Interagency Ecological Program San Francisco Estuary 20 mm Survey (20 mm) **(FISH)** Metadata

Contents

Study Management

IEP Study Name: 20-mm Survey

Program element: 033

Agency: Department of Fish and Wildlife, Bay Delta Region (R3)

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Study Overview

Purpose/Objective: The 20mm Survey monitors post-larval **(Should this say larval...? which is it post-larval or larval)** and juvenile Delta Smelt distribution and relative abundance throughout their historical spring range in the Sacramento-San Joaquin Delta and San Francisco Estuary (Bay-Delta Estuary). The data is also used to help estimate larval and juvenile Delta Smelt and Longfin Smelt entrainment at the State Water Project (SWP) and Central Valley Project (CVP). This document contains metadata for **only the fish data** of the 20 mm survey.

Data collected: Surface water temperature (°C), surface and bottom electro-conductivity (EC, μS/cm, normalized at 25 °C), Secchi depth (cm), water volume (m^3), tidal stage, and identification, counts, and

lengths (mm, fork lengths or total length for species without a forked tail) of fishes to the lowest possible taxon.

Geographic range of work: The 20mm Survey currently samples 47 stations every other week from March to July. These stations are distributed 1 station in east San Pablo Bay, 6 in the Napa River, 16 in Suisun Bay/Confluence region, 12 in the Sacramento River/Cache Slough/Deep Water Ship Channel region, and 12 in the South and Central Delta. During high outflow years, 5 additional stations are sampled in San Pablo Bay to provide greater spatial coverage of potential Delta Smelt habitat.

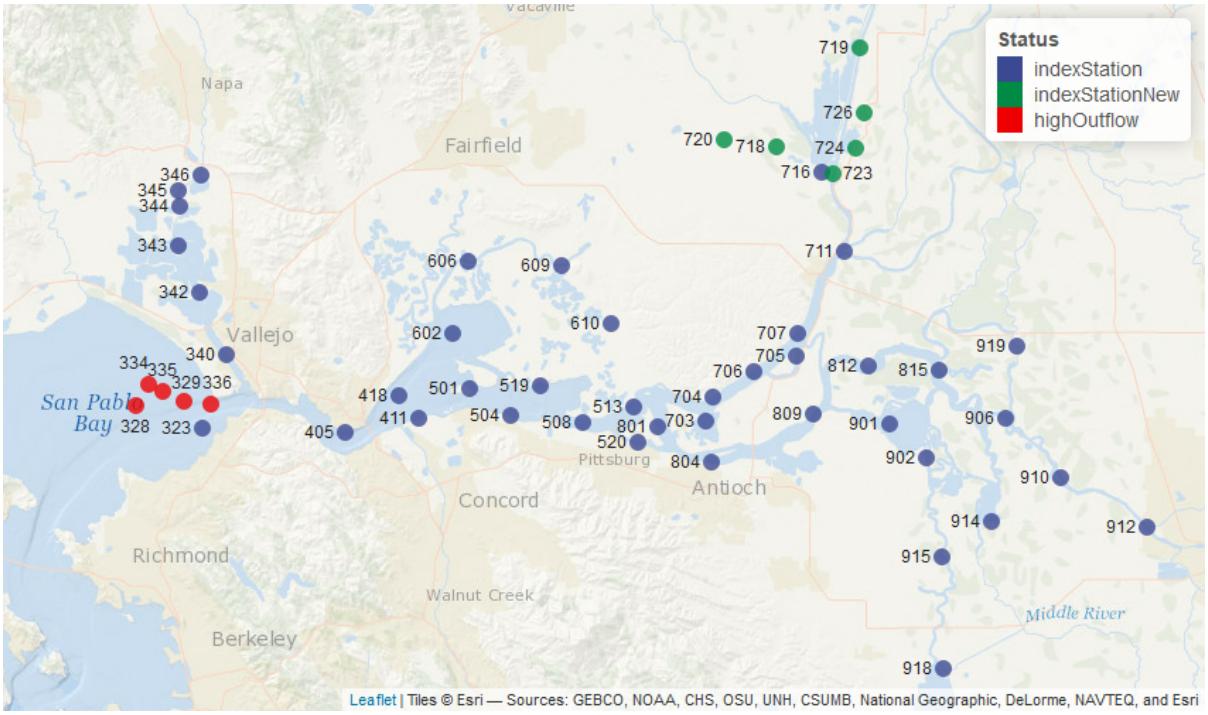

Figure 1: The geographic range of work of the 20mm Survey. Each point represents the location of a sampling station, totalling to 52 stations of primary interest. Stations are colored according to their relationship to the 20mm Index calculation, where blue represents stations that have been included since the advent of the calculation, green since 2022, and red represents high outflow stations that are not included.

Number of sites: 47 stations that are sampled yearly. During high outflow years, 5 additional stations are sampled. See the metadata section for additional details of each station.

Data range: 1995-04-24 to 2021-07-16 (YYYY-mm-dd)

Sampling frequency: Sampling begins in March/April and is conducted *every other week*. Sampling ends in July or Agust **(What are these specific ending conditions?)**. Standard sampling surveys are numbered 0-9, while supplemental sampling surveys are identified as ≥ 10.

Field Sampling Methods

Net: The 20mm Survey samples for both fish and zooplankton across multiple tows per site. A 20-mm net targets larval and juvenile fish and is a conical plankton net that is 5.5 meters (m) in length, has a mouth area of 1.51 m^2, and features a 1600 μm (1/16 in.) knotless nylon Delta mesh (35 lb. test). Fish are collected into a removable 2.2 L screened (474 μm stainless steel wire bolting cloth) cod-end jar attached to the deepest part of the net. Zooplankton are sampled concurrently with the fish net using a Clarke-Bumpus (CB) net attached to the top of the 20-mm net frame. The CB net is 78 cm in length, has a mouth area of 0.010101 m^2, and features a 160 μm knotless nylon mesh. Similar to fish, zooplankton are collected into

a removal **XXXX** L screened cod-end jar attached to the deepest part of the CB net. **(I could remove this information about the CB since this is fish only metadata?)** General Oceananics flowmeters are mounted in the mouth of the 20-mm and CB nets to estimate the volume (m^3) of water sampled by each net. After each tow, the entire sample is transferred into a labeled holding jar containing 10% formalin neutralized with sodium borate. Rose Bengal dye is added to each jar to aid in separating animals from detritus for identification under a microscope in the laboratory.

NEEDED? Was this the same for the 20 mm like the SLS?: The mesh size was altered prior to the 2014 season to 500 μm NitexR, when the original mesh size was no longer available and new nets were purchased (see 2014 changes below). These new nets were incorporated as old nets became unusable. The net is mounted on a fixed metal tube frame with skids and is connected to the frame by a canvas mouth. At the end of each tow, net contents are washed into a cod-end jar attached to the deepest part of the net.

Tow: Up to three replicate 10 minute stepped oblique tow with the boat moving at 1 m/s **(AGAINST THE CURRENT?)** to keep the CB net completely submerged is conducted at each sampling location. Specifically, fish are sampled across all tows, while zooplankton are typically sampled only once during the first tow. The amount of cable released is dependent on the water depth at the sampling location. A gradual oblique tow is achieved following the tow schedule specific to the amount of cable released and the duration of the tow. Although most tows are 10 minutes in length, tow time can be reduced during periods of heavy samples. If the net is clogged during algal blooms, jellyfish blooms, or heavy debris events and the cod end jar is overfilling with materials, the tow time can be reduced to 5 or 2.5 minutes and follow an alternate tow schedule and recording the duration on the datasheet. If materials are still overflowing from the cod-end jar in a 2.5 minute tow, the tow or entire station is dropped. Re-tows do occur if a sample is compromised, the flow meter of the fish net reads less than 10000 or greater than 30000 in a 10 minute tow, or the flow meter of the CB net reads less than 5000 or greater than 25000 in a 10 minute tow. All abnormal events are to be recorded in the "comments" section of the datasheet.

Flowmeter calibration: General Oceananics flowmeters are used to estimate the volume of water sampled by each net. This calculation relies on a calibration factor specific to the flowmeter model that equates the rotor constant with the number of counts. Prior to 2015, the calibration factor each every flow meter was calibrated at UC Davis before the start of the season. Beginning in 2015, the calibration flume at UC Davis became inoperable, and the meters were sent to General Oceanics for refurbishing before each field season to justify using the factory calibration factor. Since 2019, meters are inspected at the end of every field season and are replaced with new units if refurbshing is required–this ensures that the factory calibration factor can continue to be used to estimate tow volume.

Environmental and water quality data: Immediately prior to each tow, bottom and surface water samples are indepedently collected. The bottom water sample is taken using a Van Dorn into a bucket, while the surface water sample is taken directly using a separate bucket. From these water samples: 1) surface water temperature (°C) and surface and bottom EC (μS/cm, normalized at 25 °C) are recorded using a calibrated (before each season) and rinsed YSI Model 30; and 2) surface turbidity (NTU) is recorded using a calibrated (before each season) HACH 2100p turbidity meter (sample vials are cleaned with a Kimwipe before each sample). Secchi depth (m) is measured using Secchi discs mounted to rigid meter sticks to a maximum depth of two meters; values are measured by the same person off the side of the boat in the shade without sunglasses on for the entire day to maximize consistency. Water bottom depth (ft) is recorded using a depth finder on the boat. Tide data is recorded as the visually observed tidal stage by the crew during the tow as high slack, ebb, low slack, or flood.

Catch data: At the end of every tow, the net is washed down so that all visible vegetation, fish, sand, and debris are collected into the cod-end jar. Large debris and fish ($\geq$ 50 mm) can be removed if positively identified. When salmonids are caught, fork lengths are measured, presence of the adipose fin noted, and the fish are immediately released gently and alive. All other larval and juvenile fish are kept in distinctively labeled sampling jars and preserved in 10% buffered (sodium borate) and dyed (rose bengal) formalin for later processing in the laboratory.

Lab analysis, fish ID and QC

In the lab, before the next survey if possible, fish are identified from each sample under a microscope by trained lab staff. First, fish are separated from debris and other organisms during a process named "sorting". Then, the entire sample undergo a quality control (QC) check to ensure that fish were not missed during sorting. Finally, fish undergo ID and count by an identifier, which can be followed by a QC from a larval fish ID specialist to confirm all species identifications and counts. This ID QC process is dependent on the experience of the identifier doing the first ID. Fish identifiers will begin with all their identifications QC'ed and transition to having fewer and fewer samples QC'ed with experience, until the identifier is considered themselves a larval fish ID specialist. Samples are randomly selected to undergo this QC process. Across all samples (QC required or not), all CESA and ESA fishes and any questionable fish IDs must undergo a second ID. All fish are identified to species or the lowest possible taxon. Since the inception of the survey, *there have not been instances* **(IS THIS STILL CORRECT FOR THE 20 MM?** when of a species has been identified to a lower taxon or identified under a different name. Only the first 50 randomly selected individuals of each species from each tow are measured for lengths to the nearest millimeter, and the rest of the sample is simply enumerated. However, all Longfin Smelt and Delta Smelt are measured for lengths regardless of catch size **WILL THIS STILL BE TRUE? I remember there was talk about perhaps not doing this for LFS as you can catch thousands at some stations**.

Calculating catch per unit effort (CPUE)

Fish

The total number of fish per volume water sampled (standardized to 10000 m^3) across all replicate tows is calculated using the following equations:

$$V_t = A * K * D_t$$

Where:

V_t = volume of water (m^3) filtered through the net per tow t

A = mouth opening of the net (1.51 m^2)

K = calibration factor of the flow meter, 0.026873027 since 2015

D_t = difference in flow meter counts from start to finish of tow t

$$n_t = F_t/V_t * 10000m^3$$

Where:

n_t = number of fish per 10000 m^3

F_t = fish caught per tow t

V_t = volume of water filtered through the net m^3 per tow t

$$N_t = \frac{\sum n_t}{r_t}$$

Where:

N_t = number of fish per 10000 m^3 per tow t

F_t = fish caught per tow t

V_t = volume of water filtered through the net m^3 per tow t

Zooplankton

From 2004-current, the number of each zooplankton taxon per cubic meter sampled by the Clark-Bumpus net is calculated using the following equations:

$$V_t = A * K * D_t$$

Where:

V_t = volume of water (m^3) filtered through the net per tow t

A = mouth opening of the net (0.010101 m^2)

K = calibration factor of the flow meter, 0.026873027 since 2015

D_t = difference in flow meter counts from start to finish of tow t

$$Z = \frac{\sum \frac{C_c X}{V}}{N}$$

where:

Z = the number of zooplankton per m^3

C = the number of zooplankton taxon counted per cell c

X = the sample volume (sample diluation)

V = the volume of water filtered by the net m^3

N = number of cells completed

From 1995-2003, the number of zooplankton per m^3 was calculated as:

$$Z = \frac{\frac{CX}{V}}{S}$$

where:

Z = the number of zooplankton per m^3

C = the number of zooplankton taxon counted per cell c

X = the sample volume (sample diluation)

V = the volume of water filtered by the net m^3

S = the number of Sedgewick-Rafter cells counted

???????????????? Shouldnt this older formula also have $\sum$?

Data management

All field data are entered into a digital Access database using eletronic forms between survey events during the season. Immediately after entry, data undergoes two rounds of 'line-by-line' checks, wherein all data fields are checked against the original datasheets for fidelity. At the end of the survey field season once all the fish samples have been processed in the laboratory and data entry is complete, all data is 'finalized' to be as accurate as possible for public use. The first step in this finalization process is to conduct two additional line-by-lines. Next, a project lead will run a series of coded queries to analyze the underlying data distributions to detect potential outliers in the environmental data. Not all data is changed if it is flagged as an outlier (generally beyond 2 standard deviations of the mean). In most cases, outliers are real data.

These queries simply alert the project lead of potential erroneous data, and care is taken to edit only data that truly needs to be edited, e.g., data that was entered incorrectly or caused by equipment failures. All resulting data edits are documented in a separate log file.

The provided data tables

The "20mmStations.csv", "FishLength.csv", "FishSample.csv", "Gear.csv", "GearCodesLkp.csv", "MeterCorrection.csv", "Station.csv", "Survey.csv", and "Tow.csv" are available "relational tables" from the 20mm Access database. These tables are exported directly from Access in R and the only manipulations were to include relevant columns, fix unicode encoding errors, and fix float-point errors; all underlying data collected in the field and entered into the database remained as-is. The "TMM.csv" file is the integrated dataset that combines these relational tables together. Users should be aware of the units of the recorded values between the relational and integrated tables, as they may differ (documented in the metadata section of the EDI publication page). All steps are coded in R and the relevant codes are provided with the EDI publication and/or housed on trinhxuann/CDFW-IEP-Surveys Github page.

Zero filling

Zero filling is the process of assigning a count value of 0 for instances of no fish catch during a tow. "No fish catch" can be defined as two levels: 1) across all fish species (a tow that catches no fishes at all), or 2) specific to a singular species (a tow that catches no individuals of a particular species but does for other species). Instances of no fish catch of *any* fish species in a tow (level 1) *are not* recorded in the relational "FishSample.csv" table, but the environmental data associated with that tow *is* recorded in the relational "Tow.csv" table. The joined "TMM.csv" table flagged these instances in the `Length_NA_flag` column and filled in the corresponding catch count value (`Count`) as 0. Zero-filling was not implemented for instances of no fish catch of a particular species in a tow (level 2) in the integrated "TMM.csv" file; however, code for this step is provided in the "TTMMIntegrateEDI.R" script for users who are interested.

Count data

The count data provided is the adjusted length frequency of each recorded length per species per tow:

$$F_{a,l} = T_c\left(\frac{F_{m,l}}{T_m}\right)$$

Where:

$F_{a,l}$ = adjusted frequency of each recorded length l

T_c = total catch

$F_{m,l}$ = measured frequency of each recorded length l

T_m = total number of fish measured

Project history

The table below is a timeline of critical changes to the survey methods since its inception. The years listed below are water years, which begins three months before the new calendar year on October 1.

Table 1: History of substantial changes to the 20mm Survey since its inception. Rows are highlighted per unique water year.

Year	Changes
1995	NA
1996	Napa River Stations (341, 342, 343, 344, 345, 346, & 347) added to sampling program.
1997	Napa River stations (341 & 347) and Big Break station (802) discontinued from sampling program.
1998	Zooplankton taxa stages (Eurytermora copepodid& Pseudodiaptomus copepodid) added to database.
1999	Number of fish measured reduced from 300 to 100 (all delta smelt are measured regardless of catch size).
2000	NA
2001	Number of fish measured reduced from 100 to 50 (all delta smelt are measured regardless of catch size).
2002	Napa River stations 347, 348, & 349 added to sampling program when higher outflow conditions persist in Napa River.
2003	Zooplankton taxon Pseudodiaptomus spp. speciated to include Pseudodiaptomuseuryhalinus, Pseudodiaptomus forbesi, and Pseudodiaptomusmarinus.
2004	Zooplankton processing changed from identifying the first 200 organisms to 6% of the sub-sample.
2005	Zooplankton processing continued to process 6% of the sub-sample, but would not exceed 20 slides from a sample.
2006	Zooplankton processing will continue to process 6% of the sub-sample, but will process a minimum of 5 cells and a maximum of 20 cells from a sample. Zooplankton taxa stages (Acartia copepodid, Acartiella copepodid, and Tortanus copepodid) added to database. Cumaceans and Chironomid larvae were dropped from the list of organisms to be identified.
2007	NA
2008	Cache Slough complex stations (718, 720, 726, 724, 723, 719) added to regular sampling program.
2009	Supplemental sampling in Sacramento Deepwater Channel stations (794, 795, 796, 797, 798, 799) occurred over surveys 7 and 8.
2010	Implementation of the use of a Hach Model # 2100P Turbidimeter as Standard Operating Procedure to record turbidity in NTU's. Recorded Latitude and Longitude on datasheets, but not entered into database.
2011	Begin recording latitude and longitude coordinates of each sampling station in the field, and this data was entered into the database
2012	NA
2013	NA
2014	NA
2015	Review of project documents indicated a discrepancy between documented 20-mm net dimensions and actual 20-mm net dimensions. In 1995 staff worked with Lodi Tent and Awning to accommodate for shrinkage of the canvas-collar mouth of the nets. The problem was resolved by increasing the circumference of the mouth from 455 cm to 493 cm. It appears that all subsequent 20-mm net purchases incorporated this change; however, these changes were not incorporated into documentation of net dimensions. The updated net dimensions are now available in the protocol.

2015	A total of 6 additional tows were performed during surveys 6-9 at stations 706, 707, and 719 as part of a pilot study on Delta Smelt genetics at UC Davis. Samples were preserved in 95% EtOH and sent to Mandi Finger, with Bernie May's lab. Stations sampled each survey was based on the likelihood of Delta Smelt occurrence, as indicated by results of prior surveys.
2015	The vendor that historically supplied the net mesh to construct 20-mm nets went out of business. A new vendor was found, Christensen Net Works. New nets were constructed and used in 2015.
2015	Factory k value (0.026873027) used in the 'MeterCorrections' table. Flowmeters were not calibrated at UC Davis due to machinery malfunction. The facility is awaiting repairs.
2016	Like 2015, no flowmeter calibration occurred in 2016. The factory value was used for all meters, and 9 meters were sent for refurbishing prior to the survey season.
2017	Continued using factory k value for 'MeterCorrections.' Malfuctioning and inaccurate flowmeters were sent to General Oceanics for refurbishing prior to field season.
2018	Continued using factory k value for 'MeterCorrections.' Malfuctioning and inaccurate flowmeters were sent to General Oceanics for refurbishing prior to field season.
2019	Continued using factory k value for MeterCorrections. Flowmeters were sent to General Oceanics for refurbishing prior to field season or replaced with new meters if readings are inaccurate (assessed at the end of a season). Factory K values will continue to be used until we can test the flowmeters independently.
2020	Surveys 2 and 3 only sampled the high priority stations in the south and central Delta due to concerns related to the COVID-19 pandemic.

Station metadata

Station theoretical latitudes and longitudes and start and end dates are provided in Table 2. A visualization of the number of surveys per water year (which encapsulates a field season) is also provided in Figure 2.

Table 2: List of stations sampled by 20mm since its inception. "StartDate" indicates the date when sampling first began for a station; "EndDate" indicates the date when sampling last ended at a station, and "Ongoing" represents stations that are still actively sampled by the survey. The high outflow stations are ongoing stations, however, end dates are provided due to the intermittency of these stations.

Station	StartDate	EndDate	Status
323	1995-04-28	Ongoing	indexStation
340	1995-04-28	Ongoing	indexStation
342	1996-04-29	Ongoing	indexStation
343	1996-04-29	Ongoing	indexStation
344	1996-04-29	Ongoing	indexStation
345	1996-04-29	Ongoing	indexStation
346	1996-04-29	Ongoing	indexStation
405	1995-04-27	Ongoing	indexStation
411	1995-04-28	Ongoing	indexStation
418	1995-04-27	Ongoing	indexStation
501	1995-04-28	Ongoing	indexStation
504	1995-04-28	Ongoing	indexStation
508	1995-04-28	Ongoing	indexStation
513	1995-04-26	Ongoing	indexStation

519	1995-04-28	Ongoing	indexStation
520	1995-04-27	Ongoing	indexStation
602	1995-04-27	Ongoing	indexStation
606	1995-04-27	Ongoing	indexStation
609	1995-04-27	Ongoing	indexStation
610	1995-04-27	Ongoing	indexStation
703	1995-04-26	Ongoing	indexStation
704	1995-04-26	Ongoing	indexStation
705	1995-04-25	Ongoing	indexStation
706	1995-04-26	Ongoing	indexStation
707	1995-04-25	Ongoing	indexStation
711	1995-04-25	Ongoing	indexStation
716	1995-04-25	Ongoing	indexStation
718	2008-03-17	Ongoing	indexStationNew
719	2008-03-17	Ongoing	indexStationNew
720	2008-03-17	Ongoing	indexStationNew
723	2008-03-17	Ongoing	indexStationNew
724	2008-03-17	Ongoing	indexStationNew
726	2008-03-17	Ongoing	indexStationNew
801	1995-04-26	Ongoing	indexStation
804	1995-04-26	Ongoing	indexStation
809	1995-04-24	Ongoing	indexStation
812	1995-04-25	Ongoing	indexStation
815	1995-04-25	Ongoing	indexStation
901	1995-04-24	Ongoing	indexStation
902	1995-04-24	Ongoing	indexStation
906	1995-04-25	Ongoing	indexStation
910	1995-04-24	Ongoing	indexStation
912	1995-04-24	Ongoing	indexStation
914	1995-04-24	Ongoing	indexStation
915	1995-04-24	Ongoing	indexStation
918	1995-04-24	Ongoing	indexStation
919	1995-04-25	Ongoing	indexStation
330	1995-05-26	1995-05-26	NA
341	1996-04-29	1996-05-13	NA
802	1995-04-26	1996-06-11	NA
997	1999-06-28	1999-06-28	NA
998	1999-06-28	1999-06-28	NA
999	1999-06-28	1999-06-28	NA
348	2001-03-24	2001-06-04	NA
349	2001-03-24	2001-06-04	NA
347	1996-07-26	2002-04-19	NA
798	2009-06-01	2009-06-01	NA
799	2009-06-01	2009-06-01	NA
794	2009-06-15	2009-06-15	NA
795	2009-06-15	2009-06-15	NA
796	2009-06-15	2009-06-15	NA
797	2009-06-15	2009-06-15	NA
328	1995-07-07	2019-05-09	highOutflow
329	1995-08-04	2019-05-09	highOutflow

334	1995-08-04	2019-05-09	highOutflow
335	1995-08-04	2019-05-09	highOutflow
336	1995-07-07	2019-05-09	highOutflow

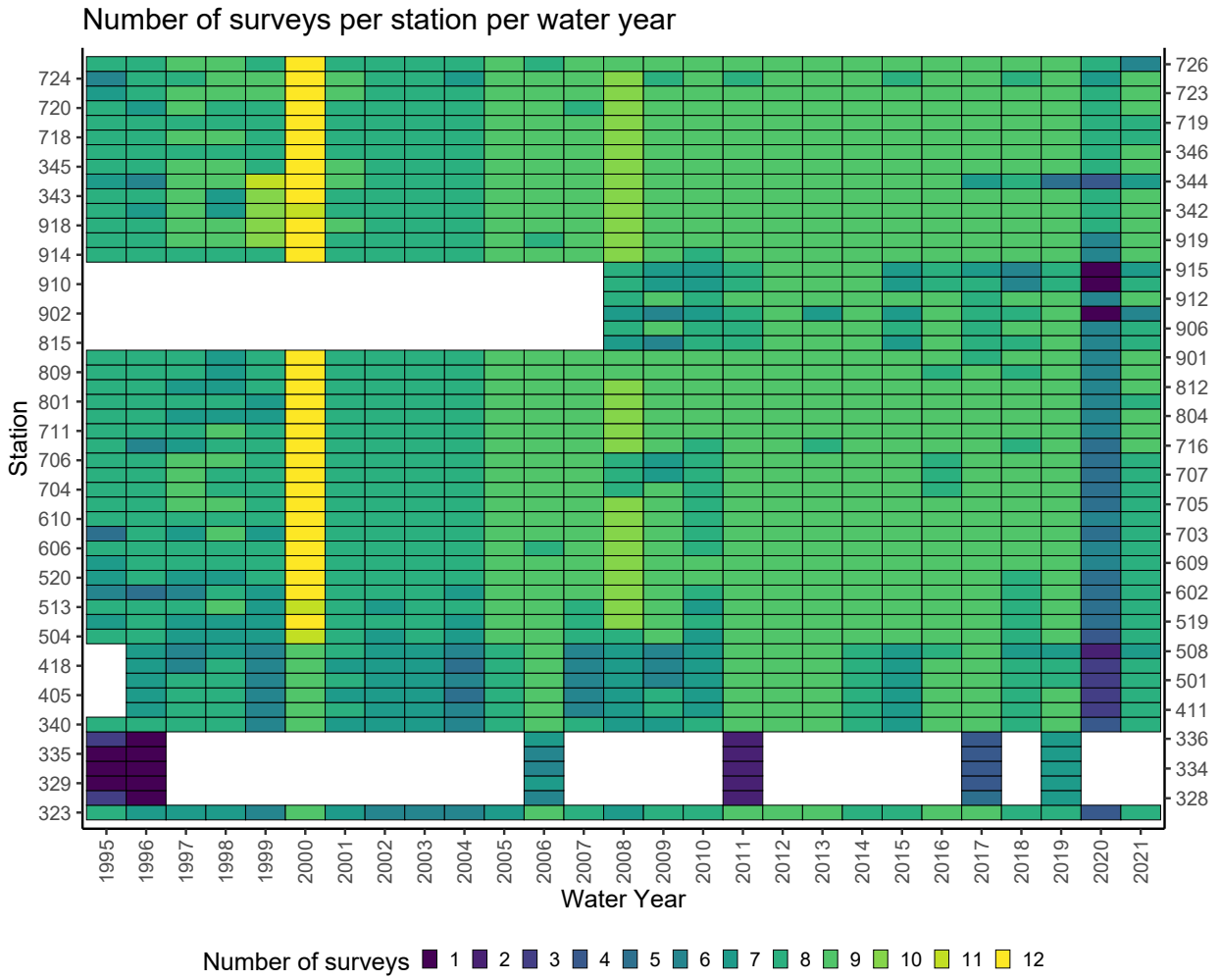

Figure 2: The number of times a station was surveyed per water year is shown in various colors, following documentation present in Table 1. No color indicates that a station was not sampled for that water year.

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995

Water Year	Station	Number of Surveys
1995	323	8
1995	328	3
1995	329	1
1995	334	1
1995	335	1
1995	336	3
1995	340	8

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
1995	405	8
1995	411	7
1995	418	8
1995	501	6
1995	504	7
1995	508	7
1995	513	8
1995	519	5
1995	520	8
1995	602	8
1995	606	8
1995	609	8
1995	610	8
1995	703	8
1995	704	8
1995	705	8
1995	706	8
1995	707	8
1995	711	8
1995	716	8
1995	801	8
1995	804	8
1995	809	8
1995	812	8
1995	815	8
1995	901	7
1995	902	8
1995	906	8
1995	910	8
1995	912	8
1995	914	8
1995	915	7
1995	918	6
1995	919	8
1996	323	7
1996	328	1
1996	329	1
1996	334	1
1996	335	1
1996	336	1
1996	340	8
1996	342	7
1996	343	7
1996	344	7
1996	345	7
1996	346	7

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
1996	405	8
1996	411	8
1996	418	8
1996	501	5
1996	504	8
1996	508	8
1996	513	8
1996	519	8
1996	520	8
1996	602	8
1996	606	8
1996	609	8
1996	610	8
1996	703	6
1996	704	8
1996	705	8
1996	706	8
1996	707	8
1996	711	8
1996	716	8
1996	801	8
1996	804	8
1996	809	8
1996	812	7
1996	815	8
1996	901	6
1996	902	8
1996	906	8
1996	910	8
1996	912	8
1996	914	7
1996	915	8
1996	918	8
1996	919	8
1997	323	7
1997	340	8
1997	342	8
1997	343	8
1997	344	8
1997	345	6
1997	346	6
1997	405	7
1997	411	7
1997	418	8
1997	501	6
1997	504	7

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
1997	508	8
1997	513	8
1997	519	7
1997	520	8
1997	602	9
1997	606	9
1997	609	9
1997	610	9
1997	703	7
1997	704	8
1997	705	7
1997	706	8
1997	707	7
1997	711	8
1997	716	8
1997	801	8
1997	804	9
1997	809	9
1997	812	9
1997	815	9
1997	901	9
1997	902	9
1997	906	8
1997	910	9
1997	912	8
1997	914	9
1997	915	9
1997	918	8
1997	919	9
1998	323	7
1998	340	8
1998	342	8
1998	343	8
1998	344	8
1998	345	8
1998	346	7
1998	405	7
1998	411	7
1998	418	9
1998	501	8
1998	504	7
1998	508	8
1998	513	8
1998	519	9
1998	520	8
1998	602	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
1998	606	8
1998	609	8
1998	610	9
1998	703	8
1998	704	9
1998	705	7
1998	706	8
1998	707	7
1998	711	7
1998	716	7
1998	801	8
1998	804	9
1998	809	9
1998	812	7
1998	815	7
1998	901	9
1998	902	9
1998	906	8
1998	910	9
1998	912	8
1998	914	8
1998	915	9
1998	918	9
1998	919	9
1999	323	6
1999	340	6
1999	342	6
1999	343	6
1999	344	6
1999	345	6
1999	346	6
1999	405	7
1999	411	7
1999	418	7
1999	501	7
1999	504	8
1999	508	8
1999	513	8
1999	519	7
1999	520	8
1999	602	8
1999	606	8
1999	609	8
1999	610	8
1999	703	8

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
1999	704	8
1999	705	7
1999	706	7
1999	707	8
1999	711	8
1999	716	8
1999	801	8
1999	804	10
1999	809	10
1999	812	10
1999	815	10
1999	901	11
1999	902	8
1999	906	8
1999	910	8
1999	912	8
1999	914	8
1999	915	9
1999	918	9
1999	919	8
2000	323	9
2000	340	9
2000	342	9
2000	343	9
2000	344	9
2000	345	9
2000	346	9
2000	405	11
2000	411	12
2000	418	11
2000	501	12
2000	504	12
2000	508	12
2000	513	12
2000	519	12
2000	520	12
2000	602	12
2000	606	12
2000	609	12
2000	610	12
2000	703	12
2000	704	12
2000	705	12
2000	706	12
2000	707	12

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2000	711	12
2000	716	12
2000	801	12
2000	804	12
2000	809	12
2000	812	11
2000	815	12
2000	901	12
2000	902	12
2000	906	12
2000	910	12
2000	912	12
2000	914	12
2000	915	12
2000	918	12
2000	919	12
2001	323	7
2001	340	7
2001	342	8
2001	343	7
2001	344	8
2001	345	7
2001	346	8
2001	405	8
2001	411	8
2001	418	8
2001	501	8
2001	504	8
2001	508	8
2001	513	8
2001	519	8
2001	520	8
2001	602	8
2001	606	8
2001	609	8
2001	610	8
2001	703	8
2001	704	8
2001	705	8
2001	706	8
2001	707	8
2001	711	8
2001	716	8
2001	801	8
2001	804	8

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2001	809	9
2001	812	8
2001	815	8
2001	901	9
2001	902	9
2001	906	8
2001	910	8
2001	912	8
2001	914	8
2001	915	9
2001	918	9
2001	919	8
2002	323	6
2002	340	7
2002	342	7
2002	343	7
2002	344	7
2002	345	7
2002	346	7
2002	405	7
2002	411	8
2002	418	7
2002	501	8
2002	504	8
2002	508	8
2002	513	8
2002	519	8
2002	520	8
2002	602	8
2002	606	8
2002	609	8
2002	610	8
2002	703	8
2002	704	8
2002	705	8
2002	706	8
2002	707	8
2002	711	8
2002	716	8
2002	801	8
2002	804	8
2002	809	8
2002	812	8
2002	815	8
2002	901	8

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2002	902	8
2002	906	8
2002	910	8
2002	912	8
2002	914	8
2002	915	8
2002	918	8
2002	919	8
2003	323	6
2003	340	7
2003	342	7
2003	343	7
2003	344	7
2003	345	7
2003	346	7
2003	405	8
2003	411	8
2003	418	8
2003	501	8
2003	504	8
2003	508	8
2003	513	8
2003	519	8
2003	520	8
2003	602	8
2003	606	8
2003	609	8
2003	610	8
2003	703	8
2003	704	8
2003	705	8
2003	706	8
2003	707	8
2003	711	8
2003	716	8
2003	801	8
2003	804	8
2003	809	8
2003	812	8
2003	815	8
2003	901	8
2003	902	8
2003	906	8
2003	910	8
2003	912	8

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2003	914	8
2003	915	8
2003	918	8
2003	919	8
2004	323	6
2004	340	6
2004	342	6
2004	343	5
2004	344	6
2004	345	5
2004	346	6
2004	405	7
2004	411	7
2004	418	8
2004	501	7
2004	504	8
2004	508	8
2004	513	8
2004	519	8
2004	520	8
2004	602	8
2004	606	8
2004	609	8
2004	610	8
2004	703	8
2004	704	8
2004	705	8
2004	706	8
2004	707	8
2004	711	8
2004	716	8
2004	801	8
2004	804	8
2004	809	8
2004	812	8
2004	815	8
2004	901	8
2004	902	8
2004	906	8
2004	910	8
2004	912	8
2004	914	8
2004	915	8
2004	918	7
2004	919	8

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2005	323	7
2005	340	8
2005	342	8
2005	343	8
2005	344	8
2005	345	8
2005	346	8
2005	405	9
2005	411	9
2005	418	9
2005	501	9
2005	504	9
2005	508	9
2005	513	9
2005	519	9
2005	520	9
2005	602	9
2005	606	9
2005	609	9
2005	610	9
2005	703	9
2005	704	9
2005	705	9
2005	706	9
2005	707	9
2005	711	9
2005	716	9
2005	801	9
2005	804	9
2005	809	9
2005	812	9
2005	815	9
2005	901	9
2005	902	9
2005	906	9
2005	910	9
2005	912	9
2005	914	9
2005	915	9
2005	918	9
2005	919	9
2006	323	9
2006	328	6
2006	329	7
2006	334	6

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2006	335	6
2006	336	7
2006	340	9
2006	342	9
2006	343	9
2006	344	9
2006	345	9
2006	346	9
2006	405	9
2006	411	9
2006	418	9
2006	501	9
2006	504	9
2006	508	9
2006	513	8
2006	519	9
2006	520	9
2006	602	9
2006	606	9
2006	609	9
2006	610	9
2006	703	9
2006	704	9
2006	705	9
2006	706	9
2006	707	9
2006	711	9
2006	716	9
2006	801	9
2006	804	8
2006	809	9
2006	812	9
2006	815	9
2006	901	9
2006	902	9
2006	906	9
2006	910	9
2006	912	9
2006	914	9
2006	915	9
2006	918	9
2006	919	8
2007	323	8
2007	340	8
2007	342	6

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2007	343	6
2007	344	6
2007	345	6
2007	346	6
2007	405	8
2007	411	8
2007	418	8
2007	501	9
2007	504	9
2007	508	9
2007	513	9
2007	519	9
2007	520	9
2007	602	9
2007	606	9
2007	609	9
2007	610	9
2007	703	9
2007	704	9
2007	705	9
2007	706	9
2007	707	9
2007	711	9
2007	716	9
2007	801	9
2007	804	9
2007	809	9
2007	812	9
2007	815	9
2007	901	9
2007	902	9
2007	906	9
2007	910	9
2007	912	9
2007	914	8
2007	915	9
2007	918	9
2007	919	9
2008	323	7
2008	340	7
2008	342	7
2008	343	7
2008	344	7
2008	345	7
2008	346	7

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2008	405	8
2008	411	10
2008	418	10
2008	501	10
2008	504	10
2008	508	10
2008	513	10
2008	519	10
2008	520	10
2008	602	10
2008	606	8
2008	609	8
2008	610	8
2008	703	10
2008	704	10
2008	705	10
2008	706	10
2008	707	10
2008	711	9
2008	716	9
2008	718	7
2008	719	8
2008	720	7
2008	723	8
2008	724	8
2008	726	8
2008	801	10
2008	804	10
2008	809	10
2008	812	10
2008	815	10
2008	901	10
2008	902	10
2008	906	10
2008	910	10
2008	912	10
2008	914	10
2008	915	10
2008	918	10
2008	919	9
2009	323	8
2009	340	7
2009	342	8
2009	343	8
2009	344	6

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2009	345	6
2009	346	6
2009	405	9
2009	411	9
2009	418	9
2009	501	9
2009	504	9
2009	508	9
2009	513	9
2009	519	9
2009	520	9
2009	602	9
2009	606	9
2009	609	7
2009	610	7
2009	703	9
2009	704	9
2009	705	9
2009	706	9
2009	707	9
2009	711	9
2009	716	9
2009	718	6
2009	719	9
2009	720	6
2009	723	9
2009	724	7
2009	726	7
2009	801	9
2009	804	9
2009	809	9
2009	812	9
2009	815	9
2009	901	9
2009	902	9
2009	906	9
2009	910	9
2009	912	9
2009	914	9
2009	915	9
2009	918	8
2009	919	9
2010	323	8
2010	340	8
2010	342	7

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2010	343	7
2010	344	7
2010	345	7
2010	346	7
2010	405	7
2010	411	8
2010	418	7
2010	501	8
2010	504	9
2010	508	9
2010	513	8
2010	519	8
2010	520	8
2010	602	8
2010	606	8
2010	609	8
2010	610	8
2010	703	8
2010	704	9
2010	705	9
2010	706	9
2010	707	9
2010	711	9
2010	716	9
2010	718	8
2010	719	8
2010	720	7
2010	723	8
2010	724	7
2010	726	7
2010	801	8
2010	804	9
2010	809	9
2010	812	9
2010	815	9
2010	901	9
2010	902	9
2010	906	9
2010	910	9
2010	912	9
2010	914	9
2010	915	9
2010	918	9
2010	919	9
2011	323	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2011	328	2
2011	329	2
2011	334	2
2011	335	2
2011	336	2
2011	340	9
2011	342	9
2011	343	9
2011	344	9
2011	345	9
2011	346	9
2011	405	9
2011	411	9
2011	418	9
2011	501	9
2011	504	9
2011	508	9
2011	513	9
2011	519	9
2011	520	9
2011	602	9
2011	606	9
2011	609	9
2011	610	9
2011	703	9
2011	704	9
2011	705	9
2011	706	9
2011	707	9
2011	711	9
2011	716	9
2011	718	8
2011	719	8
2011	720	8
2011	723	9
2011	724	8
2011	726	8
2011	801	9
2011	804	9
2011	809	9
2011	812	9
2011	815	9
2011	901	9
2011	902	9
2011	906	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2011	910	9
2011	912	9
2011	914	9
2011	915	9
2011	918	8
2011	919	9
2012	323	9
2012	340	9
2012	342	9
2012	343	9
2012	344	9
2012	345	9
2012	346	9
2012	405	9
2012	411	9
2012	418	9
2012	501	9
2012	504	9
2012	508	9
2012	513	9
2012	519	9
2012	520	9
2012	602	9
2012	606	9
2012	609	9
2012	610	9
2012	703	9
2012	704	9
2012	705	9
2012	706	9
2012	707	9
2012	711	9
2012	716	9
2012	718	9
2012	719	9
2012	720	9
2012	723	9
2012	724	9
2012	726	9
2012	801	9
2012	804	9
2012	809	9
2012	812	9
2012	815	9
2012	901	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2012	902	9
2012	906	9
2012	910	9
2012	912	9
2012	914	9
2012	915	9
2012	918	9
2012	919	9
2013	323	9
2013	340	9
2013	342	9
2013	343	9
2013	344	9
2013	345	9
2013	346	9
2013	405	9
2013	411	9
2013	418	9
2013	501	9
2013	504	9
2013	508	9
2013	513	9
2013	519	9
2013	520	9
2013	602	9
2013	606	9
2013	609	9
2013	610	9
2013	703	8
2013	704	9
2013	705	9
2013	706	9
2013	707	9
2013	711	9
2013	716	9
2013	718	9
2013	719	9
2013	720	7
2013	723	9
2013	724	9
2013	726	9
2013	801	9
2013	804	9
2013	809	9
2013	812	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2013	815	9
2013	901	9
2013	902	9
2013	906	9
2013	910	9
2013	912	9
2013	914	9
2013	915	9
2013	918	9
2013	919	9
2014	323	8
2014	340	8
2014	342	8
2014	343	8
2014	344	8
2014	345	8
2014	346	8
2014	405	9
2014	411	9
2014	418	9
2014	501	9
2014	504	9
2014	508	9
2014	513	9
2014	519	9
2014	520	9
2014	602	9
2014	606	9
2014	609	9
2014	610	9
2014	703	9
2014	704	9
2014	705	9
2014	706	9
2014	707	9
2014	711	9
2014	716	9
2014	718	9
2014	719	9
2014	720	9
2014	723	9
2014	724	9
2014	726	9
2014	801	9
2014	804	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2014	809	9
2014	812	9
2014	815	9
2014	901	9
2014	902	9
2014	906	9
2014	910	9
2014	912	9
2014	914	9
2014	915	9
2014	918	9
2014	919	9
2015	323	8
2015	340	7
2015	342	7
2015	343	7
2015	344	7
2015	345	7
2015	346	7
2015	405	9
2015	411	9
2015	418	9
2015	501	9
2015	504	9
2015	508	9
2015	513	9
2015	519	9
2015	520	9
2015	602	9
2015	606	9
2015	609	9
2015	610	9
2015	703	9
2015	704	9
2015	705	9
2015	706	9
2015	707	9
2015	711	9
2015	716	9
2015	718	7
2015	719	8
2015	720	7
2015	723	9
2015	724	7
2015	726	7

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2015	801	9
2015	804	9
2015	809	9
2015	812	9
2015	815	9
2015	901	9
2015	902	9
2015	906	9
2015	910	9
2015	912	9
2015	914	9
2015	915	9
2015	918	8
2015	919	9
2016	323	9
2016	340	9
2016	342	9
2016	343	9
2016	344	9
2016	345	9
2016	346	8
2016	405	9
2016	411	9
2016	418	9
2016	501	9
2016	504	9
2016	508	9
2016	513	9
2016	519	9
2016	520	9
2016	602	9
2016	606	8
2016	609	8
2016	610	8
2016	703	9
2016	704	9
2016	705	9
2016	706	9
2016	707	9
2016	711	8
2016	716	9
2016	718	9
2016	719	9
2016	720	9
2016	723	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2016	724	8
2016	726	8
2016	801	9
2016	804	9
2016	809	9
2016	812	9
2016	815	9
2016	901	9
2016	902	9
2016	906	9
2016	910	9
2016	912	9
2016	914	9
2016	915	9
2016	918	9
2016	919	9
2017	323	9
2017	328	5
2017	329	4
2017	334	4
2017	335	4
2017	336	4
2017	340	9
2017	342	9
2017	343	9
2017	344	9
2017	345	9
2017	346	9
2017	405	9
2017	411	9
2017	418	9
2017	501	9
2017	504	9
2017	508	9
2017	513	9
2017	519	9
2017	520	9
2017	602	9
2017	606	9
2017	609	9
2017	610	9
2017	703	9
2017	704	9
2017	705	9
2017	706	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2017	707	9
2017	711	9
2017	716	8
2017	718	8
2017	719	8
2017	720	8
2017	723	8
2017	724	8
2017	726	7
2017	801	9
2017	804	9
2017	809	9
2017	812	9
2017	815	9
2017	901	7
2017	902	9
2017	906	9
2017	910	9
2017	912	9
2017	914	9
2017	915	9
2017	918	9
2017	919	9
2018	323	8
2018	340	8
2018	342	8
2018	343	8
2018	344	8
2018	345	8
2018	346	7
2018	405	8
2018	411	8
2018	418	8
2018	501	8
2018	504	8
2018	508	9
2018	513	9
2018	519	9
2018	520	9
2018	602	9
2018	606	9
2018	609	9
2018	610	9
2018	703	8
2018	704	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2018	705	9
2018	706	9
2018	707	9
2018	711	8
2018	716	9
2018	718	8
2018	719	9
2018	720	8
2018	723	9
2018	724	6
2018	726	6
2018	801	9
2018	804	9
2018	809	9
2018	812	9
2018	815	9
2018	901	8
2018	902	9
2018	906	9
2018	910	9
2018	912	9
2018	914	9
2018	915	9
2018	918	8
2018	919	9
2019	323	8
2019	328	7
2019	329	7
2019	334	7
2019	335	7
2019	336	7
2019	340	9
2019	342	9
2019	343	9
2019	344	8
2019	345	8
2019	346	7
2019	405	9
2019	411	9
2019	418	9
2019	501	9
2019	504	9
2019	508	9
2019	513	9
2019	519	9

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2019	520	9
2019	602	9
2019	606	9
2019	609	9
2019	610	9
2019	703	9
2019	704	9
2019	705	9
2019	706	9
2019	707	9
2019	711	9
2019	716	9
2019	718	9
2019	719	9
2019	720	9
2019	723	9
2019	724	8
2019	726	8
2019	801	9
2019	804	9
2019	809	9
2019	812	9
2019	815	9
2019	901	5
2019	902	9
2019	906	9
2019	910	9
2019	912	9
2019	914	9
2019	915	9
2019	918	9
2019	919	9
2020	323	4
2020	340	4
2020	342	3
2020	343	3
2020	344	3
2020	345	3
2020	346	2
2020	405	4
2020	411	5
2020	418	5
2020	501	5
2020	504	5
2020	508	6

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2020	513	6
2020	519	5
2020	520	6
2020	602	5
2020	606	5
2020	609	5
2020	610	5
2020	703	5
2020	704	6
2020	705	6
2020	706	6
2020	707	6
2020	711	6
2020	716	6
2020	718	6
2020	719	6
2020	720	1
2020	723	6
2020	724	1
2020	726	1
2020	801	6
2020	804	6
2020	809	8
2020	812	8
2020	815	8
2020	901	4
2020	902	8
2020	906	8
2020	910	8
2020	912	8
2020	914	8
2020	915	8
2020	918	7
2020	919	8
2021	323	8
2021	340	8
2021	342	8
2021	343	8
2021	344	8
2021	345	8
2021	346	7
2021	405	8
2021	411	8
2021	418	8
2021	501	8

Table 3: Frequency of number of surveys at each station in the 20mm Survey per water year since its inception in 1995 *(continued)*

Water Year	Station	Number of Surveys
2021	504	8
2021	508	8
2021	513	8
2021	519	8
2021	520	8
2021	602	8
2021	606	8
2021	609	8
2021	610	8
2021	703	9
2021	704	9
2021	705	9
2021	706	8
2021	707	9
2021	711	9
2021	716	9
2021	718	8
2021	719	8
2021	720	6
2021	723	9
2021	724	8
2021	726	7
2021	801	9
2021	804	9
2021	809	9
2021	812	9
2021	815	9
2021	901	7
2021	902	9
2021	906	9
2021	910	8
2021	912	8
2021	914	9
2021	915	9
2021	918	9
2021	919	6