Enhanced Delta Smelt Monitoring
Preliminary Abundance Analysis
Phase 3 Sampling

DRAFT

U.S. Fish and Wildlife Service

November 13, 2017

Overview

Beginning July 2017, the Enhanced Delta Smelt Monitoring (EDSM) program started its Phase 3 sampling program. The Bay-Delta has been divided into eight geographic strata:

- Western Delta
- Suisun Bay Marsh (Suisun Bay and Marsh)
- Lower Sacramento
- Cache Slough LI (Cache Slough and Liberty Island)
- Sac DW Ship Channel (Sacramento Deep Water Shipping Channel)
- Upper Sacramento
- Lower San Joaquin
- Southern Delta

Sampling locations are generated using a generalized random-tessellation stratified (GRTS) design [1] with stratification and equal probability sampling. Trawling gear similar to that used in the California Department of Fish and Wildlife's Spring Kodiak Trawl Survey is used to conduct multiple tows per location.

Everything presented here is preliminary and subject to correction, revision, and improvement. The following points should be taken into consideration when interpreting the results:

1. Delta smelt caught in the wings of the net (as opposed to the live box or cod end) were excluded from this analysis. Fish caught in the wings are indicated by a Gear Condition Code of 9.
2. The **Week** designations used here were defined out of convenience and are subject to change.
3. Current sampling is limited to areas of the Bay-Delta with a depth of at least 8 feet at mean tide. The abundance estimation method used here assumes that the density of fish in unsampled areas (i.e., those with depth less than 8 feet) is the same as in sampled areas (i.e., those with depth greater than or equal to 8 feet).
4. The methods of analysis used here remain in development.

Change Log

Report date July 10, 2017:

- No changes.

Report date July 14, 2017:

- Sample volume corrections were made for tows in Suisun Bay Marsh during Week 1. This resulted in an increase in the abundance estimate for that week.

Report date July 21, 2017:

- Total sample volume has been added to Table 1. Sample volumes are subject to correction.
- In some strata, a single tow was conducted at one of the sites in contrast to the standard two tow minimum. This change in procedure necessitates changes to the statistical model. While these changes are in development, simple stratified ratio-expanded estimates will be shown in Table 1.

Report date July 28, 2017:

- No changes since last report.

Report date August 4, 2017:

- Sampling in the Southern Delta has been temporarily suspended as catches are expected to be low based on historic data and conditions are expected to be inhospitable. During this time, the number of sampling sites in other strata may increase as resources allow.

Report date August 11, 2017:

- Sampling for the week of August 7th occurred between Monday and Friday. This report includes data collected between Monday and Thursday; the remaining data will be included in the next report.

Report date August 18, 2017:

- Samples collected in Suisun Bay Marsh on Friday August 11th (Week 6) that were not included in the last report are now included, and the estimates for Week 6 have been recalculated. A correction has been made to Week 5 to account for the fact that one site in Suisun Bay Marsh had a single tow due to weather.

Report date August 25, 2017:

- No changes since last report.

Report date September 1, 2017:

- No changes since last report.

Report date September 8, 2017:

- Sampling for the week of September 4th occurred between Tuesday and Friday. This report includes data collected between Tuesday and Thursday; the remaining data will be included in the next report.

Report date September 15, 2017:

- Data collected on Friday September 8th have been incorporated into this report. Sampling in the Southern Delta will resume starting the week of September 18th.

Report date September 22, 2017:

- Sampling for the week of September 22nd occurred on Monday, Tuesday, Wednesay, and Friday. This report includes data collected on Monday, Tuesday, and Wednesday; the remaining data will be included in the next report. A correction was made to the total sample volume from Week 3.

Report date September 29, 2017:

- Data collected on Friday September 22nd have been incorporated into this report.

  Sampling for the week starting September 25th occurred on Monday, Tuesday, Wednesday, and Friday. This report includes data collected on Monday, Tuesday, and Wednesday; the remaining data will be included in the next report.

Report date October 6, 2017:

- Data collected on Friday September 29th have been incorporated into this report.

  Previous reports used estimates of strata volume extending to the estuary bottom. For consistency with sub-adult/adult abundance estimation analyses outside of EDSM, the volumes in this report have been changed to estimates of strata volume extending to a depth of 4 m. This has resulted in the abundance estimates being reduced.

Report date October 13, 2017:

- Sampling occurred between Tuesday October 10th and Friday October 13th this week. Data collected Tuesday through Thursday have been incorporated into this report. Data collected Friday will be included in the next report.

Report date October 20, 2017:

- Data collected on Friday October 13th have been incorporated into this report.
- During the week of October 10 - 13, sampling in the Western Delta was limited to one site in the eastern portion of the Western Delta because of poor air quality from the North Bay fires.
- Sampling for this week, October 16 - 20, is taking place Monday through Friday. Data collected on Friday will be included in the next report.

Report date October 27, 2017:

- Data collected on Friday October 20th have been incorporated into this report.

Report date November 3, 2017:

- No changes since last report.

Report date November 13, 2017:

- The data analysis procedure has been updated to exclude tows with a Gear Condition Code of 3. Code 3's cover a variety of scenarios that result in a "poor" sample - for example, net blockage by vegetation. This has resulted in changes in the total number of tows, total volume sampled, and abundance estimates for some weeks.
- Bubble plots of catch density have been removed to reduce the size of this file.

Results

Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. Values in blue use a stratified ratio-expanded estimation method that does not account for EDSM's stopping rules.

					Estimate and 95% CI		
Stratum	**Number of Sites**	**Number of Tows**	**Number Caught**	**Total Sample Volume**	**Abundance**	**Lower Bound**	**Upper Bound**
Week 1: July 3 - 7, 2017							
Western Delta	4	32	0	130,560	0*	-	-
Suisun Bay Marsh	2	5	5	12,373	140,457	55,502	296,164
Lower Sacramento	2	10	0	21,249	0*	-	-
Cache Slough LI	2	3	37	6,047	418,306	62,691	1,463,215
Sac DW Ship Channel	2	4	9	4,462	49,637	24,832	89,205
Upper Sacramento	2	13	0	44,296	0*	-	-
Lower San Joaquin	4	20	1	32,098	6,543	698	26,114
Southern Delta	6	48	0	179,539	0*	-	-
Total	24	135	52	430,624	614,944	158,954	1,662,171
Week 2: July 10 - 14, 2017							
Western Delta	2	12	0	62,818	0*	-	-
Suisun Bay Marsh	0	-	-	-	-	-	-
Lower Sacramento	2	10	0	20,226	0*	-	-
Cache Slough LI	2	7	25	10,323	396,817	86,148	1,172,834
Sac DW Ship Channel	2	7	7	10,194	37,900	8,471	110,417
Upper Sacramento	2	16	0	57,880	0*	-	-
Lower San Joaquin	4	20	0	37,240	0*	-	-
Southern Delta	6	45	0	184,584	0*	-	-
Total	20	117	32	383,265	-	-	-
Week 3: July 17 - 20, 2017							
Western Delta	4	32	0	120,388	0*	-	-
Suisun Bay Marsh	2	7	10	13,558	422,161	87,309	1,277,610
Lower Sacramento	2	9	0	14,552	0*	-	-
Cache Slough LI	2	4	27	5,117	360,756	45,363	1,354,263
Sac DW Ship Channel	2	6	40	8,721	112,926	13,984	426,429
Upper Sacramento	2	16	0	53,937	0*	-	-
Lower San Joaquin	4	20	0	40,021	0*	-	-
Southern Delta	6	48	0	199,987	0*	-	-
Total	24	142	77	456,281	895,843	271,688	2,217,295
Week 4: July 24 - 27, 2017							
Western Delta	4	26	2	116,912	36,030	6,089	119,693
Suisun Bay Marsh	2	10	2	18,635	37,340	3,573	154,831
Lower Sacramento	2	11	0	23,195	0*	-	-
Cache Slough LI	2	9	0	16,140	0*	-	-
Sac DW Ship Channel	2	2	62	2,660	573,986	395,952	805,229
Upper Sacramento	2	16	0	62,159	0*	-	-
Lower San Joaquin	4	20	0	49,623	0*	-	-

Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. Values in blue use a stratified ratio-expanded estimation method that does not account for EDSM's stopping rules.

					Estimate and 95% CI		
Stratum	**Number of Sites**	**Number of Tows**	**Number Caught**	**Total Sample Volume**	**Abundance**	**Lower Bound**	**Upper Bound**
Southern Delta	6	45	0	187,128	0*	-	-
Total	24	139	66	476,451	647,357	445,671	909,671
Week 5: July 31 - August 3, 2017							
Western Delta	8	52	8	265,007	45,755	12,742	118,790
Suisun Bay Marsh	5	15	4	29,564	47,075	14,531	115,343
Lower Sacramento	2	7	1	12,931	13,454	1,660	50,879
Cache Slough LI	2	10	0	15,046	0*	-	-
Sac DW Ship Channel	2	7	2	13,950	7,598	1,522	23,350
Upper Sacramento	2	16	0	52,469	0*	-	-
Lower San Joaquin	4	19	0	32,335	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	25	126	15	421,302	-	-	-
Week 6: August 7 - 11, 2017							
Western Delta	6	43	1	201,700	2,078	287	7,517
Suisun Bay Marsh	4	15	3	30,984	41,169	12,762	100,626
Lower Sacramento	2	10	0	19,214	0*	-	-
Cache Slough LI	2	7	1	11,903	8,862	1,539	29,087
Sac DW Ship Channel	2	10	0	15,586	0*	-	-
Upper Sacramento	2	16	0	68,334	0*	-	-
Lower San Joaquin	5	19	2	41,841	15,870	4,601	40,294
Southern Delta	0	-	-	-	-	-	-
Total	23	120	7	389,562	-	-	-
Week 7: August 14 - 17, 2017							
Western Delta	7	35	4	167,373	10,010	2,904	25,405
Suisun Bay Marsh	4	16	4	30,210	56,147	18,340	133,111
Lower Sacramento	2	10	0	21,592	0*	-	-
Cache Slough LI	2	10	0	16,495	0*	-	-
Sac DW Ship Channel	2	8	1	15,409	1,598	221	5,777
Upper Sacramento	2	14	0	45,647	0*	-	-
Lower San Joaquin	4	20	0	40,189	0*	NA	NA
Southern Delta	0	-	-	-	-	-	-
Total	23	113	9	336,916	-	-	-
Week 8: August 21 - 24, 2017							
Western Delta	8	49	3	217,979	7,603	2,943	16,244
Suisun Bay Marsh	3	9	6	21,203	172,999	61,225	390,864
Lower Sacramento	2	7	1	17,005	15,405	2,676	50,556
Cache Slough LI	2	9	0	19,815	0*	-	-
Sac DW Ship Channel	2	7	1	18,212	1,352	187	4,888
Upper Sacramento	2	15	0	66,241	0*	-	-

Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. Values in blue use a stratified ratio-expanded estimation method that does not account for EDSM's stopping rules.

					Estimate and 95% CI		
Stratum	**Number of Sites**	**Number of Tows**	**Number Caught**	**Total Sample Volume**	**Abundance**	**Lower Bound**	**Upper Bound**
Lower San Joaquin	4	16	1	39,547	4,088	563	14,801
Southern Delta	0	-	-	-	-	-	-
Total	23	112	12	400,002	-	-	-
Week 9: August 28 - 31, 2017							
Western Delta	8	64	0	286,318	0*	-	-
Suisun Bay Marsh	4	17	1	34,253	10,171	1,411	36,724
Lower Sacramento	2	7	2	17,821	33,255	6,688	102,003
Cache Slough LI	2	10	0	20,386	0*	-	-
Sac DW Ship Channel	2	10	0	20,328	0*	-	-
Upper Sacramento	2	16	0	68,813	0*	-	-
Lower San Joaquin	4	20	0	38,907	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	24	144	3	486,826	-	-	-
Week 10: September 5 - 8, 2017							
Western Delta	8	47	6	198,935	16,916	6,315	36,976
Suisun Bay Marsh	4	17	2	30,618	22,728	5,328	64,639
Lower Sacramento	2	10	1	22,027	7,864	1,088	28,433
Cache Slough LI	2	10	0	19,644	0*	-	-
Sac DW Ship Channel	2	10	0	20,371	0*	-	-
Upper Sacramento	2	16	0	66,063	0*	-	-
Lower San Joaquin	4	20	0	33,524	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	24	130	9	391,181	-	-	-
Week 11: September 11 - 14, 2017							
Western Delta	8	53	4	225,500	8,343	1,208	29,599
Suisun Bay Marsh	4	9	4	17,502	79,514	28,175	179,512
Lower Sacramento	2	10	0	21,366	0*	-	-
Cache Slough LI	2	10	0	15,500	0*	-	-
Sac DW Ship Channel	2	10	0	20,525	0*	-	-
Upper Sacramento	2	16	0	50,705	0*	-	-
Lower San Joaquin	4	19	0	32,526	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	24	127	8	383,624	-	-	-
Week 12: September 18 - 22, 2017							
Western Delta	4	23	2	93,657	8,945	2,096	25,441
Suisun Bay Marsh	4	16	2	31,611	22,014	5,161	62,606
Lower Sacramento	2	4	17	8,906	333,709	103,414	815,802
Cache Slough LI	2	10	0	18,690	0*	-	-
Sac DW Ship Channel	2	10	0	18,869	0*	-	-

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					Estimate and 95% CI		
Stratum	**Number of Sites**	**Number of Tows**	**Number Caught**	**Total Sample Volume**	**Abundance**	**Lower Bound**	**Upper Bound**
Upper Sacramento	2	16	0	70,723	0*	-	-
Lower San Joaquin	4	19	0	36,574	0*	-	-
Southern Delta	4	31	0	108,815	0*	-	-
Total	24	129	21	387,845	364,668	124,099	843,706
Week 13: September 25 - 29, 2017							
Western Delta	4	32	0	109,882	0*	-	-
Suisun Bay Marsh	3	13	2	26,026	26,741	6,266	76,068
Lower Sacramento	2	7	1	15,525	12,575	1,701	45,866
Cache Slough LI	2	10	0	28,028	0*	-	-
Sac DW Ship Channel	2	9	0	17,760	0*	-	-
Upper Sacramento	2	16	0	61,901	0*	-	-
Lower San Joaquin	4	19	1	34,256	4,740	655	17,137
Southern Delta	4	32	0	95,339	0*	-	-
Total	23	138	4	388,718	44,055	14,720	103,053
Week 14: October 2 - 5, 2017							
Western Delta	3	11	1	44,477	9,417	1,302	34,051
Suisun Bay Marsh	4	20	0	41,799	0*	-	-
Lower Sacramento	2	8	1	16,299	10,629	1,471	38,422
Cache Slough LI	2	10	0	24,411	0*	-	-
Sac DW Ship Channel	2	10	0	20,737	0*	-	-
Upper Sacramento	2	16	0	52,640	0*	-	-
Lower San Joaquin	4	20	0	41,833	0*	-	-
Southern Delta	4	32	0	98,325	0*	-	-
Total	23	127	2	340,521	20,046	4,687	57,087
Week 15: October 10 - 13, 2017							
Western Delta	1	9	0	33,443	0*	-	-
Suisun Bay Marsh	4	18	1	36,422	9,564	1,325	34,555
Lower Sacramento	2	5	38	9,104	915,343	145,602	3,121,952
Cache Slough LI	2	10	0	17,995	0*	-	-
Sac DW Ship Channel	2	10	0	19,322	0*	-	-
Upper Sacramento	2	16	0	57,040	0*	-	-
Lower San Joaquin	4	20	0	40,135	0*	-	-
Southern Delta	4	32	0	107,042	0*	-	-
Total	21	120	39	320,504	924,907	149,575	3,132,178
Week 16: October 16 - 20, 2017							
Western Delta	4	33	0	127,873	0*	-	-
Suisun Bay Marsh	4	19	1	35,052	9,928	1,375	35,876
Lower Sacramento	2	10	0	19,402	0*	-	-
Cache Slough LI	2	10	0	18,257	0*	-	-

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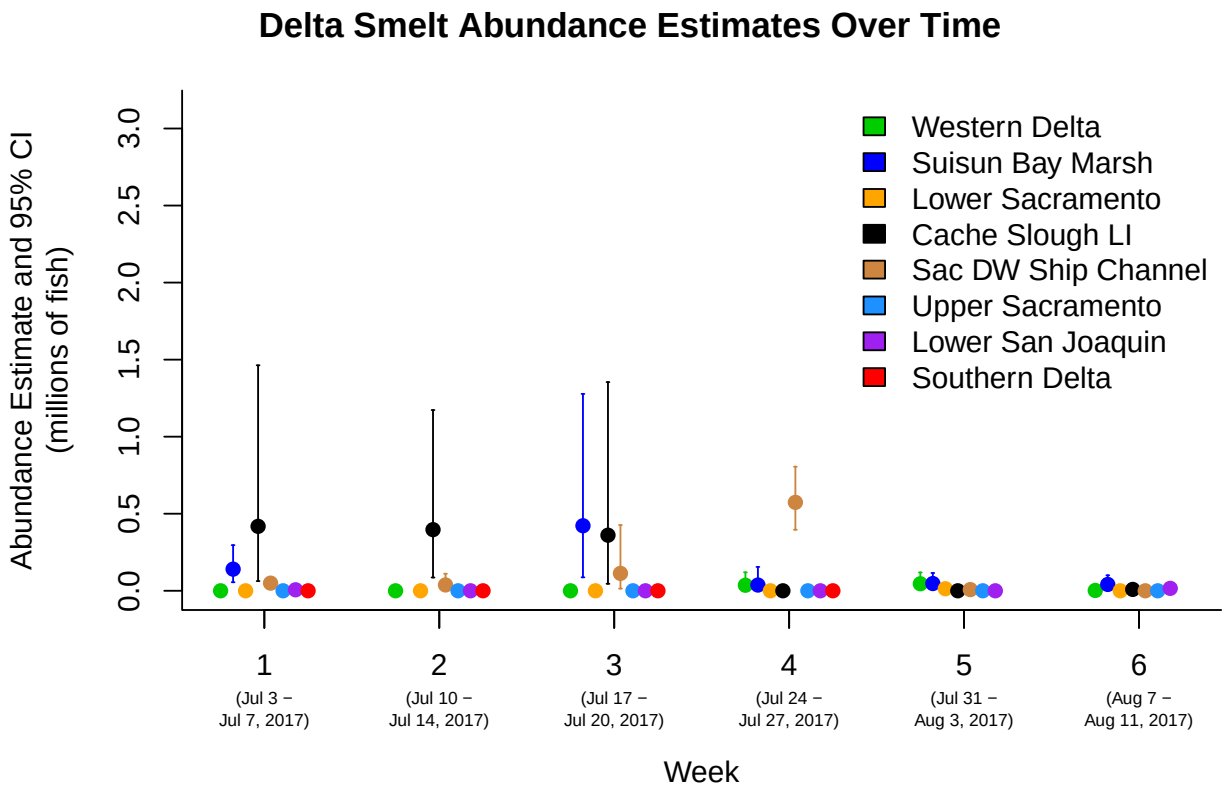
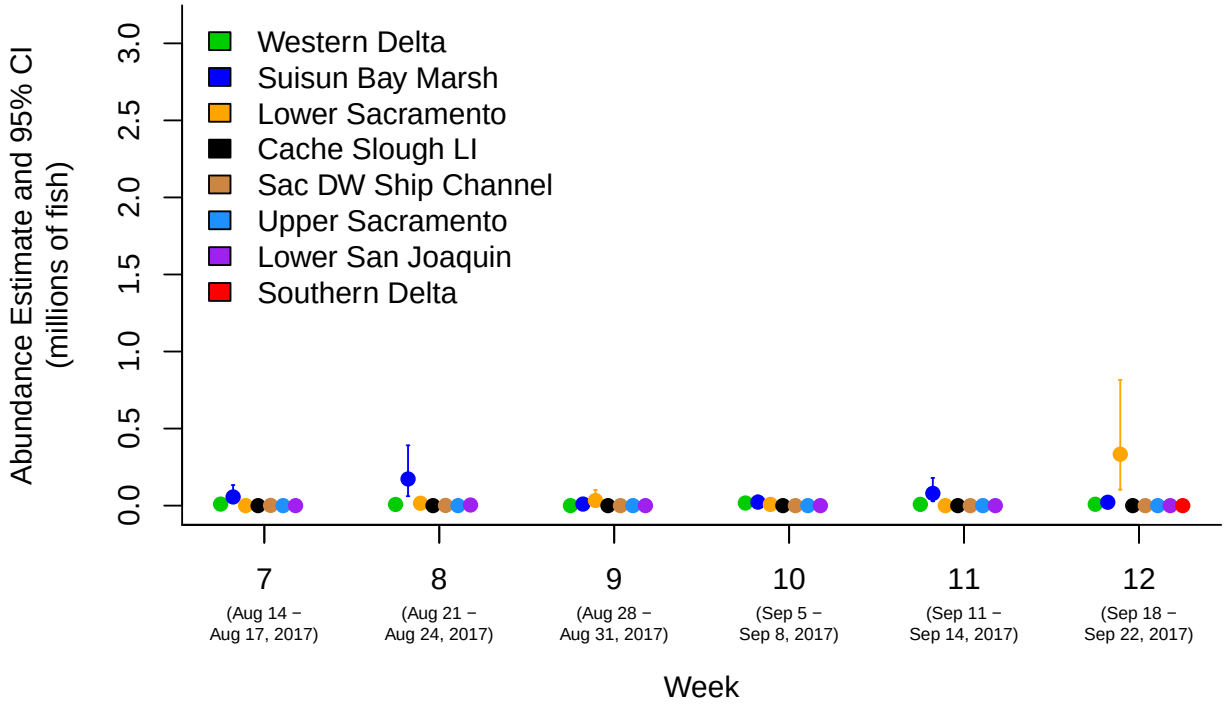
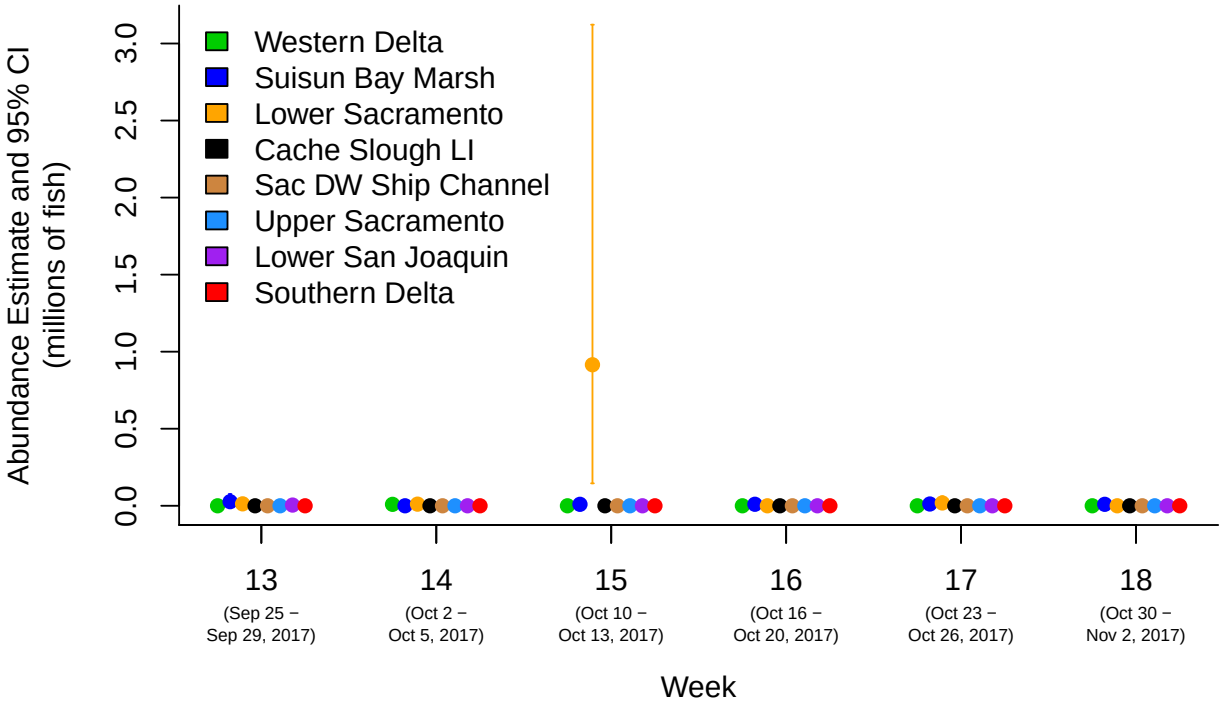
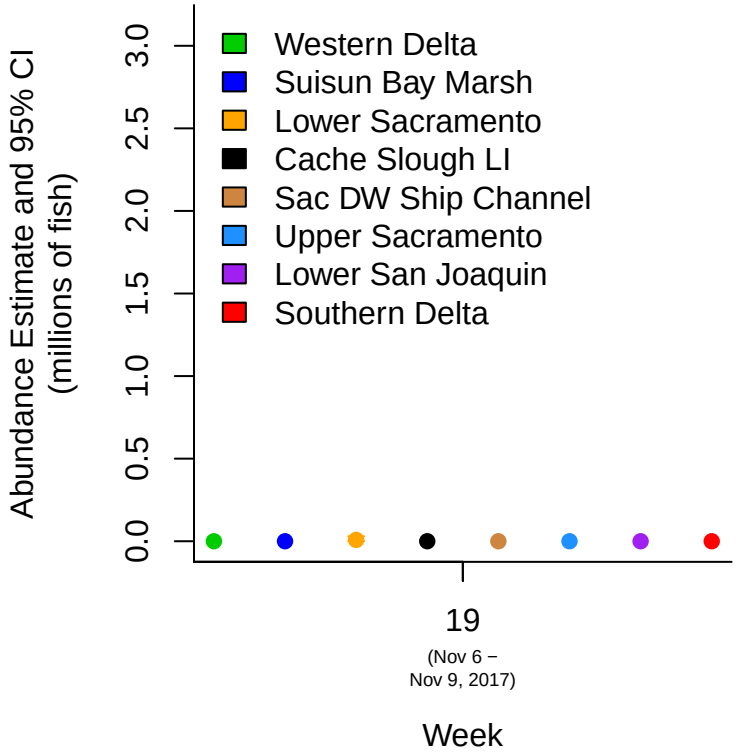
					Estimate and 95% CI		
Stratum	**Number of Sites**	**Number of Tows**	**Number Caught**	**Total Sample Volume**	**Abundance**	**Lower Bound**	**Upper Bound**
Sac DW Ship Channel	2	10	0	18,423	0*	-	-
Upper Sacramento	2	16	0	62,510	0*	-	-
Lower San Joaquin	4	20	0	43,706	0*	-	-
Southern Delta	4	28	0	93,051	0*	-	-
Total	24	146	1	418,274	9,928	1,375	35,876
Week 17: October 23 - 26, 2017							
Western Delta	4	28	0	102,385	0*	-	-
Suisun Bay Marsh	4	17	1	29,816	11,670	1,613	42,199
Lower Sacramento	2	7	1	19,124	18,325	3,131	60,580
Cache Slough LI	2	10	0	22,705	0*	-	-
Sac DW Ship Channel	2	10	0	25,349	0*	-	-
Upper Sacramento	2	16	0	57,696	0*	-	-
Lower San Joaquin	4	20	0	39,602	0*	-	-
Southern Delta	4	24	0	94,972	0*	-	-
Total	24	132	2	391,650	29,994	7,664	81,570
Week 18: October 30 - November 2, 2017							
Western Delta	4	32	0	131,149	0*	-	-
Suisun Bay Marsh	4	18	1	36,260	9,595	1,327	34,693
Lower Sacramento	2	10	0	21,340	0*	-	-
Cache Slough LI	2	10	0	21,209	0*	-	-
Sac DW Ship Channel	2	10	0	21,136	0*	-	-
Upper Sacramento	2	16	0	60,716	0*	-	-
Lower San Joaquin	4	19	0	46,177	0*	-	-
Southern Delta	4	32	0	134,672	0*	-	-
Total	24	147	1	472,658	9,595	1,327	34,693
Week 19: November 6 - 9, 2017							
Western Delta	4	30	0	131,240	0*	-	-
Suisun Bay Marsh	4	20	0	39,739	0*	-	-
Lower Sacramento	2	9	1	21,158	8,186	1,132	29,596
Cache Slough LI	2	10	0	18,834	0*	-	-
Sac DW Ship Channel	2	10	0	22,079	0*	-	-
Upper Sacramento	2	16	0	59,605	0*	-	-
Lower San Joaquin	4	18	0	39,752	0*	-	-
Southern Delta	4	32	0	125,541	0*	-	-
Total	24	145	1	457,948	8,186	1,132	29,596

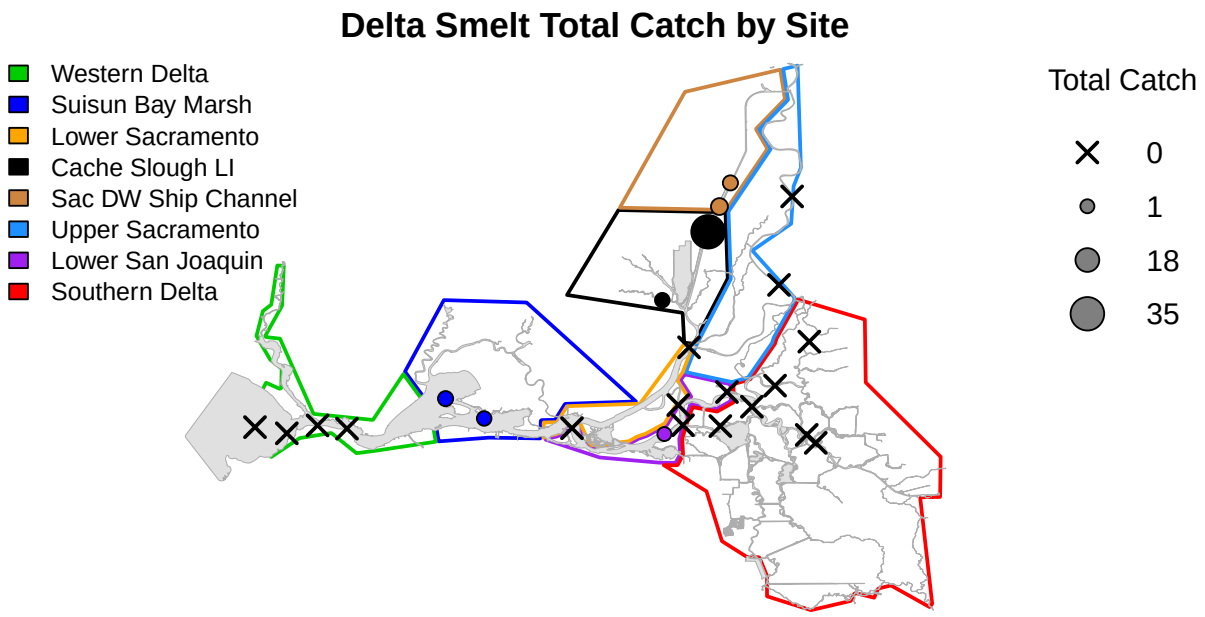

Delta Smelt Abundance Estimates Over Time
Abundance Estimate and 95% CI
(millions of fish)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Western Delta
Suisun Bay Marsh
Lower Sacramento
Cache Slough LI
Sac DW Ship Channel
Upper Sacramento
Lower San Joaquin
Southern Delta
1
(Jul 3 –
Jul 7, 2017)
2
(Jul 10 –
Jul 14, 2017)
3
(Jul 17 –
Jul 20, 2017)
4
(Jul 24 –
Jul 27, 2017)
5
(Jul 31 –
Aug 3, 2017)
6
(Aug 7 –
Aug 11, 2017)
Week


Abundance Estimate and 95% CI
(millions of fish)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Western Delta
Suisun Bay Marsh
Lower Sacramento
Cache Slough LI
Sac DW Ship Channel
Upper Sacramento
Lower San Joaquin
Southern Delta
7
(Aug 14 –
Aug 17, 2017)
8
(Aug 21 –
Aug 24, 2017)
9
(Aug 28 –
Aug 31, 2017)
10
(Sep 5 –
Sep 8, 2017)
11
(Sep 11 –
Sep 14, 2017)
12
(Sep 18 –
Sep 22, 2017)
Week

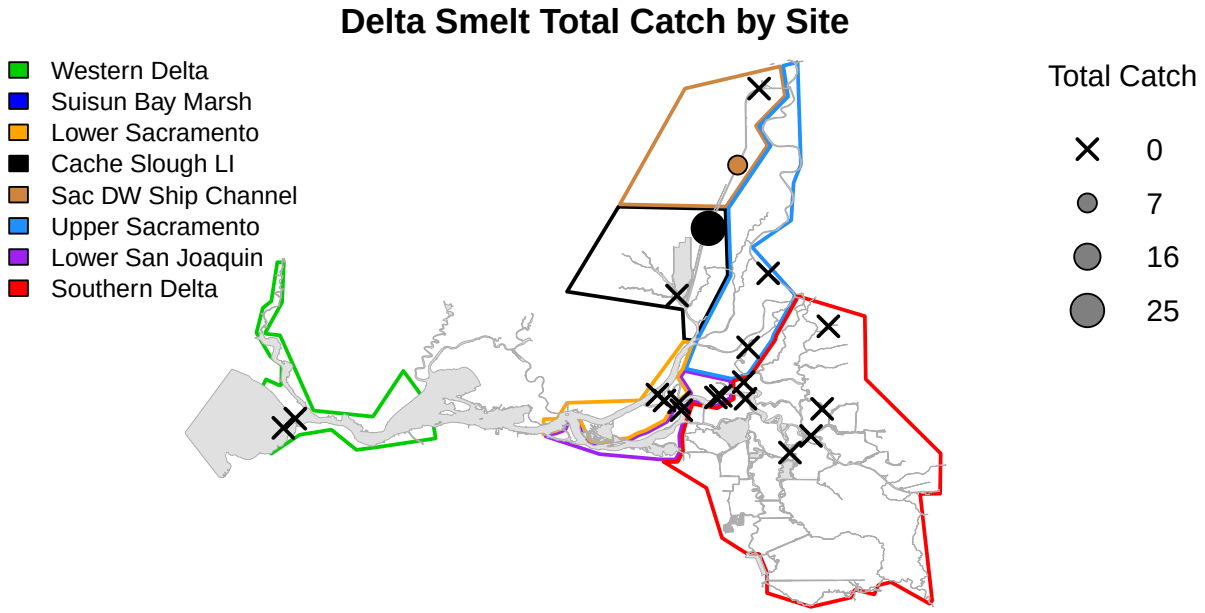

Abundance Estimate and 95% CI
(millions of fish)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Western Delta
Suisun Bay Marsh
Lower Sacramento
Cache Slough LI
Sac DW Ship Channel
Upper Sacramento
Lower San Joaquin
Southern Delta
13
(Sep 25 –
Sep 29, 2017)
14
(Oct 2 –
Oct 5, 2017)
15
(Oct 10 –
Oct 13, 2017)
16
(Oct 16 –
Oct 20, 2017)
17
(Oct 23 –
Oct 26, 2017)
18
(Oct 30 –
Nov 2, 2017)
Week


Abundance Estimate and 95% CI
(millions of fish)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Western Delta
Suisun Bay Marsh
Lower Sacramento
Cache Slough LI
Sac DW Ship Channel
Upper Sacramento
Lower San Joaquin
Southern Delta
19
(Nov 6 –
Nov 9, 2017)
Week

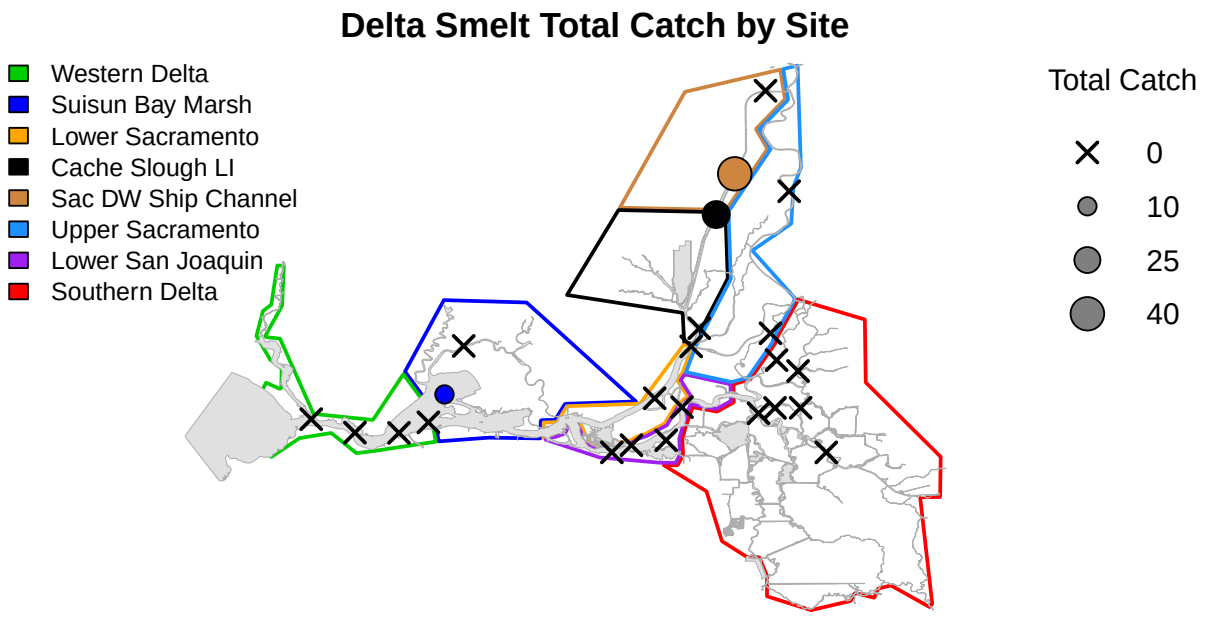
Week 1 (Jul 3 – Jul 7, 2017)



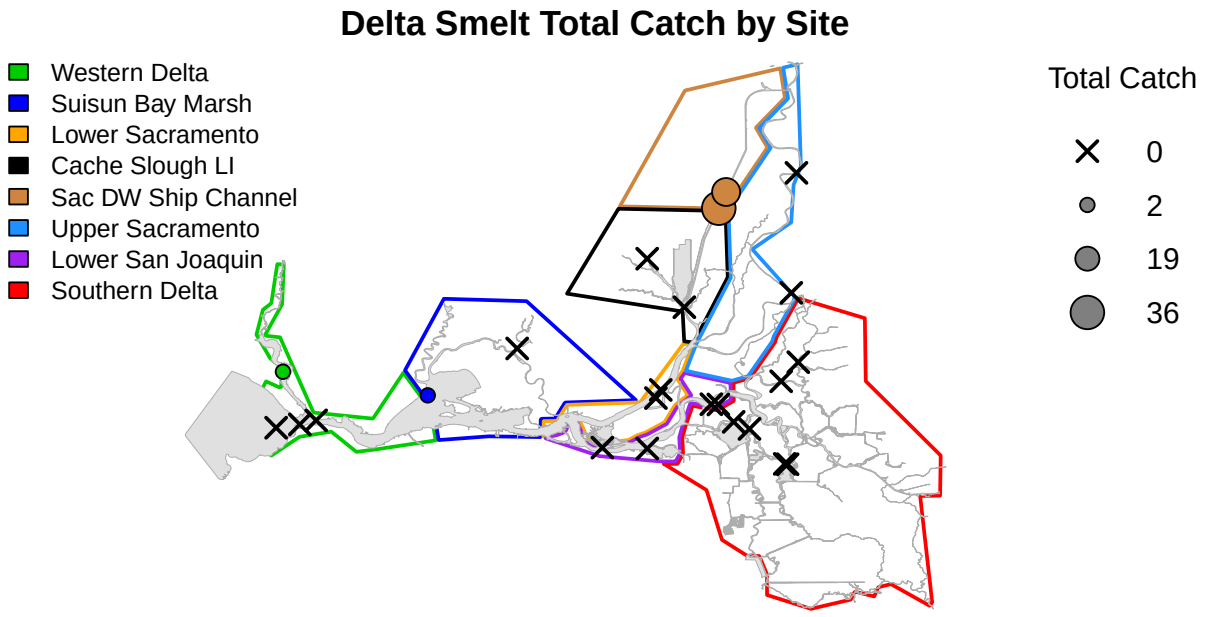
Week 2 (Jul 10 – Jul 14, 2017)



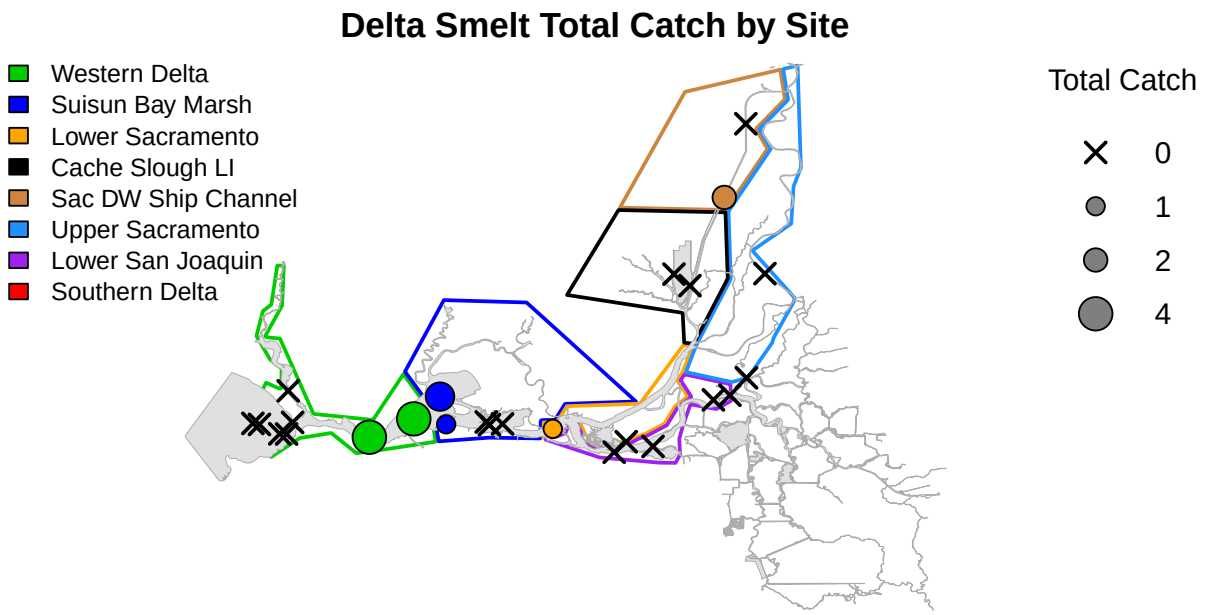
Week 3 (Jul 17 – Jul 20, 2017)



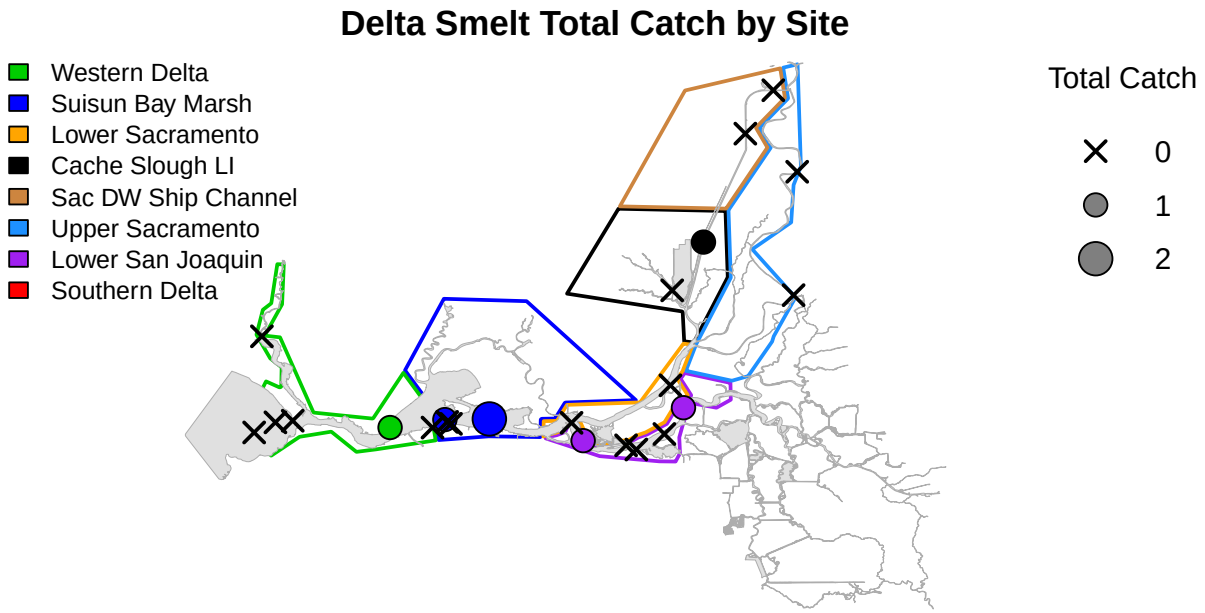
Week 4 (Jul 24 – Jul 27, 2017)



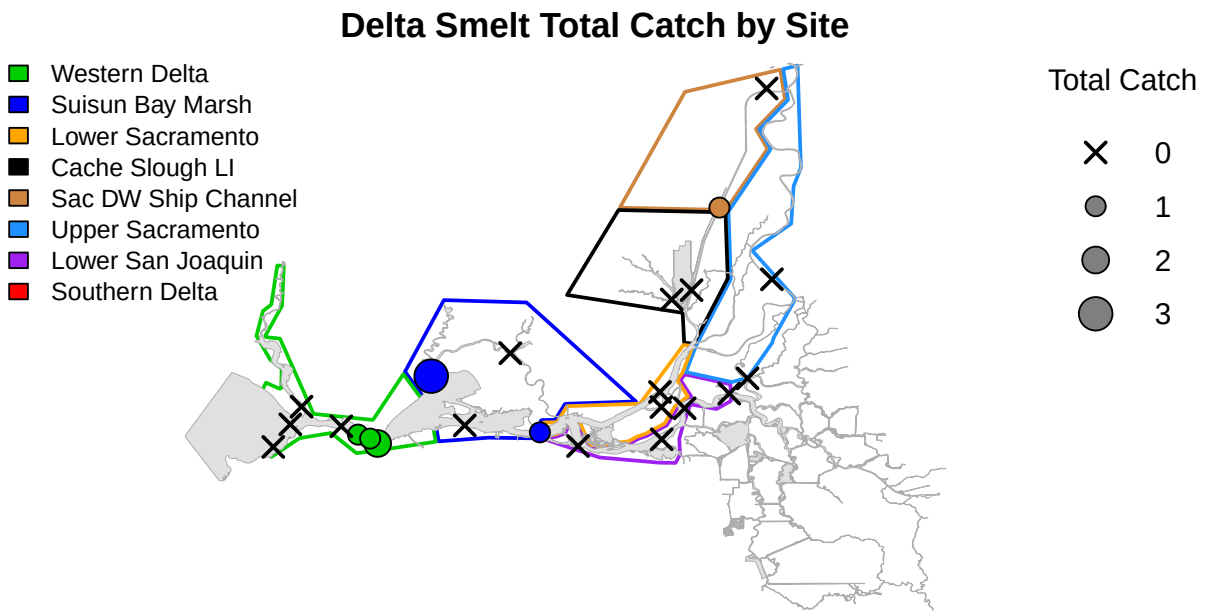
Week 5 (Jul 31 – Aug 3, 2017)



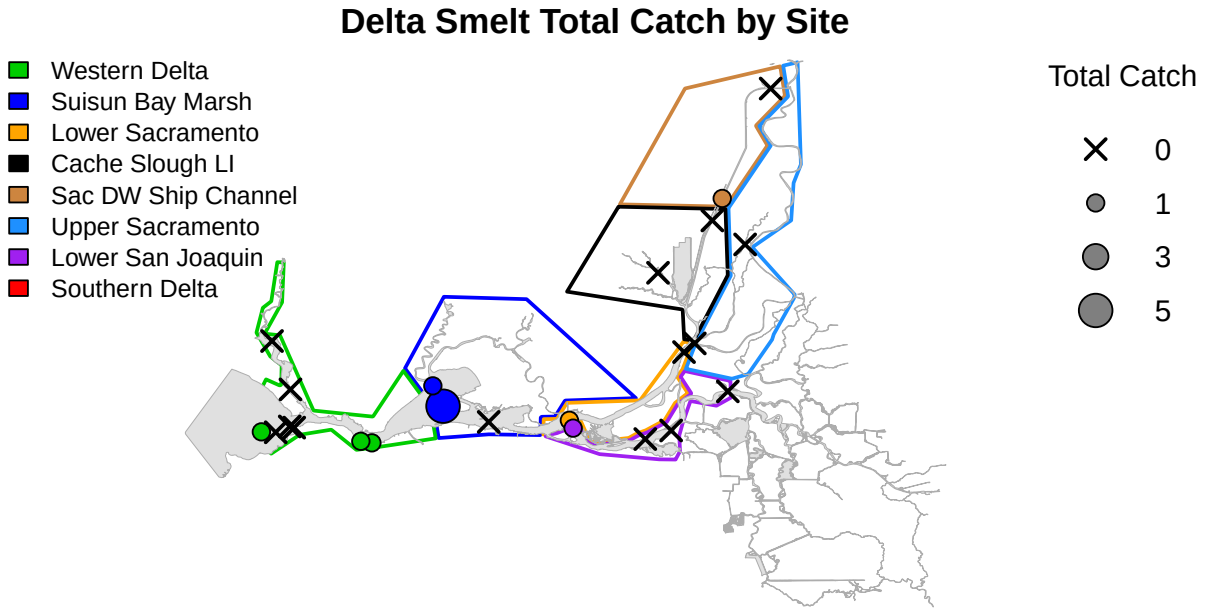
Week 6 (Aug 7 – Aug 11, 2017)



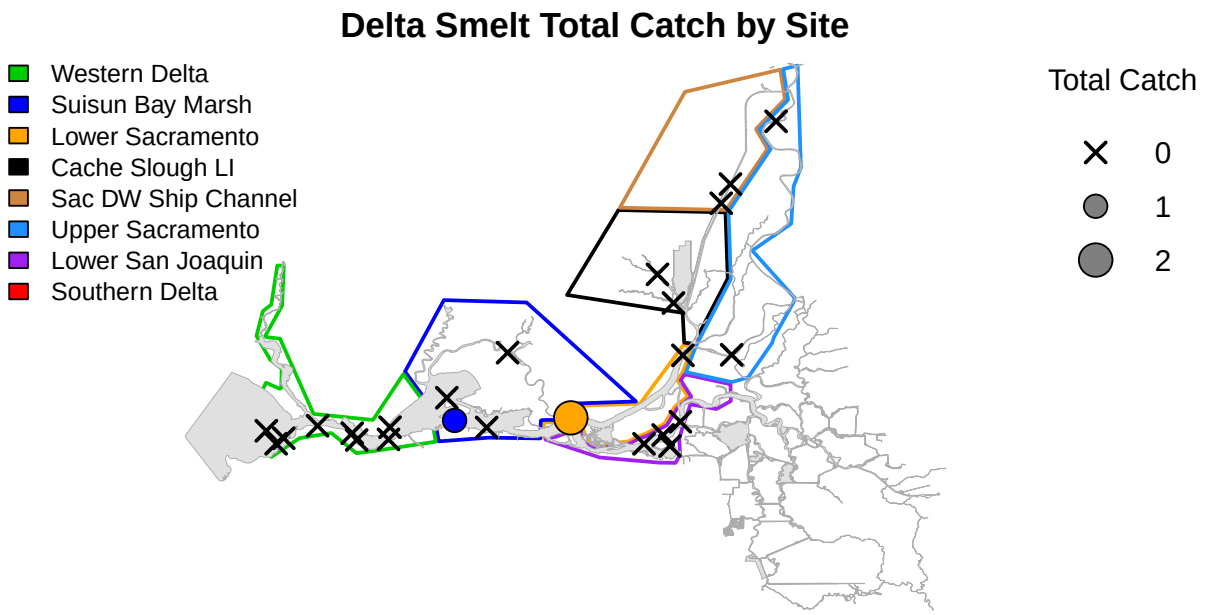
Week 7 (Aug 14 − Aug 17, 2017)



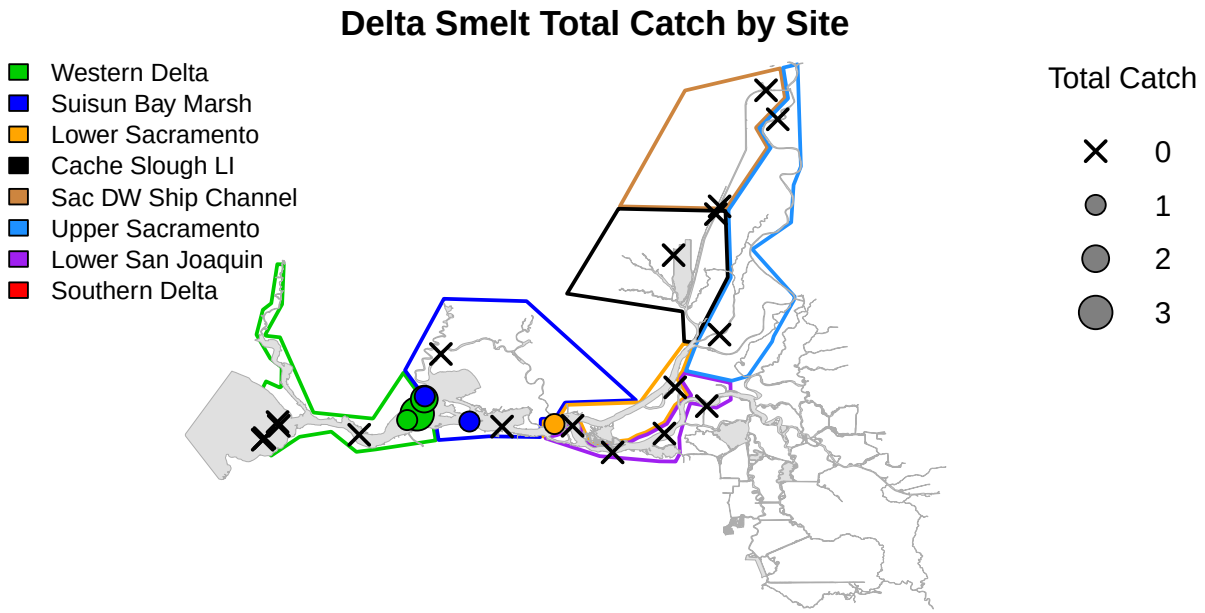
Week 8 (Aug 21 − Aug 24, 2017)



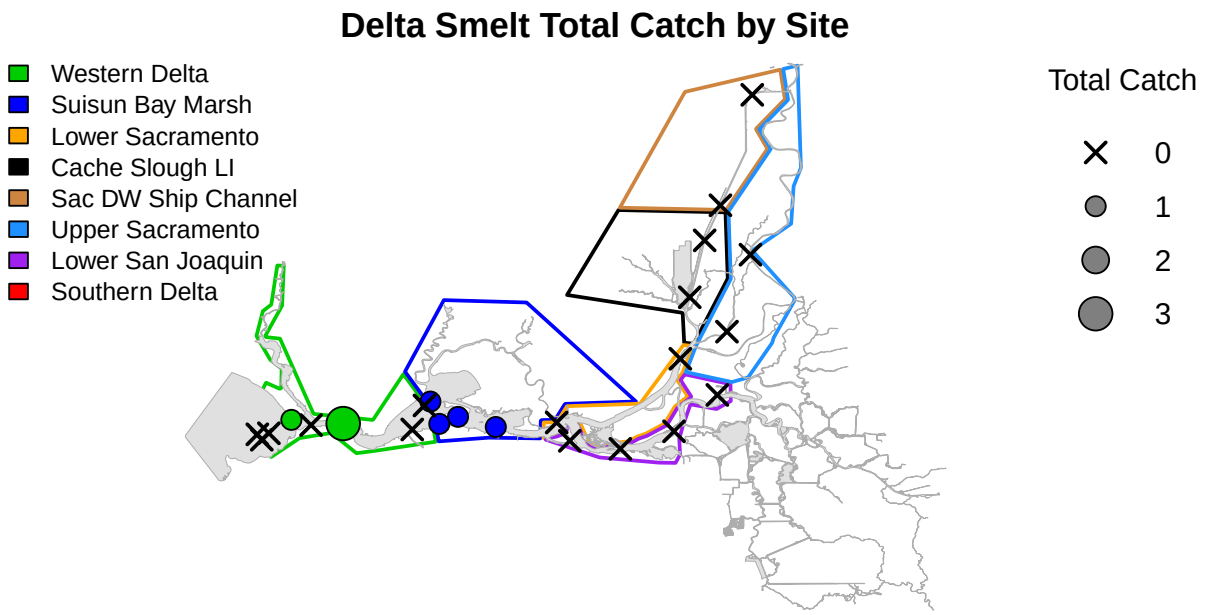
Week 9 (Aug 28 – Aug 31, 2017)



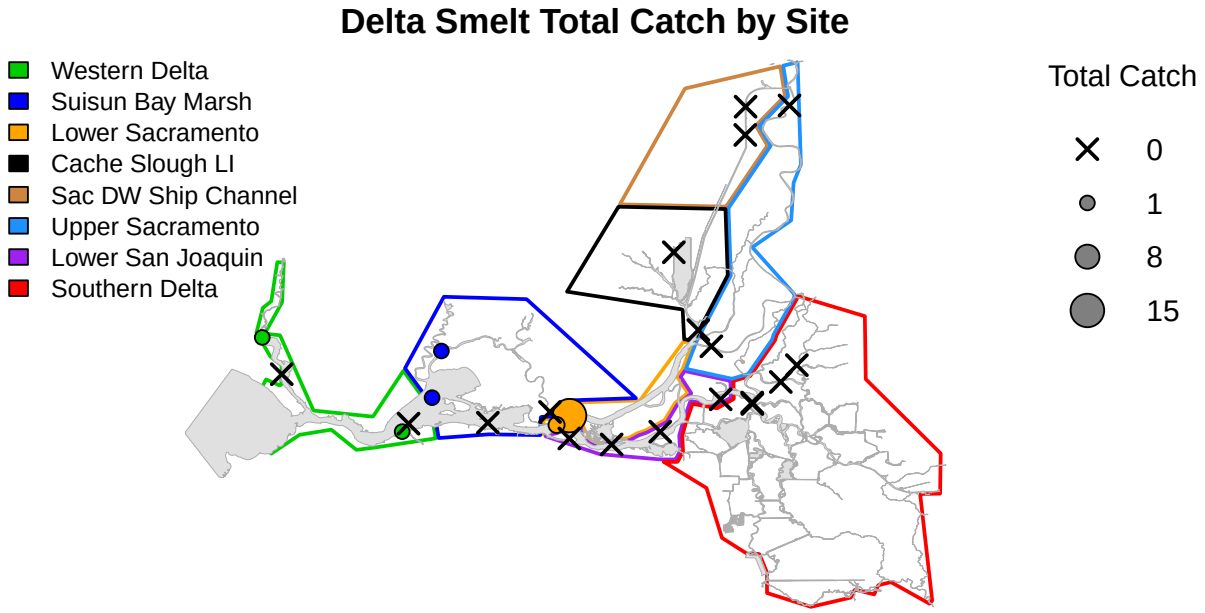
Week 10 (Sep 5 – Sep 8, 2017)



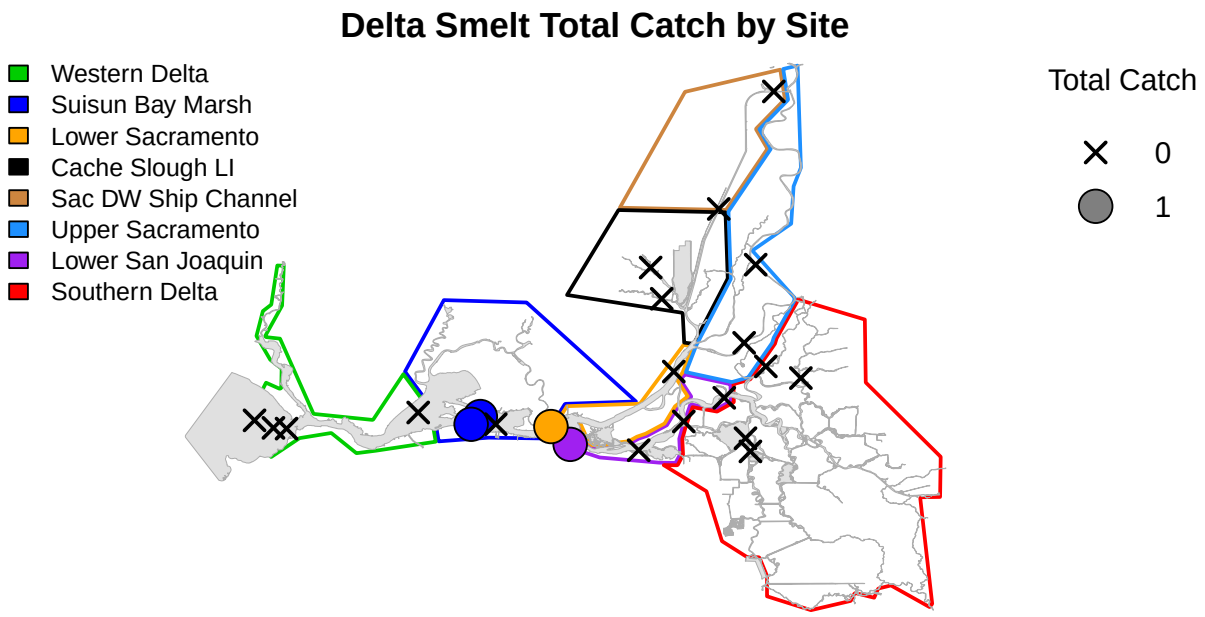
Week 11 (Sep 11 – Sep 14, 2017)



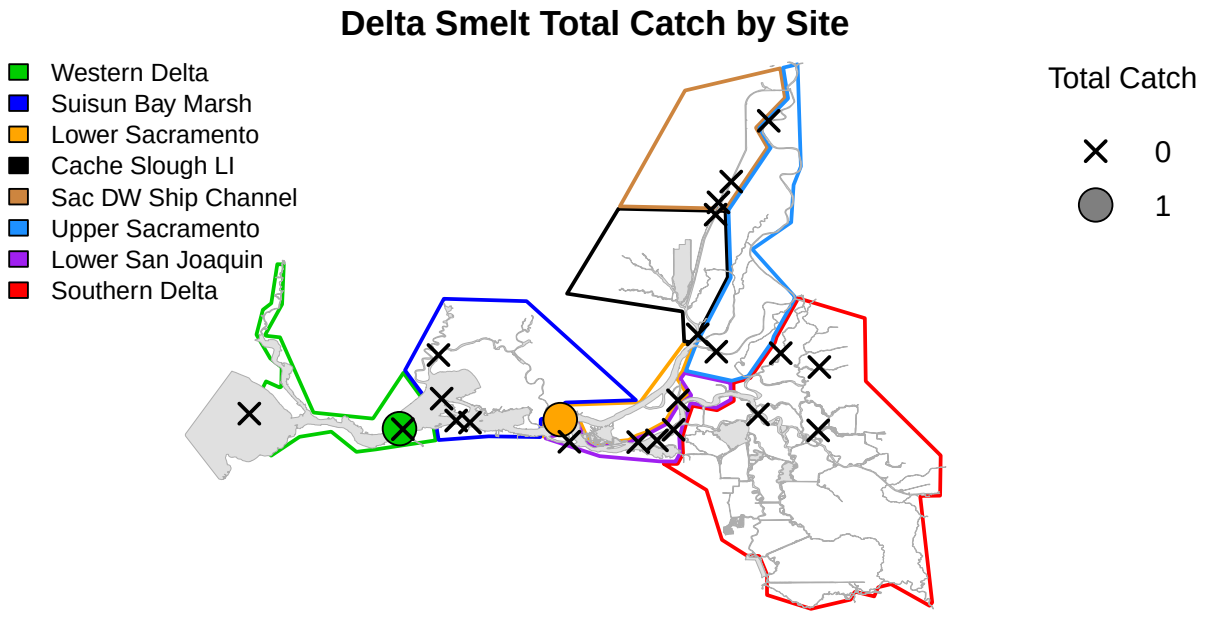
Week 12 (Sep 18 – Sep 22, 2017)



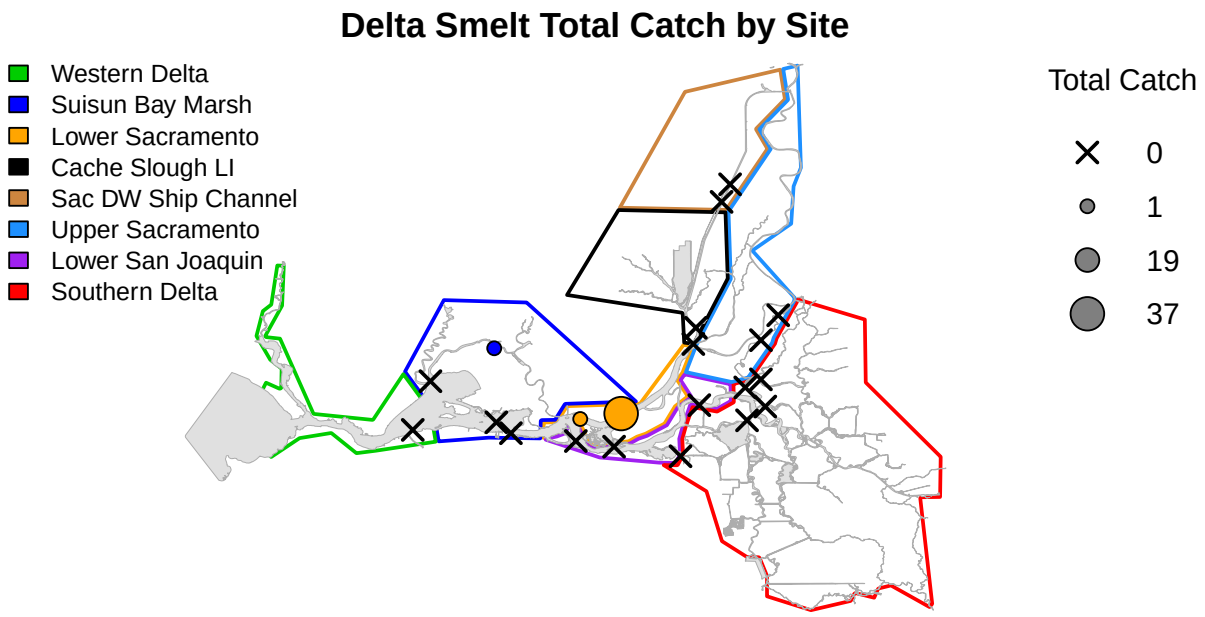
Week 13 (Sep 25 – Sep 29, 2017)



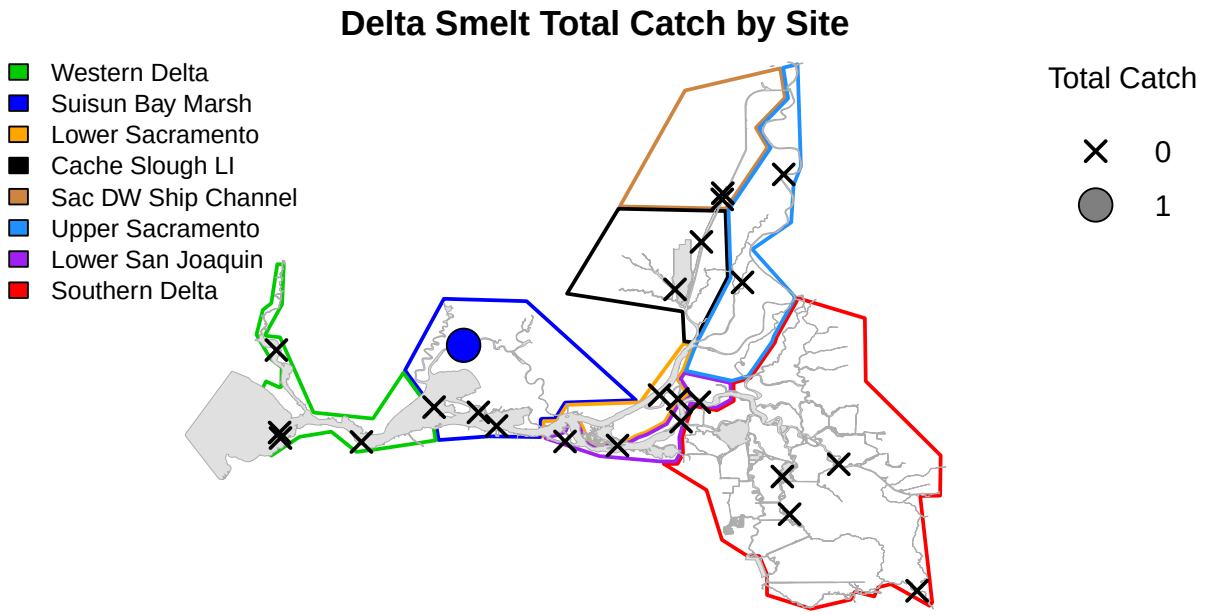
Week 14 (Oct 2 – Oct 5, 2017)



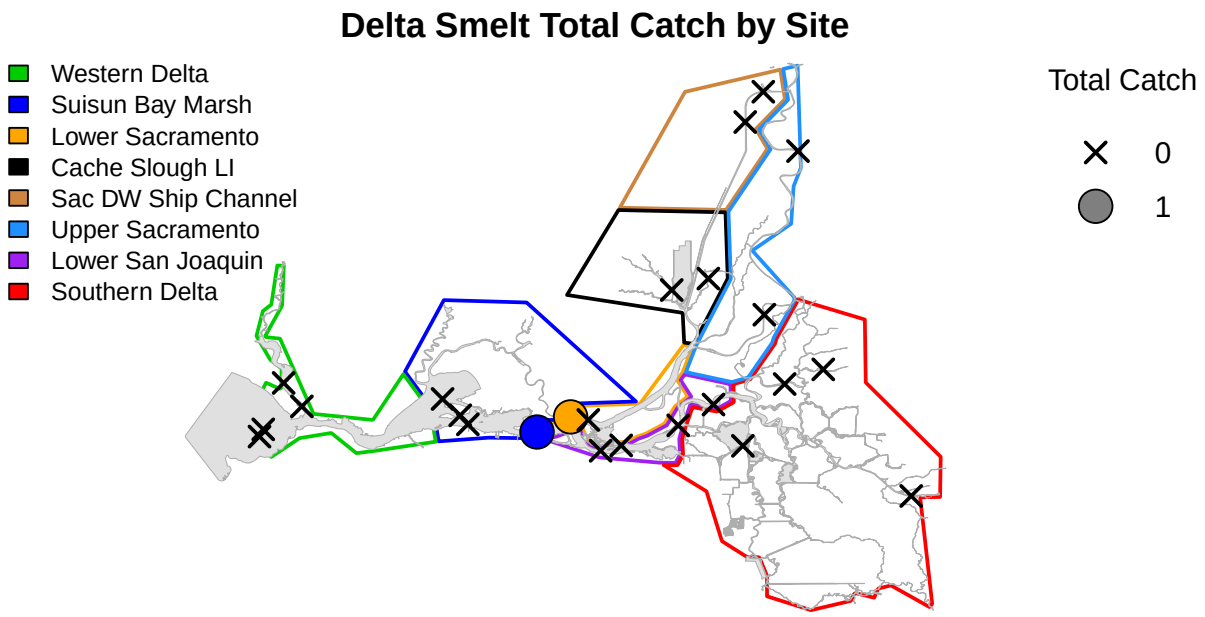
Week 15 (Oct 10 – Oct 13, 2017)



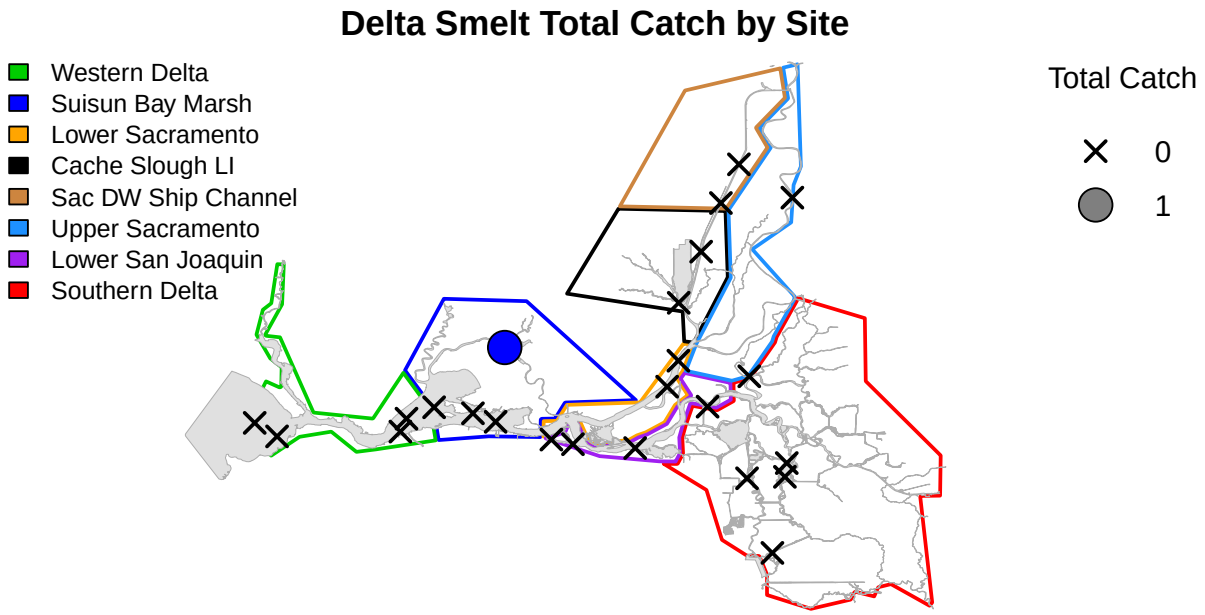
Week 16 (Oct 16 – Oct 20, 2017)



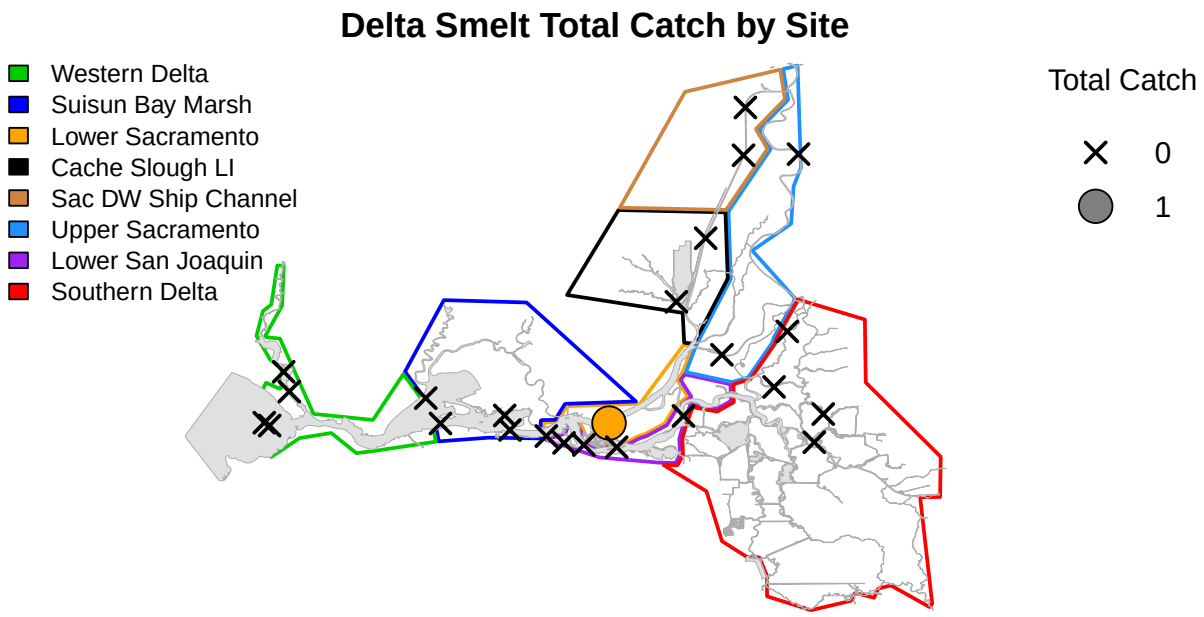
Week 17 (Oct 23 – Oct 26, 2017)

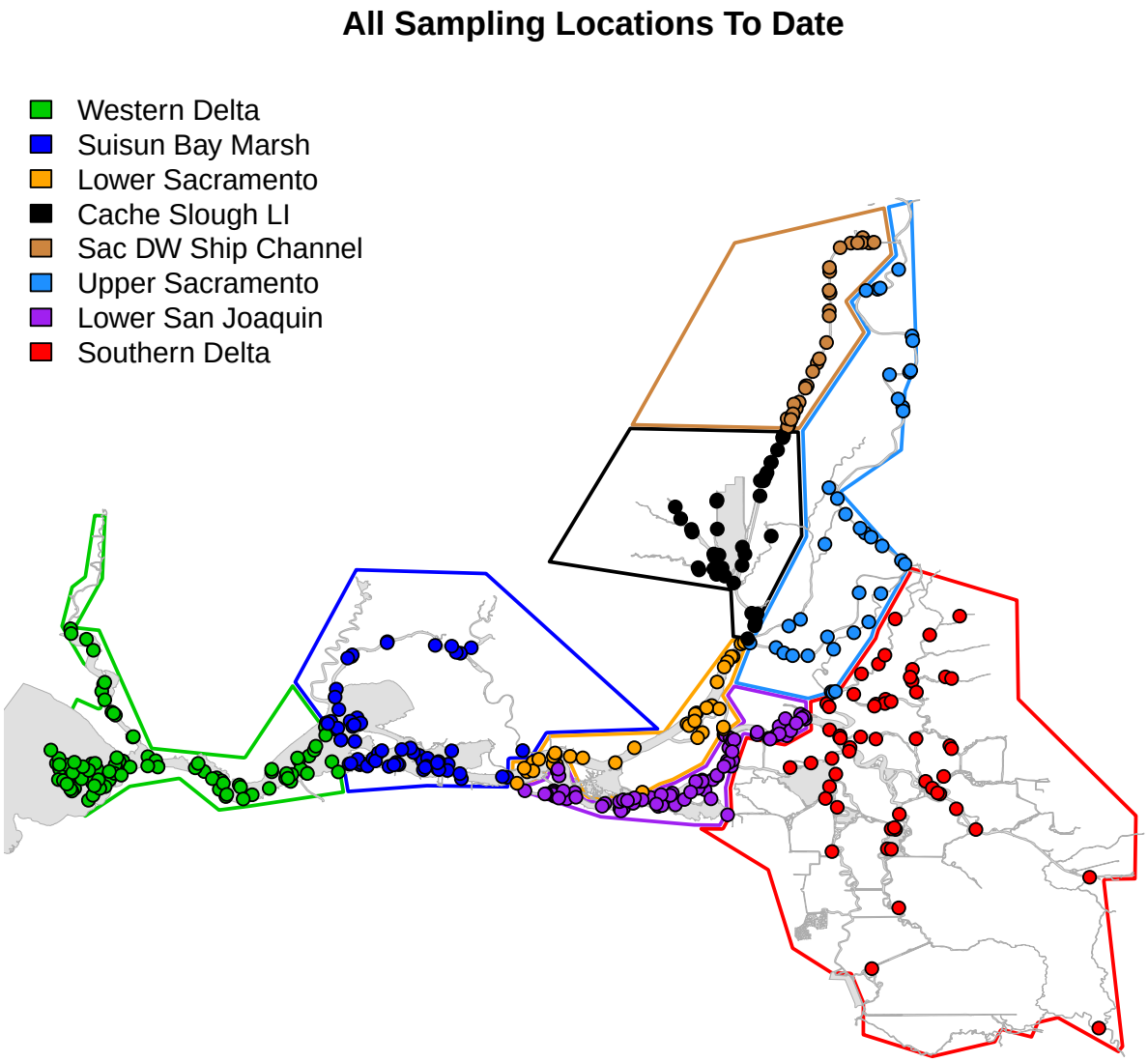


Week 18 (Oct 30 – Nov 2, 2017)



Week 19 (Nov 6 − Nov 9, 2017)





References

[1] Stevens, Don L., Olsen, Anthony R. 2004. Spatially balanced sampling of natural resources, *Journal of the American Statistical Association*, 99(465): 262 – 278.