Do eggs collected in surveys accurately reflect adult fecundities?

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Measurements of fecundity

- Spawning stock biomass (SSB)
- Population fecundity
- Stock reproductive potential (SRP)
Population fecundity

- Potential: Number of maturing oocytes
- Realized: Number of eggs in the Sea

How well do they match?
Sources of Error

- Sampling error
- Size and age structure
- Atresia
- Egg mortality
- Movement between different batches
North East Arctic cod

Graph showing changes in SSB (Mtonnes) and Proportion Fish at age-9+ (%) from 1948 to 2012.
Spawning migration survey

Mar. – Apr., since 1985

Acoustics

CTD

Bottom Trawls (N=902)

Ichthyoplankton (N=2114)
Temperature at 30 m

- Offshore: Warm Atlantic water
- Inshore: Cool runoff influenced water
- Cooling in Vestfjorden
Models of Stage I egg distribution

Generalized additive mixed models (GAMMs)

\[ y_i = X_i \beta + f_1(x_{1i}) + f_2(x_{2i}) + \cdots + f_n(x_{ni}) + Z_i b + \varepsilon_i \]

Separate for areas 00 (Vestfjorden) and 05 (Yttersida)

Models for presence/absence and non-zero abundance

**Fixed Factors**
- Local temperature at 30 m
- Bottom Depth
- Proportion of old fish (age-9+)
- Regional temperature index (Kola transect)

**Random Factors**
- Autocovariate
- Median Year Day
Models of Stage I egg distribution – 00 Vestfjorden

Höffle et al. 2014
Models of Stage I egg distribution – 05 Yttersida

Höffle et al. 2014
Real and modeled egg distribution

Survey Data

Model

Höffle et al. 2014
Scaling to annual egg production

\[ N(t) = N_{max} e^{\frac{-1}{2\sigma^2}(t-t_{max})^2} \]

\( \sigma \) .... Standard Deviation

\( t \) .... Day of the Year

\( N(t) \) .... No. eggs at day \( t \)

Peak spawning: Days 93 and 98 (>69°N)

Standard Deviation: 15
Potential fecundity – NEA cod

- Gonad samples
- Winter and Lofoten cruise
- 191 fish
- Number and size of oocytes
- Image analysis (auto-diametric)
Potential fecundity vs. length

\[ y = 0.0494e^{0.0475x} \]

\[ R^2 = 0.8118 \]
Potential fecundity vs. weight

\[ y = 0.0007x - 0.7163 \]

\[ R^2 = 0.8762 \]
Scaling to population fecundity

- Length and Weight based formulae

Data from Stock assessment and survey

- Length, weight, maturity and numbers at age
- Sex ratio
Potential and realized fecundity

-38 % vs. Length
-52 % vs. Weight
Conclusion and outlook

- Highly variable relationship of realized and potential fecundity

What next?

- Include atresia, mortality and drift
- Resolve spatial distribution of fecundities
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