Stiftung Tierärztliche Hochschule Hannover
University of Veterinary Medicine Hannover, Foundation

Prediction of the cochlear frequency map of harbour porpoise

Maria Morell, Laura Rojas, Adrien Caplot, Ursula Siebert

Institute for Terrestrial and Aquatic Wildlife Research, Büsum, Germany

Cochlea (inner ear)

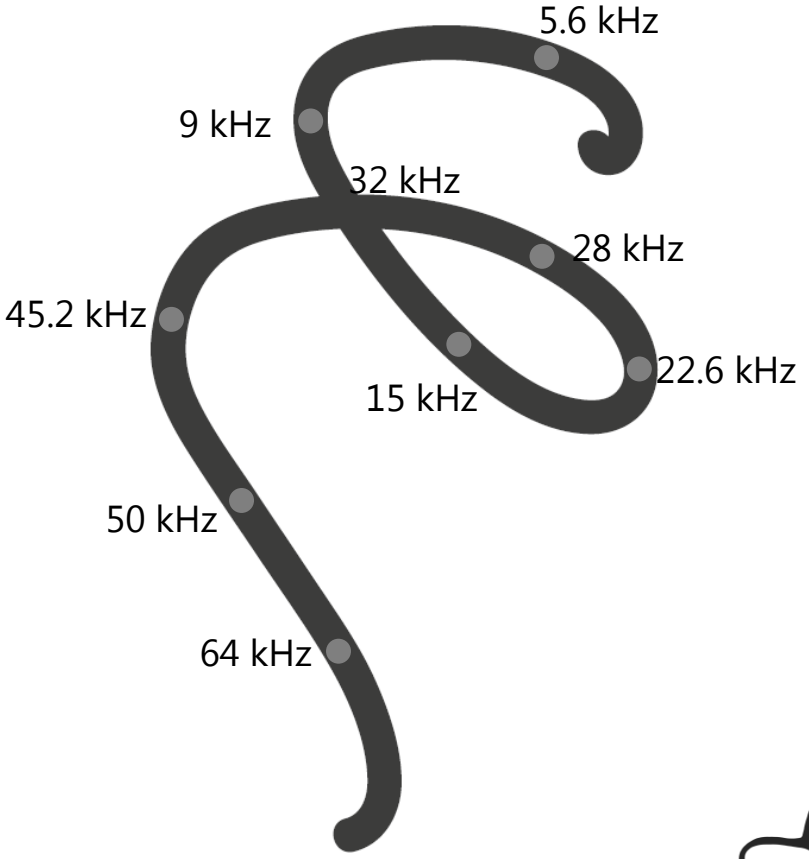
ASCOBANS

Objective: **predict the cochlear frequency map for harbour porpoise** based on morphometric characteristics of the organ of Corti

ASCOBANS/AC28/Inf.8.6

Apex:
low frequencies

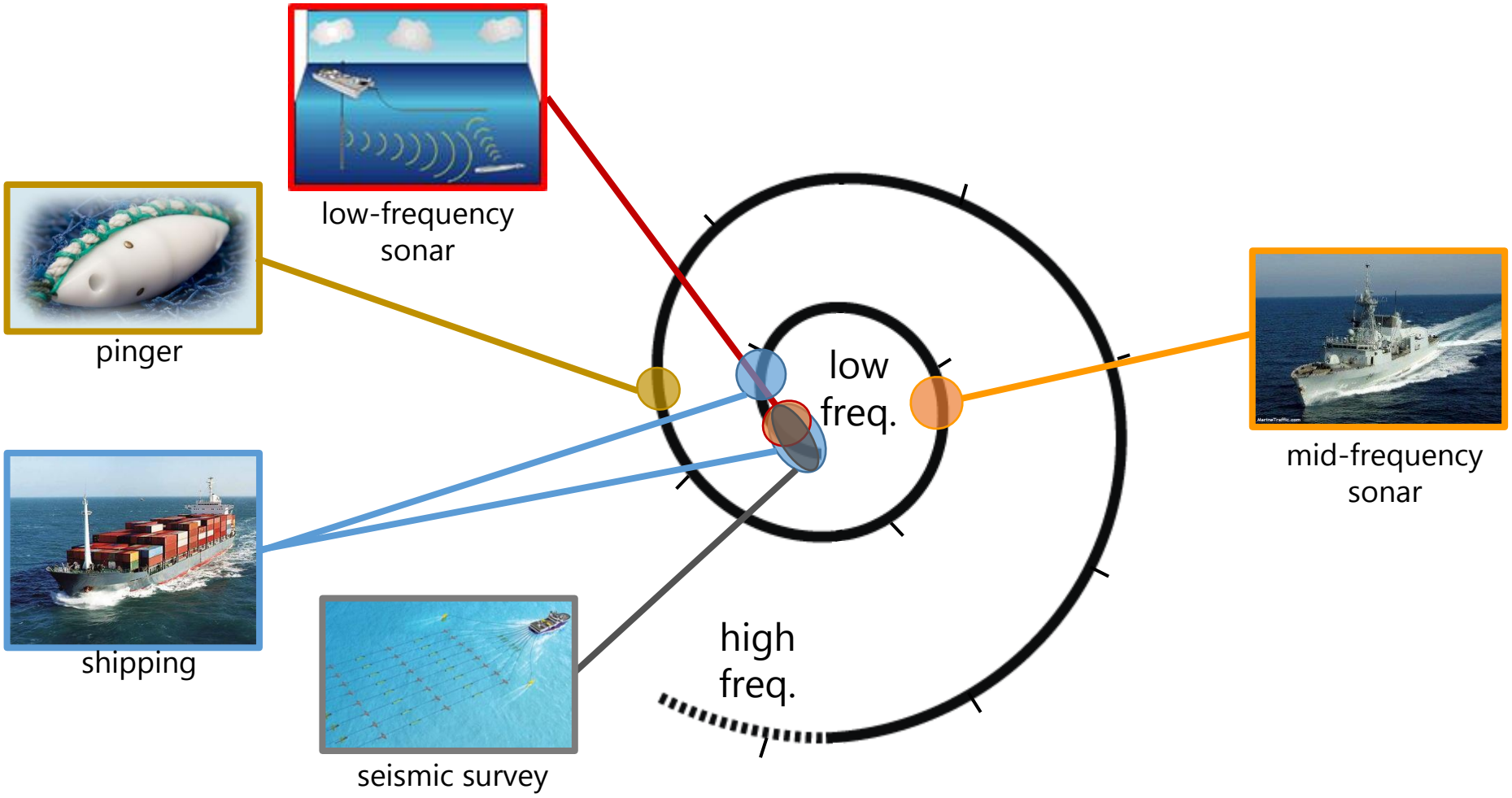
Base:
high frequencies



Cochlear frequency maps

Why?

- If a lesion is found ⟶ frequency range that is impaired ⟶ source



Cochlear frequency maps

Why?

- If a lesion is found ⟶ frequency range that is impaired ⟶ source

- Maps provide information on the full hearing range of the individual

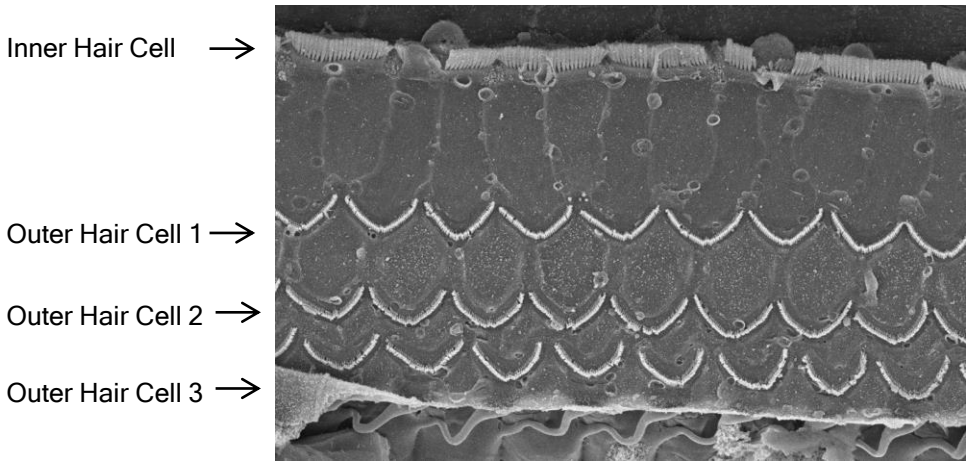
↓

Crucial to predict the hearing capabilities of species whose audiograms are not known

Inner ear analysis and cochlear frequency maps: Implications for Conservation and Management of Small Cetaceans

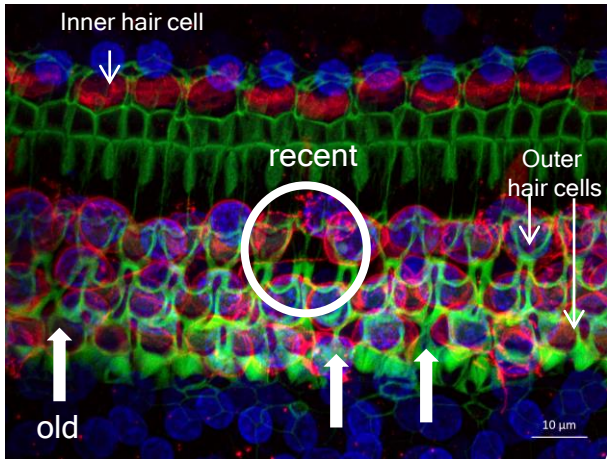
- Monitor the efficency of mitigation measures of sound sources

normal

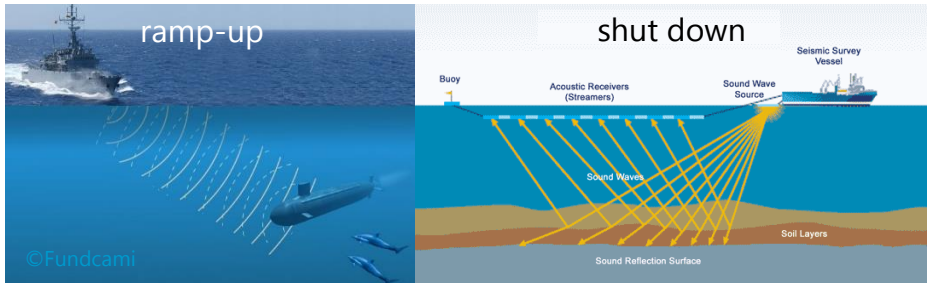


Girdlestone *et al.,* 2018. *Arctic Science*

damage (old and recent)



Morell *et al.,* 2020. *Front. Vet. Med.*



Cochlear frequency maps:
Implications for Conservation and Management of Small Cetaceans

- Monitor the efficency of mitigation measures of sound sources

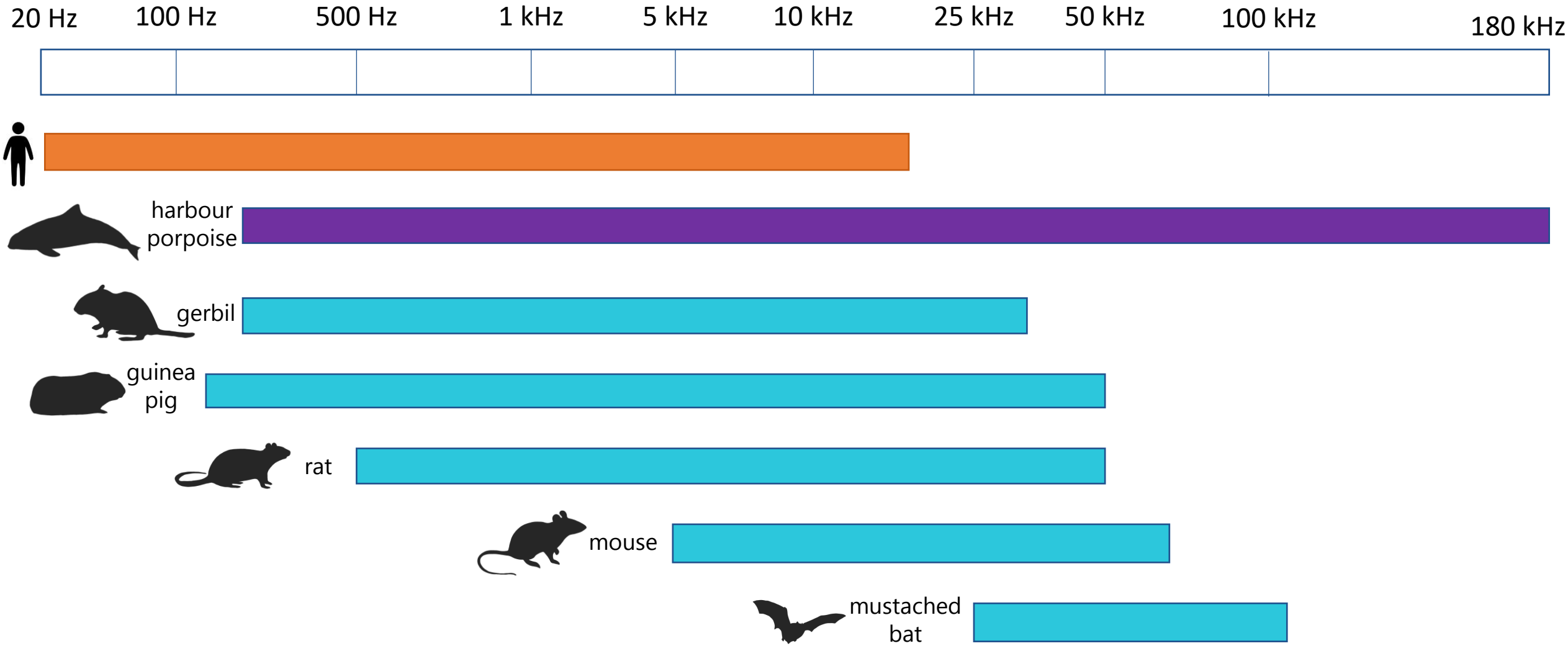
- Monitor „acoustic health“ of populations

- Predict hearing ranges of marine mammals whose audiograms are not known yet

- Allows us to make recommendations to Parties and other relevant authorities for further actions in specific sound sources

1) Relationship Shape (cells organ of Corti) and Frequency? YES

2) Is this relationship comparable among species? YES with similar hearing range


20 Hz
100 Hz
500 Hz
1 kHz
5 kHz
10 kHz
25 kHz
50 kHz
100 kHz
180 kHz
harbour porpoise
gerbil
guinea pig
rat
mouse
mustached bat

(25-111 kHz)

n=7

(0.5-54 kHz)

n=4

+

(5-68 kHz)

n=5

(0.25-30 kHz)

n=5 + 2

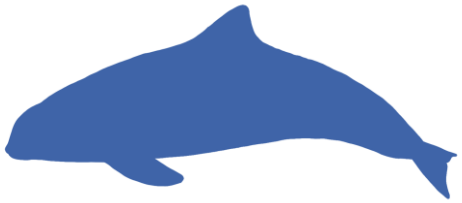
(0.15-55 kHz)

n=7

Using Machine Learning Techniques to build a Predictive Model

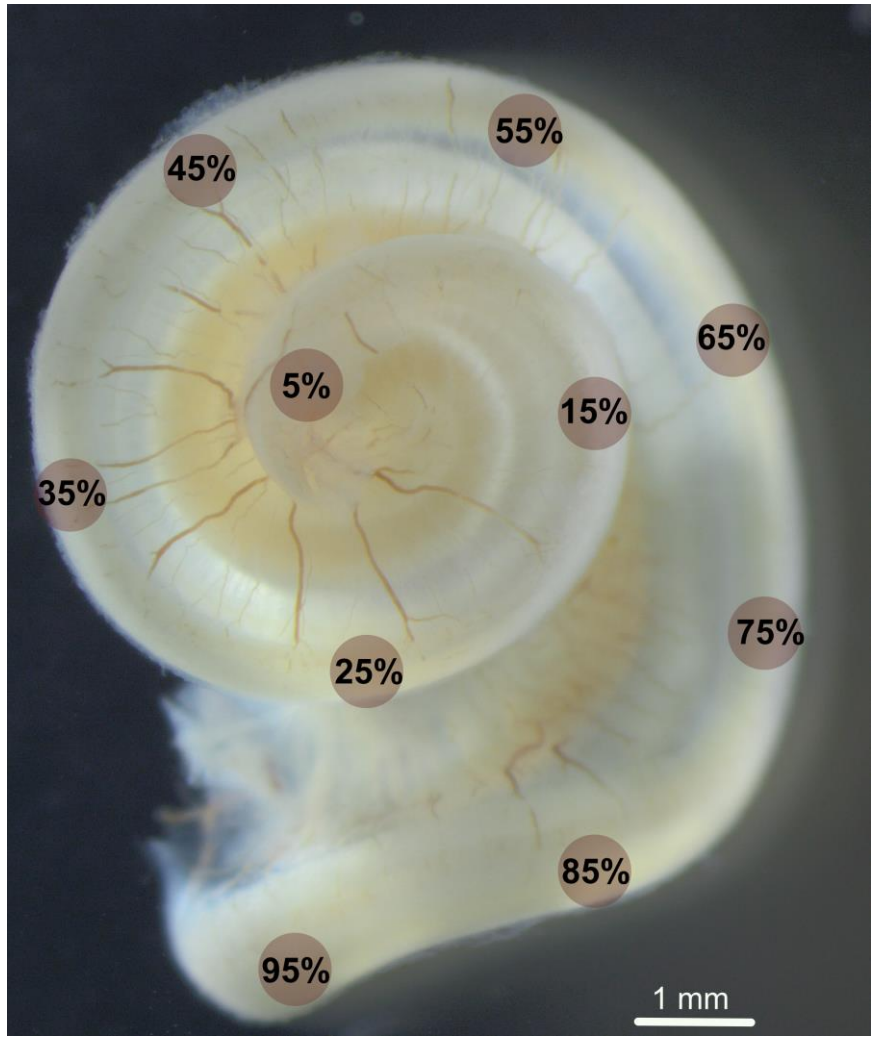
Rel. Morphometrics - Frequency

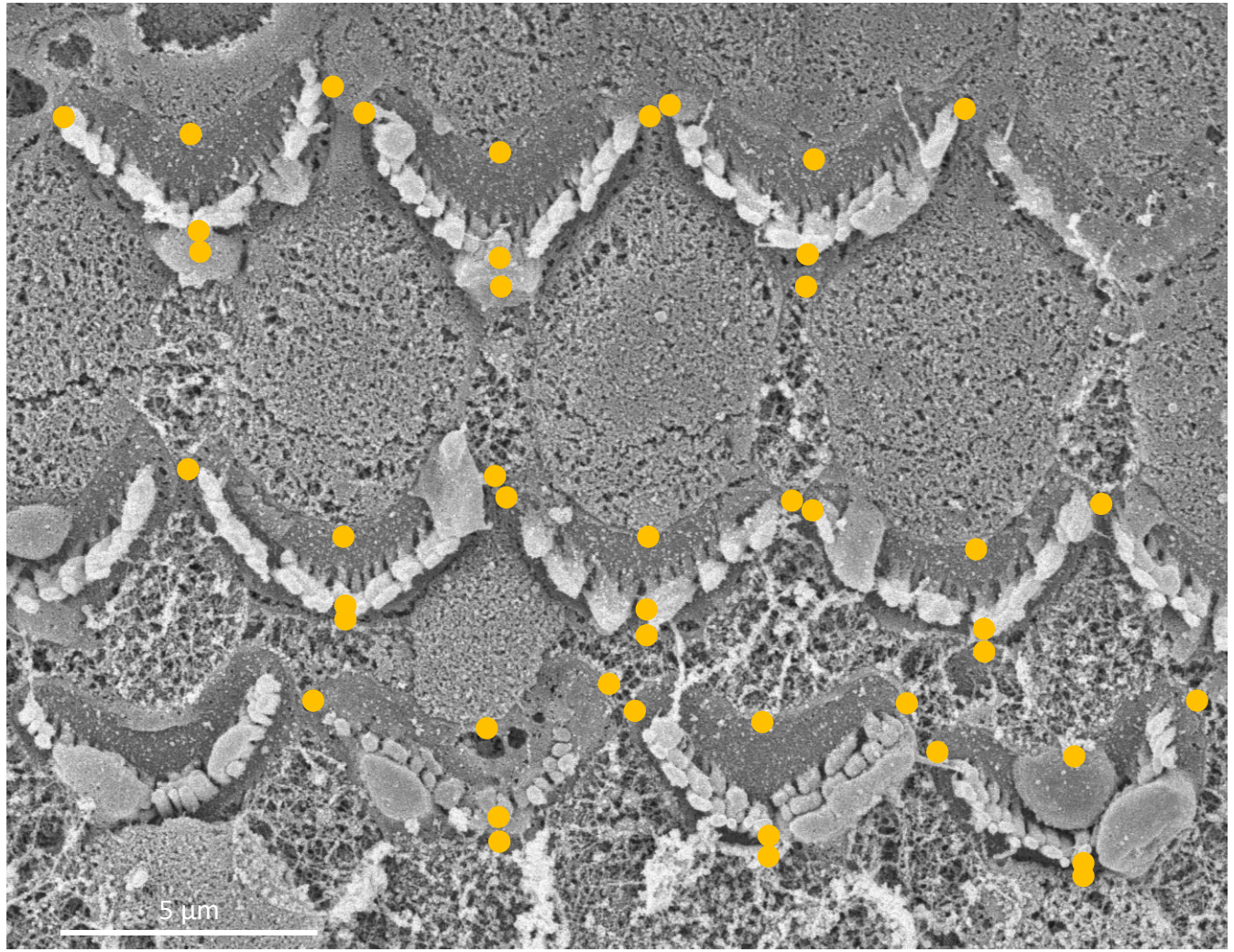
Use this predictive model with



(0.25 - 180 kHz) n=5 + 6

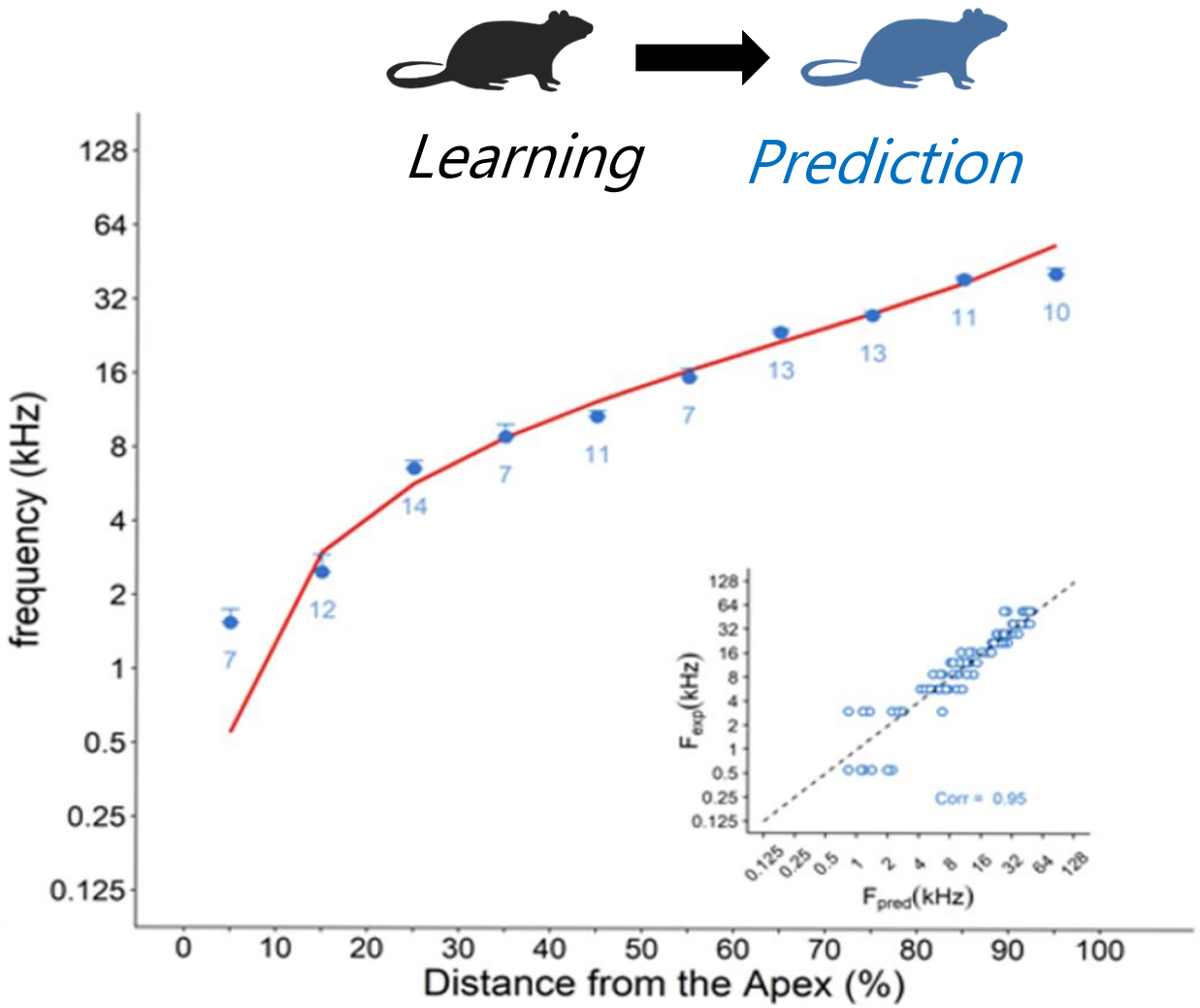
Geometric Morphometrics: Landmarks





At least 3 replicates
per location

Cross-validation between the same species

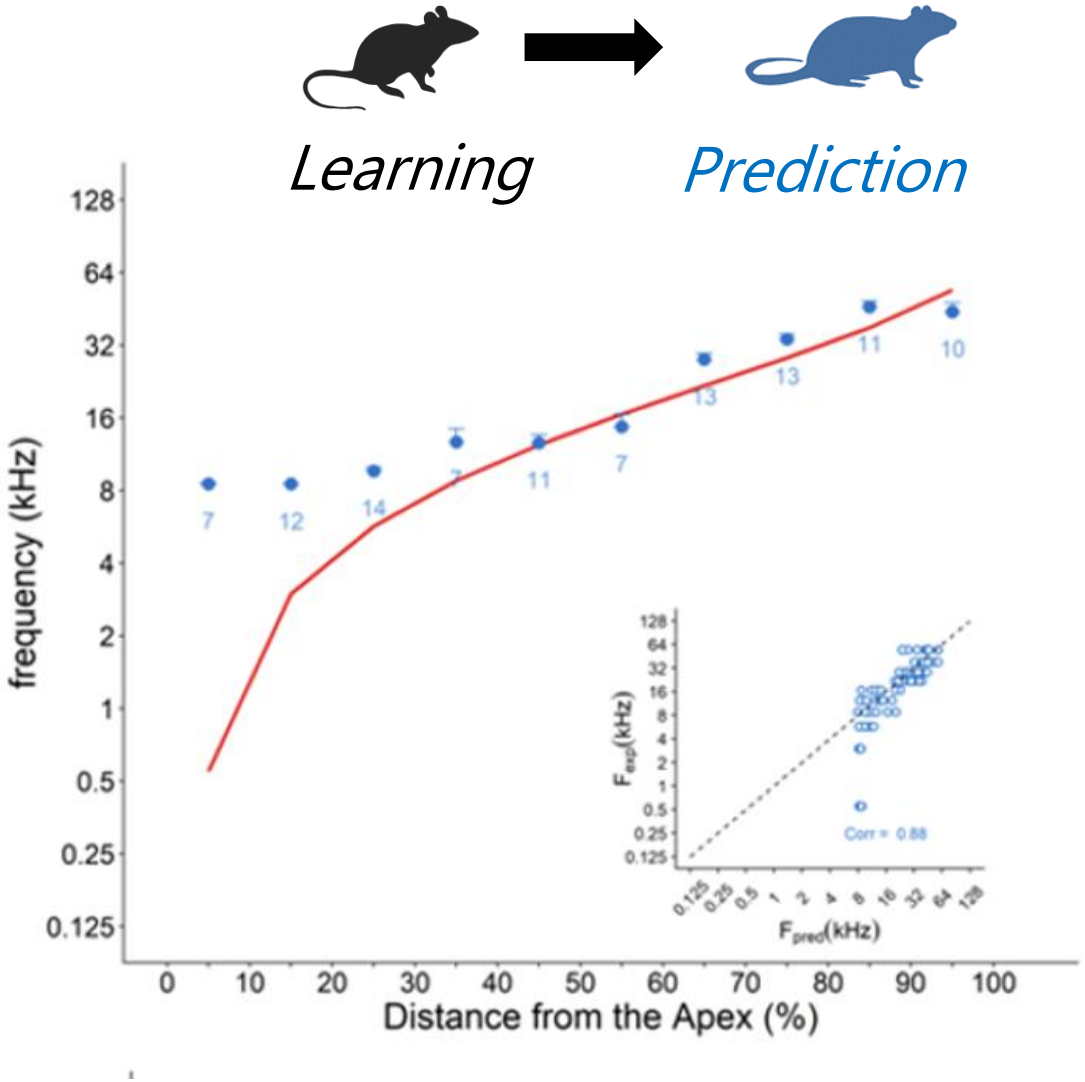


More guinea pigs

Rest of species: enough data (strong predictors)

Cochlear frequency map
Morphometric estimation

Cross-validation between different species

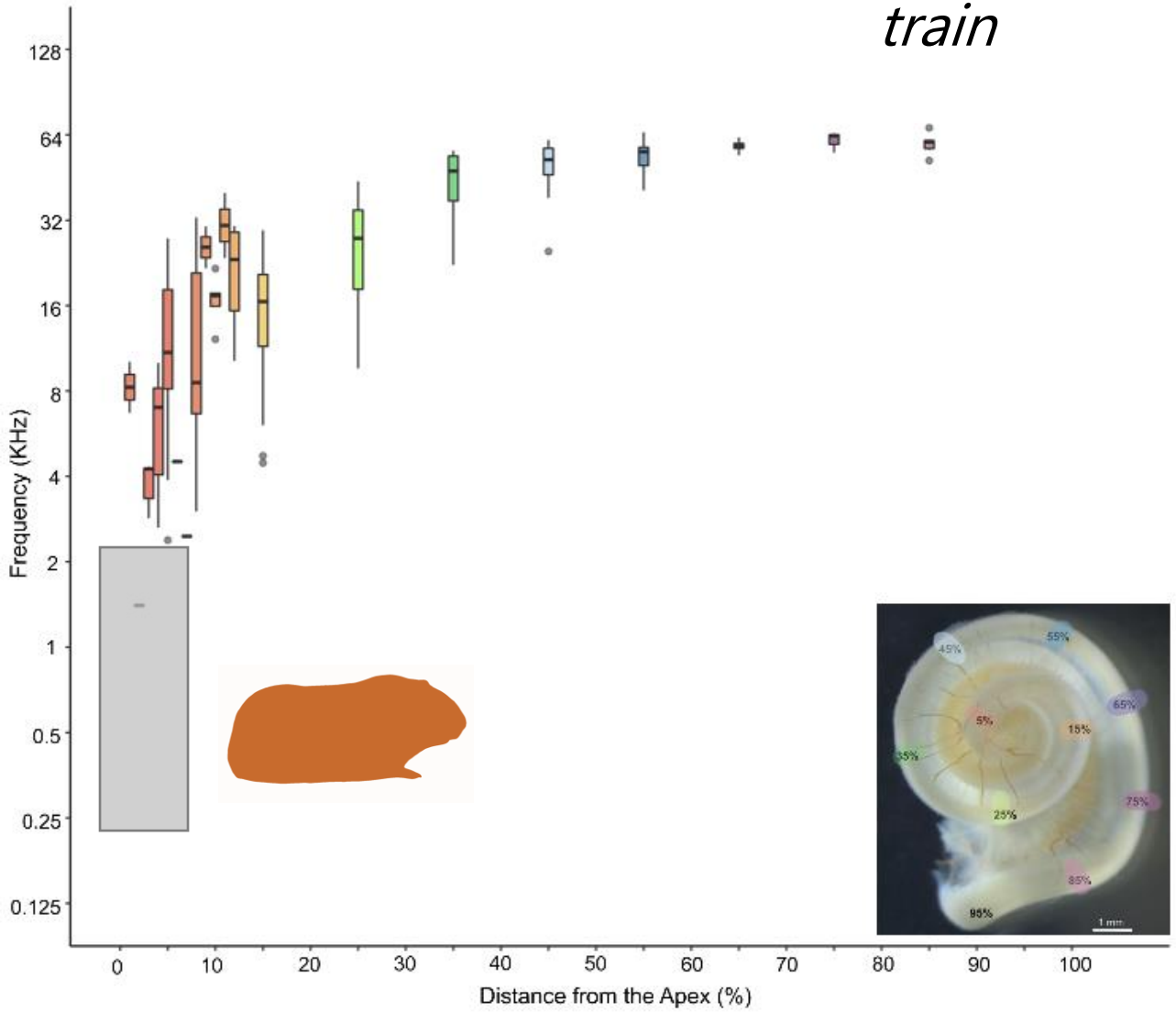


When hearing range is comparable: model predicts well between species

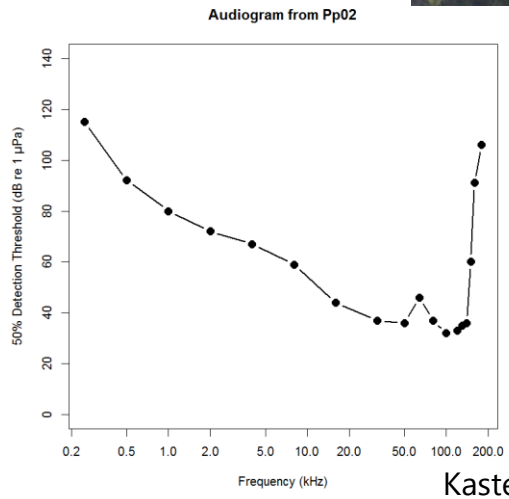
Cochlear frequency map
Morphometric estimation

Current prediction of the cochlear frequency map for harbour porpoise

train *predict*



Validate



Kastelein *et al.*, 2010

ASCOBANS

Summary

- Importance of collecting the ears during post-mortem examinations (joint ASCOBANS/ACCOBAMS best practises protocol, IJsseldijk et al., 2019)

- Create predictive model based on morphometrics of the organ of Corti of terrestrial mammals to predict the frequency map for harbour porpoise (and other species of marine mammals)

- Implications for conservation:
  - Able to identify the possible soud sources of lesions found in the inner ear that are due to noise exposure
  - Monitor the efficency of mitigation measures of sound sources
  - Monitor „acoustic health“ of populations
  - Predict hearing ranges of marine mammals whose audiograms are not known yet
  - Allows us to make recommendations to Parties and other relevant authorities for further actions in specific sound sources

Acknowledgements

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