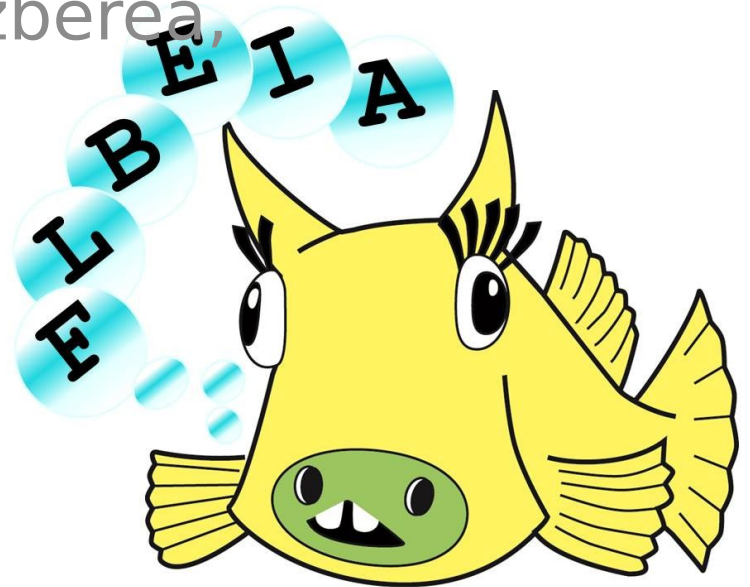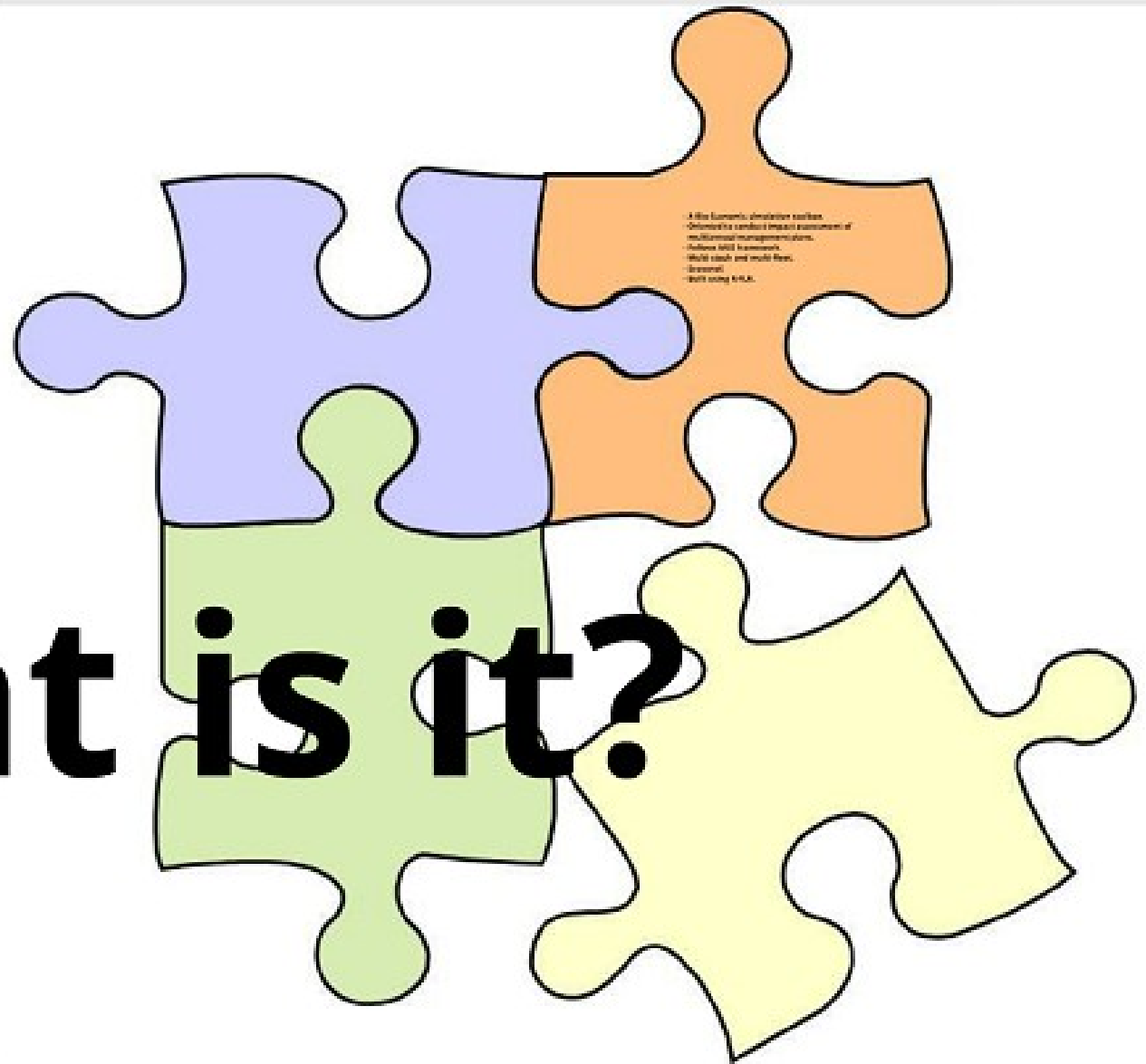# FLBEIA: A tool to conduct bio-economic impact assessments of fisheries management strategies

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What is it?

- A Bio-Economic simulation toolbox.
- Oriented to conduct impact assessment of multiannual management plans.
- Follows MSE framework.
- Multi-stock and multi-fleet.
- Seasonal.
- Built using R-FLR.

Stochastic (Monte Carlo simulation).

Motivation

- **Existing bio-oriented models tend to simplify economic part and the other way around.**
- **Biological models built on generally accepted models.**
- **Fleet dynamic models are very case specific, standard models are not available.**

How is it built up?

Composability:
*"A model is nothing more than the 'sum' of its parts,
which can be individually modelled
and then put together "*

- The model has been constructed modularly.
- The fishery and management systems are defined as the "sum" of "small" processes.
- Several models available for each process.
- 2 kind of processes:
  - **Low level**: Stock recruitment, catch production function...
  - **High level**: Population growth, fleets' short term dynamics...
- There are functions at different levels that assemble the models at lower levels.
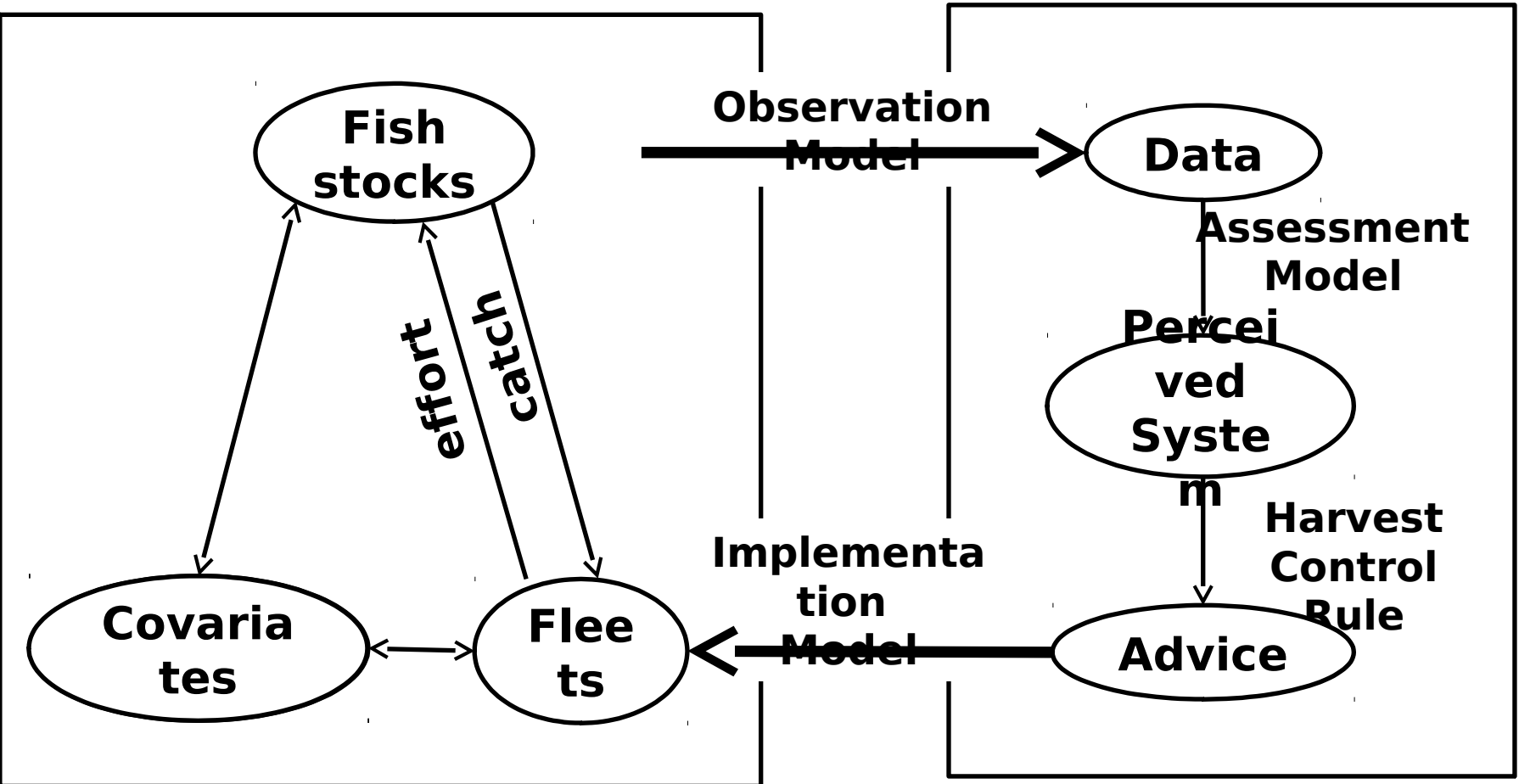
PREZI

Value given
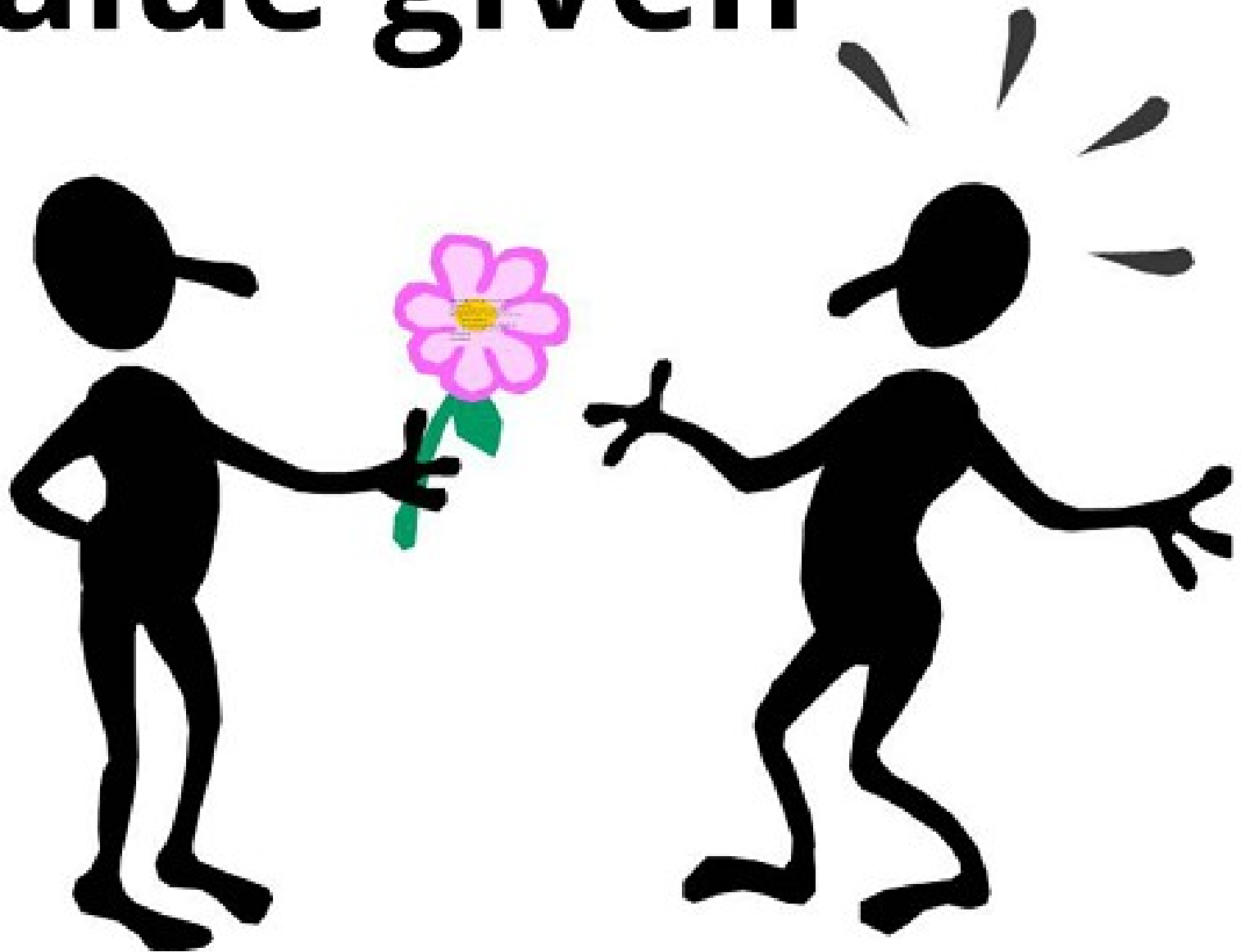
- Fully coupled: biologic and economic components.
- Balance between both components.
- Management advice can be given based on:
  - Real population.
  - Observed population through the whole management process
- Extensibility.
- Uncertainty.

Conceptual Diagram

Operating Model (OM)

Fish stocks

Observation Model

Data

Assessment Model

effort

catch

Percei ved Syste m

Covaria tes

Flee ts

Implementa tion Model

Harvest Control Rule

Advice

Management Procedure Model (MPM)

Operating Model: Stocks

- Age structured:
  - Survival exponential model + stock-recruitment relationship.
  - Seasonal cohorts.
- Aggregated in biomass:
  - Pella-Tomlinson growth model.

Operating Model: Fleets

- Fleet's activity is divided in metiers (multi-metier).

- Four processes are modelled
  - Short term dynamics (*tactic*).
  - Catch production.
  - Prices.
  - Long term dynamics (*strategic*).

Operating Model: Fleets

- Short term dynamics (*tactic*).
    - Predetermined effort
    - Mixed Fisheries.
    - Fcube approach.
    - Profit maximization.
    - Sequential Fisheries.

Operating Model: Fleets

- *Production*: Cobb Douglas.

- *Prices:* Predetermined or dependent on the level of landings.

- *Long term dynamics (strategic):* Investment and disinvestment depends on economic indicators fleet's capacity.

Operating Model: Covariates

- Room to introduce into the simulation variables of interest not included in fleets' and stocks' OM.

- Non comercial species (cetaceans, seabirds,...).

  – Environmental variables (climate change,...).

  – Economic variables (fuel prices, imports...)

- Social variables (employments,
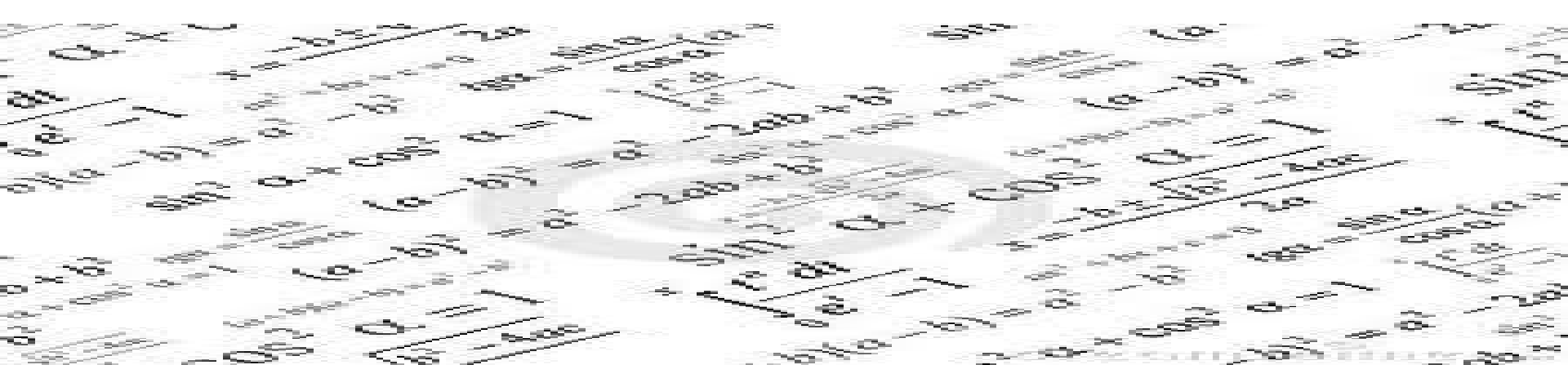
Management Procedure: Data

- Biological and catch (landings & discards).
- Abundance indices, at age or total biomass level.
- Age structured stocks can be observed at age or at total biomass level.
- All the variables observed may be subject to error.
- Error types:
  - Multiplicativo error.
  - Aging error.

Management Procedure: Assessment

- Any model coded in R/FLR can be used within FLBEIA.

  - Data input/output must follow a given format.

 - The data used by the model must be generable by the observation model.

Management Procedure: Advice

- Annual management, the management season can vary by stock (anchovy).

- The management advice is generated by the HCRs.

- At present only TAC HCRs.

- Two HCR types:

  - *Based on absolute values of abundance and fishing mortality*: ICES MSY framework HCR, Froese (2010) HCR and a flexible HCR based on `FLash`.

  - *Based on abundance indices*: HCR defined by the EC for data-poor stocks, a HCR based on control theory, specific HCRs (Greenland Halibut (NAFO) and the long term management plans of anchovy y mackerel).

Applications

- Northern Hake.
- French mixed fisheries.
- Seabream of Gulf of Cádiz.
- Redfish.
- Greenland Halibut - NAFO.
- Basque offshore fleet.
- Anchovy.

Northern Hake
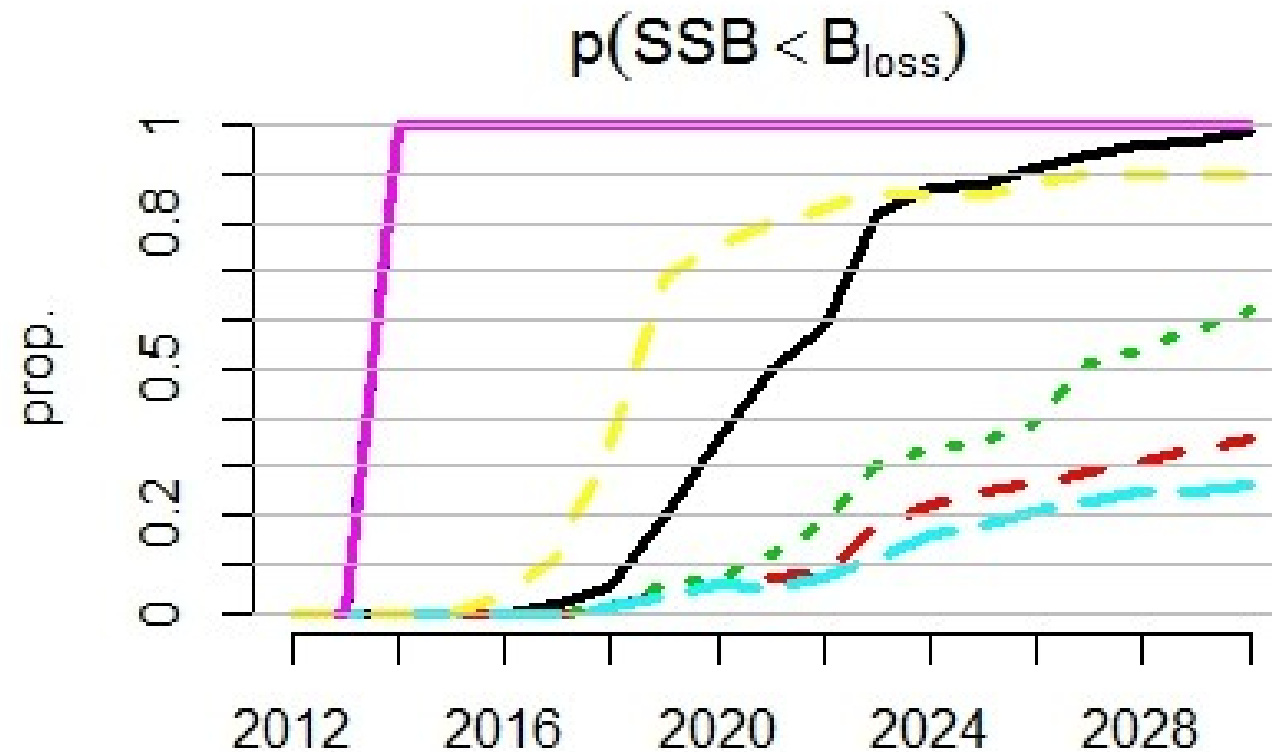
French Mixed Fisheries

Blueling BLI
Age structured

Black Scabbarfish BSF
Aggregated in biomass

Saithe POK
Age structured

Sikis SKH
Aggregated in biomass

Roundnose Grenadier RNG
Aggregated in biomass

PREZI

Fleets
- FL01 and FL02:
  - Mixed Fisheries
  - French fleets with 10 metiers.

- FLBLI, FLBSF, FLPOK , FLSKH, FLRNG:
  - Single stock fisheries.
  - Account for non-french catch.
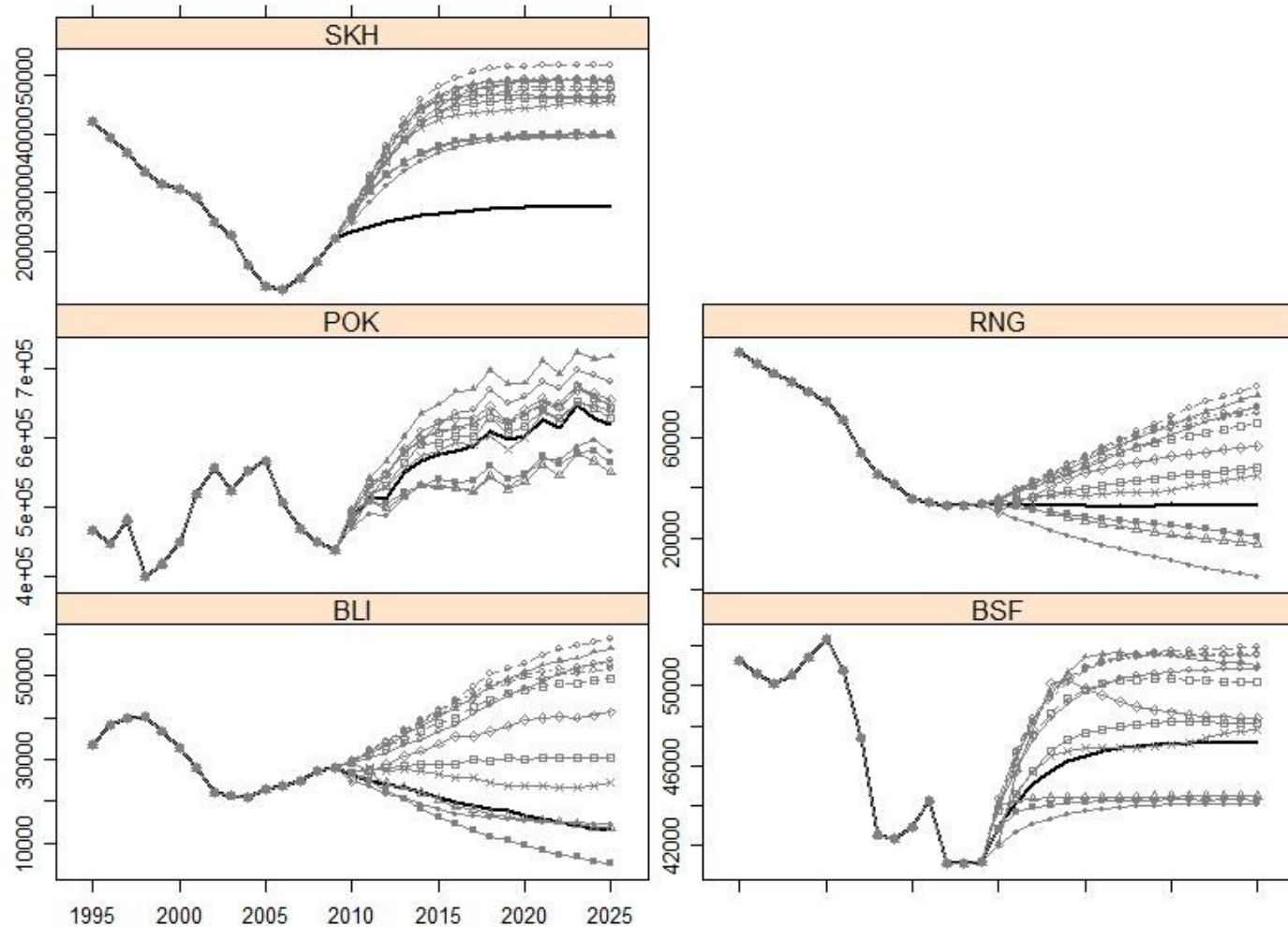
Harvest Control Rules
- BLI, BSF, RNG: Ices MSY HCR & AnnexIV HCR.
- SKH: TAL = 0 (discards allowed).
  - TAC = 500 t, 1500 t, 2500 t.
- POK: Management Plan HCR

Scenarios
- Fixed Effort.
- Simple Mixed Fisheries Behaviour (F-cube like), constrained by BLI, BSF, RNG or SKH.
- FL01: Maximization of profits constrained to comply with BLI or SKH TAC.
  The rest: SMFB.
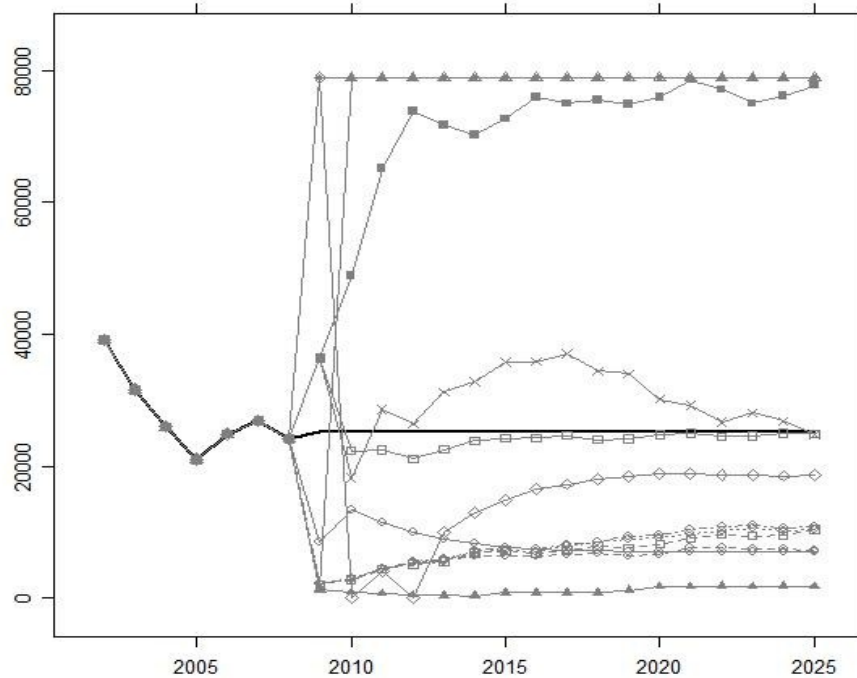
French Mixed Fisheries


Biomass

French Mixed Fisheries: p(ssb<Blim)

| Stock	Scenario	Description		2009	2010-2014	2015-2019	2020-2025
M. dypterigia	mf0	*Statu quo* Effort		0.00	0.15	0.55	0.77
	mf1	*M. dypterigia* restriction	Fcube +ICES	0.00	0.01	0.00	0.00
	mf2		MCP +ICES	0.00			
	mf3		Fcube +XSA +ICES	0.00	0.03	0.15	0.23
	mf4		Fcube +AnnexIV	0.00	0.34	0.76	0.83
	mf5,…,mf8	Sharks rest.	all scenarios	0.00			
	mf9	*A. carbo* restriction	Fcube +ICES	0.00	0.14	0.66	0.85
	mf10		Fcube +AnnexIV	0.00			
	mf11	*C. rupestris* restriction	Fcube +ICES	0.00	0.03	0.05	0.08
	mf12		Fcube +AnnexIV	0.00	0.31	0.77	0.78
C. rupestris	mf0	*Statu quo* Effort		0.50	0.51	0.52	0.51
	mf1	*M. dypterigia* restriction	Fcube +ICES	0.50	0.43	0.28	0.18
	mf2		MCP +ICES	0.50	0.33	0.07	0.01
	mf3		Fcube +XSA +ICES	0.50	0.45	0.39	0.32
	mf4		Fcube +AnnexIV	0.50	0.56	0.64	0.70
	mf5	Sharks restriction	Fcube +TAC$_{SKH}$ =500t	0.50	0.34	0.08	0.01
	mf6		MCP +TAC$_{SKH}$ =500t	0.50	0.28	0.03	0.00
	mf7		MCP +TAC$_{SKH}$ =1500t	0.50	0.28	0.03	0.00
	mf8		MCP +TAC$_{SKH}$ =2500t	0.50	0.29	0.03	0.00
	mf9	*A. carbo* restriction	Fcube +ICES	0.50	0.53	0.72	0.77
	mf10		Fcube +AnnexIV	0.50	0.31	0.06	0.00
	mf11	*C. rupestris* restriction	Fcube +ICES	0.50	0.41	0.08	0
	mf12		Fcube +AnnexIV	0.50	0.64	0.77	0.82
Sharks	all	-		0.00			
A. carbo	all	-		0.00			
P. virens	all	-		0.00			

French Mixed Fisheries
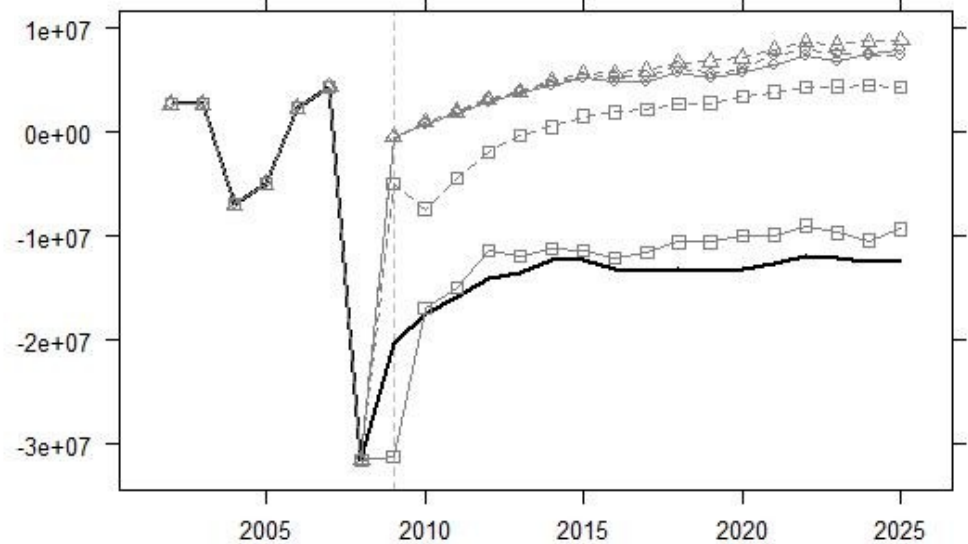
French Mixed Fisheries
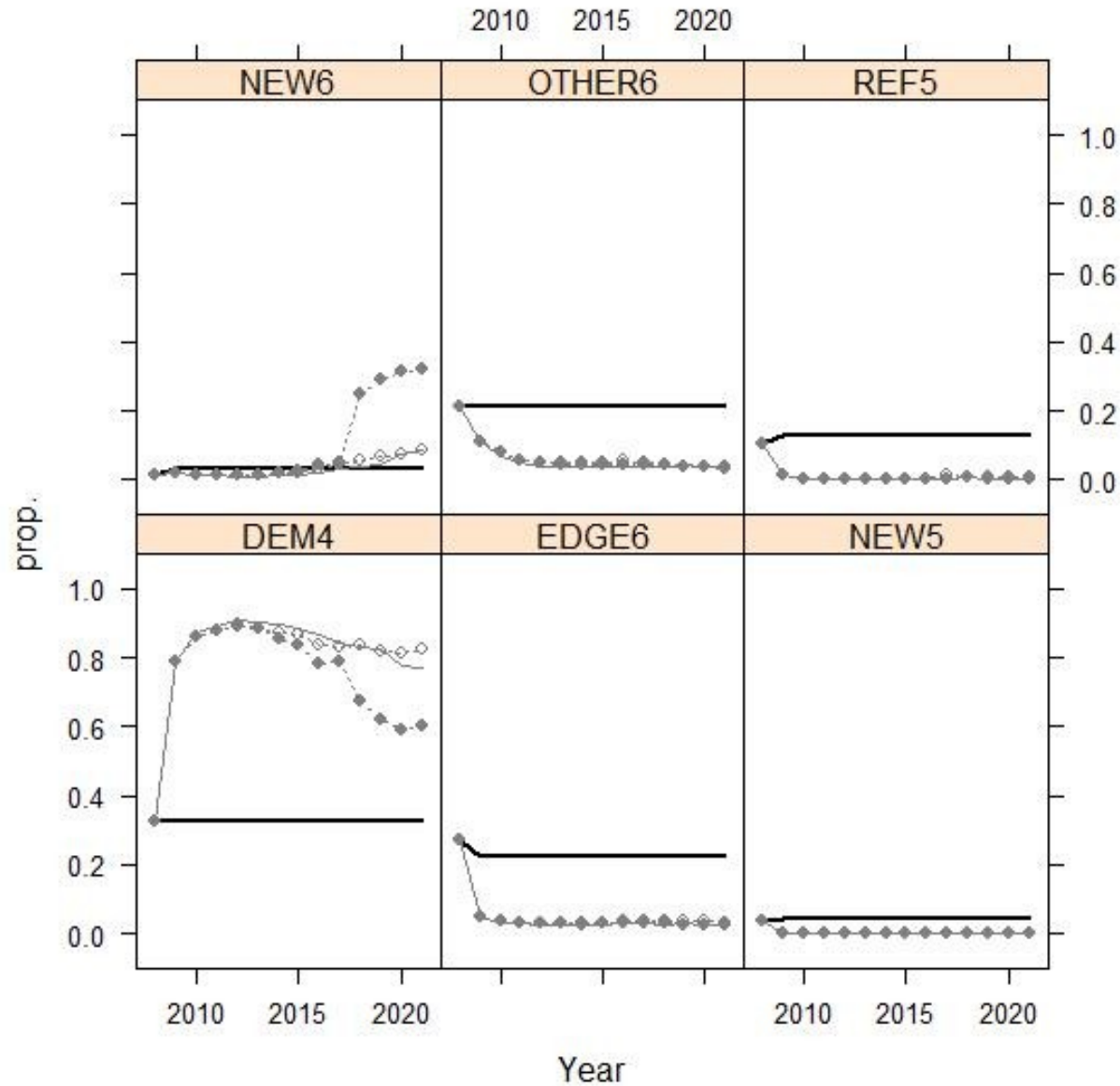
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