

## **Cape Cod Bay to Great South Channel Closure Proposal to the NMFS LWTRT: February 3, 2012**

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North Atlantic right whales continue to die from entanglements in fishing gear at levels above the allowable Potential Biological Removal (PBR). Despite gear modifications and closures that are now mandated in most fixed gear fisheries, entanglement rates remain high, apparently from vertical lines. To address the vertical line problem, the proposal presented by NMFS to the LWTRT in January of 2012 used a co-occurrence model (overlaps between fishing activity, right whales, and humpback whales) to assess potential risk areas. The proposed changes involve increasing the number of traps per endlines (vertical lines, buoy lines, and endlines are all defined here as “endlines”) with different requirements by area and zone, which led to an estimated 38% reduction in vertical lines for all areas in the gulf of Maine combined. However, the aggregation of right whale and humpback whale data together obscures understanding the effects of such measures on each species separately. Because PBR for right whales is so low (0.7 whales per year), reducing the serious and fatal entanglements of this species are a critical priority, and therefore this proposal is focused on right whales alone.

The co-occurrence model and the NMFS proposal reduce the probability of overlap between endlines and whales, but it is only the first step in calculating and reducing the risk of entanglements. Serious and fatal entanglement risk is a combination of 1) the probability of encounter between whales and endlines, 2) the probability of that encounter turning into an entanglement, and 3) the probability of that entanglement turning into a serious or fatal injury. Therefore, while the proposed level of reduction in endlines is a good start, the lack of data on the second two parts of the risk equation mean that it is impossible to translate it into a quantitative estimate of the potential reduction in serious or fatal entanglements. This lack of quantitative linkage between entanglement risk and the various proposals for endline reduction, even if we assume the 38% co-occurrence reduction directly corresponded to the reduced probability of lethal entanglement, is not enough to get right whales below PBR. Excellent right whale survey data is available for the southern Gulf of Maine, and the lack of viable alternatives to endline technology means the only quantifiable method for reducing entanglements is to eliminate endlines in high density whale habitats, so as to provide zero entanglement risk in that area.

This is a supplementary proposal designed to provide measureable protection for right whales at a critical location and time of year, Cape Cod Bay, the Outer Cape, and nearshore waters out to the Great South Channel Closure Area. We propose to close these waters to all fishing with endlines from February 1 to April 30th (in addition to the NMFS endline proposal)(Figure 2). The analysis is based upon hotspot analyses of SPUE data from the Right Whale Consortium sightings data for the period 1978 – 2010. The rationale is four-fold. One, it appears that the area is the primary feeding ground for North Atlantic right whales in the spring. Two, this analysis suggests a high level of protection for a very small closure relative to Gulf of Maine habitat. Three, there is very little fishing in the area during most of this time, so fishing displacement is minimal. Finally, this proposal provides protection for the corridor from Cape Cod Bay to the Great South Channel in late April, when the catalog data shows large number of whales moving to the offshore habitat. This proposal does not exclude the possibility that alternative fishing methods may be discovered that could be allowed within this area if no endlines were used.

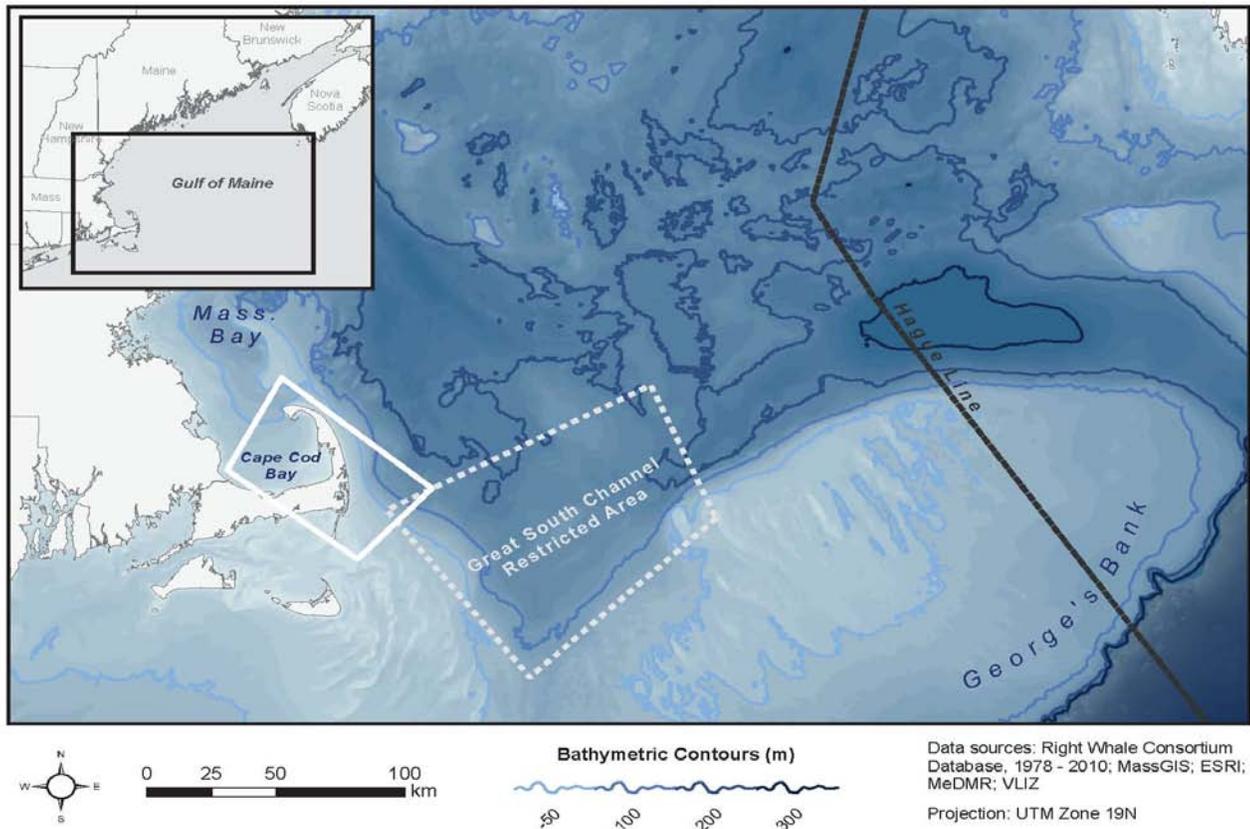


Figure 1. Proposed closure area (white line) as well as the existing Great South Channel Closure area (dotted line).

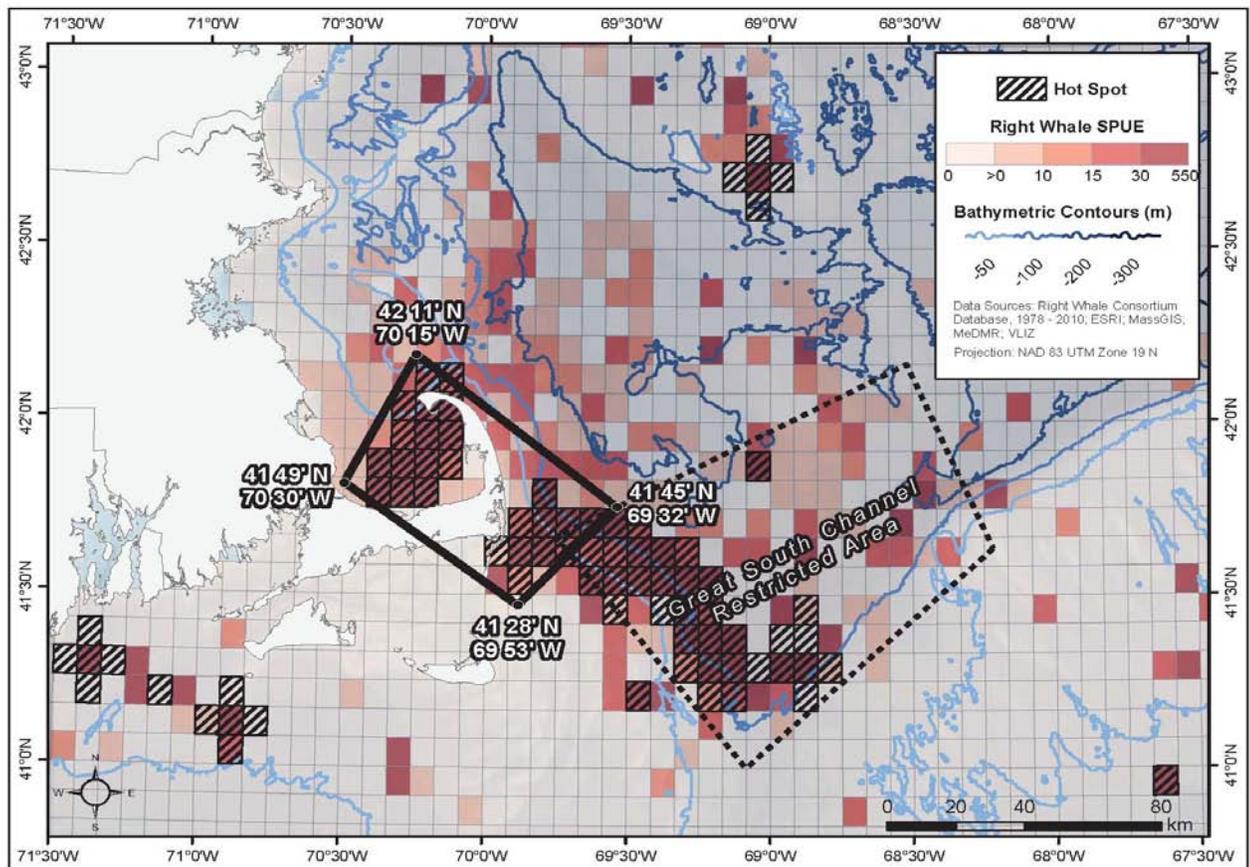
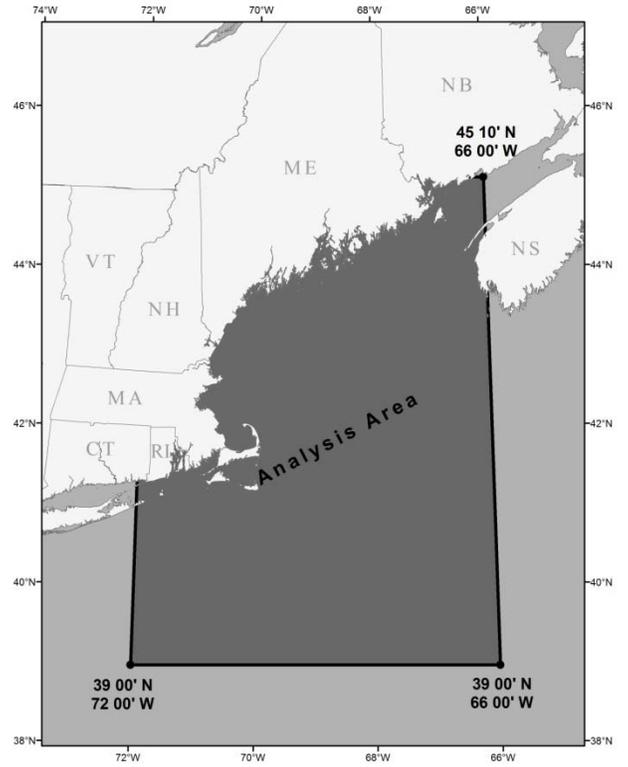


Figure 2. The proposed Closure area for February, March and April (black outline), including the results of the hotspot analysis.

## Methods and Results

The *Hot Spot Analysis* tool in ArcGIS 10 was used to identify statistically significant hot spots of right whale distribution using the Getis-Ord  $G_i^*$  statistic. The input values were North Atlantic right whale sightings per unit effort (SPUE) based on a 5' X 5' grid covering the Gulf of Maine and extending south past Georges Bank (extent: SW corner 39 N, 72 W; NE corner 45 10' N, 66 W) (see Figure 3 for the analysis area). On-effort variable parameters remained consistent with those set by Dr. Robert Kenney and The North Atlantic Right Whale Consortium Database, with the exception of inclusion of animals sighted in a beaufort sea state 4 or less, appropriate for right whales, where sightability is only slightly compromised. The Beaufort sea state of 4 is also consistent with the IE/NMFS co-occurrence model dataset. The SPUE data for the months of February, March and April showed the highest density of right whales from Cape Cod bay to the great South Channel, and only those three months were used in this analysis. To account for unreliable SPUE values where too little survey effort occurred, only 5' grid cells with total survey trackline effort of greater than 50 km were used.



**Figure 3. Hotspot Analysis area for February, March, and April**

SPUE = (Number of animals / Distance of survey trackline (km)) \* 1000. In the statistic given below,  $x$  = the SPUE value for each 5' square ( $j$ ). This analysis was applied to the entire Atlantic EEZ fishing areas north of 39 degrees North and east of 72 degree west (Figure 3). The analysis parameter applied was *Fixed Distance Band*, which analyzes each feature within the context of neighboring features found within the threshold distance, specified here at 10 km. The analysis was applied to the whole study area and resulted in 77 five minute cells identified as statistically significant hot spots, with  $p$ -values < 0.01 and  $z$ -scores > 0 (Figure 3). Table 1 includes those identified cells and their corresponding  $p$ -values,  $z$ -scores, and SPUE value for the months of February, March and April. For cell reference numbers, see Figure 3.

The Getis-Ord local statistic is given as:

$$G_i^* = \frac{\sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^n w_{i,j}^2 - \left( \sum_{j=1}^n w_{i,j} \right)^2}{n-1}}} \quad (1)$$

where  $x_j$  is the attribute value for feature  $j$ ,  $w_{i,j}$  is the spatial weight between feature  $i$  and  $j$ ,  $n$  is equal to the total number of features and:

$$\bar{X} = \frac{\sum_{j=1}^n x_j}{n} \quad (2)$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \quad (3)$$

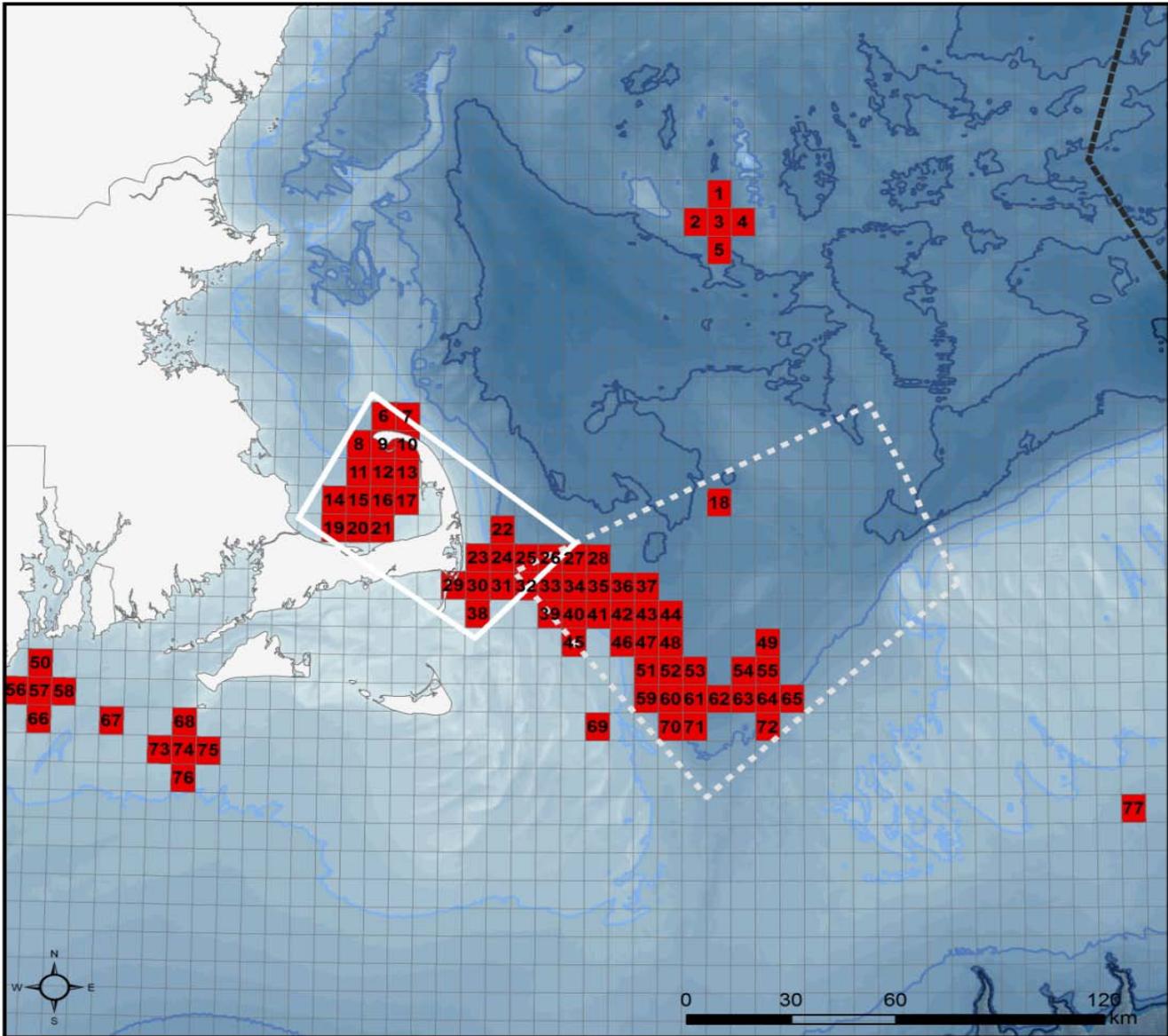
The  $G_i^*$  statistic is a  $z$ -score so no further calculations are required.

The results are provided in Table 1, and includes referenced cells and their corresponding p-values, z-scores, and SPUE value for the months of February, March and April. For cell references, see Figure 4. The analytical method described above shows some squares with 0 sightings, and some squares outside the expected and known habitats as “hotspots”. These are due to two factors. One, if a cell is adjacent to one or more cells with a high number of sightings, it frequently is weighted high enough to become a hotspot. This is biologically legitimate, as we know that whales do not confine their movements to our neatly defined boundaries. Two, some isolated cells have very high SPUE values, usually because of very low survey effort with a few right whale sightings (usually from a single sighting in the 30 year period). These cases are highlighted in yellow in Table 1, and have been excluded from analyses on the degree of protection afforded by hot spot closures, because they do not represent consistently identified habitat.

**Table 1. Hot Spot Analysis results by 5’ analysis cell.**

Cell Ref. Number	P-Value	Z-Score	Feb/Mar/Apr SPUE
1	0	5.193308	0
2	0.000259	3.652716	0
3	0.000886	3.324375	140.014738
4	0.000006	4.522896	0
5	0.000886	3.324375	0
6	0.002843	2.984245	28.056628
7	0.00412	2.868805	21.280775
8	0.005712	2.76388	23.453693
9	0.000005	4.586685	49.769032
10	0.000057	4.026907	34.011072
11	0.000178	3.748172	24.493758
12	0	5.39012	48.812703
13	0.000382	3.551951	38.432994
14	0.001607	3.154592	31.128822
15	0.000005	4.56492	43.112655
16	0	5.553756	50.656021
17	0.004043	2.874794	26.706433
18	0.00999	2.576167	77.700078
19	0.000933	3.310051	35.191247
20	0.000088	3.920848	33.951686
21	0.000088	3.922813	48.592003
22	0.001078	3.269446	33.820138
23	0.000056	4.029312	15.793333
24	0	5.446585	67.857637
25	0.000006	4.524511	42.317708
26	0.000103	3.883482	35.30005
27	0.002115	3.073606	49.636003
28	0.000256	3.65632	20.181635
29	0.003291	2.939145	4.701457
30	0.000084	3.933561	73.80679
31	0	5.85972	54.347826
32	0.000051	4.052063	29.802843
33	0.000634	3.416739	21.459227
34	0	5.897632	18.455049
35	0	5.180299	79.435128
36	0	6.747314	45.122475
37	0.000696	3.391285	20.463847

38	0.005125	2.799072	12.642225
39	0.000001	4.900971	38.223517
40	0.00007	3.975073	60.904872
41	0	8.328248	41.64188
42	0	6.900005	114.545455
43	0	7.056511	63.590116
44	0.00332	2.936487	35.252644
45	0.000064	3.999384	3.516174
46	0.000021	4.25585	0
47	0.000001	4.960399	36.514119
48	0.00136	3.202946	27.624309
49	0.005646	2.767651	7.037298
50	0.001631	3.150288	0
51	0.000128	3.831023	69.427225
52	0	7.868228	36.382536
53	0.00043	3.520961	56.546324
54	0.00114	3.25351	0
55	0.000049	4.060009	0
56	0.007321	2.681874	0
57	0.007321	2.681874	117.574257
58	0.00003	4.176549	0
59	0.000002	4.764625	12.15436
60	0	5.702663	108.736408
61	0	6.192158	53.951983
62	0.004828	2.818275	0
63	0.000154	3.783871	33.863867
64	0.001142	3.253013	100.755668
65	0.000081	3.941631	2.902758
66	0.007321	2.681874	0
67	0.000191	3.730999	0
68	0	7.84214	0
69	0.005394	2.782482	35.714286
70	0.000111	3.864951	11.855365
71	0.005308	2.787751	20.942408
72	0.004888	2.814303	0
73	0	8.200499	4.589261
74	0	8.538257	297.805643
75	0	7.84214	0
76	0	8.40686	19.723866
77	0.000614	3.425443	58.365759



**Figure 4. Hot Spot Analysis results. Significant hot spots shown in red, and are linked to the data in Table 1 by cell number shown here.**

Currently, the Great South Channel Restricted Area (GSCRA), shown outlined in dotted white (Fig. 2), includes 57% of the hot spot area excluding the outlying<sup>1</sup> hot spot cells (shown in yellow in Table 1). With the addition of the proposed area, shown outlined in solid white (Fig. 4), an additional 39% (excluding outlying hot spot cells) would be covered. Accounting for a small overlapping area, the combined protected closure area of the GSCRA and the proposed CCB closure area would include 95% of the hot spot areas identified in this analysis (excluding outlying hot spot cells).

The percent of right whales currently protected with the GSCRA for the months February, March, and April is under 10% of the entire analysis area (Figure 3) during this period (calculated from the sum of animals sighted within 5' grid cells which had centerpoints within the GSCRA, based on Right Whale Consortium sightings data 1978 – 2010). The addition of the proposed Cape closure area (which is only 1% of the total analysis area) would increase the percentage of right whales protected in the months February, March, and April by 76%. Thus the number of right whales protected during these months from the combined GSCRA and the proposed Cape closure will be 85% of all sightings in the analysis area. This proposal has a high benefit (protection for 76% of wintering right whales in the analysis area) with a very low cost to fisheries (total closure of only 1% the total analysis area).

<sup>1</sup>outlying hot spot cells: 1-5, 50, 56-58, 66-68, 73-77.