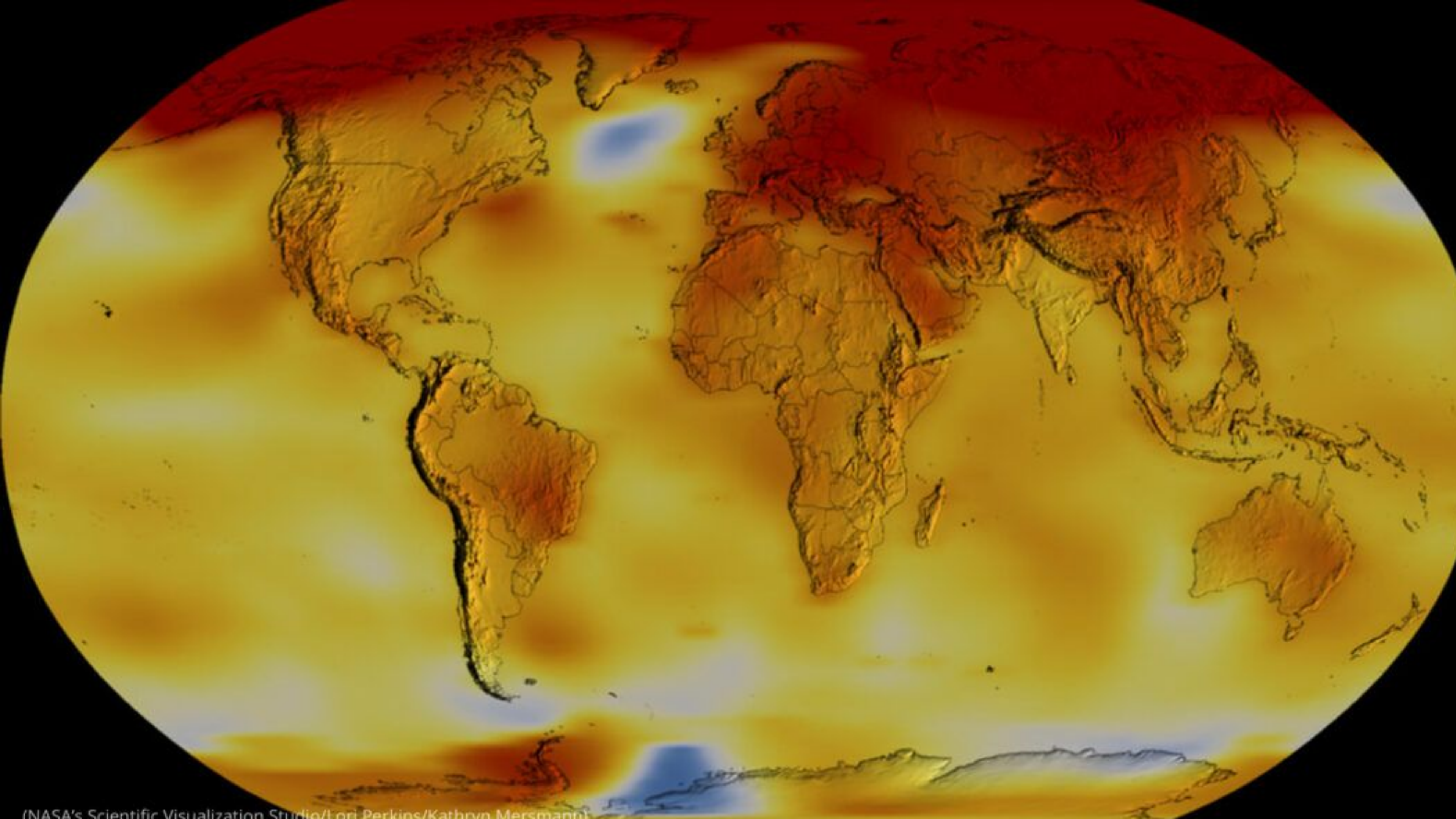
Potential ecosystem effects of Offshore Wind Development on North Atlantic Right Whales

Sean Hayes, NEFSC presenting

Image from: Hasager, C. B., L. Rasmussen, A. Peña, L. E. Jensen, and P.-E. Réthoré. 2013. Wind Farm Wake: The Horns Rev Photo Case. 6:696-716.


VINEGAR BITTERS


SAMPLE
No.



(NASA's Scientific Visualization Studio/Lori Perkins/Kathryn Mersmann)

Energy & Environment | Energy Markets & Governance | Renewables & Advanced Energy | United States and Canada

EnergySource | June 27, 2022

30 GW by 2030: Policies for expanding US offshore wind capacity

By Joseph Webster

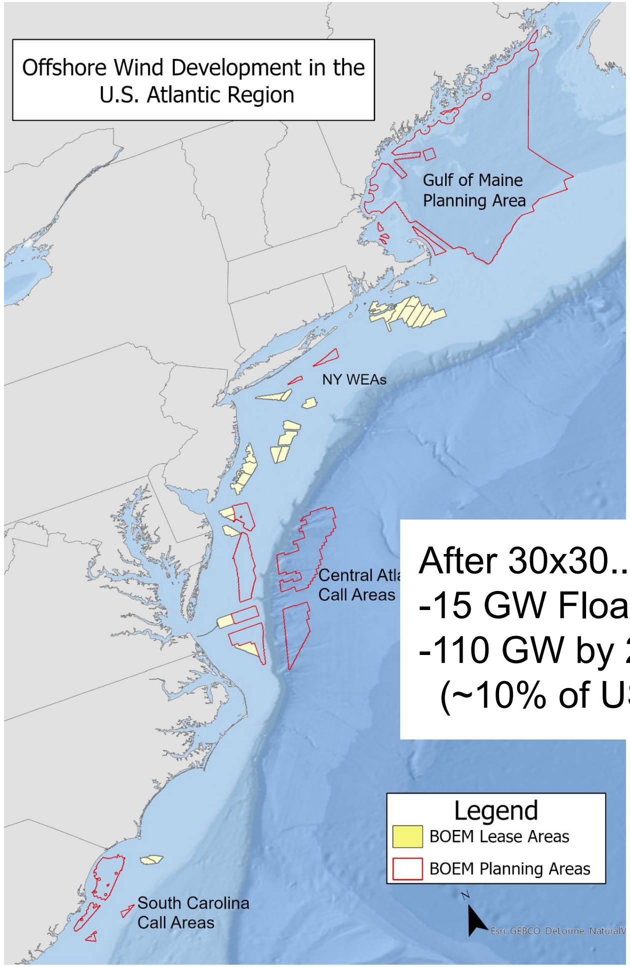
THE WHITE HOUSE

BRIEFING ROOM

FACT SHEET: Biden Administration Jumpstarts Offshore Wind Energy Projects to Create Jobs

MARCH 29, 2021 • STATEMENTS AND RELEASES

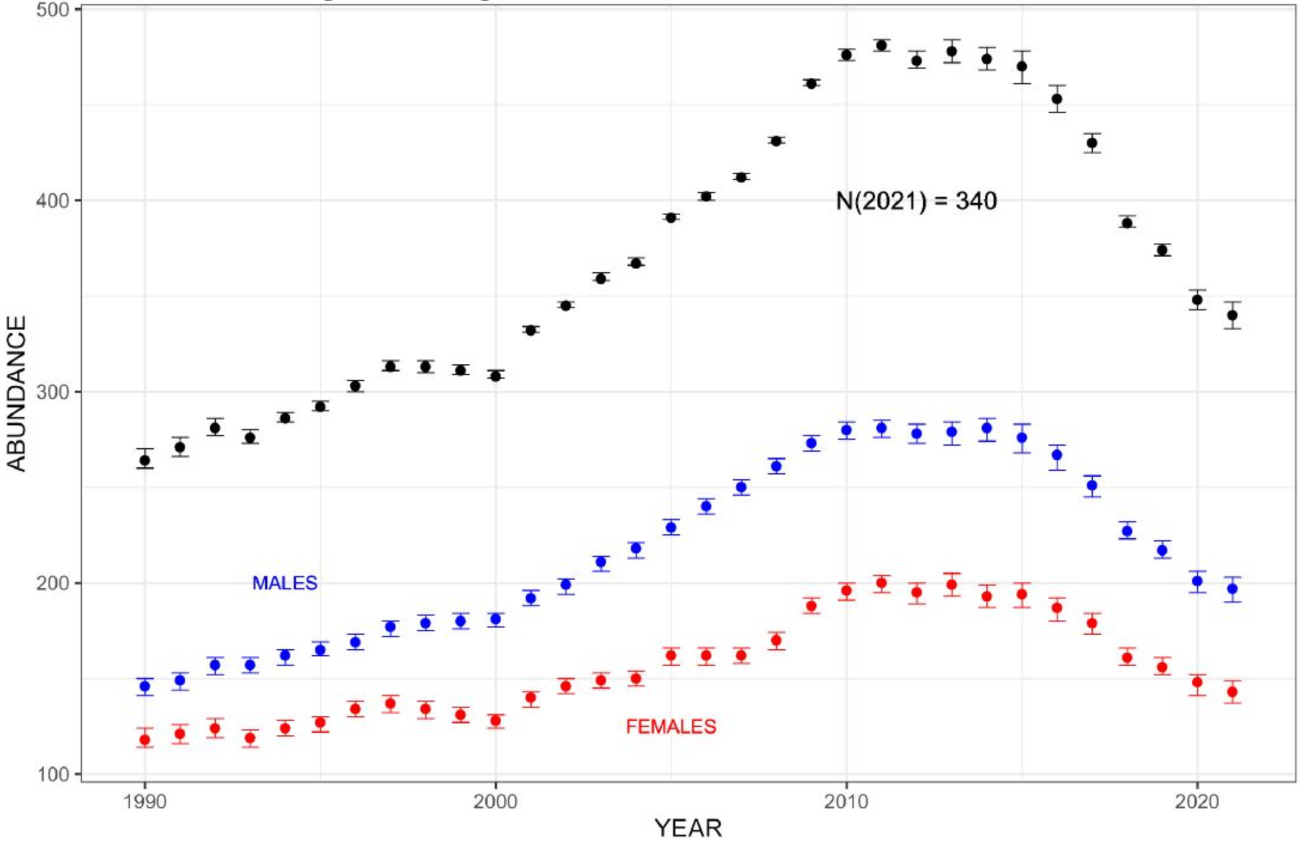
„The Departments of Interior (DOI), Energy (DOE), and Commerce (DOC) are announcing a shared goal to deploy 30 gigawatts (GW) of offshore wind in the United States by 2030, <u>while protecting biodiversity and promoting ocean co-use….</u>



After 30x30..
-15 GW Floating by 2035
-110 GW by 2050
(~10% of US demand)

Right whale population estimate update

As of the beginning of 2021



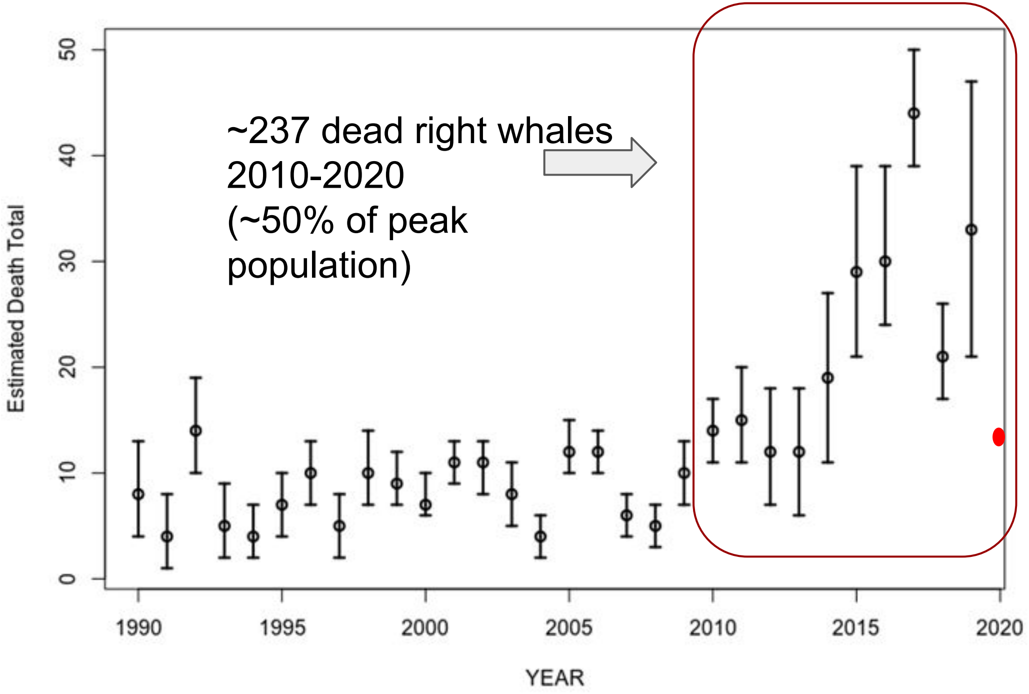
Population: 340
(credible interval 333-347)

Females: 143
(CI 137-149)

Known reproductive: <70 with >50% probability of being alive

Estimated Annual Mortality

($d[t] = N[t] + b[t] - N[t+1]$)

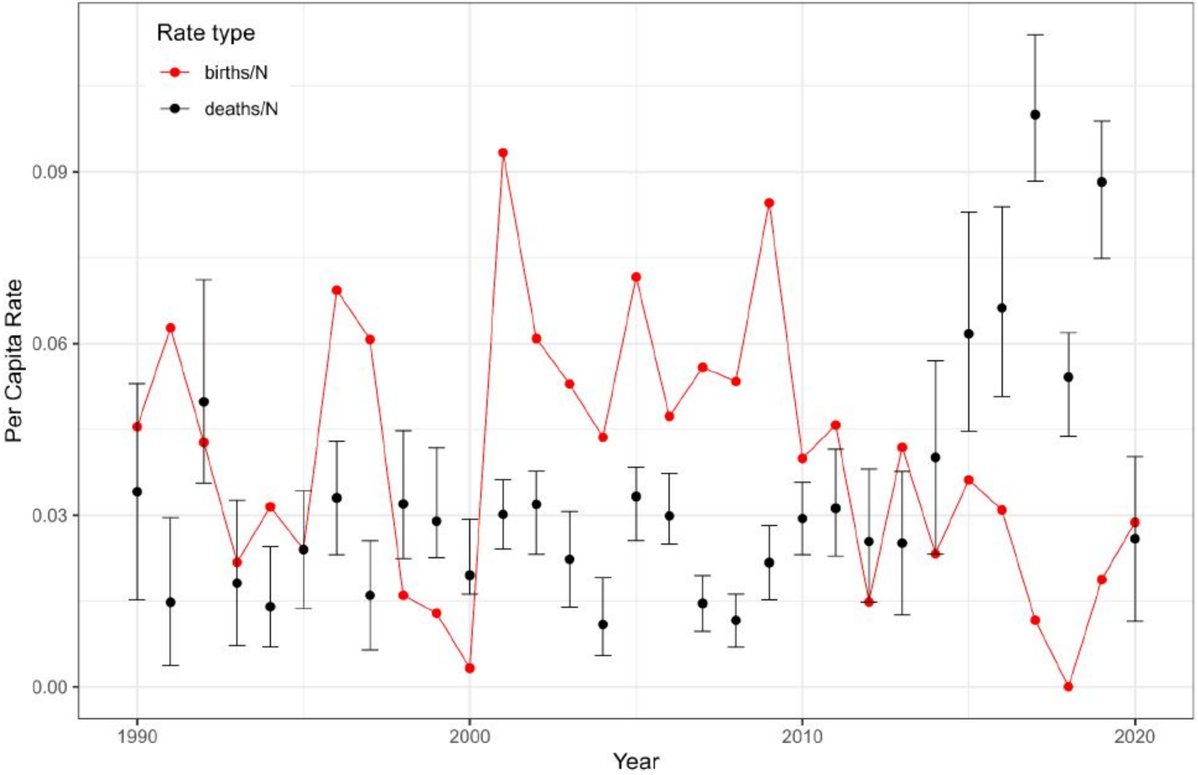


YEAR	EST Mort (median)	Obs Mort	Obs SI	Obs SI+M
2015	29	3	4	7
2016	30	4	9	13
2017	43	17	2	19
2018	21	3	6	9
2019	33	10	2	12
2020	13			

Hayes, S., et al. 2022. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2021 NOAA Tech Memo NMFS NE-288. 288: 479. Available from https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports

Method in: **Pace III, R.M., et al.** 2021. Cryptic mortality of North Atlantic right whales. Conservation Science and Practice. 3(2): e346. doi:https://doi.org/10.1111/csp2.346.

Birth rates are down… (N[t+1] = N[t] + b[t] - d[t])



Hayes, S., et al. 2022. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments-2021 NOAA Tech Memo NMFS NE-288. 288: 479. Available from https://www.fisheries.noaa.gov/national/marine-mammal-protection/marine-mammal-stock-assessment-reports *2020 values in review for 2023 assessment. Figure from IWC report

Why?

- Ecosystem shifts
- Whale behavior/distribution change into ‘unmanaged’ areas
- More encounters between whales, fishing gear and vessels
- Skinny whales don’t have babies

Right Whales are specialists
= less resilience to change

https://www.andersoncabotcenterforoceanlife.org/blog/a-zoomed-in-look-at-our-aerial-survey-photographs/

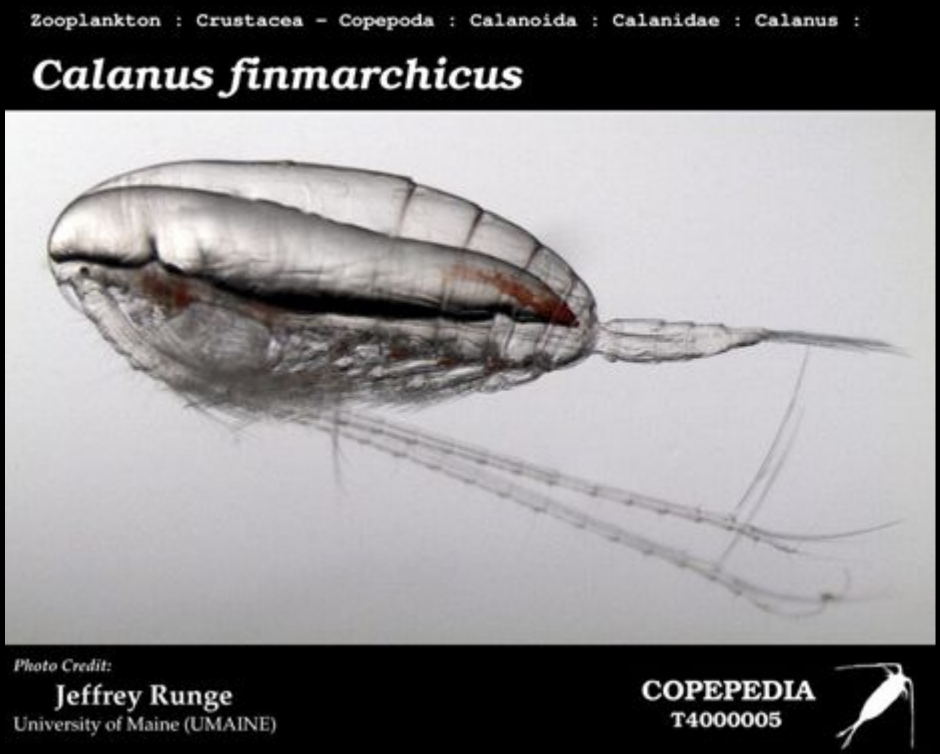
Foraging rates of ram-filtering North Atlantic right whales

	Bowhead Whale *Balaena mysticetus*	**North Atlantic right whale** *Eubalaena glacialis*	**Whale shark** *Rhincodon typus*	**Basking shark** *Cetorhinus maximus*
Gape Area	4.23 m^2	1–2 m^2	0.1 m^2	0.4 m^2
Body Length	12 m	10–14 m	6 m	4–6.5 m
Speed	0.7 m/s	1.2 m/s	0.3–1 m/s	0.85 m/s
Filtration Rate	3.0 m^3/s	1.4–2.4 m^3/s	0.01–0.1 m^3/s	0.3 m^3/s
Prey Concentration	1–10 g/m^3	>170 g/m^3 10^3–10^5 copepods/m^3	10^4 plankton/m^3	0.3–3 g/m^3
Pause Interval	150 s	50 s	120–180 s	30–60 s
References	Werth (2004) Simon et al. (2009) Laidre et al. (2007)	This study Murison & Gaskin (1989) Baumgartner & Mate (2003)	Nelson & Eckert (2007) Motta et al. (2010)	Hallacher (1977) Sims (2000)

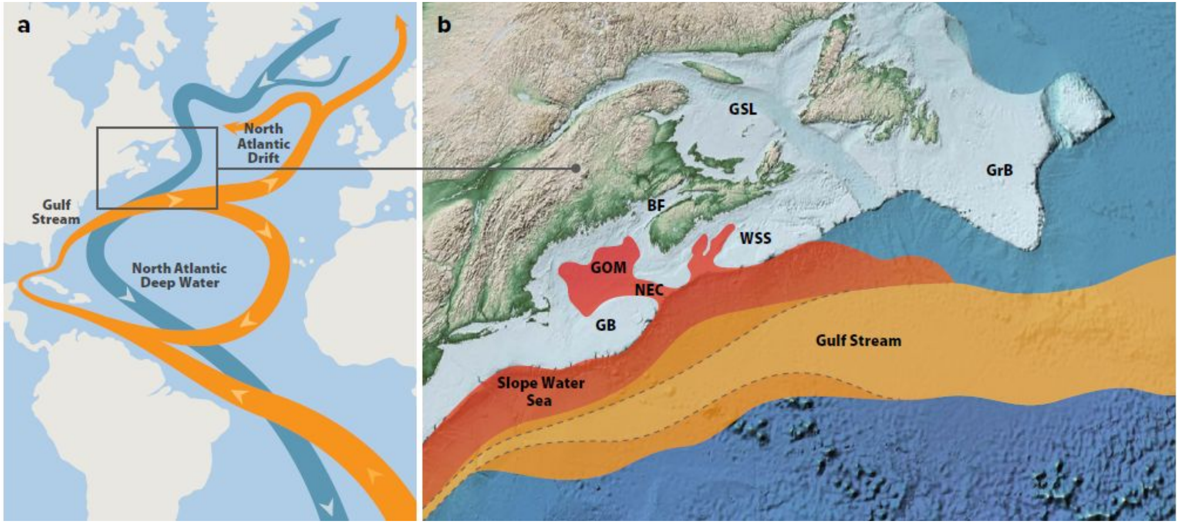
Functional Ecology, Volume: 33, Issue: 7, Pages: 1290-1306, First published: 11 May 2019, DOI: (10.1111/1365-2435.13357)

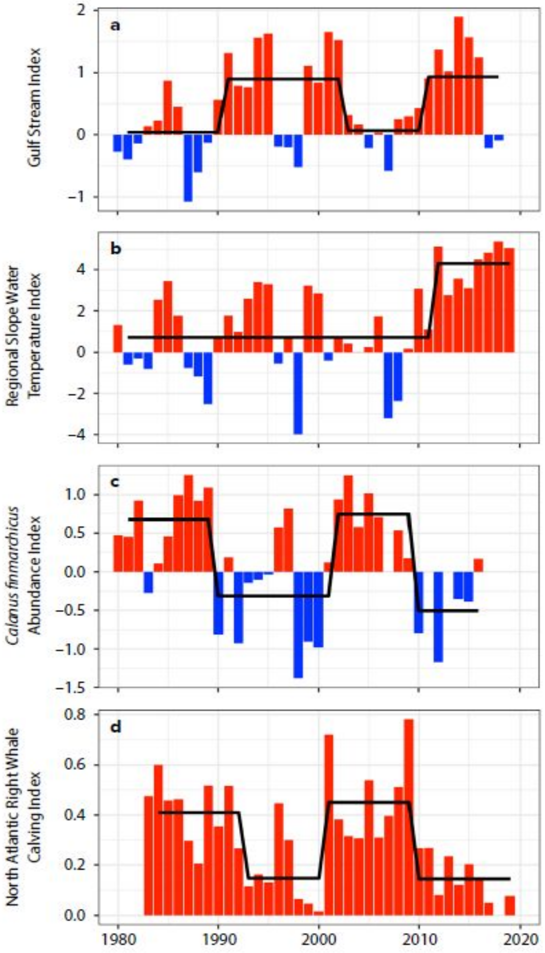
Plankton disruption concerns

- Abundance
- Distribution/Distance
- Density/Aggregation
- Energy content



Costs of Ecosystem Change

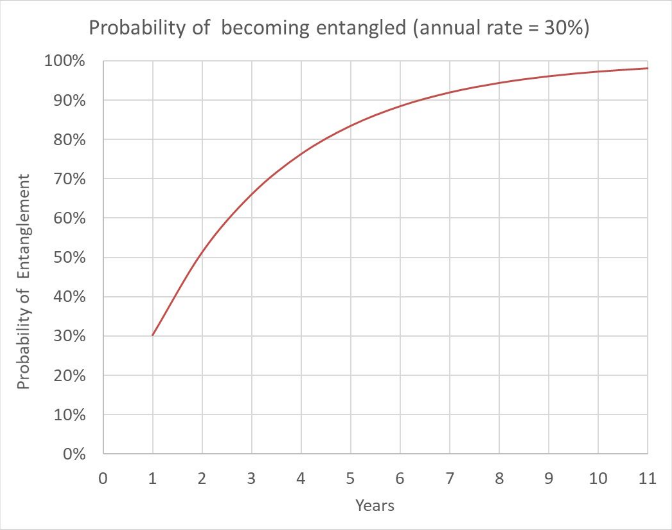


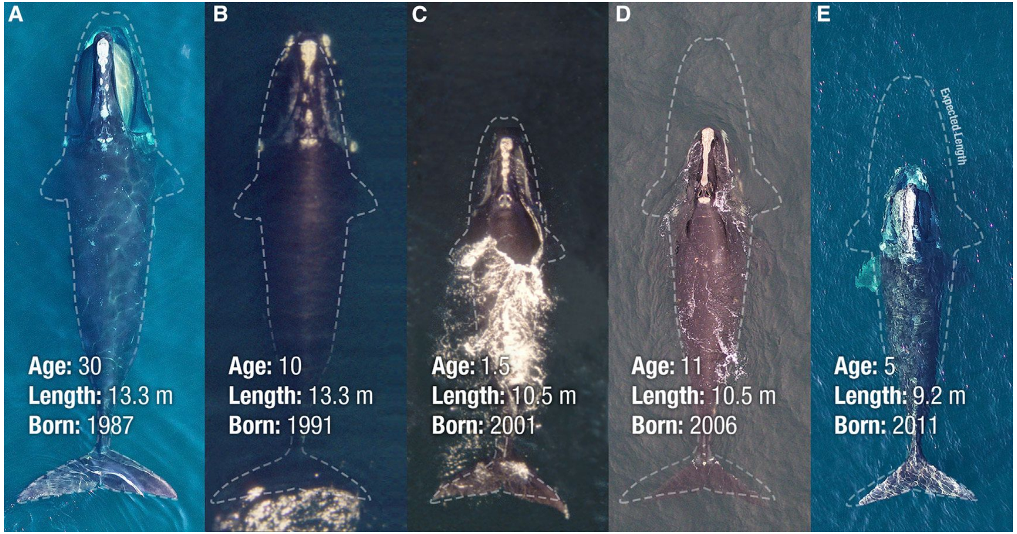


- 2010- NW Atlantic regime shift in gulf stream- warm water arrived
- Calanus abundance declines
- Calving rate declines
- Most successful moms find food in Gulf of St Lawrence
- Vessel strike and entanglement increase

Bishop, A.L. et al. 2022. Maternal lineage and habitat use patterns explain variation in the fecundity of a critically endangered baleen whale. Front Ecol Environ 9: 880910.
Meyer-Gutbrod, E.L., et al. 2021. Ocean Regime Shift is Driving Collapse of the North Atlantic Right Whale Population. Oceanography 34(3): 22-31.

NARW Stress and Energetic Costs of Entanglement





- Entanglement chronic- ~30% show fresh entanglement injury annually
- NARW increasingly stunted through entanglement stress -> less fecund
- Capital breeder- must acquire sufficient resources to produce calves
  - Breeding interval currently doubled from 4 to 8 years between calves, and most animal die before 40
  - Approx lifetime calving potential dropped from >15 to <4

Hamilton, P.K. et al 2022. Maintenance of the North Atlantic Right Whale Catalog . Anderson Cabot Center for Ocean Life, New England Aquarium. Submitted to NOAA/NMFS/NEFSC Contract No. 1305M2-18-P-NFFM-0108. https://www.narwc.org/narw-catalog-reports.html
Stewart, J.D., et al. 2021. Decreasing body lengths in North Atlantic right whales. 31(14): 3174-3179. e3173.
Stewart, J.D., et al. 2022. Larger females have more calves: influence of maternal body length on fecundity in North Atlantic right whales. MEPS 689: 179-189.
Pettis et al 2022NARW report card 2022 https://www.narwc.org/uploads/1/1/6/6/116623219/2022reportcardfinal.pdf

Potential conservation concerns with wind development

General threat categories

1. Vessel Strikes
2. Entanglement
   a. Fisheries Displacement
   b. Increased pot/trap fishing?
   c. Ghost gear on cables/pilings
   d. Floating wind structures?
3. Noise
4. Ecosystem change
   a. Predation
   b. Habitat alterations
   c. Oceanographic processes

- Evaluated at project level and above scaled up across many projects
- NMFS PET PVA considers 1-4 in general but specifics require more development

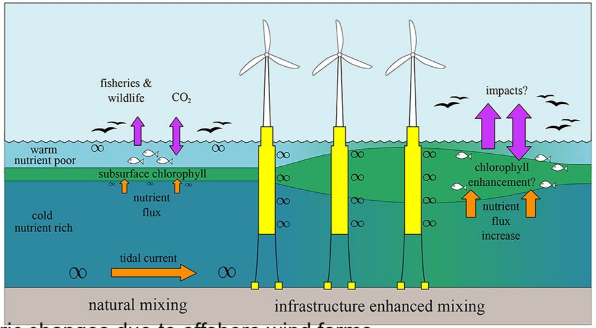

Offshore Wind Energy Development and North Atlantic Right Whale Foraging Ecology
1
Ocean Circulation
Wind energy development affects both horizontal and vertical ocean circulation in the area
2
Zooplankton
Ocean circulation impacts zooplankton abundance, density, energy content, and distribution in foraging habitat
3
Health
Changes in zooplankton communities affect body condition and health
4
Population
Changes in body condition affect female calving rates
NOAA FISHERIES

Wake effects of concern

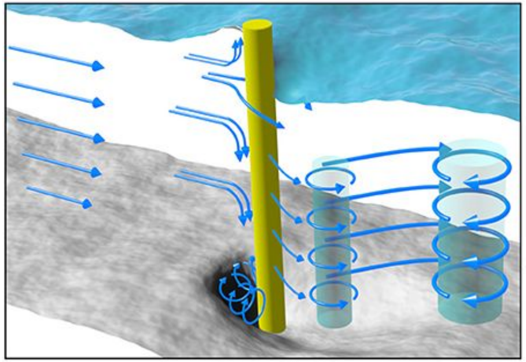
- Attenuation/energy loss
- ‘Damming’ effect
- Large scale dipoles
- Lateral and vertical flow change
- Stratification effects
    - Temperature
    - Salinity
- Magnitudes ? 1->10%?

Christiansen, N., et al. 2022. Emergence of Large-Scale Hydrodynamic Structures Due to Atmospheric Offshore Wind Farm Wakes. Front. Mar. Sci., 03 February 2022 | https://doi.org/10.3389/fmars.2022.818501.
Daewel, U., et al. 2022. Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the North Sea. Communications Earth & Environment 3(1): 292. doi:10.1038/s43247-022-00625-0.
Golbazi, M., C. L. Archer, and S. Alessandrini. 2022. Surface impacts of large offshore wind farms. J Environmental Research Letters 17:064021

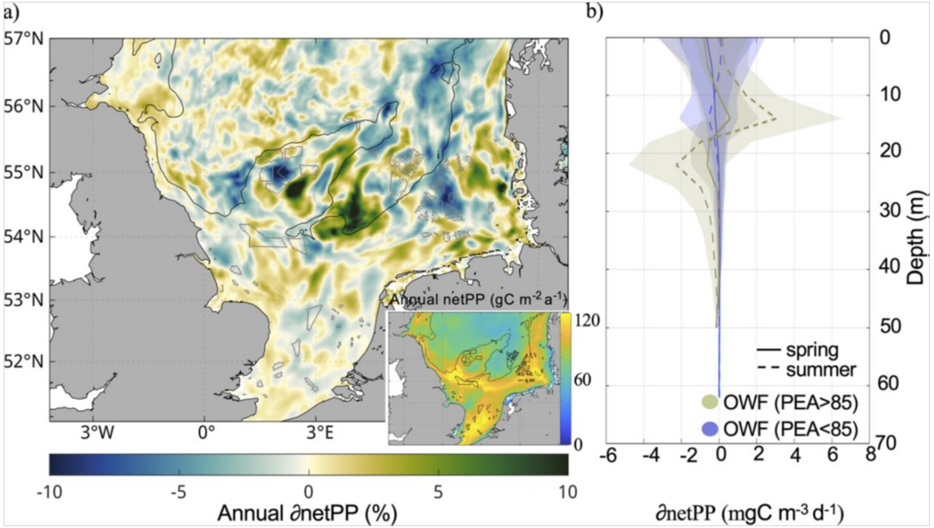
Sub-surface Mixing effects



- Wake turbulence
- Mixes cool bottom & warm surface water
  - Nutrient flux ↑
  - Chlorophyll ↑
  - Reduced stratification
  - Decreased DO
  - Plankton?



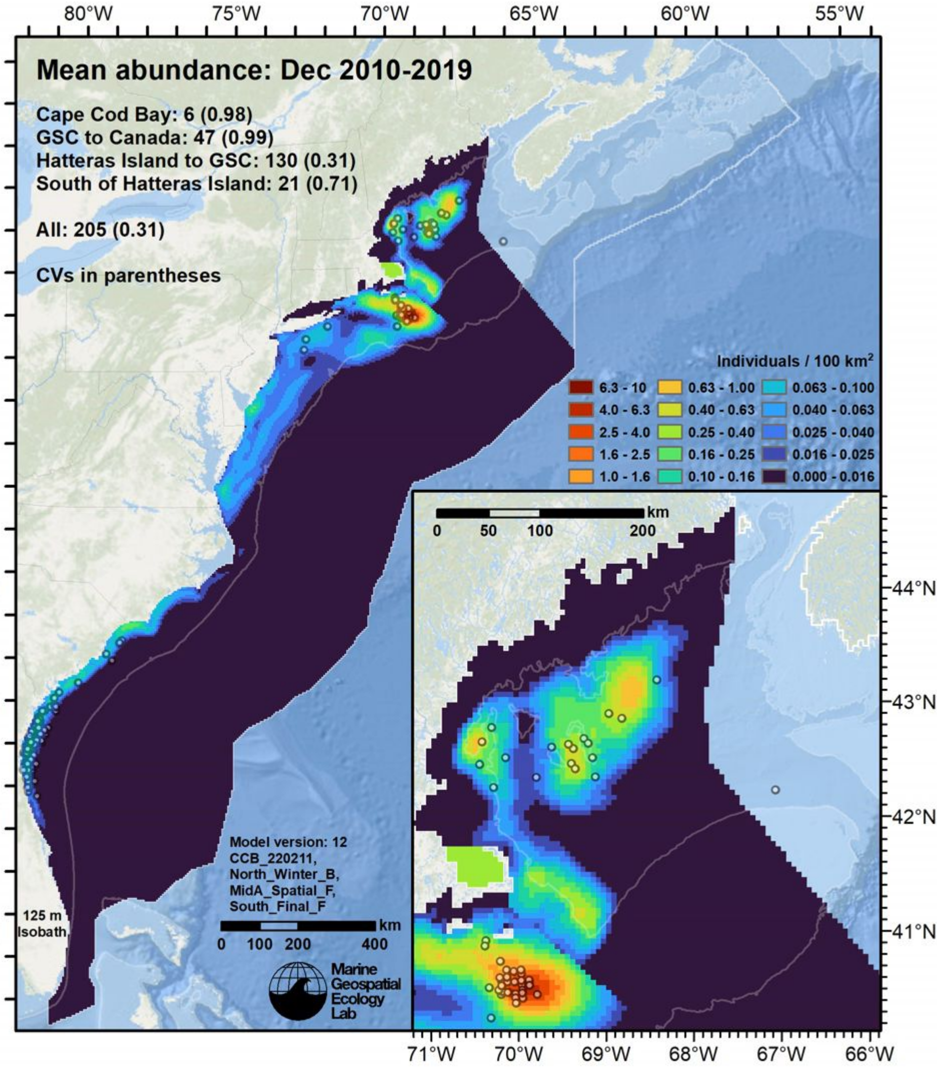
Annual mean response of net primary productions (netPP) to atmospheric changes due to offshore wind farms.



Daewel, U., et al. 2022. Offshore wind farms are projected to impact primary production and bottom water deoxygenation in the North Sea. Communications Earth & Environment 3(1): 292. doi:10.1038/s43247-022-00625-0.
Dorrell, R. M., et al 2022. Anthropogenic Mixing in Seasonally Stratified Shelf Seas by Offshore Wind Farm Infrastructure. Front. Mar. Sci., 22 March 2022 | https://doi.org/10.3389/fmars.2022.830927.
Ramasco, V. 2022. Glider study at Hywind Scotland. Akvaplan-niva https://cdn.equinor.com/files/h61q9gi9/global/c6c3696bf8a2c3c3055a85eeca3d53d25005ea51.pdf?report-hywind-scotland-sailbuoy-campaign-equinor.pdf

NARW and Nantucket shoals

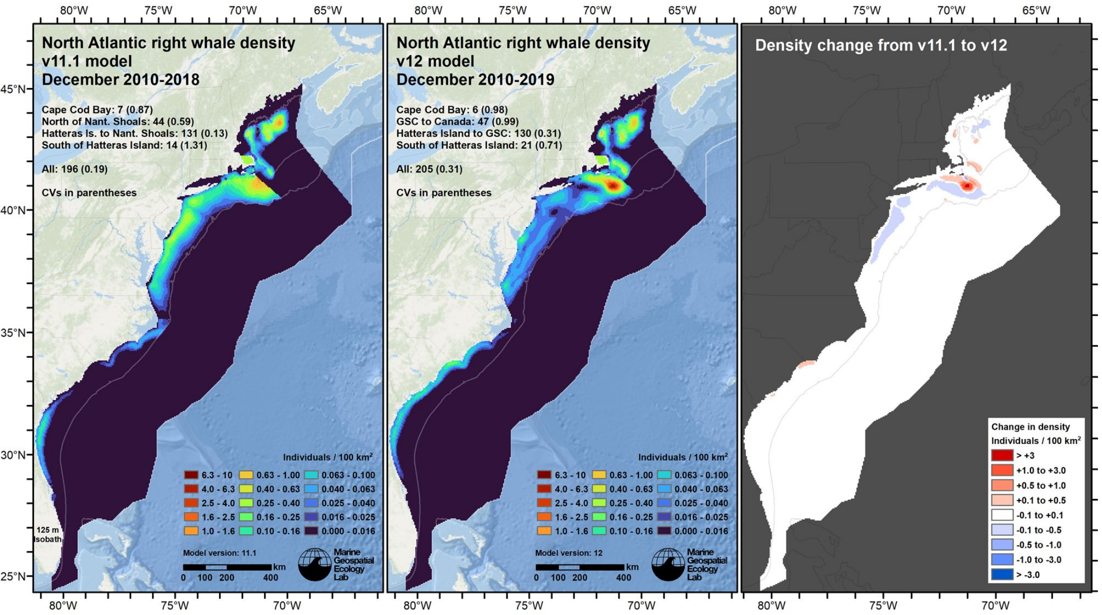
- Nantucket Shoals is a critical foraging area - Nov-May (only known area Nov-Feb)
- OSW will likely change oceanographic features and may change zooplankton dynamics - question is magnitude and importance of change (science need)



Duke Habitat based cetacean density model- [Version 12 (sightings 2011-22) updated March 2022]

[Roberts, J. J., et al. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6:22615.]

NARW habitat use at Nantucket Shoals increasing year round



- Adding 2020 data- density at NS increased in all 12 months
- Raw sightings still increasing Aug-Oct for 2017-2022

Quintana-Rizzo, E., et al 2021. Residency, demographics, and movement patterns of North Atlantic right whales Eubalaena glacialis in an offshore wind energy development in southern New England, USA. Endangered Species Research 45: 251-268. Available from https://www.int-res.com/abstracts/esr/v45/p251-268/

Duke Habitat based cetacean density model- Version 12 (sightings 2011-22) updated March 2022

Roberts, J. J., et al. 2016. Habitat-based cetacean density models for the U.S. Atlantic and Gulf of Mexico. Scientific Reports 6:22615.

Questions NMFS management needs addressed:

- What is the potential change to zooplankton?
  - Abundance
  - Density
  - Distribution
  - Energy content
- What is spatial and temporal scale of potential risk/change to zooplankton from wind farms?
- How does this vary at turbine, lease area, and wind energy area scales?
- What is the anticipated temporal lag time between wind farm operations and impacts on zooplankton?
- Does location of the wind farm relative to certain oceanographic features impact magnitude or spatial extent of potential prey impacts? If so, what types of features?
- Will forage fish/plankton/jellyfish/salps be affected by changes to oceanographic features? If so, what is the magnitude and temporal-spatial extent of impacts? (re. fin, humpback, delphinid and sea turtle diet)
- If impacts are expected, what measures are needed to mitigate the impacts?

What is the range of impacts for a specialist that has experienced 50% mortality in past decade and reduced calving?

Our Mission:

NOAA Fisheries is responsible for the stewardship of the nation's ocean resources and their habitat.