The following supplement accompanies the article

Relationship among prey availability, habitat, and the foraging behavior, distribution, and abundance of common terns *Sterna hirundo* and roseate terns *S. dougallii*

Holly F. Goyert[1,2,*]

[1]**Department of Biology, Doctoral Subprogram in Ecology, Evolutionary Biology and Behavior, The Graduate Center, City University of New York, 365 Fifth Avenue, New York, NY 10016, USA**
[2]**College of Staten Island, CUNY, 6S-143, 2800 Victory Boulevard, Staten Island, NY 10314, USA**

[3]***Present address:*** **Department of Forestry and Environmental Resources, Fisheries andWildlife Program, Jordan Hall Addition 5215, North Carolina State University, Raleigh, NC 27695, USA**

*Corresponding author: hgoyert@gc.cuny.edu

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Supplement. Estimated tern abundance, as compared to censused populations (Table S1), mapped covariate data layers (Fig. S1), plotted detection functions (Fig. S2), and plotted relationships among tern abundance and covariates (Fig. S3).

Table S1. Sampled, estimated, and actual (censused) abundance of common terns *Sterna hirundo* and roseate terns *S. dougallii* in Massachusetts (MA), USA. Distance sampling abundance calculations of common, roseate, and/or mixed terns ('CRMT') across 2 or 3 surveys, are compared to 2010–2011 mean MA breeding population sizes (right column, calculated from Mostello 2011, 2012). For each cluster of tern observations (Obs.), the detection function (see Fig. S2) computes detection probabilities (p) over the distance range. These probabilities are used to calculate the estimated abundance (Estim. Abund.) of tern clusters and individuals (Ind.) over the entire study area (6750 km^2), based on the percentage of area covered by the sampled abundance of terns (N). The density-surface models (see Table 1 in the main text) fit N to the covariates, then predict abundance over the study area, based on the average of those covariates across surveys. Spr: spring

Response	Surveys	Obs.	Range	Mean p (%)	Sampled Abund. (N)	Sampled Area (%)	Expected cluster size	Estim. Abund. Cluster	Estim. Abund. Ind.	Model	Mean MA pop.
CRMT	3	390	0–500	25.7	1517.5	10.4	3.8	14643.2	55043.2	2	35736
CT	3	344	0–300	36.0	956.9	6.2	3.5	15389.5	53818.0	6	32984
CT	2 - spr	334	0–300	35.3	944.9	4.4	3.5	21585.1	75871.1	8	32984
RT	2 - spr	30	0–300	2.0	1493.6	4.4	2.3	34116.7	78026.8	10	2752

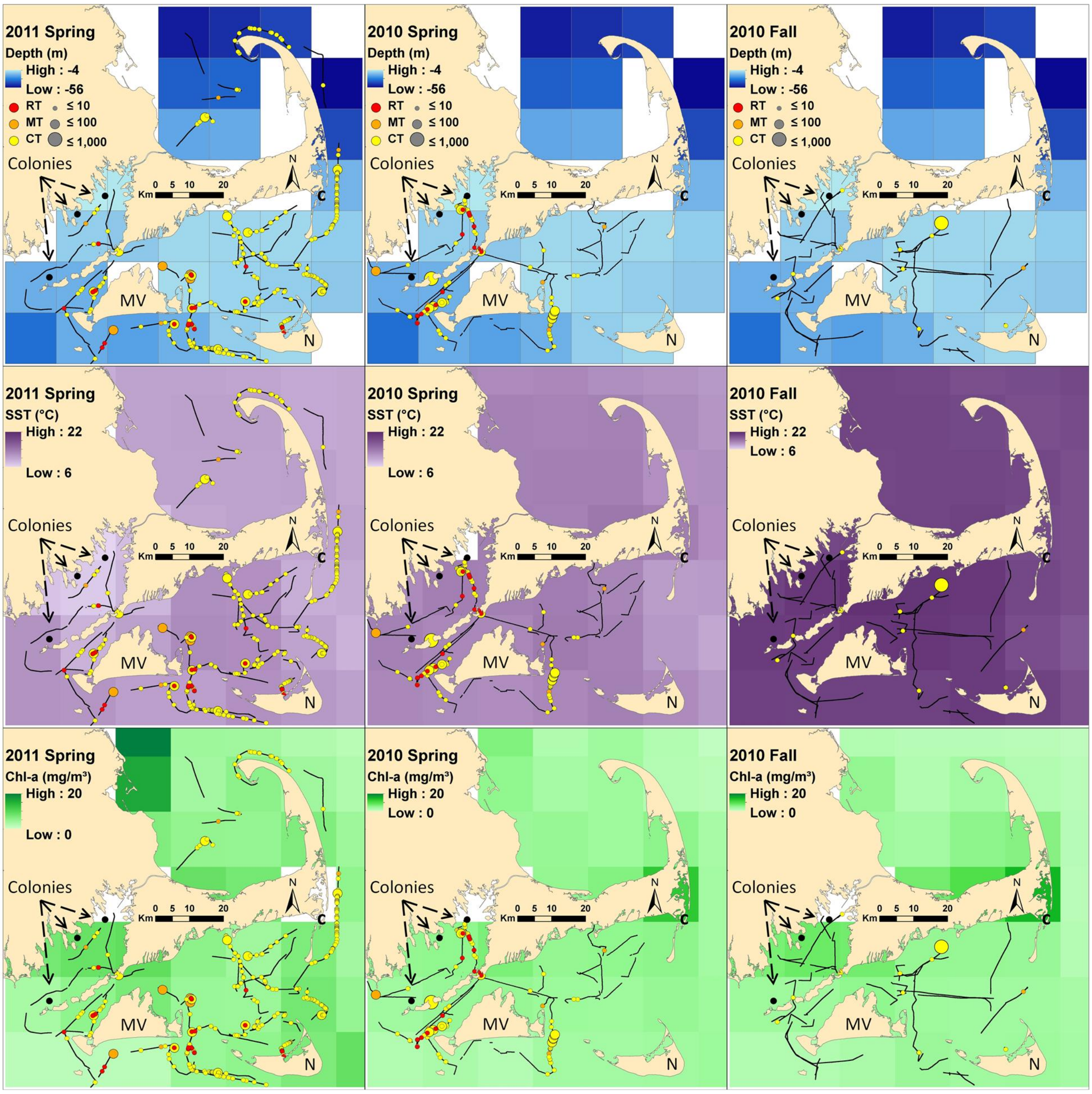


Fig. S1 (**a**)

Fig. S1. Tern habitat and prey covariate data layers for the 3 inshore surveys. For details on the study area, refer to Fig. 2 in the main text. Transect effort (black line), during the spring 2011 (left), spring 2010 (center), and fall 2010 (right) is overlapped by counts of observed common, roseate, and mixed terns (circles), and interspersed with prey sampling stations (small black dots). (a) Bathymetry, top row, delineates the 30 sampled grid cells (each 15 km × 15 km) used in the density-surface modeling; white cells indicate missing covariate data. The 3 habitat covariate layers depict depth, sea surface temperature (SST), and chlorophyll concentration. (b) The 3 prey covariate layers depict counts of sandlance, herring, and anchovy (<16 cm length). The grid cell between MV and Buzzards Bay is outlined to highlight its persistent sandlance abundance and roseate tern observations in spring 2010 and 2011

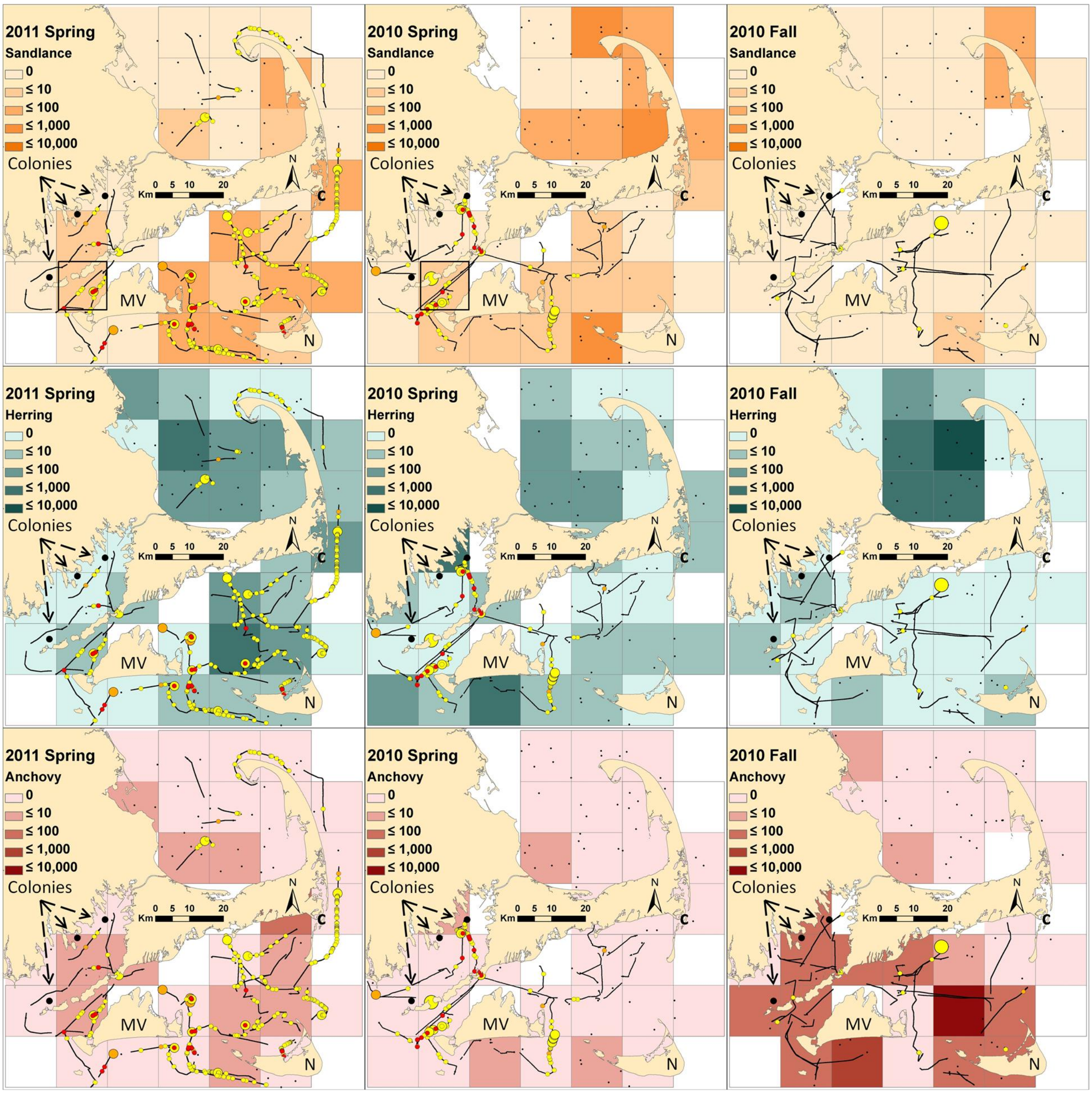
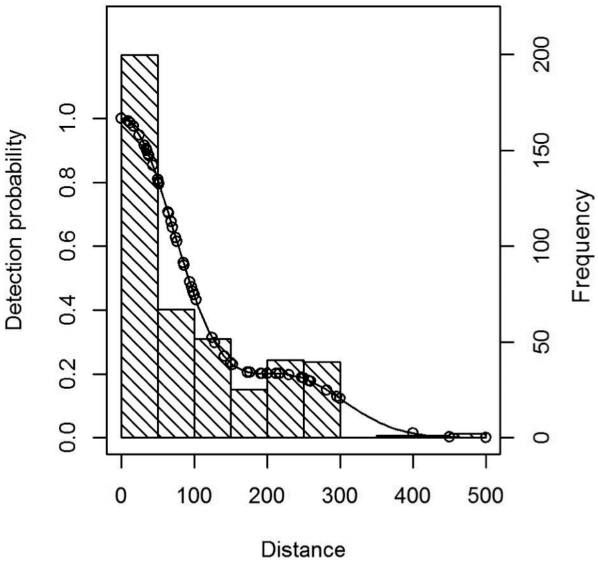
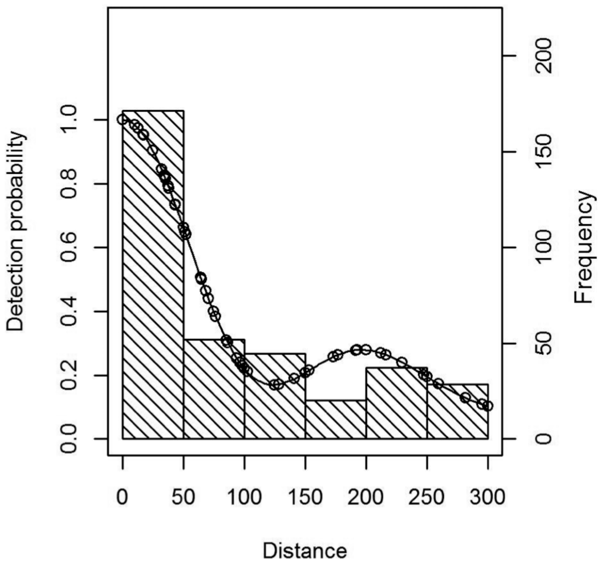

2011 Spring
Sandlance
0
≤ 10
≤ 100
≤ 1,000
≤ 10,000
Colonies
Km 0 5 10 20
N
C
MV
N
2010 Spring
Sandlance
2010 Fall
Sandlance
2011 Spring
Herring
2010 Spring
Herring
2010 Fall
Herring
2011 Spring
Anchovy
2010 Spring
Anchovy
2010 Fall
Anchovy

Fig. S1 **(b)**

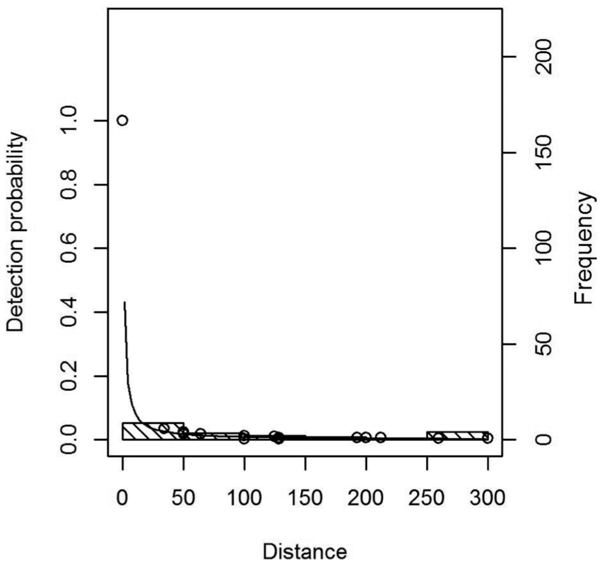


(a)



(b)

Fig. S2. Detection function plots. Detection probabilities (lines with points) and frequency histogram (number of observations per distance band) of (a) common terns *Sterna hirundo*, roseate terns *S. dougallii*, and mixed terns across all 3 surveys using conventional distance sampling (CDS); and across the 2 spring surveys: (b) common terns (CDS) and (c) roseate terns, using visibility in multiple covariate distance sampling (MCDS)



(c)

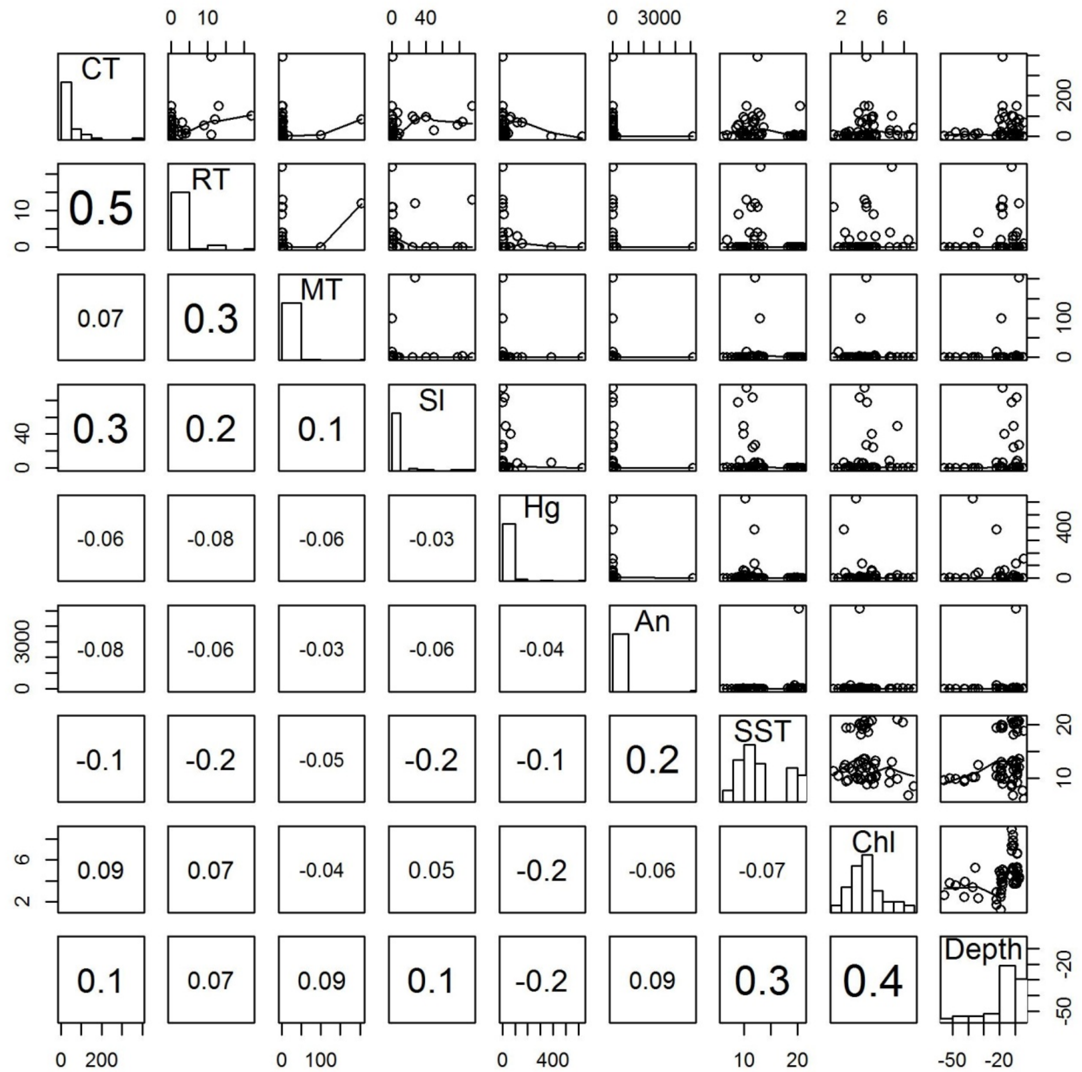


Fig. S3. Relationships among the response variables and covariates across all 3 inshore surveys. This 'pairplot' (Zuur et al. 2012) shows histograms of each variable on the diagonal, pairwise Spearman rank correlation coefficients (font size proportional to value), and scatterplots with a LOESS smoother, axes labeled alternately (*x* at top or bottom, *y* at left or right). The response variables are in the top rows and left columns (n = 52), common terns *Sterna hirundo* ('CT'), roseate terns *S. dougallii* ('RT'), or mixed terns ('MT'); prey covariates are sandlance ('Sl'), herring ('Hg'), and anchovy ('An'), and habitat covariates are sea surface temperature (SST), chlorophyll concentration ('Chl'), and depth.

LITERATURE CITED

Mostello CS (2011) Inventory of terns, laughing gulls, and black skimmers nesting in Massachusetts in 2010. MDFW, NHESP, Westborough, MA

Mostello CS (2012) Inventory of terns, laughing gulls, and black skimmers nesting in Massachusetts in 2011. MDFW, NHESP, Westborough, MA

Zuur AF, Saveliev AA, Ieno EN (2012) Zero inflated models and generalized linear mixed models with R. Highland Statistics, Ltd., Newburgh