Sperm whales reduce foraging effort during exposure to 1-2 kHz sonar and killer whale sounds

Isojunno S, Cure C, Kvadsheim PH, Lam FPA, Tyack PL, Wensveen PJ, Miller PJO 2015, in press for Ecological Applications

Motivation



- Animals have evolved to respond to both the *familiar and* unfamiliar aspects of their environment
- Individuals weigh the cost-benefit of behavioural change against perceived risk, but the assessment is not perfect
- How much time and energy an individual invests away (or *divests*) from its fitness-enhancing activities
- **Divestment** \propto level of perceived risk in a given context, e.g. in a high quality foraging patch

Life

Behaviour function Vital rates

Population

Approach

1. Define "fitness-enhancing activities"

= behaviours that help individual's chances to survive and reproduce

2. Quantify time and energy allocation



Cosmopolitan distribution (yellow)

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A resting sperm whale

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Cosmopolitan distribution (yellow)

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A resting sperm whale

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12 DTAG:S to record depth, 3-axis acceleration, acoustics





"A functional state approach to behavioral context" Isojunno, S., and P. J. O. Miller. 2014. Effects of Noise on Aquatic Life. Springer, New York, New York, USA.

• Hidden state models: learn from data, given our prior knowledge about sperm whale behaviour







All time series available at:

Saana Isojunno and Patrick J. O. Miller 2015. Sperm whale response to tag boat presence: biologically informed hidden state models quantify lost feeding opportunities. Ecosphere 6:art6. <u>http://dx.doi.org/10.1890/ES14-00130.1</u>



h from tot

Incidental sonar



4.7-5.1 kHz down-sweep, SPL 89-133 dB re 1μ Pa

2. Quantify time and energy allocation



2. Quantify time and energy allocation

- Model selection supported the state-switching effect to last
 - > 8 min into post-exposure of LFAS
 - > 19 min into post-exposure of KW playbacks
- But did state-switching result in significant changes in total time budget during and after LFAS and KW playbacks?
 - Analysis: random time budgets from pre-exposure were compared to exposure (LFAS +8min, and KW playback +19min)
 - Result: significant (at 5%) increases in time spent in non-foraging active state (5/6 LFAS exposures and 3/5 KW playbacks)

Conclusions 1/2

 1-2kHz LFAS and killer whale playbacks elicited a similar stateswitching response away from foraging state to a non-foraging active state

→ Significant changes in time budgets from pre-exposure

Duration of the divestment ~ one dive or dive cycle

- LFAS 30-40min + 8min = 38-48 min
- KW PB 15min + 19min= 34min

→ Indicates similar magnitude of perceived risk

But, faster recovery to LFAS also suggests differentiation between the signals, and perhaps faster habituation

Conclusions 2/2

- Response to LFAS occurred at low RL (SPL 131-165 dB re 1μPa)
- No effects were detected in response to MFAS or incidental sonar (SPL 73-158 dB re 1µPa)
 Signal type

Received SPL/SEL levels were not statistically supported over signal presence and type

Signal type	Freq.	max SL 199 re 1µPa m
LFAS up- and down-sweeps	1-2 kHz	214
MFAS up-sweep	6-7 kHz	199
Incidental down-sweep	4.7-5.1	?

→ SL or lower frequency appear to have modulated response

- Role of source level? Lower thresholds at the edge of audibility?
- Habituation?

Thank you!

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