Delta Smelt Spatiotemporal Domain

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## Load and process Delta Smelt data

Grab Delta Smelt data from the integrated fish dataset (LTMRdata package by Sam Bashevkin et al.) and produce one fish data per row. I will exclude fish with no length measurement. Note that unmeasured fish that were collected alongside measured fish were converted to have fish length per LTMRdata documentation. I converted count to integer however, since the process that Sam implemented created decimal points for counts.

Surveys included in this calculation:

1. San Francisco Bay Study
2. Suisun Marsh Study
3. Fall Midwater Trawl
4. Spring Kodiak Trawl
5. Delta Juvenile Fish Monitoring Program
6. Enhanced Delta Smelt Monitoring
7. 20-mm Survey
8. Smelt Larval Survey
9. Summer Townet Survey

#Use deltafish to load data  
surv <- open\_survey()  
fish <- open\_fish()  
  
  
# filter for taxa of interest  
fish\_deltasmelt <- fish %>%   
 filter(Taxa %in% c("Hypomesus transpacificus"))  
  
  
# do a join and collect the resulting data frame  
# collect executes the sql query and gives you a table  
data\_deltasmelt<-left\_join(surv, fish\_deltasmelt) %>%   
 collect()   
  
  
#Create time series summary  
data\_deltasmelt\_time\_summary<-data\_deltasmelt %>% group\_by(Source) %>% summarise(StartDate=min(Date),EndDate=max(Date))  
data\_deltasmelt\_time\_summary

## # A tibble: 9 x 3  
## Source StartDate EndDate   
## <chr> <date> <date>   
## 1 20mm 1995-04-24 2021-07-16  
## 2 Bay Study 1980-01-23 2020-12-01  
## 3 DJFMP 1976-03-08 2020-12-31  
## 4 EDSM 2016-12-15 2021-03-25  
## 5 FMWT 1967-09-13 2020-12-15  
## 6 SKT 2002-01-07 2021-04-29  
## 7 SLS 2009-01-05 2021-03-17  
## 8 STN 1959-06-14 2021-08-19  
## 9 Suisun 1979-05-16 2021-09-23

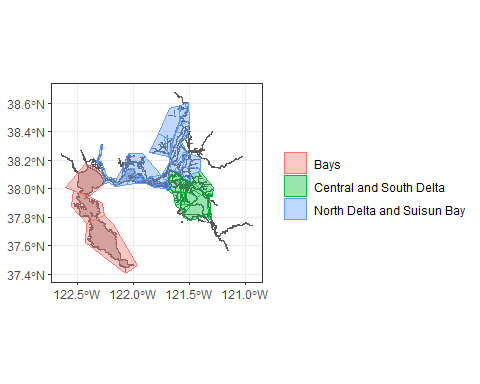
#Remove 0 counts, only use years 1994 and after, only ones with non-zero lengths  
data\_deltasmelt <- data\_deltasmelt %>%   
 filter(Count>0) %>% filter(year(Date)>=1994) %>% filter(!is.na(Length))  
  
#Change count to integer  
data\_deltasmelt$Count<-as.integer(data\_deltasmelt$Count)  
#Remove zero catch data  
data\_deltasmelt<- data\_deltasmelt%>% filter(Count>0)  
  
#Create long form, remove data prior to 1994  
data\_deltasmelt\_long <-data\_deltasmelt[rep(1:nrow(data\_deltasmelt), data\_deltasmelt$Count),] %>% mutate(Count=1)

## San Francisco Bay-Delta (all regions)

### Regions

Shown below are the regional cutoffs used to better understand when fish are found in a particular area within the estuary

## # A tibble: 13 x 1  
## SubRegion   
## <chr>   
## 1 San Joaquin River at Twitchell Island  
## 2 San Joaquin River at Prisoners Pt   
## 3 Franks Tract   
## 4 Holland Cut   
## 5 Middle River   
## 6 Upper San Joaquin River   
## 7 Victoria Canal   
## 8 Grant Line Canal and Old River   
## 9 San Joaquin River near Stockton   
## 10 Old River   
## 11 Disappointment Slough   
## 12 Rock Slough and Discovery Bay   
## 13 Mildred Island



## Create spatial data frame, categorizing fish catch into regions

## Size cutoffs used for Delta Smelt

Larvae: (<20mm FL)

Juvenile: (20-58mm FL)

Adult: (>58mm FL)

### Brood year cutoff for the life stages

Larvae: brood year = calendar year

Juvenile: brood year starts in March 1st of current year to February 28th or 29th of the following year

Adult: brood year starts in June 1st of current year to May 31st of the following year

## Adult Delta Smelt

(>58 mm FL, cohort year set to June 1st - May 31st)

### Bays Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1995 | 03-05-1996 | 03-05-1996 | 03-05-1996 | 03-05-1996 | 03-05-1996 | 03-05-1996 | 44 |
| 1996 | 01-09-1997 | 01-09-1997 | 01-09-1997 | 02-05-1997 | 02-05-1997 | 02-05-1997 | 3 |
| 1997 | 09-03-1997 | 09-03-1997 | 03-02-1998 | 03-04-1998 | 03-04-1998 | 03-04-1998 | 15 |
| 1998 | 08-16-1998 | 08-16-1998 | 12-02-1998 | 03-03-1999 | 03-03-1999 | 03-03-1999 | 14 |
| 1999 | 03-08-2000 | 03-08-2000 | 03-08-2000 | 03-08-2000 | 03-08-2000 | 03-08-2000 | 1 |
| 2016 | 03-02-2017 | 03-02-2017 | 03-02-2017 | 03-02-2017 | 03-02-2017 | 03-02-2017 | 1 |

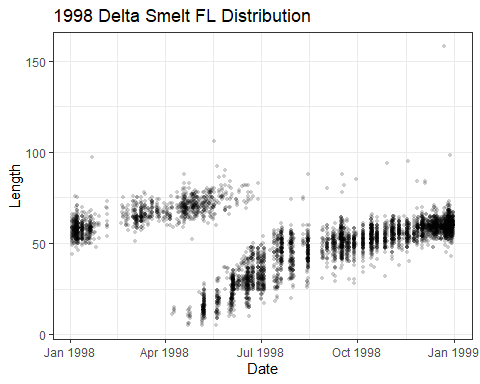
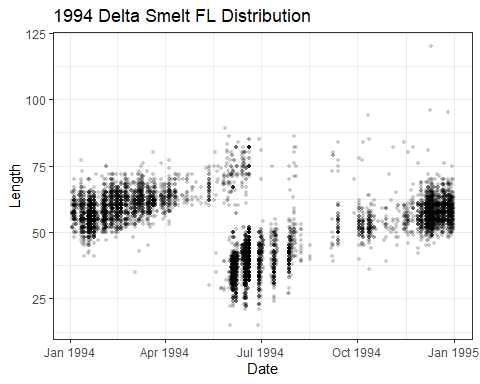
### North Delta and Suisun Bay Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1994 | 06-01-1994 | 06-20-1994 | 11-23-1994 | 04-22-1995 | 05-06-1995 | 05-31-1995 | 2004 |
| 1995 | 06-01-1995 | 09-25-1995 | 10-25-1995 | 05-10-1996 | 05-16-1996 | 05-31-1996 | 14254 |
| 1996 | 06-03-1996 | 06-03-1996 | 06-08-1996 | 05-19-1997 | 05-27-1997 | 05-31-1997 | 932 |
| 1997 | 06-01-1997 | 06-08-1997 | 06-20-1997 | 05-01-1998 | 05-11-1998 | 05-30-1998 | 1670 |
| 1998 | 06-01-1998 | 11-28-1998 | 12-15-1998 | 05-02-1999 | 05-11-1999 | 05-29-1999 | 4745 |
| 1999 | 06-01-1999 | 10-07-1999 | 11-08-1999 | 03-07-2000 | 04-03-2000 | 05-31-2000 | 5624 |
| 2000 | 06-07-2000 | 10-05-2000 | 11-08-2000 | 03-19-2001 | 04-27-2001 | 05-31-2001 | 1660 |
| 2001 | 06-01-2001 | 07-03-2001 | 08-23-2001 | 03-06-2002 | 03-20-2002 | 05-25-2002 | 1510 |
| 2002 | 06-04-2002 | 09-30-2002 | 11-14-2002 | 04-03-2003 | 05-07-2003 | 05-31-2003 | 1688 |
| 2003 | 06-01-2003 | 08-19-2003 | 12-09-2003 | 03-22-2004 | 04-08-2004 | 05-13-2004 | 1529 |
| 2004 | 06-02-2004 | 10-04-2004 | 11-08-2004 | 04-21-2005 | 05-11-2005 | 05-31-2005 | 1562 |
| 2005 | 06-01-2005 | 06-20-2005 | 07-05-2005 | 04-26-2006 | 05-12-2006 | 05-31-2006 | 1211 |
| 2006 | 06-01-2006 | 06-06-2006 | 06-19-2006 | 04-05-2007 | 04-05-2007 | 05-22-2007 | 1017 |
| 2007 | 06-06-2007 | 09-19-2007 | 12-10-2007 | 04-08-2008 | 04-10-2008 | 05-30-2008 | 395 |
| 2008 | 06-06-2008 | 09-03-2008 | 12-16-2008 | 03-18-2009 | 04-15-2009 | 05-27-2009 | 754 |
| 2009 | 06-01-2009 | 07-24-2009 | 08-18-2009 | 04-15-2010 | 04-22-2010 | 05-26-2010 | 700 |
| 2010 | 06-07-2010 | 07-19-2010 | 08-16-2010 | 04-06-2011 | 04-11-2011 | 05-25-2011 | 893 |
| 2011 | 06-01-2011 | 09-07-2011 | 10-07-2011 | 04-17-2012 | 05-02-2012 | 05-25-2012 | 2062 |
| 2012 | 06-01-2012 | 06-25-2012 | 07-13-2012 | 03-07-2013 | 04-04-2013 | 05-24-2013 | 836 |
| 2013 | 06-07-2013 | 07-22-2013 | 11-13-2013 | 04-08-2014 | 04-10-2014 | 05-08-2014 | 594 |
| 2014 | 06-02-2014 | 07-16-2014 | 09-02-2014 | 02-12-2015 | 03-11-2015 | 05-06-2015 | 161 |
| 2015 | 07-01-2015 | 08-03-2015 | 09-01-2015 | 04-04-2016 | 04-04-2016 | 05-23-2016 | 57 |
| 2016 | 06-07-2016 | 12-08-2016 | 12-08-2016 | 03-01-2017 | 03-08-2017 | 05-31-2017 | 402 |
| 2017 | 06-07-2017 | 07-20-2017 | 08-09-2017 | 02-14-2018 | 03-07-2018 | 03-22-2018 | 81 |
| 2018 | 07-09-2018 | 09-17-2018 | 10-09-2018 | 02-11-2019 | 02-12-2019 | 03-03-2019 | 42 |
| 2019 | 11-29-2019 | 11-29-2019 | 12-04-2019 | 03-05-2020 | 03-16-2020 | 03-16-2020 | 17 |

### Central and South Delta Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1994 | 12-08-1994 | 12-08-1994 | 02-08-1995 | 04-03-1995 | 05-01-1995 | 05-01-1995 | 11 |
| 1995 | 01-04-1996 | 01-04-1996 | 01-05-1996 | 04-01-1996 | 04-01-1996 | 04-27-1996 | 40 |
| 1996 | 01-15-1997 | 01-15-1997 | 03-03-1997 | 04-16-1997 | 04-16-1997 | 04-16-1997 | 13 |
| 1997 | 06-02-1997 | 06-02-1997 | 06-02-1997 | 03-05-1998 | 03-05-1998 | 03-05-1998 | 9 |
| 1998 | 03-01-1999 | 03-01-1999 | 03-01-1999 | 05-10-1999 | 05-28-1999 | 05-28-1999 | 13 |
| 1999 | 06-04-1999 | 06-08-1999 | 10-12-1999 | 03-09-2000 | 04-03-2000 | 05-08-2000 | 40 |
| 2000 | 06-12-2000 | 06-12-2000 | 09-13-2000 | 05-07-2001 | 05-07-2001 | 05-07-2001 | 13 |
| 2001 | 12-03-2001 | 01-07-2002 | 01-07-2002 | 03-04-2002 | 03-04-2002 | 04-02-2002 | 74 |
| 2002 | 06-16-2002 | 12-26-2002 | 01-23-2003 | 04-16-2003 | 04-16-2003 | 04-16-2003 | 46 |
| 2003 | 01-12-2004 | 01-12-2004 | 01-12-2004 | 04-05-2004 | 04-05-2004 | 05-03-2004 | 278 |
| 2004 | 01-03-2005 | 01-03-2005 | 01-24-2005 | 02-18-2005 | 03-11-2005 | 03-11-2005 | 15 |
| 2005 | 01-23-2006 | 01-23-2006 | 01-23-2006 | 04-11-2006 | 04-24-2006 | 04-24-2006 | 10 |
| 2006 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 5 |
| 2007 | 01-07-2008 | 01-07-2008 | 01-07-2008 | 03-17-2008 | 03-17-2008 | 03-17-2008 | 6 |
| 2008 | 01-12-2009 | 01-12-2009 | 01-12-2009 | 04-13-2009 | 04-13-2009 | 04-13-2009 | 12 |
| 2009 | 02-08-2010 | 02-08-2010 | 02-08-2010 | 03-23-2010 | 03-23-2010 | 03-23-2010 | 4 |
| 2010 | 01-10-2011 | 01-10-2011 | 01-10-2011 | 04-04-2011 | 04-04-2011 | 04-04-2011 | 10 |
| 2011 | 02-06-2012 | 02-06-2012 | 02-13-2012 | 04-02-2012 | 04-02-2012 | 05-07-2012 | 38 |
| 2012 | 08-09-2012 | 01-07-2013 | 01-07-2013 | 04-29-2013 | 04-29-2013 | 04-29-2013 | 34 |
| 2013 | 03-10-2014 | 03-10-2014 | 03-10-2014 | 05-05-2014 | 05-05-2014 | 05-05-2014 | 3 |
| 2014 | 12-15-2014 | 12-15-2014 | 01-05-2015 | 02-09-2015 | 02-09-2015 | 02-09-2015 | 17 |
| 2015 | 02-08-2016 | 02-08-2016 | 02-08-2016 | 02-08-2016 | 02-08-2016 | 02-08-2016 | 1 |
| 2016 | 12-15-2016 | 12-15-2016 | 12-27-2016 | 03-01-2017 | 03-07-2017 | 03-16-2017 | 59 |
| 2018 | 01-29-2019 | 01-29-2019 | 01-29-2019 | 01-29-2019 | 01-29-2019 | 01-29-2019 | 1 |

Note that adult Delta Smelt can linger for more than a year (i.e, 1+ year old Delta Smelt). 2-year old Delta Smelt have even been observed in the past. This is why the first adult smelt can sometimes show up in June or July in the table. This phenomenon of 1+ year old Delta Smelt appear to be more common in the 1990s (or whenever smelt were more abundant). Example below:



## Juvenile Delta Smelt

(20-58 mm FL, cohort year set to March 1st - February 28th/29th)

### Bays Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1995 | 07-11-1995 | 07-11-1995 | 07-21-1995 | 09-07-1995 | 09-07-1995 | 10-12-1995 | 27 |
| 1996 | 03-05-1996 | 03-05-1996 | 03-05-1996 | 07-26-1996 | 07-26-1996 | 07-26-1996 | 10 |
| 1998 | 03-04-1998 | 07-13-1998 | 07-21-1998 | 08-16-1998 | 09-03-1998 | 12-08-1998 | 35 |
| 1999 | 03-31-1999 | 03-31-1999 | 03-31-1999 | 07-09-1999 | 07-09-1999 | 07-09-1999 | 3 |
| 2000 | 11-02-2000 | 11-02-2000 | 11-02-2000 | 12-26-2000 | 12-26-2000 | 12-26-2000 | 2 |
| 2002 | 08-15-2002 | 08-15-2002 | 08-15-2002 | 08-15-2002 | 08-15-2002 | 08-15-2002 | 2 |
| 2005 | 01-10-2006 | 01-10-2006 | 01-10-2006 | 01-10-2006 | 01-10-2006 | 01-10-2006 | 1 |
| 2006 | 05-19-2006 | 05-19-2006 | 05-19-2006 | 07-01-2006 | 07-01-2006 | 07-01-2006 | 15 |
| 2017 | 08-23-2017 | 08-23-2017 | 08-23-2017 | 09-12-2017 | 09-12-2017 | 09-12-2017 | 2 |

### North Delta and Suisun Bay Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1994 | 03-02-1994 | 06-05-1994 | 06-07-1994 | 12-15-1994 | 01-04-1995 | 02-24-1995 | 8158 |
| 1995 | 03-03-1995 | 06-21-1995 | 07-06-1995 | 01-13-1996 | 01-16-1996 | 02-20-1996 | 8115 |
| 1996 | 03-01-1996 | 05-24-1996 | 05-29-1996 | 12-07-1996 | 12-10-1996 | 02-05-1997 | 5375 |
| 1997 | 03-04-1997 | 05-31-1997 | 06-11-1997 | 12-30-1997 | 01-09-1998 | 02-25-1998 | 2992 |
| 1998 | 03-04-1998 | 06-05-1998 | 06-18-1998 | 12-30-1998 | 01-08-1999 | 02-23-1999 | 3022 |
| 1999 | 03-08-1999 | 06-04-1999 | 06-10-1999 | 12-21-1999 | 01-05-2000 | 02-22-2000 | 4833 |
| 2000 | 03-07-2000 | 06-01-2000 | 06-13-2000 | 12-18-2000 | 01-30-2001 | 02-26-2001 | 5344 |
| 2001 | 03-02-2001 | 05-05-2001 | 05-05-2001 | 10-10-2001 | 10-10-2001 | 02-15-2002 | 2391 |
| 2002 | 03-06-2002 | 05-15-2002 | 06-11-2002 | 10-16-2002 | 11-06-2002 | 01-24-2003 | 888 |
| 2003 | 05-06-2003 | 06-05-2003 | 06-17-2003 | 01-27-2004 | 01-27-2004 | 02-24-2004 | 1284 |
| 2004 | 03-09-2004 | 05-25-2004 | 05-26-2004 | 10-07-2004 | 11-24-2004 | 02-24-2005 | 772 |
| 2005 | 03-02-2005 | 05-13-2005 | 05-26-2005 | 10-03-2005 | 12-14-2005 | 02-22-2006 | 793 |
| 2006 | 05-05-2006 | 05-20-2006 | 06-03-2006 | 01-10-2007 | 01-22-2007 | 02-22-2007 | 1081 |
| 2007 | 03-06-2007 | 05-10-2007 | 06-12-2007 | 08-21-2007 | 12-12-2007 | 02-04-2008 | 184 |
| 2008 | 04-29-2008 | 06-03-2008 | 06-09-2008 | 01-14-2009 | 01-14-2009 | 02-13-2009 | 443 |
| 2009 | 03-18-2009 | 05-06-2009 | 05-20-2009 | 08-26-2009 | 10-26-2009 | 01-14-2010 | 429 |
| 2010 | 03-10-2010 | 05-10-2010 | 05-10-2010 | 08-11-2010 | 10-04-2010 | 02-10-2011 | 763 |
| 2011 | 04-01-2011 | 05-25-2011 | 06-07-2011 | 12-07-2011 | 01-19-2012 | 02-22-2012 | 2222 |
| 2012 | 03-05-2012 | 05-21-2012 | 05-23-2012 | 07-26-2012 | 09-04-2012 | 02-06-2013 | 711 |
| 2013 | 04-08-2013 | 05-06-2013 | 05-07-2013 | 09-03-2013 | 09-18-2013 | 02-12-2014 | 1074 |
| 2014 | 03-12-2014 | 04-28-2014 | 05-12-2014 | 08-14-2014 | 10-09-2014 | 01-15-2015 | 302 |
| 2015 | 04-16-2015 | 04-27-2015 | 05-08-2015 | 09-01-2015 | 09-01-2015 | 12-01-2015 | 162 |
| 2016 | 03-09-2016 | 04-13-2016 | 04-27-2016 | 12-28-2016 | 12-28-2016 | 02-08-2017 | 128 |
| 2017 | 03-08-2017 | 05-08-2017 | 05-24-2017 | 09-18-2017 | 10-10-2017 | 01-10-2018 | 513 |
| 2018 | 05-02-2018 | 07-05-2018 | 07-17-2018 | 11-07-2018 | 12-28-2018 | 02-25-2019 | 160 |
| 2019 | 04-29-2019 | 06-18-2019 | 07-03-2019 | 09-17-2019 | 10-15-2019 | 01-15-2020 | 146 |
| 2020 | 05-05-2020 | 05-11-2020 | 05-19-2020 | 09-23-2020 | 01-06-2021 | 01-26-2021 | 35 |
| 2021 | 05-06-2021 | 05-06-2021 | 05-06-2021 | 05-06-2021 | 05-06-2021 | 05-06-2021 | 1 |

### Central and South Delta Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1994 | 06-02-1994 | 06-02-1994 | 06-06-1994 | 06-16-1994 | 07-27-1994 | 01-10-1995 | 20 |
| 1995 | 07-03-1995 | 07-03-1995 | 07-03-1995 | 08-18-1995 | 08-18-1995 | 08-18-1995 | 3 |
| 1996 | 05-09-1996 | 05-09-1996 | 05-09-1996 | 07-22-1996 | 07-22-1996 | 11-04-1996 | 26 |
| 1997 | 04-28-1997 | 04-28-1997 | 05-13-1997 | 06-27-1997 | 07-08-1997 | 01-12-1998 | 35 |
| 1998 | 05-04-1998 | 05-04-1998 | 05-04-1998 | 07-10-1998 | 07-10-1998 | 07-10-1998 | 4 |
| 1999 | 04-27-1999 | 05-10-1999 | 05-24-1999 | 06-14-1999 | 06-24-1999 | 11-08-1999 | 219 |
| 2000 | 04-24-2000 | 05-07-2000 | 05-15-2000 | 06-26-2000 | 06-26-2000 | 07-21-2000 | 90 |
| 2001 | 04-30-2001 | 05-15-2001 | 05-29-2001 | 10-04-2001 | 01-07-2002 | 02-04-2002 | 104 |
| 2002 | 05-13-2002 | 05-13-2002 | 05-13-2002 | 06-24-2002 | 06-24-2002 | 06-29-2002 | 99 |
| 2003 | 05-06-2003 | 05-19-2003 | 05-19-2003 | 01-26-2004 | 02-11-2004 | 02-23-2004 | 41 |
| 2004 | 05-10-2004 | 05-10-2004 | 05-10-2004 | 06-07-2004 | 06-09-2004 | 07-19-2004 | 49 |
| 2005 | 05-09-2005 | 05-09-2005 | 05-09-2005 | 01-17-2006 | 01-17-2006 | 01-17-2006 | 6 |
| 2006 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 01-08-2007 | 1 |
| 2007 | 06-04-2007 | 06-04-2007 | 06-04-2007 | 07-03-2007 | 07-03-2007 | 07-03-2007 | 2 |
| 2008 | 05-12-2008 | 05-12-2008 | 05-12-2008 | 06-16-2008 | 06-30-2008 | 06-30-2008 | 15 |
| 2009 | 06-01-2009 | 06-01-2009 | 06-01-2009 | 06-01-2009 | 06-01-2009 | 06-01-2009 | 1 |
| 2010 | 06-14-2010 | 06-14-2010 | 06-14-2010 | 07-29-2010 | 07-29-2010 | 07-29-2010 | 2 |
| 2011 | 06-06-2011 | 06-06-2011 | 06-06-2011 | 06-06-2011 | 06-06-2011 | 06-06-2011 | 1 |
| 2012 | 05-07-2012 | 05-07-2012 | 05-21-2012 | 06-25-2012 | 07-09-2012 | 08-06-2012 | 25 |
| 2013 | 04-22-2013 | 05-06-2013 | 05-06-2013 | 06-10-2013 | 06-24-2013 | 06-24-2013 | 42 |
| 2014 | 05-12-2014 | 05-12-2014 | 05-12-2014 | 05-12-2014 | 05-12-2014 | 05-12-2014 | 1 |
| 2015 | 04-28-2015 | 04-28-2015 | 04-28-2015 | 06-08-2015 | 06-08-2015 | 06-08-2015 | 2 |
| 2016 | 05-11-2016 | 05-11-2016 | 05-11-2016 | 12-22-2016 | 12-22-2016 | 12-22-2016 | 4 |
| 2017 | 08-09-2017 | 08-09-2017 | 08-09-2017 | 08-09-2017 | 08-09-2017 | 08-09-2017 | 1 |

## Larval Delta Smelt

(<20 mm FL, cohort year set to just calendar year)

### Bays Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1995 | 05-12-1995 | 05-12-1995 | 05-12-1995 | 05-26-1995 | 05-26-1995 | 05-26-1995 | 228 |
| 1996 | 04-17-1996 | 04-17-1996 | 04-17-1996 | 04-17-1996 | 04-17-1996 | 04-17-1996 | 2007 |
| 2006 | 04-22-2006 | 04-22-2006 | 04-22-2006 | 05-19-2006 | 05-19-2006 | 06-17-2006 | 587 |
| 2011 | 04-25-2011 | 04-25-2011 | 04-25-2011 | 05-10-2011 | 05-10-2011 | 05-10-2011 | 666 |
| 2019 | 04-24-2019 | 04-24-2019 | 04-24-2019 | 04-24-2019 | 04-24-2019 | 04-24-2019 | 13 |

### North Delta and Suisun Bay Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1995 | 04-27-1995 | 05-10-1995 | 05-12-1995 | 07-19-1995 | 07-20-1995 | 08-07-1995 | 228 |
| 1996 | 04-11-1996 | 04-27-1996 | 04-30-1996 | 06-14-1996 | 06-26-1996 | 07-25-1996 | 2007 |
| 1997 | 04-15-1997 | 05-13-1997 | 05-14-1997 | 06-11-1997 | 06-11-1997 | 07-24-1997 | 1148 |
| 1998 | 04-08-1998 | 04-24-1998 | 05-06-1998 | 06-18-1998 | 06-20-1998 | 07-30-1998 | 229 |
| 1999 | 04-13-1999 | 04-16-1999 | 04-30-1999 | 07-08-1999 | 07-08-1999 | 08-03-1999 | 1378 |
| 2000 | 03-21-2000 | 04-07-2000 | 05-03-2000 | 06-14-2000 | 06-15-2000 | 07-11-2000 | 2007 |
| 2001 | 03-21-2001 | 04-07-2001 | 04-07-2001 | 05-05-2001 | 05-05-2001 | 06-30-2001 | 4193 |
| 2002 | 04-16-2002 | 04-17-2002 | 04-17-2002 | 06-14-2002 | 06-14-2002 | 06-29-2002 | 300 |
| 2003 | 03-25-2003 | 03-26-2003 | 04-09-2003 | 06-18-2003 | 07-01-2003 | 07-03-2003 | 363 |
| 2004 | 04-01-2004 | 04-14-2004 | 04-14-2004 | 05-27-2004 | 06-10-2004 | 06-22-2004 | 309 |
| 2005 | 03-16-2005 | 04-27-2005 | 04-28-2005 | 06-08-2005 | 06-09-2005 | 07-08-2005 | 384 |
| 2006 | 04-21-2006 | 05-18-2006 | 05-19-2006 | 06-17-2006 | 06-29-2006 | 07-18-2006 | 587 |
| 2007 | 03-14-2007 | 03-16-2007 | 03-16-2007 | 06-20-2007 | 06-20-2007 | 06-20-2007 | 31 |
| 2008 | 04-14-2008 | 04-14-2008 | 04-14-2008 | 06-09-2008 | 06-09-2008 | 06-12-2008 | 62 |
| 2009 | 04-06-2009 | 04-08-2009 | 04-22-2009 | 06-15-2009 | 06-15-2009 | 07-01-2009 | 168 |
| 2010 | 03-17-2010 | 04-12-2010 | 04-26-2010 | 06-25-2010 | 07-08-2010 | 07-08-2010 | 430 |
| 2011 | 03-15-2011 | 04-26-2011 | 04-26-2011 | 06-21-2011 | 07-05-2011 | 07-07-2011 | 666 |
| 2012 | 03-19-2012 | 03-19-2012 | 03-20-2012 | 06-05-2012 | 06-06-2012 | 07-12-2012 | 948 |
| 2013 | 03-18-2013 | 03-18-2013 | 03-19-2013 | 05-20-2013 | 05-21-2013 | 07-03-2013 | 655 |
| 2014 | 03-03-2014 | 03-04-2014 | 03-18-2014 | 05-12-2014 | 05-13-2014 | 05-27-2014 | 132 |
| 2015 | 03-03-2015 | 03-16-2015 | 03-25-2015 | 05-13-2015 | 05-13-2015 | 06-23-2015 | 42 |
| 2016 | 03-15-2016 | 03-15-2016 | 03-28-2016 | 05-12-2016 | 05-25-2016 | 06-22-2016 | 67 |
| 2017 | 03-13-2017 | 03-15-2017 | 03-15-2017 | 05-24-2017 | 06-05-2017 | 07-05-2017 | 116 |
| 2018 | 03-12-2018 | 03-12-2018 | 03-12-2018 | 03-29-2018 | 04-11-2018 | 06-12-2018 | 33 |
| 2019 | 03-11-2019 | 03-11-2019 | 03-12-2019 | 05-21-2019 | 06-05-2019 | 06-05-2019 | 13 |
| 2020 | 03-17-2020 | 03-17-2020 | 03-17-2020 | 05-11-2020 | 05-19-2020 | 05-20-2020 | 38 |

### Central and South Delta Region

| Cohort Year | 0.0% | 5.0% | 10.0% | 90.0% | 95.0% | 100.0% | Sample size |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1994 | 06-02-1994 | 06-02-1994 | 06-02-1994 | 06-29-1994 | 06-29-1994 | 06-29-1994 | 2 |
| 1995 | 07-03-1995 | 07-03-1995 | 07-03-1995 | 07-03-1995 | 07-03-1995 | 07-03-1995 | 228 |
| 1996 | 04-10-1996 | 04-10-1996 | 04-11-1996 | 06-08-1996 | 06-09-1996 | 07-08-1996 | 2007 |
| 1997 | 03-31-1997 | 04-14-1997 | 04-14-1997 | 05-27-1997 | 05-27-1997 | 07-08-1997 | 1148 |
| 1998 | 06-01-1998 | 06-01-1998 | 06-01-1998 | 06-01-1998 | 06-01-1998 | 06-01-1998 | 229 |
| 1999 | 04-12-1999 | 04-12-1999 | 04-28-1999 | 06-14-1999 | 06-14-1999 | 07-06-1999 | 1378 |
| 2000 | 03-20-2000 | 04-17-2000 | 04-18-2000 | 06-13-2000 | 06-13-2000 | 07-10-2000 | 2007 |
| 2001 | 04-02-2001 | 04-16-2001 | 04-30-2001 | 05-30-2001 | 06-11-2001 | 06-13-2001 | 4193 |
| 2002 | 04-02-2002 | 04-02-2002 | 04-02-2002 | 05-29-2002 | 06-11-2002 | 06-24-2002 | 300 |
| 2003 | 03-24-2003 | 04-07-2003 | 04-07-2003 | 06-17-2003 | 06-30-2003 | 07-01-2003 | 363 |
| 2004 | 03-29-2004 | 04-13-2004 | 04-26-2004 | 05-24-2004 | 06-07-2004 | 06-09-2004 | 309 |
| 2005 | 03-15-2005 | 03-28-2005 | 03-28-2005 | 06-06-2005 | 06-07-2005 | 07-05-2005 | 384 |
| 2006 | 05-16-2006 | 05-16-2006 | 05-16-2006 | 05-16-2006 | 05-16-2006 | 05-16-2006 | 587 |
| 2007 | 05-07-2007 | 05-07-2007 | 05-07-2007 | 05-07-2007 | 05-07-2007 | 05-07-2007 | 31 |
| 2008 | 04-14-2008 | 04-14-2008 | 04-15-2008 | 05-28-2008 | 06-09-2008 | 06-09-2008 | 62 |
| 2009 | 04-06-2009 | 04-06-2009 | 04-06-2009 | 05-20-2009 | 06-16-2009 | 06-16-2009 | 168 |
| 2010 | 04-13-2010 | 04-13-2010 | 04-13-2010 | 06-22-2010 | 06-22-2010 | 06-22-2010 | 430 |
| 2011 | 05-23-2011 | 05-23-2011 | 05-23-2011 | 06-06-2011 | 06-06-2011 | 06-06-2011 | 666 |
| 2012 | 03-19-2012 | 03-19-2012 | 03-19-2012 | 06-05-2012 | 06-18-2012 | 06-18-2012 | 948 |
| 2013 | 03-18-2013 | 03-18-2013 | 03-19-2013 | 05-20-2013 | 06-03-2013 | 06-17-2013 | 655 |
| 2014 | 03-17-2014 | 03-17-2014 | 03-17-2014 | 05-12-2014 | 05-27-2014 | 05-27-2014 | 132 |
| 2015 | 03-24-2015 | 03-24-2015 | 03-24-2015 | 05-11-2015 | 05-11-2015 | 05-11-2015 | 42 |
| 2016 | 03-14-2016 | 03-14-2016 | 03-14-2016 | 06-06-2016 | 06-06-2016 | 06-06-2016 | 67 |
| 2018 | 03-19-2018 | 03-19-2018 | 03-19-2018 | 03-19-2018 | 03-19-2018 | 03-19-2018 | 33 |