Prediction of the cochlear frequency map of harbour porpoise

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

Apex: low frequencies

Base: high frequencies
Cochlear frequency maps

Why?
- If a lesion is found → frequency range that is impaired → source

- Low-frequency sonar
- Mid-frequency sonar
- High-frequency sonar

- Pinger
- Shipping
- Seismic survey
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 efficiency of mitigation measures of sound sources

Girdlestone et al., 2018. *Arctic Science*

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

- Monitor the efficacy 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
Using Machine Learning Techniques to build a Predictive Model

Rel. Morphometrics - Frequency

Use this predictive model with

(0.25 - 180 kHz)  n=5 + 6

(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
Geometric Morphometrics: Landmarks

At least 3 replicates per location
Cross-validation between the same species

Learning  Prediction

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

Validate
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 sound sources of lesions found in the inner ear that are due to noise exposure
  - Monitor the efficiency 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
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