SUPPLEMENT TO FINAL REPORT BOEM 2017-071

Atlantic Marine Assessment Program for Protected Species: 2010-2014

Appendix I

Appendix I: Density Models and Maps

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1 Study Area

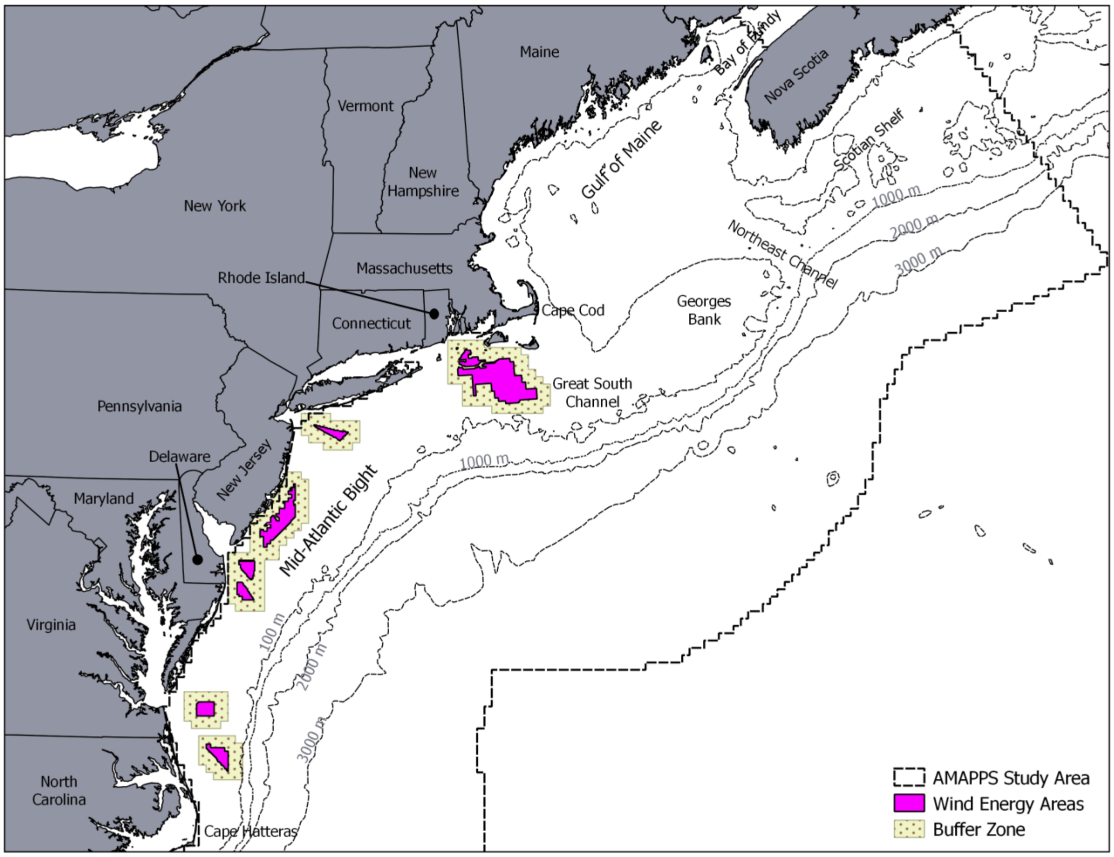

Figure 1-1 AMAPPS study area and Massachusetts to North Carolina wind energy study areas
As defined by BOEM (December 2015). This study proposed a 10km buffer zone surrounding the wind energy areas for the abundance estimates.

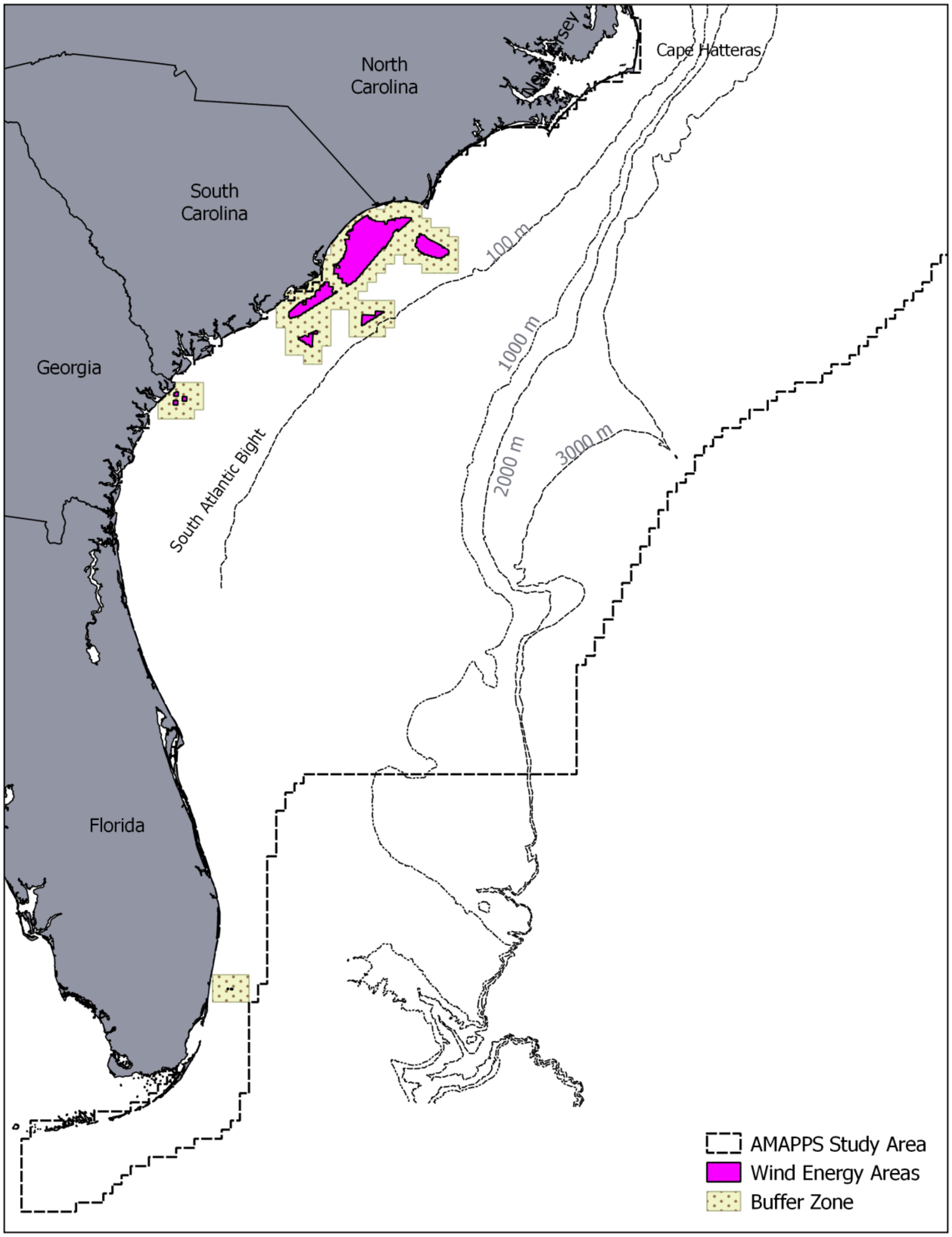

Figure 1-2 AMAPPS study area and North Carolina to Florida wind energy study areas
As defined by BOEM (December 2015). This study proposed a 10km buffer zone surrounding the wind energy areas for the abundance estimates.

2 Humpback Whale (*Megaptera novaeangliae*)

Figure 2-1 Humpback whale. Credit: NOAA/NEFSC/Kelly Slivka
Image collected under MMPA research permit #775-1875.

2.1 Data Collection

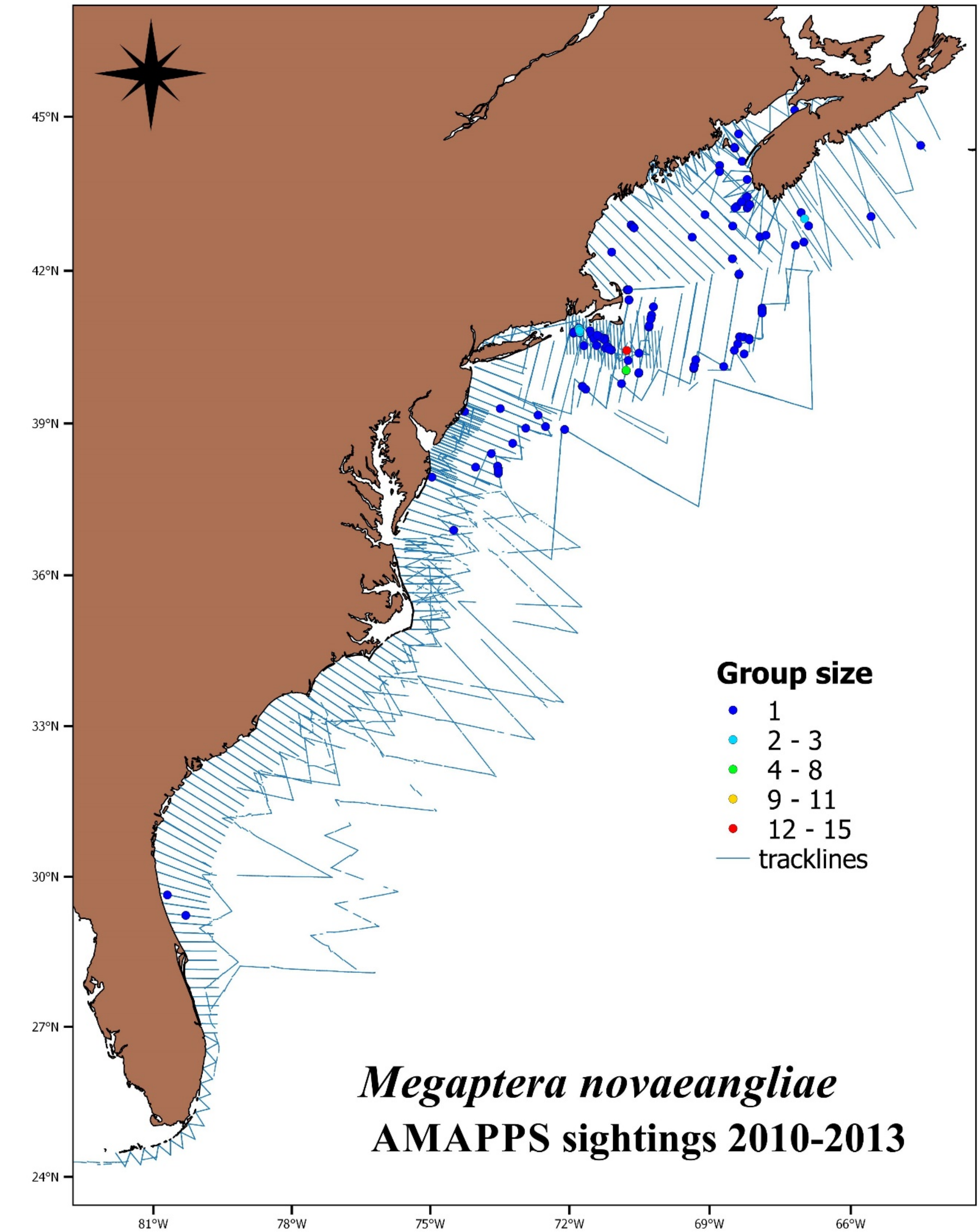

Figure 2-2 Track lines and humpback whale sightings during 2010 - 2013

Table 2-1 Research effort 2010 - 2013 and humpback whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Humpback whale	*Megaptera novaeangliae*	0/0	57/83	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	13/16	28/35	29/43	1/1
SE Shipboard	0	8,537	2,093	0	-	-	0/0	1/1	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	6/7	0/0	2/2	3/3

2.2 Mark-Recapture Distance Sampling Analysis

Table 2-2 Parameter estimates from humpback whale (HUWH) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 1	1	CBWH,FIWH,HUWH MIWH,RIWH,SPWH	Distance*observer	Distance+sea	400	HR	0.898	0.091	0.318	0.659	0.671
	2		-	Distance+sea	562	HN	-	-	0.221	0.737	0.758
NE-aerial group 1	1	CBWH, FISE,FIWH, HUWH, MIWH, RIWH,SEWH,SPWH UNWH	Distance	Distance+time of day	900	HR	0.503	0.168	0.369	0.992	0.985
	2		-	Distance+glare	5240	HR	-	-	0.245	0.832	0.905
SE-shipboard group 1	-	FIWH,HUWH, RIWH,SPWH	Distance*observer + sea	Distance+sea	8840	HN	0.472	0.228	0.326	0.122	0.137
NE-shipboard group 2	-	HUWH	Distance	Distance+cue	7600	HR	0.361	0.315	0.159	0.993	0.994

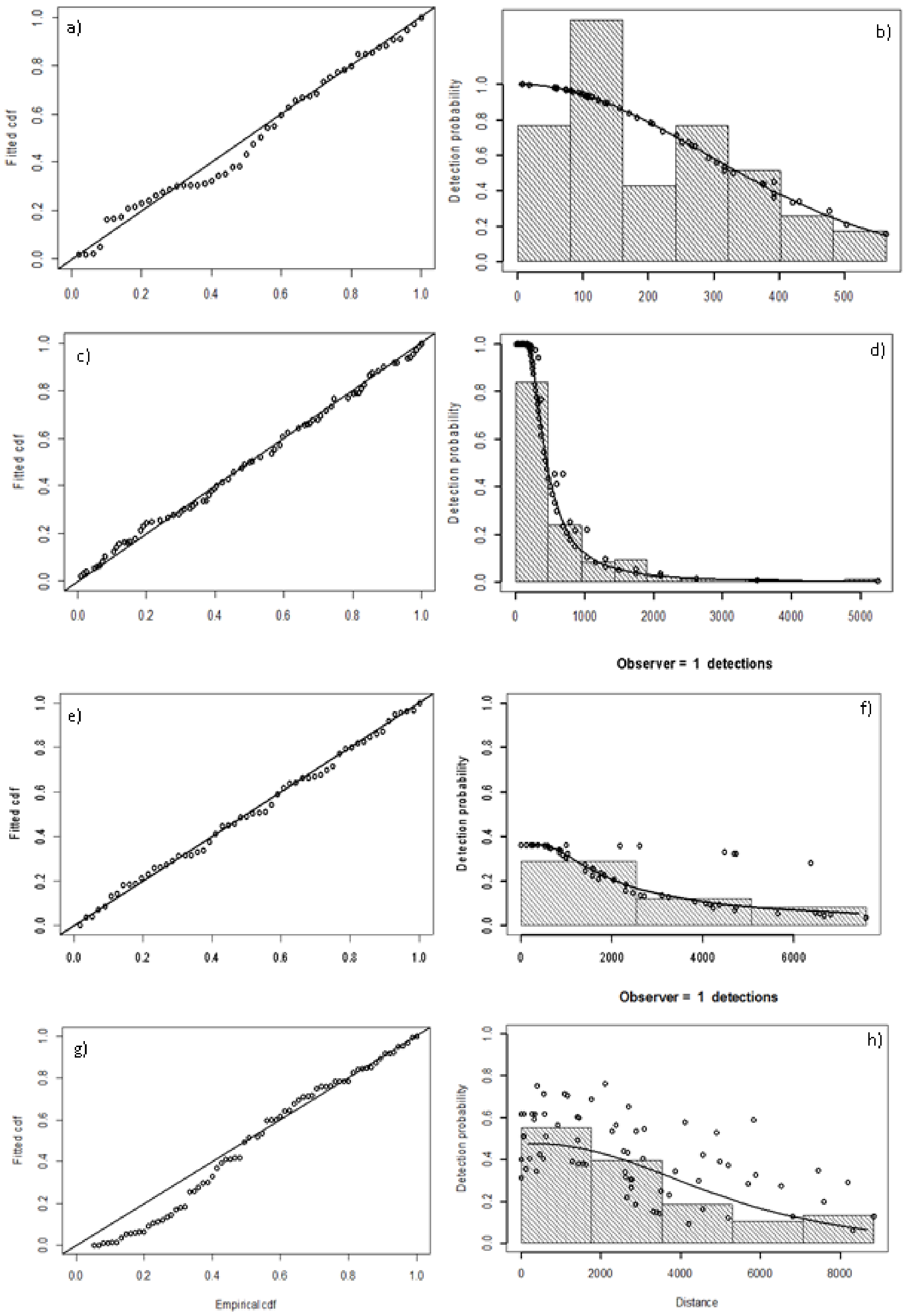

Figure 2-3 Q-Q plots and detection functions from humpback whale MRDS analysis
Group 1 aerial southeast region (a,b), group 1 aerial northeast region (c,d), group 2 shipboard northeast region (e,f) and group 1 shipboard southeast region (g,h).

2.3 Generalized Additive Model Analysis

Table 2-3 Habitat model output for humpback whales

Approximate significance of smooth terms						
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(chl)	0.7331	4	2.167	0.000533	4.68E-04	***
s(sst)	1.125	4	38.245	< 2e-16	1.30E-02	***
s(pp)	2.9421	4	25.605	< 2e-16	4.43E-05	***
s(dist125)	0.965	4	22.514	< 2e-16	8.86E-09	***
s(lat)	3.2378	4	34.42	< 2e-16	3.78E-01	***
Scale	-	-	-	-	9.70E-01	

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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom : Total = 10

R^2 (adjusted) = 0.00524   Deviance explained = 31.9%

REML = 502.95 Scale estimate = 0.21056   sample size = 11276

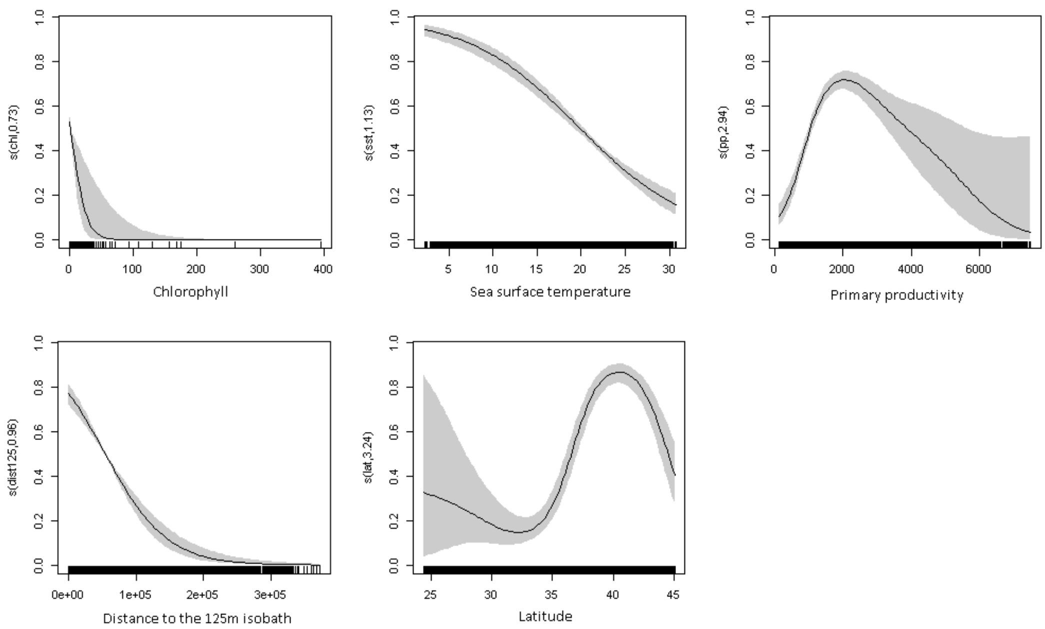

Figure 2-4 Humpback whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 2-4 Diagnostic statistics from humpback whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.277	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	91.9	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.07	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.003	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

2.4 Abundance Estimates for AMAPPS Study Area

Table 2-5 Humpback whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.649, CV=0.185; shipboard 1, CV=0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	1,510	0.294	859 – 2,655
Summer (June-August)	1,246	0.177	883 – 1,758
Fall (September-November)	1,399	0.172	1,001 – 1,955

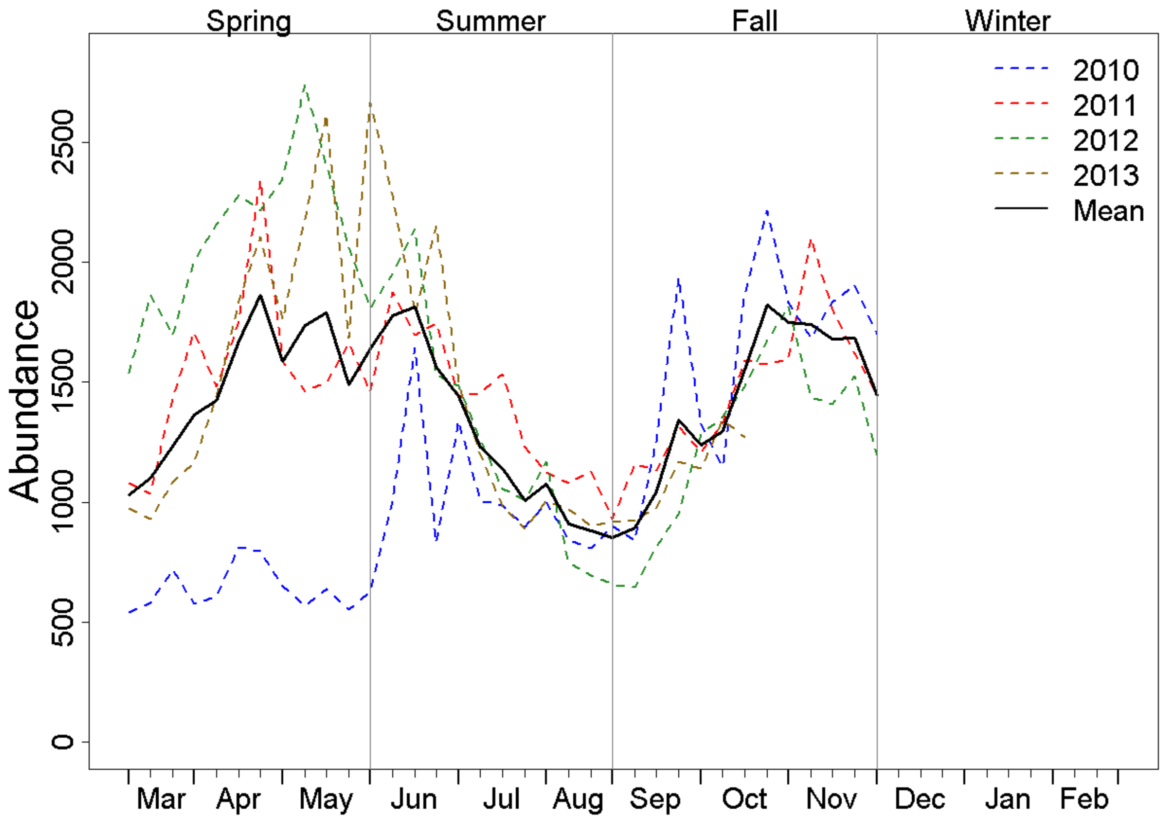

Figure 2-5 Annual abundance trends for humpback whales for AMAPPS study area

2.5 Seasonal Prediction Maps

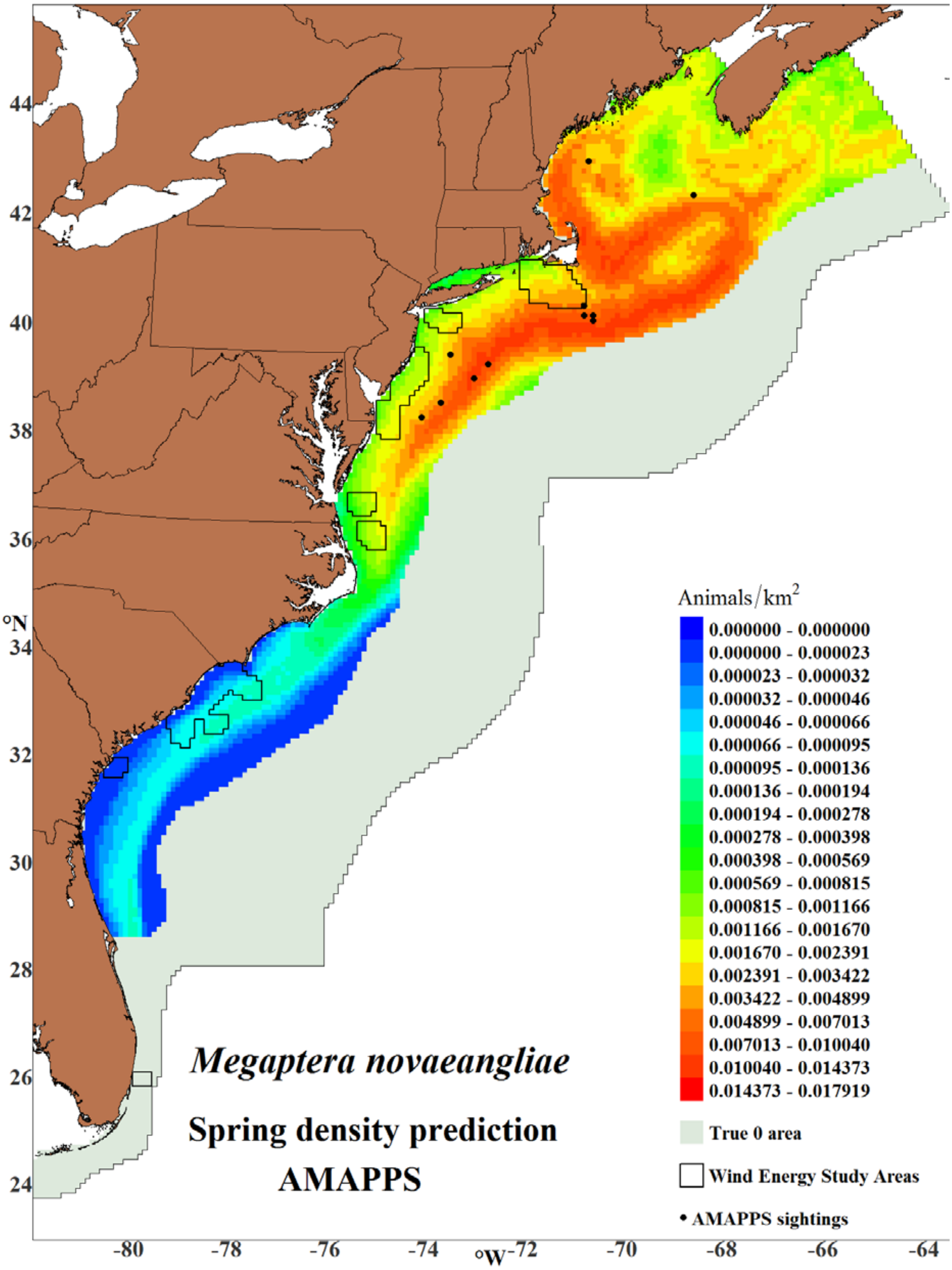

Figure 2-6 Humpback whale spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

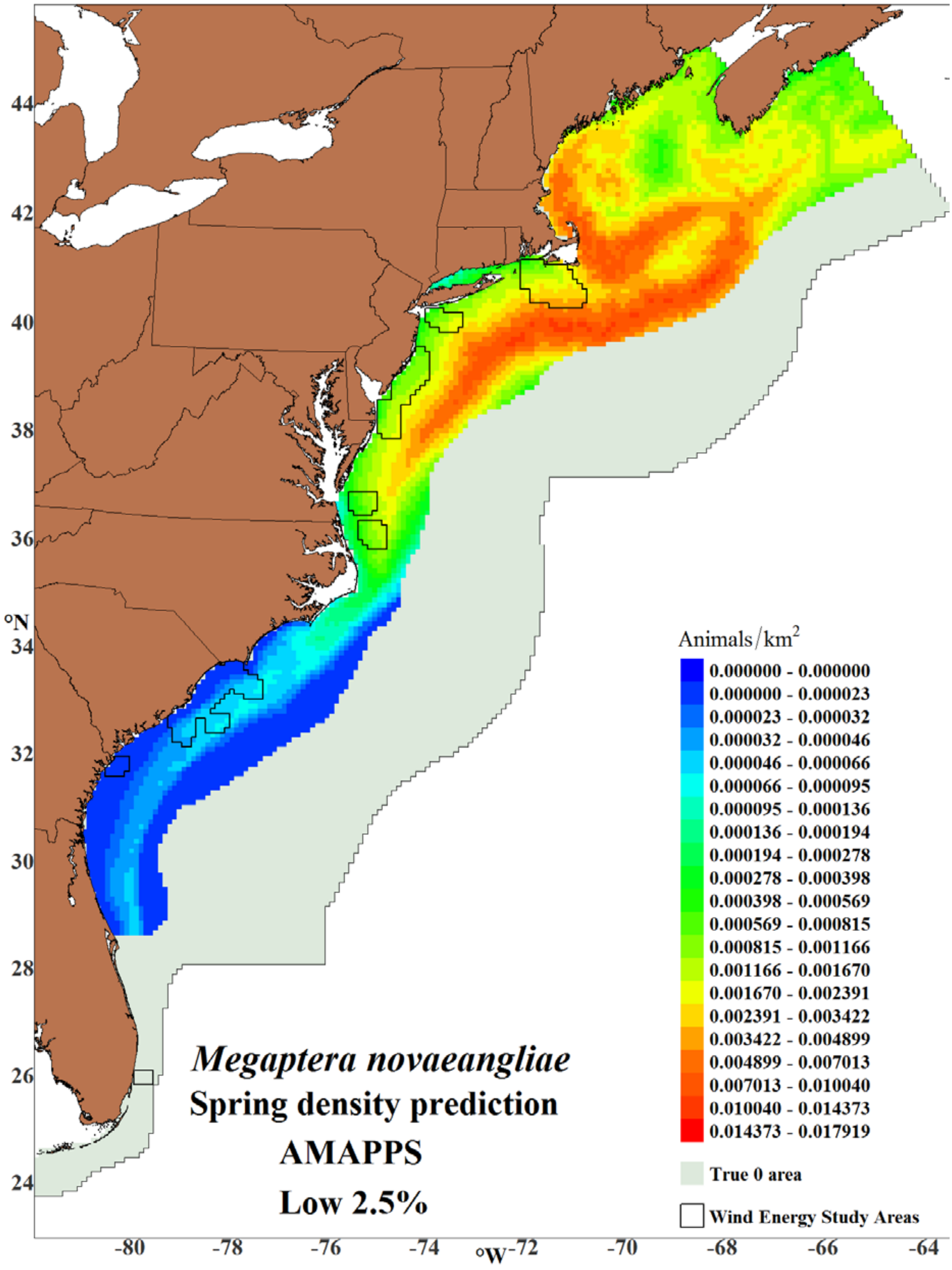

Figure 2-7 Lower 2.5% percentile of spring humpback whale estimates

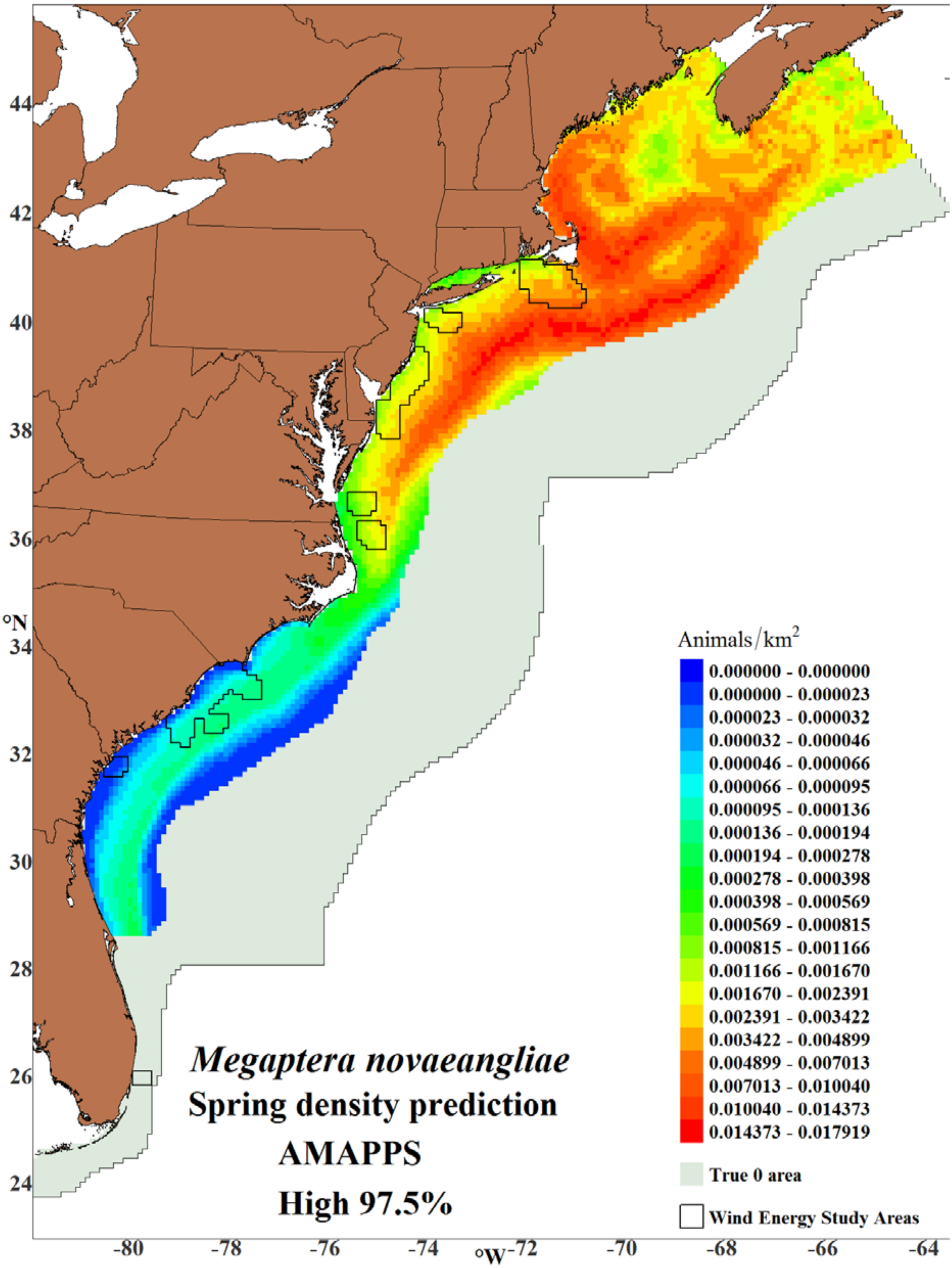

Figure 2-8 Upper 97.5% percentile of spring humpback whale estimates

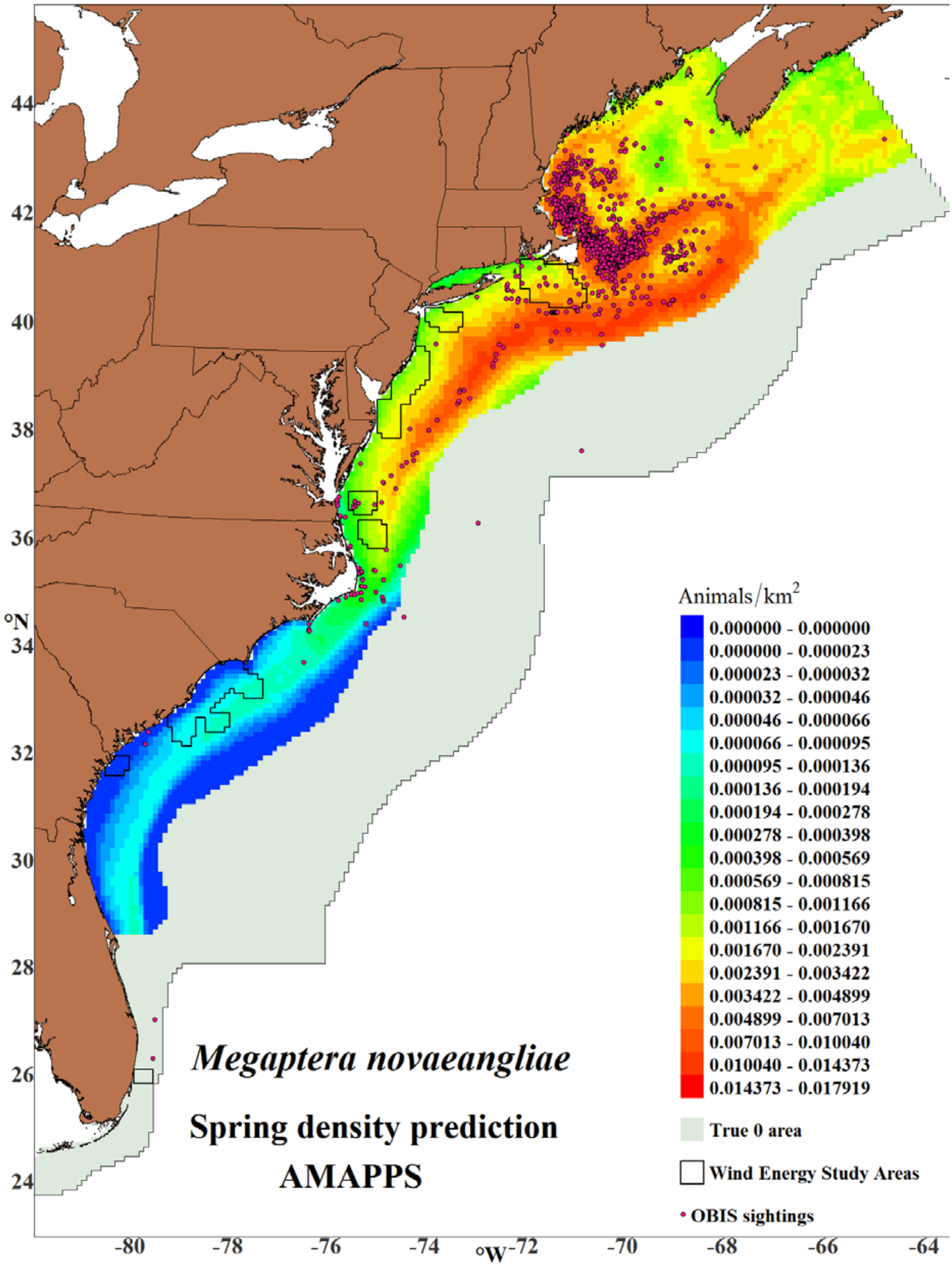

Figure 2-9 Humpback whale 2010-2013 spring density and 1970-2014 OBIS sightings pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

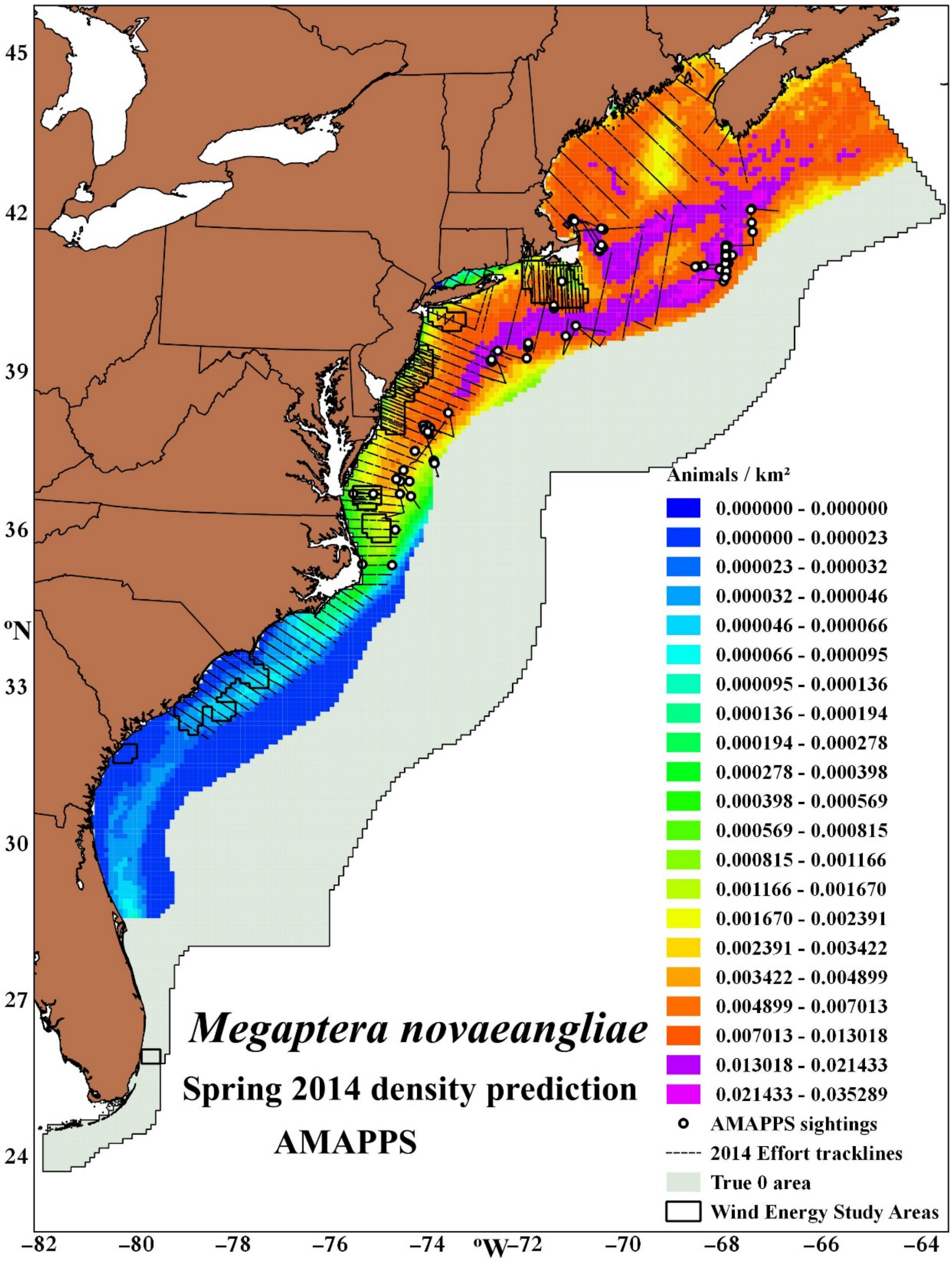

Figure 2-10 Humpback whale spring 2014 density and AMAPPS 2014 tracks and sightings
These sightings were not used to develop the density-habitat model.

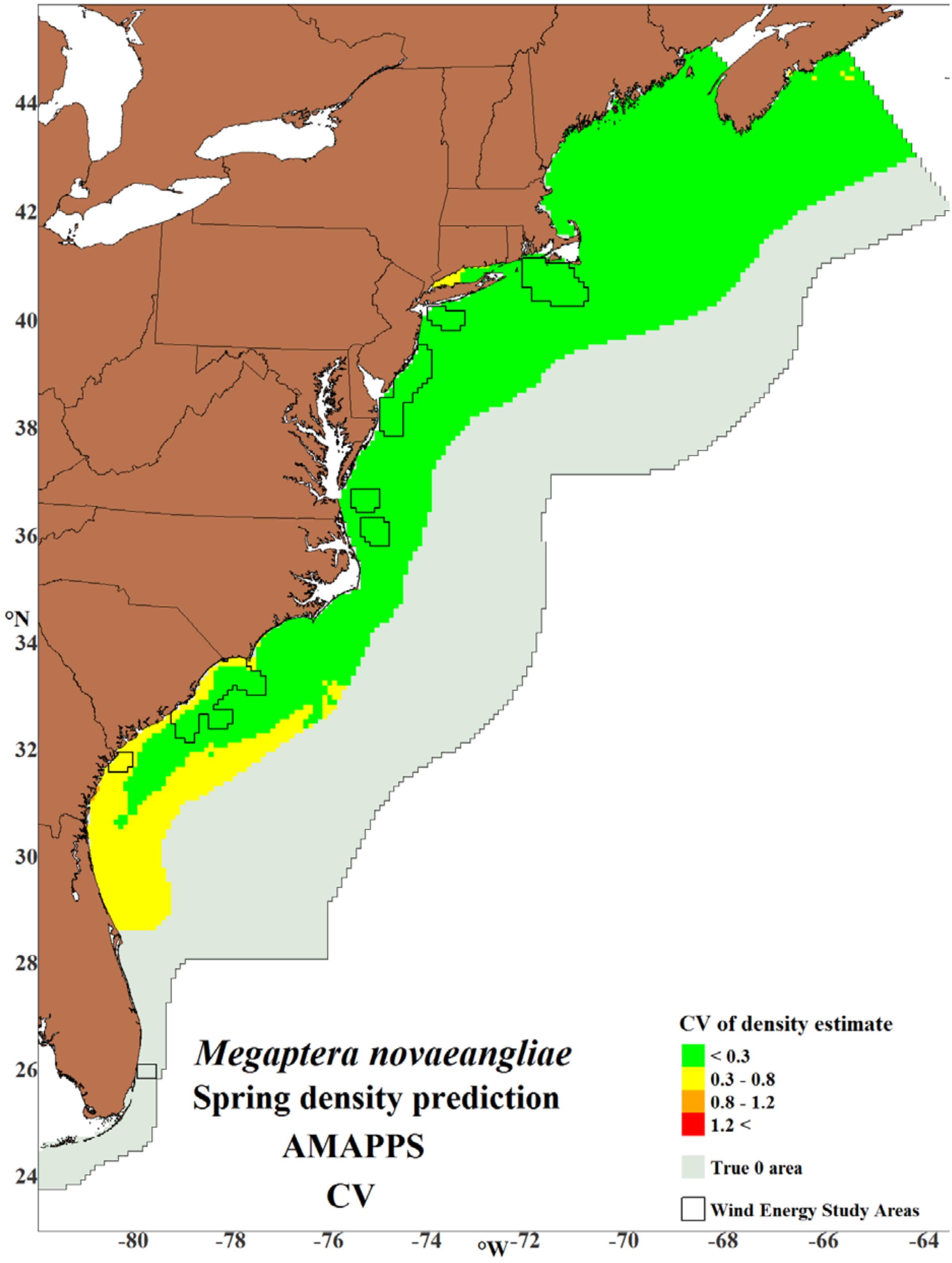

Figure 2-11 CV of spring density estimates for humpback whales

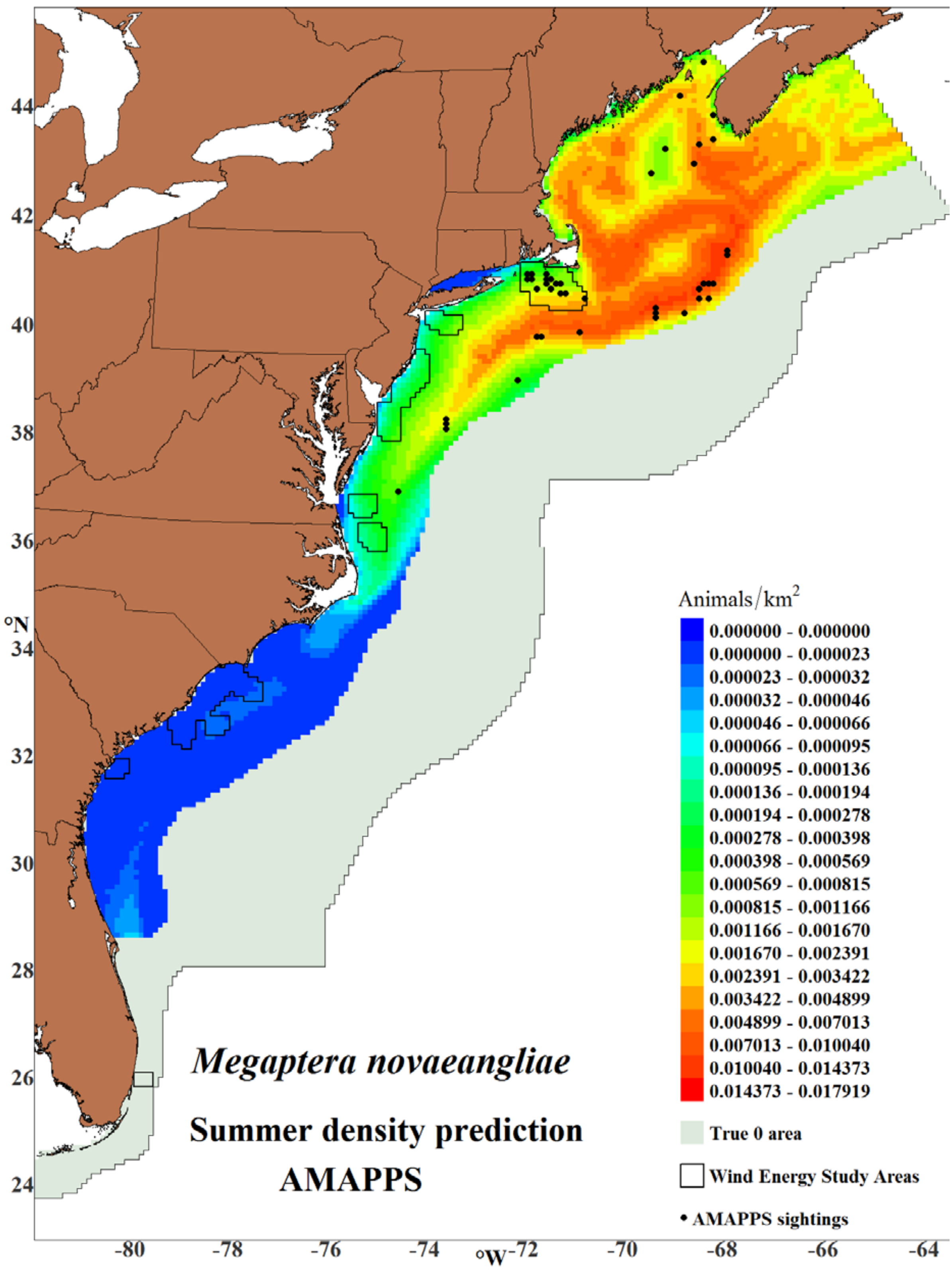

Figure 2-12 Humpback whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

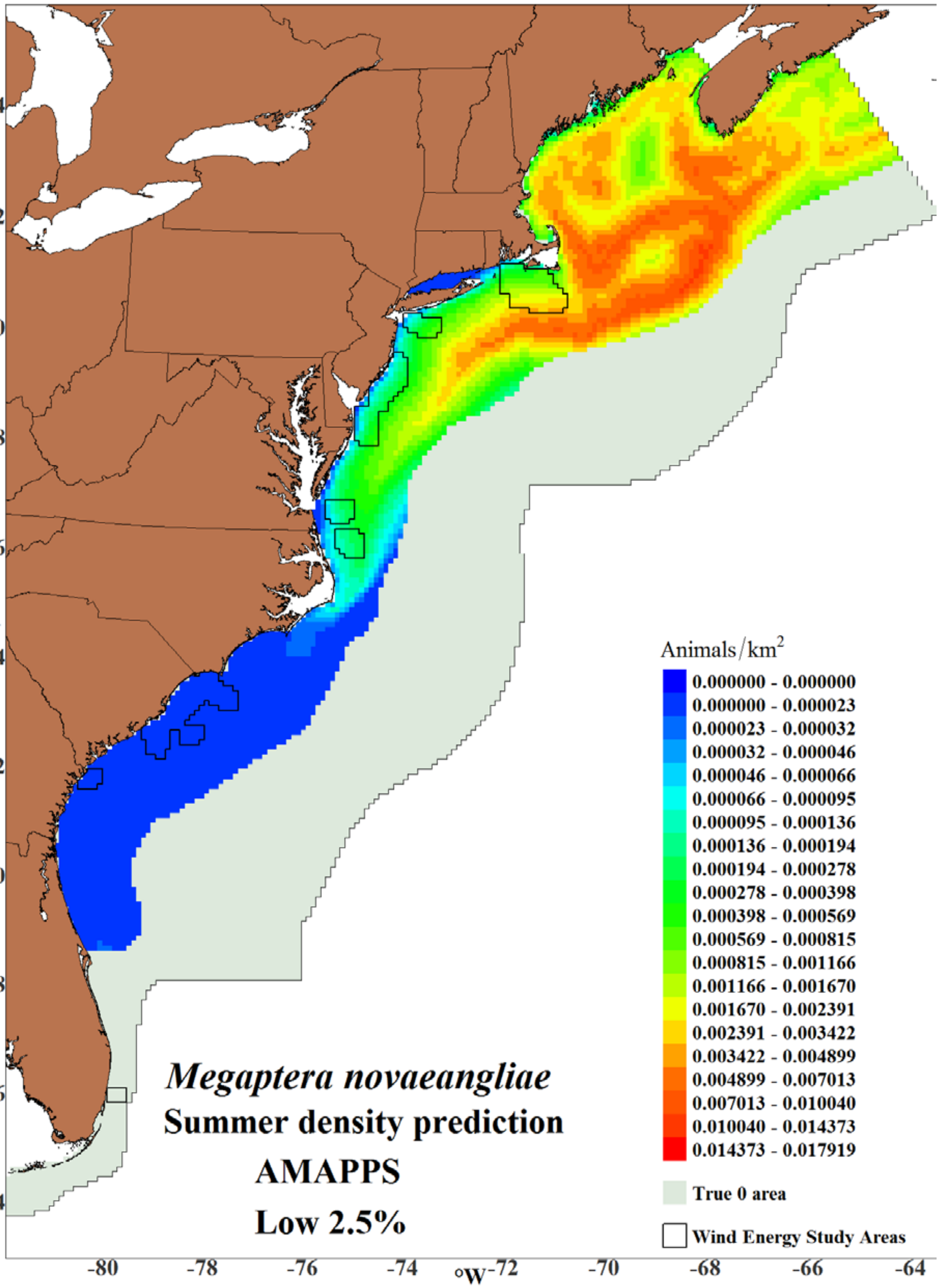

Figure 2-13 Lower 2.5% percentile of summer humpback whale estimates

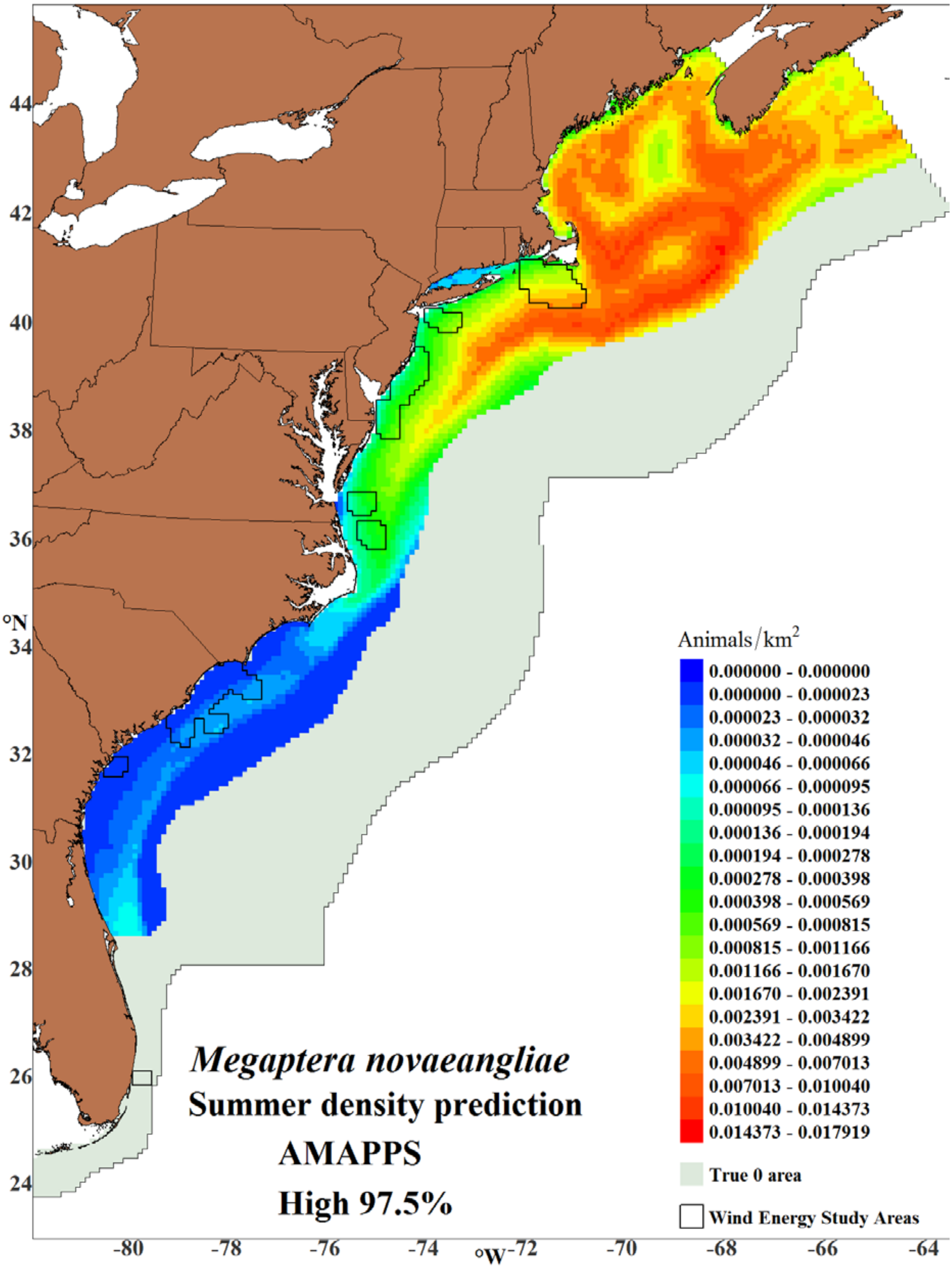

Figure 2-14 Upper 97.5% percentile of summer humpback whale estimates

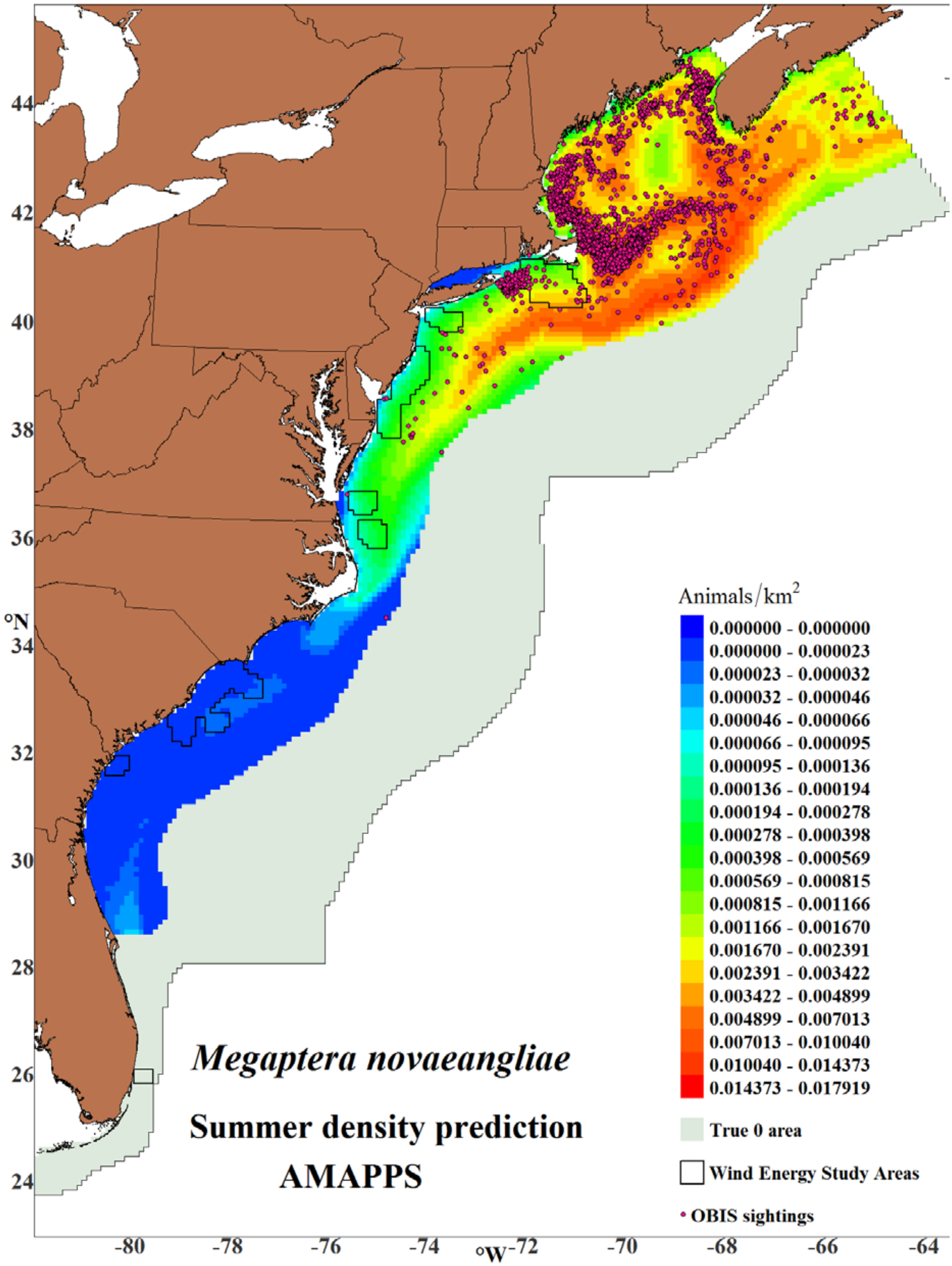

Figure 2-15 Humpback whale 2010-2013 summer density and 1970-2014 OBIS sightings pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

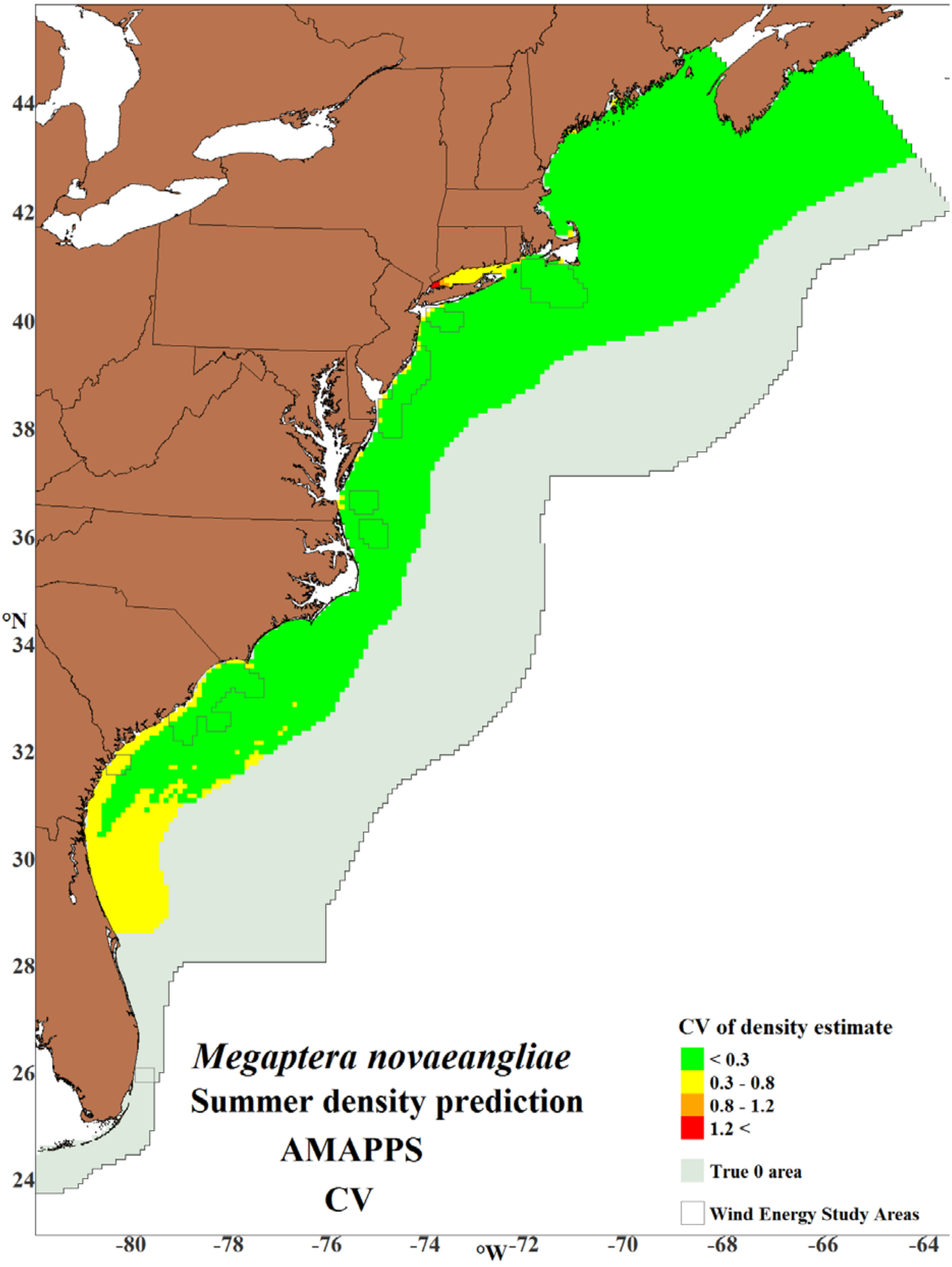

Figure 2-16 CV of summer density estimates for humpback whales

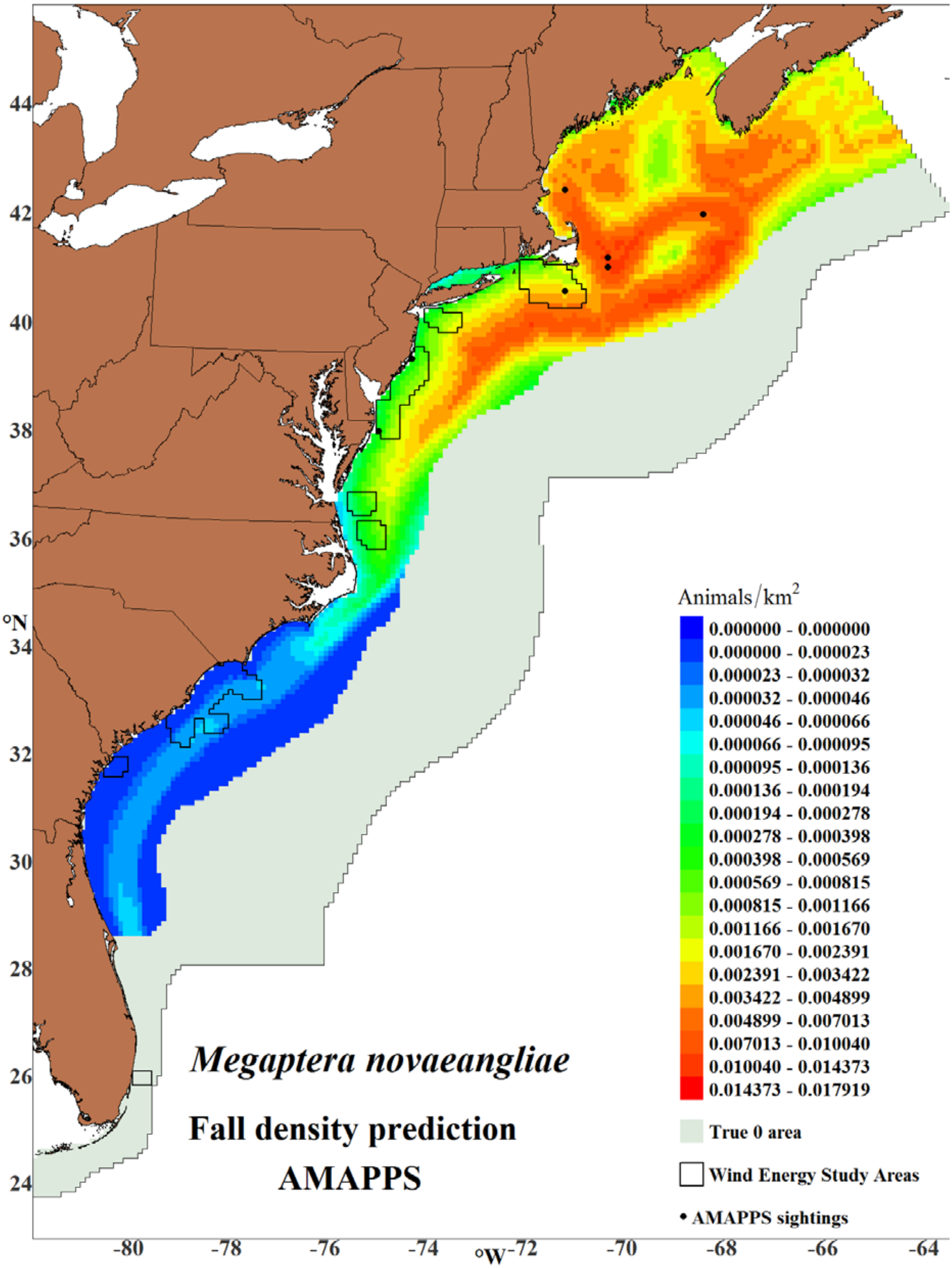

Figure 2-17 Humpback whale fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

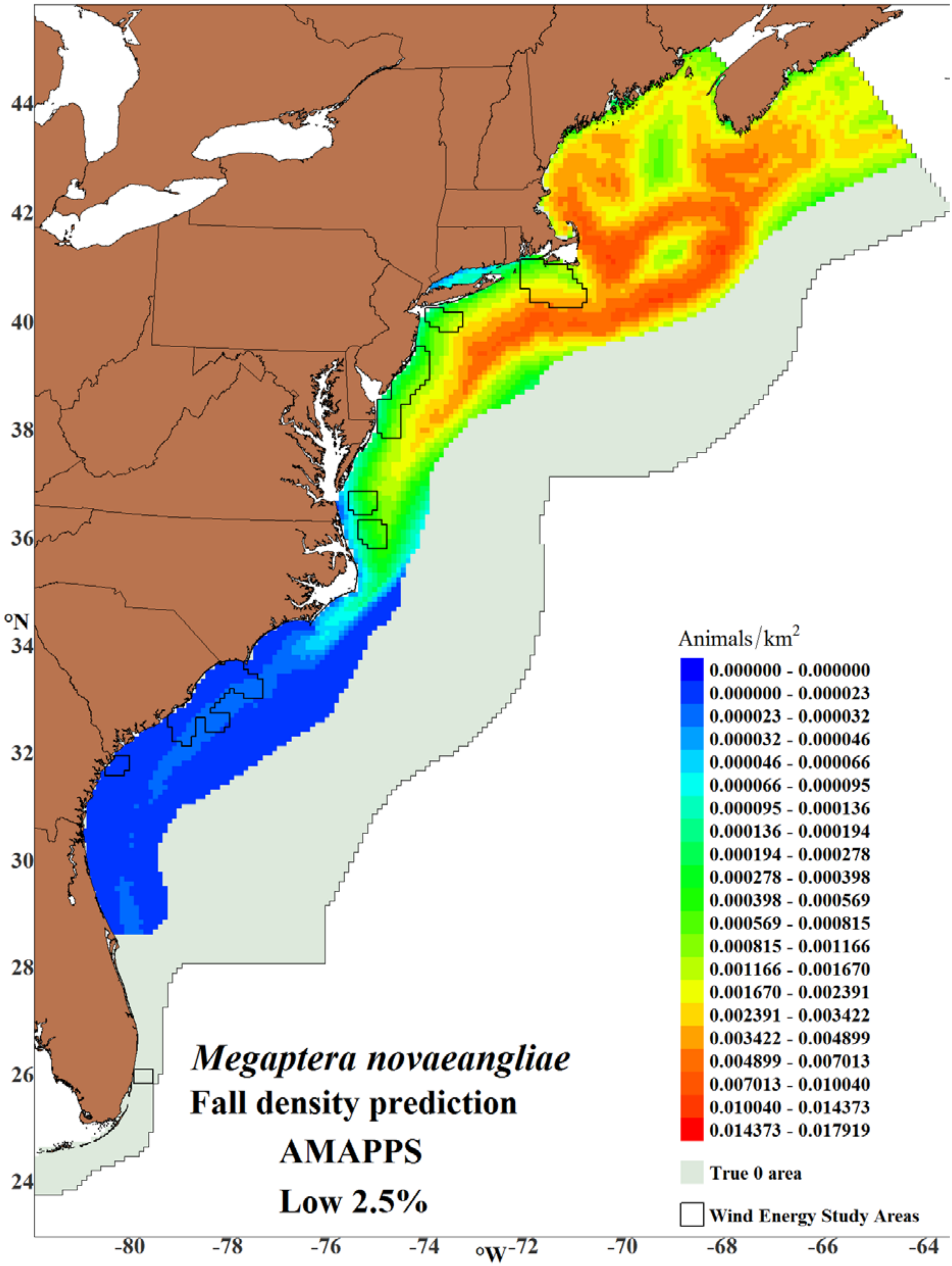

Figure 2-18 Lower 2.5% percentile of fall humpback whale estimates

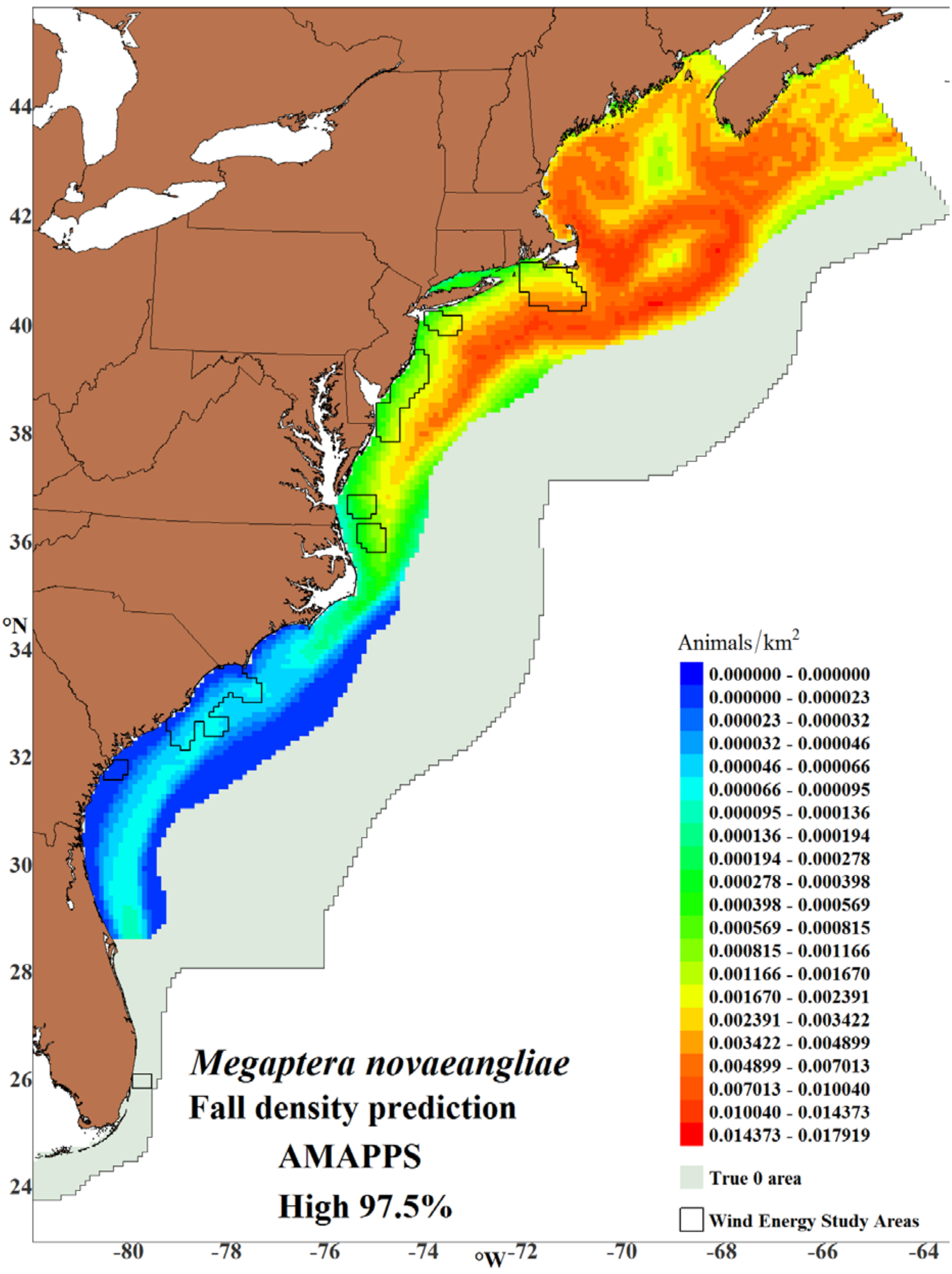

Figure 2-19 Upper 97.5% percentile of fall humpback whale estimates

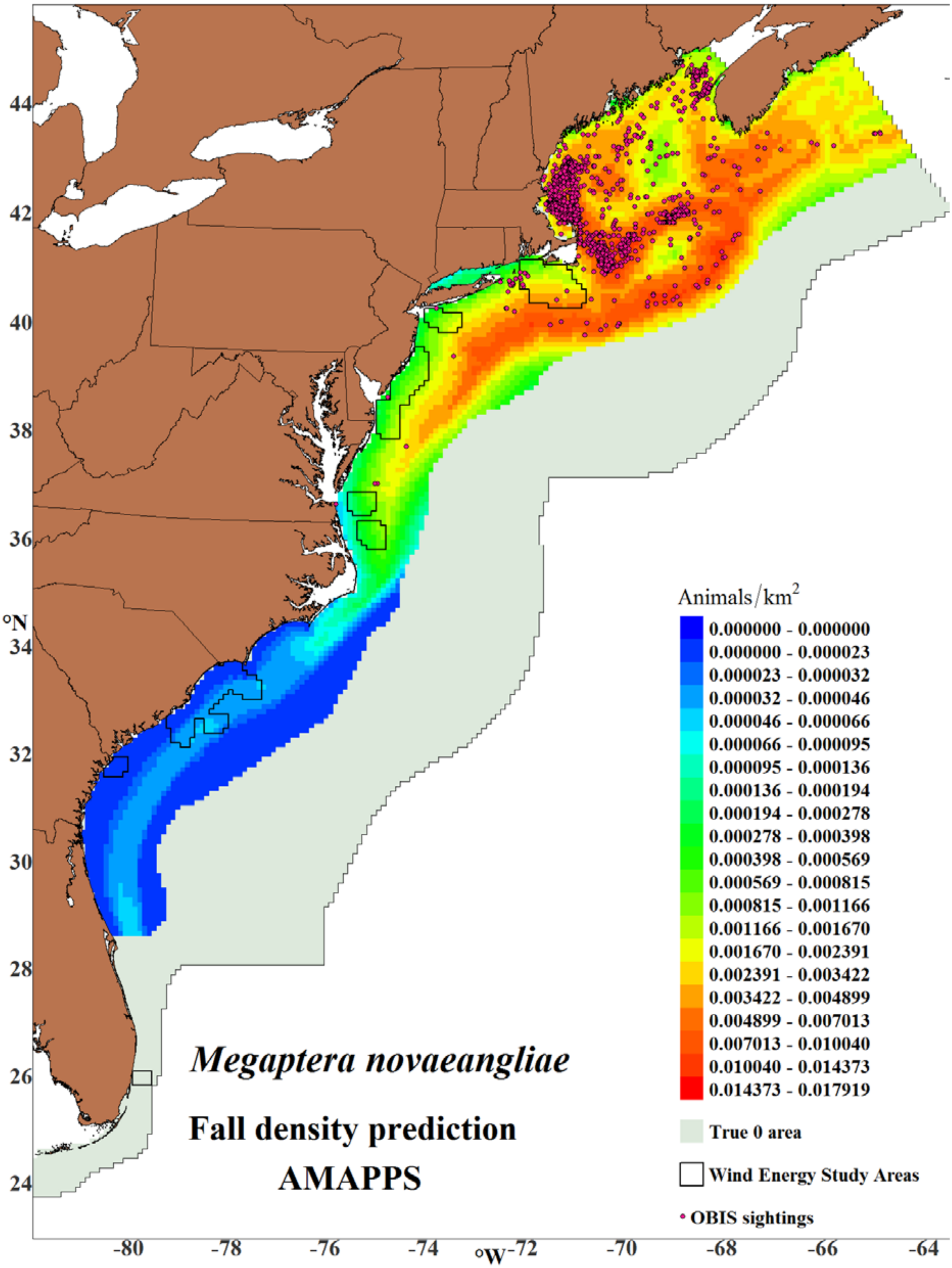

Figure 2-20 Humpback whale 2010-2013 fall density and 1970-2014 OBIS sightings
Pink circles (Halpin *et al.* 2009). These sightings were not used to develop the density-habitat model.

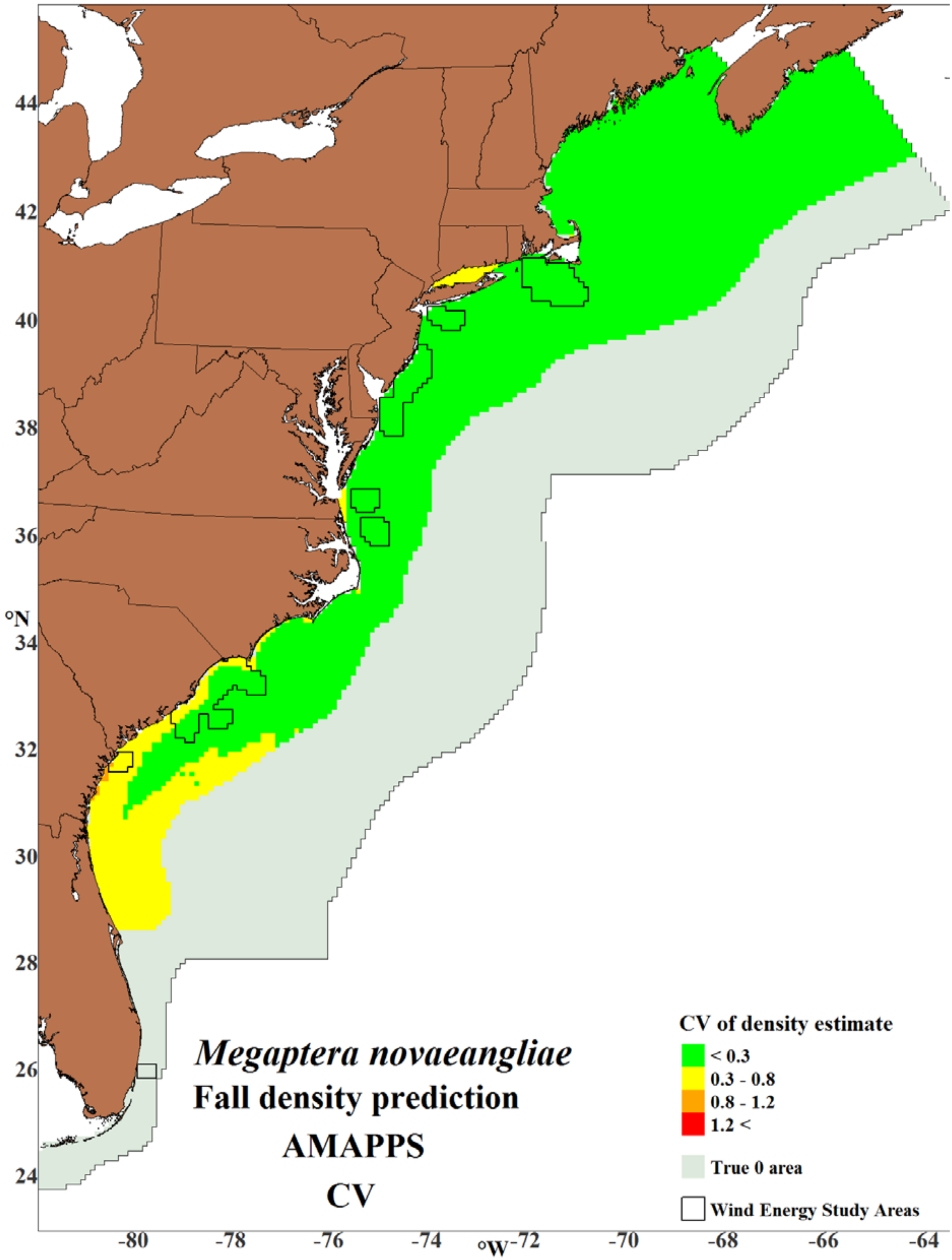

Figure 2-21 CV of fall density estimates for humpback whales

2.6 Wind Energy Study Areas

Table 2-6 Humpback whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.649, CV= 0.185; shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	37	0.128	29 - 47
(March-May)	New York	5	0.144	4 - 6
	New Jersey	9	0.136	7 - 12
	Delaware/ Maryland	6	0.121	5 - 8
	Virginia	3	0.128	2 - 4
	North Carolina	4	0.14	3 - 6
	South Carolina/ North Carolina	1	0.251	1 - 1
	Georgia	0	0.398	0 - 0
	Florida	N/A	-	-
Summer	Rhode Island/ Massachusetts	22	0.103	18 - 27
(June-August)	New York	1	0.155	1 - 2
	New Jersey	2	0.182	1 - 2
	Delaware/ Maryland	1	0.144	1 - 2
	Virginia	1	0.13	0 - 1
	North Carolina	1	0.143	1 - 1
	South Carolina/ North Carolina	0	0.236	0 - 0
	Georgia	0	0.331	0 - 0
	Florida	N/A	-	-
Fall	Rhode Island/ Massachusetts	33	0.096	27 - 39
(September-November)	New York	3	0.137	2 - 4
	New Jersey	5	0.149	4 - 7
	Delaware/ Maryland	3	0.139	2 - 4
	Virginia	1	0.139	1 - 2
	North Carolina	2	0.144	1 - 2
	South Carolina/ North Carolina	0	0.249	0 - 1
	Georgia	0	0.448	0 - 0
	Florida	N/A	-	-

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model. N/A indicates it was assumed to be in the True 0 modeled area.

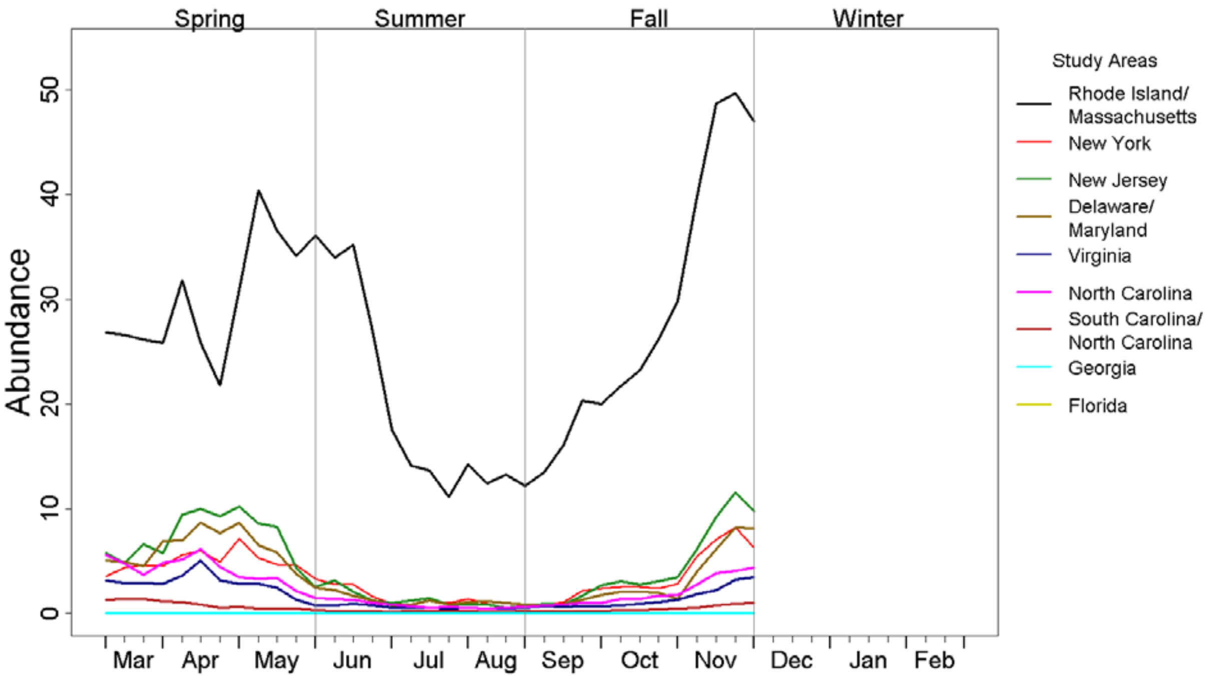

Figure 2-22 Annual abundance trends for humpback whales in wind energy study areas

3 Fin Whale (Balaenoptera physalus)

Figure 3-1 Fin whale. Credit: NOAA/NEFSC/Brenda Rone
Image collected under MMPA research Permit #775-1600.

3.1 Data Collection

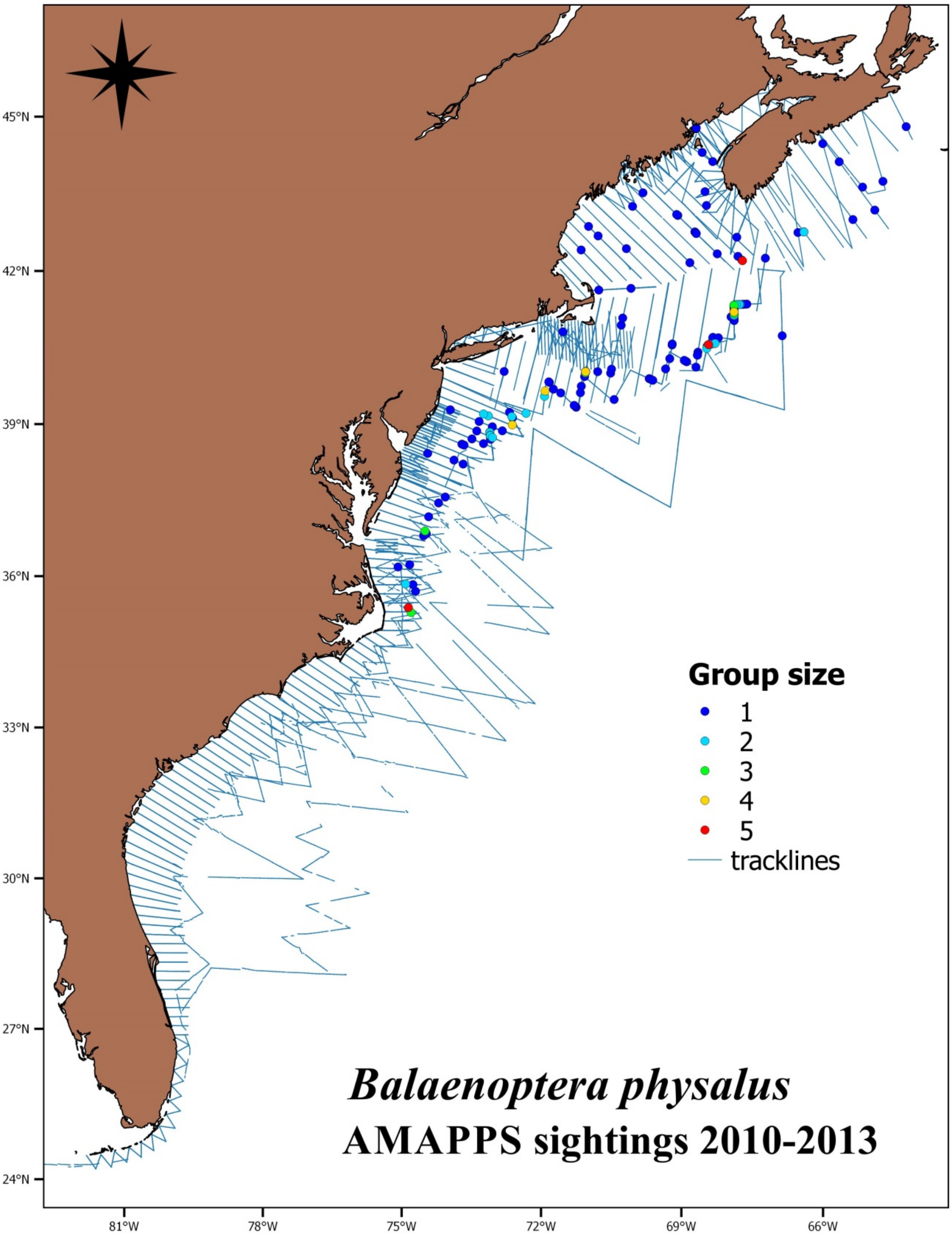

Figure 3-2 Track lines and fin whale sightings during 2010 - 2013

Table 3-1 Research effort 2010 - 2013 and fin whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Fin whale	*Balaenoptera physalus*	0	91/127	0	0
NE Aerial	7,502	10,468	11,038	3,573	-	-	23/34	17/17	25/26	1/1
SE Shipboard	0	8,537	2,093	0	-	-	0	5/8	3/9	0
SE Aerial	17,978	16,835	11,818	6,007	-	-	8/11	4/5	6/10	3/3

3.2 Mark-Recapture Distance Sampling Analysis

Table 3-2 Parameter estimates from fin whale (FIWH) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 1	1	CBWH,FIWH, HUWH, MIWH,RIWH,SPWH	Distance*observer	Distance+sea	400	HR	0.898	0.091	0.318	0.659	0.671
	2		-	Distance+sea	562	HN	-	-	0.221	0.737	0.758
NE-aerial group 1	1	CBWH, FISE,FIWH, HUWH,MIWH,RIWH SEWH, SPWH UNBW	Distance	Distance+time of day	900	HR	0.503	0.168	0.369	0.992	0.985
	2		-	Distance+glare	5240	HR	-	-	0.245	0.832	0.905
SE-shipboard group 1	-	FIWH,HUWH, RIWH,SPWH	Distance*observer + sea	Distance+sea	8840	HN	0.472	0.228	0.326	0.122	0.137
NE-shipboard group 1	-	CBWH, FISE,FIWH, HUWH,MIWH, RIWH, SEWH,SPWH,UNBW	Distance	Distance+glare	4000	HR	0.513	0.136	0.220	0.991	0.979

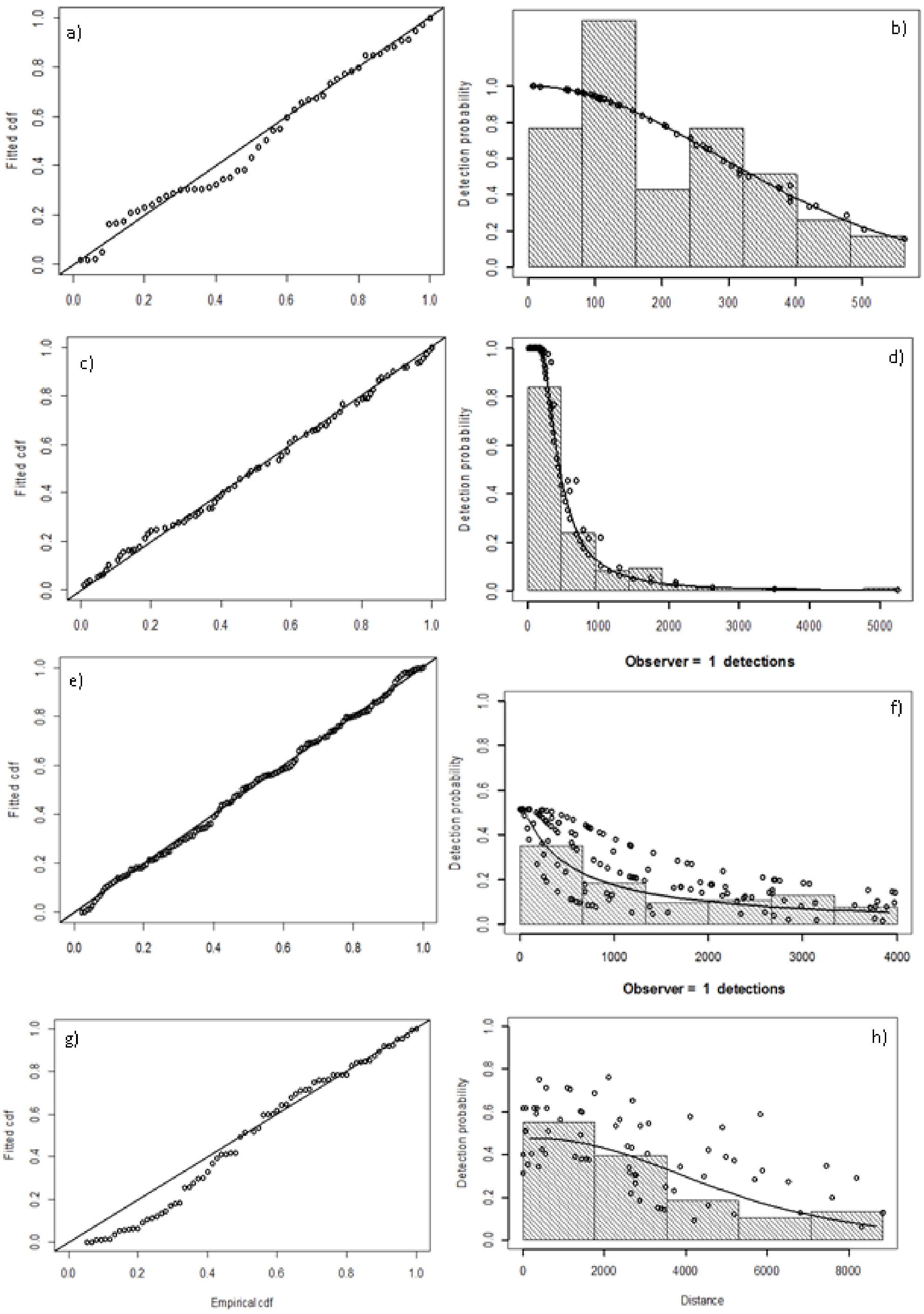

Figure 3-3 Q-Q plots and detection functions from fin whale MRDS analysis
Group 1 aerial southeast region (a,b), group 1 aerial northeast region (c,d), group 1 shipboard northeast region (e,f) and group 1 shipboard southeast region (g,h).

3.3 Generalized Additive Model Analysis

Table 3-3 Habitat model output for fin whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(chl)	0.7927	4	3.752	1.31E-05	1.28E-03	***
s(btemp)	3.0314	4	31.781	< 2e-16	2.04E-01	***
s(dist125)	0.9924	4	45.547	< 2e-16	1.27E-08	***
s(lat)	2.5743	4	41.771	< 2e-16	3.80E-01	***
Scale	-	-	-	-	1.18E+00	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: Total = 8.39

R^2 (adjusted) = 0.017   Deviance explained = 34.7%

REML = 616.2 Scale estimate = 0.27135   sample size = 11644

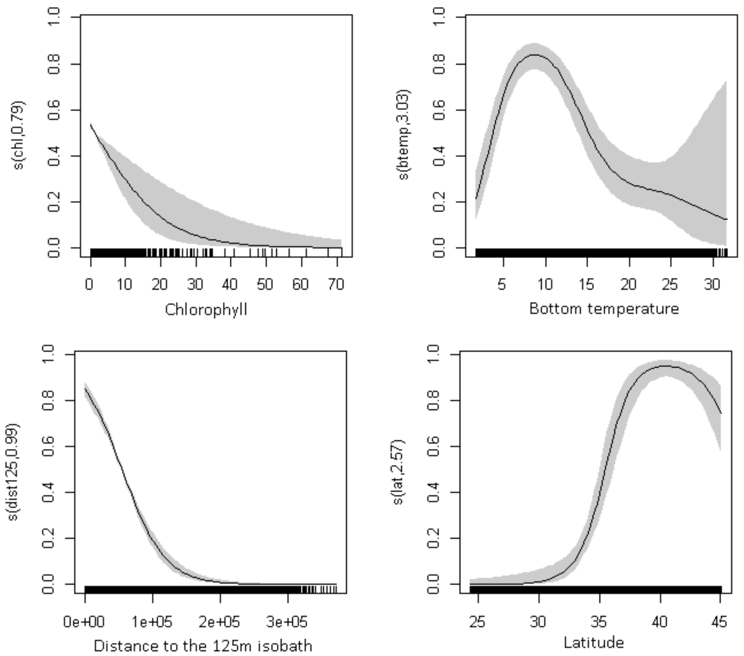

Figure 3-4 Fin whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 3-4 Diagnostic statistics from fin whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.117	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	88.72	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.128	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.006	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

3.4 Abundance Estimates for AMAPPS Study Area

Table 3-5 Fin whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.374, CV=0.336; shipboard 1, CV=0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	3,817	0.217	2,508 – 5,809
Summer (June-August)	4,718	0.129	3,667 – 6,070
Fall (September-November)	4,514	0.123	3,545 – 5,742

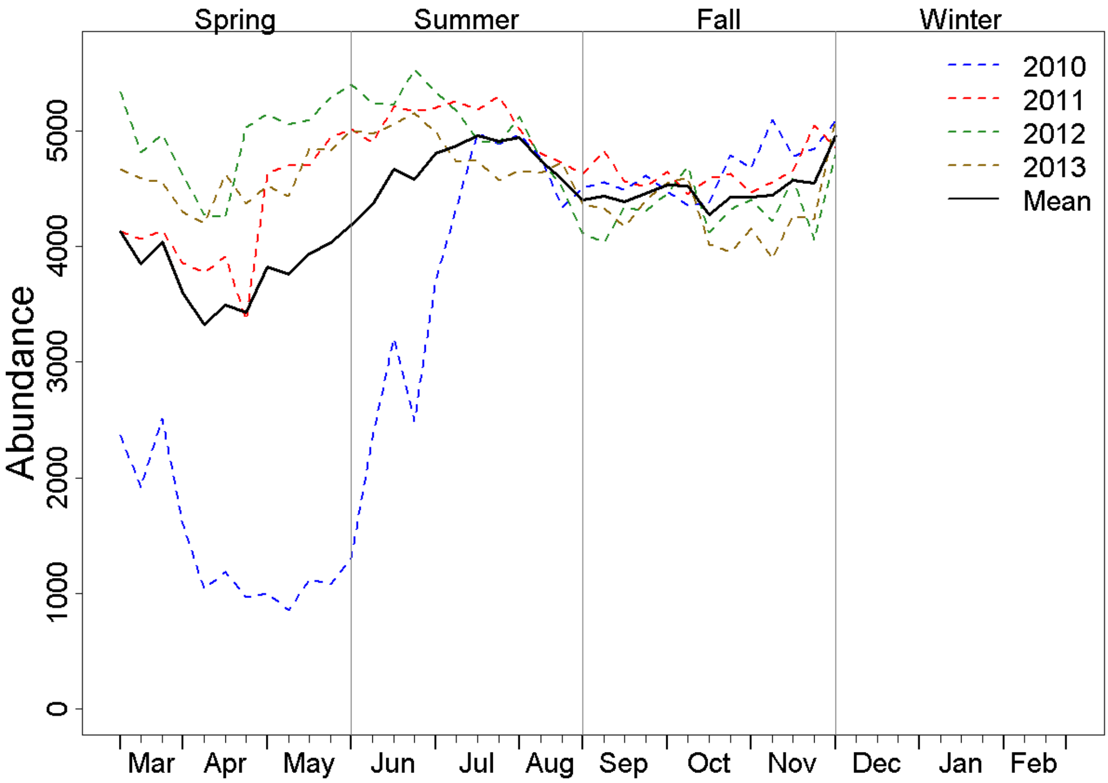

Figure 3-5 Annual abundance trends for fin whales for AMAPPS study area

3.5 Seasonal Prediction Maps

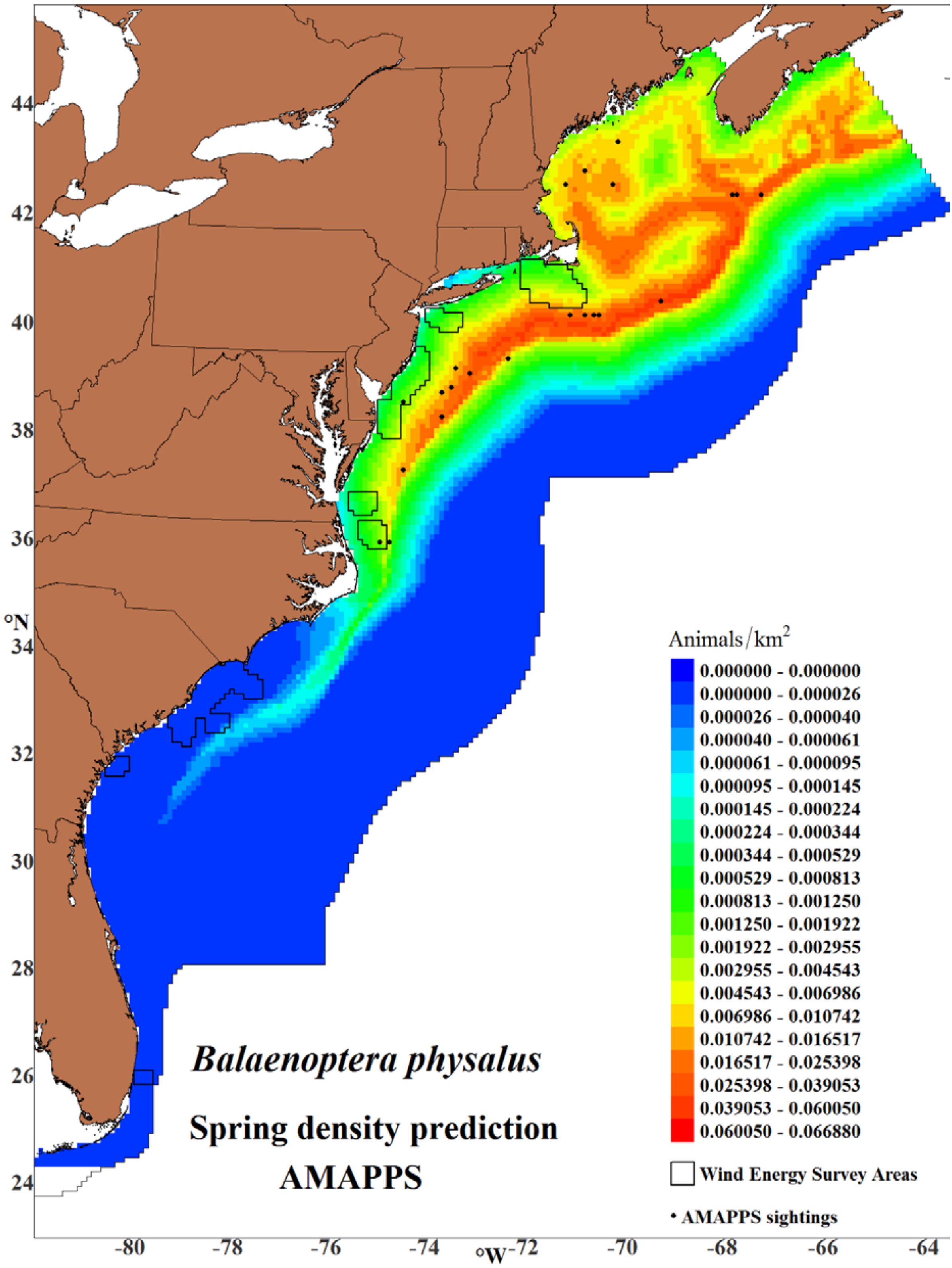

Figure 3-6 Fin whale spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

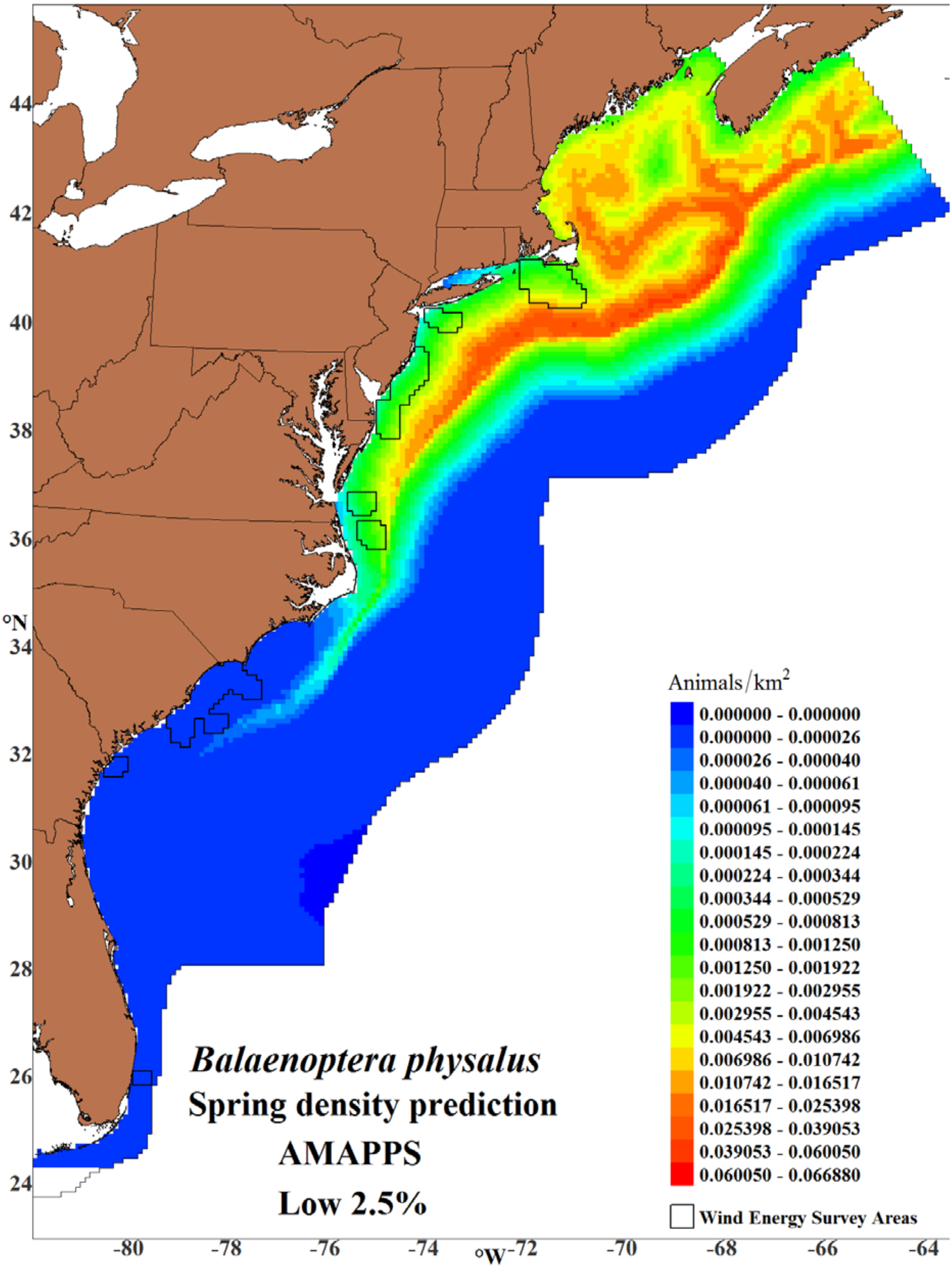

Figure 3-7 Lower 2.5% percentile of spring fin whale estimates

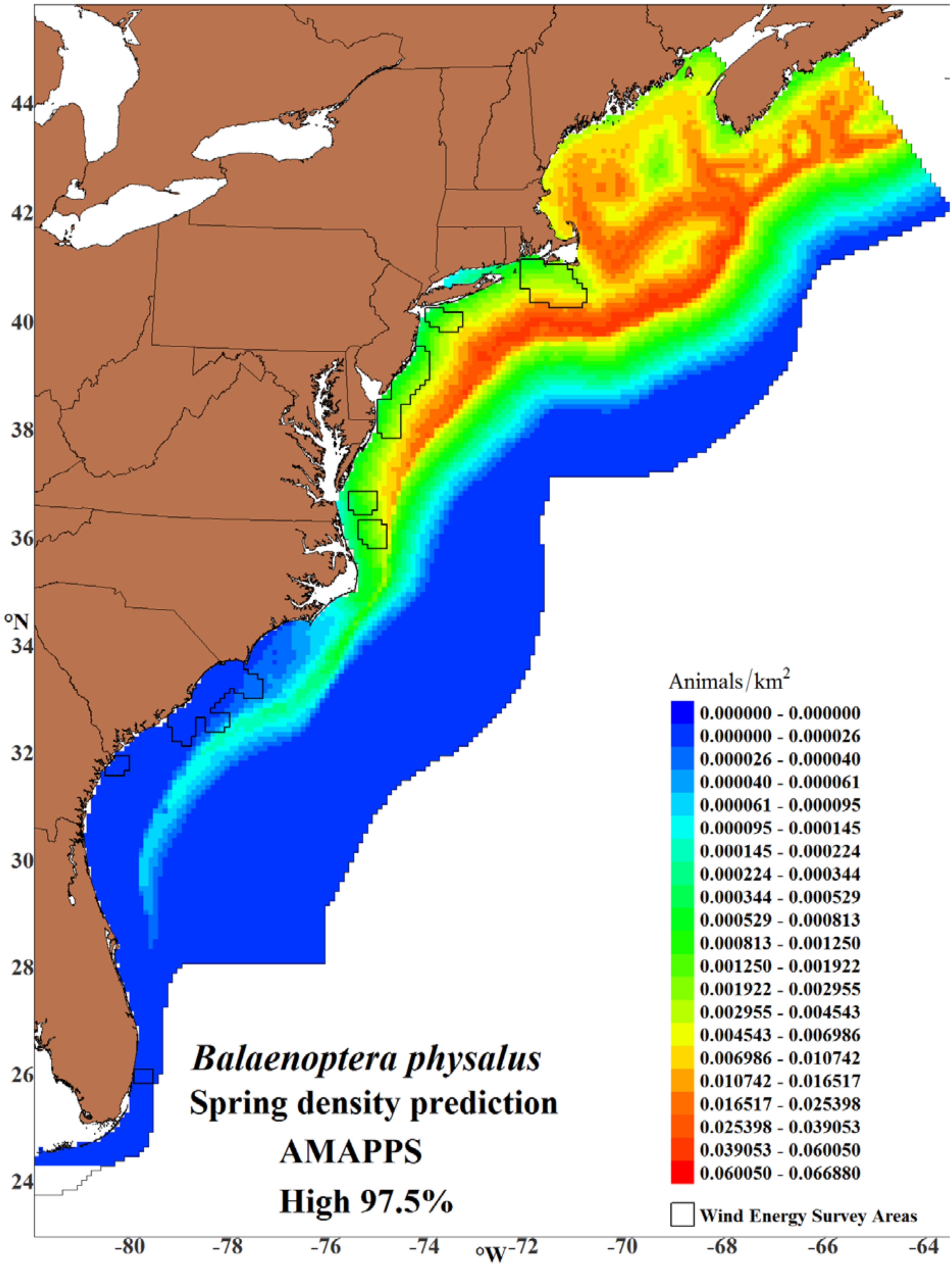

Figure 3-8 Upper 97.5% percentile of spring fin whale estimates

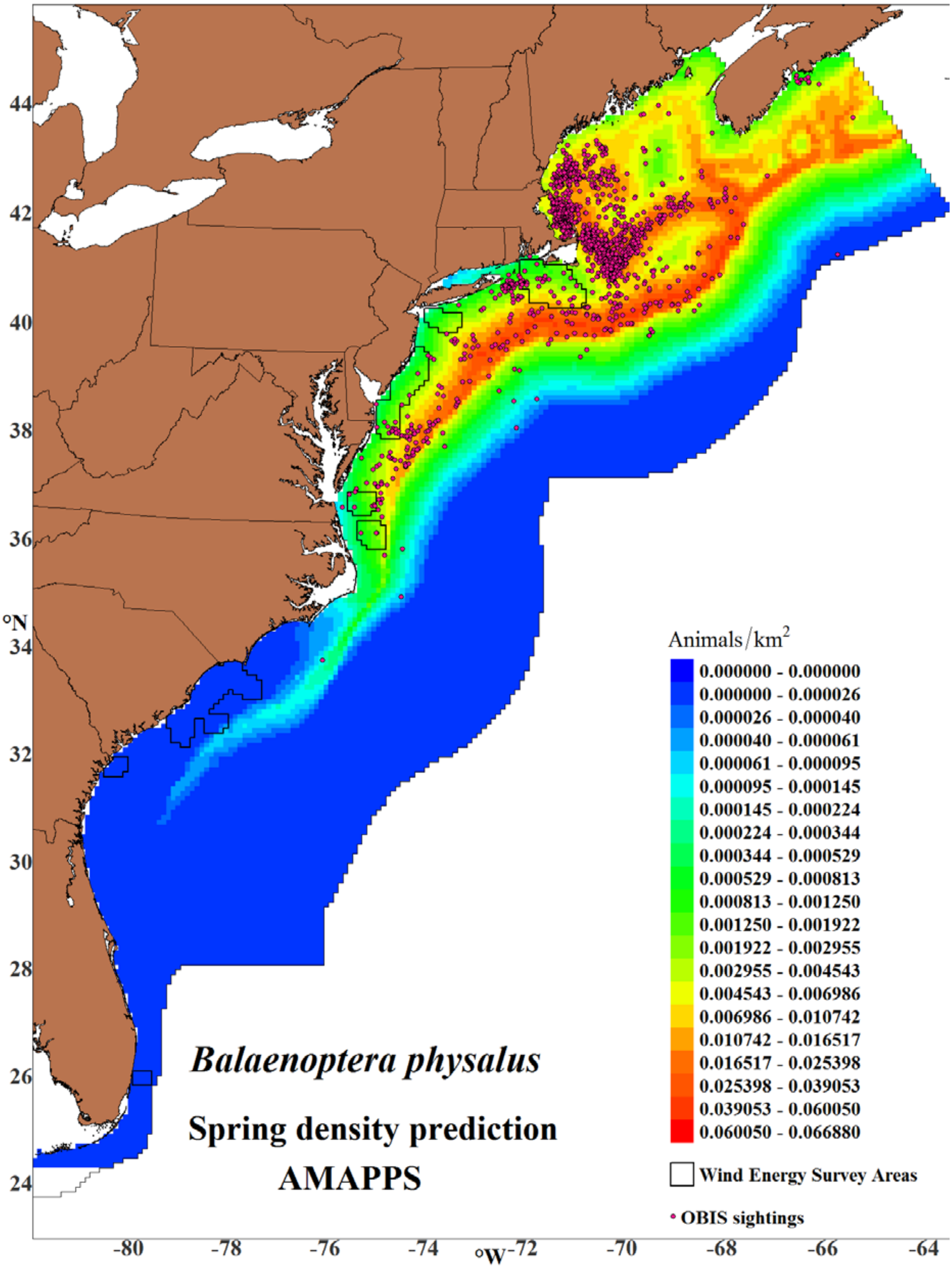

Figure 3-9 Fin whale 2010-2013 spring density and 1970-2014 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

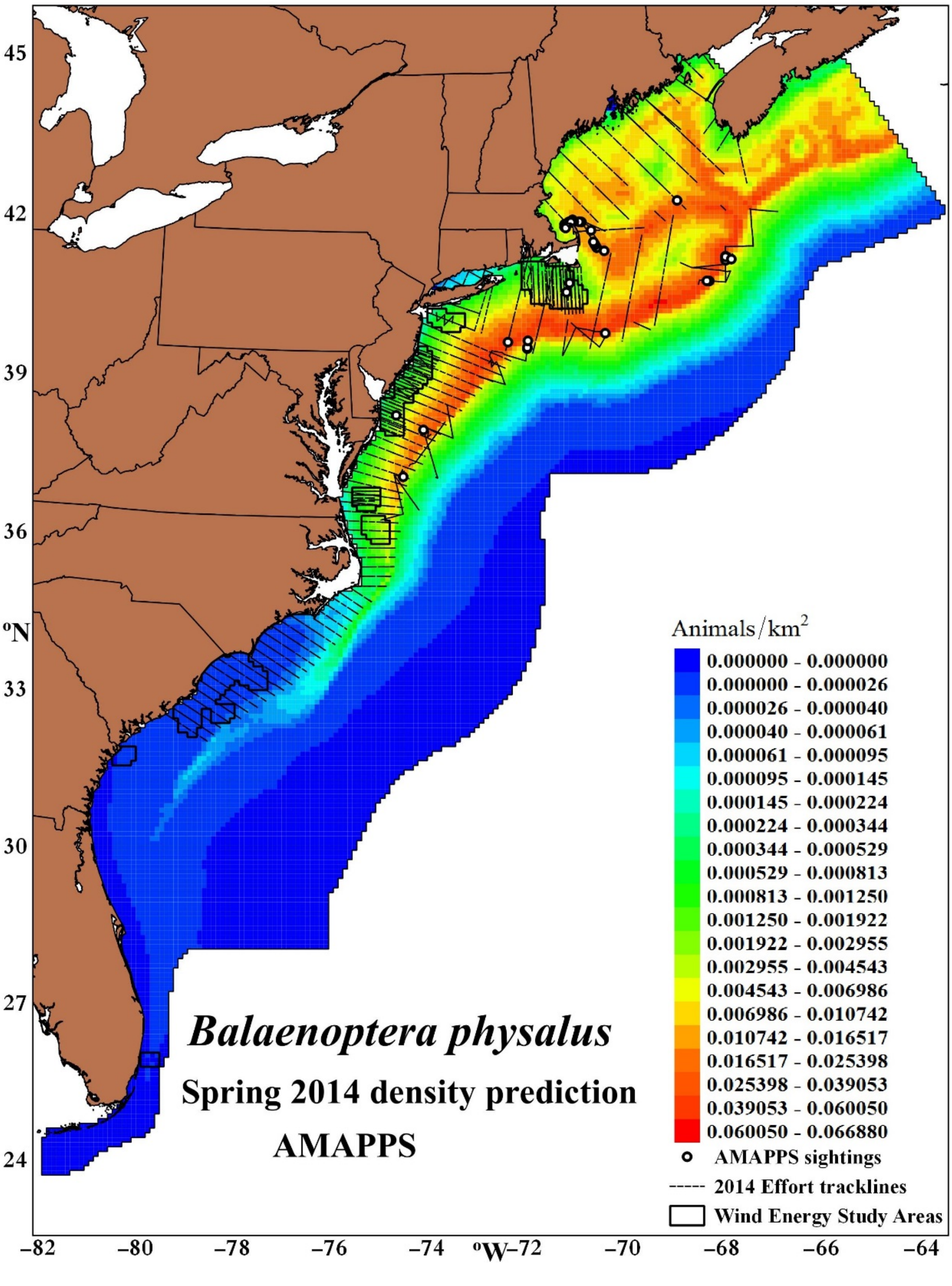

Figure 3-10 Fin whale spring 2014 density and AMAPPS 2014 tracks and sightings
These sightings were not used to develop the density-habitat model.

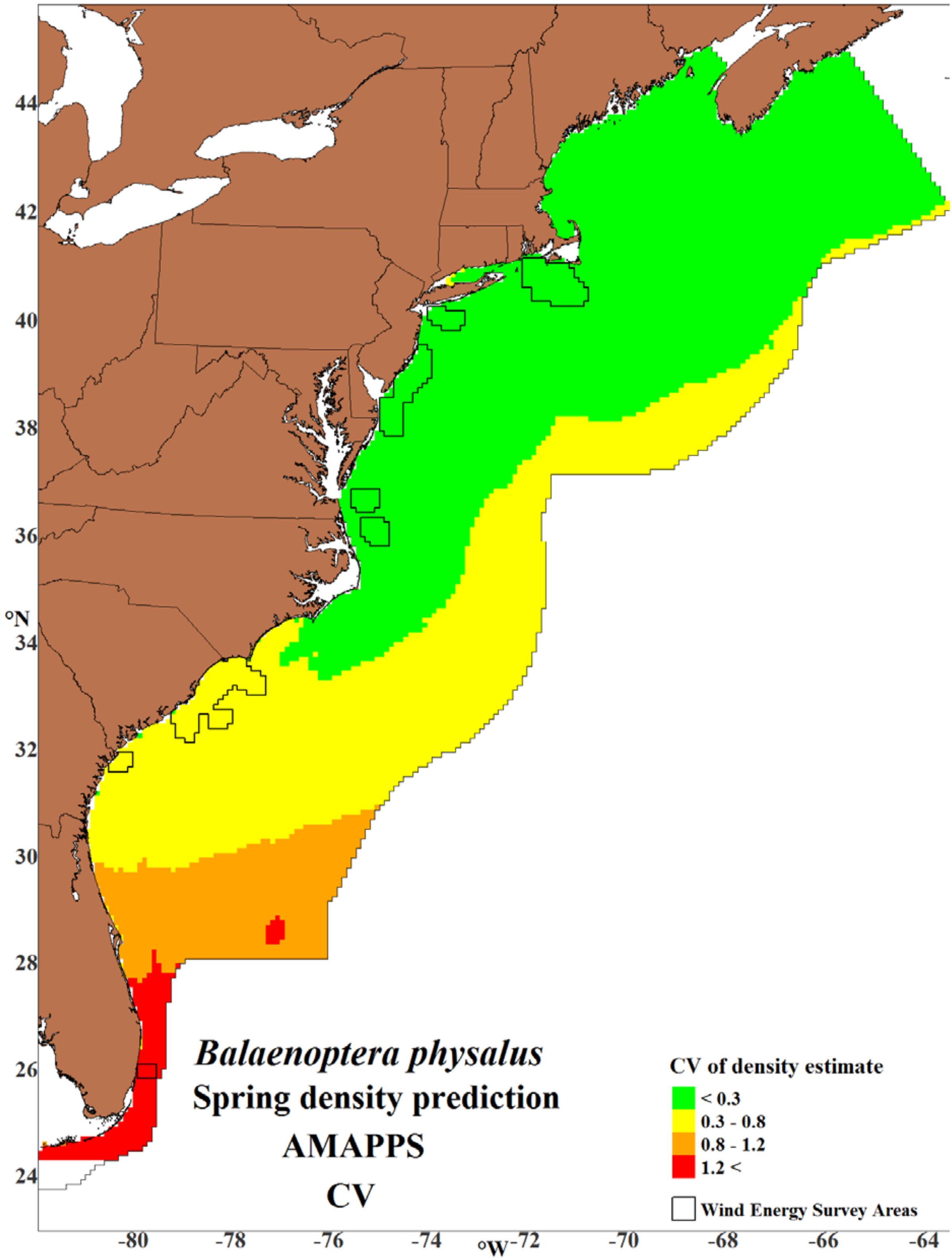

Figure 3-11 CV of spring density estimates for fin whales

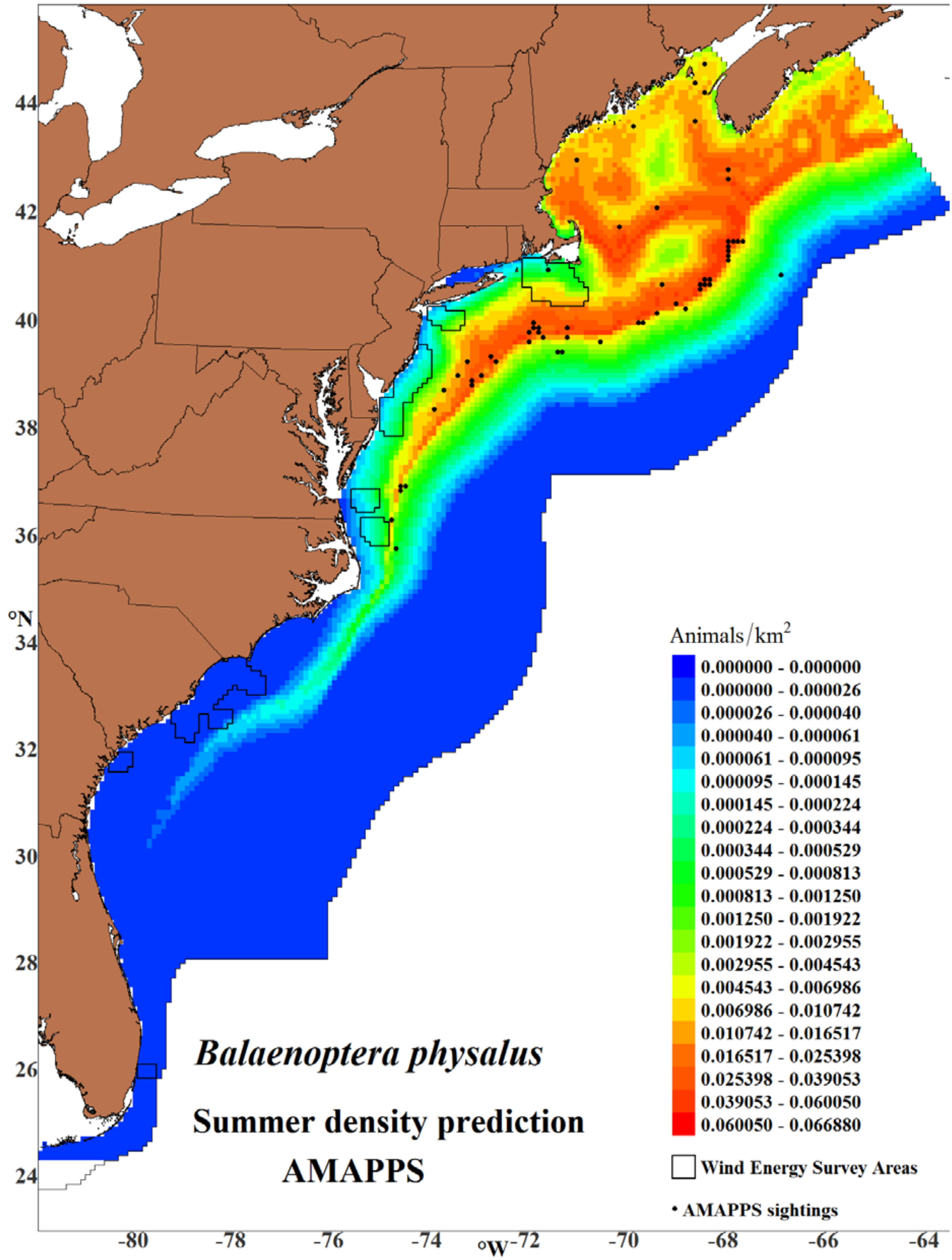

Figure 3-12 Fin whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

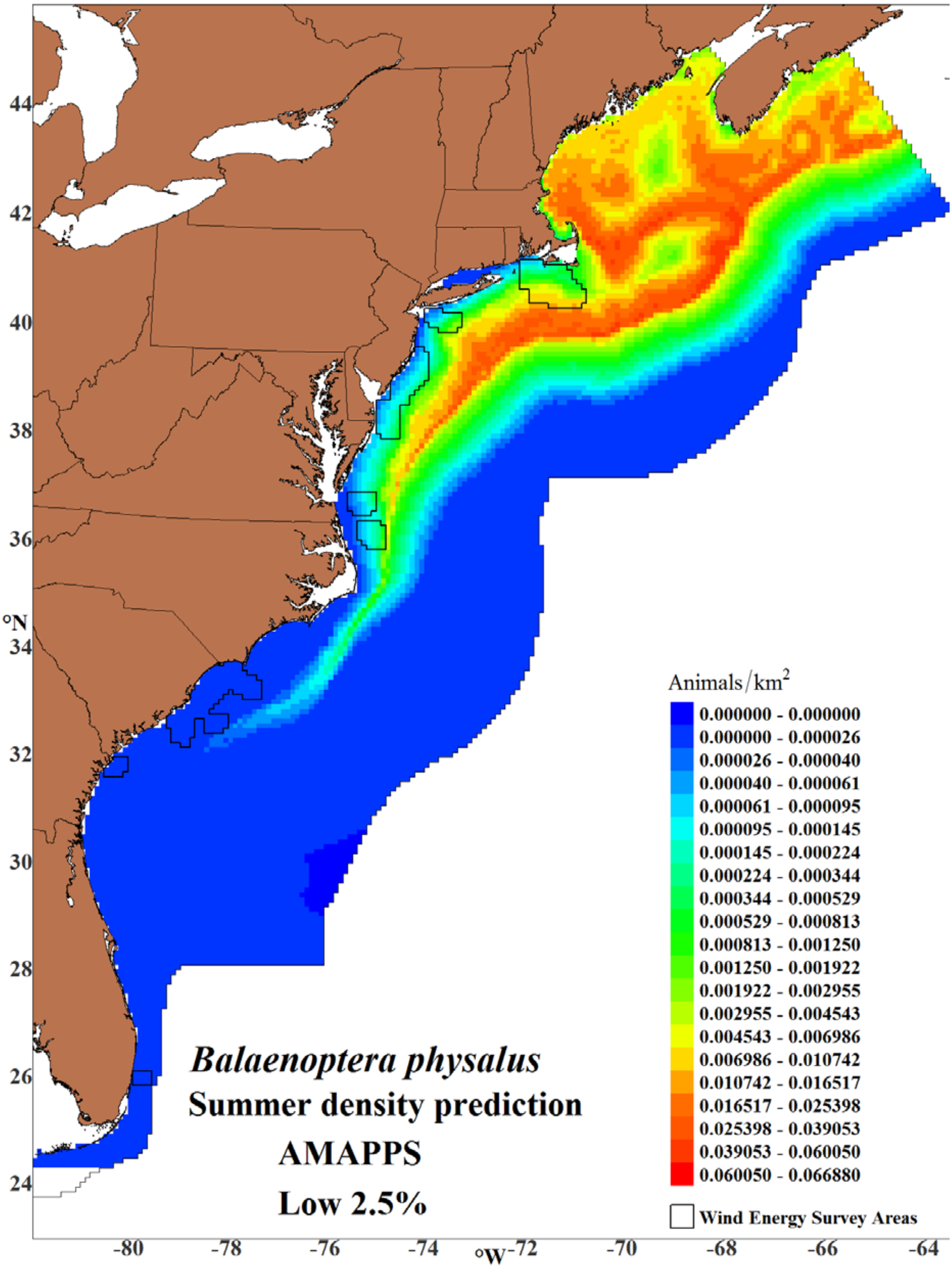

Figure 3-13 Lower 2.5% percentile of summer fin whale estimates

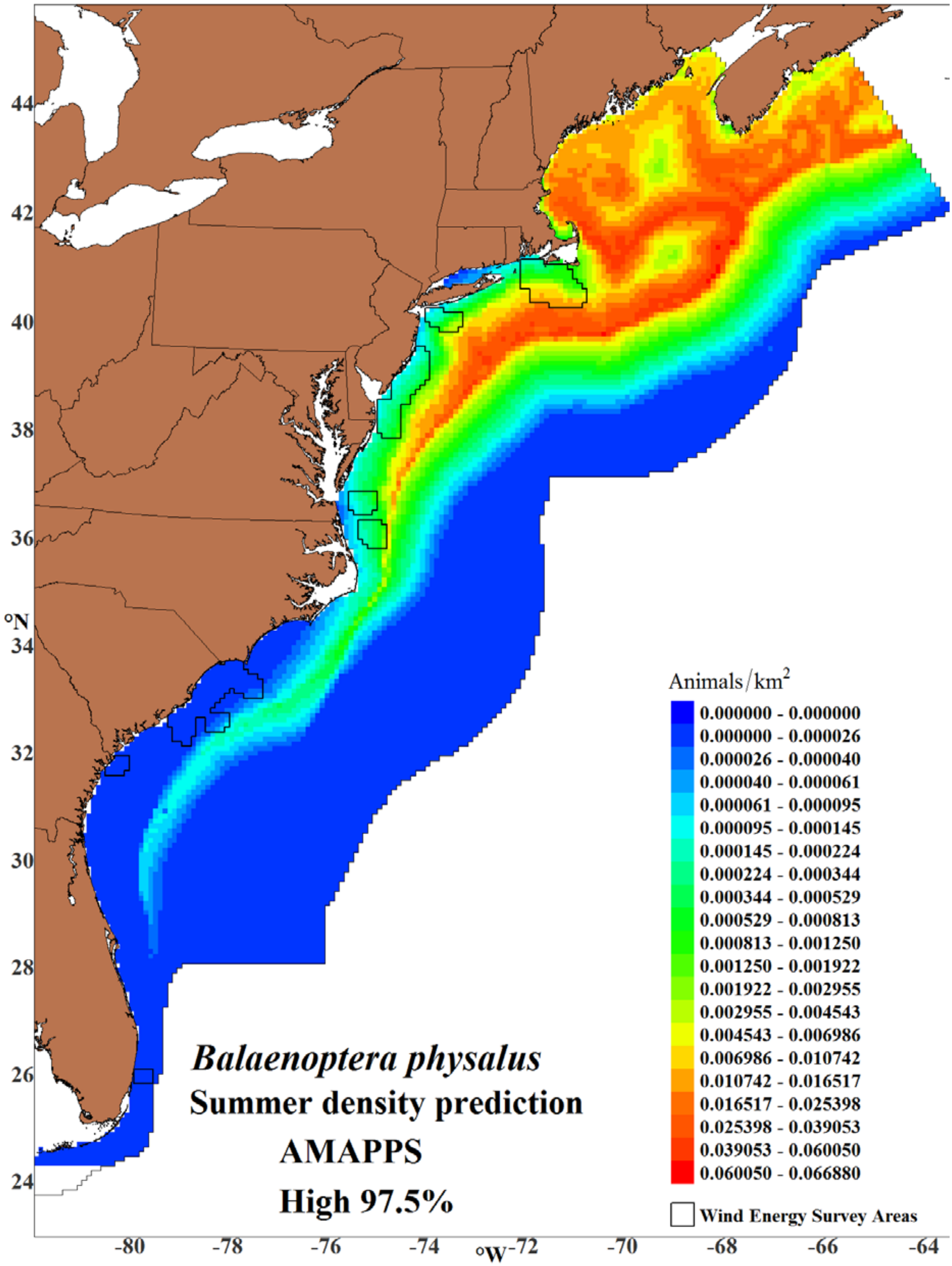

Figure 3-14 Upper 97.5% percentile of summer fin whale estimates

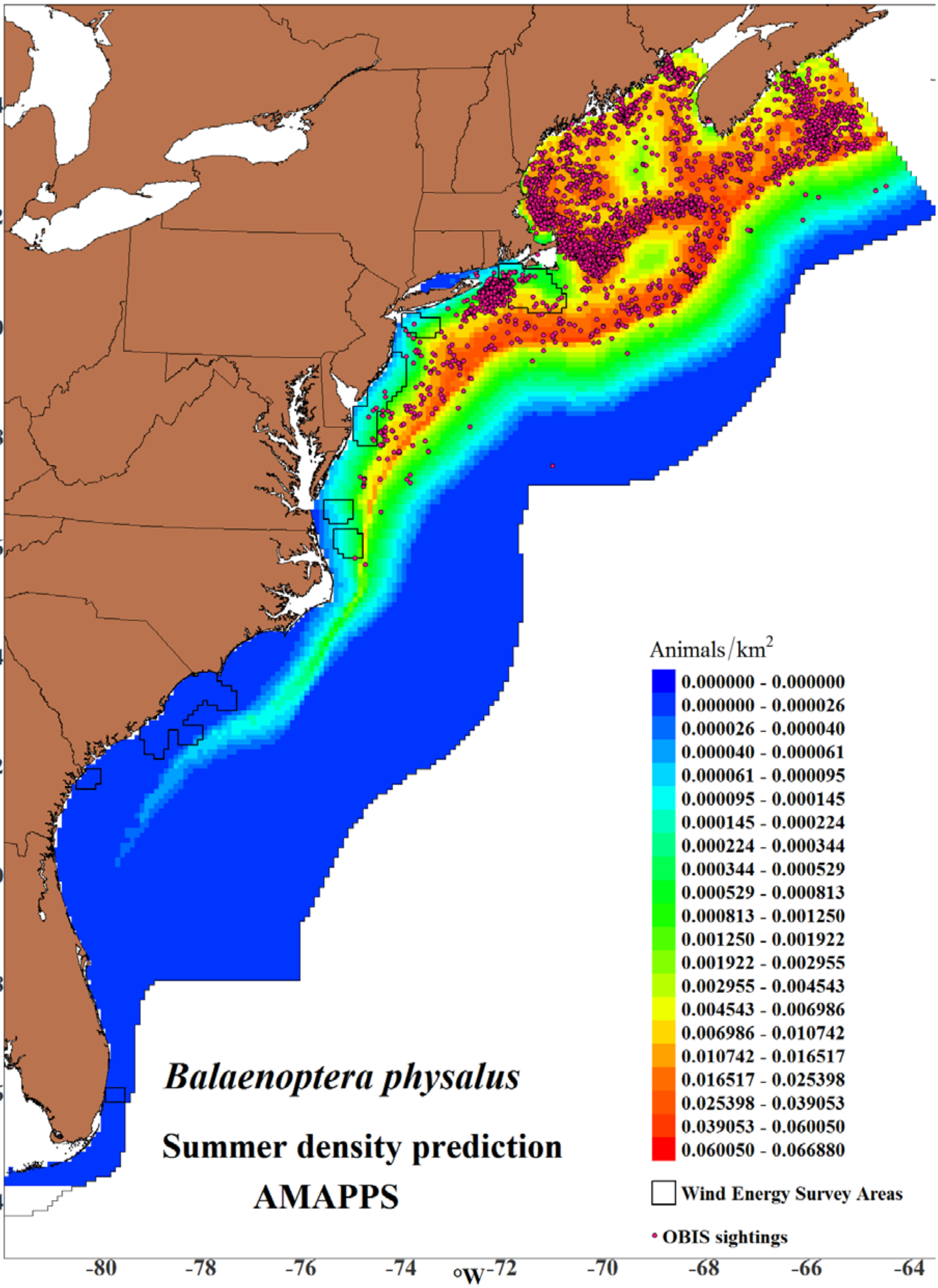

Figure 3-15 Fin whale 2010-2013 summer density and 1970-2014 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

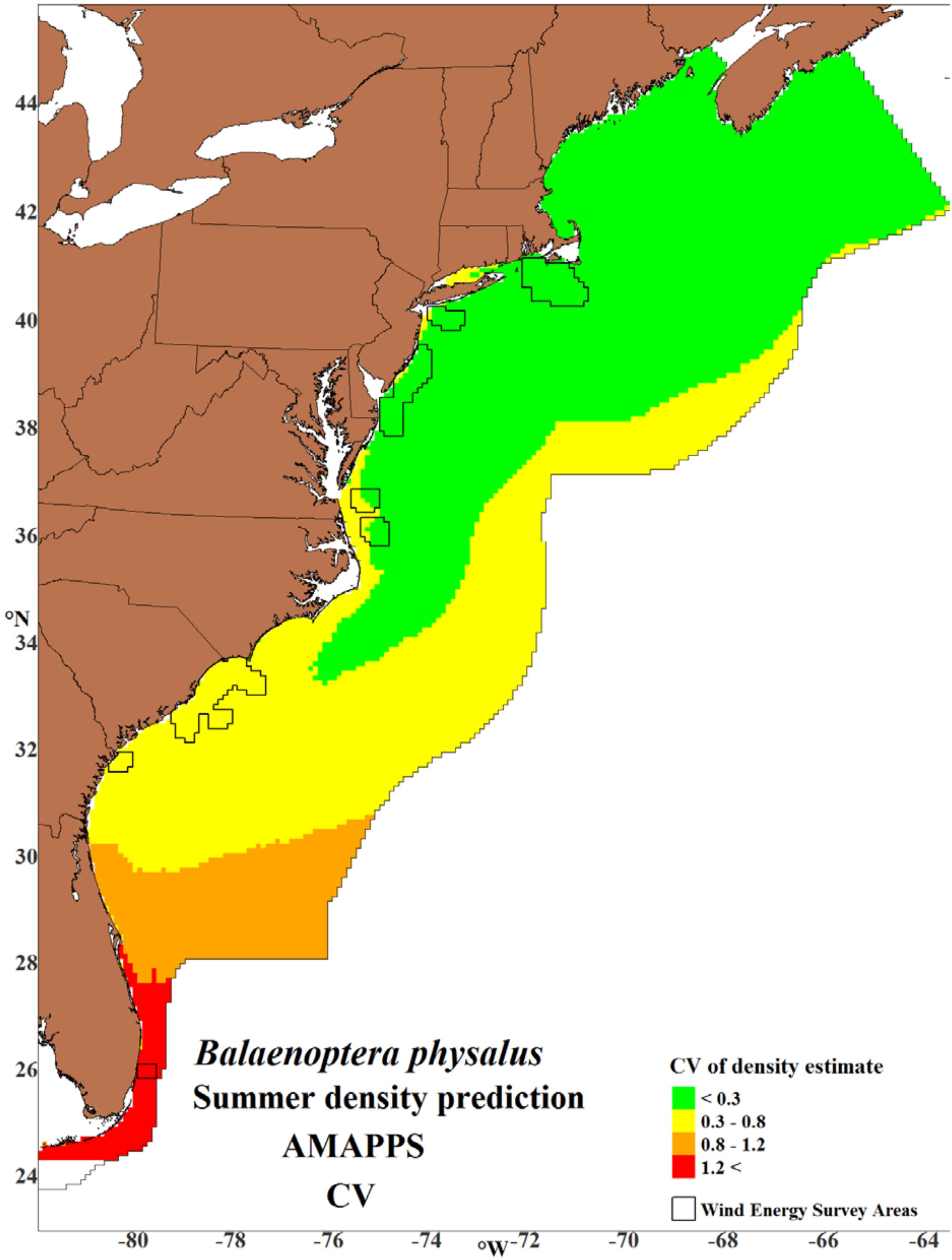

Figure 3-16 CV of summer density estimates for fin whales

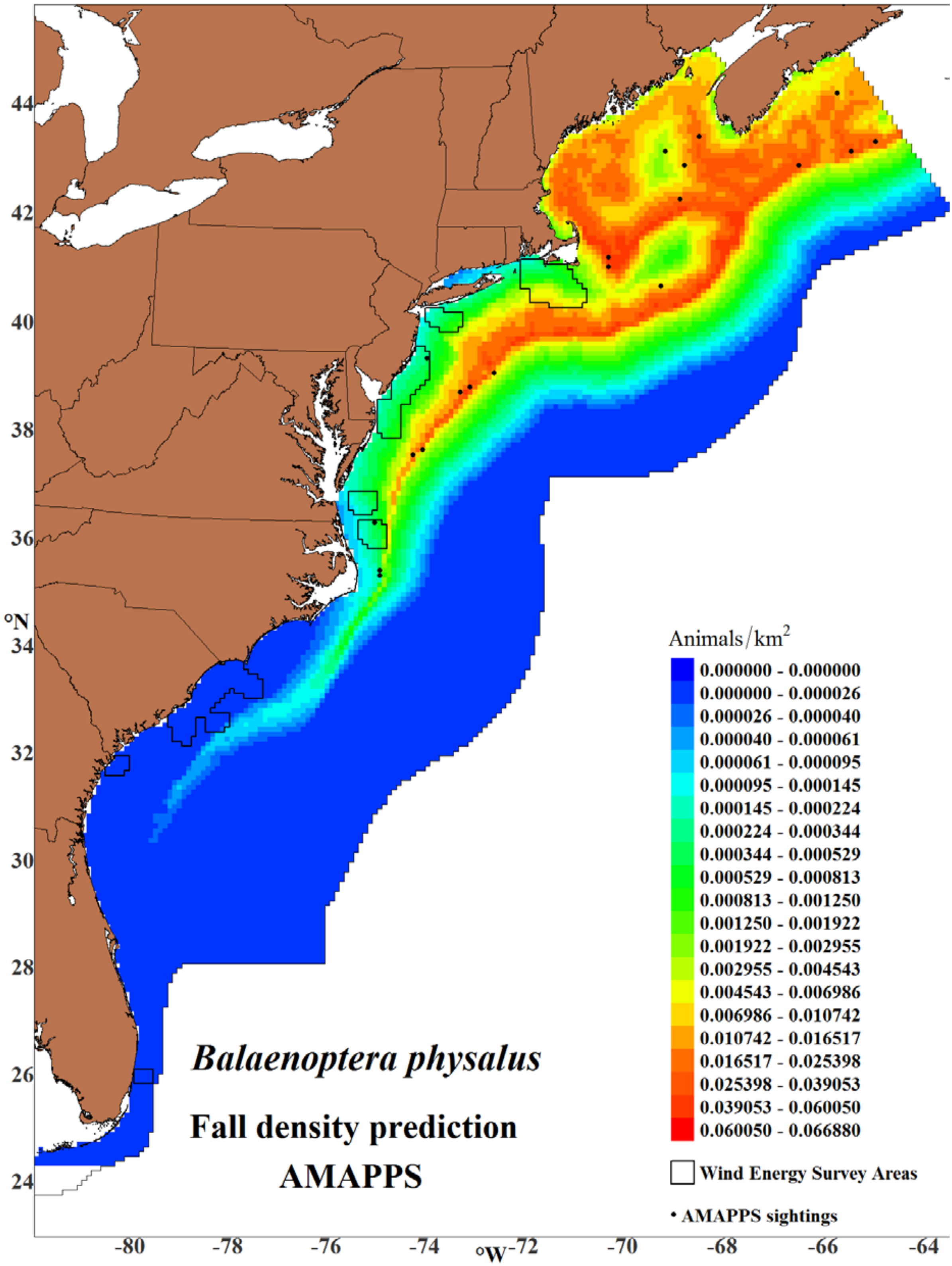

Figure 3-17 Fin whale fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

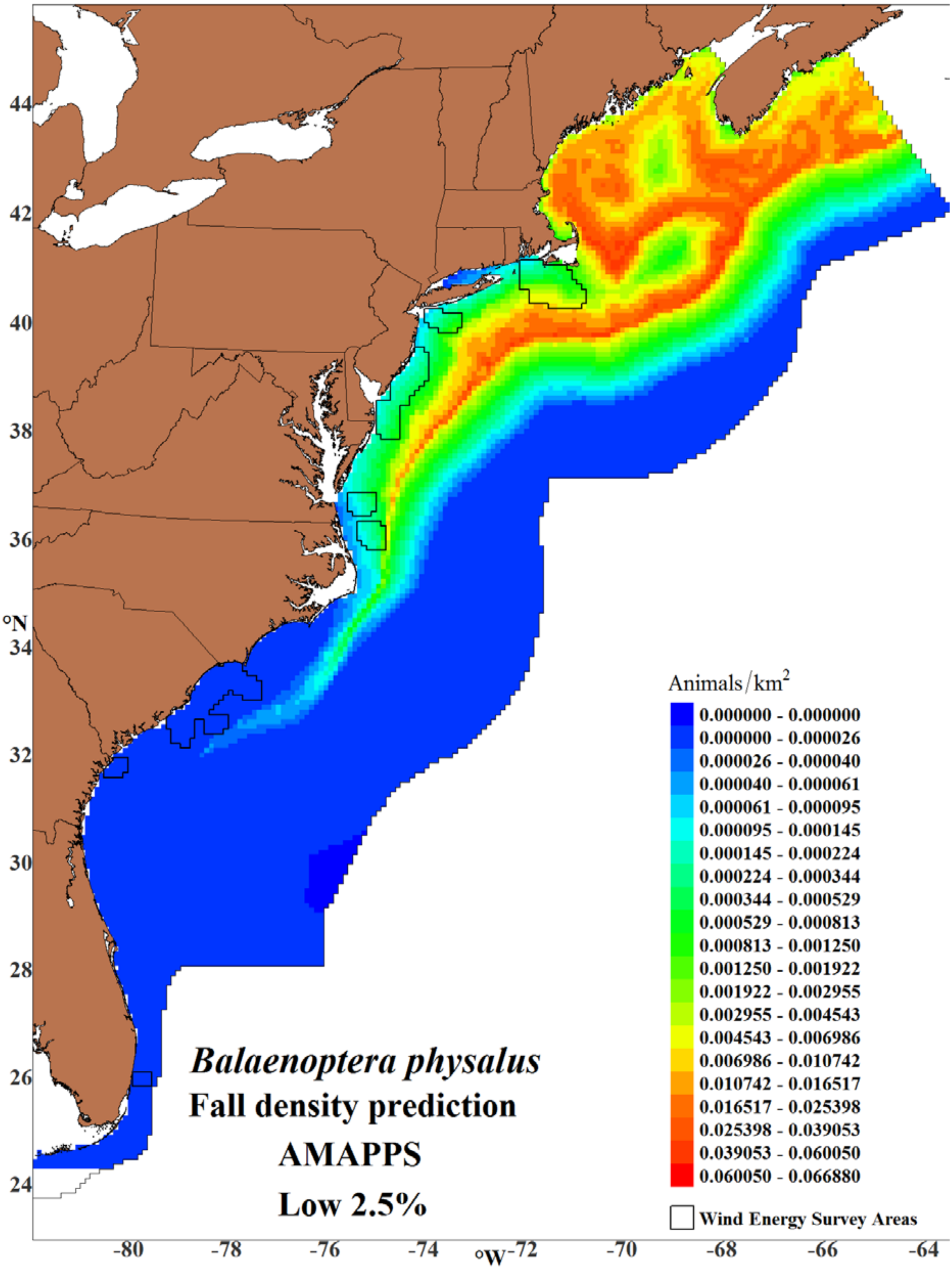

Figure 3-18 Lower 2.5% percentile of fall fin whale estimates

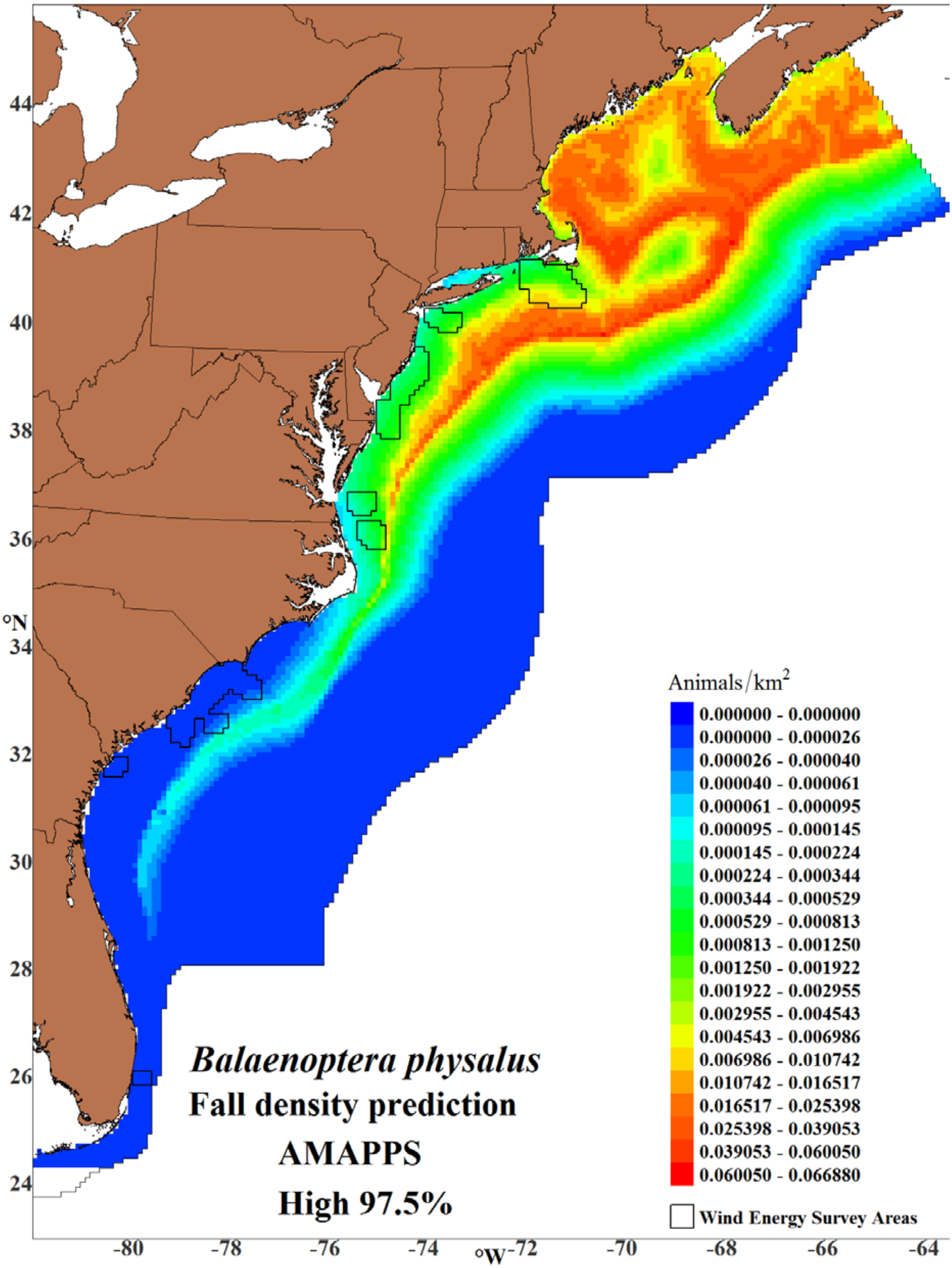

Figure 3-19 Upper 97.5% percentile of fall fin whale estimates

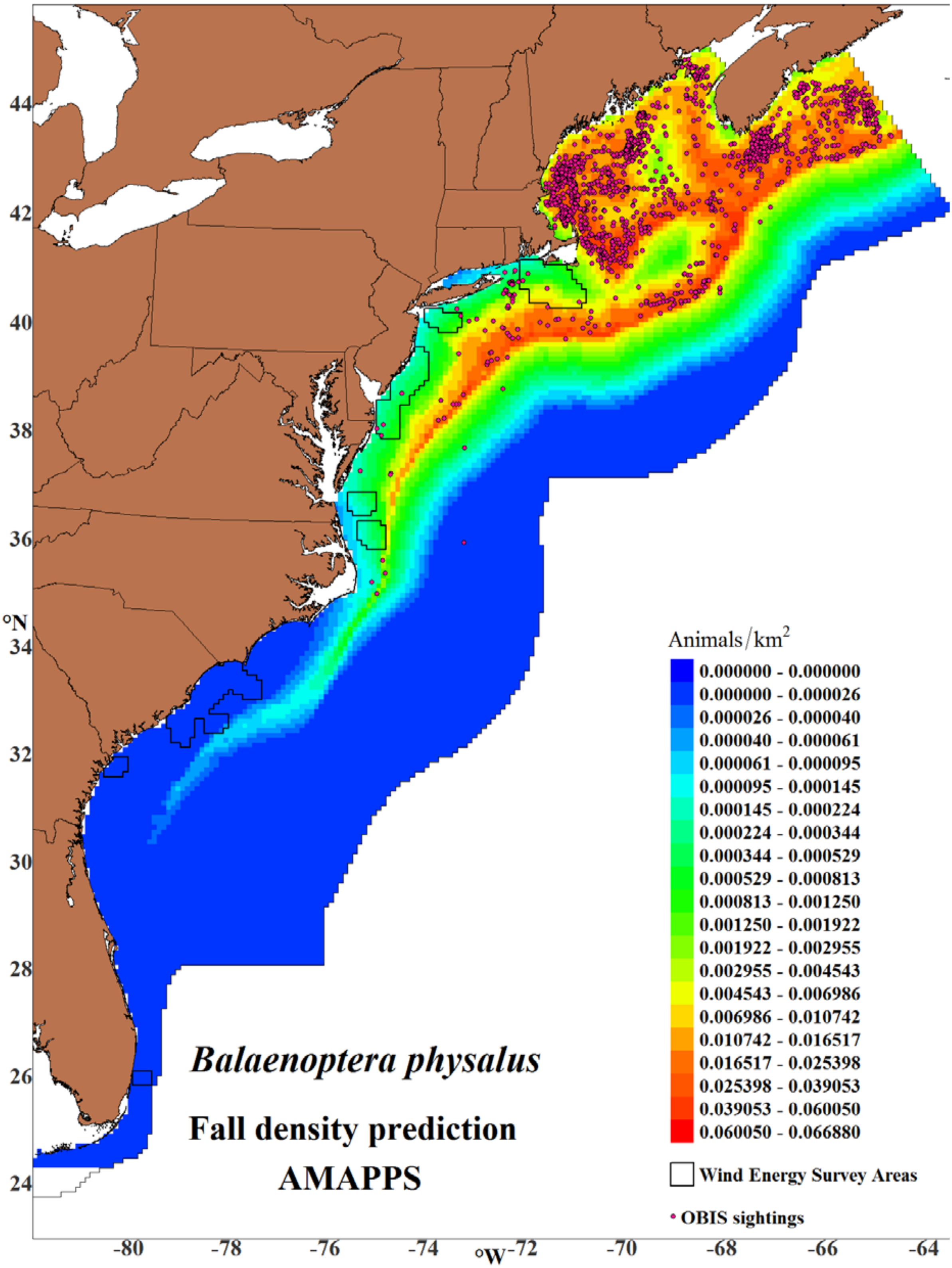

Figure 3-20 Fin whale 2010-2013 fall density and 1970-2014 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

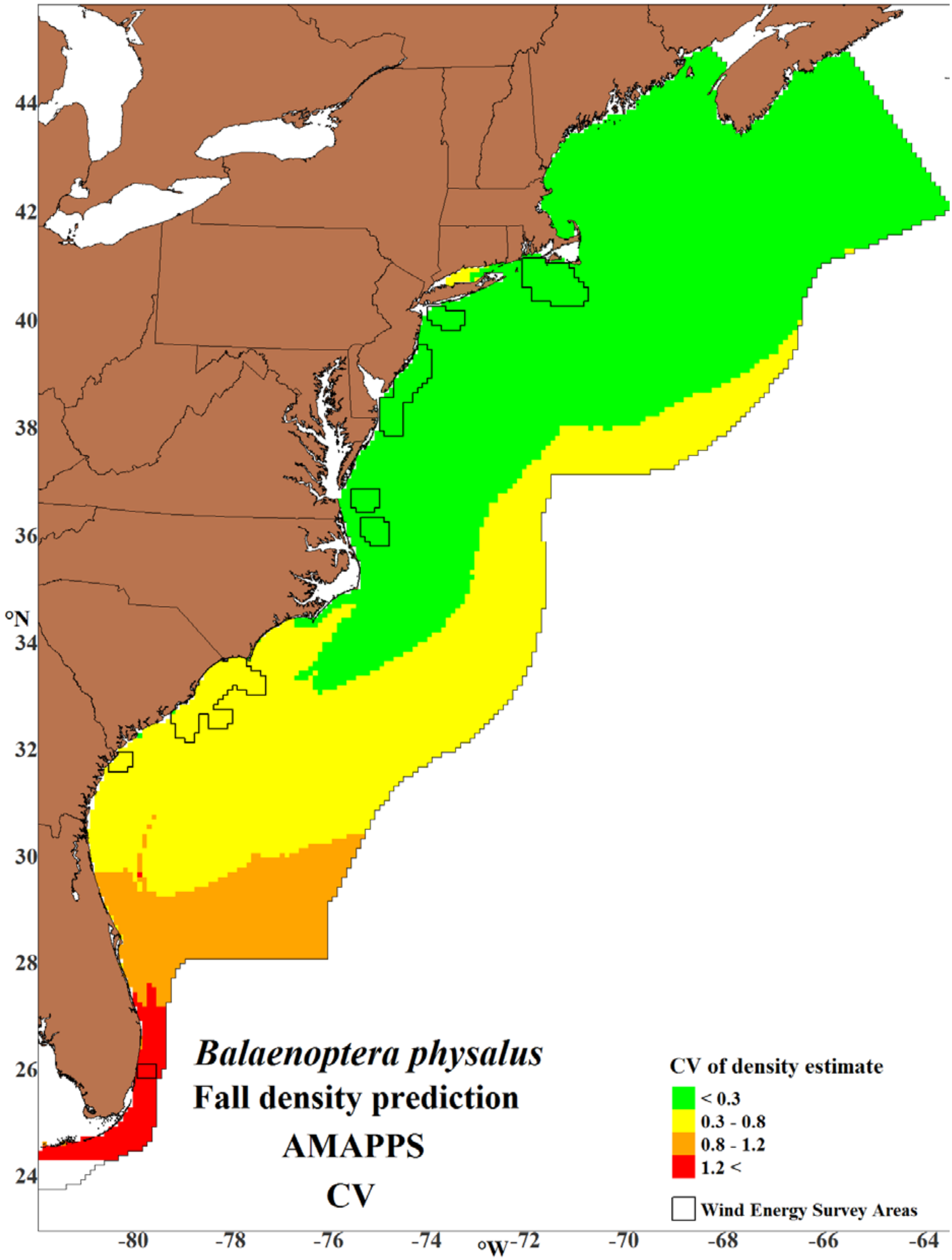

Figure 3-21 CV of fall density estimates for fin whales

3.6 Wind Energy Study Areas

Table 3-6 Fin whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.374, CV=0.336; shipboard 1.0, CV=0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	48	0.094	40 - 58
(March-May)	New York	5	0.126	4 - 6
	New Jersey	8	0.129	6 - 11
	Delaware/ Maryland	6	0.109	5 - 8
	Virginia	3	0.119	2 - 4
	North Carolina	5	0.13	4 - 7
	South Carolina/ North Carolina	0	0.39	0 - 0
	Georgia	0	0.593	0 - 0
	Florida	0	1.685	0 - 0
Summer	Rhode Island/ Massachusetts	50	0.086	43 - 60
(June-August)	New York	3	0.143	2 - 3
	New Jersey	1	0.221	1 - 2
	Delaware/ Maryland	1	0.219	1 - 2
	Virginia	1	0.256	0 - 1
	North Carolina	1	0.201	1 - 2
	South Carolina/ North Carolina	0	0.51	0 - 0
	Georgia	0	0.716	0 - 0
	Florida	0	1.629	0 - 0
Fall	Rhode Island/ Massachusetts	34	0.091	28 - 40
(September-November)	New York	2	0.151	1 - 2
	New Jersey	3	0.171	2 - 4
	Delaware/ Maryland	2	0.152	1 - 2
	Virginia	1	0.166	1 - 1
	North Carolina	2	0.155	1 - 2
	South Carolina/ North Carolina	0	0.403	0 - 0
	Georgia	0	0.542	0 - 0
	Florida	0	1.573	0 - 0

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model.

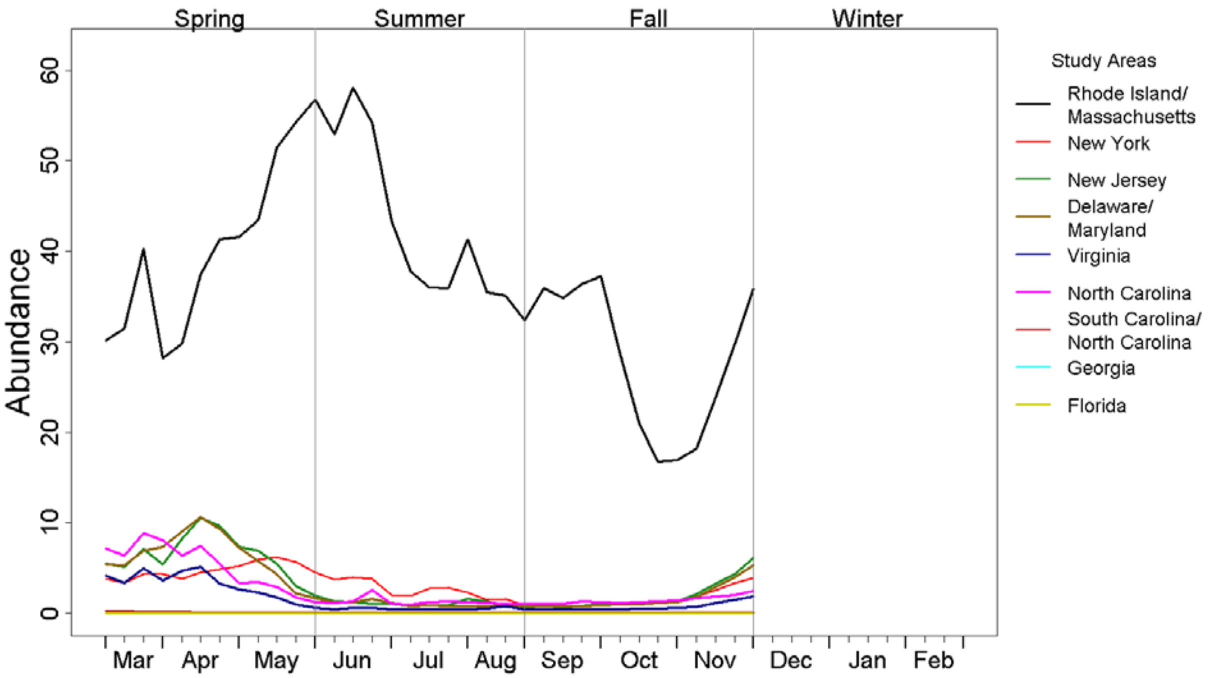

Figure 3-22 Annual abundance trends for fin whales in wind energy study areas

4 Sei Whale (*Balaenoptera borealis*)

Figure 4-1 Sei whale. Credit: NOAA/NEFSC/Christin Khan
Image collected under MMPA Research permit #17355.

4.1 Data Collection

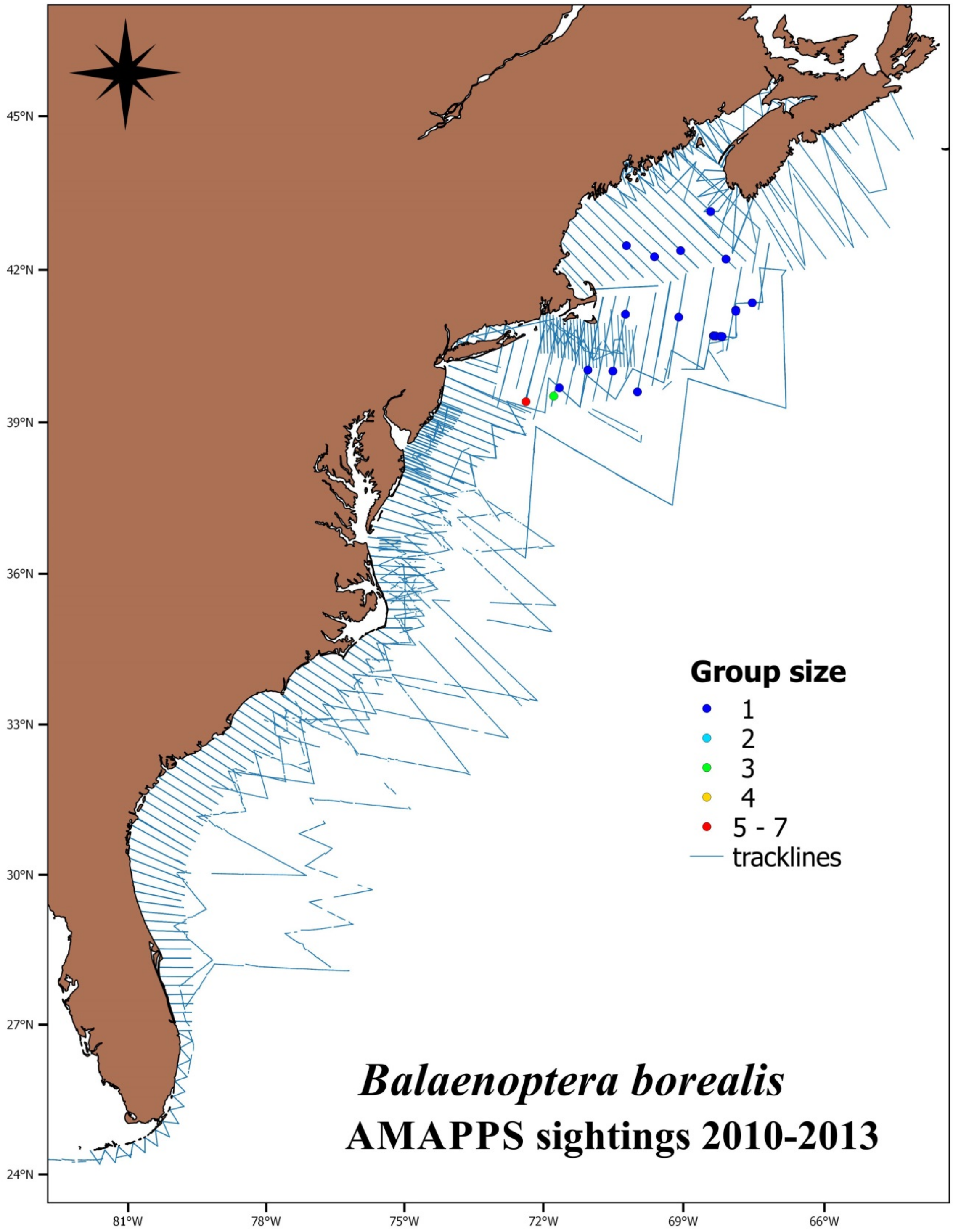

Figure 4-2 Track lines and sei whale sightings during 2010 - 2013

Table 4-1 Research effort 2010 - 2013 and sei whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Sei whale	*Balaenoptera borealis*	0/0	9/10	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	5/6	2/2	3/9	3/6
SE Shipboard	0	8,537	2,093	0	-	-	0/0	0/0	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	0/0	0/0	0/0	0/0

4.2 Mark-Recapture Distance Sampling Analysis

Table 4-2 Parameter estimates from sei whale (SEWH) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE-aerial group 1	1	CBWH,FISE,FIWH, HUWH,MIWH,RIWH, SEWH, SPWH, UNWH,	Distance	Distance+time of day	900	HR	0.503	0.168	0.369	0.992	0.985
	2		-	Distance+glare	5240	HR	-	-	0.245	0.832	0.905
NE-shipboard group 1	-	CBWH,FISE,FIWH, HUWH,MIWH,RIWH, SEWH,SPWH,UNBW,	Distance	Distance+glare	4000	HR	0.513	0.136	0.220	0.991	0.979

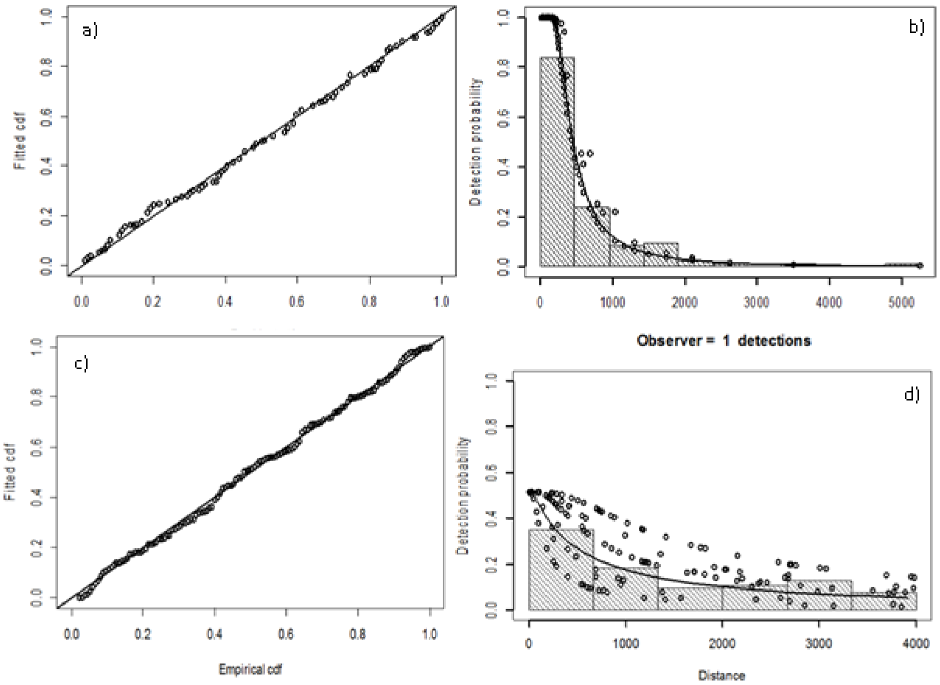

Figure 4-3 Q-Q plots and detection functions from sei whale MRDS analysis
Group 1 aerial northeast region (a,b) and group 1 shipboard northeast region (c,d).

4.3 Generalized Additive Model Analysis

Table 4-3 Habitat model output for sei whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(chl)	0.8478	4	17.45	<2e-16	3.42E-03	***
s(sst)	1.1154	4	98.17	<2e-16	2.13E-02	***
s(pic)	0.792	4	14.35	<2e-16	1.03E+03	***
s(mld)	0.8068	4	13.7	<2e-16	6.48E-05	***
s(dist2shore)	3.6234	4	66.84	<2e-16	2.37E-02	***
s(dist125)	0.8957	4	27.65	<2e-16	1.44E-08	***
s(lat)	0.8739	4	16.89	<2e-16	3.31E-02	***
Scale					1.46E+00	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: Total = 9.96

R^2 (adjusted) = 0.0328 Deviance explained = 57.8%

REML = 223.56 Scale estimate = 0.14001 sample size = 11851

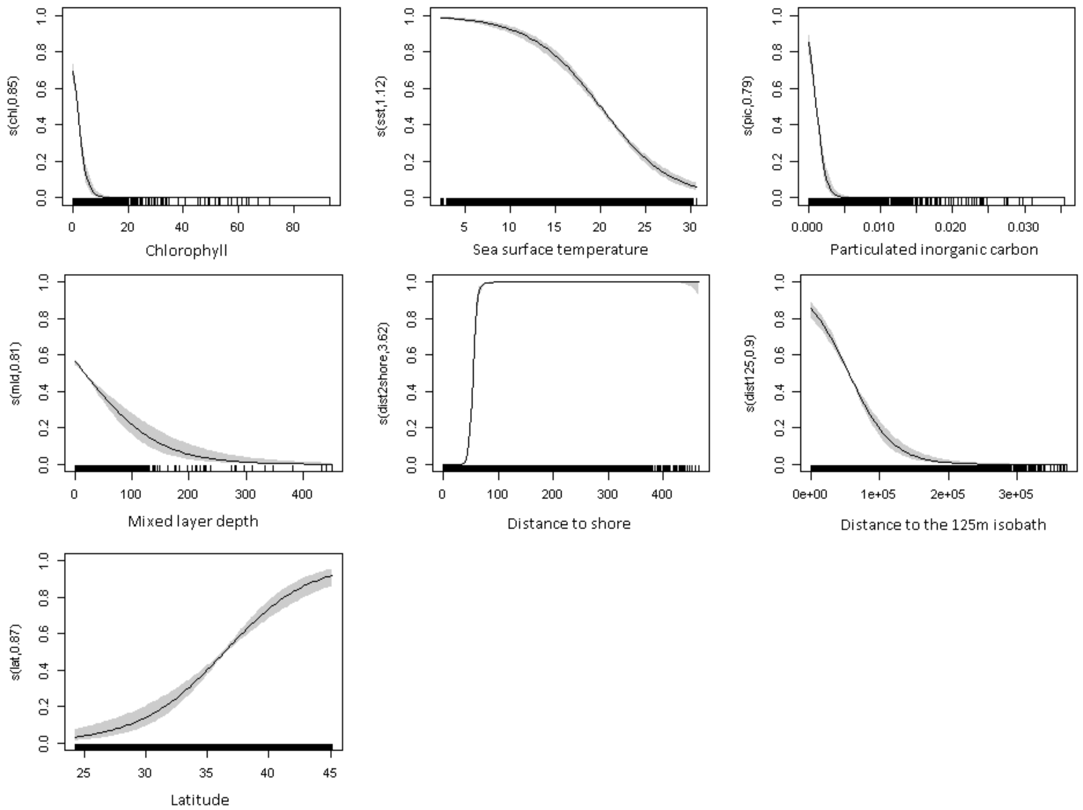

Figure 4-4 Sei whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 4-4 Diagnostic statistics from sei whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.2391	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	87.17	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.07	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.003	Excellent

The cutoff values are taken from Kinlan et al. (2012)
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

4.4 Abundance Estimates for AMAPPS Study Area

Table 4-5 Sei whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.417, CV=0.517; shipboard 1, CV= 0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	6,292	1.015	1,209 – 32,733
Summer (June-August)	1,872	0.421	849 – 4,129
Fall (September-November)	2,489	0.488	1,006 – 6,158

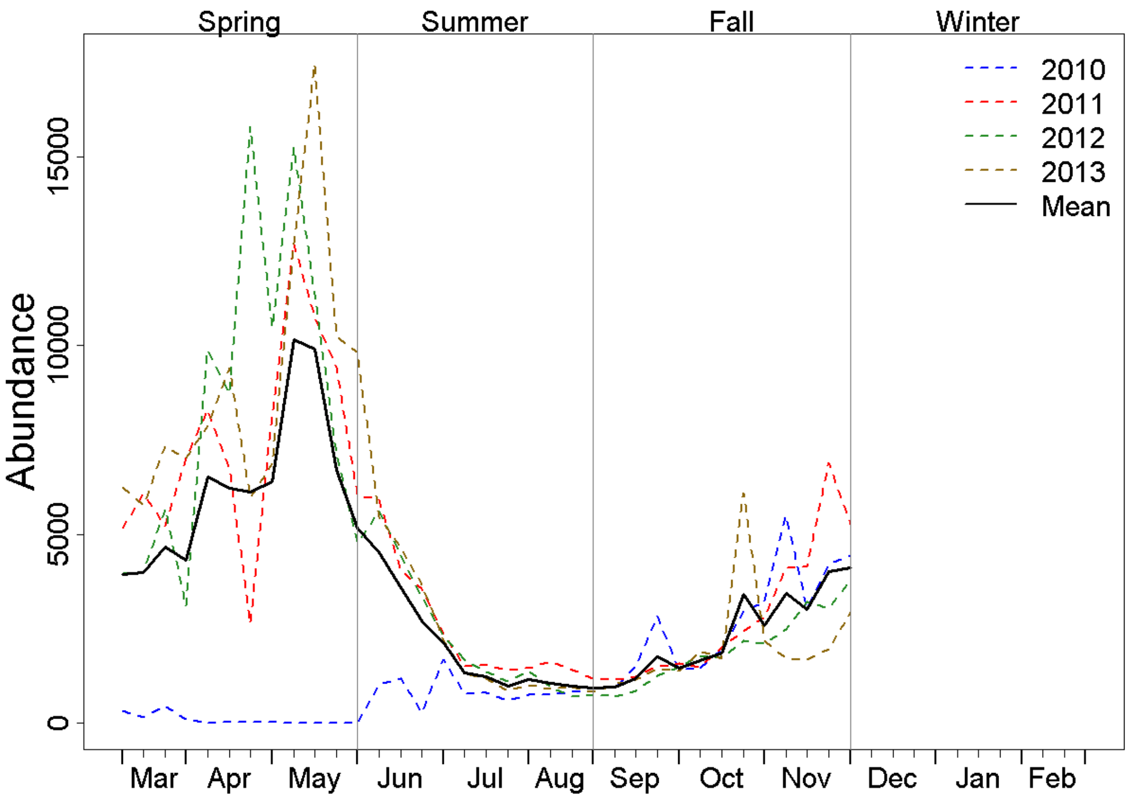

Figure 4-5 Annual abundance trends for sei whales for AMAPPS study area

4.5 Seasonal Prediction Maps

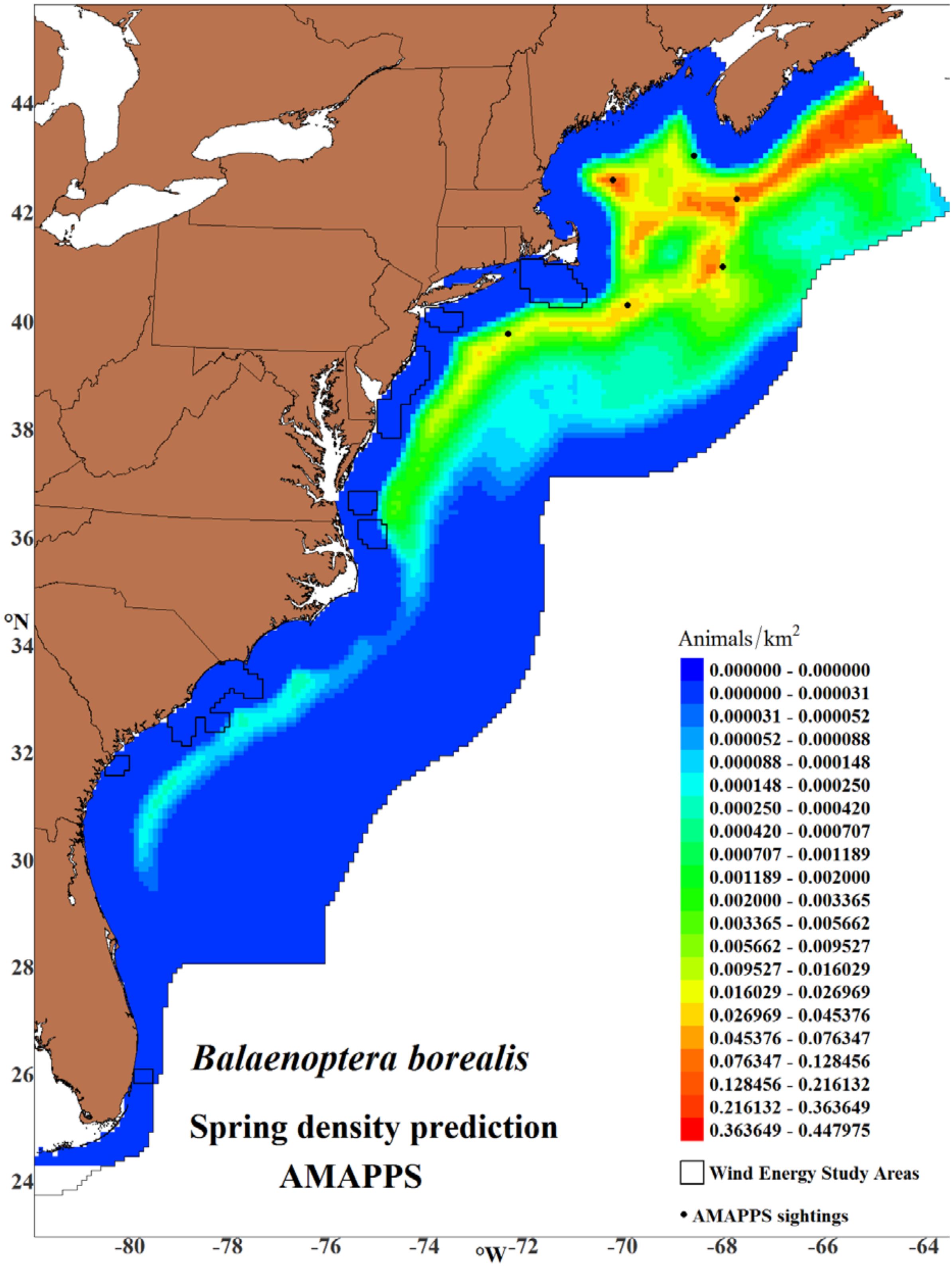

Figure 4-6 Sei whale spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

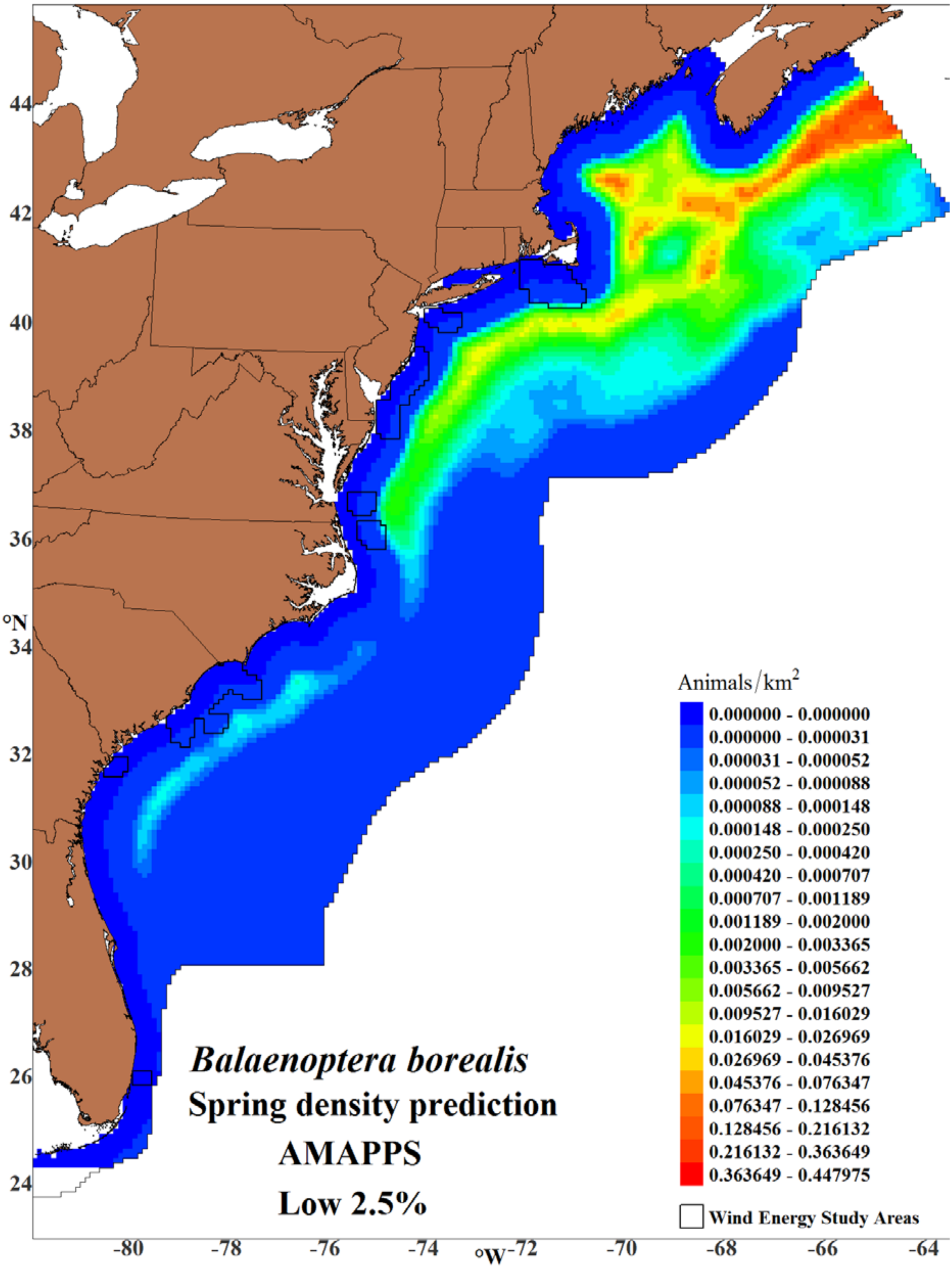

Figure 4-7 Lower 2.5% percentile of spring sei whale estimates

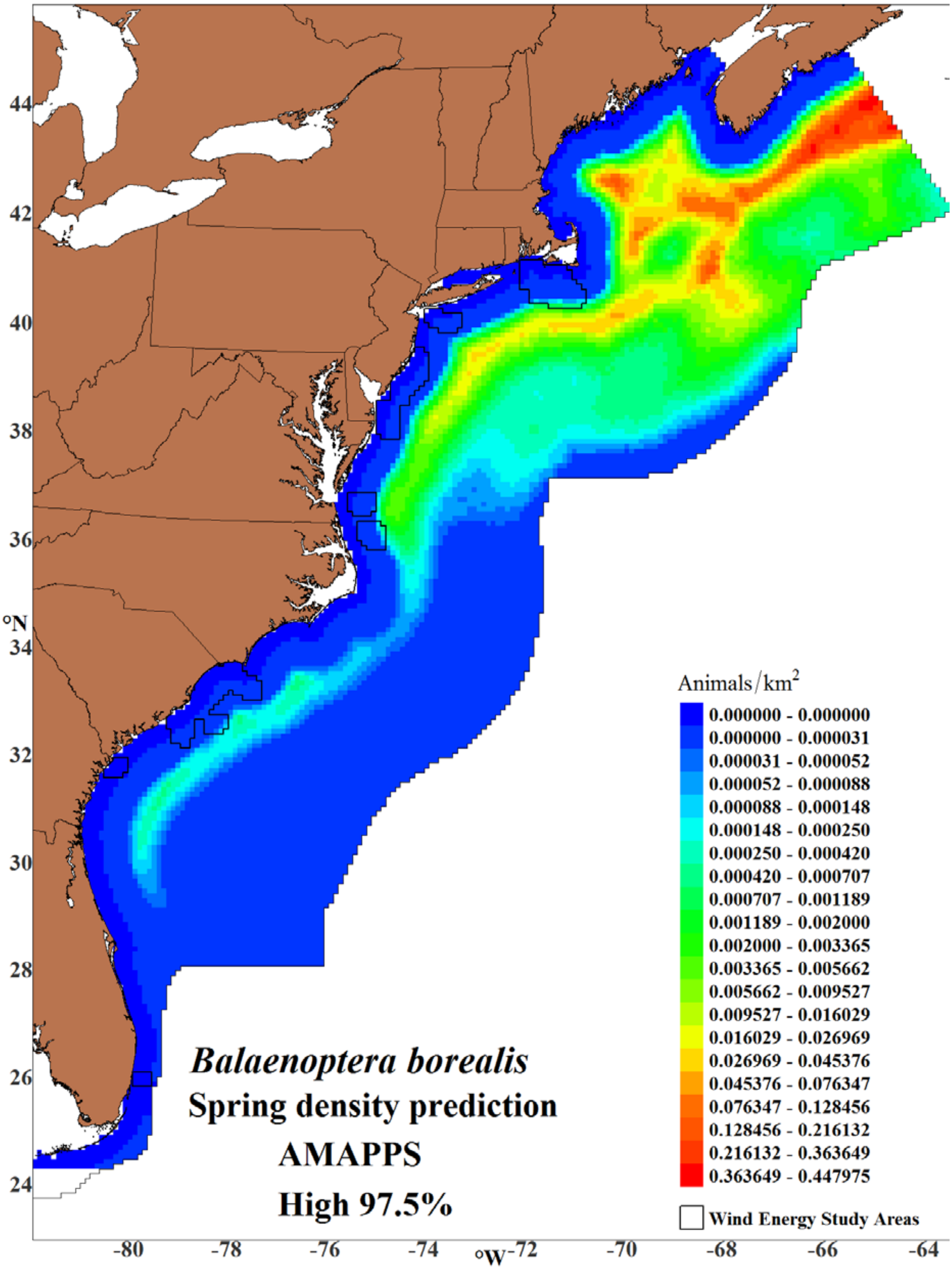

Figure 4-8 Upper 97.5% percentile of spring sei whale estimates

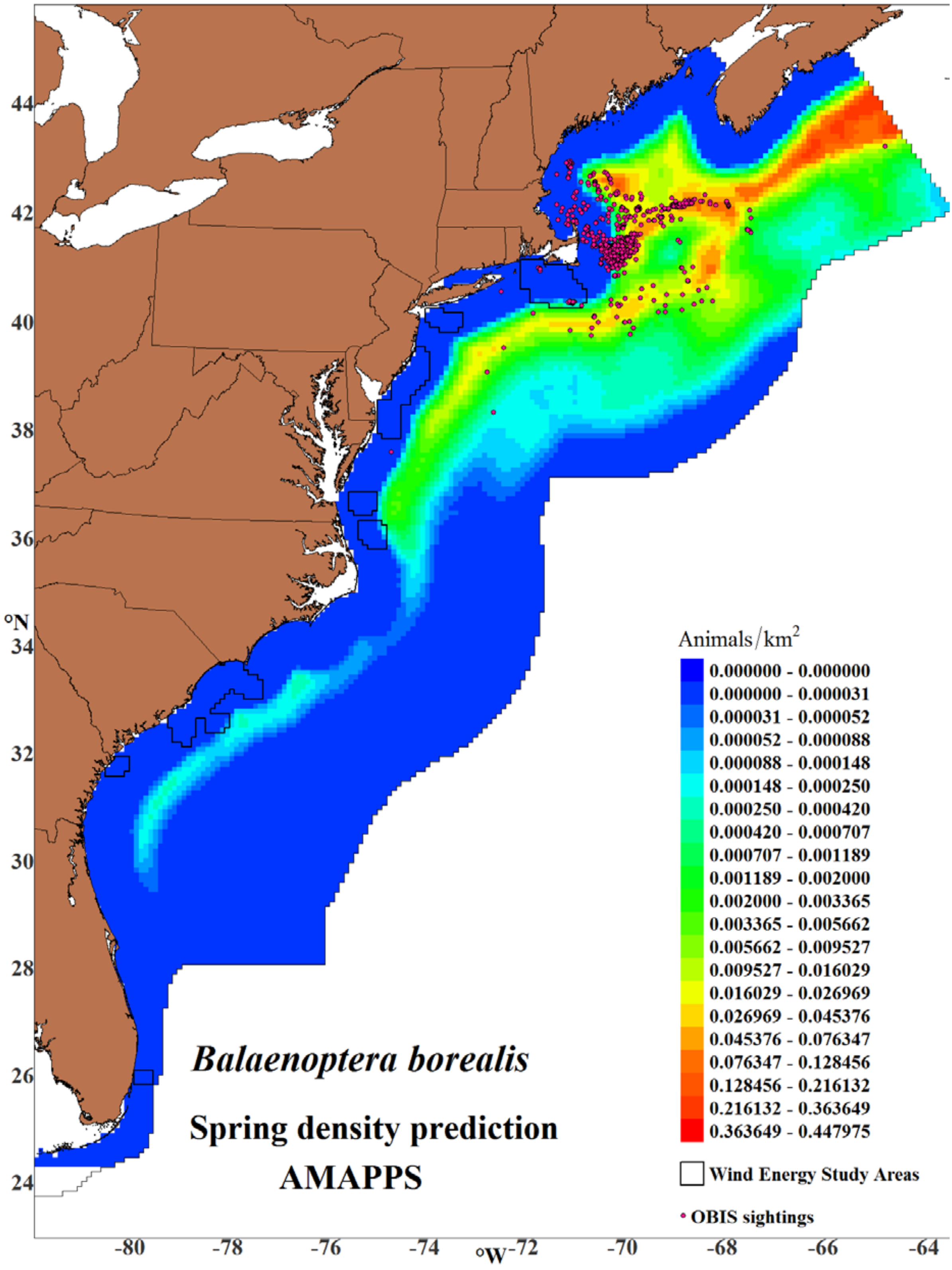

Figure 4-9 Sei whale 2010-2013 spring density and 1968-2013 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

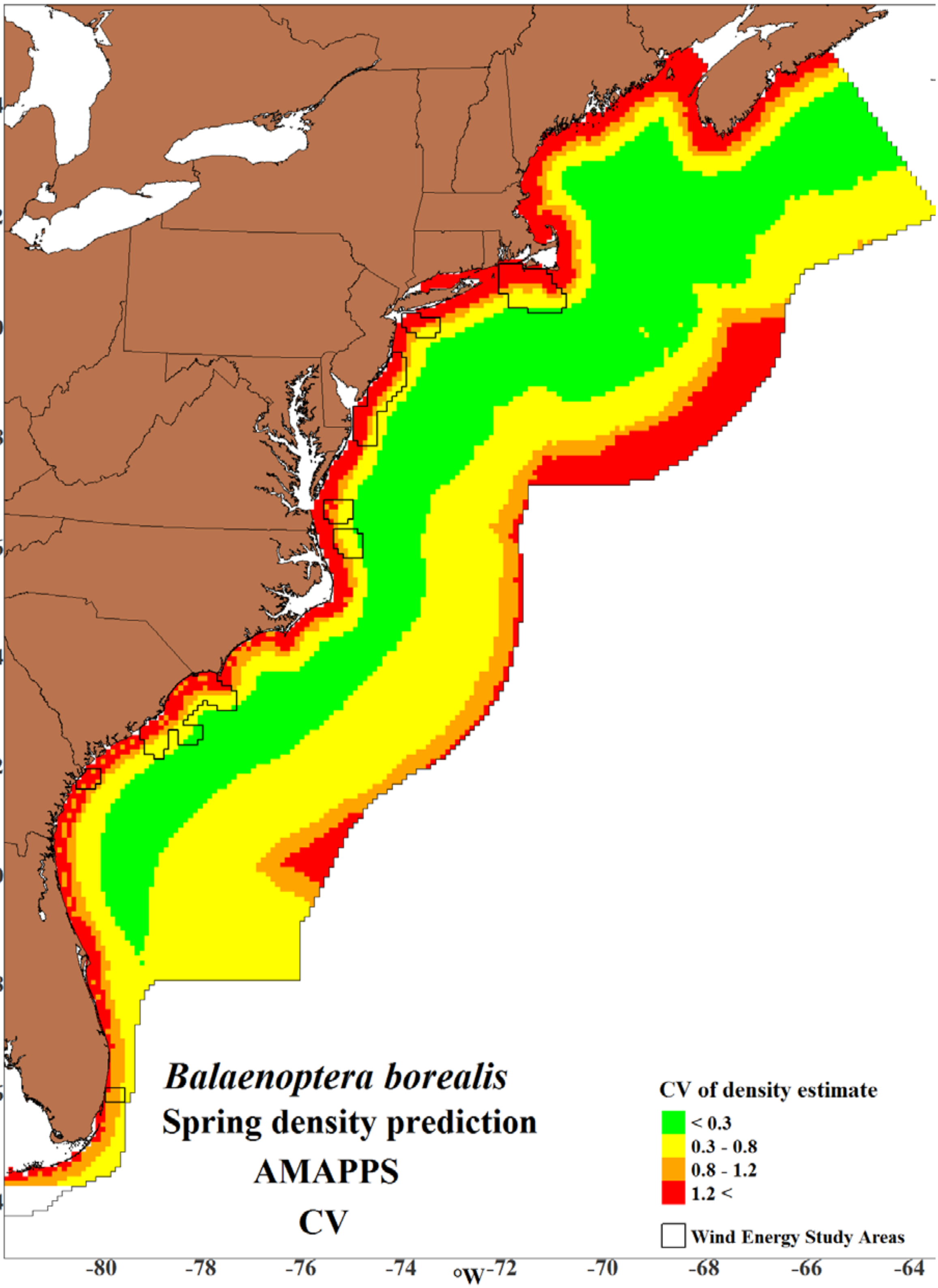

Figure 4-10 CV of spring density estimates for sei whales

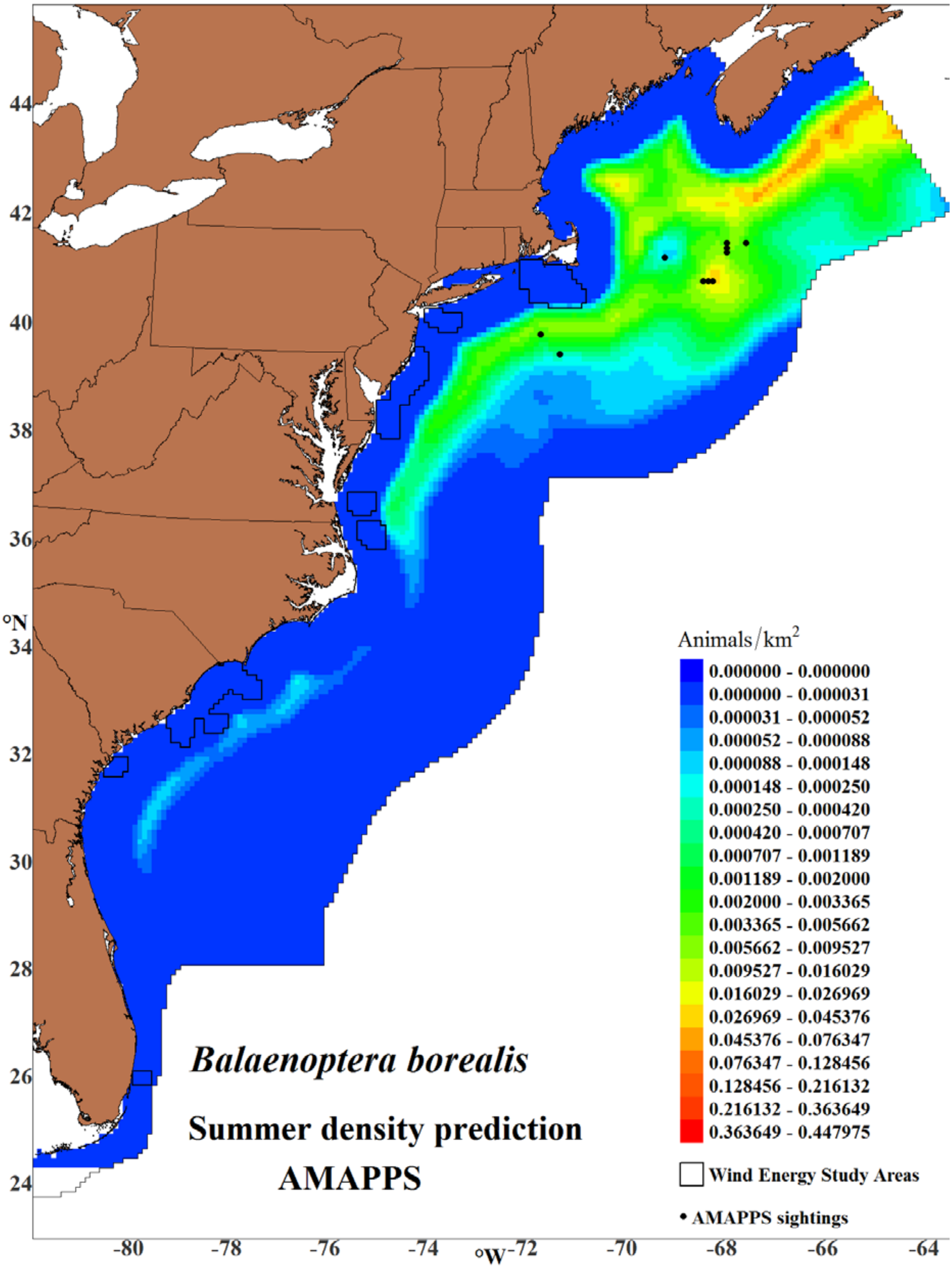

Figure 4-11 Sei whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

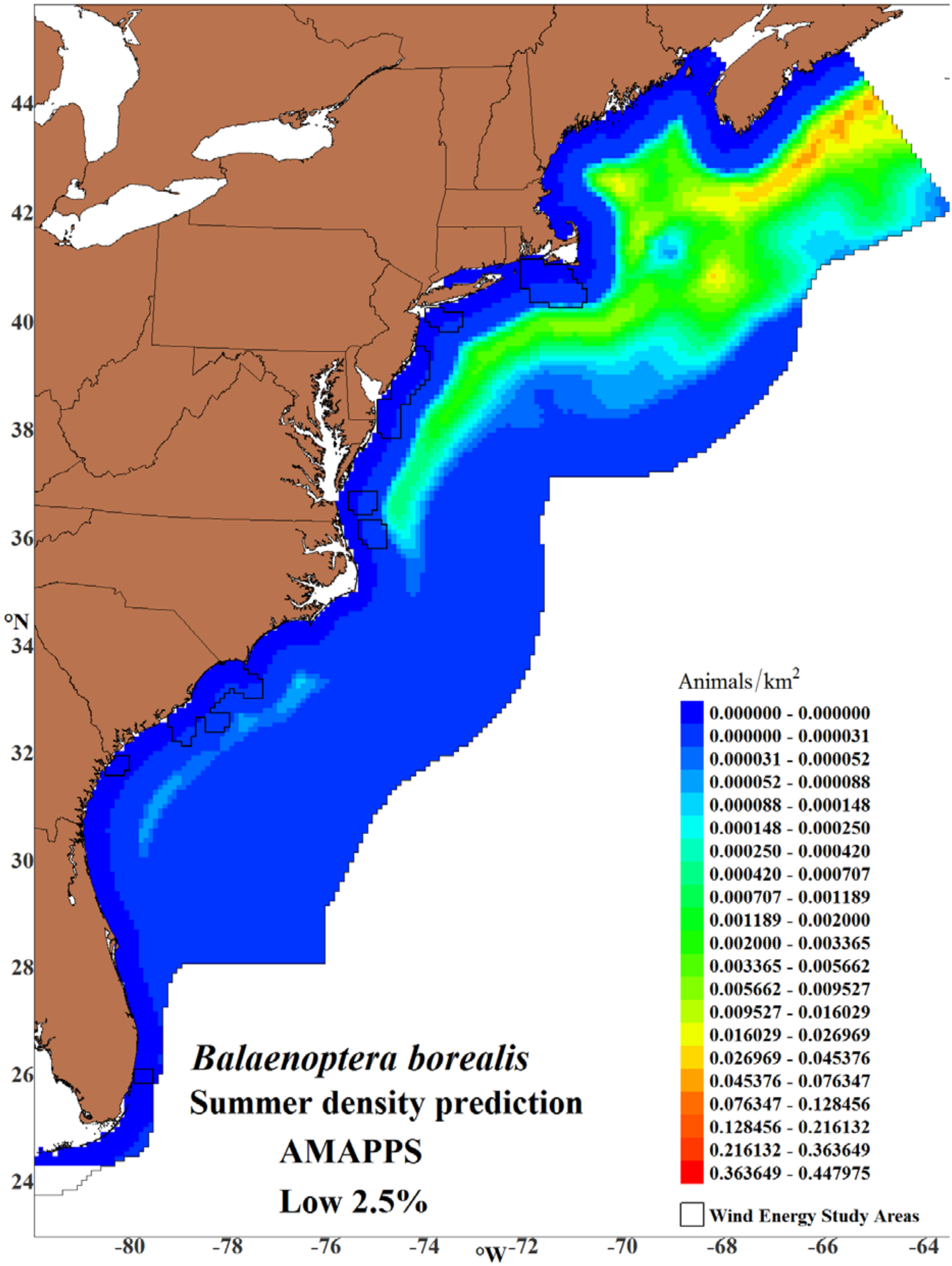

Figure 4-12 Lower 2.5% percentile of summer sei whale estimates

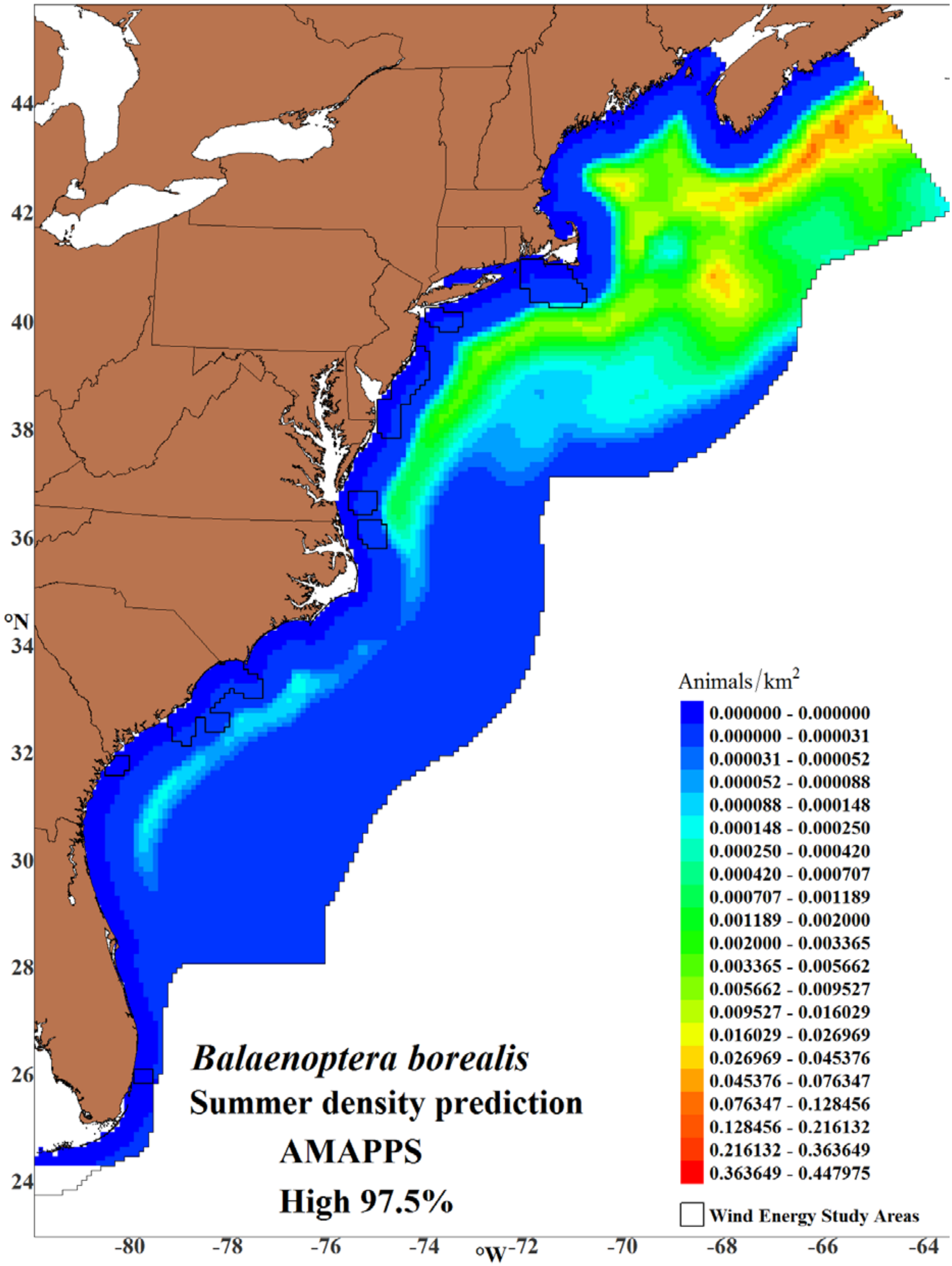

Figure 4-13 Upper 97.5% percentile of summer sei whale estimates

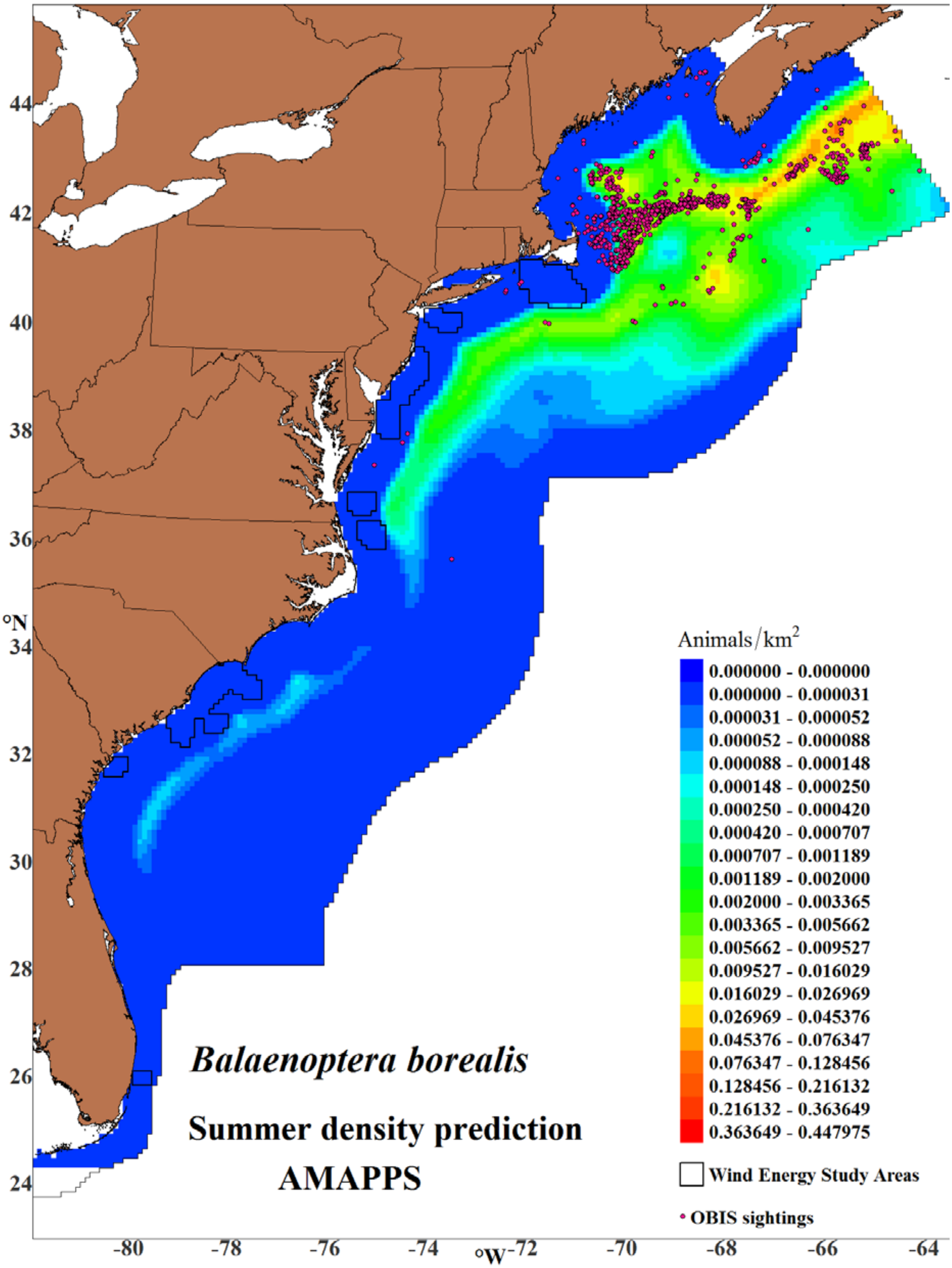

Figure 4-14 Sei whale 2010-2013 summer density and 1968-2013 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

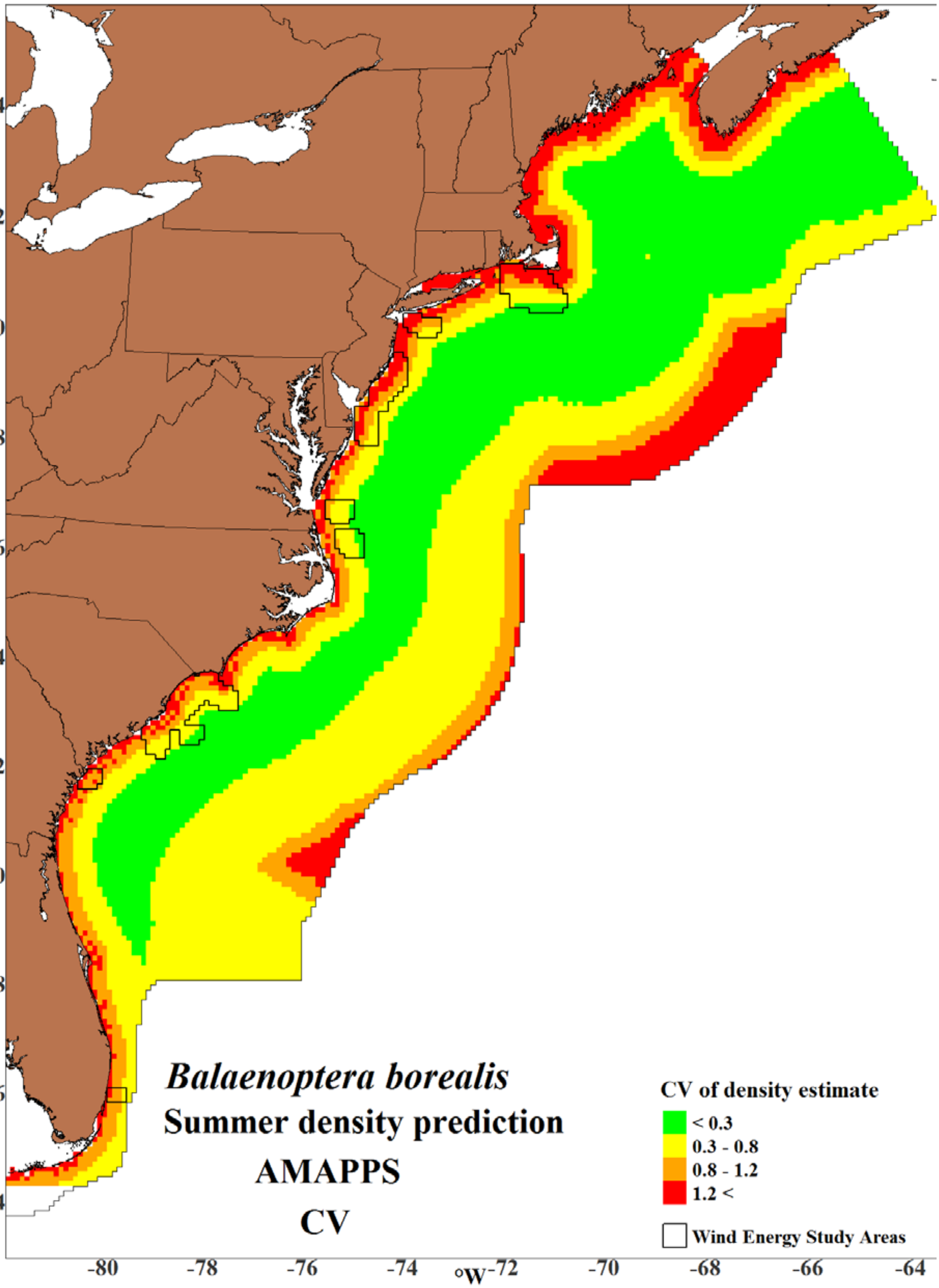

Figure 4-15 CV of summer density estimates for sei whales

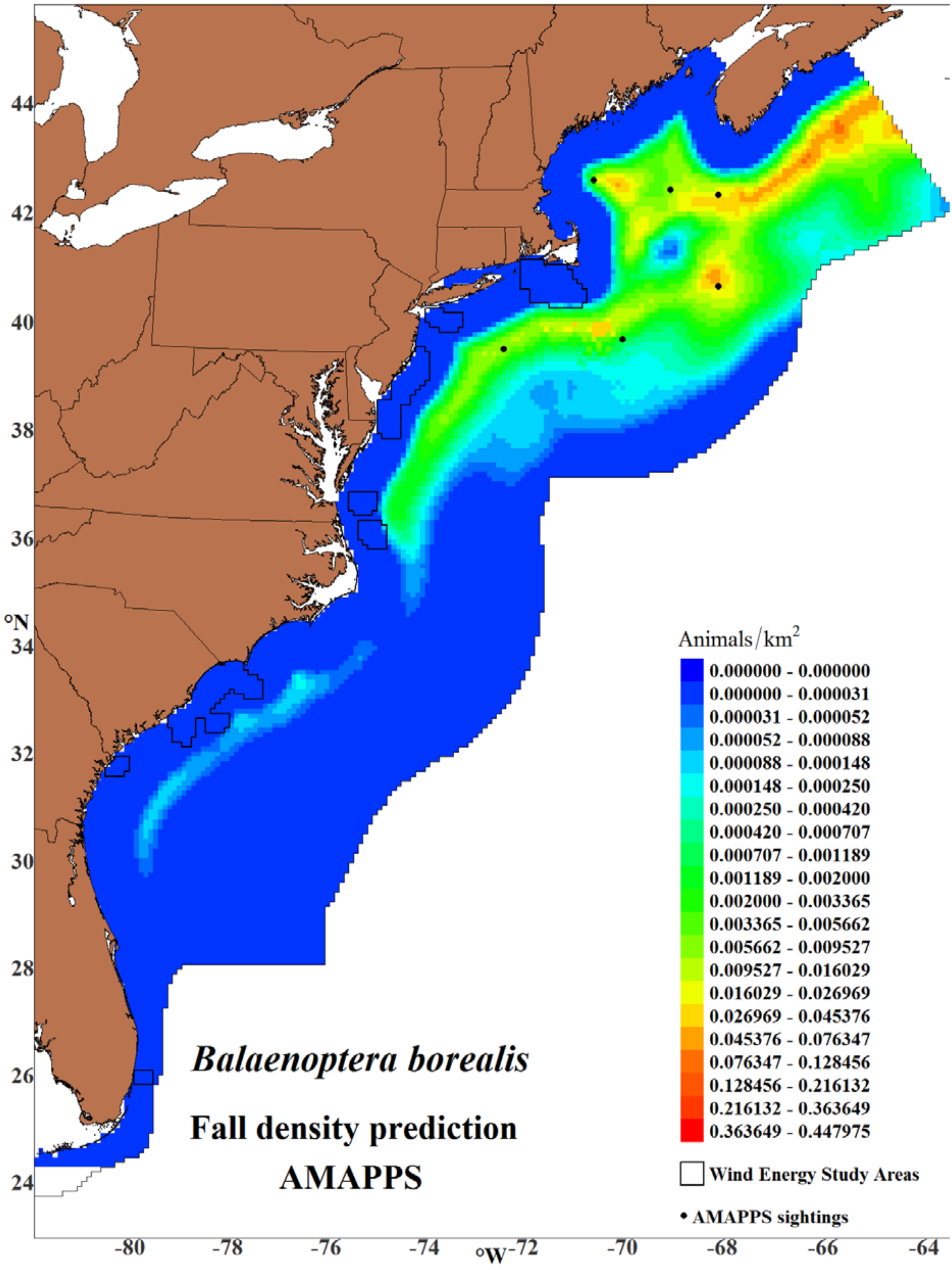

Figure 4-16 Sei whale fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

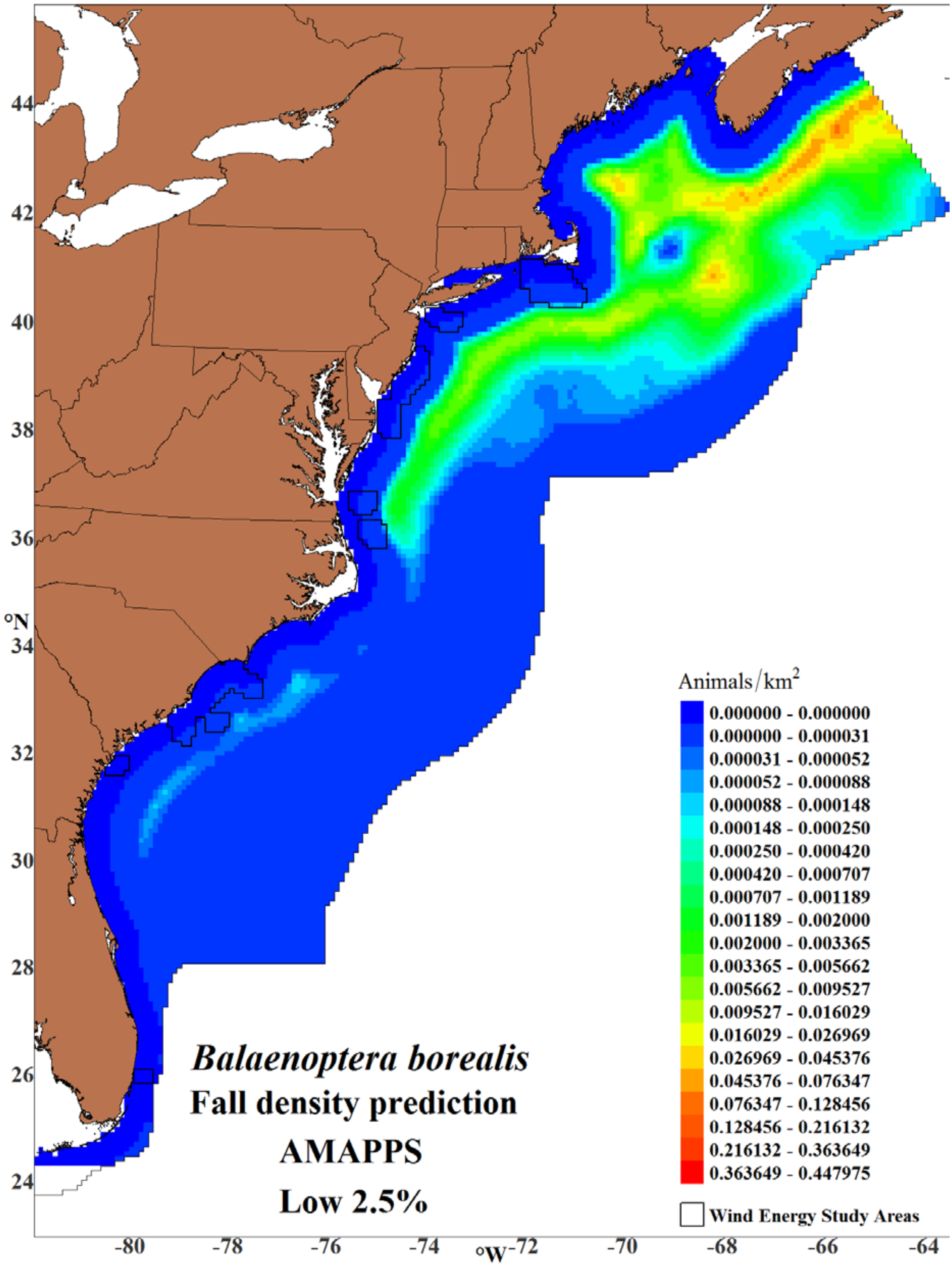

Figure 4-17 Lower 2.5% percentile of fall sei whale estimates

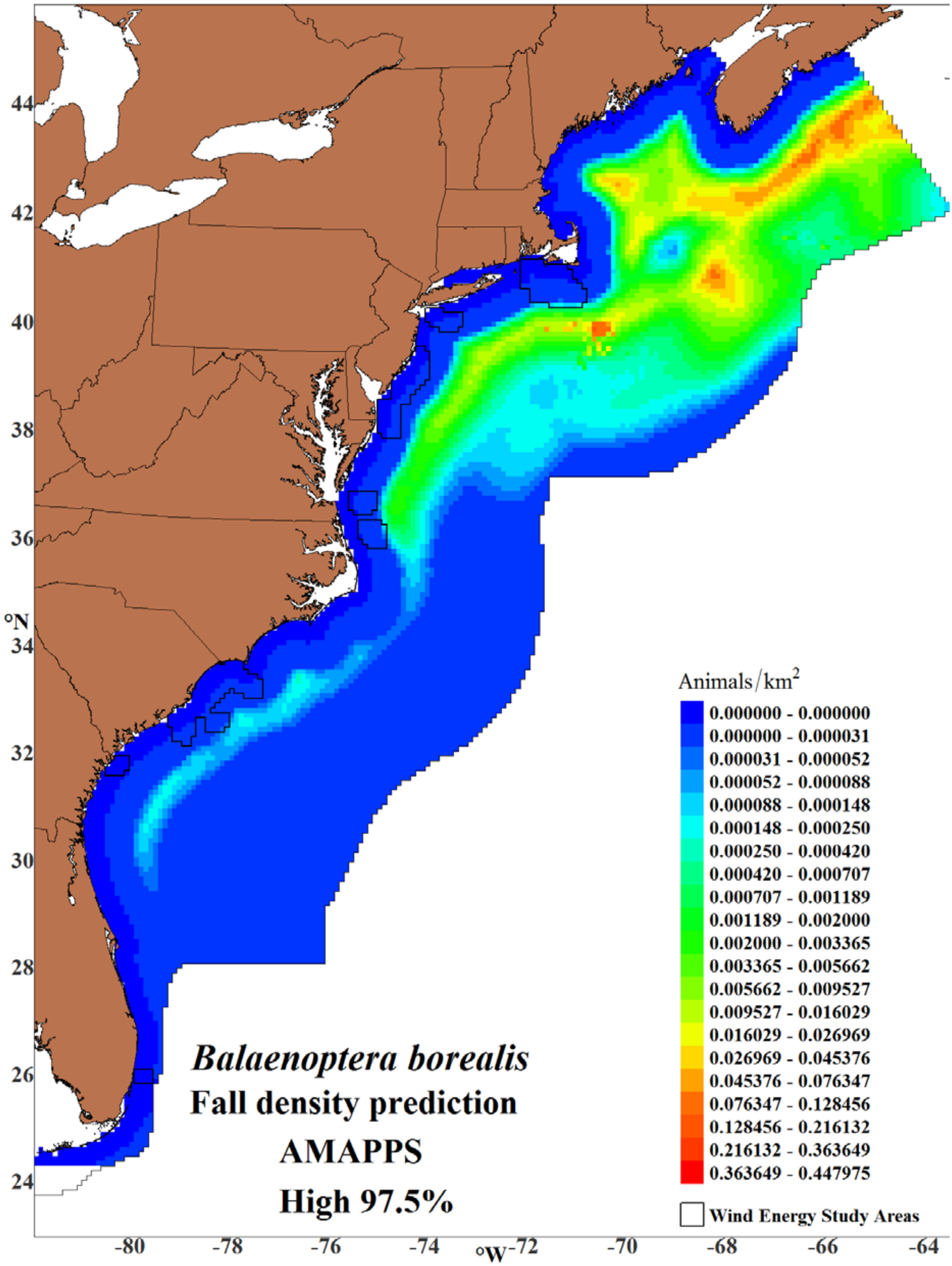

Figure 4-18 Upper 97.5% percentile of fall sei whale estimates

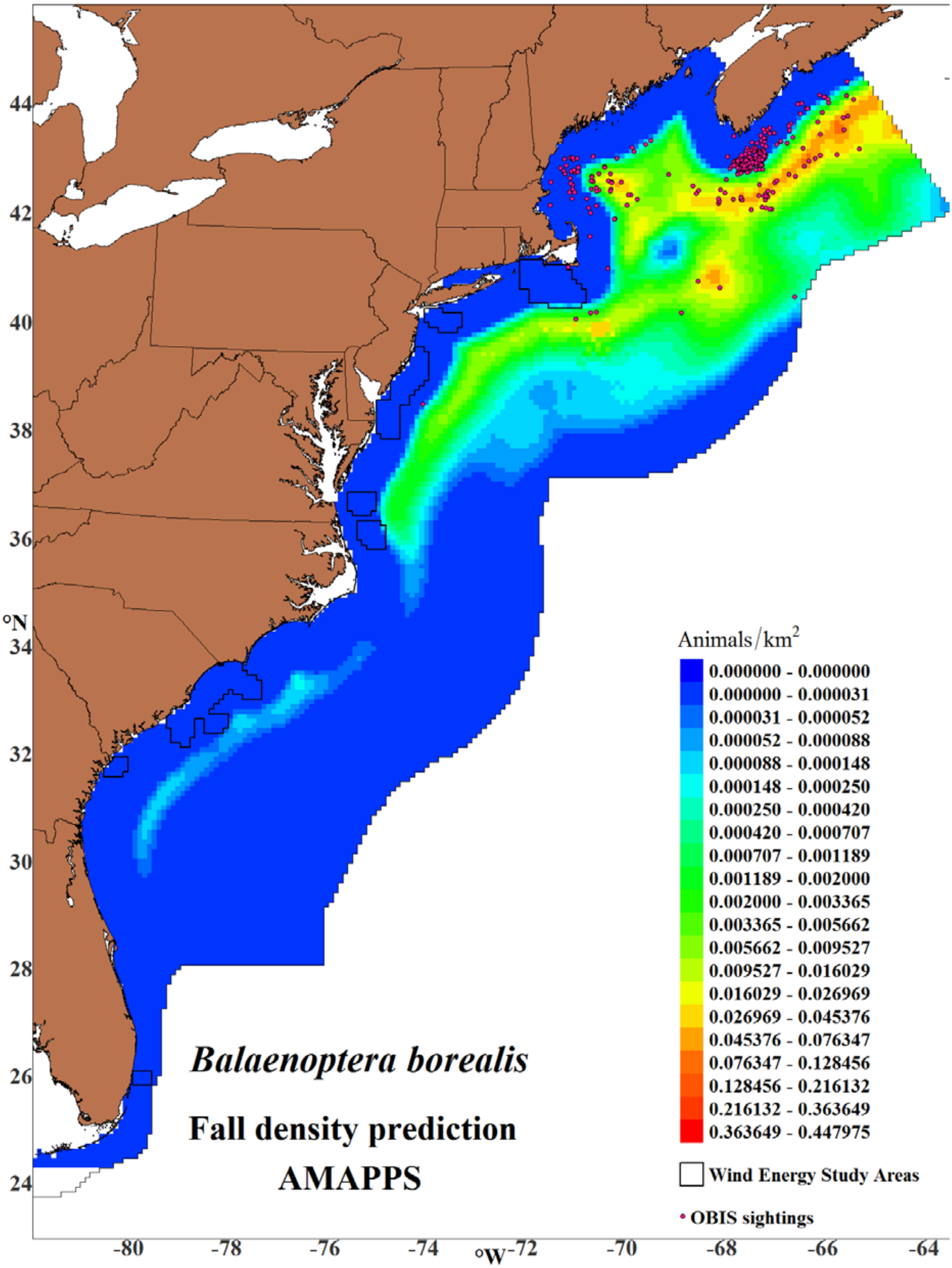

Figure 4-19 Sei whale 2010-2013 fall density and 1968-2013 OBIS sightings
Pink circles (Halpin *et al.* 2009). These sightings were not used to develop the density-habitat model.

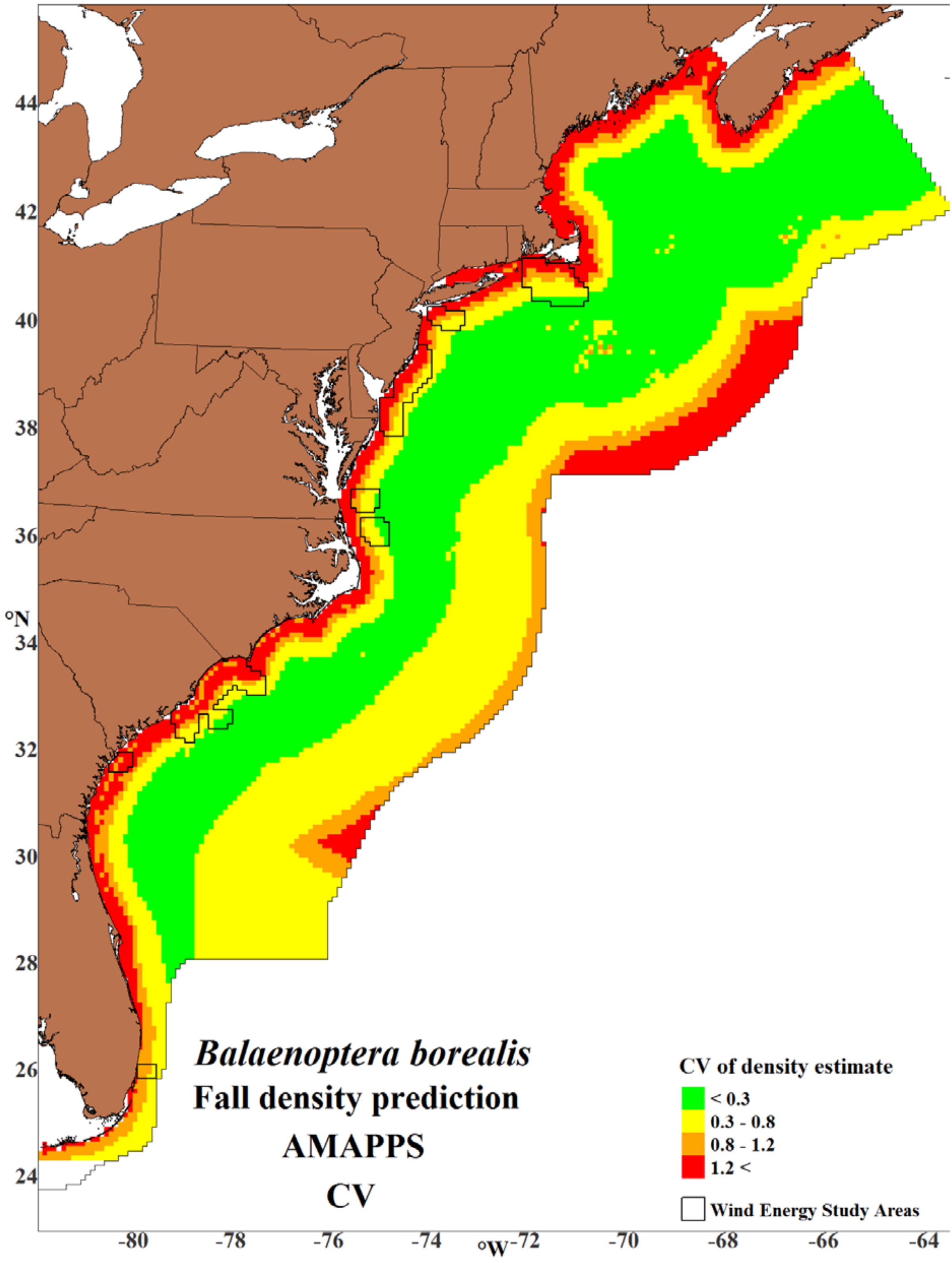

Figure 4-20 CV of fall density estimates for sei whales

4.6 Wind Energy Study Areas

Table 4-6 Sei whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.417, CV=0.517; shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	0	0.249	0 - 1
(March-May)	New York	0	0.521	0 - 0
	New Jersey	0	0.608	0 - 0
	Delaware/ Maryland	0	0.566	0 - 0
	Virginia	0	0.343	0 - 0
	North Carolina	0	0.283	0 - 0
	South Carolina/ North Carolina	0	0.227	0 - 0
	Georgia	0	1.173	0 - 0
	Florida	0	0.742	0 - 0
Summer	Rhode Island/ Massachusetts	0	0.201	0 - 0
(June-August)	New York	0	0.603	0 - 0
	New Jersey	0	0.712	0 - 0
	Delaware/ Maryland	0	0.567	0 - 0
	Virginia	0	0.268	0 - 0
	North Carolina	0	0.223	0 - 0
	South Carolina/ North Carolina	0	0.238	0 - 0
	Georgia	0	1.021	0 - 0
	Florida	0	0.725	0 - 0
Fall	Rhode Island/ Massachusetts	0	0.174	0 - 0
(September-November)	New York	0	0.438	0 - 0
	New Jersey	0	0.572	0 - 0
	Delaware/ Maryland	0	0.468	0 - 0
	Virginia	0	0.258	0 - 0
	North Carolina	0	0.188	0 - 0
	South Carolina/ North Carolina	0	0.218	0 - 0
	Georgia	0	1.607	0 - 0
	Florida	0	0.665	0 - 0

***** The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model.

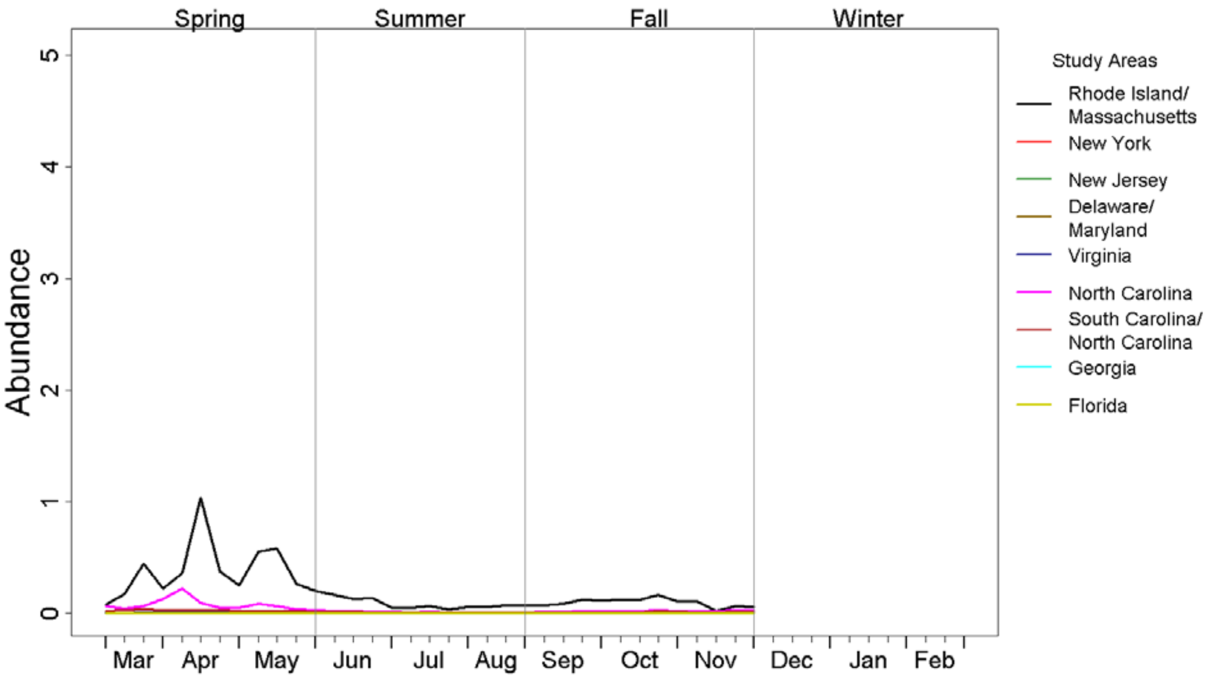

Figure 4-21 Annual abundance trends for sei whales in wind energy study areas

5 Minke Whale (Balaenoptera acutorostrata)

Figure 5-1 Minke whale: Credit: NOAA/NEFSC/Cynthia Christman
Image collected under MMPA Research permit #775-1875.

5.1 Data Collection

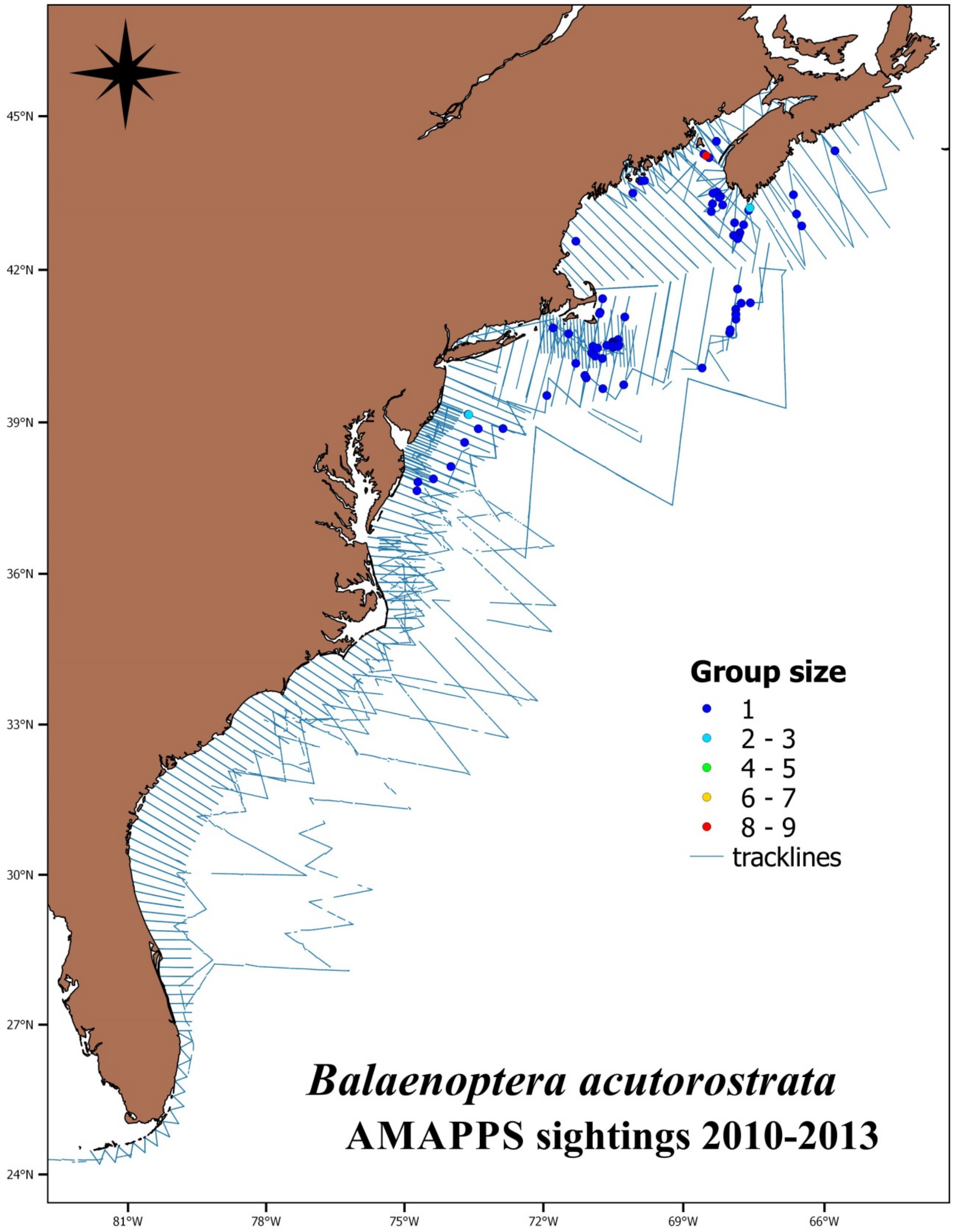

Figure 5-2 Track lines and minke whale sightings during 2010 - 2013

Table 5-1 Research effort 2010 - 2013 and minke whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Minke whale	*Balaenoptera acutorostrata*	0/0	29/29	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	7/7	23/23	20/31	1/1
SE Shipboard	0	8,537	2,093	0	-	-	0/0	0/0	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	5/6	0/0	3/3	0/0

5.2 Mark-Recapture Distance Sampling Analysis

Table 5-2 Parameter estimates from minke whale (MIWH) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 1	1	CBWH,FIWH,HUWH, MIWH, RIWH,SPWH	Distance*observer	Distance+sea	400	HR	0.898	0.091	0.318	0.659	0.671
	2		-	Distance+sea	562	HN	-	-	0.221	0.737	0.758
NE-aerial group 1	1	CBWH,FISE,FIWH, MIWH,RIWH,SEWH, SPWH,UNBW	Distance	Distance+time of day	900	HR	0.503	0.168	0.369	0.992	0.985
	2		-	Distance+glare	5240	HR	-	-	0.245	0.832	0.905
SE-shipboard group 1	-	FIWH,HUWH,RIWH, SPWH	Distance*observer+ sea	Distance+sea	8840	HN	0.472	0.228	0.326	0.122	0.137
NE-shipboard group 1	-	CBWH,FISE,FIWH, HUWH,MIWH,RIWH, SEWH,SPWH,UNBW	Distance	Distance+glare	4000	HR	0.513	0.136	0.220	0.991	0.979

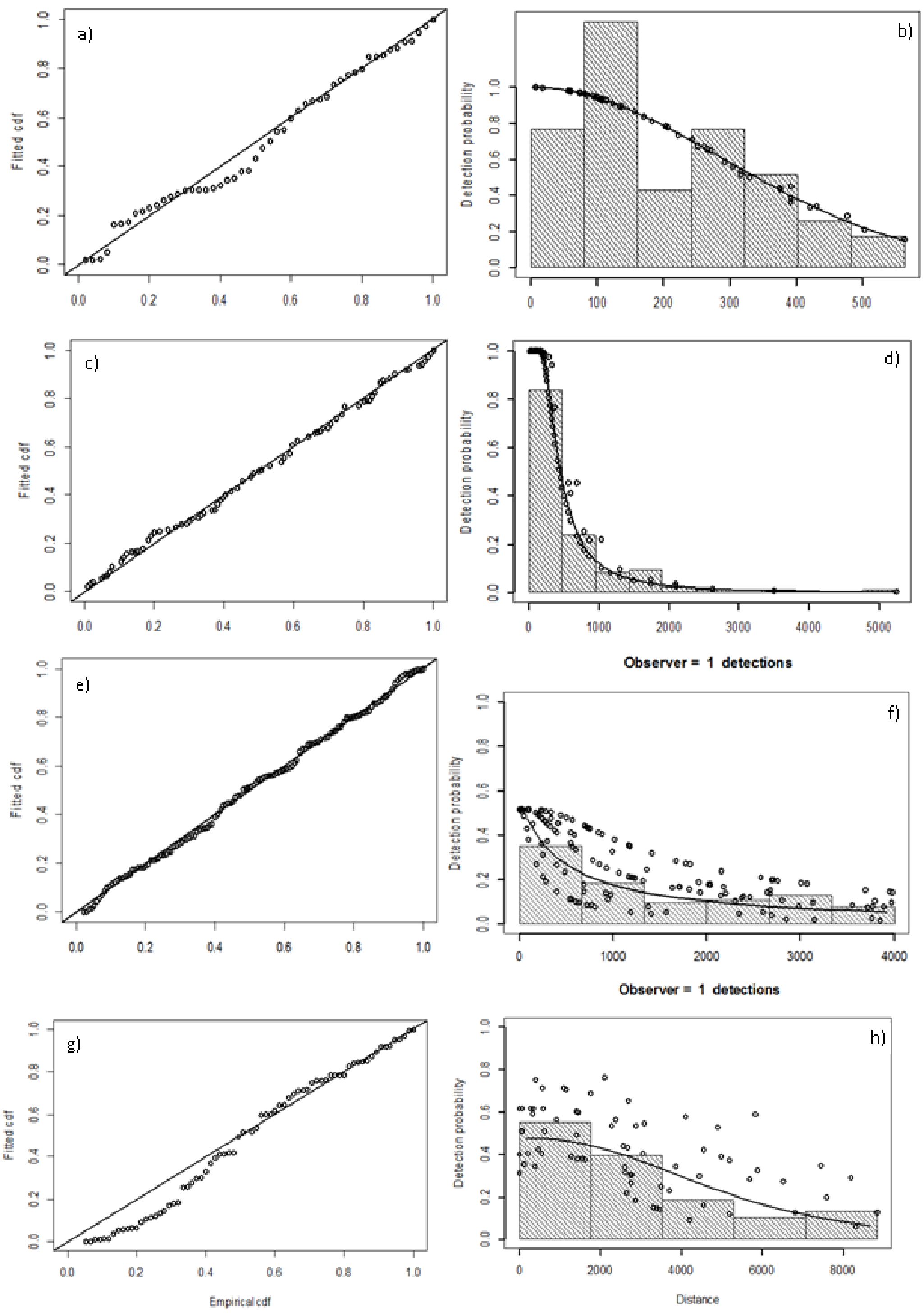

Figure 5-3 Q-Q plots and detection functions from minke whale MRDS analysis
Group 1 aerial southeast region (a,b), group 1 aerial northeast region (c,d), group 1 shipboard northeast region (e,f) and group 1 shipboard southeast region (g,h).

5.3 Generalized Additive Model Analysis

Table 5-3 Habitat model output for minke whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	1.1527	4	28.36	< 2e-16	2.02E-02	***
s(poc)	0.8877	4	11.75	9.90E-14	4.12E-06	***
s(pp)	3.3867	4	46.38	< 2e-16	7.09E-05	***
s(dist2shore)	0.9733	4	23.47	< 2e-16	2.22E-04	***
s(dist125)	0.9314	4	19.24	< 2e-16	1.01E-08	***
s(lat)	2.2424	4	22.85	< 2e-16	6.78E-01	***
Scale	-	-	-	-	1.46E+00	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom: Total = 10.57

R^2 (adjusted) = 0.0103 Deviance explained = 39.9%

REML = 333.3 Scale estimate. = 0.3096 sample size = 11772

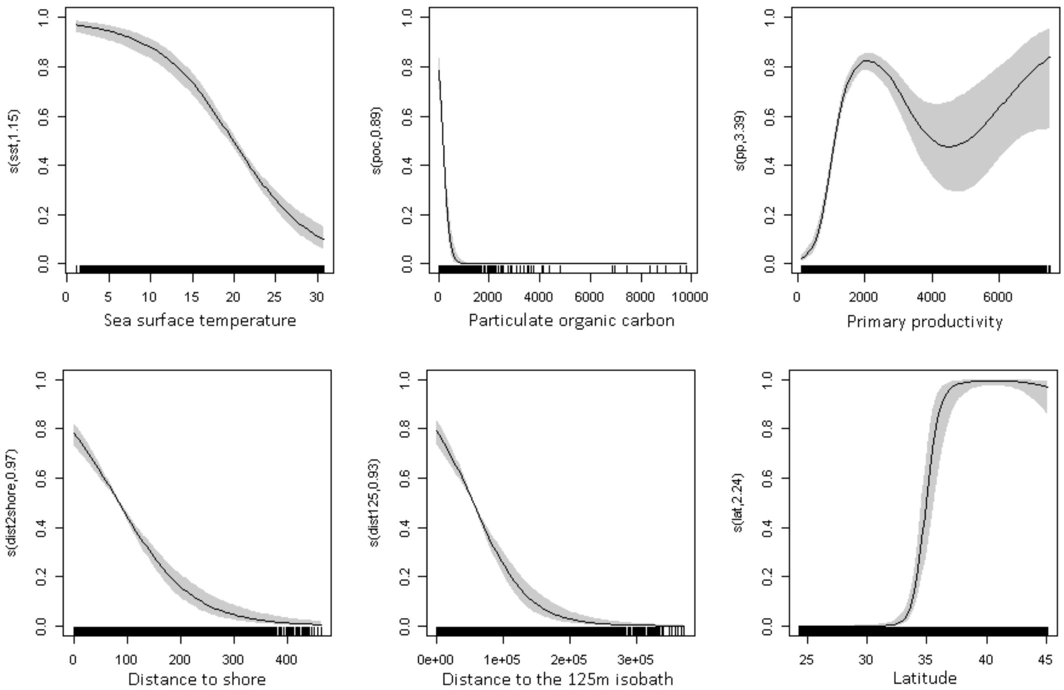

Figure 5-4 Minke whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 5-4 Diagnostic statistics from minke whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.5	Excellent
MAPE	Mean absolute percentage error	Non-zero density	94.59	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.088	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.006	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

5.4 Abundance Estimates for AMAPPS Study Area

Table 5-5 Minke whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.307, CV=0.397; shipboard 1, CV= 0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	1,484	0.578	518 – 4,251
Summer (June-August)	2,834	0.247	1,760 – 4,563
Fall (September-November)	2,829	0.255	1,729 – 4,630

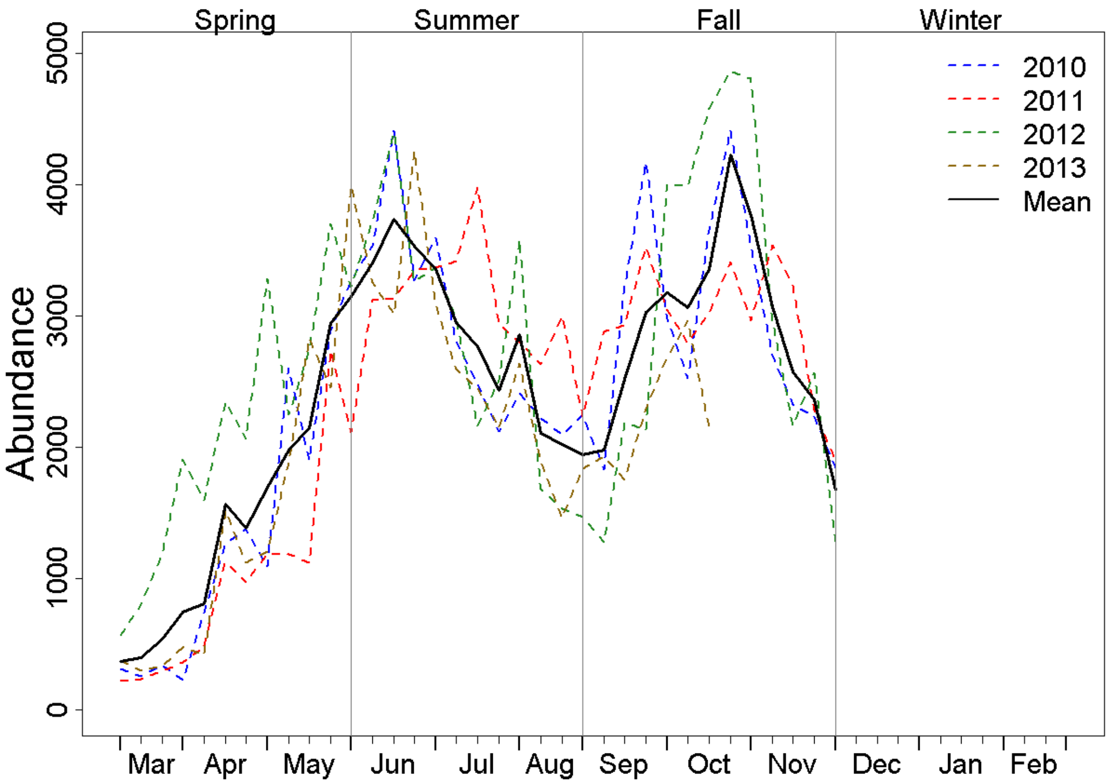

Figure 5-5 Annual abundance trends for minke whales for AMAPPS study area

5.5 Seasonal Prediction Maps

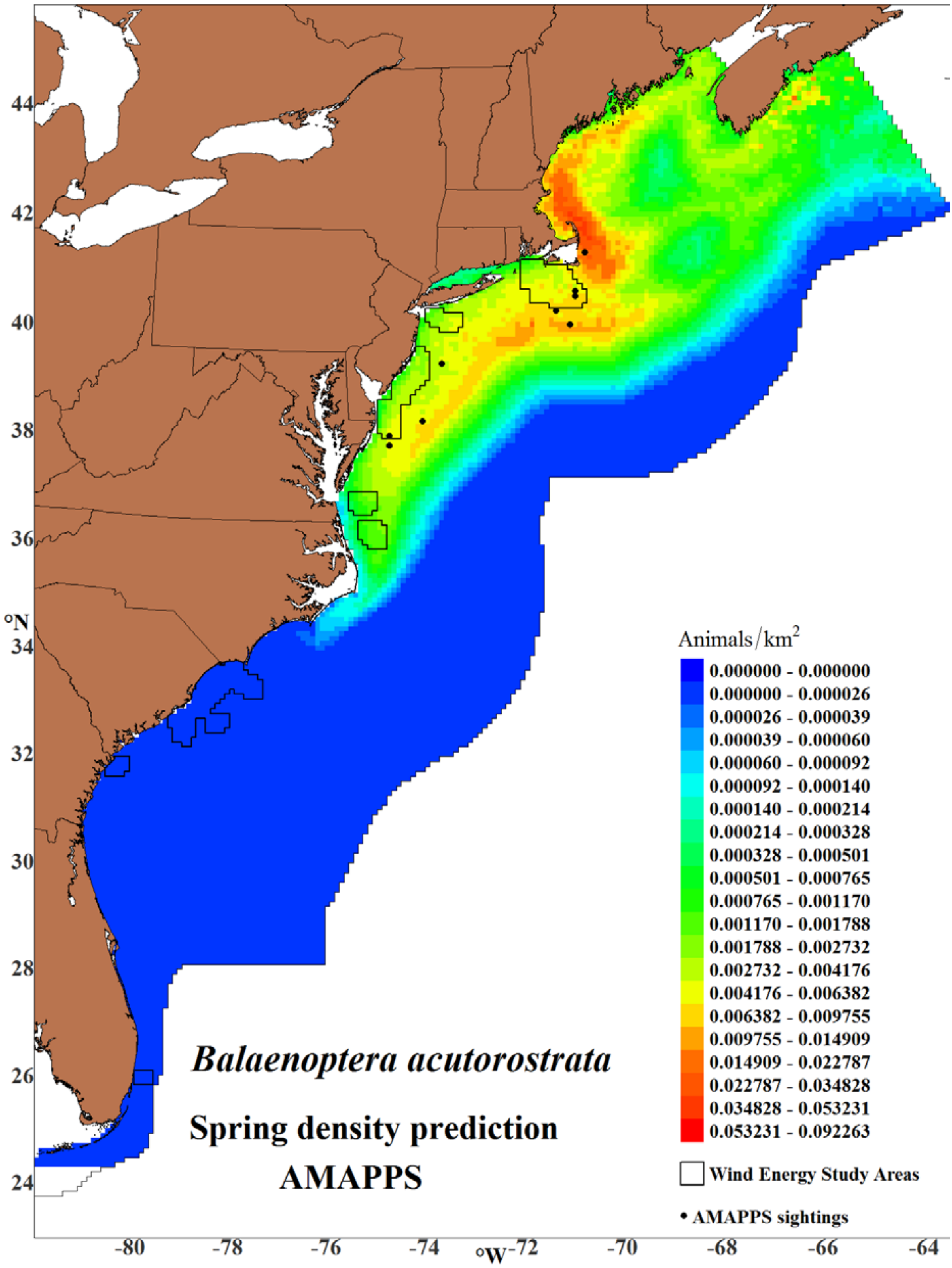

Figure 5-6 Minke whale spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

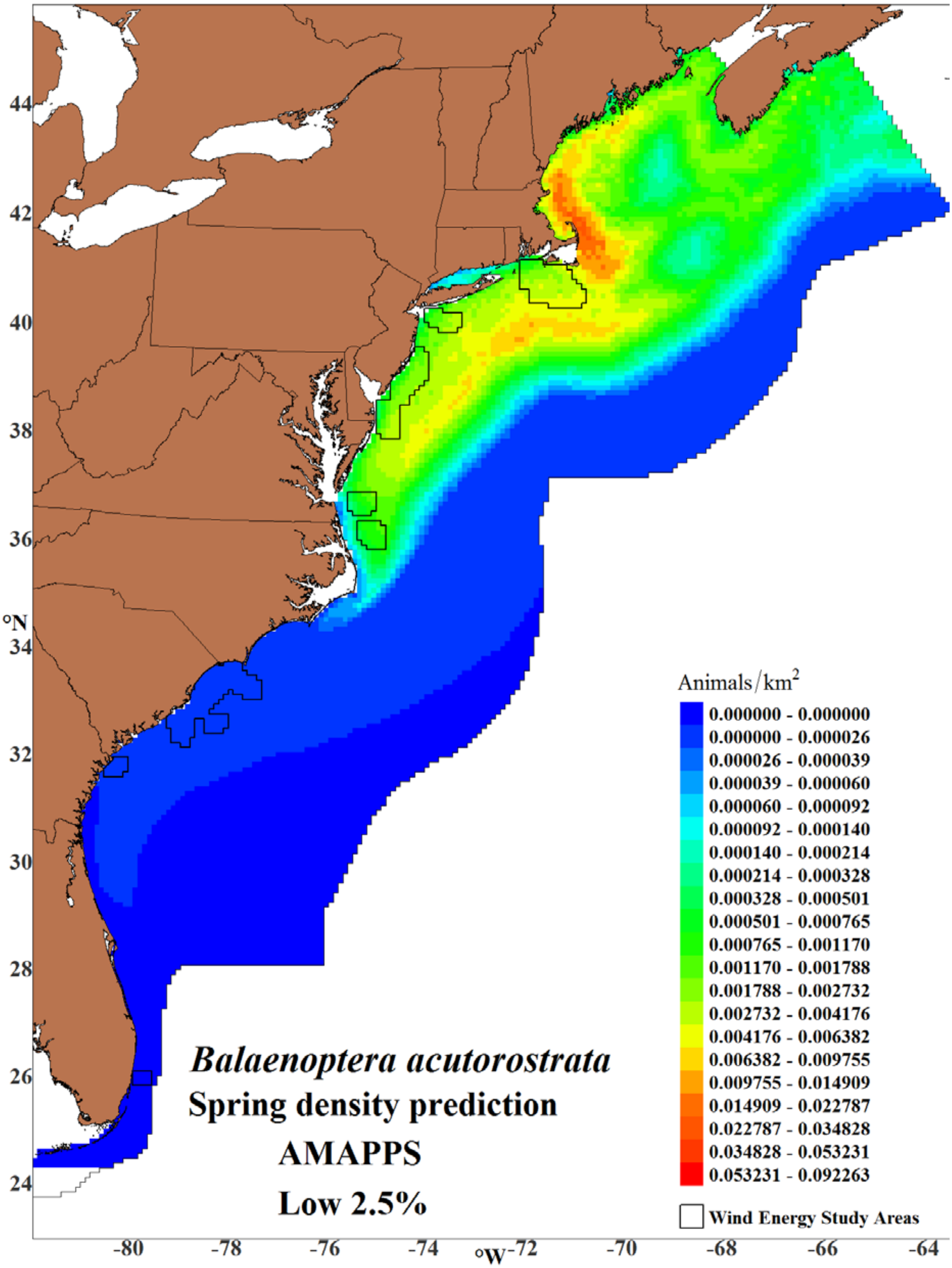

Figure 5-7 Lower 2.5% percentile of spring minke whale estimates

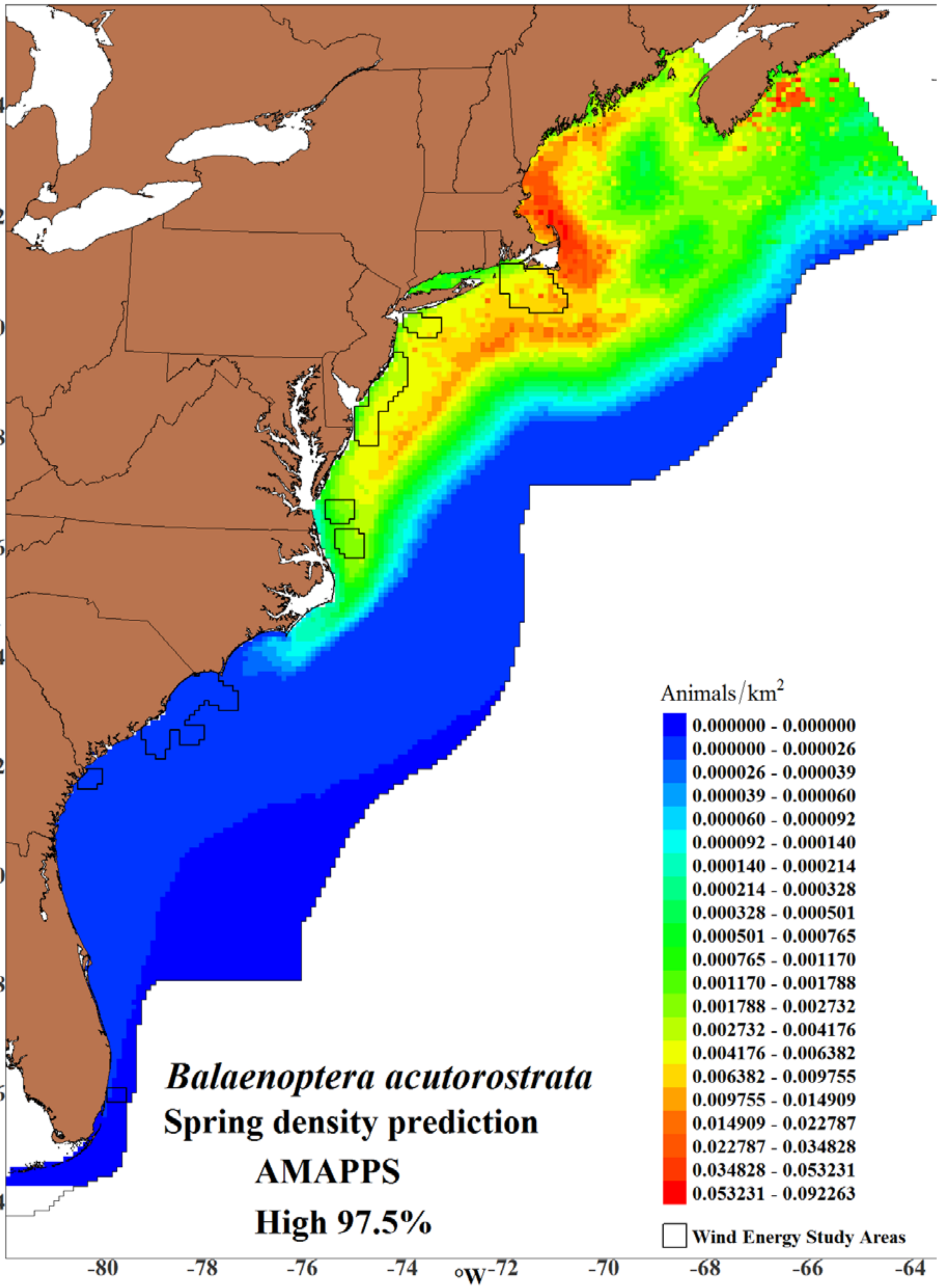

Figure 5-8 Upper 97.5% percentile of spring minke whale estimates

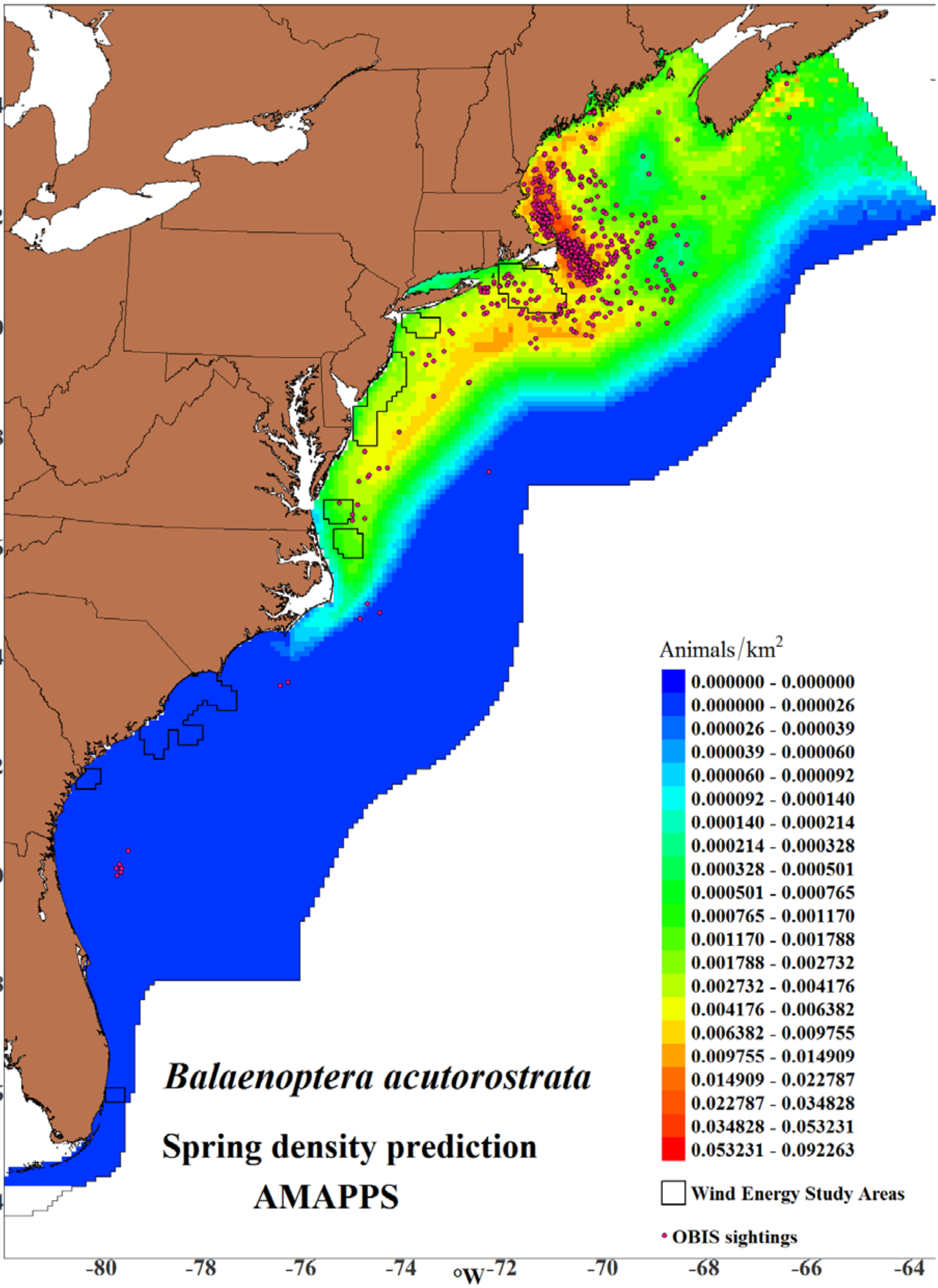

Figure 5-9 Minke whale 2010-2013 spring density and 1974-2014 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

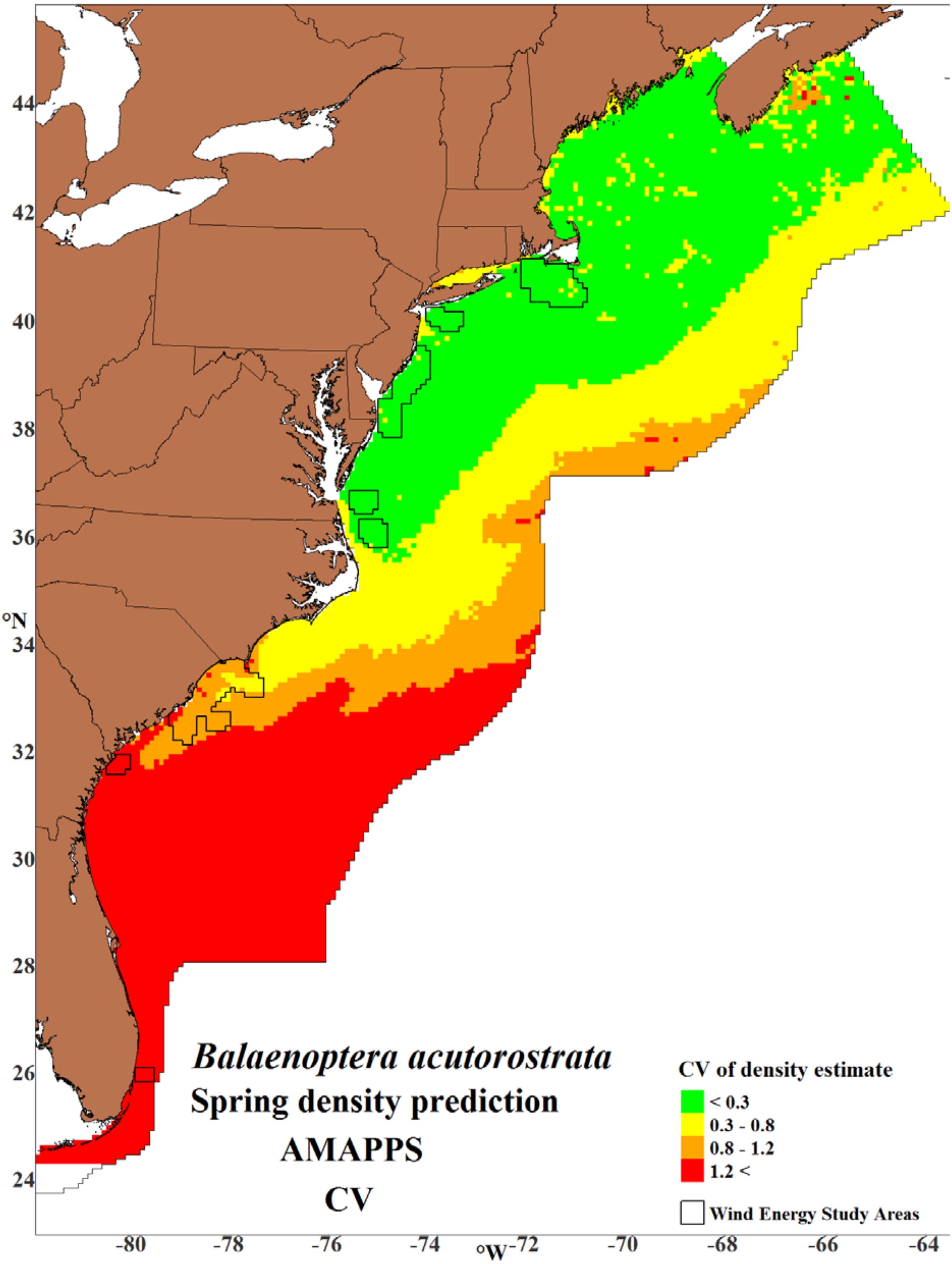

Figure 5-10 CV of spring density estimates for minke whales

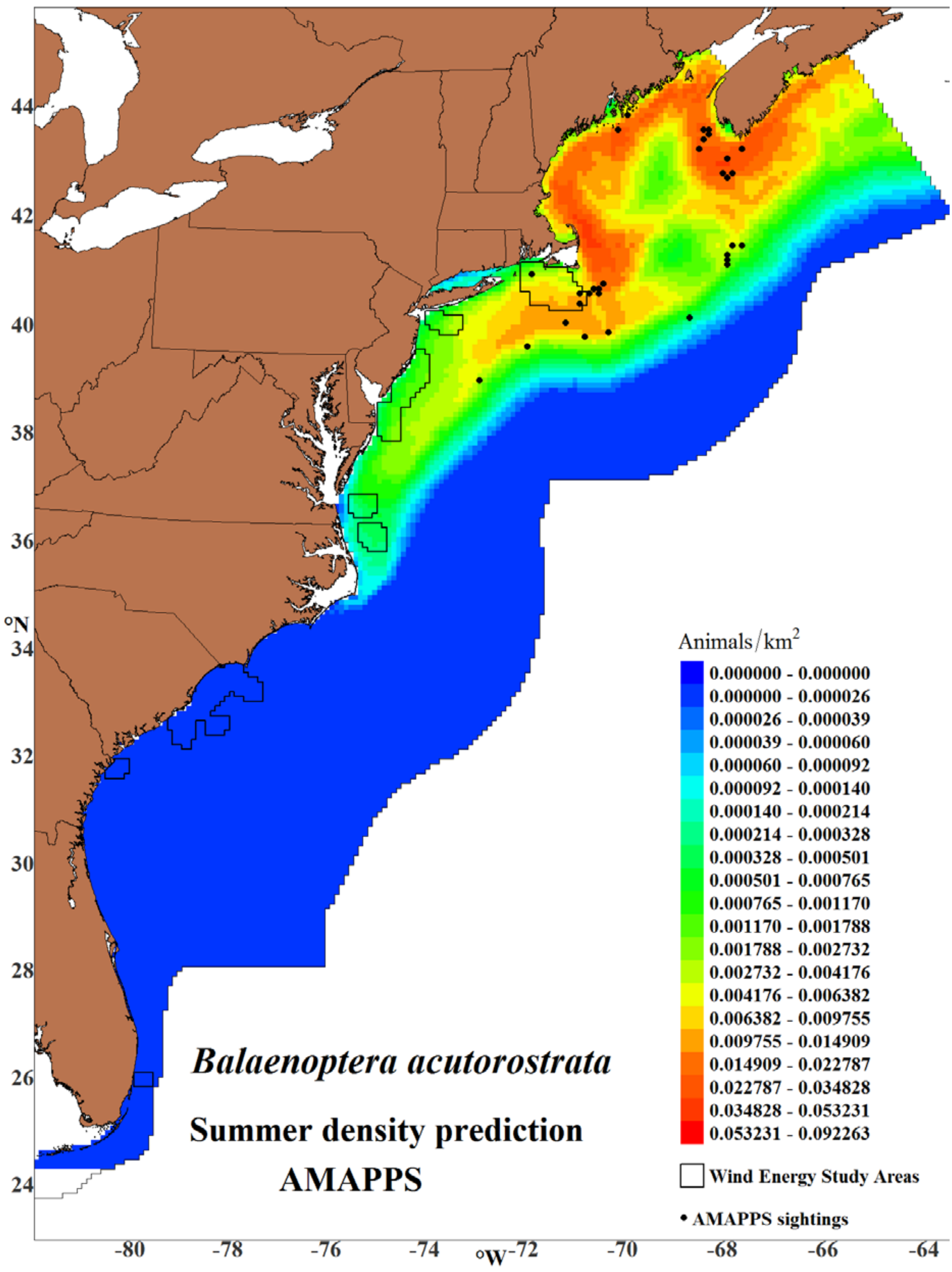

Figure 5-11 Minke whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

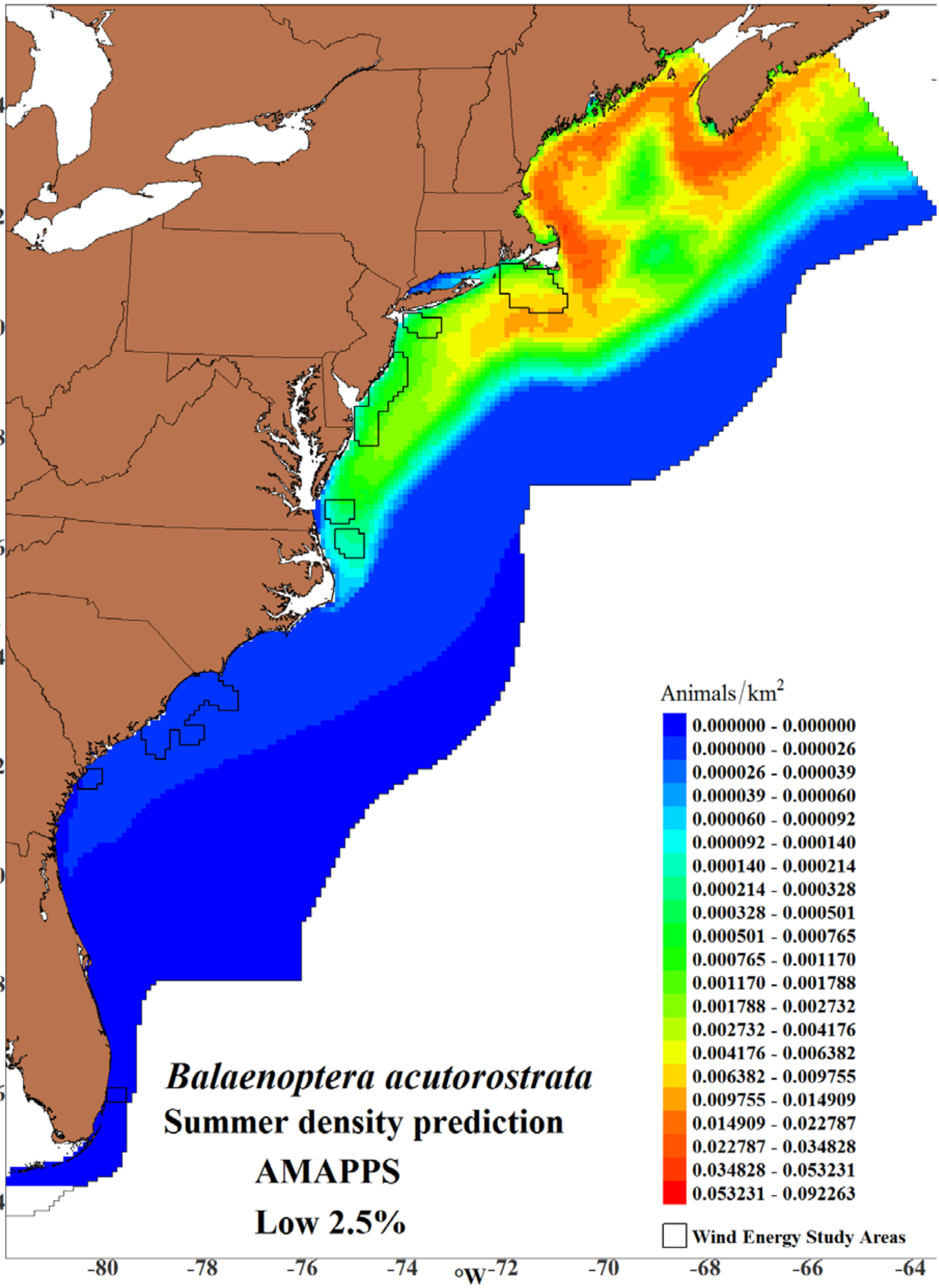

Figure 5-12 Lower 95% percentile of summer minke whale estimates

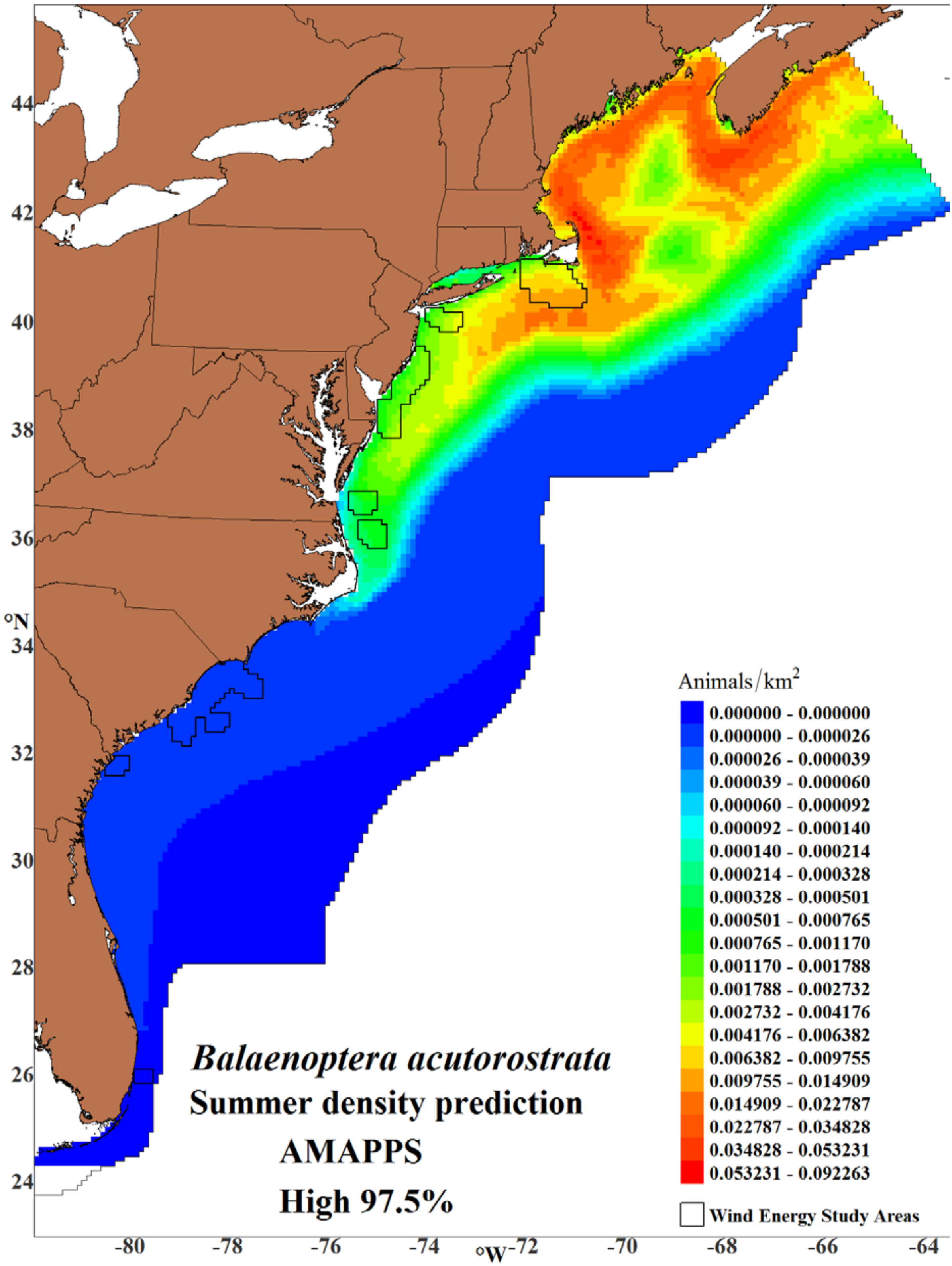

Figure 5-13 Upper 97.5% percentile of summer minke whale estimates

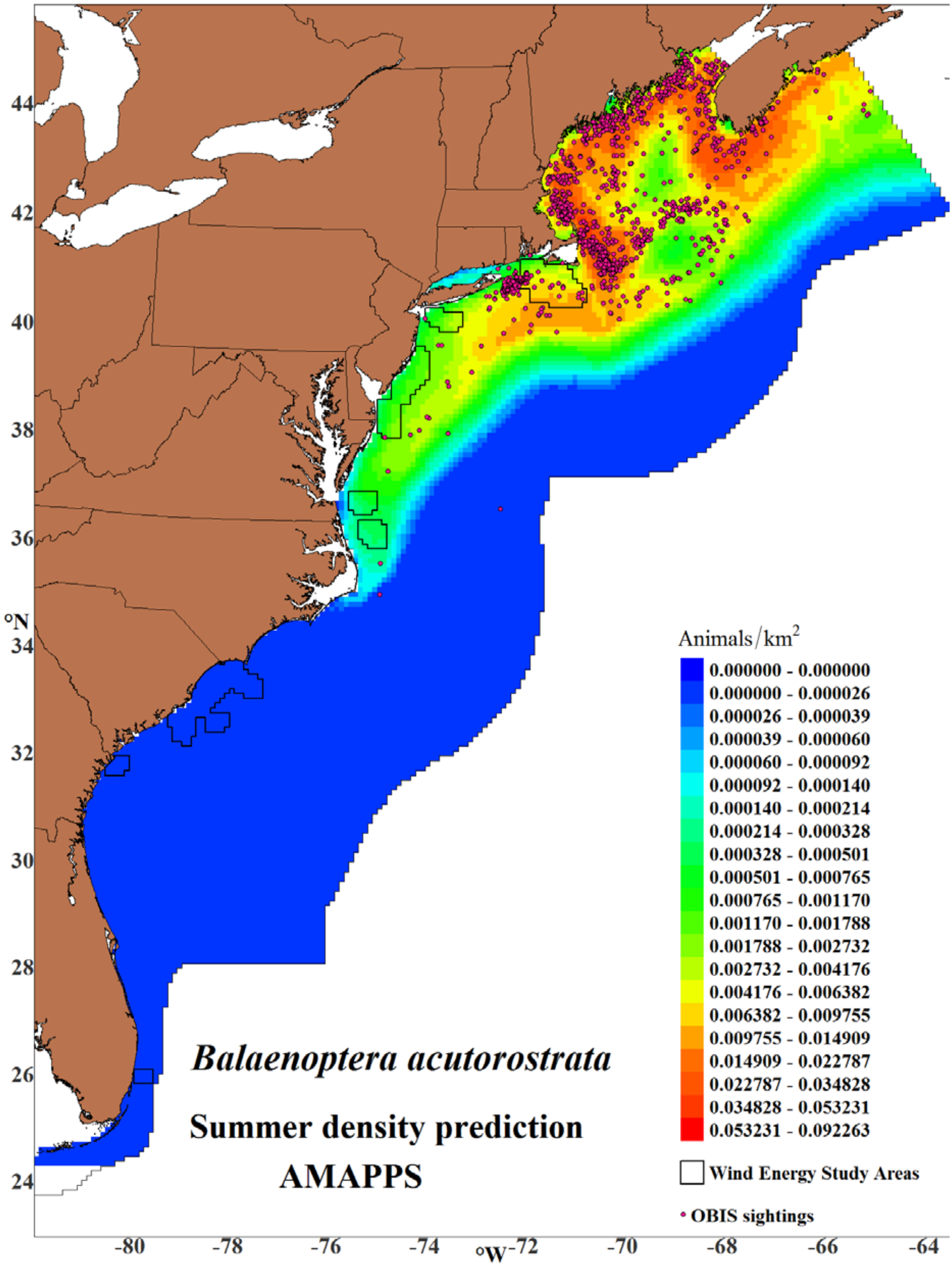

Figure 5-14 Minke whale 2010-2013 summer density and 1974-2014 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

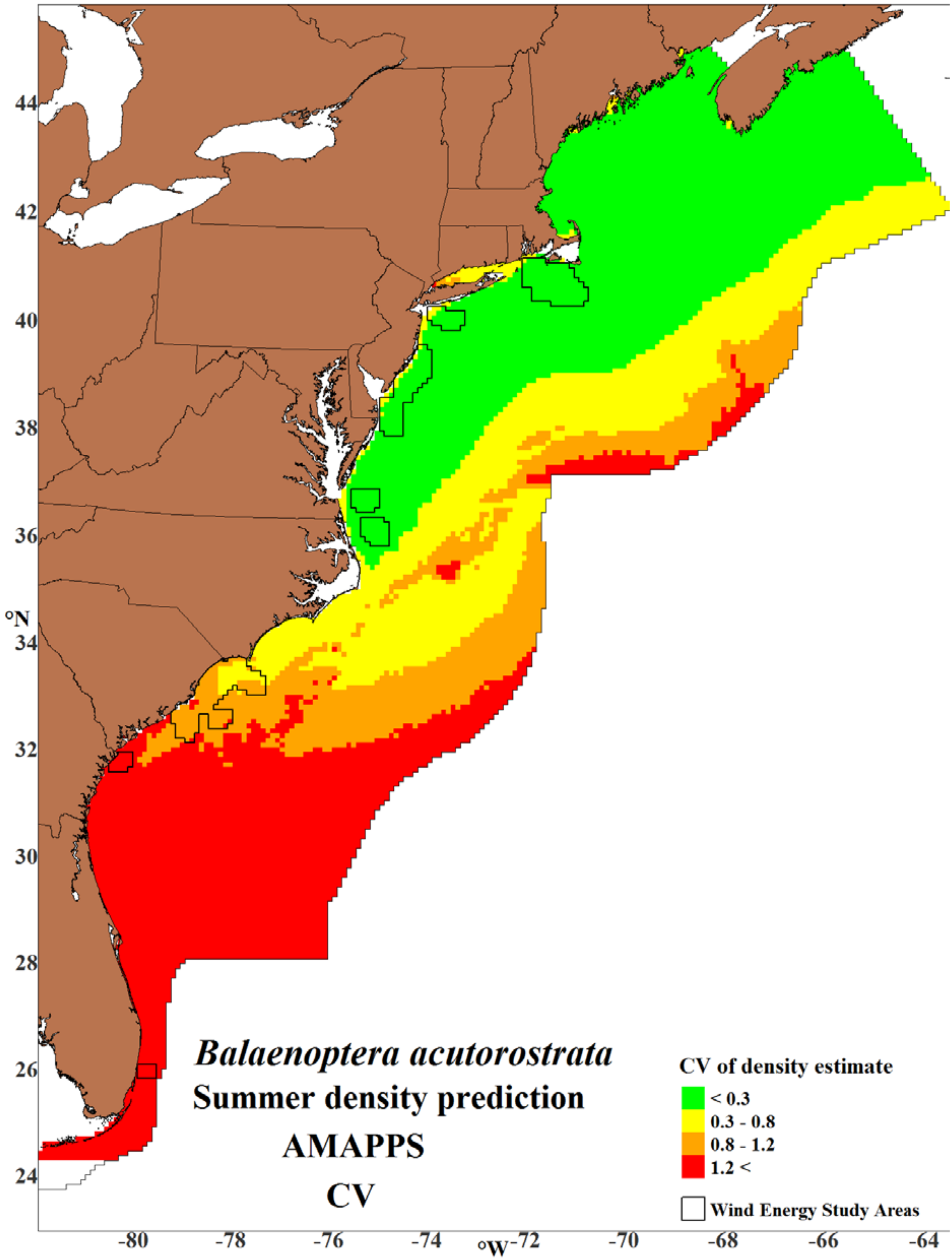

Figure 5-15 CV of summer density estimates for minke whales

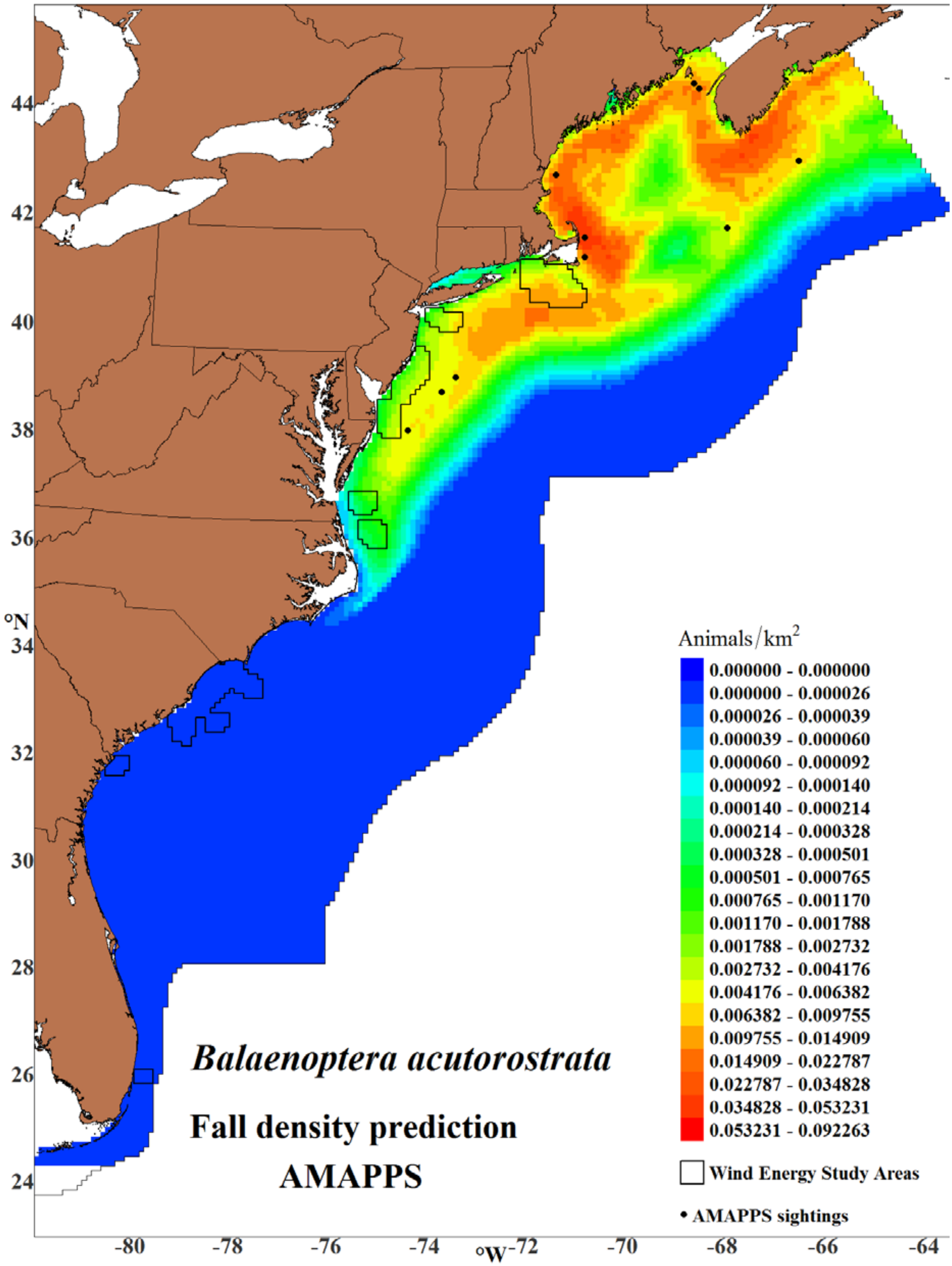

Figure 5-16 Minke whale fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

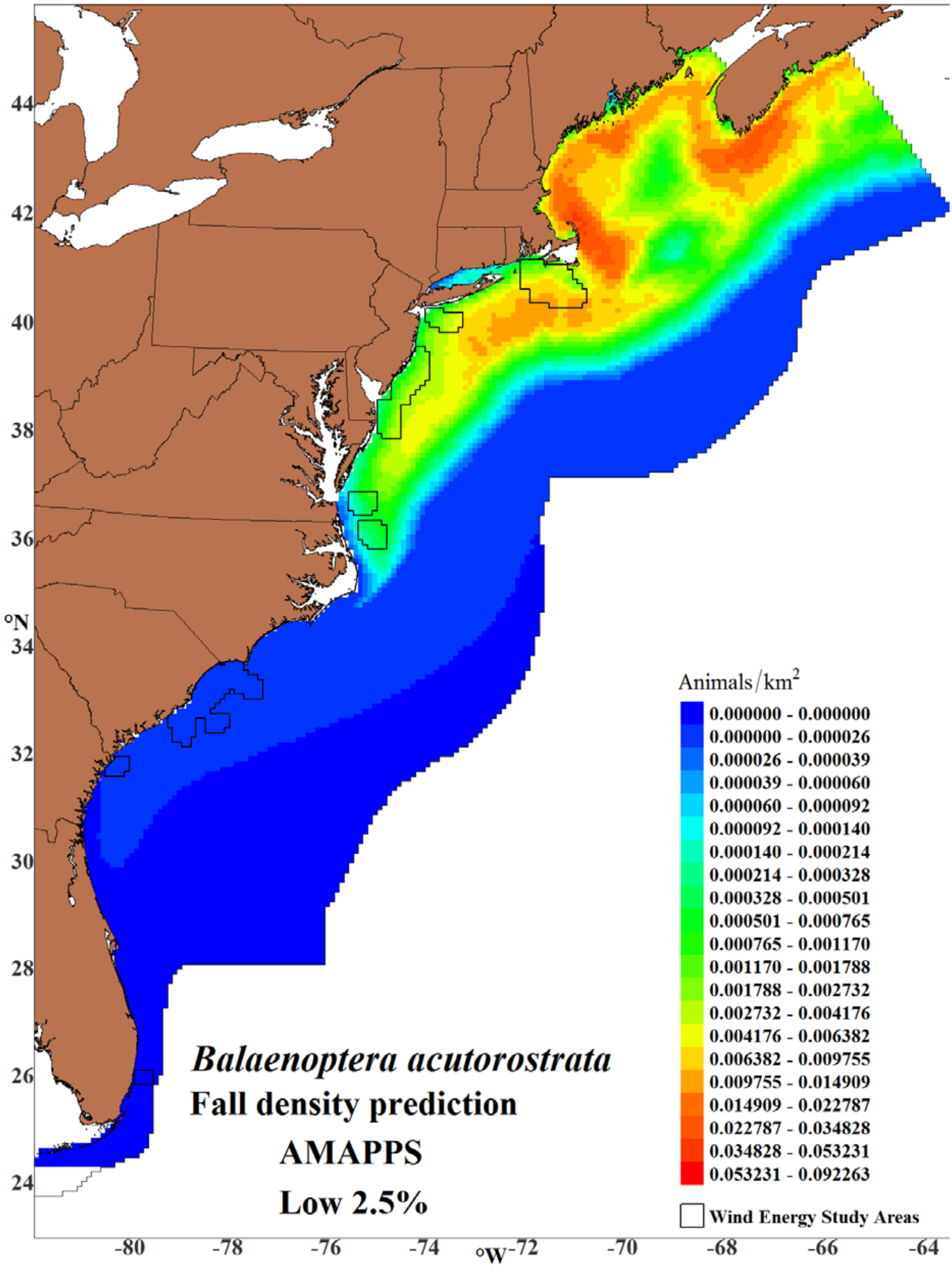

Figure 5-17 Lower 2.5% percentile of fall minke whale estimates

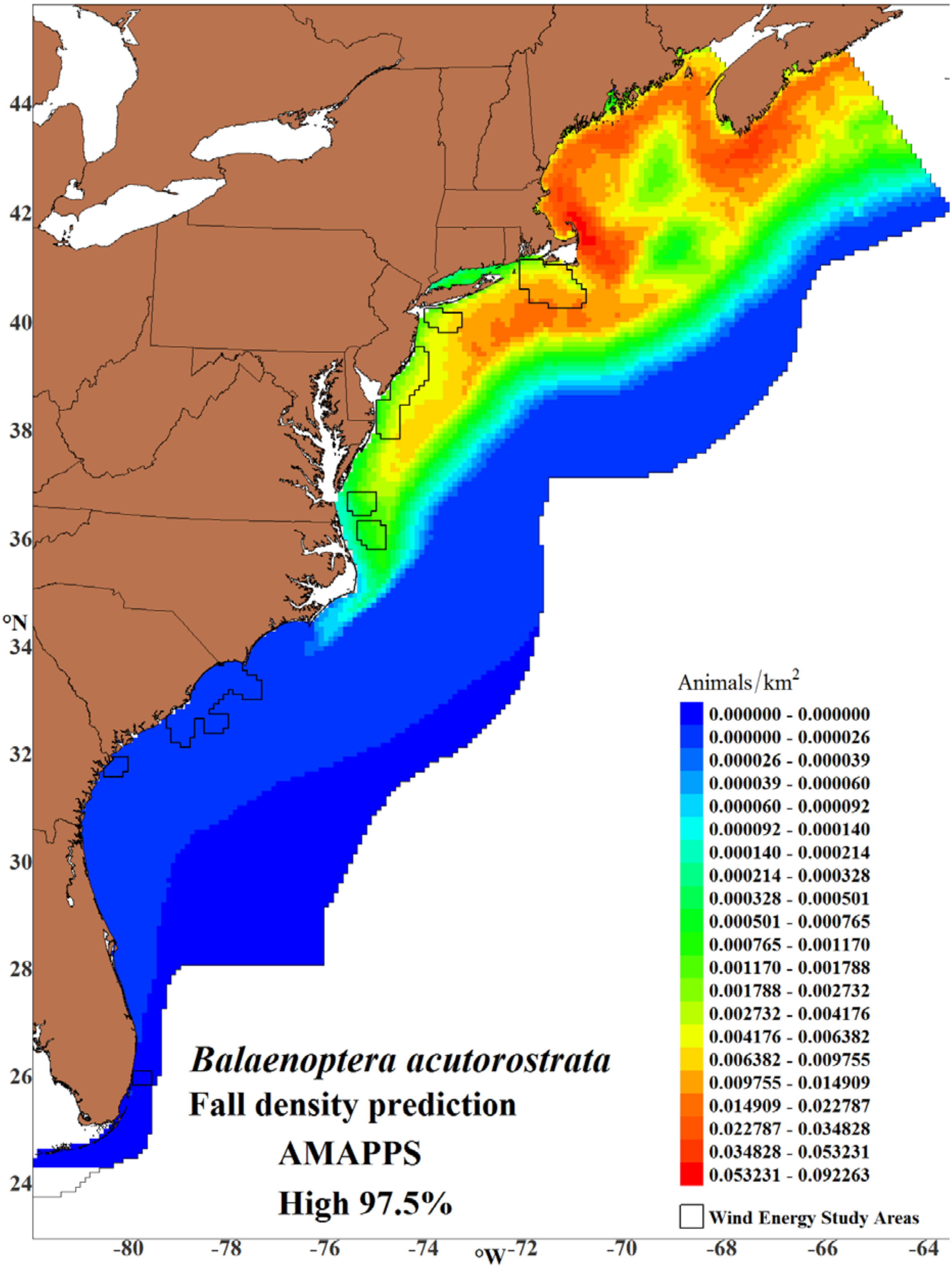

Figure 5-18 Upper 97.5% percentile of fall minke whale estimates

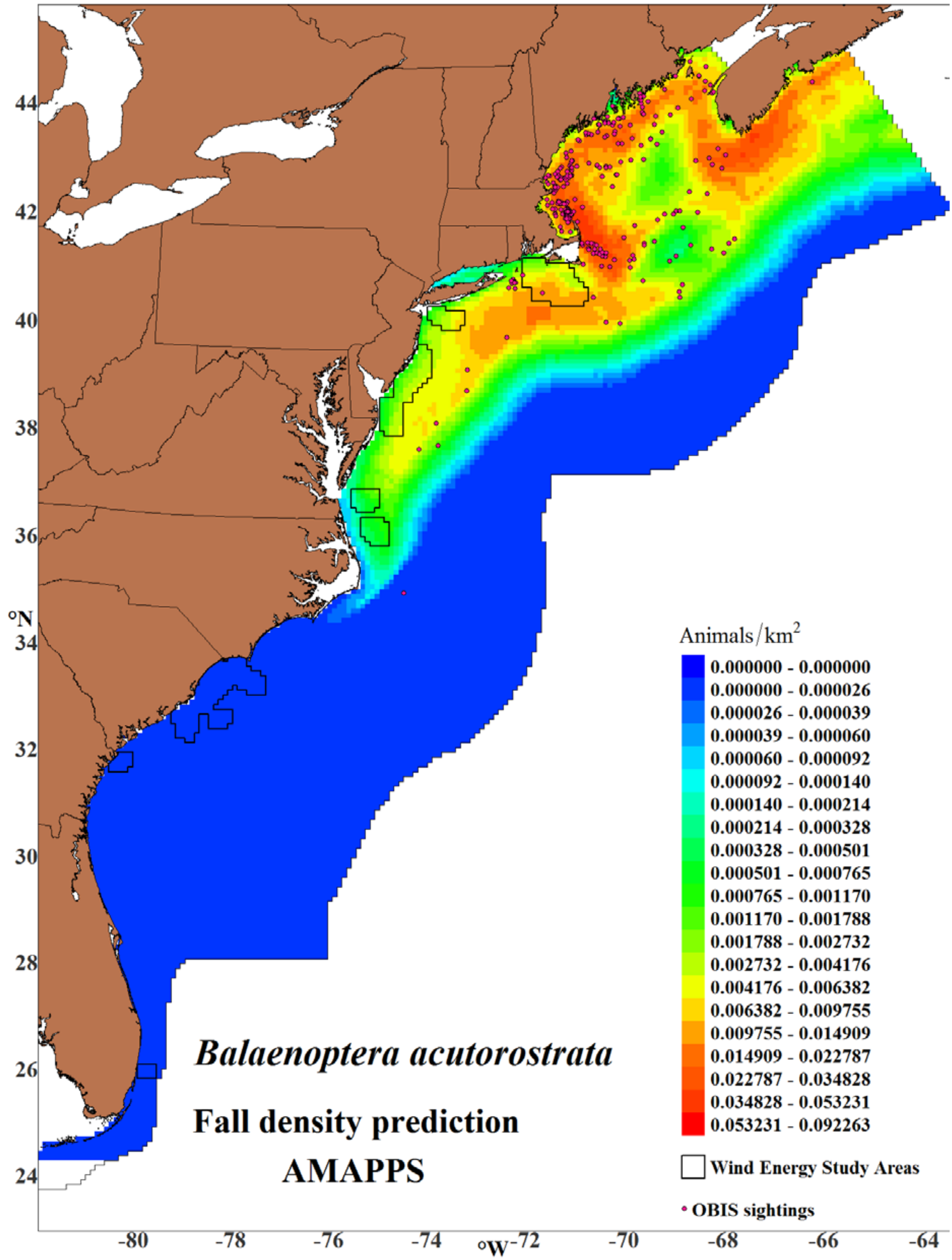

Figure 5-19 Minke whale 2010-2013 fall density and 1974-2014 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

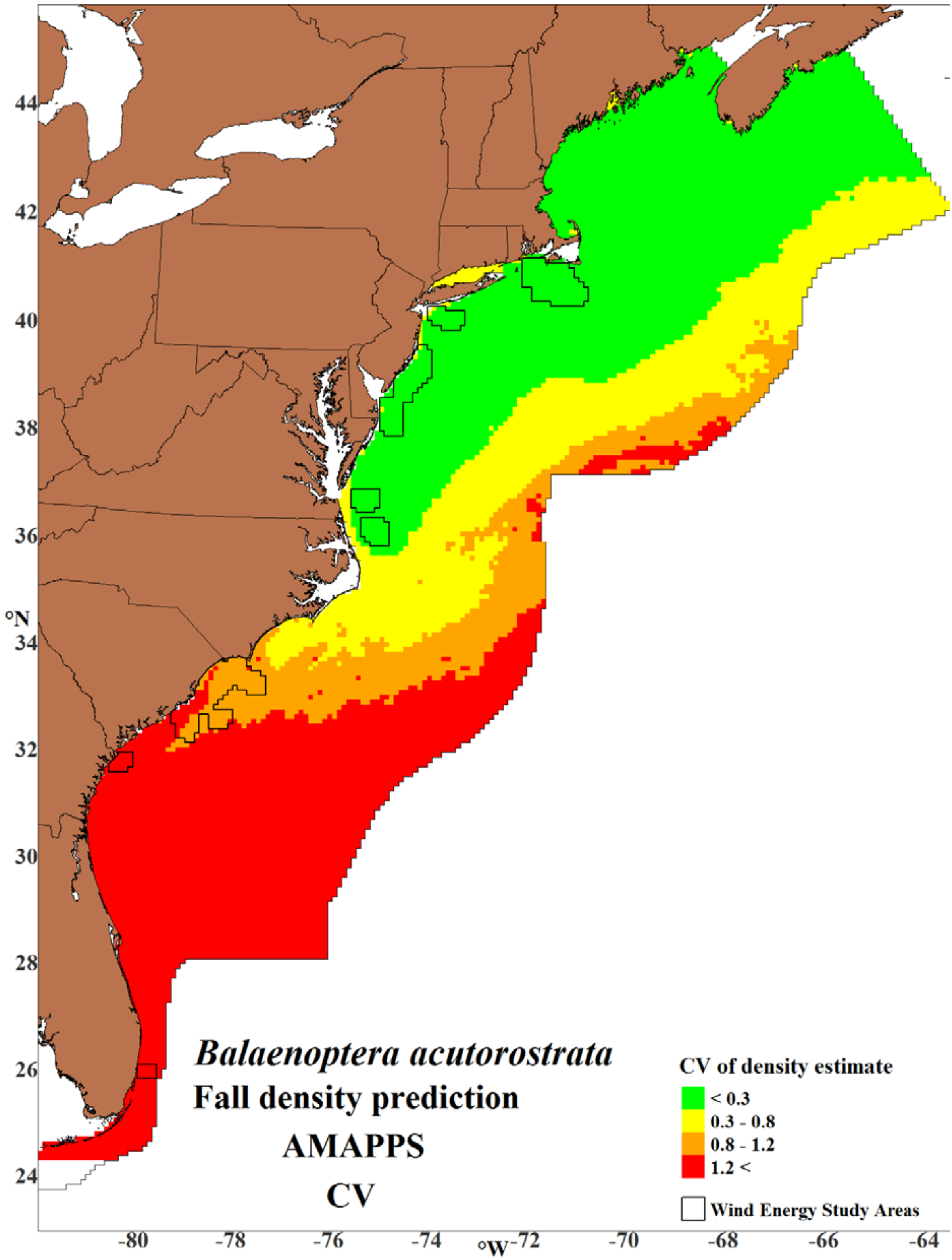

Figure 5-20 CV of fall density estimates for minke whales

5.6 Wind Energy Study Areas

Table 5-6 Minke whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.307, CV=0.397; shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	62	0.196	42 - 90
(March-May)	New York	9	0.188	6 - 13
	New Jersey	18	0.18	13 - 25
	Delaware/ Maryland	11	0.156	8 - 16
	Virginia	3	0.186	2 - 5
	North Carolina	4	0.229	3 - 7
	South Carolina/ North Carolina	0	0.848	0 - 0
	Georgia	0	1.749	0 - 0
	Florida	0	5.477	0 - 0
Summer	Rhode Island/ Massachusetts	83	0.118	65 - 104
(June-August)	New York	6	0.178	4 - 8
	New Jersey	8	0.203	5 - 11
	Delaware/ Maryland	5	0.166	3 - 6
	Virginia	1	0.179	1 - 2
	North Carolina	1	0.24	1 - 2
	South Carolina/ North Carolina	0	0.836	0 - 0
	Georgia	0	1.458	0 - 0
	Florida	0	5.642	0 - 0
Fall	Rhode Island/ Massachusetts	97	0.109	78 - 120
(September-November)	New York	11	0.15	8 - 15
	New Jersey	17	0.164	13 - 24
	Delaware/ Maryland	8	0.16	6 - 12
	Virginia	2	0.201	1 - 3
	North Carolina	2	0.24	1 - 3
	South Carolina/ North Carolina	0	0.998	0 - 0
	Georgia	0	2.083	0 - 0
	Florida	0	5.528	0 - 0

***** The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model.

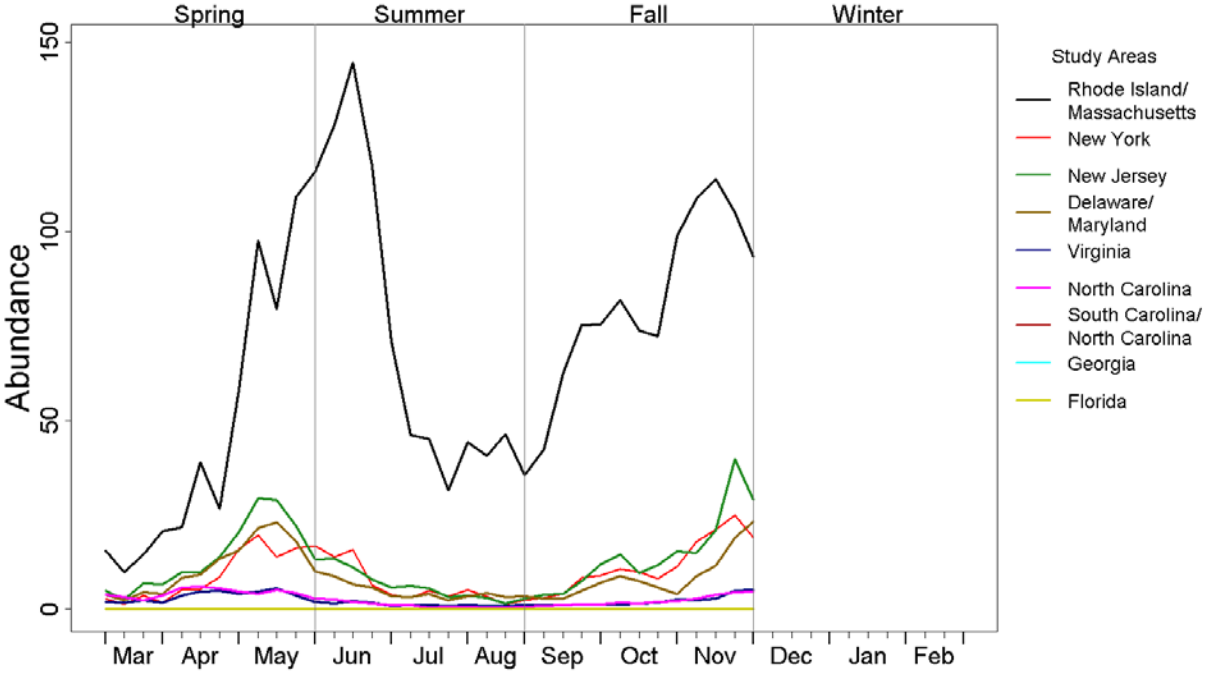

Figure 5-21 Annual abundance trends for minke whales in wind energy study areas

6 Sperm Whale (*Physeter macrocephalus*)

Figure 6-1 Sperm whale. Credit: NOAA/NEF NEFSC/Christin Khan
Image collected under MMPA Research permit #775-1875.

6.1 Data Collection

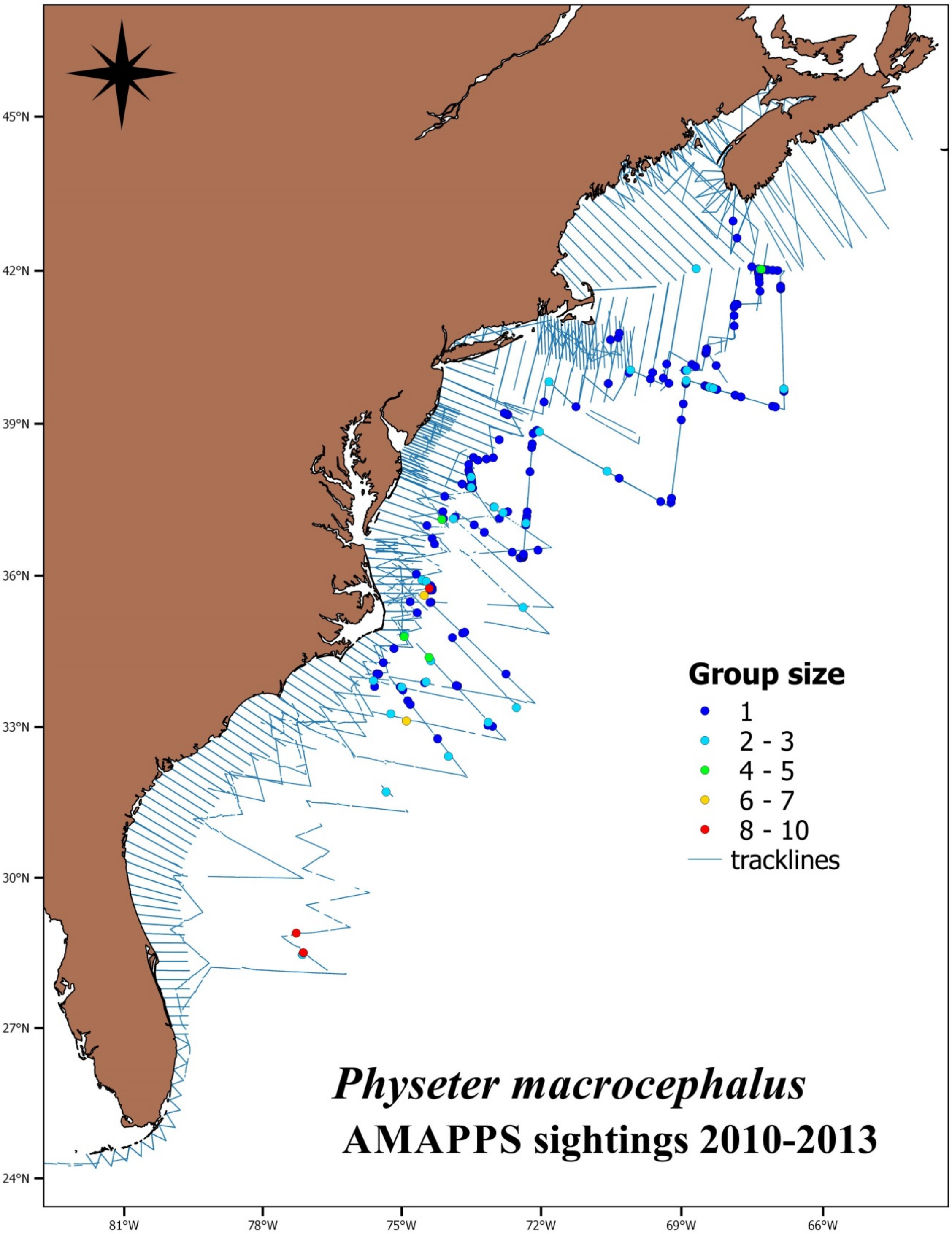

Figure 6-2 Track lines and sperm whale sightings during 2010 - 2013

Table 6-1 Research effort 2010 - 2013 and sperm whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Sperm whale	*Physeter macrocephalus*	0/0	138/208	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	3/3	3/6	4/4	0/0
SE Shipboard	0	8,537	2,093	0	-	-	0/0	52/126	13/42	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	6/6	2/2	0/0	0/0

6.2 Mark-Recapture Distance Sampling Analysis

Table 6-2 Parameter estimates from sperm whale (SPWH) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE - aerial group 1	1	CBWH,FIWH,HUWH,MIWH,RIWH, SPWH	Distance*observer	Distance+sea	400	HR	0.898	0.091	0.318	0.659	0.671
	2		-	Distance+sea	562	HN	-	-	0.221	0.737	0.758
NE - aerial group 1	1	CBWH,FISE,FIWH, HUWH,MIWH, RIWH,SEWH, SPWH, UNBW	Distance	Distance+time of day	900	HR	0.503	0.168	0.369	0.992	0.985
	2		-	Distance+glare	5240	HR	-	-	0.245	0.832	0.905
SE - shipboard group 1	-	FIWH,HUWH, RIWH,SPWH	Distance*observer+ sea	Distance+sea	8840	HN	0.472	0.228	0.326	0.122	0.137
NE - shipboard group 3	-	SPWH	Distance*observer	Distance	7600	HR	0.605	0.131	0.936	0.940	0.969

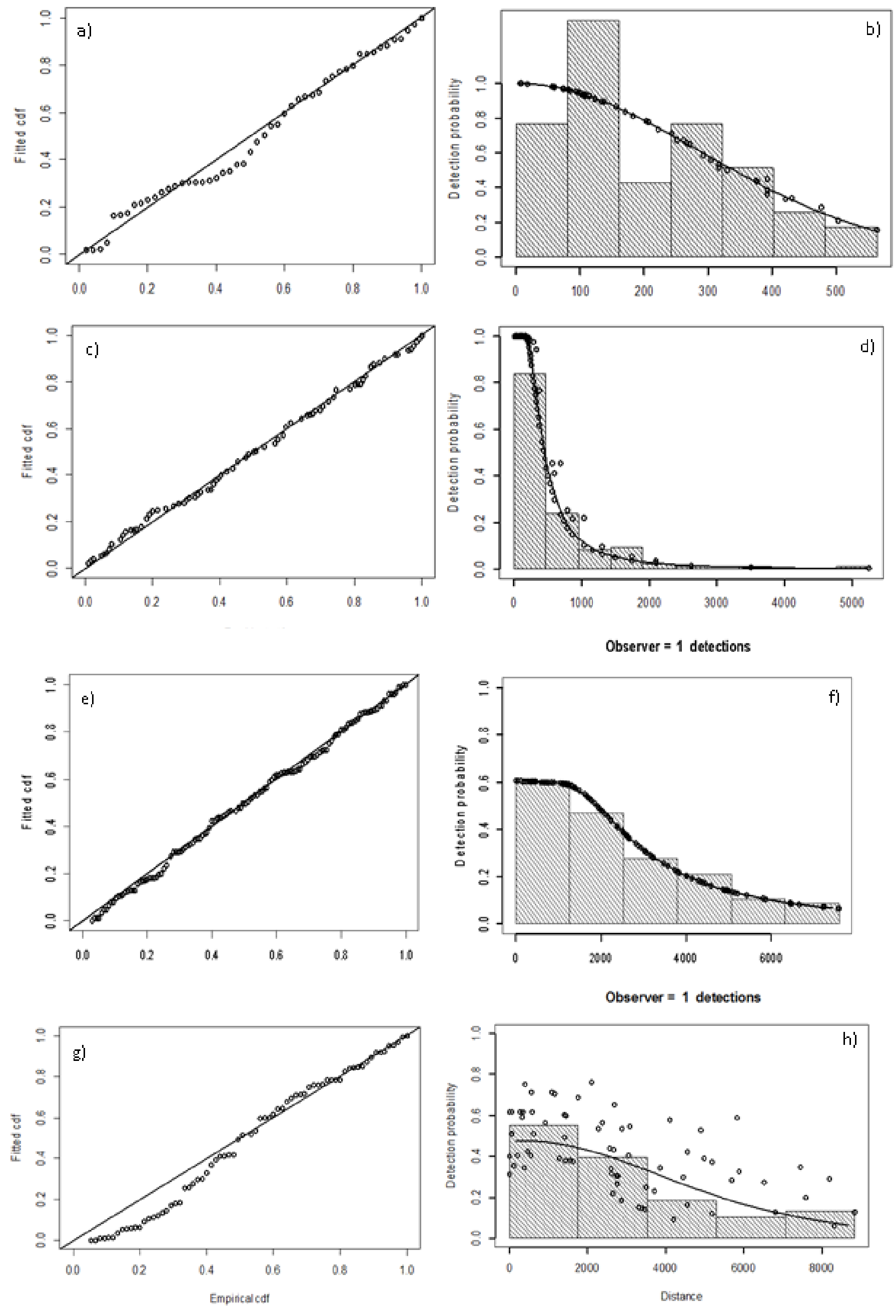

Figure 6-3 Q-Q plots and detection functions from sperm whale MRDS analysis
Group 1 aerial southeast region (a,b), group 1 aerial northeast region (c,d), group 3 shipboard northeast region (e,f) and group 1 shipboard southeast region (g,h).

6.3 Generalized Additive Model Analysis

Table 6-3 Habitat model output for sperm whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(chl)	0.9095	4	10.17	2.11E-11	4.61E-03	***
s(sst)	3.8512	4	79.98	< 2e-16	2.83E-01	***
s(pp)	2.8644	4	58.22	< 2e-16	5.03E-05	***
s(slope)	3.0721	4	110.09	< 2e-16	3.06E-01	***
s(btemp)	3.1548	4	44.83	< 2e-16	3.82E-01	***
Scale	-	-	-	-	7.49E-01	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: Total = 14.85

R^2 (adjusted) = 0.0249 Deviance explained = 33.5%

REML = 891.68 Scale estimate = 0.13065 sample size = 11247

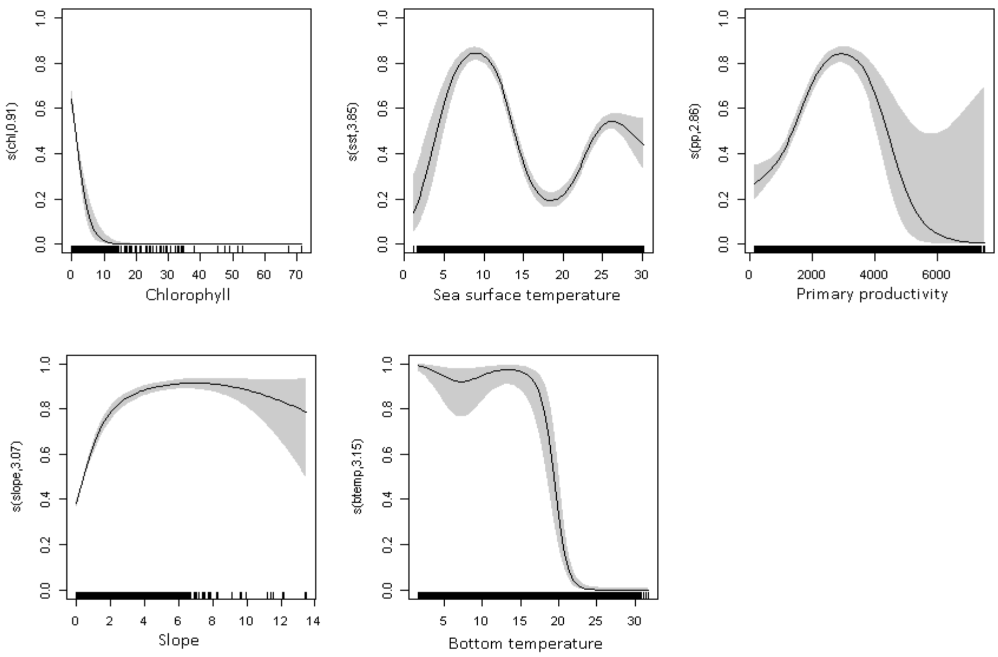

Figure 6-4 Sperm whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 6-4 Diagnostic statistics from sperm whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.227	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	82.01	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.157	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.05	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

6.4 Abundance Estimates for AMAPPS Study Area

Table 6-5 Sperm whale average abundance estimates for AMAPS study area
Availability bias correction: aerial 0.145, CV=0.005; shipboard 0.613, CV= 0.247.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	4,766	0.449	2,058 – 11,039
Summer (June-August)	3,663	0.143	2,772 – 4,841
Fall (September-November)	3,557	0.147	2,669 – 4,741

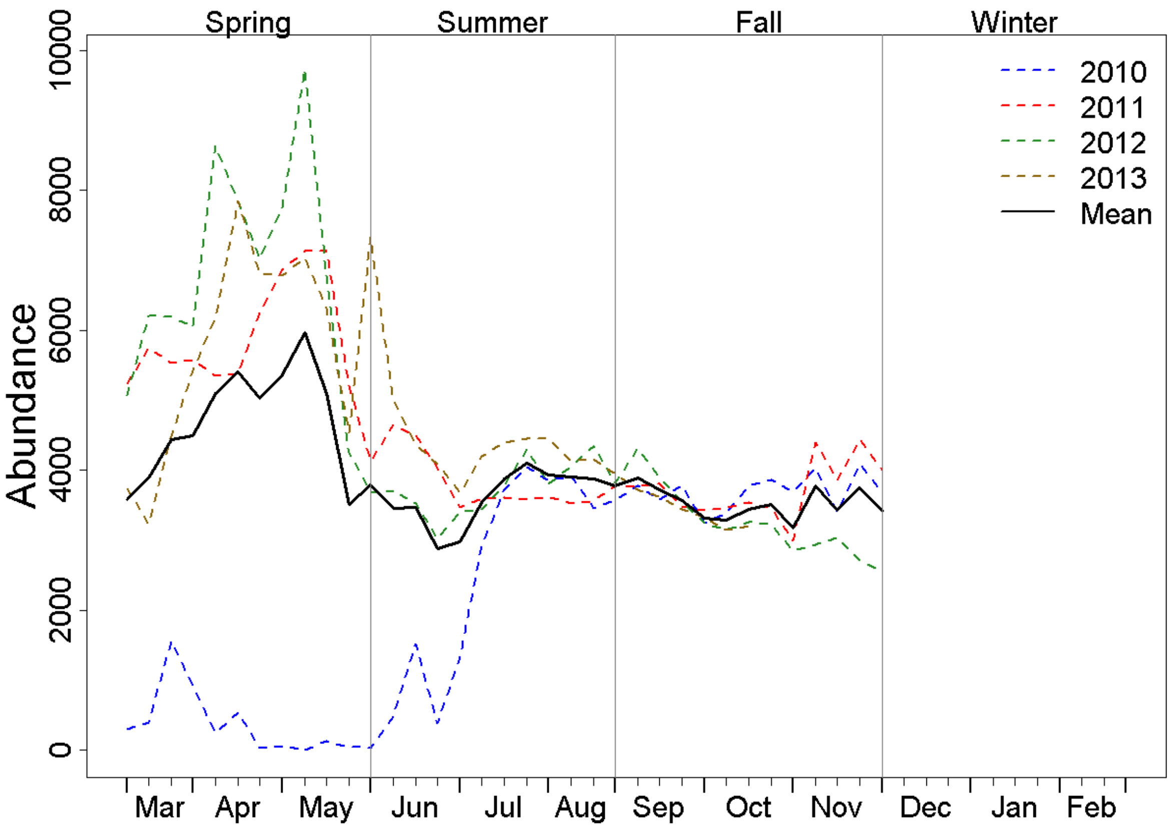

Figure 6-5 Annual abundance trends for sperm whales in wind energy study areas

6.5 Seasonal Prediction Maps

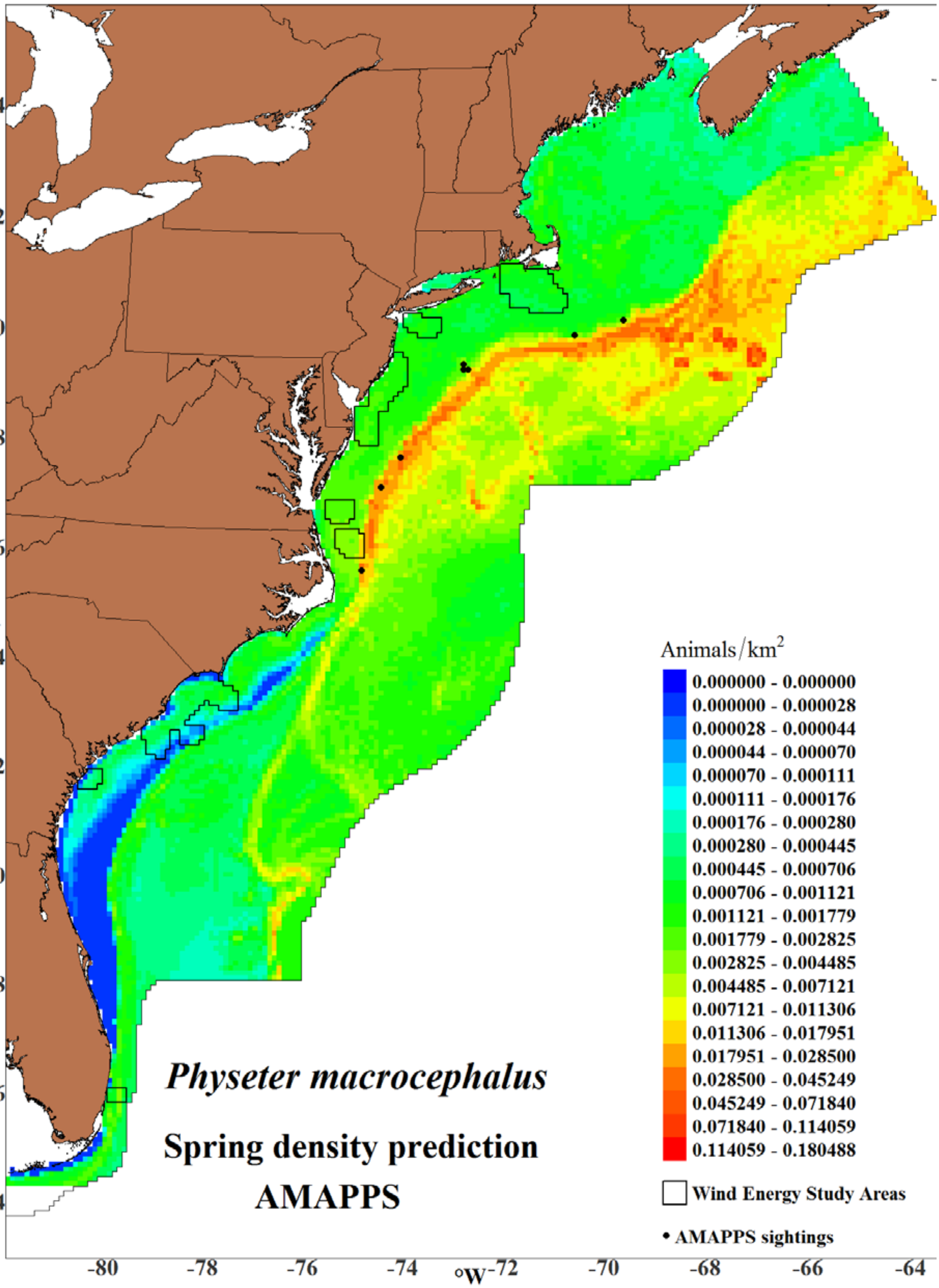

Figure 6-6 Sperm whale spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

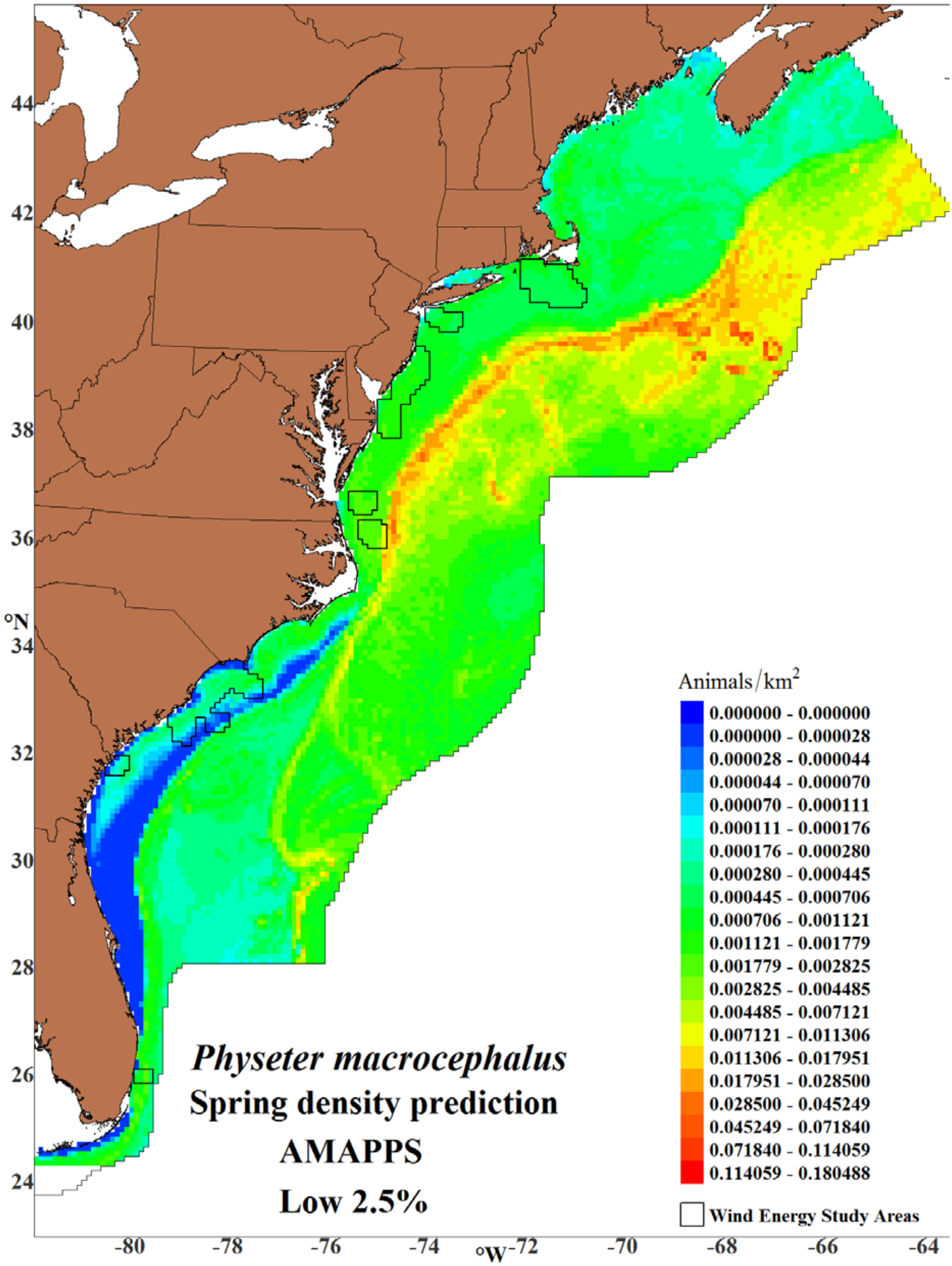

Figure 6-7 Lower 95% percentile of spring sperm whale estimates

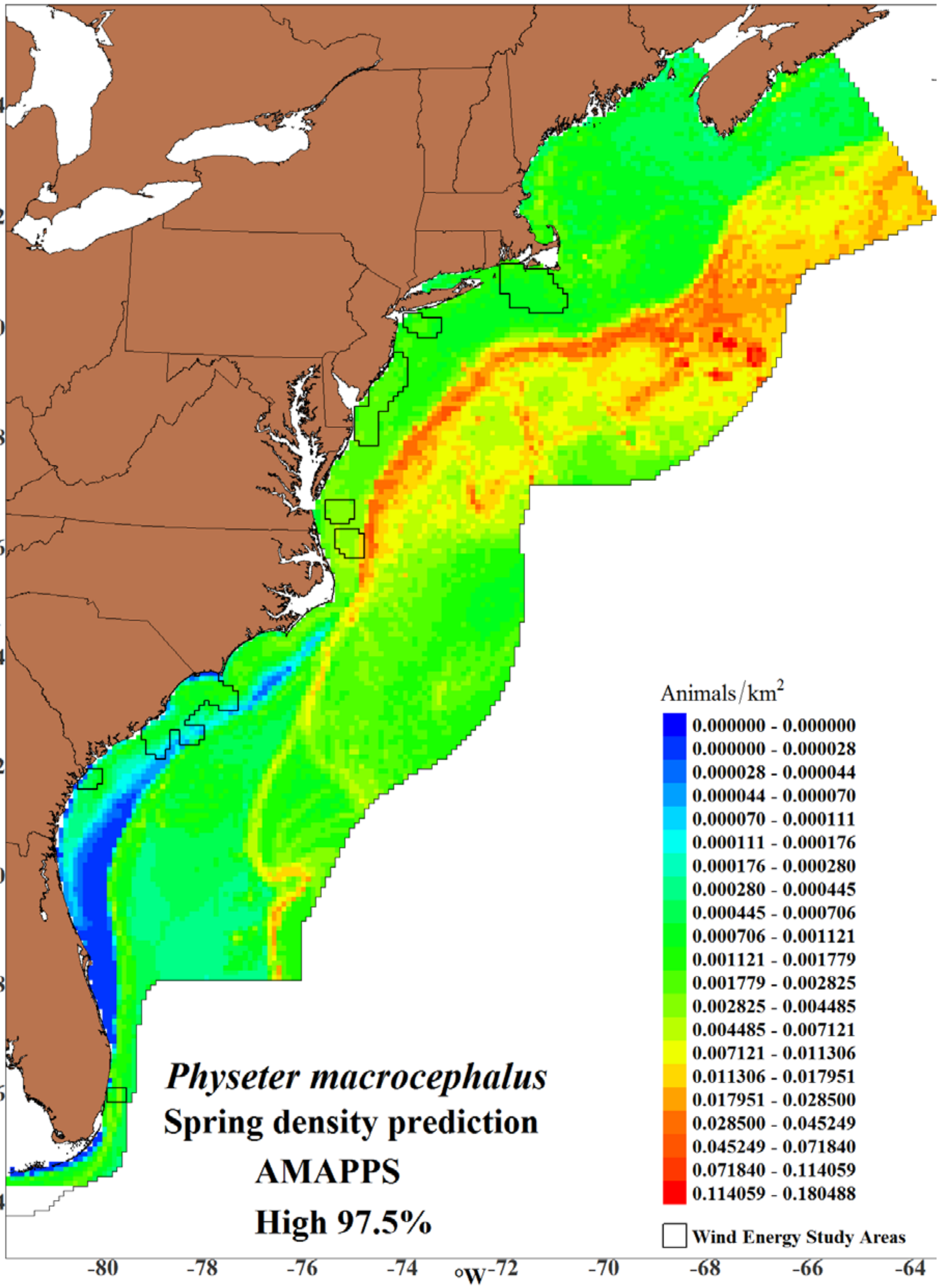

Figure 6-8 Upper 97.5% percentile of spring sperm whale estimates

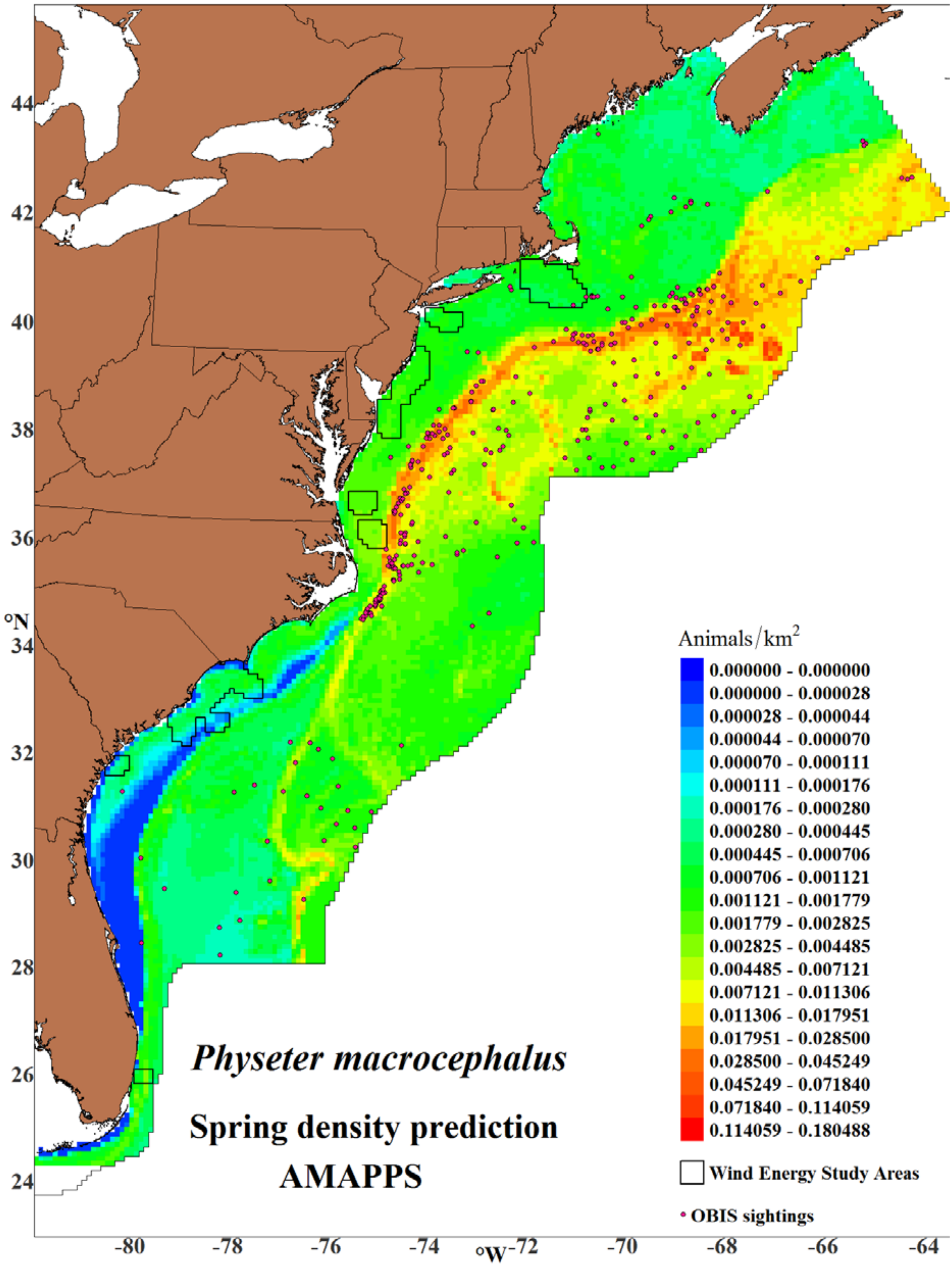

Figure 6-9 Sperm whale 2010-2013 spring density and 1970-2013 OBIS sightings
Pink circles (Halpin *et al.* 2009). These sightings were not used to develop the density-habitat model.

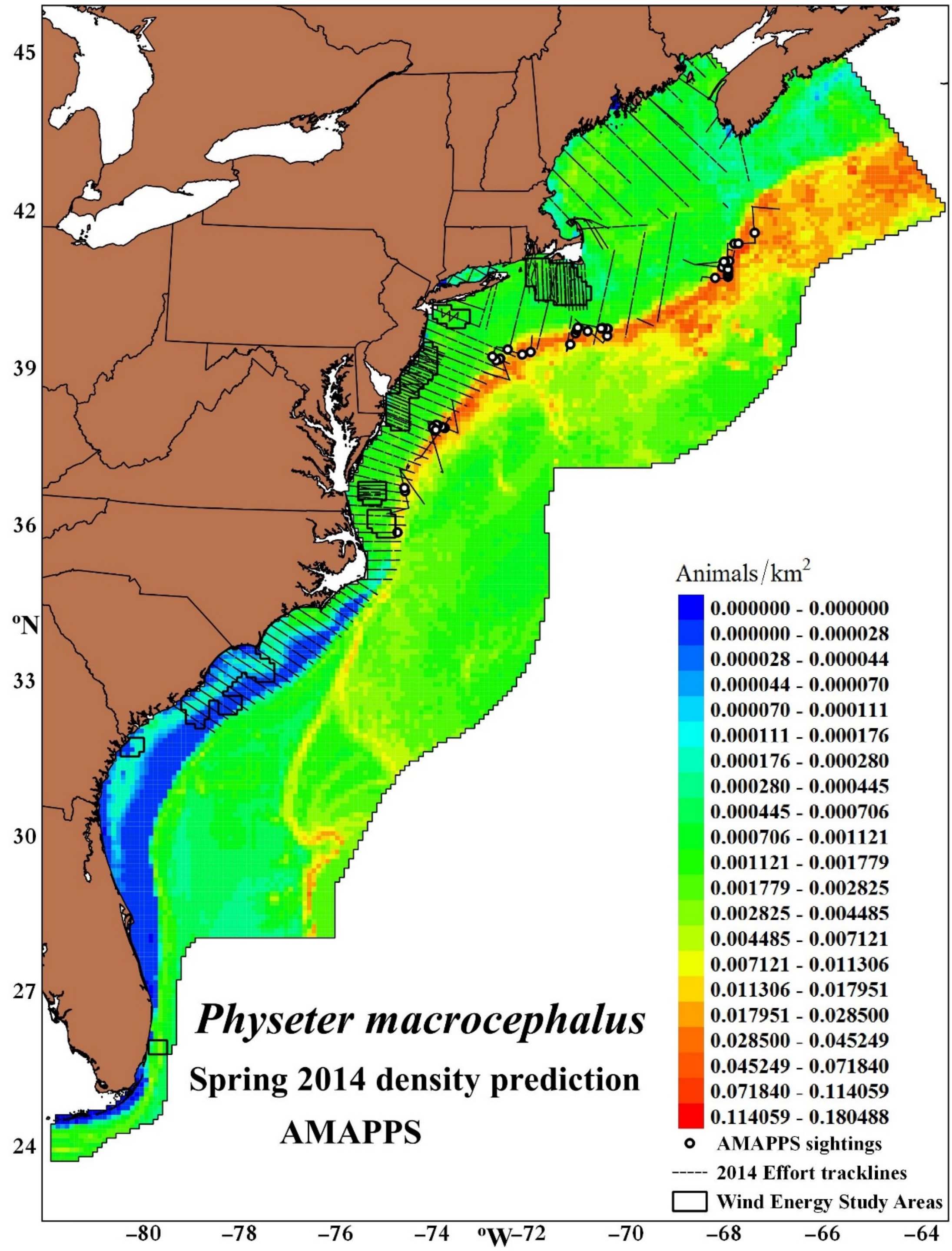

Figure 6-10 Sperm whale spring 2014 density and AMAPPS 2014 tracks and sightings
These sightings were not used to develop the density-habitat model.

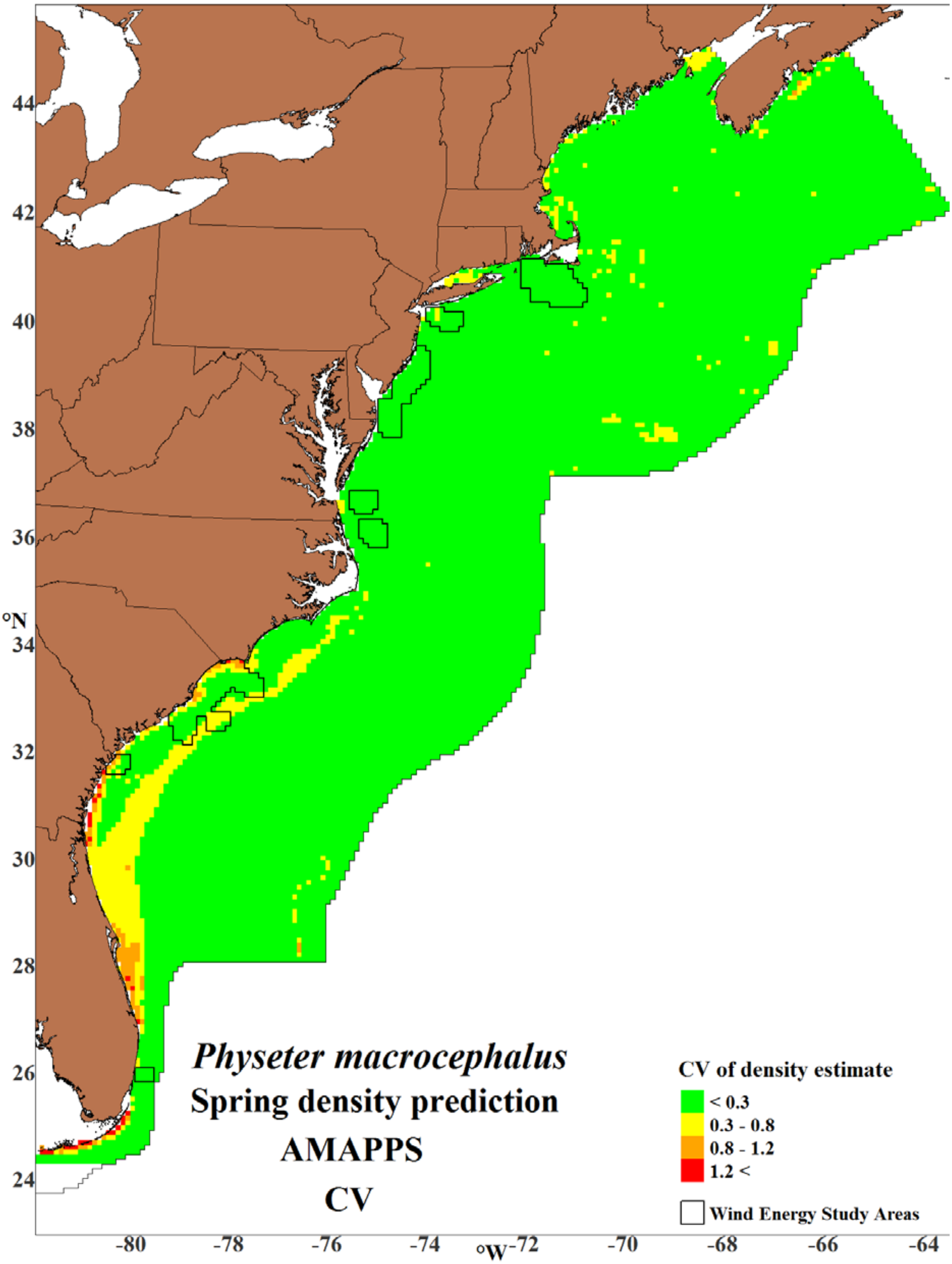

Figure 6-11 CV of spring estimates for sperm whales

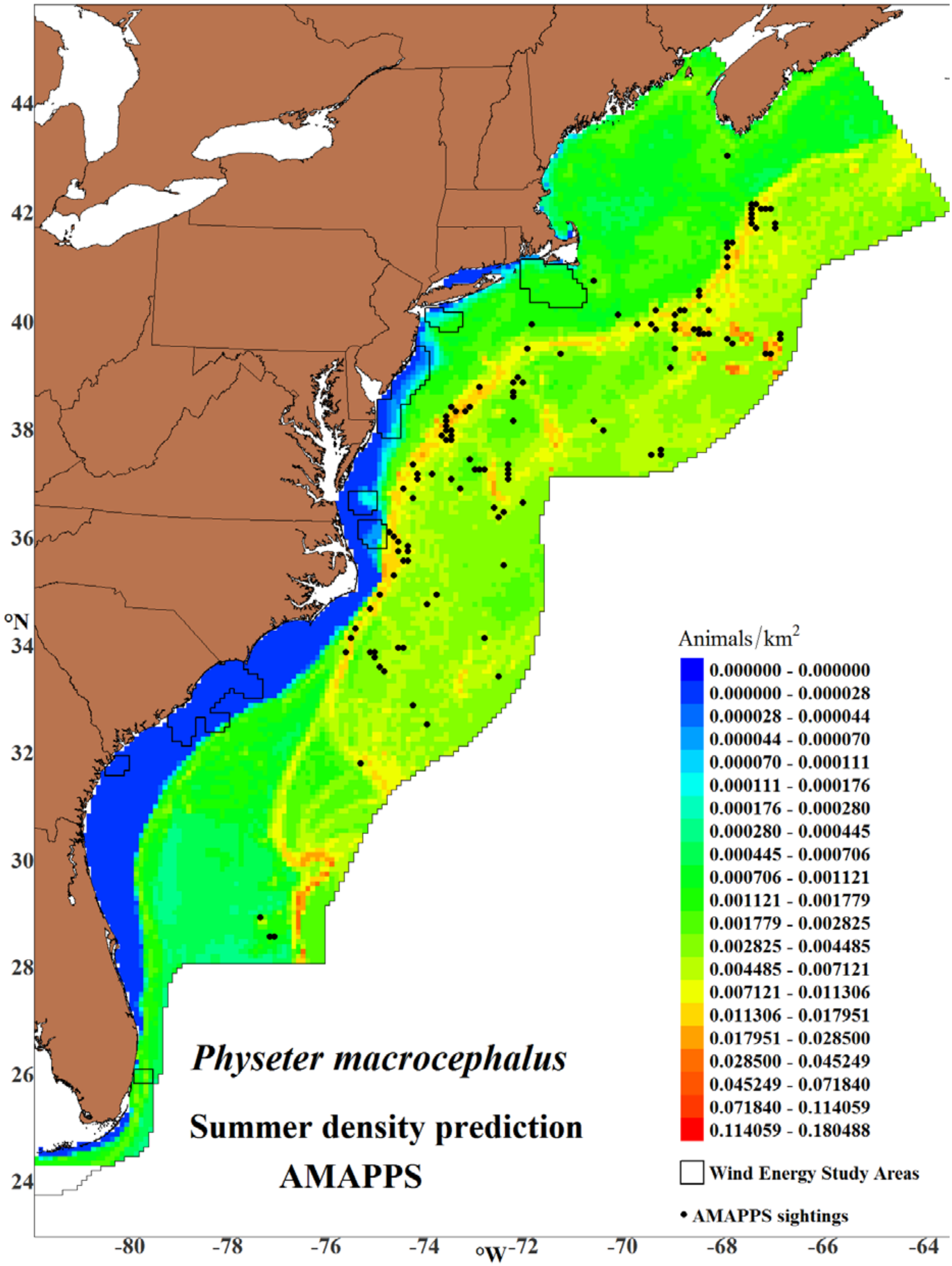

Figure 6-12 Sperm whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

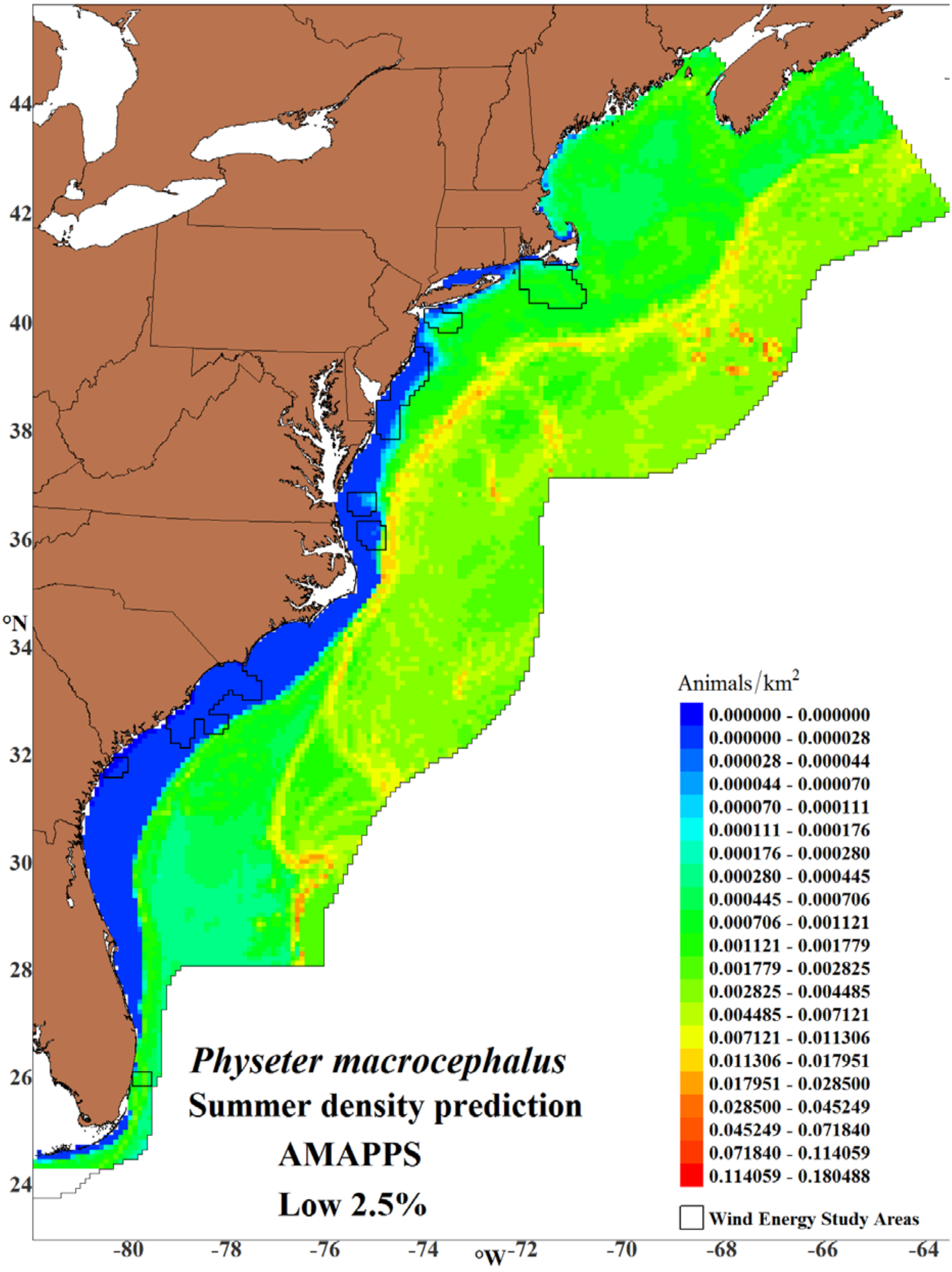

Figure 6-13 Lower 2.5% percentile of summer sperm whale estimates

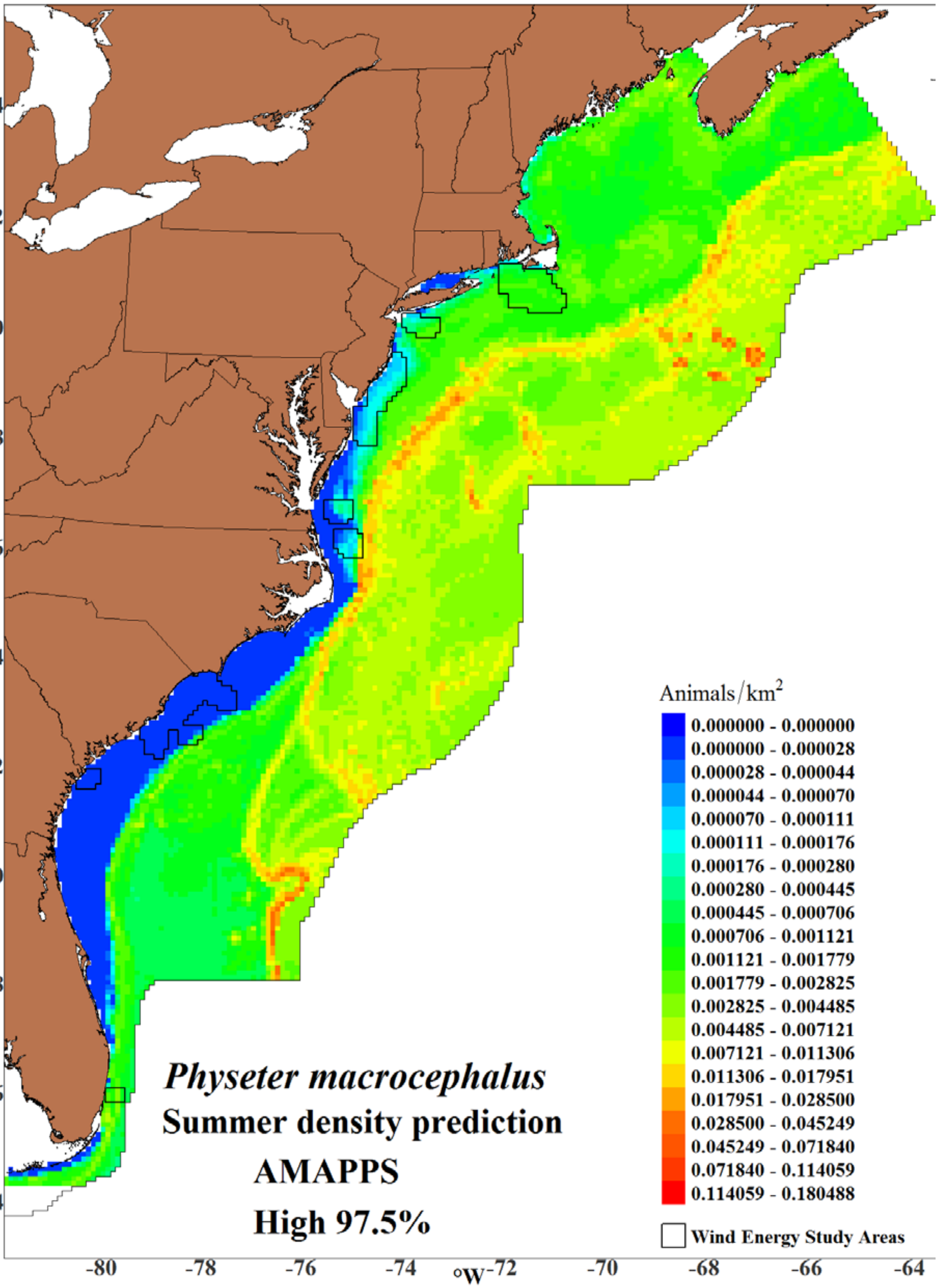

Figure 6-14 Upper 97.5% percentile of summer sperm whale estimates

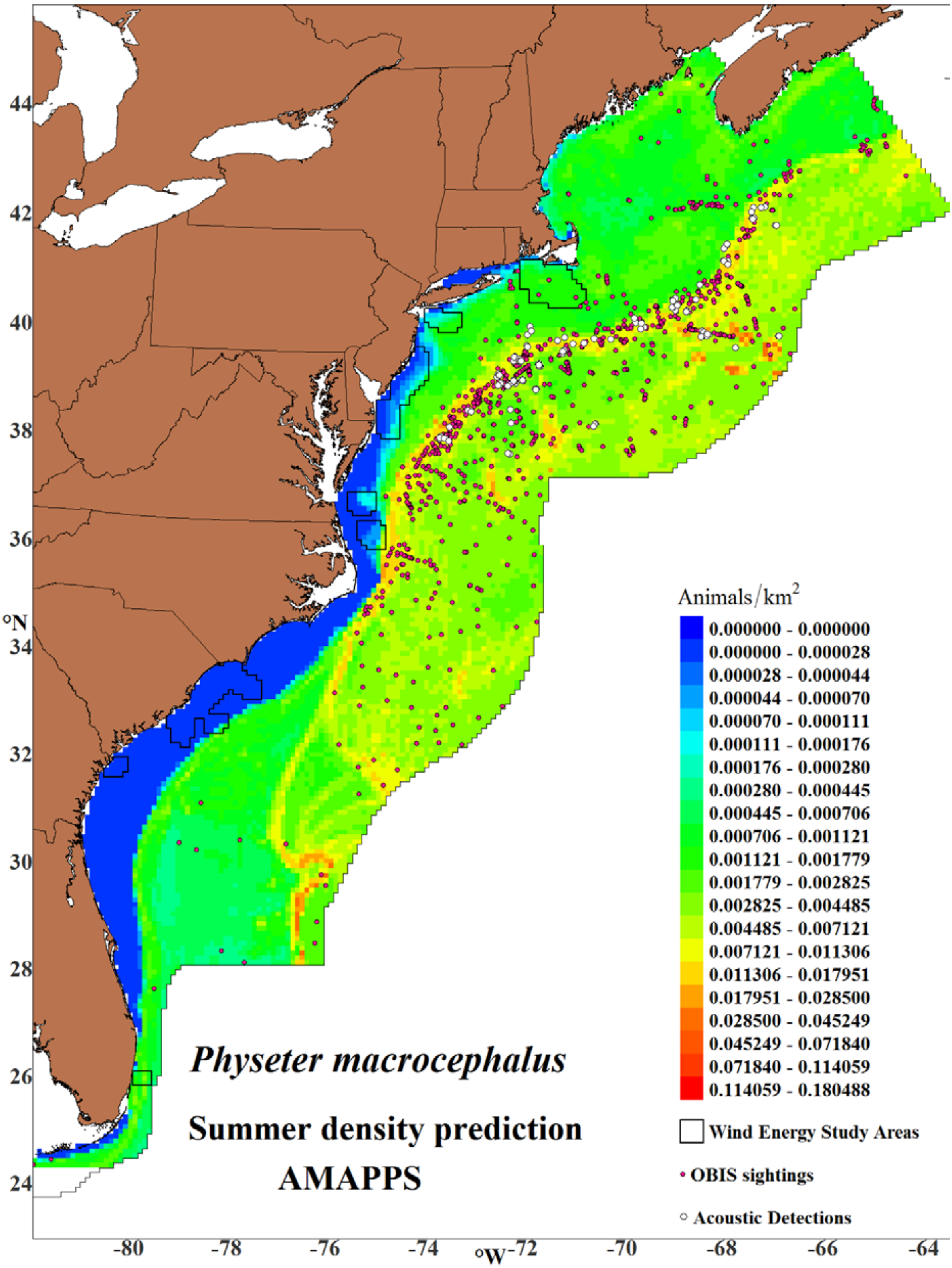

Figure 6-15 Sperm whale 2010-2013 summer density and 1970-2013 OBIS sightings
Pink circles (Halpin *et al*. 2009), and passive acoustic detections from the 2013 NEFSC towed hydrophone array survey (white circles). These sightings were not used to develop the density-habitat model.

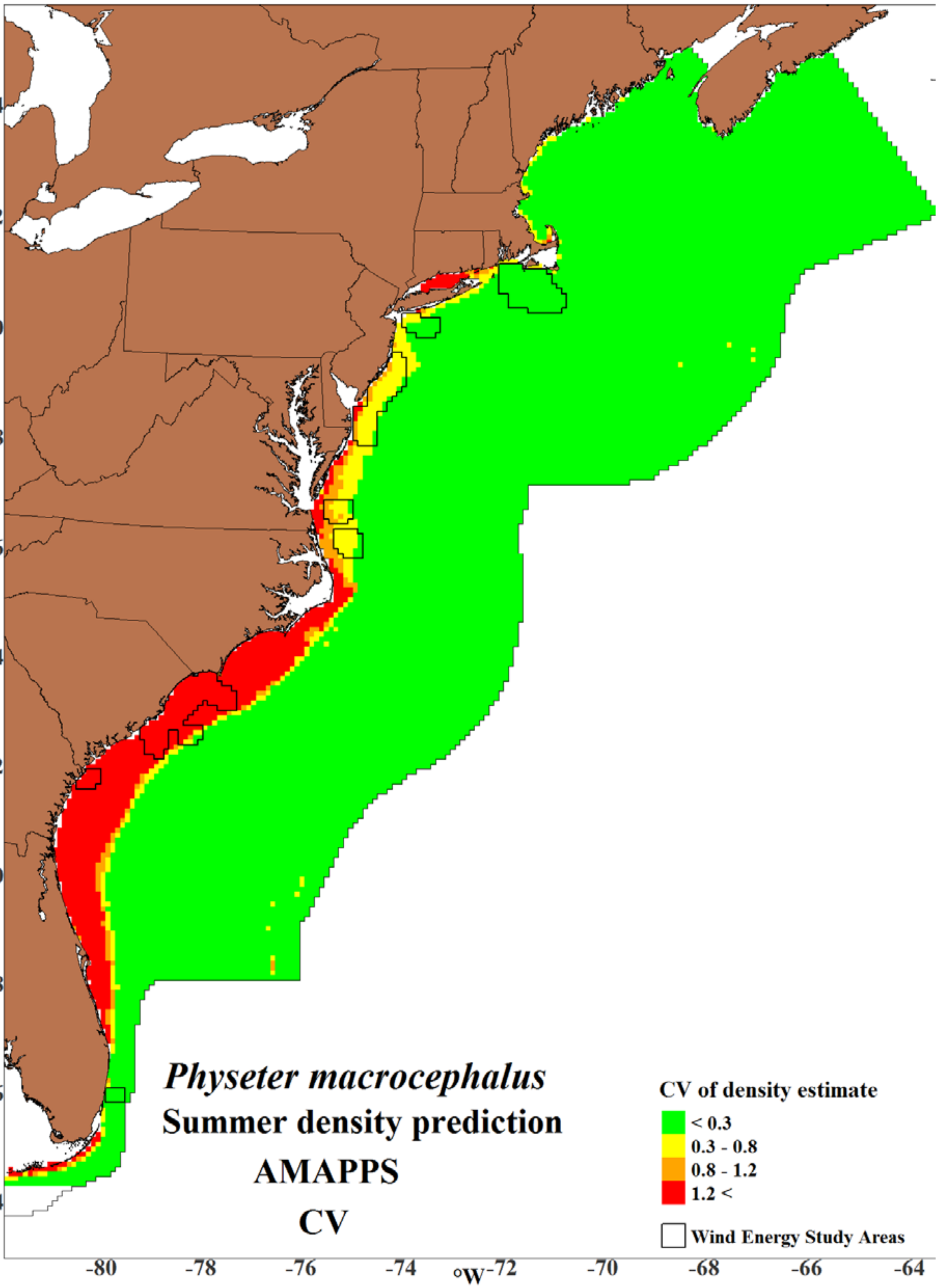

Figure 6-16 CV of summer density estimates for sperm whales

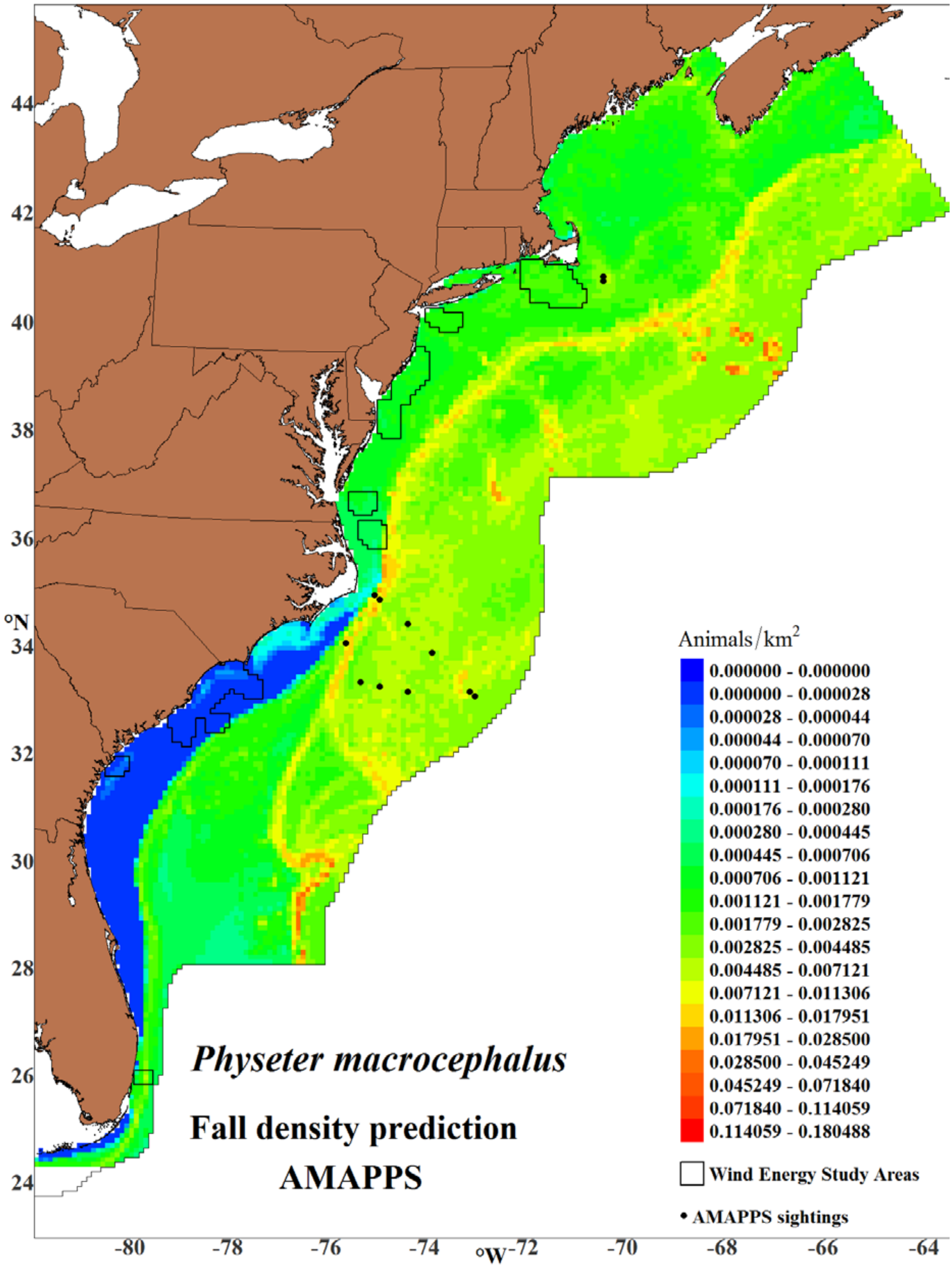

Figure 6-17 Sperm whale fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

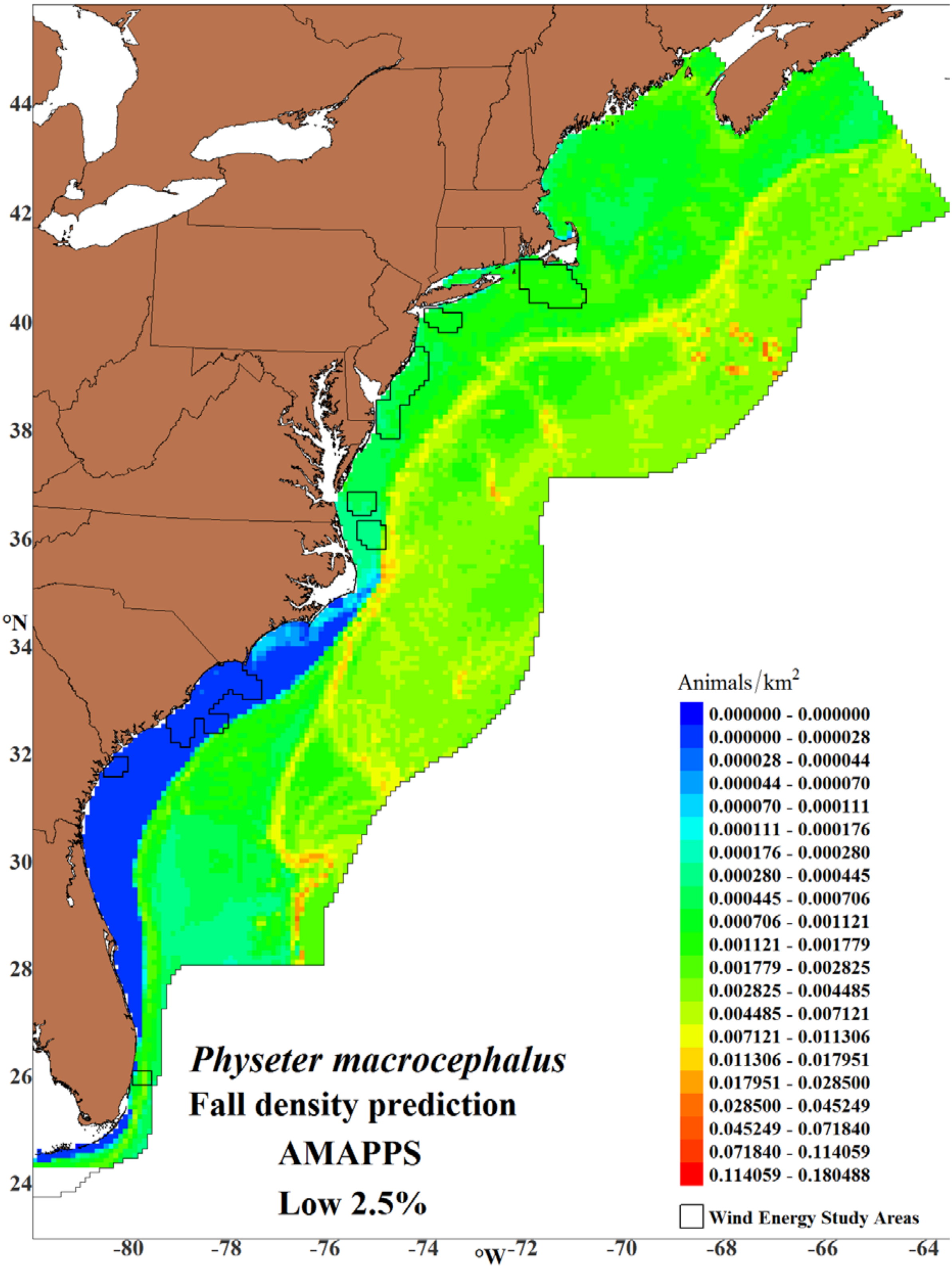

Figure 6-18 Lower 2.5% percentile of fall sperm whale estimates

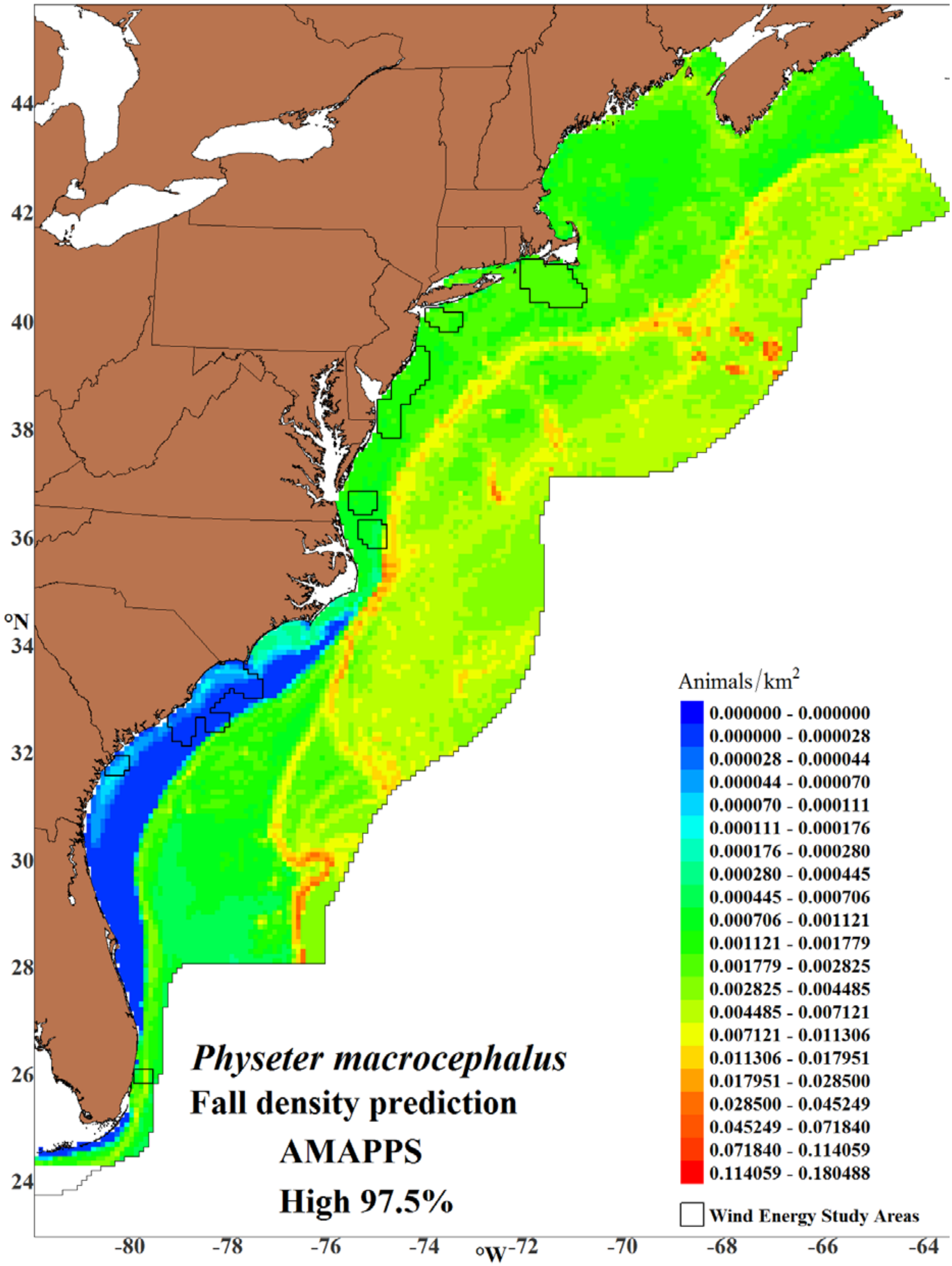

Figure 6-19 Upper 97.5% percentile of fall sperm whale estimates

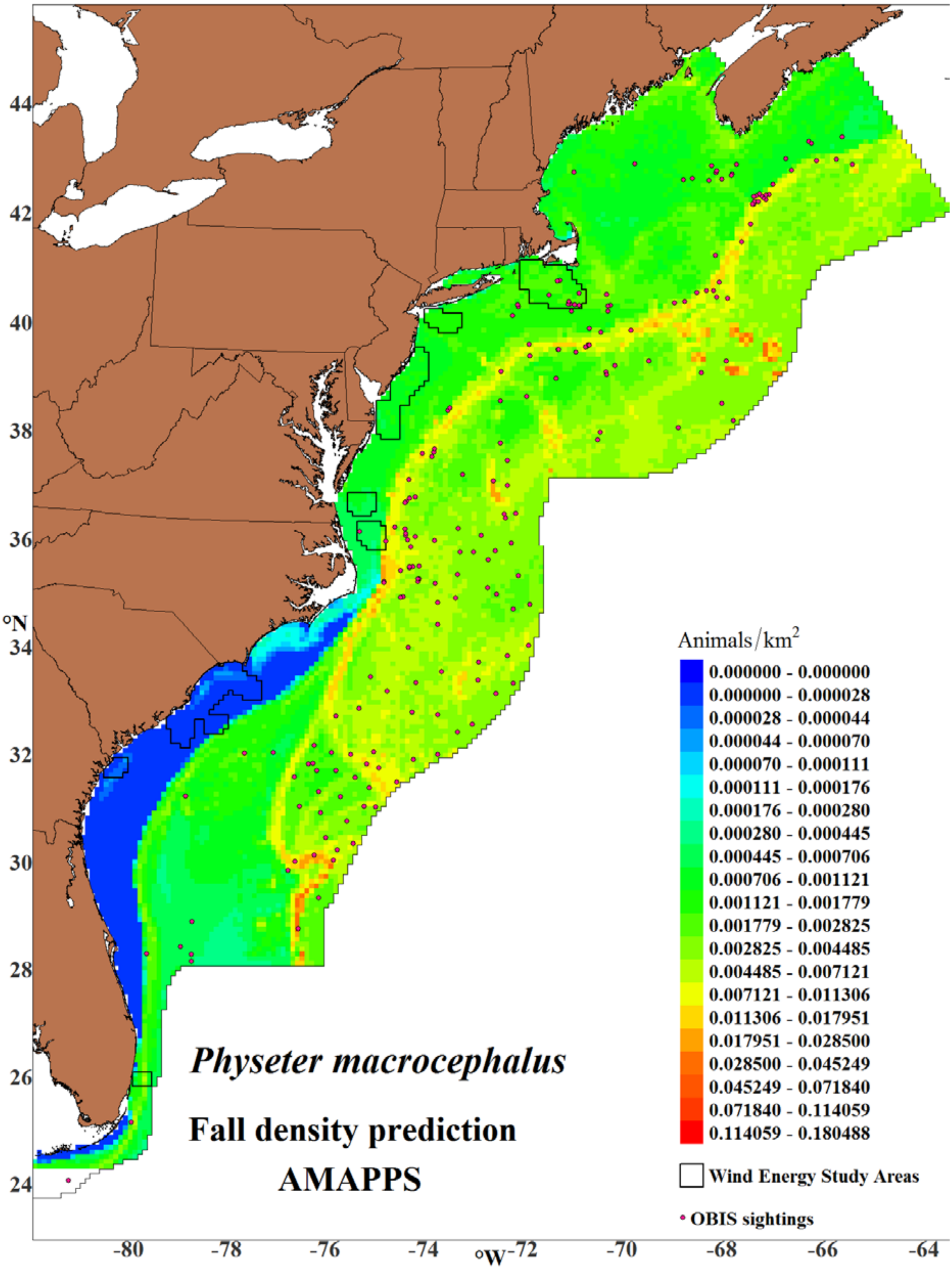

Figure 6-20 Sperm whale 2010-2013 fall density and 1970-2013 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

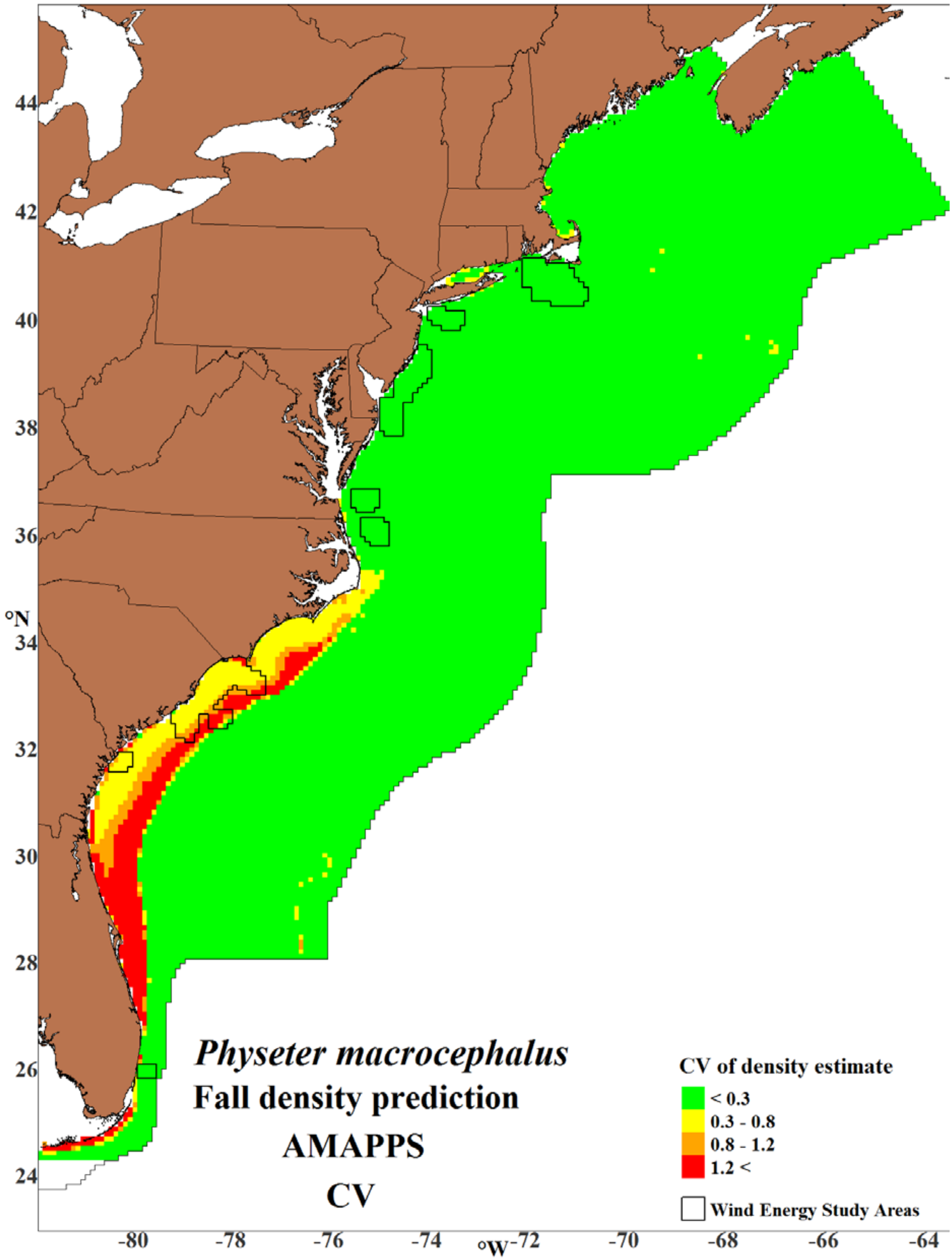

Figure 6-21 CV of fall density estimates for sperm whales

6.6 Wind Energy Study Areas

Table 6-6 Sperm whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.145, CV=0.005; shipboard 0.613, CV= 0.247.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	11	0.145	8 - 14
(March-May)	New York	3	0.198	2 - 4
	New Jersey	10	0.147	8 - 14
	Delaware/ Maryland	7	0.133	5 - 9
	Virginia	7	0.129	5 - 9
	North Carolina	15	0.136	12 - 20
	South Carolina/ North Carolina	6	0.238	4 - 10
	Georgia	1	0.274	0 - 1
	Florida	2	0.104	1 - 2
Summer	Rhode Island/ Massachusetts	15	0.122	12 - 20
(June-August)	New York	2	0.176	1 - 3
	New Jersey	1	0.374	0 - 1
	Delaware/ Maryland	0	0.391	0 - 1
	Virginia	0	0.413	0 - 0
	North Carolina	3	0.13	2 - 3
	South Carolina/ North Carolina	0	0.166	0 - 0
	Georgia	0	2.731	0 - 0
	Florida	2	0.116	1 - 2
Fall	Rhode Island/ Massachusetts	22	0.117	18 - 28
(September- November)	New York	4	0.172	3 - 5
	New Jersey	7	0.185	5 - 10
	Delaware/ Maryland	4	0.204	2 - 5
	Virginia	2	0.185	1 - 3
	North Carolina	4	0.144	3 - 5
	South Carolina/ North Carolina	0	0.329	0 - 1
	Georgia	0	0.514	0 - 0
	Florida	2	0.105	2 - 3

***** The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model.

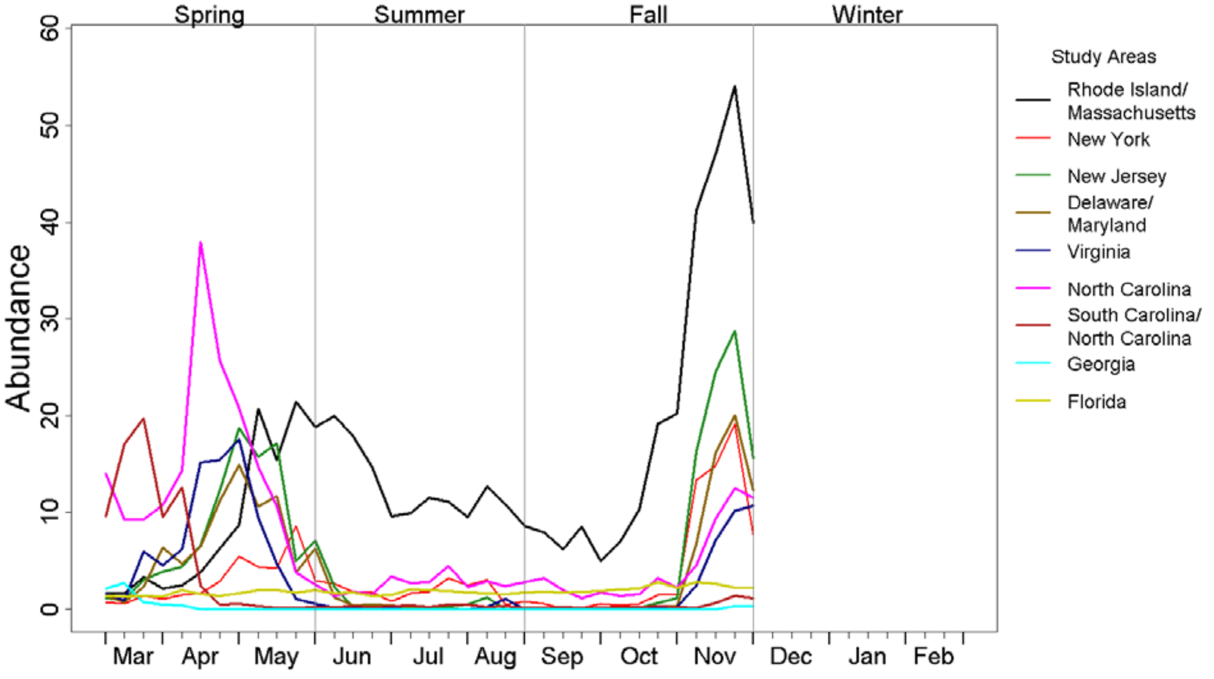

Figure 6-22 Annual abundance trends for sperm whales in wind energy study areas

7 Cuvier’s Beaked Whale (*Ziphius cavirostris*)

Figure 7-1 Cuvier's beaked whale. Credit: NOAA/SEFSC
Image collected under MMPA Research permit #779-1633**.**

7.1 Data Collection

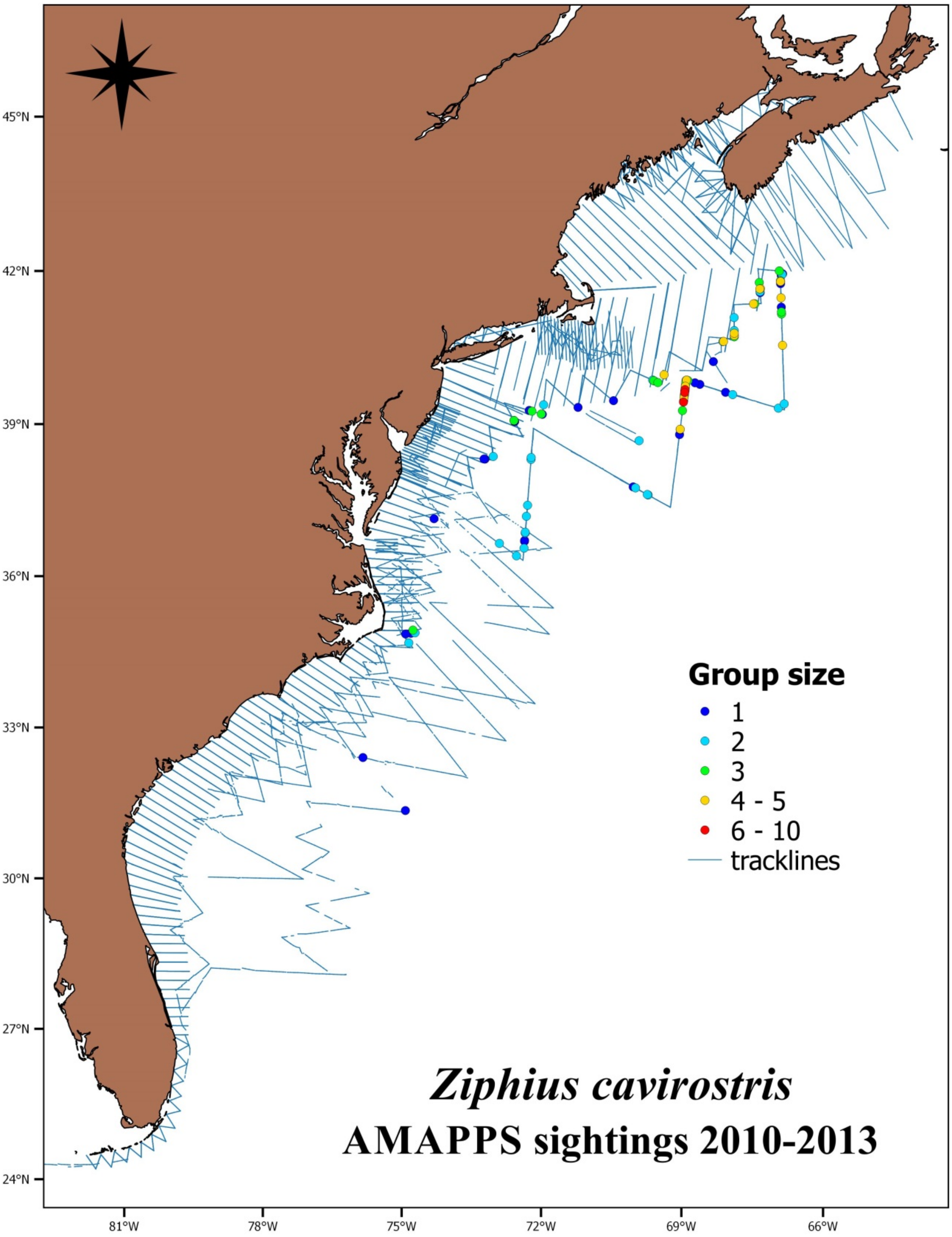

Figure 7-2 Track lines and Cuvier's beaked whale sightings during 2010 - 2013

Table 7-1 Research effort 2010 - 2013 and Cuvier's beaked whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Cuvier’s beaked whale	*Ziphius cavirostris*	0/0	101/246	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	1/1	0/0	0/0	0/0
SE Shipboard	0	8,537	2,093	0	-	-	0/0	2/2	5/9	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	1/1	0/0	0/0	0/0

7.2 Mark-Recapture Distance Sampling Analysis

Table 7-2 Parameter estimates from Cuvier's beaked whale (CBWH) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE-shipboard group 4	-	CBWH,DSWH, GBWH,PSWH, SBWH,UNBW, UNKO	Distance +observer	Distance+ swell+ sea	6000	HR	0.554	0.105	0.564	0.457	0.867
SE-shipboard group 2	-	BBWH,CBWH, DSWH, PSWH, UNBW, UNKO	Distance	Distance	8310	HR	0.355	0.403	0.600	0.909	0.918

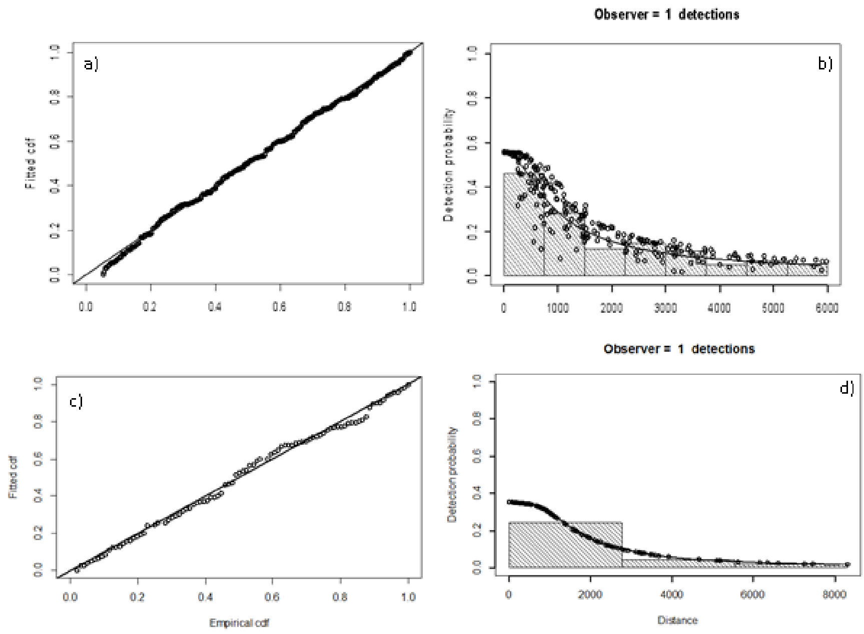

Figure 7-3 Q-Q plots and detection functions from Cuvier's beaked whale MRDS analysis Group 4 shipboard northeast region (a,b) and group 2 shipboard southeast region (c,d).

7.3 Generalized Additive Model Analysis

Table 7-3 Habitat model output for Cuvier's beaked whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	0.6001	4	1.189	0.00409	5.77E-03	**
s(btemp)	0.9606	4	9.169	2.84E-11	6.55E-02	***
s(depth)	1.1752	4	4.908	1.11E-06	6.74E-06	***
s(slope)	0.9357	4	10.368	1.76E-11	1.05E-02	***
s(lat)	1.0479	4	14.662	< 2e-16	3.17E-02	***
Scale	-	-	-	-	7.28E-01	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: Total = 9.3

R^2 (adjusted) = 0.0414 Deviance explained = 34%

REML = 203.91 Scale estimate = 0.16114 sample size = 2375

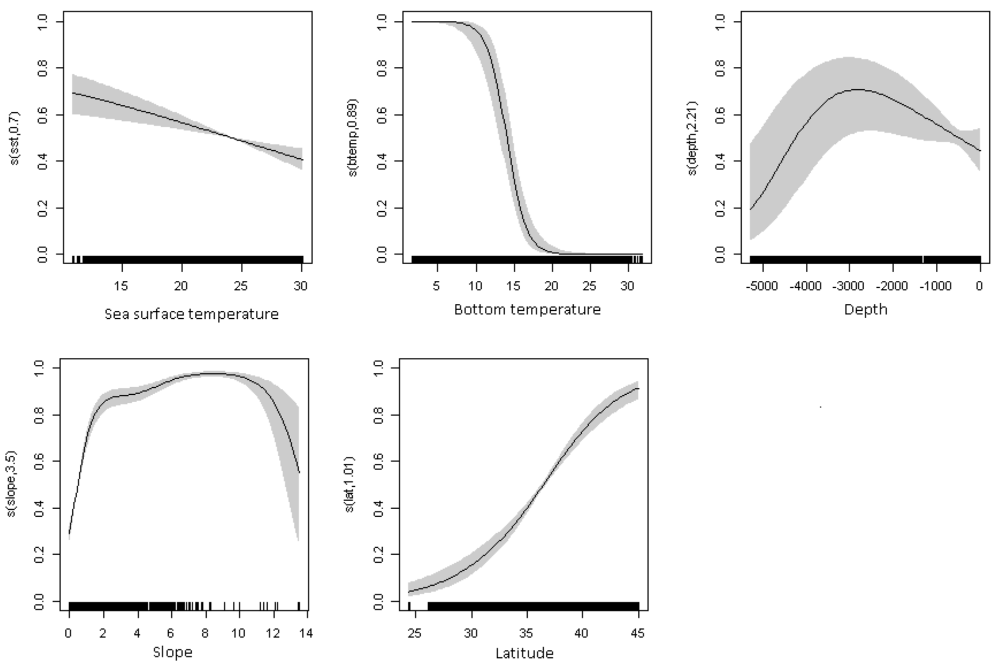

Figure 7-4 Cuvier's beaked whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 7-4 Diagnostic statistics from Cuvier's beaked whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.09	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	86.03	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.190	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.01	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

7.4 Abundance Estimates for AMAPPS Study Area

Table 7-5 Cuvier's beaked whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.142, CV=0.462; shipboard 0.7644, CV= 0.246.

Season	Abundance	CV	95% Confidence Interval
Summer (June-August)	3,425	0.302	1,920 – 6,108

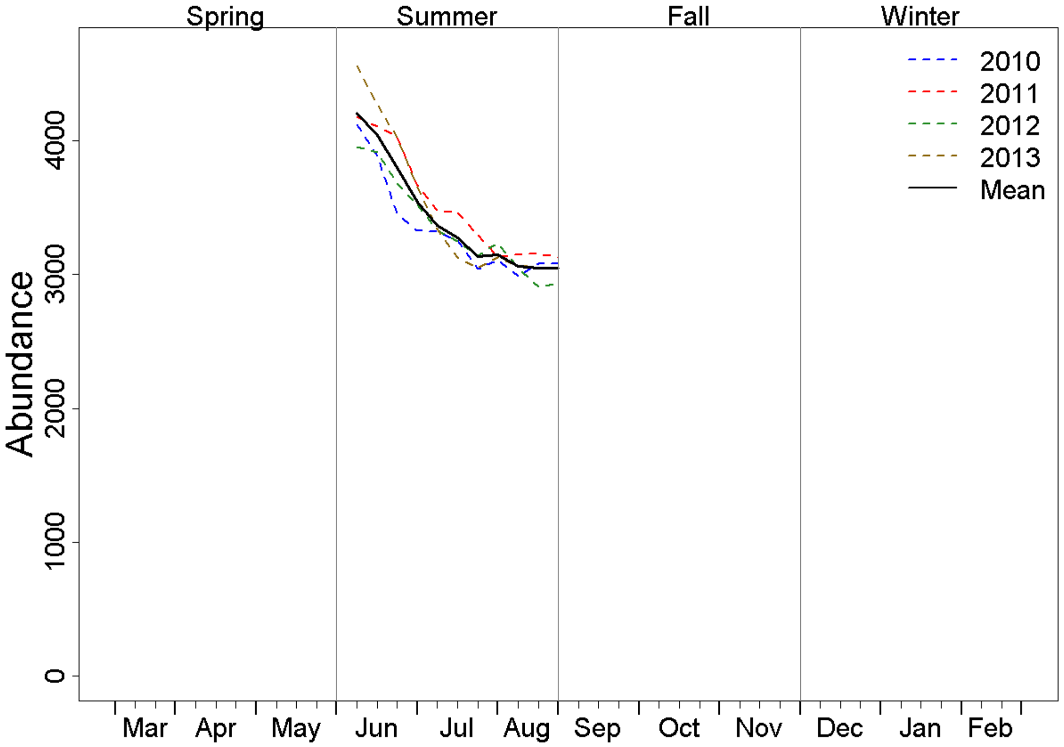

Figure 7-5 Annual abundance trends for Cuvier's beaked whales for AMAPPS study area

7.5 Seasonal Prediction Maps

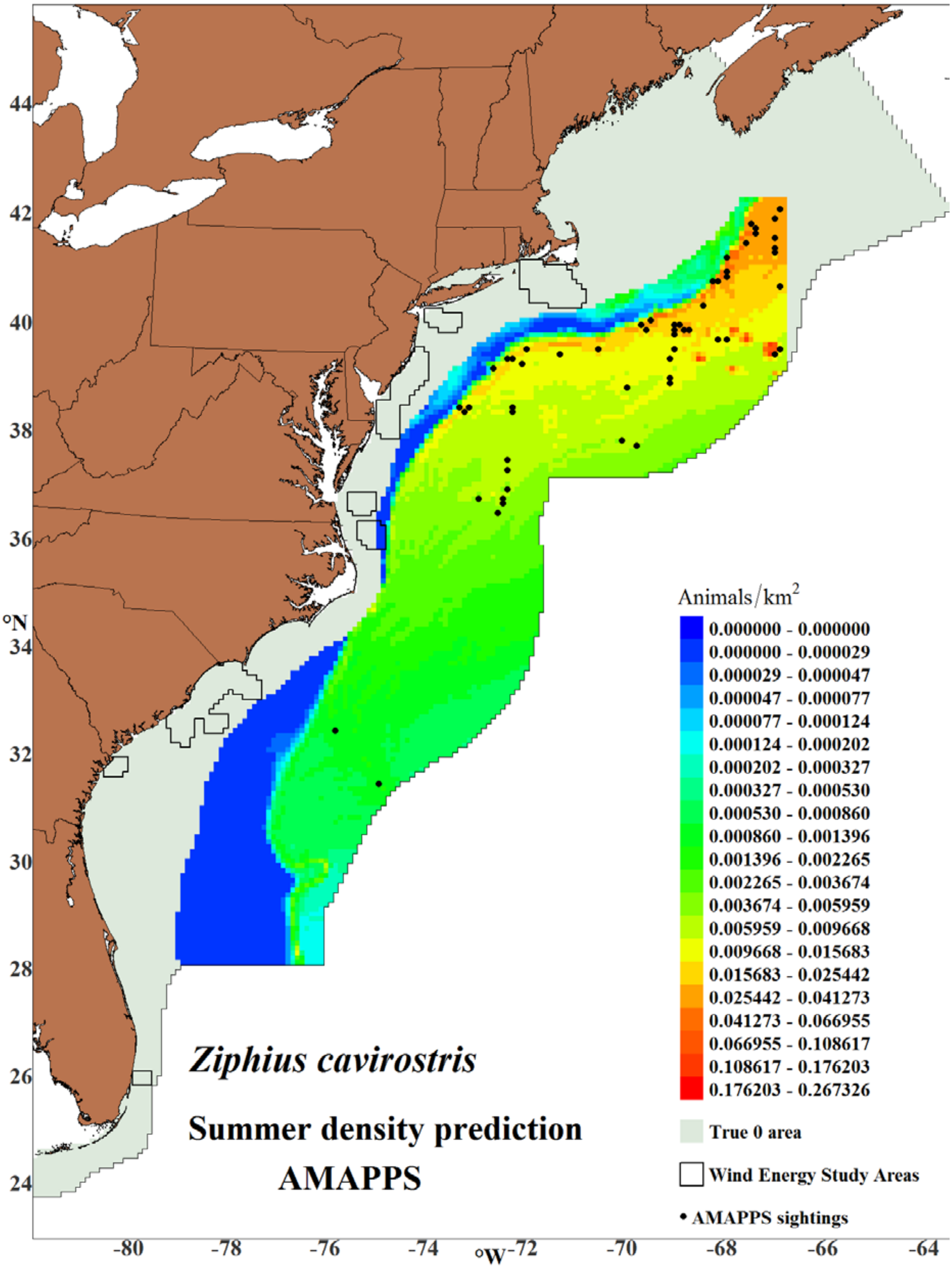

Figure 7-6 Cuvier's beaked whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

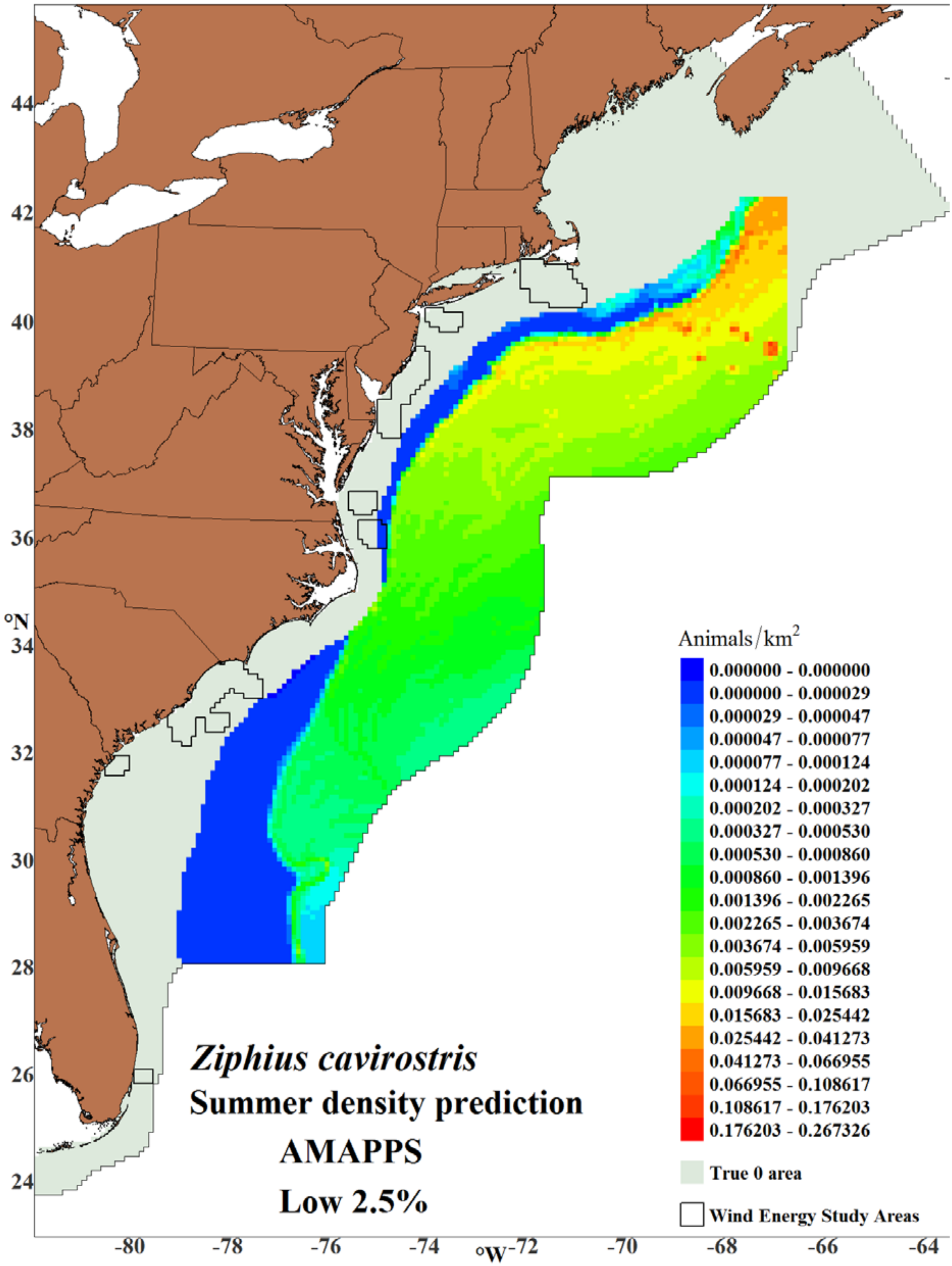

Figure 7-7 Lower 2.5% percentile of summer Cuvier's beaked whale estimates

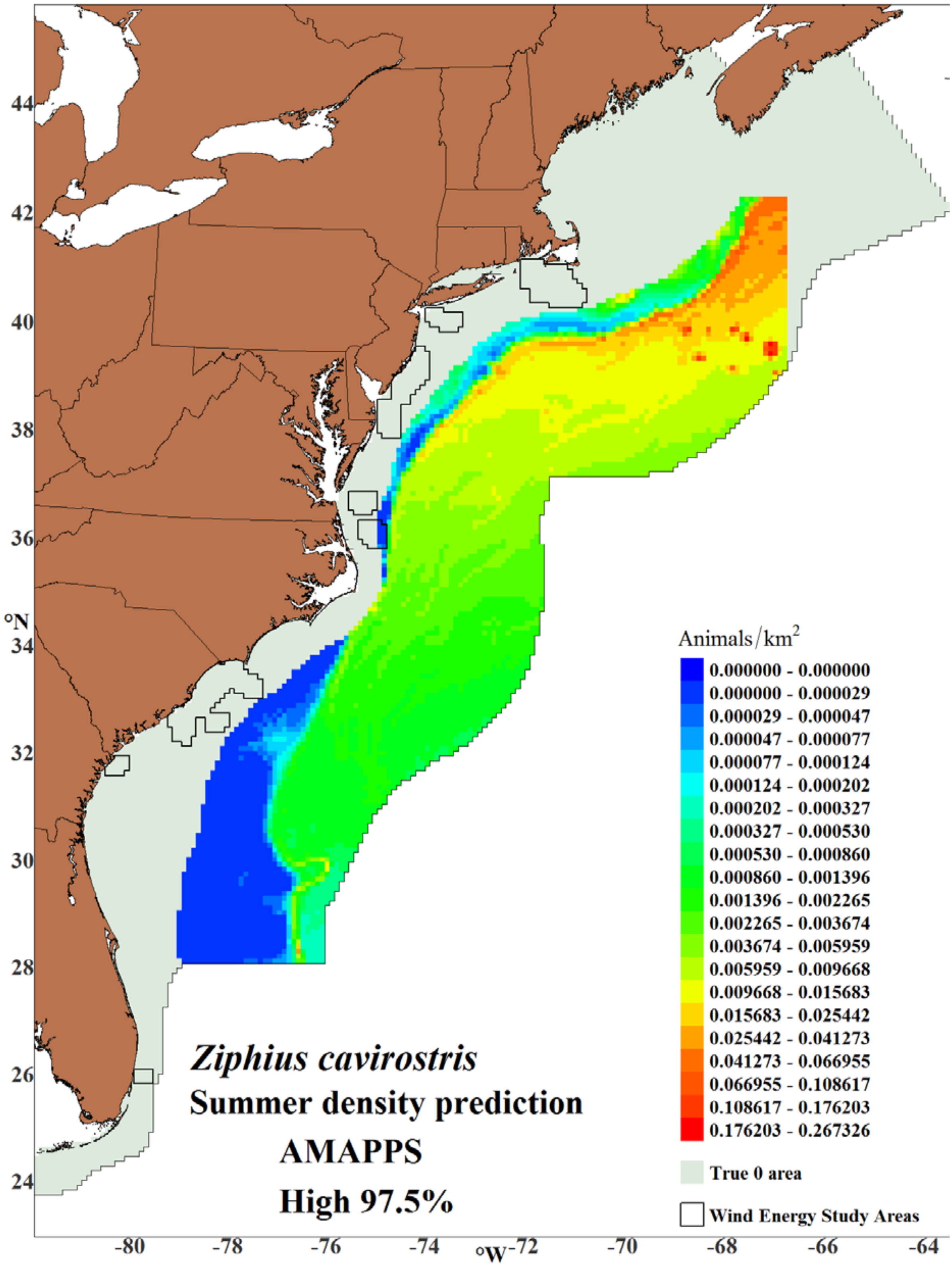

Figure 7-8 Upper 97.5% percentile of summer Cuvier's beaked whale estimates

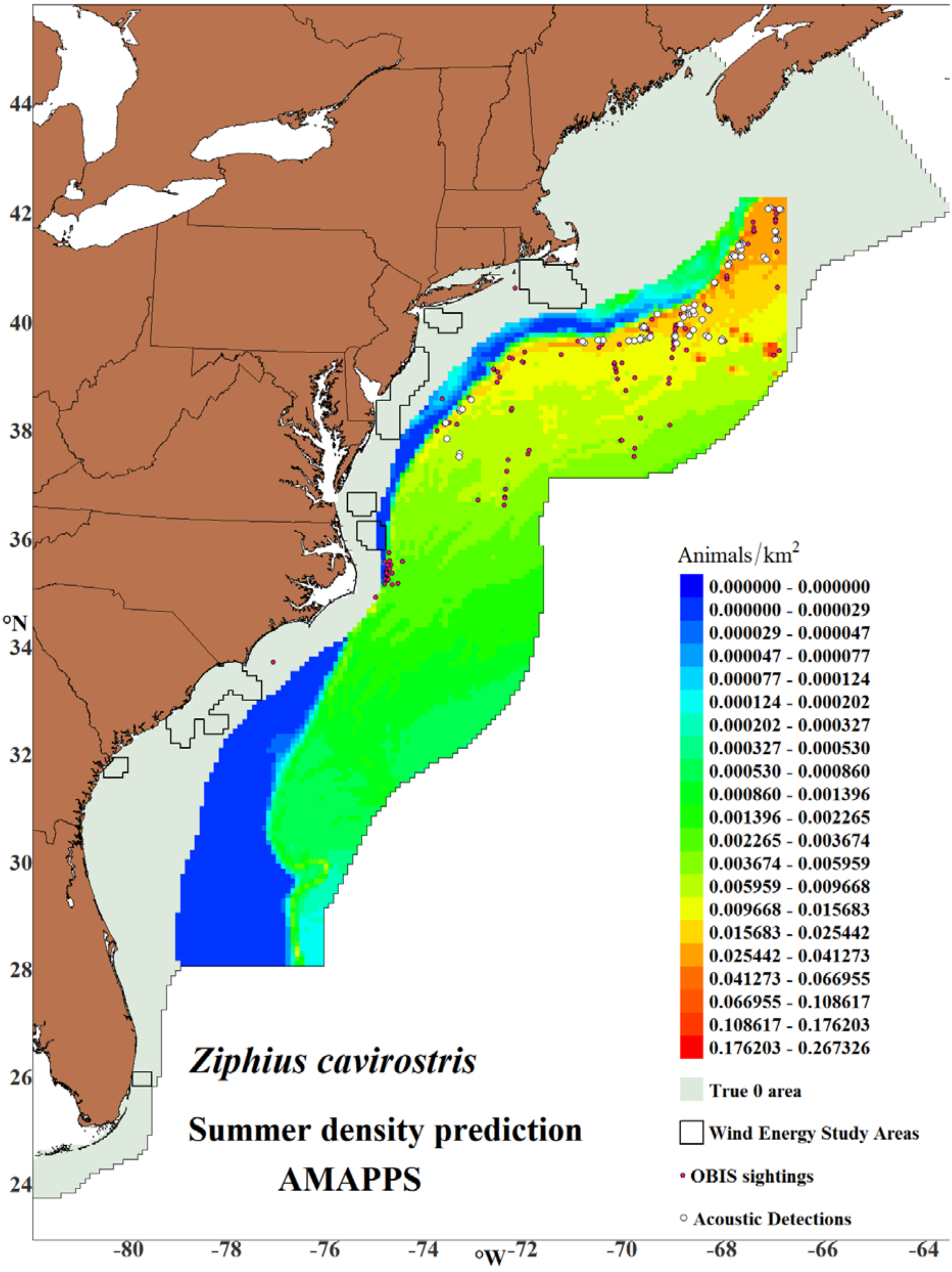

Figure 7-9 Cuvier's beaked whale 2010-2013 summer density and 1970-2013 OBIS sightings
Pink circles (Halpin *et al*. 2009), and passive acoustic detections from the 2013-2015 NEFSC towed hydrophone array surveys (white circles). These sightings were not used to develop the density-habitat model.

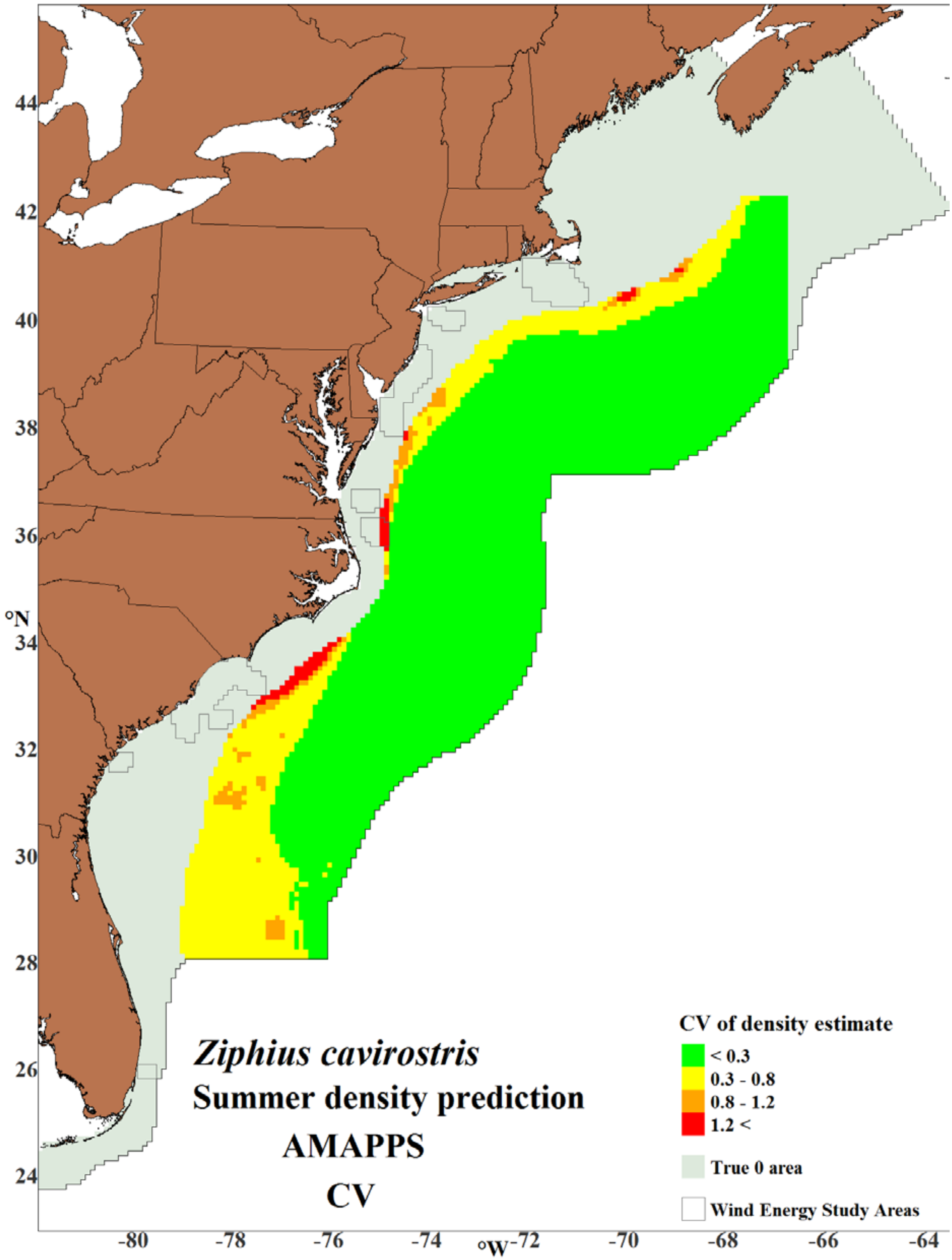

Figure 7-10 CV of summer density estimates for Cuvier's beaked whales

7.6 Wind Energy Study Areas

Table 7-6 Cuvier's beaked whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.142, CV=0.462; shipboard 0.7644, CV= 0.246.

Season	Area	Abundance*	CV	95% Confidence Interval
Summer	Rhode Island/ Massachusetts	N/A	-	-
(June-August)	New York	N/A	-	-
	New Jersey	N/A	-	-
	Delaware/ Maryland	N/A	-	-
	Virginia	N/A	-	-
	North Carolina	0	1.801	0 - 0
	South Carolina/ North Carolina	N/A	-	-
	Georgia	N/A	-	-
	Florida	N/A	-	-

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model. N/A indicates it was assumed to be in the True 0 modeled area.

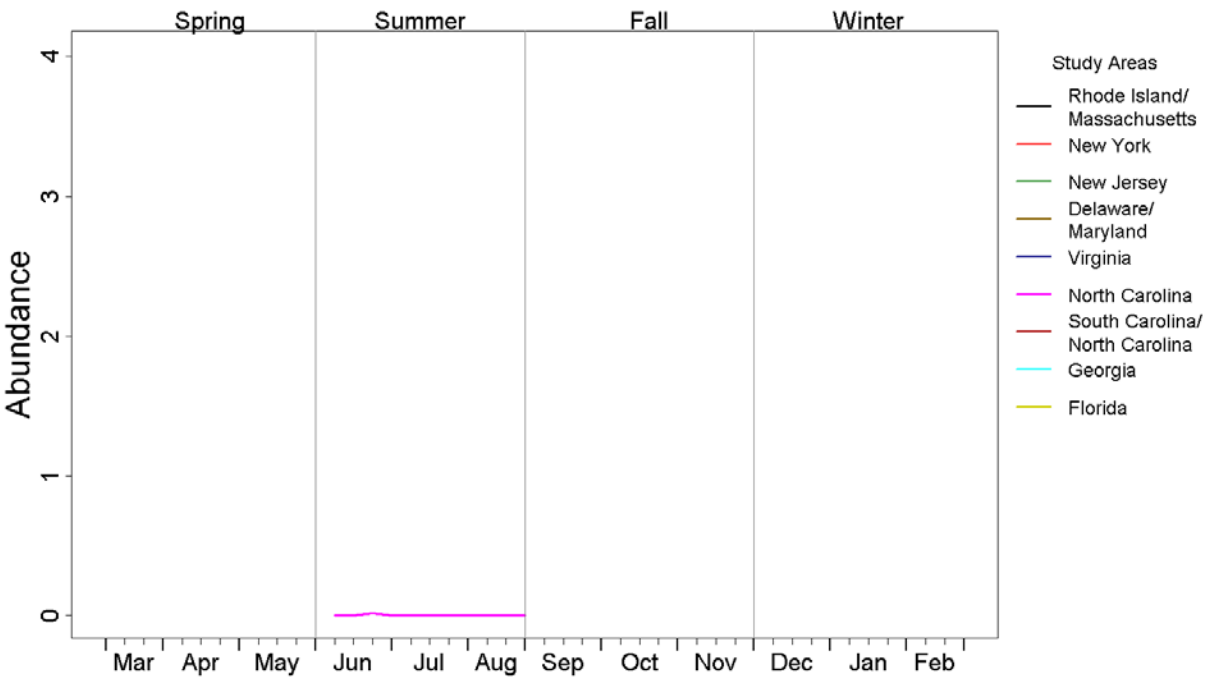

Figure 7-11 Annual abundance trends for Cuvier's beaked whales in wind energy study areas

8 Sowerby's Beaked Whale (*Mesoplodon bidens*)

Figure 8-1 Sowerby's beaked whale. Credit: NOAA/NEFSC/Desray Reeb
Image collected under MMPA Research permit #17355.

8.1 Data Collection

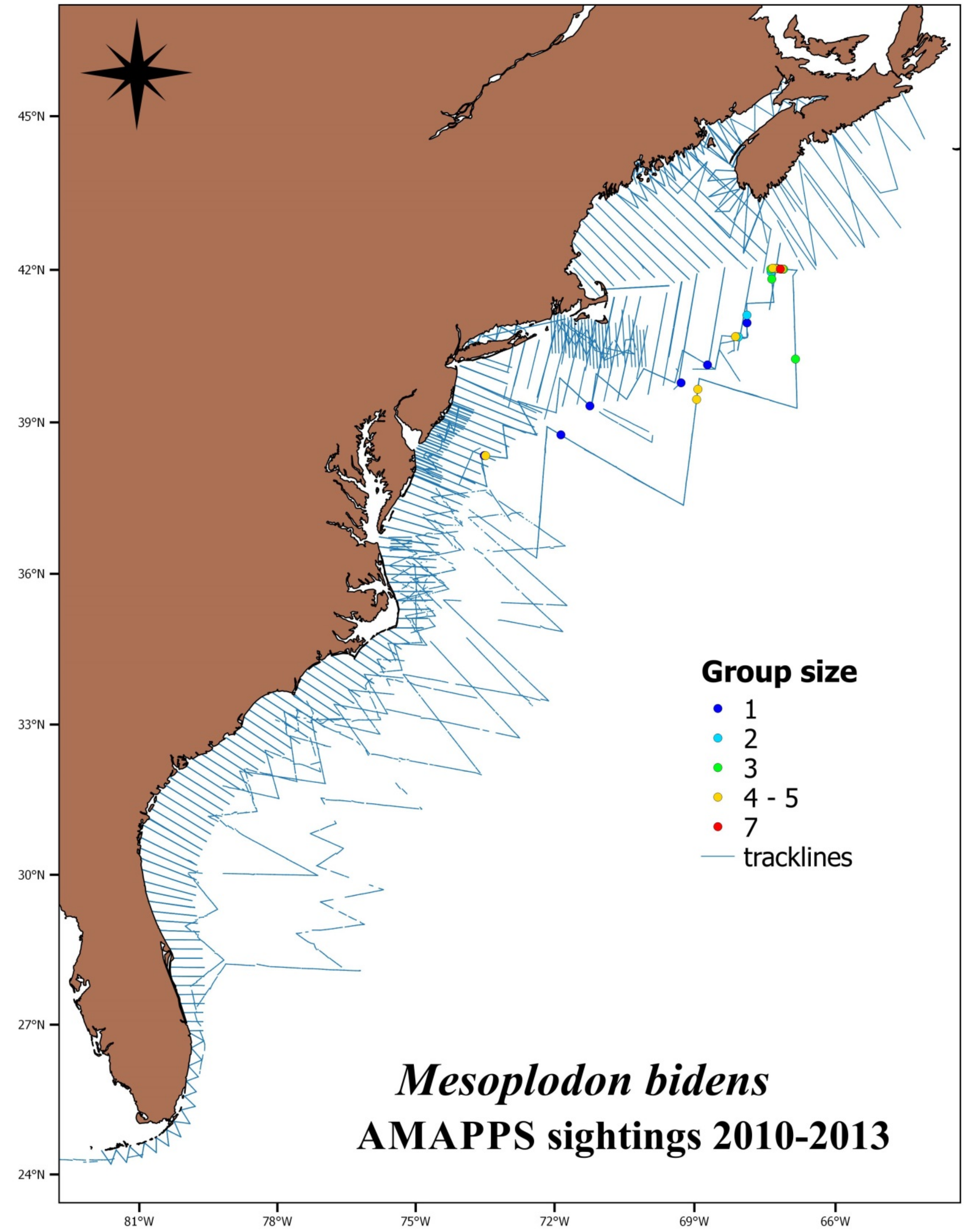

Figure 8-2 Track lines and Sowerby's beaked whale sightings during 2010 - 2013

Table 8-1 Research effort 2010 - 2013 and Sowerby's beaked whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Sowerby's beaked whale	*Mesoplodon bidens*	0/0	27/75	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	0/0	0/0	0/0	0/0
SE Shipboard	0	8,537	2,093	0	-	-	0/0	0/0	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	0/0	0/0	0/0	0/0

8.2 Mark-Recapture Distance Sampling Analysis

Table 8-2 Parameter estimates from Sowerby's beaked whale (SBWH) MRDS analysis
H=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE -shipboard group 4	-	CBWH,DSWH, GBWH,PSWH, SBWH,UNBW, UNKO	Distance+observer	Distance+swell+ sea	6000	HR	0.554	0.105	0.564	0.457	0.867
SE - shipboard group 2	-	BBWH,CBWH, DSWH, PSWH, UNBW, UNKO	Distance	Distance	8310	HR	0.355	0.403	0.600	0.909	0.918

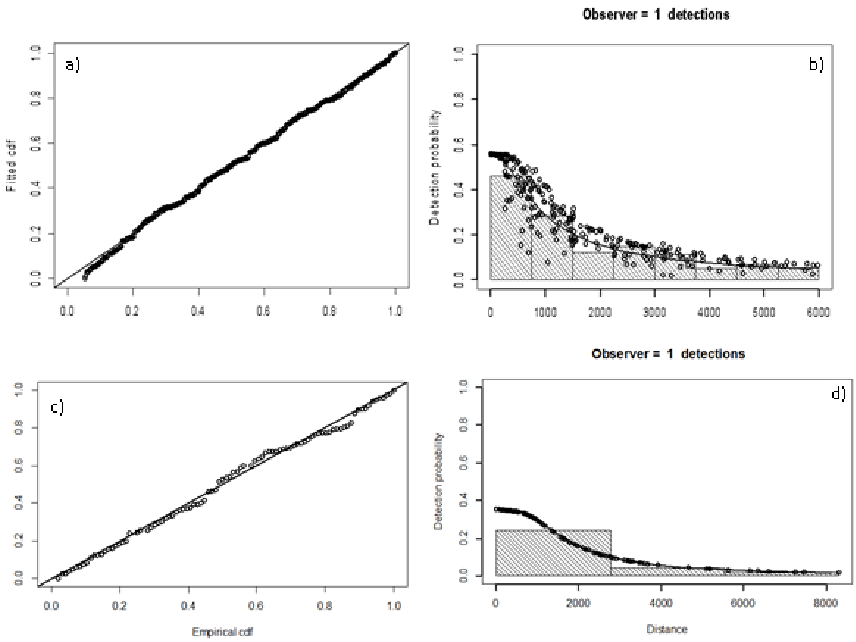

Figure 8-3 Q-Q plots and detection functions from Sowerby's beaked whale MRDS analysis
Group 4 shipboard northeast region (a,b) and group 2 shipboard southeast region (c,d).

8.3 Generalized Additive Model Analysis

Table 8-3 Habitat model output for Sowerby's beaked whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(mld)	0.4144	4	1.319	3.15E-04	3.46E-03	***
s(btemp)	0.8519	4	9.821	8.37E-12	1.19E-02	***
s(sha)	0.731	4	6.051	3.94E-09	1.65E+00	***
s(dist1000)	0.9045	4	11.326	2.24E-13	1.15E-08	***
s(lat)	0.9686	4	30.443	< 2e-16	7.28E-02	***
Scale	-	-	-	-	8.27E-01	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Estimated degrees of freedom: Total = 5.2
R^2 (adjusted) = 0.0677 Deviance explained = 41.1%
REML = 78.473 Scale estimate. = 0.085096 sample size = 2375

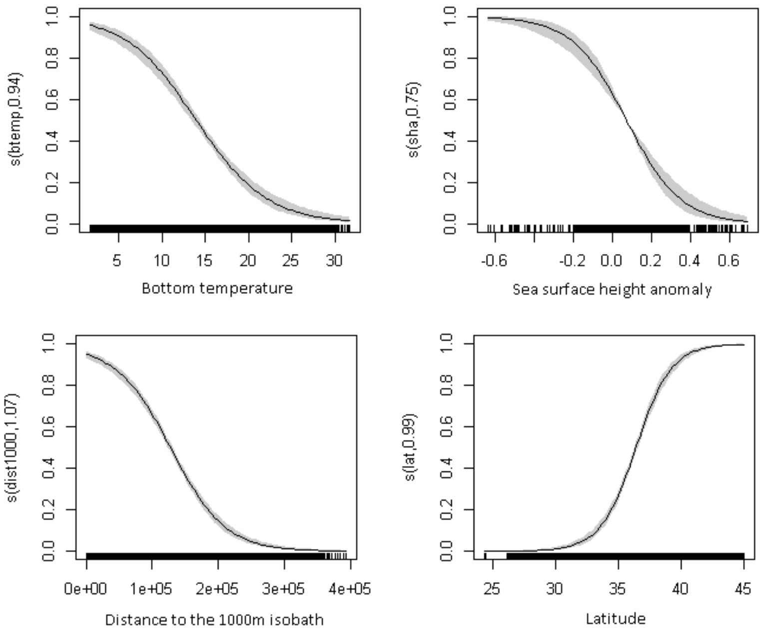

Figure 8-4 Sowerby's beaked whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 8-4 Diagnostic statistics from Sowerby's beaked whale model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.378	Excellent
MAPE	Mean absolute percentage error	Non-zero density	92.23	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.127	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.03	Excellent

The cutoff values are taken from Kinlan et al. 2012.
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

8.4 Abundance Estimates for AMAPPS Study Area

Table 8-5 Sowerby's beaked whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.142, CV=0.462; shipboard 0.7644, CV= 0.246.

Season	Abundance	CV	95% Confidence Interval
Summer (June-August)	679	0.384	328 – 1,405

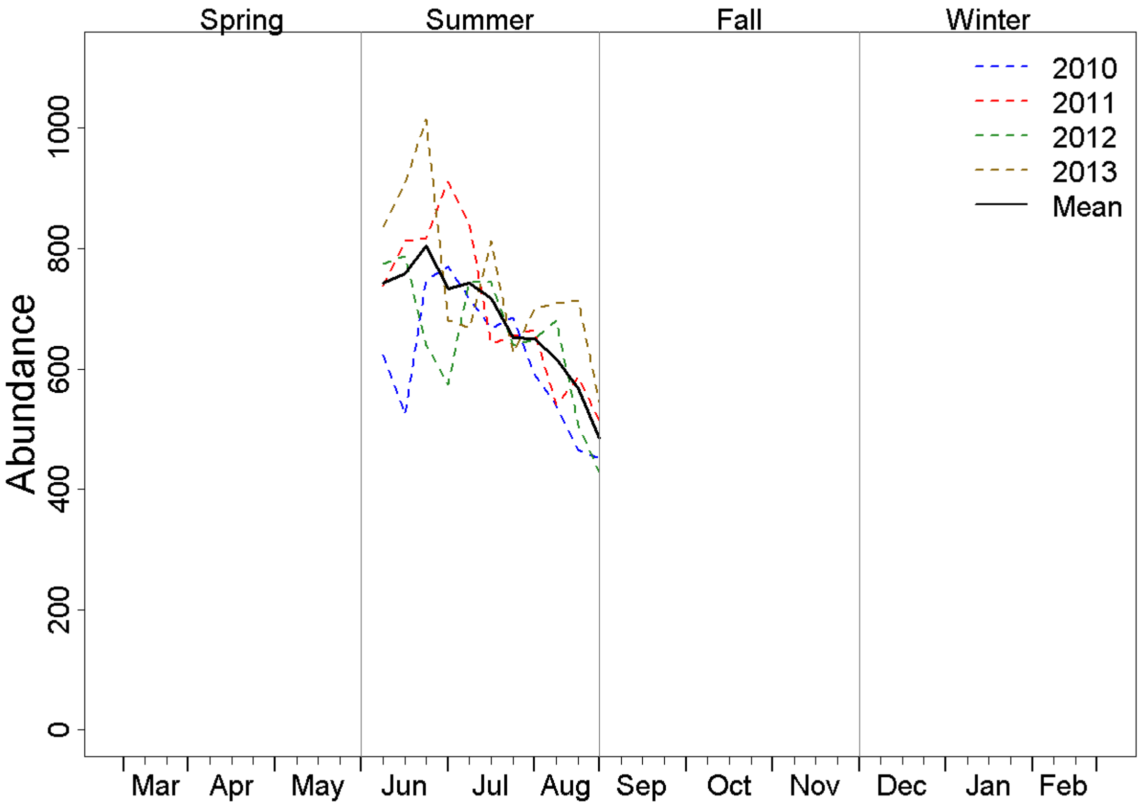

Figure 8-5 Annual abundance trends for Sowerby's beaked whales for AMAPPS study area

8.5 Seasonal Prediction Maps

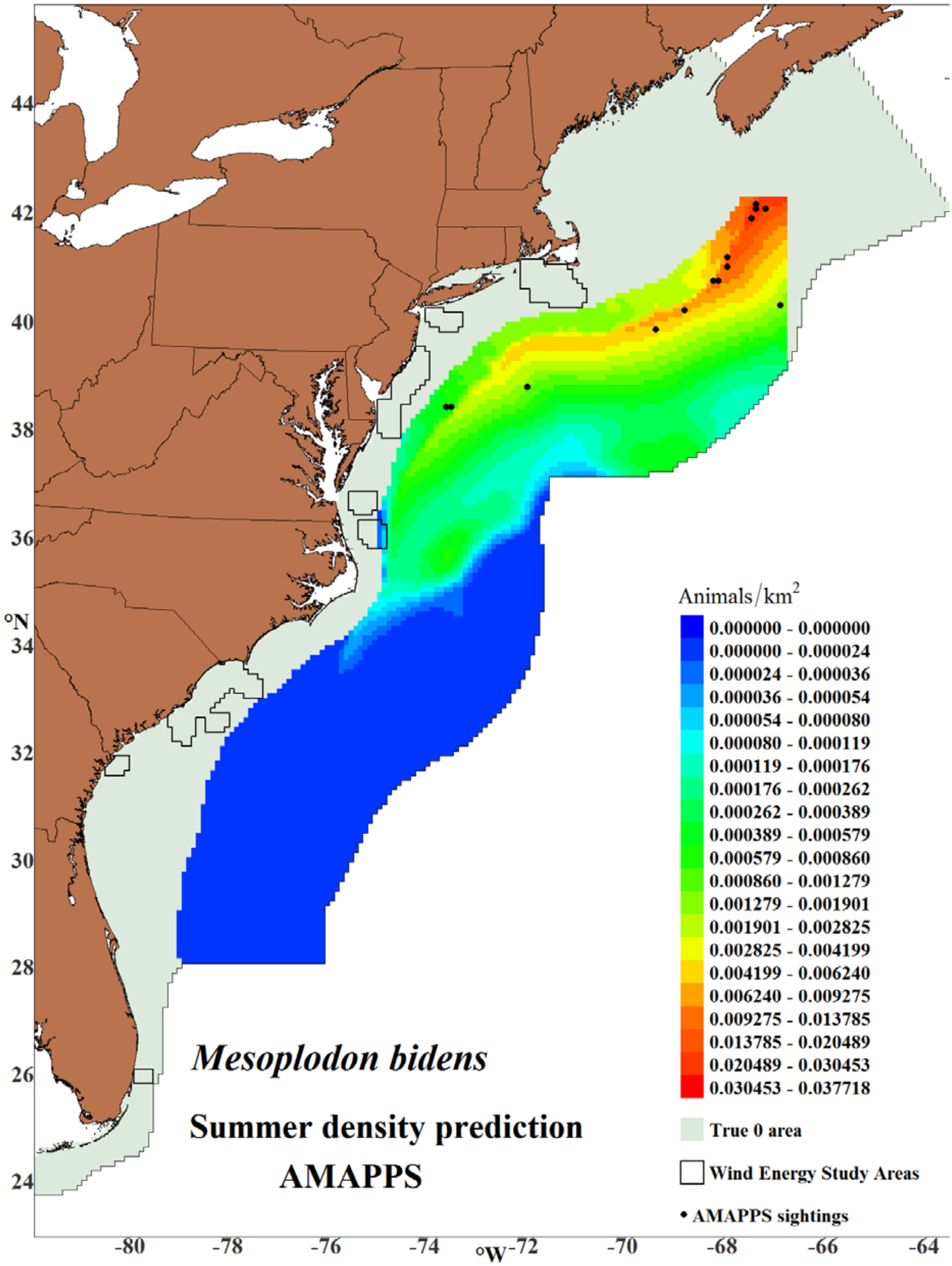

Figure 8-6 Sowerby's beaked whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

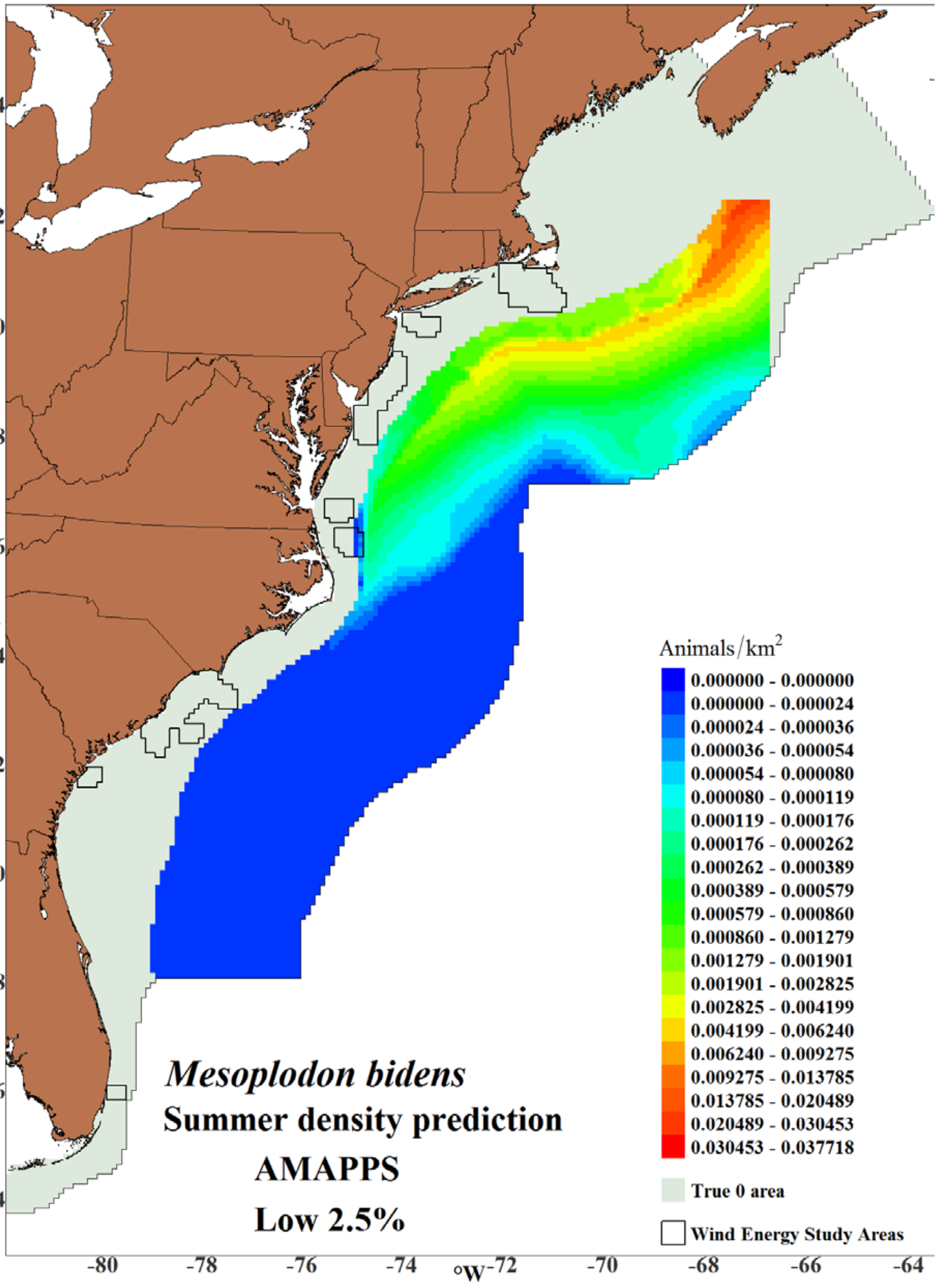

Figure 8-7 Lower 2.5% percentile of summer Sowerby's beaked whale estimates

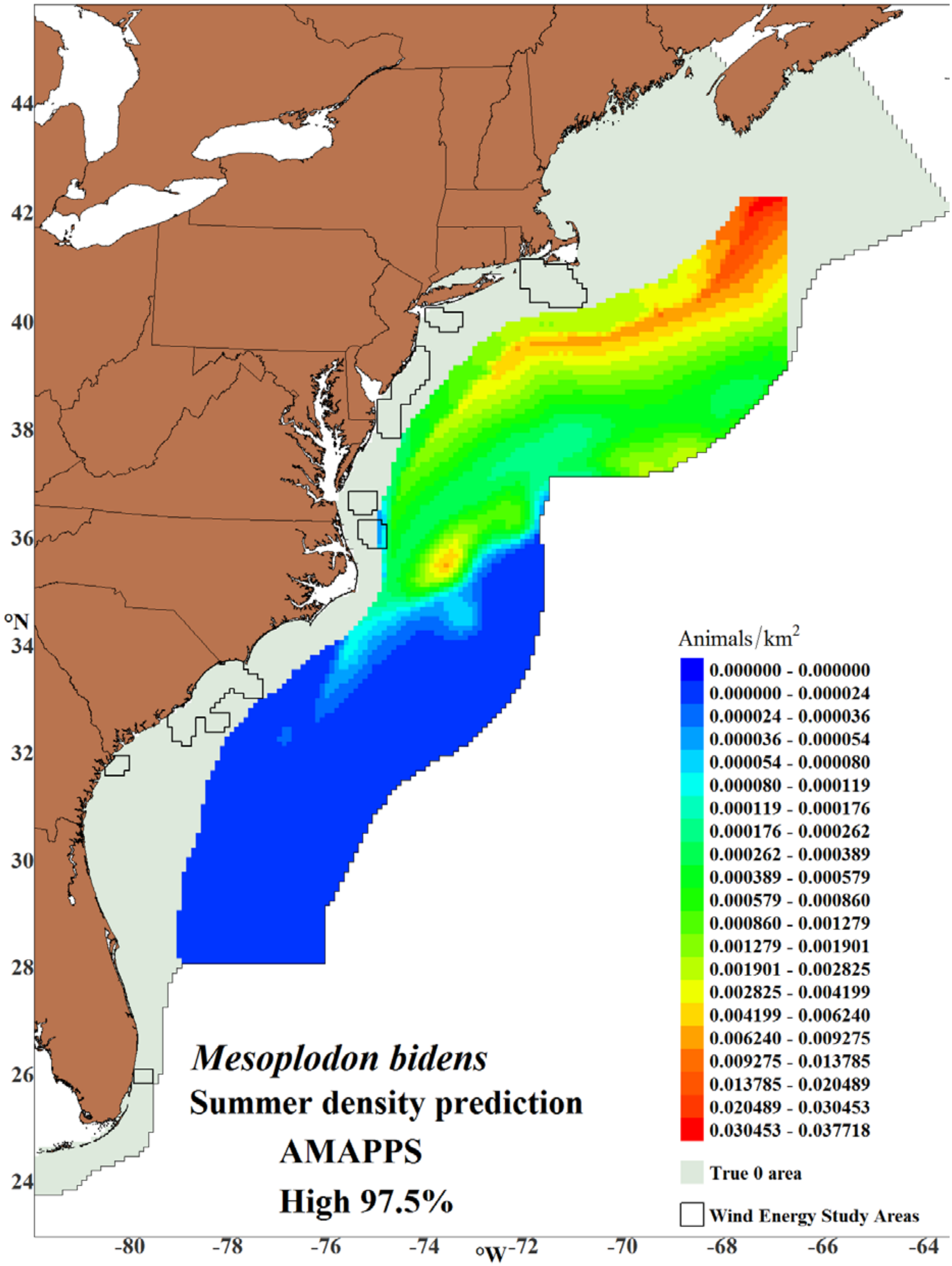

Figure 8-8 Upper 97.5% percentile of summer Sowerby's beaked whale estimates

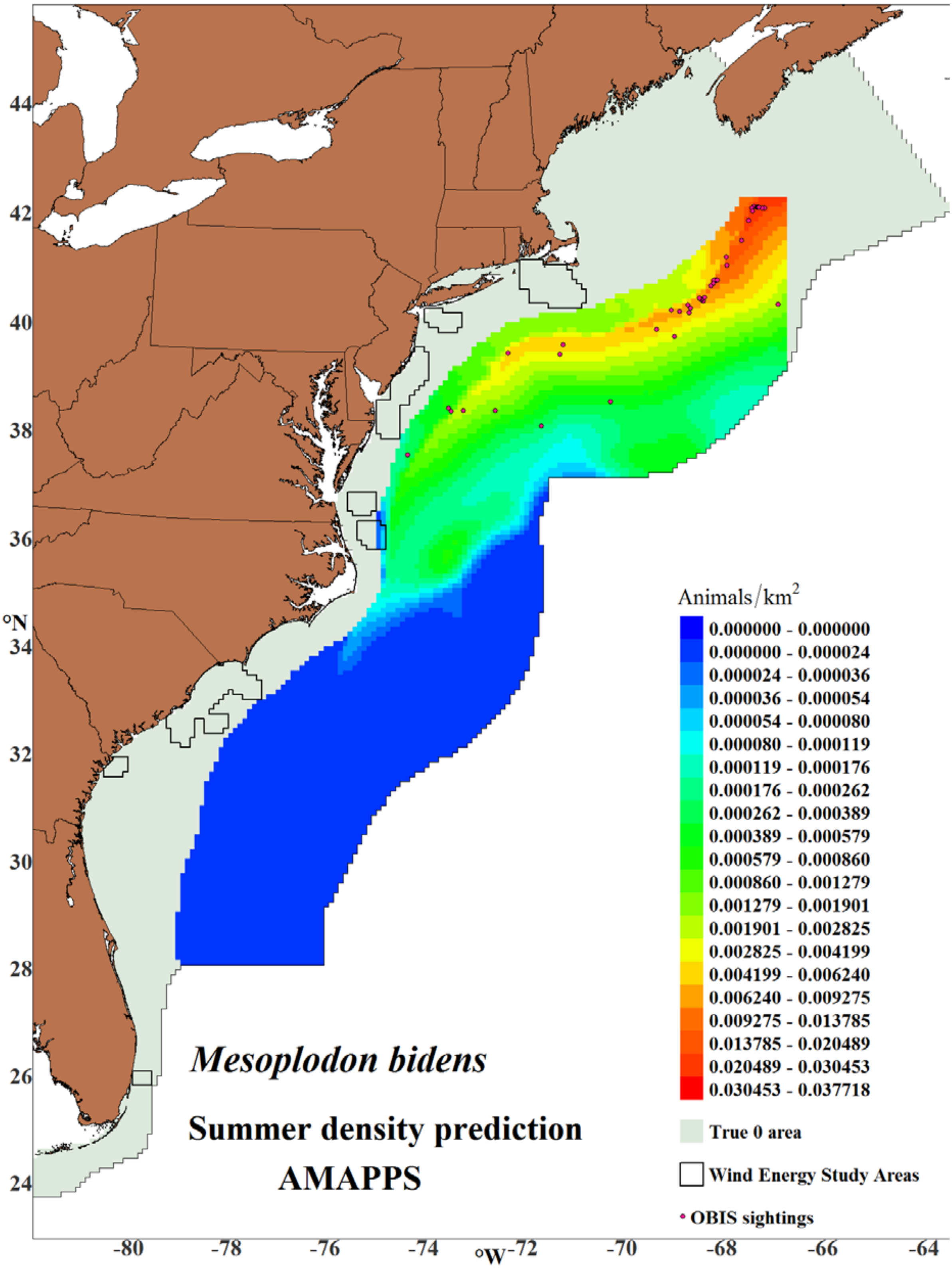

Figure 8-9 Sowerby's beaked whale 2010-2013 summer density and 1995-2014 OBIS sightings Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

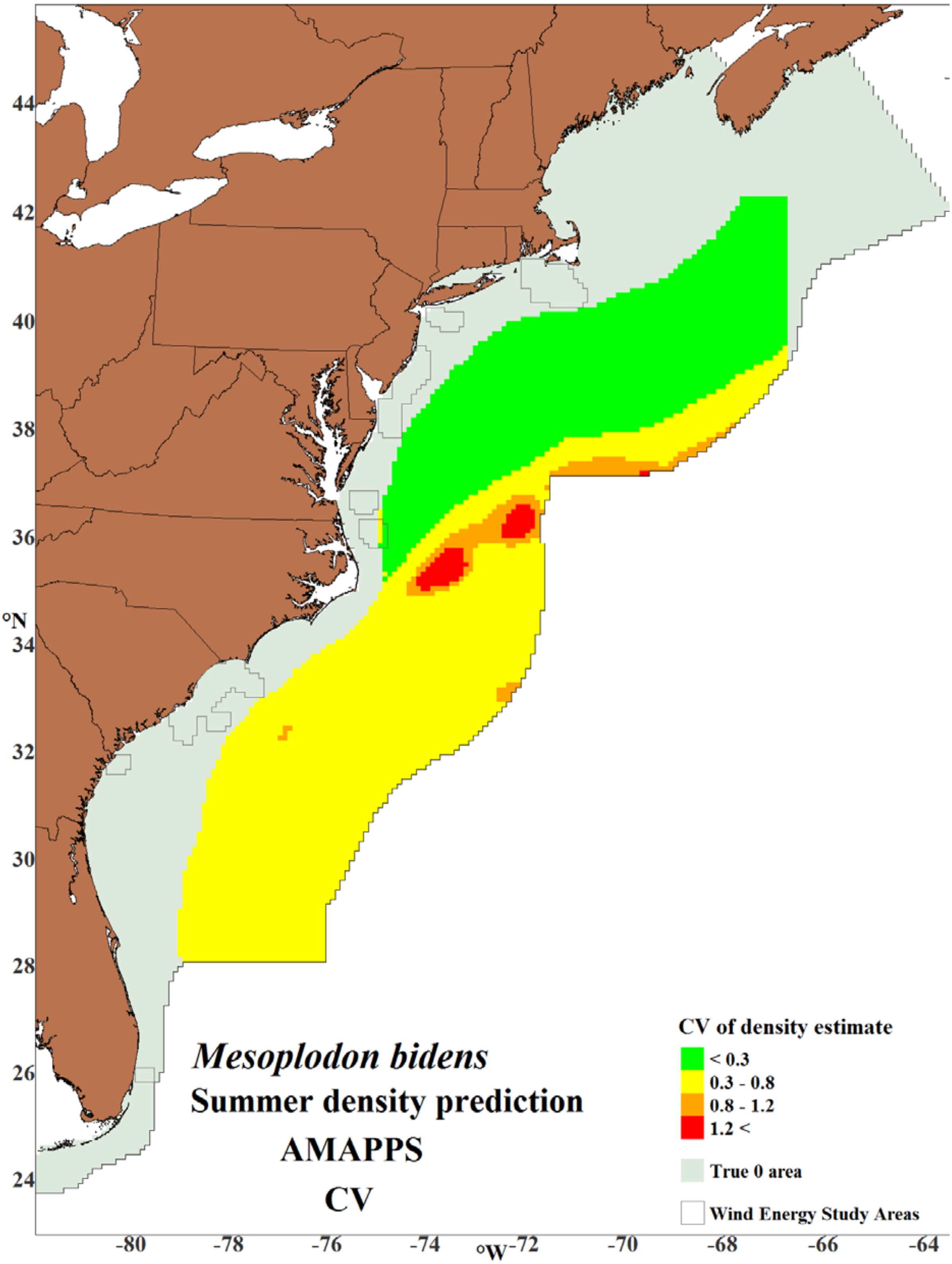

Figure 8-10 CV of summer density estimates for Sowerby's beaked whales

8.6 Wind Energy Study Areas

Table 8-6 Sowerby's beaked whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.142, CV=0.462; shipboard 0.7644, CV= 0.246.

Season	Area	Abundance*	CV	95% Confidence Interval
Summer	Rhode Island/ Massachusetts	N/A	-	-
(June-August)	New York	N/A	-	-
	New Jersey	N/A	-	-
	Delaware/ Maryland	N/A	-	-
	Virginia	N/A	-	-
	North Carolina	0	0.277	0 - 0
	South Carolina/ North Carolina	N/A	-	-
	Georgia	N/A	-	-
	Florida	N/A	-	-

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model. N/A indicates it was assumed to be in the True 0 modeled area.

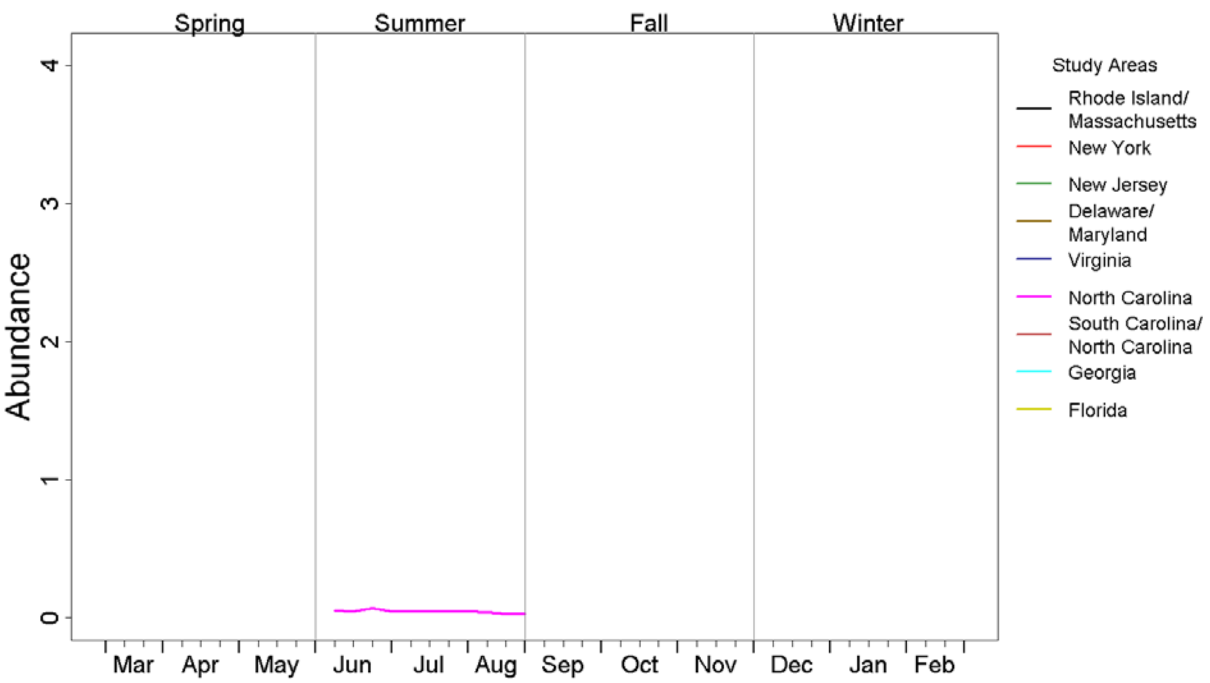

Figure 8-11 Annual abundance trends for Sowerby's beaked whales in wind energy study areas

9 Unidentified Beaked Whales

Figure 9-1 Unidentified beaked whales. Credit: NOAA/NEFSC/Peter Duley
Image collected under MMPA Research permit #775-1600.

9.1 Data Collection

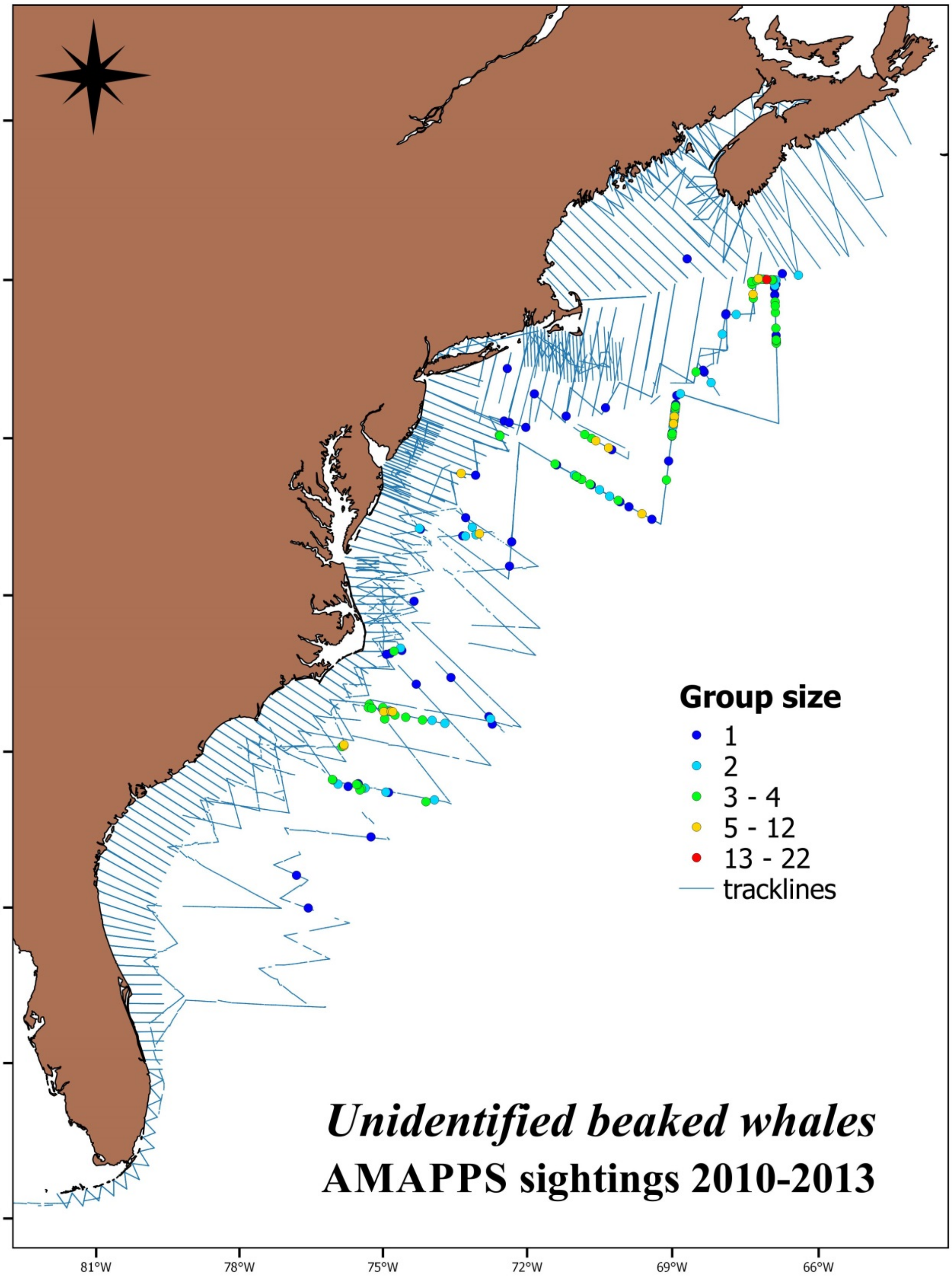

Figure 9-2 Track lines and unidentified beaked whale sightings during 2010-2013

Table 9-1 Research effort 2010 - 2013 and unidentified beaked whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Unidentified beaked whale	-	0/0	87/230	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	4/8	1/1	3/6	0/0
SE Shipboard	0	8,537	2,093	0	-	-	0/0	22/48	2/5	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	0/0	0/0	0/0	0/0

9.2 Mark-Recapture Distance Sampling Analysis

Table 9-2 Parameter estimates from unidentified beaked whale (UNBW) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE-shipboard group 4	-	CBWH,DSWH, GBWH,PSWH, SBWH,UNBW, UNKO	Distance+observer	Distance+swell + sea	6000	HR	0.554	0.105	0.564	0.457	0.867
SE-shipboard group 2	-	BBWH,CBWH, DSWH, PSWH, UNBW, UNKO	Distance	Distance	8310	HR	0.355	0.403	0.600	0.909	0.918

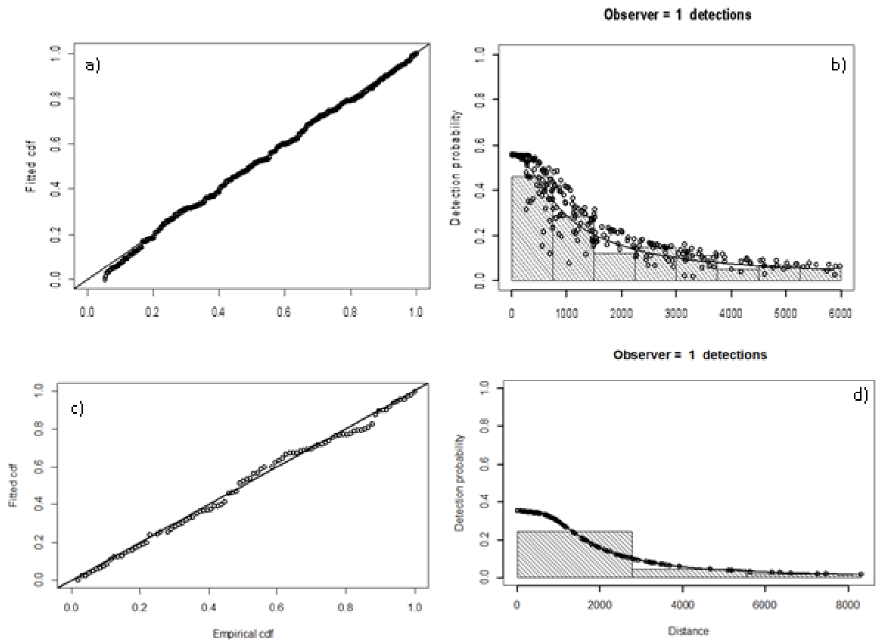

Figure 9-3 Q-Q plots and detection functions from unidentified beaked whale MRDS analysis
Group 4 shipboard northeast region (a,b) and group 2 shipboard southeast region (c,d).

9.3 Generalized Additive Model Analysis

Table 9-3 Habitat model output for unidentified beaked whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	0.0511	4	0.034	0.0912	1.47E-03	.
s(pic)	0.7324	4	1.742	0.001909	2.13E+3	**
s(depth)	3.3261	4	45.000	< 2e-16	6.64E-05	***
s(dist1000)	1.8710	4	3.551	0.000112	3.23E-08	***
s(lat)	3.7158	4	26.096	< 2e-16	3.21E+00	***
Scale	-	-	-	-	6.90E-01	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: Total = 9.68

R^2 (adjusted) = 0.0876 Deviance explained = 38.9%

REML = 2760.84 Scale estimate = 0.16591 sample size = 2364

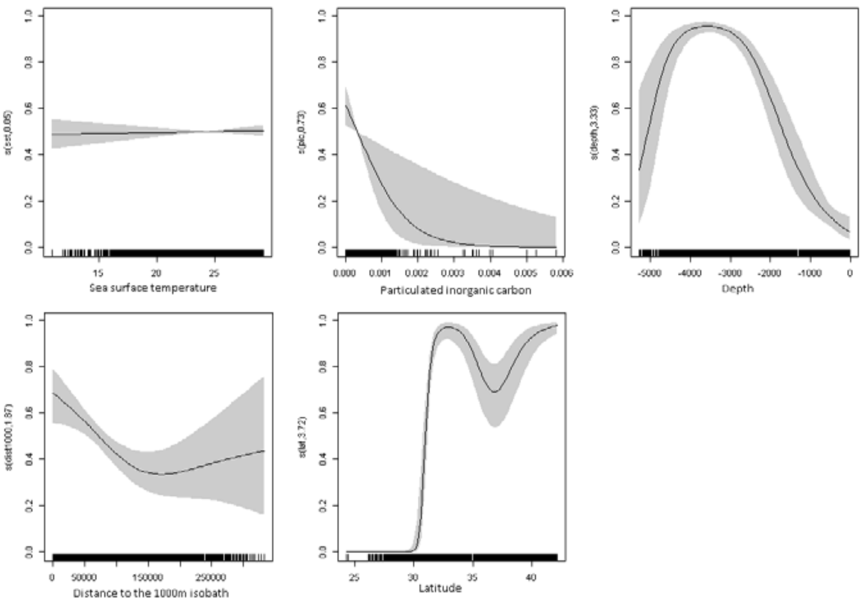

Figure 9-4 Unidentified beaked whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 9-4 Diagnostic statistics from unidentifed beaked whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.428	Excellent
MAPE	Mean absolute percentage error	Non-zero density	81.19	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.181	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.01	Excellent

The cutoff values are taken from Kinlan et al. 2012.
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

9.4 Abundance Estimates for AMAPPS Study Area

Table 9-5 Unidentified beaked whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.142, CV=0.462; shipboard 0.7644, CV=0.246.

Season	Abundance	CV	95% Confidence Interval
Summer (June-August)	6,987	0.284	4,051 – 12,051

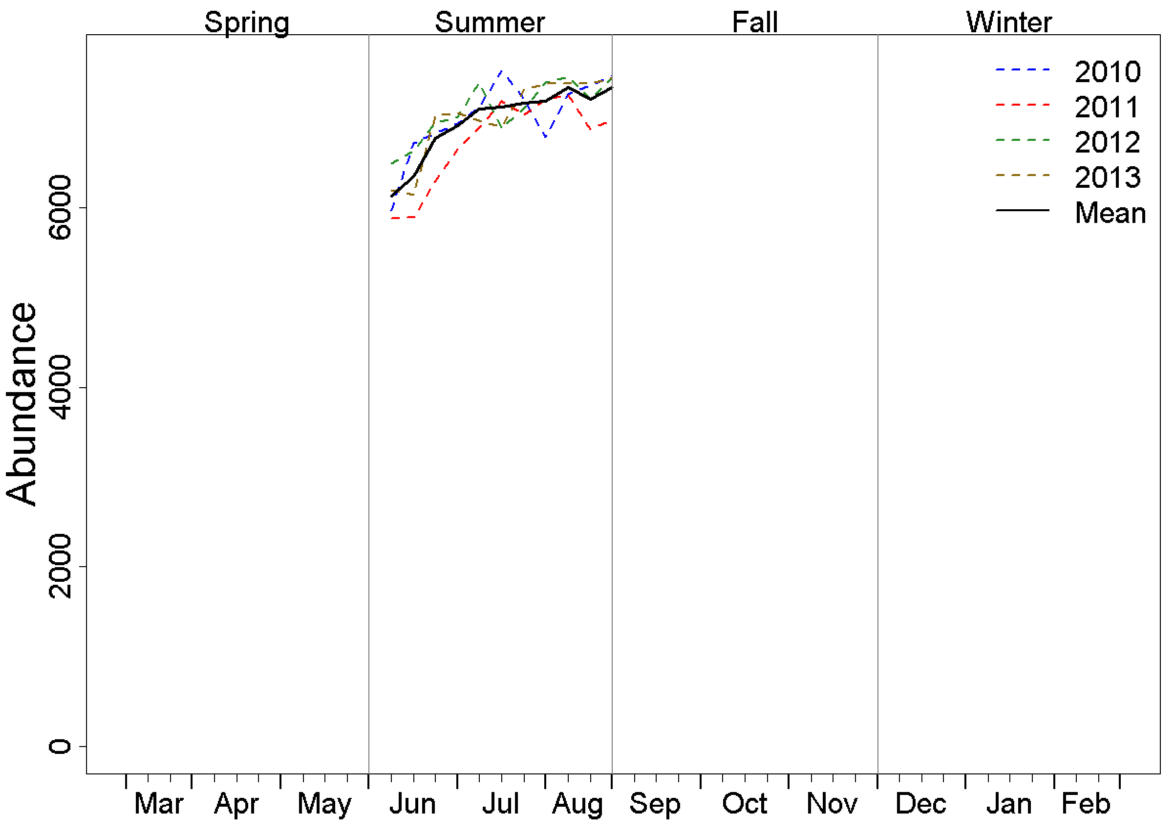

Figure 9-5 Annual abundance trends for unidentified beaked whales for AMAPPS study area

9.5 Seasonal Prediction Maps

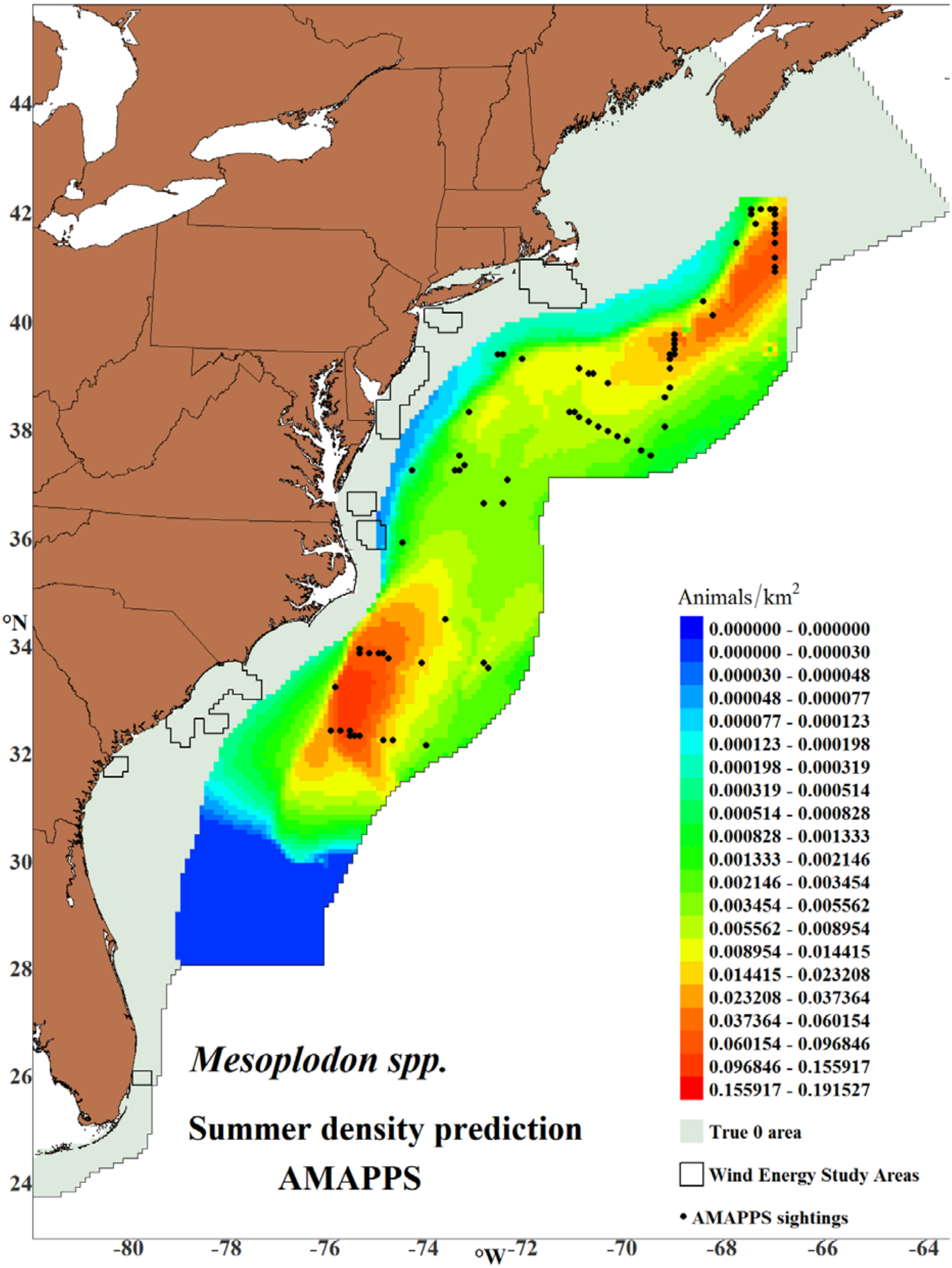

Figure 9-6 Unidentified beaked whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

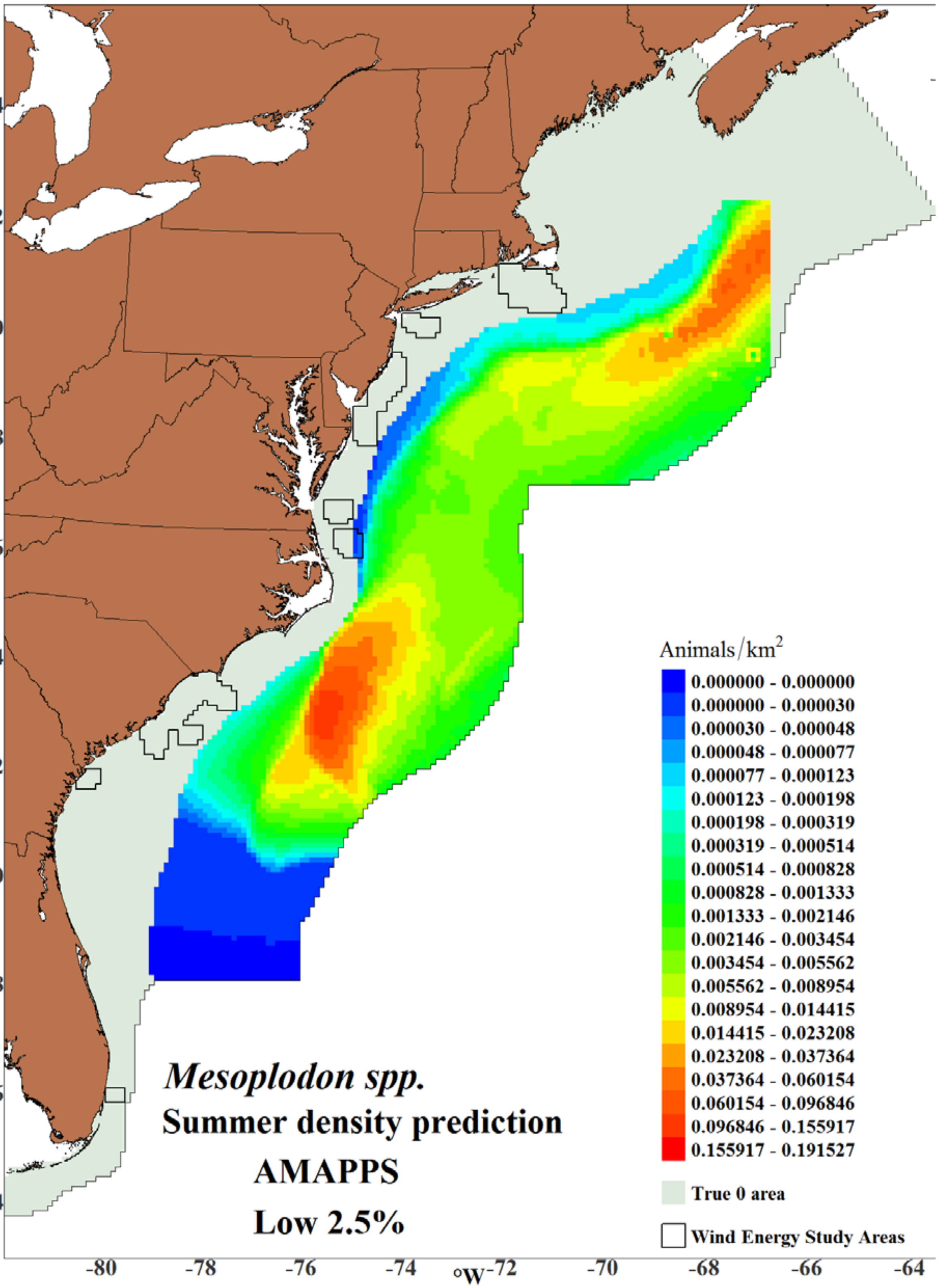

Figure 9-7 Lower 2.5% percentile of summer unidentified beaked whale estimates

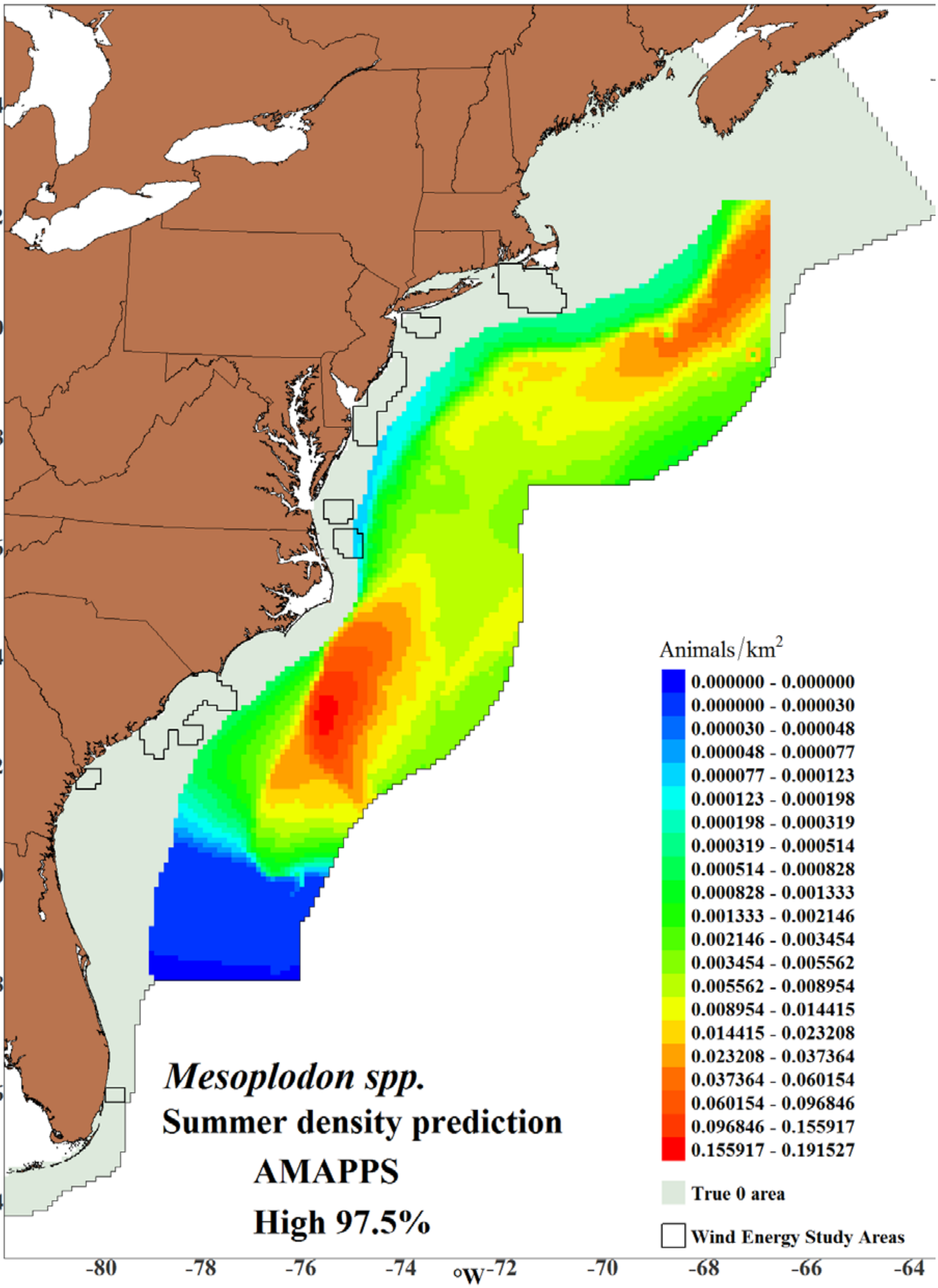

Figure 9-8 Upper 97.5% percentile of summer unidentified beaked whale estimates

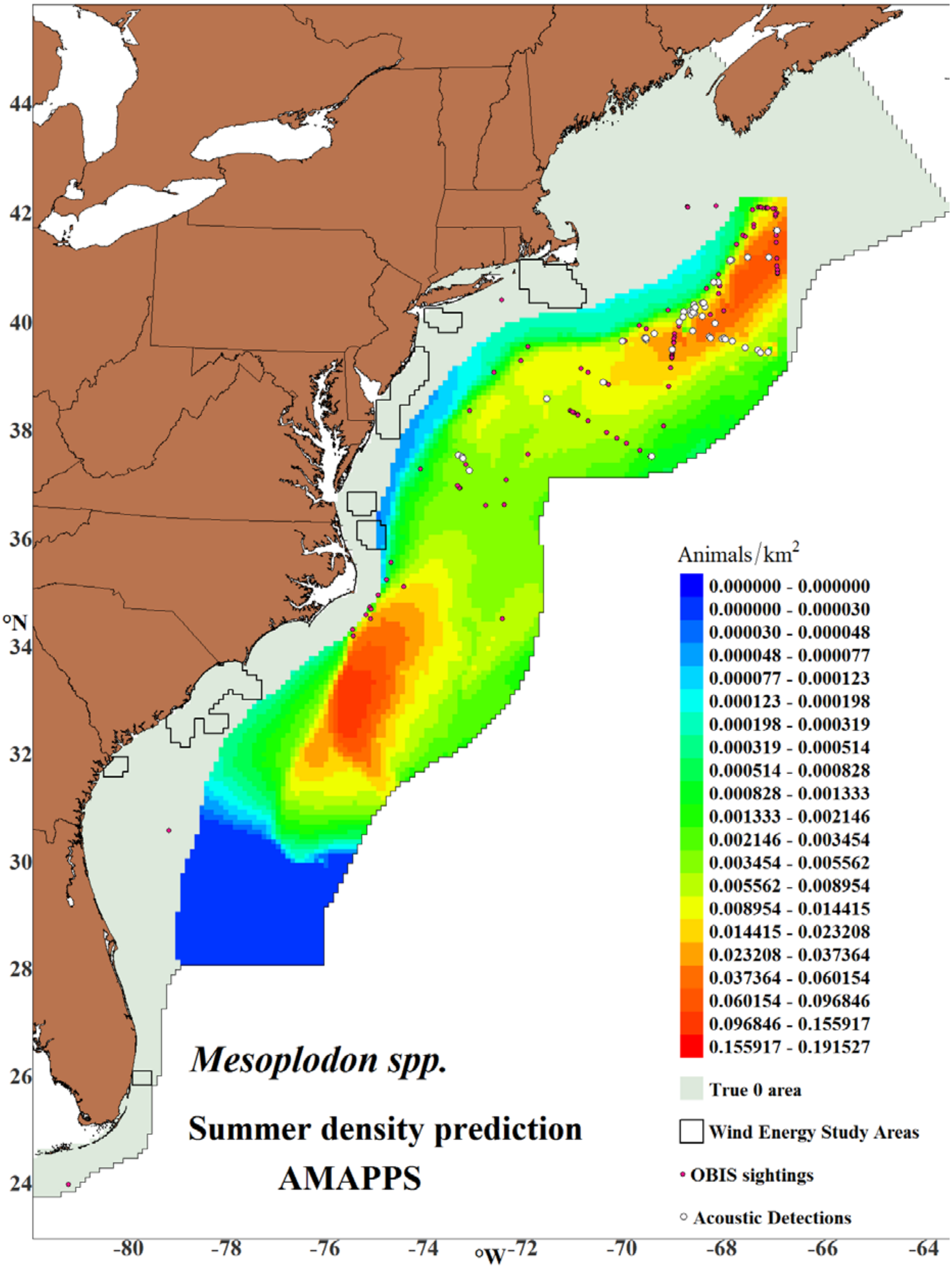

Figure 9-9 Unidentified beaked whale 2010-2013 summer density and 1970-2013 OBIS sightings
Pink circles (Halpin et al. 2009), and passive acoustic detections from the 2013-2015 NEFSC towed hydrophone array surveys (white circles). These sightings were not used to develop the density-habitat model.

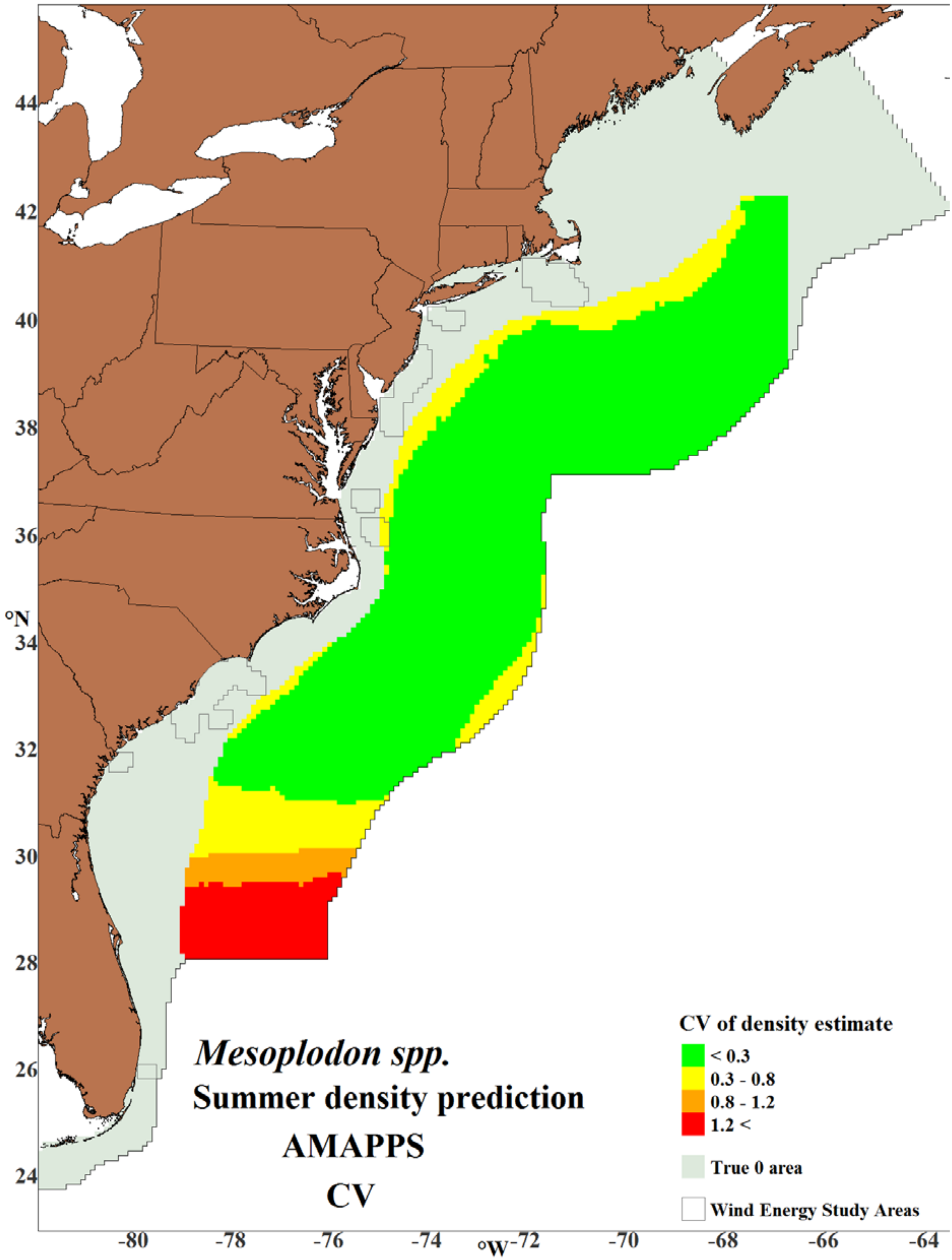

Figure 9-10 CV of summer density estimates for unidentified beaked whales

9.6 Wind Energy Study Areas

Table 9-6 Unidentified beaked whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.142, CV=0.462; shipboard 0.7644, CV= 0.246.

Season	Area	Abundance*	CV	95% Confidence Interval
Summer	Rhode Island/ Massachusetts	N/A	-	-
(June-August)	New York	N/A	-	-
	New Jersey	N/A	-	-
	Delaware/ Maryland	N/A	-	-
	Virginia	N/A	-	-
	North Carolina	0	0.346	0 - 0
	South Carolina/ North Carolina	N/A	-	-
	Georgia	N/A	-	-
	Florida	N/A	-	-

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model. N/A indicates it was assumed to be in the True 0 modeled area.

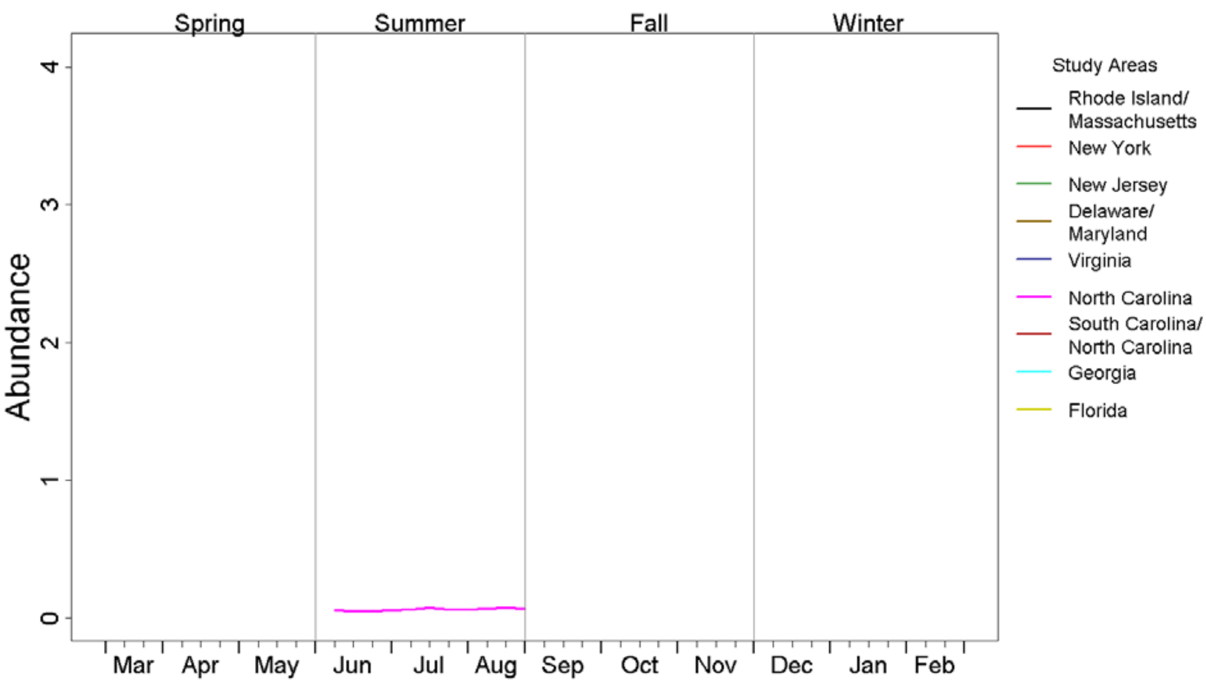

Figure 9-11 Annual abundance trends for unidentified beaked whales in wind energy study areas

10 Pygmy/Dwarf Sperm Whales (*Kogia* spp)

Figure 10-1 Pygmy or dwarf sperm whale. Credit: NOAA/SEFSC
Image collected under MMPA Research permit #779-1638.

10.1 Data Collection

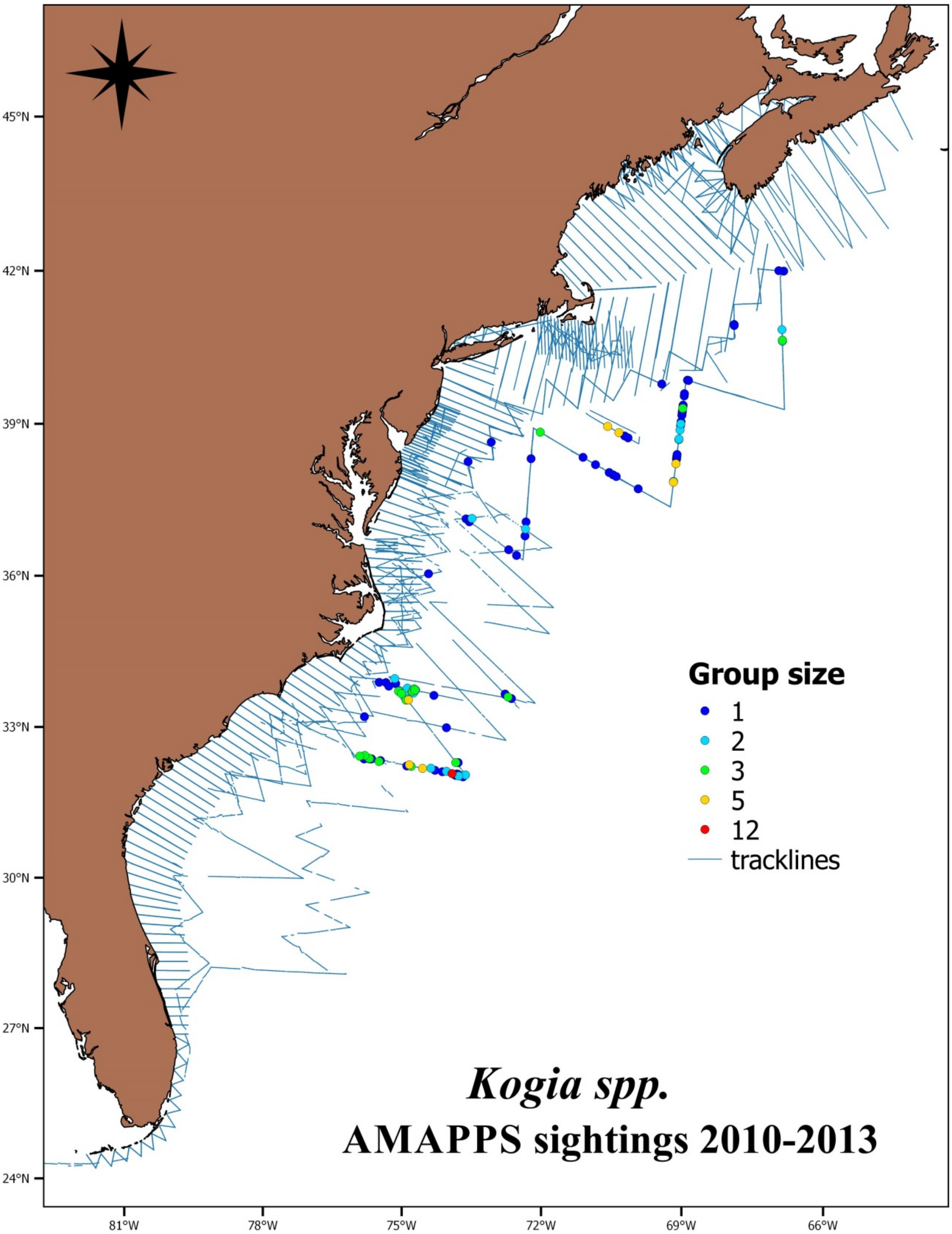

Figure 10-2 Track lines and *Kogia* sightings during 2010 - 2013

Table 10-1 Research effort 2010 - 2013 and *Kogia* sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Dwarf sperm whale	*Kogia simus*	0	20/37	0	0
					Pygmy sperm whale	*Kogia breviceps*	0	25/33	0	0
					Unknown Pygmy/Dwarf sperm whale	-	0	10/11	0	0
NE Aerial	7,502	10,468	11,038	3,573	Dwarf sperm whale	*Kogia simus*	0	0	0	0
					Pygmy sperm whale	*Kogia breviceps*	0	0	0	0
					Unknown Pygmy/Dwarf sperm whale	-	0	0	0	0
SE Shipboard	0	8,537	2,093	0	Dwarf sperm whale	*Kogia simus*	0	6/9	0	0
					Pygmy sperm whale	*Kogia breviceps*	0	2/4	0	0
					Unknown Pygmy/Dwarf sperm whale	-	0	52/107	2/2	0
SE Aerial	17,978	16,835	11,818	6,007	Dwarf sperm whale	*Kogia simus*	0	0	0	0
					Pygmy sperm whale	*Kogia breviceps*	0	0	0	0
					Unknown Pygmy/Dwarf sperm whale	-	0	0	0	0

10.2 Mark-Recapture Distance Sampling Analysis

Table 10-2 Parameter estimates from *Kogia* (UNKO, DSWH, PSWH) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE-shipboard group 4	-	CBWH,DSWH, GBWH,PSWH, SBWH,UNBW, UNKO	Distance+observer	Distance+swell+ sea	6000	HR	0.554	0.105	0.564	0.457	0.867
SE-shipboard group 2	-	BBWH,CBWH, DSWH, PSWH, UNBW, UNKO	Distance	Distance	8310	HR	0.355	0.403	0.600	0.909	0.918

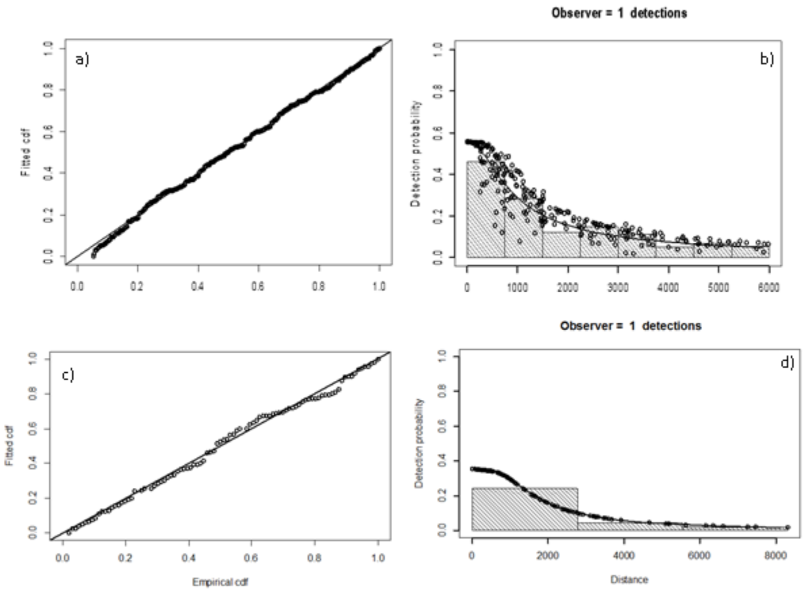

Figure 10-3 Q-Q plots and detection functions from *Kogia* MRDS analysis
Group 4 shipboard northeast region (a,b) and group 2 shipboard southeast region (c,d).

10.3 Generalized Additive Model Analysis

Table 10-3 Habitat model output for *Kogia*

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(chl)	0.8628	4	4.158	2.45e-06	0.436113	***
s(salinity)	0.6835	4	1.560	0.00153	0.054235	**
s(depth)	3.1749	4	31.175	< 2e-16	5.84E-05	***
s(slope)	0.7627	4	1.793	0.00196	0.008725	**
s(dist1000)	1.0053	4	7.679	6.40e-09	5.32E-09	***
Scale	-	-	-	-	0.768719	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Estimated degrees of freedom: Total = 7.49
R^2 (adjusted) = 0.0414 Deviance explained = 33.7%
REML = 310.03 Scale estimate = 0.21316 sample size = 2330

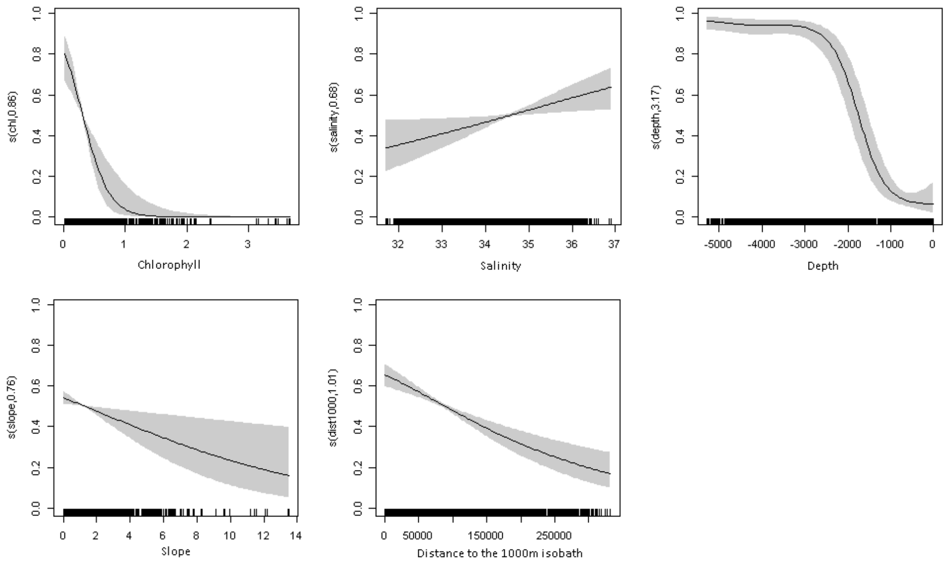

Figure 10-4 *Kogia* density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 10-4 Diagnostic statistics from *Kogia* habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.403	Excellent
MAPE	Mean absolute percentage error	Non-zero density	82.28	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.195	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.017	Excellent

The cutoff values are taken from Kinlan et al. 2012.
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

10.4 Abundance Estimates for AMAPPS Study Area

Table 10-5 *Kogia* average abundance estimates for AMAPPS study area
Availability bias correction: aerial N/A; shipboard 0.5393, CV= 0.307.

Season	Abundance	CV	95% Confidence Interval
Summer (June-August)	9,951	0.207	6,661 – 14,865

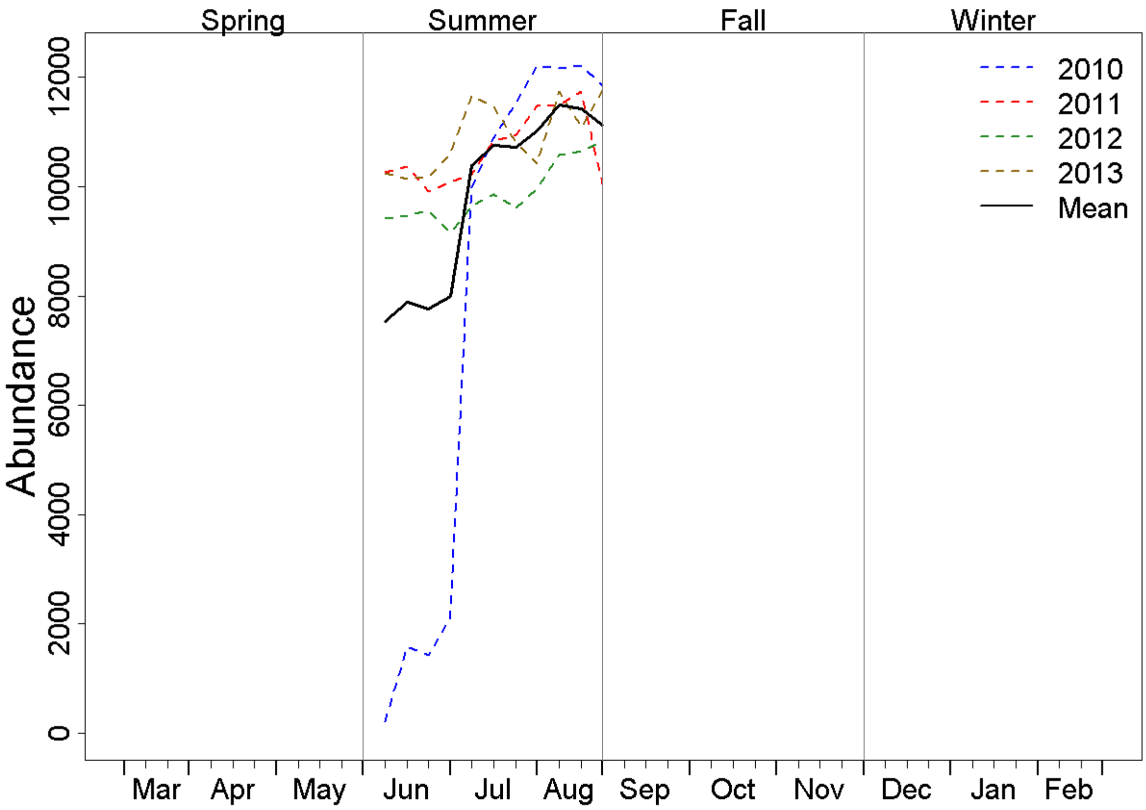

Figure 10-5 Annual abundance trends for *Kogia* for AMAPPS study area

10.5 Seasonal Prediction Maps

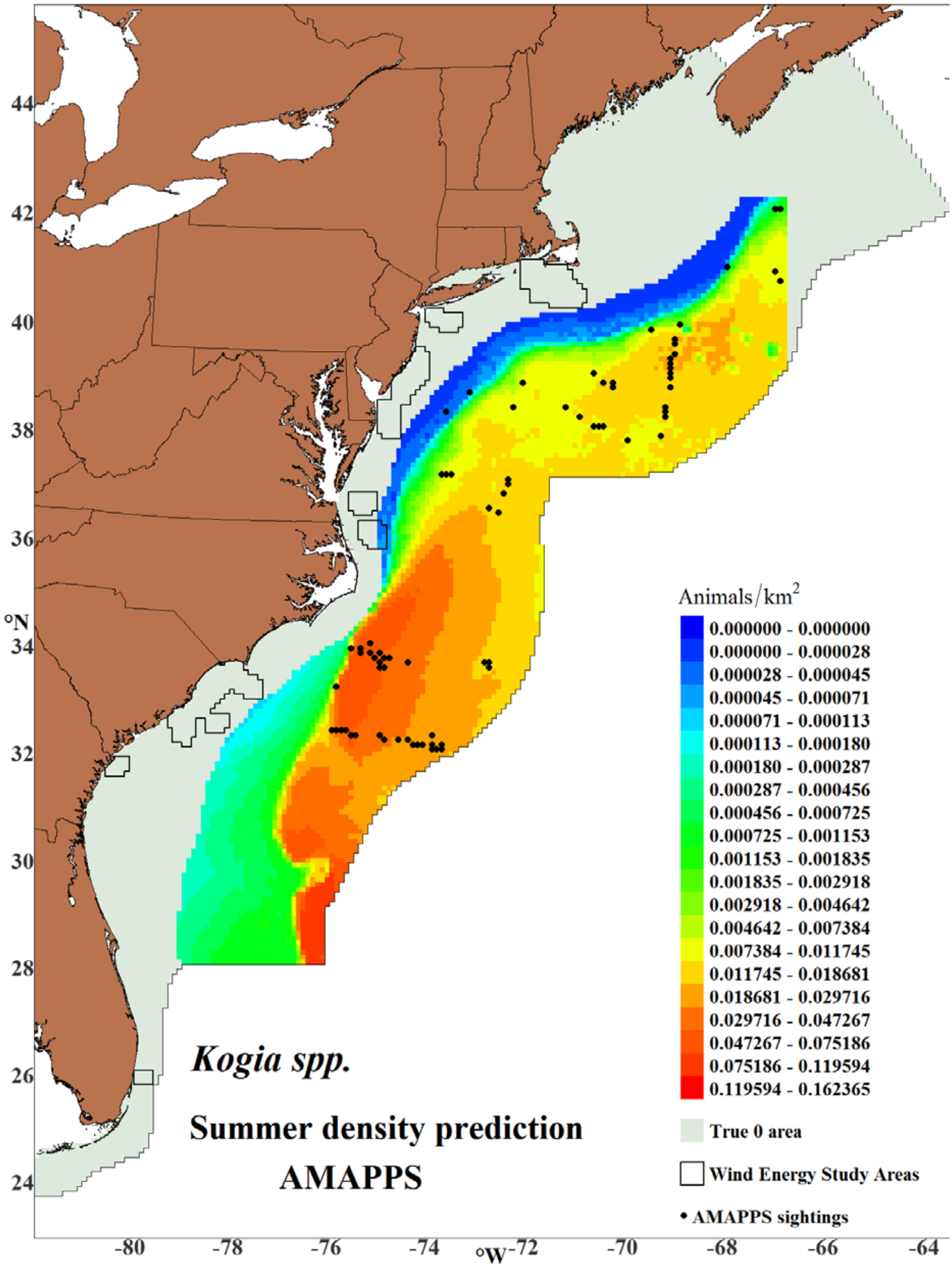

Figure 10-6 *Kogia* summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

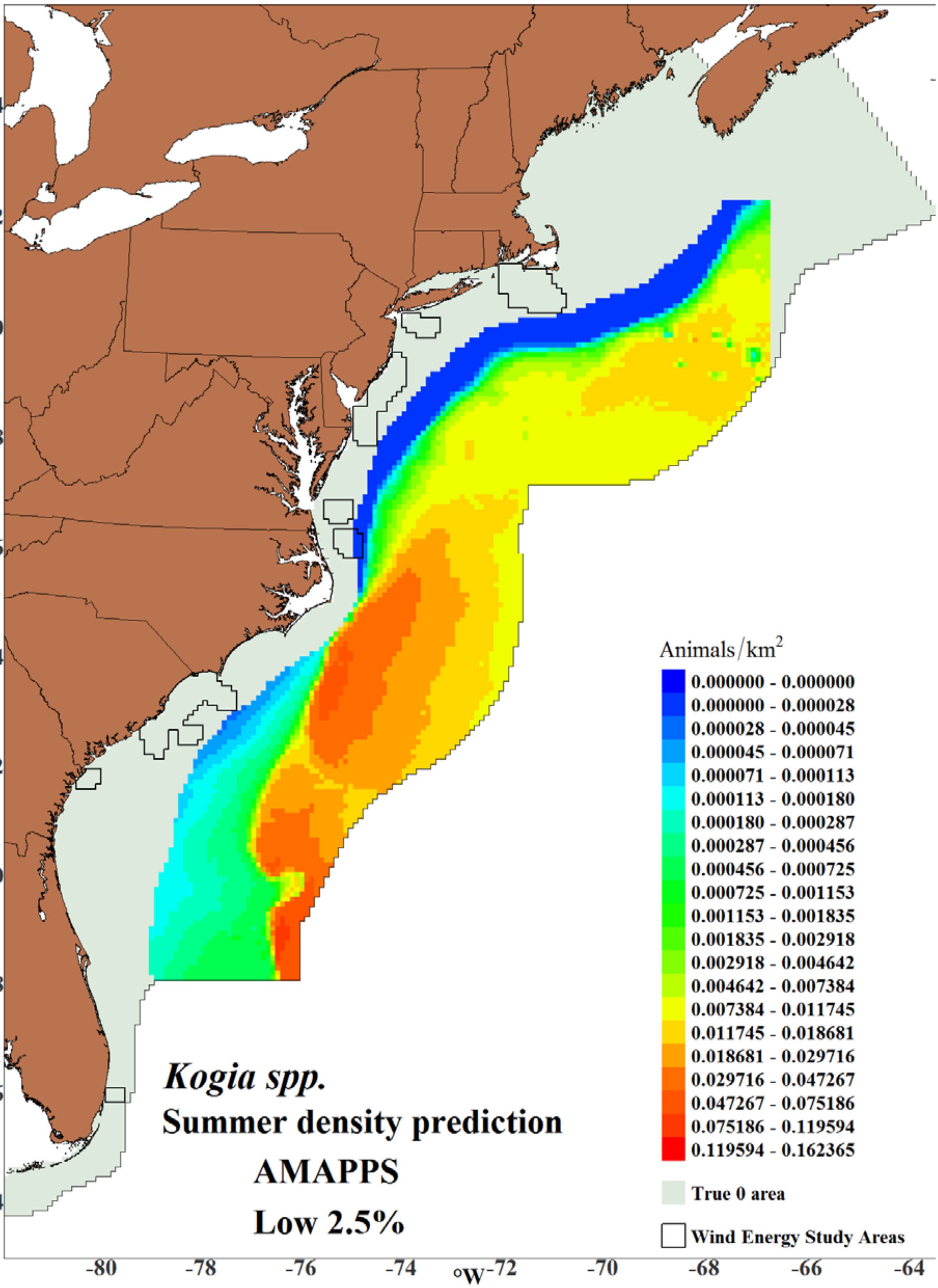

Figure 10-7 Lower 2.5% percentile of summer *Kogia* estimates

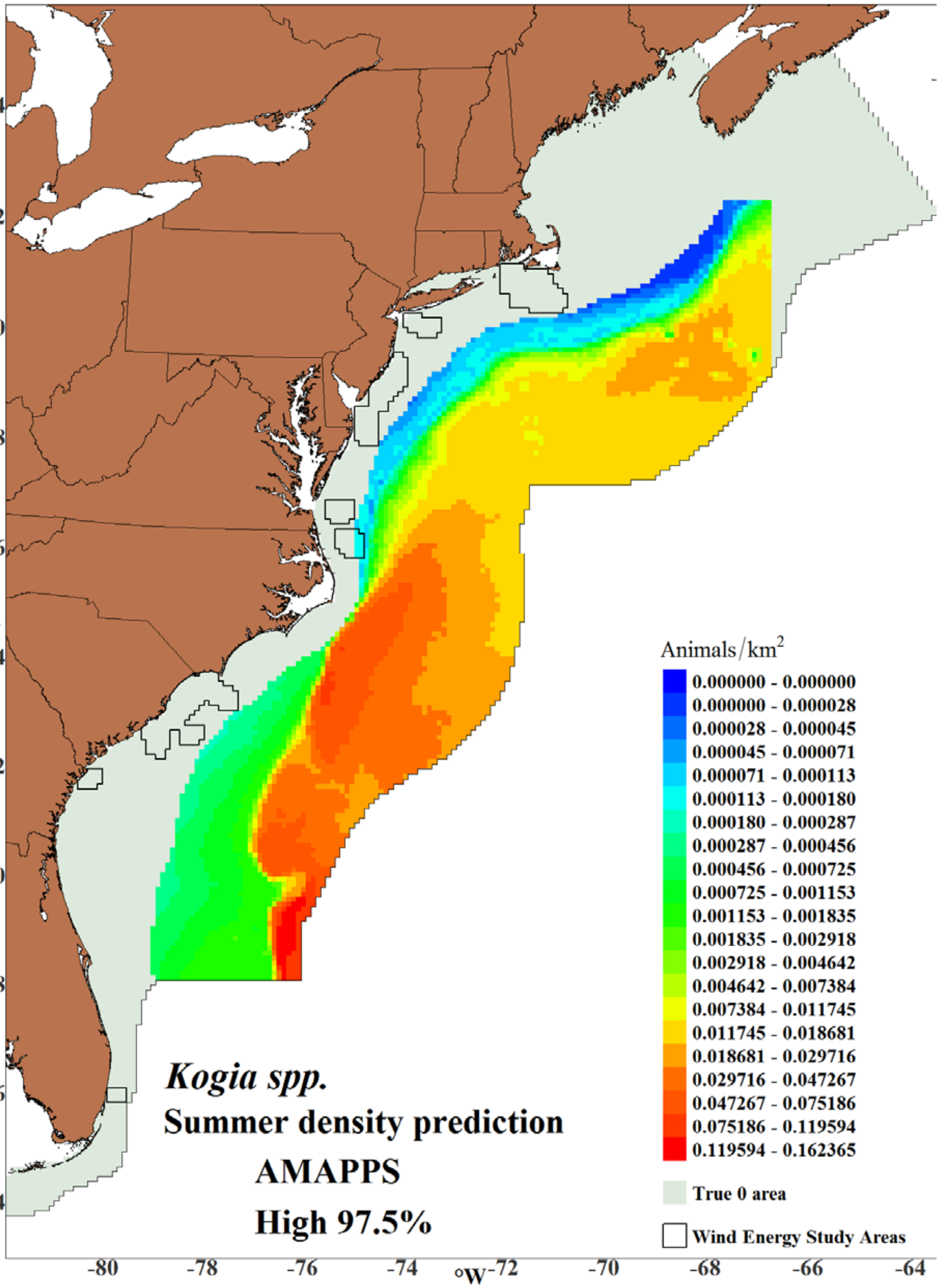

Figure 10-8 Upper 97.5% percentile of summer *Kogia* estimates

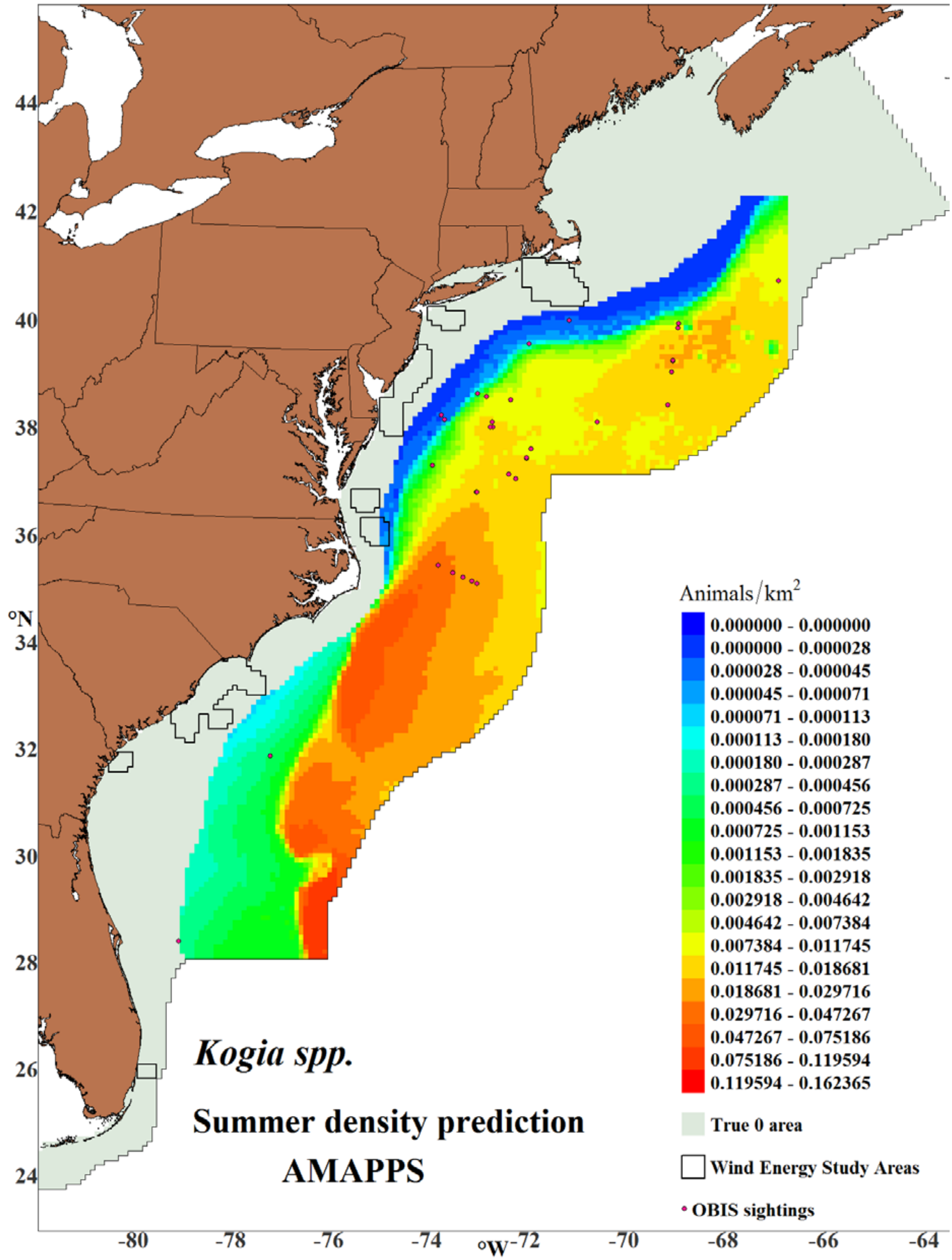

Figure 10-9 *Kogia* 2010-2013 summer density and 1980-2013 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

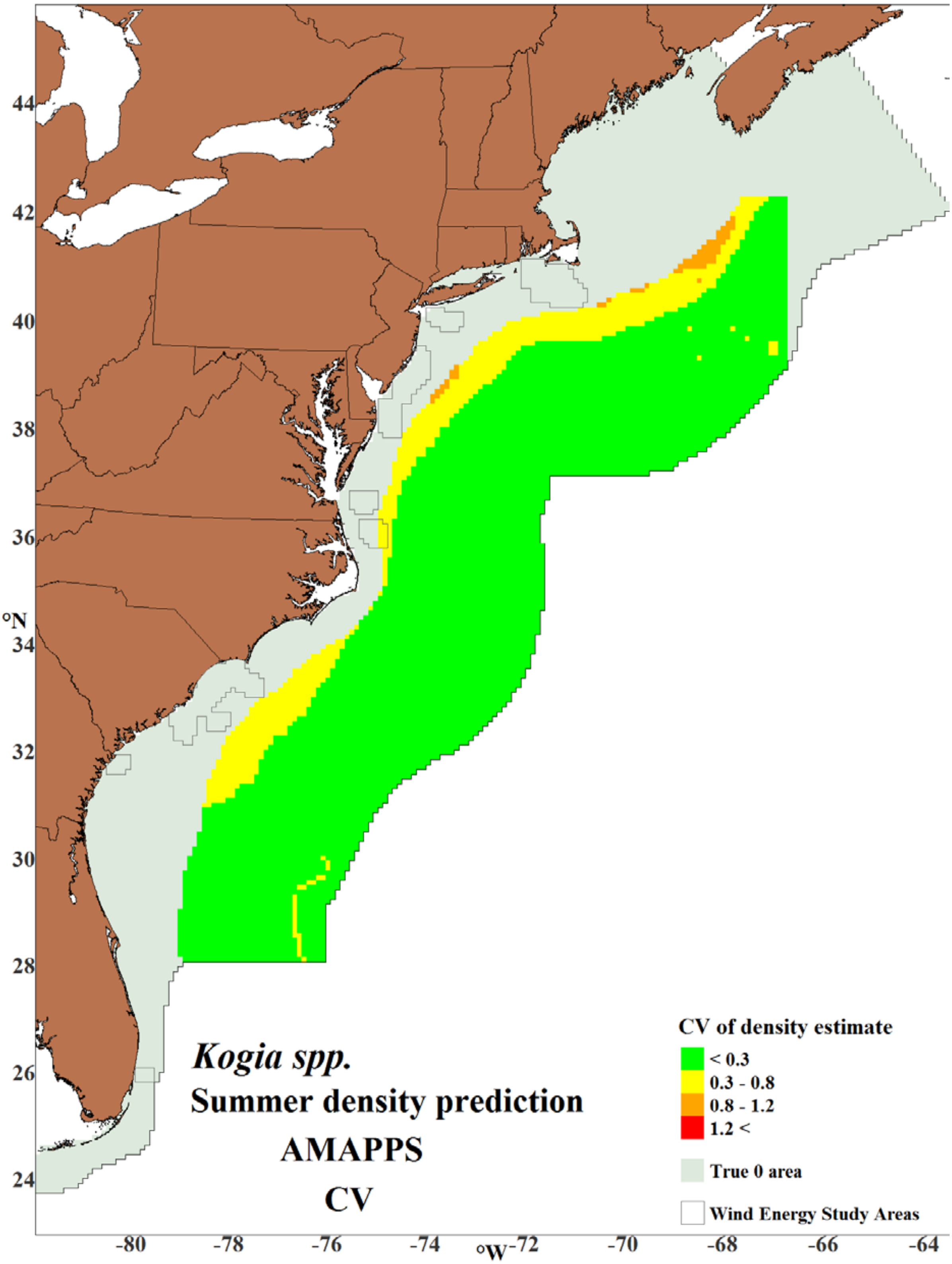

Figure 10-10 CV of summer density estimates for *Kogia*

10.6 Wind Energy Study Areas

Table 10-6 *Kogia* average abundance estimates for wind energy study areas
Availability bias correction: aerial N/A; shipboard 0.5393, CV= 0.307.

Season	Area	Abundance*	CV	95% Confidence Interval
Summer	Rhode Island/ Massachusetts	N/A	-	-
(June-August)	New York	N/A	-	-
	New Jersey	N/A	-	-
	Delaware/ Maryland	N/A	-	-
	Virginia	N/A	-	-
	North Carolina	0	0.585	0 - 0
	South Carolina/ North Carolina	N/A	-	-
	Georgia	N/A	-	-
	Florida	N/A	-	-

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model. N/A indicates it was assumed to be in the True 0 modeled area.

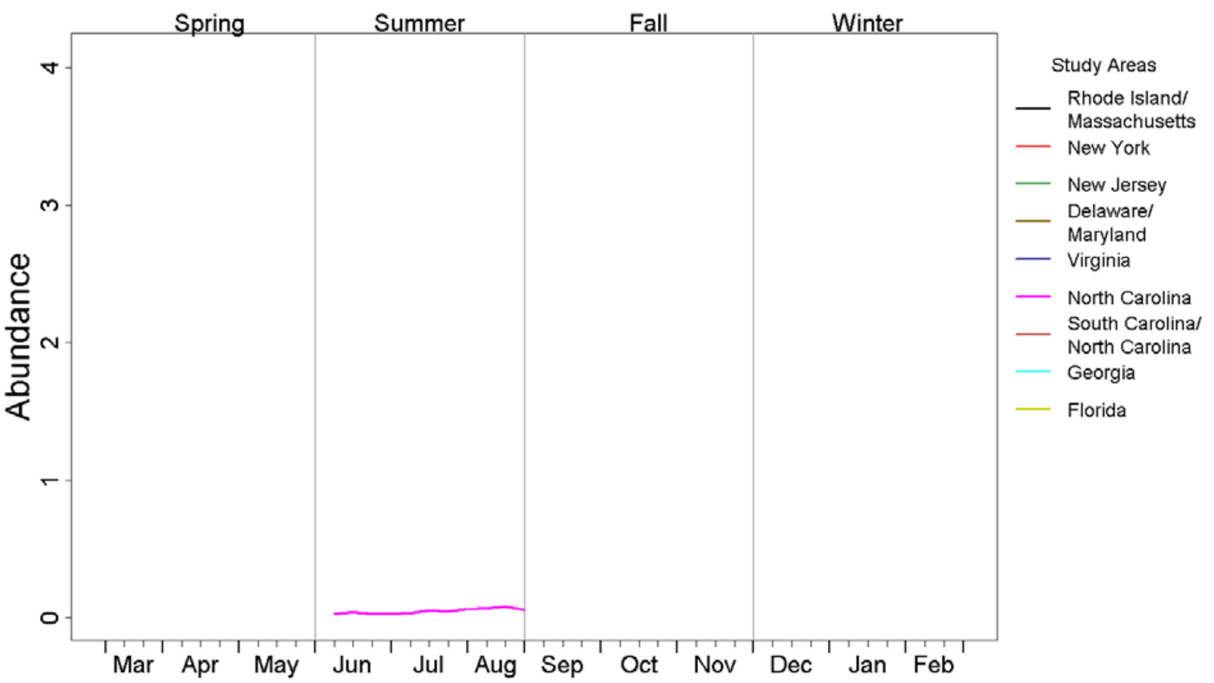

Figure 10-11 Annual abundance trends for *Kogia* in wind energy study areas

11 Pilot Whales (*Globicephala* spp)

Figure 11-1 Pilot whale. Credit: NOAA/NEFSC/Peter Duley
Image collected under MMPA Research permit #775-1600.

11.1 Data Collection

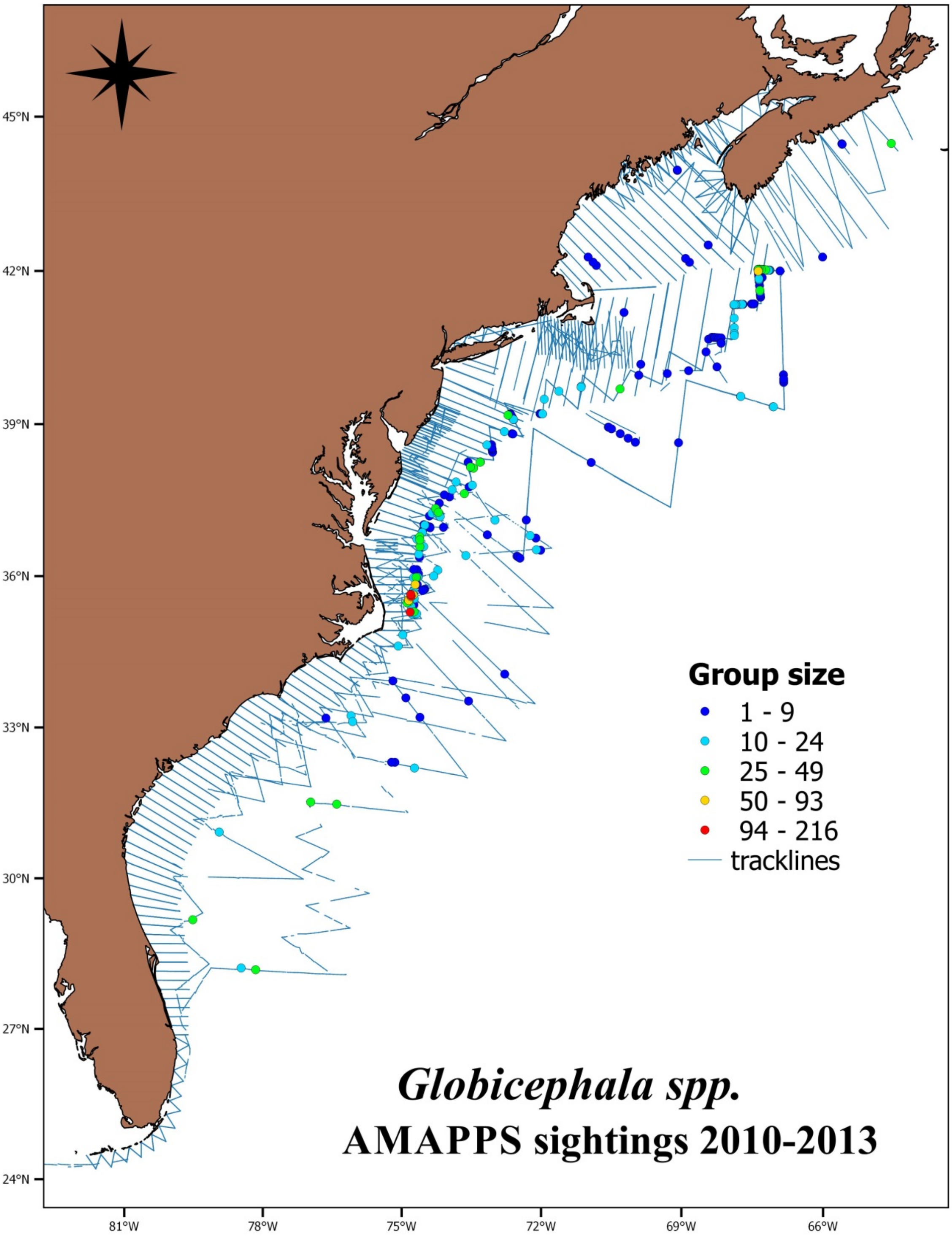

Figure 11-2 Track lines and pilot whale sightings during 2010 - 2013

Table 11-1 Research effort 2010 - 2013 and pilot whale sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Long-finned pilot whale	*Globicephala melas*	0/0	1/17	0/0	0/0
					Short-finned pilot whale	*Globicephala macrorhynchus*	0/0	3/18	0/0	0/0
					Unknown pilot whale	-	0/0	129/1,405	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	Long-finned pilot whale	*Globicephala melas*	0/0	0/0	0/0	0/0
					Short-finned pilot whale	*Globicephala macrorhynchus*	0/0	0/0	0/0	0/0
					Unknown pilot whale	-	3/4	2/3	8/45	5/6
SE Shipboard	0	8,537	2,093	0	Long-finned pilot whale	*Globicephala melas*	0/0	0/0	0/0	0/0
					Short-finned pilot whale	*Globicephala macrorhynchus*	0/0	0/0	0/0	0/0
					Unknown pilot whale	-	0/0	44/829	35/467	0/0
SE Aerial	17,978	16,835	11,818	6,007	Long-finned pilot whale	*Globicephala melas*	0/0	0/0	0/0	0/0
					Short-finned pilot whale	*Globicephala macrorhynchus*	0/0	0/0	0/0	0/0
					Unknown pilot whale	-	1/135	20/538	16/268	0/0

11.2 Mark-Recapture Distance Sampling Analysis

Table 11-2 Parameter estimates from pilot whale (LSPW, LFPW, and SFPW) MRDS analysis
HR=Hazard Rate, HN= Half Normal, LT= Left truncation, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 2	-	LSPW,RIDO, RTDO	Distance+Observer	Distance	400	HR	0.712	0.171	0.454	0.331	0.389
NE-aerial group 2	1	CBDO,LSPW, RIDO	Distance	Distance+sea	LT35-861	HR	0.647	0.147	0.397	0966	0.958
	2		-	Distance	861	HR	-	-	0.129	0.892	0.765
SE-shipboard group 3	-	FKWH,LSPW, RIDO,RTDO	Distance	Distance+sea	5000	HR	0.671	0.114	0.683	0.918	0.925
NE-shipboard group 5	-	LFPW,LSPW, SFPW	Distance*observer	Distance+glare	5000	HR	0.740	0.090	0.372	0.991	0.942

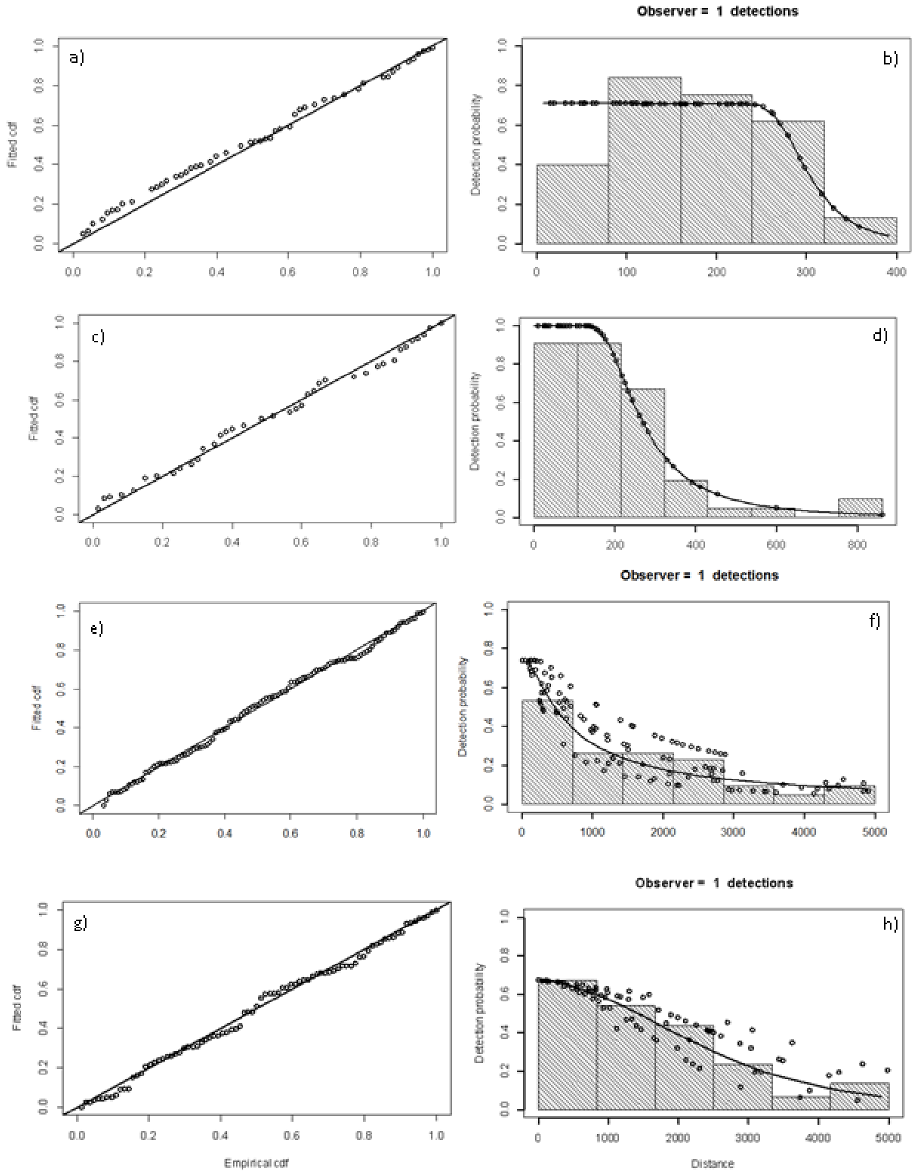

Figure 11-3 Q-Q plots and detection functions from pilot whale MRDS analysis
Group 2 aerial southeast region (a,b), group 2 aerial northeast region (c,d), group 5 shipboard northeast region(e,f) and group 3 shipboard southeast region (g,h).

11.3 Generalized Additive Model Analysis

Table 11-3 Habitat model output for pilot whales

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(pic)	0.9727	4	44.85	<2e-16	1.44E+03	***
s(pp)	2.6109	4	116.98	<2e-16	1.01E-04	***
s(btemp)	3.5678	4	29.93	<2e-16	3.54E-01	***
s(slope)	3.2387	4	196.86	<2e-16	4.31E-01	***
s(lat)	3.7312	4	96.57	<2e-16	3.71E-01	***
Scale	-	-	-	-	1.88E+00	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom: Total = 15.12

R^2 (adjusted) = 0.0533 Deviance explained = 56.2%

REML = 1223 Scale estimate = 0.68115 sample size = 11419

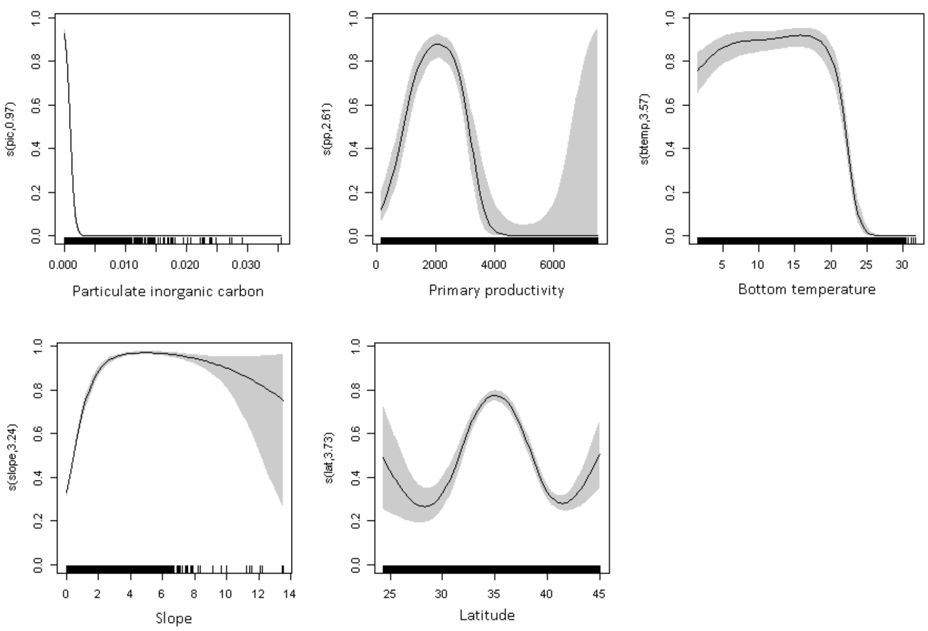

Figure 11-4 Pilot whale density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 11-4 Diagnostic statistics from pilot whale habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0. 529	Excellent
MAPE	Mean absolute percentage error	Non-zero density	88.92	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0. 148	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.097	Excellent

The cutoff values are taken from Kinlan et al. 2012.
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

11.4 Abundance Estimates for AMAPPS Study Area

Table 11-5 Pilot whale average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.679, CV=0.241; shipboard 1.0, CV= 0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	26,441	0.396	12,525 – 55,820
Summer (June-August)	24,670	0.293	14,052 – 43,311
Fall (September-November)	29,559	0.305	16,489 – 52,989

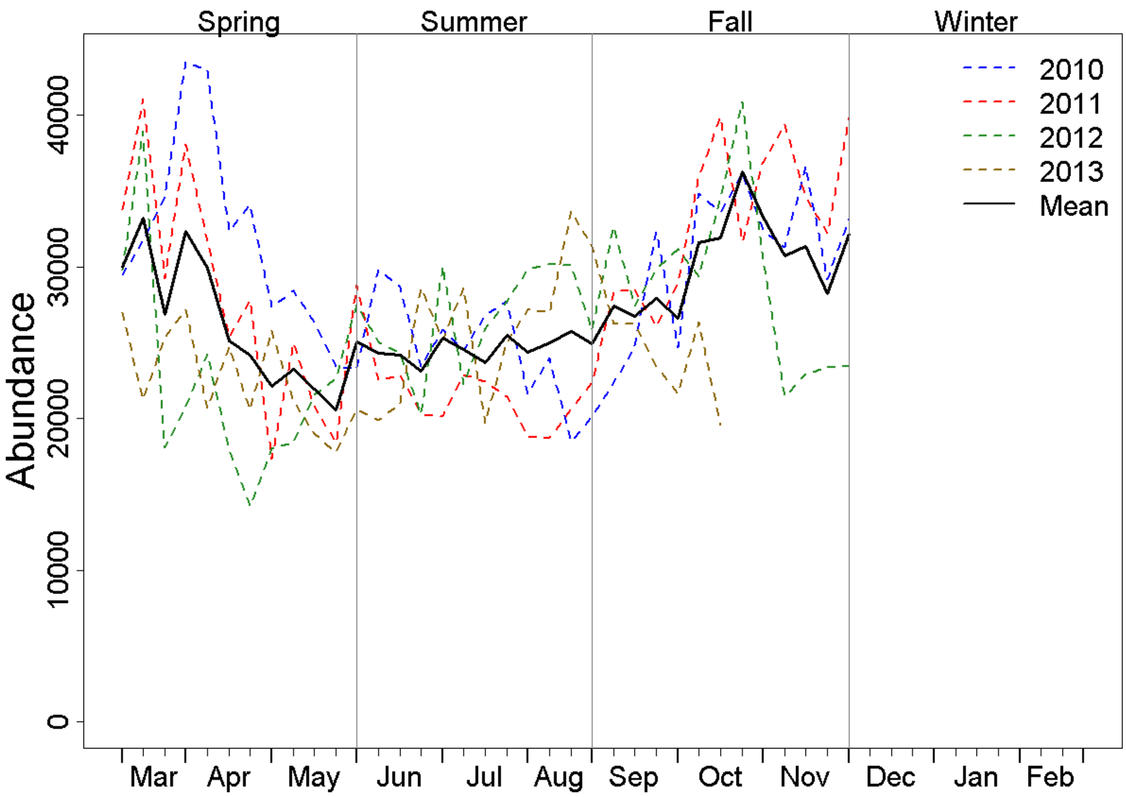

Figure 11-5 Annual abundance trends for pilot whales in wind energy study areas

11.5 Seasonal Prediction Maps

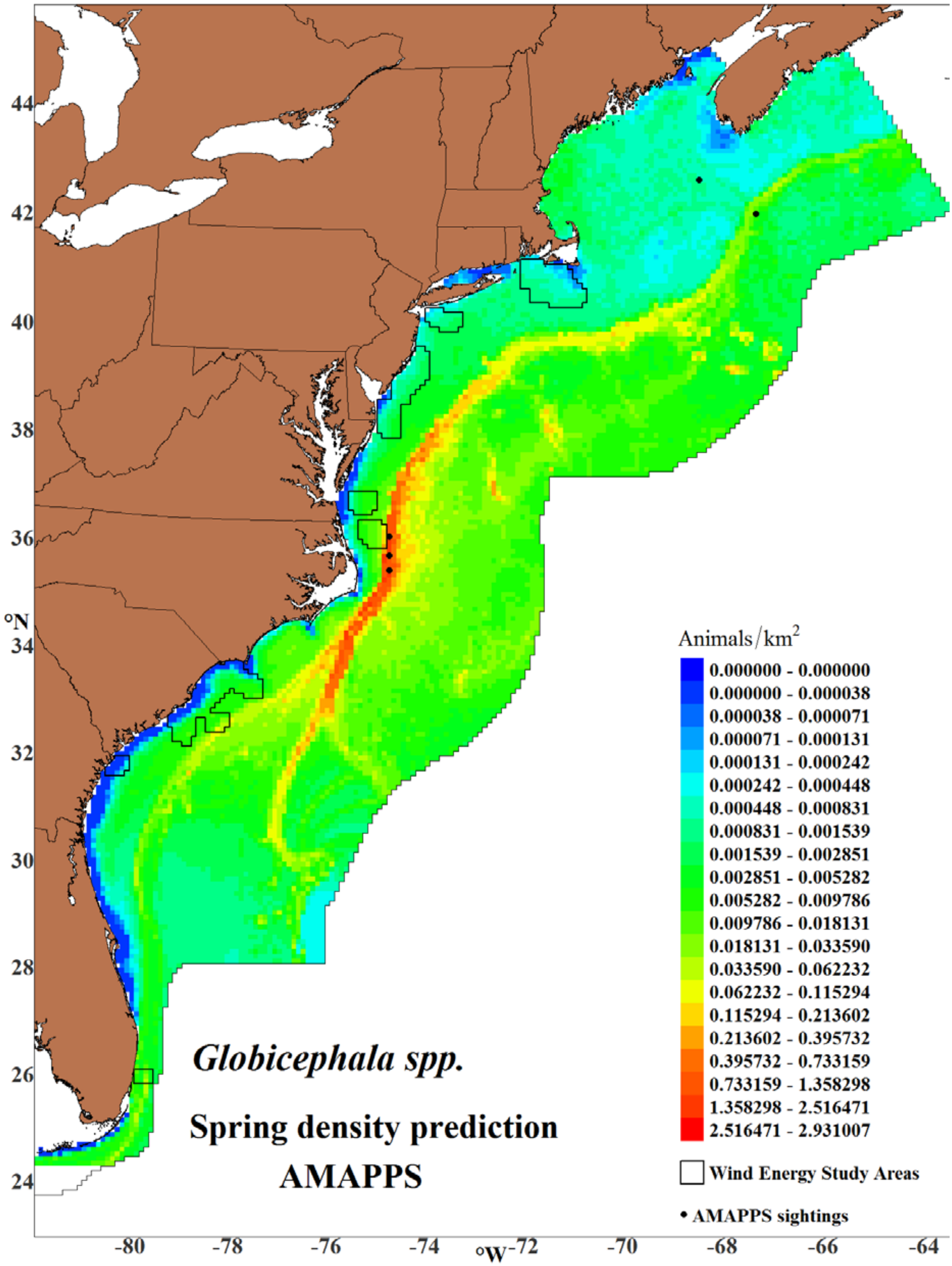

Figure 11-6 Pilot whale spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

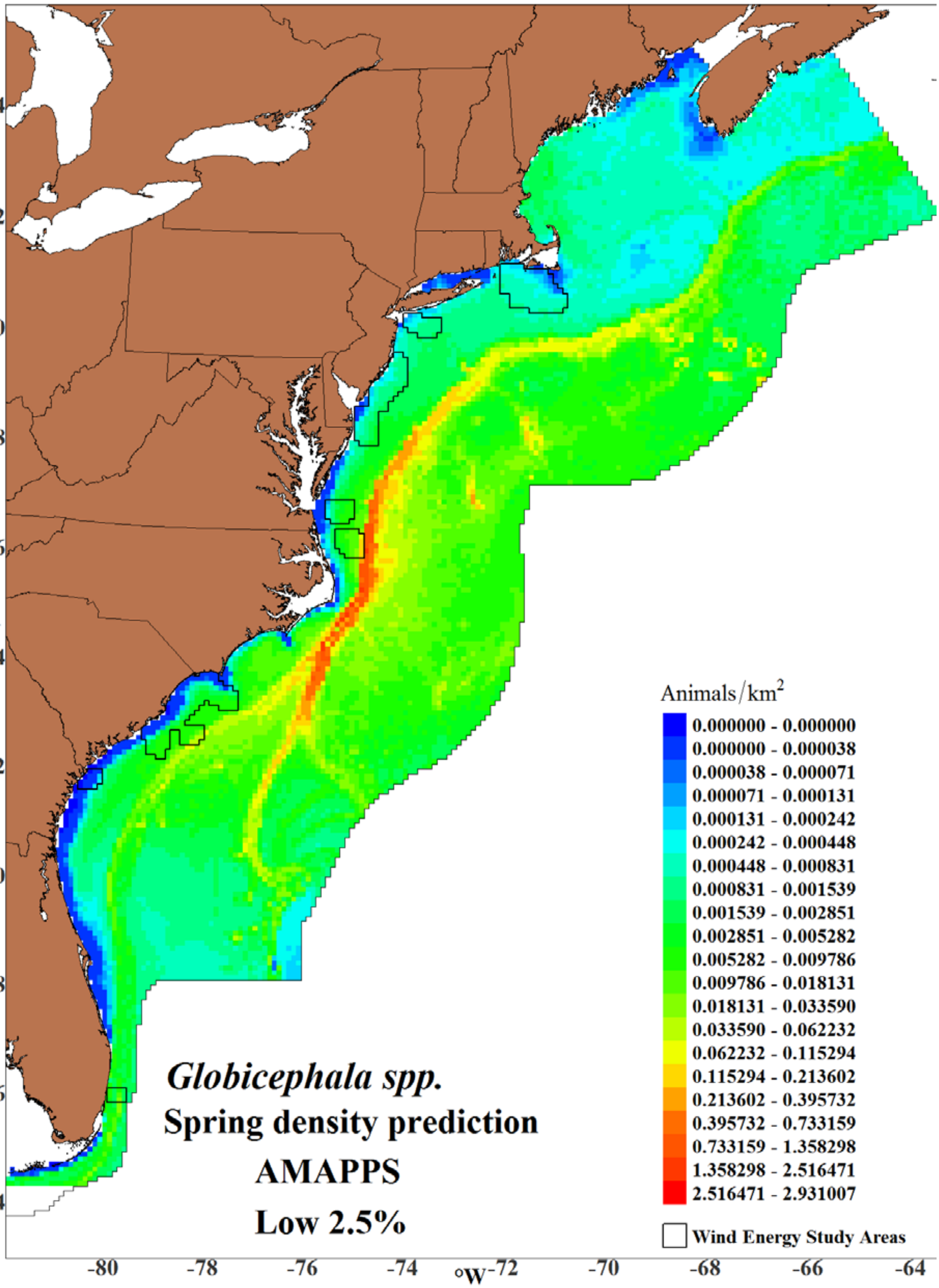

Figure 11-7 Lower 2.5% percentile of spring pilot whale estimates

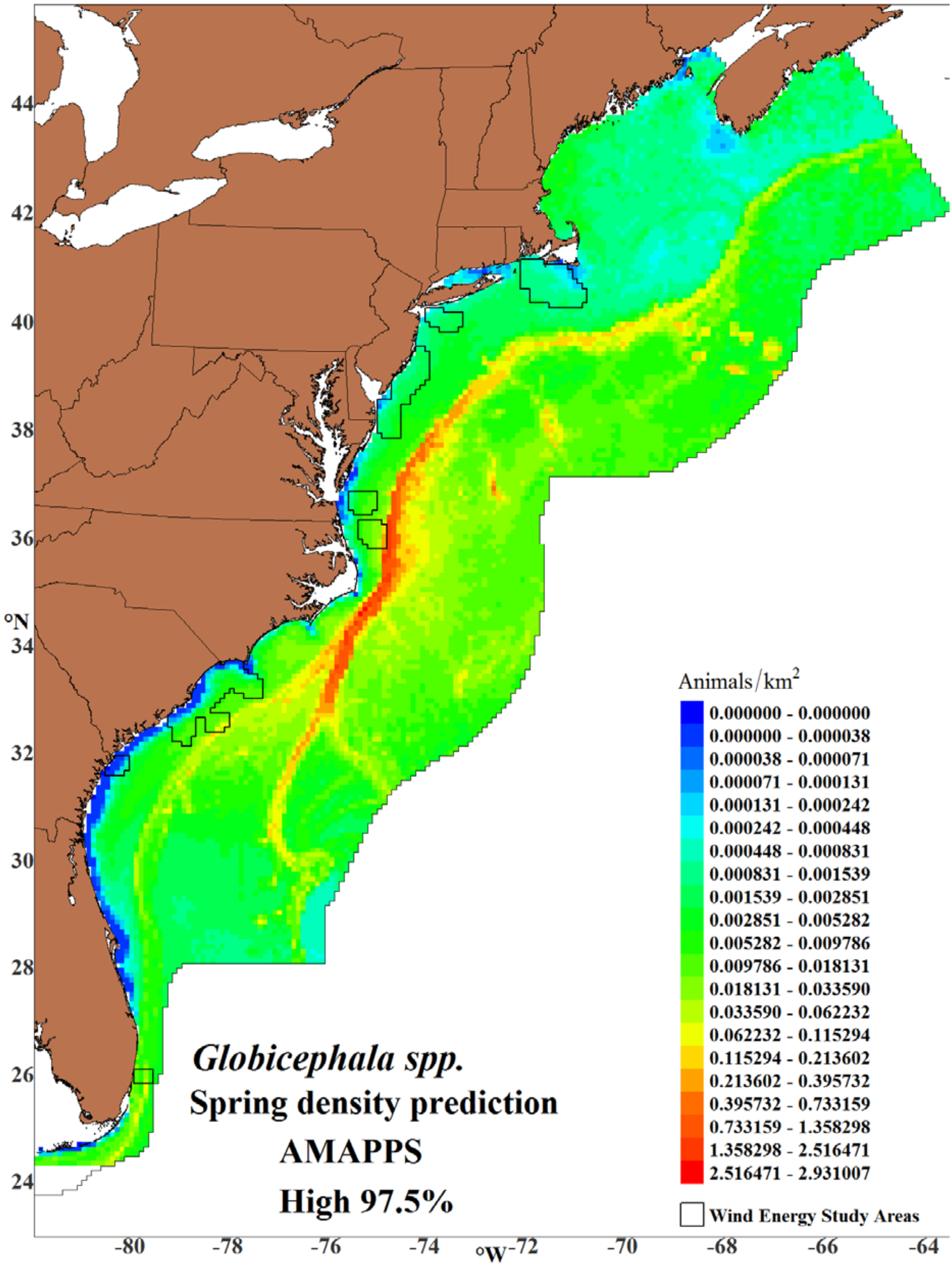

Figure 11-8 Upper 97.5% percentile of spring pilot whale estimates

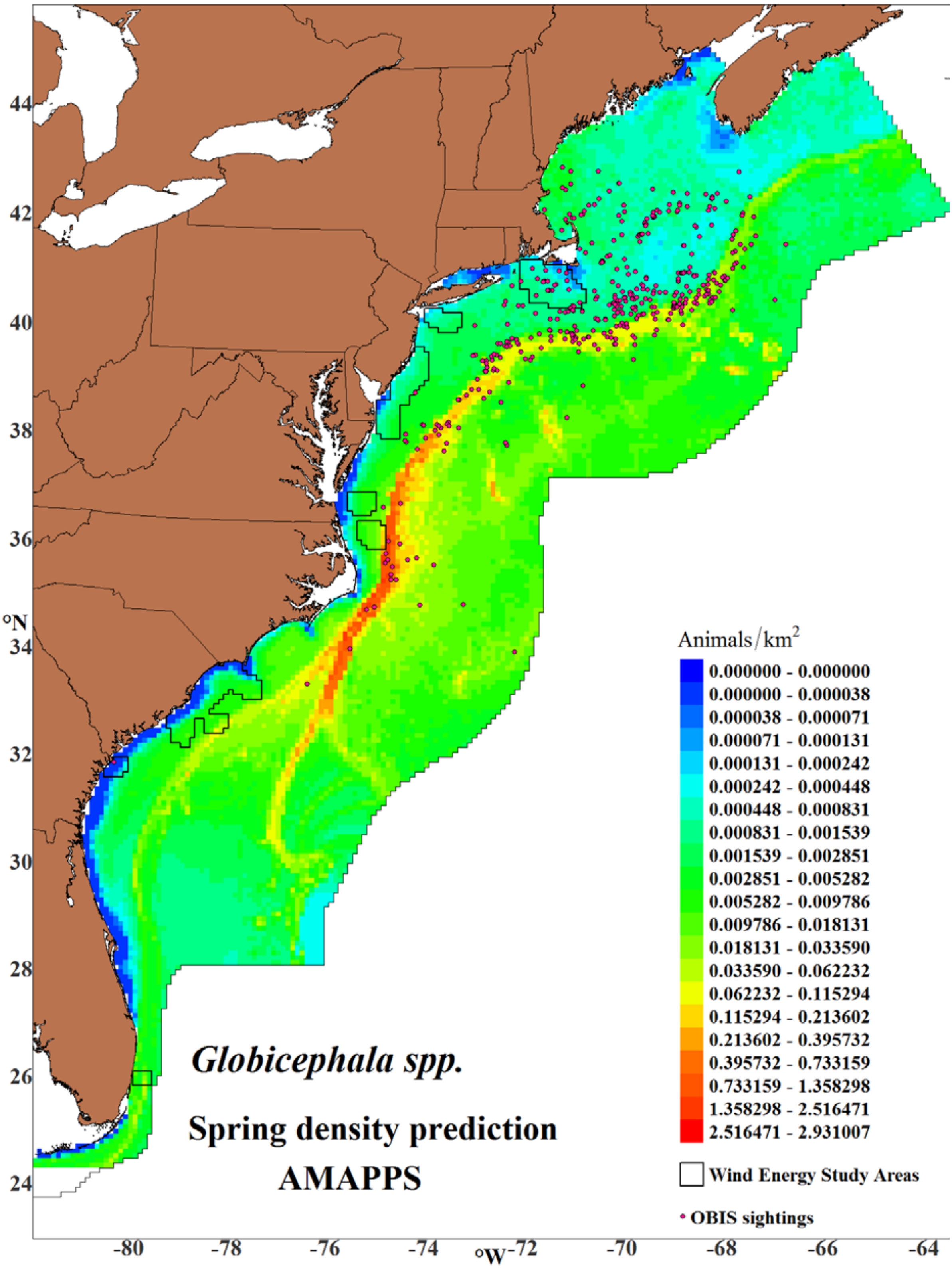

Figure 11-9 Pilot whale 2010-2013 spring density and 1970-2014 OBIS sightings
Pink circles (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

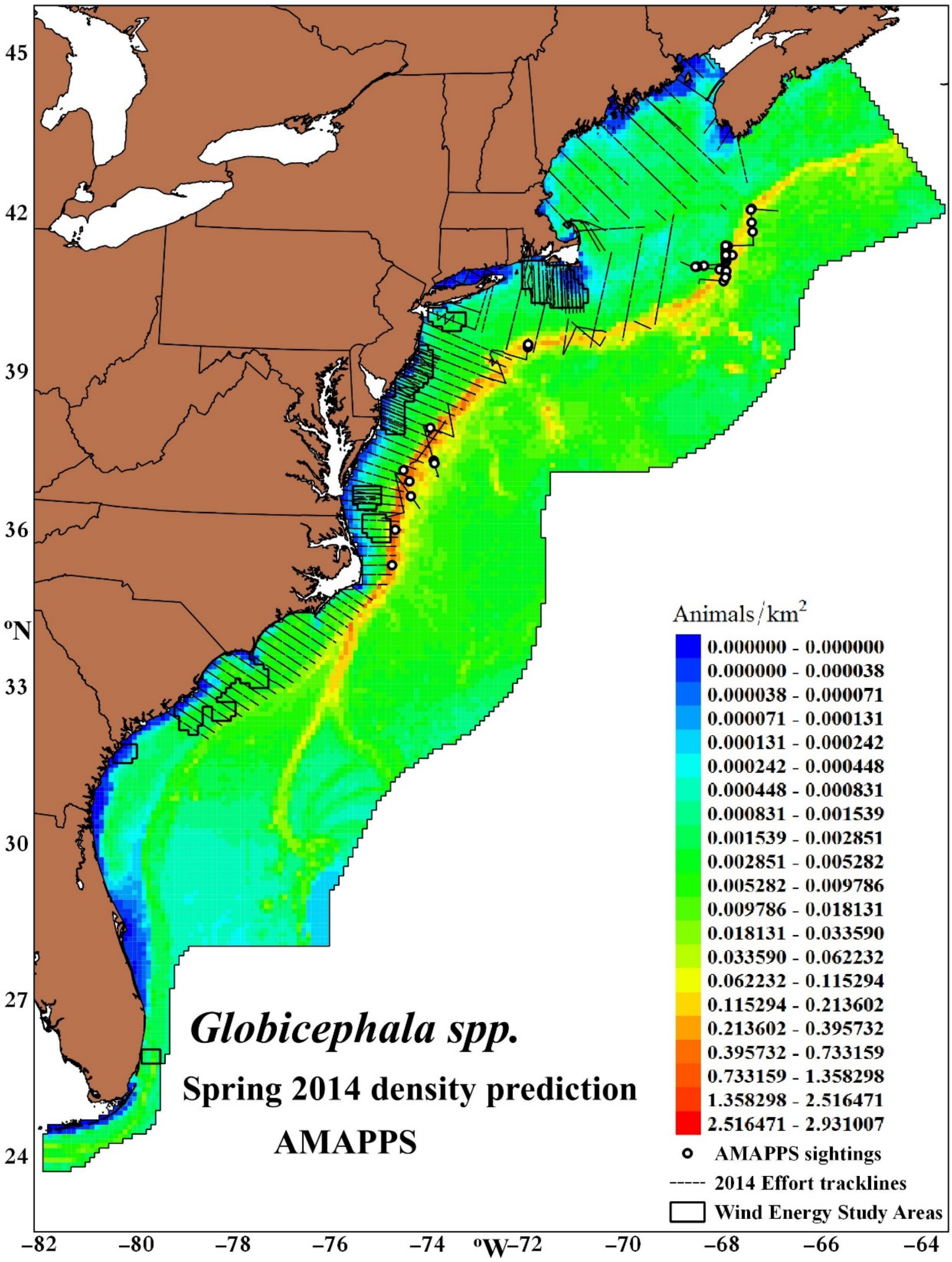

Figure 11-10 Pilot whle spring 2014 density and AMAPPS 2014 tracks and sightings
These sightings were not used to develop the density-habitat model.

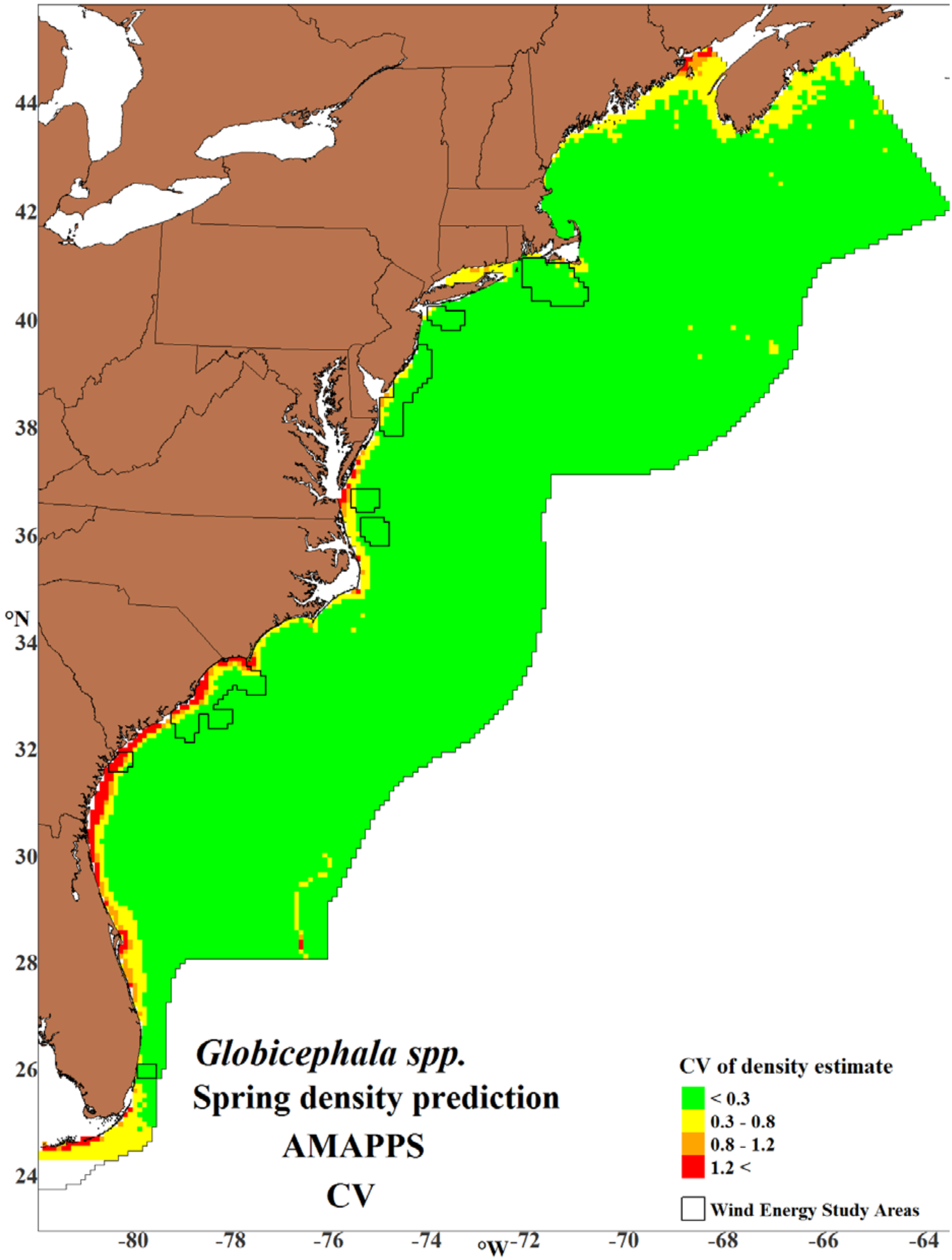

Figure 11-11 CV of spring density estimates for pilot whales

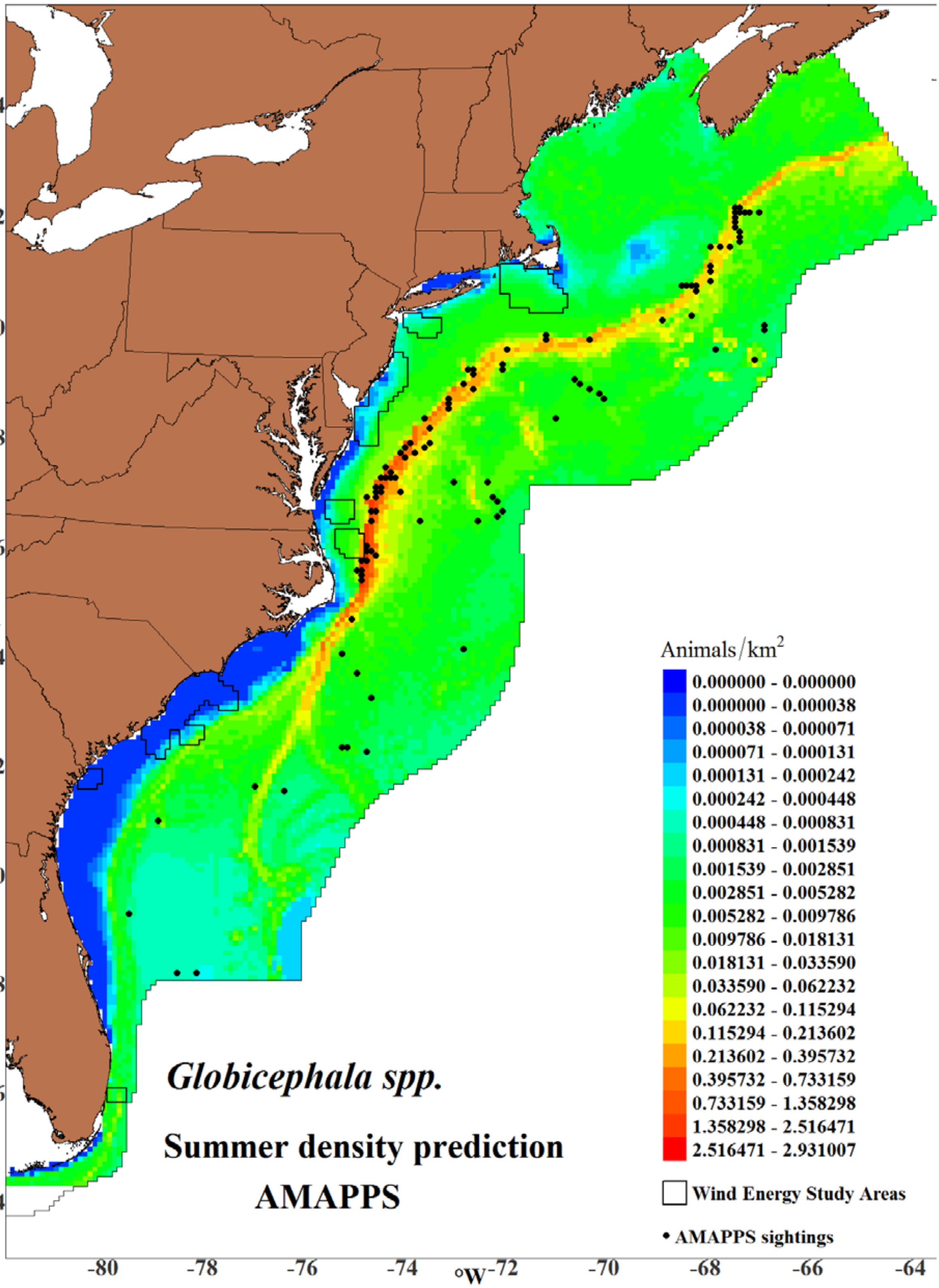

Figure 11-12 Pilot whale summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

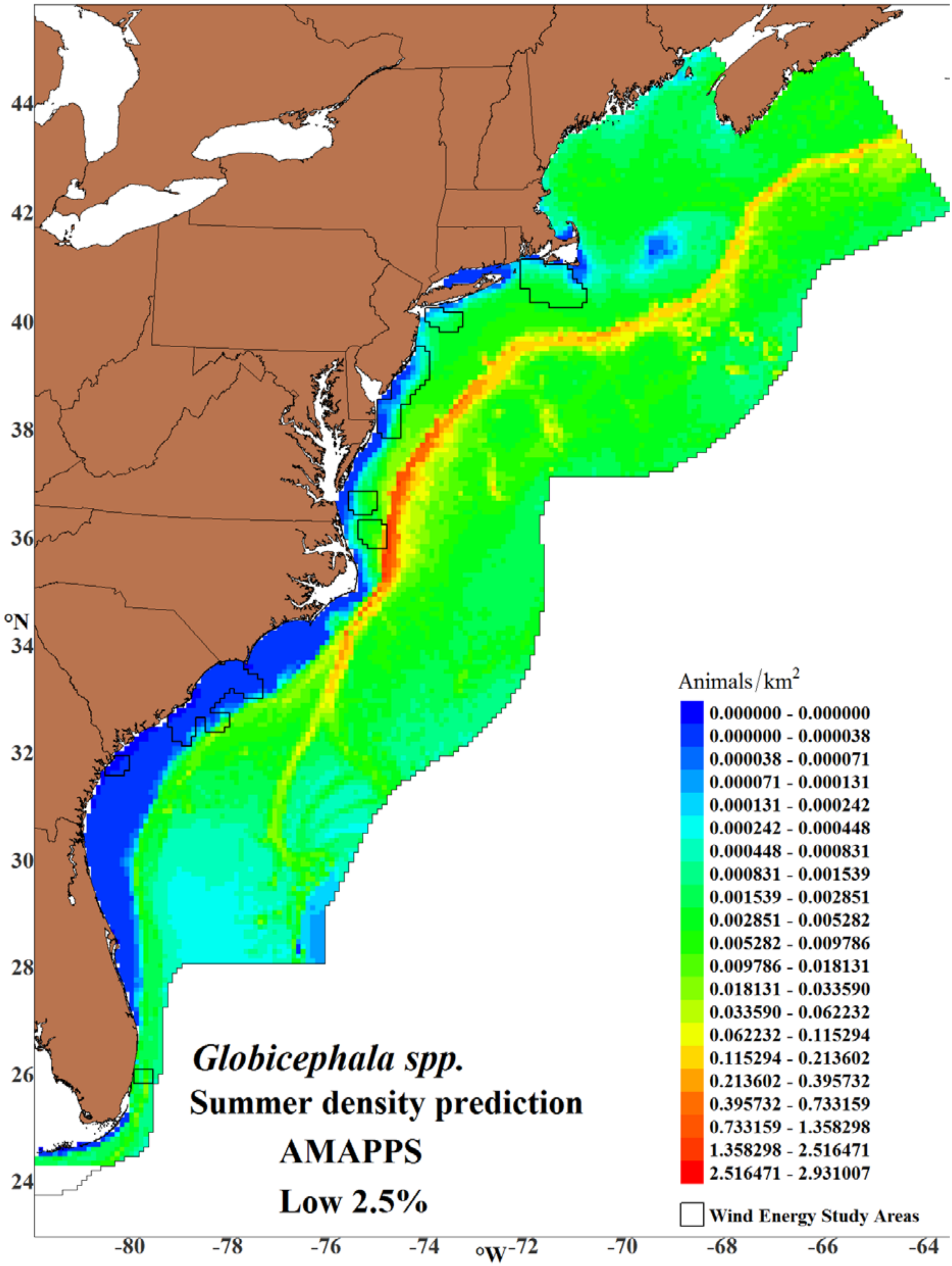

Figure 11-13 Lower 2.5% percentile of spring pilot whale estimates

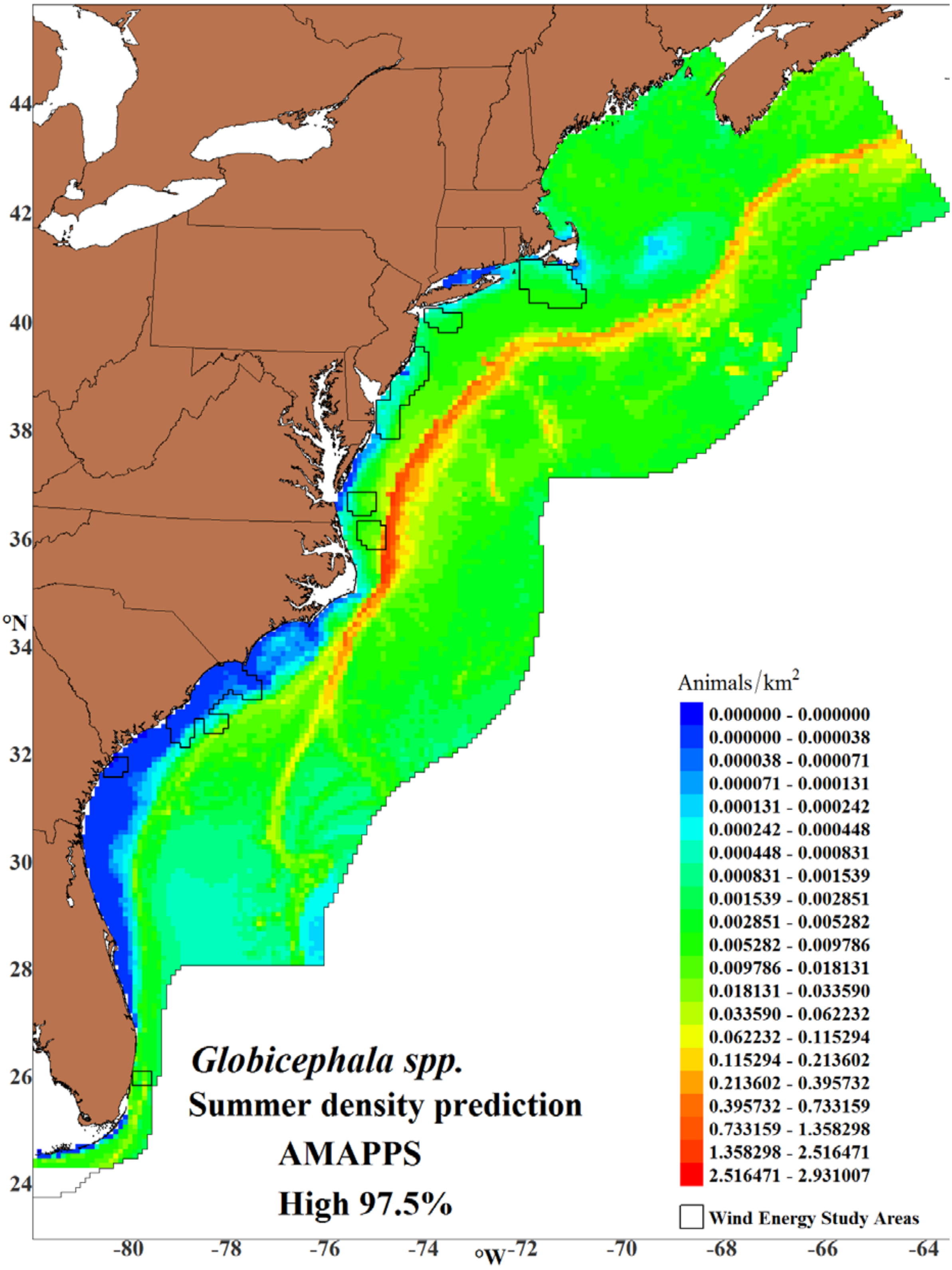

Figure 11-14 Upper 97.5% percentile of summer pilot whale estimates

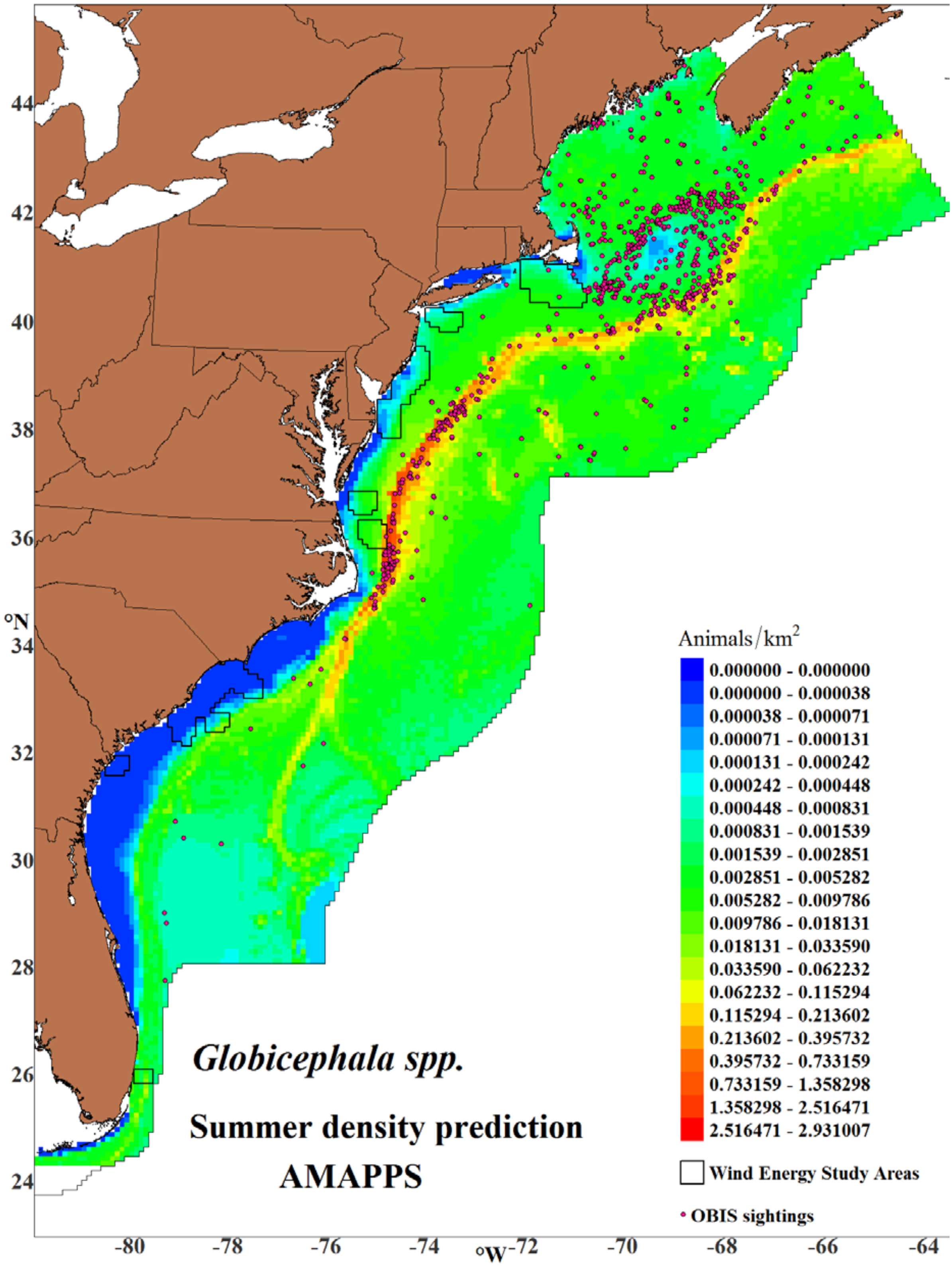

Figure 11-15 Pilot whale 2010-2013 summer density and 1970-2014 OBIS sightings
Pink circles; Halpin *et al*., 2009). These sightings were not used to develop the density-habitat model.

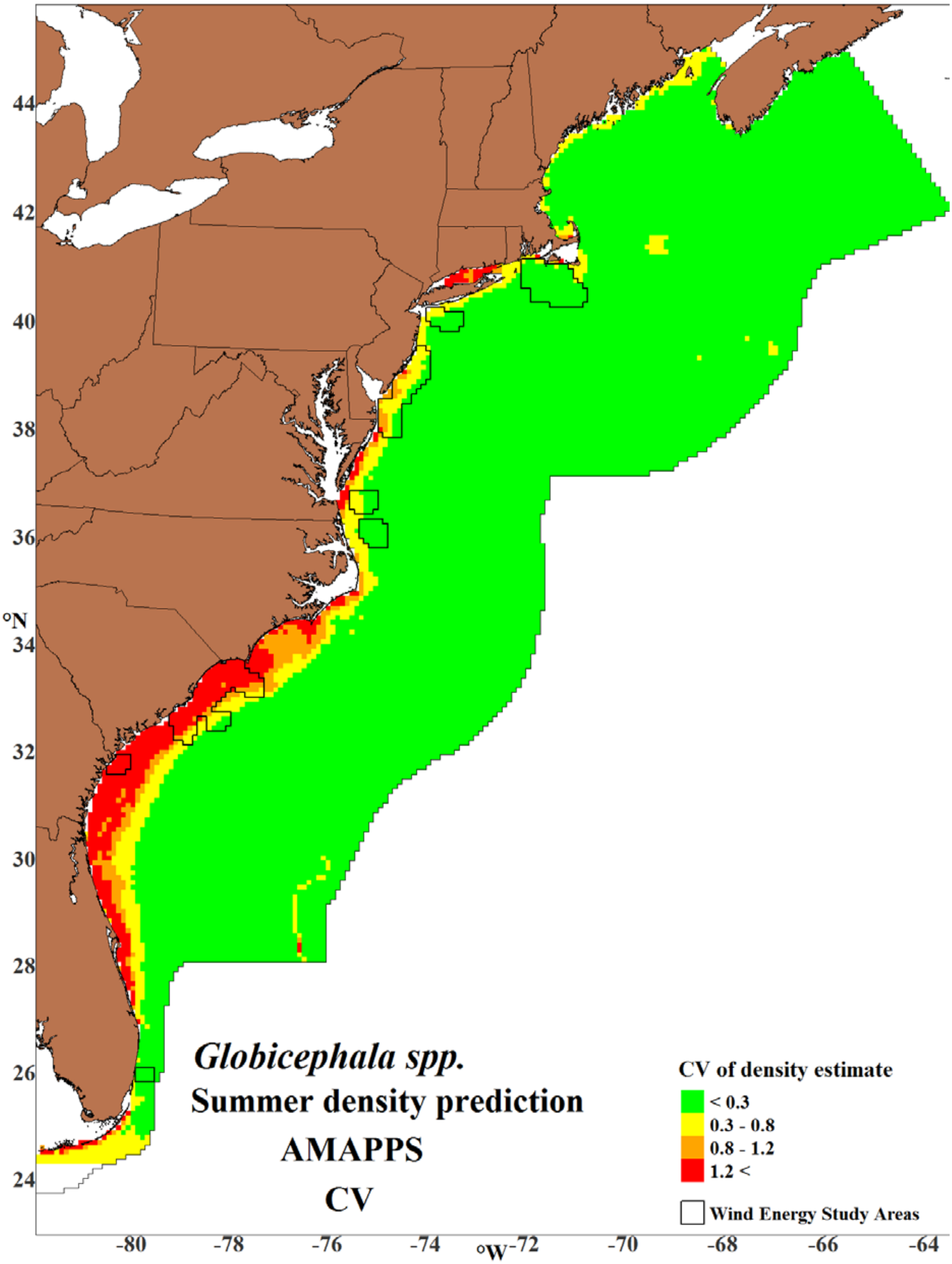

Figure 11-16 CV of summer density estimates for pilot whales

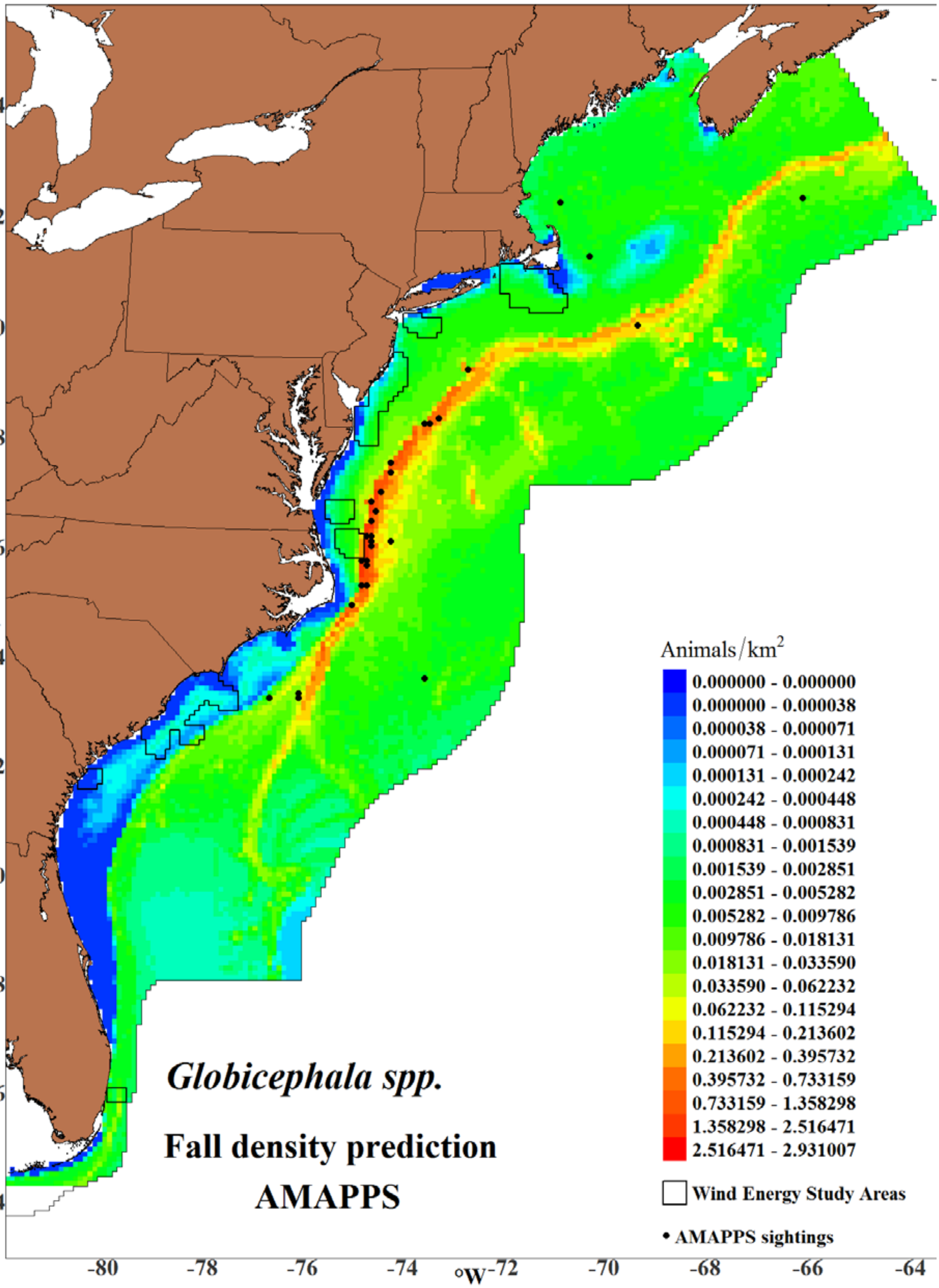

Figure 11-17 Pilot whale fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

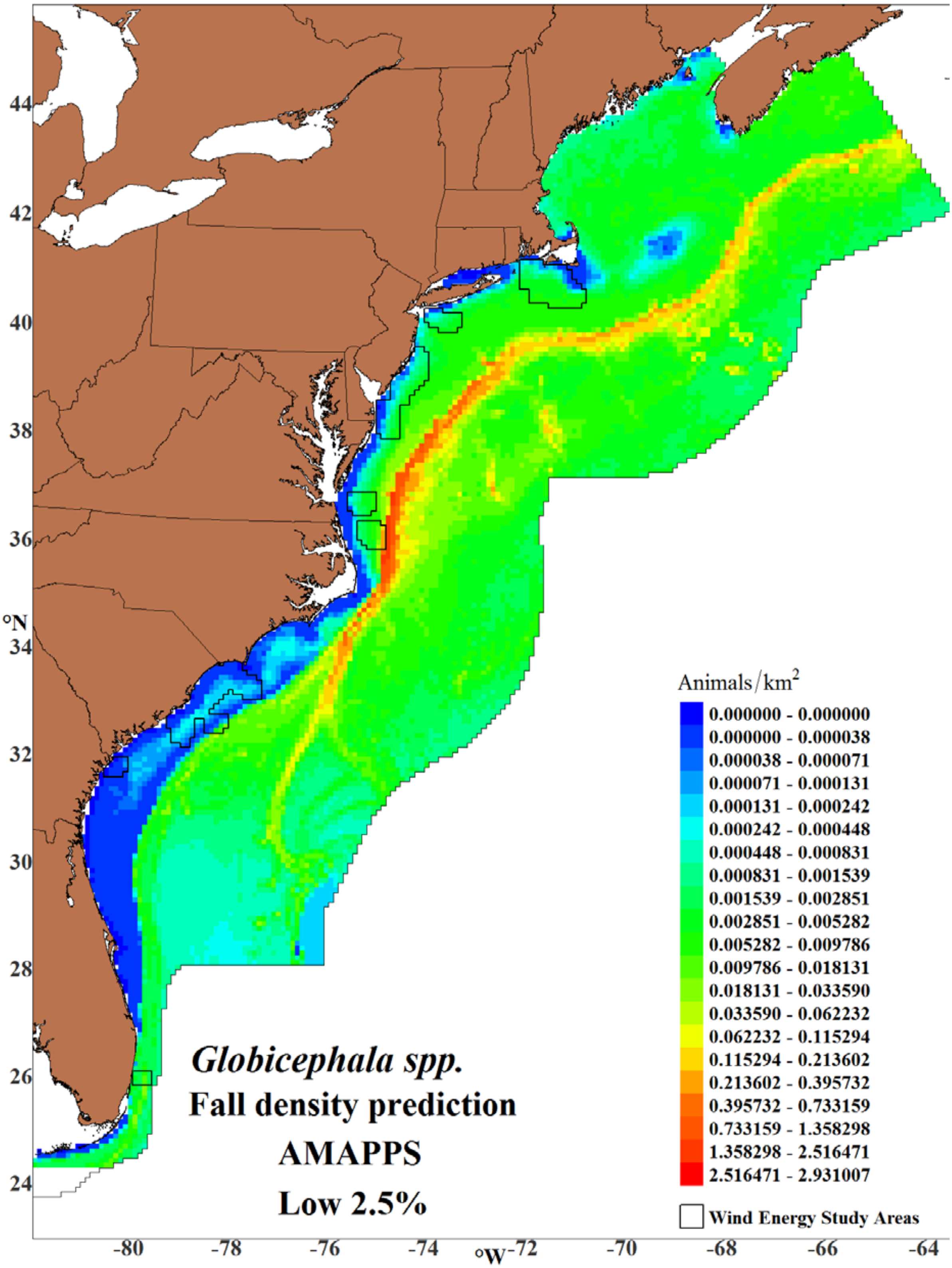

Figure 11-18 Lower 2.5% percentile of fall pilot whale estimates

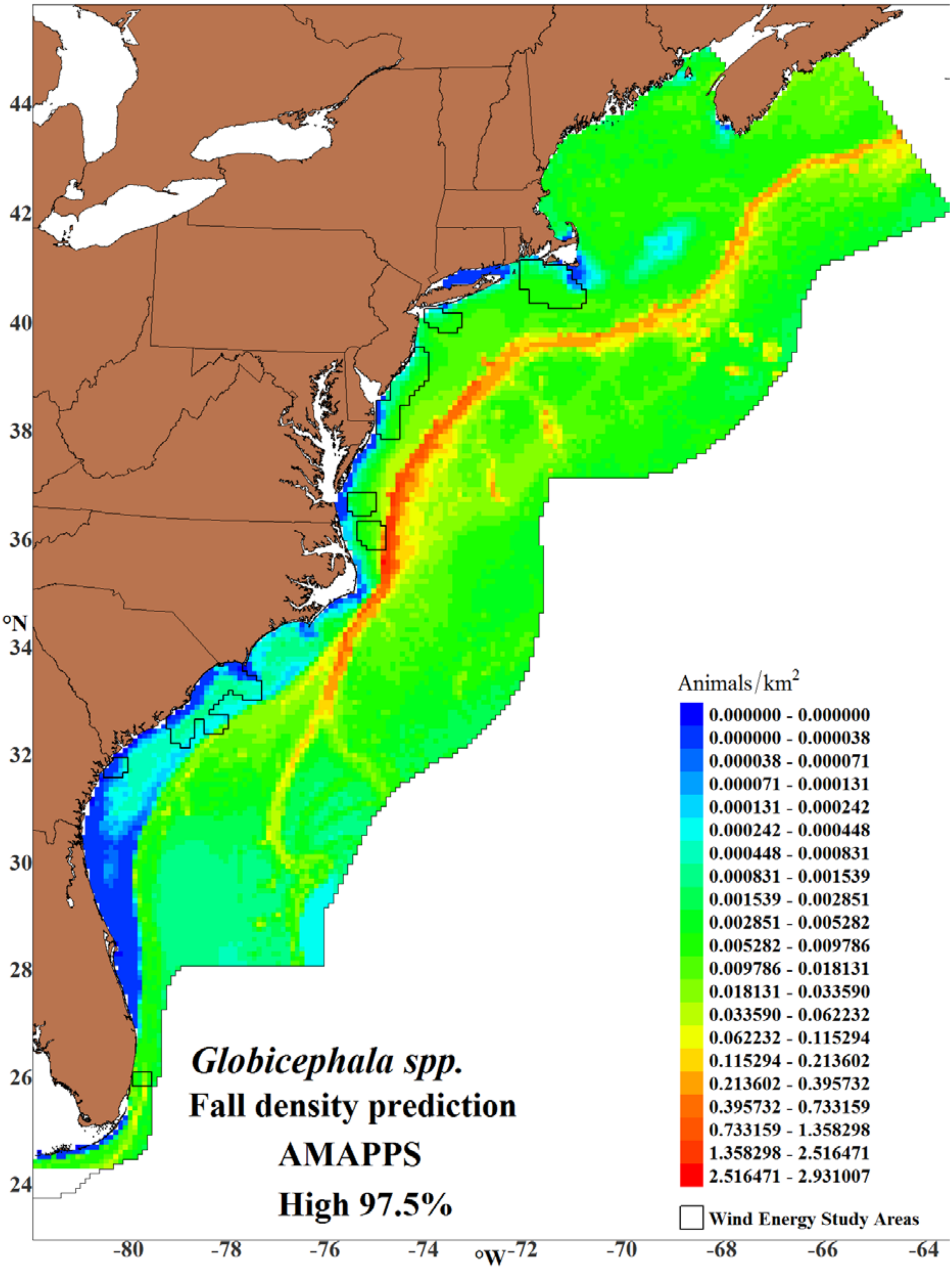

Figure 11-19 Upper 97.5% percentile of fall pilot whale estimates

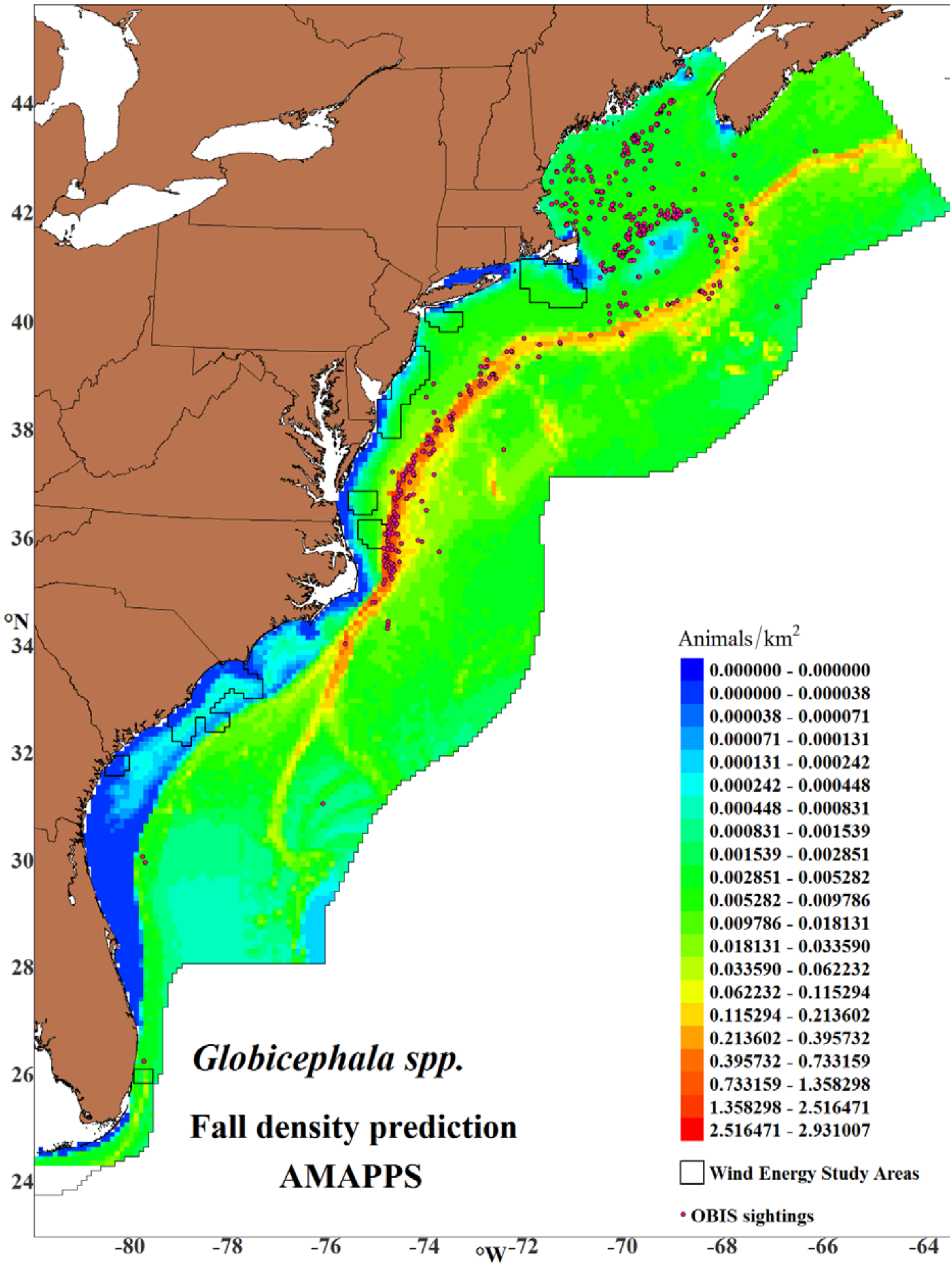

Figure 11-20 Pilot whale 2010-2013 fall density and 1970-2014 OBIS sightings
Pink circles (Halpin *et al.* 2009). These sightings were not used to develop the density-habitat model.

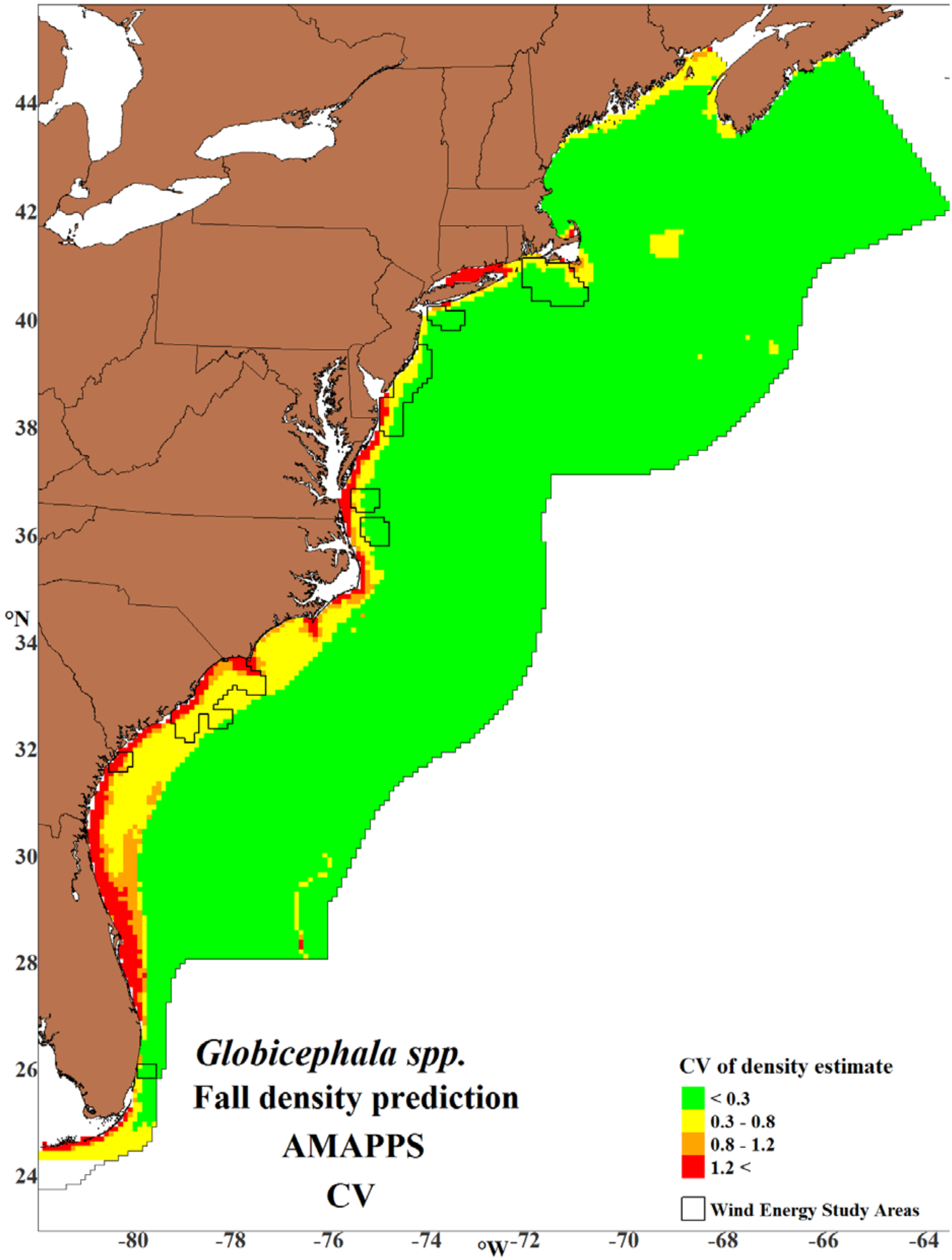

Figure 11-21 CV of fall density estimates for pilot whales

11.6 Wind Energy Study Areas

Table 11-6 Pilot whale average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.679, CV=0.241; shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	8	0.163	6 - 11
(March-May)	New York	4	0.169	3 - 5
	New Jersey	9	0.173	7 - 13
	Delaware/ Maryland	7	0.175	5 - 10
	Virginia	15	0.158	11 - 20
	North Carolina	124	0.112	100 - 155
	South Carolina/ North Carolina	82	0.133	63 - 106
	Georgia	0	0.35	0 - 0
	Florida	12	0.257	7 - 20
Summer	Rhode Island/ Massachusetts	37	0.122	29 - 47
(June-August)	New York	6	0.179	4 - 9
	New Jersey	9	0.251	5 - 14
	Delaware/ Maryland	6	0.214	4 - 10
	Virginia	14	0.203	9 - 20
	North Carolina	175	0.096	145 - 211
	South Carolina/ North Carolina	11	0.158	8 - 15
	Georgia	0	2.304	0 - 0
	Florida	7	0.237	5 - 12
Fall	Rhode Island/ Massachusetts	47	0.137	36 - 62
(September- November)	New York	9	0.18	6 - 13
	New Jersey	18	0.248	11 - 29
	Delaware/ Maryland	9	0.236	6 - 14
	Virginia	12	0.221	8 - 19
	North Carolina	165	0.105	134 - 202
	South Carolina/ North Carolina	9	0.221	6 - 14
	Georgia	0	0.695	0 - 0
	Florida	9	0.256	6 - 15

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value predicted by the habitat model.

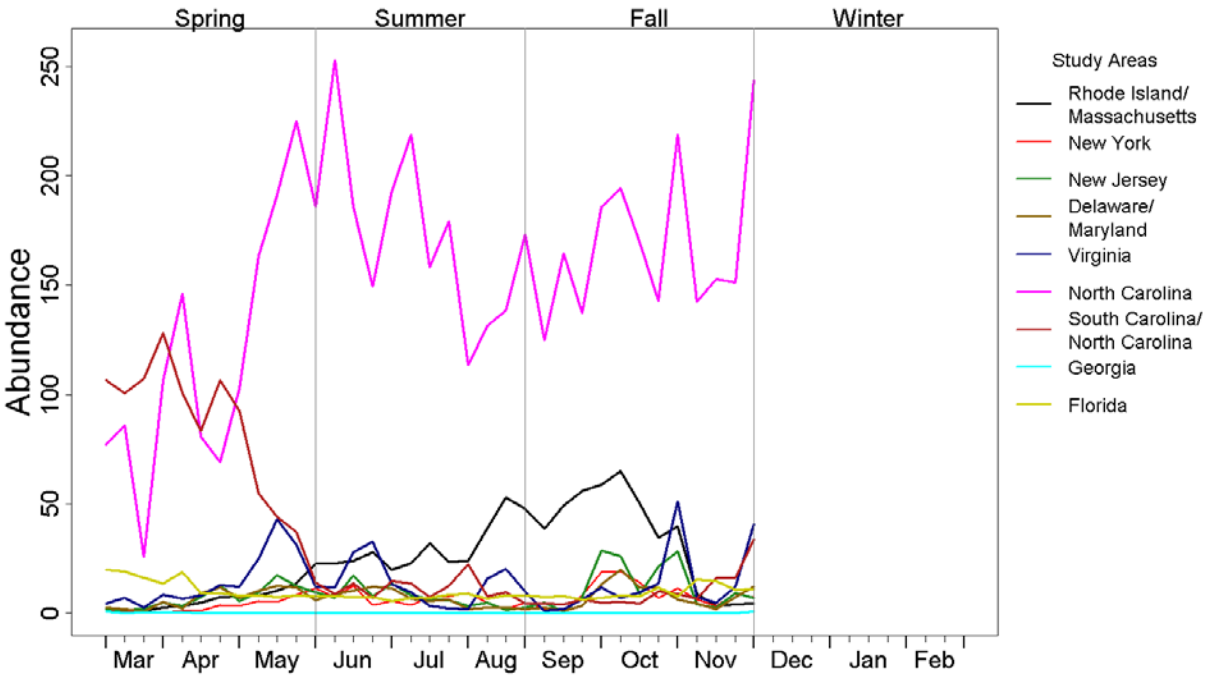

Figure 11-22 Annual abundance trends for pilot whales in wind energy study areas

12 Risso's Dolphin (*Grampus griseus*)

Figure 12-1 Risso's dolphin. Credit: NOAA/NEFSC/Peter Duley
Image collected under MMPA Research permit #775-1875.

12.1 Data Collection

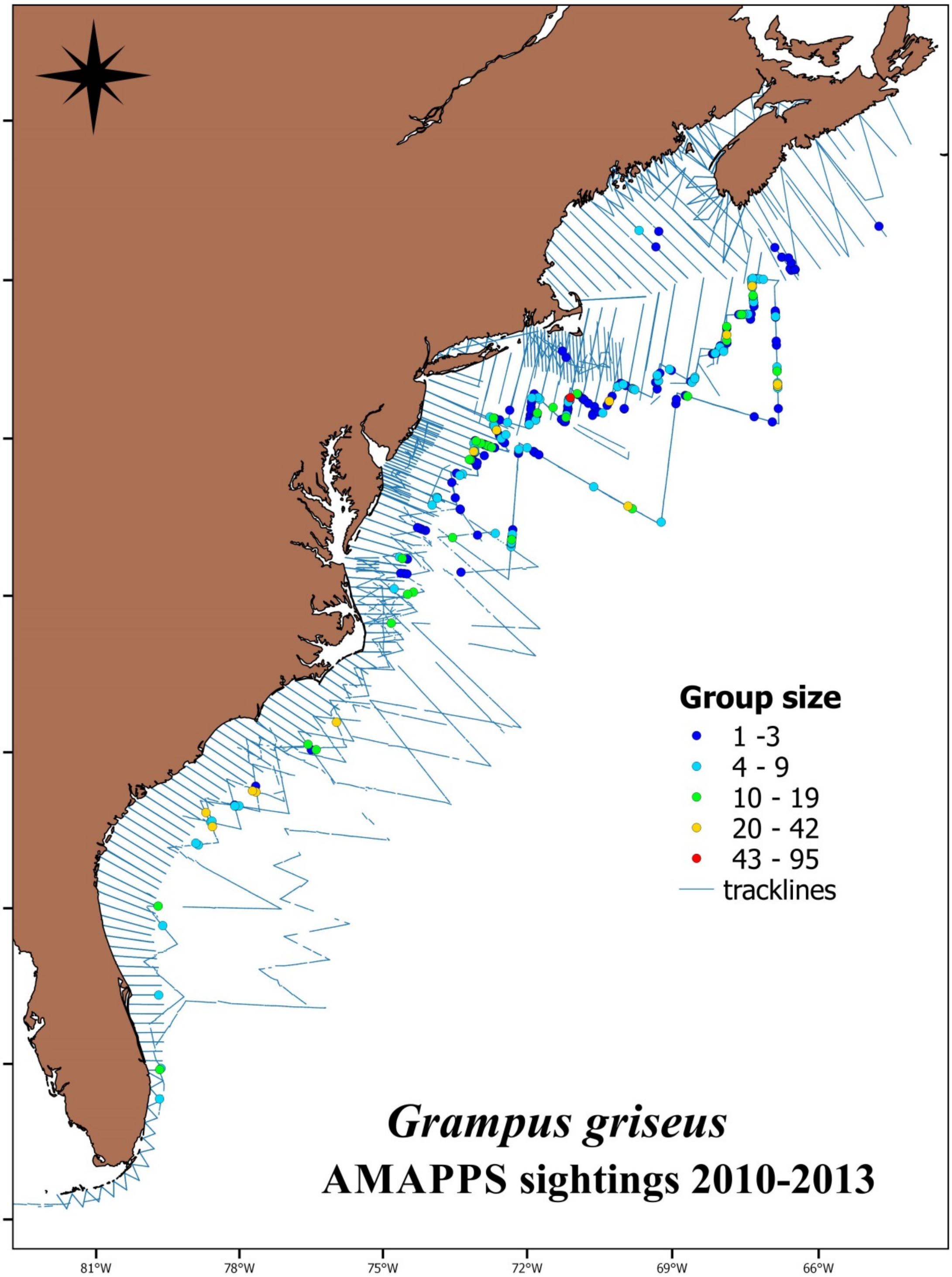

Figure 12-2 Track lines and Risso's dolphin sightings during 2010 - 2013

Table 12-1 Research effort 2010 - 2013 and Risso's dolphin sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Risso’s dolphin	*Grampus griseus*	0/0	224/1,215	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	11/33	1/15	18/143	23/61
SE Shipboard	0	8,537	2,093	0	-	-	0/0	21/254	5/44	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	22/106	11/162	1/5	0/0

12.2 Mark-Recapture Distance Sampling Analysis

Table 12-2 Parameter estimates from Risso's dolphin (RIDO) MRDS analysis
HR=Hazard Rate, HN= Half Normal, LT= Left truncation, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 2	-	LSPW,RIDO, RTDO	Distance+observer	Distance	400	HR	0.712	0.171	0.454	0.331	0.389
NE-aerial group 2	1	CBDO,LSPW, RIDO	Distance	Distance+sea	LT35-861	HR	0.647	0.147	0.397	0.966	0.958
	2		-	Distance	861	HR	-	-	0.129	0.892	0.765
SE-shipboard group 3	-	FKWH,LSPW , RIDO,RTDO	Distance	Distance+sea	5000	HR	0.671	0.114	0.683	0.918	0.925
NE-shipboard group 6	-	LFPW,LSPW, SFPW	Distance+observer	Distance+swell	5000	HR	0.674	0.073	0.329	0.815	0.880

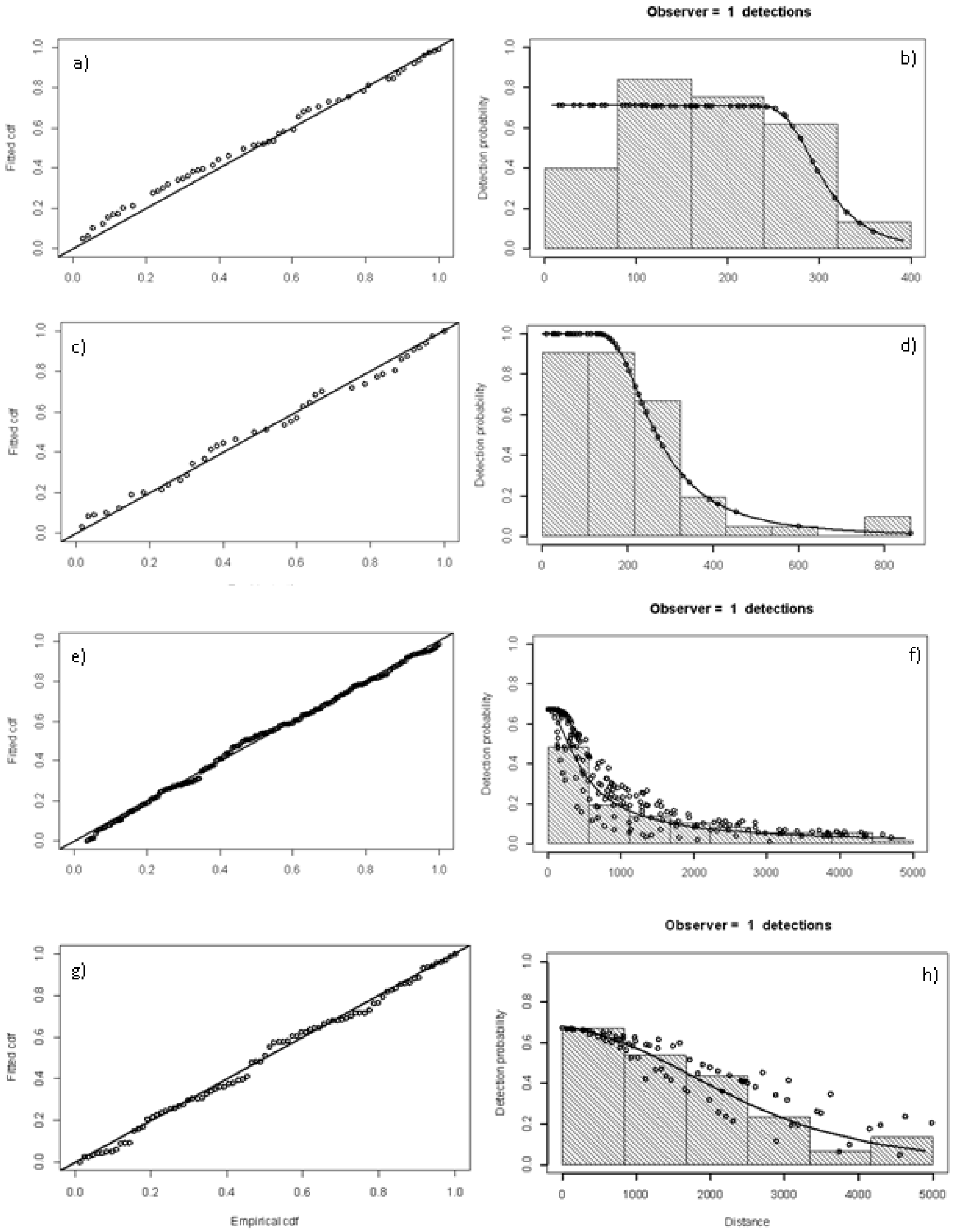

Figure 12-3 Q-Q plots and detection functions from Risso's dolphin MRDS analysis
Group 2 aerial southeast region (a,b), group 2 aerial northeast region (c,d), group 6 shipboard northeast region (e,f) and group 3 shipboard southeast region (g,h).

12.3 Generalized Additive Model Analysis

Table 12-3 Habitat model output for Risso's dolphins

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	1.314	4	62.33	<2e-16	1.14E-02	***
s(btemp)	2.866	4	32.99	<2e-16	1.61E-01	***
s(dist2shore)	3.607	4	150.68	<2e-16	3.02E-03	***
s(slope)	3.69	4	67.32	<2e-16	1.08E+00	***
s(dist125)	3.534	4	100.9	<2e-16	1.71E-07	***
Scale	-	-	-	-	1.59E+00	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom: Total = 16.01

R^2 (adjusted) = 0.028 Deviance explained = 49.6%

REML = 1351.5 Scale estimate = 0.55835 sample size = 11493

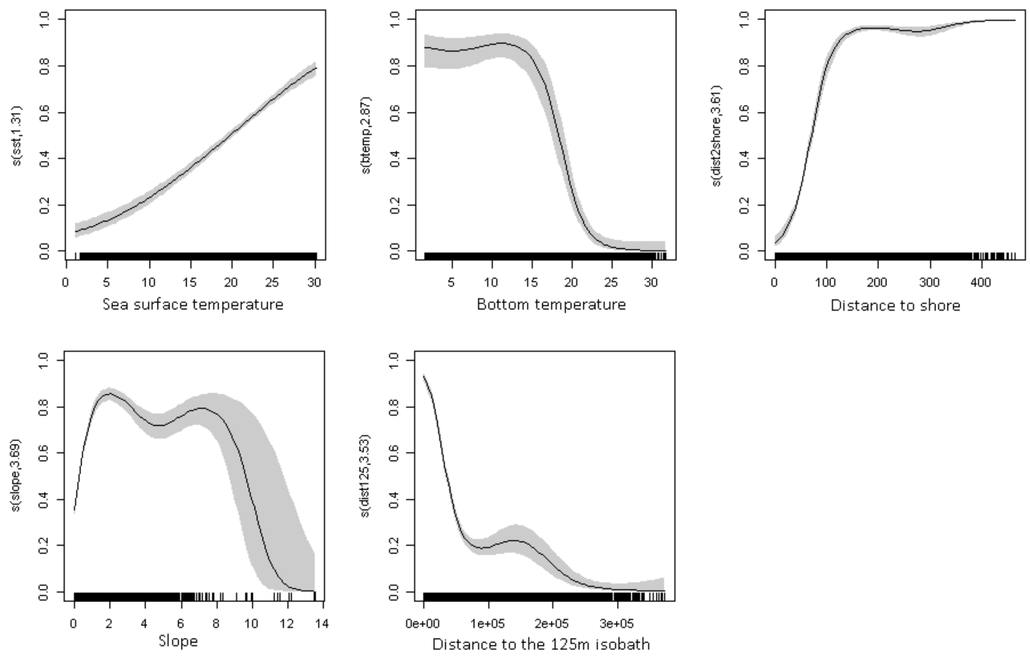

Figure 12-4 Risso's dolphin density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 12-4 Diagnostic statistics from Risso's dolphin habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.102	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	85.38	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.186	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.076	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

12.4 Abundance Estimates for the AMAPPS Study area

Table 12-5 Risso's dolphin average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.850, CV=0.173; shipboard 1.0, CV=0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	12,759	0.207	8,540 – 19,061
Summer (June-August)	36,785	0.205	24,738 – 54,699
Fall (September-November)	29,093	0.205	19,551 – 43,292

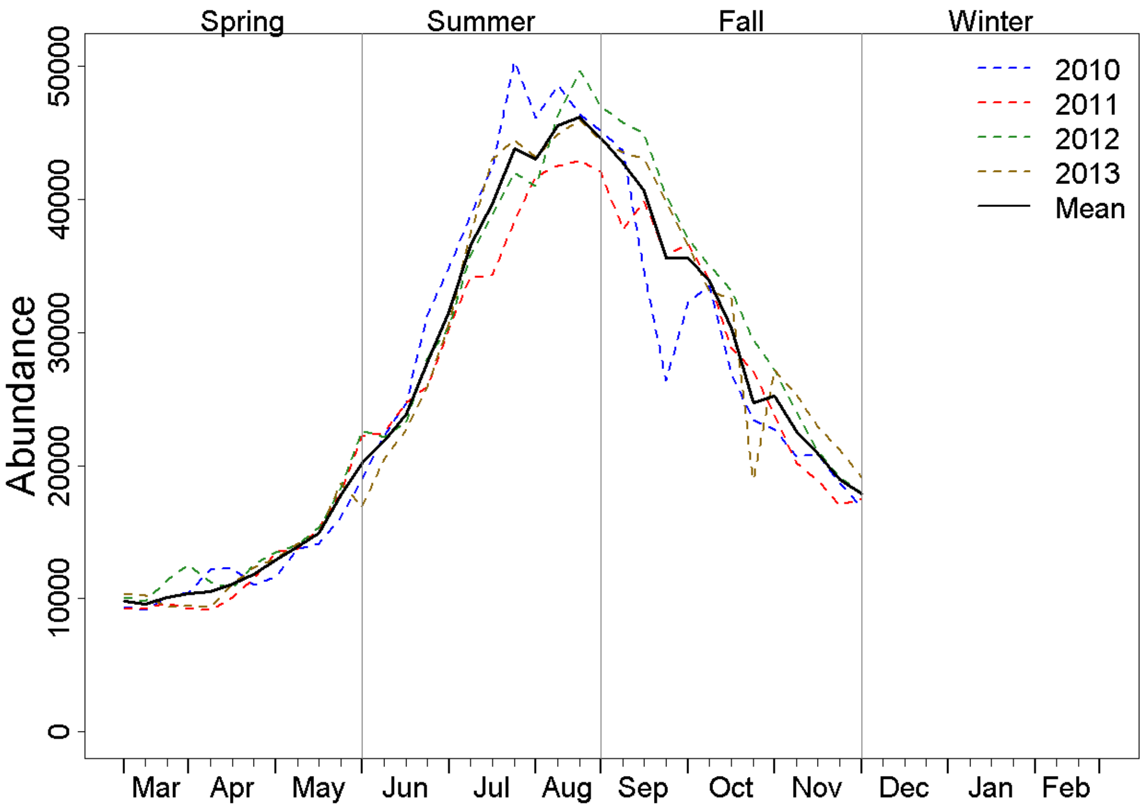

Figure 12-5 Annual abundance trends for Risso's dolphins for AMAPPS study area

12.5 Seasonal Prediction Maps

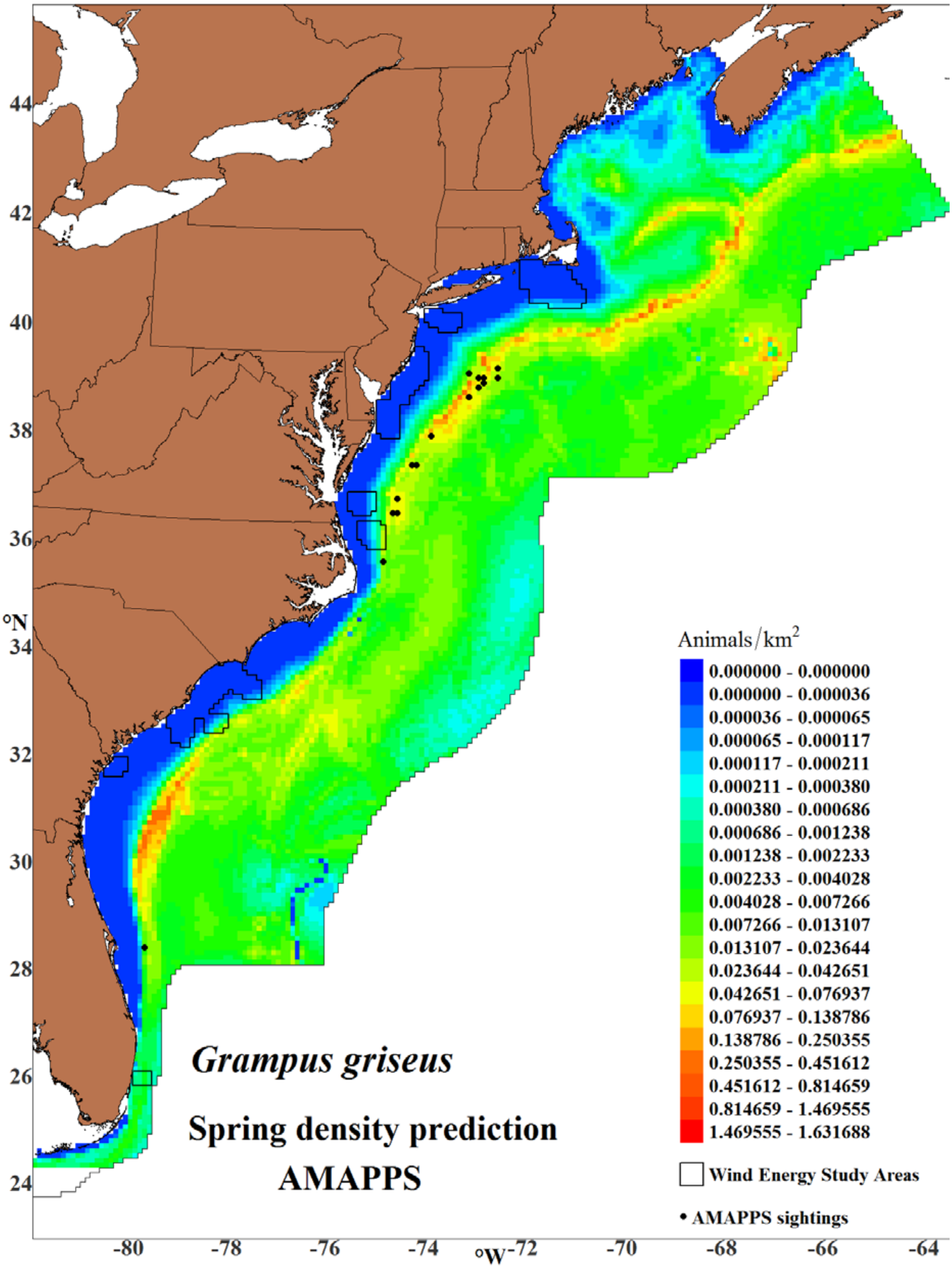

Figure 12-6 Risso's dolphin spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

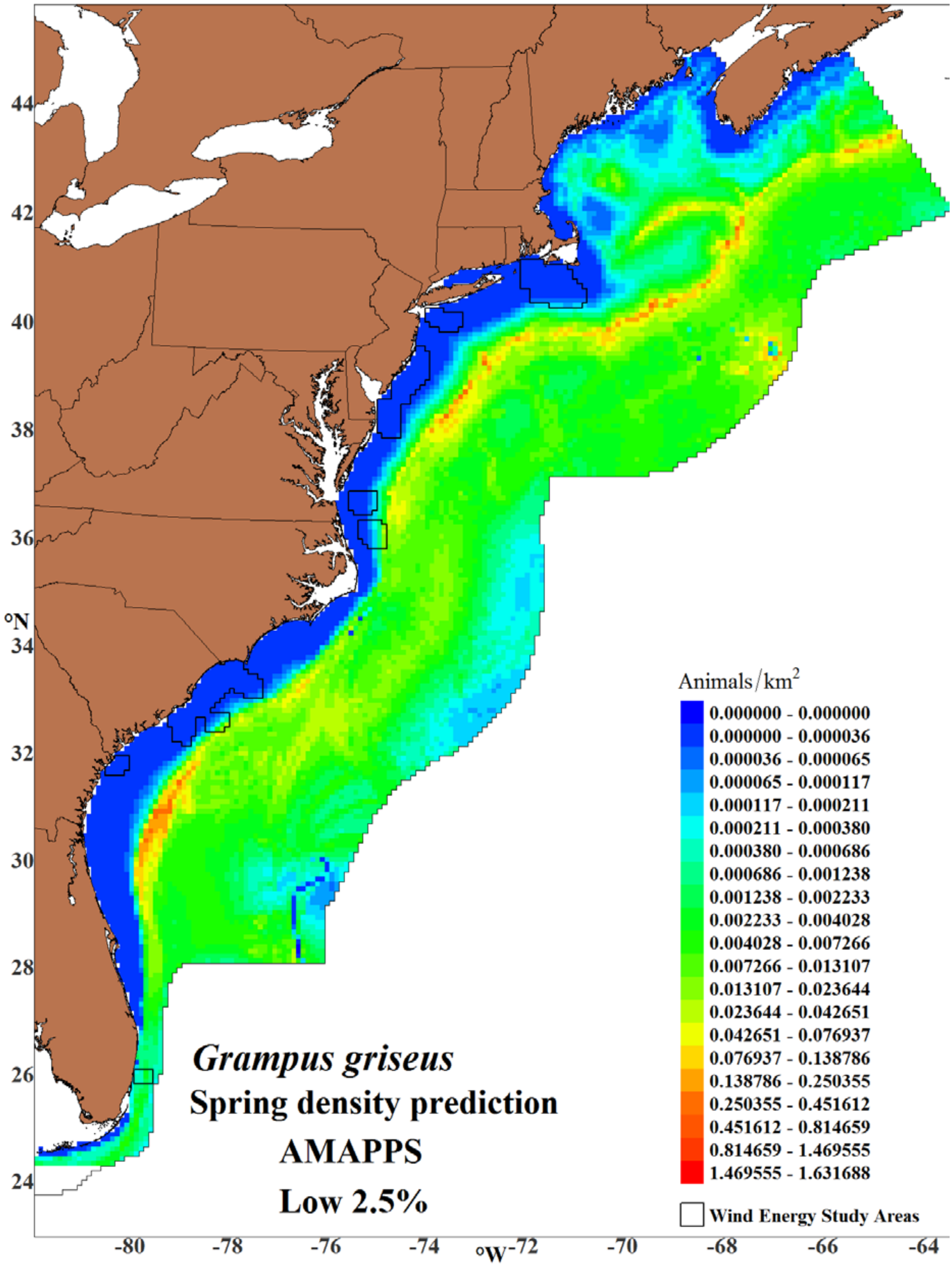

Figure 12-7 Lower 2.5% percentile of spring Risso's dolphin estimates

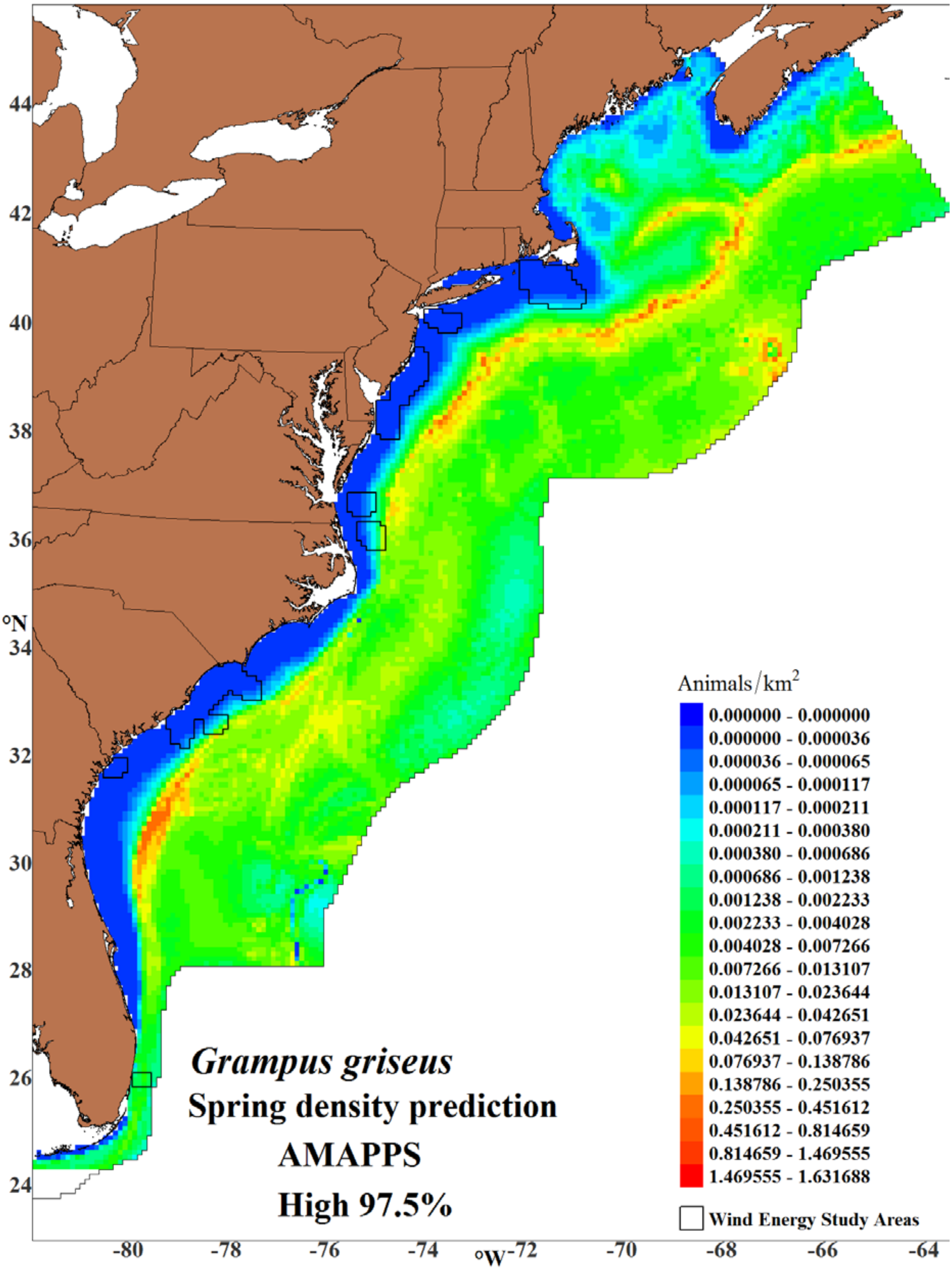

Figure 12-8 Upper 97.5% percentile of spring Risso's dolphin estimates

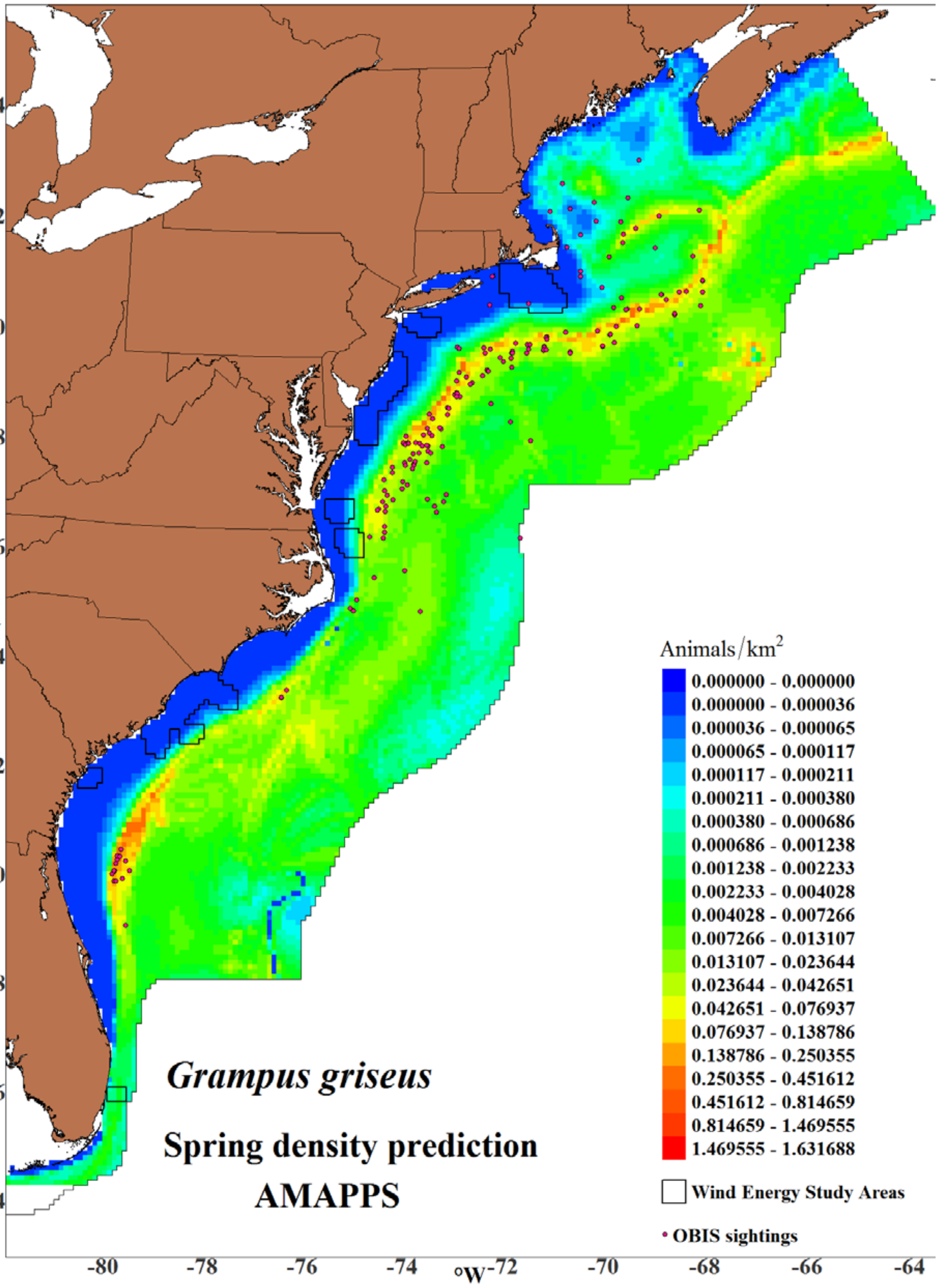

Figure 12-9 Risso's dolphin 2010-2013 spring density and 1970-2014 OBIS sightings
Pink circle (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

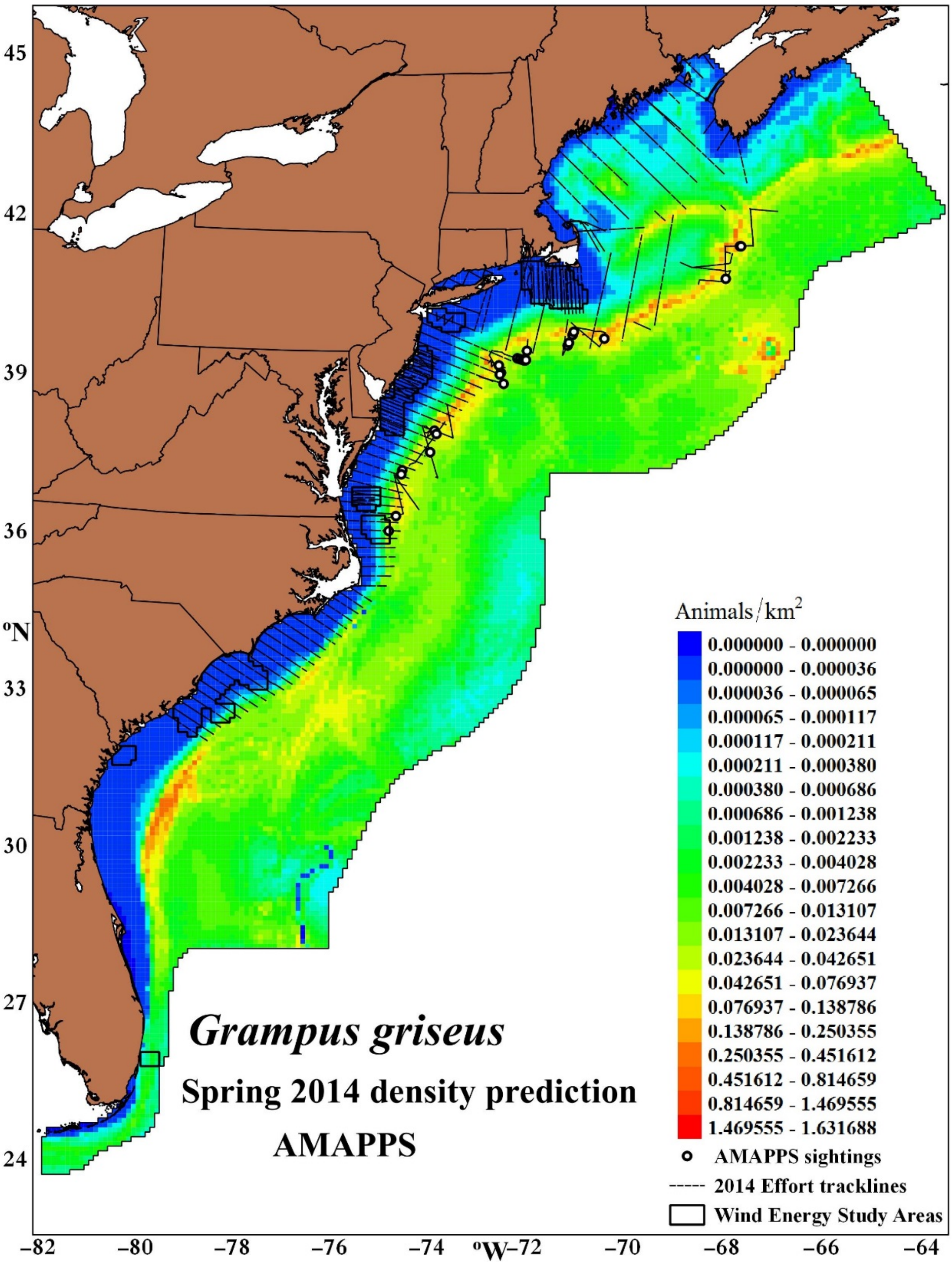

Figure 12-10 Risso's dolphin spring 2014 density and AMAPPS 2014 tracks and sightings
These sightings were not used to develop the density-habitat model.

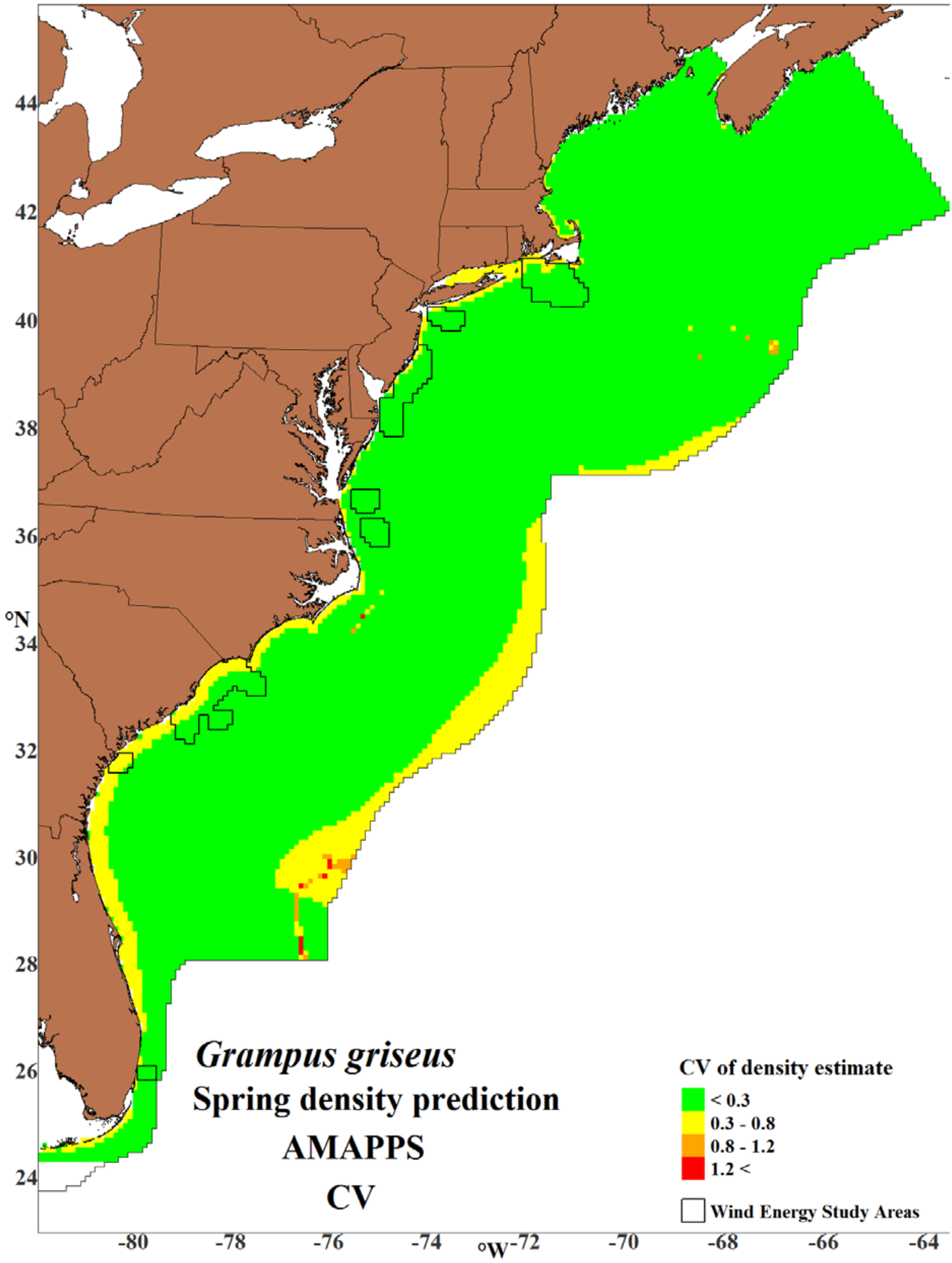

Figure 12-11 CV of spring density estimates for Risso's dolphins

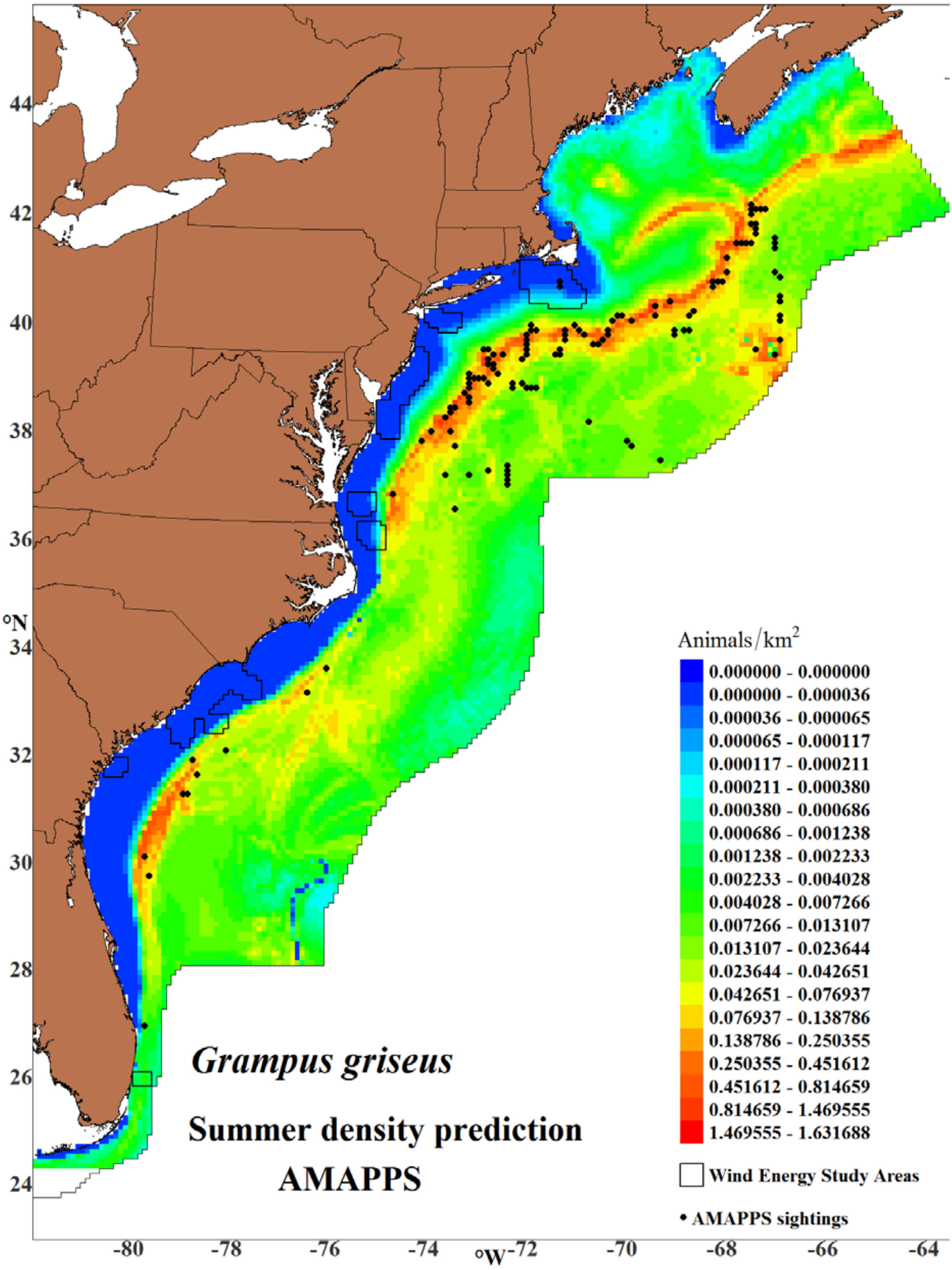

Figure 12-12 Risso's dolphin summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

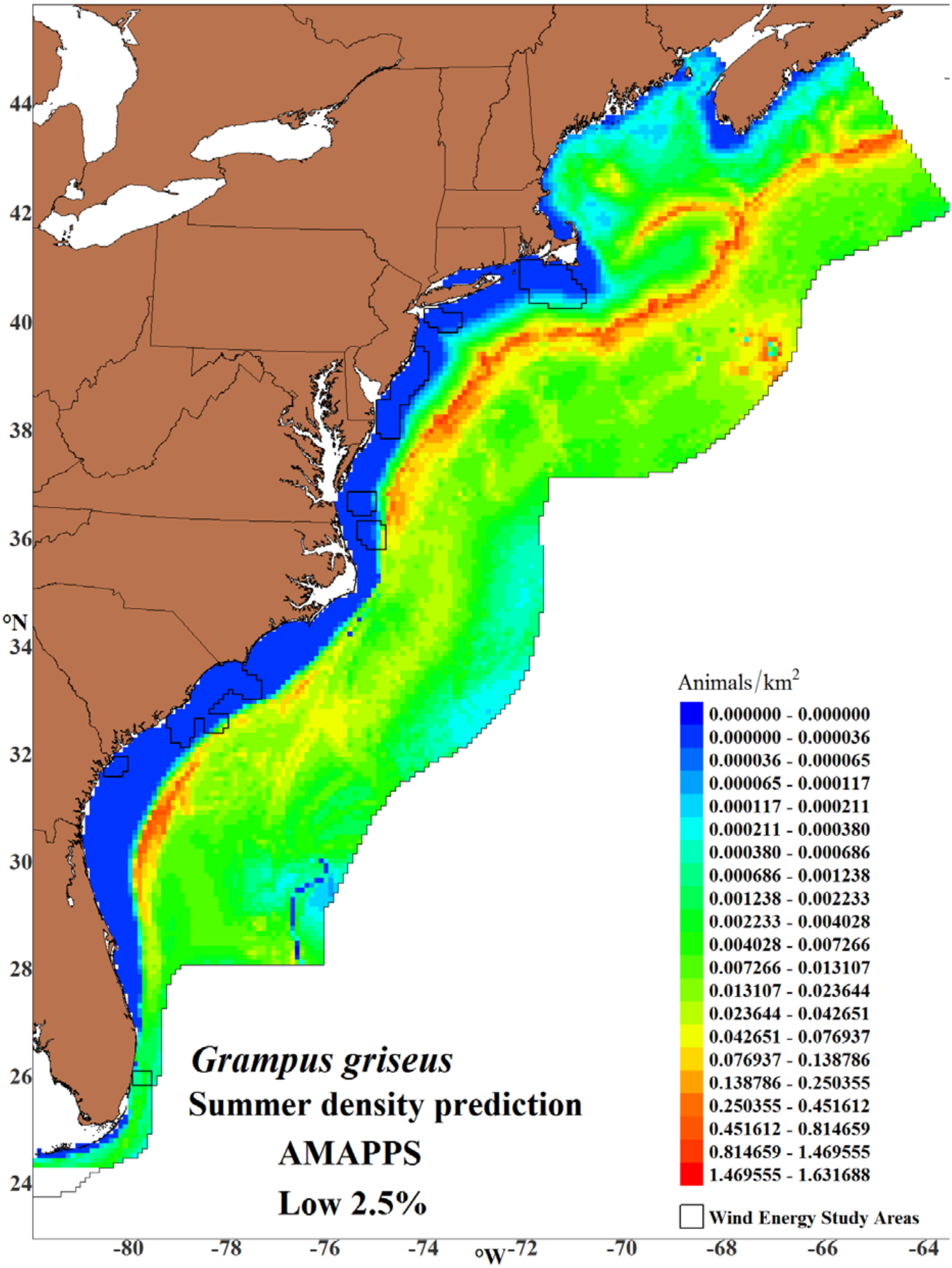

Figure 12-13 Lower 2.5% percentile of summer Risso's dolphin estimates

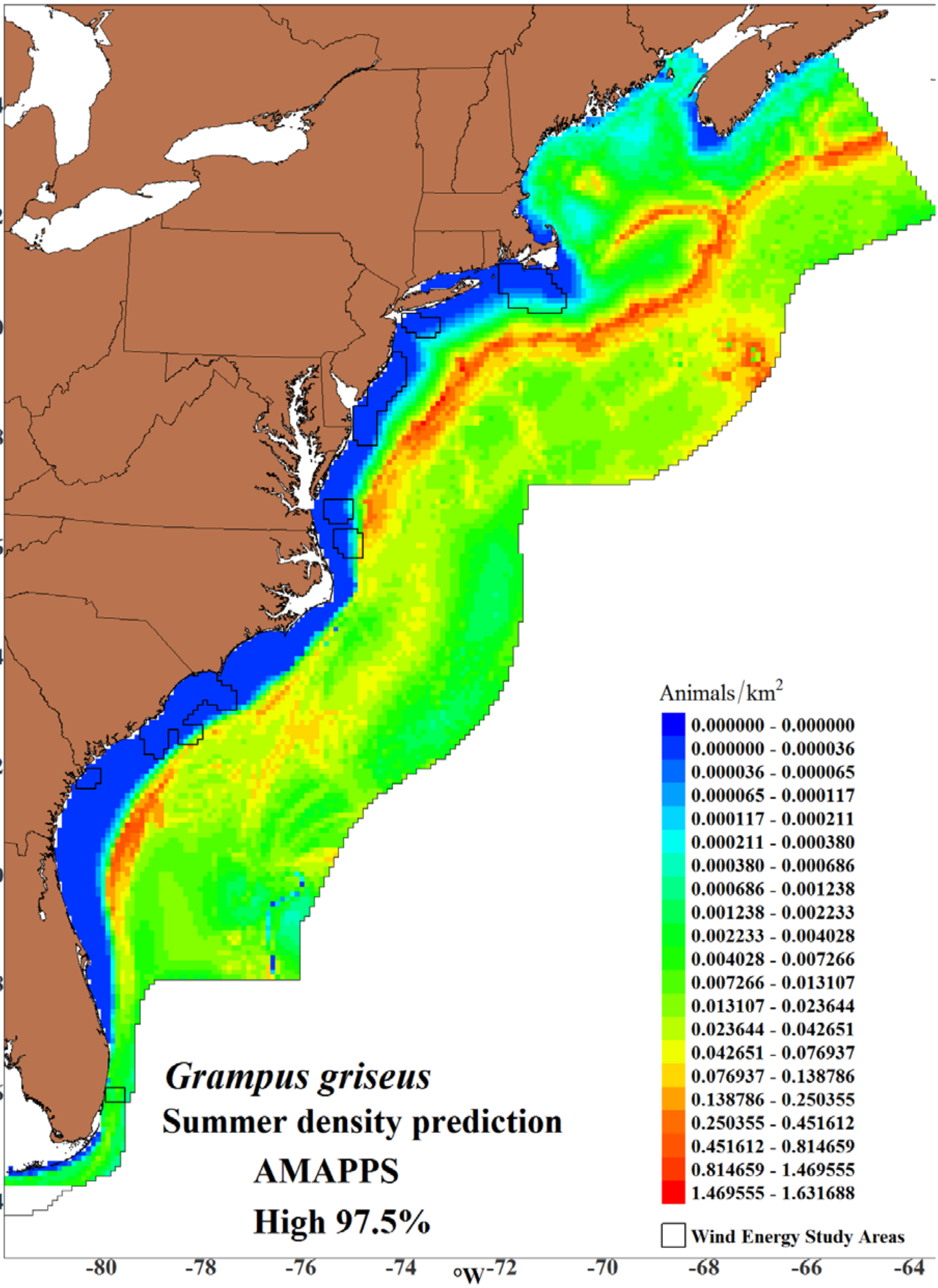

Figure 12-14 Upper 97.5% percentile of summer Risso's dolphin estimates

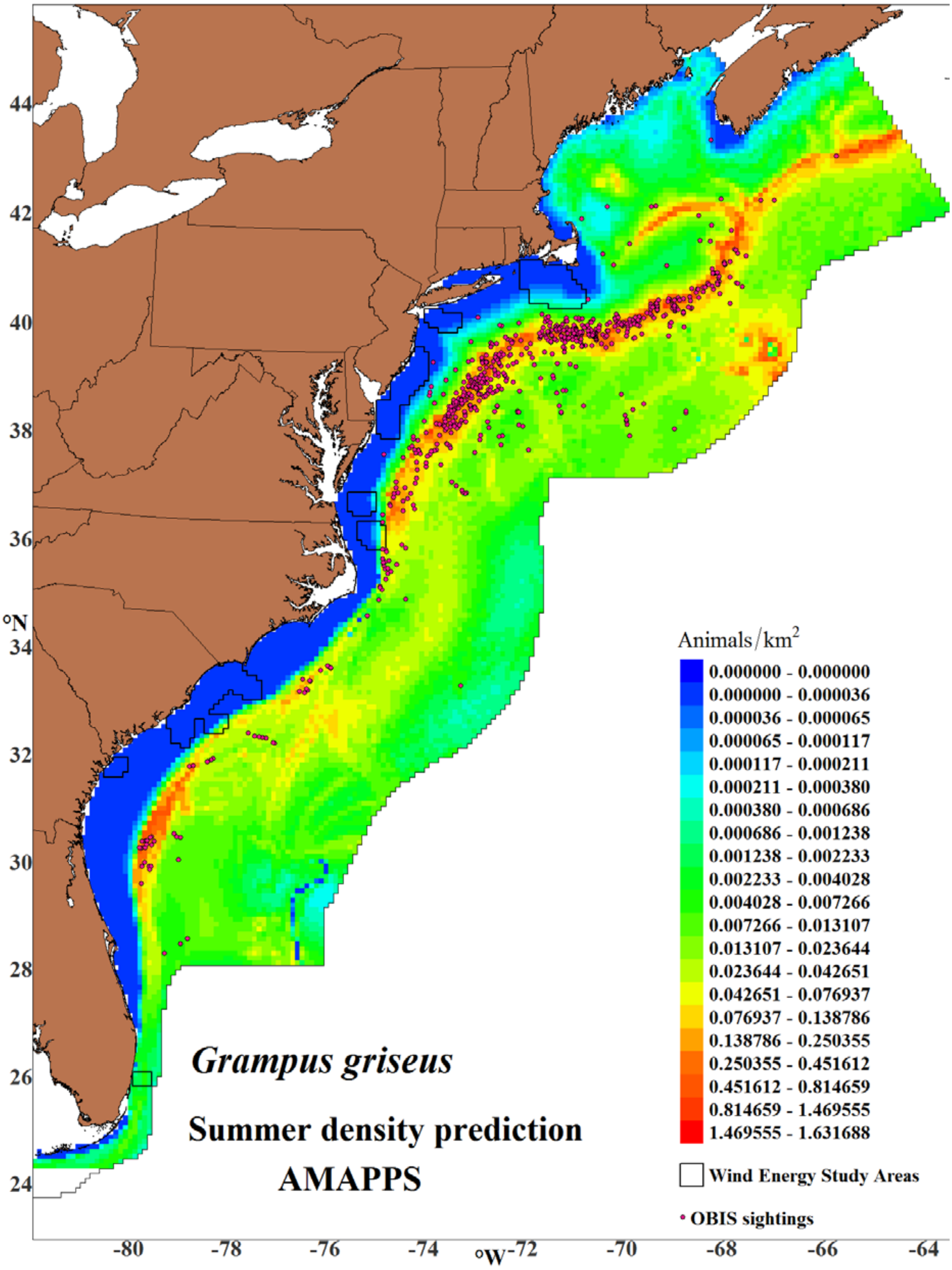

Figure 12-15 Risso's dolphin 2010 - 2013 summer density and 1970-2014 OBIS sightings pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

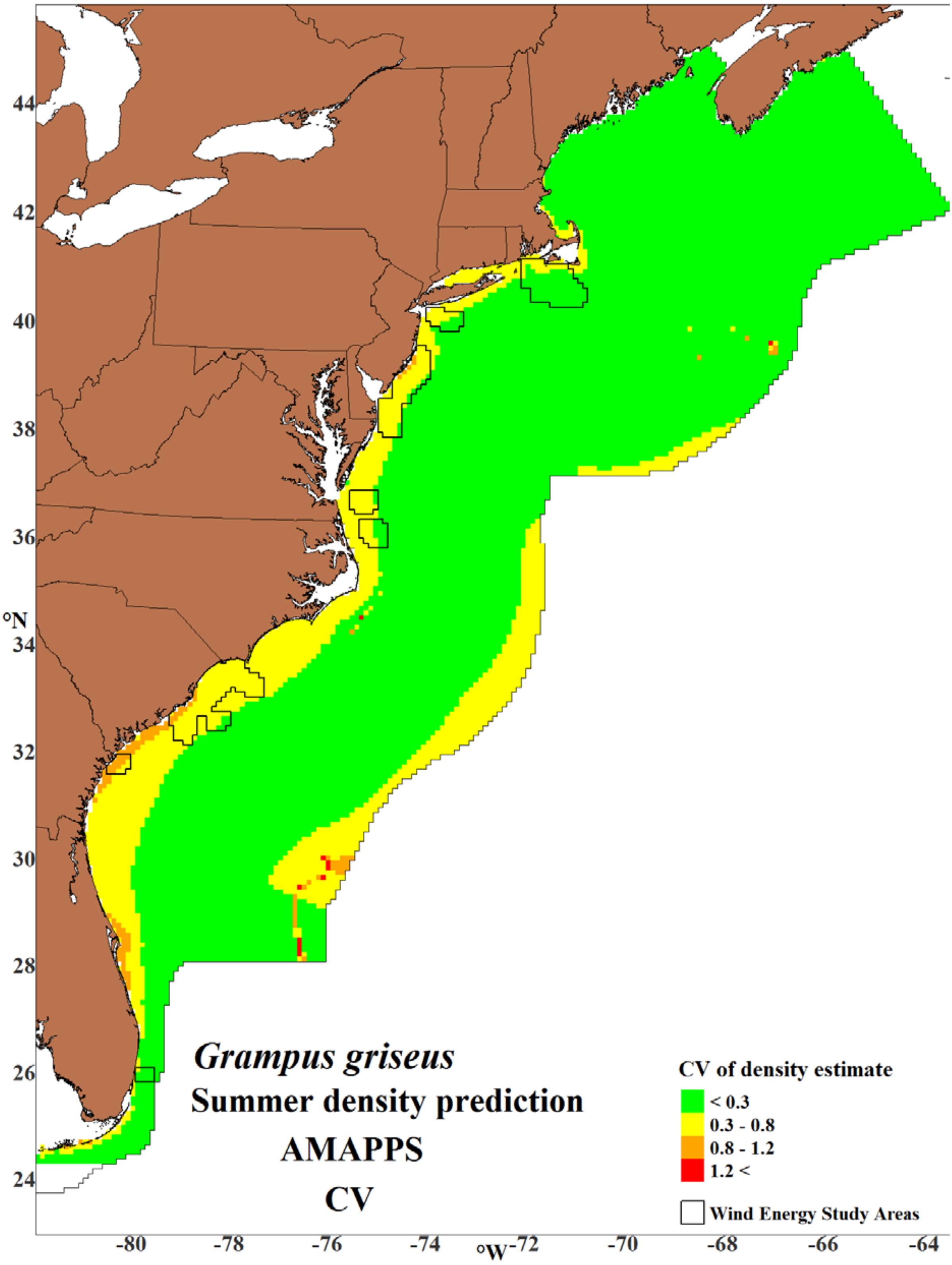

Figure 12-16 CV of summer density estimates for Risso's dolphin

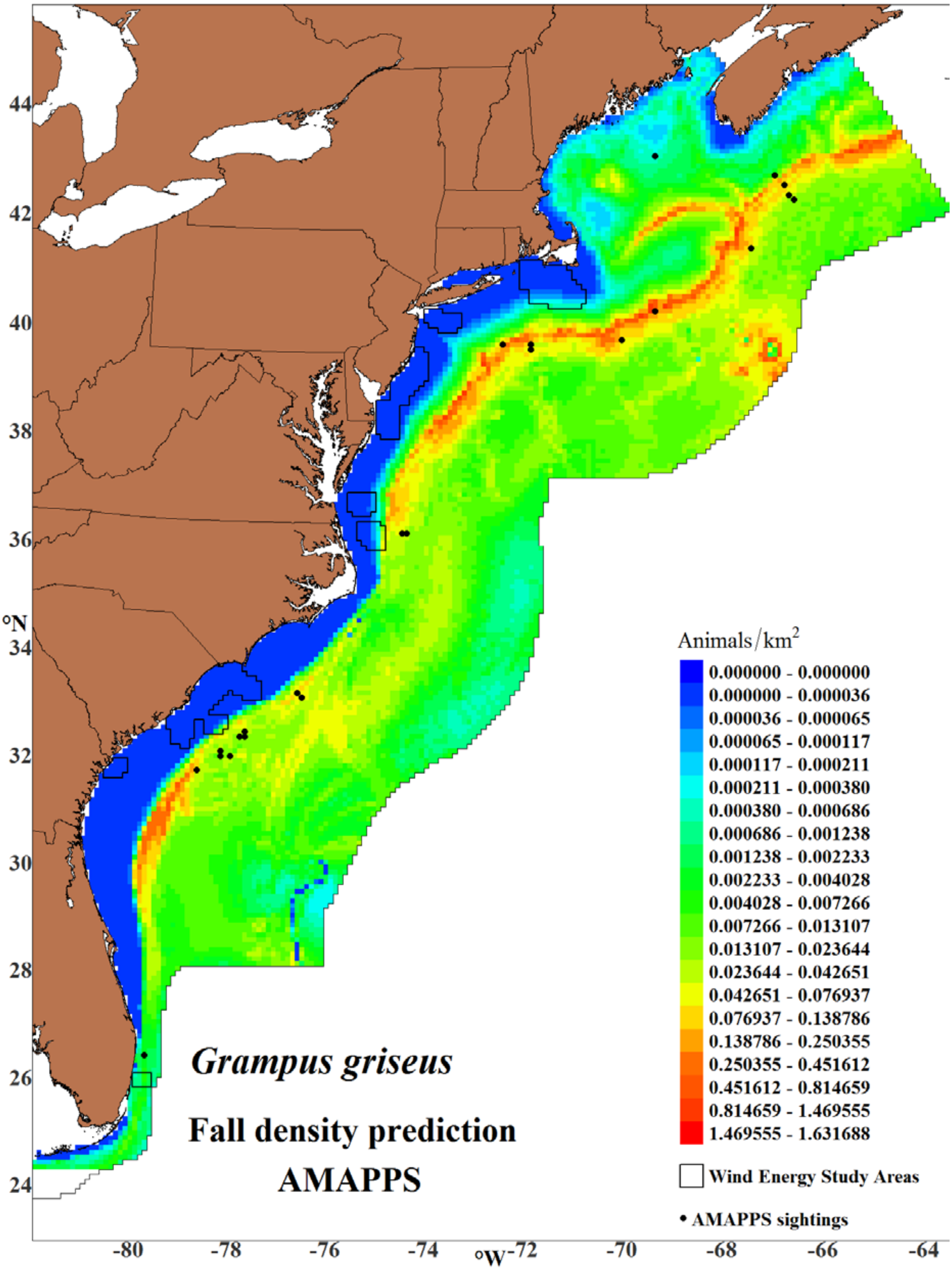

Figure 12-17 Risso's dolphin fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

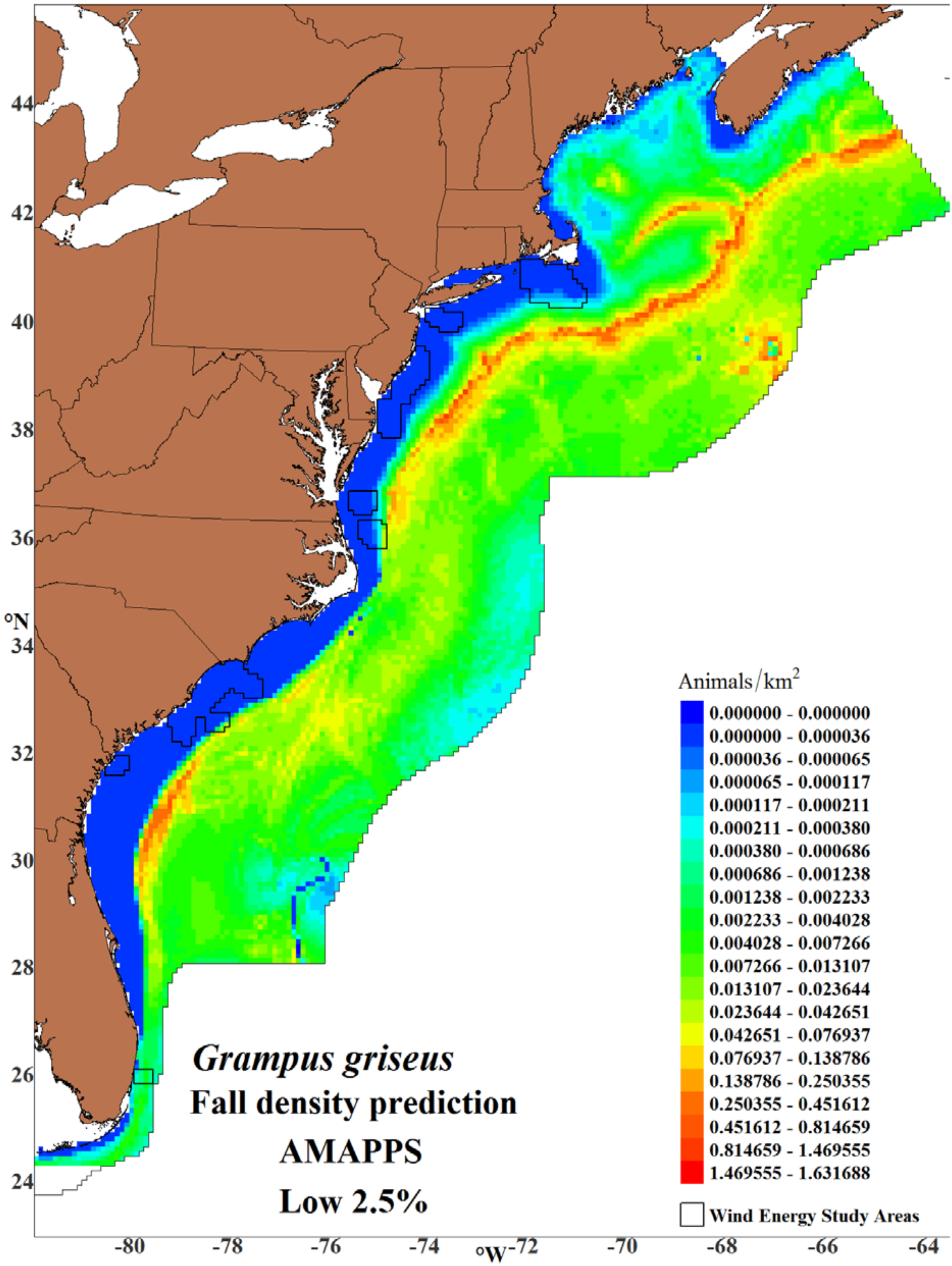

Figure 12-18 Lower 2.5% percentile of fall Risso's dolphin estimates

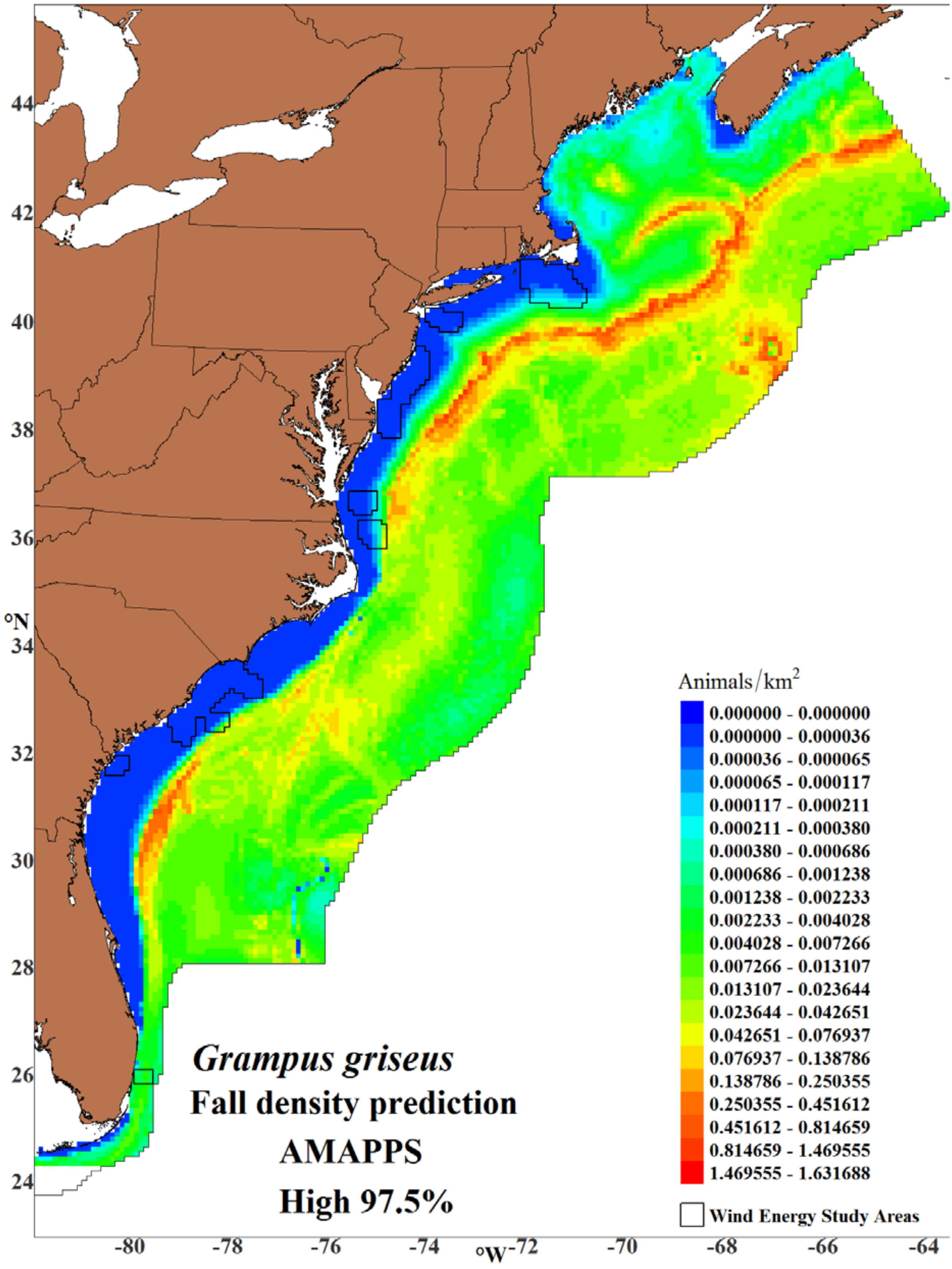

Figure 12-19 Upper 97.5% percentile of fall Risso's dolphin estimates

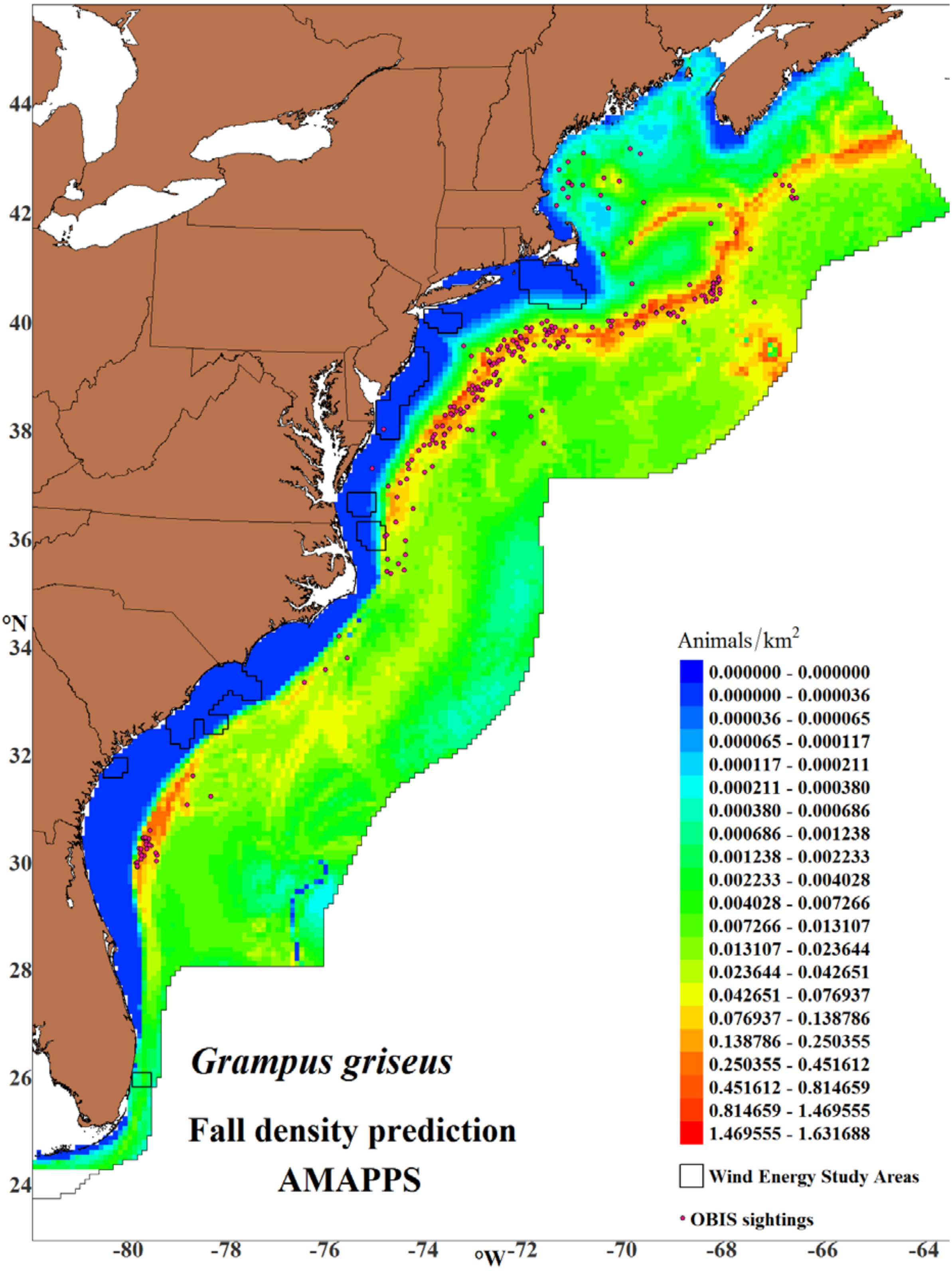

Figure 12-20 Risso's dolphin 2010-2013 fall density and 1970-2014 OBIS sightings
Pink circles (Halpin *et al.* 2009). These sightings were not used to develop the density-habitat model.

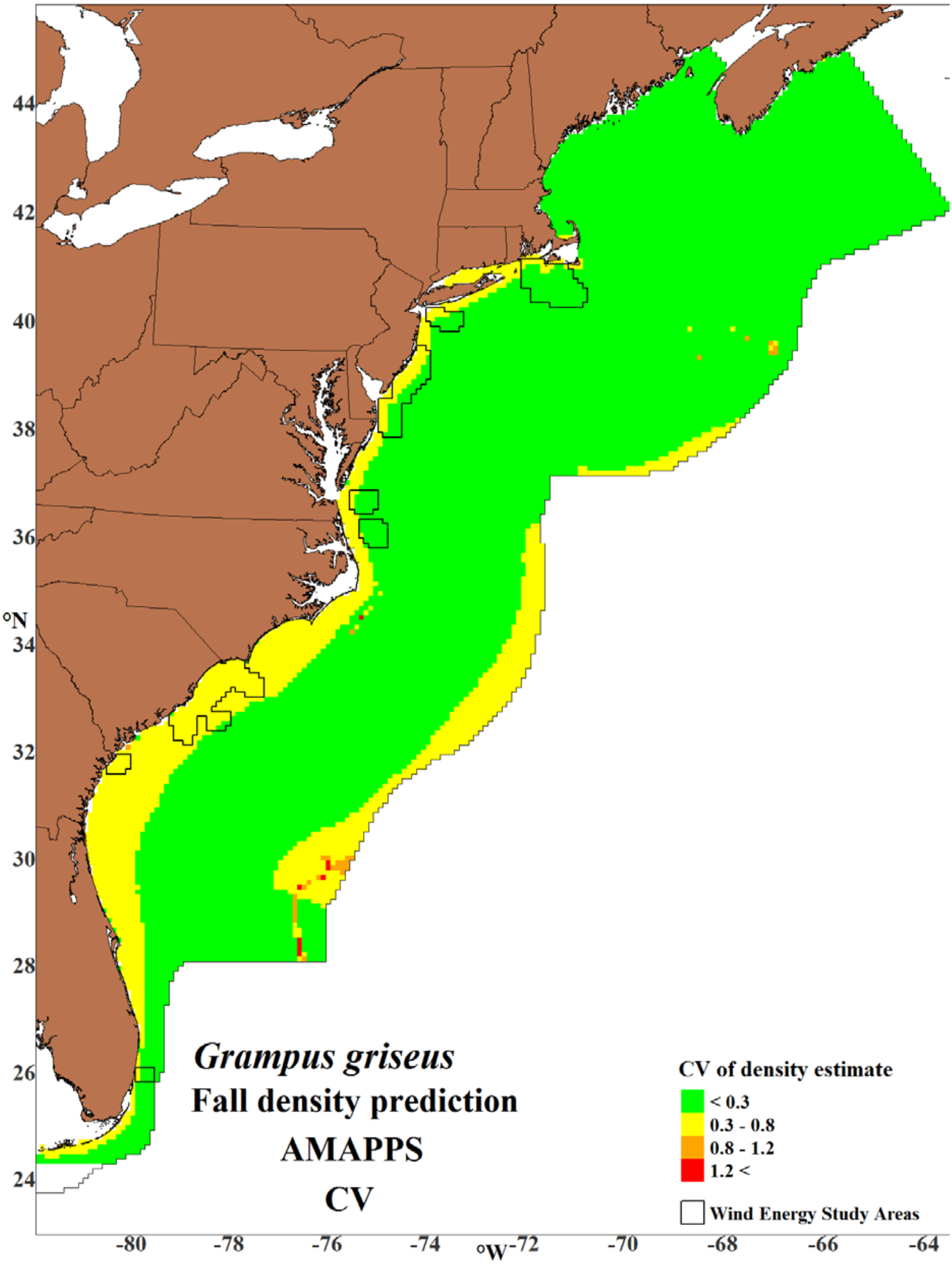

Figure 12-21 CV of fall density estimates for Risso's dolphins

12.6 Wind Energy Study Areas

Table 12-6 Risso's dolphin average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.850, CV= 0.173; shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	0	0.149	0 - 0
(March-May)	New York	0	0.22	0 - 0
	New Jersey	0	0.221	0 - 0
	Delaware/ Maryland	0	0.192	0 - 0
	Virginia	0	0.138	0 - 0
	North Carolina	14	0.09	12 - 17
	South Carolina/ North Carolina	7	0.082	6 - 8
	Georgia	0	0.353	0 - 0
	Florida	2	0.187	1 - 3
Summer	Rhode Island/ Massachusetts	1	0.131	1 - 2
(June-August)	New York	0	0.206	0 - 0
	New Jersey	0	0.356	0 - 0
	Delaware/ Maryland	0	0.296	0 - 0
	Virginia	0	0.268	0 - 0
	North Carolina	29	0.081	25 - 34
	South Carolina/ North Carolina	11	0.076	9 - 13
	Georgia	0	0.809	0 - 0
	Florida	3	0.198	2 - 4
Fall	Rhode Island/ Massachusetts	1	0.138	1 - 1
(September- November)	New York	0	0.232	0 - 0
	New Jersey	0	0.276	0 - 0
	Delaware/ Maryland	0	0.248	0 - 0
	Virginia	0	0.194	0 - 0
	North Carolina	18	0.085	15 - 21
	South Carolina/ North Carolina	5	0.088	4 - 6
	Georgia	0	0.536	0 - 0
	Florida	2	0.193	2 - 3

***** The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value predicted by the habitat model.

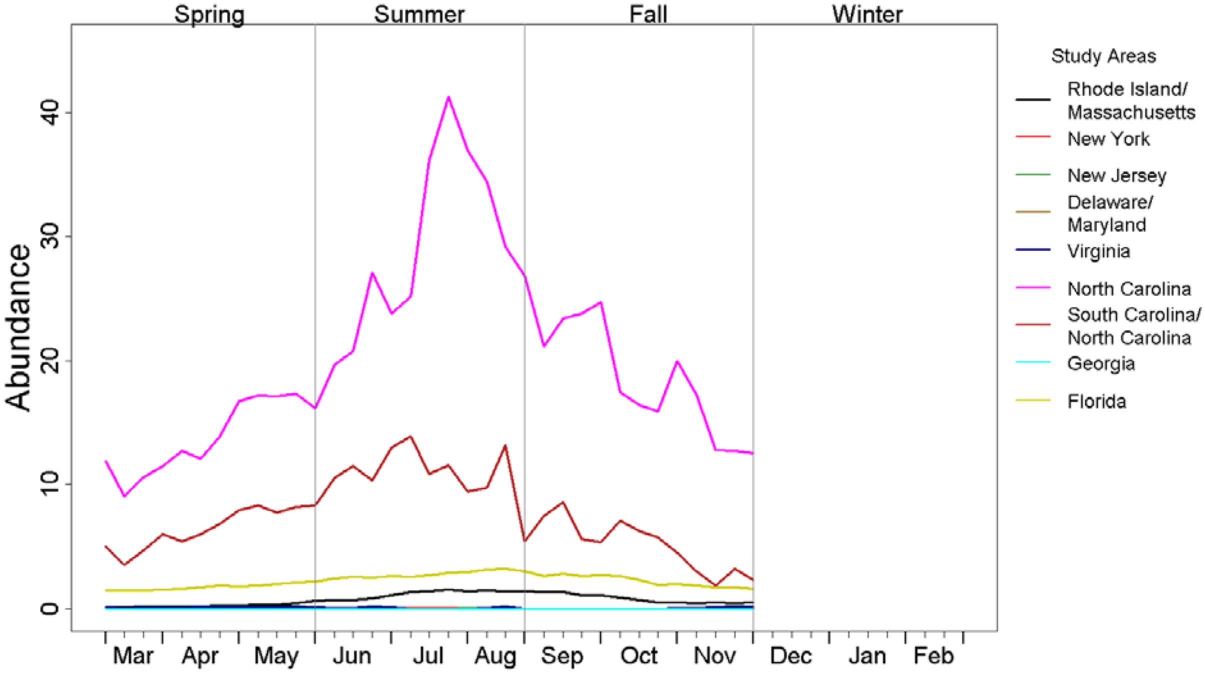

Figure 12-22 Annual abundance trends for Risso's dolphins in wind energy study areas

13 Atlantic White-sided Dolphin (*Lagenorhynchus acutus*)

Figure 13-1 Atlantic white-sided dolphin. Credit: NOAA/NEFSC
Image collected under MMPA Research permit #775-1875.

13.1 Data Collection

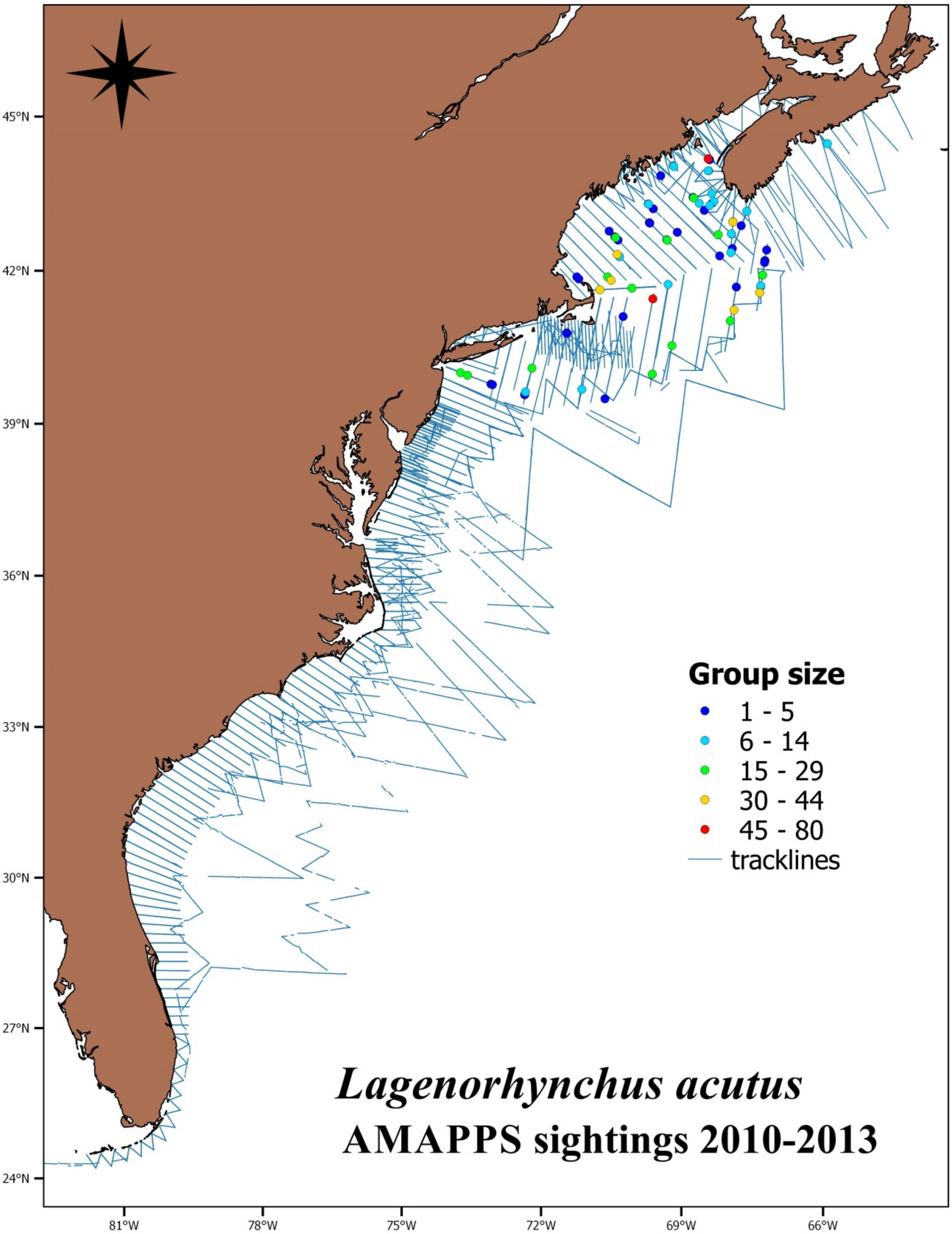

Figure 13-2 Track lines and Atlantic white-sided dolphin sightings during 2010-2013

Table 13-1 Research effort 2010 - 2013 and Atlantic white-sided dolphin sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Atlantic white-sided dolphin	*Lagenorhynchus acutus*	0/0	1/34	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	37/366	25/408	13/315	18/132
SE Shipboard	0	8,537	2,093	0	-	-	0/0	0/0	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	0/0	0/0	0/0	0/0

13.2 Mark-Recapture Distance Sampling Analysis

Table 13-2 Parameter estimates from Atlantic white-sided dolphin (WSDO) MRDS analysis
HR=Hazard Rate, HN= Half Normal, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE-aerial group 4	1	UNCW,WBDO WSDO	Distance*observer	Subjavg	1000	HN	0.600	0.196	0.875	0.661	0.465
	2		-	Distance	600	HR	-	-	0.452	0.916	0.960

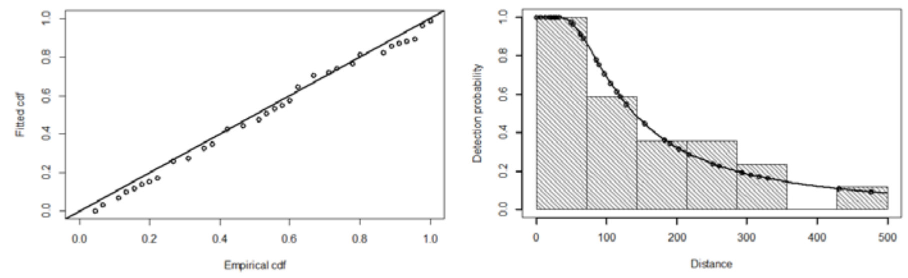

Figure 13-3 Q-Q plots and detection functions from Atlantic white-sided dolphin MRDS analysis

13.3 Generalized Additive Model Analysis

Table 13-3 Habitat model output for Atlantic white-sided dolphins

Approximate significance of smooth terms						
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(chl)	0.8218	4	2.004	0.0018	2.32E-03	**
s(sst)	1.9629	4	3.668	2.32E-04	1.12E-01	***
s(mld)	0.7015	4	1.322	0.00508	7.67E-05	**
s(slope)	0.56	4	0.829	0.01348	1.06E-02	*
s(dist125)	0.9681	4	6.845	6.05E-08	3.48E-08	***
Scale	-	-	-	-	3.92E+00	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: Total = 6.01

R^2 (adjusted) = 0.00642 Deviance explained = 18.5%

REML = 360.95 Scale estimate = 6.9696 sample size = 2392

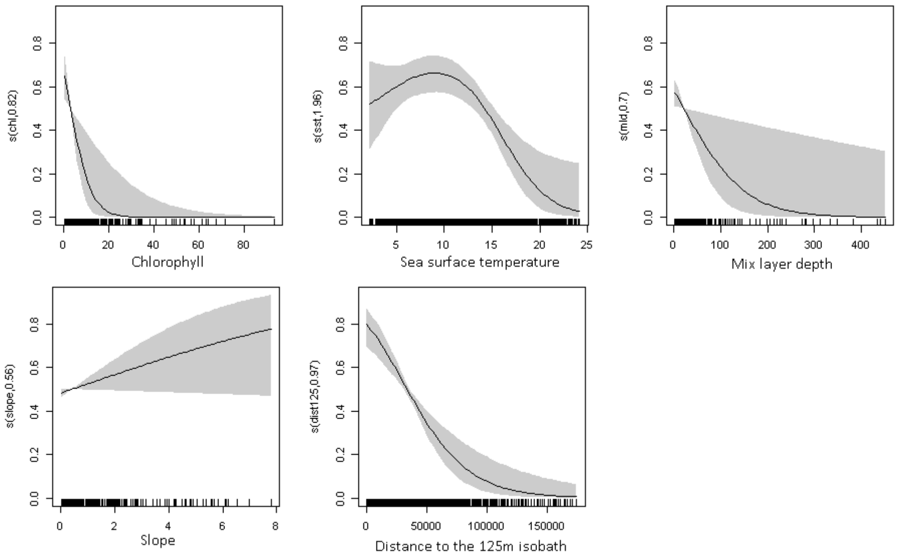

Figure 13-4 Atlantic white-sided dolphin density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 13-4 Diagnostic statistics from Atlantic white-sided dolphin habitat model

Diagnostic Statistic	**Description**	**Calculated with**	**Model Values (x)**	**Score**
RHO	Spearman rank correlation	Non-zero density	0.313	Excellent
MAPE	Mean absolute percentage error	Non-zero density	86.47	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.079	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.329	Fair to good

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

13.4 Abundance Estimates for AMAPPS Study Area

Table 13-5 Atlantic white-sided dolphin average abundance estimates for AMAPPS study area

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	47,370	0.666	14,454 – 155,248
Summer (June-August)	42,985	0.463	18,128 – 101,923
Fall (September-November)	44,276	0.394	21,047 – 93,144

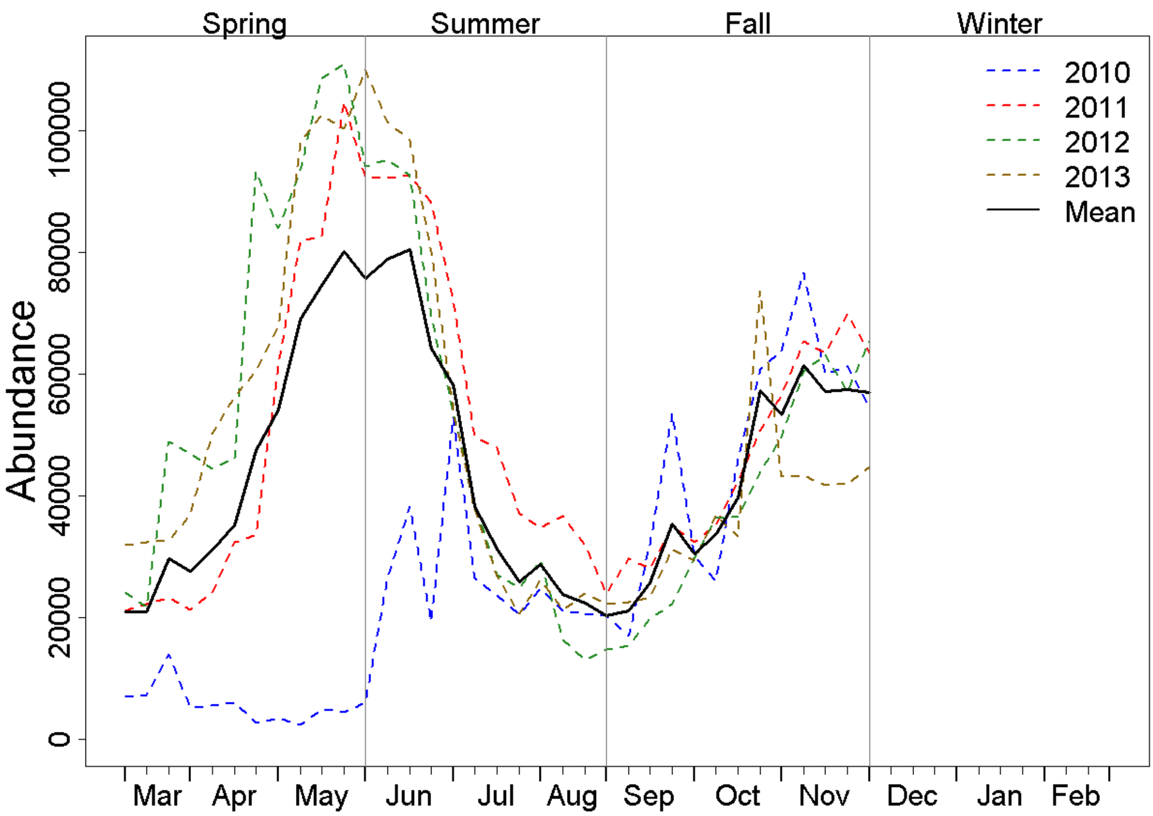

Figure 13-5 Annual abundance trends for Atlantic white-sided dolphins for AMAPPS study area

13.5 Seasonal Prediction Maps

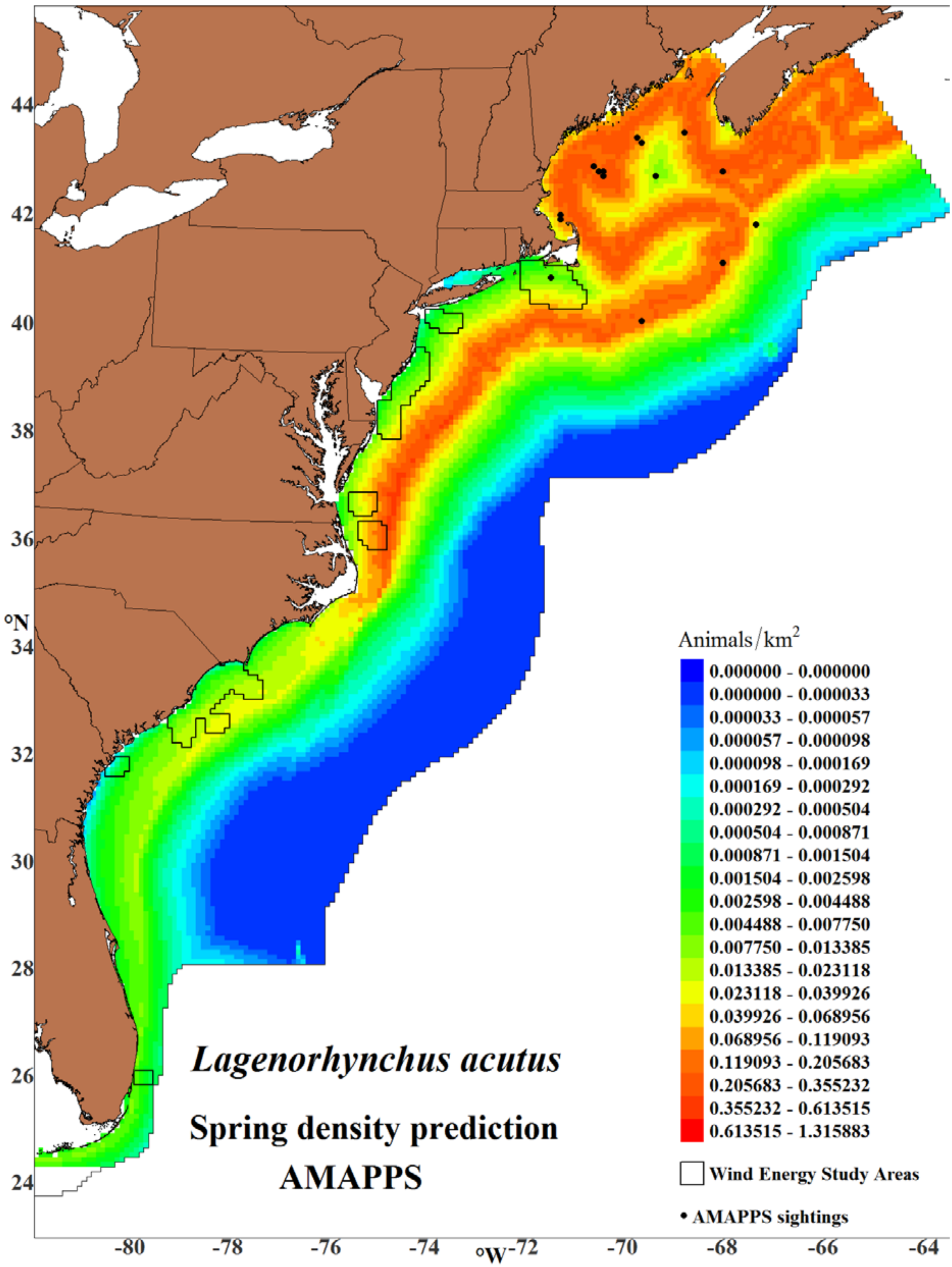

Figure 13-6 Atlantic white-sided dolphin spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

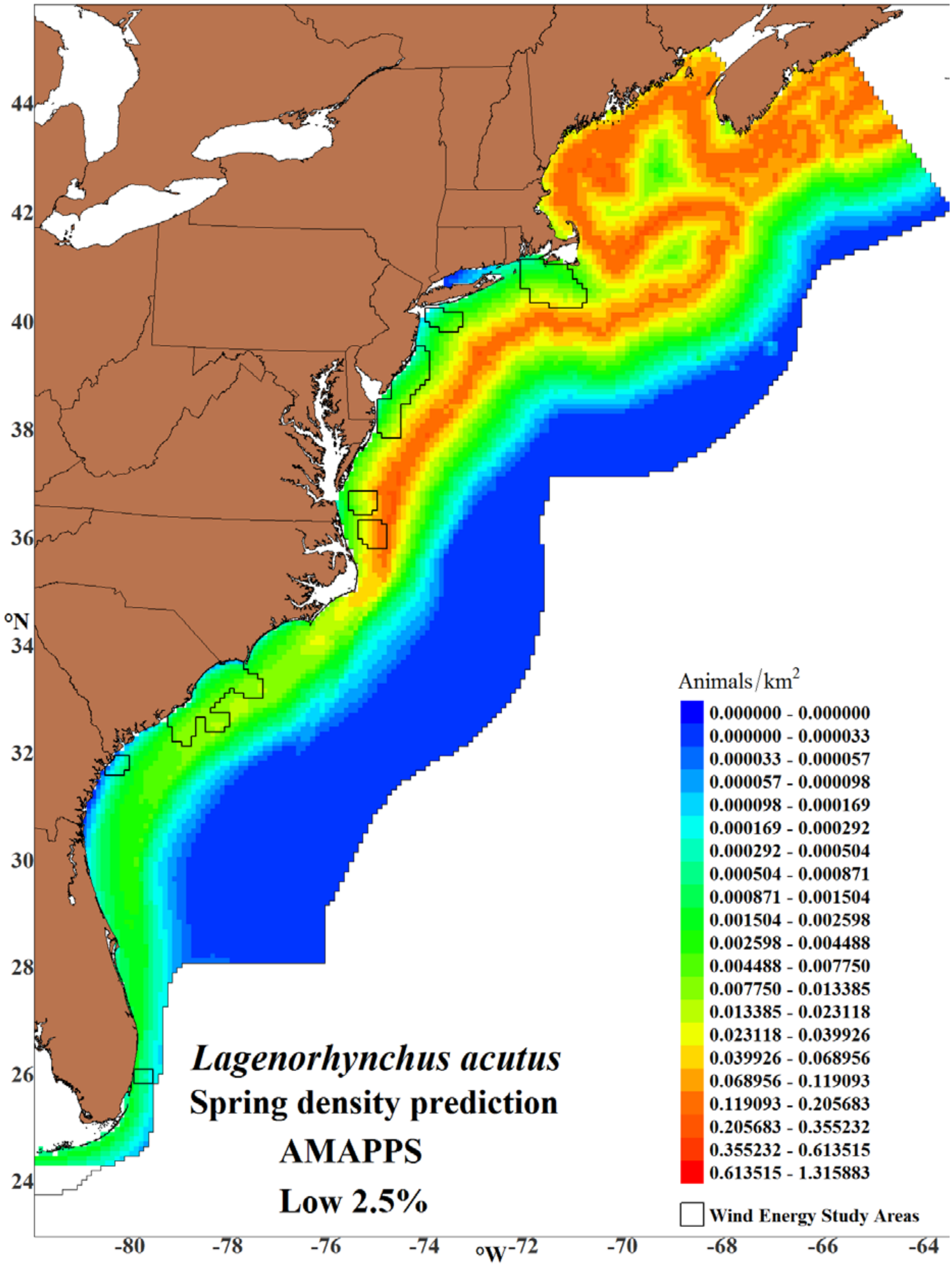

Figure 13-7 Lower 2.5% percentile of spring Atlantic white-sided dolphin estimates

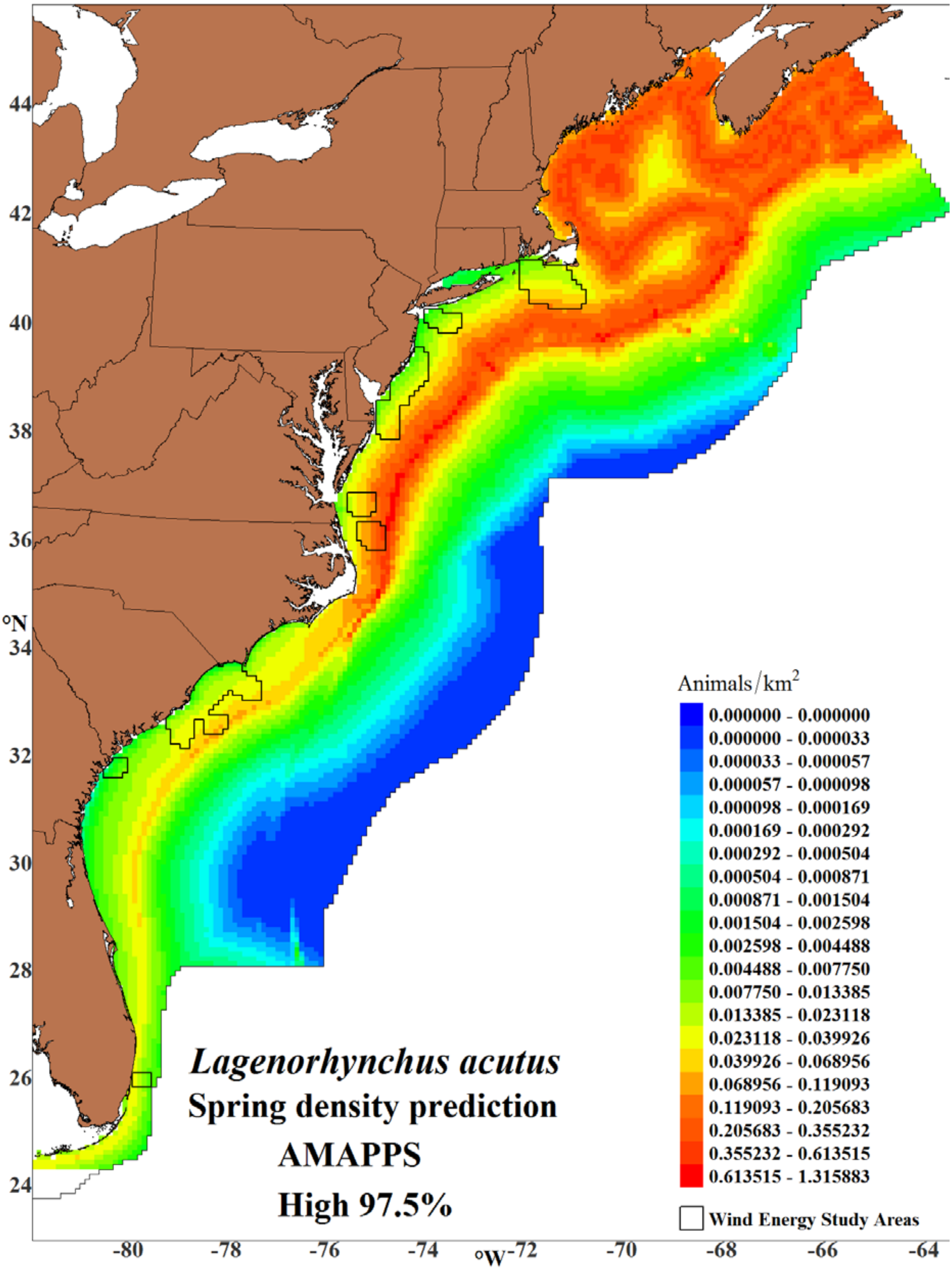

Figure 13-8 Upper 97.5% percentile of spring Atlantic white-sided dolphin estimates

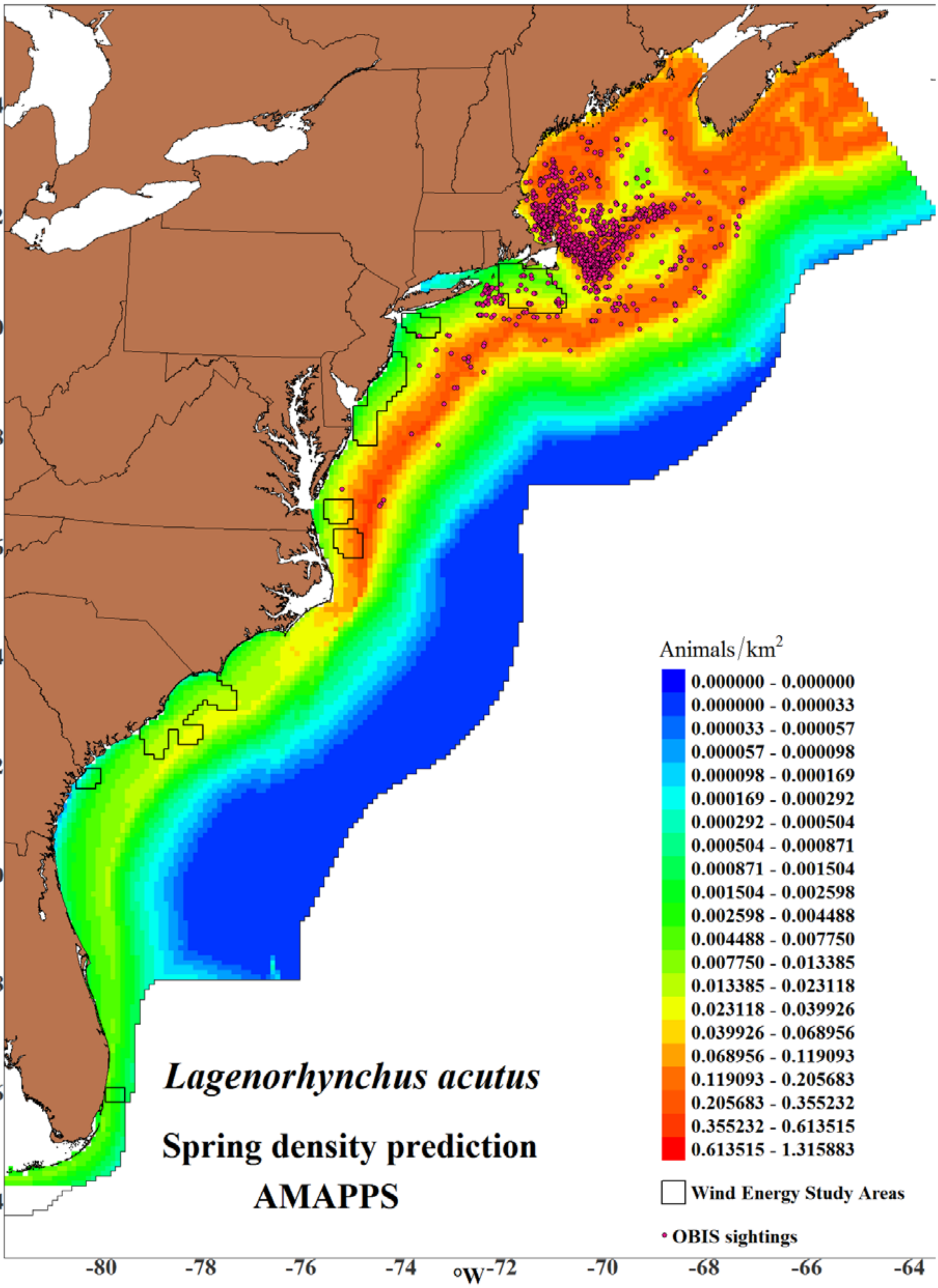

Figure 13-9 Atlantic white-sided dolphin 2010-2013 spring density and 1970-2013 OBIS sightings
pink circles(Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

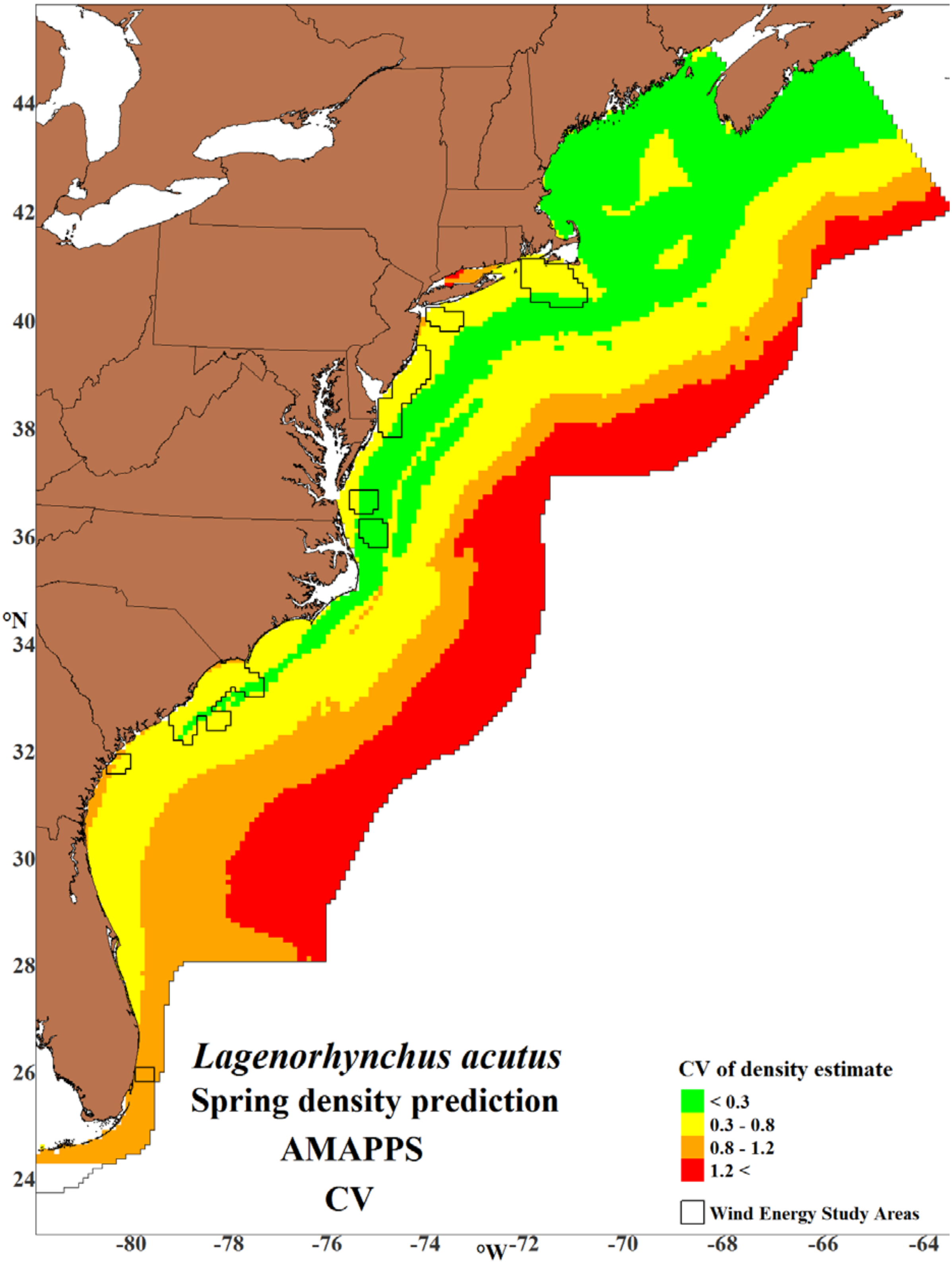

Figure 13-10 CV of spring density estimates for Atlantic white-sided dolphins

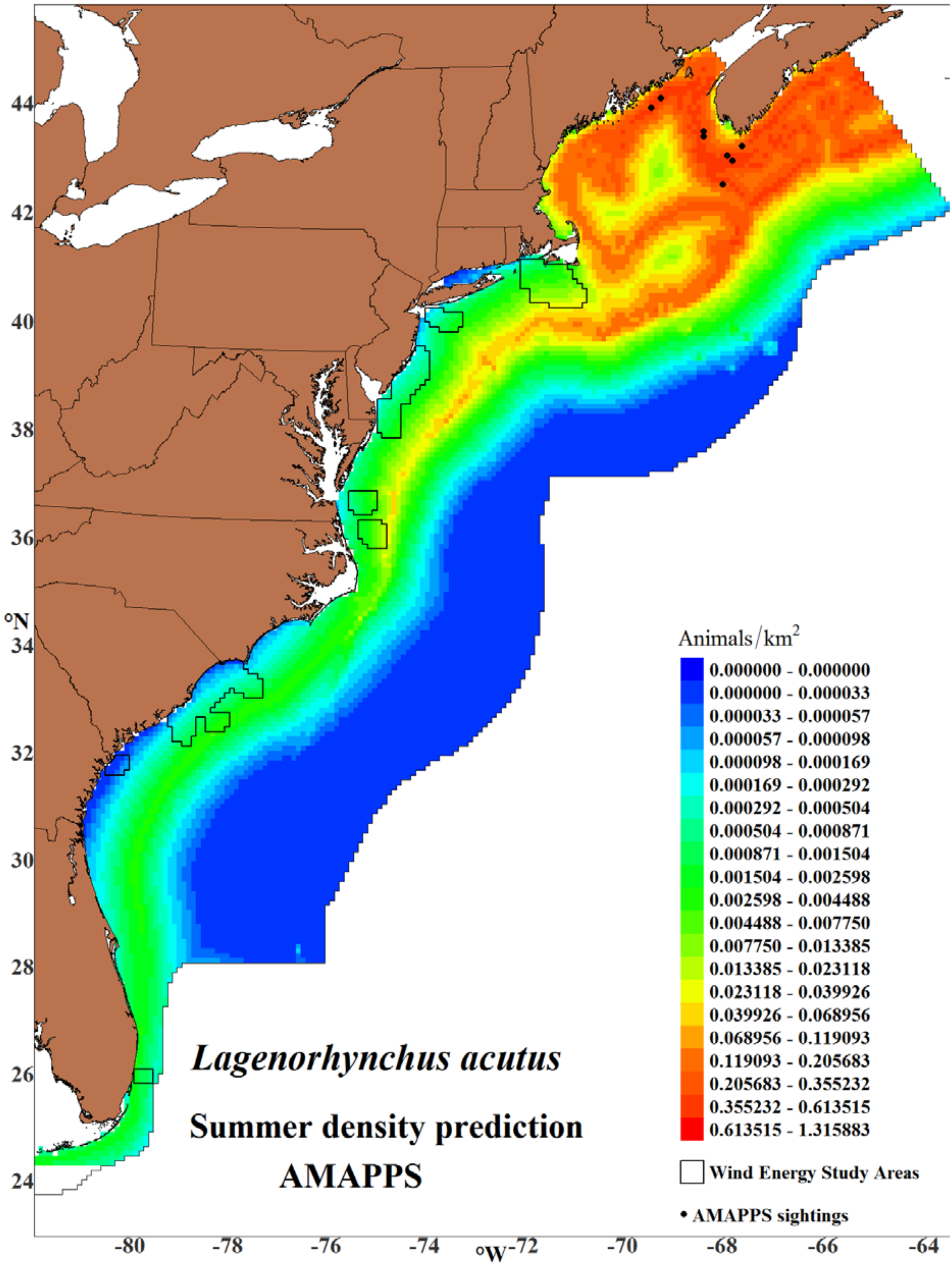

Figure 13-11 Altantic white-sided dolphin summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

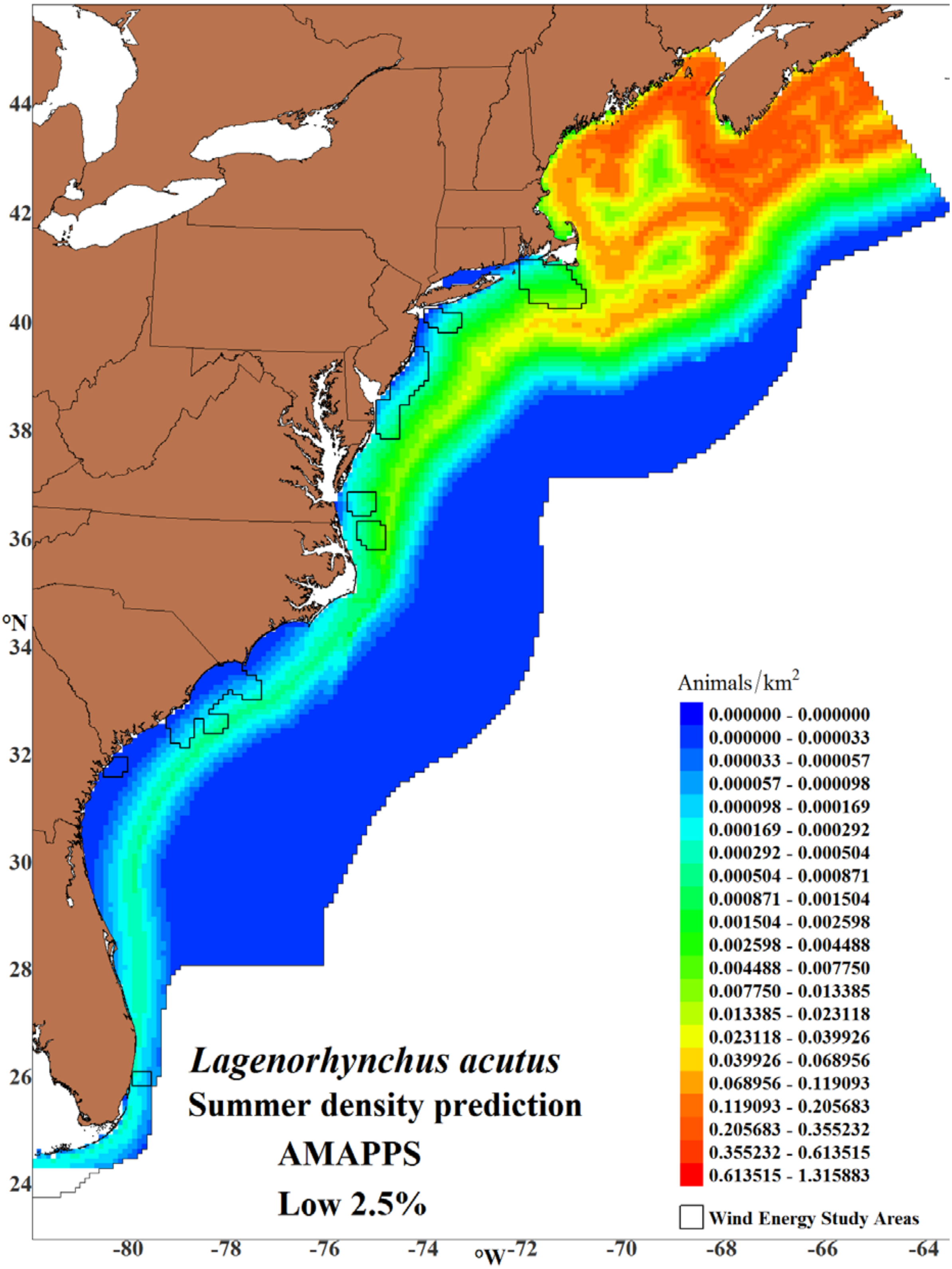

Figure 13-12 Lower 2.5% percentile of summer Atlantic white-sided dolphin estimates

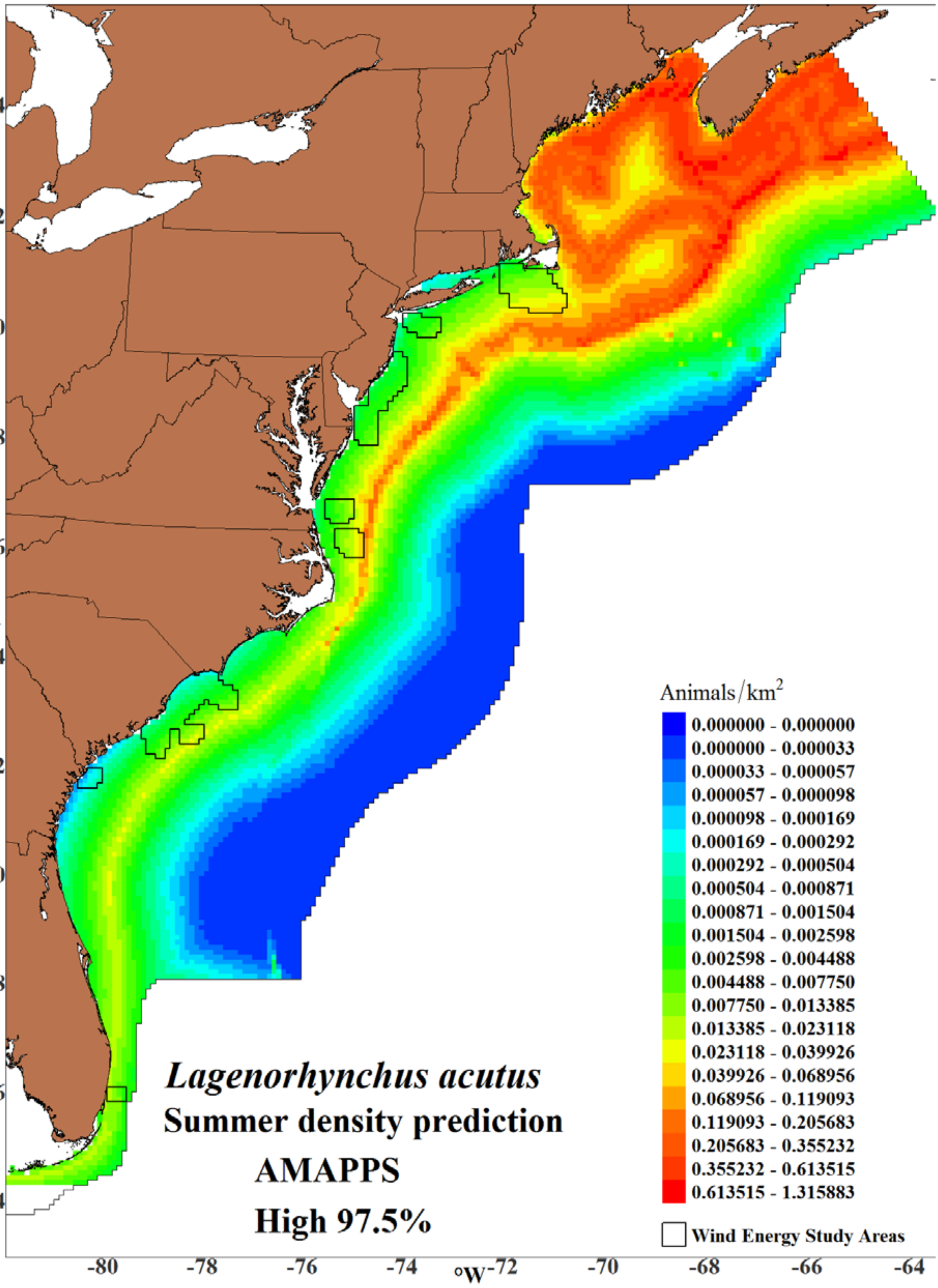

Figure 13-13 Upper 97.5% percentile of summer Atlantic white-sided dolphin estimates

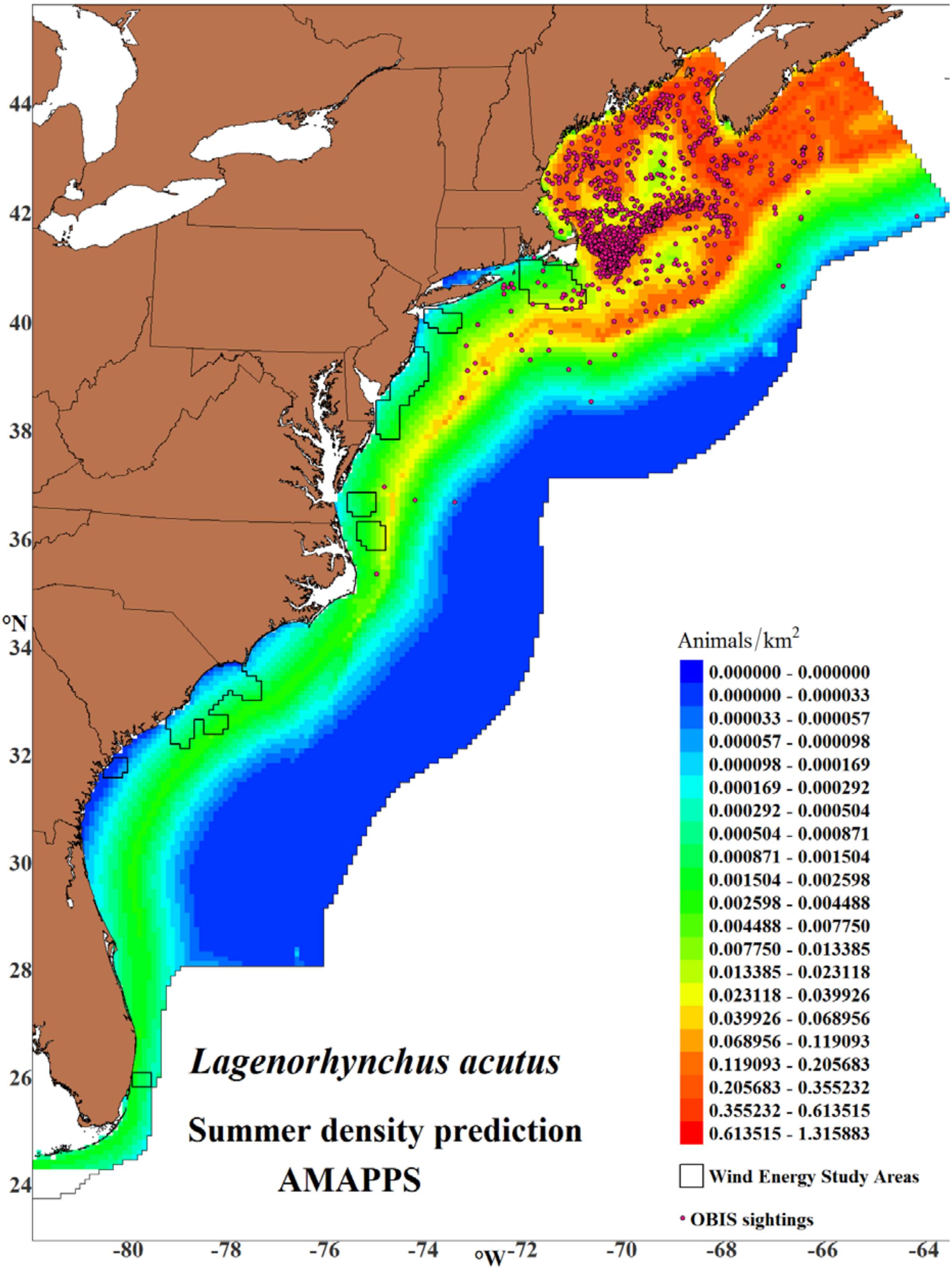

Figure 13-14 Atlantic white-sided dolphin summer density and 1970-2013 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

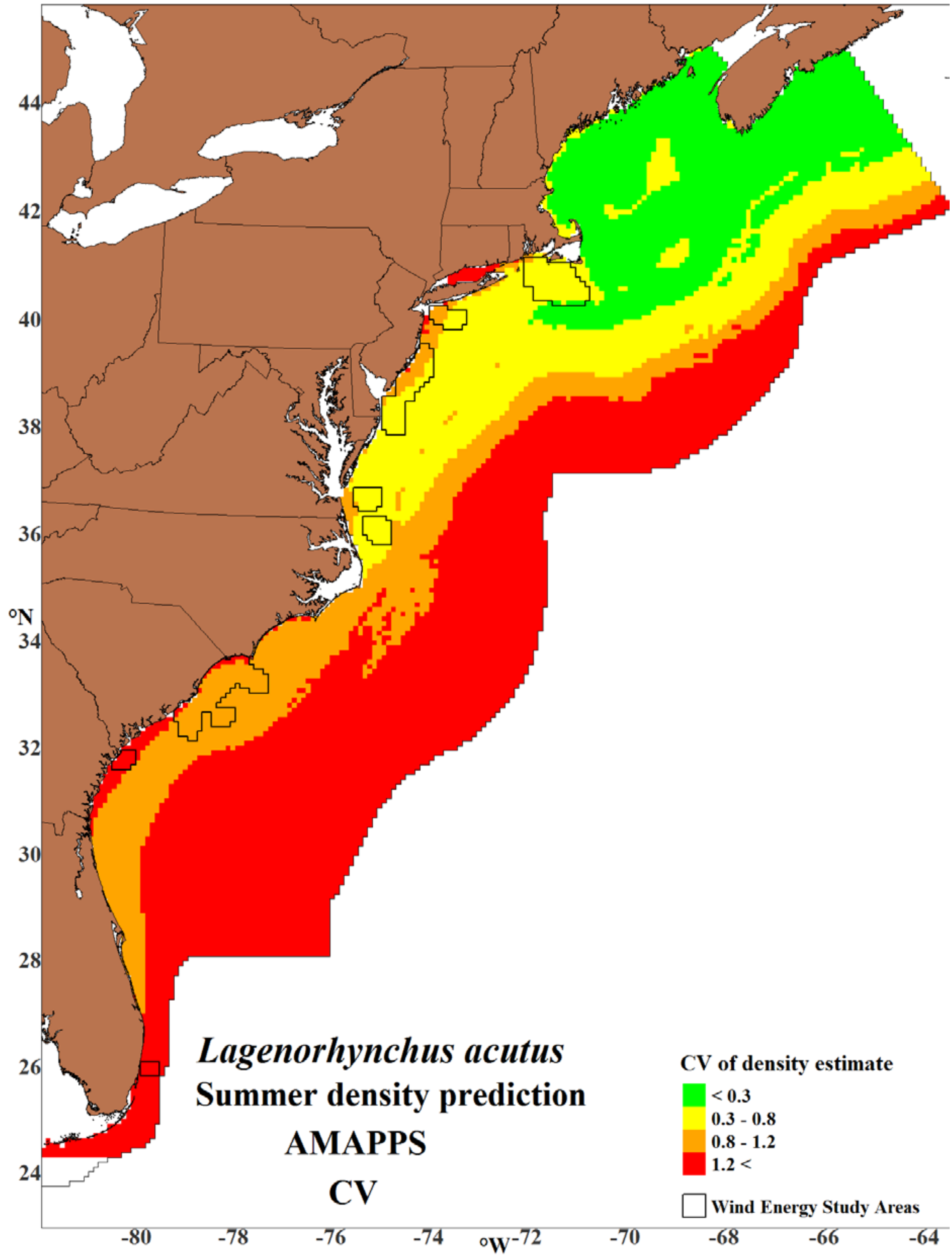

Figure 13-15 CV of summer density estimates for Atlantic white-sided dolphins

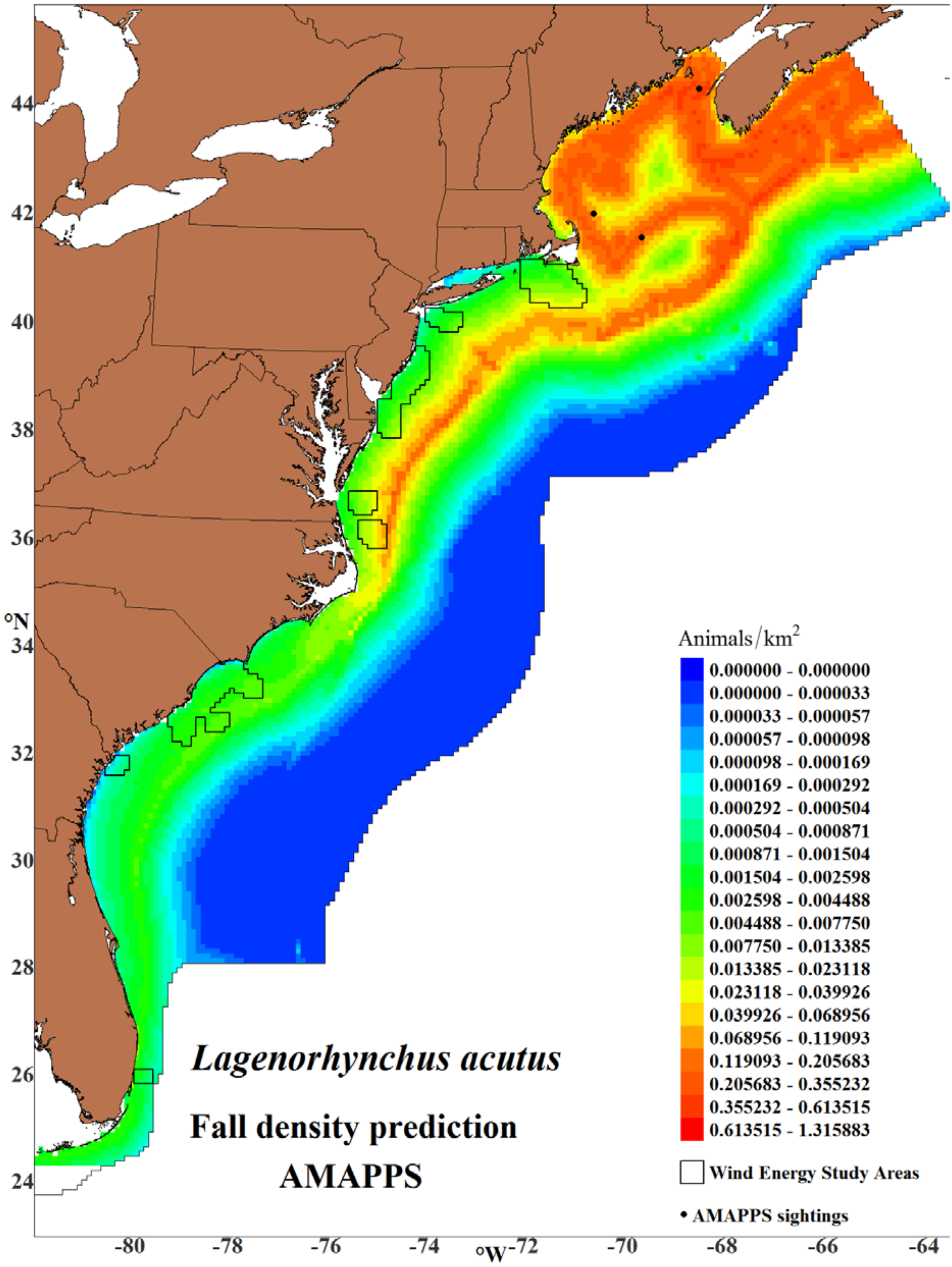

Figure 13-16 Atlantic white-sided dolphin fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

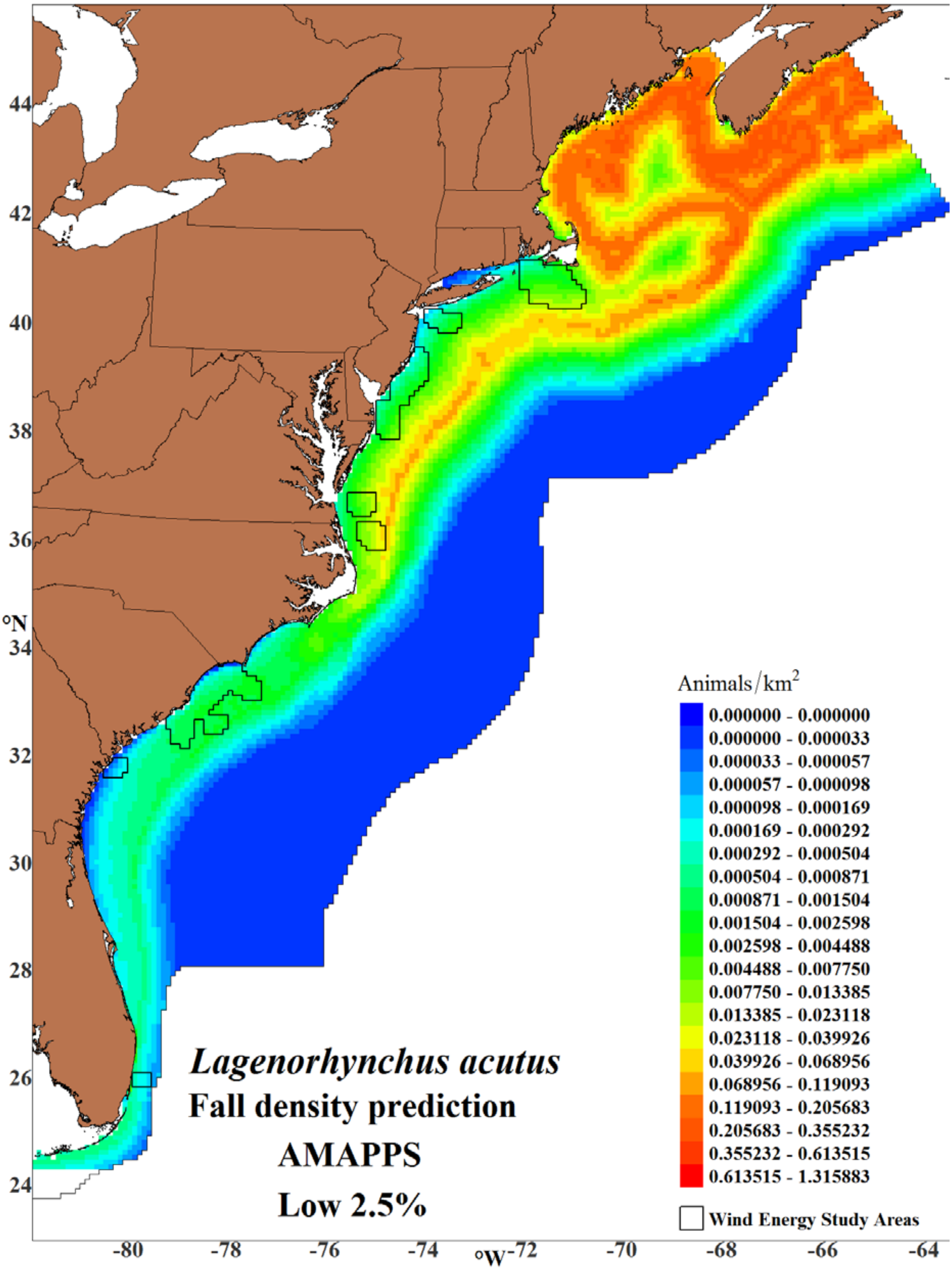

Figure 13-17 Lower 2.5% percentile of fall Atlantic white-sided dolphin estimates

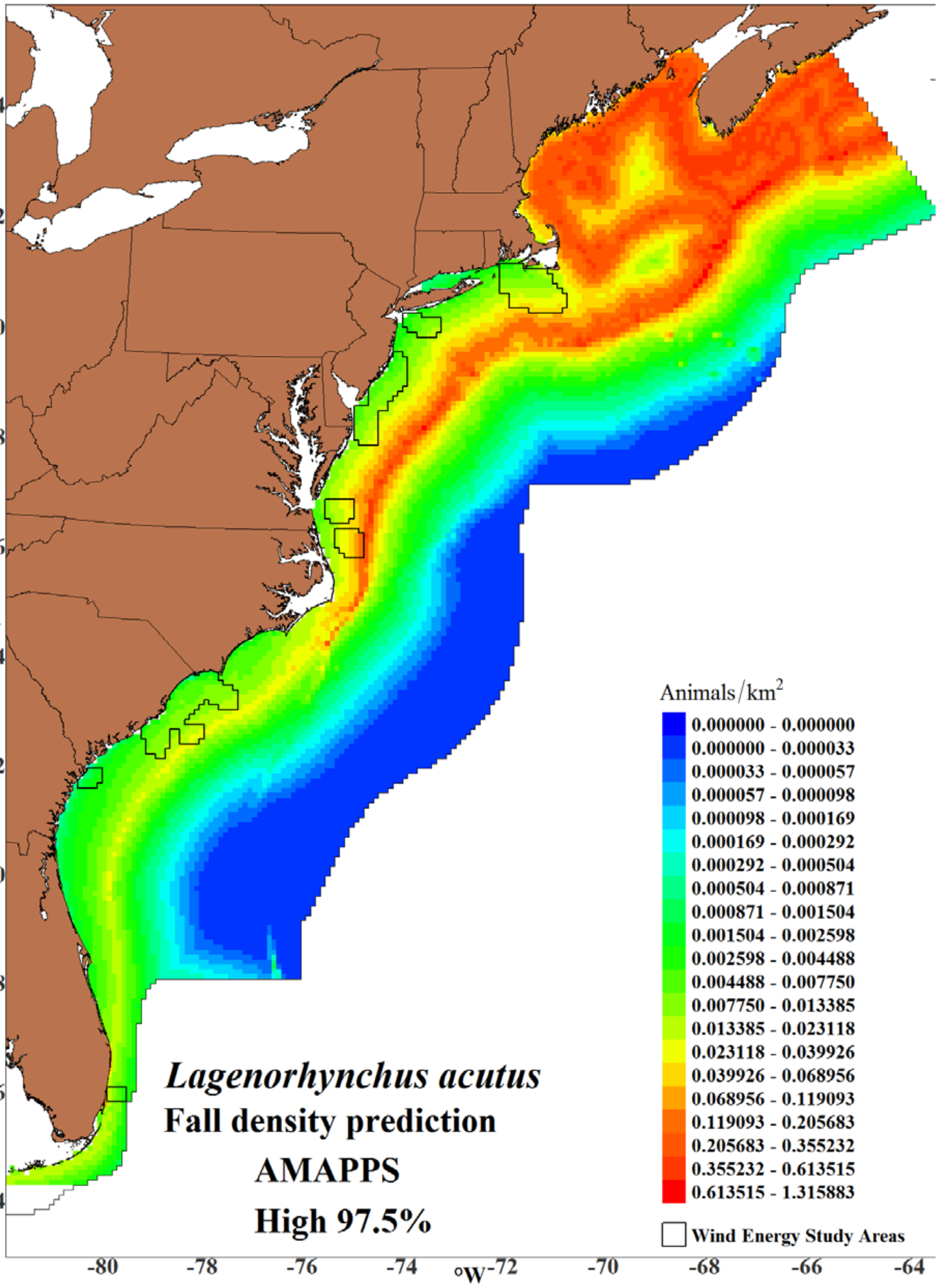

Figure 13-18 Upper 97.5% percentile of fall Atlantic white-sided dolphin estimates

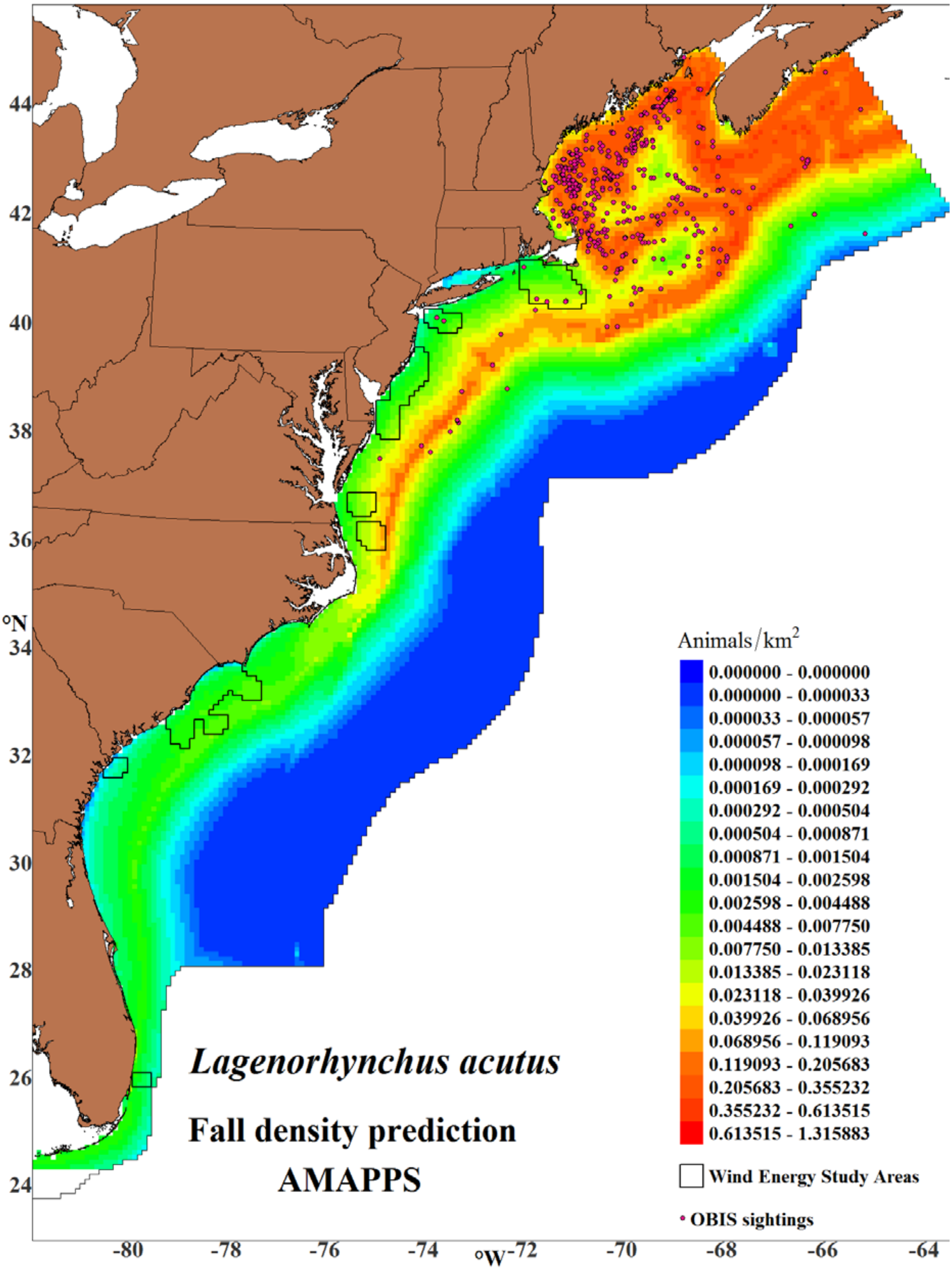

Figure 13-19 Atlantic white-sided dolphin 2010-2013 fall density and 1970-2013 OBIS sightings Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

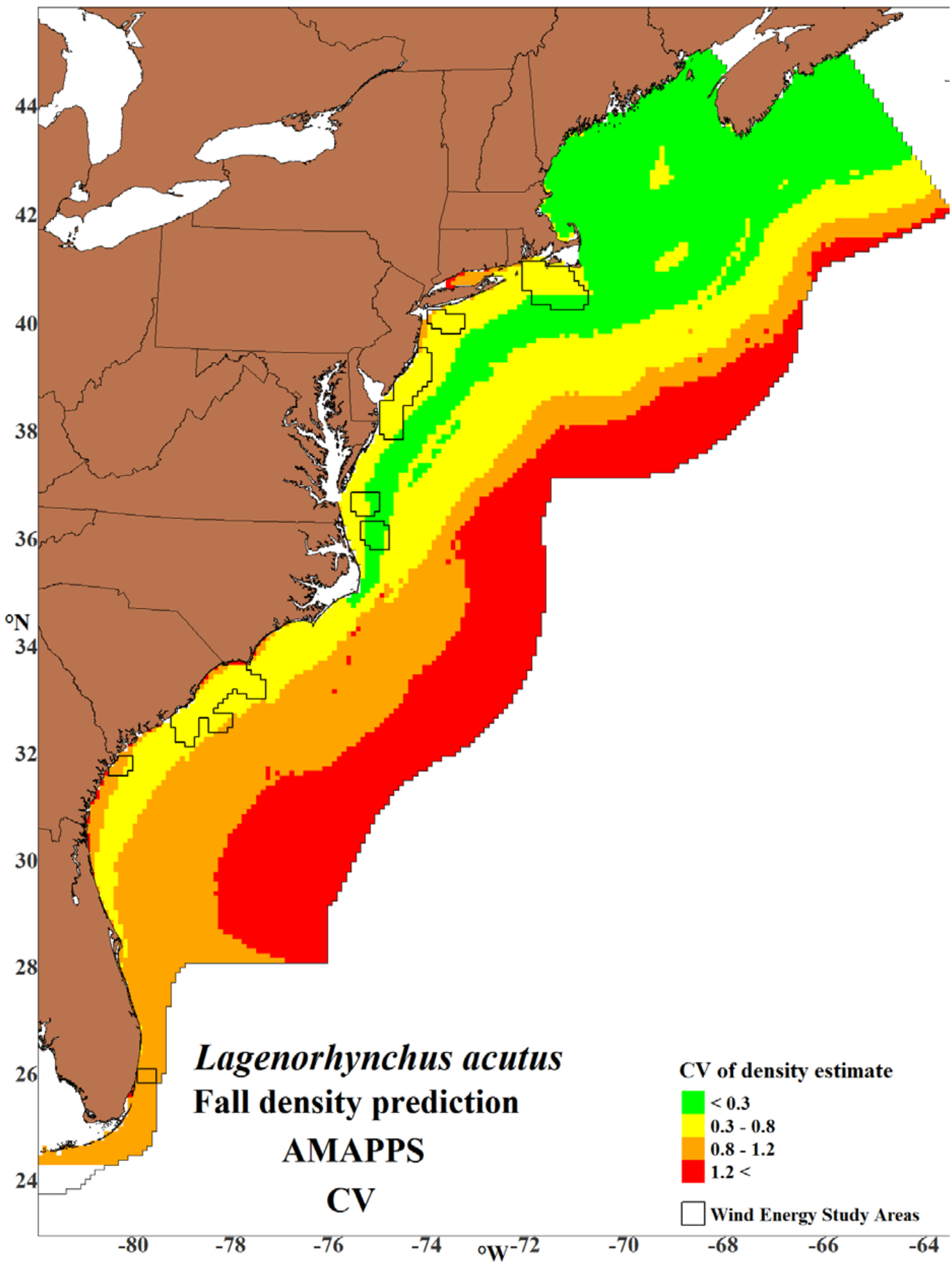

Figure 13-20 CV of fall density estimates for Atlantic white-sided dolphins

13.6 Wind Energy Study Areas

Table 13-6 Atlantic white-sided dolphin average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.890, CV= 0.186; shipboard N/A.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	254	0.323	137 - 471
(March-May)	New York	20	0.454	9 - 48
	New Jersey	51	0.432	23 - 116
	Delaware/ Maryland	66	0.314	36 - 120
	Virginia	110	0.22	72 - 168
	North Carolina	376	0.171	269 - 524
	South Carolina/ North Carolina	184	0.36	93 - 364
	Georgia	2	0.679	1 - 7
	Florida	4	0.949	1 - 18
Summer	Rhode Island/ Massachusetts	107	0.395	51 - 226
(June-August)	New York	3	0.69	1 - 11
	New Jersey	5	0.802	1 - 18
	Delaware/ Maryland	5	0.644	2 - 17
	Virginia	6	0.702	2 - 20
	North Carolina	22	0.702	6 - 75
	South Carolina/ North Carolina	10	1.122	2 - 61
	Georgia	0	1.296	0 - 0
	Florida	1	1.322	0 - 10
Fall	Rhode Island/ Massachusetts	134	0.315	74 - 245
(September- November)	New York	10	0.486	4 - 24
	New Jersey	22	0.531	8 - 58
	Delaware/ Maryland	25	0.392	12 - 52
	Virginia	37	0.294	21 - 64
	North Carolina	105	0.278	62 - 180
	South Carolina/ North Carolina	49	0.611	16 - 147
	Georgia	1	0.808	0 - 3
	Florida	2	1.101	0 - 10

***** The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value predicted by the habitat model.

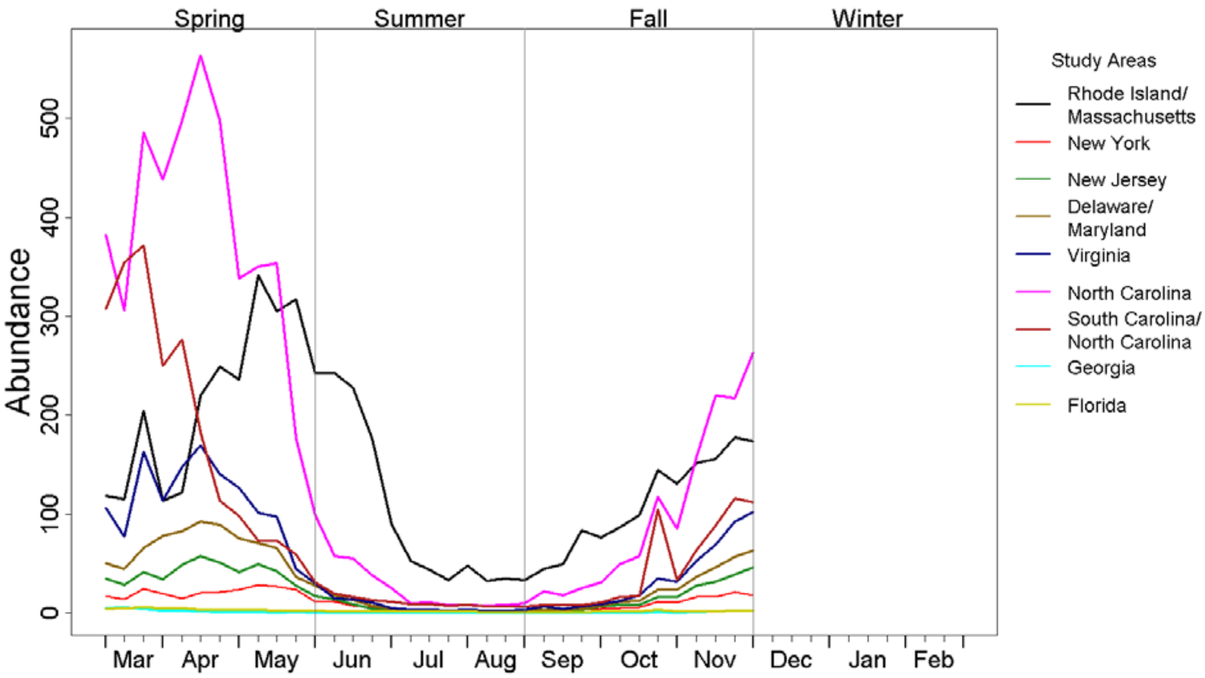

Figure 13-21 Annaul abundance trends for Atlantic white-sided dolphins in wind energy study areas

14 Common Dolphin (*Delphinus delphis*)

Figure 14-1 Common dolphin. Credit: NOAA/NEFSC/Allison Henry
Image collected under MMPA Research permit #775-1875.

14.1 Data Collection

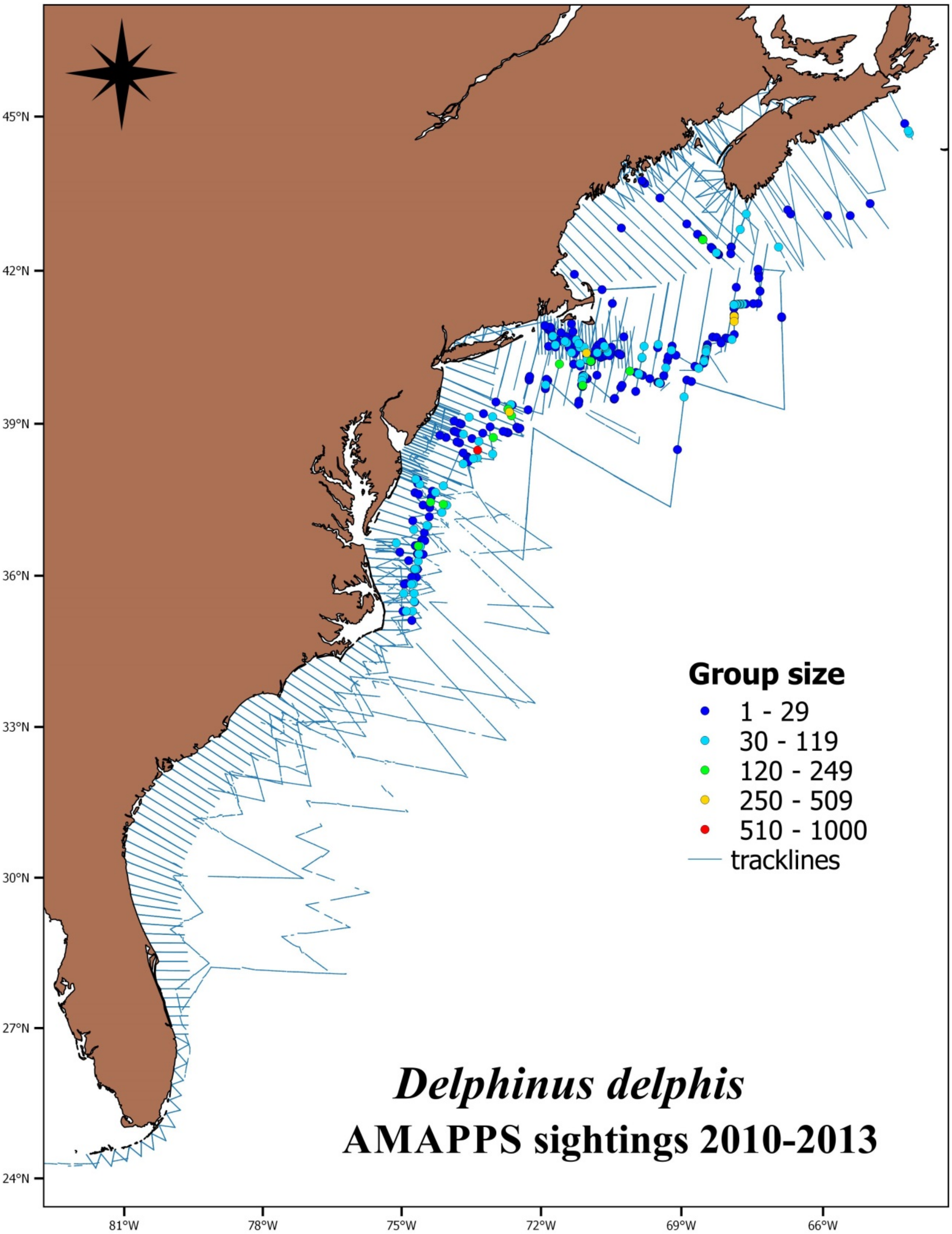

Figure 14-2 Track lines and common dolphin sightings during 2010 - 2013

Table 14-1 Research effort 2010 - 2013 and common dolphin sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Common dolphin	*Delphinus delphis*	0/0	239/7,967	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	5/49	16/672	64/1,436	17/569
SE Shipboard	0	8,537	2,093	0	-	-	0/0	2/269	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	68/3,229	7/510	3/89	2/64

14.2 Mark-Recapture Distance Sampling Analysis

Table 14-2 Parameter estimates from common dolphin (CODO) MRDS analysis
HR=Hazard Rate, HN= Half Normal, LT= Left truncation, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 3	1	CODO, STDO	Distance	Distance+Time of day	330	HR	0.859	0.065	0.642	0.977	0.861
	2		-	Distance	330	HR	-	-	0.137	0.914	0.710
NE-aerial group 3	1	CODO, STDO	Distance	Distance	LT10-500	HR	0.706	0.151	0.421	0.748	0.861
	2		-	Distance+glare	LT10-500	HR	-	-	0.102	0.722	0.618
SE-shipboard group 4	-	ASDO,PSDO, STDO,CODO	Distance+observer	Distance+sea	4500	HR	0.722	0.100	0.190	0.993	0.969
NE-shipboard group 7	-	CODO	Distance	Distance+swell	6000	HR	0.600	0.073	0.461	0.800	0.806

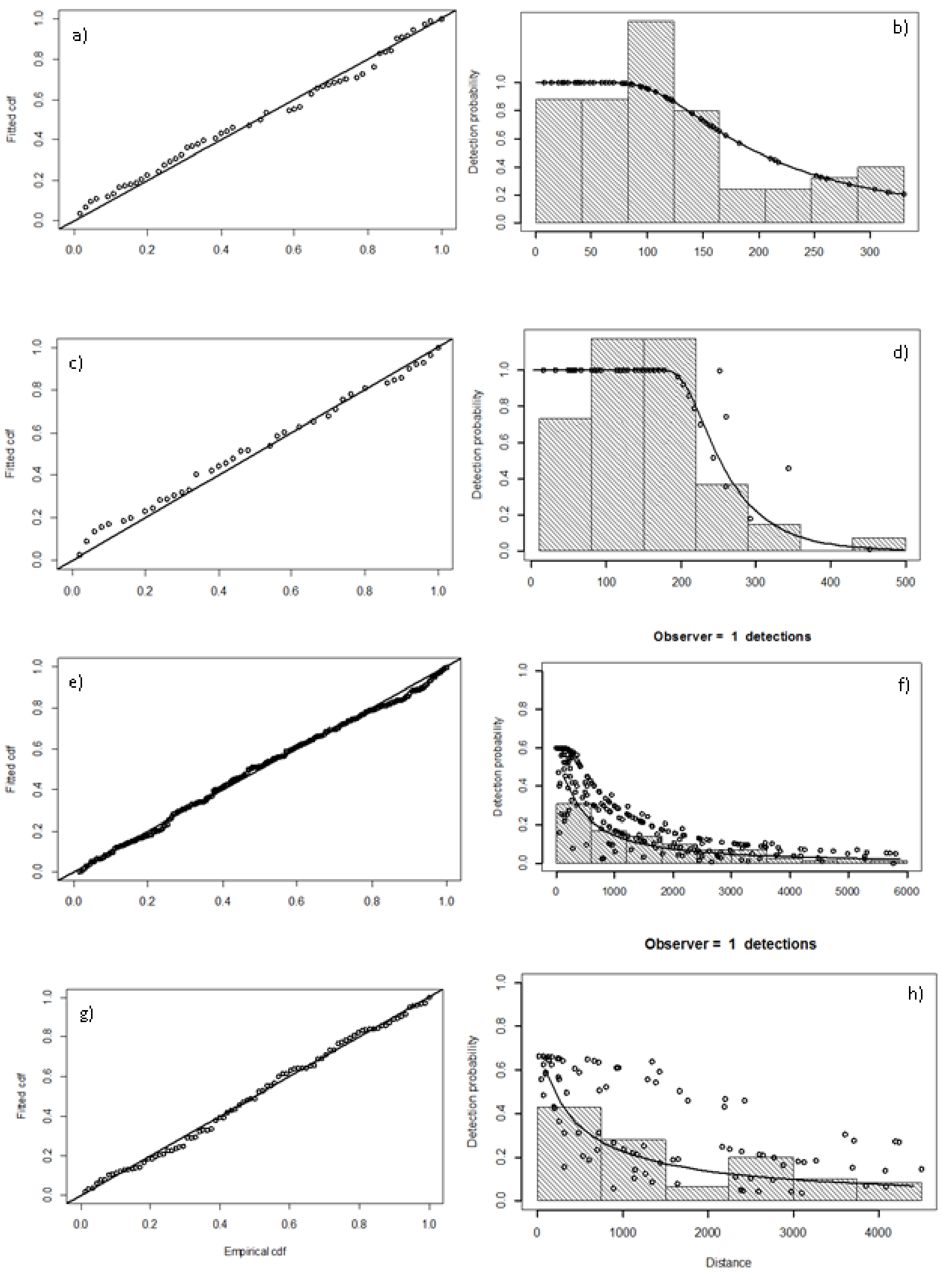

Figure 14-3 Q-Q plots and detection functions from common dolphin MRDS analysis
Group 3 aerial southeast region (a,b), group 3 aerial northeast region (c,d), group 7 shipboard northeast region (e,f) and group 4 shipboard southeast region (g,h).

14.3 Generalized Additive Model Analysis

Table 14-3 Habitat model output for common dolphins

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	3.482	4	129.96	<2e-16	1.66E-01	***
s(dist2shore)	3.75	4	91.48	<2e-16	1.07E-02	***
s(dist1000)	3.223	4	70.69	<2e-16	9.77E-08	***
s(lat)	2.633	4	55.91	<2e-16	4.55E-01	***
Scale	-	-	-	-	3.14E+00	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom: Total = 14.09

R^2 (adjusted) = 0.0296   Deviance explained = 42.1%

REML = 1828.8 Scale estimate = 2.2474   sample size = 11888

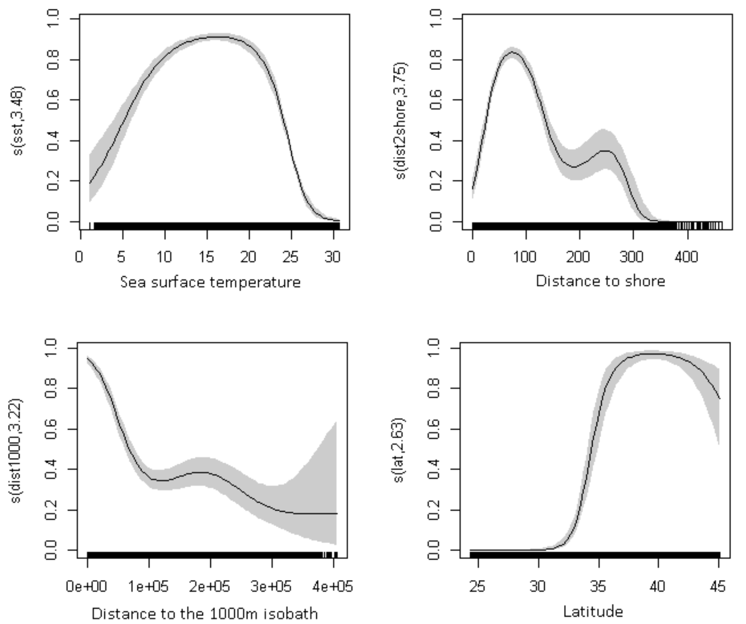

Figure 14-4 Common dolphin density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 14-4 Diagnostic statistics from common dolphin habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.191	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	104.38	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.187	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.268	Fair to good

The cutoff values are taken from Kinlan et al. 2012.
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

14.4 Abundance Estimates for AMAPPS Study Area

Table 14-5 Common dolphin average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.93, CV=0.138; shipboard 1.0, CV= 0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	111,041	0.216	73,071 – 168,741
Summer (June-August)	118,695	0.213	78,490 – 179,494
Fall (September-November)	183,509	0.185	127,981 – 263,128

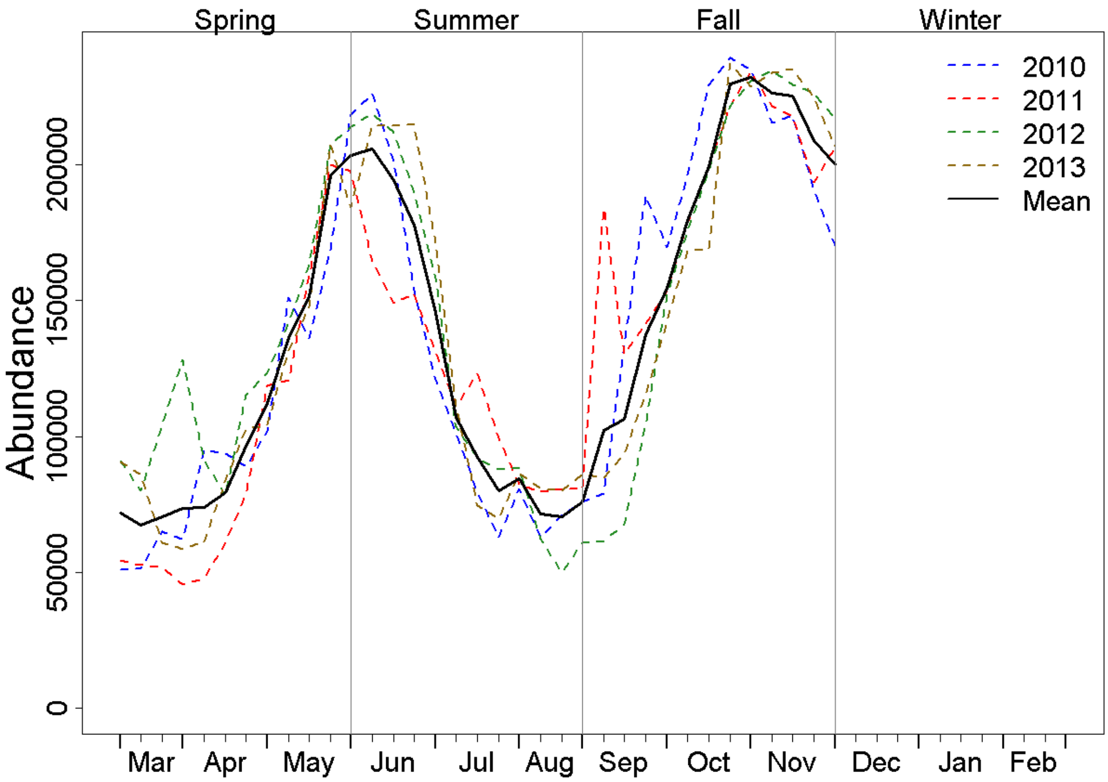

Figure 14-5 Annual abudance trends for common dolphins for AMAPPS study area

14.5 Seasonal Prediction Maps

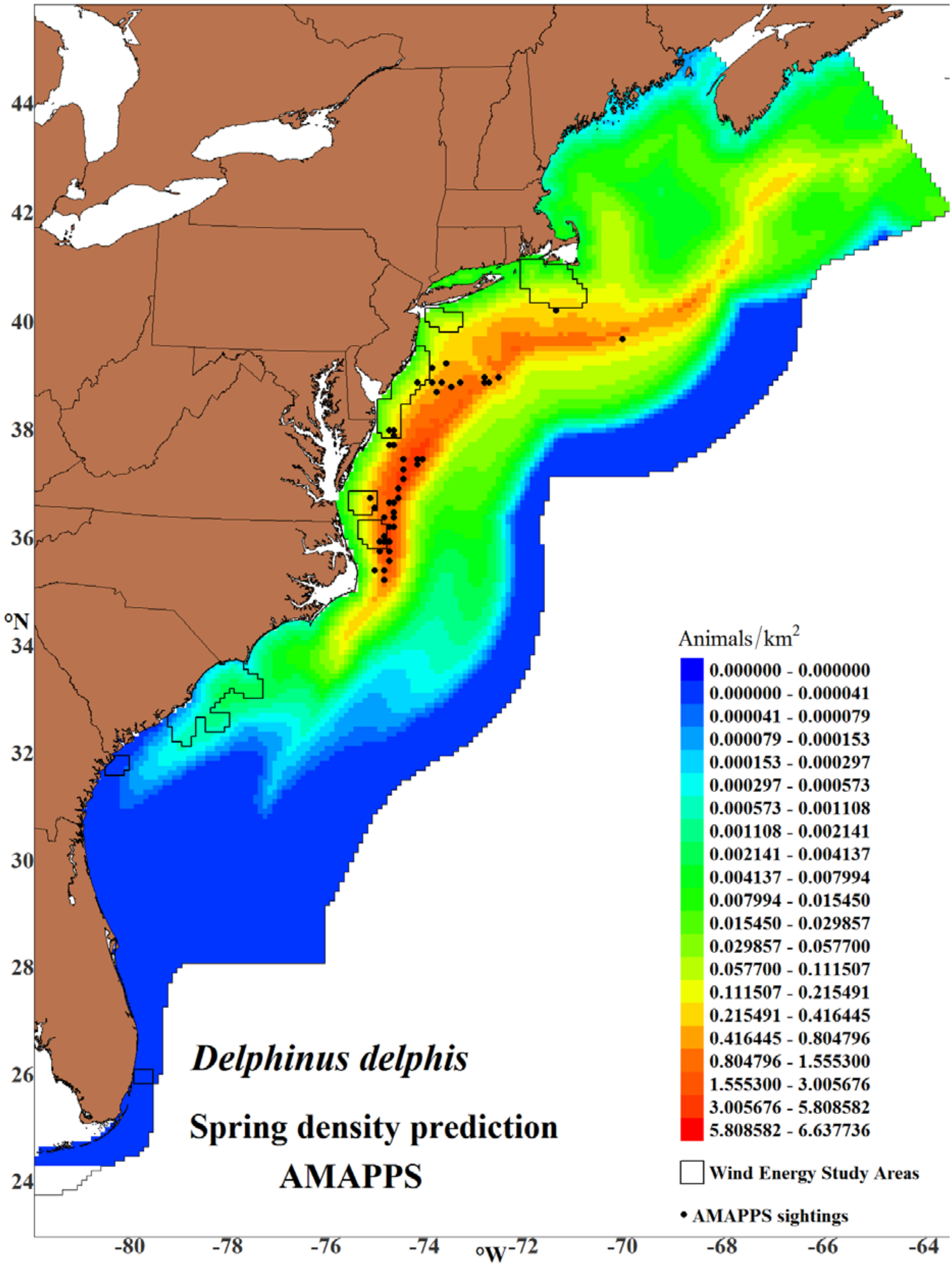

Figure 14-6 Common dolphin spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

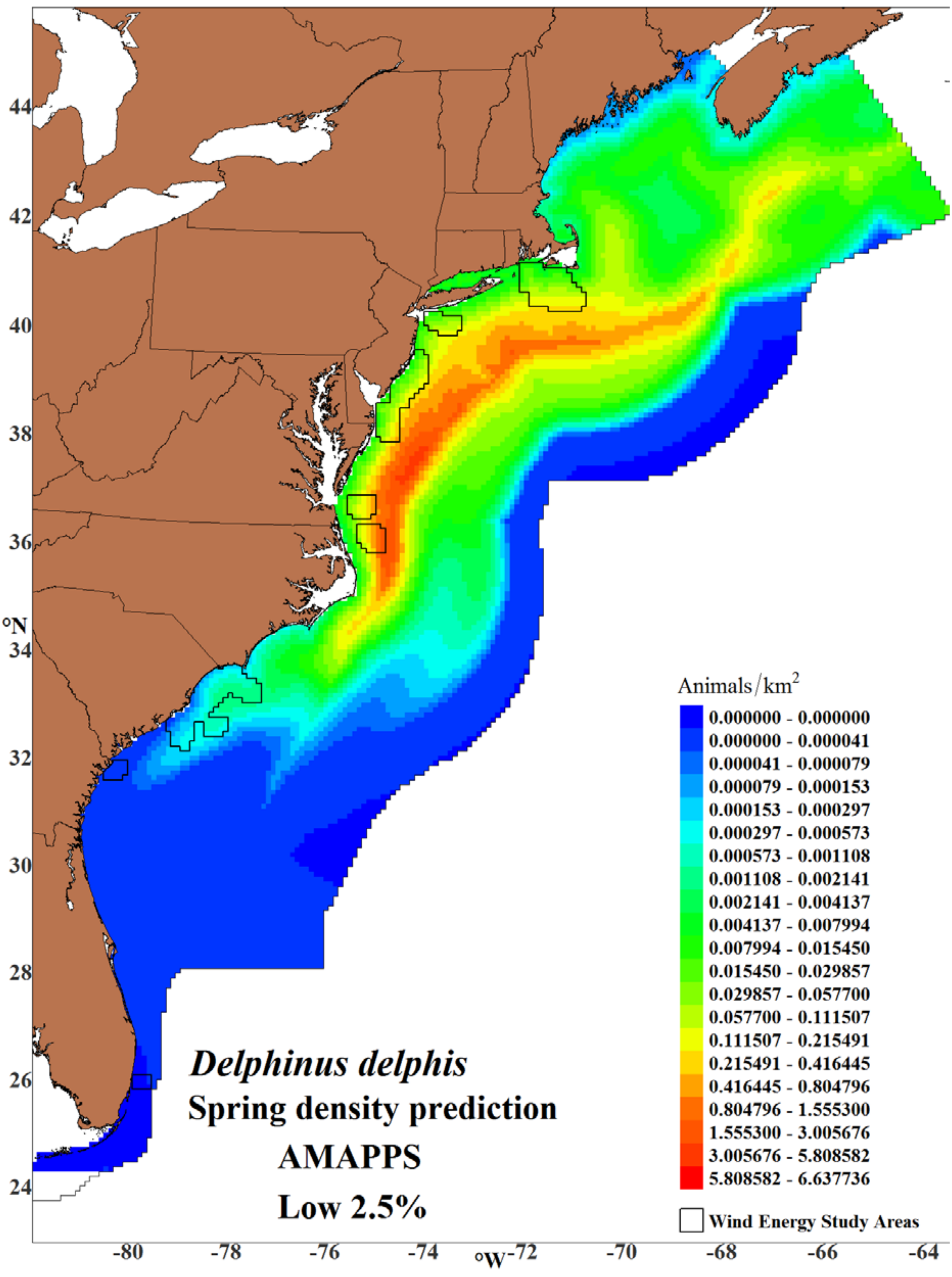

Figure 14-7 Lower 2.5% percentile of spring common dolphin estimates

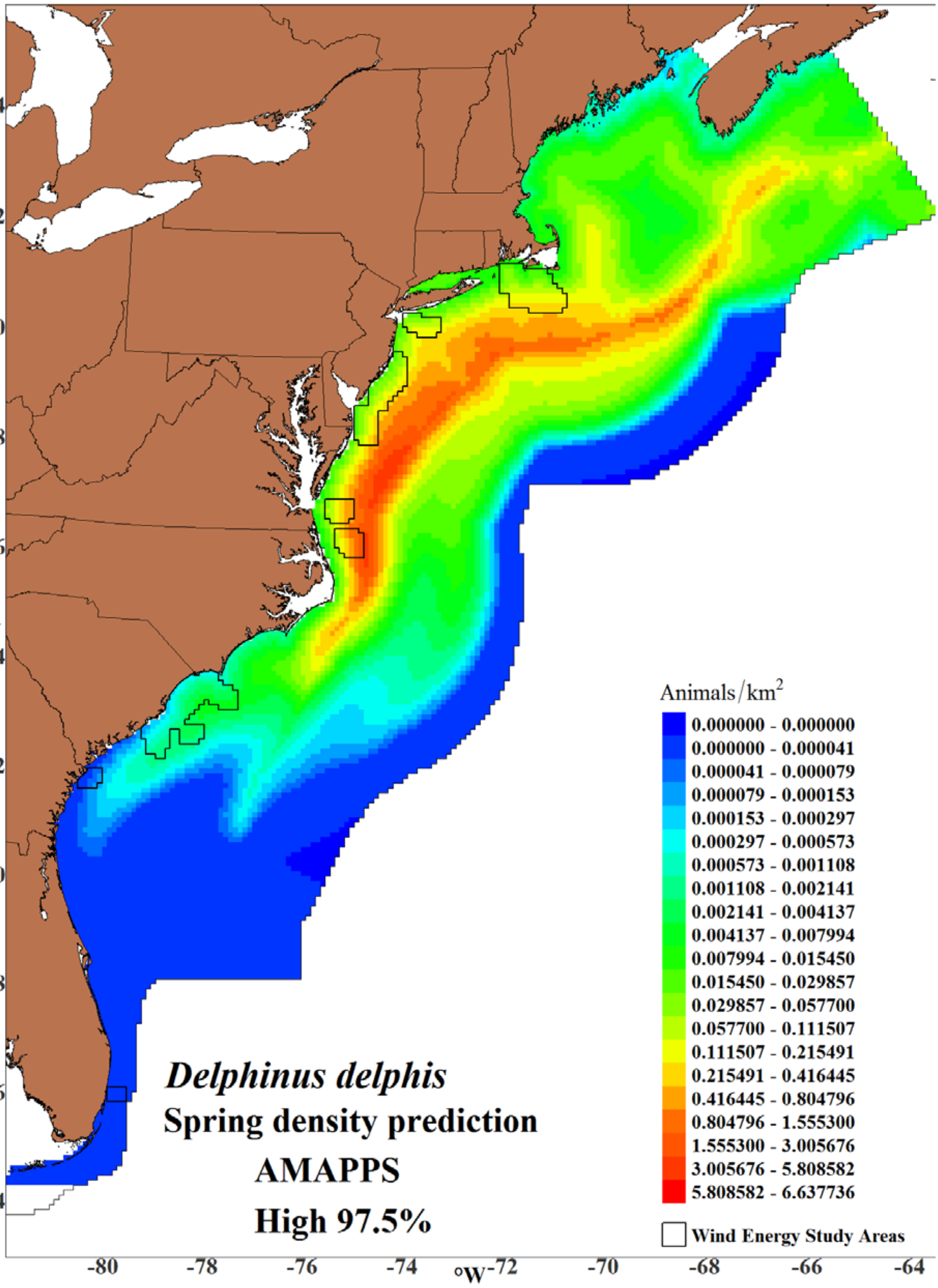

Figure 14-8 Upper 97.5% percentile of spring common dolphin estimates

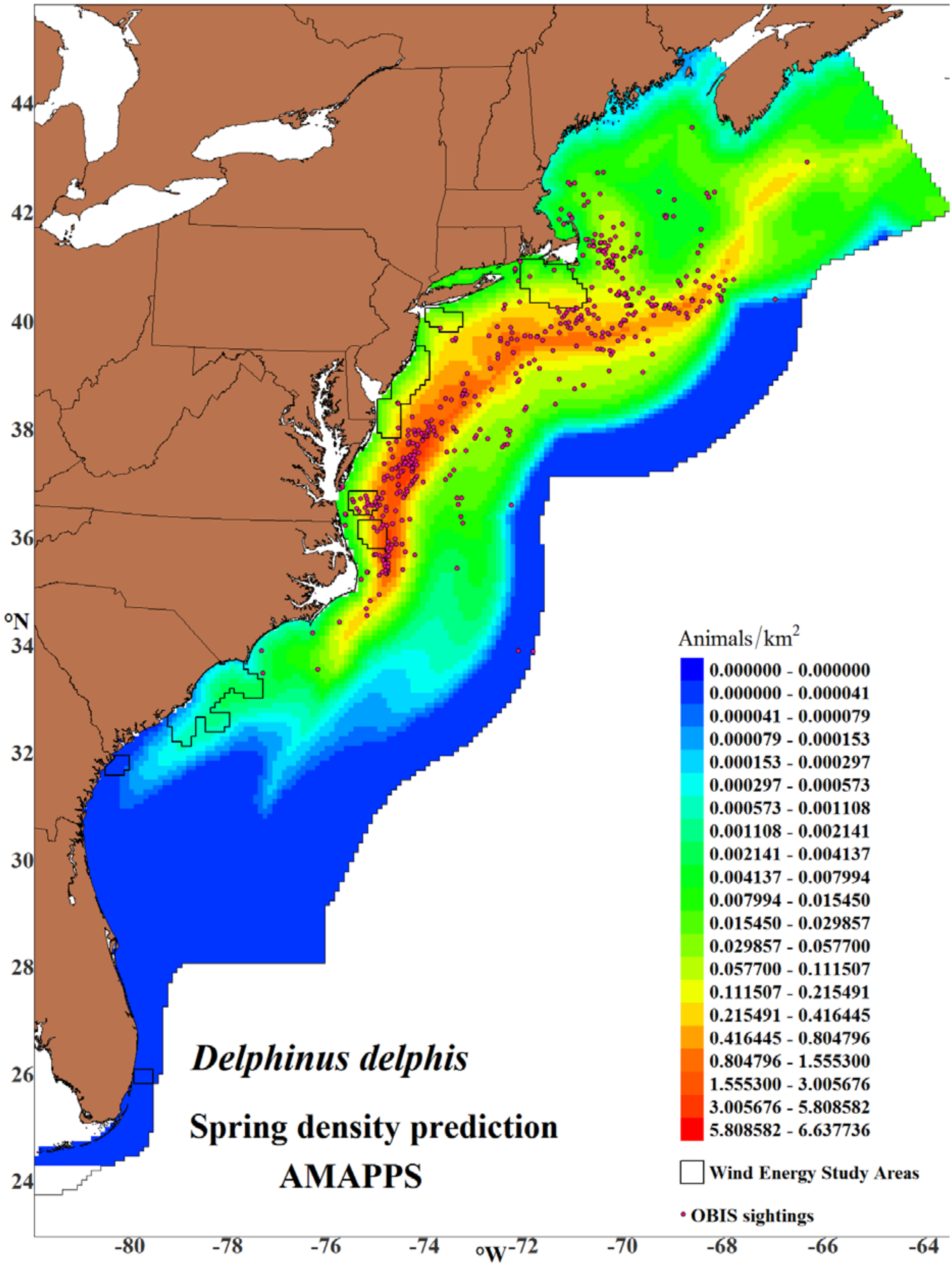

Figure 14-9 Common dolphin 2010-2013 spring density and 1963-2014 OBIS sightings pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

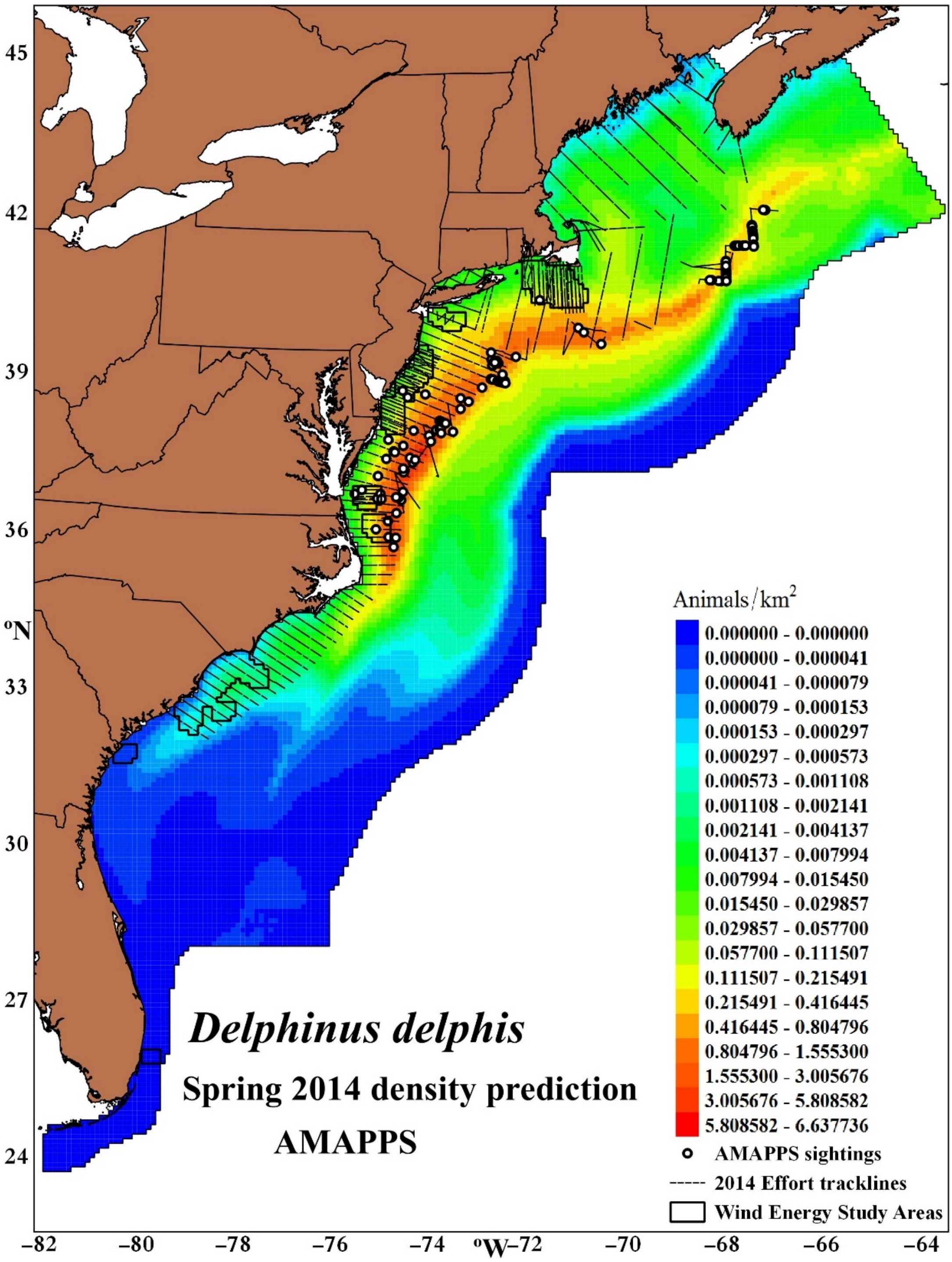

Figure 14-10 Common dolphin spring 2014 density and AMAPPS 2014 tracks and sightings
These sightings were not used to develop the density-habitat model.

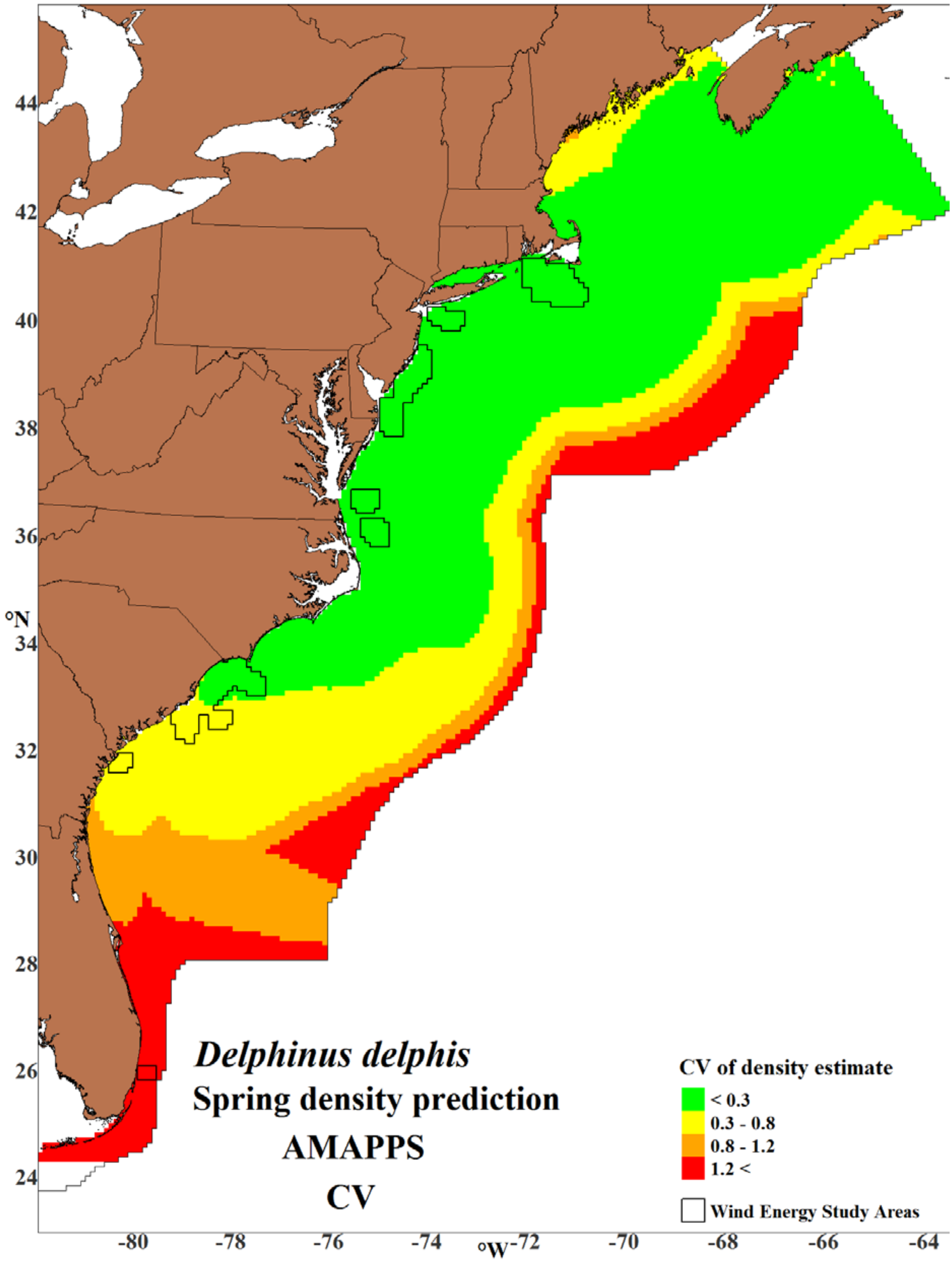

Figure 14-11 CV of spring density estimates for common dolphins

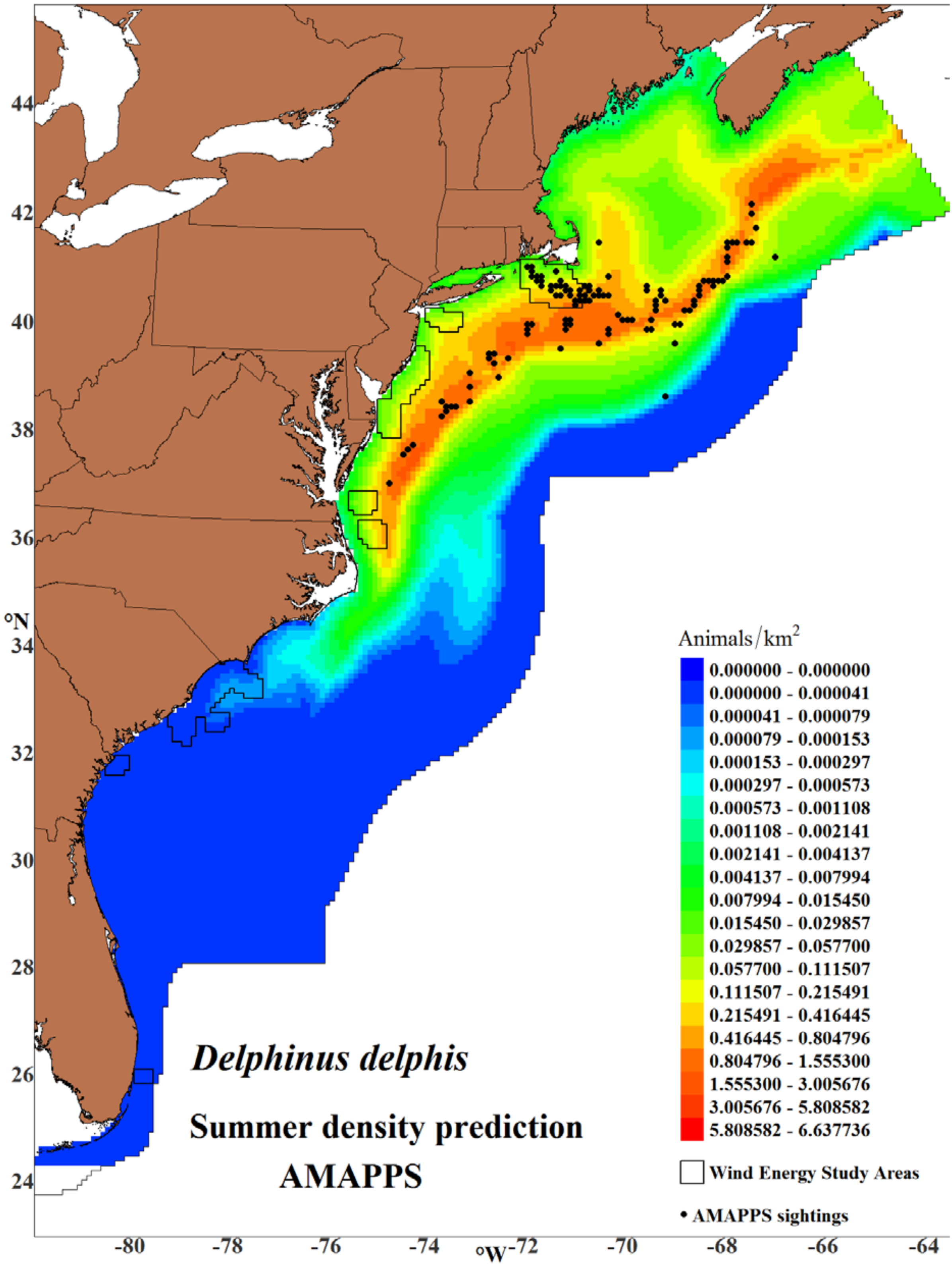

Figure 14-12 Common dolphin summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

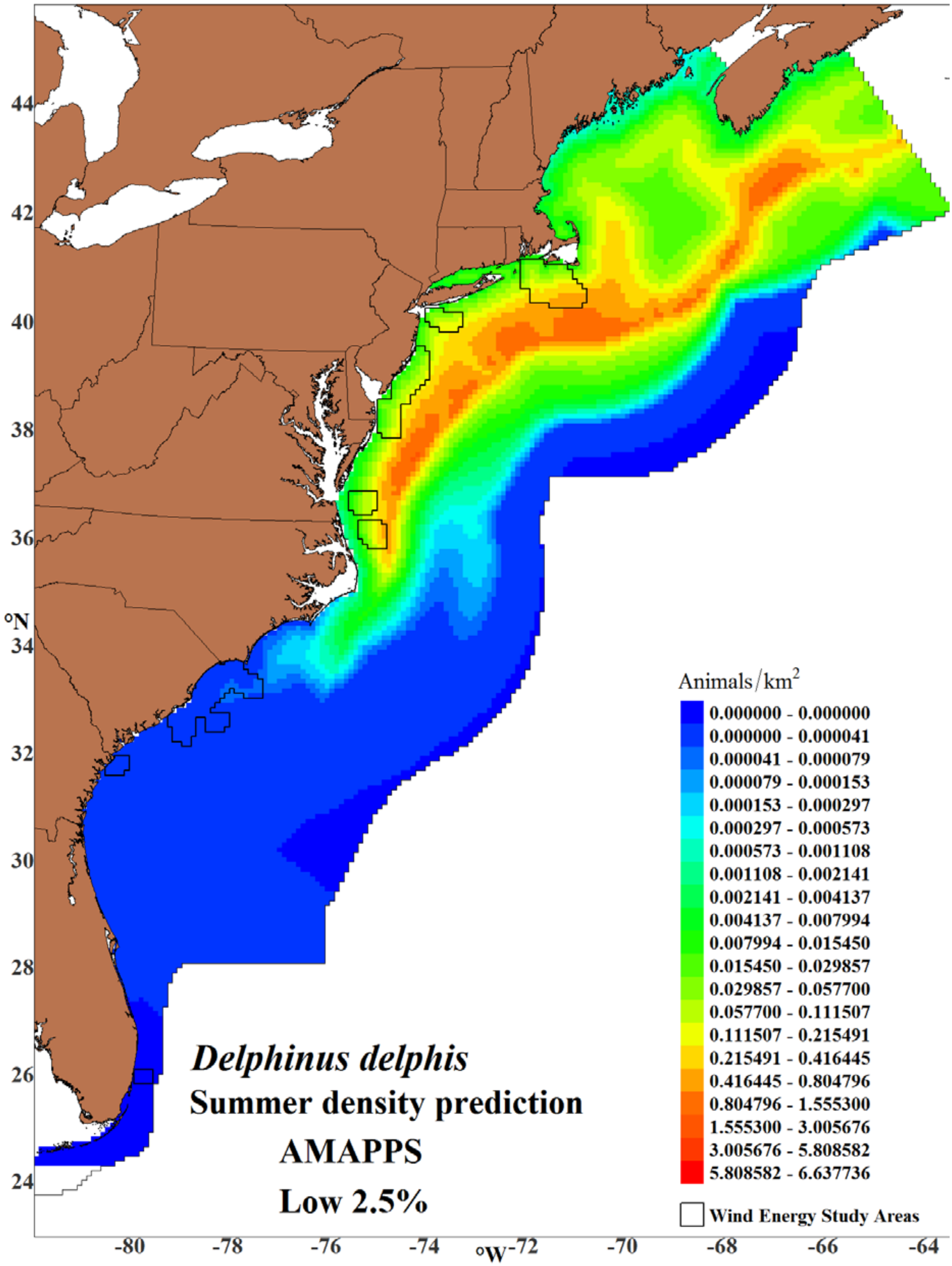

Figure 14-13 Lower 2.5% percentile of summer common dolphin estimates

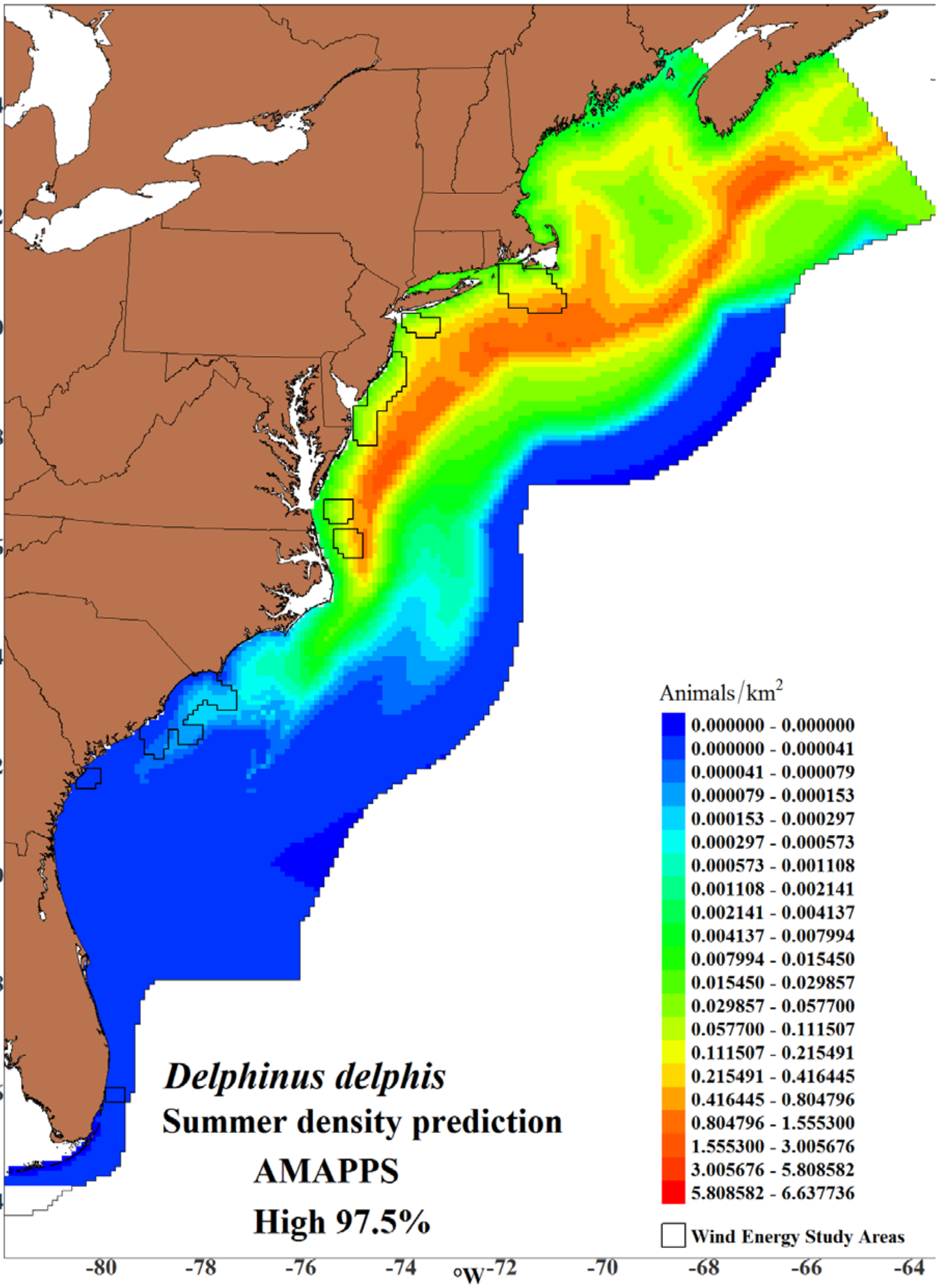

Figure 14-14 Upper 97.5% percentile of summer common dolphin estimates

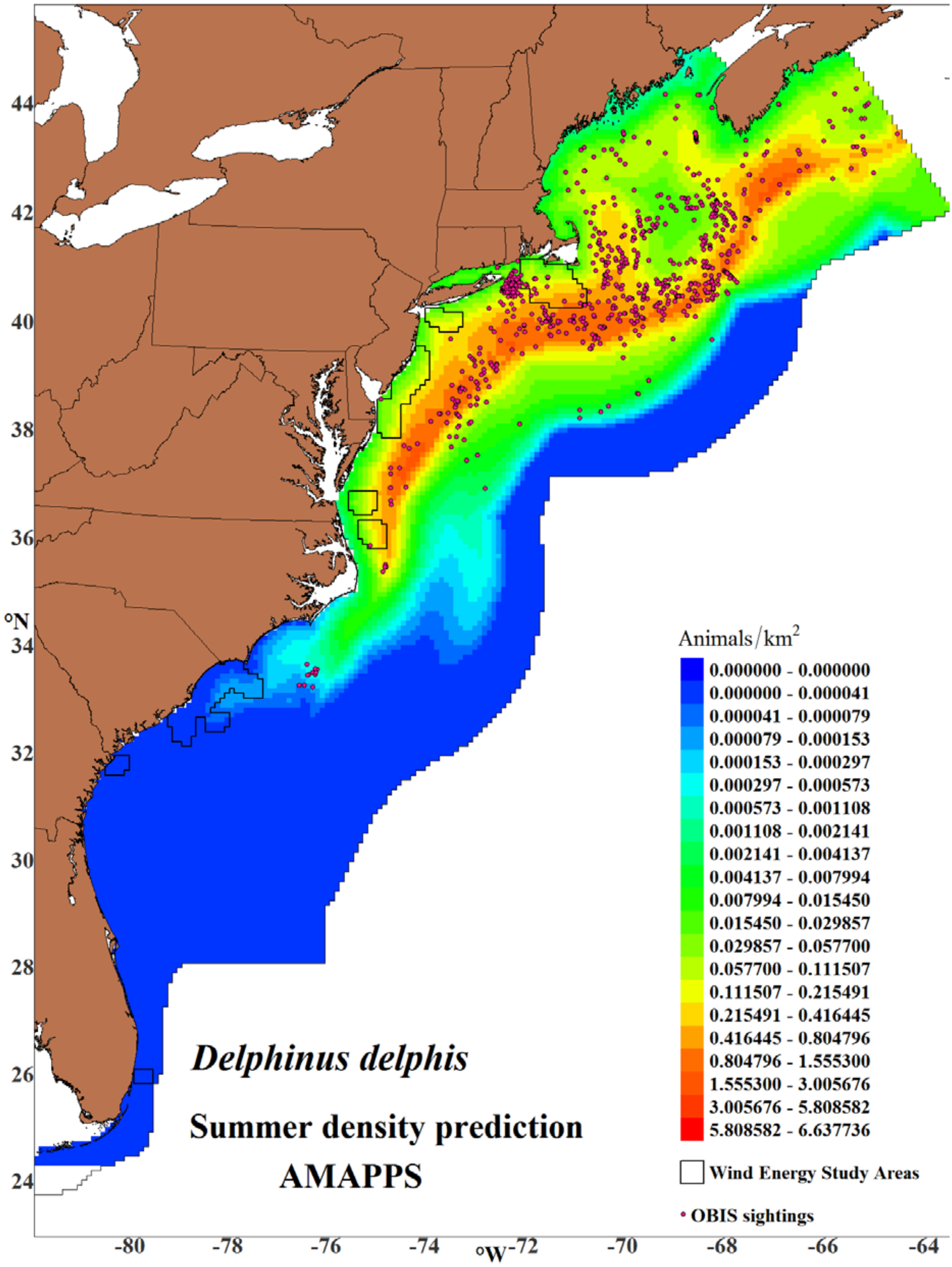

Figure 14-15 Common dolphin 2010-2013 summer density and 1963-2014 OBIS sightings pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

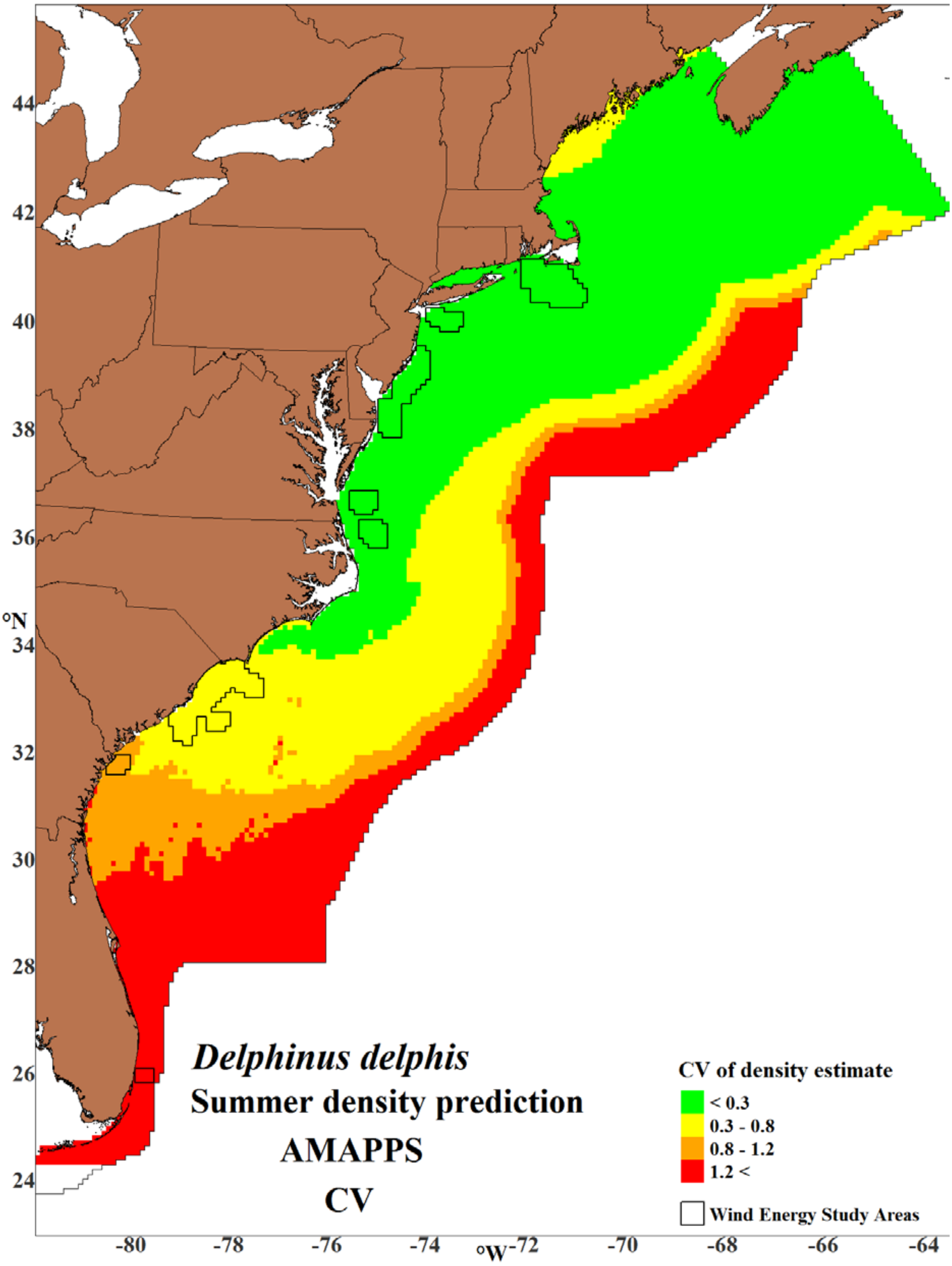

Figure 14-16 CV of summer density estimates for common dolphins

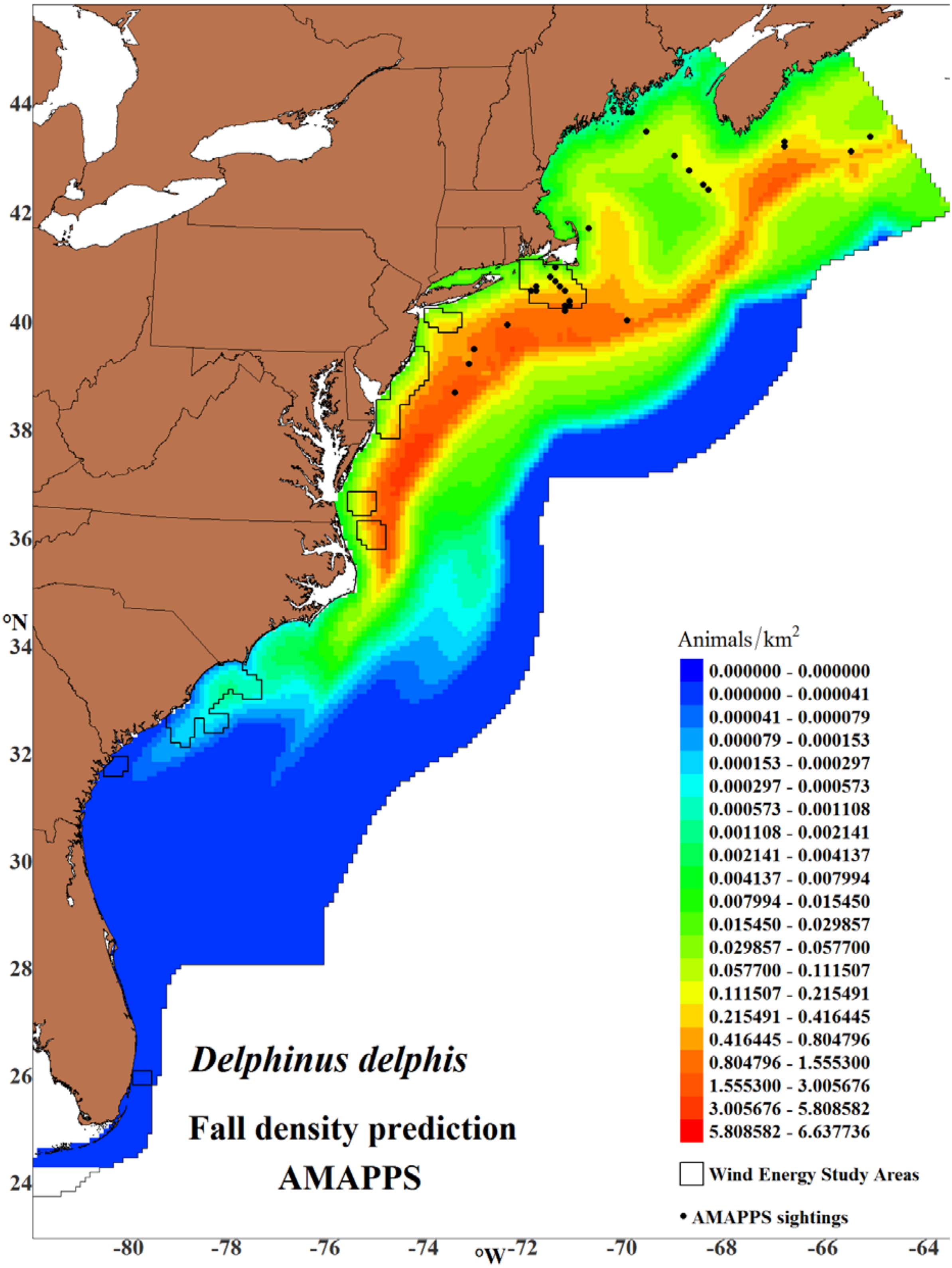

Figure 14-17 Common dolphin fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

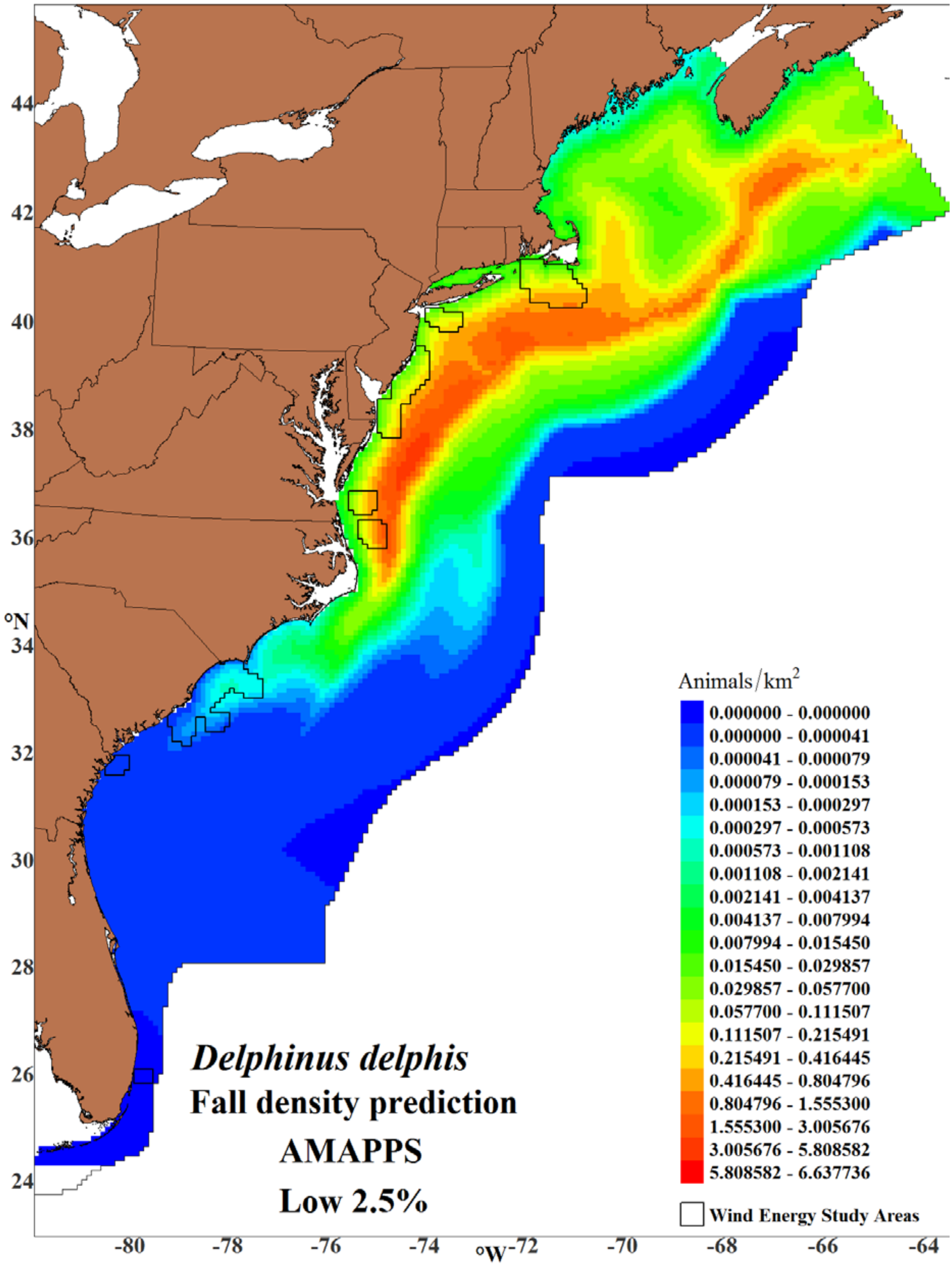

Figure 14-18 Lower 2.5% percentile of fall common dolphin estimates

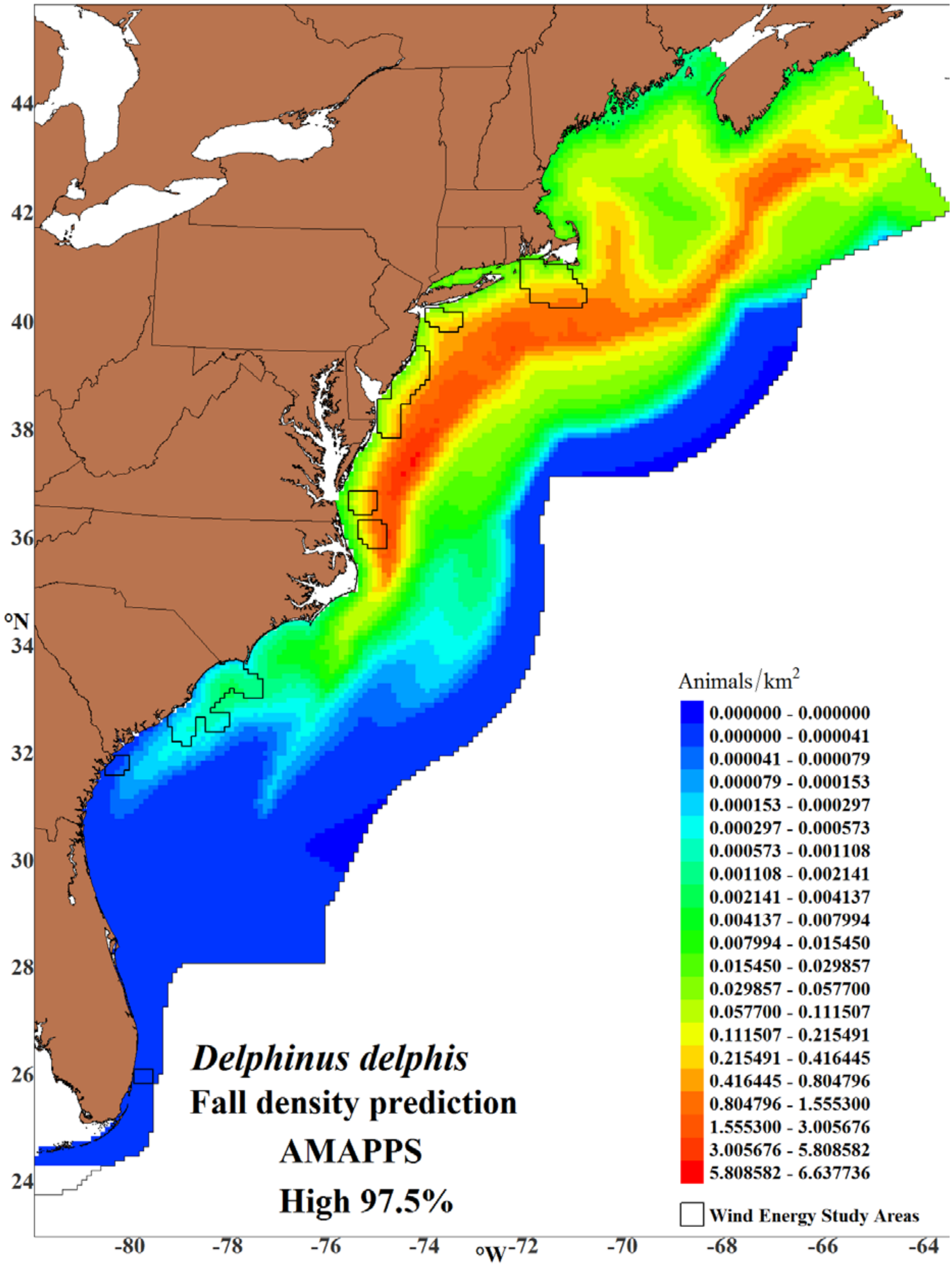

Figure 14-19 Upper 97.5% percentile of fall common dolphin estimates

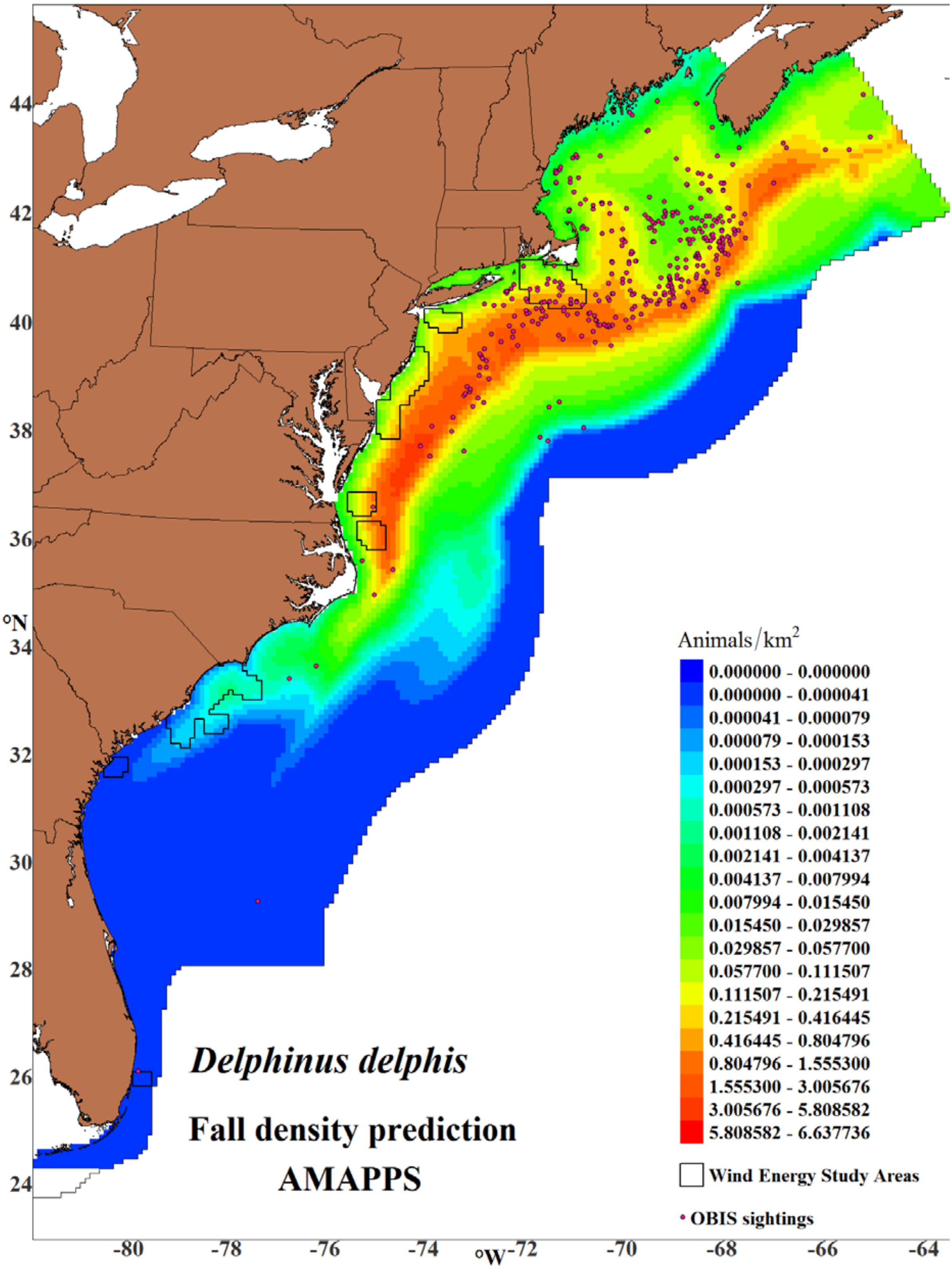

Figure 14-20 Common dolphin 2010-2013 fall density and 1963-2014 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not included in the density model.

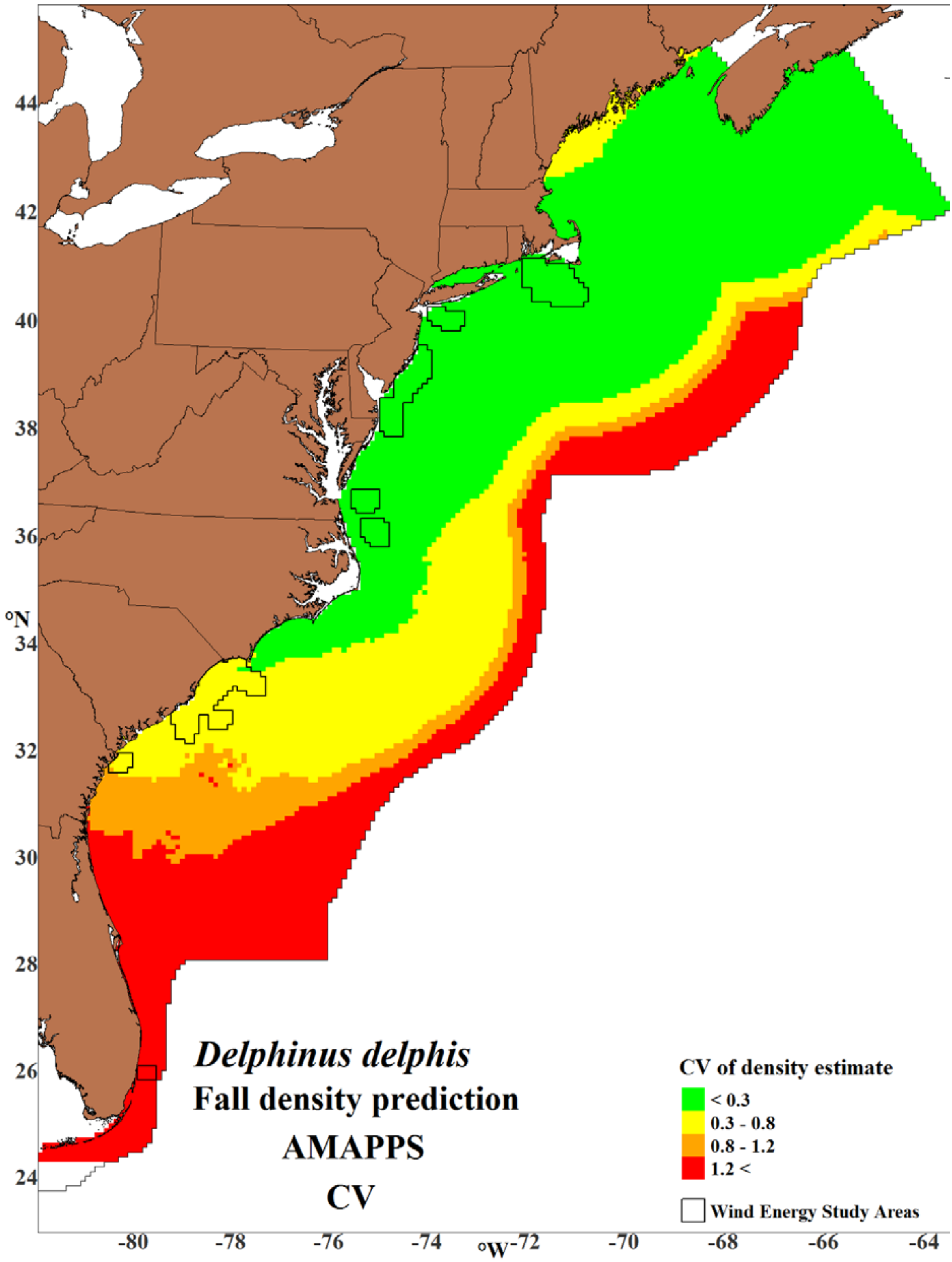

Figure 14-21 CV of fall density estimates for common dolphins

14.6 Wind Energy Study Areas

Table 14-6 Common dolphin average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.93, CV= 0.138; shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	1,161	0.088	977 – 1,380
(March-May)	New York	232	0.104	189 - 284
	New Jersey	536	0.091	449 - 640
	Delaware/ Maryland	454	0.088	382 - 538
	Virginia	690	0.082	588 - 809
	North Carolina	2,301	0.067	2,017 – 2,625
	South Carolina/ North Carolina	17	0.281	10 - 29
	Georgia	0	0.539	0 - 0
	Florida	0	2.416	0 - 0
Summer	Rhode Island/ Massachusetts	3,246	0.065	2,860 – 3,685
(June-August)	New York	313	0.096	259 - 377
	New Jersey	467	0.098	385 - 567
	Delaware/ Maryland	318	0.103	260 - 390
	Virginia	239	0.118	190 - 301
	North Carolina	663	0.115	529 - 829
	South Carolina/ North Carolina	1	0.448	0 - 1
	Georgia	0	0.911	0 - 0
	Florida	0	2.559	0 - 0
Fall	Rhode Island/ Massachusetts	3,760	0.06	3,342 – 4,231
(September- November)	New York	505	0.078	434 - 589
	New Jersey	936	0.075	808 – 1,085
	Delaware/ Maryland	714	0.077	614 - 831
	Virginia	852	0.079	729 - 995
	North Carolina	2,296	0.072	1,994 – 2,644
	South Carolina/ North Carolina	7	0.374	3 - 14
	Georgia	0	0.735	0 - 0
	Florida	0	2.79	0 - 0

***** The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value predicted by the habitat model.

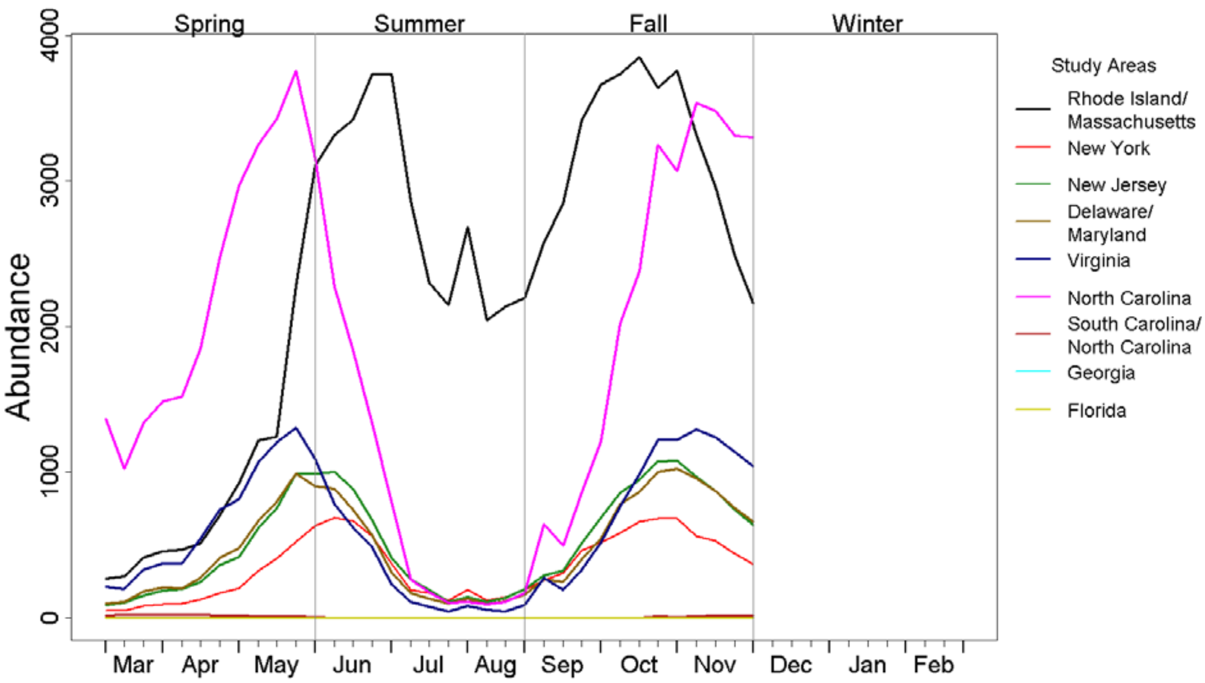

Figure 14-22 Annual abundance trends for common dolphins in wind energy study areas

15 Atlantic Spotted Dolphin (*Stenella frontalis*)

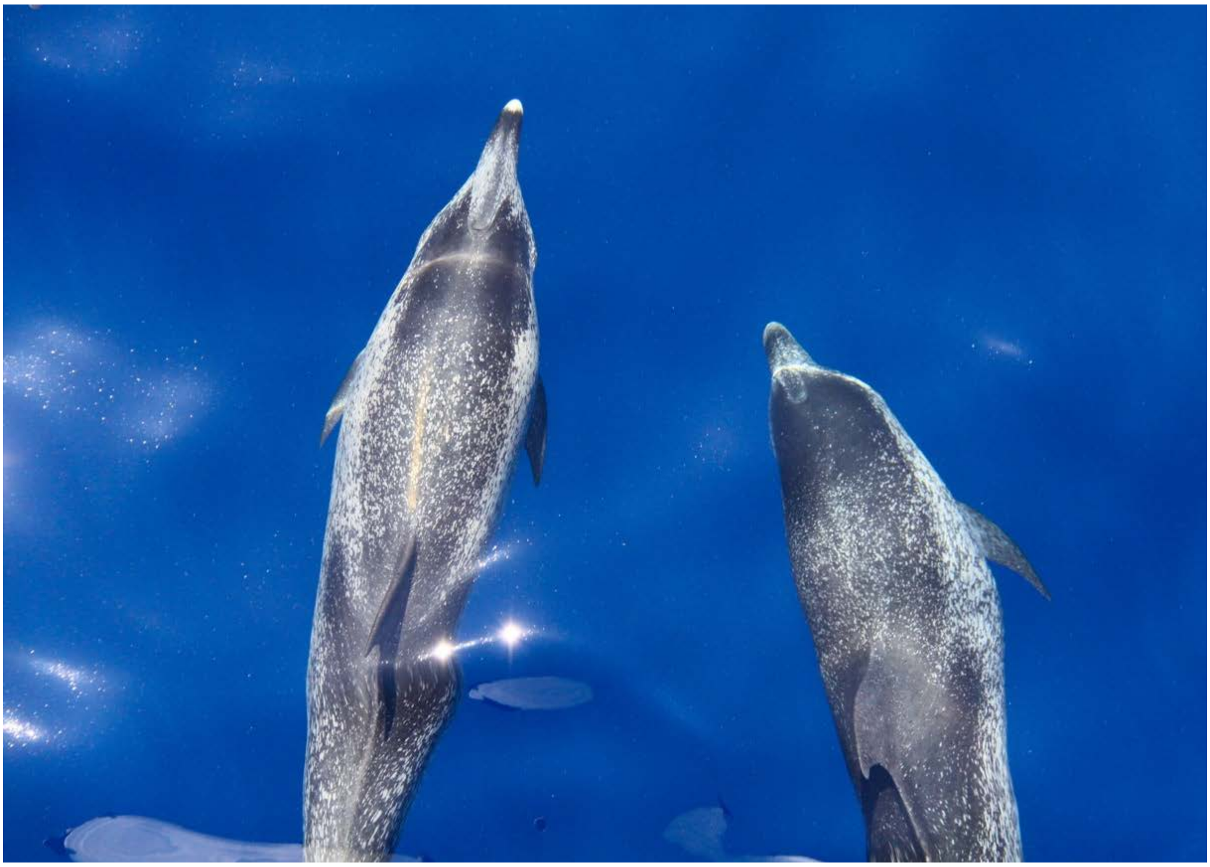

Figure 15-1 Atlantic spotted dolphin. Credit: NOAA/NEFSC/Kelly Slivka
Image collected under MMPA Research permit #775-1875.

15.1 Data Collection

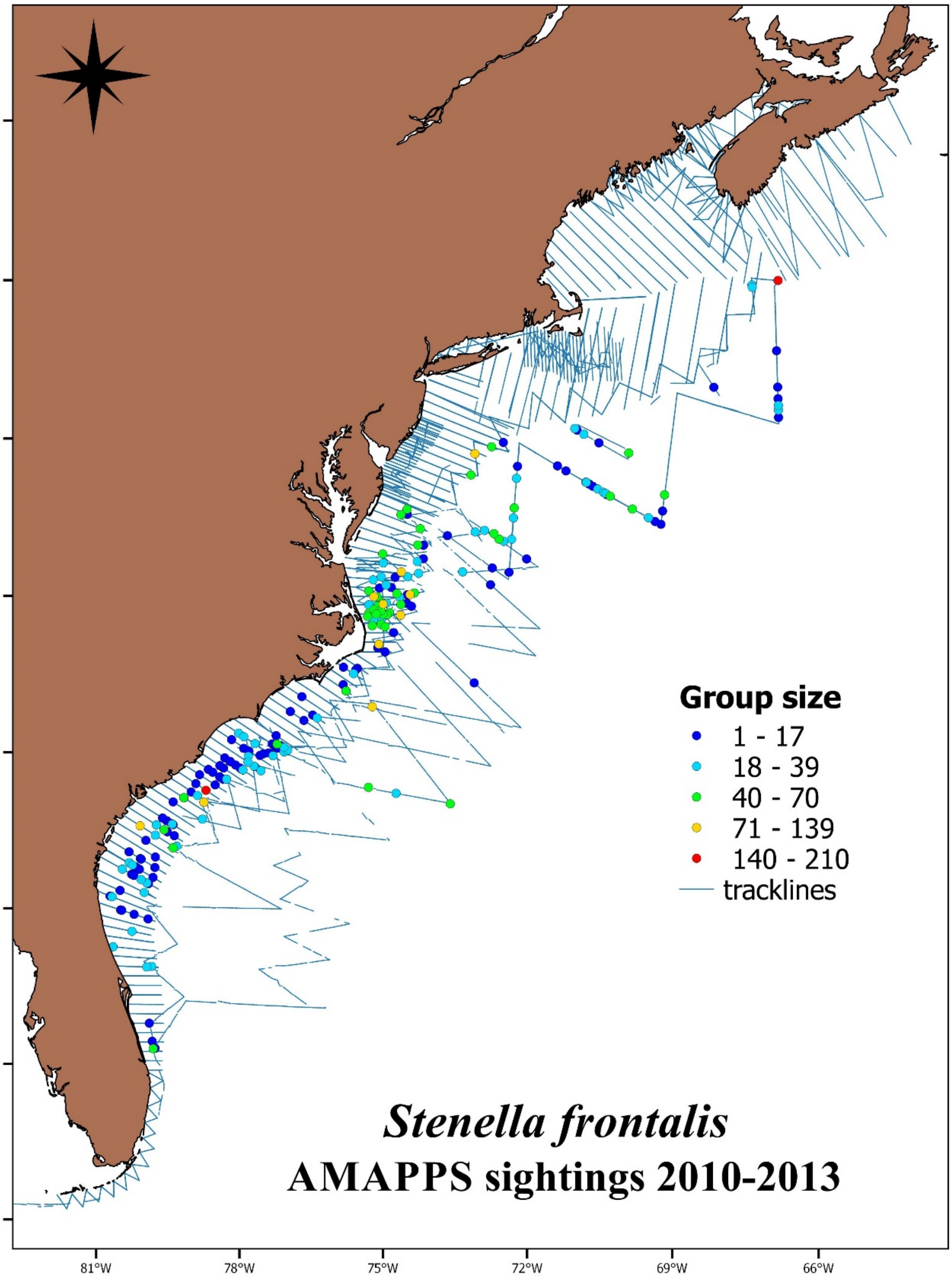

Figure 15-2 Track lines and Atlantic spotted dolphin sightings during 2010 - 2013

Table 15-1 Research effort 2010 - 2013 and Atlantic spotted dolphin sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Atlantic spotted dolphin	*Stenella frontalis*	0	46/1,334	0	0
NE Aerial	7,502	10,468	11,038	3,573	-	-	0	0	0	0
SE Shipboard	0	8,537	2,093	0	-	-	0	66/2,380	18/692	0
SE Aerial	17,978	16,835	11,818	6,007	-	-	32/481	33/861	22/234	7/385

15.2 Mark-Recapture Distance Sampling Analysis

Table 15-2 Parameter estimates from Atlantic spotted dolphin (ASDO) MRDS analysis
HR= Hazard Rate, HN= Half Normal, LT= Left truncation, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 4	1	ASDO	Distance+observer	Distance+sea	LT50-392	HN	0.843	0.101	0.676	0.952	0.974
	2		-	Distance+sea	392	HN	-	-	0.24	0.717	0.766
NE-shipboard group 9	-	ASDO	Distance+observer	Distance+size+sea	4984	HR	0.924	0.049	0.375	0.970	0.953
SE-shipboard group 4	-	ASDO, PSDO, CODO, STDO	Distance+Observer	Distance+sea	4500	HR	0.722	0.100	0.190	0.993	0.969

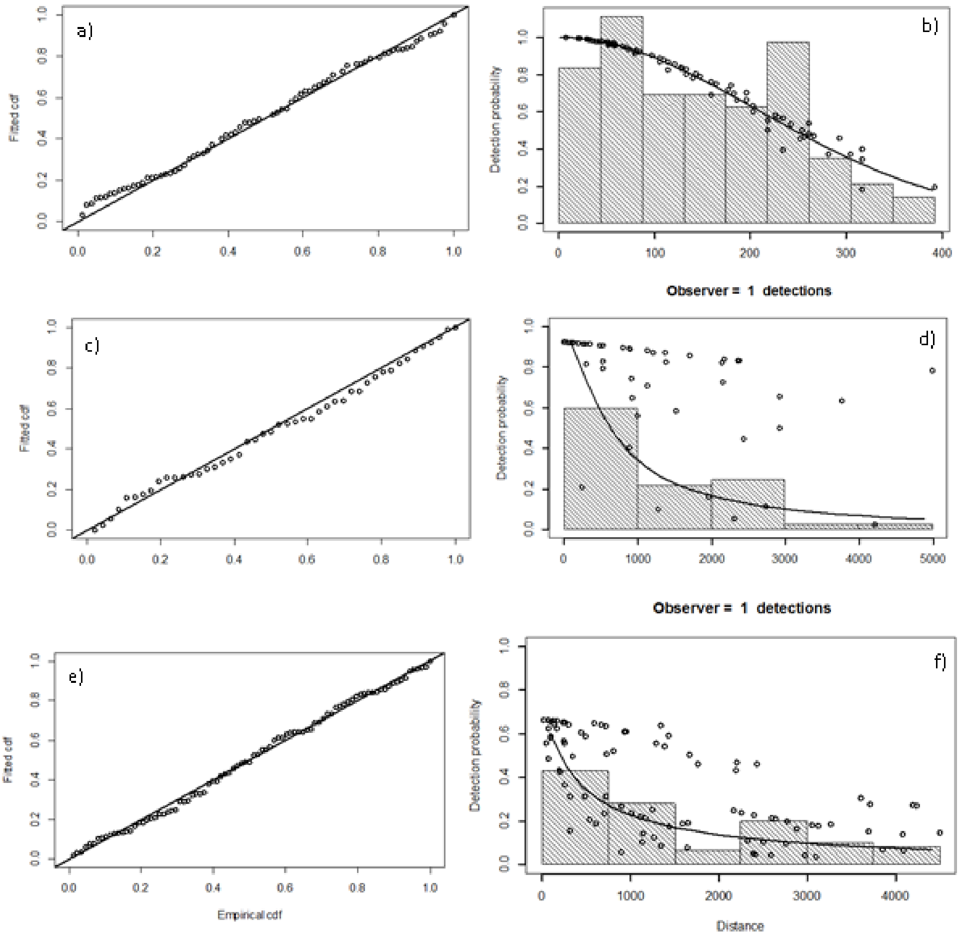

Figure 15-3 Q-Q plots and detection functions from Atlantic spotted dolphin MRDS analysis
Group 4 aerial southeast region (a,b), group 9 shipboard northeast region ((c,d) and group 4 shipboard southeast region (e,f).

15.3 Generalized Additive Model Analysis

Table 15-3 Habitat model output for Atlantic spotted dolphins

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(pic)	0.9535	4	9.233	3.92E-10	4.39E+02	***
s(pp)	3.5883	4	21.568	< 2e-16	4.56E-05	***
s(salinity)	2.8044	4	20.826	< 2e-16	9.56E-01	***
s(lat)	3.1857	4	34.305	< 2e-16	2.28E-01	***
Scale	-	-	-	-	2.79E+00	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Estimated degrees of freedom: Total = 11.53
R^2 (adjusted) = 0.00569 Deviance explained = 16.2%
REML = 1671.5 Scale estimate = 3.3661 sample size = 9096

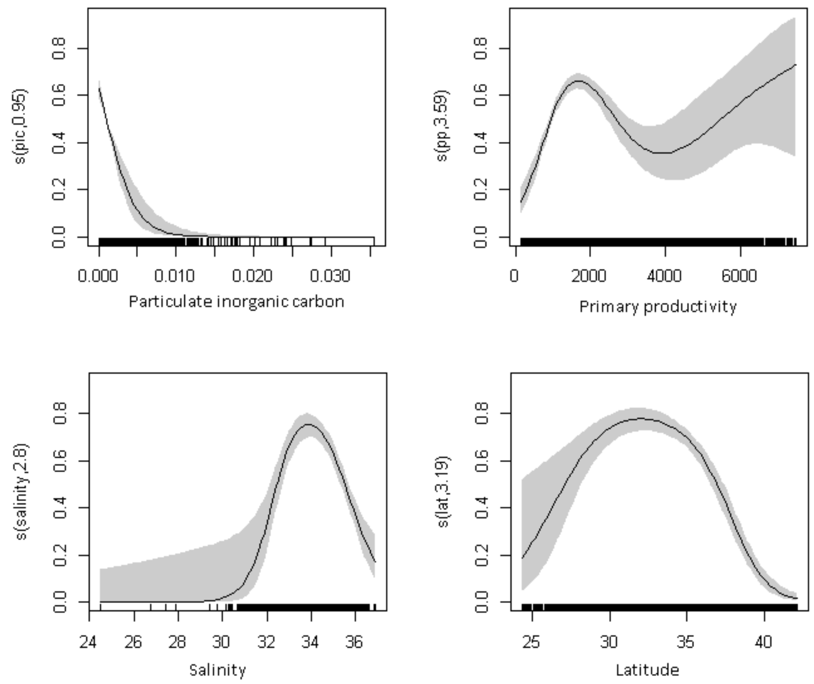

Figure 15-4 Atlantic spotted dolphin density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 15-4 Diagnostic statistics from Atlantic spotted dolphin habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.272	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	87.86	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.131	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.193	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

15.4 Abundance Estimates for AMAPPS Study Area

Table 15-5 Atlantic spotted dolphin average abundance estimates for AMAPPS study area
Availability bias correction: aerial and shipboard 1.0, CV= 0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	65,948	0.156	48,703 – 89,299
Summer (June-August)	54,731	0.153	40,633 – 73,720
Fall (September-November)	56,372	0.165	40,868 – 77,758

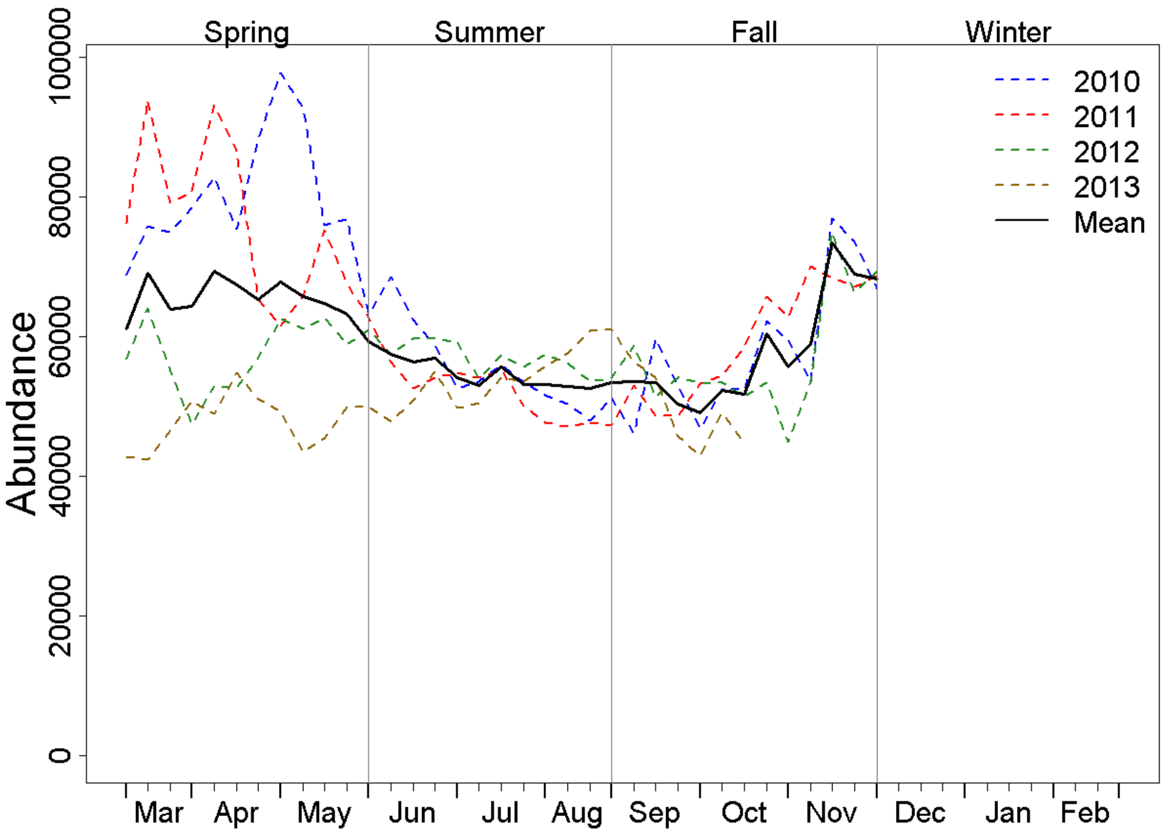

Figure 15-5 Annual abundance trends for Atlantic spotted dolphins for AMAPPS study area

15.5 Seasonal Prediction Maps

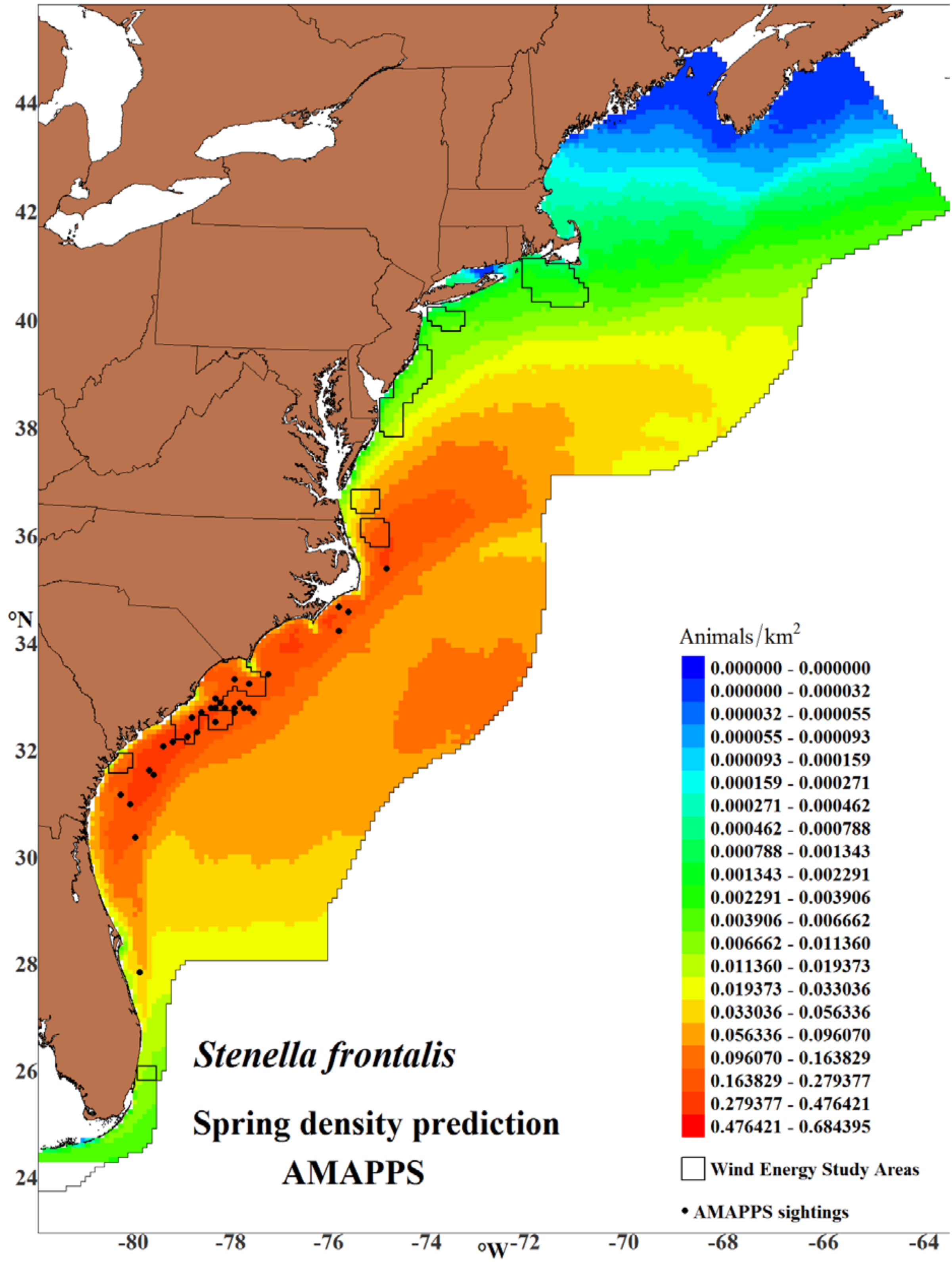

Figure 15-6 Altantic spotted dolphin spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

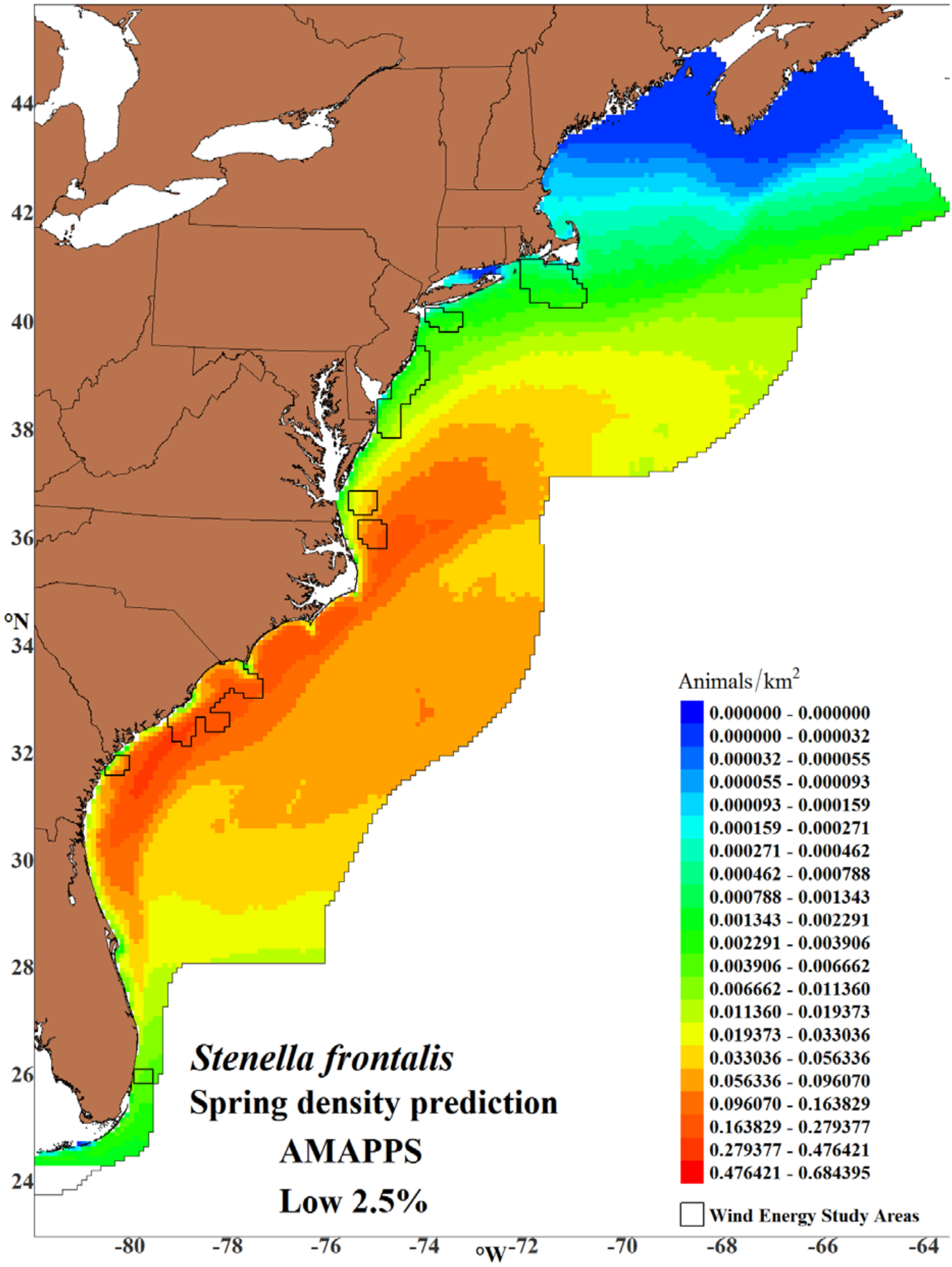

Figure 15-7 Lower 2.5% percentile of spring Atlantic spotted dolphin estimates

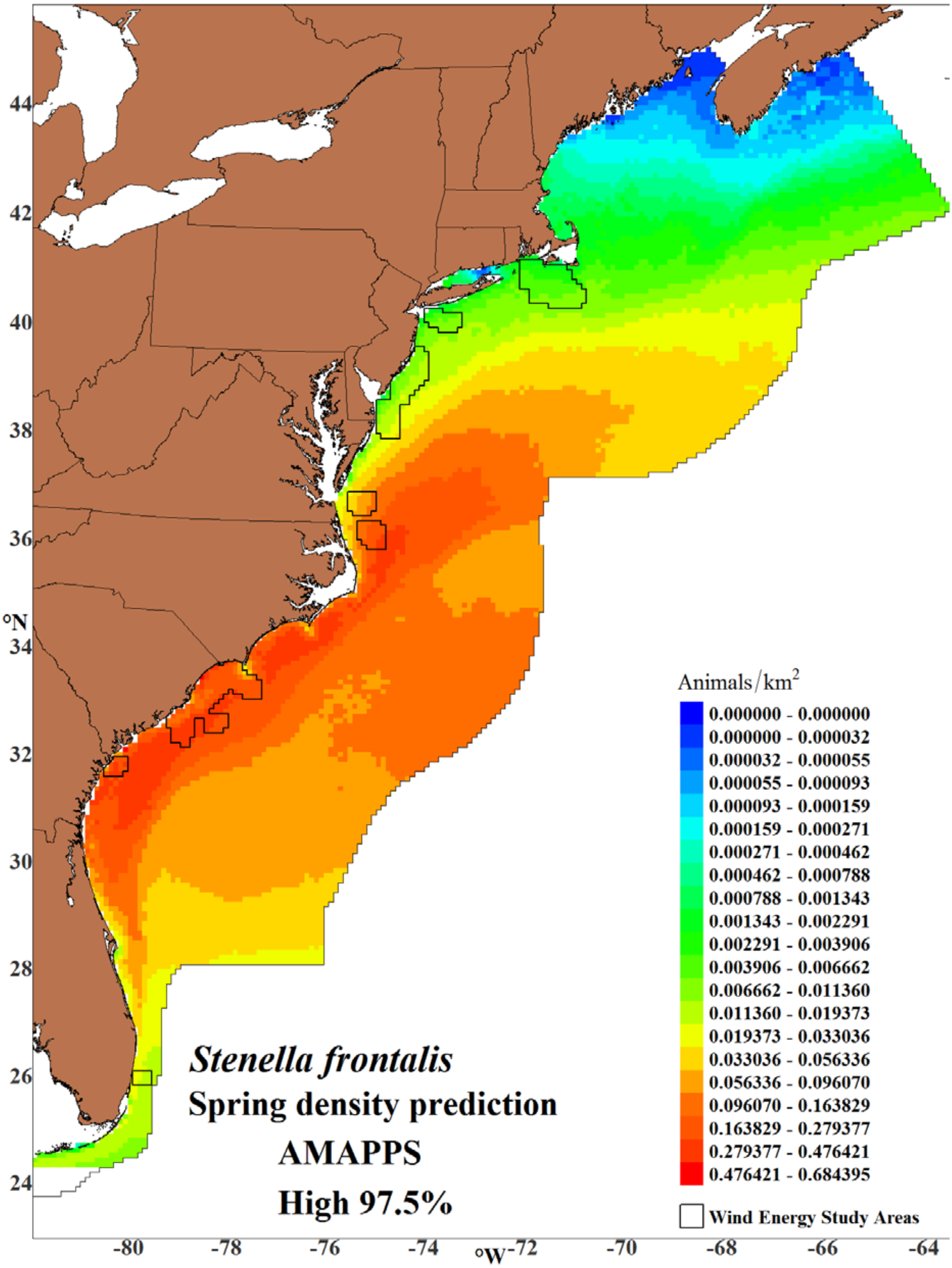

Figure 15-8 Upper 97.5% percentile of spring Atlantic spotted dolphin estimates

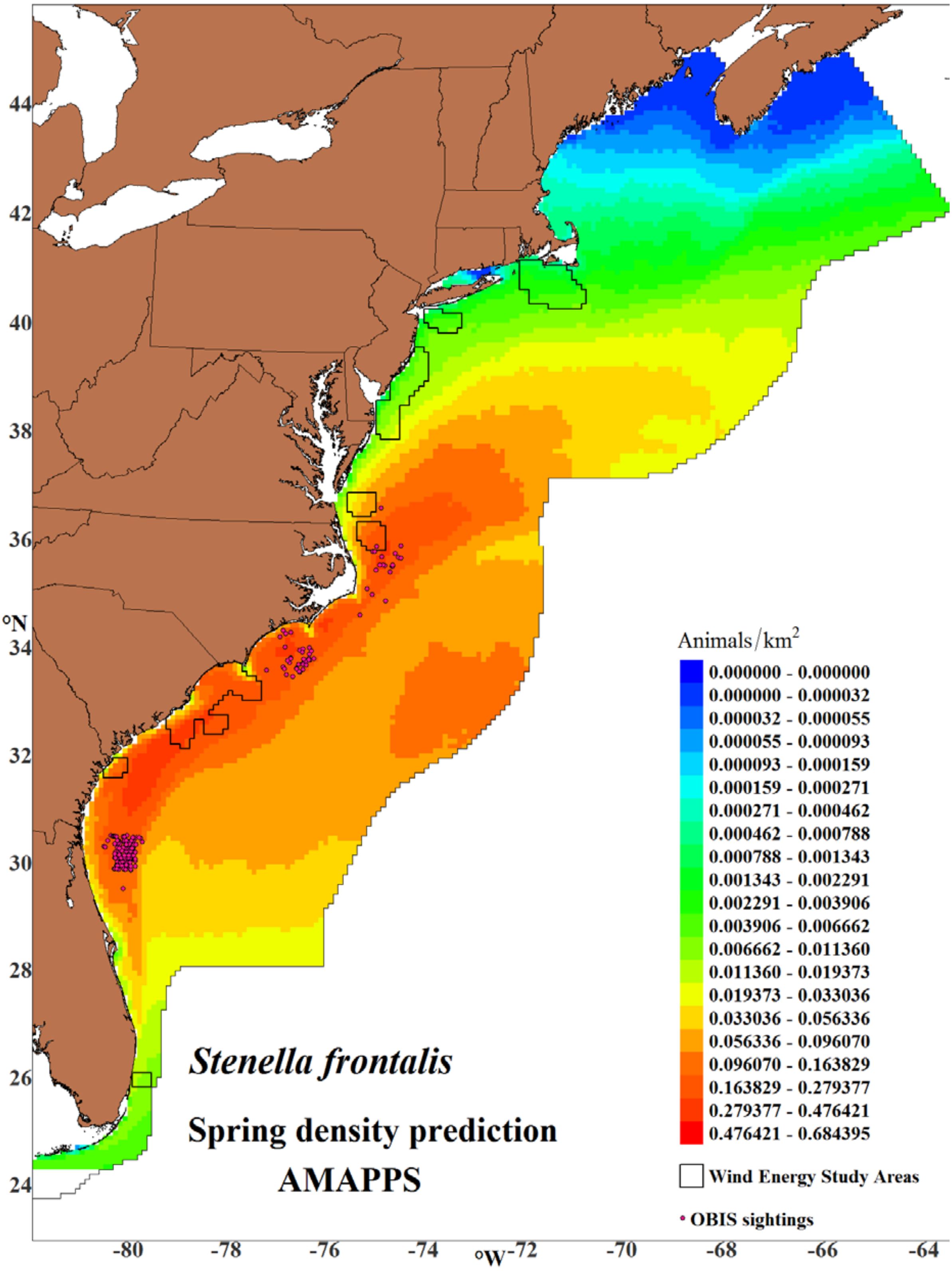

Figure 15-9 Atlantic spotted dolphin 2010-2013 spring density and 1984-2013 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

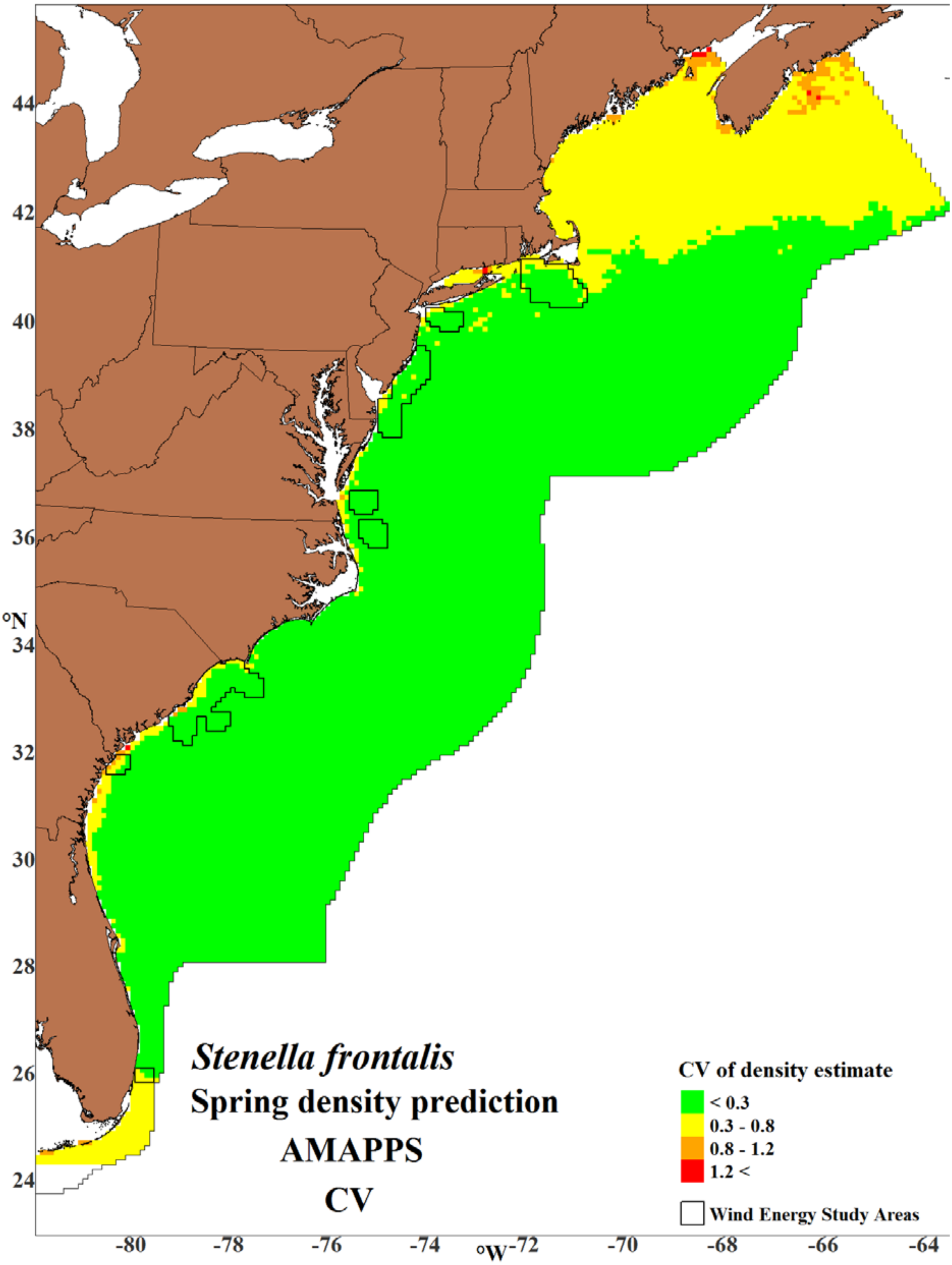

Figure 15-10 CV of spring density estimates for Atlantic spotted dolphins

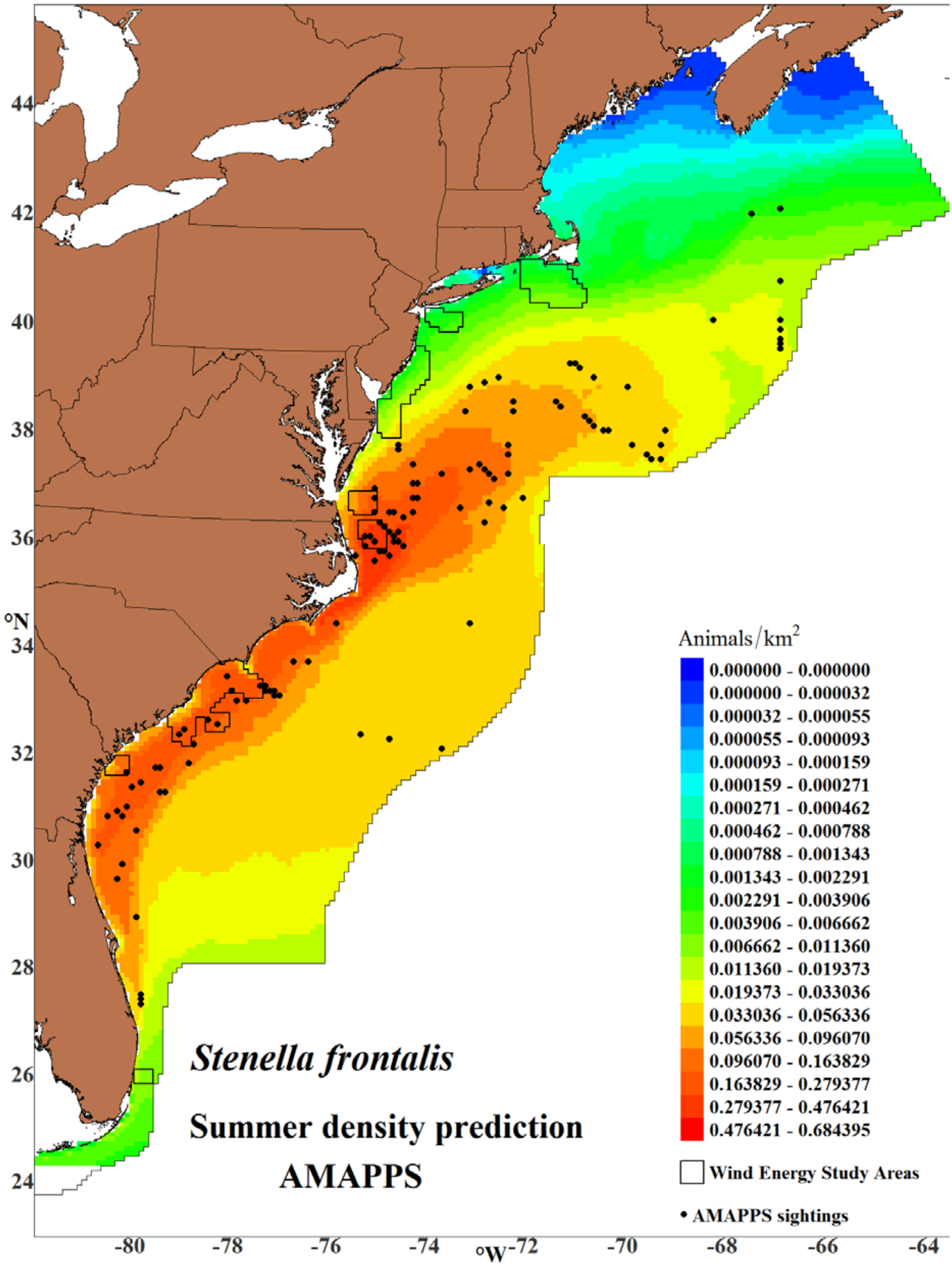

Figure 15-11 Atlantic spotted dolphin summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

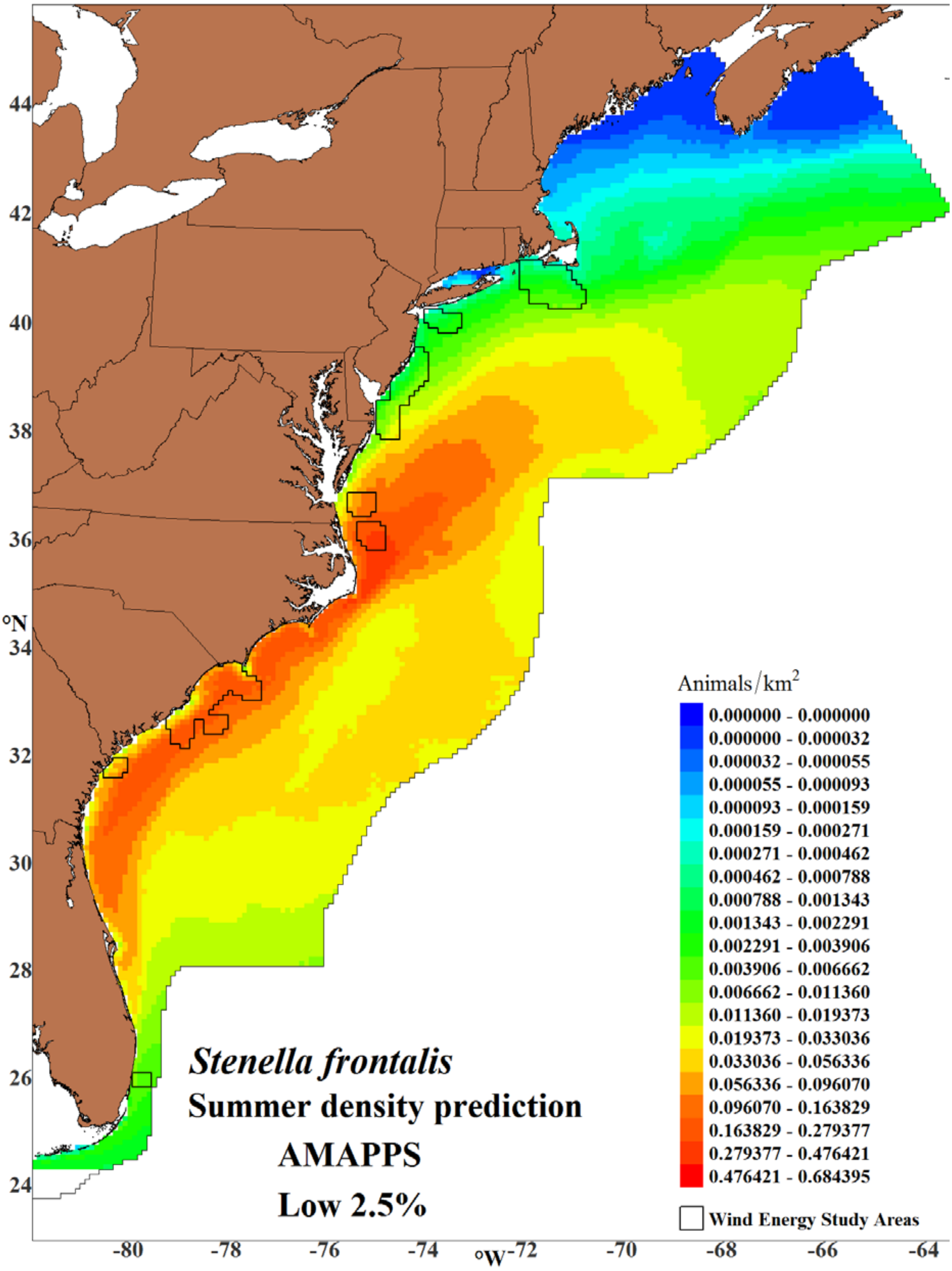

Figure 15-12 Lower 2.5% percentile of summer Atlantic spotted dolphin estimates

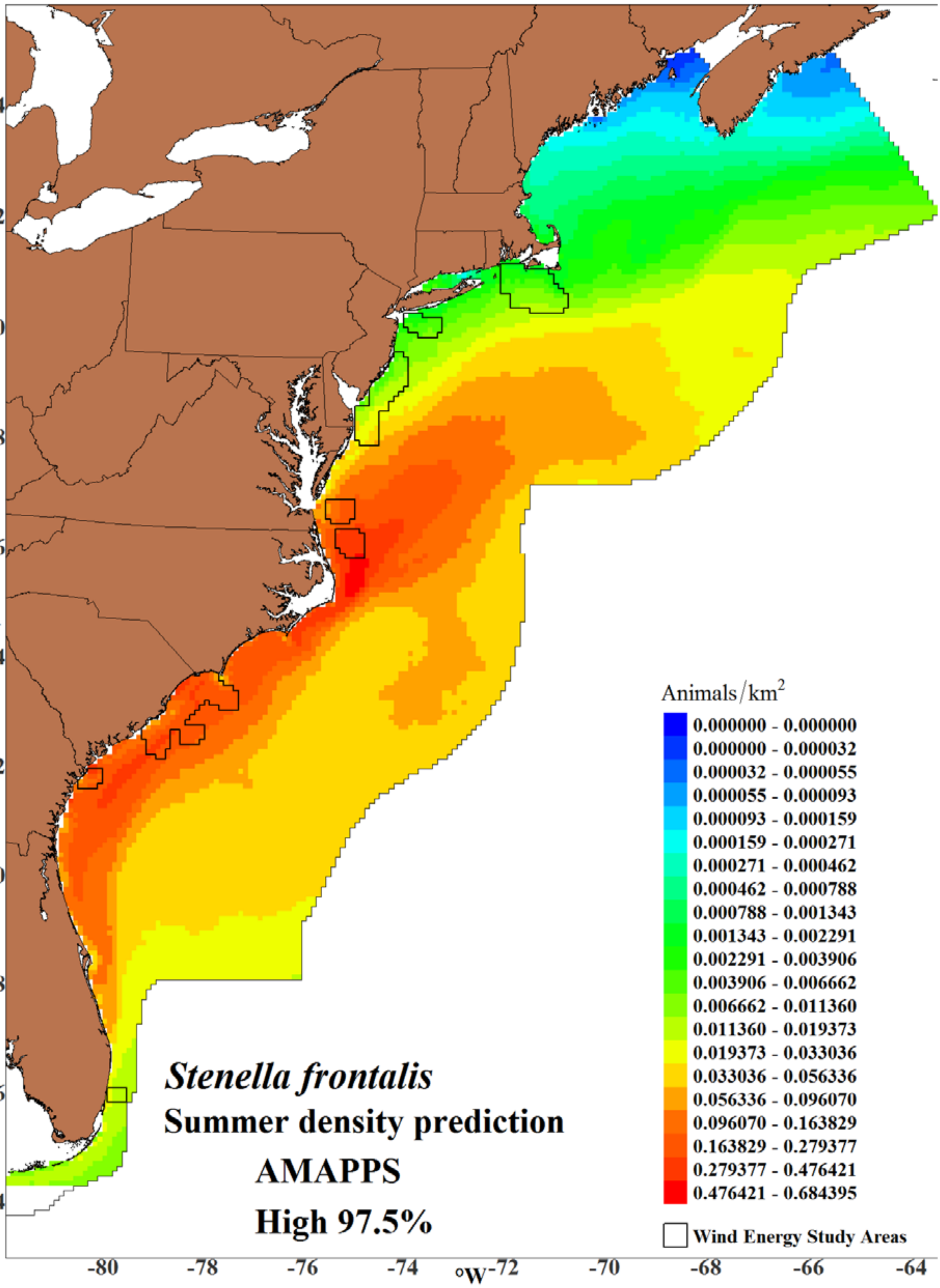

Figure 15-13 Upper 97.5% percentile of summer Atlantic spotted dolphin estimates

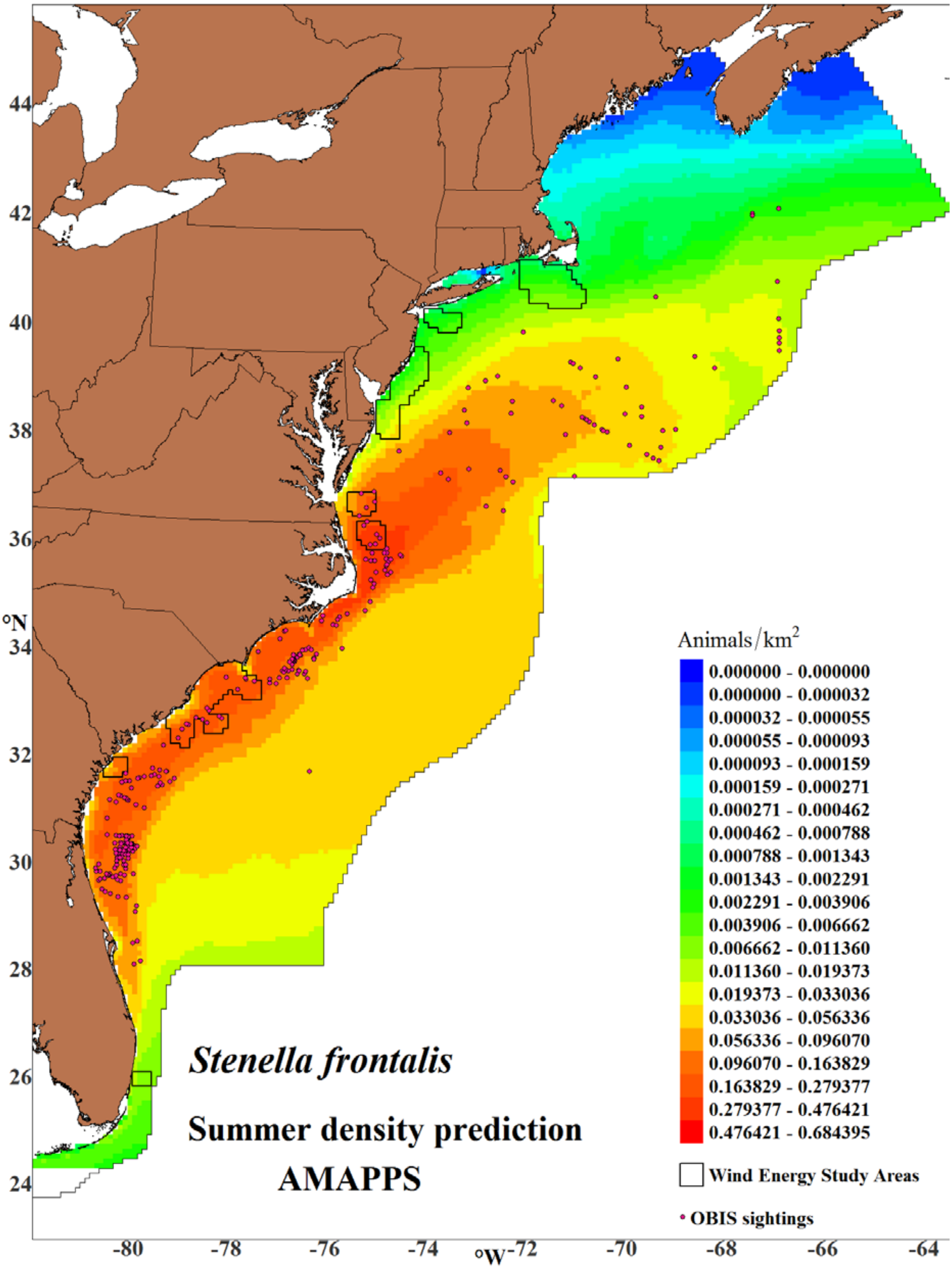

Figure 15-14 Atlantic spotted dolphin 2010-2013 summer density and 1984-2013 OBIS sightings

Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

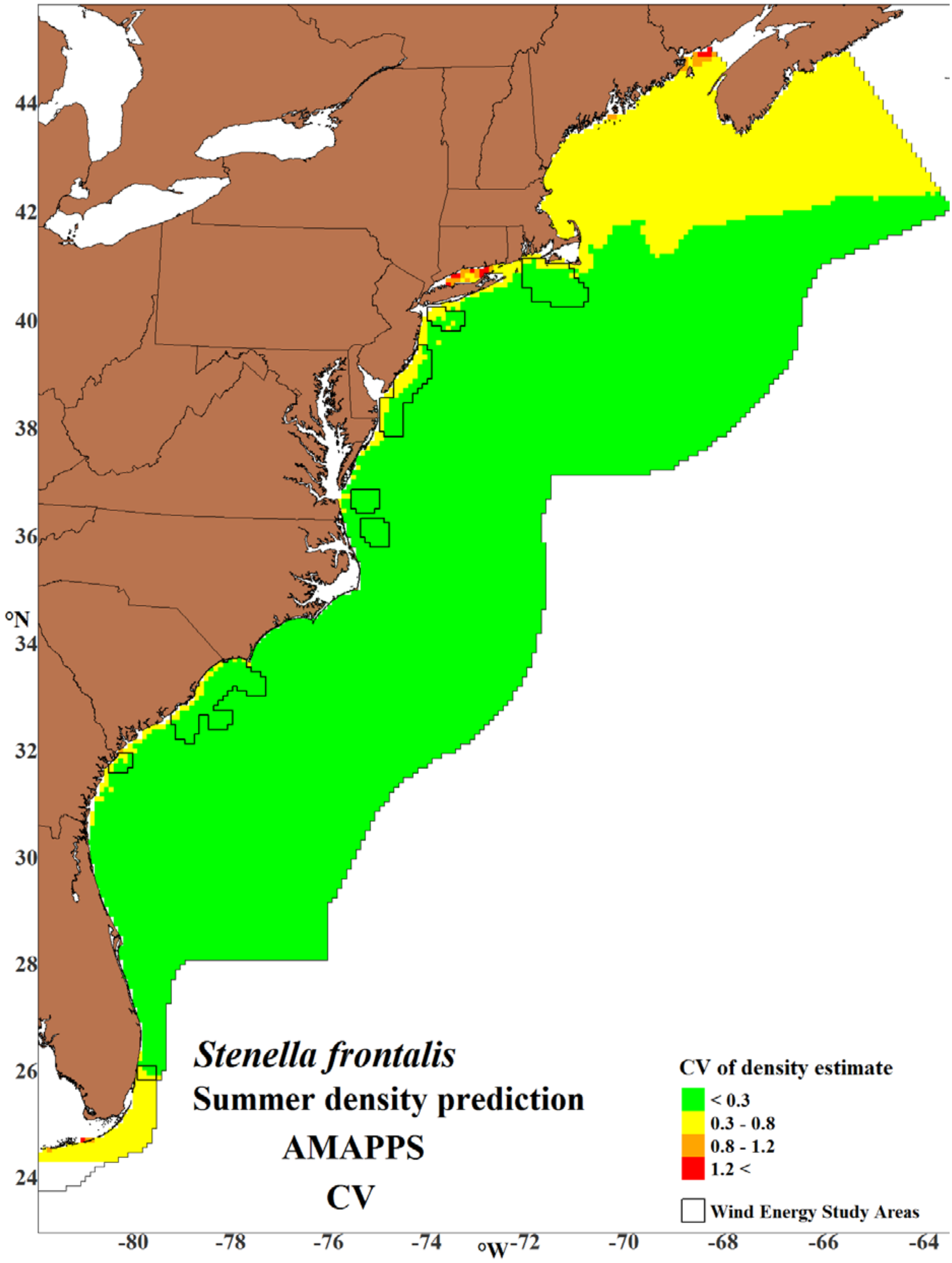

Figure 15-15 CV of summer density estimates for Atlantic spotted dolphins

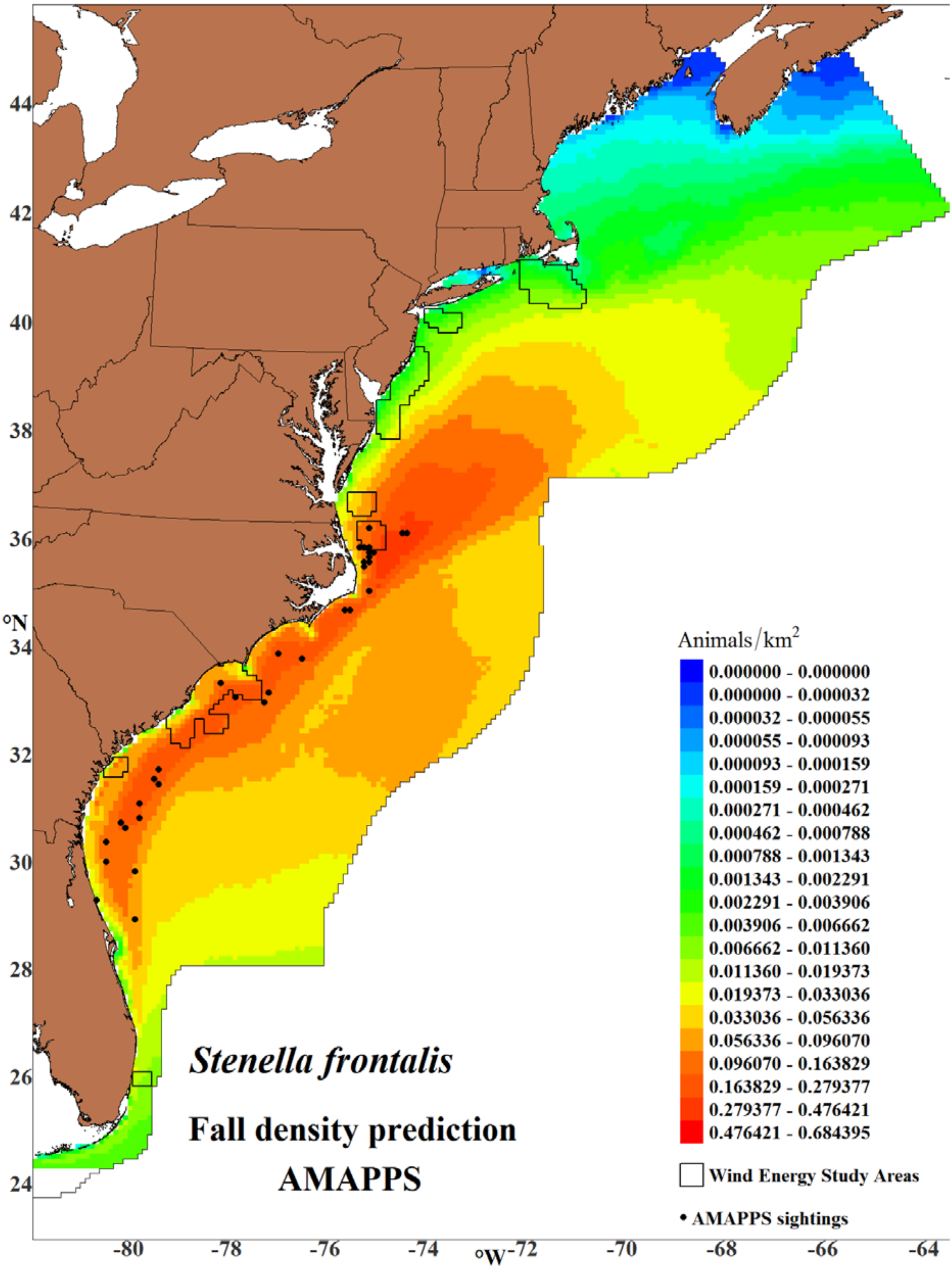

Figure 15-16 Atlantic spotted dolphin fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

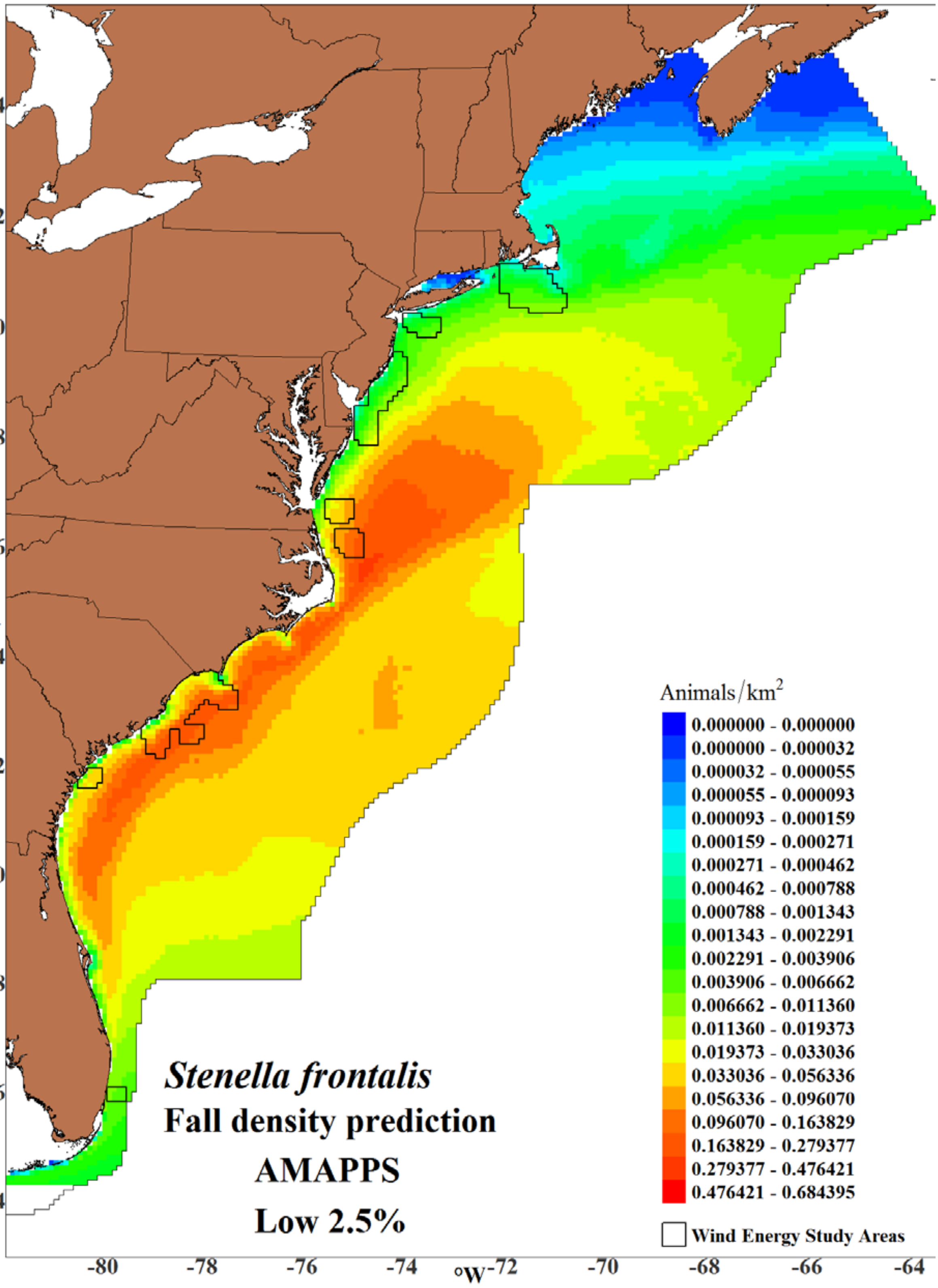

Figure 15-17 Lower 2.5% percentile of fall Atlantic spotted dolphin estimates

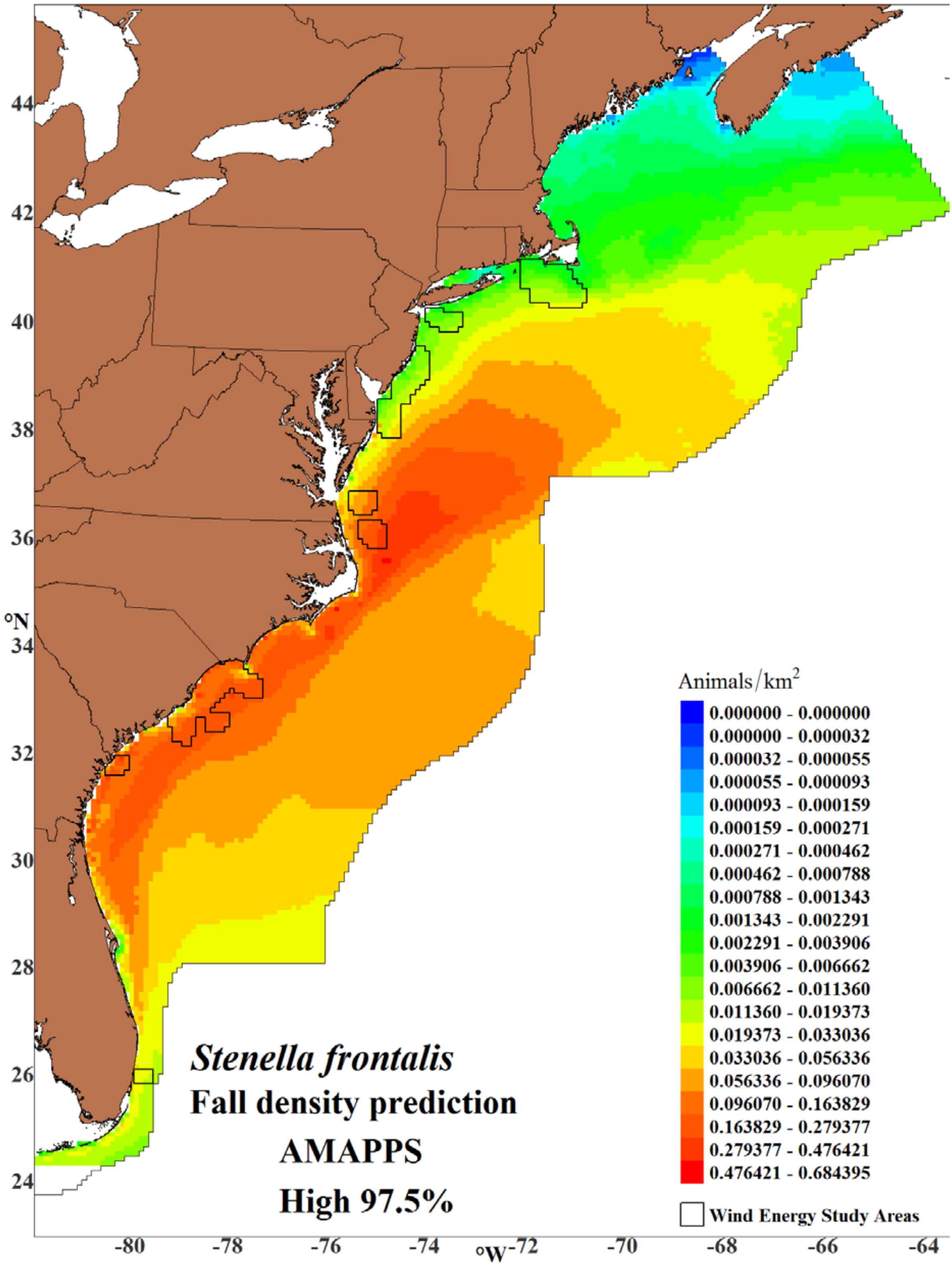

Figure 15-18 Upper 97.5% percentile of fall Atlantic spotted dolphin estimates

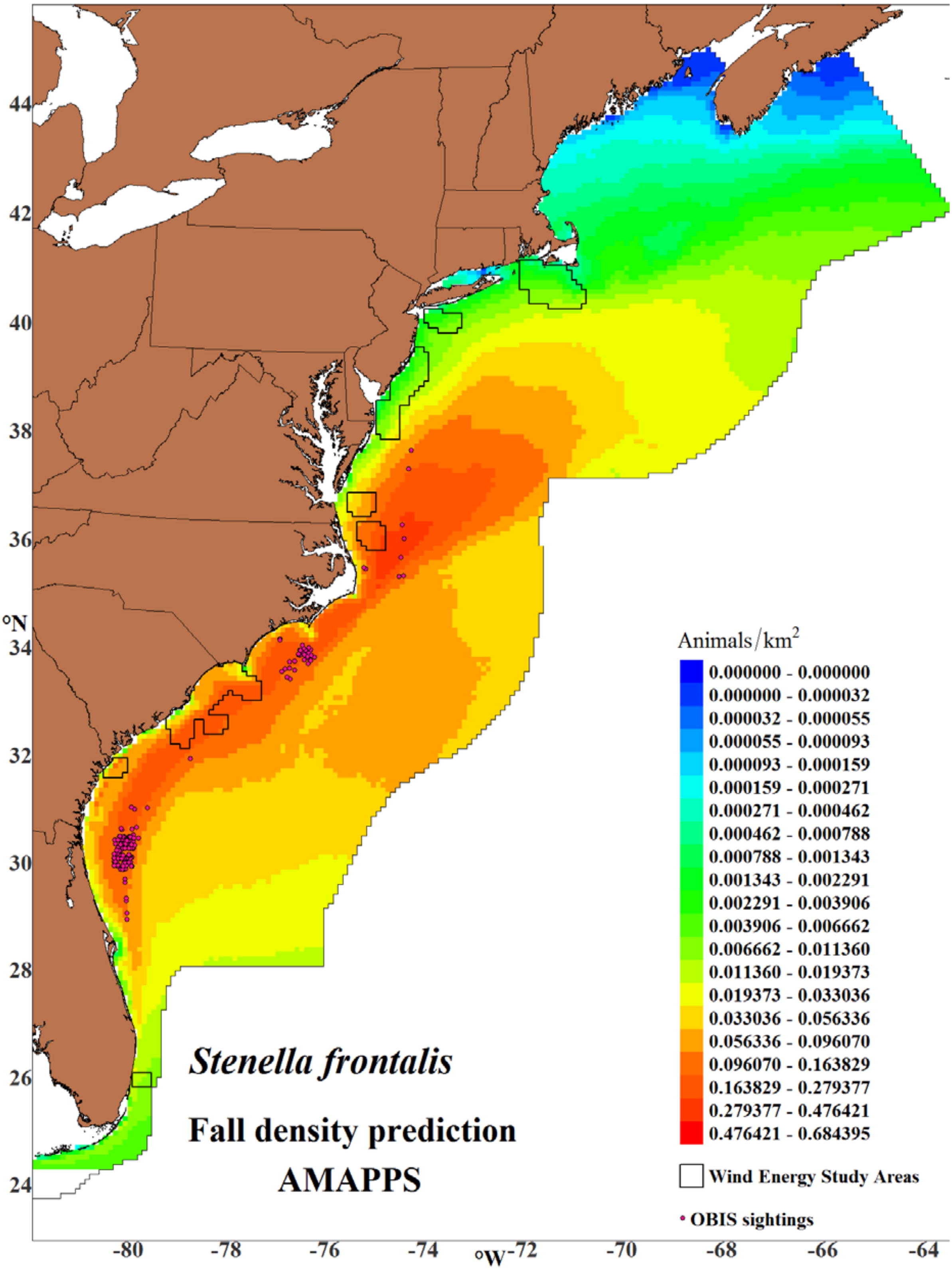

Figure 15-19 Atlantic spotted dolphin 2010-2013 fall density and 1984-2013 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

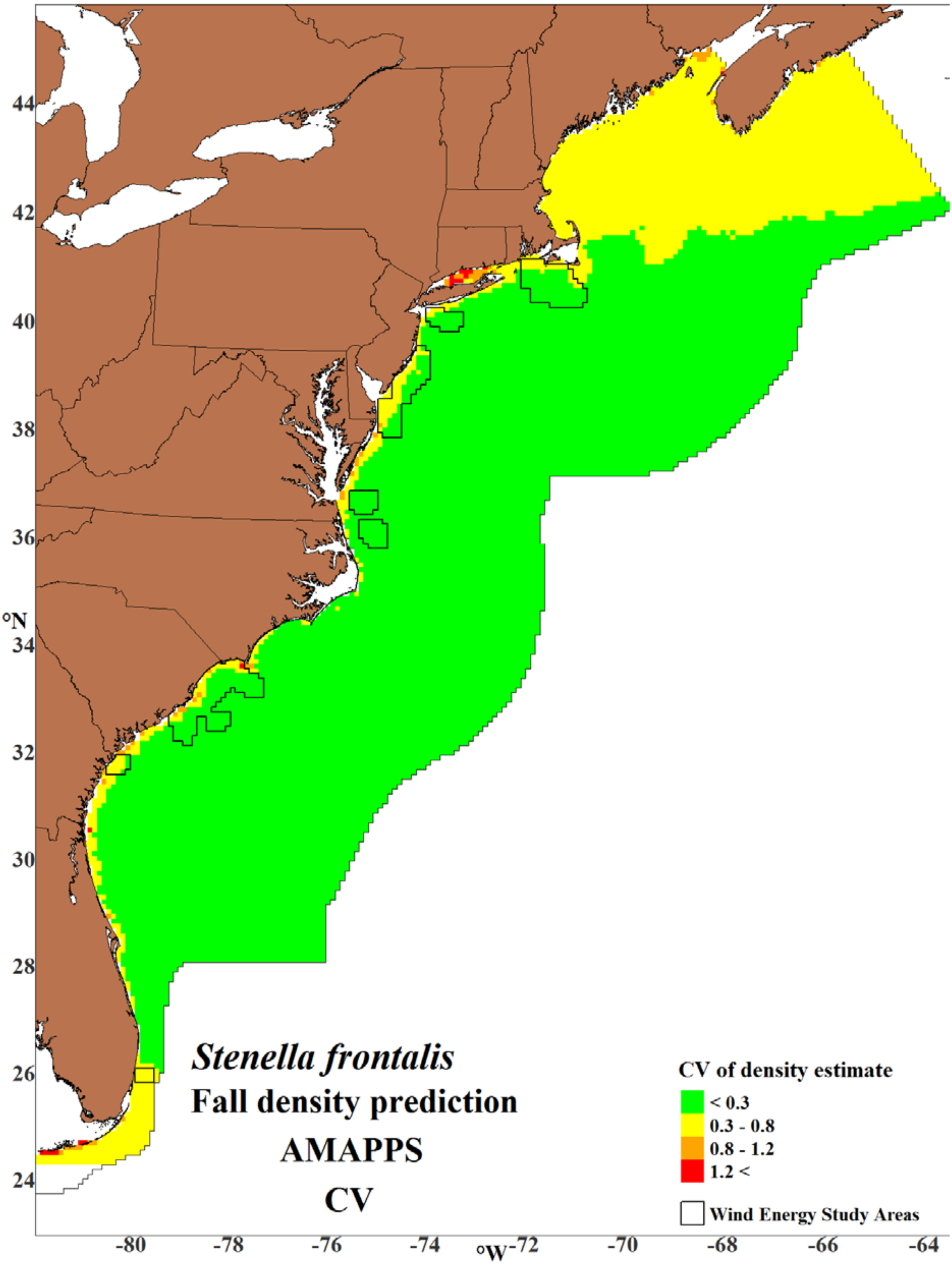

Figure 15-20 CV of fall density estimates for Atlantic spotted dolphins

15.6 Wind Energy Study Areas

Table 15-6 Atlantic spotted dolphin average abundance estimates for wind energy study areas
Availability bias correction: aerial and shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	40	0.255	24 - 65
(March-May)	New York	13	0.226	8 - 20
	New Jersey	51	0.200	34 - 75
	Delaware/ Maryland	44	0.175	32 - 62
	Virginia	149	0.148	112 - 199
	North Carolina	530	0.107	430 - 654
	South Carolina/ North Carolina	2,919	0.126	2,280 – 3,736
	Georgia	204	0.339	107 - 390
	Florida	13	0.301	7 - 24
Summer	Rhode Island/ Massachusetts	55	0.214	36 - 83
(June-August)	New York	9	0.262	5 - 15
	New Jersey	47	0.259	29 - 78
	Delaware/ Maryland	70	0.207	47 - 105
	Virginia	367	0.110	295 - 455
	North Carolina	1,024	0.086	865 – 1,212
	South Carolina/ North Carolina	2,599	0.118	2,065 – 3,270
	Georgia	163	0.285	94 - 281
	Florida	12	0.31	6 - 21
Fall	Rhode Island/ Massachusetts	69	0.230	44 - 107
(September-November)	New York	14	0.227	9 - 22
	New Jersey	45	0.268	27 - 75
	Delaware/ Maryland	46	0.263	28 - 77
	Virginia	183	0.166	132 - 253
	North Carolina	565	0.127	441 - 723
	South Carolina/ North Carolina	1,944	0.141	1,477 – 2,558
	Georgia	118	0.444	52 - 271
	Florida	14	0.332	8 - 27

***** The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model.

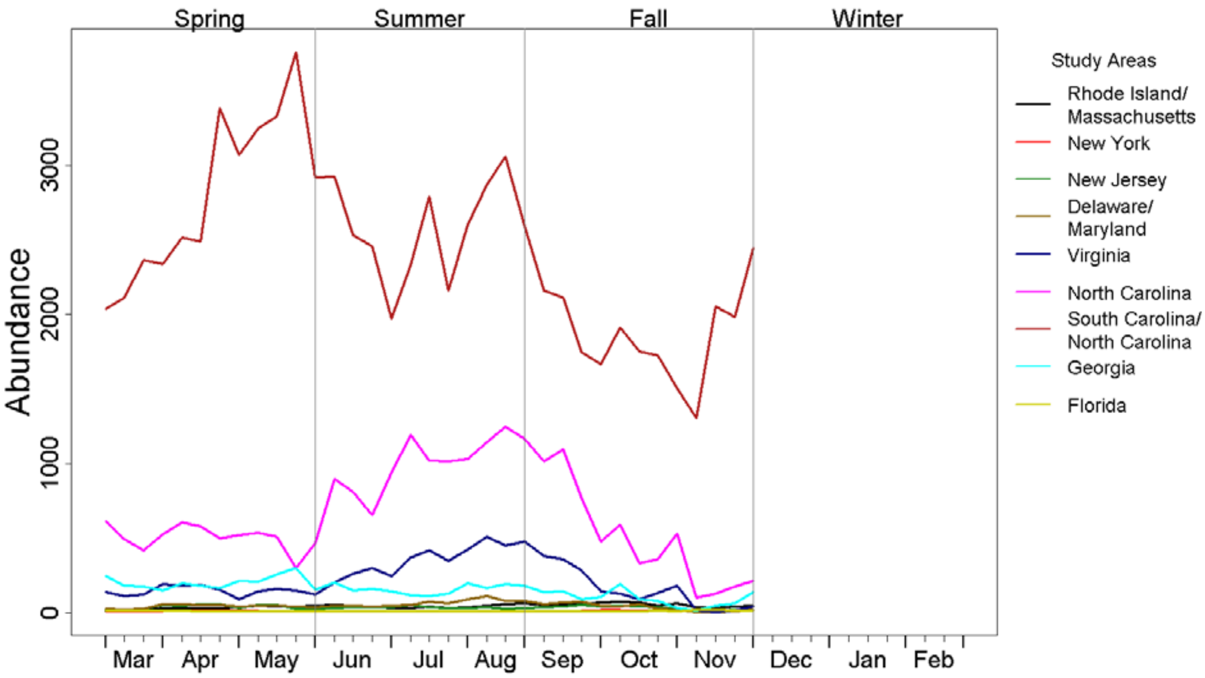

Figure 15-21 Annual abundance trends for Atlantic spotted dolphins in wind energy study areas

16 Striped Dolphin (*Stenella coeruleoalba*)

Figure 16-1 Striped dolphin. Credit: NOAA/NEFSC/Rich Pagen
Image collected under MMPA Research permit #755-1600.

16.1 Data Collection

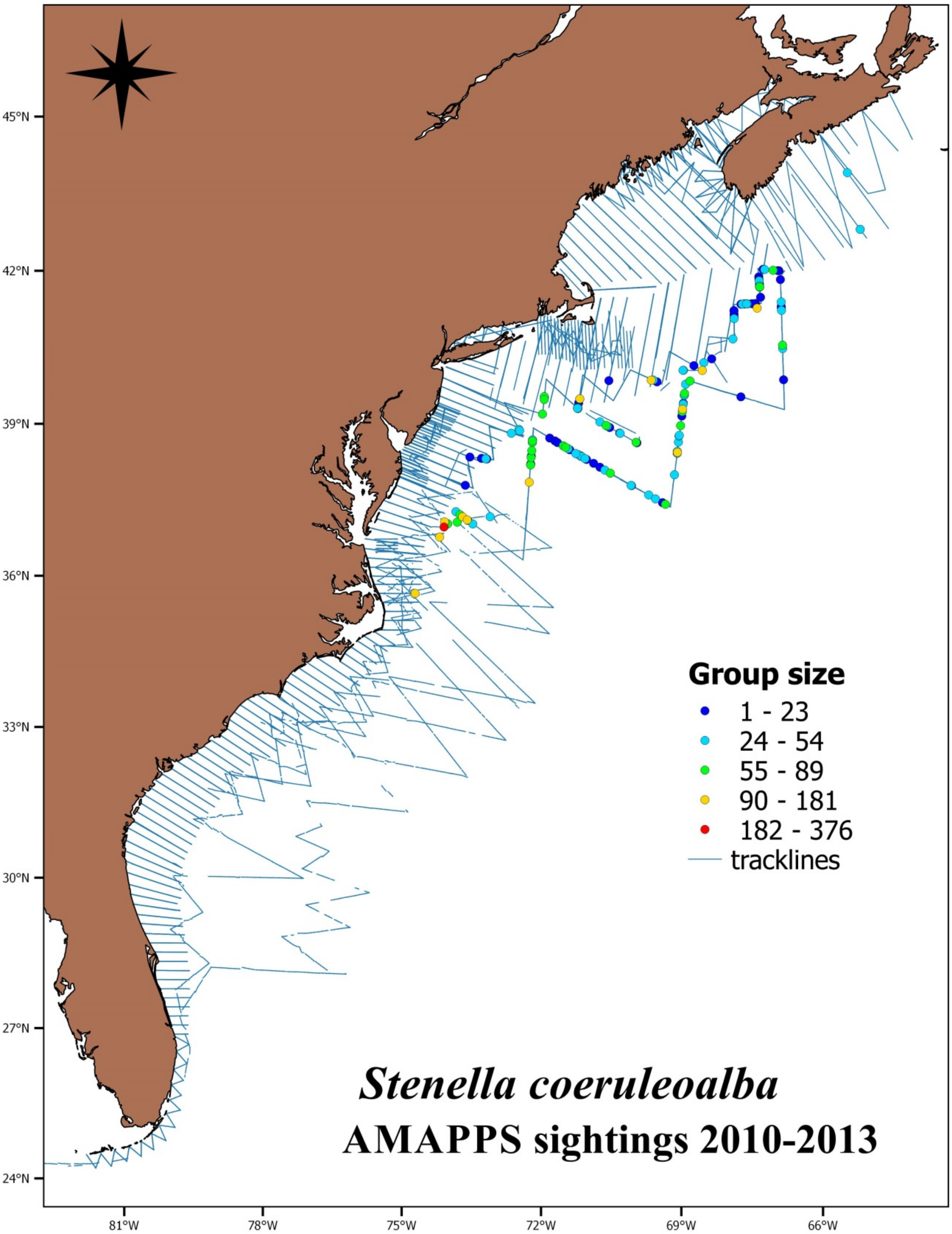

Figure 16-2 Track lines and striped dolphin sightings during 2010-2013

Table 16-1 Research effort 2010 - 2013 and striped dolphin sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Striped dolphin	*Stenella coeruleoalba*	0/0	133/5,218	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	1/100	0/0	7/325	0/0
SE Shipboard	0	8,537	2,093	0	-	-	0/0	6/883	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	1/110	0/0	0/0	0/0

16.2 Mark-Recapture Distance Sampling Analysis

Table 16-2 Parameter estimates from striped dolphin (STDO) MRDS analysis
HR= Hazard Rate, HN= Half Normal, LT= Left truncation, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 3	1	CODO, STDO	Distance+observer	Distance+sea	300	HR	0.856	0.065	0.642	0.977	0.861
	2		-	Distance+sea	300	HR	-	-	0.137	0.914	0.710
NE-aerial group 3	1	CODO, STDO	Distance	Distance	LT10-500	HR	0.706	0.151	0.421	0748	0.861
	2		-	Distance+glare	LT10-500	HR	-	-	0.102	0.722	0.618
SE-shipboard group 4	-	ASDO,PSDO, CODO,STDO	Distance+observer	Distance+sea	4500	HR	0.722	0.100	0.190	0.993	0.969
NE-shipboard group 8	-	STDO	Distance	Distance+sea	5000	HR	0.764	0.064	0.537	0.992	0.990

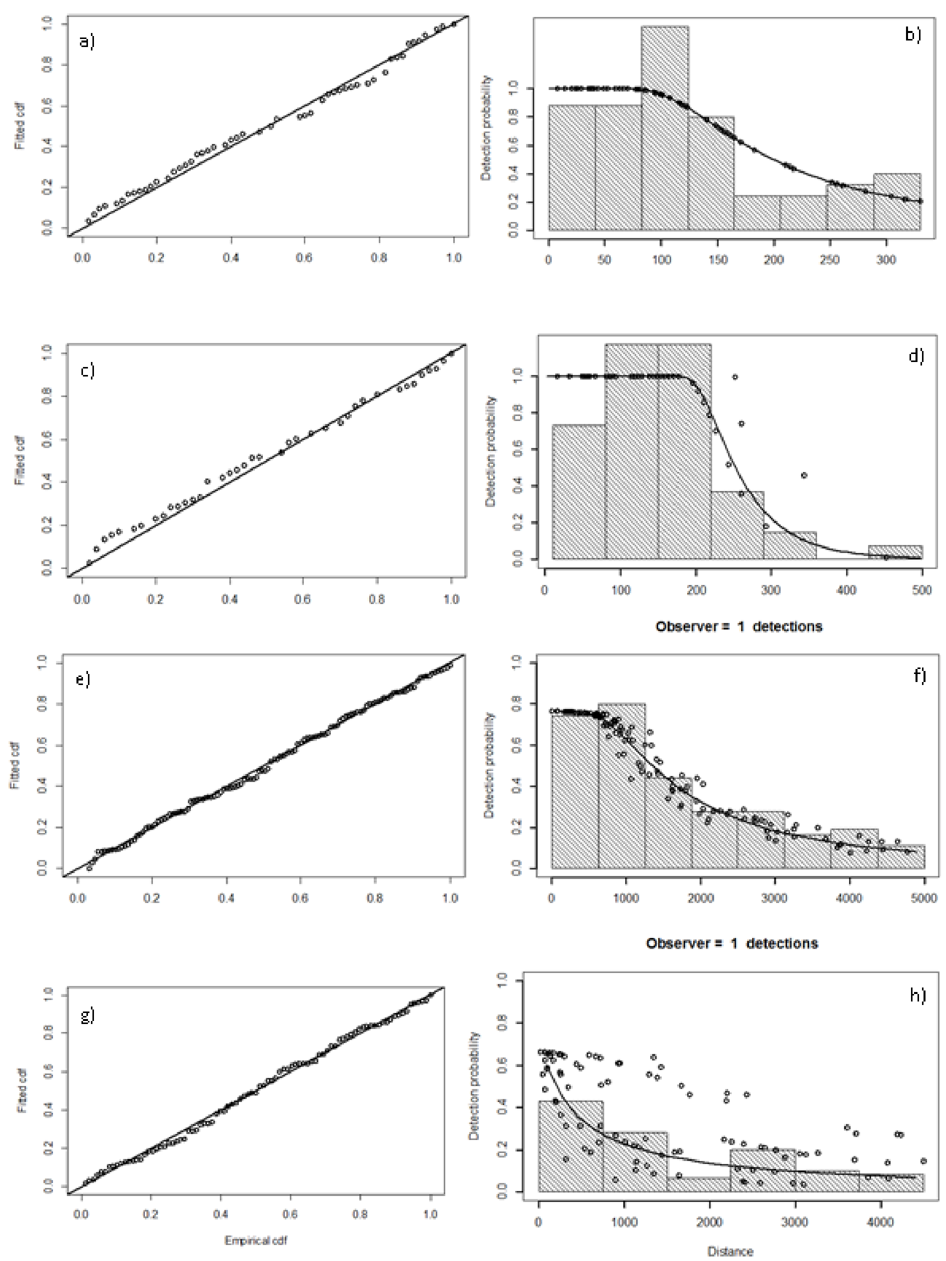

Figure 16-3 Q-Q plots and detection functions from striped dolphin MRDS analysis
Group 3 aerial southeast region (a,b), group 3 aerial northeast region (c,d), group 8 shipboard northeast region (e,f) and group 4 shipboard southeast region (g,h).

16.3 Generalized Additive Model Analysis

Table 16-3 Habitat model output for striped dolphins

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	2.69679	4	45.483	<2e-16	2.61E-01	***
s(pp)	0.08489	4	0.135	1.12E-02	2.82E-07	*
s(btemp)	1.08434	4	85.304	<2e-16	5.09E-02	***
s(dist1000)	1.55334	4	19.659	<2e-16	1.77E-08	***
Scale	-	-	-	-	1.55E+00	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom: Total = 6.42

R^2 (adjusted) = 0.0767 Deviance explained = 52.8%

REML = 457.75 Scale estimate = 0.39474 sample size = 3809

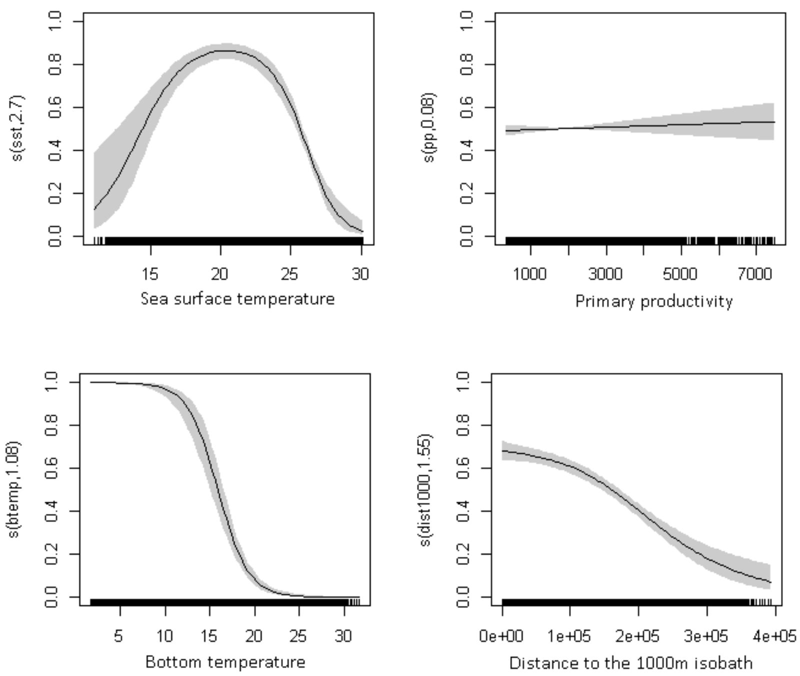

Figure 16-4 Striped dolphin density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 16-4 Diagnostic statistics for striped dolphin habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.289	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	76.430	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.209	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.062	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

16.4 Abundance Estimates for AMAPPS Study Area

Table 16-5 Striped dolphin average abundance estimates for AMAPPS study area
Availability bias correction: aerial and shipboard 1.0, CV= 0.0.

Season	Abundance	CV	95% Confidence Interval
Summer (June-August)	81,512	0.121	64,365 – 103,227

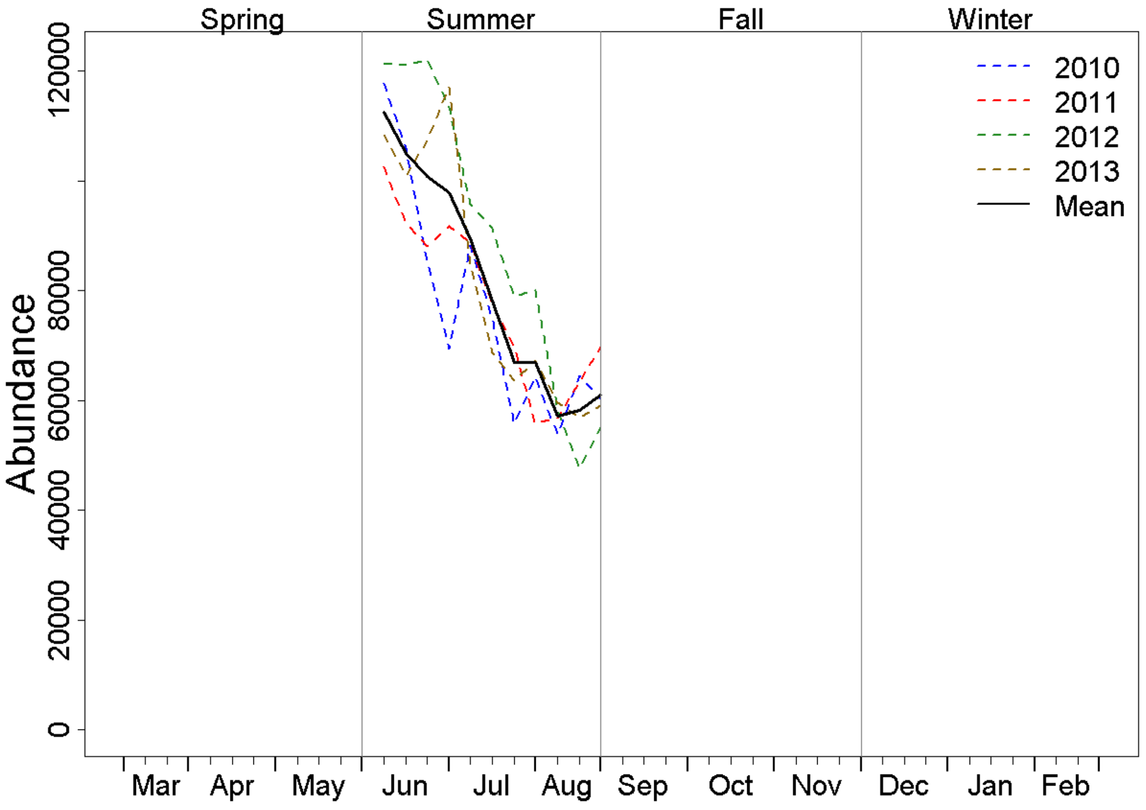

Figure 16-5 Annual abundance trends for striped dolphins for AMAPPS study area

16.5 Seasonal Prediction Maps

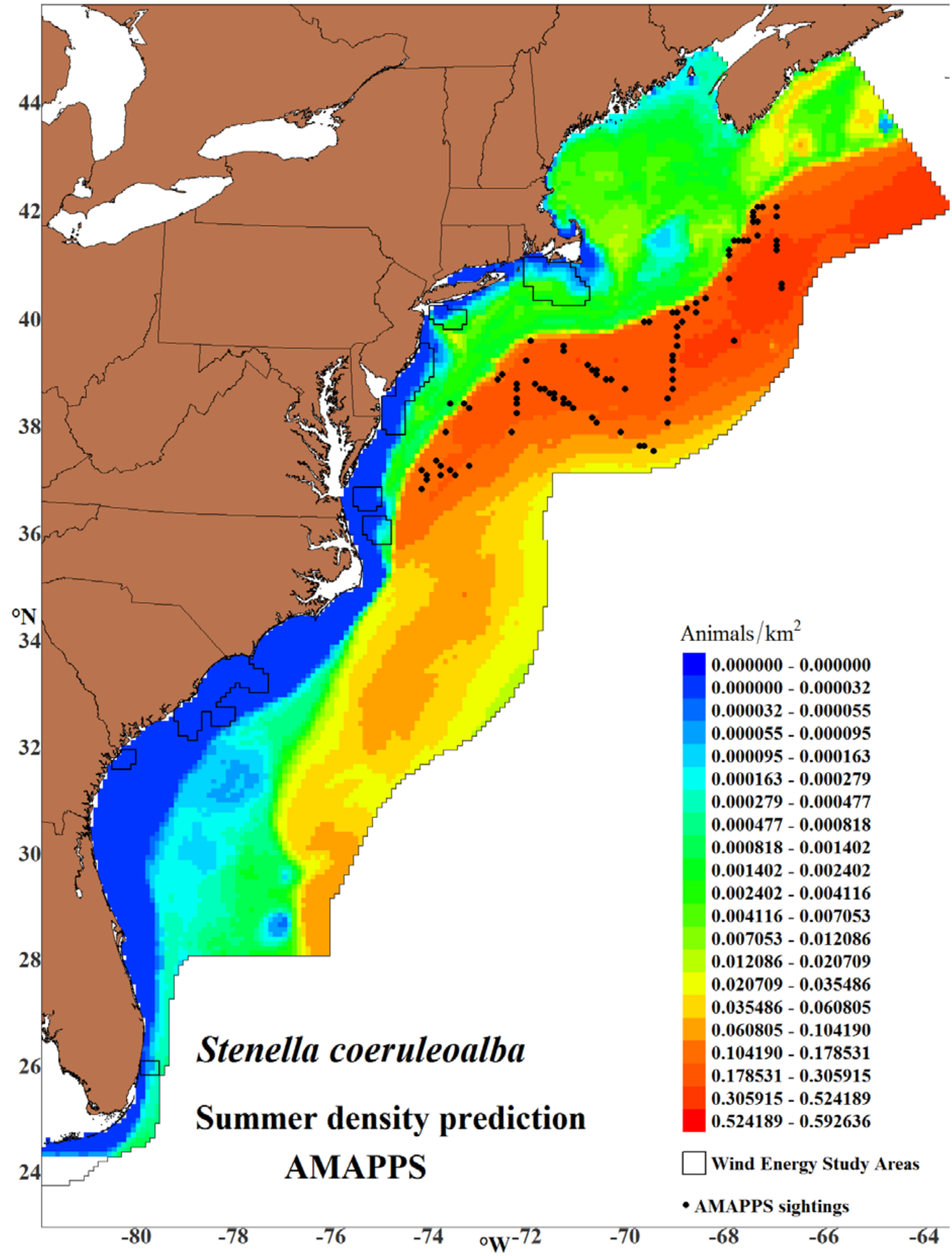

Figure 16-6 Striped dolphin summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

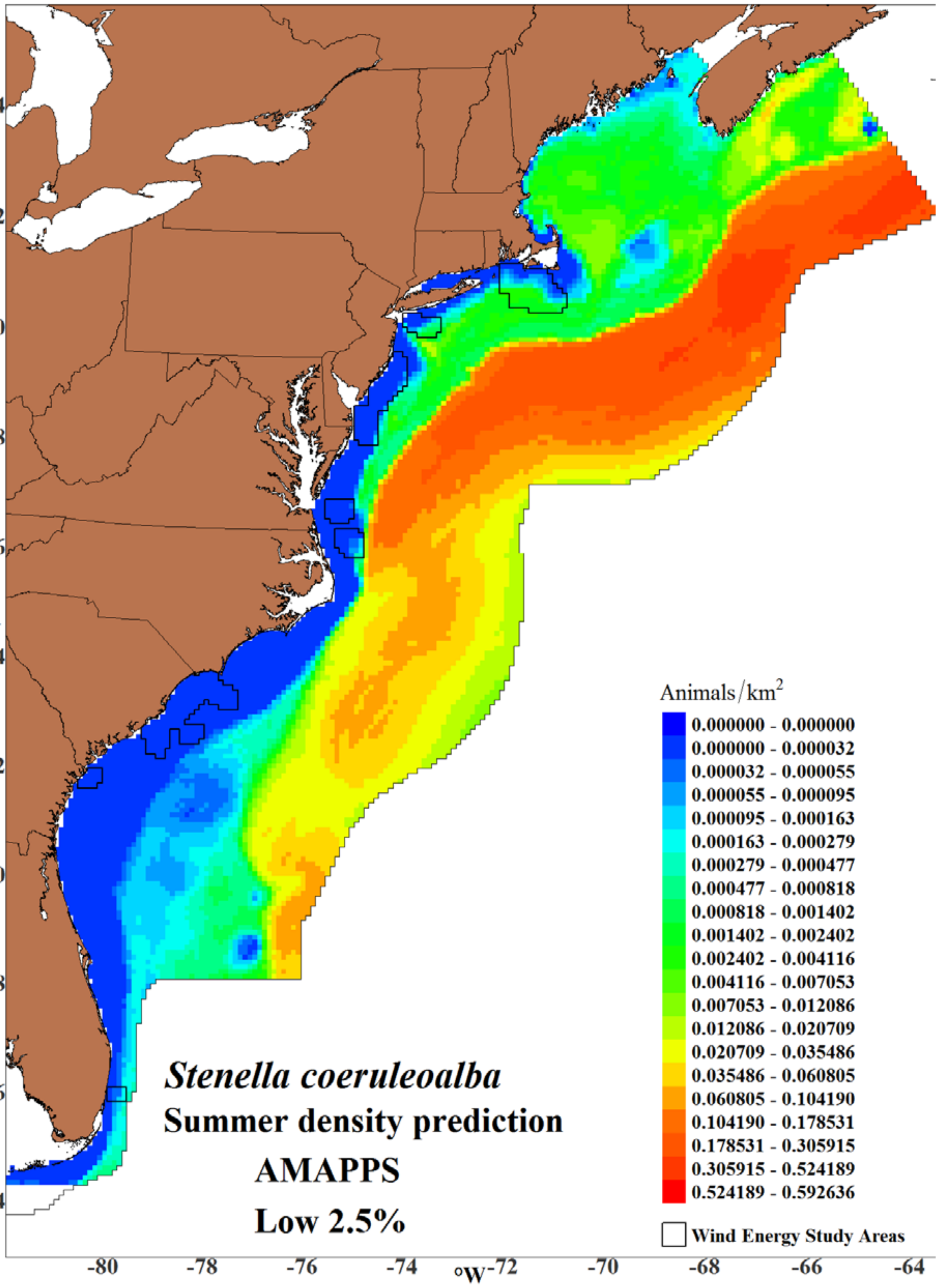

Figure 16-7 Lower 2.5% percentile of summer striped dolphin estimates

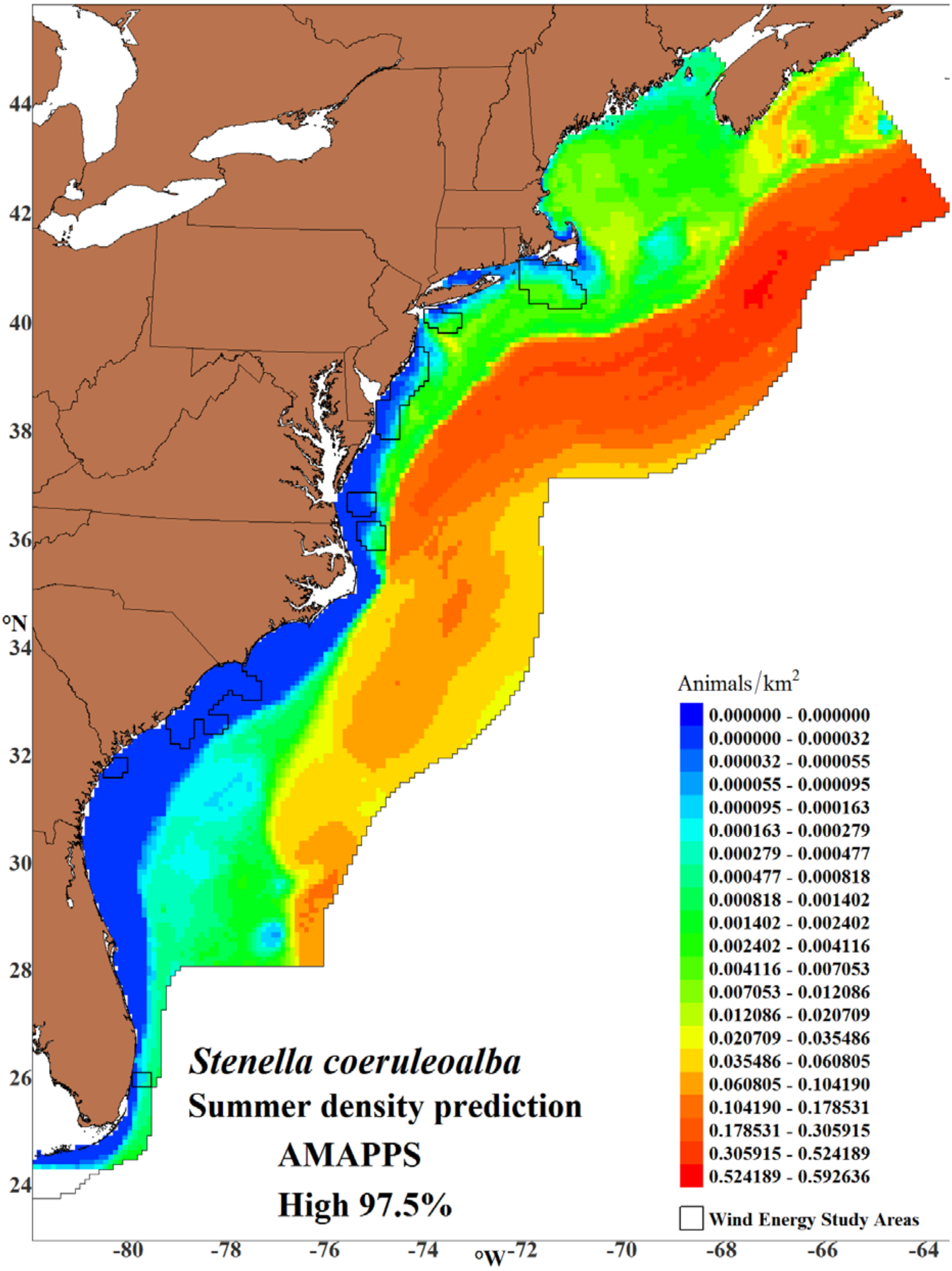

Figure 16-8 Upper 97.5% percentile of summer striped dolphin estimates

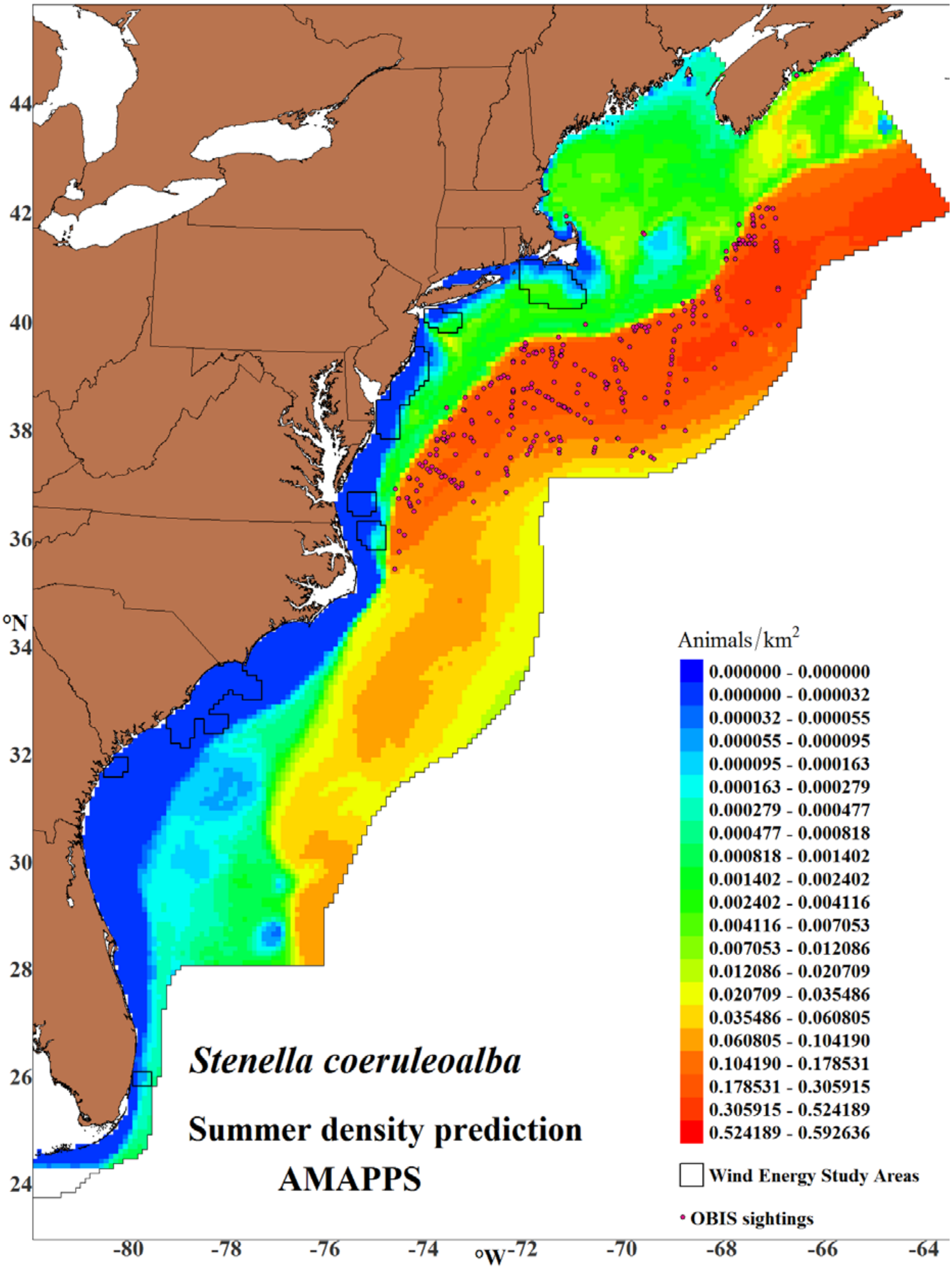

Figure 16-9 Striped dolphin 2010-2013 summer density and 1976-2013 OBIS sightings pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

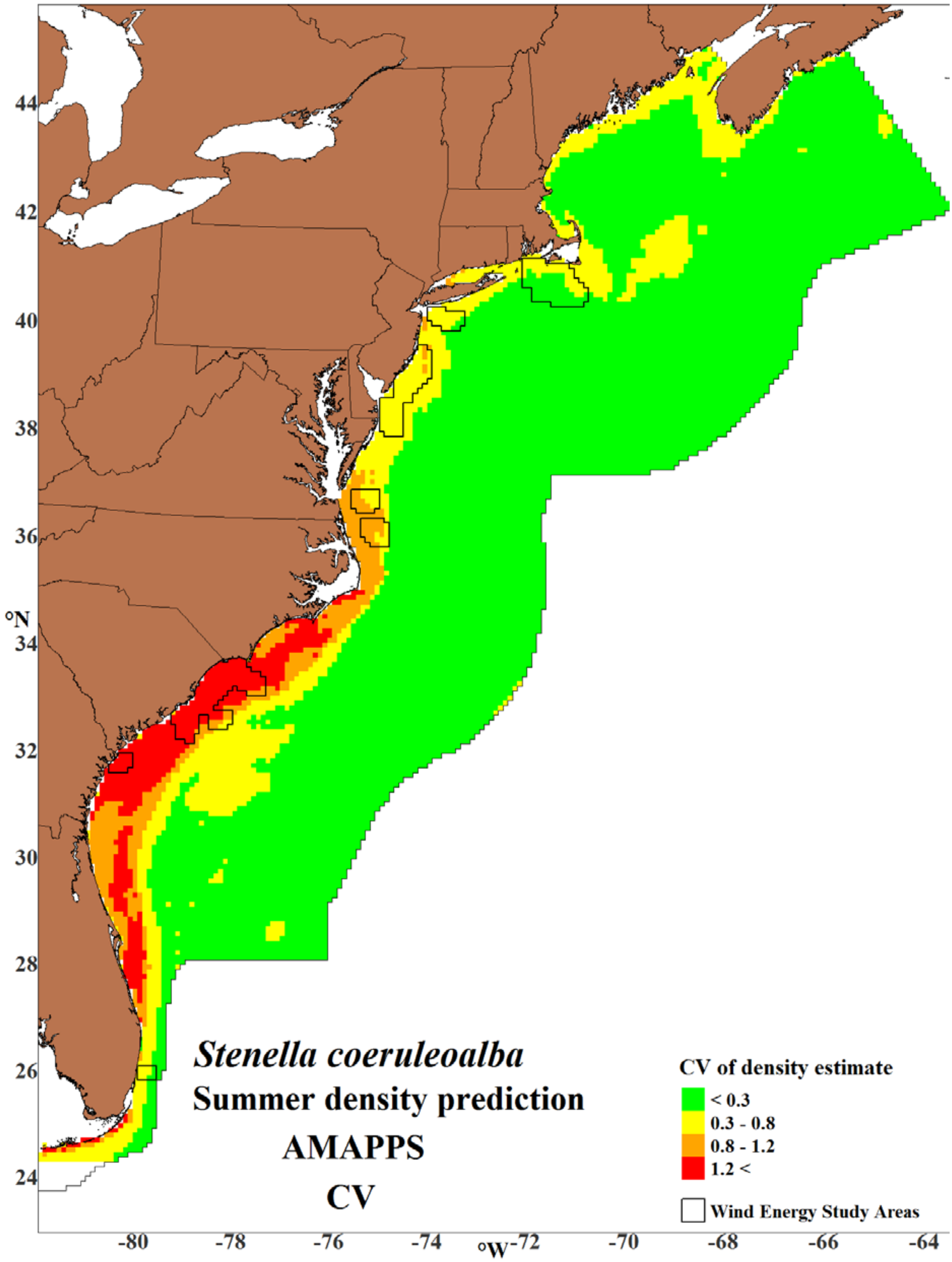

Figure 16-10 CV of summer density estimates for striped dolphins

16.6 Wind Energy Study Areas

Table 16-6 Striped dolphin average abundance estimates for wind energy study areas
Availability bias correction: aerial and shipboard 1.0, CV= 0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Summer	Rhode Island/ Massachusetts	19	0.192	13 - 27
(June-August)	New York	3	0.337	1 - 5
	New Jersey	0	0.661	0 - 1
	Delaware/ Maryland	0	0.625	0 - 1
	Virginia	0	0.622	0 - 0
	North Carolina	0	0.619	0 - 1
	South Carolina/ North Carolina	0	0.609	0 - 0
	Georgia	0	1.662	0 - 0
	Florida	0	0.303	0 - 0

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model.

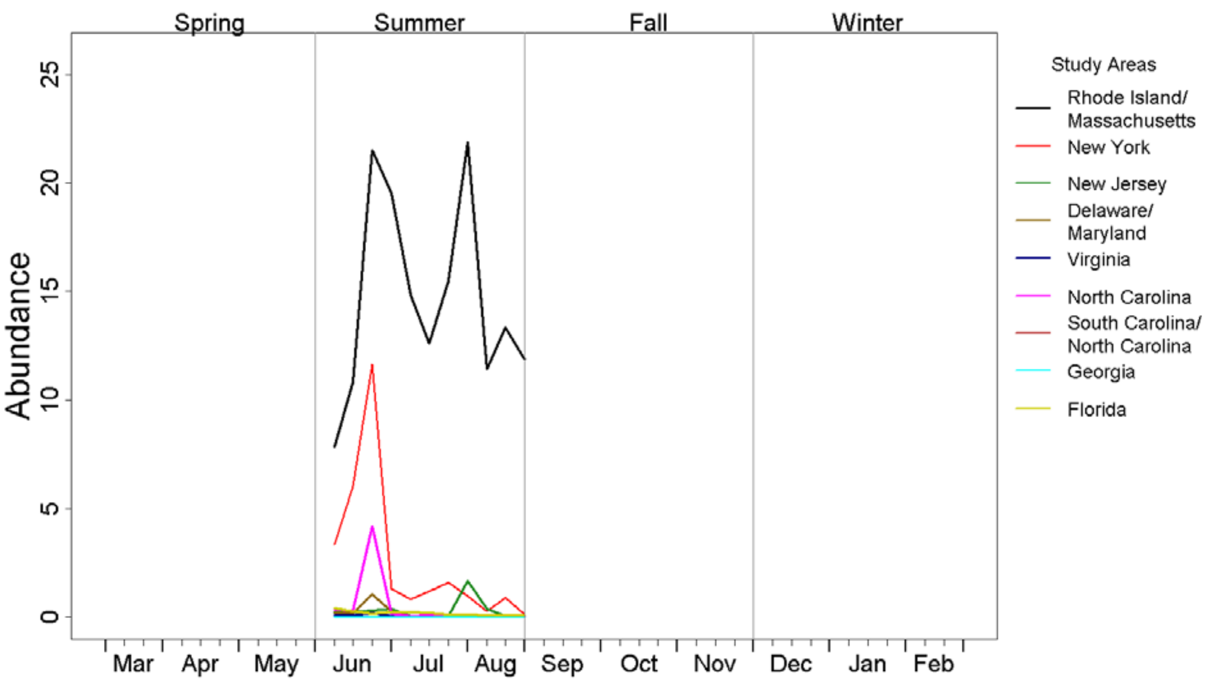

Figure 16-11 Annual abundance trends for striped dolphins in wind energy study areas

17 Common Bottlenose Dolphin (*Tursiops truncatus*)

Figure 17-1 Common bottlenose dolphin. Credit: NOAA/NEFSC/Danielle Cholewiak
Image collected under MMPA Research permit #17355.

17.1 Data Collection

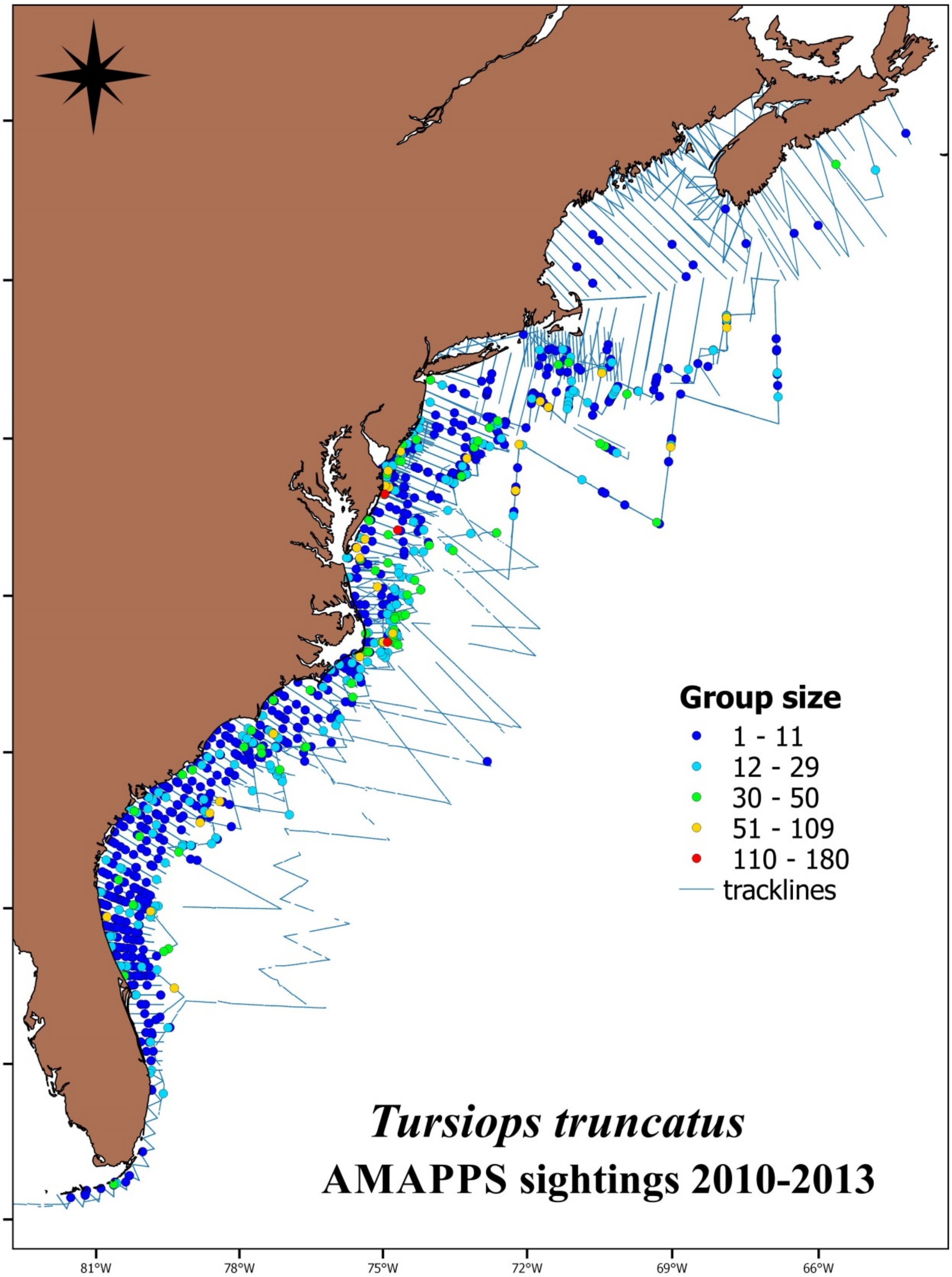

Figure 17-2 Track lines and common bottlenose dolphin sightings 2010 - 2013

Table 17-1 Research effort 2010 - 2013 and common bottlenose dolphin sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Common bottlenose dolphin	*Tursiops truncatus*	0/0	188/2014	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573			34/176	3/51	29/370	0/0
SE Shipboard	0	8,537	2,093	0			0/0	102/2149	35/695	0/0
SE Aerial	17,978	16,835	11,818	6,007			219/2046	222/2760	146/1875	82/542

17.2 Mark-Recapture Distance Sampling Analysis

Table 17-2 Parameter estimates from common bottlenose dolphin (CBDO) MRDS analysis
HR=Hazard Rate, HN= Half Normal, LT= Left truncation, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
SE-aerial group 5	1	CBDO	Distance*observer+size+sea	Distance+sea	400	HR	0.814	0.039	1.94E-3	0.486	0.671
	2		-	Distance	400	HR	-	-	3.01E-5	0.743	0.667
NE-aerial group 6	1	CBDO	Distance+glare	Distance	LT50-350	HN	0.657	0.183	0.079	0.797	0.542
	2		-	Distance	LT50-350	HN	-	-	0.943	0.799	0.661
SE–shipboard group 5	-	CBDO	Distance	Distance+sea	4300	HR	0.609	0.110	0.525	0.956	0.975
NE-shipboard group 10	-	CBDO	Distance*observer+size+sea	Distance+sea	5000	HR	0.643	0.105	0.253	0.854	0.929

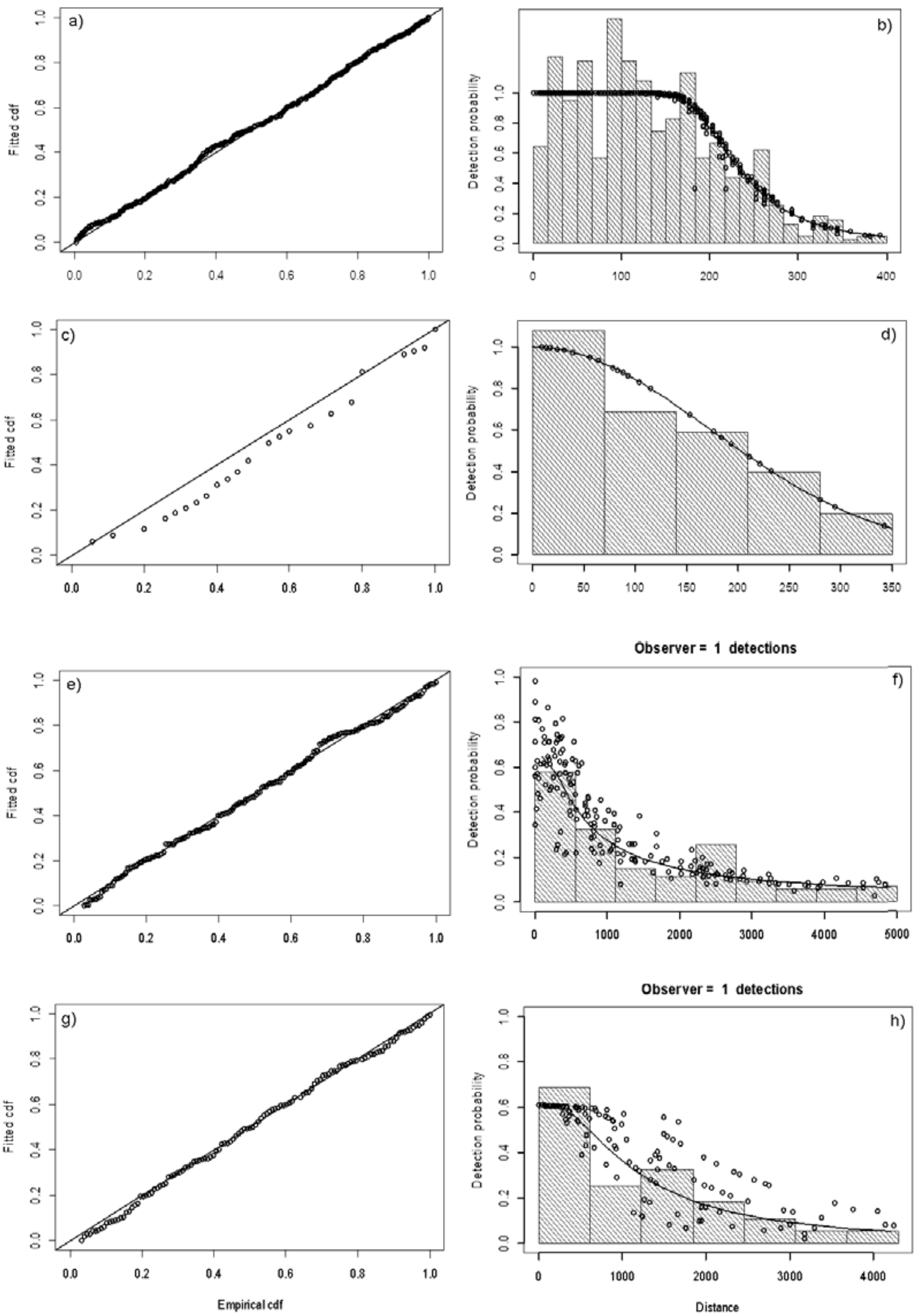

Figure 17-3 Q-Q plots and detection functions from common bottlenose dolphin MRDS analysis
Group 5 aerial southeast region (a,b), group 6 aerial northeast region (c,d), group 10 shipboard northeast region (e,f) and group 5 shipboard southeast region (g,h).

17.3 Generalized Additive Model Analysis

Table 17-3 Habitat model output from common bottlenose dolphins

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	3.3606	4	6.229	5.29e-06	6.1344e-02	***
s(pp)	2.5684	4	31.460	< 2e-16	5.4862e-06	***
s(mld)	3.5618	4	19.937	< 2e-16	6.2836e-03	***
s(dist2shore)	3.4029	4	27.955	< 2e-16	1.8349e-03	***
s(slope)	0.8898	4	3.458	4.80e-05	4.7549e-03	***
s(dist200)	3.6778	4	38.428	< 2e-16	1.7829e-07	***
te(lat,btemp)	18.265	24	17.033	< 2e-16		***
Scale					2.0935e+00	

--

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom : Total = 35.74

R^2 (adjusted) = 0.0363 Deviance explained = 22.3%

REML = 4973.4 Scale estimate = 2.4748 sample size = 11083

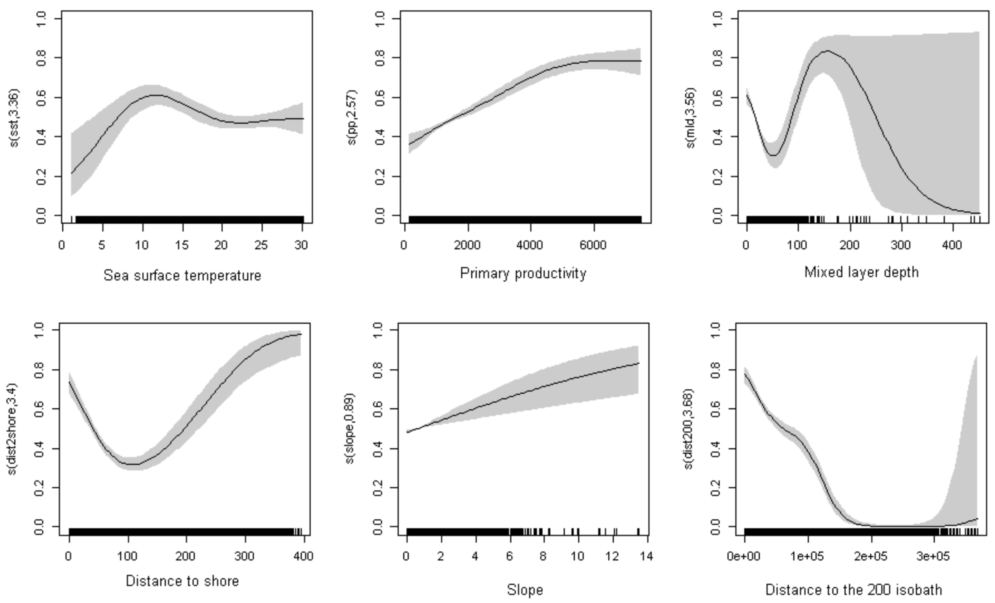

Figure 17-4 Common bottlenose dolphin density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 17-4 Diagnostic statistics from common bottlenose dolphin habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.314	Excellent
MAPE	Mean absolute percentage error	Non-zero density	77.60	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.187	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.386	Fair to good

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

17.4 Abundance Estimates for AMAPPS Study Area

Table 17-5 Common bottlenose dolphin average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.785, CV=0.364; shipboard 1, CV=0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	111,720	0.376	54,756 – 227,943
Summer (June-August)	138,700	0.364	69,417 – 277,133
Fall (September-November)	104,971	0.24	65,967 – 167,038
Winter (December-March)	110,485	0.54	41,027 – 297,536

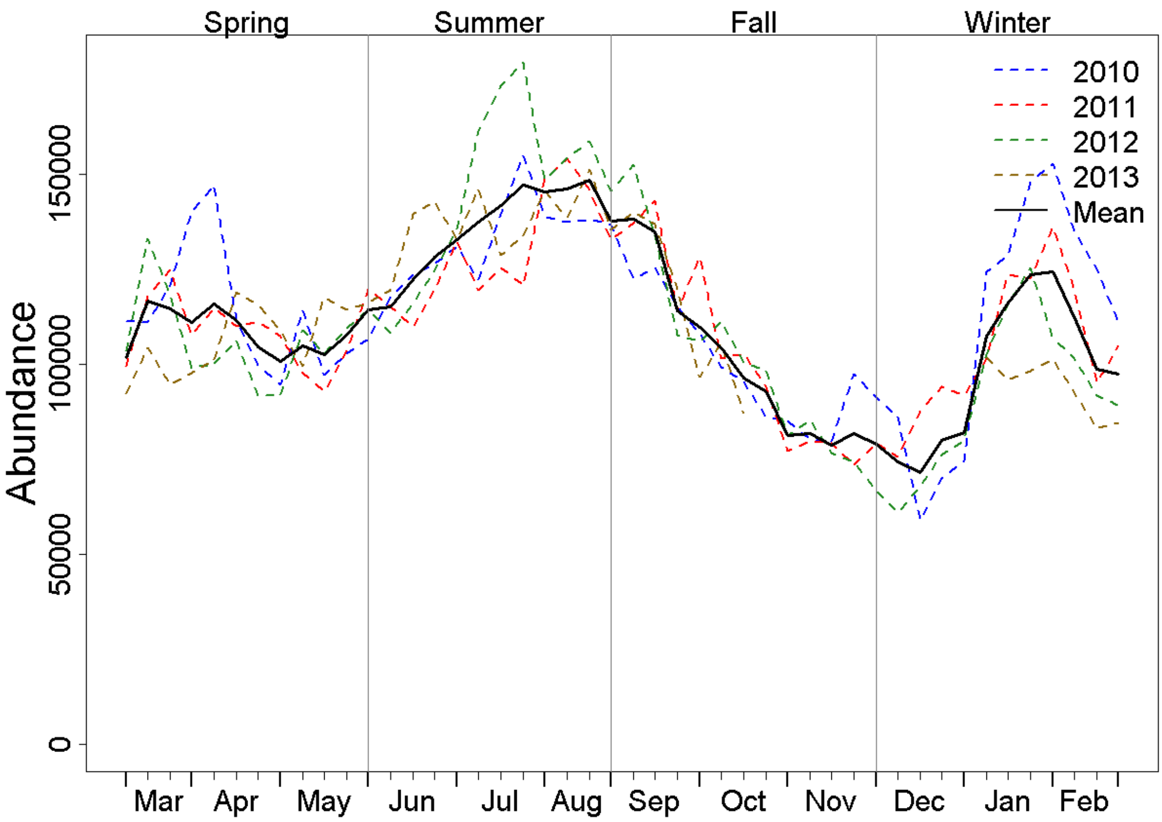

Figure 17-5 Annual abundance trends for common bottlenose dolphins for AMAPPS study area

17.5 Seasonal Prediction Maps

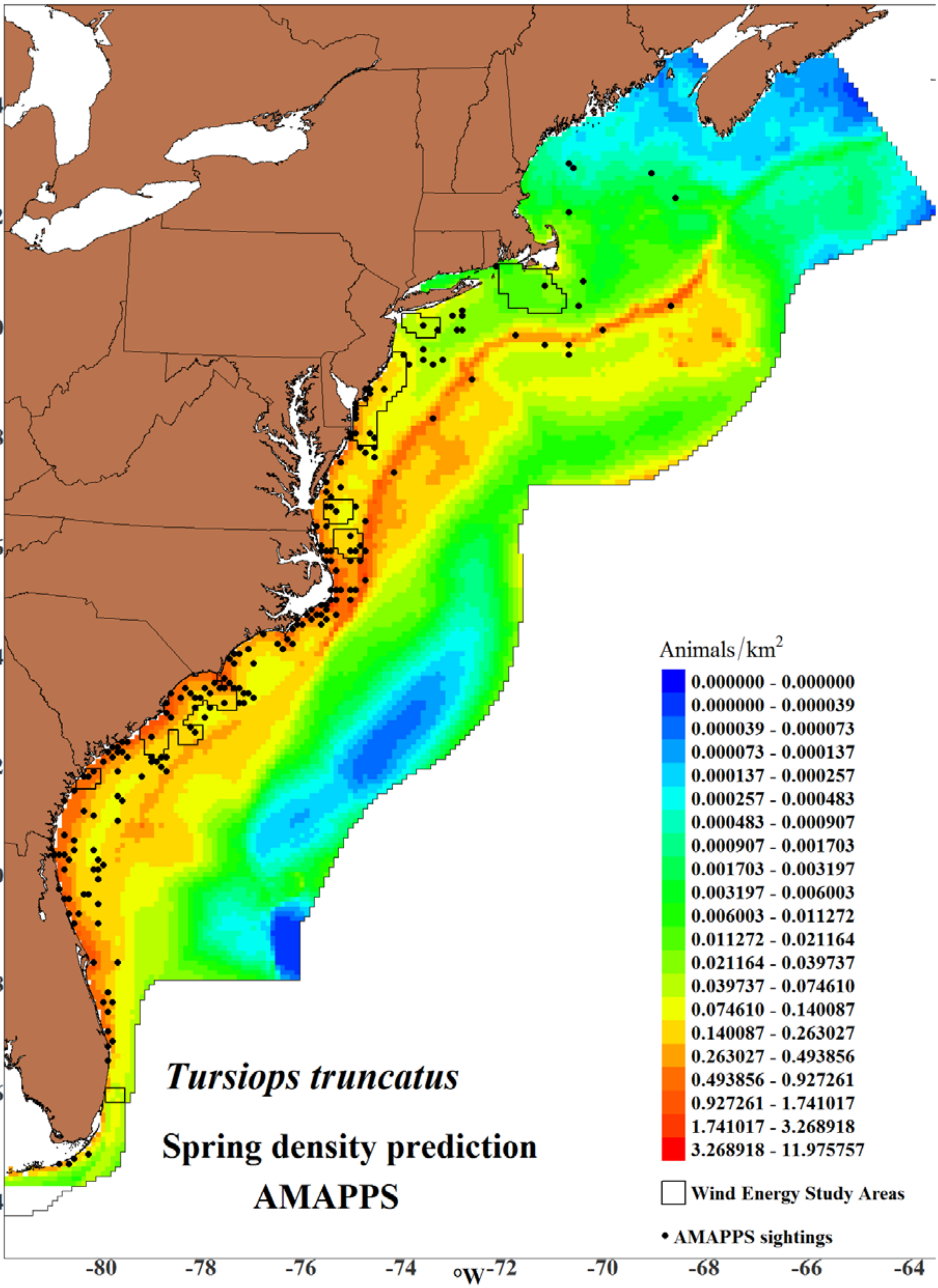

Figure 17-6 Common bottlenose dolphin spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

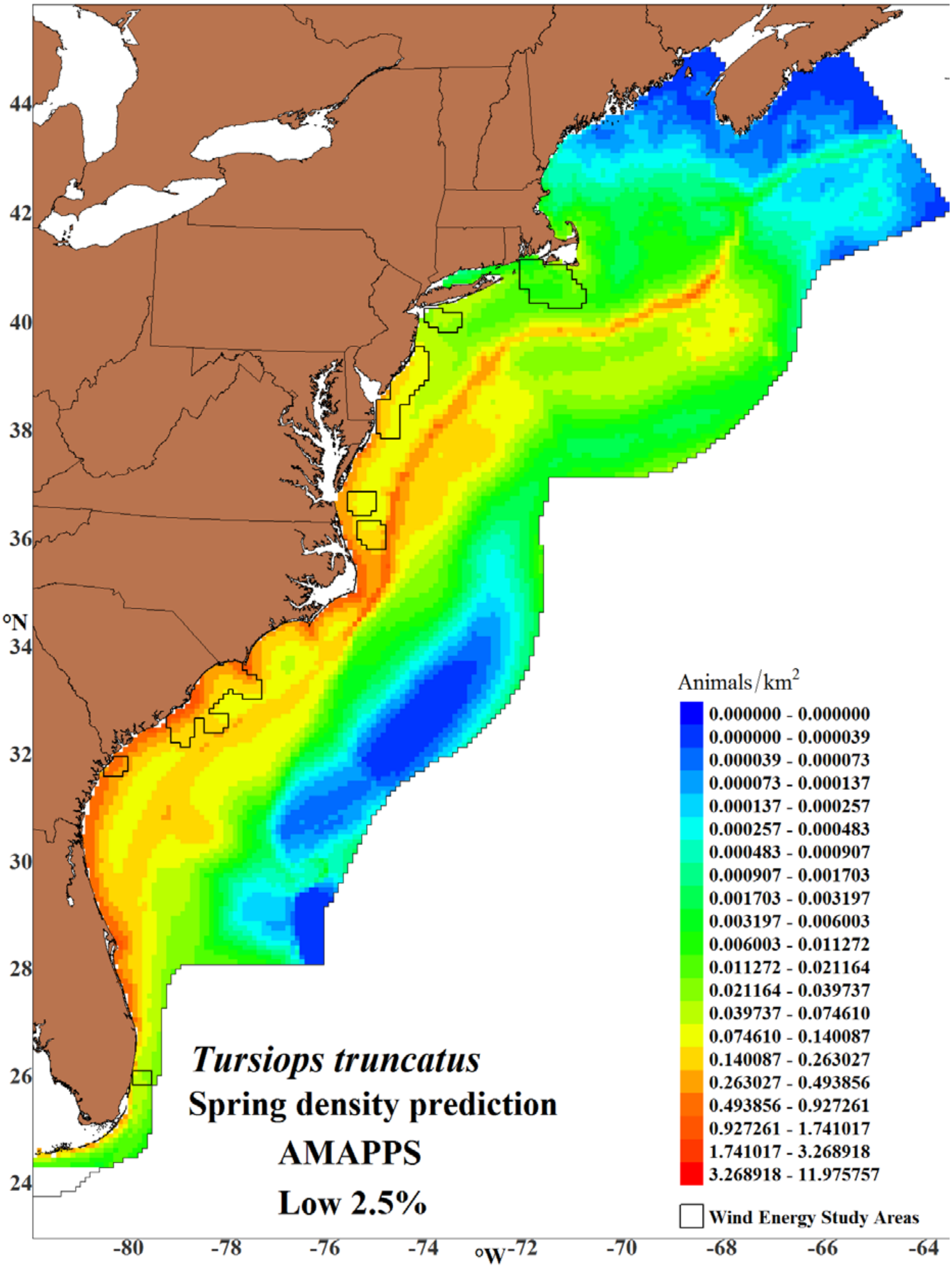

Figure 17-7 Lower 2.5% percentile of spring common bottlenose dolphin estimates

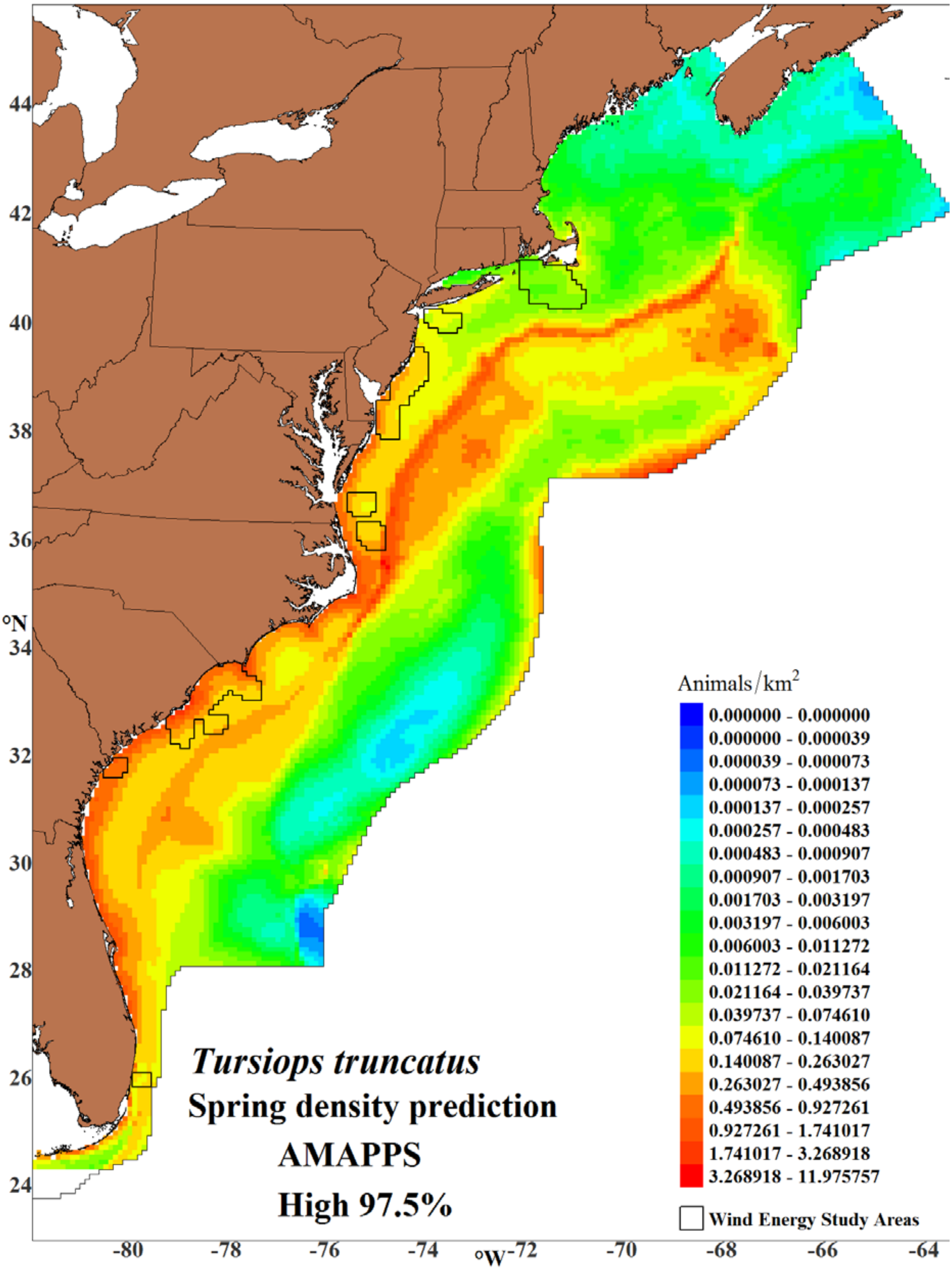

Figure 17-8 Upper 97.5% percentile of spring common bottlenose dolphin estimates

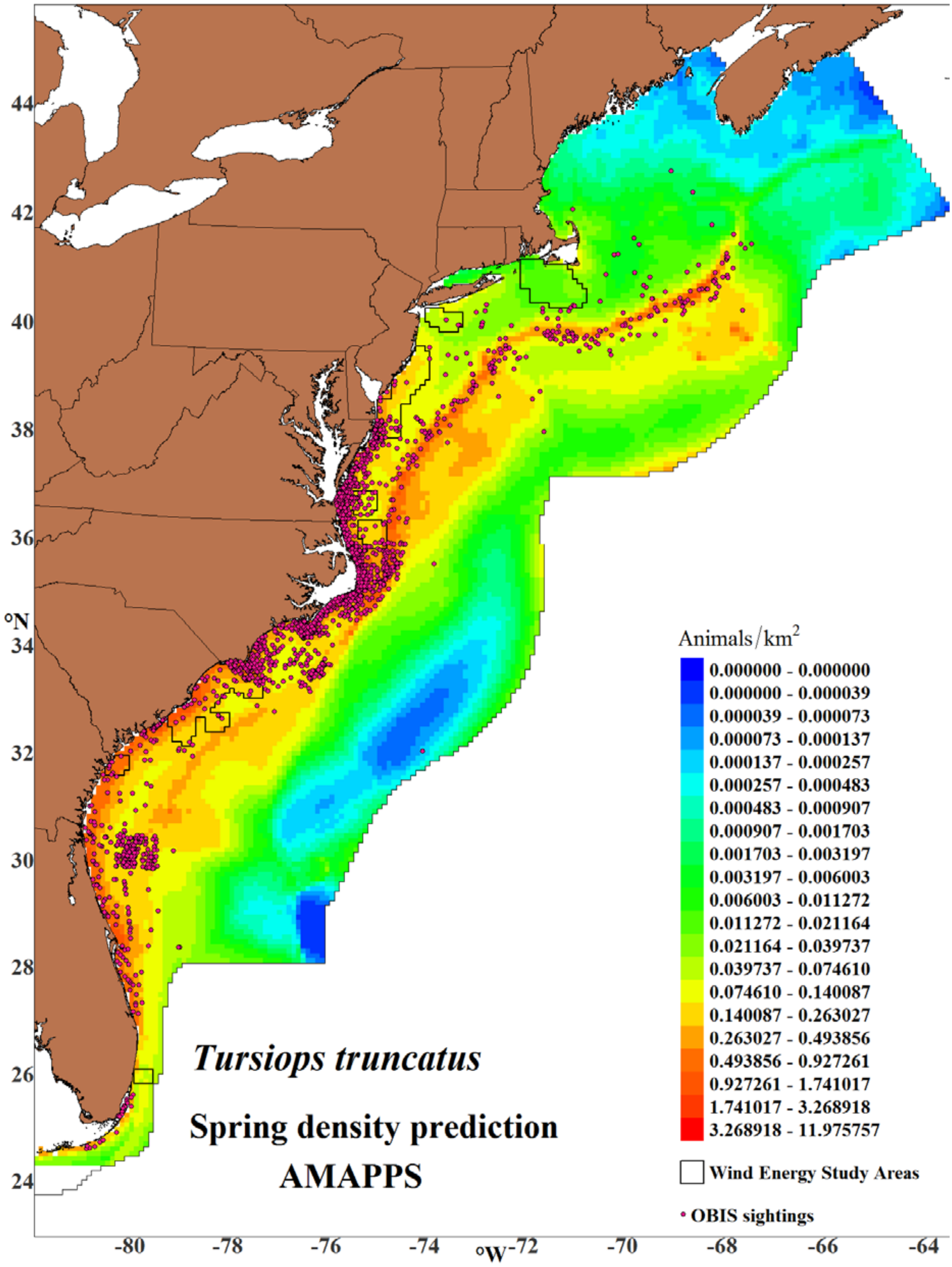

Figure 17-9 Common bottlenose dolphin 2010-2013 spring density and 1968-2014 OBIS sightings

Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

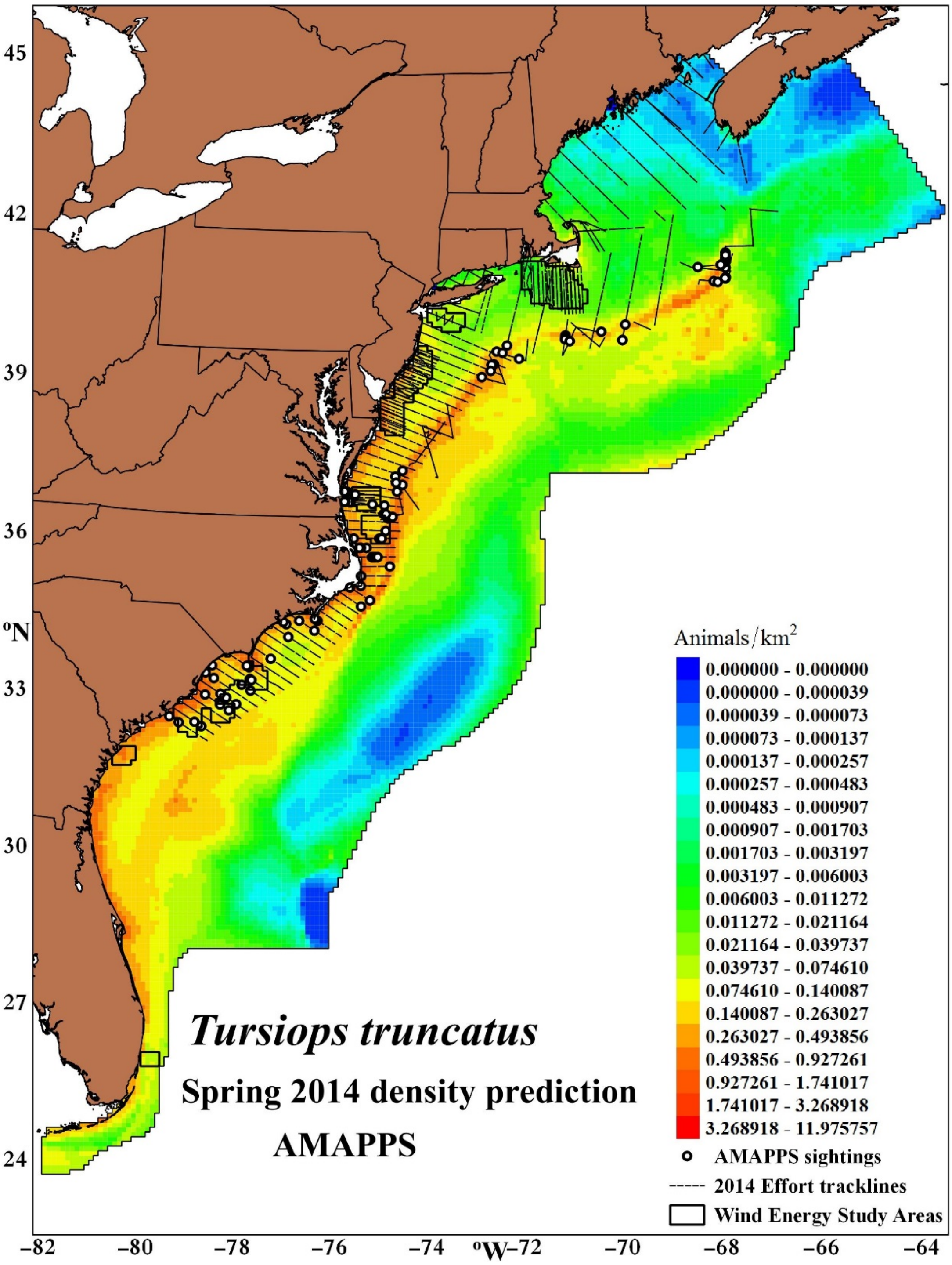

Figure 17-10 Common bottlenose dolphin spring 2014 density and AMAPPS 2014 tracks and sightings
These sightings were not used to develop the density-habitat model.

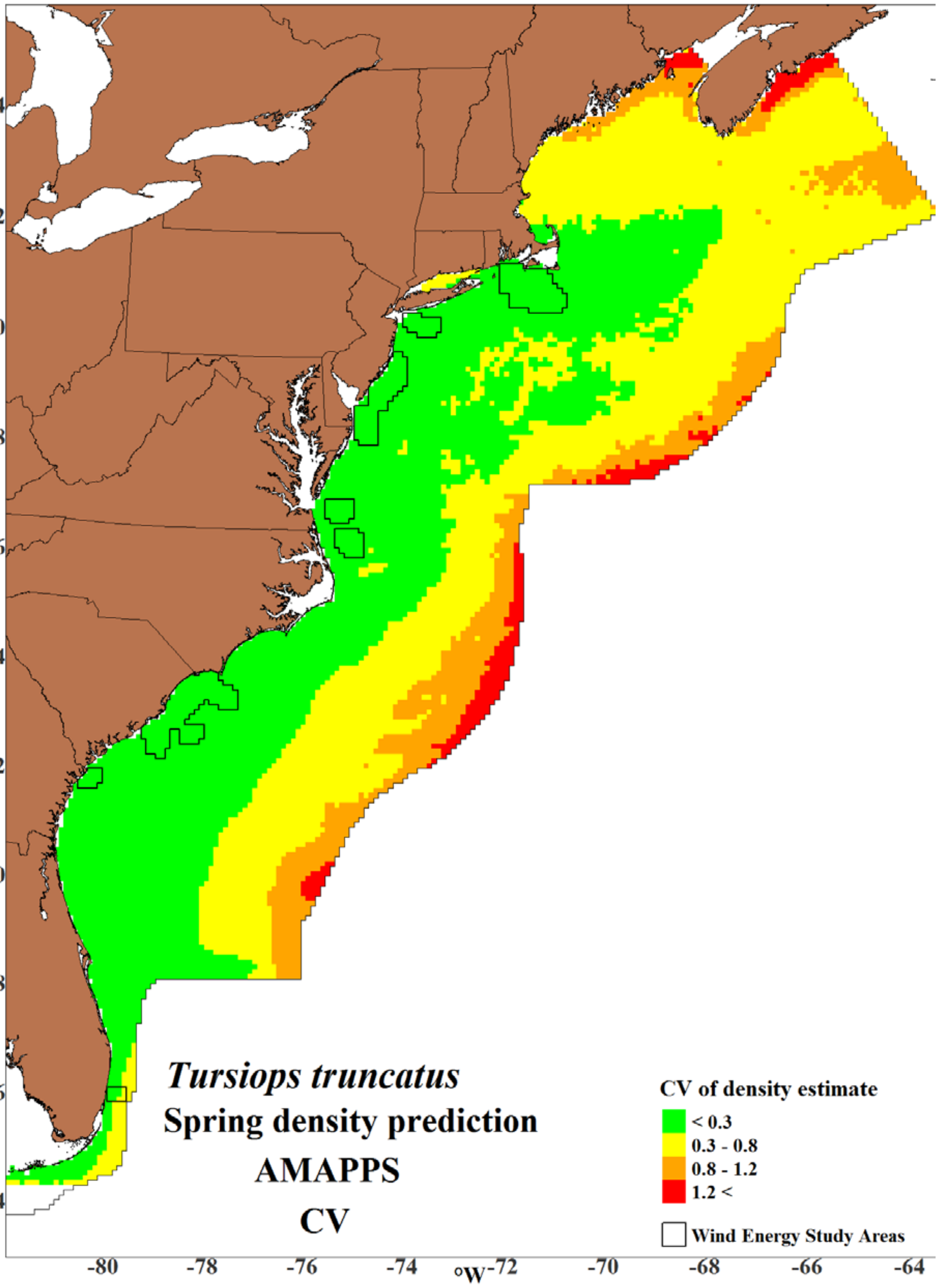

Figure 17-11 CV of spring denstiy estimates for common bottlenose dolphins

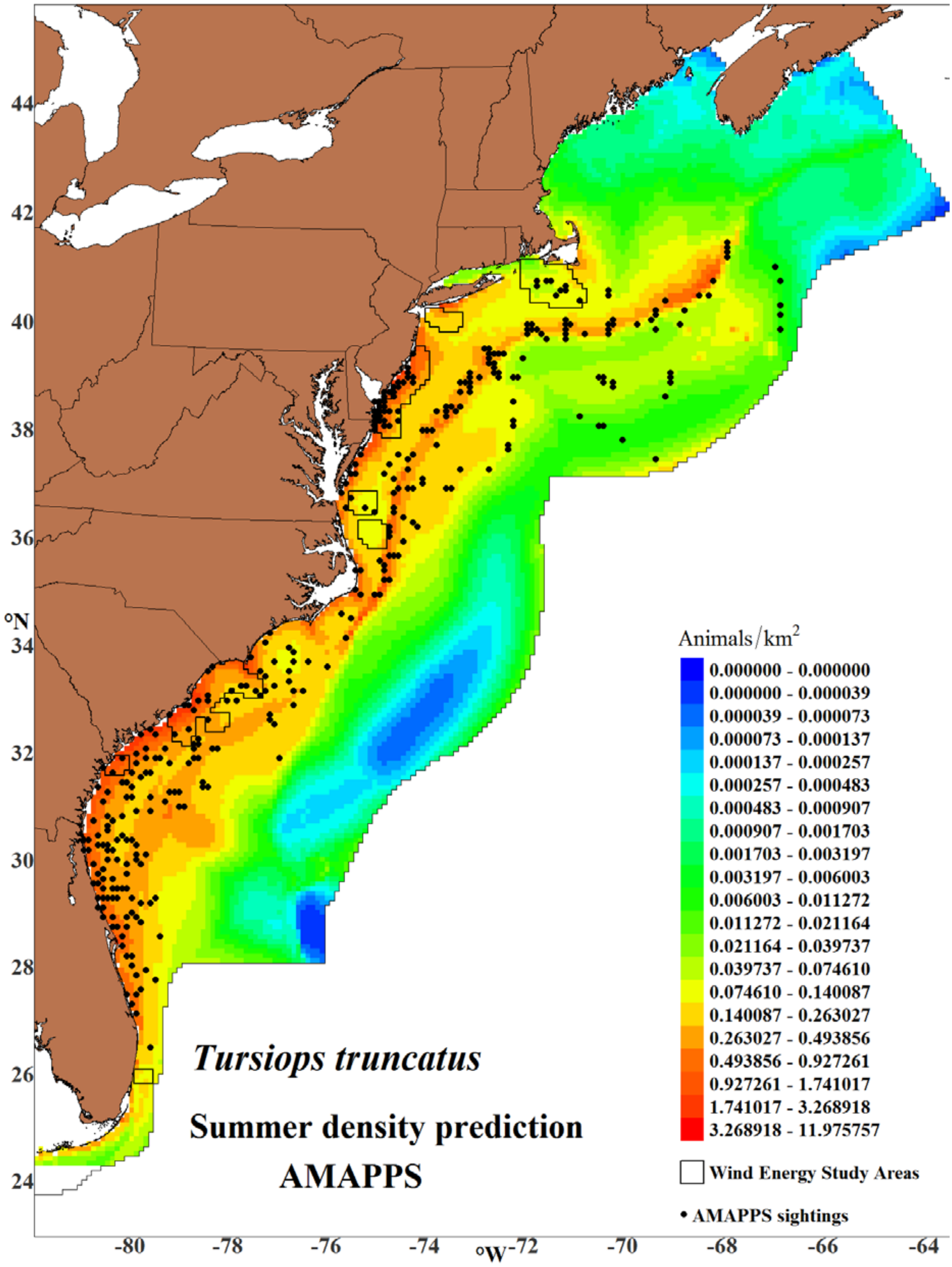

Figure 17-12 Common bottlenose dolphin summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

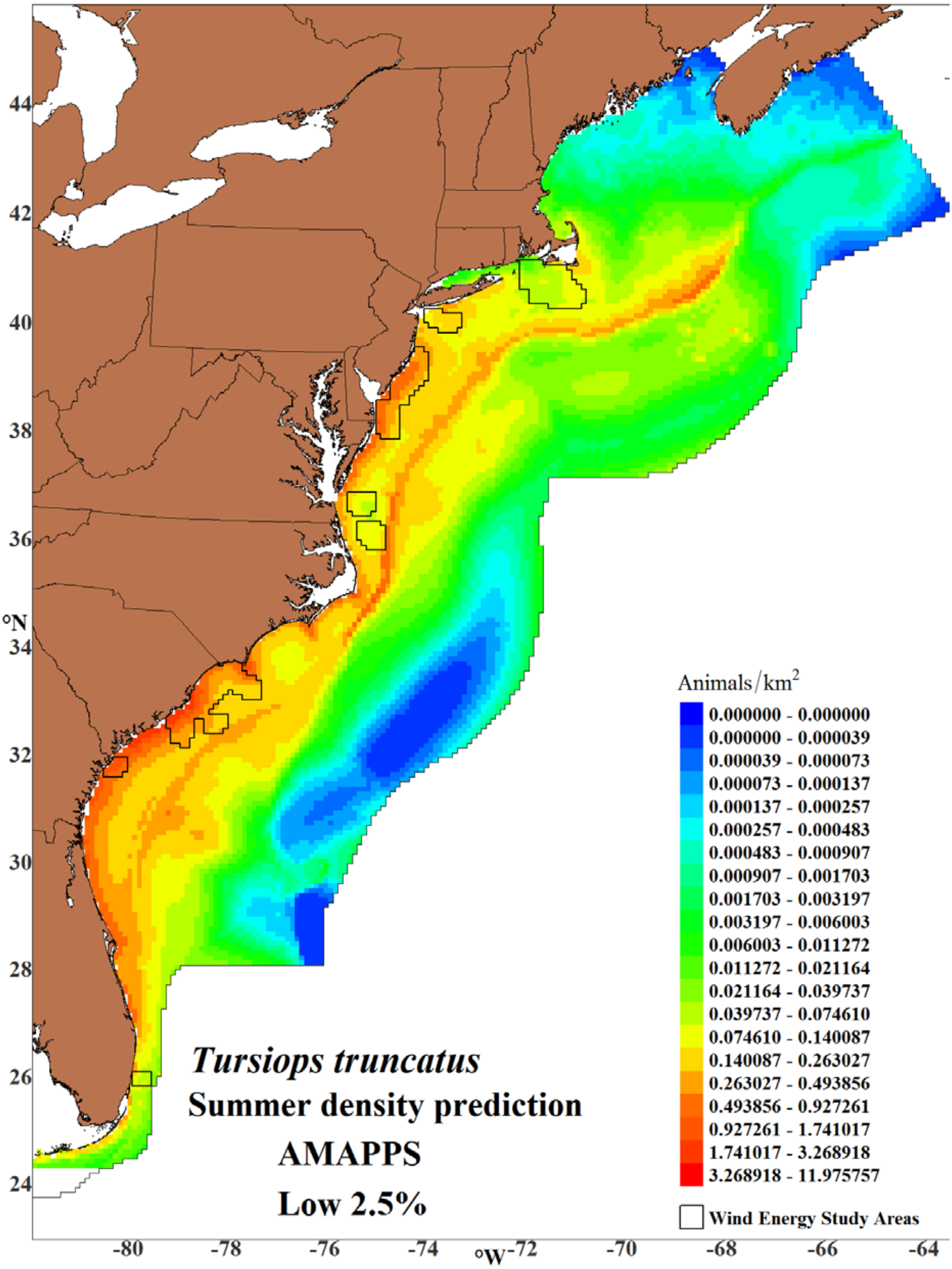

Figure 17-13 Lower 2.5% percentile of summer common bottlenose dolphin estimates

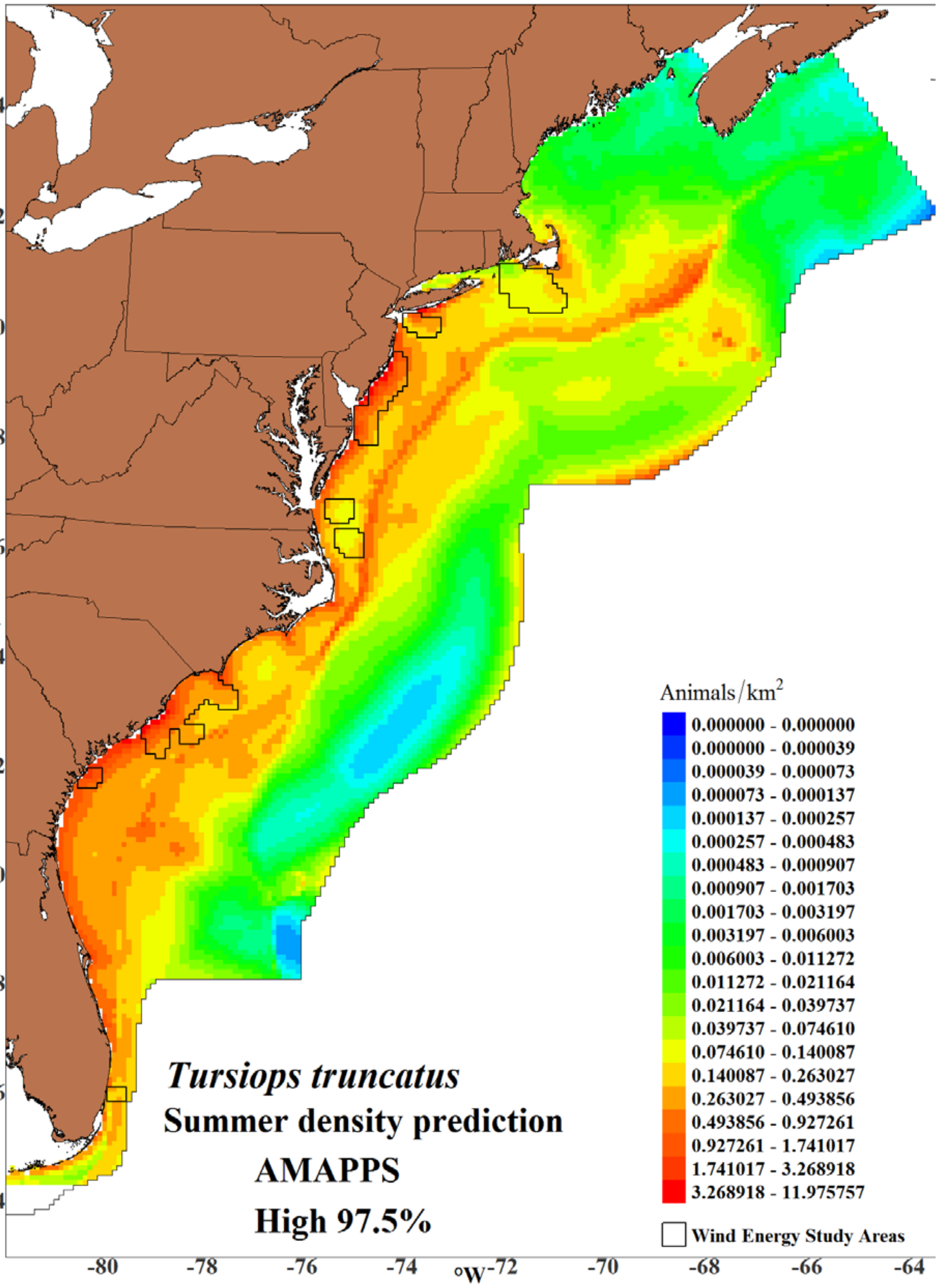

Figure 17-14 Upper 97.5% percentile of summer common bottlenose dolphin estimates

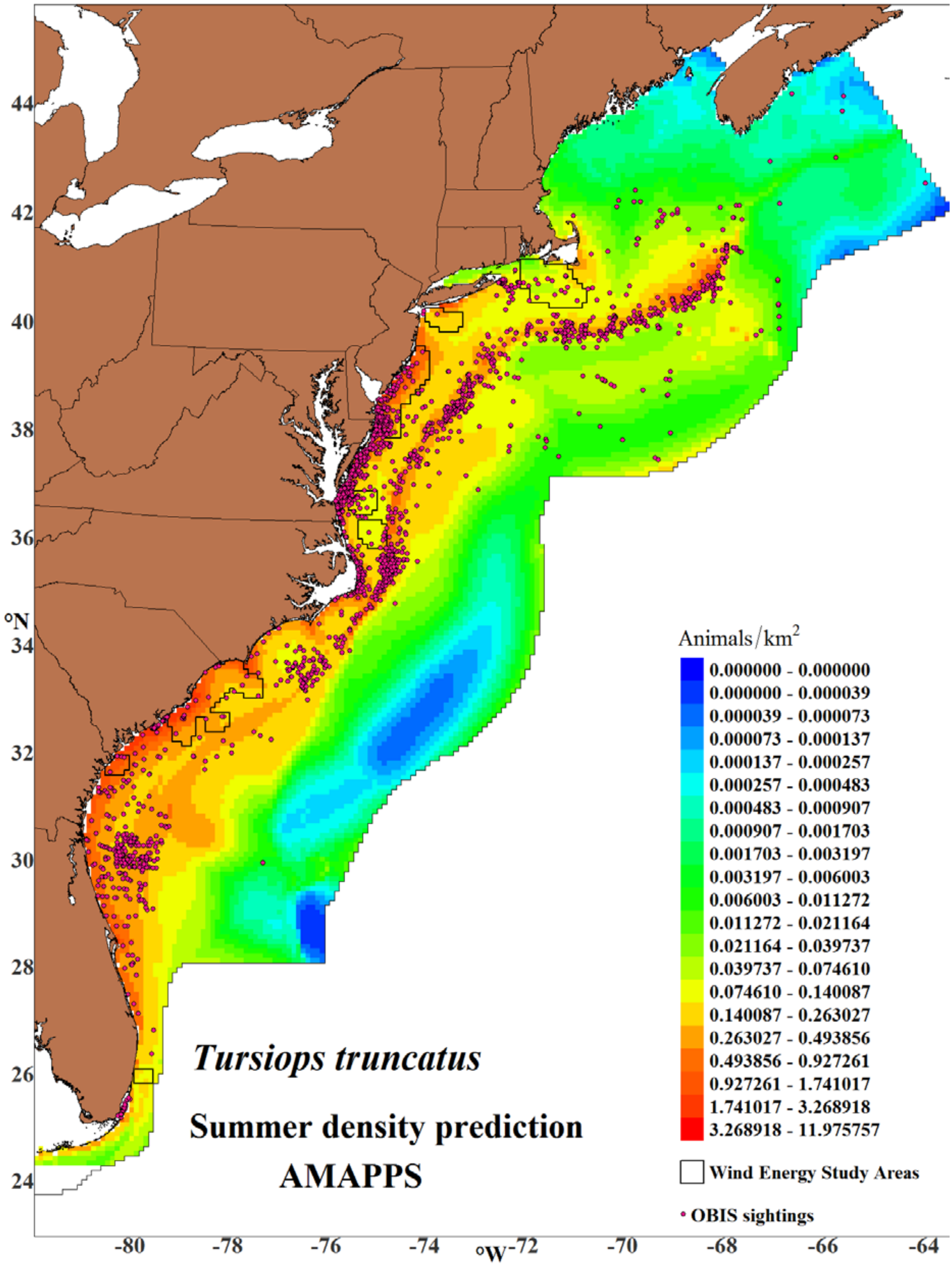

Figure 17-15 Common bottlenose dolphin 2010 - 2013 summer density and 1968-2014 OBIS sightings

Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

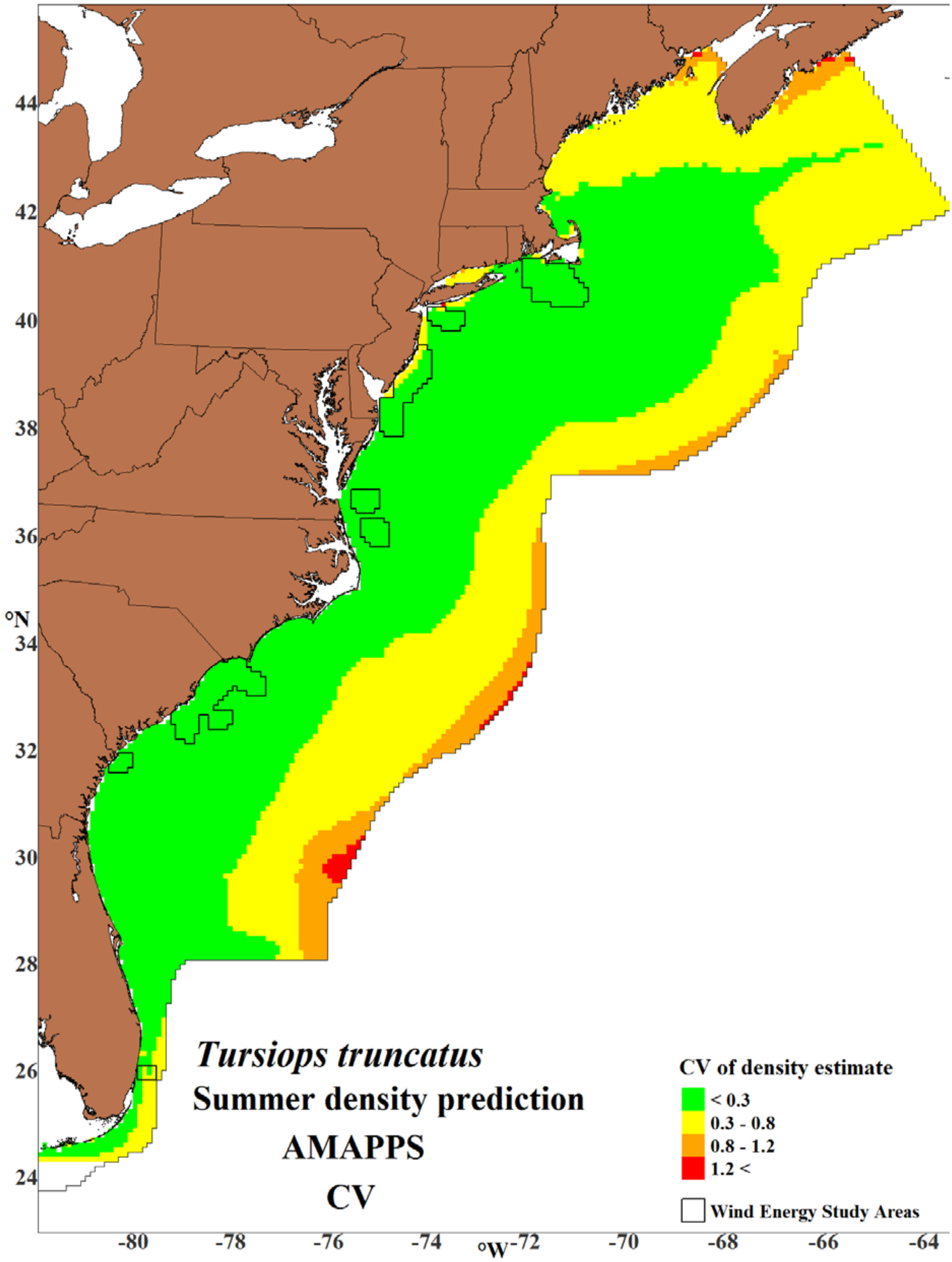

Figure 17-16 CV of summer density estimates for common bottlenose dolphins

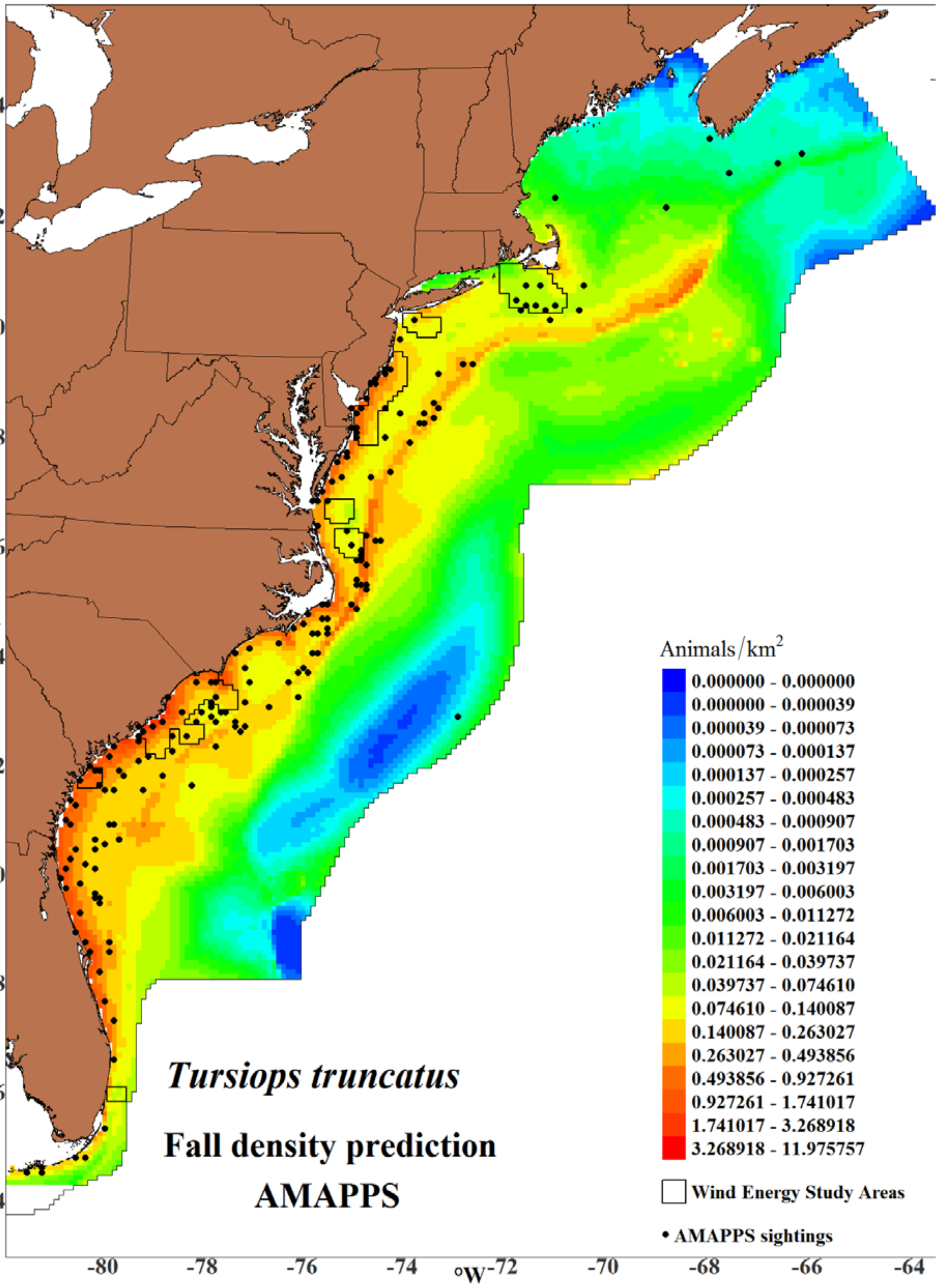

Figure 17-17 Common bottlenose dolphin fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

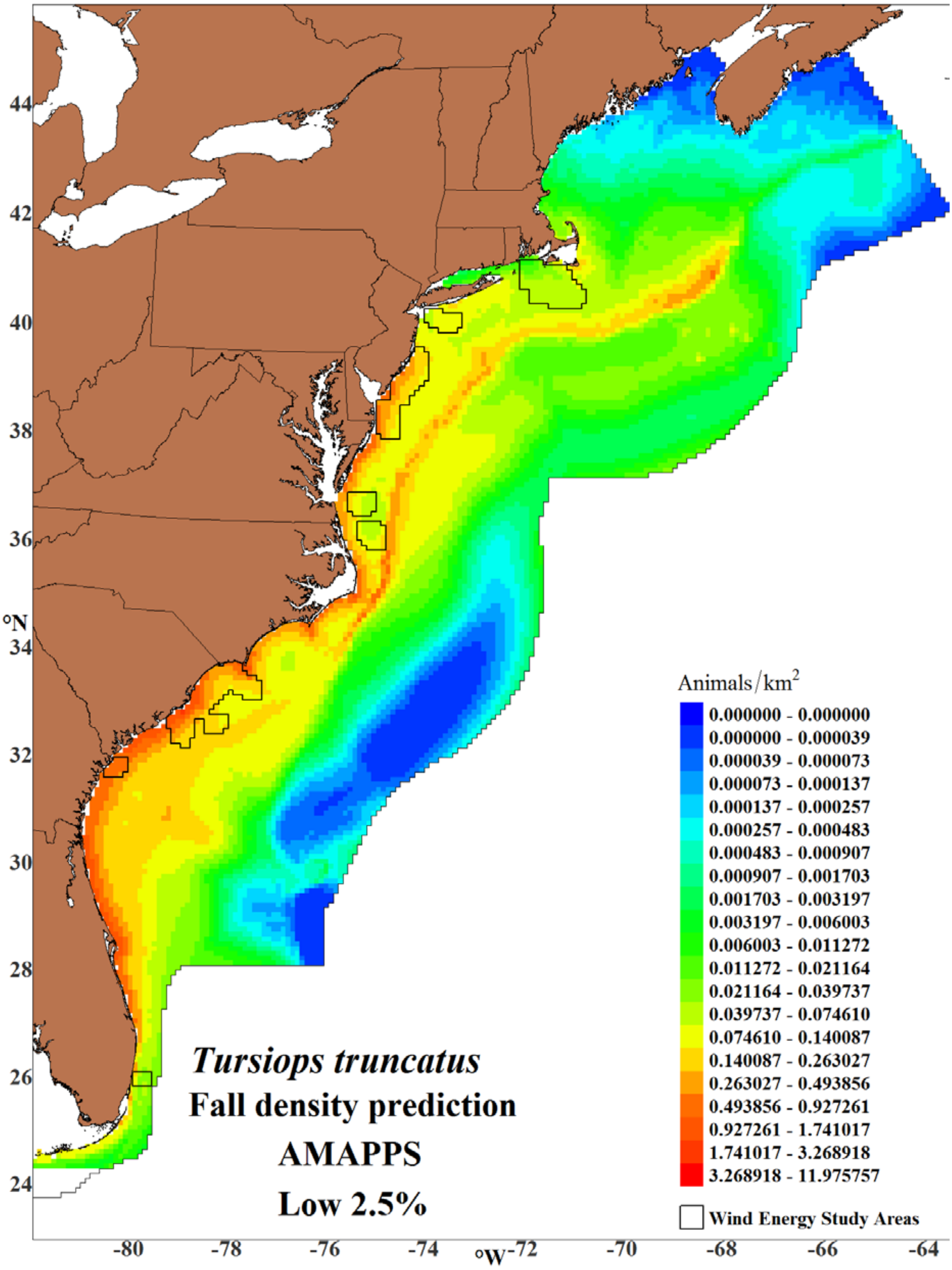

Figure 17-18 Lower 2.5% percentile of fall common bottlenose dolphin estimates

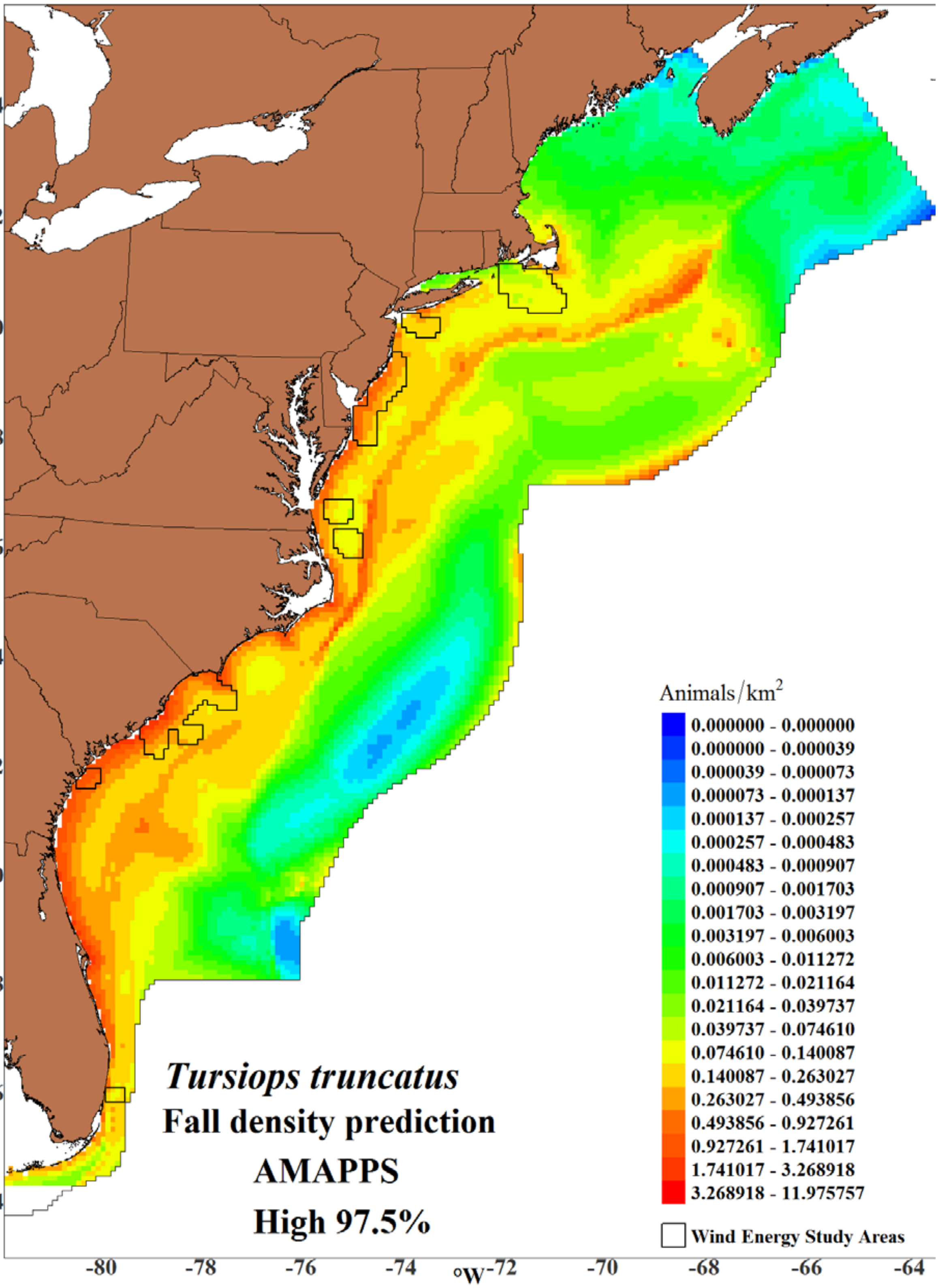

Figure 17-19 Upper 97.5% percentile of fall common bottlenose dolphin estimates

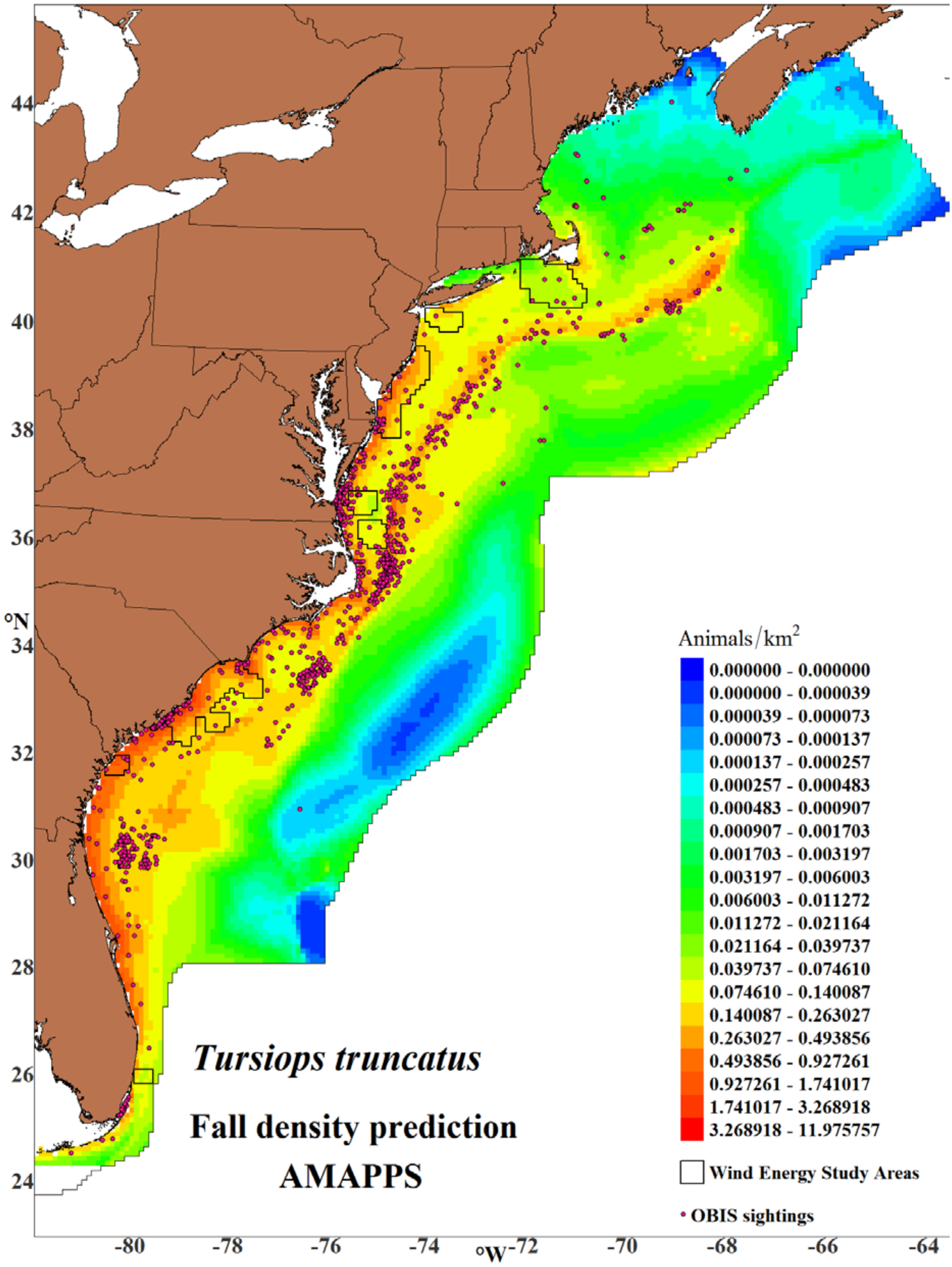

Figure 17-20 Common bottlenose dolphin 2010-2013 fall density and 1968-2014 OBIS sightings Pink circle (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

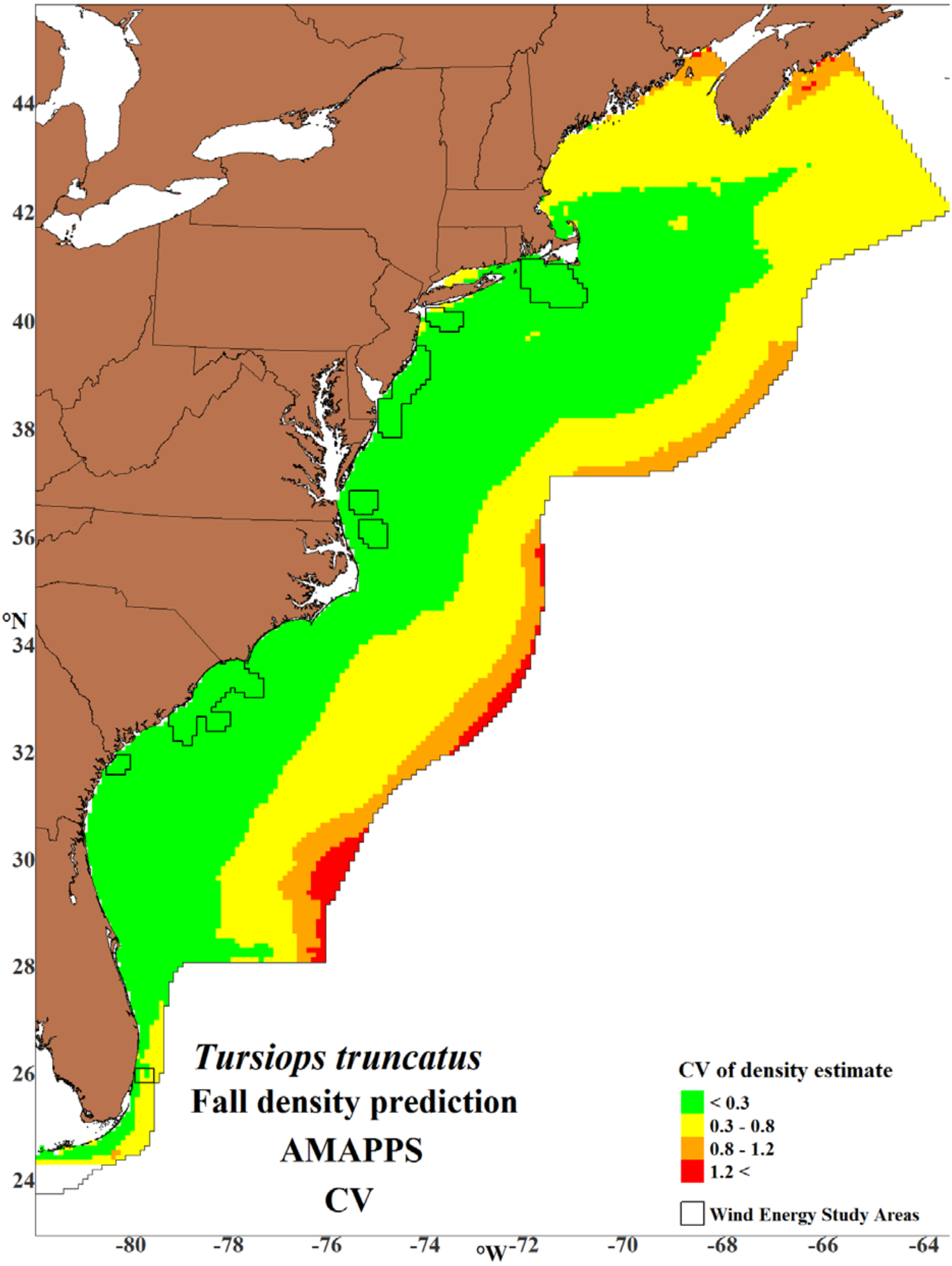

Figure 17-21 CV of fall density estimates for common bottlenose dolphins

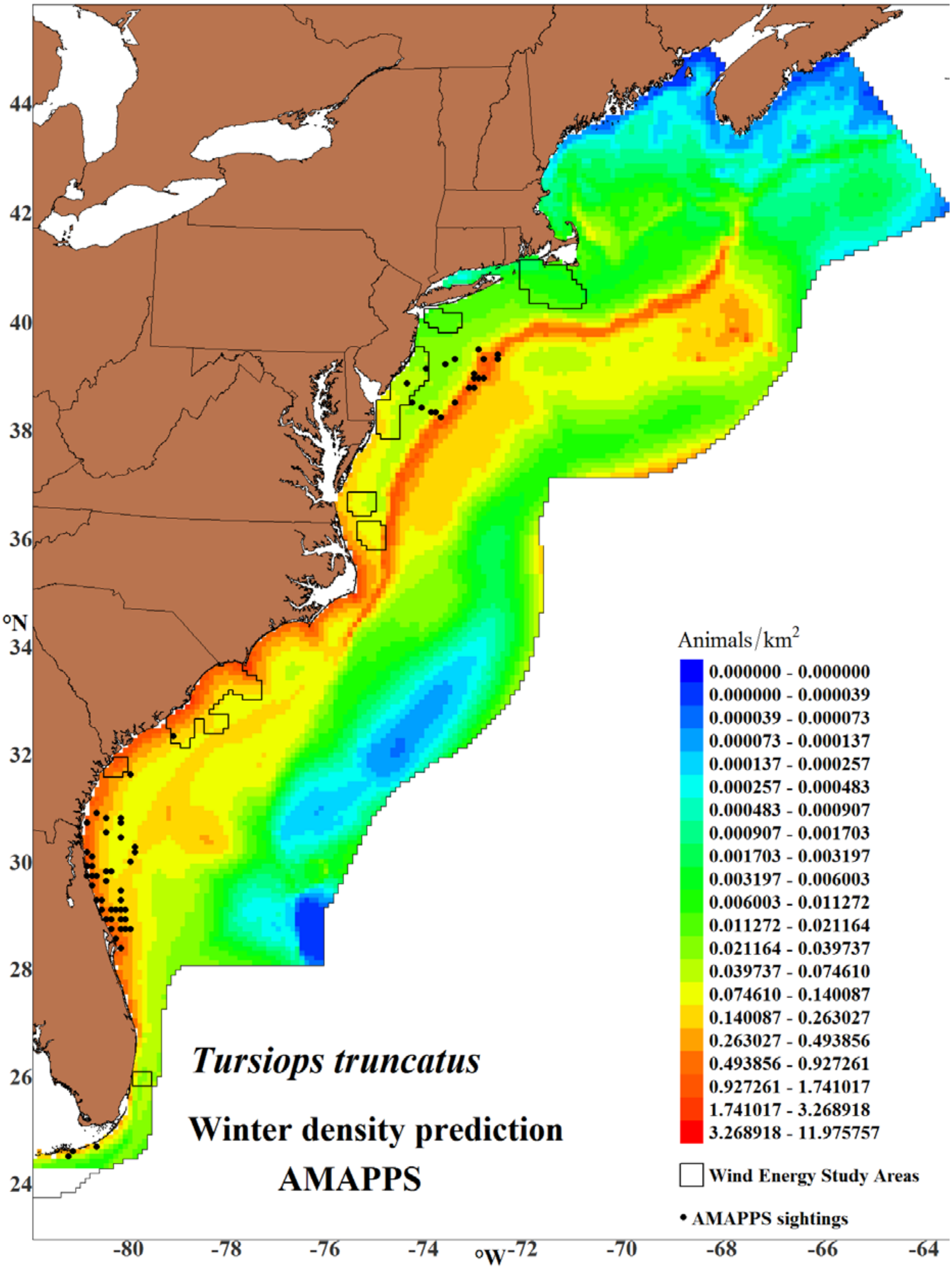

Figure 17-22 Common bottlenose dolphin winter average density estimates
Black circles indicate grid cells with one or more animal sightings.

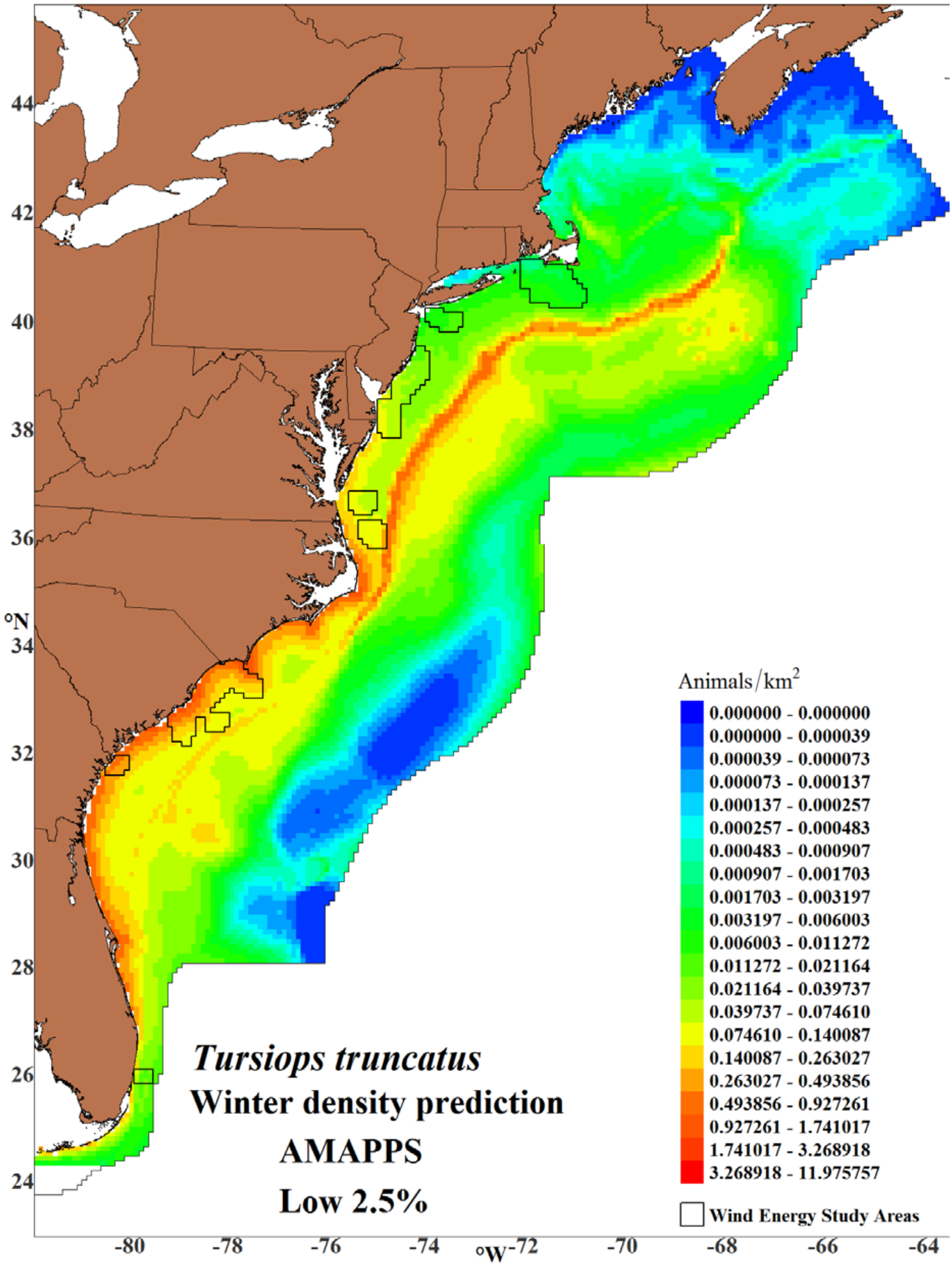

Figure 17-23 Lower 2.5% percentile of winter common bottlenose dolphin estimates

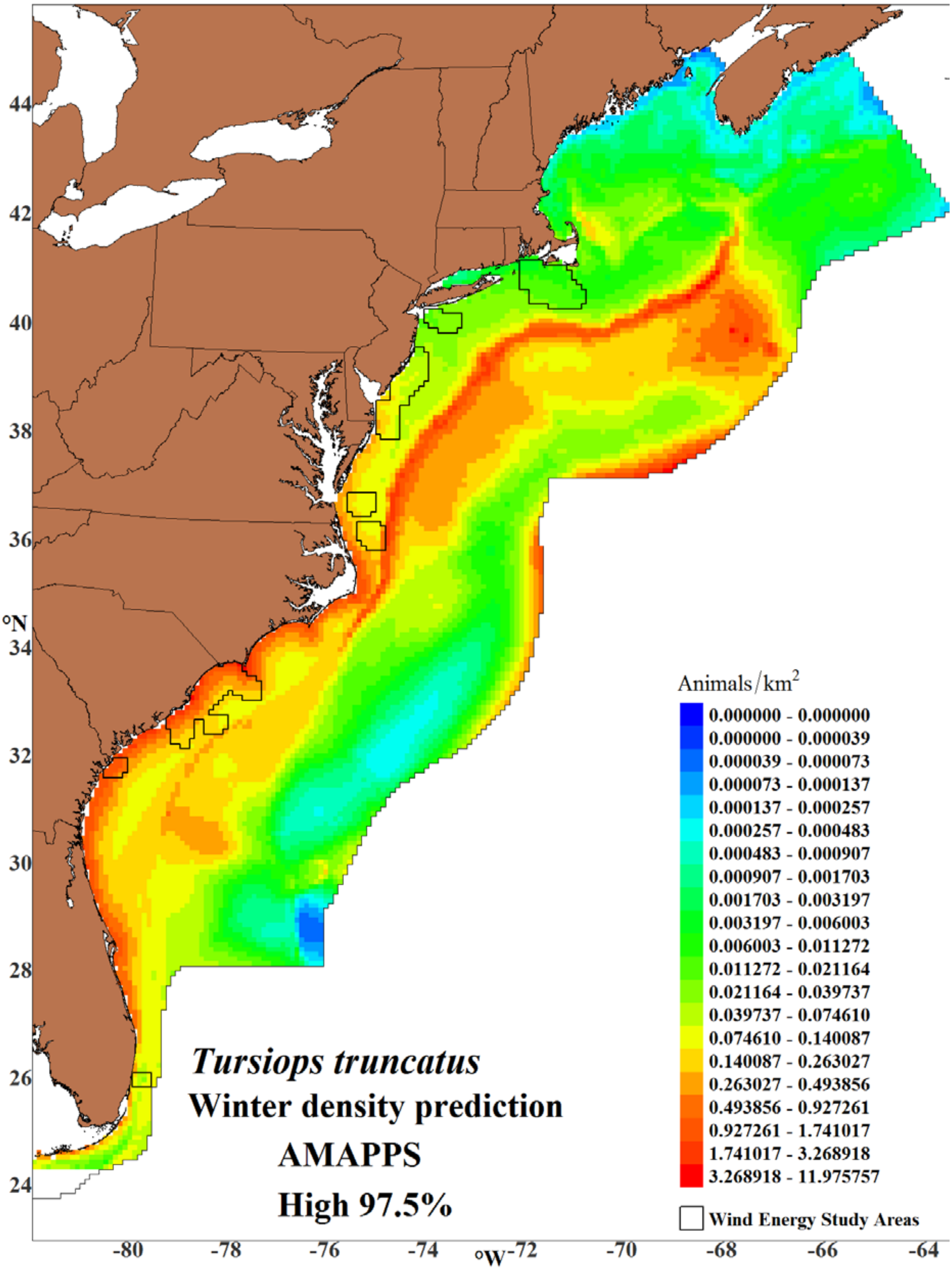

Figure 17-24 Upper 97.5% percentile of winter common bottlenose dolphin estimates

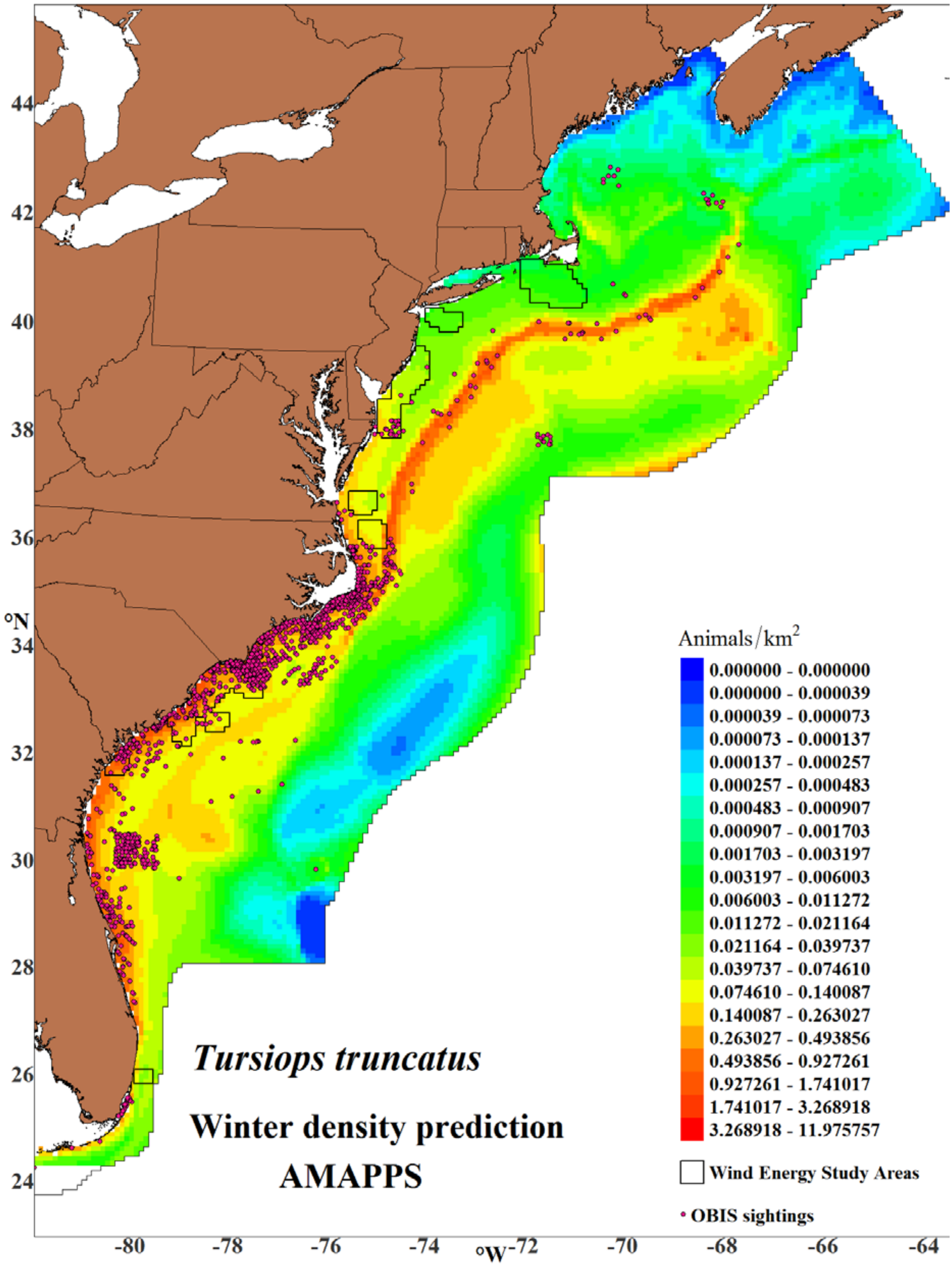

Figure 17-25 Common bottlenose dolphin 2010-2013 winter density and 1968-2014 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

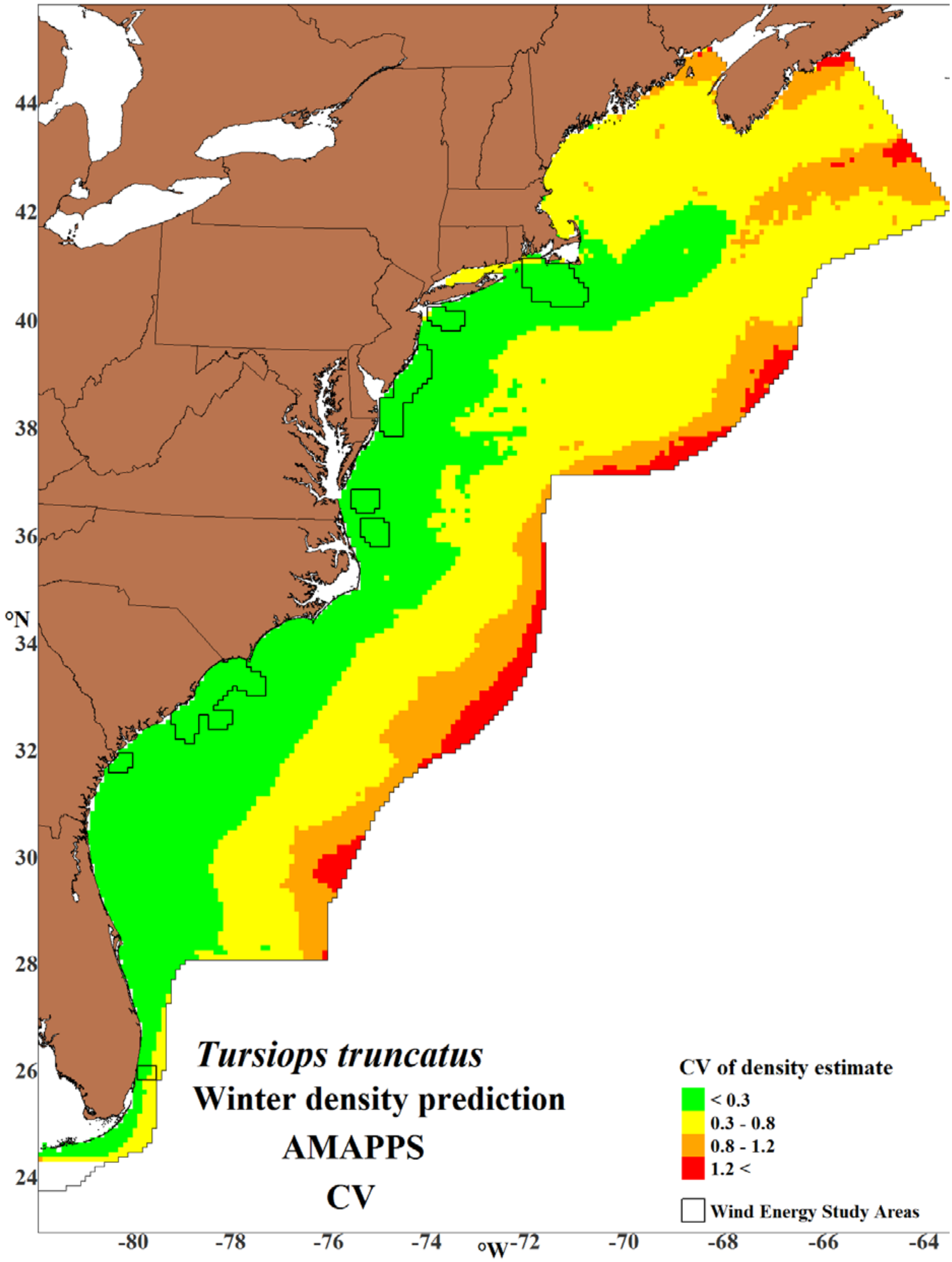

Figure 17-26 CV of winter density estimates for common bottlenose dolphins

17.6 Wind Energy Study Areas

Table 17-6 Common bottlenose dolphin average abundance estimates for wind energy study areas

Availability bias correction: aerial 0.785, CV=0.364; shipboard 1, CV=0.0.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	246	0.197	168 - 360
(March-May)	New York	171	0.17	123 - 238
	New Jersey	1,169	0.133	902 – 1,515
	Delaware/ Maryland	913	0.104	745 – 1,119
	Virginia	448	0.107	364 - 552
	North Carolina	751	0.147	564 – 1,000
	South Carolina/ North Carolina	7,234	0.092	6,048 – 8,653
	Georgia	986	0.107	800 – 1,214
	Florida	101	0.261	61 - 168
Summer	Rhode Island/ Massachusetts	1,110	0.13	861 – 1,430
(June-August)	New York	720	0.202	487 - 1066
	New Jersey	6,106	0.31	3,371 – 11,060
	Delaware/ Maryland	2,417	0.144	1,824 – 3,203
	Virginia	366	0.107	297 - 451
	North Carolina	421	0.1	347 - 512
	South Carolina/ North Carolina	11,288	0.076	9,722 – 13,106
	Georgia	1857	0.089	1,559 – 2,211
	Florida	160	0.288	92 - 278
Fall	Rhode Island/ Massachusetts	777	0.14	592 – 1,020
(September-November)	New York	394	0.212	261 - 594
	New Jersey	2,428	0.14	1,850 – 3,188
	Delaware/ Maryland	1,534	0.109	1,240 – 1,898
	Virginia	333	0.101	273 - 405
	North Carolina	350	0.104	285 - 429
	South Carolina/ North Carolina	8,263	0.084	7,012 – 9,736
	Georgia	1,315	0.098	1,087 – 1,592
	Florida	116	0.296	66 - 205

Table 17-6 (cont'd)

Season	Location	Abundance*	CV	95% Confidence Interval
Winter	Rhode Island/ Massachusetts	105	0.233	67 - 165
(December-February)	New York	47	0.203	32 - 70
	New Jersey	343	0.181	241 - 487
	Delaware/ Maryland	395	0.171	283 - 550
	Virginia	278	0.122	219 - 353
	North Carolina	550	0.163	400 - 756
	South Carolina/ North Carolina	8,336	0.155	6,158 – 11,283
	Georgia	1,110	0.201	752 – 1,639
	Florida	67	0.263	40 - 111

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model. N/A indicates it was assumed to be in the True 0 modeled area.

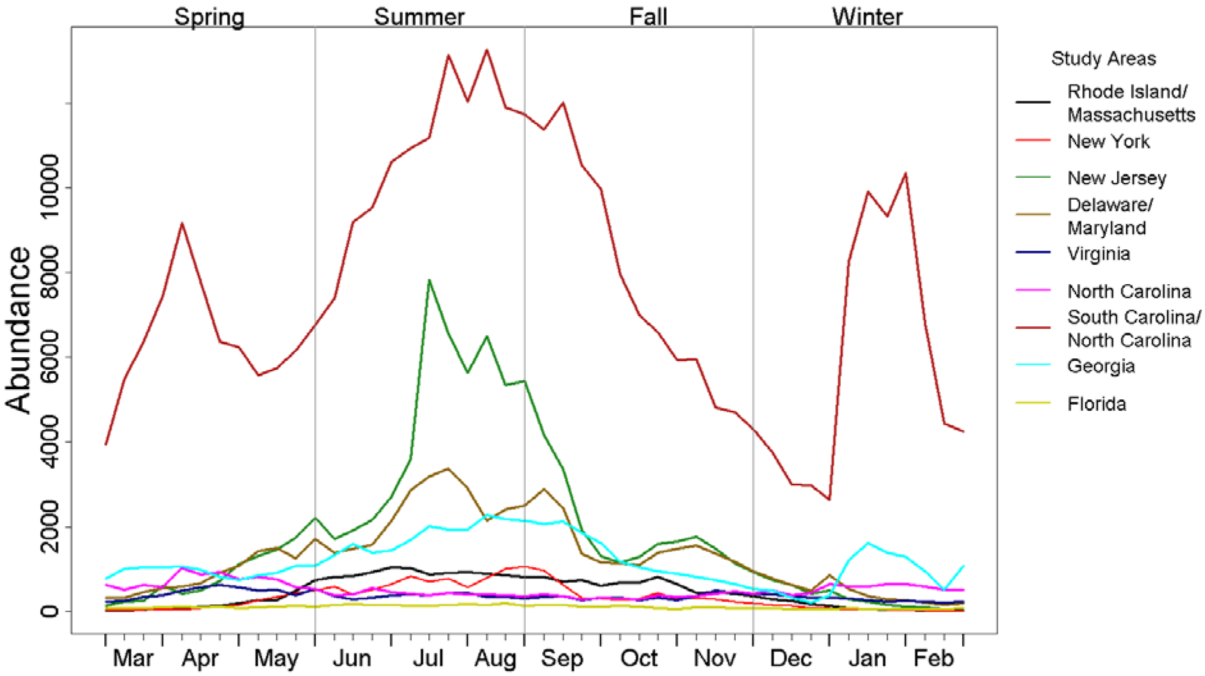

Figure 17-27 Annual abundance trends for common bottlenose dolphins in wind energy study areas

18 Harbor Porpoise (*Phocoena phocoena*)

Figure 18-1 Harbor porpoise. Credit: NOAA/NEFSC/Peter Duley
Image collected under MMPA Research permit #775-1875.

18.1 Data Collection

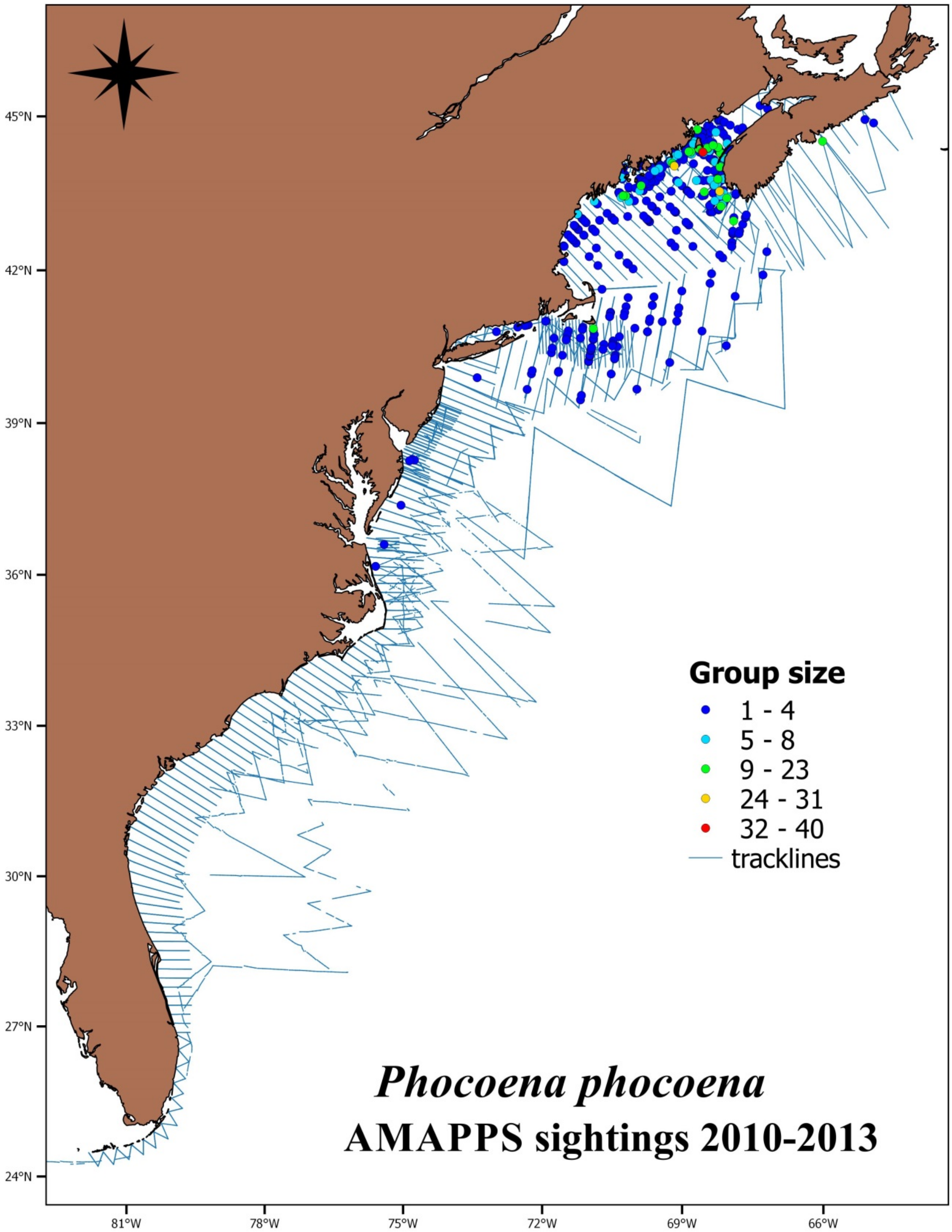

Figure 18-2 Track lines and harbor porpoise sightings during 2010 - 2013

TABLE 17.1. AMAPPS research effort 2010 – 2013 and harbor porpoise sightings.

Table 18-1 Research effort 2010 - 2013 and harbor porpoise sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Harbor porpoise	*Phocoena phocoena*	0/0	4/6	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	-	-	125/175	347/1,232	50/128	66/88
SE Shipboard	0	8,537	2,093	0	-	-	0/0	0/0	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	-	-	4/6	0/0	0/0	2/4

18.2 Mark-Recapture Distance Sampling Analysis

Table 18-2 Parameter estimates from harbor porpoise (HAPO) MRDS analysis
HR= Hazard Rate, HN= Half Normal, codes explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE-aerial group 5	1	HAPO	Distance*observer	Distance	600	HN	0.399	0.208	0.171	0.725	0.773
	2		-	Distance	300	HN	-	-	0.181	0.447	0.615

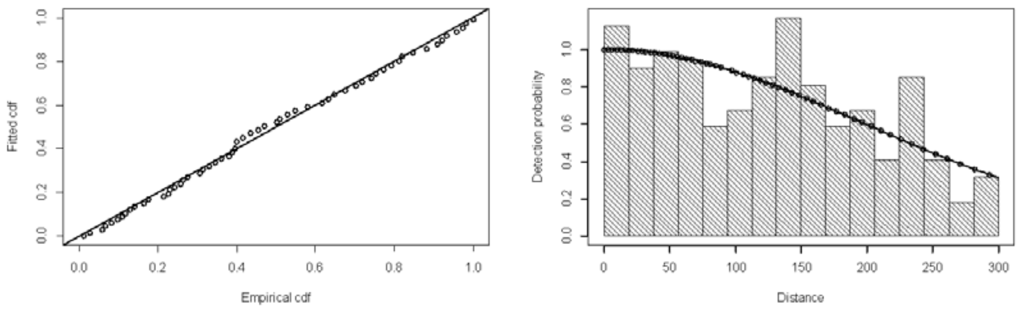

Figure 18-3 Q-Q plots and detection functions from harbor porpoise MRDS analysis

18.3 Generalized Additive Model Analysis

Table 18-3 Spring habitat model output for harbor porpoises

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(pp)	0.9518	4	26.5	<2e-16	8.43E-07	***
s(dist2shore)	2.958	4	34.71	<2e-16	4.56E-03	***
s(dist200)	1.1935	4	17.77	<2e-16	2.73E-08	***
s(lat)	1.8657	4	72.18	<2e-16	1.15E+00	***
Scale	-	-	-	-	1.74E+00	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: Total = 7.97

R^2 (adjusted) = 0.0642   Deviance explained = 49.9%

REML = 311.49 Scale estimate. = 0.41138   sample size = 3894

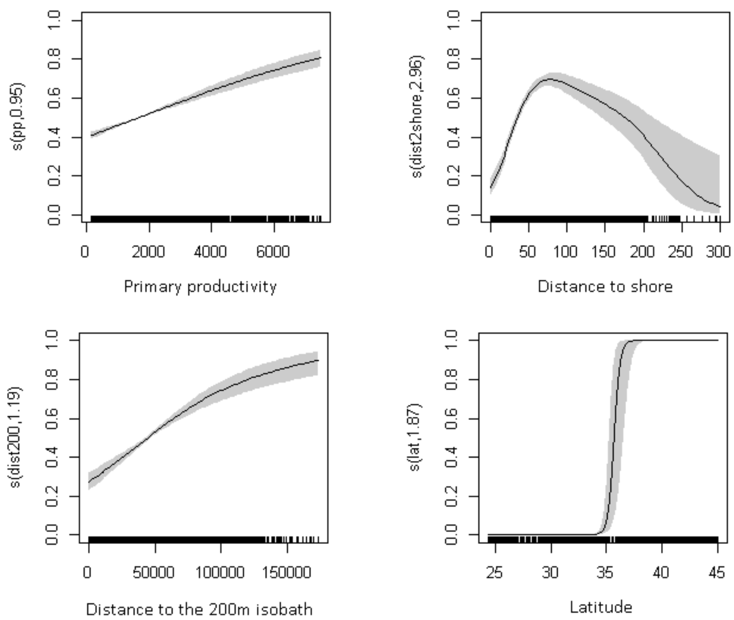

Figure 18-4 Harbor porpoise spring density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 18-4 Summer habitat model output for harbor porpoises

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(pic)	0.9714	4	71.38	<2e-16	4.51E+02	***
s(mld)	0.9724	4	99	<2e-16	8.02E-04	***
s(depth)	0.9729	4	113.45	<2e-16	3.06E-05	***
s(lat)	1.9164	4	177	<2e-16	4.74E+00	***
Scale	-	-	-	-	2.16E+00	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom: Total = 5.83

R^2 (adjusted) = 0.107 Deviance explained = 69.3%

REML = 520.64 Scale estimate = 0.35874 sample size = 5880

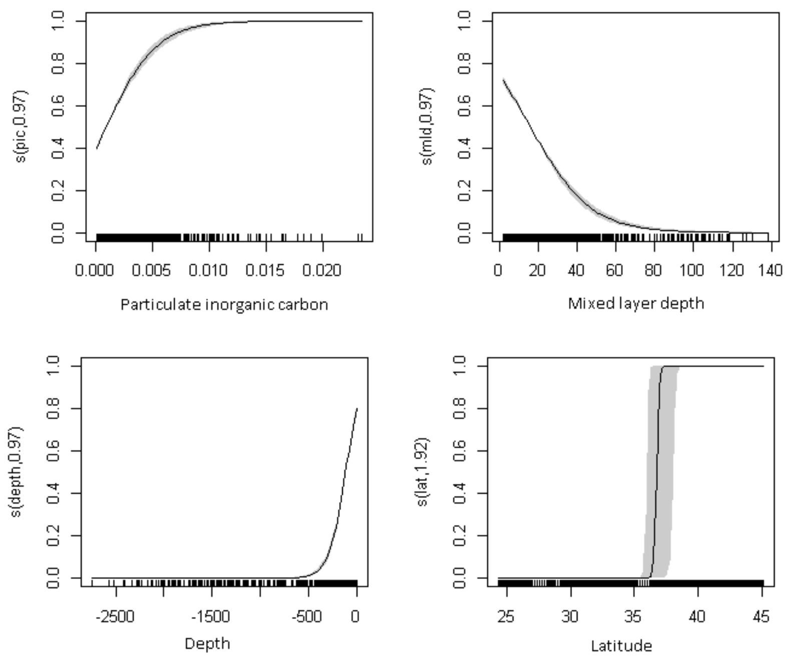

Figure 18-5 Harbor porpoise summer density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 18-5 Fall habitat model output for harbor porpoises

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	0.582	4	5.025	1.74E-09	2.87E-02	***
s(dist2shore)	0.9488	4	68.294	< 2e-16	1.08E-03	***
s(dist200)	0.8208	4	20.741	< 2e-16	2.31E-08	***
s(lat)	0.8733	4	28.397	< 2e-16	8.13E-02	***
Scale.	-	-	-	-	2.12E+00	

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Estimated degrees of freedom: Total = 4.23

R^2 (adjusted) = 0.183 Deviance explained = 66.6%

REML = 100.59 Scale estimate = 0.21189 sample size = 2461

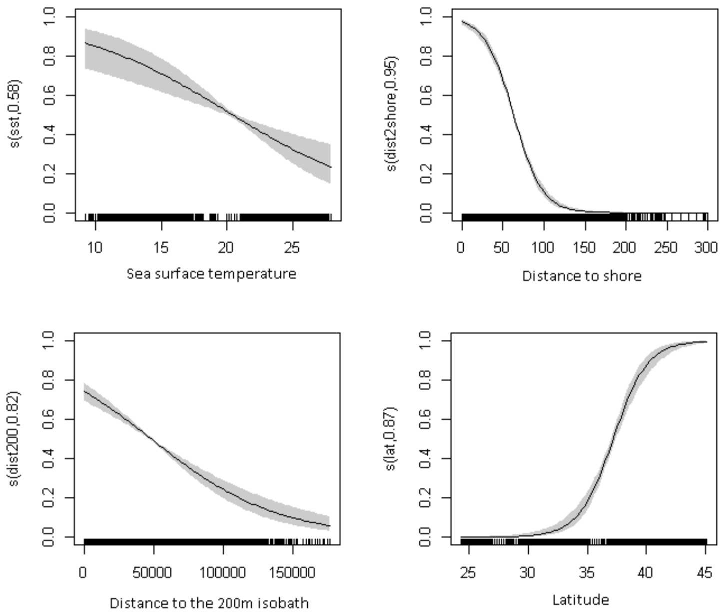

Figure 18-6 Harbor porpoise fall density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 18-6 Diagnostic statistics from harbor porpoise spring habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero density	0.241	Fair to good
MAPE	Mean absolute percentage error	Non-zero density	87.97	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.171	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.048	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

Table 18-7 Diagnostic statistics from harbor porpoise summer habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero	0.260	Fair to good
MAPE	Mean absolute percentage error	Non-zero	80.40	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.252	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.127	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

Table 18-8 Diagnostic statistics from harbor porpoise fall habitat model

Diagnostic Statistic	Description	Calculated with	Model Values (x)	Score
RHO	Spearman rank correlation	Non-zero	0.178	Fair to good
MAPE	Mean absolute percentage error	Non-zero	85.77	Fair to good
RHO	Spearman rank correlation	All data divided in 25 random samples	0.163	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.047	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

18.4 Abundance Estimates for AMAPPS Study Area

Table 18-9 Harbor porpoise average abundance estimates for AMAPPS study area
Availability bias correction: aerial 0.628, CV= 0.299; shipboard 1, CV= 0.0.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	30,126	0.195	20,646 – 43,959
Summer (June-August)	83,250	0.176	59,139 – 117,191
Fall (September-November)	17,943	0.485	7,287 – 44,180

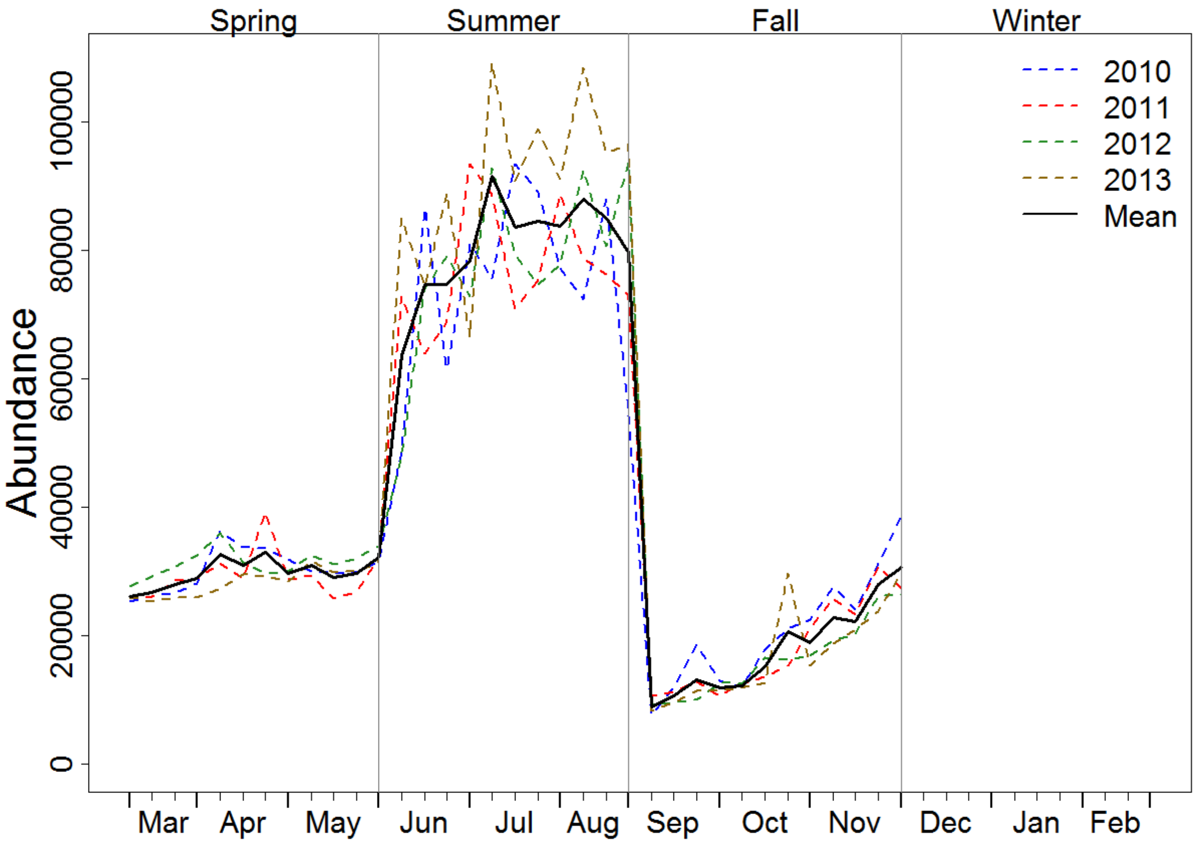

Figure 18-7 Annual abundance trends for harbor porpoises for AMAPPS study area

18.5 Seasonal Prediction Maps

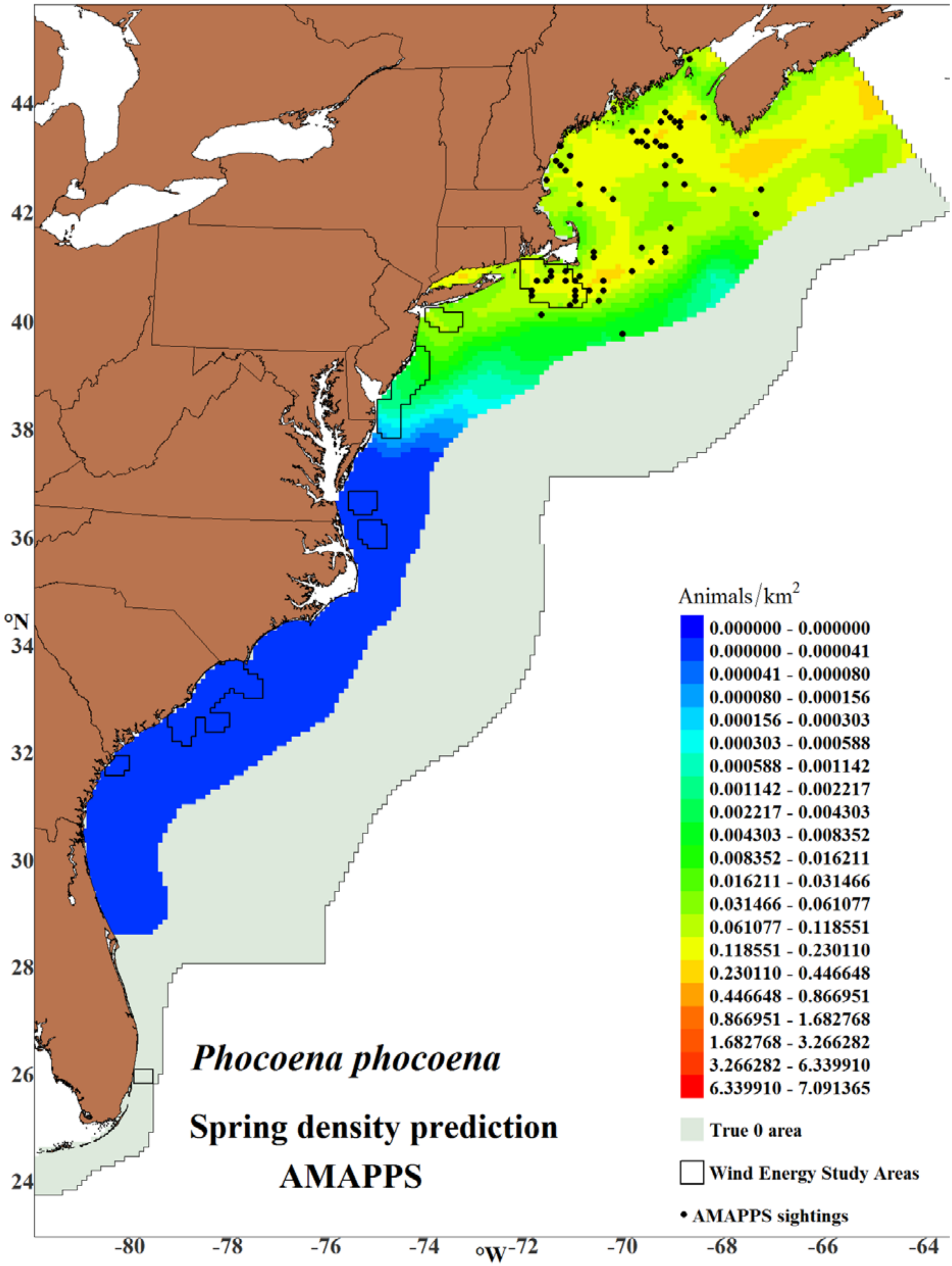

Figure 18-8 Harbor porpoise spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

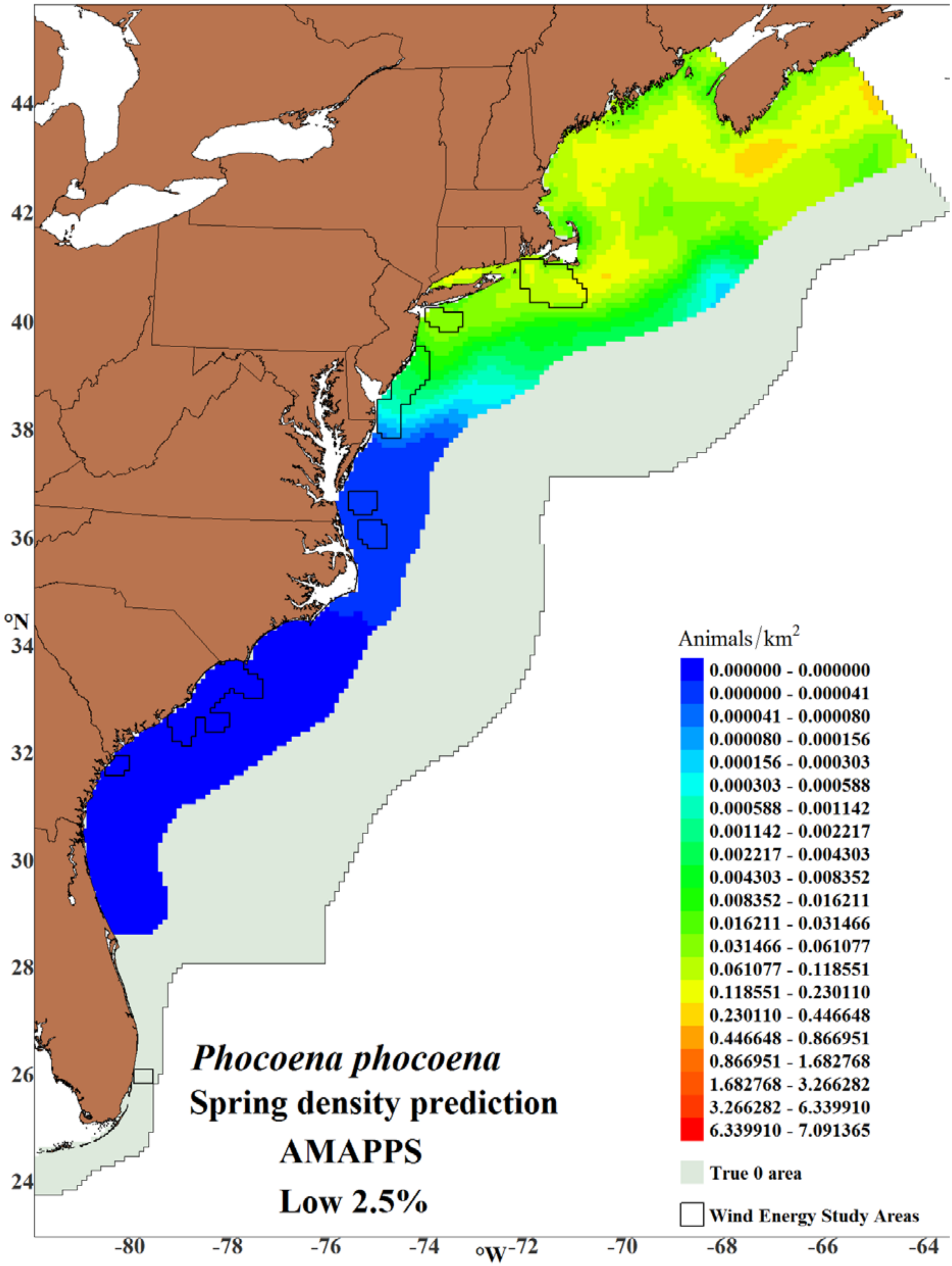

Figure 18-9 Lower 2.5% percentile of spring harbor porpoise estimates

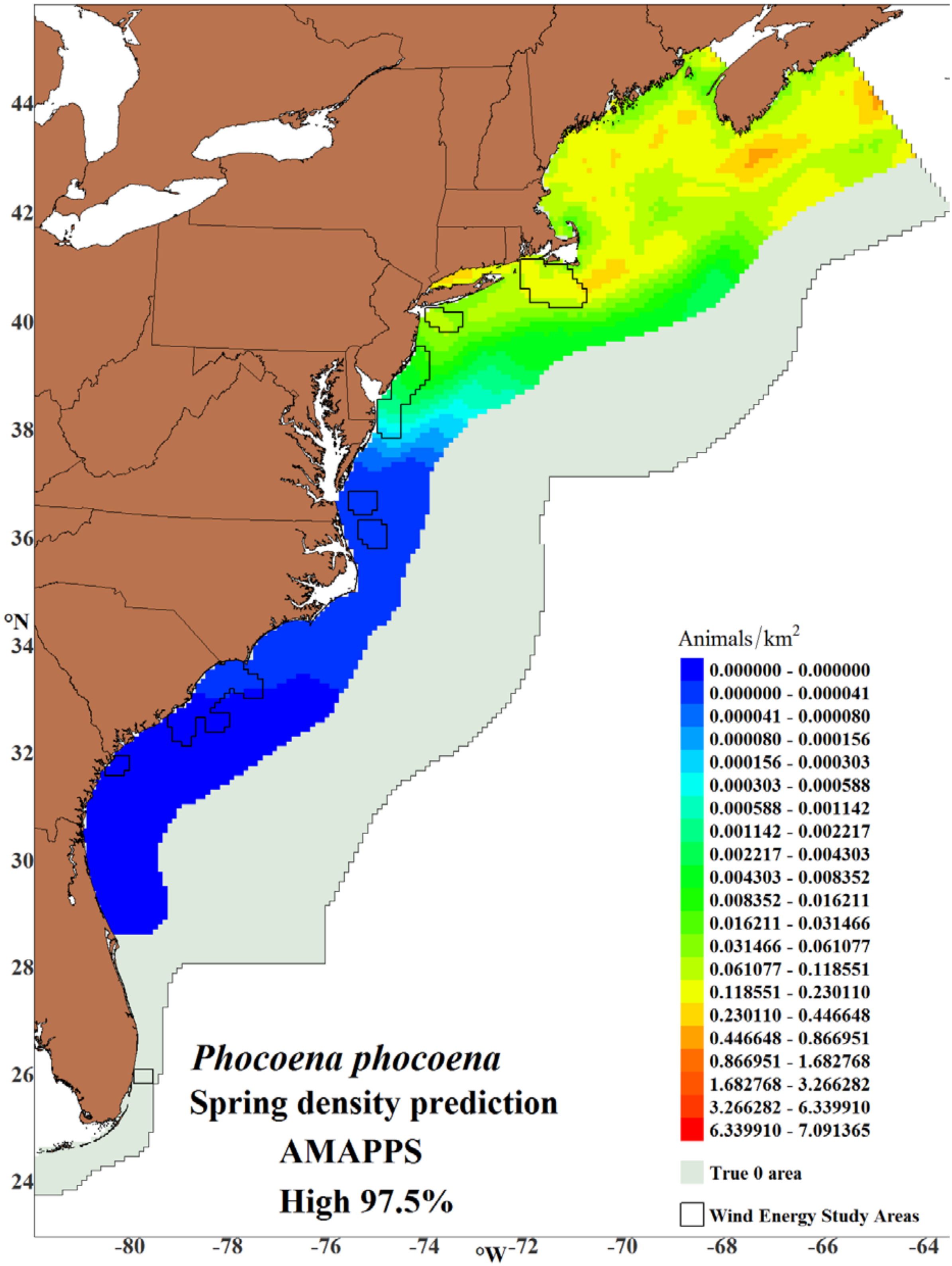

Figure 18-10 Upper 97.5% percentile of spring harbor porpoise estimates

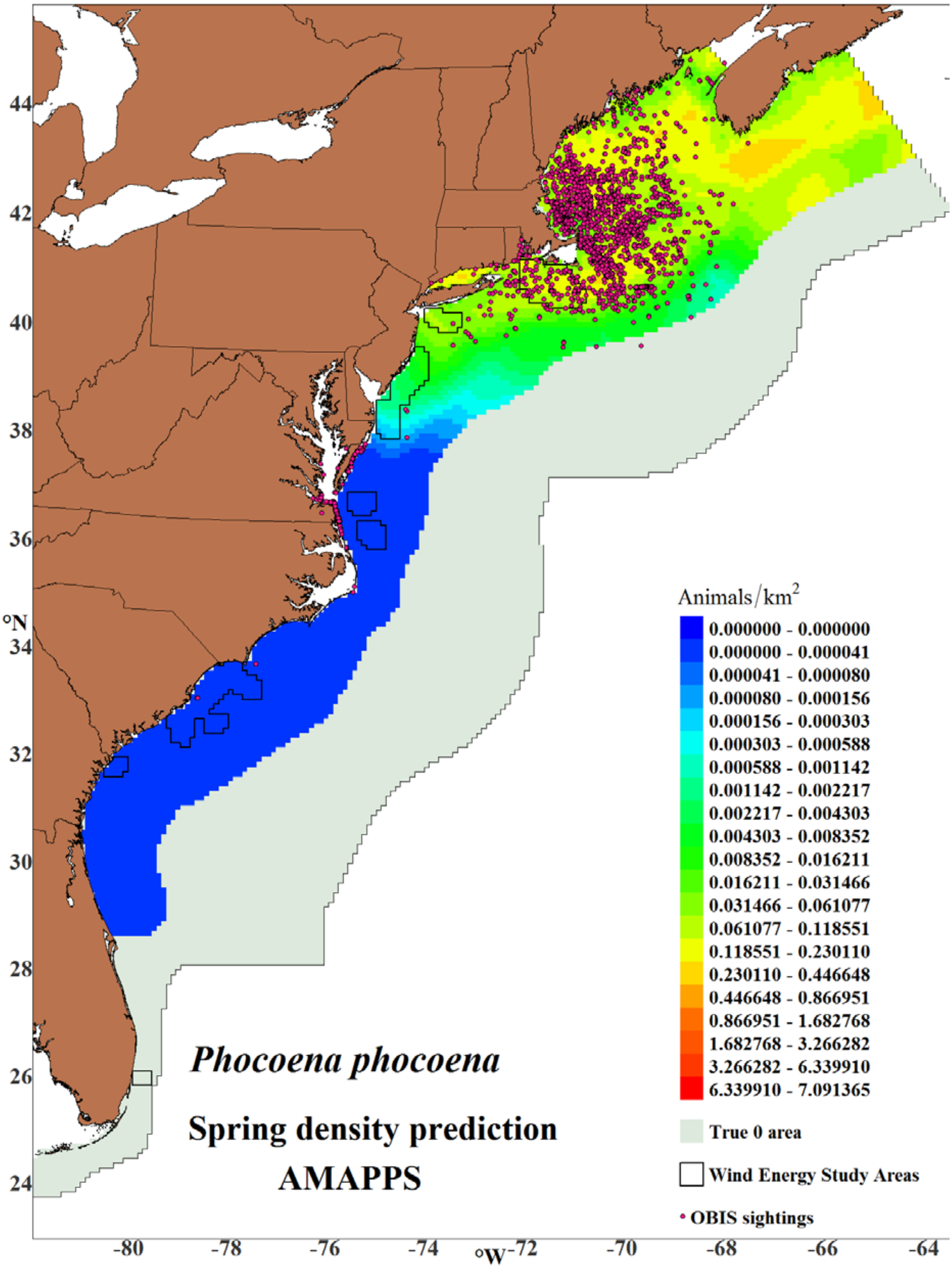

Figure 18-11 Harbor porpoise 2010-2013 spring density and 2010-2013 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

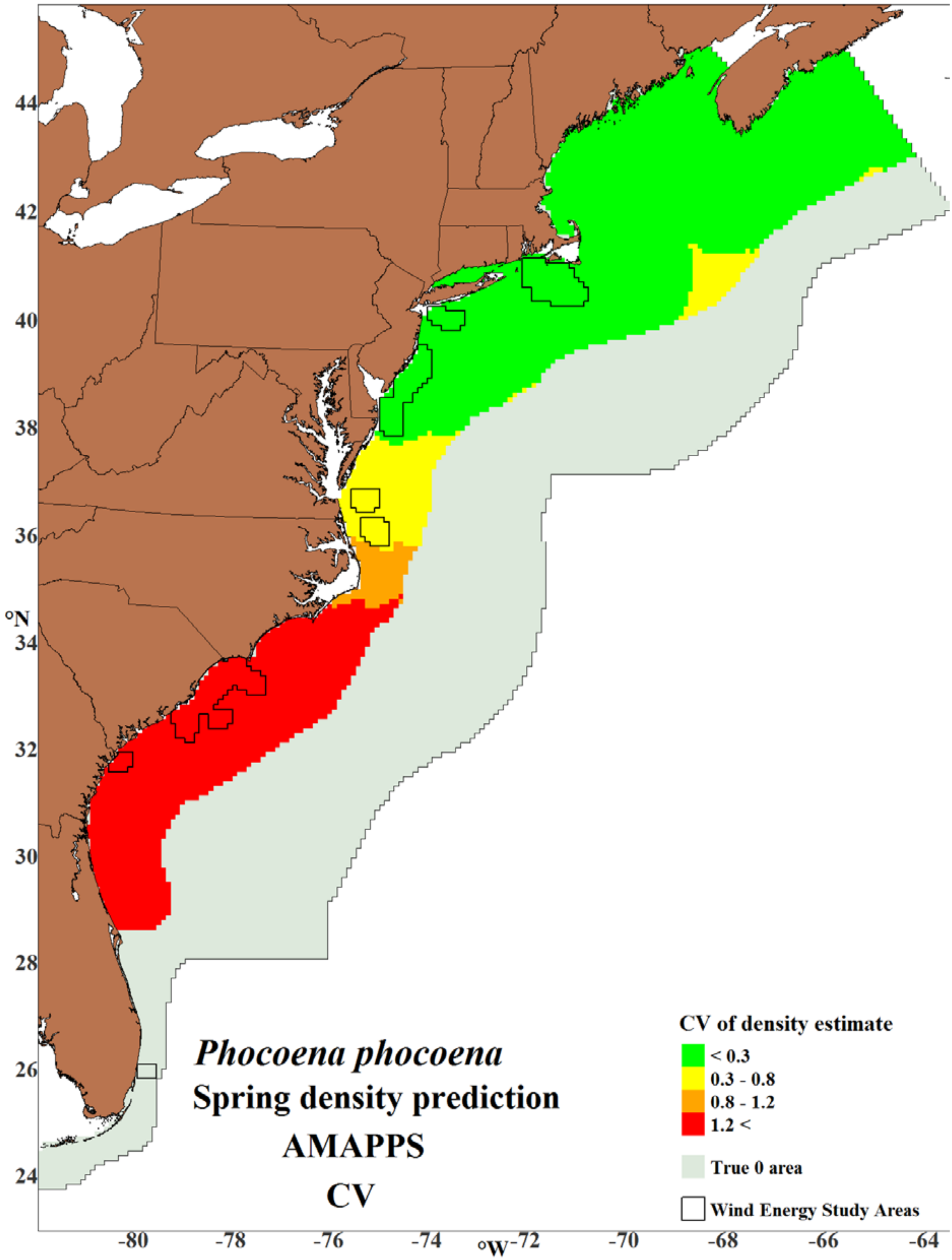

Figure 18-12 CV of spring density estimates for harbor porpoises

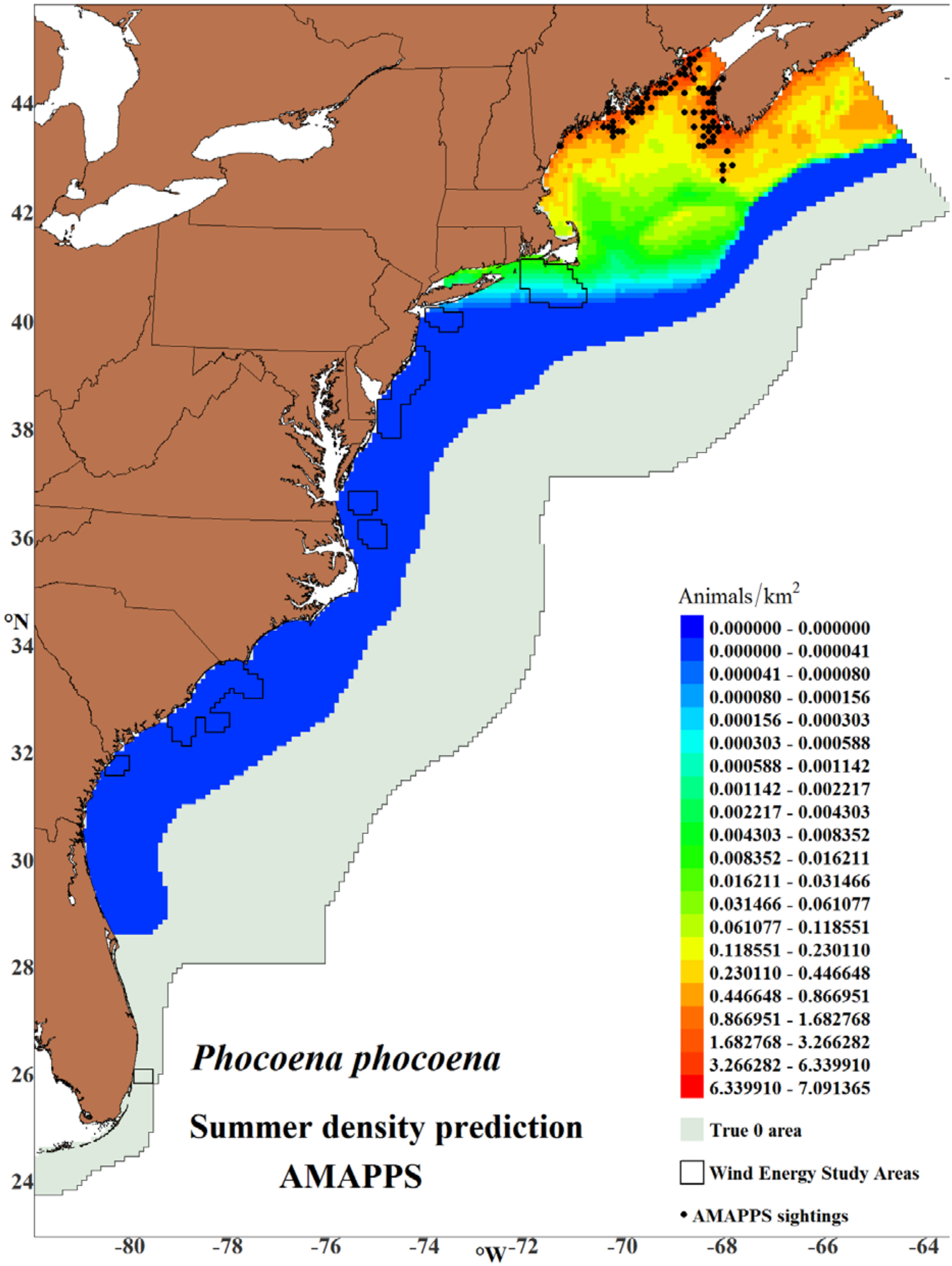

Figure 18-13 Harbor porpoise summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

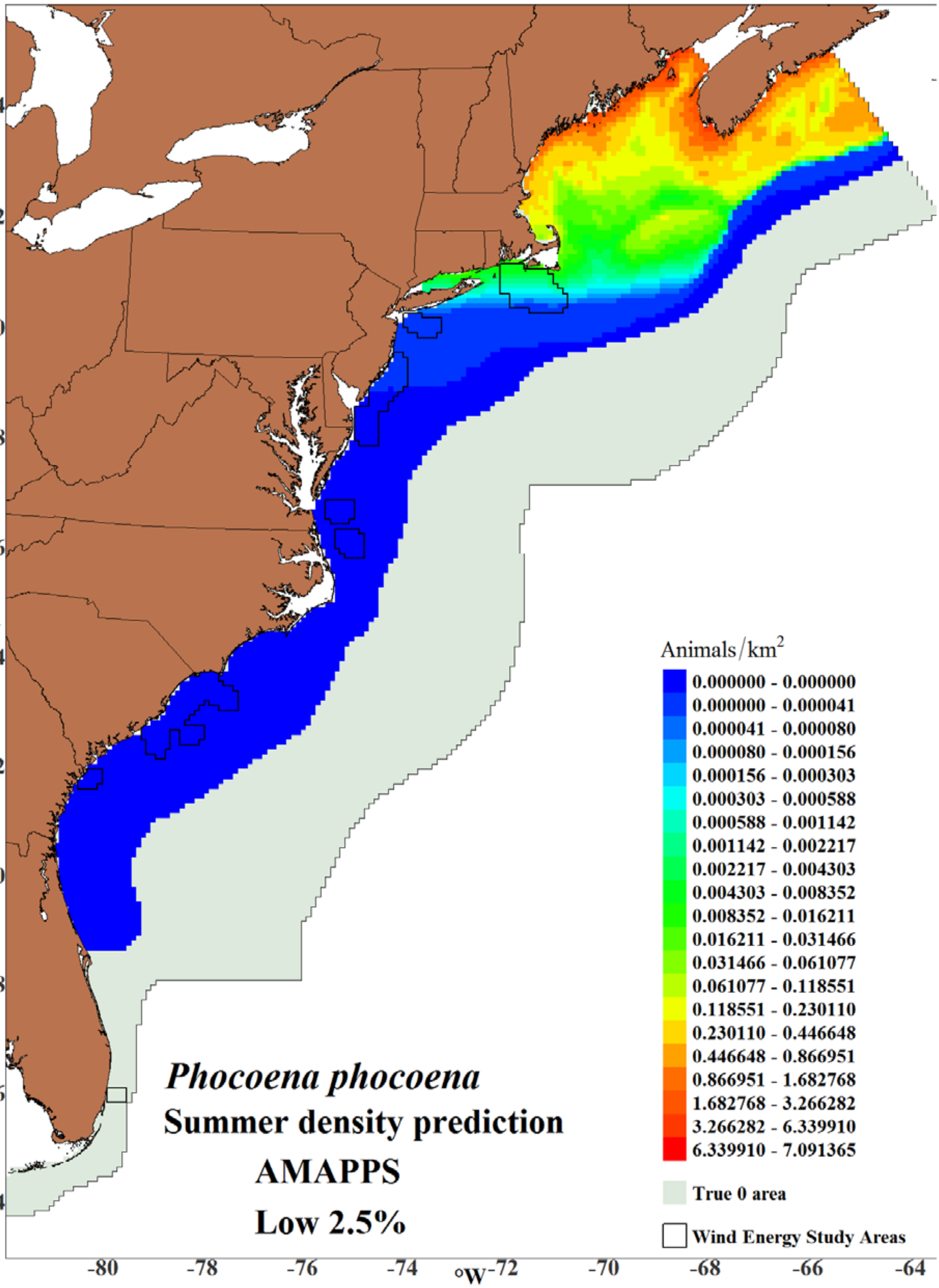

Figure 18-14 Lower 2.5% percentile of summer harbor porpoise estimates

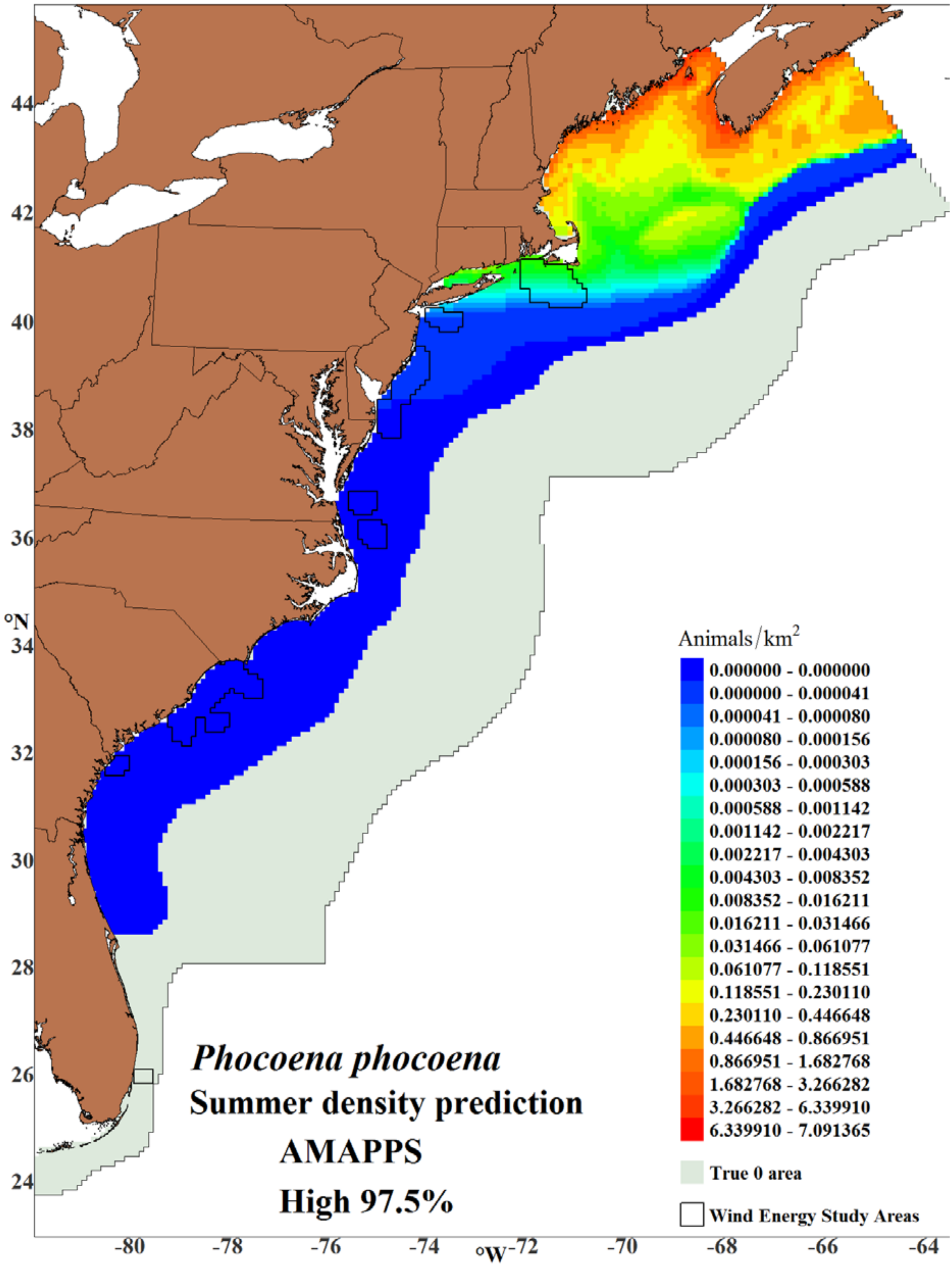

Figure 18-15 Upper 97.5% percentile of summer harbor porpoise estimates

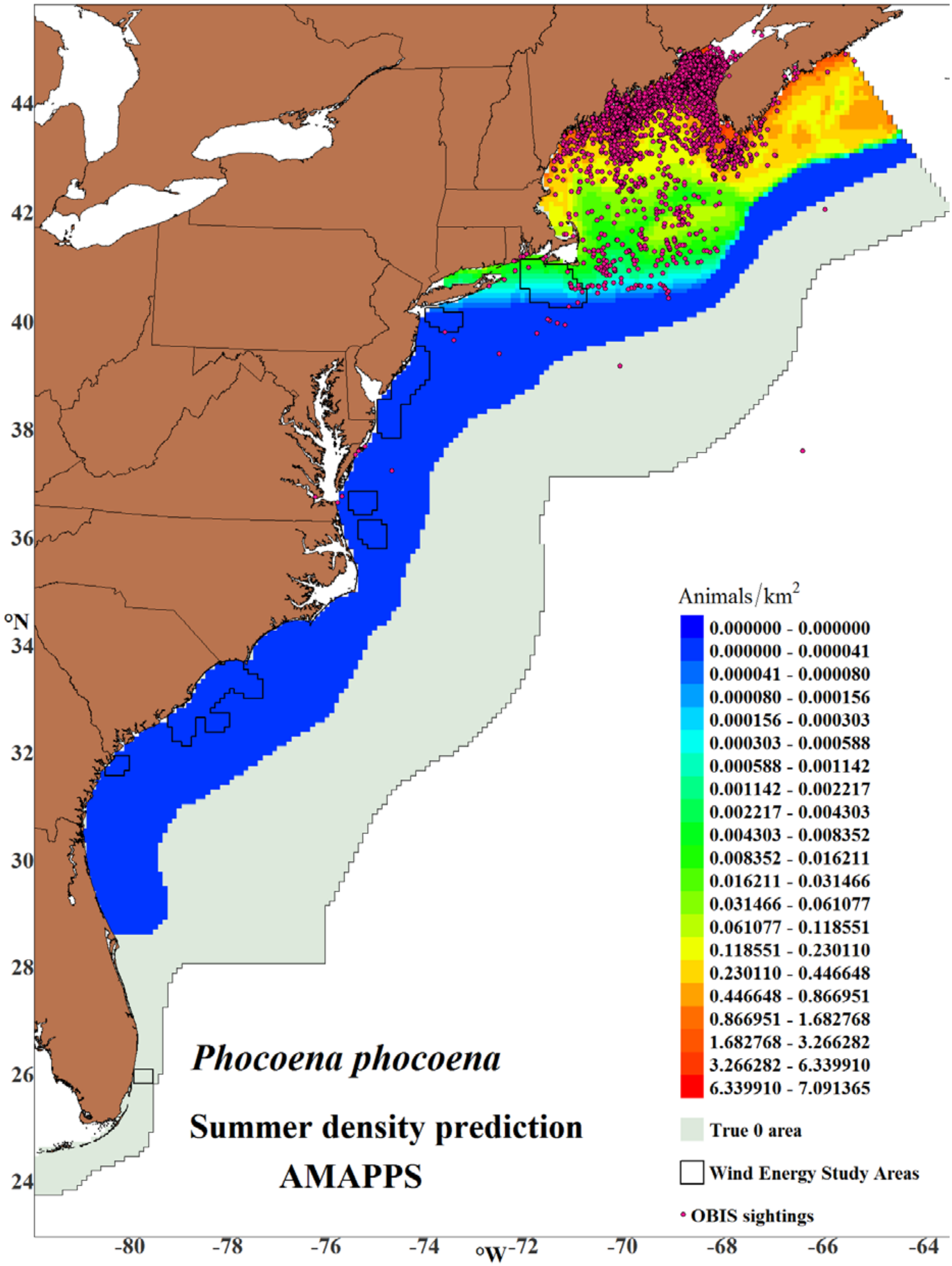

Figure 18-16 Harbor porpoise 2010-2013 summer density and 2010-2013 OBIS sightings
Pink circles (Halpin et al. 2009). These sightings were not used to develop the density-habitat model.

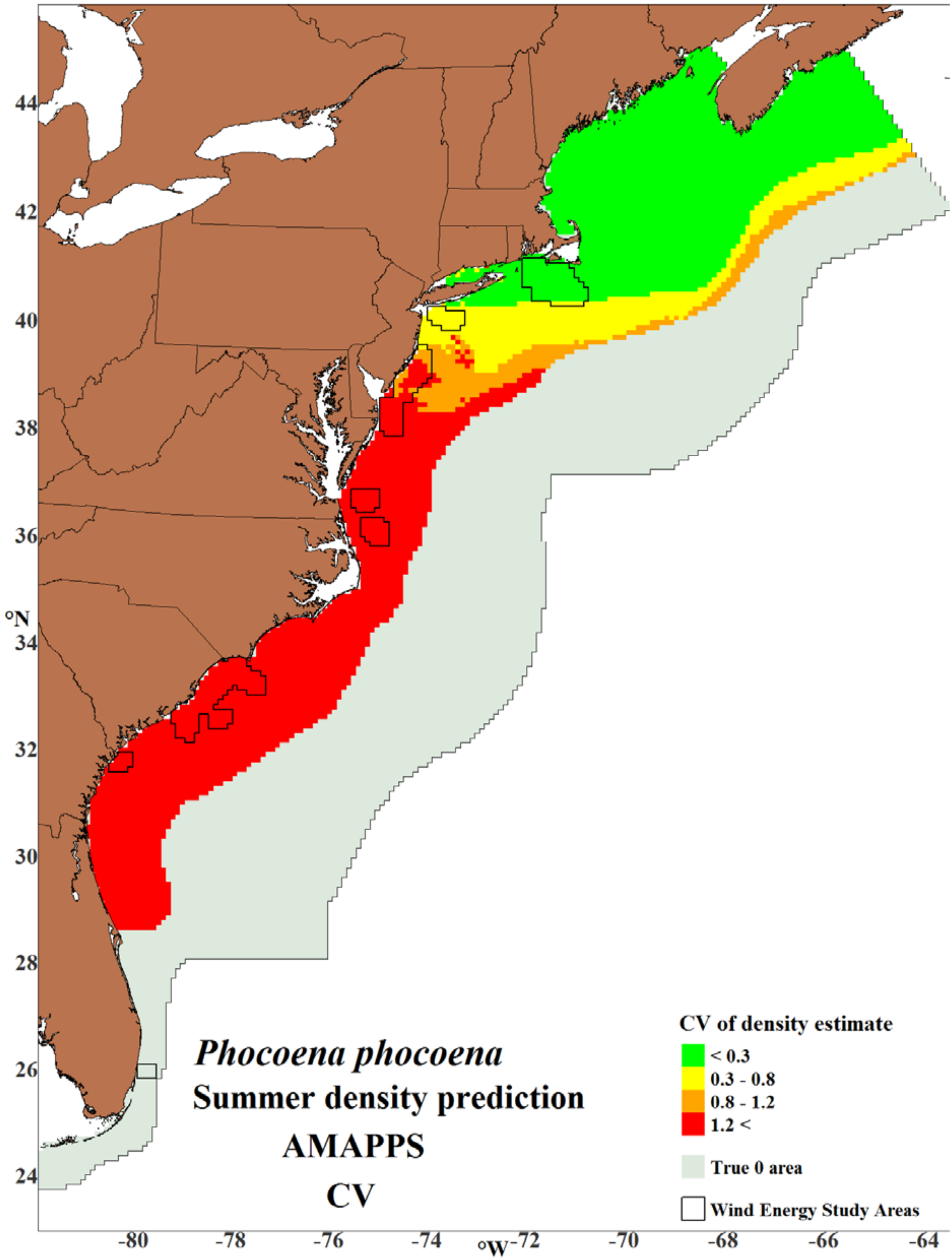

Figure 18-17 CV of summer density estimates for harbor porpoises

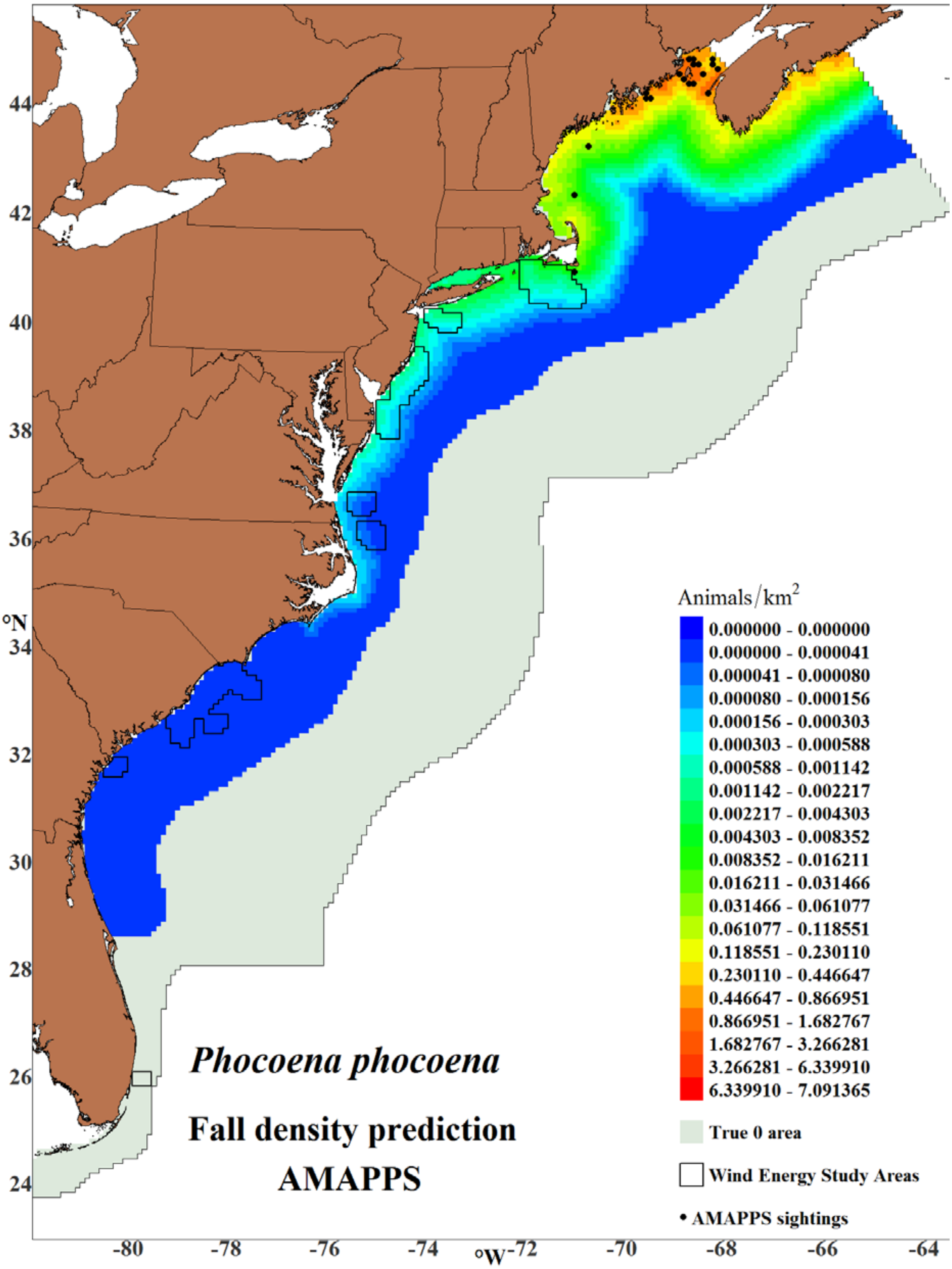

Figure 18-18 Harbor porpoise fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

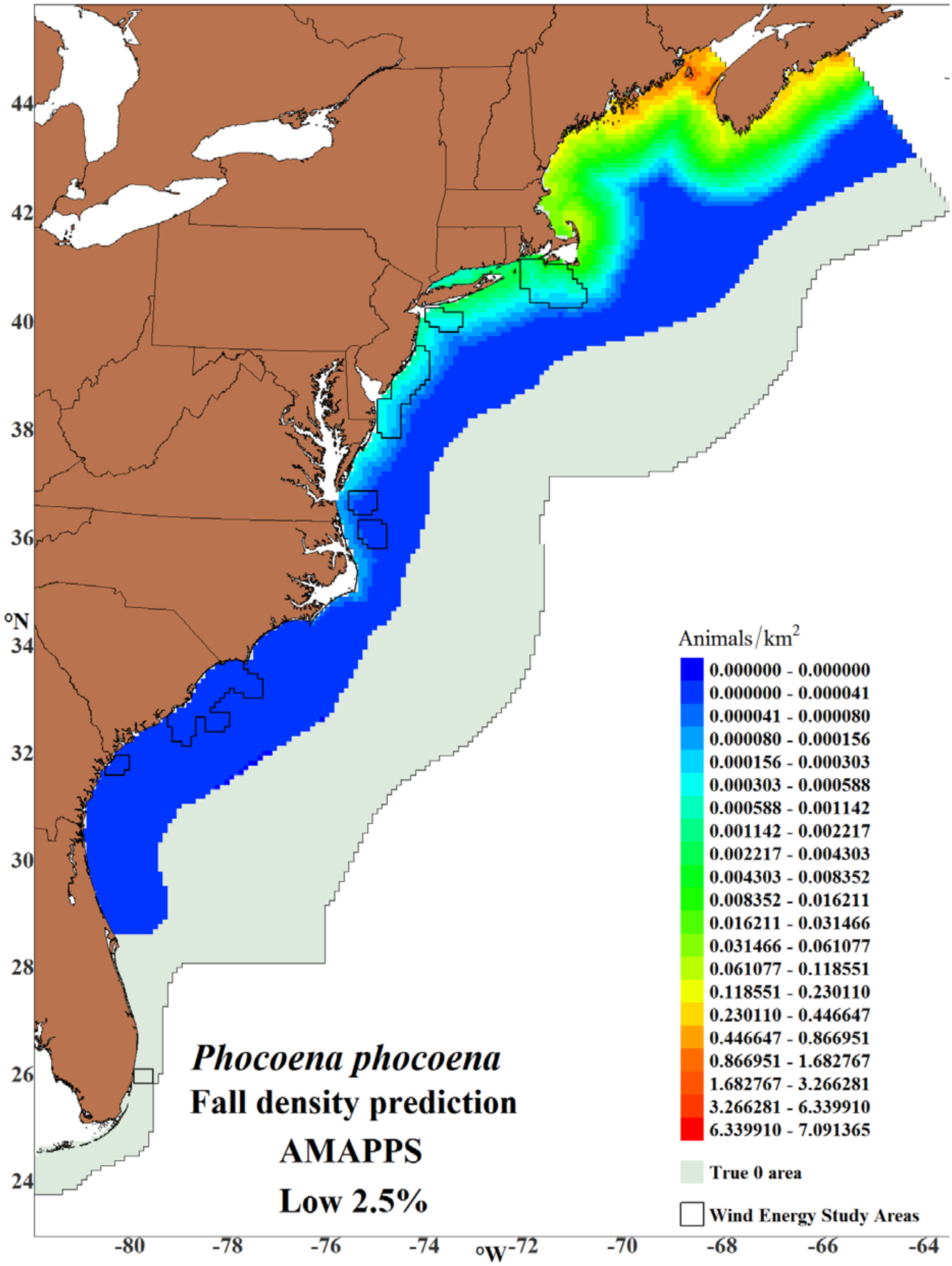

Figure 18-19 Lower 2.5% percentile of fall harbor porpoise estimates

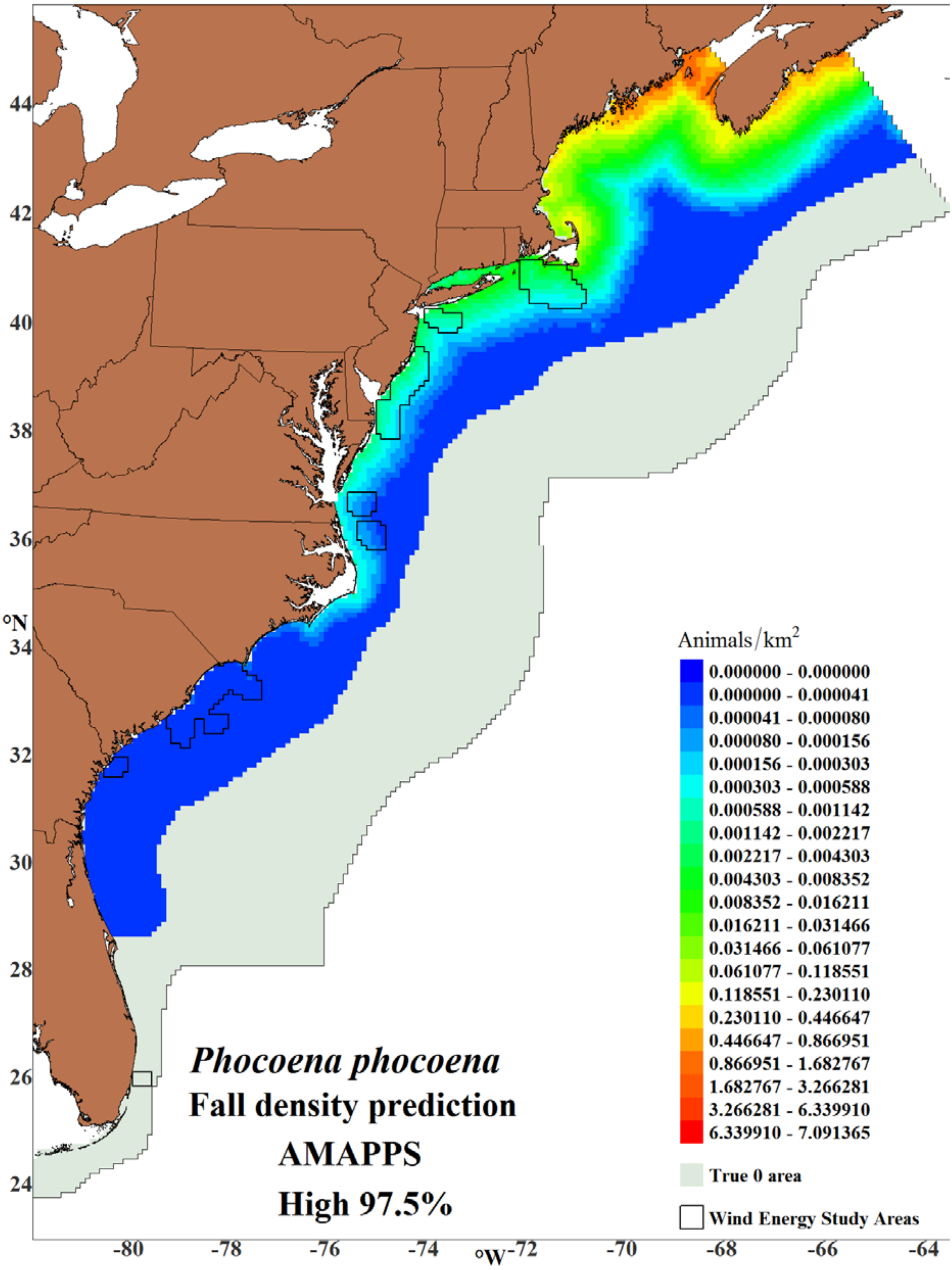

Figure 18-20 Upper 97.5% percentile of fall harbor porpoise estimates

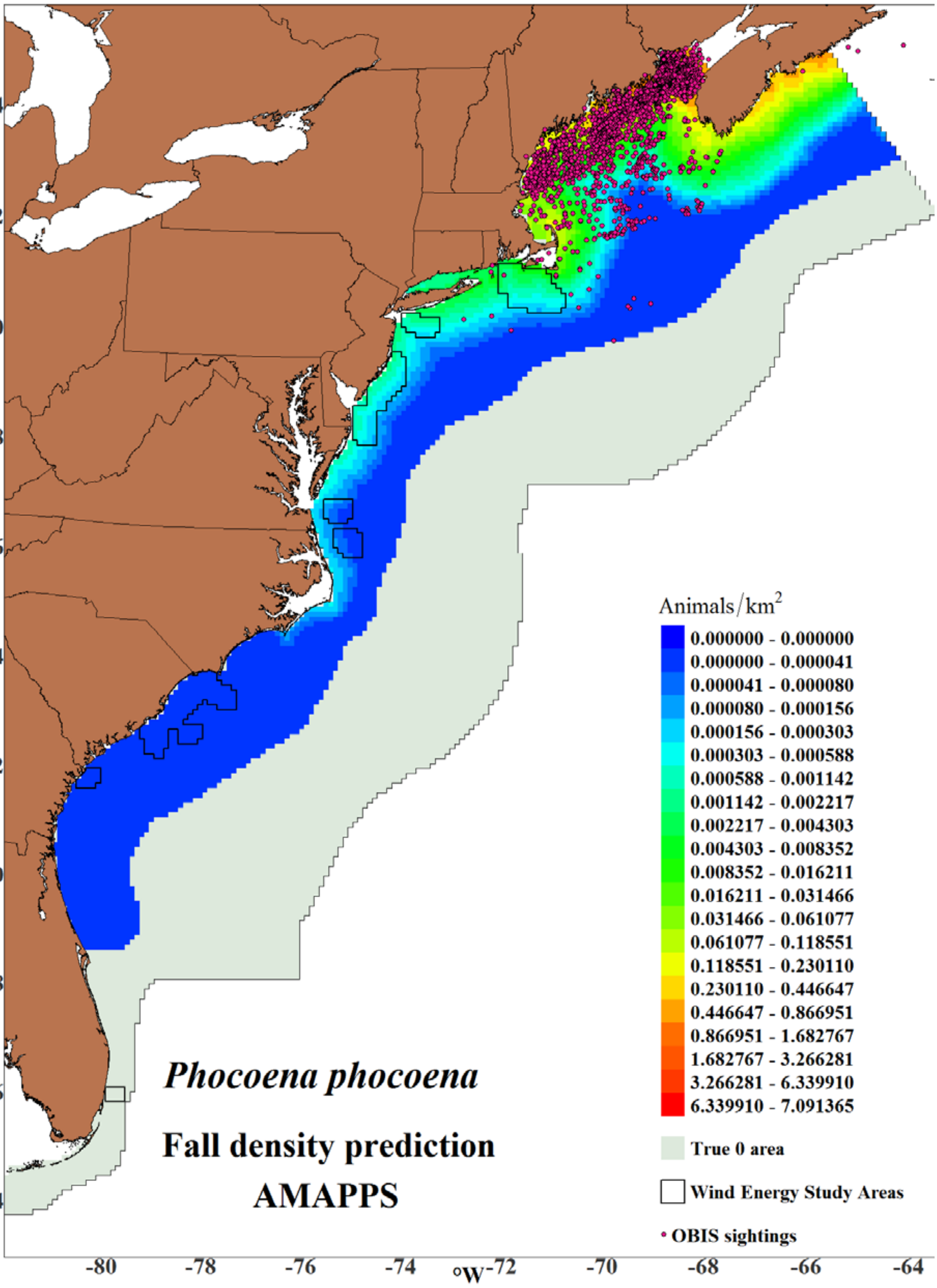

Figure 18-21 Harbor porpoise 2010-2013 fall density and 2010-2013 OBIS sightings Pink circle (Halpin *et al*. 2009). These sightings were not used to develop the density-habitat model.

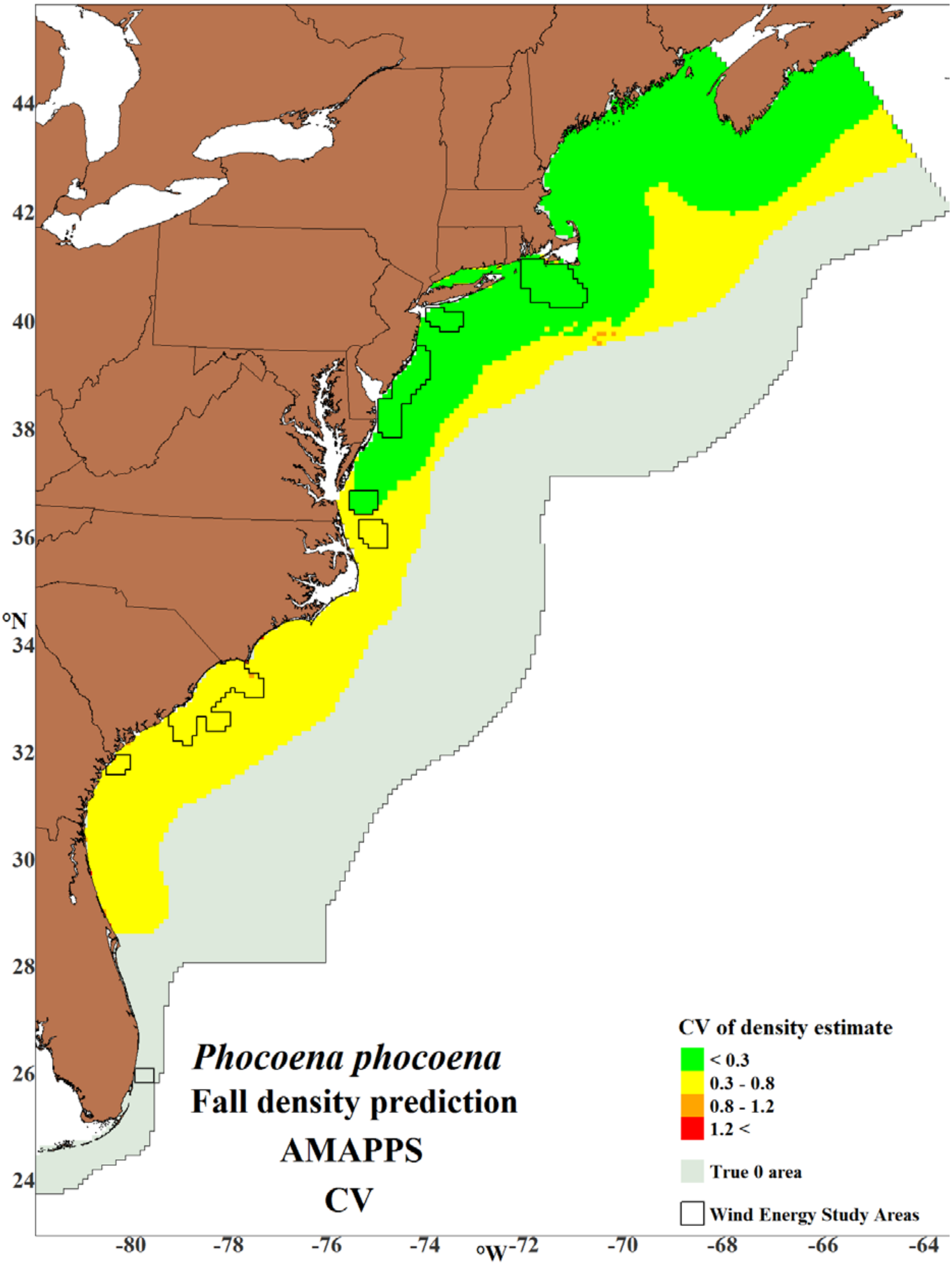

Figure 18-22 CV of fall density estimates for harbor porpoises

18.6 Wind Energy Study Areas

Table 18-10 Harbor porpoise average abundance estimates for wind energy study areas
Availability bias correction: aerial 0.628, CV= 0.299; shipboard 1.0, CV= 0.0

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	1,478	0.079	1,266 – 1,725
(March-May)	New York	166	0.082	141 - 195
	New Jersey	36	0.135	28 - 47
	Delaware/ Maryland	3	0.213	2 - 4
	Virginia	0	0.535	0 - 0
	North Carolina	0	0.684	0 - 0
	South Carolina/ North Carolina	0	2.037	0 - 0
	Georgia	0	3.003	0 - 0
	Florida	N/A	-	-
Summer	Rhode Island/ Massachusetts	26	0.174	18 - 36
(June-August)	New York	0	0.371	0 - 0
	New Jersey	0	0.935	0 - 0
	Delaware/ Maryland	0	2.057	0 - 0
	Virginia	0	2.603	0 - 0
	North Carolina	0	3.298	0 - 0
	South Carolina/ North Carolina	0	8.628	0 - 0
	Georgia	0	11.327	0 - 0
	Florida	N/A	-	-
Fall	Rhode Island/ Massachusetts	21	0.159	16 - 29
(September- November)	New York	3	0.18	2 - 4
	New Jersey	4	0.217	3 - 7
	Delaware/ Maryland	2	0.24	1 - 3
	Virginia	0	0.292	0 - 0
	North Carolina	0	0.323	0 - 0
	South Carolina/ North Carolina	0	0.486	0 - 0
	Georgia	0	0.642	0 - 0
	Florida	N/A	-	-

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat models.

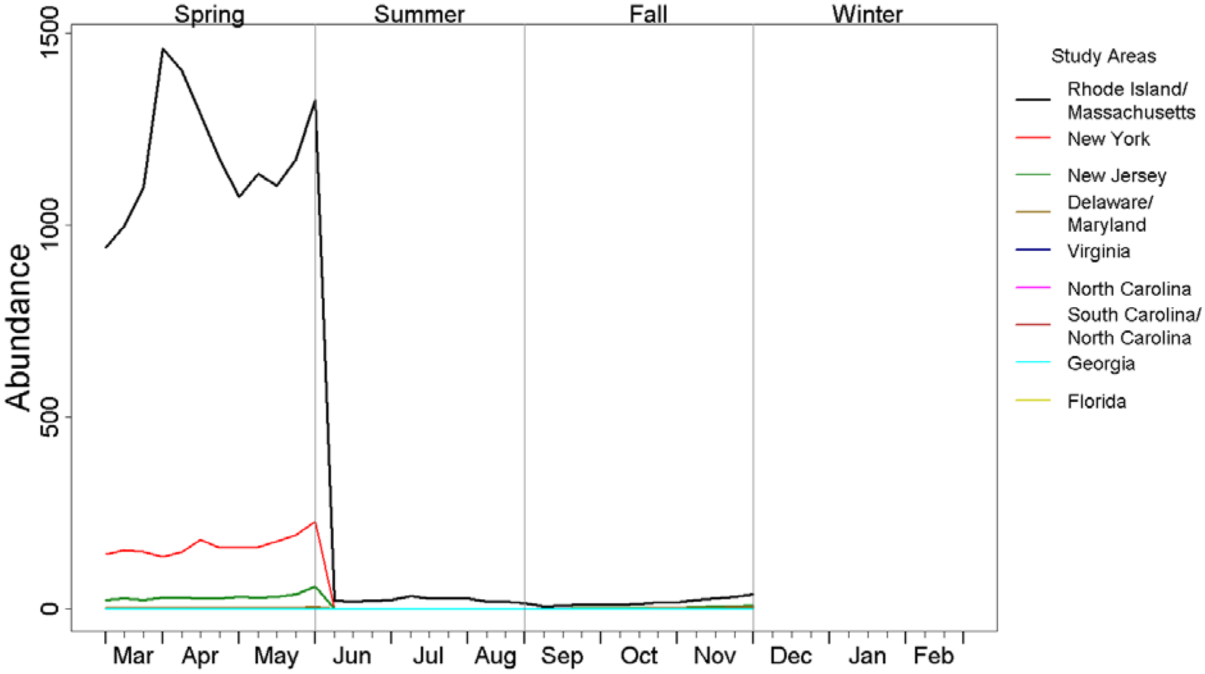

Figure 18-23 Annual abundance trends for harbor porpoises in wind energy study areas

19 *Phocidae* At-sea

Figure 19-1 Gray seal at-sea. Credit: NOAA/NEFSC/Peter Duley
Image collected under MMPA Research permit #775-1875.

19.1 Data Collection

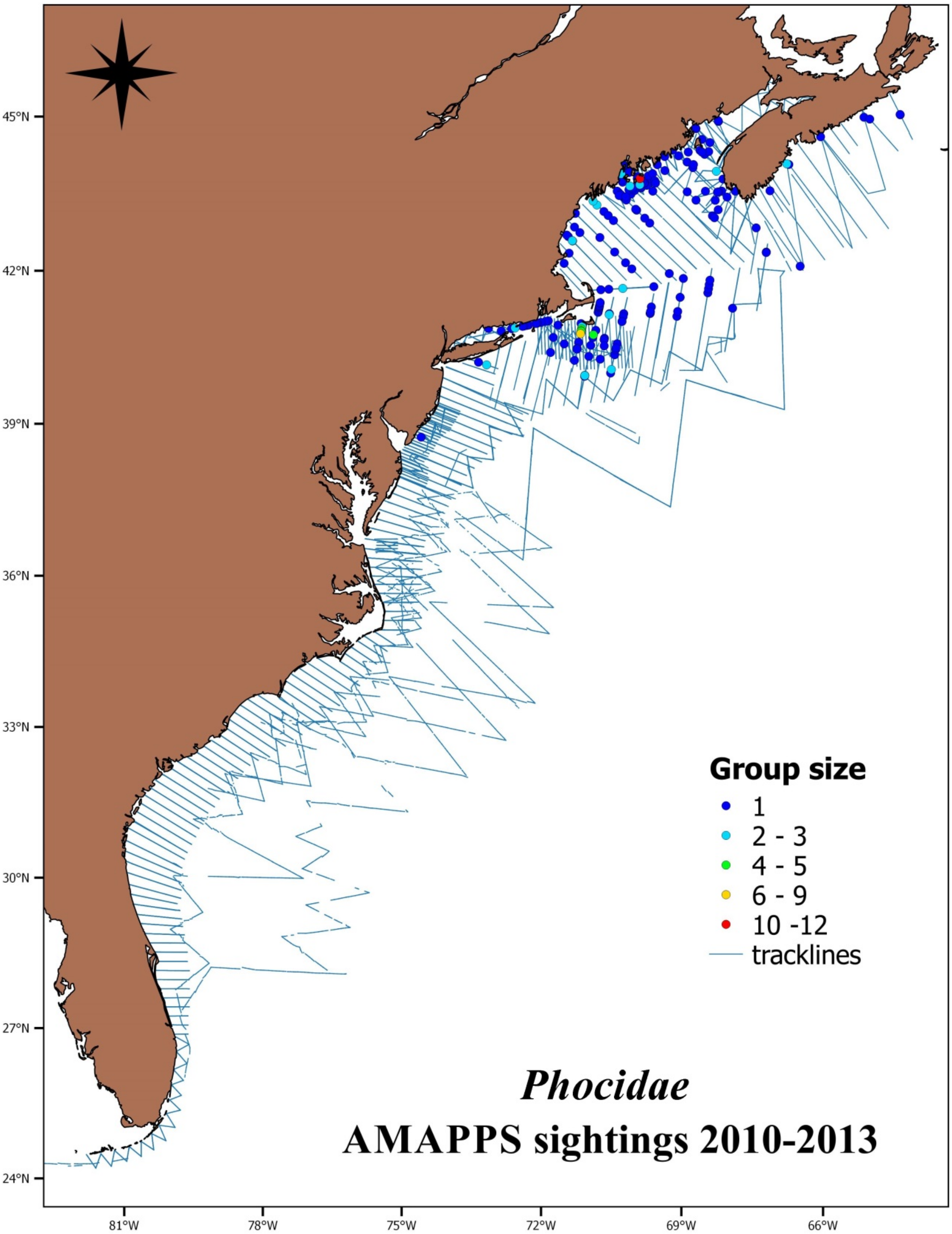

Figure 19-2 Track lines and seals at-sea sightings during 2010 - 2013

Table 19-1 Research effort 2010 - 2013 and at-sea seal sightings

Platform	Effort (km)				Common name	Species	Total sightings / Total animals			
	Spring	Summer	Fall	Winter			Spring	Summer	Fall	Winter
NE Shipboard	0	8,146	0	0	Grey seal	*Halichoerus grypus*	0/0	0/0	0/0	0/0
					Harbor seal	*Phoca vitulina*	0/0	0/0	0/0	0/0
					Unknown seal		0/0	1/1	0/0	0/0
NE Aerial	7,502	10,468	11,038	3,573	Grey seal	*Halichoerus grypus*	1/1	0/0	2/26	0/0
					Harbor seal	*Phoca vitulina*	0/0	3/3	2/2	0/0
					Unknown seal		87/116	44/48	6/6	0/0
SE Shipboard	0	8,537	2,093	0	Grey seal	*Halichoerus grypus*	0/0	0/0	0/0	0/0
					Harbor seal	*Phoca vitulina*	0/0	0/0	0/0	0/0
					Unknown seal		0/0	0/0	0/0	0/0
SE Aerial	17,978	16,835	11,818	6,007	Grey seals	*Halichoerus grypus*	0/0	0/0	0/0	0/0
					Harbor seals	*Phoca vitulina*	0/0	0/0	0/0	0/0
					Unknown seals		0/0	0/0	0/0	1/1

19.2 Mark-Recapture Distance Sampling Analysis

Table 19-2 Parameter estimates from seals at-sea mark-recapture distance sampling
HN= Half Normal, LT= Left truncation, codes are explained in main text.

ID	Step	Species	Mark-Recapture Model	Distance Sampling Model	Truncation (m)	Key function	p(0)	p(0) CV	Chi-square p-value	K-S p-value	CvM p-value
NE-aerial Seals		*Phocidae*	Distance*observer	Distance+Subj	453	HR	0.181	0.439	0.012	0.991	0.995

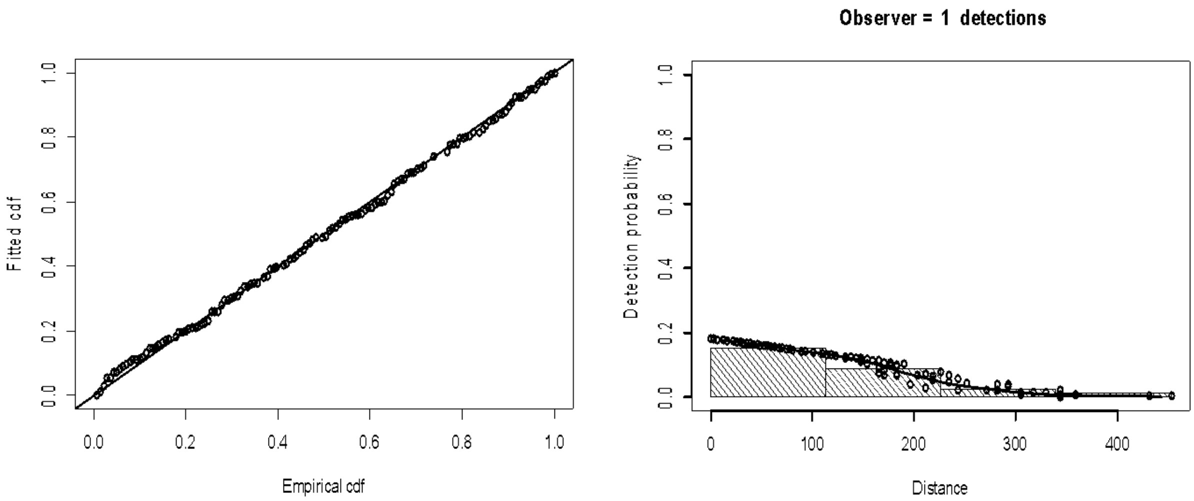

Figure 19-3 Q-Q plots and detection functions from seals at-sea MRDS analysis

19.3 Generalized Additive Model Analysis

Table 19-3 Habitat model output for seals at-sea

	Approximate significance of smooth terms					
	edf	**Ref.df**	**F**	**p-value**	**std.dev**	
s(sst)	1.2308	4	18.218	< 2e-16	2.28e-02	***
s(pic)	3.1120	4	6.692	1.78e-06	3.49e+04	***
s(pp)	0.8464	4	1.322	0.00437	6.11e-07	**
s(dist200)	3.6927	4	7.925	5.35e-07	5.45e-07	***
s(lat)	0.2114	4	0.066	0.2608	1.03e-02	
Scale					1.79e+00	

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Estimated degrees of freedom: total = 11.3

R-sq.(adj) = 0.0973   Deviance explained = 30.4%

-REML = 469.35 Scale est. = 3.2398   n = 2367

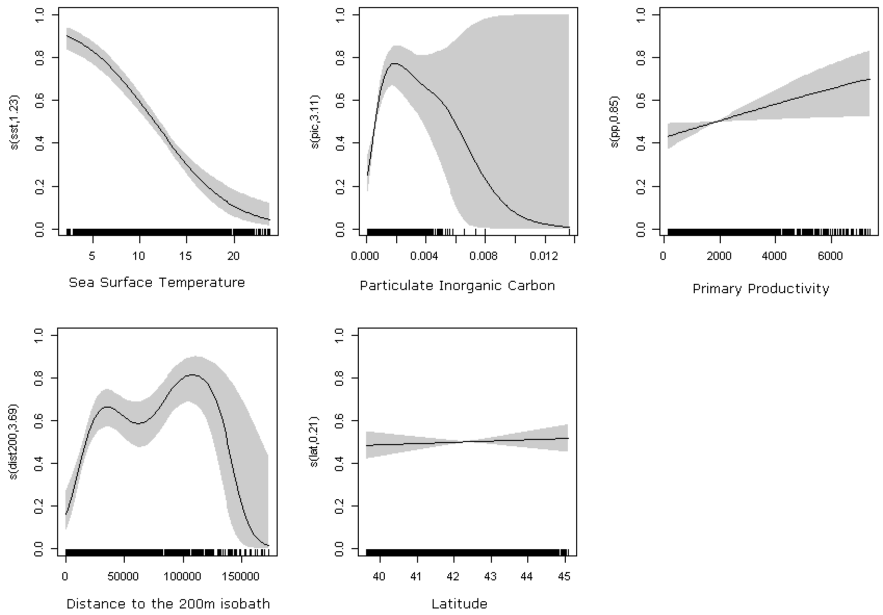

Figure 19-4 Seals at-sea density related to significant habitat covariates
Shaded region represents the 95% credible intervals.

Table 19-4 Diagnostic statistics for seals at-sea habitat model

Diagnostic Statistic	**Description**	**Calculated with**	**Model Values (x)**	**Score**
RHO	Spearman rank correlation.	Non-zero density	0.378	Excellent
MAPE	Mean absolute percentage error	Non-zero density	87.66	Fair to good
RHO	Spearman rank correlation.	All data divided in 25 random samples	0.223	Fair to good
MAE	Mean absolute error	All data divided in 25 random samples	0.100	Excellent

The cutoff values are taken from Kinlan et al. 2012
Rank R: Poor= x<0.05; Fair to good =0.05<=x<0.3; Excellent= x>0.3
MAPE: Poor= x>150%; Fair to good= 150%>=x>50%; Excellent= x<=50%
MAE: Poor= x>1; Fair to good = 1>=x>0.25; Excellent= x<=0.25

19.4 Abundance Estimates for AMAPPS Study Area

Table 19-5 Seals at-sea average abundance estimates for AMAPPS study area
Availability bias correction was not included in the estimates.

Season	Abundance	CV	95% Confidence Interval
Spring (March- May)	43,781	0.265	26,237 – 73,056
Summer (June-August)	5,721	0.204	3,848 – 8,505
Fall (September-November)	6,279	0.273	3,711 – 10,625

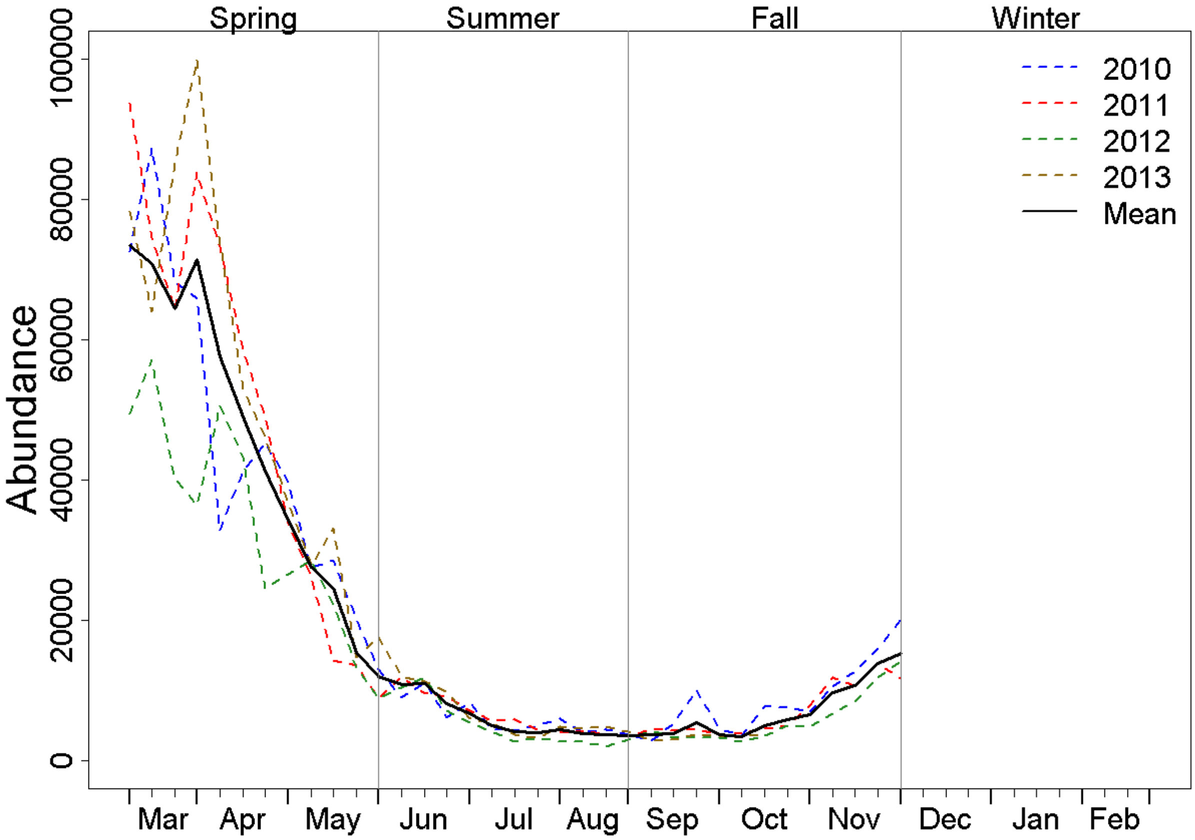

Figure 19-5 Annual abundance trends for seals at-sea for AMAPPS study area

19.5 Seasonal Prediction Maps

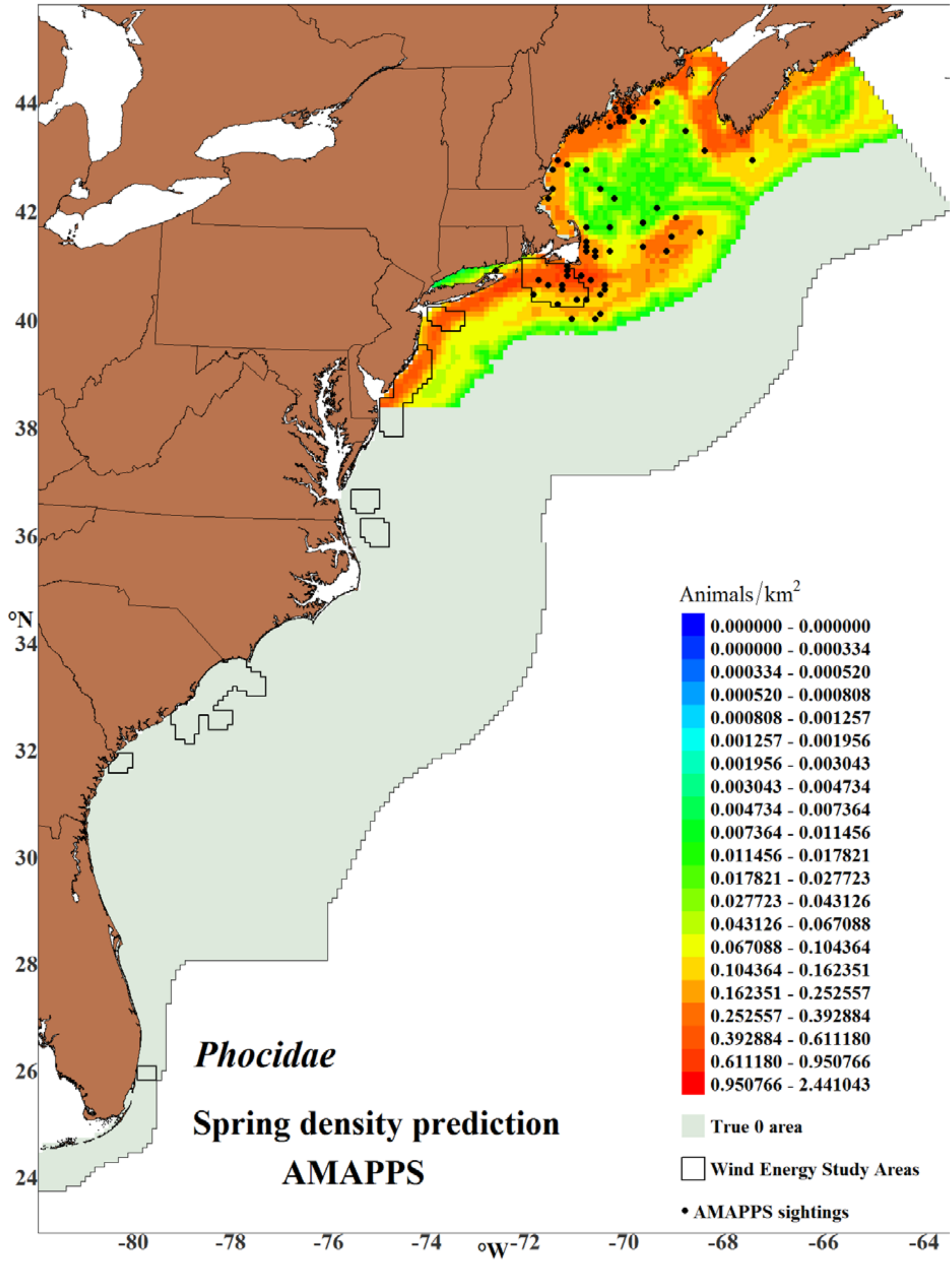

Figure 19-6 Seals at-sea spring average density estimates
Black circles indicate grid cells with one or more animal sightings.

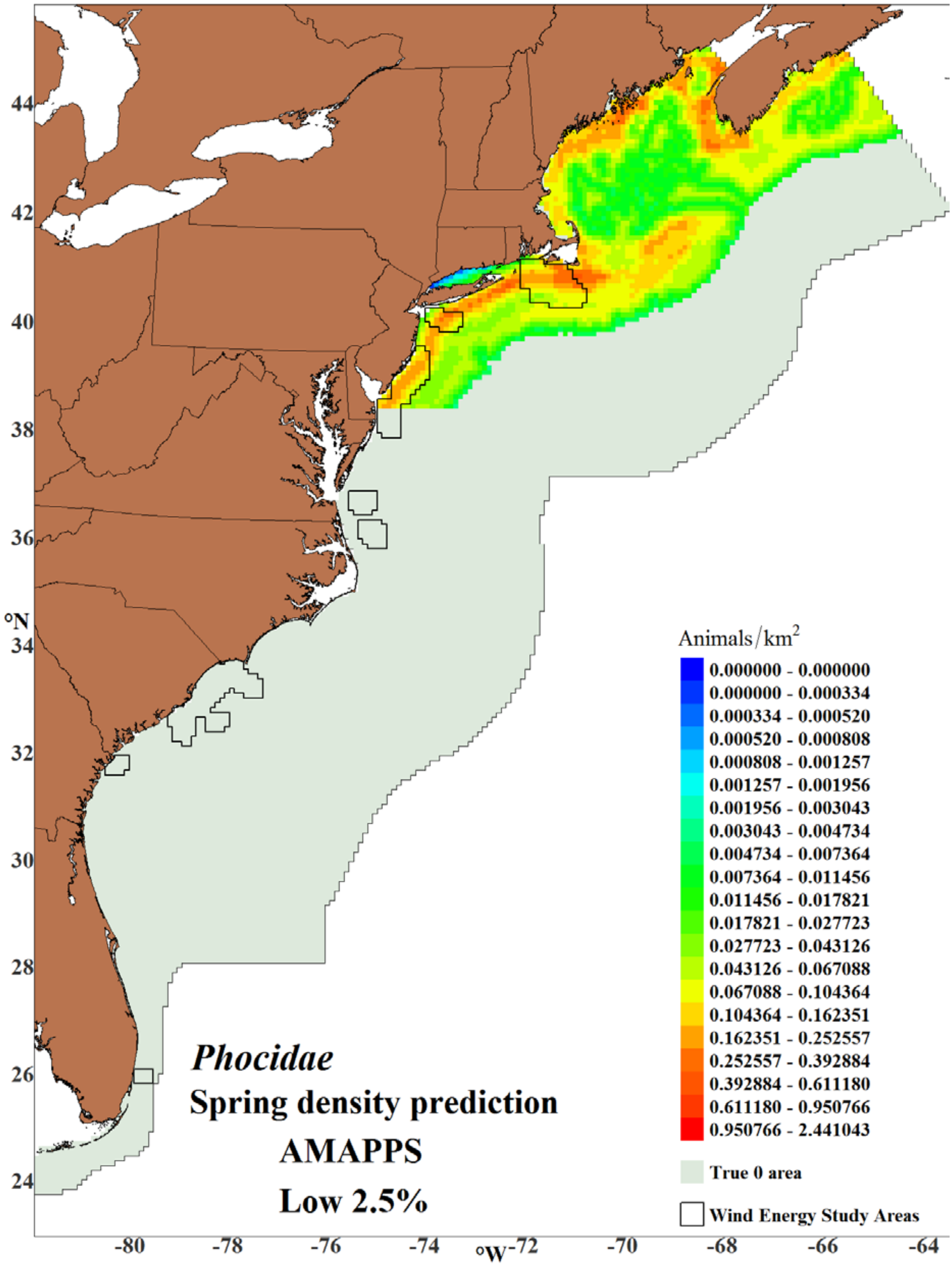

Figure 19-7 Lower 2.5% percentile of spring seals at-sea estimates

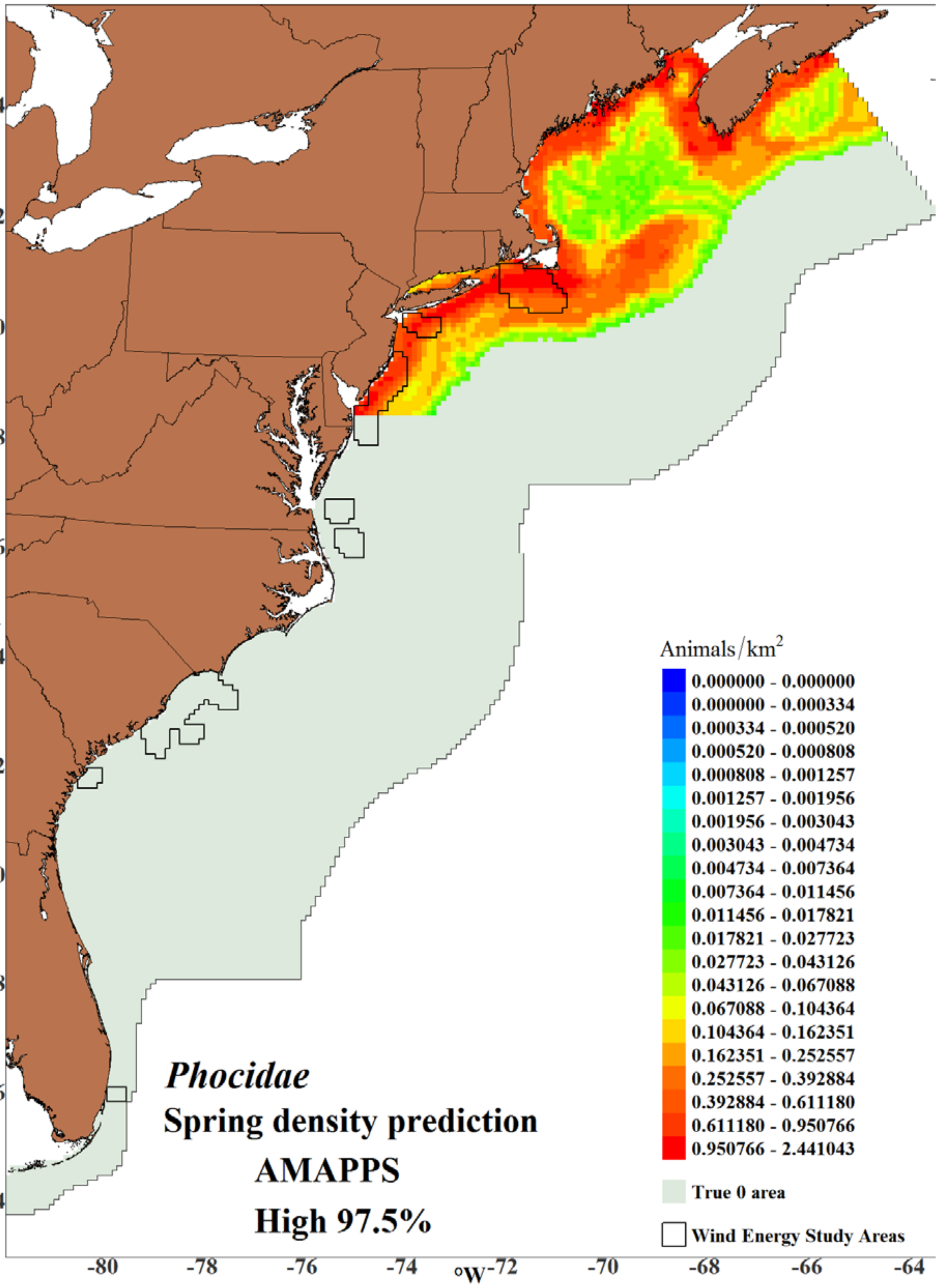

Figure 19-8 Upper 97.5% percentile of spring seals at-sea estimates

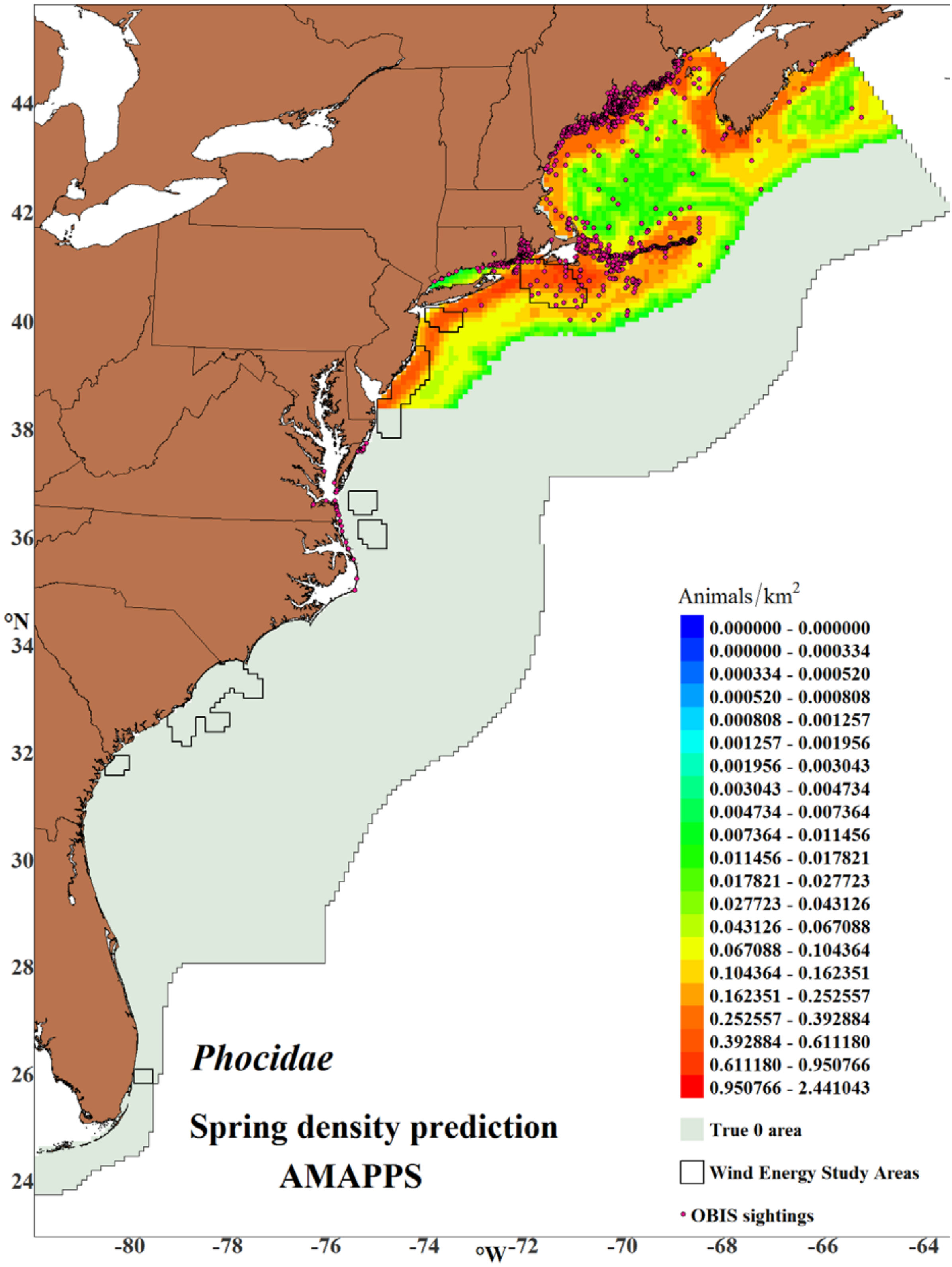

Figure 19-9 Seals at-sea 2010-2013 spring density and 1995-2015 OBIS sightings
pink circles (Halpin *et al*. 2009), NEFSC database, and Duke University (Moxley et al. 2017). These sightings were not used to develop the density-habitat model.

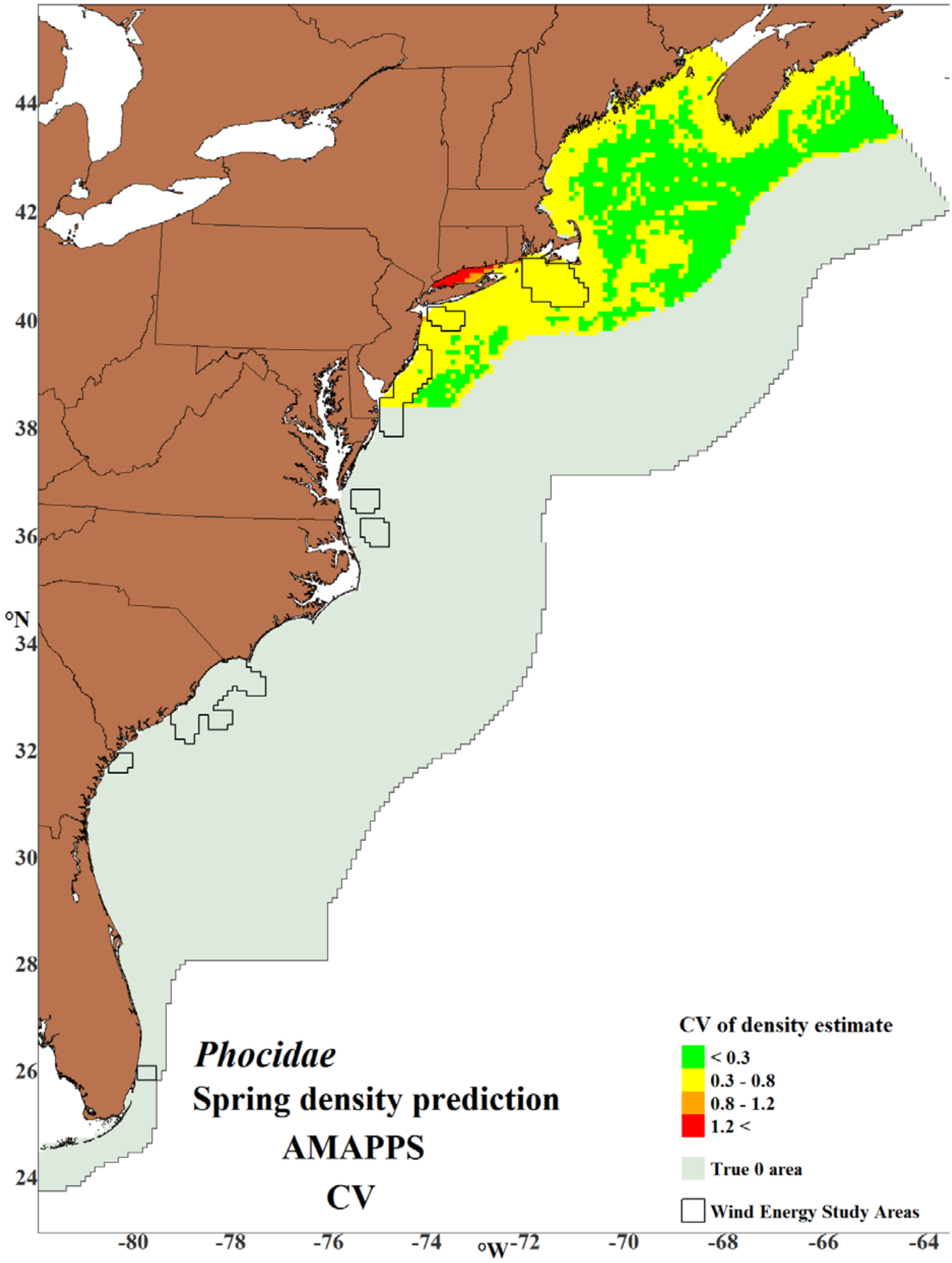

Figure 19-10 CV of spring density estimates for seals at-sea

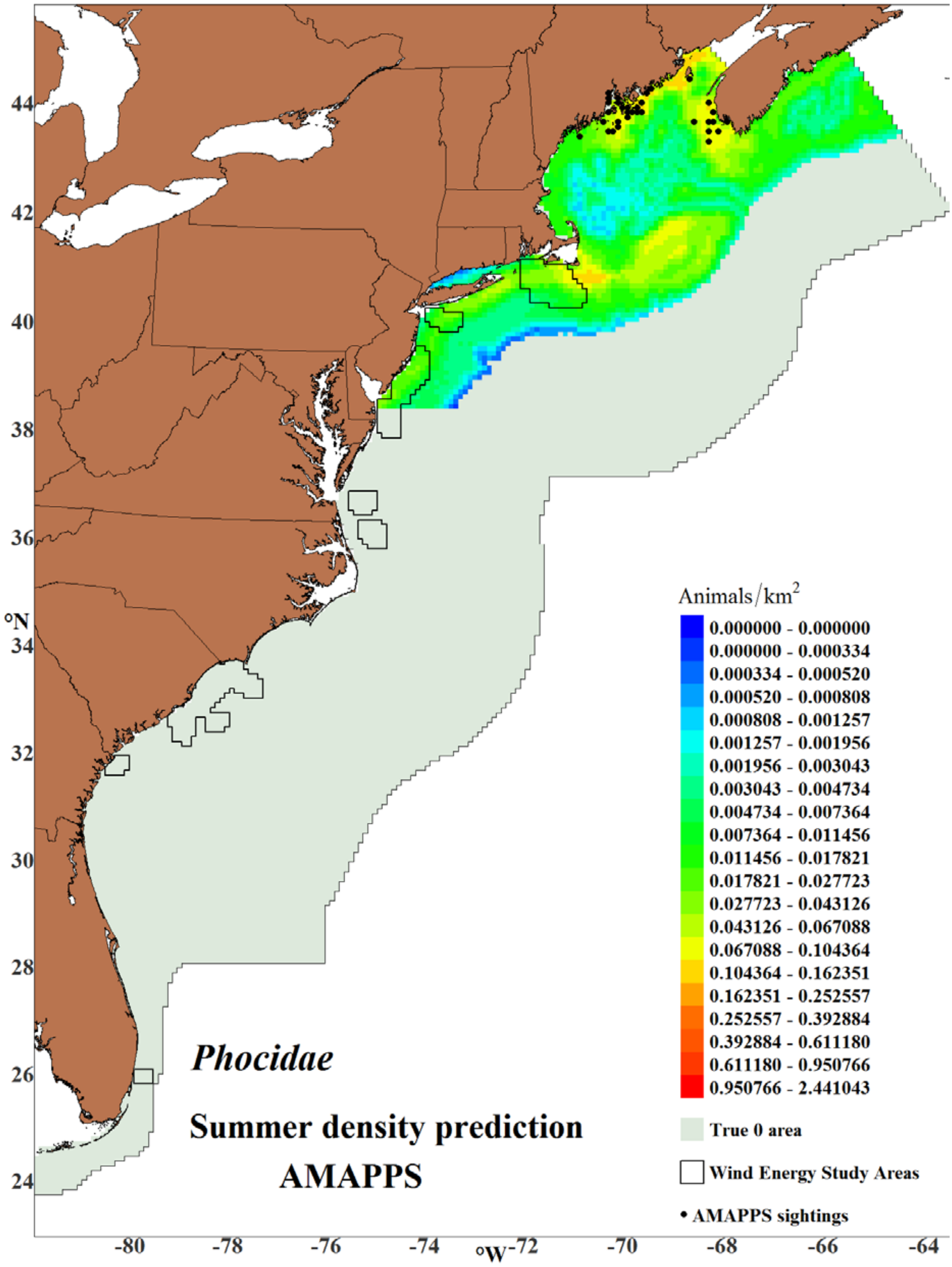

Figure 19-11 Seals at-sea summer average density estimates
Black circles indicate grid cells with one or more animal sightings.

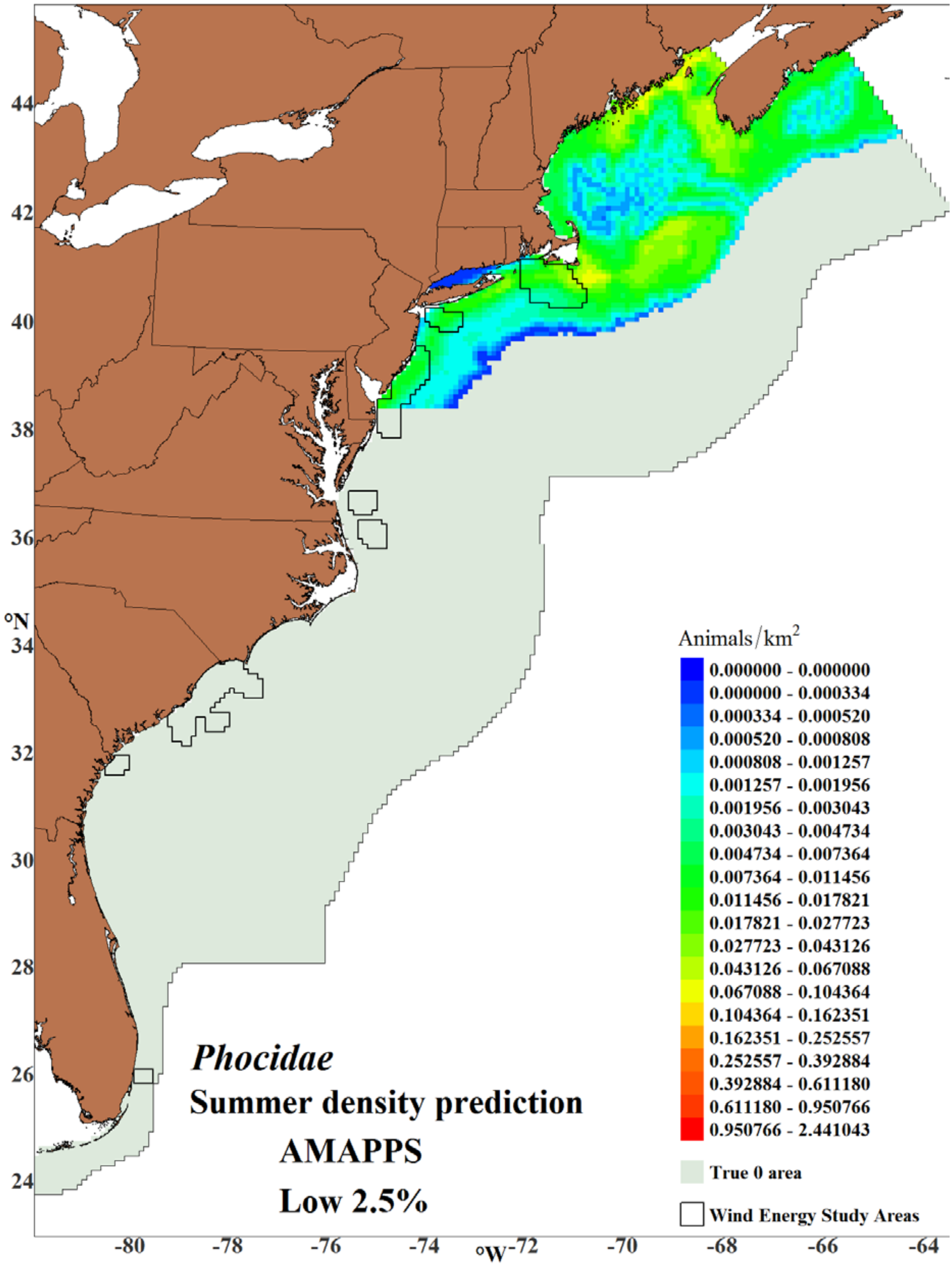

Figure 19-12 Lower 2.5% percentile of summer seals at-sea estimates

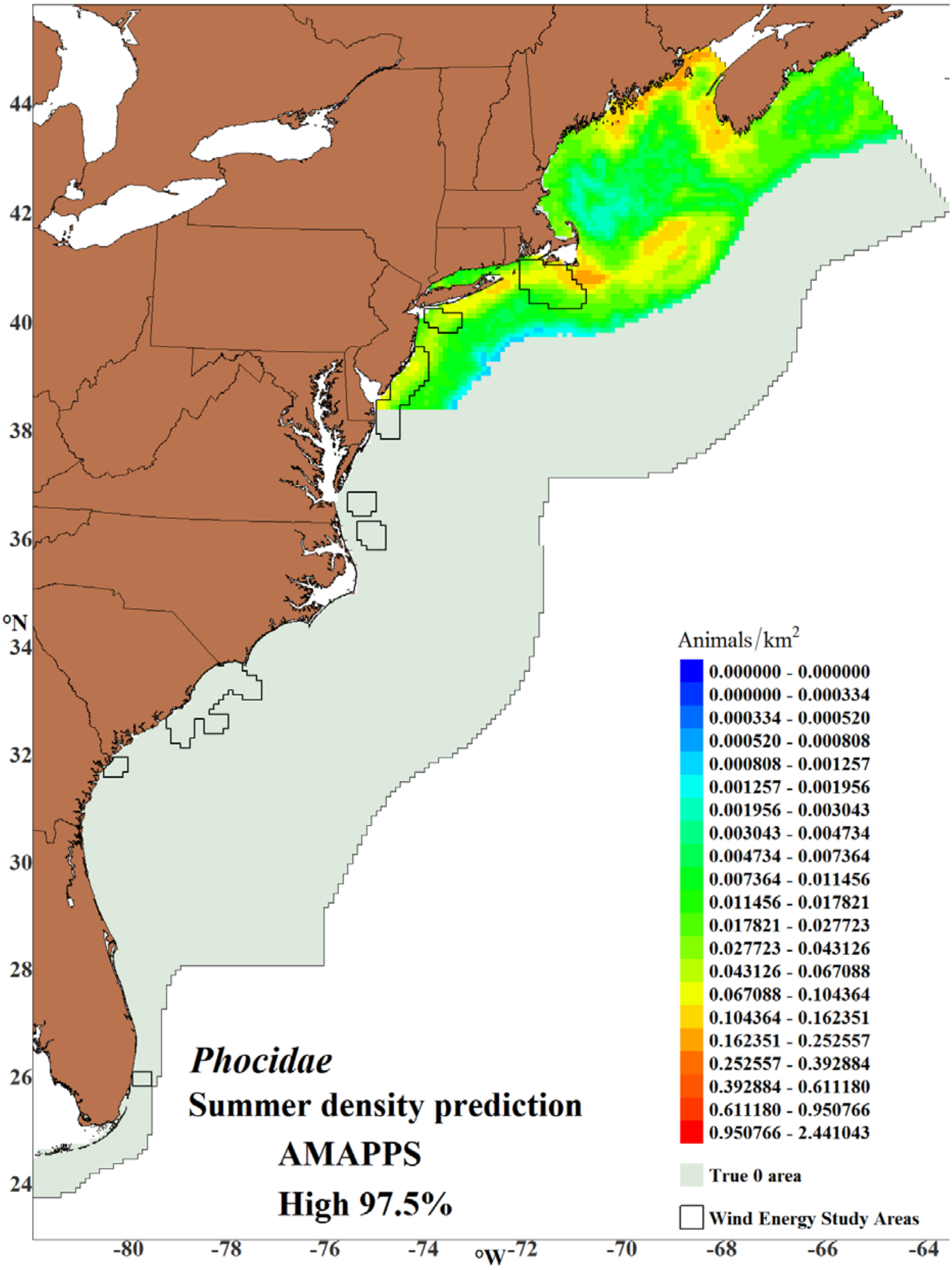

Figure 19-13 Upper 97.5% percentile of summer seals at-sea estimates

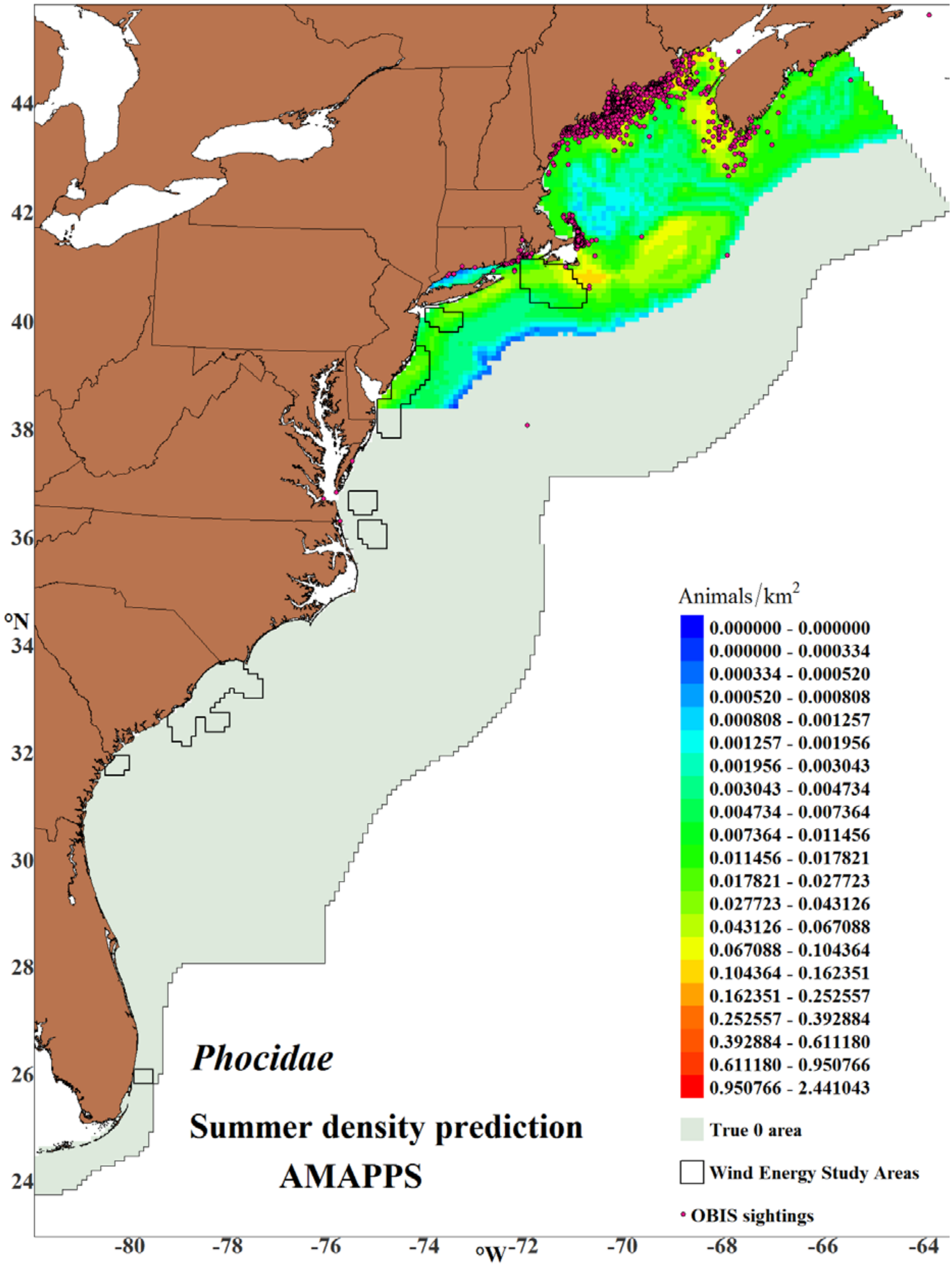

Figure 19-14 Seals at-sea 2010-2013 summer density and 1995-2015 OBIS sightings pink circles (Halpin *et al.* 2009), NEFSC database, and Duke University (Moxley *et al*, 2017). These sightings were not used to develop the density-habitat model.

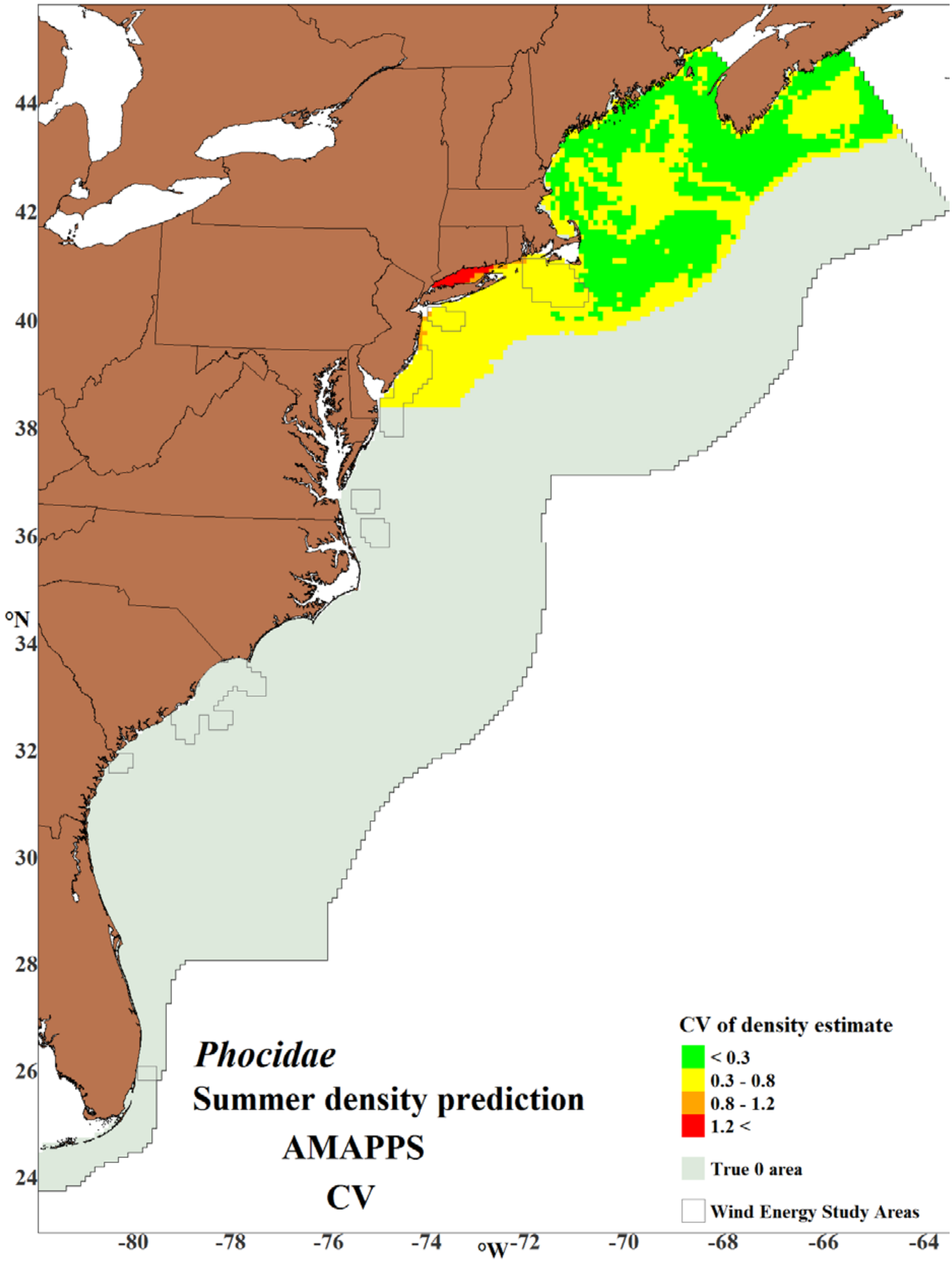

Figure 19-15 CV of summer density estimates for seals at-sea

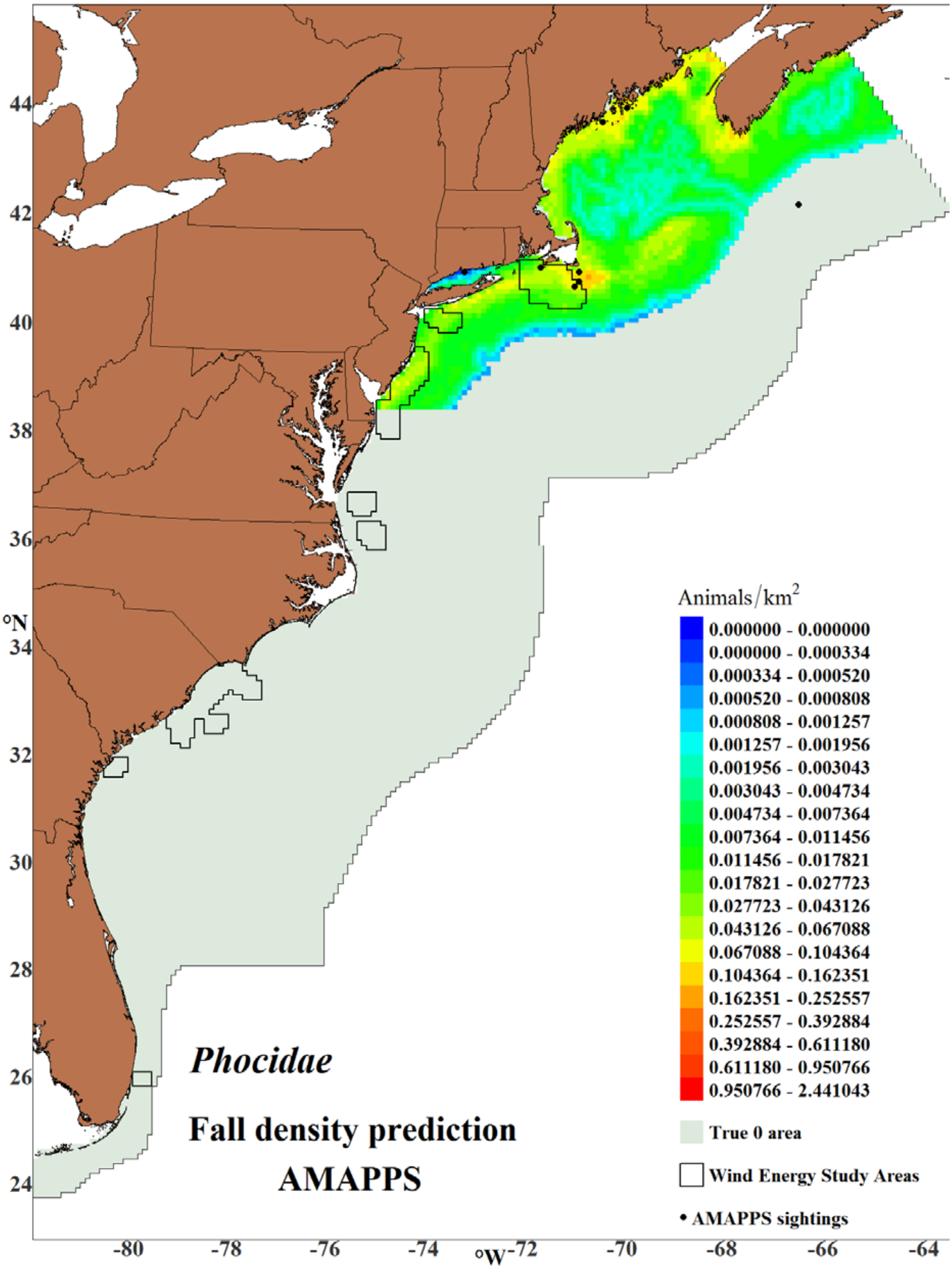

Figure 19-16 Seals at-sea fall average density estimates
Black circles indicate grid cells with one or more animal sightings.

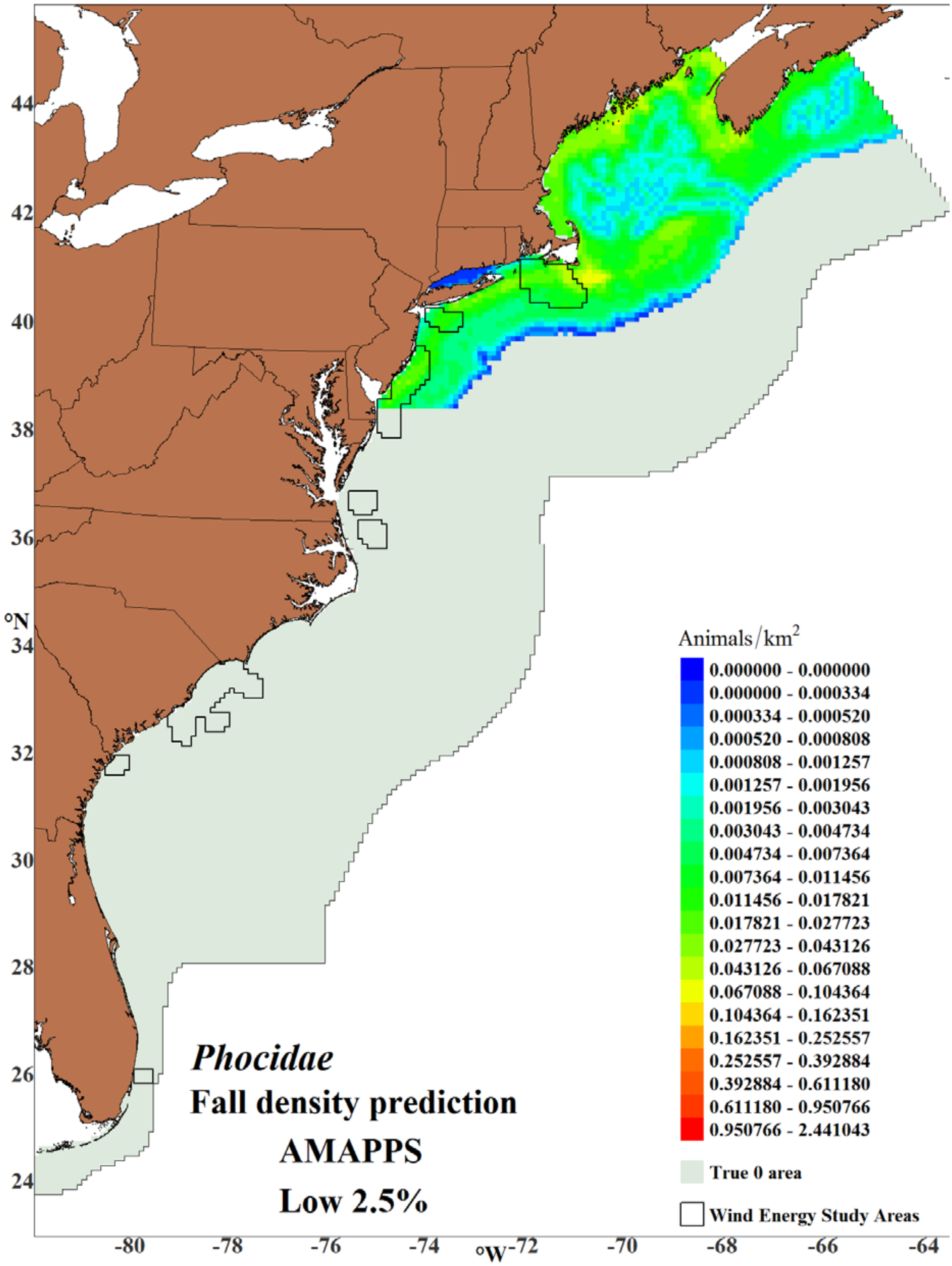

Figure 19-17 Lower 2.5% percentile of fall seals at-sea estimates

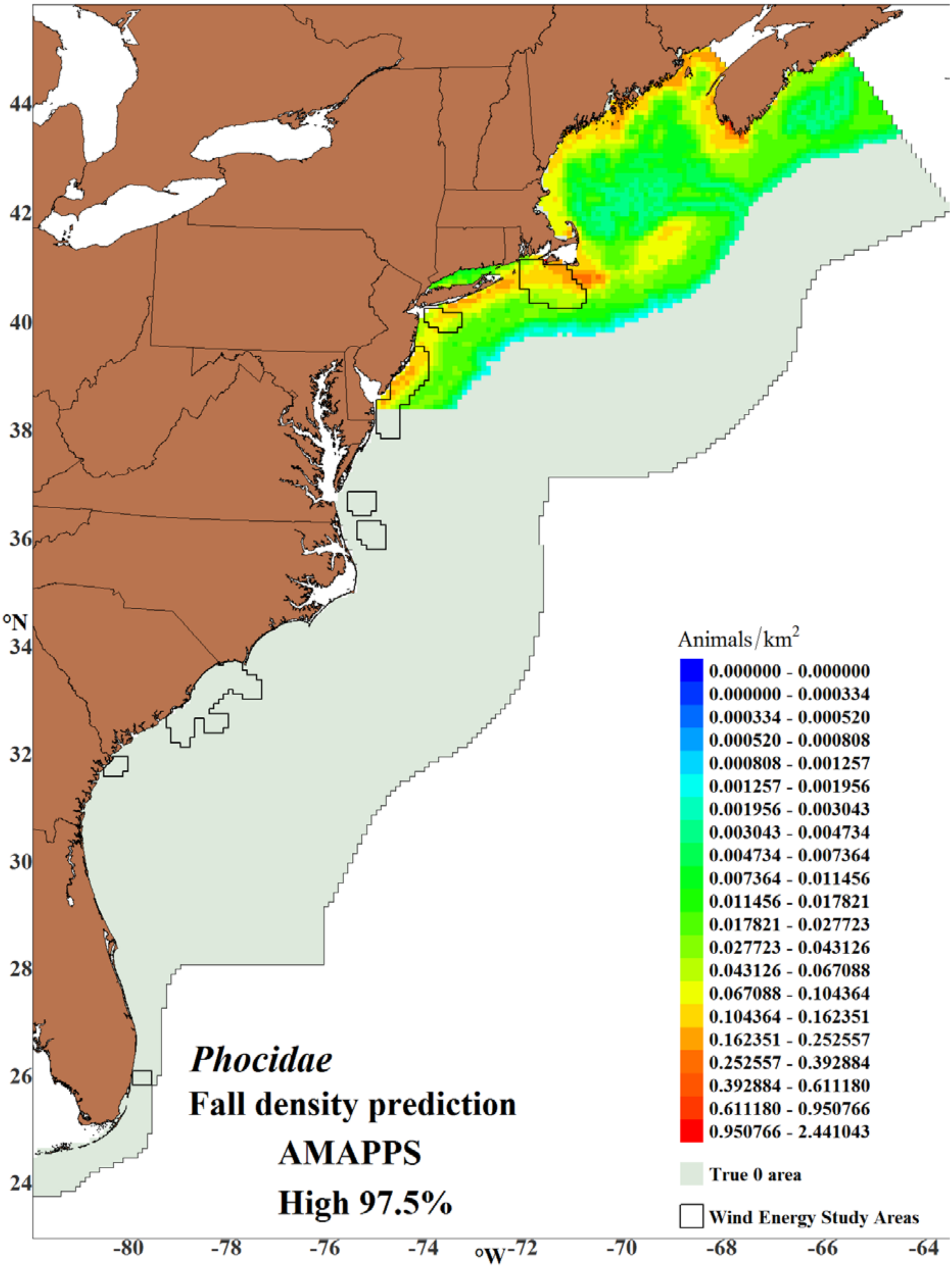

Figure 19-18 Upper 97.5% percentile of fall seals at-sea estimates

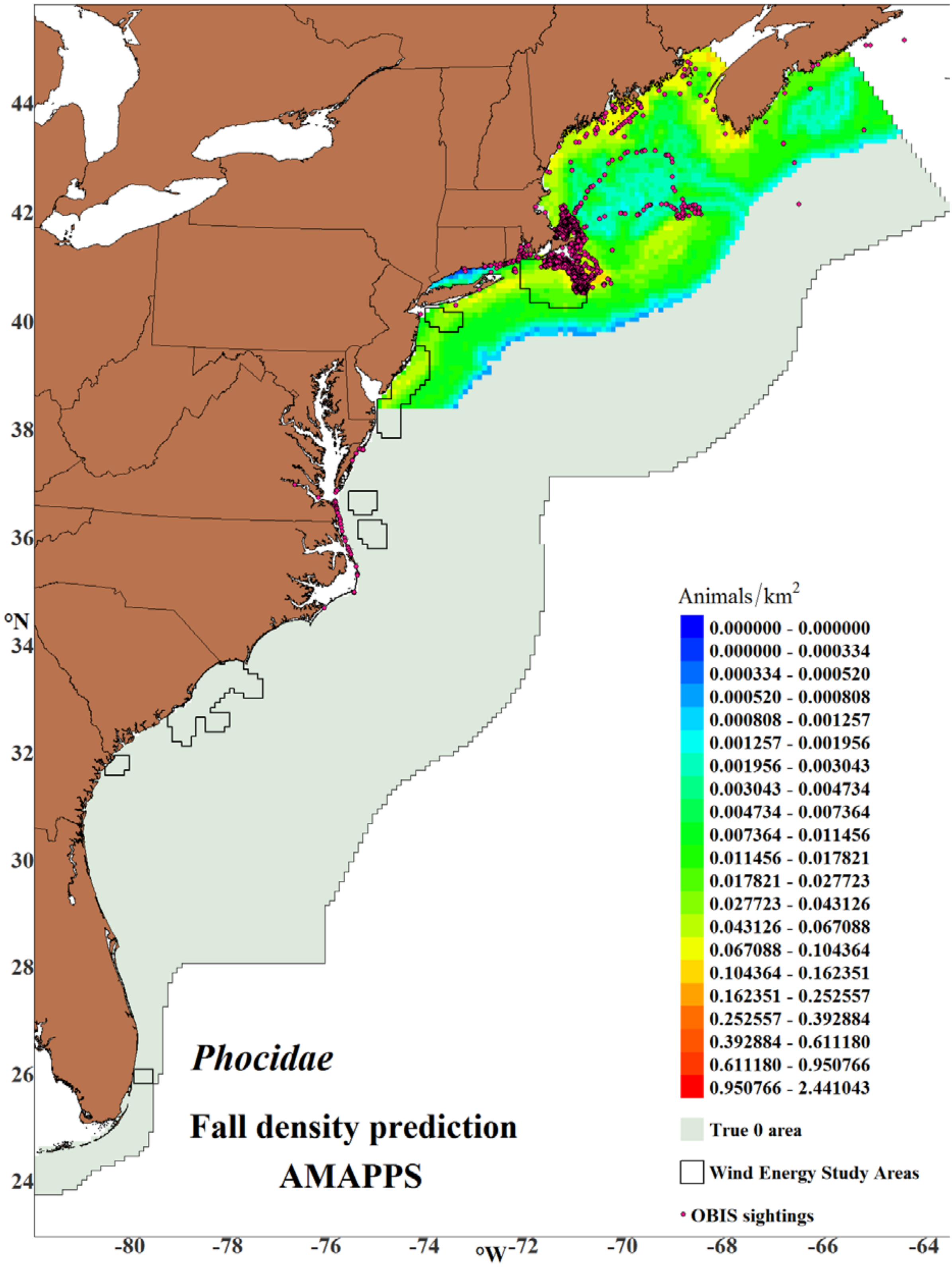

Figure 19-19 Seals at-sea 2010-2013 fall density and 1995-2015 OBIS sightings pink circles (Halpin *et al*. 2009), NEFSC database, and Duke University (Moxley *et al*. 2017). These sightings were not used to develop the density-habitat model.

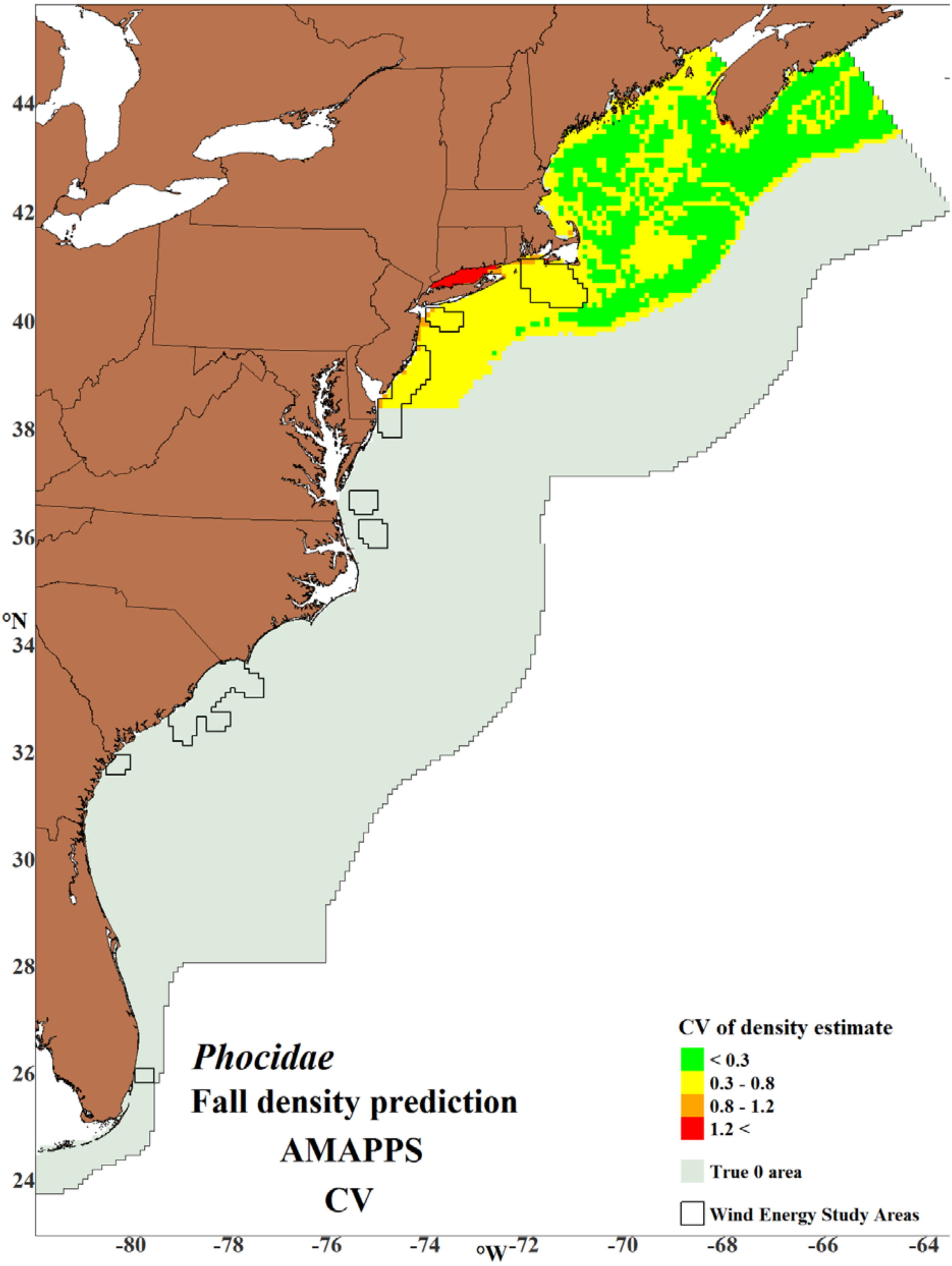

Figure 19-20 CV of fall density estimates for seals at-sea

19.6 Wind Energy Study Areas

Table 19-6 Seals at-sea average abundance estimates for wind energy study areas
Availability bias correction was not included in the estimates.

Season	Area	Abundance*	CV	95% Confidence Interval
Spring	Rhode Island/ Massachusetts	4,668	0.447	2,022 – 10,777
(March-May)	New York	908	0.403	424 – 1,943
	New Jersey	2,125	0.402	994 – 4,543
	Delaware/Maryland	383	0.463	161 - 910
	Virginia	N/A	-	-
	North Carolina	N/A	-	-
	South Carolina/ North Carolina	N/A	-	-
	Georgia	N/A	-	-
	Florida	N/A	-	-
Summer	Rhode Island/ Massachusetts	370	0.371	183 - 748
(June-August)	New York	47	0.519	18 - 122
	New Jersey	126	0.546	46 - 342
	Delaware/Maryland	23	0.515	9 - 60
	Virginia	N/A	-	-
	North Carolina	N/A	-	-
	South Carolina/ North Carolina	N/A	-	-
	Georgia	N/A	-	-
	Florida	N/A	-	-
Fall	Rhode Island/ Massachusetts	561	0.460	237 – 1,325
(September- November)	New York	85	0.565	30 -238
	New Jersey	294	0.515	113 - 761
	Delaware/Maryland	34	0.580	12 - 99
	Virginia	N/A	-	-
	North Carolina	N/A	-	-
	South Carolina/ North Carolina	N/A	-	-
	Georgia	N/A	-	-
	Florida	N/A	-	-

* The mean abundance is rounded to the nearest integer. If the mean abundance was rounded to zero, the CV calculation was performed using the actual abundance value as estimated by the habitat model. N/A indicates it was assumed to be in the True 0 modeled area.

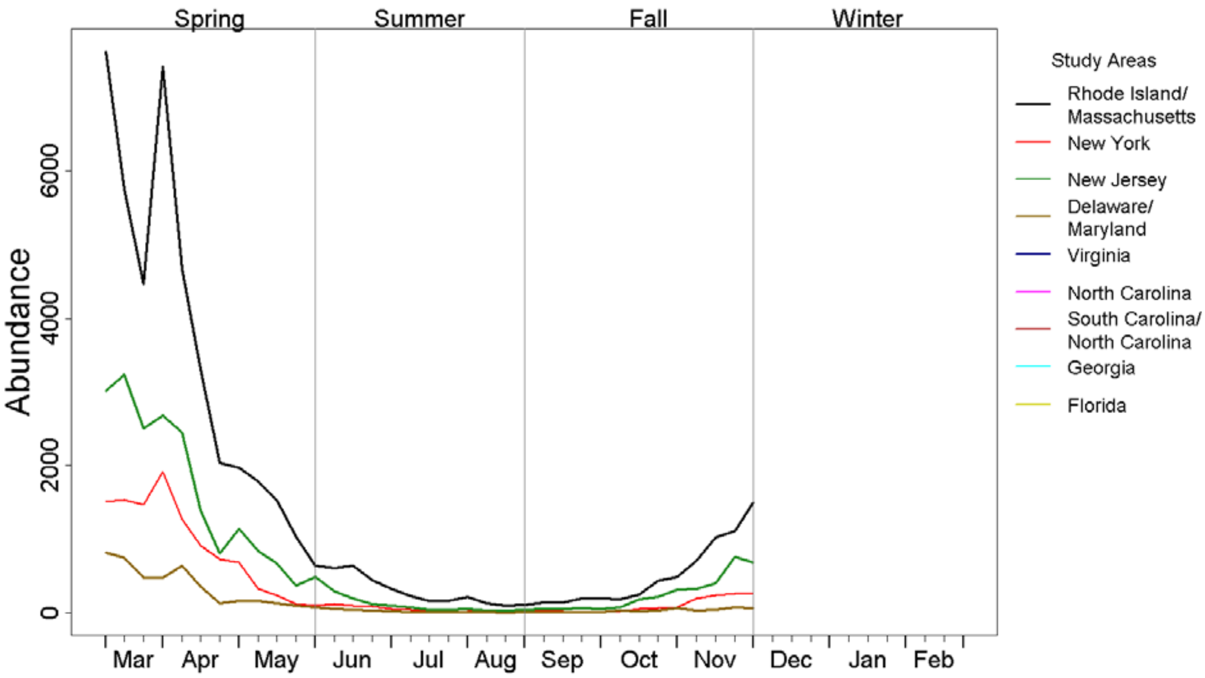

Figure 19-21 Annual abundance trends for seals at-sea in wind energy study areas

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