

Impacts of subsampling, detector performance & ambient noise levels on biological inferences



Data interpretation is subject to multiple biasing factors:

	availability biases
	presence of calling individuals
	vocal behavior of focal species
	detection biases
1	recording settings (e.g. sampling schemes, bandwidth)
2	call detectability (received call & ambient noise levels)
3	detector performance (detection method & threshold)

Motivation

- Analysis of PAM data requires manual or automatic detection of the focal species' vocalizations.
- Parameter settings during data collection & analysis determine representativeness of PAM data.
- Inferences based on biased data may lead to misinterpretation of a species' vocal behavior.
- Understanding these impediments is essential to avoid misleading biological inferences.

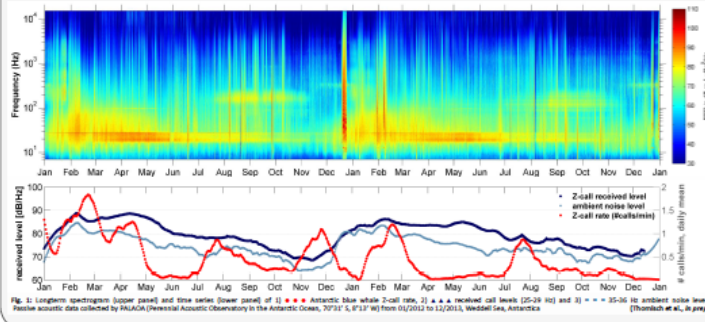


Fig. 1: Long-term spectrogram (upper panel) and time series (lower panel) of 1) Antarctic blue whale 2-call rate, 2) a received call level (25-29 Hz) and 3) a 35-36 Hz ambient noise level. Passive acoustic data collected by PALAQA (Passive Acoustic Listening to Antarctic Quakes, 70°S, 5°E) at WJ from 02/2013 to 12/2013, Weddell Sea, Antarctica. (Thomisch et al., in prep.)

How are inferences from passive acoustic data influenced by ...

1. ... subsampling?

Do different duty cycles affect assessment of acoustic presence & call rate?

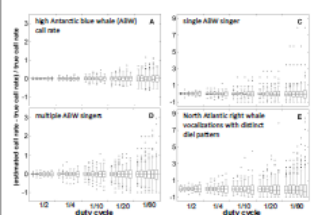


Fig. 2: Between-regime comparisons of ratios of estimated call rates from subsampled data to true call rates at different subsampling schemes. Within a given duty cycle, scenarios represent different cycle periods (from left to right: 1, 2, 3, 4, 6, 8 hours). (Thomisch et al. 2015, modified after Fig. 4)

- continuous acoustic recordings often subsampled for more efficient processing
- reduced reliability of call rate & acoustic presence estimates with decreasing duty cycles & increasing cycle periods

Need to decide on (sub)sampling scheme? Consider intensity & clustering of vocal activity! Use short, frequent sampling periods, if knowledge is limited! (Thomisch et al. 2015)

2. ... ambient noise?

Does seasonal call rate variation reflect changes in animal presence and density?

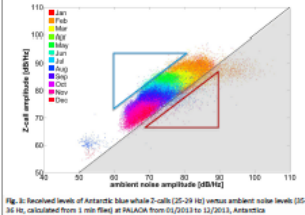


Fig. 3: Received levels of Antarctic blue whale 2-calls (25-29 Hz) versus ambient noise levels (35-36 Hz) calculated from 1 min files at PALAQA from 02/2013 to 12/2013, Antarctica. (Thomisch et al., in prep.)

- no loud calls in Oct/Nov during low noise
animals further out? (hundreds of km)
no vocalizations of animals close by?
quieter vocalizations?
- only loud calls in Jan/Feb during high noise
detector limitation (SNR ≥ 0)?
animals closer by (tens of km)?
animals vocalize louder?

Need to separate noise & behavioral effects? Localize animals & determine propagation loss! Ideal: Collect long term tag data on vocal behavior!

3. ... detector thresholds?

Do high detection thresholds allow reliable acoustic presence estimates?

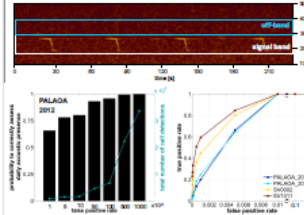


Fig. 4: Detector threshold setting & effects of detector thresholds (representing different false positive rates) on daily acoustic presence assessments of Antarctic blue whale from passive acoustic data collected between 2010 and 2013. (Thomisch et al. 2015, Thomisch et al., in prep.)

Work in progress:

- detection method: spectrogram correlation threshold parameter: correlation coefficient of events detected in "off-band"
- > 30% underestimation of acoustic presence when minimal false positive rates requested

How influential is the detection threshold? Risk of underestimating acoustic presence particularly high for species with low vocal activity!

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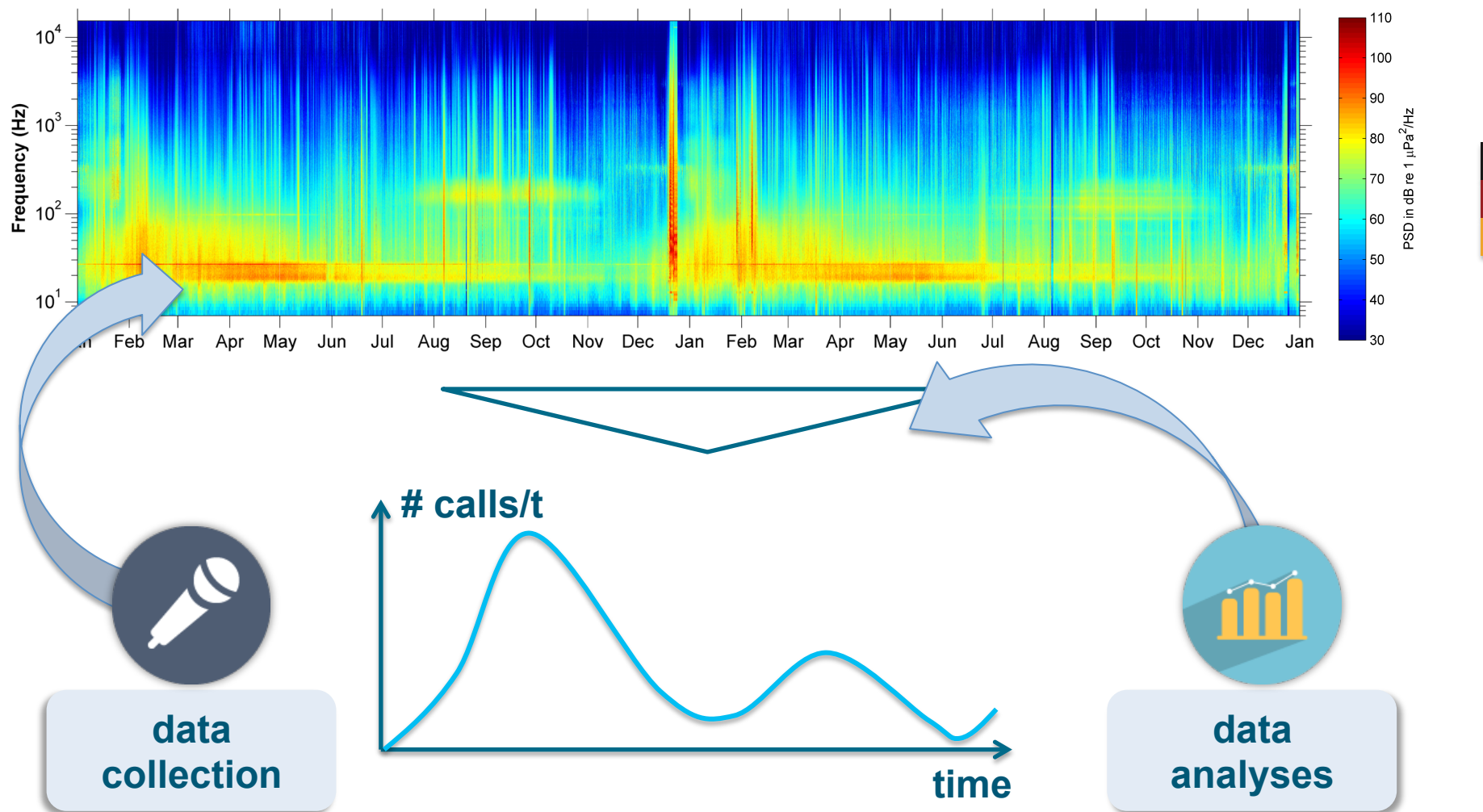
Potential pitfalls in interpretation of acoustic data

- Subsampling may lead to misrepresentations of daily acoustic presence & call rate.
- Varying ambient noise limits detectability/discriminability of calls. → Coupling of noise and call levels inconclusive!
- Detector threshold impacts on daily acoustic presence and call rate. → Off-band tests facilitate objective decision on threshold setting!

References

Thomisch, K., Boebel, O., Zitterbart, D.P., Samaran, F., Van Parijs, S., Van Opzeeland, I. (2015, in press). Effects of subsampling of passive acoustic recordings on acoustic metrics. J. Acoust. Soc. Am.
Thomisch, K., Boebel, O., Clark, C.W., Spiesecke, S., Zitterbart, D.P., Van Opzeeland, I. (in prep.). Spatio-temporal patterns in acoustic presence & distribution of Antarctic blue whales in the Weddell Sea.

Motivation



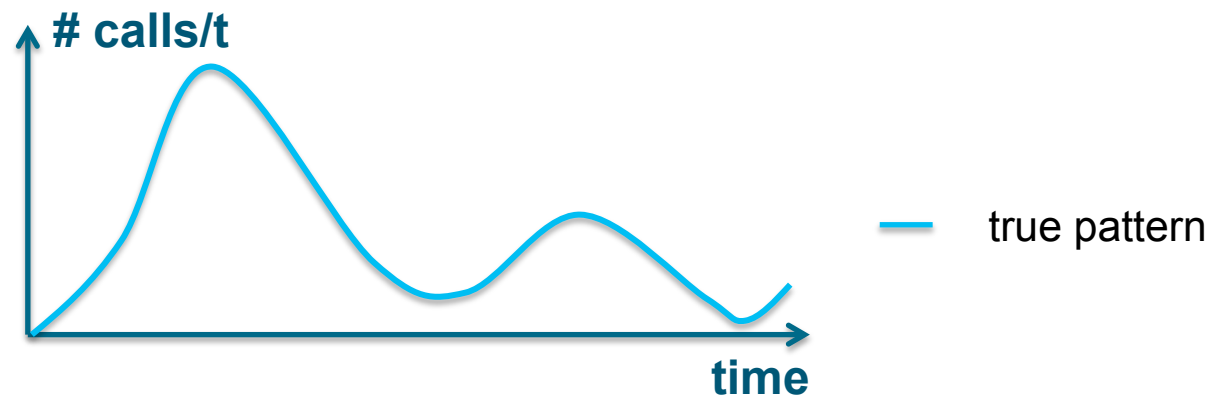
What influences PAM data interpretation?

Multiple biases → misinterpretation of vocal behavior?!

subsampling

ambient noise

detection threshold



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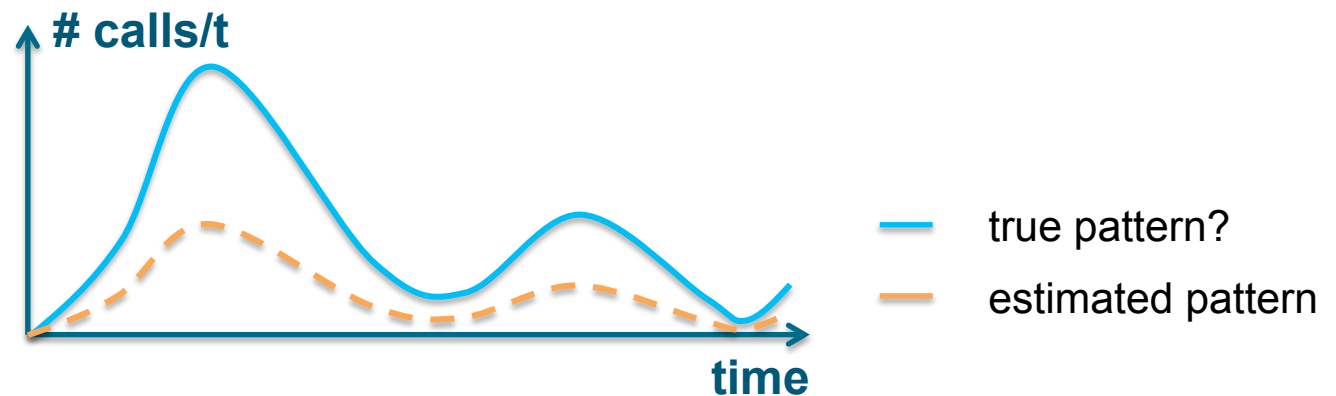
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Does duty cycle affect
acoustic presence & call rate?



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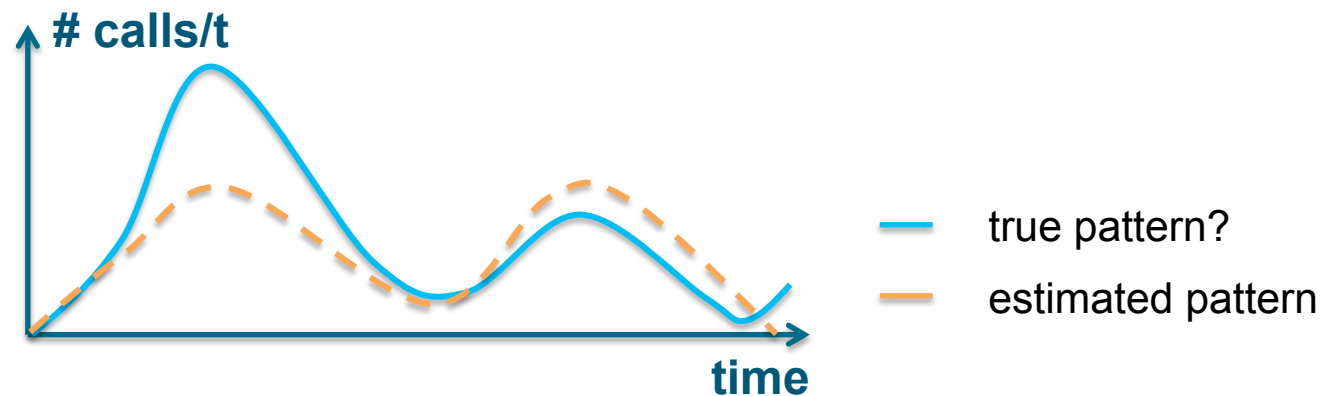
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Impact of seasonal variability of noise on call rate
& hence presence estimates?



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