Contribution of a bioenergetics model to investigate on growth and survival of European seabass in the Northeast Atlantic

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Outline

• Introduction
• Model development
• Starvation ability of early life stages
• Impact of temperature and food on growth of early life stages
• Conclusion
Why working on European seabass?

Worrying state of the ICES « Northern stock » (since 2013)

→ European Commission set management measures (since 2015)
European seabass lifecycle

Introduction

Model development

Starvation effect

T & f effect

Conclusion

OFFSHORE

Drift

SPAWNING AREA

NURSERY

FEEDING AREA

COAST

Migration

Starvation effect

T & f effect
Still a lot of unknown concerning its lifecycle in the wild.

Studies have been carried out to better understand:
• the spatio-temporal structure of the population
• the recruitment process

➔ Would help to define management measures for a sustainable exploitation
Still a lot of unknown concerning its lifecycle in the wild.

Studies have been carried out to better understand:

- the spatio-temporal structure of the population
- the recruitment process (e.g. connectivity between spawning areas and nurseries)

Would help to define management measures for a sustainable exploitation
Modelling seabass lifecycle

- Life traits and their key drivers
- Population resilience
- Management & conservation strategies

Movements (e.g. connectivity)
Metabolic acceleration in Mediterranean Perciformes

Konstadia Lika a, b, Sebastiaan A.L.M. Kooijman b, Nikos Papandroulakis c

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A DEB model for European sea bass (Dicentrarchus labrax): Parameterisation and application in aquaculture

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https://doi.org/10.1016/j.seares.2018.05.008
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Volume 94, November 2014, Pages 37-46

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aquaculture

Orestis Stavridis-Zachou a, b, Nikos Papandroulakis a, Konstadia Lika b

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https://doi.org/10.1016/j.seares.2018.05.008
Egg – Non feeding larvae – Feeding larvae – Juveniles – Adults
Acceleration of growth for larvae
Reproduction between January and May
At the end of the reproduction season, $E_R = 0$
Calibration

14 parameters: \( \kappa, \{ \dot{p}_{Am} \}, \nu, \{ \dot{p}_M \}, [EG], E^h_H, E^b_H, E^j_H, E^p_H, \delta_{Mb}, \delta_{Mj}, TA, TAL, f \)

Covariance Matrix Adaptation Evolution Strategies (see e.g. Gatti et al., 2017)

\[
F_{cost} = \sum_{i}^{\text{stages variables}} \sum_{j} \frac{1}{n_{\text{obs} \ i, j}} \sum_{k}^{n_{\text{obs} \ i, j}} \left( \frac{x_{i,j,k} - y_{i,j,k}}{\sigma_{\text{obs} \ i, j}} \right)^2 + \sum_{l}^{\text{thresholds}} \left( \frac{x_l - z_l}{\sigma} \right)^2
\]
Calibration

14 parameters: $\kappa, \{\dot{p}_{Am}\}, \dot{v}, [\dot{p}_M], [EG], E^h_E, E^b_E, E^j_E, E^p_E, \delta_M, \delta_M, TA, TAL, f$

4 maturity thresholds

Covariance Matrix Adaptation Evolution Strategies (see e.g. Gatti et al., 2017)

$$F_{cost} = \sum_{i}^{stages \ variables} \sum_{j}^{variables} \frac{1}{n_{obs \ i,j}} \sum_{k}^{n_{obs \ i,j}} \left( \frac{x_{i,j,k} - y_{i,j,k}}{\sigma_{obs \ i,j}} \right)^2 + \sum_{l}^{thresholds} \left( \frac{x_l - z_l}{\sigma} \right)^2$$
Calibration

14 parameters: $\kappa, \{\hat{p}_{Am}\}, \hat{v}, [\hat{p}_M], [EG], E^h_H, E^b_H, E^j_H, E^p_H, \delta_{Mb}, \delta_{Mj}, TA, TAL, f$

4 maturity thresholds

<table>
<thead>
<tr>
<th>Stage « threshold »</th>
<th>Size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hatching</td>
<td>0.3 (Regner &amp; Dulcic, 1993)</td>
</tr>
<tr>
<td>Mouth opening</td>
<td>0.6 (Kennedy &amp; Fitzmaurice, 1972)</td>
</tr>
<tr>
<td>Metamorphosis</td>
<td>2 (Barnabé, 1990)</td>
</tr>
<tr>
<td>Maturity</td>
<td>42 (Drogou et al., 2017)</td>
</tr>
</tbody>
</table>

Covariance Matrix Adaptation Evolution Strategies (see e.g. Gatti et al., 2017)

$$F_{\text{cost}} = \sum_{i} \sum_{j} \frac{1}{n_{\text{obs} i,j}} \sum_{k} \left( \frac{x_{i,j,k} - y_{i,j,k}}{\sigma_{\text{obs} i,j}} \right)^2 + \sum_{l} \left( \frac{x_l - z_l}{\sigma} \right)^2$$
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Datasets

**AQUACULTURE**
- Length and weight data from 7 to 1600 days at 15°C
- $T = 15°C$
- $f = 1$ (ad libitum)

**WILD**
- Length and weight data from 6 months to 22 years from surveys and fish markets
- $T = \text{mean per days from tagged seabass}$
- $f = ?$ (calibrated)

**Model development**

Introduction

Starvation effect

$T \& f$ effect

Conclusion

**Temperature (°C)**

**Datasets**
Fitting the length

**AQUACULTURE**

Length and weight data from 7 to 250 days at 20°C

- T = 20°C
- f = 1 (ad libitum)

Length and weight data from 7 to 1600 days at 15°C

- T = 15°C
- f = 1 (ad libitum)

**WILD**

Length and weight data from 6 months to 22 years from surveys and fish markets

- T = mean per days from tagged seabass
- f = ? (calibrated)

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**Data**

**Model**

0 – 8 months

0 – 4 years

0 – 22 years
Fitting the weight

**AQUACULTURE**
Length and weight data from 7 to 1600 days at 15°C

\[ T = 15°C \]
\[ f = 1 \text{ (ad libitum)} \]

**WILD**
Length and weight data from 6 months to 22 years from surveys and fish markets

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**Introduction**

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**Model development**

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**Starvation effect**

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**T & f effect**

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**Conclusion**

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0 – 8 months

0 – 4 years

0 – 22 years
Young seabass facing starvation
Young seabass facing starvation

Month at which starvation starts

Survival time

Month of birth

10/04/2019
Growth with T & f

\[ f = 0.05 \]
f = 0.05

Minimal length observed in Bristol Channel and Celtic Sea nurseries (Jennings & Pawson, 1992)
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Minimal length observed in Bristol Channel and Celtic Sea nurseries (Jennings & Pawson, 1992)

\[ f = 0.05 \]

\[ f = 0.25 \]

\[ f = 0.65 \]
Take home messages

• First DEB model calibrated for wild Atlantic European seabass
• Young life stages adapted for a drift in winter but need food on nurseries
• Rising temperatures help to survive low level of food
• Useful tool to study the connectivity between spawning areas and nurseries (on going work)
Thanks for your attention!

Any questions?

Fundings: