

Effects of wind-generated underwater noise on southern right whale group dynamics

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Introduction: whales hear their world

- Whales rely on hearing to assess the world around them, communicate, avoid predators, and find mates, because even in clear water, visibility is seldom greater than one or two hundred feet (Roberts, 2013)
- Underwater noise levels are affected by many factors, including weather such as wind (Lide, 1991)
- Noise due to wind may interfere with whale communication and their ability to alert each other of danger (Stafford, 2016)



Introduction: wind noise versus communication



- Masking occurs when sounds are made at the same frequency band and time as another sound rendering it inaudible (Clark et. al., 2009)
- The Up call is a distinct sound southern right whales use to communicate (Clark, 1982)
- The Up call is in the 50-200 Hz range (Clark, 1982)
- Wenz found that wind created underwater noise that ranges from 100 to 1000 Hz (Wenz, 1962)
- Murugan found that wind generates underwater noise in the frequency range of 100 Hz to 5000 Hz (Murugan, 2011)
- Wind could potentially create noise that masks Up calls

Audio: Payne, R. (1995). Right Whales. On *Deep Voices* [MP3 file]. Living Music/Earth Music Productions

Methods

- This study spans ten years from 1987-1996.
- I investigated group dynamics in the southern right whale population that calves off the coast of Península Valdés (PV), Argentina.
- Scientists survey whales from a plane and place them into groups based on proximity.
- The study assumes that the number of whales in a group is an accurate measure of whale proximity.
- Whales are classified as in a group if there is more than one adult whale.





Methods

- Wind speed is used to represent underwater noise
- Wind speed data comes from NOAA's ERRDAP server which provides wind speed every six hours
- Exploratory analysis comparing group size to the average wind speed over the day before, showed there was a significant relationship (p= 1.21*10⁻⁸)
- However, we wanted to study individual whale behavior instead of group behavior. Why is a whale in a group at all?
- A binomial logistic regression explains the probability of a whale being in a group due to wind speed and treats each whale as an individual



What is the effect of underwater noise caused by wind on right-whale grouping behavior?

Photo: Fredrick Christiansen

Three Possible Responses to Underwater Noise

Whales form larger groups as wind speed increases

- Grouping increases vigilance and survival (Mann, 2000)
- A decrease in ability to hear could makes the mothers and calves more vulnerable to predators like orcas
- Mothers may stay closer together to alert each other to predators over background noise

There is no significant change in group size due to wind speed Whales form smaller groups as wind speed increases

- Mother and calf pairs tend to spread out to conserve energy
- The Up call to contact other mothers may be masked by increased underwater noise
- Whales may spread out because they cannot locate each other over the noise

Results: group-size and wind-speed variation



Neither variable is normally distributed

Results: group size by wind speed

Linear Model of Wind and Whale Group Size



This naïve test along with many other exploratory analysis showed a correlation between average wind speed 24 hours before an aerial survey and group size which prompted further testing

Results: whales in groups by wind speed

Sign and Magnitude of Wind-speed Effect Depends on Time to Aerial Survey



There is a statistically significant correlation between wind speed and if a whale joins a group

Wind speed 9pm the night before has the largest effect on if a whale chooses to be in a group

Wind speed at 9pm two days before has a negative effect on if a whale chooses to be in a group

Conclusion and Discussion

- There is a significant relationship between increased underwater noise and a whale choosing to join a group.
- Underwater noise at 9pm the night before an aerial survey has the largest effect on a whale becoming part of a group
 - Why does stronger wind at 9pm two days before the aerial survey decrease the likelihood of whales joining a group?
 - Maybe because it makes wind the next night seem like less of a big deal?
 - Maybe because if they expended energy the night before to form a group due to high winds they are less likely to expend energy the next night to move into a group?



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