Density model for Blue whale in the AFTT area - version 1

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This report documents the density model developed for Blue whale in the AFTT area. It provides information on available data, methodological decisions, the selected model, predictions, uncertainty and qualitative evaluation of predictions based on the literature. Information on classification of ambiguous sightings, detection function fitting and g(0) estimates can be found in the EEZ model report for this taxon (Roberts et al. 2015).

Citation for this model: Mannocci L, Roberts JJ, Miller DL, Halpin PN (2015) Density model for Blue whale in the AFTT area. Version 1, 2015-01-23. Marine Geospatial Ecology Lab, Duke University, Durham, NC.

Citation for the related peer-review publication: Mannocci L, Roberts JJ, Miller DL, Halpin PN. Here be dragons: extrapolating cetacean densities into the unsurveyed high seas of the western North Atlantic. Submitted to Ecological Applications.

1- Available data

Table 1: Effort (km) and sightings per region (CAR: Caribbean, EC: East coast, EU: European Atlantic, GM: Gulf of Mexico, MAR: Mid-Atlantic ridge).

Region	Effort	Sightings
EC	1044357.704	8
EU	27526.342	1
MAR	2424.421	4
All regions	1074308.466	13

Table 2: Effort (km) and sightings per month.

Month	Effort	Sightings
January	71406.04	0
February	96993.70	0
March	98664.69	0
April	105121.39	1
May	107303.24	0
June	119895.45	5
July	140462.97	1
August	110040.12	1
September	52584.62	0
October	57619.14	4
November	60008.94	1
December	54208.17	0
All Months	1074308.47	13

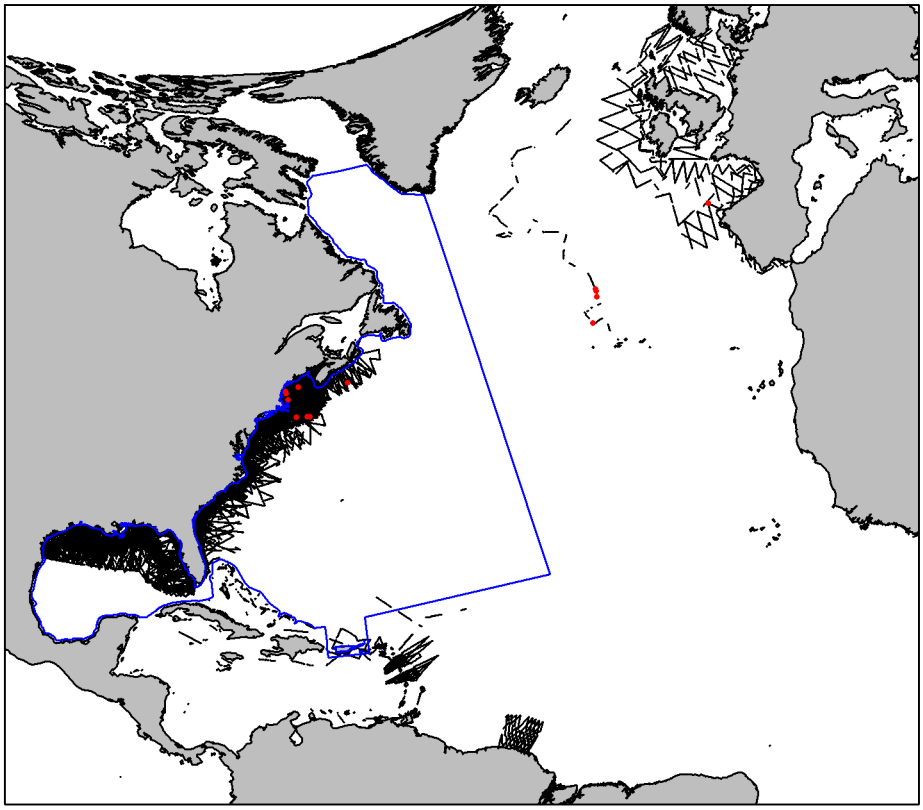

Figure 1: Map of segments (black lines) and sighting locations (red dots). An Albers equal area projection optimized for the AFT area is used.

2- Methodological decisions

Modeled taxon

Blue whale (*Balaenoptera musculus*)

Model type

The extremely small sample size did not allow us to fit a habitat-based density model for this taxon; as a result we fitted a stratified density model.

Modeled season

The sample size was too small to consider fitting seasonal models so we fitted a year-round model.

Segments

We used segments from the east coast, mid-Atlantic ridge and European Atlantic since these were the three regions that had sightings.

Area of assumed presence

Blue whales were assumed to be present in the entire AFTT area, except in the Gulf of Mexico where only two strandings have been documented in the past decades and their occurrence appears exceptional (Jefferson and Schiro 1997).

3- Predictions

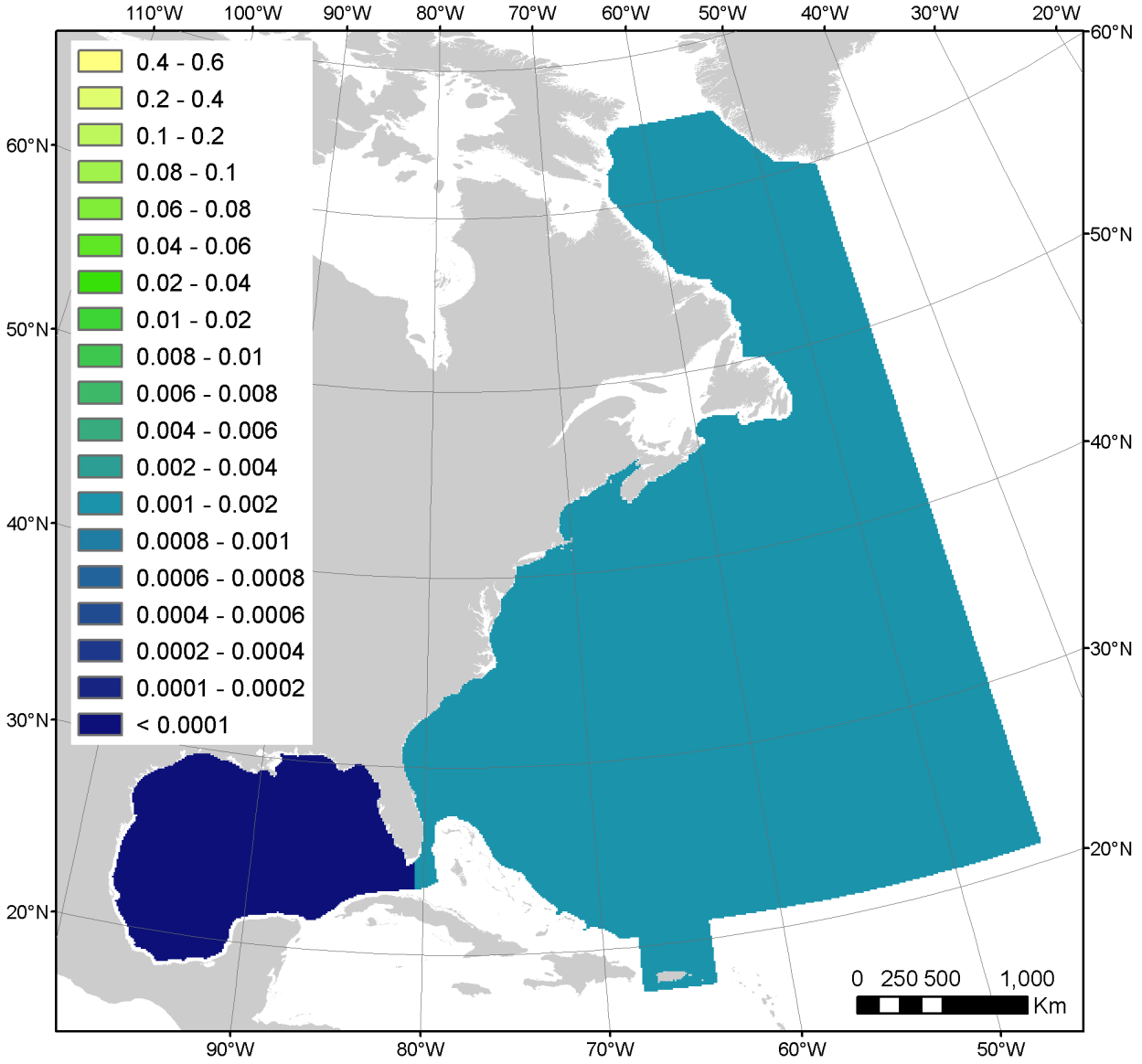

Figure 5: Mean predicted densities (individuals 100 km-2) in the AFTT area. An Albers equal area projection is used.

Table 3: Mean predicted abundance (individuals) in the AFTT area and associated coefficient of variation (CV). The CV only reflects uncertainty in the estimated GAM parameters (in this case only the intercept) and is therefore strongly underestimated.

Abundance	CV
104	0.346

4- Uncertainty

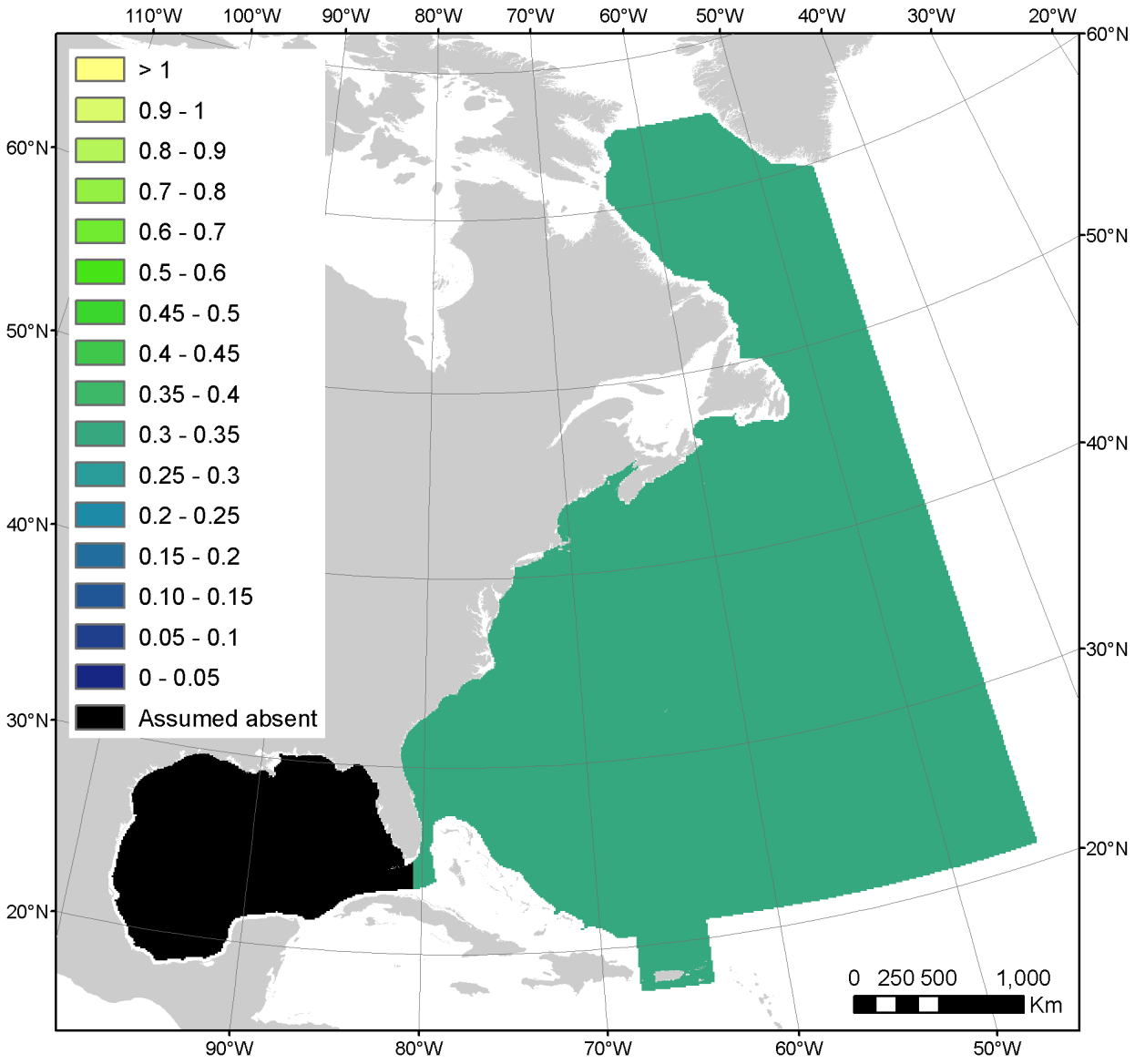

Figure 6: Mean predicted coefficient of variation (unit-less) in the AFTT area. An Albers equal area projection is used.

5- Qualitative evaluation of predictions

Model predictions are generally supported by acoustic detections from the U.S. Navy Sound Surveillance System (SOSUS) in the western North Atlantic (Clark 1995, Clark and Gagnon 2004). Acoustic detections revealed little difference in the seasonal presence of blue whales by latitude (but propagation conditions may have influenced seasonal and latitudinal comparisons). The overall higher number of detections at higher latitudes suggested that most singers were distributed north of 45º N. The highest song rates were observed in the eastern shelf edge off Newfoundland and Labrador. The SOSUS system allowed the acoustic tracking of an individual blue whale for 43 days in the North Atlantic gyre.

Predictions appear consistent with visual records from the Gully canyon (Hookers et al. 1999) and West Greenland (Sears and Larsen 2002).

Future model improvements

Additional sightings data would be needed to increase the reliability of predictions for this rare taxon and maybe fit a habitat-based density model.

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Sears, R., and F. Larsen. 2002. Long range movements of a blue whale (Balaenoptera musculus) between the Gulf of St. Lawrence and West Greenland. Marine mammal science 18:281-285.