North Carolina Offshore Wind and Wildlife Solutions Summit

July 19th, 2022

Panel Questions

Birds and Bats

1. Are there energetic bottlenecks in the life history of some bird species that the intertidal nature of turbines might alleviate? i.e. are some pelagic birds food-limited such that the new food sources at turbines would have a positive population-level impact?
    a. Offshore wind turbines are unlikely to provide any positive population-level benefits to birds *at scale*. In shallow waters, it is conceivable that very localized foraging enhancements might benefit certain sea ducks. For example, if below-surface support structures create more substrate for benthic bivalve attachment, local food supplies could be locally boosted. Such enhancements are far less likely in the pelagic realm, however. Early modeling efforts to understand oceanographic impacts expected from turbine farms indicate limited or no changes to current flow, at least to a level that might enhance biological productivity. And collision risks to marine birds would likely offset any population benefits from wind turbines anyway.
2. Chris Haney said <u>less</u> lightning is better for reducing conflict/collisions; intuitively I would have expected lights to deter some birds from colliding with turbines, especially at night. Is the rule "less lightning is better" universal?
    a. Light pollution is a serious conservation threat to birds on land and sea. Neither land nor marine birds are used to dealing with artificial lighting, whether during their seasonal migrations or for local movements to find food. Procellariiform seabirds (shearwaters, petrels, etc.) are especially prone to collide with lit structures. White lights in particular first disorient birds, then act as an attractant, pulling them into the lit structure where they collide, then die or become seriously injured. Red lighting and high-pressure sodium lights may be less disruptive (Rodríguez, A., Dann, P. and Chiaradia, A., 2017. Reducing light-induced mortality of seabirds: high-pressure sodium lights decrease the fatal attraction of shearwaters. *Journal for Nature Conservation* 39: 68–72). Light shielding (orienting the light downward) can also help. No birds, however, require lights to "see" during their habitual flights, and at least some seabirds are repelled by artificial (man-made) lighting sources (Syposz, M., Padget, O., Willis, J., Van Doren, B.M., Gillies, N., Fayet, A.L., Wood, M.J., Alejo, A. and Guilford, T. 2021. Avoidance of different durations, colours and intensities of artificial light by adult seabirds. *Scientific Reports* 11: 1–13.). Lighting disorientation can even affect seabird movements up to 4 km away (Rodríguez, A., García, D., Rodríguez, B., Cardona, E., Parpal, L. and Pons, P. 2015. Artificial lights and seabirds: is light pollution a threat for the threatened Balearic petrels? *Journal of Ornithology* 156: 893–902). Collision risks from light pollution are worsened during conditions of mist, fog, and intense precipitation (Ryan, P.G., Ryan, E.M. and Glass, J.P., 2021. Dazzled by the light: the impact of light pollution from ships on seabirds at Tristan da Cunha. *Ostrich* 92: 218–222.).

3. In regards to monitoring. The PLL industry is subject to 100% electronic monitoring, will these wind turbines be under such scrutiny?
    a. I am unsure if it is or not, but this would be a good recommendation for public comment.
4. For Cris - Most analyses of bats and offshore wind such as construction and operation plans and NEPA analyses have stated that impacts from offshore wind to bats are negligible? Do you agree with that? Is there enough data to support those findings?
    a. It really depends. We dont have a good handle on how far from the coast bats are active. If wind farms are sited outside the area of high activity, risks to bats can be greatly minimized. Another unknown is how bats will respond to wind turbines. Some species approach and interact with land-based wind turbines and that may happen offshore. If that is the case, then it will likely increase risk even if facilities are sited outside of high activity areas. Risks to bats also depends on the season, and particular species. Risks in the Atlantic seem highest in the autumn and greatest for tree bats.
5. Can MOTUS equipment be located on wind turbines?
    a. Yes, Motus receivers can be placed on offshore wind turbines, site assessment buoys, and other offshore platforms. See, for example: https://briwildlife.org/offshore-motus-guidance/. There has been a test turbine on the Block Island Wind farm for a few years– there have been some issues with data collection (possibly due to interference from turbine electronics) and tower maintenance, but the experience has helped to highlight some ways that the process could be improved, such as centralizing offshore turbine operations (an option currently being explored by the US Fish and Wildlife Service).
6. Is there any research using acoustics to warn birds?
    a. Acoustic playback warnings of predators or prey can be used to ward off gulls, for example. However, as far as I am aware there is no research that shows that this method works effectively in offshore environments. Also, it would be exceedingly unlikely to work for seabirds that don't routinely encounter predators in the offshore environment.
7. The U.S. coast guard has assured and made statements that turbines would be lit for navigational safety, while experts on the panel have clearly stated negative effects of lit turbines. Major conflict of interest. Who wins here?
    a. Red lighting and high-pressure sodium lights may be less disruptive to marine and other birds (Rodríguez, A., Dann, P. and Chiaradia, A., 2017. Reducing light-induced mortality of seabirds: high-pressure sodium lights decrease the fatal attraction of shearwaters. *Journal for Nature Conservation* 39: 68–72). Light shielding upward (orienting the light downward towards the sea) can also help.
8. How will we know if collision mortality occurs in offshore settings and how will monitoring of collision mortalities be conducted?
    a. Good question. Aside from pressure- or vibration-sensitive monitoring instrumentation that is linked to the turbine blades (so as to detect a 'hit'), along with videography of the collision itself, we are unlikely to be able to measure or even estimate accurately the actual collision frequency of birds and bats. Unlike land-based wind turbines, we cannot

search the 'ground' nearby. Carcasses that fall to the sea surface surrounding the turbines will either sink, get eaten, or be swept away.

9. Do we know the number of protected species and is the current language on limiting "take" relevant?
    a. For North Carolina (and most other offshore wind energy lease areas in the Atlantic Outer Continental Shelf) we have pretty good to excellent knowledge of the protected that are placed at most risk from development. For birds at least, and although there were recent attempts to eliminate the "take" provisions found in the Migratory Bird Treaty Act, the original intent and protections in that law have been restored. Measurement or estimates of "take" can be used for mitigation during offshore wind development, including compensatory mitigation in which conservation investments cab be made elsewhere to 'offset' any harms caused by offshore wind.
10. With the lack of overall knowledge and data in regards to highly migratory seabirds, precaution should rule the day. NMFS has a bad habit of ignoring issues as industries get started and then being forced to correct the problems after the damage is already done.
    a. We actually know a good deal about the composition and distribution of marine birds off North Carolina, at least enough to know most of the 'hotspots' and at least some of the dead zones for seabirds (locations with few or no birds). But precaution is especially prudent for addressing conservation needs of and the risks to the most imperiled of seabirds occurring off North Carolina: Black-capped (*Pterodroma hasitata*), Bermuda (*P. cahow*), Trindade (*P. arminjoniana*), and Fea's Petrels (*P. feae*).
11. Offshore wind farms are prevalent in the Black Sea and off Scotland in northern latitudes. What kind of technology is used to understand the impacts to birds, bats, and marine life?
    a. Early in offshore wind energy planning, smart mapping techniques are used to site offshore wind farms where there is least harm to (or minimal conflict with) marine wildlife (e.g., see here: Best, B.D. and Halpin, P.N. 2019. Minimizing wildlife impacts for offshore wind energy development: Winning tradeoffs for seabirds in space and cetaceans in time. *Plos One* 14: p.e0215722). In addition to aerial and vessel surveys (which can use visual, still-camera, and video detection methods), a rather wide array of advanced technology is either currently available or in active testing. Machine learning and artificial intelligence systems can be used to detect and classify seabirds, waterfowl, and other marine wildlife from digital aerial imagery. LiDAR, or Light Detection and Ranging, is a remote sensing method that uses a pulsed laser to measure vertical distances relative to the earth; this is under testing for measuring avian flight heights, a key variable determining turbine collision risk. An integrated automated radio telemetry system called Motus can be implemented for pre- and post-construction monitoring for offshore wind farms. This technology is used to track animal movements, particularly for small-bodied bird and bat species that cannot handle the heavier satellite or GPS transmitters. Passive acoustic monitoring can be used to detect cetaceans below the sea surface, and bats and birds above the sea, in order to furnish information about timing and relative volume of animal movements around offshore wind farms. For larger bird species, as well as sea turtles and cetaceans, satellite tags provide us with long-term

data on animal movements so that we can understand how likely and for how long marine wildlife encounter wind energy structures. Some turbine systems and entire wind farms can use radar detection to shut down briefly (a process called curtailment) during intervals of high wildlife passage.

Marine Mammals and Turtles

1. Is DOD a part of research and are they helping with solutions?
    a. Yes, they are. They are funding several large projects on the US East Coast. The US Navy Fleet (NAVFAC) funds two projects that Duke leads: updated density maps of cetaceans (N62470-20-2-2011-02), and the Atlantic Behavioral Response Study (co-led by Southall Environmental Associates). The US Navy's Living Marine Resources Department also helped fund the density modeling effort. SERDP (DOD) is funding a project run out of the University of St Andrews to look at multiple stressors on cetaceans, and there is an NARW case study therein. The working group for this project is funded by the US Office of Naval Research.
2. What effect, if any, could OSW have on predation? Will it attract or repel white sharks?
    a. We would say that at present this is unknown. There have been four document right whale mortalities caused by white sharks (Taylor et al. 2013 Marine Mammal Science). White sharks are now commonly seen off the coast of North Carolina as seal populations (their main prey) continue to reinhabit area along the barrier islands. Sharks are sensitive to electromagnetics and their responses to sources of this energy is an active area of research; we are focused on mammals and don't really have the expertise to answer questions about sharks. As far as predation by marine mammals, specifically baleen whales, we are not aware of any research on this overall topic, but there are discussions about the turbines being aggregation points for fish, so that might increase predation activity, but again this has not been demonstrated. Also, we know that there is active research on the interaction between the turbines and the oceanography in the area.
3. Do panelists have opinions on vessel speed and size limits in OSW construction zones? Do you think restrictions will be year-round? Should only large vessels be restricted?
    a. Two papers that stand out in the NARW community are Kelly et al. 2021, and Vanderlaan and Taggart (2007). Both indicate that lethality scales with speed, so slower is better. Kelly indicates that large vessels, even if traveling below the 10-knot threshold mentioned in Vanderlaan's work, can cause significant damage to the animals. Injuries from smaller vessels can have sub-lethal or even lethal impacts as well, so we feel that all vessels should be considered. There have been numerous sub-lethal vessels strikes that contribute to right whale morbidity and ultimately with their ability to reproduce on a regular schedule (Moore et al. 2021 Diseases of Aquatic Organisms). In terms of year-round, we feel that gap analyses need to be considered to determine times and places where animals are less likely to be impacted. Since this meeting took place NOAA Fisheries has published new draft seasonal speed restrictions that should be finalized within the next year. Please refer to the Federal Register for the proposed plan.

4. What do we know of the impacts of noise or vibrations from the large turbines on marine mammals?
    a. We know virtually nothing about any effects of operating turbines on baleen whales and for the majority of toothed whales. The vast majority of the research on the effects of wind farms on marine mammals has been on harbor porpoises. Harbor porpoises have been shown to be sensitive to construction activities (e.g., pile driving), though they are considered to be a relatively sensitive species overall. The general wisdom is that once the wind farms are constructed and operating, the porpoise distributions are back to 'normal'. Specific to right whales we must proceed with utmost caution as large areas of that shelf are developed with OSW. We have very little information about the effects on pinnipeds.
5. Why are we not satellite tagging right whales to keep track of them?
    a. There are in fact a few tagging efforts right now – off Virginia Beach by HDR, and in the Gulf of St Lawrence by the Canadian Department of Fisheries and Oceans. There have been animal welfare concerns in the community with the more invasive tags in the past, which has halted some tagging. The current efforts are using the LIMPET configurations to minimize these. This specific tag design has been shown to be operational on very short time frames od days to weeks and no tag has lasted for months on a right whale. Too, right whales are very physical animals, and will often – through body-to-body contact – damage the antenna on the tags rendering them inoperable or even rub the tags off completely. With so few animals remaining, the tradeoff between data and insights gleaned on one hand and impact to the animals on the other, has to be considered.
6. Is it reasonable to try to link a beach lighting reduction plan to benefit nesting turtles to an offshore energy production effort?
    a. Not sure we see a logical link between these two, other than the fact that beach lighting reduction comes with the reduced energy consumption, but that doesn't really link to offshore wind other than the overall conservation coupling of reducing consumption and green energy. The wind turbines are planned to be far enough offshore that they will not interact with any onshore activities, other than where the electrical cables come to shore, which will certainly not be on beaches of concern for turtles.
7. Considering prey distributions and changing conditions in southern critical habitat, how do you balance decision making with previously collected data vs. projected data?
    a. This is a great question, which came up in the panel. To be specific, if the question is focusing on the southern critical calving habitat there is little/no evidence that right whales are feeding below Cape Hatteras therefore prey distribution shifts are likely a small problem. But to the bigger habitat question, one approach is to simply bias your model(ing) towards more recently collected data. Care needs to be taken when doing this as right whales are long lived species with spatial memory, so old data doesn't necessarily have no influence on where we expect to see right whales now. Process-based models that account for some of these historical patterns can be informative, especially if we are able to see and quantify how patterns have changed

over time. Given that the mid-Atlantic migratory corridor is one of the least well-known and studied portions of their range and it's also where most of the OSW development will take place, it's still critically important to assume we need to protect and monitor this area carefully. For example, in poorer calving years, fewer NARW are seen in the Southeast, but in no way should this be interpreted as the southeast being of less importance. If anything, poor calving years are times in which we need to be even more careful.

8. How far do sound and vibrations travel from turbines?
    a. There have been only a few measurements of this, and the largest operating turbines in Europe have been detected a few kilometers way, though only under extreme conditions could they be detected in operation out to a few km, it depends on other noise in the area (e.g., wind/sea state conditions or vessel noise presence, Tougaard et al. 2020). The turbines will become part of the background noise within the general area of the wind farms and is really something to be considered for baleen whales given the low frequency output. This noise should really be considered in the context of masking rather than disturbance, and given the relatively small area over which they are audible (again depending on ambient conditions) the area and severity of masking are likely minimal. The noise of maintenance vessels needs also to be considered in this regard.
9. What are the known concerns from electromagnetic transmission in other countries?
    a. We are not experts in this area, though electromagnetics have not been a major concern for marine mammals as they have been for elasmobranchs.
10. We know there are major impacts during the construction phase on whales, dolphins, sea turtles etc. What would be the long term impacts for such animals from the electromagnetic fields, vibrations, and continued maintenance?
    a. See above for thoughts on electromagnetics. For continued wind farm maintenance, the biggest threat for marine mammals would be ship traffic associated with maintenance, i.e., ship strikes and noise.
11. What about BOEM's environmental studies program for all environmental resources: birds, bats, marine mammals, etc?
    a. We can't speak directly to this, but BOEM has funded the University of St Andrews to conduct a forward simulation study that combines, data, movement simulations, and expert elicitation to produce a tool that examines different scenarios for construction impacts. This is a bioenergetics-based model that tracks simulated whales over a year's time frame to examine the impact of disturbance on vital rates. From past experiences it would be expected that OSW managers will develop longterm monitoring programs as wind projects are developed off the North Carolina coast.
12. Given the drivers of NARW declines (e.g. ship strikes and entanglement) pre-date OSW, can we promote OSW development in a way that can create net benefit for the species? (e.g. have OSW invested in cross-sector mitigation?)
    a. We will speak as a panel that is interested in NARW and say that we should consider ways to make better use of the PAM data in conjunction with opportunistic data, as well as line transect data so that we can better understand how NARW are moving through

throughout their habitat. We also think that with the PAM data we have information on multiple species; as such given the recent development in joint species distribution models, there is benefit to begin examining the data in this fashion. Additionally, given the rapidly declining NARW population, the total level of harassment and "takes" need to be reduced significantly. If offshore uses that have high levels of takes were to be transitioned to lower impact uses these same areas could still provide employment and keep the habitat sustainable to NARWs.

Fish and benthic Habitats

1. What have we learned about fisheries impact where wind projects have been established?
    a. Answered during session
2. Duke and Total have committed $43 million for economic development and workforce training. Do you have thoughts on how to use those funds for environmental protection and fishers?
    a. Answered during session
3. What type of fishing is expected to be excluded from offshore wind facilities?
    a. Answered during session
4. Will all types of fisheries be affected by OSW development in the same way?
    a. Answered during session
5. If fish are associated with artificial hard bottom habitat, would that not translate to a positive association between offshore wind turbines/ foundations/ scour protection and will these structures not attract more fish?
    a. Answered during session
6. Any fixed structure that is put into place will result in additional closed areas to the PLL industry. When you deny access to any area you hinder and/ or restrict the ability to avoid unwanted interactions with any and all species including protected species (not a question).
7. Can we design an underwater acoustic receiver array to study current distribution of tagged animals/ fish for comparison to after wind energy installations?
    a. Answered during session
8. For Dewey - It looks like the point is only a small portion of Area F. If the point was excluded, would you still be opposed to offshore wind placed in the remainder of that area?
    a. Answered during session
9. "The Point" is a high biodiversity hotspot for fish, birds, marine mammals, inverts, etc. Why is Area F, which includes The Point, a site that the state tells BOEM is off the table? i.e. can the state block specific spots of deep import to the state's wildlife people, industries, economy?
    a. Answered during session
10. Do you think EMF from cables (including in-water cables from floating wind facilities) will impact fish and benthic species? What about vibrations from the fixed foundation?
    a. Multiple reports (Copping et al., 2016, BOEM in the Virginia Offshore Project with Dominion Energy's Project boem.gov/sites/default/files/domuments/renewable-energy/state-activities/Appendix-AA-Offshore-EMF.pdf, etc.) have stated that EMF levels are far below levels where there

would be any physiological or behavioral impacts. There have been some statements that additional studies might need to be done with more sensitive species (sharks and rays). Burying the transmission lines and cables 1 - 2 m is recommended and where they can't be buried, such as in rocky terrain, a 6 - 12 inch mat should be placed over the cable. Burial removes most of the EM while the mat is not as effective. It should be noted that there are recommendations for further study of the potential EM and vibration impacts on wildlife.

11. For Dewey - those near-shore parts of the Central Atlantic Call Area that you've said are lower impact for fisheries are higher impact for marine mammals. Is there a compromise where we focus on nearer shore but all vessels are restricted to 10 knots?
    a. Dewey –The only known stated was for the KHWEA with it being more of a pass thru traveling thru area for fishermen that a known go to fishing spot. I didn't speak on higher impact for marine mammals, My focus for discussion are under comment for BOEM Offshore for lease in 2023 area F and E ,Is where the Pelagic Longline fishery is located fishing and is very productive area, Pelagic longline [PLL] and floating or fixed platform aren't compatible together period , because gear is free floating drifting with ocean currents and spin-off of tidal eddys ,Area F is meeting area of the Labrador and Gulf-stream coming together. When fishermen set their gear it can drift depending on gulf stream current and can travel 10-50 miles before finishing retrieving the gear. Associated with area F is highly productive and probably no other place like it.
12. How many wind turbines are projected to be in the Kitty Hawk field and the Wilmington East field?
    a. Kitty Hawk is projected to ultimately have a capacity of 2500 MW when fully built out. It is going to be developed in 3 phases with ~800 MW added in each phase. Although the Avangrid is still in the planning phases, the size of this farm is similar to Dominion Energy's design off the Coast of Virginia. The Virginia farm will have 176 turbines, each with a 14.7 MW Capacity. Kitty Hawk will be similar to this, most likely, with 160 - 180 turbines depending on the size of turbines used. The Wilmington East area is smaller. The estimated capacity of both of the lease areas (Total and Duke) is ~1300 MW. Assuming similar size turbines, though this may change, you would be looking at 80 to 100 turbines. It is unknown how Total and Duke will develop these tracts however.
13. A. How far away will a commercial fisherman be required to fish from a field?
    a. I think this will become a discussion topic. The Block Island recreational fishermen are fishing adjacent to the turbines. The question is whether there will be "too many" fisherman and vessel congestion around the turbines. And this applies to commercial fishermen if there are seen to be large impacts with vessel traffic, trawl lines, anchorage, etc. There is a summary article that addresses some of the issues from a Sea Grant publication that references Block Island and more (Legal Limits on Recreational Fishing Near offshore Wind Facilities, 2020; also, 2018 article on Can Offshore Wind and Commercial Fishing Coexist?)
14. Do transmission lines damage existing habitat or create new structure for new habitat?

    a. Transmission lines running from the farm to the mainland take 2 forms. In unconsolidated sediments the cable is trenched into the subsurface, usually 1 - 2 m. Trenching minimizes the disturbance of the seafloor though there will be a narrow disturbed zone and in some cases turbidity generated. In areas of rock/hardgrounds the cables will be laid on the seafloor and then covered by mats; the mats are of various materials but often are somewhat flexible rock maps (encased in a mesh to allow flexing placement. In the case of mats, they may create habitat similar to hardgrounds for attachment.

15. Are there challenges of pelagic long-line fishing within an existing wind array or is the concern primarily during construction?
    a. Dewey-The PLL fleet predominantly operates outside the 100fathom-600ft depth so any pre-construction vessel survey outside 100 fathom would be a issue of fishing loss and then any construction after that if area is chosen would be a closed area to PLL fishermen along with loss of production of Highly Migratory Species [HMS] which in return mean more import which don't have any conservation standard as US fisherman have to fish under for the same species, yet the US allows these imports with no standards into our country.
16. Offshore wind has a huge impact on benthic habitats. How is this positive in any way?
    a. Answered during session

Infrastructure

1. Revenue sharing, NIMBY. Coastal communities will need to expand infrastructure to support offshore wind. Some towns are against this form of growth, is there any thought of revenue sharing?
    a. Revenue sharing is a federal issue - two proposed bills (RISEE and BREEZE) attempt to address, but it's politically sensitive given the state v. federal revenue question
2. Can wind turbines rotate to find and optimize energy capture? If there must be energy development, it should be optimized within the footprint permitted.
    a. Yes, turbines are very highly optimized in every way from the machine to the layout to ensure maximum output:
    How do wind turbines work? - Rebecca J. Barthelmie and Sara C. Pryor
    b. Turbines rotate into the direction of wind direction to optimize wind capture. The turbines are also spaced to optimize the wind with no interference patterns.
3. Given that we don't have any Jones Act vessels to support construction and maintenance, and given other supply chain issues, is the timetable for the construction of OSW by 2030 realistic?
    a. Yes, there are already wind farms under construction in the Northeast now. There are numerous Jones Act compliant operations vessels and construction vessels are being built now. There are also ways to be Jones Act compliant when bringing in turbine components from outside the U.S. as is required for the first few projects.
    b. As mentioned in the panel, a new large capacity ship is being constructed now by Dominion Energy. This vessel will be "online" in late 2023 and it will be able to handle

the tallest and heaviest components of the new large turbines like the 14+MW 800 ft plus structures. The ship is the Charybdis.

4. Is the jacket system the same as the monopile? Is Block Island only operating 18% of the time an accurate baseline?
    a. Jacket is different than monopile.
    b. The jacket system includes multiple piles (3 or 4) that attach to the seafloor. Some of these may be a composite jacket and suction design. The monopile is one large metal structure jetted and or driven into the seafloor.
    c. Block Island has a nearly 50% capacity factor, which is exactly what is expected/predicted for offshore wind turbines
5. Is there a specific infrastructure plan for the types of turbines to be used in the E and F zones of the proposed wilmington east project?
    a. Infrastructure plans are not developed this early in the process - E and F are not yet defined wind energy areas and may not become WEAs. In any water depths greater than 60m it is assumed that floating foundations will be utilized
6. How severe of a storm event can a monopile foundation tower withstand? What about the future floating turbines?
    a. Answered during session
    b. Turbines have built-in mechanisms to "lock and feather" the blades to reduce surface area when wind speeds exceed ~55 mph. Of course the turbine's foundation has to withstand waves and seafloor movement (reason for the apron around the base of the structure to prevent scour.
    c. There is some new research that is looking at having the blades/rotor face downwind instead of into the wind. It is believed this new design could employ less heavy blades.
    d. At wind speeds of >110 mph (Cat 3 start), studies indicate that there would possibly start to be damage to turbines. But studies/design are ongoing. It has been suggested by some researchers that turbines may manage gusts to 156 mph (pbs.org/newshour/science/offshore-wind-turbines)
7. One of the panelists showed a slide indicating that 16% of projects are gravity-based foundations. Offshore wind developers in the US often seem to treat gravity-based foundations as novel technology. Where and how frequently are gravity-based foundations used?
    a. Answered during session
    b. There has been a shift away from gravity-based to more monopiles. In 2010, gravity-based was 24% of the total. By the end of 2019 these were only 6% of the total. Monopiles went from 63% to 81% during this same time.
    c. A few comments on gravity-based:
        - Require some site preparation
        - Require extensive scour protection
        - They are heavy (though some are formed as shells and then filled on site) and large, requiring heavy lift equipment and large storage sites.
        - Somewhat lower production costs than other structures
        - Low noise pollution versus monopiles etc. that require hammering