

## APPENDIX

The snippet database included the following fields:

SnipUID	Unique ID (a composite of study code, date, and a sequence number)
SUBJECT	Species or List included in SUMOBS and MAXOBS, in this case ASSP
STUDY	Study code (4 characters)
PLATFORM	Survey platform (Ship or Air)
SUMOBS	Number of SUBJECT observed
MAXOBS	Largest SUBJECT sighting
MONTH	
YEAR	
DATE	MM/DD/YYYY
LON	Longitude of snippet midpoint (decimal degrees)
LAT	Latitude of snippet midpoint (decimal degrees)
SST	Average SST (°C) for the location and month of snippet (data from 1985-2009)
DEPTH	Depth (m) at the location of snippet
DISTLAND	Distance (km) to nearest point on mainland
DISTTOP	Distance (km) to nearest point on shelf-top (200 m contour)
DISTBOT	Distance (km) to nearest point on shelf-bottom (2000 m contour)
DISTCOL	Distance (km) to nearest ASSP colony
MAXAREA	Maximum snippet area (km <sup>2</sup> )
SNIPAREA	Area of snippet (not more than MAXAREA, km <sup>2</sup> )
SNIPLENGTH	Length of snippet (km)
SNIPWIDTH	Mean strip width of corridor for snippet (area divided by length - units in km)

Explanatory variables and their spatial scales and sources, with more detail provided in a series of publications in which repeatedly they have been used (Briggs *et al.* 1987, Oedekoven *et al.* 2001, Ford *et al.* 2003, Ainley *et al.* 2009, Nur *et al.* 2011):

SST – sea surface temperature for the month in which a count was made, data from 1985 through 2009 downloaded as GeoTIFF files and converted to ASCII files (NODC 2012). Monthly average values (all years combined) were derived for a 10 min latitude-longitude grid. Identifies water mass, location of persistent fronts.

DEPTH – bottom depth (meters) based on a 1-min grid (ETOPO1 Global Relief Model (NOAA)). Identifies presence in shelf, slope or oceanic habitat.

DISTLAND – distance (km) to the mainland coast of California (see NOAA 2003, Nur *et al.* 2011). Identifies degree of association with coastal roosting and breeding sites in which seabird populations are poorly quantified.

DISTTOP – distance (km) to the 200 m bathymetric line, downloaded from USGS (CAORWALL: Bathymetry for the California, Oregon, and Washington Exclusive Economic Zone (publication date 1991). This is upper depth of continental slope where the shelf-break front occurs, a major oceanographic and faunal boundary.

DISTBOT – distance (km) to the 2000 m bathymetric line, downloaded from USGS (CAORWALL: Bathymetry for the California, Oregon, and Washington Exclusive Economic Zone (publication date 1991). This is the lower depth of the continental slope, beyond which is the deep ocean. Position of the shelf-break front, identifiable using temperature-salinity by depth, which are data not available without direct measurement.

DISTCOL – distance (km) to the nearest of three ASSP colonies that are the largest for the species (Prince Island, SE Farallon Island, and Northeastern Santa Cruz Island).

PLATFORM- Survey platform (Ship or Air)

Model covariates and their significance levels using the R package (R Core Team 2017).

The response variable (SUMOBS) and the explanatory variables are defined above.

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```
zeroinfl(formula = SUMOBS ~ DISTLAND + DISTBOT + DISTCOL + LAT | DISTLAND +
DISTBOT + DISTCOL + DISTTOP + SST + LAT, data = retraceNplus, offset = SnipArea, dist =
"negbin")
```

Pearson residuals:

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Min	1Q	Median	3Q	Max
-0.1756	-0.1027	-0.0512	-0.0198	655.4498

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Count model coefficients (negbin with log link):

	Estimate	Std. Error	z value	Pr(> z ) <sup>b</sup>
(Intercept)	-12.518879	1.650001	-7.587	3.27e-14 ***
DISTLAND	-0.017257	0.001274	-13.549	< 2e-16 ***
DISTBOT	-0.003924	0.000985	-3.983	6.80e-05 ***
DISTCOL	0.010750	0.003213	3.346	0.00082 ***
LAT	0.311827	0.043687	7.138	9.49e-13 ***
Log(theta)	-3.374893	0.120526	-28.001	< 2e-16 ***

Zero-inflation model coefficients (binomial with logit link):

	Estimate	Std. Error	z value	Pr(> z ) <sup>b</sup>
(Intercept)	23.014037	3.164351	7.273	3.52e-13 ***
DISTLAND	-0.056391	0.009885	-5.705	1.17e-08 ***
DISTBOT	0.011241	0.001122	10.022	< 2e-16 ***
DISTCOL	0.046778	0.003788	12.350	< 2e-16 ***
DISTTOP	0.027415	0.008240	3.327	0.000878 ***
SST	-0.825139	0.089875	-9.181	< 2e-16 ***
LAT	-0.319266	0.073125	-4.366	1.27e-05 ***

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<sup>a</sup> The response variable (SUMOBS) and the predictor variables are defined above.

<sup>b</sup> Significance \*\*\* = 0.001; Theta = 0.0342; Number of iterations in BFGS optimization: 64; Log-likelihood: -7756 on 13 Df

**Additional References:**

- AINLEY, D.G., DUGGER, K.D., FORD, R.G. ET AL. 2009. Association of predators and prey at frontal features in the California Current: Competition, facilitation, and co-occurrence. *Marine Ecology Progress Series* 389: 271–294.
- FORD, R.G., AINLEY, D.G., CASEY, J.L., KEIPER, C.A., SPEAR, L.B. & BALLANCE, L.T. 2004. The biogeographic patterns of seabirds in the central portion of the California Current. *Marine Ornithology* 32: 77–96
- NODC (NATIONAL OCEANOGRAPHIC DATA CENTER) 2012. *4 km AVHRR Pathfinder v5.0 Global Day-Night Sea Surface Temperature Monthly and Yearly Averages, 1985–2009 (NODC Accession 0077816)*. Version 2.3. Silver Spring, USA: National Oceanographic Data Center, National Oceanic and Atmospheric Administration.
- NUR, N., JAHNCKE, J., HERZOG, M.P. ET AL. 2011. Where the wild things are: predicting hotspots of seabird aggregations in the California Current System. *Ecological Applications* 21: 2241–2257.
- OEDEKOVEN, C.S. AINLEY, D.G. & SPEAR, L.B. 2001. Variable responses of seabirds to change in marine climate: California Current, 1985–1994. *Marine Ecology Progress Series* 212: 265–281.
- R CORE TEAM 2017. *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing.