Density Model for Striped Dolphin (*Stenella coeruleoalba*) for the U.S. Gulf of Mexico: Supplementary Report

Duke University Marine Geospatial Ecology Lab*

Model Version 2.3 - 2015-10-05

Citation

When referencing our methodology or results generally, please cite our open-access article:

Roberts JJ, Best BD, Mannocci L, Fujioka E, Halpin PN, Palka DL, Garrison LP, Mullin KD, Cole TVN, Khan CB, McLellan WM, Pabst DA, Lockhart GG (2016) Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6: 22615. doi: 10.1038/srep22615

To reference this specific model or Supplementary Report, please cite:

Roberts JJ, Best BD, Mannocci L, Fujioka E, Halpin PN, Palka DL, Garrison LP, Mullin KD, Cole TVN, Khan CB, McLellan WM, Pabst DA, Lockhart GG (2015) Density Model for Striped Dolphin (*Stenella coeruleoalba*) for the U.S. Gulf of Mexico Version 2.3, 2015-10-05, and Supplementary Report. Marine Geospatial Ecology Lab, Duke University, Durham, North Carolina.

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Revision History

Version	Date	Description of changes
1	2014-10-23	Initial version.
2	2014-11-13	Adjusted "GulfSCAT Aerial Survey" detection function. Removed CumVGPM180 predictor. Updated documentation.
2.1	2015-02-02	Updated the documentation. No changes to the model.
2.2	2015-05-14	Updated calculation of CVs. Switched density rasters to logarithmic breaks. No changes to the model.
2.3	2015-10-05	Updated the documentation. No changes to the model.

*For questions, or to offer feedback about this model or report, please contact Jason Roberts (jason.roberts@duke.edu)

Survey Data

Survey	Period	Length (1000 km)	Hours	Sightings
SEFSC GOMEX92-96 Aerial Surveys	1992-1996	27	152	0
SEFSC Gulf of Mexico Shipboard Surveys, 2003-2009	2003-2009	19	1156	19
SEFSC GulfCet I Aerial Surveys	1992-1994	50	257	8
SEFSC GulfCet II Aerial Surveys	1996-1998	22	124	8
SEFSC GulfSCAT 2007 Aerial Surveys	2007-2007	18	95	0
SEFSC Oceanic CetShip Surveys	1992-2001	49	3102	51
SEFSC Shelf CetShip Surveys	1994-2001	10	707	6
Total		195	5593	92

Table 2: Survey effort and sightings used in this model. Effort is tallied as the cumulative length of on-effort transects and hours the survey team was on effort. Sightings are the number of on-effort encounters of the modeled species for which a perpendicular sighting distance (PSD) was available. Off effort sightings and those without PSDs were omitted from the analysis.

Period	Length (1000 km)	Hours	Sightings
1992-2009	195	5592	92
1998-2009	62	2679	40
% Lost	68	52	57

Table 3: Survey effort and on-effort sightings having perpendicular sighting distances. % Lost shows the percentage of effort or sightings lost by restricting the analysis to surveys performed in 1998 and later, the era in which remotely-sensed chlorophyll and derived productivity estimates are available. See Figure 1 for more information.

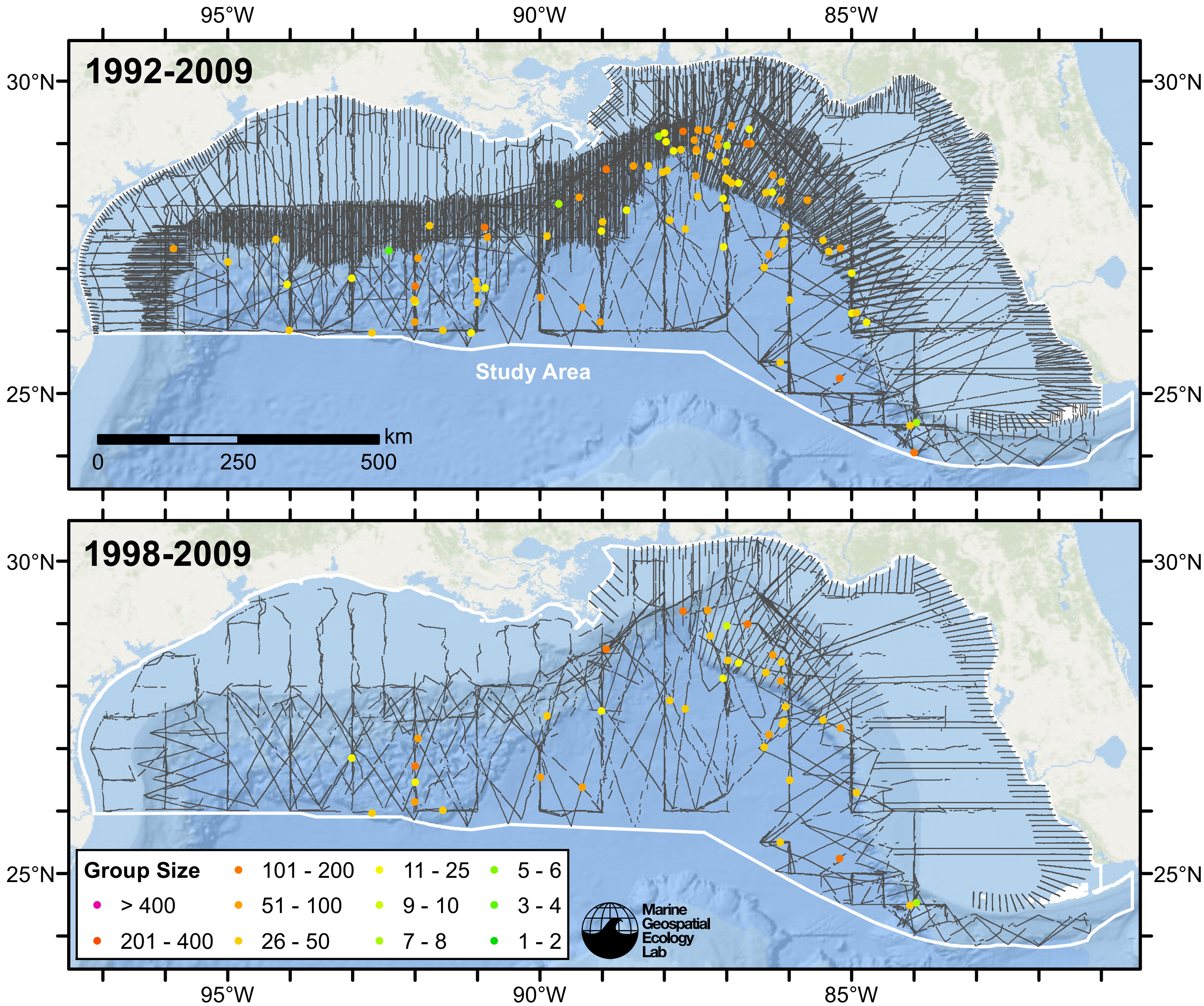


Figure 1: Striped dolphin sightings and survey tracklines. The top map shows all surveys. The bottom map shows surveys performed in 1998 or later. the era in which remotely-sensed chlorophyll and derived productivity estimates are available. Models fitted to contemporaneous (day-of-sighting) estimates of those predictors only utilize these surveys. These maps illustrate the survey data lost in order to utilize those predictors. Models fitted to climatogical estimates of those predictors do not suffer this data loss.

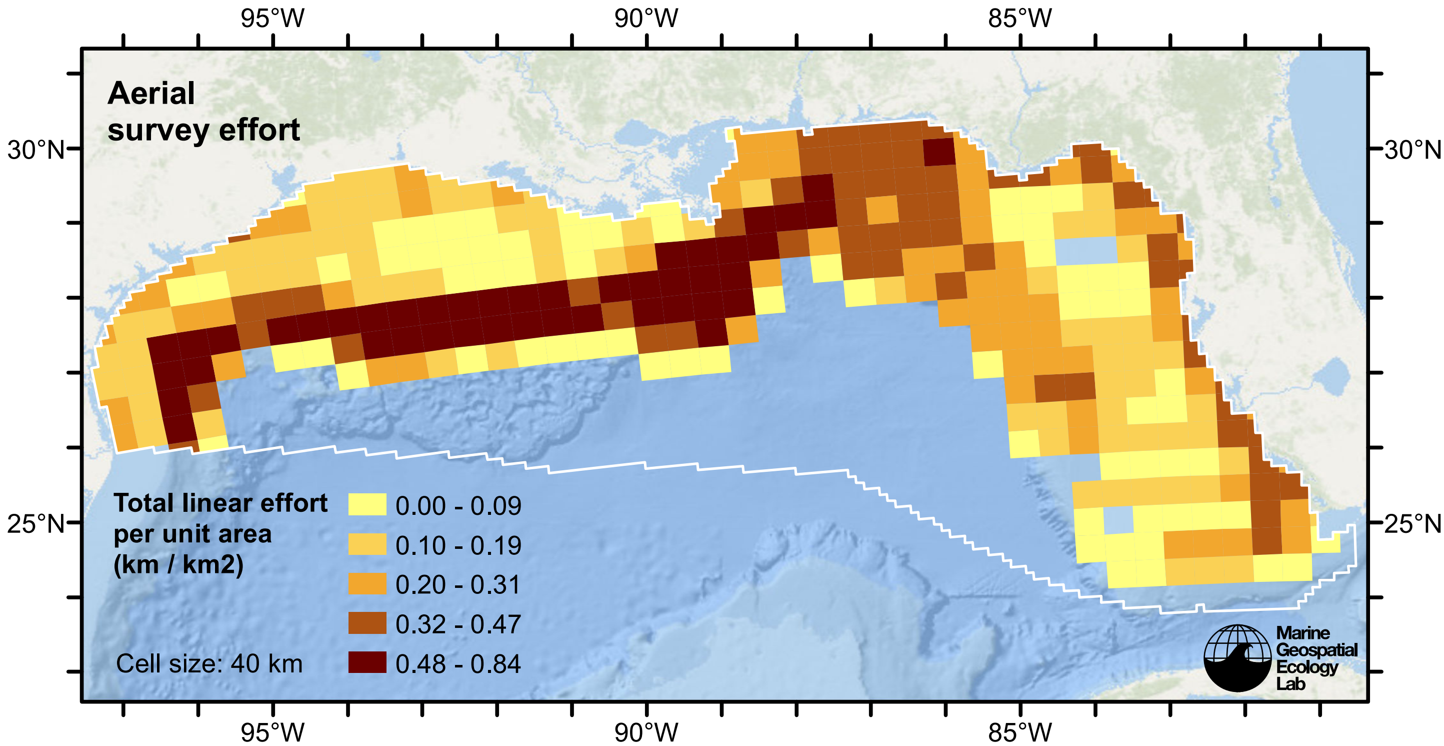


Figure 2: Aerial linear survey effort per unit area.

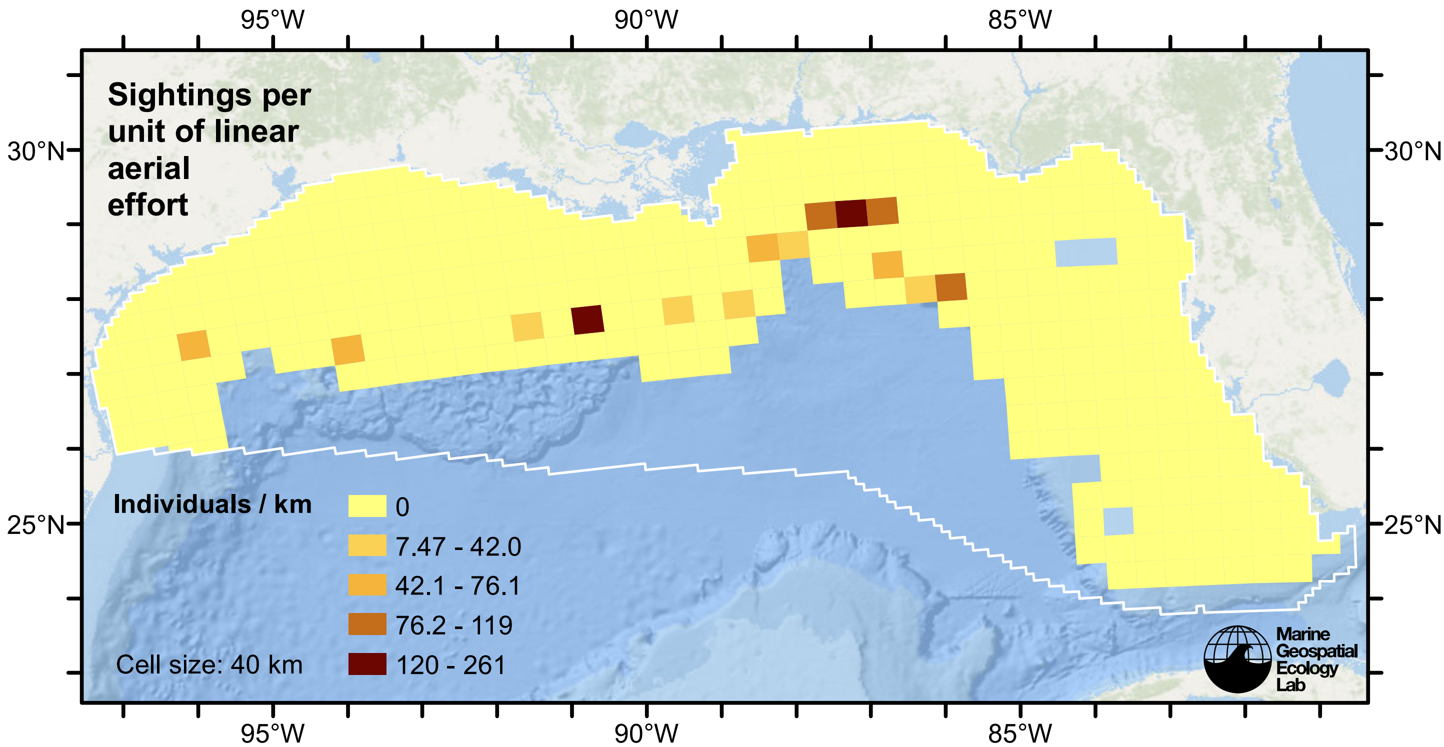


Figure 3: Striped dolphin sightings per unit aerial linear survey effort.

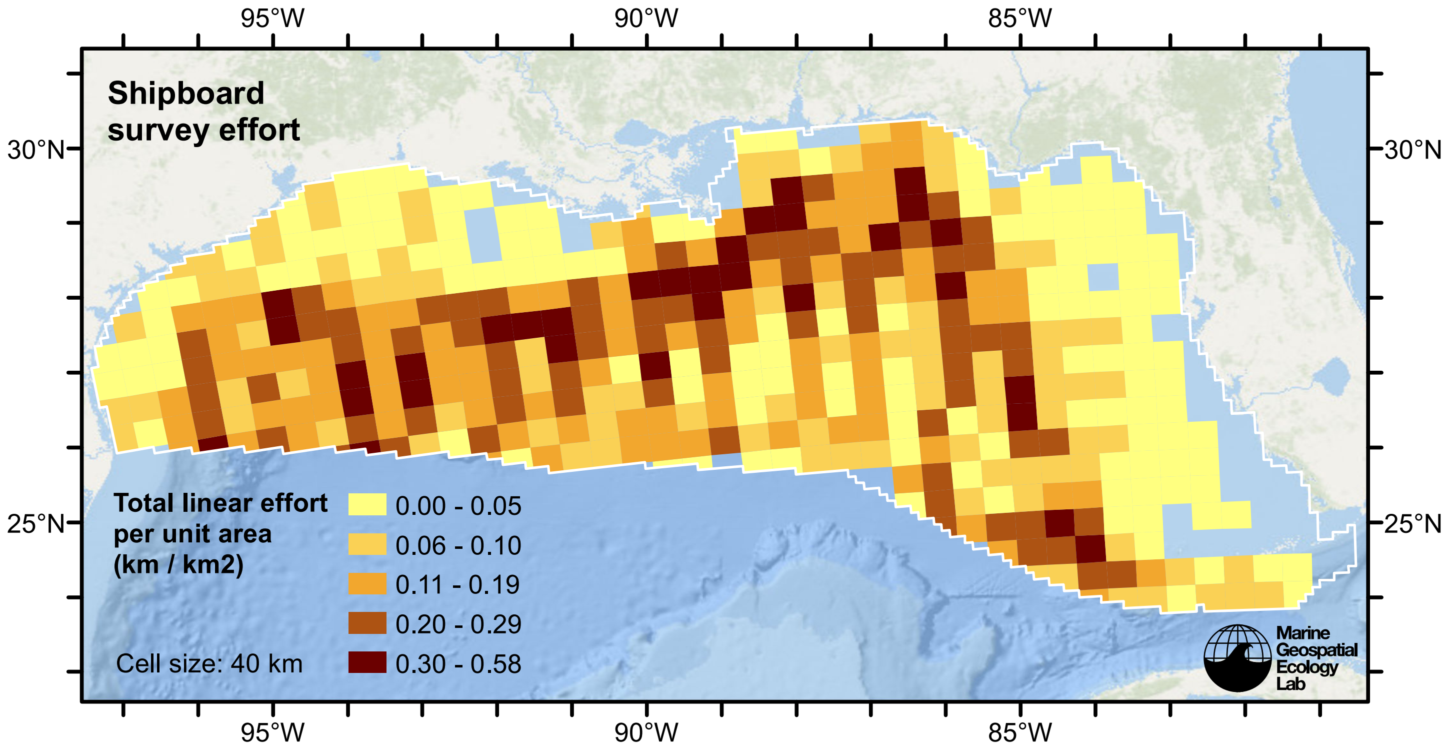


Figure 4: Shipboard linear survey effort per unit area.

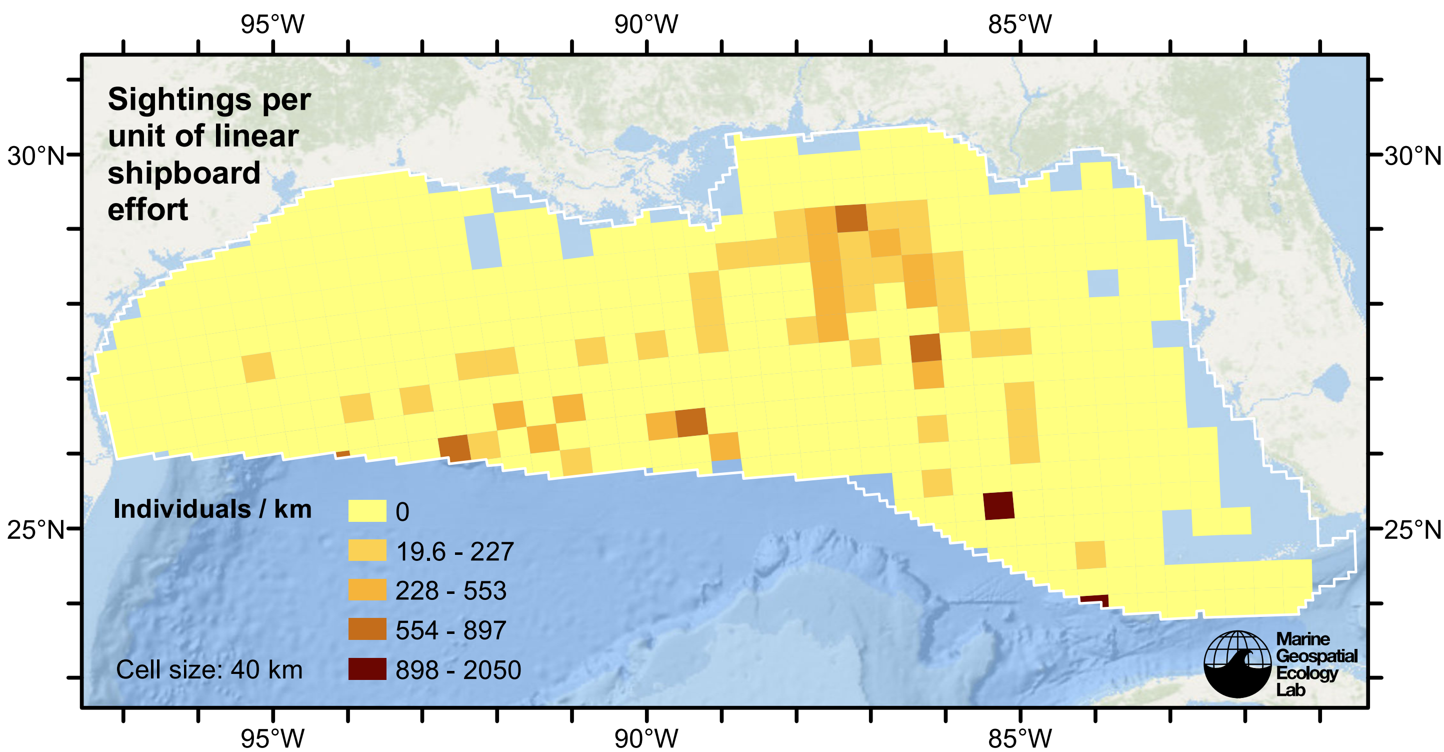


Figure 5: Striped dolphin sightings per unit shipboard linear survey effort.

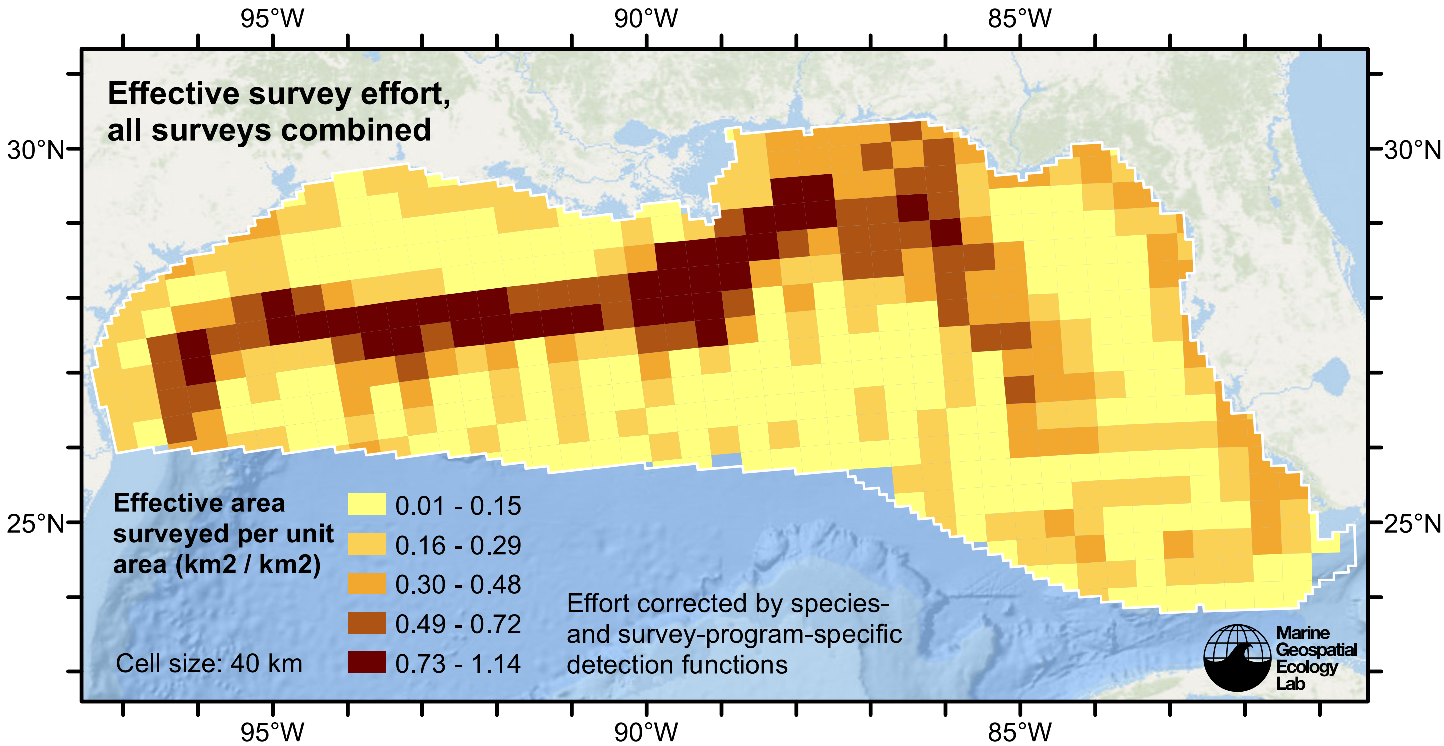


Figure 6: Effective survey effort per unit area, for all surveys combined. Here, effort is corrected by the species- and survey-program-specific detection functions used in fitting the density models.

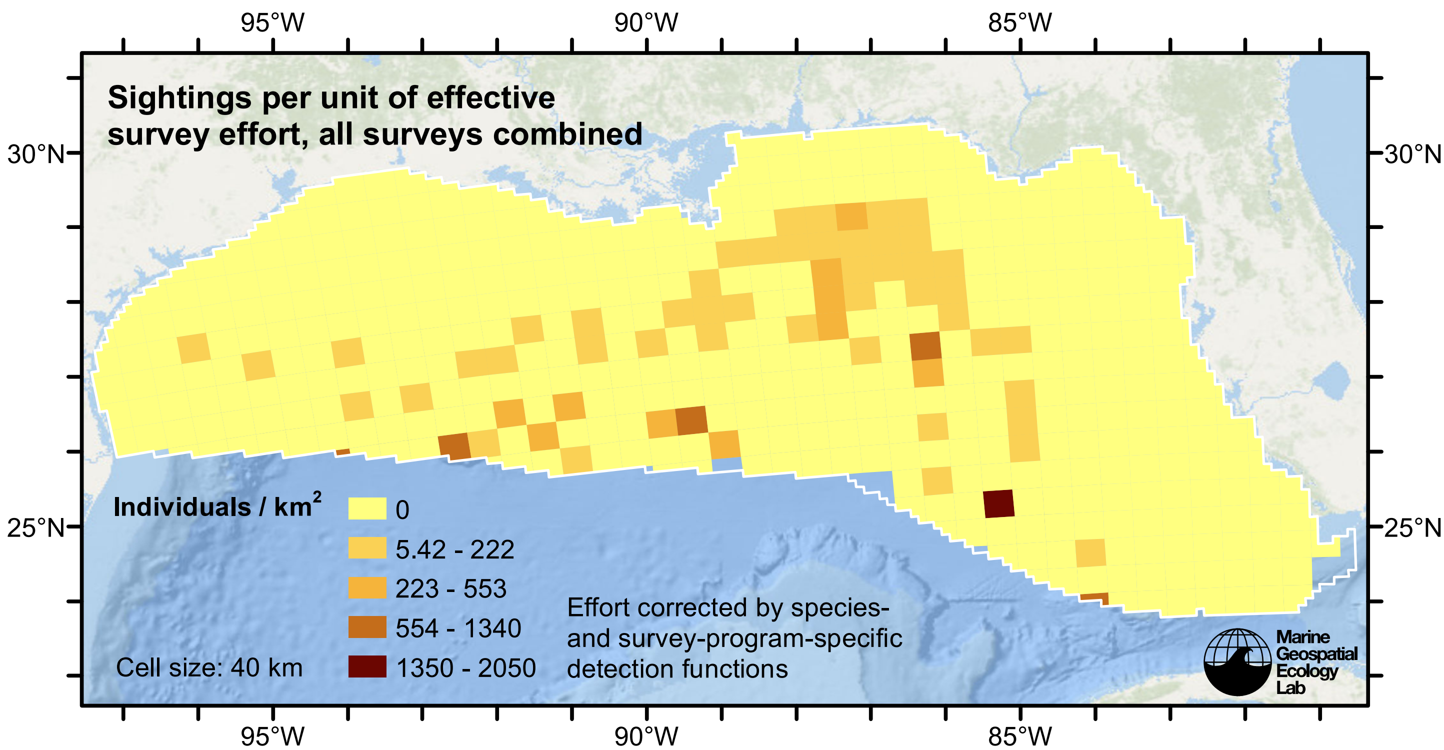


Figure 7: Striped dolphin sightings per unit of effective survey effort, for all surveys combined. Here, effort is corrected by the species- and survey-program-specific detection functions used in fitting the density models.

Detection Functions

The detection hierarchy figures below show how sightings from multiple surveys were pooled to try to achieve Buckland et. al's (2001) recommendation that at least 60-80 sightings be used to fit a detection function. Leaf nodes, on the right, usually represent individual surveys, while the hierarchy to the left shows how they have been grouped according to how similar we believed the surveys were to each other in their detection performance.

At each node, the red or green number indicates the total number of sightings below that node in the hierarchy, and is colored green if 70 or more sightings were available, and red otherwise. If a grouping node has zero sightings–i.e. all of the surveys within it had zero sightings–it may be collapsed and shown as a leaf to save space.

Each histogram in the figure indicates a node where a detection function was fitted. The actual detection functions do not appear in this figure; they are presented in subsequent sections. The histogram shows the frequency of sightings by perpendicular sighting distance for all surveys contained by that node. Each survey (leaf node) recieves the detection function that is closest to it up the hierarchy. Thus, for common species, sufficient sightings may be available to fit detection functions deep in the hierarchy, with each function applying to only a few surveys, thereby allowing variability in detection performance between surveys to be addressed relatively finely. For rare species, so few sightings may be available that we have to pool many surveys together to try to meet Buckland's recommendation, and fit only a few coarse detection functions high in the hierarchy.

A blue Proxy Species tag indicates that so few sightings were available that, rather than ascend higher in the hierarchy to a point that we would pool grossly-incompatible surveys together, (e.g. shipboard surveys that used big-eye binoculars with those that used only naked eyes) we pooled sightings of similar species together instead. The list of species pooled is given in following sections.

Shipboard Surveys

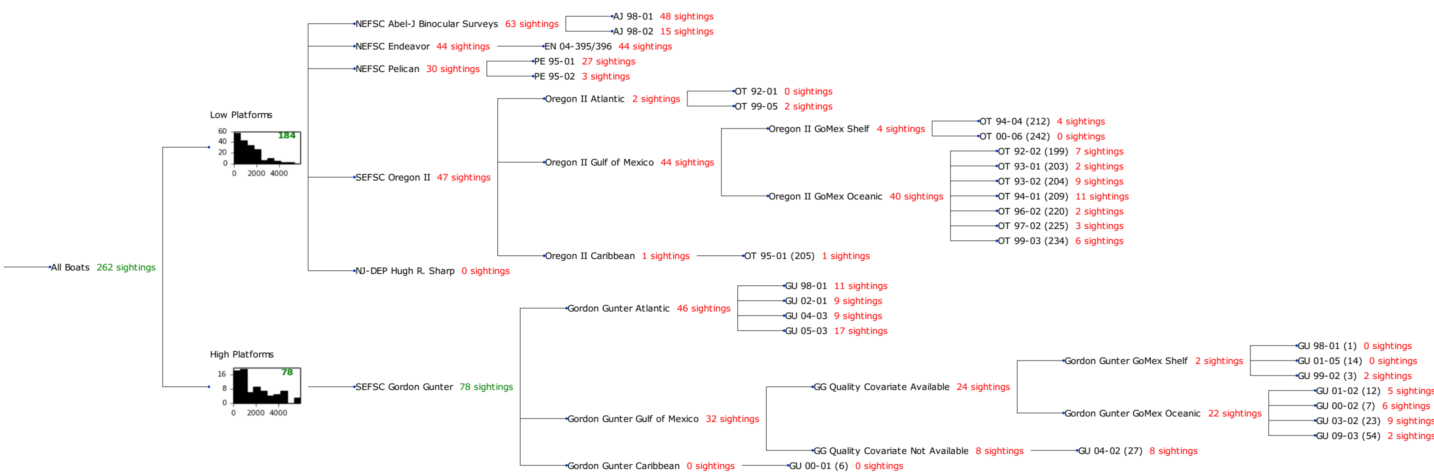


Figure 8: Detection hierarchy for shipboard surveys

Low Platforms

The sightings were right truncated at 5500m.

Covariate	Description
beaufort	Beaufort sea state.
size	Estimated size (number of individuals) of the sighted group.

Table 4: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr			beaufort, size	Yes	0.00	2183
hr			beaufort	Yes	0.71	2211
hn	cos	2		Yes	2.70	1914
hr			size	Yes	3.15	2149
hn			size	Yes	3.63	2174
hn			beaufort, size	Yes	4.16	2165
hn			beaufort	Yes	4.28	2165
hn				Yes	4.29	2172
hr				Yes	4.42	2182
hr	poly	2		Yes	5.40	2062
hn	cos	3		Yes	5.69	2024
hr	poly	4		Yes	5.78	2101
hn	herm	4		Yes	6.11	2168

Table 5: Candidate detection functions for Low Platforms. The first one listed was selected for the density model.

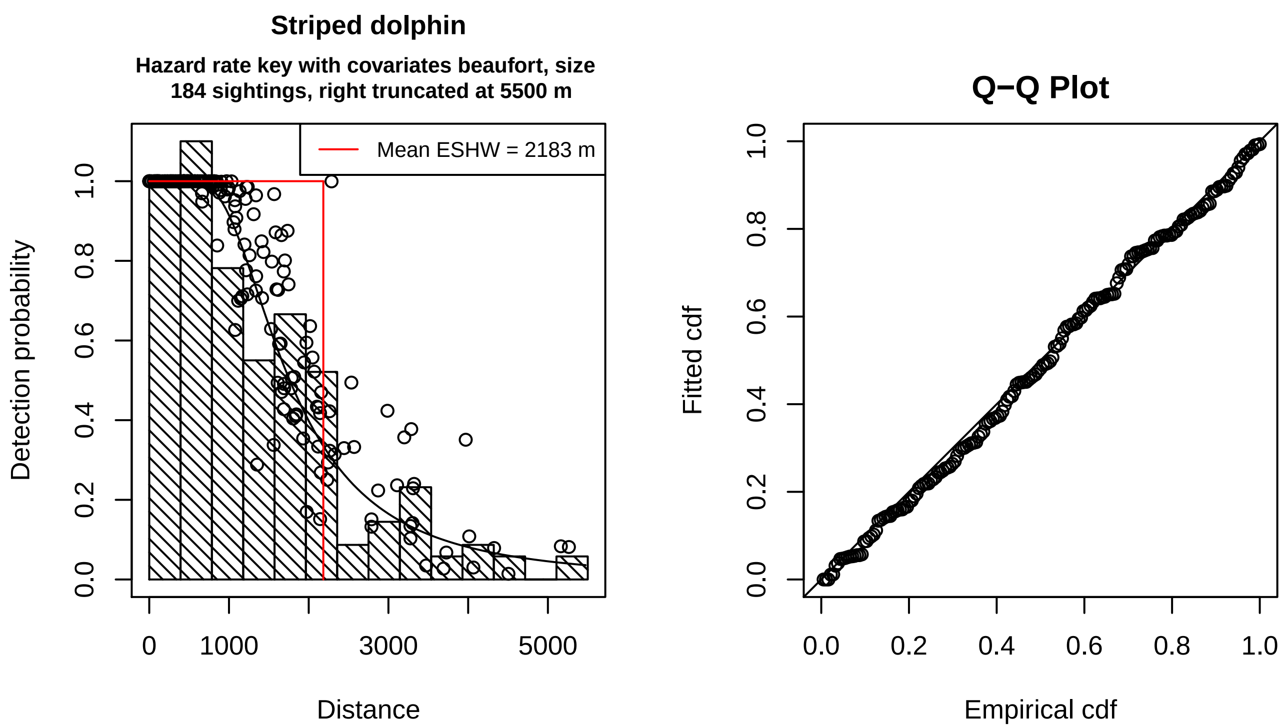


Figure 9: Detection function for Low Platforms that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
```

```
Number of observations :  184
Distance range         :  0  -  5500
AIC                    :  3006.098

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
              estimate         se
(Intercept)  7.7694676 0.23407524
beaufort    -0.1951875 0.07300312
size         0.1262197 0.08875196

Shape parameters:
            estimate        se
(Intercept) 1.004424 0.1479439

                       Estimate          SE         CV
Average p             0.3805409  0.02890388 0.07595473
N in covered region 483.5222264 46.44093426 0.09604716
```

Additional diagnostic plots:

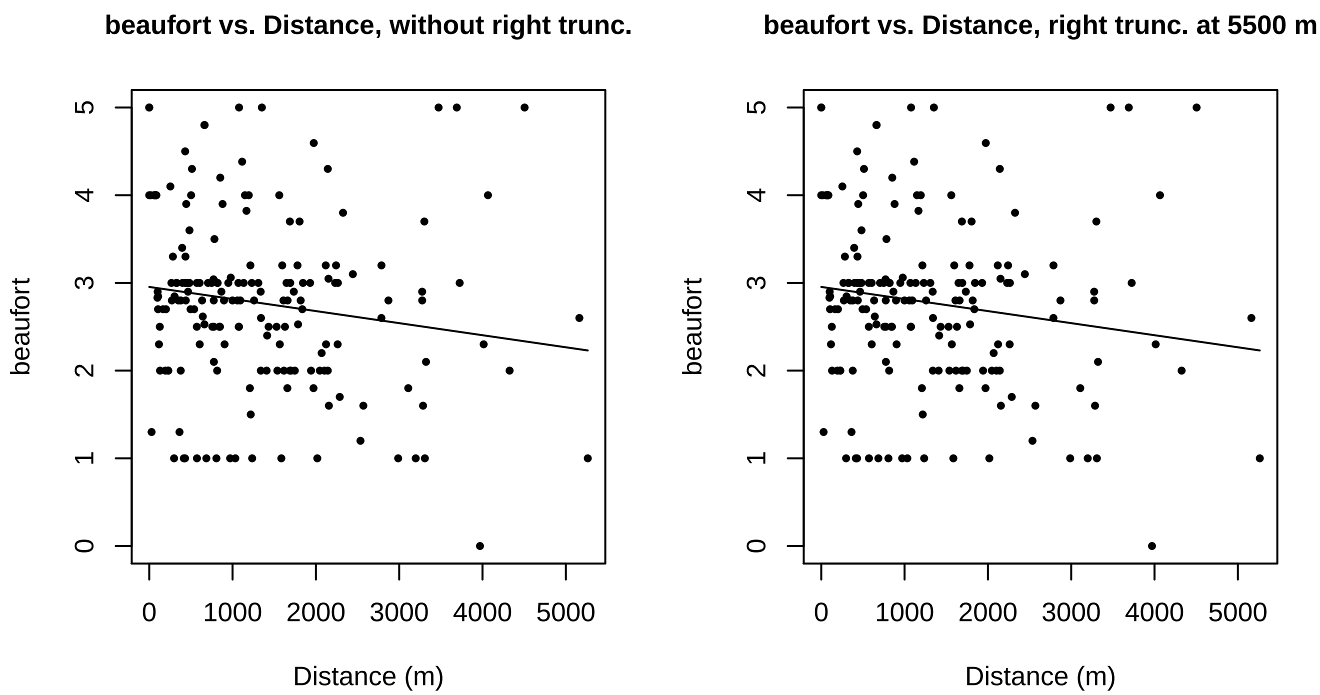


Figure 10: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

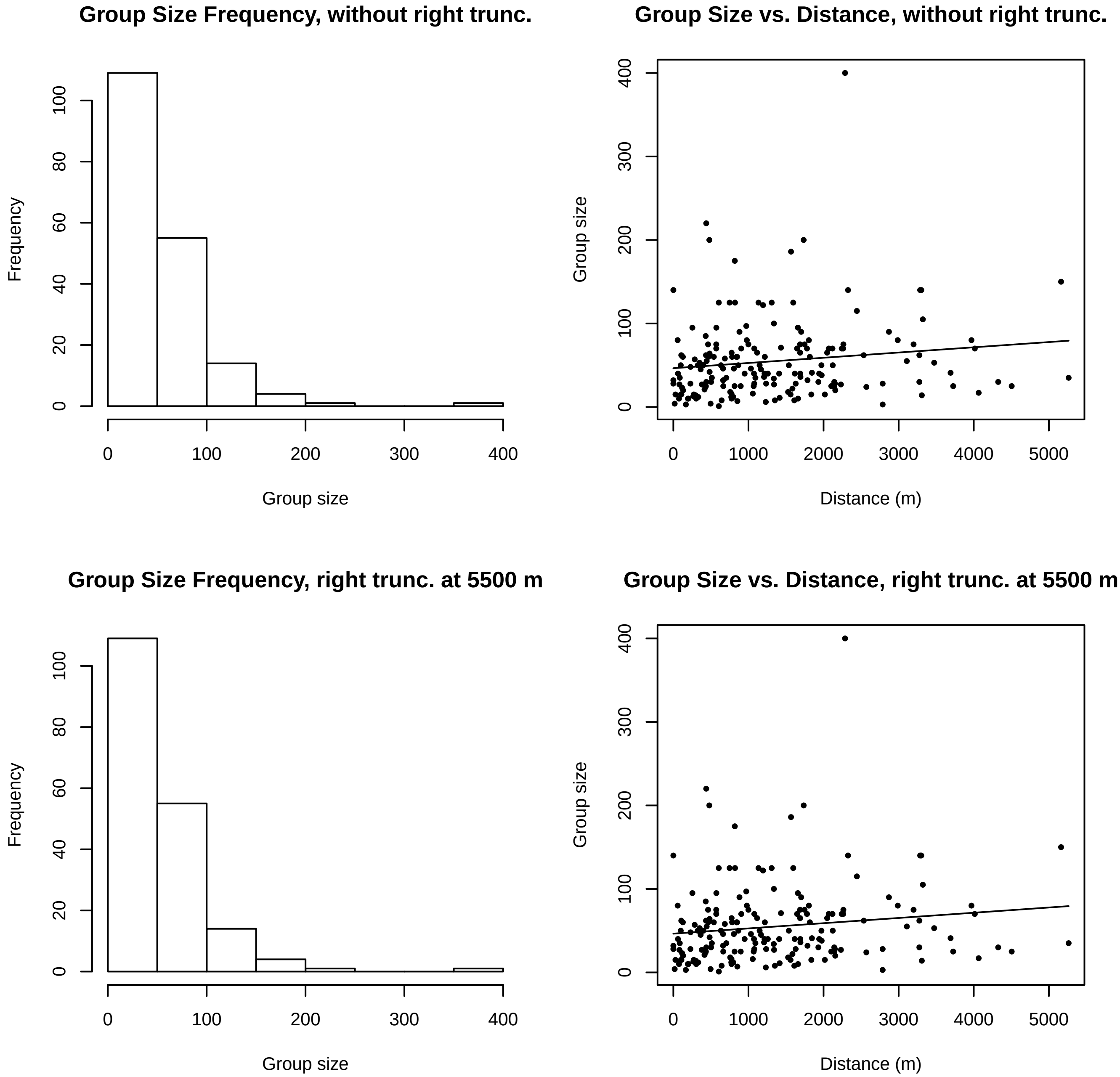


Figure 11: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

High Platforms

The sightings were right truncated at 6000m.

Covariate	Description
beaufort	Beaufort sea state.
size	Estimated size (number of individuals) of the sighted group.

Table 6: Covariates tested in candidate “multi-covariate distance sampling” (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr				Yes	0.00	2273
hn	cos	3		Yes	1.13	2466
hn	cos	2		Yes	1.41	2592
hr	poly	4		Yes	1.79	2252
hr	poly	2		Yes	2.00	2273
hn				Yes	2.99	3220
hn			beaufort	Yes	4.12	3214
hn	herm	4		Yes	4.86	3207
hr			beaufort	No		
hr			size	No		
hn			size	No		
hr			beaufort, size	No		
hn			beaufort, size	No		

Table 7: Candidate detection functions for High Platforms. The first one listed was selected for the density model.

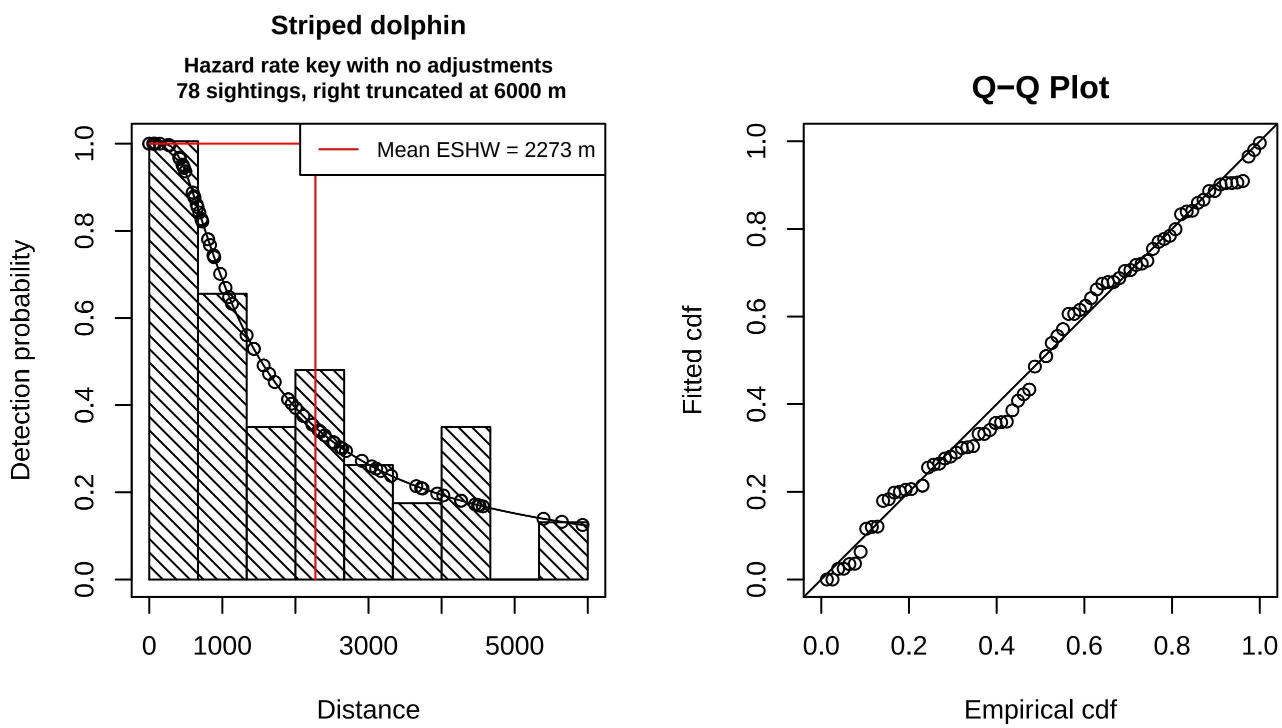


Figure 12: Detection function for High Platforms that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
```

```
Number of observations :  78
Distance range         :  0  -  6000
AIC                    :  1326.307

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
            estimate        se
(Intercept) 7.033466 0.5105103

Shape parameters:
            estimate       se
(Intercept) 0.195866 0.310027

                       Estimate          SE        CV
Average p             0.3788994  0.09170662 0.2420342
N in covered region 205.8593996 53.10350463 0.2579601
```

Additional diagnostic plots:

Figure 13: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

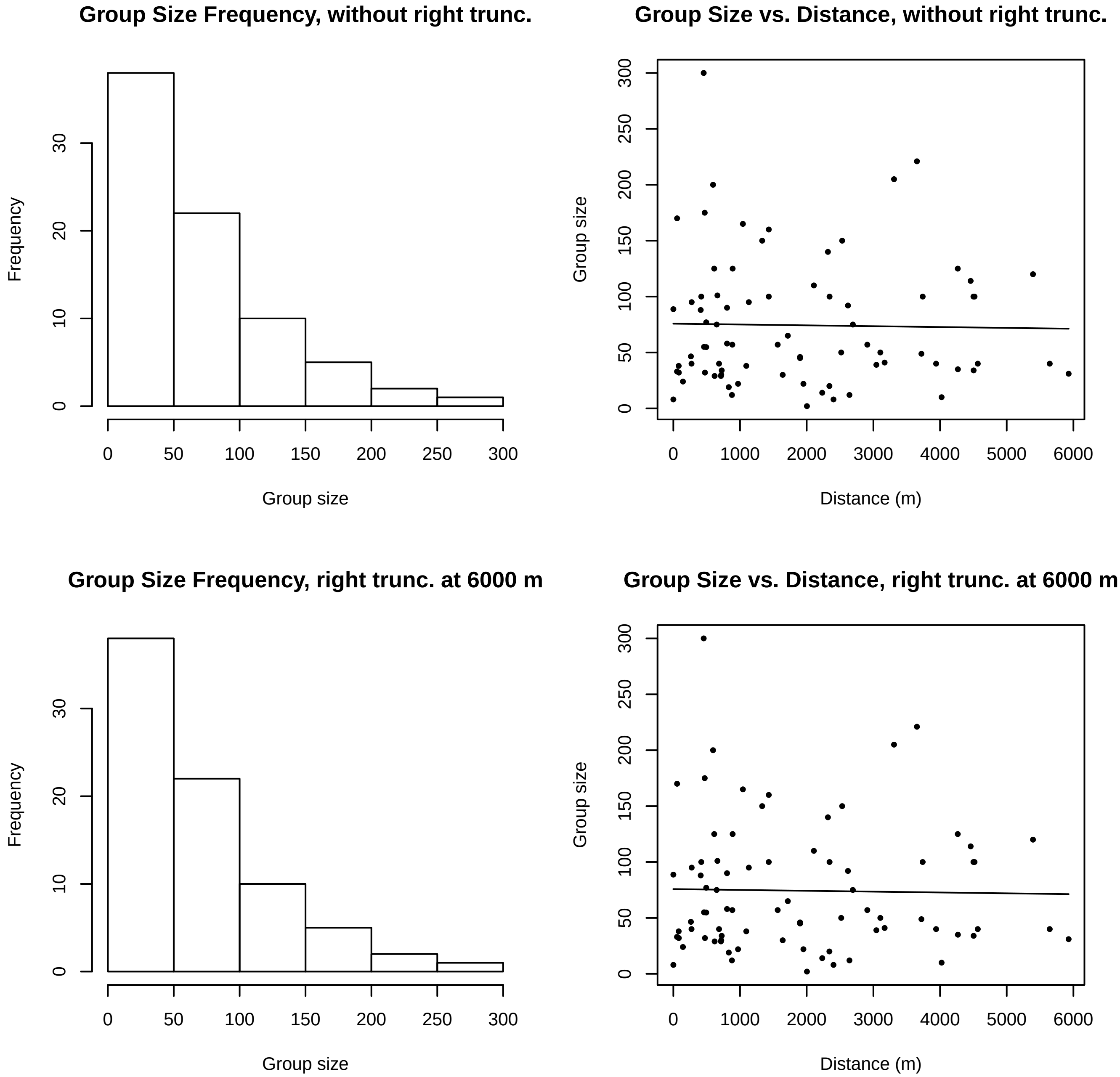


Figure 14: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Aerial Surveys

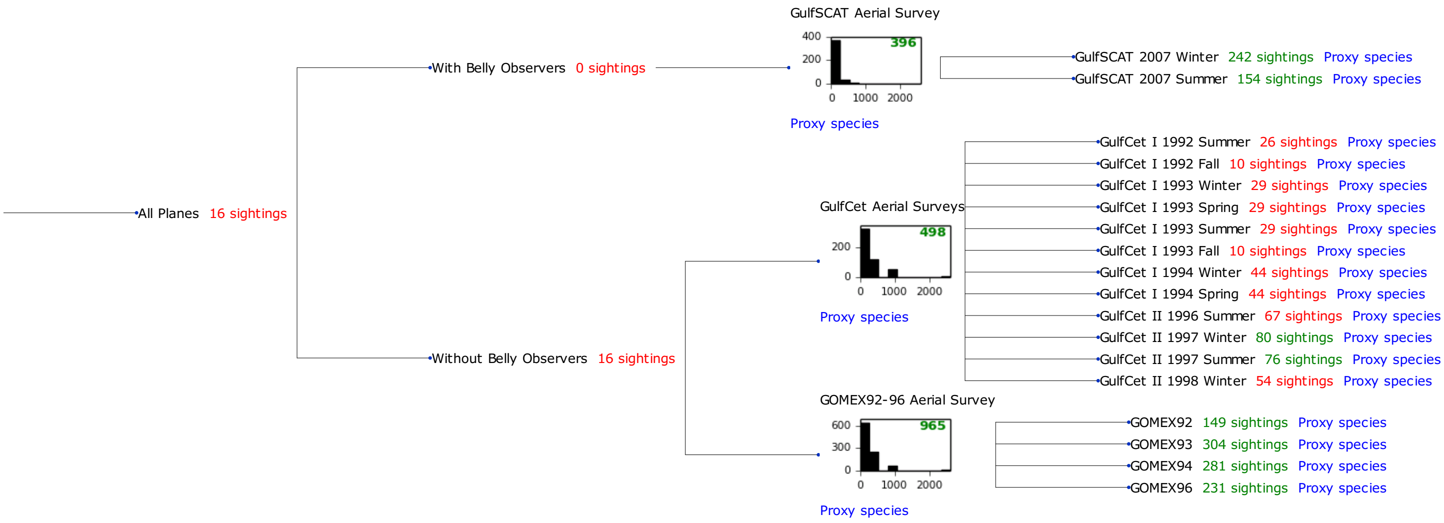


Figure 15: Detection hierarchy for aerial surveys

GulfSCAT Aerial Survey

Because this taxon was sighted too infrequently to fit a detection function to its sightings alone, we fit a detection function to the pooled sightings of several other species that we believed would exhibit similar detectability. These "proxy species" are listed below.

Reported By Observer	Common Name	n
Delphinus capensis	Long-beaked common dolphin	0
Delphinus delphis	Short-beaked common dolphin	0
Delphinus delphis/Lagenorhynchus acutus	Short-beaked common or Atlantic white-sided dolphin	0
Delphinus delphis/Stenella	Short-beaked common dolphin or Stenella spp.	0
Delphinus delphis/Stenella coeruleoalba	Short-beaked common or striped dolphin	0
Grampus griseus	Risso's dolphin	0
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	0
Lagenorhynchus acutus	Atlantic white-sided dolphin	0
Lagenorhynchus albirostris	White-beaked dolphin	0
Lagenorhynchus albirostris/Lagenorhynchus acutus	White-beaked or white-sided dolphin	0
Stenella	Unidentified Stenella	0
Stenella attenuata	Pantropical spotted dolphin	0
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	0
Stenella coeruleoalba	Striped dolphin	0
Stenella frontalis	Atlantic spotted dolphin	15
Stenella frontalis/Tursiops truncatus	Atlantic spotted or Bottlenose dolphin	0
Stenella longirostris	Spinner dolphin	0

Steno bredanensis	Rough-toothed dolphin	0
Steno bredanensis/Tursiops truncatus	Bottlenose or rough-toothed dolphin	0
Tursiops truncatus	Bottlenose dolphin	381
Total		396

Table 8: Proxy species used to fit detection functions for GulfSCAT Aerial Survey. The number of sightings, n, is before truncation.

The sightings were right truncated at 400m.

Covariate	Description
beaufort	Beaufort sea state.
quality	Survey-specific index of the quality of observation conditions, utilizing relevant factors other than Beaufort sea state (see methods).
size	Estimated size (number of individuals) of the sighted group.

Table 9: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hn	herm	4		Yes	0.00	218
hn	cos	2		Yes	0.09	221
hn				Yes	0.90	199
hn			size	Yes	2.21	199
hn	cos	3		Yes	2.37	209
hr	poly	2		Yes	2.39	218
hr	poly	4		Yes	2.47	223
hr				Yes	4.46	230
hr			size	Yes	5.04	232
hn			beaufort	No		
hr			beaufort	No		
hn			quality	No		
hr			quality	No		
hn			beaufort, quality	No		
hr			beaufort, quality	No		
hn			beaufort, size	No		
hr			beaufort, size	No		
hn			quality, size	No		
hr			quality, size	No		
hn			beaufort, quality, size	No		
hr			beaufort, quality, size	No		

Table 10: Candidate detection functions for GulfSCAT Aerial Survey. The first one listed was selected for the density model.

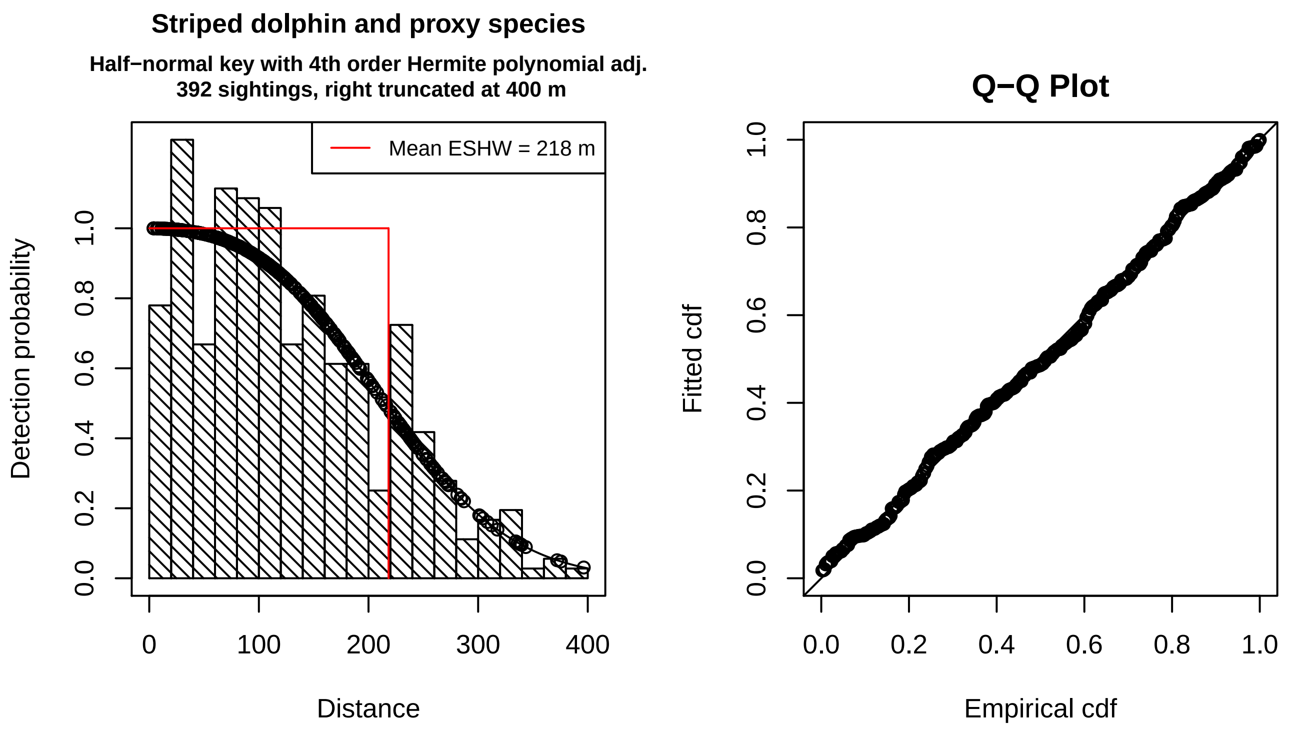


Figure 16: Detection function for GulfSCAT Aerial Survey that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  392
Distance range         :  0  -  400
AIC                    :  4505.917

Detection function:
 Half-normal key function with Hermite polynomial adjustment term of order 4

Detection function parameters
Scale Coefficients:
            estimate         se
(Intercept) 4.855665 0.07416808

Adjustment term parameter(s):
                 estimate         se
herm, order 4 -0.04125499 0.01270729


Monotonicity constraints were enforced.
                       Estimate         SE         CV
Average p             0.5457488  0.0420123 0.07698101
N in covered region 718.2791638 60.4587998 0.08417173

Monotonicity constraints were enforced.
```

Additional diagnostic plots:

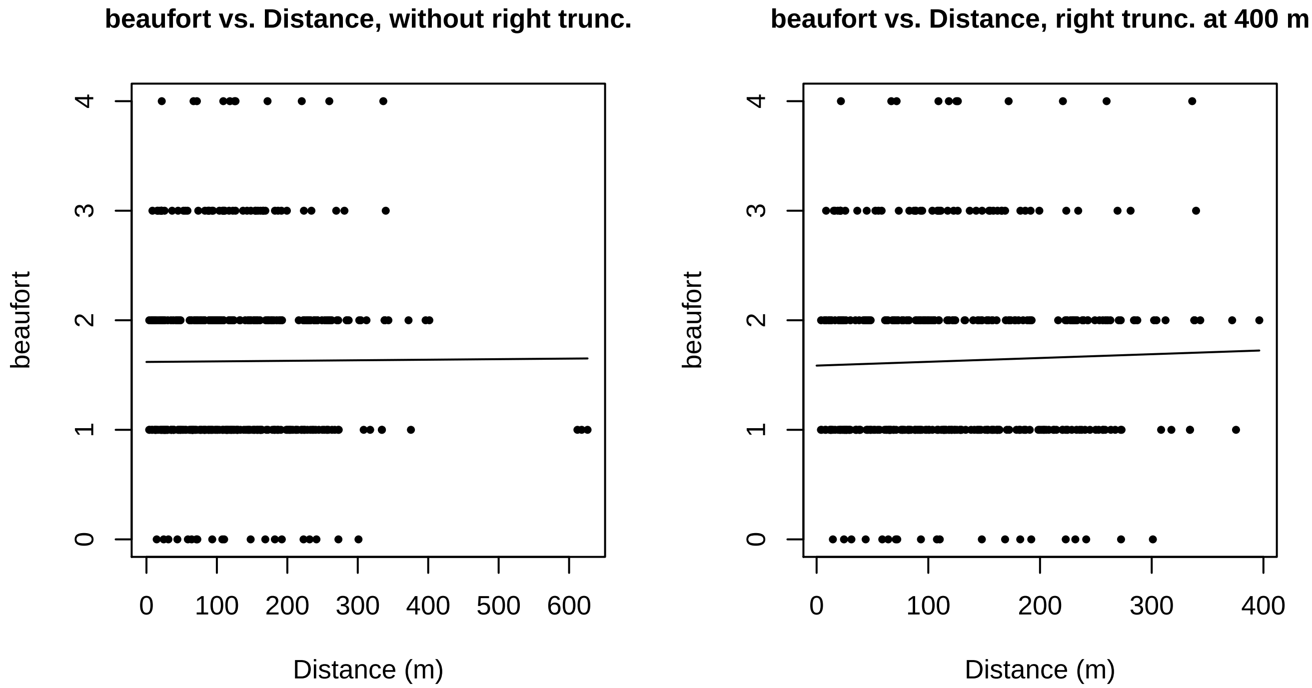


Figure 17: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

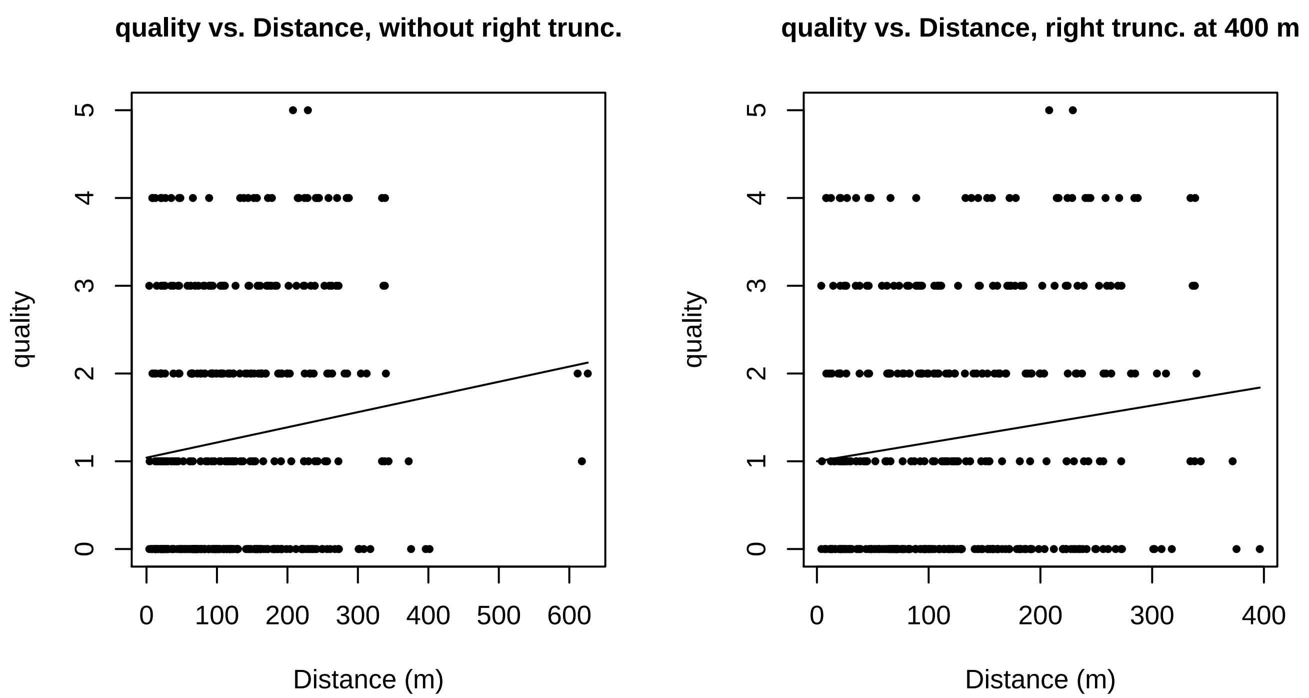


Figure 18: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

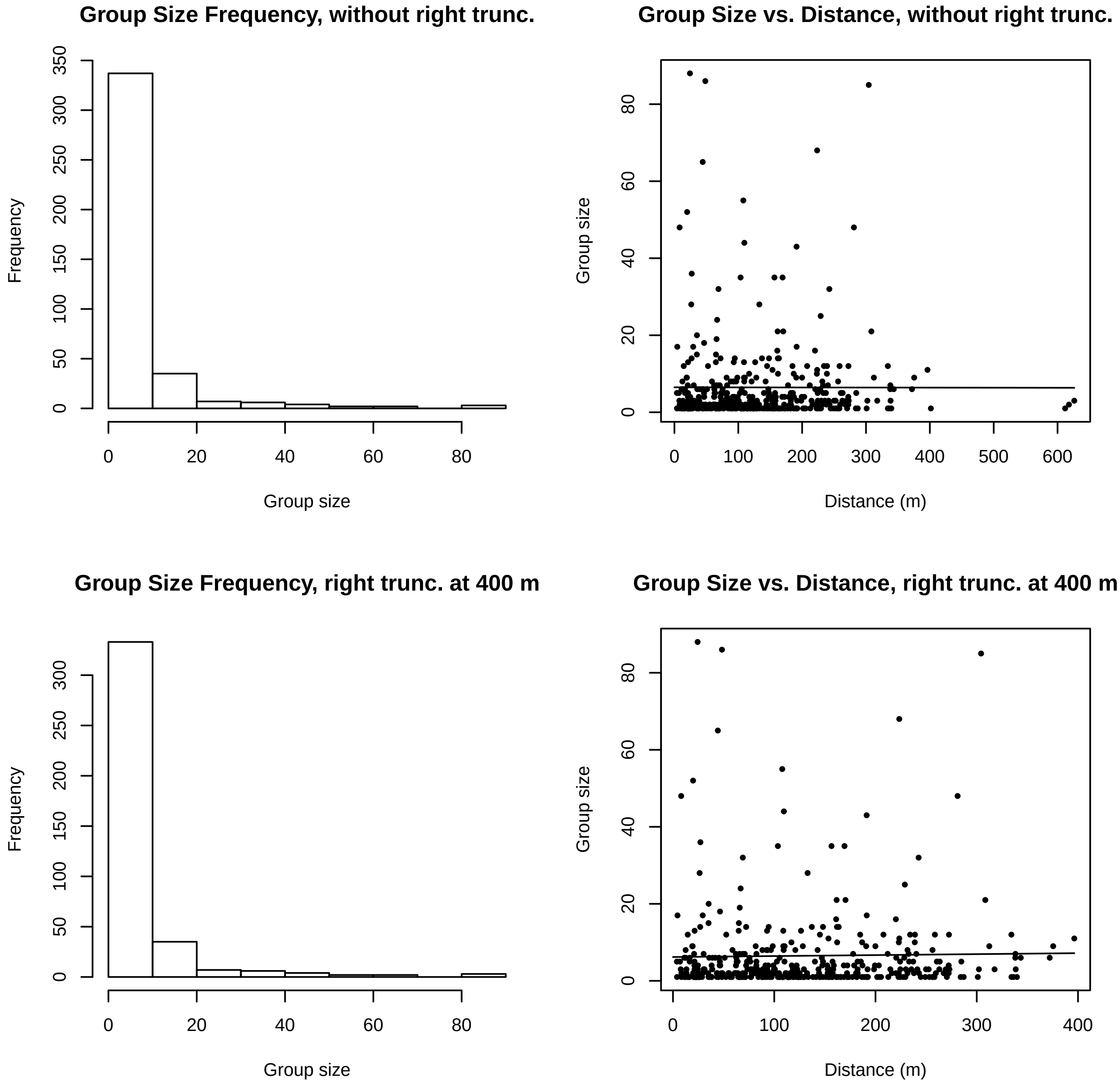


Figure 19: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

GulfCet Aerial Surveys

Because this taxon was sighted too infrequently to fit a detection function to its sightings alone, we fit a detection function to the pooled sightings of several other species that we believed would exhibit similar detectability. These "proxy species" are listed below.

Reported By Observer	Common Name	n
Delphinus capensis	Long-beaked common dolphin	0
Delphinus delphis	Short-beaked common dolphin	0

Delphinus delphis/Lagenorhynchus acutus	Short-beaked common or Atlantic white-sided dolphin	0
Delphinus delphis/Stenella	Short-beaked common dolphin or Stenella spp.	0
Delphinus delphis/Stenella coeruleoalba	Short-beaked common or striped dolphin	0
Grampus griseus	Risso's dolphin	71
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	2
Lagenorhynchus acutus	Atlantic white-sided dolphin	0
Lagenorhynchus albirostris	White-beaked dolphin	0
Lagenorhynchus albirostris/Lagenorhynchus acutus	White-beaked or white-sided dolphin	0
Stenella	Unidentified Stenella	10
Stenella attenuata	Pantropical spotted dolphin	94
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	12
Stenella coeruleoalba	Striped dolphin	16
Stenella frontalis	Atlantic spotted dolphin	36
Stenella frontalis/Tursiops truncatus	Atlantic spotted or Bottlenose dolphin	0
Stenella longirostris	Spinner dolphin	11
Steno bredanensis	Rough-toothed dolphin	9
Steno bredanensis/Tursiops truncatus	Bottlenose or rough-toothed dolphin	0
Tursiops truncatus	Bottlenose dolphin	237
Total		498

Table 11: Proxy species used to fit detection functions for GulfCet Aerial Surveys. The number of sightings, n, is before truncation.

The sightings were right truncated at 1296m.

Covariate	Description
beaufort	Beaufort sea state.
quality	Survey-specific index of the quality of observation conditions, utilizing relevant factors other than Beaufort sea state (see methods).
size	Estimated size (number of individuals) of the sighted group.

Table 12: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr			size	Yes	0.00	402
hr				Yes	1.41	394
hr	poly	2		Yes	3.41	394
hr	poly	4		Yes	3.41	394

hn	cos	2		Yes	4.97	368
hn	cos	3		Yes	10.69	340
hn			size	Yes	31.42	441
hn				Yes	34.80	439
hn	herm	4		Yes	36.57	439
hr			beaufort	No		
hn			beaufort	No		
hr			quality	No		
hn			quality	No		
hr			beaufort, quality	No		
hn			beaufort, quality	No		
hr			beaufort, size	No		
hn			beaufort, size	No		
hr			quality, size	No		
hn			quality, size	No		
hr			beaufort, quality, size	No		
hn			beaufort, quality, size	No		

Table 13: Candidate detection functions for GulfCet Aerial Surveys. The first one listed was selected for the density model.

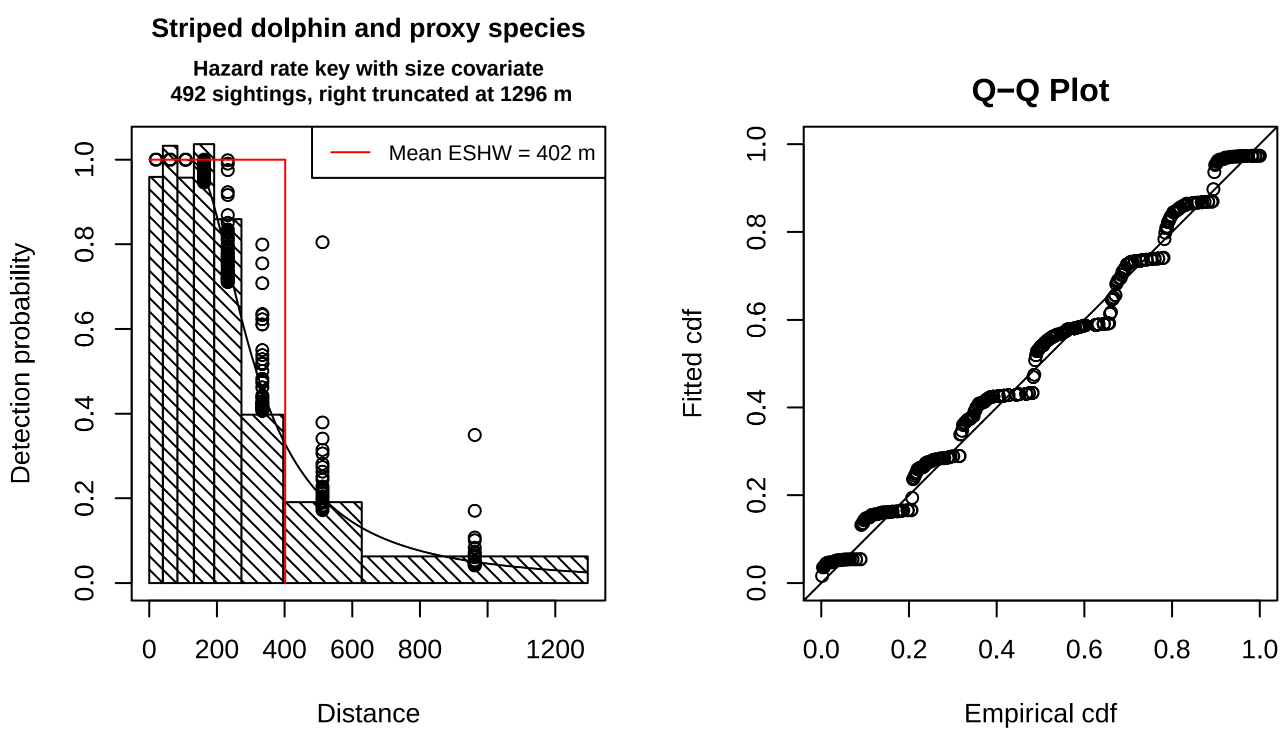


Figure 20: Detection function for GulfCet Aerial Surveys that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  492
Distance range         :  0  -  1296
AIC                    :  2031.84

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
             estimate         se
(Intercept) 5.5354386 0.09101914
size        0.1398343 0.06269366

Shape parameters:
             estimate         se
(Intercept) 0.8669391 0.08291978

                        Estimate           SE         CV
Average p              0.3057321   0.01666672 0.05451413
N in covered region 1609.2517747 106.64340484 0.06626894
```

Additional diagnostic plots:

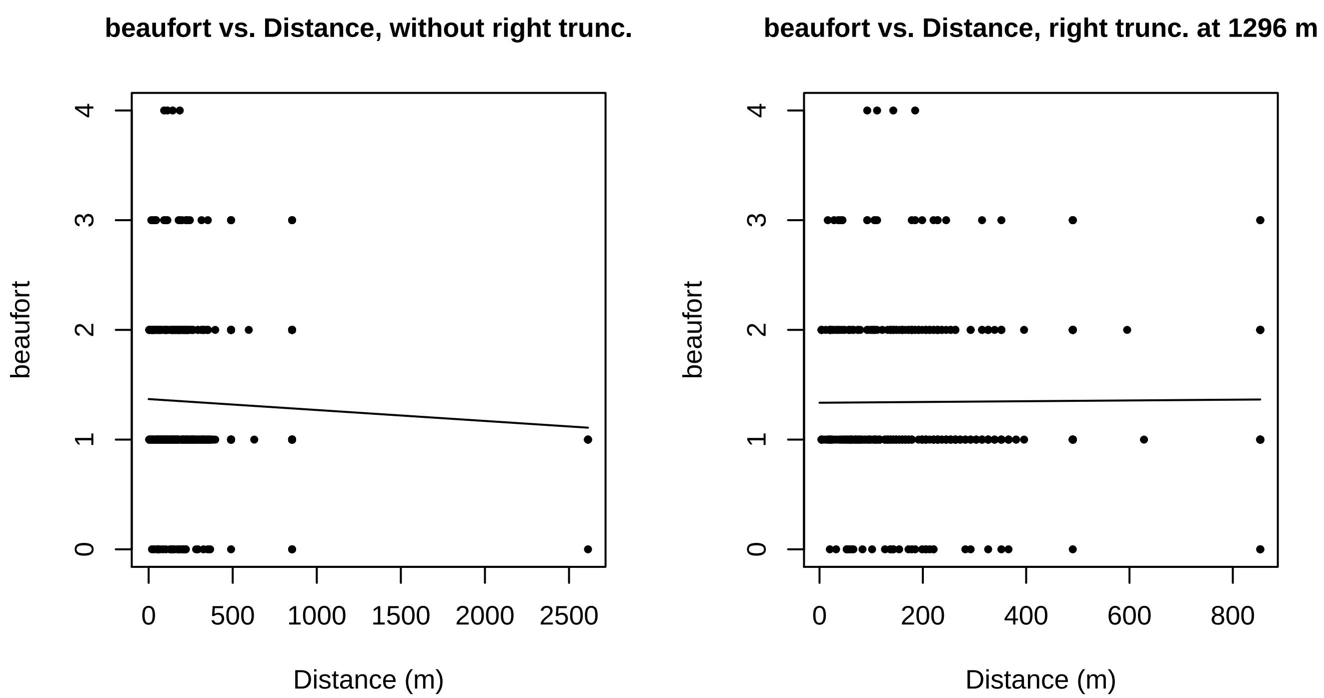


Figure 21: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

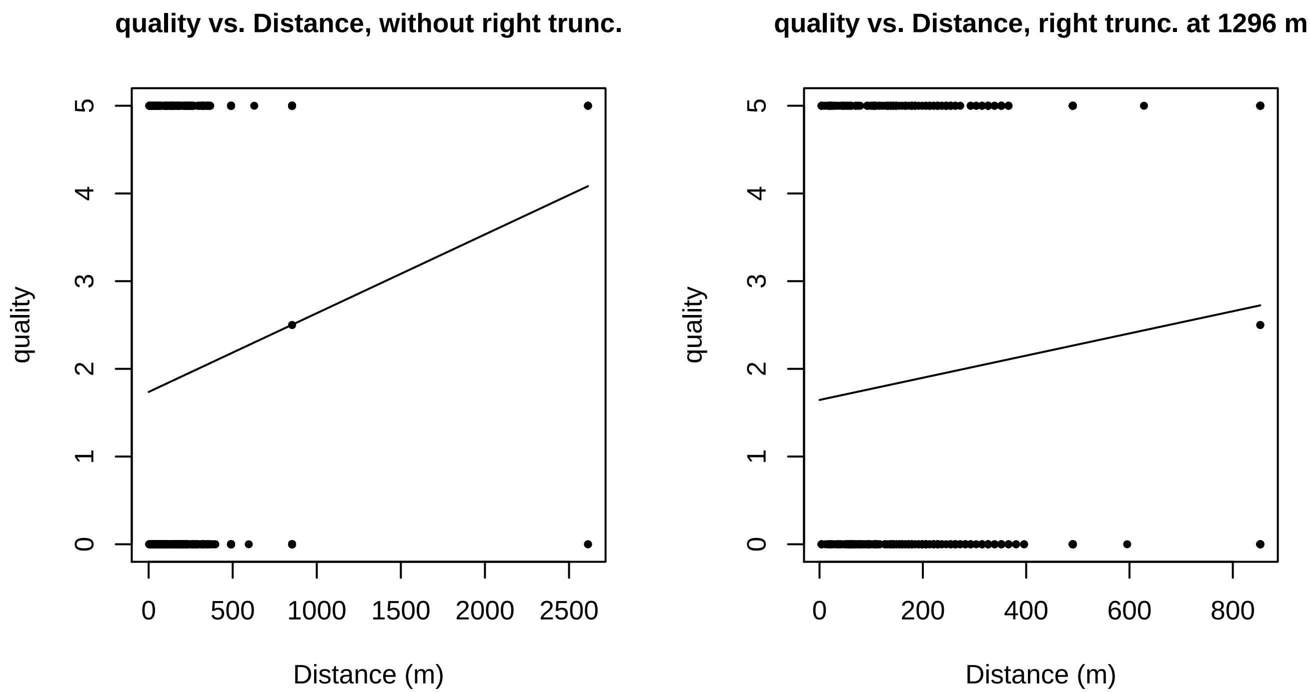


Figure 22: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

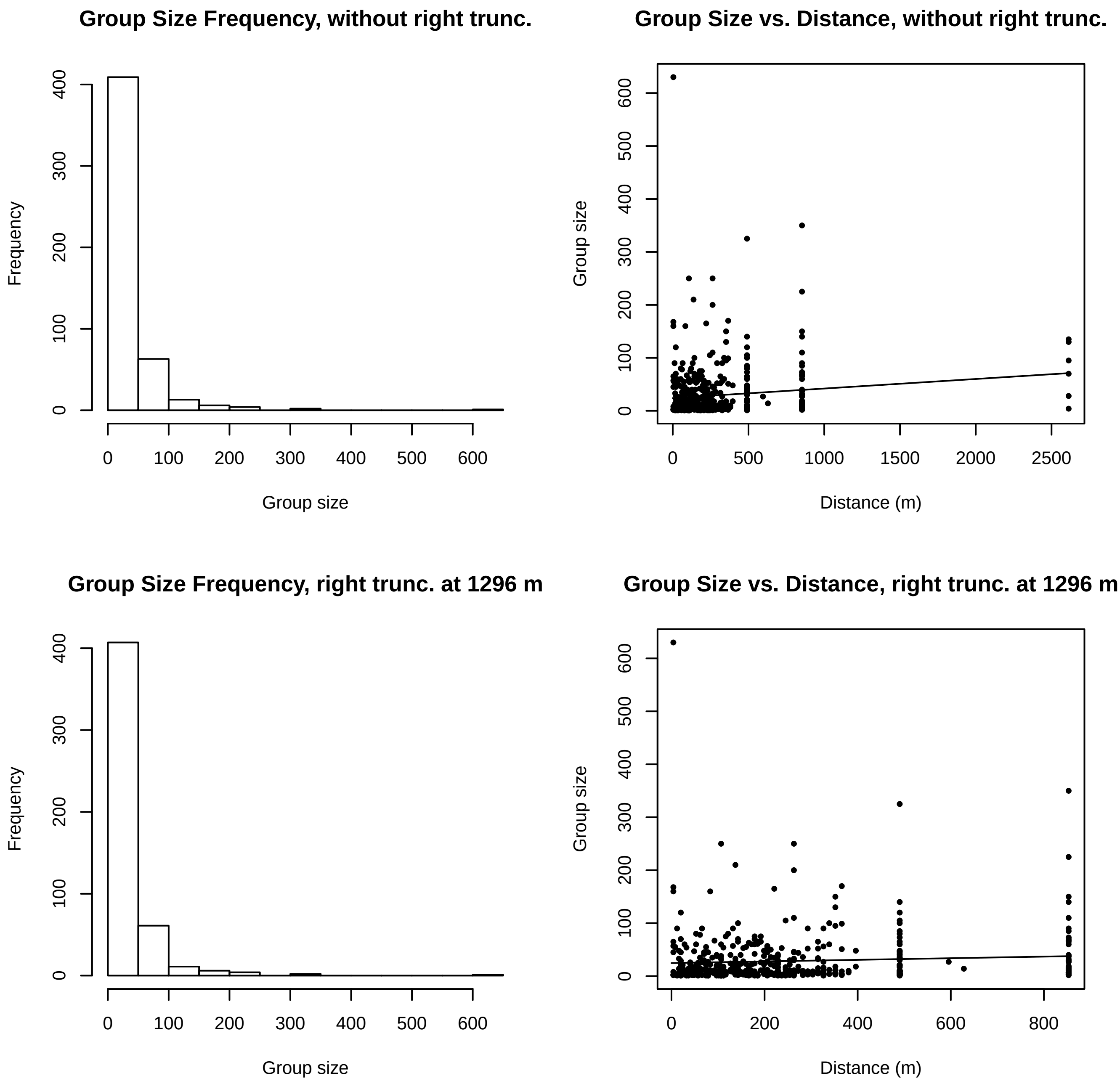


Figure 23: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

GOMEX92-96 Aerial Survey

Because this taxon was sighted too infrequently to fit a detection function to its sightings alone, we fit a detection function to the pooled sightings of several other species that we believed would exhibit similar detectability. These "proxy species" are listed below.

Reported By Observer	Common Name	n
Delphinus capensis	Long-beaked common dolphin	0
Delphinus delphis	Short-beaked common dolphin	0

Delphinus delphis/Lagenorhynchus acutus	Short-beaked common or Atlantic white-sided dolphin	0
Delphinus delphis/Stenella	Short-beaked common dolphin or Stenella spp.	0
Delphinus delphis/Stenella coeruleoalba	Short-beaked common or striped dolphin	0
Grampus griseus	Risso's dolphin	4
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	0
Lagenorhynchus acutus	Atlantic white-sided dolphin	0
Lagenorhynchus albirostris	White-beaked dolphin	0
Lagenorhynchus albirostris/Lagenorhynchus acutus	White-beaked or white-sided dolphin	0
Stenella	Unidentified Stenella	1
Stenella attenuata	Pantropical spotted dolphin	0
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	0
Stenella coeruleoalba	Striped dolphin	0
Stenella frontalis	Atlantic spotted dolphin	24
Stenella frontalis/Tursiops truncatus	Atlantic spotted or Bottlenose dolphin	0
Stenella longirostris	Spinner dolphin	0
Steno bredanensis	Rough-toothed dolphin	0
Steno bredanensis/Tursiops truncatus	Bottlenose or rough-toothed dolphin	0
Tursiops truncatus	Bottlenose dolphin	936
Total		965

Table 14: Proxy species used to fit detection functions for GOMEX92-96 Aerial Survey. The number of sightings, n, is before truncation.

The sightings were right truncated at 1296m. Due to a reduced frequency of sightings close to the trackline that plausibly resulted from the behavior of the observers and/or the configuration of the survey platform, the sightings were left truncted as well. Sightings closer than 83 m to the trackline were omitted from the analysis, and it was assumed that the the area closer to the trackline than this was not surveyed. This distance was estimated by inspecting histograms of perpendicular sighting distances.

Covariate	Description
beaufort	Beaufort sea state.
quality	Survey-specific index of the quality of observation conditions, utilizing relevant factors other than Beaufort sea state (see methods).
size	Estimated size (number of individuals) of the sighted group.

Table 15: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr			size	Yes	0.00	281

hn	cos	3		Yes	4.86	220
hr				Yes	4.90	278
hr	poly	4		Yes	6.90	278
hr	poly	2		Yes	6.90	278
hn	cos	2		Yes	12.08	259
hn			size	Yes	39.54	304
hn				Yes	41.95	304
hn	herm	4		Yes	43.71	304
hr			beaufort	No		
hn			beaufort	No		
hr			quality	No		
hn			quality	No		
hr			beaufort, quality	No		
hn			beaufort, quality	No		
hr			beaufort, size	No		
hn			beaufort, size	No		
hr			quality, size	No		
hn			quality, size	No		
hr			beaufort, quality, size	No		
hn			beaufort, quality, size	No		

Table 16: Candidate detection functions for GOMEX92-96 Aerial Survey. The first one listed was selected for the density model.

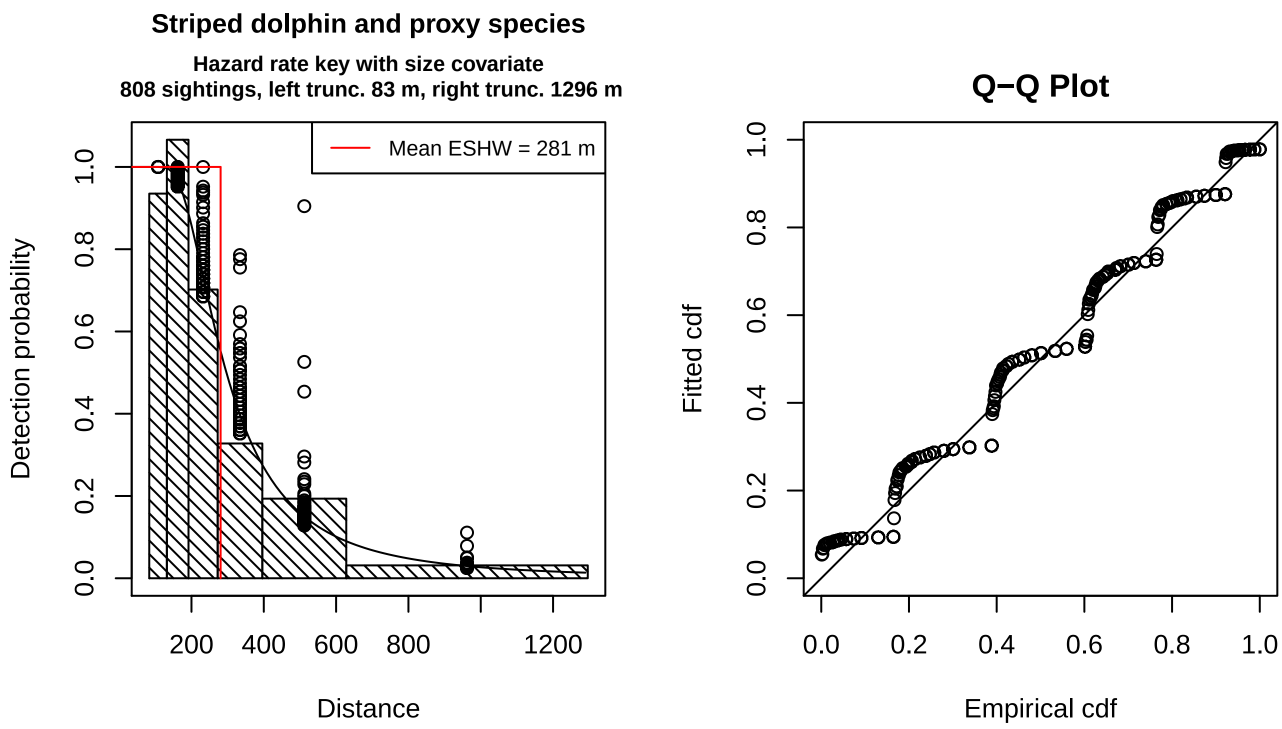


Figure 24: Detection function for GOMEX92-96 Aerial Survey that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  808
Distance range         :  83.2036  -  1296
AIC                    :  2832.21

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
              estimate         se
(Intercept) 5.48993350 0.06755593
size        0.09571101 0.04017188

Shape parameters:
             estimate         se
(Intercept) 0.9892248 0.05853657

                        Estimate           SE         CV
Average p              0.2138271   0.01146024 0.05359584
N in covered region 3778.7542797 234.43000362 0.06203896
```

Additional diagnostic plots:

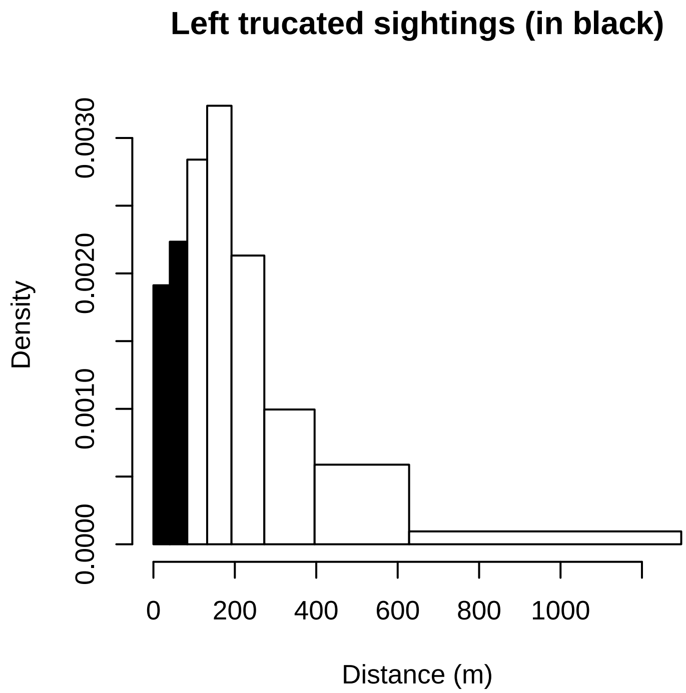


Figure 25: Density of sightings by perpendicular distance for GOMEX92-96 Aerial Survey. Black bars on the left show sightings that were left truncated.

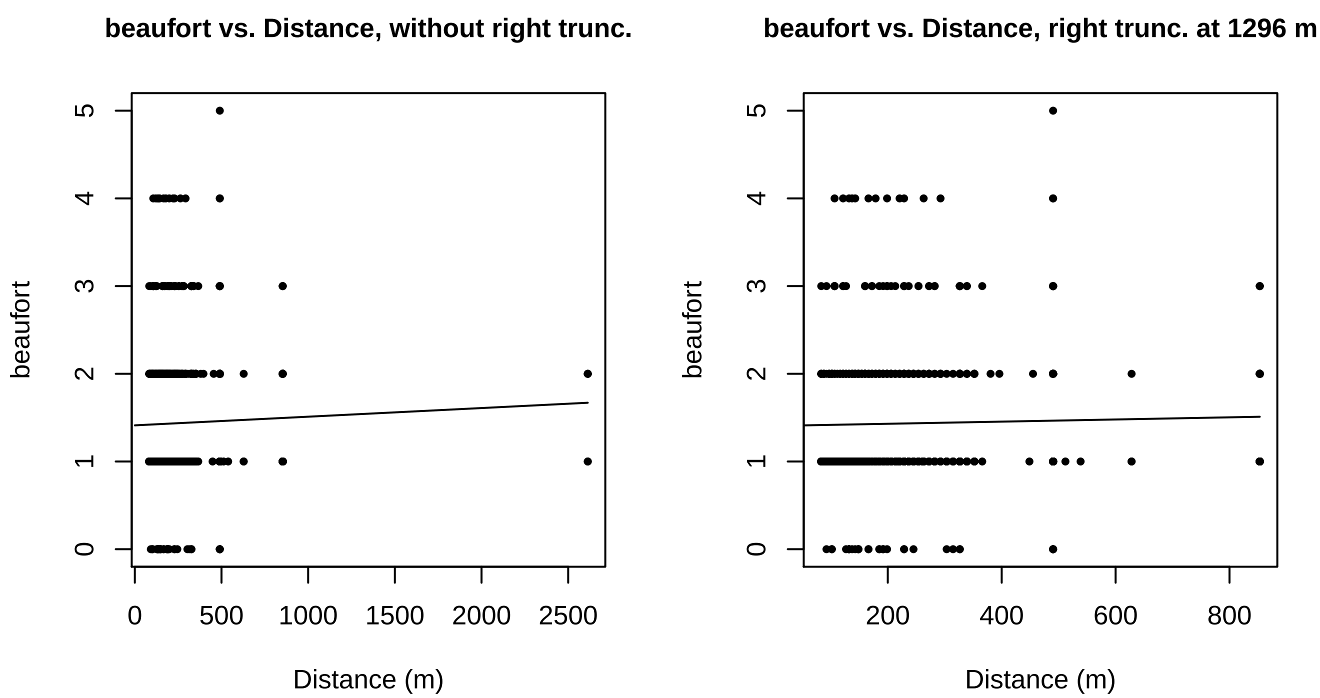


Figure 26: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

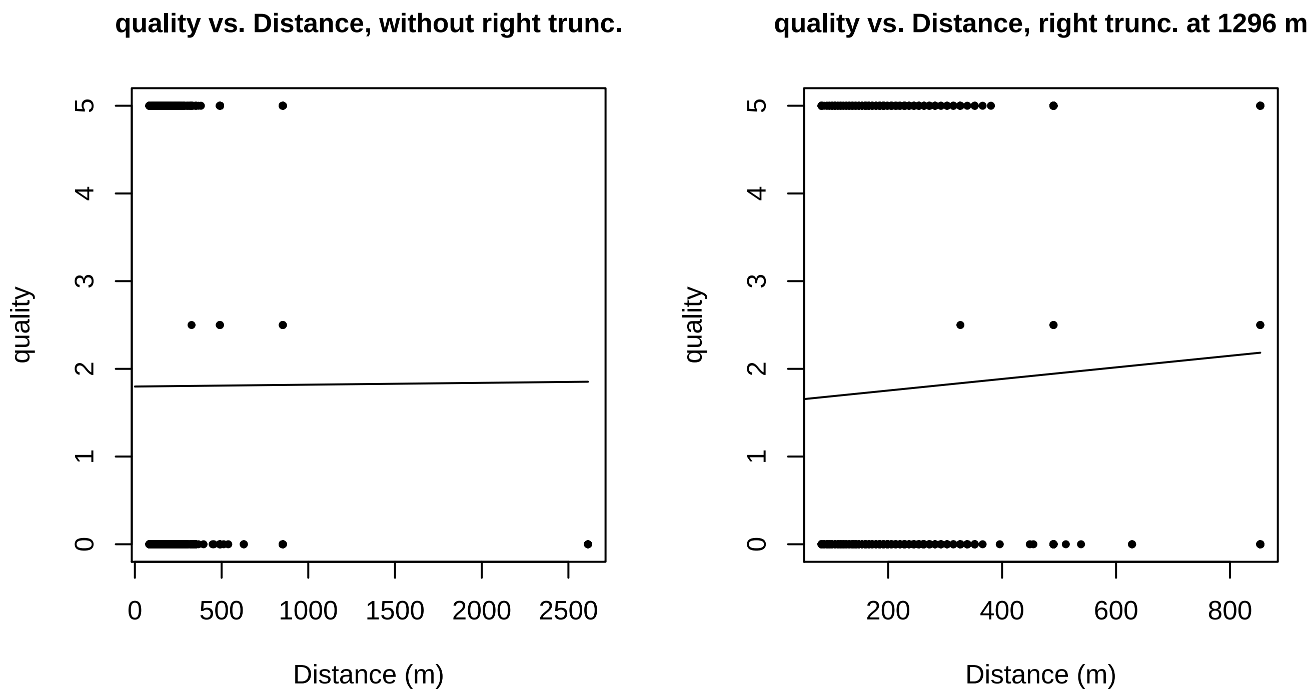


Figure 27: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

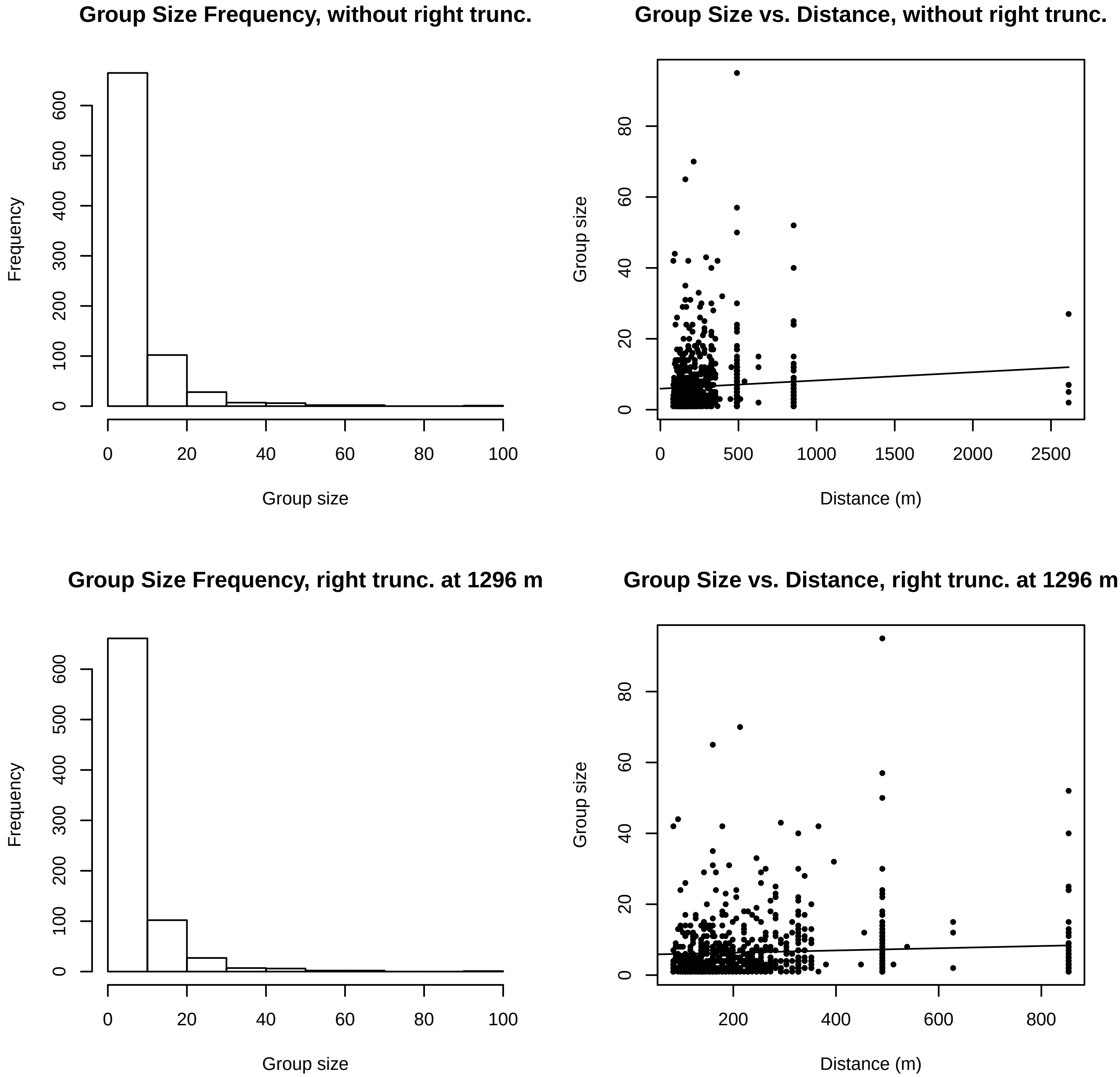


Figure 28: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

g(0) Estimates

Platform	Surveys	Group Size	*g(0)*	Biases Addressed	Source
Shipboard	All	1-20	0.856	Perception	Barlow and Forney (2007)
		>20	0.970	Perception	Barlow and Forney (2007)
Aerial	All	1-5	0.43	Both	Palka (2006)
		>5	0.960	Both	Carretta et al. (2000)

Table 17: Estimates of *g(0)* used in this density model.

No g(0) estimates were published for any of the shipboard surveys available to us from this region. Instead, we utilized Barlow and Forney's (2007) estimates for delphinids, produced from several years of dual-team surveys that used bigeye binoculars and similar protocols to the surveys in our study. This study provided separate estimates for small and large groups, but pooled sightings of several species together to provide a generic estimate for all delphinids, due to sample-size limitations. To our knowledge, there is no species-specific shipboard g(0) estimate that treats small and large groups separately, so we believe Barlow and Forney (2007) provide the best general-purpose alternative. Their estimate accounted for perception bias but not availability bias; dive times for dolphins are short enough that availability bias is not expected to be significant for dolphins observed from shipboard surveys.

For aerial surveys, we were unable to locate species-specific g(0) estimates in the literature. For small groups, defined here as 1-5 individuals, we used Palka's (2006) estimate of g(0) for groups of 1-5 small cetaceans, estimated from two years of aerial surveys using the Hiby (1999) circle-back method. This estimate accounted for both availability and perception bias, but pooled sightings of several species together to provide a generic estimate for all delphinids, due to sample-size limitations. For large groups, defined here as greater than 5 individuals, Palka (2006) assumed that g(0) was 1. When we discussed this with NOAA SWFSC reviewers, they agreed that it was safe to assume that the availability bias component of g(0) was 1 but insisted that perception bias should be slightly less than 1, because it was possible to miss large groups. We agreed to take a conservative approach and obtained our g(0) for large groups from Carretta et al. (2000), who estimated g(0) for both small and large groups of delphinids. We used Carretta et al.'s g(0) estimate for groups of 1-25 individuals (0.960), rather than their larger one for more than 25 individuals (0.994), to account for the fact that we were using Palka's definition of large groups as those with more than 5 individuals.

Density Models

Striped dolphins are found throughout the the world in tropical and warm-temperate waters (Archer and Perrin 1999). In the North Atlantic, striped dolphin is an oceanic species found in the Gulf of Mexico, Caribbean Sea, along the east coast of North America, and in the eastern Atlantic from the United Kingdom southward (Archer and Perrin 1999). All of the sightings reported by our surveys occurred off the continental shelf, over both the continental slope and abyssal waters, consistent with the habitat described in the literature. Accordingly, we fitted our model to the effort that occurred in off-shelf waters, defined here as those deeper than the 100m isobath.

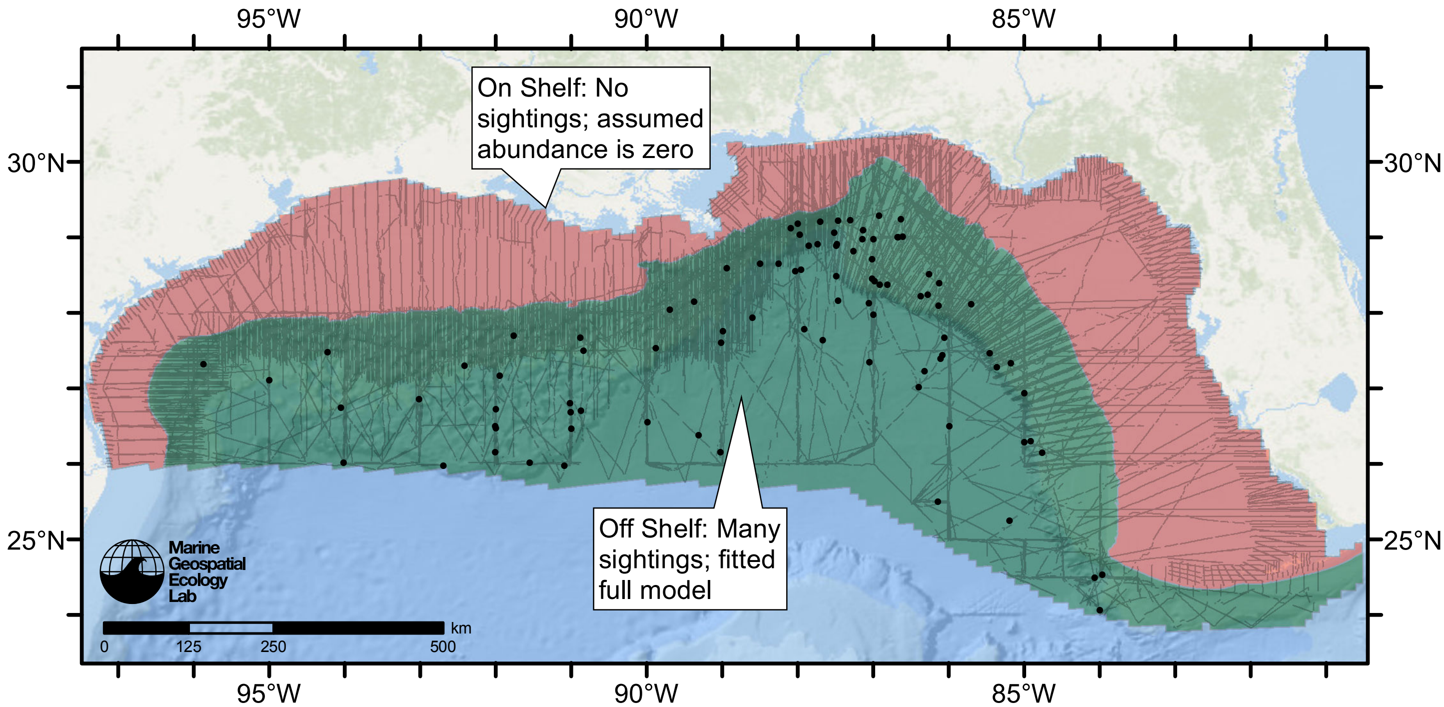


Figure 29: Striped dolphin density model schematic. All on-effort sightings are shown, including those that were truncated when detection functions were fitted.

Climatological Model

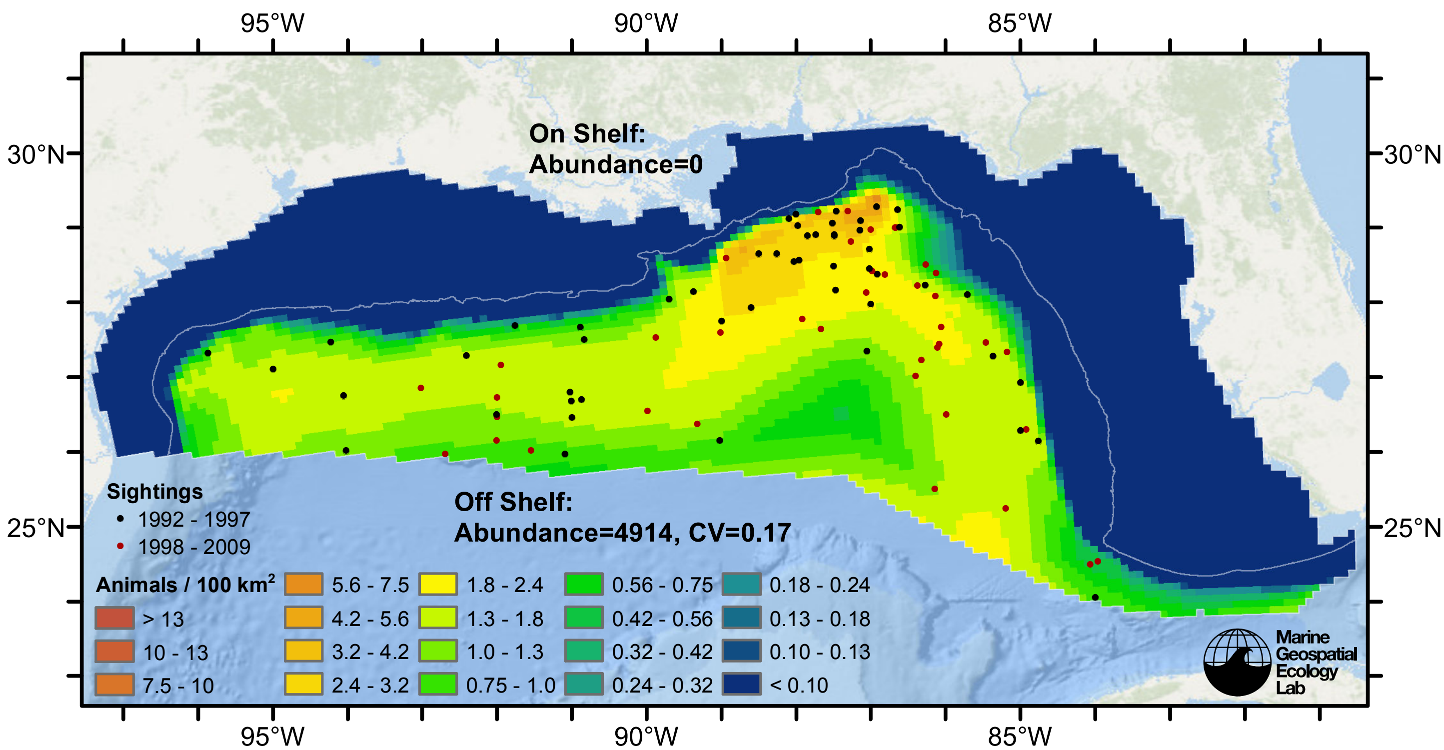


Figure 30: Striped dolphin density predicted by the climatological model that explained the most deviance. Pixels are 10x10 km. The legend gives the estimated individuals per pixel; breaks are logarithmic. Abundance for each region was computed by summing the density cells occuring in that region.

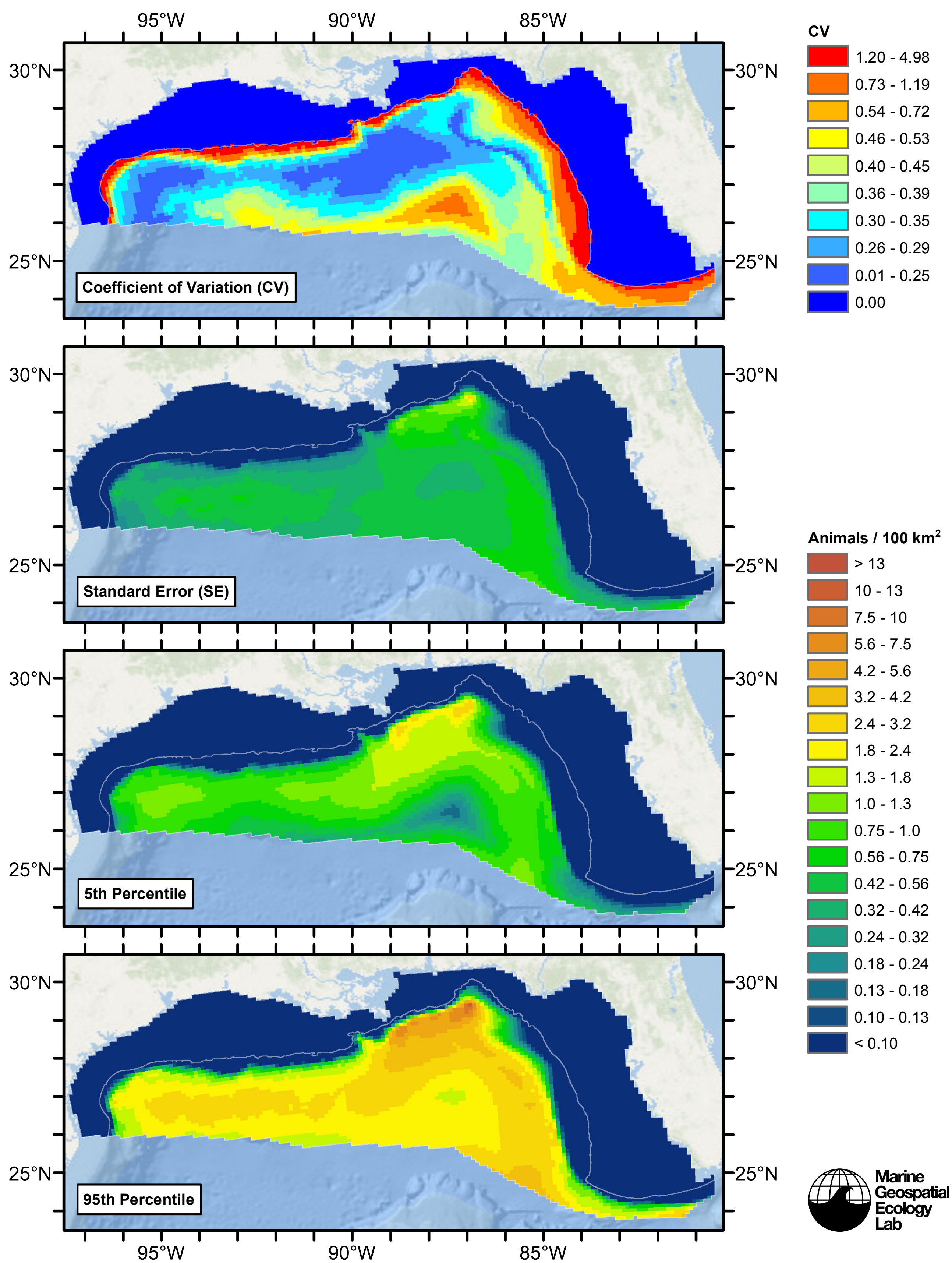


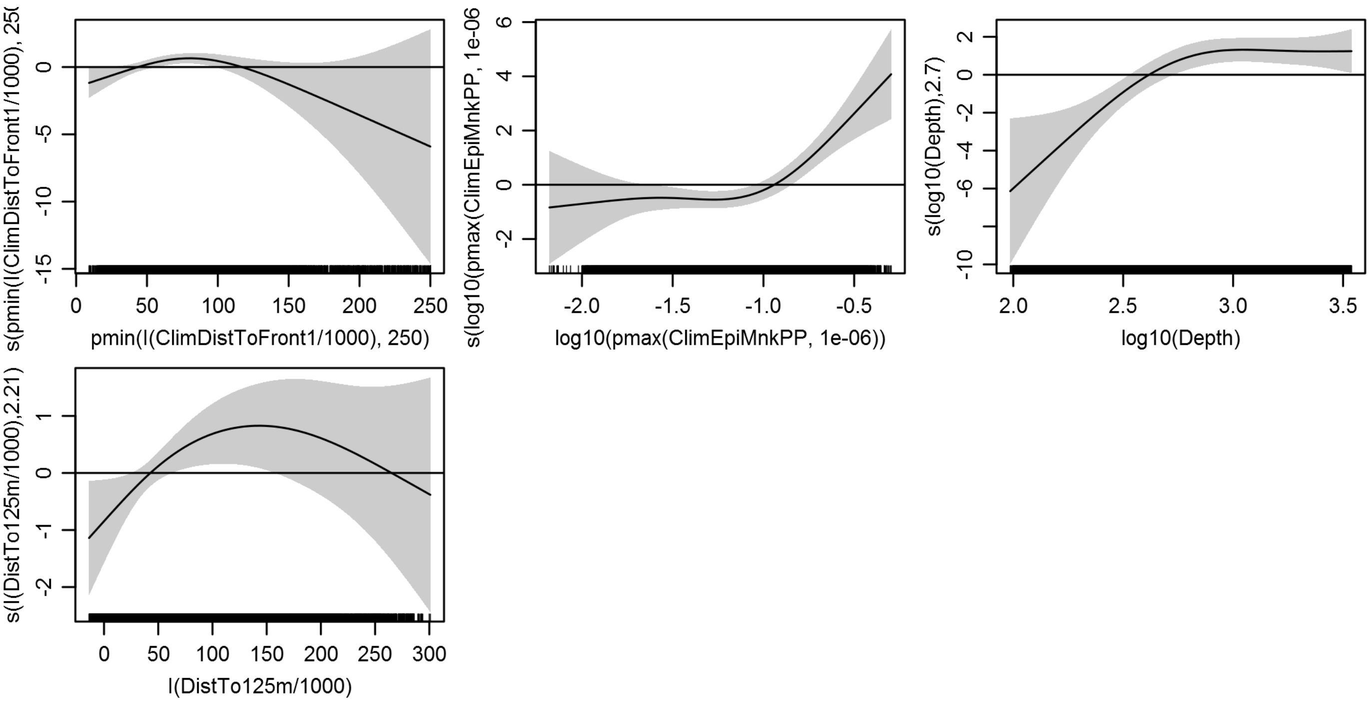
Figure 31: Estimated uncertainty for the climatological model that explained the most deviance. These estimates only incorporate the statistical uncertainty estimated for the spatial model (by the R mgcv package). They do not incorporate uncertainty in the detection functions, g(0) estimates, predictor variables, and so on.

Off Shelf

Statistical output

```
Rscript.exe: This is mgcv 1.8-3. For overview type 'help("mgcv-package")'.


Family: Tweedie(p=1.258)
Link function: log

Formula:
abundance ~ offset(log(area_km2)) + s(log10(Depth), bs = "ts",
    k = 5) + s(I(DistTo125m/1000), bs = "ts", k = 5) + s(pmin(I(ClimDistToFront1/1000),
    250), bs = "ts", k = 5) + s(log10(pmax(ClimEpiMnkPP, 1e-06)),
    bs = "ts", k = 5)

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)   -5.726      0.313  -18.29   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
                                     edf Ref.df     F  p-value
s(log10(Depth))                    2.702      4 4.961 3.74e-05 ***
s(I(DistTo125m/1000))              2.211      4 1.964   0.0141 *
s(pmin(I(ClimDistToFront1/1000), 250)) 2.382      4 3.212   0.0012 **
s(log10(pmax(ClimEpiMnkPP, 1e-06)))    2.770      4 8.159 2.47e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.00376   Deviance explained = 15.5%
-REML = 1051.1  Scale est. = 164.58    n = 14455

All predictors were significant. This is the final model.
Creating term plots.
Diagnostic output from gam.check():

Method: REML   Optimizer: outer newton
full convergence after 14 iterations.
Gradient range [-3.141048e-08,5.023113e-09]
(score 1051.09 & scale 164.5782).
Hessian positive definite, eigenvalue range [0.5181981,368.8705].
Model rank =  17 / 17

Basis dimension (k) checking results. Low p-value (k-index<1) may
indicate that k is too low, especially if edf is close to k'.

                                         k'   edf k-index p-value
s(log10(Depth))                        4.000 2.702   0.782    0.03
s(I(DistTo125m/1000))                  4.000 2.211   0.779    0.00
s(pmin(I(ClimDistToFront1/1000), 250)) 4.000 2.382   0.813    0.28
s(log10(pmax(ClimEpiMnkPP, 1e-06)))    4.000 2.770   0.777    0.01

Predictors retained during the model selection procedure: Depth, DistTo125m, ClimDistToFront1,
ClimEpiMnkPP

Predictors dropped during the model selection procedure: Slope, ClimSST, ClimEKE
```

Model term plots



Diagnostic plots

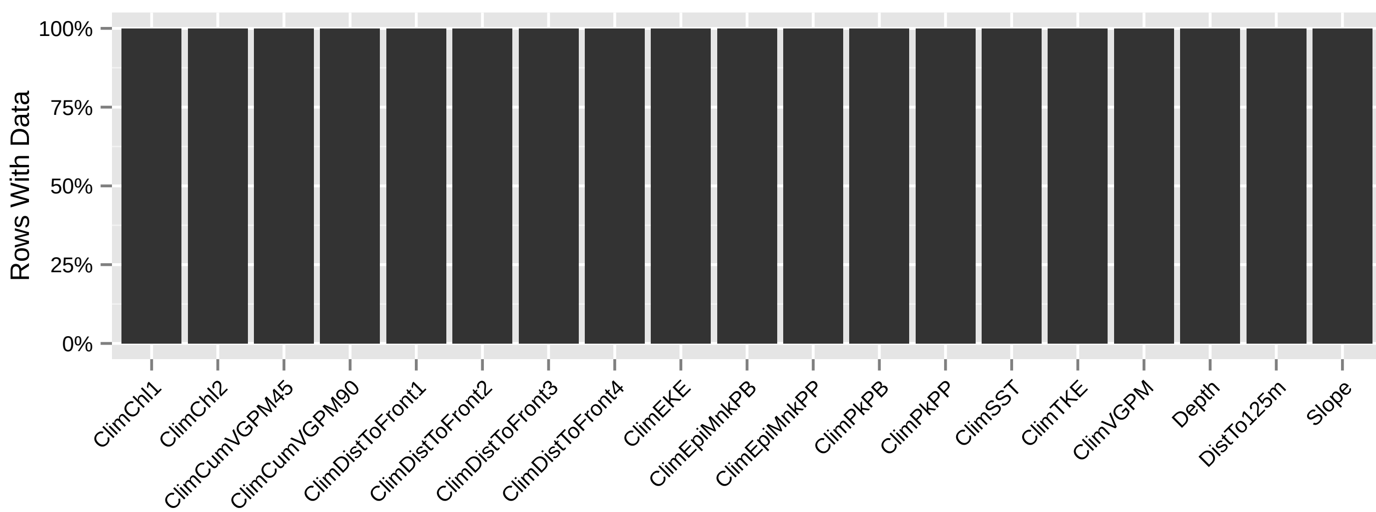


Figure 32: Segments with predictor values for the Striped dolphin Climatological model, Off Shelf. This plot is used to assess how many segments would be lost by including a given predictor in a model.

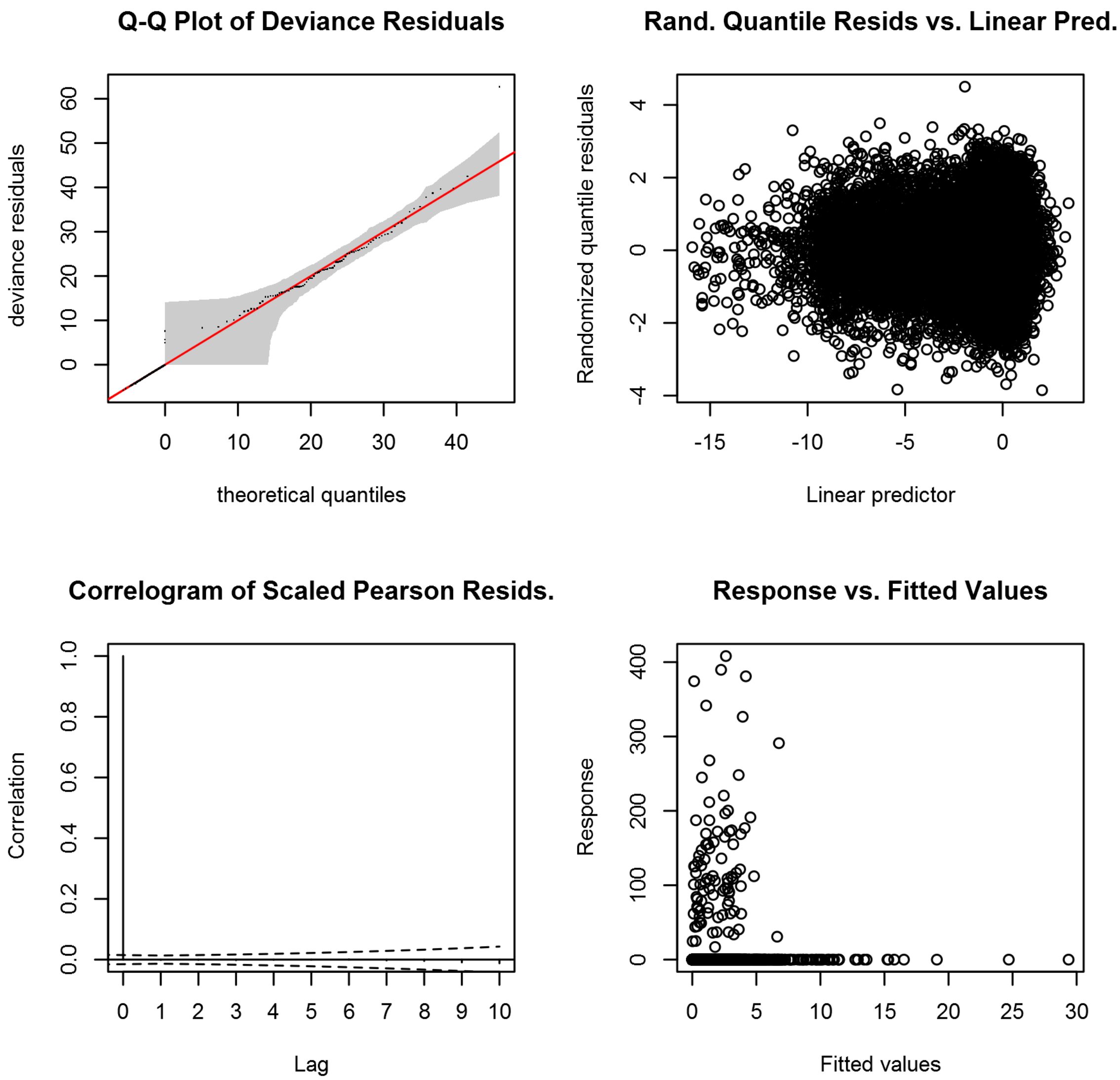


Figure 33: Statistical diagnostic plots for the Striped dolphin Climatological model, Off Shelf.

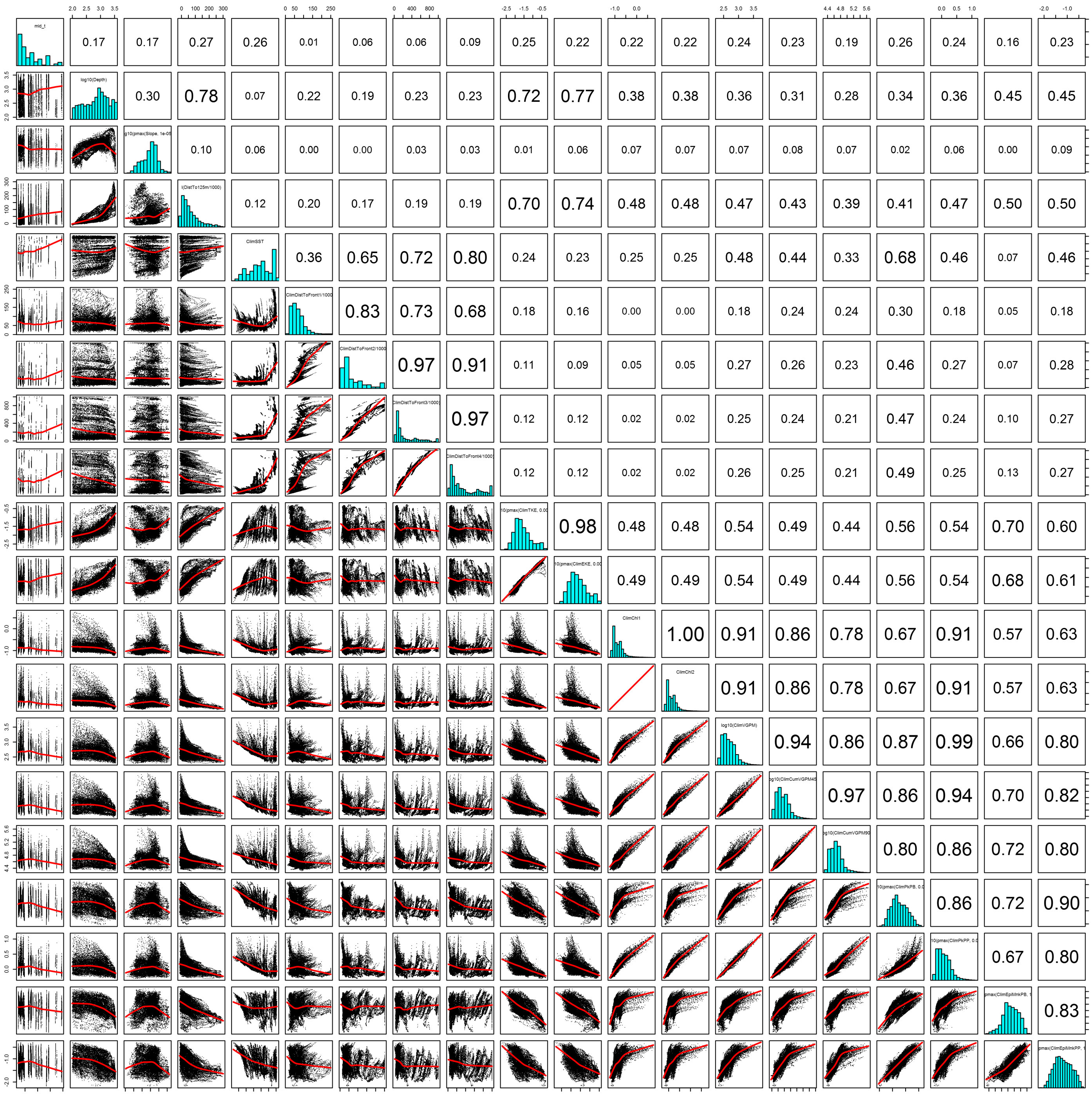


Figure 34: Scatterplot matrix for the Striped dolphin Climatological model, Off Shelf. This plot is used to inspect the distribution of predictors (via histograms along the diagonal), simple correlation between predictors (via pairwise Pearson coefficients above the diagonal), and linearity of predictor correlations (via scatterplots below the diagonal). This plot is best viewed at high magnification.

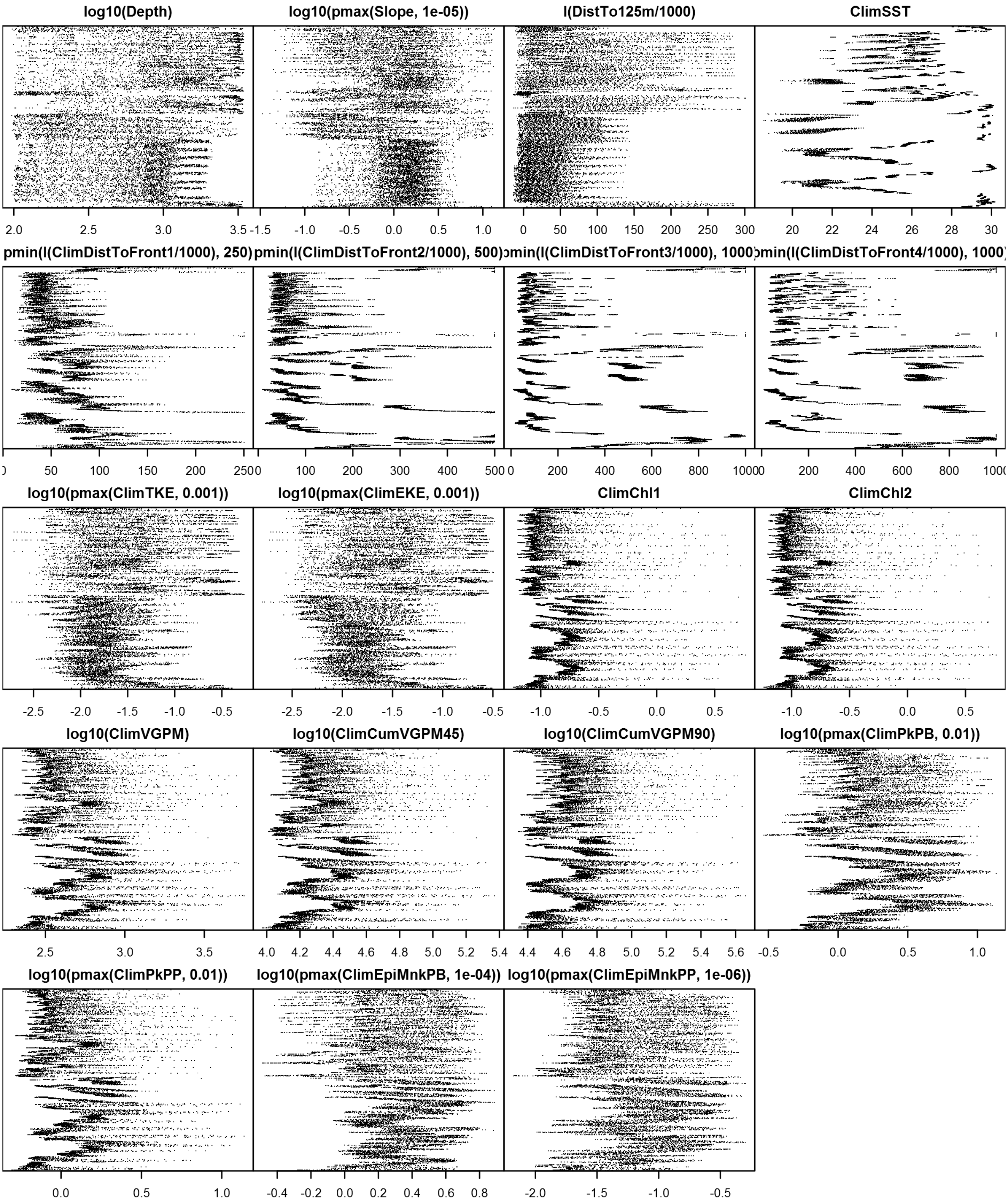


Figure 35: Dotplot for the Striped dolphin Climatological model, Off Shelf. This plot is used to check for suspicious patterns and outliers in the data. Points are ordered vertically by transect ID, sequentially in time.

On Shelf

Density assumed to be 0 in this region.

Contemporaneous Model

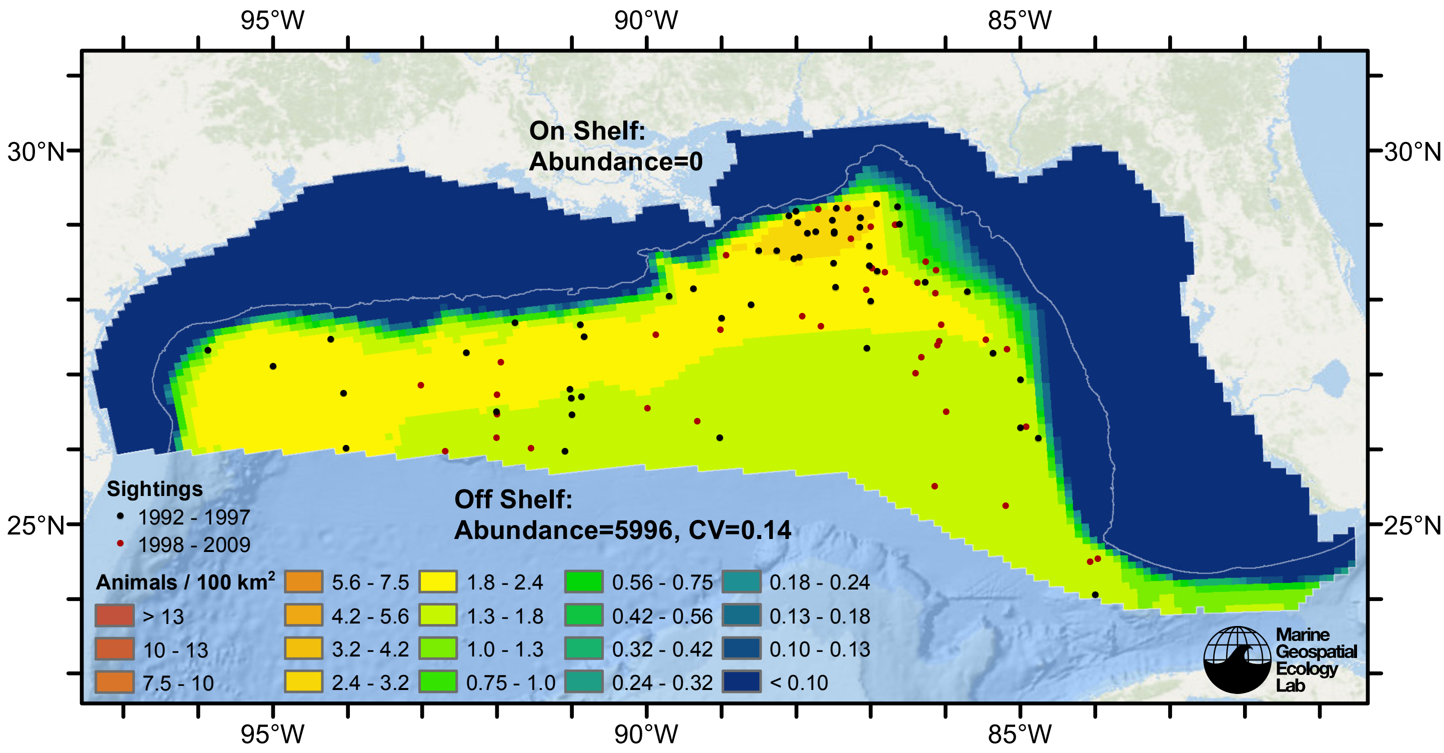


Figure 36: Striped dolphin density predicted by the contemporaneous model that explained the most deviance. Pixels are 10x10 km. The legend gives the estimated individuals per pixel; breaks are logarithmic. Abundance for each region was computed by summing the density cells occuring in that region.

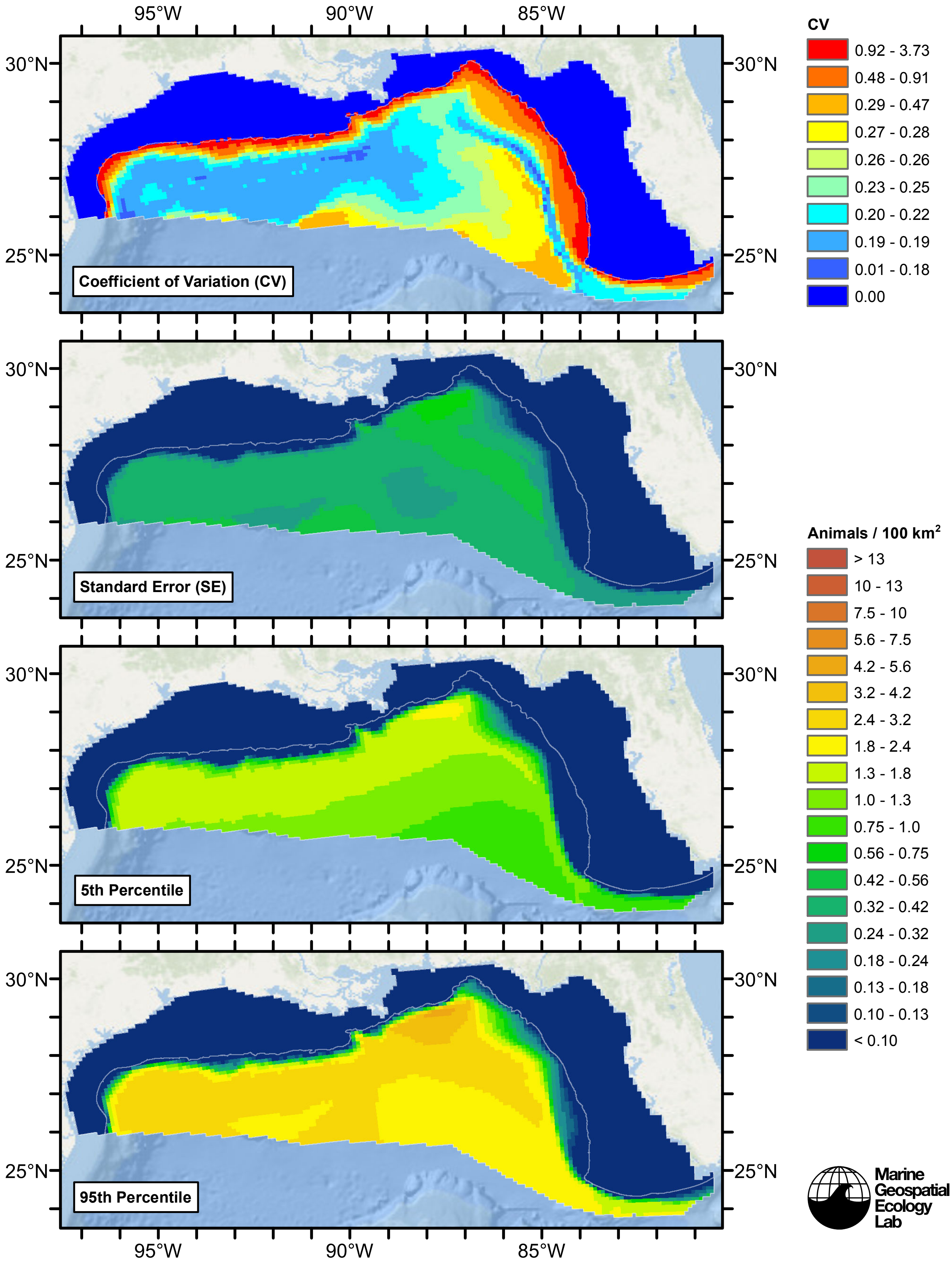


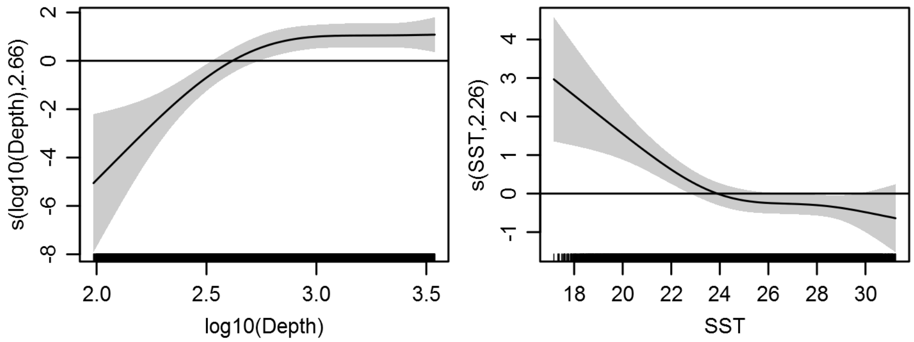
Figure 37: Estimated uncertainty for the contemporaneous model that explained the most deviance. These estimates only incorporate the statistical uncertainty estimated for the spatial model (by the R mgcv package). They do not incorporate uncertainty in the detection functions, g(0) estimates, predictor variables, and so on.

Off Shelf

Statistical output

```
Rscript.exe: This is mgcv 1.8-3. For overview type 'help("mgcv-package")'.


Family: Tweedie(p=1.268)
Link function: log

Formula:
abundance ~ offset(log(area_km2)) + s(log10(Depth), bs = "ts",
    k = 5) + s(SST, bs = "ts", k = 5)

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -5.0812     0.2247  -22.61   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
                  edf Ref.df     F  p-value
s(log10(Depth)) 2.659      4 5.474 1.36e-05 ***
s(SST)          2.256      4 5.507 5.58e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.00229   Deviance explained = 10.2%
-REML = 1053.8  Scale est. = 173.56    n = 14455

All predictors were significant. This is the final model.
Creating term plots.
Diagnostic output from gam.check():

Method: REML   Optimizer: outer newton
full convergence after 10 iterations.
Gradient range [-0.0003559591,3.361113e-05]
(score 1053.759 & scale 173.5552).
Hessian positive definite, eigenvalue range [0.4141965,360.4009].
Model rank =  9 / 9

Basis dimension (k) checking results. Low p-value (k-index<1) may
indicate that k is too low, especially if edf is close to k'.

                   k'   edf k-index p-value
s(log10(Depth)) 4.000 2.659   0.734    0.06
s(SST)          4.000 2.256   0.762    0.24

Predictors retained during the model selection procedure: Depth, SST

Predictors dropped during the model selection procedure: Slope, DistTo125m, DistToFront1
```

Model term plots



Diagnostic plots

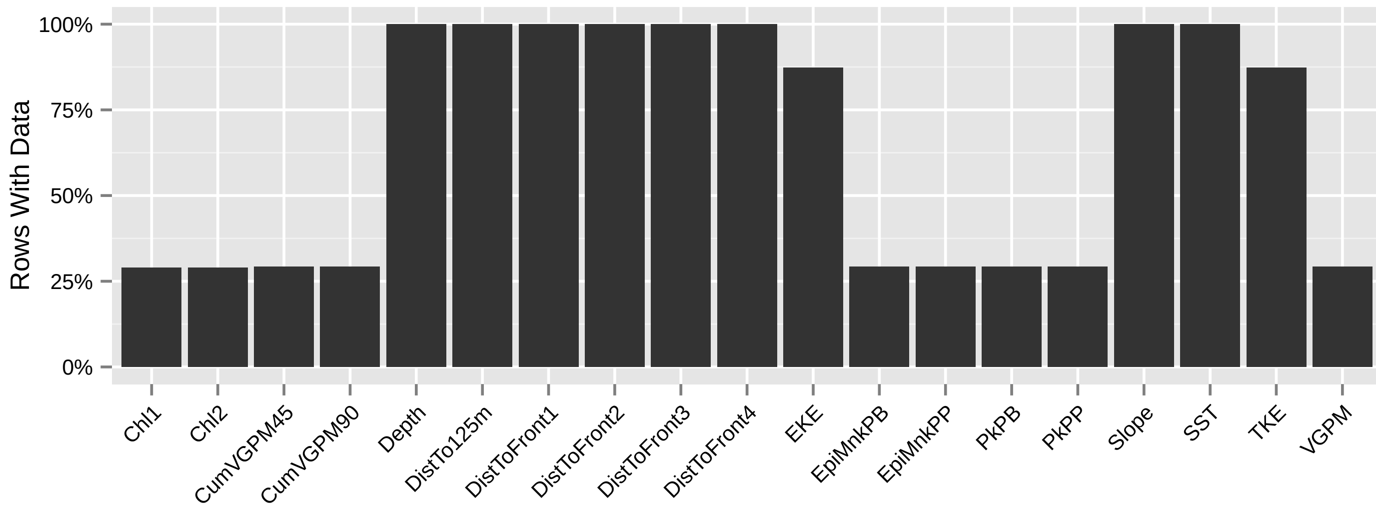


Figure 38: Segments with predictor values for the Striped dolphin Contemporaneous model, Off Shelf. This plot is used to assess how many segments would be lost by including a given predictor in a model.

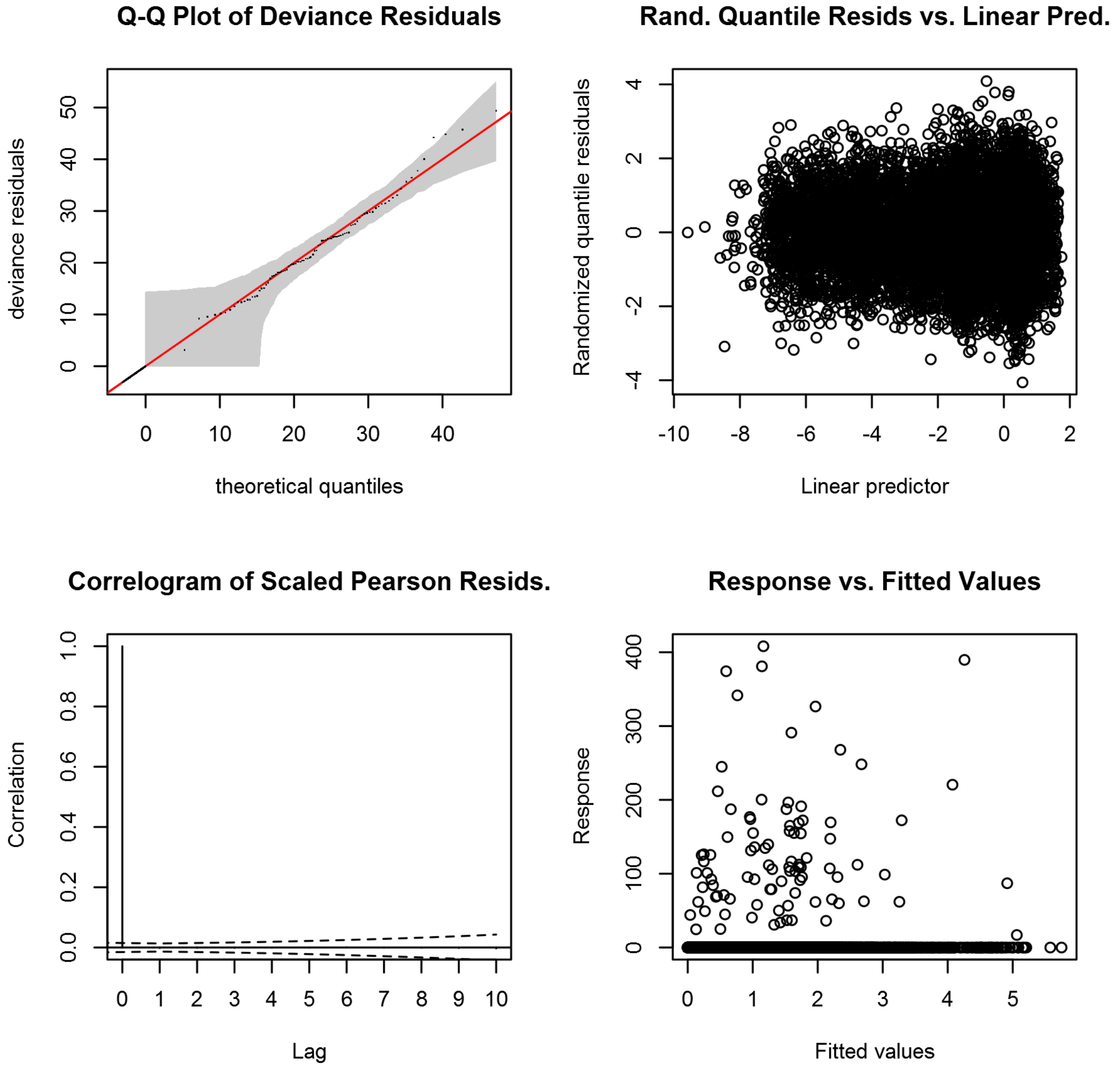


Figure 39: Statistical diagnostic plots for the Striped dolphin Contemporaneous model, Off Shelf.

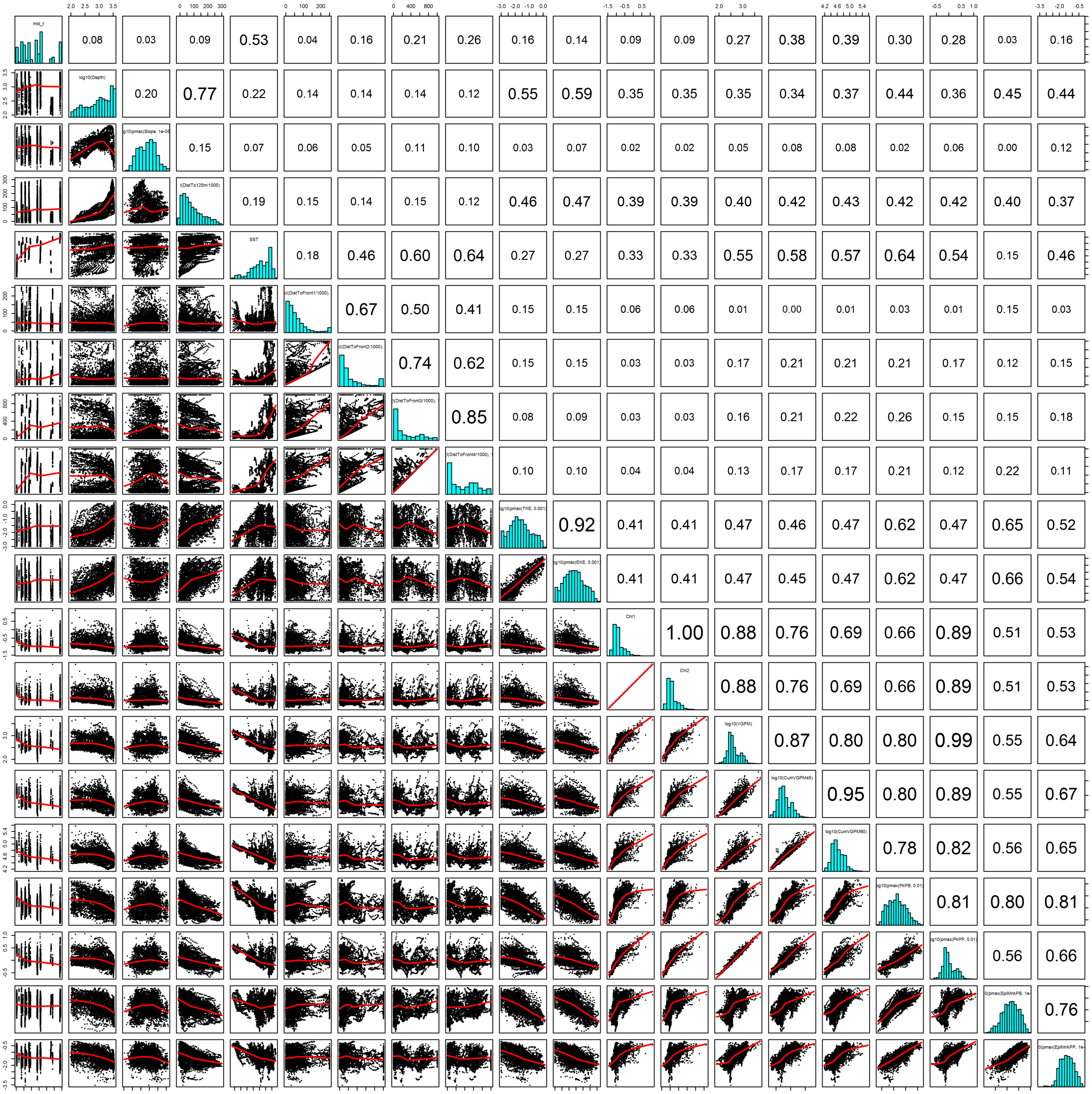


Figure 40: Scatterplot matrix for the Striped dolphin Contemporaneous model, Off Shelf. This plot is used to inspect the distribution of predictors (via histograms along the diagonal), simple correlation between predictors (via pairwise Pearson coefficients above the diagonal), and linearity of predictor correlations (via scatterplots below the diagonal). This plot is best viewed at high magnification.

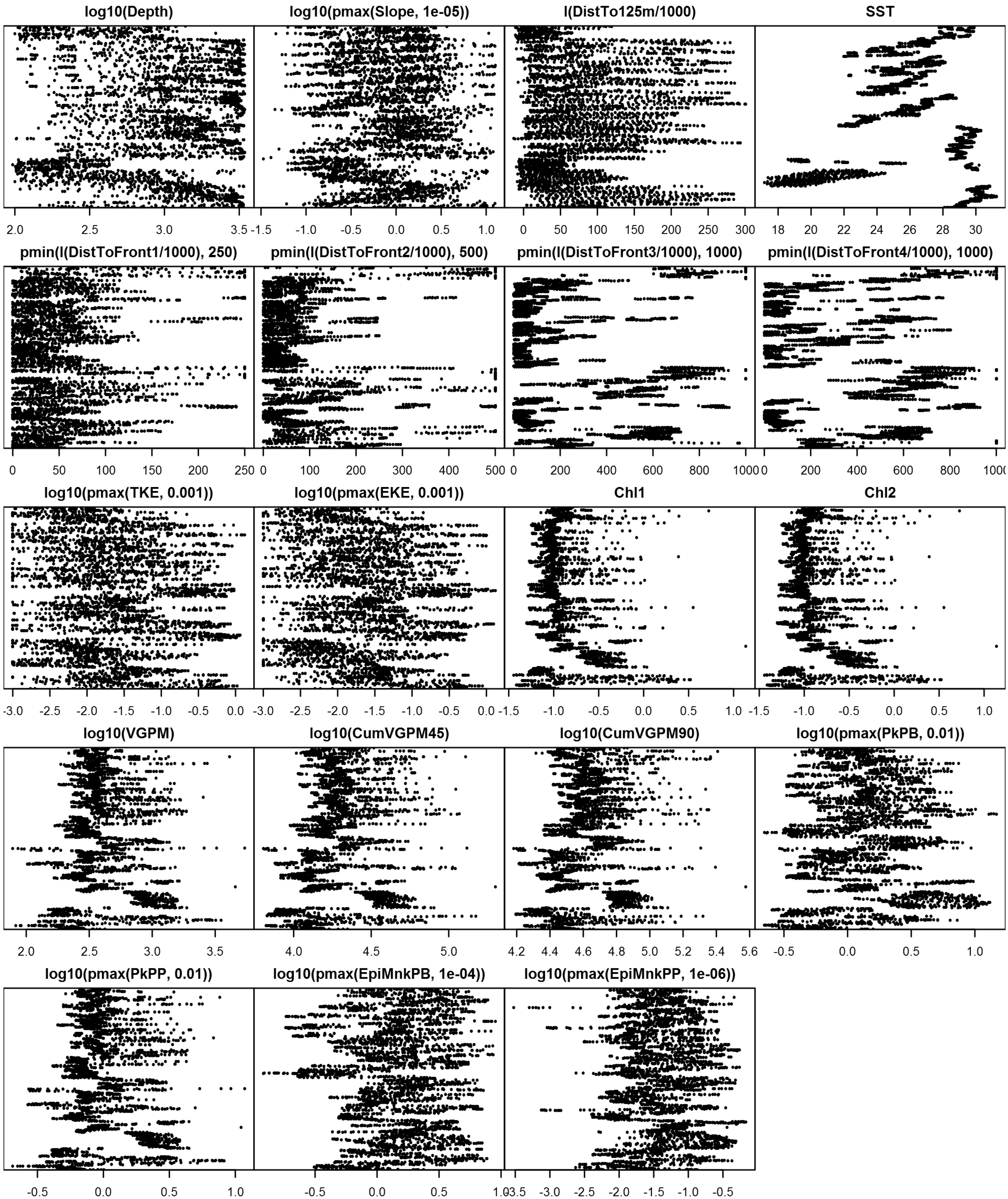


Figure 41: Dotplot for the Striped dolphin Contemporaneous model, Off Shelf. This plot is used to check for suspicious patterns and outliers in the data. Points are ordered vertically by transect ID, sequentially in time.

On Shelf

Density assumed to be 0 in this region.

Climatological Same Segments Model

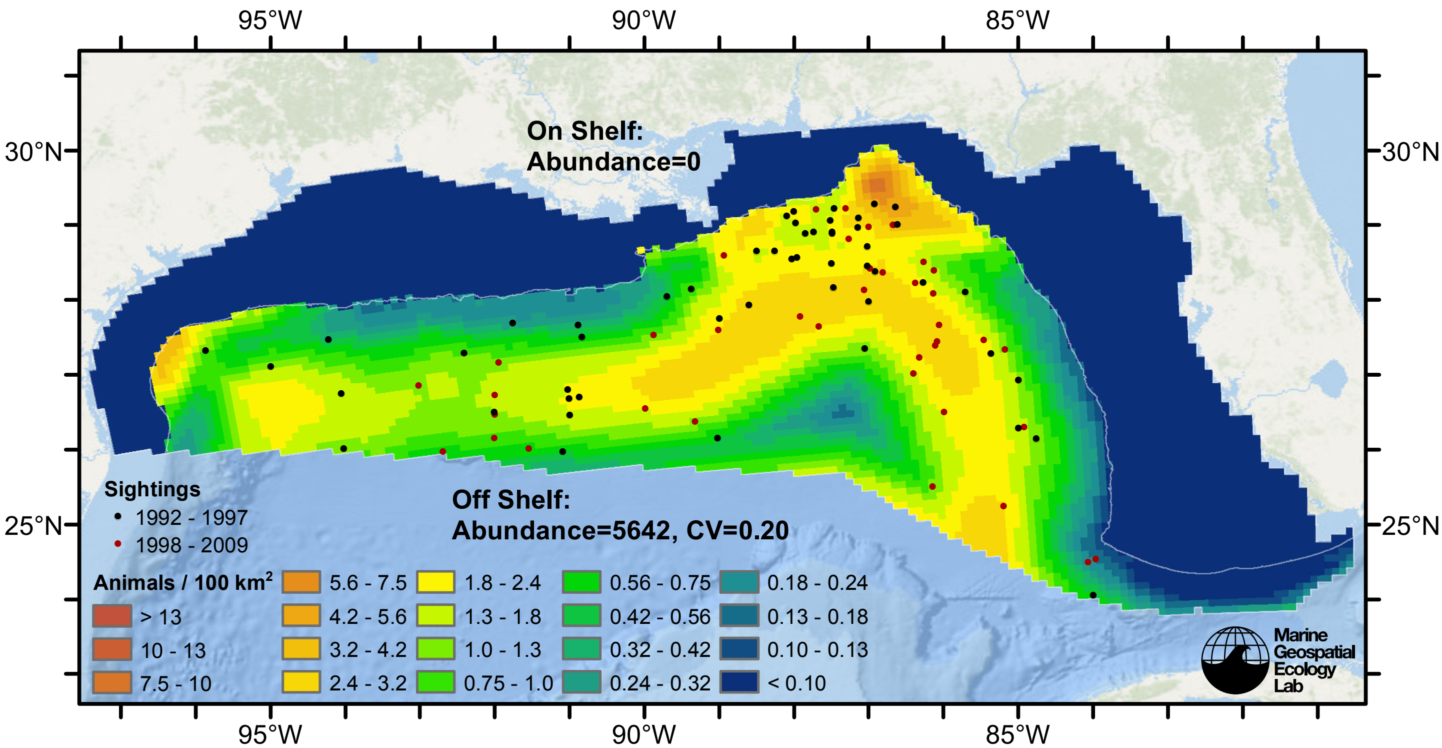


Figure 42: Striped dolphin density predicted by the climatological same segments model that explained the most deviance. Pixels are 10x10 km. The legend gives the estimated individuals per pixel; breaks are logarithmic. Abundance for each region was computed by summing the density cells occuring in that region.

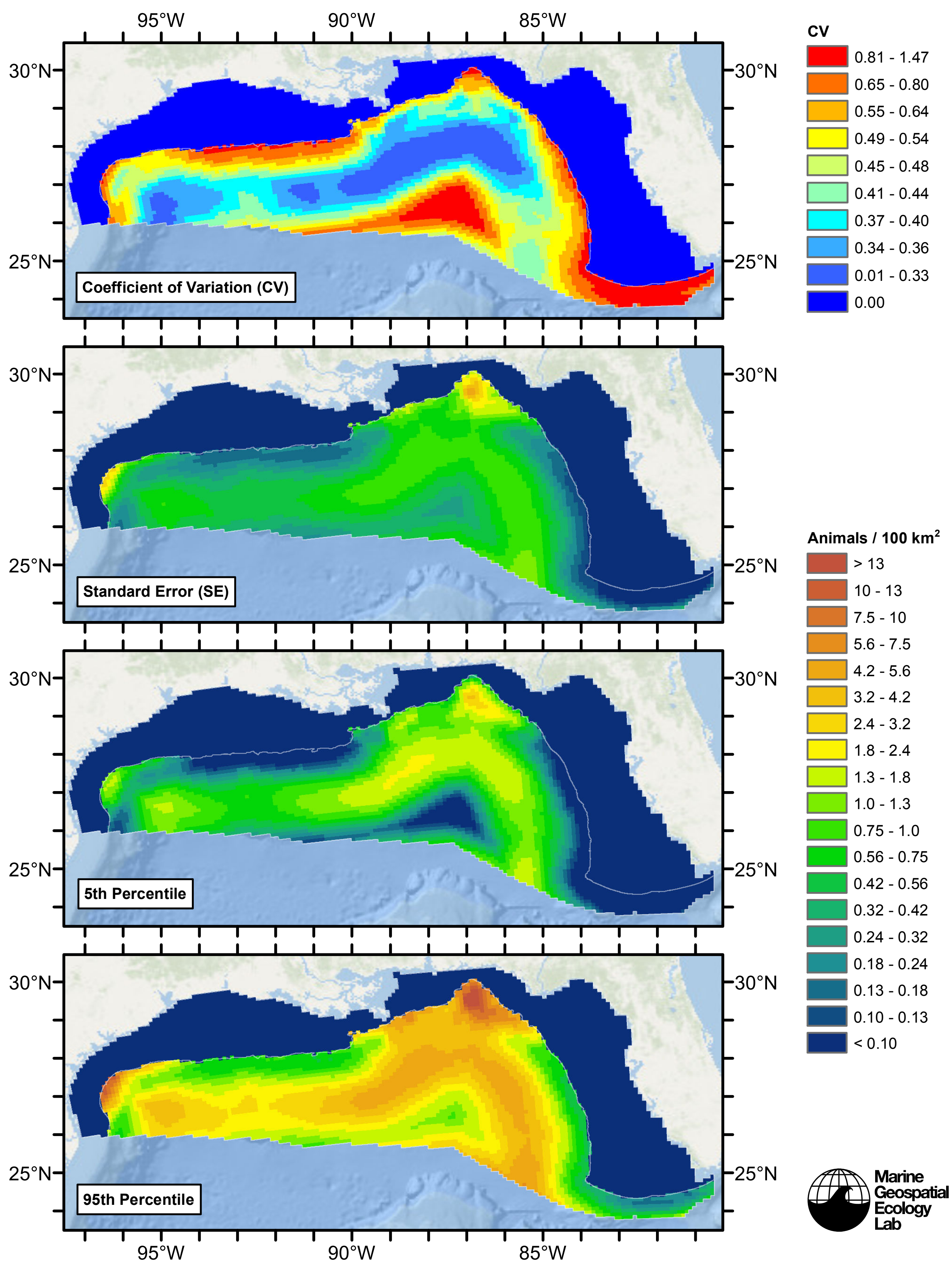


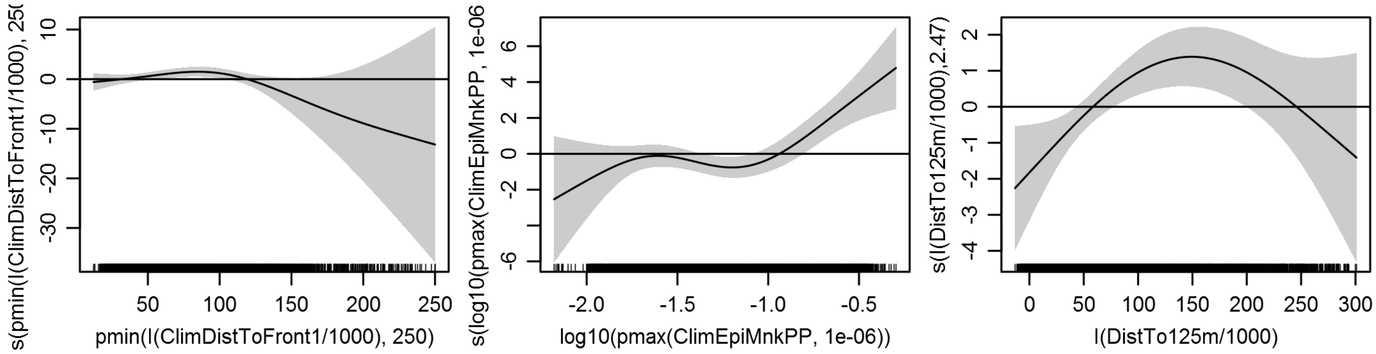
Figure 43: Estimated uncertainty for the climatological same segments model that explained the most deviance. These estimates only incorporate the statistical uncertainty estimated for the spatial model (by the R mgcv package). They do not incorporate uncertainty in the detection functions, g(0) estimates, predictor variables, and so on.

Off Shelf

Statistical output

```
Rscript.exe: This is mgcv 1.8-3. For overview type 'help("mgcv-package")'.


Family: Tweedie(p=1.249)
Link function: log

Formula:
abundance ~ offset(log(area_km2)) + s(I(DistTo125m/1000), bs = "ts",
    k = 5) + s(pmin(I(ClimDistToFront1/1000), 250), bs = "ts",
    k = 5) + s(log10(pmax(ClimEpiMnkPP, 1e-06)), bs = "ts", k = 5)

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -5.3963     0.4316   -12.5   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
                                         edf Ref.df     F  p-value
s(I(DistTo125m/1000))                  2.475      4 3.289  0.00105 **
s(pmin(I(ClimDistToFront1/1000), 250)) 2.458      4 2.948  0.00288 **
s(log10(pmax(ClimEpiMnkPP, 1e-06)))    3.019      4 6.461 1.93e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.00544   Deviance explained = 18.7%
-REML = 455.81  Scale est. = 155.46    n = 4219

All predictors were significant. This is the final model.
Creating term plots.
Diagnostic output from gam.check():

Method: REML   Optimizer: outer newton
full convergence after 11 iterations.
Gradient range [-1.295077e-07,1.919133e-08]
(score 455.8141 & scale 155.4642).
Hessian positive definite, eigenvalue range [0.328446,159.3765].
Model rank =  13 / 13

Basis dimension (k) checking results. Low p-value (k-index<1) may
indicate that k is too low, especially if edf is close to k'.

                                          k'   edf k-index p-value
s(I(DistTo125m/1000))                  4.000 2.475   0.798    0.63
s(pmin(I(ClimDistToFront1/1000), 250)) 4.000 2.458   0.784    0.19
s(log10(pmax(ClimEpiMnkPP, 1e-06)))    4.000 3.019   0.790    0.30

Predictors retained during the model selection procedure: DistTo125m, ClimDistToFront1, ClimEpiMnkPP

Predictors dropped during the model selection procedure: Depth, Slope, ClimSST, ClimEKE
```

Model term plots



Diagnostic plots

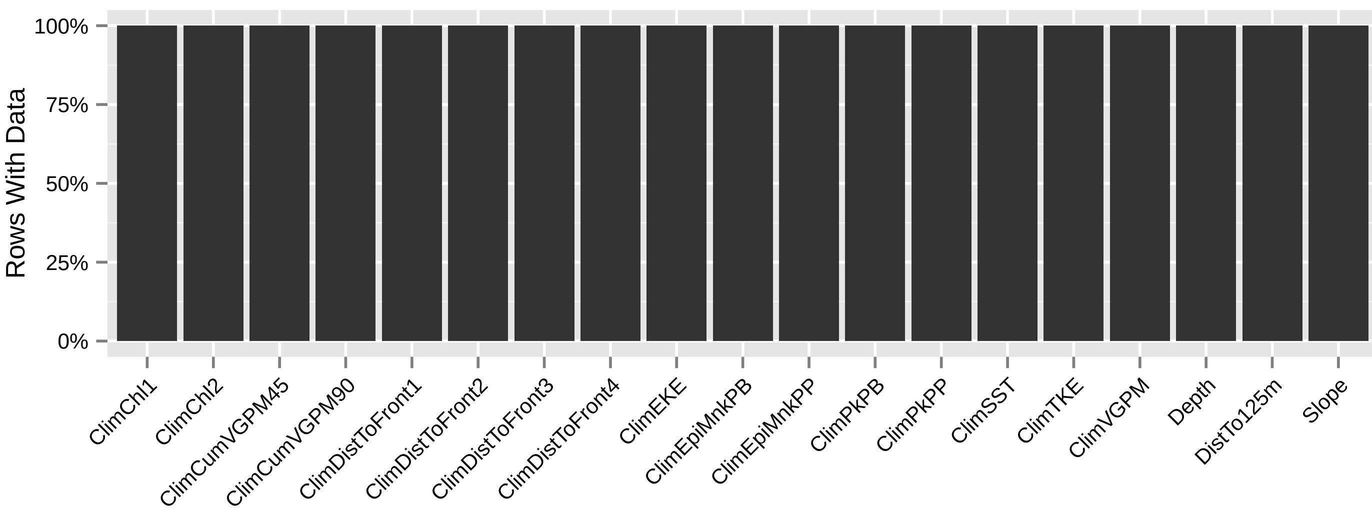


Figure 44: Segments with predictor values for the Striped dolphin Climatological model, Off Shelf. This plot is used to assess how many segments would be lost by including a given predictor in a model.

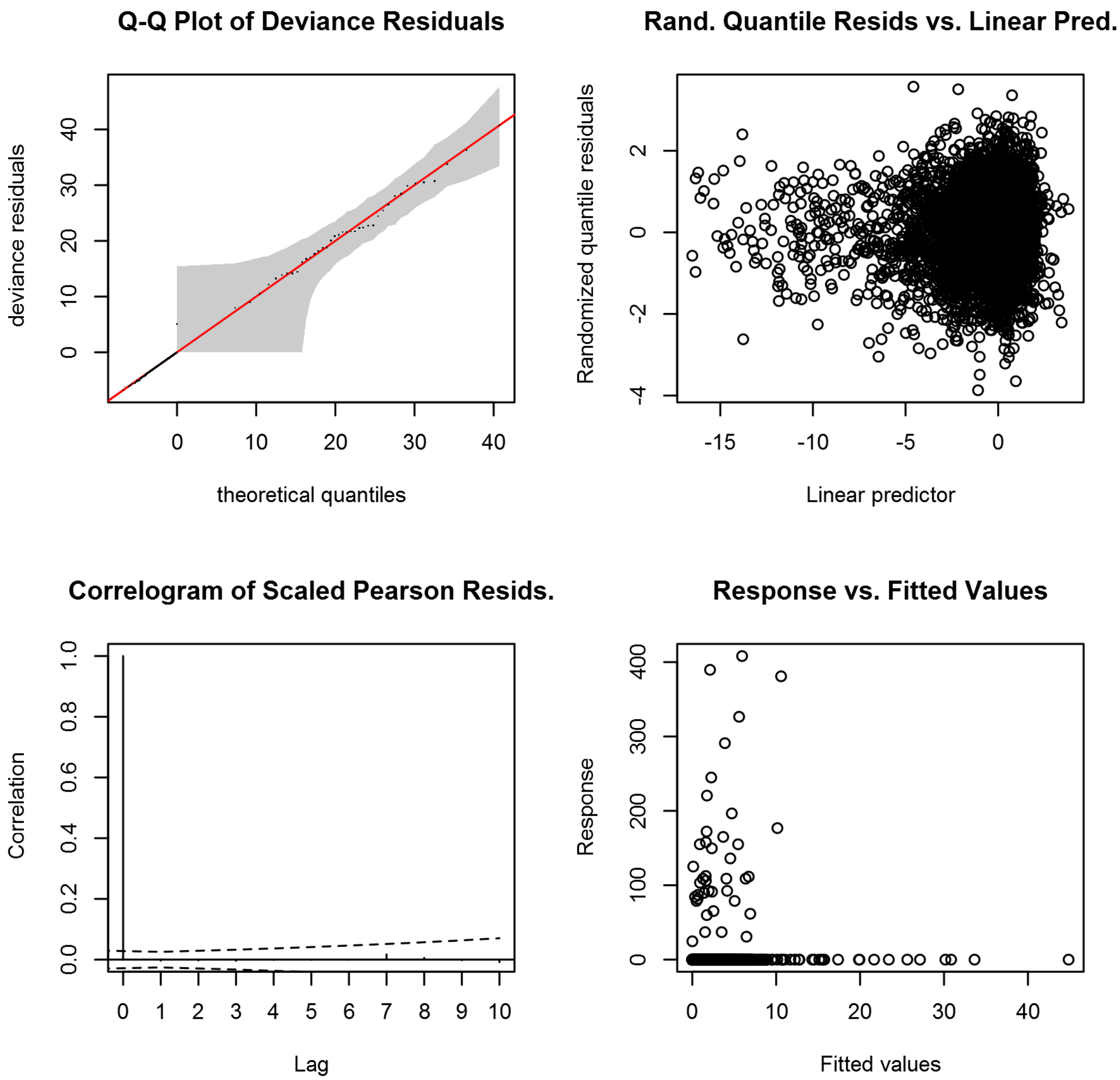


Figure 45: Statistical diagnostic plots for the Striped dolphin Climatological model, Off Shelf.

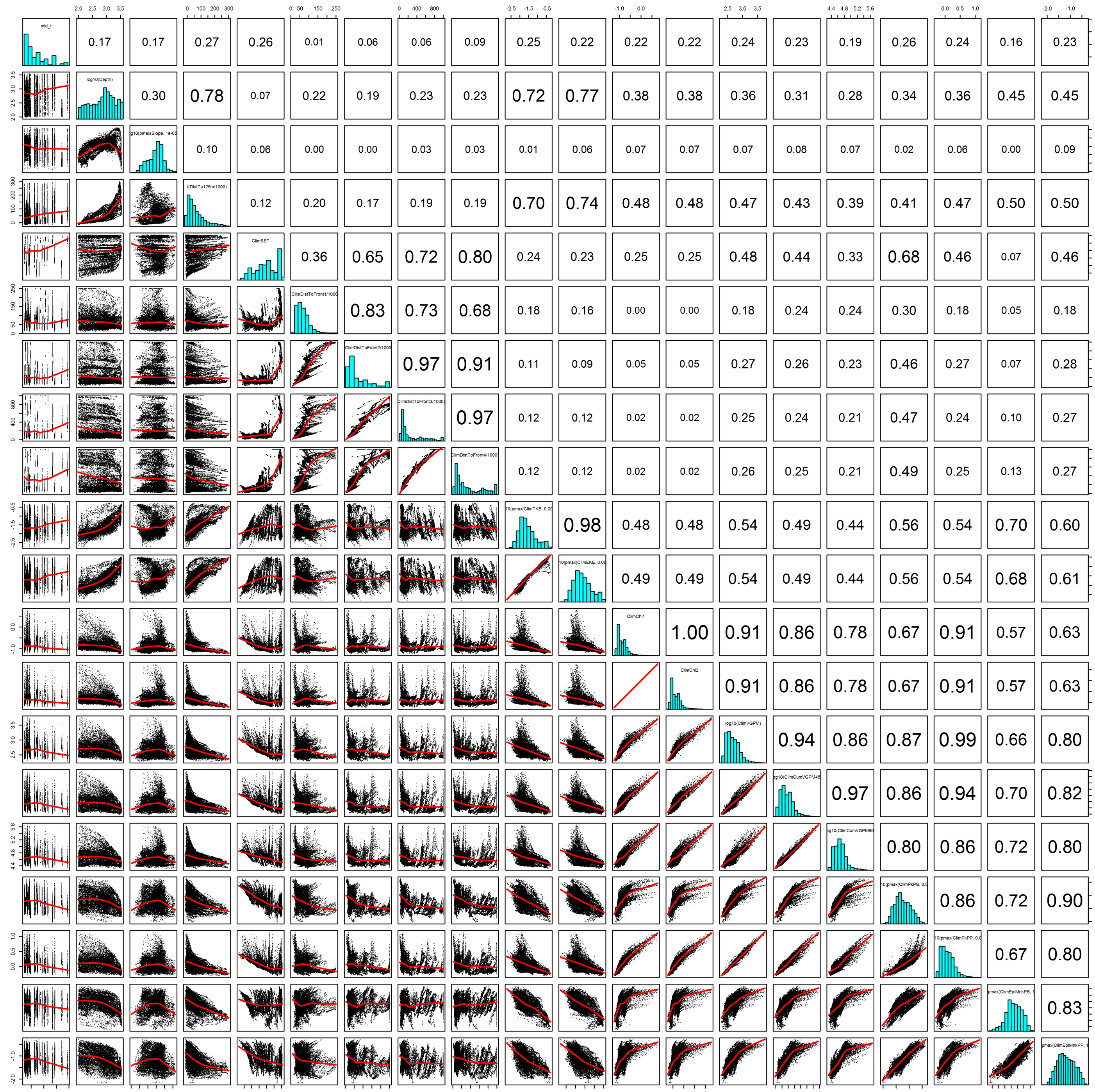


Figure 46: Scatterplot matrix for the Striped dolphin Climatological model, Off Shelf. This plot is used to inspect the distribution of predictors (via histograms along the diagonal), simple correlation between predictors (via pairwise Pearson coefficients above the diagonal), and linearity of predictor correlations (via scatterplots below the diagonal). This plot is best viewed at high magnification.

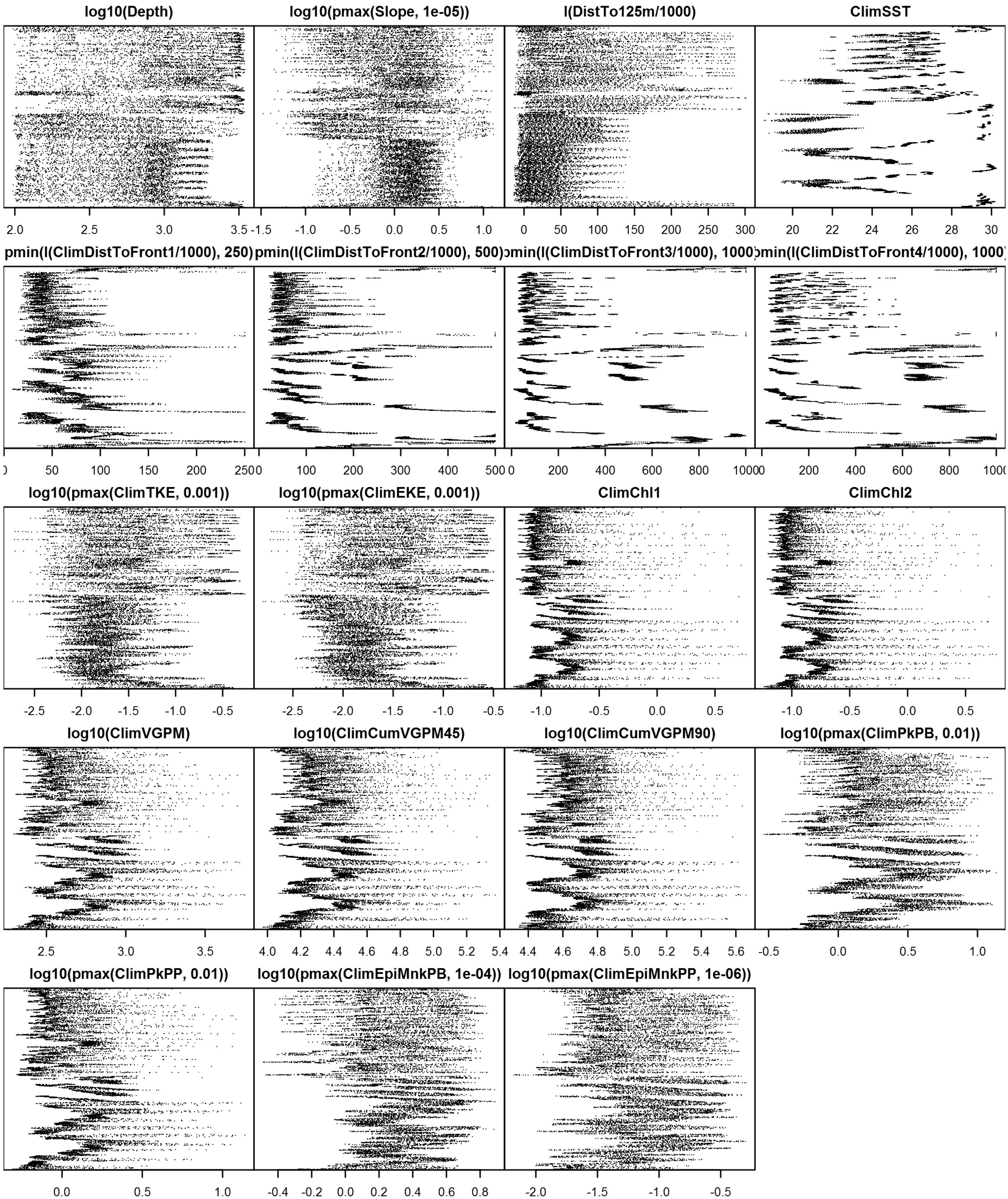


Figure 47: Dotplot for the Striped dolphin Climatological model, Off Shelf. This plot is used to check for suspicious patterns and outliers in the data. Points are ordered vertically by transect ID, sequentially in time.

On Shelf

Density assumed to be 0 in this region.

Model Comparison

Spatial Model Performance

The table below summarizes the performance of the candidate spatial models that were tested. The first model contained only physiographic predictors. Subsequent models added additional suites of predictors of based on when they became available via remote sensing.

For each model, three versions were fitted; the % Dev Expl columns give the % deviance explained by each one. The "climatological" models were fitted to 8-day climatologies of the environmental predictors. Because the environmental predictors were always available, no segments were lost, allowing these models to consider the maximal amount of survey data. The "contemporaneous" models were fitted to day-of-sighting images of the environmental predictors; these were smoothed to reduce data loss due to clouds, but some segments still failed to retrieve environmental values and were lost. Finally, the "climatological same segments" models fitted climatological predictors to the segments retained by the contemporaneous model, so that the explantory power of the two types of predictors could be directly compared. For each of the three models, predictors were selected independently via shrinkage smoothers; thus the three models did not necessarily utilize the same predictors.

Predictors derived from ocean currents first became available in January 1993 after the launch of the TOPEX/Poseidon satellite; productivity predictors first became available in September 1997 after the launch of the SeaWiFS sensor. Contemporaneous and climatological same segments models considering these predictors usually suffered data loss. Date Range shows the years spanned by the retained segments. The Segments column gives the number of segments retained; % Lost gives the percentage lost.

Predictors	Climatol % Dev Expl	Contemp % Dev Expl	Climatol Same Segs % Dev Expl	Segments	% Lost	Date Range
Phys	6.2			14455		1992-2009
Phys+SST	10.4	10.2	10.4	14455	0.0	1992-2009
Phys+SST+Curr	11.2	10.2	11.2	14455	0.0	1992-2009
Phys+SST+Curr+Prod	15.5	9.1	18.7	4219	70.8	1998-2009

Table 18: Deviance explained by the candidate density models.

Abundance Estimates

The table below shows the estimated mean abundance (number of animals) within the study area, for the models that explained the most deviance for each model type. Mean abundance was calculated by first predicting density maps for a series of time steps, then computing the abundance for each map, and then averaging the abundances. For the climatological models, we used 8-day climatologies, resulting in 46 abundance maps. For the contemporaneous models, we used daily images, resulting in 365 predicted abundance maps per year that the prediction spanned. The Dates column gives the dates to which the estimates apply. For our models, these are the years for which both survey data and remote sensing data were available.

The Assumed g(0)=1 column specifies whether the abundance estimate assumed that detection was certain along the survey trackline. Studies that assumed this did not correct for availability or perception bias, and therefore underestimated abundance. The In our models column specifies whether the survey data from the study was also used in our models. If not, the study provides a completely independent estimate of abundance.

Dates	Model or study	Estimated abundance	CV	Assumed g(0)=1	In our models

1992-2009	Climatological model*	4914	0.17	No	
1992-2009	Contemporaneous model	5996	0.14	No	
1992-2009	Climatological same segments model	5642	0.20	No	
2009	Oceanic waters, Jun-Aug (Waring et al. 2013)	1849	0.77	Yes	Yes
2003-2004	Oceanic waters, Jun-Aug (Mullin 2007)	3325	0.48	Yes	Yes
1996-2001	Oceanic waters, Apr-Jun (Mullin and Fulling 2004)	6505	0.43	Yes	Yes
1991-1994	Oceanic waters, Apr-Jun (Hansen et al. 1995)	4858	0.44	Yes	Yes

Table 19: Estimated mean abundance within the study area. We selected the model marked with * as our best estimate of the abundance and distribution of this taxon. For comparison, independent abundance estimates from NOAA technical reports and/or the scientific literature are shown. Please see the Discussion section below for our evaluation of our models compared to the other estimates. Note that our abundance estimates are averaged over the whole year, while the other studies may have estimated abundance for specific months or seasons. Our coefficients of variation (CVs) underestimate the true uncertainty in our estimates, as they only incorporated the uncertainty of the GAM stage of our models. Other sources of uncertainty include the detection functions and g(0) estimates. It was not possible to incorporate these into our CVs without undertaking a computationally-prohibitive bootstrap; we hope to attempt that in a future version of our models.

Density Maps

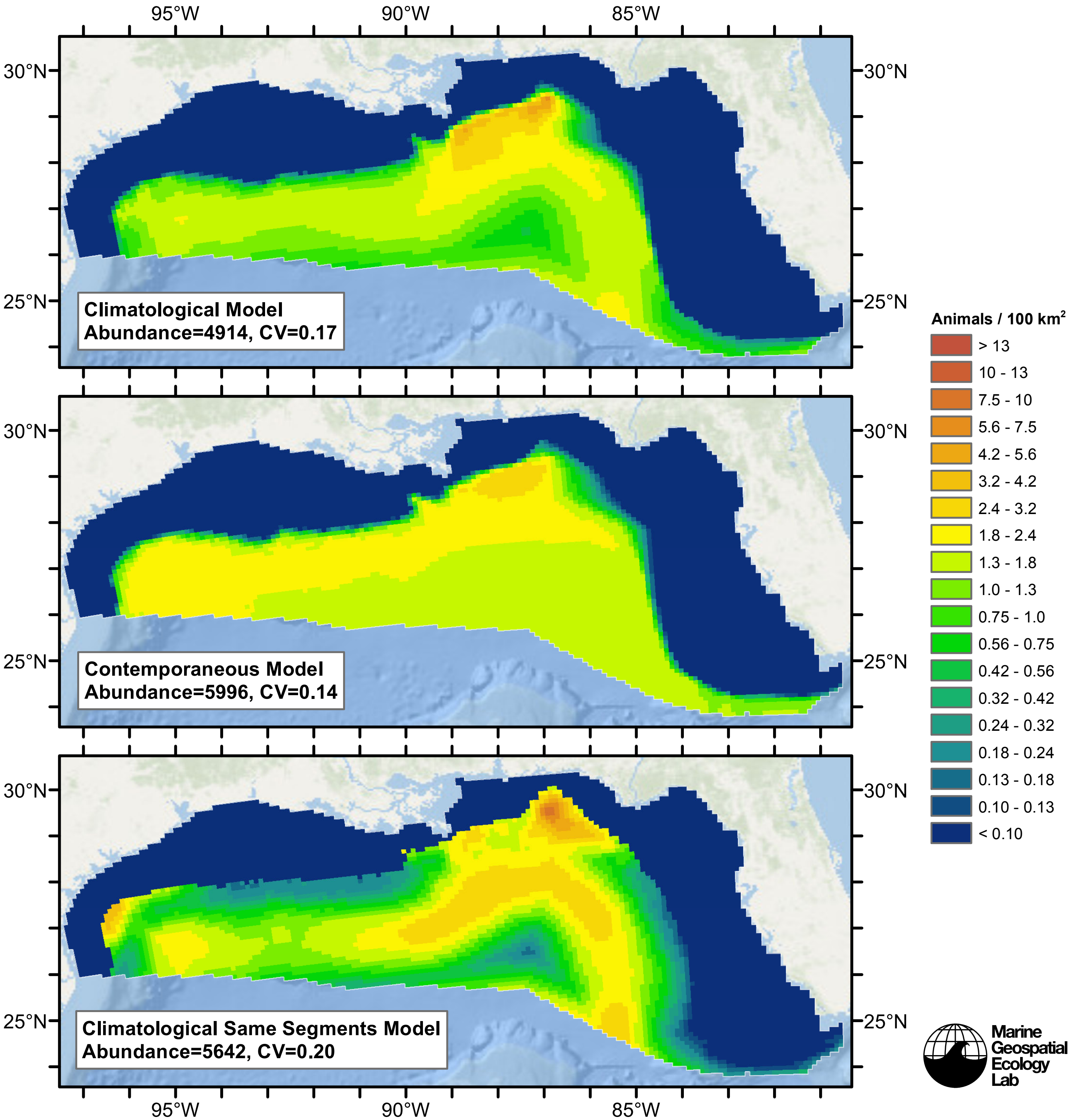


Figure 48: Striped dolphin density and abundance predicted by the models that explained the most deviance. Regions inside the study area (white line) where the background map is visible are areas we did not model (see text).

Temporal Variability

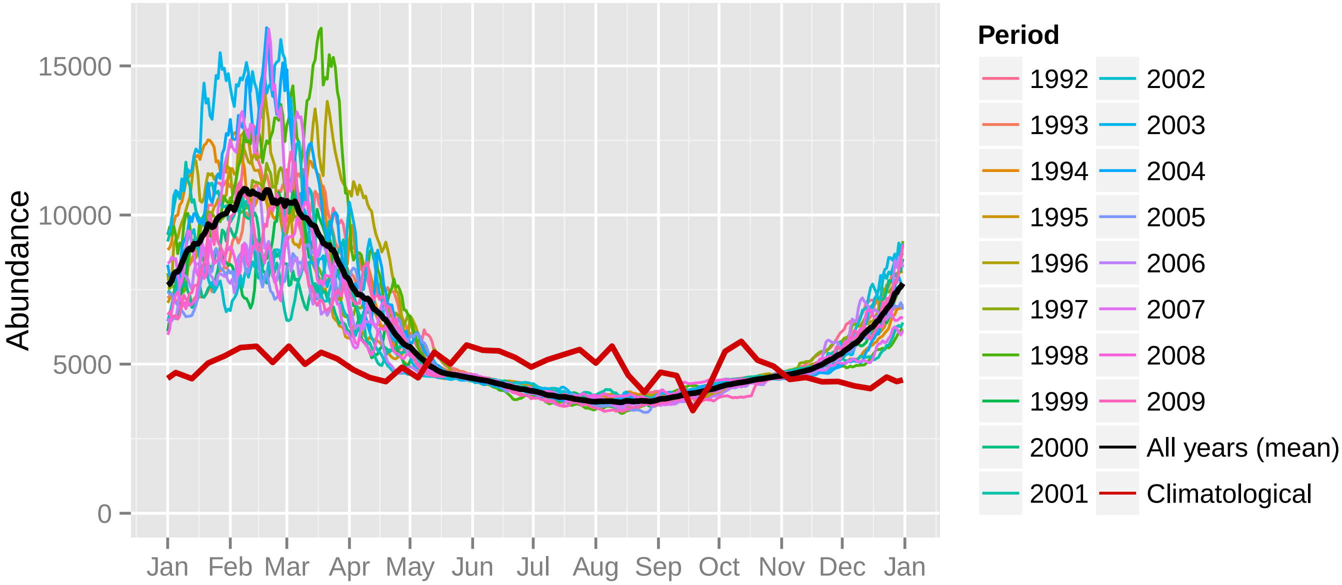


Figure 49: Comparison of Striped dolphin abundance predicted at a daily time step for different time periods. Individual years were predicted using contemporaneous models. "All years (mean)" averages the individual years, giving the mean annual abundance of the contemporaneous model. "Climatological" was predicted using the climatological model. The results for the climatological same segments model are not shown.

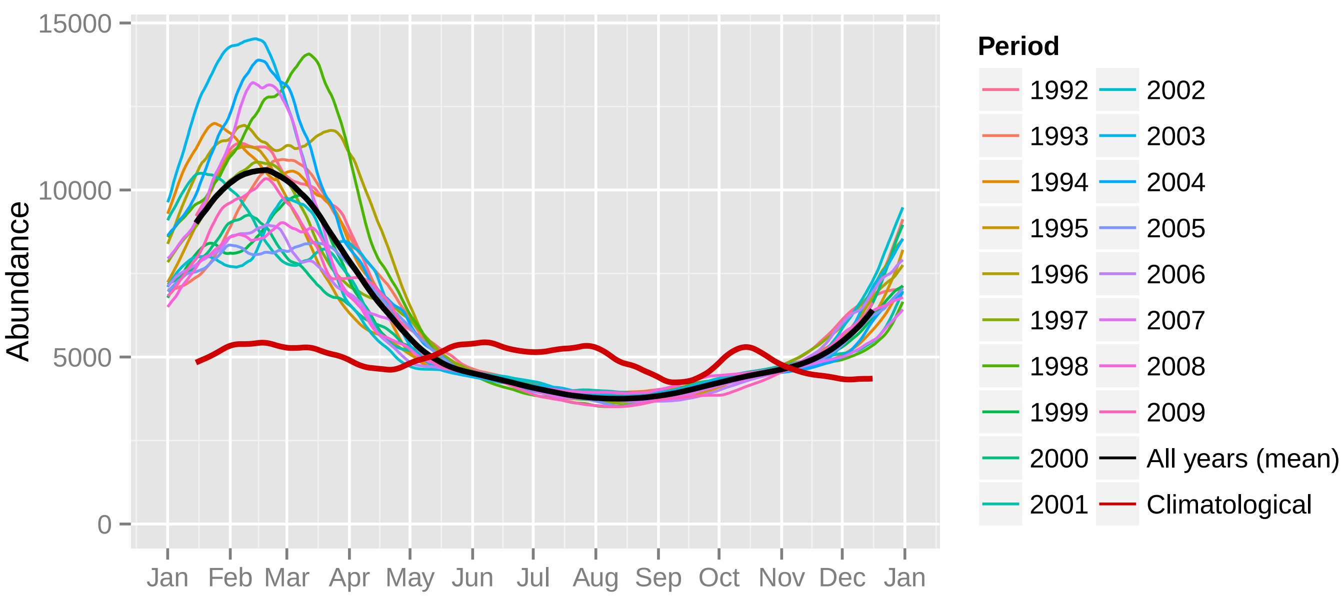
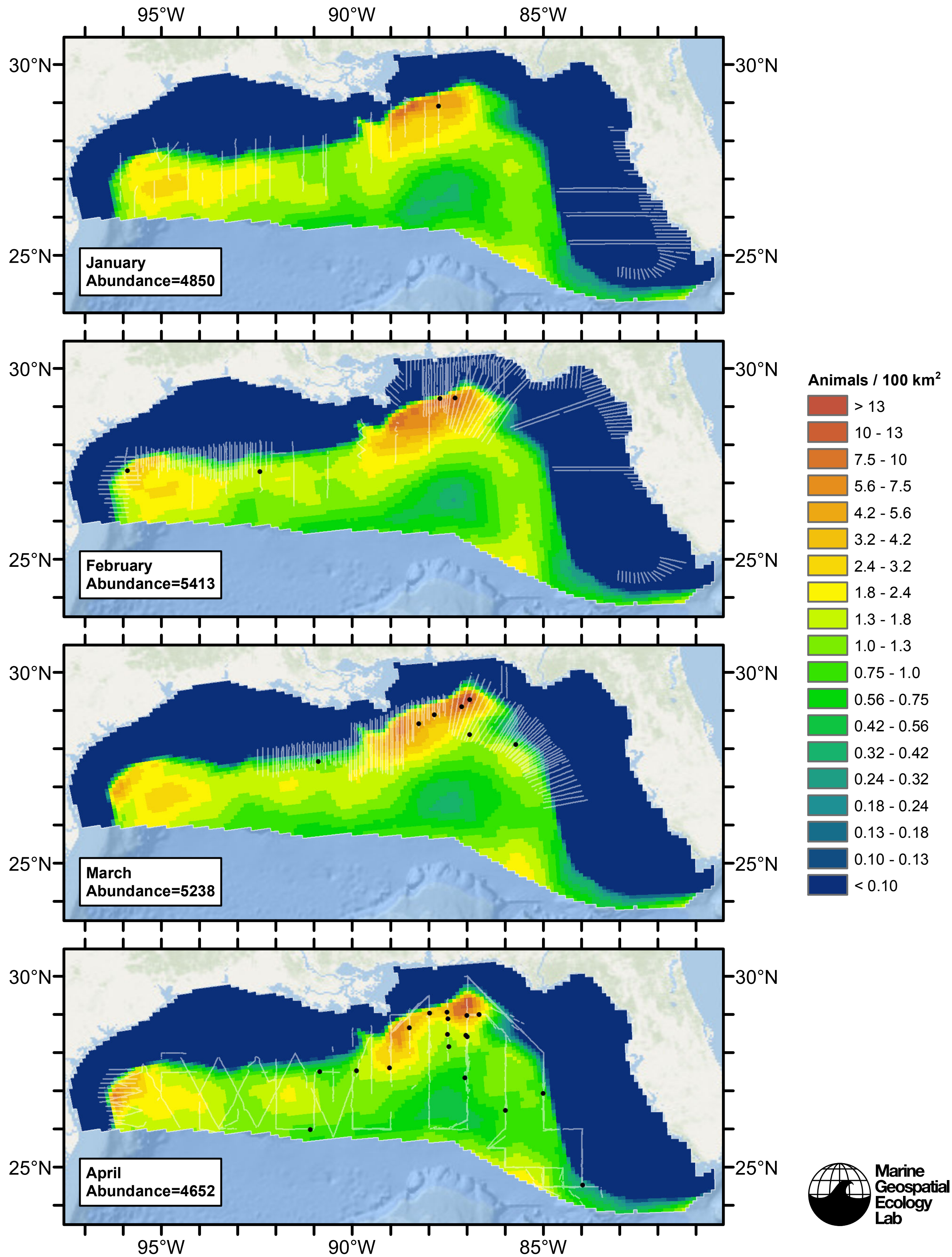
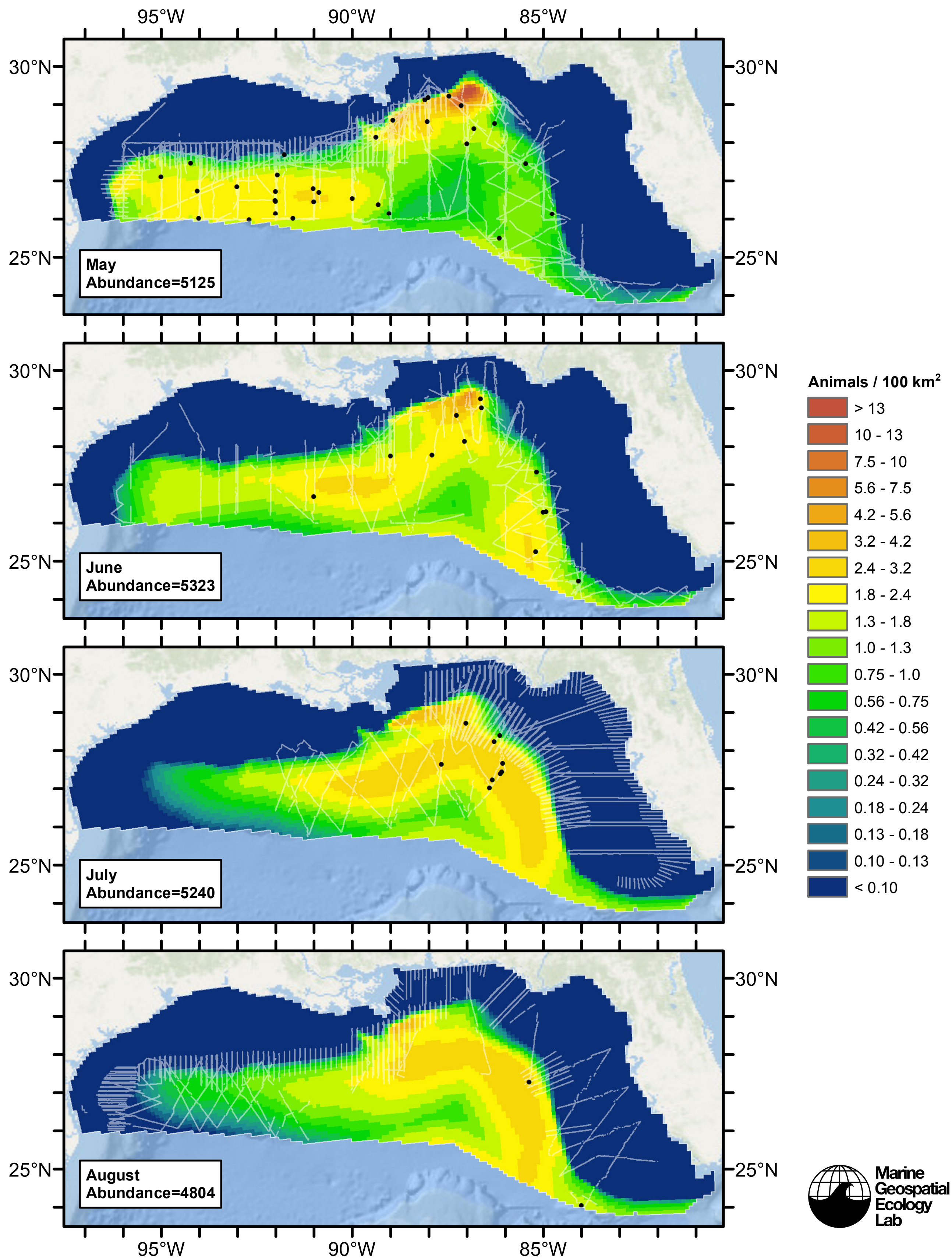


Figure 50: The same data as the preceding figure, but with a 30-day moving average applied.

Climatological Model




95°W
90°W
85°W
30°N
25°N
May
Abundance=5125
June
Abundance=5323
July
Abundance=5240
August
Abundance=4804
Animals / 100 km²
> 13
10 - 13
7.5 - 10
5.6 - 7.5
4.2 - 5.6
3.2 - 4.2
2.4 - 3.2
1.8 - 2.4
1.3 - 1.8
1.0 - 1.3
0.75 - 1.0
0.56 - 0.75
0.42 - 0.56
0.32 - 0.42
0.24 - 0.32
0.18 - 0.24
0.13 - 0.18
0.10 - 0.13
< 0.10
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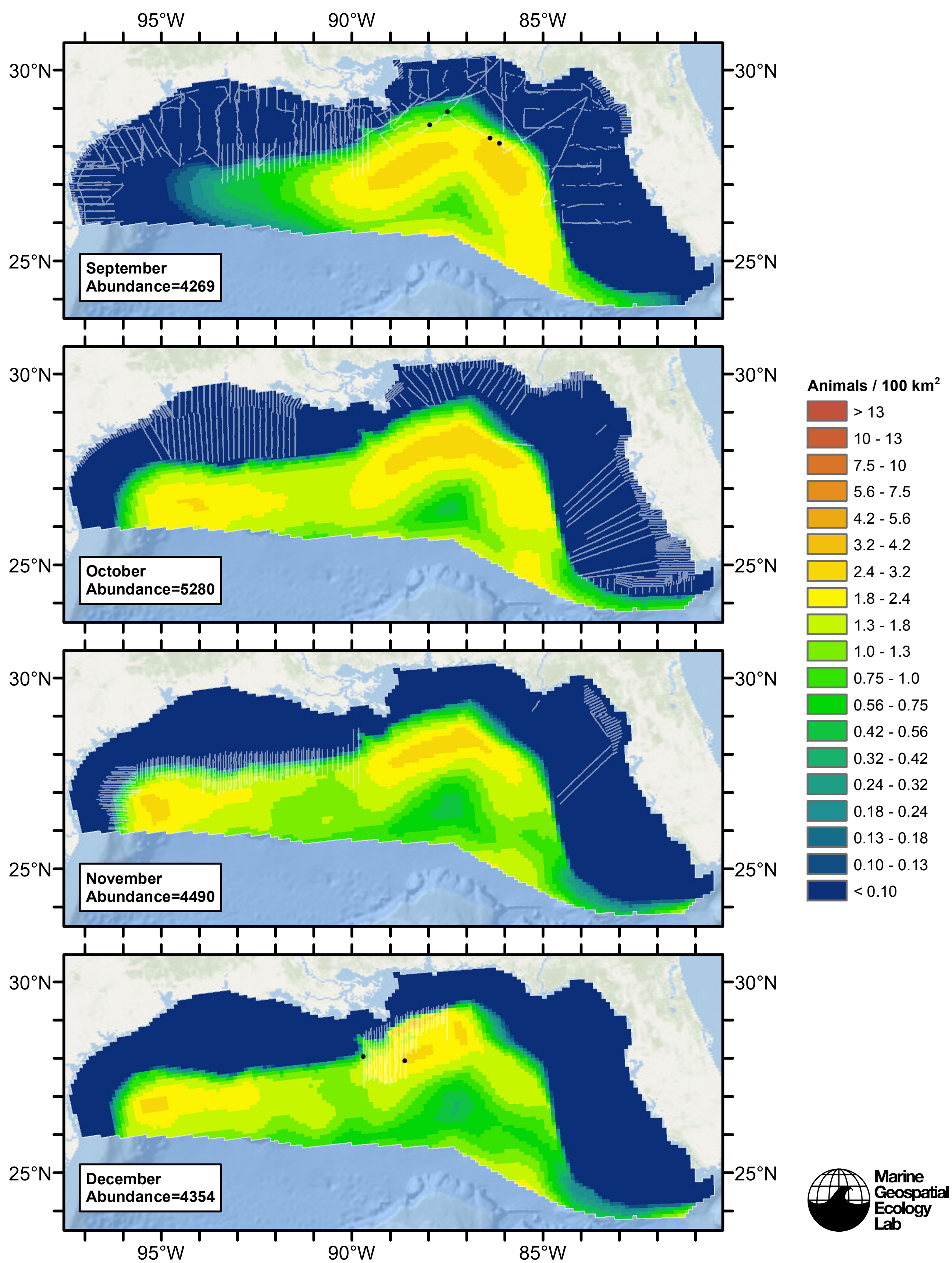
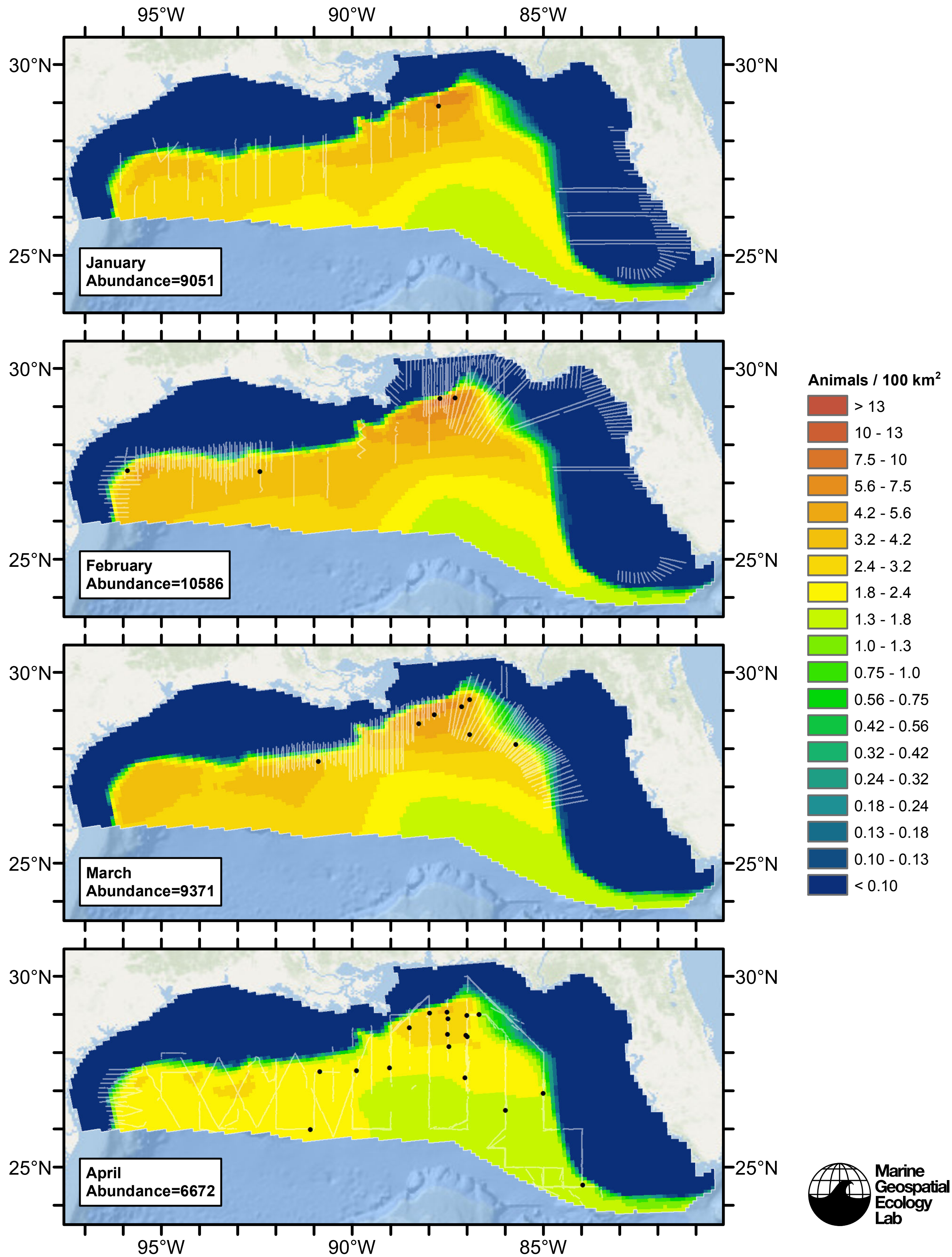
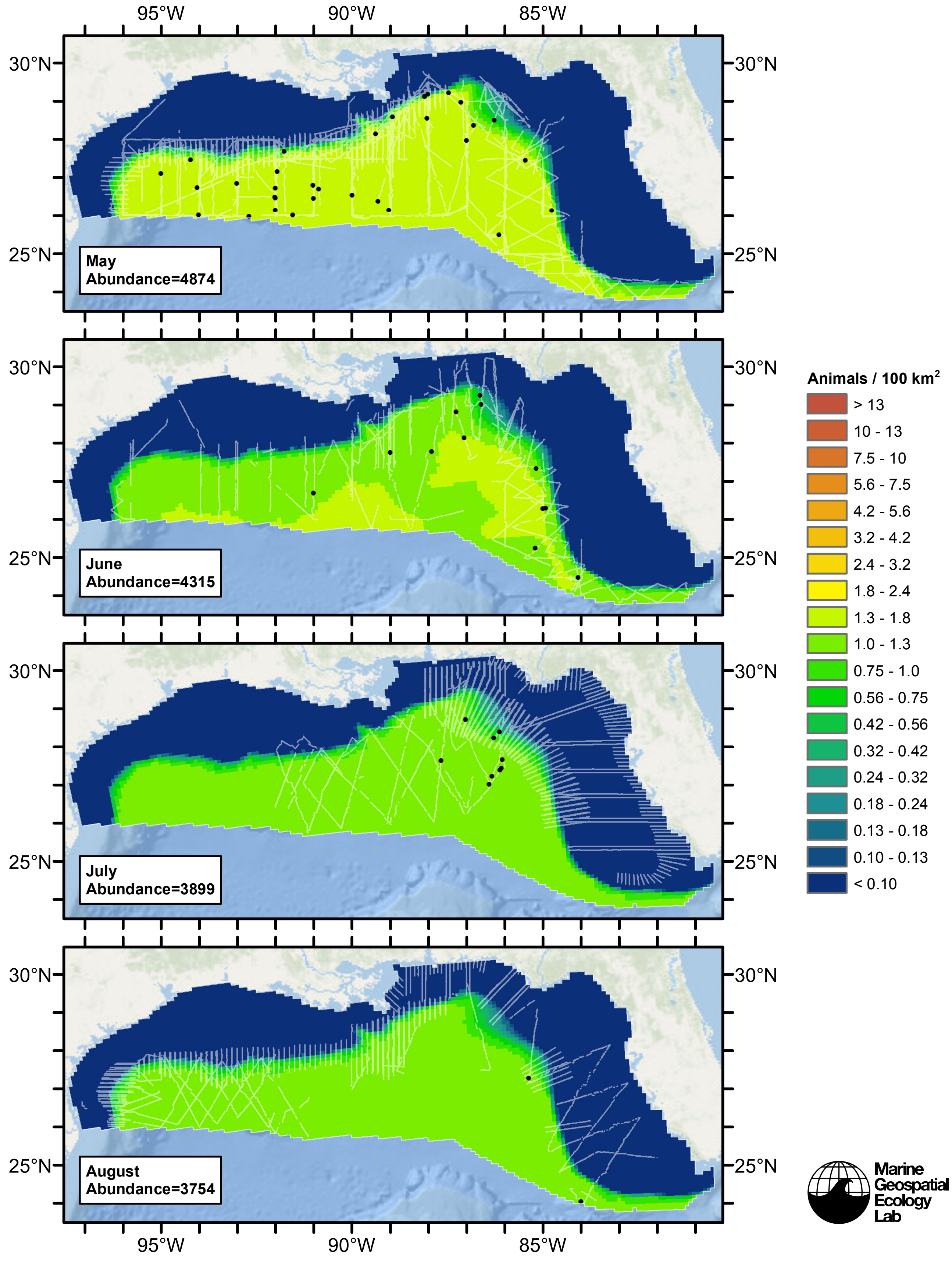
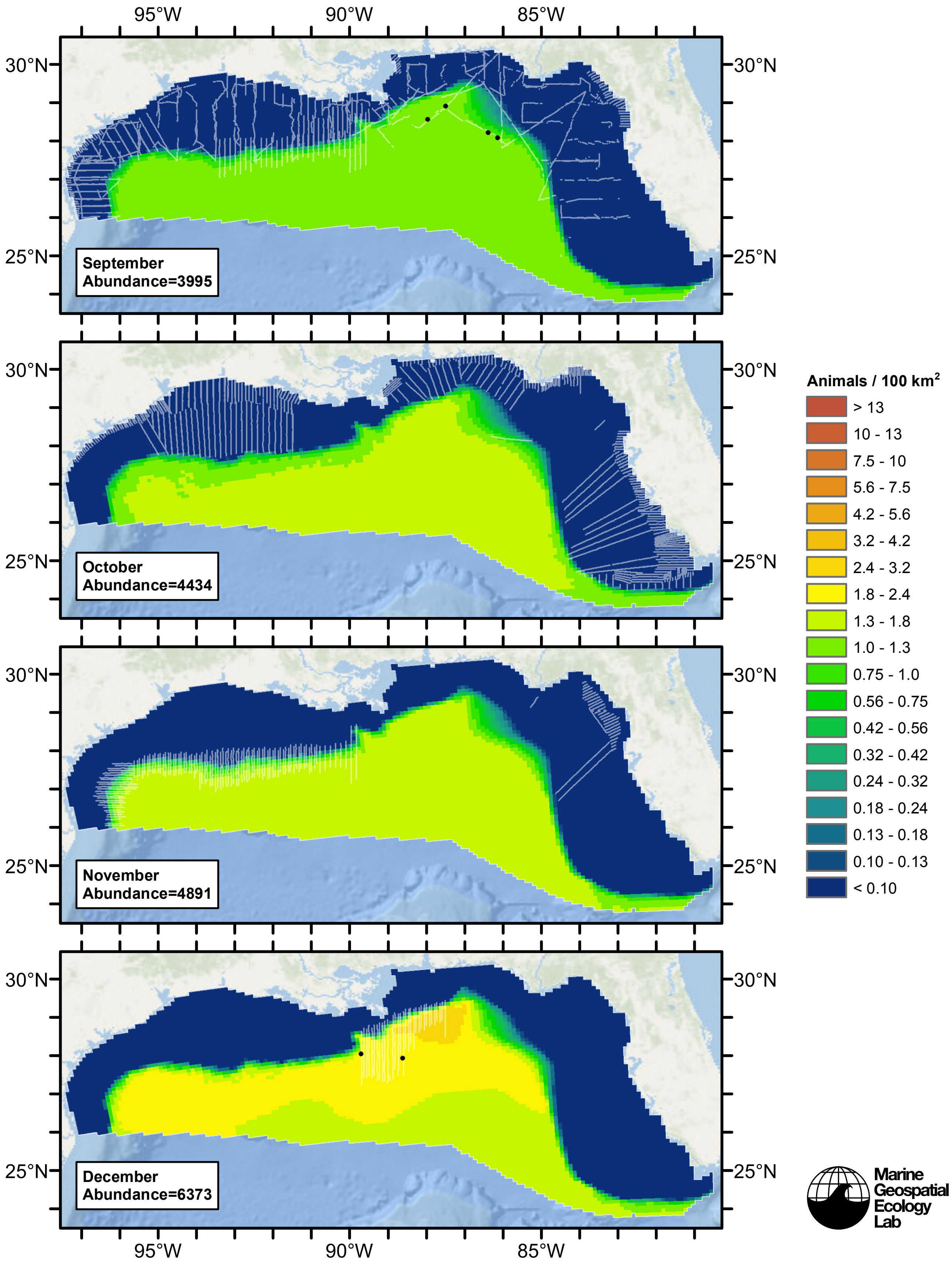


95°W
90°W
85°W
30°N
25°N
September
Abundance=4269
October
Abundance=5280
November
Abundance=4490
December
Abundance=4354
Animals / 100 km²
> 13
10 - 13
7.5 - 10
5.6 - 7.5
4.2 - 5.6
3.2 - 4.2
2.4 - 3.2
1.8 - 2.4
1.3 - 1.8
1.0 - 1.3
0.75 - 1.0
0.56 - 0.75
0.42 - 0.56
0.32 - 0.42
0.24 - 0.32
0.18 - 0.24
0.13 - 0.18
0.10 - 0.13
< 0.10
Marine Geospatial Ecology Lab

Contemporaneous Model




95°W
90°W
85°W
30°N
25°N
May
Abundance=4874
June
Abundance=4315
July
Abundance=3899
August
Abundance=3754
Animals / 100 km²
> 13
10 - 13
7.5 - 10
5.6 - 7.5
4.2 - 5.6
3.2 - 4.2
2.4 - 3.2
1.8 - 2.4
1.3 - 1.8
1.0 - 1.3
0.75 - 1.0
0.56 - 0.75
0.42 - 0.56
0.32 - 0.42
0.24 - 0.32
0.18 - 0.24
0.13 - 0.18
0.10 - 0.13
< 0.10
Marine Geospatial Ecology Lab



95°W
90°W
85°W
30°N
25°N
September
Abundance=3995
October
Abundance=4434
November
Abundance=4891
December
Abundance=6373
Animals / 100 km^2
> 13
10 - 13
7.5 - 10
5.6 - 7.5
4.2 - 5.6
3.2 - 4.2
2.4 - 3.2
1.8 - 2.4
1.3 - 1.8
1.0 - 1.3
0.75 - 1.0
0.56 - 0.75
0.42 - 0.56
0.32 - 0.42
0.24 - 0.32
0.18 - 0.24
0.13 - 0.18
0.10 - 0.13
< 0.10
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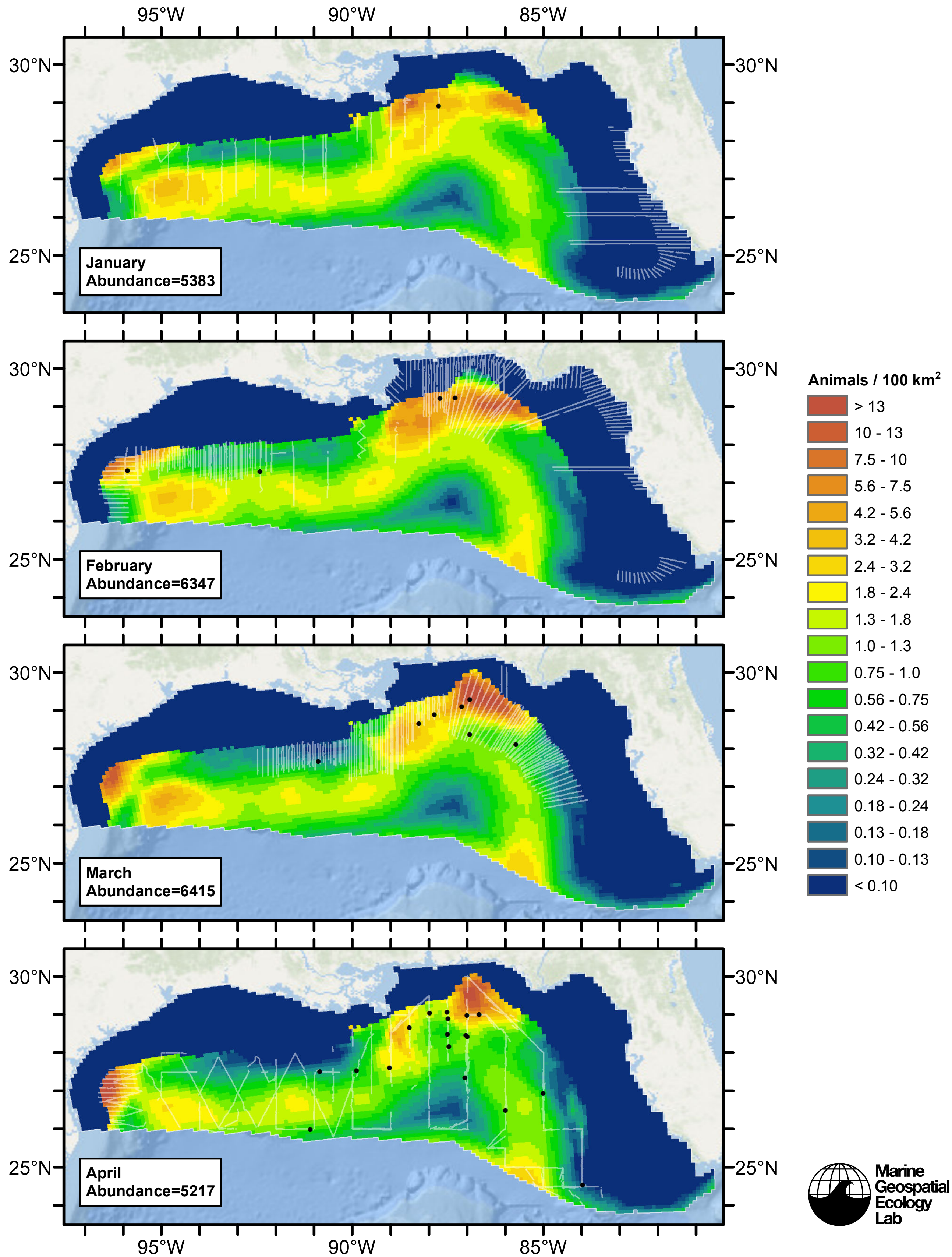
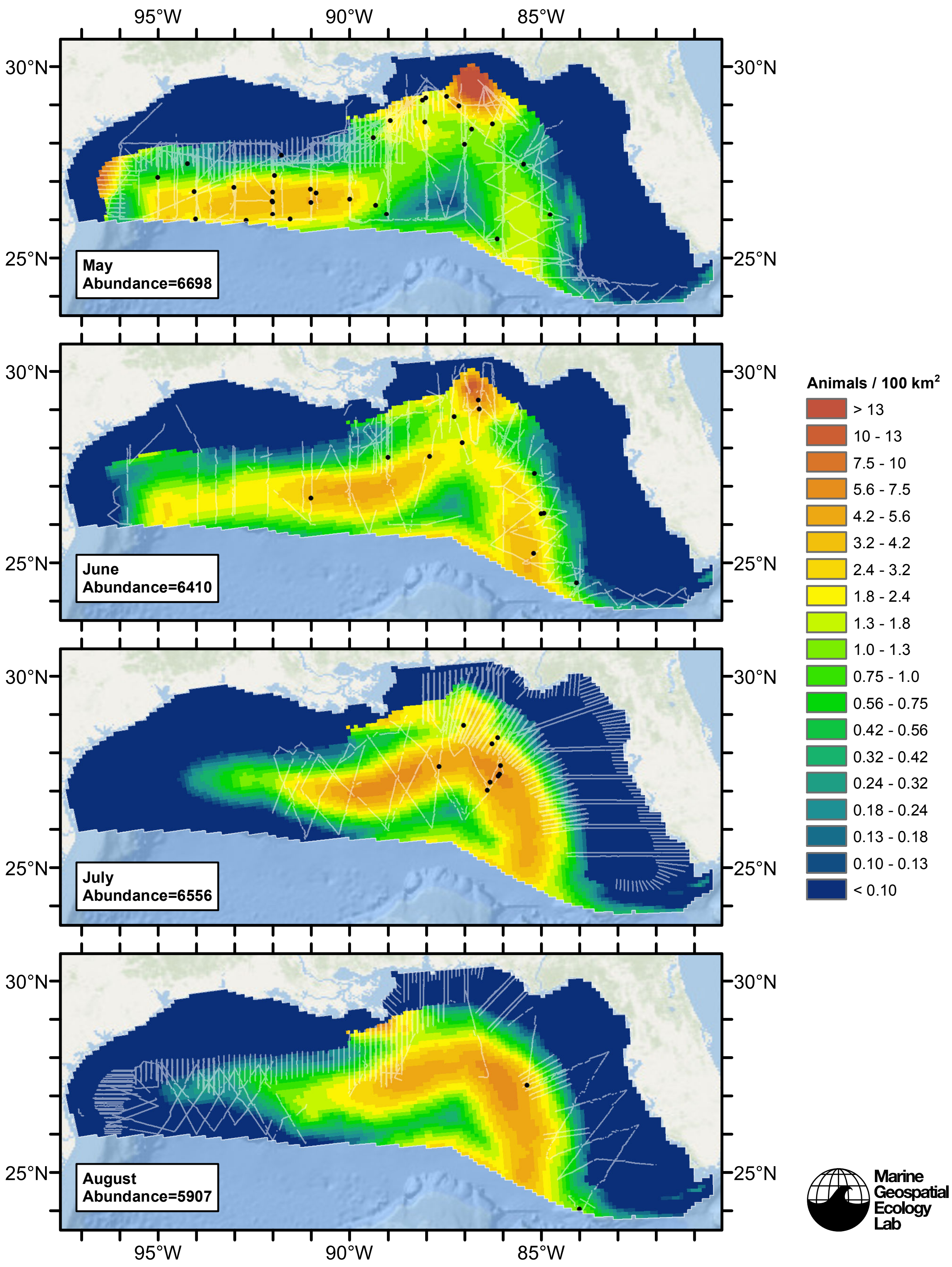
Ecology
Lab

Climatological Same Segments Model




95°W
90°W
85°W
30°N
25°N
May
Abundance=6698
June
Abundance=6410
July
Abundance=6556
August
Abundance=5907
Animals / 100 km^2
> 13
10 - 13
7.5 - 10
5.6 - 7.5
4.2 - 5.6
3.2 - 4.2
2.4 - 3.2
1.8 - 2.4
1.3 - 1.8
1.0 - 1.3
0.75 - 1.0
0.56 - 0.75
0.42 - 0.56
0.32 - 0.42
0.24 - 0.32
0.18 - 0.24
0.13 - 0.18
0.10 - 0.13
< 0.10
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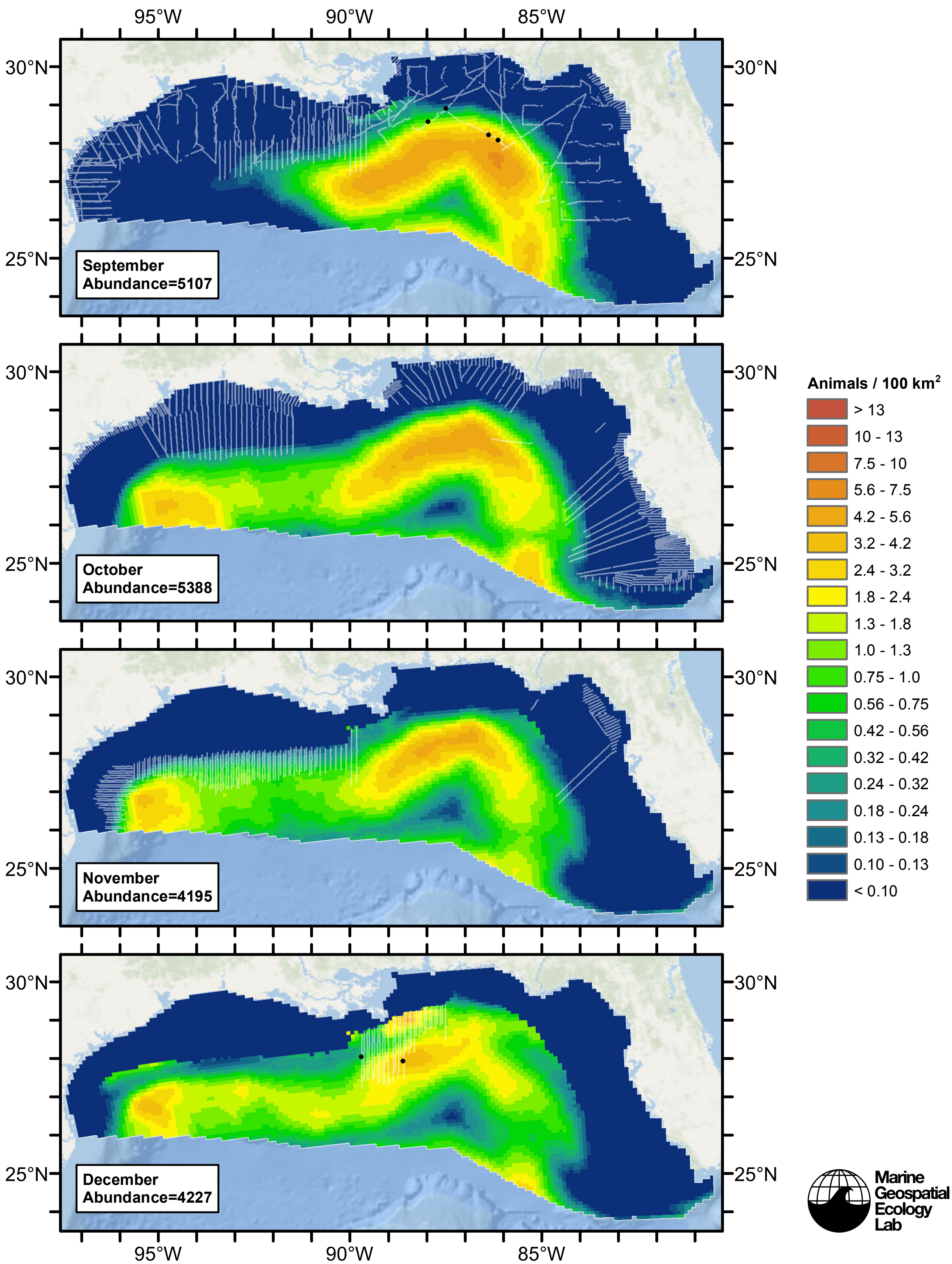
Geospatial
Ecology
Lab


95°W
90°W
85°W
30°N
25°N
September
Abundance=5107
October
Abundance=5388
November
Abundance=4195
December
Abundance=4227
Animals / 100 km²
> 13
10 - 13
7.5 - 10
5.6 - 7.5
4.2 - 5.6
3.2 - 4.2
2.4 - 3.2
1.8 - 2.4
1.3 - 1.8
1.0 - 1.3
0.75 - 1.0
0.56 - 0.75
0.42 - 0.56
0.32 - 0.42
0.24 - 0.32
0.18 - 0.24
0.13 - 0.18
0.10 - 0.13
< 0.10
Marine Geospatial Ecology Lab

Discussion

Models that utilized climatological predictors consistently explained more deviance than models that utilized contemporaneous predictors. The best contemporaneous model in terms of explained deviance utilized just two predictors–depth and SST–which resulted in no loss of segments. When biological productivity parameters were introduced, one of them was retained, resulting in a loss of 70.8% of the segments. Even in this scenario, the climatological model fitted to those segments explained over twice as much deviance. Also, the contemporaneous model predicted abundance would double between August and February, with the high in winter, when the least surveying occurred; plus we had no suggestion in the literature that such a large change in striped dolphin abundance would occur in the Gulf of Mexico. On the basis of higher explanatory power and a more stable abundance prediction, we selected the contemporaneous model fitted to all segments as our best estimate of striped dolphin distribution and abundance in the Gulf of Mexico.

Because the survey effort used as input to this model was biased toward spring and summer and was spatiotemporally patchy (see maps in the Temporal Variability section above), we were not confident that our models could produce realistic predictions at a monthly temporal resolution. This problem affected all species that we modeled in the Gulf of Mexico, and we recommend that year-round average predictions be used for all Gulf of Mexico species.

Our abundance estimate of 4914 fell within the range of NOAA's estimates, which ranged from a low of 1849 in 2009 to a high in 6505 in 1996-2001. Unlike some other species, we do not believe differences in the g(0) parameter between our models and NOAA's to be an important factor for explaining differences between our estimate and theirs. Nearly all of the sightings were of large groups of dolphins; we used g(0)=0.970 and g(0)=0.960 for large groups sighted from ships or aircraft, respectively; thus our g(0) for most sightings was roughly the same as NOAA's.

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