Enhanced Delta Smelt Monitoring
Preliminary Abundance Analysis
Larval/Juvenile Lifestages

DRAFT

U.S. Fish and Wildlife Service

June 26, 2017

Overview

As of April 2017, the Enhanced Delta Smelt Monitoring (EDSM) program has started sampling for larval and juvenile Delta Smelt. The Bay-Delta has been divided into four geographic strata:

- Western Low Risk, Low Density
- Low Risk, High Density
- High Risk
- Eastern Low Risk, Low Density

and each stratum has been further divided into two depth substrata:

- Deep Water (DW) zones with tidally averaged depths of 8 feet or more
- Shallow Water (SW) zones with tidally averaged depths of less than 8 feet.

Deep water sampling sites are generated using a generalized random-tessellation stratified (GRTS) design [1] with stratification and equal probability sampling. Each shallow sampling site is paired with a nearby deep water site, and sampling at the paired sites is carried out concurrently. Trawling gear similar to that used in the California Department of Fish and Wildlife's 20-mm Survey is used to conduct two oblique tows at deep water sites, while a 1/3 scale version of the same gear without a sled is used to collect two samples in the top 2 1/2 feet of water at shallow water sites. Because of logistical constraints, only a subset of deep water sites have paired shallow water sites. This means that shallow water density and abundance estimates are based on few samples from a limited area within a geographic stratum.

Although deep water sampling sites are generated with a GRTS design, classic simple random sample (SRS) design-based ratio expansions are being used to calculate the abundance estimates and standard errors presented here. While the point estimates may be similar between the two sampling designs, the variances are expected to be different. Work to improve the methods used here is in progress. Size-selectivity of the deep and shallow water nets are accounted for using preliminary results from a gear selectivity analysis.

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. The **Week** designations used here were defined out of convenience and are subject to change.
2. The methods of analysis used here remain in development.

Change Log

Report date May 1, 2017:

- Shallow water sampling in Week 1 involved gear and protocol testing and should be considered preliminary.

Report date May 8, 2017:

- Trying to estimate separate deep and shallow water abundances requires separate estimates of the total volume of water within deep and shallow smelt habitat. We currently do not have these separate estimates, so an estimate of the total volume of water within the Low Risk, High Density stratum, to 10 m depth, was used to calculate the Low Risk, High Density/Deep Water estimate in Week 2. This estimate includes both deep and shallow habitat volume. When separate habitat volumes are available, they will be used to recalculate past weeks.

Report date May 15, 2017:

- Preliminary deep and shallow water volumes estimates are now available and have been used to calculate all of the abundance estimates shown in this report. The same estimates will be used in the future unless otherwise noted.

Report date May 22, 2017:

- No changes.

Report date May 26, 2017:

- Corrections were made to the deep and shallow water volume estimates. The corrected estimates have been used to recalculate results from all weeks and will be used going forward. The new results are qualitatively similar to the previous results.

Report date June 5, 2017:

- Further corrections were made to the deep and shallow water volume estimates. The corrected estimates have been used to recalculate results from all weeks and will be used going forward. The new results are qualitatively similar to the previous results.

Report date June 12, 2017:

- The number of tows completed during Week 4 and the number of stations sampled in Week 6 have changed relative to previous reports because of corrections in the database.

Report date June 19, 2017:

- No changes.

Report date June 26, 2017:

- No changes.

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 abundance Subtotals and Totals are currently only calculated when sampling has occurred in all eight substrata.

				Estimate and 95% CI		
	Number of Sites	**Number of Tows**	**Number Caught**	**Abundance**	**Lower Bound**	**Upper Bound**
Week 1: April 24 - April 27, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Low Risk, High Density						
Deep Water	6	12	0	0*	-	-
Shallow Water	3	4	0	0*	-	-
Subtotal	9	16	0	0*	-	-
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
Eastern Low Risk, Low Density						
Deep Water	4	7	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	4	7	0	-	-	-
Total	22	41	0	-	-	-
Week 2: May 1 - May 3, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Low Risk, High Density						
Deep Water	6	12	6	3,536,089	509,630	12,571,258
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	6	-	-	-
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
Eastern Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	2	3	0	0*	-	-
Subtotal	5	9	0	0*	-	-
Total	20	39	6	-	-	-

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 abundance Subtotals and Totals are currently only calculated when sampling has occurred in all eight substrata.

				Estimate and 95% CI		
	Number of Sites	**Number of Tows**	**Number Caught**	**Abundance**	**Lower Bound**	**Upper Bound**
Week 3: May 8 - May 11, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	4	512,679	70,212	1,860,865
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	4	-	-	-
Low Risk, High Density						
Deep Water	4	8	0	0*	-	-
Shallow Water	2	4	1	323,565	44,650	1,170,856
Subtotal	6	12	1	323,565	44,650	1,170,856
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
Eastern Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Total	18	36	5	-	-	-
Week 4: May 15 - May 17, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Low Risk, High Density						
Deep Water	6	12	1	2,921,908	404,295	10,561,727
Shallow Water	2	4	0	0*	-	-
Subtotal	8	16	1	2,921,908	404,295	10,561,727
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
Eastern Low Risk, Low Density						
Deep Water	3	7	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	7	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 abundance Subtotals and Totals are currently only calculated when sampling has occurred in all eight substrata.

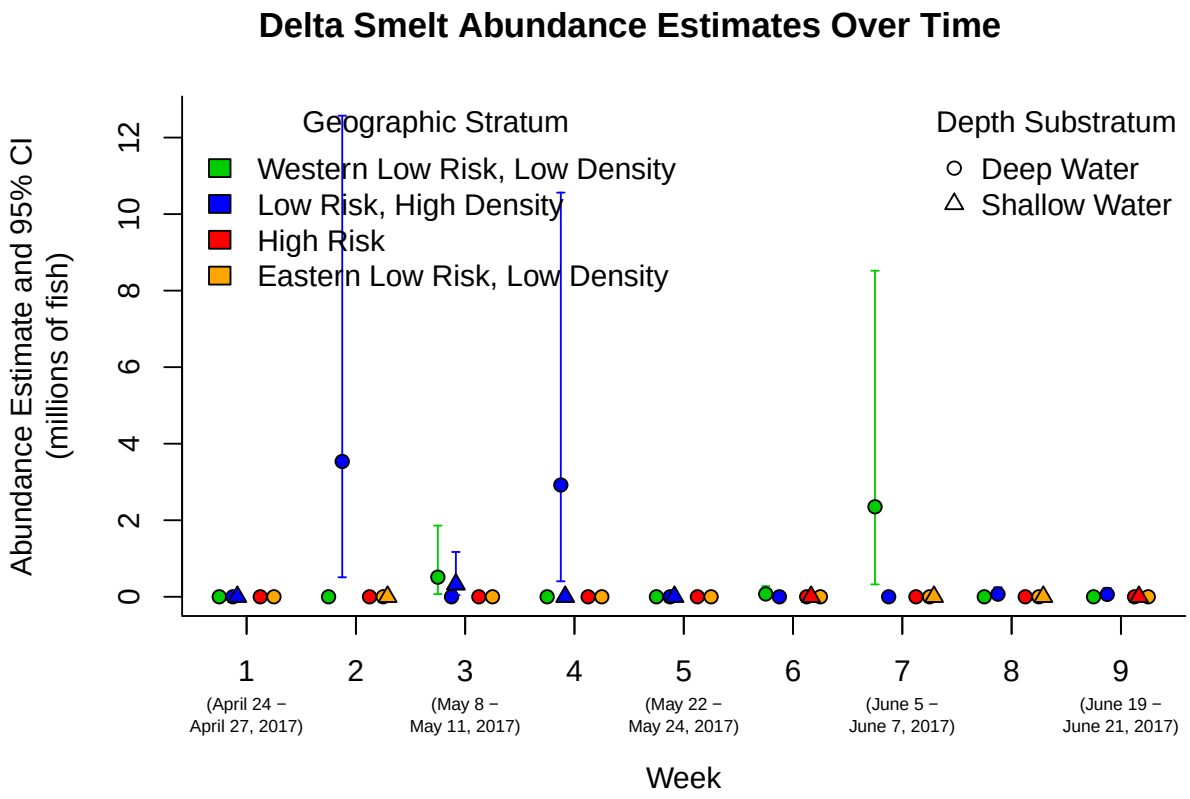
				Estimate and 95% CI		
	Number of Sites	**Number of Tows**	**Number Caught**	**Abundance**	**Lower Bound**	**Upper Bound**
Total	20	41	1	-	-	-
Week 5: May 22 - May 24, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Low Risk, High Density						
Deep Water	6	12	0	0*	-	-
Shallow Water	1	2	0	0*	-	-
Subtotal	7	14	0	0*	-	-
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
Eastern Low Risk, Low Density						
Deep Water	3	7	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	7	0	-	-	-
Total	19	39	0	-	-	-
Week 6: May 30 - June 1, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	1	74,353	9,497	277,426
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	1	-	-	-
Low Risk, High Density						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	2	4	0	0*	-	-
Subtotal	8	16	0	0*	-	-
Eastern Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	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 abundance Subtotals and Totals are currently only calculated when sampling has occurred in all eight substrata.

				Estimate and 95% CI		
	Number of Sites	**Number of Tows**	**Number Caught**	**Abundance**	**Lower Bound**	**Upper Bound**
Total	20	40	1	-	-	-
Week 7: June 5 - June 7, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	1	2,351,289	323,313	8,520,581
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	1	-	-	-
Low Risk, High Density						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
Eastern Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	2	4	0	0*	-	-
Subtotal	5	10	0	0*	-	-
Total	20	40	1	-	-	-
Week 8: June 12 - June 14, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Low Risk, High Density						
Deep Water	6	12	1	69,184	9,732	248,408
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	1	-	-	-
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	0	-	-	-
Eastern Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	2	4	0	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 abundance Subtotals and Totals are currently only calculated when sampling has occurred in all eight substrata.

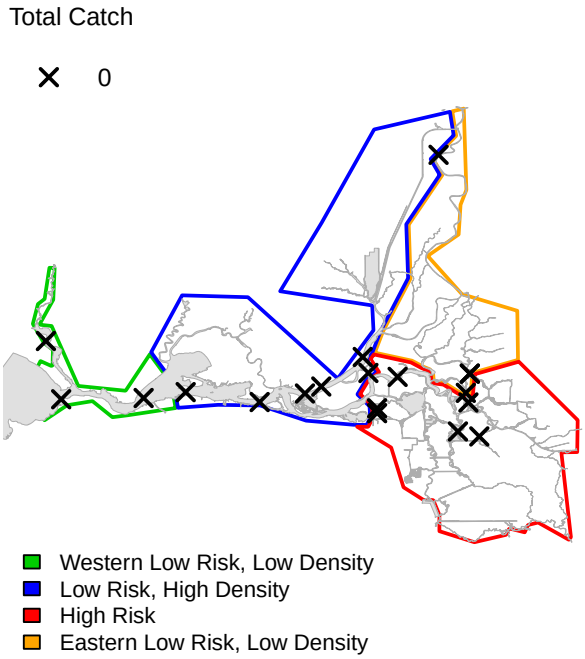
				Estimate and 95% CI		
	Number of Sites	**Number of Tows**	**Number Caught**	**Abundance**	**Lower Bound**	**Upper Bound**
Subtotal	5	10	0	0*	-	-
Total	20	40	1	-	-	-
Week 9: June 19 - June 21, 2017						
Western Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Low Risk, High Density						
Deep Water	6	12	1	62,611	8,757	225,339
Shallow Water	0	-	-	-	-	-
Subtotal	6	12	1	-	-	-
High Risk						
Deep Water	6	12	0	0*	-	-
Shallow Water	2	3	0	0*	-	-
Subtotal	8	15	0	0*	-	-
Eastern Low Risk, Low Density						
Deep Water	3	6	0	0*	-	-
Shallow Water	0	-	-	-	-	-
Subtotal	3	6	0	-	-	-
Total	20	39	1	-	-	-


Delta Smelt Abundance Estimates Over Time
Geographic Stratum
Western Low Risk, Low Density
Low Risk, High Density
High Risk
Eastern Low Risk, Low Density
Depth Substratum
Deep Water
Shallow Water
Abundance Estimate and 95% CI
(millions of fish)
0
2
4
6
8
10
12
1
2
3
4
5
6
7
8
9
(April 24 –
April 27, 2017)
(May 8 –
May 11, 2017)
(May 22 –
May 24, 2017)
(June 5 –
June 7, 2017)
(June 19 –
June 21, 2017)
Week

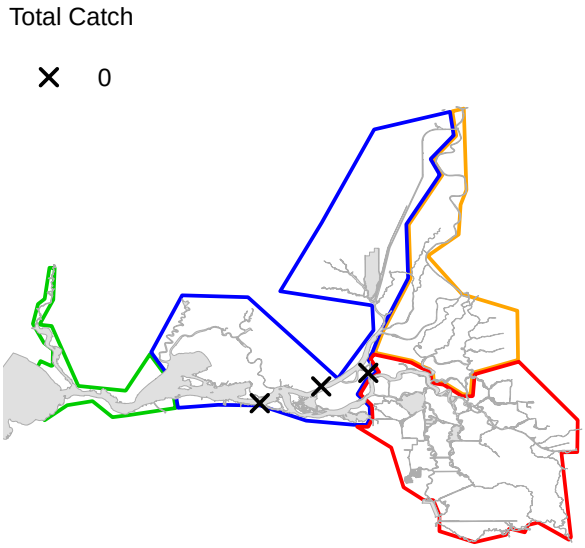
Week 1 (4/24/17 – 4/27/17)

19 deep water sites; 3 shallow water sites; 0 Delta Smelt total

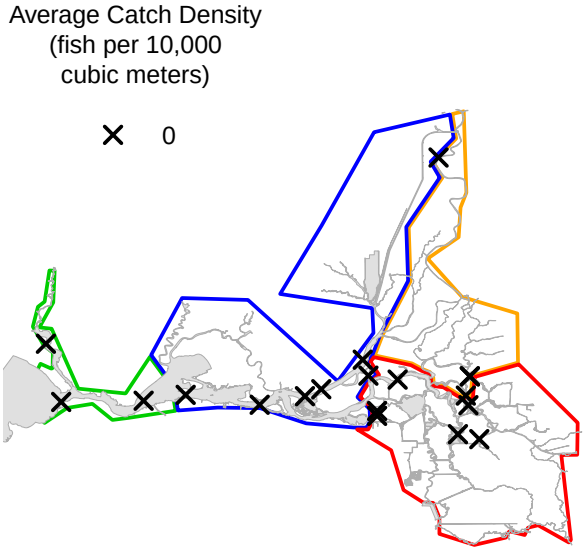
Delta Smelt Total Catch by DW Site



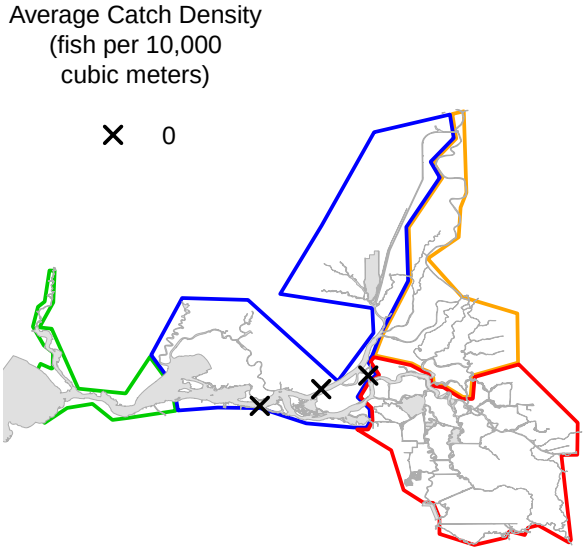
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



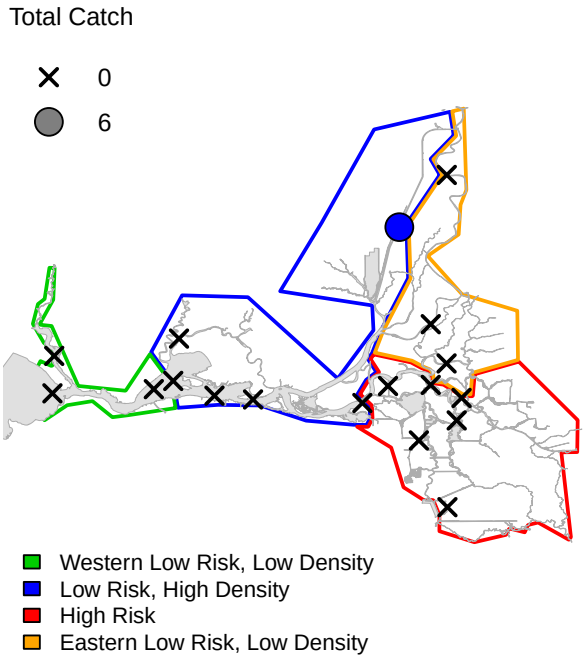
Delta Smelt Catch Density by SW Site



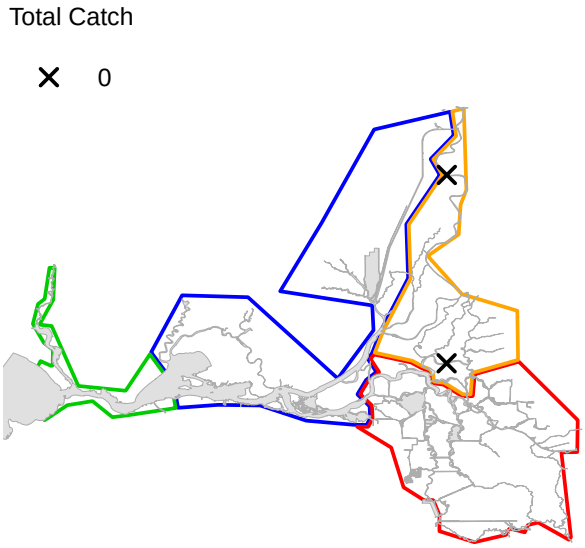
Week 2 (5/1/17 – 5/3/17)

18 deep water sites; 2 shallow water sites; 6 Delta Smelt total

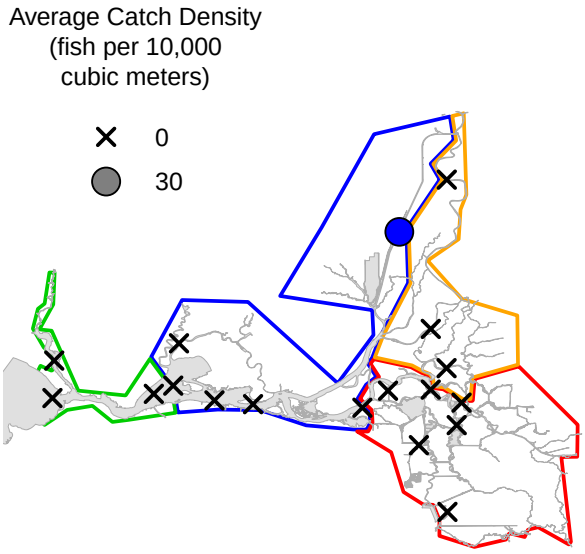
Delta Smelt Total Catch by DW Site



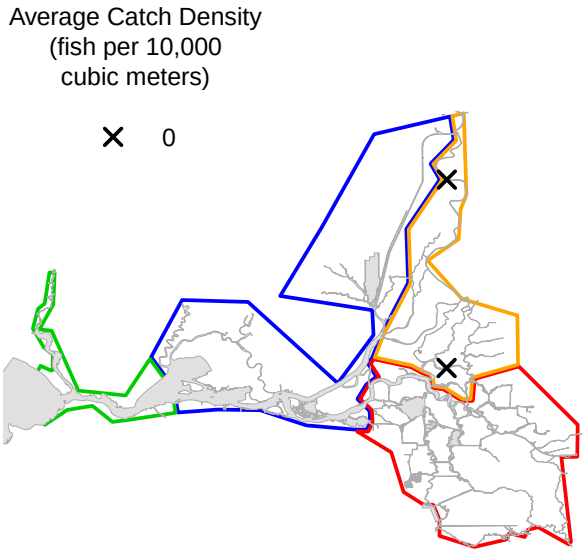
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



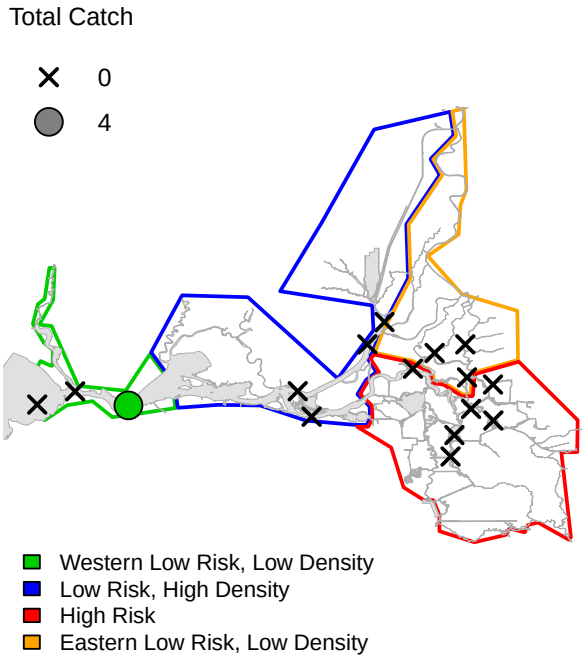
Delta Smelt Catch Density by SW Site



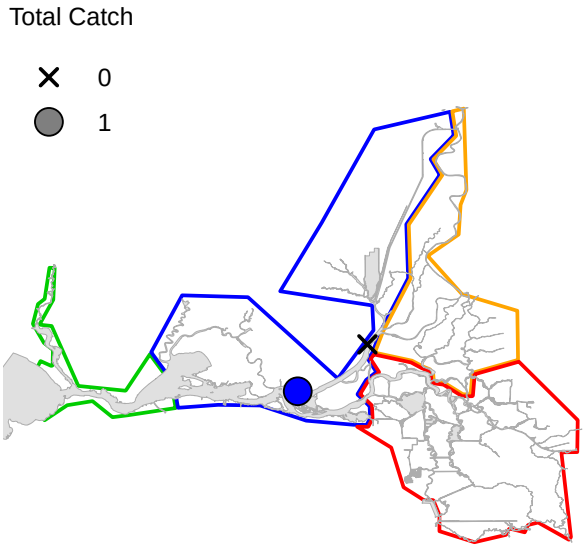
Week 3 (5/8/17 – 5/11/17)

16 deep water sites; 2 shallow water sites; 5 Delta Smelt total

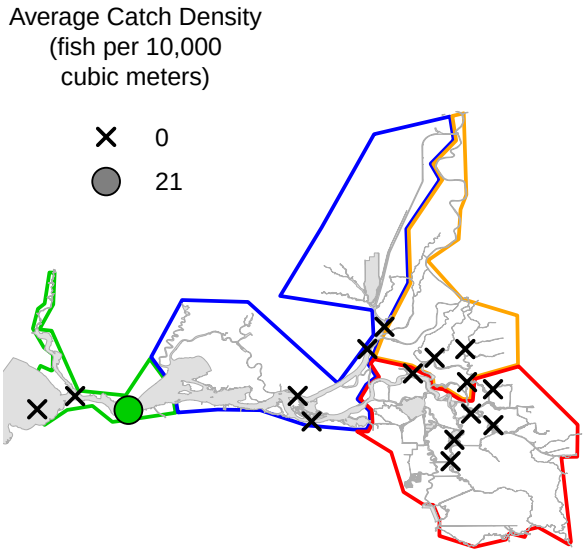
Delta Smelt Total Catch by DW Site



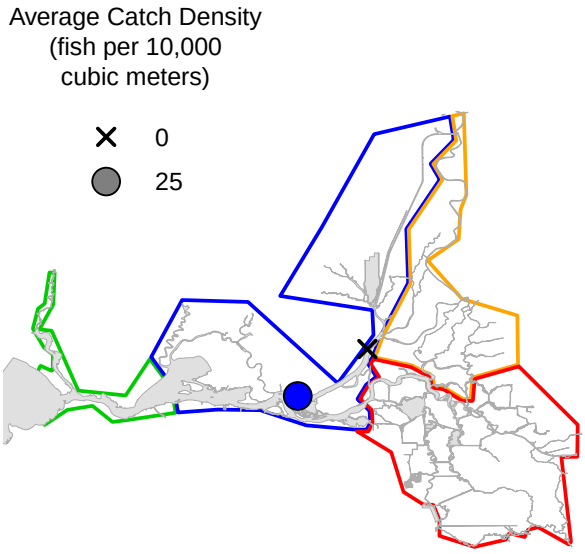
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



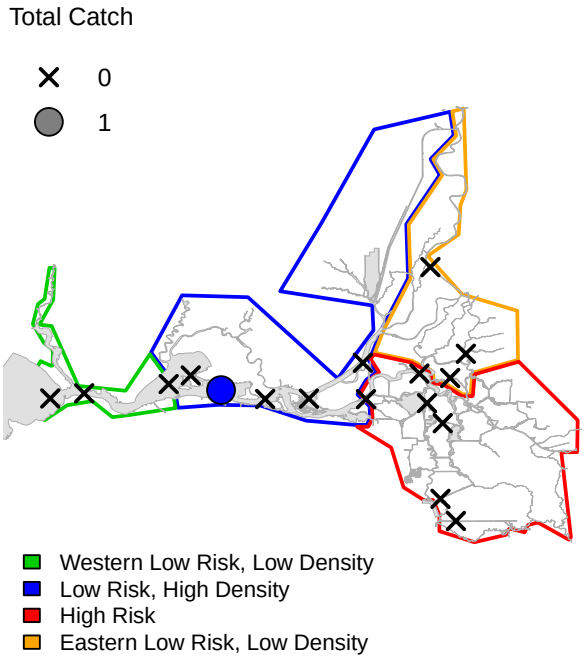
Delta Smelt Catch Density by SW Site



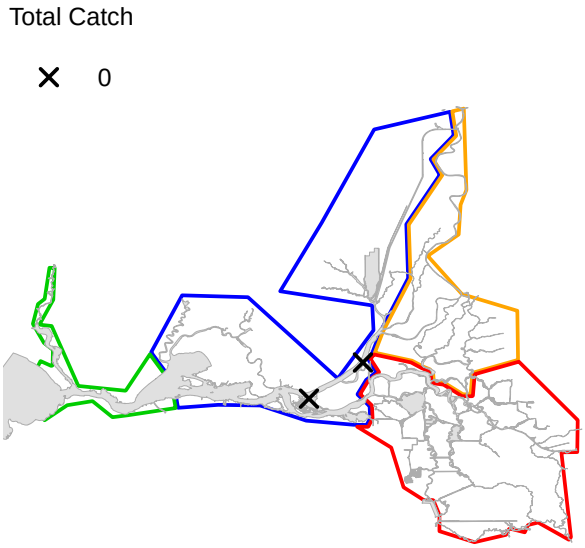
Week 4 (5/15/17 – 5/17/17)

18 deep water sites; 2 shallow water sites; 1 Delta Smelt total

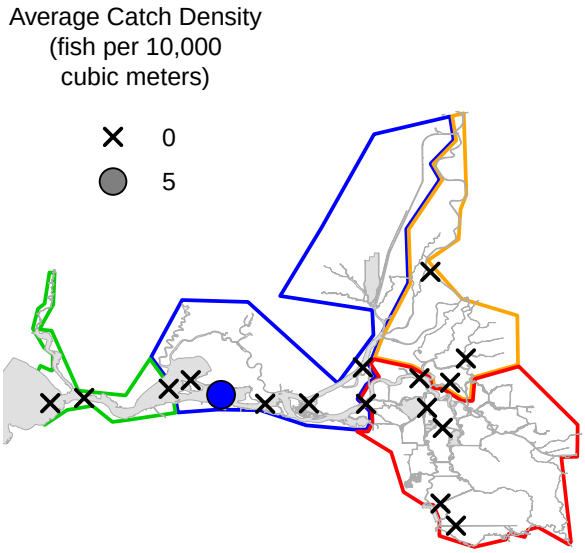
Delta Smelt Total Catch by DW Site



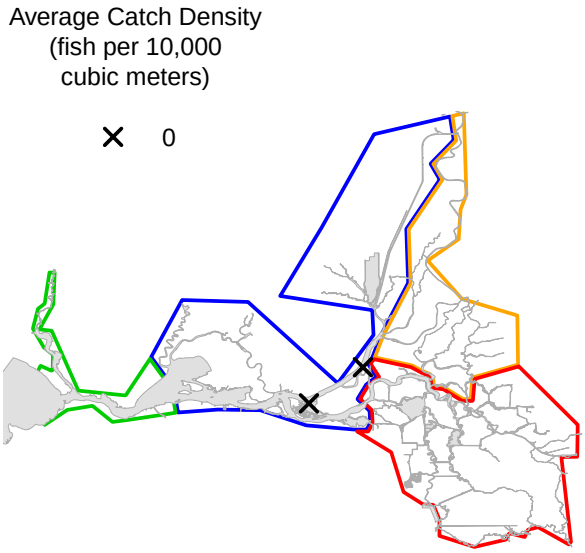
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



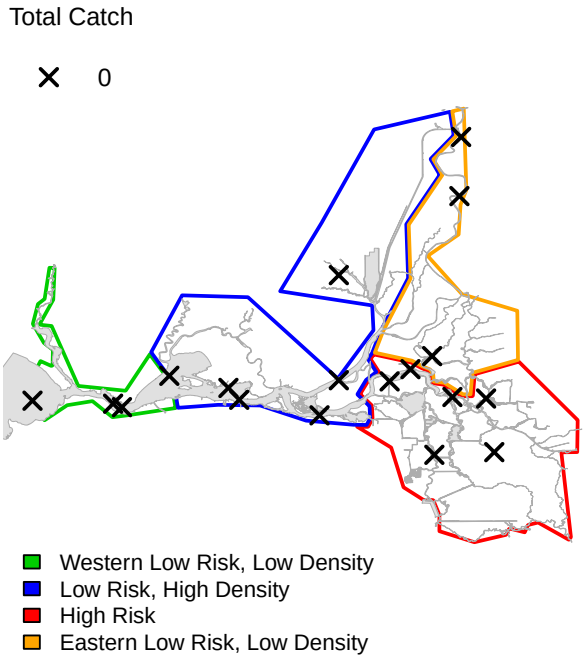
Delta Smelt Catch Density by SW Site



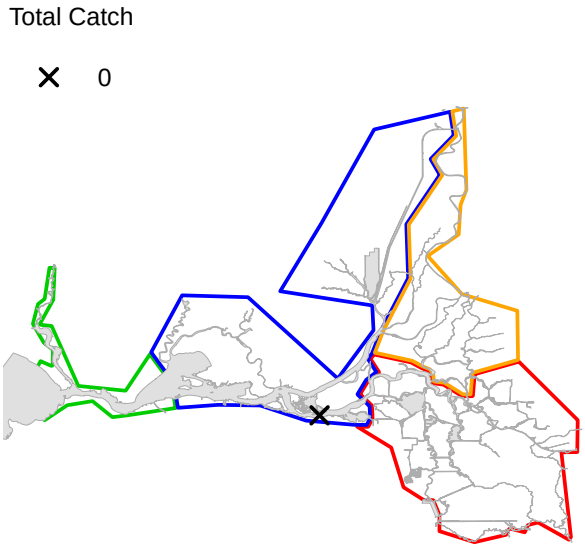
Week 5 (5/22/17 – 5/24/17)

18 deep water sites; 1 shallow water sites; 0 Delta Smelt total

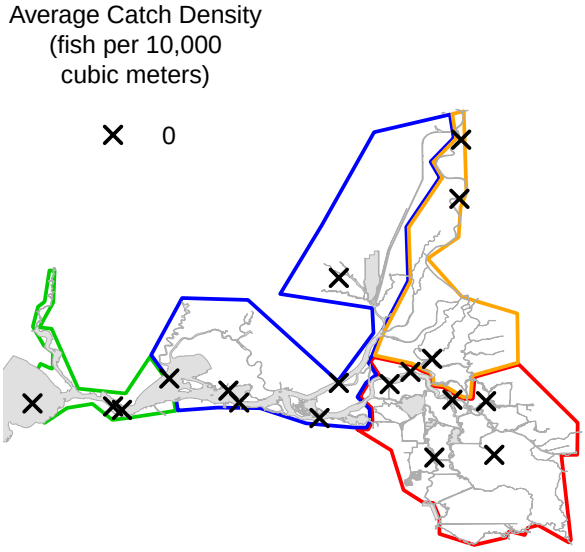
Delta Smelt Total Catch by DW Site



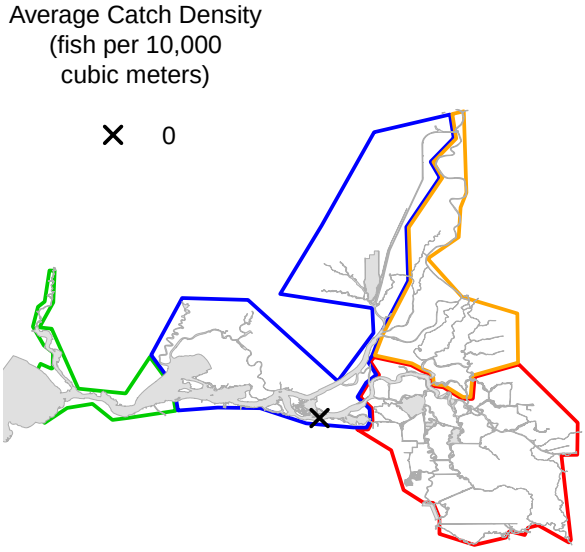
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



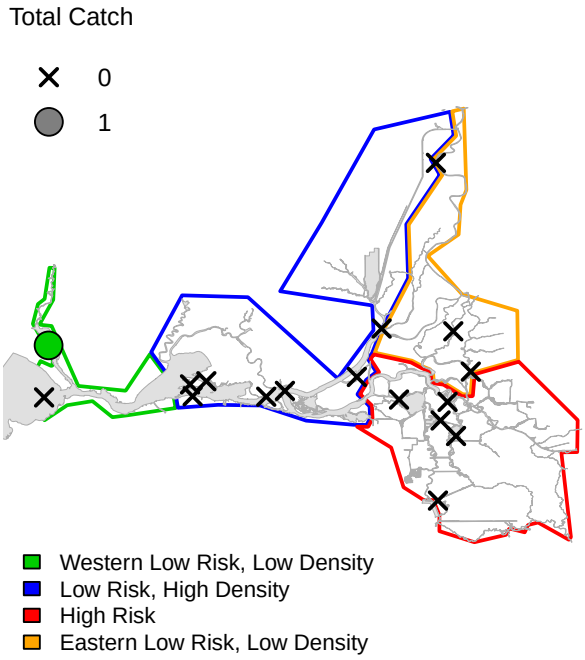
Delta Smelt Catch Density by SW Site



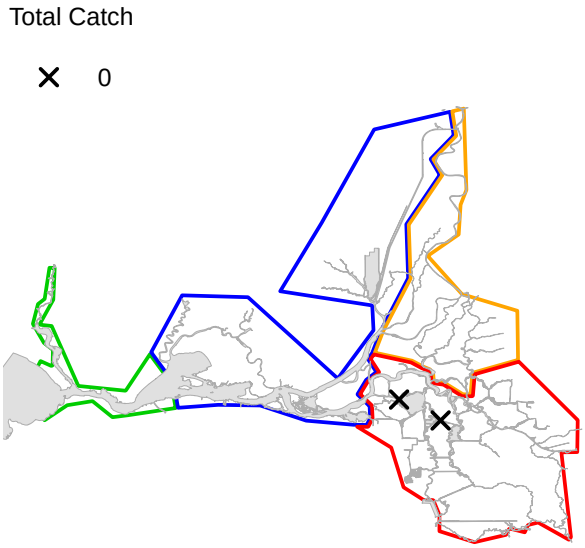
Week 6 (5/30/17 – 6/1/17)

18 deep water sites; 2 shallow water sites; 1 Delta Smelt total

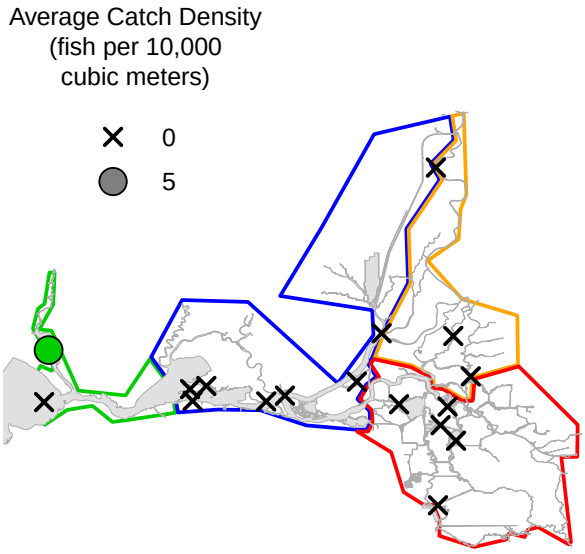
Delta Smelt Total Catch by DW Site



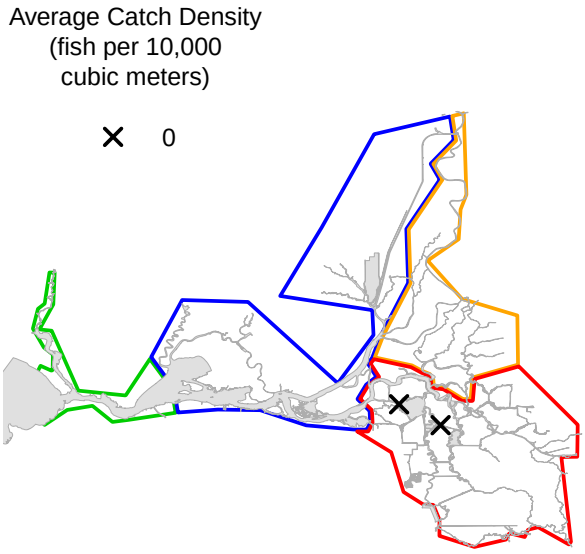
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



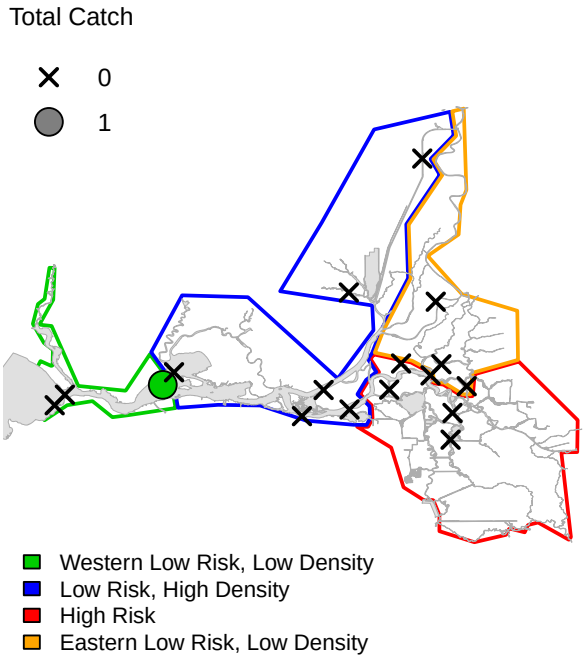
Delta Smelt Catch Density by SW Site



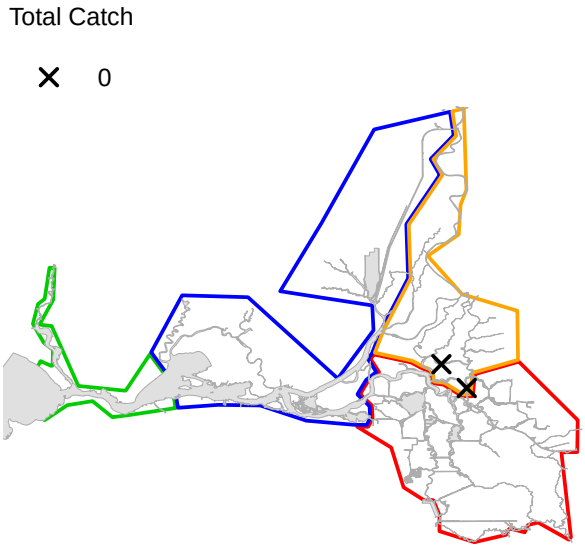
Week 7 (6/5/17 – 6/7/17)

18 deep water sites; 2 shallow water sites; 1 Delta Smelt total

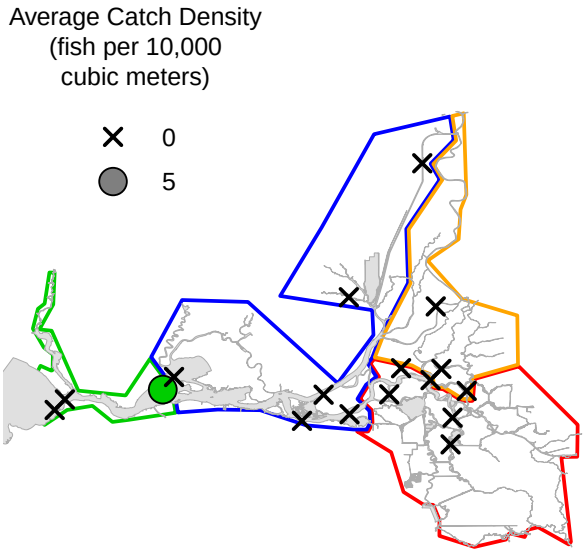
Delta Smelt Total Catch by DW Site



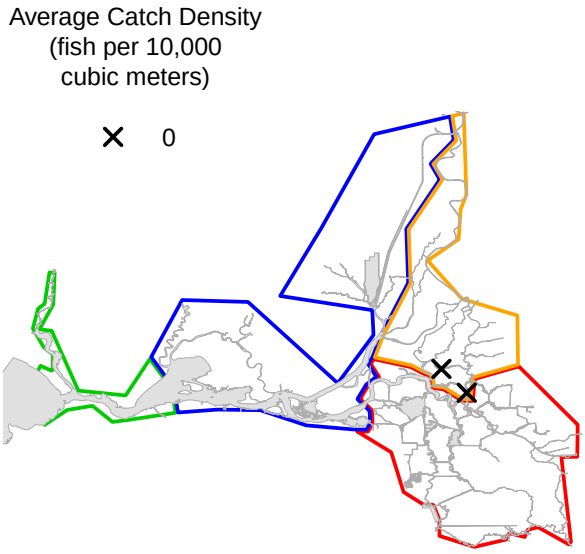
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



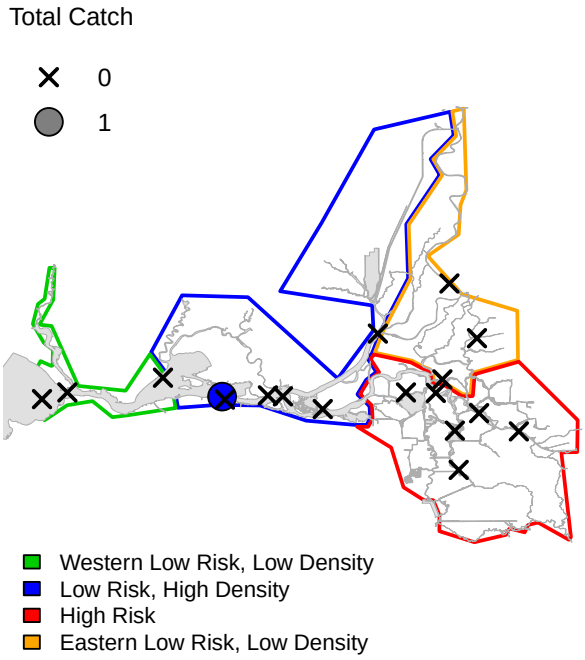
Delta Smelt Catch Density by SW Site



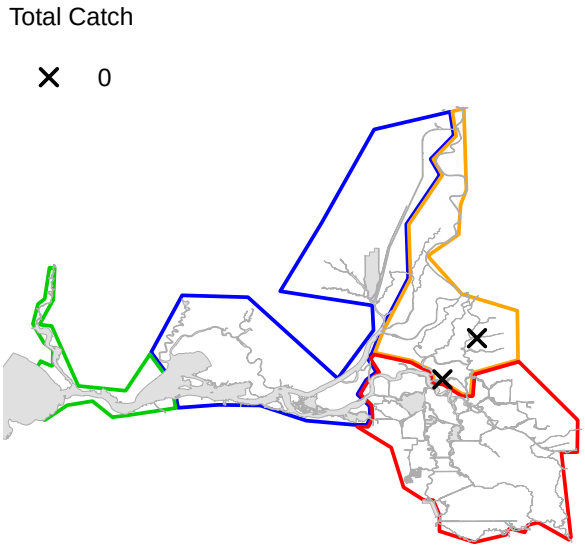
Week 8 (6/12/17 – 6/14/17)

18 deep water sites; 2 shallow water sites; 1 Delta Smelt total

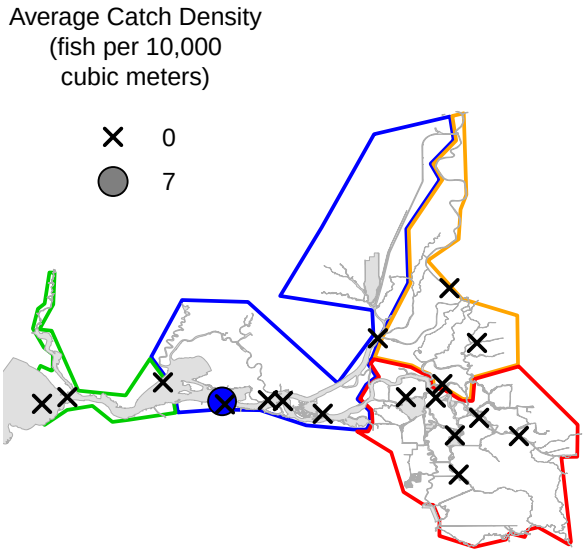
Delta Smelt Total Catch by DW Site



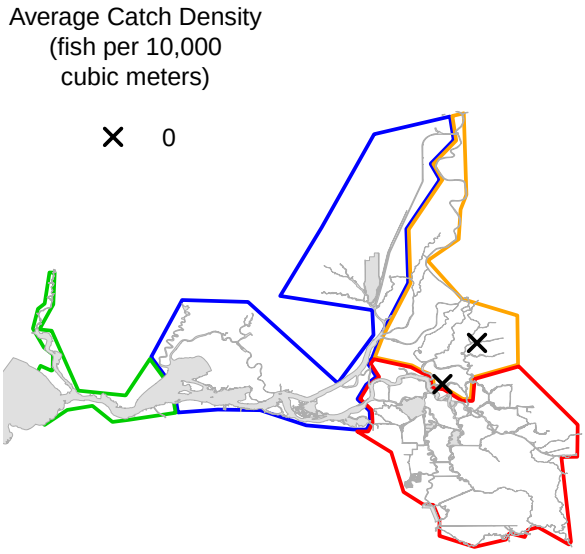
Delta Smelt Total Catch by SW Site



Delta Smelt Catch Density by DW Site



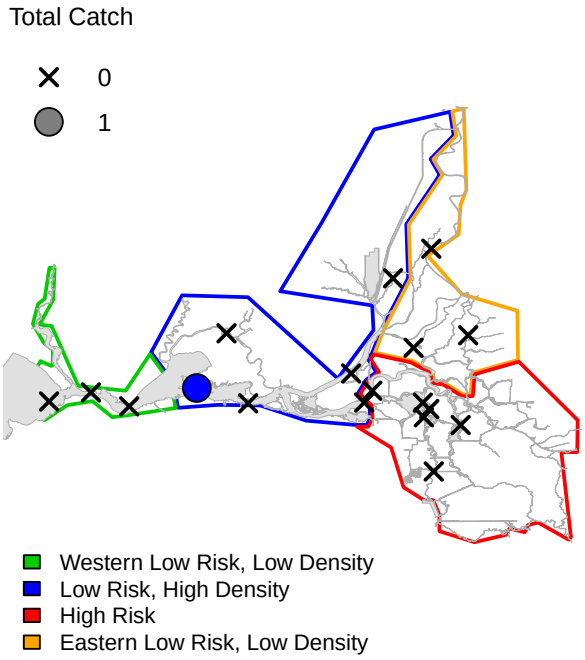
Delta Smelt Catch Density by SW Site



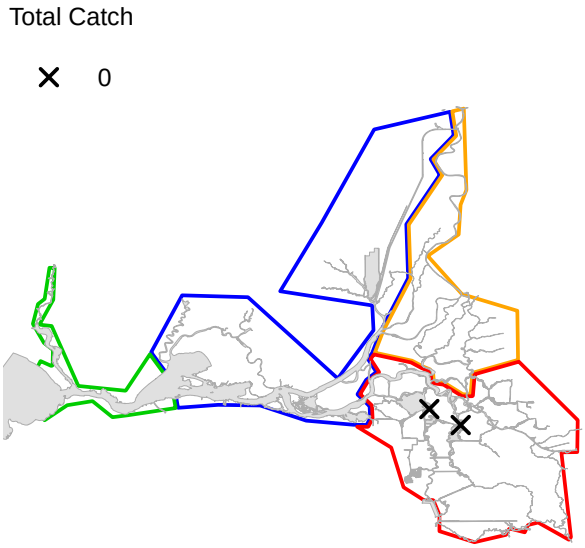
Week 9 (6/19/17 – 6/21/17)

18 deep water sites; 2 shallow water sites; 1 Delta Smelt total

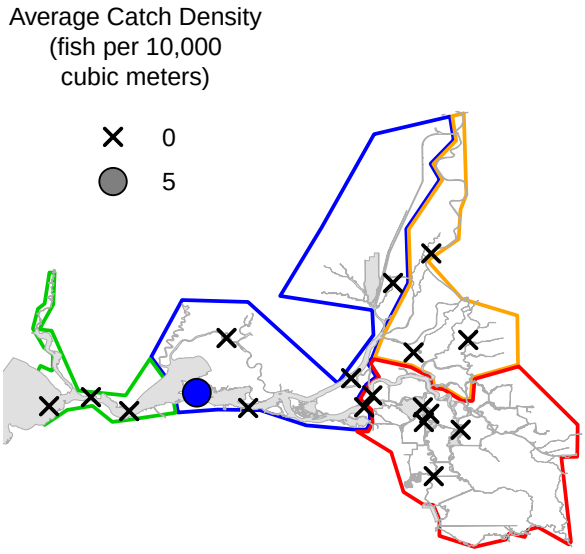
Delta Smelt Total Catch by DW Site



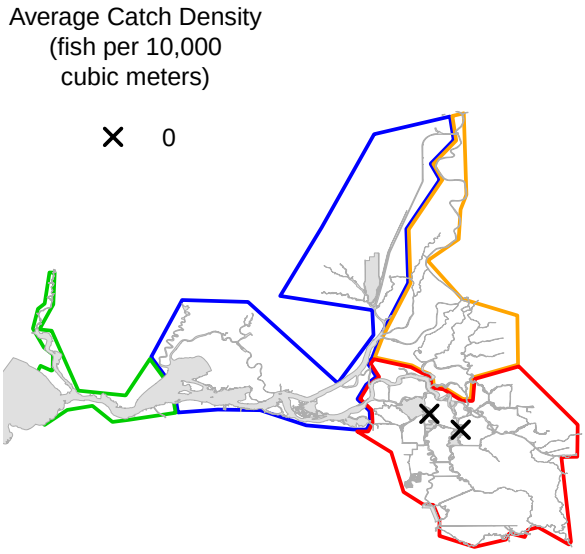
Delta Smelt Total Catch by SW Site

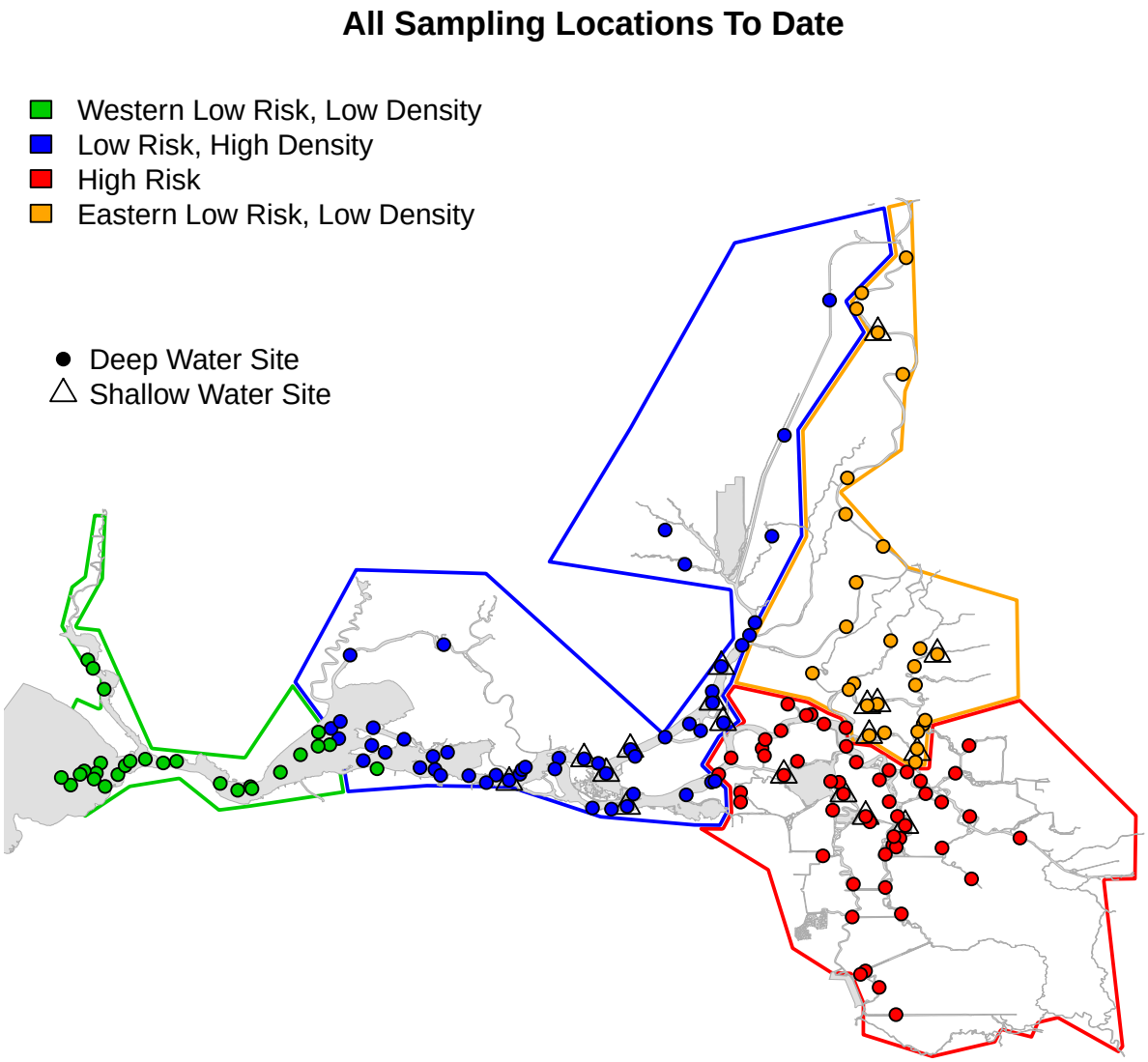


Delta Smelt Catch Density by DW Site



Delta Smelt Catch Density by SW 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.