The following supplements (1 & 2) accompany the article

Community structure in pelagic marine mammals at large spatial scales

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Supplement 1. Additional information on the 3 assumptions that went into the ordination analysis: (1) lumping data from different sources; (2) the size of the sampling plots used; and (3) the chosen number of dimensions in the resulting ordinations. We include tabular results as well as graphical results to support the decisions we made during the analysis.

Assumptions that went into the analysis

As detailed in the main text, several simplifying assumptions were made. We explore the effects of some of these assumptions in further detail here. (1) We did not distinguish sightings by platform type, i.e. a species' location was counted equally regardless of whether the species was seen from a boat or a plane. (2) We chose the sites to be 50 km hexagons. (3) We settled on a 3D ordination for each of the 3 areas.

1. Effect of platform type on ordination results

To investigate the effects of lumping sighting platforms in the ordination, we took the most data rich region (North of Hatteras, NOH) and re-ran the ordinations with the sightings input data being split out by platform. Specifically, we split the main data frame of individual sightings according to the platform type prior to the assembly of the species by sites matrix. Using these new data frames, we then repeated the processing steps outlined in the methods section of the main text. Our goal was to determine the effects both quantitatively and graphically.

To spatially represent the platform-specific density of survey effort across the 3 regions, we created platform-specific line density raster surfaces using the LineDensity command in ArcGIS. We then tallied and aggregated the mean survey effort per hexagon. Results from this indicated that NOH is the only region with effort by both platforms, and with a boat-based effort that was less dense and more broadly distributed spatially than plane-based effort (Fig. S1). Effort from planes was concentrated inshore, although it covered the same extent as boats (Fig. S1).

We used the results from the 3D ordinations, and summarized them in 2 ways. First, we tallied the number of sites or hexagons on which each species was seen by platform type. We report these results along with the group membership vector for each ordination in Table S1. Second, we reproduced the ordination plots as seen in the main text. The first of these plots shows the main results for each ordination with chl *a* as the environmental background (chosen at random) (Fig. S2). We also produced 4 panel plots as in the main text, which allowed visualization of the placement of species in ordination space in relation to each of 4 environmental variables (Figs. S3 & S4).

Results from the pooling of sightings across survey platform types indicated 2 important patterns. First, the majority and the diversity of sightings in the NOH region were from boats. Thus, the results from the pooled ordination and the boat-only ordination were very similar (Fig. S2). The second important result is that the grouping as determined by partial Mantel tests seemed coherent across the platform types. While the offshore species were under-represented in the plane-only results, the grouping was very similar to that of the boat ordination (Figs. S3 & S4). The relative lack of offshore species in the plane-only results makes sense for 2 reasons. First, as planes have limited offshore range, the plane-based effort is concentrated onshore (Fig. S1). Second, because planes transit through any given area at a much higher speed, they are likely to miss some of the deeper diving species like beaked whales (Fig. S2).

One interesting point of comparison is the position of bottlenose dolphins (BODO) in each of the 3 comparison ordinations.

These results assured us that pooling species across platform types was appropriate in this application because (a) results followed the dominant platform, and (b) species grouping was similar regardless of platform.

2. Hexagon size

To construct the ordination, we first had to assemble the suite of sampling plots. We assumed in advance that there would be a balance between spatial resolution and spatial extent. The smaller the hexagons, the finer the ecological distinctions we would be able to make. However, smaller hexagons would result in lower species diversity on each plot. Lower diversity would in turn result in higher incidences of rare species and of very far distances in species space.

We started with 10 km hexagons, and performed the data setup necessary for the ordination. However, we were unable to reach convergence in the ordination. Choosing 30 km hexagons again did not allow us to reach convergence. Thus, we tried 50 km, and reached convergence for 4 ordinations (NOH, and NOH, SOH, GOM with rare species removed).

3. Stress plots and number of dimensions in the ordination

For each of the 3 geographic regions, we chose a 3D solution to the ordination. This solution was based on a compromise between fit and interpretability. To arrive at this solution, we iterated from 1 to 5 dimensions in calculating a solution to the multidimensional scaling (MDS) for each region. The isoMDS() function in vegan returns a ‘stress’ statistic (Oksanen et al. 2010), which we plotted as a function of each of the 5 dimensions. We looked for elbows in this plot, which indicate that further increase in dimensionality does not add to the ordination (McCune et al. 2002). Here we show the results for NOH, which showed a 36 and 27% reduction in stress values as dimensionality increased from 1 to 2 and from 2 to 3 dimensions (Fig. S5).

Table S1. Summary of 3 different ordinations for the North of Hatteras (NOH) region. The data used in the ordinations were (1) all sightings regardless of platform type (boat, plane); (2) all sightings by boat; and (3) all sightings by plane. Results here are the number of hexagons on which each species was seen (Sightings), and the Group membership as determined using partial Mantel test (see main text for details). Sightings by platform do not always sum to the value in the Sightings column since rarity was calculated per ordination. BODO: bottlenose dolphin; STDO: striped dolphin; GRAM: Risso's dolphin; PIWH: pilot whale; SPWH: sperm whale; UNBW: unidentified beaked whale; SADO: common (saddleback) dolphin; WSDO: Atlantic white-sided dolphin; HAPO: harbor porpoise; MIWH: minke whale; FIWH: fin whale; HUWH: humpback whale; RIWH: right whale; UNKO: pygmy or dwarf sperm whale; GOBW: Cuvier's (goose-) beaked whale; SOBW: Sowerby's (North Sea) beaked whale; ASDO: Atlantic spotted dolphin

Species	Sightings (all)	Group membership (all)	Sightings (boat)	Group membership (boat)	Sightings (plane)	Group membership (plane)
BODO	42	1	34	1	10	1
STDO	46	1	45	1	NA	NA
GRAM	52	1	49	1	6	3
PIWH	66	1	47	1	23	2
SPWH	61	1	58	1	5	1
UNBW	38	1	35	1	NA	NA
SADO	63	2	34	1	32	2
WSDO	47	2	12	2	33	2
HAPO	32	2	16	2	30	2
MIWH	35	2	14	2	24	2
FIWH	62	2	37	2	31	2
HUWH	40	2	15	2	26	2
RIWH	14	2	6	2	12	4
UNKO	14	3	14	3	NA	NA
GOBW	18	4	18	4	NA	NA
SOBW	13	5	13	5	NA	NA
ASDO	16	6	15	6	NA	NA

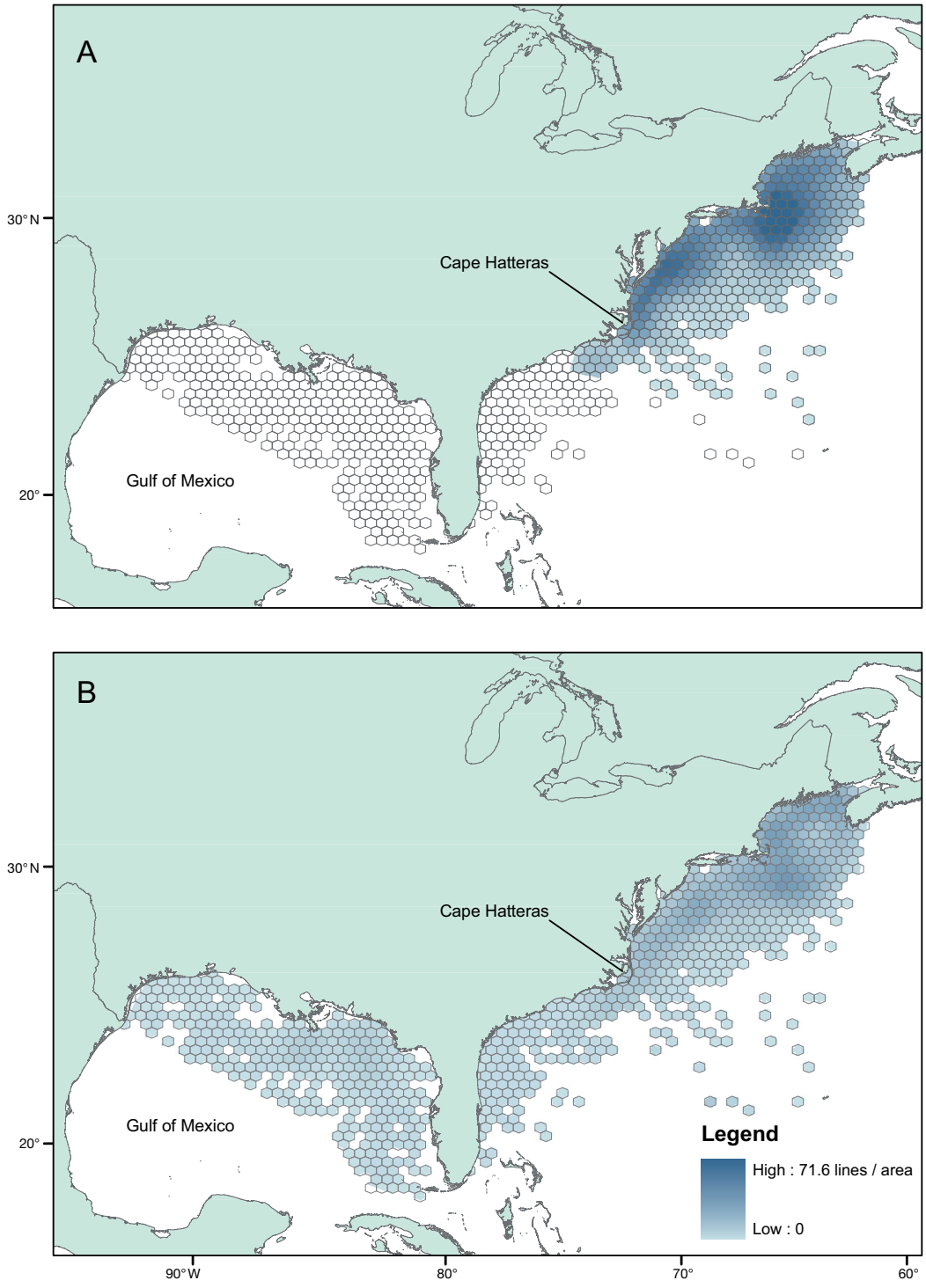

Fig. S1. Density of summertime survey effort by platform type: (A) plane, and (B) boat. North of Hatteras is essentially the only region with some overlap in platform type. SOH has some plane effort immediately south of Cape Hatteras; all sightings in GOM are from boats. The color scale is the same in the 2 panels, indicating a higher density of nearshore survey effort from planes. The underlying raster grid of effort was created with the LineDensity command in ArcGIS, which uses a kernel density estimator to estimate lines per unit area

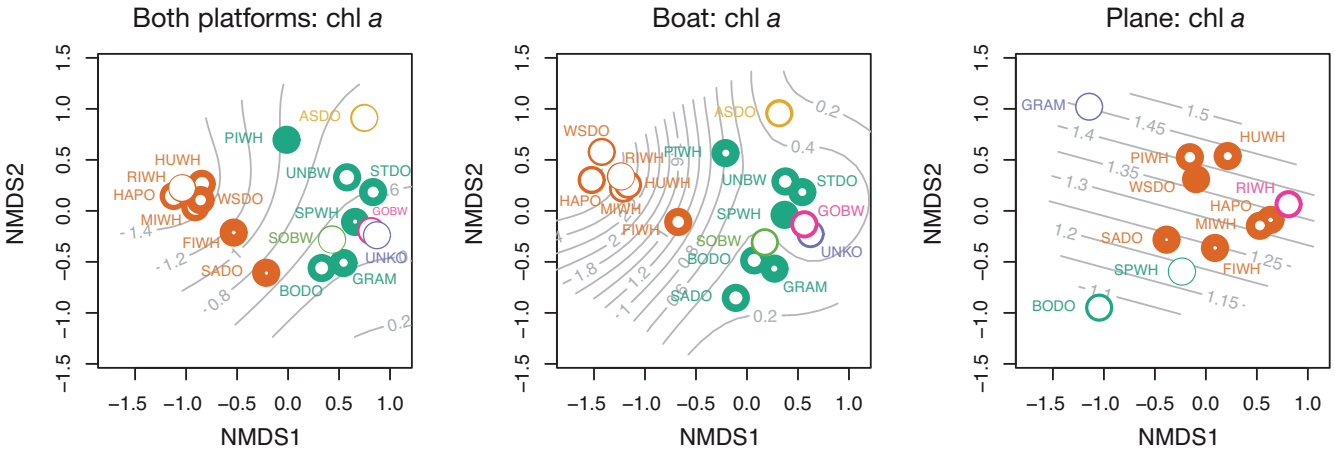

Fig. S2. Ordination results overlaid on chl *a* surface (grey contour lines; mg m^{-3}) from left to right: all platforms; sightings from boat only; sightings from plane only. NMDS: nonmetric multidimensional scaling. Note the similarity in the ordination between all platforms and the boat only platform, which makes sense given the preponderance of sightings from boats (Table S1). The groupings were also very similar across all 3 ordinations, the main difference being that certain members of the offshore (green) group in the first 2 ordinations were either not seen or were rarely seen from planes (Table S1). (See Table S1 for meanings of species abbreviations)

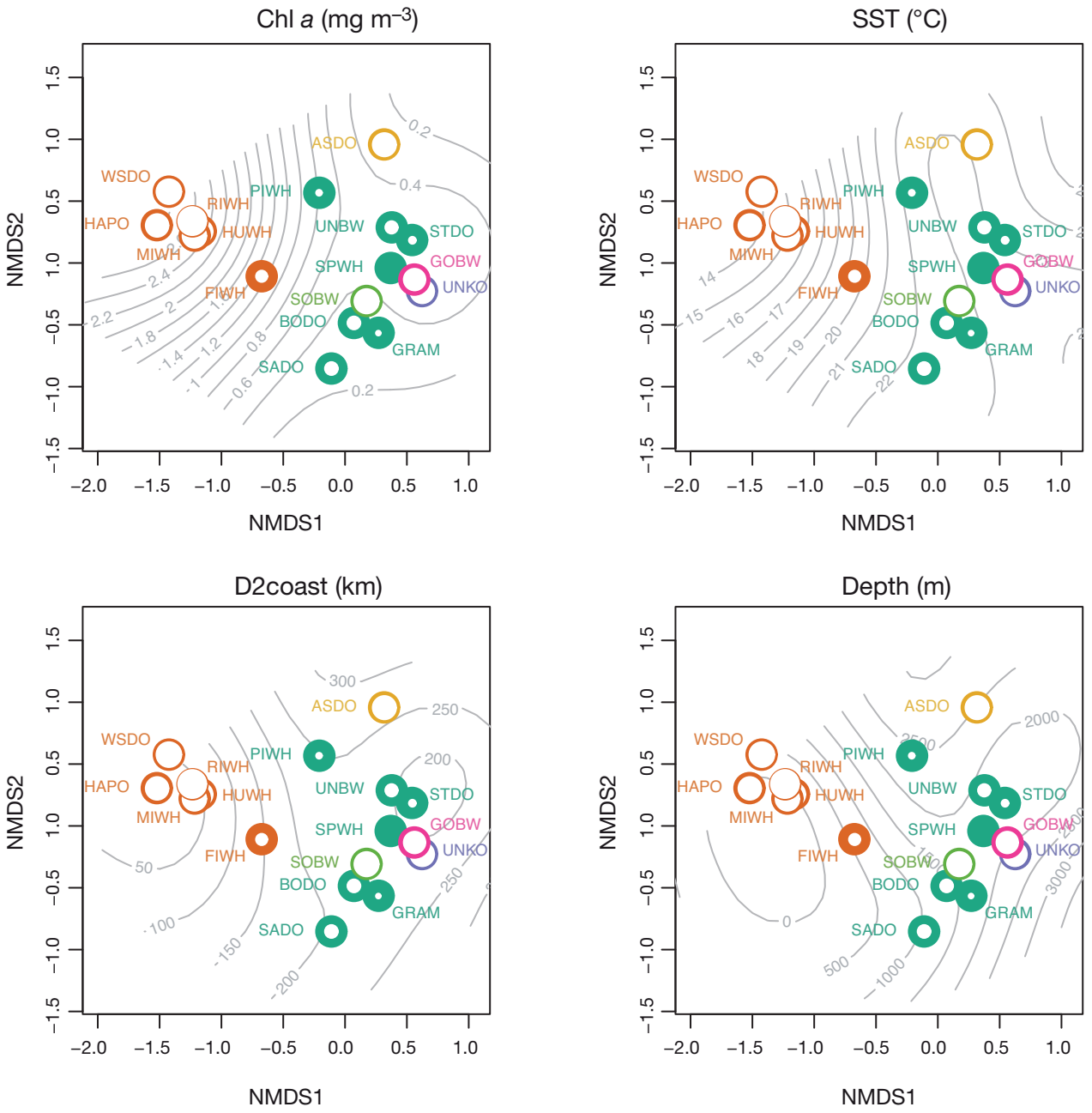

Fig. S3. Ordination results for the boat-only platform with each of 4 interpolated environmental surfaces in the background (grey contour lines). NMDS: nonmetric multidimensional scaling; SST: sea surface temperature; D2coast: distance to coast. Note the similarity between this and the all platform ordination. The only major change is the switch of SADO from the onshore group to the offshore group. (See Table S1 for meanings of species abbreviations)

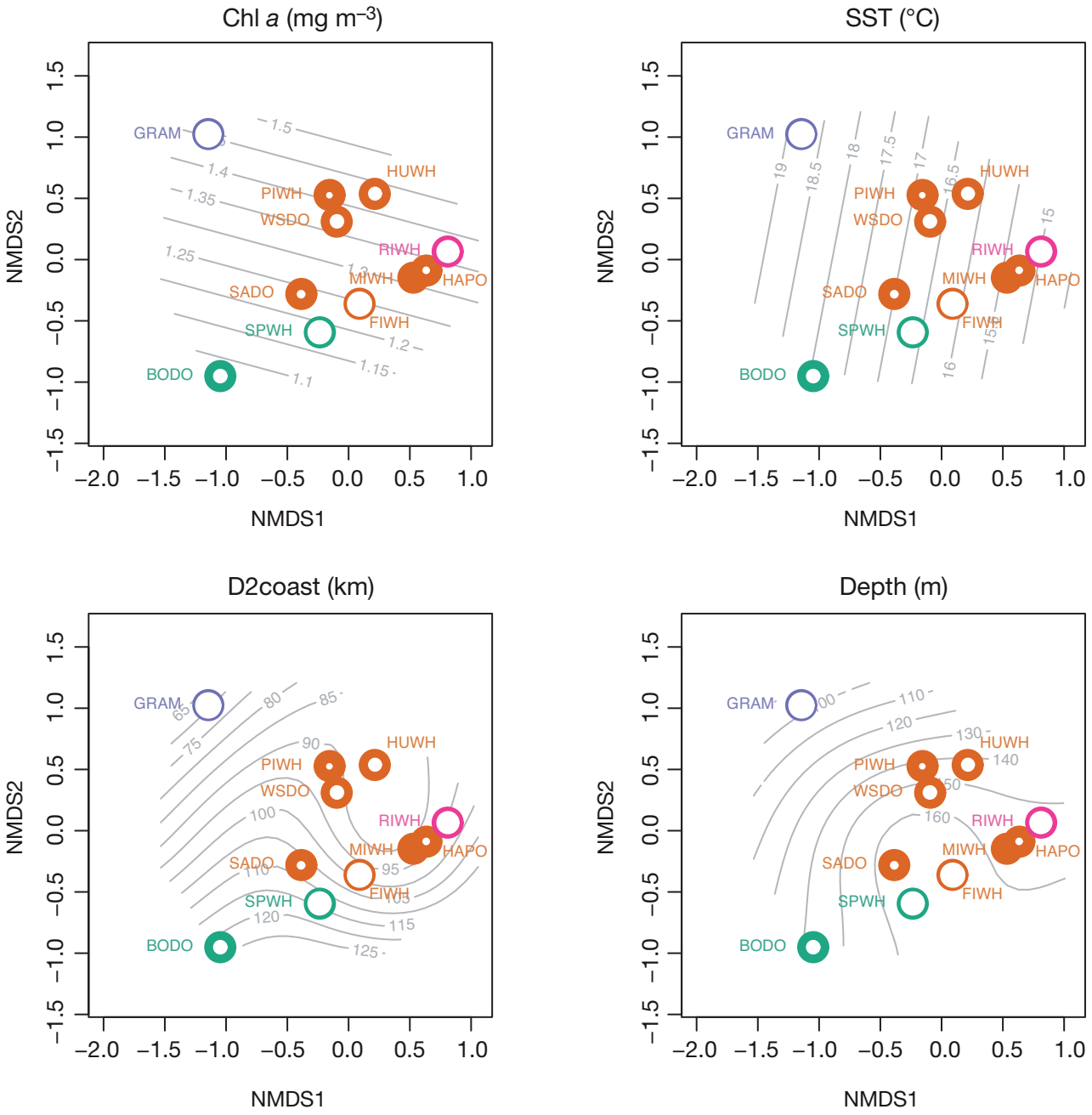

Fig. S4. Ordination results for the plane-only platform with each of 4 interpolated environmental surfaces in the background (grey contour lines). NMDS: nonmetric multidimensional scaling; SST: sea surface temperature; D2coast: distance to coast. The major difference between this and the boat platform ordination (Fig. S3) is the lack of the offshore (green) species that were seen in the full and boat-only ordinations. In addition, right whales grouped out separately from the onshore (orange) species here, although the placement of right whales in this group was sensitive to begin with (see main text, section on lumping and splitting). (See Table S1 for meanings of species abbreviations)

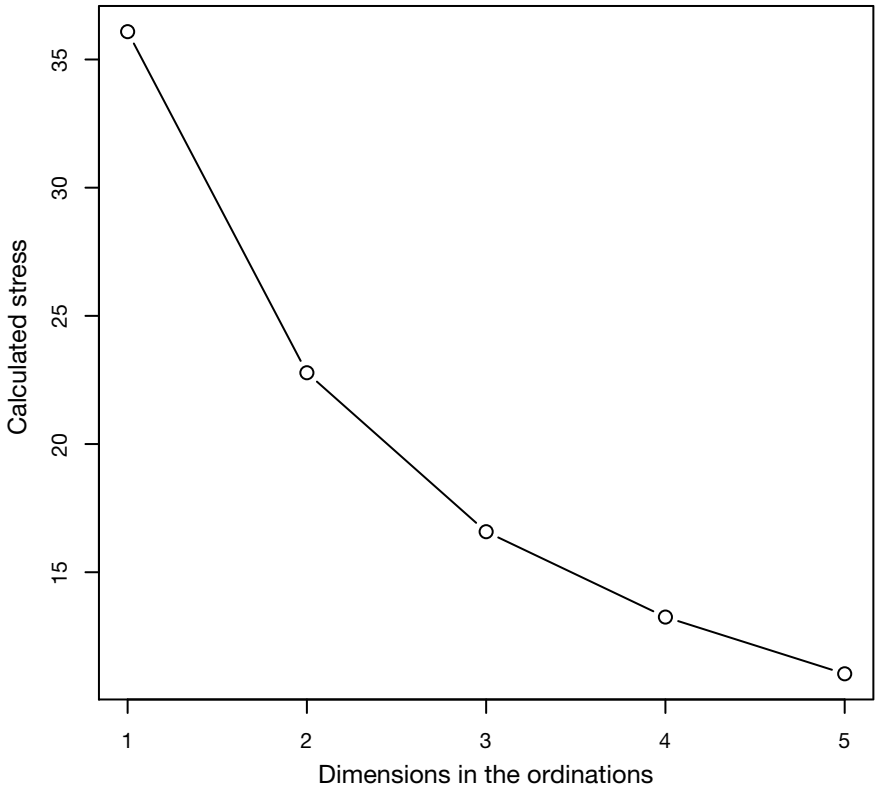

Fig. S5. Stress plot for the rare species removed ordination in the North of Hatteras region. We settled on an ordination with 3 dimensions

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McCune B, Grace JB, Urban DL (2002). Analysis of ecological communities. MjM Software Design, Corvallis, OR

Oksanen J, Guillaume Blanchet F, Kindt R, Legendre P and others (2010) vegan: community ecology package. Available at http://vegan.r-forge.r-project.org/

Supplement 2. Tabular information on the different species that went into each of the 3 ordination analyses. The tables show information on the taxonomic rank, the common name, the abbreviation that is used in the main ordination figures, the rarity (%), and the group ID. The rarity percentage details the percentage of sampling plots on which the species was seen; lower numbers indicate it was seen on fewer plots. Group ID corresponds to the groups created by the cluster analysis, and the colors in the main figures.

Table S2. Summary of the data in the NOH ordination, including information on species name, % rarity, and group membership identifier. Rarity: percentage of sites where individual species were sighted

Rank	Common name	Abbreviation	Rarity (%)	Group ID
Species	Rough-toothed dolphin	RTDO	1	1
Species	Bottlenose dolphin	BODO	23	2
Species	Striped dolphin	STDO	27	2
Species	Risso's dolphin	GRAM	30	2
Genus	Pilot whale	PIWH	35	2
Species	Sperm whale	SPWH	37	2
Family	Beaked whale	BEWH	20	2
Species	Long-snouted spinner dolphin	SNDO	1	3
Species	Killer whale	KIWH	1	3
Species	Pantropical Spotted dolphin	PWDO	1	4
Species	Dwarf sperm whale	DSWH	0	4
Species	Clymene dolphin	CLDO	1	5
Species	Short-finned pilot whale	PIWH	1	5
Species	Common dolphin	SADO	34	6
Species	Atlantic white-sided dolphin	WSDO	29	6
Species	Harbor porpoise	HAPO	20	6
Species	Minke whale	MIWH	21	6
Species	Fin whale	FIWH	35	6
Species	Humpback whale	HUWH	25	6
Species	Northern right whale	RIWH	8	6
Species	Pygmy killer whale	PYKW	1	7
Species	False killer whale	FKWH	2	8
Genus	Pygmy sperm whale	PSWH	7	9
Species	Pygmy sperm whale	PSWH	1	10
Species	True's beaked whale	TRBW	0	10
Species	Cuvier's beaked whale	GOBW	9	11
Genus	Beaked whale	BEWH	2	12
Species	North Atlantic beaked whale	SOBW	7	13
Species	Blainville's beaked whale	BLBW	1	14
Species	Sei whale	SEWH	4	15
Species	Atlantic spotted dolphin	ASDO	8	16

Table S3. Summary of the data in the NOH ordination, with rare species removed. Table includes information on species name, and group membership identifier

Rank	Common name	Abbreviation	Group ID
Species	Bottlenose dolphin	BODO	1
Species	Striped dolphin	STDO	1
Species	Risso's dolphin	GRAM	1
Genus	Pilot whale	PIWH	1
Species	Sperm whale	SPWH	1
Family	Beaked whale	UNBW	1
Species	Common dolphin	SADO	2
Species	Atlantic white-sided dolphin	WSDO	2
Species	Harbor porpoise	HAPO	2
Species	Minke whale	MIWH	2
Species	Fin whale	FIWH	2
Species	Humpback whale	HUWH	2
Species	Northern right whale	RIWH	2
Genus	Pygmy sperm whale	UNKO	3
Species	Cuvier's beaked whale	GOBW	4
Species	North Atlantic beaked whale	SOBW	5
Species	Atlantic spotted dolphin	ASDO	6

Table S4. Summary of the data in the SOH ordination, with rare species removed. Table includes information on species name and group membership identifier

Rank	Common name	Abbreviation	Group ID
Species	Bottlenose dolphin	BODO	1
Species	Common dolphin	SADO	1
Species	Risso's dolphin	GRAM	1
Genus	Pilot whale	PIWH	1
Species	Atlantic spotted dolphin	ASDO	1
Species	Pantropical spotted dolphin	PSDO	2
Genus	Pygmy sperm whale	UNKO	2
Family	Beaked whale	UNBW	3

Table S5. Summary of the data in the GOM ordination, with rare species removed. Table includes information on species name, and group membership identifier

Rank	Common name	Abbreviation	Group ID
Species	Rough-toothed dolphin	RTDO	1
Species	Melon-headed whale	MHWH	1
Species	Bottlenose dolphin	BODO	2
Species	Long-snouted spinner dolphin	SNDO	2
Species	Pantropical spotted dolphin	PSDO	2
Species	Striped dolphin	STDO	2
Species	Risso's dolphin	GRAM	2
Species	Sperm whale	SPWH	2
Genus	Pygmy sperm whale	UNKO	2
Species	Clymene dolphin	CLDO	3
Species	Dwarf sperm whale	DSWH	3
Genus	Beaked whale	BEWH	3
Species	Killer whale	KIWH	4
Species	Pygmy sperm whale	PSWH	4
Family	Beaked whale	UNBW	5
Species	Atlantic spotted dolphin	ASDO	6