

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

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This report documents the density model developed for Killer 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).

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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
CAR	24264.473	2
EC	1044357.704	4
EU	27526.342	1
GOM	194715.349	16
MAR	2424.421	1
All regions	1293288.288	24

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

Month	Effort	Sightings
January	77892.79	0
February	123591.37	0
March	117923.54	2
April	117929.72	1
May	149765.03	11
June	132713.99	6
July	162324.31	2
August	129660.43	2
September	71696.07	0
October	82560.18	0
November	69210.92	0
December	58019.93	0
All Months	1293288.29	24

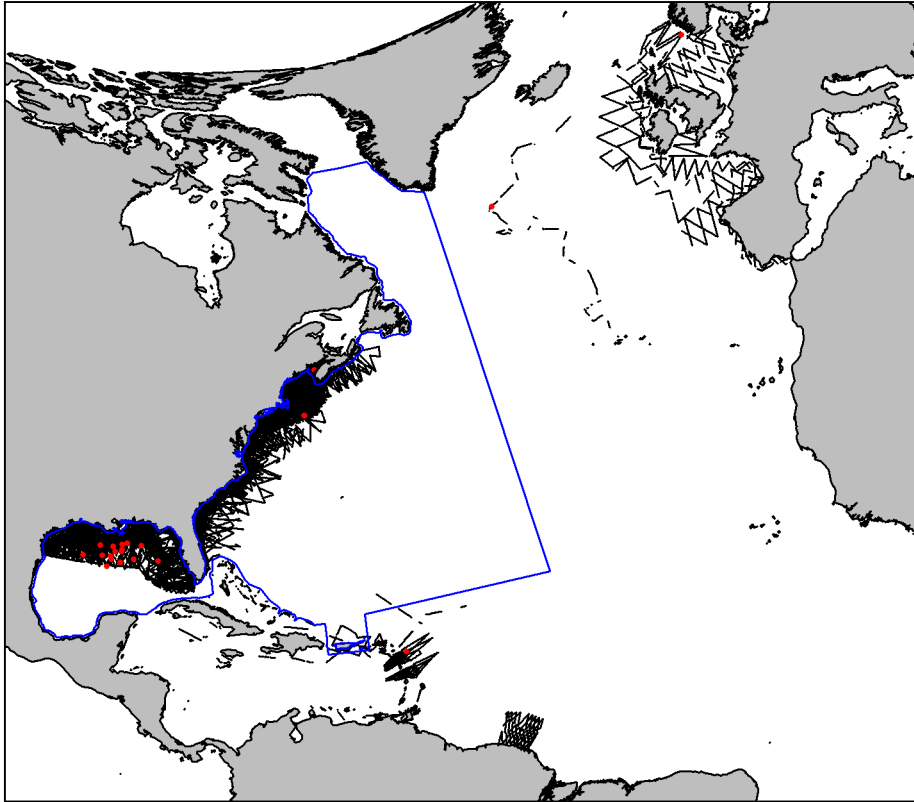


Figure 1: Map of segments (black lines) and sighting locations (red dots). An Albers equal area projection optimized for the AFT area is used.

2- Methodological decisions

Modeled taxon

Killer whale (*Orcinus orca*)

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 five regions since they all included sightings.

Area of assumed presence

Killer whale were assumed present in the entire AFTT area in accordance with the cosmopolitan distribution of that species (Forney and Wade 2007). We fitted stratified density models in three separate areas following the documented variations of killer whale abundance: the area North of Nova Scotia where killer whales are more common than around lower latitudes (Forney and Wade 2007, Lawson and Stevens 2014); the Gulf of Mexico where they regularly occur (O'Sullivan and Mullin 1997, Jefferson and Schiro 1997); and the rest of the AFTT area.

3- Predictions

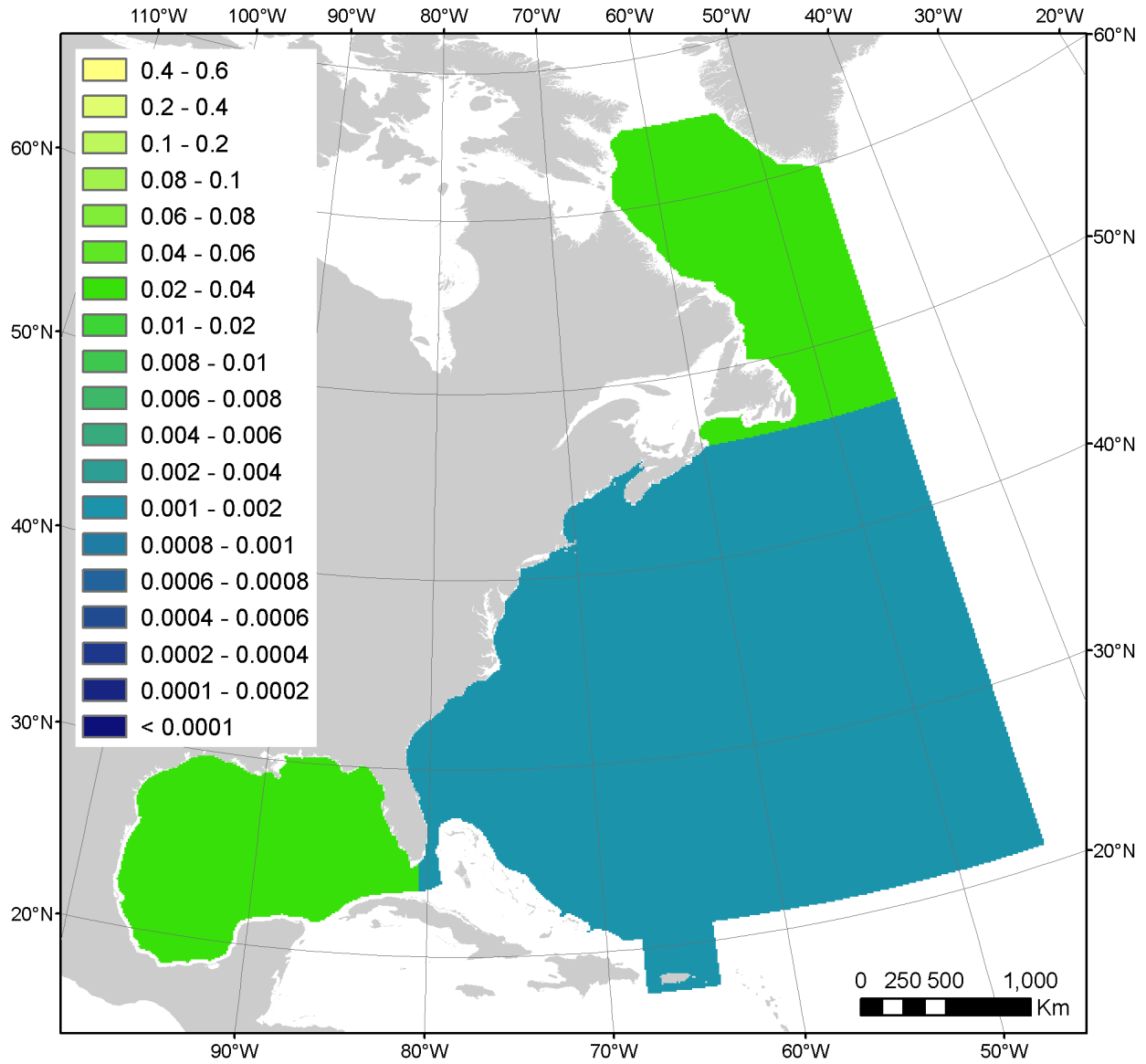


Figure 5: Mean predicted densities (individuals 100 km⁻²) in the AFTT area. An Albers equal area projection is used.

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
849	0.517

4- Uncertainty

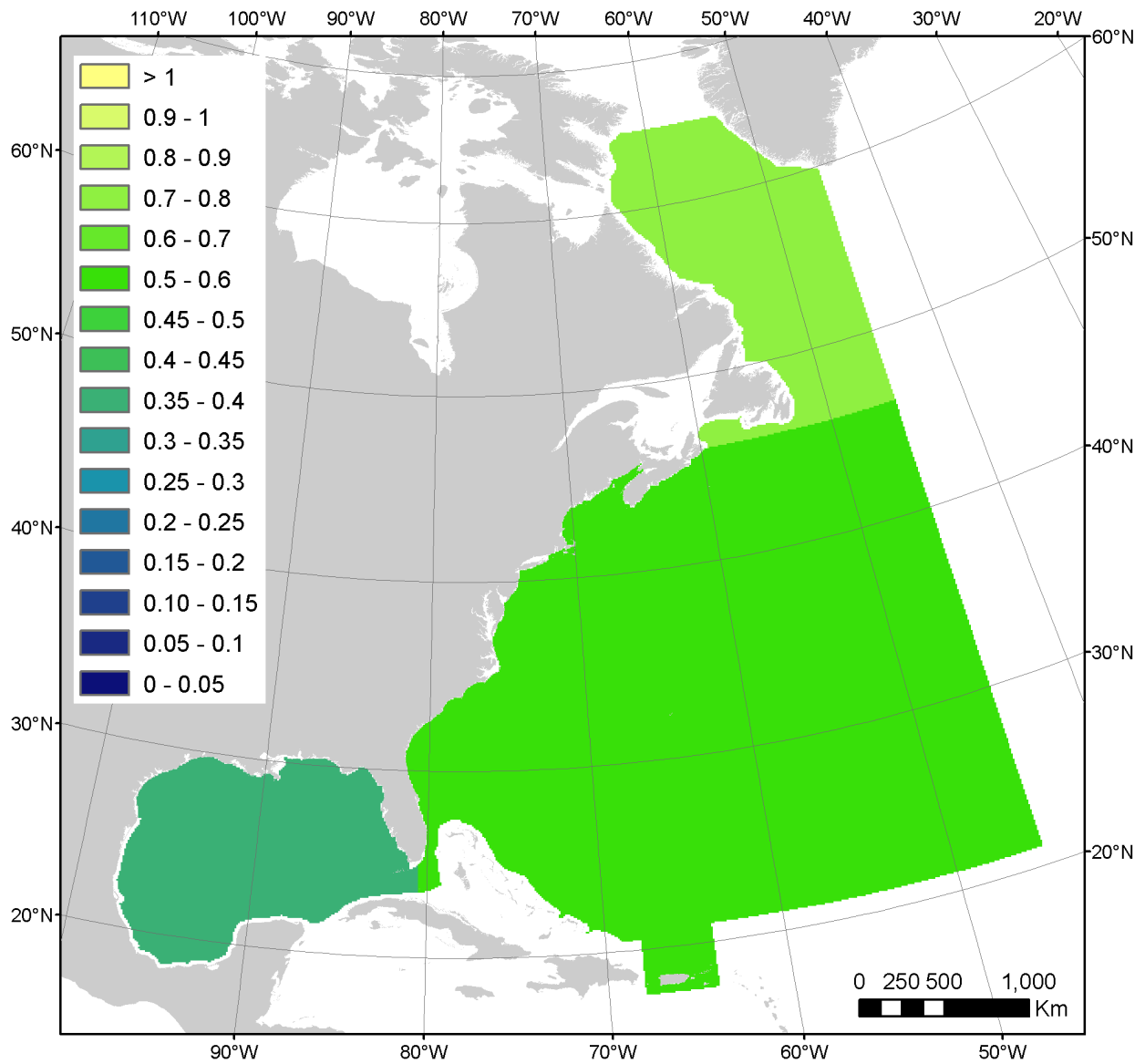


Figure 6: Mean predicted coefficient of variation (unit-less) in the AFTT area. An Albers equal area projection is used.

5- Qualitative evaluation of predictions

There are few records of killer whales in the North Atlantic. Model predictions are generally consistent with sightings in northeast Canada (Lawson and Stevens 2014), satellite tracking data in the eastern Canadian Arctic (Matthews et al. 2001), sightings and strandings in the southern Gulf of Mexico (Ortega-Ortiz 2002), off Puerto Rico and the Virgin islands (Mignucci-Giannoni 1998, Bolaños-Jiménez et al. 2014).

Future model improvements

Additional sightings data would be needed to increase the reliability of predictions for this rare taxon.

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