



California Coastal Pelagic Species Survey



7 December 2021

Nearshore Aerial Survey Biomass for the 2021 Northern Anchovy Central Subpopulation Stock Assessment

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Outline

- Background
 - CCPSS History
 - CCPSS Methods
- CSNA Data from CCPSS
 - Biomass (Survey Observations)
 - Observer Bias Correction factor (NCS Point Sets)
 - 2015-2019
 - 2020-2021
 - Biological Information
 - NCS Point Set samples – (2019-2020)
 - Nearshore acoustic surveys – LBC samples (2020-2021)
 - Fishery samples (2016-2021)
- Current Research



Background

- California Coastal Pelagic Species Survey (CCPSS)
 - Began 2012 in southern CA for Pacific sardine
 - Northern anchovy added to survey in 2013
 - 2017 PFMC Methodology Review
- Nearshore Cooperative Survey (NCS) research
 - Began August 2018
 - Develop variance estimator
 - Replicate Flights on Transects
 - Validate observer tonnage estimates
 - Point Sets (biological data)
 - Observer Bias correction factor derived



Background

- 2019 Anchovy Research Meeting
 - Direct biomass estimates from surveyed areas
 - Aerial + Acoustic-trawl survey coordination
 - More data needed for validation of anchovy estimates
 - Transect replicates recommended
- 2020 Sardine STAR Meeting
 - CCPSS data used to adjust catchability of acoustic-trawl survey
 - Biomass and variance calculation method (2015-2019)
 - Transect replicates recommended



CCPSS Methods (2012–2021)

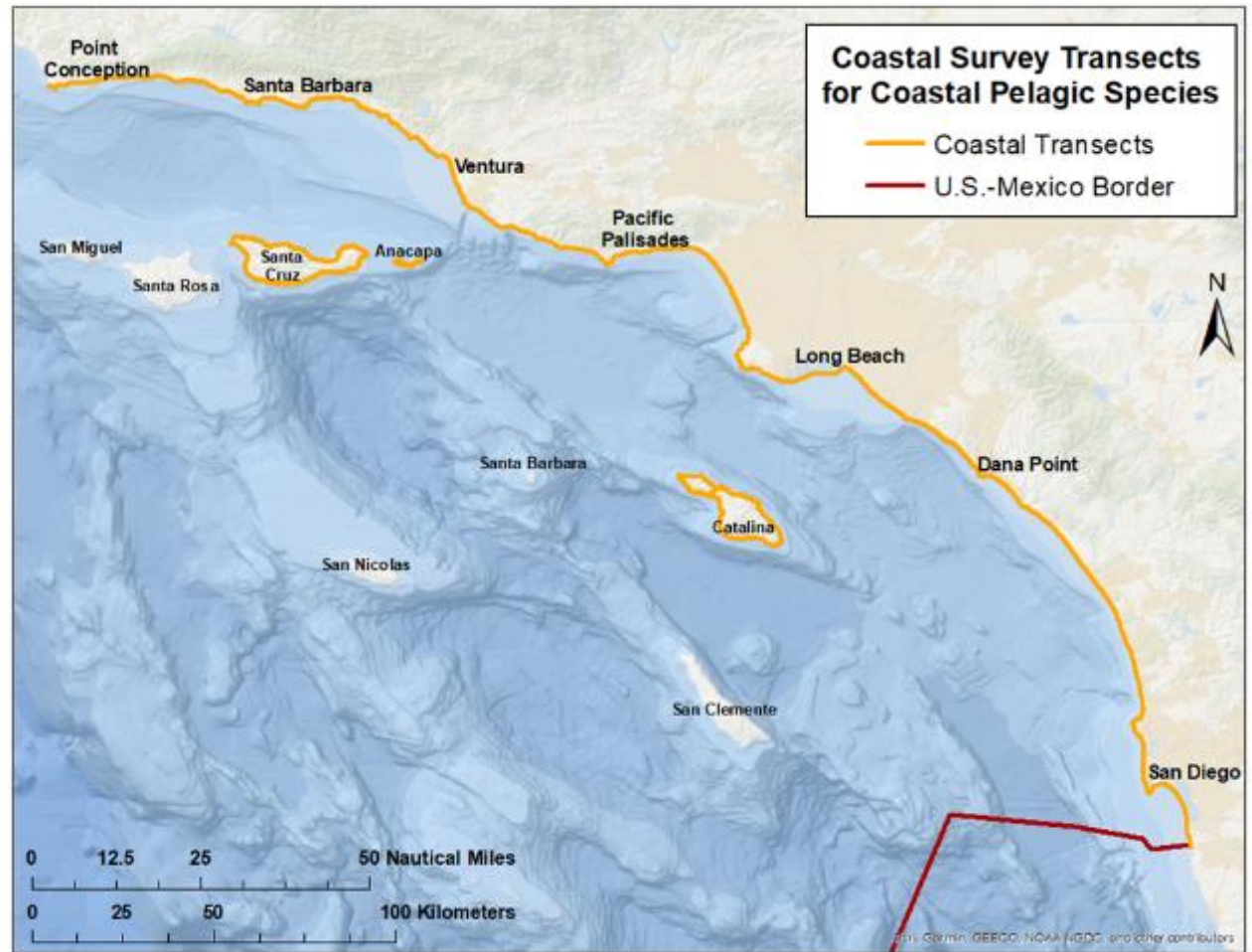
- Spring and summer surveys
- Previous surveys
 - Open water
 - Altitude
 - Coastal bands
- Northern CA surveys began 2017
- Survey methods consistent 2015-2019

Year	Season	Transect Types	Altitude (ft)	Coastal Bands
2012	Summer	Coastal	1000	N/A
		Open Water	2000	N/A
2013	Spring	Coastal	1000	N/A
		Open Water	2000	N/A
	Summer	Coastal	1000	N/A
		Open Water	2000	N/A
2014	Spring	Coastal	1000	3
	Summer	Coastal	1500	N/A
		Open Water	1500	N/A
2015	Summer	Coastal	1500	2
2016	Spring	Coastal	1500	2
	Summer	Coastal	1500	2
2017	Spring	Coastal	1500	2
	Summer	Coastal	1500	2
2018	Spring	Coastal	1500	2
	Summer	Coastal	1500	2
	Fall	Coastal	1500	2
2019	Spring	Coastal	1500	2
	Summer	Coastal	1500	2
	Summer	Coastal	1500	2
2020	Fall	Coastal	1500	3 (2 reps)
	Fall	Coastal	1500	3 (2 reps)
2021	Spring	Coastal	1500	3 (2 reps)
	Fall	Coastal	1500	3 (2 reps)
	Fall	Coastal	1500	3 (2 reps)



CCPSS – 2015-2019 Surveys (S CA)

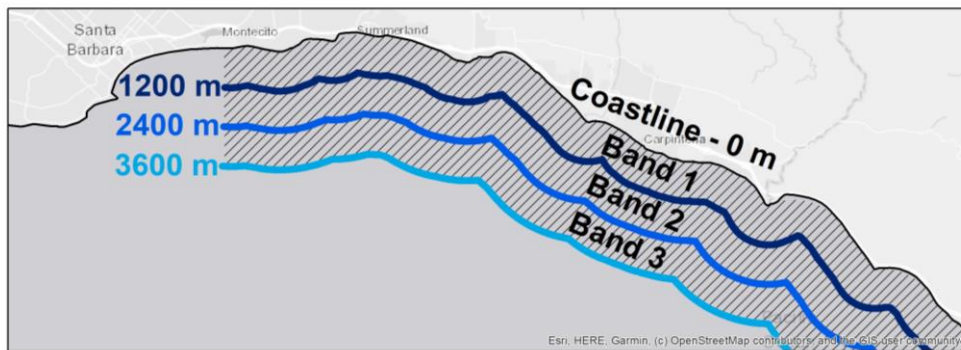
- Transects chosen per weather
- 1,500 feet altitude
- 2 coastal bands to 2,400 m (1.3 nm)
- Spotter looks to right
- Plane detours off transect when fish spotted
- Pilot is not a spotter





CCPSS – 2020–2021

- Stratified survey design
 - Surveyed strata
 - Expansion of biomass in non-surveyed areas

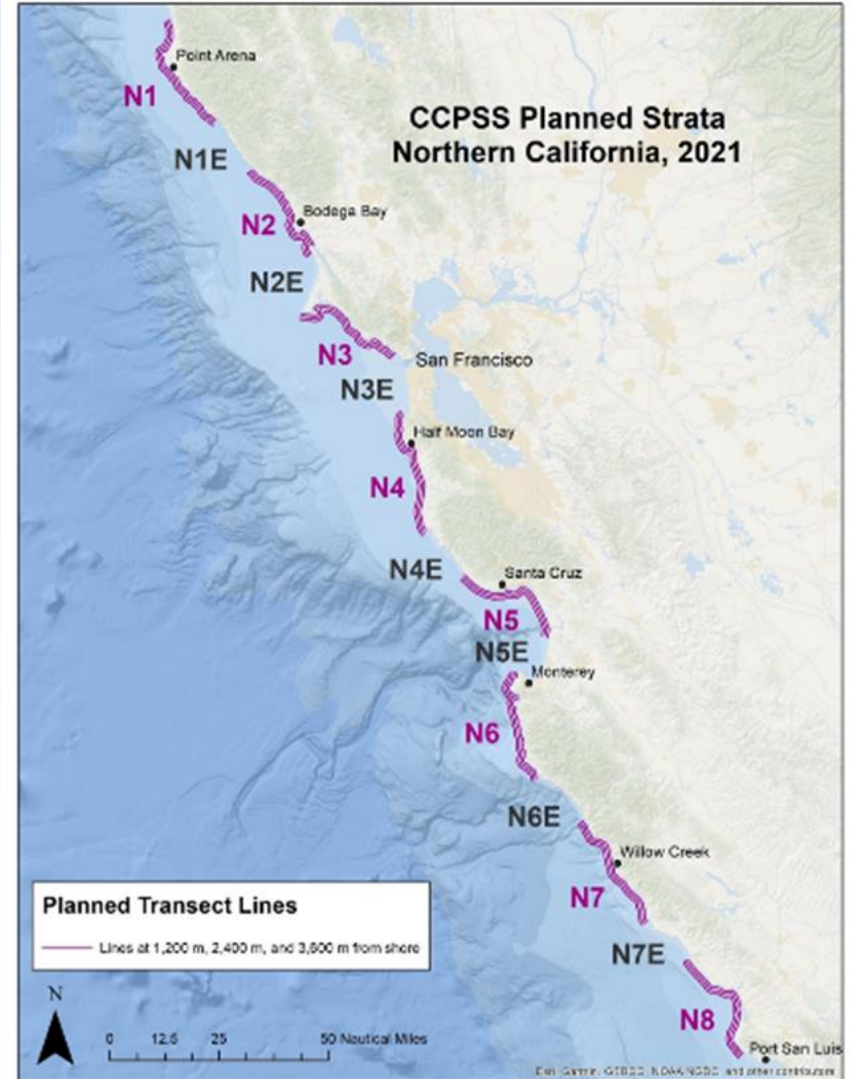


- Additional offshore area surveyed (1,200 meters)
- Replicate transects
- Design and methods under review

		Survey Years	
		2015-2019	2020-2021
Transects (distance from shore)	1 - (0-1,200m)	X	X
	2 - (1,200-2,400m)	X	X
	3 - (2,400-3,600m)		X
Number of Replicates		1	2

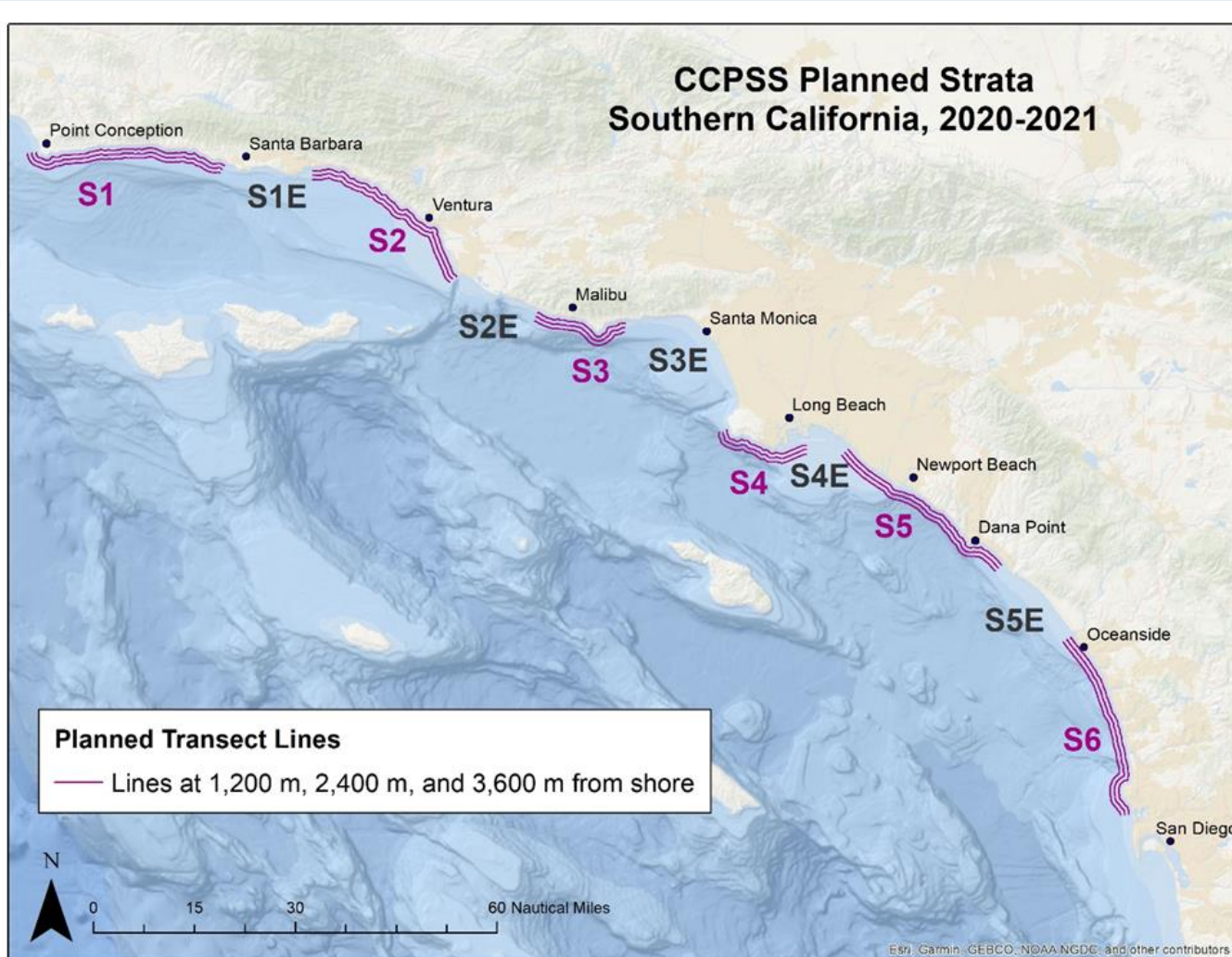


CCPSS – N CA (2020–2021)





CCPSS – S CA (2020–2021)





CCPSS Methods – Sample Data

- NCS Point Sets (2019-2020)
- Nearshore Vessel – F/V *Long Beach Carnage*
 - CCPSS:
 - Summer 2020 (N CA, S CA)
 - CCPSS & offshore AT (*Reuben Lasker*) – nearshore acoustics:
 - Spring 2021 (S CA)
 - Summer 2021 (N CA, S CA)
- Fishery Samples (2016-2021)



CCPSS Methods – 2015-2019

- Therefore, only total biomass was estimated for each band in the analysis as follows:

$$B_{j,A} = \sum_{i=1}^{n(j)} b_{i,j,A} \quad (1)$$

where $b_{i,j,A}$, is the biomass estimated for each single (or aggregated) school i (total number of schools = $n(j)$) on band j in area A ;

- The estimate in inshore biomass in area A is then

$$B_A^{tot} = \sum_{j=1}^2 B_{j,A} \quad (2)$$

- For daily biomass observed in a given area, the mean of total biomass across the two bands, can be estimated as follows:

$$\bar{B}_A = \frac{1}{2} \sum_{j=1}^2 B_{j,A} \quad (3)$$

- And the variance of each daily biomass (\bar{B}_A) is estimated as follows:

$$V(\bar{B}_A) = \frac{1}{(2-1)} \sum_{j=1}^2 (B_{j,A} - \bar{B}_A)^2 \quad (4)$$

Variance of a given season where x areas were surveyed is computed as:

$$\sum_{A=1}^x 4 \times V(\bar{B}_A) \quad (5)$$



CCPSS Methods – 2020-2021

Stratum Density

$$D_s = \frac{B_s^{tot}}{A_s} \quad (9)$$

Var_{Density} to Var_{Biomass}

$$Var(D_s) = \frac{1}{(A_s)^2} \times Var(B_s^{tot}) \quad (10)$$

Mean Regional Density

$$\bar{D}_{s,R} = \frac{1}{n(s)} \sum_{s=1}^{n(s)} D_s \quad (11)$$

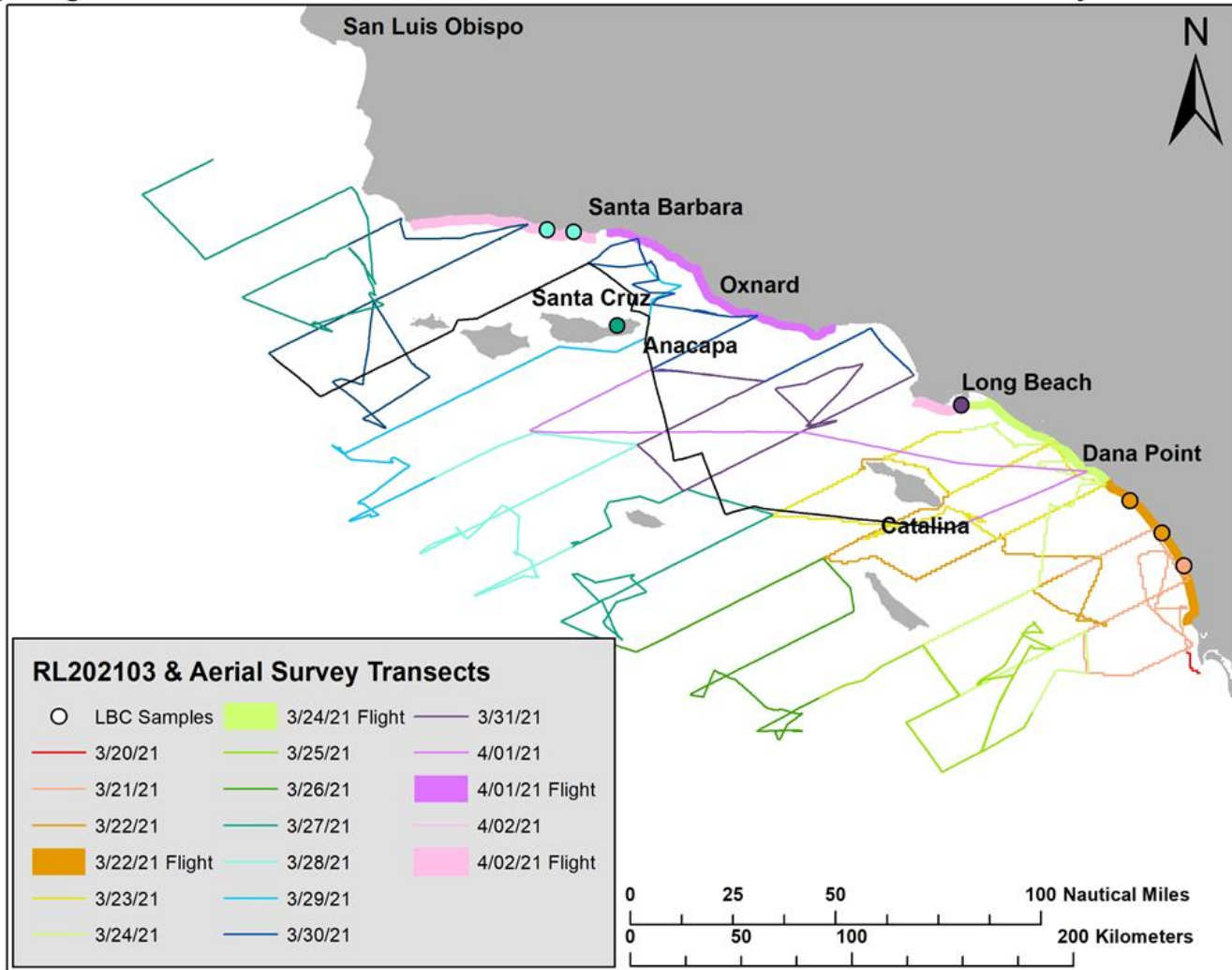
Regional Biomass

$$B_R^{tot} = \sum_{s=1}^{n(s)} \bar{D}_{s,R} A_s \quad (12)$$



CCPSS-AT Transects (2021-S CA)

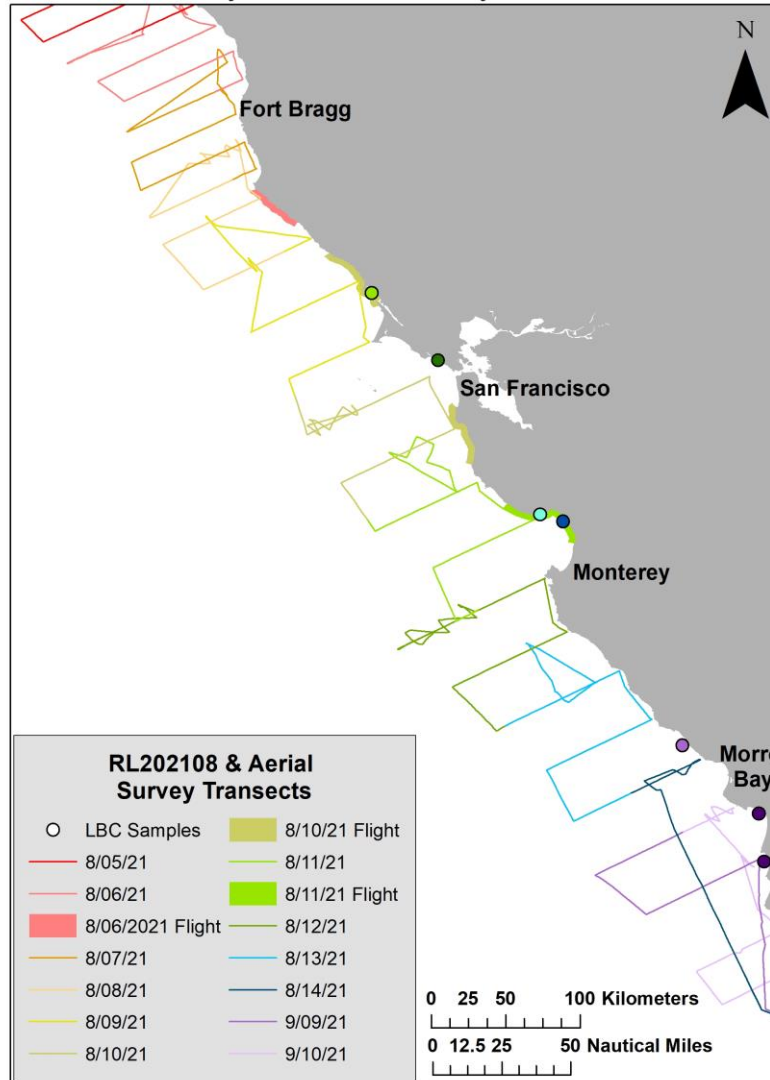
Spring 2021 Southern California Acoustic-Trawl & Aerial Survey Transects





CCPSS-AT Transects (2021-N CA)

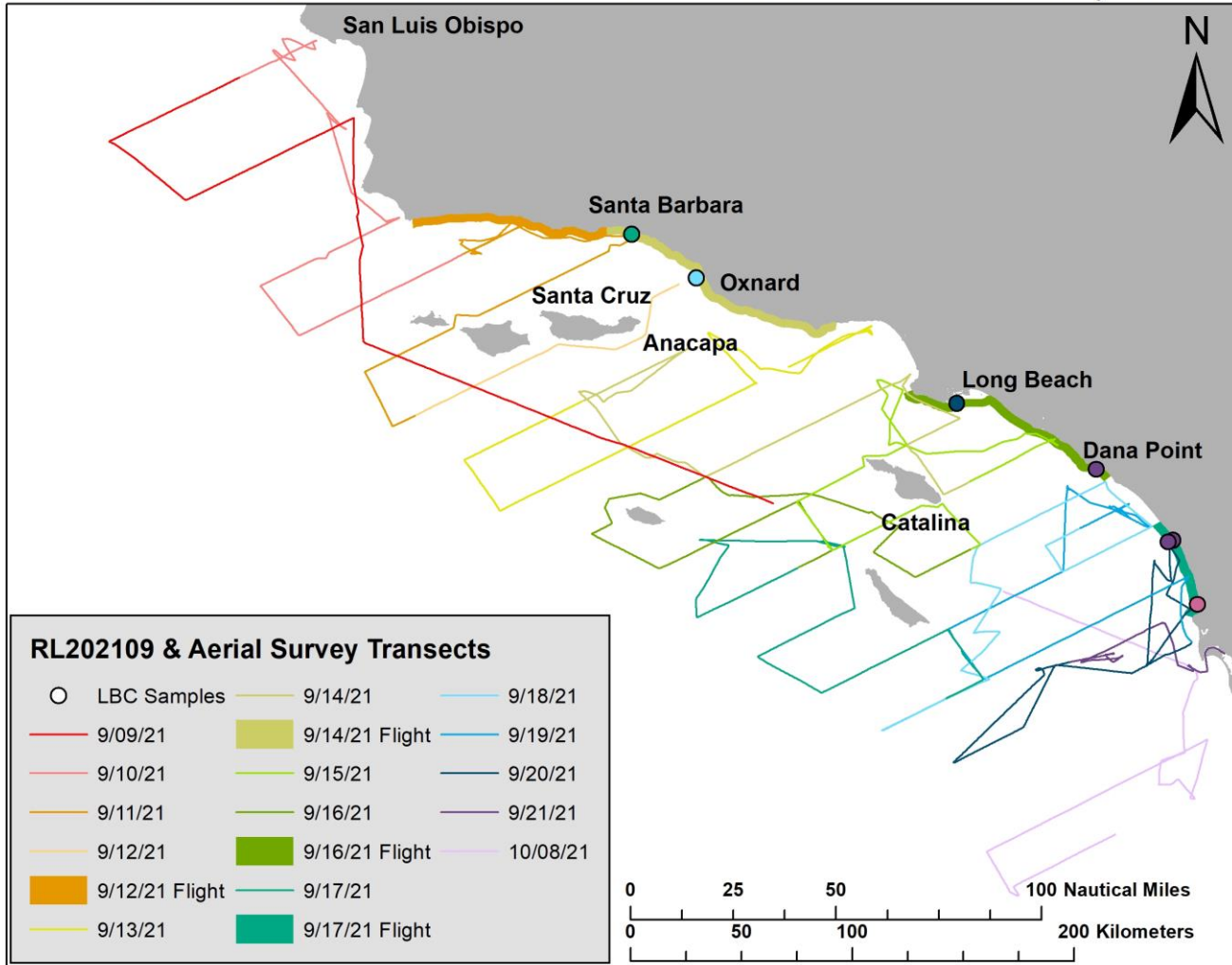
Summer 2021 Northern California Acoustic-Trawl Surveys & Aerial Survey Transects





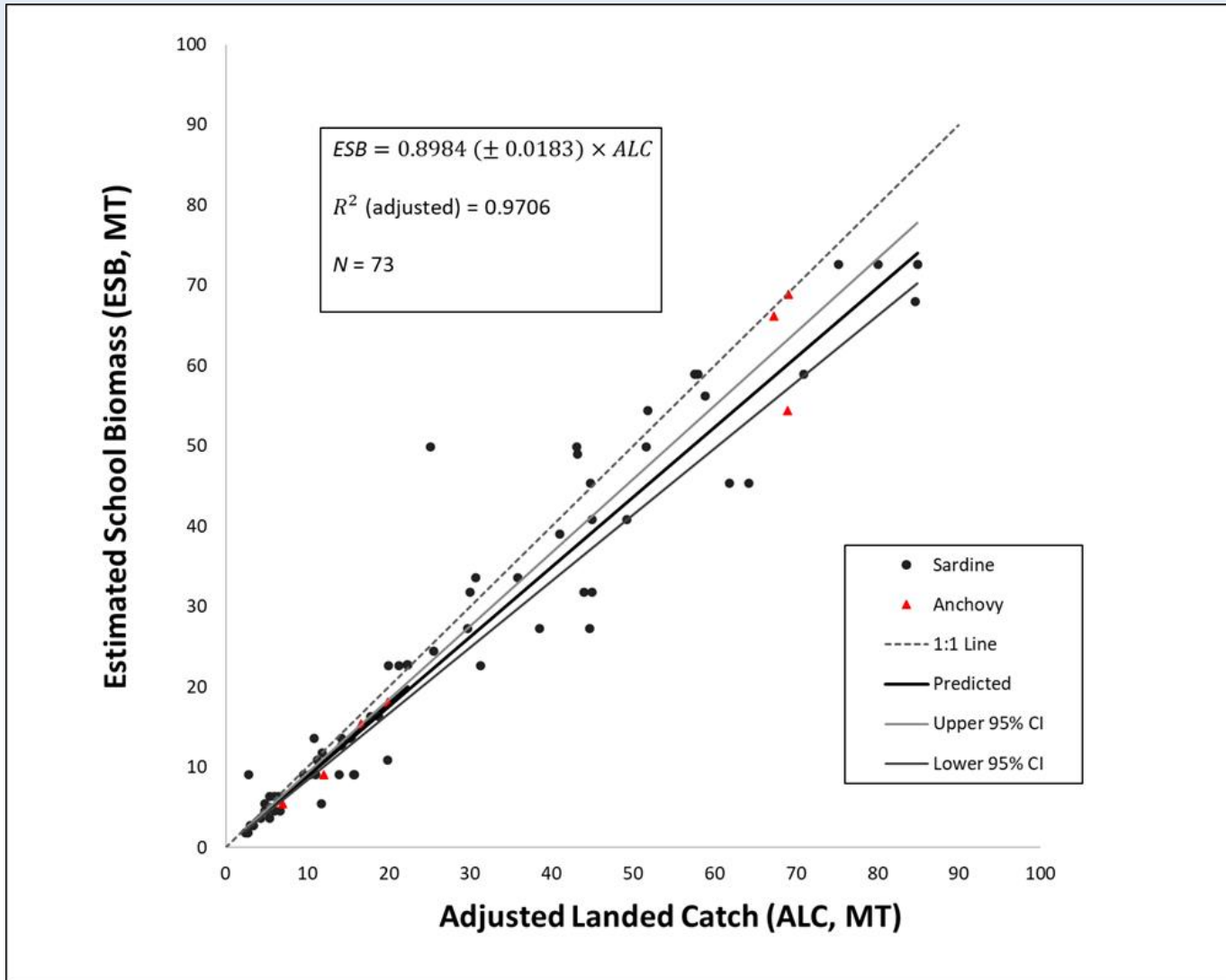
CCPSS-AT Transects (2021-S CA)

Summer 2021 Southern California Acoustic-Trawl & Aerial Survey Transects



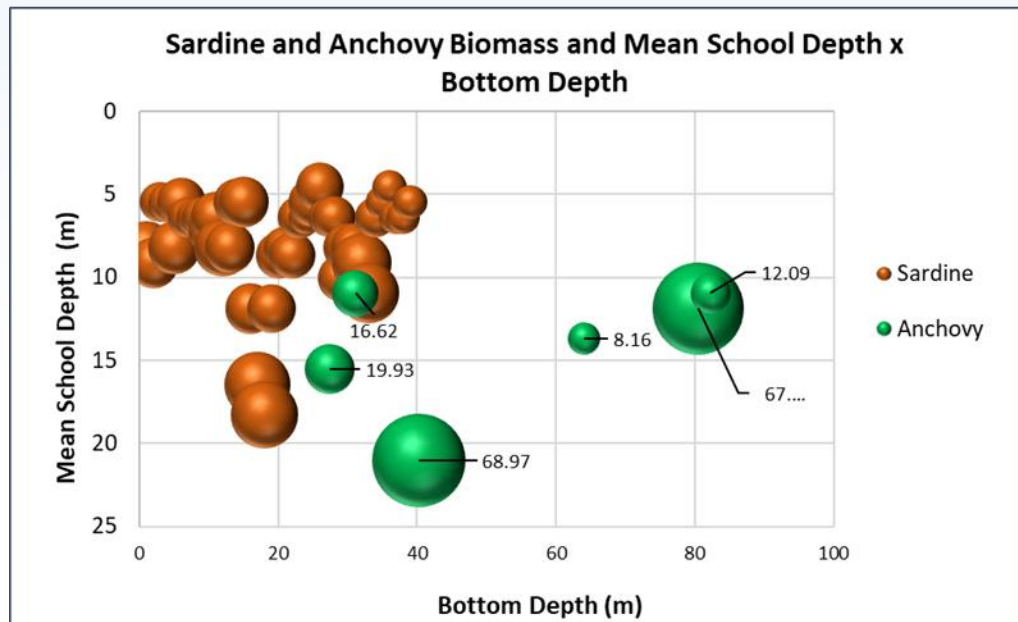
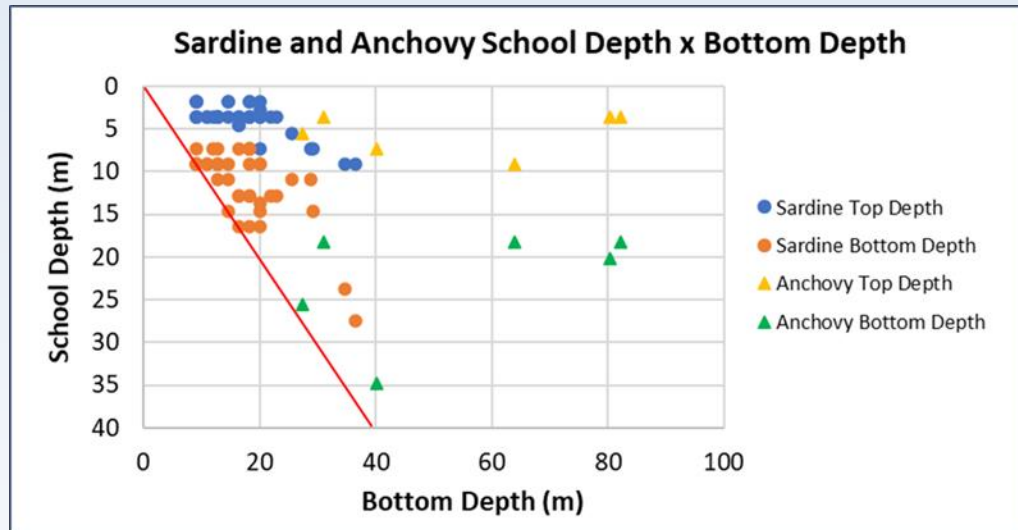


Calibration Curve – Point Sets





CPS School Data – Point Sets





CCPSS Biomass – 2015-2019

Dates	Year	Region	Area (km ²)	Density (mt/km ²)	Area B (mt)	Area B SD	Area B CV
8/7 - 8/26	2015	SCA	1046.88	0.00	0	0	NA
10/2 - 10/3		SCA	1058.67	0.00	0	0	NA
4/16 - 5/1	2016	SCA	984.35	1.07	1,050	1.80	0.24
5/23 - 6/23		SCA	1043.50	4.08	4,262	2.18	1.04
8/11 - 8/29		SCA	1037.10	0.03	29	1.68	1.41
3/28 - 3/30	2017	SCA	327.56	0.90	294	2.01	0.56
8/3 - 8/10		NCA	1352.58	55.70	75,338	2.54	0.71
4/24 - 4/27	2018	SCA	1053.52	0.30	315	2.38	1.35
5/4		SCA	1055.14	0.32	338	1.68	1.41
9/10 - 9/13		SCA	995.79	0.03	32	2.38	1.01
10/13		NCA	239.22	292.48	69,967	1.68	1.41
5/29 - 6/28	2019	SCA	926.50	3.46	3,201	1.68	1.41
8/6 - 8/8		NCA	1388.02	35.03	48,623	2.38	1.37
8/27 - 8/29		SCA	1044.32	9.37	9,783	2.45	0.18



CCPSS Biomass – 2020-2021

	Region	1	2	3	4	5
	Year	NCA	SCA	SCA	NCA	SCA
	Season	2020	2020	2021	2021	2021
		Summer	Summer	Spring	Summer	Summer
1	Regional Density (mt/km ²)	25.34	3.07	5.34	15.33	6.68
2	Regional Total Area (km ²)	2259.18	1514.68	1514.68	1372.76	1514.68
3	Regional Surveyed Total Area (km ²)	1340.95	985.58	1246.14	667.66	1171.91
4	Biomass_Surveyed Area (mt)	33,985	3,025	6,657	10,237	7,833
5	Biomass_Expanded Area (mt)	23,272	1,624	1,435	10,811	2,291
6	Biomass_Region (mt)	57,257	4,649	8,092	21,049	10,124
7	Biomass_Actual Surveyed Area (mt)	39,321	3,553	8,164	11,866	11,611
8	Biomass_Actual+Expanded Area (mt)	62,593	5,177	9,599	22,677	13,902

1 – Average densities of flown strata (unweighted)

2 – Total area of all strata, bounded by flown strata

3 – Total area of flown strata only (includes regular and E strata), used for calculating 1

4 – Regional Density x Regional Surveyed Area

5 – Biomass from unflown area within Regional Total Area, (Regional Density)*(Regional Total Area – Regional Surveyed Total Area)

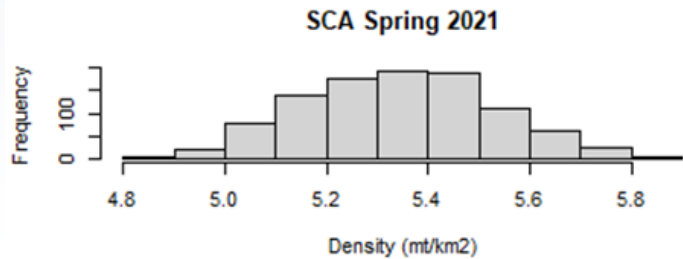
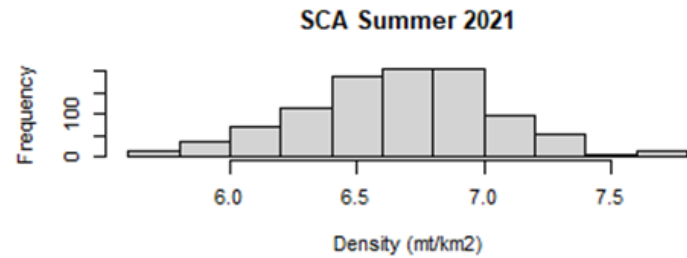
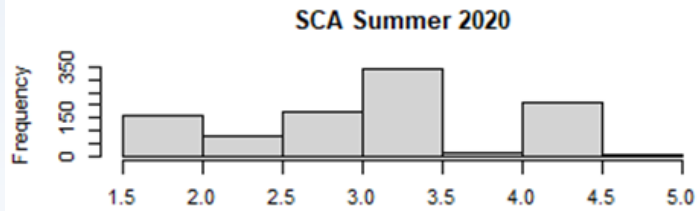
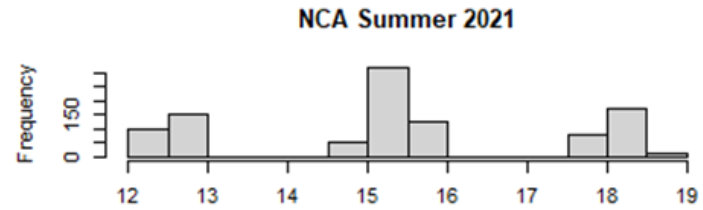
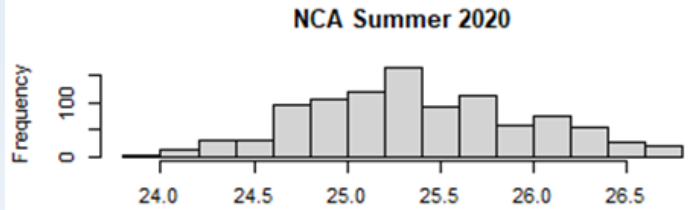
6 – Regional Density X Regional Total Area

7 - Biomass from observed surveys. Note – can add these values to calculated Biomass_Expanded Area to get a total Regional Biomass as well (#8). But using the survey data directly and not a mean density derived from all flown strata can mean a less conservative result.

8 - Biomass from observed strata + expanded biomass for unflown strata/areas.



CCPSS Biomass – 2020-2021



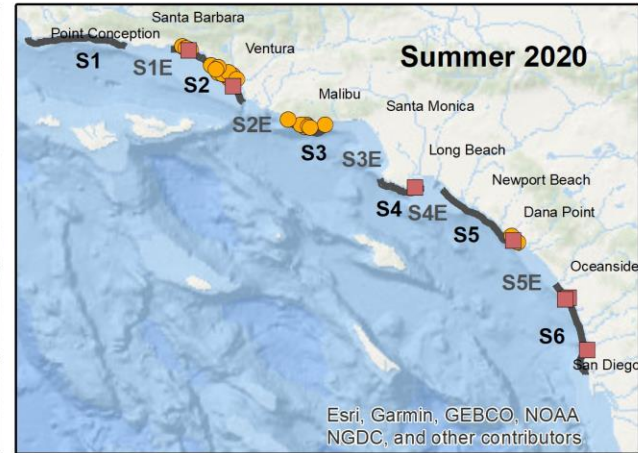


CCPSS Biomass – 2020-2021

Dates	Region	Year	Season	Area_Region (km ²)	Density_Region (mt/km ²)	CV_Density	Biomass_Region (mt)	SD_Biomass	CV_Biomass
9/5 - 9/16	NCA	2020	Summer	2,259.18	25.34	0.02	57,257	1,316	0.02
9/18 - 9/20	SCA	2020	Summer	1,514.70	3.07	0.27	4,649	1,263	0.27
3/22 - 4/2	SCA	2021	Spring	1,514.70	5.34	0.03	8,092	281	0.03
8/6 - 8/11	NCA	2021	Summer	1,372.76	15.33	0.13	21,049	2,740	0.13
9/12 - 9/17	SCA	2021	Summer	1,514.70	6.68	0.06	10,124	591	0.06

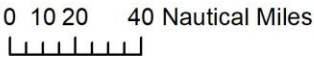


CCPSS – 2019-2021 (S CA)



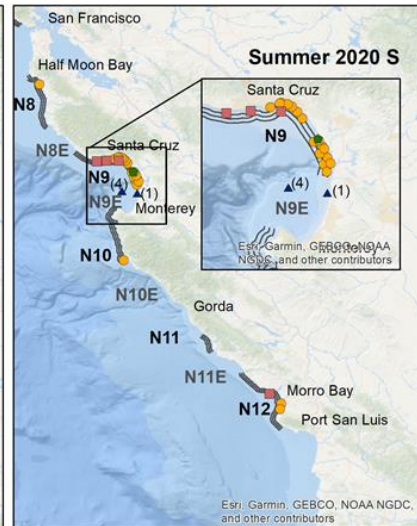
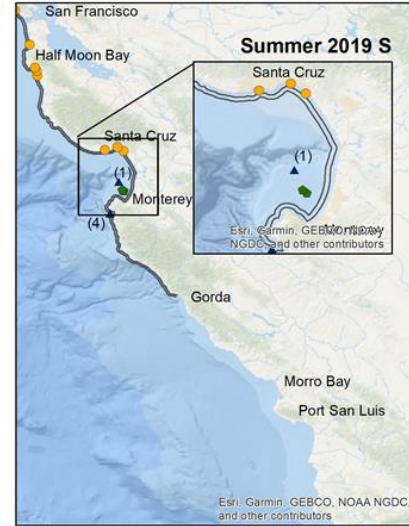
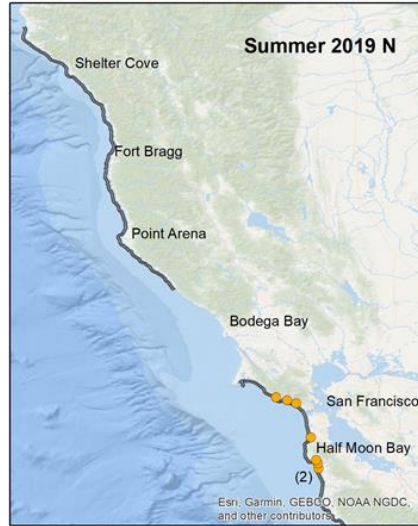
Anchovy Data

- Aerial Survey Observations (orange dot)
- Long Beach Carnage (red square)
- Aerial Survey Transects (black line)



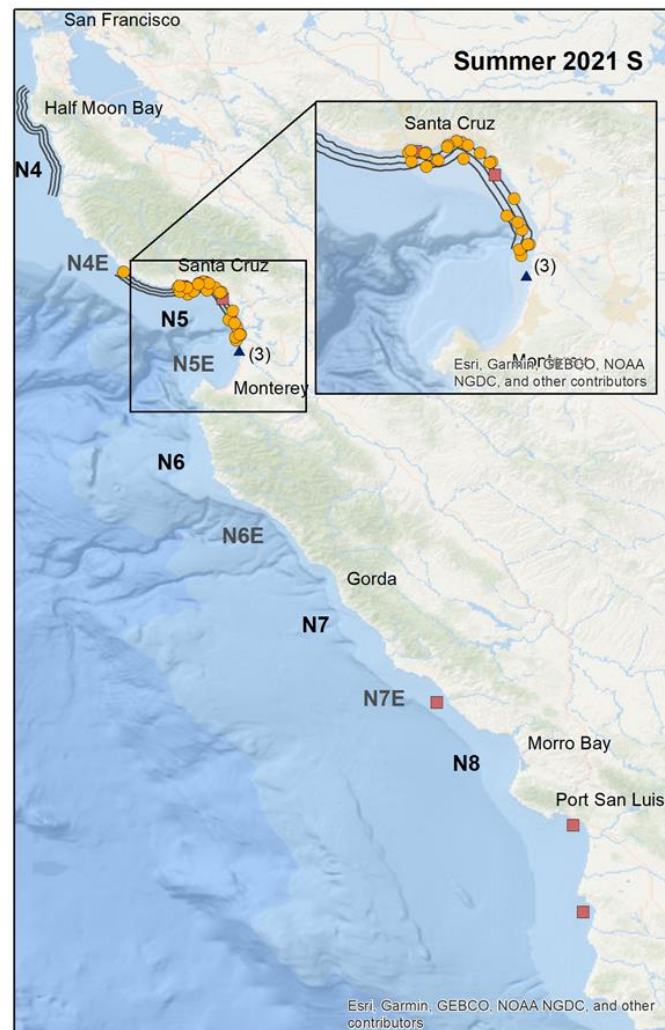
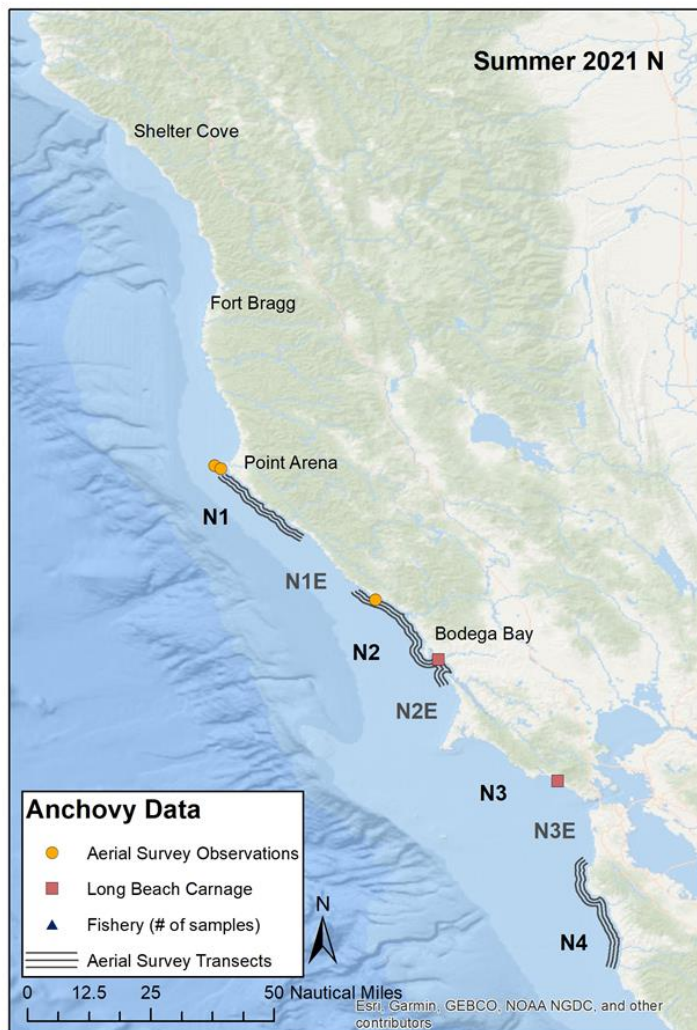


CCPSS – 2019-2020 (N CA)





CCPSS – 2021 (N CA)





Biological Data – Point Sets

Date	Region	Vessel	Landed Weight (mt)	CCPSS Dates
8/14/2019	NCA	Sea Wave	10.88	8/6/19 - 8/8/19
8/15/2019	NCA	Sea Wave	67.33	8/6/19 - 8/8/19
9/12/2019	NCA	King Philip	62.07	8/6/19 - 8/8/19
4/14/2020	NCA	Sea Wave	69.10	9/5/20 - 9/16/20
6/18/2020	SCA	Triton	16.62	9/18/20 - 9/20/20
10/12/2020	NCA	King Philip	7.03	9/5/20 - 9/16/20



Biological Data – *LB Carnage*

Date	Region	B (mt)	Lat	Long	Mixed?
9/9/2020	NCA	8.07	37.964	-122.821	N
9/9/2020	NCA	28.25	37.931	-122.806	N
9/10/2020	NCA	4.04	36.942	-122.077	Y
9/10/2020	NCA	3.63	36.947	-122.013	Y
9/10/2020	NCA	3.23	36.946	-121.933	N
9/12/2020	NCA	16.14	35.417	-120.944	Y
9/17/2020	SCA	8.07	34.388	-119.556	Y
9/18/2020	SCA	16.14	34.212	-119.294	Y
9/20/2020	SCA	6.46	33.705	-118.239	Y
9/21/2020	SCA	NA	33.438	-117.674	Y
9/21/2020	SCA	NA	33.151	-117.362	Y
9/21/2020	SCA	NA	33.144	-117.382	Y
9/22/2020	SCA	NA	32.891	-117.264	Y

Date	Region	B (mt)	Lat	Long	Mixed?
3/21/2021	SCA	8.07	33.063	117.315	Y
3/22/2021	SCA	605.39	33.195	117.404	N
3/22/2021	SCA	16.14	33.325	117.534	Y
3/27/2021	SCA	80.72	34.029	119.613	Y
3/28/2021	SCA	32.29	34.415	119.898	Y
3/28/2021	SCA	8.07	34.405	119.790	N
3/31/2021	SCA	0.81	33.709	118.218	Y
8/12/2021	NCA	16.14	38.292	-123.024	N
8/13/2021	NCA	1.61	37.884	-122.622	N
8/14/2021	NCA	NA	36.949	-122.005	N
8/15/2021	NCA	16.14	36.908	-121.867	N
8/19/2021	NCA	NA	36.602	-121.156	Y
8/20/2021	NCA	40.36	35.136	-120.684	N
8/20/2021	NCA	40.36	34.844	-120.651	Y
9/13/2021	SCA	40.36	34.371	-119.498	N
9/13/2021	SCA	24.22	34.259	-119.286	N
9/15/2021	SCA	1.61	34	-118.507	N
9/15/2021	SCA	2.42	33.73	-118.367	Y
9/17/2021	SCA	12.11	33.708	-118.213	Y
9/18/2021	SCA	24.22	33.182	-117.386	Y

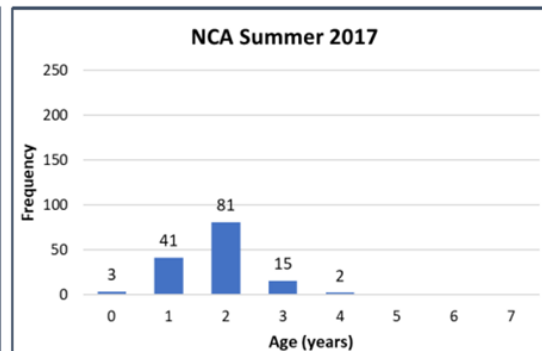
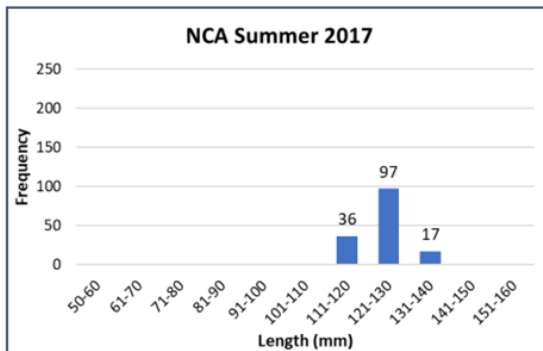
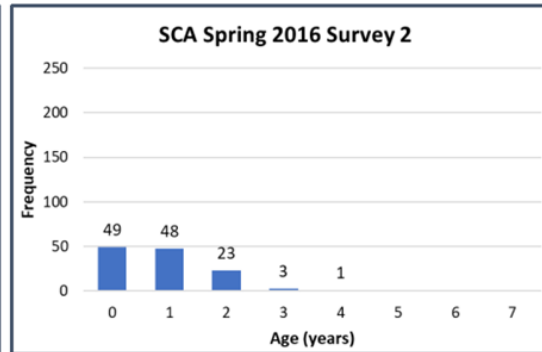
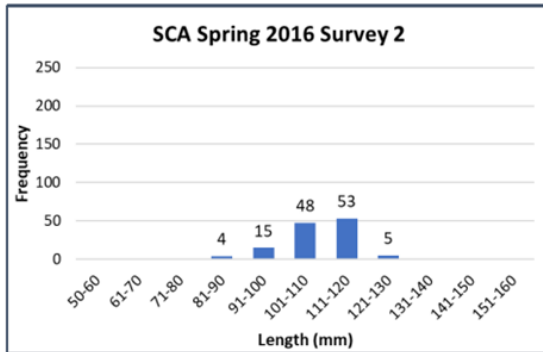
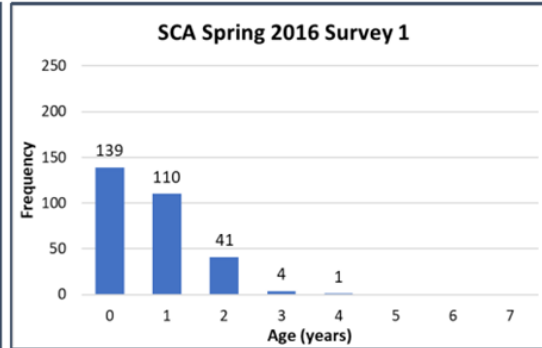
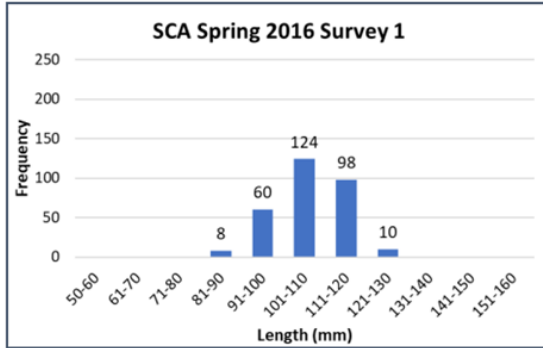


Biological Data - Fishery

Dates	Year	Region	# Samples - Week	# Samples - Month
4/16 - 5/2	2016	SCA	4	12
5/23 - 6/23	2016	SCA	0	5
8/3 - 8/10	2017	NCA	0	6
10/13	2018	NCA	5	24
8/6 - 8/8	2019	NCA	1	5
9/5 - 9/16	2020	NCA	2	5
8/6 - 8/11	2021	NCA	0	3

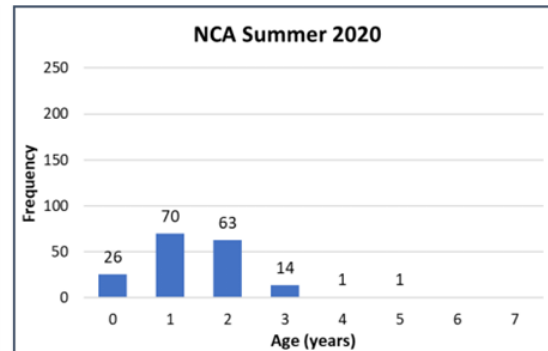
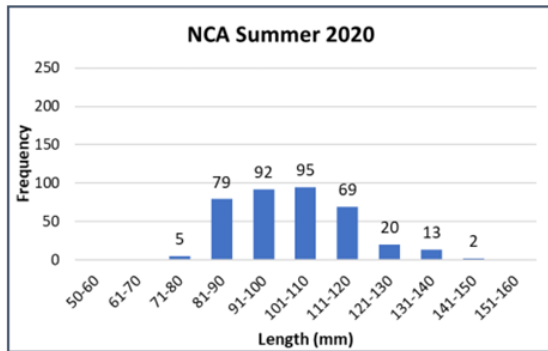
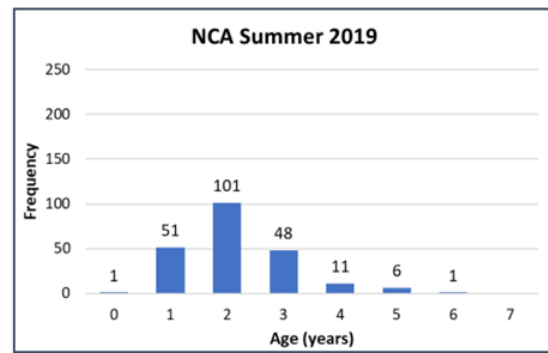
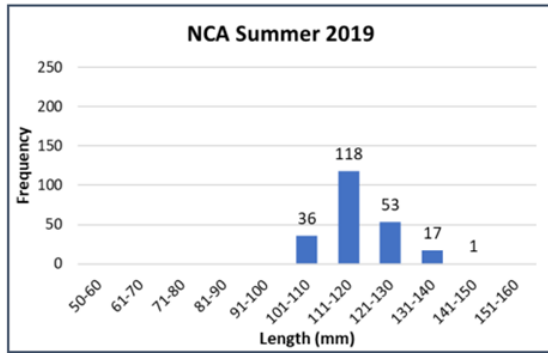
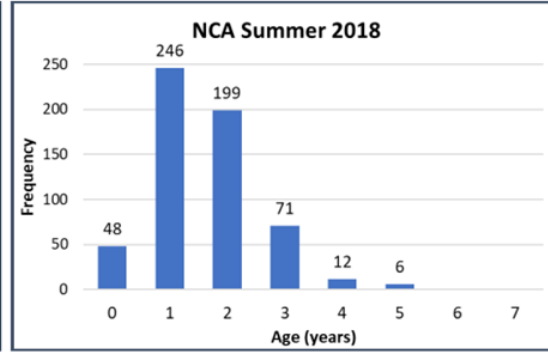
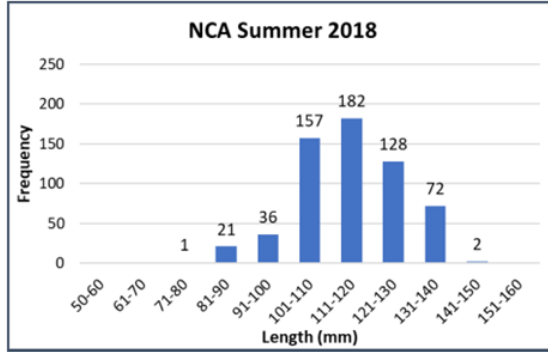


Length/Age – 2016-2017



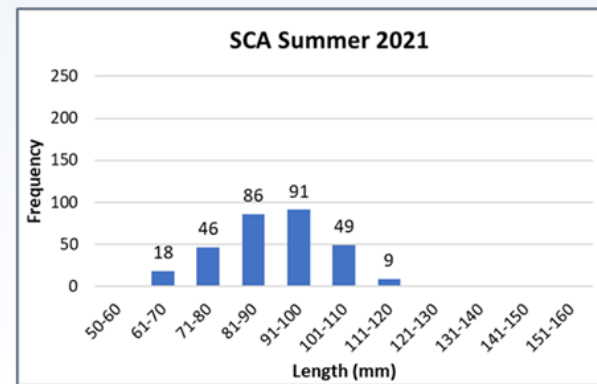
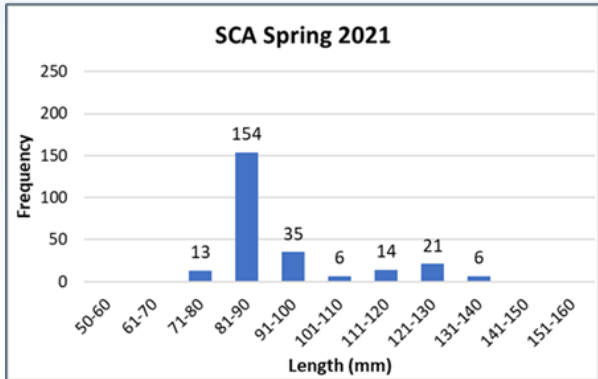
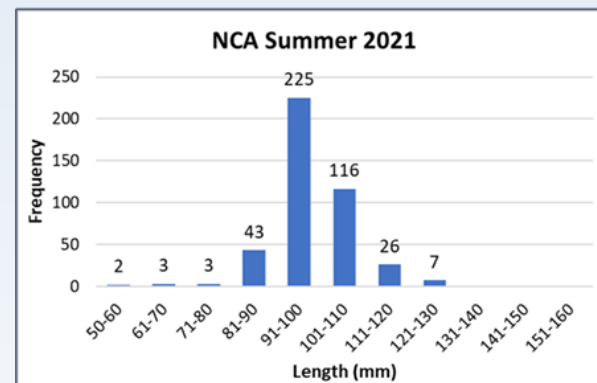
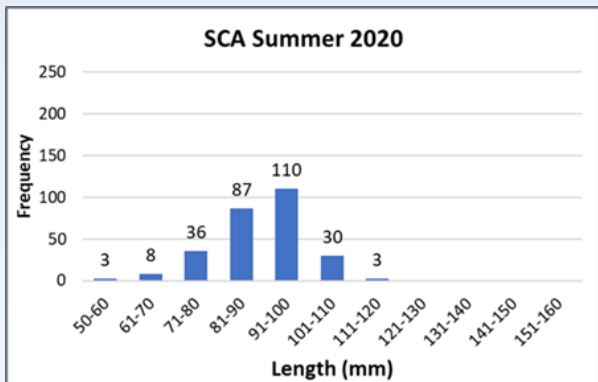


Length/Age – 2018-2020



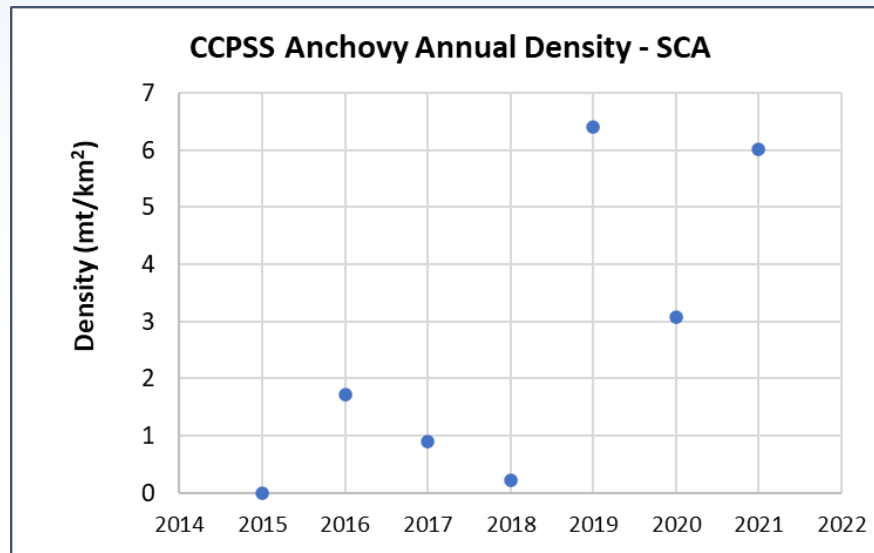
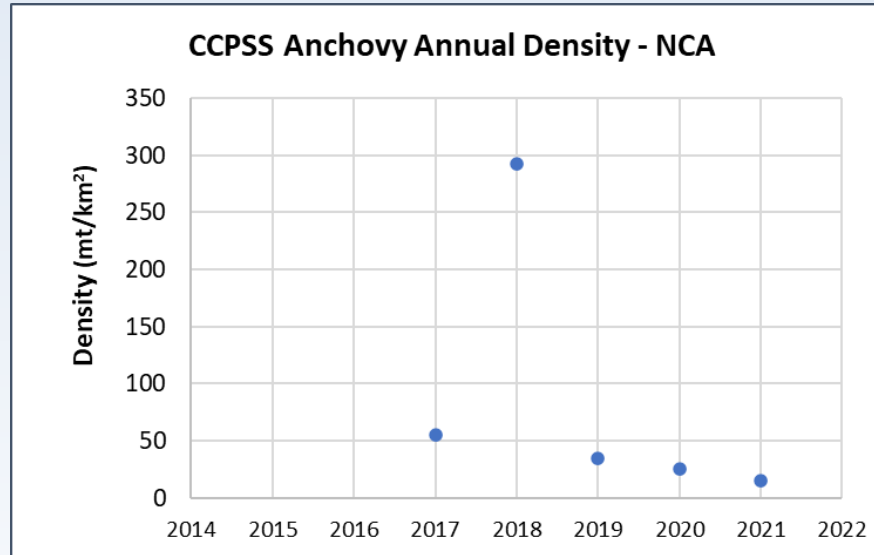


Length – 2020 - 2021





CCPSS – Index of Abundance





Research

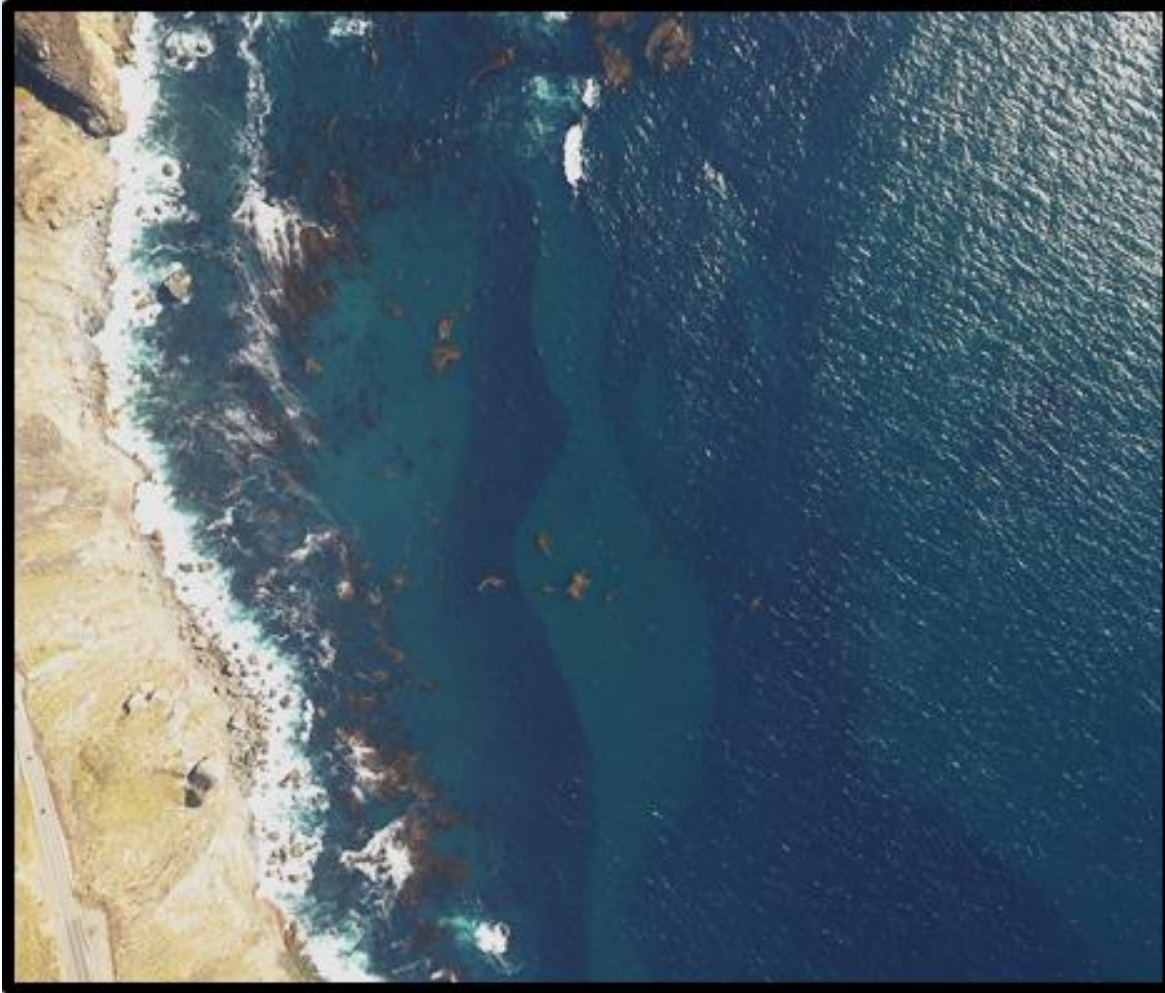
- **Pinheads (from 2019 CSNA meeting)**
 - Goal: determine % of pinheads within anchovy schools
 - Fishery nets not designed to catch them
 - Markets cannot process, no demand
 - CDFW attempts to secure gear/vessels and develop methods not successful – efforts ongoing
- **Remote Sensing of CPS (Fall 21-Spring 22)**
 - Goal: test use of camera systems on UAS to collect images of CPS schools (CDFW + contractor)
 - Use RGB and multi-spectral sensors to photograph CPS schools
 - Contractor to process and analyze images
 - Compare imagery data with spotter data
 - Potentially automate species ID and biomass estimation



Acknowledgments

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Thank You



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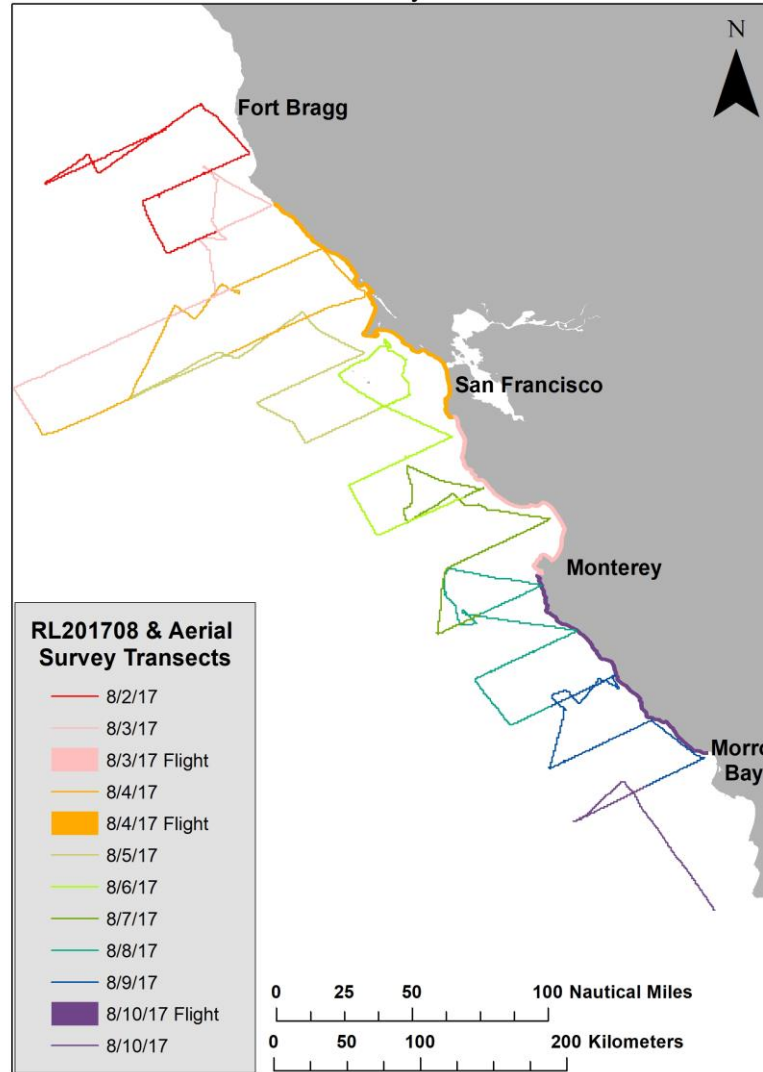
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CCPSS-AT Transects (2017-N CA)

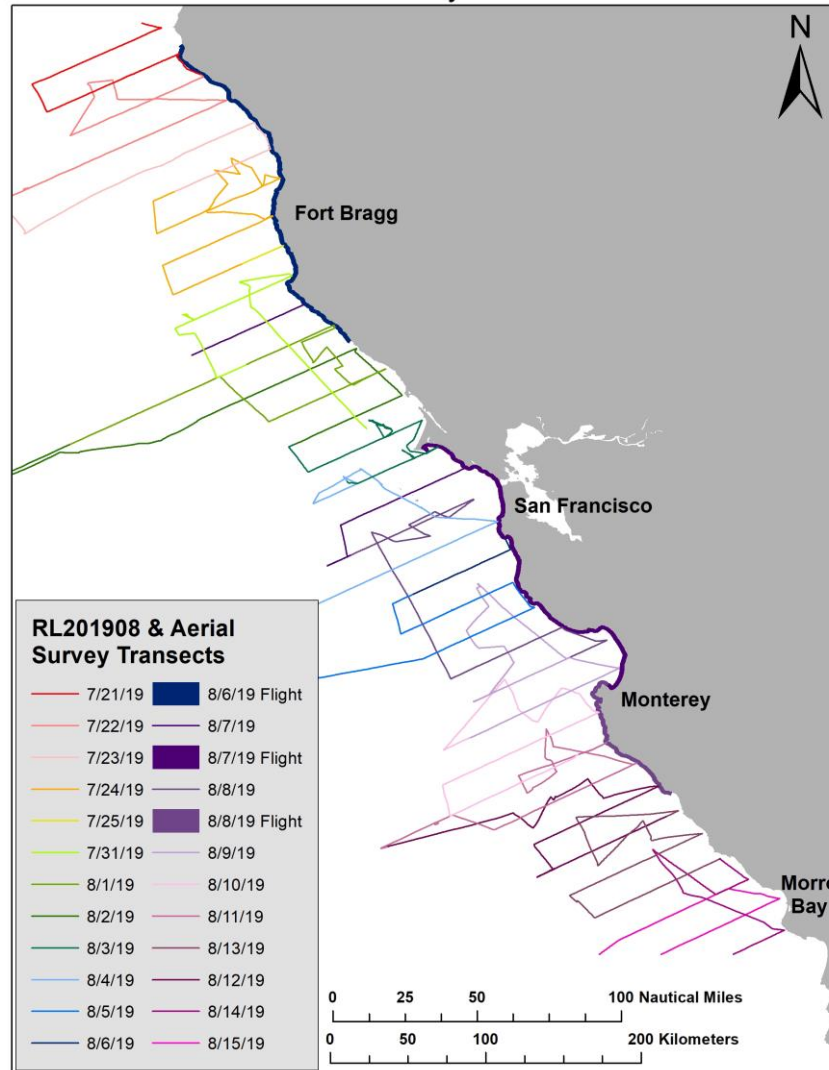
Summer 2017 Northern California Acoustic-Trawl & Aerial Survey Transects





CCPSS-AT Transects (2019-N CA)

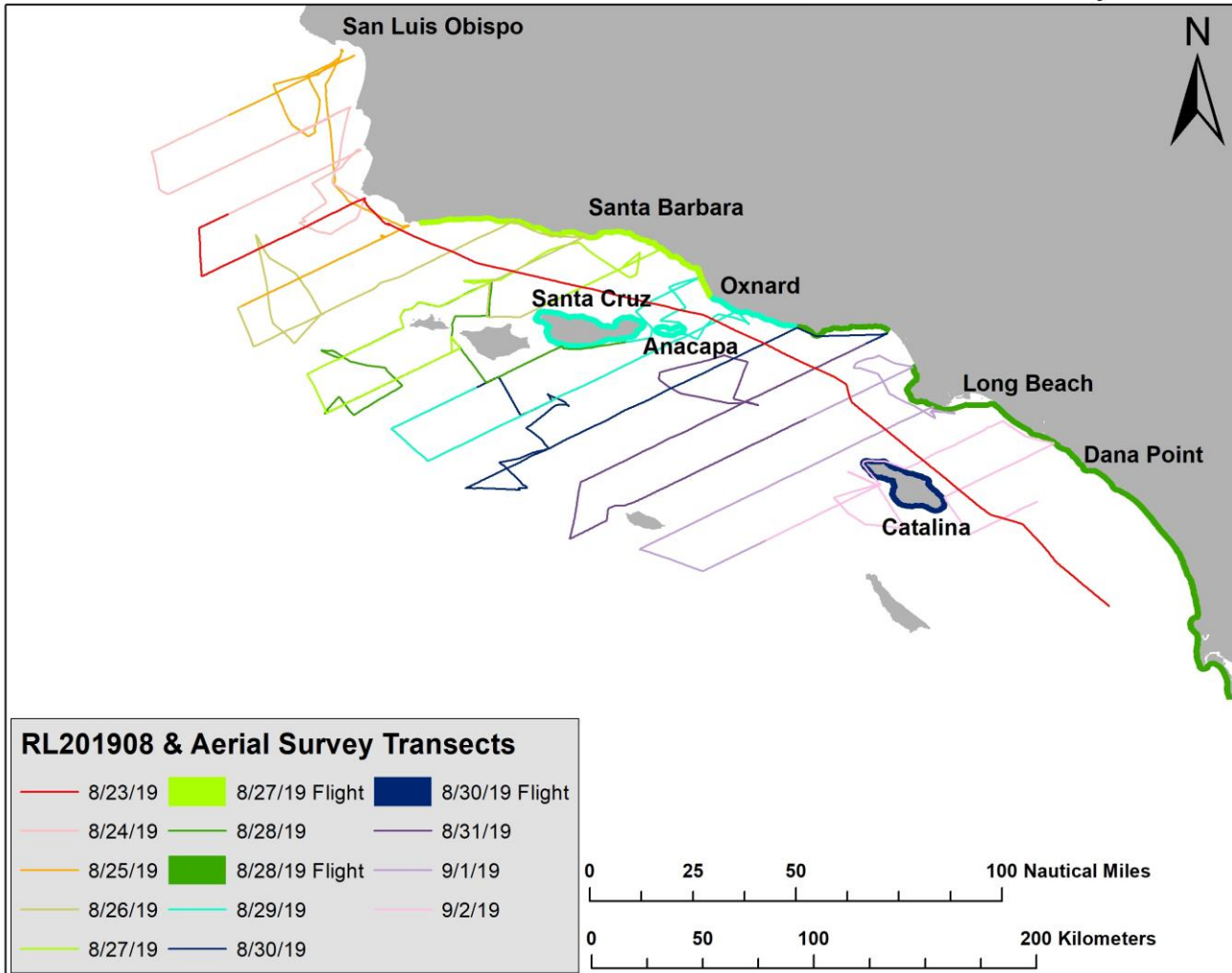
Summer 2019 Northern California Acoustic-Trawl & Aerial Survey Transects





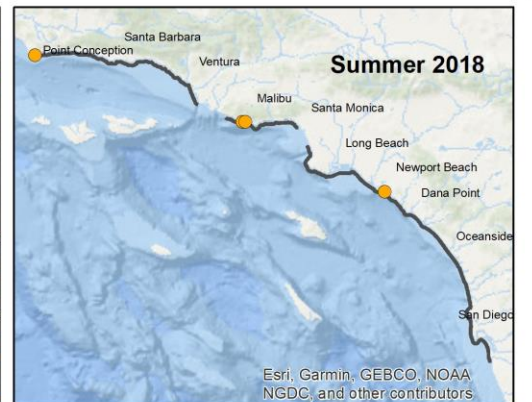
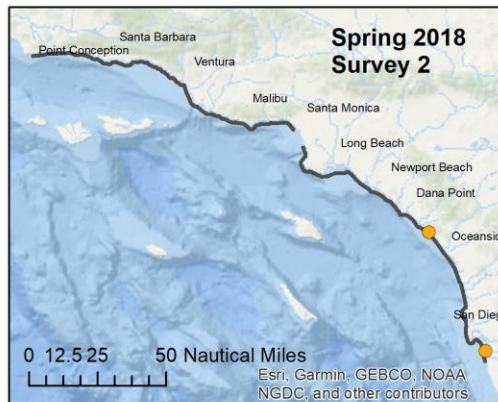
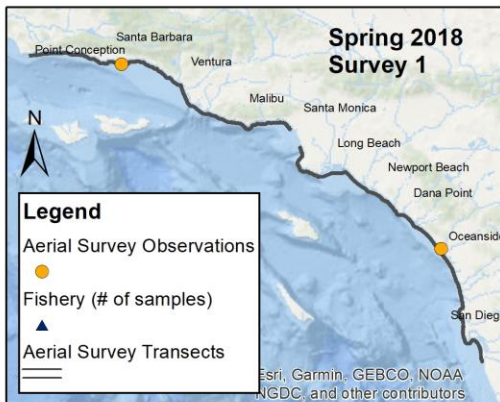
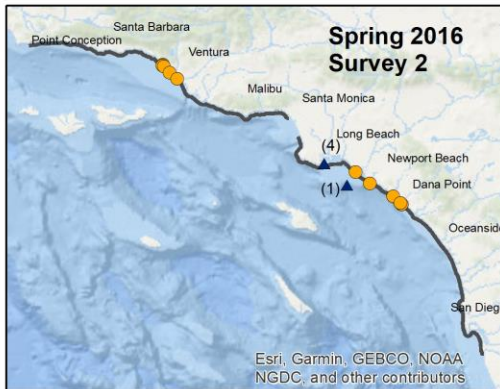
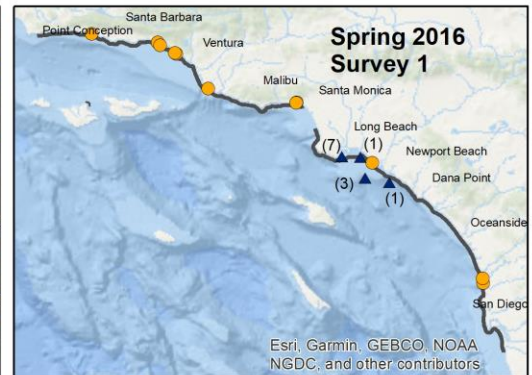
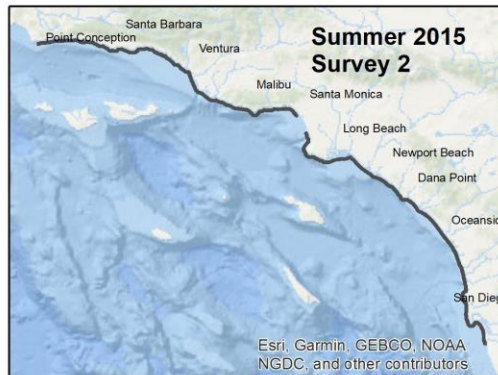
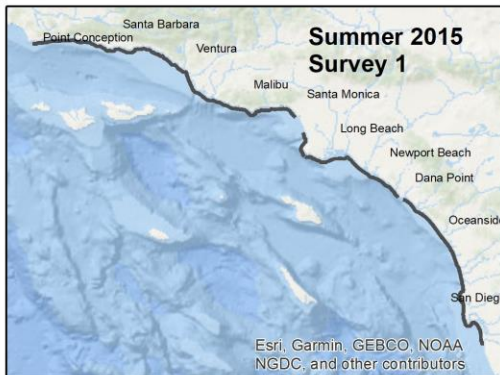
CCPSS-AT Transects (2019-S CA)

Summer 2019 Southern California Acoustic-Trawl & Aerial Survey Transects



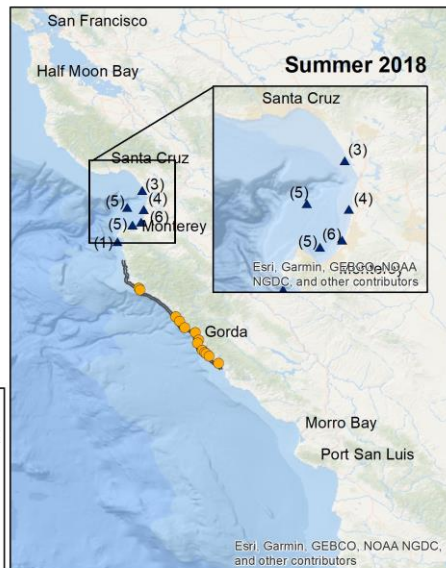
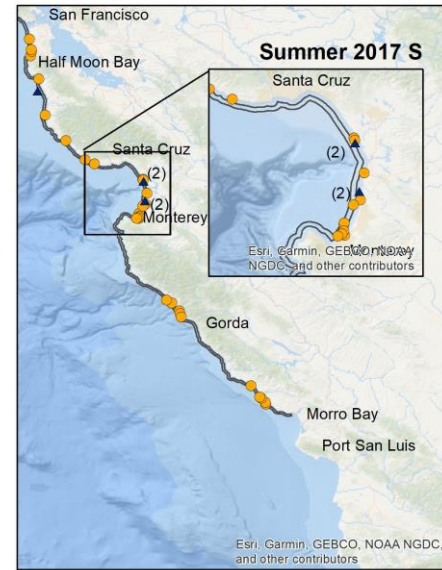
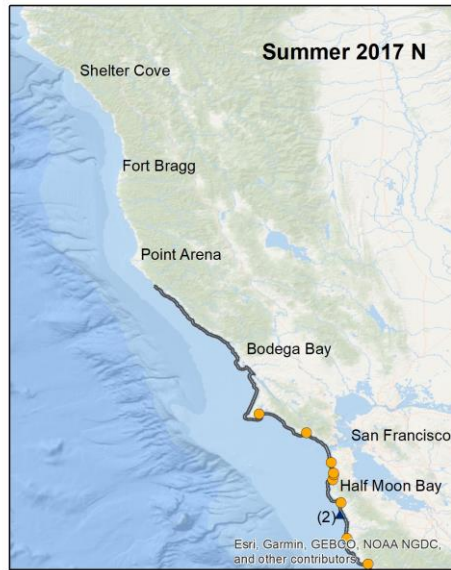


CCPSS – 2015-2018 (S CA)





CCPSS – 2017-2018 (N CA)



Anchovy Data

- Aerial Survey Observations
●
- Fishery (# of samples)
▲
- Aerial Survey Transects
—





NCS – CSNA Point Sets by Size

Northern Anchovy Point Sets - S CA	
School Size (mt)	2020
0-10	0
10-20	2
20-30	0
30-40	0
40-50	0
50-60	0
60-70	0
70-80	0
80-90	0
90-100	0
100+	0
Total	2

Northern Anchovy Point Sets - Monterey				
School Size (mt)	2019	2020	2021	Total
0-10	0	0	1	1
10-20	1	0	0	1
20-30	0	0	0	0
30-40	0	0	0	0
40-50	0	0	0	0
50-60	0	0	0	0
60-70	2	1	0	3
70-80	0	0	0	0
80-90	0	0	0	0
90-100	0	0	0	0
100+	0	0	0	0
Total	3	1	1	5



NCS – PS Point Sets by Size

Pacific Sardine Point Sets - Southern California						
School Size (mt)	2010	2018	2019	2020	Total	Target
0-10	4	12	0	0	16	10
10-20	6	4	1	0	11	4
20-30	3	0	3	0	6	4
30-40	2	0	0	1	3	1
40-50	6	0	1	0	7	1
50-60	0	0	2	0	2	
60-70	2	0	0	0	2	1
70-80	1	0	1	0	2	
80-90	2	0	0	0	2	
90-100	0	0	0	0	0	2
100+	0	0	0	0	0	
Total	26	16	8	1	51	23

Pacific Sardine Point Sets - Monterey			
School Size (mt)	2019	2020	Total
0-10	1	1	2
10-20	2	2	4
20-30	1	2	3
30-40	0	0	0
40-50	0	2	2
50-60	1	2	3
60-70	0	0	0
70-80	0	0	0
80-90	0	1	1
90-100	0	0	0
100+	0	0	0
Total	5	10	15