Effects of Low Frequency Seismic Exploration Sounds on the Distribution of Cetaceans in the Northern Gulf of Mexico

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Abstract: The increasing use of seismic exploration has created a need to understand the effects that low frequency sounds have on the distribution, abundance, and behavior of cetaceans. The goal of this study is to determine the possible impacts of seismic exploration on the distribution of cetaceans in the Northern Gulf of Mexico. Low frequency sounds originating from seismic exploration were collected via a towed passive hydrophone array on three research cruises in 1996-97. This data set was compared with the presence or absence of cetaceans. For odontocetes, no relationship between presence of seismic noise and distribution of animals was found on the relatively large spacial scale of hundreds of kilometers. Our findings suggest that the repetitive signals generated by seismic exploration may not have a negative impact on the distribution of odontocetes in the Gulf of Mexico.

INTRODUCTION

Use of intense low frequency seismic sounds for oil exploration has been increasing in occurrence and is expanding further into offshore waters, with the Gulf of Mexico maintaining the largest seismic fleet in the world (4). Considering that typical airgun arrays produce sounds that can exceed 250 dB re 1 μPa-m (3), concerns have been raised regarding the potential impact that oil exploration may have on marine mammals.

In seawater, where visibility is significantly less than that on land, the auditory sense of cetaceans is well adapted for communication and assessment of the environment (5). While several studies have noted short term behavioral reactions of mysticetes to presence of sounds from seismic exploration (3), few have examined odontocetes or the potential large scale distributional impacts. One study found a brief reaction to the onset of seismic blasts, and it was suggested that observed changes in distribution might be due to prey availability (2).

The purpose of this study is to examine the effects of the presence of seismic sounds on the distribution of cetaceans in the Northern Gulf of Mexico. This region of the Gulf is influenced by dynamic hydrographic features which influence nutrient flow, chlorophyll, and biological activity (1), and potentially cetacean distribution. Boundaries of five hydrographic features were determined by analysis of temperature and salinity profiles, as well as sea surface height (SSH) data collected by satellite altimetry. The distribution of cetaceans was determined by means of visual observation methods, and the presence of seismics was determined by acoustic monitoring. These relationships were examined for the different hydrographic regions within the study area.

METHODS

Three two-week research cruises (1996-97) consisting of line transect data in the Northern Gulf of Mexico were analyzed. The study area consisted of a focal study in continental slope region south of the Mississippi River outflow, and a second aspect focusing on the Eastern Planning Area (EPA) of the Northeastern Gulf of Mexico.

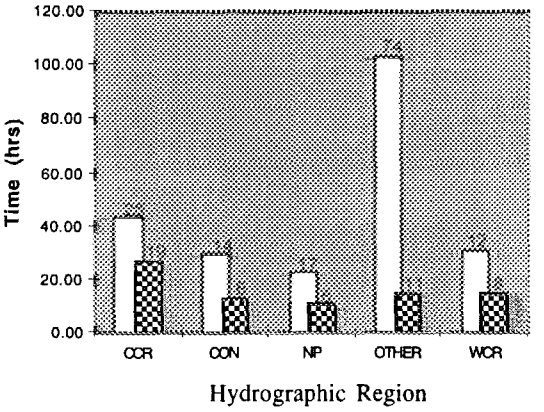
Acoustic Monitoring: Presence of sounds from seismic exploration were recorded by a towed passive acoustic array onto an eight channel Racal V-Store analog tape recorder. Signal processing was conducted utilizing SIGNAL™ software, which contains a subroutine that provides real time spectographs (RTS). Playback of signals at 3x recorded speed (15/16 ips), with a sampling rate of 3 kHz, allowed for analysis of seismic pulses.

Visual Observations: Visual methods consisted of two teams of three people, with two people using 25x "big-eye" binoculars. The third observer recorded data into a laptop computer interfaced with a global positioning system (GPS). Species were identified to the lowest taxonomical level possible.

Oceanography: Splined temperature and salinity profiles were measured from expendable bathythermographs (XBT) and conductivity-temperature-depth (CTD) casts. Satellite altimetry data provided images of the mesoscale hydrographic features by displaying SSH anomalies. Examination of this data allowed for definition of 5 hydrographic regions: cold core rings (CCR), northern periphery of CCR (NP), confluence (CON), warm core rings (WCR), and areas outside these defined features (OTHER).

RESULTS

Over 228 hours of total effort were analyzed for the combined three research cruises, with 18.8% of effort occurring within CCRs, 13% in CON, 9.9% in NP, 44.9% in OTHER, and 13.3% in WCRs (Fig.1). Presence of seismics was high (>44%) in all regions except for OTHER (14.6%), nearly all of which occurred in the EPA (>85%). The observed sightings of cetaceans within regions containing seismics were not significantly different from the expected based on random distribution (χ^2=2.224, p=.695). Likewise, distributions of sperm whales as well as the other odontocetes often occurred in areas of high intensity seismic exploration.



Solid white bars depict total time (in hours) "on effort" in each hydrographic feature, with the number of cetacean sightings for that feature.

Checked bars indicate the time (of total) in which sounds from seismic exploration were present, with the number of cetacean sightings within seismic regions.

Figure 1. Time on effort and cetacean sightings, with and without seismic sounds, within 5 hydrographic regions

DISCUSSION

For each hydrographic region, the observed distribution of cetaceans associated with seismic sounds does not significantly differ from that expected given random distribution, contrary to previous findings (6). Seismic sounds show a high rate of occurrence in the focal area of the study, yet they are relatively uncommon in the EPA region. The increased productivity associated with the dynamic hydrography of the focal area, where geophysical exploration is concentrated, may be responsible for the apparent lack of effect on cetacean distribution. This study does not, however, present any information regarding smaller scale behavioral impacts. In addition to simultaneous cetacean observations with seismic exploration, acoustical monitoring indicated presence of cetacean vocalizations (including Stenella coeruleoalba, S. attenuata, S. longirostris, Physeter macrocephalus, and Steno bredanensis). Future work will include data from GulfCet I cruises, allowing for better examination of the potential impact seismic exploration may have on the distribution of cetaceans, as well as provide an examination of long-term trends.

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