SEER

U.S. OFFSHORE WIND SYNTHESIS OF ENVIRONMENTAL EFFECTS RESEARCH

PRESENCE OF VESSELS: EFFECTS OF VESSEL COLLISION ON MARINE LIFE

MAIN TAKEAWAYS

- Marine life, including marine mammals and sea turtles, that spend significant time near the water surface or in areas where vessel routes overlap with migration, feeding, or breeding grounds have the potential to be struck by vessels associated with offshore wind energy development.
- There are two types of potential trauma associated with vessel collisions—blunt force and sharp force—both of which can result in death.
- The effects of vessel collisions are likely to be underrepresented due to a lack of reporting awareness and because not all struck marine animals are recoverable for documentation.
- Vessel speed reductions and route restrictions have shown to be effective mitigation measures for reducing the probability of injury and mortality related to vessel collisions.
- A broad evaluation of the risk of injury and mortality from vessel collisions on marine mammals and sea turtles associated with offshore wind activities is needed to develop effective mitigation measures that are species dependent.

Please visit **Tethys** to view the literature reviewed to inform the development of this research brief.

TOPIC DESCRIPTION

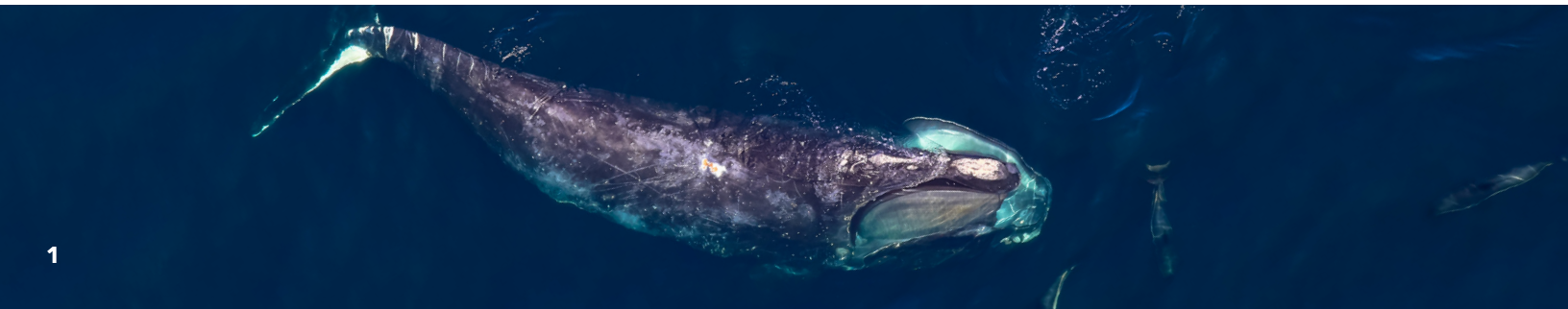
Many types of vessels are used during the life cycle of an offshore wind (OSW) farm. The presence of vessels introduces the risk of vessel collision with marine life. Vessel collision risk is not specific to OSW development—vessel-based activities are an essential part of global infrastructure and support a wide array of industries (e.g., trade, tourism, resource development, national defense). However, because of the potential consequences to marine life, vessel collision is an important consideration in the OSW environmental assessment process.

> Offshore wind development requires the use of many types of vessels during the life cycle of a wind farm, introducing the risk of vessel collision with marine life.

At the beginning of 2020, the total world fleet comprised 98,140 commercial ships (100 gross tons and above). At that time, there were 32 OSW turbine installation vessels and 14 foundation installation vessels operating globally. The number of OSW-related installation vessels is expected to increase, including in the United States, as multiple companies have committed to build and operate vessels compliant with the Jones Act. The Jones Act generally requires vessels carrying goods between any two points in the United States to be domestically manufactured and registered and to be owned and crewed by U.S. citizens or permanent residents. Additionally, a variety of purpose-built and existing vessels will be needed for development, construction, operation and maintenance, and eventual decommissioning of an OSW farm as well as ancillary activities such as site surveying and cable laying. Estimates show that the U.S. wind energy industry will need at least 112 different vessels at peak demand to support the Biden Administration's goal of 30 GW of offshore wind by 2030.

Species that spend significant time near the water surface and in areas where vessel routes overlap with migration, feeding, or breeding grounds can be more susceptible to individual impacts from vessel collisions (i.e., injury or mortality). Given the higher visibility of strandings and the low population levels of some species, whales have long been considered the primary marine animal impacted by vessel collisions, this has instigated the need for special protections through the National Oceanic and Atmospheric Administration's (NOAA's) conservation and recovery programs (e.g., Endangered Species Act, Marine Mammal Protection Act) that have resulted in more quantification of vessel strikes. Between 2015 and 2019, 26 large whales died on the U.S. Pacific Coast due to vessel strikes. However, recent estimates suggest that vessel collisions could cause up to 84 deaths per year among endangered whales that are prevalent in U.S. waters (blue, humpback, fin, and Atlantic right whales) that coincide with potential OSW developments on the Atlantic and Pacific Coasts.

While impacts to whales and other large marine animals are often realized through documented strandings, the total impact is likely to be underrepresented. This is because of a lack of collision reporting awareness (whether the impact was felt, seen, or otherwise witnessed) when the incident occurred, limited detection capabilities to find carcasses at sea, and sub-lethal injuries that may



Types of Vessels Supporting Offshore Wind Development

The classification of vessel size is based on the following categories: Small, up to 25 meters in length; Medium, more than 25 meters but less than 50 meters; Large, more than 50 meters.

OFFSHORE WIND ACTIVITY	VESSEL TYPE	VESSEL SIZE
Pre-installation	**Survey Vessels** *(Fig. 1)*	**Small - Large**
Installation	**Jack-up Vessel** *(Fig. 2)*	**Large**
	Dredging Vessel	**Large**
	Wind Turbine Installation Vessel *(Fig. 3)*	**Large**
	Feeder/Supply Vessel	**Large**
	Tugs	**Small - Medium**
	Barges	**Small - Large**
	Heavy Lift Vessel	**Large**
	Crew Transfer Vessel *(Fig. 4)*	**Small - Large**
	Cable-Laying Vessel	**Small - Large**
	Support Vessels	**Small - Large**
Operations and Maintenance	**Heavy Maintenance Vessel**	**Large**
	Service Operation Vessel *(Fig. 5)*	**Small - Large**
	Crew Transfer Vessel	**Small - Large**
	Survey Vessels	**Small - Large**
	Support Vessels	**Small - Large**
Decommissioning	**Uses the same vessels as installation**	**Uses the same vessels as installation**

not be observable. Animals such as sea turtles may be underrepresented for the same lack of collision reporting awareness, but also because of difficulties recovering carcasses. It is estimated that nearly one-third of stranded loggerhead, leatherback, and green sea turtles in Florida had injuries that could be attributed to vessel collisions. Overall, research has shown that up to 75 different marine species may be involved in global vessel collisions.

Mitigating vessel collision impacts to the North Atlantic right whale on the U.S. Atlantic Coast is a national priority due to the species' critically endangered population and slow reproductive rate. Other large whale species, such as fin, humpback, and blue whales and several species of sea turtles, are also considered to be at risk of vessel collision in areas targeted for OSW development on the U.S. Atlantic and Pacific Coasts.

The development, installation, operation, maintenance, and decommissioning of an OSW farm requires a variety of vessels that differ in size, speed, and operating procedures (see table above). These differences result in a wide range of collision risk levels for different vessels and OSW development activities. For instance, while crew transport vessels might transit from port to site on a routine basis throughout the construction of a project, other construction vessels may transit to the site much less frequently and remain stationary for the construction of a single turbine before transiting to the next installation location at reduced speeds, as is the case with jack-up vessels (Figure 2). Cable-laying vessels operate at 1 knot or less, whereas high-resolution geophysical survey vessels (Figure 1) have an operating speed of approximately 4 knots. Vessels less than 65 feet (20 m) in length may fall outside designated speed regulations, creating an increased risk of high-force collisions with some marine animals. If large OSW components are manufactured overseas, transoceanic transport will be necessary, further increasing risk of vessel collisions.

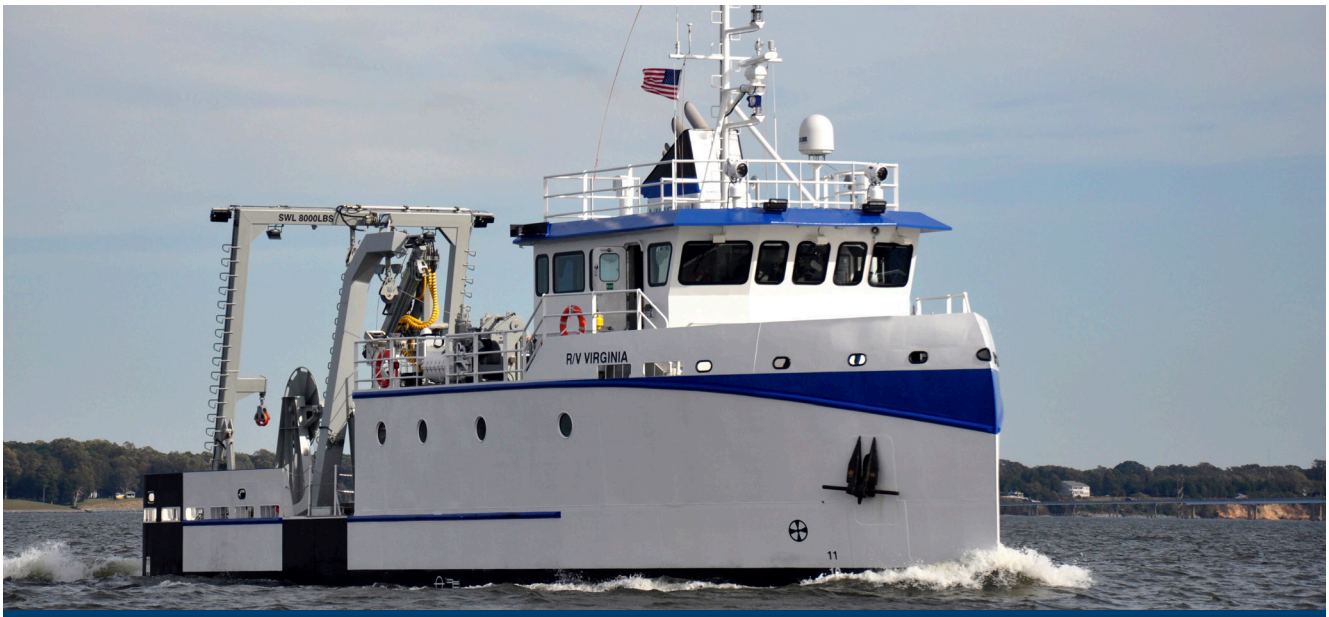


Figure 1. *Survey vessel used for geological and geophysical surveys. Photo from J. Goins,* ***Virginia Institute of Marine Science****.*

MAIN RISKS & EFFECTS

Resting, foraging, nursing, mating, migrating, and socializing are all surface-level activities that can distract marine animals from detecting and avoiding oncoming vessels. Some whale species spend a significant amount of time at the surface during nighttime hours when they tend to forage less, but what drives this increased surface presence is still uncertain. Areas of high vessel traffic that feature regionally concentrated populations of surface-dwelling marine animals can be high-risk areas for vessel collisions.

There are two types of potential trauma associated with vessel collisions—blunt force and sharp force. Blunt force trauma is a result of collisions with surfaces of the vessel or dull components protruding from the vessel, such as dull bulbous bows. Injuries associated with blunt force trauma can include abrasions, contusions, lacerations, and fractures (skull and bone). Sharp force trauma is a result of collisions with sharper vessel components, such as rotating propeller blades or certain hull shapes. Injuries associated with sharp force trauma can include lacerations and potentially the amputation of flukes and flippers.

Vessel type, vessel speed, and species type are all primary factors in determining the likelihood of collision and severity of potential injury. Compared to smaller vessels, large vessels' increased length, width, and draft create extensive footprints that make encounters with marine animals more likely. However, should a collision occur, vessels of all sizes can yield stresses high enough to cause lethal injuries to large whales.

Whether an encounter involves a collision depends on the combination of animal behavior, vessel speed, and vessel maneuverability. Slower speeds can provide time for marine animals and some vessel operators to react to avoid collisions. However, evidence suggests that large whales exhibit limited avoidance behaviors in close range.

Animals that experience impacts at lower speeds may have a higher probability of survival because of reduced force associated with these collisions. For instance, there is some evidence that the probability of lethal injuries for large whales falls to less than 50% when speeds of large vessels are reduced to 10 knots. However, modeling suggests that large vessels

can still produce large enough stresses to cause lethal injuries for large whales even when travelling at reduced speeds. Moreover, small species such as sea turtles require more stringent speed reductions before lethal injury probabilities are reduced. More research is needed to fully understand the correlation among vessel size, vessel speed, vessel hull type/technology, and species-specific impacts.

Injured marine animals must expend increased amounts of energy on healing (instead of growing and reproducing). This extra energy can put the individual at risk of mortality while decreasing its potential to reproduce, which can result in significant population consequences for certain species. When population numbers are low, the health and vitality of an individual animal plays an integral role in whether the species population level is capable of recovery.

For instance, population numbers for the North Atlantic right whale have created a scenario in which losses from vessel collisions and other anthropogenic (i.e., human-influenced) activities have limited the potential for population recovery. Current evidence indicates there are fewer than 350 North Atlantic right whales remaining, with fewer than 100 breeding females. In response to the limited number of North Atlantic right whales, the potential biological removal level for the western stock is 0.8 whales per year. Potential biological removal is defined by the Marine Mammal Protection Act as "the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population." This means that if the population is to recover, less than one North Atlantic right whale can be lost to anthropogenic causes in any given year.

On the Pacific Coast, there is growing evidence that mortalities from vessel collisions with blue, fin, and humpback whales are a significant contributor to anthropogenic deaths and could have negative impacts at the population level. While the population level impacts from vessel collisions for certain whale species are somewhat understood, similar consequences for other marine species (both large and small) are yet to be determined.

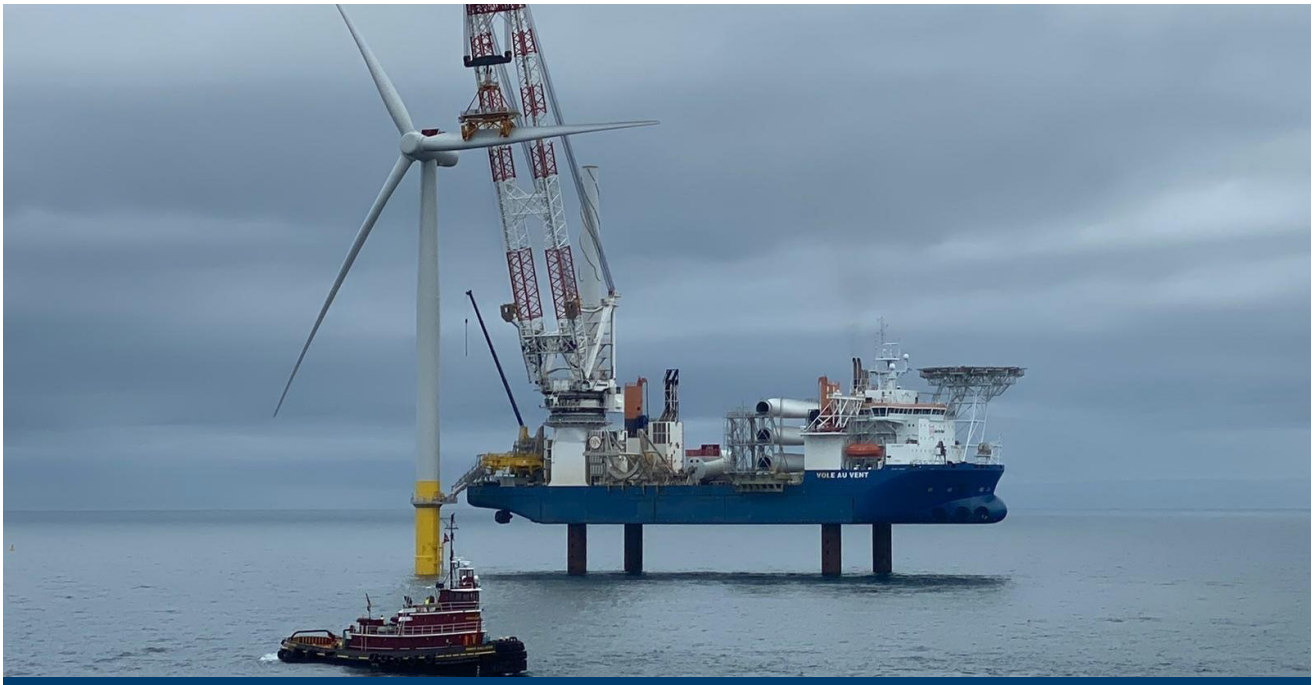


Figure 2. *Jack-up vessel used for turbine installation at the Coastal Virginia Offshore Wind project. Photo by* ***Dominion Energy****.*

MONITORING & MITIGATION METHODOLOGIES

Monitoring for marine animals in the vicinity of vessels can help safeguard marine life against vessel collision. In the United States, protected species observers (PSOs) are used to visually monitor areas for the presence of species that are federally protected under the Endangered Species Act and/or Marine Mammal Protection Act. OSW activities that involve the use of vessels such as high-resolution geophysical surveys, construction (including pile driving), and installation require the use of PSOs to monitor for marine life. PSOs typically monitor for protected marine mammals, including whales and dolphins, and sea turtles; other marine animals that may be observable and reported near the water surface include manta rays, sharks, and other fish species. PSOs collect information about the behavior, distribution, and abundance of marine animals in the vicinity of offshore activities and relay observations to vessel operators to institute mitigation measures to avoid vessel interactions with marine life, including potential collisions, such as reducing the vessel speed and/or changing course. However, the effectiveness of PSOs detecting marine life can be influenced by a number of factors like environmental conditions such as sea state, visibility, marine life behavior (e.g., animals diving beneath the water for long periods of time), the location of the observers (e.g., vessel, aircraft, or land), and the level of observer experience.

In addition to PSOs, passive acoustic monitoring systems can be used to detect marine mammals by listening for vocalizations underwater. On the Atlantic Coast, a passive acoustic monitoring system has been installed off the New England coast to specifically monitor for the endangered North Atlantic right whale. The system communicates monitoring information to a sighting advisory system that alerts mariners of the presence of right whales. Aerial surveys are also used as early warning systems to monitor protected species; reported sightings are made available to mariners in an effort to increase awareness.

Real-time vessel-based reporting, whether voluntary or mandatory, can also be used to reduce vessel collisions with marine life. Vessel-based software can be used to track marine animal

Reducing Vessel Collisions with North Atlantic Right Whales

On the U.S. Atlantic Coast, vessel speed restrictions are driven by conservation efforts to protect the endangered North Atlantic right whale. In 2008, the National Oceanic and Atmospheric Administration implemented a mandatory Ship Strike Reduction Rule that includes measures in certain areas and at certain times of the year to reduce the likelihood of serious injuries and deaths from collisions with vessels.

In general, the rule requires vessels 65 feet or longer to travel at 10 knots or less in certain locations called seasonal management areas where right whales are likely to be present during specific times of the year. Vessels less than 65 feet in length are encouraged to follow the rule as well. Some vessels are not subject to the rule, such as those owned or operated by the federal government, U.S. military vessels, foreign military vessels while engaged in exercises with the U.S. Navy, and active state law enforcement/rescue vehicles. The rule also allows for voluntary dynamic management areas to be established based on visual sightings that identify the presence of three or more right whales within an area. Mariners are encouraged to avoid these areas and travel at 10 knots or less.

An assessment of the rule's effectiveness concluded that during the 10 years after speed restrictions were implemented, the number of documented right whale vessel collision mortalities and serious injuries decreased by 33% within seasonal management areas.

Figure 3. *Wind turbine installation vessel used to transport components for installation.*

sighting locations and share sighting information with mariners. In addition, mobile phone technology can be used to share marine animal sighting information and potential mitigation measures with others via mobile phone alerting systems.

Several mitigation approaches can be used to reduce the risk of vessels colliding with marine animals. Speed restrictions are widely implemented to reduce vessel collision risk. In 2008, mandatory vessel speed restrictions were instituted in certain areas and at certain times of the year off the Atlantic Coast to reduce the risk of vessel collisions with North Atlantic right whales. In 2015, voluntary vessel speed reductions were implemented in shipping routes off California to reduce the number of whale mortalities caused by vessel collision. Using a ship strike model, which is a tool for estimating marine life mortality as a result of vessel collisions, researchers estimate that if 95% of mariners follow the voluntary vessel speed limit reduction in the shipping lanes near California, twice as many blue whale mortalities and three times as many humpback whale mortalities would be avoided.

> Vessel speed reductions and route restrictions are effective mitigation measures for reducing marine animal injuries and deaths from vessel collisions.

Vessels can also change course or be rerouted to avoid interactions and collisions with marine animals. On the Atlantic and Pacific Coasts, vessel routes have been amended to reduce vessel collisions with blue, humpback, and North Atlantic right whales. In addition, vessel exclusion zones, or "areas to be avoided," can be established. Areas of avoidance have been established off the coast of Costa Rica to protect humpback whales and off the Atlantic Coast to protect North Atlantic right whales. A proposal for an expanded area to be avoided in the Channel Islands region of Southern California to protect blue and humpback whales has been submitted and will be reviewed by the International Maritime Organization's subcommittee for navigation safety in the spring of 2022.

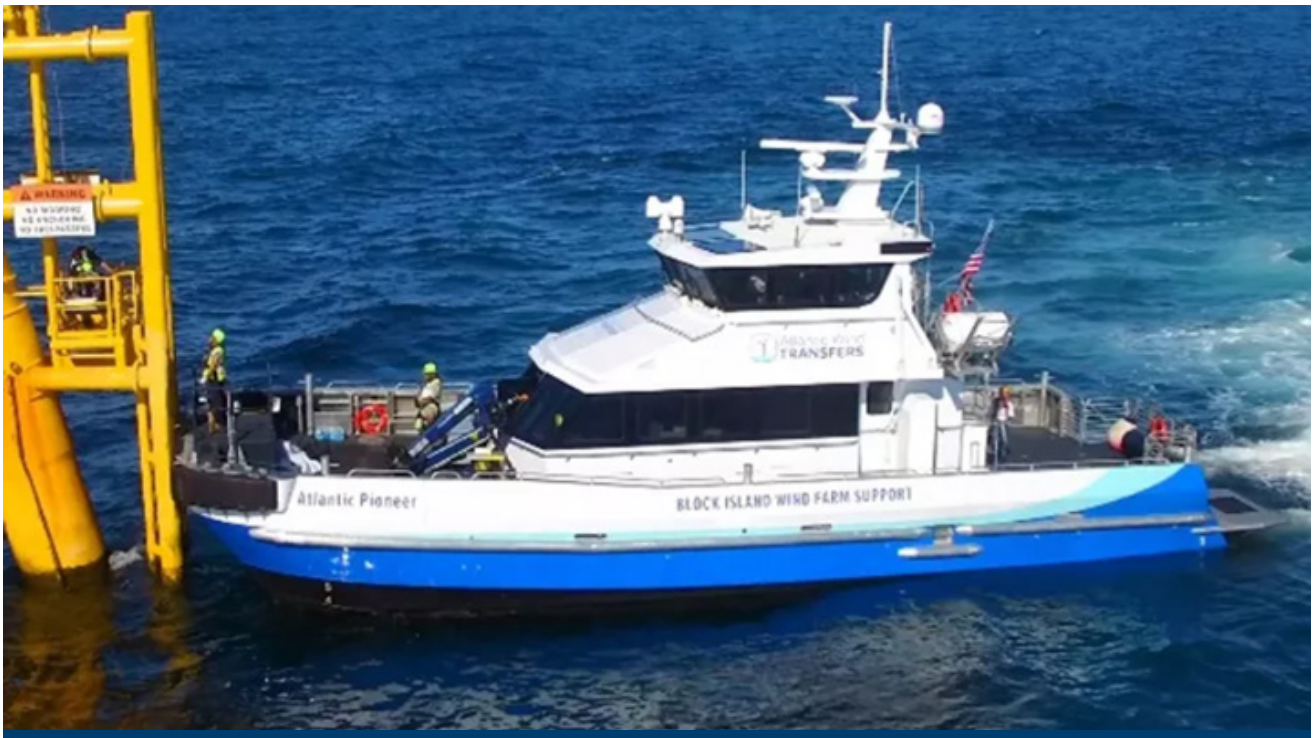


Figure 4. *Crew transfer vessel used at Block Island Wind Farm. Photo by* ***Atlantic Wind Transfers.***

KNOWLEDGE GAPS & RESEARCH NEEDS

As OSW development continues to advance in the United States, several knowledge gaps and research needs must be addressed to develop a more comprehensive understanding of vessel collision risk. The risk of marine animal injury and mortality from collision with vessels associated with OSW activities must be evaluated to inform the development of effective mitigation measures. Additionally, the effectiveness of those strategies must be monitored.

Uncertainty remains regarding the distribution of collision risk and mortality estimates over large whale species, especially for North Atlantic right and fin whales on the Atlantic Coast and blue, humpback, fin, and gray whales on the Pacific Coast.

Regarding sea turtles, there is a need to understand the seasonal and geographic patterns of the risk of injury and mortality from vessel collisions associated with OSW activities to inform mitigation measures.

> The risk of marine animal injury and mortality from collision with vessels associated with offshore wind activities must be evaluated to inform the development of effective mitigation measures.

Areas with a high risk of vessel collisions need to be identified, and OSW- and non-OSW-related vessel patterns need to be understood.

For smaller marine animals, little is known about the extent of collision incidences. Protocols must be developed and instituted to identify collision-related blunt force trauma during necropsy procedures.

A vessel collision database (similar to an existing database developed for whales by the International Whaling Commission) can help identify smaller marine animals most affected by vessel collision, high-risk areas, and correlations among species, vessel speed, and injury. Vessel speed reductions and route restrictions have successfully mitigated vessel collision risk for whales, and similar approaches may be effective to avoid interactions with other marine species, although a high level of compliance will be required of vessel operators.

Education and awareness about the risks of vessel collision with marine life are critical for mariners to implement appropriate mitigation approaches for OSW- and non-OSW-related activities. Federal organizations including NOAA and the Bureau of Ocean Energy Management, along with state and regional wildlife entities, are taking steps to increase public awareness of vessel collision risk and to identify research priorities to develop a more comprehensive understanding of the risks to vulnerable species in regions targeted for OSW development in the United States.

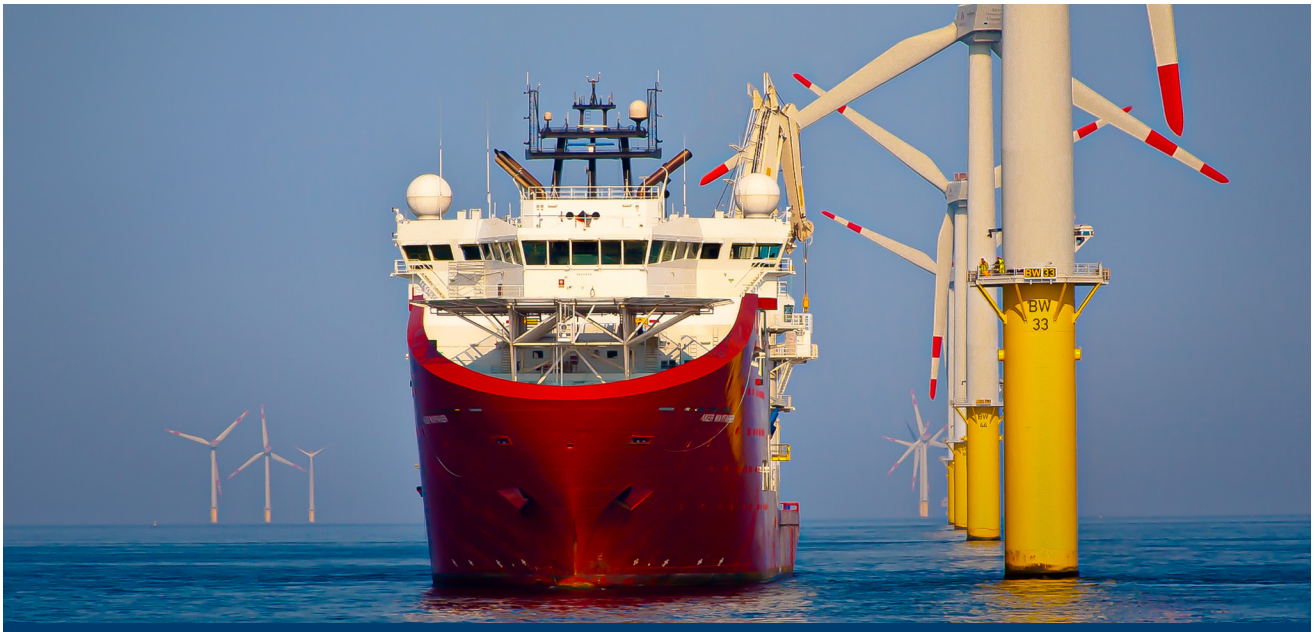


Figure 5. *Service operation vessel that provides accommodations for workers during turbine service and repair work.*

For more information on the literature reviewed to develop this Research Brief, visit: Tethys

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