An intercalibration study for surveys of hake in the Benguela marine ecosystem

John Cotter
FishWorld Science
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Trawl surveys use standardised fishing methods to estimate fish abundance assuming

\[ C = qN \]

Advantages:
• Independent of the fisheries and commercial pressures
• Scientifically controlled methods

Disadvantages:
• Catch rate assumption may not hold everywhere
• Costs per day are high
• Need for intercalibration occasionally
Intercalibration is needed:

- To relate one survey to another with different $q$
- When a vessel is renewed
- When trawl gear is updated

Benguela has 3 trawl surveys:

- FAO-Nansen – RV Dr Fridtjof Nansen – Gisund trawl
- Namibia – RV Blue Sea – Gisund trawl
- South Africa – RV Africana – ‘Old’ & ‘New’ type trawls
Vessel effects

Reaction of haddock to noise of propeller (PP).
pt = pelagic trawl; s = sweeps

Trawl differences

**Strap across warps:**
- FAO-Nansen
- Namibia: **YES**
- South Africa: **NO**

**Codend mesh:**
- FAO-Nansen: 10 mm
- Namibia
- South Africa: 35 mm

Greenpeace picture
Example: 2005, quarter 1 surveys

Red: Namibia
Black: FAO-Nansen
Green: SA, new trawl

‘Fish’ = *Merluccius paradoxus*
Effects of depth and latitude, 3 surveys

M. capensis, 2005, Qtr 1 (N=150)
Intercalibration approach:
Pair close stations & check for bias

Matched-pair stations
FAO.Nan.Gisund - SA.Afr.Dem_old, 29.1 to 35.2 S, 2006 Q1

Matched-pair stations & depths: 2006

Distance
Nautical miles

Depth
metres

Date
days

Time: sv1=\, sv2=/
Time of day
Length frequency distributions:

Matched-pair stations: 29.1 to 36 S, 2010 Q1

Catch ratios for each length class of each station pair

50 pairs of stations
Catch ratios depend on the selectivities of the 2 nets.
Serial correlation of catch ratios because of misaligned length modes:

![Graph showing serial correlation of catch ratios](image)
M. capensis, F-Nan-Gis/N-Blu-Gis

Hake: 27.6 to 29.6 S, 2008 Q1

Hake: 17.3 to 19.7 S, 2009 Q1

\[ \log \text{CR} = 0 + \epsilon \]
M. paradoxus, F-Nan-Gis/N-Blu-Gis

Hake: 27.6 to 29.6 S, 2008 Q1

Hake: 17.3 to 19.7 S, 2009 Q1


\[
\log CR = \frac{b}{L} + \epsilon
\]

\[
\log CR = k + \epsilon \quad k > 0
\]
M. capensis, F-Nan-Gis/S-Afr-Old

Hake: 29.1 to 35.3 S, 2003 Q1

Hake: 29.1 to 35.2 S, 2006 Q1

Hake: 29.1 to 36 S, 2010 Q1

$\log CR = b/L + \epsilon$

$\log CR = 0 + \epsilon$

$\log CR = b/L + \epsilon$
M. paradoxus, F-Nan-Gis/S-Afr-Old

Hake: 29.1 to 35.3 S, 2003 Q1

\[ \log \text{CR} = \frac{b}{L} + \epsilon \]

Hake: 29.1 to 35.2 S, 2006 Q1

log CR = \frac{b}{L} + \epsilon

Hake: 29.1 to 36 S, 2010 Q1

\[ \log \text{CR} = 0 + \epsilon \]
M. capensis, F-Nan-Gis/S-Afr-New

**Hake: 29 to 31.2 S, 2005 Q1**

**Hake: 29.7 to 35.3 S, 2007 Q1**

**Hake: 29.1 to 32.7 S, 2008 Q1**

**Hake: 29 to 35.4 S, 2009 Q1**

**Hake: 29.1 to 35.5 S, 2011 Q1**

\[
\log \text{CR} = k + \epsilon \quad k > 0
\]

except 2009:

\[
\log \text{CR} = 0 + \epsilon
\]
M. paradoxus, F-Nan-Gis/S-Afr-New

2005:
log CR = k + ε  \( k > 0 \)

2007:
log CR = 0 + ε

2008, 09, 11:
log CR = b/L + ε
Model-free method with broader length classes to reduce serial correlation of catch ratios (1):

F-Nan-Gis/N-Blu-Gis, 2008,09
Model-free method with broader length classes to reduce serial correlation of catch ratios (2):

F-Nan-Gis/SA-Afr-Old, 2003,06, 10

New length classes

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Model-free method with broader length classes to reduce serial correlation of catch ratios (2):
Model-free method with broader length classes to reduce serial correlation of catch ratios (3):

F-Nan-Gis/SA-Afr-New, 2005, 07, 08, 09, 11

<table>
<thead>
<tr>
<th>Length</th>
<th>CatchRatio</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>+</td>
</tr>
<tr>
<td>30</td>
<td>+</td>
</tr>
<tr>
<td>40</td>
<td>+</td>
</tr>
<tr>
<td>50</td>
<td>+</td>
</tr>
</tbody>
</table>

New length classes
**Provisional intercalibration factors**

For *Merluccius capensis*:
- By ratio
- Estimated

For *Merluccius paradoxus*:
- By ratio
- Estimated
Application

\[ \text{Survey}(B) = \text{Survey}(A) \times \text{Intercal.factor}(R) \]

\[ \log B = \log A + \log R \]

\[ \because \text{because of independence} \]

\[ \text{st.err} (\log B) = \sqrt{\text{var} (\log A) + \text{var} (\log R)} \]
Before:

(1000s)/square NM
M. paradoxus, 2011, Qtr 1 (N=120)

After:

Calibrated (1000s)/square NM
M. paradoxus, 2011, Qtr 1 (N=120)

Length range: 18 to 26 cm
How good are these factors?

Problems were

• Best models of log catch ratios are sometimes straight, sometimes curved for the same pair of surveys
• Serial correlation and some biases
• Judgement was used to pick best factors because of theoretical problems
• Small fish poorly represented in analyses
• Standard error factors ≈ 1.15 (large fish) to 1.4 (small fish)
Thank you

and to Tore Strømme, Tracey Fairweather, Paulus Kainge for providing and advising on data, to BCC for organisational support.
Would modelling give better estimates?

e.g. Sullivan (1992), Fournier et al (1990)

- Catches per sq.NM span many orders of magnitude – puts much reliance on assumed distribution
- Requires accurate growth and mortality data
- Thousands of hauls $\rightarrow$ long computations
- Estimates a difference between surveys but why?
  - Location?
  - Timing?
  - Different catching powers?