

# Southern California Coastal Pelagic Species Aerial Survey



**California Department of Fish and Wildlife**  
**California Wetfish Producers Association**

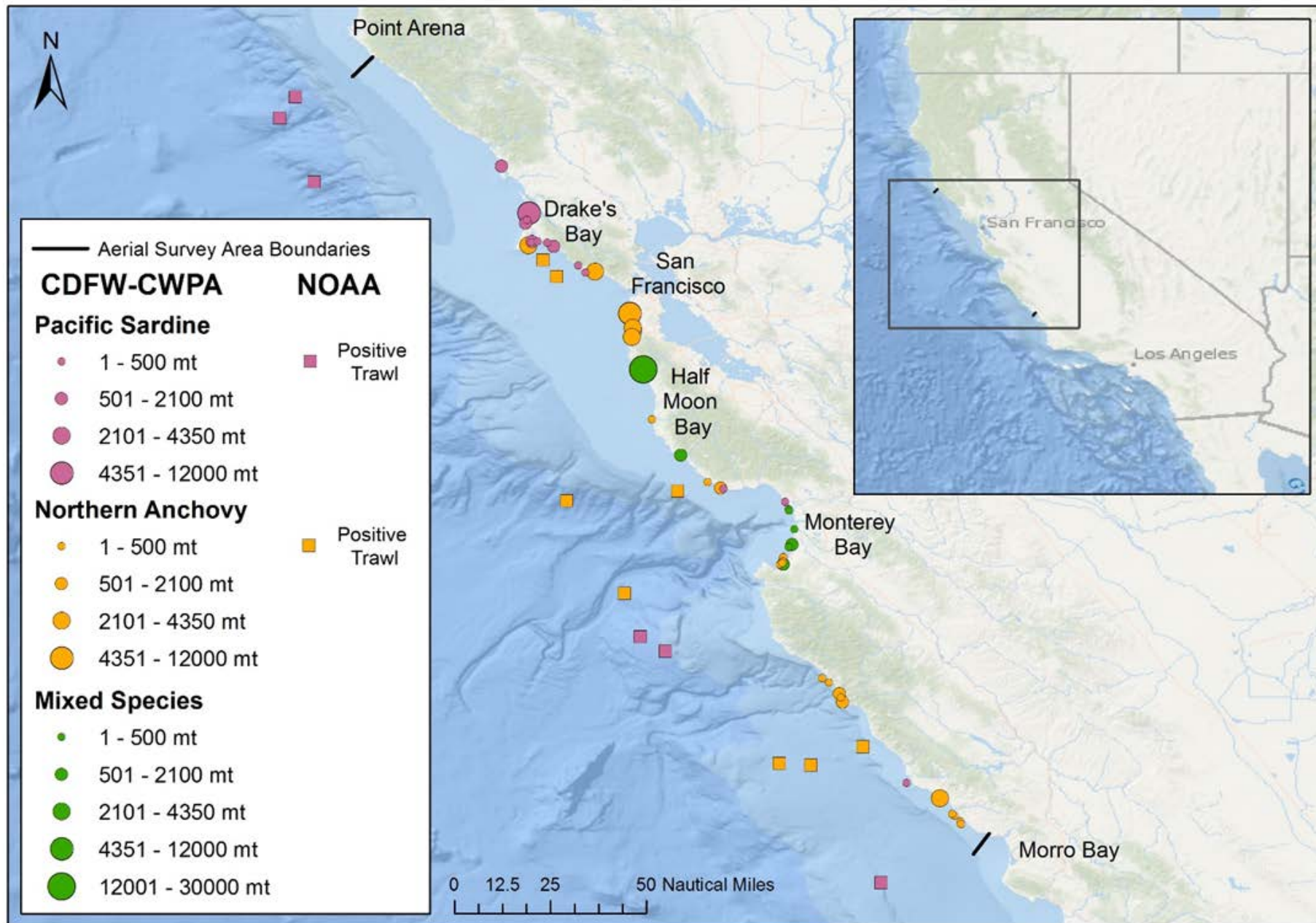
Kirk Lynn, Dianna Porzio, Trung Nguyen, Laura Ryley



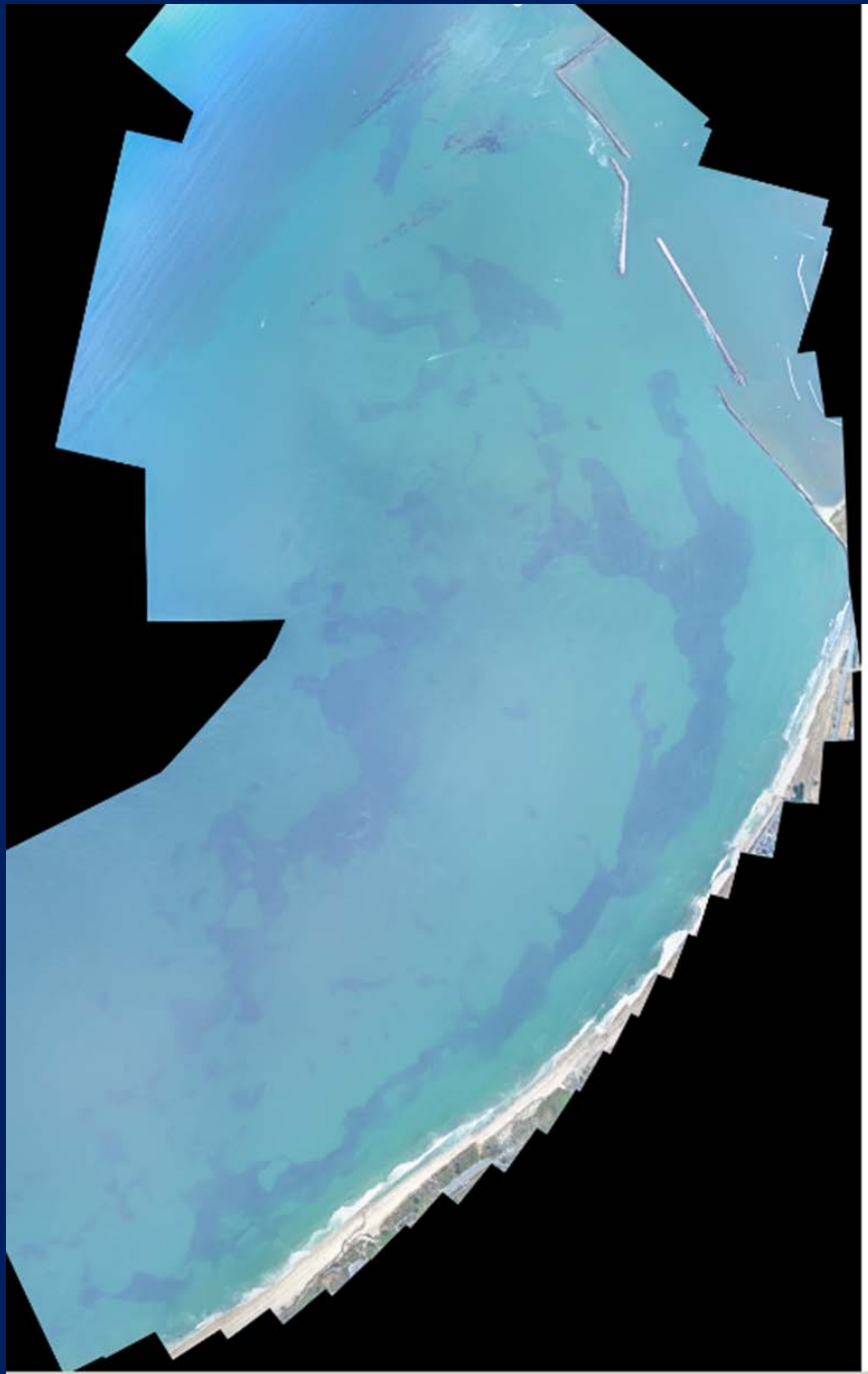
*Pacific Fishery Management Council*  
*January 2018*

# Northern California Summer 2017 Survey Observations

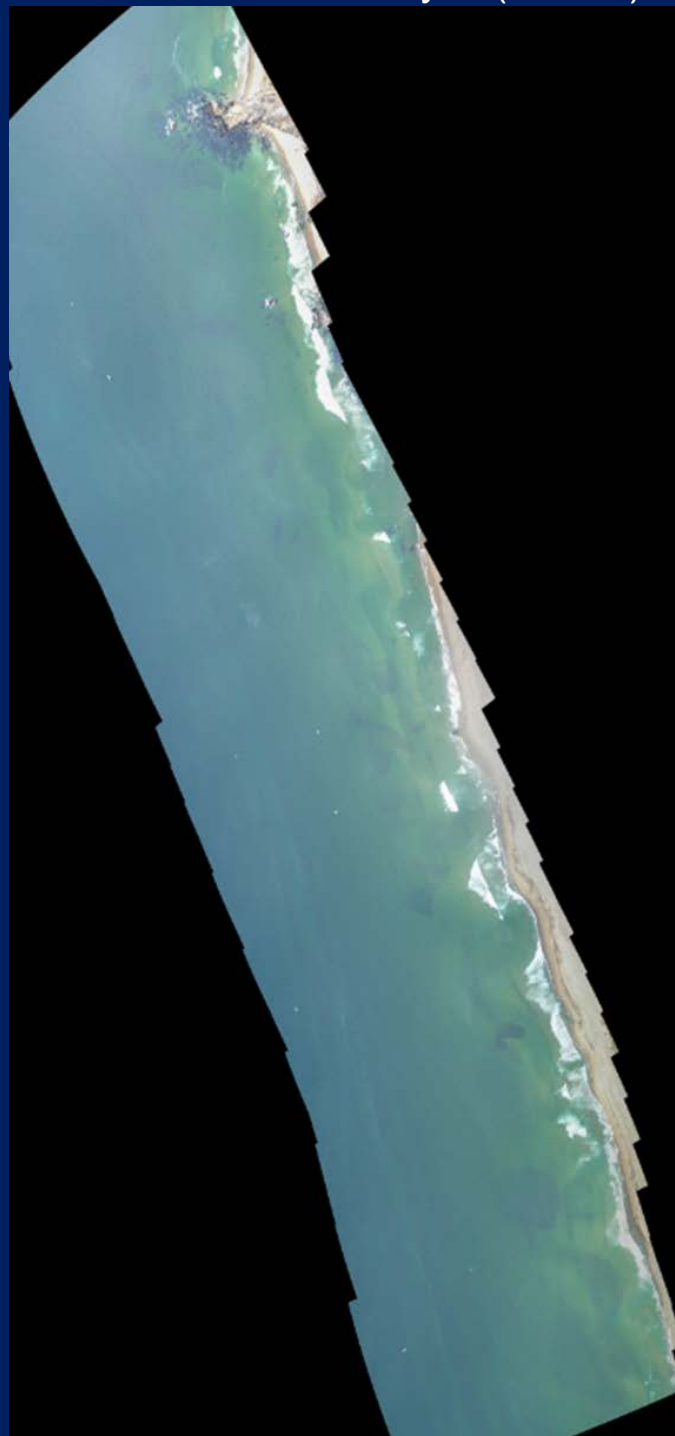
## CDFW-CWPA Aerial Survey and NOAA Acoustic-Trawl Survey



Anchovy (~27k mt) and sardine (~3k mt)  
@ Half Moon Bay



Sardine off Point Reyes (~9k mt)



## Sardine and anchovy biomass estimates by year and season

Year	Season	Biomass (mt)	
		Sardine	Anchovy
2012	Summer	9,549	---
2013	Spring	2,281	---
	Summer	4,729	13,776
2014	Spring	2,998	7,310
	Summer 1	56	980
	Summer 2	0	515
2015	Spring	No Survey	
	Summer 1	105	0
	Summer 2	420	0
2016	Spring 1	3,049	954
	Spring 2	6,390	3,829
	Summer	6,722	26
2017	Spring	No Survey	
	Summer*	18,118	67,684

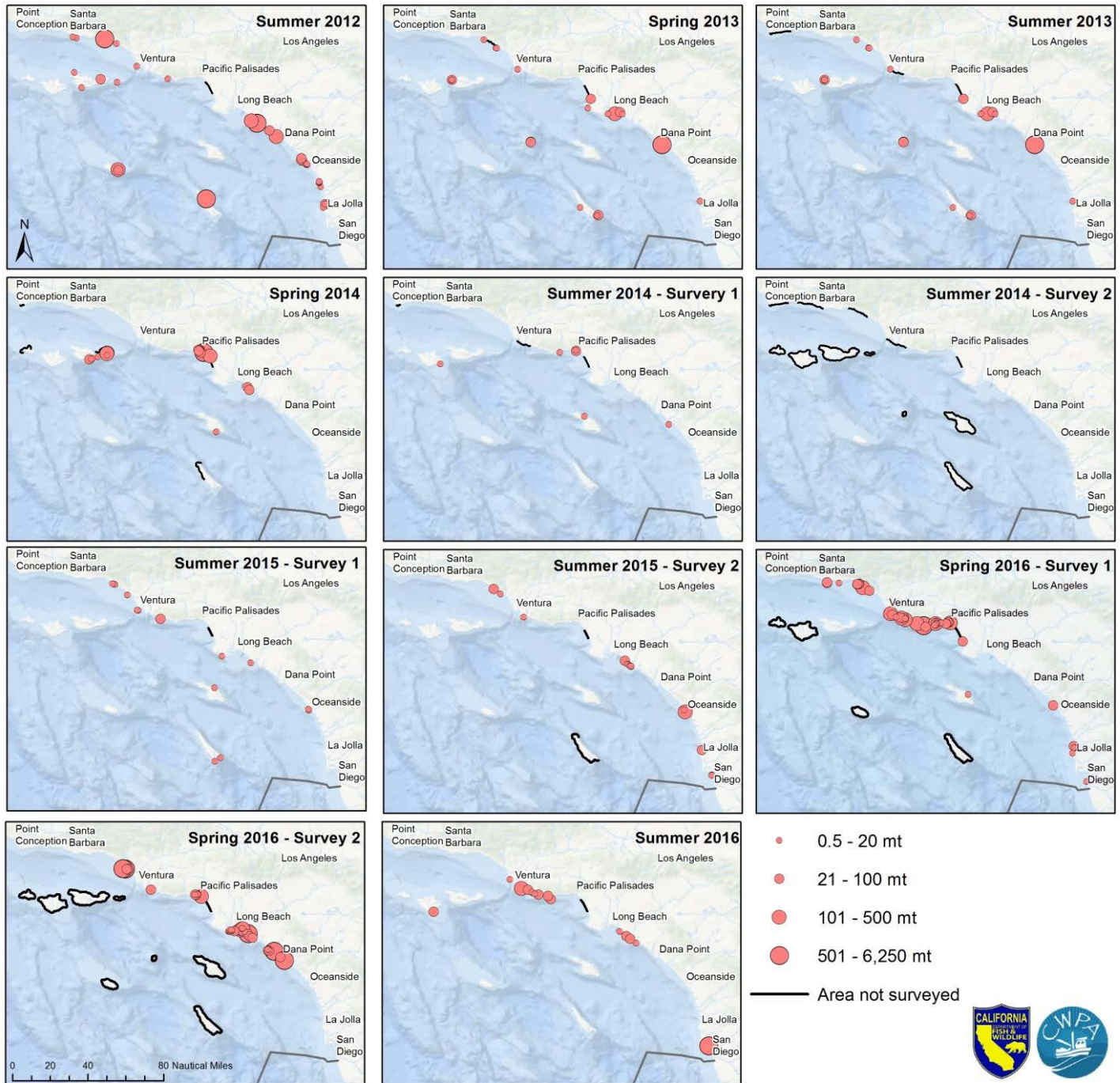
\*Summer 2017 survey in N CA

# Results

## Sardine

2012-2016  
(S CA)

### Pacific Sardine Observations

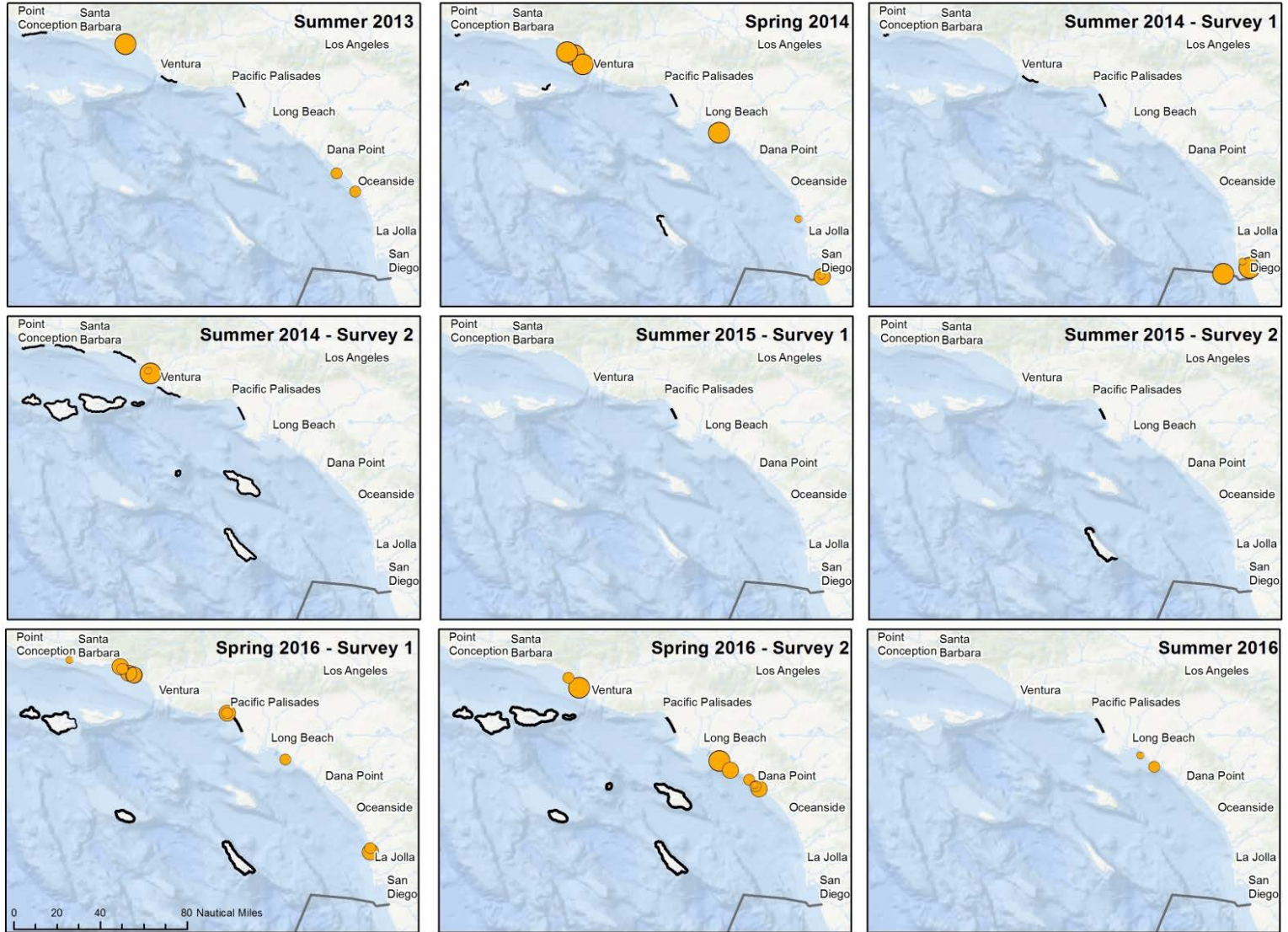


# Results

## Anchovy

### 2013-2016 (S CA)

#### Northern Anchovy Observations



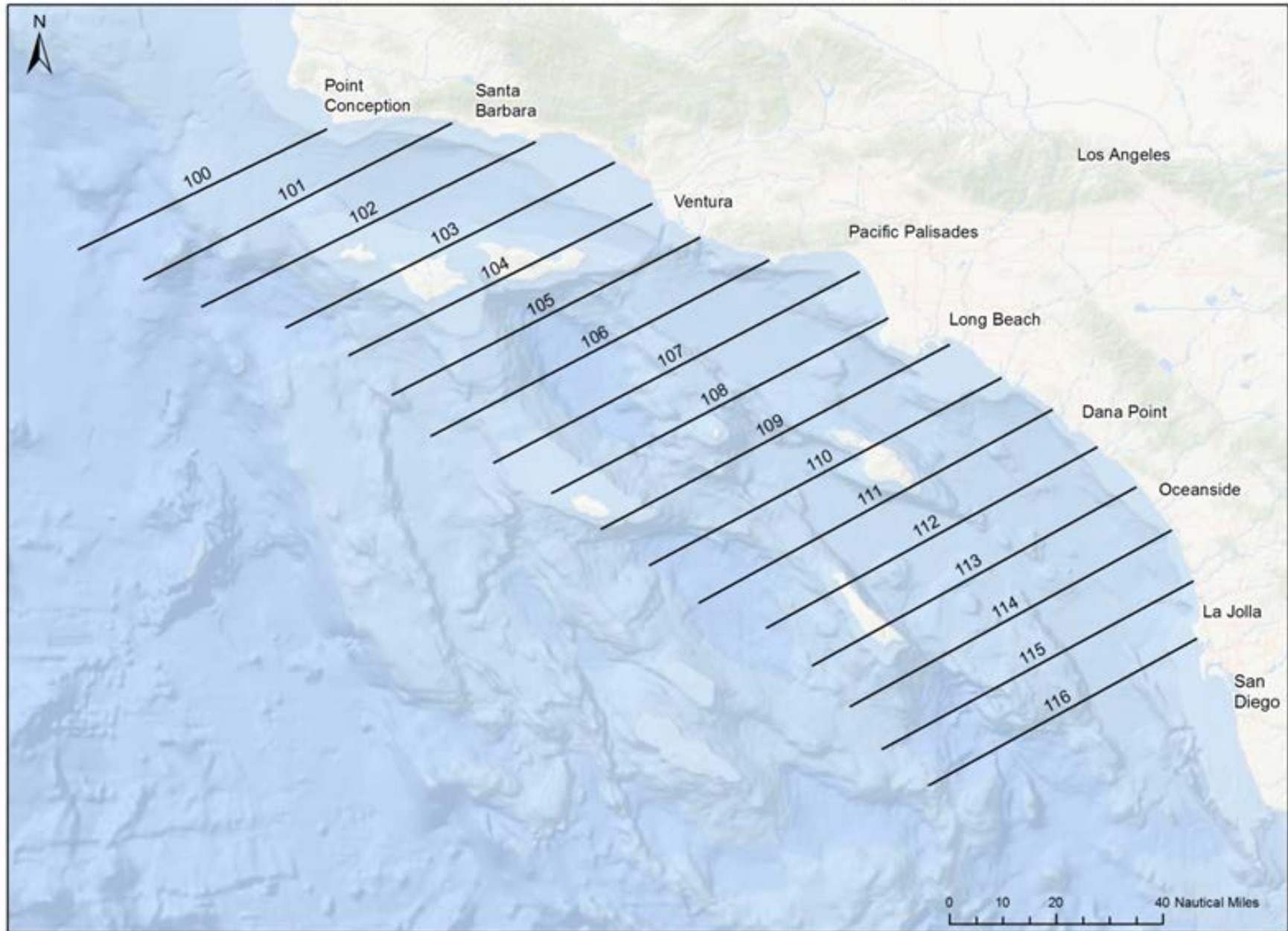
- 0.5 - 20 mt
- 21 - 60 mt
- 61 - 250 mt
- 251 - 13,700 mt

— Area not surveyed



# Methods - Project 2

NOAA Acoustic Trawl Survey - Southern California Bight Transect Lines



# Methods – Analyses

## Project 2

Goal: Total SCB estimate (offshore and inshore)

1. Combine ATM (offshore) and SCCPSS (inshore) estimates for SCB

$$T = T_{ATM} + T_{SCCPSS}$$

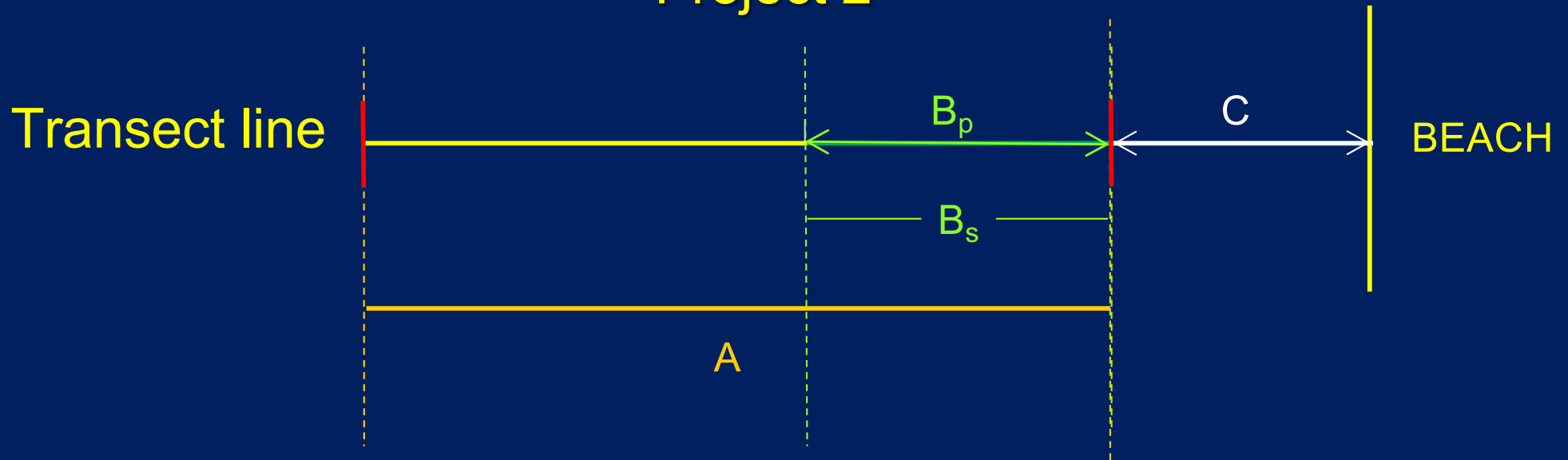
2. Combine ATM (offshore) and calculated tonnage (inshore) from SCCPSS and ATM data

$$T = T_A + \left( \frac{\sum T_C}{\sum T_{Bp}} \right) * T_{Bs}$$



# Methods – Analyses

## Project 2



Total SCB Biomass Estimate (T) = Biomass offshore + Biomass inshore

$$T = T_A + \left( \frac{\sum T_C}{\sum T_{B_p}} \right) * T_{B_s}$$

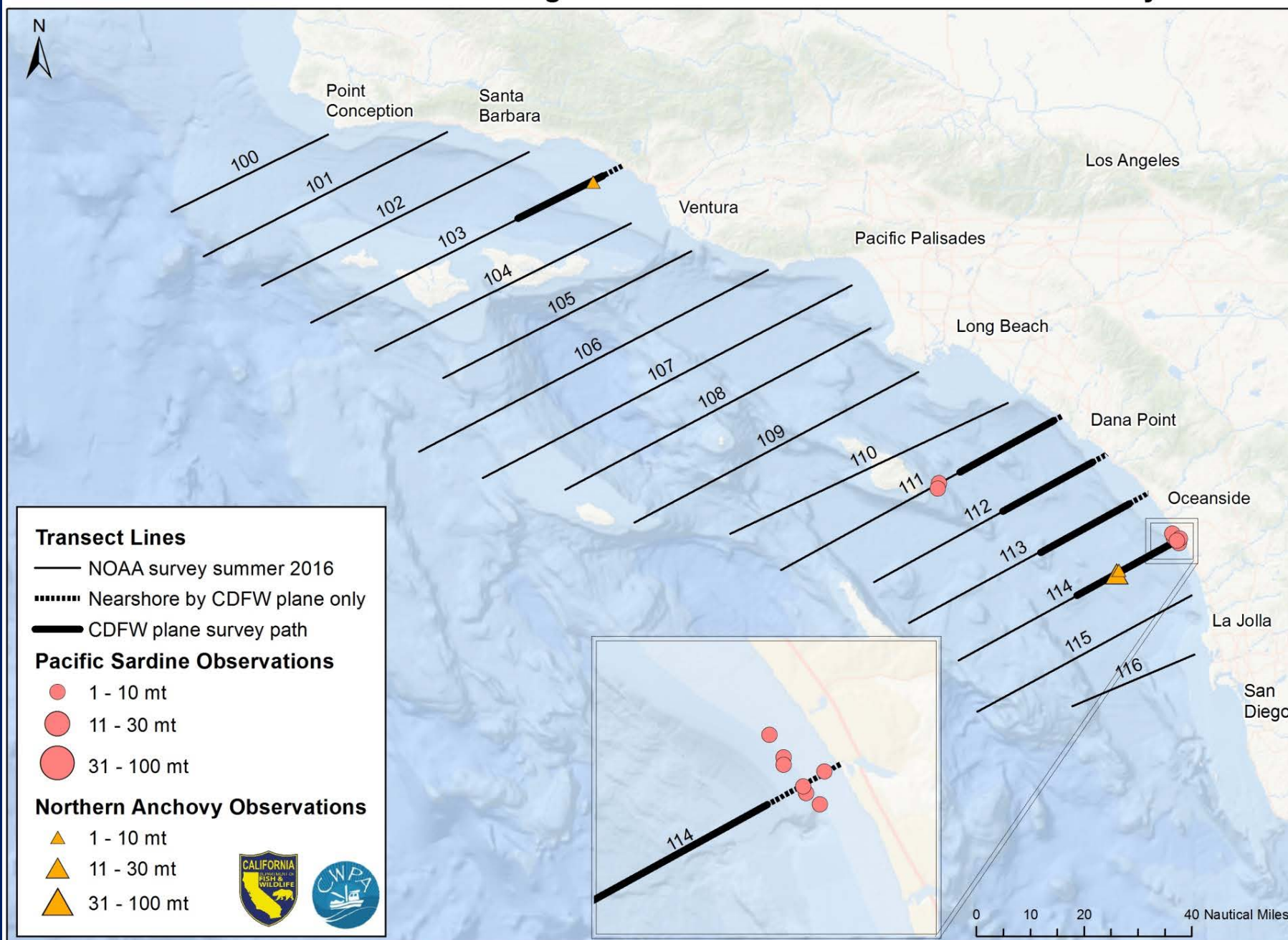
A = Area represented by ATM transect line

B = Plane-ship overlap (B<sub>p</sub> = Transect line B flown by plane for overflight study, B<sub>s</sub> = Area represented by ship)

C = Nearshore line flown by plane for overflight study

# Results – Project 2

## SCCPSS Observations During Summer 2016 NOAA Acoustic Trawl Survey

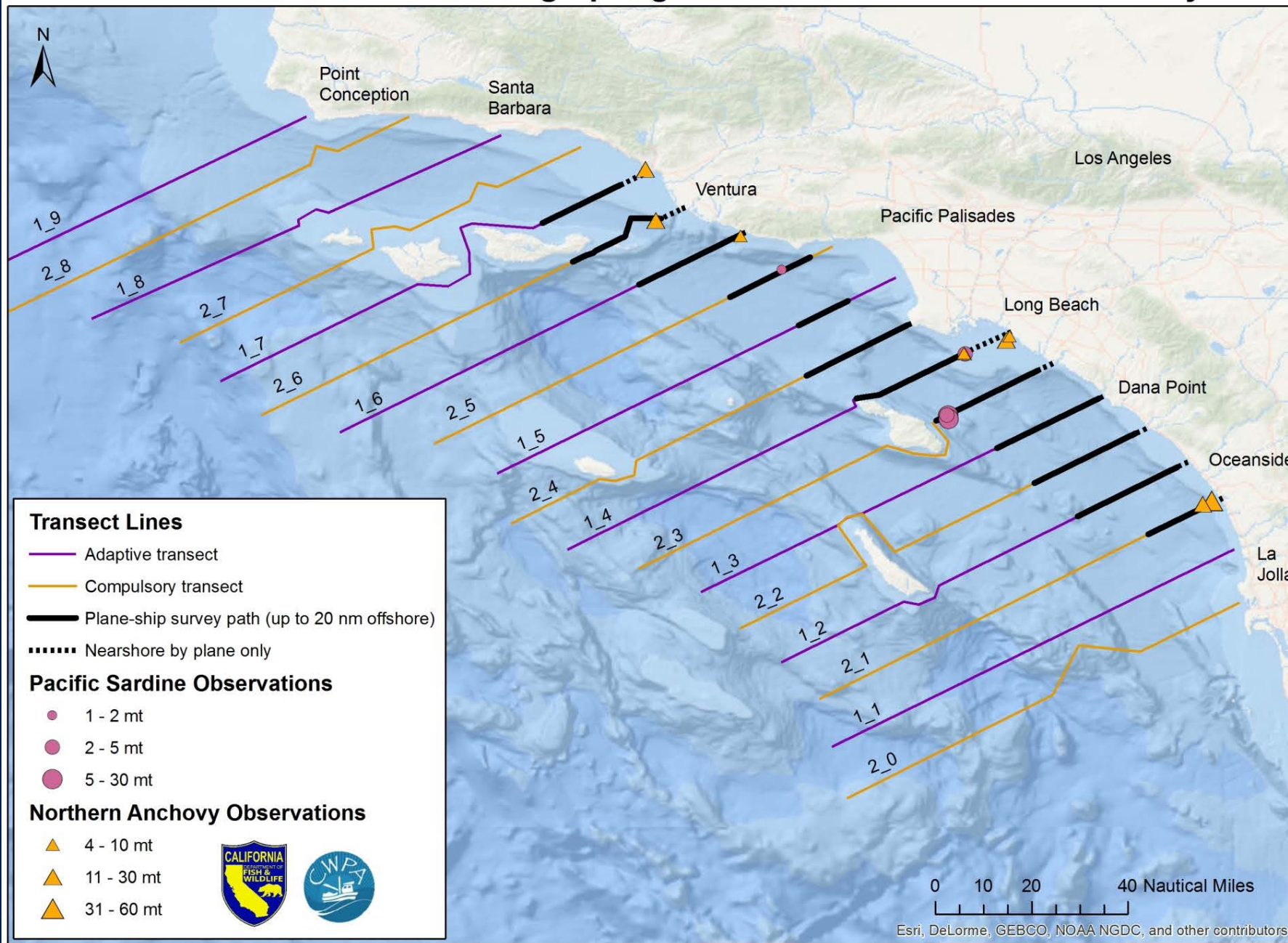


## Results – Project 2

Observations from September 2016 SCCPSS Overflights of NOAA Acoustic Survey							
Date	Line	Biomass (mt)		Offshore	Inshore	Location	
		Sardine	Anchovy			Latitude	Longitude
9/7/2016	103		6	X		34.2798	-119.5077
9/14/2016	111	3		X		33.315	-118.2408
9/14/2016	111	7.2		X		33.3318	-118.236
9/15/2016	114	4			X	33.1452	-117.3728
9/15/2016	114	4			X	33.1581	-117.3794
9/15/2016	114	4.5			X	33.1485	-117.3725
9/15/2016	114		11	X		33.0379	-117.5873
9/15/2016	114	3.5			X	33.133	-117.3618
9/15/2016	114	3.5			X	33.128	-117.355
9/15/2016	114	3			X	33.1419	-117.3523
9/15/2016	114	2.5			X	33.1358	-117.3632
9/15/2016	114		0.5	X		33.0486	-117.5793

# Results – Project 2

## SCCPSS Observations During Spring 2017 NOAA Acoustic Trawl Survey



## Results – Project 2

Observations from March 2017 SCCPSS Overflights of NOAA Acoustic Survey							
Date	Line	Biomass (mt)		Offshore	Inshore	Location	
		Sardine	Anchovy			Latitude	Longitude
3/24/2017	2_1		60	X		33.1298	-117.373
3/24/2017	2_1		30	X		33.1203	-117.404
3/26/2017	2_3	30		X		33.4244	-118.285
3/26/2017	2_3	30		X		33.4141	-118.283
3/26/2017	2_3	5		X		33.427	-118.288
3/26/2017	1_4		5		X	33.6995	-118.072
3/26/2017	1_4		10	X		33.6377	-118.226
3/26/2017	1_4		8	X		33.6412	-118.23
3/26/2017	1_4	4		X		33.6377	-118.226
3/28/2017	1_4		15		X	33.6875	-118.083
3/28/2017	2_5	2		X		33.9293	-118.86
3/30/2017	2_6		20	X		34.1006	-119.296
3/30/2017	1_7		20		X	34.2778	-119.332
3/30/2017	1_6		4		X	34.0464	-119.002



# Results – Project 2

	Sardine		Anchovy	
	TBp	TC	TBp	TC
	offshore	inshore	offshore	inshore
Field	30	5	60	5
Tonnages	30		30	15
	4		10	20
	2		8	4
			20	
$\Sigma =$	66	5	128	44

$$T = TA + (\Sigma TC / \Sigma TBp) * TBs$$

T = Total biomass estimate (tons) in SCB waters

A = Area represented by ATM transect line (offshore)

B = Plane-ship overlap

Bp = Transect line B flown by plane for overflight study

Bs = Area surveyed by ship

C = Nearshore line flown by plane for overflight study

Ex.	TA	30,000
	TBs	10,000

T =	<b>30,758</b>	<b>33,438</b>
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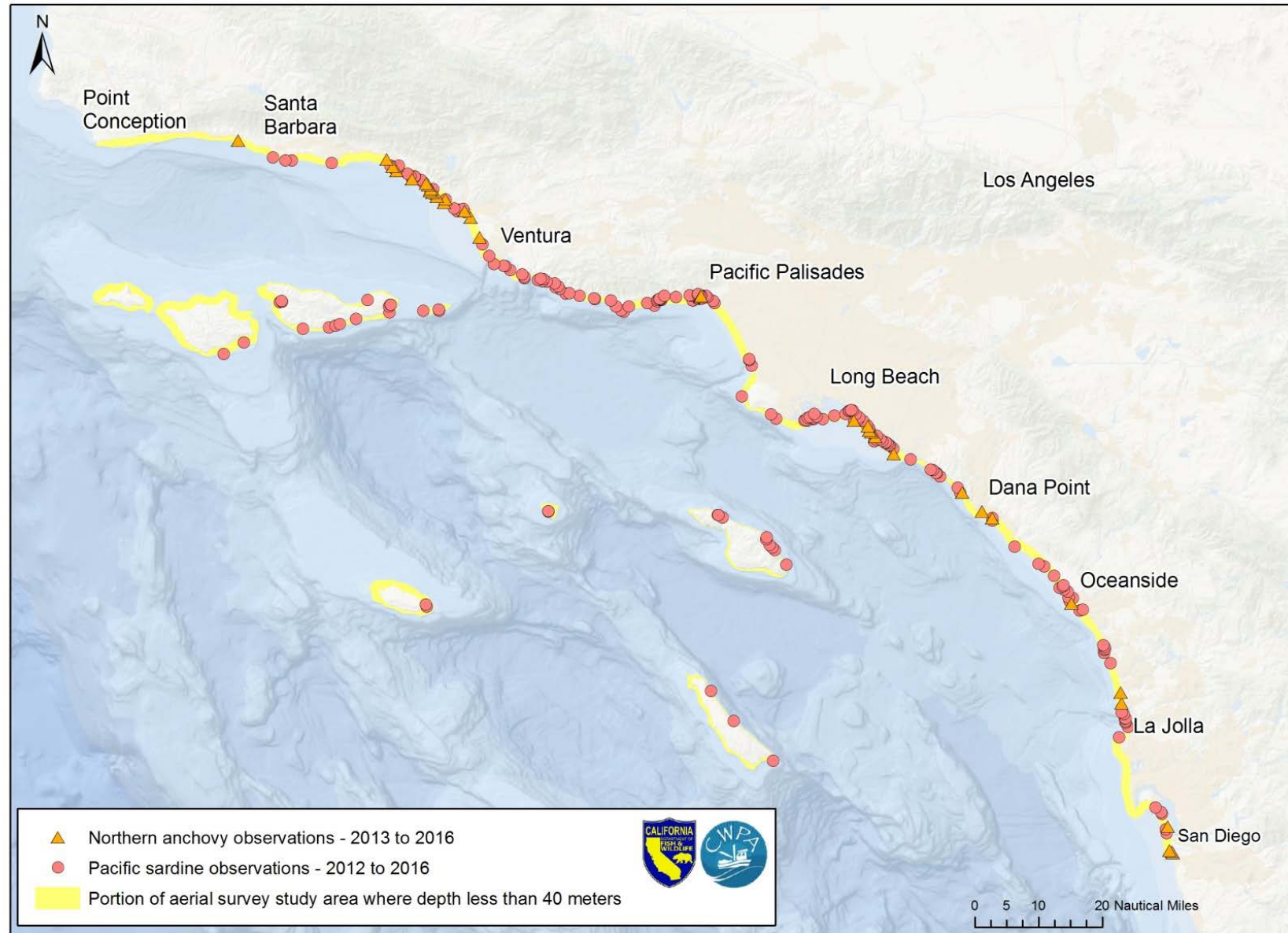
# Background

- Sardine stock assessment survey indices
  - Surveys - Offshore waters
- CDFW-CWPA partnership (2012+)
- Nearshore surveys -
  - California - nearshore sardine fishery
  - Sardine has had historical centers of spawning and recruitment in nearshore California waters
  - Anchovy reside in nearshore when stock is high or low
  - Young fish congregate nearshore – data may inform recruitment
  - Provide data on coastal abundance (within 2 nm)



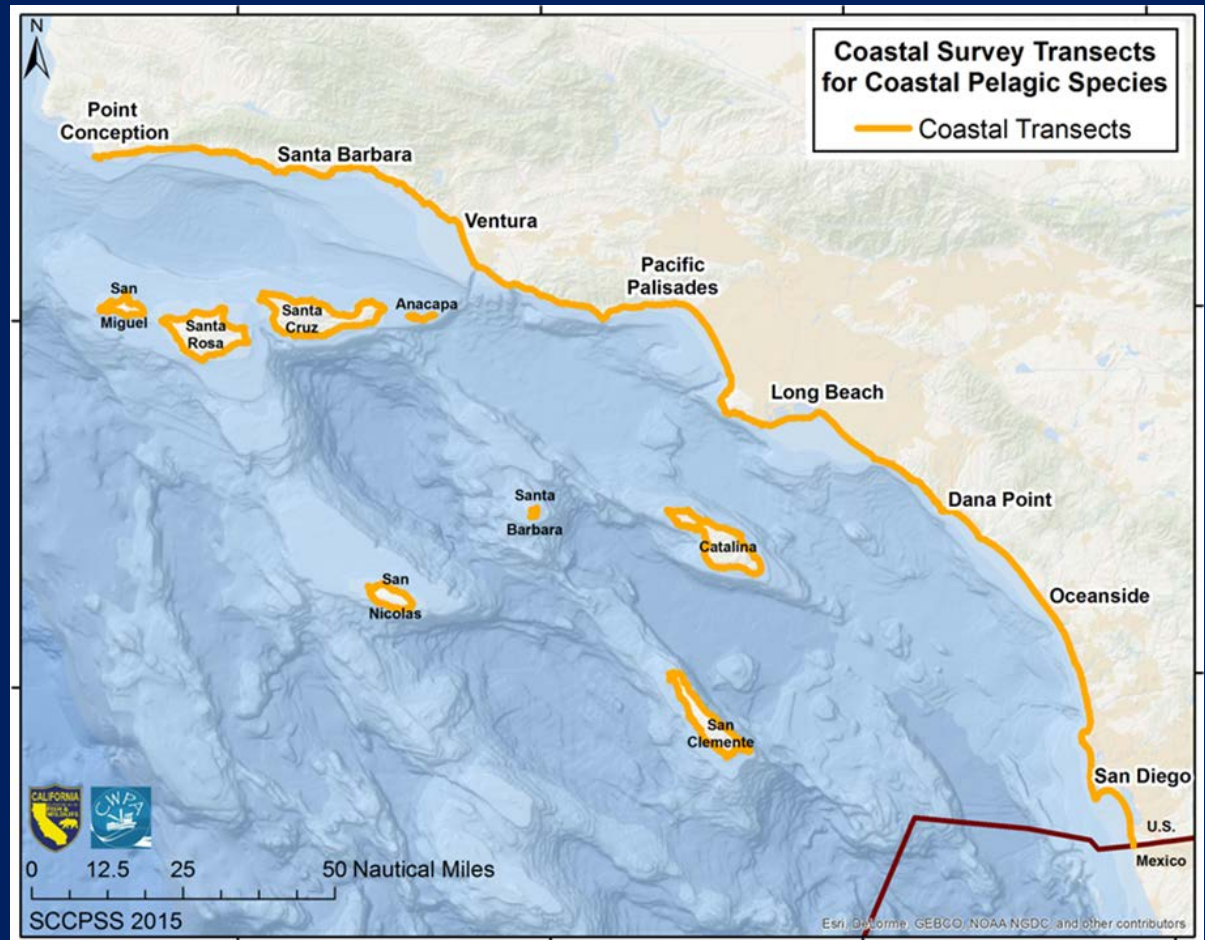
# Aerial Survey and CPS Management

Aerial Survey Observations from Depths Shallower Than Minimum Operational Depth of ATM Vessel



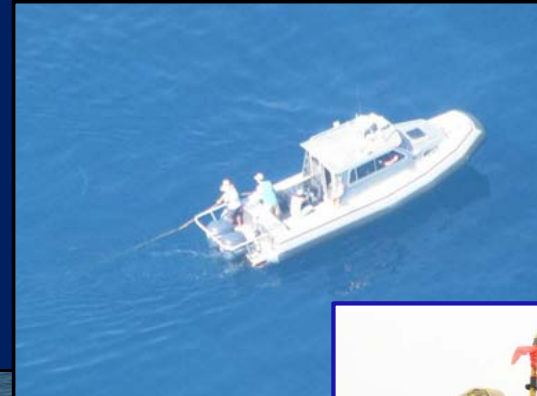
# Methods – Design/Operations

- Coastal areas
- Survey conducted during spring and summer
- Summer 2012 – Summer 2016
- Flights dependent on weather and plane availability



# Methods – Boat Sampling

- Conducted each season
- Boat directed by plane to fish school
- Aerial observer ID species
- Boat samples fish
  - tow camera (right) or diver video
  - Hook and line (sabiki rig), gillnet, purse seine
- Water temperature, clarity, salinity recorded



Deploying tow camera



Fish schools under boat

# Methods – Design/Operations

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	Spring	<b>NO SURVEY</b>		
	Summer	Coastal	1500	2
2016	Spring	Coastal	1500	2
	Summer	Coastal	1500	2
2017	Spring	<b>NO SURVEY</b>		
	Summer	Coastal	1500	2

# Management

- Aerial Survey Methodology Review – April 2017
  - Negatively-biased biomass estimate to be added to ATM estimate
  - Use of survey data contingent on development of variance estimator and further work on validation of observer tonnage estimations and species identifications
- Research
  - Collaborative research and EFP for work in 2018 to collect data for variance estimator and observer validation

# Summary

- CDFW-CWPA collaborative aerial surveys for CPS abundance conducted since summer 2012
- Survey efforts focused on nearshore areas  $< 2$  nm from shore
- Observed biomass represent minimum estimates of abundance due to depth limitations of observer
- Surveyed areas cover partial range of sardine and anchovy stocks
- Continuing research to develop variance estimations, validate observer tonnage estimates and species identifications, and collect biological information





# Methods – Transects

## Project 1

- Verify species
- Get tonnage estimate
- Photo passes
- Frame/time noted
- Resume transect



Microsoft Excel - 20120731.xls

1	Type	Time	Lat	Lon	RadAlt	Alt	Spd	Lens	OL	Mode	Internal	Count	GCS	GCF	GPSAlt	GPSSpeed	G	
2	S	12:50:10																
3	X	12:51:25	33.8123	118.1536	1649.1	3000	130	24	1	1	5.46	625	4500	3000	32	WAAS	9	0
4	C	13:44:17	33.8131	118.1532	2499.99	takeoff												
5	X	13:56:04	33.7283	118.4167	2499.99	2000	130	24	1	1	3.64	626	3000	2000	1983	WAAS	7	132.71
6	X	13:56:08	33.7295	118.419	1649.1	2000	130	24	1	1	3.64	627	3000	2000	1975	WAAS	6	132.18
7	X	13:56:11	33.7314	118.4205	1649.1	2000	130	24	1	1	3.64	628	3000	2000	1963	WAAS	7	131.06
8	X	13:56:15	33.7335	118.4208	1649.1	2000	130	24	1	1	3.64	629	3000	2000	1948	WAAS	8	129.13
9	X	13:56:19	33.7356	118.4202	1649.1	2000	130	24	1	1	3.64	630	3000	2000	1947	WAAS	7	124.96
10	X	13:56:22	33.7373	118.4187	1649.1	2000	130	24	1	1	3.64	631	3000	2000	1962	WAAS	8	120.83
11	X	13:56:26	33.7388	118.4171	1649.1	2000	130	24	1	1	3.64	632	3000	2000	1992	WAAS	9	119.11
12	X	13:56:30	33.7406	118.416	1649.1	2000	130	24	1	1	3.64	633	3000	2000	2018	WAAS	8	119.87
13	X	13:56:33	33.7426	118.4156	2499.99	2000	130	24	1	1	3.64	634	3000	2000	2020	WAAS	8	122.9
14	X	13:56:37	33.7446	118.4161	1649.1	2000	130	24	1	1	3.64	635	3000	2000	1995	WAAS	8	128.2
15	X	13:56:41	33.7467	118.4172	1649.1	2000	130	24	1	1	3.64	636	3000	2000	1962	WAAS	7	131.64
16	X	13:56:44	33.7486	118.4186	1649.1	2000	130	24	1	1	3.64	637	3000	2000	1942	WAAS	8	134.46
17	X	13:56:48	33.7504	118.4202	2499.99	2000	130	24	1	1	3.64	638	3000	2000	1933	WAAS	8	135.6

Data Log file

CPS Aerial Survey  
Transect Flight Log

Date: 8-28-13 Pilot: Tom Evans Observer(s): Devin Reed, Kirk Lynn

Page 1 of 3

Transect(s)		Start Time	Start Photo No.	End Photo No.						
9, Catalina		~1004	9270							
Obs No.	Fish Sp	Time	Frame Start No.	Frame End No.	Est Tonn (st)	Num of Schools	Cloud/Glare	Wind	Altitude	Comments
		1008	9211				1/2	<5kts	~1400	an entire Catalina #9 (best available as of now)
		1021	9363		START TRANSECT		9	(5band)		-some question if start pt is correct -also LAX airspace restricted
		1038	9489				2/2	8-10kts		more clouds - spotty
		1042	9522		PAUSE TRANSECT		9			too many clouds -pause ~21 miles short
		1043	9526							an note → Catalina (two herbers)
		1053	9710		START CATALINA					
		1058	9800							banking, can't find (near seal)
		1104	~9869							past West end
		1105	9887							a couple of logs - the decide to back from other end (sun rising)
		1114	9979							turn @ quarry - →
1	S	1115	10000	10003	3-4	1		~5kts		
2	PM	1118	10081	10084	2-3	1				(pic, 2013-08-28 school, 1st time seen - 2 schools)
3	S/PM	1123	10176	10190	6	1				~10% (or less) PM
4	S	1124	10215	10216	1	1				

Fish species code: S - sardine, A - anchovy, PM - Pacific mackerel  
 Glare code: 1 - No glare, 2 - glare <50%, 3 - glare >50%, 4 - Cloud shadows <50%, 5 - Cloud shadows >50%, 6 - No visibility  
 Cloud Cover code: 1 - Clear, 2 - Cloud Coverage <50%, 3 - Cloud Coverage >50%, 4 - No Visibility  
 Beaufort Wind Scale: Refer to attached Beaufort Wind Scale (0-12) to quantify sea state (or indicate wind speed in knots)

Logsheets







# Future Work

- Continue boat sampling - validate species ID, collect additional samples
- Collect more data for Project 2 inshore/offshore ratio
- Potential index of recruitment
- Continued CDFW and CWPA support
  - Next survey – May 2017
- Coordinated Aerial-Acoustic surveys
  - Nearshore sampling proposal – Summer 2018

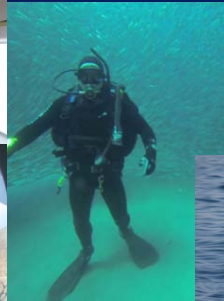
# Results - Project 1

Year	Season	Dates	Area Surveyed (km <sup>2</sup> )	Sardine			Anchovy		
				B (mt)	D (mt/km <sup>2</sup> )	RE (%)	B (mt)	D (mt/km <sup>2</sup> )	RE (%)
2012	Summer	7/30 - 8/17	880	7225	8.21	2.8	-	-	-
2013	Spring	4/22 - 5/21	831	1543	1.86	3.3	-	-	-
	Summer	8/1 - 10/4	945	6278	6.64	3.3	15199	16.08	5.2
2014	Spring	5/13 - 6/20	2074	3859	1.86	4.2	7612	3.67	10.8
	Summer 1	8/4 - 8/18	832	62	0.07	3.2	386	0.88	5.3
	Summer 2	8/25 - 8/26	370	0	0	-	568	1.54	5.1
2015	Spring	NO SURVEY							
	Summer 1	8/7 - 8/29	1736	116	0.07	1.8	0	0	-
	Summer 2	10/1 - 10/6	1650	375	0.23	2.6	0	0	-
2016	Spring 1	4/16 - 5/2	1290	3364	2.61	1.5	1052	0.82	2.0
	Spring 2	5/23 - 6/23	798	7050	8.83	2.0	4224	5.29	3.9
	Summer	8/11 - 9/6	1679	7560	4.50	4.8	29	0.02	4.8

# Summary

- Survey covers coastal nearshore areas of Southern California Bight
- Results useful for:
  - Index of nearshore abundance (Project 1)
  - Supplement to ATM offshore data to account for nearshore biomass (Project 2)
  - Minimum absolute abundance estimate for surveyed nearshore areas – added to ATM estimate
  - Biological data provide information on age/length composition of nearshore fish
- Additional data stream for CPS stocks

# Acknowledgements



- CWPA - Diane Pleschner-Steele
- CWPA Observers - Devin Reed, Drew White
- CDFW Warden-Pilots - Tom Evans, Gary Schales, Kevin Kintz
- CDFW Office of Spill Prevention and Response
  - Christian Corbo, Mark Crossland, Sean Moe, Sau Garcia
- CDFW biologist / analyst staff
  - Alex Kesaris, John Budrick, Joe Weinstein, Phil Law, Briana Brady, Chelsea Protasio, Dan Averbuj, Kim Boone, Bill Miller, Paul Ton, Michelle Horeczko, Elizabeth Hellmers, Kenin Greer, Mia Roberts, Julianne Taylor, Roy Kim, Kathryn Johnson, Jeannette Miller
- Collaborative Fisheries Research West





# Methods – Design/Operations

## Project 1

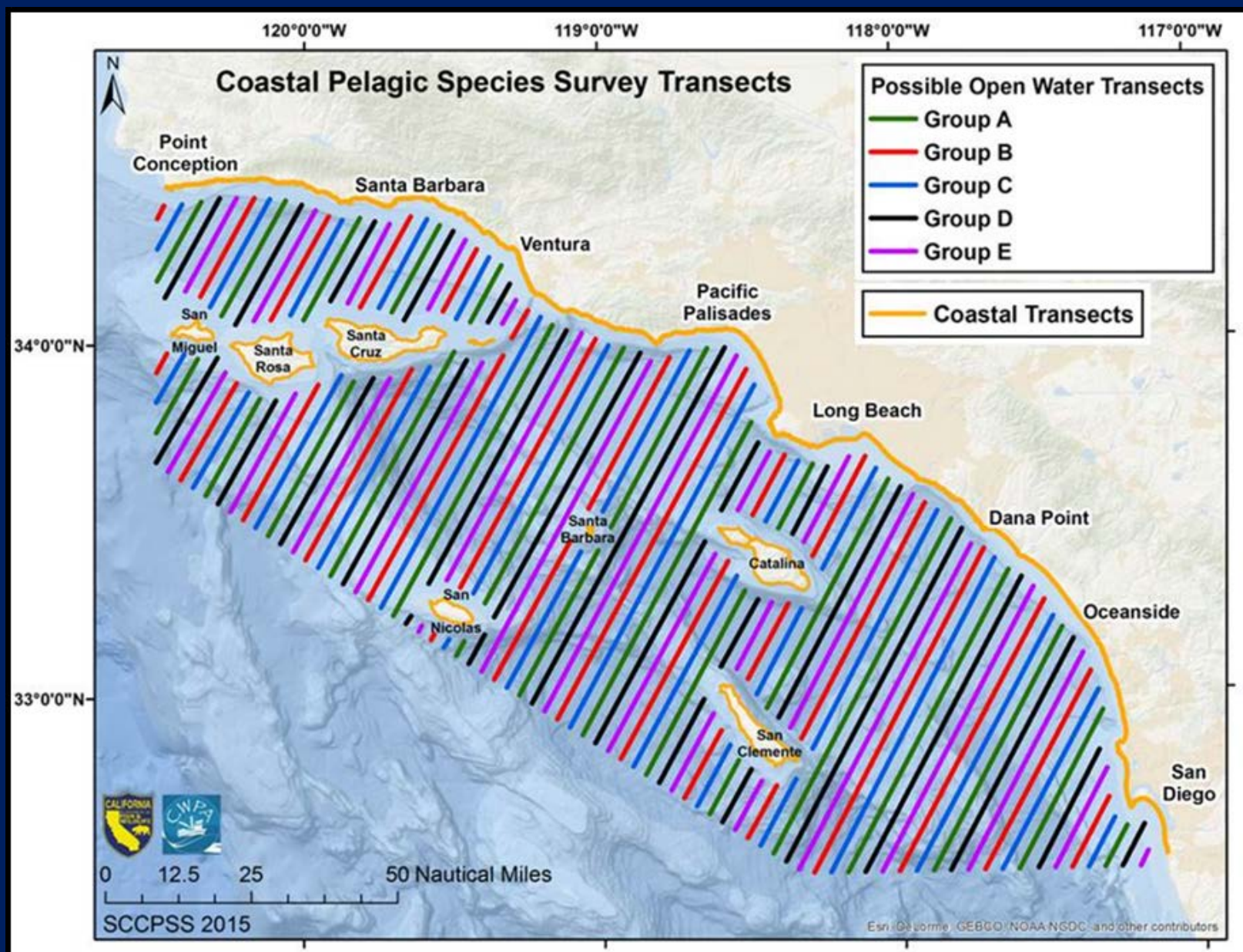
- November 2013, 2015 – Survey proposed for methodology review
- April 2014 - Informal review @ SWFSC

### Recommendations included:

- Focus on spring surveys (recruitment of Northern stock)
- Focus on coastal areas. Open water areas problematic (detectability, expansion of data)
- Add survey layers (“bands”) from coast to cover more area offshore →
- Shorten time to complete transects
- Evaluate transect widths
- Increase sampling from boat surveys
- Examine day vs. night survey observations
- Species selectivity when boat sampling



# Open Water Transects

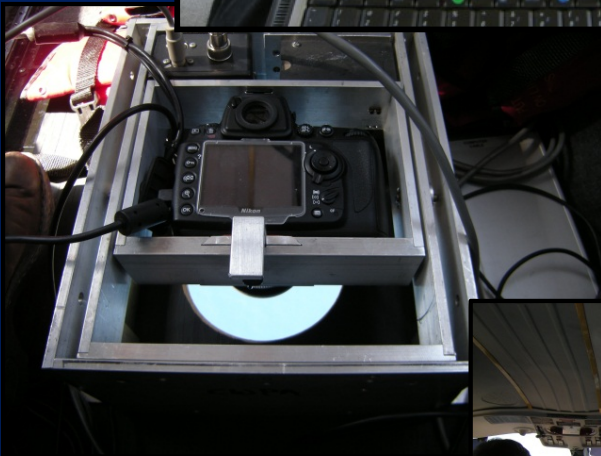


# Methods – Analyses

	Adjusted Plane- Estimated Tons	Landed Tons				
<b>i</b>	<b>x</b>	<b>y</b>	<b>y/x</b>	<b>r<sub>j</sub>-r<sub>0</sub></b>	<b>w<sub>j</sub></b>	<b>[w<sub>j</sub>(r<sub>j</sub>-r<sub>0</sub>)]<sup>2</sup></b>
1	5	4.8	0.97	-0.133	0.00568	0.0000006
2	27	40.2	1.49	0.385	0.03069	0.0001396
3	22.5	25.7	1.14	0.041	0.02558	0.0000011
4	30	38.5	1.28	0.181	0.0341	0.0000382
5	5	10.1	2.02	0.919	0.00568	0.0000273
6	15	10.9	0.73	-0.377	0.01705	0.0000414
7	15	15.4	1.02	-0.079	0.01705	0.0000018
8	9.5	15.0	1.57	0.472	0.0108	0.0000259
9	5	6.7	1.35	0.242	0.00568	0.0000019
10	10.8	17.9	1.66	0.556	0.01228	0.0000466
11	10	2.8	0.28	-0.819	0.01137	0.0000867
12	10	9.6	0.96	-0.142	0.01137	0.0000026
13	9.5	14.9	1.56	0.460	0.0108	0.0000247
14	25	20.0	0.80	-0.302	0.02842	0.0000737
15	11.4	10.7	0.94	-0.161	0.01296	0.0000044
16	47.5	58.7	1.24	0.133	0.054	0.0000513
17	25	31.3	1.25	0.150	0.02842	0.0000181
18	35	44.0	1.26	0.153	0.03979	0.0000368
19	61.75	67.4	1.09	-0.012	0.07019	0.0000007
20	45	45.0	1.00	-0.103	0.05115	0.0000275
21	49.5	38.8	0.78	-0.319	0.05627	0.0003220
22	52.25	23.9	0.46	-0.645	0.0594	0.0014673
23	42.75	46.8	1.10	-0.008	0.0486	0.0000002
24	80	84.9	1.06	-0.042	0.09094	0.0000146
25	23.75	20.2	0.85	-0.253	0.027	0.0000468
26	50	64.2	1.28	0.181	0.05684	0.0001053
27	31.5	40.5	1.29	0.182	0.03581	0.0000423
28	50	76.8	1.54	0.433	0.05684	0.0006049
29	75	84.6	1.13	0.025	0.08526	0.0000044
Sum	879.70	970.55			1	0.0032586
	$r_0 = \Sigma y / \Sigma x =$	<b>1.1033</b>		$V(r_0) = [w_j(r_j - r_0)]^2 [n/n-1] =$		0.003374998
				SE =		0.058094732

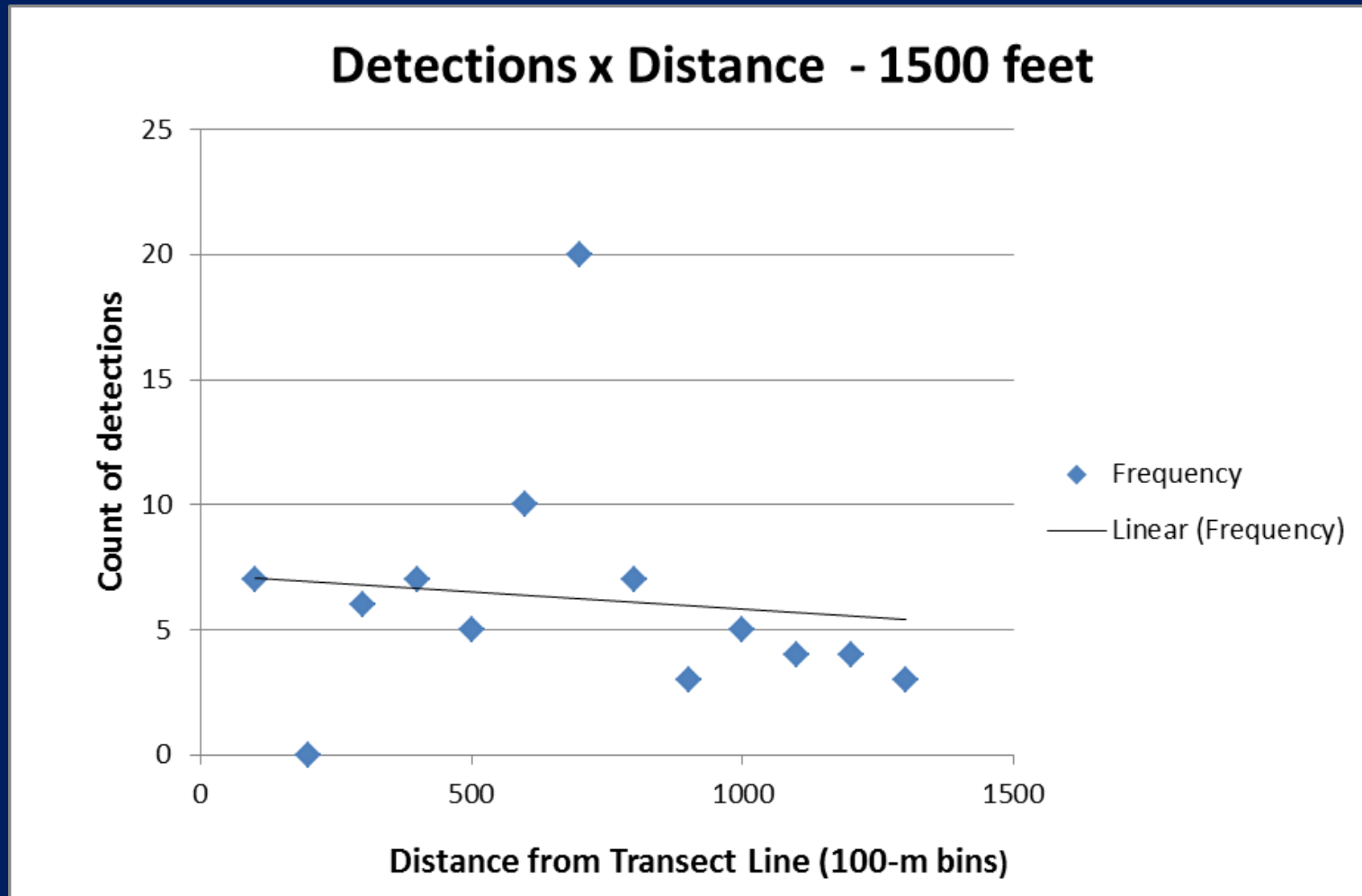
# Methods – Transects

## Project 1

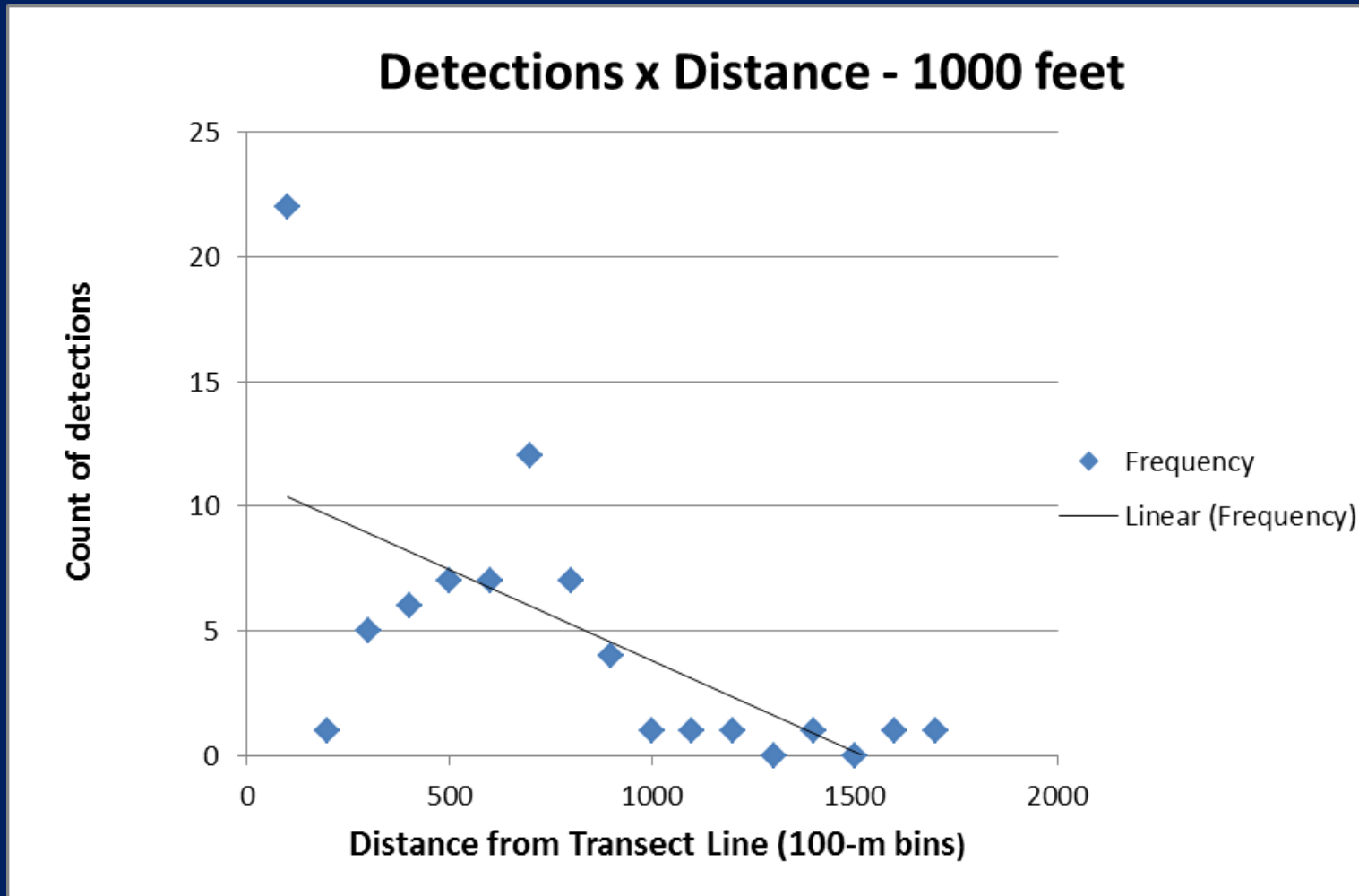


- Conditions noted
- FMC camera system / GPS
- Camera auto-fire from takeoff
- Photo Overlap setting varied
- Observer looking right
- Plane travel adjusted for glare

# Detection Distance



# Detection Distance



# Results - Project 1

## SCCPSS Boat Sampling

