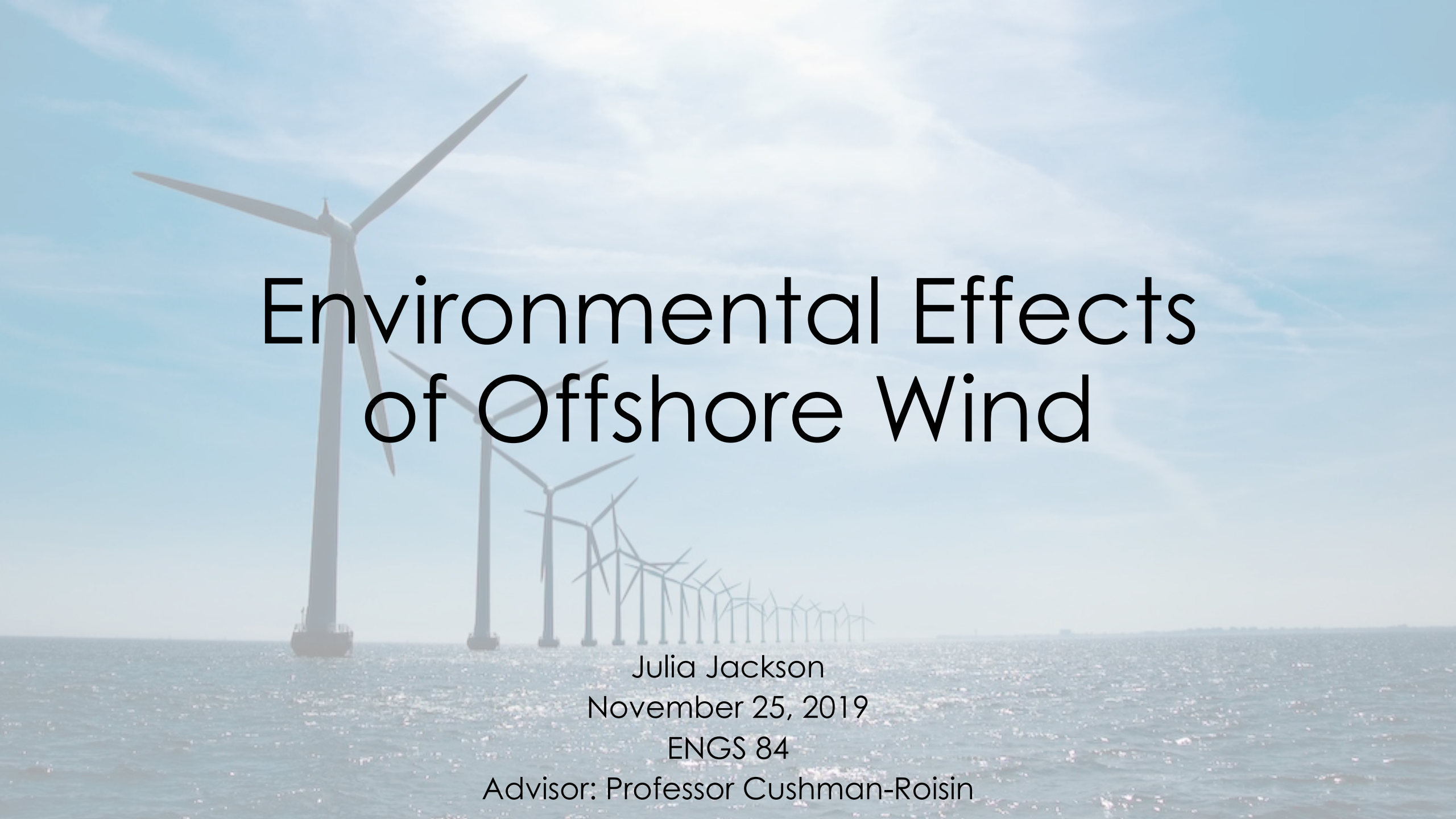


Environmental Effects of Offshore Wind

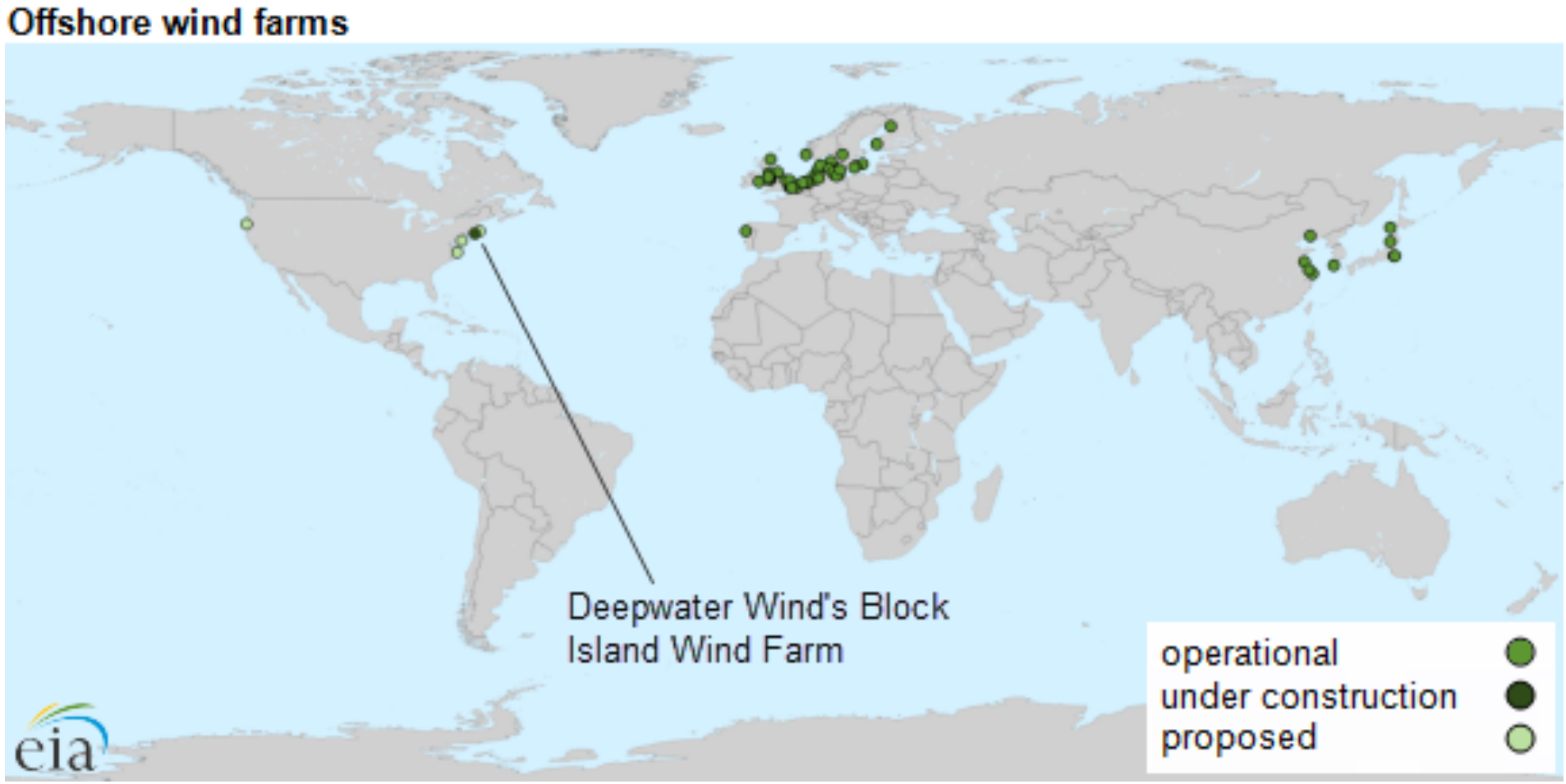
Julia Jackson

November 25, 2019

ENGS 84

Advisor: Professor Cushman-Roisin

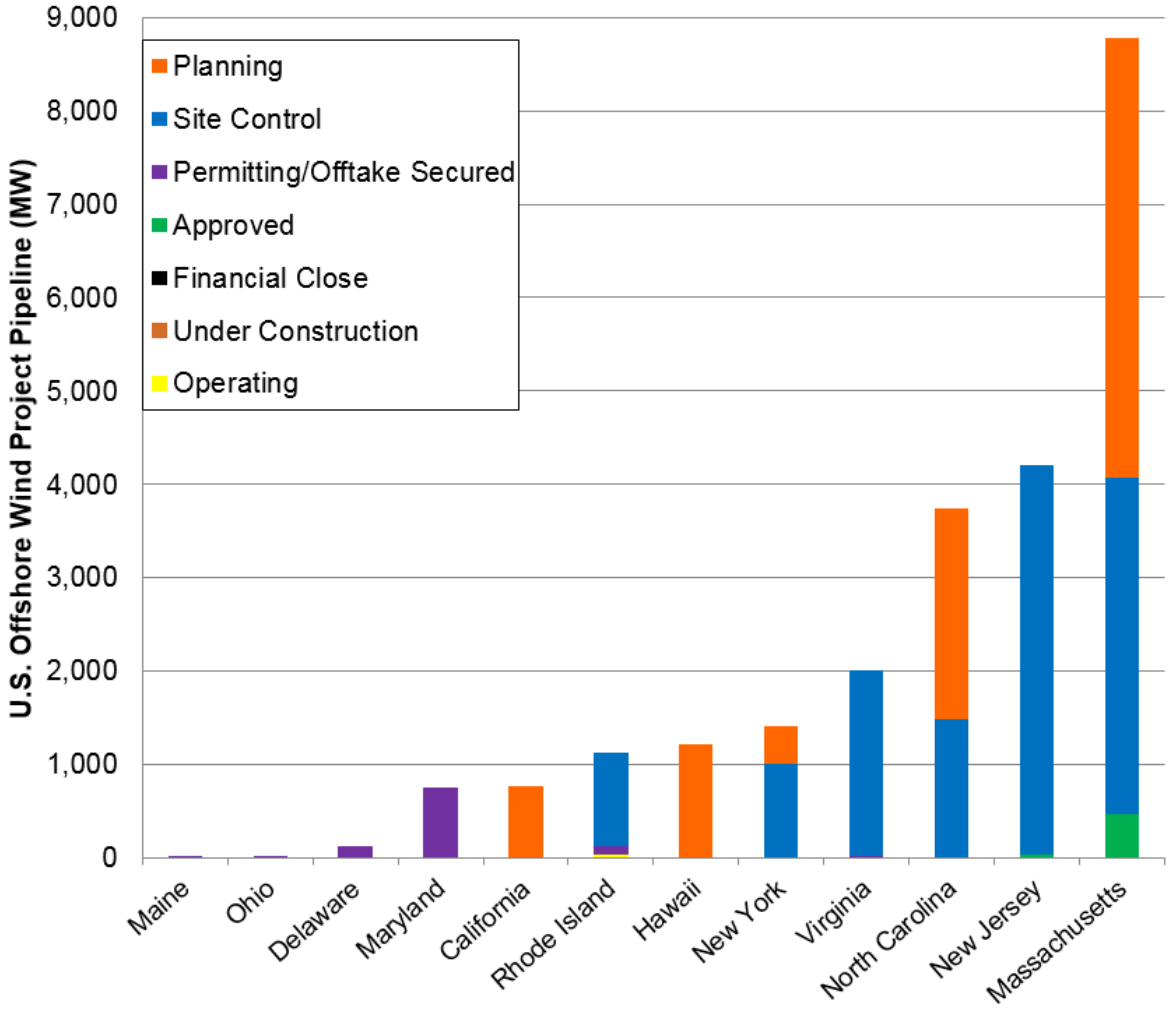
Introduction to Global Offshore Wind



https://www.eia.gov/todayinenergy/detail.php?id=22512

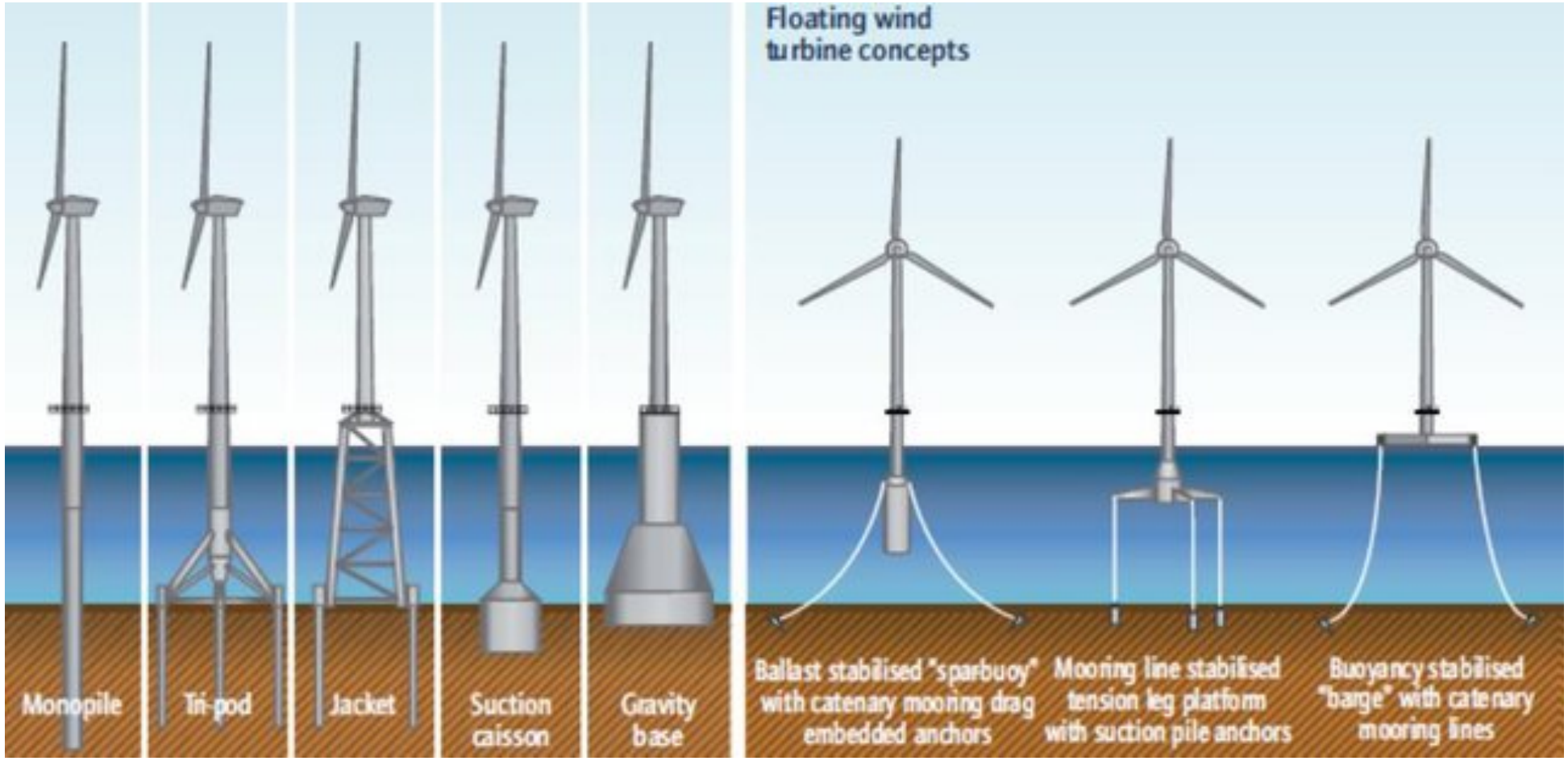
Offshore Wind In the U.S.

- Bigger Turbines
- Farther Offshore
- Floating Foundations



https://www.energy.gov/eere/articles/4-emerging-trends-us-offshore-wind-technologies

Offshore Wind Technology



(Konstantinidis & Botsaris, 2016)

Primary Concerns with Offshore Wind

Impacts on Aerial Ecosystems

Main Impact Categories:

1. Habitat Loss Due to Disturbance
2. Barrier Effects
3. Fatal Collisions

Most Significant Threat:

Barrier Effects

https://www.dailymail.co.uk/sciencetech/article-4783076/Night-vision-protect-birds-bats-wind-farms.html

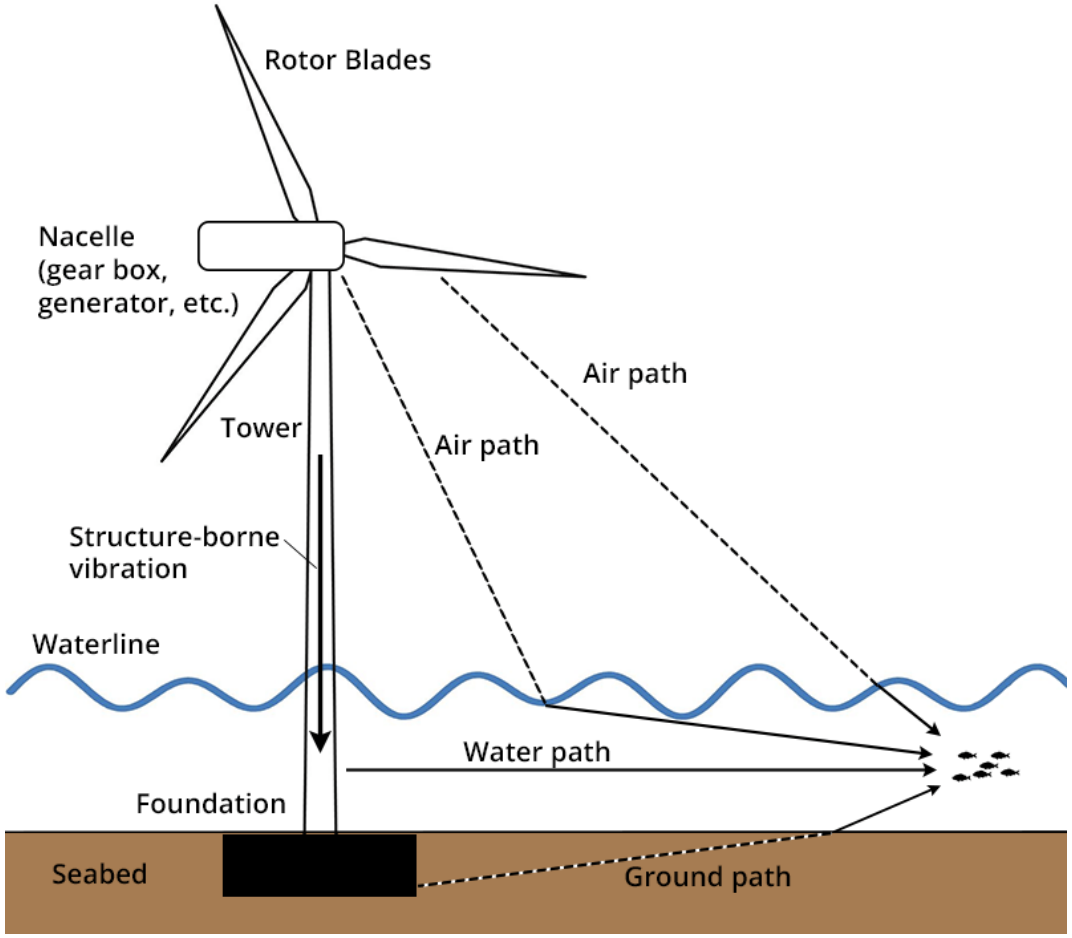
Impacts on Pelagic Ecosystems

Main Impact Categories:

1. Noise & Vibration
2. Sediment Disturbance
3. Electromagnetic Fields

Most Significant Threat:

Noise (especially for marine mammals)



https://dosits.org/animals/effects-of-sound/anthropogenic-sources/wind-turbine/

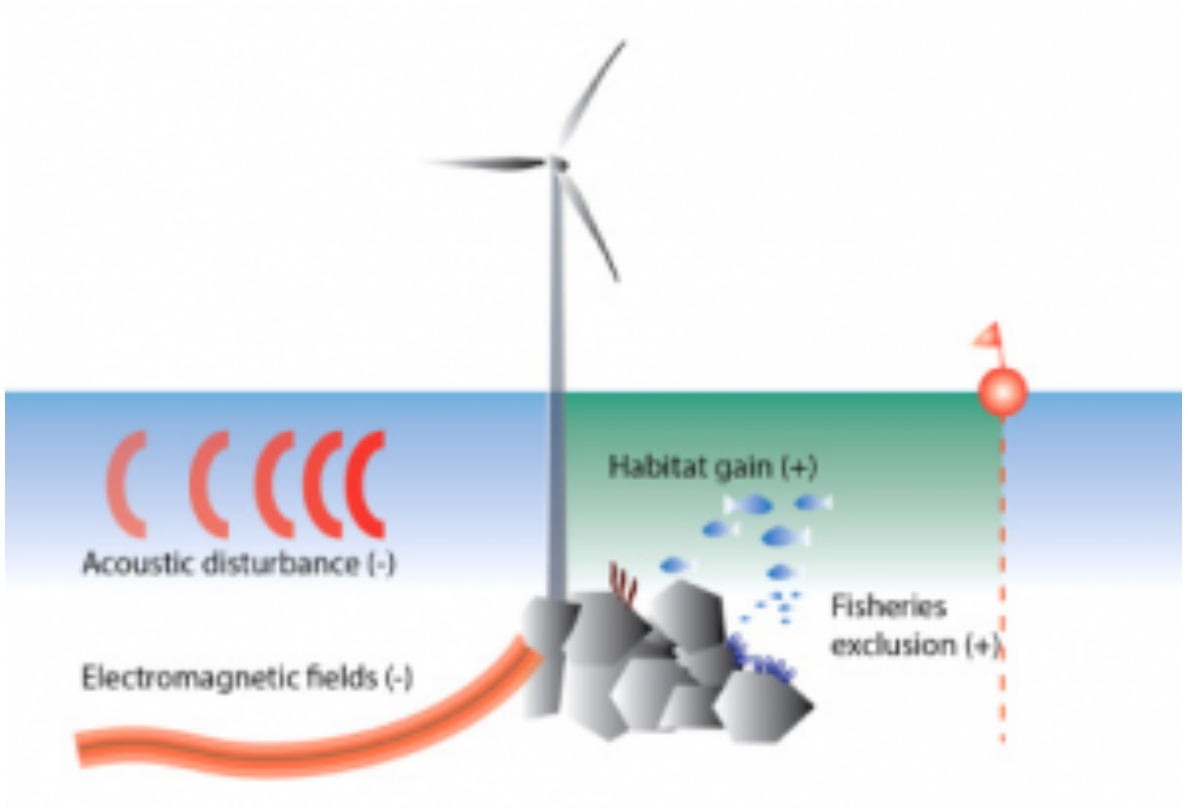
Impacts on Benthic Ecosystems

Main Impact Categories:

1. Noise & Vibration
2. Temperature
3. Electromagnetic Fields
4. Contaminants and Disturbance

Most Significant Threat:

Habitat Disturbance



https://sharkresearch.rsmas.miami.edu/offshore-windmills-impact-on-the-marine-environment/

Reef Effect

Definition & Potential Benefits

Benthic organisms like mussels and barnacles colonize hard structures, and over time, attract other marine species, creating a new environment

Lacroix & Pioch, 2011

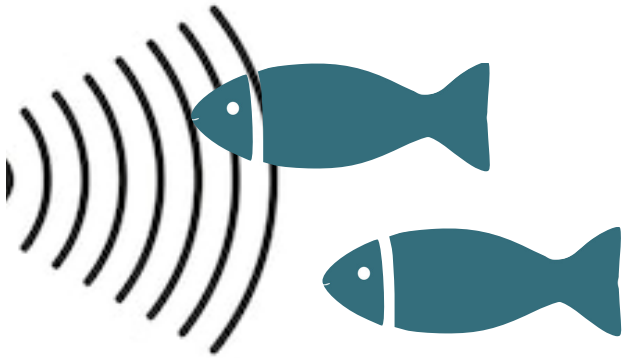
Potential Consequences

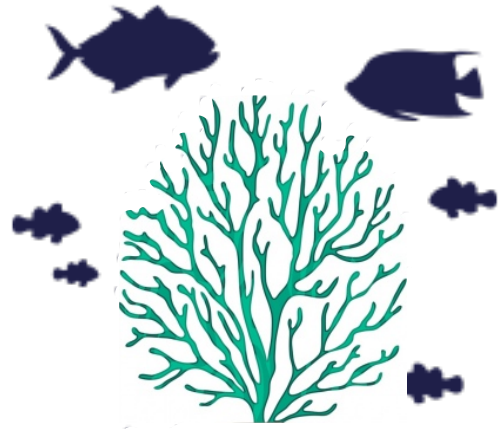
https://animalogic.ca/blog/plastic-pirates-rubbish-in-the-ocean-ferrying-invasive-species-to-the-coasts-of-britain

- Altering ecosystems
- Invasive species
- Reef effect on undersea cables may allow for spreading

Moving Forward

Knowledge Gaps





Possible Solutions & Technology

- Collisions: Bird monitoring
- Noise: bubble curtains during pile driving
- Aquatic Habitat Disturbance: floating wind turbines, online marine habitat database
- General: Environmental Impact Statements and environmental reviews

Aquaculture and wind turbines (Besio & Losada, 2008)

Sources

- Divider Images:
  - Title: https://www.aweablog.org/americanwindweek-offshore-wind-powers-opportunity-new-ocean-energy-resource/
  - https://www.stormgeo.com/solutions/renewables/offshore-wind-energy/offshore-wind-metocean-web-portal/
  - https://undark.org/article/deep-sea-mining-sustainably/
  - https://www.nationalgeographic.com/photography/photos/schools-fish/
  - https://metro.co.uk/2018/04/19/half-as-many-birds-are-being-killed-by-wind-turbines-as-previously-thought-7479726/
  - https://www.dw.com/en/how-do-offshore-wind-farms-affect-ocean-ecosystems/a-40969339
  - https://www.lkabminerals.com/en/industry-uses/offshore-energy/offshore-wind-structures/
- Research:
  - Besio, G., and Losada, M. A. “Sediment Transport Patterns at Trafalgar Offshore Windfarm” Ocean Engineering 35.7 (2008): 653-65. Web.
  - Dafforn, K.A., Johnston, E.L. & Glasby, T.M. (2009) Shallow moving structures promote marine invader dominance. Biofouling, 25, 277–287.
  - Dai, K., Gao, K., & Huang, Z. (2017). Environmental and Structural Safety Issues Related to Wind Energy. In *Wind Energy Engineering* (pp. 475-491). Academic Press.
  - https://earther.gizmodo.com/what-americas-first-offshore-wind-farm-can-teach-us-abo-1818965886
  - https://www.renewableenergyworld.com/2013/10/07/next-generation-approaches-to-wind-turbine-wake-modeling/#gref
  - Konstantinidis, E. I., & Botsaris, P. N. (2016, November). Wind turbines: current status, obstacles, trends and technologies. In *IOP Conference Series: Materials Science and Engineering* (Vol. 161, No. 1, p. 012079). IOP Publishing.
  - Lacroix, Denis, and Sylvain Pioch. “The Multi-use in Wind Farm Projects: More Conflicts or a Win-win Opportunity?” *Aquatic Living Resources* 24.2 (2011): 129-35. Print.
  - Langhamer, O. (2012). Artificial reef effect in relation to offshore renewable energy conversion: state of the art. *The Scientific World Journal*, *2012*.
  - Simon, T., Joyeux, J. C., & Pinheiro, H. T. (2013). Fish assemblages on shipwrecks and natural rocky reefs strongly differ in trophic structure. *Marine environmental research*, *90*, 55-65.
  - Taormina, B., Bald, J., Want, A., Thouzeau, G., Lejart, M., Desroy, N., & Carlier, A. (2018). A review of potential impacts of submarine power cables on the marine environment: Knowledge gaps, recommendations and future directions. *Renewable and Sustainable Energy Reviews*, *96*, 380-391.
  - Zucco, C., Wende, W., Merck, T., Köchling, I., & Köppel, J. (2006). Ecological research on offshore wind farms: International exchange of experiences. Part A: Assessment of Ecological Impacts. Bonn.