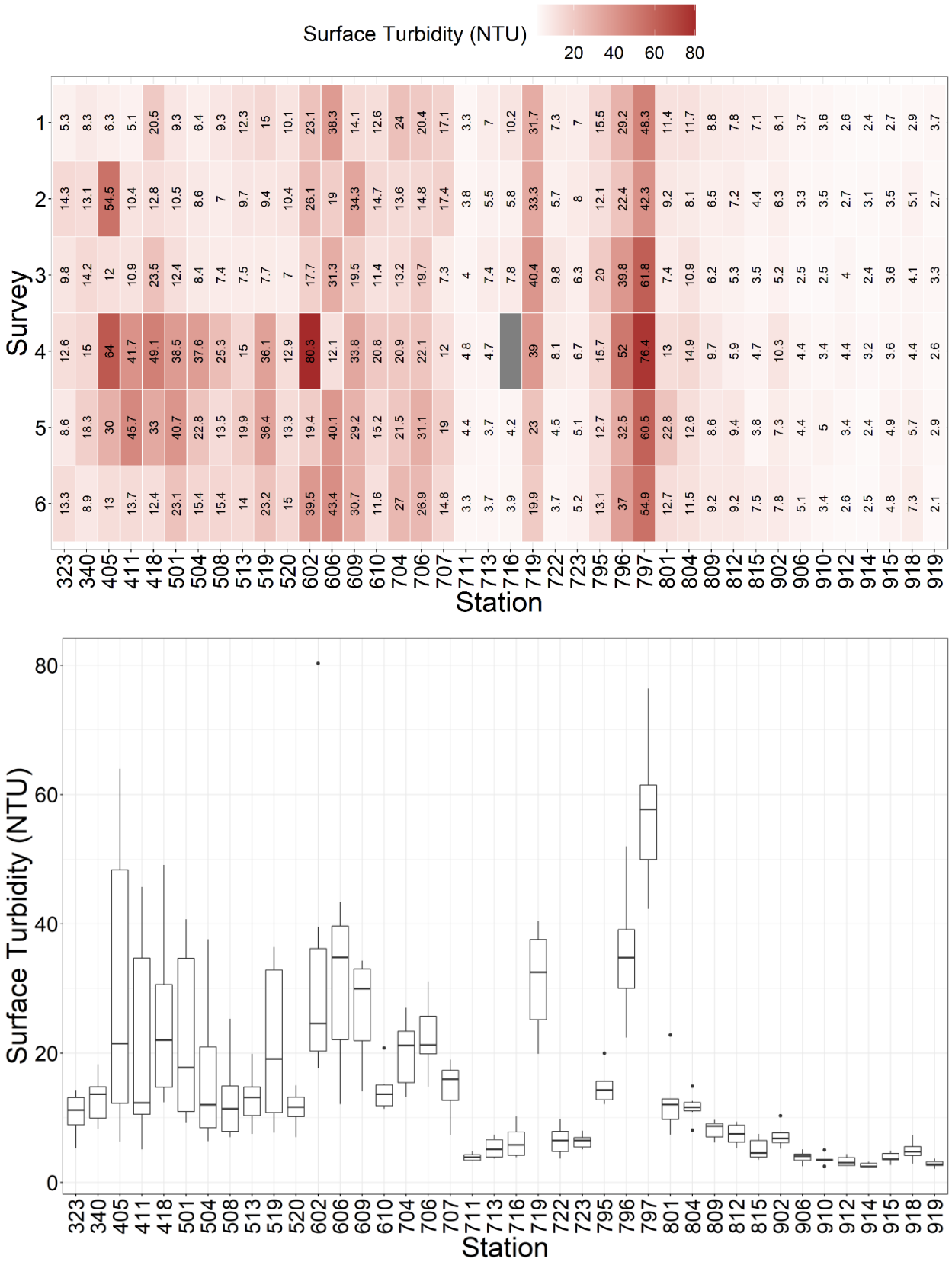

Surface Turbidity (NTU)
20
40
60
80
Survey
1
2
3
4
5
6
Station
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919
Surface Turbidity (NTU)
0
20
40
60
80
Station
323 340 405 411 418 501 504 508 513 519 520 602 606 609 610 704 706 707 711 713 716 719 722 723 795 796 797 801 804 809 812 815 902 906 910 912 914 915 918 919

Figure 8. Surface turbidity (NTU) across station and survey (top) and the overall distribution at each survey (bottom). Grey tiles within the top plot represent missing turbidity readings.

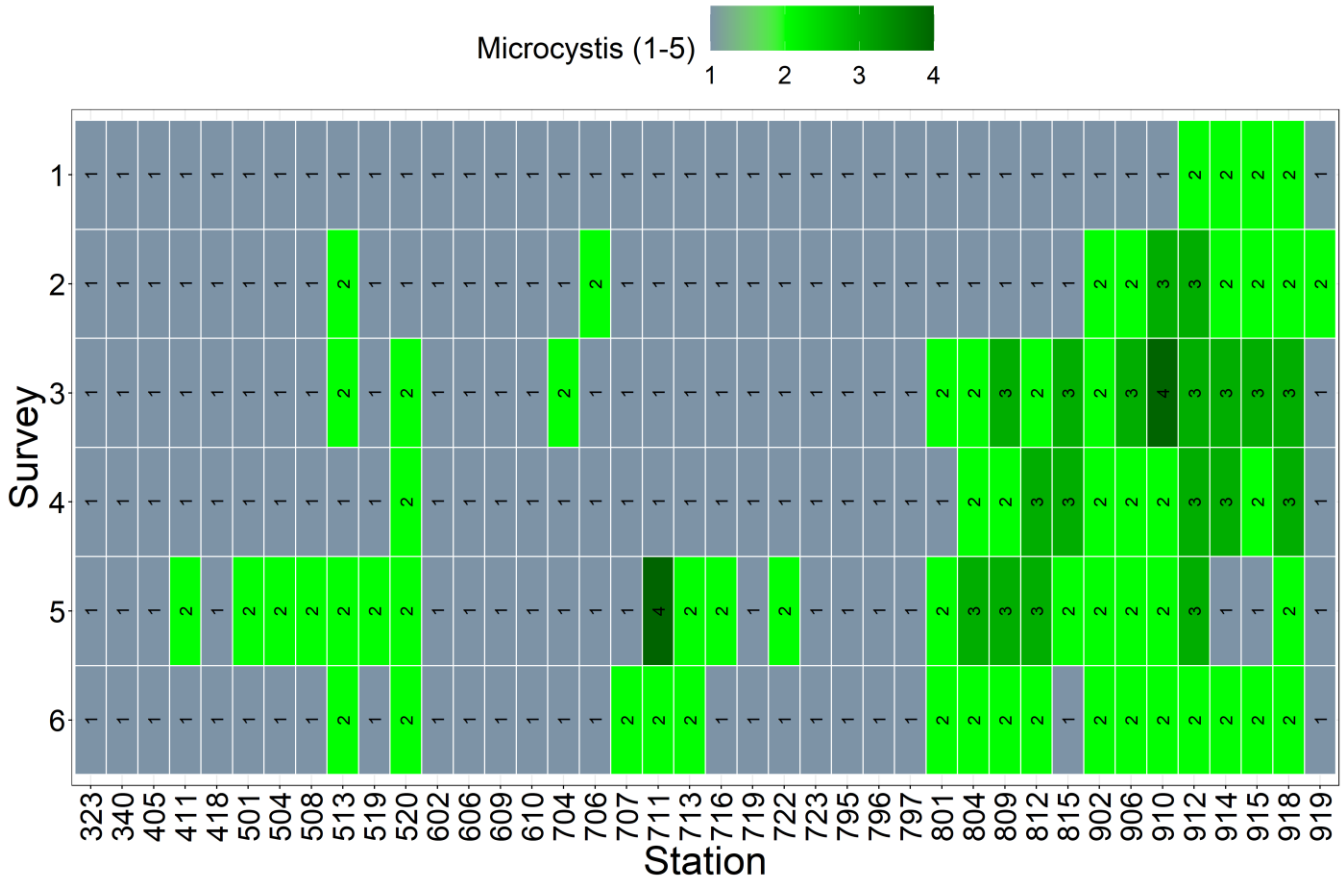


Figure 9. Ranking of Microcystis presence at each station, over each survey. 1 is an absence of Microcystis (blue) and 5 is the highest presence of Microcystis that can be reported (dark green).

Visual observation of *Microcystis* (Figure 9, Appendix 2) in the surface waters was present as individual flakes early as survey 1, within the South and East Delta. *Microcystis* presence increased over time, appearing to peak in early August over most of the STN sampling range. Contrary to previous years, *Microcystis* was only ranked up to 4 with dense flakes, rather than the top value of 5 of a continuous mat (Appendix 2). Even the rank of 4 was only recorded twice, once in survey 3 at station 910 (outside of Stockton, CA) and station 711 in survey 5 (outside of Rio Vista, CA).

Catch Per Unit Effort

Fish

Fish catch increased in 2022, compared to previous years, and this was driven greatly by *Tridentiger* goby catch (Table 3, Fig. 10) in every survey. The total CPUE of *Tridentiger* fishes in 2022 (774.94) increased 5.5x relative to 2021 (141.38 CPUE). By

survey 3, we observed that among the developing *Tridentigers*, Shokihaze gobies were more numerous than Shimofuri gobies. Another notable change in fish catch in 2022 was an increase in Northern Anchovy catch, particularly in survey 4. This may be due to ongoing drought conditions leading to greater salinity intrusion.

Smelt observations were mixed in 2022. Since the STN 2017 sampling season, no Delta Smelt catch has occurred within the Summer Townet sampling range and period. As a result the Delta Smelt index was 0. Longfin Smelt catch however increased in 2022 (8.1 CPUE) compared to 2021 (4.3 CPUE). As with previous years, catch mostly occurred in the first survey with cooler water temperatures.

The category 'Unknown Damaged' (UNID) generally pertains to small damaged larval fish (≤13 mm). Damage can occur during removal from the net prior to preservation, an instance of poor preservation (such as during large catches of other larval fish) or during processing in the laboratory.

Figure 10. A jar of several hundred larval fish collected from one tow at station 706.

Age-0 Striped Bass catch was highest in survey 1 and decreased over time. The total CPUE of age-0 Striped Bass was higher in 2022 than 2021. This is despite a decrease in Striped Bass presence at STN index stations. In survey 3, no Striped Bass were caught at index stations making it impossible to calculate an age-0 Striped Bass index. More details are available in the 2022 Striped Bass Index memo.

Spatially, the highest fish catch (Figure 11) occurred within the Montezuma Slough region (602, 606, 609, and 610; Figure 12) as well as the lower Sacramento River approaching the confluence with the San Joaquin River (704, 706 and 707; Figure 12). These stations were often dominated by *Tridentiger* spp., particularly at station 706 (Figure 10 above) in Survey 3 where total catch reached 5,640 fish. As in previous years, fish catch was also higher in the SDWSC (Figure 12), but still does not approach the high catch observed in the Montezuma Slough or Lower Sacramento River. No fish were recorded at stations 713 or 906.

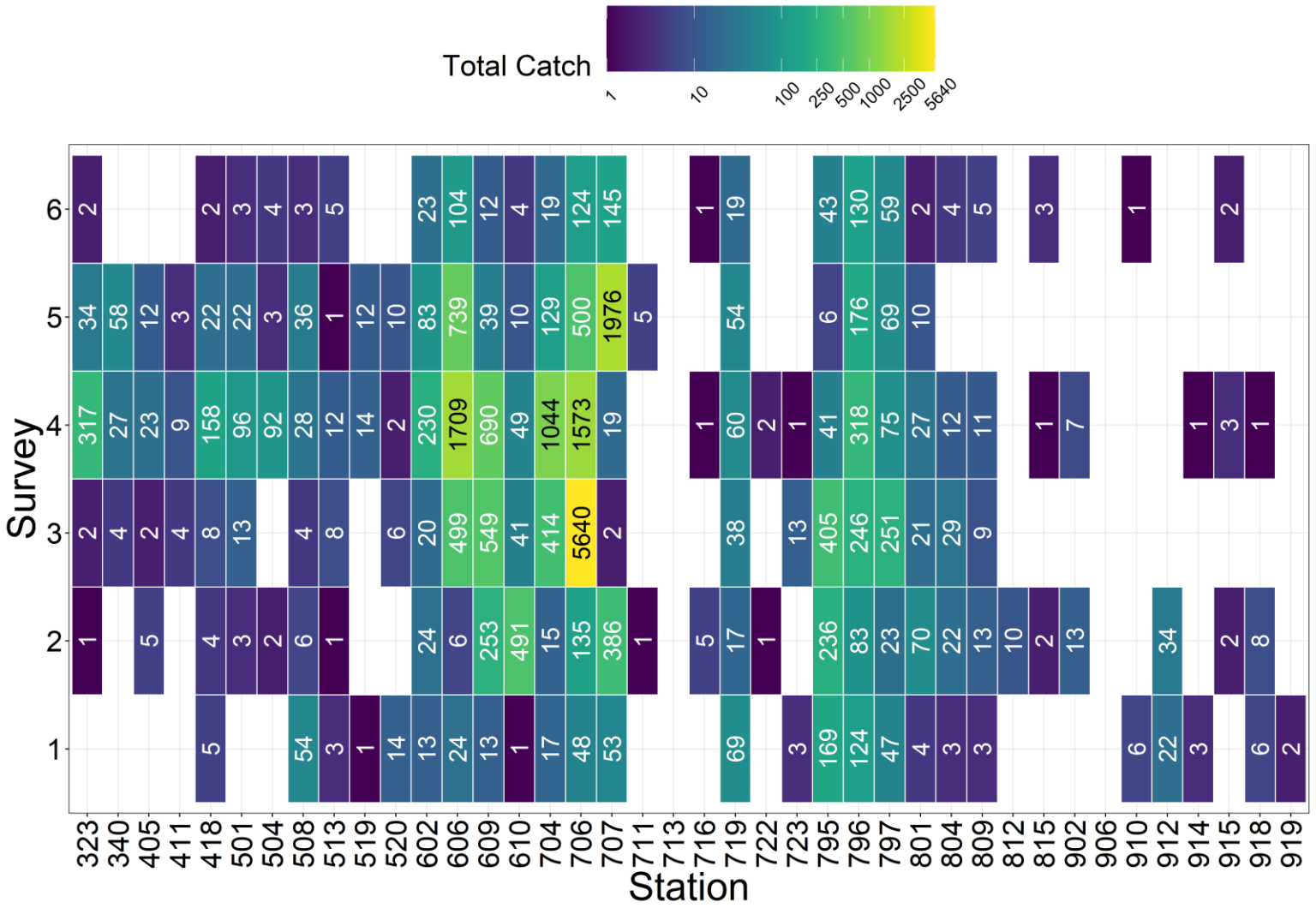


Figure 11. Total fish catch at each station across each survey. Blank fields note zero catch.

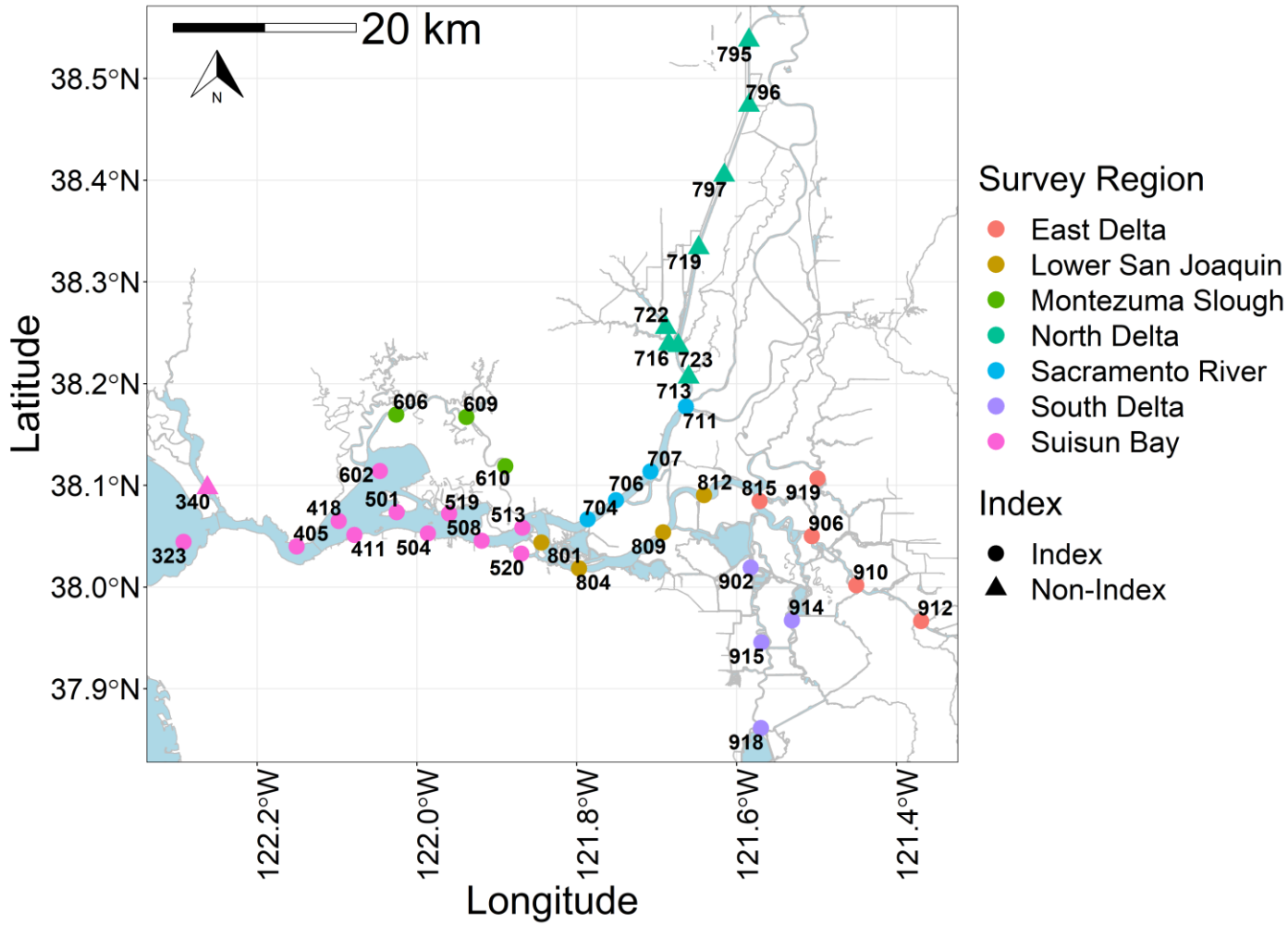


Figure 12. The Summer Townet Survey stations color-coded by regions.

Table 3. Summer Townet fish CPUE (Catch per 10,000 m^3 volume of water) for each survey in 2022, the total seasonal CPUE and the percent of CPUE represented by each taxonomic category.

Common Name	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6	Total CPUE	Percent CPUE
Tridentiger spp.	51.67	415.55	2160.22	1040.18	905.77	101.75	774.94	**70.555**
Shokihaze Goby	0.00	0.10	210.02	540.43	207.87	33.26	168.10	**15.305**
Northern Anchovy	1.97	9.81	11.51	241.87	42.32	23.57	57.17	**5.205**
Threadfin Shad	4.76	20.75	35.08	36.60	43.09	15.20	25.84	**2.353**
Shimofuri Goby	3.42	16.46	83.18	23.17	16.82	8.70	25.05	**2.281**
Age-0 Striped Bass	32.93	21.88	12.60	2.19	0.33	0.66	11.94	**1.087**
Unknown Damaged (UNID)	0.93	10.12	29.97	3.58	17.70	0.77	10.34	**0.941**
Longfin Smelt	46.49	1.02	0.11	0.00	0.11	0.00	8.10	**0.738**
American Shad	17.60	2.96	3.26	1.89	0.22	0.33	4.45	**0.405**
Mississippi Silverside	0.00	10.53	0.22	3.78	1.10	3.41	3.23	**0.295**
Topsmelt	0.00	0.00	0.00	2.39	13.63	0.00	2.60	**0.237**
Yellowfin Goby	0.83	0.92	0.65	5.27	2.42	0.11	1.74	**0.158**
White Catfish	0.10	3.37	4.13	0.40	0.77	0.55	1.55	**0.141**
Wakasagi	1.55	0.82	1.41	2.29	0.33	1.43	1.32	**0.120**
Gobies (Unid)	0.00	0.82	0.22	1.39	0.11	0.00	0.44	**0.040**
Plainfin Midshipman	0.00	0.00	0.00	0.90	0.77	0.11	0.30	**0.027**
Unknown Fish (UNID)	0.10	0.10	0.11	0.00	1.10	0.11	0.25	**0.022**
Jacksmelt	0.10	0.00	0.00	0.20	0.00	0.77	0.18	**0.016**
Pacific Herring	0.41	0.41	0.00	0.10	0.00	0.00	0.16	**0.014**

Common Name	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6	Total CPUE	Percent CPUE
Herring (Unid)	0.10	0.31	0.11	0.20	0.00	0.11	0.14	**0.013**
Three Spine Stickleback	0.10	0.10	0.00	0.00	0.00	0.11	0.05	**0.005**
Largemouth Bass	0.00	0.10	0.00	0.00	0.00	0.22	0.05	**0.005**
Starry Flounder	0.00	0.10	0.00	0.10	0.00	0.11	0.05	**0.005**
Bay Pipefish	0.00	0.00	0.11	0.20	0.00	0.00	0.05	**0.005**
Rainwater Killifish	0.00	0.00	0.11	0.10	0.00	0.11	0.05	**0.005**
Larval *Tridentiger* spp. or Striped Bass (UNID)	0.21	0.00	0.00	0.00	0.00	0.00	0.04	**0.003**
Bluegill	0.00	0.20	0.00	0.00	0.00	0.00	0.04	**0.003**
Splittail	0.00	0.00	0.22	0.00	0.00	0.00	0.04	**0.003**
Chameleon Goby	0.00	0.00	0.00	0.00	0.11	0.11	0.04	**0.003**
Catfish (Unid)	0.10	0.00	0.00	0.00	0.00	0.00	0.02	**0.002**
Hitch	0.00	0.00	0.11	0.00	0.00	0.00	0.02	**0.002**
Bay Goby	0.00	0.00	0.00	0.10	0.00	0.00	0.02	**0.002**
Black Crappie	0.00	0.00	0.00	0.10	0.00	0.00	0.02	**0.002**
Cheekspot Goby	0.00	0.00	0.00	0.00	0.11	0.00	0.02	**0.002**
Pacific Lamprey	0.00	0.00	0.00	0.00	0.11	0.00	0.02	**0.002**

Invertebrates

The 3 most common invertebrates in the Summer Townet catch (Table 4) were all invasive species including the jellyfish *Maeotias marginata and the shrimps Exopalaemon modestus* (Siberian Prawn), and *Palaemon spp*. As is typical, *M. marginata* dominated the invertebrate catch at 42% of the total CPUE, followed by *E. modestus* at 32% of the total CPUE. Native *Crangon* spp. shrimp, as a percentage of catch decreased compared to 2021, however the total CPUE was higher (96.6 CPUE) than the previous two years (2020= 32.6 CPUE and 2021= 70.1 CPUE).

Shrimp were present across the Delta, but sparse within south Delta stations (Figure 13). The highest shrimp catch was at station 606 in Montezuma Slough (Figure 13) and more commonly occurred in the SDWSC (Figure 13). Shrimp numbers also appeared to be greater later in the season during the July and August surveys. Jellies were present mainly within the mixing regions of the Delta; Suisun Bay and the confluence of the Sacramento and San Joaquin rivers (Figure 14). The highest catch occurred in survey 4 at station 508 and was extremely high compared to other stations sampled near this region as well as across the STN season at station 508. Jellies, like shrimp, also appeared to be in greater numbers later in the season, with lower catch occurring in earlier surveys.

Table 4. Invertebrate CPUE (Catch per 10,000 m^3 volume of water) for each survey in 2022, the total seasonal CPUE and the percent of CPUE represented by each taxonomic category.

Taxon	Survey 1	Survey 2	Survey 3	Survey 4	Survey 5	Survey 6	Total CPUE	Percent Catch
Maeotias marginata	0.10	6.95	331.31	597.41	745.94	550.81	367.69	**42.947**
Exopalaemon modestus	126.64	92.21	251.06	326.90	295.26	605.87	279.74	**32.674**
Palaemon spp.	19.88	26.58	26.50	189.06	343.95	69.04	111.69	**13.045**
Crangon spp.	132.65	45.29	13.57	188.56	165.55	26.87	96.60	**11.283**
Polyorchis penicillatus	0.00	0.10	2.39	0.00	0.00	0.00	0.40	**0.047**
Pleurobrachia spp.	0.00	0.00	0.00	0.20	0.00	0.00	0.04	**0.004**

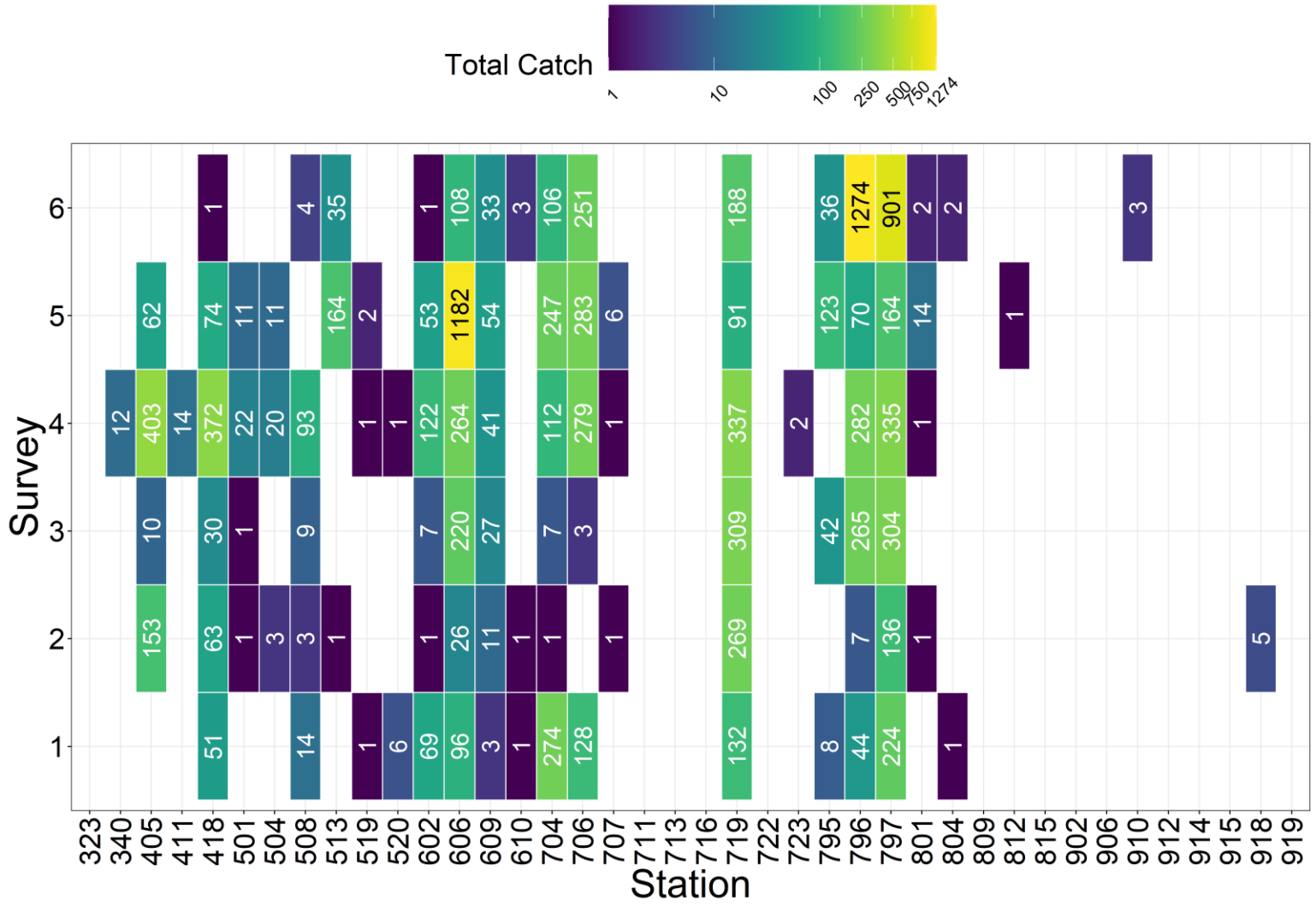


Figure 13. Total Summer Townet catch for shrimp at each station across each survey in 2022. Blank fields indicate zero shrimp catch.

Figure 14. Total Summer Townet catch for jellyfish at each station across each survey in 2022. Blank fields indicate zero jellyfish catch.

Fork Length Frequencies

Fork length frequency histograms for the following fish were extracted from the STN website (1/3/2022). Catch efficiency for STN for fish such as Delta Smelt (Mitchel et al. 2019) have the highest catch efficiency for fish with fork lengths between 20-40 mm. Most other species caught also fall within this range, typically catching young-of-year fish. A subset of these fish (American Shad (*Alosa sapidissima*), Delta & Longfin Smelt, Splittail (*Pogonichthys macrolepidotus*), age-0 Striped Bass and Threadfin Shad (*Dorosoma petenense*)) is presented below using length frequency histograms.

American Shad

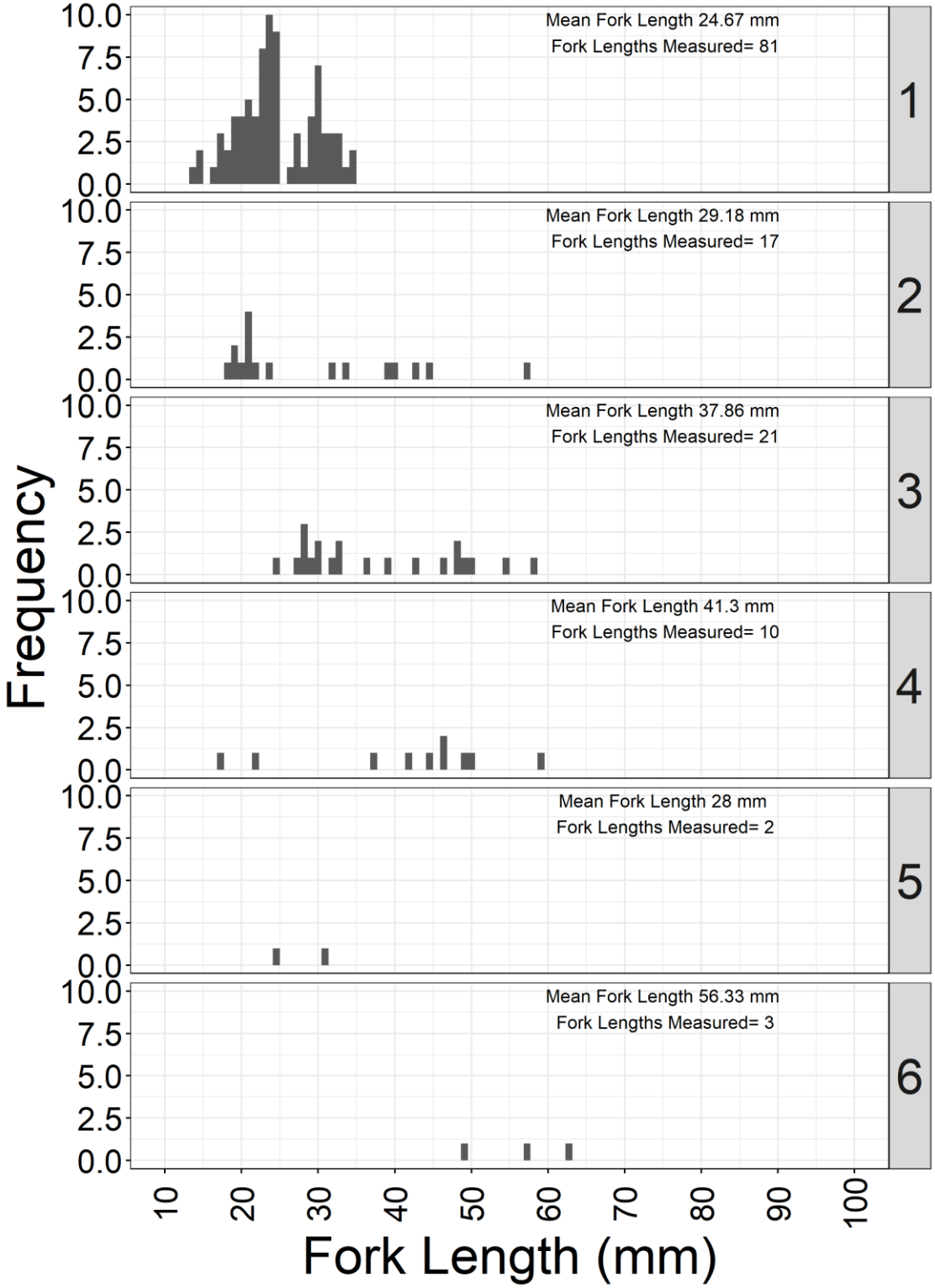


Figure 15. Length (mm) frequency histograms for American Shad among biweekly surveys in 2022. Survey number (right), the number of American Shad fish catch (N) measured and mean fork length are displayed on each histogram.

American Shad were observed in the greatest numbers during survey 1 (Figure 15) and fork length patterns appear to have two peaks in length frequencies and could suggest two separate cohorts (mean 24 mm and a mean of 30 mm). American Shad catch decreased over the STN season, but by survey 6 the mean fork length was 56.3 mm.

Delta Smelt

No Delta Smelt were caught during the 2022 STN survey season. These fish are critically endangered and have not been caught in this survey since 2017.

Longfin Smelt

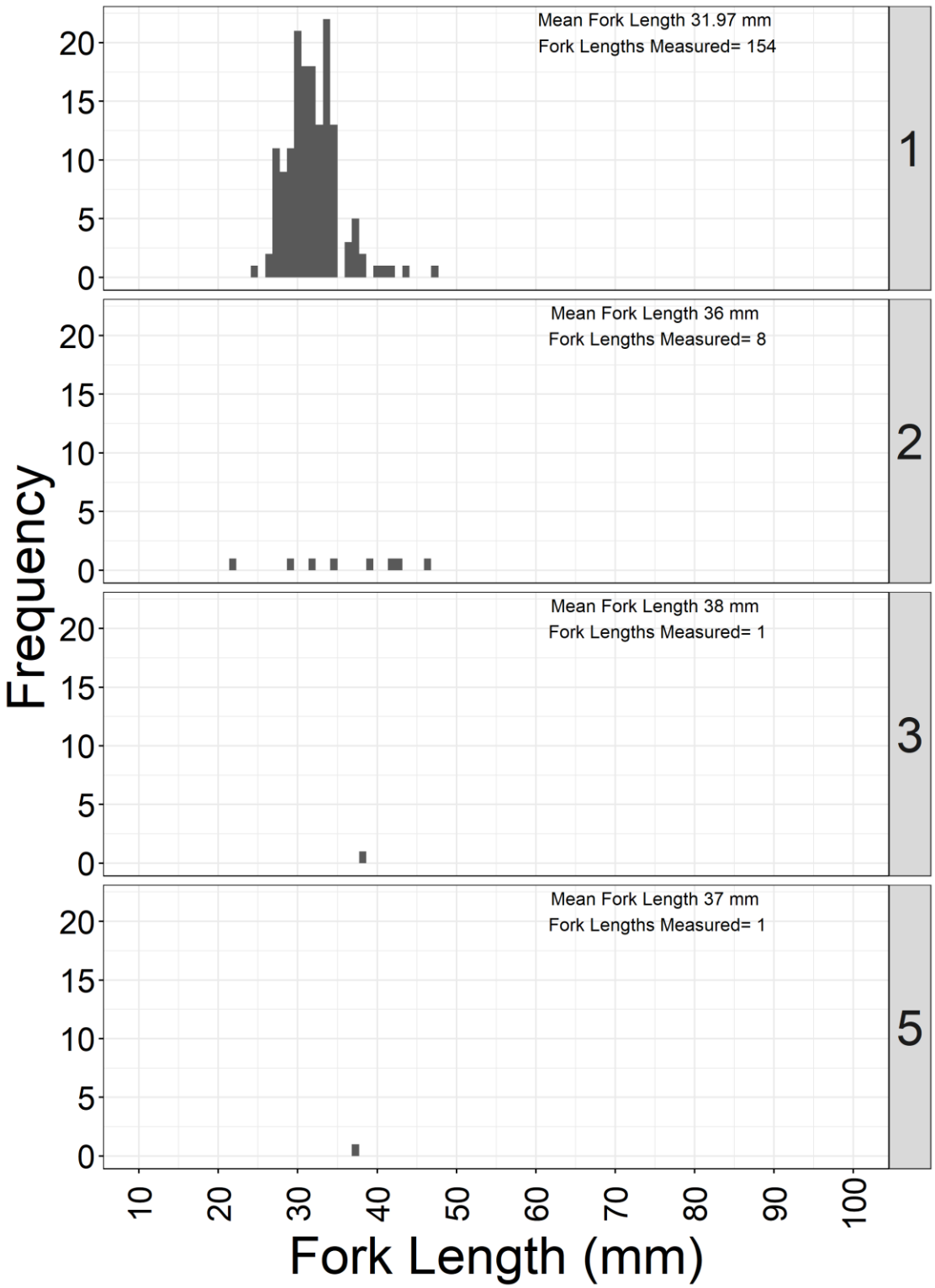


Figure 16. Length (mm) frequency histograms for Longfin Smelt among biweekly surveys in 2022. Survey number (right), the number of Longfin fish catch (N) and mean fork length are displayed on each histogram. Note surveys 4 and 6 had zero catch.

Longfin Smelt were mainly present in survey 1 and catch greatly decreased in survey 2. The mean length of Longfin Smelt was 32 mm in survey 1, however the largest Longfin Smelt (47 mm) caught during the survey was also observed in survey 1. This was most likely an age-1 fish while the majority of Longfin captured were likely age-0.

Splittail

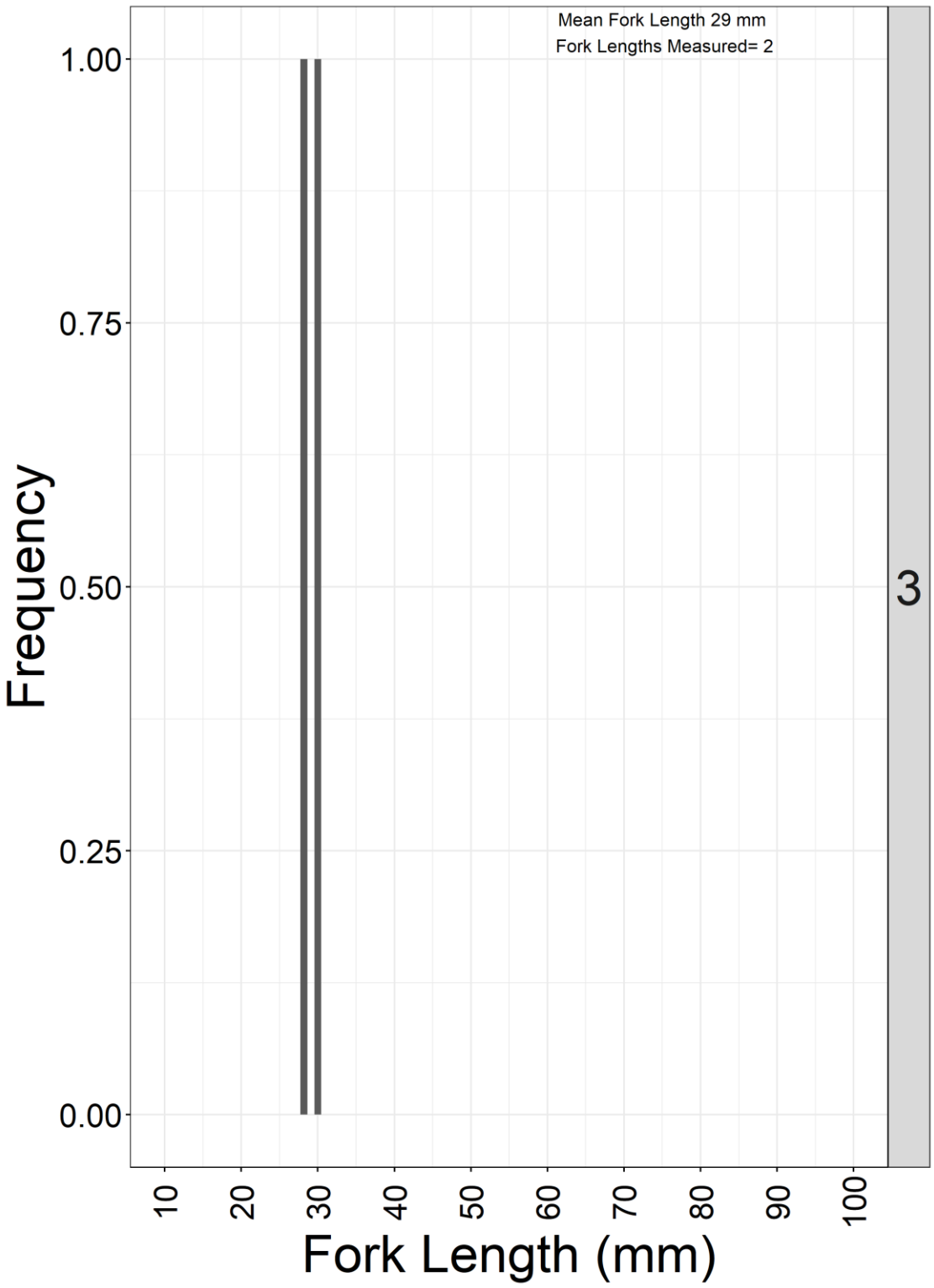

Mean Fork Length 29 mm
Fork Lengths Measured= 2
Frequency
1.00
0.75
0.50
0.25
0.00
3
10
20
30
40
50
60
70
80
90
100
Fork Length (mm)

Figure 17. Length (mm) frequency histogram for Splittail among biweekly surveys in 2022. Survey number (right), the number of Splittail fish catch (N) measured and mean fork length are displayed on each histogram. Note all but survey 3 had zero catch.

Only two splittail (Figure 17) were observed in 2022. Both were sampled in survey 3 near Cache Slough and were 28 mm and 30 mm. Splittail are not commonly caught by the Summer Townet Survey.

Age-0 Striped Bass

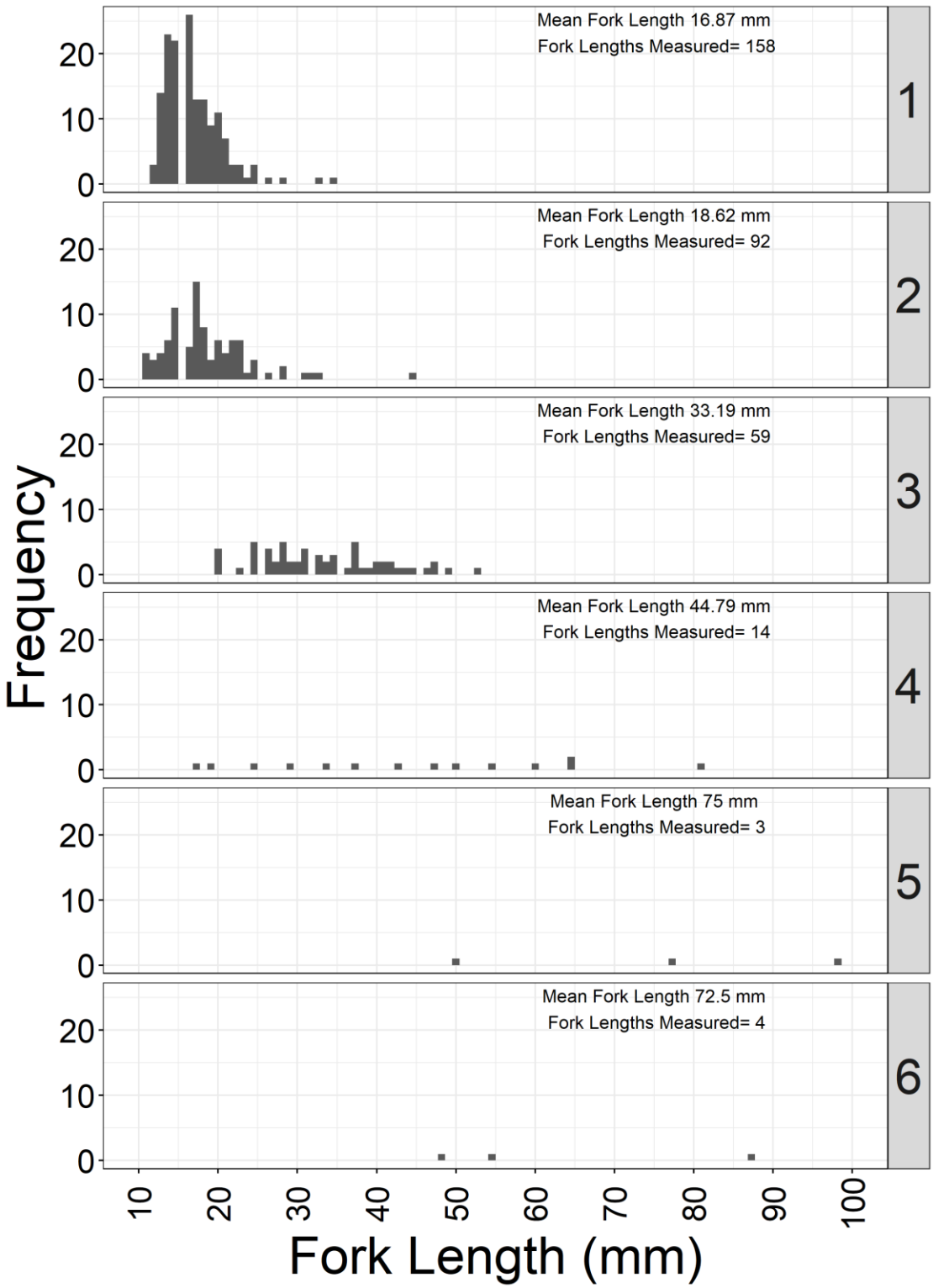


Figure 18. Length (mm) frequency histograms for Age-0 Striped Bass among biweekly surveys in 2022. Survey number (right), the number of Age-0 Striped Bass fish catch (N) measured and mean fork length are displayed on each histogram.

Striped Bass were caught in large numbers during surveys 1-3 but catch quickly dropped off during the second half of the Summer Townet Season (July-August). A single peak in the histogram may suggest that STN observed the presence of only one cohort of young Striped Bass in 2022.

Threadfin Shad

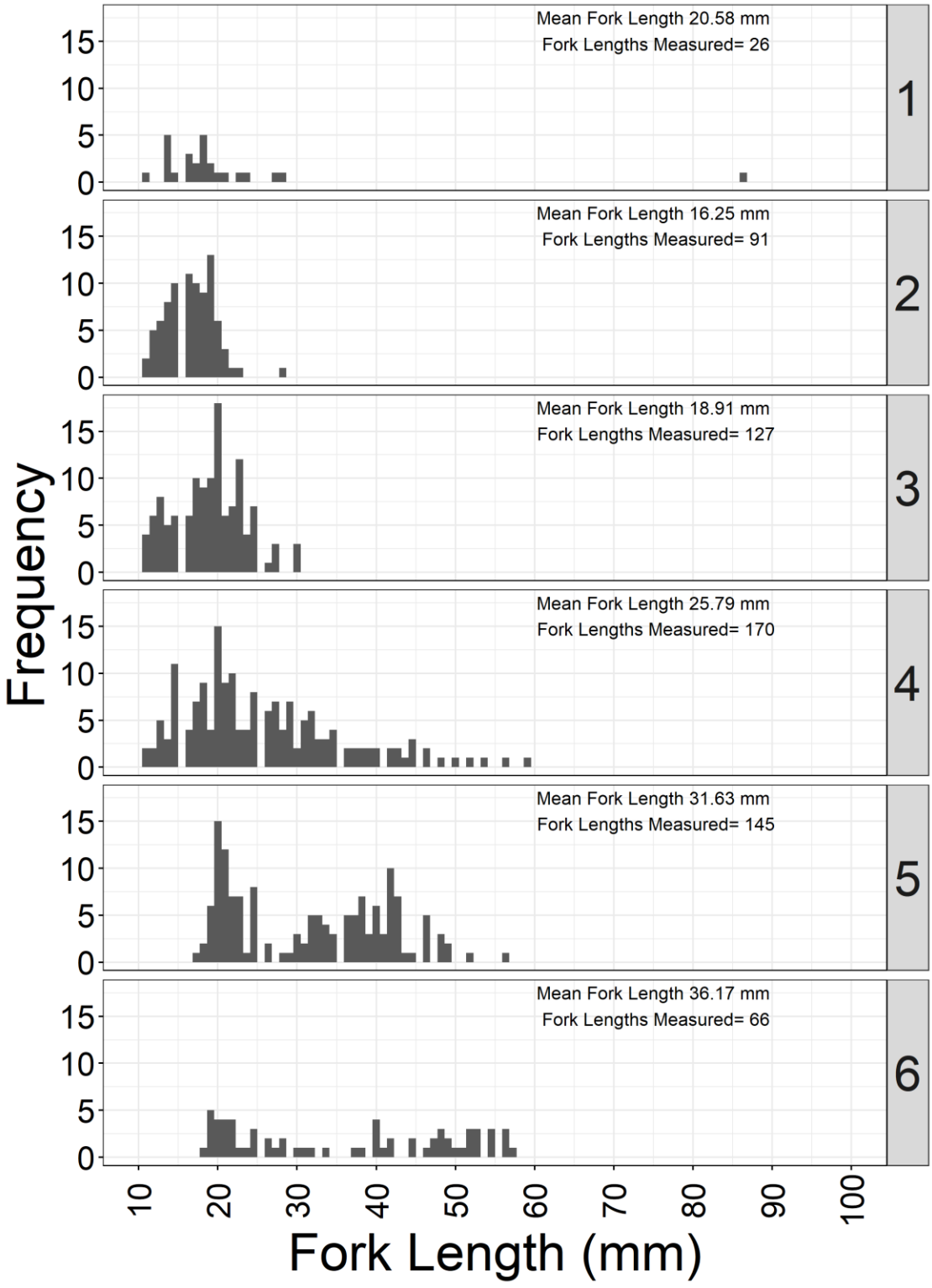


Figure 19. Length (mm) frequency histograms for Threadfin Shad among biweekly surveys in 2022. Survey number (right), the number of Threadfin fish measured (N) and mean fork length are displayed on each histogram.

Threadfin Shad (Figure 19) were caught consistently throughout the STN 2022 season. Shad catches took off in survey 2 (n= 103), with a mean fork length of 16.3 mm. By Survey 4, Threadfin Shad ranged in lengths between 11-59 mm. In survey 5 and 6, two peaks in fork length frequencies are observed, possibly indicating multiple cohorts of Threadfin Shad.

Acknowledgements

This work was conducted under the auspices of the Interagency Ecological Program. Funding for the Summer Townet Survey was supported by contracts with the Department of Water Resources and the US Bureau of Reclamation. Many individuals were involved with the success of the 2022 Summer Townet Survey including: Steve Slater, James White, Spencer Breining-Aday, Nene Ugbah, Ken Flowers, Ramiro Soto, Mike Grady, Spencer Lewis, Paul Macias, Dave Hull, Kevin Juranek, Zach Liddle, Trevin Li, Tricia Bippus, Margaret Johnson, Denisse Anaya, Allegra Rocha, Jorge Chagoya, and Jimmy Pham.

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Appendices

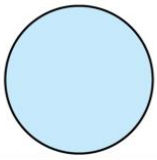
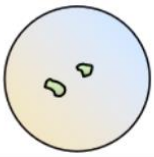
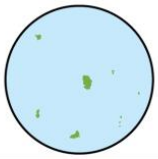
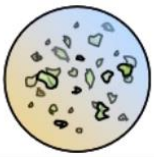
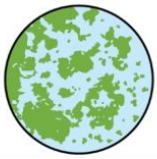
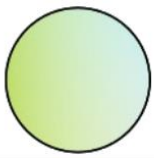
Appendix 1. List of quantitative and qualitative environmental variables measured by Summer Townet Survey.

Variable	Type	Values	Units
Tidal state	Qualitative	High Slack, Ebb, Low Slack, Flood	n/a
Station depth	Quantitative	Nearest foot	feet
Tow direction	Qualitative	with, against, unknown (relative to current)	n/a
Weather	Qualitative rank	1= cloud coverage 0-33%, 2= cloud coverage 33-66%, 3= cloud coverage 66-100%, 4= raining	n/a
Wave status	Qualitative rank	1= calm, 2= waves without whitecaps, 3= waves with whitecaps	n/a
Wind direction	Qualitative	N, NE, E, SE, S, SW, W, NW, N/A	n/a
Secchi depth	Quantitative	Nearest cm	cm
Microcystis spp.	Qualitative rank	1= absent, 2= low, 3= medium, 4= high, 5= very high	n/a
Microcystis spp. Present in CB	Binomial	0= Absent, 1=Present	n/a
Bottom water temperature	Quantitative	Nearest tenth of degree	°C
Bottom water electrical conductivity (proxy for salinity)	Quantitative	Nearest whole value	specific conductance µS/cm ; normalized @ 25°C
Top water temperature	Quantitative	Nearest tenth of degree	°C
Top water electrical conductivity (proxy for salinity)	Quantitative	Nearest whole value	specific conductance µS/cm ; normalized @ 25°C
Top water turbidity	Quantitative	Nearest tenth of value	Nephelometric Turbidity Unit (NTU)

Appendix 2. Microcystis spp. ranking scale.

Update to Microcystis Scale Graphics

Revised 1/30/2020

Old Graphic	Updated Graphic	Score
		**1 – Absent** No visible *Microcystis* colonies
		**2 – Low** Visible but widely scattered *Microcystis* colonies.
		**3 - Medium** Adjacent colonies of *Microcystis*.
		**4 - High** Contiguous colonies of *Microcystis*.
		**5. Very High** Concentrated contiguous colonies of *Microcystis* forming mats or scum.

Graphics for the Microcystis Scale were updated using Adobe Illustrator based on photographs of *Microcystis* blooms found in peer-reviewed online publications.

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USGS. Photograph taken by Jennifer L. Graham, June 29, 2006. Downloaded on 1/30/2020 from https://toxics.usgs.gov/highlights/algal_toxins/.