

Northeast Fisheries Science Center Technical Memorandum 456

Population size estimation of North Atlantic right whales from 1990–2025

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SUMMARY

This report serves to update the population size estimate of North Atlantic right whales (*Eubalaena glacialis*; hereafter, right whales) for the most recent year of available sightings data. Using an established capture-recapture framework (Pace et al., 2017) and a new calf-integration approach (Linden, 2025b), the estimated median population size at the start of 2025 was 382 whales, with a 95% credible interval ranging from 371 to 393. The number of breeding females was estimated to be 73 [71, 76] while the total mortality estimate from 2024–2025 was 17 [9, 26].The sharp decrease in the population size observed from 2015–2020 appears to have slowed, though the right whale population continues to experience annual mortalities above recovery thresholds. The updated right whale population estimate will be provided to the Atlantic Scientific Review Group for consideration in the next Atlantic Stock Assessment Review process.

METHODS

I used a Bayesian version of a multistate Jolly-Seber capture-recapture model fit to sightings records of right whales to estimate population parameters including annual abundance and survival. The general approach has been described in detail elsewhere (Pace et al., 2017; Pace, 2021), including a new modification to integrate known births (Linden, 2025b). Here I document the updated data and clarify modeling decisions to improve reproducibility.

Data

The New England Aquarium (NEAq), as data stewards of the North Atlantic Right Whale Consortium (NARWC), provided updated records on 31 August 2026 that included >90,000 sightings of 777 whales observed from 1990 to 2025. Individuals are identified primarily by natural markings (Hamilton et al., 2007) with additional information from genetic sampling (Frasier et al., 2007). Along with individual sightings, records of calving events that could be associated with known mothers were shared, including observations of calves that were known or presumed to be lost. Lost calves were defined by 1 of 4 situations: 1) a neonate carcass recovered and linked to a mother; 2) documented mortality of a mother during the calf's first 4 months of life; 3) a documented fatal injury of a calf without the carcass recovered; or 4) sighting of a mother with a calf and then without on the calving grounds.

The sightings were aggregated by individual into survey years (1 December–November 30) to align with the calving season and the seasonal distribution of survey effort (Pace et al., 2017). Annual capture histories ($y_{i,t}$) contained a binary observation (1 = seen alive or 2 = not seen alive) indicating whether an individual (i) was sighted in the given survey year (t), across a total of 36 years.

The capture histories corresponded to a matrix of true states ($z_{i,t}$) with the following definitions: 1 = not yet entered the population; 2 = alive; and 3 = dead. Individuals seen during a

survey year were assigned a known alive state ($z_{i,t} = 2$), while those discovered dead were assigned a known dead state ($z_{i,t} = 3$) for the following survey year. Known alive states were also assigned for all survey years between the first and last years with sightings, including for individuals first seen prior to 1990. Additionally, any adult whales seen during the 2026 calving season and not seen in 2025 were assigned a known alive state for 2025. Along with sightings of live and dead individuals, those with known birth years were assigned a known state of $z_{i,t} = 1$ for all survey years prior to birth. Any years that were missing evidence of the known state for an individual were assigned as unknown ($z_{i,t} = \text{NA}$). For the terminal year in 2025, there were 11 calves included as potential recruits to the population.

Age and sex were known for 64% and 95% of individuals, respectively. Given a known birth year, individuals were classified each year into 1 of 6 age classes (0,1,2,3,4,5+) to accommodate modeling variation in survival for younger animals. While several options exist to handle unknown ages (Pace, 2021), including explicit modeling of age 0 entry (Hostetter et al., 2021), here I assigned the age at entry to be 5+ (adult age class) for individuals with an unknown birth year, consistent with the original approach (Pace et al., 2017).

Model fitting

The multistate Jolly-Seber capture-recapture model uses a hierarchical formulation to describe probabilities of observations conditional on true states and transitions between states over time (Kéry & Schaub, 2012; Royle & Dorazio, 2012). I used Markov chain Monte Carlo (MCMC) methods for model fitting and directly estimated the partially latent true states across time. By having at least 3 true states, the processes of recruitment and survival could be estimated, in addition to population size. Our state transition matrix was specified as follows:

$$\boldsymbol{\Omega} = \begin{array}{c} \\ z_{i,t} \end{array} \begin{array}{c} \begin{array}{ccc} z_{i,t+1} & & \end{array} \\ \begin{bmatrix} 1-\gamma_t & \gamma_t & 0 \\ 0 & \phi_{i,t} & 1-\phi_{i,t} \\ 0 & 0 & 1 \end{bmatrix} \end{array}$$

where γ_t is the probability of entry and $\phi_{i,t}$ is the probability of survival. The matrix makes clear which transitions are allowed (e.g., $z_{i,t+1} = 2$ after $z_{i,t} = 1$) and which are not allowed (e.g., $z_{i,t+1} = 2$ after $z_{i,t} = 3$). The observation matrix was defined as follows:

$$\boldsymbol{\Theta} = \begin{array}{c} \\ z_{i,t} \end{array} \begin{array}{c} \begin{array}{cc} y_{i,t} & \end{array} \\ \begin{bmatrix} 0 & 1 \\ p_{i,t} & 1-p_{i,t} \\ 0 & 1 \end{bmatrix} \end{array}$$

where $p_{i,t}$ is the probability of sighting individual i in year t, given the true state $z_{i,t}$.

In this formulation, entry is a removal process given that only available individuals (those not yet entered) can transition into the population (Kéry & Schaub, 2012). The entry probability

is typically a nuisance parameter and not directly related to per-capita recruitment, though the realized counts of recruits (i.e., population entries) can be derived from the posterior distributions of true states. Here, I used a birth-integrated Jolly-Seber model (Linden, 2025b) to improve the population estimation process and increase accuracy of the terminal year estimate. Annual calf counts (Table 1), with observed losses subtracted from the total observed births, were used to define the expected number of entries for all years $t > 1$. The γ_t entry probabilities were then a function of the expected entries. Calf mortality probability (κ), representing the probability that calves that may have survived the winter calving season but did not recruit to the population, was assumed constant.

I used parameter-expanded data augmentation as part of the MCMC approach to model fitting (Royle & Dorazio, 2012), where the capture history matrix of observed individuals is augmented with a number of additional all-zero capture histories representing potential individuals that were never sighted. Here, I added 300 additional capture histories, resulting in $M = 1077$ total individuals in the $y_{i,t}$ data.

The likelihoods of the true states and the observations conditional on true states were then specified as follows:

$$z_{i,t+1}|z_{i,t} \sim \text{categorical}(\Omega_{z_{i,t},1:3})$$

$$y_{i,t}|z_{i,t} \sim \text{categorical}(\Theta_{z_{i,t},1:2})$$

To facilitate convenient model fitting, I added a dummy occasion before year 1 where $\Pr(z_{i,t} = 1) = 1$ for all individuals (Kéry & Schaub, 2012), allowing γ_1 to represent the proportion of M individuals either born in 1990 or already in the population before 1990.

I accommodated individual and temporal variation in survival and sighting probabilities using logit-linear models. For survival probability:

$$\text{logit}(\phi_{i,t}) = \beta_0 + \beta_{\text{age}} \times \text{Age}_{i,t} + \beta_{\text{female}} \times \text{Sex}_i \times \text{Adult}_{i,t} + \epsilon_t^{\phi}$$

Here, β_0 is the average survival probability for $\text{Age}_{i,t} = 0$ individuals (0.5 year olds); β_{age} is the coefficient for linear change in survival with ages from 1–5; β_{female} is the coefficient of difference in survival for adult females; and ϵ_t^{ϕ} is the random effect of year. Pace (2021) added a "regime effect" to estimate the change in expected survival after 2010, but this was largely characterizing a perturbation in mortality rate from 2014–2019 that has since subsided (Linden et al., 2025). Temporal variation in survival is more flexibly described by the random effect specification, and removal of the regime coefficient had little influence on model results (*not shown*).

For sighting probability the logit-linear model was as follows:

$$\text{logit}(p_{i,t}) = \alpha_0 + \alpha_{\text{female}} \times \text{Sex}_i + \epsilon_t^p + \epsilon_i^p$$

Here, α_0 is the average sighting probability for males; α_{female} is the coefficient of difference in sighting for females; ϵ_t^p is the random effect of year; and ϵ_i^p is the random effect of individual.

I used vague priors for most parameters including Uniform(0,1) for intercept probabilities, Uniform(-5,5) for regression coefficients, and Uniform(0,10) for random effect standard deviations. To assign a value for individuals with unknown sex, I estimated a general sex ratio according to Bernoulli(π_{female}) with an informed prior of Beta(5,5). Known states were provided as data during model fitting, and unknown states were initialized as $z_{i,t} = 1$ for all years prior to first sighting and $z_{i,t} = 3$ for all years following the last sighting. Augmented individuals were initialized at $z_{i,t} = 1$ for all years.

I fit the model in R (R Core Team, 2025) using MCMC with NIMBLE (de Valpine et al., 2017, 2022). The MCMC algorithm was run for 25,000 iterations over 3 chains, after a burn-in of 5,000 iterations. Convergence was assessed by examining trace plots and the potential scale reduction factor (R-hat; Brooks & Gelman (1998)), the latter indicating a value of <1.1 for all parameters. Parameter estimates are presented as the median of the posterior distribution followed by upper and lower 95% credible intervals in brackets. Model code and data are available on Github (https://github.com/NEFSC/PSD-NARW_popsize).

Results

The birth-integrated Jolly-Seber model achieved convergence and exhibited expected patterns of variation regarding sex, age, and temporal characteristics of survival and sighting probabilities (Table 2). There was moderate evidence that females had a lower average sighting probability ($\alpha_{\text{female}} = -0.279$ [−0.544, −0.015]) than males (Figure 1). There was strong evidence of reduced survival for adult females ($\beta_{\text{female}} = -0.379$ [−0.607, −0.149]) and increased survival for older whales ($\beta_{\text{age}} = 0.147$ [0.065, 0.225]). Annual fluctuations in estimated survival probability indicated a period of low survival between 2014–2019 before an increase between 2020–2023 (Figure 2); the latest estimate, encapsulating probability of survival between 2024 and 2025, was the lowest since 2019.

The probability of unobserved calf mortality (κ) in the first 6 months was estimated at 0.020 [0.001, 0.072]. Given that the 33 observed calf losses (Table 1) were already subtracted as potential recruits in the model, this parameter is meant to represent losses *beyond* those observed. Other model results indicated no evidence of further calf loss beyond those that were observed. Of the 486 total births during 1991–2023 that could yield a potential recruit to the population,

410 were accounted for by individuals with a known birth year in the catalog. For the remaining 76 births, there were 104 individuals first seen after 1990 with an unknown birth year and 26 of those were predicted to have been born in 1990 or earlier. Thus, nearly all entries to the population were accounted for by observed births. Finally, the total recruits during 1991–2024 were estimated to be 489 [482, 495], matching the total observed births during that period. More work is needed to fully understand the role of κ in the birth-integrated model.

The most recent estimate of total population size in 2025 was 382 whales, with a 95% credible interval ranging from 371 to 393. The 60% credible interval, helpful for identifying N_{min} as used in calculating the Potential Biological Removal, ranged from 377 to 387. While the long-term population trend continues to be in decline since 2011 (Table 3; Figure 3), the short-term trend is positive. Although some negative bias in the terminal year abundance estimate might be expected (Pace, 2021), this bias should be greatly reduced with the birth-integrated model (Linden, 2025b). This year's revised estimate of the 2024 population size was 389 [386, 392]; last year, the initial 2024 population estimate using the birth-integrated model had been 384 individuals [375, 394] (Linden, 2025a). The overlapping uncertainty intervals further support a reduction in bias for the terminal year estimate as a result of the new model formulation.

Given the lower survival for adult females, patterns in sex-specific abundance continue to diverge across time series (Figure 4), as originally noted by Pace et al. (2017). The 2025 estimate included 161 [153, 170] females and 221 [214, 228] males. The number of known reproductive females (with previous evidence of calving) estimated to be alive was 73 [71, 76]. Predicted number of deaths from 2024–2025 were the highest since 2019–2020 (Table 4; Figure 5), after a period of low mortality during 2020–2024. Observations in summer 2026 include some individuals that were not seen in 2025 (*New England Aquarium, personal communication*), suggesting there may be a downward adjustment to the 2024–2025 mortality estimate when 2026 sightings data are fit to the model. Either way, these annual mortality estimates are still well above the Potential Biological Removal rate identified for right whales (Hayes et al. (2022)).

Acknowledgements

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REFERENCES

Brooks, S., & Gelman, A. (1998). General methods for monitoring convergence of iterative simulations. *Journal of Computational and Graphical Statistics*, *7*(4), 434–455.

de Valpine, P., Paciorek, C., Turek, D., Michaud, N., Anderson-Bergman, C., Obermeyer, F., Wehrhahn Cortes, C., Rodrìguez, A., Temple Lang, D., & Paganin, S. (2022). *NIMBLE: MCMC, particle filtering, and programmable hierarchical modeling* (0.12.2). https://doi.org/10.5281/zenodo.1211190

de Valpine, P., Turek, D., Paciorek, C., Anderson-Bergman, C., Temple Lang, D., & Bodik, R. (2017). Programming with models: Writing statistical algorithms for general model structures with NIMBLE. *Journal of Computational and Graphical Statistics*, *26*, 403–413. https://doi.org/10.1080/10618600.2016.1172487

Frasier, T., McLeod, B., Gillett, R., Brown, M., & White, B. (2007). Right whales past and present as revealed by their genes. In S. D. Kraus & R. M. Rolland (Eds.), *The urban whale: North Atlantic right whales at the crossroads.* (pp. pp. 200–231). Harvard University Press.

Hamilton, P., Knowlton, A., & Marx, M. (2007). Right whales tell their own stories: The photo-identification catalog. In S. D. Kraus & R. M. Rolland (Eds.), *The urban whale: North Atlantic right whales at the crossroads.* (pp. pp. 75–104). Harvard University Press.

Hayes, S. H., Josephson, E., Maze-Foley, K., Rosel, P. E., & Wallace, J. (2022). *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments 2021*. NOAA Tech Memo NMFS-NE-288. https://doi.org/10.25923/6tt7-kc16

Hostetter, N. J., Lunn, N. J., Richardson, E. S., Regehr, E. V., & Converse, S. J. (2021). Age-structured jolly-seber model expands inference and improves parameter estimation from capture-recapture data. *PLoS One*, *16*(6), e0252748.

Kéry, M., & Schaub, M. (2012). *Bayesian population analysis using WinBUGS: A hierarchical perspective*. Academic Press.

Linden, D. W. (2025a). *Population size estimation of North Atlantic right whales from 1990-2024. NOAA Tech Memo NMFS-NE 338*. https://doi.org/10.25923/ha3d-2f70

Linden, D. W. (2025b). Using known births to account for delayed marking in population estimation of North Atlantic right whales. *Ecology and Evolution*, *15*(3), e71035. https://doi.org/10.1002/ece3.71035

Linden, D. W., Runge, M. C., Hostetler, J. A., Borggaard, D. L., Garrison, L. P., Knowlton, A. R., Lesage, V., Williams, R., & Pace, R. M. (2025). *Update to a management-focused population viability analysis for North Atlantic right whales*. *NOAA Tech Memo NMFS-NE 337*. https://doi.org/10.25923/0xdp-8s42

Pace, R. M., III. (2021). *Revisions and further evaluations of the right whale abundance model: Improvements for hypothesis testing. NOAA Tech Memo NMFS-NE 269*.

Pace, R. M., III, Corkeron, P. J., & Kraus, S. D. (2017). State–space mark–recapture estimates reveal a recent decline in abundance of North Atlantic right whales. *Ecology and Evolution*, *7*(21), 8730–8741.

R Core Team. (2025). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Royle, J. A., & Dorazio, R. M. (2012). Parameter-expanded data augmentation for bayesian analysis of capture–recapture models. *Journal of Ornithology*, *152*(Suppl 2), 521–537.

TABLES

Table 1: Count of observed North Atlantic right whale calving events associated with known mothers, including losses due to observed mortality events (either calf or mother) occuring in the first 6 months of the calendar year during 1990–2025.

Year	Born	Lost
1990	12	0
1991	17	0
1992	12	0
1993	6	0
1994	9	1
1995	7	0
1996	21	2
1997	19	0
1998	5	0
1999	4	0
2000	1	0
2001	31	4
2002	21	0
2003	19	0
2004	16	1
2005	28	1
2006	19	3
2007	23	0
2008	23	2
2009	39	1
2010	19	1
2011	22	2
2012	7	1
2013	20	0
2014	11	1
2015	17	0
2016	14	2
2017	5	0
2018	0	0
2019	7	0
2020	10	2
2021	20	1
2022	15	2
2023	12	1
2024	20	5
2025	11	0

Table 2: Posterior summaries of main parameters from multistate capture-recapture model of North Atlantic right whales from 1990-2025. Parameters include: logit-linear coefficients for sighting probability, including the intercept (α_0) and the effect of individuals being female (α_{female}); logit-linear coefficients for survival probability, including the intercept (β_0), the linear effect of age from 0-5 (β_{age}), and the effect of being an adult female (β_{female}); the probability of a whale being female (π_{female}); the probability of calf mortality (κ); the standard deviation of individual variation in sighting probability ($\sigma^{p(i)}$); the standard deviation of temporal variation in sighting probability ($\sigma^{p(t)}$); and the standard deviation of temporal variation in survival probability ($\sigma^{\phi(t)}$).

	mean	sd	2.5%	50%	97.5%	Rhat	n.eff
α_{female}	−0.278	0.135	−0.544	−0.279	−0.015	1.00	1868
α_0	2.269	0.092	2.092	2.268	2.454	1.00	1943
β_{age}	0.146	0.041	0.065	0.147	0.225	1.00	10128
β_{female}	−0.378	0.117	−0.607	−0.379	−0.149	1.00	11596
β_0	3.149	0.178	2.803	3.144	3.518	1.00	9426
π_{female}	0.468	0.018	0.432	0.468	0.504	1.00	11810
κ	0.025	0.019	0.001	0.020	0.072	1.00	6450
$\sigma^{p(i)}$	1.400	0.059	1.290	1.398	1.520	1.00	1857
$\sigma^{p(t)}$	1.028	0.134	0.803	1.013	1.332	1.00	8386
$\sigma^{\phi(t)}$	0.602	0.103	0.425	0.592	0.834	1.00	2402

Table 3: Posterior summaries of estimated population sizes from multistate capture-recapture model of North Atlantic right whales, including an integration of known calf counts, from 1990–2025.

	Year	mean	sd	2.5%	50%	97.5%
N[1]	1990	288.84	3.25	283	289	295
N[2]	1991	297.64	3.50	291	298	305
N[3]	1992	305.43	3.25	299	305	312
N[4]	1993	298.76	3.17	293	299	305
N[5]	1994	302.62	2.72	298	302	308
N[6]	1995	304.89	2.55	300	305	310
N[7]	1996	319.64	2.69	315	320	325
N[8]	1997	329.21	2.68	324	329	335
N[9]	1998	329.11	2.59	324	329	334
N[10]	1999	327.67	2.29	323	328	332
N[11]	2000	319.39	1.86	316	319	323
N[12]	2001	346.10	1.67	343	346	350
N[13]	2002	355.39	1.44	353	355	358
N[14]	2003	364.84	1.53	362	365	368
N[15]	2004	372.34	1.61	370	372	376
N[16]	2005	396.43	1.38	394	396	399
N[17]	2006	401.18	1.39	399	401	404
N[18]	2007	413.45	1.15	412	413	416
N[19]	2008	429.59	1.20	428	429	432
N[20]	2009	465.63	1.24	464	465	468
N[21]	2010	475.82	1.77	473	476	480
N[22]	2011	482.77	1.83	480	483	487
N[23]	2012	473.34	2.49	469	473	479
N[24]	2013	481.89	3.12	476	482	488
N[25]	2014	477.89	3.18	472	478	484
N[26]	2015	474.21	4.71	465	474	484
N[27]	2016	457.68	3.75	451	457	466
N[28]	2017	434.18	2.61	430	434	440
N[29]	2018	390.32	1.50	388	390	394
N[30]	2019	381.46	1.22	380	381	384
N[31]	2020	359.70	1.25	358	360	362
N[32]	2021	372.34	1.12	371	372	375
N[33]	2022	374.63	1.30	372	375	377
N[34]	2023	381.41	1.35	379	381	384
N[35]	2024	388.90	1.73	386	389	392
N[36]	2025	382.26	5.63	371	382	393

Table 4: Posterior summaries of estimated deaths from multistate capture-recapture model of North Atlantic right whales from 1990–2025. Note that these deaths do not include early calf losses (<6 months).

	Year.range	mean	sd	2.5%	50%	97.5%
Nd[2]	1990–1991	5.86	1.65	2	6	9
Nd[3]	1991–1992	3.32	1.51	1	3	7
Nd[4]	1992–1993	13.15	2.16	9	13	17
Nd[5]	1993–1994	5.03	1.68	2	5	9
Nd[6]	1994–1995	3.25	1.15	1	3	6
Nd[7]	1995–1996	6.49	1.54	4	6	10
Nd[8]	1996–1997	9.35	1.76	6	9	13
Nd[9]	1997–1998	4.66	1.54	2	5	8
Nd[10]	1998–1999	9.90	1.97	6	10	14
Nd[11]	1999–2000	9.02	1.76	6	9	13
Nd[12]	2000–2001	5.89	1.19	4	6	9
Nd[13]	2001–2002	9.84	1.24	7	10	12
Nd[14]	2002–2003	10.55	1.53	8	11	13
Nd[15]	2003–2004	8.10	1.62	5	8	11
Nd[16]	2004–2005	4.63	1.36	2	4	8
Nd[17]	2005–2006	11.98	1.45	9	12	15
Nd[18]	2006–2007	8.90	1.30	7	9	12
Nd[19]	2007–2008	5.74	1.11	4	6	8
Nd[20]	2008–2009	3.14	0.94	1	3	5
Nd[21]	2009–2010	8.91	1.58	6	9	12
Nd[22]	2010–2011	12.91	1.57	10	13	16
Nd[23]	2011–2012	15.59	2.30	11	16	20
Nd[24]	2012–2013	9.16	2.66	4	9	15
Nd[25]	2013–2014	11.58	2.96	6	11	18
Nd[26]	2014–2015	16.57	4.51	8	17	26
Nd[27]	2015–2016	29.66	5.07	20	29	40
Nd[28]	2016–2017	28.65	3.86	22	28	37
Nd[29]	2017–2018	43.86	2.74	39	44	50
Nd[30]	2018–2019	15.90	1.50	13	16	19
Nd[31]	2019–2020	29.91	1.45	27	30	33
Nd[32]	2020–2021	5.41	1.07	4	5	8
Nd[33]	2021–2022	10.94	1.20	9	11	13
Nd[34]	2022–2023	5.09	1.06	3	5	7
Nd[35]	2023–2024	5.77	1.28	3	6	8
Nd[36]	2024–2025	17.11	4.25	9	17	26

Figures

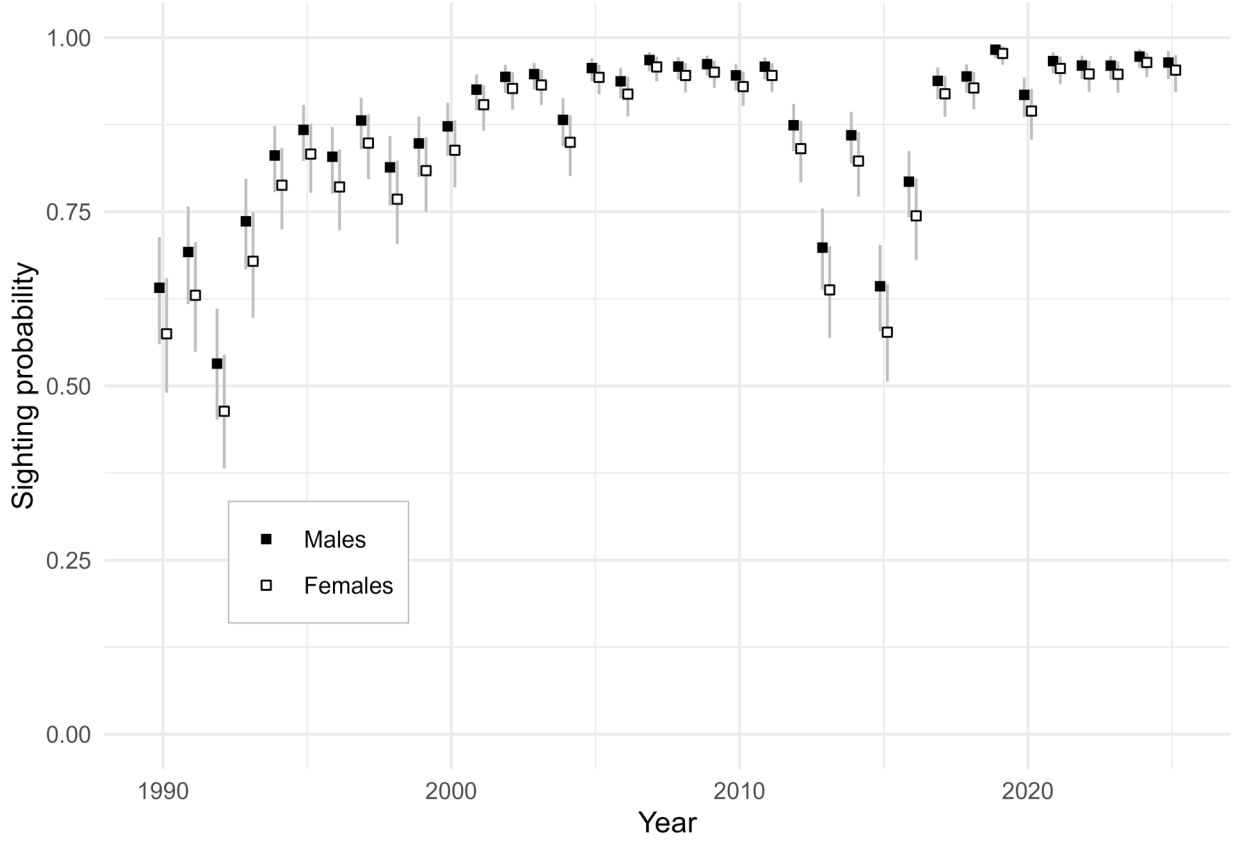


Figure 1: Sighting probabilities for North Atlantic right whales (*Eubalaena glacialis*) estimated from a Bayesian capture-recapture model of sightings data from 1990–2025.

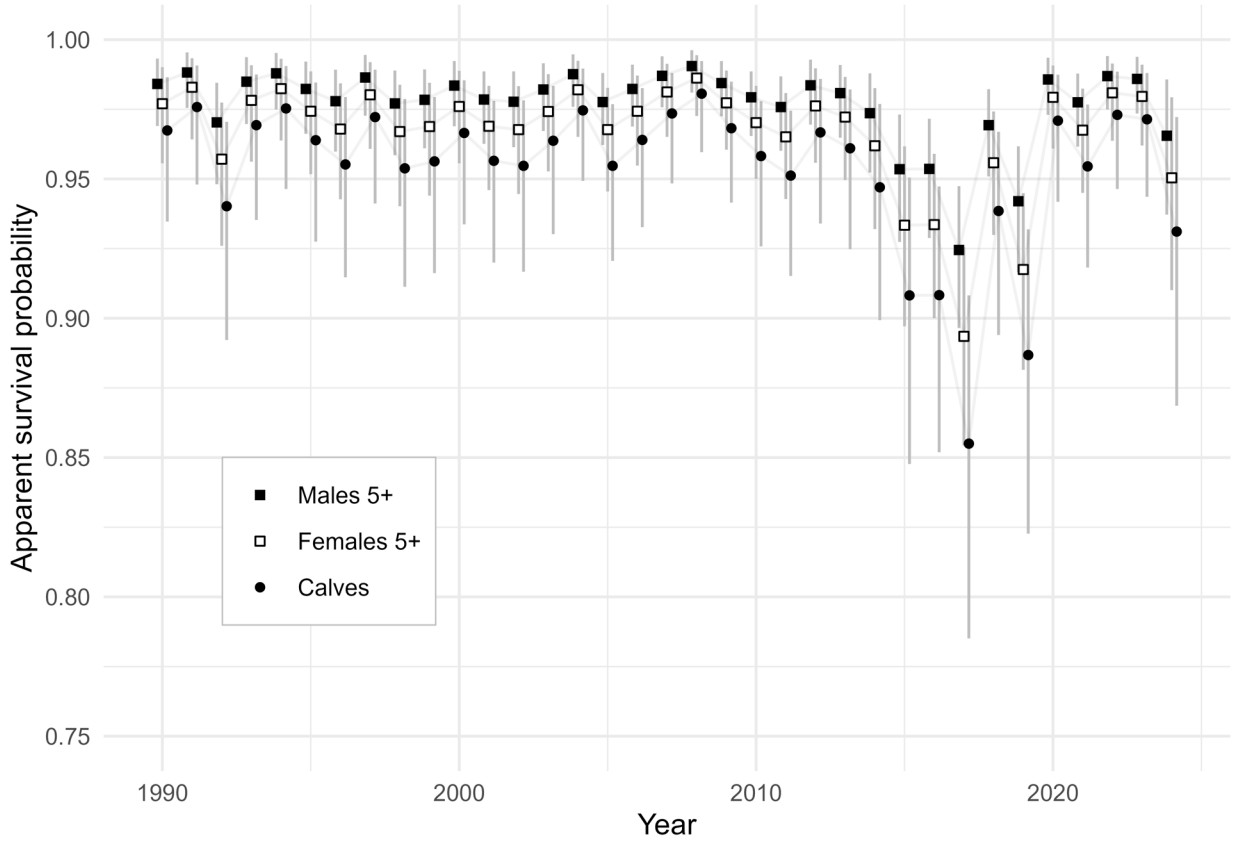


Figure 2: Apparent survival probabilities for North Atlantic right whales (*Eubalaena glacialis*) estimated from a Bayesian capture-recapture model of sightings data from 1990–2025.

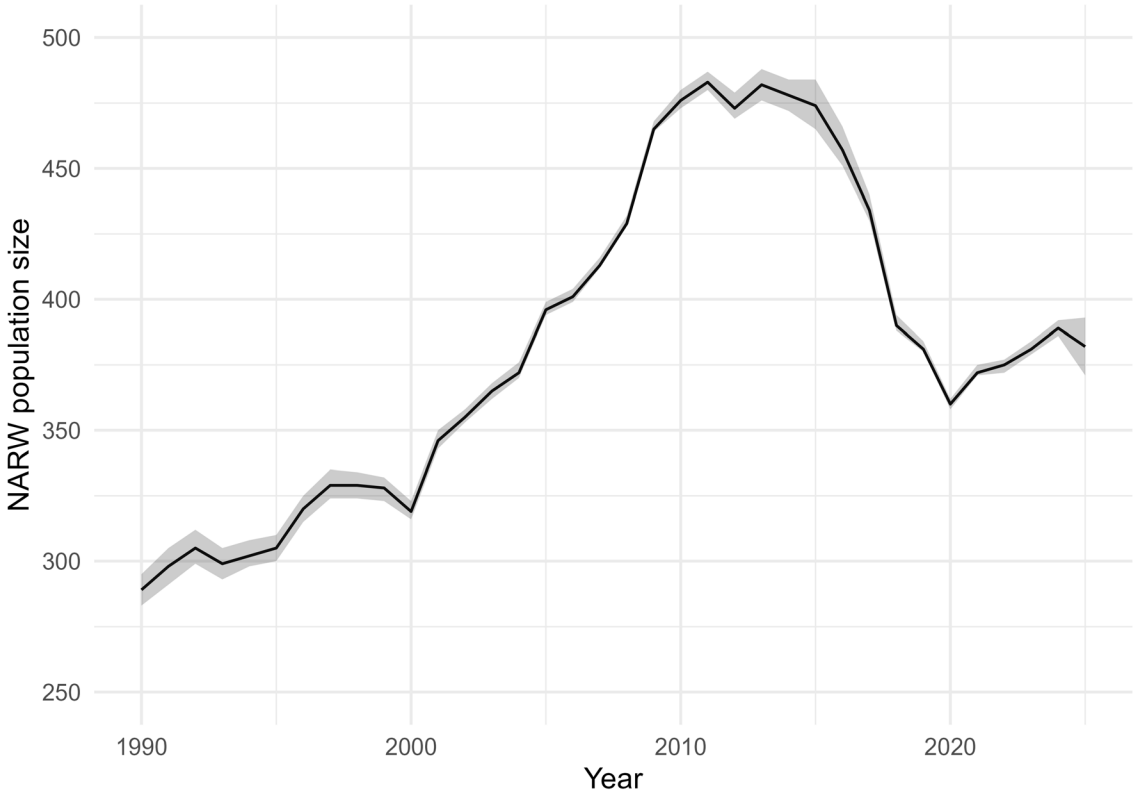


Figure 3: Population size of North Atlantic right whales (*Eubalaena glacialis*) estimated from a Bayesian capture-recapture model of sightings data, including an integration of known calf counts, from 1990–2025. Solid line indicates median of posterior distribution, with shading for the 95% credible interval.

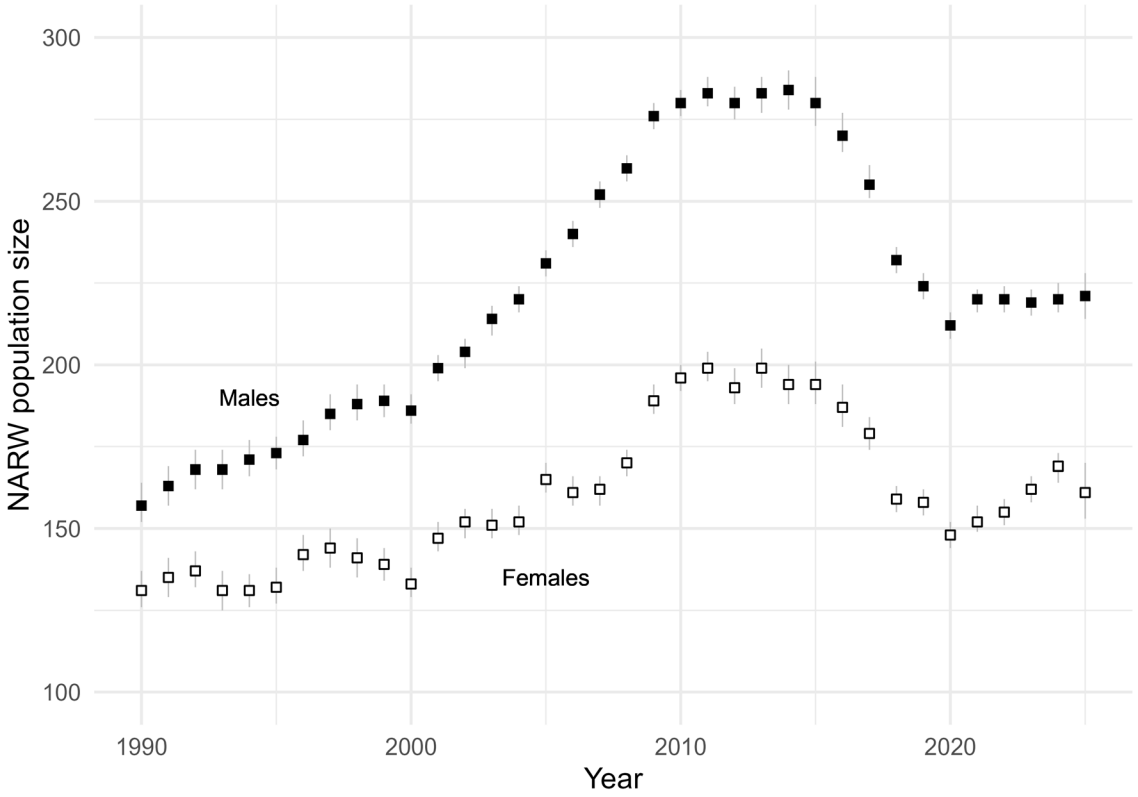


Figure 4: Median abundance (with 95% credible intervals) of female and male North Atlantic right whales (*Eubalaena glacialis*) estimated from a Bayesian capture-recapture model of sightings data from 1990–2025.

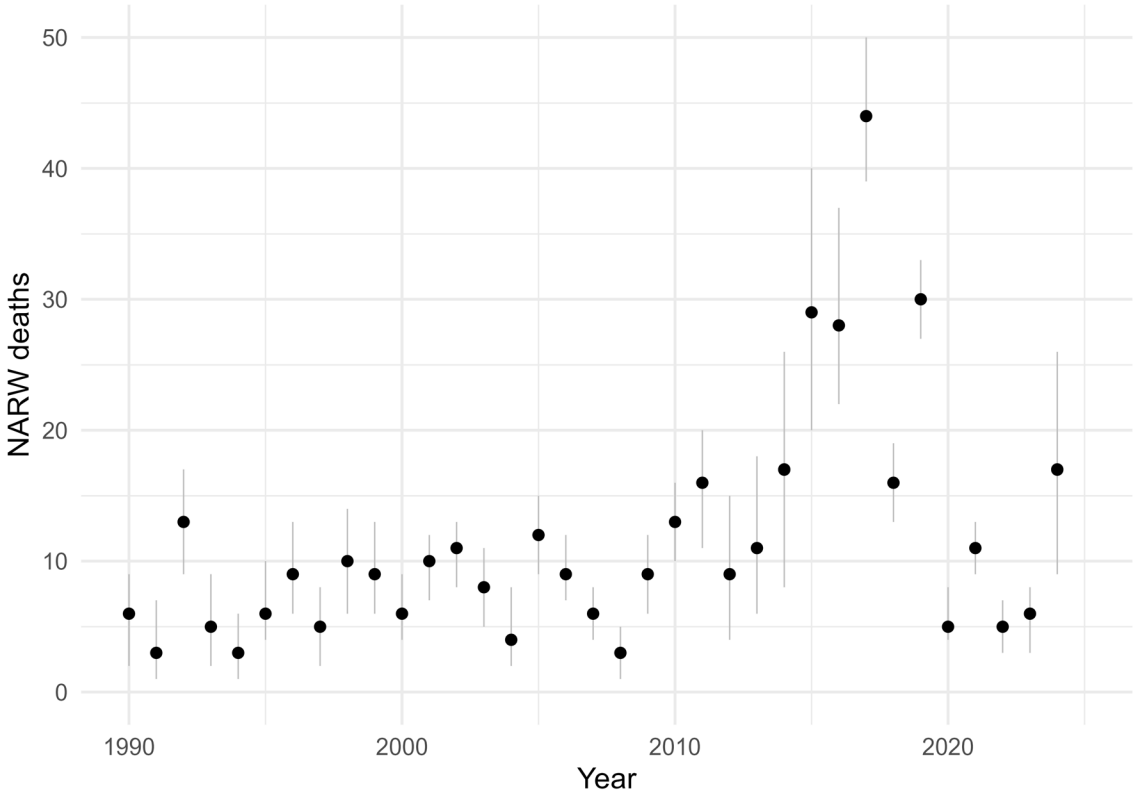


Figure 5: Median deaths (with 95% credible intervals) of North Atlantic right whales (*Eubalaena glacialis*) estimated from a Bayesian capture-recapture model of sightings data from 1990–2025. Note: these deaths do not include early calf losses (< 6 months).

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