Environmental Studies Program: Ongoing Study

Field	Study Information
Title	Mortality Risk for Whale and Basking Sharks During Energy Operations (NT-21-06)
Administered by	Office of Environmental Programs
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Procurement Type(s)	Contract
Conducting Organization(s)	Blue World Research Institute; NOAA/NMFS Pascagoula Science Center
Total BOEM Cost	$400,000
Performance Period	FY 2022–2024
Final Report Due	December 2024
Date Revised	October 12, 2023
Problem	BOEM authorized projects have been shown to cause mortality to large bodied elasmobranchs that feed at a low trophic level. While much work has been accomplished on commercially valuable species habitat use and relationship to oil and gas infrastructure, specific data gaps remain as to the relationship between non-commercially harvested species whose populations continue to decline. Information on the behavioral ecology of these world's largest fishes can inform an understanding as to continued risk posed.
Intervention	Gathering behavioral information on habitat use as well as synthesizing existing telemetry would inform assessment of risk associated BOEM actions.
Comparison	Direct observations of mortality to these species have occurred with energy operations both in the US and internationally. Not pursuing this study will likely lead to continued mortality, which is not accounted for in national and regional impact analysis due to inadequate documentation of these events.
Outcome	The outcome of this study would describe the behavioral ecology of select large pelagic species of fishes, both basking sharks and whale sharks, impacted by geophysical activity and ship-strikes during exploration and construction phases of energy development.
Context	National need (transects program areas and regions)

BOEM Information Need(s): Populations of whale and basking sharks have been in dramatic decline. Documenting mortality events of these two species is difficult as, unlike whale carcasses that float at the surface for an extended time period, shark carcasses sink to the bottom of the ocean allowing for only a brief time period to observe the event. As a result of this combined with their epipelagic nature, there is considerable risk that BOEM activities may contribute to whale and basking shark mortality, further adding to their population decline due to a lack of mandated reporting and observation challenges. Despite this, direct observations of mortality to these species has occurred with energy operations both in the US and internationally. These species move across regional program area boundaries as well as

across BOEM program areas and may face significant cumulative impacts as a result. Not pursuing this study will likely lead to continued mortality, which is currently not factored into national and regional impact analysis due to inadequate documentation of these events.

Background: Similar to marine mammals, lower-trophic-level-feeding, large-bodied sharks spend a significant amount of time at, or just below, the ocean's surface. This behavior could lead to a higher risk of mortality due to spatial and temporal overlap with energy industry operations (i.e., geophysical surveys), increased vessel traffic, and/or increased noise exposure levels. The risk of ship strikes or entanglement in geophysical gear may be considerable in waters where Bureau of Ocean Energy Management (BOEM) permitted activities occur. Unlike large whales, which float post-mortem, large sharks such as whale sharks (Rhincodon typus) and basking sharks (Cetorhinus maximus) are negatively buoyant and sink; this likely leads to under-reporting of mortalities from vessel interactions. These species are of concern internationally and are protected by international treaties of which the U.S. is a signatory to the Convention on Migratory Species (CMS) and the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). Multiple geophysical surveys, offshore energy construction, and associated vessel traffic intersect with known aggregations of these species. Information from this study, focused on whale and basking sharks, will better quantify the risk of entanglement and ship strikes associated with energy development. Further, results from this study could be applied to other lower-trophic-level-feeding, large-bodied fishes and be used in preparation of BOEM environmental impact analyses.

Lower-trophic-level-feeding, large-bodied sharks are found globally. Whale sharks typically aggregate at the surface in large numbers in the Atlantic, Pacific, and northern Gulf of Mexico. Additionally, basking sharks are found throughout the U.S. Atlantic and Pacific waters. This surface aggregating behavioral trait exposes both species to energy operations in multiple countries during their respective migrations. The fourth International Whale Shark Conference in 2016 brought together whale shark experts from around the world to discuss research, conservation, behavior, and population status of the world's largest fish. A common theme emerged that activities associated with oil and gas development likely impact this species globally. At least one confirmed mortality due to entanglement in geophysical survey gear associated with oil and gas development was reported to the Bureau of Safety and Environmental Enforcement (BSEE) in November of 2014. However, with the exception of nodal surveys, reporting whale shark mortalities has not been required by BSEE. Anecdotal reports of mortalities of whale sharks associated with geophysical operations and vessel traffic associated with oil and gas development have occurred in Mozambique, Mexico, and Belize. Scarification studies demonstrate susceptibility to small vessel strikes (Ramirez-Macias et al. 2012), however risk to large vessel collisions and streamer entanglement risk has not been quantified. Seasonal aggregation sites in the northern and southern Gulf of Mexico represent two of the largest whale shark feeding aggregations known worldwide (de la Parra-Venegas et al. 2013, Hoffmayer et al. 2013; McKinney et al. 2017), suggesting that whale sharks may be more susceptible to ship strikes in this region. Additionally, during the Deepwater Horizon explosion, oil spill, and response, whale sharks were documented by National Oceanic & Atmospheric Administration (NOAA) airborne surveys swimming in the surface oil slick.

A 2016 update by the International Union for the Conservation of Nature (IUCN) Shark Specialist Group listed the population status of the whale shark as endangered globally (Pierce and Norman 2016). Recent data from mark-recapture and telemetry studies indicate that the Atlantic population has declined about 30% and the Pacific population declined approximately 50% since the last assessment conducted in 2010. Whale sharks support a multi-million dollar tourism industry upon which coastal

communities depend. This tourism industry includes SCUBA diving and whale shark watching excursions and extends from the southern U.S. coastal states throughout Central America. (Rooker et al., 2019)

The nation of Qatar limits geophysical survey activity and ship speed in the Al-Shaheen oil fields during seasonal aggregations of whale sharks due to their affinity to oil platforms. U.S. Federal Regulations specify that geophysical operations must not "Cause harm or damage to life (including fish and other aquatic life), property, or to the marine, coastal, or human environment" as a result of geophysical surveys (30 CFR §551.6 (a)(2)). However, BOEM currently does not employ mitigation measures to protect fishes. Information from this study will be used to understand the risk of mortality in relation to energy operations, and potentially aid in the development of mitigation measures to protect these species.

Objectives: The purpose of this study is to understand how ecological and behavioral drivers impact risk of mortality to whale and basking sharks; an ongoing and active issue in the offshore energy industry.

Methods: The study will collect new, and synthesize existing, data on spatial and behavioral ecology of these species in the vicinity of both renewable and non-renewable energy operations to determine risk in relation to habitat use. It will leverage existing data sets collected by government, academia and NGO studies. Additional telemetry data will improve fine scale behavior and interaction risk. Animal-borne sensors which sample at rapid intervals, typically sub-second, collect information on pitch, roll, heading and depth as well as other oceanographic variables can be utilized to visualize an animal's behavior. These methods are widely recognized for understanding behavioral ecology and have been used to understand vessel strike risk on similar species, such as large whales. Methods are additionally employed at several BOEM studies investigating fine scale habitat use.[1]

- Use of data logging inertial measurement tags to describe the fine scale behavior of whale sharks.
- Gathering spatial information on movement in relation to energy operations using satellite linked telemetry.
- Use of available land and satellite based automatic identification system (AIS) receivers to characterize vessel traffic, specifically energy operations and support vessels, in the vicinity of whale shark aggregation areas to assess spatial and temporal overlap.
- Combining the information gathered in the above methods to produce a risk assessment model that can be extrapolated to other lower-trophic-level-feeding, large-bodied sharks which exhibit similar behavior (see Vanderlaan, 2007).
- An education component, in partnership with the Association of Zoos and Aquariums, including video content distributed to NOAA's Ocean Today Kiosk Network and telemetry shared via Science on a Sphere to deliver educational content to an estimated 60 million visitors to partner institutions globally.

Specific Research Question(s): How does site fidelity and surface feeding behavior impact risk of mortality to large bodied/low trophic feeding elasmobranchs? Risk will be assessed by quantifying the amount of time these large bodied/low trophic elasmobranchs spend within core BOEM activity areas.

[1] For example, Fine-scale dive profiles and activity patterns of sea turtles in the Gulf of Mexico.

Current Status: First field season completed; second field effort planned for summer 2024.

Publications Completed: N/A

Affiliated WWW Sites:

https://matos.asascience.com/project/detail/239

https://portal.atn.ioos.us/#metadata/d3236ed5-22e4-4150-aff2-585bed2426b3/project

https://www.usm.edu/fisheries-research-development/whale-shark-research.php

https://www.usm.edu/news/2023/release/whale-sharks-gulf-coast.php

https://www.usm.edu/fisheries-research-development/whale-shark-big-mel.php

References:

de la Parra Venegas R, Hueter R, González Cano J, Tyminski J, Gregorio Remolina J, Maslanka M, Ormos A, Weigt L, Carlson B, Dove A, 2011. An unprecedented aggregation of whale sharks, (*Rhincodon typus*), in Mexican coastal waters of the Caribbean Sea. PLoS ONE. 6:e18994.

Hoffmayer E, McKinney JA, Franks JS, Hendon J, Driggers III WB. 2013. Whale Shark Aggregations in the Northern Gulf of Mexico. PeerJ PrePrints 1:e85v1. https://doi.org/10.7287/peerj.preprints.85v1.

McKinney JA, Hoffmayer ER, Holmberg J, Graham RT, Driggers III WB, de la Parra-Venegas R, Galvan-Pastoriza, BG, Fox S, Pierce S, Dove AD. 2017. Long-term assessment of whale shark population demography and connectivity using photo-identification in the Western Atlantic Ocean. PLOSone. 12(8):e0180495.

Rooker JR, Dance MA, Wells RJD, Ajemian MJ, Block BA, Castleton MR, Drymon JM, Falterman BJ, Franks JS, Hammerschlag N, et al. 2019. Population connectivity of pelagic megafauna in the Cuba-Mexico-United States triangle. Scientific Reports. 9(1):1663.

Pierce SJ, Norman B. 2016. *Rhincodon typus*. The IUCN Red List of Threatened Species 2016:e.T19488A2365291; [accessed 2016 July 06].

Ramírez-Macías D, Meekan M, La Parra-Venegas D, Remolina-Suárez F, Trigo-Mendoza M, Vázquez-Juárez R. 2012. Patterns in composition, abundance and scarring of whale sharks Rhincodon typus near Holbox Island, Mexico. Journal of Fish Biology. 80(5):1401–1416.

Vanderlaan ASM, Taggart CT. 2007. Vessel collisions with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science. 23(1):145–156.