Acoustic detections of minke whales in Northeast Scotland

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Background

- Minke whale presence in Scotland from **April to October**
- Visual sightings in the Moray Firth peak in **Summer** (July to August)
- **Winter** distribution data mostly missing
- Improved monitoring tools required, for example in the context of **MPA** designations and **Marine Renewable Energy** projects

Source: Paxton *et al.* (2014) SNH Commissioned Report No. 594
Background

- Most frequently recorded North Atlantic minke whale vocalizations: **low-frequency pulse trains**
- Peak frequency: **50-130 Hz**
- Duration: **10 – 45 sec**
- 3 main categories: slow-down (a-d), constant (e-f), speed-up (g)
- Most records from the **western North Atlantic** and mid-Atlantic ridge
- Only **one record from Scotland**, off the Isle of Mull (Swift et al. 1996)
Questions

1. Can minke whales be acoustically detected in Scottish waters?

2. How does an existing minke whale pulse train detector perform in the Scottish context?

3. How do observed spatial, seasonal and diel patterns of minke whale occurrence compare to visual data?
Methods: Data collection

- East Coast Marine Mammal Acoustic Study (ECOMMAS): monitoring bottlenose dolphin movement and ambient noise since 2013
- **10 sites** close to shore (5 - 15 km)

![Image of SM2M recording device](source: www.dolphincommunicationproject.org)

- **SM2M** (Wildlife Acoustics) broadband recorders
- Sample Rate: **96 kHz**
- Duty cycle: **10/20 min** on/off
- 3 years of data analysed: **2015 - 2017**
Methods: Pulse train detection & classification

1) Spectrogram conditioning
   • 75-300 Hz type II Chebyshev band pass filter
   • Spectrogram cropped to filter bounds

2) Image processing
   • Binarization based on image intensity

3) Application of energy projection function and application of rules for pulse train detection
   • local maxima above threshold
   • min and max number of local maxima above threshold
   • range of local maxima spacing (based on IPI)

4) Feature extraction & rule-based classification
   • duration, number of pulses, average and center bandwidth, mean, mode and max IPI, SNR etc.

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Results: Detections

1. Can minke whales be acoustically detected in Scottish waters?

   - high miss rate of individual calls
   - low precision due to prevalent seismic surveys & shipping noise
   - but few (6%) detection positive hours missed

North Sea, Scotland, UK

Gulf of Maine, USA
Results: Seasonal & spatial distribution

[Diagram showing seasonal and spatial distribution with missing data for 2016]
Results: Inter-annual variation

- Seasonal occupancy from May/June - October matches visual survey data for the Moray Firth (Robinson et al. 2007)
- No detections during winter (November - February)
Results: Diel pattern

2015

2016

2017

GAM-GEE model
Summary

1. First description of minke whale pulse trains from the east coast of Scotland and North Sea

2. Current detector needs improvement to take account of local ambient noise conditions

3. Diel and seasonal patterns match visual sightings and vocal behaviour in other parts of the North Atlantic
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