Sound impact on fish: from individual hearing to population effects

James Campbell & Hans Slabbekoorn
Fish live in an acoustic world!
• Predator/prey interactions
• Courtship/spawning
• Soundscape orientation

Fig. 2. Percentage catch of reef fishes in light traps deployed with speakers broadcasting reef noise (filled bars) and silent traps (open bars) during summer months at Lizard Island. Data are shown for those families for which more than 20 individuals were collected during the study.
> 800 species (109 families) known to produce sound.
Toadfish use the swim bladder and special sonic muscles

Cichlids use the pharyngeal jaws to generate sounds
Fish are sensitive to particle motion
Fish are sensitive to sound pressure

Paratilapia polleni

Schulz-Mirbach et al. 2012
Fish hearing is multimodal and we lack insights into fish-relevant sound fields.
Acoustic wave reflecting off a pressure release boundary

Particle Velocity

Acoustic Pressure
Marine Strategy Framework Directive (MSFD)


- The MSFD aims to achieve Good Environmental Status in Europe’s seas by 2020.

- Last of 11 qualitative descriptors for determining good environmental status: *Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.*
Fish seem to be affected (echosounder data)

Engås et al. 1996
Fisheries can be affected (neg/pos)

Reduced catches:
- Trawl (both species): 70%
- Longline (haddock): 70%
- Longline (cod): 45%

Distances:
18 nautical miles

Time:
At least 5 days

Engås et al. 1996
The PCAD-approach applied to fish

**Airgun Exposure**

1. Behavioural Change
2. Physiological Change
3. Direct Impact on Fisheries
4. Feeding Impact
   - Predation Risk
   - Swimming Energetics
   - Reproductive Opportunities
5. Chronic Stress
   - Immunocompetence
   - Developmental Impact
   - Reproductive Investment
6. Indirect Impact on Fisheries
7. Growth rate
8. Survival
9. Reproduction
10. Individual Fitness
11. Population Consequences of Airgun Disturbance (PCAD-model)
12. Population Health & Stock Development

Slabbekoorn 2015
Impact of airgun sound exposure on fish: integrating population-level modelling and collection of empirical data

I  II  III  IV

Energy-flow, Individual-based and Population-level Modelling
Real-life Airgun Exposure of Tagged Fish and Local Animal Community
Life-stage Comparisons for Behavioural and Physiological Impact
Sound Field Measurements and Modelling including Particle Motion

\[ \dot{p}_c = \left\{ \dot{p}_{A_m} \right\} \frac{[E]^{2/3}}{[E_m]} - [E] \frac{dV}{dt} \]
Basin Experiment: Setup

Top

Side
Floating pen at acoustic test site
Year: Phase II 1 2
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THANK YOU!

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