Dynamics of seal bomb use in Channel Islands and Monterey Bay National Marine Sanctuaries

Objectives

The goal of this project is to evaluate how commercial fishing of California market squid and the related use of marine mammal acoustic deterrents known as "seal bombs" affect acoustic habitats in Monterey Bay and Channel Islands National Marine Sanctuaries. In 2020, NOAA's National Marine Fisheries Service proposed a rule guiding the use of marine mammal deterrents. Our project provides analysis important to the implementation of the proposed rule and supports our client, NOAA's Office of National Marine Sanctuaries, in monitoring sound within sanctuary boundaries to improve the management of sanctuary resources and wildlife. This analysis was completed by: (1) assessing the dynamics of seal bomb use by correlating spatial and temporal distribution of squid fishing activity with confirmed seal bomb detonations recorded on passive acoustic monitoring data sets, (2) spatially overlaying squid fishing pressure with cetacean biologically important areas, highlighting where regions of high-intensity squid fishing pressure, a proxy for seal bomb use, may overlap with important cetacean habitat, and (3) providing recommendations for management options for fisheries to lessen impacts to acoustically sensitive marine mammals.

Background

The California coast is home to a rich assortment of marine wildlife and hosts four National Marine Sanctuaries that work to manage the state's unique biological diversity. The California Current drives cold water from northern latitudes down the coast, causing an upwelling of nutrient-rich waters. This effect creates "biological hotspots" in which many marine species congregate and thrive off of the productive waters (Gaines & Airame, 2017). For this reason, the southernmost two National Marine Sanctuaries in California, Monterey Bay (MBNMS) and Channel Islands National Marine Sanctuary (CINMS), are home to a variety of endangered species and key market fish, and also provide critical habitat and migratory corridors for many cetaceans.

As levels of anthropogenic underwater noise have increased significantly since the 1960s (Swaddle et al. 2015; Buxton et al. 2017), ocean noise is a growing concern for protected marine mammals that rely on vocalizations to communicate and navigate. One concerning source of anthropogenic noise stems from the top-grossing fishery in the state: the California market squid. While squid is a valuable market good, it is also a primary prey source for pinnipeds, including the California sea lion (Zalophus californianus).

Squid fishing vessels anchored off Santa Barbara Island.
Photo: Jenna Wisniewski

As such, the squid fishing industry often competes with these animals, and so utilizes legal acoustic deterrents called "seal bombs". These explosives release a sonic blast a few meters below the water's surface to scare away pinnipeds and prevent them from stealing catch or damaging fishing gear (Meyer-Loebbecke et al., 2015). Previous studies have shown seal bombs used in extremely large numbers, and the current understanding is that peak seal bomb use in MBNMS occurs in the summer, with as many as 88 explosions in one hour and 335 in one day occurring in 2018 (Simonis et al. 2020). Initial investigations have indicated that the impulsive sound from a seal bombs detonation can travel underwater for tens of miles depending on benthic topography and ocean conditions. As a result, the acoustic impacts of seal bombs often reach beyond the target pinnipeds, impacting sensitive non-target species in the region (Simonis et al. 2020).

The Office of National Marine Sanctuaries (ONMS) recognizes the importance of managing potential sources of anthropogenic noise in sanctuary soundscapes. ONMS is working with the National Marine Fisheries Service,

Example of a seal bomb.
Photo: Wiggins et al. 2021

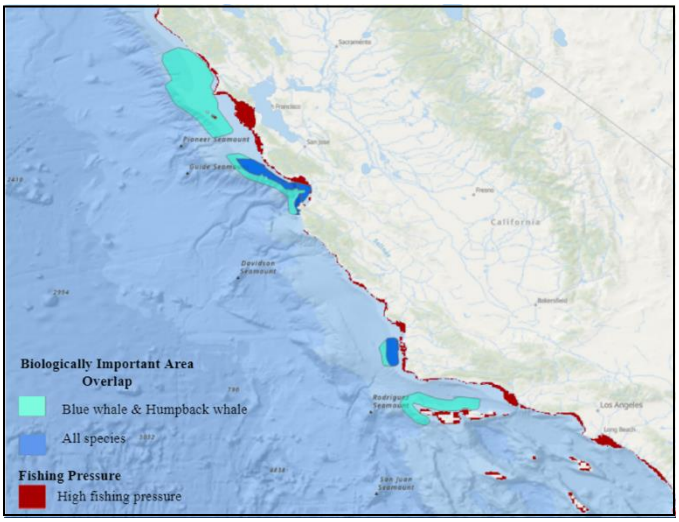
California Department of Fish and Wildlife, and numerous sanctuary partners to research the dynamics of anthropogenic sound to better understand how it impacts surrounding marine habitat and develop robust management strategies to limit these impacts. While the research of ONMS has studied multiple sources of underwater sound, our project focuses solely on seal bomb acoustic deterrents. Here, we describe the steps taken to analyze and identify key areas within both MBNMS and CINMS where the presence of cetacean species overlaps with high squid fishing pressure and notable seal bomb use. The results from our analysis will provide important information on priority areas for seal bomb use limitation relative to seasonality, and can further inform sound sanctuary management.

Results

Our analysis found that in MBNMS, seal bomb use is heaviest in the early morning with a similar peak occurring in the evening. Use throughout the day is comparatively much lower. Seal bombs recorded in CINMS are concentrated from early evening to midnight, however, there is some heavy usage in the early morning. Seasonal analysis of results shows that seal bombs are more heavily used in the summer months (May-August) in Monterey Bay, while seal bomb use peaks in the winter (November-February) in the Channel Islands. Additionally, recorded seal bomb detections are noticeably higher in MBNMS than CINMS despite there being more hydrophones in the Channel Islands region. Using squid fishing pressure as a proxy for seal bomb use, our model shows that high squid fishing pressure geographically overlaps with or occurs near multiple cetacean Biologically Important Areas (BIAs) in northern California and around the Channel Islands during the summer. During the month of July, high fishing pressure in northern California overlaps or borders BIA "hotspots", which delineate regions where four distinct cetaceans' BIAs are present. In November and continuing into the winter, high fishing pressure overlaps with the BIAs of only one species in southern California and around the Channel Islands.

Conclusions

Understanding the temporal and spatial dynamics of seal bombs in the larger marine soundscape is important for the effective management of sanctuary resources. Areas experiencing significant overlap would benefit from management strategies to lessen impact, including seasonal seal bomb "limitation zones". These zones could serve to reduce the use of marine mammal acoustic deterrents, and therefore reduce the potential impact on non-target species. The proposed network of seal bomb limitation zones produced by our analysis identifies critical areas to protect at-risk marine mammals based on their distribution and areas of biological importance. These recommended zones are based on the amount of overlap that occurs between areas experiencing high fishing pressure and areas likely to provide critical habitats for marine mammals that rely on sanctuary waters for resources and protection.



Overlap of high fishing pressure and cetacean Biologically Important Areas. Image: Anastasia Kunz & Jenna Wisniewski

Our research also found that fishing pressure cannot be used as a complete one-to-one proxy for seal bomb use. Passive acoustic monitoring systems will provide the best tools for understanding the future temporal and spatial dynamics of seal bomb use, as well as predicting future impact on cetaceans.

While this study does not definitively identify whether seal bomb acoustic deterrent use constitutes a violation of the Marine Mammal Protection Act (MMPA), our results indicate that there is significant overlap and close proximity of cetaceans and seal bomb use in both MBNMS and CINMS. Our findings of seal bomb use near non-target species emphasize the need for further research on how seal bombs impact cetaceans and pinnipeds directly and indirectly. These nuances are complex and the species mentioned in this report will likely require more than the proposed guidance for long-term protection, however, creating a well-planned management strategy for marine mammal deterrent use is a meaningful starting point and could provide benefits to these irreplaceable species in the long term.

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