Enhanced Delta Smelt Monitoring
Preliminary Abundance Analysis
Phase 3 Sampling

DRAFT

U.S. Fish and Wildlife Service

September 15, 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.

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.

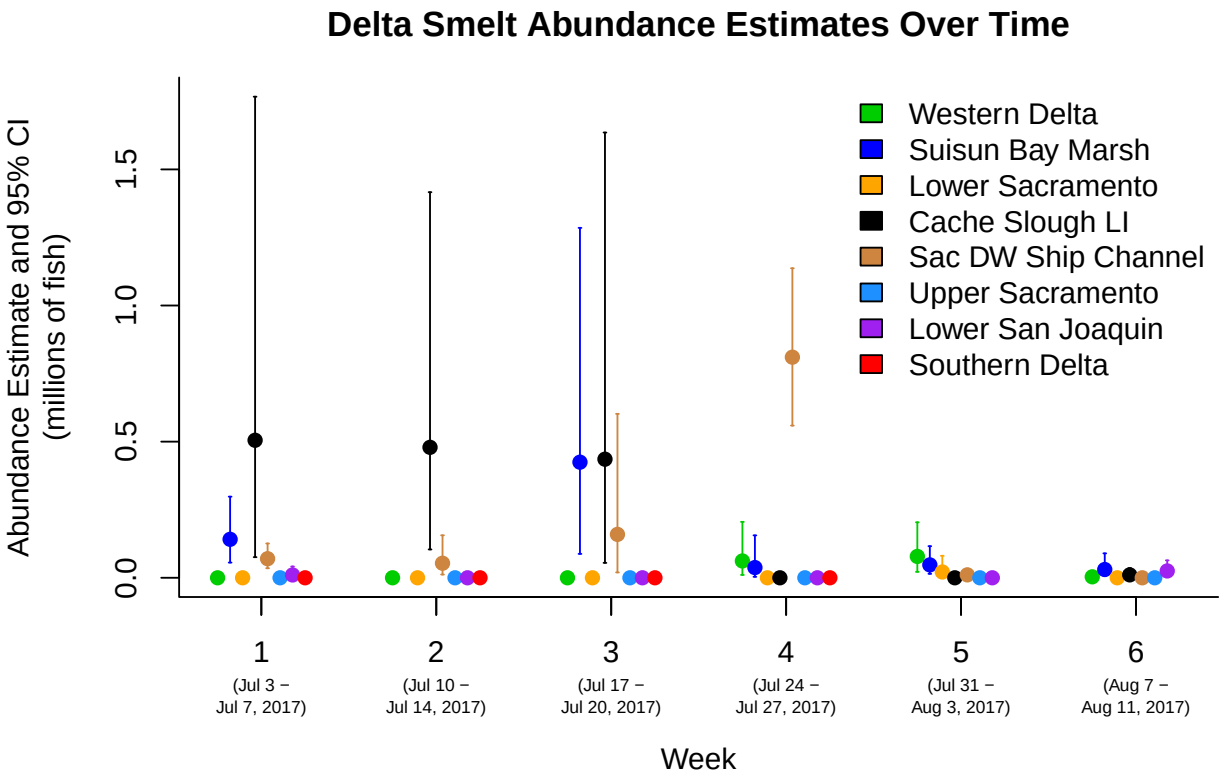
					Estimate and 95% CI		
Stratum	**Number of Sites**	**Number of Tows**	**Number Caught**	**Total Sample Volume**	**Abundance**	**Lower Bound**	**Upper Bound**
Week 1: July 3 - 7, 2017							
Western Delta	4	32	0	130,560	0*	-	-
Suisun Bay Marsh	2	5	5	12,373	141,293	55,832	297,925
Lower Sacramento	2	10	0	21,249	0*	-	-
Cache Slough LI	2	3	37	6,047	505,151	75,706	1,766,992
Sac DW Ship Channel	2	4	9	4,462	70,077	35,057	125,938
Upper Sacramento	2	13	0	44,296	0*	-	-
Lower San Joaquin	4	20	1	32,098	10,376	1,107	41,414
Southern Delta	6	48	0	179,539	0*	-	-
Total	24	135	52	430,624	726,897	183,533	1,989,343
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	479,200	104,033	1,416,325
Sac DW Ship Channel	2	7	7	10,194	53,507	11,959	155,885
Upper Sacramento	2	16	0	57,880	0*	-	-
Lower San Joaquin	4	20	0	37,240	0*	-	-
Southern Delta	6	48	0	191,973	0*	-	-
Total	20	120	32	390,654	-	-	-
Week 3: July 17 - 20, 2017							
Western Delta	4	32	0	120,388	0*	-	-
Suisun Bay Marsh	2	7	10	13,558	424,672	87,828	1,285,210
Lower Sacramento	2	10	0	15,534	0*	-	-
Cache Slough LI	2	4	27	5,117	435,653	54,781	1,635,421
Sac DW Ship Channel	2	6	40	8,721	159,427	19,743	602,025
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	143	77	457,263	1,019,752	307,430	2,532,564
Week 4: July 24 - 27, 2017							
Western Delta	4	26	2	116,912	61,789	10,442	205,263
Suisun Bay Marsh	2	10	2	18,635	37,562	3,594	155,752
Lower Sacramento	2	11	0	23,195	0*	-	-
Cache Slough LI	2	10	0	18,250	0*	-	-
Sac DW Ship Channel	2	2	62	2,660	810,345	558,999	1,136,809
Upper Sacramento	2	16	0	62,159	0*	-	-
Lower San Joaquin	4	20	0	49,623	0*	-	-

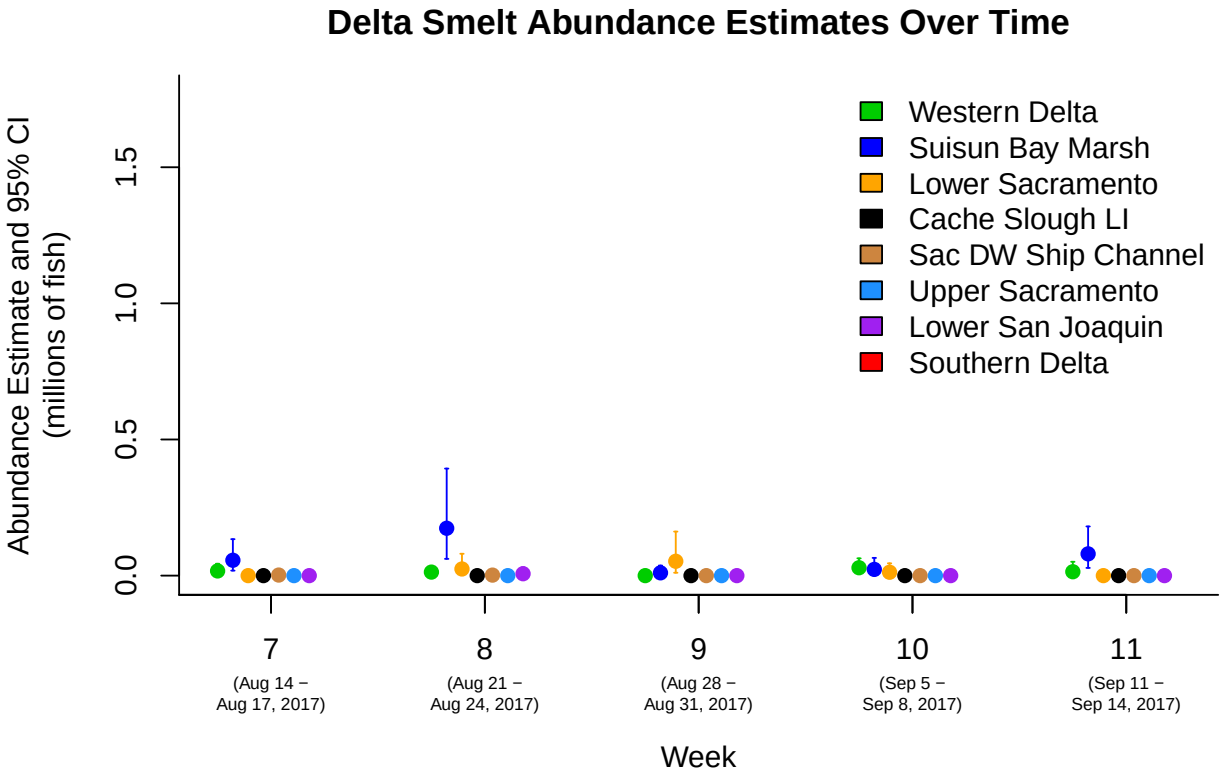
Table 1: Delta smelt catch summary and abundance estimates by week. An asterisk (*) is used to emphasize weeks when no delta smelt were caught and a dash (-) is used to indicate that sampling did not occur or that a quantity could not be calculated. In order to avoid confusion, weekly totals are currently 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	49	0	201,306	0*	-	-
Total	24	144	66	492,739	909,696	630,017	1,272,003
Week 5: July 31 - August 3, 2017							
Western Delta	8	52	8	265,007	78,466	21,851	203,714
Suisun Bay Marsh	5	15	4	29,564	47,355	14,617	116,029
Lower Sacramento	2	7	1	12,931	21,336	2,632	80,685
Cache Slough LI	2	10	0	15,046	0*	-	-
Sac DW Ship Channel	2	7	2	13,950	10,727	2,149	32,965
Upper Sacramento	2	16	0	52,469	0*	-	-
Lower San Joaquin	4	20	0	34,067	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	25	127	15	423,034	-	-	-
Week 6: August 7 - 11, 2017							
Western Delta	6	43	1	201,700	3,564	492	12,891
Suisun Bay Marsh	4	16	3	33,180	30,333	6,585	89,655
Lower Sacramento	2	10	0	19,214	0*	-	-
Cache Slough LI	2	7	1	11,903	10,701	1,858	35,126
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	25,167	7,296	63,901
Southern Delta	0	-	-	-	-	-	-
Total	23	121	7	391,758	-	-	-
Week 7: August 14 - 17, 2017							
Western Delta	7	35	4	167,339	17,170	4,981	43,576
Suisun Bay Marsh	4	16	4	30,200	56,481	18,450	133,898
Lower Sacramento	2	10	0	21,592	0*	-	-
Cache Slough LI	2	10	0	16,495	0*	-	-
Sac DW Ship Channel	2	9	1	16,409	2,119	293	7,659
Upper Sacramento	2	16	0	51,845	0*	-	-
Lower San Joaquin	5	21	0	41,818	0*	NA	NA
Southern Delta	0	-	-	-	-	-	-
Total	24	117	9	345,698	-	-	-
Week 8: August 21 - 24, 2017							
Western Delta	8	49	3	217,979	13,039	5,047	27,857
Suisun Bay Marsh	3	9	6	21,203	174,028	61,590	393,190
Lower Sacramento	2	7	1	17,005	24,430	4,243	80,174
Cache Slough LI	2	10	0	22,146	0*	-	-
Sac DW Ship Channel	2	7	1	18,212	1,909	264	6,900
Upper Sacramento	2	16	0	70,222	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.

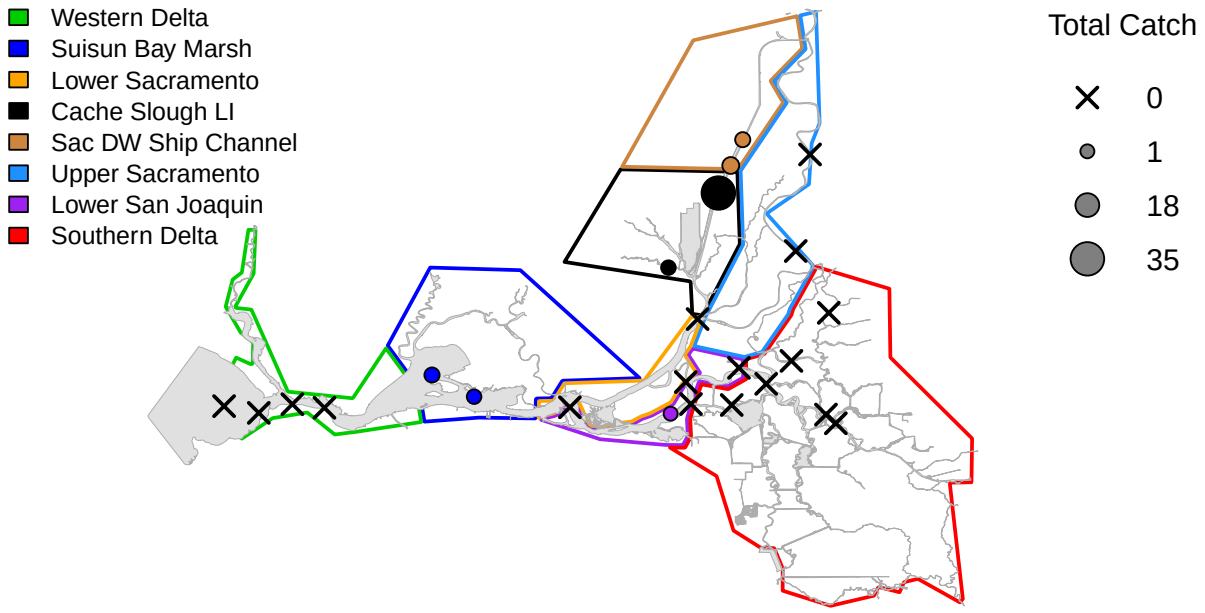
					Estimate and 95% CI		
Stratum	**Number of Sites**	**Number of Tows**	**Number Caught**	**Total Sample Volume**	**Abundance**	**Lower Bound**	**Upper Bound**
Lower San Joaquin	4	17	1	41,423	6,975	576	30,359
Southern Delta	0	-	-	-	-	-	-
Total	23	115	12	408,192	-	-	-
Week 9: August 28 - 31, 2017							
Western Delta	8	64	0	286,318	0*	-	-
Suisun Bay Marsh	4	17	1	34,253	10,232	1,420	36,943
Lower Sacramento	2	7	2	17,821	52,737	10,606	161,759
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	29,009	10,830	63,411
Suisun Bay Marsh	4	17	2	30,618	22,863	5,359	65,024
Lower Sacramento	2	10	1	22,027	12,472	1,725	45,090
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	14,307	2,072	50,760
Suisun Bay Marsh	4	9	4	17,502	79,987	28,343	180,580
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	20	0	34,451	0*	-	-
Southern Delta	0	-	-	-	-	-	-
Total	24	128	8	385,549	-	-	-


Delta Smelt Abundance Estimates Over Time
Abundance Estimate and 95% CI
(millions of fish)
0.0
0.5
1.0
1.5
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

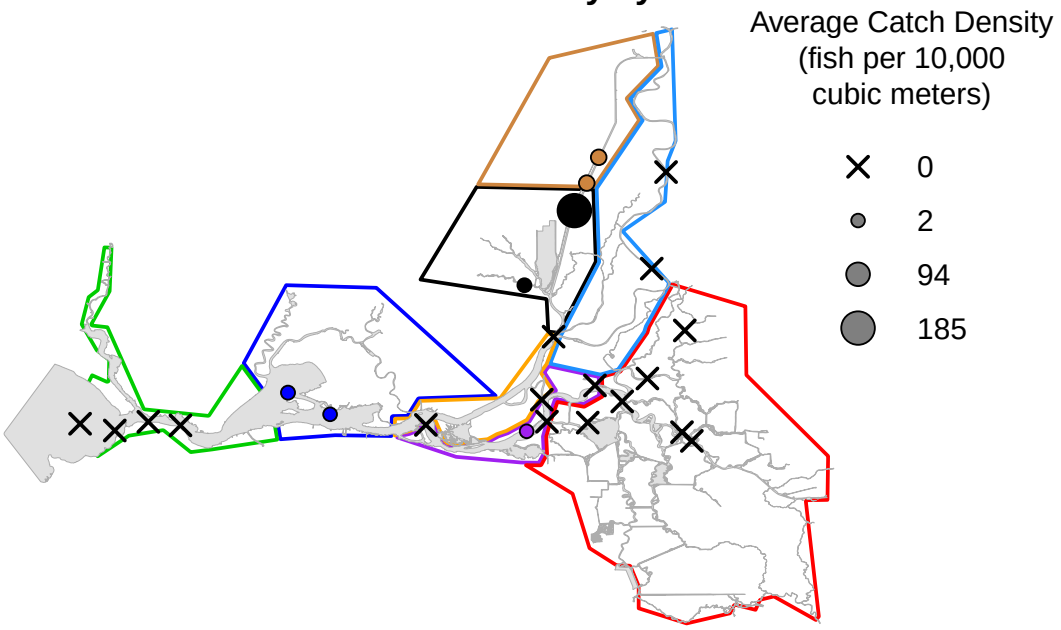

Delta Smelt Abundance Estimates Over Time
Abundance Estimate and 95% CI
(millions of fish)
0.0
0.5
1.0
1.5
Western Delta
Suisun Bay Marsh
Lower Sacramento
Cache Slough LI
Sac DW Ship Channel
Upper Sacramento
Lower San Joaquin
Southern Delta
7
(Aug 14 –
Aug 17, 2017)
8
(Aug 21 –
Aug 24, 2017)
9
(Aug 28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

Week 1 (Jul 3 – Jul 7, 2017)

Delta Smelt Total Catch by Site

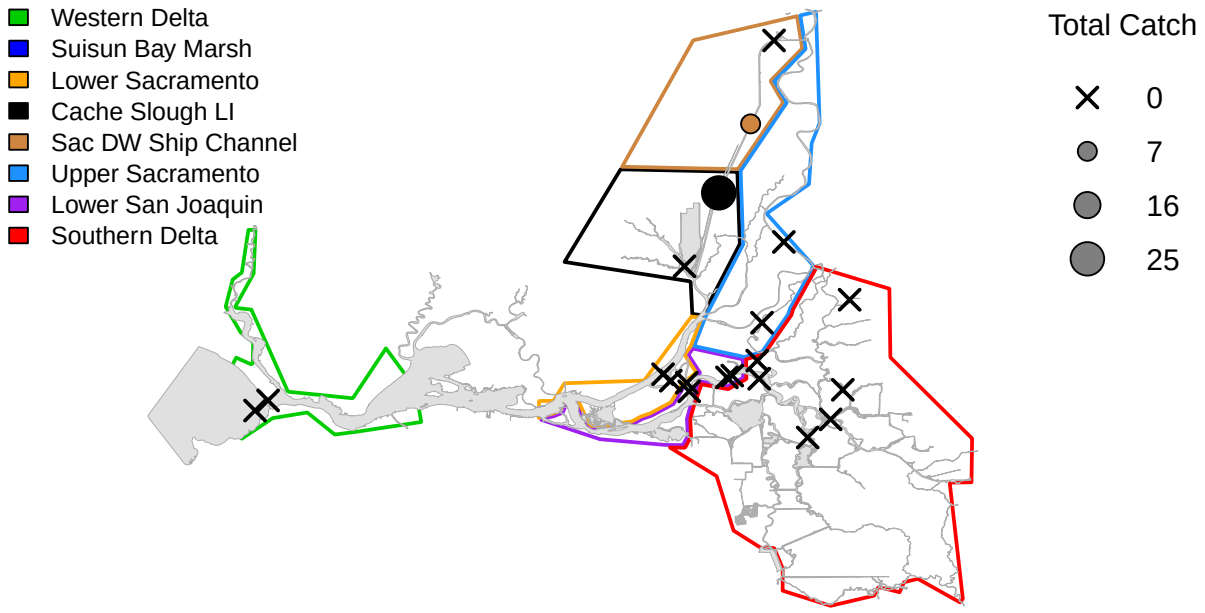


Delta Smelt Catch Density by Site

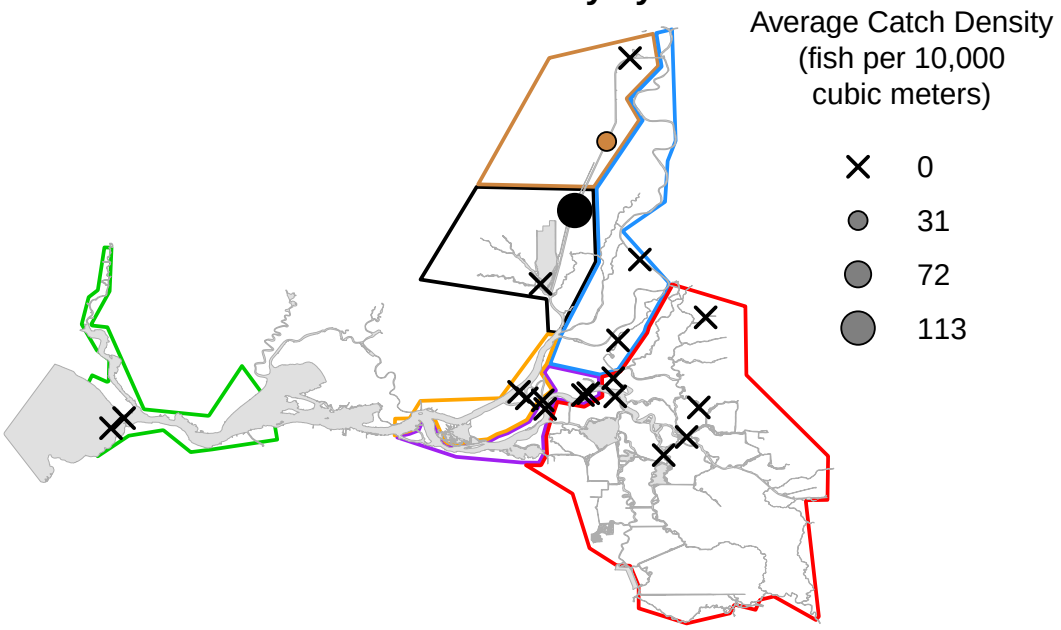


Week 2 (Jul 10 – Jul 14, 2017)

Delta Smelt Total Catch by Site

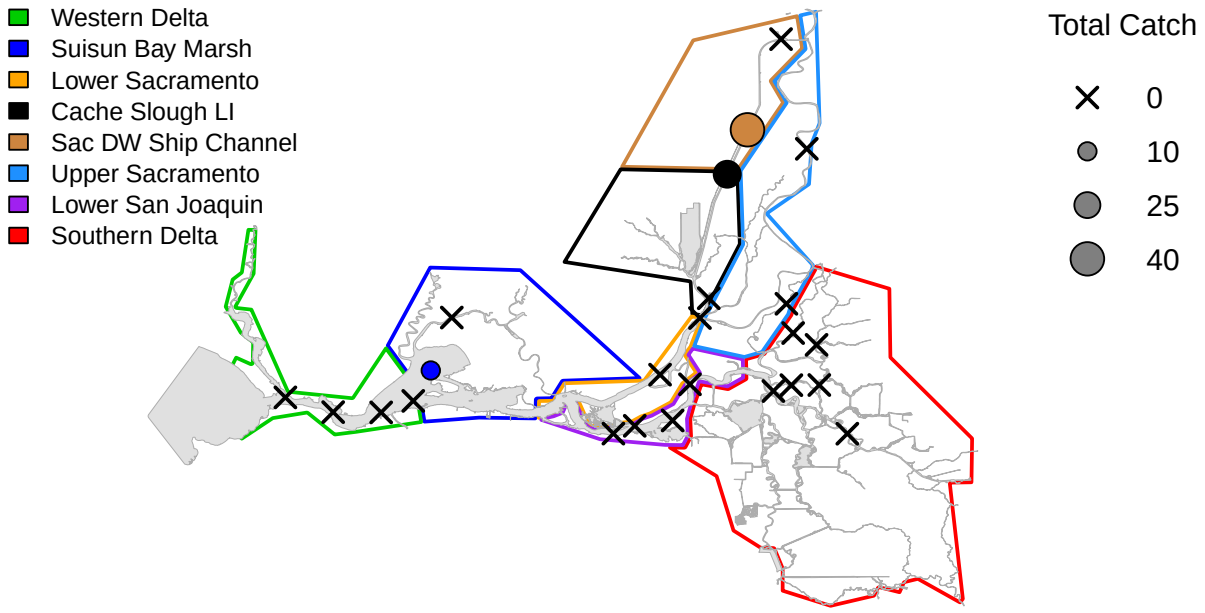


Delta Smelt Catch Density by Site

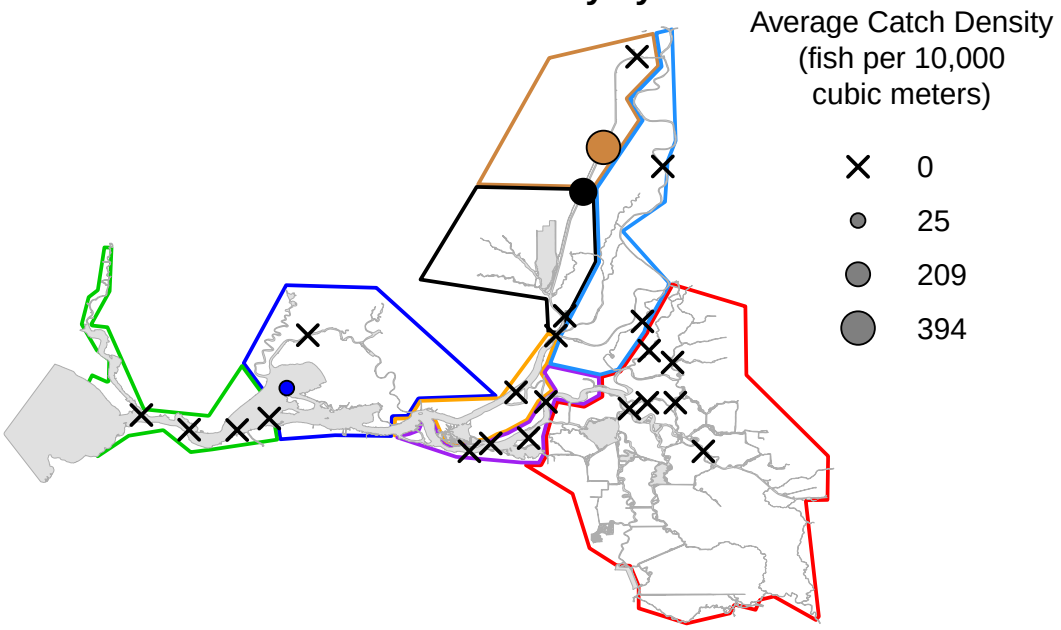


Week 3 (Jul 17 – Jul 20, 2017)

Delta Smelt Total Catch by Site

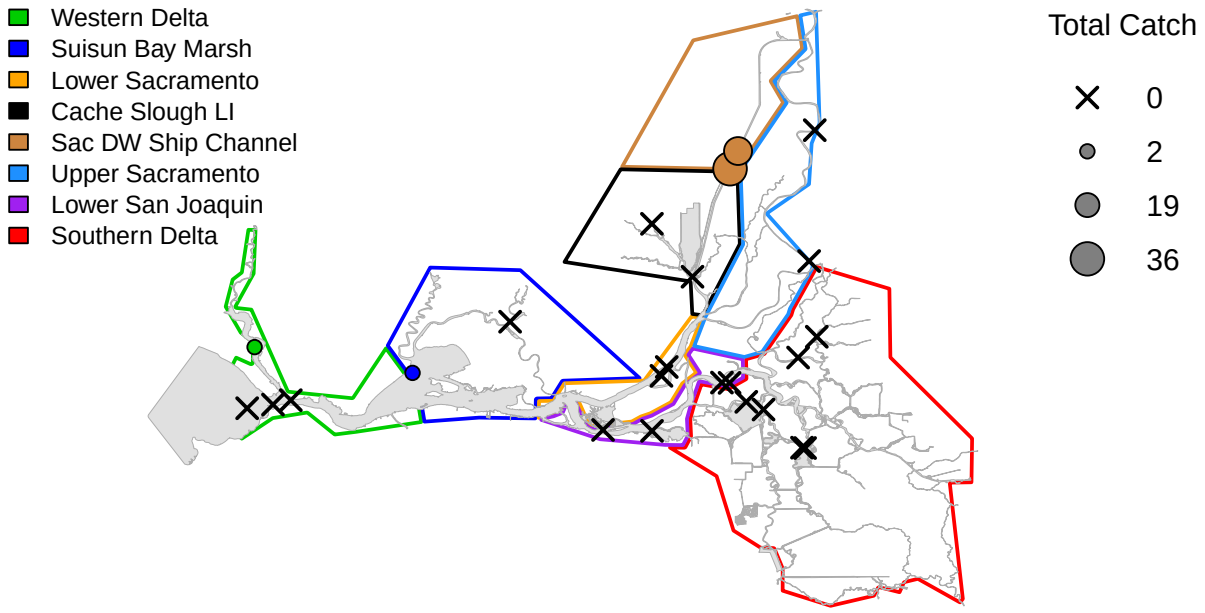


Delta Smelt Catch Density by Site

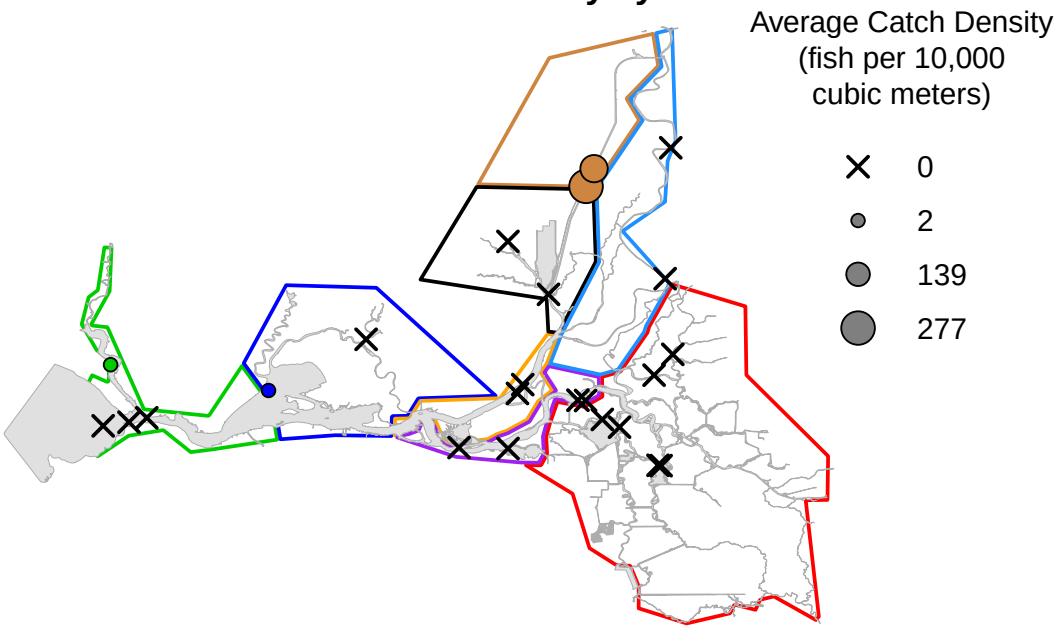


Week 4 (Jul 24 – Jul 27, 2017)

Delta Smelt Total Catch by Site

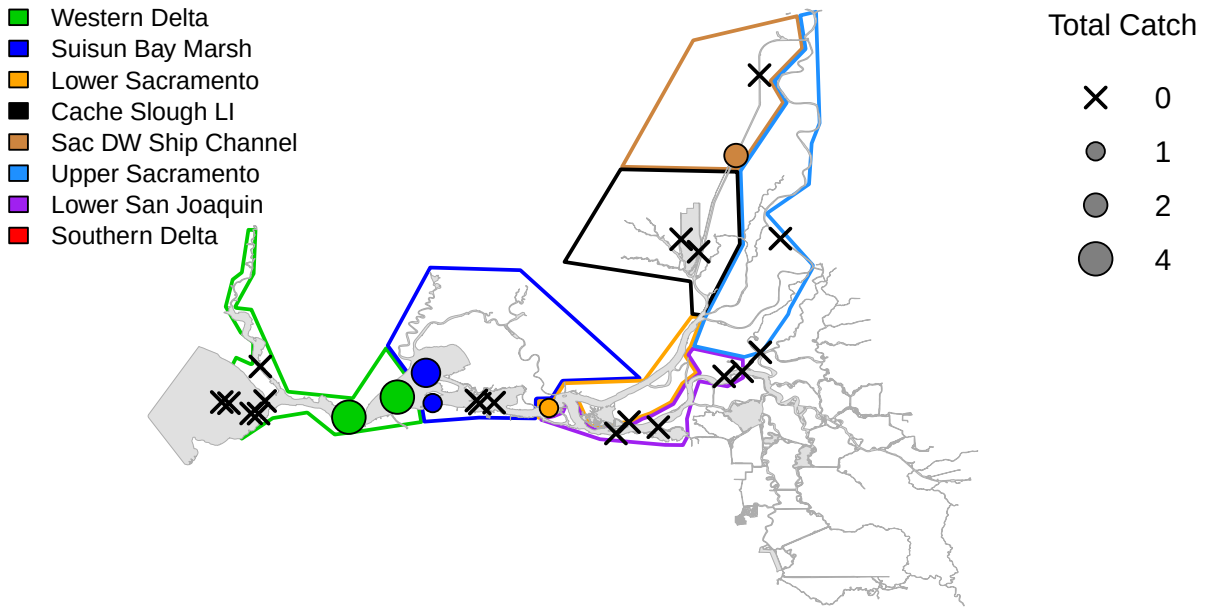


Delta Smelt Catch Density by Site

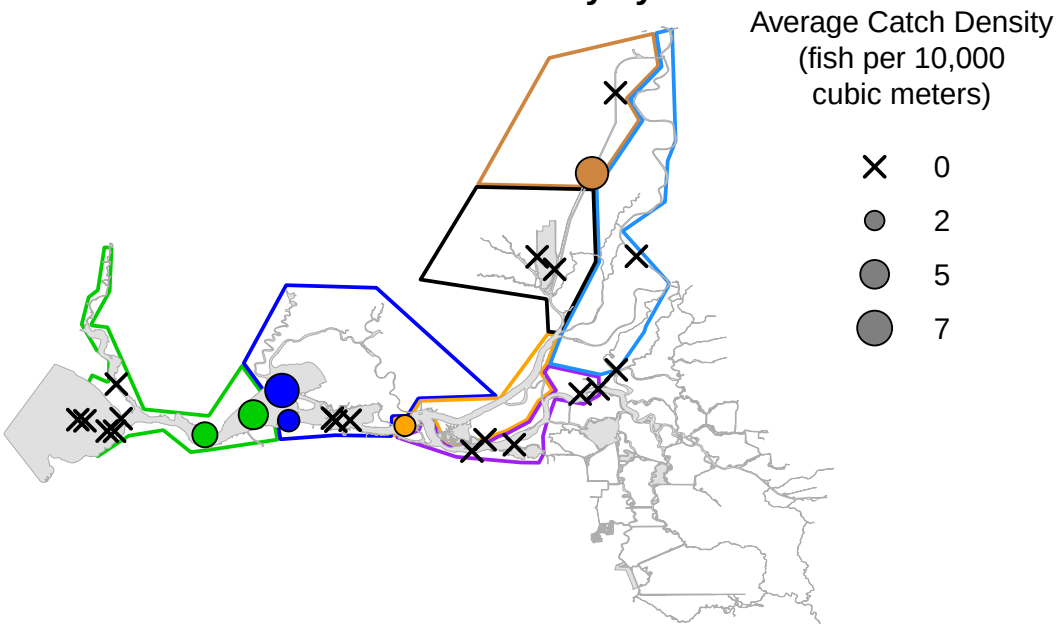


Week 5 (Jul 31 – Aug 3, 2017)

Delta Smelt Total Catch by Site

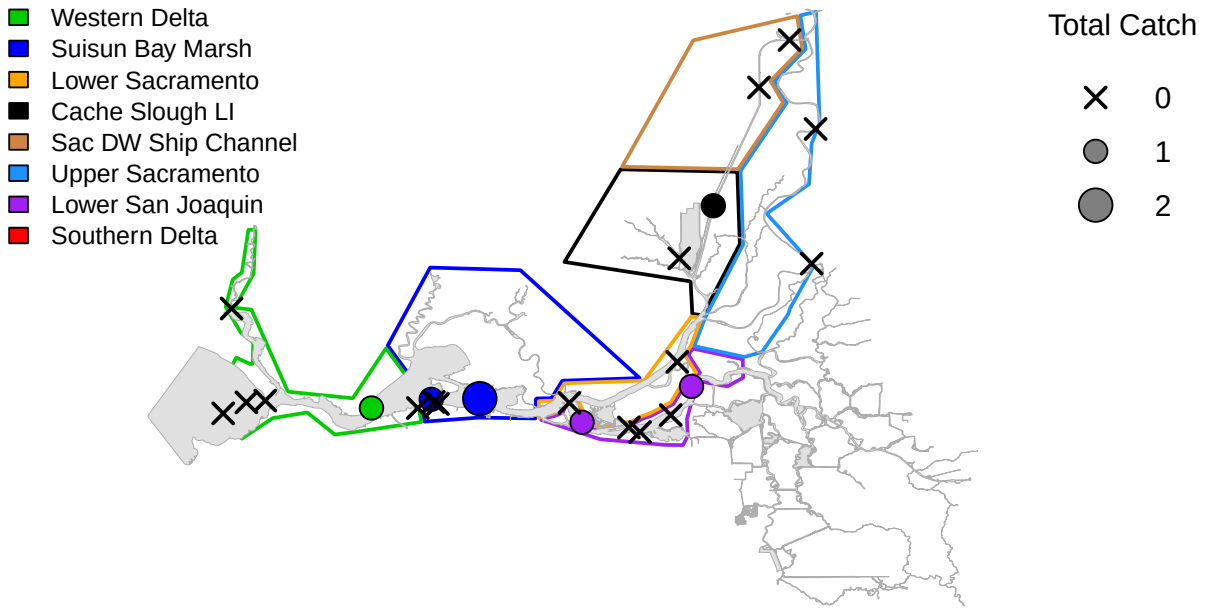


Delta Smelt Catch Density by Site

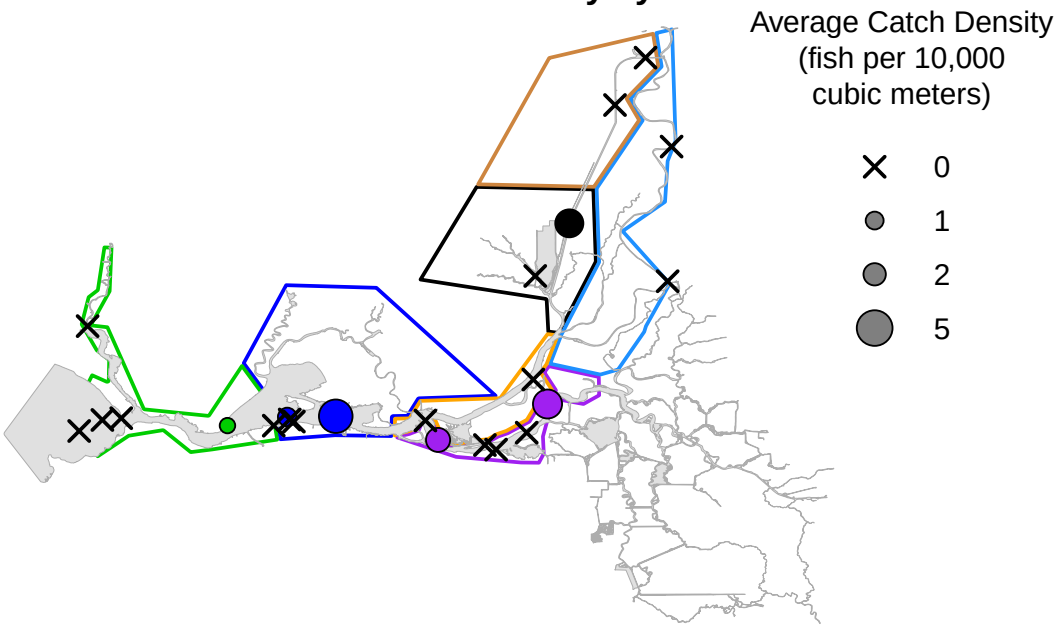


Week 6 (Aug 7 − Aug 11, 2017)

Delta Smelt Total Catch by Site

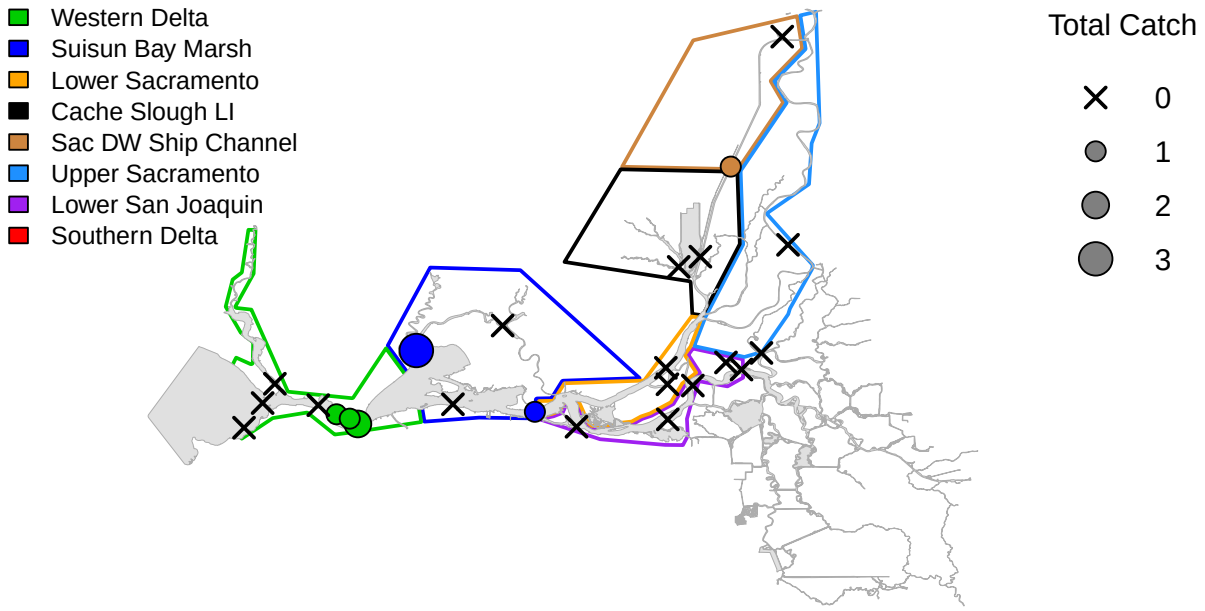


Delta Smelt Catch Density by Site

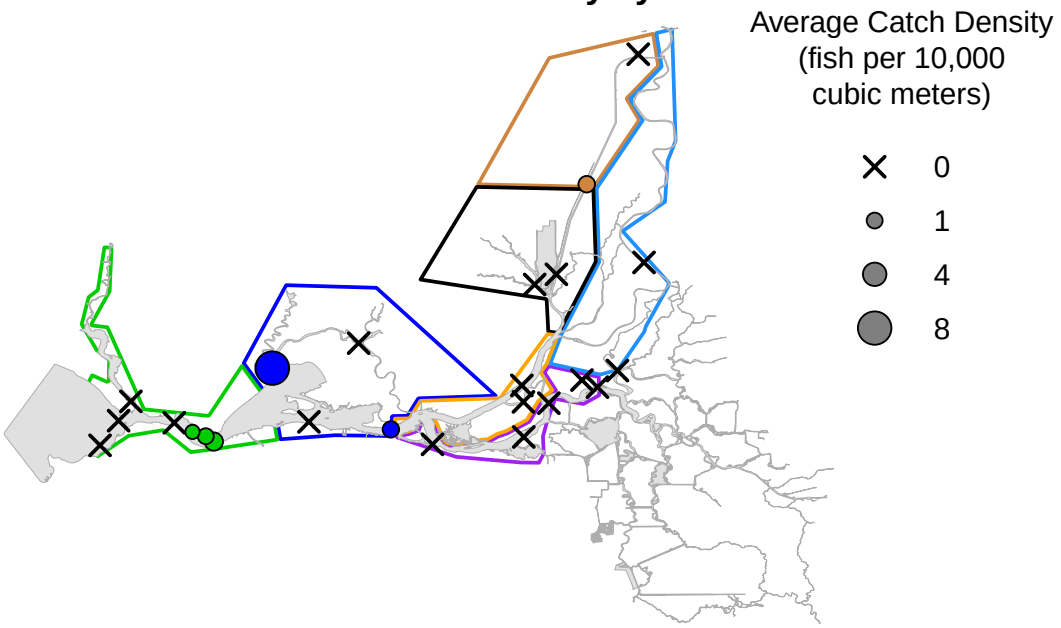


Week 7 (Aug 14 − Aug 17, 2017)

Delta Smelt Total Catch by Site

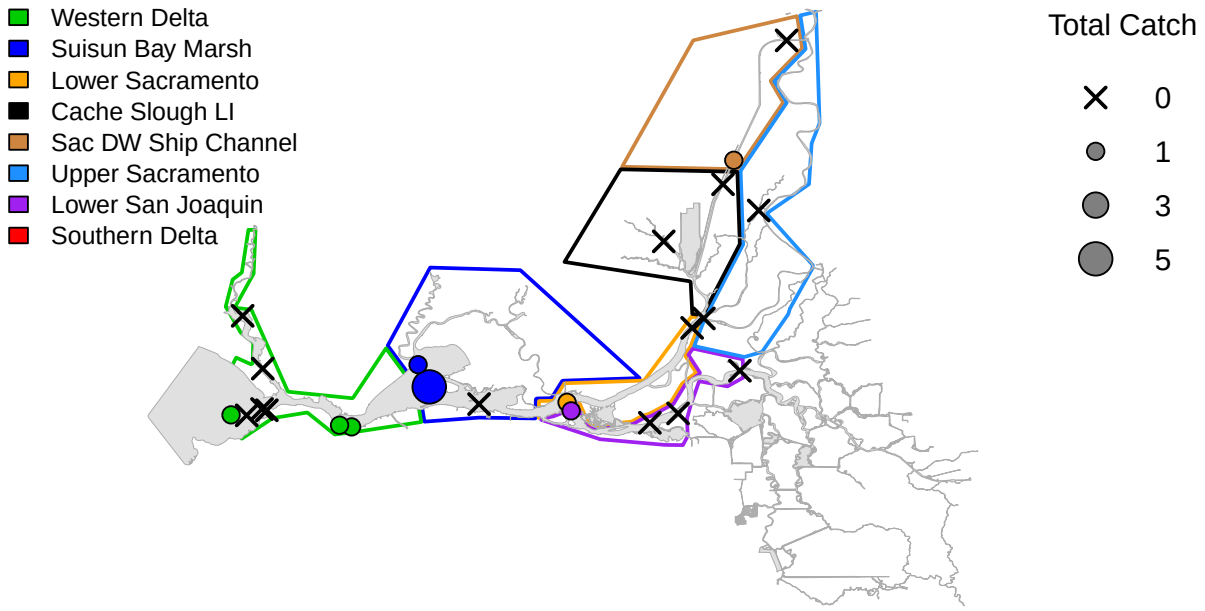


Delta Smelt Catch Density by Site

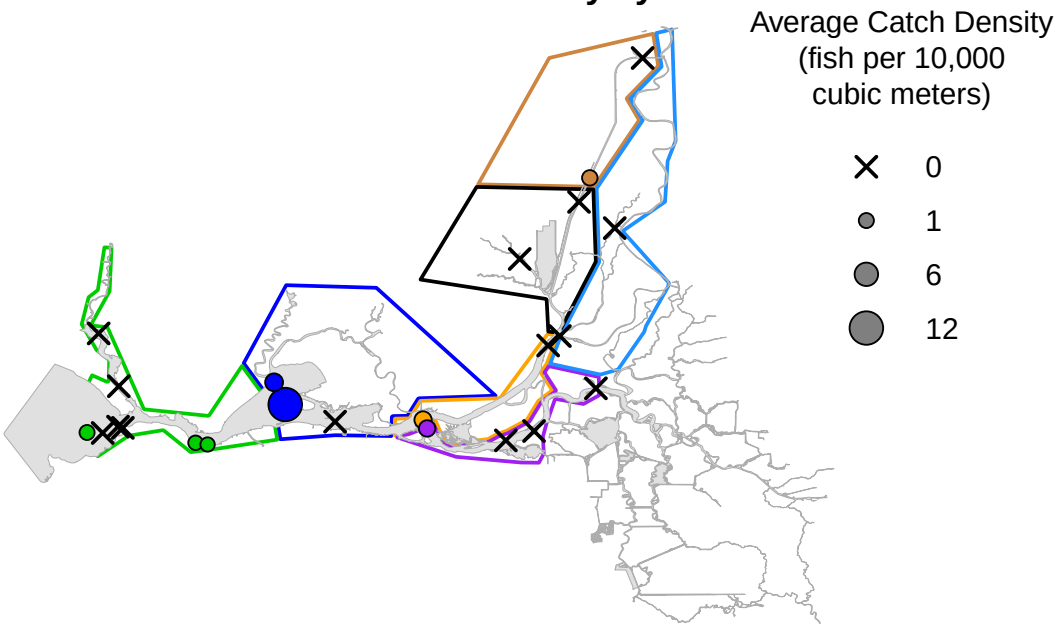


Week 8 (Aug 21 – Aug 24, 2017)

Delta Smelt Total Catch by Site

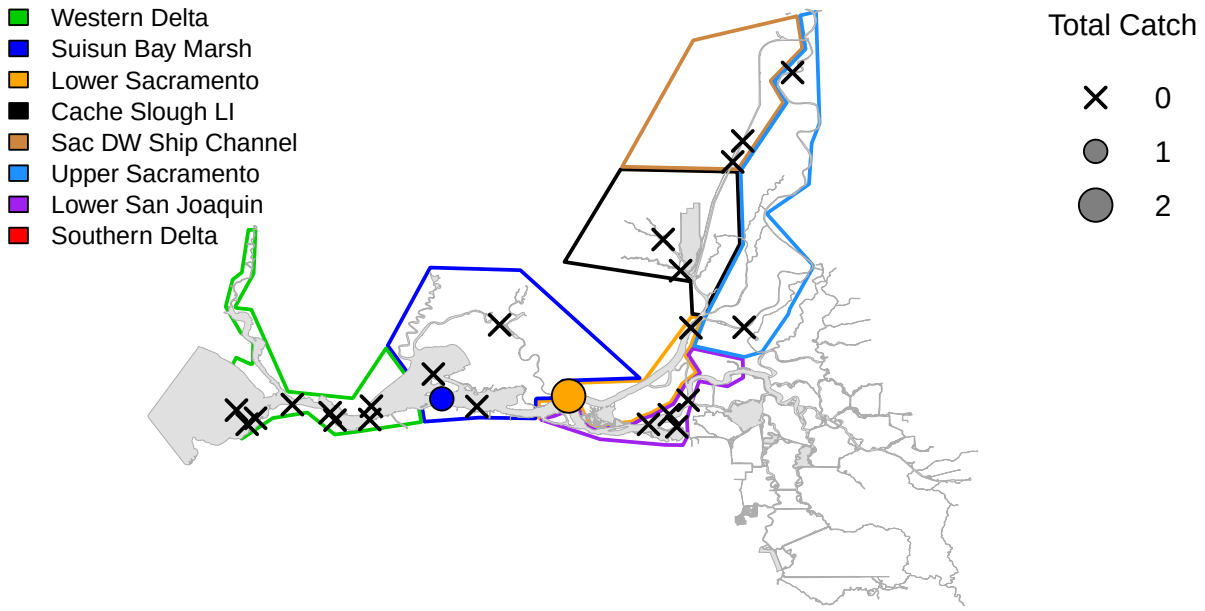


Delta Smelt Catch Density by Site

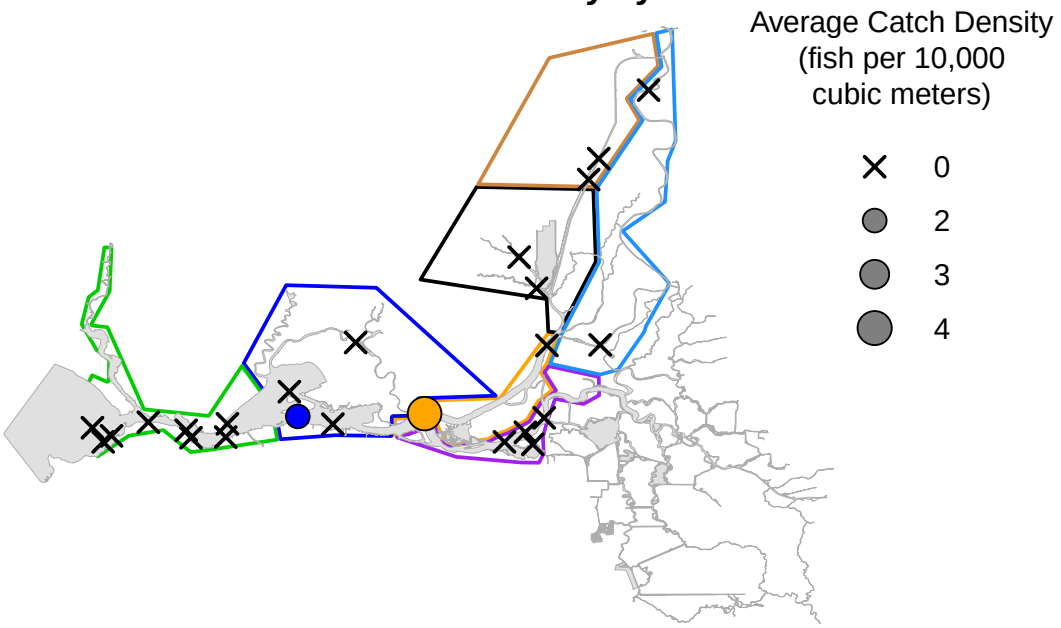


Week 9 (Aug 28 − Aug 31, 2017)

Delta Smelt Total Catch by Site

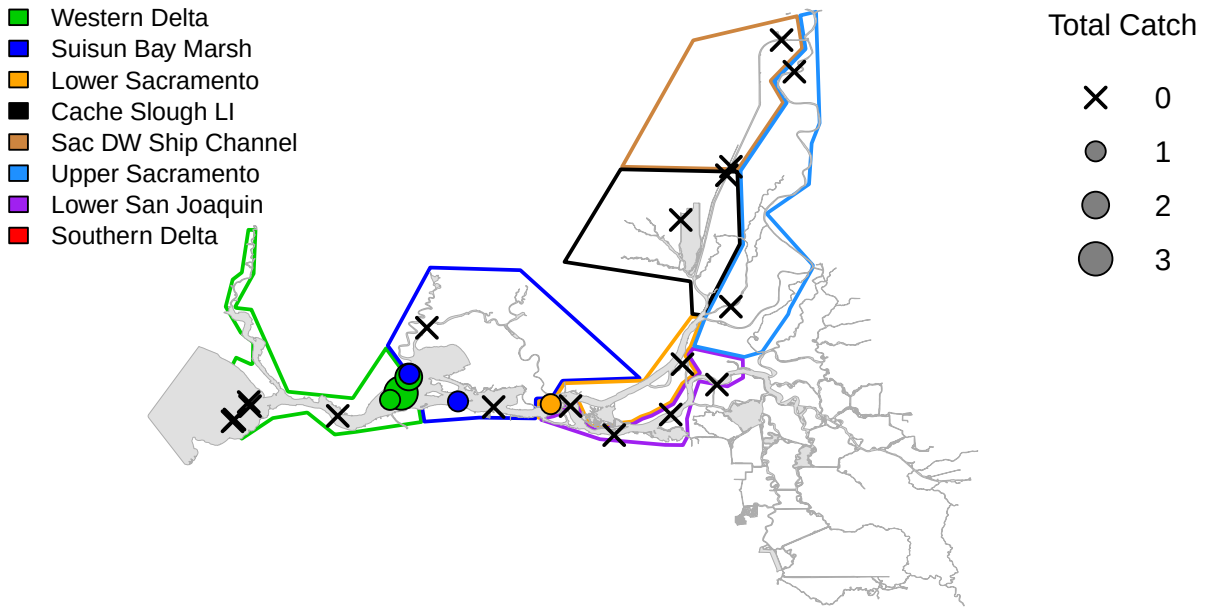


Delta Smelt Catch Density by Site

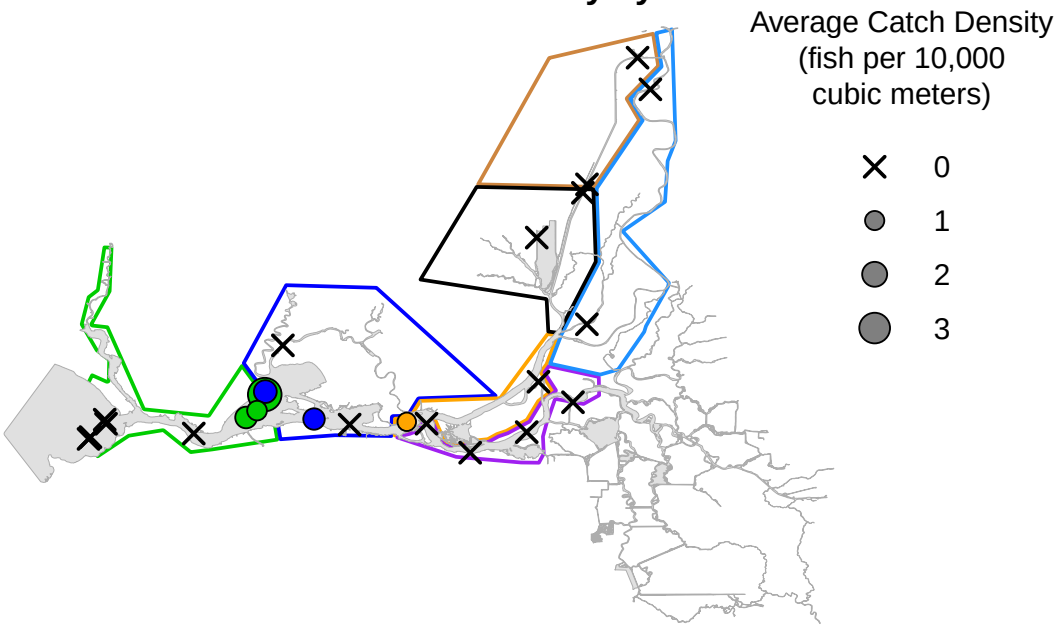


Week 10 (Sep 5 – Sep 8, 2017)

Delta Smelt Total Catch by Site

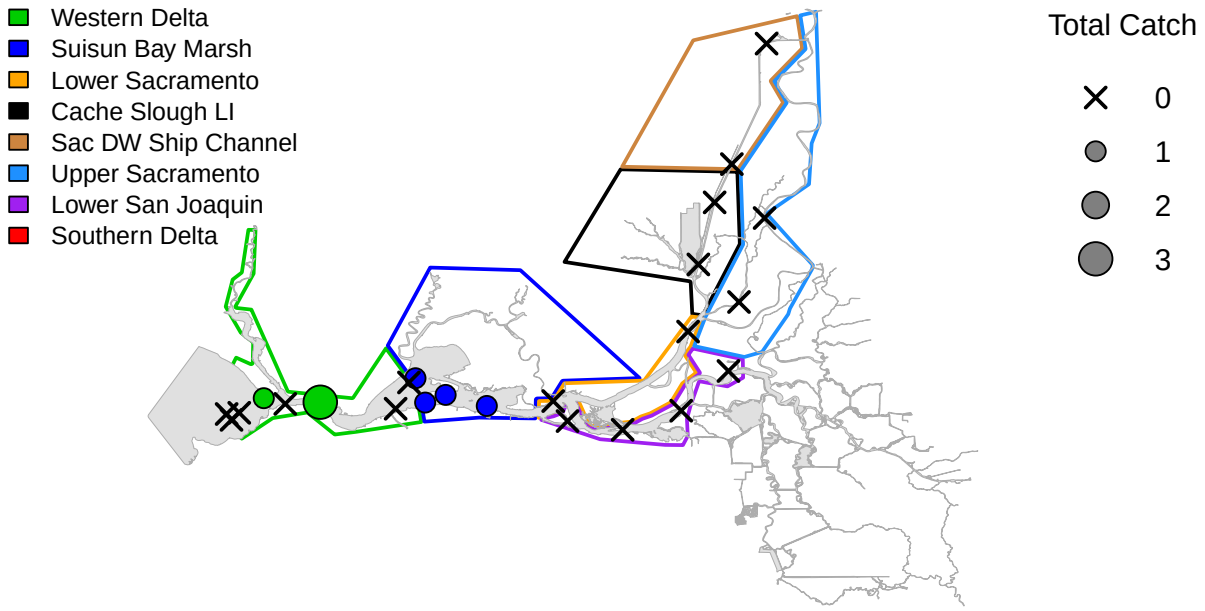


Delta Smelt Catch Density by Site

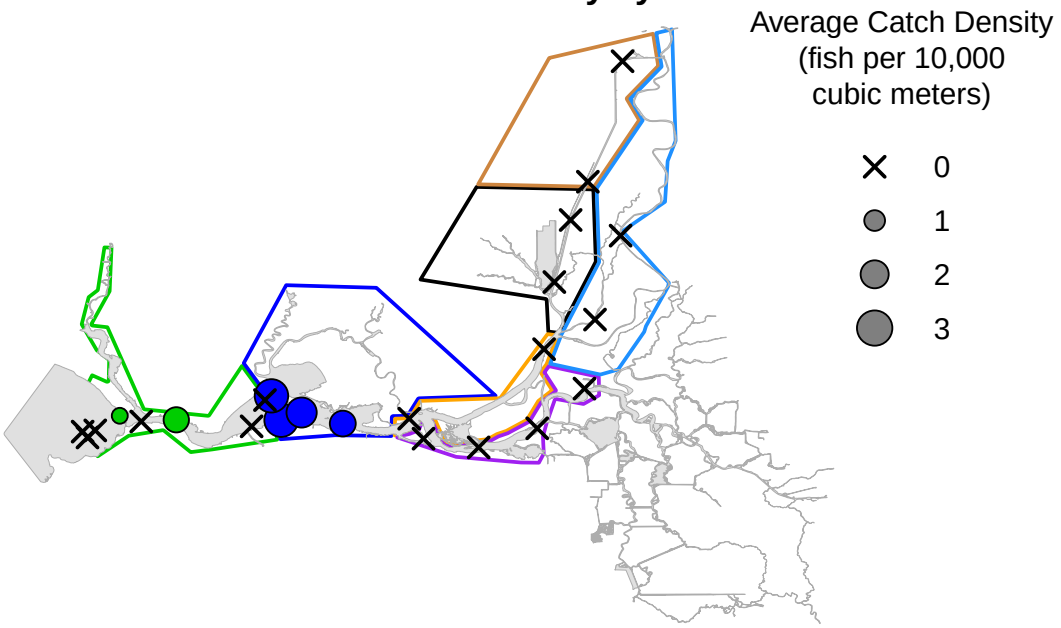


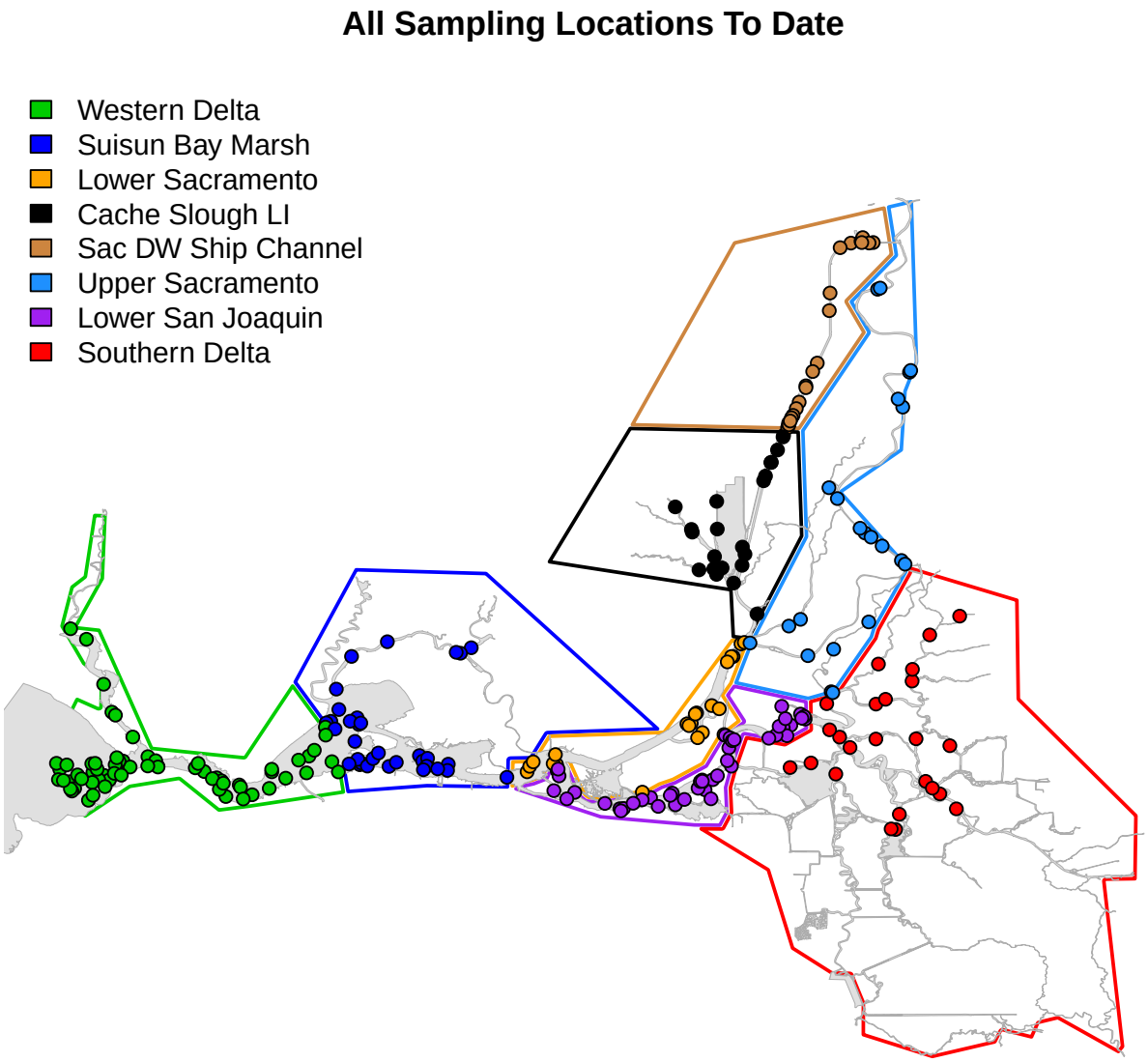
Week 11 (Sep 11 – Sep 14, 2017)

Delta Smelt Total Catch by Site



Delta Smelt Catch Density by Site





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.