Mass Mortality of Cassin's Auklets in 2014-15: Legacy of the Blob?

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Cassin's Auklet Encounter Rate 2014/2015

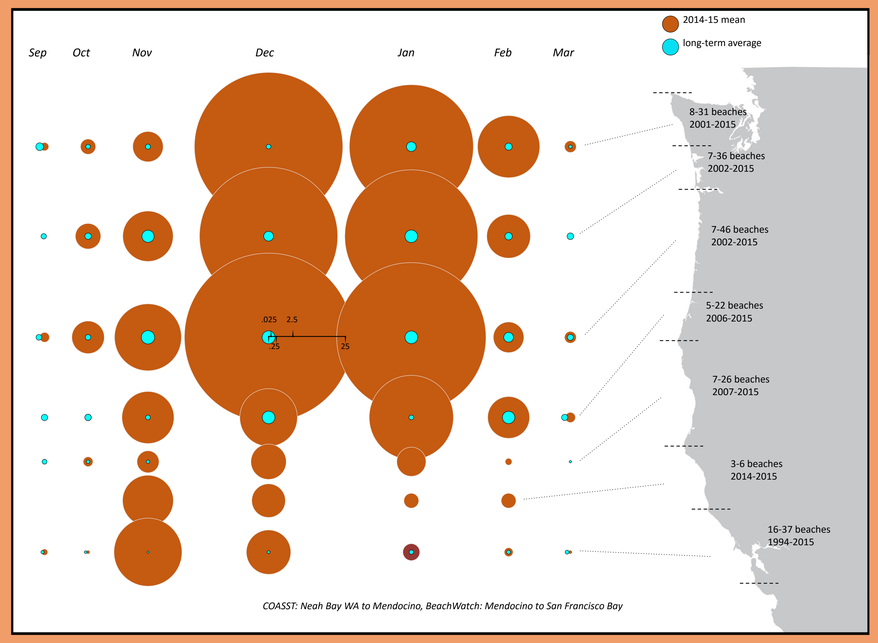

Figure 1. Bubble plot showing the progression of the 2014 Cassin's Auklet wreck. Bubble sizes indicate long-term average and 2014/2015 observations of encounter rate (birds/km surveyed)

In the late summer and early fall of 2014, untoward numbers of Cassin's Auklets (*Ptychoramphus aleuticus*) washed ashore starting in northern California (Nov) and progressing northward into northern Oregon and the outer coast of Washington (Dec).

Three citizen science programs, which collectively monitor over 200 beach sites on a monthly basis, documented monthly encounter rates (carcasses per km of beach surveyed) that were 1-3 orders of magnitude above regional long-term averages. Across the four month event, more than ***8,000 carcasses*** were found. Although the data collection effort was large, it represented less than 2% of kilometer days, indicating that ***total deposition may have been in the hundreds of thousands.***

SST > 1°C

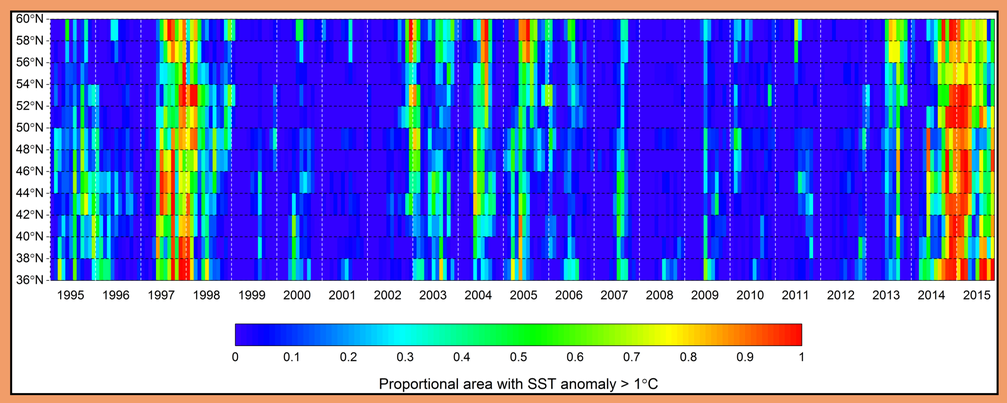

Figure 2. Plot showing the proportional ocean area (coast-200km offshore) where SST anomaly exceeded 1°C as a function of time and latitude (split into 2° bands)

We explored relationships between auklet annual encounter rates and ***four forcing factors***:

1. Colony production - proxied by 25-day chick mass on Triangle Island, BC. Hypothesis: more chicks = more carcasses through expected juvenile mortality.

2. Food type and availability - proxied by southern and northern copepod biomass (measured along the Newport Line). Hypotheses: higher abundance of northern assemblage = fewer carcasses due to better food supply, and vice versa.

3. Post-breeding habitat availability - proxied by the proportion of ocean area (coast – 200 km offshore) with SST anomaly > 1°C. Hypothesis: narrower strip of available cold water equates to habitat compression = more carcasses due to live population closer to shore increasing the chance of beaching regardless of mortality rate.

4. Winter storminess - proxied by average significant wave height. Hypothesis: increased storm exposure = more carcasses via physiological stress, or winterkill.

All variables were generated as annualized indices. All possible GLM combinations of these predictors, as well as all two-way interactions, were evaluated and ranked based on AICc.

Best Models

Table 1. Model summary table for the ten best models fitted to the Cassin's encounter rate data (2001-2014). Table includes estimated regression coefficients and model summary statistics.

Predictor	Regression coefficients									
25d mass anom						0.00			0.00	
N copepod anom					-0.02		0.10			0.14
S copepod anom	1.16	0.79		1.15	1.13	1.17	0.45	1.65		0.81
Ave Hsig				-0.14						
Prop SST anom > 1		0.04	0.08					0.00	0.09	0.06
N cope anom:S cope anom							-1.70			
S cope anom: Prop SST > 1								0.20		
Model rank	**1**	**2**	3	4	5	6	7	8	9	10
AICc	**-5.3**	**-3.5**	-2.8	-2.8	-1.7	-1.7	-1.4	-1.2	-0.1	0.2
delta AICc	**0.0**	**1.8**	2.5	2.5	3.6	3.6	3.9	4.1	5.2	5.5
Weight	**0.30**	**0.12**	0.09	0.09	0.05	0.05	0.04	0.04	0.02	0.02
adj-R^2	**0.54**	**0.56**	0.46	0.54	0.50	0.50	0.58	0.58	0.45	0.54

The highest ranking (AICc) models included the ***sole effect of southern copepod biomass***, and this factor with the ***added effect of the proportion of habitat with an SST anomaly >1°C*** (Table 1). Both factors were explanatory even excluding the outlier point 2014, which drove the full time window relationships. There were no discernable effects of colony-based variables or storminess.

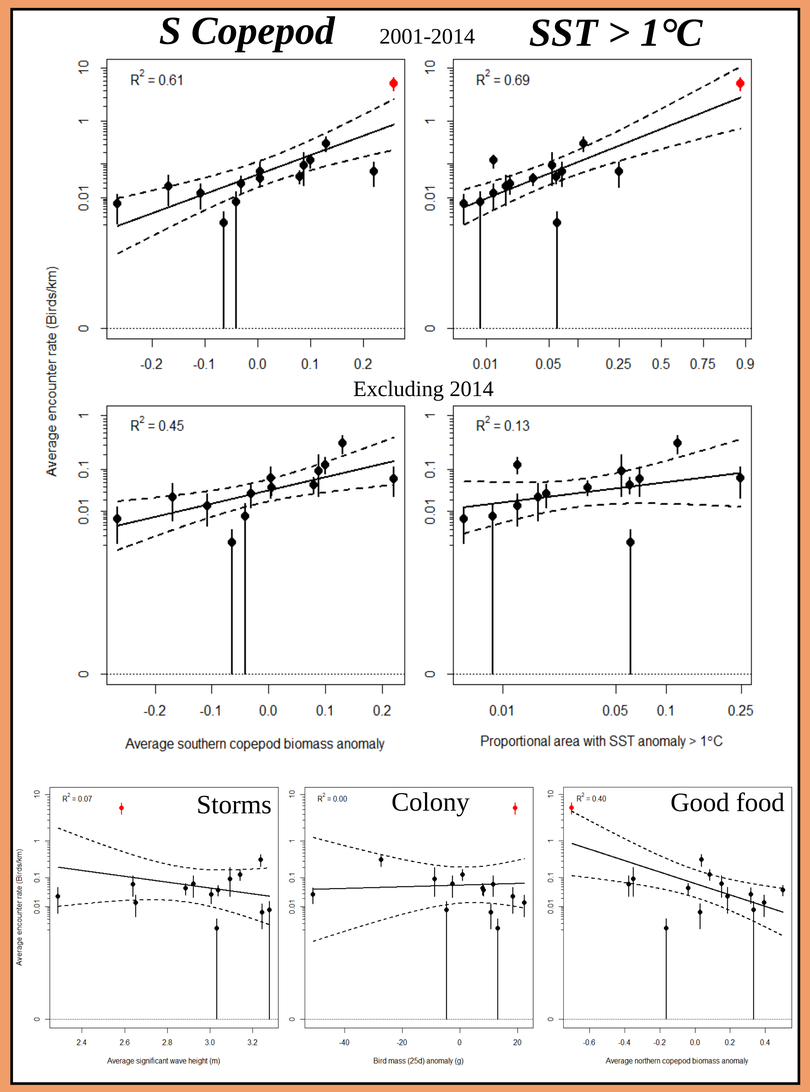

Figure 3. Cassin's Auklets mean encounter rate (± 95 % CI) plotted against southern copepod biomass and habitat compression indices (SST anomaly). The lower panel shows the same response plotted against average significant wave height, 25-day chick mass anomaly, and northern copepod biomass anomaly. In all cases regression lines and R^2 values are for models with just those individual factors. Red points in all panels are 2014.

These preliminary analyses suggest that ***introgression of the "wrong" type of food*** – smaller, less energetically valuable copepods may have stressed dispersing auklets, and that this stressed population may have simultaneously been ***compressed into remnant cold water concentrated along the coastline*** as seasonal upwelling transitioned into downwelling, pushing anomalously warm offshore water shoreward.

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