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Investigating tradeoffs in alternative catch share systems with a vessel-based bio-economic model.

Manuel Bellanger*, Claire Macher, Mathieu Merzéréaud, Olivier Guyader, Christelle Le Grand.

Investigating trade-offs in alternative catch share systems: an individual-based bio-economic model applied to the Bay of Biscay sole fishery. 2018. **CJFAS** (*in press*)

**** Ifremer, UMR 6308 Amure***

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Background

- Catch share designs: ITQs, collective catch shares (co-management), ...
- Few integrated assessments of different catch share designs across the ecological, economic and social dimensions
- Most bioeconomic models overlook catch share management mechanisms and their constraints on producers at the vessel level

Background

- French quota co-management system implemented in 2006
- Based on producer organizations (POs = groups of fishers that collectively hold rights to manage their members' fishing activities)
- POs are responsible for quota allocation
- Individual fishing allocations are non-transferable
- Most stakeholders opposed to ITQs

Objective

- Develop a bioeconomic model that integrates institutional arrangements related to catch share management and their constraints on producers at the vessel level

- Exploration and comparison of different catch share management options:

Current co-management system implemented in France

ITQ system

Producer organizations and quota management in France

- 6 POs in the Bay of Biscay
- 35 – 800 vessels
- Quota system:

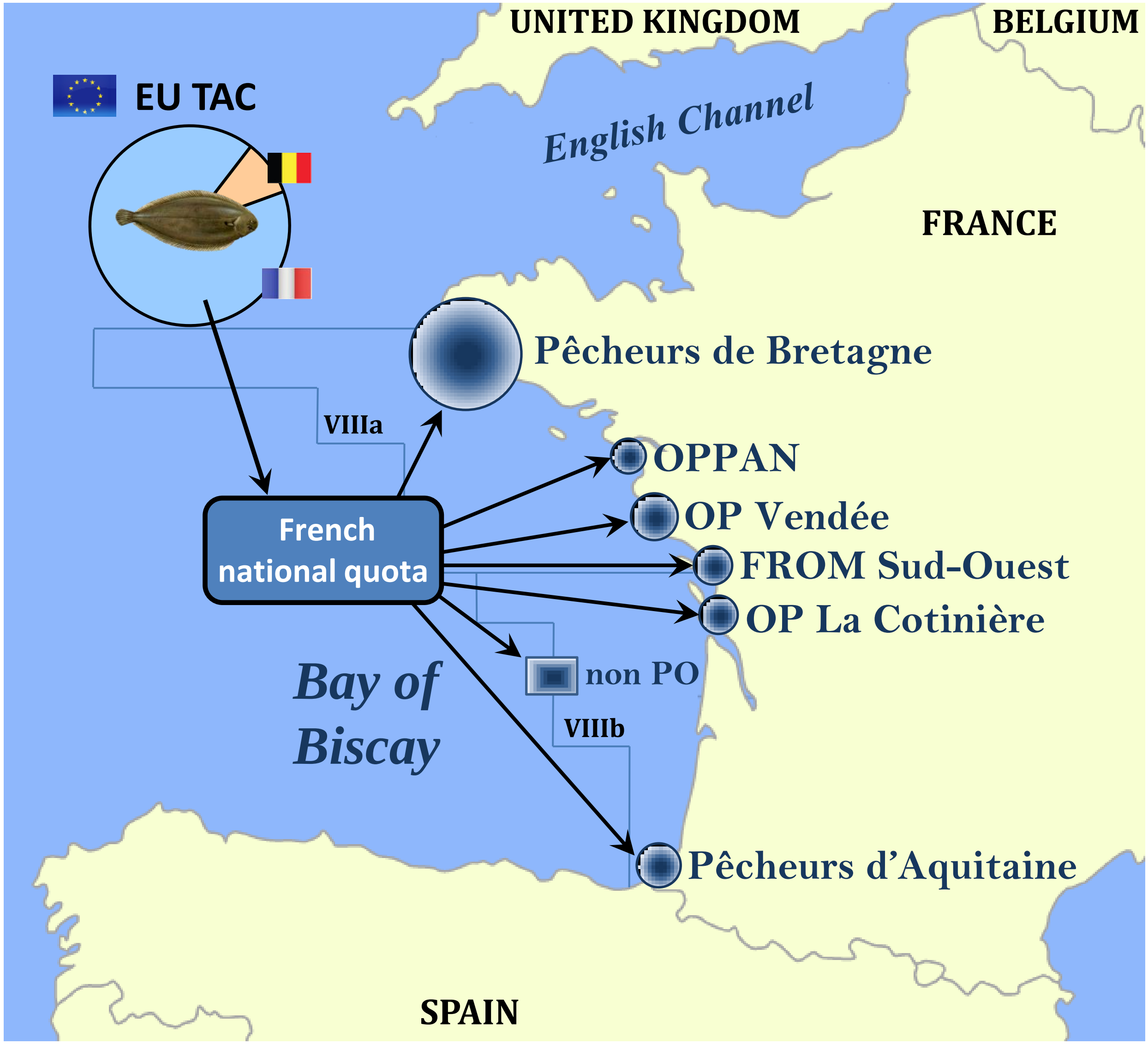
(1) French share is based on a relative stability key

(2) quota share by PO is based on historical landings (2001-2003) of their members

(3) each PO organizes quota redistribution among its members according to self-established rules

quota transfers:

- between POs ✔
- among individuals ✘

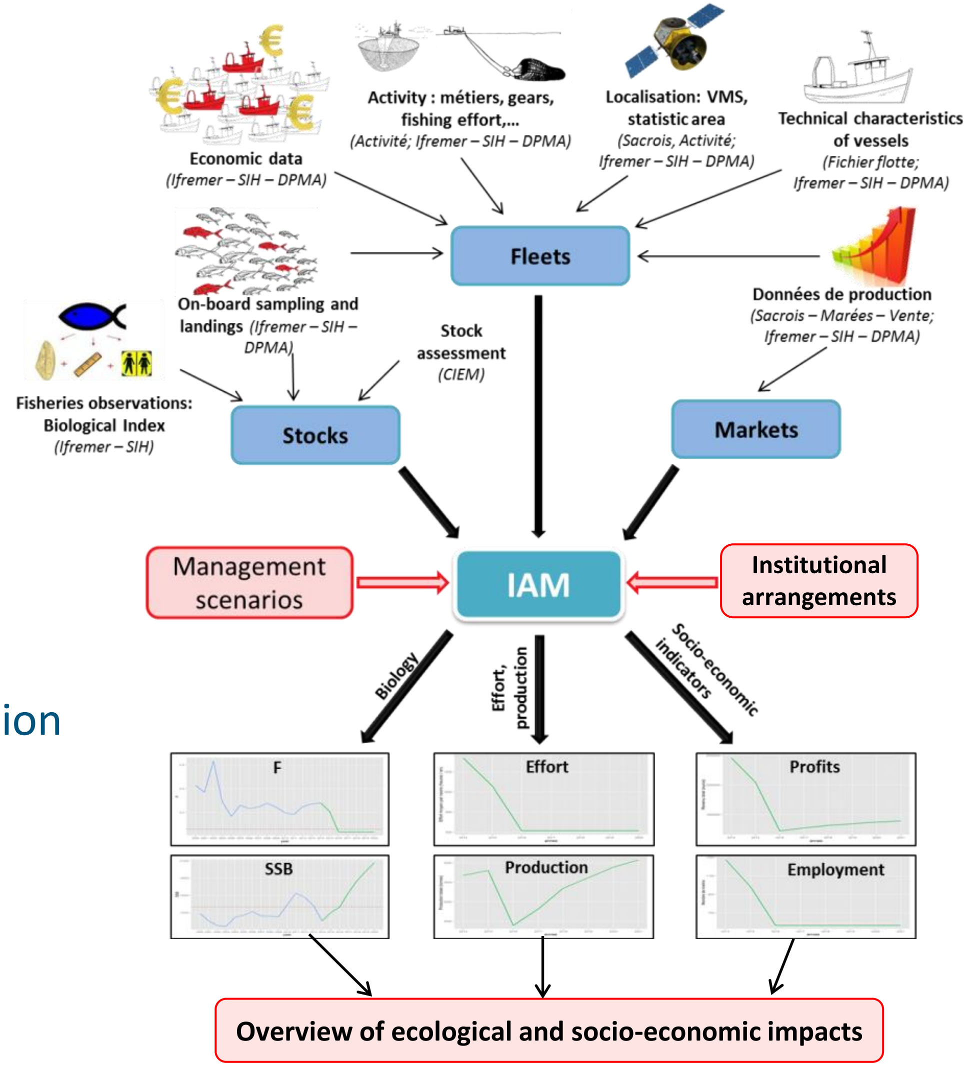


Methods

- Bio-economic model coupled with institutional arrangement model
- Assessment of ecological and socio-economic impacts of options
- Vessel-based, Multi-species, age structured, multi-métier
- Annual time step
- Production function: Baranov equation → interactions between agents

IAM: Impact Assessment Model for Fisheries Management

(Merzéréaud et al., 2011)

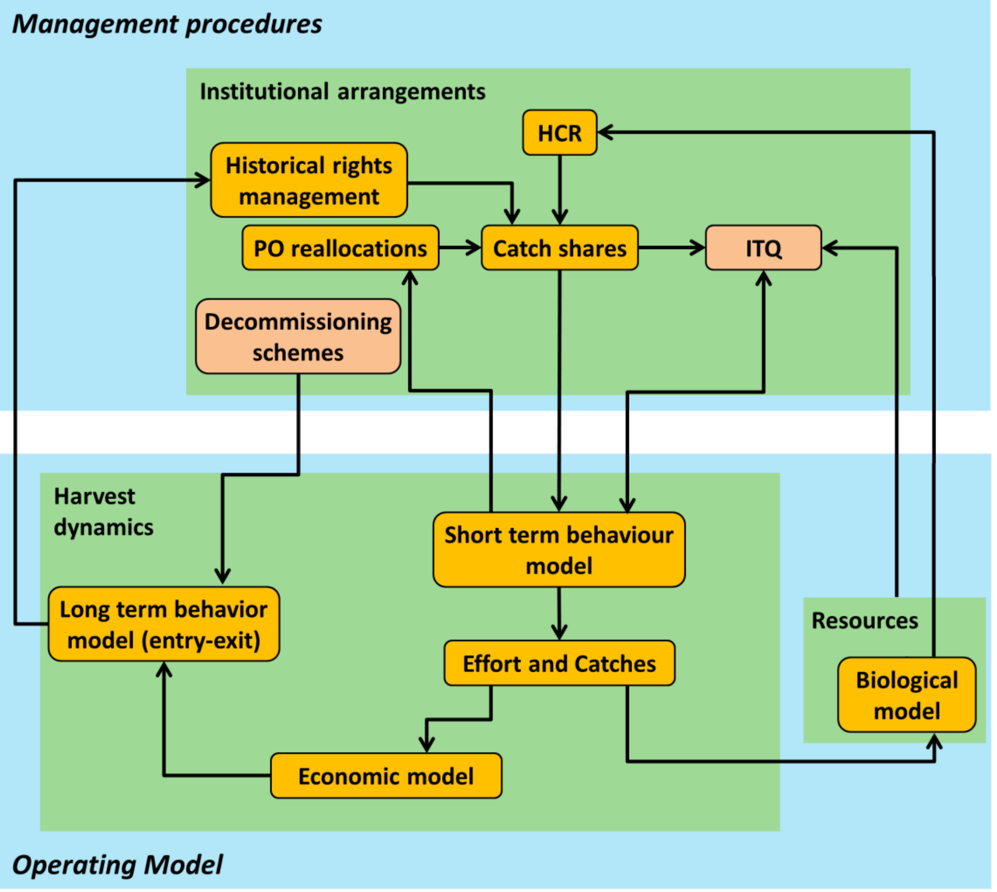


Methods

Bio-economic model: calibrated and validated in previous studies

Macher et al. 2011; Guillen et al. 2013, 2014, 2016; STECF 2011, 2015

IAM: Impact Assessment Model for Fisheries Management

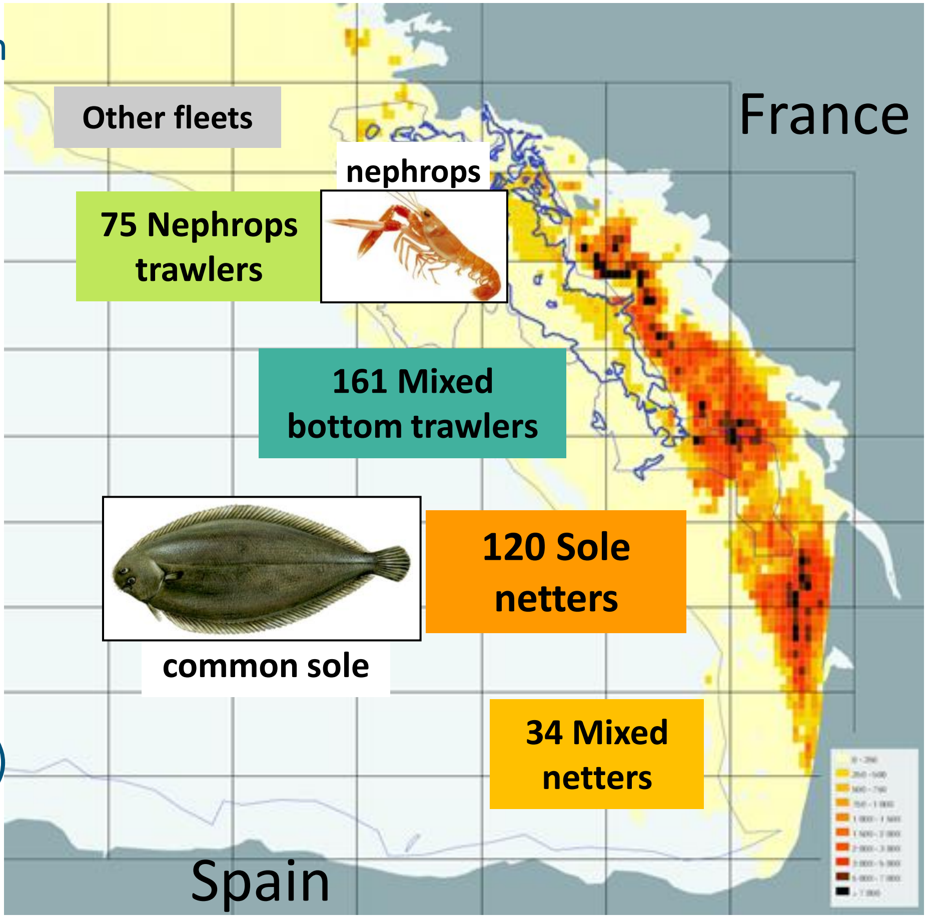


Bellanger et al., 2018

- Integration of institutional arrangements related to catch share management
  - harvest control rule (TAC at MSY)
  - distribution of catch shares (TAC → MS quotas → PO sub-quotas → Individual Quotas)
  - PO allocations / ITQs
- Short term behavior model
- Long term behavior model

The Bay of Biscay sole fishery

- High value fishery
  - ➢ 400 vessels (> 1 Ton), 1280 fishermen
  - ➢ 157 million euros (gross revenue)
- Multi-species fishery
- Multiple fleet segments
  - ➢ netters / trawlers
  - ➢ small-scale / large-scale
- Total Allowable Catch (TAC)
- Multi-annual management plan (MSY)
- Quota co-management by POs
  - ➢ individual quotas (IQs)
  - ➢ various allocation rules



Sole landings (Gepeto project, 2008)

Scenarios

Baseline scenario

- Quota co-management
- POs operate quota distribution
- Individual allocations are non-transferable

Decommissioning scheme scenario

- Quota co-management (similar to baseline scenario)
- Simulation of decommissioning scheme
- Transfer of historical rights of scrapped vessels to reserves

ITQ scenario

- ITQ lease market (leasing in=buying quota; leasing out=selling)
- Sole is the only species that can be traded
- Price and trades of quota depend on marginal profitability

✓ initialization on 2014 data, simulations 2015-2025
✓ Sole and Nephrops biological dynamics
✓ 359 individual vessels
✓ Transition to MSY: yearly TACs set such that $F=FMSY_{sole}$

Results

- Fleet evolution

Baseline scenario
limited decrease in number of vessels

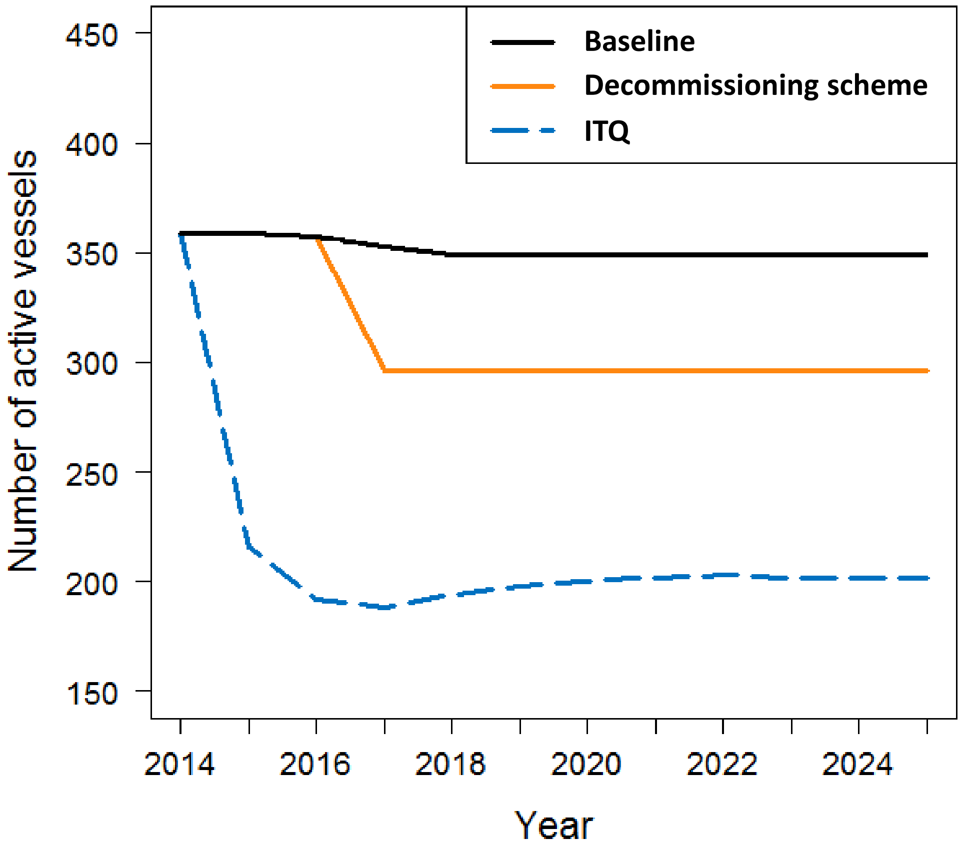
Driver: profitability

Decommissioning scheme scenario
exit of 61 vessels

Driver: net present value of staying vs decommissioning premium

ITQ scenario
Around 40% of vessels leasing out their quota

Driver: marginal profit by kg of sole vs equilibrium price of quota

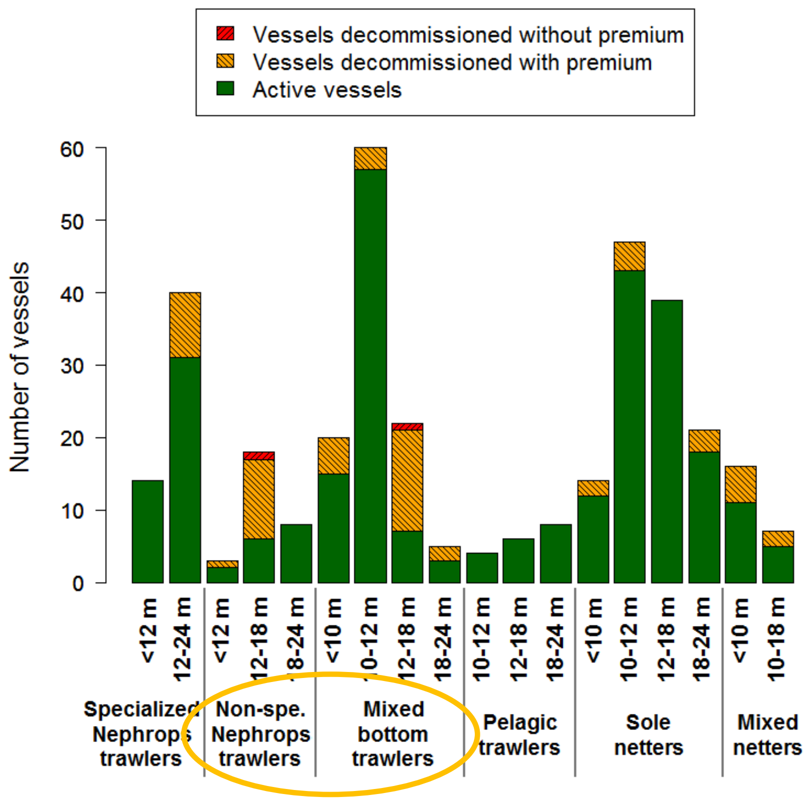


- ✓ initialization on 2014 data, simulations 2015-2025
- ✓ Sole and Nephrops biological dynamics
- ✓ 359 individual vessels
- ✓ Transition to MSY: yearly TACs set such that $F=FMSY_{sole}$

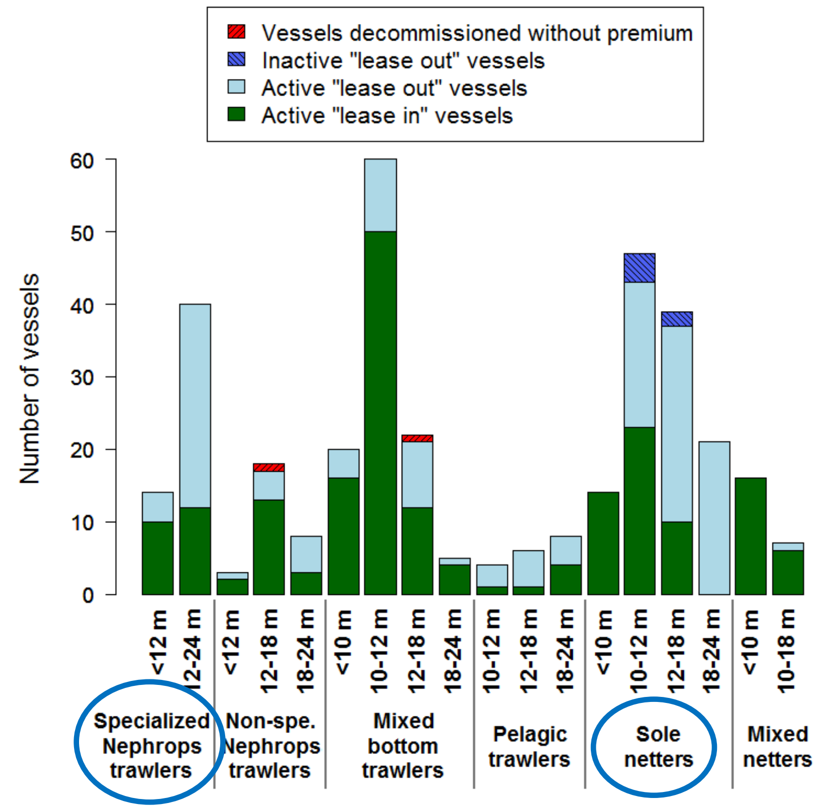
Results

- Changes in fleet structure

Decommissioning scheme scenario



ITQ scenario



Results

- Trade-offs between ecological, economic, and social impacts
  - ➢ effectiveness of decommissioning scheme and ITQ options relative to the baseline

		Indicator	Transition phase (2017)		Long-term impacts (2025)	
			Decommissioning scheme	ITQ	Decommissioning scheme	ITQ
ECOLOGICAL IMPACTS	Impacts on habitats	Fishing effort (h/year)	-10%	36%	-10%	33%
		Trawling energy effort (kWh)	-16%	53%	-15%	52%
	Carbon footprint	Fuel consumption (L/year)	-11%	41%	-11%	38%
	Stock status	SSB sole (t)	0%	0%	0%	-8%
		SSB Nephrops (t)	0%	-3%	5%	-9%
		Landings sole (t)	0%	11%	0%	2%
ECONOMIC IMPACTS	Profits	Gross Operating Surplus (€)	15%	69%	7%	27%
	Economic efficiency	Cumulative net present value of Net Profit (€)			6%	33%
	Economic viability	Gross Operating Surplus > 0 (% vessels)	7%	6%	2%	2%
	Economic inequality	Theil index applied to gross value of landings	-7%	23%	-5%	25%
SOCIAL IMPACTS	Employment	Crew * hours at sea (h/year)	-10%	23%	-10%	18%
	Acceptability	Average yearly wage per crew (€/year)	13%	41%	13%	34%
		Average hourly wage (€/h)	8%	-4%	10%	-4%
		Time at sea (h/year)	7%	35%	6%	30%
		Wage inequality	-12%	94%	-5%	97%

Discussion

- Current co-management arrangements, potentially associated with a decommissioning scheme, favor social acceptability

- ITQs would improve economic situation but may cause social and ecological concerns: increased inequalities, carbon footprint, trawling effort
  - ➢ safeguards on tradability to meet ecological and social objectives

- Added value of integrating POs in the bio-economic model
  - ➢ endogenization of the role played by POs in the management of catch shares
  - ➢ consideration of individual constraints of fishers
  - ➢ enhanced comparability of PO-based co-management systems vs ITQ systems

Future work

- Parameterization of the initial allocation of catch shares
  - allocation rules are not necessarily made public by POs

- Stochatiscity to account for resource variability
  - high demand for computational resources required by the combination of vessel-based modelling and the Baranov catch equation
  - avoid situations where uncertainty makes it impossible to discriminate the impacts of different management measures

Thank you for your attention

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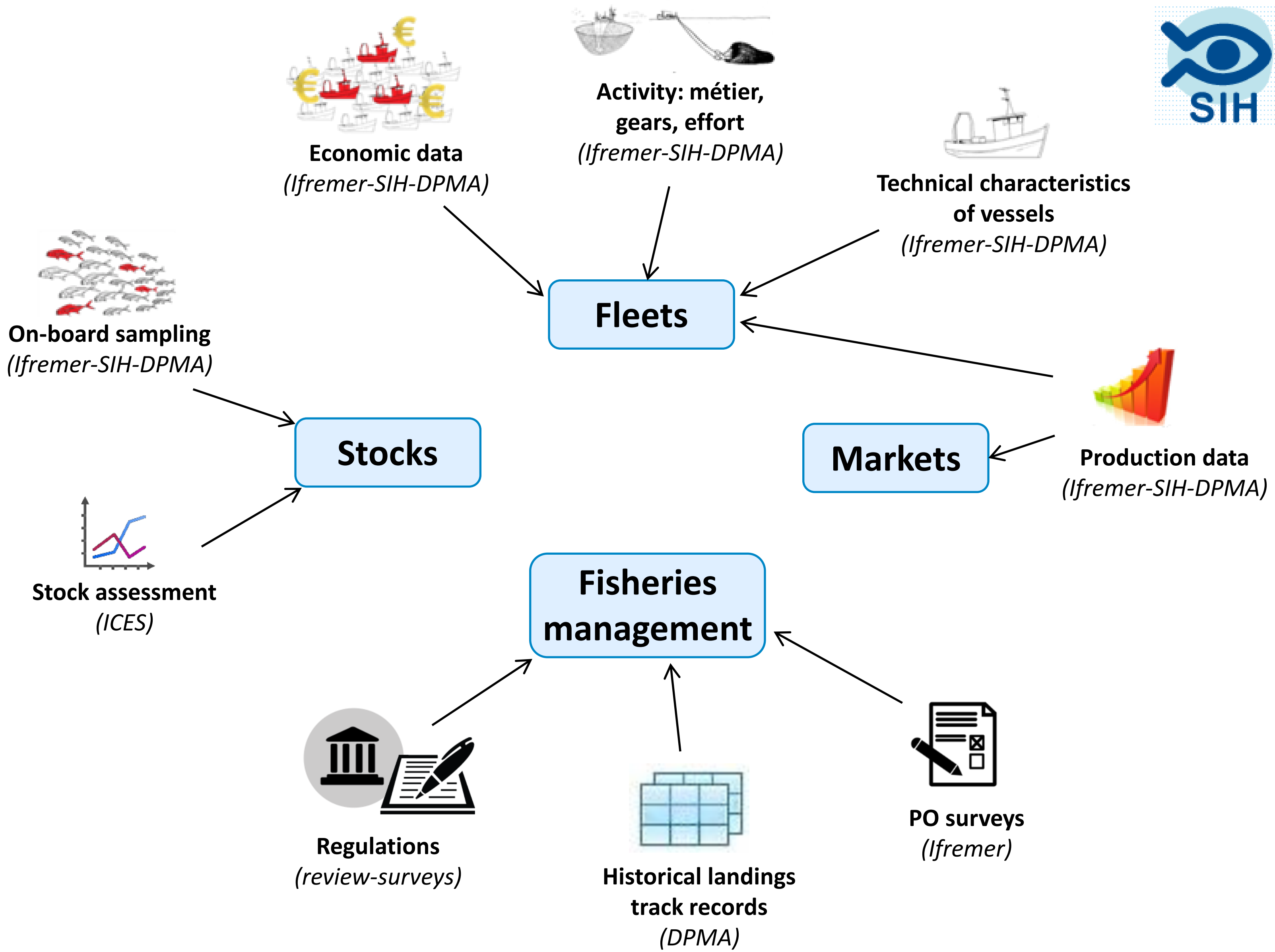
Ifremer

Région BRETAGNE

Backup slides

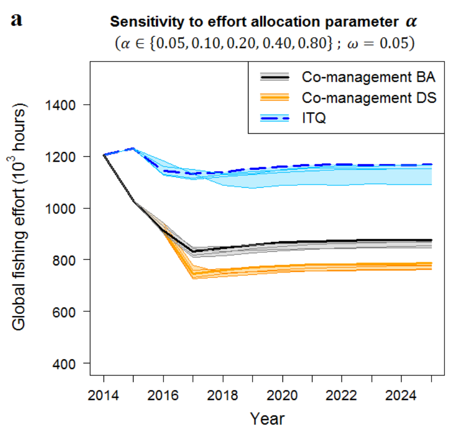
Material

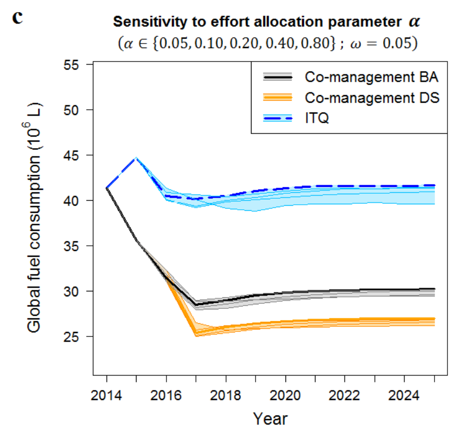


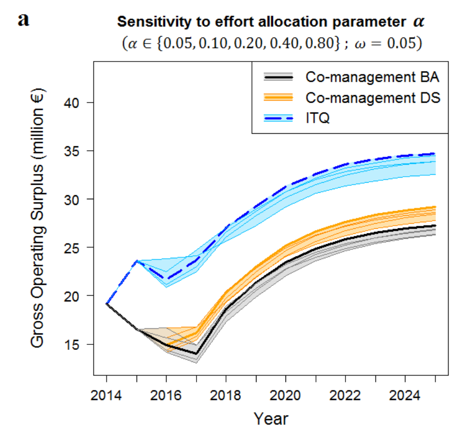
Economic data
(Ifremer-SIH-DPMA)
Activity: métier,
gears, effort
(Ifremer-SIH-DPMA)
Technical characteristics
of vessels
(Ifremer-SIH-DPMA)
SIH
On-board sampling
(Ifremer-SIH-DPMA)
Fleets
Stocks
Markets
Production data
(Ifremer-SIH-DPMA)
Stock assessment
(ICES)
Fisheries
management
Regulations
(review-surveys)
Historical landings
track records
(DPMA)
PO surveys
(Ifremer)

Sensitivity analysis

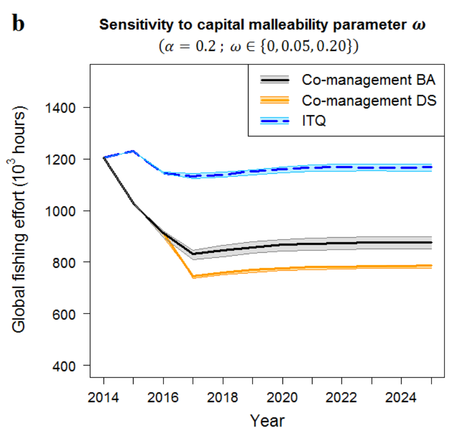
- ➢ short-term dynamics parameters: profit-tradition weight

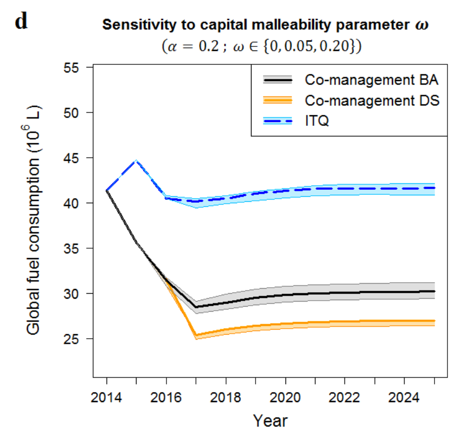


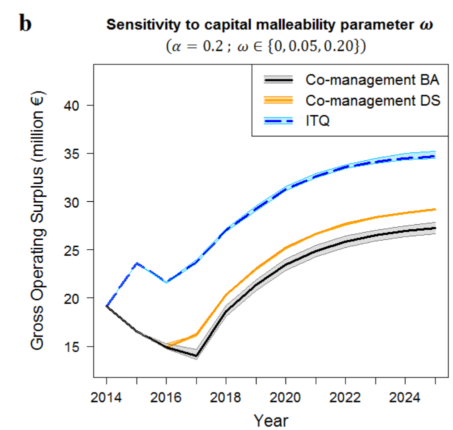




- ➢ long-term dynamics parameters: capital malleability for (dis)investment decisions







Baranov equation

$$C_i = N.\frac{F_i}{\sum_i F_i + M}\left(1 - e^{-(\sum_i F_i + M)}\right)$$