

CALIFORNIA COASTAL PELAGIC SPECIES AERIAL SURVEY SUMMER 2021 RESULTS

The California Coastal Pelagic Species Survey (CCPSS) is an aerial survey of Pacific sardine (sardine) and northern anchovy (anchovy) in nearshore waters conducted since 2012 by the California Department of Fish and Wildlife (CDFW) and the California Wetfish Producers Association (Lynn et al. 2019). Nearshore aerial biomass data from the CCPSS were used in the latest Pacific sardine and central subpopulation of northern anchovy stock assessments to inform Southwest Fisheries Science Center acoustic-trawl (AT) survey catchability (PFMC 2022, PFMC 2021a). The CCPSS continued in 2021 in both Northern California and Southern California, using generally the same sampling design and methods as for 2020 (PFMC 2021b, Lynn et al. 2021). The 2021 surveys were coordinated with the offshore AT vessel as well as an inshore industry vessel running acoustics and collecting biological samples. The total aerial biomass estimate for nearshore sardine in 2021 in Northern California was 14,942 mt and in Southern California was 13,141 mt. Based on average monthly sea surface temperature data and the sardine habitat model, sardine spotted in Southern California in summer 2021 were from the southern subpopulation. For anchovy, the total nearshore biomass estimate in Northern California was 21,049 mt and in Southern California was 10,124 mt. This document describes CCPSS results for summer 2021.

2021 Summer Aerial Survey

For summer 2021, a Northern California aerial survey was again completed in coordination with both acoustic survey vessels. CCPSS was able to survey four strata (N1, N2, N4, N5) between August 6-11 (Figure 1). The summer CCPSS season began approximately three weeks earlier than planned, in order to coordinate with a change in acoustic survey schedule due to weather. This resulted in even more of a challenge in completing survey strata, as weather in Northern California typically moderates later in summer. After a brief pause due to a port call for AT survey vessel maintenance, the survey covered Southern California waters from Point Conception to San Diego between September 12-17, completing nine strata (S1-S6, S1E, S2E, S4E). CCPSS in Southern California was successful in surveying all strata including expansion strata, except for S3E and S5E; therefore, only S3E and S5E biomass and variance will be derived from expansion analysis (Figure 2).

Biological Sampling

In 2021, the fishing vessel *Long Beach Carnage* was available to support the CCPSS by collecting biological samples off the California coast from Bodega Bay to San Diego. As with previous 2020 and 2021 surveys, sampling took place using the same survey strata as the CCPSS aerial flight path, but occurred independently of aerial surveys, although attempts were made to sample as close

in time as possible (ideally, no more than three days apart from aerial survey of those strata). The *Long Beach Carnage* began in the north on August 12 with stratum N2 and proceeded southward, ending on September 19 at stratum S6 (Figures 1 and 2).

Results

Total sardine and anchovy aerial biomass were calculated from the four survey strata (N1, N2, N4, N5) from Northern California and nine survey strata (S1-S6, S1E, S2E, S4E) from Southern California (Table 1). The total summer 2021 aerial biomass estimate for nearshore sardine in Northern California was 14,942 mt and in Southern California was 13,141 mt. Based on average monthly sea surface temperature data and the sardine habitat model, 2021 summer Southern California sardine were from the southern subpopulation. For anchovy, the total summer nearshore Northern California biomass estimate was 21,049 mt and in Southern California was 10,124 mt. The 2021 results are in line with previous aerial surveys showing higher densities of sardine compared to anchovy in Southern California, and the reverse for Northern California (Table 1).

Sardine and anchovy were found generally in the same areas in Northern California, primarily within the Monterey Bay area (Figures 3 and 4). In Southern California, sardine were observed in several survey areas, with the highest concentrations off Santa Barbara and San Diego County (Figure 5). Anchovy were primarily observed between Santa Barbara and Ventura (Figure 6).

A total of 19 sardine samples were collected from *Long Beach Carnage* for the summer 2021 surveys, seven from Northern California and 12 from Southern California (Table 2). For anchovy, 13 samples were collected, seven from Northern California and six from Southern California (Table 3).

References

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Table 1. 2015-2021 CCPSS survey biomass estimates by year, season, region, and species, with flown survey area indicated. Note 2020-2021 seasons implemented a new survey design with replicated transects within strata. Summer Southern California sardine estimates are considered to be for the southern subpopulation.

Year	Season	Area (km ²)	Sardine						Anchovy					
			SCA			NCA			SCA			NCA		
			Biomass (mt)	CV	Density (mt/km ²)	Biomass (mt)	CV	Density (mt/km ²)	Biomass (mt)	CV	Density (mt/km ²)	Biomass (mt)	CV	Density (mt/km ²)
2015	Summer	1046.88	96	0.40	0.09				0	NA	0.00			
	Summer	1058.67	379	1.07	0.36				0	NA	0.00			
2016	Spring	984.35	3,396	0.83	3.45				1,050	0.24	1.07			
	Spring	1043.50	7,131	0.63	6.83				4,262	1.04	4.08			
	Summer	1037.10	7,475	1.29	7.21				29	1.41	0.03			
2017	Spring	327.56	0	NA	0.00				294	0.56	0.90			
	Summer	1352.58				20,217	1.13	14.95				75,338	0.71	55.70
2018	Spring	1053.52	2,697	1.05	2.56				315	1.35	0.30			
	Spring	1055.14	2,283	1.41	2.16				338	1.41	0.32			
	Summer	995.79	553	0.69	0.56				32	1.01	0.03			
	Summer	239.22				15,034	1.41	62.85				69,967	1.41	292.48
2019	Spring	926.50	28,976	0.98	31.27				3,201	1.41	3.46			
	Summer	1388.02				11,736	1.34	8.46				48,623	1.37	35.03
	Summer	1044.32	25,475	0.55	24.39				9,783	0.18	9.37			
2020	Summer	2,259.18				8,688	0.16	3.85				57,257	0.02	25.34
	Summer	1,514.70	17,221	0.22	11.37				4,649	0.27	3.07			
2021	Spring	1,514.70	18,409	0.05	12.15				8,092	0.03	5.34			
	Summer	1,372.76				14,942	0.15	10.88				21,049	0.13	15.33
	Summer	1,514.70	13,141	0.02	8.68				10,124	0.06	6.68			

Table 2. Sardine samples collected from *Long Beach Carnage* from summer 2021 surveys. Biomass estimates provided are vessel captain estimates of school biomass from which samples were collected using dip nets.

Date	Region	B (mt)	Lat	Long
8/13/2021	NCA	1.46	37.884	-122.622
8/14/2021	NCA	NA	36.949	-122.005
8/18/2021	NCA	NA	36.058	-121.601
8/18/2021	NCA	9.07	35.999	-121.519
8/18/2021	NCA	36.29	35.993	-121.516
8/19/2021	NCA	NA	35.602	-121.156
8/20/2021	NCA	45.36	34.844	-120.651
9/12/2021	SCA	NA	33.464	-120.218
9/13/2021	SCA	NA	33.966	-119.693
9/13/2021	SCA	NA	33.961	-119.698
9/15/2021	SCA	2.72	33.73	-118.367
9/16/2021	SCA	6.80	33.368	-118.341
9/17/2021	SCA	13.61	33.708	-118.213
9/18/2021	SCA	27.22	33.182	-117.386
9/18/2021	SCA	NA	33.061	-117.314
9/18/2021	SCA	90.72	33.029	-117.301
9/18/2021	SCA	4.99	32.987	-117.288
9/19/2021	SCA	13.61	32.882	-117.261
9/19/2021	SCA	NA	32.787	-117.271

Table 3. Anchovy samples collected from *Long Beach Carnage* from summer 2021 surveys. Biomass estimates provided are vessel captain estimates of school biomass from which samples were collected using dip nets.

Date	Region	B (mt)	Lat	Long
8/12/2021	NCA	16.14	38.292	-123.024
8/13/2021	NCA	1.61	37.884	-122.622
8/14/2021	NCA	NA	36.949	-122.005
8/15/2021	NCA	16.14	36.908	-121.867
8/19/2021	NCA	NA	36.602	-121.156
8/20/2021	NCA	40.36	35.136	-120.684
8/20/2021	NCA	40.36	34.844	-120.651
9/13/2021	SCA	40.36	34.371	-119.498
9/13/2021	SCA	24.22	34.259	-119.286
9/15/2021	SCA	1.61	34	-118.507
9/15/2021	SCA	2.42	33.73	-118.367
9/17/2021	SCA	12.11	33.708	-118.213
9/18/2021	SCA	24.22	33.182	-117.386

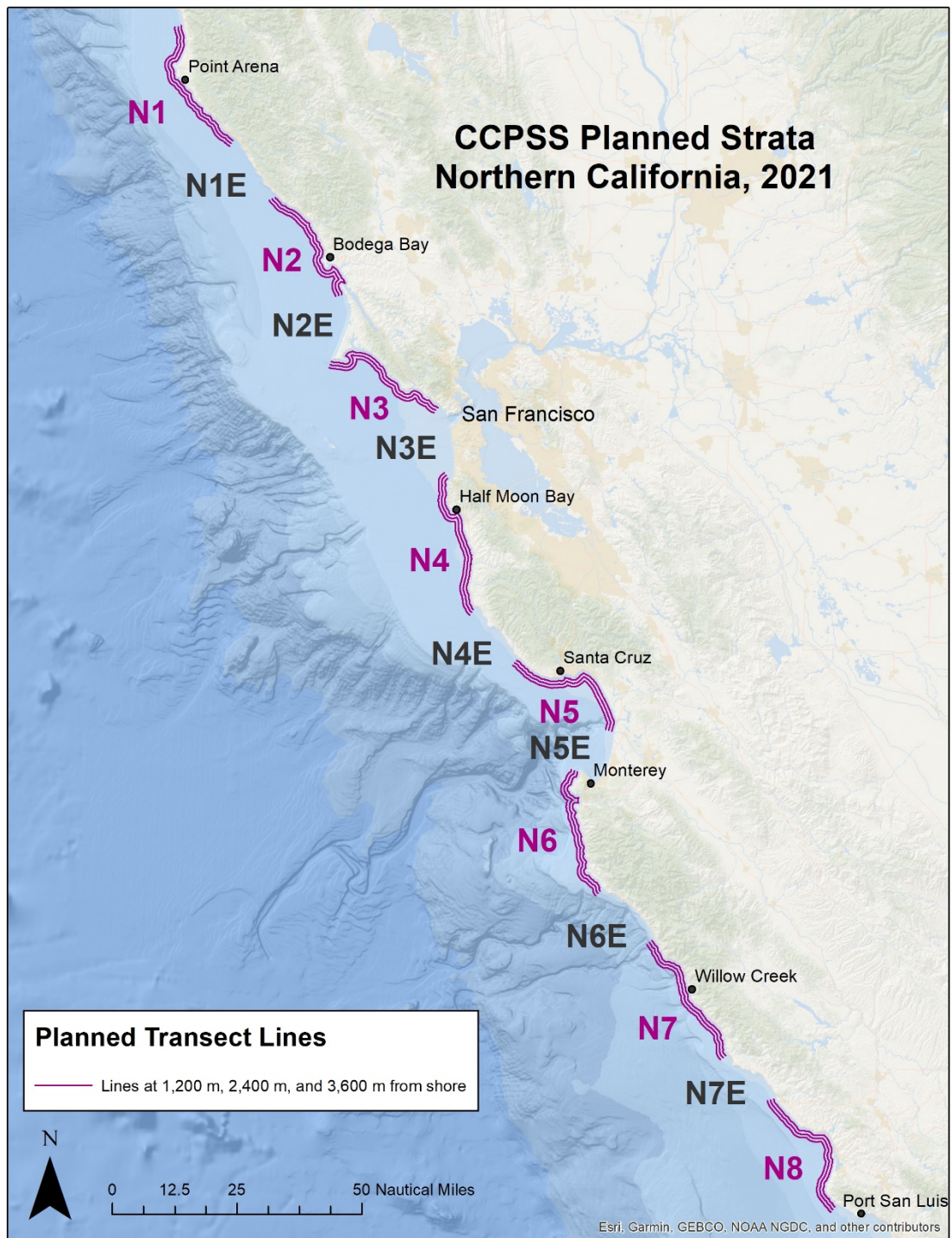


Figure 1. CCPSS strata for Northern California. Survey strata are in purple, and expansion strata are in black and denoted with “E”. In summer 2021, strata N1, N2, N4, and N5 were surveyed. The remaining strata were unsurveyable within the study time period due to weather conditions.

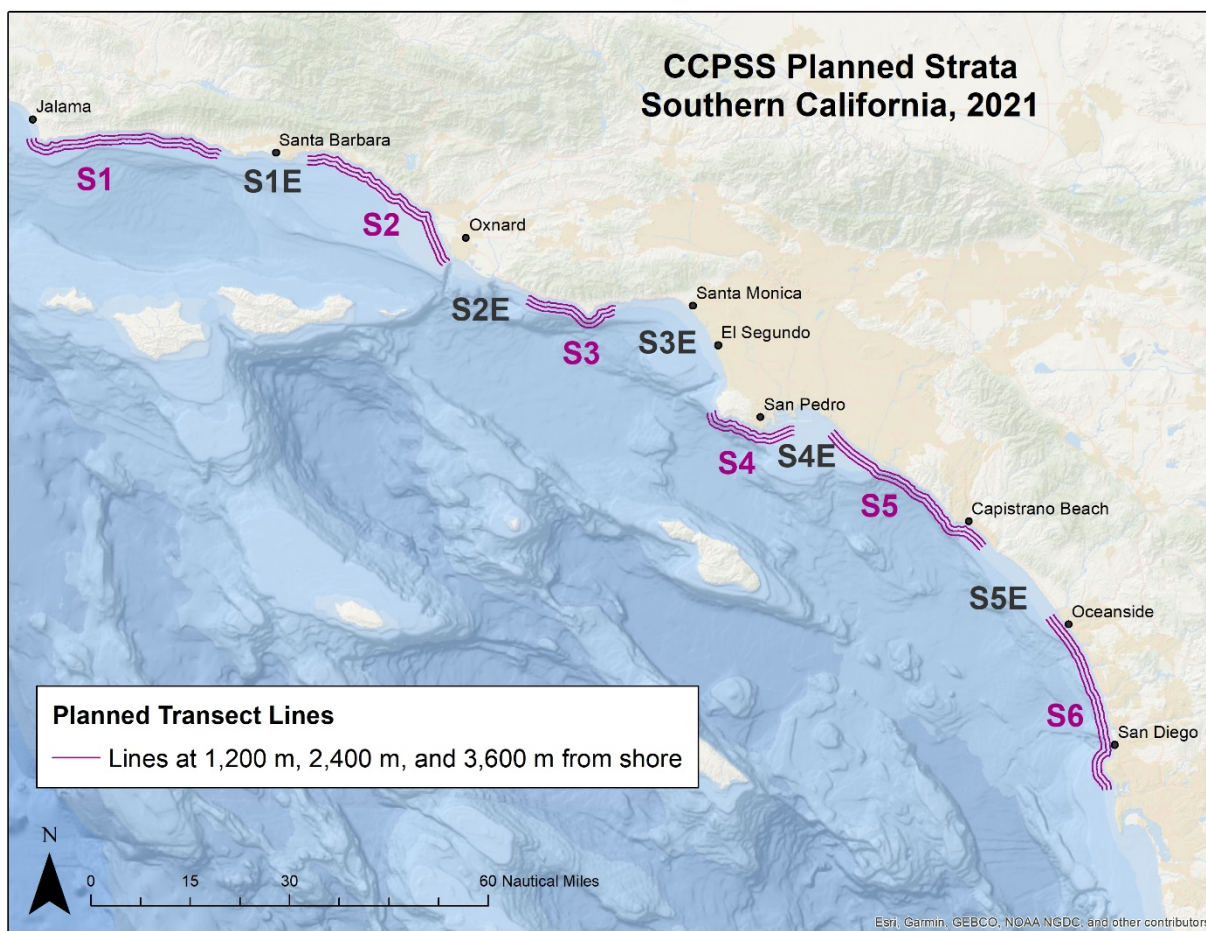


Figure 2. CCPSS strata for Southern California. Survey strata labels are in purple, and expansion strata are in black and denoted with “E”. Note strata S3 and S4 are smaller to circumvent airspace restrictions. In summer 2021, all Southern California survey strata except S3E and S5E were surveyed.

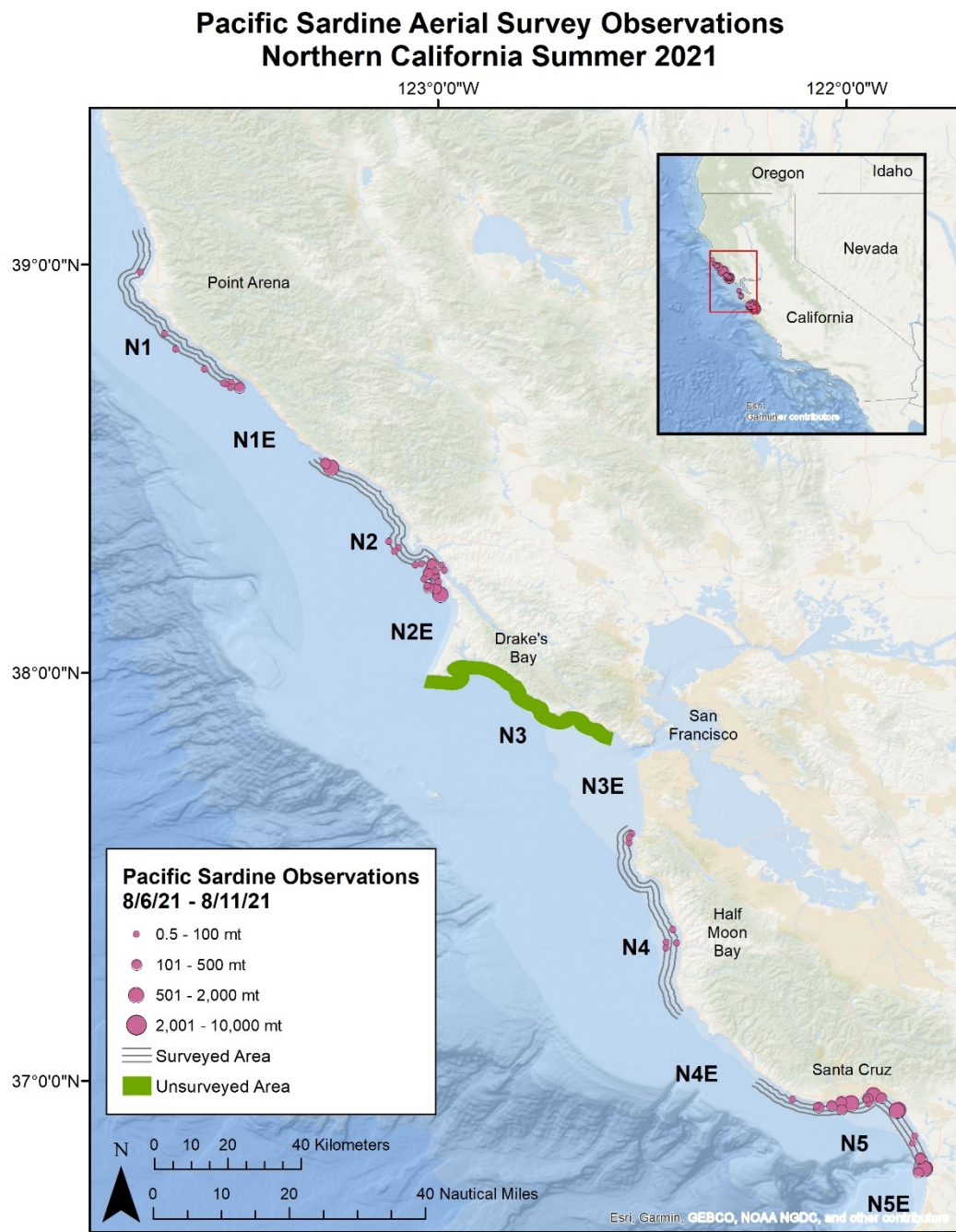


Figure 3. Location of Pacific sardine schools observed from summer 2021 in Northern California.

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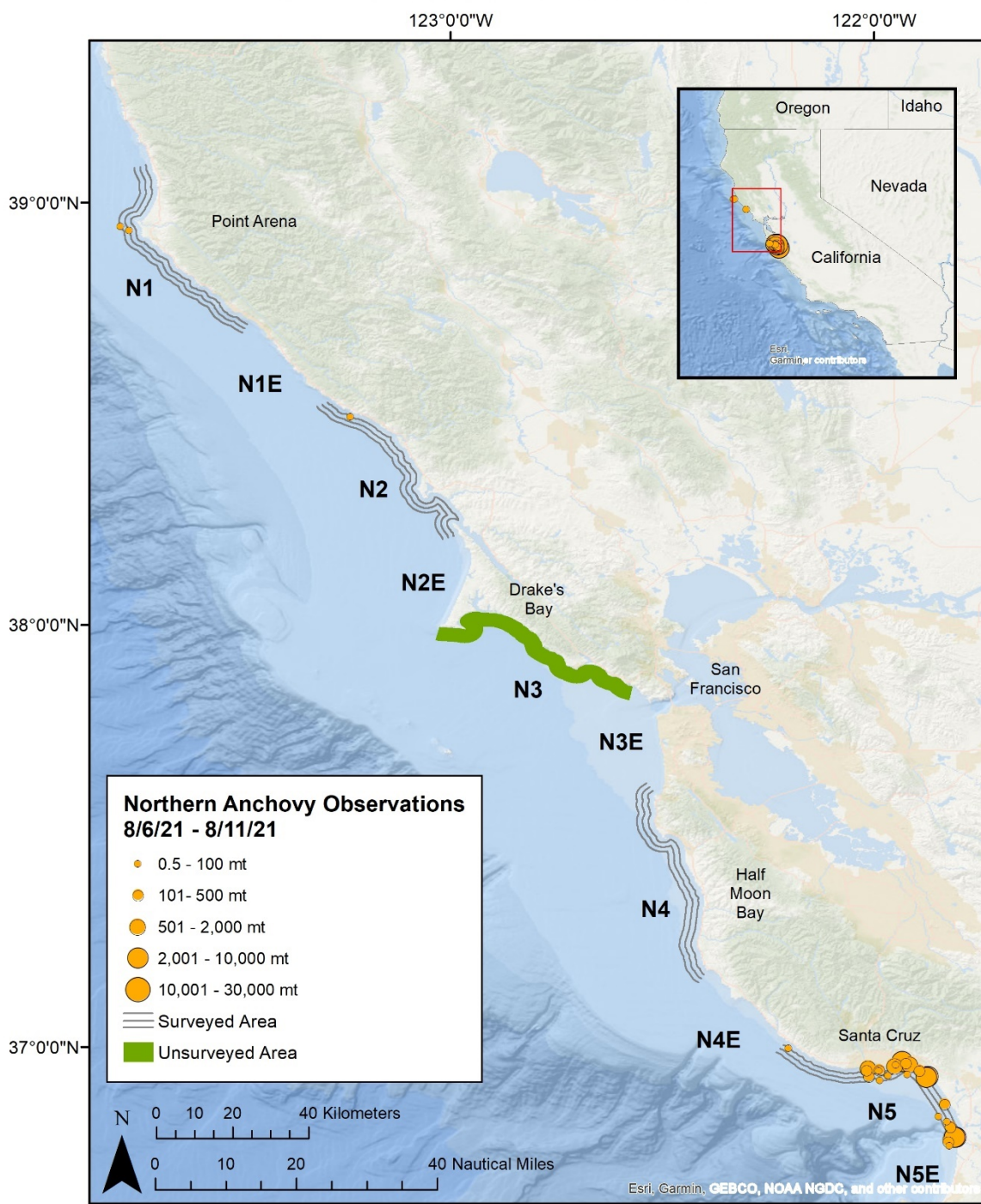


Figure 4. Location of northern anchovy schools observed from summer 2021 in Northern California.

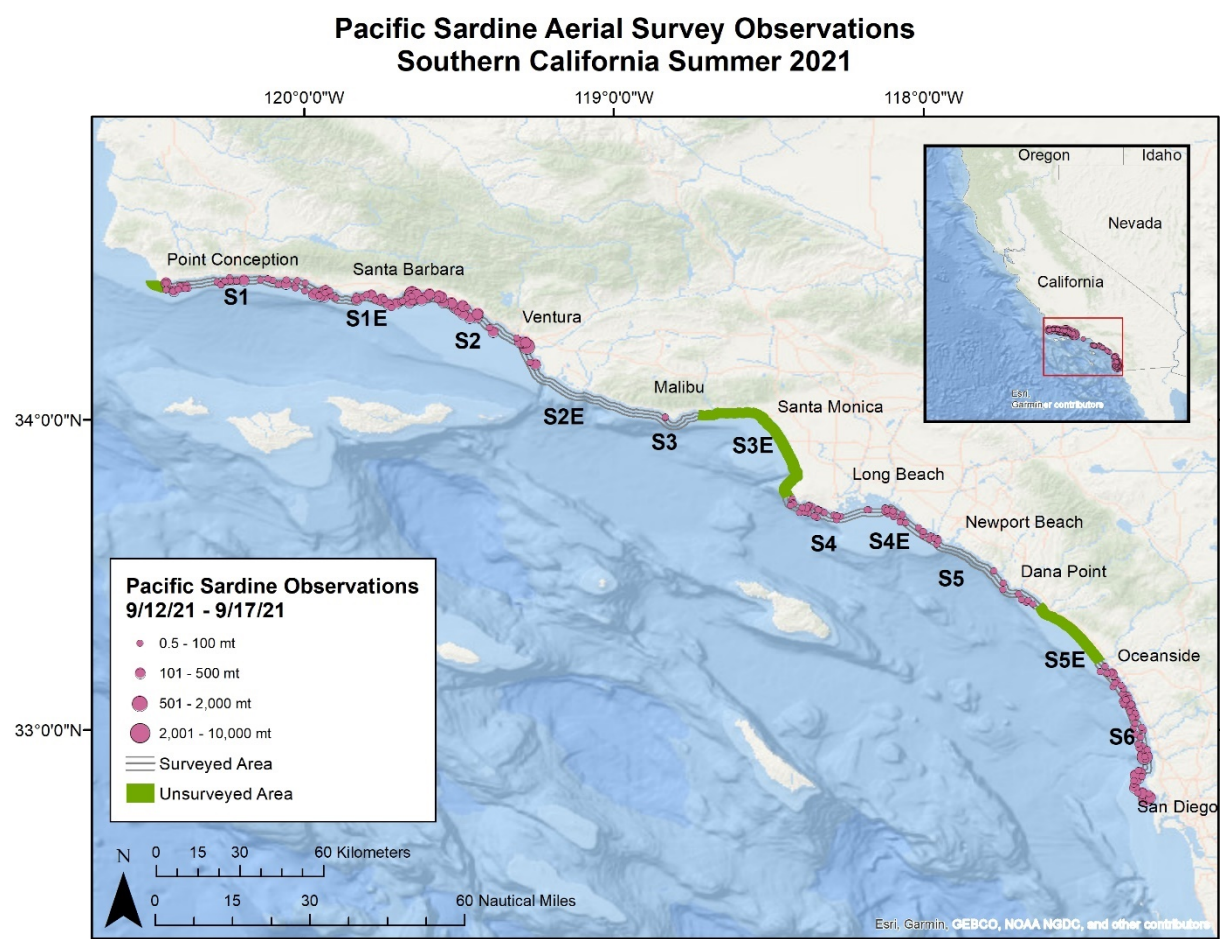


Figure 5. Location of Pacific sardine schools observed from summer 2021 in Southern California. Note: these observations are considered to be that of southern subpopulation sardine. All strata were surveyed except S3E and S5E.

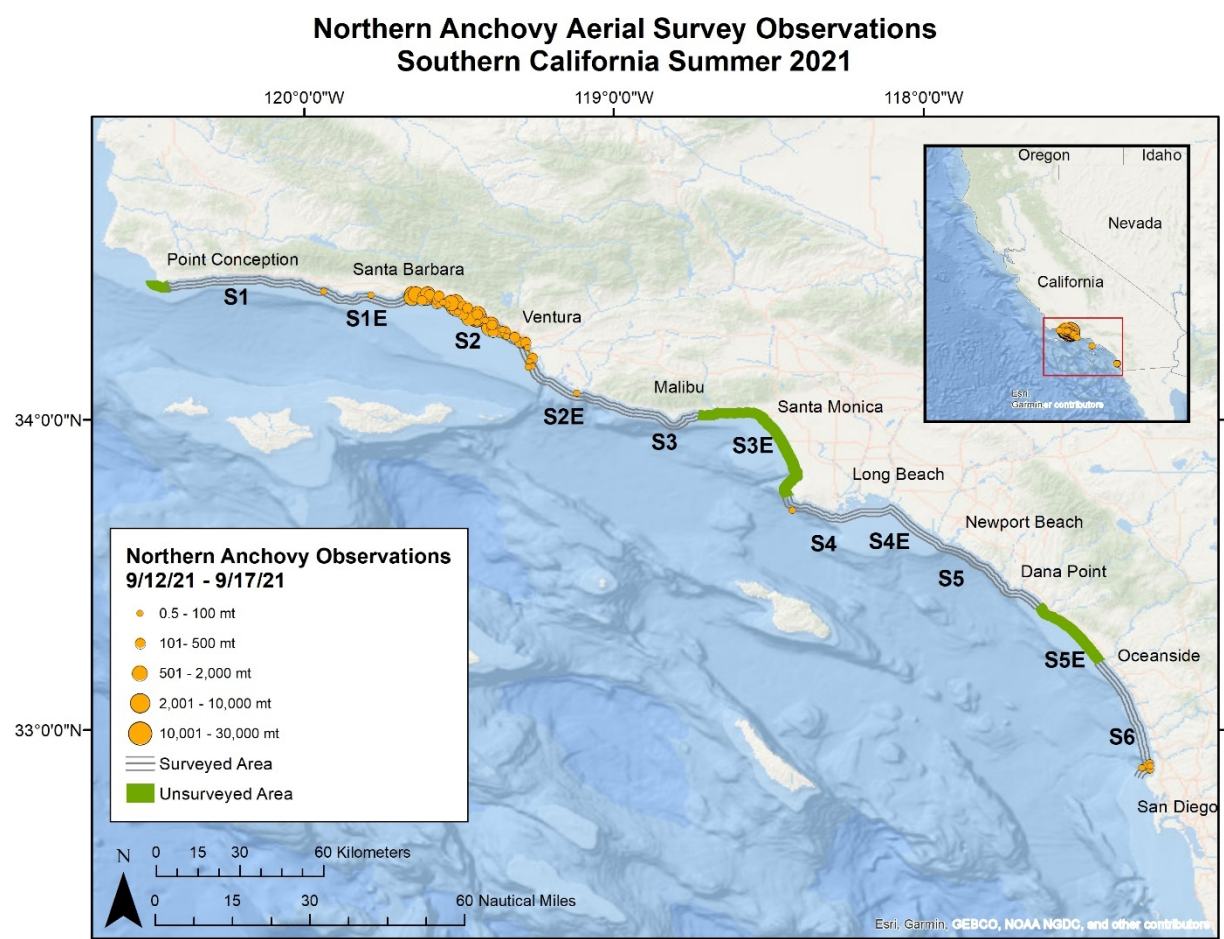


Figure 6. Location of northern anchovy schools observed from summer 2021 in Southern California. All strata were surveyed except S3E and S5E.