



Investigating the relationship between sea ice extent and *Erignathus barbatus* breeding phenology in the Alaskan Arctic



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Introduction:

- In a changing Arctic Ocean, understanding the relationship between sea ice, ambient noise, and phocid breeding is vital for guiding management and preserving this ecosystem.
- Ice obligate bearded seals are culturally important and at significant risk of habitat degradation.
- As sea ice declines, ambient noise in the Arctic is expected to increase alongside anthropogenic use.

Research Questions:

- How does peak calling change in years with different sea ice conditions?
- How do call characteristics change in relation to ambient noise?

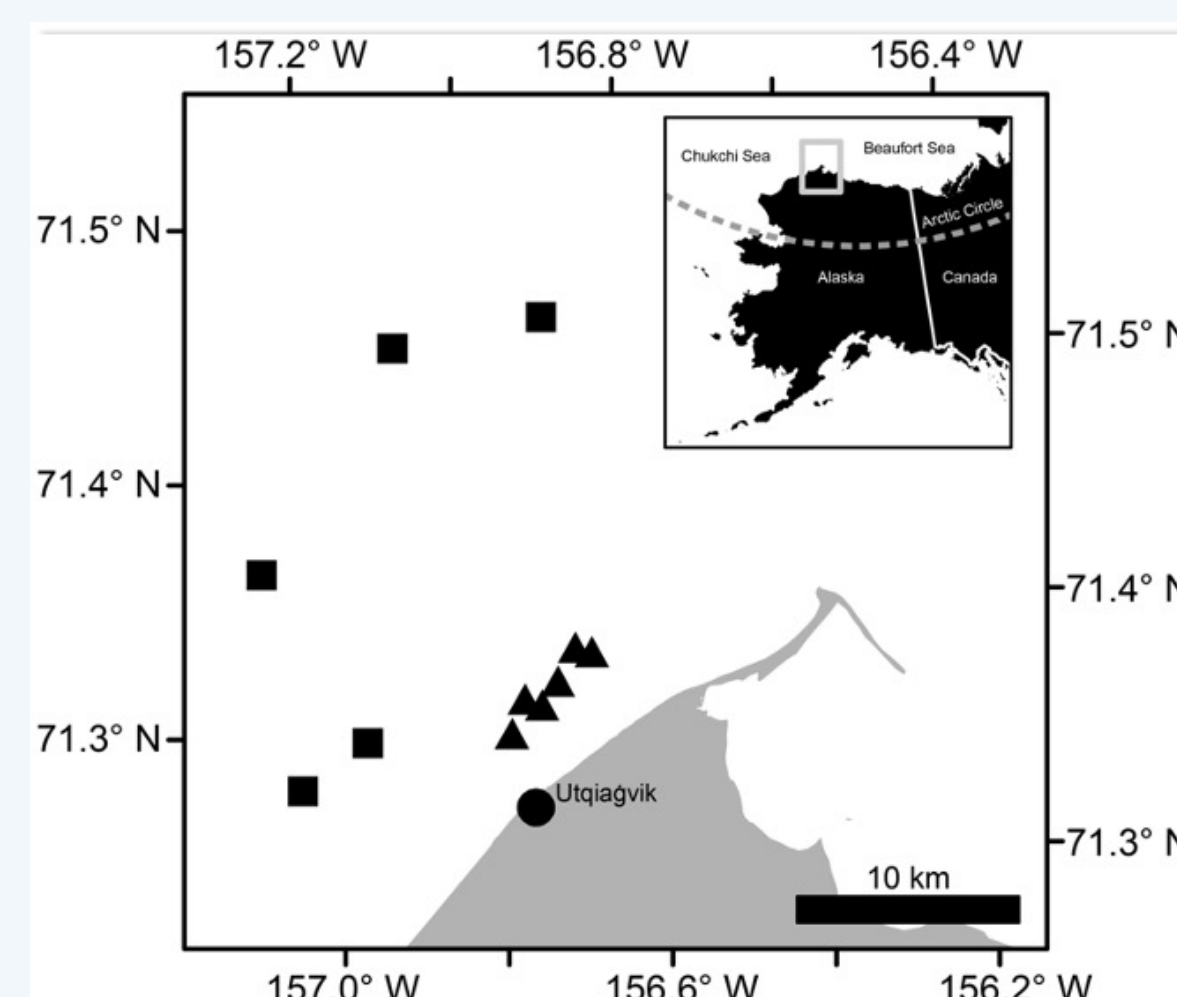


Fig. 1: Map of hydrophone location. 2010 is in triangles and 2011 is squares (Fournet et. al, 2021).

Methods:

- Acoustic data from census for Bering-Chukchi-Beaufort bowhead whales used from April-May 2010 & 2011.
- Bottom mounted hydrophones deployed along ice edge adjacent to Utqiagvik, AK recording continuously (2000 Hz sampling rate, 10-900 Hz bandwidth, $-145.5 \text{ dB re } 1 \text{ V } \mu\text{Pa}^{-1}$ sensitivity).
- A daily sample from sunrise, solar noon, sunset, and solar midnight was annotated using Raven Pro 1.6.4 (K. Lisa Yang Center for Bioacoustics).*
- Sea ice concentration collected from the Aqua/ASMR-E NASA data at a resolution of 12 km.
- Relationship between calling & sea ice as a function of year tested with a general linear model using a Poisson distribution.
- Peak frequency and 90% duration were used as call characteristics consistently available in this dataset.

*For days with 24-hour sunlight, a sample from each quarter of the day was used.

Results:

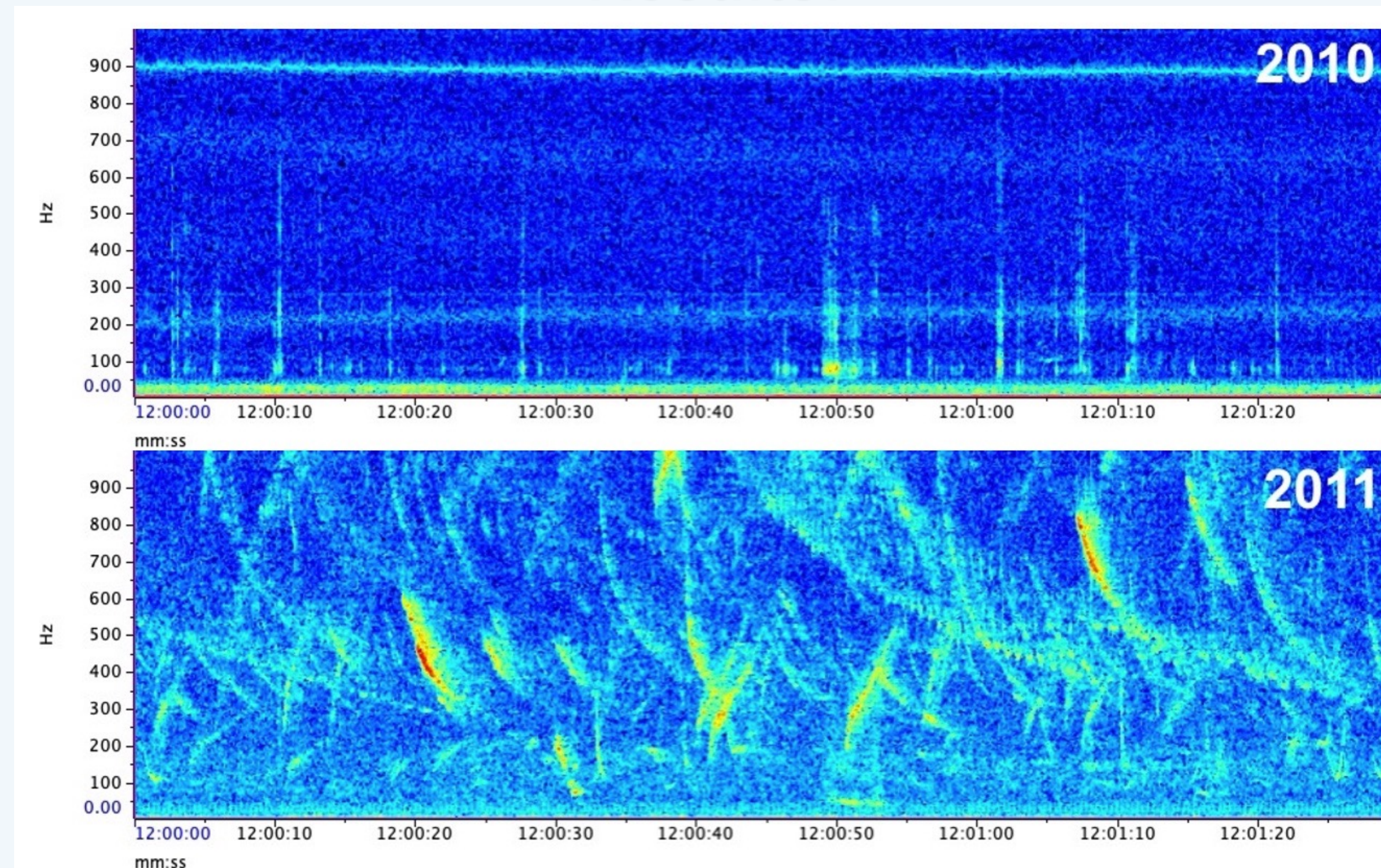


Fig. 2: Spectrograms displaying the difference in presence of bearded seal calls on April 28 for 2010 (above) and 2011 (below) (FFT = 512). Most calls in the 2011 spectrogram are from bearded seals.

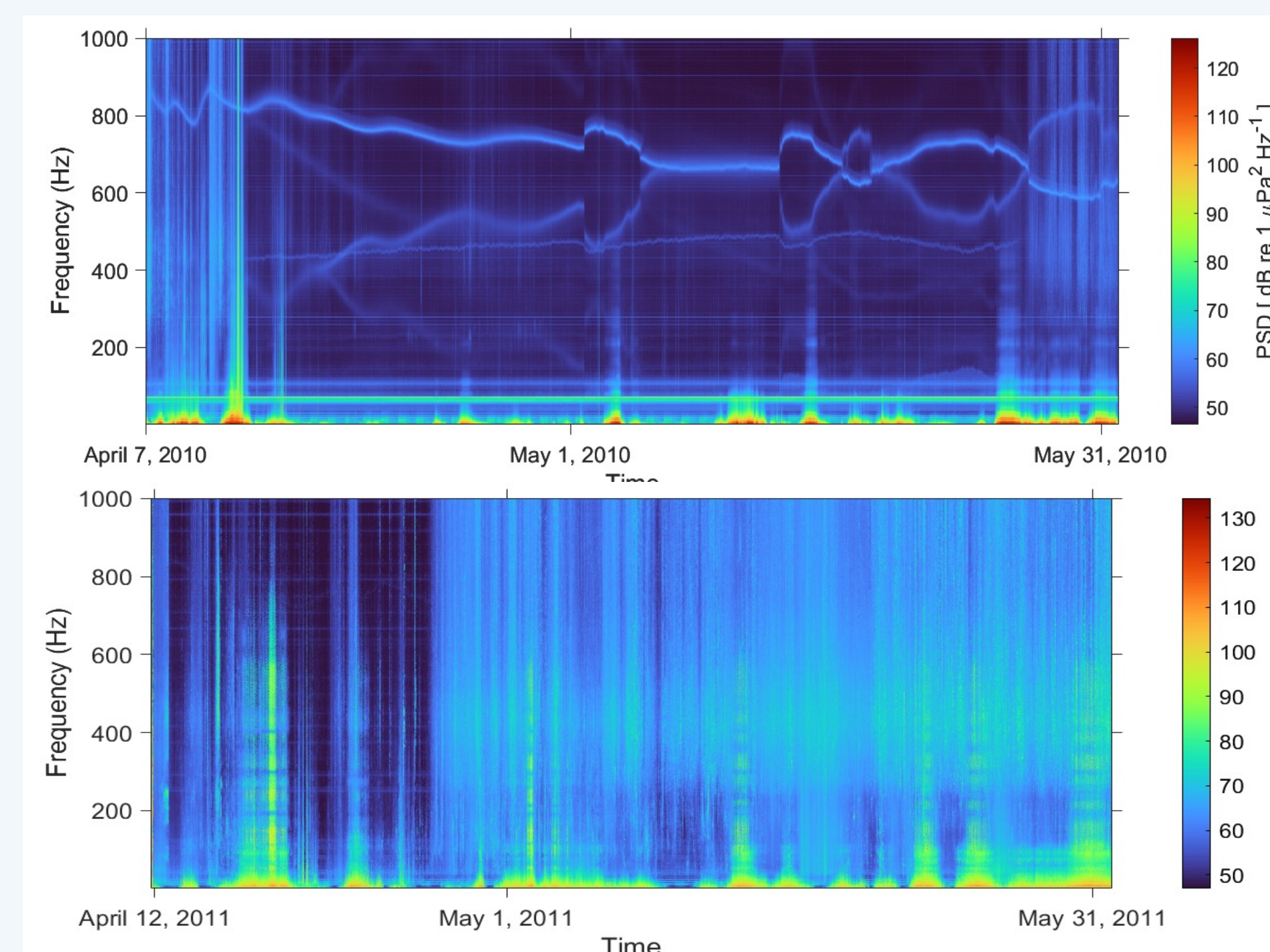


Fig. 3: LTSAs displaying noise and pitch from April-May in 2010 and 2011. May 2010 distinctly lacks the noise created by chorusing bearded seals present in May 2011.

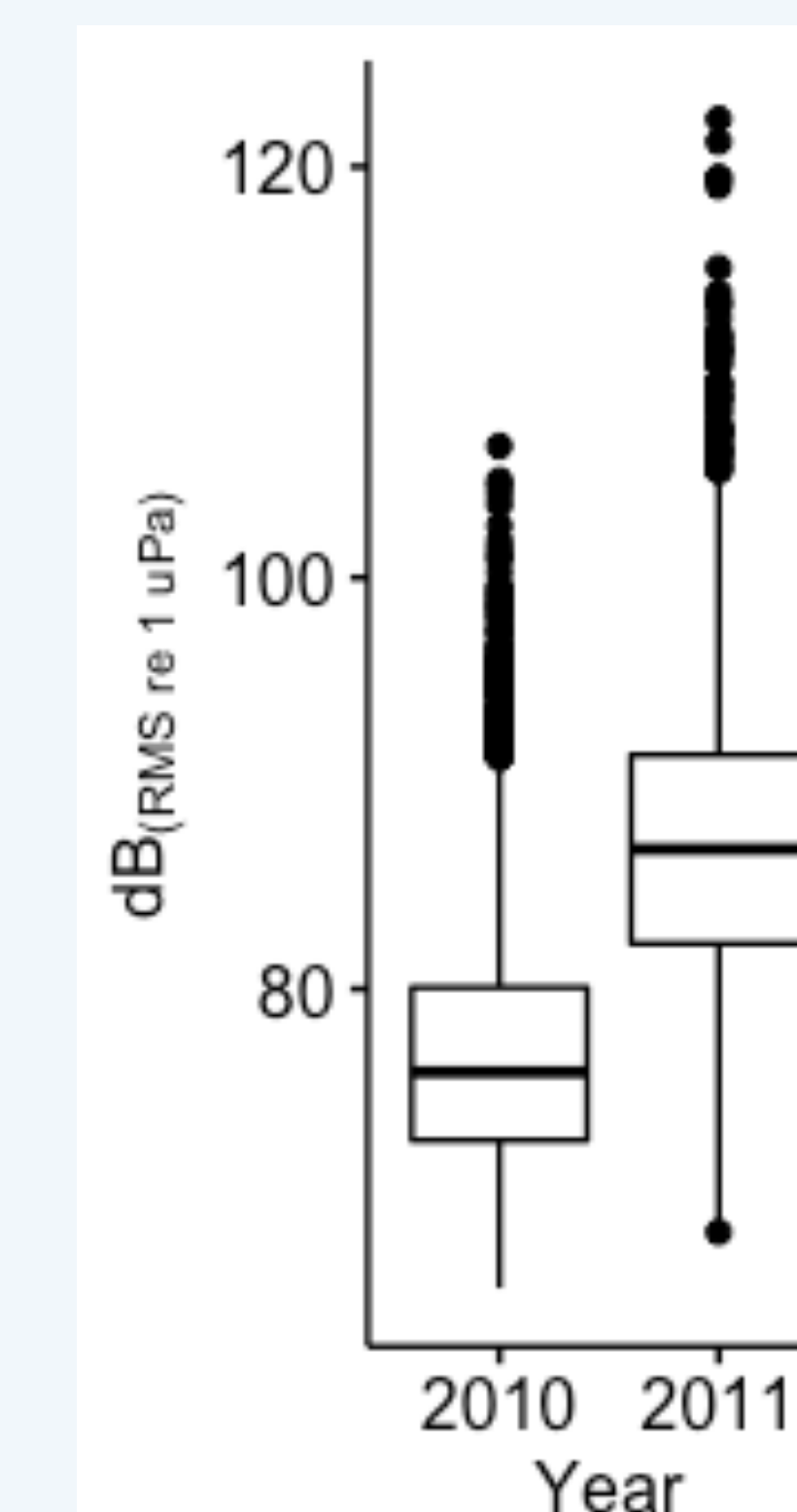


Fig. 4: Comparing ambient noise levels by year.

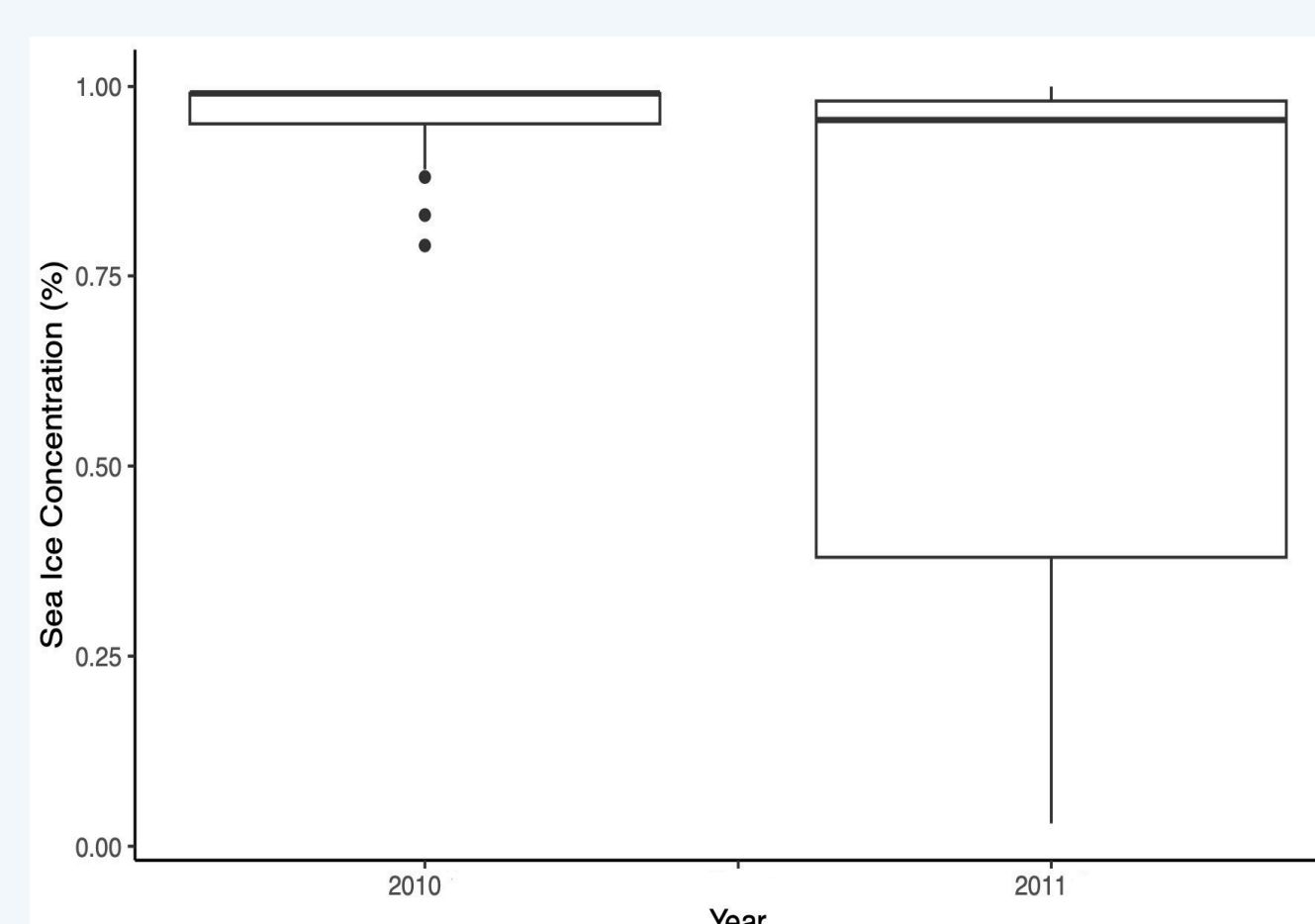


Fig. 5: Comparing variation in sea ice concentration during the breeding season from 2010 to 2011 (2010 min. = 0.79, median = 0.99, max. = 0.99) (2011 min. = 0.03, median = 0.95, max. = 1.00).

Scan to listen to 2011 spectrogram!



- 362% ↑ in calls in 2011 (95% CI 330%-399%, $p < 0.0001$) (Fig. 6).
- 25% ↑ in calls for every one unit ↓ in sea ice (95% CI 18%-31%, $p < 0.0001$) (Fig. 6).
- 2011 had significantly more variation in sea ice concentration than 2010, when the median concentration was higher (Kruskal-Wallis, $p = 0.001$) (Fig. 5).
- Sound levels in 2011 were an average of 10 dB higher than in 2010 (95% CI 9.7-10.2 dB, $p < 0.001$) (Fig. 4).
- There is no relationship between peak frequency and ambient noise; aligns with what is known about phocid calling behavior.
- For every 1 dB ↑ in noise, duration ↑ by 1.73 seconds. On average, duration is 0.18 sec. longer in 2011 than 2010 ($p < 0.0001$). Further analysis forthcoming.

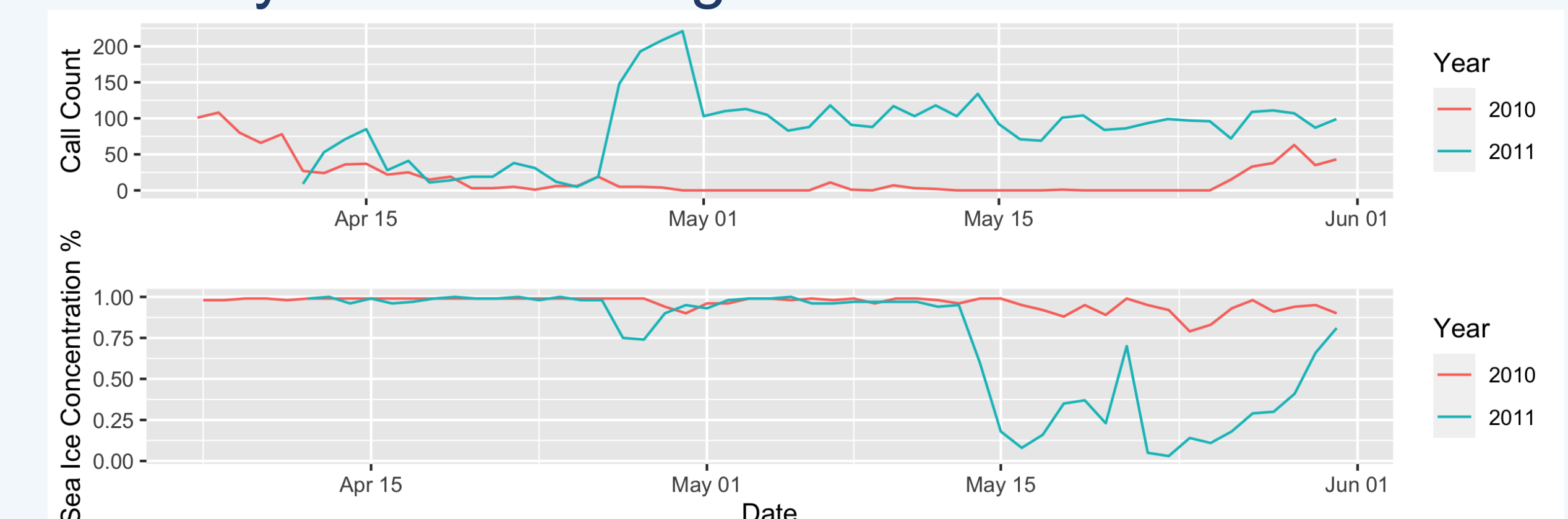


Fig. 6: Comparing sea ice concentration over one hydrophone by day to calls recorded per day by that instrument.

Conclusions:

- When ice breaks up earlier, seals call earlier and more often, altering the ambient soundscape.
- There is variation in call duration, possible call switching, that needs further analysis to be explained.
- Future research should evaluate whether the increase in calls due to sea ice variation is explained by the same individuals calling more often, or an increase in the number of callers.

Acknowledgements:

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