

Ecosystem model of Icelandic waters

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ICES WGSAM 2017

MareFrame

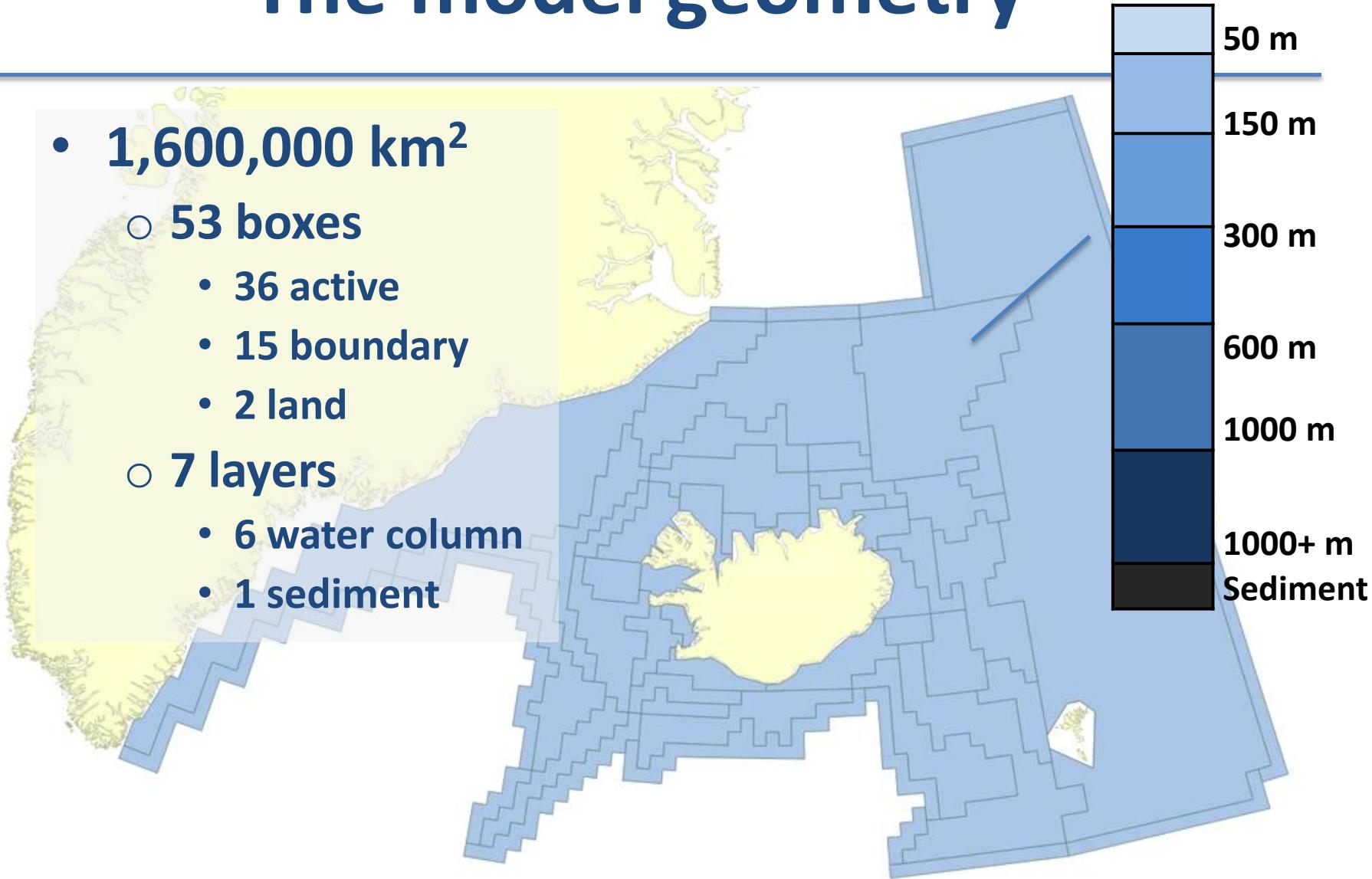


Atlantis

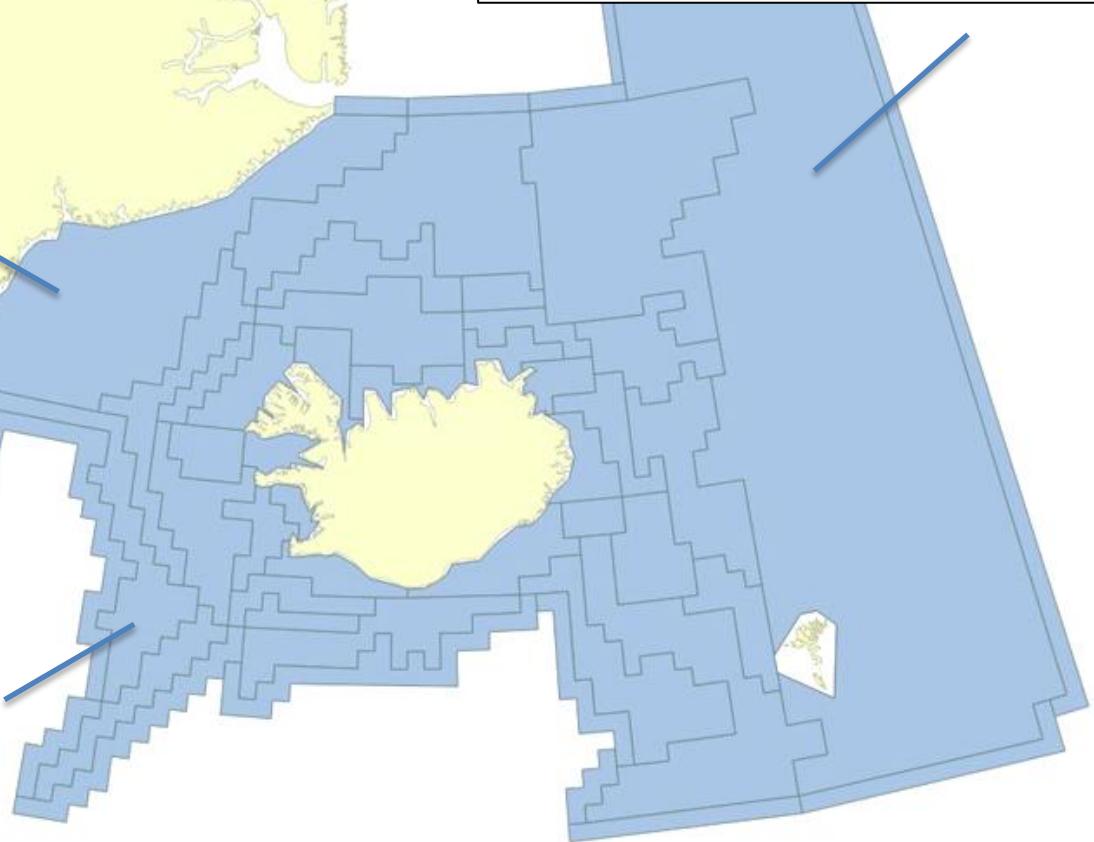
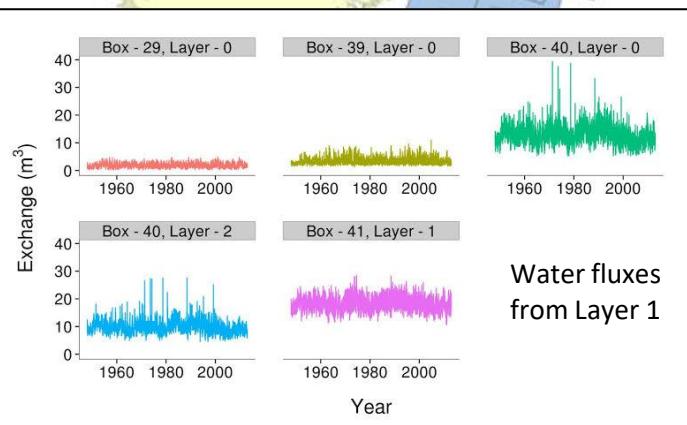
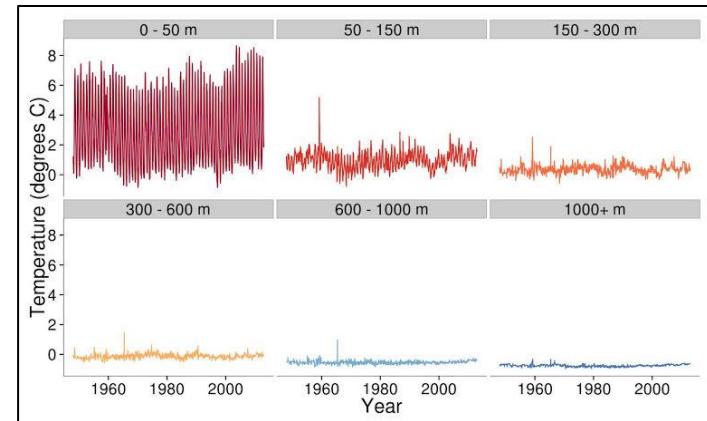
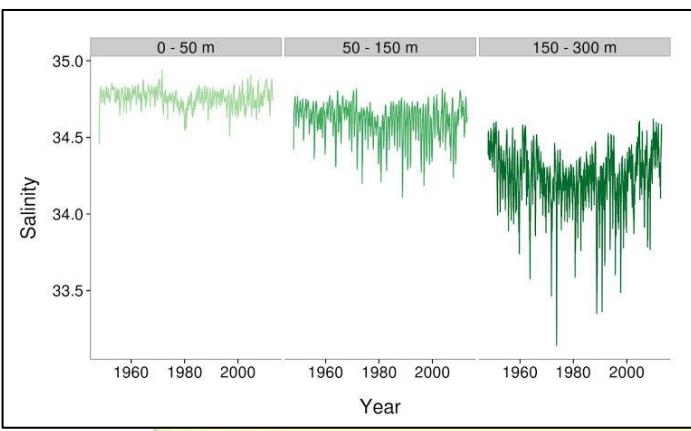
- Simulates the entire ecosystem.
- Ecosystem model
- Fisheries model
- Sampling and assessment model
- Management model
- Socio-economic model



The model geometry



The oceanography model



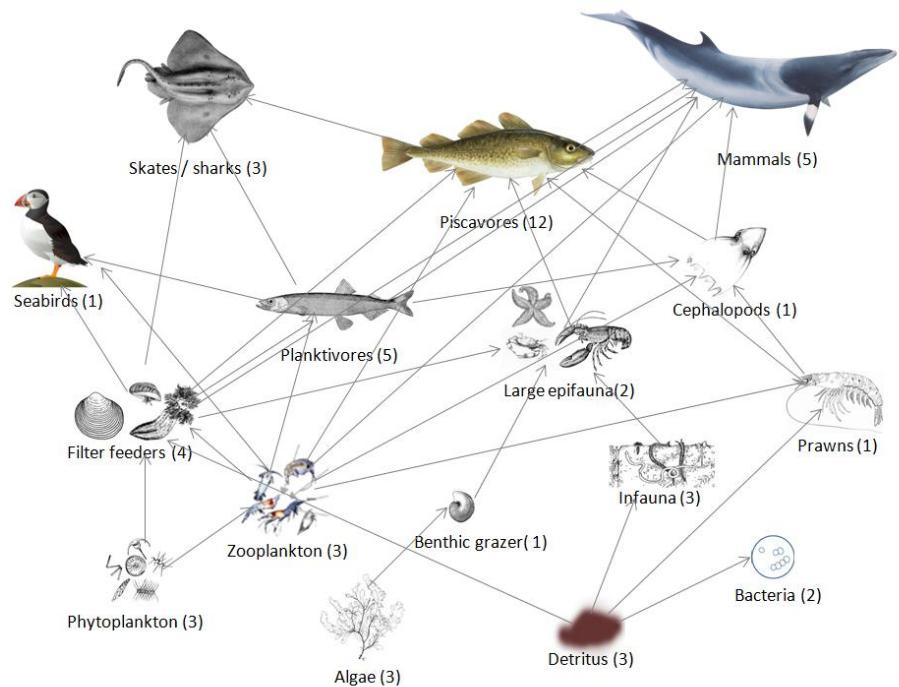
The biology model

- Functional groups
- Consumption
- Predation
- Growth
- Reproduction
- Movement
- Migration



The functional groups

- **52 functional group**
 - **26 vertebrates**
 - 17 fish
 - 3 shark/skates
 - 5 mammal
 - 1 seabird
 - **16 invertebrate groups**
 - **5 primary producers**
 - **2 bacteria**
 - **3 detritus**



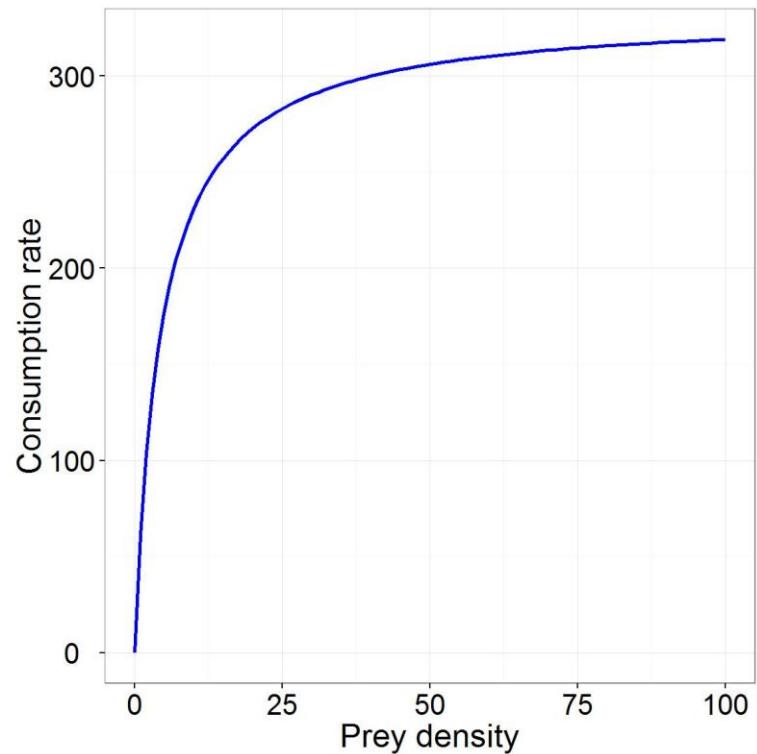
The biology model

- **Vertebrates**
 - **10 age classes**
 - Numbers per age
within ageclass
 - **Weight in mg N per individual**
 - Reserved weight
 - Structural weight
- **Invertebrates**
 - **2 ageclasses**
 - **Biomass pools mg N m⁻³**

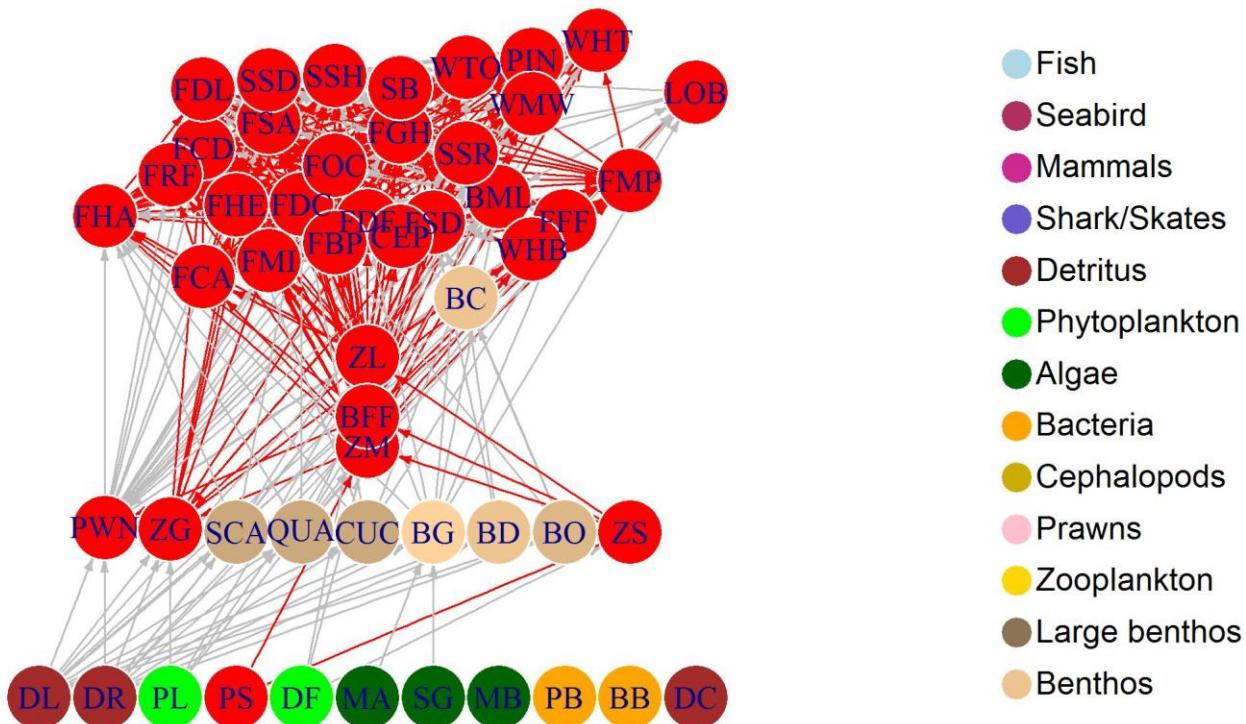
Consumption

- Holling type II
- Gape limitation
- Prey availability

$$Q_{ij} = \frac{a_{ij} \cdot \text{Prey}_i \cdot C_j}{1 + \frac{C_j}{\mu_j} \sum_k \text{Prey}_k \cdot \epsilon_{ij} \cdot a_{ij}}$$



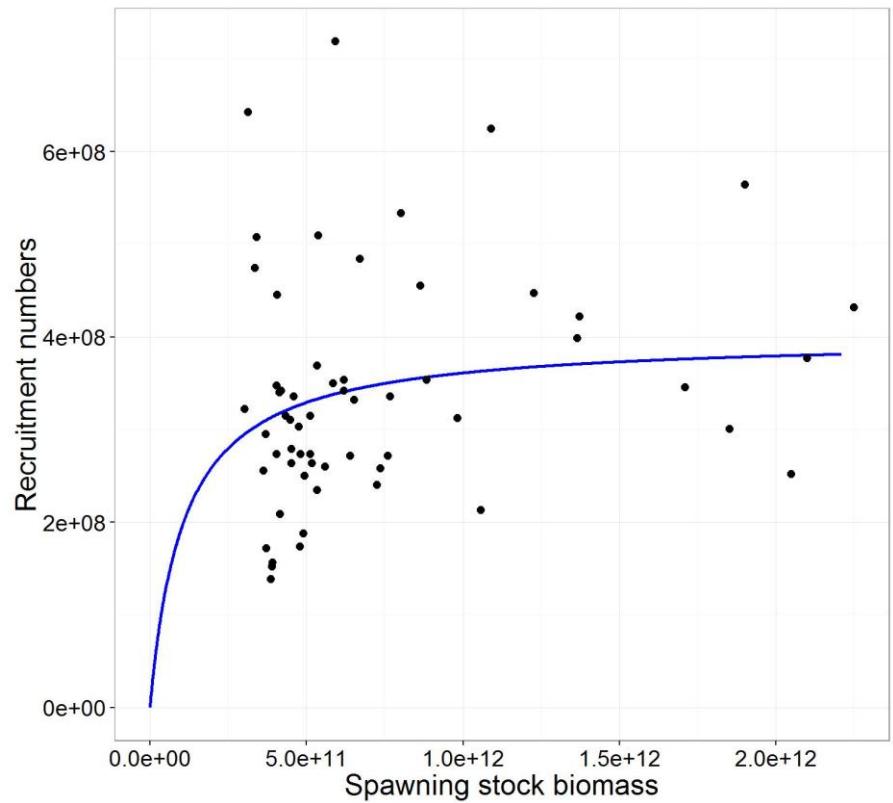
Food web from the Atlantis model



Reproduction

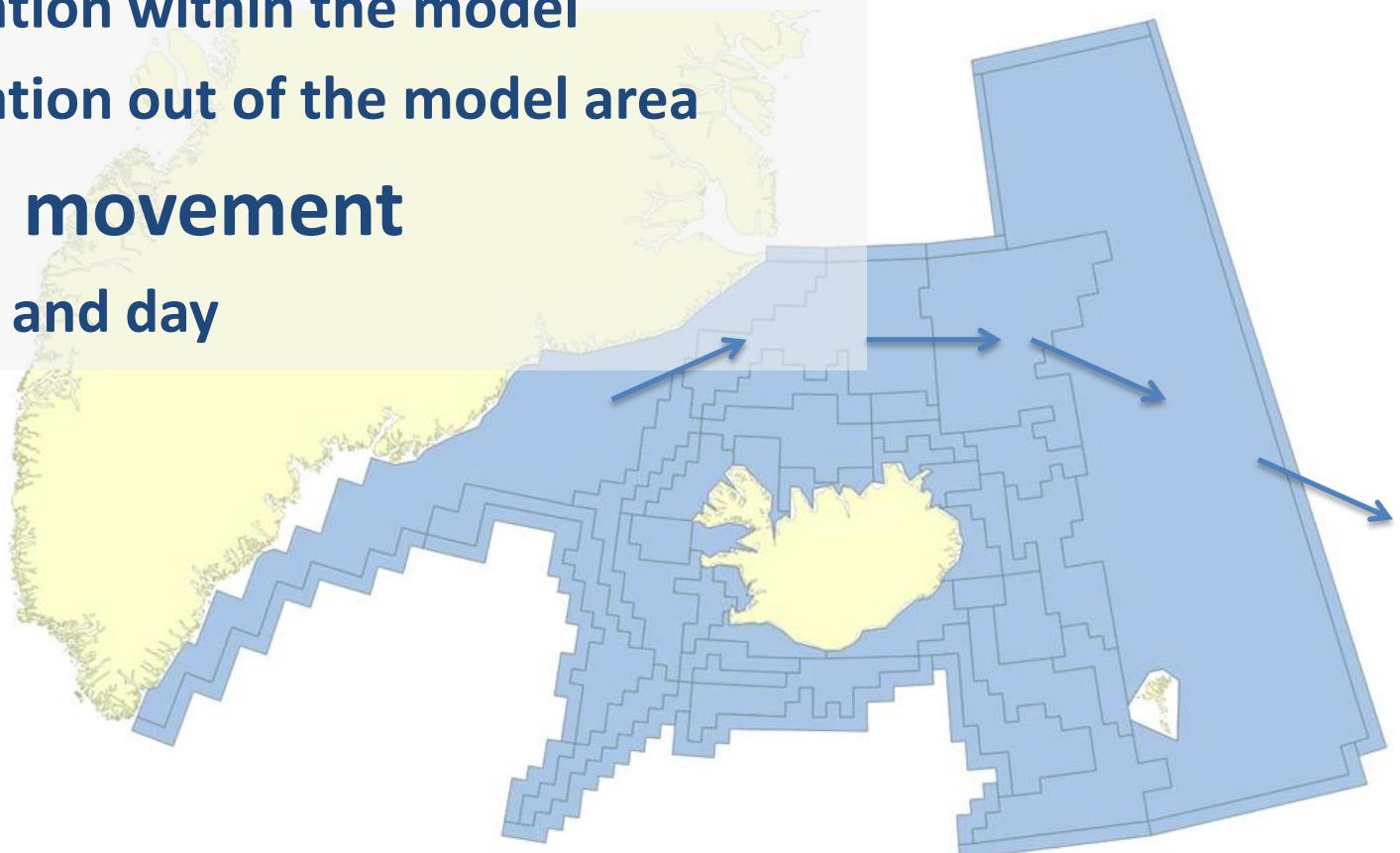
- Beverton – Holt
- Fixed number per adult

$$N_{\text{Rec}} = \frac{SSB \cdot \alpha}{\beta + SSB}$$

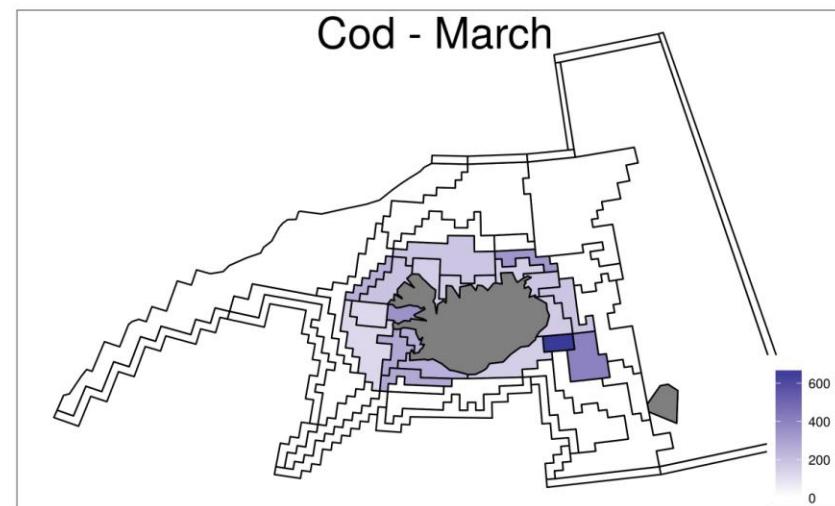
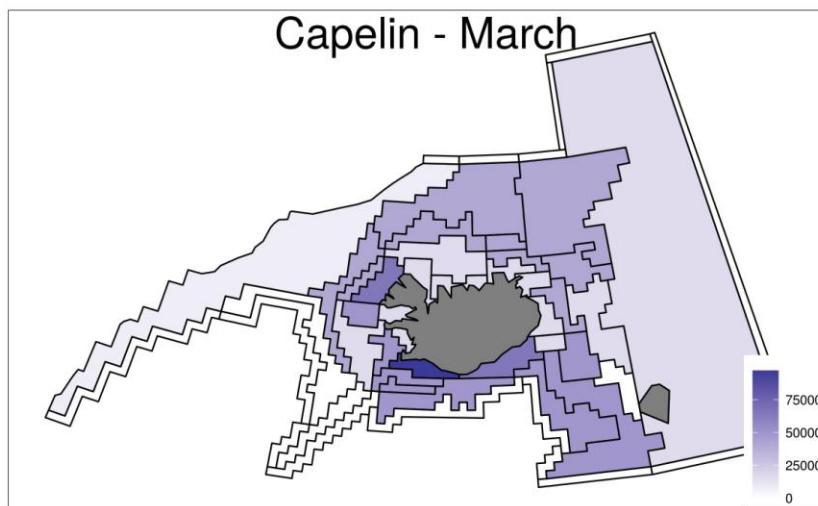
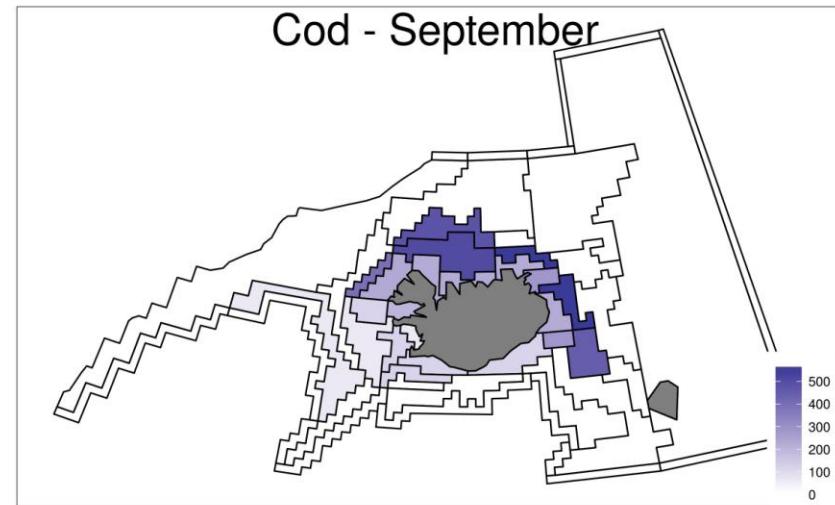
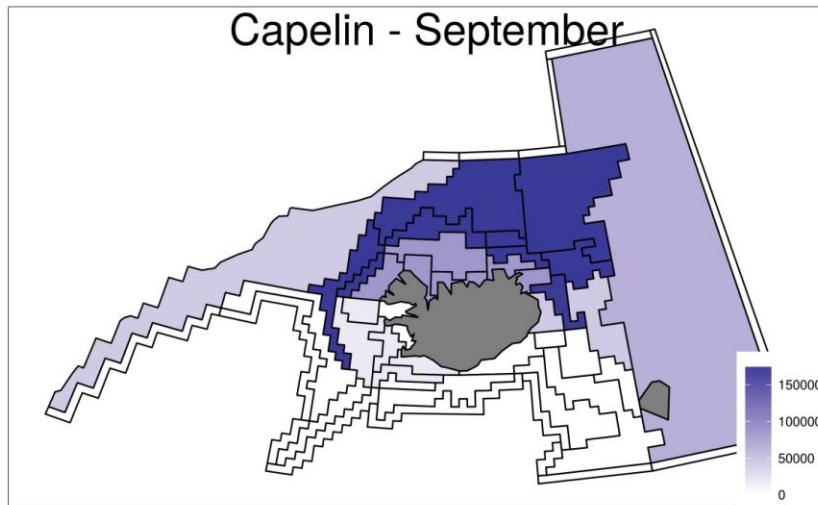


Migration and movement

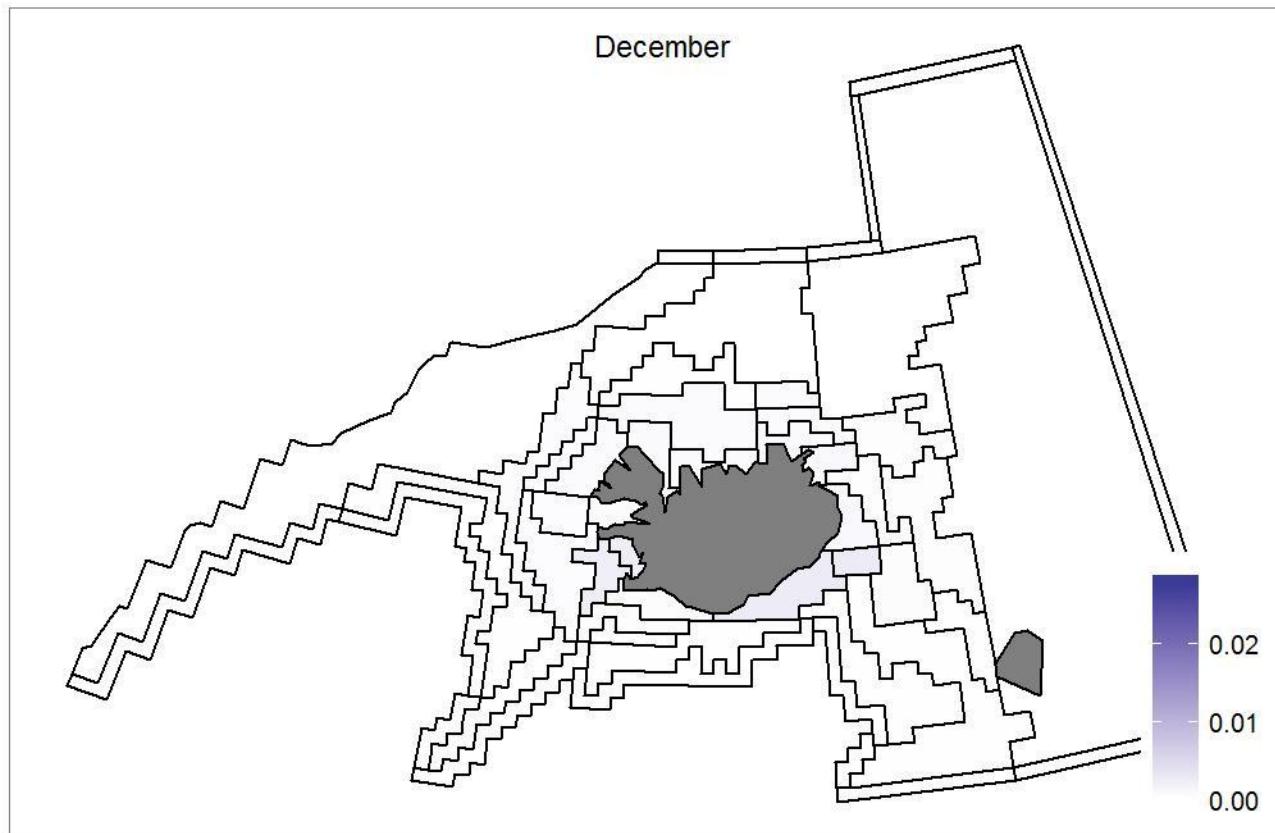
- Horizontal movement
 - Migration within the model
 - Migration out of the model area
- Vertical movement
 - Night and day



Spatial distribution



Migration of Minke Whale



The fisheries model

- **Fisheries**
 - **Multiple fleets**
 - **Gear**
 - **Target**
 - **Selectivity**



Photo: Sigurður Bergþórsson



Photo: Magnús Jónsson



Photo Vinnslustöðin

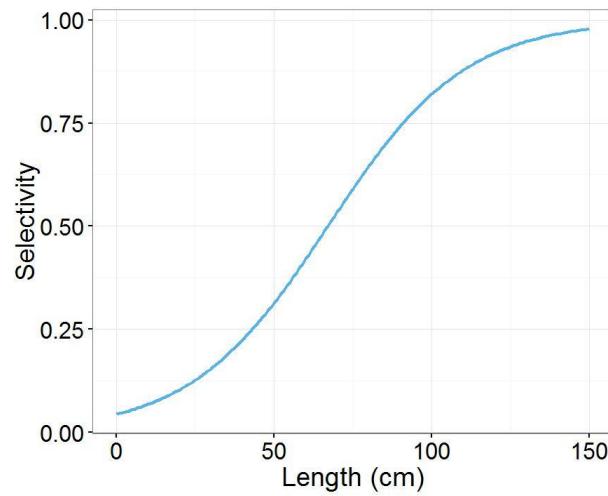
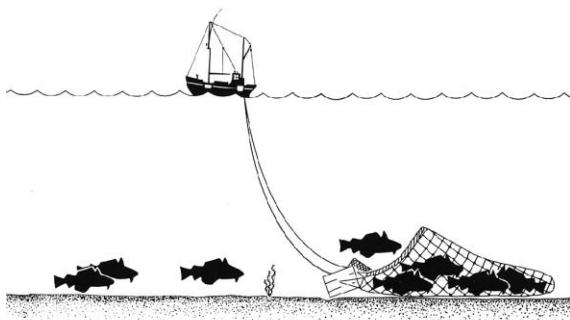
Fishing

Fishing gear

Selectivity

Harvest rate

Catch biomass



Skill assessment

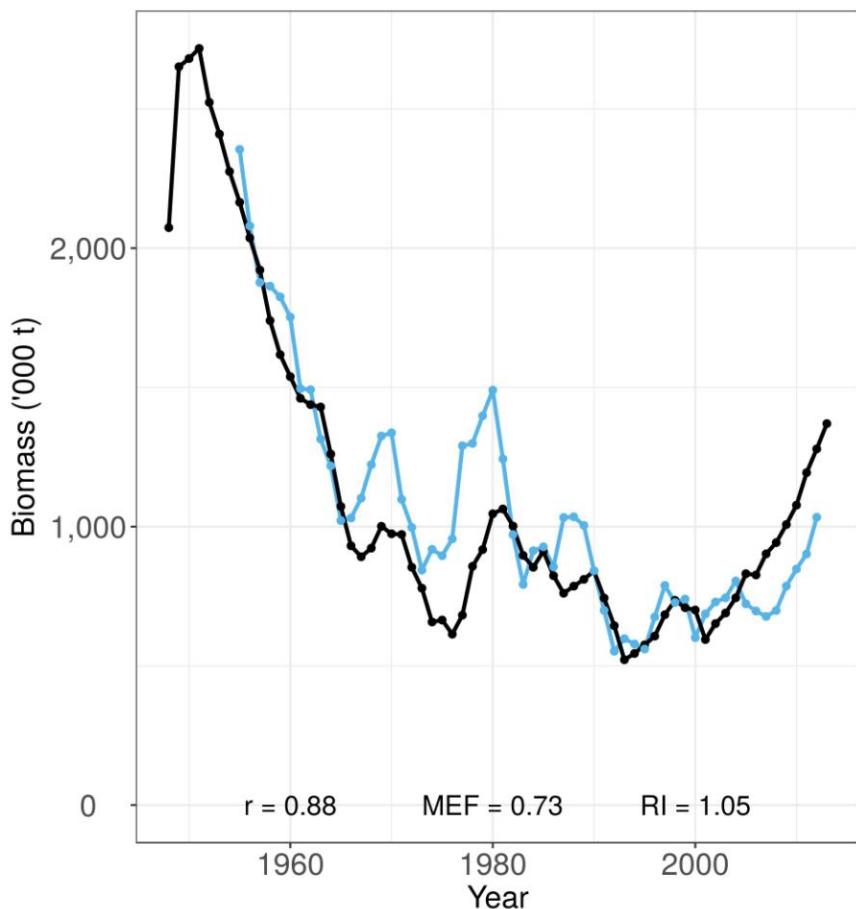
$$r = \frac{\sum_{i=1}^n (O_i - \bar{O})(P_i - \bar{P})}{\sqrt{\sum_{i=1}^n (O_i - \bar{O})^2 \sum_{i=1}^n (P_i - \bar{P})^2}}$$

$$RI = \exp \sqrt{\frac{1}{n} \sum_{i=1}^n \left(\log \frac{O_i}{P_i} \right)^2}$$

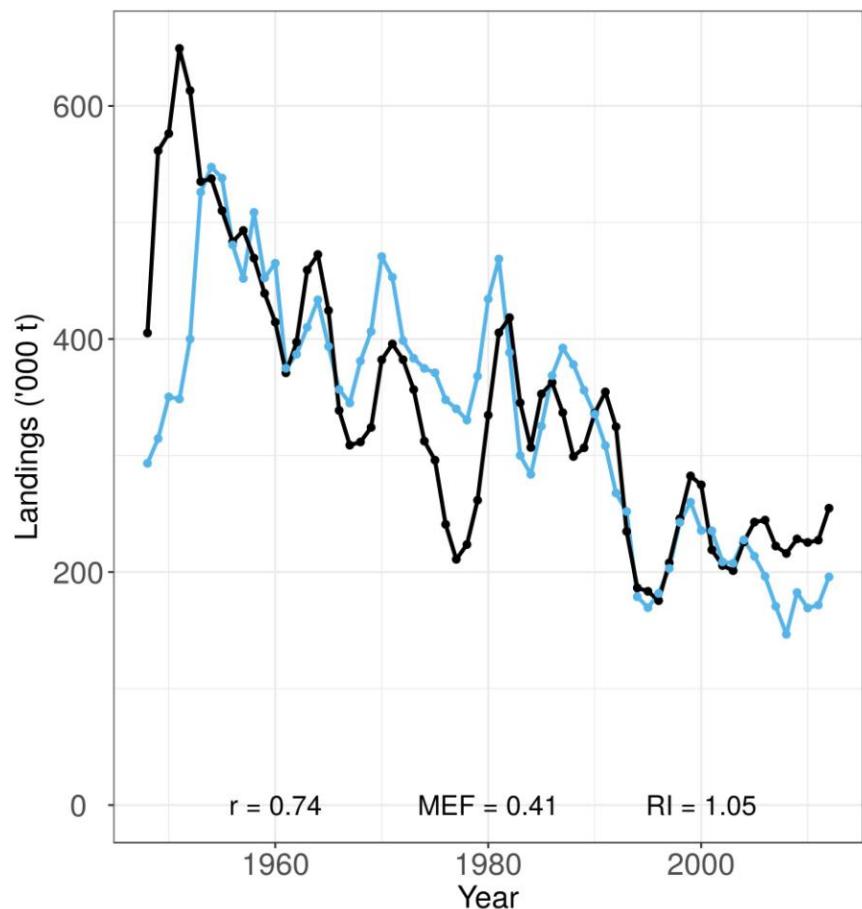
$$MEF = \frac{\sum_{i=1}^n (O_i - \bar{O})^2 - \sum_{i=1}^n (P_i - O_i)^2}{\sum_{i=1}^n (O_i - \bar{O})^2}$$

Cod

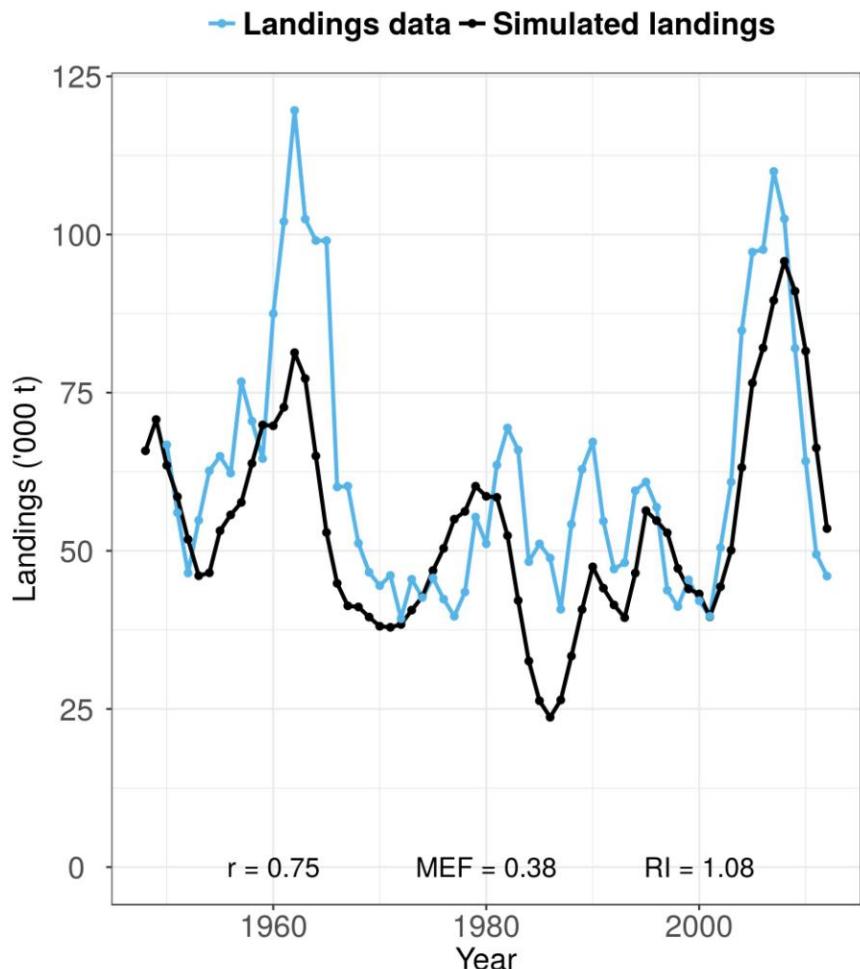
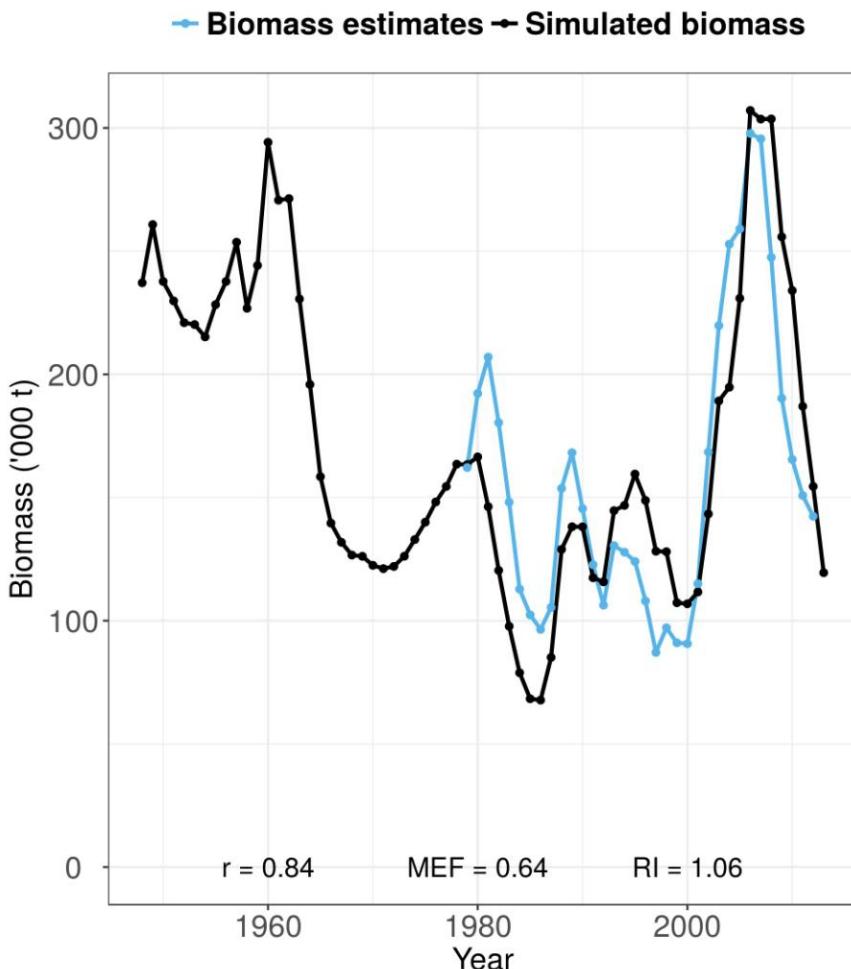
— Biomass estimates ← Simulated biomass



— Landings data ← Simulated landings

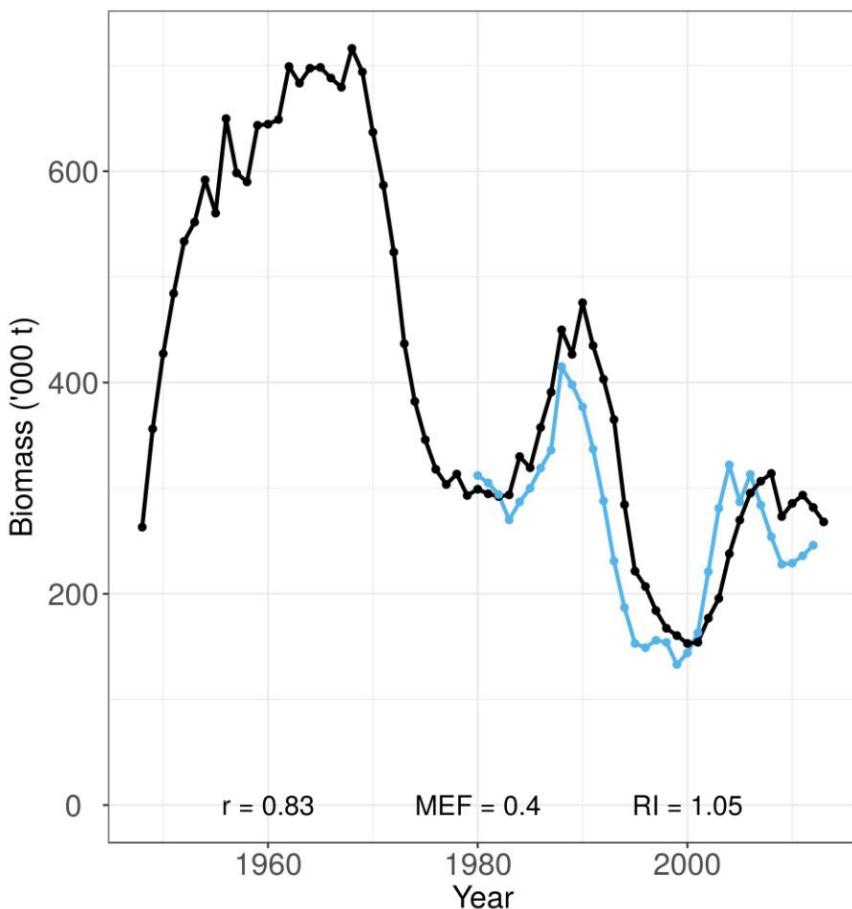


Haddock

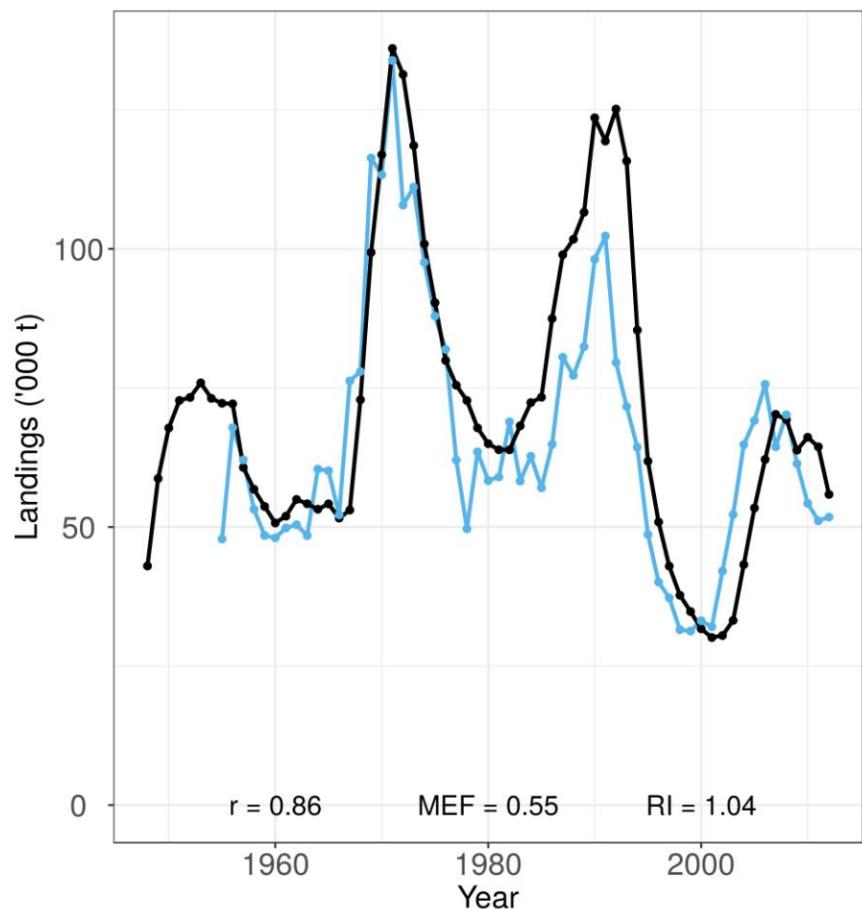


Saithe

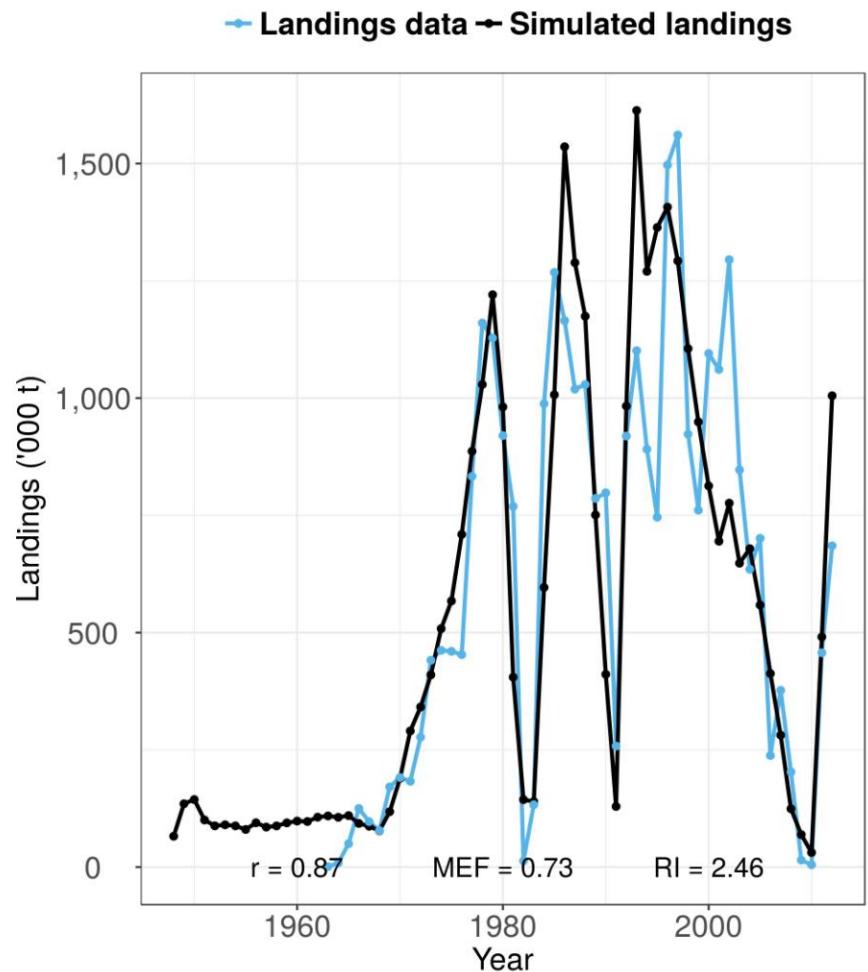
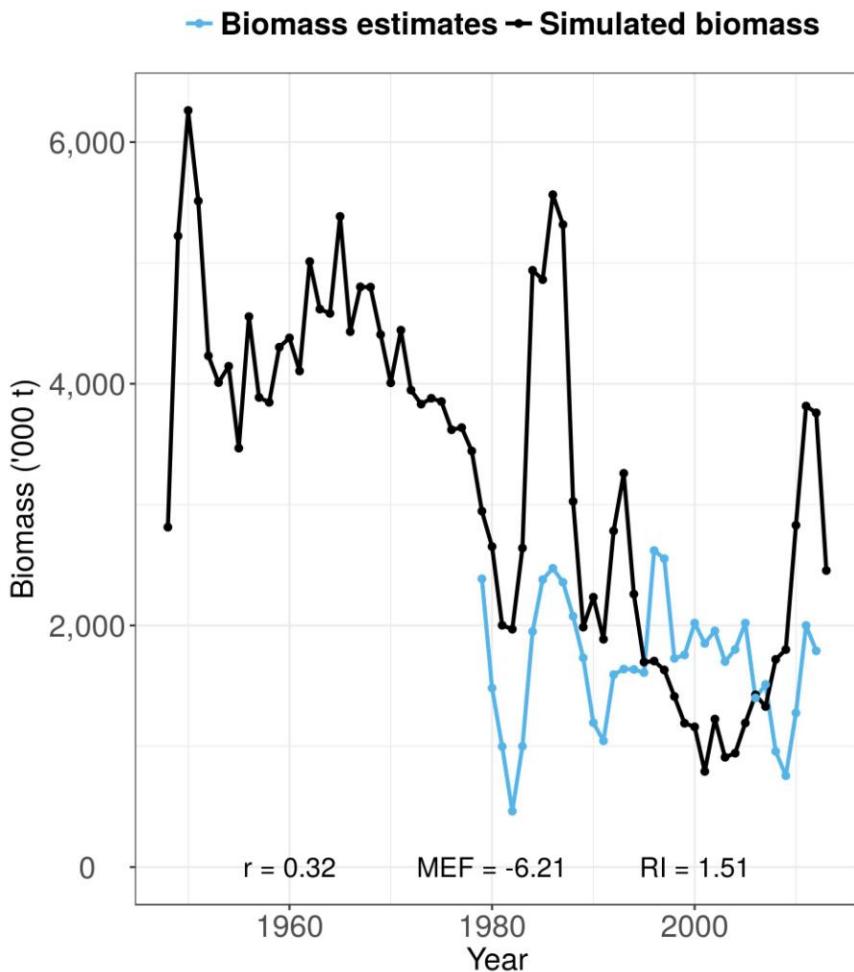
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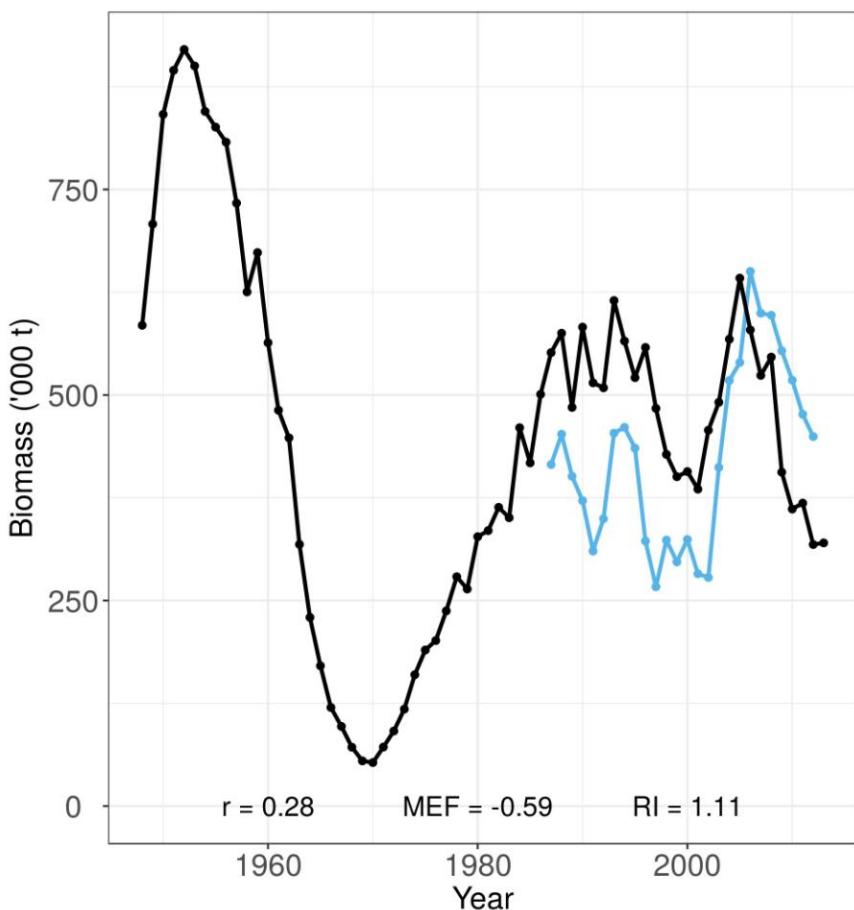


Capelin

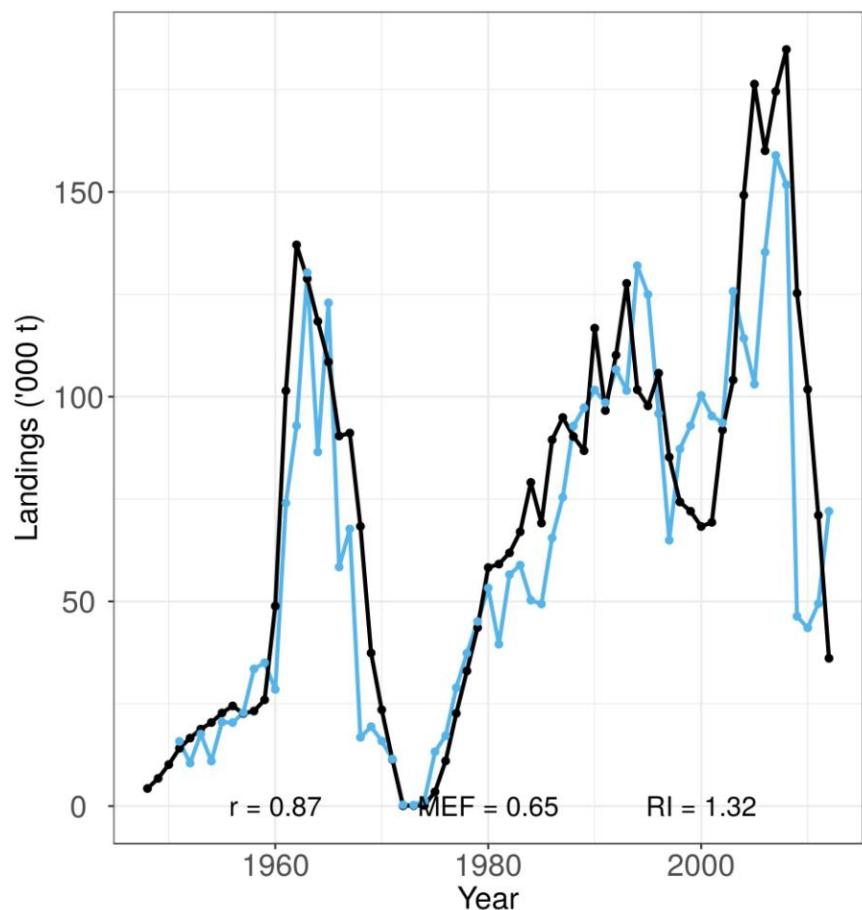


Herring

— Biomass estimates — Simulated biomass



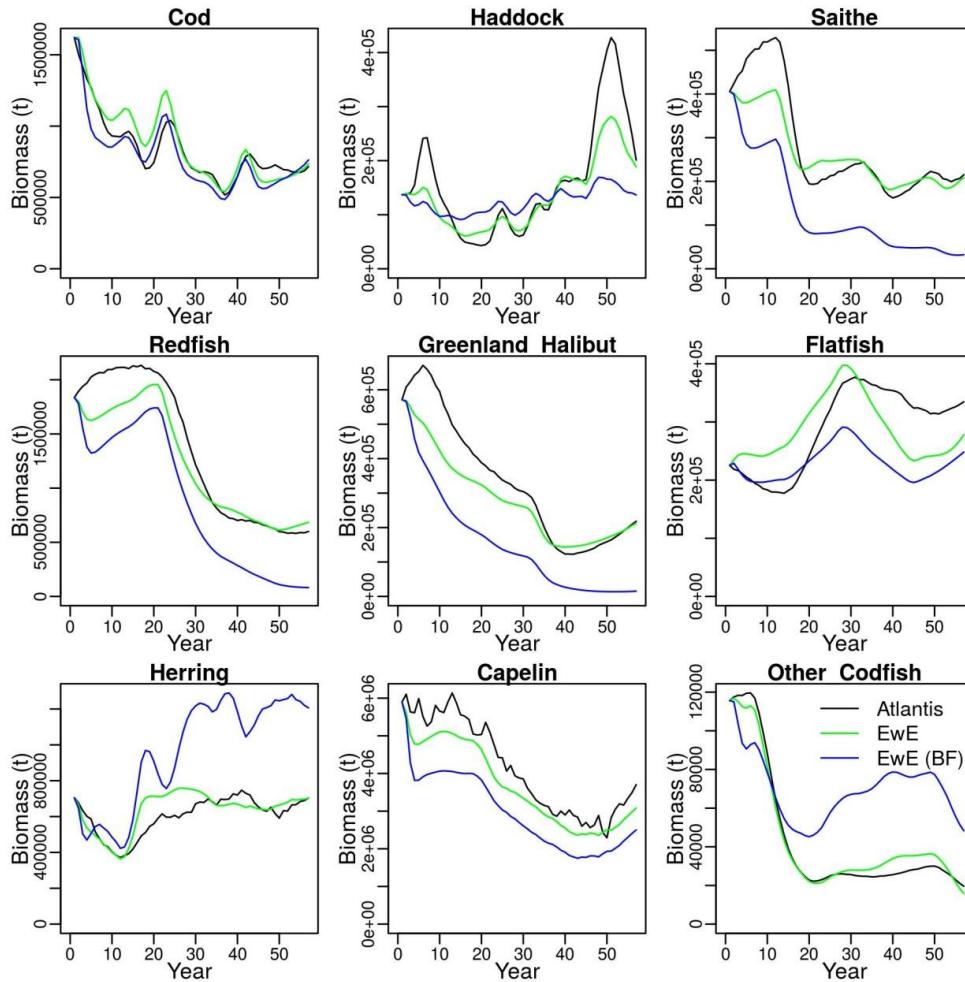
— Landings data — Simulated landings



Use of Atlantis

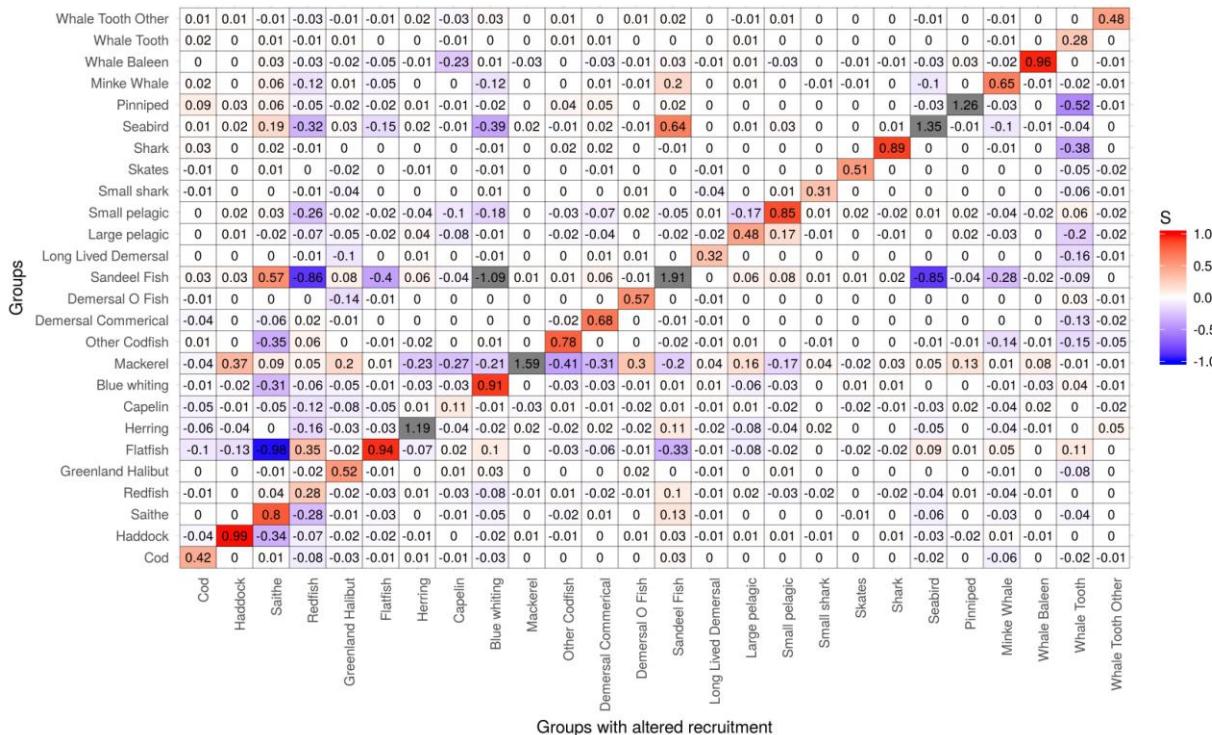
- **Operating model**
 - **Atlantis => EwE**
 - **Atlantis => Gadget**
- **Scenarios**
 - **Fishing pressure**
 - **Effect of discards**
- **Management strategy evaluation**

Can EwE mimic the Atlantis ecosystem?



Sensitivity study

- Testing sensitivity of the model output towards recruitment and growth parameters



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This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 613571 and from the European Commission's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 634495 for the project Science, Technology, and Society Initiative to minimize Unwanted Catches in European Fisheries (MINOUW)



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