Introduction to the EU SC05 project: "Multispecies Fisheries Assessment for NAFO"

European Maritime and Fisheries Fund
Framework Programme UE EMFF/2016/008

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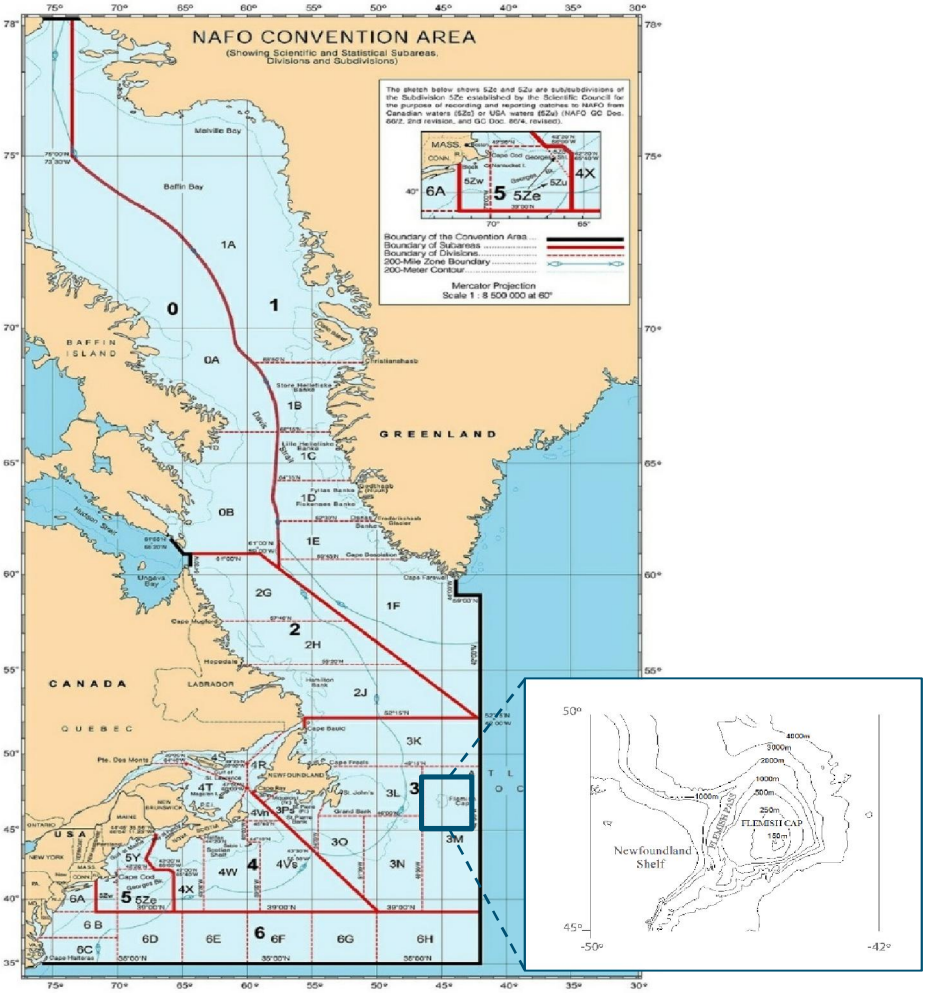
Brief history of events that promoted SC05

Geographical scope: NAFO
Case study: Flemish Cap



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Previous studies

1. Albikovskaya, L.K., and Gerasimova, O.V. 1993. Food and feeding patterns of cod (Gadus morhua L.) and beaked redfish (Sebastes mentella Travin). NAFO Scientific Council Studies **19**: 31-39.

2. Casas, J.M., and Paz, J. 1994. Diet of Flemish Cap Cod with Particular Reference to Predation on Redfish: 1988-1993. NAFO SCR Doc. 94/24.

3. González, C., Paz, X., Román, E., and Hermida, M. 2006. Feeding Habits of Fish Species Distributed on the Grand Bank (NAFO Divisions 3NO, 2002-2005). NAFO SCR Doc 06/31(Journal Article).

4. Lilly, G. 1985. Cod (Gadus morhua) on the Flemish Cap fed primarily on redfish (Sebastes sp.) in winter 1984. NAFO SCR 85/72(Journal Article).

5. Lilly, G. 1982. Cannibalism in Atlantic cod Gadus morhua on Flemish Cap in winter, 1978-82. NAFO SCR Doc. 82/VI/36.

6. Paz, J., Casas, J.M., and Pérez-Gandaras, G. 1993. The feeding of Cod (Gadus morhua L.) on Flemish Cap 1989-90. NAFO Scientific Council Studies **19**(Magazine Article): 41-51.

7. Pérez-Rodríguez, A., González-Iglesias, C., Koen-Alonso, M., and Saborido-Rey, F. 2011. Analysis of common trends in feeding habits of the main fish demersal species of Flemish Cap. NAFO SCR Doc 11/77(Journal Article).

8. Pérez-Rodríguez, A., Koen-Alonso, M., and Saborido-Rey, F. 2012. Changes and trends in the demersal fish community of the Flemish Cap, Northwest Atlantic, in the period 1988-2008. ICES Journal of Marine Science **69**(5): 902-912.

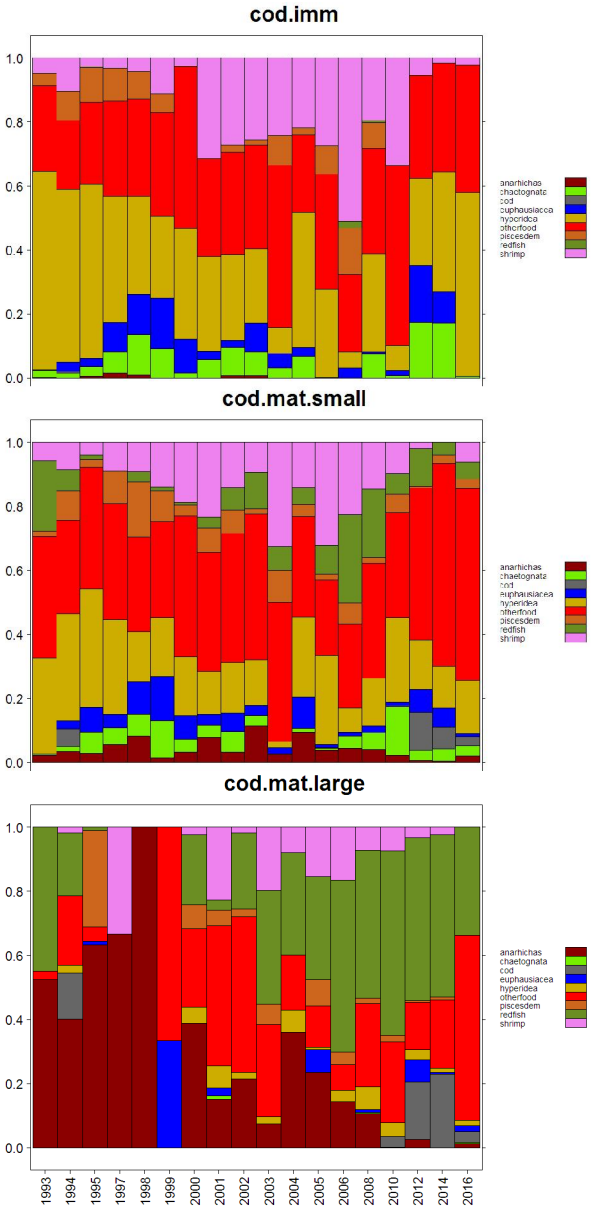
9. Pérez-Rodríguez, A., and Saborido-Rey, F. 2012. Food consumption of Flemish Cap cod Gadus morhua and redfish Sebastes sp. using generic bioenergetic models. NAFO SCR Doc.12/068.

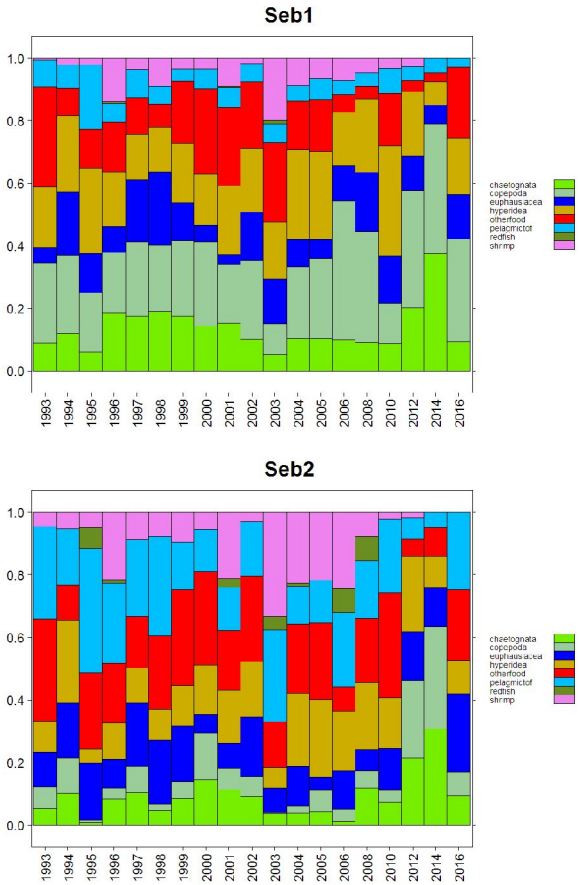
10. Rodríguez-Marín, E., Punzón, A., Paz, J., and Olaso, I. 1994. Feeding of Most Abundant Fish Species in Flemish Cap in Summer 1993. *In* NAFO Scientific Council Reports.

11. Román, E., González, C., and Ceballos, E. 2004. Food and Feeding of Most Abundant Fish Species in Flemish Cap. NAFO SCR Doc. 04/58.

12. Torres, P., Rodríguez-Marin, E., and Loureiro, I. 2000. Preliminary results from feeding analysis for the most abundant demersal fishes in Flemish Cap during summer (1993-2000). NAFO SCR Doc 00/96(Journal Article).

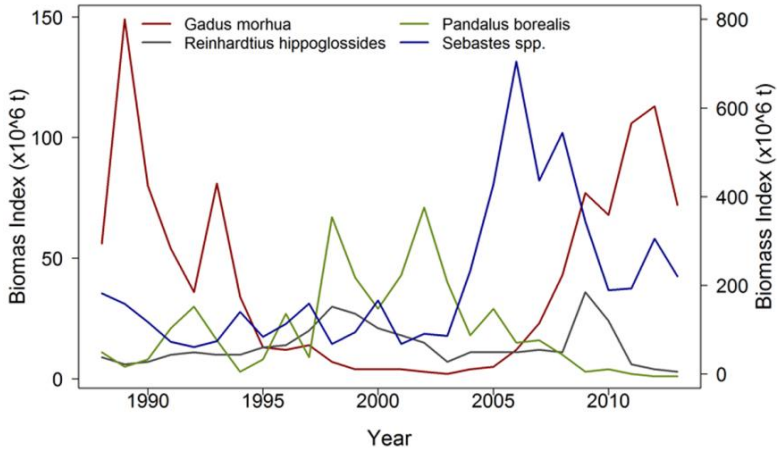
Trophic interactions



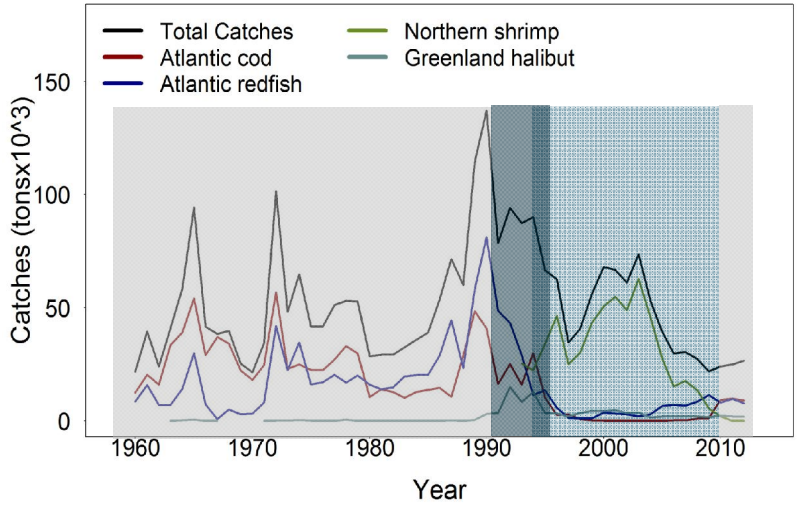


Complementary dynamic in survey indices and commercial catches

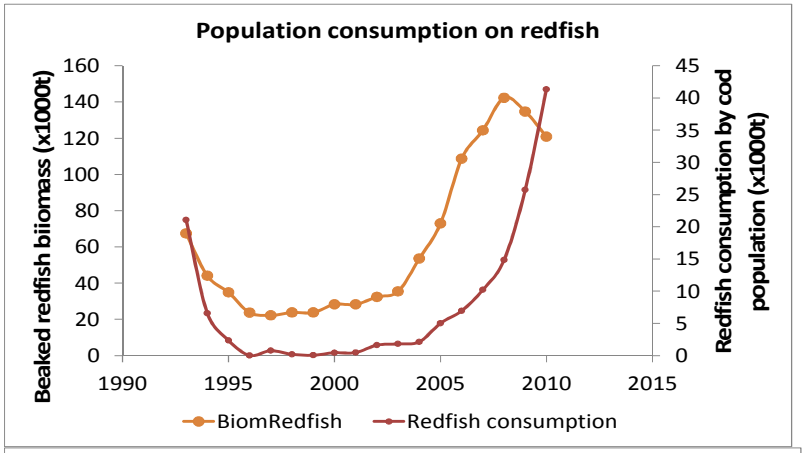
Survey index

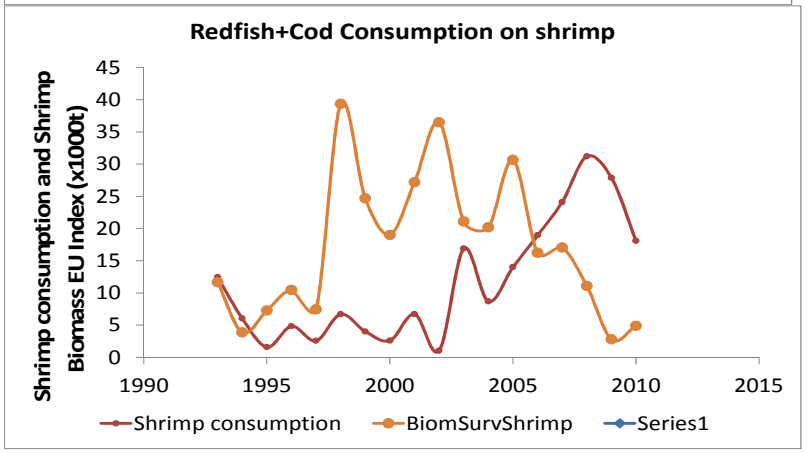


Commercial catches



Consumption estimates

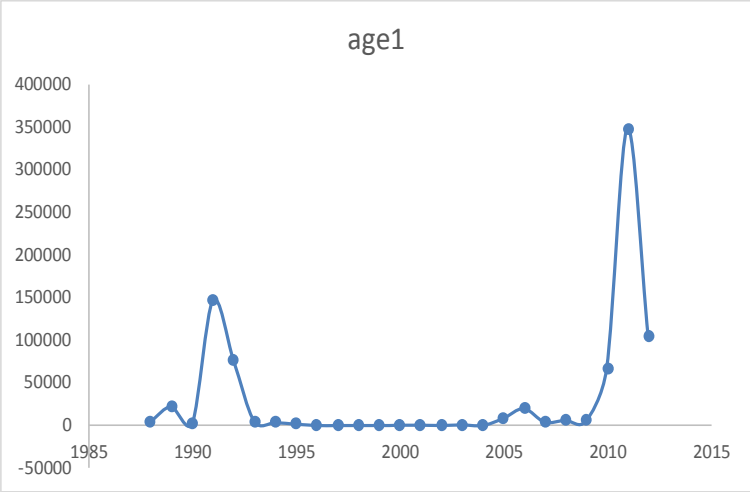




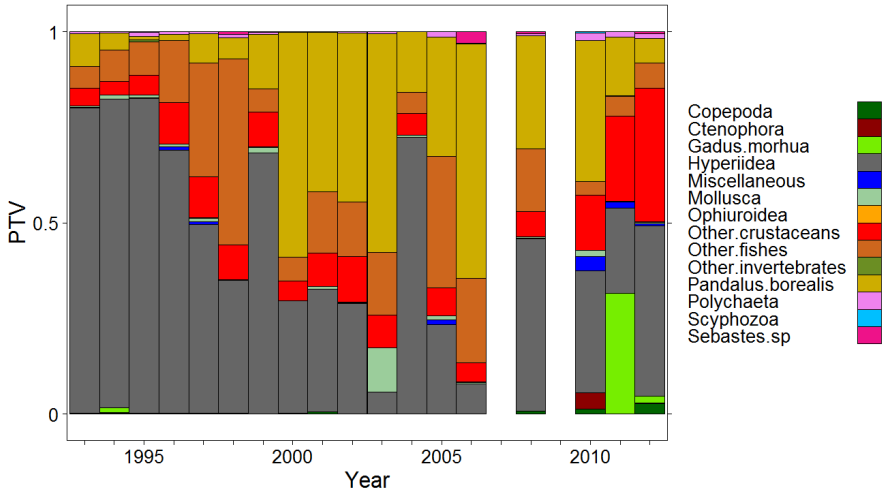
Pérez-Rodríguez, A. and F. Saborido-Rey (2012). "Food consumption of Flemish Cap cod Gadus morhua and redfish Sebastes sp. using generic bioenergetic models." NAFO SCR Doc.12/068.

Cannibalism

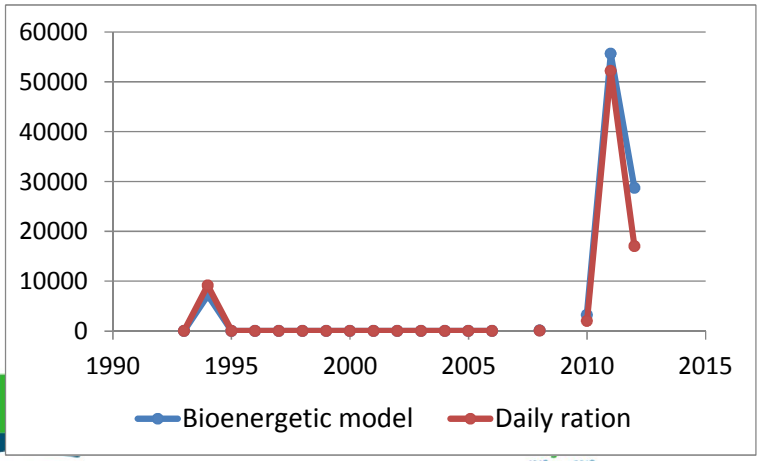
EU Survey Index Age 1



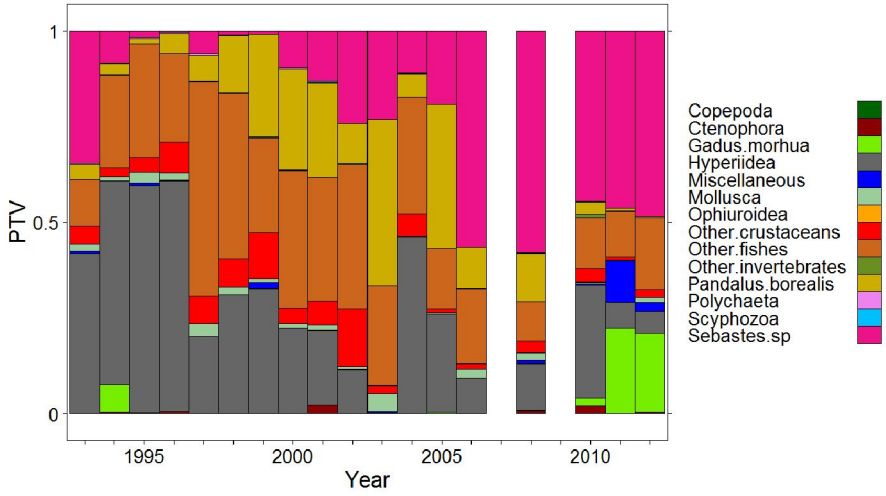
Gadus morhua ≤ 45cm



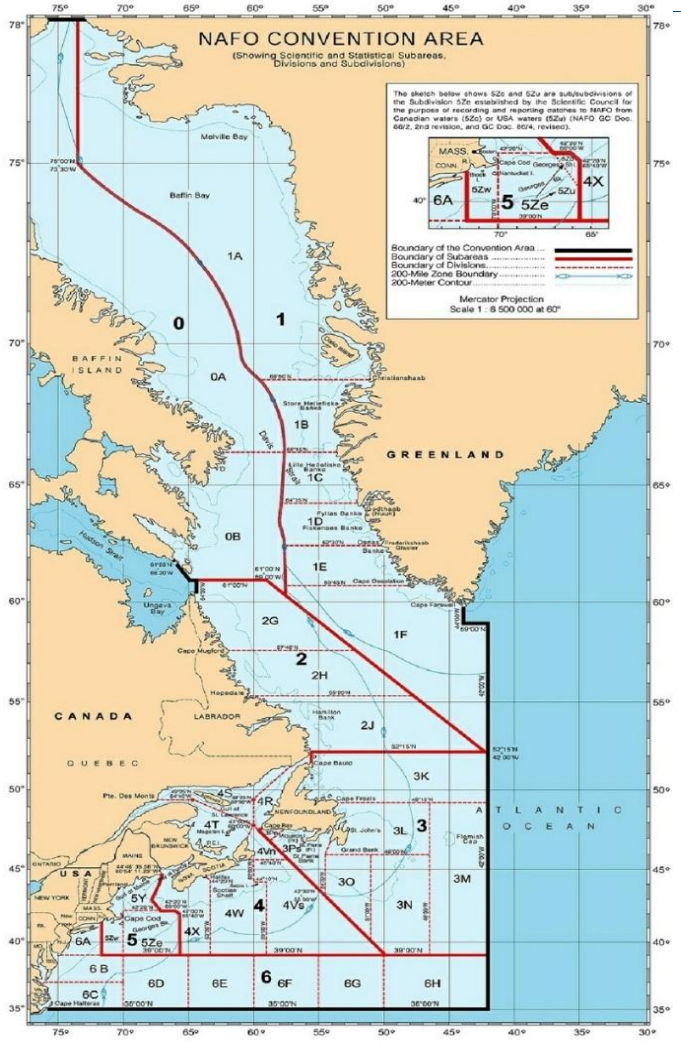
Total estimated cannibalism consumption



Gadus morhua ≥ 45cm



NAFO and the EAF



- In 2007 amendments to the NAFO convention
- NAFO convention indicates in its preamble that *"effective conservation and management of these fishery resources should be based on the **best available scientific advice and the precautionary approach**"* while it commits to *"**apply an ecosystem approach to fisheries management** in the Northwest Atlantic that includes safeguarding the marine environment, conserving its marine biodiversity, minimizing the risk of long term or irreversible adverse effects of fishing activities, and **taking account of the relationship between all components** of the ecosystem"*.

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Request of NAFO FC to the WGESA

- *"On the Flemish Cap, there seems to be a connection between the most recent decline of the shrimp stock, the recovery of the cod stock and the reduction of the redfish stock. The Fisheries Commission requests the Scientific Council to provide an explanation on the possible connection between these phenomena. It is also requested that SC advises on the feasibility and the manner by which these three species are maintained at levels capable of producing a combined maximum sustainable yield, in line with the objectives of the NAFO Convention."*

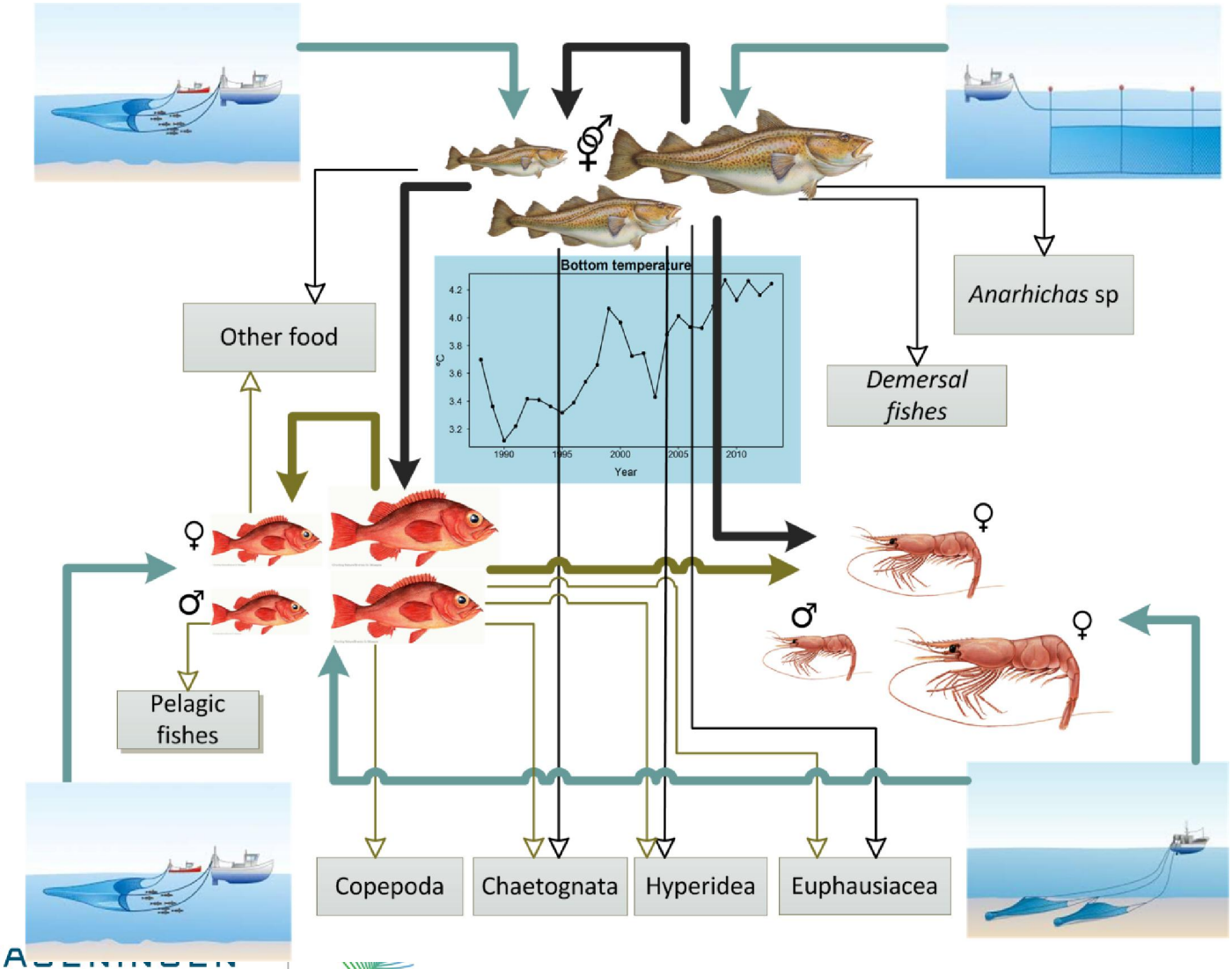
EU Marie Curie project: GadCap

- Proyecto EU Marie Curie:

"Implementation of a multispecies model GADGET to the ecosystem of Flemish Cap in support of the fisheries stock assessment of NAFO; a case study: cod, redfish and shrimp"

- Años 2014-2015
- Institute of Marine Research. Bergen (Norway)
- IIM-CSIC, IEO, IPMA.
- Supervisor: Daniel Howell y Bjarte Bogstad

Model Structure



Ecology related components

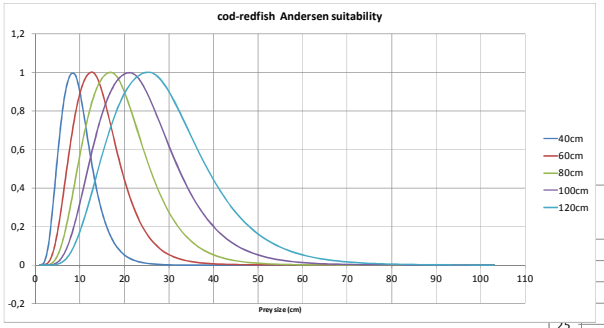
- Consumption
  - Maximum consumption
  - Diet composition
  - Prey preference
  - Prey-predator size relationship
  - Prey-predator suitability function

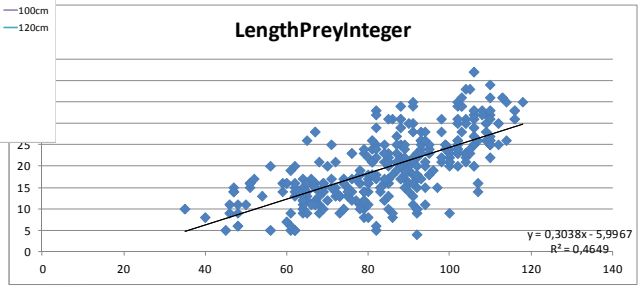
$$C_p(l,L) = \frac{N_L M_L \psi_L F_p(l,L)}{\sum_p F_p(l,L)}$$

$$\psi_L = \frac{\sum_p F_p(l,L)}{H\Delta_t + \sum_p F_p(l,L)}$$

$$M_L = m_0 \Delta t e^{(m_1 T - m_2 T^3)} L^{m_3}$$

$$F_p(l,L) = (S_p(l,L) E_p N_l W_l)^d$$





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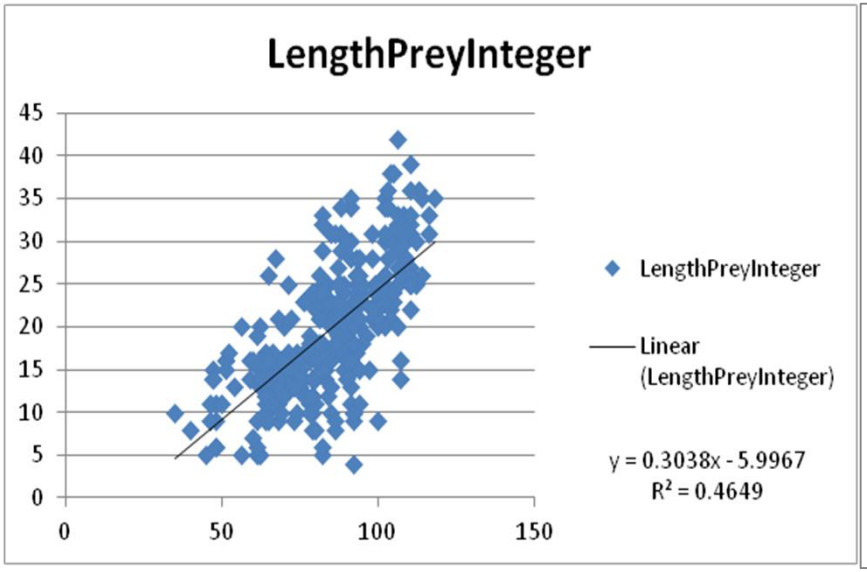
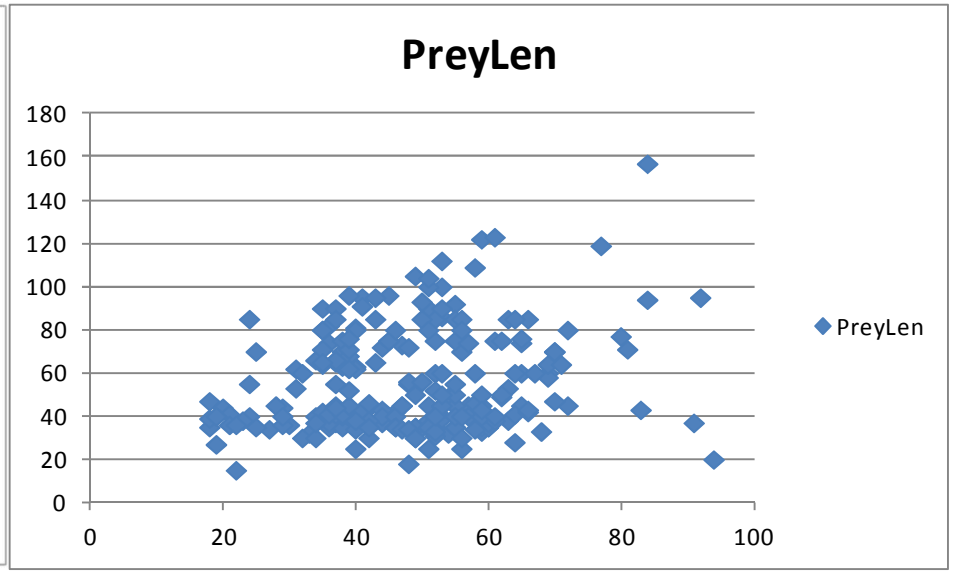
Prey-Predator length relationship

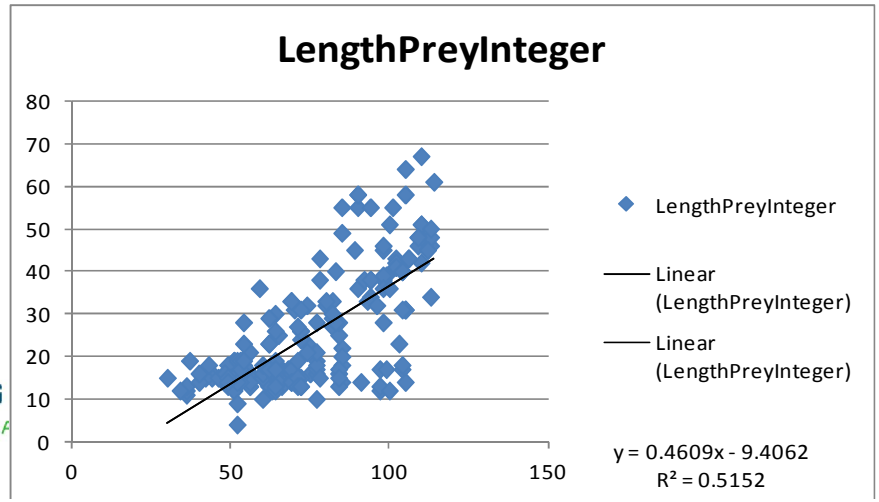
cod-redfish



cod-shrimp



cod-cod



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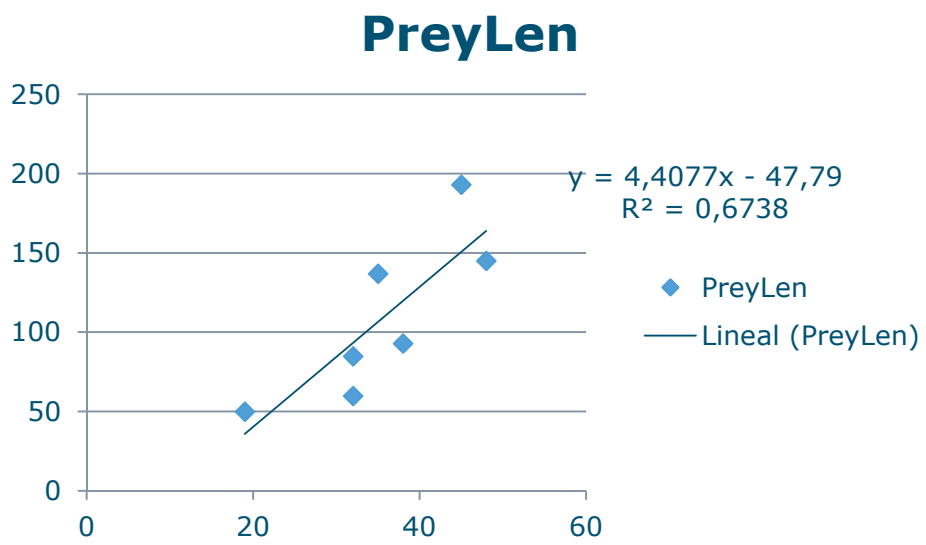
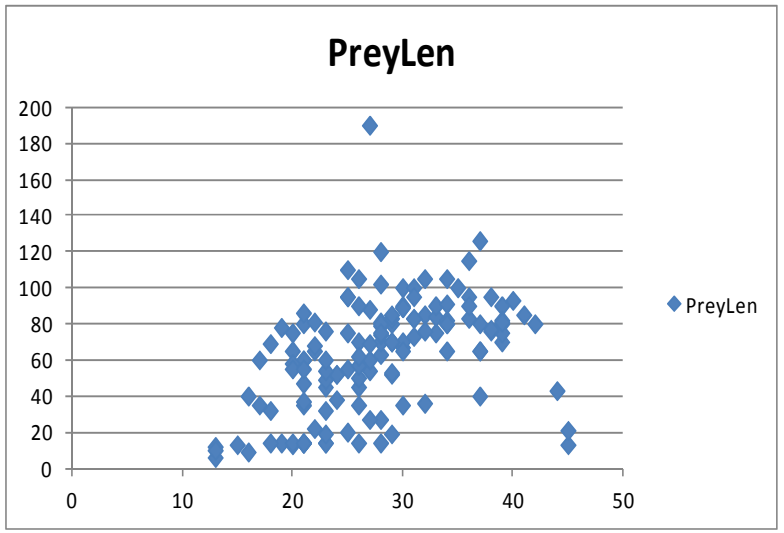
Prey-Predator length relationship

redfish-redfish



redfish-shrimp



1st question

"… *connection between the most recent decline of the shrimp stock, the recovery of the cod stock and the reduction of the redfish stock."*

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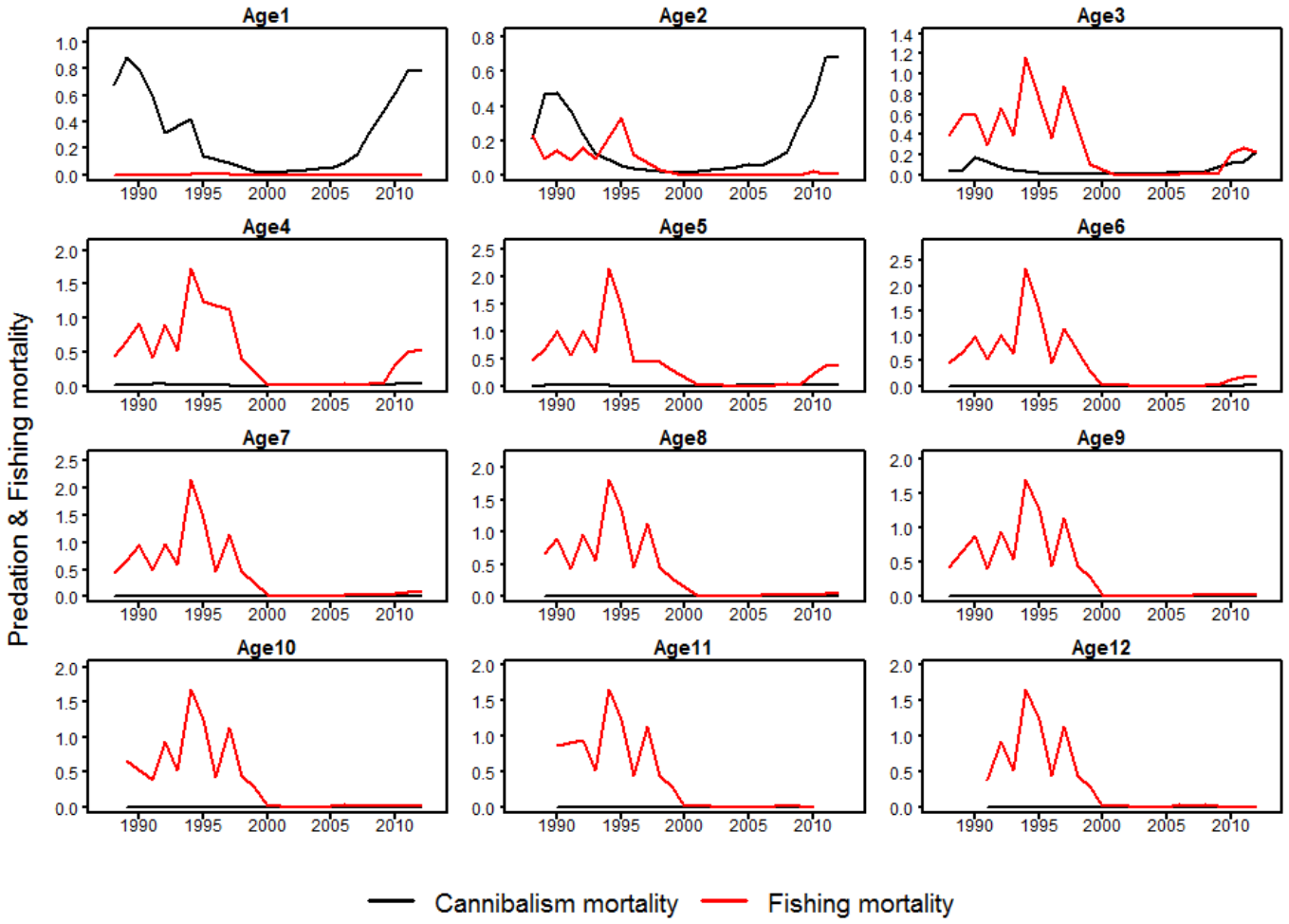
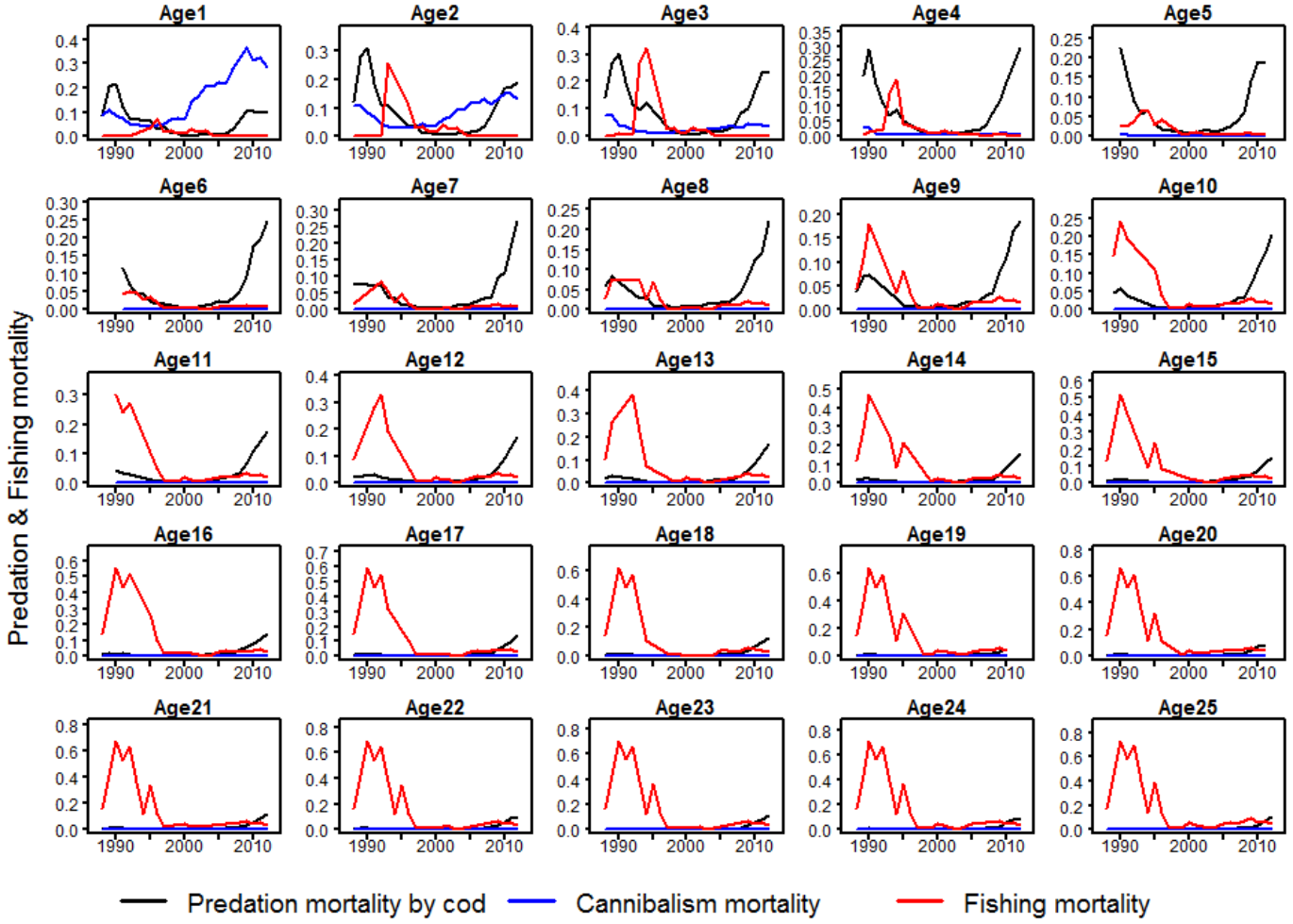
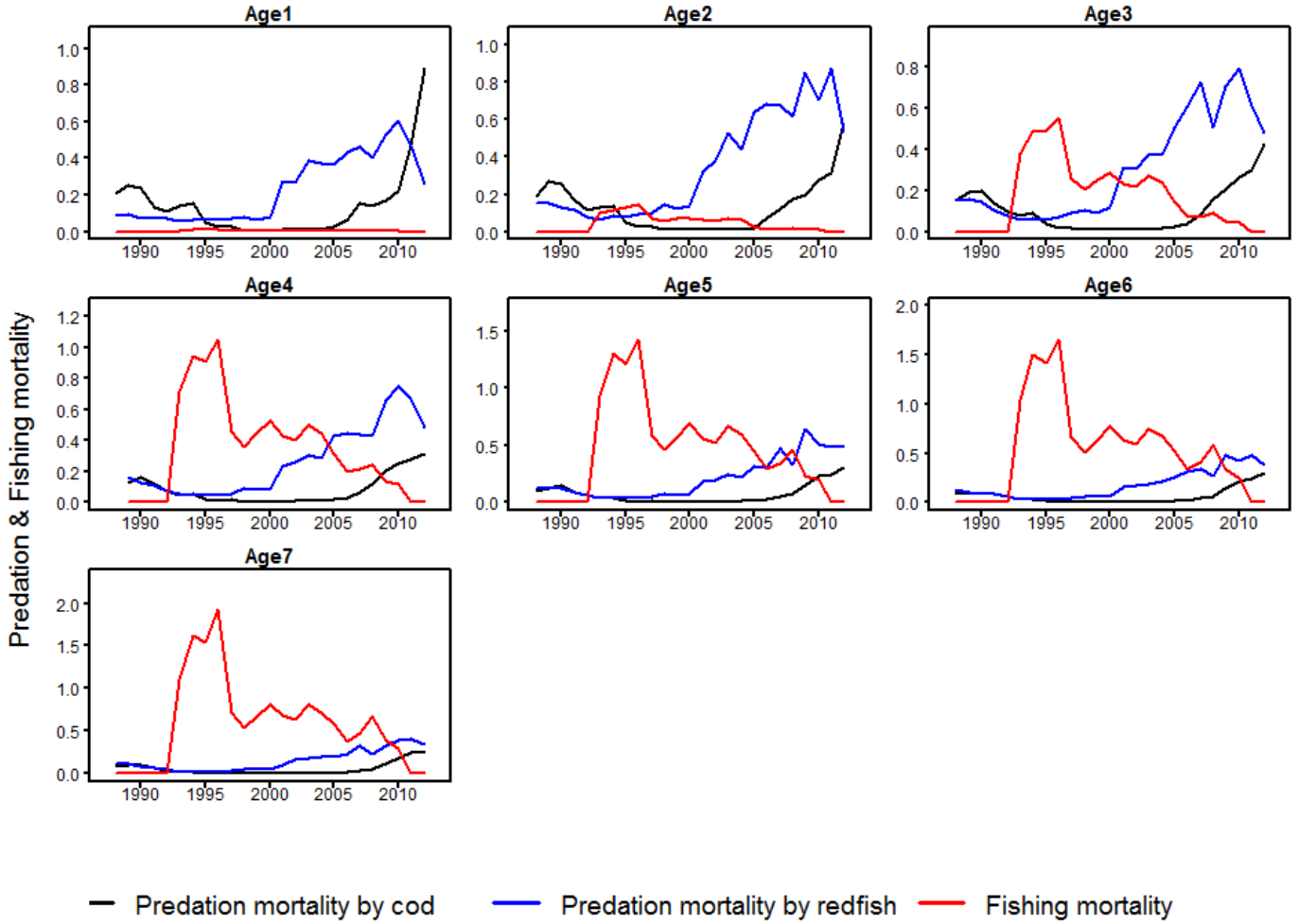
Mortality rates
Cod



Mortality rates
Redfish



Mortality rates
Shrimp



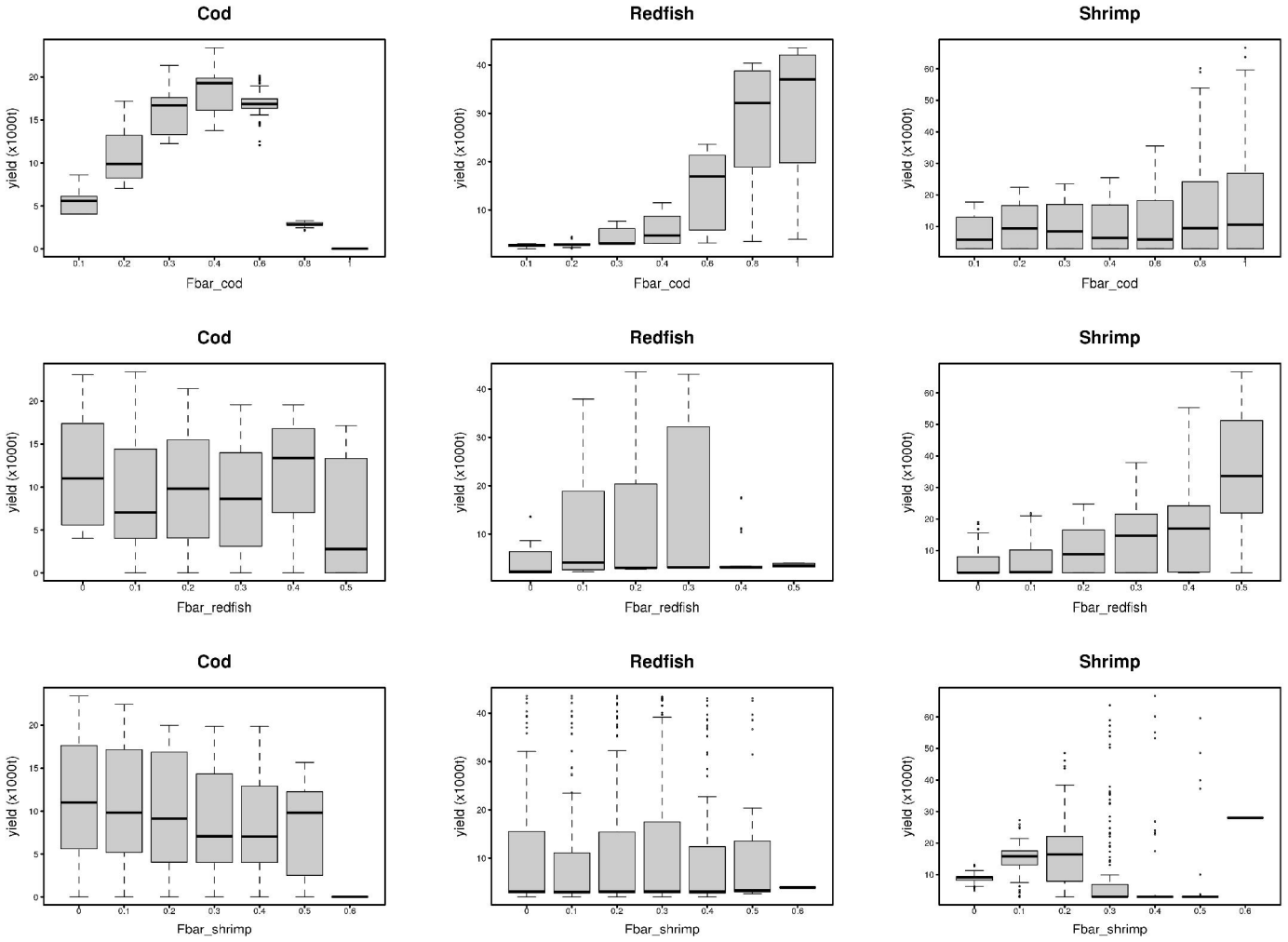
2nd question

"… *feasibility and the manner by which these three species are maintained at levels capable of producing a combined maximum sustainable yield."*

Simulations

- Period **2013-2100**
- All **parameters averaged** to the period 2007-2012
- **Ricker stock recruitment relationship**
- 10 different levels of **fishing mortality** for each species: **1000 combinations**
- Estimate stock biomass, SSB, catches and recruitment for each especies on each of these 1000 combinations.

Yield



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Specific Contract no. 5
"Multispecies Fisheries Assessment for NAFO"

Objectives of SC 05

- Providing a **comprehensive overview** on how multispecies assessments would fit into the scientific and decision-making processes within NAFO

- Develop **specific analyses and techniques** on a case study, the Flemish Cap, that result in potential practical implementations for the multispecies approach.

- Identifying **future steps and research activities** to progress in the implementation of the multispecies assessment in the Flemish Cap, and extensively in the area NAFO.

SCO5 Project tasks
Overview

- **Task 1:** Setting the context
  - A general overview of the multispecies approach worldwide
  - Description of the biological, ecological, fishery and scientific features of the Flemish Cap.
- **Task 2:** Updating **GadCap**
  - An updated version of the multispecies model GadCap: a gadget cod, redfish an shrimp **multispecies model in the Flemish Cap**.
- **Task 3:** First approach to implement multispecies assessment
  - Explore the provision of scientific advice for a multispecies approach in the Flemish Cap
    - Use of multispecies natural mortality estimates in stock assessment
    - **Multispecies MSE framework and potential new multispecies HCRs.**
- **Task 4:** Economyc trade-offs
  - First analysis of the socio/economic implications
  - Available techniques and models needed to assess the trade-offs
- **Task 5:** Dissemination to scientists and stakeholders
  - Discussion and interaction between scientists and other stakeholders: workshop.
  - Presentation and integration of results in the NAFO-WGESA and NAFO Scientific Council meetings
- **Task 6:** Further research
  - Identify future necessary steps and research activities

Task 1 – Setting the Context

Subtask 1.1 Multispecies approach in other management organizations

- Selection and revision of areas and international projects
- Approaches to operationalize the multispecies approach.
- Determination of multispecies based reference points and Harvest Control Rules (HCRs).
- Socio-economic related aspects in the multispecies approach.

Subtask 1.2 Revision of the case study: Flemish Cap and NAFO

- Describe the ecological and fisheries features, the scientific knowledge as well as the conditions in NAFO that would support the Flemish Cap within NAFO as a candidate case study.
- Summarizing the main elements of the NAFO roadmap for an EAF and the way the development of the multispecies approach would fit within this framework.

Task 2 – Update and Improvement of Gadcap Multispecies Model

Subtask 2.1 Updating model input databases

- Updating commercial, survey and oceanographic input data and revision of the input data from 1988 to 2012.

Subtask 2.2 Improving of GadCap model

- The structure and different parameters and submodels of GadCap will be checked for potential improvement

Subtask 2.3 Model assemblage

- The model will be assembled with all the new information and model parameters will be optimized. All the necessary sensitivity analysis and diagnostics will be conducted.

It is expected that these three subtasks will be developed almost in parallel.

Task 3 – Application of Multispecies Model in Stock Assessment in the Flemish Cap

Subtask 3.1 Estimates of natural mortality (M1+M2) and use in single species short term forecast

- Estimates of natural mortality for cod, redfish and shrimp will be delivered.
- Complimentary effort to connect SC05 with SC03

Subtask 3.2 Explore multispecies reference points and HCRs

- Define MSY reference points considering the trade-offs and interdependency between cod, redfish and shrimp in the Flemish Cap.
- Alternative HCRs containing multispecies considerations and reference points
- Close communication with the NAFO Designated Experts in charge of the Flemish Cap stock assessments.

Subtask 3.2 Multispecies Management Strategy Evaluation

- Assemblage of a Multispecies MSE (msMSE)
- Assessment of ecological implications: explore different management objectives.

Task 4 – Evaluation Of Economic Implications Of Trade-offs

Subtask 4.1 Identification and description of the existing economic data and the ecological-economic models suitable to be applied on multispecies assessment

- Review all up-to-date economic fisheries models
- Define the best modelling approach to cope with the economic evaluation, based in the HCRs and the availability of economic related data.
- An analysis of the challenges to use a full coupled model.

Subtask 4.2 Trade-offs between different fleet-sectors within and among countries (special interest in the EU countries)

- Based in the possibilities defined in previous step an economic evaluation of the arising trade-offs of the multi-species HCRs will be executed.
- Results including uncertainty estimates derived from the modelling output coming from tasks 2 and 3.

Task 5 – Discussion and Interaction between Scientists and other Stakeholders

Subtask 5.1 Organization of a workshop to present the results of the study to main stakeholders and administrations in the EU

- A two day workshop with the main stakeholders from the fishing industry, EU administrations and leaders of Tasks 3, 4 and 5
- Promote a constructive discussion around the topic
- Create awareness of this relatively new approach
- Optimize the quality and quantity of feedback from stakeholders. Use previous experiences in the presentation and discussion with stakeholders (Kempf et al, 2016)

Subtask 5.2 Integration of results on the NAFO Roadmap for the development of an ecosystem approach to fisheries management

- Integrate the results of this project into the roadmap for the EAFM in NAFO.

Task 6 – Future Research Directions and Needs

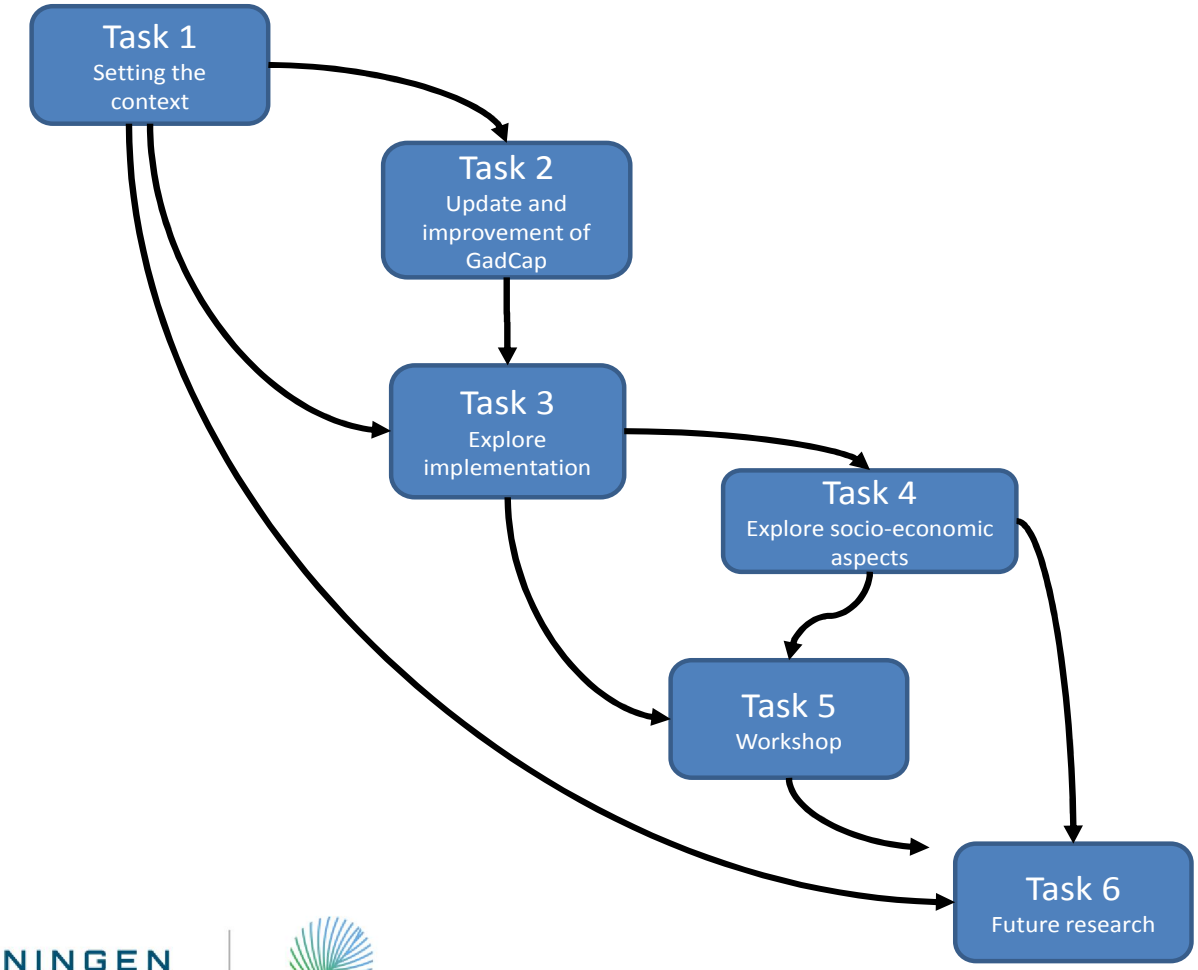
Subtask 6.1 Analyses about the progress and implementation of multispecies assessment

- Review the progress made by this study and identify the challenges and limitations encountered (ecological, economic, methodology, data, etc) and how they could be addressed in the future.
- Lessons learned

Subtask 6.2 Research activities to strengthen the multispecies assessment implementation within the NAFO roadmap for an EAF

- Propose activities to address the limitations within the NAFO case study.
- Description of research activities, their potential contribution to the multispecies implementation, and best way to be taken forward as part of the NAFO roadmap for EAF

Project tasks
Connection and interdependence



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