Quantitative estimates of the movement and distribution of North Atlantic right whales along the northeast coast of North America

Sean W. Brillant*, Angelia S. M. Vanderlaan, Robert W. Rangeley, Christopher T. Taggart

*Corresponding author: seanb@cwf-fcf.org

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Supplement.

Table S1. Monthly transition matrices of the probability (standard error) of right whales moving within a 30 day period from each of the seven regions (origin) to any of the other regions (destination) including staying within the original region (diagonal). For each origin (row), the average probability for all other destinations (i.e. excluding the origin) is shown as *P*(Emig), and for each destination (column), the average probability from all other origins excluding the origin is shown as Mean ~*P*(Immig). The subset regions are identified as South (south-of 40° N), CCB (Cape Cod Bay), GSC (Great South Channel), GOM (Gulf of Maine), BOF (Bay of Fundy), RB (Roseway Basin) and Northeast (east of Roseway Basin and/or Northeast of 45.5° N).

January	Destination				
Origin	South	CCB	GSC	GOM	*P*(Emig)
South	0.85	0.04 (0.02)	0.10 (0.08)	0.01 (0.06)	0.15
CCB	0.06 (0.03)	0.51	< 0.01 (0.13)	0.42 (0.11)	0.49
GSC	0.19 (0.11)	0.23 (0.09)	0.36	0.22 (0.13)	0.64
GOM	0.03 (0.02)	0.01 (0.04)	0.15 (0.11)	0.80	0.20
Mean ~*P*(Immig)	0.09	0.09	0.08	0.22	

February	Destination				
Origin	South	CCB	GSC	GOM	*P*(Emig)
South	0.72	0.11 (0.02)	0.13 (0.04)	0.04 (0.04)	0.28
CCB	0.05 (0.02)	0.69	0.12 (0.05)	0.14 (0.06)	0.31
GSC	0.12 (0.09)	0.11 (0.07)	0.73	0.03 (0.07)	0.27
GOM	0.25 (0.13)	< 0.01 (0.08)	0.31 (0.12)	0.44	0.56
Mean ~*P*(Immig)	0.14	0.07	0.18	0.07	

March	Destination				
Origin	South	CCB	GSC	GOM	*P*(Emig)
South	0.50	0.08 (0.03)	0.29 (0.08)	0.12 (0.09)	0.50
CCB	0.09 (0.05)	0.37	0.29 (0.08)	0.25 (0.08)	0.63
GSC	<0.01 (0.05)	0.12 (0.04)	.82	0.06 (0.06)	0.18
GOM	0.26 (0.16)	0.06 (0.07)	0.09 (0.15)	0.59	0.41
Mean ~*P*(Immig)	0.12	0.09	0.22	0.14	

April	Destination					
Origin	South	CCB	GSC	GOM	Northeast	*P*(Emig)
South	0.76	0.03 (0.06)	0.09 (0.08)	0.10 (0.07)	0.02 (0.07)	0.24
CCB	0.04 (0.05)	0.48	0.29 (0.10)	0.18 (0.05)	0.01 (0.05)	0.53
GSC	0.05 (0.10)	0.09 (0.06)	0.60	0.08 (0.07)	0.18 (0.10)	0.40
GOM	0.29 (0.06)	0.08 (0.05)	0.24 (0.09)	0.38	0.01 (0.06)	0.62
Northeast	0.17 (0.09)	< 0.01 (0.04)	0.08 (0.08)	0.08 (0.05)	0.67	0.33
Mean ~*P*(Immig)	0.14	0.05	0.18	0.11	0.06	

May	Destination							
Origin	South	CCB	GSC	BOF	RB	GOM	Northeast	*P*(Emig)
South	0.23	0.11 (0.07)	0.17 (0.06)	0.10 (0.06)	0.14 (0.07)	0.14 (0.08)	0.10 (0.01)	0.77
CCB	0.04 (0.06)	0.36	0.11 (0.06)	0.03 (0.05)	0.14 (0.06)	0.20 (0.08)	0.11 (0.06)	0.64
GSC	0.23 (0.07)	0.17 (0.07)	0.10	0.11 (0.05)	0.18 (0.07)	0.12 (0.05)	0.09 (0.07)	0.90
BOF	< 0.01 (0.06)	0.17 (0.06)	0.12 (0.07)	0.46	0.13 (0.06)	0.08 (0.08)	0.02 (0.06)	0.54
RB	0.12 (0.06)	< 0.01 (0.06)	0.03 (0.06)	< 0.01 (0.05)	0.64	0.09 (0.08)	0.12 (0.06)	0.36
GOM	< 0.01 (0.07)	0.20 (0.07)	0.08 (0.04)	0.13 (0.06)	0.26 (0.07)	0.19	0.14 (0.07)	0.81
Northeast	0.04 (0.06)	0.13 (0.06)	0.06 (0.06)	< 0.01 (0.04)	< 0.01 (0.06)	0.05 (0.08)	0.72	0.28
Mean ~*P*(Immig)	0.08	0.13	0.09	0.06	0.14	0.12	0.10	

June	Destination							
Origin	South	CCB	GSC	BOF	RB	GOM	Northeast	*P*(Emig)
South	0.40	0.11 (0.07)	0.05 (0.07)	0.16 (0.08)	0.04 (0.06)	0.09 (0.07)	0.16 (0.07)	0.60
CCB	0.14 (0.06)	0.41	0.12 (0.08)	< 0.01 (0.07)	0.10 (0.06)	0.21 (0.07)	0.02 (0.06)	0.59
GSC	0.28(0.08)	0.12 (0.07)	0.04	0.13 (0.06)	0.09 (0.09)	0.12 (0.06)	0.21 (0.09)	0.96
BOF	0.28 (0.06)	0.07 (0.06)	< 0.01 (0.08)	0.27	0.04 (0.06)	0.21 (0.06)	0.13 (0.06)	0.73
RB	< 0.01 (0.07)	< 0.01 (0.06)	0.01 (0.06)	0.14 (0.09)	0.50	0.18 (0.07)	0.17 (0.07)	0.50
GOM	0.25 (0.06)	0.15 (0.06)	0.02(0.05)	0.13 (0.06)	0.09 (0.07)	0.30	0.06 (0.06)	0.70
Northeast	0.08 (0.06)	0.04 (0.06)	0.06 (0.06)	0.18 (0.07)	0.10 (0.06)	< 0.01 (0.06)	0.54	0.46
Mean ~*P*(Immig)	0.17	0.08	0.04	0.12	0.08	0.14	0.12	

July	Destination							
Origin	South	CCB	GSC	BOF	RB	GOM	Northeast	*P*(Emig)
South	0.37	0.02 (0.05)	0.08 (0.06)	0.11 (0.07)	0.12 (0.06)	0.11 (0.05)	0.19 (0.06)	0.60
CCB	0.13 (0.06)	0.39	0.08 (0.06)	0.10 (0.06)	0.06 (0.06)	0.13 (0.05)	0.11 (0.05)	0.59
GSC	0.06 (0.06)	0.02 (0.05)	0.39	0.09 (0.06)	0.35 (0.06)	0.05 (0.05)	0.05 (0.06)	0.96
BOF	0.19 (0.08)	0.02 (0.06)	0.21 (0.08)	0.17	0.18 (0.06)	0.07 (0.07)	0.17 (0.07)	0.73
RB	0.01 (0.03)	< 0.01 (0.02)	0.06 (0.05)	0.11 (0.05)	0.80	< 0.01 (0.04)	0.01 (0.05)	0.50
GOM	0.12 (0.05)	0.10 (0.07)	0.10 (0.06)	0.11 (0.06)	0.13 (0.058)	0.35	0.08 (0.05)	0.70
Northeast	0.23 (0.06)	0.14 (0.04)	0.23 (0.06)	0.11 (0.06)	0.01 (0.06)	< 0.01 (0.06)	0.28	0.46
Mean ~*P*(Immig)	0.17	0.08	0.04	0.12	0.08	0.14	0.12	

August	Destination							
Origin	South	CCB	GSC	BOF	RB	GOM	Northeast	*P*(Emig)
South	0.21	0.06 (0.05)	0.10 (0.05)	0.28 (0.11)	0.08 (0.06)	0.11 (0.05)	0.15 (0.05)	0.79
CCB	0.15 (0.05)	0.33	0.06 (0.06)	0.08 (0.06)	0.13 (0.06)	0.11 (0.05)	0.13 (0.06)	0.67
GSC	0.02 (0.06)	0.01 (0.05)	0.40	0.16 (0.06)	0.08 (0.064)	0.15 (0.05)	0.17 (0.07)	0.60
BOF	0.32 (0.07)	0.01 (0.06)	0.14 (0.07)	0.20	0.15 (0.05)	0.13 (0.06)	0.04 (0.07)	0.80
RB	0.06 (0.02)	< 0.01 (0.01)	0.04 (0.04)	0.05 (0.03)	0.82	< 0.01 (0.02)	0.02 (0.05)	0.18
GOM	0.12 (0.05)	0.10 (0.07)	0.08 (0.06)	0.15 (0.08)	0.14 (0.05)	0.26	0.15 (0.06)	0.74
Northeast	0.03 (0.05)	< 0.01 (0.04)	0.13 (0.06)	0.03 (0.05)	0.22 (0.06)	< 0.01 (0.05)	0.58	0.42
Mean ~*P*(Immig)	0.12	0.03	0.09	0.13	0.14	0.08	0.11	

September	Destination							
Origin	South	CCB	GSC	BOF	RB	GOM	Northeast	*P*(Emig)
South	0.40	0.04 (0.07)	0.07 (0.06)	0.15 (0.11)	0.10 (0.07)	0.10 (0.06)	0.14 (0.06)	0.60
CCB	0.17 (0.06)	0.28	0.14 (0.06)	0.08 (0.07)	0.15 (0.06)	0.11 (0.05)	0.06 (0.06)	0.72
GSC	0.15 (0.05)	< 0.01 (0.04)	0.51	0.10 (0.08)	0.14 (0.07)	0.10 (0.06)	< 0.01 (0.07)	0.49
BOF	0.31 (0.10)	0.01 (0.05)	0.21 (0.11)	0.16	0.04 (0.07)	0.12 (0.07)	0.14 (0.10)	0.84
RB	0.05 (0.03)	< 0.01 (0.02)	0.08 (0.06)	0.01 (0.03)	0.64	0.10 (0.04)	0.12 (0.06)	0.36
GOM	0.13 (0.06)	0.14 (0.06)	0.14 (0.06)	0.08 (0.10)	0.19 (0.07)	0.18	0.13 (0.06)	0.36
Northeast	0.12 (0.05)	< 0.01 (0.04)	0.08 (0.07)	0.14 (0.08)	0.03 (0.06)	0.08 (0.06)	0.55	0.45
Mean ~*P*(Immig)	0.16	0.03	0.12	0.09	0.11	0.12	0.10	

October	Destination							
Origin	South	CCB	GSC	BOF	RB	GOM	Northeast	*P*(Emig)
South	0.17	0.22 (0.07)	0.13(0.06)	0.24(0.07)	0.12 (0.06)	0.1 (0.06)	0.02 (0.06)	0.83
CCB	0.14 (0.05)	0.37	0.10 (0.06)	0.04 (0.07)	0.22 (0.06)	0.08 (0.06)	0.04 (0.06)	0.63
GSC	0.08 (0.06)	< 0.01 (0.04)	0.50	0.17 (0.07)	0.10 (0.06)	0.11 (0.063)	0.04 (0.06)	0.50
BOF	0.02 (0.05)	0.09 (0.03)	0.15 (0.08)	0.05	0.49 (0.08)	0.18 (0.07)	0.02 (0.08)	0.95
RB	0.07 (0.06)	0.21 (0.04)	0.08 (0.06)	0.23 (0.08)	0.22	0.13 (0.06)	0.05 (0.06)	0.77
GOM	< 0.01 (0.05)	0.04 (0.04)	0.04 (0.07)	< 0.01 (0.07)	< 0.01 (0.07)	0.91	< 0.01 (0.06)	0.09
Northeast	0.22 (0.05)	0.14 (0.04)	0.05 (0.06)	0.15 (0.07)	0.03 (0.07)	< 0.01 (0.06)	0.41	0.59
Mean ~*P*(Immig)	0.09	0.12	0.09	0.14	0.16	0.10	0.03	

November	Destination					
Origin	South	CCB	BOF	GOM	N	*P*(Emig)
South	0.71	< 0.01 (0.06)	0.05 (0.07)	0.11 (0.06)	0.13 (0.08)	0.29
CCB	0.17 (0.08)	0.44	0.10 (0.09)	0.07 (0.09)	0.22 (0.08)	0.56
BOF	0.11 (0.08)	< 0.01 (0.09)	0.77	0.03 (0.07)	0.09 (0.08)	0.23
GOM	0.01 (0.01)	< 0.01 (0.07)	0.13 (0.06)	0.77	0.09 (0.07)	0.23
N	0.02 (0.09)	0.20 (0.09)	0.23 (0.09)	0.34 (0.10)	0.21	0.79
Mean ~*P*(Immig)	0.08	0.05	0.13	0.14	0.13	

December	Destination				
Origin	South	CCB	GSC	GOM	*P*(Emig)
South	0.95	0.01 (0.04)	< 0.01 (0.06)	0.04 (0.06)	0.05
CCB	< 0.01 (0.05)	0.37	0.44 (0.11)	0.19 (0.12)	0.63
GSC	0.02 (0.08)	0.07 (0.09)	0.45	0.46 (0.17)	0.55
GOM	0.02 (0.02)	0.04 (0.06)	0.31 (0.13)	0.63	0.37
Mean ~*P*(Immig)	0.01	0.04	0.25	0.23	

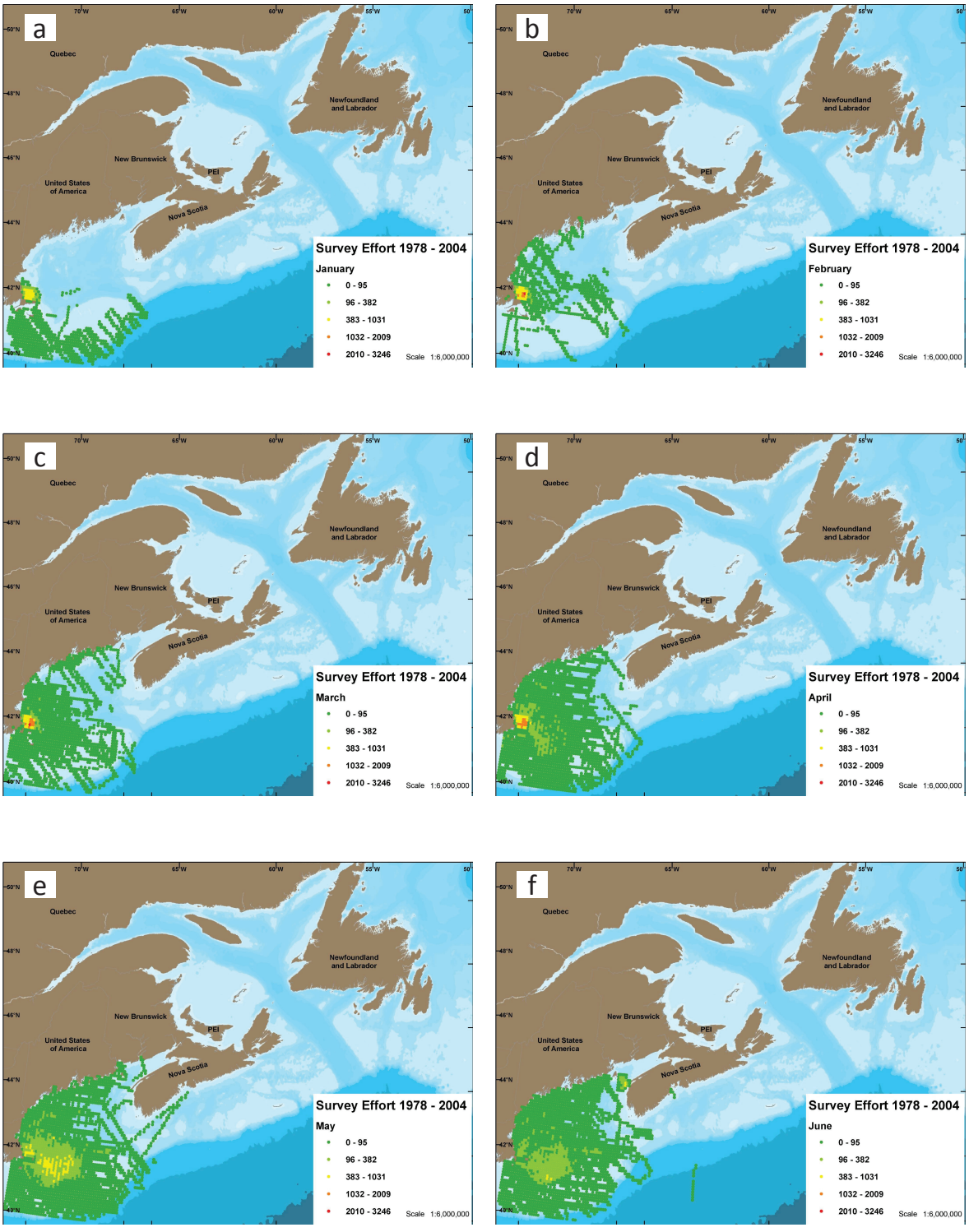

Figure S1. Total monthly survey effort (km) in each 0.05° (3-minute) grid-cell from 1978 to 2004 (Right Whale Consortium, 2008). The colour scale is the same for all 12 monthly maps. The smallest scale of survey effort (≤ 95 km, dark green) represents < 1 complete annual survey of that grid-cell (approximately 4 km across) since 1978.

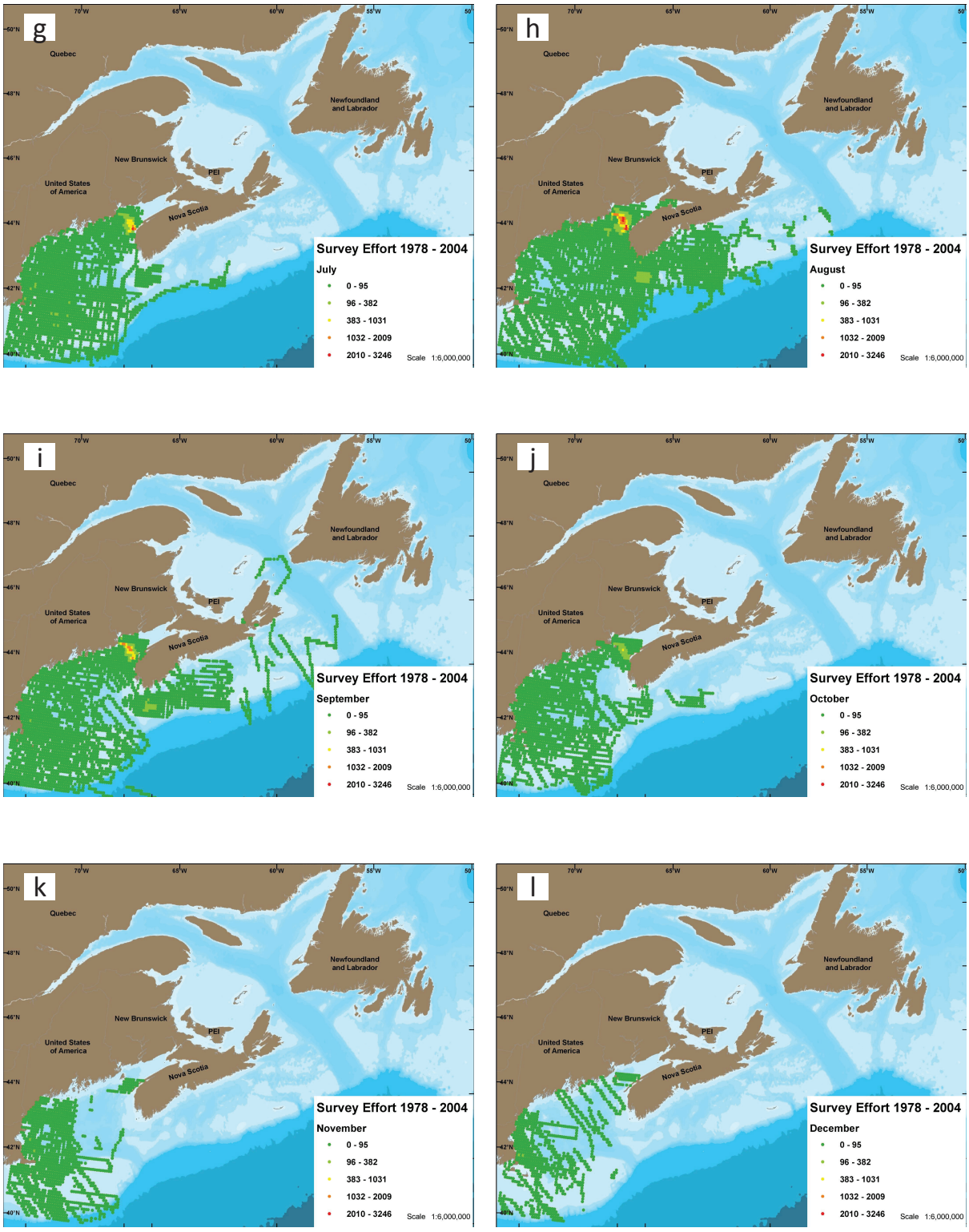

Figure S1 (Cont.)

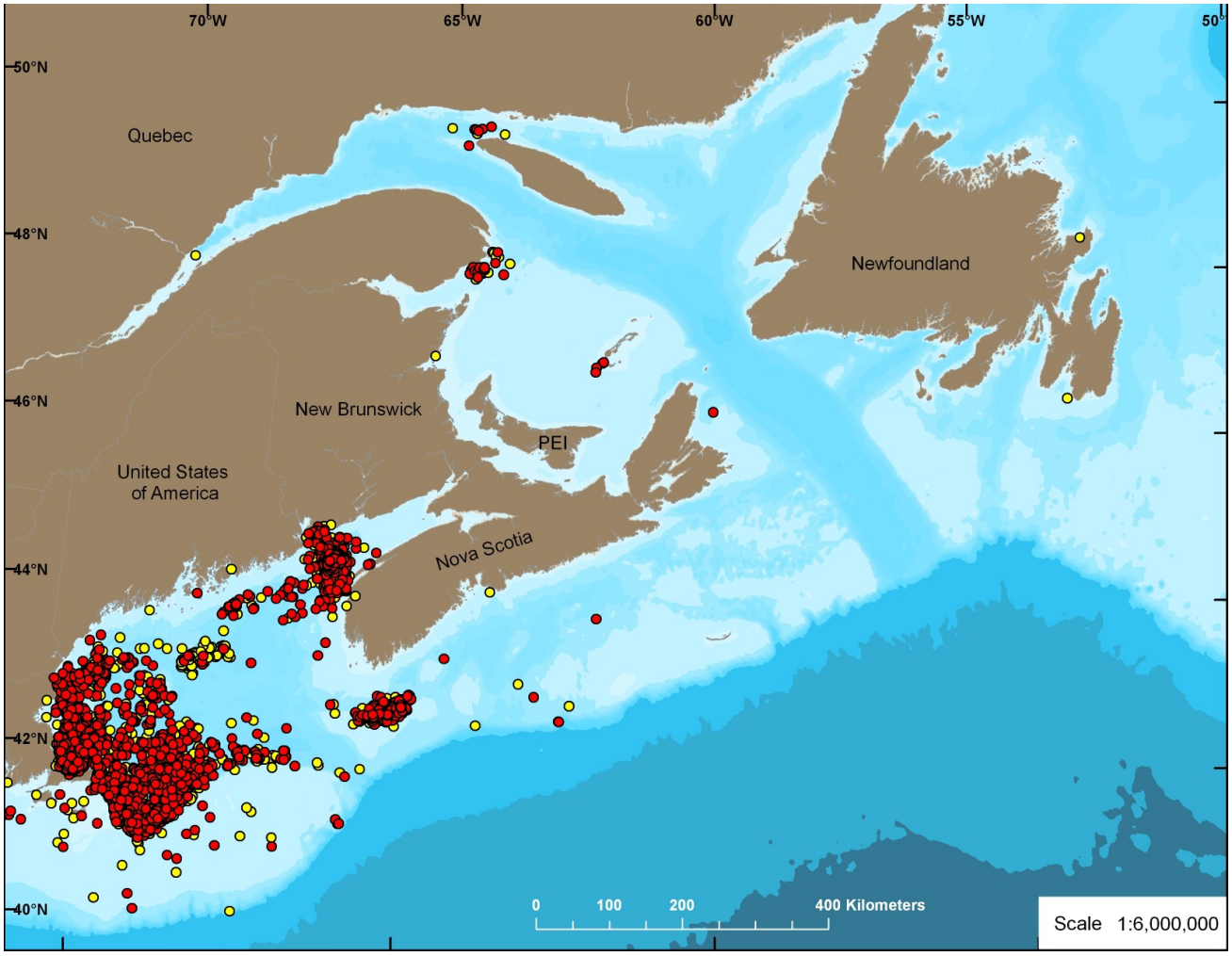

Figure S2. Known locations of all photo-identified North Atlantic right whales from 1978 through 2007 that were used for the Brownian bridge model (red dots; ≤ 30 days between consecutive observations) and those that did not meet the criteria (yellow dots; single observations or > 30 days between consecutive observations; Right Whale Consortium Identification Database 2008).