Density Model for Striped Dolphin (*Stenella coeruleoalba*) for the U.S. East Coast: Supplementary Report

Duke University Marine Geospatial Ecology Lab*

Model Version 3.3 - 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. East Coast Version 3.3, 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	2014-10-22	Initial version.
2	2014-11-20	Reconfigured detection hierarchy and adjusted NARWSS detection functions based on additional information from Tim Cole. Removed CumVGPM180 predictor. Updated documentation.
3	2014-12-04	Fixed bug that applied the wrong detection function to segments NE_narwss_1999_widgeon_hapo dataset. Refitted model. Updated documentation.
3.1	2015-03-06	Updated the documentation. No changes to the model.
3.2	2015-05-14	Updated calculation of CVs. Switched density rasters to logarithmic breaks. No changes to the model.
3.3	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
NEFSC Aerial Surveys	1995-2008	70	412	1
NEFSC NARWSS Harbor Porpoise Survey	1999-1999	6	36	0
NEFSC North Atlantic Right Whale Sighting Survey	1999-2013	432	2330	5
NEFSC Shipboard Surveys	1995-2004	16	1143	137
NJDEP Aerial Surveys	2008-2009	11	60	0
NJDEP Shipboard Surveys	2008-2009	14	836	0
SEFSC Atlantic Shipboard Surveys	1992-2005	28	1731	48
SEFSC Mid Atlantic Tursiops Aerial Surveys	1995-2005	35	196	0
SEFSC Southeast Cetacean Aerial Surveys	1992-1995	8	42	1
UNCW Cape Hatteras Navy Surveys	2011-2013	19	125	3
UNCW Early Marine Mammal Surveys	2002-2002	18	98	0
UNCW Jacksonville Navy Surveys	2009-2013	66	402	0
UNCW Onslow Navy Surveys	2007-2011	49	282	0
UNCW Right Whale Surveys	2005-2008	114	586	0
Virginia Aquarium Aerial Surveys	2012-2014	9	53	0
Total		895	8332	195

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.

Season	Months	Length (1000 km)	Hours	Sightings
All_Year	All	897	8332	195

Table 3: Survey effort and on-effort sightings having perpendicular sighting distances.

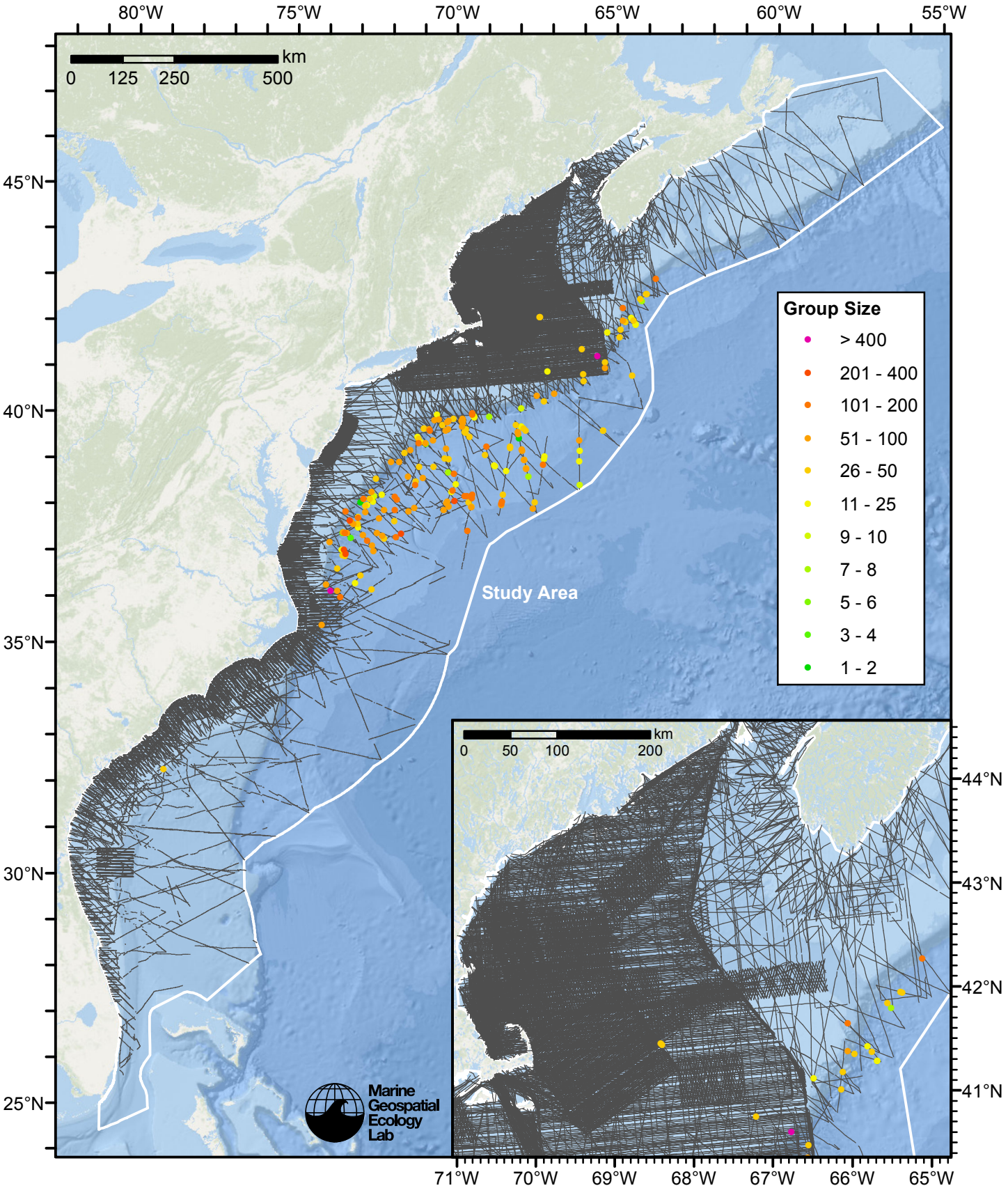


Figure 1: Striped dolphin sightings and survey tracklines.

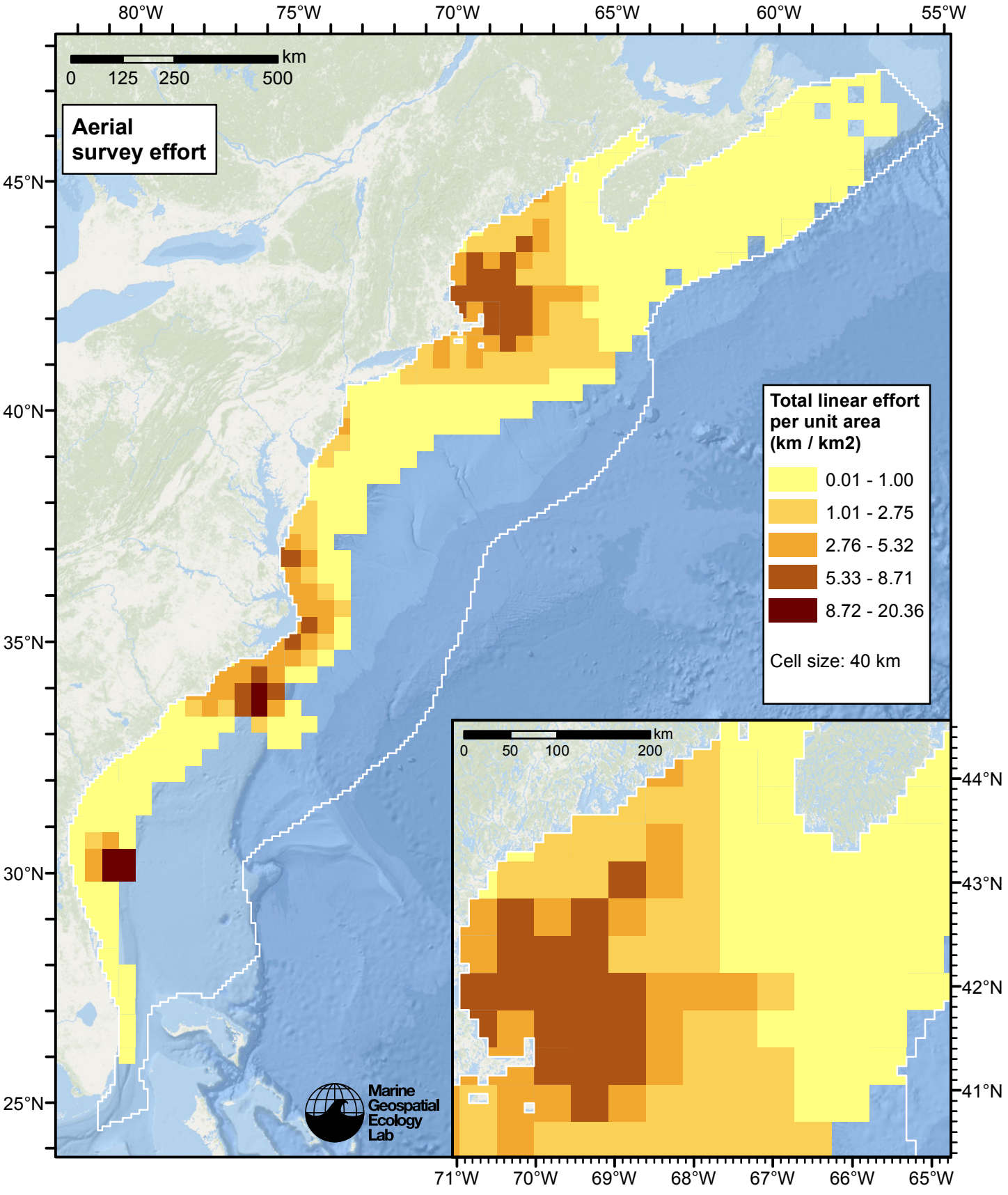


Figure 2: Aerial linear survey effort per unit area.

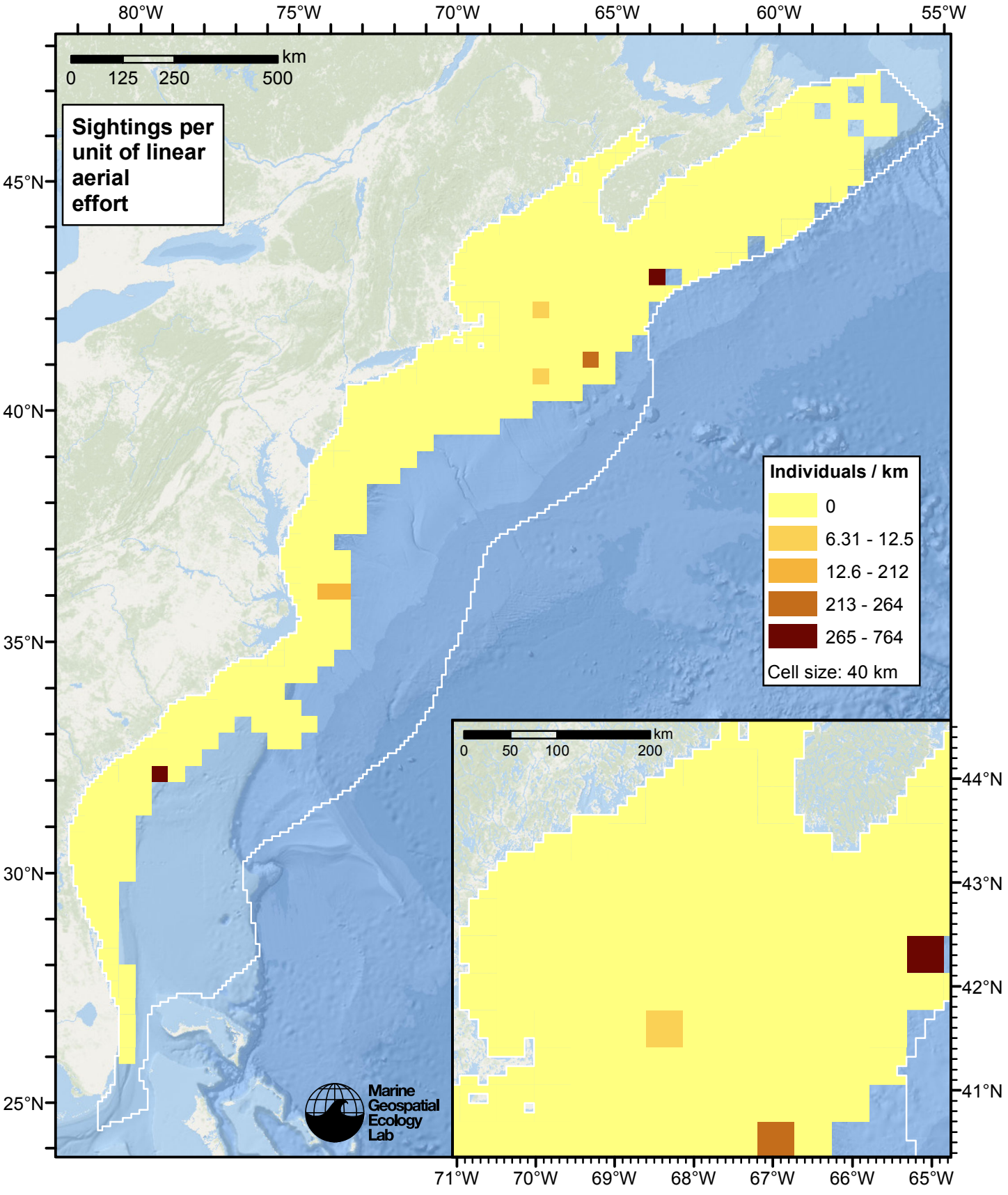


Figure 3: Striped dolphin sightings per unit aerial linear survey effort.

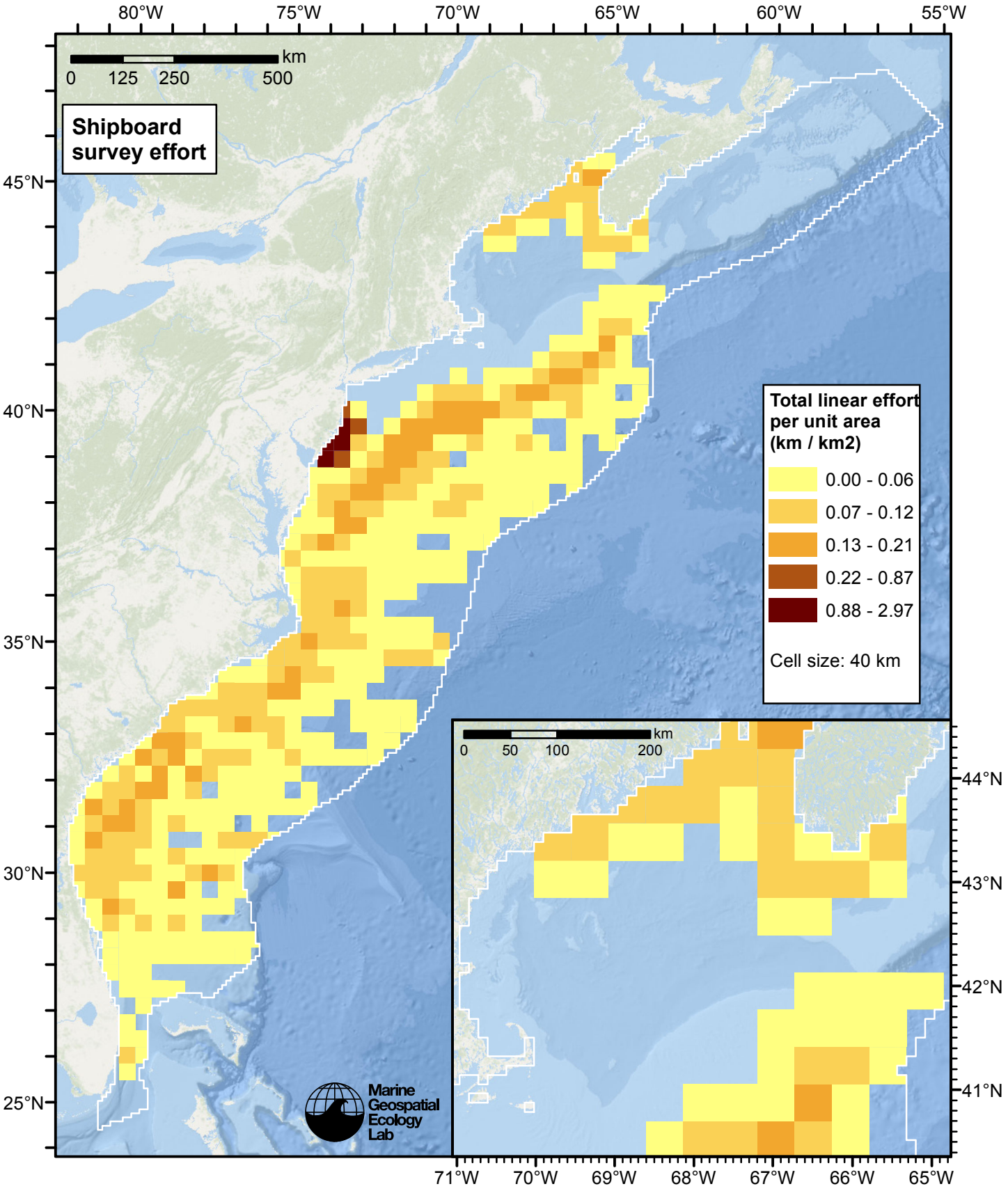


Figure 4: Shipboard linear survey effort per unit area.

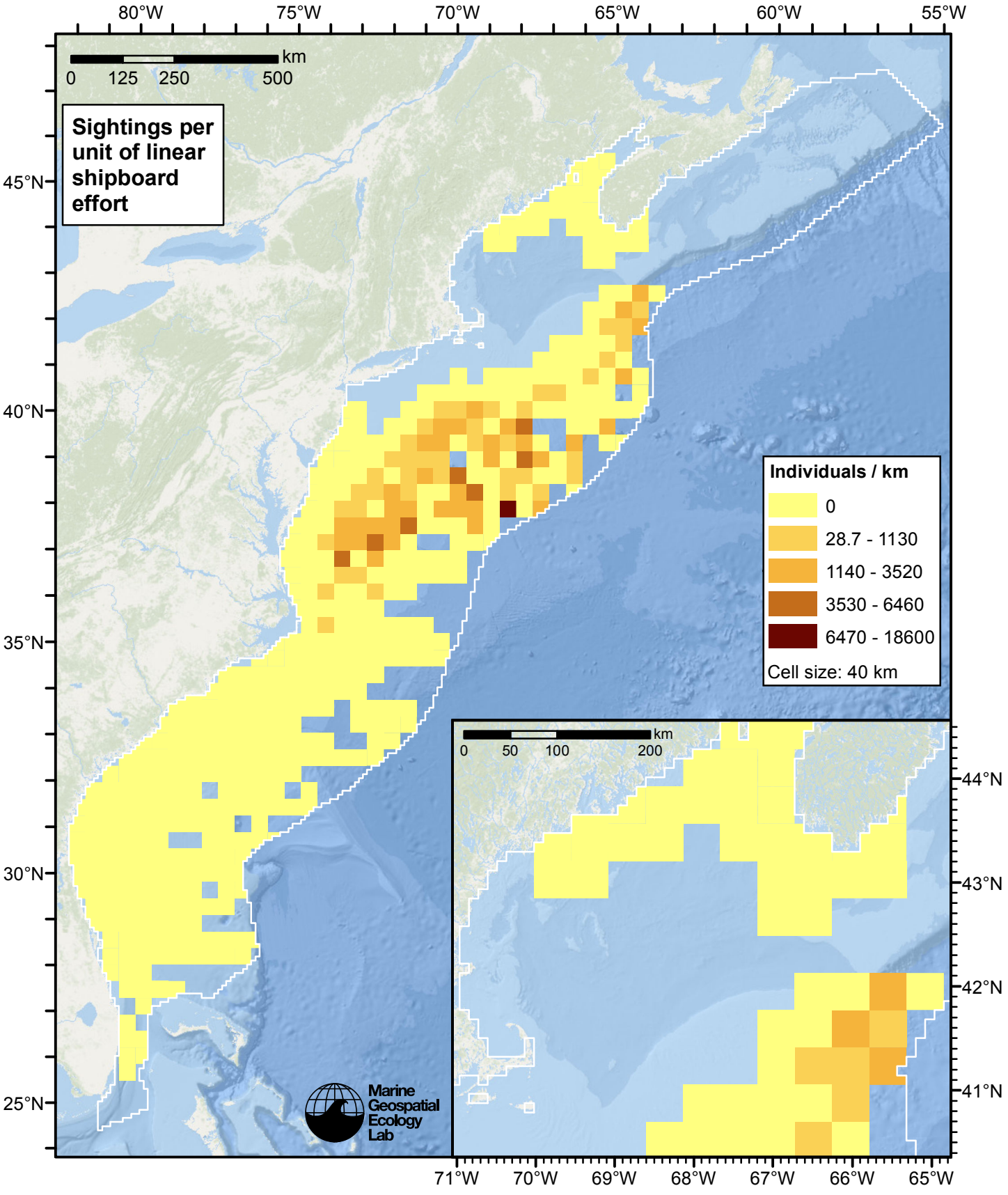


Figure 5: Striped dolphin sightings per unit shipboard linear survey effort.

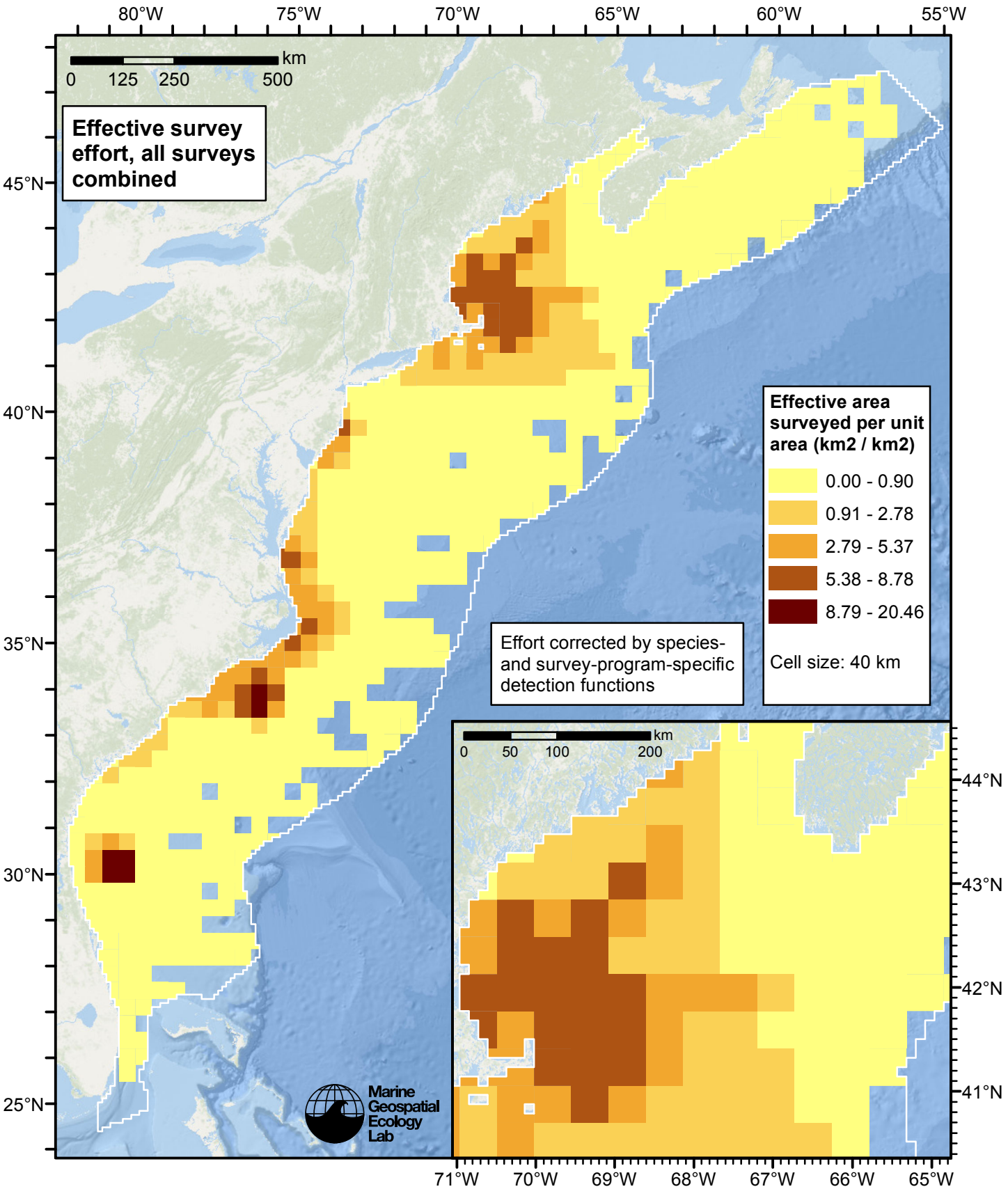


Figure 6: Effective survey effort per unit area, for all surveys combined. Here, effort is corrected by the species- and survey-program-specific detection functions used in fitting the density models.

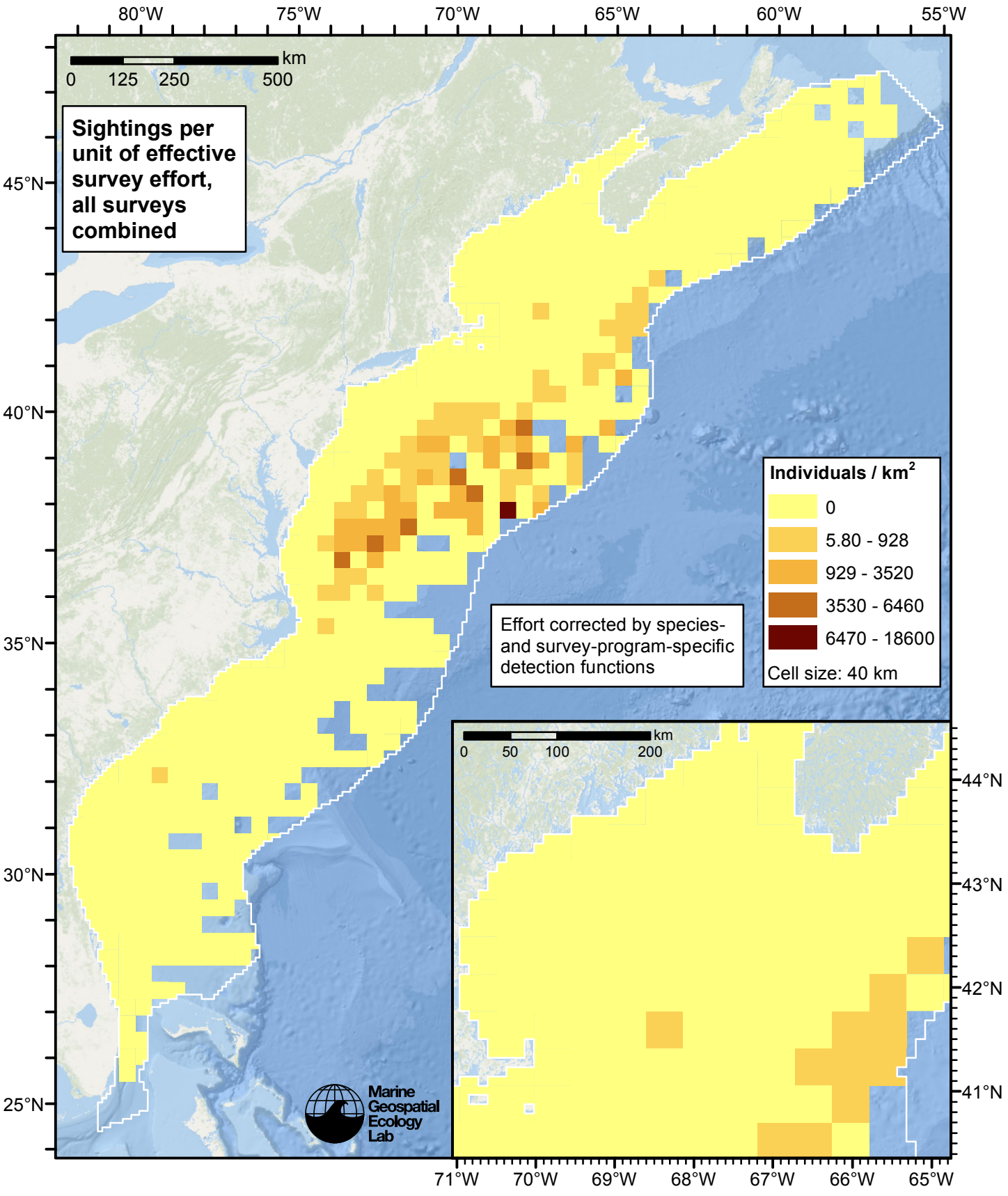


Figure 7: Striped dolphin sightings per unit of effective survey effort, for all surveys combined. Here, effort is corrected by the species- and survey-program-specific detection functions used in fitting the density models.

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

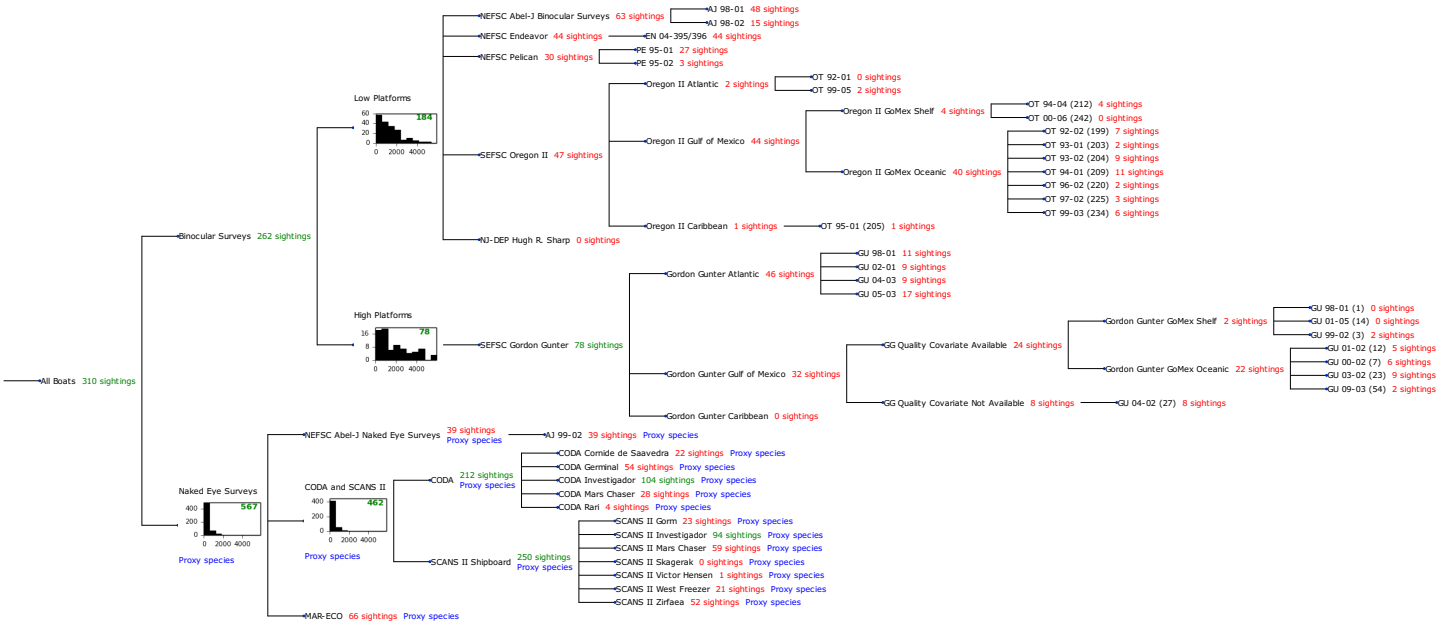


Figure 8: Detection hierarchy for shipboard surveys

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.

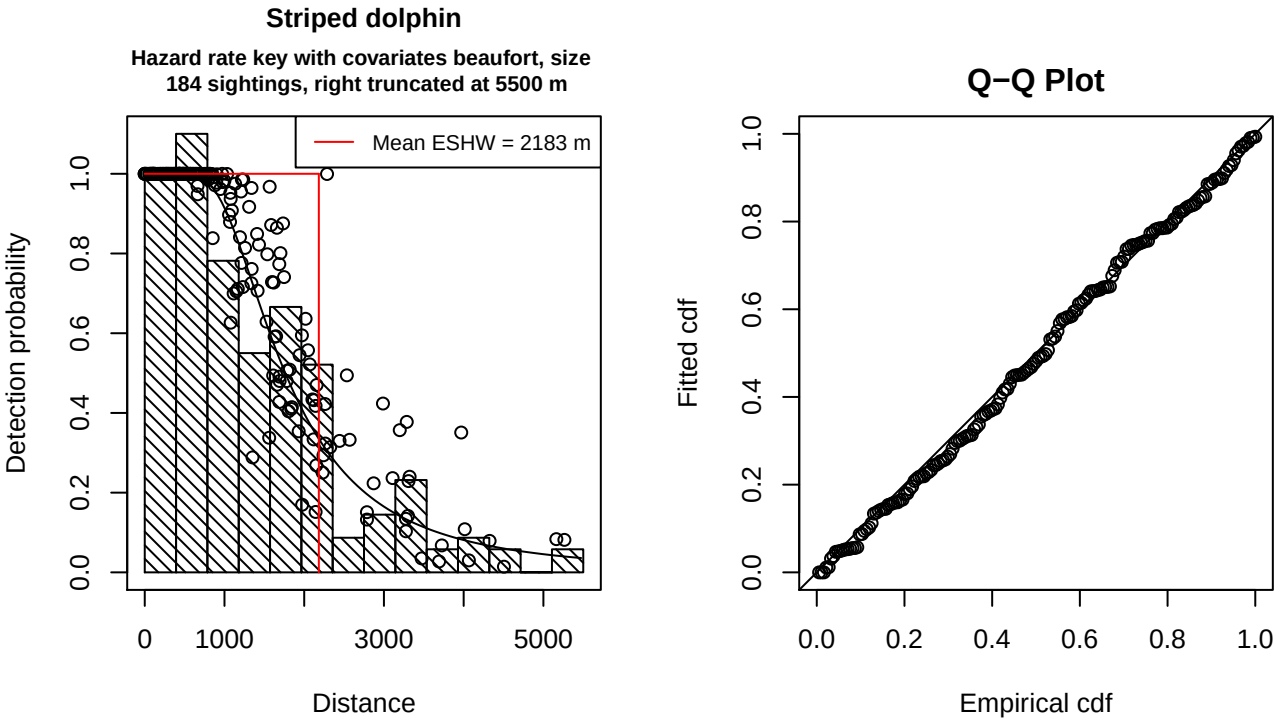


Figure 9: Detection function for Low Platforms that was selected for the density model

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.

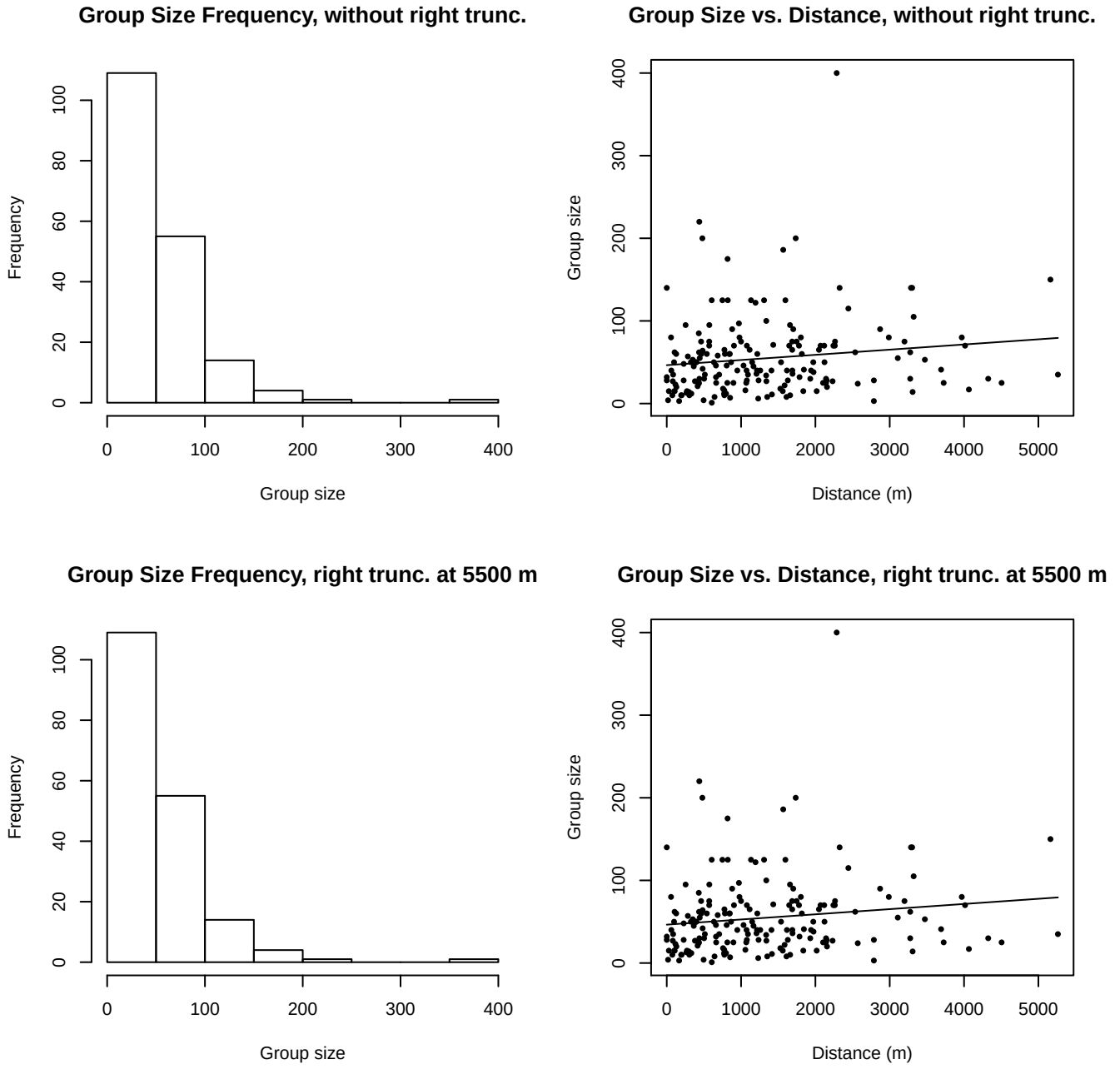


Figure 11: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

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.

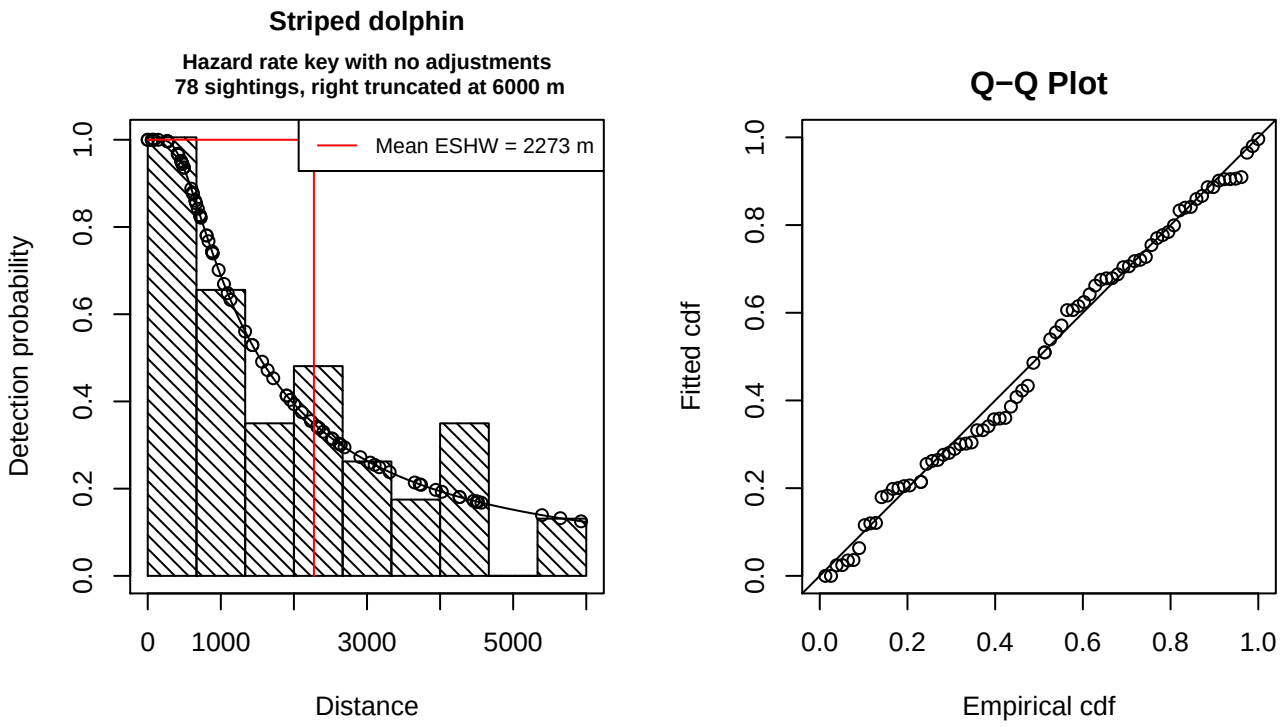


Figure 12: Detection function for High Platforms that was selected for the density model

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:

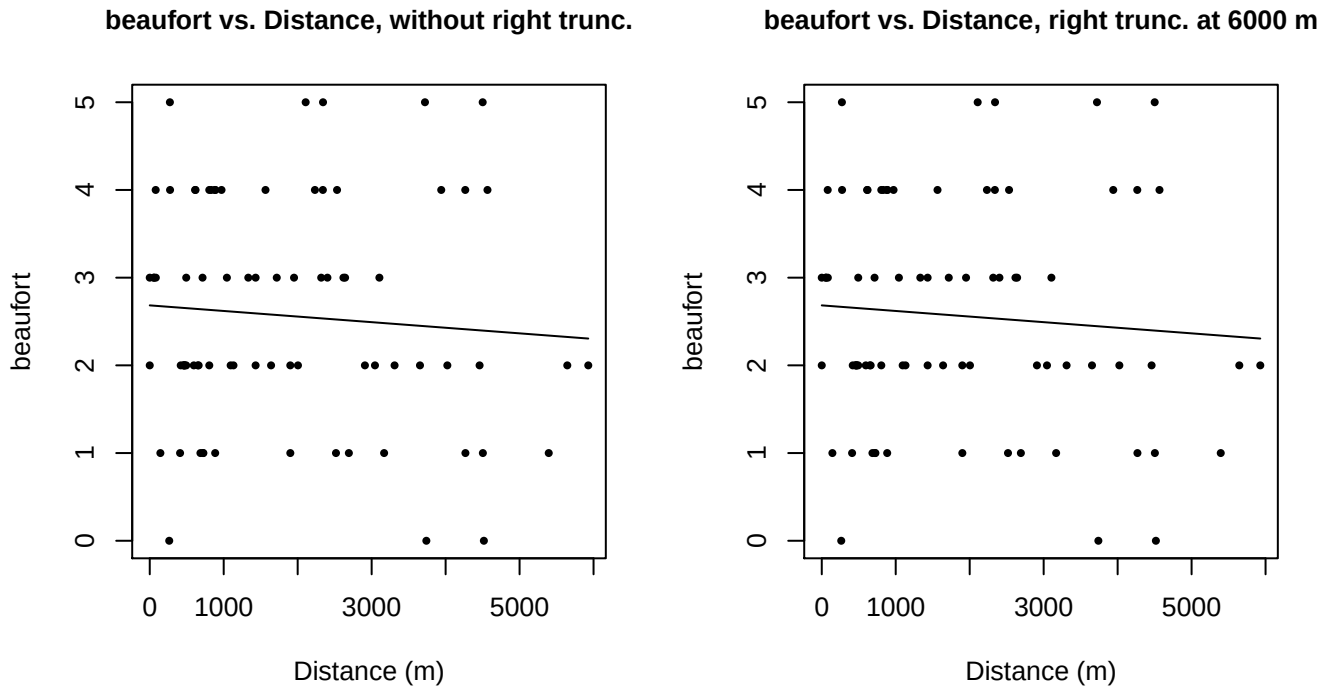


Figure 13: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

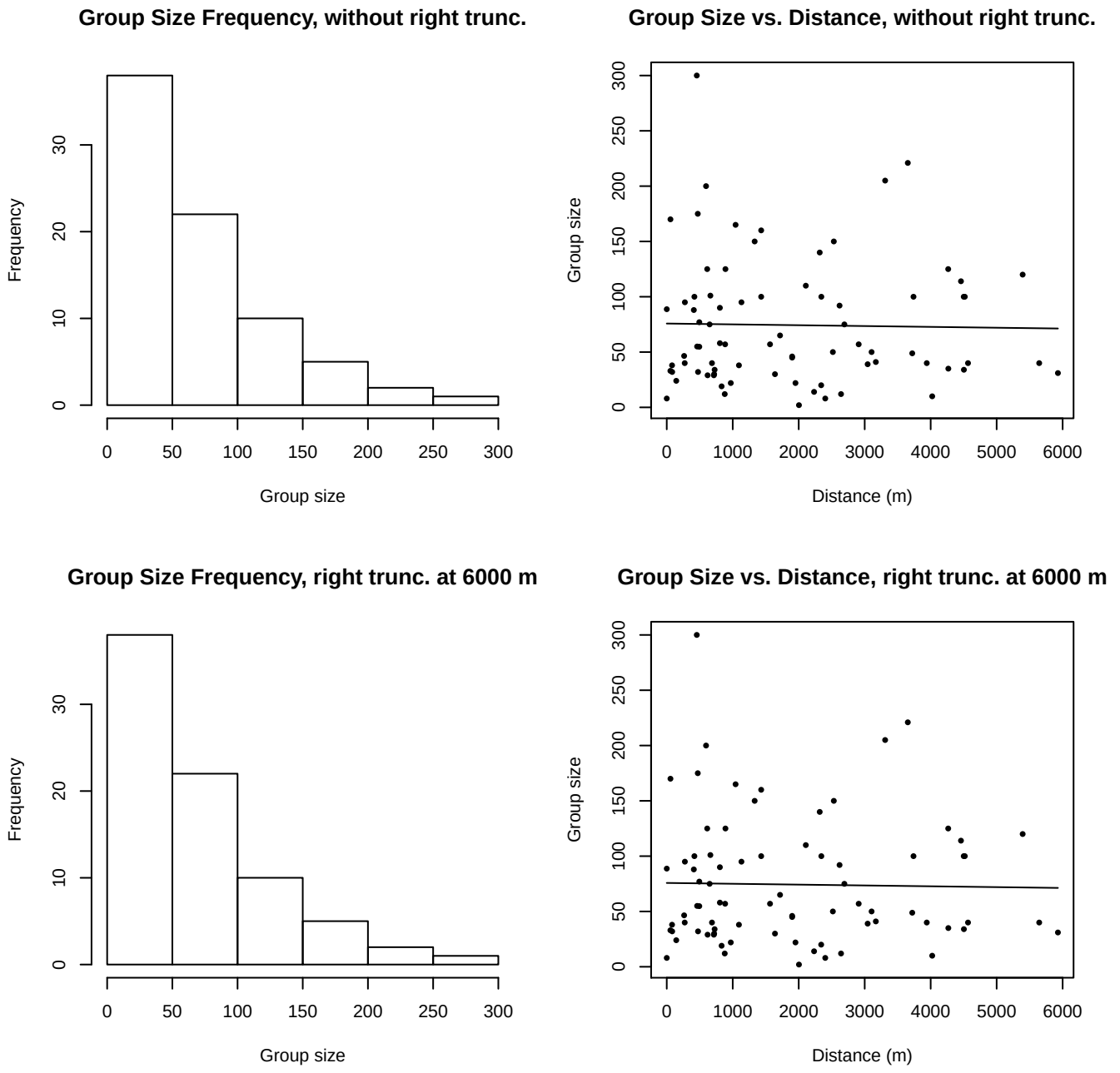


Figure 14: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Naked Eye 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	255

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	72
Grampus griseus	Risso's dolphin	9
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	0
Lagenorhynchus acutus	Atlantic white-sided dolphin	102
Lagenorhynchus albirostris	White-beaked dolphin	36
Lagenorhynchus albirostris/Lagenorhynchus acutus	White-beaked or white-sided dolphin	4
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	48
Stenella frontalis	Atlantic spotted dolphin	0
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	41
Total		567

Table 8: Proxy species used to fit detection functions for Naked Eye Surveys. The number of sightings, n, is before truncation.

The sightings were right truncated at 1000m.

Covariate	Description
beaufort	Beaufort sea state.
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)
hr			beaufort, size	Yes	0.00	329
hr			beaufort	Yes	5.52	306
hr			size	Yes	7.76	330
hr	poly	2		Yes	8.35	253
hr	poly	4		Yes	11.34	266
hn	cos	2		Yes	14.63	339

hr				Yes	14.95	308
hn	cos	3		Yes	29.74	330
hn			beaufort, size	Yes	33.37	434
hn			size	Yes	39.64	433
hn			beaufort	Yes	47.43	427
hn				Yes	53.26	426
hn	herm	4		Yes	54.28	425

Table 10: Candidate detection functions for Naked Eye Surveys. The first one listed was selected for the density model.

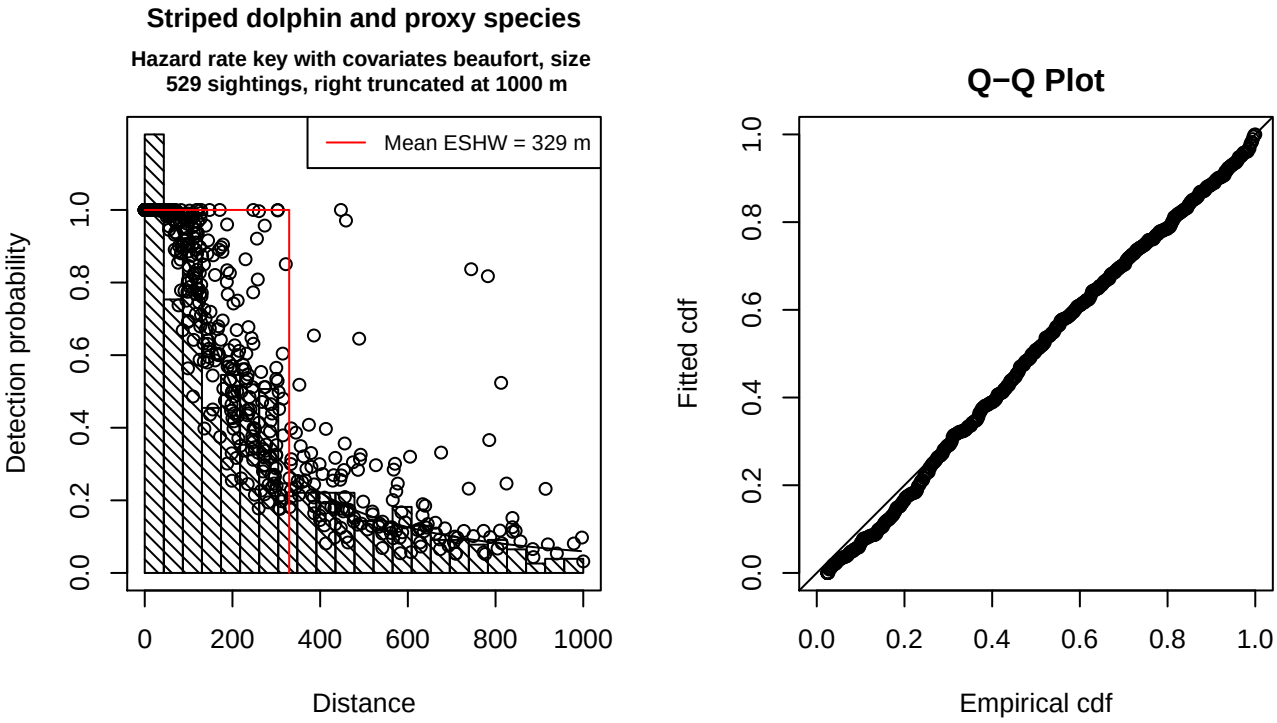


Figure 15: Detection function for Naked Eye Surveys that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  529
Distance range         :  0  -  1000
AIC                    :  6866.942

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
              estimate         se
(Intercept)  5.4796299 0.21489966
beaufort    -0.2095913 0.06594519
```

```
size         0.5152091 0.16341040

Shape parameters:
             estimate         se
(Intercept) 0.4966405 0.08804302

                          Estimate           SE         CV
Average p                0.2987683   0.02050381 0.06862779
N in covered region 1770.6030180 138.21190973 0.07805923
```

Additional diagnostic plots:

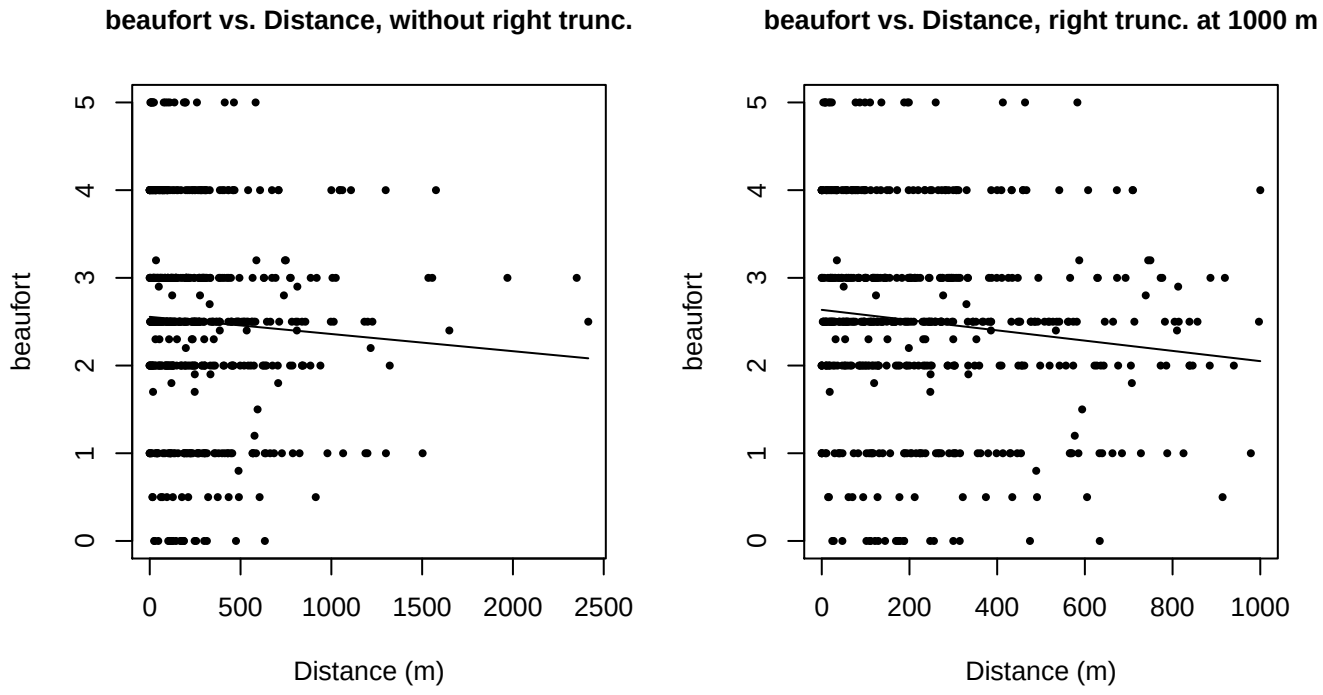


Figure 16: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

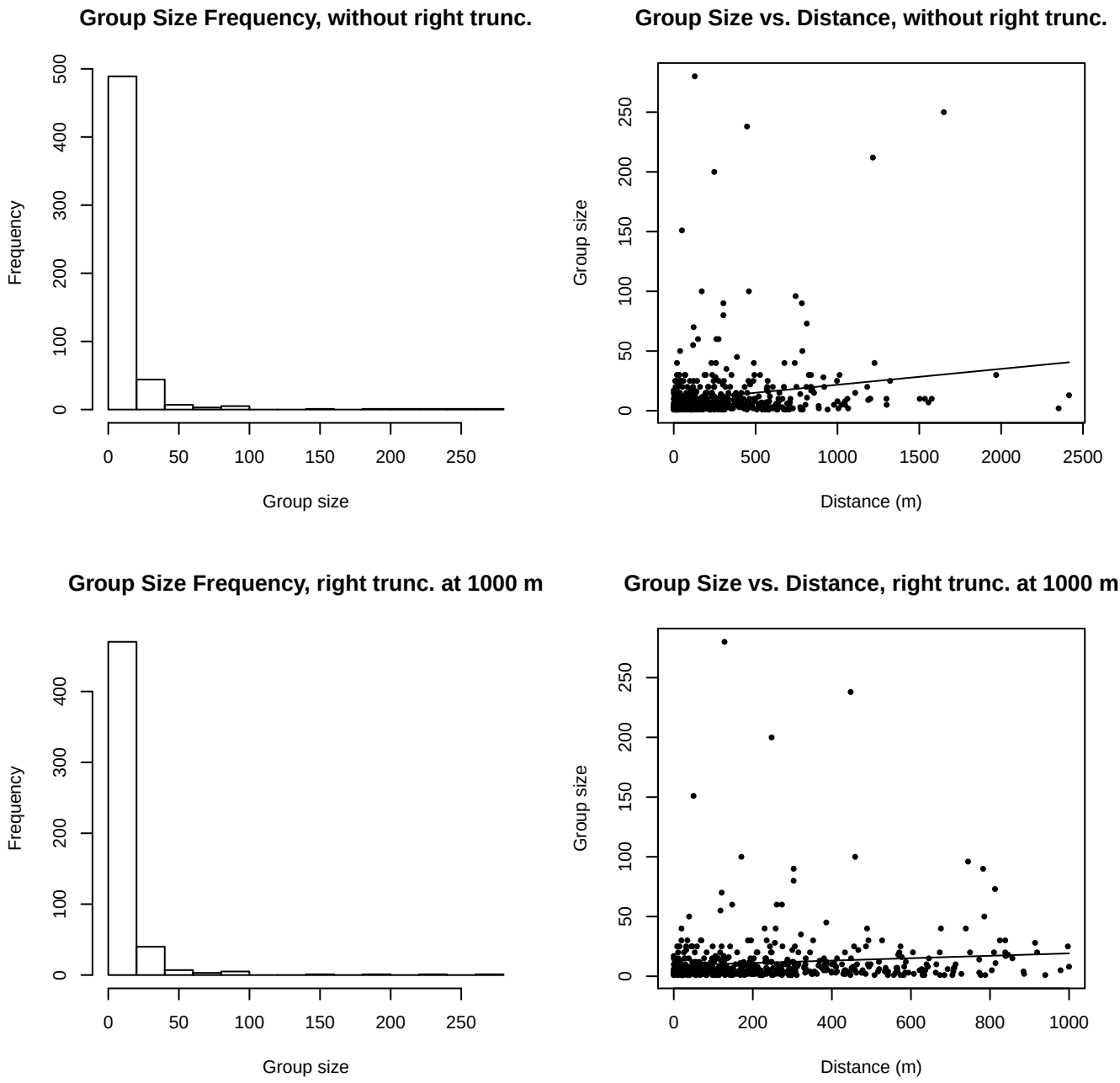


Figure 17: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

CODA and SCANS II

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	227

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	57
Grampus griseus	Risso's dolphin	9
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	0
Lagenorhynchus acutus	Atlantic white-sided dolphin	56
Lagenorhynchus albirostris	White-beaked dolphin	32
Lagenorhynchus albirostris/Lagenorhynchus acutus	White-beaked or white-sided dolphin	4
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	36
Stenella frontalis	Atlantic spotted dolphin	0
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	41
Total		462

Table 11: Proxy species used to fit detection functions for CODA and SCANS II. The number of sightings, n, is before truncation.

The sightings were right truncated at 1000m.

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			quality, size	Yes	0.00	326
hr			quality	Yes	0.85	325
hr	poly	2		Yes	2.85	257
hr			beaufort, size	Yes	3.50	319

hr			beaufort	Yes	4.73	315
hr	poly	4		Yes	5.08	288
hn	cos	2		Yes	5.71	335
hr			size	Yes	6.16	322
hr				Yes	7.78	319
hn	cos	3		Yes	15.49	324
hn			quality, size	Yes	21.34	416
hn			beaufort, size	Yes	22.76	417
hn			beaufort, quality, size	Yes	23.17	416
hn			quality	Yes	25.50	413
hn			size	Yes	26.46	418
hn			beaufort, quality	Yes	27.47	413
hn			beaufort	Yes	28.47	414
hn				Yes	32.88	414
hn	herm	4		Yes	34.17	413
hr			beaufort, quality	No		
hr			beaufort, quality, size	No		

Table 13: Candidate detection functions for CODA and SCANS II. The first one listed was selected for the density model.

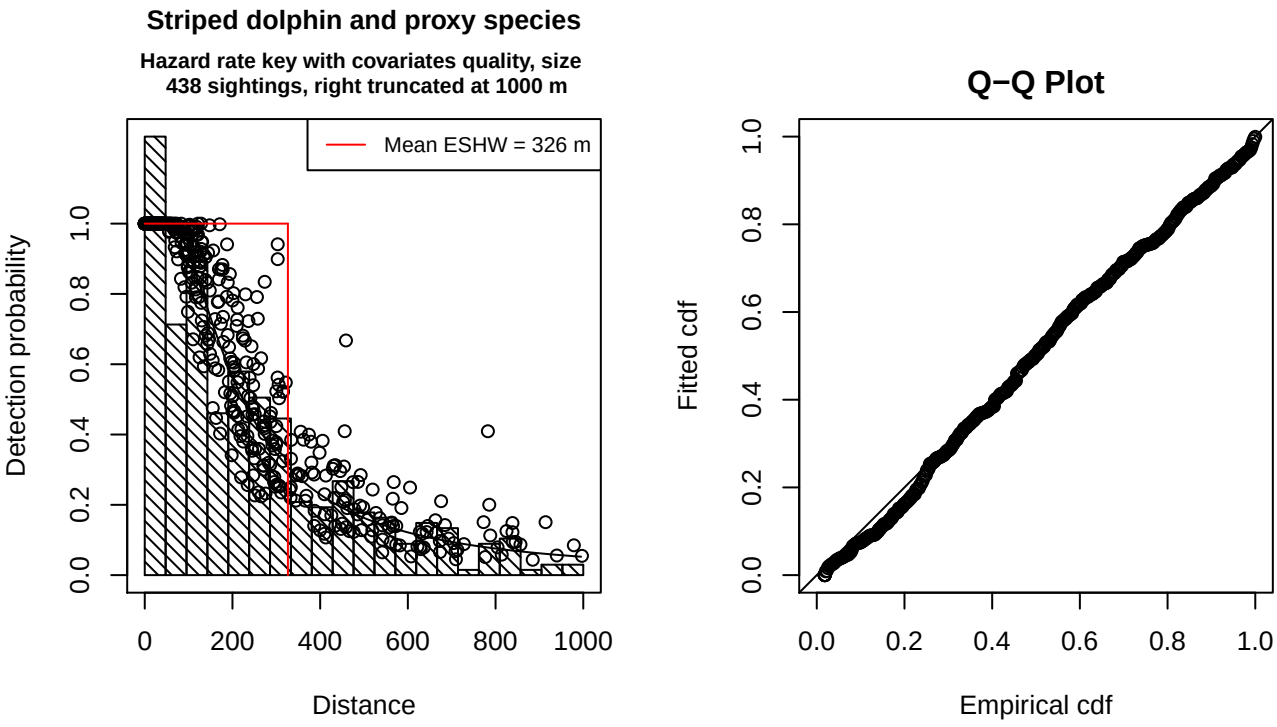


Figure 18: Detection function for CODA and SCANS II that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  438
Distance range         :  0  -  1000
AIC                    :  5674.066

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
              estimate         se
(Intercept)  5.4624136 0.17286880
quality     -0.1426257 0.05036964
size         0.2194236 0.11538504

Shape parameters:
             estimate         se
(Intercept) 0.5741026 0.09733169

                         Estimate           SE         CV
Average p               0.3097732   0.02170451 0.07006582
N in covered region 1413.9378602 114.19755693 0.08076561
```

Additional diagnostic plots:

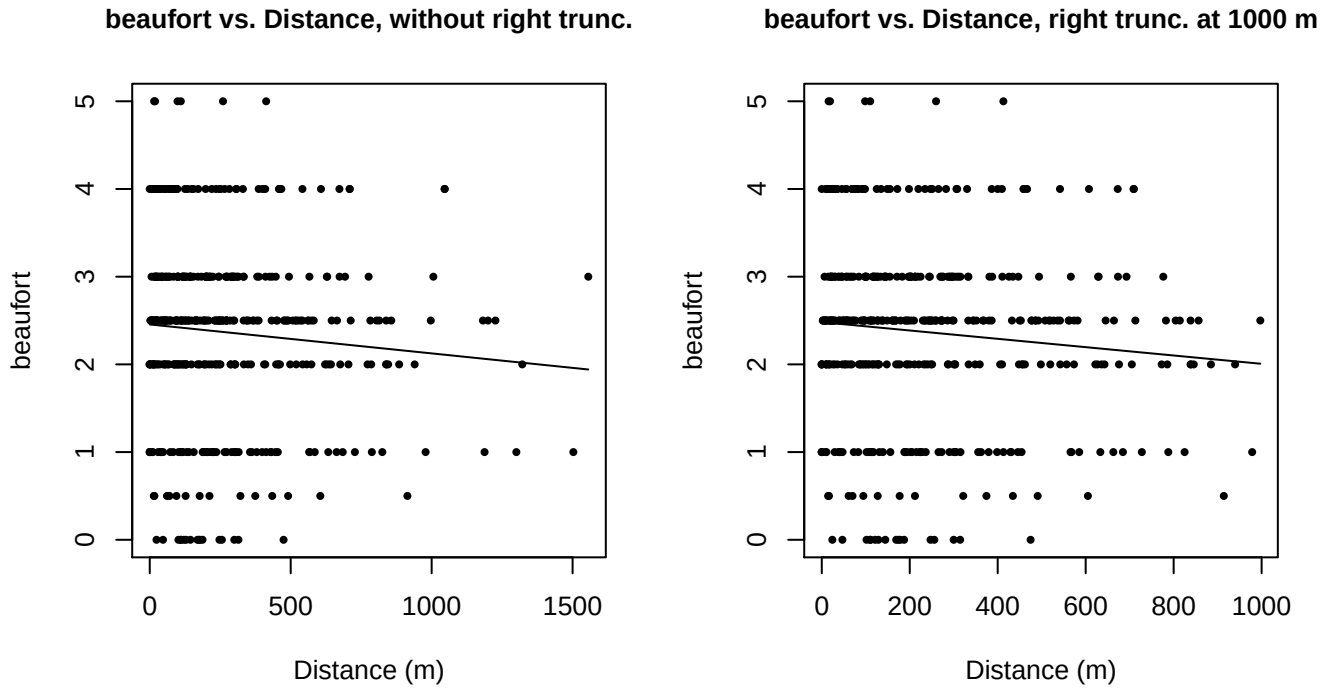


Figure 19: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

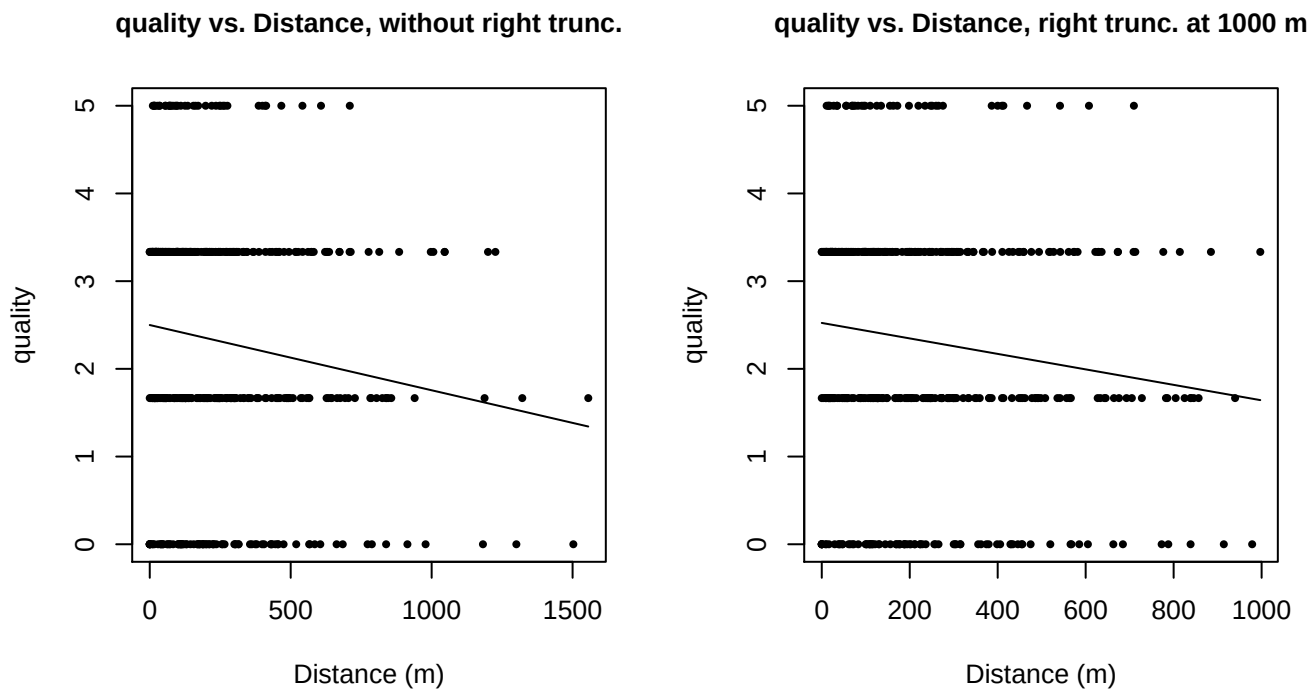


Figure 20: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

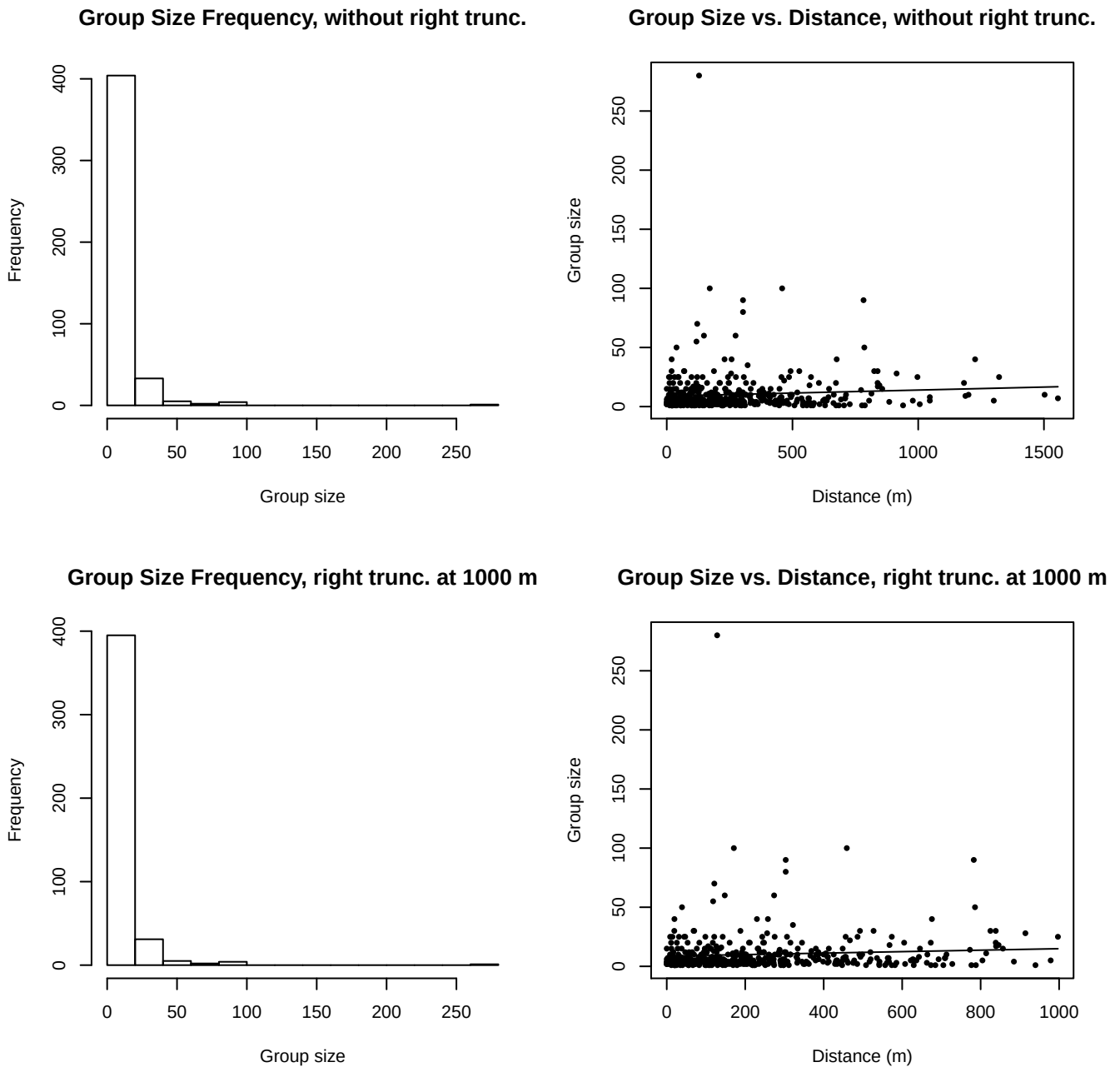


Figure 21: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Aerial Surveys

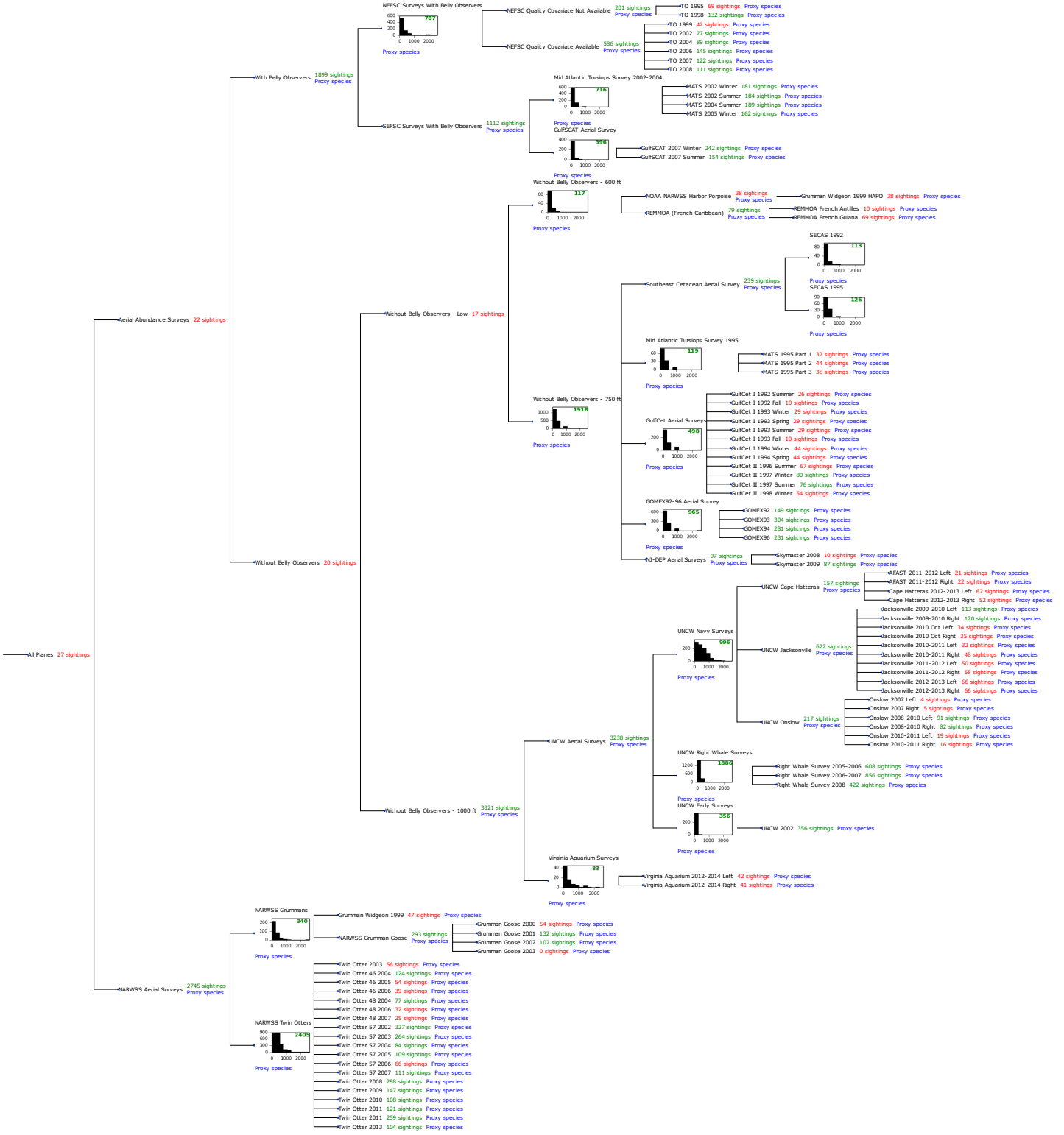


Figure 22: Detection hierarchy for aerial surveys

NEFSC Surveys With Belly Observers

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	311
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	148
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	0
Lagenorhynchus acutus	Atlantic white-sided dolphin	220
Lagenorhynchus albirostris	White-beaked dolphin	5
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	2
Stenella frontalis	Atlantic spotted dolphin	2
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	99
Total		787

Table 14: Proxy species used to fit detection functions for NEFSC Surveys With Belly Observers. The number of sightings, n, is before truncation.

The sightings were right truncated at 1000m.

Covariate	Description
beaufort	Beaufort sea state.
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	380
hr	poly	4		Yes	18.20	354
hr				Yes	20.16	359
hr	poly	2		Yes	20.32	350
hn	cos	2		Yes	20.44	311
hn			size	Yes	25.50	370
hn	cos	3		Yes	37.76	322
hn				Yes	43.60	364
hn	herm	4		No		
hn			beaufort	No		
hr			beaufort	No		
hn			beaufort, size	No		
hr			beaufort, size	No		

Table 16: Candidate detection functions for NEFSC Surveys With Belly Observers. The first one listed was selected for the density model.

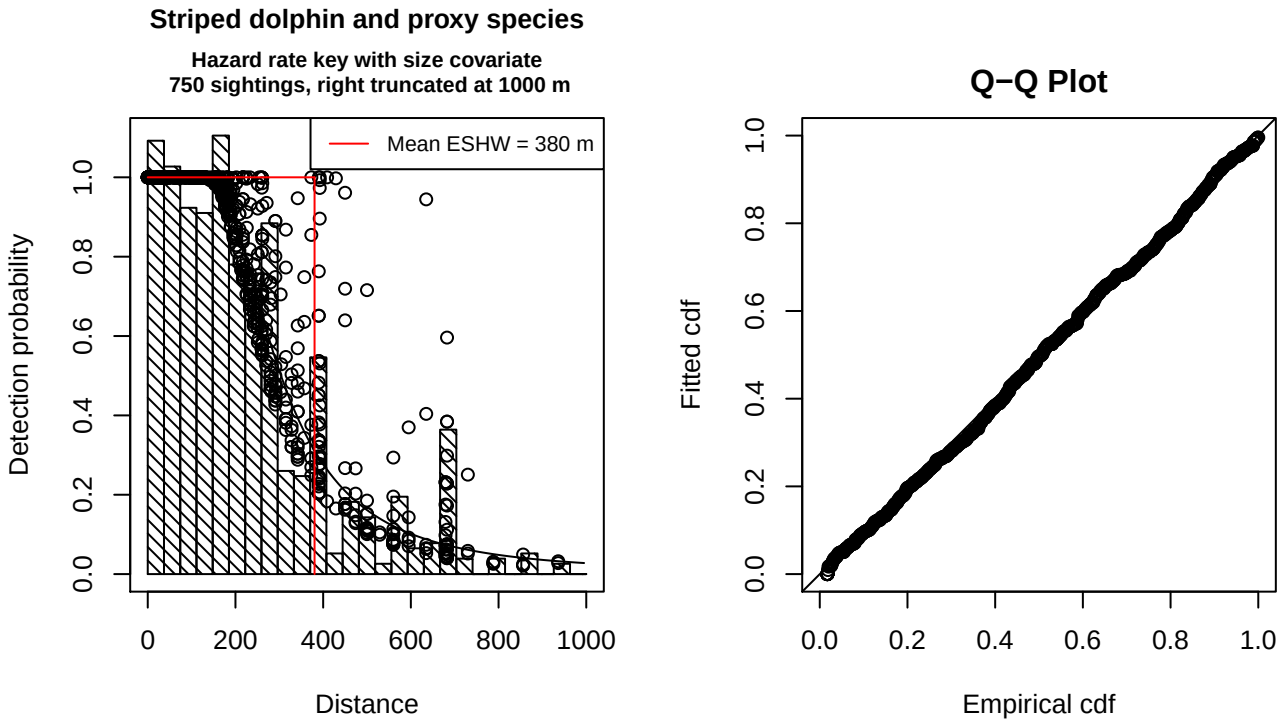


Figure 23: Detection function for NEFSC Surveys With Belly Observers that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  750
```

```
Distance range         :  0  -  1000
AIC                    :  9547.646

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
             estimate         se
(Intercept) 5.4723434 0.05875063
size        0.4897148 0.09093801

Shape parameters:
            estimate         se
(Intercept) 1.119312 0.06987572

                         Estimate          SE         CV
Average p                0.3611765  0.01276499 0.03534280
N in covered region 2076.5469236 95.75679628 0.04611348
```

Additional diagnostic plots:

Figure 24: 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.

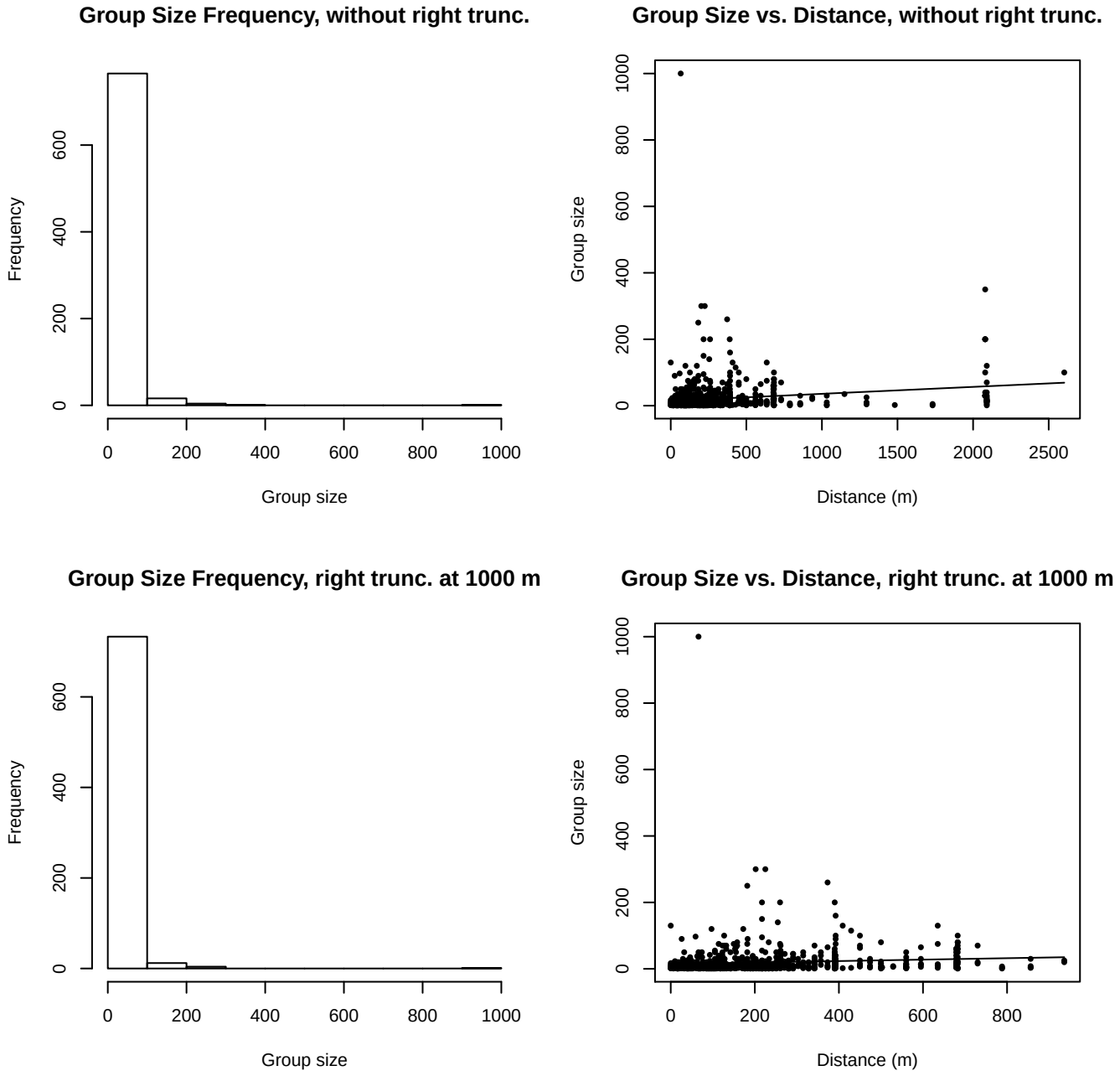


Figure 25: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Mid Atlantic Tursiops Survey 2002-2004

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	3

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	4
Stenella attenuata	Pantropical spotted dolphin	2
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	1
Stenella coeruleoalba	Striped dolphin	0
Stenella frontalis	Atlantic spotted dolphin	107
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	599
Total		716

Table 17: Proxy species used to fit detection functions for Mid Atlantic Tursiops Survey 2002-2004. The number of sightings, n, is before truncation.

The sightings were right truncated at 1296m. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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 18: 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	325
hr			beaufort	Yes	7.24	320
hr			size	Yes	15.12	325

hr				Yes	19.50	320
hr	poly	4		Yes	21.50	320
hr	poly	2		Yes	21.50	320
hn			beaufort, size	Yes	24.60	291
hn			beaufort, quality, size	Yes	26.60	291
hn	cos	2		Yes	30.33	279
hn			beaufort	Yes	31.06	289
hn			beaufort, quality	Yes	33.06	289
hn			size	Yes	40.68	292
hn	cos	3		Yes	41.28	267
hn			quality, size	Yes	42.58	292
hn				Yes	44.72	289
hn			quality	Yes	46.63	289
hn	herm	4		Yes	46.67	289
hr			quality	No		
hr			beaufort, quality	No		
hr			quality, size	No		
hr			beaufort, quality, size	No		

Table 19: Candidate detection functions for Mid Atlantic Tursiops Survey 2002-2004. The first one listed was selected for the density model.

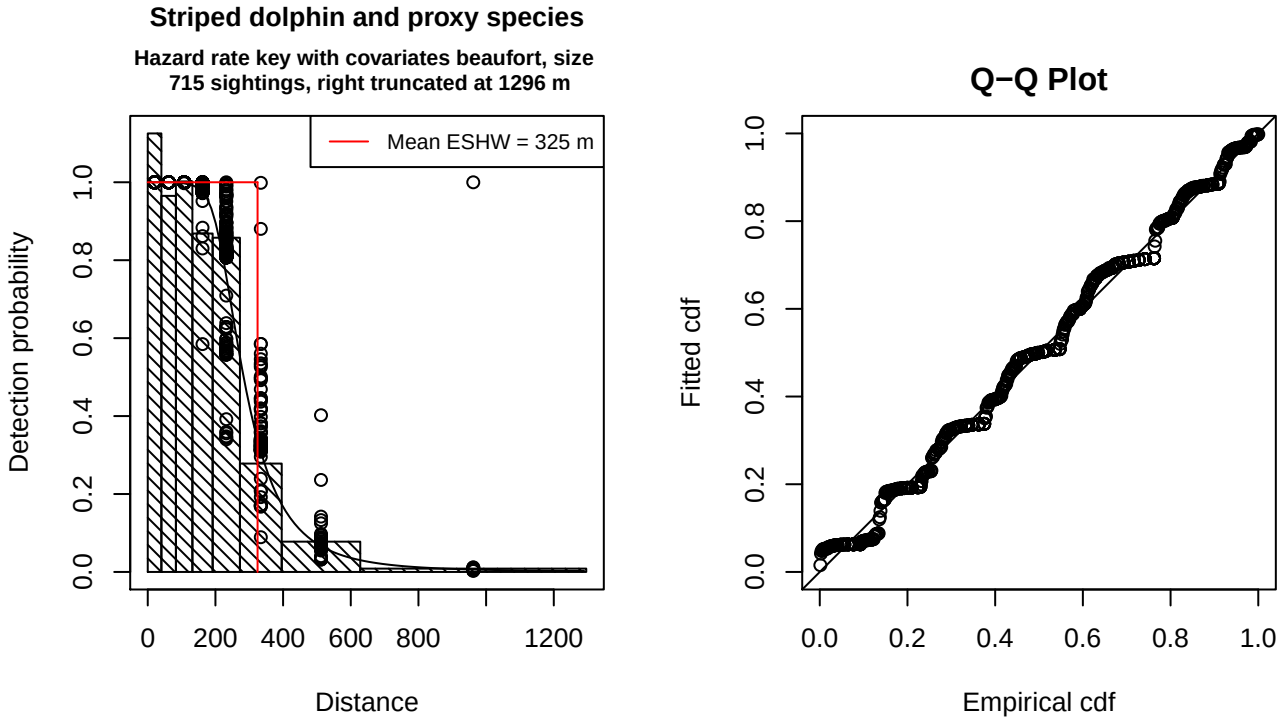


Figure 26: Detection function for Mid Atlantic Tursiops Survey 2002-2004 that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  715
Distance range         :  0  -  1296
AIC                    :  2772.625

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
              estimate         se
(Intercept)  5.7367970 0.06707586
beaufort    -0.1711625 0.03979058
size         0.3020980 0.11348684

Shape parameters:
            estimate         se
(Intercept) 1.410835 0.06851877

                        Estimate           SE         CV
Average p              0.2429646 7.460291e-03 0.03070526
N in covered region 2942.8157278 1.320027e+02 0.04485592
```

Additional diagnostic plots:

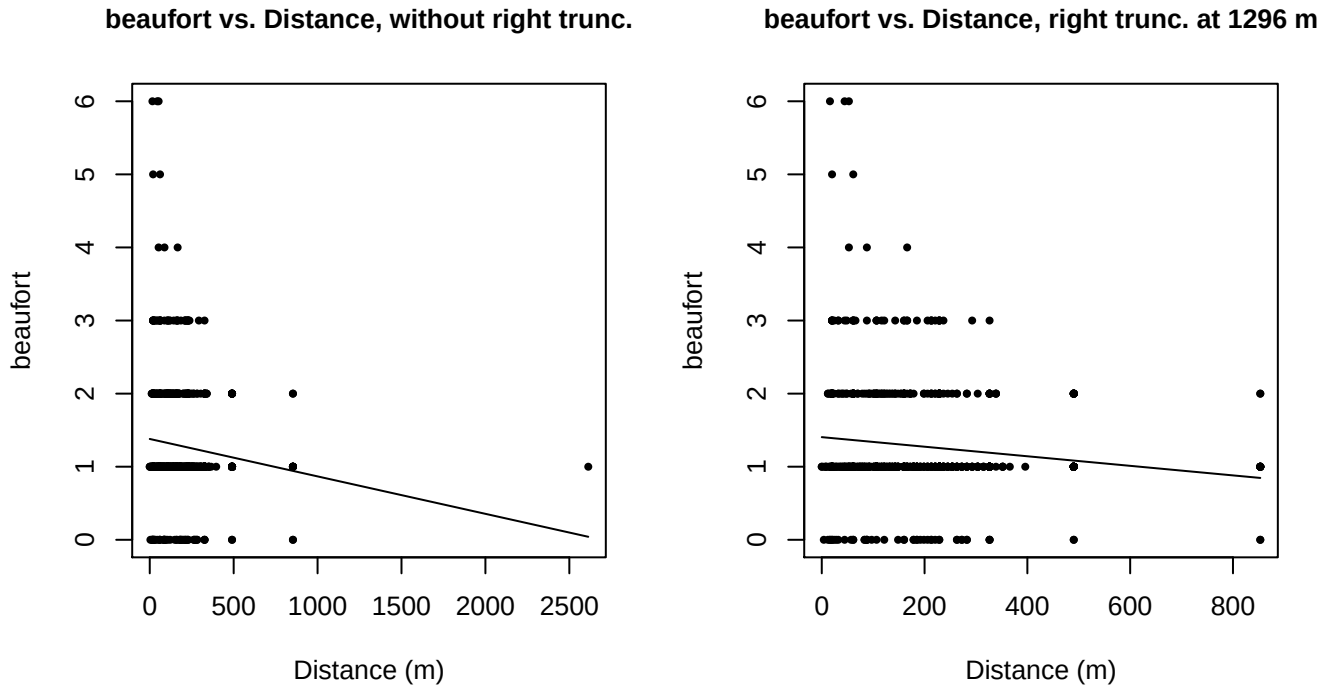


Figure 27: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

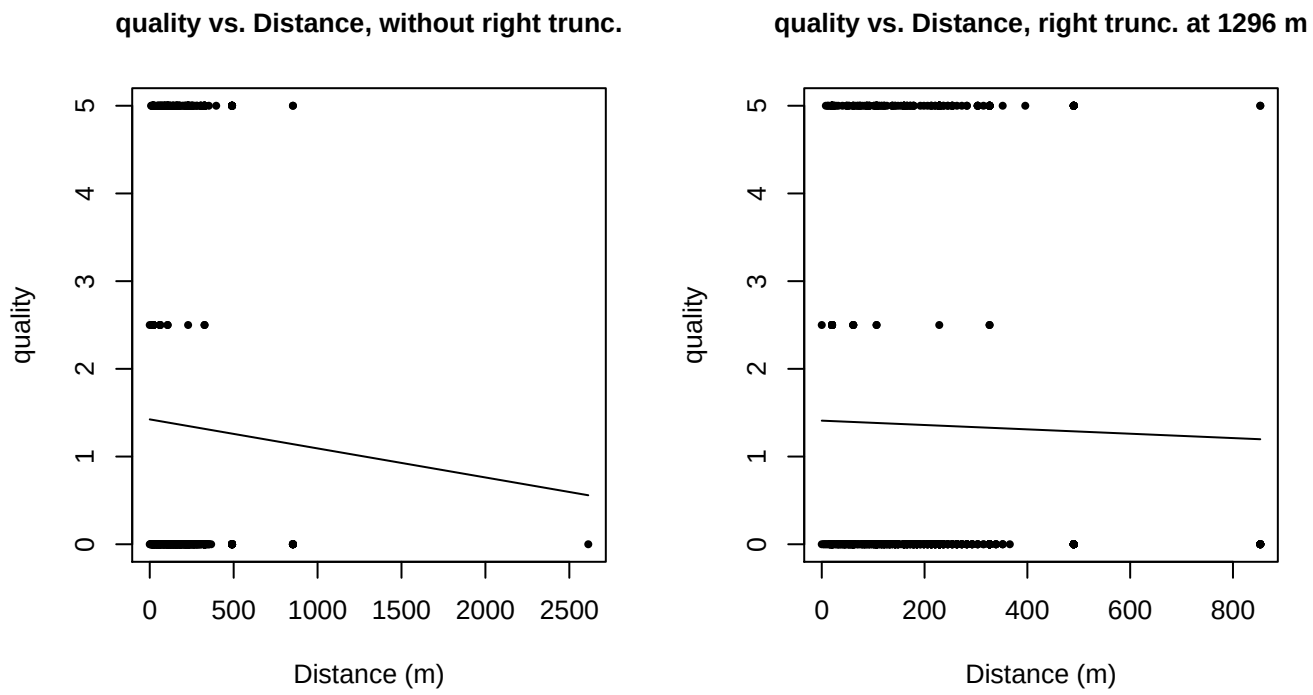


Figure 28: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

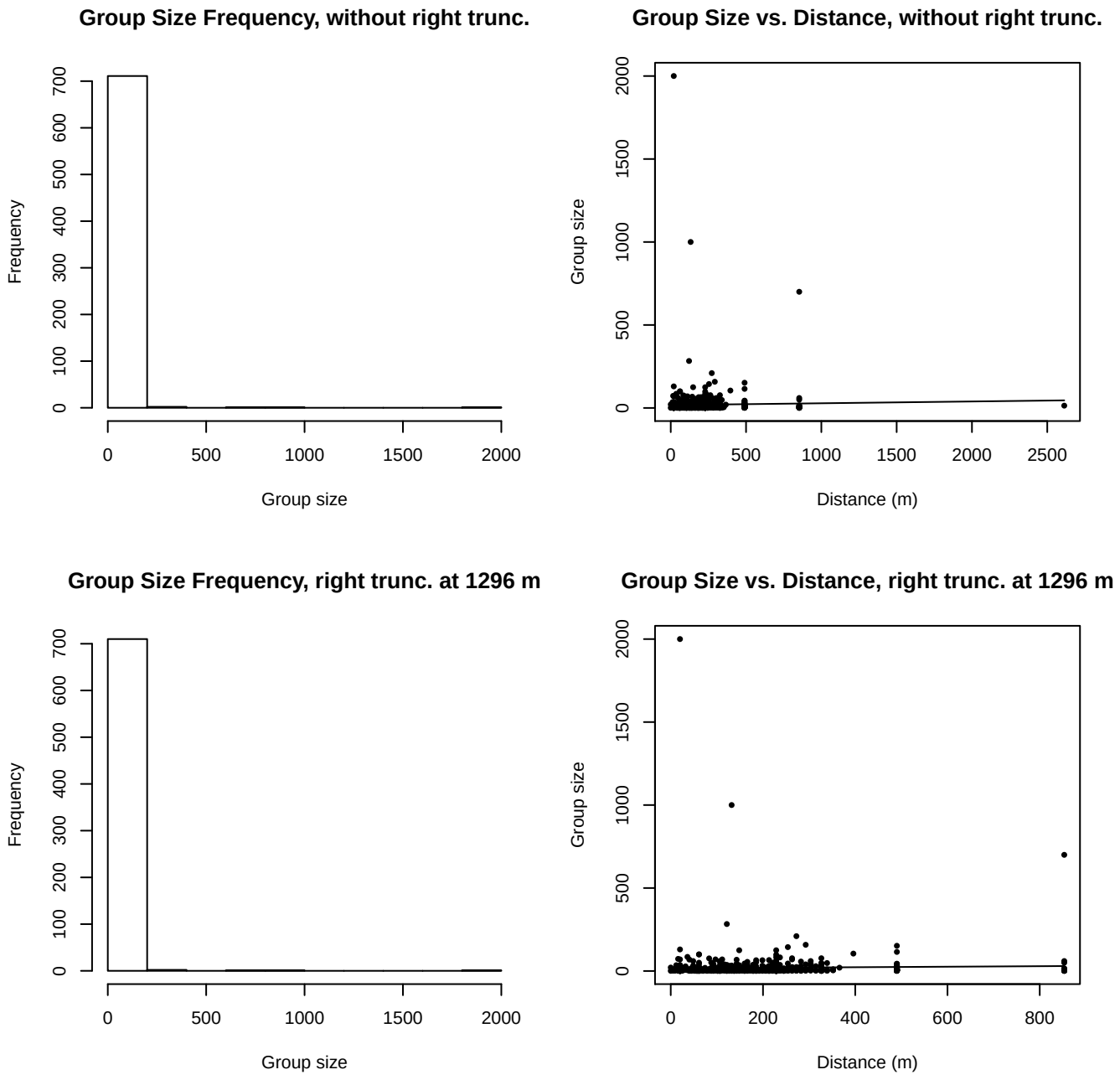


Figure 29: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

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 20: 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 21: 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 22: Candidate detection functions for GulfSCAT Aerial Survey. The first one listed was selected for the density model.

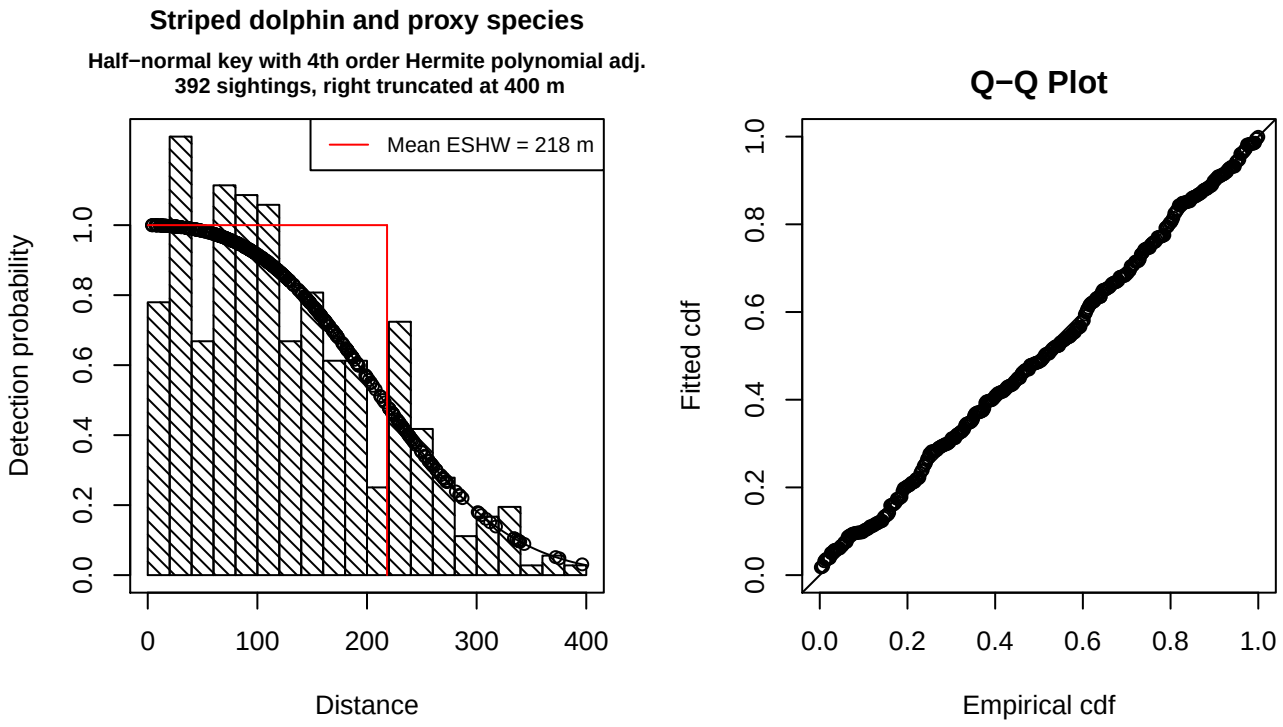


Figure 30: Detection function for GulfSCAT Aerial Survey that was selected for the density model

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) 4.855664 0.07416788

Adjustment term parameter(s):
                 estimate         se
herm, order 4 -0.04125508 0.01270725


Monotonicity constraints were enforced.
                       Estimate          SE         CV
Average p             0.5457491  0.04201236 0.07698108
N in covered region 718.2787706 60.45880788 0.08417179

Monotonicity constraints were enforced.
```

Additional diagnostic plots:

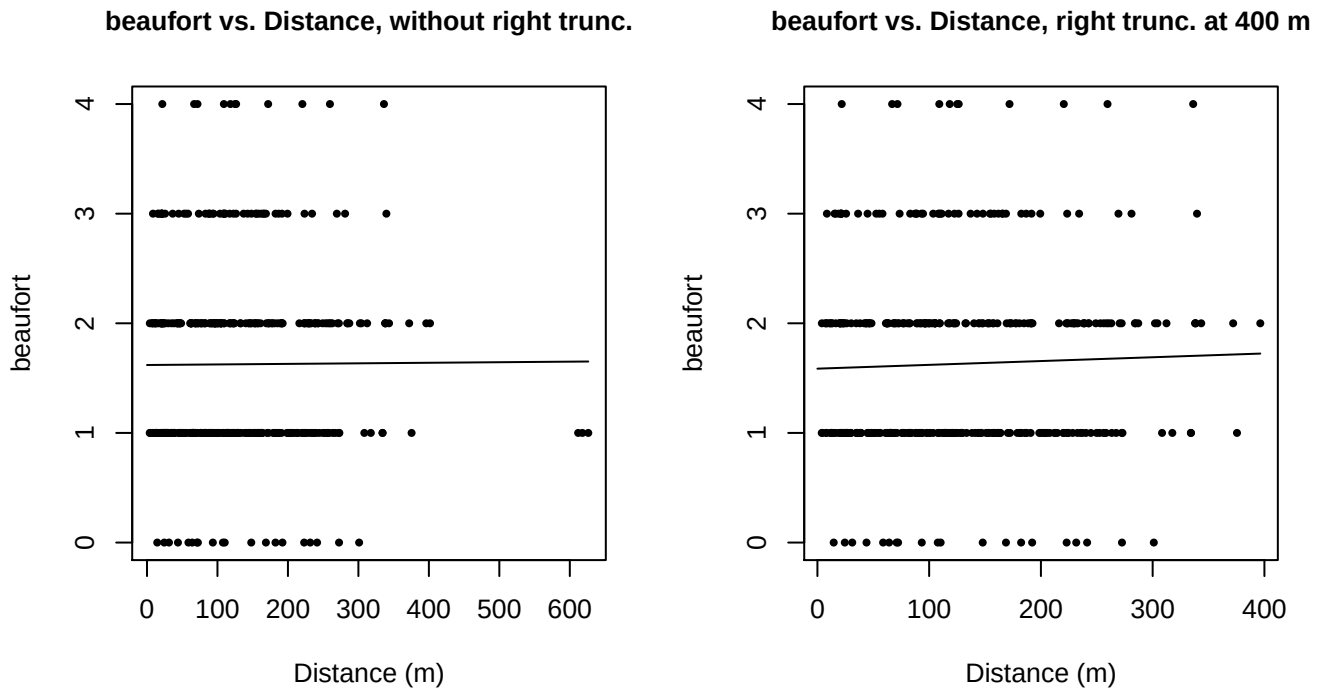


Figure 31: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

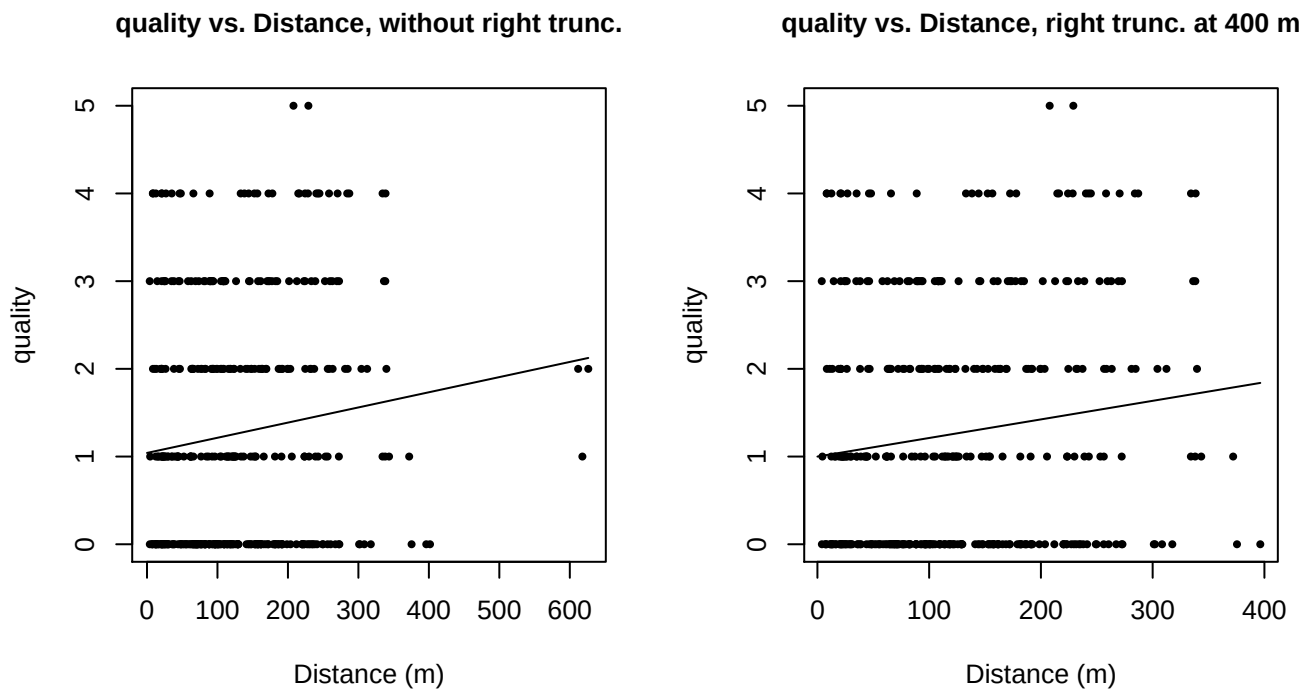


Figure 32: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

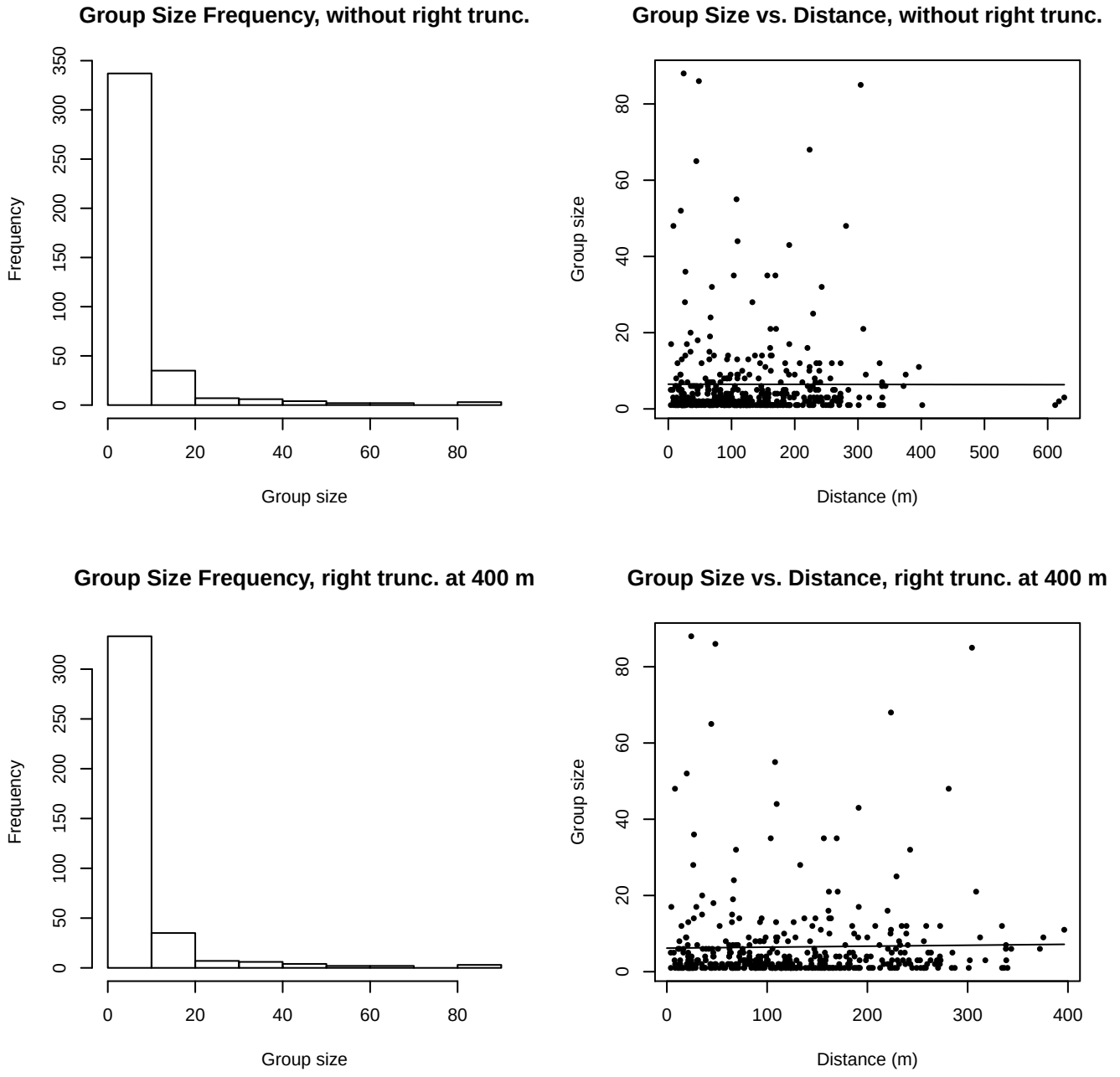


Figure 33: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Without Belly Observers - 600 ft

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	5

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	3
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	4
Lagenorhynchus acutus	Atlantic white-sided dolphin	31
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	4
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	0
Stenella coeruleoalba	Striped dolphin	0
Stenella frontalis	Atlantic spotted dolphin	0
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	70
Total		117

Table 23: Proxy species used to fit detection functions for Without Belly Observers - 600 ft. The number of sightings, n, is before truncation.

The sightings were right truncated at 600m.

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

Table 24: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hn				Yes	0.00	273
hr				Yes	0.47	313
hn	cos	3		Yes	0.63	294
hn	cos	2		Yes	1.46	297
hn			beaufort	Yes	1.82	273
hn	herm	4		Yes	1.85	280

hn			size	Yes	1.98	273
hr	poly	4		Yes	2.01	305
hr			beaufort	Yes	2.15	308
hr	poly	2		Yes	2.38	298
hn			beaufort, size	Yes	3.80	273
hr			size	No		
hr			beaufort, size	No		

Table 25: Candidate detection functions for Without Belly Observers - 600 ft. The first one listed was selected for the density model.

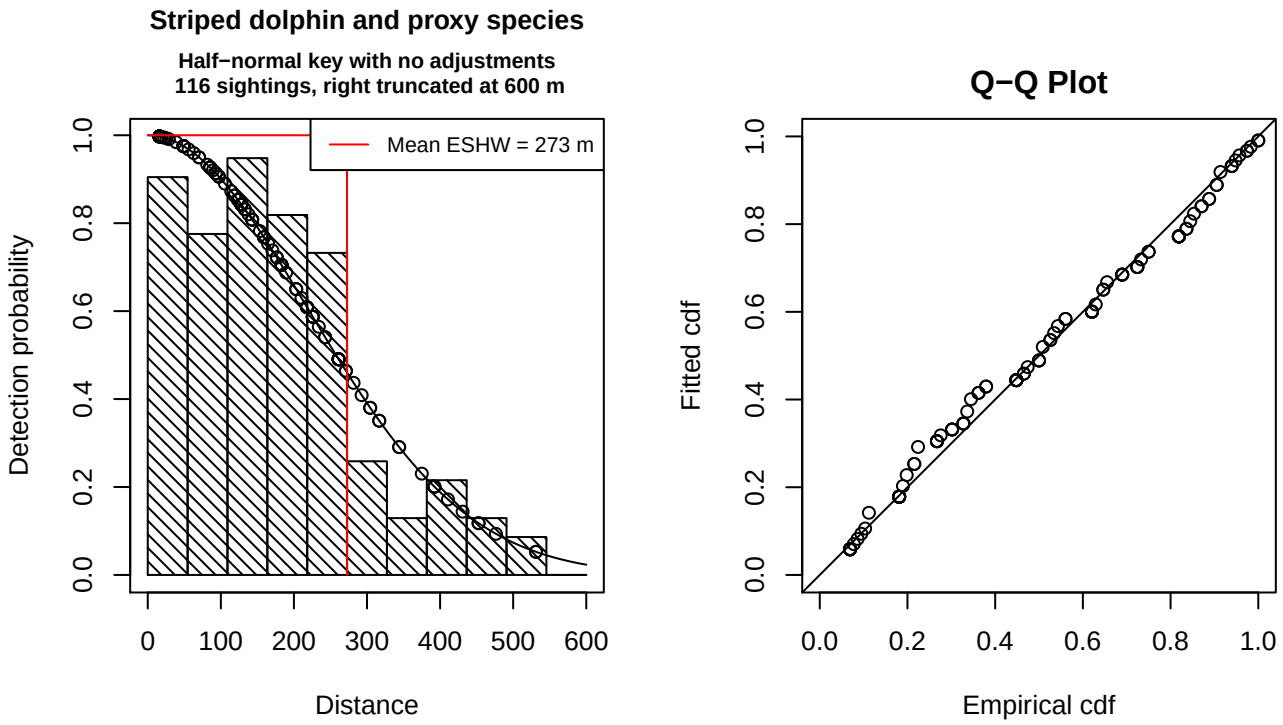


Figure 34: Detection function for Without Belly Observers - 600 ft that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  116
Distance range         :  0  -  600
AIC                    :  1413.111

Detection function:
 Half-normal key function

Detection function parameters
Scale Coefficients:
            estimate         se
(Intercept) 5.388383 0.07654643
```

```
                      Estimate          SE         CV
Average p             0.4543498  0.03299346 0.07261686
N in covered region 255.3098755 25.50172372 0.09988538
```

Additional diagnostic plots:

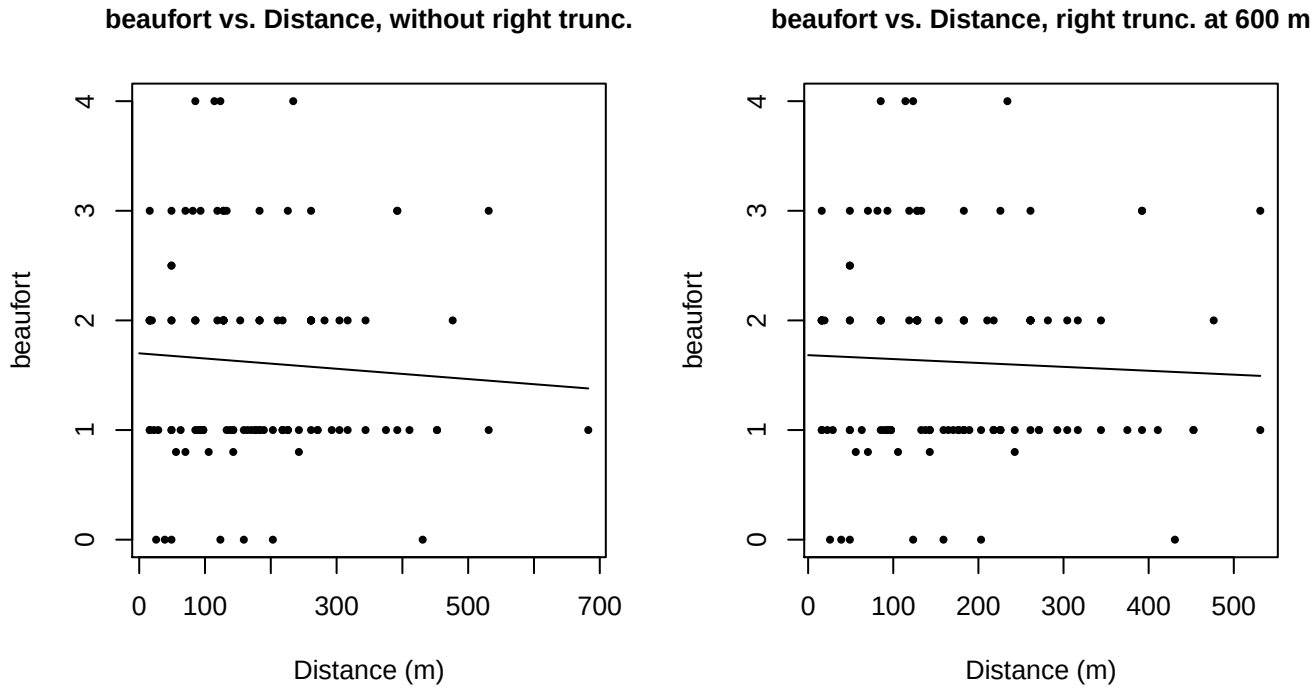


Figure 35: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

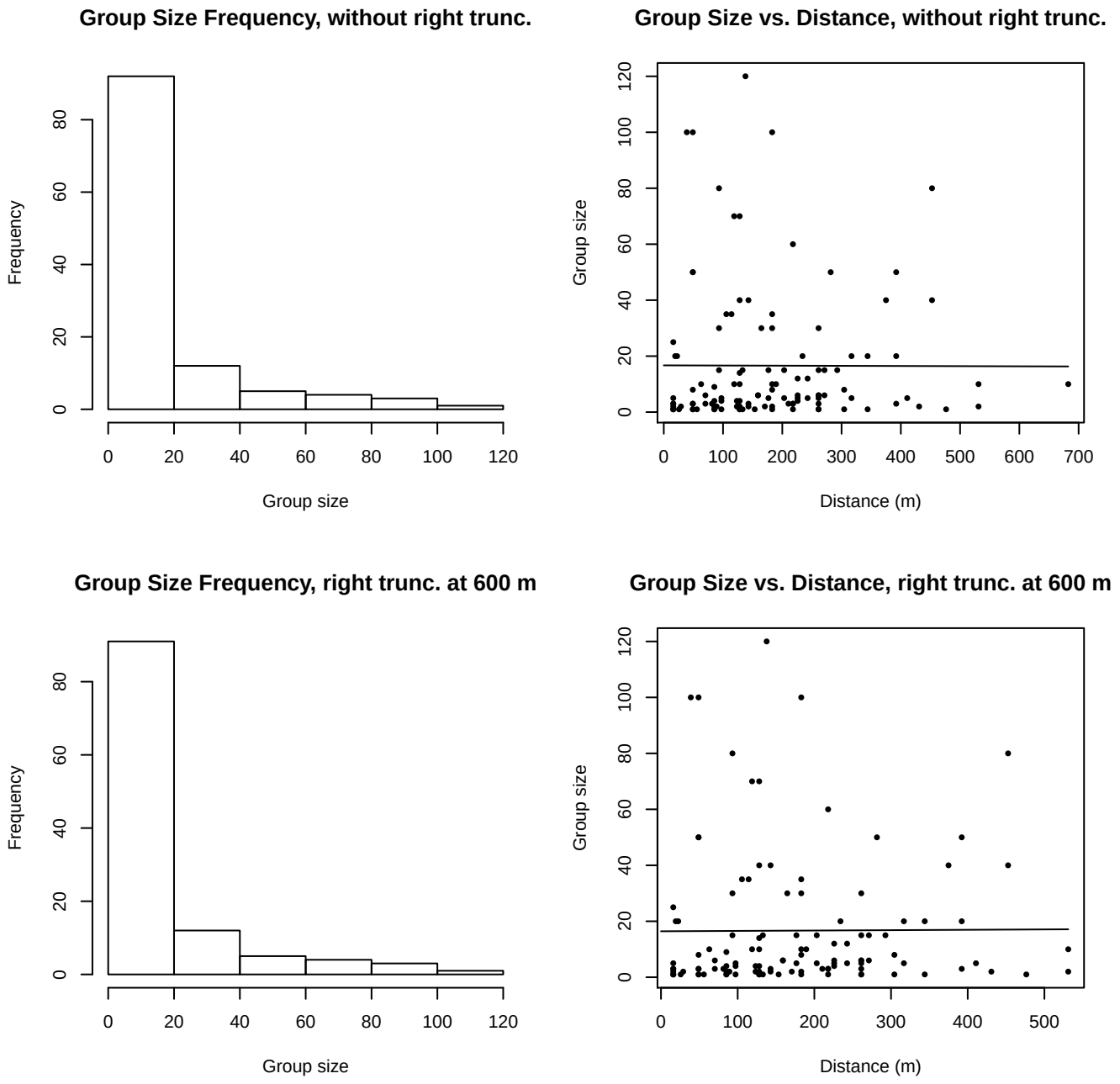


Figure 36: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Without Belly Observers - 750 ft

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	5

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	75
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	14
Stenella attenuata	Pantropical spotted dolphin	94
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	12
Stenella coeruleoalba	Striped dolphin	17
Stenella frontalis	Atlantic spotted dolphin	82
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	1597
Total		1918

Table 26: Proxy species used to fit detection functions for Without Belly Observers - 750 ft. The number of sightings, n, is before truncation.

The sightings were right truncated at 1296m. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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 27: 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	392
hr				Yes	8.40	388
hr	poly	2		Yes	10.38	388

hr	poly	4		Yes	10.38	388
hn	cos	2		Yes	39.35	354
hn	cos	3		Yes	59.72	342
hn			size	Yes	81.81	402
hn				Yes	95.30	401
hn	herm	4		Yes	96.81	401
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 28: Candidate detection functions for Without Belly Observers - 750 ft. The first one listed was selected for the density model.

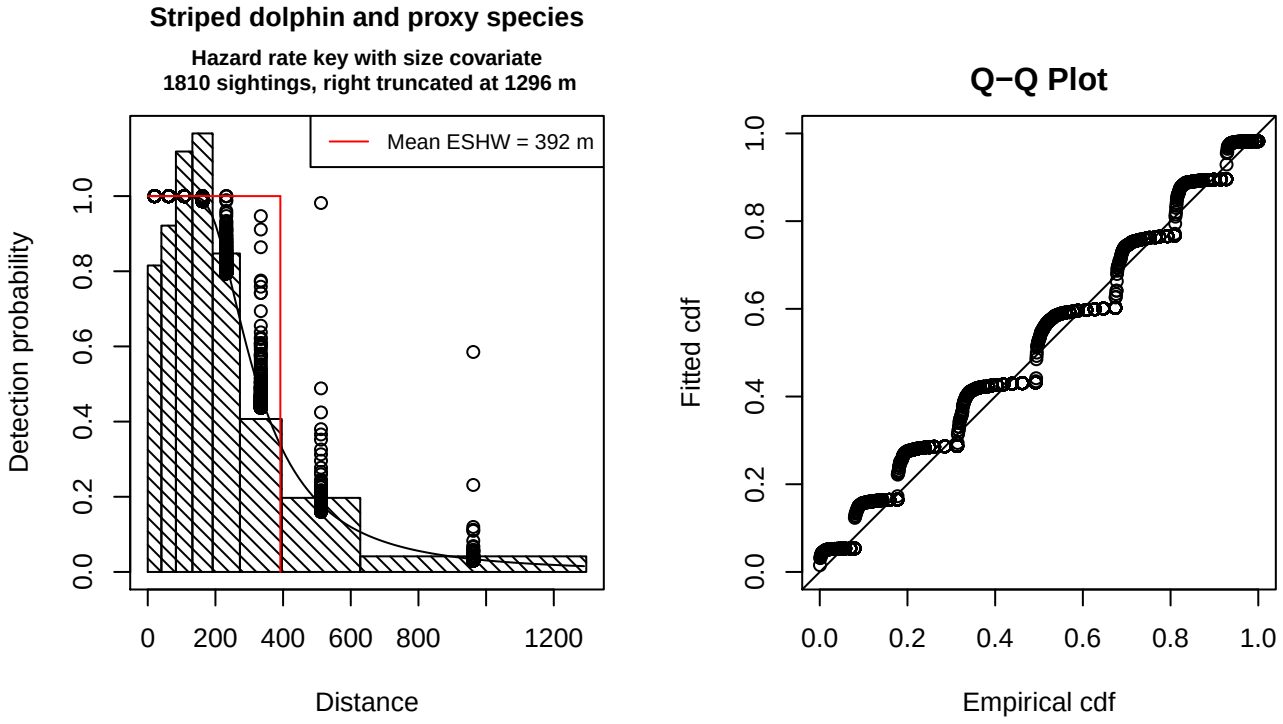


Figure 37: Detection function for Without Belly Observers - 750 ft that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  1810
Distance range         :  0  -  1296
AIC                    :  7378.672

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
             estimate         se
(Intercept) 5.6088057 0.03890075
size        0.1034633 0.02841209

Shape parameters:
            estimate         se
(Intercept) 1.023516 0.04368421

                         Estimate           SE         CV
Average p              0.2999988 7.471092e-03 0.02490374
N in covered region 6033.3566458 1.915759e+02 0.03175279
```

Additional diagnostic plots:

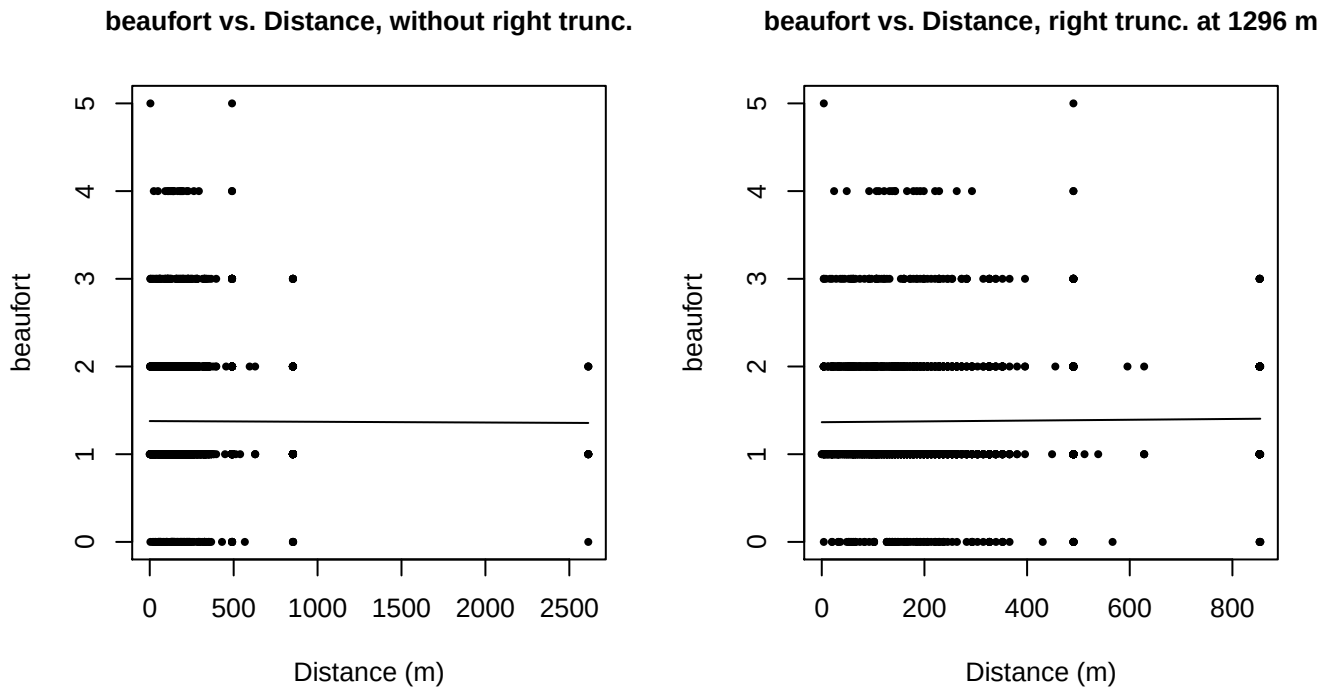


Figure 38: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

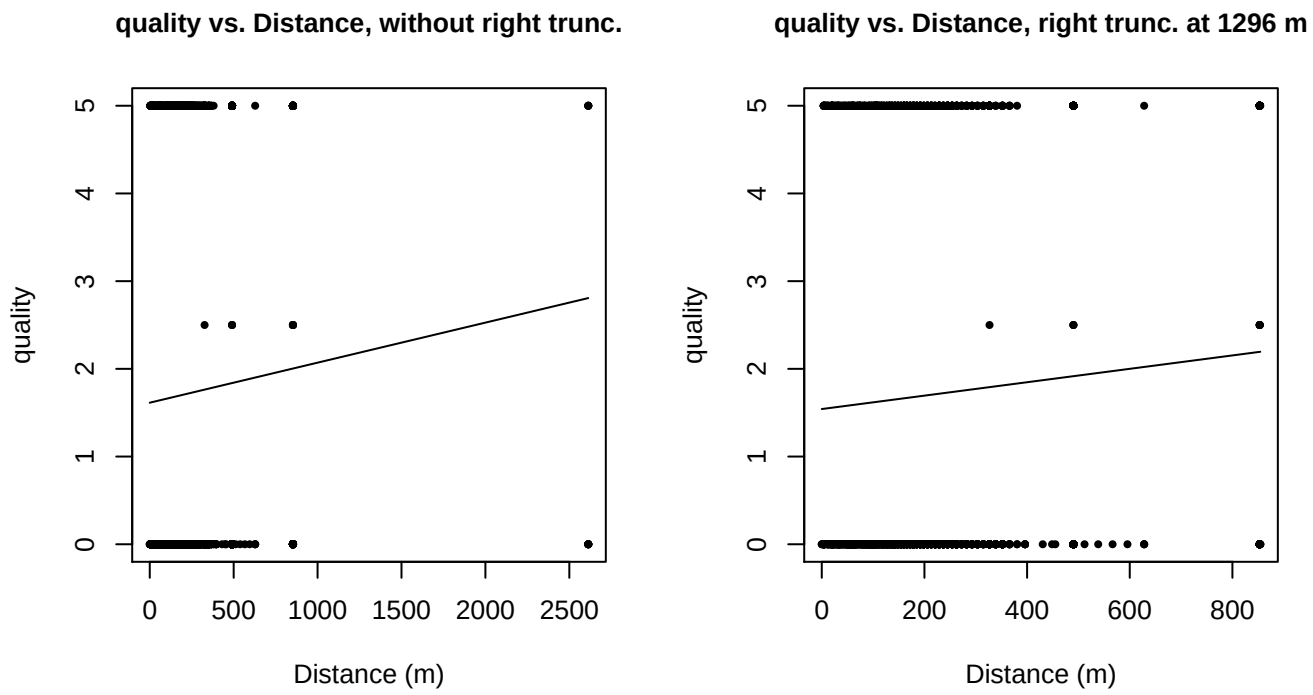


Figure 39: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

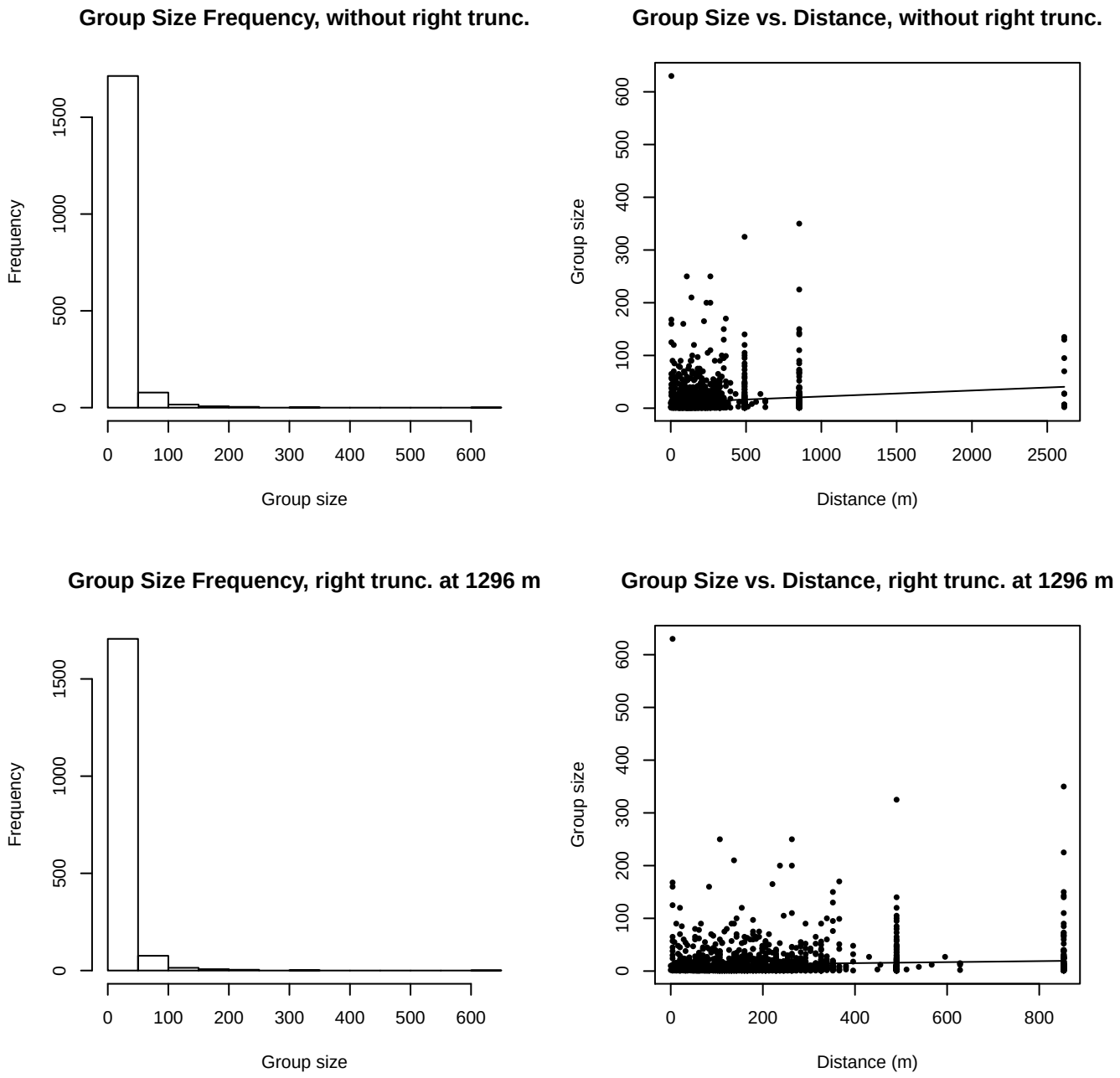


Figure 40: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

SE_secas92

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	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	9
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	103
Total		113

Table 29: Proxy species used to fit detection functions for SE_secas92. The number of sightings, n, is before truncation.

The sightings were right truncated at 900m. 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 40 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. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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

Table 30: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr			beaufort	Yes	0.00	249
hr			beaufort, size	Yes	1.98	254

hr			size	Yes	15.77	257
hr				Yes	18.01	216
hn	cos	2		Yes	19.23	189
hr	poly	2		Yes	20.01	216
hr	poly	4		Yes	22.44	187
hn			beaufort	Yes	35.20	260
hn				Yes	41.73	264
hn	cos	3		Yes	41.97	219
hn	herm	4		Yes	43.30	264
hn			size	No		
hn			beaufort, size	No		

Table 31: Candidate detection functions for SE_secas92. The first one listed was selected for the density model.

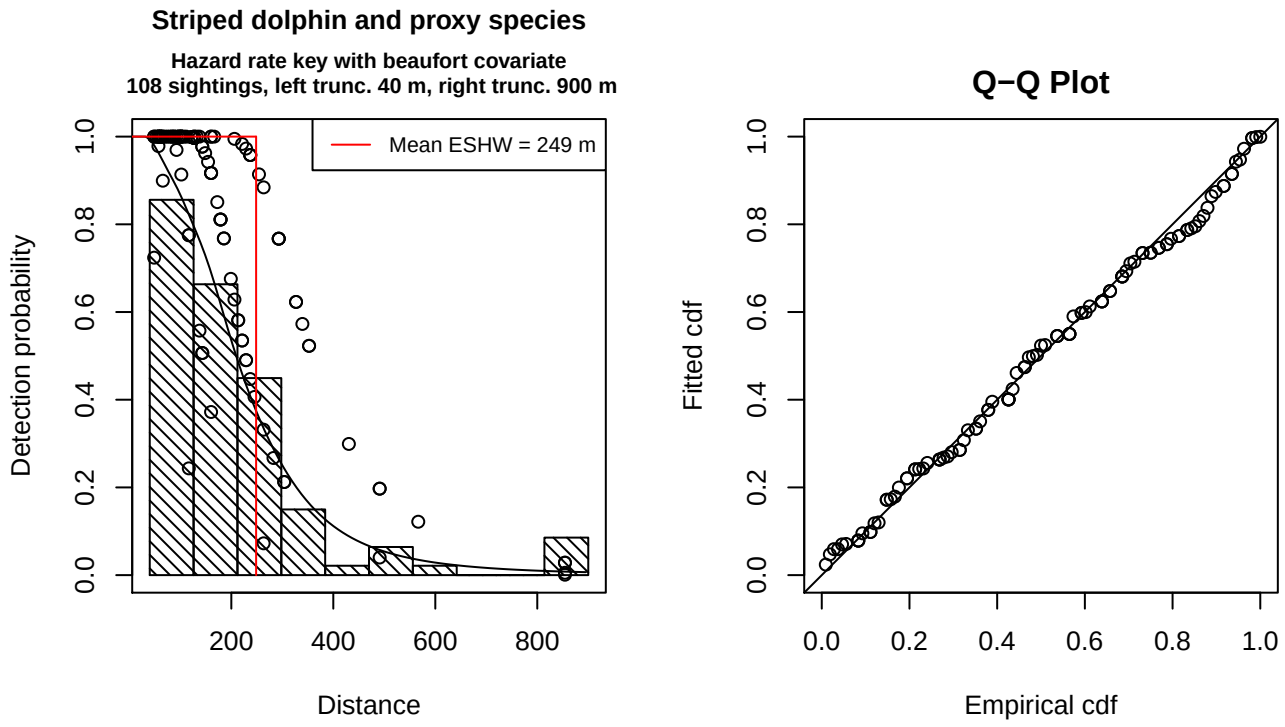


Figure 41: Detection function for SE_secas92 that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  108
Distance range         :  40  -  900
AIC                    :  1288.381

Detection function:
 Hazard-rate key function
```

```
Detection function parameters
Scale Coefficients:
             estimate         se
(Intercept)  5.7829497 0.12346060
beaufort    -0.4573296 0.09973202

Shape parameters:
            estimate        se
(Intercept) 1.299333 0.1172672

                       Estimate          SE        CV
Average p              0.2208124  0.03796305 0.1719244
N in covered region 489.1028683 94.44375144 0.1930959
```

Additional diagnostic plots:

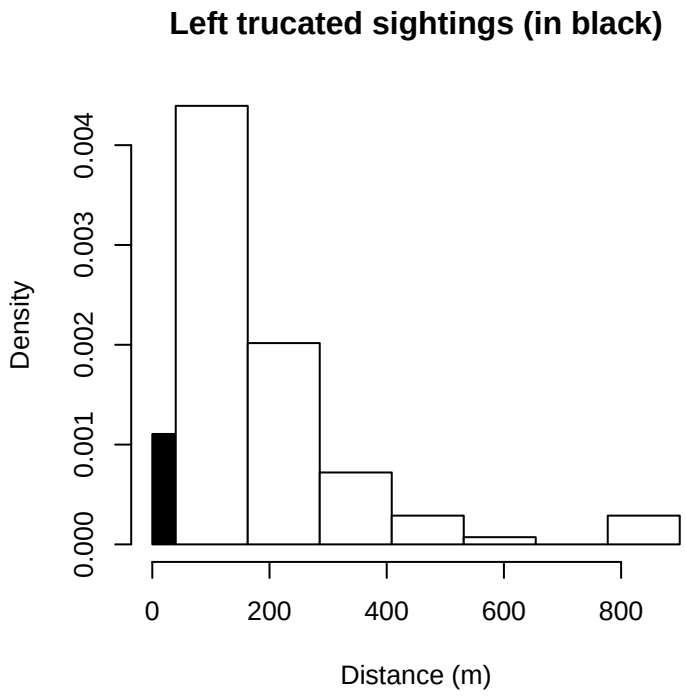


Figure 42: Density of sightings by perpendicular distance for SE_secas92. Black bars on the left show sightings that were left truncated.

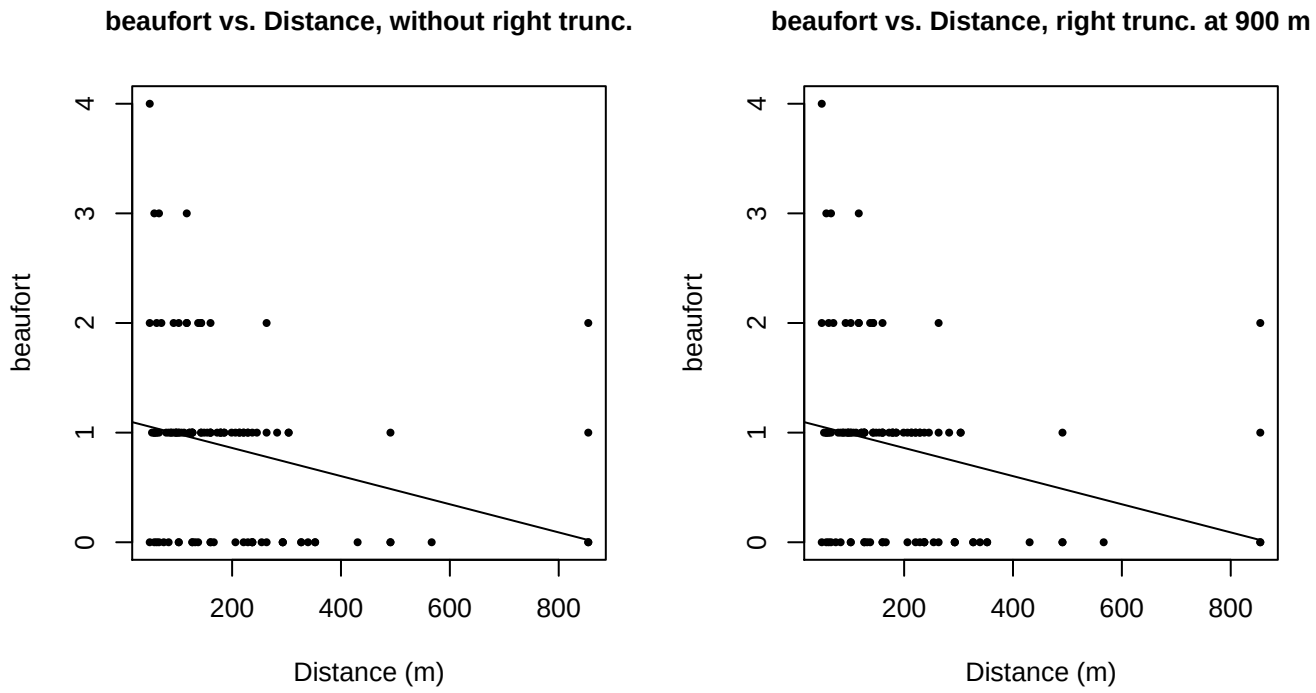


Figure 43: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

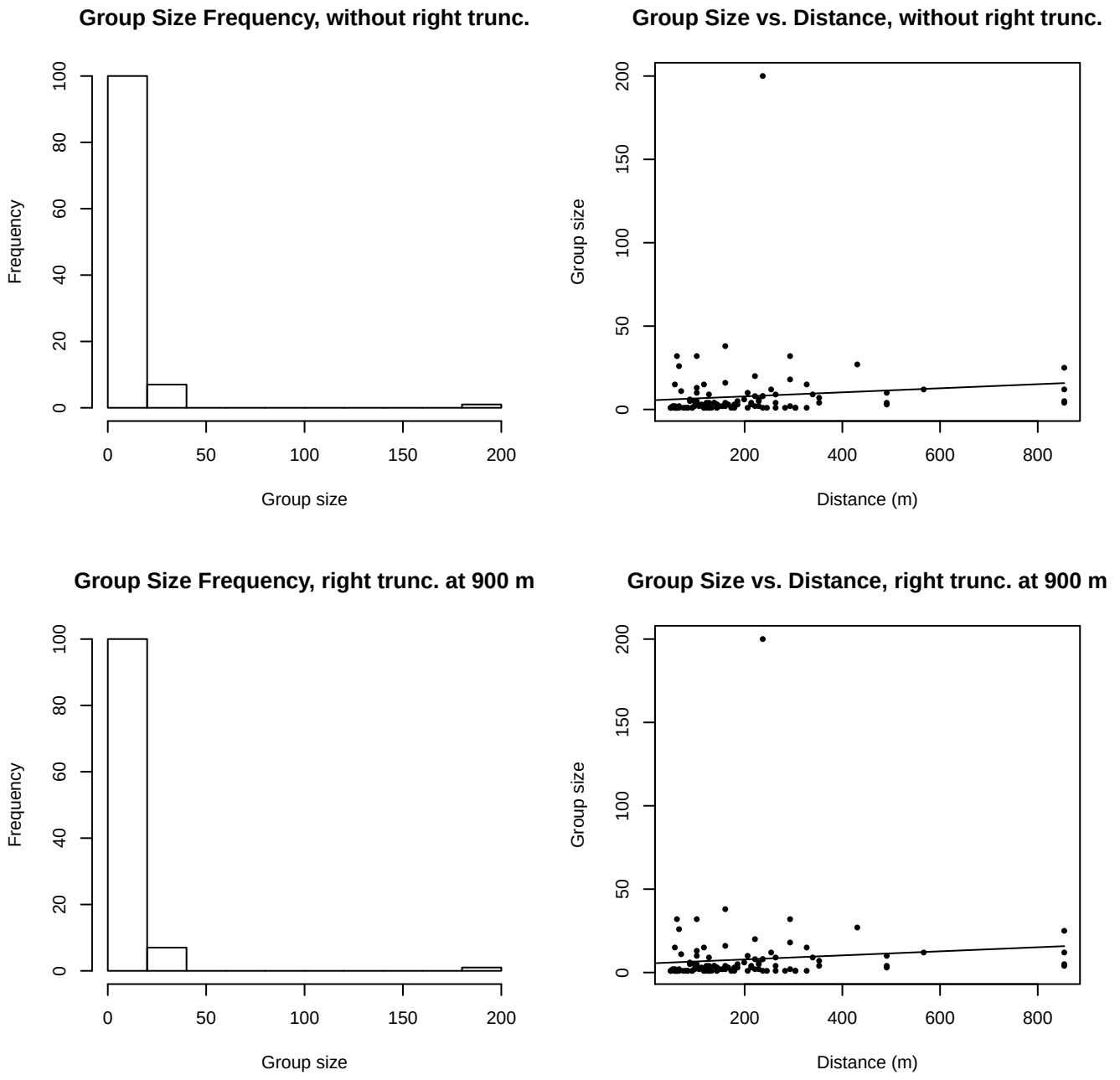


Figure 44: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

SE_secas95

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	2
Stenella attenuata	Pantropical spotted dolphin	0
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	0
Stenella coeruleoalba	Striped dolphin	1
Stenella frontalis	Atlantic spotted dolphin	10
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	113
Total		126

Table 32: Proxy species used to fit detection functions for SE_secas95. The number of sightings, n, is before truncation.

The sightings were right truncated at 900m. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr			quality	Yes	0.00	361
hr				Yes	1.17	370
hr	poly	2		Yes	3.17	370

hr	poly	4		Yes	3.17	370
hn			quality	Yes	3.44	351
hn				Yes	4.36	352
hn	cos	3		Yes	5.36	390
hn			beaufort, quality	Yes	5.41	351
hn	cos	2		Yes	5.97	333
hn	herm	4		Yes	6.17	351
hn			beaufort	Yes	6.35	352
hr			beaufort	No		
hn			size	No		
hr			size	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 34: Candidate detection functions for SE_secas95. The first one listed was selected for the density model.

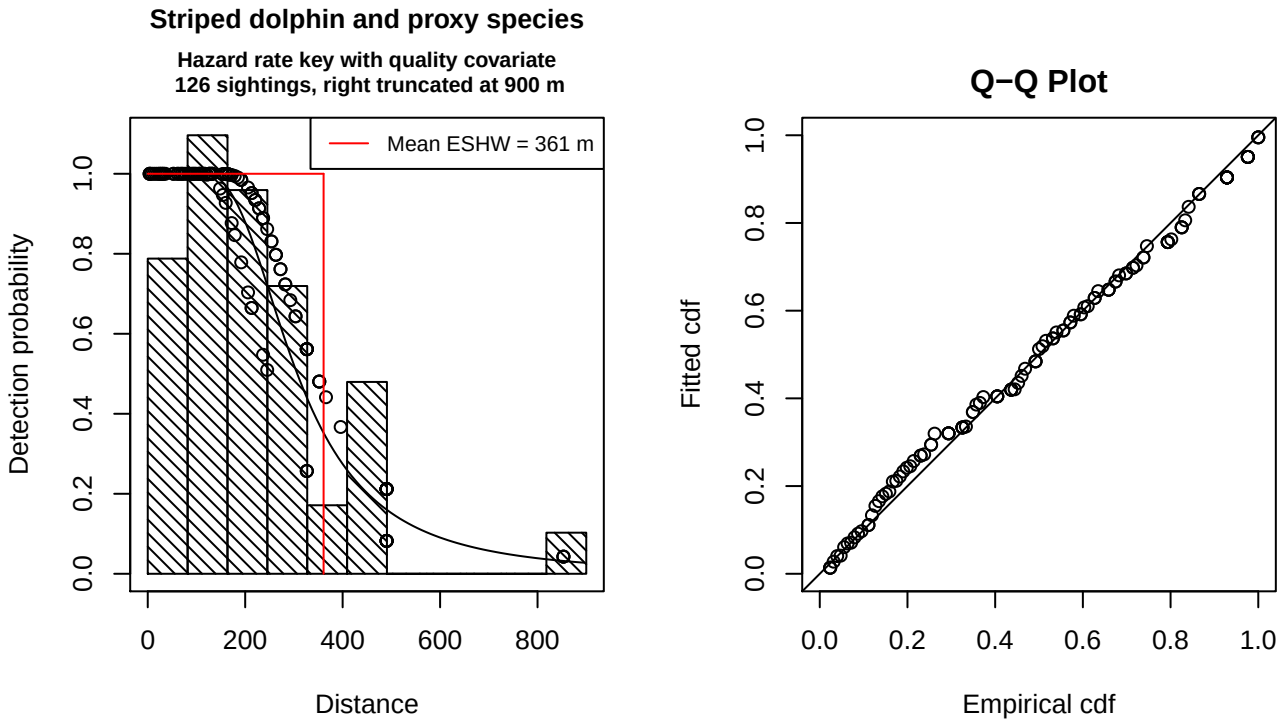


Figure 45: Detection function for SE_secas95 that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  126
Distance range         :  0  -  900
AIC                    :  1599.263

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
               estimate         se
(Intercept)  5.72521560 0.13241064
quality     -0.06684612 0.03458459

Shape parameters:
            estimate        se
(Intercept) 1.116802 0.1798011

                        Estimate          SE         CV
Average p              0.3924197  0.03385989 0.08628489
N in covered region 321.0848094 35.66094937 0.11106396
```

Additional diagnostic plots:

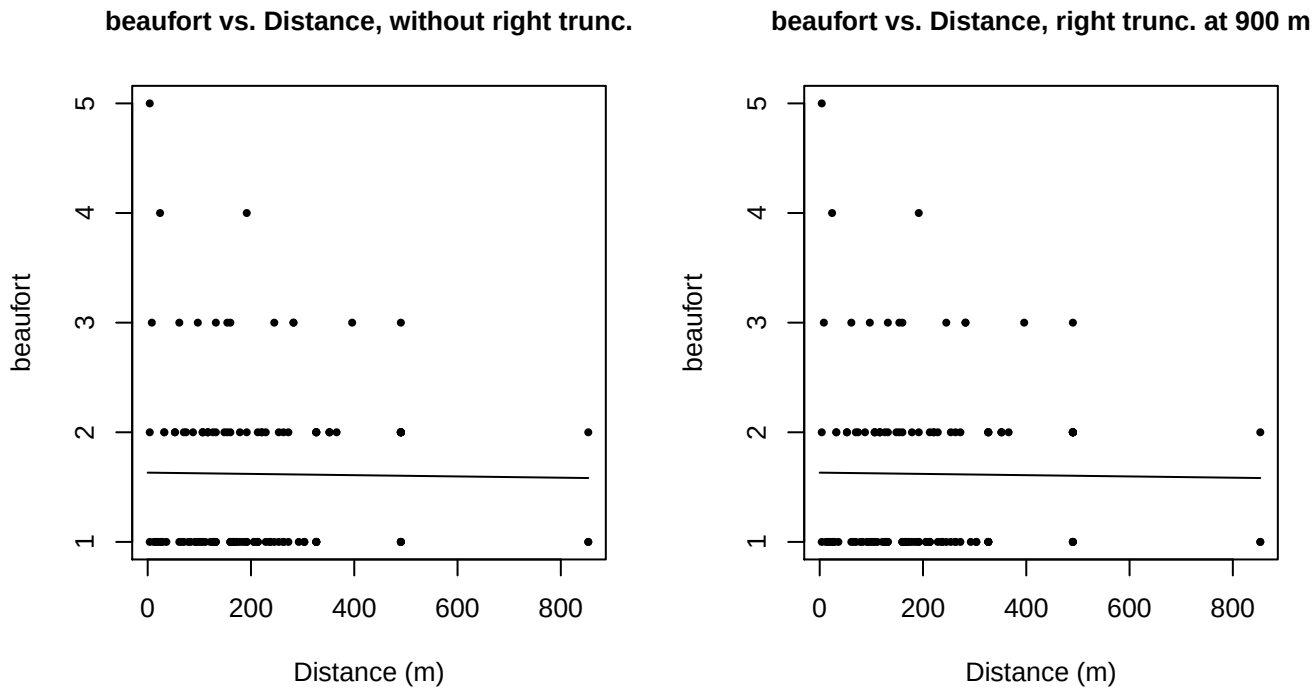


Figure 46: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

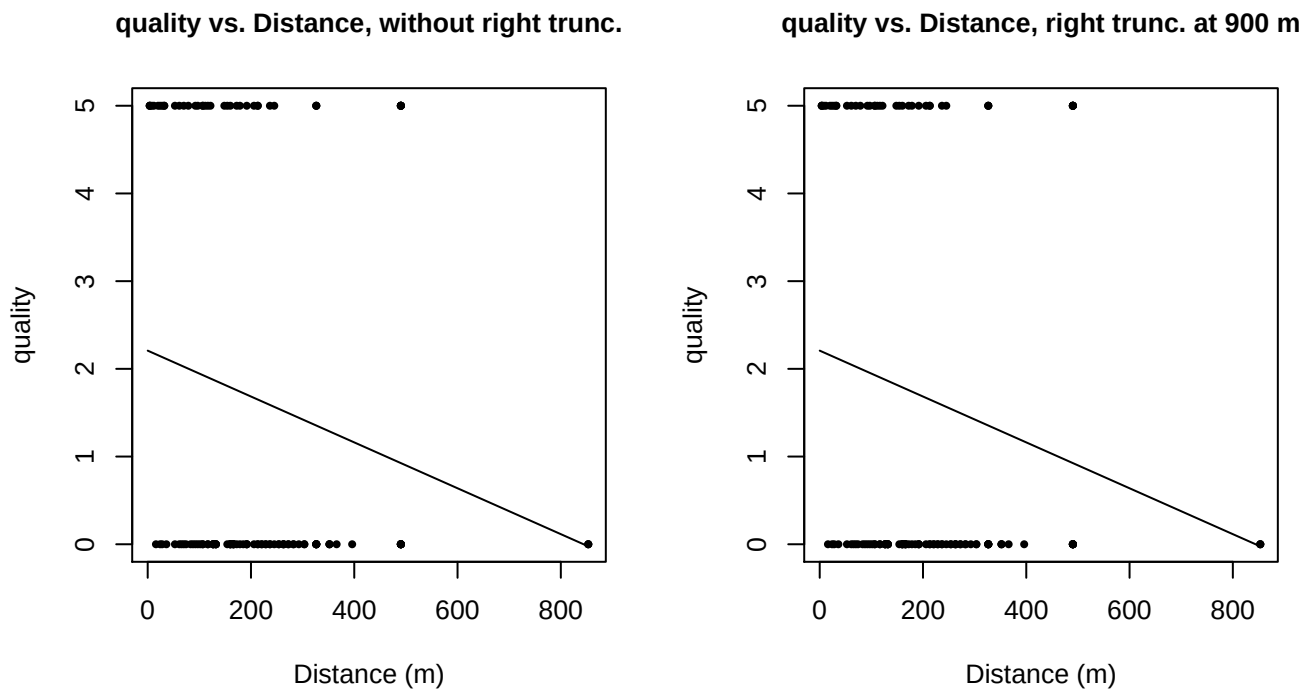


Figure 47: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

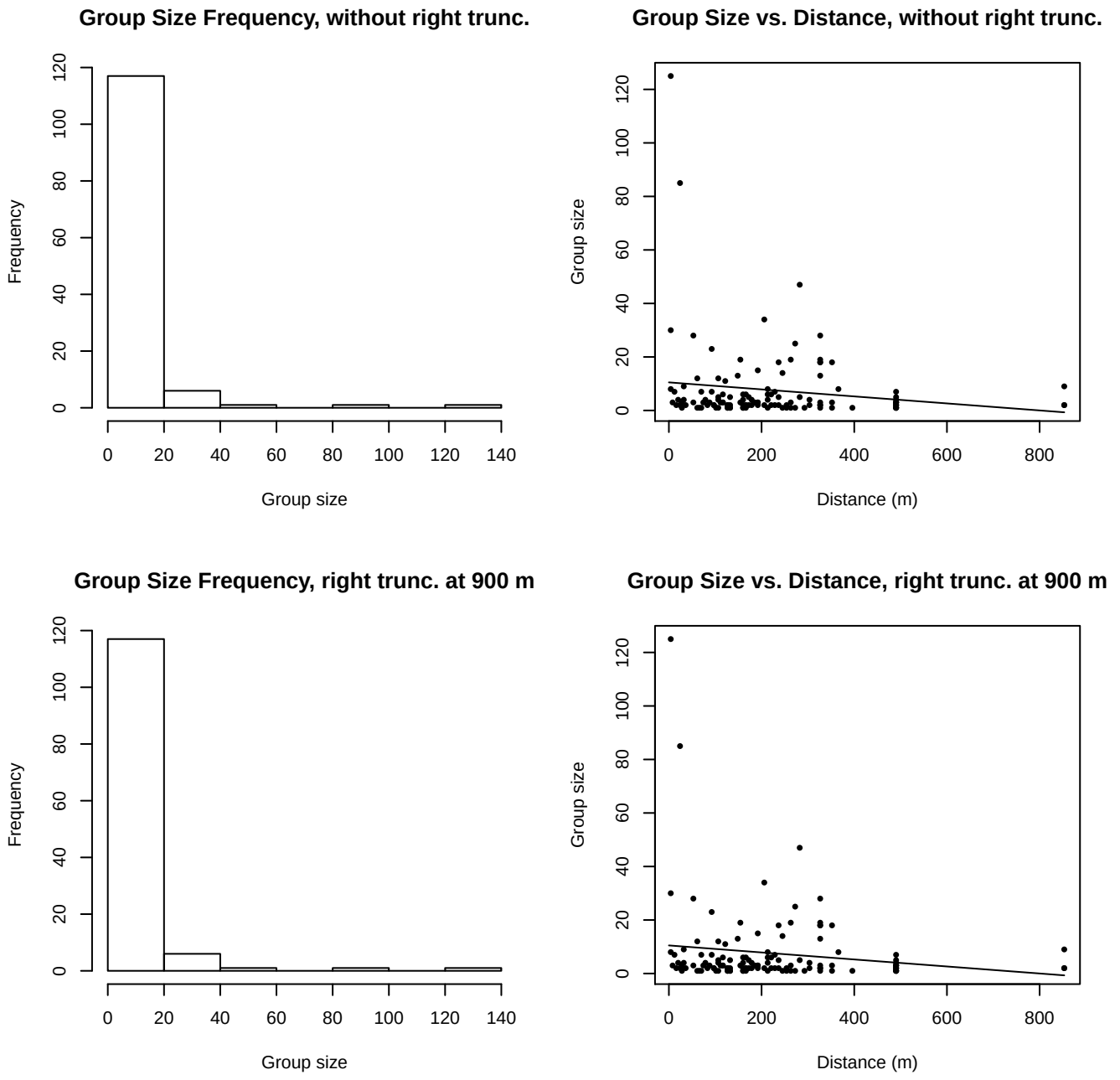


Figure 48: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Mid Atlantic Tursiops Survey 1995

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	3
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	116
Total		119

Table 35: Proxy species used to fit detection functions for Mid Atlantic Tursiops Survey 1995. The number of sightings, n, is before truncation.

The sightings were right truncated at 1296m. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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 36: 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	416
hr			quality	Yes	1.20	425
hr			size	Yes	1.63	420

hr	poly	4		Yes	2.00	416
hr	poly	2		Yes	2.00	416
hr			quality, size	Yes	3.04	426
hn	cos	2		Yes	3.19	334
hn				Yes	6.62	397
hn			quality	Yes	7.34	397
hn			size	Yes	7.67	397
hn	cos	3		Yes	8.38	376
hn	herm	4		Yes	8.59	397
hn			quality, size	Yes	8.74	397
hr			beaufort	No		
hn			beaufort	No		
hr			beaufort, quality	No		
hn			beaufort, quality	No		
hr			beaufort, size	No		
hn			beaufort, size	No		
hr			beaufort, quality, size	No		
hn			beaufort, quality, size	No		

Table 37: Candidate detection functions for Mid Atlantic Tursiops Survey 1995. The first one listed was selected for the density model.

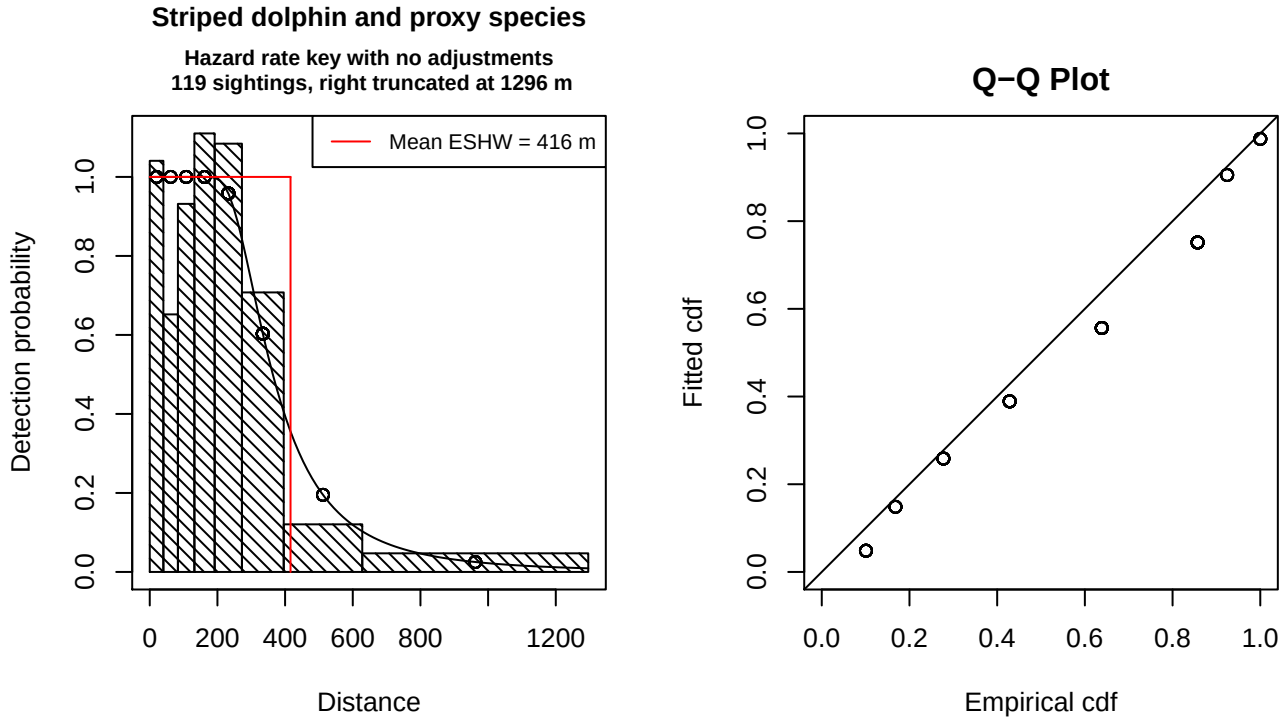


Figure 49: Detection function for Mid Atlantic Tursiops Survey 1995 that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  119
Distance range         :  0  -  1296
AIC                    :  481.8113

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
            estimate       se
(Intercept) 5.788509 0.117856

Shape parameters:
            estimate        se
(Intercept)  1.22245 0.1594061

                     Estimate          SE        CV
Average p             0.32101  0.02785003 0.0867575
N in covered region 370.70494 42.64341671 0.1150333
```

Additional diagnostic plots:

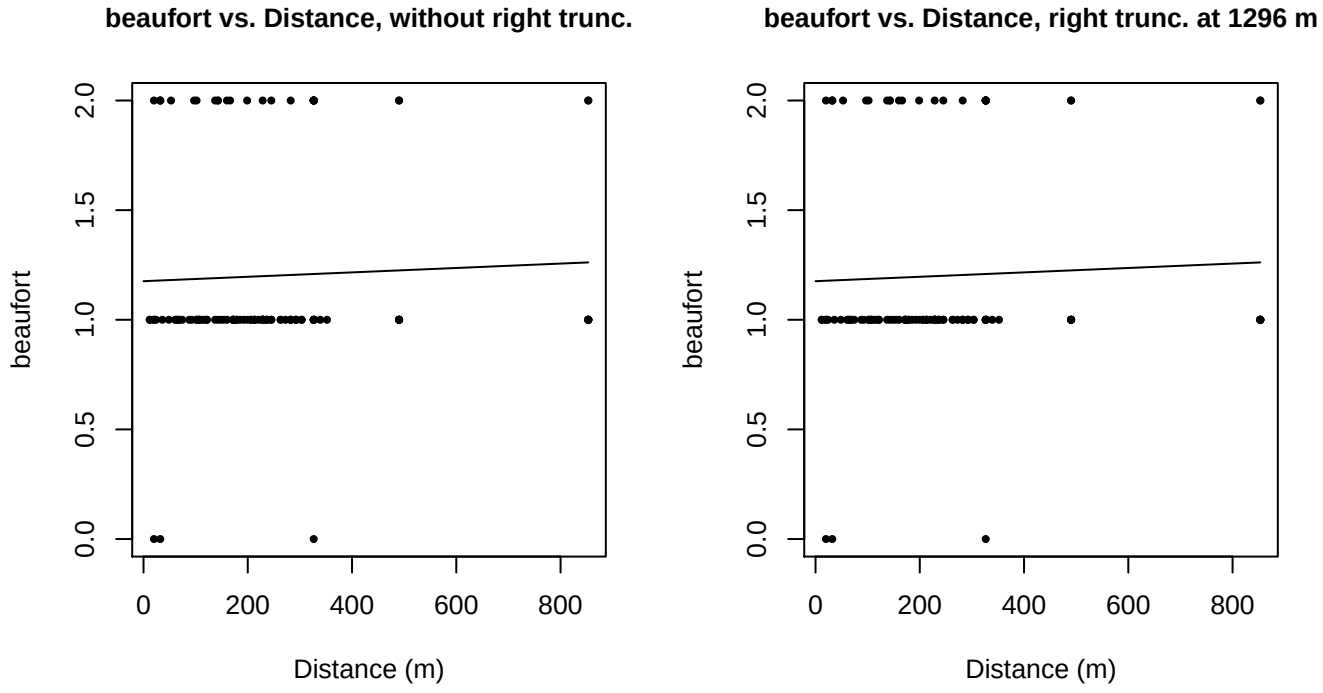


Figure 50: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

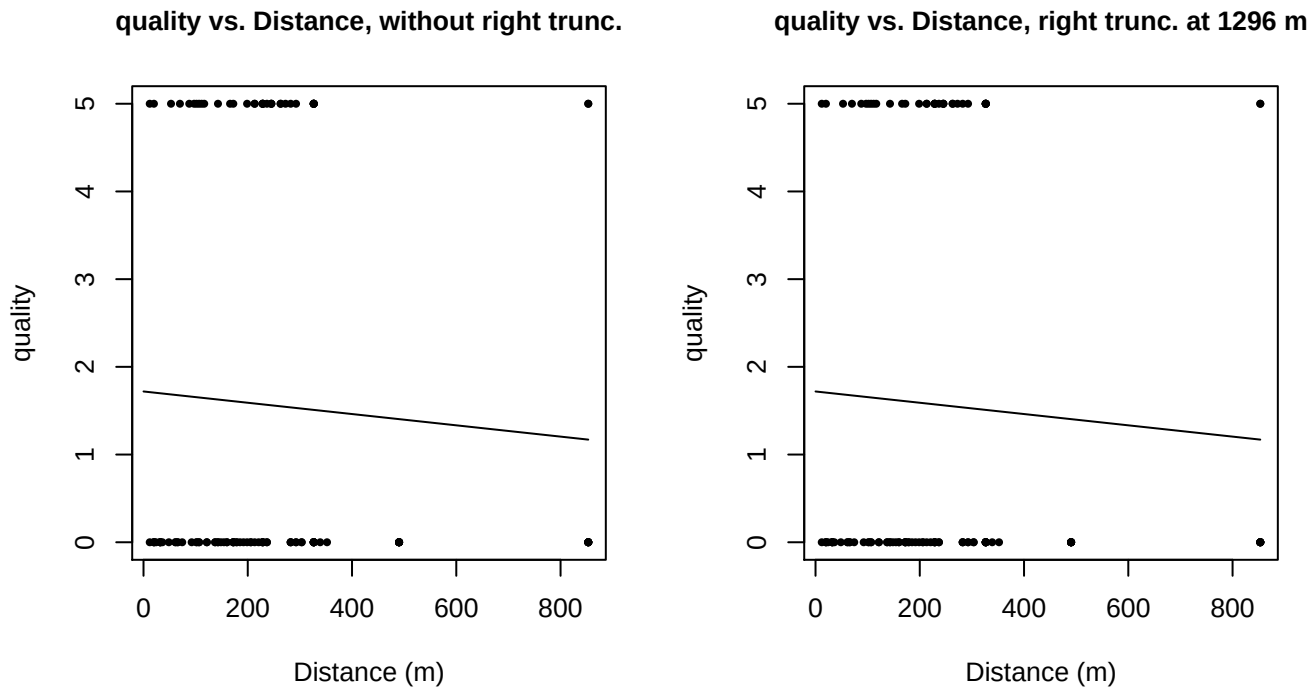


Figure 51: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

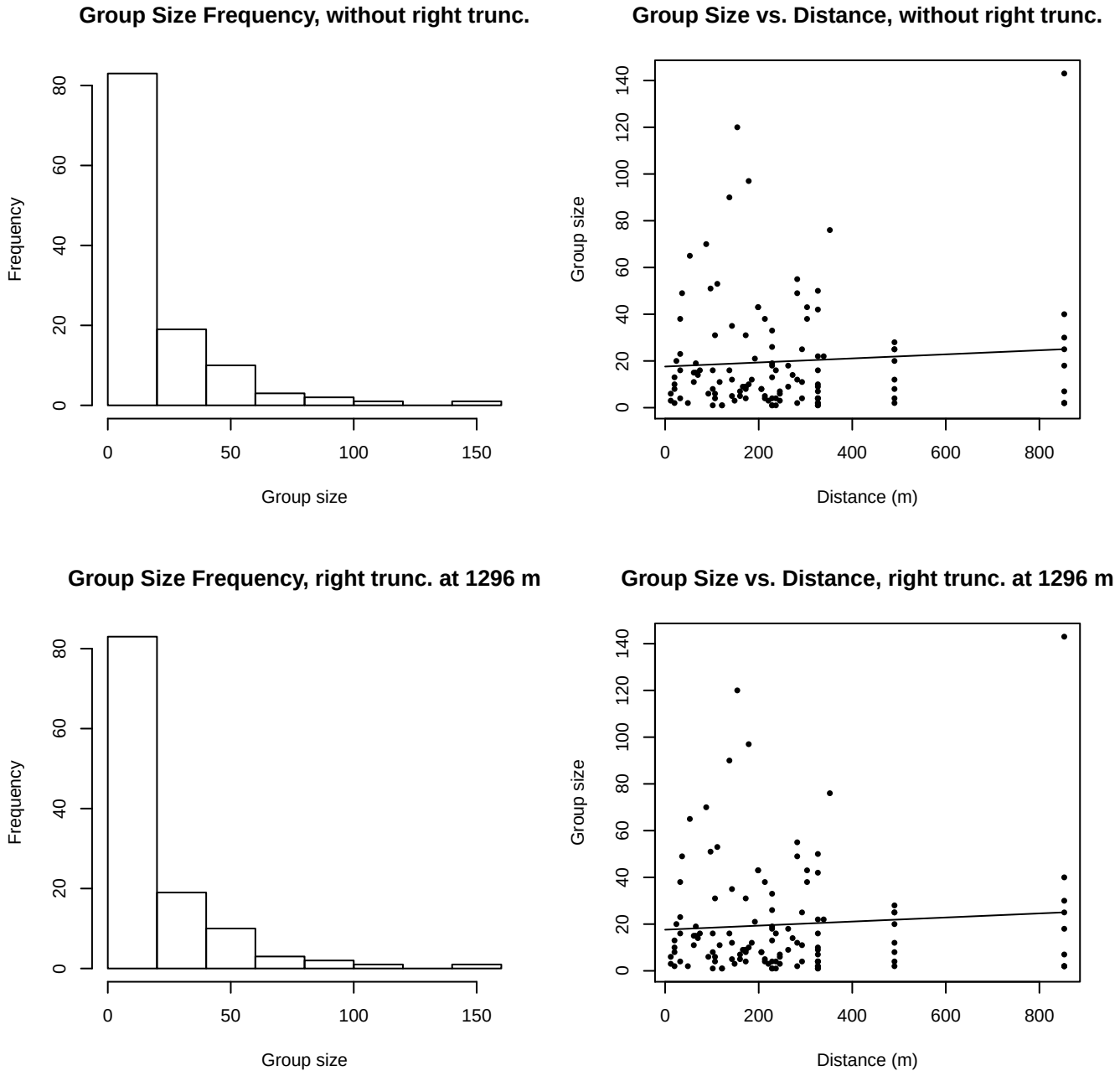


Figure 52: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

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 38: 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. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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 39: 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 40: Candidate detection functions for GulfCet Aerial Surveys. The first one listed was selected for the density model.

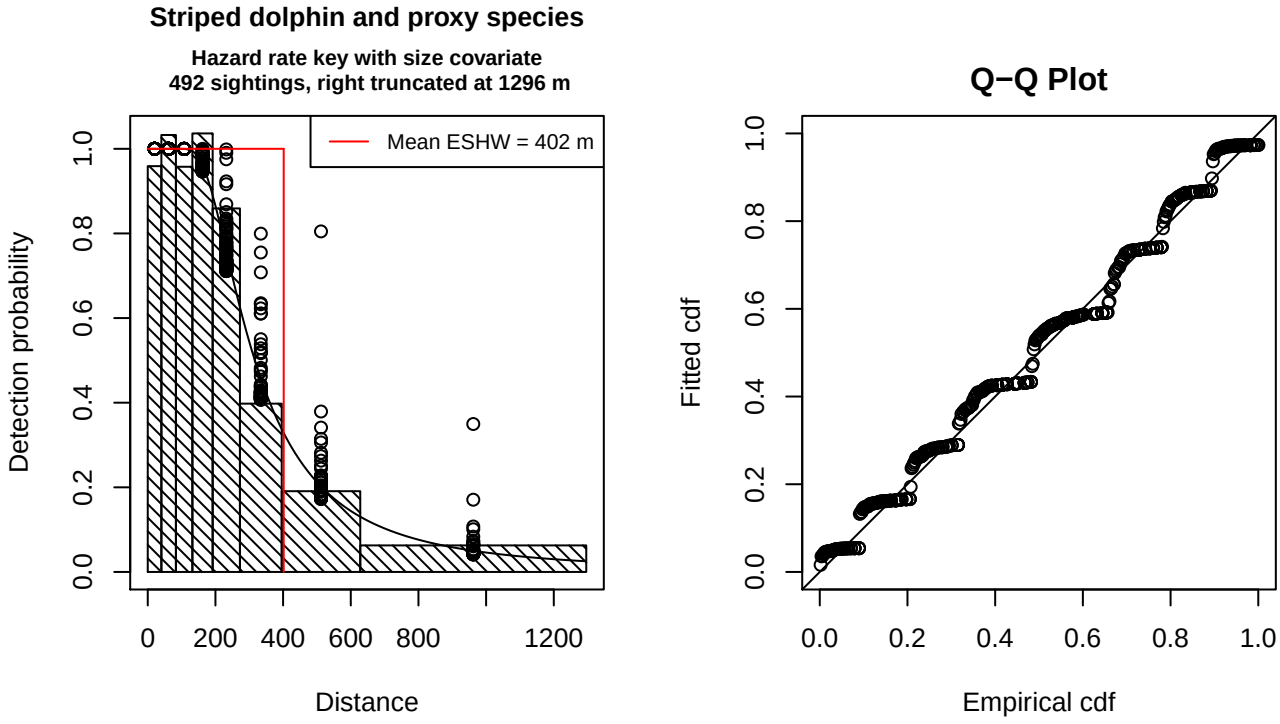


Figure 53: Detection function for GulfCet Aerial Surveys that was selected for the density model

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:

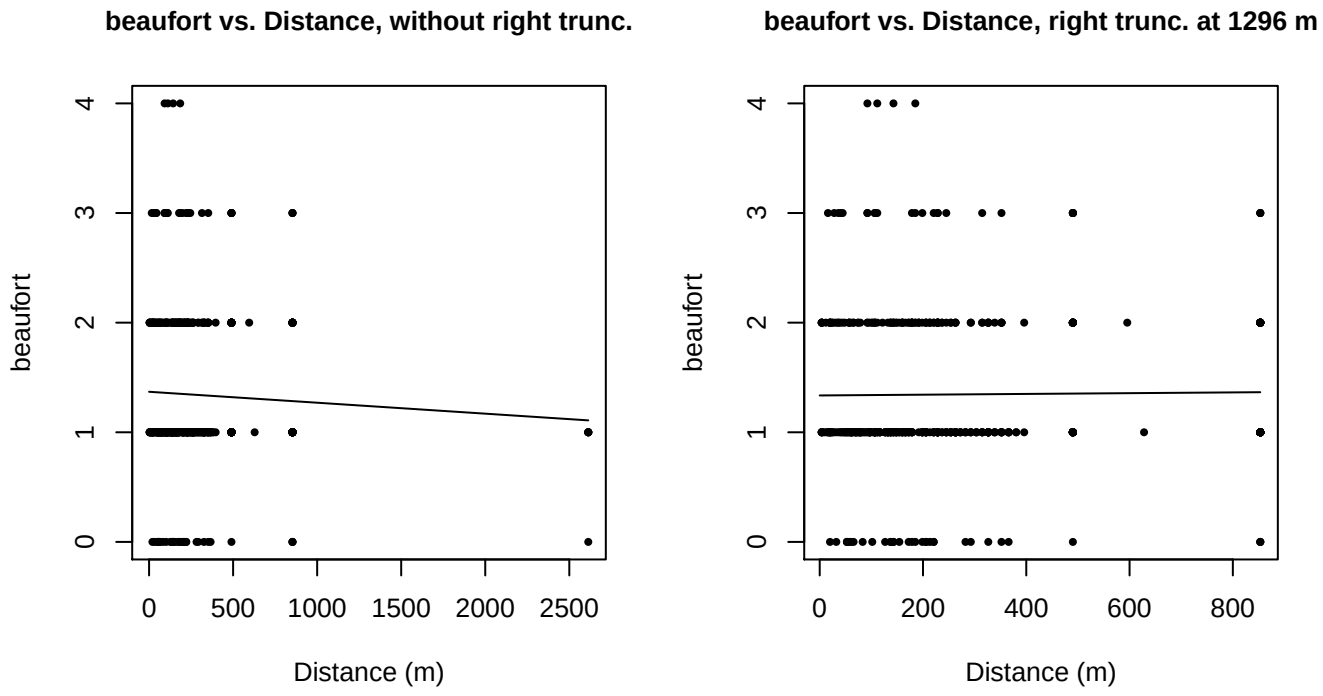


Figure 54: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

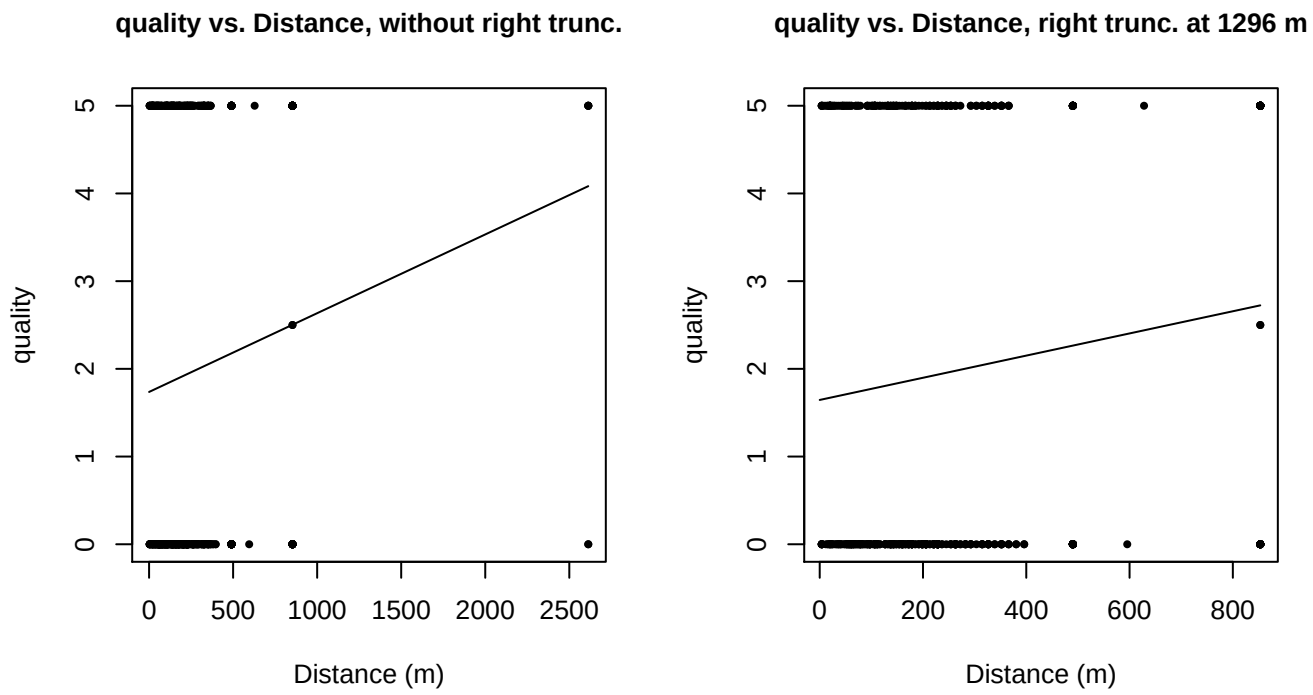


Figure 55: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

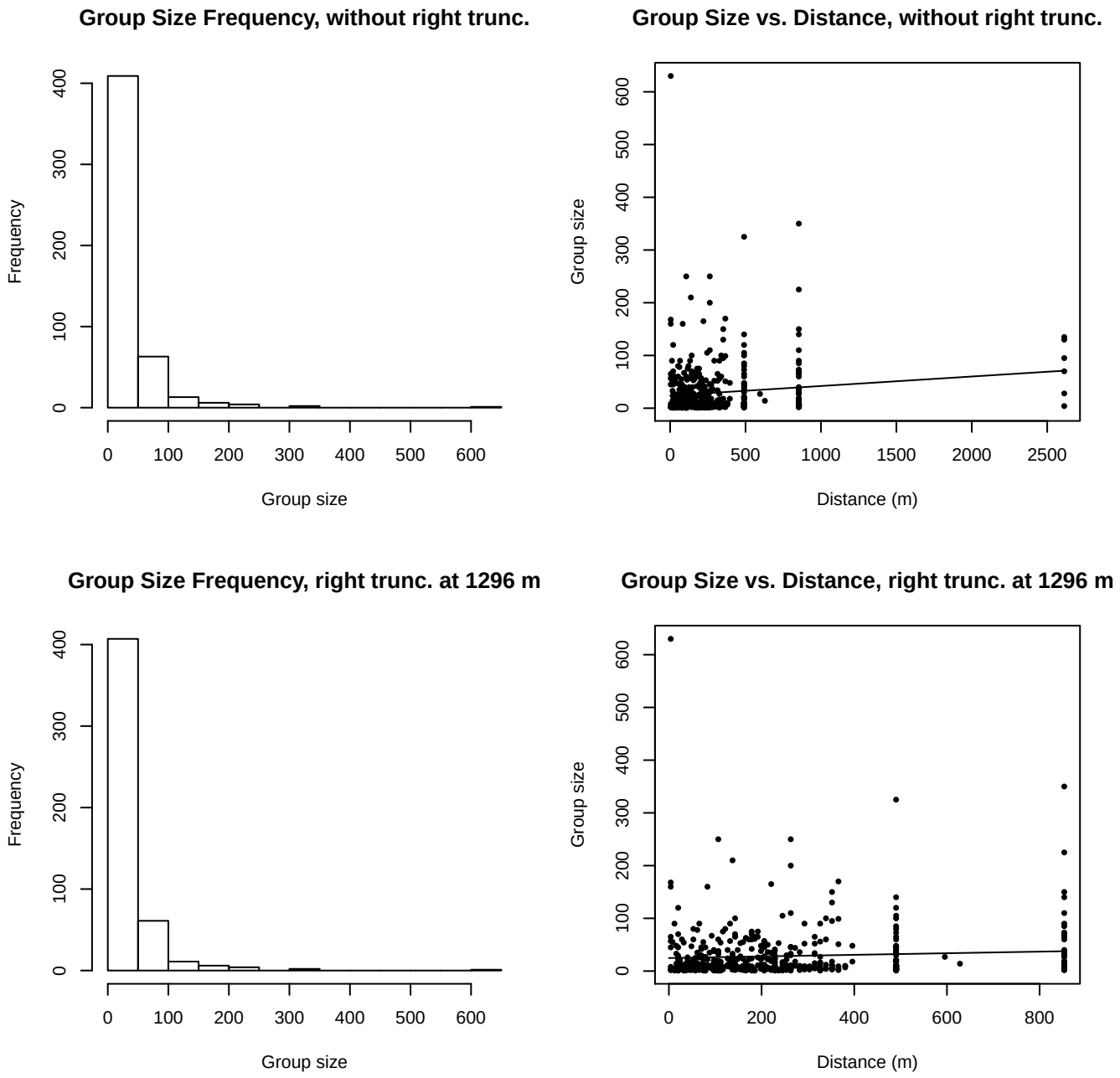


Figure 56: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

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 41: 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. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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 42: 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 43: Candidate detection functions for GOMEX92-96 Aerial Survey. The first one listed was selected for the density model.

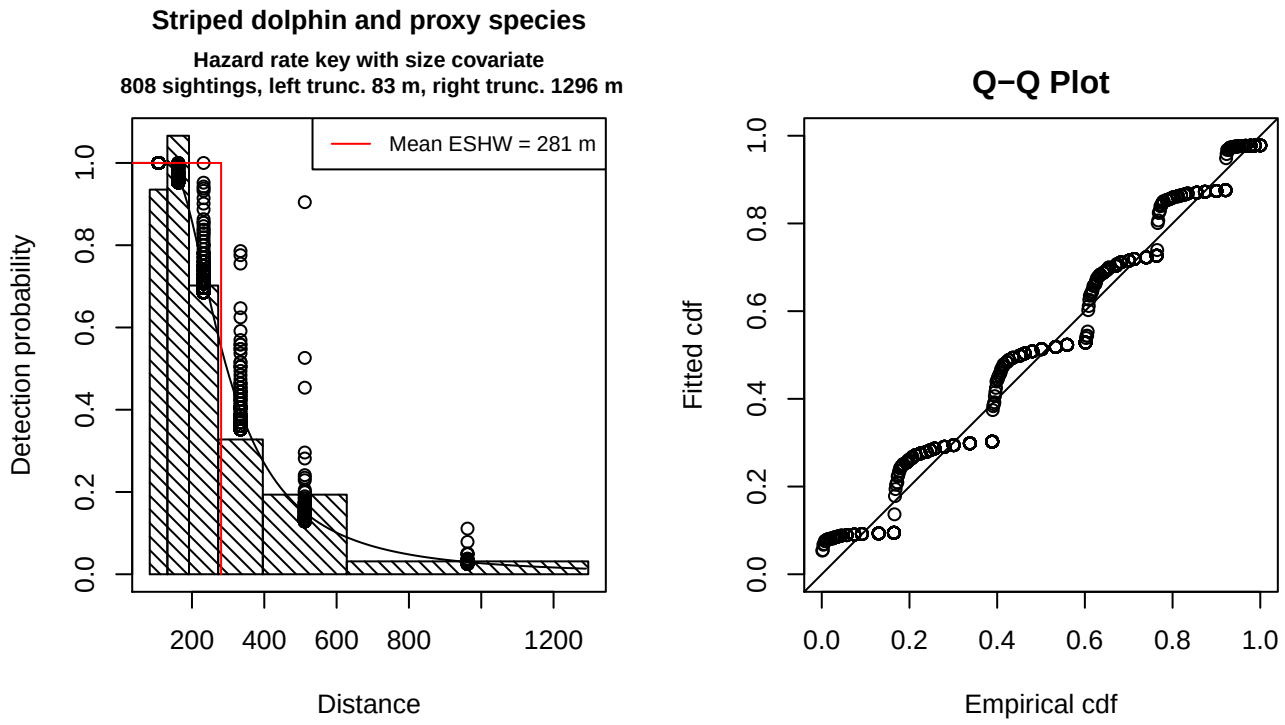


Figure 57: Detection function for GOMEX92-96 Aerial Survey that was selected for the density model

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:

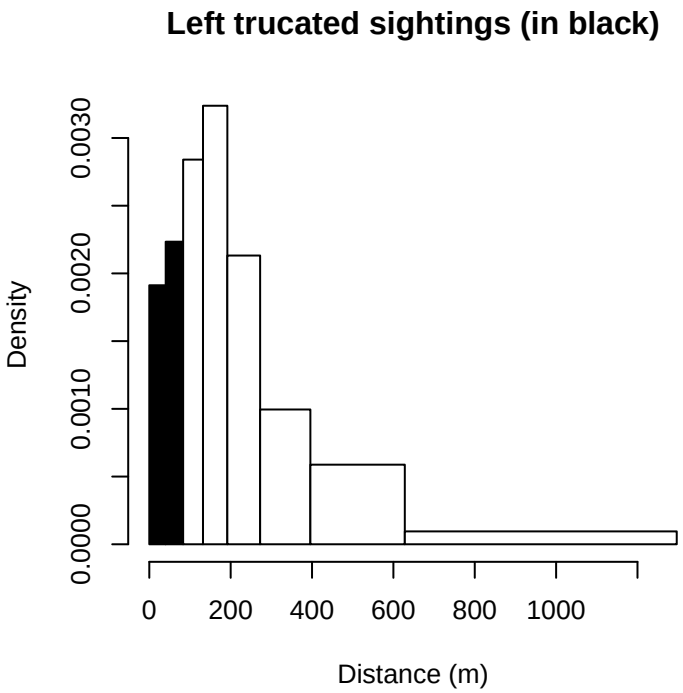


Figure 58: Density of sightings by perpendicular distance for GOMEX92-96 Aerial Survey. Black bars on the left show sightings that were left truncated.

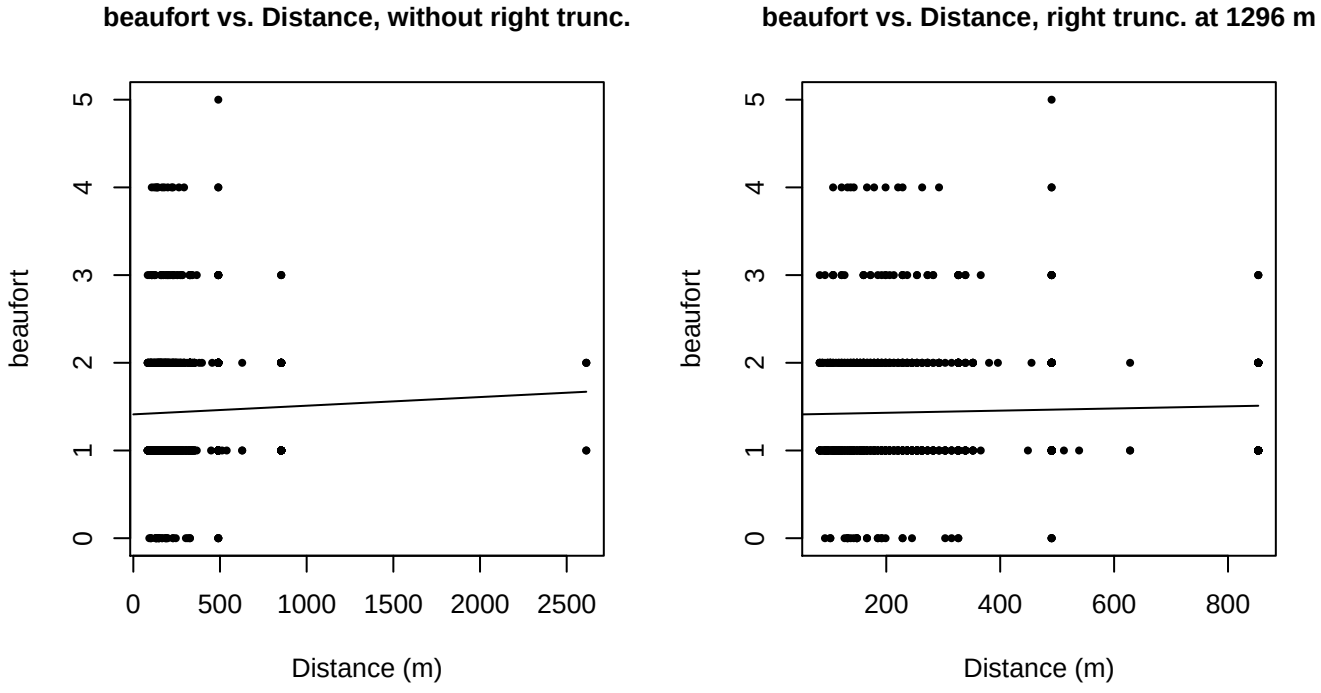


Figure 59: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

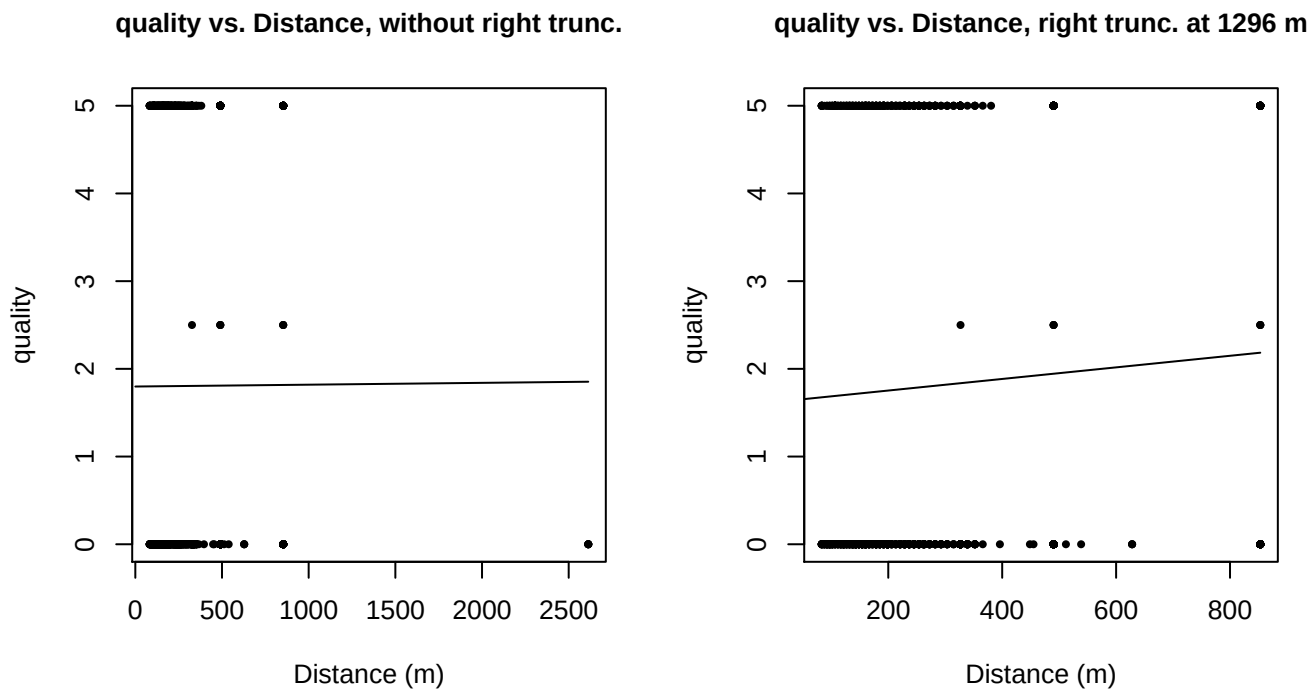


Figure 60: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

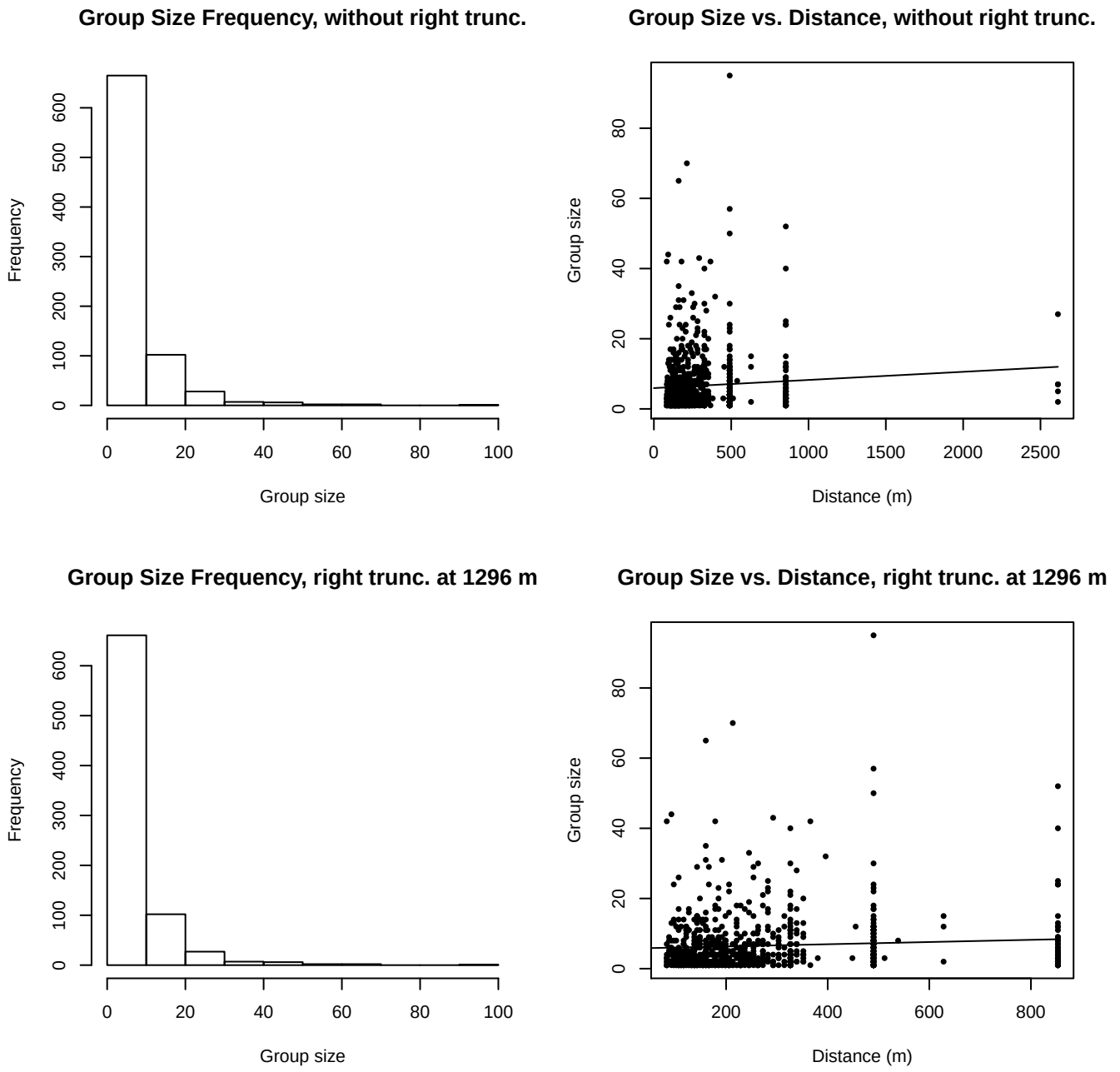


Figure 61: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

UNCW Navy 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	13

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	56
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	1
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	1
Stenella attenuata/frontalis	Pantropical or Atlantic spotted dolphin	0
Stenella clymene	Clymene dolphin	3
Stenella coeruleoalba	Striped dolphin	3
Stenella frontalis	Atlantic spotted dolphin	341
Stenella frontalis/Tursiops truncatus	Atlantic spotted or Bottlenose dolphin	0
Stenella longirostris	Spinner dolphin	1
Steno bredanensis	Rough-toothed dolphin	9
Steno bredanensis/Tursiops truncatus	Bottlenose or rough-toothed dolphin	0
Tursiops truncatus	Bottlenose dolphin	567
Total		996

Table 44: Proxy species used to fit detection functions for UNCW Navy Surveys. The number of sightings, n, is before truncation.

The sightings were right truncated at 1500m.

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

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hn			size	Yes	0.00	754
hn			quality, size	Yes	0.22	754
hn			beaufort, size	Yes	1.76	754
hn			beaufort, quality, size	Yes	1.86	755

hn	herm	4		Yes	4.03	787
hn	cos	2		Yes	6.16	795
hn				Yes	6.29	753
hn			quality	Yes	7.23	753
hr	poly	2		Yes	7.54	825
hn	cos	3		Yes	8.04	736
hn			beaufort	Yes	8.24	753
hn			beaufort, quality	Yes	9.14	753
hr	poly	4		Yes	9.77	841
hr			size	Yes	10.22	901
hr			quality, size	Yes	10.94	900
hr			beaufort, size	Yes	12.22	901
hr			beaufort, quality, size	Yes	12.93	900
hr				Yes	16.65	887
hr			quality	Yes	17.70	886
hr			beaufort	No		
hr			beaufort, quality	No		

Table 46: Candidate detection functions for UNCW Navy Surveys. The first one listed was selected for the density model.

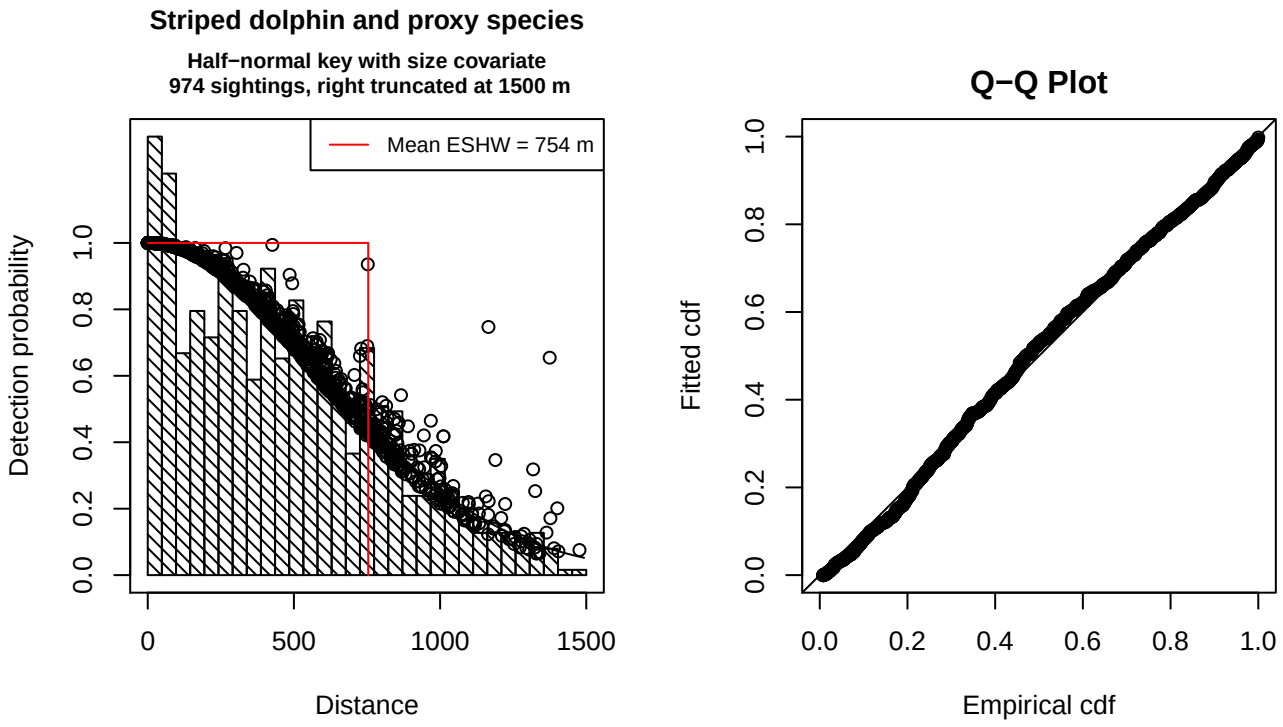


Figure 62: Detection function for UNCW Navy Surveys that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  974
Distance range         :  0  -  1500
AIC                    :  13779.06

Detection function:
 Half-normal key function

Detection function parameters
Scale Coefficients:
             estimate         se
(Intercept) 6.3388868 0.04000233
size        0.1172576 0.05082555

                         Estimate          SE         CV
Average p                0.4997021  0.01337788 0.02677171
N in covered region 1949.1611578 68.45627661 0.03512089
```

Additional diagnostic plots:

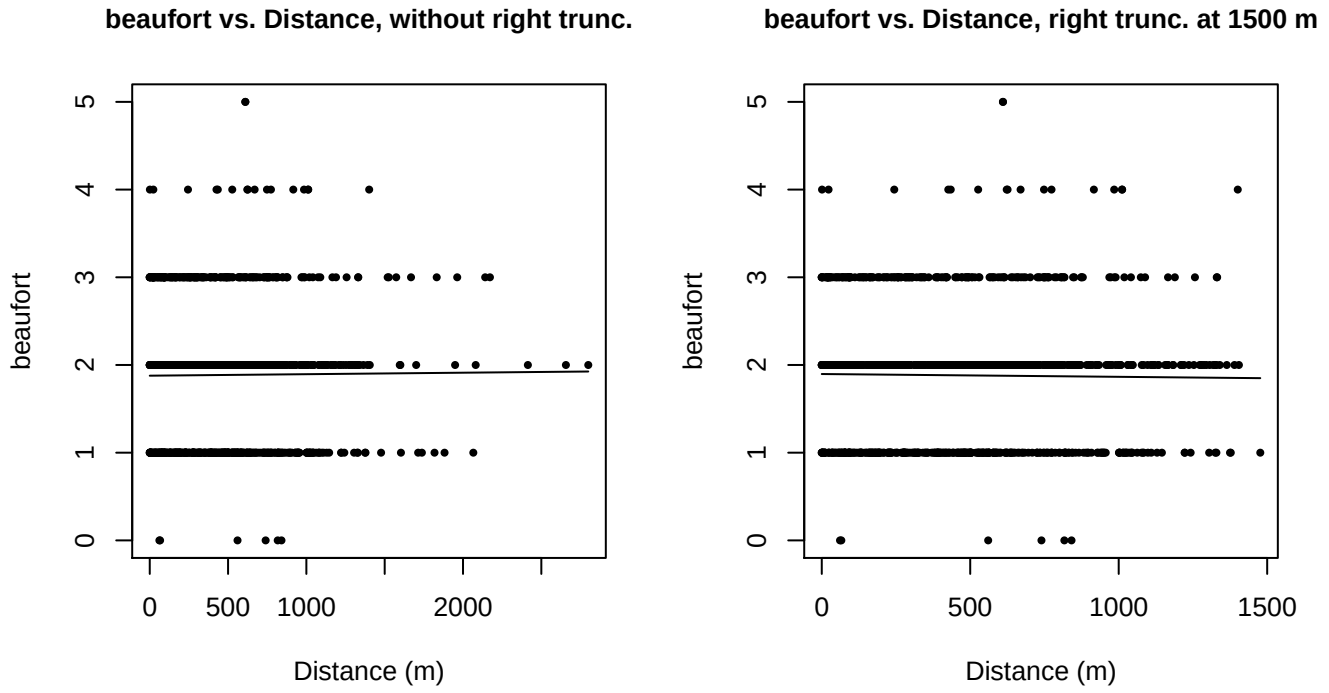


Figure 63: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

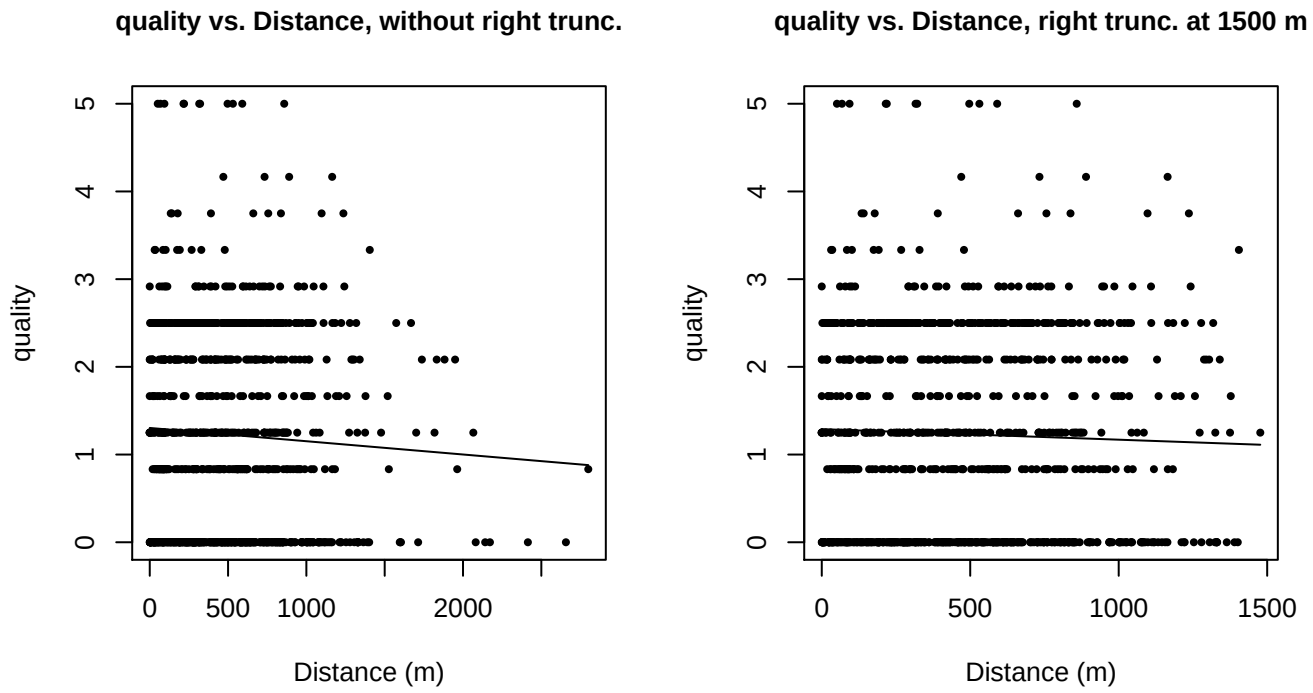


Figure 64: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

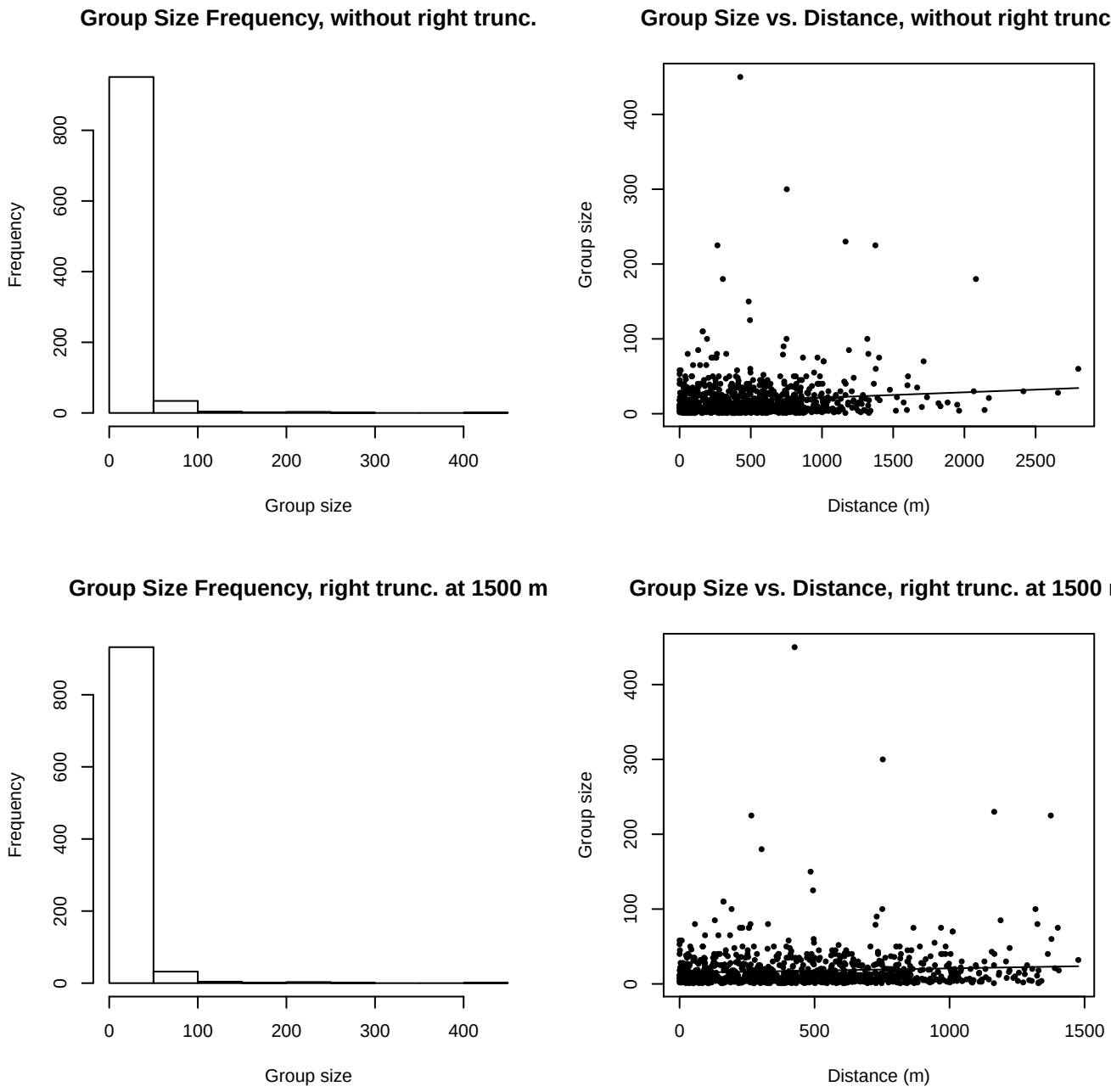


Figure 65: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

UNCW Right Whale 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	26

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	5
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	1855
Total		1886

Table 47: Proxy species used to fit detection functions for UNCW Right Whale Surveys. The number of sightings, n, is before truncation.

The sightings were right truncated at 837m. 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 111 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. The vertical sighting angles were heaped at 10 degree increments, so the candidate detection functions were fitted using linear bins scaled accordingly.

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

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)

hr			beaufort	Yes	0.00	162
hr			beaufort, size	Yes	1.38	162
hr				Yes	2.22	161
hr	poly	2		Yes	4.22	161
hr	poly	4		Yes	4.22	161
hn	cos	2		Yes	62.20	87
hn				Yes	77.91	103
hn	cos	3		Yes	78.05	117
hn	herm	4		Yes	79.70	103
hn			beaufort	No		
hn			quality	No		
hr			quality	No		
hn			size	No		
hr			size	No		
hn			beaufort, quality	No		
hr			beaufort, quality	No		
hn			beaufort, size	No		
hn			quality, size	No		
hr			quality, size	No		
hn			beaufort, quality, size	No		
hr			beaufort, quality, size	No		

Table 49: Candidate detection functions for UNCW Right Whale Surveys. The first one listed was selected for the density model.

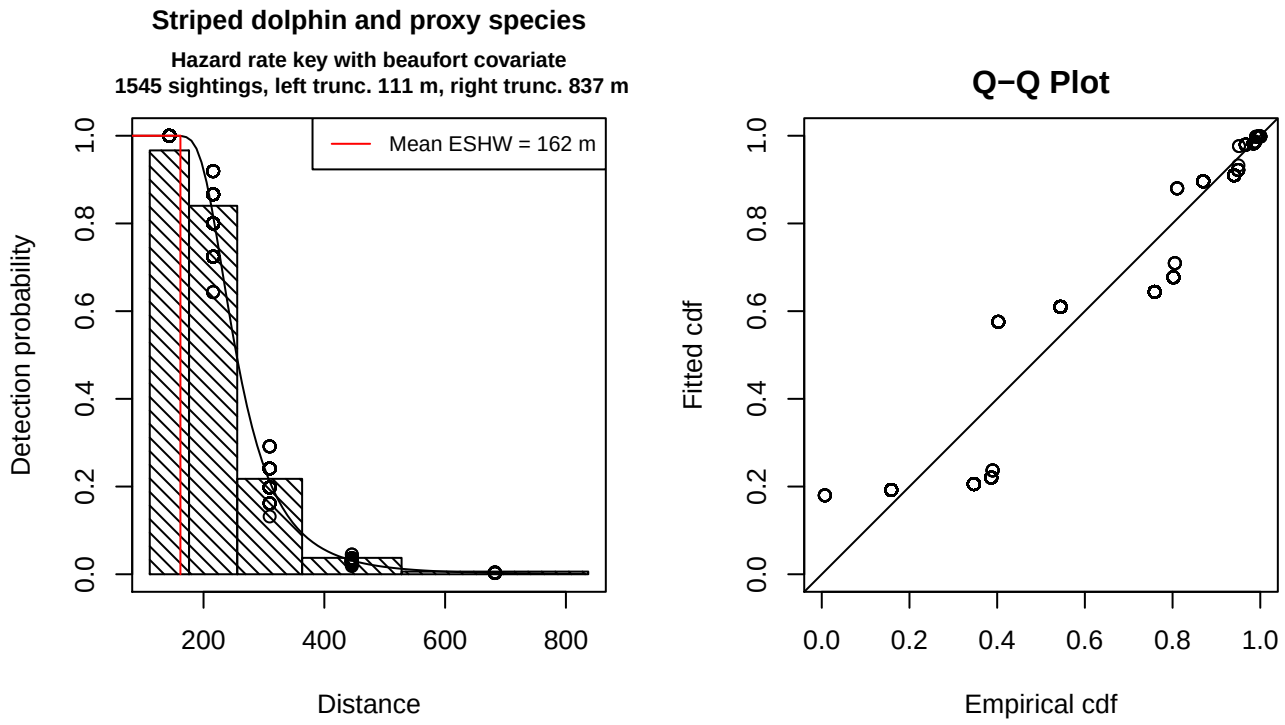


Figure 66: Detection function for UNCW Right Whale Surveys that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  1545
Distance range         :  110.9381  -  837
AIC                    :  3681.827

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
               estimate         se
(Intercept)  5.54196336 0.04042409
beaufort    -0.04042406 0.02041452

Shape parameters:
            estimate         se
(Intercept) 1.707667 0.04319172

                         Estimate           SE         CV
Average p               0.1927444   0.00547895 0.02842598
N in covered region 8015.7956844 292.42037285 0.03648052
```

Additional diagnostic plots:

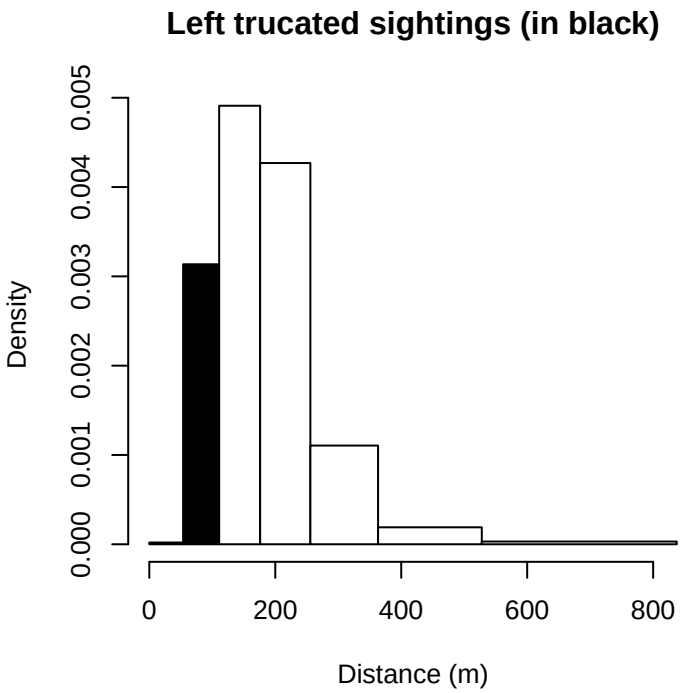


Figure 67: Density of sightings by perpendicular distance for UNCW Right Whale Surveys. Black bars on the left show sightings that were left truncated.

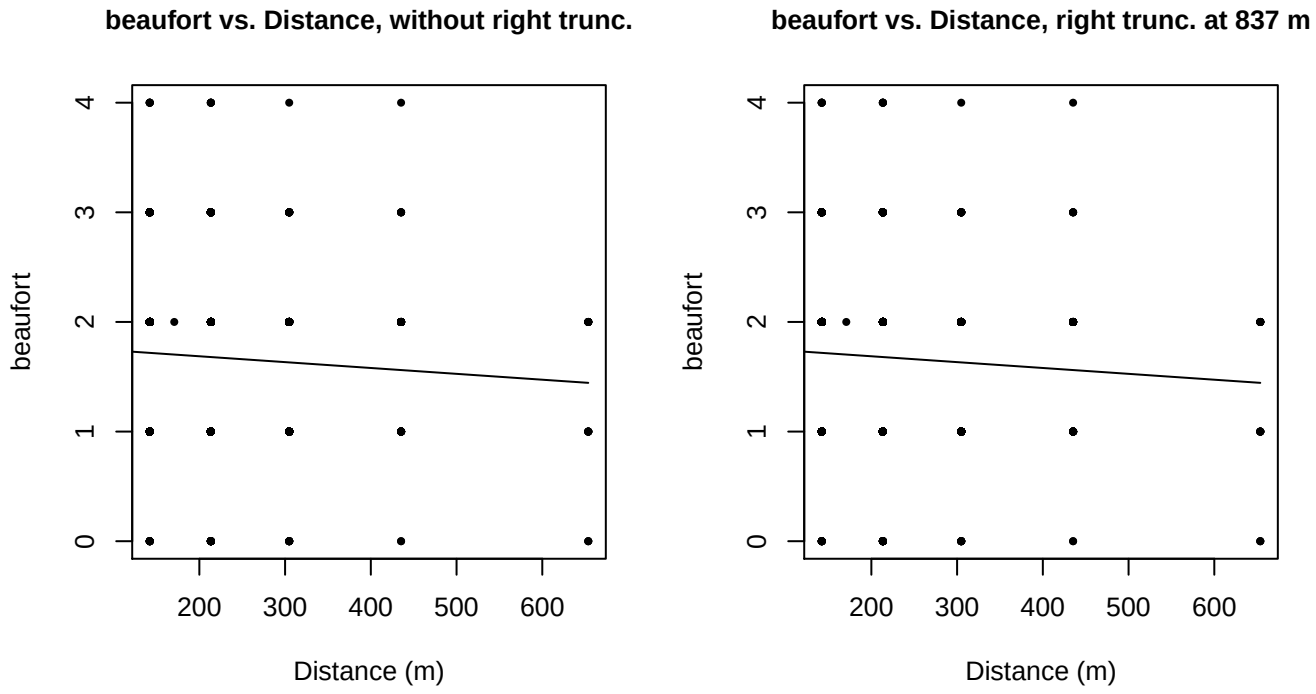


Figure 68: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

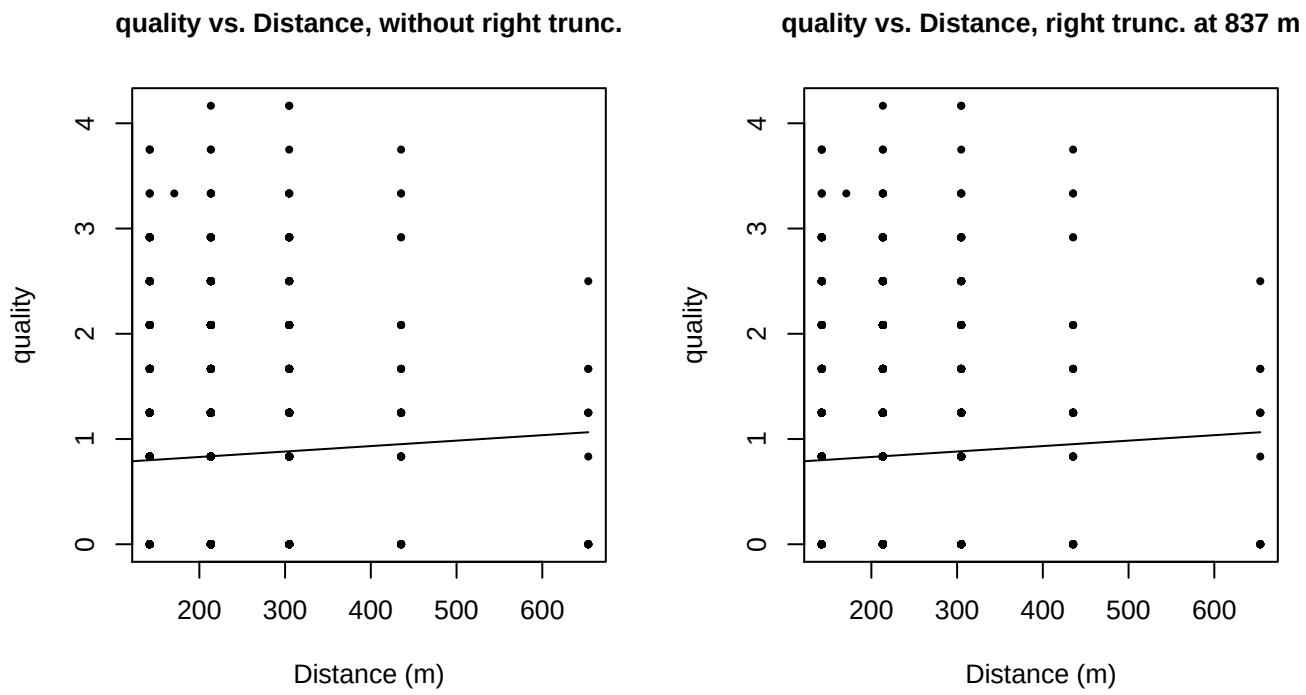


Figure 69: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

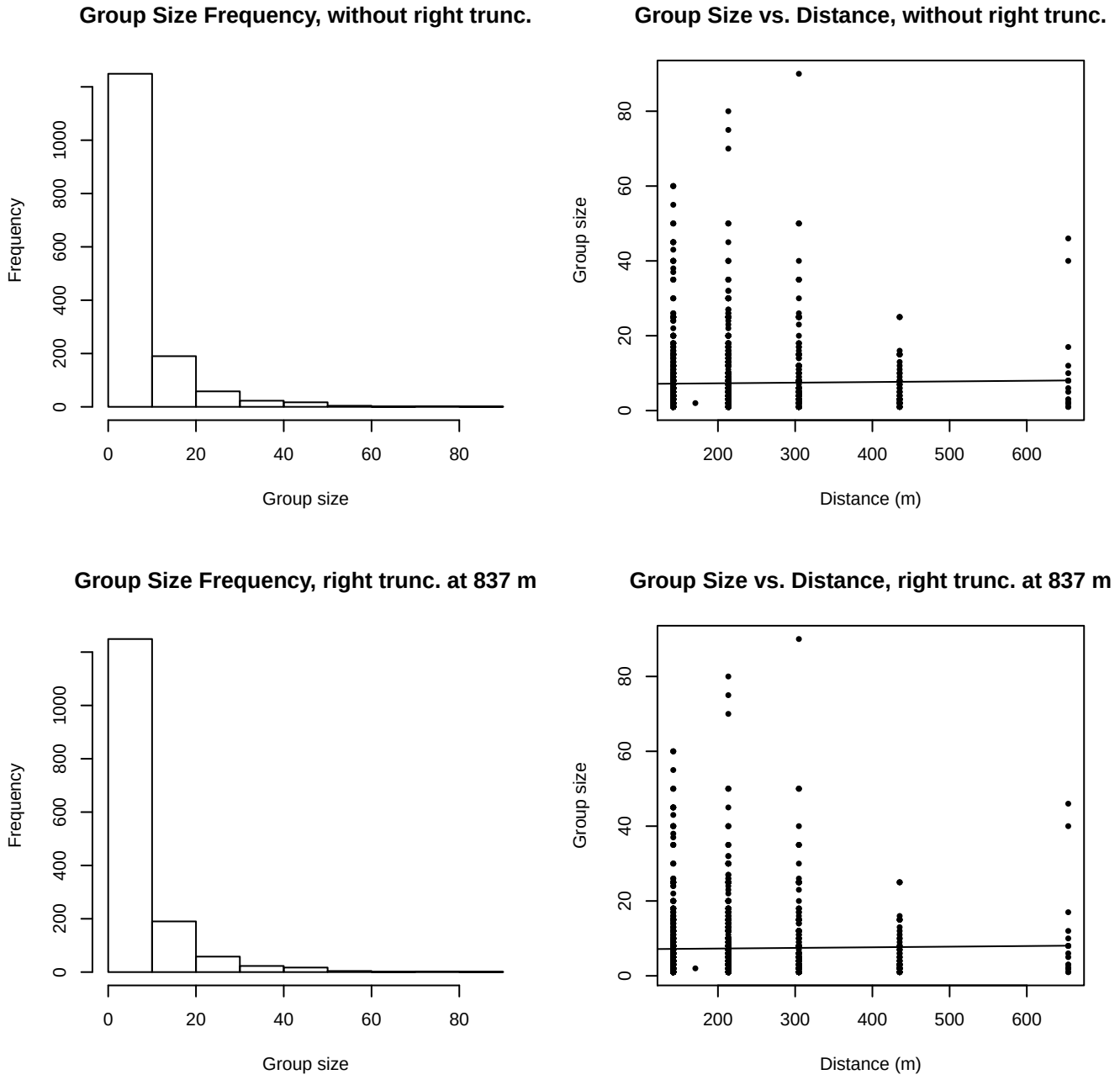


Figure 70: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

UNCW Early 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	5

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	1
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	350
Total		356

Table 50: Proxy species used to fit detection functions for UNCW Early Surveys. The number of sightings, n, is before truncation.

The sightings were right truncated at 332m. 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 13 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 51: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hn			beaufort	Yes	0.00	158

hn				Yes	2.97	157
hn	herm	4		Yes	4.33	164
hn	cos	2		Yes	4.73	164
hn			quality	Yes	4.80	157
hr	poly	4		Yes	4.86	167
hn	cos	3		Yes	4.95	159
hr	poly	2		Yes	5.37	165
hr			beaufort	Yes	5.57	187
hr				Yes	8.04	173
hr			quality	Yes	9.35	173
hn			size	No		
hr			size	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 52: Candidate detection functions for UNCW Early Surveys. The first one listed was selected for the density model.

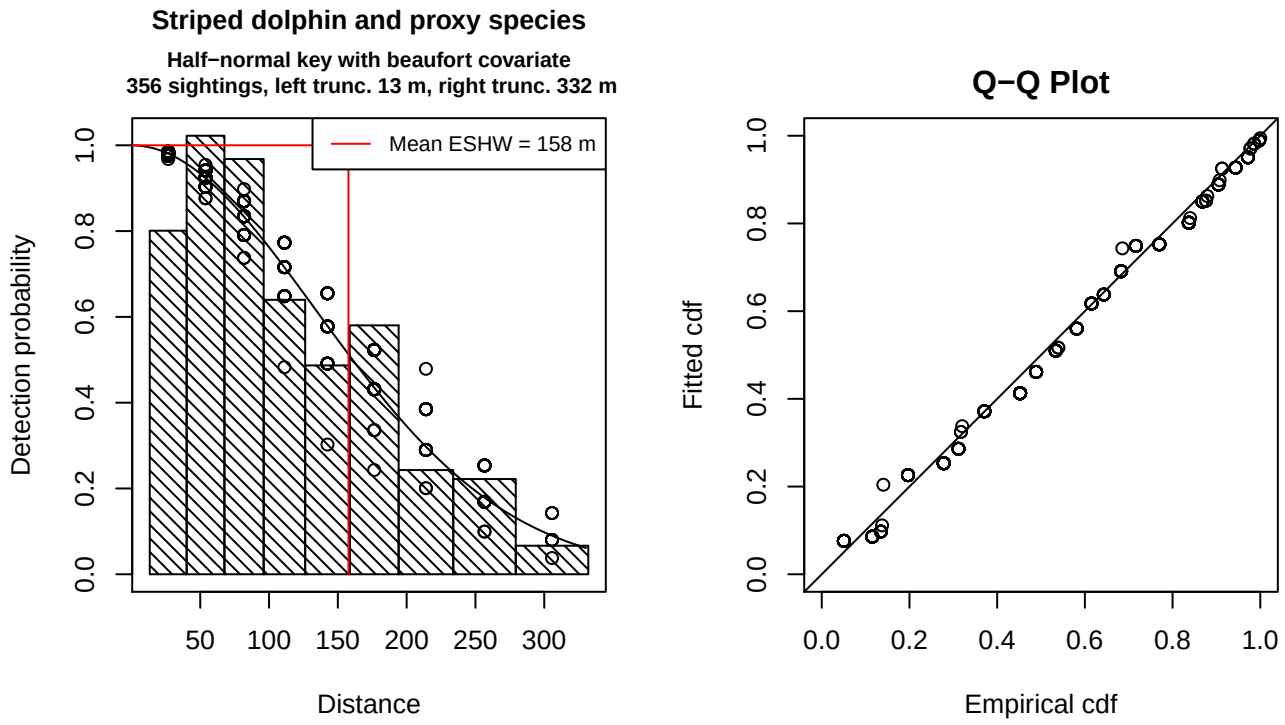


Figure 71: Detection function for UNCW Early Surveys that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  356
Distance range         :  13.30786  -  332
AIC                    :  1491.715

Detection function:
 Half-normal key function

Detection function parameters
Scale Coefficients:
             estimate         se
(Intercept)  5.1726896 0.13721406
beaufort    -0.1299227 0.06484242

                      Estimate          SE         CV
Average p             0.4700677  0.02238003 0.04761023
N in covered region 757.3377587 46.49751992 0.06139601
```

Additional diagnostic plots:

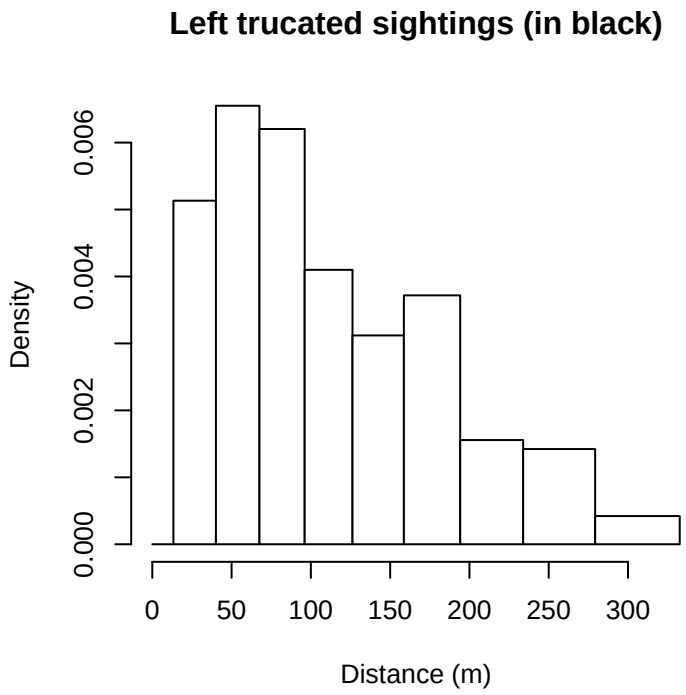


Figure 72: Density of sightings by perpendicular distance for UNCW Early Surveys. Black bars on the left show sightings that were left truncated.

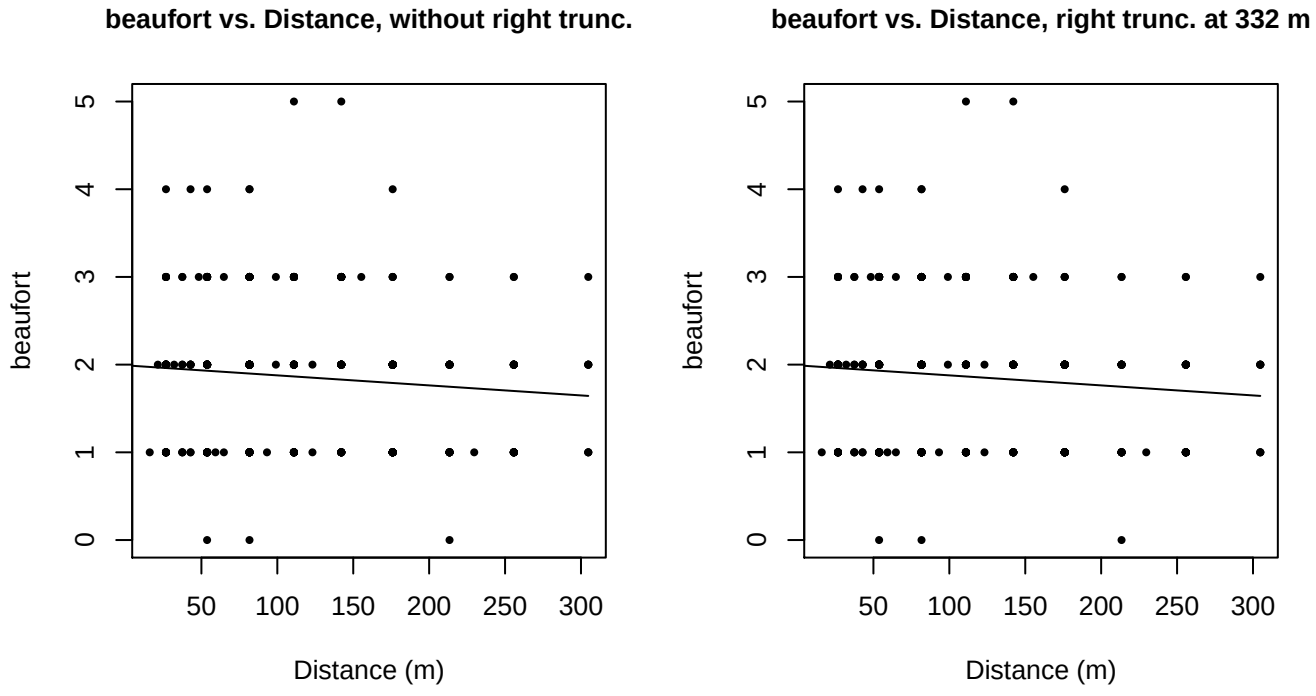


Figure 73: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

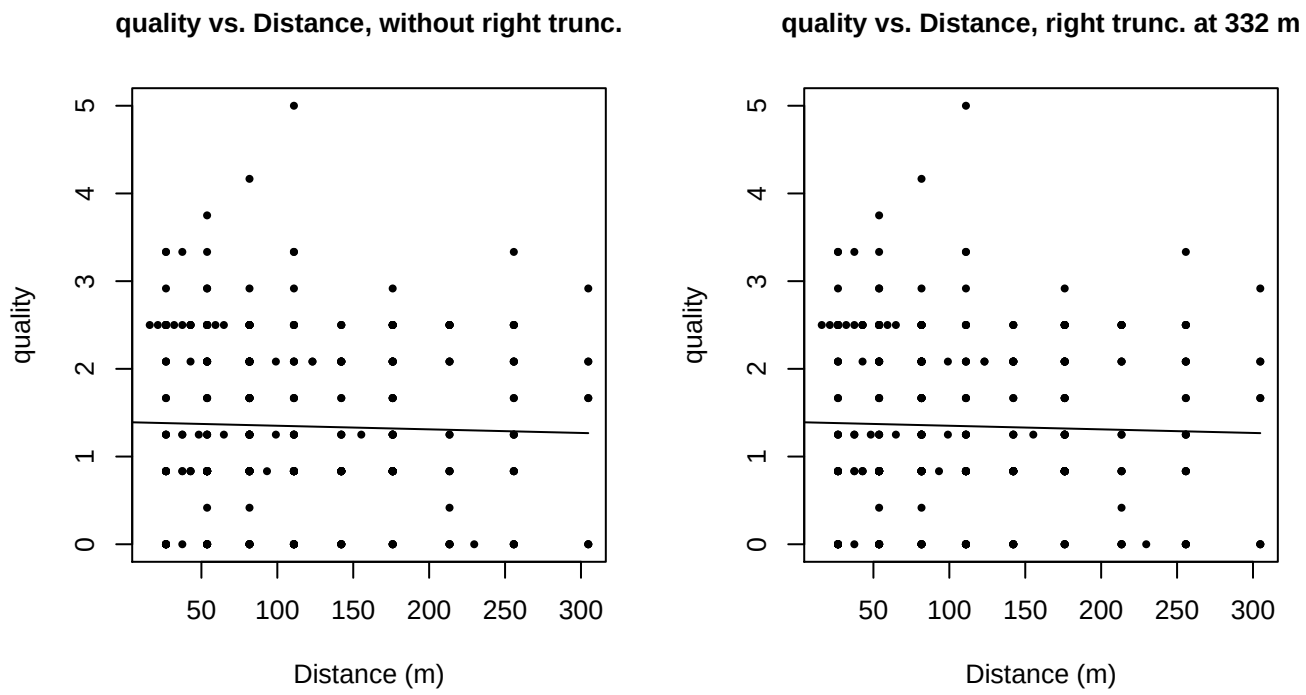


Figure 74: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

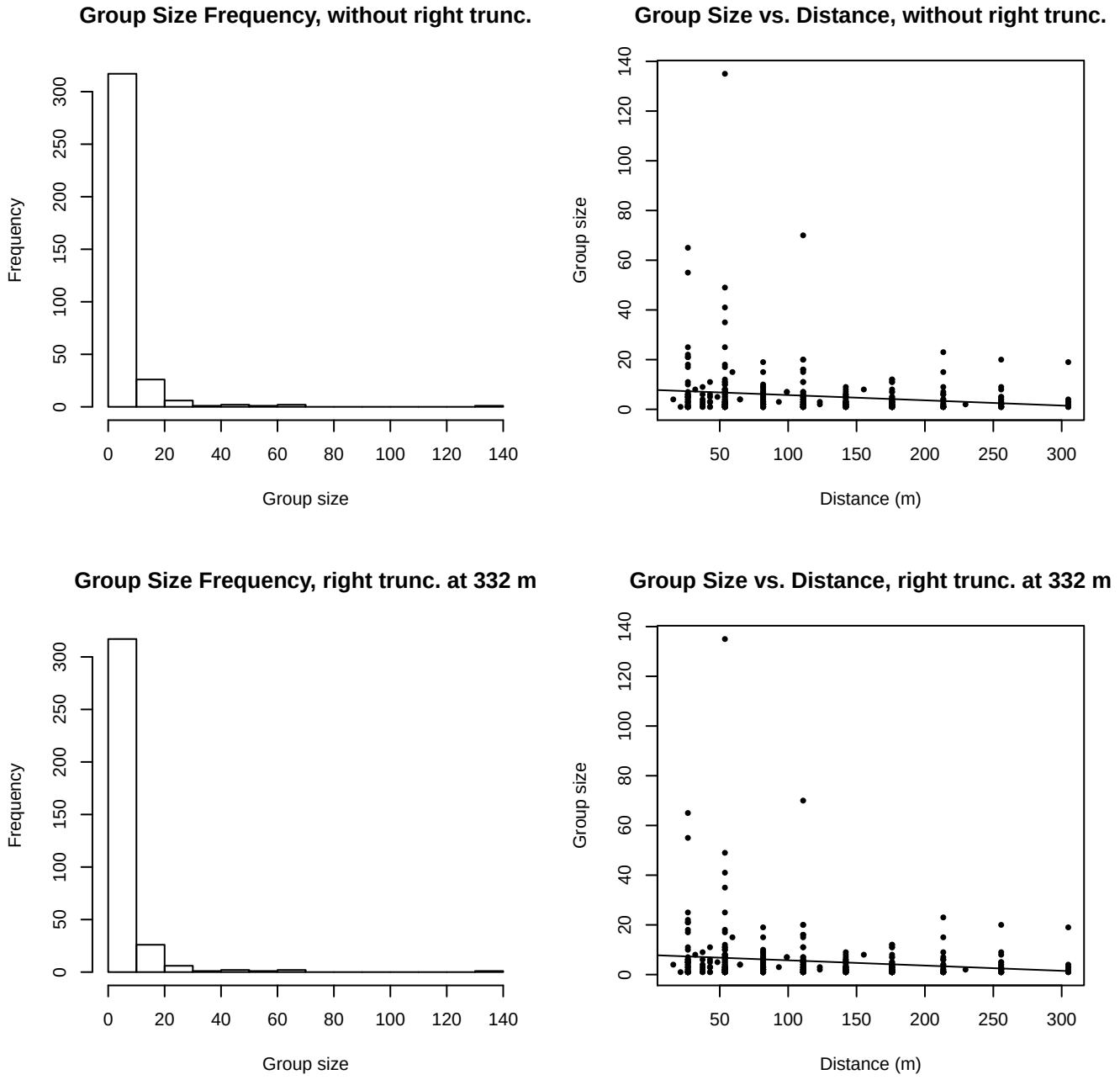


Figure 75: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

Virginia Aquarium 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	16

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	0
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	67
Total		83

Table 53: Proxy species used to fit detection functions for Virginia Aquarium Surveys. The number of sightings, n, is before truncation.

The sightings were right truncated at 1500m.

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

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr			quality, size	Yes	0.00	413
hr			quality	Yes	2.75	381
hr			size	Yes	2.86	408
hr				Yes	5.08	379

hr	poly	4		Yes	7.07	377
hr	poly	2		Yes	7.08	379
hn	cos	2		Yes	8.57	438
hn			quality, size	Yes	10.48	567
hn	cos	3		Yes	11.42	404
hn			quality	Yes	11.94	549
hn			beaufort, quality, size	Yes	12.28	569
hn			beaufort, quality	Yes	13.90	549
hn			beaufort, size	Yes	17.69	567
hn			beaufort	Yes	18.02	563
hn				Yes	18.13	562
hn			size	Yes	18.73	562
hn	herm	4		No		
hr			beaufort	No		
hr			beaufort, quality	No		
hr			beaufort, size	No		
hr			beaufort, quality, size	No		

Table 55: Candidate detection functions for Virginia Aquarium Surveys. The first one listed was selected for the density model.

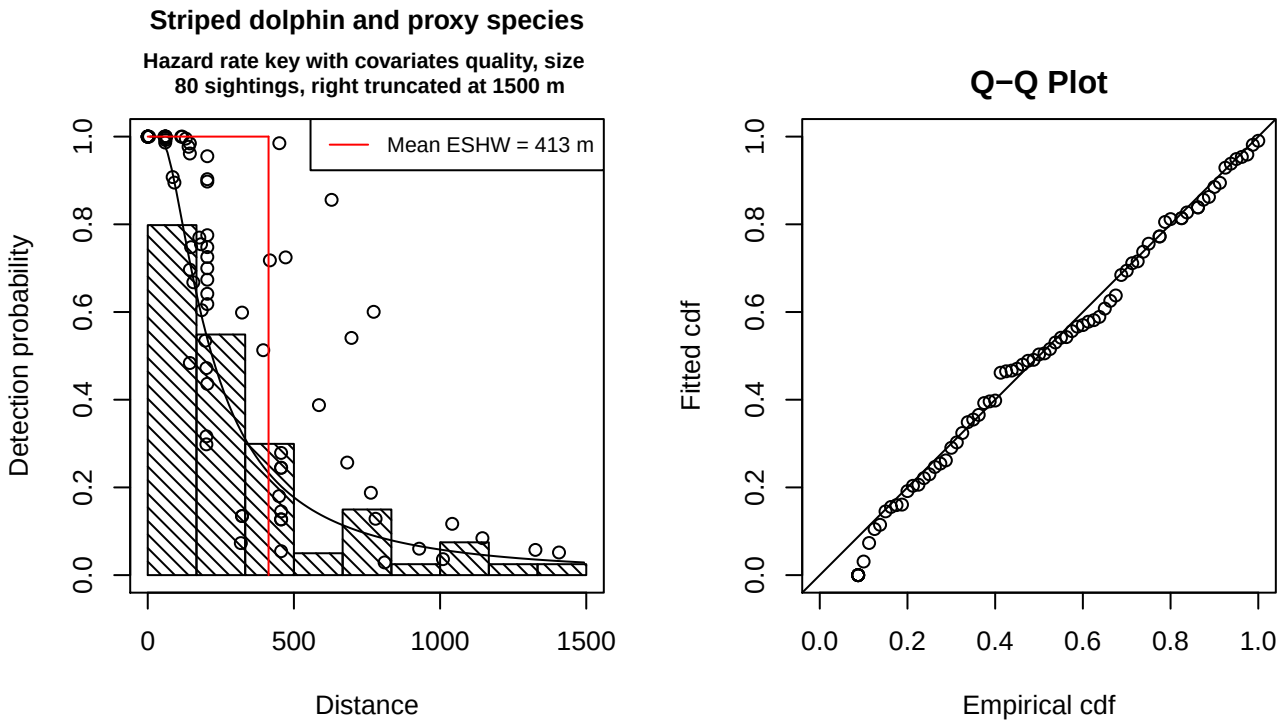


Figure 76: Detection function for Virginia Aquarium Surveys that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  80
Distance range         :  0  -  1500
AIC                    :  1076.058

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
              estimate        se
(Intercept)  5.6518239 0.3734155
quality     -0.3758731 0.1494911
size         0.3255962 0.2331376

Shape parameters:
             estimate        se
(Intercept) 0.6332354 0.1825191

                       Estimate          SE        CV
Average p             0.2217122  0.03813113 0.1719848
N in covered region 360.8280660 72.14728675 0.1999492
```

Additional diagnostic plots:

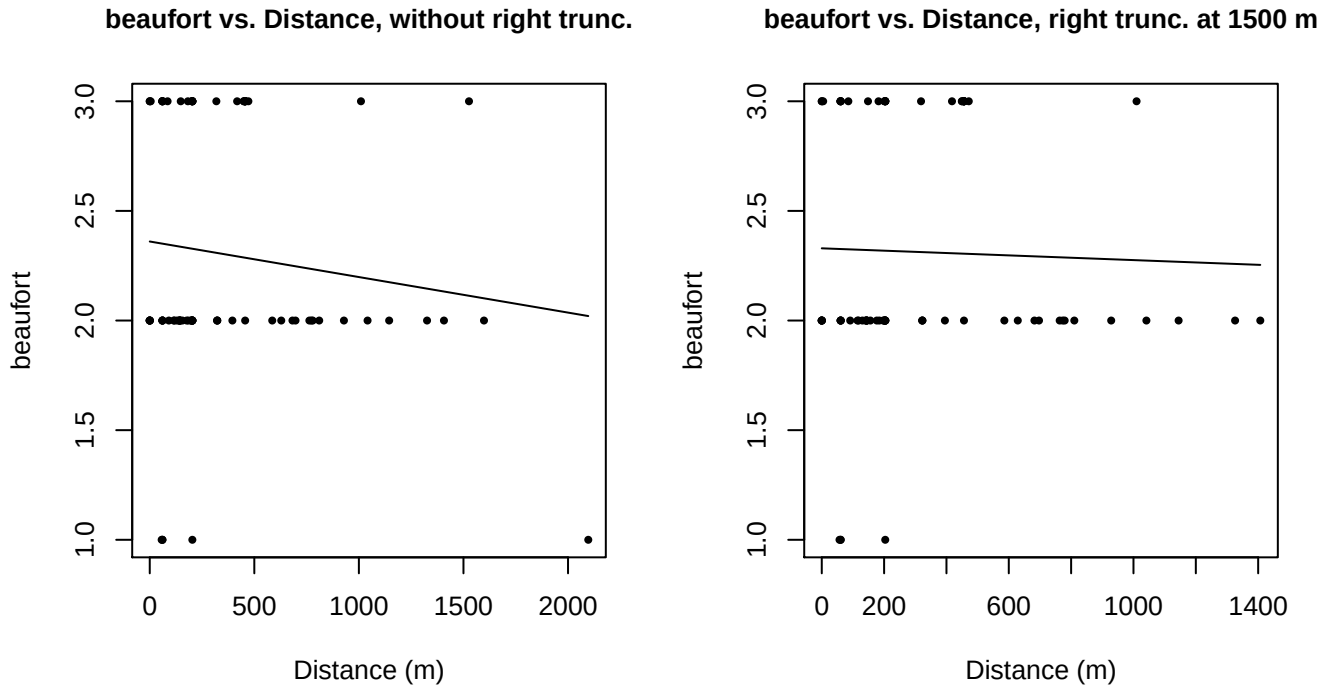


Figure 77: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

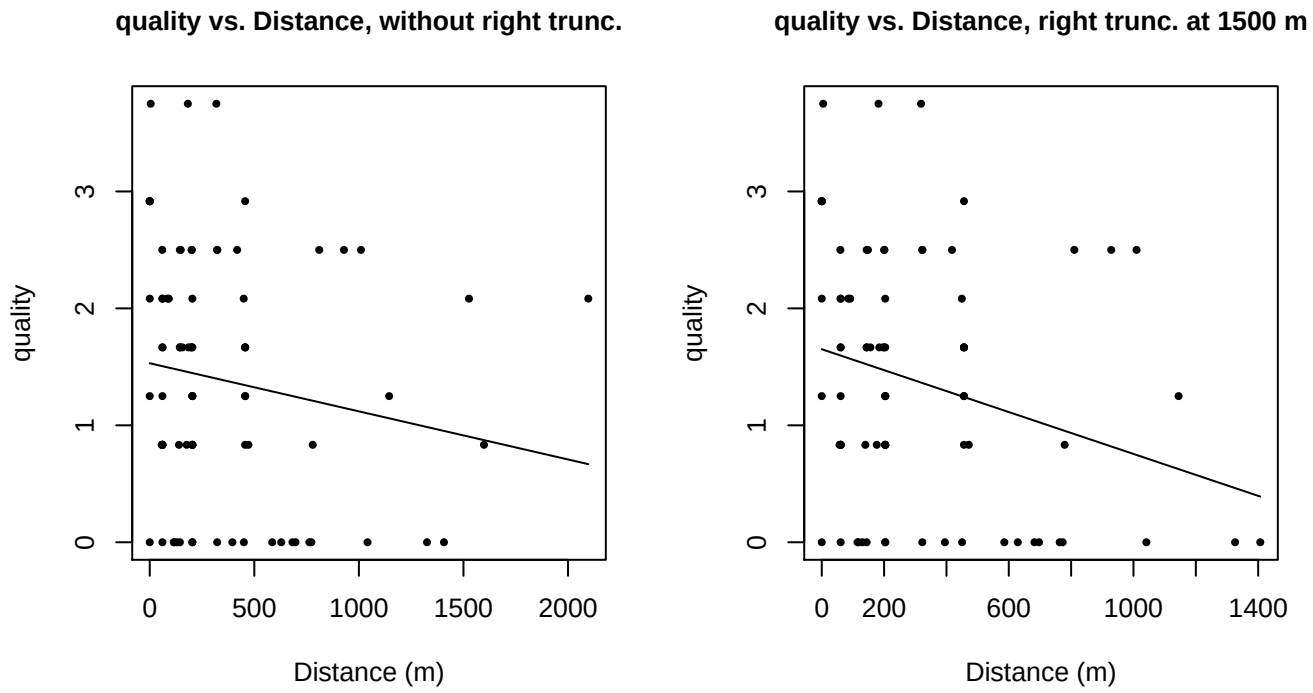


Figure 78: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

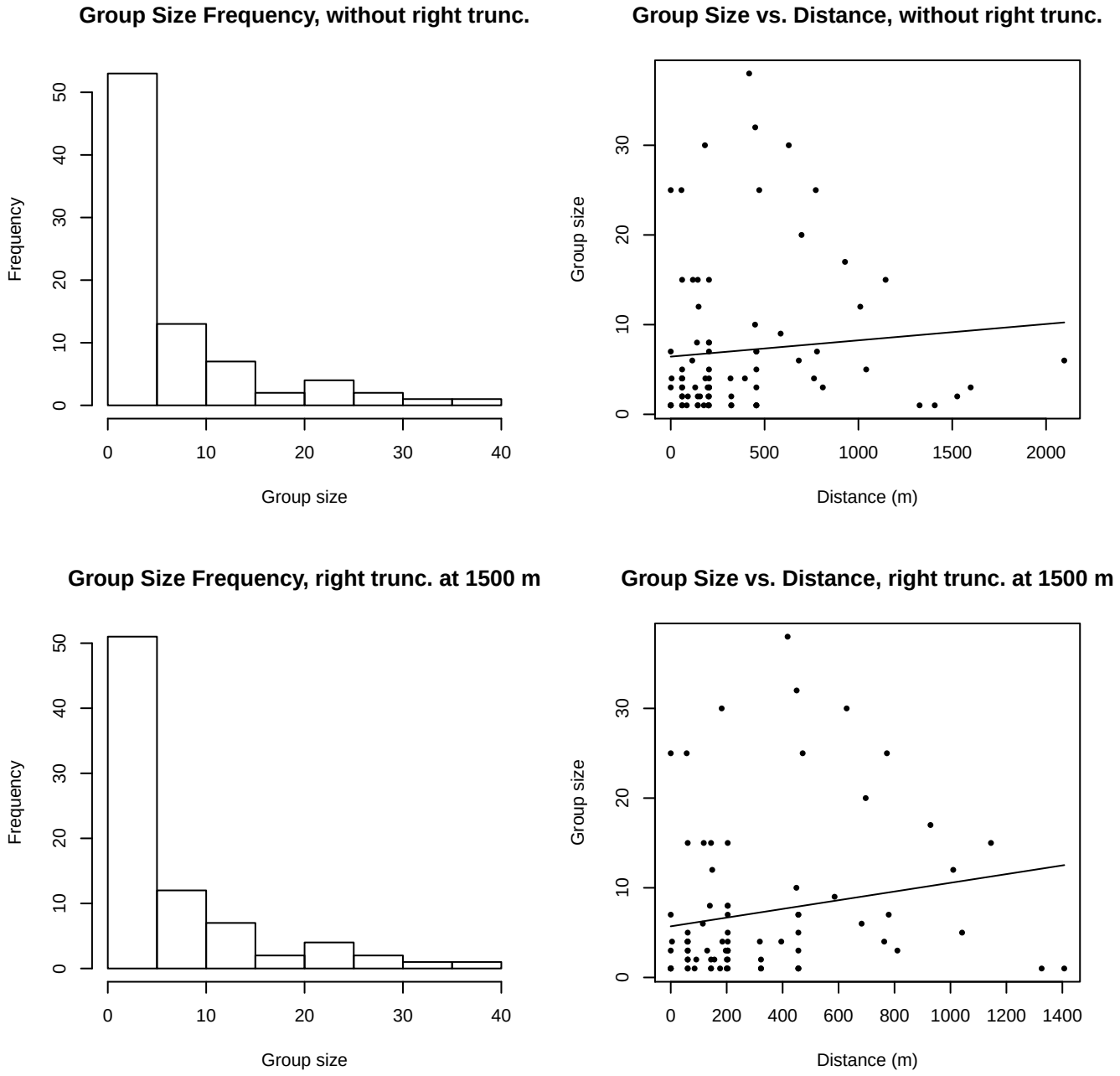


Figure 79: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

NARWSS Grummans

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	42

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	288
Lagenorhynchus albirostris	White-beaked dolphin	3
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	1
Stenella frontalis	Atlantic spotted dolphin	0
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	6
Total		340

Table 56: Proxy species used to fit detection functions for NARWSS Grummans. The number of sightings, n, is before truncation.

The sightings were right truncated at 800m. 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 107 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 57: Covariates tested in candidate "multi-covariate distance sampling" (MCDS) detection functions.

Key	Adjustment	Order	Covariates	Succeeded	Δ AIC	Mean ESHW (m)
hr			quality, size	Yes	0.00	235

hr			size	Yes	5.95	231
hr			beaufort, size	Yes	7.81	233
hr			quality	Yes	11.76	213
hn			size	Yes	14.26	231
hn			quality, size	Yes	14.51	233
hn			beaufort, size	Yes	16.23	231
hr				Yes	20.06	203
hr	poly	4		Yes	21.78	200
hr			beaufort	Yes	22.05	204
hr	poly	2		Yes	22.06	203
hn				Yes	33.54	223
hn			quality	Yes	33.86	223
hn	cos	3		Yes	34.13	179
hn	herm	4		Yes	35.13	222
hn	cos	2		No		
hn			beaufort	No		
hn			beaufort, quality	No		
hr			beaufort, quality	No		
hn			beaufort, quality, size	No		
hr			beaufort, quality, size	No		

Table 58: Candidate detection functions for NARWSS Grummans. The first one listed was selected for the density model.

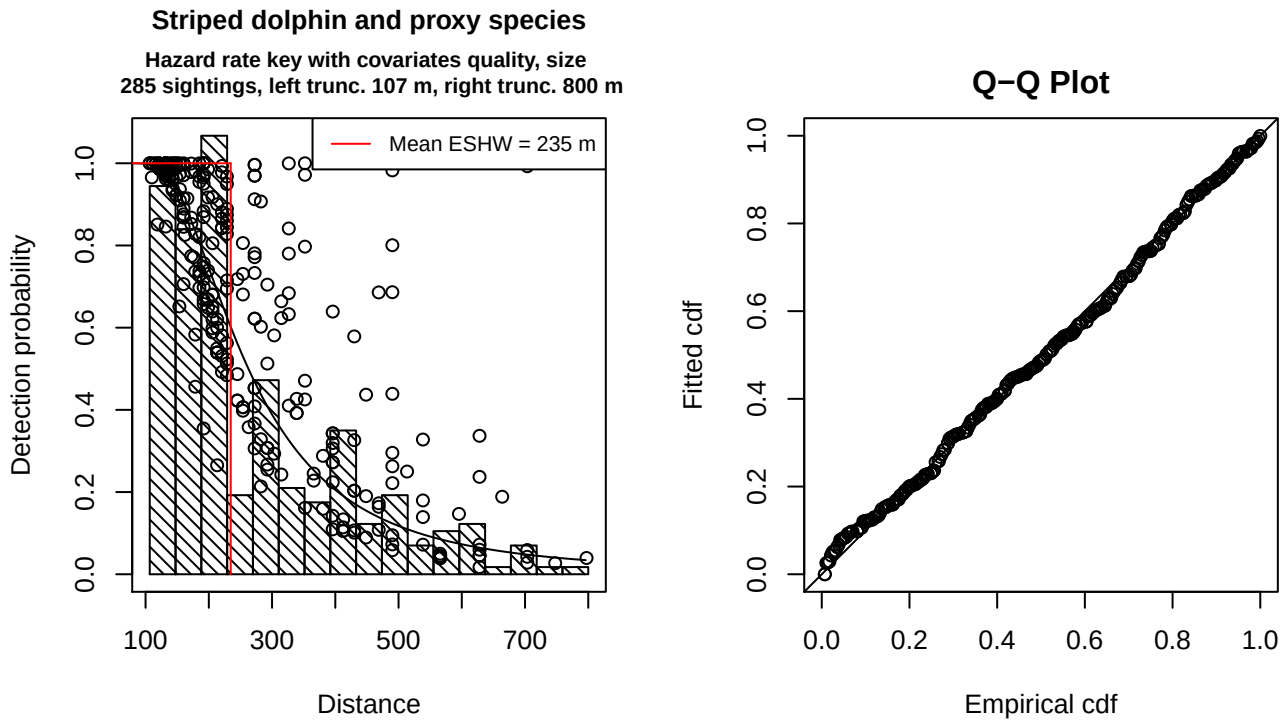


Figure 80: Detection function for NARWSS Grummans that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  285
Distance range         :  106.5979  -  800
AIC                    :  3450.827

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
             estimate         se
(Intercept)  5.5620259 0.12398130
quality     -0.2408179 0.09290192
size         0.2953779 0.09400126

Shape parameters:
            estimate        se
(Intercept) 1.119906 0.1056045

                        Estimate           SE        CV
Average p              0.2541682   0.03062592 0.1204947
N in covered region 1121.3045461 147.37019002 0.1314274
```

Additional diagnostic plots:

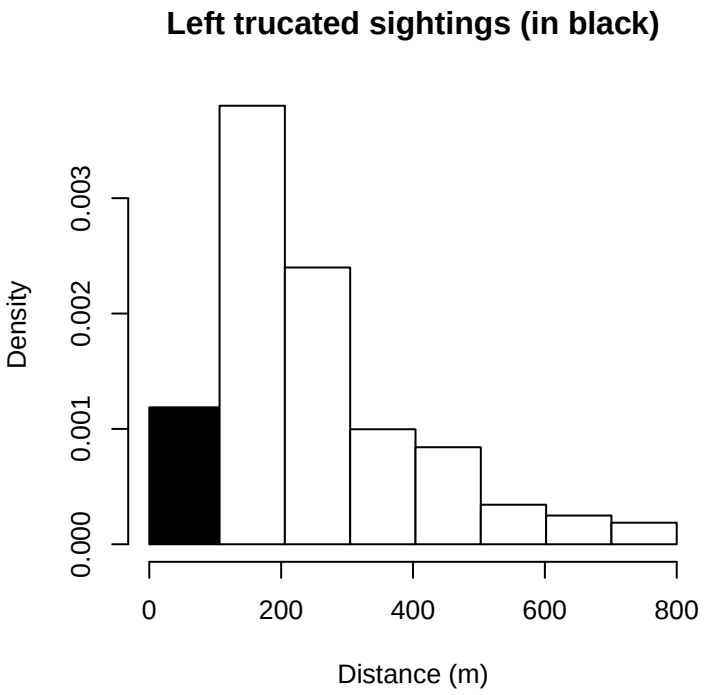


Figure 81: Density of sightings by perpendicular distance for NARWSS Grummans. Black bars on the left show sightings that were left truncated.

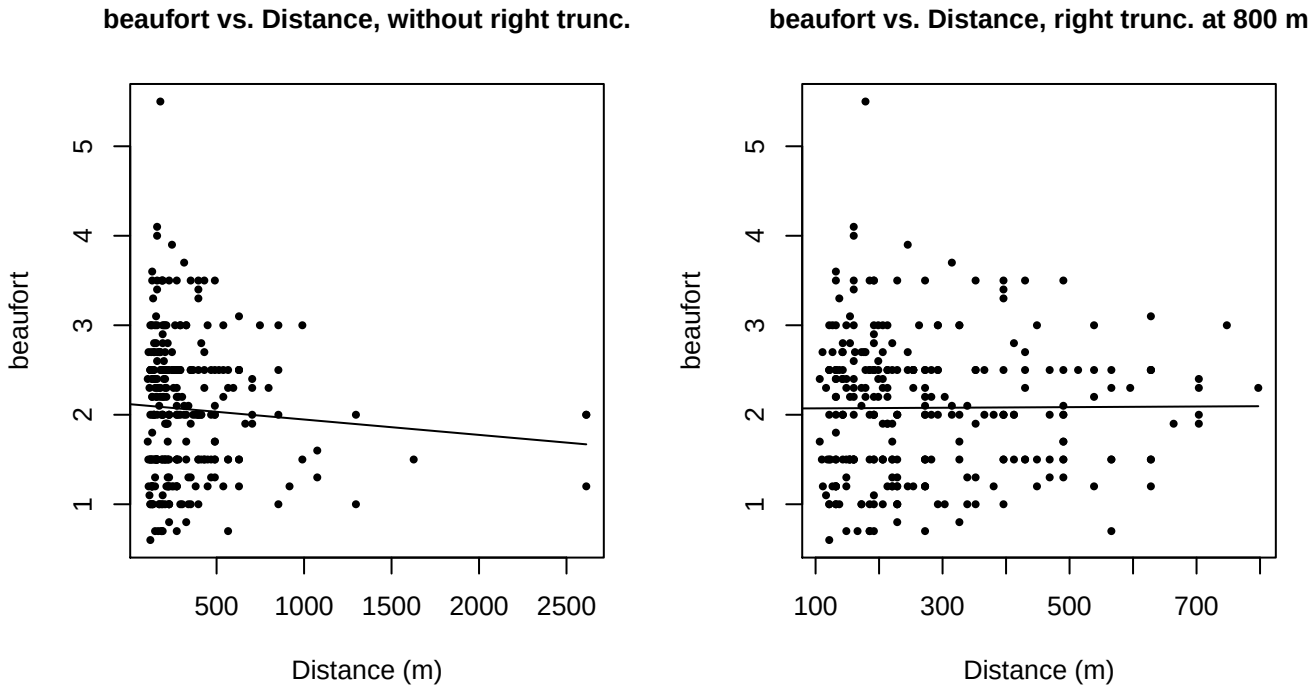


Figure 82: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

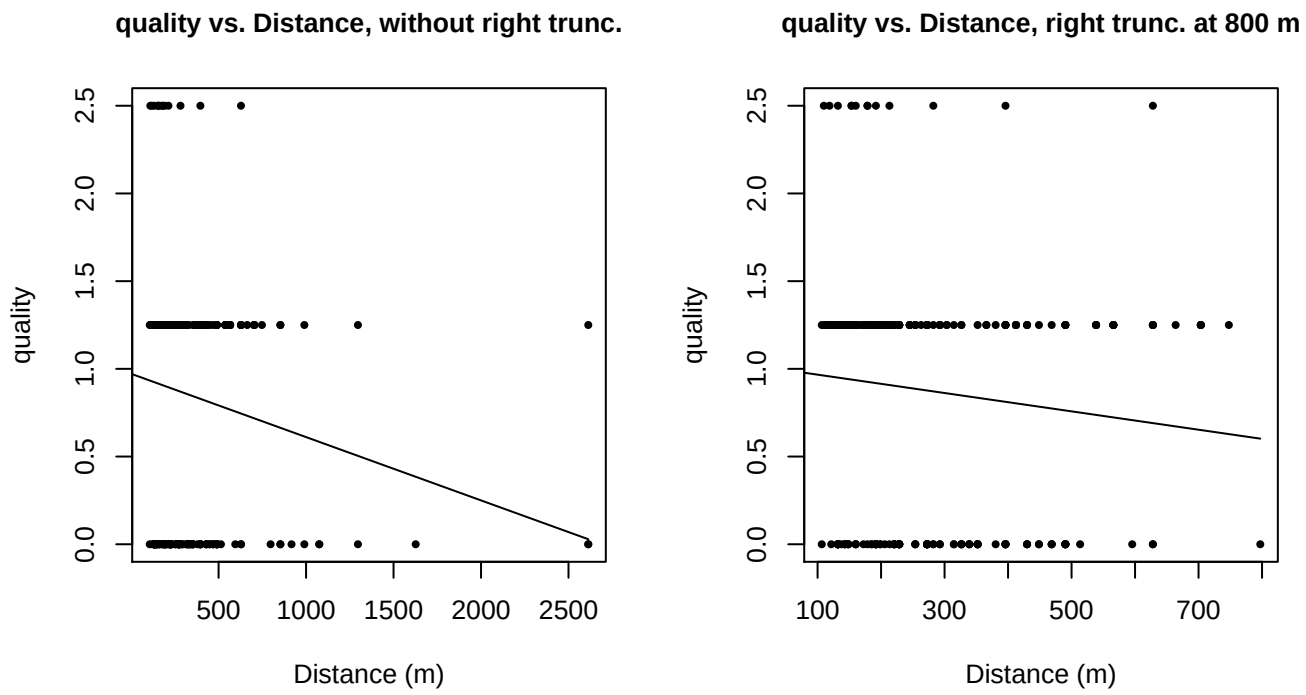


Figure 83: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

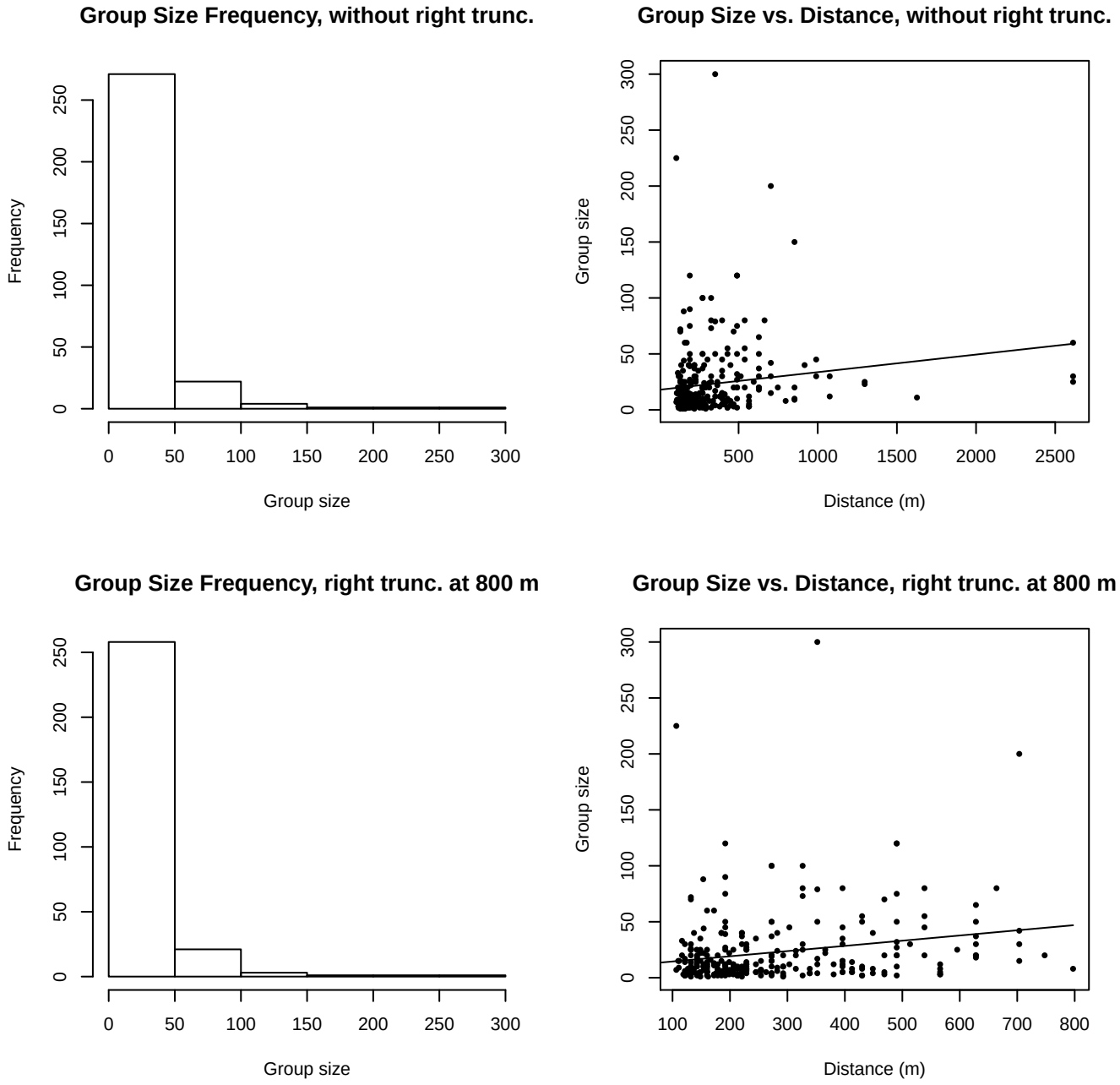


Figure 84: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

NARWSS Twin Otters

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	539

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	86
Grampus griseus/Tursiops truncatus	Risso's or Bottlenose dolphin	0
Lagenodelphis hosei	Fraser's dolphin	0
Lagenorhynchus acutus	Atlantic white-sided dolphin	1732
Lagenorhynchus albirostris	White-beaked dolphin	4
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	4
Stenella frontalis	Atlantic spotted dolphin	0
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	39
Total		2405

Table 59: Proxy species used to fit detection functions for NARWSS Twin Otters. The number of sightings, n, is before truncation.

The sightings were right truncated at 2500m. 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 160 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. The vertical sighting angles were heaped at 10 degree increments up to 80 degrees and 1 degree increments thereafter, so the candidate detection functions were fitted using linear bins scaled accordingly.

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 60: 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	470
hr			size	Yes	5.29	463
hr			quality, size	Yes	7.11	463
hr	poly	2		Yes	9.16	430
hr	poly	4		Yes	10.71	442
hr			beaufort	Yes	17.46	464
hr				Yes	22.55	458
hr			quality	Yes	24.49	458
hn	cos	2		Yes	33.82	434
hn	cos	3		Yes	54.89	361
hn			beaufort, size	Yes	162.73	517
hn			size	Yes	162.85	518
hn			quality, size	Yes	164.00	518
hn			beaufort, quality, size	Yes	164.45	517
hn			beaufort	Yes	185.34	516
hn				Yes	186.28	516
hn	herm	4		Yes	186.91	516
hn			beaufort, quality	Yes	187.34	516
hn			quality	Yes	188.03	516
hr			beaufort, quality	No		
hr			beaufort, quality, size	No		

Table 61: Candidate detection functions for NARWSS Twin Otters. The first one listed was selected for the density model.

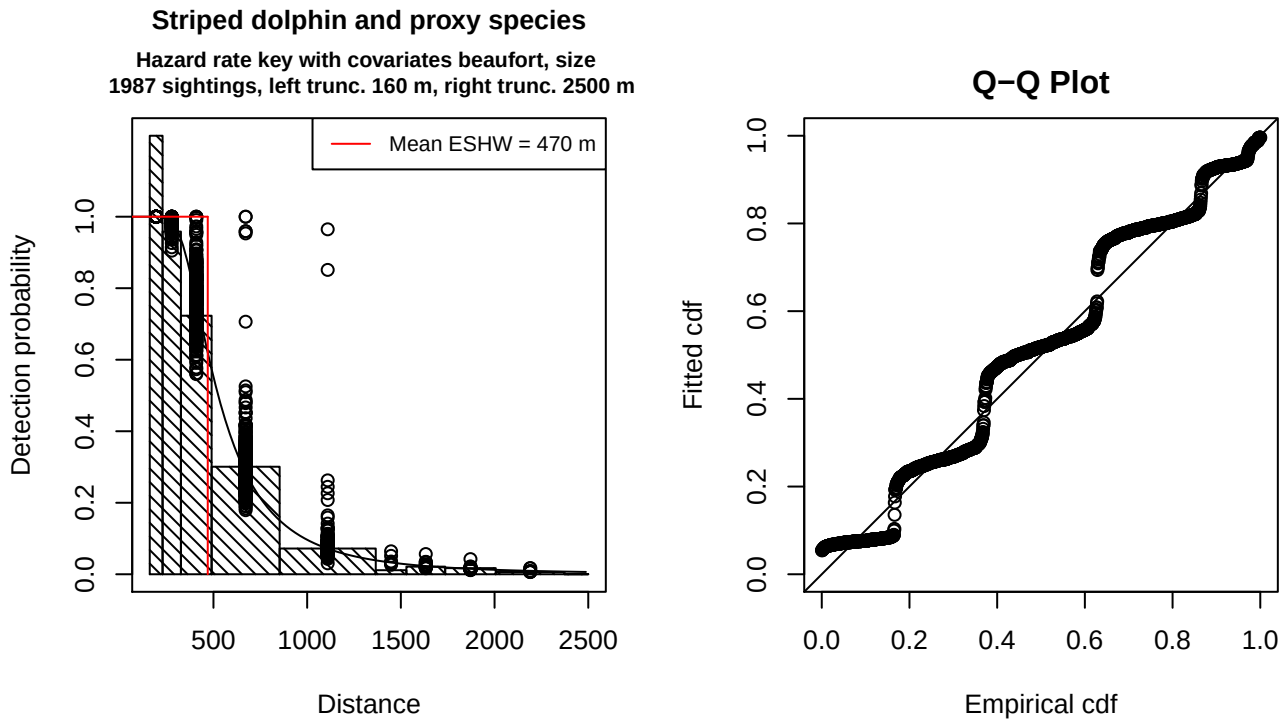


Figure 85: Detection function for NARWSS Twin Otters that was selected for the density model

Statistical output for this detection function:

```
Summary for ds object
Number of observations :  1987
Distance range         :  160.0674  -  2500
AIC                    :  6745.856

Detection function:
 Hazard-rate key function

Detection function parameters
Scale Coefficients:
               estimate         se
(Intercept)  6.26395198 0.06468196
beaufort    -0.07274292 0.02643651
size         0.08974254 0.02445737

Shape parameters:
            estimate        se
(Intercept) 1.110483 0.0356417

                        Estimate           SE         CV
Average p           1.845364e-01 5.774489e-03 0.03129187
N in covered region 1.076752e+04 4.016208e+02 0.03729928
```

Additional diagnostic plots:

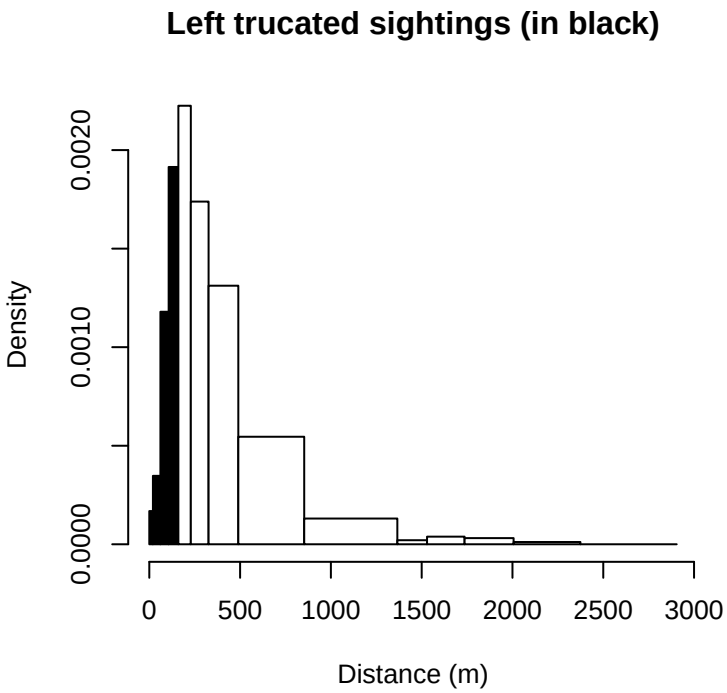


Figure 86: Density of sightings by perpendicular distance for NARWSS Twin Otters. Black bars on the left show sightings that were left truncated.

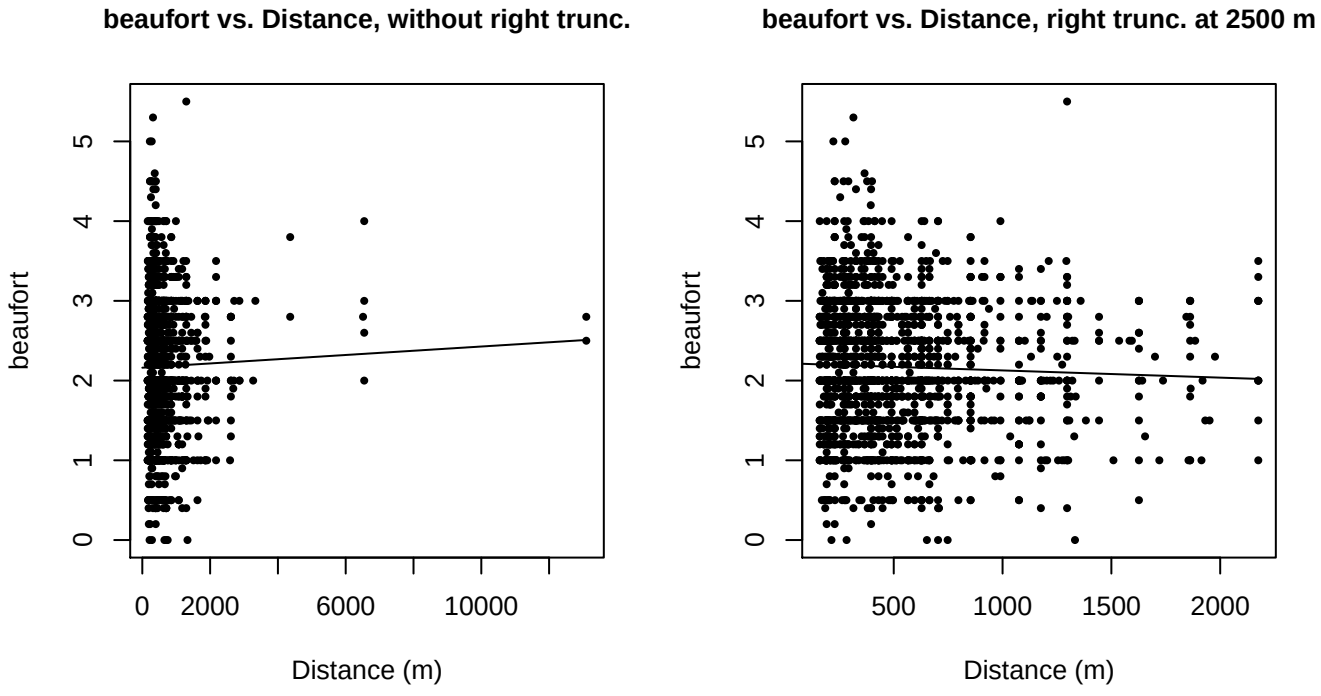


Figure 87: Scatterplots showing the relationship between Beaufort sea state and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). The line is a simple linear regression.

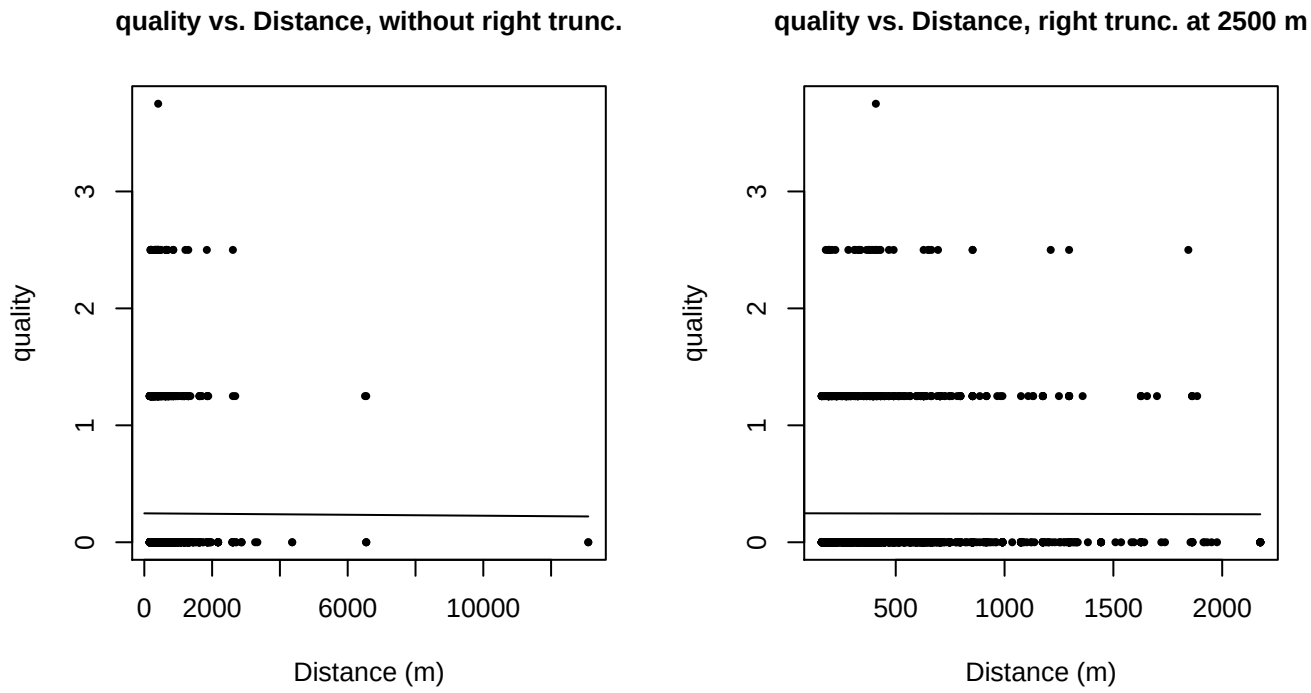


Figure 88: Scatterplots showing the relationship between the survey-specific index of the quality of observation conditions and perpendicular sighting distance, for all sightings (left) and only those not right truncated (right). Low values of the quality index correspond to better observation conditions. The line is a simple linear regression.

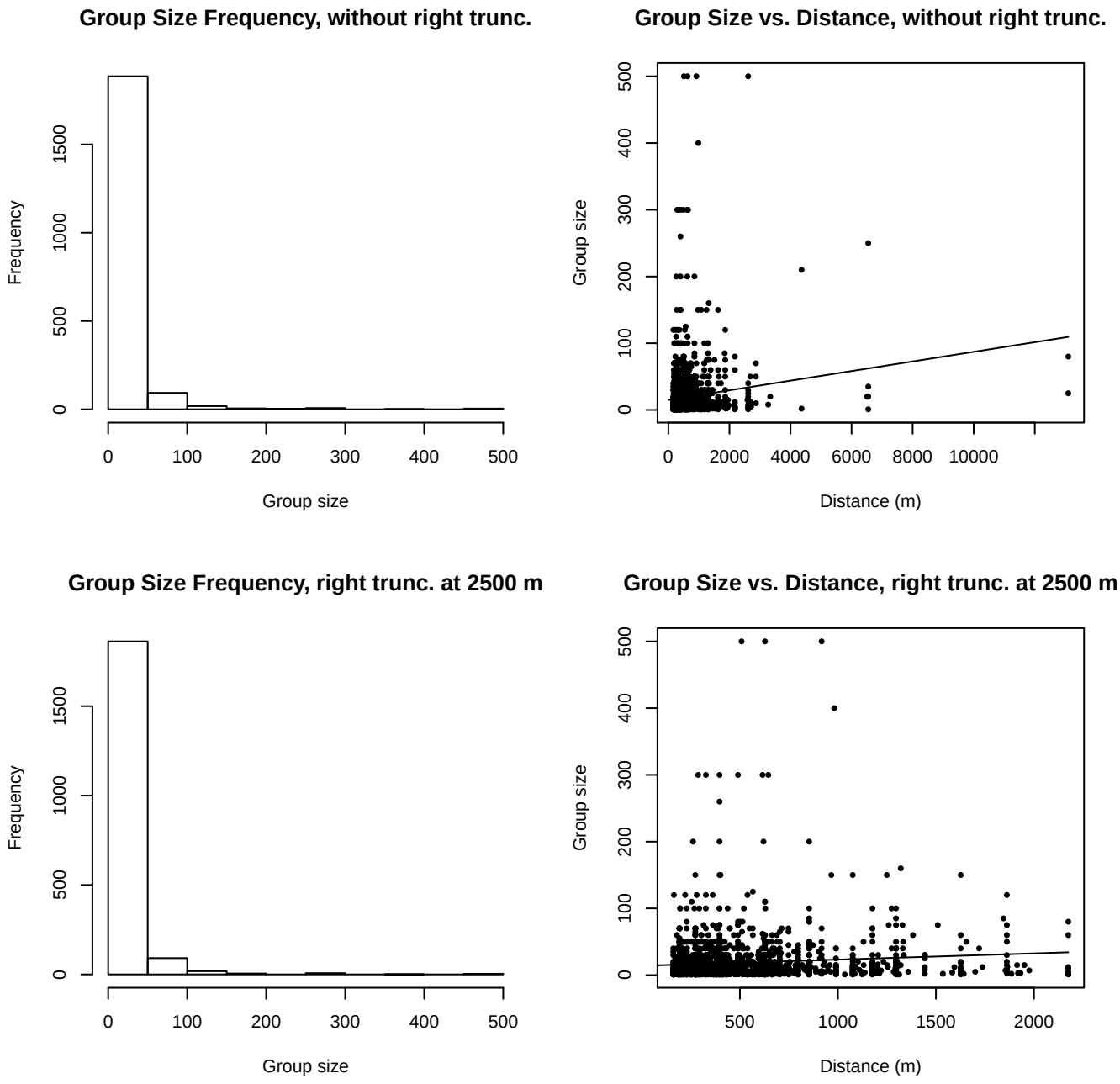


Figure 89: Histograms showing group size frequency and scatterplots showing the relationship between group size and perpendicular sighting distance, for all sightings (top row) and only those not right truncated (bottom row). In the scatterplot, the line is a simple linear regression.

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)
Shipboard	NEFSC Abel-J Binocular Surveys	Any	0.61	Perception	Palka (2006)
Shipboard	NEFSC Endeavor	Any	0.57	Perception	Palka (2006)
Aerial	All	1-5	0.43	Both	Palka (2006)
		>5	0.960	Both	Carretta et al. (2000)

Table 62: Estimates of *g(0)* used in this density model.

For shipboard surveys other than the NOAA NEFSC cruises for which Palka (2006) provided survey-specific estimates of g(0), we utilized Barlow and Forney's (2007) estimates for delphinids, produced from several years of dual-team surveys that used similar binoculars and 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). The northern range of the species is not well-established, with some studies reporting that the northern limit is a function of water temperature (Bloch et al. 1996, Doksaeter et al. 2008) and affected by processes such as meanderings of the Gulf Stream (Archer and Perrin 1999). Sightings and strandings occur occasionally along the east coast of Canada (Baird et al. 1993, Hooker et al. 1999).

Despite being described as a warm water species, the sightings of striped dolphin reported by the surveys utilized in our study occurred mainly north of the Gulf Stream, although roughly 90% of the sightings were in waters 18 C or warmer. The coldest sighting occurred in 8 C. Nearly all of the sightings occurred over the continental slope or abyssal waters, with only 6 sightings occurring at depths less than 200 m, and only one of these was relatively far from the continental shelf break, sighted along the western edge of Georges Bank in June 2007. In oceanic waters, striped dolphins were reported to be associated with the north wall of the Gulf Stream and warm-core rings (Waring et al. 2014) and, at the mid-Atlantic Ridge, with warm, saline waters over steeper slopes than non-dolphin species.

The literature did not report seasonal movements other than a possible shift related to water temperature. Having no description of migratory behavior, we modeled striped dolphin density with a single, year-round model that incorporated all available survey data.

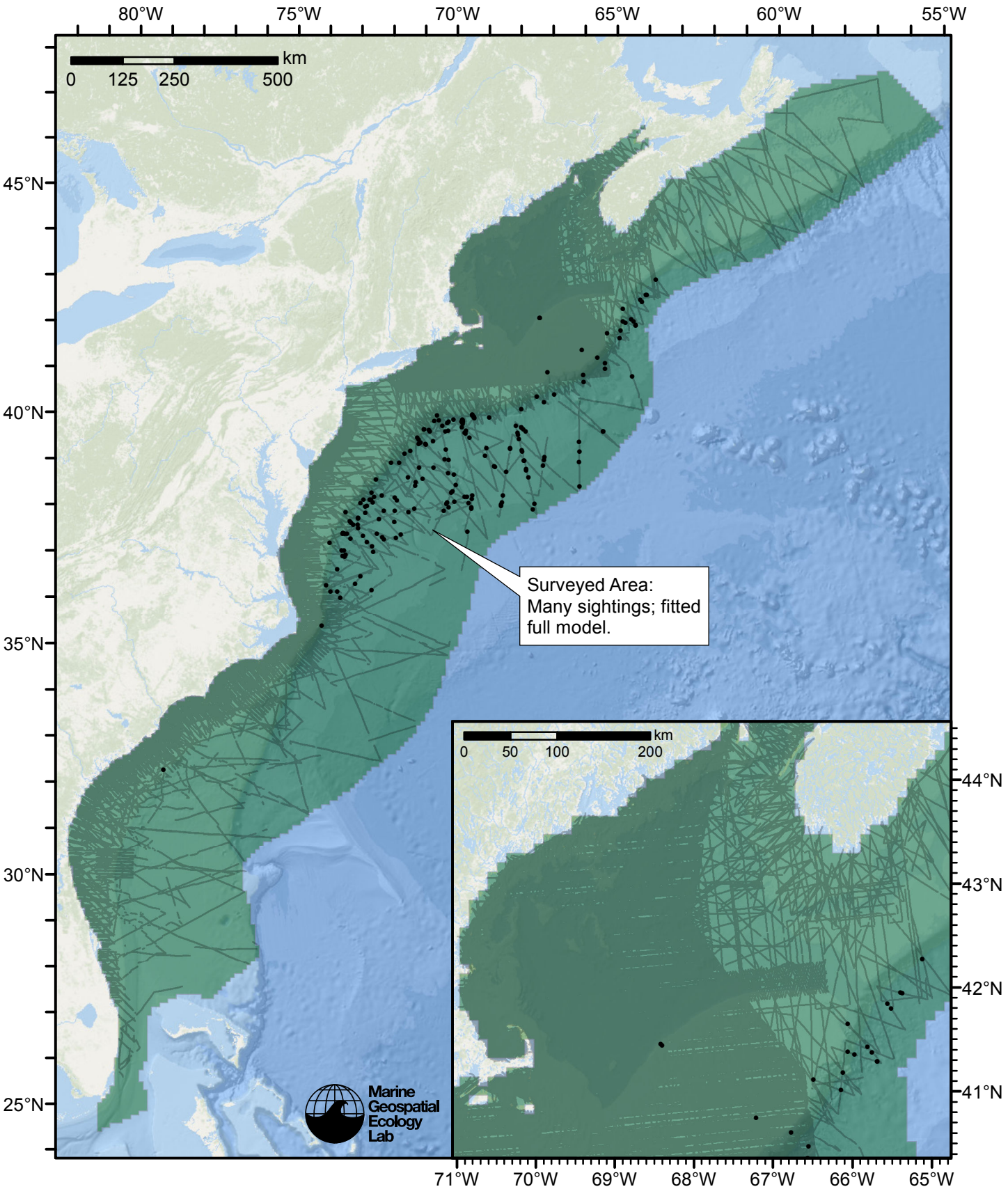


Figure 90: Striped dolphin density model schematic. All on-effort sightings are shown, including those that were truncated when detection functions were fitted.

Climatological Model

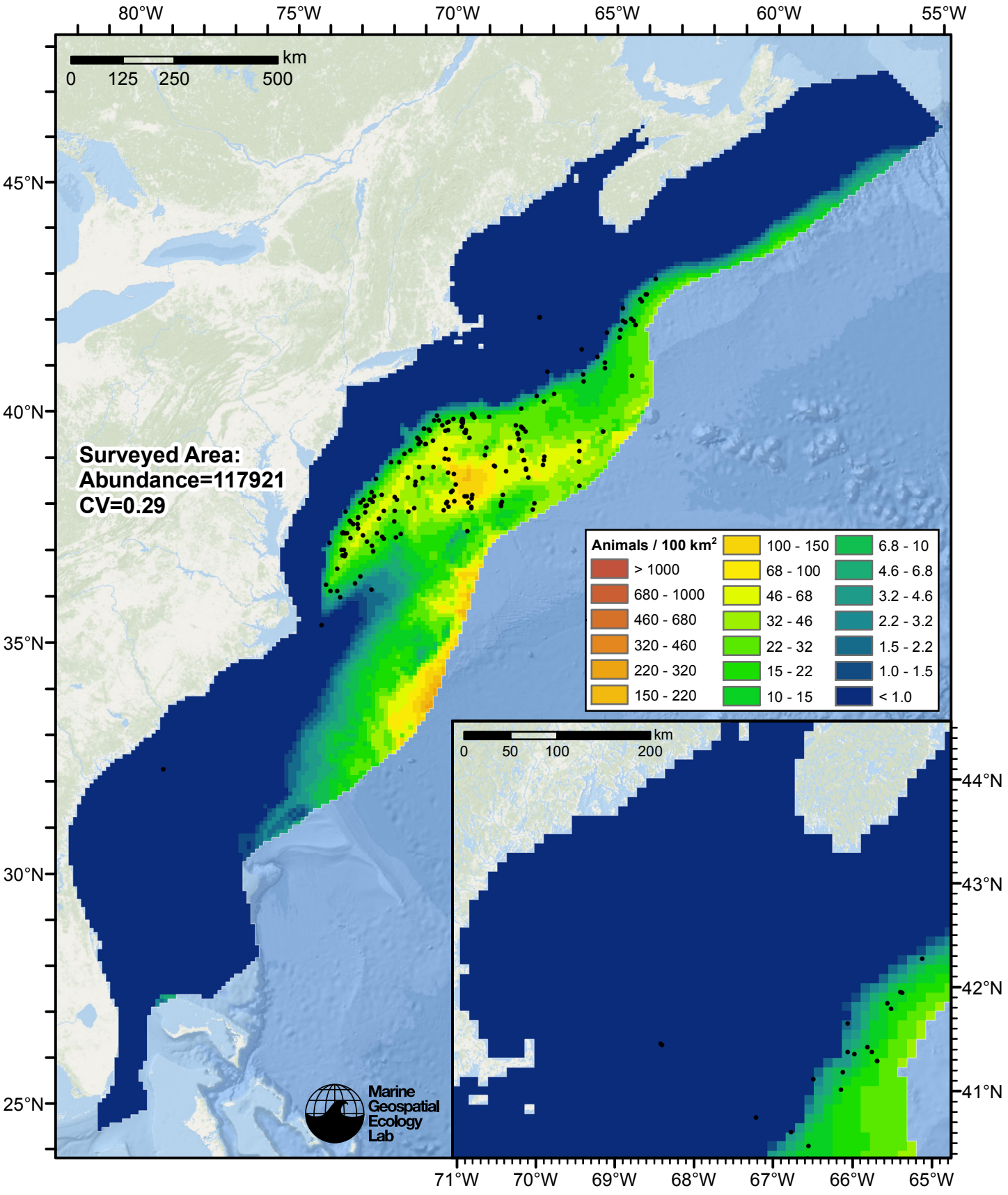


Figure 91: Striped dolphin density predicted by the climatological model that explained the most deviance. Pixels are 10x10 km. The legend gives the estimated individuals per pixel; breaks are logarithmic. Abundance for each region was computed by summing the density cells occuring in that region.

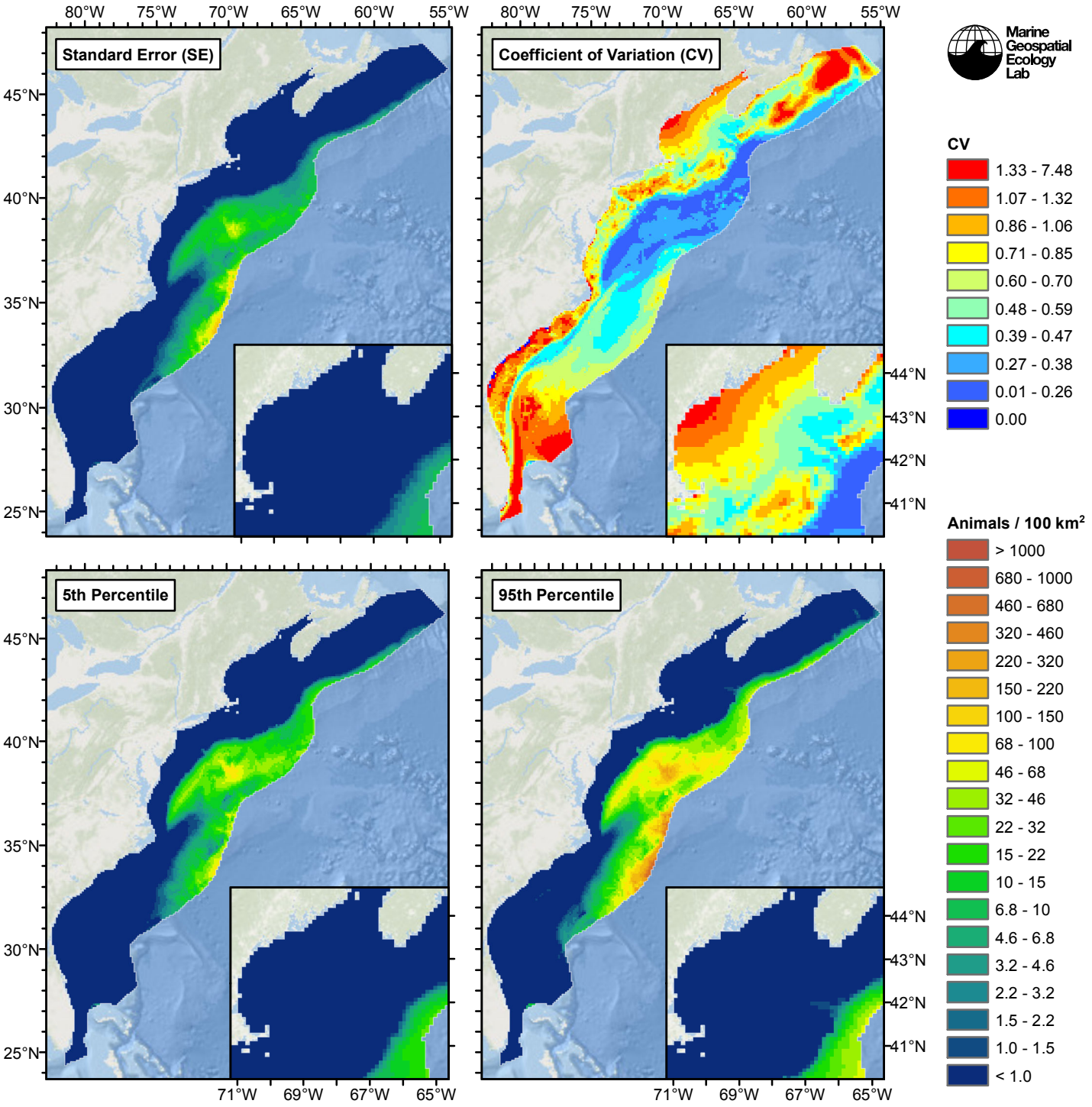


Figure 92: Estimated uncertainty for the climatological model that explained the most deviance. These estimates only incorporate the statistical uncertainty estimated for the spatial model (by the R mgcv package). They do not incorporate uncertainty in the detection functions, g(0) estimates, predictor variables, and so on.

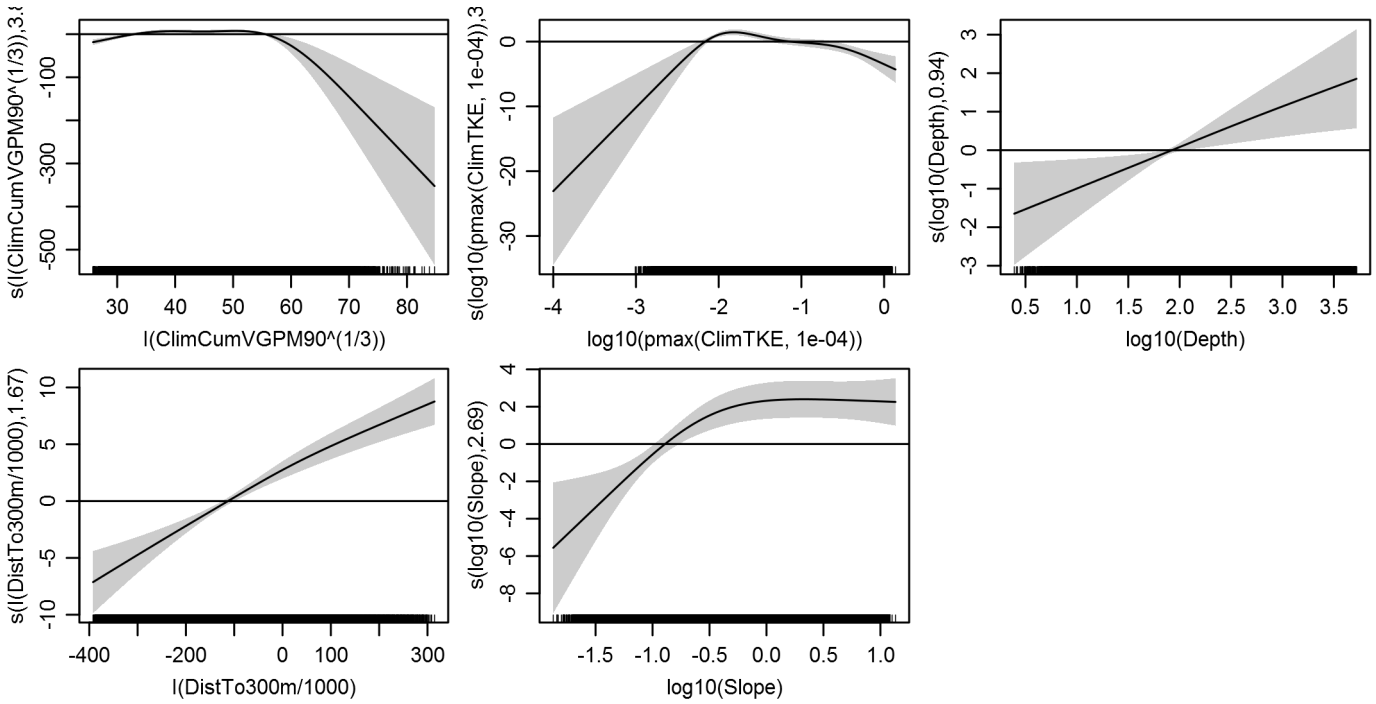
Surveyed Area

Statistical output

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


Family: Tweedie(p=1.284)
```

```
Link function: log

Formula:
abundance ~ offset(log(area_km2)) + s(log10(Depth), bs = "ts",
    k = 5) + s(log10(Slope), bs = "ts", k = 5) + s(I(DistTo300m/1000),
    bs = "ts", k = 5) + s(log10(pmax(ClimTKE, 1e-04)), bs = "ts",
    k = 5) + s(I(ClimCumVGPM90^(1/3)), bs = "ts", k = 5)

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -16.417      1.894   -8.67   <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))               0.9359      4  2.114  0.00164 **
s(log10(Slope))               2.6888      4  6.008 2.85e-06 ***
s(I(DistTo300m/1000))         1.6694      4 19.868  < 2e-16 ***
s(log10(pmax(ClimTKE, 1e-04))) 3.7137      4 14.582 5.46e-13 ***
s(I(ClimCumVGPM90^(1/3)))     3.8050      4 10.301 8.98e-09 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.0652   Deviance explained = 76.6%
-REML = 1691.9  Scale est. = 161.46    n = 104236

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 18 iterations.
Gradient range [-5.852667e-05,5.241486e-05]
(score 1691.915 & scale 161.4571).
Hessian positive definite, eigenvalue range [0.3193409,534.1852].
Model rank =  21 / 21

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 0.936   0.733    0.00
s(log10(Slope))               4.000 2.689   0.795    0.00
s(I(DistTo300m/1000))         4.000 1.669   0.896    0.00
s(log10(pmax(ClimTKE, 1e-04))) 4.000 3.714   0.936    0.32
s(I(ClimCumVGPM90^(1/3)))     4.000 3.805   0.900    0.00

Predictors retained during the model selection procedure: Depth, Slope, DistTo300m, ClimTKE,
ClimCumVGPM90

Predictors dropped during the model selection procedure: DistTo125m, ClimSST, ClimDistToFront2
```

Model term plots



Diagnostic plots

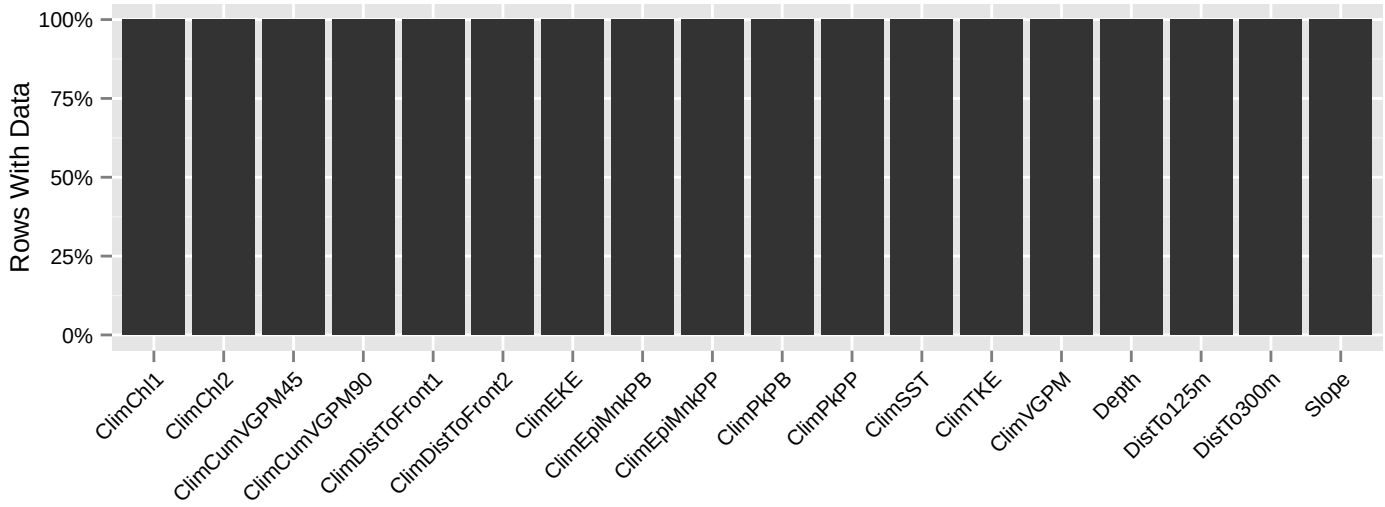


Figure 93: Segments with predictor values for the Striped dolphin Climatological model, Surveyed Area. This plot is used to assess how many segments would be lost by including a given predictor in a model.

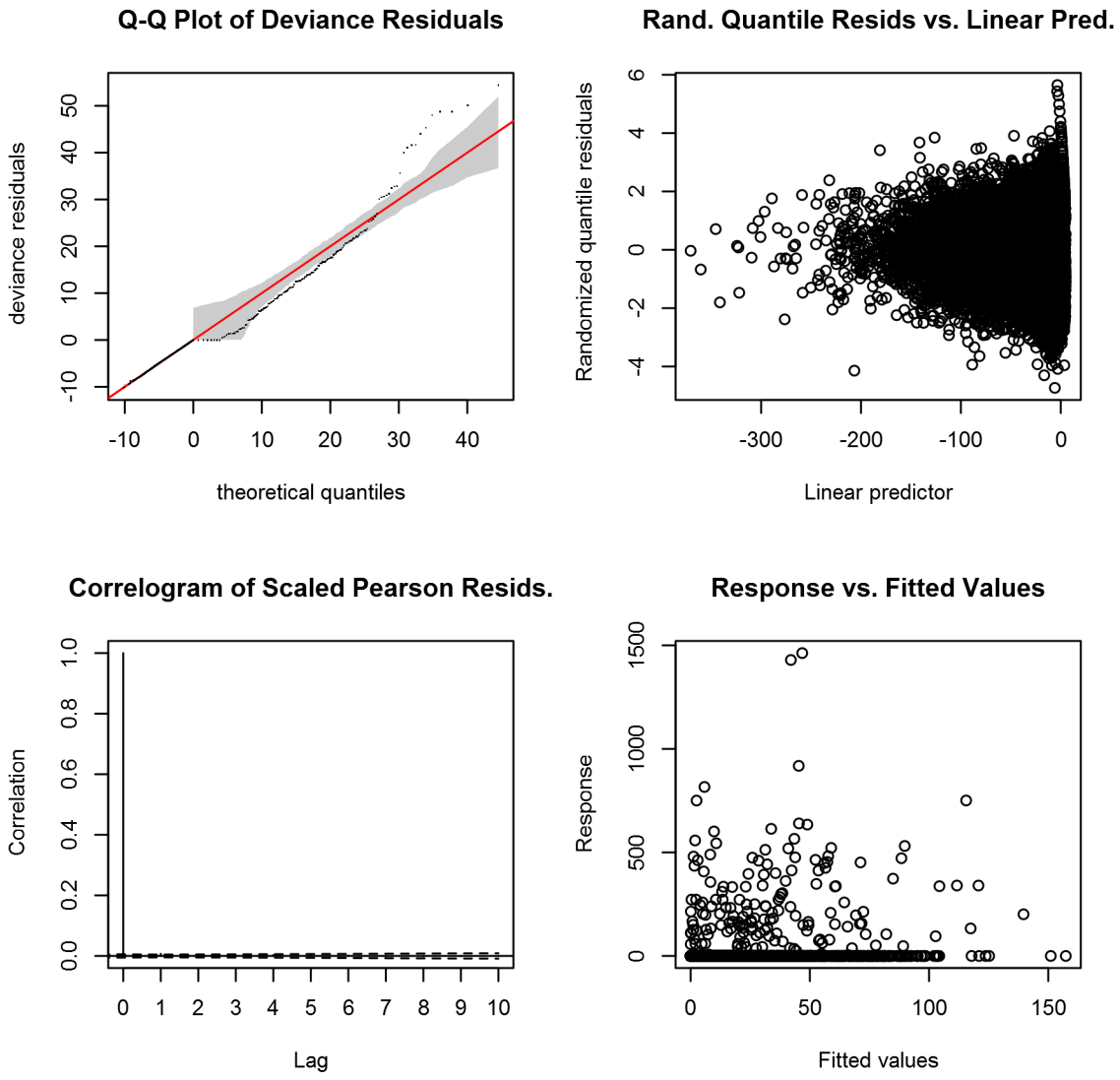


Figure 94: Statistical diagnostic plots for the Striped dolphin Climatological model, Surveyed Area.

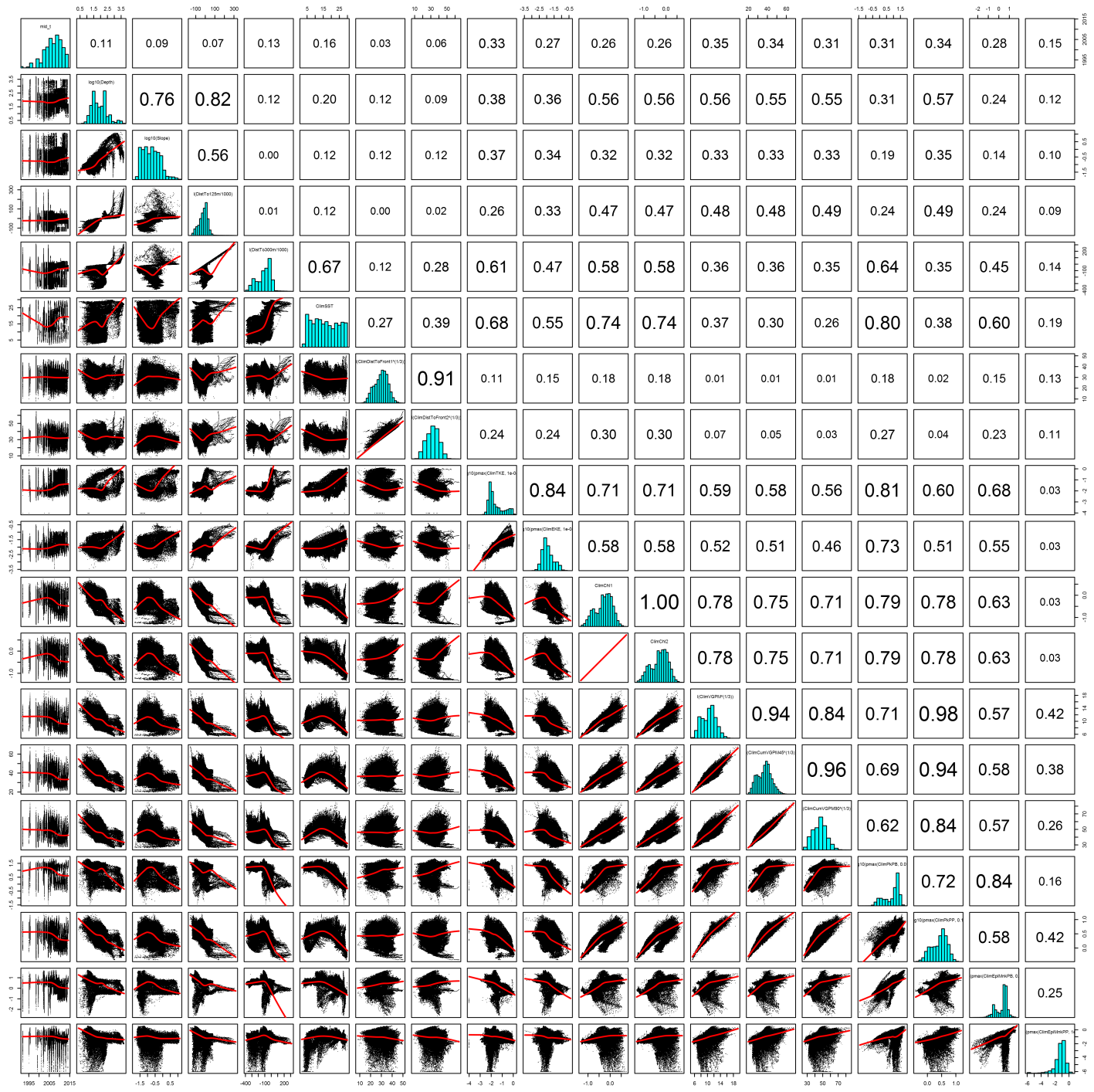


Figure 95: Scatterplot matrix for the Striped dolphin Climatological model, Surveyed Area. This plot is used to inspect the distribution of predictors (via histograms along the diagonal), simple correlation between predictors (via pairwise Pearson coefficients above the diagonal), and linearity of predictor correlations (via scatterplots below the diagonal). This plot is best viewed at high magnification.

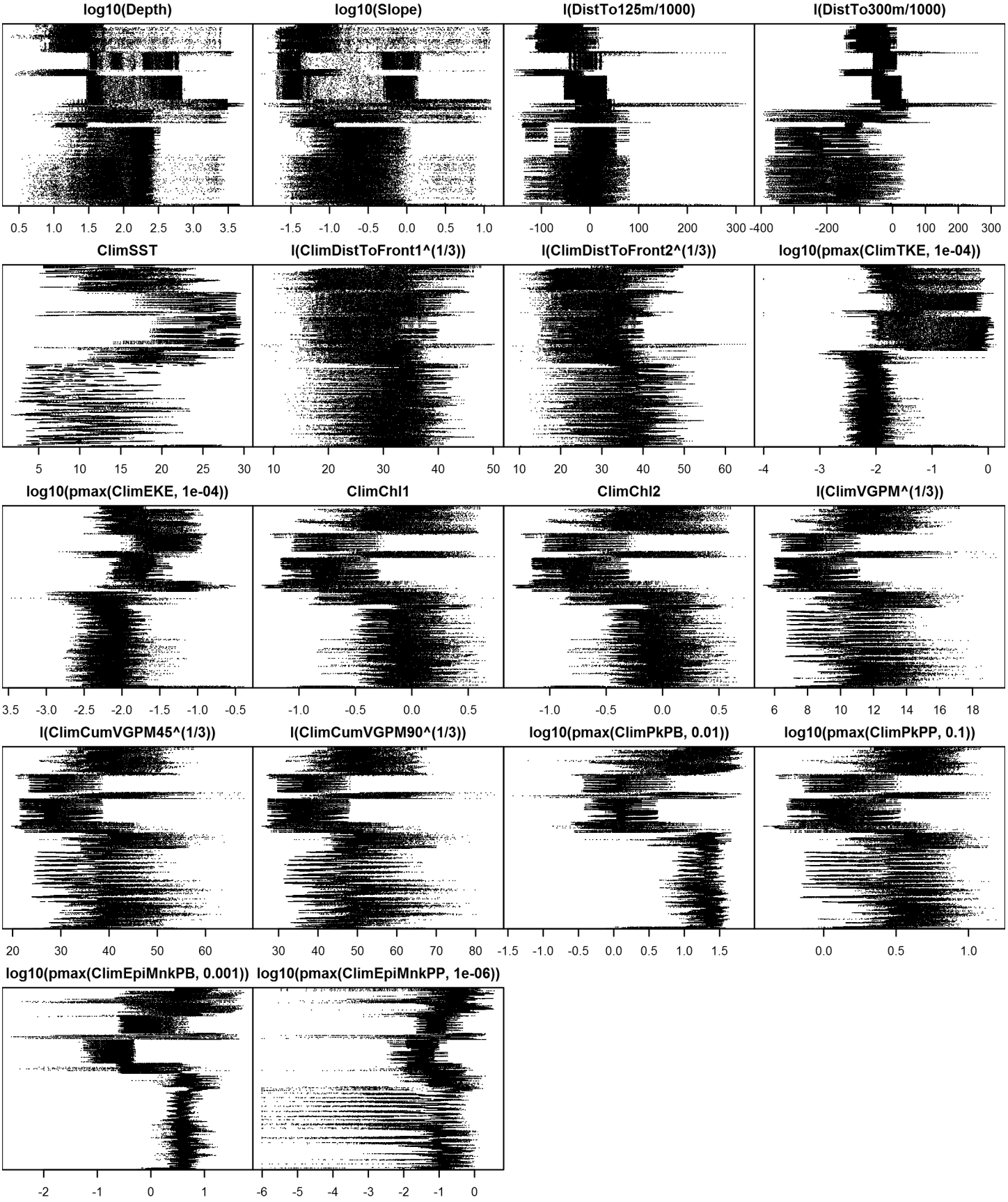


Figure 96: Dotplot for the Striped dolphin Climatological model, Surveyed Area. This plot is used to check for suspicious patterns and outliers in the data. Points are ordered vertically by transect ID, sequentially in time.

Contemporaneous Model

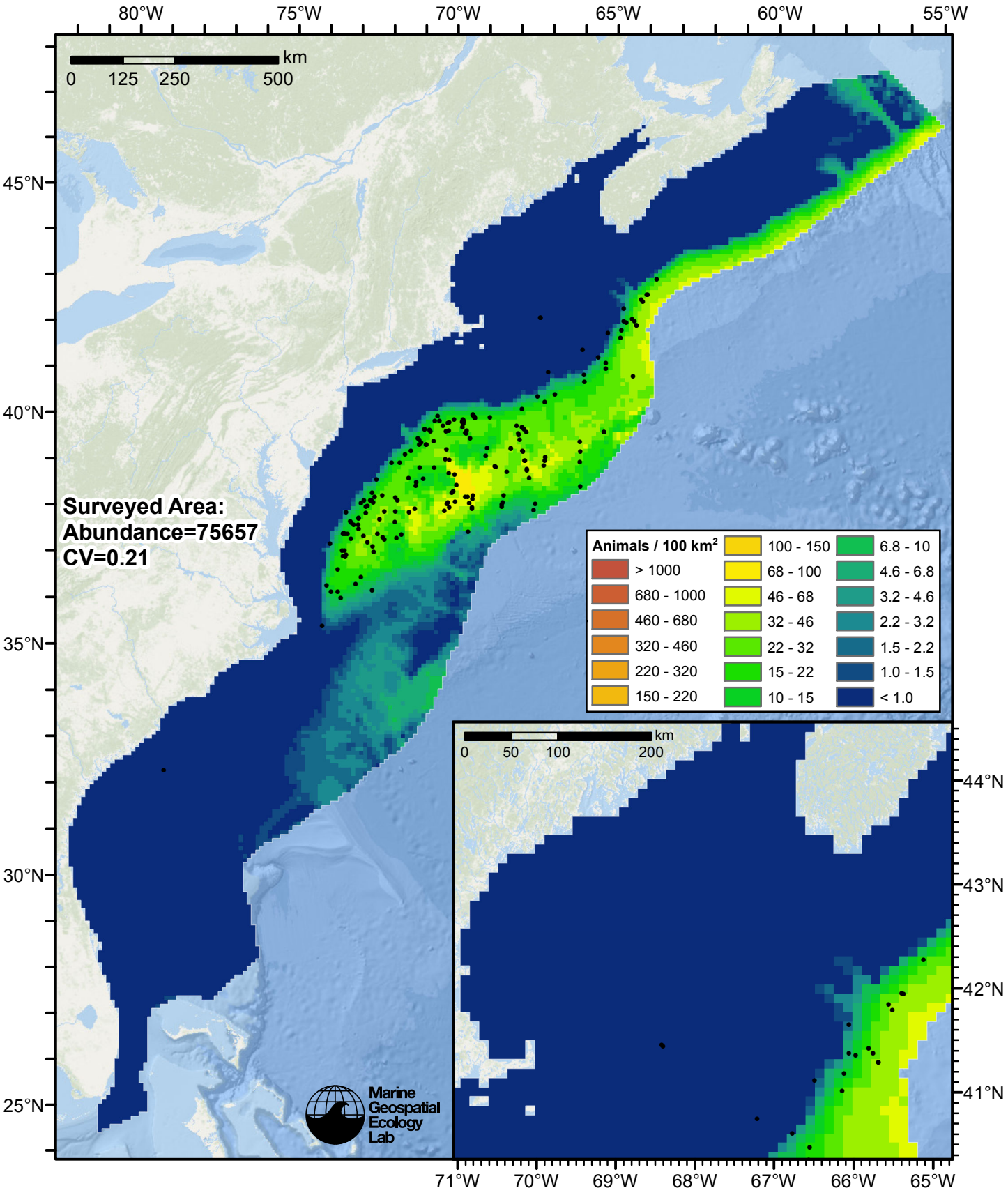


Figure 97: Striped dolphin density predicted by the contemporaneous model that explained the most deviance. Pixels are 10x10 km. The legend gives the estimated individuals per pixel; breaks are logarithmic. Abundance for each region was computed by summing the density cells occuring in that region.

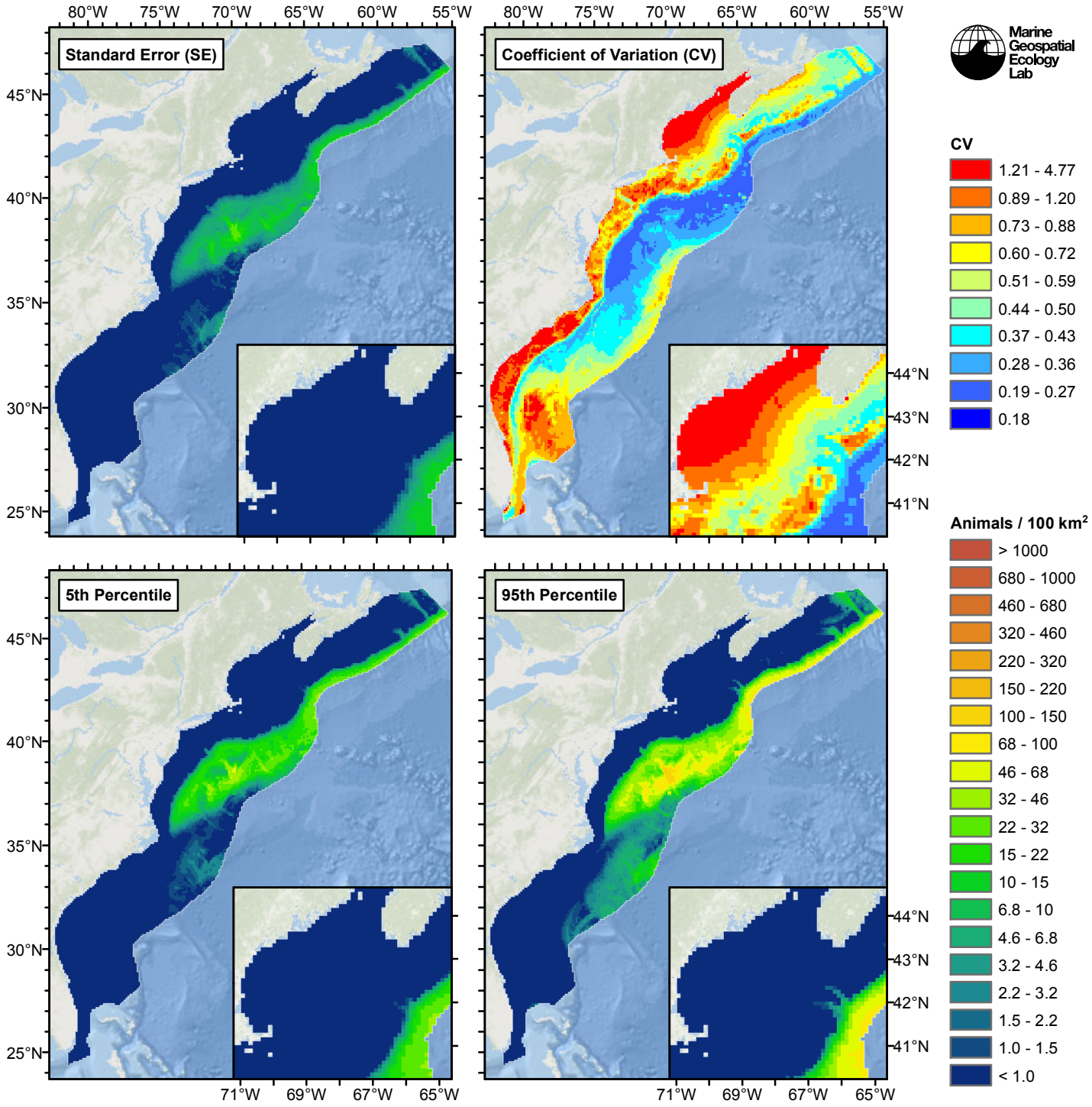


Figure 98: Estimated uncertainty for the contemporaneous model that explained the most deviance. These estimates only incorporate the statistical uncertainty estimated for the spatial model (by the R mgcv package). They do not incorporate uncertainty in the detection functions, g(0) estimates, predictor variables, and so on.

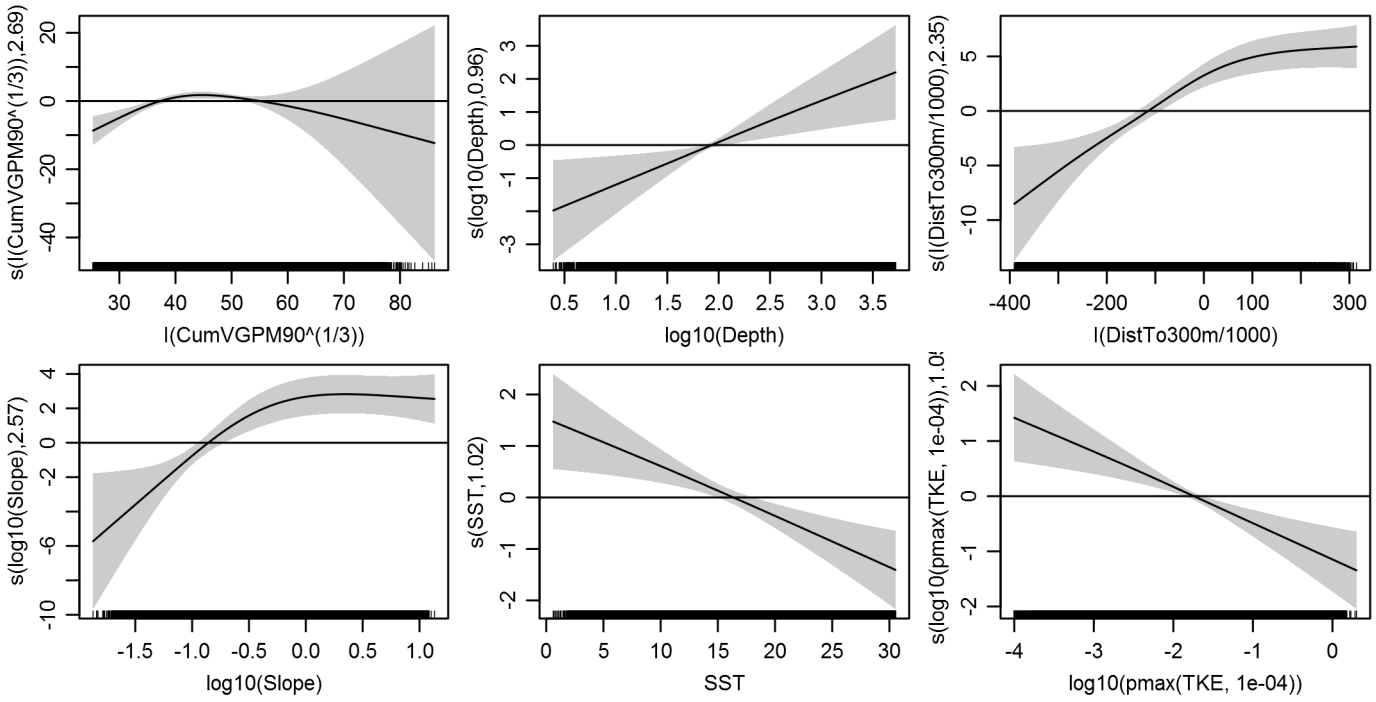
Surveyed Area

Statistical output

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


Family: Tweedie(p=1.282)
```

```
Link function: log

Formula:
abundance ~ offset(log(area_km2)) + s(log10(Depth), bs = "ts",
    k = 5) + s(log10(Slope), bs = "ts", k = 5) + s(I(DistTo300m/1000),
    bs = "ts", k = 5) + s(SST, bs = "ts", k = 5) + s(log10(pmax(TKE,
    1e-04)), bs = "ts", k = 5) + s(I(CumVGPM90^(1/3)), bs = "ts",
    k = 5)

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) -11.1437     0.6825  -16.33   <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))            0.9596      4  2.410 0.000488 ***
s(log10(Slope))            2.5735      4  6.649 4.74e-07 ***
s(I(DistTo300m/1000))      2.3510      4 11.656 4.90e-12 ***
s(SST)                     1.0200      4  3.558 7.42e-05 ***
s(log10(pmax(TKE, 1e-04))) 1.0473      4  4.271 1.66e-05 ***
s(I(CumVGPM90^(1/3)))      2.6897      4 10.204 5.08e-10 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.0607   Deviance explained = 76.2%
-REML = 1436.7  Scale est. = 177.21    n = 100027

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 12 iterations.
Gradient range [-1.522488e-05,1.491069e-05]
(score 1436.691 & scale 177.2083).
Hessian positive definite, eigenvalue range [0.3249201,452.0683].
Model rank =  25 / 25

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 0.960   0.884    0.00
s(log10(Slope))            4.000 2.573   0.894    0.00
s(I(DistTo300m/1000))      4.000 2.351   0.940    0.01
s(SST)                     4.000 1.020   0.915    0.00
s(log10(pmax(TKE, 1e-04))) 4.000 1.047   0.943    0.03
s(I(CumVGPM90^(1/3)))      4.000 2.690   0.929    0.00

Predictors retained during the model selection procedure: Depth, Slope, DistTo300m, SST, TKE,
CumVGPM90

Predictors dropped during the model selection procedure: DistTo125m, DistToFront2
```

Model term plots



Diagnostic plots

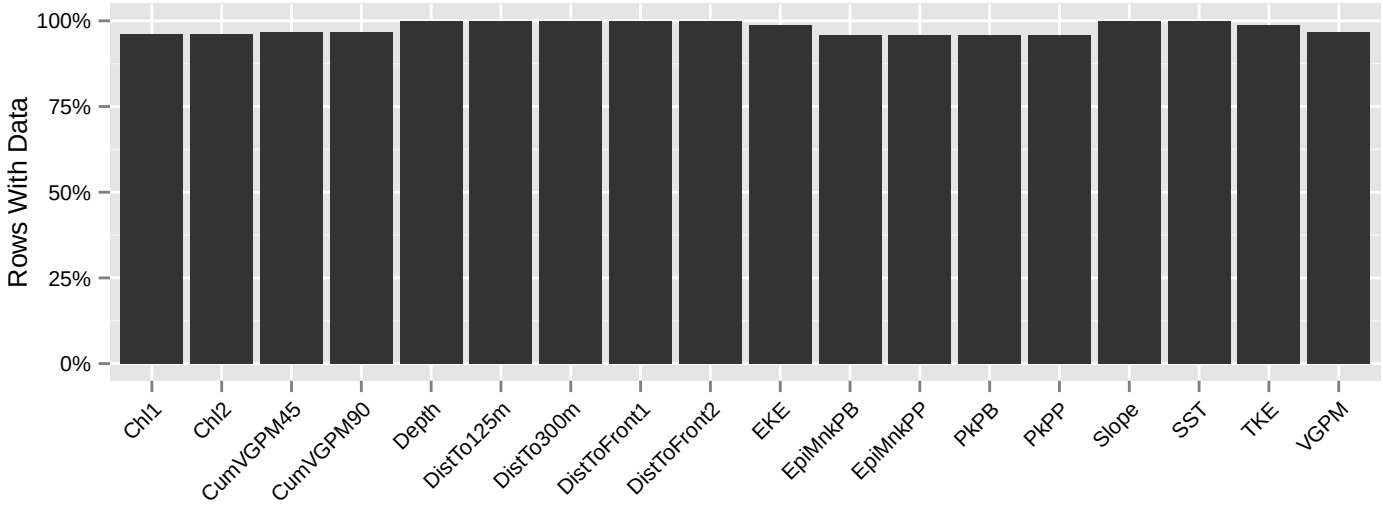


Figure 99: Segments with predictor values for the Striped dolphin Contemporaneous model, Surveyed Area. This plot is used to assess how many segments would be lost by including a given predictor in a model.

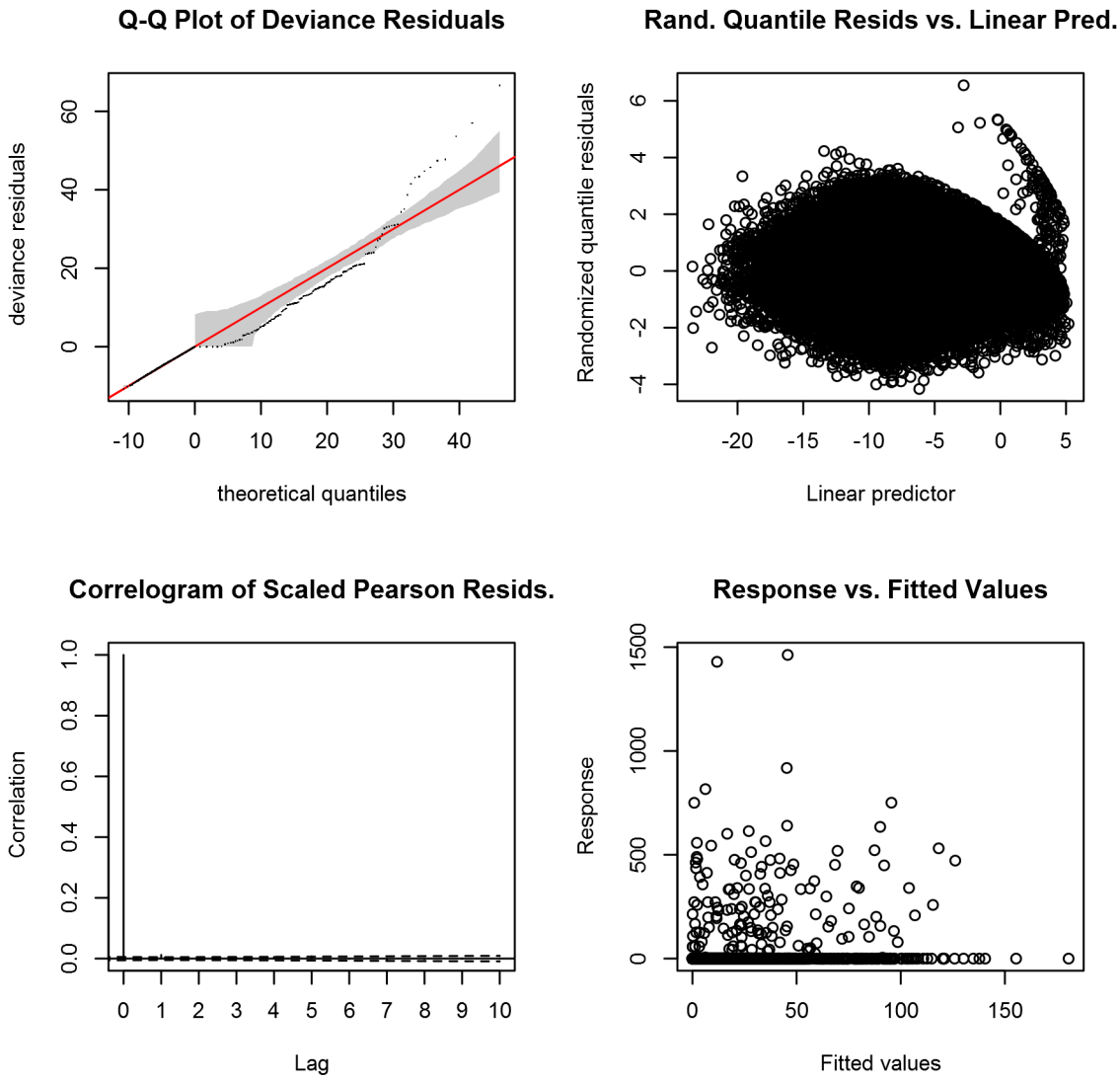


Figure 100: Statistical diagnostic plots for the Striped dolphin Contemporaneous model, Surveyed Area.

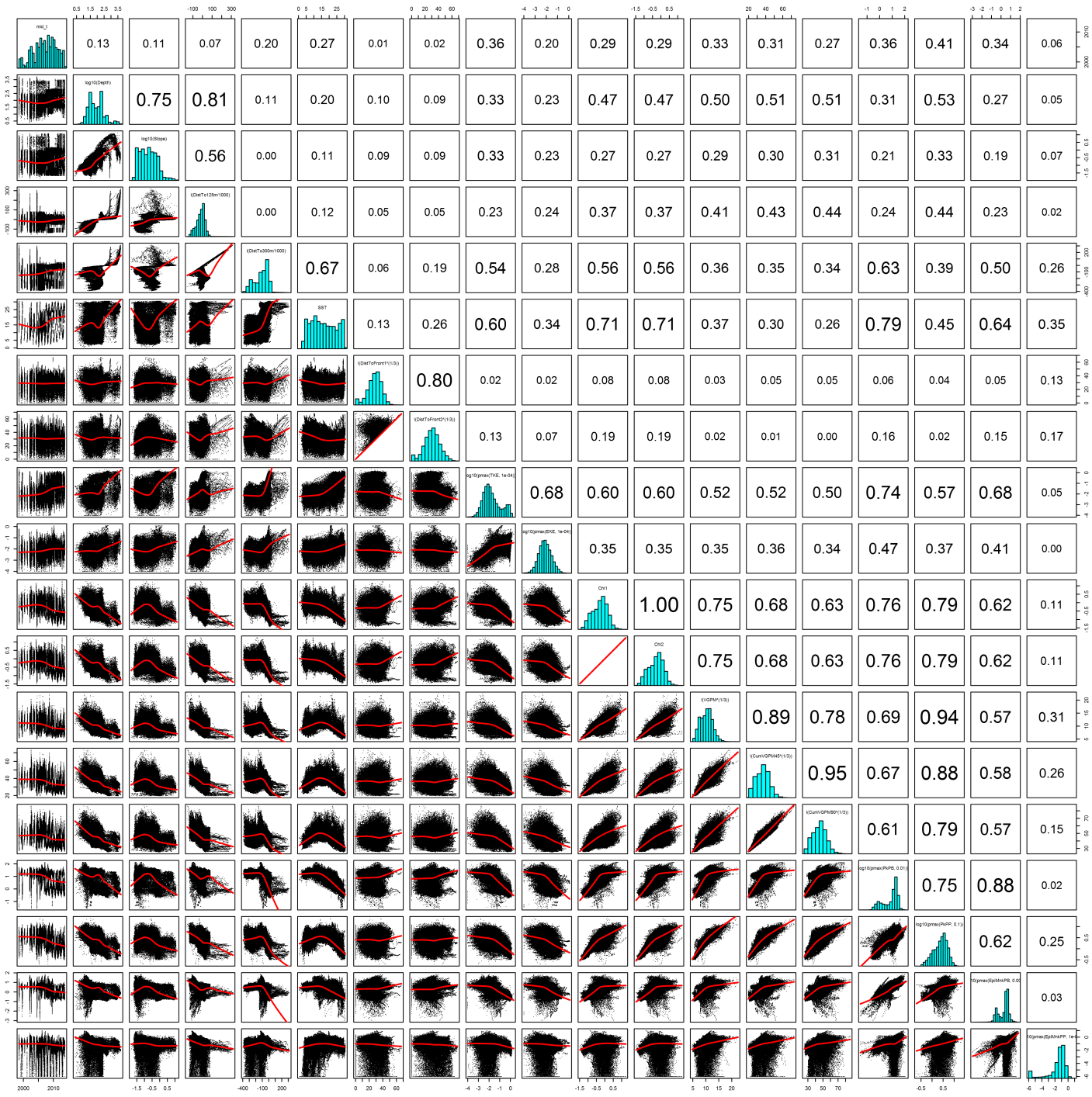


Figure 101: Scatterplot matrix for the Striped dolphin Contemporaneous model, Surveyed Area. This plot is used to inspect the distribution of predictors (via histograms along the diagonal), simple correlation between predictors (via pairwise Pearson coefficients above the diagonal), and linearity of predictor correlations (via scatterplots below the diagonal). This plot is best viewed at high magnification.

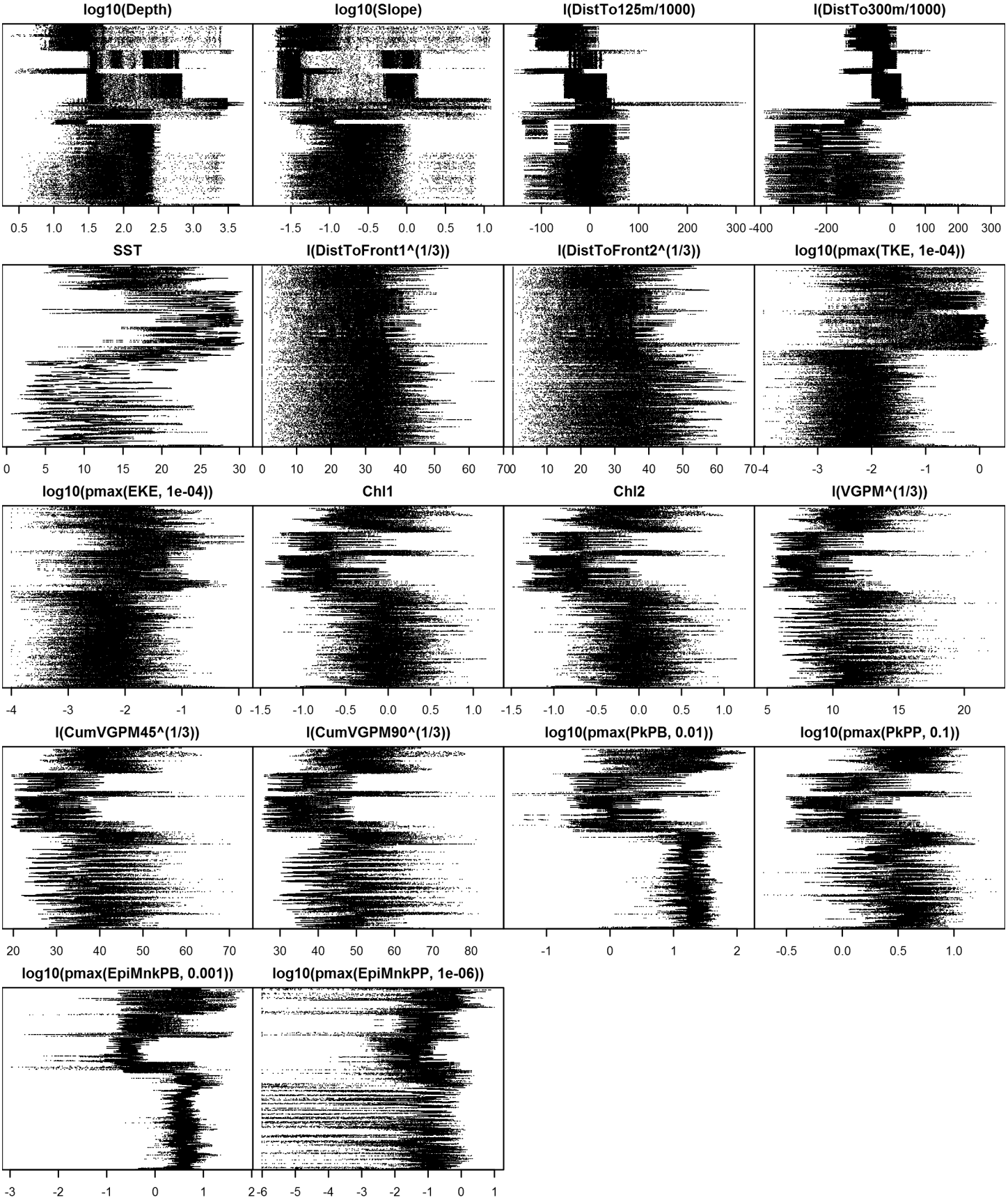


Figure 102: Dotplot for the Striped dolphin Contemporaneous model, Surveyed Area. This plot is used to check for suspicious patterns and outliers in the data. Points are ordered vertically by transect ID, sequentially in time.

Climatological Same Segments Model

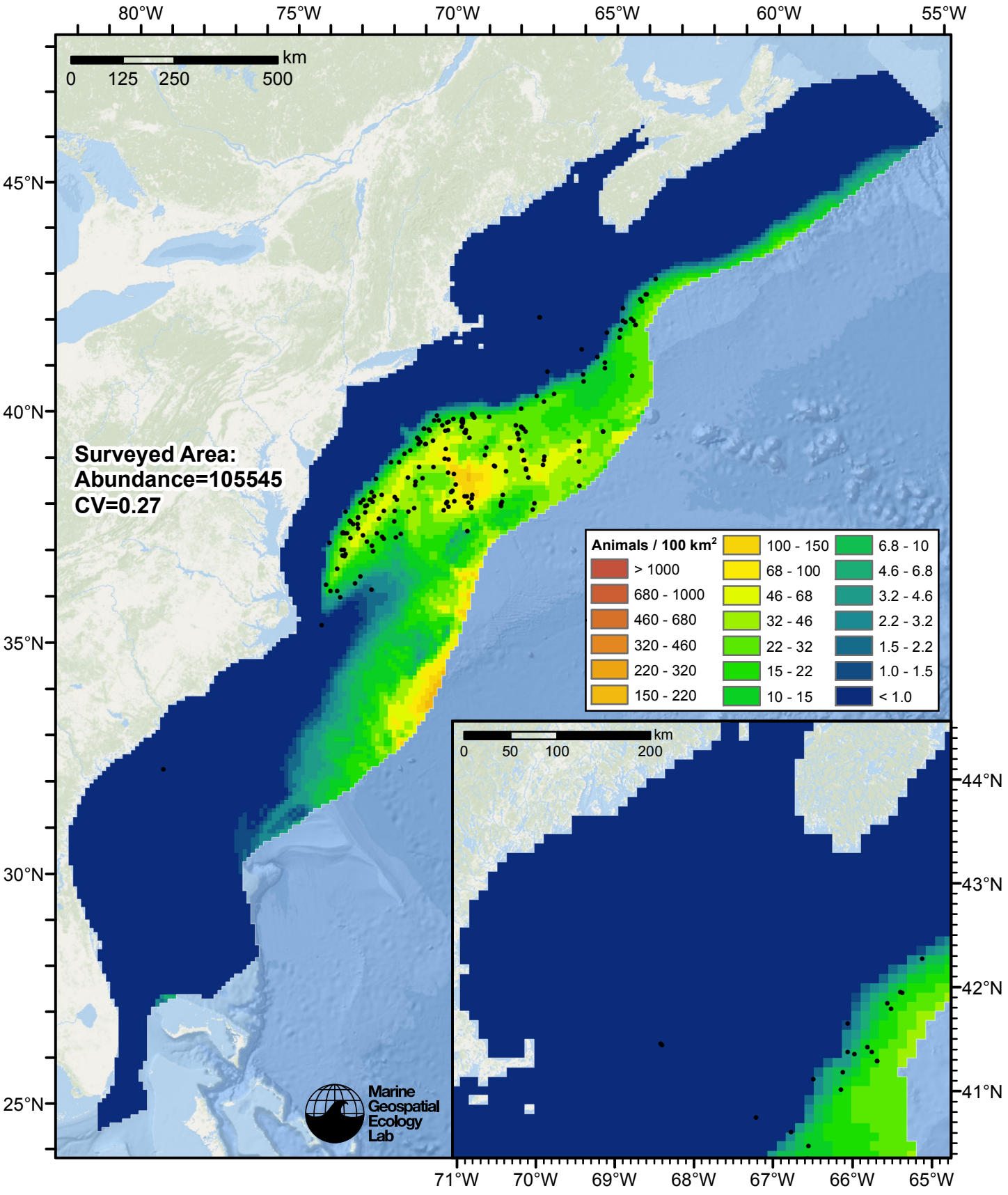


Figure 103: Striped dolphin density predicted by the climatological same segments model that explained the most deviance. Pixels are 10x10 km. The legend gives the estimated individuals per pixel; breaks are logarithmic. Abundance for each region was computed by summing the density cells occuring in that region.

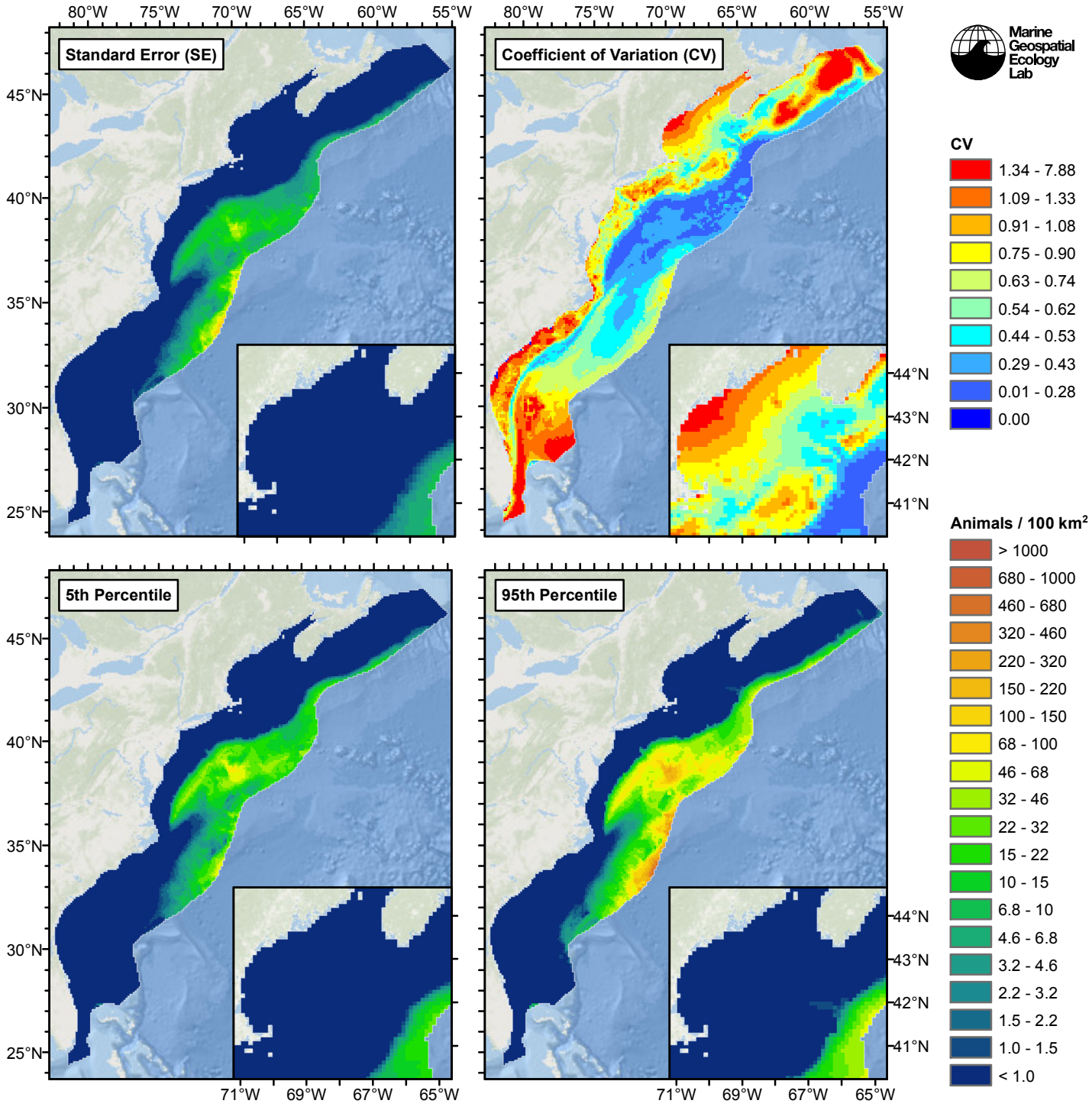


Figure 104: Estimated uncertainty for the climatological same segments model that explained the most deviance. These estimates only incorporate the statistical uncertainty estimated for the spatial model (by the R mgcv package). They do not incorporate uncertainty in the detection functions, g(0) estimates, predictor variables, and so on.

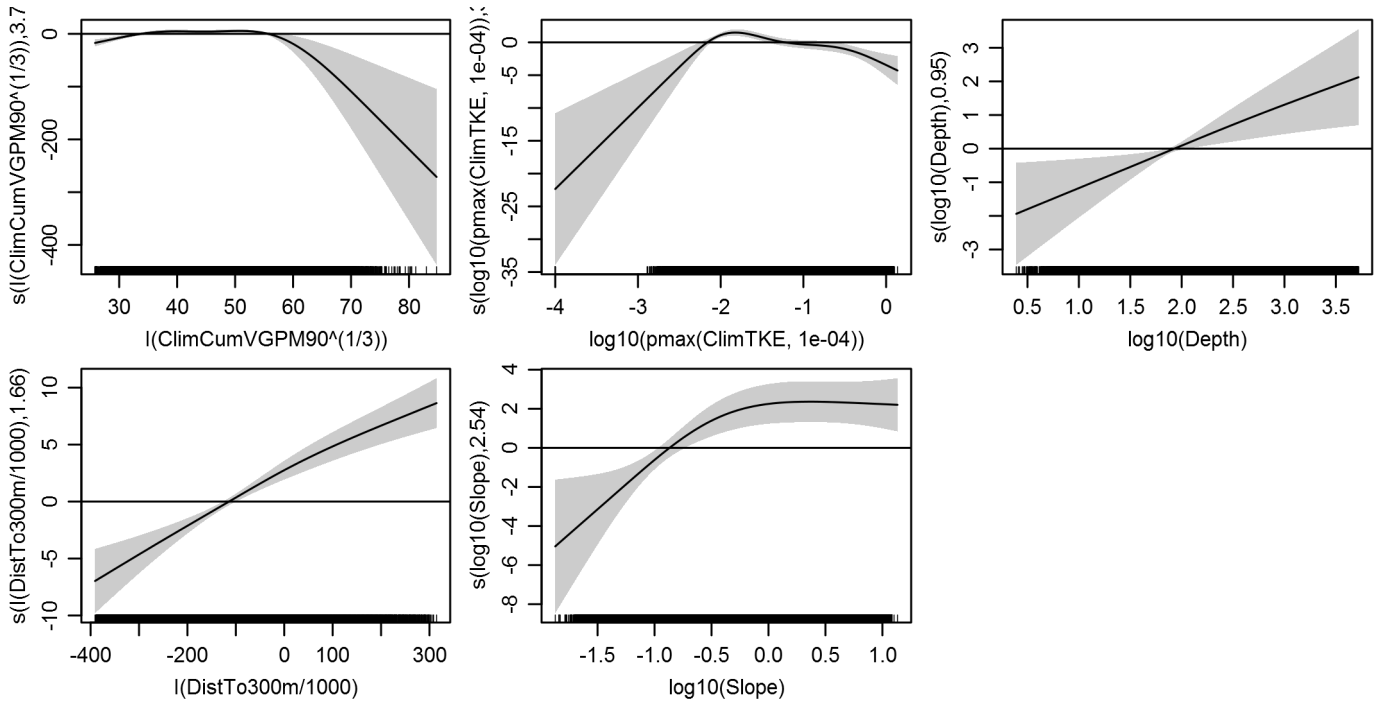
Surveyed Area

Statistical output

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


Family: Tweedie(p=1.284)
```

```
Link function: log

Formula:
abundance ~ offset(log(area_km2)) + s(log10(Depth), bs = "ts",
    k = 5) + s(log10(Slope), bs = "ts", k = 5) + s(I(DistTo300m/1000),
    bs = "ts", k = 5) + s(log10(pmax(ClimTKE, 1e-04)), bs = "ts",
    k = 5) + s(I(ClimCumVGPM90^(1/3)), bs = "ts", k = 5)

Parametric coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  -14.431      1.544  -9.344   <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))                0.9544      4  2.262  0.00118 **
s(log10(Slope))                2.5440      4  5.188 1.26e-05 ***
s(I(DistTo300m/1000))          1.6617      4 17.007  < 2e-16 ***
s(log10(pmax(ClimTKE, 1e-04))) 3.6995      4 13.573 4.10e-12 ***
s(I(ClimCumVGPM90^(1/3)))      3.7450      4  9.158 7.13e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.065   Deviance explained = 77.3%
-REML = 1436.4  Scale est. = 172.22    n = 100027

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 16 iterations.
Gradient range [-2.61183e-08,2.562867e-09]
(score 1436.422 & scale 172.2184).
Hessian positive definite, eigenvalue range [0.2708668,449.9687].
Model rank =  21 / 21

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 0.954   0.750    0.00
s(log10(Slope))                4.000 2.544   0.842    0.00
s(I(DistTo300m/1000))          4.000 1.662   0.851    0.00
s(log10(pmax(ClimTKE, 1e-04))) 4.000 3.699   0.904    0.04
s(I(ClimCumVGPM90^(1/3)))      4.000 3.745   0.882    0.00

Predictors retained during the model selection procedure: Depth, Slope, DistTo300m, ClimTKE,
ClimCumVGPM90

Predictors dropped during the model selection procedure: DistTo125m, ClimSST, ClimDistToFront2
```

Model term plots



Diagnostic plots

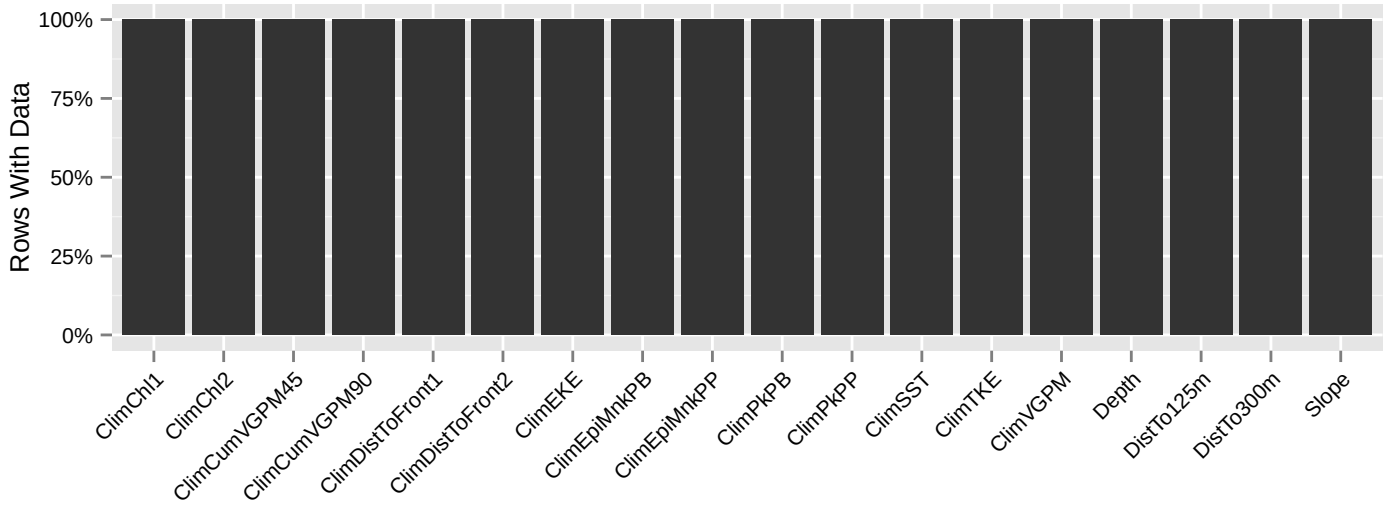


Figure 105: Segments with predictor values for the Striped dolphin Climatological model, Surveyed Area. This plot is used to assess how many segments would be lost by including a given predictor in a model.

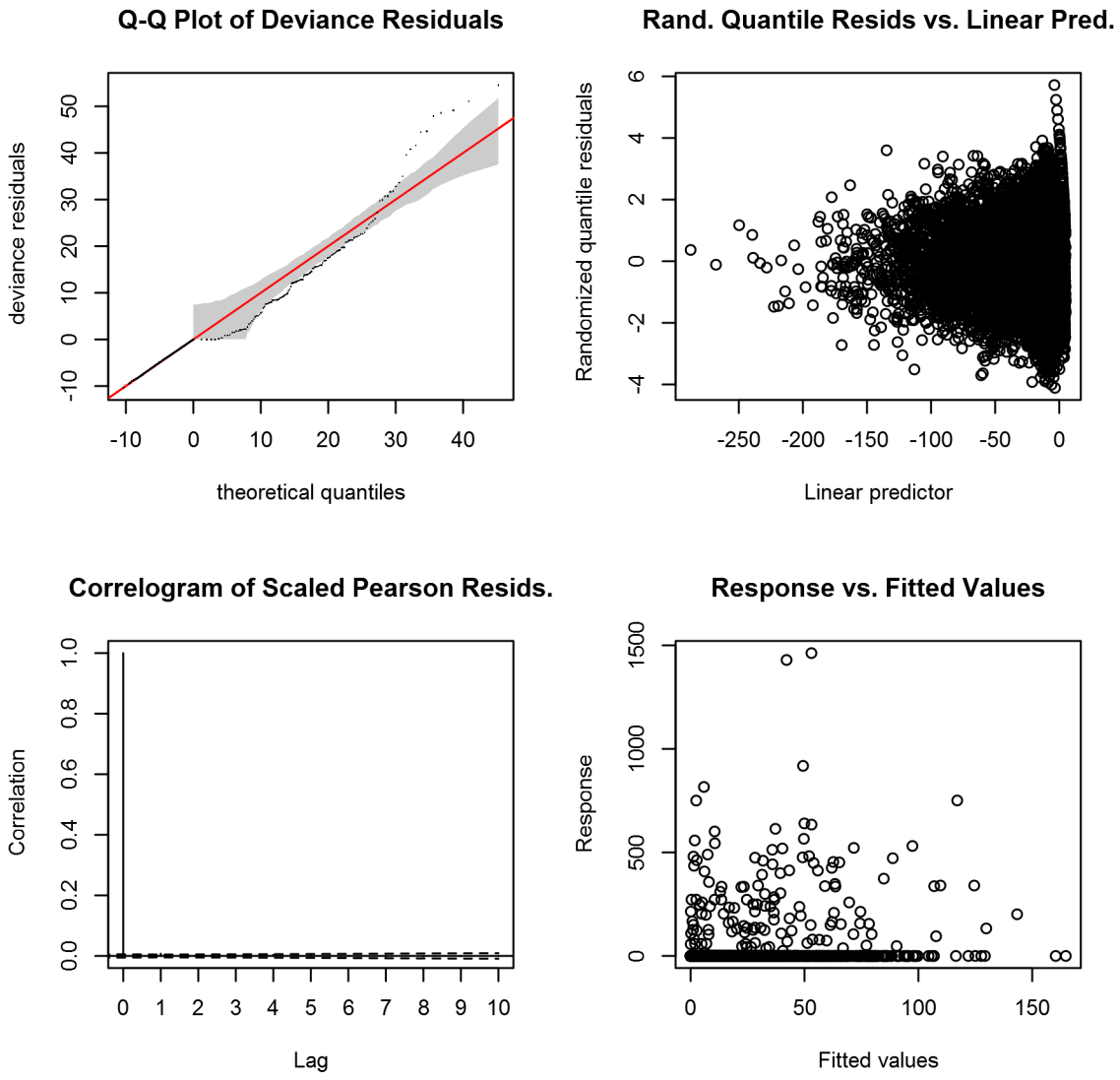


Figure 106: Statistical diagnostic plots for the Striped dolphin Climatological model, Surveyed Area.

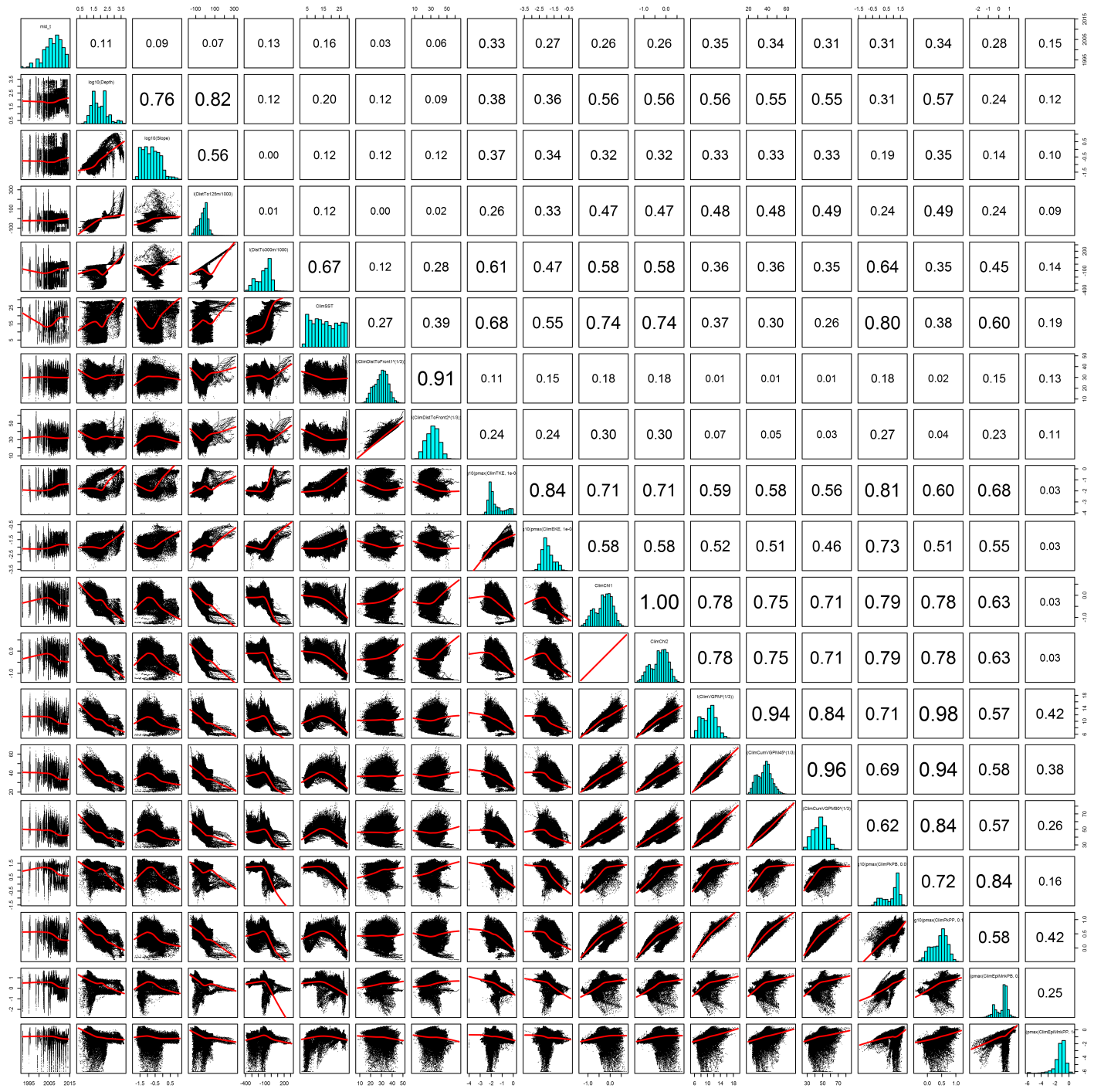


Figure 107: Scatterplot matrix for the Striped dolphin Climatological model, Surveyed Area. This plot is used to inspect the distribution of predictors (via histograms along the diagonal), simple correlation between predictors (via pairwise Pearson coefficients above the diagonal), and linearity of predictor correlations (via scatterplots below the diagonal). This plot is best viewed at high magnification.

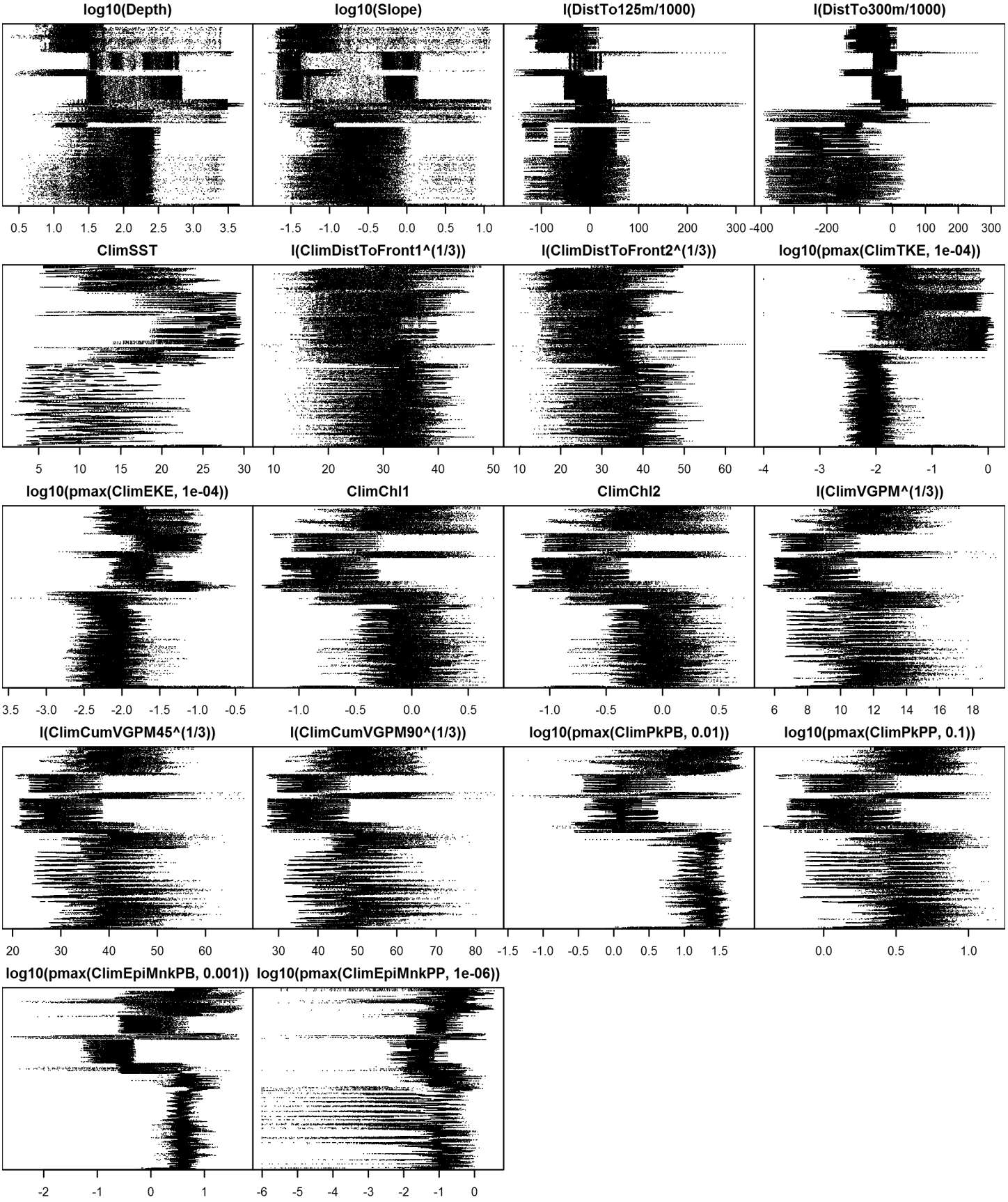


Figure 108: Dotplot for the Striped dolphin Climatological model, Surveyed Area. This plot is used to check for suspicious patterns and outliers in the data. Points are ordered vertically by transect ID, sequentially in time.

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	65.5			104236		1992-2014
Phys+SST	69.6	69.7	69.6	104236	0.0	1992-2014
Phys+SST+Curr	73.9	72.8	74.2	102911	1.3	1995-2013
Phys+SST+Curr+Prod	76.6	76.2	77.3	100027	4.0	1998-2013

Table 63: 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
1992-2014	Climatological model	117921	0.29	No	
1998-2013	Contemporaneous model*	75657	0.21	No	
1992-2014	Climatological same segments model	105545	0.27	No	

Jun-Aug 2011	Central Virginia to lower Bay of Fundy (Waring et al. 2014)	46882	0.33	No	No
Jun-Aug 2011	Central Florida to central Virginia (Waring et al. 2014)	7925	0.66	No	No
Jun-Aug 2011	Central Florida to lower Bay of Fundy, combined	54807	0.30	No	No
Jun-Aug 2004	Maryland to Bay of Fundy (Waring et al. 2013)	52055	0.57	No	Yes
Jun-Aug 2004	Florida to Maryland (Waring et al. 2013)	42407	0.53	No	Yes
Jun-Aug 2004	Florida to Bay of Fundy, combined	94462	0.40	No	Yes
Jul-Sep 1998	Maryland to Gulf of St. Lawrence (Waring et al. 2006)	39720	0.45	No	Yes
Jul-Aug 1998	Florida to Maryland (Waring et al. 2006)	10225	0.91	Yes	Yes
Jul-Aug 1998	Florida to Gulf of St. Lawrence, combined	49945	0.40	Yes/No	Yes

Table 64: 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

Climatological Model

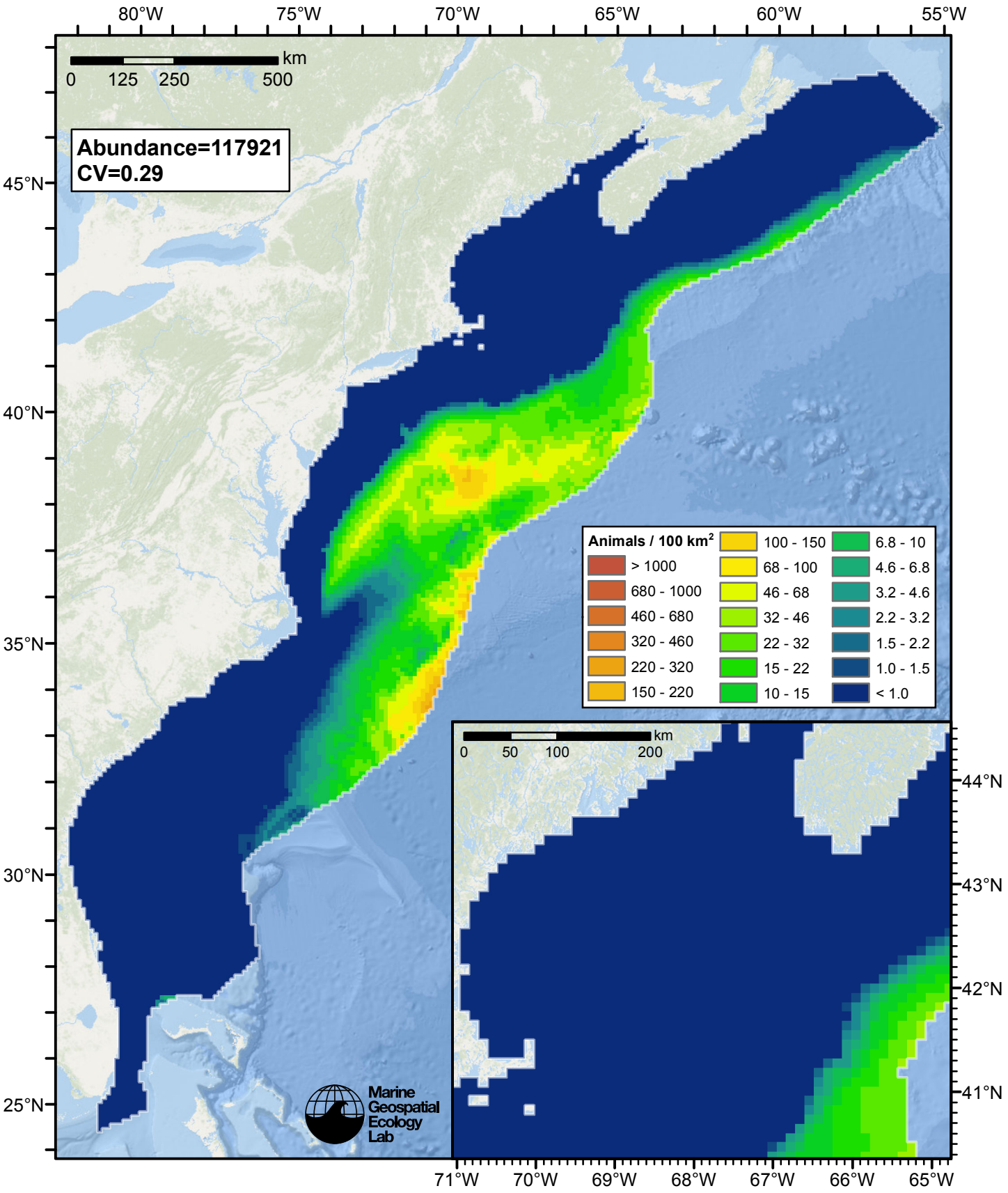


Figure 109: Striped dolphin density and abundance predicted by the climatological model that explained the most deviance. Regions inside the study area (white line) where the background map is visible are areas we did not model (see text).

Contemporaneous Model

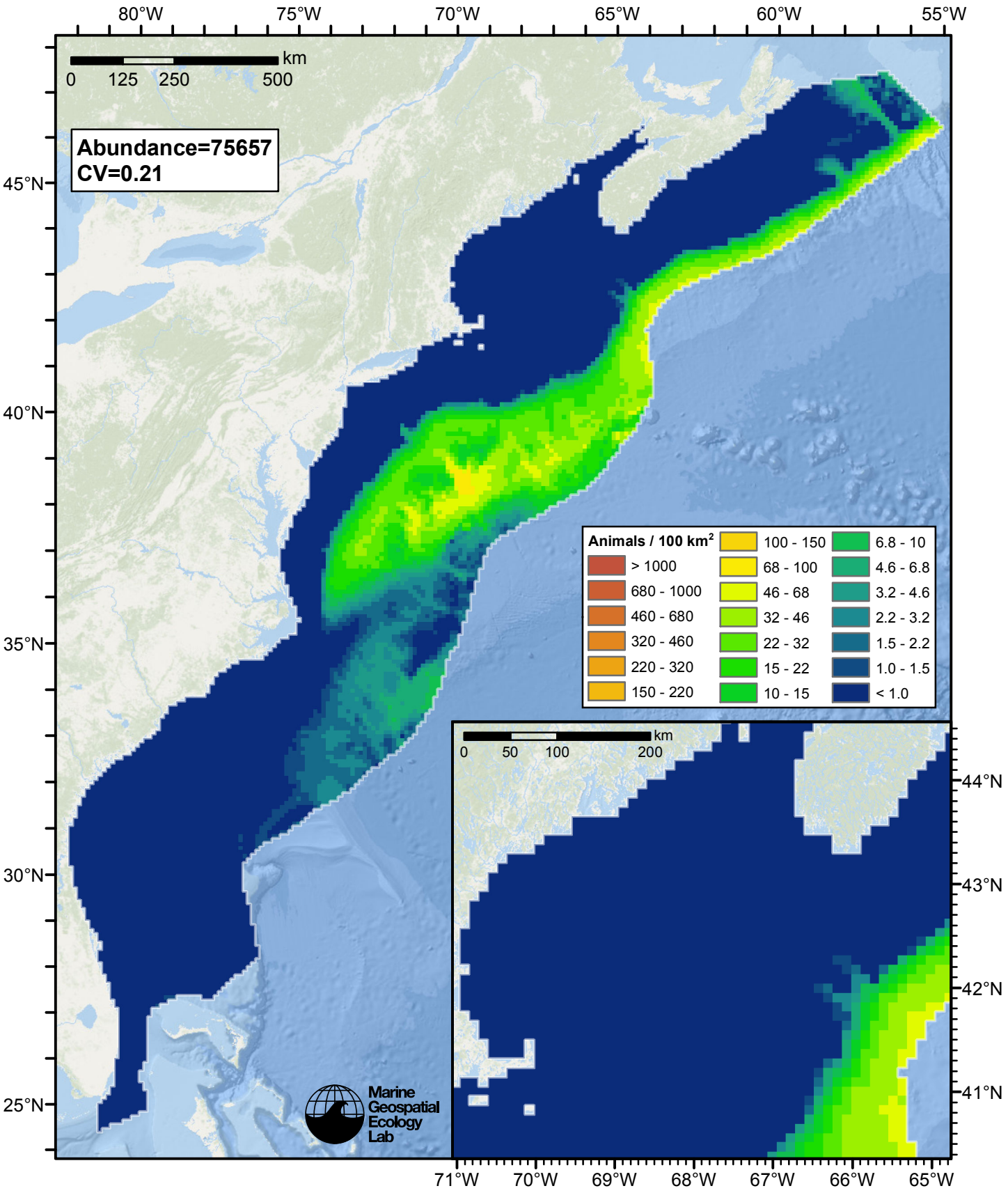


Figure 110: Striped dolphin density and abundance predicted by the contemporaneous model that explained the most deviance. Regions inside the study area (white line) where the background map is visible are areas we did not model (see text).

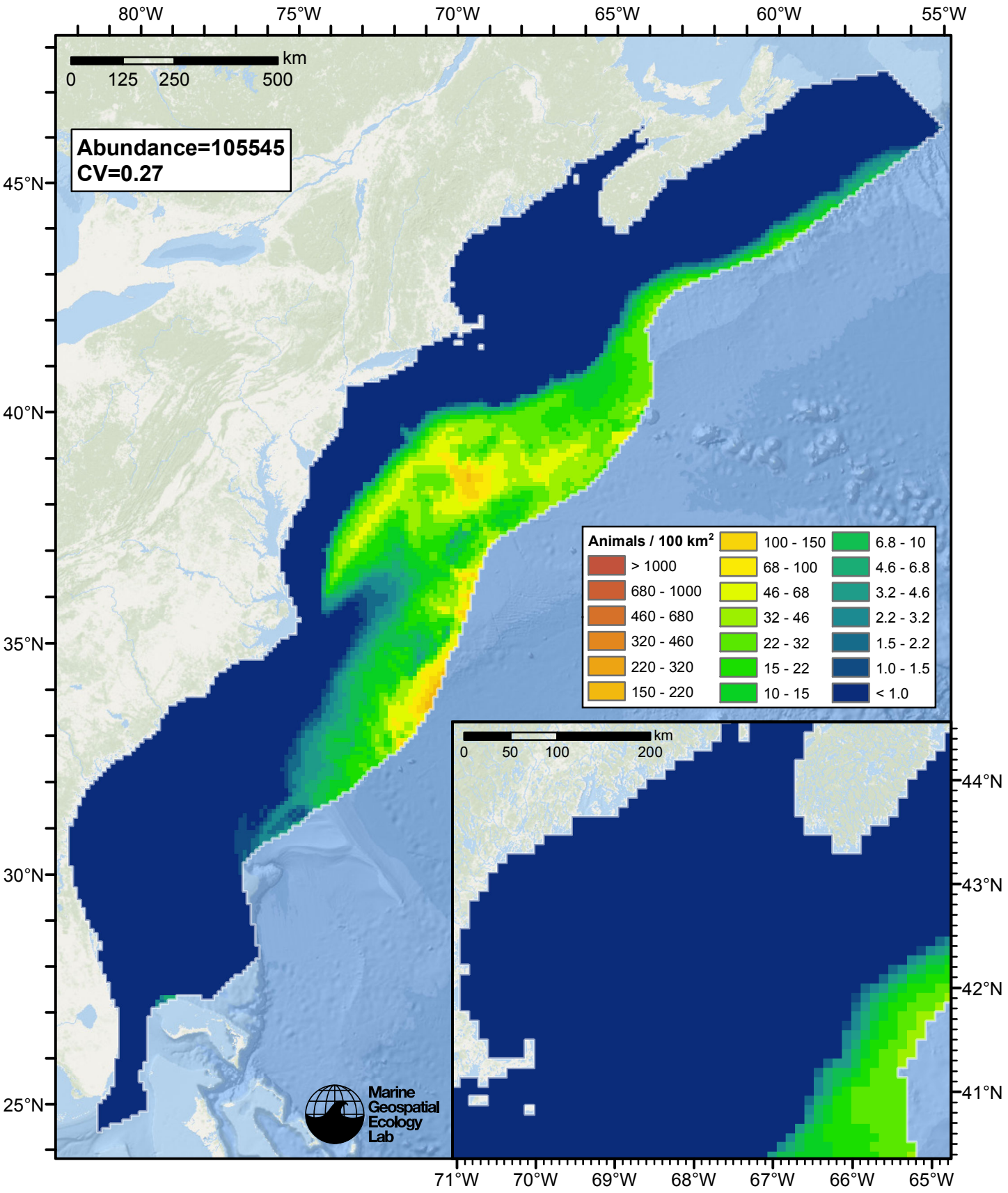


Figure 111: Striped dolphin density and abundance predicted by the climatological same segments model that explained the most deviance. Regions inside the study area (white line) where the background map is visible are areas we did not model (see text).

Temporal Variability

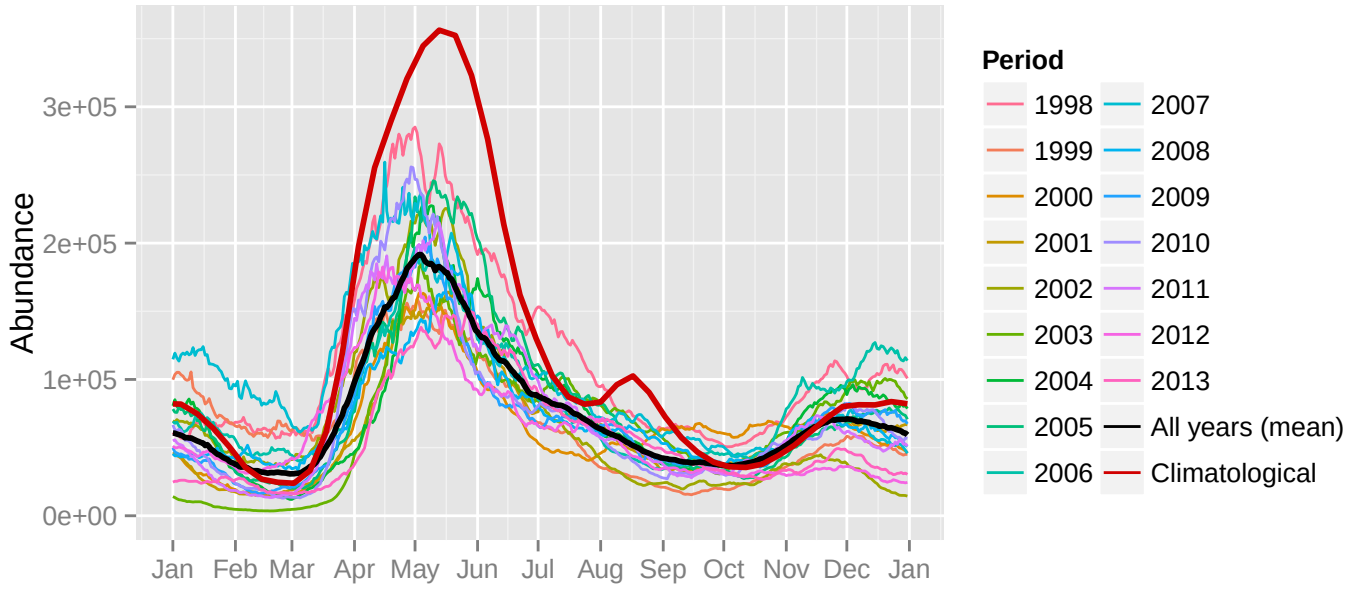


Figure 112: Comparison of Striped dolphin abundance predicted at a daily time step for different time periods. Individual years were predicted using contemporaneous models. "All years (mean)" averages the individual years, giving the mean annual abundance of the contemporaneous model. "Climatological" was predicted using the climatological model. The results for the climatological same segments model are not shown.

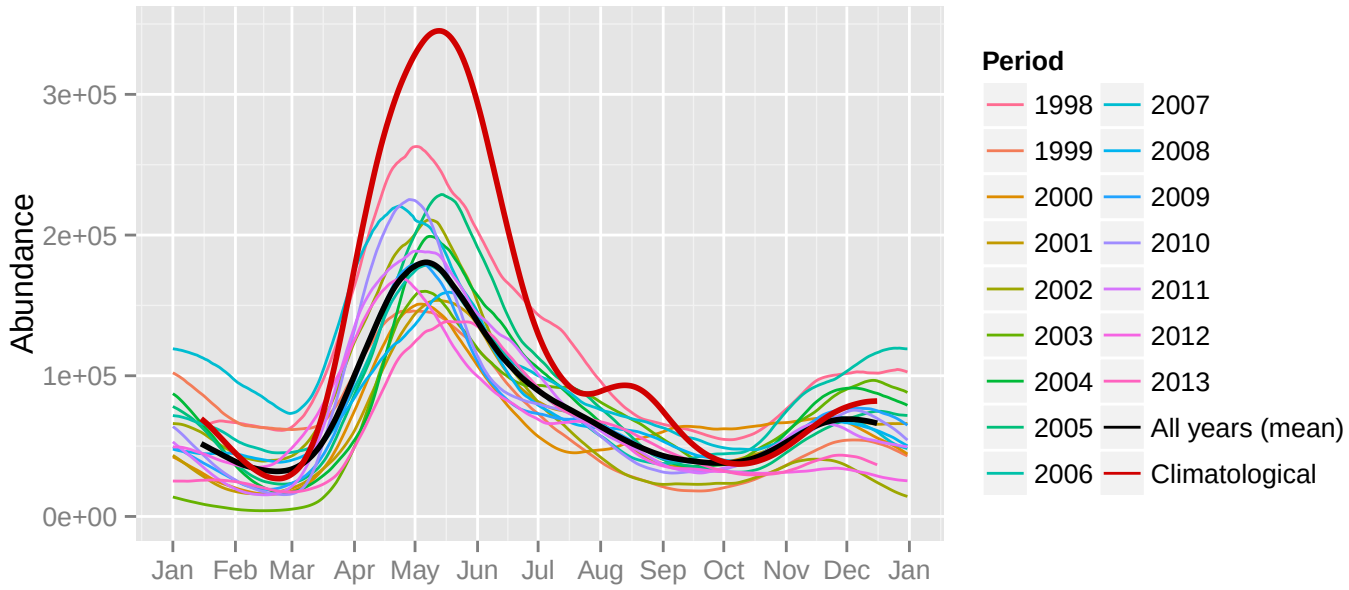
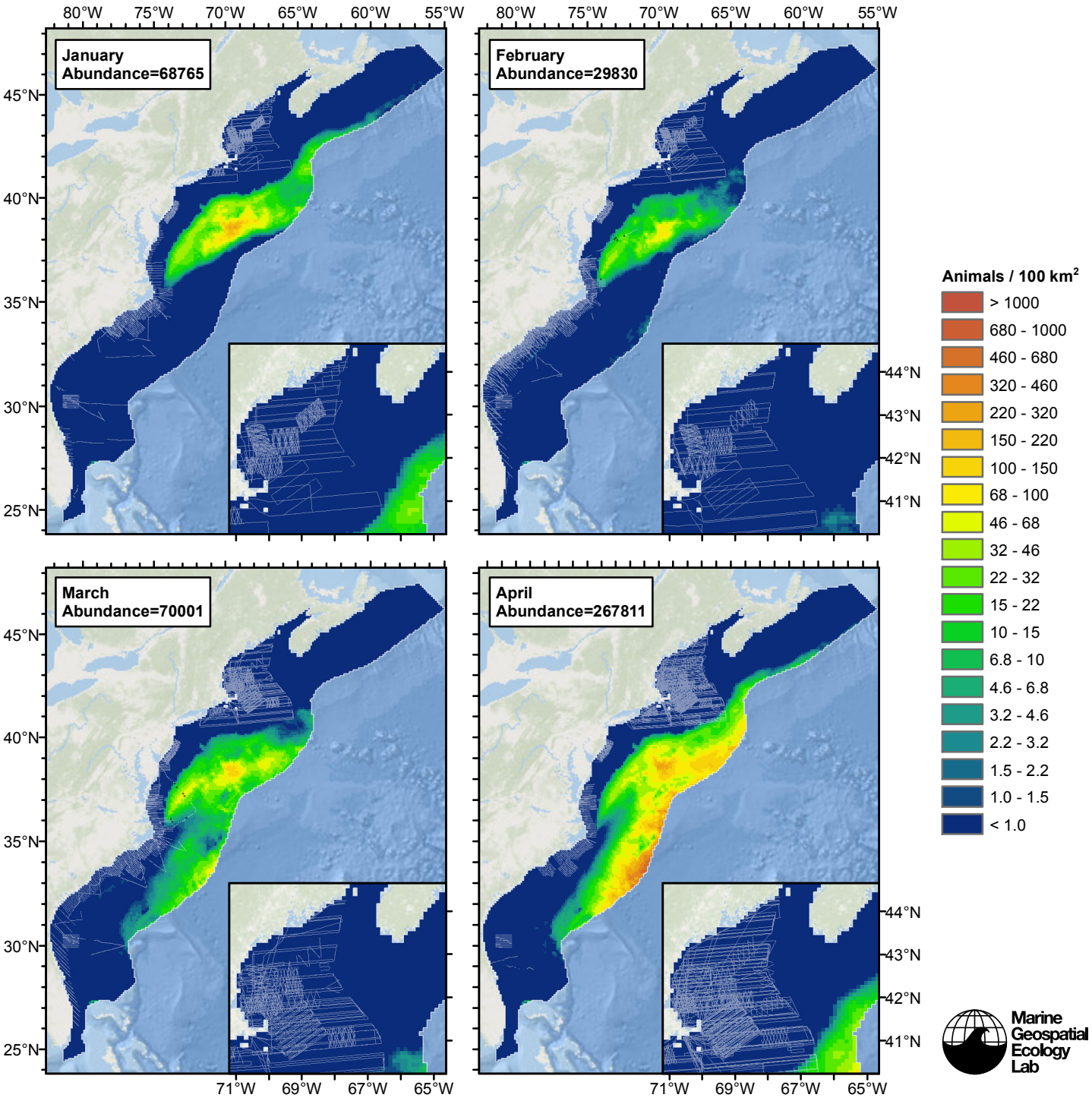
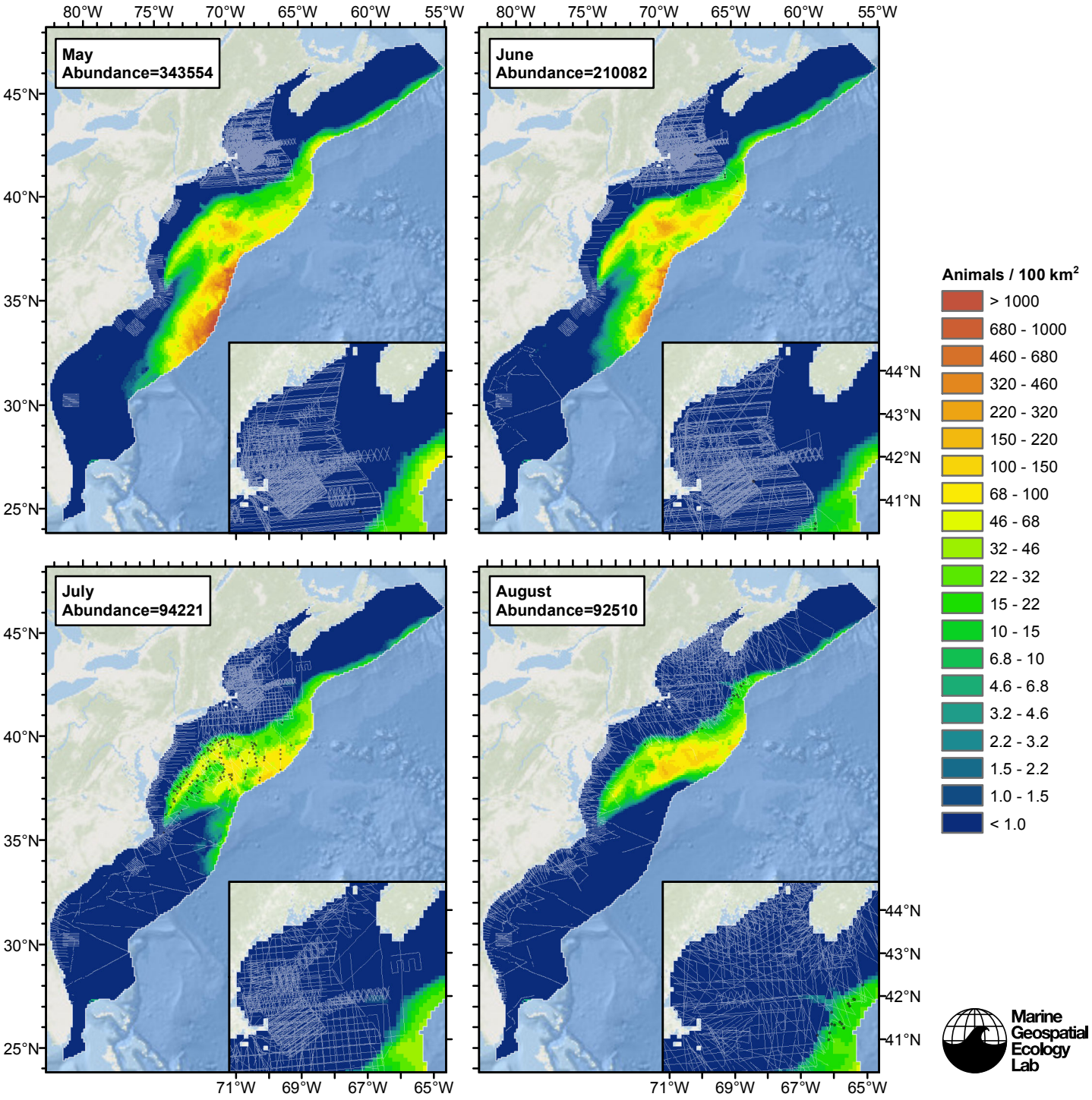
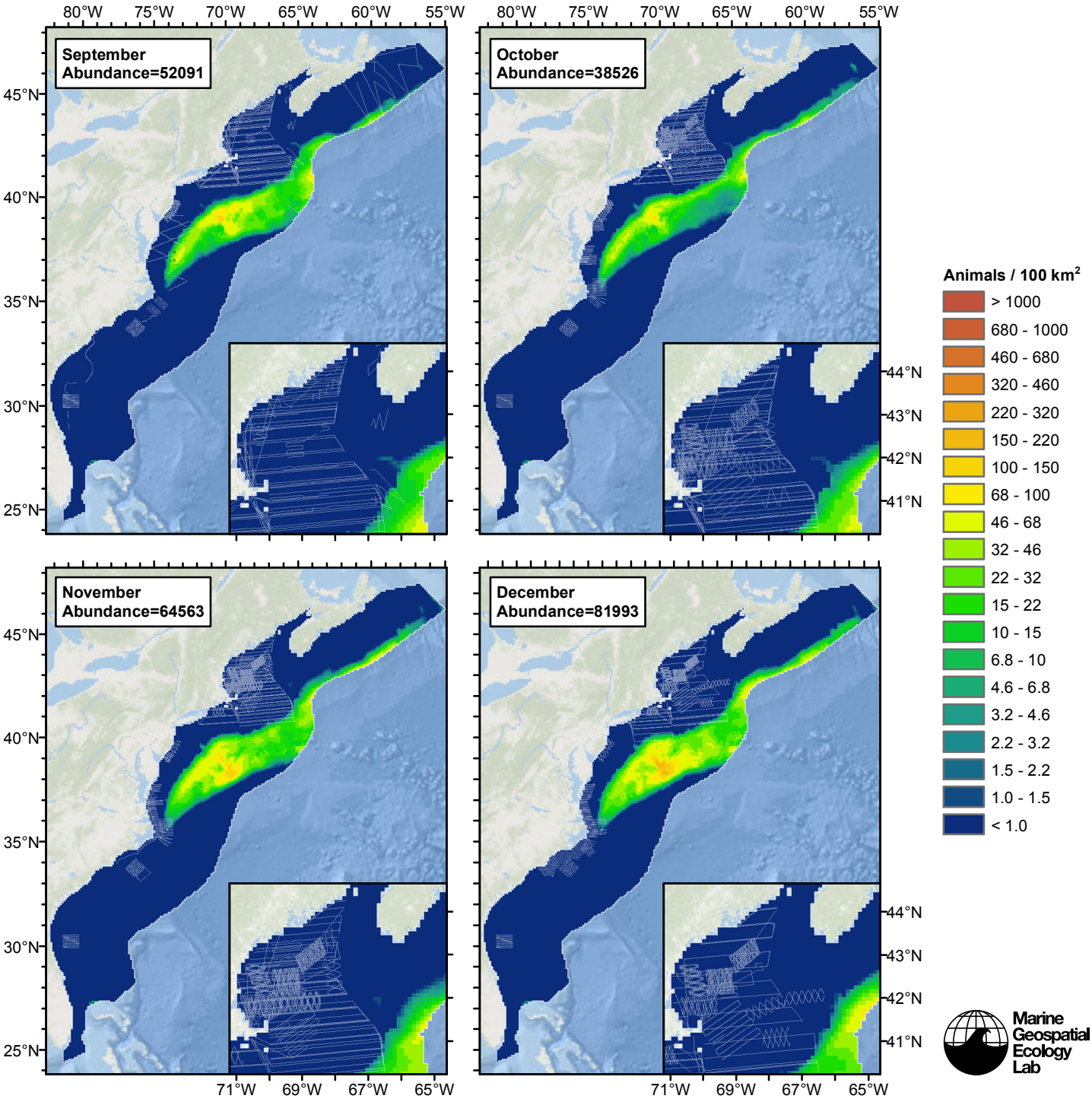


Figure 113: The same data as the preceding figure, but with a 30-day moving average applied.

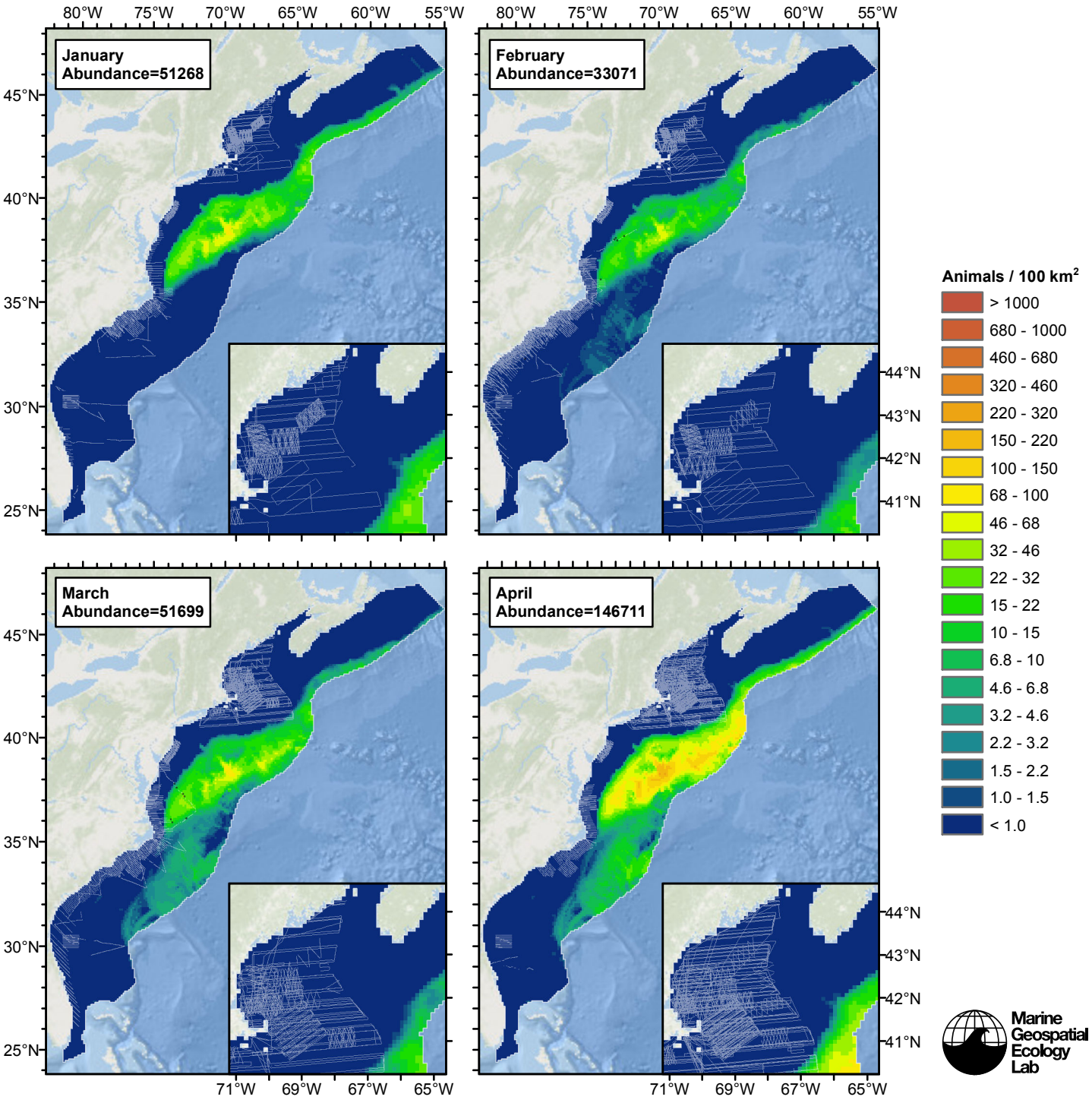
Climatological Model

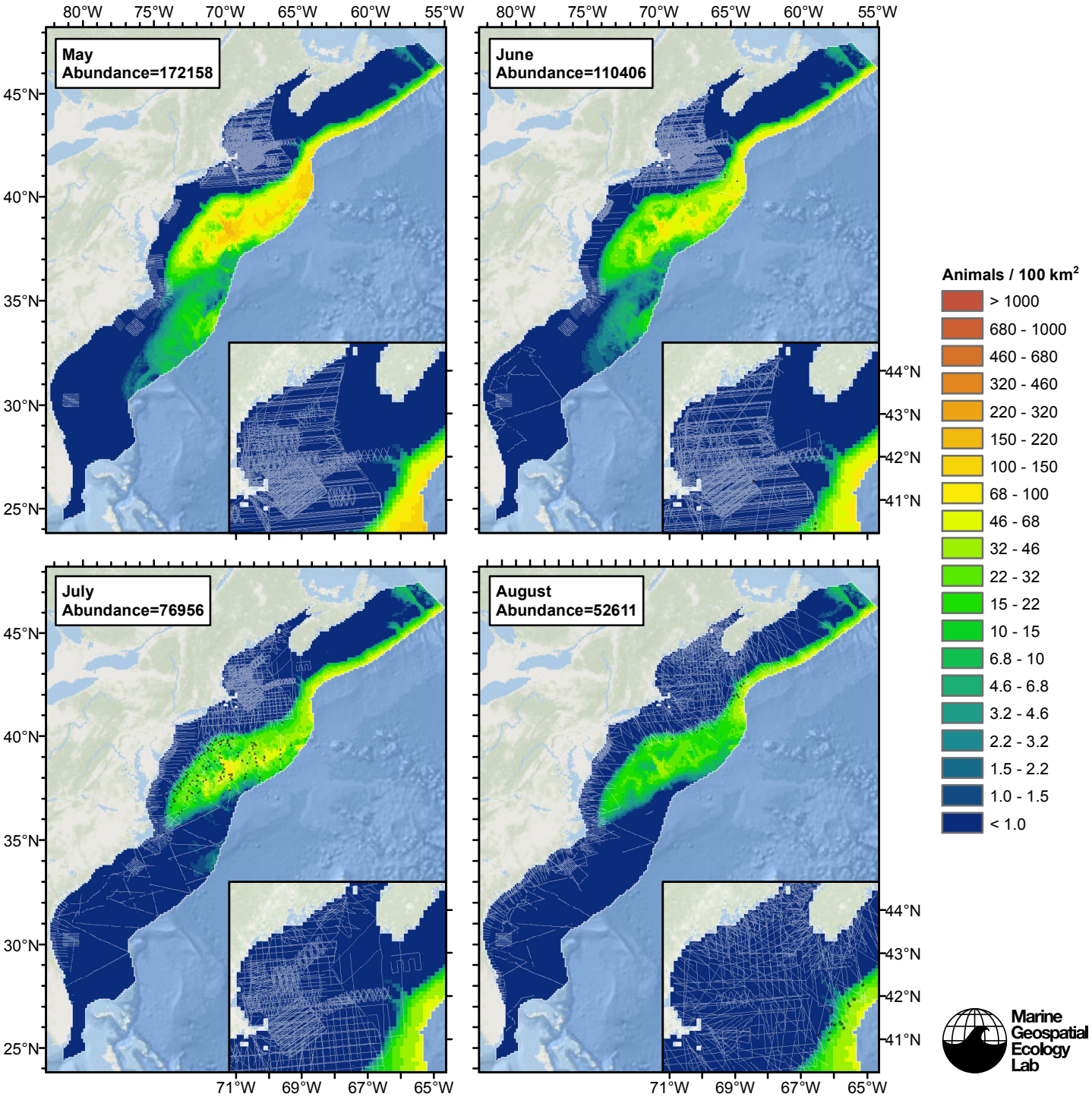


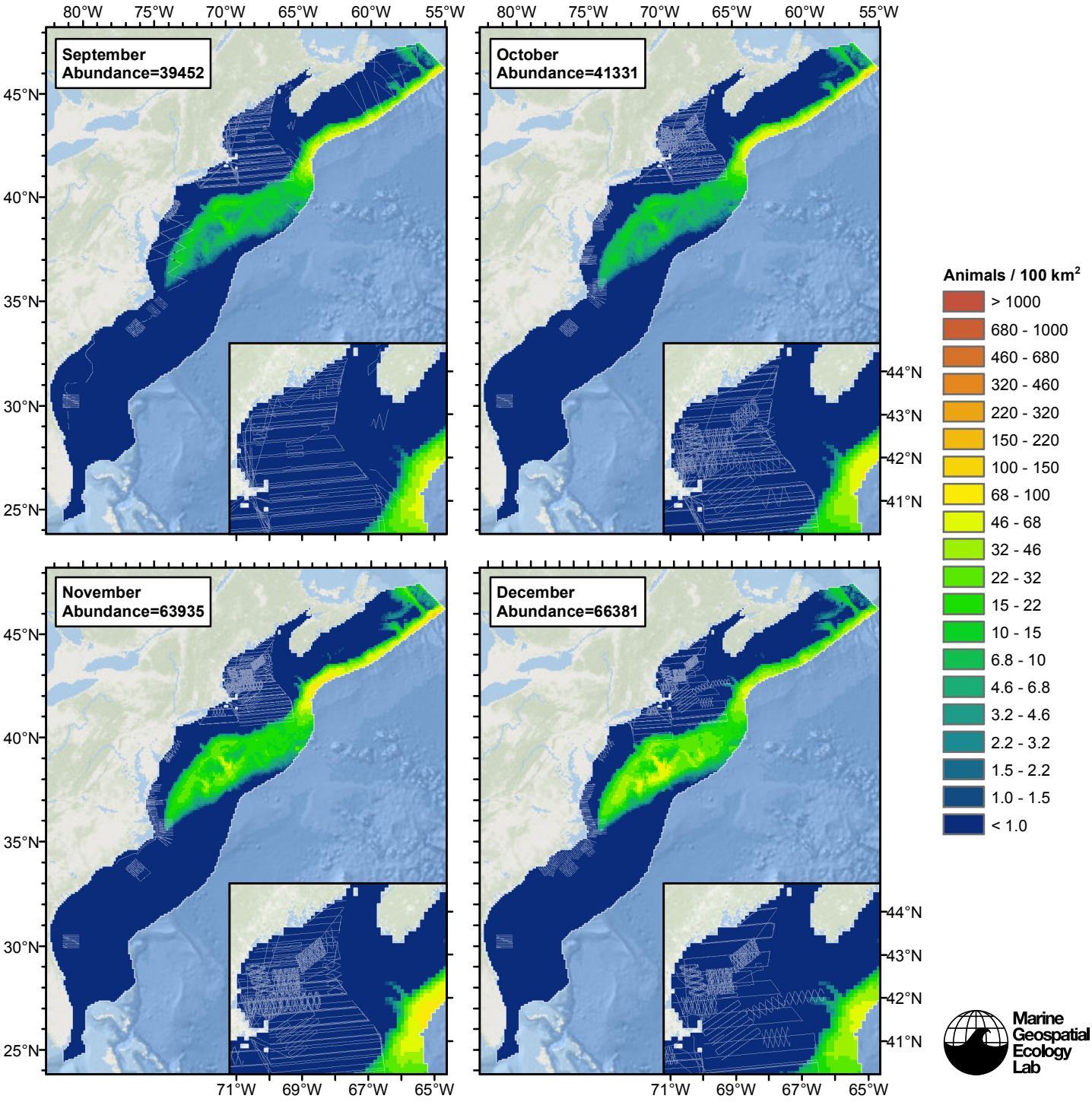

May
Abundance=343554
June
Abundance=210082
July
Abundance=94221
August
Abundance=92510
80°W
75°W
70°W
65°W
60°W
55°W
45°N
40°N
35°N
30°N
25°N
44°N
43°N
42°N
41°N
71°W
69°W
67°W
65°W
Animals / 100 km²
> 1000
680 - 1000
460 - 680
320 - 460
220 - 320
150 - 220
100 - 150
68 - 100
46 - 68
32 - 46
22 - 32
15 - 22
10 - 15
6.8 - 10
4.6 - 6.8
3.2 - 4.6
2.2 - 3.2
1.5 - 2.2
1.0 - 1.5
< 1.0
Marine
Geospatial
Ecology
Lab


September
Abundance=52091
October
Abundance=38526
November
Abundance=64563
December
Abundance=81993
80°W
75°W
70°W
65°W
60°W
55°W
45°N
40°N
35°N
30°N
25°N
44°N
43°N
42°N
41°N
71°W
69°W
67°W
65°W
Animals / 100 km²
> 1000
680 - 1000
460 - 680
320 - 460
220 - 320
150 - 220
100 - 150
68 - 100
46 - 68
32 - 46
22 - 32
15 - 22
10 - 15
6.8 - 10
4.6 - 6.8
3.2 - 4.6
2.2 - 3.2
1.5 - 2.2
1.0 - 1.5
< 1.0
Marine
Geospatial
Ecology
Lab

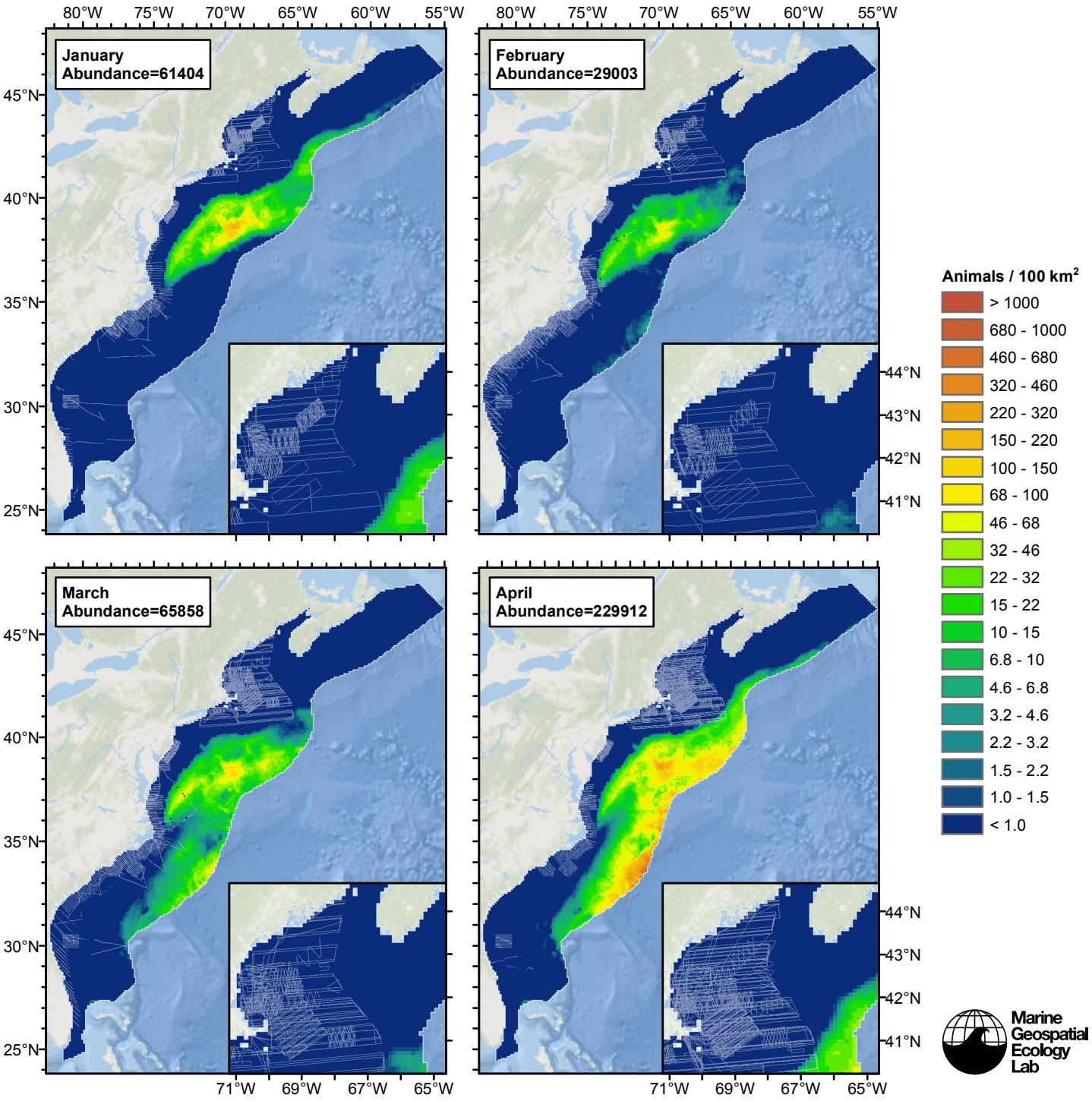
Contemporaneous Model

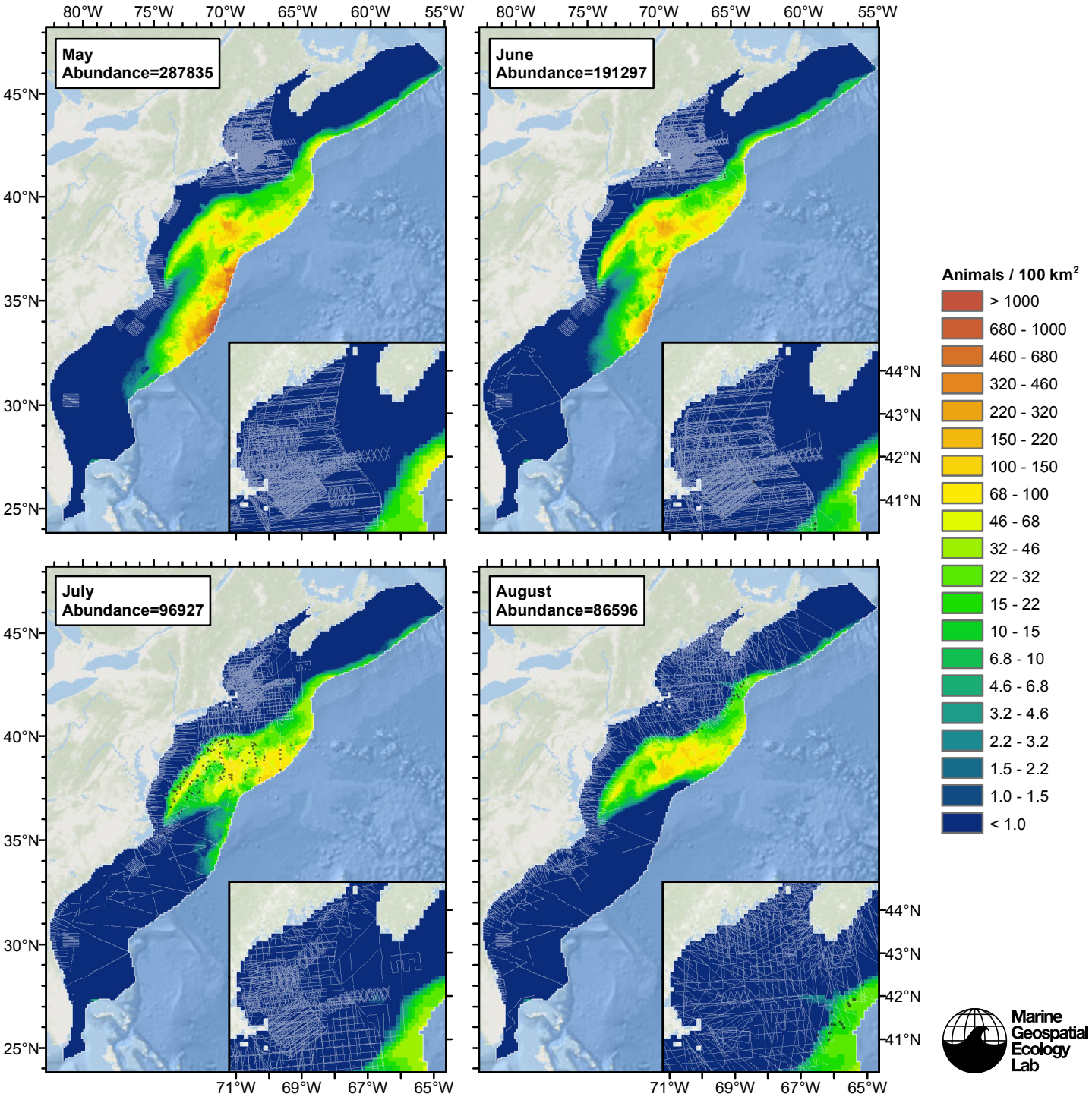


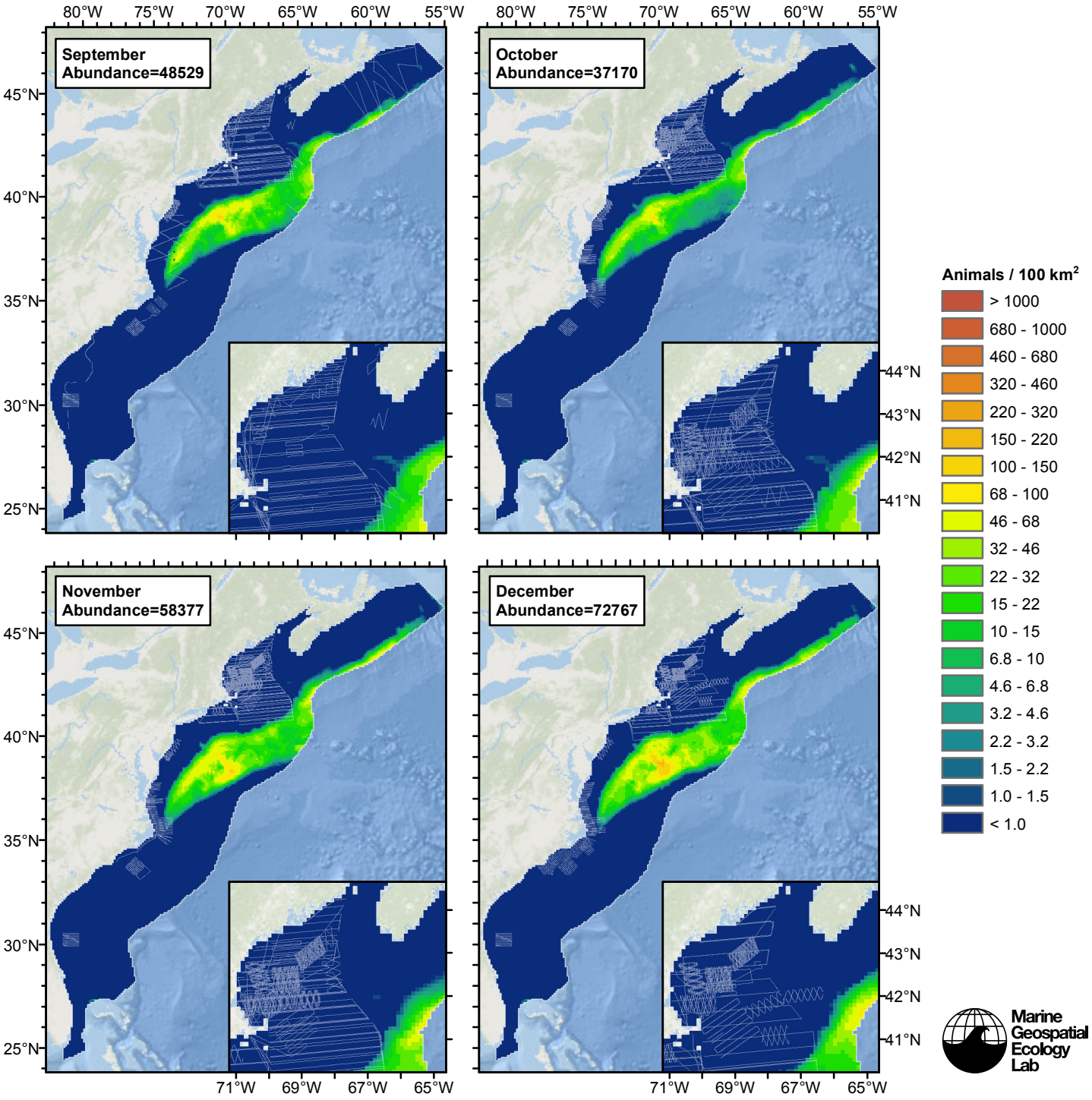

May
Abundance=172158
June
Abundance=110406
July
Abundance=76956
August
Abundance=52611
80°W
75°W
70°W
65°W
60°W
55°W
45°N
40°N
35°N
30°N
25°N
44°N
43°N
42°N
41°N
71°W
69°W
67°W
65°W
Animals / 100 km²
> 1000
680 - 1000
460 - 680
320 - 460
220 - 320
150 - 220
100 - 150
68 - 100
46 - 68
32 - 46
22 - 32
15 - 22
10 - 15
6.8 - 10
4.6 - 6.8
3.2 - 4.6
2.2 - 3.2
1.5 - 2.2
1.0 - 1.5
< 1.0
Marine
Geospatial
Ecology
Lab


September
Abundance=39452
October
Abundance=41331
November
Abundance=63935
December
Abundance=66381
80°W
75°W
70°W
65°W
60°W
55°W
45°N
40°N
35°N
30°N
25°N
44°N
43°N
42°N
41°N
71°W
69°W
67°W
65°W
Animals / 100 km²
> 1000
680 - 1000
460 - 680
320 - 460
220 - 320
150 - 220
100 - 150
68 - 100
46 - 68
32 - 46
22 - 32
15 - 22
10 - 15
6.8 - 10
4.6 - 6.8
3.2 - 4.6
2.2 - 3.2
1.5 - 2.2
1.0 - 1.5
< 1.0
Marine
Geospatial
Ecology
Lab

Climatological Same Segments Model




May
Abundance=287835
June
Abundance=191297
July
Abundance=96927
August
Abundance=86596
80°W
75°W
70°W
65°W
60°W
55°W
45°N
40°N
35°N
30°N
25°N
44°N
43°N
42°N
41°N
71°W
69°W
67°W
65°W
Animals / 100 km²
> 1000
680 - 1000
460 - 680
320 - 460
220 - 320
150 - 220
100 - 150
68 - 100
46 - 68
32 - 46
22 - 32
15 - 22
10 - 15
6.8 - 10
4.6 - 6.8
3.2 - 4.6
2.2 - 3.2
1.5 - 2.2
1.0 - 1.5
< 1.0
Marine
Geospatial
Ecology
Lab



Discussion

When only predictors related to physiography and sea surface temperature were considered, models built with contemporaneous predictors explained more deviance than models built with climatological predictors. But when predictors related to ocean currents and biological productivity were introduced, the situation reversed, with climatological models explaining slightly more deviance than contemporaneous models. However, the total abundance estimated with climatological models had a substantially higher CV (0.29 and 0.27) than abundance estimated with the best contemporaneous model (0.21). This difference was traceable mainly to a dubious prediction of extreme abundance in the months of April-June, when abundance peaked in May at 343,554 due to a large suspicious hotspot far offshore between 33-37 N. This area was not surveyed during these months and we believe this extrapolation to be in error.

The contemporaneous model also showed a peak in May, but it was much lower, at 172,158, and it did not exhibit the hotspot. Although we do not have sufficient data in May to evaluate the validity of a peak in that month, the center of this predicted abundance is in the area north of the Gulf Stream where striped dolphins were sighted in large numbers in July. On the basis of not exhibiting the dubious hotspot while explaining nearly as much deviance as the climatological models, we selected the contemporaneous model as our best estimate of striped dolphin distribution and abundance.

We note that this model predicted relatively little abundance south of the Gulf Stream, and what was predicted occurred mainly in the March-June period. The model fitted a negative correlation with SST, suggesting that striped dolphins are found more frequently in colder waters in our study area. The sightings seem to bear this out; the surveying south of the Gulf Stream was comparable to the surveying north of it yet yielded almost no sightings (Fig. 1). At first glance, this seems contrary to the literature, but perhaps SST governs the colder limit of the striped dolphin's range, and the waters north of the Gulf Stream constitute better feeding habitat while remaining within an acceptable temperature range for much of the year. Additional surveying in the southeast offshore waters, particularly in non-summer seasons, would help clarify the striped dolphin's distribution in our study area.

In the northeast, the model predicted sustained abundance along the slope of the Scotian Shelf through December. While we have no survey data to validate this prediction at present, we note that Baird et al. (1997) reported that stranding records in eastern Canada primarily occurred in late fall and winter.

Given the lack of information about seasonal movements in striped dolphins, and the relatively lower quantity of survey effort in offshore waters particularly in non-summer seasons, we recommend that our year-round prediction of striped dolphin density be utilized in management applications, rather than the monthly predictions.

The year-round abundance estimate from our best model (75,657) as well as the June-August average from that model (79,991) fall between NOAAs June-August estimates from 2004 (94,462) and 2011 (54,807), although our study area extent was closer to NOAA's 2004 study than their 2011 study. The CVs of NOAA's estimates indicate our estimate is within their confidence intervals.

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Waring GT, Josephson E, Maze-Foley K, Rosel PE, eds. (2014) U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2013. NOAA Tech Memo NMFS NE 228; 464 p.