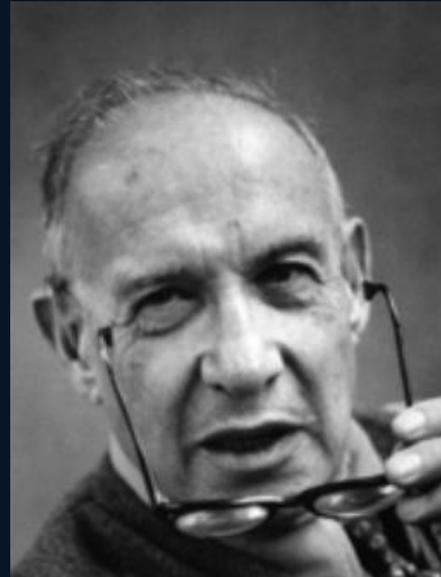


Fishery management from data collection to management plans

The harvest strategy case study in the Adriatic Sea

Dr. G. Scarcella (CNR-IRBIM)



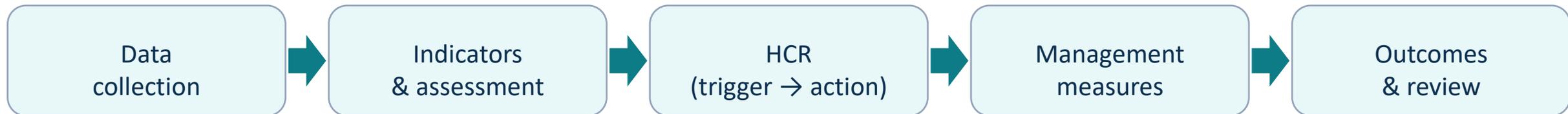
You can't manage what you don't measure.

— Peter Drucker —

“We can manage only what we can measure.”

Why it matters in fisheries

- Clear objectives need measurable indicators (biological, economic, social, ecosystem).
- Data collection turns “concerns” into evidence: trends, status, and uncertainty.
- Harvest strategies link indicators to pre-agreed actions via Harvest Control Rules (HCRs).
- Monitoring closes the loop: evaluate outcomes and adjust when performance is off-track.



Key takeaway: invest in measurement (surveys, logbooks, observers, VMS/ERS, biological sampling) to enable robust, transparent decisions.

Roadmap

From observations → indicators → advice → harvest strategy → management plan

1) Data collection

- Fishery-dependent data (landings, effort, logbooks)
- Fishery-independent surveys (MEDITS / MEDIAS)
- Quality control, standardisation, uncertainty

2) Science-to-policy chain

- Indicators & stock assessment outputs (F, SSB, reference points)
- Management toolbox (input / output / spatial)
- Fleet balance & overcapacity diagnostics

3) Harvest strategies & HCRs

- Objectives, monitoring, reference points
- Harvest Control Rules (HCRs) as decision rules
- Management Strategy Evaluation (MSE)

4) Adriatic case study

- GFCM demersal management plan (GSAs 17–18)
- Effort-based HCRs & biomass safeguards
- Implementation, monitoring, lessons learned

Data collection: what feeds management advice

Fishery-dependent + fishery-independent + compliance & context

Fishery-dependent

- Landings & value (by species, size, port)
- Fishing effort (days at sea, kW·days, gear, area)
- Logbooks, sales notes, VMS/AIS, onboard sampling
- Socio-economic data (costs, profitability)

Strengths: high frequency, broad coverage · Risks: misreporting, changes in behaviour/selectivity



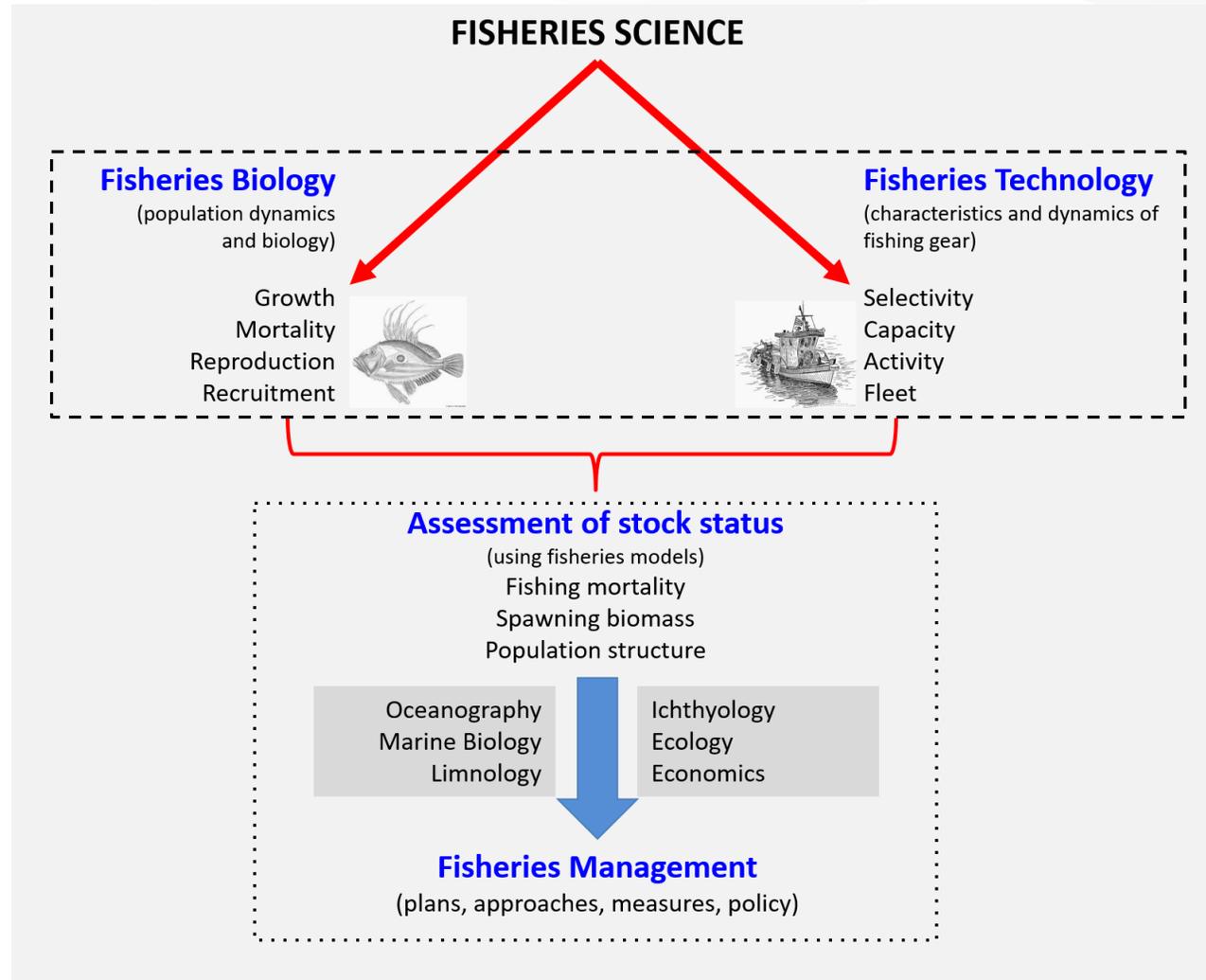
Fishery-independent

- Standardised scientific surveys (e.g., MEDITS, MEDIAS)
- Abundance/biomass indices, spatial distributions
- Biological sampling (length, age, maturity)
- Environmental covariates (temperature, depth, etc.)

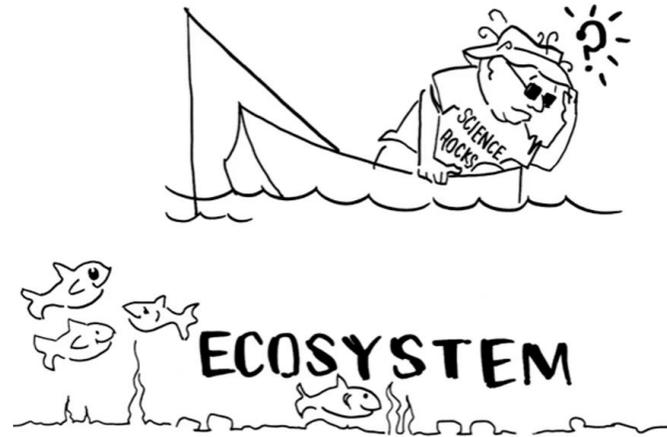
Strengths: controlled design · Limits: cost, timing, gear catchability



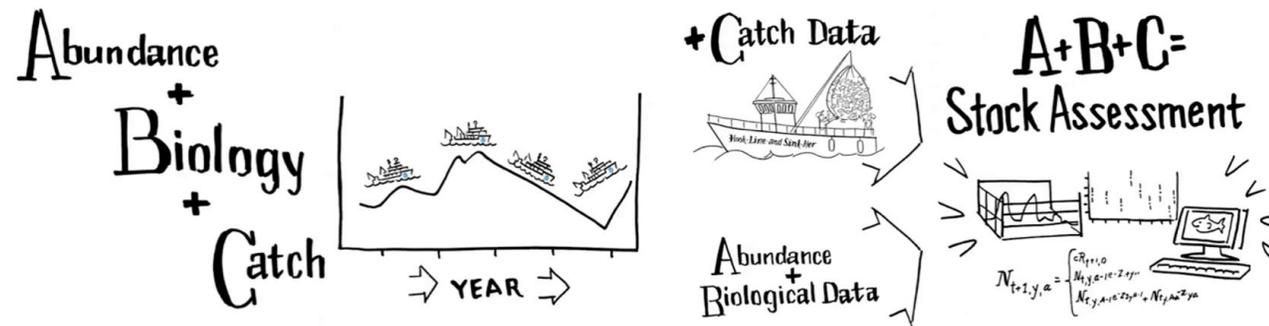
How many fish in the sea?



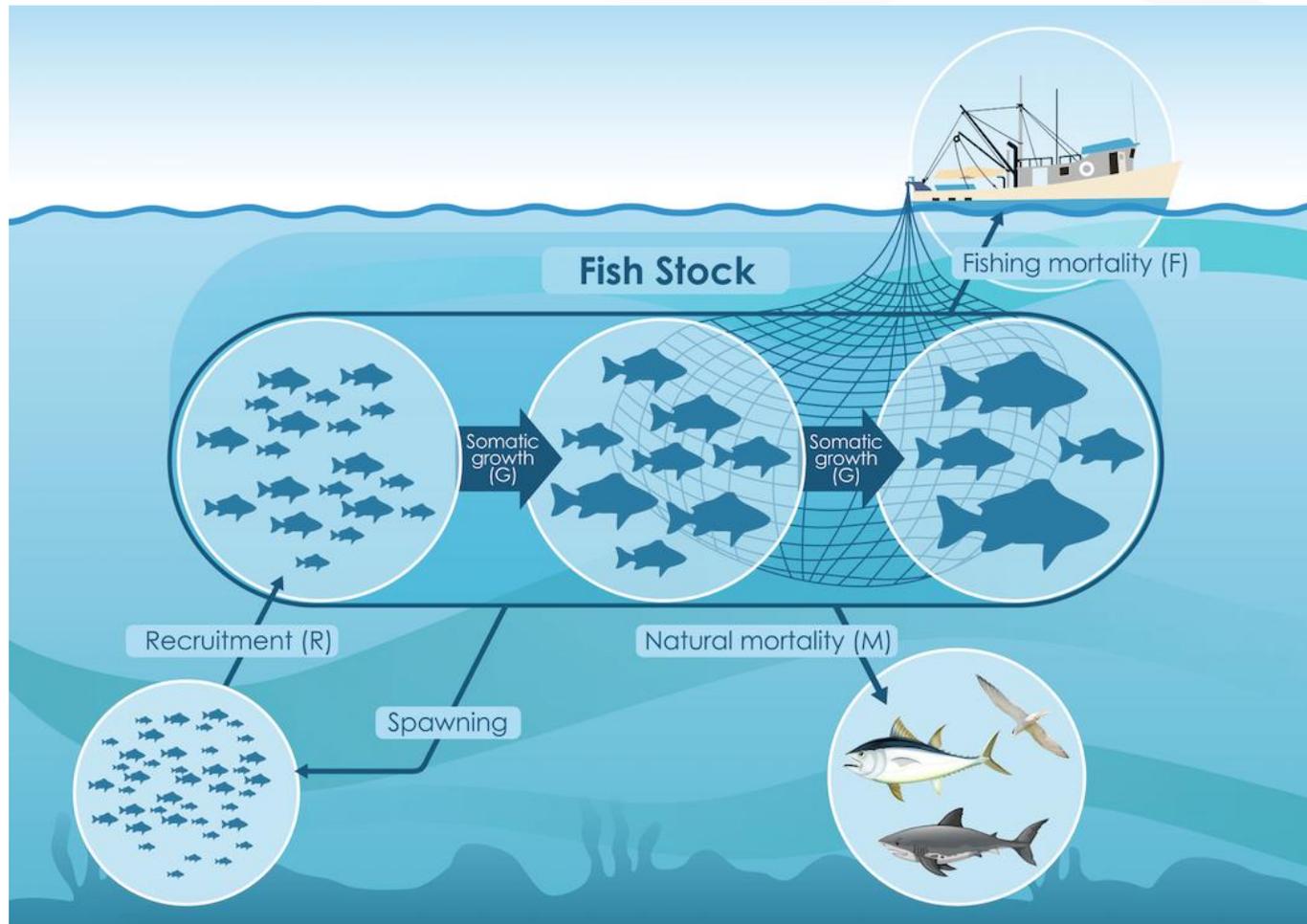
How many fish in the sea?



In reality and in connection to the society and economy, this is the package of stock assessment and ecosystem management



How many fish in the sea?



Population processes used in fisheries biology

Age

Lifespan, longevity and age determination methods

Growth

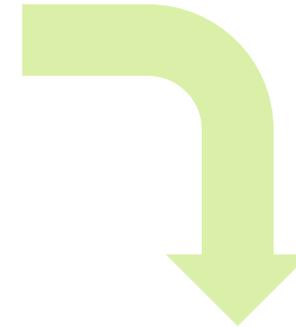
Length-weight relationships, growth parameters, interrelationships and methods

Reproduction

Size at maturity, onset and duration of spawning, fecundity

Mortality

Natural, fishing, total and methods of estimation



1. For studying the biology of marine organisms even of non-commercial ones
2. Assessing the stock status using single-species approach and methods

Usually stock are assessed using **age-based methods** that require the estimation of all biological parameters (**length-weight relationships, growth parameters, length at maturity, natural mortality**) by age or by length, which is then converted to age using an inverse von Bertalanffy equation

Often not available

Age

Lifespan, longevity and age determination methods

Growth

Length-weight relationships, growth parameters, interrelationships and methods

Reproduction

Size at maturity, onset and duration

Mortality

Natural, fishing, total and methods of estimation



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Available data used in fisheries biology

Catches

Landings by species, by year, statistics, discards

Effort

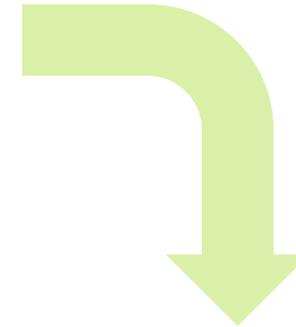
Number of vessels, number of days at sea

CPUE

Abundance data from survey or from commercial data

Expert knowledge

Changes in fishery regulation, resilience of a species



1. To understand the status of a stock in term of Fishing mortality and Biomass
2. To allow management procedures.

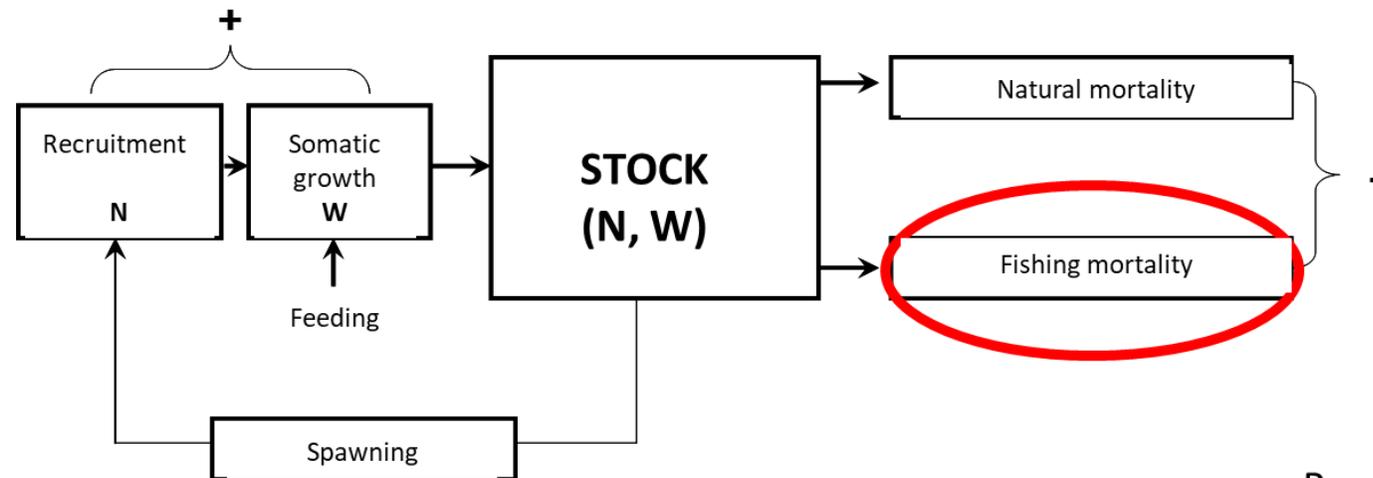
Usually stock can be assess with **production models** that does not require the estimation of all biological parameters by age or by length, but only fishery statistics

MSY and reference points in fisheries

Maximum sustainable yield (**MSY**) is one of the fundamental concepts in fisheries science

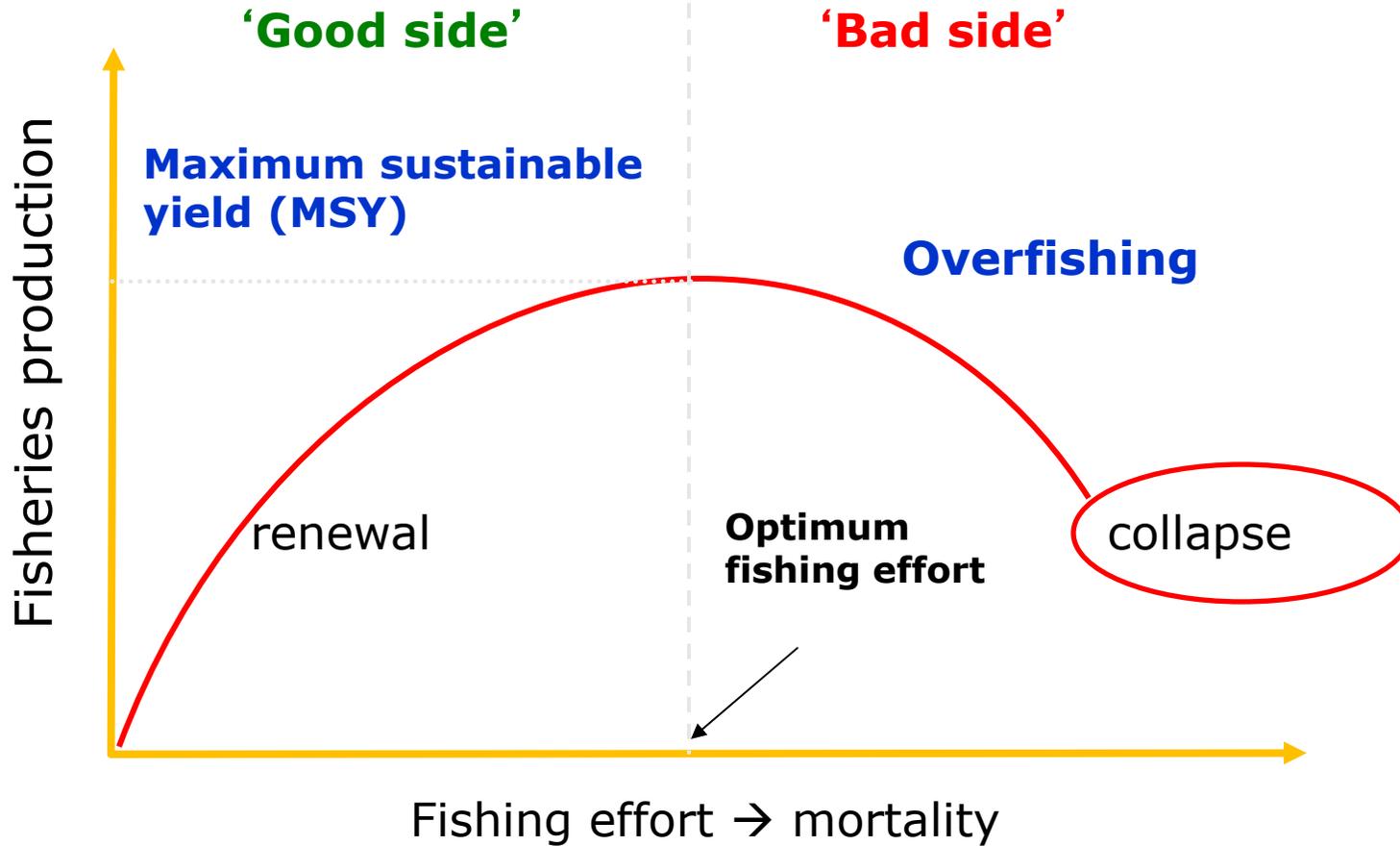
It refers to the removal of the largest possible biomass without risking the collapse of a stock

«Live on the interest and not the capital»



Russell 1931

The classic curve in fisheries science



Fishing effort → mortality

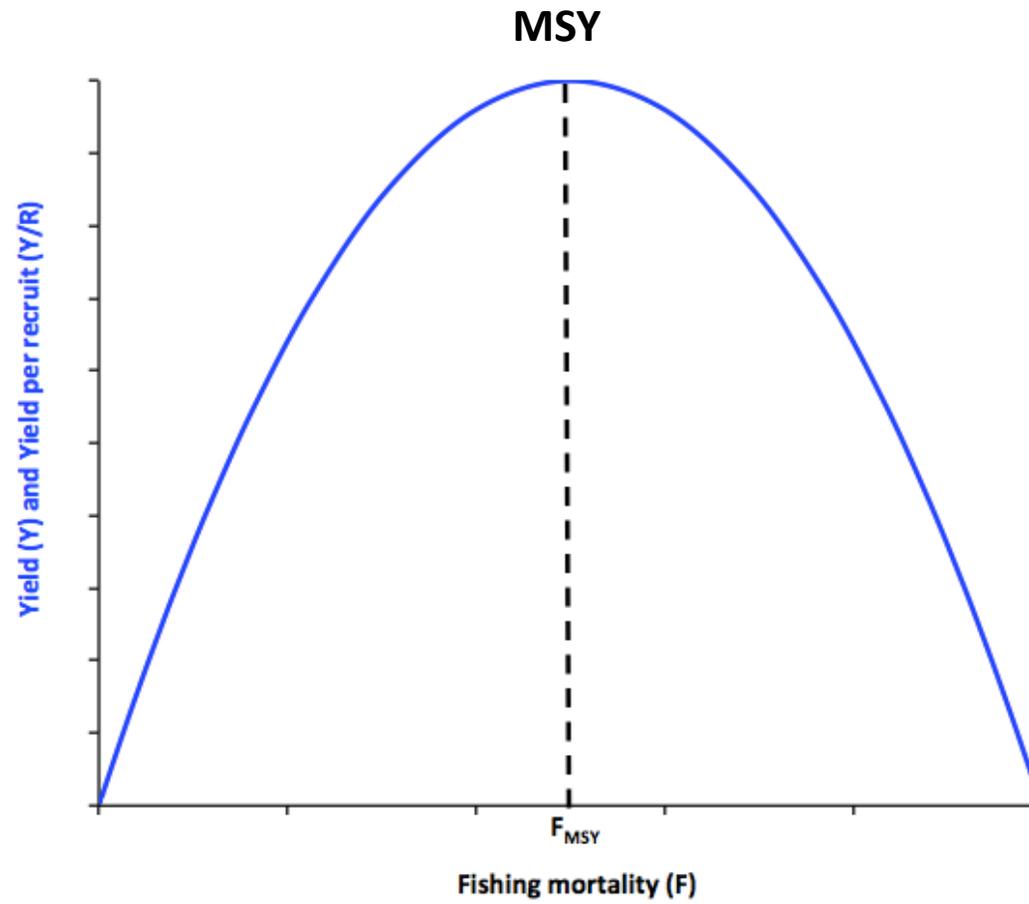


Fishing industry

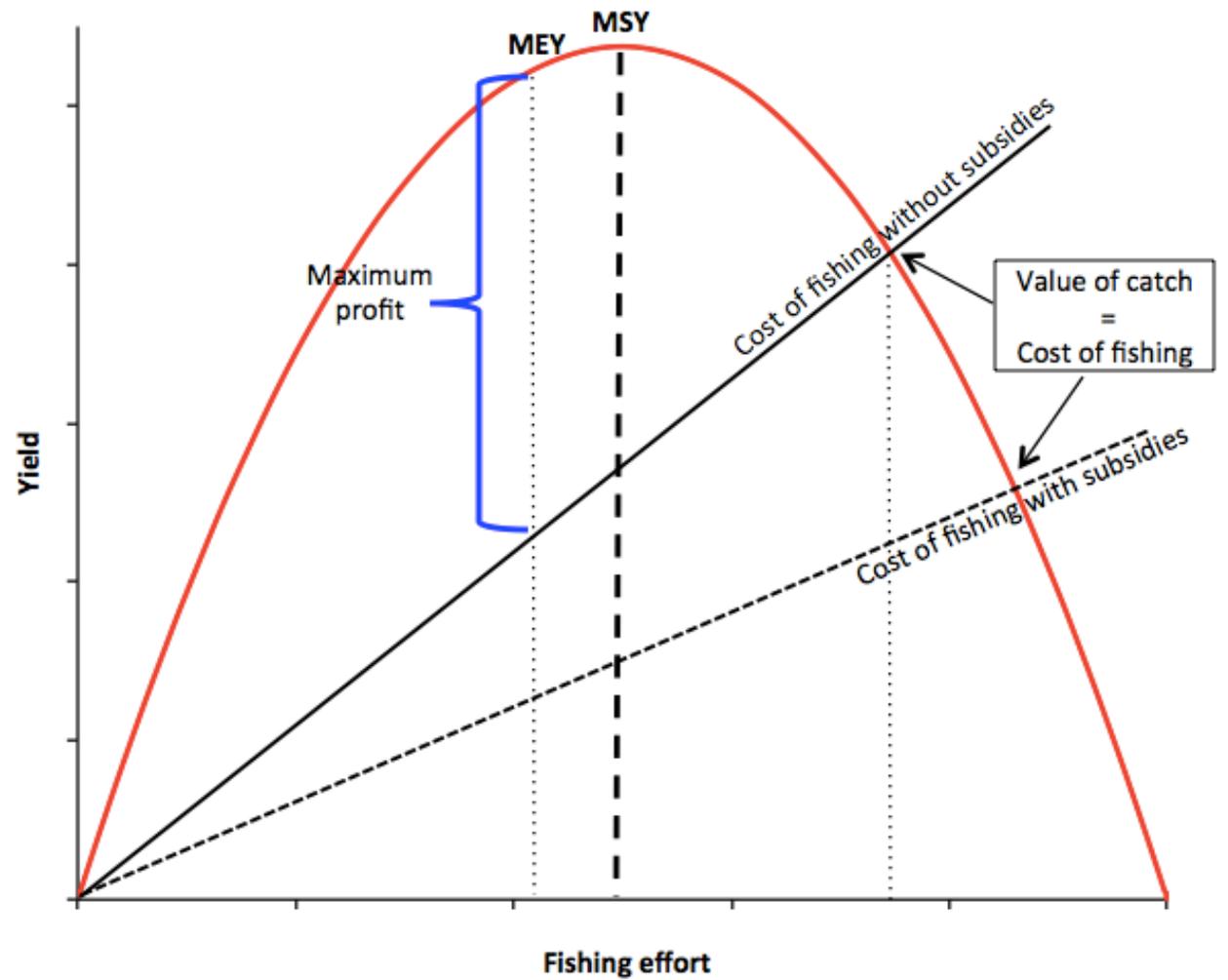
Fisheries Science



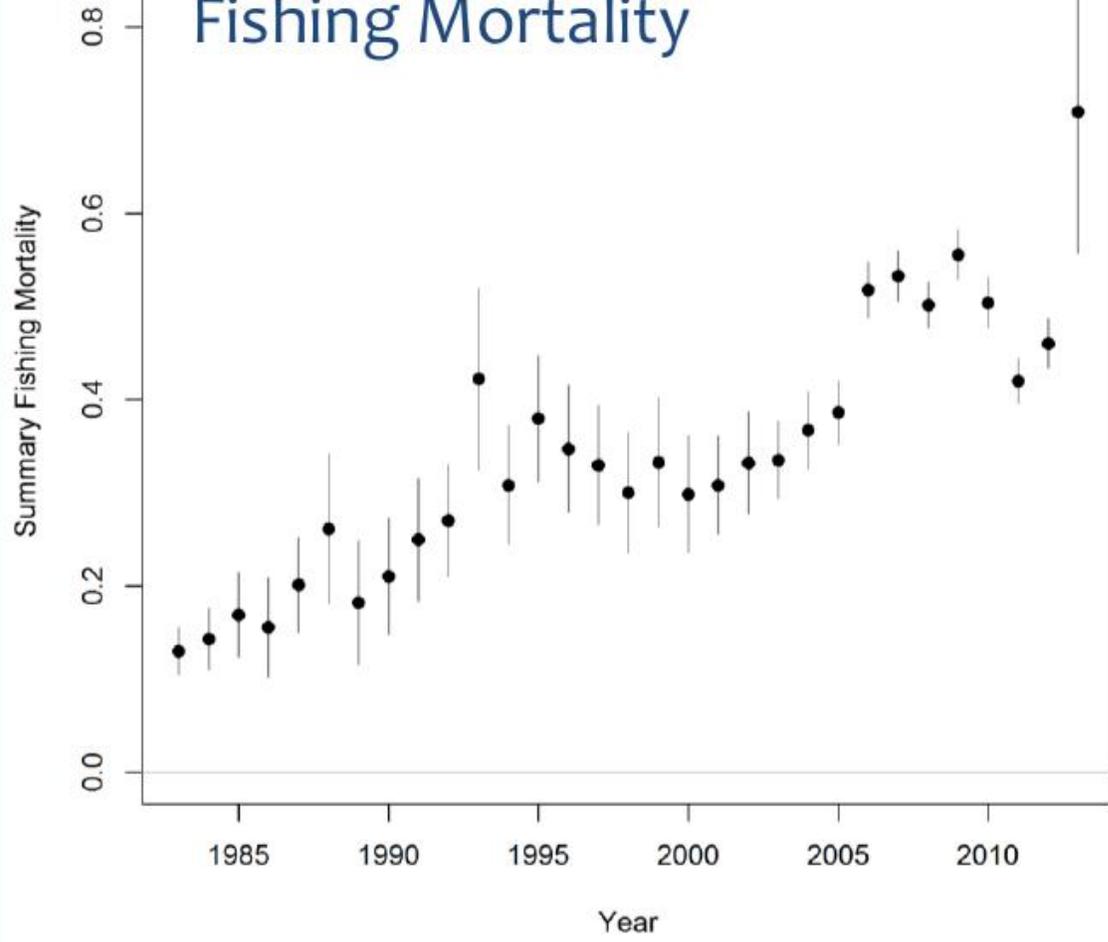
MSY is achieved at intermediate fishing pressure



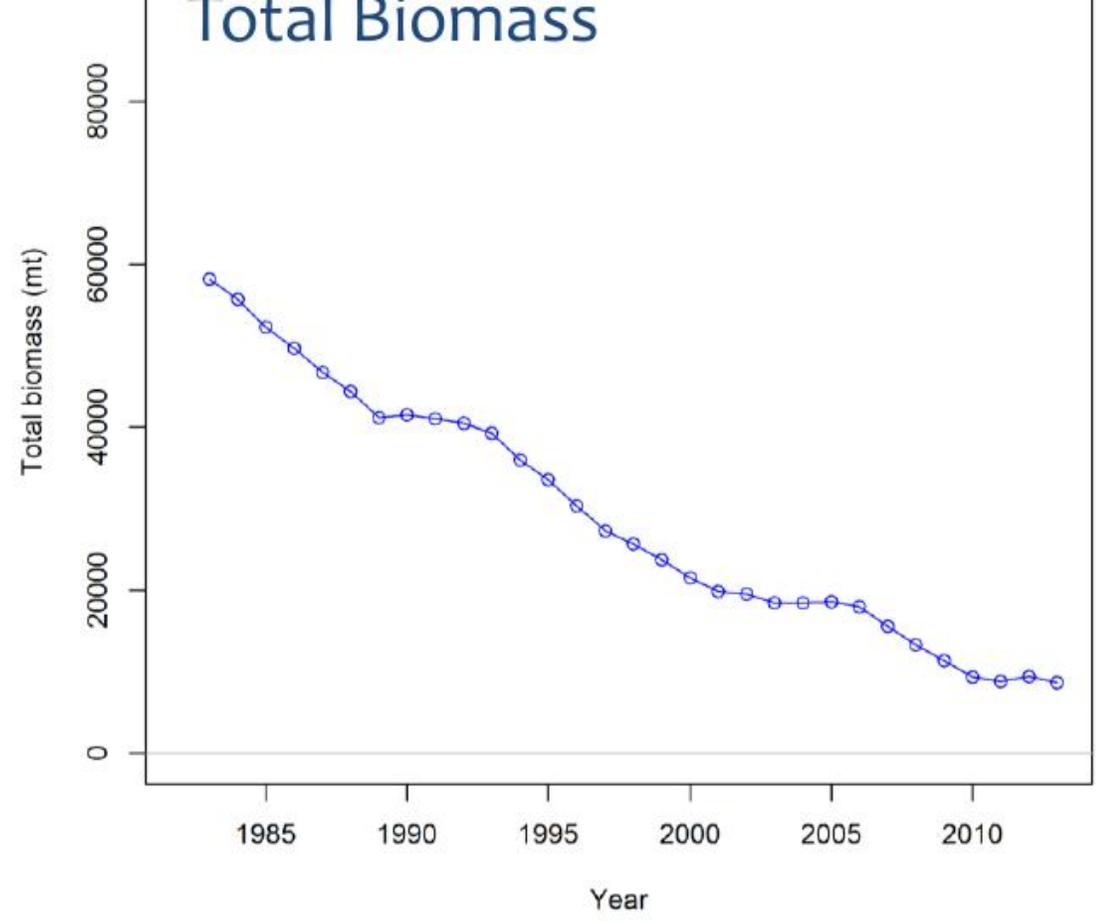
Profit for fishers is also maximized near MSY



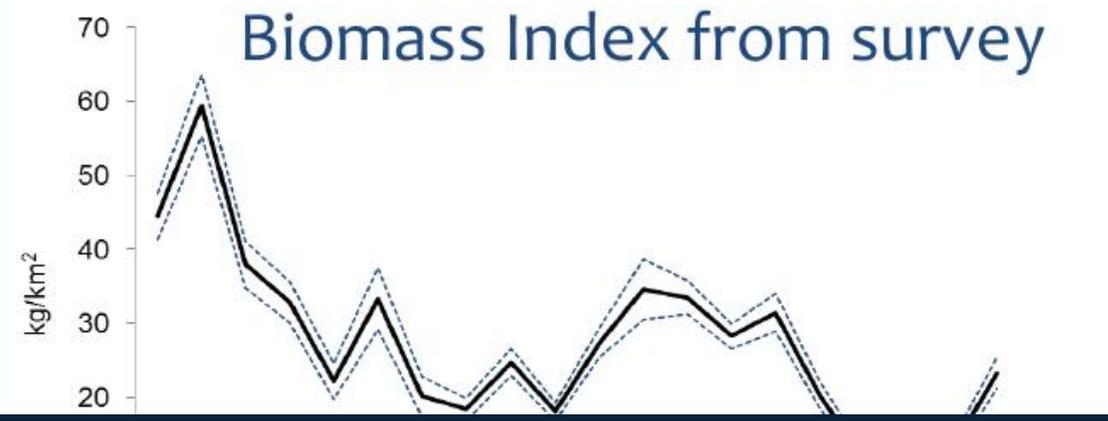
Fishing Mortality



Total Biomass



Biomass Index from survey



Management options

Fisheries are managed by controlling either the INPUT (for example, access to grounds, number of vessels, seasonal closures) or the OUTPUT (for example, catches).

- LIMIT TO NUMBER OF FISHING VESSELS, DIMENSIONS AND POWER (LICENCES)
- LIMIT TO CATCH (TAC)
- TIME CLOSURES (BIOLOGICAL AND TECHNICAL)
- MINIMUM LANDING SIZE
- TECHNICAL MEASURES (GEAR PROPERTIES)
- SPATIAL RESTRICTIONS (COASTAL AREA, MPAs, ARTIFICIAL REEF, Etc.)

Questions & Answers

Q & A

Overcapacity

Background

- Since 2008, there have been **STECF** guidelines on the balance between fishing capacity and fishing opportunities. They were adopted following work by STECF working groups in 2007-2008.
- The guidelines were reworked and become **Commission** Guidelines in 2014: *Guidelines for the analysis of the balance between fishing capacity and fishing opportunities according to Art 22 of Regulation (EU) No 1380/2013 of the European Parliament and the Council on the CFP*. Com(2014) 545 final of 2.9.2014.

The 2014 Guidelines

- *“I do not know what h. is, but I know it when I see it”* said a US Supreme Court judge in 1964. Widely used since in all kind of circumstances, also in fisheries.
- If you replace “h.” by “overcapacity” you will be reading a very common statement used to escape the question.
- The Guidelines are a tool to help MS in analysing the balance between fishing capacity and fishing opportunities and hence of providing an answer to the above lack of definition.
- 3 types of indicators:
 - BIO: SHI and SAR
 - ECO: ROI and CR/BER
 - TECH: Inactive fleet and vessel utilisation

Sustainable Harvest indicator (SHI)

SHI is the weighted (in values) average of the normalized fishing mortalities F^* for all the stocks that are exploited by the fleet and assessed..

An indicator trying to link **Economy** (using values of landings) and **Ecology** (using knowledge on stock status)

Sustainable Harvest indicator (SHI)

Technical aspect

SHI formula :

$$\frac{\sum_{i=1}^{i=n} V_{ir} \frac{F_i}{F_{msy_i}}}{\sum_{i=1}^{i=n} \sum V_{ir}}$$

SHI is the weighted (in values) average of the normalized fishing mortalities F^* for all the stocks that are exploited by the fleet and assessed..

Questions & Answers

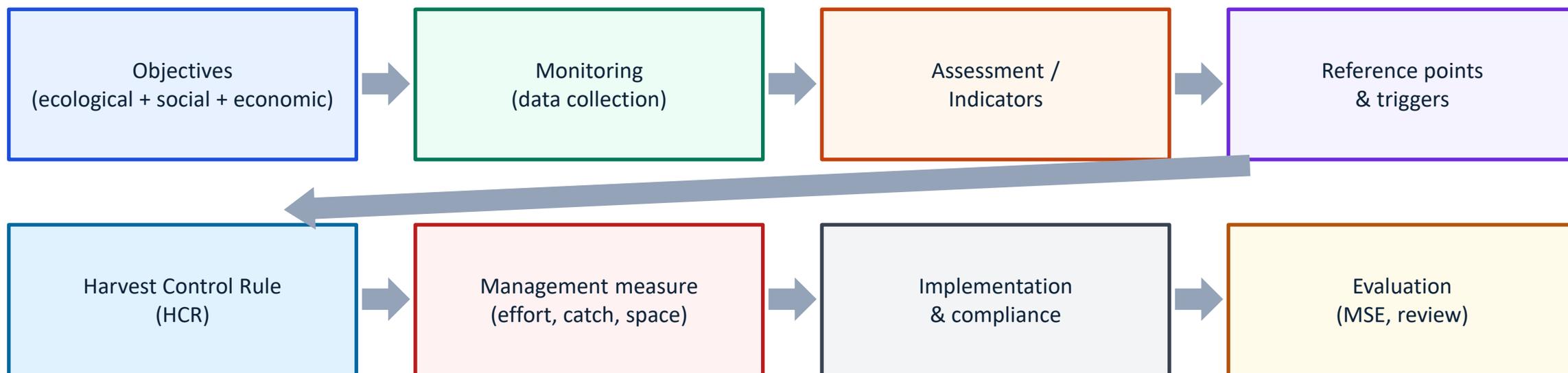
Q & A

What is a harvest strategy?

A pre-agreed framework linking monitoring → decision rules → management actions

Working definition

A harvest strategy is a pre-agreed approach for making management decisions (e.g., setting effort or catch limits) based on indicators of stock/fishery status, designed to achieve explicit objectives under uncertainty.



*Key idea: reduce ad-hoc decisions by agreeing *in advance* how management responds when indicators change.*

Harvest Control Rules (HCRs)

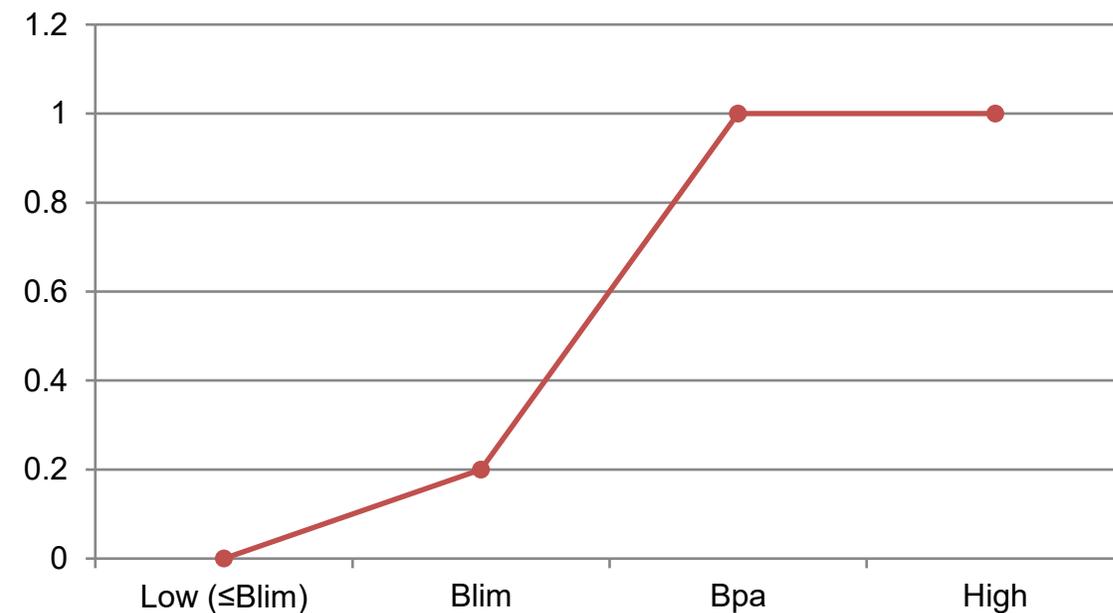
Pre-defined “if-then” rules that adjust fishing pressure based on indicators

Why HCRs?

- Make management predictable & transparent
- Link decisions to objectives and reference points
- Handle uncertainty with safeguards (e.g., biomass triggers)
- Reduce negotiation each year (focus on data + compliance)

Common structure

- Indicator: SSB, F, CPUE, survey index...
- Triggers: Blim, Bpa, target reference point...
- Control action: effort days / TAC / closures / gear rules



Red:
rebuild

Amber:
safeguard

Green:
normal

Note: this is a generic example; real HCRs can use effort, catch, or mixed controls, and may include stability constraints.

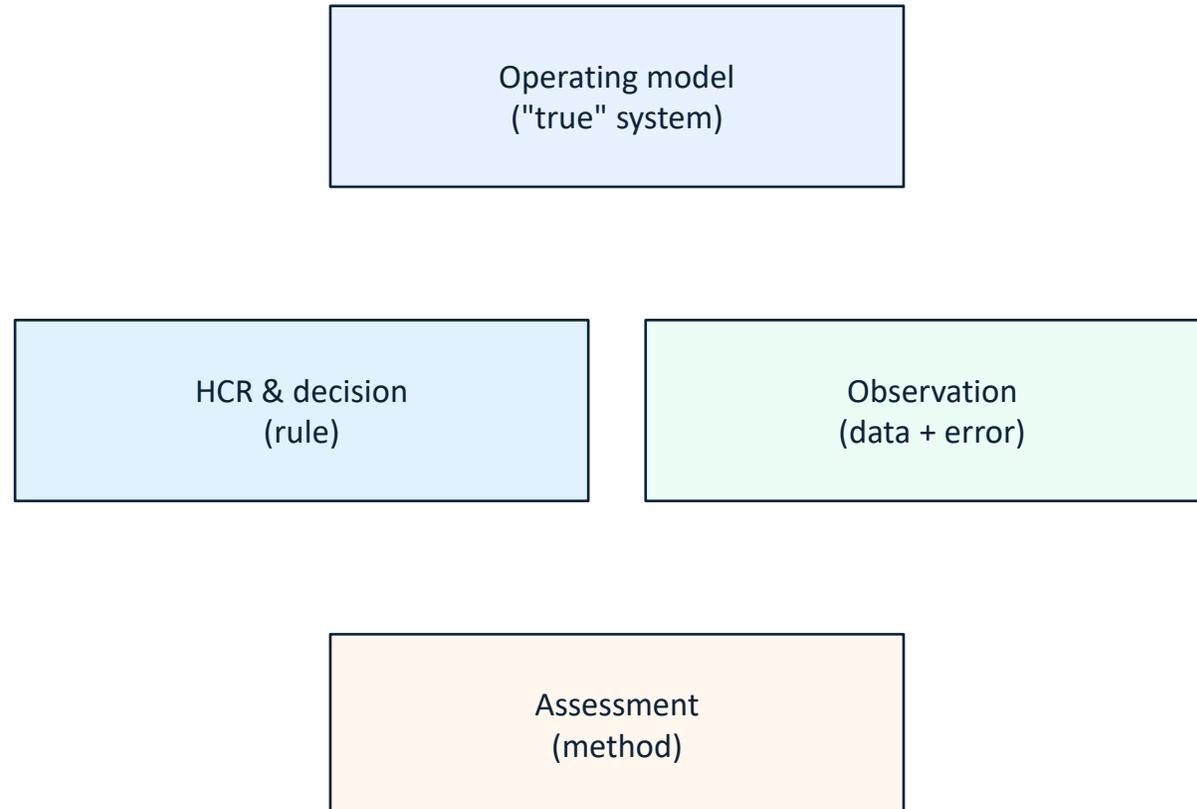
Management Strategy Evaluation (MSE)

Testing harvest strategies in simulation before (and during) implementation

MSE asks: “Will this harvest strategy meet our objectives across plausible futures?”

- Compare candidate HCRs/management measures under uncertainty (recruitment, catchability, compliance, climate)
- Evaluate trade-offs: rebuilding speed vs stability; yield vs risk; ecosystem vs economics
- Select a robust strategy, then monitor & revise as evidence accumulates

Performance metrics: probability($SSB < Blim$), long-term yield, interannual variability, bycatch, profits, distributional impacts



Questions & Answers

Q & A

GFCM Adriatic Demersal Management Plan

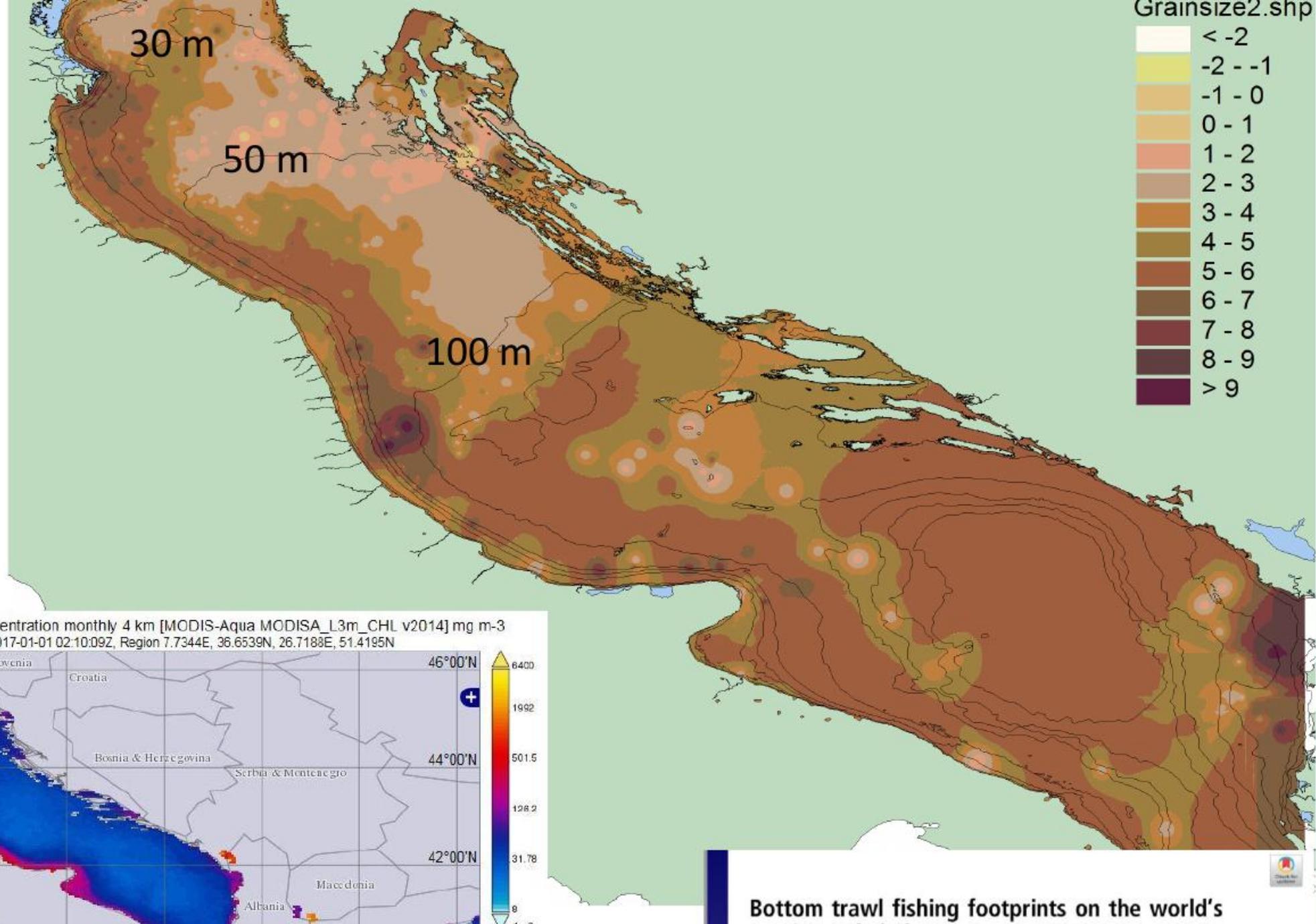
How the effort-based Harvest Control Rules (HCRs) are working (2020–2026)



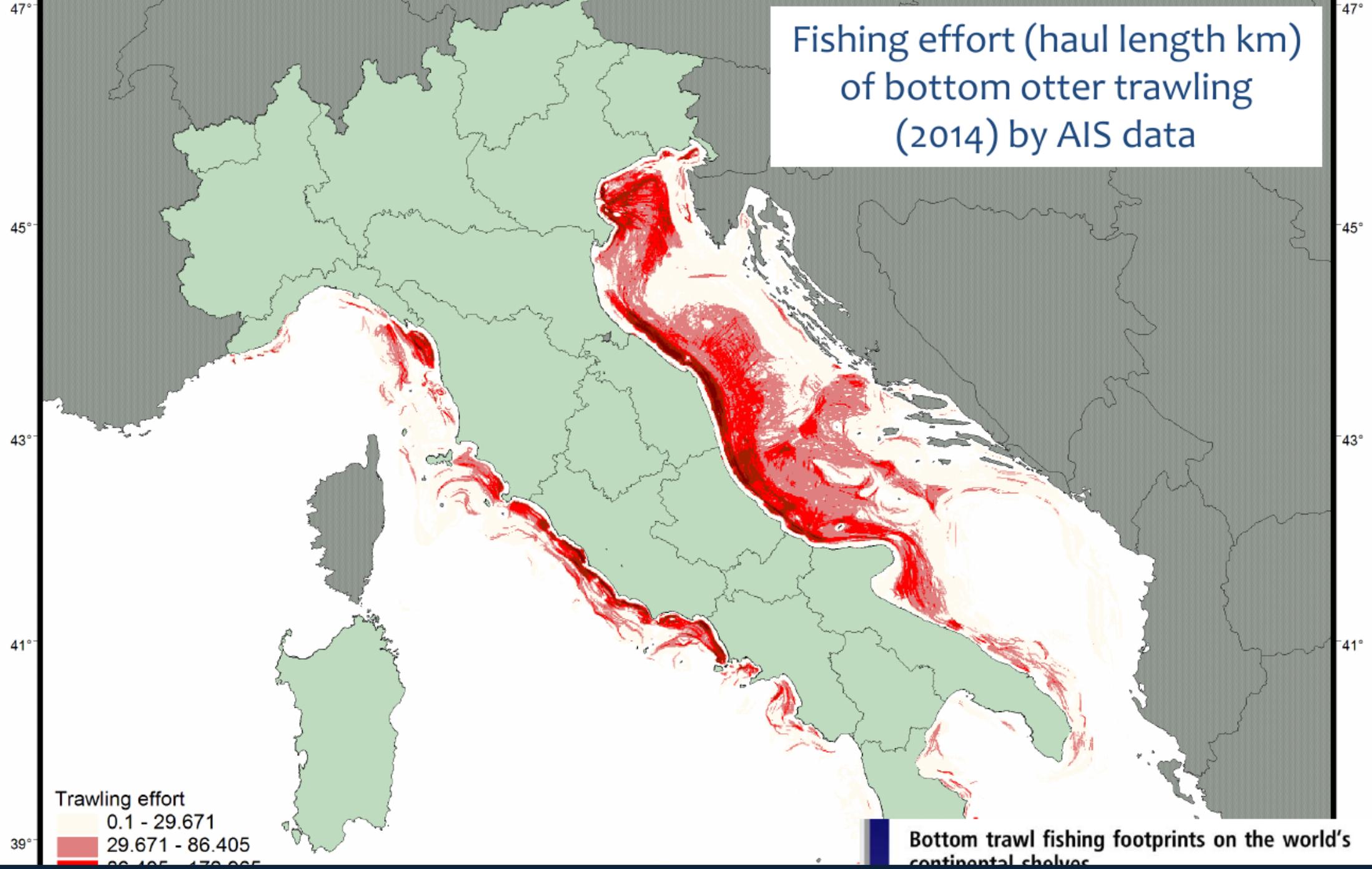
Adriatic Sea (GSAs 17–18)

General Fisheries Commission for the Mediterranean (GFCM)

- soft bottoms
- shallow water
- surface 12-24°C
- 1/3 Med. fresh water
- water
- low salinity
- high production



Fishing effort (haul length km) of bottom otter trawling (2014) by AIS data



Adriatic, fishery resource distribution and **geopolitical asset** have led to the identification of the two management units, called Geographical SubAreas (GSA)

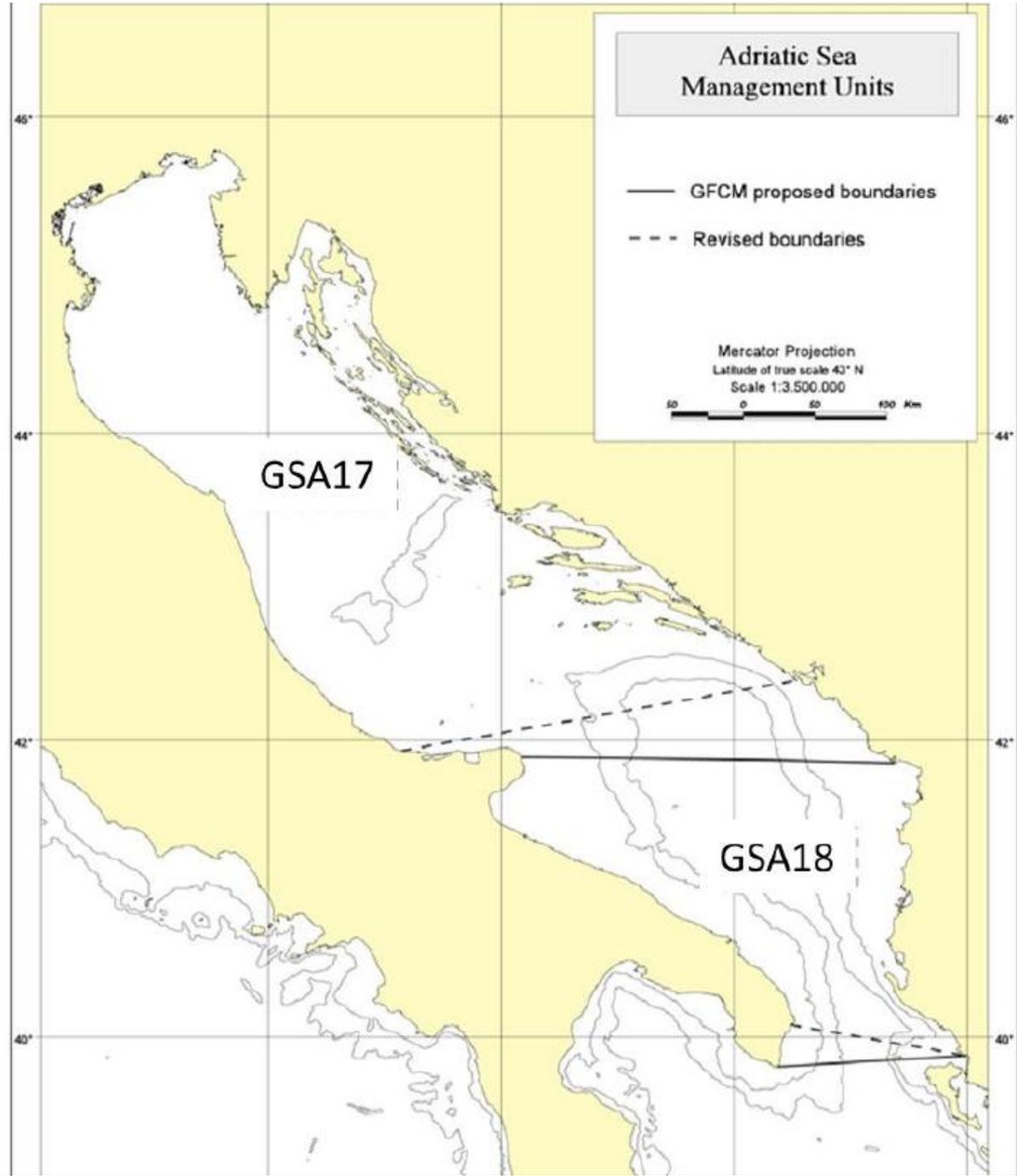
General Fisheries Commission for the Mediterranean (GFCM)

- [Home](#) [Background](#) [Activities](#) [Decisions](#) [Meetings](#) [Reports](#) [Publications](#) [Data & Information](#) [News](#) [Links](#)

Data & Info > [GSAs](#)

Geographical subareas (GSAs)

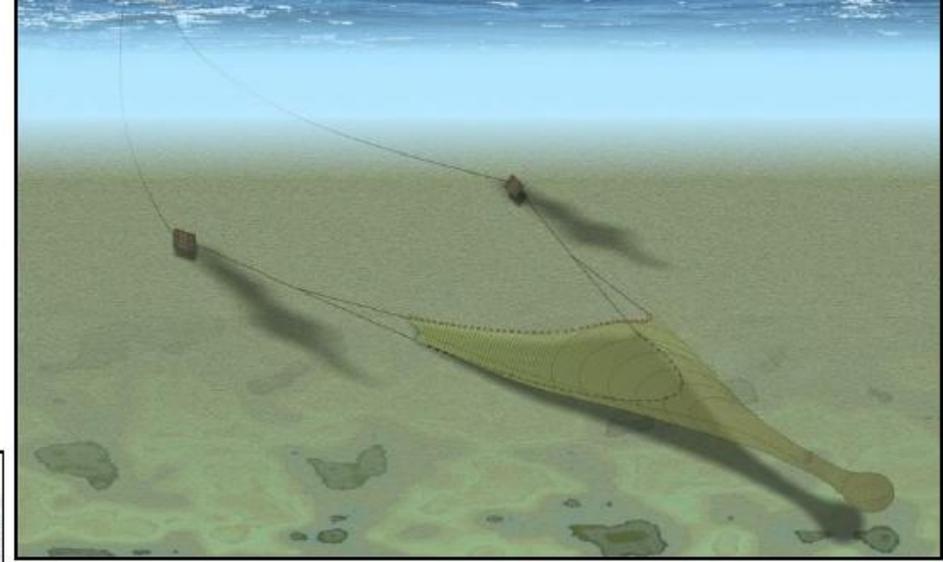
- | | |
|---|--------------------------|
| 1 Northern Alboran Sea | 16 Southern Sicily |
| 2 Alboran Island | 17 Northern Adriatic |
| 3 Southern Alboran Sea | 18 Southern Adriatic Sea |
| 4 Algeria | 19 Western Ionian Sea |
| 5 Balearic Island | 20 Eastern Ionian Sea |
| 6 Northern Spain | 21 Southern Ionian Sea |
| 7 Gulf of Lion | 22 Aegean Sea |
| 8 Corsica | 23 Crete |
| 9 Ligurian Sea and North Tyrrhenian Sea | 24 Northern Levant Sea |
| 10 Southern and Central Tyrrhenian Sea | 25 Cyprus |
| 11.1 Western Sardinia | 26 Southern Levant Sea |
| 11.2 Eastern Sardinia | 27 Eastern Levant Sea |



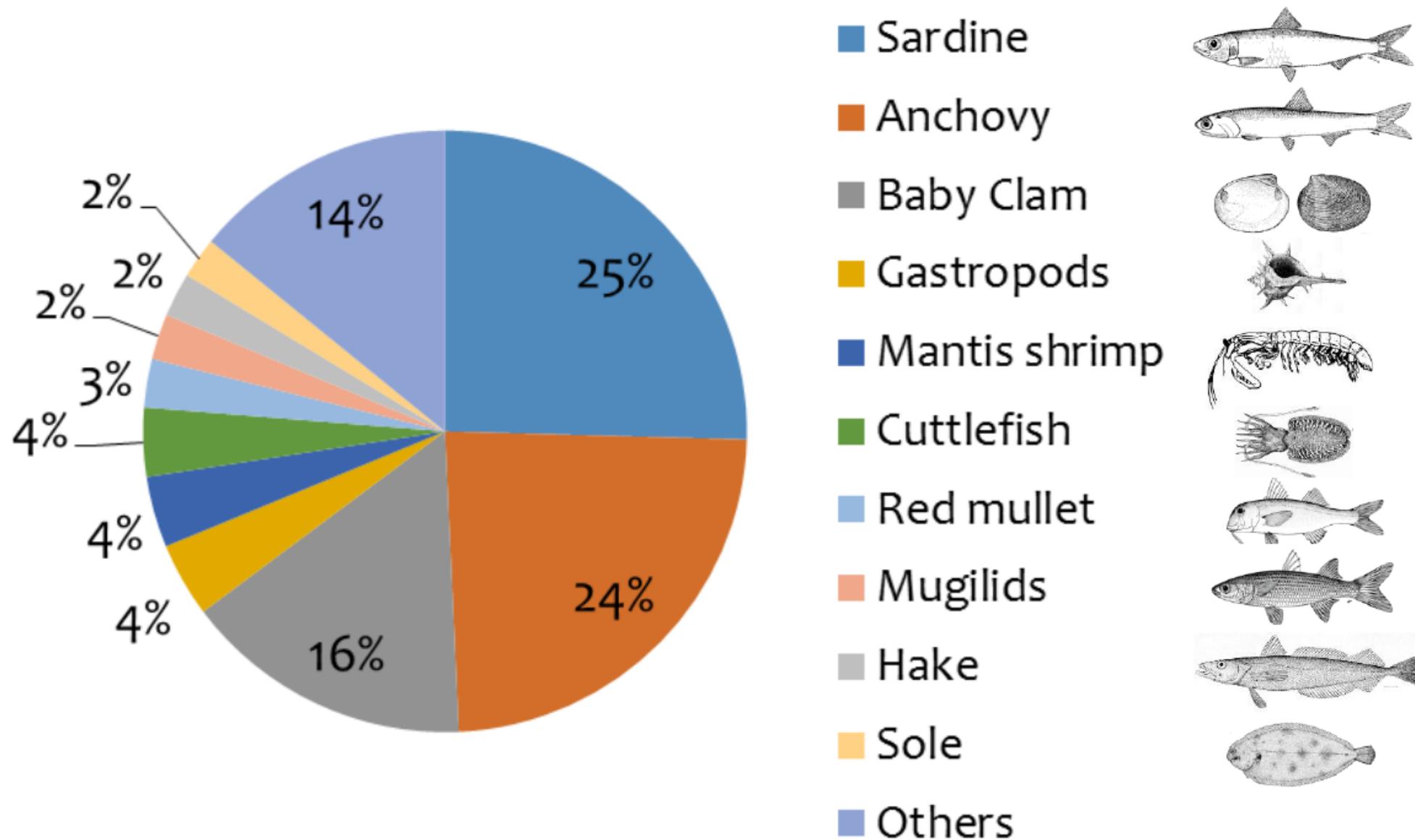
- Surrounding nets (e.g. purse seines)
- Seine nets (beach and boat seines)
- Trawl nets (Otter, Rapido and Pelagic)
- Dredges
- Lift nets
- Cast nets
- Harpoons, spearguns

Passive gears

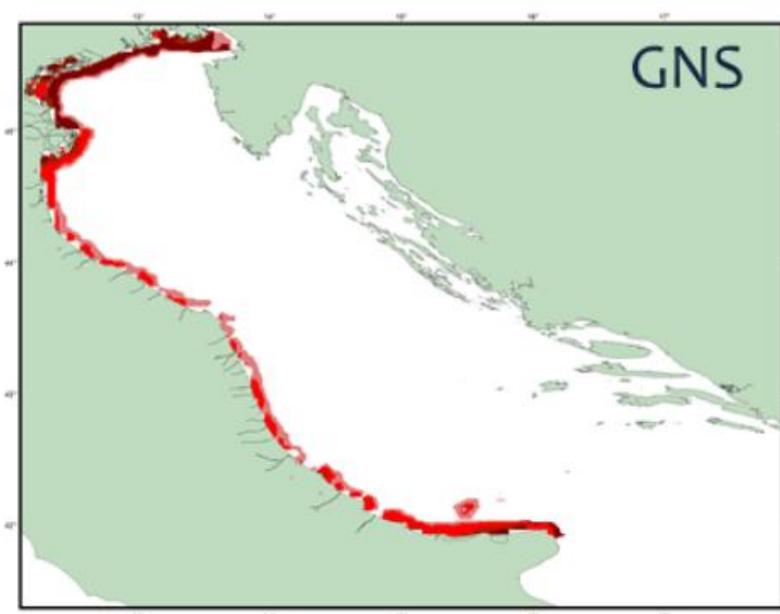
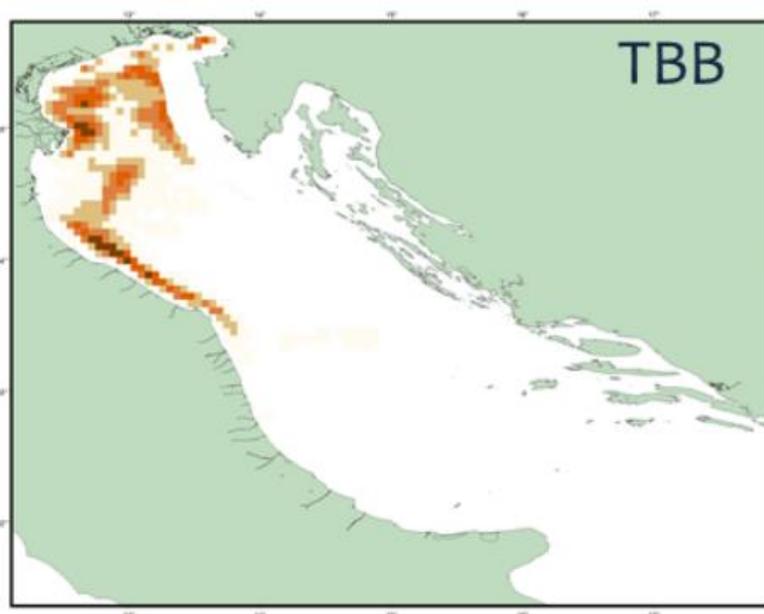
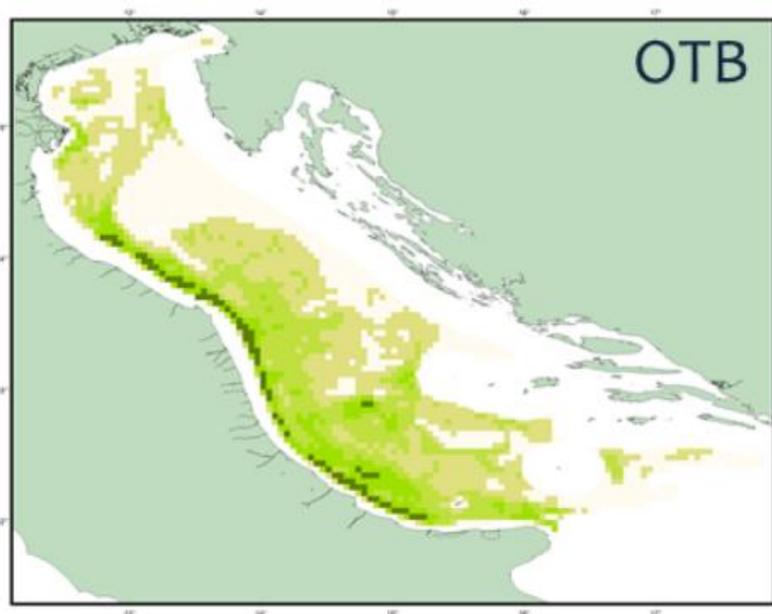
- Gillnets and trammel
- Traps
- Hooks and lines



GSA17 Italian fleet (2015): 89,000 tons



- n. vessels (Loa, GT, kW) using OTB, TBB and GNS per harbour;
- fishing areas (VMS for OTB and TBB, model of Stefanos Kavadas for GNS);
- fuel consumption by vessel type (fishing, navigation and neutral) and price;
- landings, CPUE, assessment and market prices for hake, red mullet, common sole and mantis shrimp;
- spatial distribution of the four target species by survey data (MEDITS and SOLEMON).



Committee on Fisheries (SAC)

during each annual meeting revise the stock assessment and recommendation made by the Working Groups (e.g. demersal, small pelagics, etc.)

General Fisheries Commission for the Mediterranean (GFCM) is the Regional Fisheries Management Organization, its measures can relate for instance to the regulation of fishing methods, fishing gear and minimum landing size, the establishment of open and closed fishing seasons and areas and fishing effort control.

Committee for Fisheries (STEFCF)

The European Commission may consult the group on any matter relating to marine and fisheries biology, fishing gear technology, fisheries economics, fisheries governance, ecosystem effects of



Data Collection Framework (DCF): landings, surveys, etc.

Questions & Answers

Q & A

1) What is the plan, and what does it manage?



Geographical scope: GFCM GSAs 17 & 18

Effort regime applies to towed gears targeting key demersal stocks.

Key stocks in the HCR “basket”

- European hake (*Merluccius merluccius*)
- Red mullet (*Mullus barbatus*)
- Deep-water rose shrimp (*Parapenaeus longirostris*)
- Norway lobster (*Nephrops norvegicus*)
- Common sole (*Solea solea*; GSA 17)

Main effort-controlled gears

Bottom otter trawls (OTB)
Beam trawls (TBB)
(+ included in the plan: PTB & OTT during the transitional regime)

Plan “goalposts”

Reach / maintain fishing mortality consistent with FMSY, with safeguards if spawning biomass falls below B_{pa} or B_{lim} .

2) The effort HCR in plain language



Two-step implementation (built into the HCR design)

2020–2021

Transitional precautionary effort regime

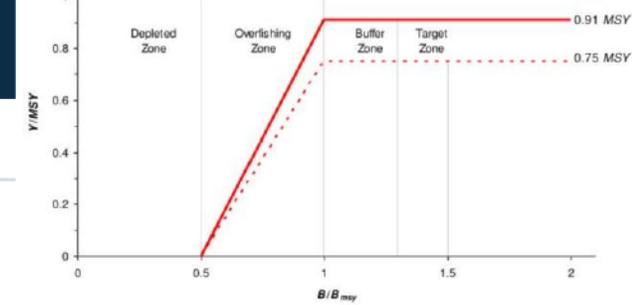
- Global reductions (OTB & TBB)
- Effort quotas allocated by CPC
- Builds the baseline for annual advice-driven quotas

2022–2026

Five-year effort regime with annual updates

- Each year: quotas set “on the basis of SAC advice”
- Expressed as fishing days per CPC and effort group
- Built-in safeguards if biomass is low

3) Safeguards: biomass triggers that tighten the effort rule



Why safeguards matter

Effort-based rules are “input controls”. Safeguards ensure that if the stock’s spawning biomass is too low, the allowable effort must be tightened beyond the normal path to FMSY.

In the Adriatic plan, safeguards are defined using two biomass thresholds:

Trigger 1: $SSB < B_{pa}$

Effort must be set at levels consistent with fishing mortality lower than FMSY, taking into account the biomass decline.

Trigger 2: $SSB < B_{lim}$

Further remedial measures may include suspending targeted fisheries for the stock and/or additional reductions of effort or catch limits.

How the HCR “tightens”

Green zone

$SSB \geq B_{pa}$
Normal annual path to FMSY

Amber zone

$B_{lim} \leq SSB < B_{pa}$
Set effort for $F < FMSY$

Red zone

$SSB < B_{lim}$
Additional measures; possible suspension

If spawning biomass drops below reference points, the HCR requires “remedial measures”.

4) How effort is defined, allocated, and adjusted

Effort unit and segmentation

- Unit: fishing days
- Reported and managed by effort groups (gear × vessel length class)
- Annual allocations are expressed per CPC and effort group

Flexibility (within limits)

CPCs may transfer fishing days across effort groups within the same GSA and/or gear, using conversion factors based on best available scientific advice.

Allocation rule (who gets how many days?)

CPC shares of the total effort reduction are proportional to their contribution to effort in the reference period, using a formula defined in the plan's Annex 4.

Practical impact:

- Predictable “top-down” total effort
- Stable relative shares unless the formula is revised

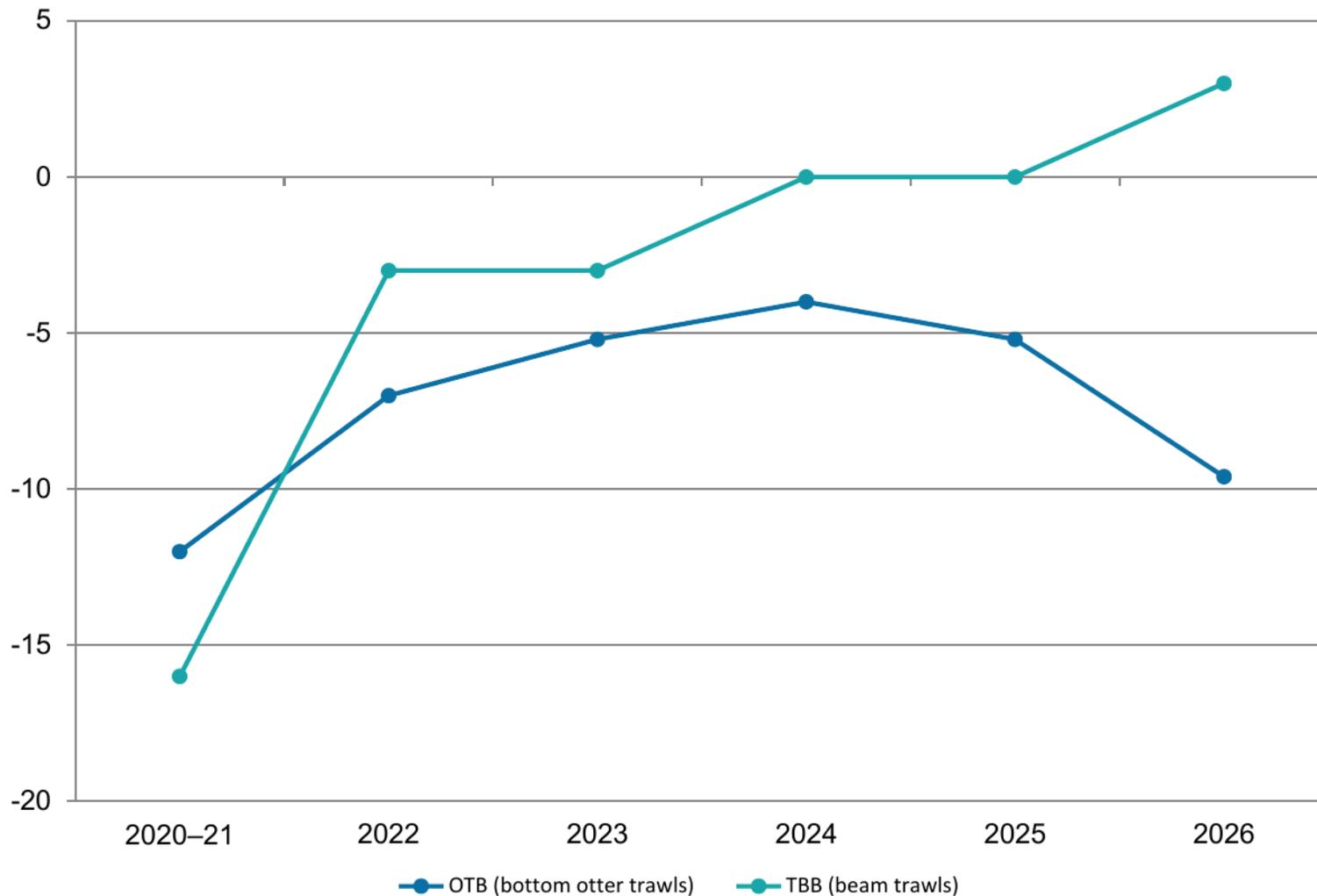
Special case: national fleets with <1,000 OTB fishing days in the reference period are exempt from the reduction rule, but capped at 3,000 days/year.

Effort groups (example)

Gear	Length class	Effort group
OTB	< 12 m	EFF/MED3_OTB_TR1
OTB	12–24 m	EFF/MED3_OTB_TR2
OTB	≥ 24 m	EFF/MED3_OTB_TR3
TBB	12–24 m	EFF/MED3_TBB_TR2

5) Evidence the effort HCR is “doing its job”: annual quota updates

Annual adjustments to allowable effort (fishing days)



Reading the chart

- OTB sees steady cuts (science-driven)
- TBB is held flat in 2024–25
- 2026 increases TBB (+3%) while cutting OTB harder (−9.6%)

What “working” looks like for an effort HCR

- Clear annual update cycle
- Adjusts by gear & fleet segment
- Tracks a path toward FMSY
- Can loosen/tighten when signals change

Track the fleet

- Authorized vessels only
- VMS for vessels >12 m (from 2021)
- Geopositioning solution for <12 m assessed by CoC

Track the catch & effort

- Electronic logbook (from 2022 for >12 m)
- Logbook catch reporting includes key stocks
- Effort monitored as fishing days by effort group

Enforce the limit

- If an effort quota is exhausted, CPC must notify GFCM
- CPC must prohibit further fishing in the fishery where the quota/limit is reached
- Designated ports & risk-based inspections support compliance

The rule only works if effort consumption is measured reliably and enforced when limits are reached.

7) What the recent adjustments suggest (early outcomes + adaptivity)

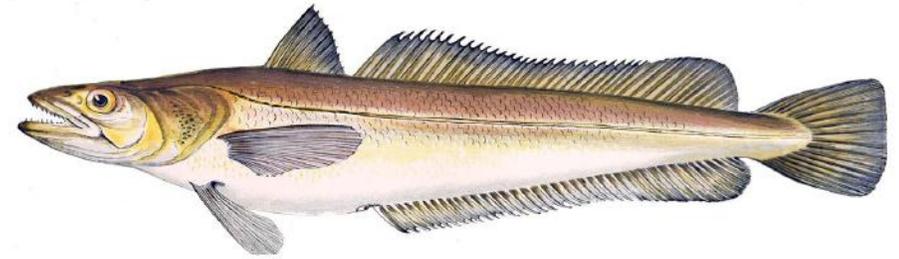
Reported signals (as of 2025)

- Four of five key demersal stocks show positive trends under the plan
- Common sole is described as sustainably exploited
- The HCR continues to tighten OTB effort, while relaxing TBB in 2026

Why the 2026 split matters

An effort HCR is not just “cuts every year”. A key test is whether it can: (1) keep tightening where overexploitation persists, and (2) avoid unnecessary restrictions where a stock/gear combination appears on track.

2026 does exactly that: OTB -9.6%, TBB +3%.



European hake



Norway lobster (Nephrops)

8) What seems to be working — and what remains hard

What looks strong

- Clear annual “set-the-limit” cycle
- Rules anchored to FMSY and safeguards
- Differentiates between gears (e.g., 2026 split)
- Transfer mechanism allows some operational flexibility

What remains hard

- Effort \neq fishing mortality (catchability changes, “effort creep”)
- Mixed fisheries: one gear affects multiple stocks
- Displacement risk (effort moves in space/time)
- Needs timely data + strong compliance to work as designed

Key takeaways

From data collection to implementable, adaptive management plans

Takeaways

- Data collection is the foundation: consistent surveys + reliable effort/catch reporting.
- Indicators and reference points translate observations into decision-relevant signals.
- Harvest strategies reduce uncertainty via pre-agreed decision rules (HCRs) and safeguards.
- The Adriatic demersal plan operationalises this via annual effort quotas and biomass triggers.
- Monitoring & compliance are as important as the rule itself.

Discussion prompts

- Which indicators are most robust for mixed demersal fisheries in the Adriatic?
- How to detect and correct “effort creep” in an effort-based HCR?
- When should spatial measures complement effort controls?
- How can MSE refine the HCR basket and safeguards?
- What changes as climate shifts productivity and distributions?

Questions & Answers

Q & A