Poster Presentation from SMM conference 2019

Species distribution models and a novel approach to include soundscape information for North Atlantic right whales and other species at risk

Erin LaBrecque, Independent Consultant
erinlab@gmail.com
Lynne Hodge, Independent Consultant
lw32@duke.edu
Erin Ashe, Oceans Initiative
erin@oceansinitiative.org
Rob Williams, Oceans Initiative
rob@oceansinitiative.org

Background

Despite the importance of the acoustic environment for marine organisms, acoustic attributes have not been incorporated into species distribution models (SDMs). We explore methodologies for incorporating acoustic data into SDMs, both at a species level and at a community level to provide a generalizable framework for ecological inference from these types of models.

Acoustic Parameters

- Octave band SPLs
- 1/3 octave band SPLs for frequencies of main call type of species of interest
- Sound level exceedance percentiles
- 1- or 3-hour bins
- Acoustic detections

Ecoacoustic Metrics

- Acoustic Complexity Index
- Acoustic Entropy Index
- Acoustic Diversity Index
- Roughness Index

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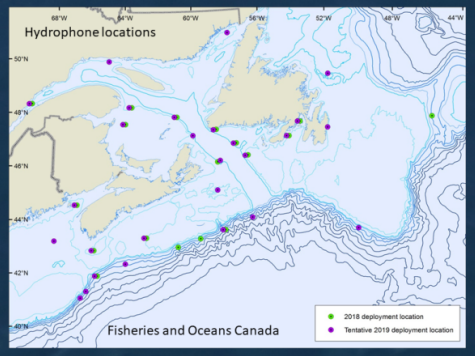
Proposed models for incorporating soundscape metrics



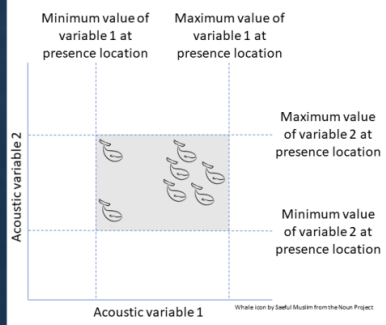
Presence-only SDMs

Model Type	Pros	Cons
Envelope	Simple, acoustic description of the environment	Single outlier has same weight as many records in core of range
Maximum Entropy	Probability of occurrence	Tends to overfit
Acoustic Distance	Fine scale spatial description of detections	Lots of signal processing work

An adult male right whale, #1327, feeding and accompanied by white-sided dolphins. Image collected under MMPA research permit #17355. Credit: NOAA Fisheries/Allison Henry

Program ID #654

Envelope



Maximum Entropy

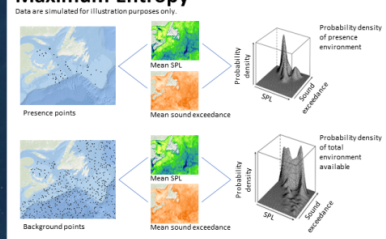
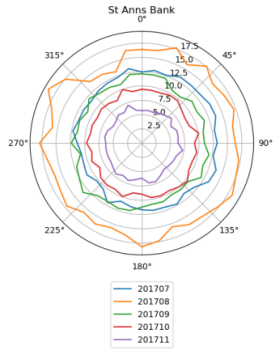


Figure adapted from Elith et al. (2011) *A statistical explanation of MaxEnt for ecologist. Diversity and Distributions, 17, 43-57*

Acoustic Distance

Detection range estimates (km) of North Atlantic right whales off St. Anns Bank from July 2017 to November 2017



Analysis by Jinshan Xu
Fisheries and Ocean Canada

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Together for Science and Conservation

A review of SDMs and a novel approach to including soundscape information for species at risk

- We wrote a literature review that provided:
  - an overview of soundscapes,
  - a review of different sound and noise measurements,
  - a review of the different types of species distribution models (SDMs) that could allow for the incorporation of soundscape parameters,
  - a proposal of three model types into which one could potentially incorporate soundscape parameters,
  - the proposed sound metrics we suggest including in SDMs, and
  - recommendations for moving forward.

- We also provided a Zotero library of all supporting literature reviewed.

A review of SDMs and a novel approach to including soundscape information for species at risk

- Proposed model types into which one could potentially incorporate soundscape parameters:
  - Envelope model
  - Maximum Entropy model
  - Acoustic Distance model

- Proposed sound metrics to include in SDMs:
  - Octave band SPLs
  - 1/3 octave band SPLs for the frequencies of the focal species' main call type
    - For NARWs: 63-200 Hz encompasses main frequencies of up-calls
  - Sound level exceedance percentiles
  - Acoustic detections
  - ACI and/or the acoustic entropy index

Model Type	Pros	Cons
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A review of SDMs and a novel approach to including soundscape information for species at risk

- Recommendations
  - Acoustic parameters and/or metrics should be included in SDMs because sound is part of a marine mammal's habitat.
  - The important acoustic parameters/metrics to include will vary for different species.
  - Need to collect acoustic data on full range of currently known species distributions.
  - New PAM efforts determine species density (Marques et al. 2009, Marques et al. 2012, Thode et al. 2020, Barlow et al. 2021)