

Enhanced Delta Smelt Monitoring

2023 Phase 3 Preliminary Analysis

U.S. Fish and Wildlife Service

December 4, 2023

DRAFT

Overview

The Enhanced Delta Smelt Monitoring (EDSM) program started its 2023 Phase 3 sampling program for juvenile and sub-adult Delta Smelt on July 3, 2023. Sampling effort is focused on geographic areas where Delta Smelt are likely to be present based on historical data. Sampling locations are generated using a generalized random-tessellation stratified (GRTS) design (Stevens 2004) 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 (<https://wildlife.ca.gov/Conservation/Delta/Spring-Kodiak-Trawl>) is used to conduct multiple tows per site.

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 captured outside of the live box or cod end of the net could not be assigned to a specific tow and were excluded from this analysis. These fish are included in the daily catch summary and are indicated by a Gear Condition Code of 9. Delta Smelt captured in highly impaired samples, e.g., samples with large net blockages of debris or vegetation, were also excluded from this analysis. These fish are included in the daily catch summary and are indicated by a Gear Condition Code of 3.
2. Current sampling is limited to areas of the Bay-Delta that can be safely navigated by the boats, which means areas with a minimum depth of approximately 8 feet. 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).
3. The methods of analysis used here remain in development.

Summary of Delta Smelt Releases

Table 1: Summary of Delta Smelt experimental releases for winter 2023 - 2024.

Release	Site	Date(s)	Total Released
1	Rio Vista	November 15, 2023	14,104

Results

Table 2: Delta Smelt catch summary and abundance estimates by week. Lower Bound and Upper Bound represent a 95% confidence interval on the point estimate. An asterisk (*) is used to emphasize weeks when no Delta Smelt were caught and NA 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 only calculated when sampling has occurred in every stratum. Sample volumes are in cubic meters. See Table 3 for the dates corresponding to each week number.

Week	Stratum	Number of Sites	Number of Tows	Total Number Caught	Total Sample Volume	Abundance Estimate	Lower Bound	Upper Bound	Number Marked
1	Suisun Bay	3	8	1	37,918	10,438	1,443	37,743	0
1	Suisun Marsh	6	24	0	108,886	0*	NA	NA	0
1	Lower Sacramento	5	16	0	66,318	0*	NA	NA	0
1	Cache Slough LI	6	22	0	84,936	0*	NA	NA	0
1	Sac DW Ship Channel	6	22	0	90,622	0*	NA	NA	0
1	Lower San Joaquin	3	12	0	51,961	0*	NA	NA	0
1	All Strata	29	104	1	440,642	10,438	1,443	37,743	0
2	Suisun Bay	6	24	1	92,030	4,302	595	15,554	0
2	Suisun Marsh	6	23	0	95,239	0*	NA	NA	0
2	Lower Sacramento	6	24	0	94,564	0*	NA	NA	0
2	Cache Slough LI	6	24	0	95,810	0*	NA	NA	0
2	Sac DW Ship Channel	6	24	0	97,845	0*	NA	NA	0
2	Lower San Joaquin	6	22	0	94,028	0*	NA	NA	0
2	All Strata	36	141	1	569,516	4,302	595	15,554	0
3	Suisun Bay	3	12	0	53,549	0*	NA	NA	0
3	Suisun Marsh	6	24	0	98,027	0*	NA	NA	0
3	Lower Sacramento	6	24	0	102,156	0*	NA	NA	0
3	Cache Slough LI	6	24	0	90,722	0*	NA	NA	0
3	Sac DW Ship Channel	6	24	0	88,049	0*	NA	NA	0
3	Lower San Joaquin	6	20	0	89,296	0*	NA	NA	0
3	All Strata	33	128	0	521,798	0*	NA	NA	0
4	Suisun Bay	6	24	0	98,287	0*	NA	NA	0
4	Suisun Marsh	6	24	0	105,852	0*	NA	NA	0
4	Lower Sacramento	6	24	0	93,012	0*	NA	NA	0
4	Cache Slough LI	6	22	0	88,528	0*	NA	NA	0
4	Sac DW Ship Channel	6	24	0	93,623	0*	NA	NA	0
4	Lower San Joaquin	6	24	0	95,242	0*	NA	NA	0
4	All Strata	36	142	0	574,543	0*	NA	NA	0
6	Suisun Bay	6	24	0	101,634	0*	NA	NA	0
6	Suisun Marsh	6	24	0	104,747	0*	NA	NA	0
6	Lower Sacramento	6	22	0	87,248	0*	NA	NA	0
6	Cache Slough LI	6	24	0	86,173	0*	NA	NA	0
6	Sac DW Ship Channel	6	24	0	97,844	0*	NA	NA	0
6	Lower San Joaquin	6	24	0	102,778	0*	NA	NA	0
6	All Strata	36	142	0	580,425	0*	NA	NA	0
7	Suisun Bay	3	12	0	47,974	0*	NA	NA	0
7	Suisun Marsh	6	23	0	93,663	0*	NA	NA	0
7	Lower Sacramento	6	24	0	98,863	0*	NA	NA	0
7	Cache Slough LI	6	24	0	89,577	0*	NA	NA	0
7	Sac DW Ship Channel	6	22	0	81,235	0*	NA	NA	0
7	Lower San Joaquin	6	24	0	95,258	0*	NA	NA	0
7	All Strata	33	129	0	506,570	0*	NA	NA	0

Week	Stratum	Number of Sites	Number of Tows	Total Number Caught	Total Sample Volume	Abundance Estimate	Lower Bound	Upper Bound	Number Marked
8	Suisun Bay	6	24	0	97,526	0*	NA	NA	0
8	Suisun Marsh	6	24	0	100,150	0*	NA	NA	0
8	Lower Sacramento	6	24	0	94,342	0*	NA	NA	0
8	Cache Slough LI	6	24	0	92,829	0*	NA	NA	0
8	Sac DW Ship Channel	6	24	0	92,179	0*	NA	NA	0
8	Lower San Joaquin	6	24	0	94,743	0*	NA	NA	0
8	All Strata	36	144	0	571,769	0*	NA	NA	0
9	Suisun Bay	5	20	0	88,562	0*	NA	NA	0
9	Suisun Marsh	3	12	0	50,445	0*	NA	NA	0
9	Lower Sacramento	6	24	0	92,542	0*	NA	NA	0
9	Cache Slough LI	6	24	0	87,528	0*	NA	NA	0
9	Sac DW Ship Channel	3	12	0	45,849	0*	NA	NA	0
9	Lower San Joaquin	3	12	0	49,242	0*	NA	NA	0
9	All Strata	26	104	0	414,168	0*	NA	NA	0
10	Suisun Bay	3	10	0	38,328	0*	NA	NA	0
10	Suisun Marsh	6	24	0	91,591	0*	NA	NA	0
10	Lower Sacramento	6	24	0	91,757	0*	NA	NA	0
10	Cache Slough LI	6	21	0	83,162	0*	NA	NA	0
10	Sac DW Ship Channel	6	24	0	92,305	0*	NA	NA	0
10	Lower San Joaquin	6	24	0	90,040	0*	NA	NA	0
10	All Strata	33	127	0	487,182	0*	NA	NA	0
11	Suisun Bay	6	24	0	95,522	0*	NA	NA	0
11	Suisun Marsh	5	20	0	79,216	0*	NA	NA	0
11	Lower Sacramento	6	24	0	99,395	0*	NA	NA	0
11	Cache Slough LI	6	24	0	95,404	0*	NA	NA	0
11	Sac DW Ship Channel	6	24	0	97,435	0*	NA	NA	0
11	Lower San Joaquin	6	24	0	93,959	0*	NA	NA	0
11	All Strata	35	140	0	560,931	0*	NA	NA	0
12	Suisun Bay	4	15	0	67,635	0*	NA	NA	0
12	Suisun Marsh	6	22	1	83,211	1,271	174	4,607	0
12	Lower Sacramento	4	16	0	60,585	0*	NA	NA	0
12	Cache Slough LI	6	22	0	84,362	0*	NA	NA	0
12	Sac DW Ship Channel	4	16	0	66,819	0*	NA	NA	0
12	Lower San Joaquin	6	24	0	87,761	0*	NA	NA	0
12	All Strata	30	115	1	450,374	1,271	174	4,607	0
13	Suisun Bay	6	24	1	112,424	3,521	487	12,733	0
13	Suisun Marsh	6	22	1	104,234	1,016	136	3,725	0
13	Lower Sacramento	6	24	0	91,820	0*	NA	NA	0
13	Cache Slough LI	6	22	0	84,685	0*	NA	NA	0
13	Sac DW Ship Channel	6	22	0	94,277	0*	NA	NA	0
13	Lower San Joaquin	6	24	0	98,245	0*	NA	NA	0
13	All Strata	36	138	2	585,686	4,537	877	14,175	0
14	Suisun Bay	6	24	0	94,639	0*	NA	NA	0
14	Suisun Marsh	6	22	0	88,711	0*	NA	NA	0
14	Lower Sacramento	6	22	1	92,942	2,079	110	10,285	0
14	Cache Slough LI	6	24	0	91,120	0*	NA	NA	0
14	Sac DW Ship Channel	6	24	0	97,108	0*	NA	NA	0
14	Lower San Joaquin	6	24	0	98,119	0*	NA	NA	0
14	All Strata	36	140	1	562,639	2,079	110	10,285	0
15	Suisun Bay	3	12	0	47,928	0*	NA	NA	0

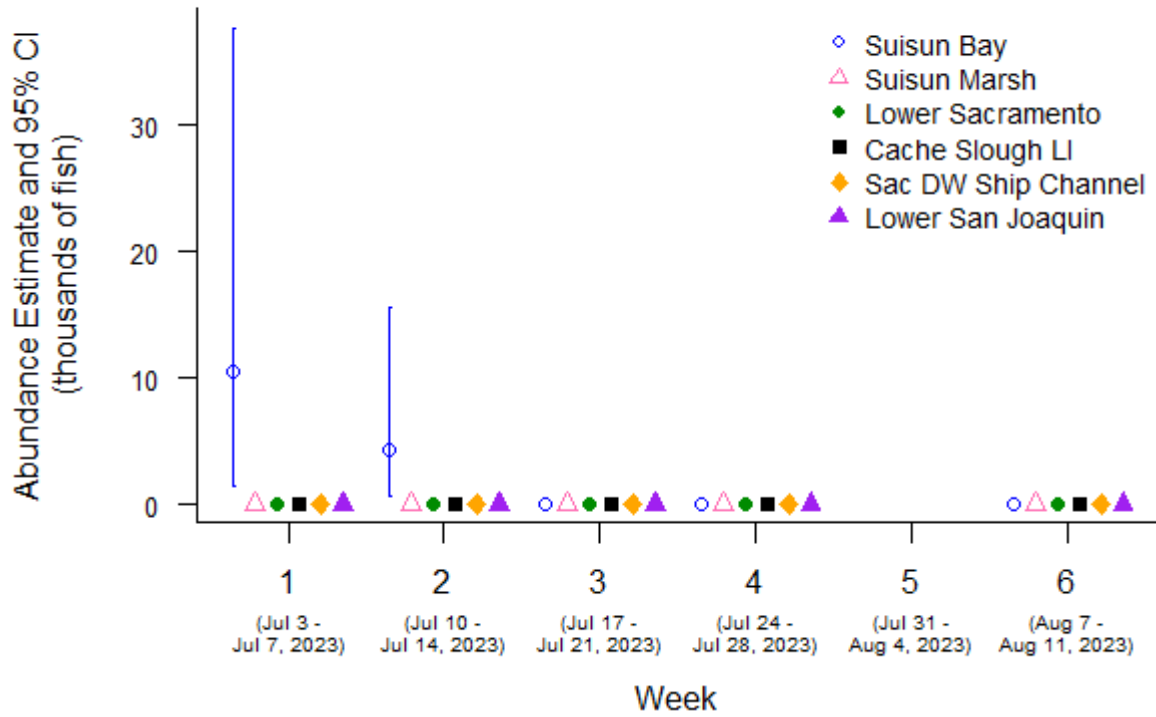
Week	Stratum	Number of Sites	Number of Tows	Total Number Caught	Total Sample Volume	Abundance Estimate	Lower Bound	Upper Bound	Number Marked
15	Suisun Marsh	6	24	0	92,990	0*	NA	NA	0
15	Lower Sacramento	6	24	0	98,518	0*	NA	NA	0
15	Cache Slough LI	6	22	0	80,571	0*	NA	NA	0
15	Sac DW Ship Channel	6	24	0	99,690	0*	NA	NA	0
15	Lower San Joaquin	6	24	0	93,824	0*	NA	NA	0
15	All Strata	33	130	0	513,521	0*	NA	NA	0
16	Suisun Bay	6	24	0	104,408	0*	NA	NA	0
16	Suisun Marsh	5	18	0	71,117	0*	NA	NA	0
16	Lower Sacramento	6	24	0	95,732	0*	NA	NA	0
16	Cache Slough LI	6	22	0	83,227	0*	NA	NA	0
16	Sac DW Ship Channel	6	24	0	93,554	0*	NA	NA	0
16	Lower San Joaquin	6	24	0	93,209	0*	NA	NA	0
16	All Strata	35	136	0	541,248	0*	NA	NA	0
17	Suisun Bay	6	24	0	109,054	0*	NA	NA	0
17	Suisun Marsh	6	24	0	109,032	0*	NA	NA	0
17	Lower Sacramento	6	22	1	91,910	1,328	184	4,803	0
17	Cache Slough LI	6	24	0	92,960	0*	NA	NA	0
17	Sac DW Ship Channel	6	24	0	93,716	0*	NA	NA	0
17	Lower San Joaquin	6	24	0	94,717	0*	NA	NA	0
17	All Strata	36	142	1	591,389	1,328	184	4,803	0
18	Suisun Bay	6	24	0	98,060	0*	NA	NA	0
18	Suisun Marsh	6	24	0	98,086	0*	NA	NA	0
18	Lower Sacramento	6	24	0	97,480	0*	NA	NA	0
18	Cache Slough LI	6	24	0	91,692	0*	NA	NA	0
18	Sac DW Ship Channel	6	24	0	97,853	0*	NA	NA	0
18	Lower San Joaquin	6	24	0	91,408	0*	NA	NA	0
18	All Strata	36	144	0	574,579	0*	NA	NA	0
19	Suisun Bay	6	24	0	98,541	0*	NA	NA	0
19	Suisun Marsh	6	24	0	105,001	0*	NA	NA	0
19	Lower Sacramento	6	24	0	101,061	0*	NA	NA	0
19	Cache Slough LI	6	24	0	100,244	0*	NA	NA	0
19	Sac DW Ship Channel	6	24	0	100,420	0*	NA	NA	0
19	Lower San Joaquin	6	24	0	99,306	0*	NA	NA	0
19	All Strata	36	144	0	604,572	0*	NA	NA	0
20	Suisun Bay	6	24	0	99,880	0*	NA	NA	0
20	Suisun Marsh	6	24	0	97,530	0*	NA	NA	0
20	Lower Sacramento	6	24	1	94,437	1,293	179	4,674	0
20	Cache Slough LI	5	20	0	77,206	0*	NA	NA	0
20	Sac DW Ship Channel	6	24	0	89,562	0*	NA	NA	0
20	Lower San Joaquin	6	24	0	101,243	0*	NA	NA	0
20	All Strata	35	140	1	559,857	1,293	179	4,674	0
21	Suisun Bay	5	18	0	76,127	0*	NA	NA	0
21	Suisun Marsh	6	24	0	100,051	0*	NA	NA	0
21	Lower Sacramento	3	12	0	49,092	0*	NA	NA	0
21	Cache Slough LI	4	14	0	52,247	0*	NA	NA	0
21	Sac DW Ship Channel	6	22	0	87,056	0*	NA	NA	0
21	Lower San Joaquin	6	24	0	89,341	0*	NA	NA	0
21	All Strata	30	114	0	453,914	0*	NA	NA	0
22	Suisun Bay	6	22	0	92,969	0*	NA	NA	0
22	Suisun Marsh	5	18	0	80,691	0*	NA	NA	0

Week	Stratum	Number of Sites	Number of Tows	Total Number Caught	Total Sample Volume	Abundance Estimate	Lower Bound	Upper Bound	Number Marked
22	Lower Sacramento	6	24	0	94,781	0*	NA	NA	0
22	Cache Slough LI	6	24	0	86,434	0*	NA	NA	0
22	Sac DW Ship Channel	6	24	0	89,664	0*	NA	NA	0
22	Lower San Joaquin	6	24	0	90,343	0*	NA	NA	0
22	All Strata	35	136	0	534,882	0*	NA	NA	0

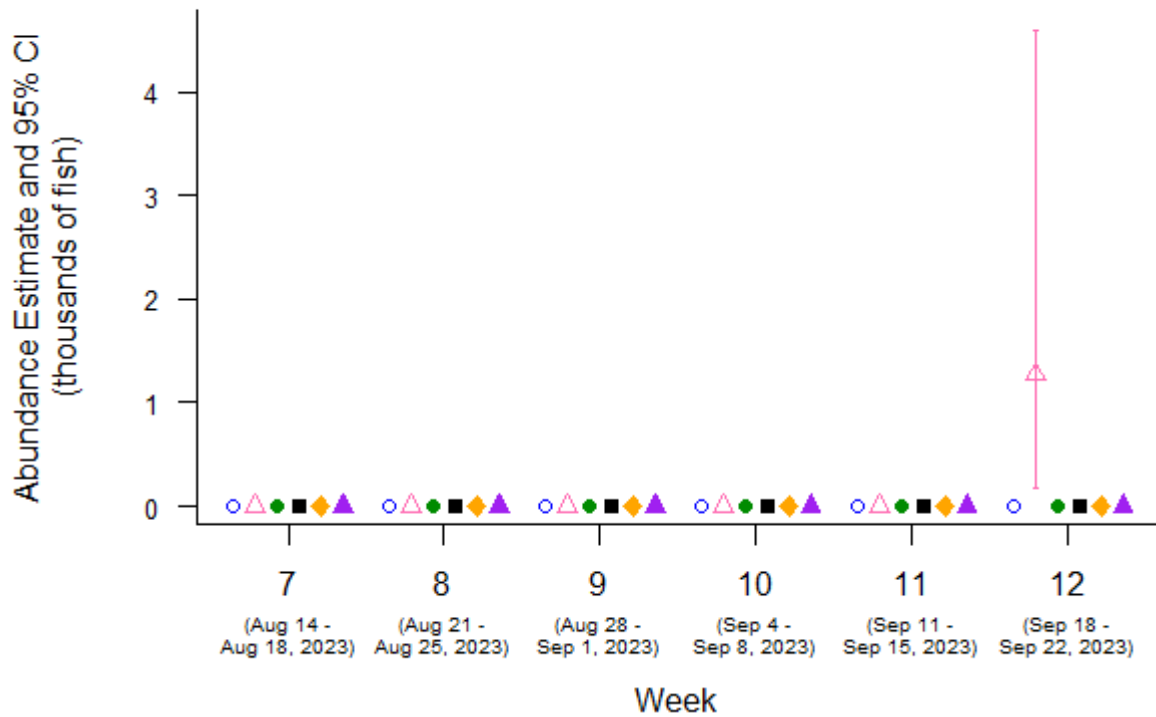
Table 3: Week numbers and corresponding dates used in Table 2.

Week	Dates
1	July 3 - 7, 2023
2	July 10 - 14, 2023
3	July 17 - 21, 2023
4	July 24 - 28, 2023
6	August 7 - 11, 2023
7	August 14 - 18, 2023
8	August 21 - 25, 2023
9	August 28 - September 1, 2023
10	September 4 - 8, 2023
11	September 11 - 15, 2023
12	September 18 - 22, 2023
13	September 25 - 29, 2023
14	October 2 - 6, 2023
15	October 9 - 13, 2023
16	October 16 - 20, 2023
17	October 23 - 27, 2023
18	October 30 - November 3, 2023
19	November 6 - 10, 2023
20	November 13 - 17, 2023
21	November 20 - 24, 2023
22	November 27 - December 1, 2023

Delta Smelt Abundance Estimates Over Time

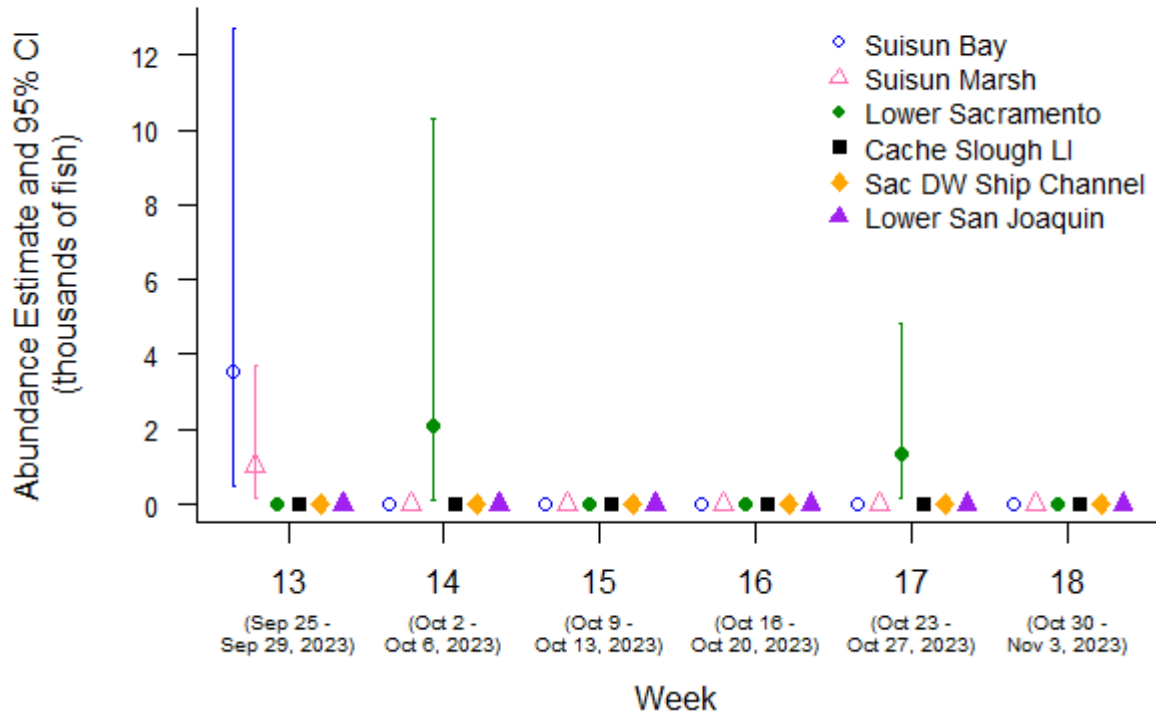


1Figure 1: Delta Smelt abundance estimates and 95% confidence intervals by week number and stratum for weeks 1 through 6.

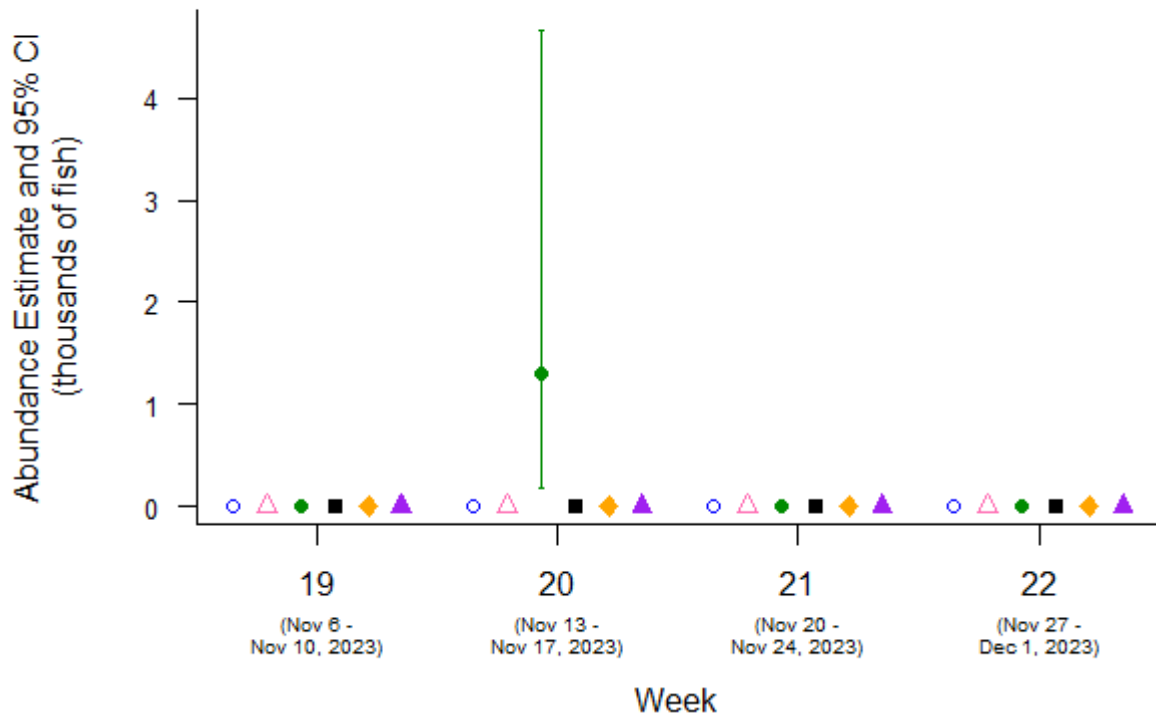


2Figure 2: Delta Smelt abundance estimates and 95% confidence intervals by week number and stratum for weeks 7 through 12.

Delta Smelt Abundance Estimates Over Time

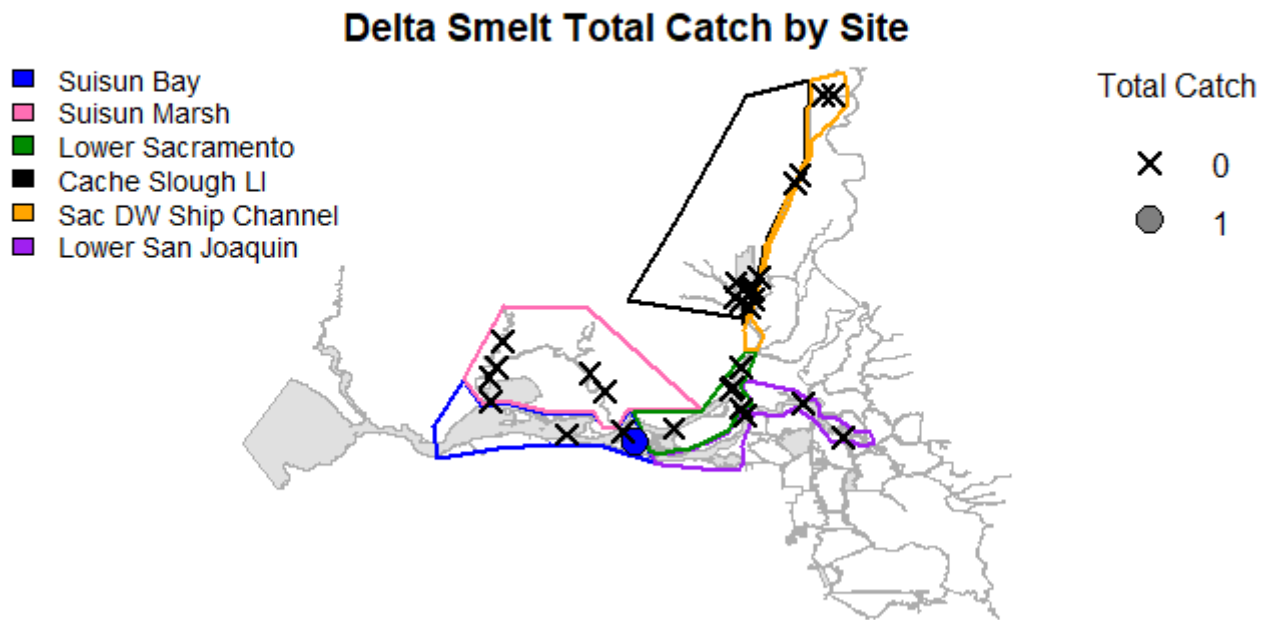


3Figure 3: Delta Smelt abundance estimates and 95% confidence intervals by week number and stratum for weeks 13 through 18.



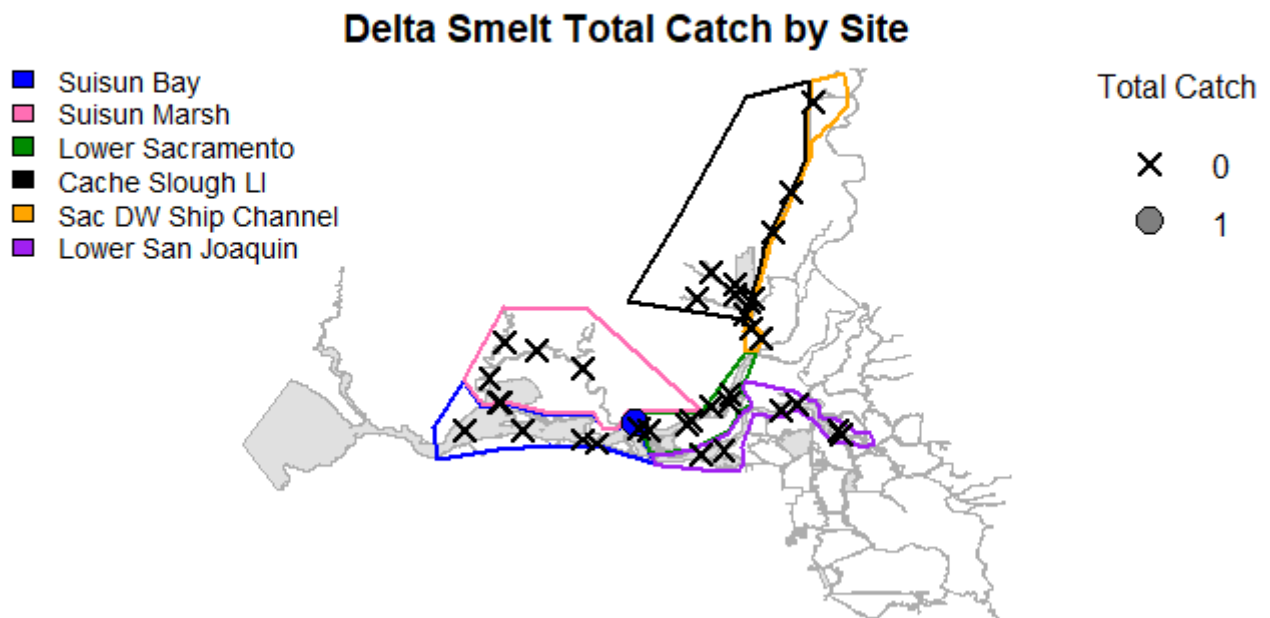
4Figure 4: Delta Smelt abundance estimates and 95% confidence intervals by week number and stratum for weeks 19 through 22.

Week 1 (July 3 - 7, 2023)



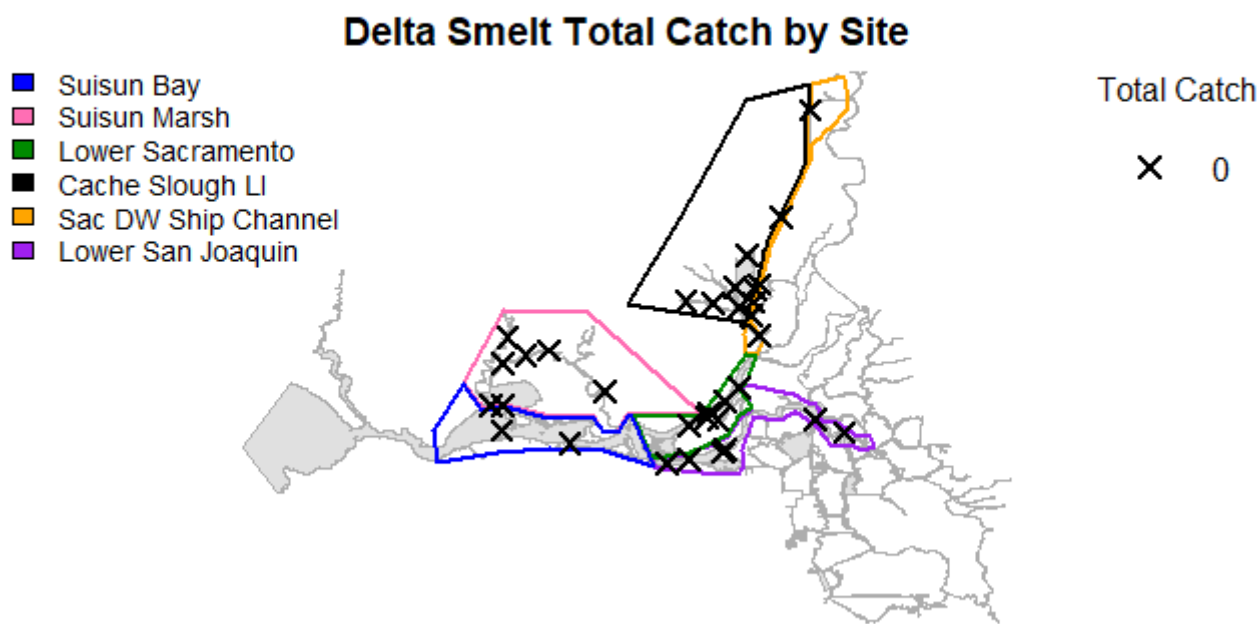
5Figure 5: Map of total Delta Smelt catch by site in Week 1.

Week 2 (July 10 - 14, 2023)



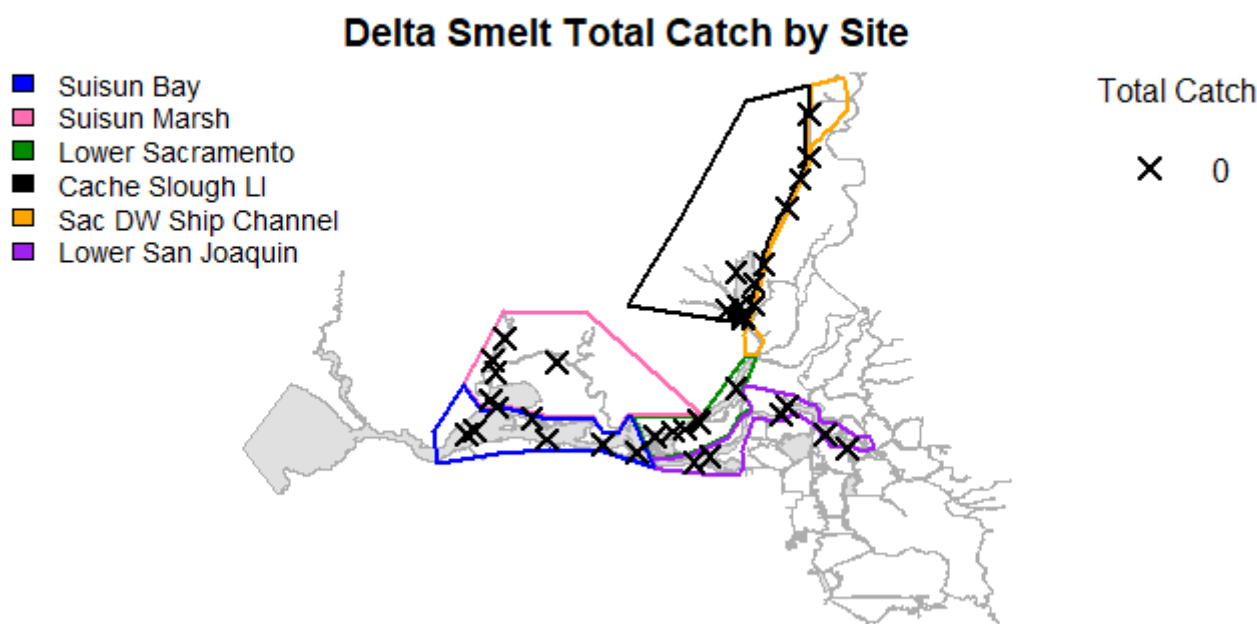
6Figure 6: Map of total Delta Smelt catch by site in Week 2.

Week 3 (July 17 - 21, 2023)



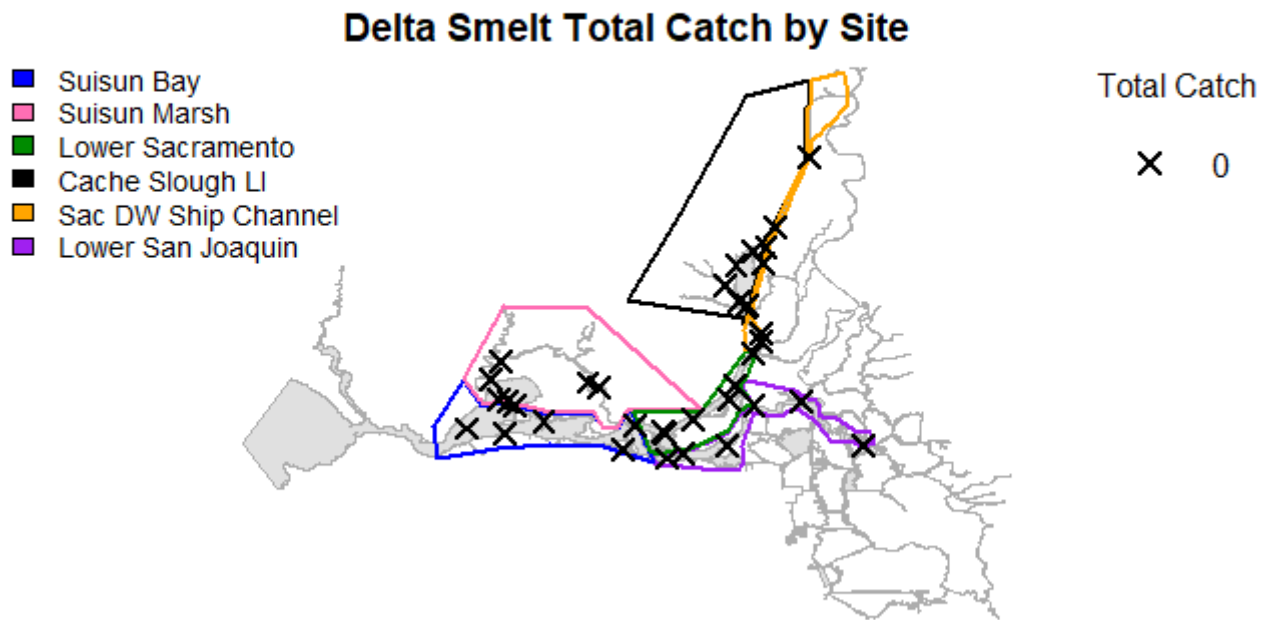
7Figure 7: Map of total Delta Smelt catch by site in Week 3.

Week 4 (July 24 - 28, 2023)



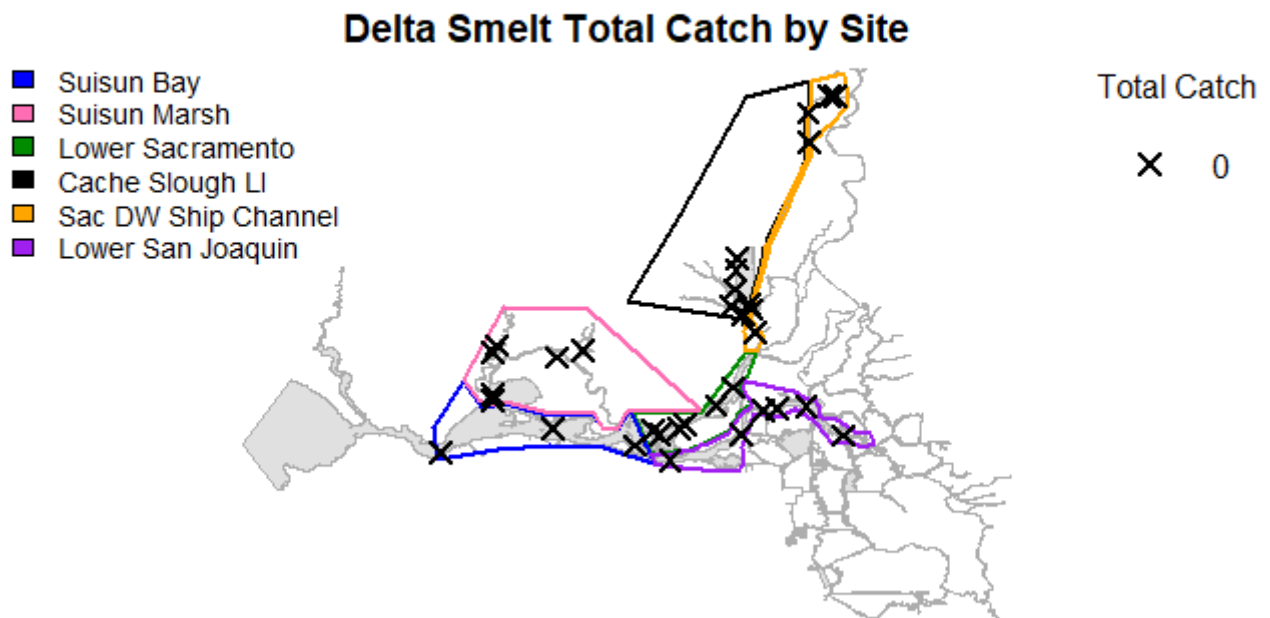
8Figure 8: Map of total Delta Smelt catch by site in Week 4.

Week 6 (August 7 - 11, 2023)



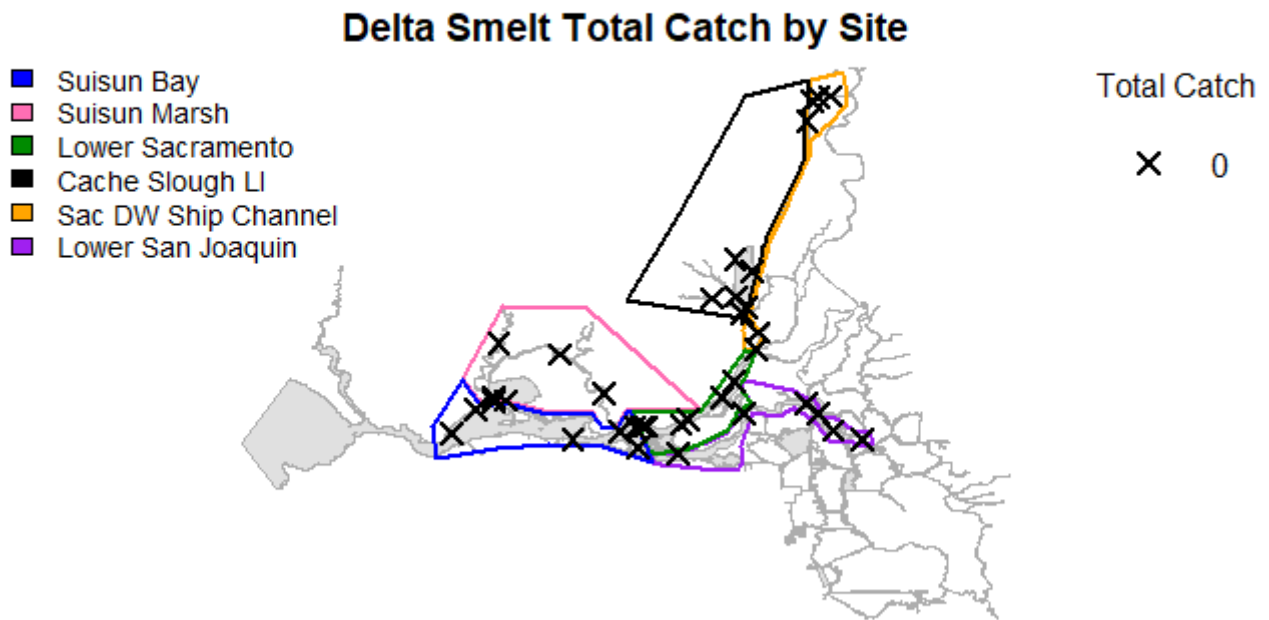
9Figure 9: Map of total Delta Smelt catch by site in Week 6.

Week 7 (August 14 - 18, 2023)



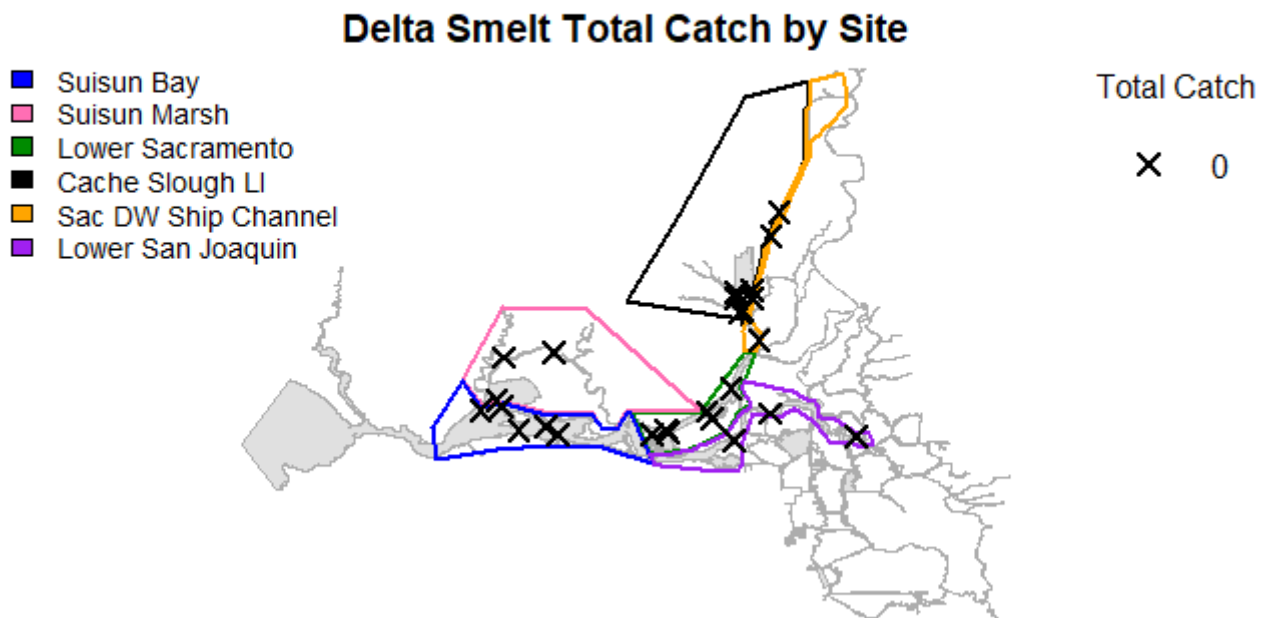
10Figure 10: Map of total Delta Smelt catch by site in Week 7.

Week 8 (August 21 - 25, 2023)



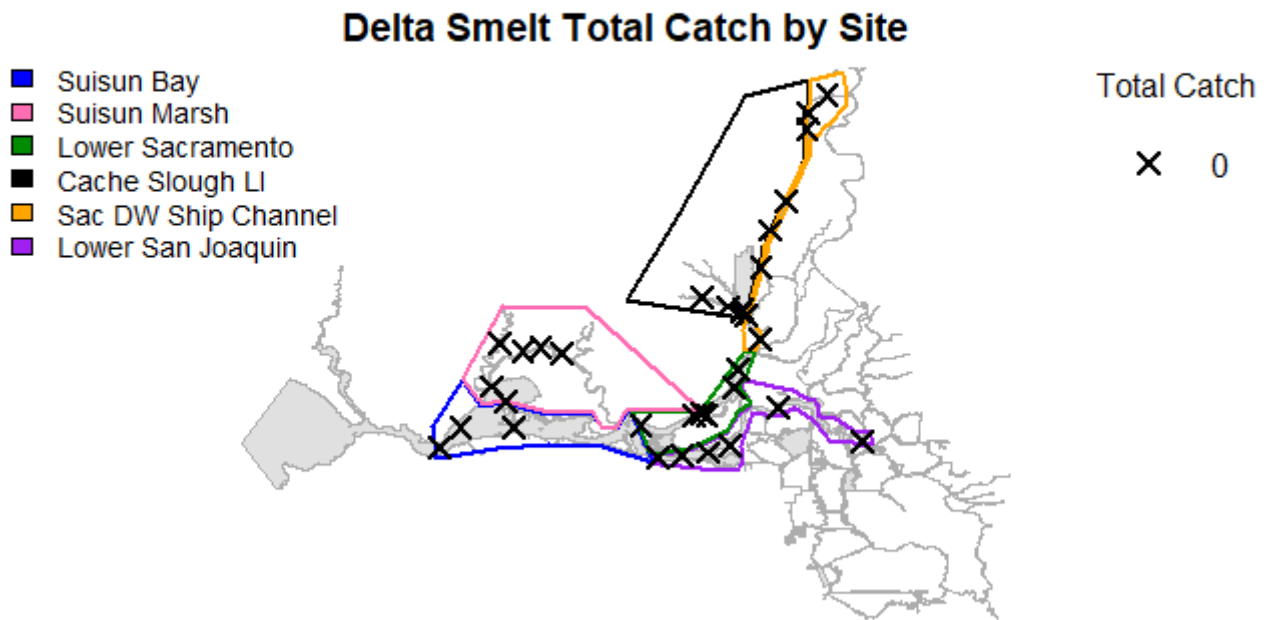
11Figure 11: Map of total Delta Smelt catch by site in Week 8.

Week 9 (August 28 - September 1, 2023)



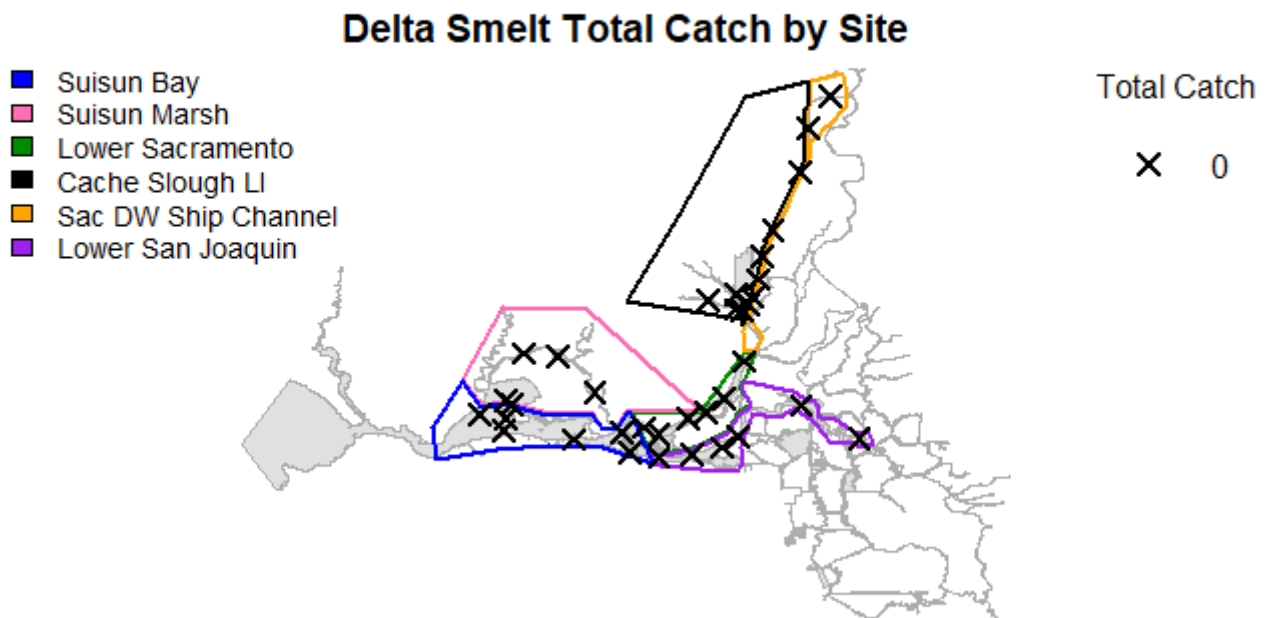
12Figure 12: Map of total Delta Smelt catch by site in Week 9.

Week 10 (September 4 - 8, 2023)



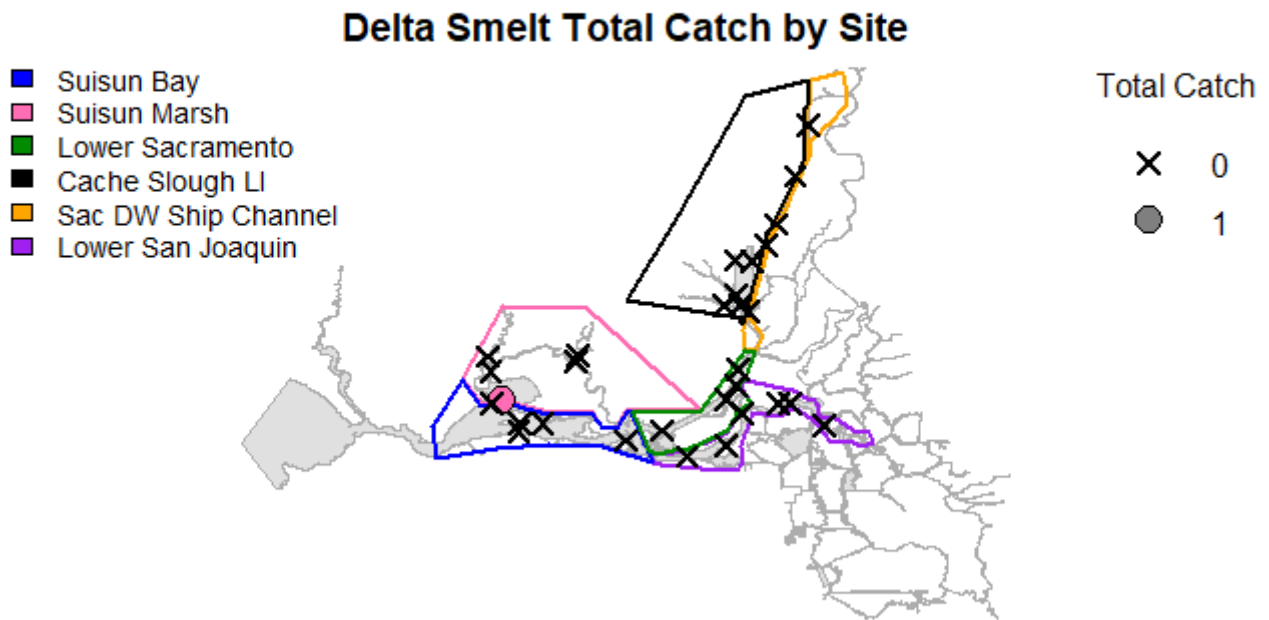
13Figure 13: Map of total Delta Smelt catch by site in Week 10.

Week 11 (September 11 - 15, 2023)



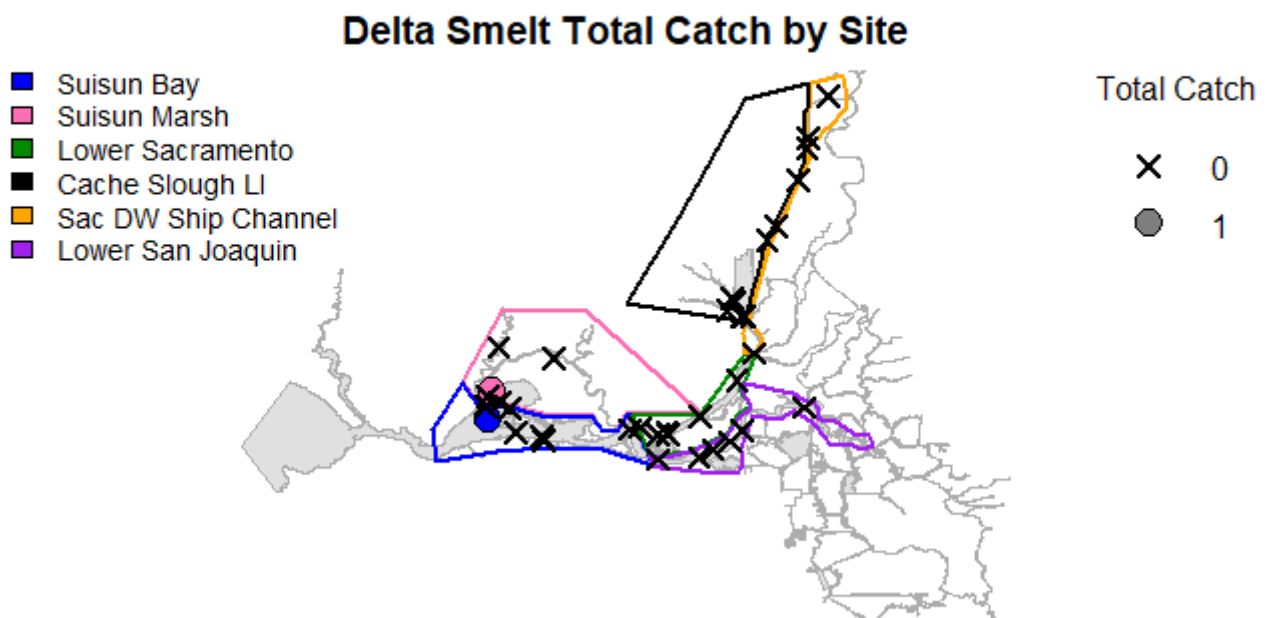
14Figure 14: Map of total Delta Smelt catch by site in Week 11.

Week 12 (September 18 - 22, 2023)



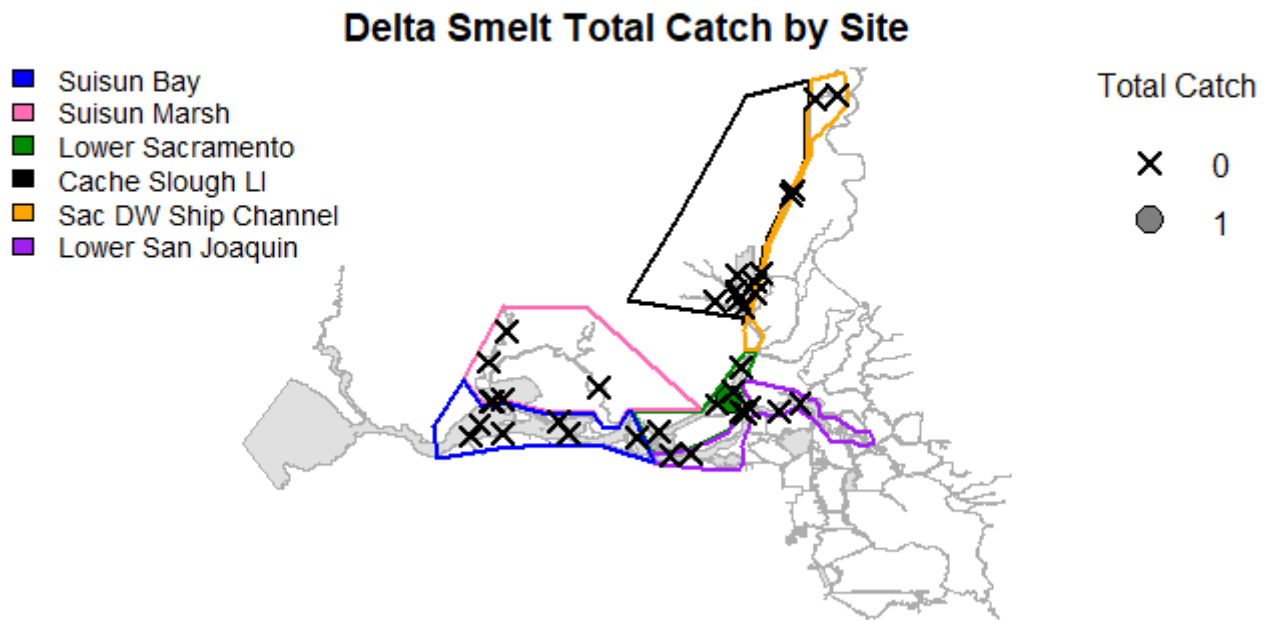
15Figure 15: Map of total Delta Smelt catch by site in Week 12.

Week 13 (September 25 - 29, 2023)



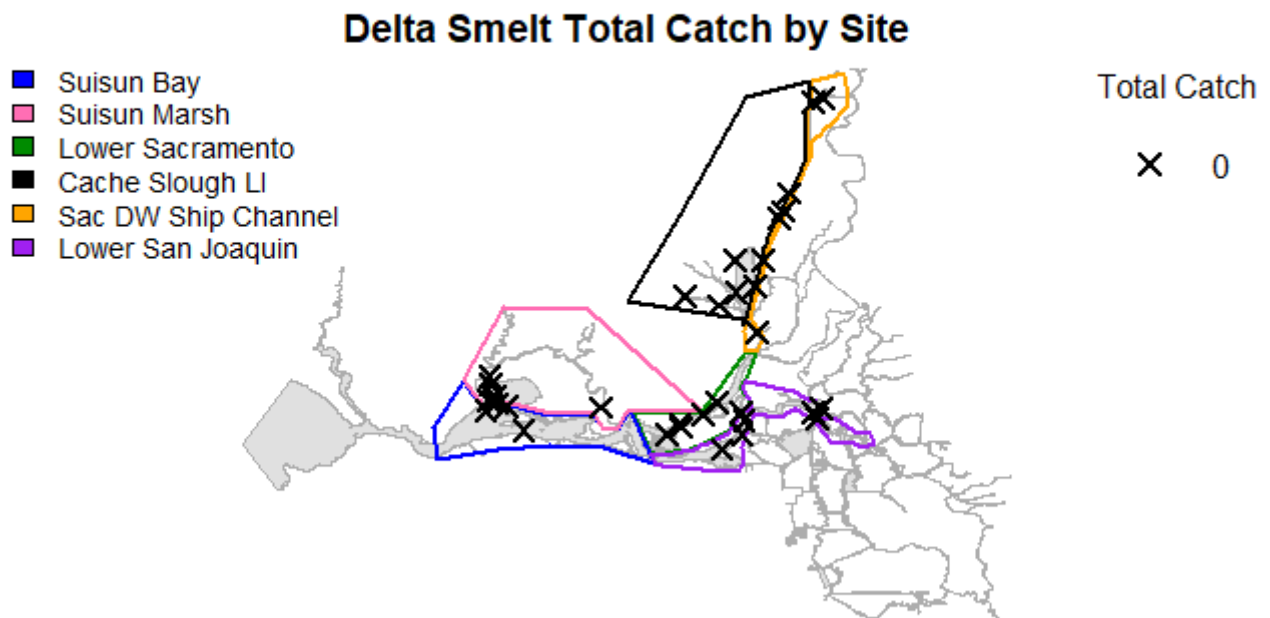
16Figure 16: Map of total Delta Smelt catch by site in Week 13.

Week 14 (October 2 - 6, 2023)



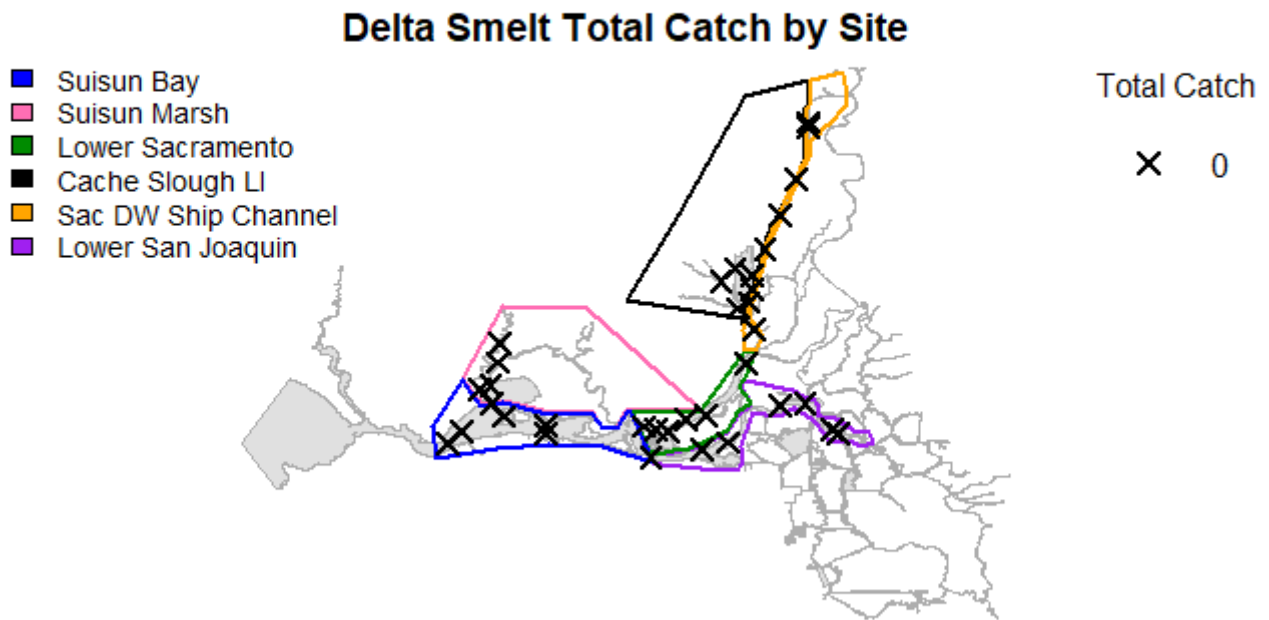
17Figure 17: Map of total Delta Smelt catch by site in Week 14.

Week 15 (October 9 - 13, 2023)



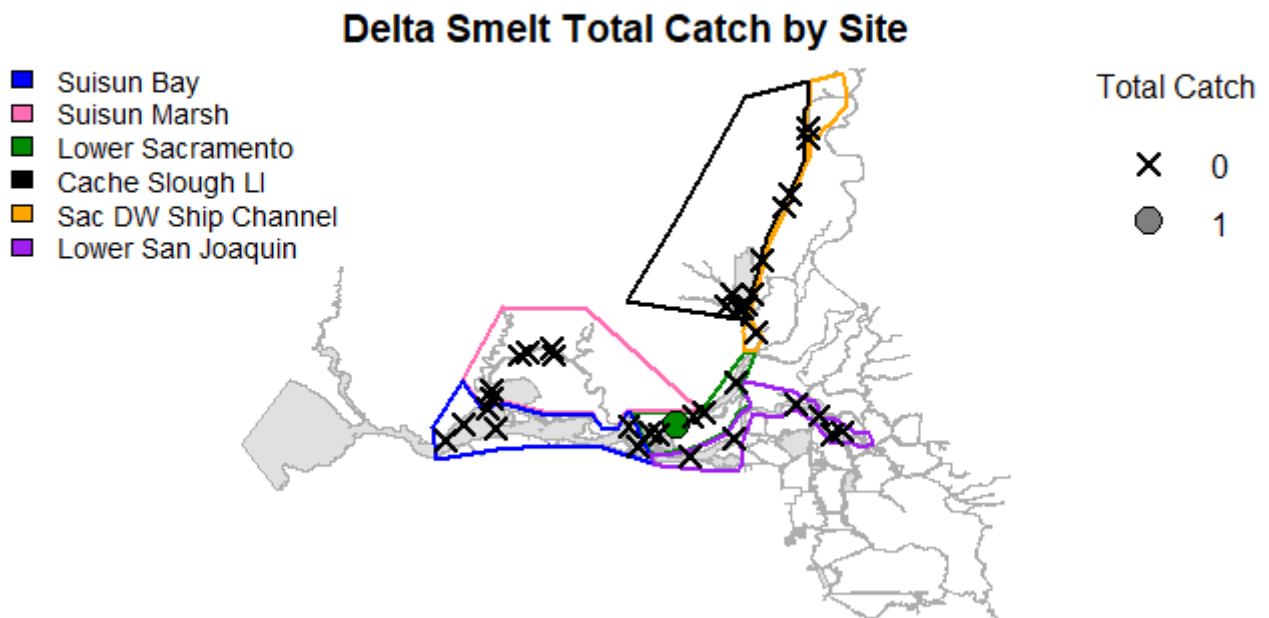
18Figure 18: Map of total Delta Smelt catch by site in Week 15.

Week 16 (October 16 - 20, 2023)



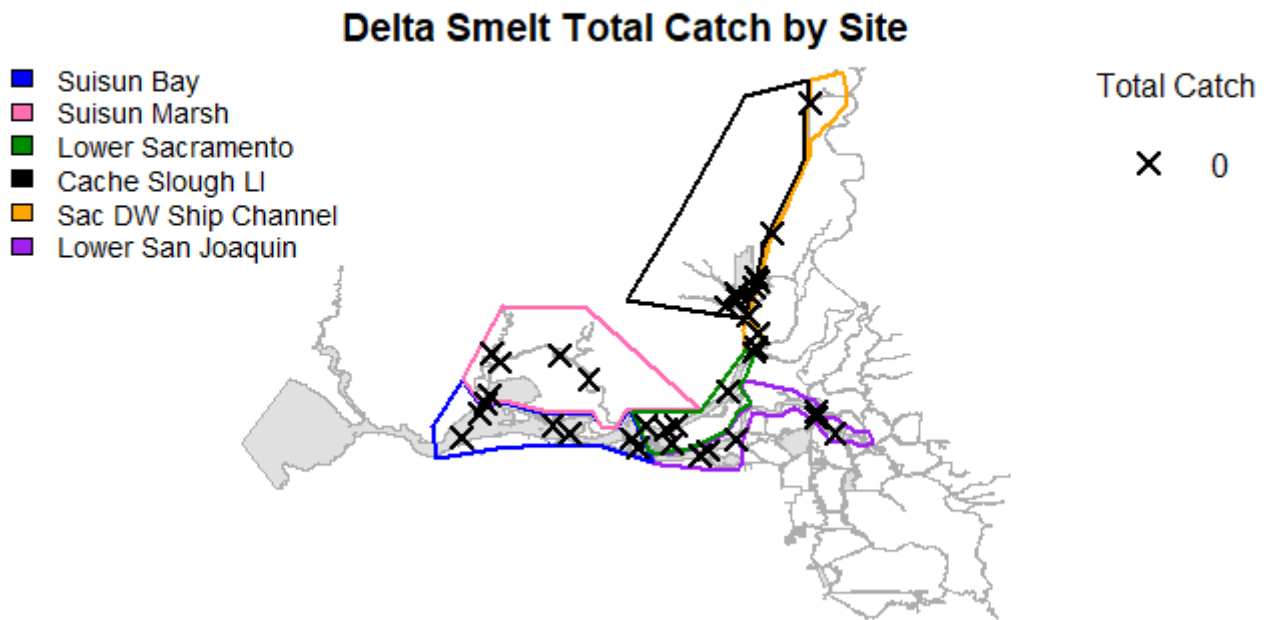
19Figure 19: Map of total Delta Smelt catch by site in Week 16.

Week 17 (October 23 - 27, 2023)



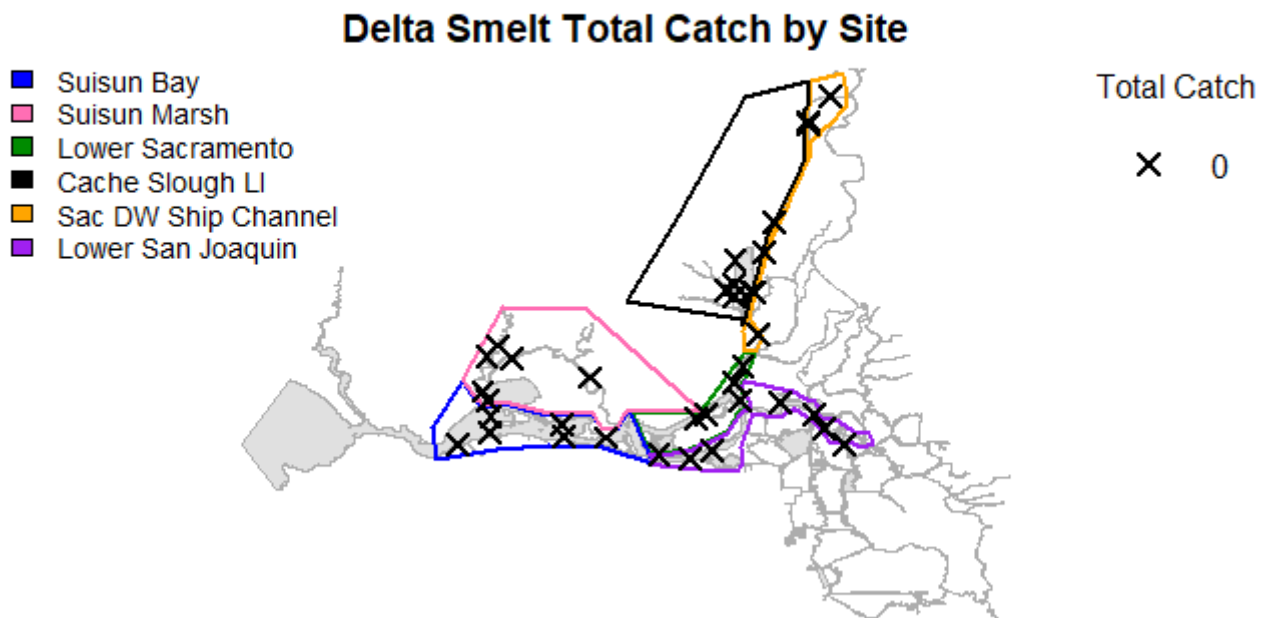
20Figure 20: Map of total Delta Smelt catch by site in Week 17.

Week 18 (October 30 - November 3, 2023)



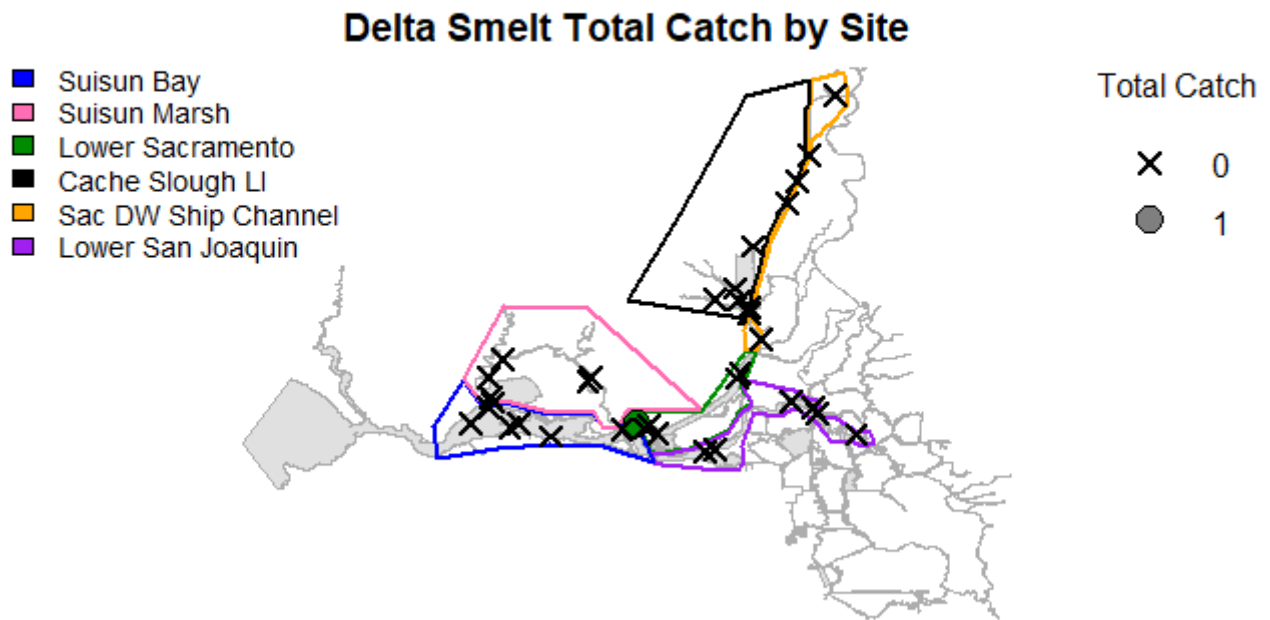
21Figure 21: Map of total Delta Smelt catch by site in Week 18.

Week 19 (November 6 - 10, 2023)



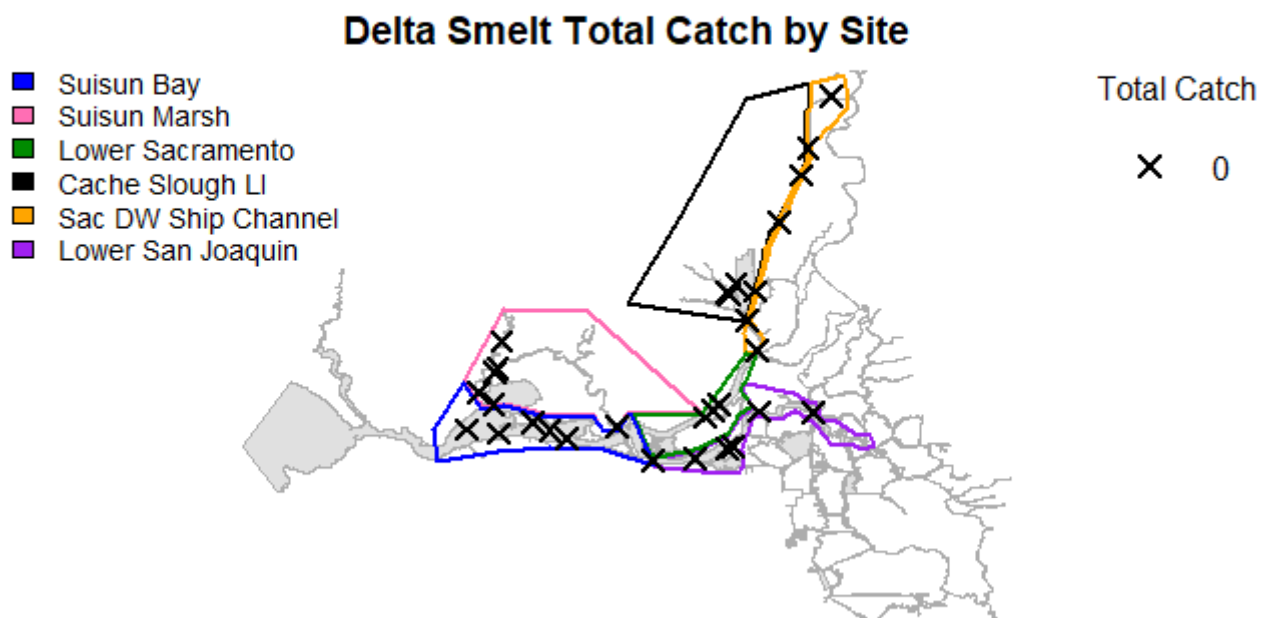
22Figure 22: Map of total Delta Smelt catch by site in Week 19.

Week 20 (November 13 - 17, 2023)



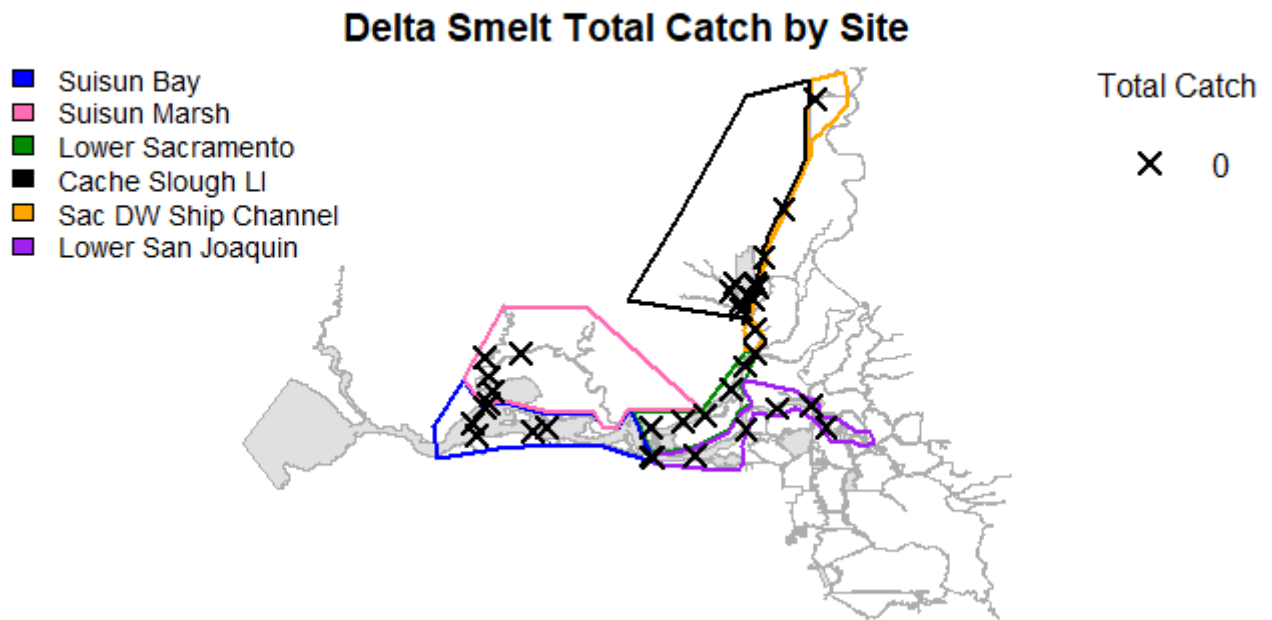
23Figure 23: Map of total Delta Smelt catch by site in Week 20.

Week 21 (November 20 - 24, 2023)



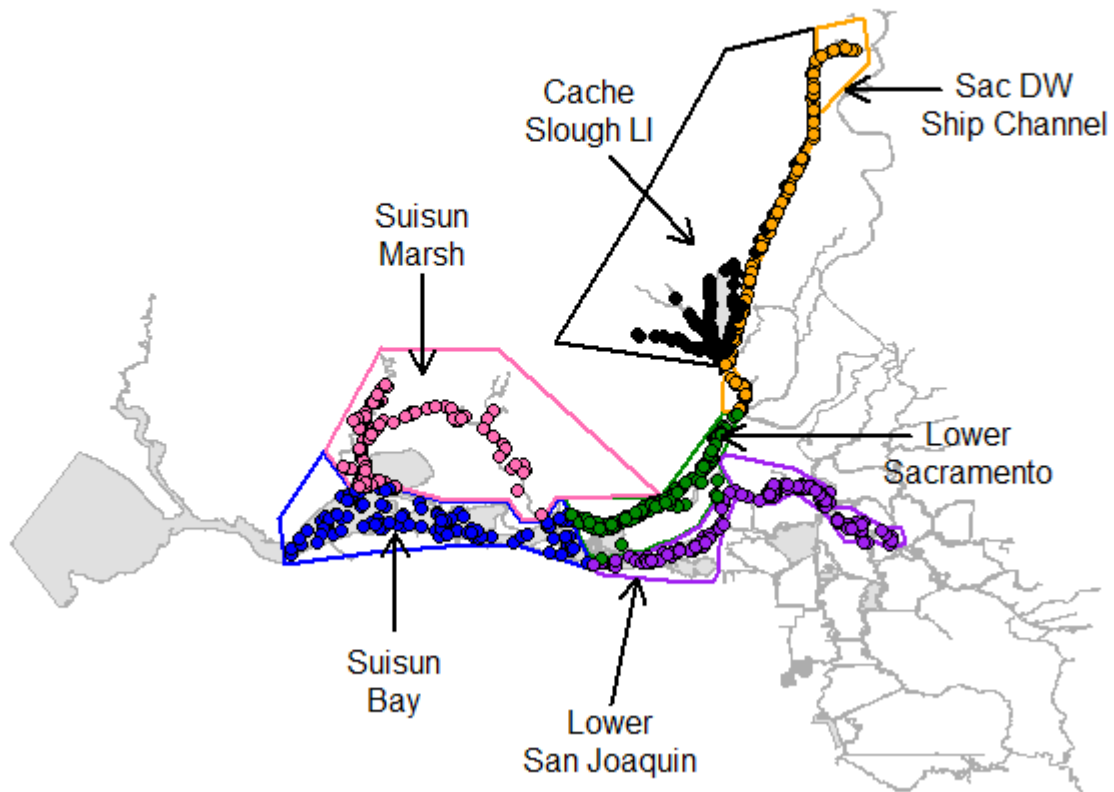
24Figure 24: Map of total Delta Smelt catch by site in Week 21.

Week 22 (November 27 - December 1, 2023)



25Figure 25: Map of total Delta Smelt catch by site in Week 22.

All Sampling Locations To Date



26Figure 26: Map of all sampling sites in this phase.

Habitat Volume Estimates

Table 4: Estimates of water volume (cubic meters) between 0.5-m and 4.5-m depth, by stratum.

Stratum	Volume
Suisun Bay	285,840,678
Suisun Marsh	76,278,718
Lower Sacramento	88,162,170
Cache Slough LI	33,420,492
Sac DW Ship Channel	30,411,491
Lower San Joaquin	122,096,565

References

D. L. Stevens and A. R. Olsen. Spatially balanced sampling of natural resources. *Journal of the American Statistical Association*, 99(465):262 – 278, 2004.