Review of European trials of barium sulfate and metal oxide nets

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Review of European trials of barium sulfate and metal oxide nets

BACKGROUND

• Many attempts at enhancing acoustic detectability of gillnets:
  – Many different materials, e.g. metal beads, air filled tubes, etc.
  – None fulfilled the two basic requirements:
    • Reduced bycatch
    • No negative effects on target catch

• 1999: acoustically reflective gillnets
  – Danish North Sea trial in 2000
  – UK North Sea trial in 2002-2003
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DANISH AND UK TRIALS

Danish trial in 2000
- One vessel in the Danish North Sea
- Cod/mixed species fishery
- September-October 2000
- Controlled experiment
- Iron oxide nets vs. nylon nets
- Full observer coverage
- Detailed catch data

UK trial in 2002-2003
- One vessel in the UK North Sea
- Skate fishery
- October 2002-September 2003
- Controlled experiment
- Barium sulphate nets vs. nylon nets
- Full observer coverage
- No catch data
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### DANISH AND UK TRIALS

<table>
<thead>
<tr>
<th></th>
<th>DANISH TRIAL</th>
<th>UK TRIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net type</strong></td>
<td>Nylon</td>
<td>Iron oxide</td>
</tr>
<tr>
<td><strong>Twine size (mm)</strong></td>
<td>0.59</td>
<td>0.58</td>
</tr>
<tr>
<td><strong>Twine colour</strong></td>
<td>Green</td>
<td>Red-brown</td>
</tr>
<tr>
<td><strong>Mesh size (mm)</strong></td>
<td>156</td>
<td>156</td>
</tr>
<tr>
<td><strong>Hanging ratio</strong></td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Float interval (m)</strong></td>
<td>2.46</td>
<td>2.16</td>
</tr>
</tbody>
</table>
## RESULTS - Danish trial

<table>
<thead>
<tr>
<th>NET TYPE</th>
<th>CATCH (numbers)</th>
<th>EFFORT (km*days)</th>
<th>CPUE (numbers/km*days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Porpoises</td>
<td>Cod</td>
<td>Porpoises</td>
</tr>
<tr>
<td>Nylon</td>
<td>8</td>
<td>845</td>
<td>61</td>
</tr>
<tr>
<td>Iron oxide</td>
<td>0</td>
<td>685</td>
<td>68</td>
</tr>
</tbody>
</table>

* *P < 0.05*
RESULTS - Danish trial

- Nylon
  - Catch: 8
  - Effort: 845 km*days
  - CPUE: 0.13 numbers/km*days
  - Target species CPUE reduction = 29%*

- Iron oxide
  - Catch: 0
  - Effort: 685 km*days
  - CPUE: 0* numbers/km*days
  - Target species CPUE reduction = 29%*

* P < 0.05

- Worse by weight
- Even worse by value

**Graph:**
- Length frequencies of cod
- High density nets
- Control nets

**Legend:**
- Frequency [%]
- Length (cm)
## RESULTS - UK trial

<table>
<thead>
<tr>
<th>NET TYPE</th>
<th>CATCH (numbers)</th>
<th>HOLES (hauls)</th>
<th>EFFORT (hauls)</th>
<th>CPUE (numbers/hauls)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Porpoises</td>
<td>Seals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nylon</td>
<td>3</td>
<td>5</td>
<td>105</td>
<td>173</td>
</tr>
<tr>
<td>BaSO4</td>
<td>8</td>
<td>10</td>
<td>76</td>
<td>171</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Porpoises</th>
<th>Seals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nylon</td>
<td>0.017</td>
<td>0.029</td>
</tr>
<tr>
<td>BaSO4</td>
<td>0.047</td>
<td>0.058</td>
</tr>
</tbody>
</table>

- **P < 0.1**
- **P < 0.2**

### Nylon vs. BaSO4:
- Bycatch probably not related to acoustic properties of nets
- Smaller mesh size and larger twine size of BaSO4 nets favours retention of bycatch

### Danish trials vs. UK trials:
- Differences maybe related to mesh size (156 mm vs. 241-267 mm)
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NET BEHAVIOUR AND STIFFNESS

<table>
<thead>
<tr>
<th>STIFFNESS</th>
<th>Nylon</th>
<th>Iron oxide</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-module</td>
<td>784 MPa</td>
<td>2617 MPa</td>
</tr>
</tbody>
</table>
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TARGET STRENGTH

not stirred...

"target strength" (dB)

noise floor

s

h

α

K

ε

h

BaSO₄

FeO

nylon

time (minutes)
### Conclusion

**Mechanical Properties of the Nets**

<table>
<thead>
<tr>
<th>MECHANICAL PROPERTIES of the nets</th>
<th>DIFFERENT</th>
<th>CAUSE of differences in catch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanging ratio</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Mesh size</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Twine size</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Target strength</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Colour</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>Stiffness</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>
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BYCATCH HYPOTHESES

1. Porpoise cannot detect nylon gillnets at sufficient distance to avoid entanglement
2. Porpoises do not use their sonar all the time
3. Porpoises detect the nets but do not perceive them as an obstacle
4. Porpoises are distracted in the vicinity of the nets
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**BYCATCH HYPOTHESIS 1**

Porpoise cannot detect nylon gillnets at sufficient distance to avoid entanglement

- **Hatakeyama & Soeda (1990)**
  - estimated 2 m detection distance
- **Kastelein et al. (2000)**
  - estimated 3-6 m detection distance
- **Mooney et al. (2004)**
  - estimated 3-5 m detection distance
- **Villadsgaard, Wahlberg & Tougaard (2007)**
  - estimated harbour porpoise SL $\approx 205$ dB
  - corresponds to 13-26 m detection distance

**Conclusion: Hypothesis 1 can be rejected**

Detection Distance is a function of:
- Source Level
- Ambient noise
- Target Strength
Porpoises do not use their sonar all the time

- **Verfuss et al.** (2005)
  - in captivity
  - sonar used continuously
  - in daylight & good visibility

- **Akamatsu et al.** (2007)
  - in the wild
  - 90% silent periods < 20 s
  - 4% silent periods > 50 s
  - scanning ahead c. 50 m
  - 148 dB threshold

**Conclusion:** Hypothesis 2 can probably be rejected, but more studies of animals in the wild are needed
Porpoises do not perceive the nets as an obstacle and/or
Porpoises are distracted in the vicinity of the nets

- Kastelein et al. (1995)

- If true, will it help to increase TS and how much is needed?
  - TS of a 20 cm herring is -40 dB
  - TS of a 25 cm herring is -38 dB
  - This corresponds to a nylon twine diameter of 1.5 – 2 mm
  - Alternatively, with a twine diameter of 0.58 the net needs to be made of steel
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RESEARCH NEEDS

• **We need to know why porpoises are caught in gillnets**
  - Studies of fine-scale behaviour of porpoises around gillnets
  - Direct observations of bycatch

• **We also need studies of:**
  - Acoustic behaviour in the wild, *e.g.* using data loggers on animals
  - Detection experiments in noise
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Porpoise behaviour around gillnets

from Nielsen *et al.* In press in MEPS
THE END