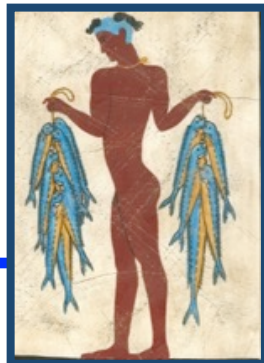
Fisheries stock assessment and management

ODYSSEA

Athanassios Tsikliras

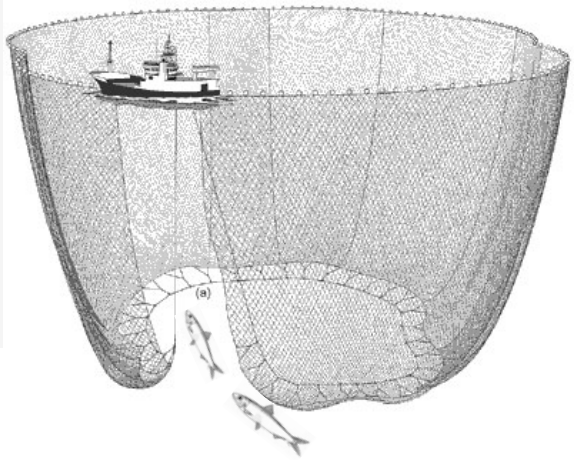
Marine Fisheries and Fish Biology Research Group



Laboratory of Ichthyology, School of Biology, Aristotle University of Thessaloniki

My main research interests are fisheries oriented

- assessing exploitation level & status of marine fisheries resources
- ecosystem based fisheries management
- studying life-history strategies of Mediterranean marine fishes
- climate change and variability



Co-chairing (since 2016) an ICES Working (WGSPEC) and editing several journals (PLoS ONE, Frontiers in Marine Science, Acta Adriatica, Acta Ichthyologica et Piscatoria)

Our small group is involved in three EU projects and several small national ones

(3 PhD, 2 MSc, 7 undergrads)

Marine Fisheries and Fish Biology Research Group

FishBase

Various para-scientific interests

Vol. 13: 23–25, 2013
doi: 10.3354/esep00133
ETHICS IN SCIENCE AND ENVIRONMENTAL POLITICS
Ethics Sci Environ Polit
Published online April 25

Parallels in economic and ecosystem crises

Athanassios C. Tsikliras[1,*], U. Rashid Sumaila[2], Konstantinos I. Stergiou[1]

Mediterranean Marine Science

What's on the (publication fee) menu, who pays the bill and what should be the venue?

A. C. TSIKLIRAS, K. I. STERGIOU

ESEP THEME SECTION

Global university rankings uncovered

Editors: K.I. Stergiou and A.C. Tsikliras (Guest Editor)

1st Session : 09:00-13:00

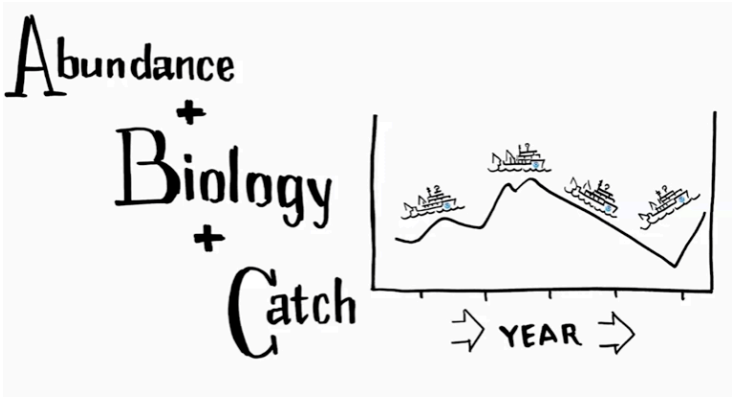
Stock assessment and fisheries management

10.00-11.00

Introduction to fisheries and main models

11.00-13.00

Assessments and management exercise



Break **: 13:00-15:00**

2nd Session : 15:00-18:00

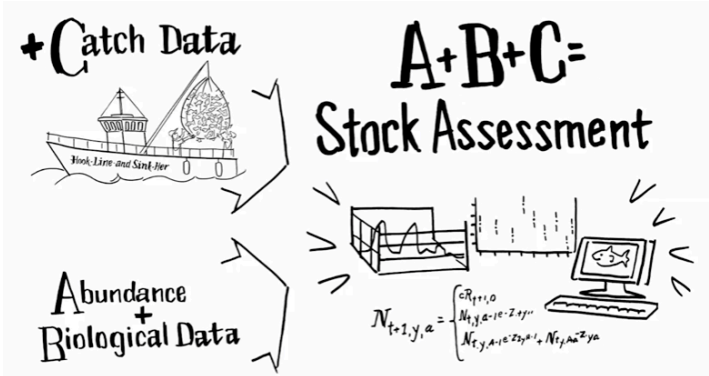
Ecosystem management and modelling

15.30-16.30

Benefits of marine protected areas and data defficiencies

16.30-18.00

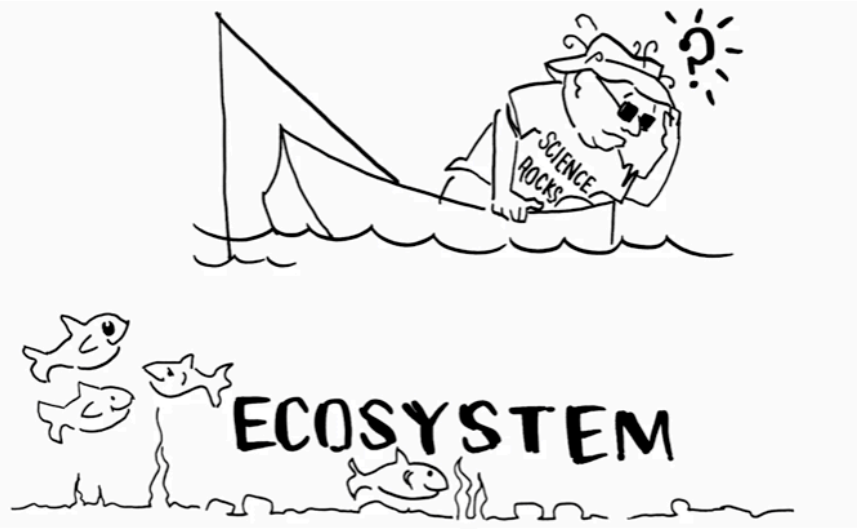
Data requirements for ECOPATH models



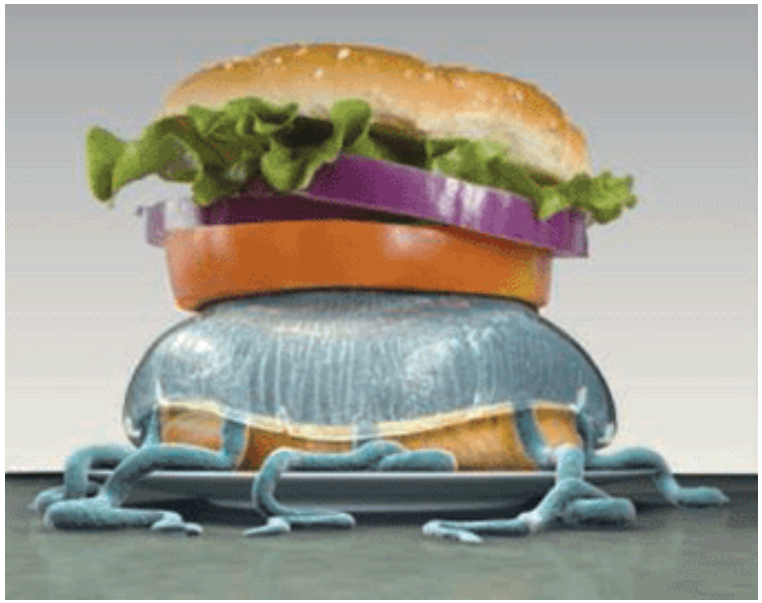
Friday

3rd Session : 09:00-14:00

Ecosystem management and modelling



PART I
Stock assessment and fisheries management



Athanassios Tsikliras

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Catch

The biomass removed from the sea, including corals, sponges, jellyfish etc

→ target species/stock

→ by-catch

Non targeted catch

Catch = Landings + Discards

Total catch (i.e. the biomass removed) equals landings plus discards

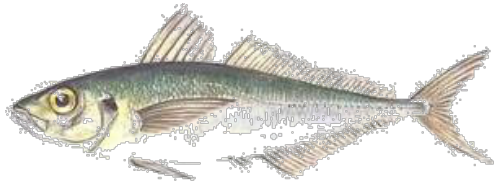
Landings: the proportion of catch landed and officially recorded

Discards: the proportion of catch thrown back into the sea because it is unwanted

- it is not among the target species
- undersized (i.e. below minimum landing size)
- **Food (= energy) returns back to the ecosystem**

anchovy

sardine



Horse mackerel

Mackerel

bonito

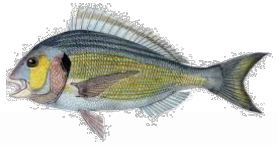
amberjack

Live in the water column and vary in size from small (sardine and anchovy) to large (tuna and swordfish)

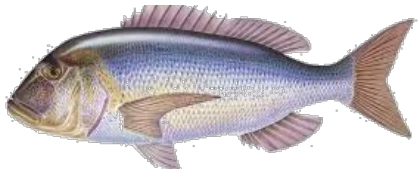
Bluefin tuna

swordfish

seabreams



Live near the seabed but with no somatic adaptation

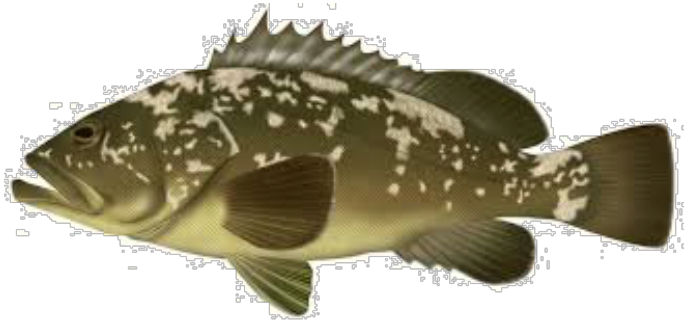


dentex

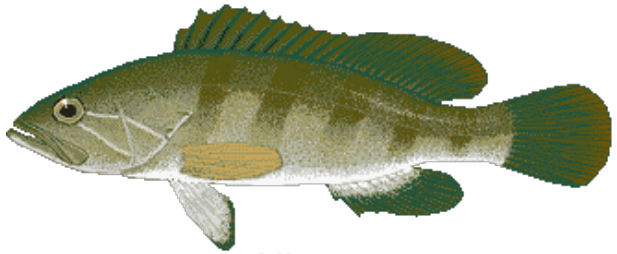
bogue

Groupers

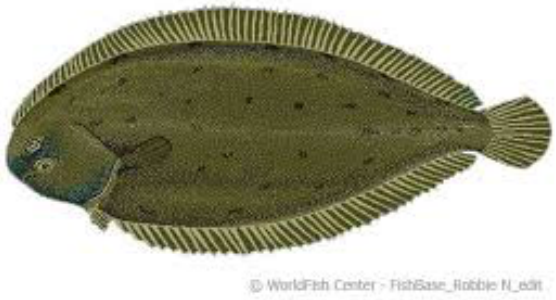
Red mullets



John Dory



Hake



Common sole

Adaptations for living on the seabed

weever

skates

stargazer

Anglerfish

stingray

Rabbit fish

Devil ray

Electric ray

dogfish

Thresher shark

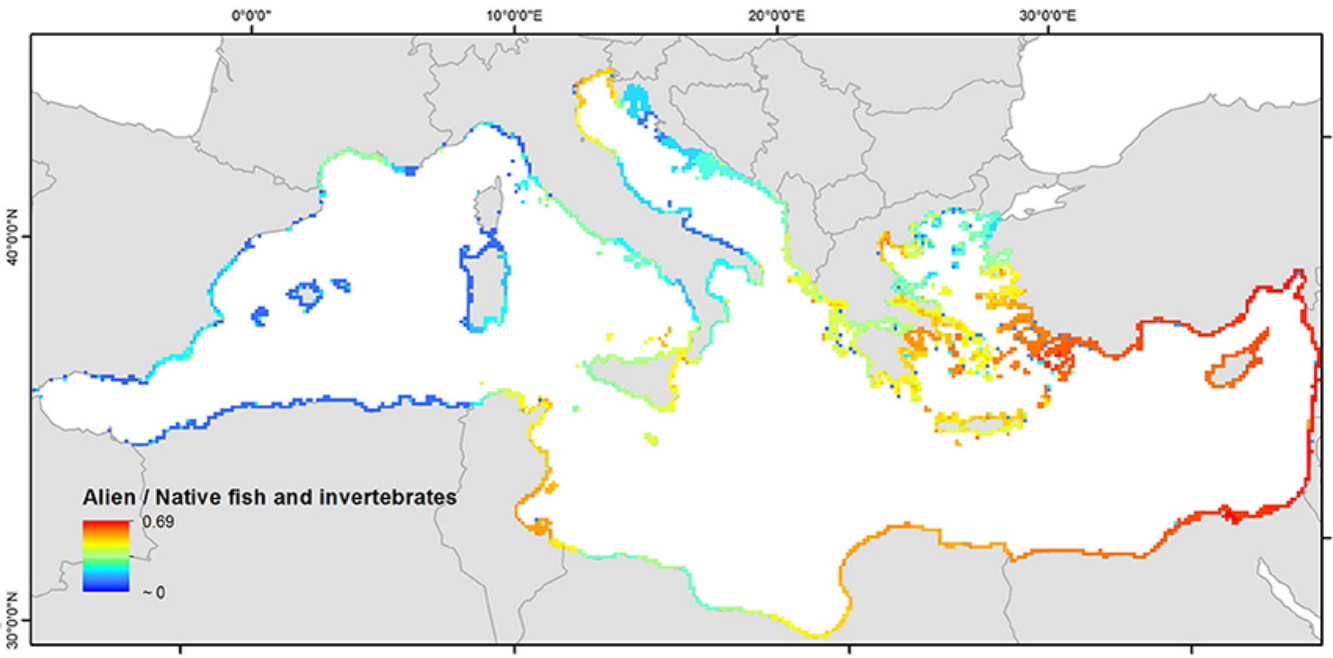
Other

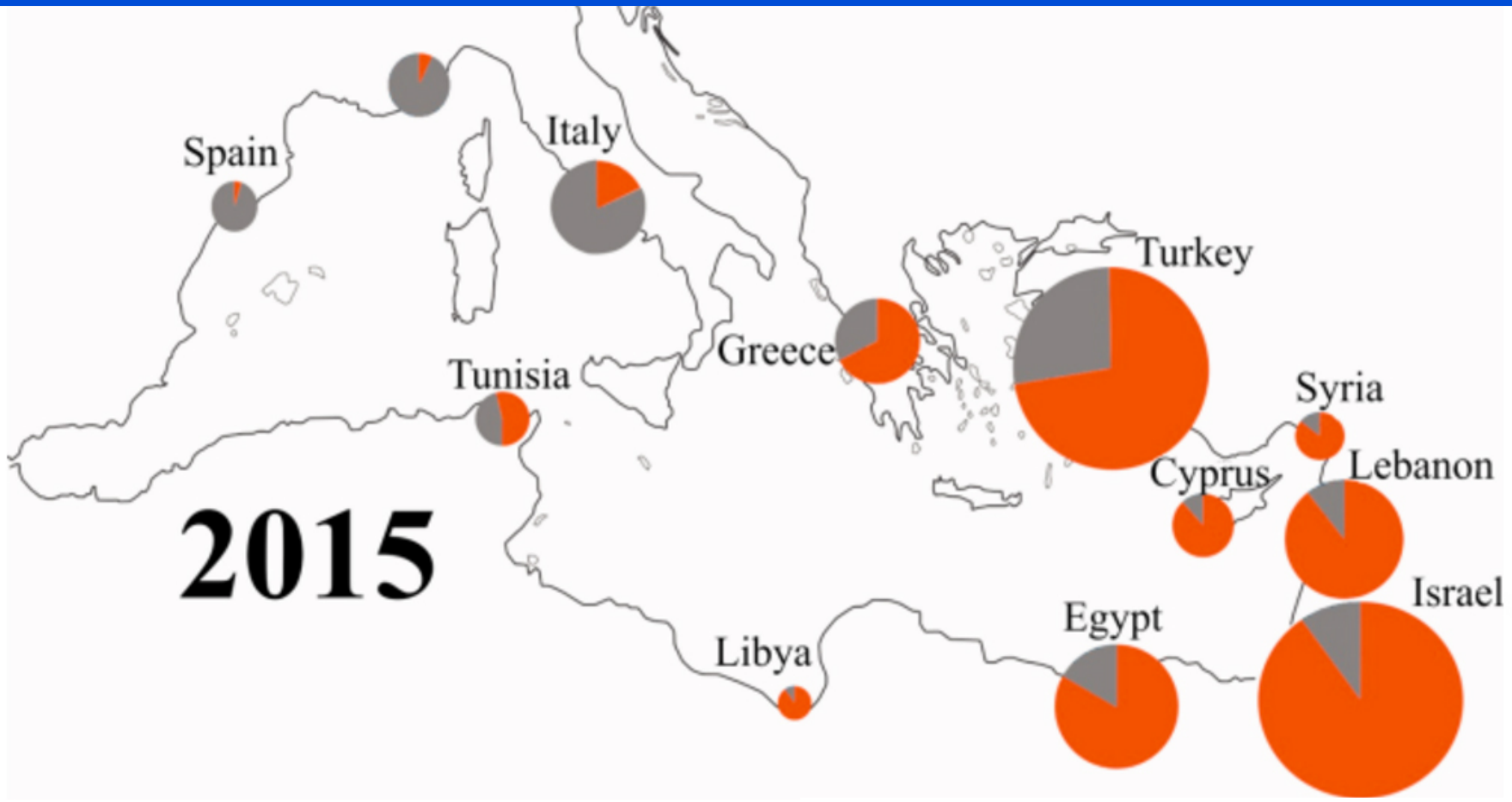

reeflifesurvey.com


www.naturfoto.cz
Jan Sevcik

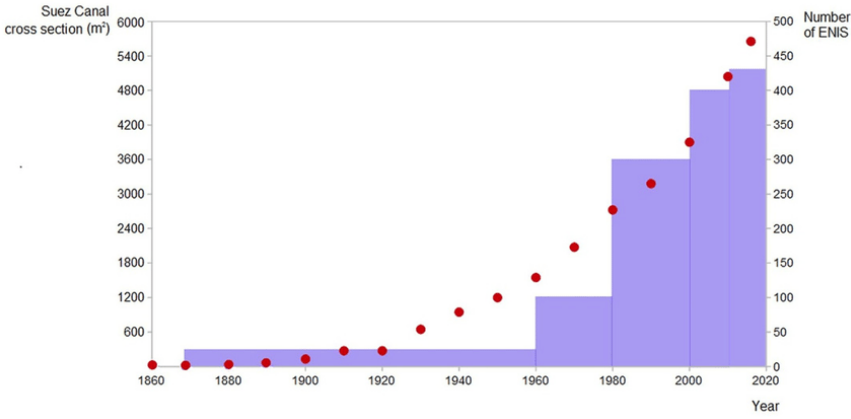

reeflifesurvey.com

Entering through Suez canal

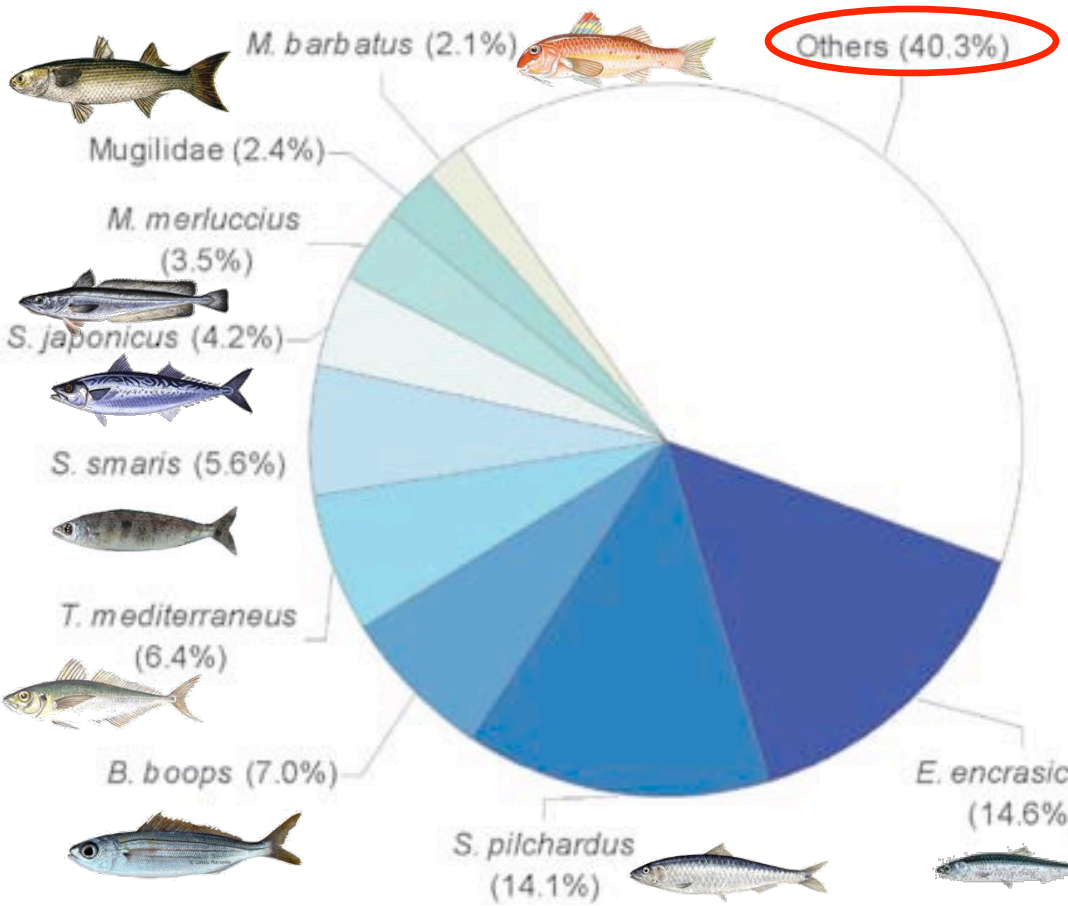




Entering through Suez canal



Comparison with professional fisheries catches in Greek waters



Purse seine

sardine

anchovy

Bottom trawl

hake

Red mullet

Beach seine

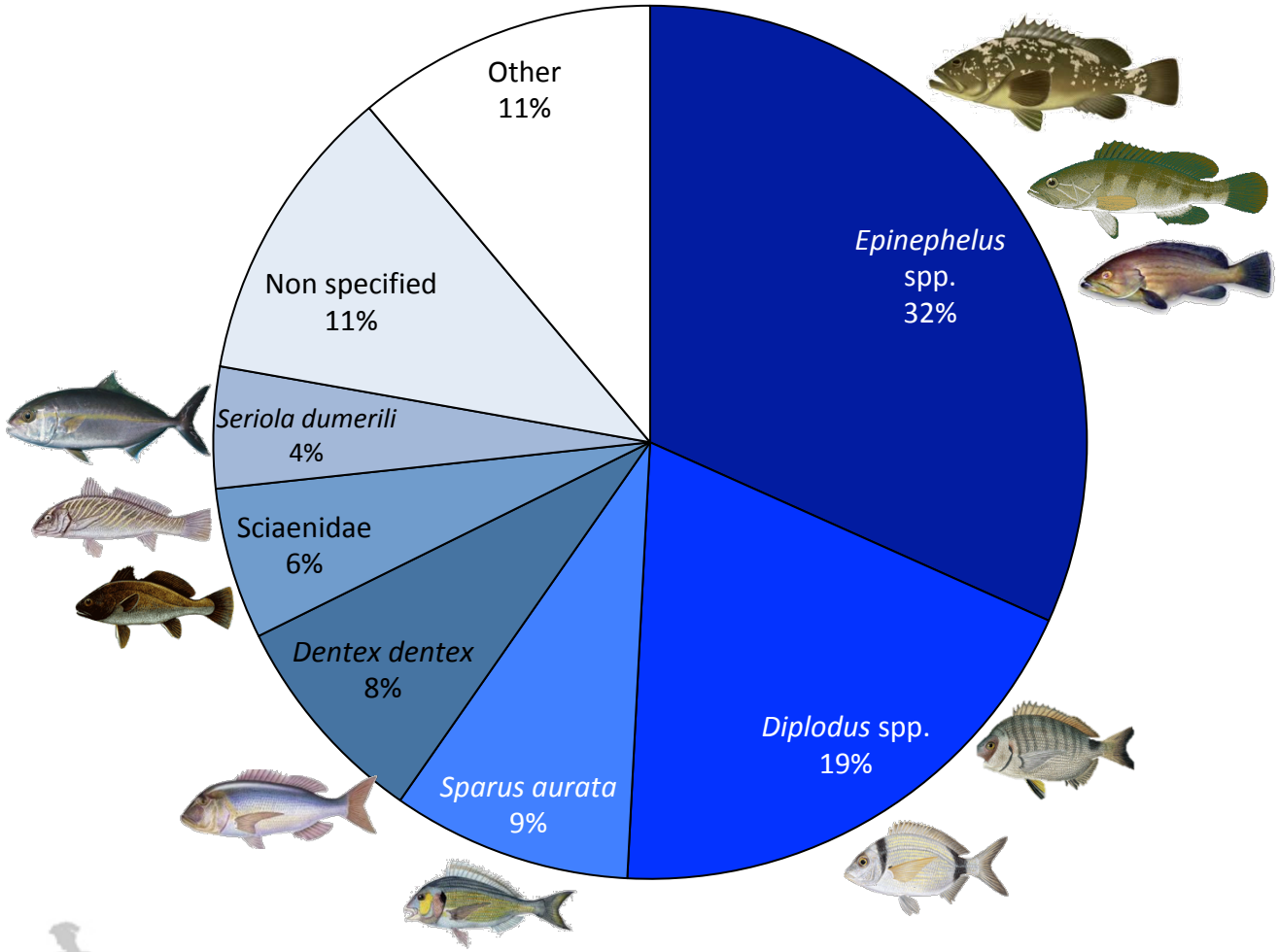
picarel

bogue

Overall not overlapping, only partly with coastal fisheries

Various species, some of which are targeted by spearfishers

Spearfishing catches (abundance per species)



As expected the composition of spearfishing catches differs with large serranids and sparids being the species with the highest catches in terms of abundance.

Diplodus sargus was the species with the highest catch, followed by *Epinephelus marginatus*

Do not include plant material or remains after processing (e.g. guts), with the exception of sharks

Does not include recreational fisheries

Kelleher 2002, FAO

In general

Discarding opposes to sustainable fisheries

Exceptions...

Returning back to the sea (alive) berried lobsters and norway lobsters

Returning back to the sea (alive) marine mammals and reptiles

Returning back to the sea organisms with high probability of survival (crabs, seastars)

Why Discard?

Undersized → Those below minimum landing size, that are illegal to fish

Low market value → profit lower compared to the cost of handling it

Destroyed by other organisms → Some organisms depredate on the catch

(Dolphins, Seals, Turtles)

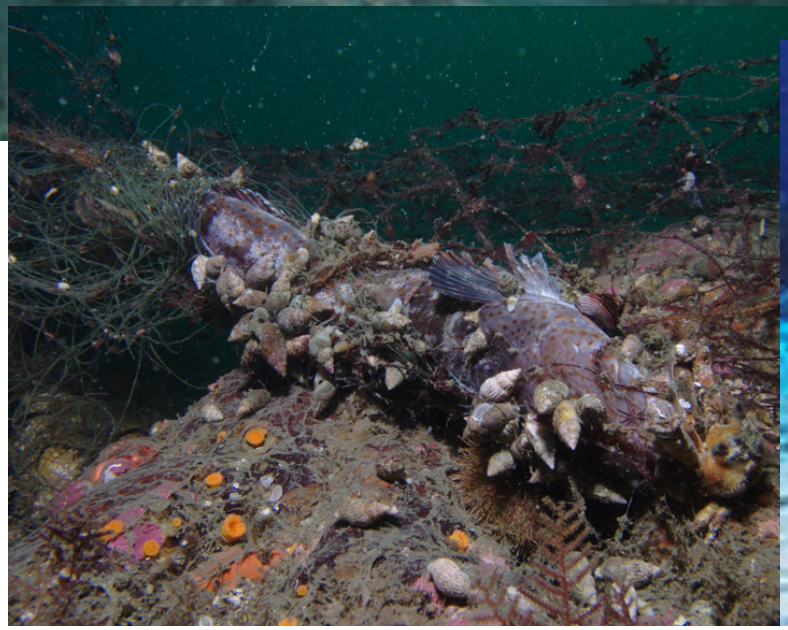
Incidental catch

Rare incidents of catching marine mammals and reptiles, even seabirds

Recorded in numbers not biomass

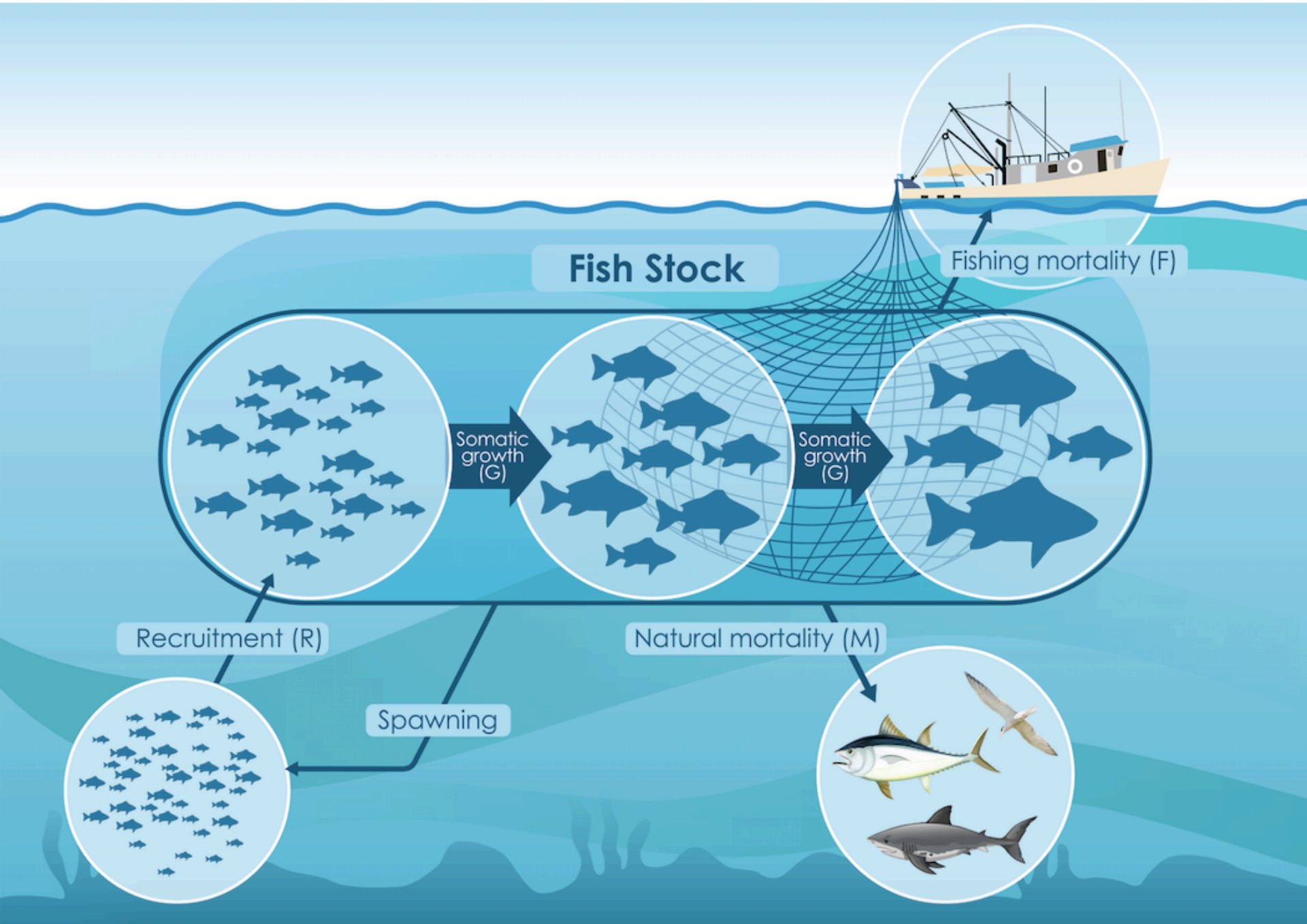
Always discarded and survive

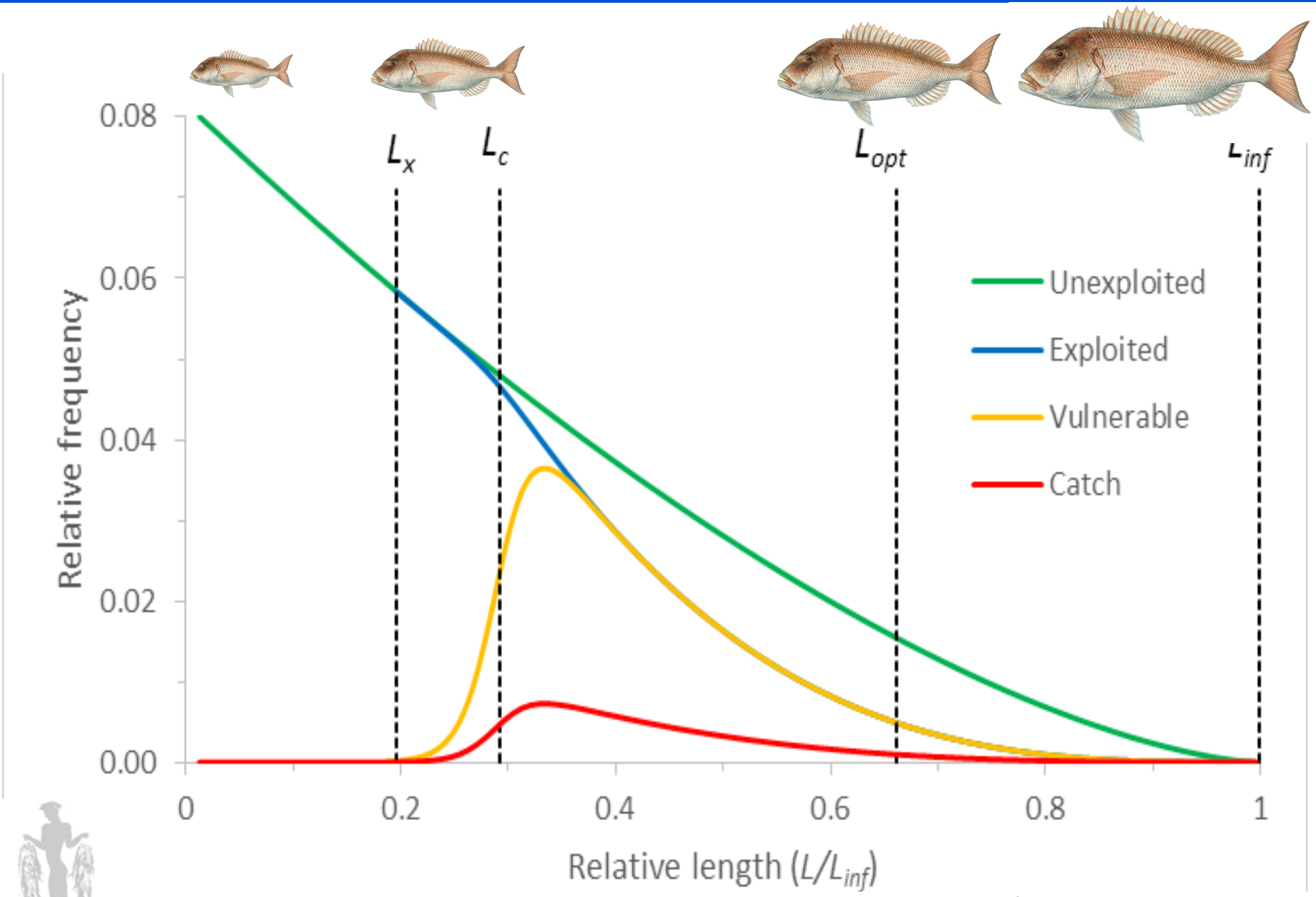
Nets



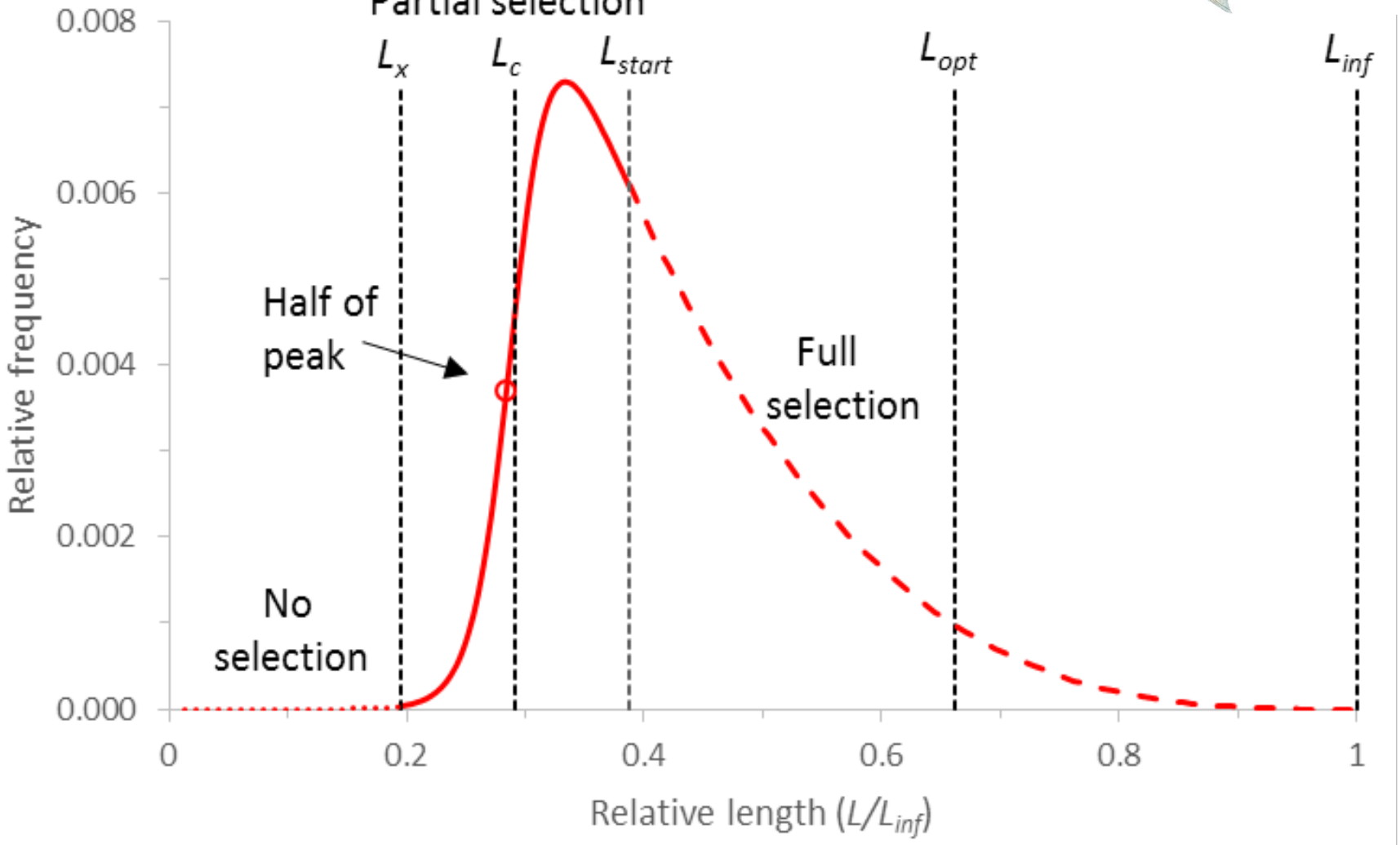
Traps

Population processes and fishing





Froese et al. 2018, ICES J Mar Sci



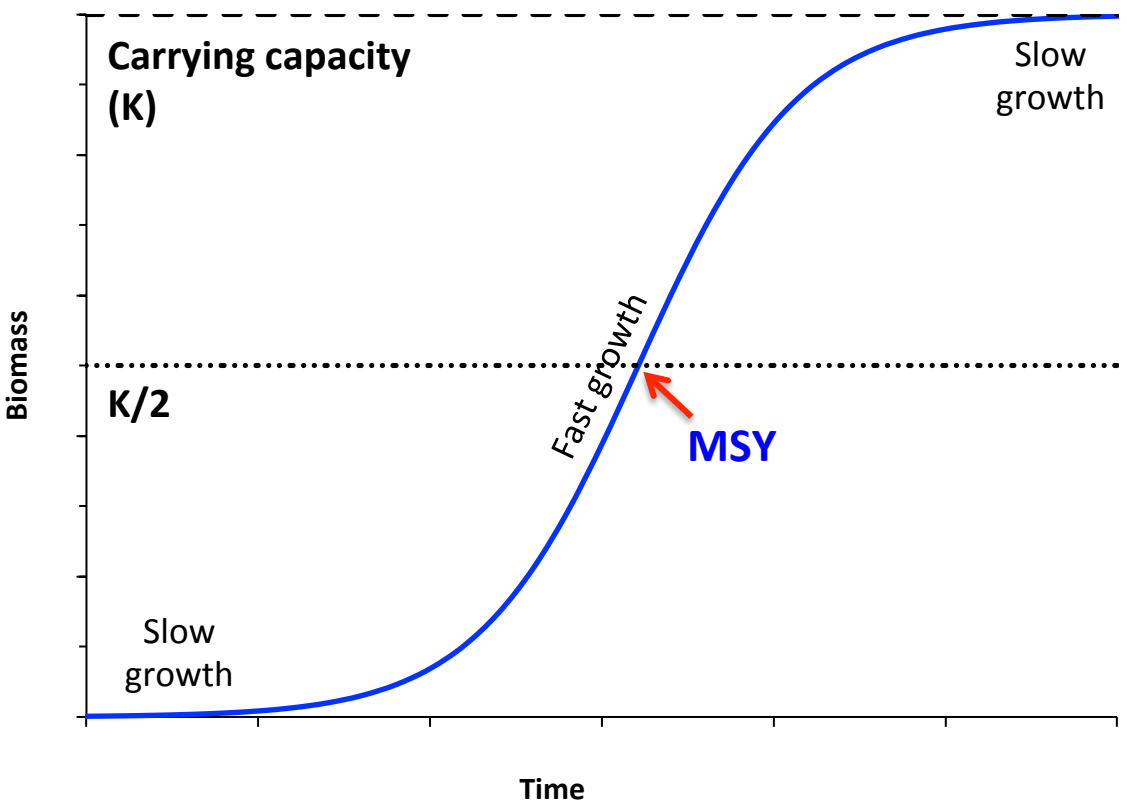
Froese et al. 2018, ICES J Mar Sci

$$\frac{dN}{dt} = r_{max} N_t (1 - \frac{N_t}{K})$$

$$N_t = \frac{K}{1 + e^{-r_{max} t}} = \frac{K\ N_0\ e^{r_{max}\ t}}{K + N_0 (e^{r_{max}\ t} - 1)}$$

The maximum intrinsic rate of population increase

$$r_{max}$$



Is a single number that summarizes
maximum size,
longevity,
maturity,
mortality,
somatic growth, and
reproductive success.

"The power of population is indefinitely greater than the power in the earth to produce subsistence for man"

Thomas Robert Malthus
(1766 – 1834, English Economist)

Tsikliras & Froese 2018, Encyclopedia of Ecology

Importance to conservation

Because it determines the **doubling time**, i.e.
how fast populations can recover from a depleted state
(crashed stocks from overexploitation)

Doubling time = log (2) / r_{max} ~ 0.7/ r_{max}

For a stock with r_{max} = 0.7 (e.g. a small pelagic fish) the population doubles in **one** year

For a stock with r_{max} = 0.07 (e.g. a large shark) the population doubles in **ten** years

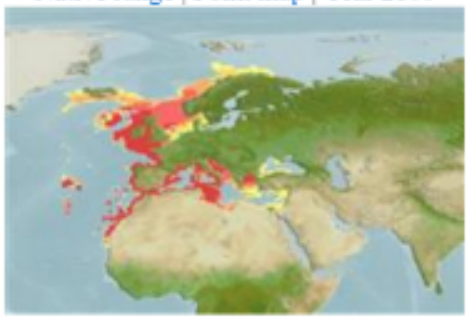
Must be considered when designing fisheries management measures and marine protected areas

Merluccius merluccius (Linnaeus, 1758)
European hake

Upload your photos and videos
Pictures | Stamps, Coins | Google image

Merluccius merluccius
Picture by Svensen, R.

Add your observation in Fish Watcher
Native range | Point map | Year 2100



Merluccius merluccius AquaMaps Data sources: GBIF OBIS

Estimates of some properties based on models

Resilience (Ref. 69278): Medium, minimum population doubling time 1.4 - 4.4 years (K=0.07-0.3; tmax=20; Fecundity=7 million).

Prior r = 0.46, 2 SD range = 0.22 - 0.95, log(r) = -0.78, SD log(r) = 0.37, Based on: 3 M, 76 K, 24 tgen, 7 tmax, 38 Fec records

Management decisions are (ideally) based on **fisheries reference points** that are related to:

1. the intensity of fishing **F** (fishing mortality, fishing effort, fishing pressure)

Common reference point: F/Fmsy

Should be low to ensure stock renewal.

2. the state of the stock **B** (biomass, abundance)

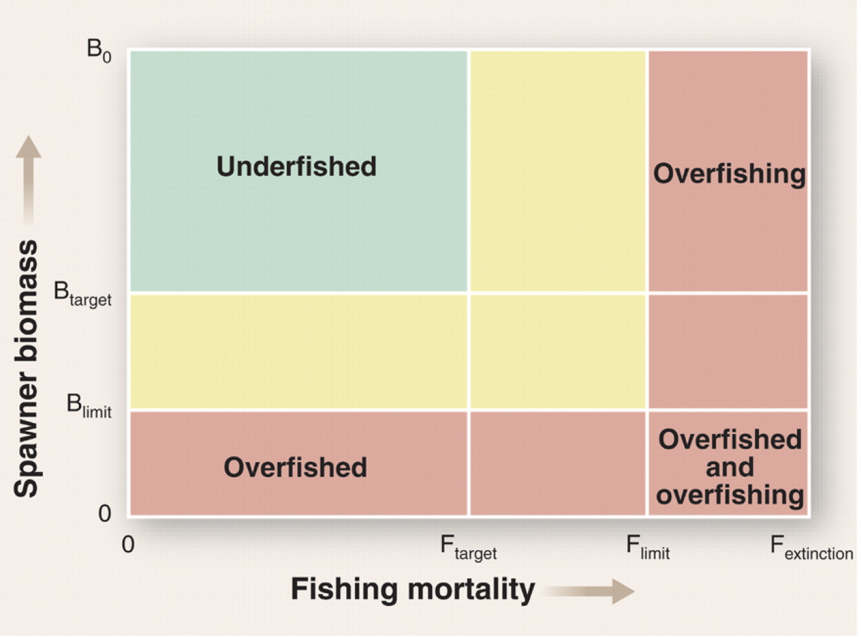
Common reference point: B/Bmsy

Should be high to ensure high catches.

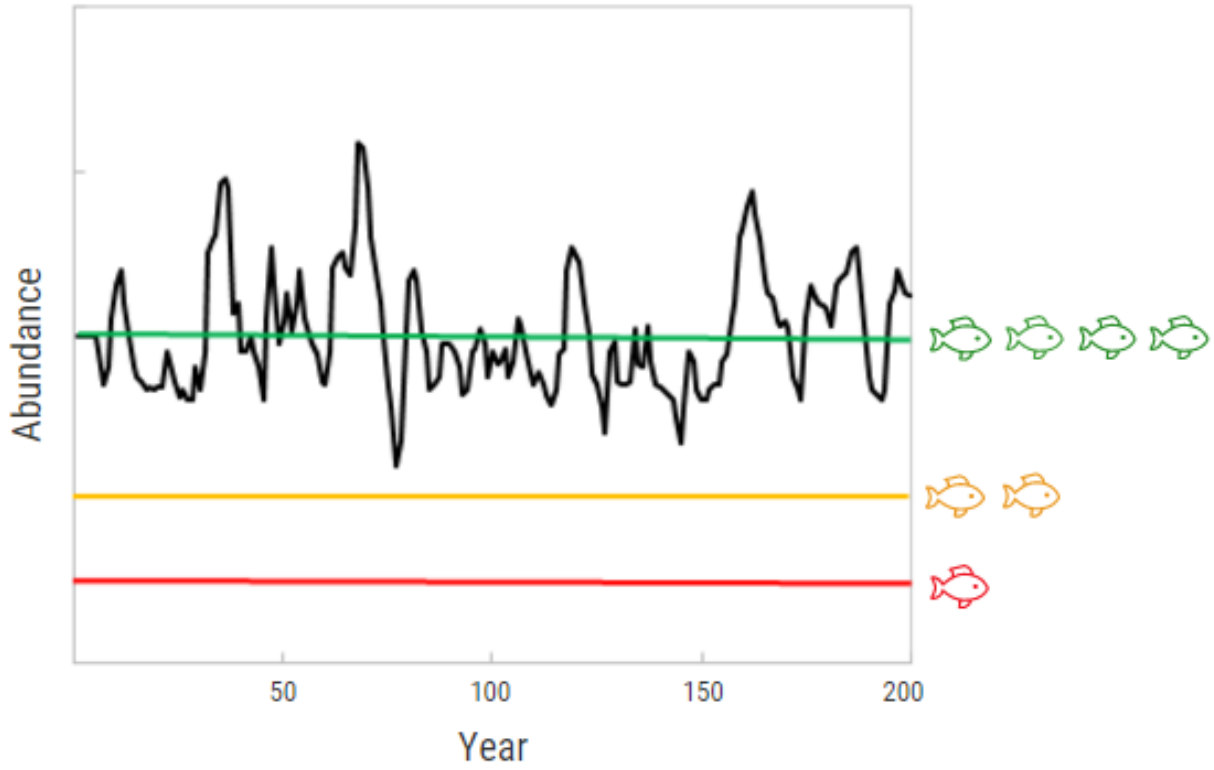
2. the age and stock structure of the population

Common reference point: L/Lopt

Should be as close to unexploited stock conditions.



(1) and (2) used in CFP, MSFD includes (3)



Management target

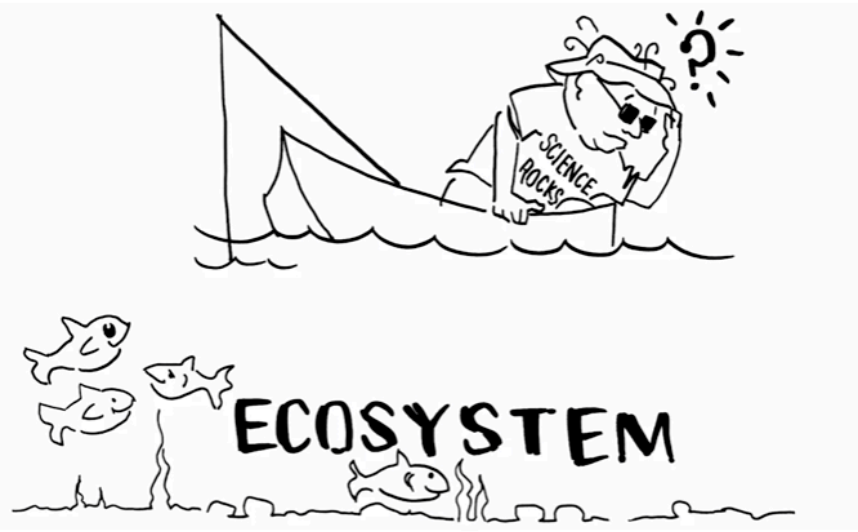
For a healthy fishery, we want fish stocks to fluctuate around this level .

Soft limit

If a fish stock falls below this level, we manage it to rebuild it. For example, we reduce the total amount of fish that fishers can catch.

Hard limit

If a stock falls below this level, we consider it 'collapsed'. We may close the fishery to rebuild it.

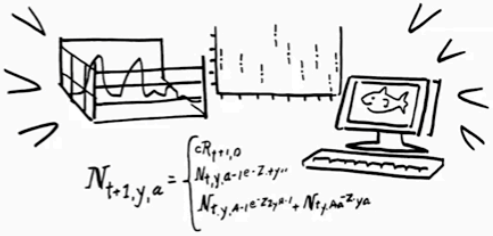


Abundance
+
Biology
+
Catch

+Catch Data

Abundance
+
Biological Data

A+B+C=
Stock Assessment



Disagreement in global fisheries matters

- Overfishing or not?

(Worm et al. 2006 Science, Worm et al. 2009 Science)

- Fishing down, through or up?

(Pauly et al. 1998 Science, Branch et al. 2010 Nature)

- Selective or balanced harvesting?

(Froese et al. 2008 Fish Res, Garcia et al. 2012 Science)

- Assessment based on catches or survey data?

(Pauly 2013 Nature, Hilborn & Branch 2013 Nature)

The two sides (conservation biology-economic benefits) are well and clearly represented (sea and fish-fishers and industry)

D. Pauly
University of British Columbia

"…the larger, longer-lived fishes of the top of the food web are depleted faster than the smaller, shorter-lived fish and invertebrates".



R. Hilborn
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The debate

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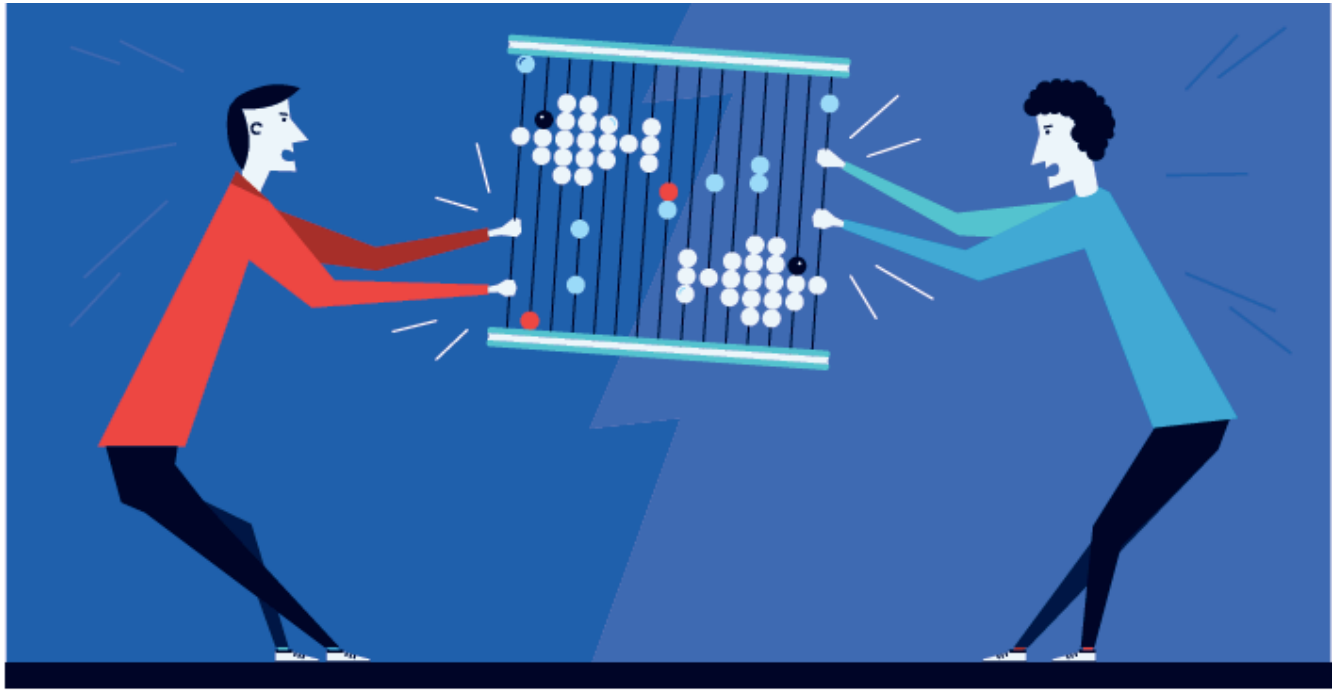
Stock assessment and survey data

Catch data



Does catch reflect abundance?

Researchers are divided over the wisdom of using estimates of the amount of fish hauled in each year to assess the health of fisheries.

POINT

Yes, it is a crucial signal

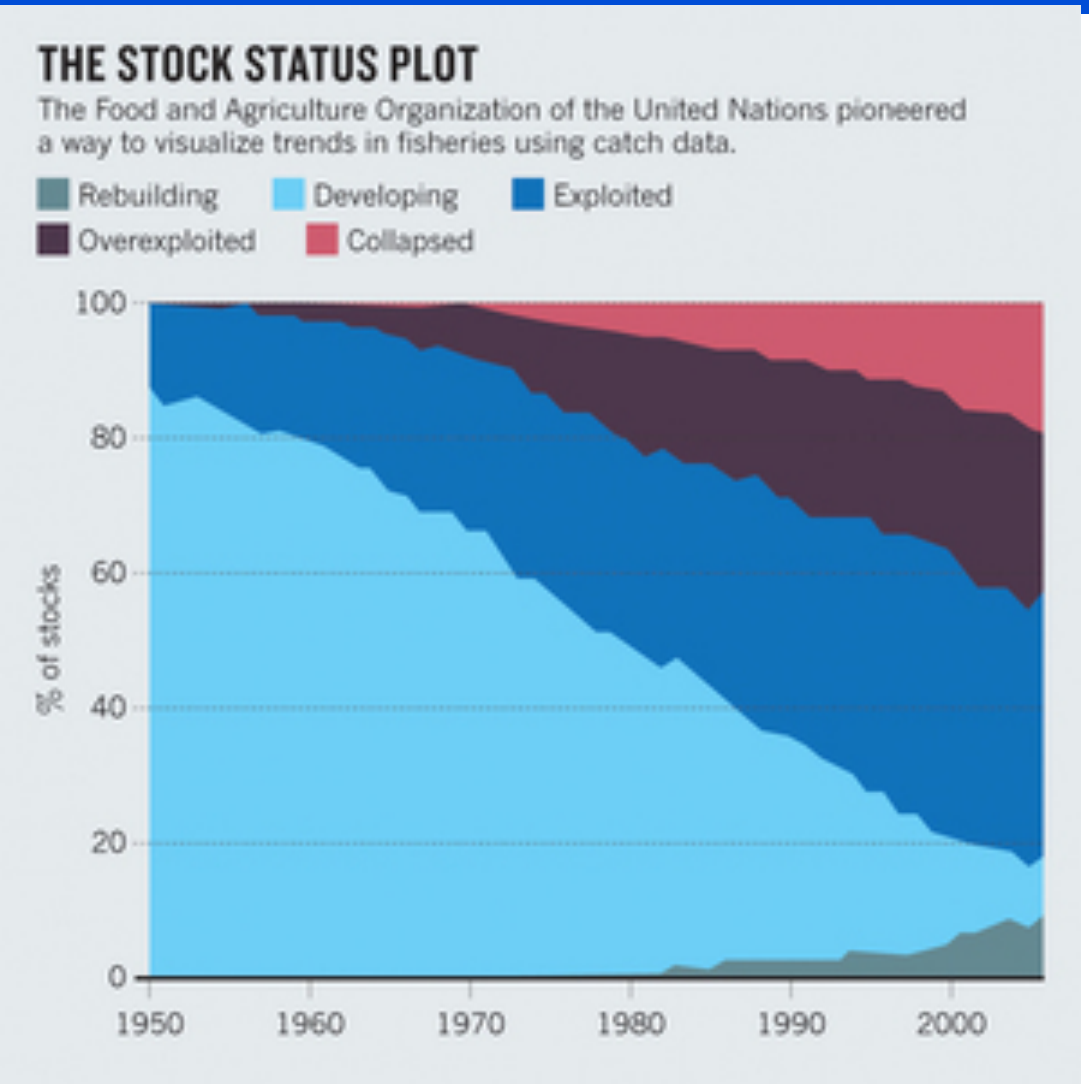
The only data available for most fisheries are the weight of fish caught each year, insists Daniel Pauly.

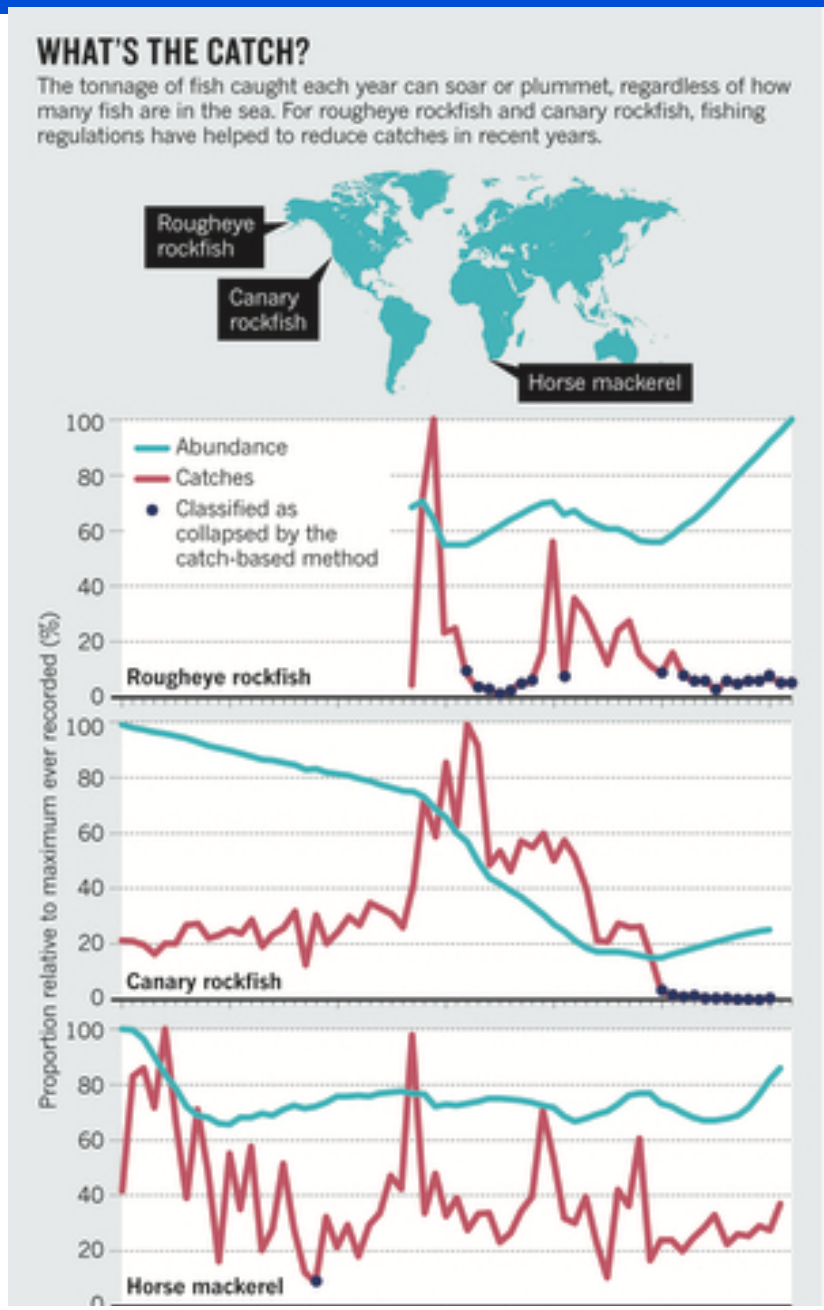
COUNTERPOINT

No, it is misleading

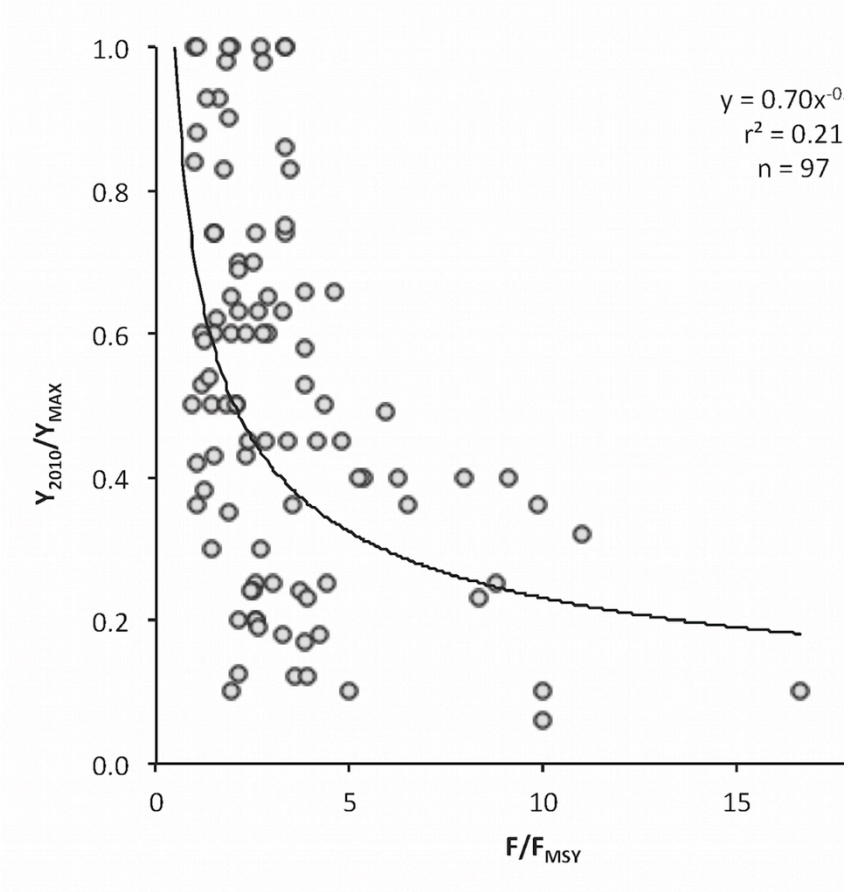
Many factors as well as abundance determine the hauls of fishermen, warn Ray Hilborn *and* Trevor A. Branch.

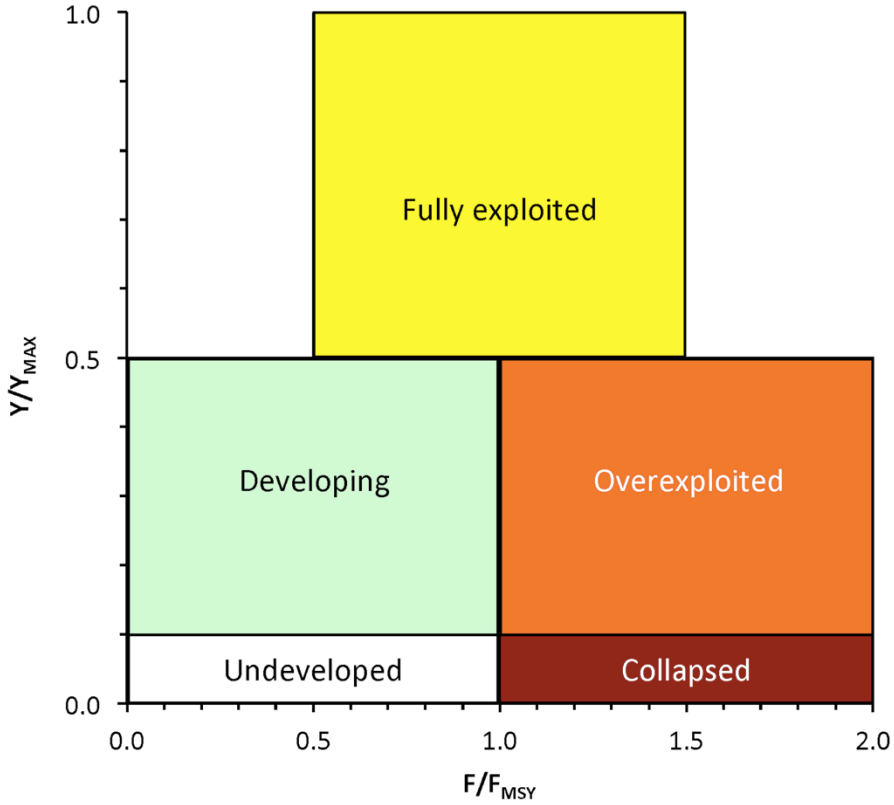
Does catch reflect abundance?





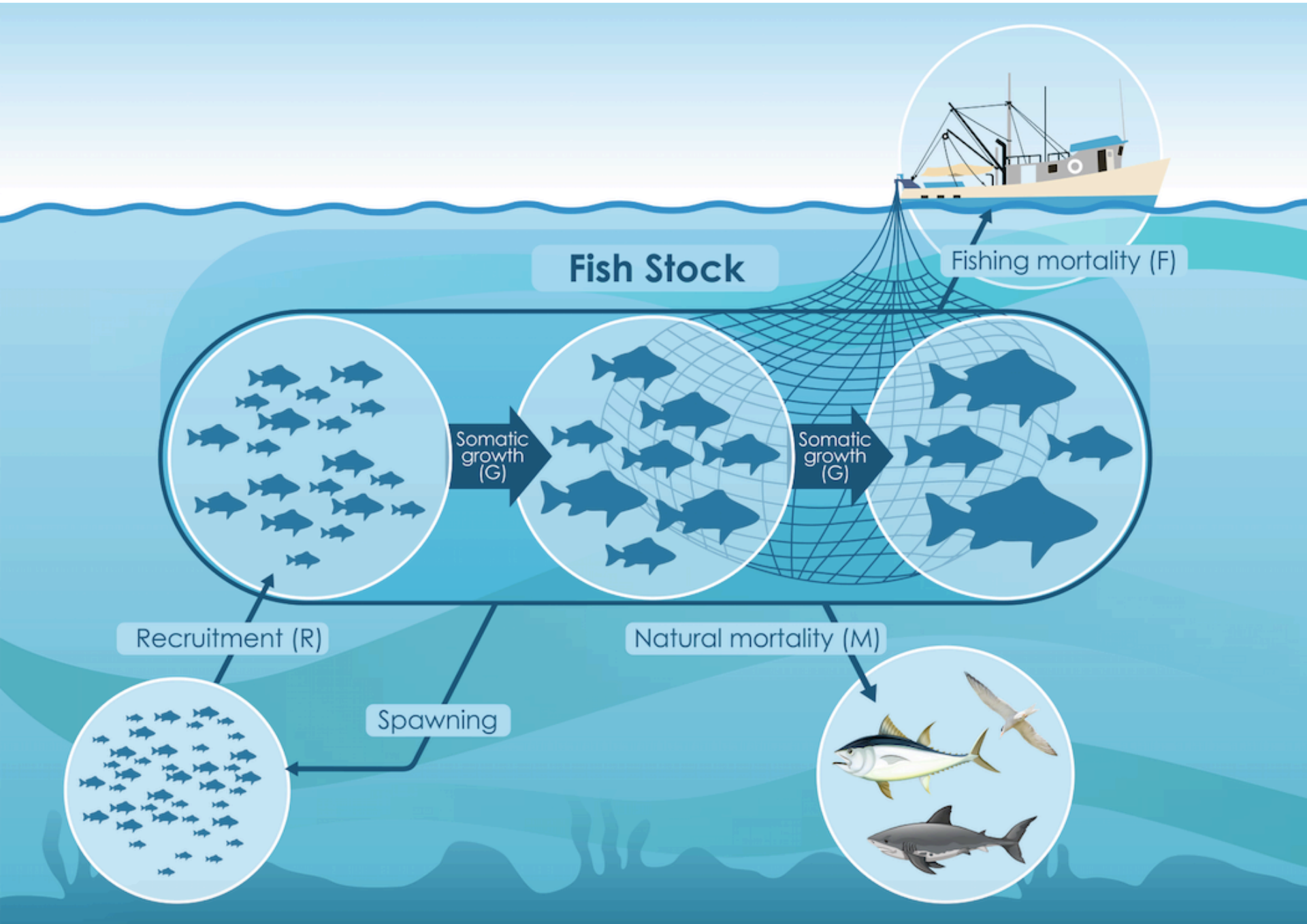
Catch corresponds well with biomass in the Mediterranean





Tsikliras et al 2015 PLoS ONE

Population processes and fishing

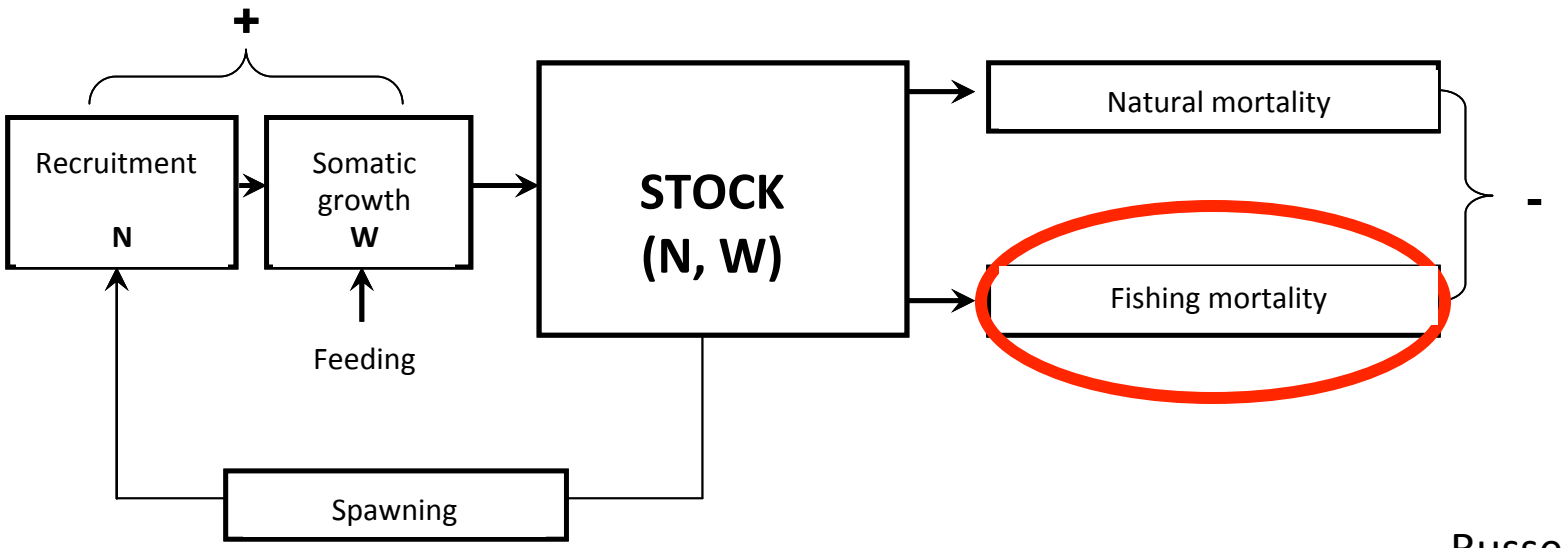


Maximum sustainable yield (**MSY**) is one of the fundamental concepts in fisheries science

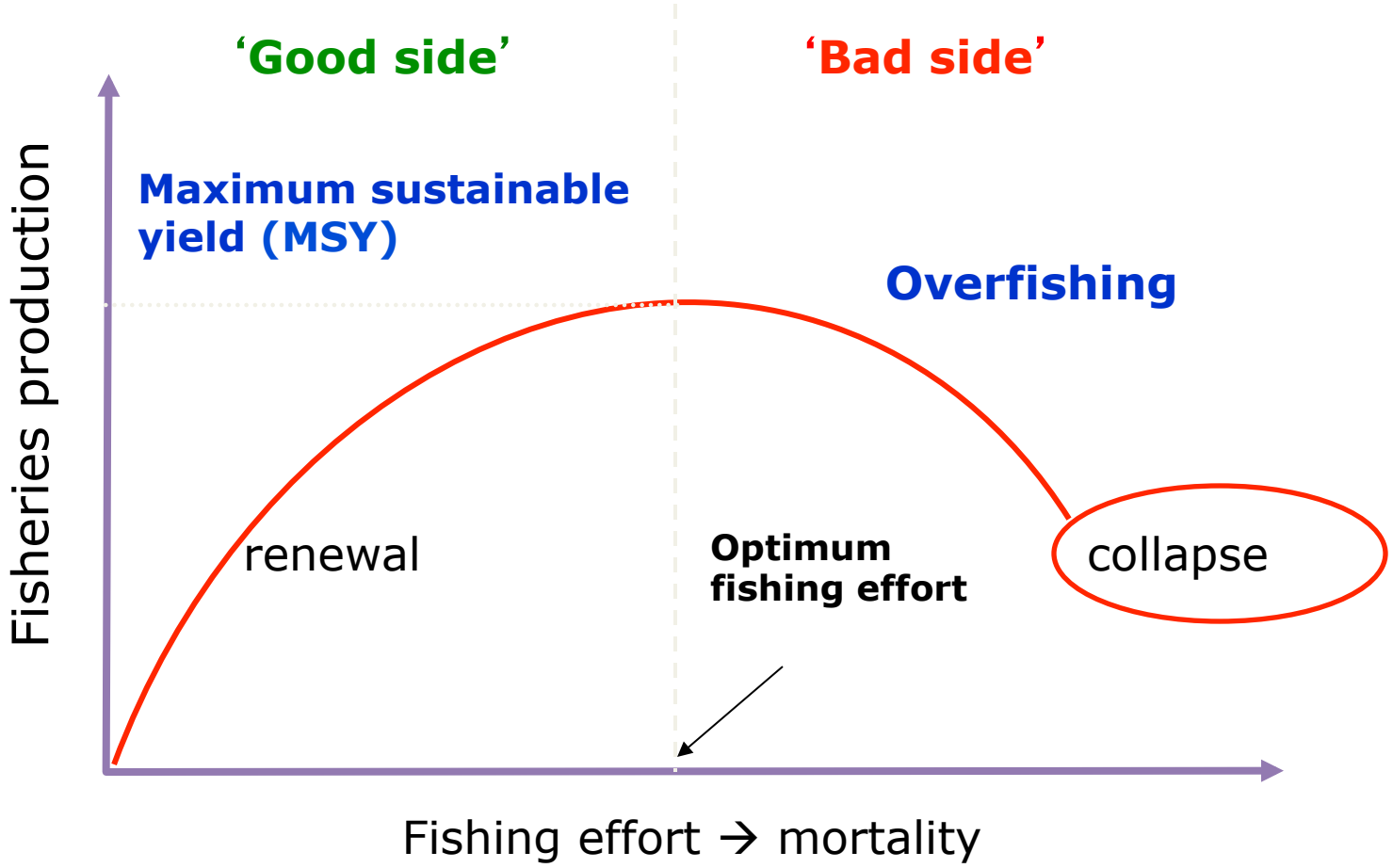
It refers to the removal of the largest possible biomass without risking the collapse of a stock

«Live on the interest and not the capital»

Stock processes



Russell 1931



Fishing industry

Fisheries Science

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No -------- Overfishing ---------- Yes

Recently revealed

- What data to use?
- Methodology?
- How many definitions of overfishing?
- Researchers vs. academics and *vice versa*
- Common fisheries Policy ή Marine strategy?
- Do we need NGOs and what is their role?
- Do we favour fishers or fishes?

Science and research are benefited!

Remarkable similarities between economic and ecosystem crises, all refer to people

Vol. 13: 23–25, 2013
doi: 10.3354/esep00133

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Parallels in economic and ecosystem crises

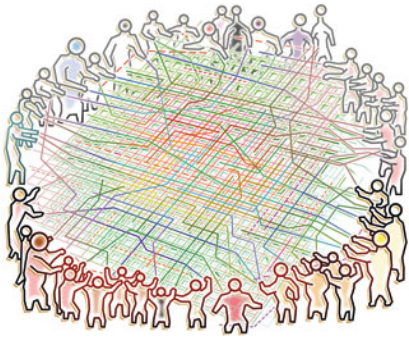
Athanassios C. Tsikliras[1,*], U. Rashid Sumaila[2], Konstantinos I. Stergiou[1]

- short-sighted idiosyncrasy
- greed and opportunism
- corruption at various levels
- lack of political will
- *regulatory capture* (legislation/measures detract from public good)

(Tsikliras et al. 2013, *ESEP*)

Tragedy of the commons for ecosystems

(Hardin 1968)



ARTICLE

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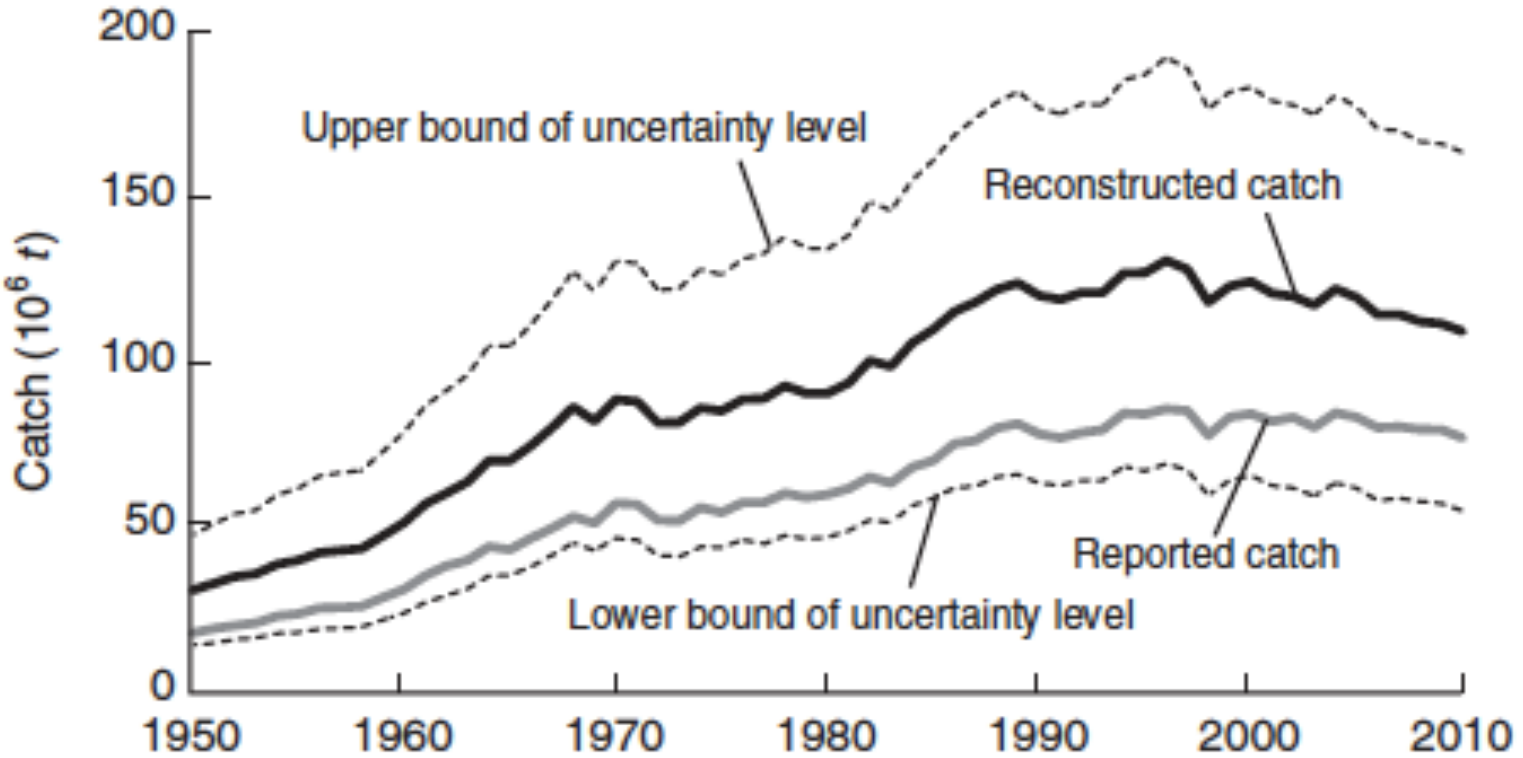
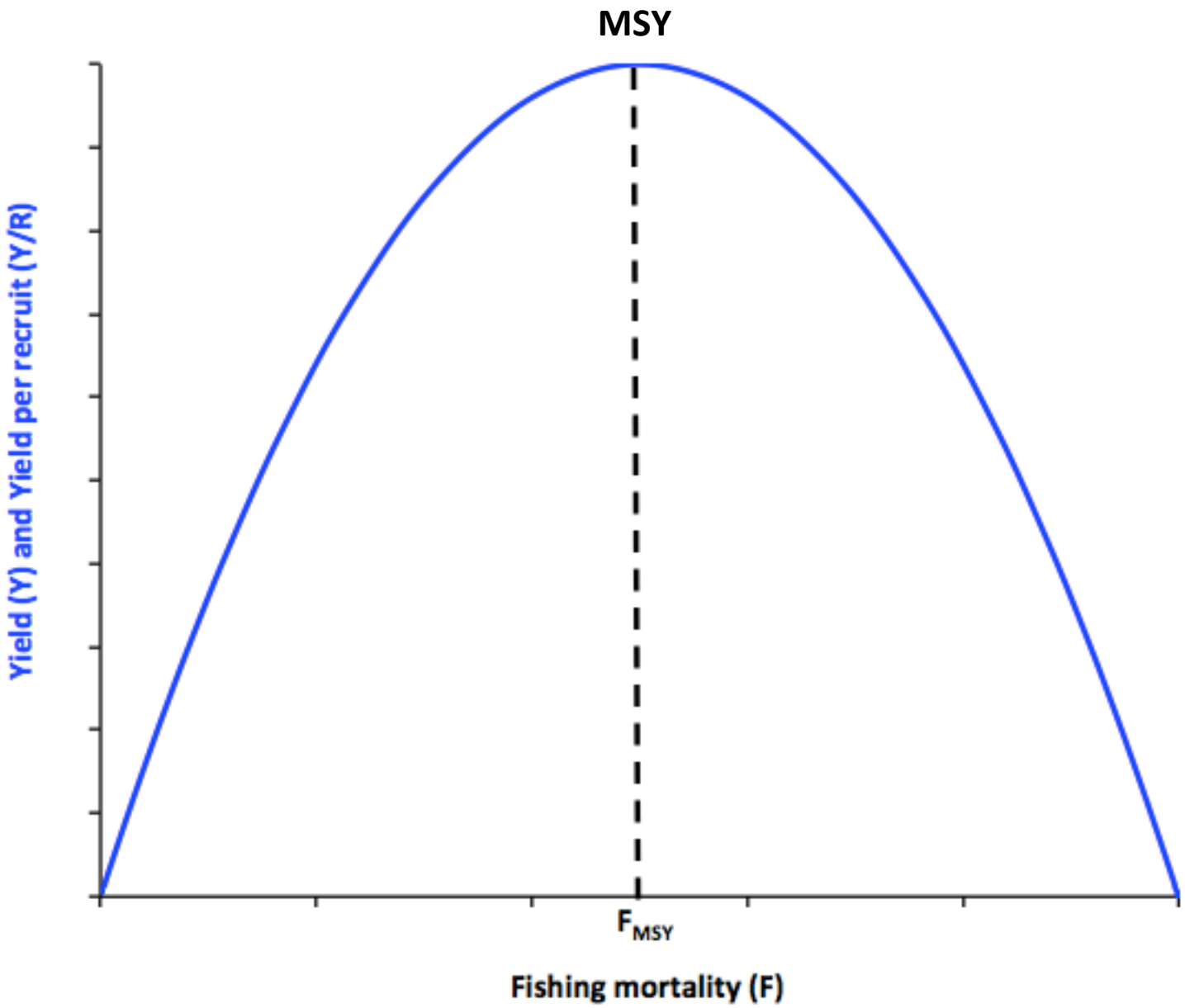
DOI: 10.1038/ncomms10244 OPEN

Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining

Daniel Pauly[1] & Dirk Zeller[1]

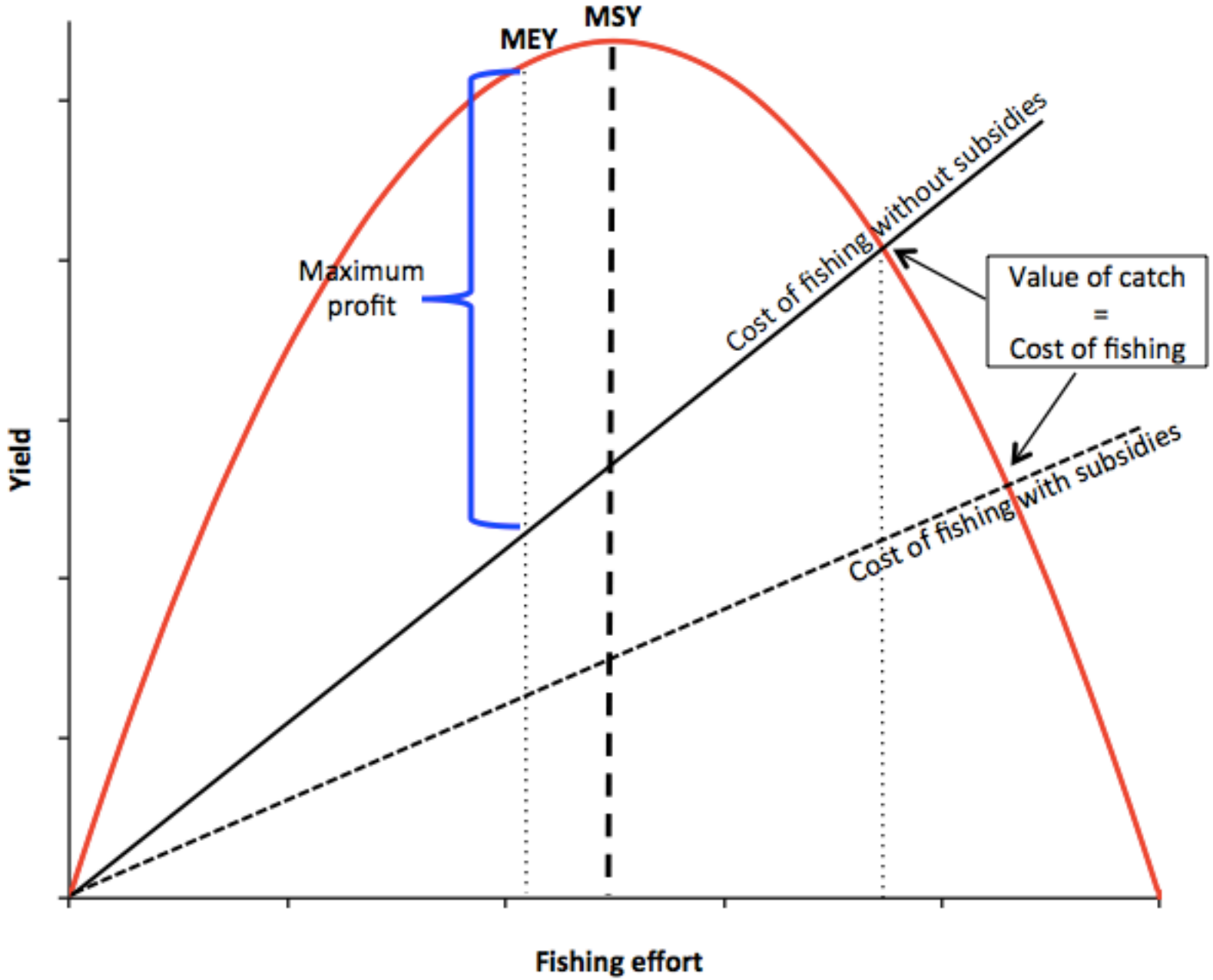


MSY is achieved at intermediate fishing pressure



Tsikliras & Froese 2018, Encyclopedia of Ecology

Profit for fishers is also maximized near MSY



Tsikliras & Froese 2018, Encyclopedia of Ecology

Stock assessment models

There are two types of models used in stock assessments:

1. Surplus production models

Simple, easy to use, require less data, ideal for data poor areas

SPiCT, CMSY

2. Age-structured models

Time consuming, data hungry, require age structured, ideal for data rich areas

A4A, SS3

Tsikliras & Froese 2018, Encyclopedia of Ecology

Milner Baily Schaefer

(1912 – 1970, US Fisheries Scientist)

Some aspects of the dynamis of populations important to the management of the commercial marine fisheries (1954)

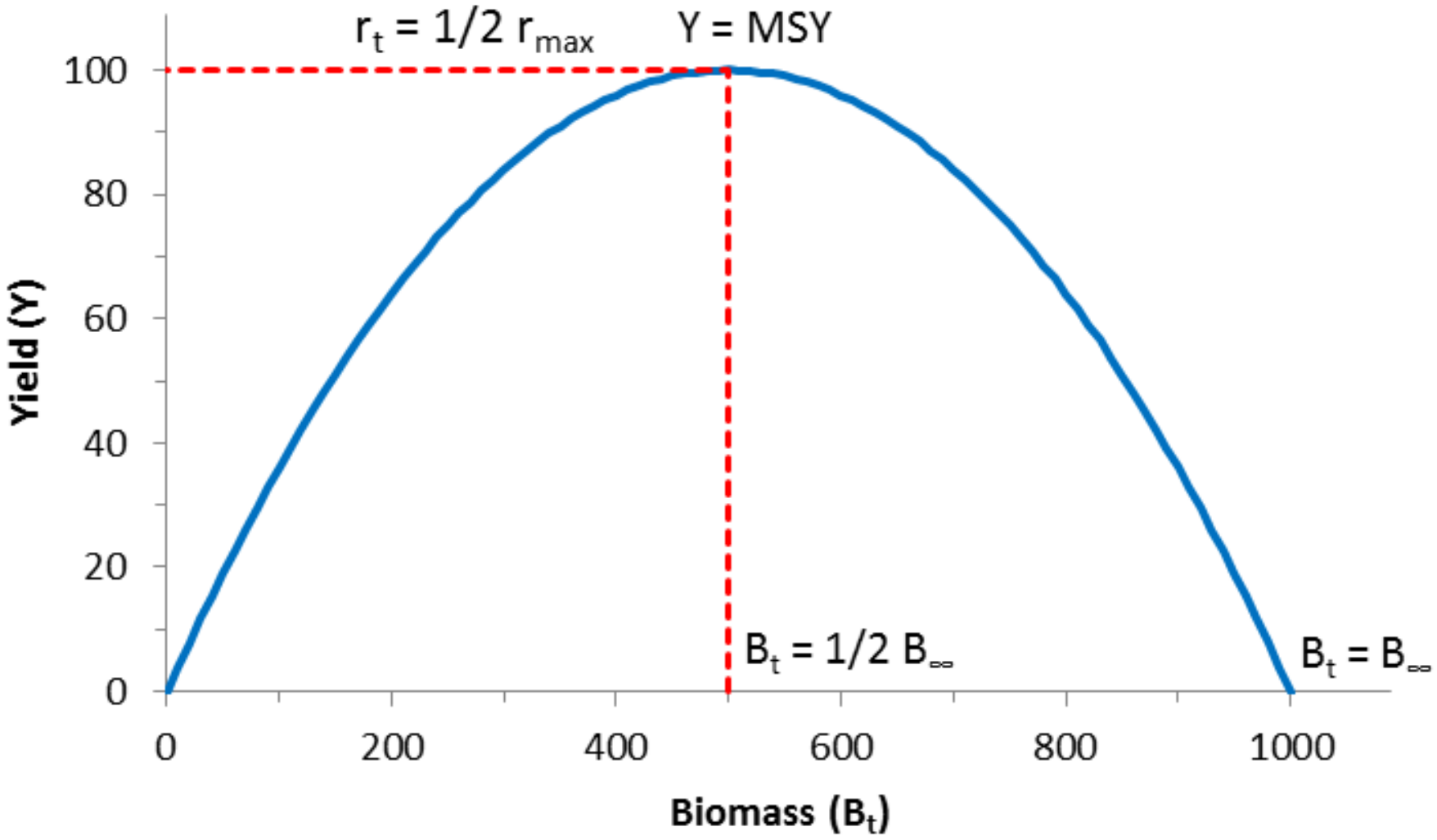
The **Schaefer model** builds on the logistic curve, replaces population numbers with biomass, defines surplus production as yield, and establishes the *MSY* concept of **m**aximum **s**ustainable **y**ield.

$$MSY = \frac{r_{max}}{2}\frac{B_\infty}{2} = \frac{r_{max}\,B_\infty}{4}$$

where Y is the surplus production or **y**ield, B_t is the biomass at time t, and B_∞ is the carrying capacity of the ecosysystem for this population.

Tsikliras & Froese 2018, Encyclopedia of Ecology

Surplus production models-The Schaefer model



Tsikliras & Froese 2018, Encyclopedia of Ecology

Overfished and healthy stocks

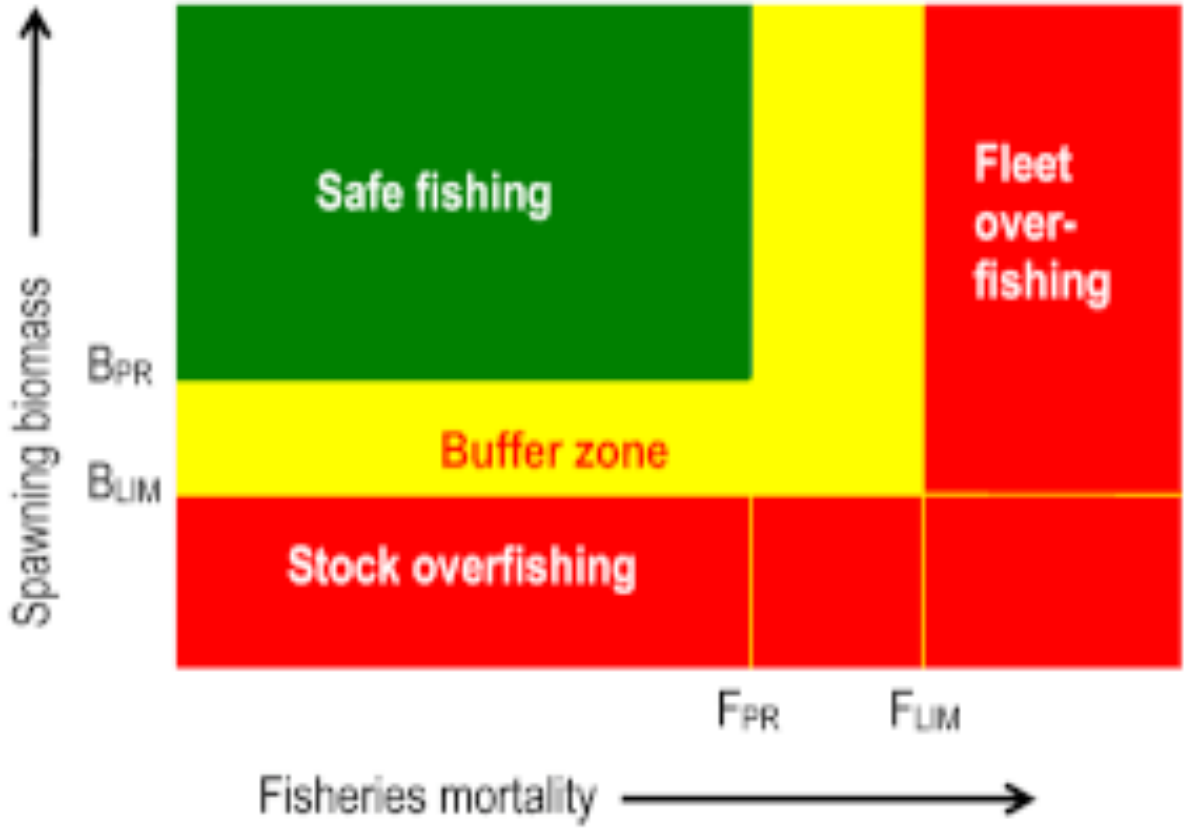
When current fishing mortality F exceeds F_{msy}
AND current biomass B is lower than B_{msy}

Then the stock is **overfished (=RED)**

BOTH conditions should hold at the same time for a stock to be **healthy (=GREEN)**

$F < F_{msy}$

$B > B_{msy}$



Stock status and exploitation are two different terms that are often confused

Stock status refers to the biomass (B) of a stock compared to the biomass that corresponds to the MSY (B_{MSY}) – *it is a **biological** concept and depends on the population characteristics of a species*

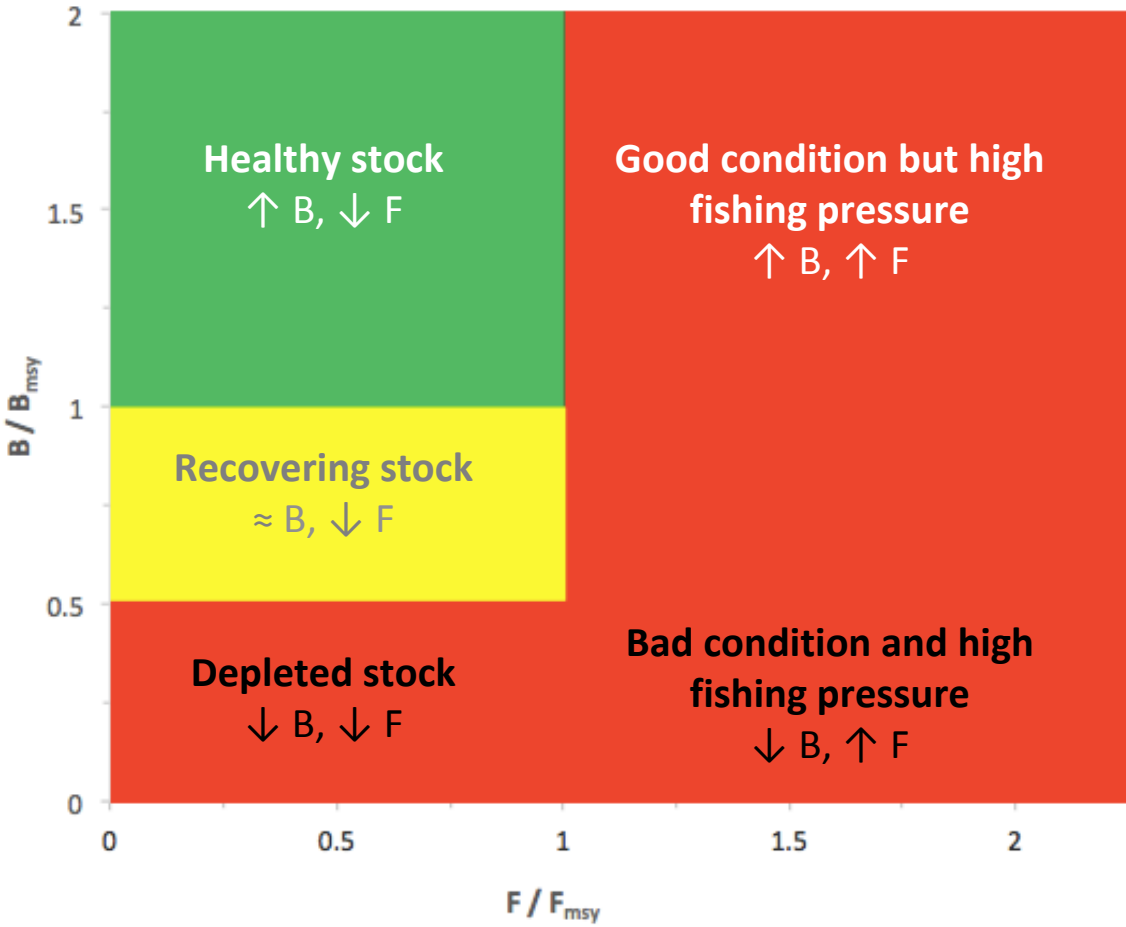
It has to be high ($B > B_{MSY}$)

Exploitation refers to the fishing pressure (F) Applied to a stock compared to the one that ensures MSY (F_{MSY}) – relates to the fleet and fishing intensity

It has to be low ($F < F_{MSY}$)

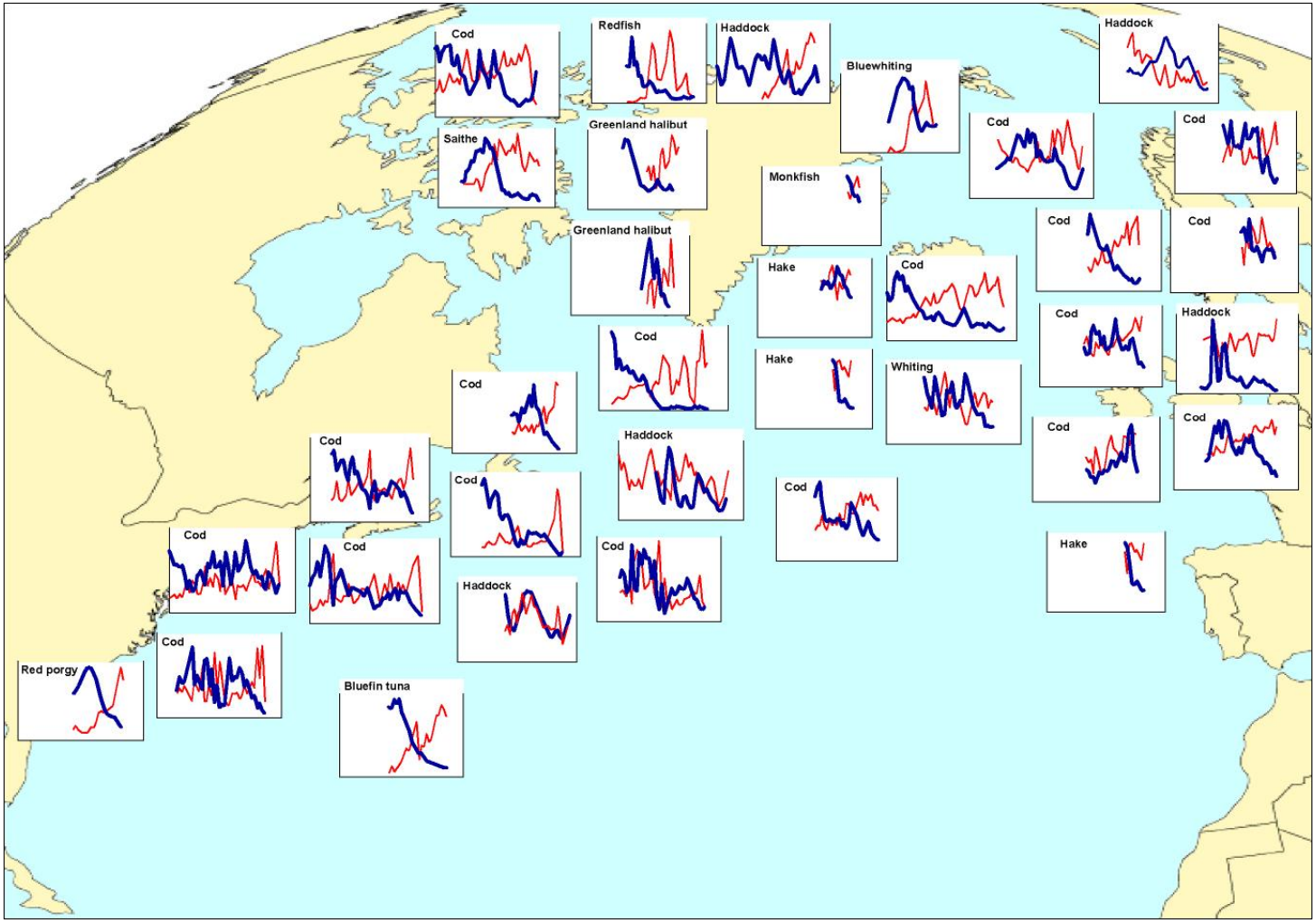
A stock is **healthy** only when **both** conditions apply at the same time

(+ a third one related to the size and age structure of a population))



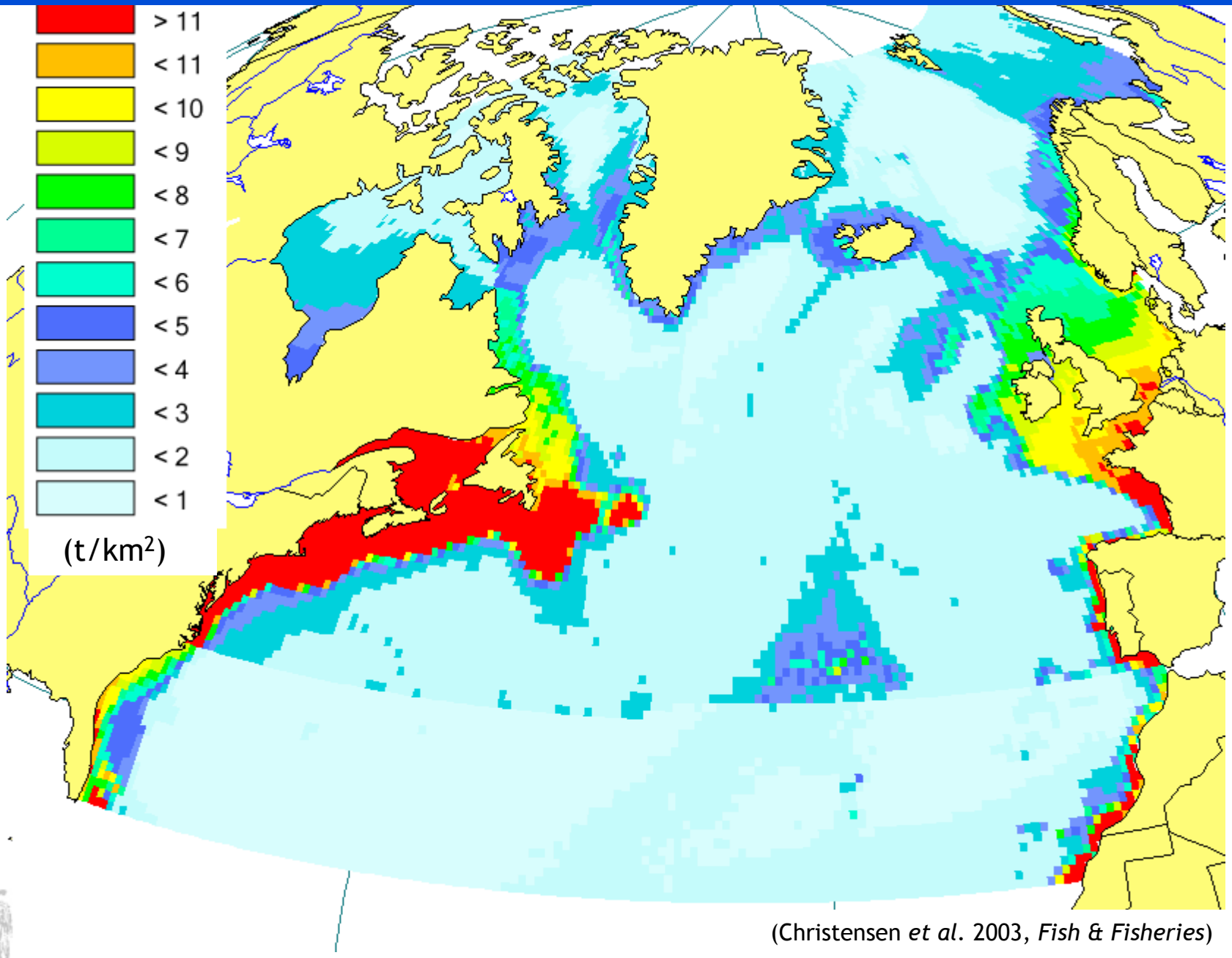
North Atlantic Stocks

Abundance (blue) has been affected by strong fishing effort (red).



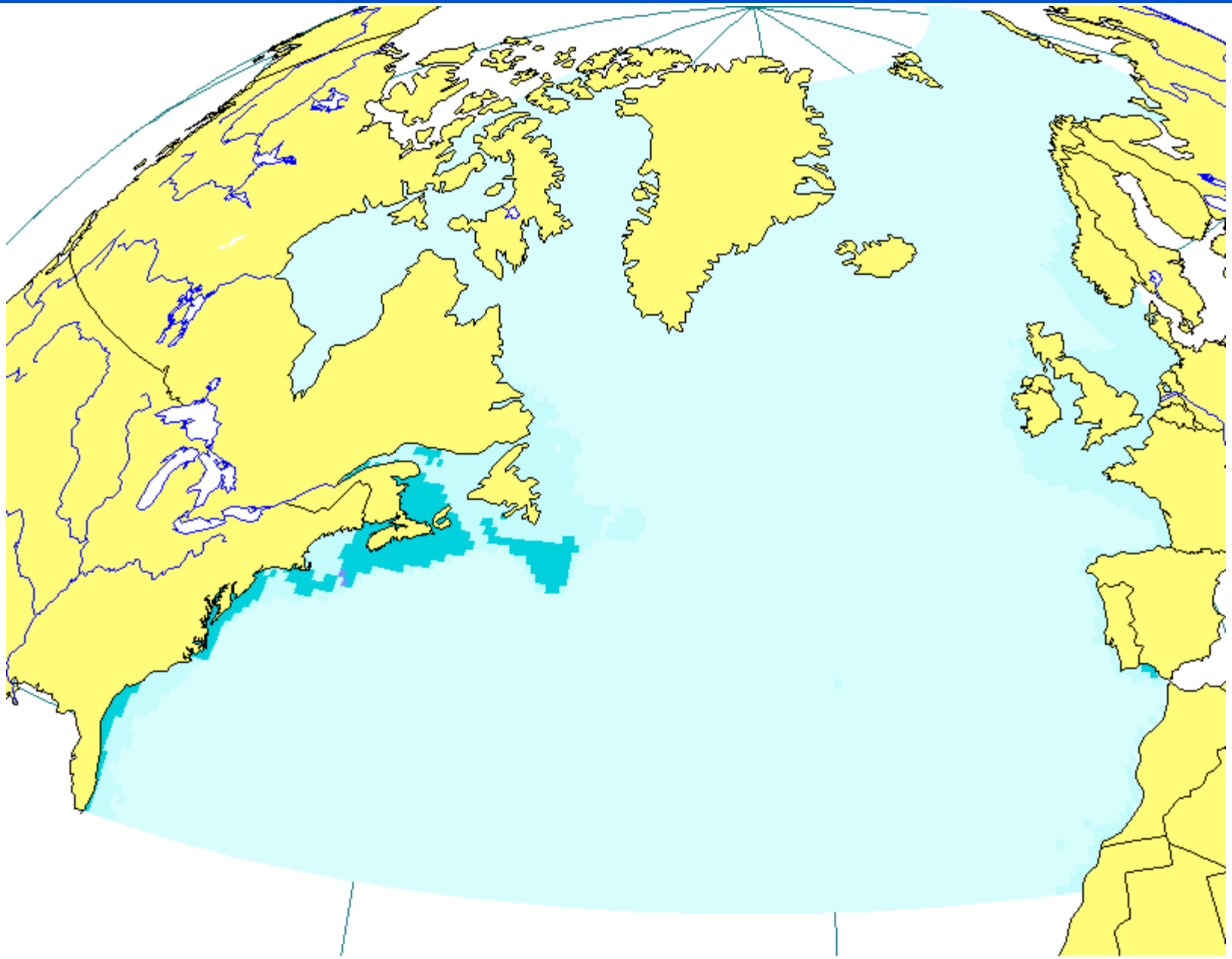
Source:
NMFS, DFO, DIFMAR, IFREMER, etc.

Fish Biomass in the Atlantic in 1900



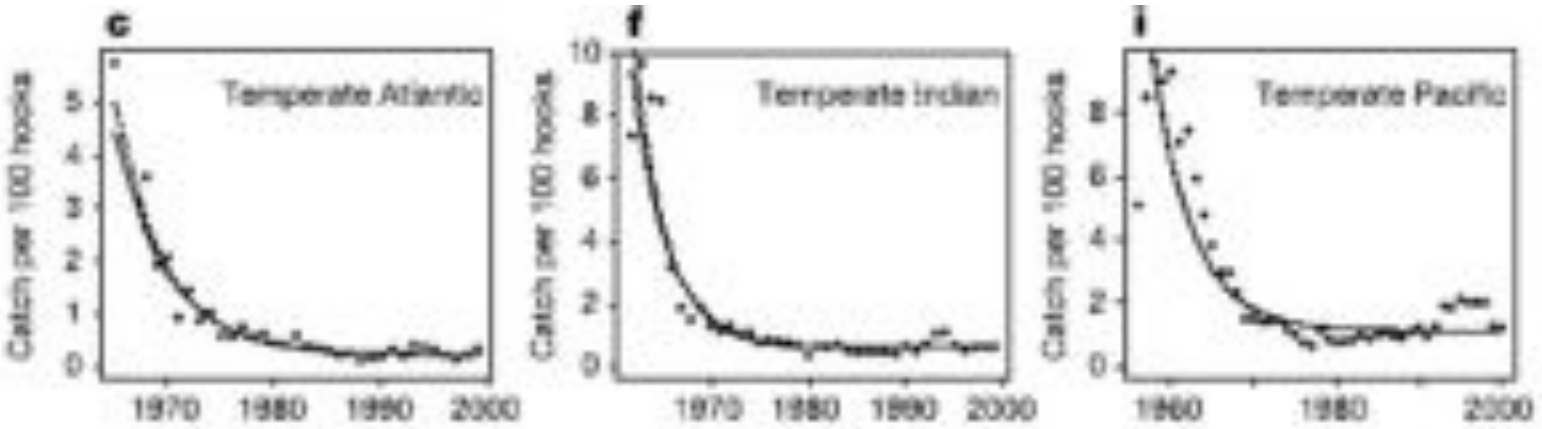
(Christensen *et al*. 2003, *Fish & Fisheries*)

Fish Biomass in the Atlantic in 1900

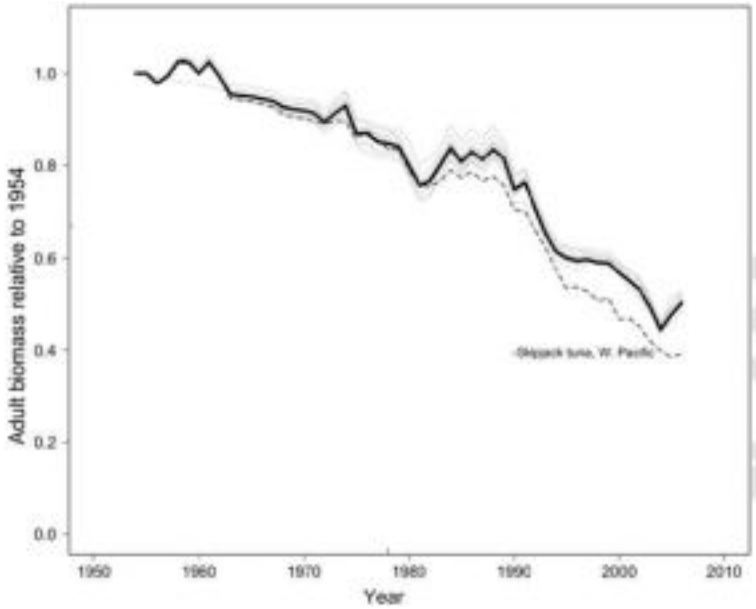


Large predatory fish (tunas, groupers, sharks)

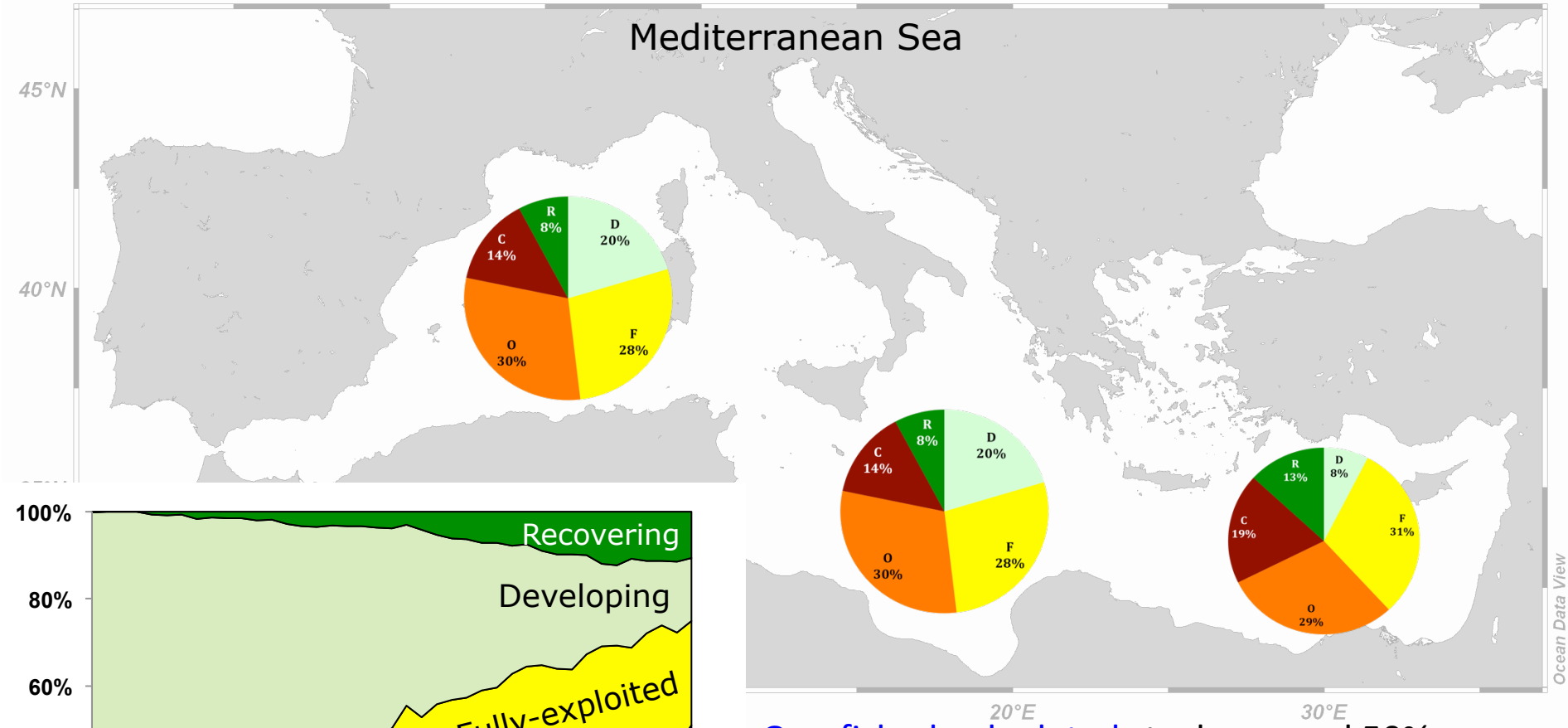
Depleted by 90% (Worm et al. 2003)???

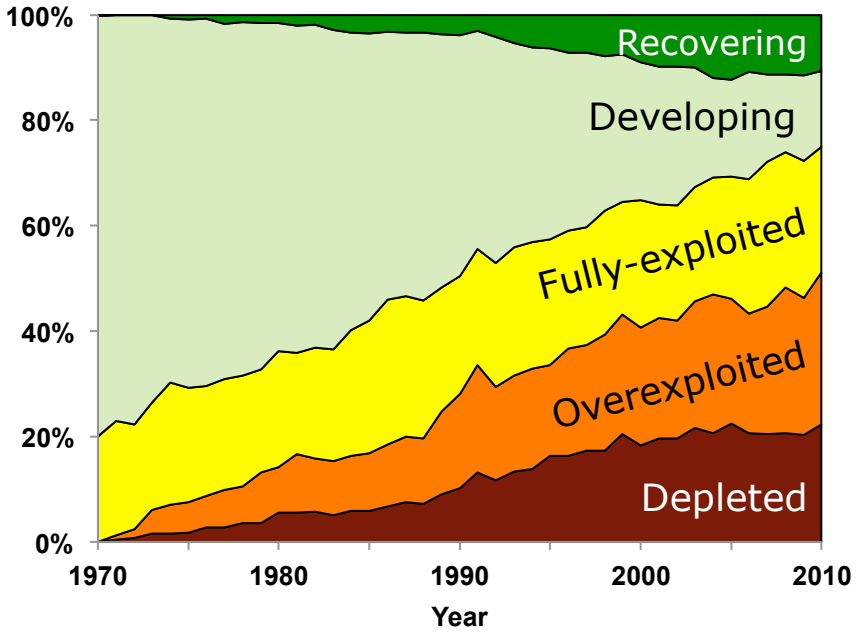


Depleted by 10-20% (Juan-Jorda et al. 2011)???



Most stocks are **overfished**, only a few fisheries are **developing**, some recover





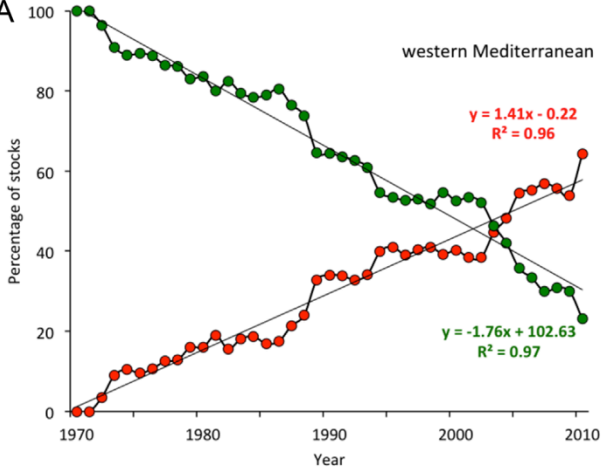
Overfished + depleted stocks exceed 50%

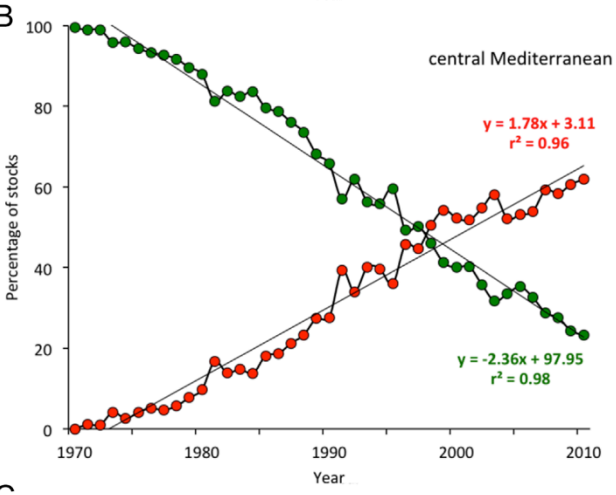
(Tsikliras et al. 2015 *PLoS ONE*)

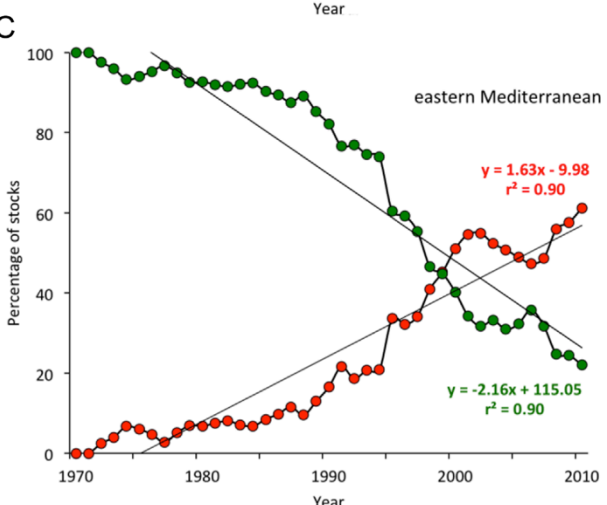
81% of stocks assessed are overfished

(Colloca et al. 2013, *Fish Fish*)

Exploitation status based on catches and assessments







The cumulative percentage of **overexploited and depleted** stocks has been increasing with time at all areas but **faster** in the central Med

The cumulative percentage of **fully exploited and developing** stocks has been increasing with time at all areas but **faster** in the central Med

Stergiou et al. 2016, Env. Dev.

Despite its fisheries exploitation for millennia and the long tradition of fishing methods used,
the **number of stocks officially assessed** in the Mediterranean is **very low** compared to other areas of the world.

Less than 150 stocks have been officially and fully assessed, usually multiple assessments of the main target species on a GSA level
(hake, red mullet, anchovy, sardine, deepwater rose shrimp, bluefin tuna)

None of the stocks of the southern coastline has ever been fully assessed!

General Fisheries Commission for the Mediterranean
Commission générale des pêches pour la Méditerranée

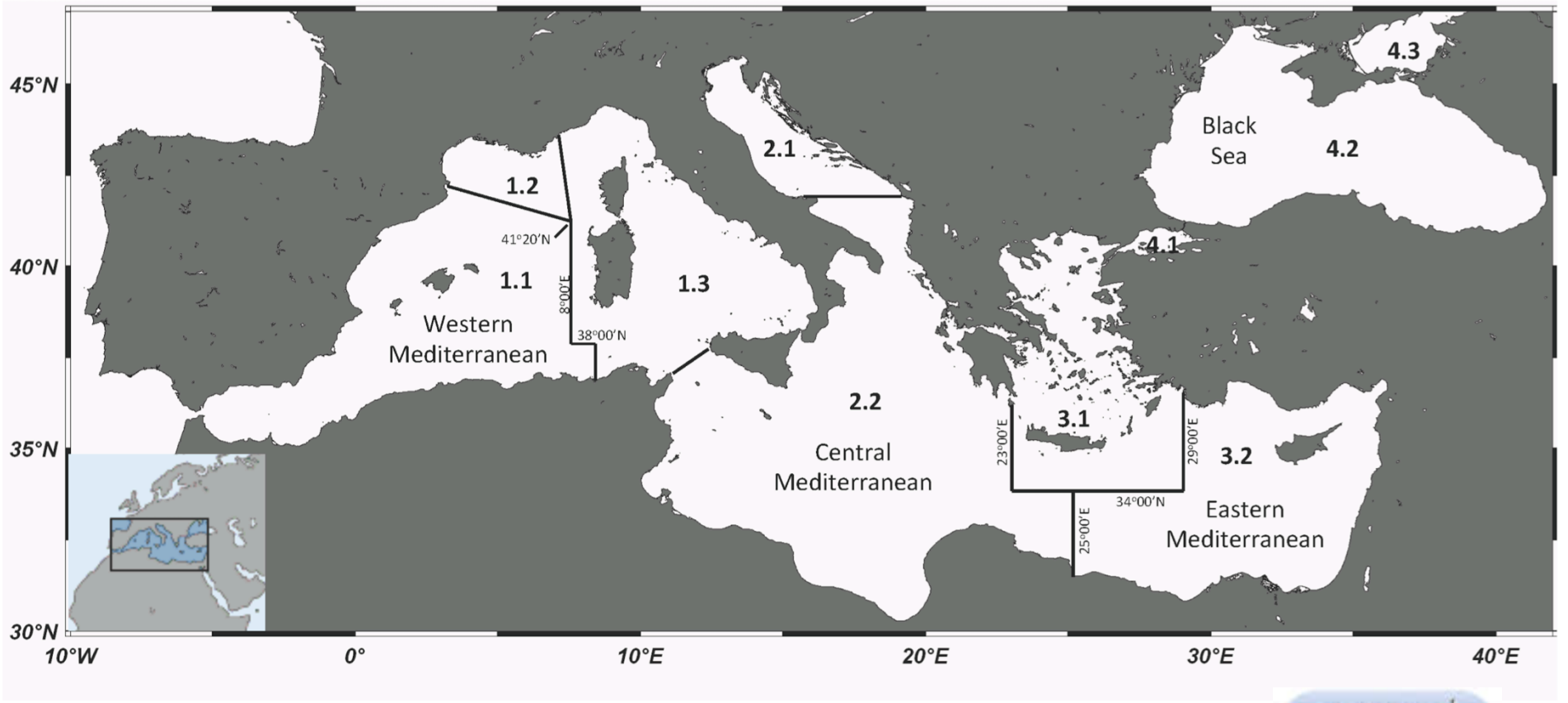
JRC SCIENTIFIC AND POLICY REPORTS

REPORT OF THE SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES ON

Assessment of Mediterranean Sea stocks – part 1

(STECF 12-19)

Division of the Mediterranean into **three subregions** (western, central, eastern) **and seven subdivisions** (plus 3 more in the Black Sea) in FAO and General Fisheries Commission for the Mediterranean (GFCM)



FAO/GFCM databases

Official fisheries data collection on country and area basis

(e.g. Greece/Aegean Sea)

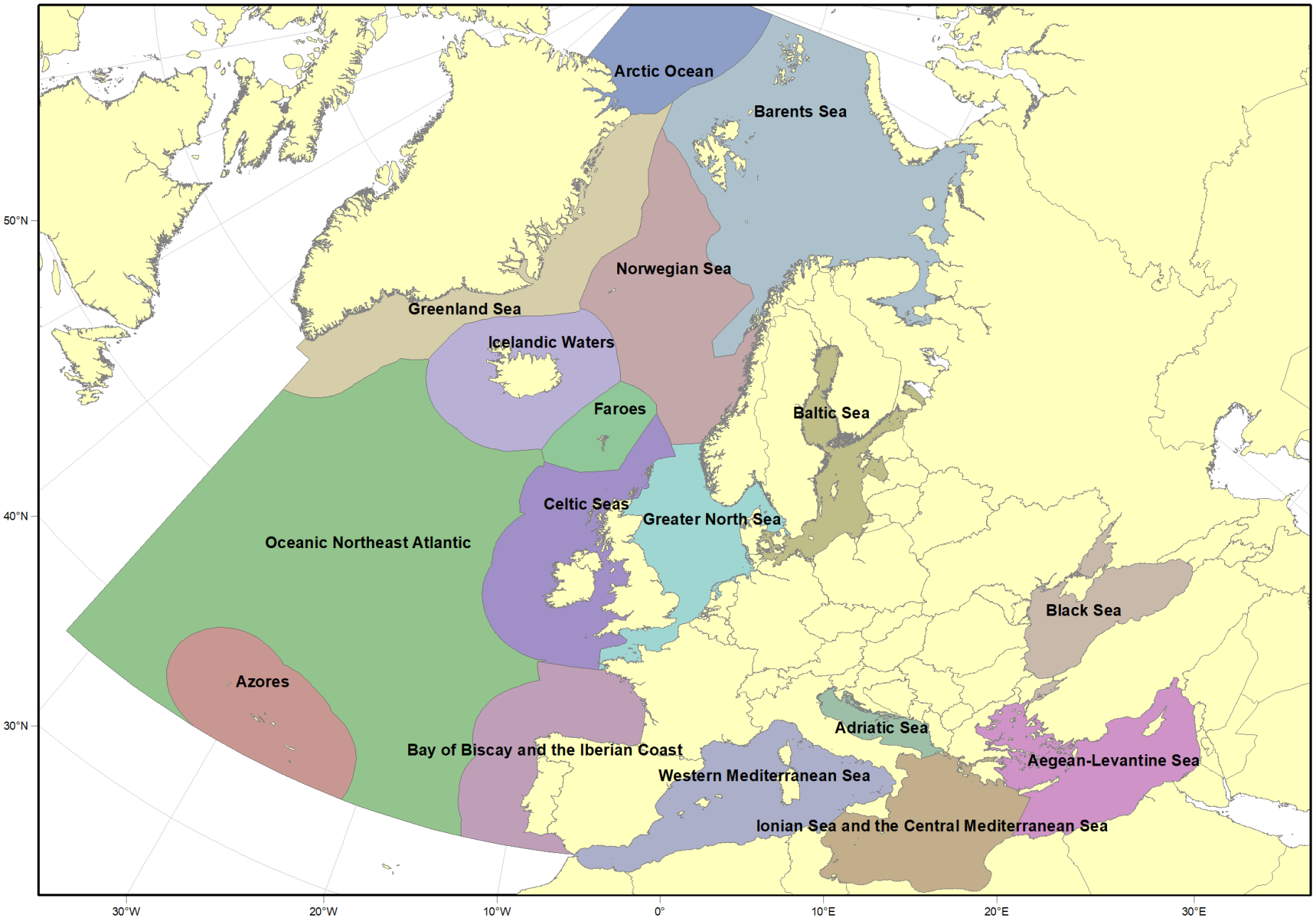
Further subdivision from GFCM to small units for management purposes

Geographical Sub-Areas (GSAs)

The reference points in stock assessments are determined on a GSA level

(GSA 19-20 is the Ionian Sea, GSA 22 is the Aegean Sea and GSA 23 is Crete alone)

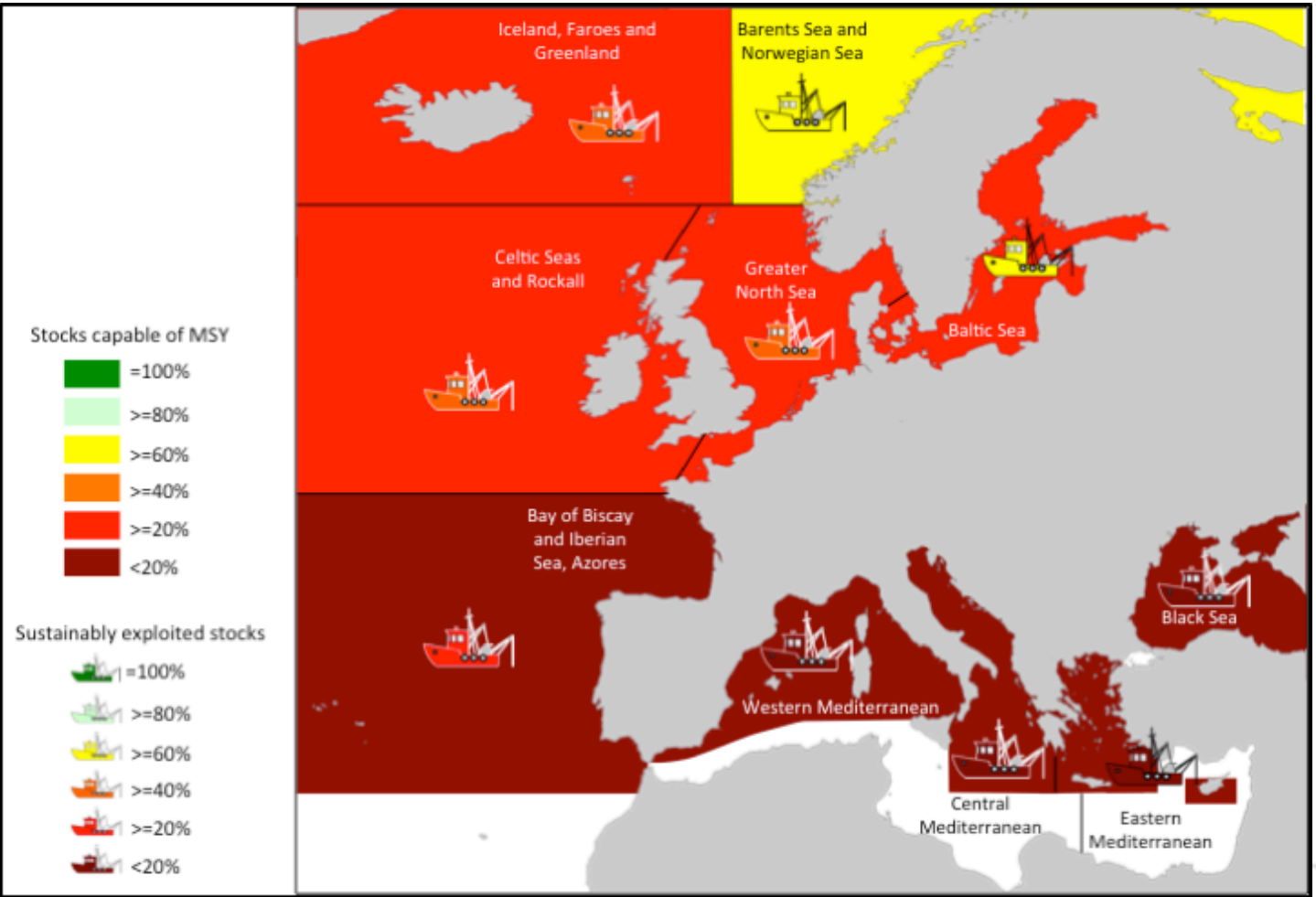
Mediterranean Sea: ecoregions



A recent assessment of nearly 400 european fish and invertebrate stocks revealed that…

The majority of European fish and invertebrate stocks are in **bad condition** and are **overexploited**

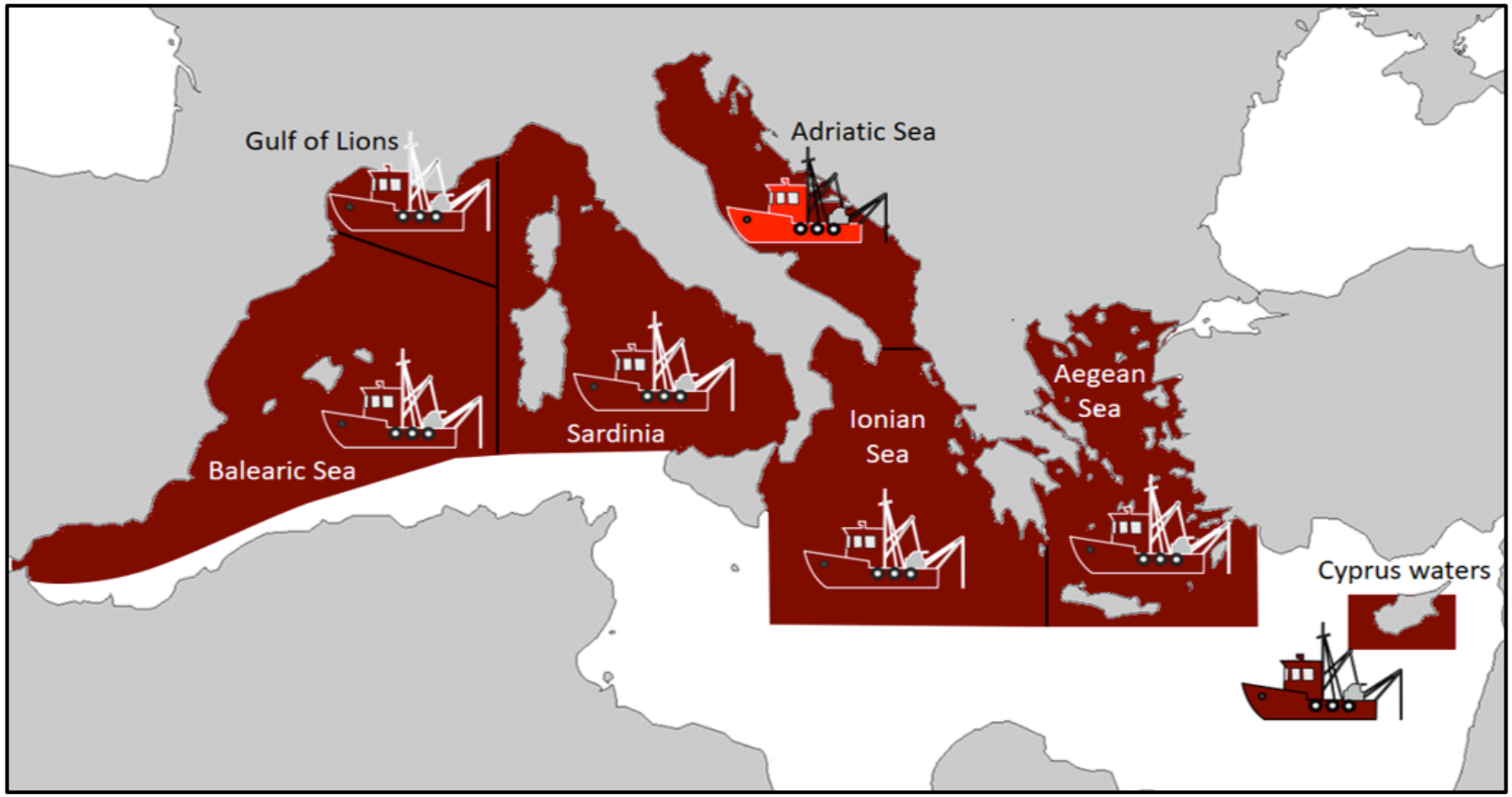
A striking north → south gradient was observed, with the southern stocks being in worst state



Froese et al. 2016, 2018

The detailed assessment per area of the 169 Mediterranean stocks showed the same picture

The vast majority of Mediterranean fish and invertebrate stocks are in bad condition because they are **overexploited** and **mismanaged**

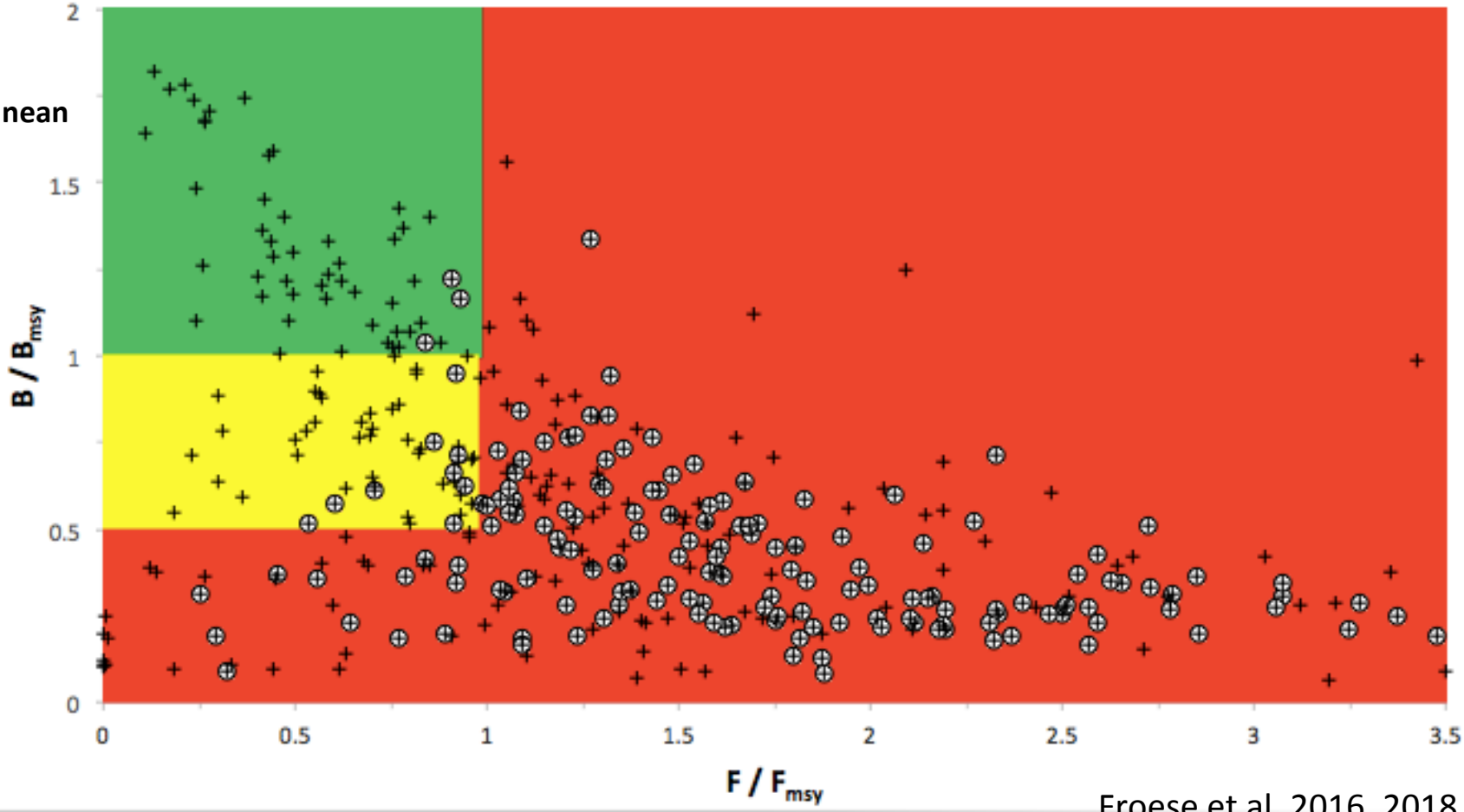


Tsikliras et al. in preparation

The NE Atlantic stocks are in better condition compared to the Mediterranean ones that are concentrated in the **RED** area of the plot

+ : Atlantic

⊕ : Mediterranean



Froese et al. 2016, 2018

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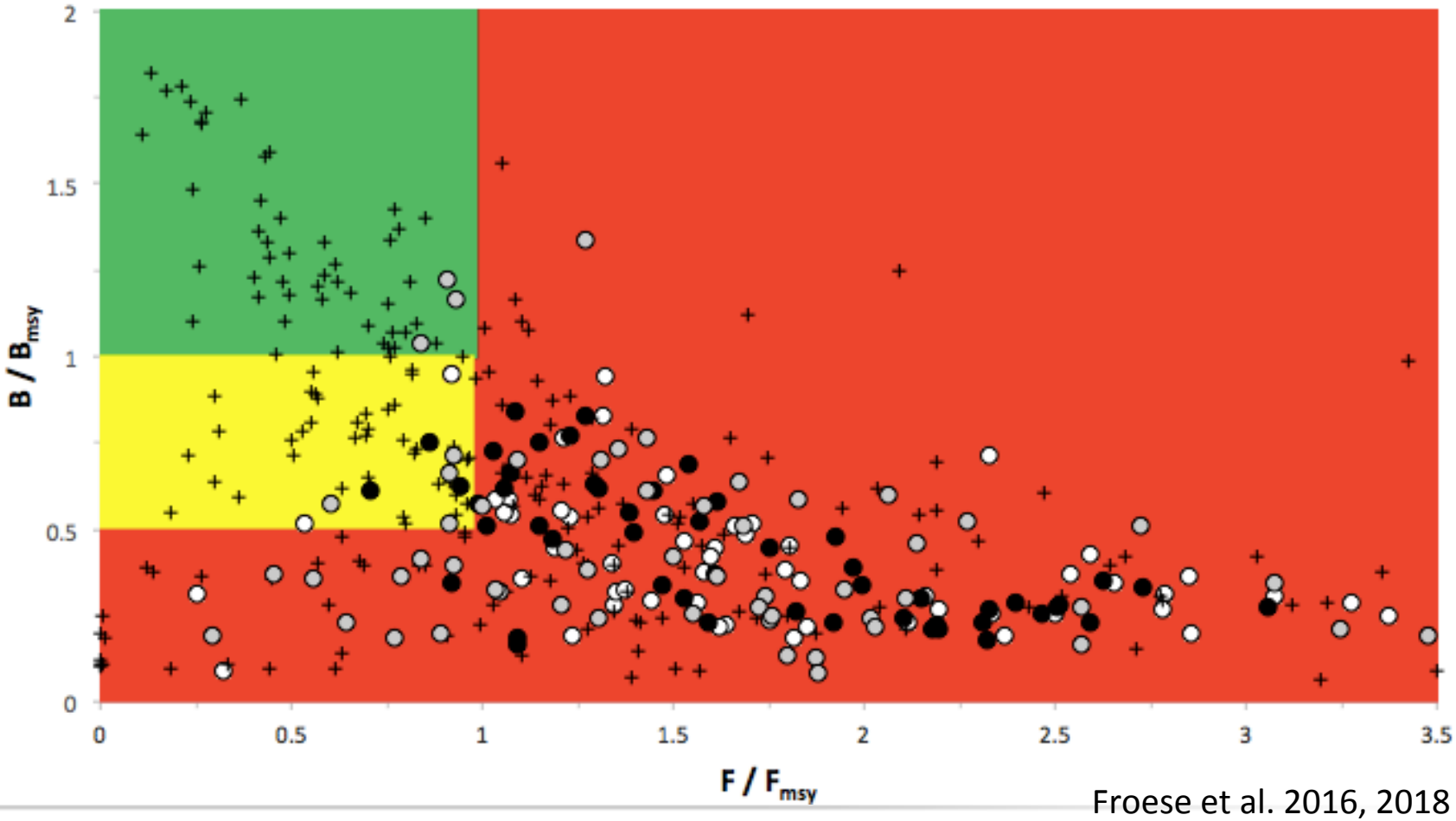
○ : C Med

● : E Med

○ : W Med



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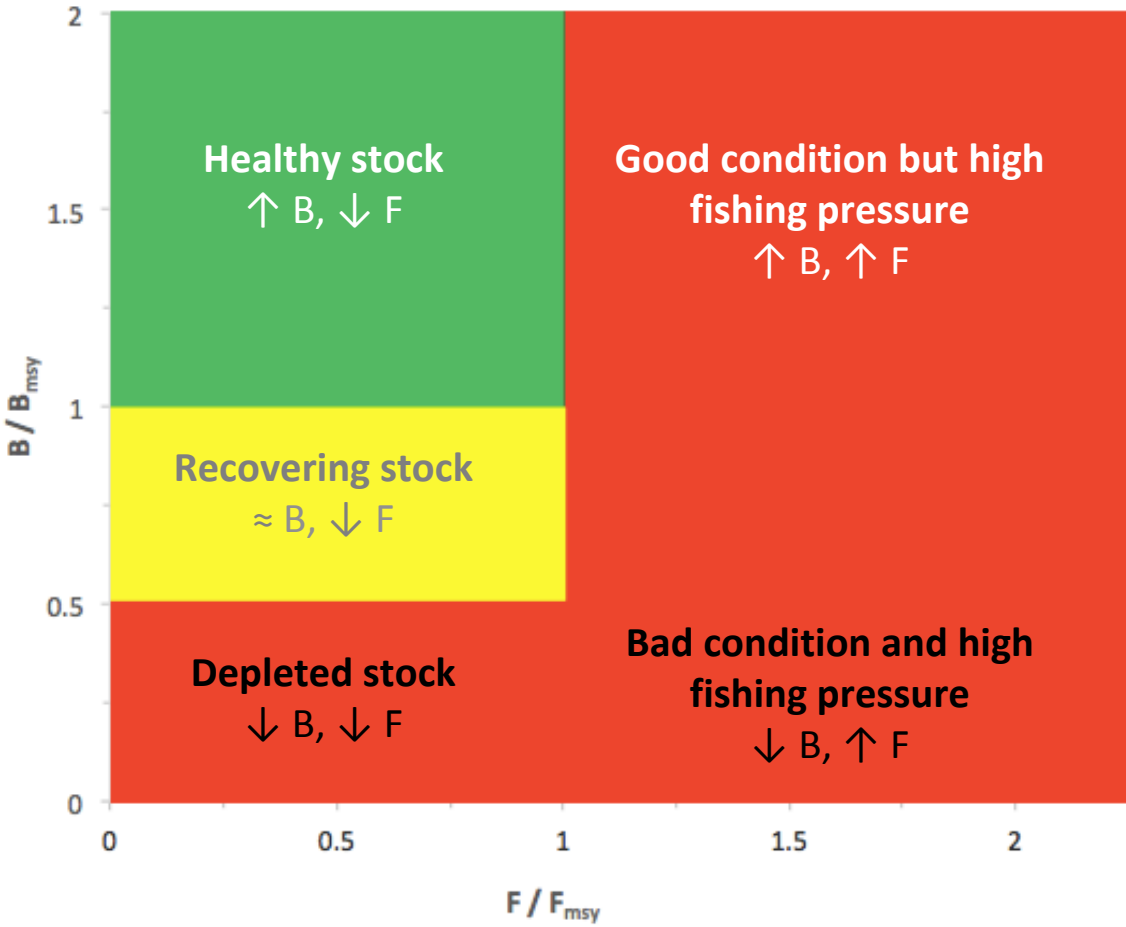
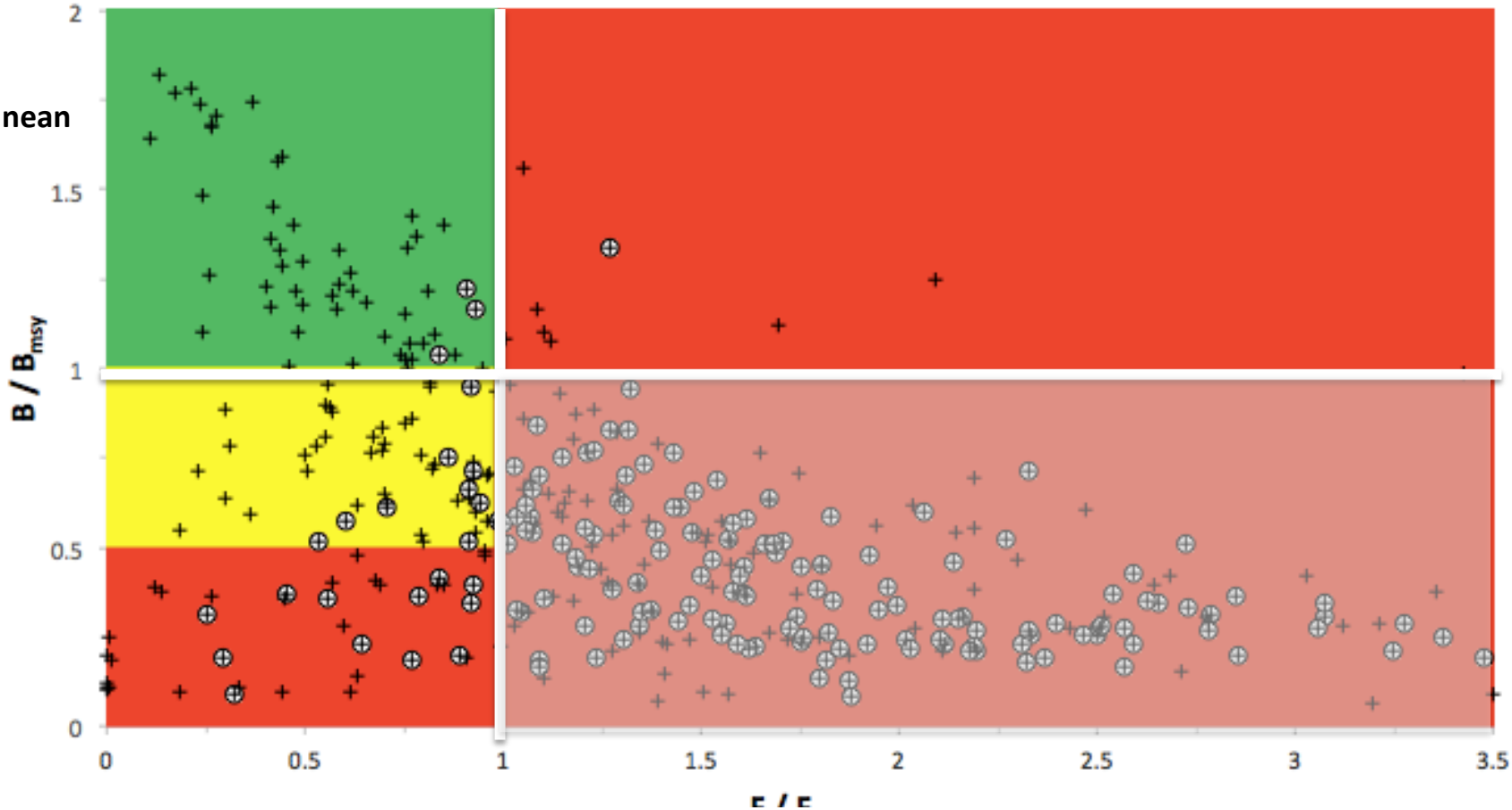


The Mediterranean stocks are doing really bad and we are not willing to ease the pressure one them

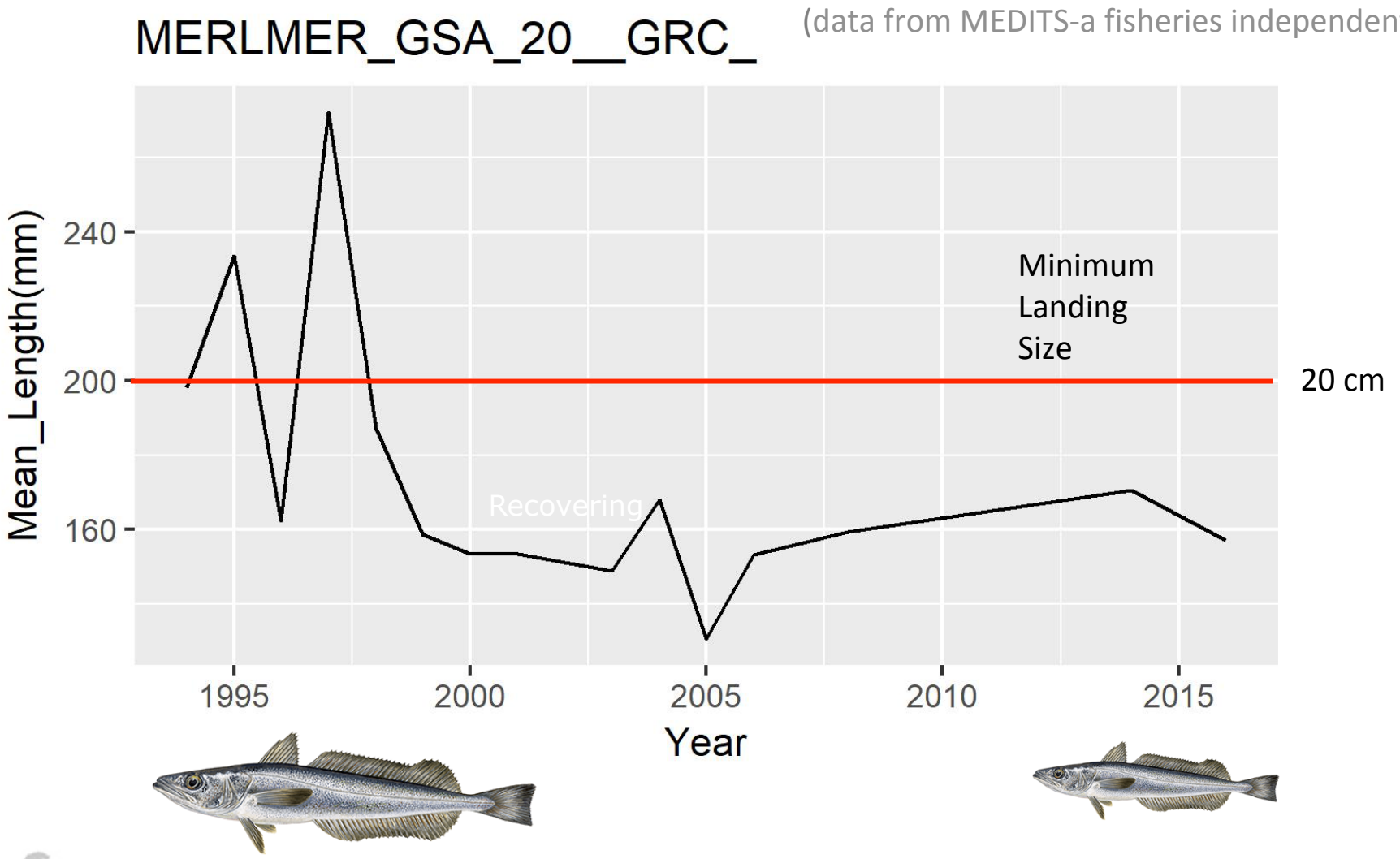
+ : Atlantic

⊕ : Mediterranean



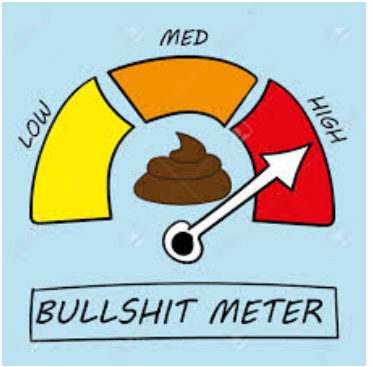
Froese et al. 2016

The mean length of hake in the Ionian Sea declines since 1998



Most hakes caught are undersized, in fact **juveniles**

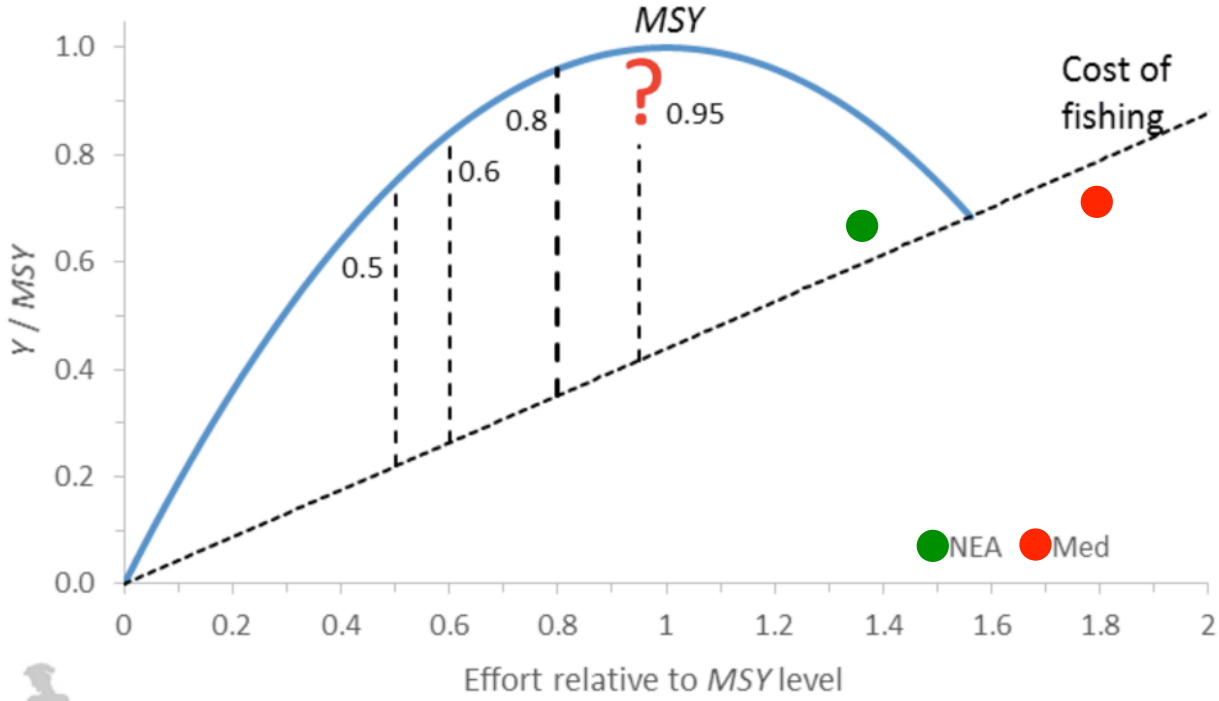
One of the greatest ^@£@%!@ in fisheries science?



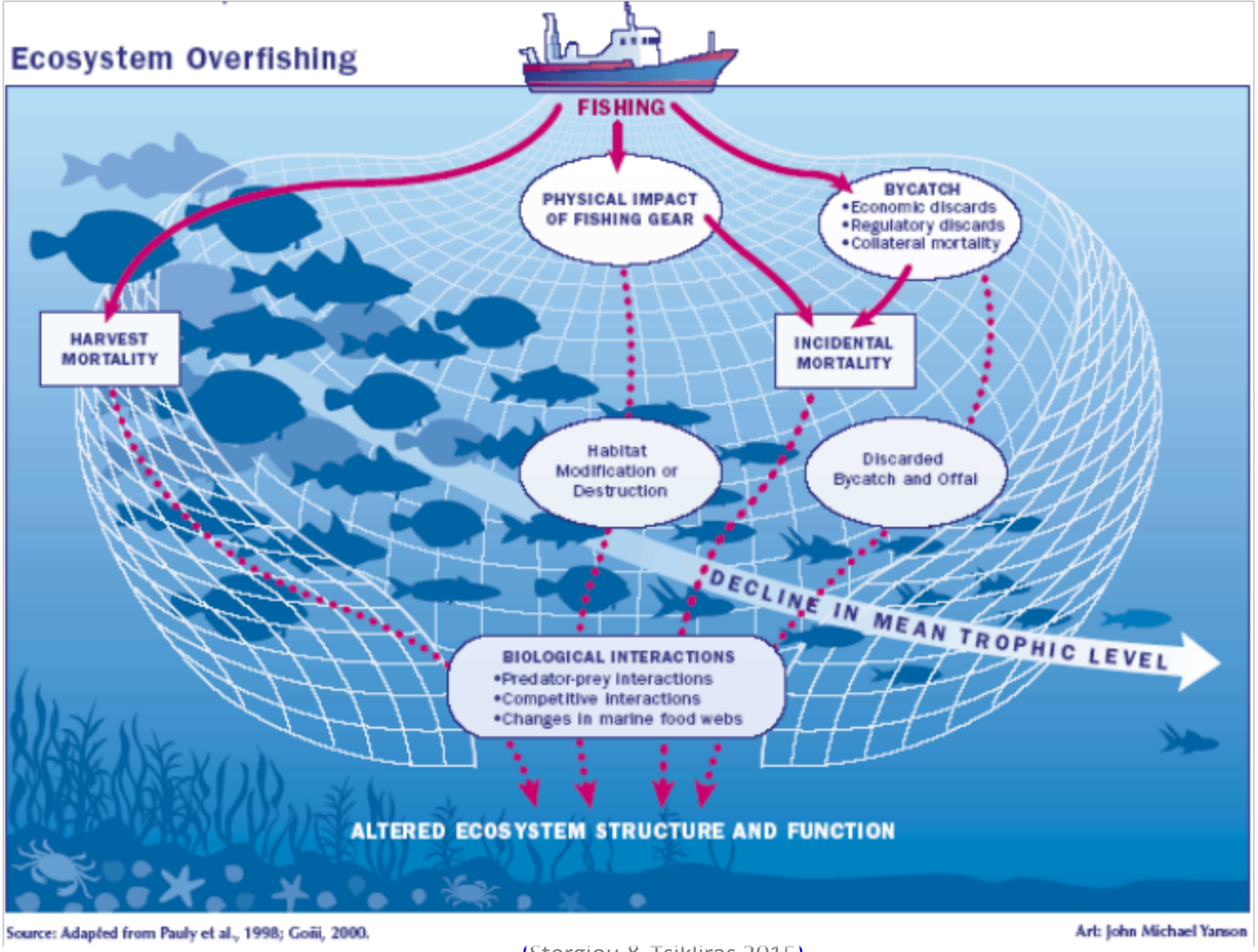
The illusion that *higher fishing effort results in higher profits*...

Only **cost** is linearly related to fishing effort

Profit is maximized **ONLY** when stocks are sustainably exploited.



Froese et al. 2018, Marine Policy



(Stergiou & Tsikliras 2015)

Ecosystems malfunction and become less resilient to external pressures (e.g. climate change)

Disagreement in global fisheries matters

- Overfishing or not?

(Worm et al. 2006 Science, Worm et al. 2009 Science)

- Fishing down, through or up?

(Pauly et al. 1998 Science, Branch et al. 2010 Nature)

- Selective or balanced harvesting?

(Froese et al. 2008 Fish Res, Garcia et al. 2012 Science)

- Assessment based on catches or survey data?

(Pauly 2013 Nature, Hilborn & Branch 2013 Nature)

The two sides (conservation biology-economic benefits) are well and clearly represented (sea and fish-fishers and industry)

D. Pauly
University of British Columbia

"…the larger, longer-lived fishes of the top of the food web are depleted faster than the smaller, shorter-lived fish and invertebrates".

R. Hilborn
University of Washington

"…the notion that fishers sequentially deplete food webs - starting with the predators and working their way down - is not supported by data"

The debate

R. Hilborn
University of Washington

D. Pauly
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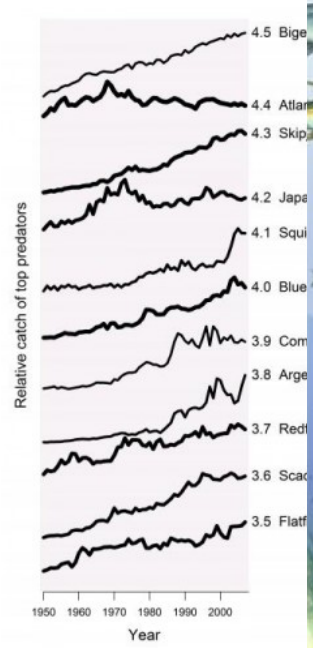
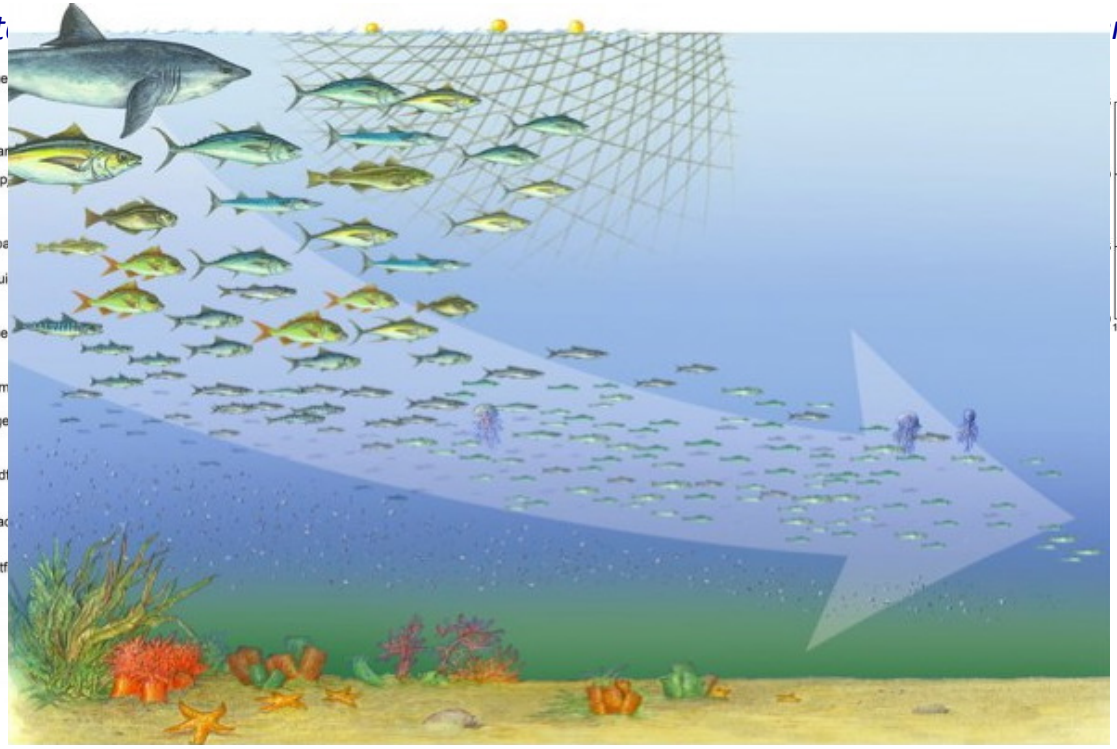
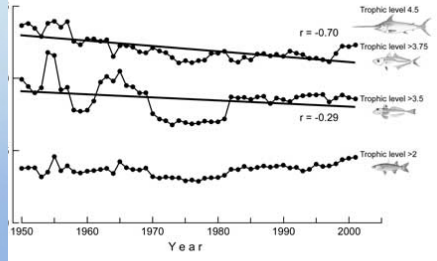


Branch et al. 2010

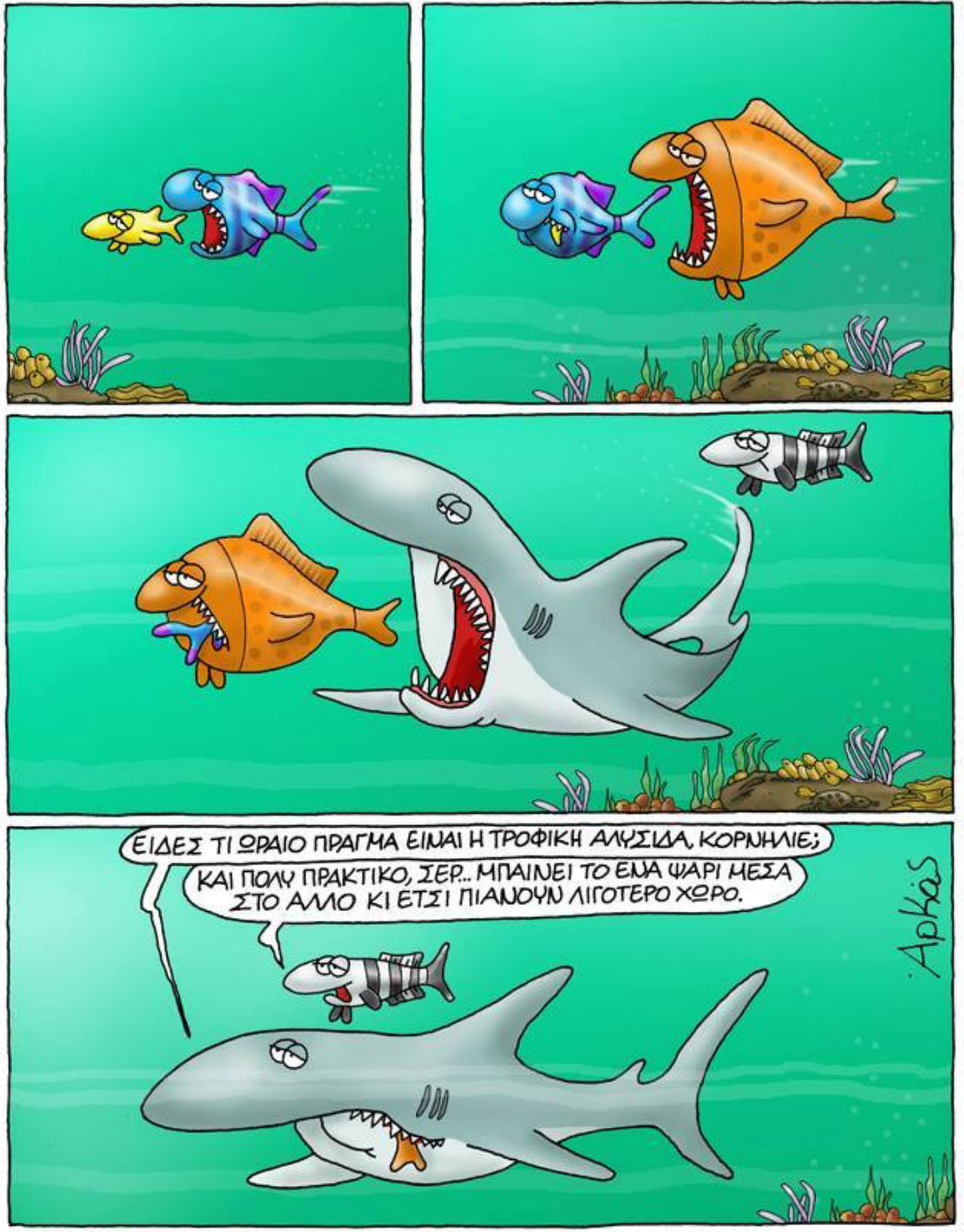




Stergiou 2005

No --------- Fishing-down ---------- Yes

Food web dynamics



Trophic level estimation

Trophic level, TL

$$TL_i = \sum_j TL_j \cdot DC_{ij}$$

Position of an organism in the marine food web

Mean trophic level of the catch

$$\overline{TL}_k = \frac{\sum_i (TL_i) \cdot (Y_{ik})}{\sum_i Y_{ik}}$$

Evaluate the effect of fisheries on marine organisms and ecosystems

Feeding and trophic level

The trophic level of marine organisms ranges from 2.0 to 5.5:

- 2.0 for herbivores

Sarpa salpa

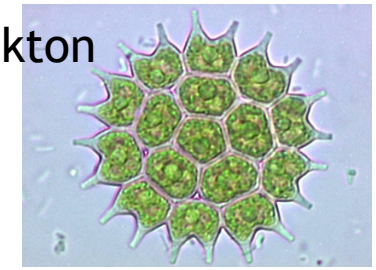
- 5.5 specialized top predators feeding on marine mammals

Orcinus orca

Phytoplankton and detritus are positioned by definition at the bottom of the food web

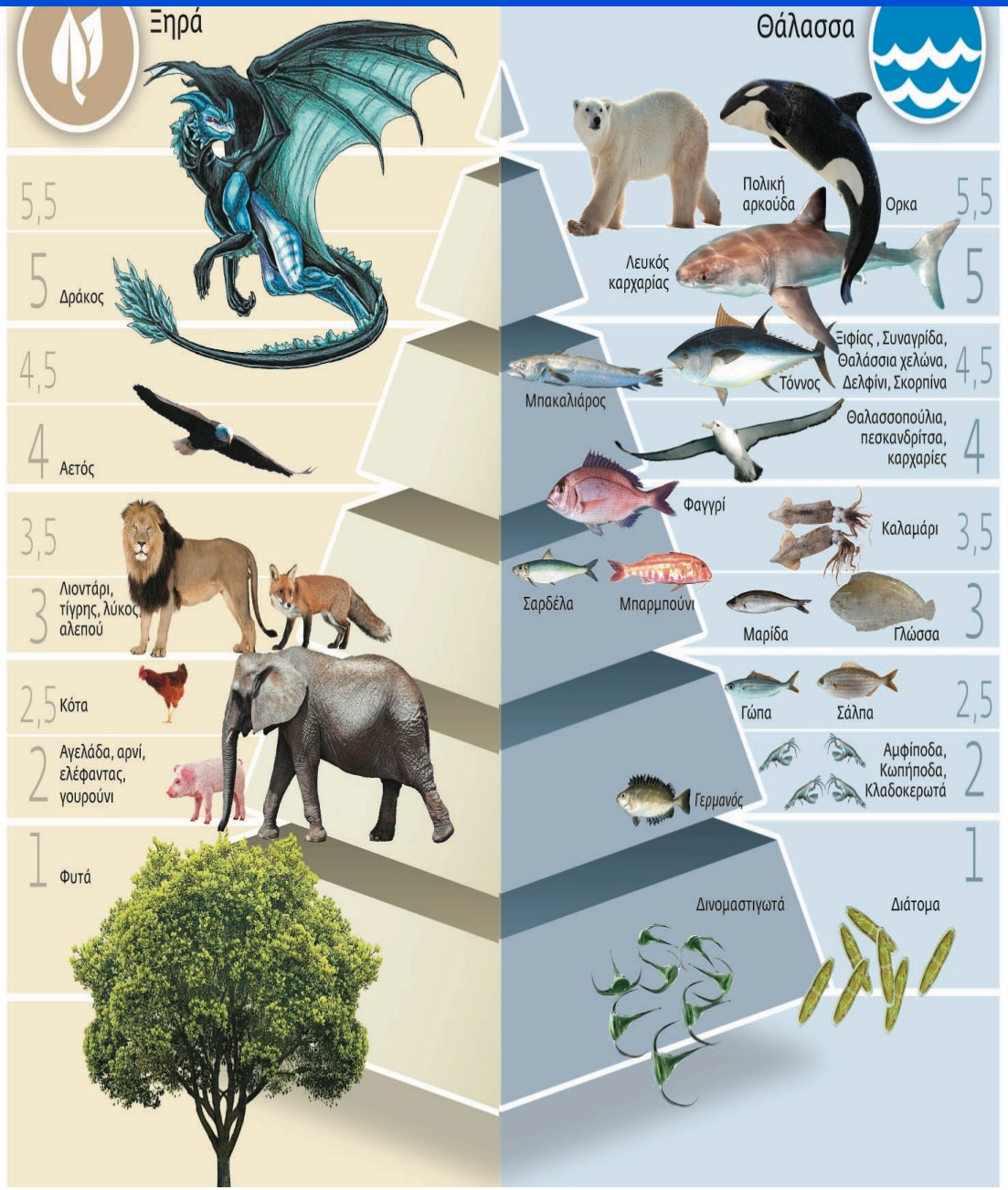
trophic level = 1

Zooplankton feeding on phytoplankton at 2.0



Comparing terrestrial and marine ecosystems

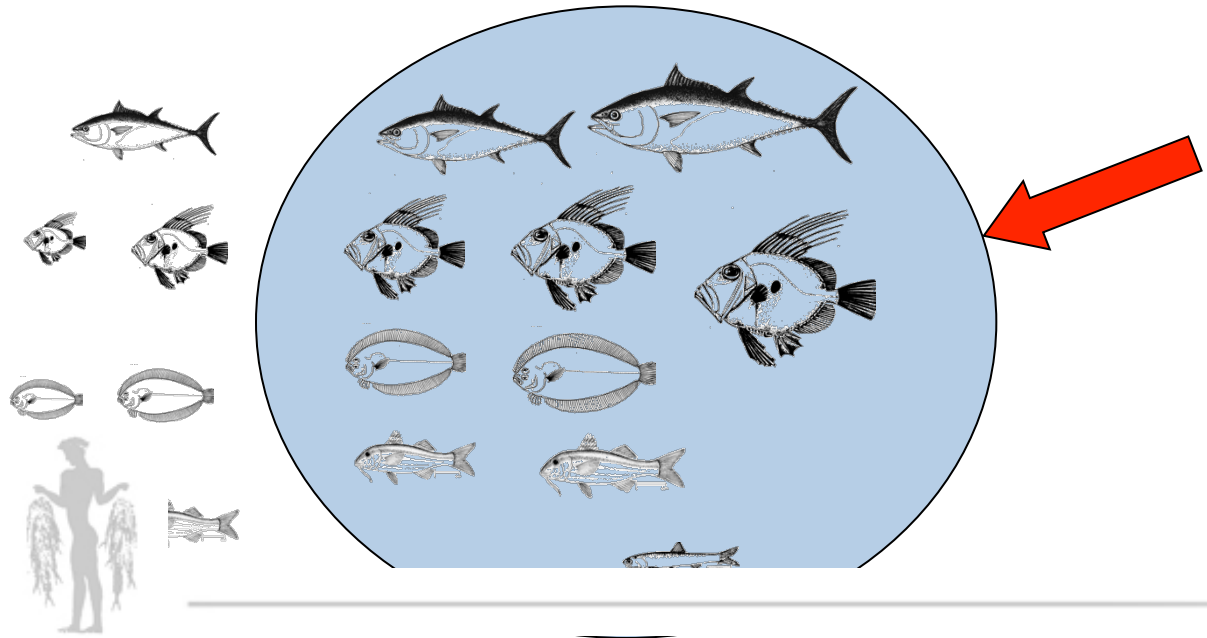
Human trophic level 2,5



Size matters

Because trophic level increases with size
(big fish eating smaller fish)

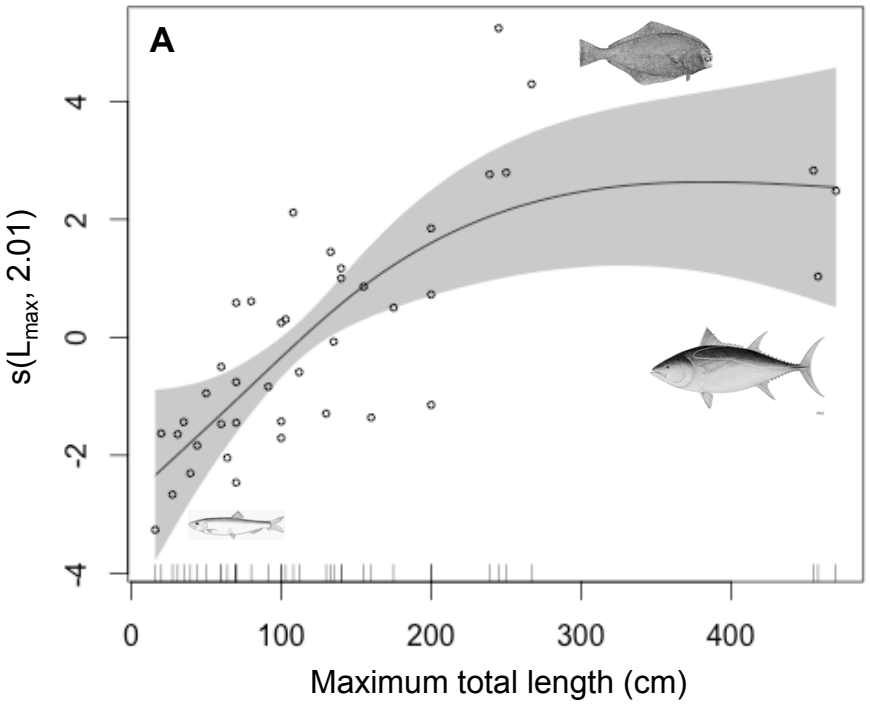
Because fishing selectively targets and removes larger species and individuals (stored biomass)



Within and among species

Target determined by size?

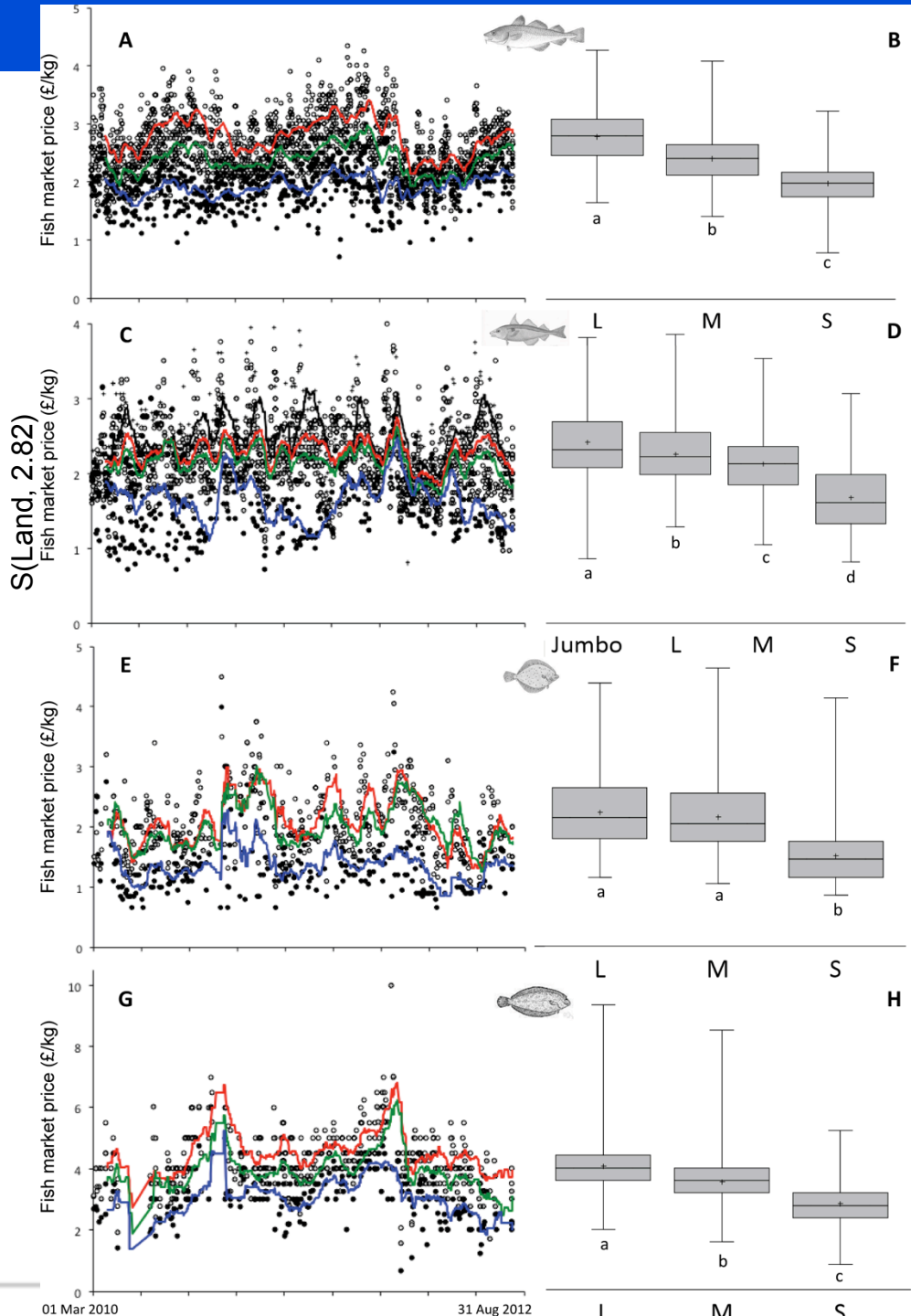
Within species



→Positive correlation with

→ maximum total length

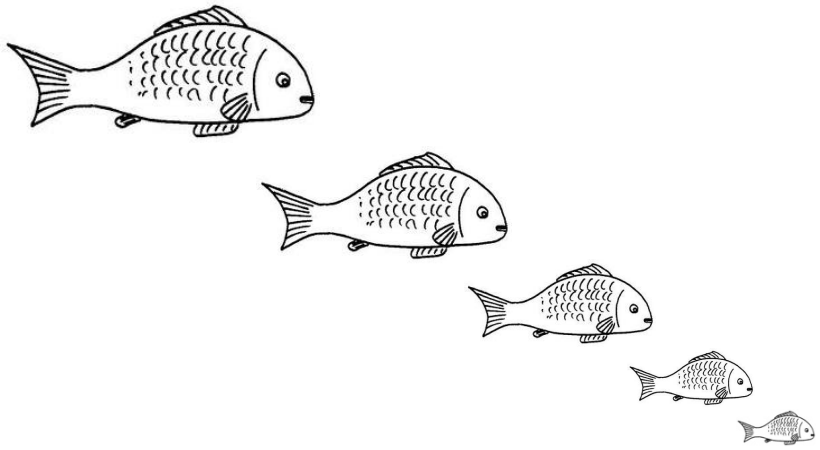
→ common total length

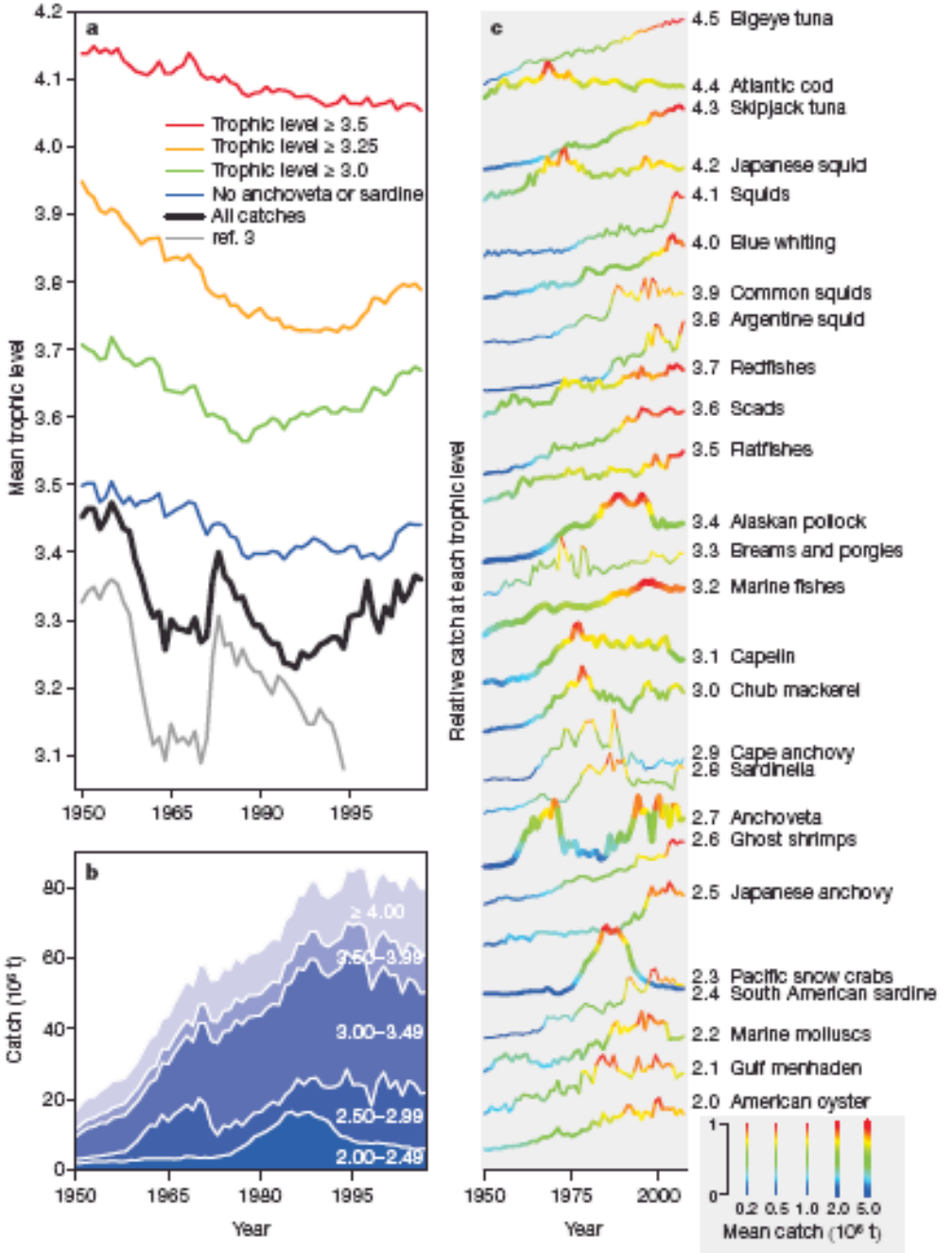


Size matters

Mean trophic level and mean size at catch are declining,

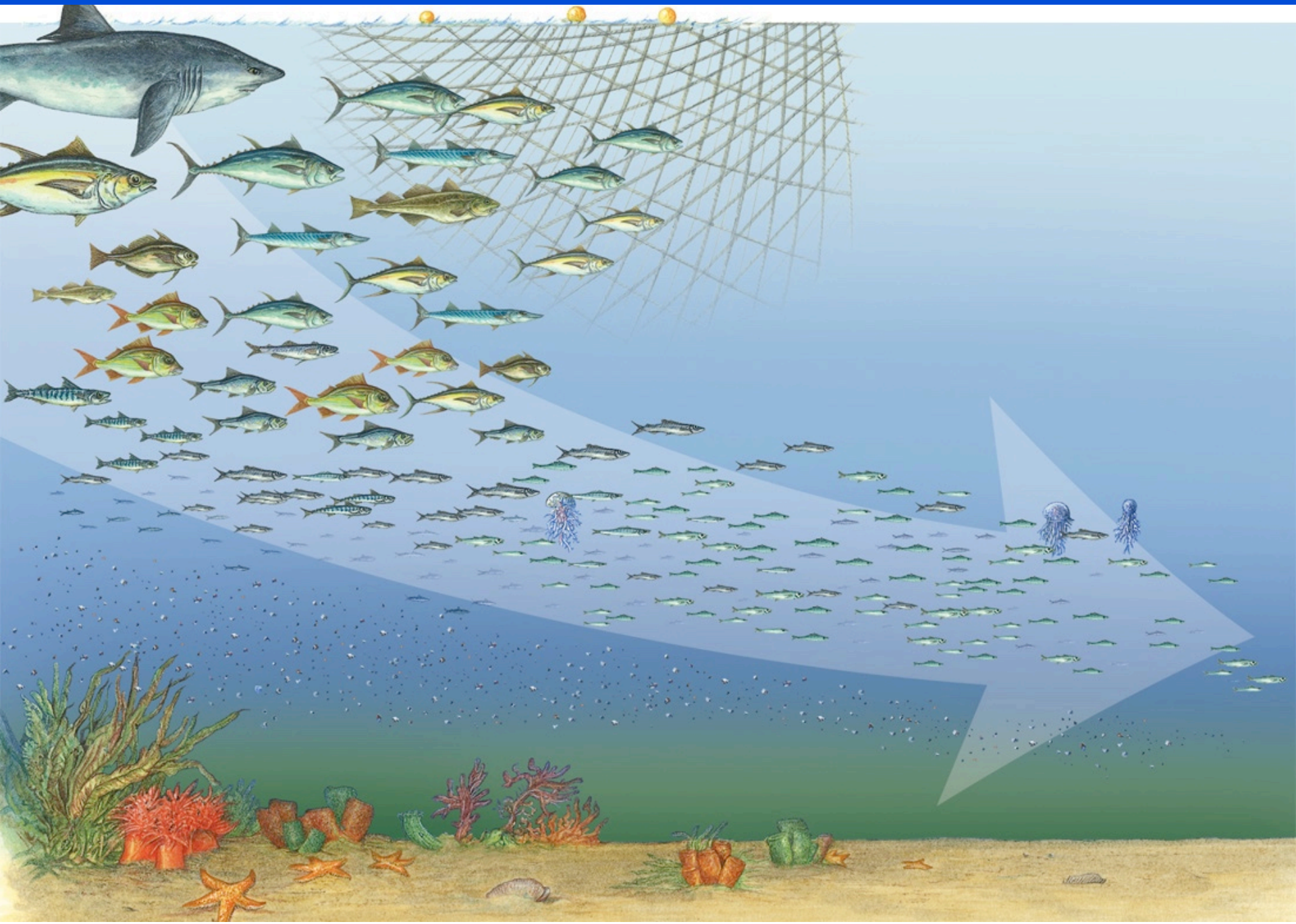
Reflecting the decline in sizes within the marine ecosystem



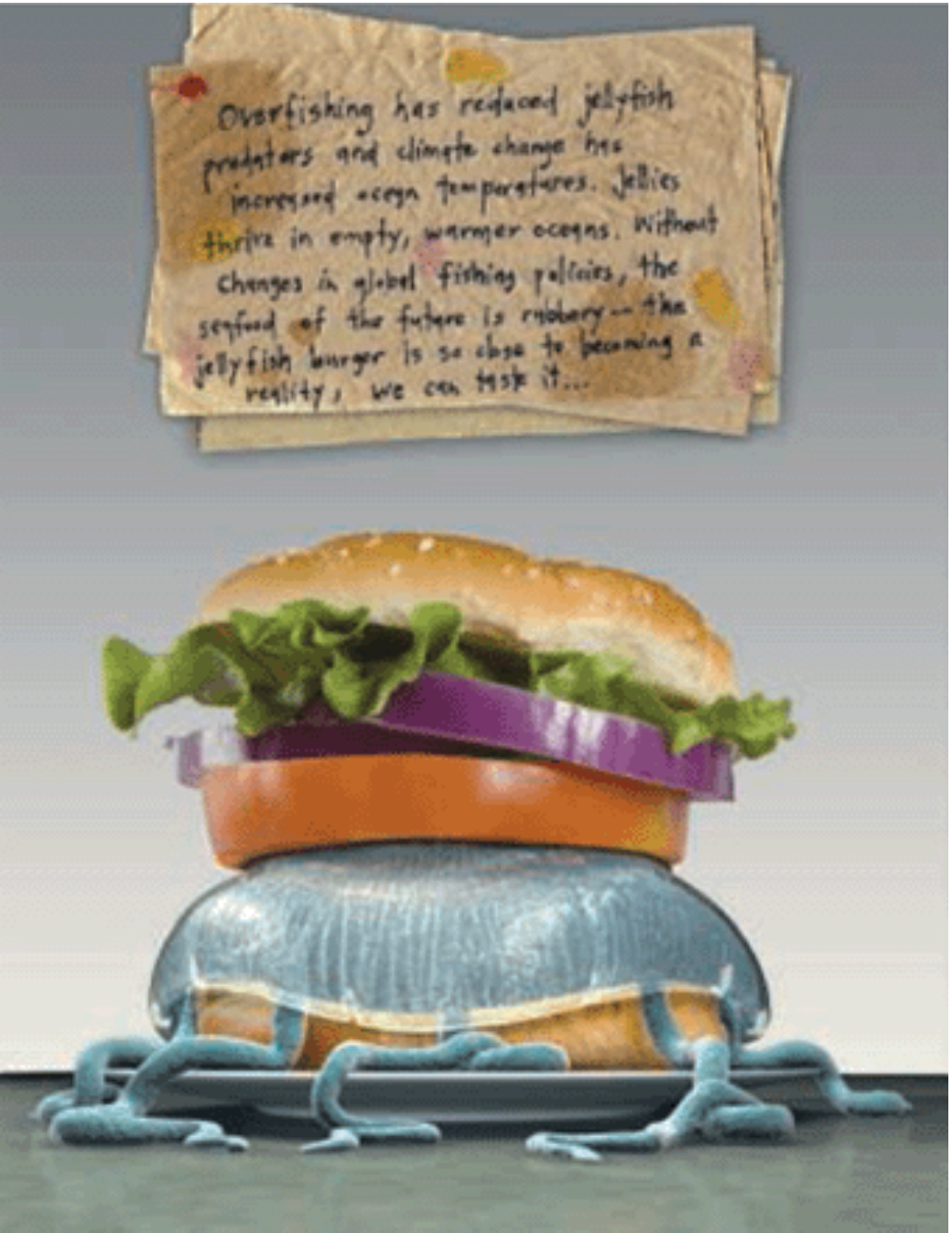


(Branch et al. 2010)

Fishing down the marine food webs



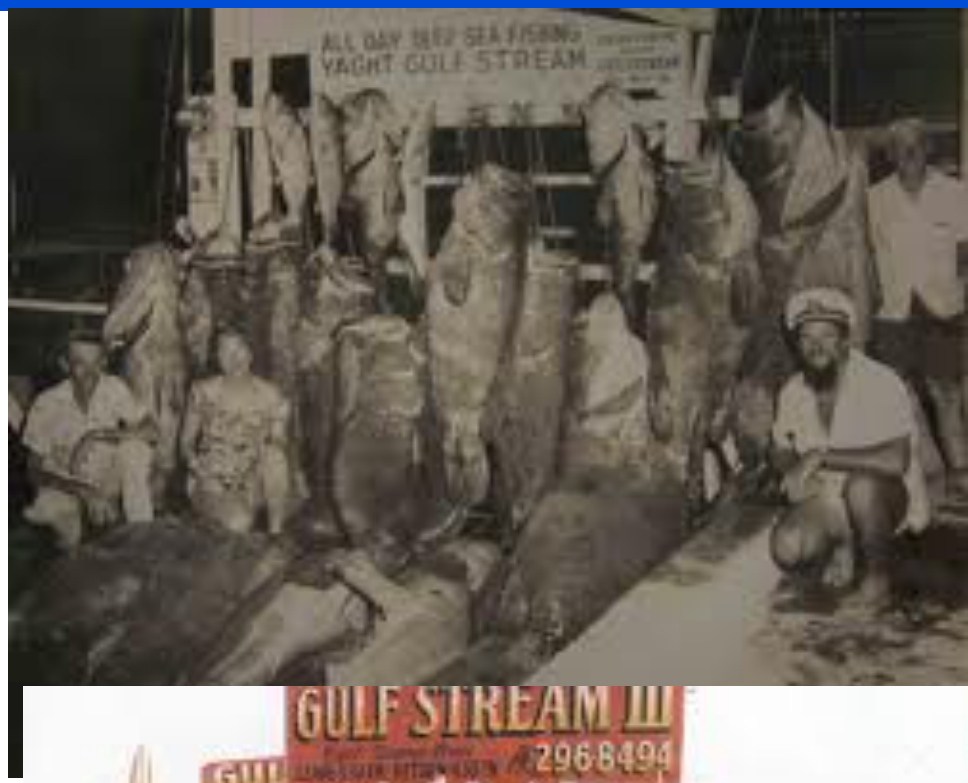
Jellyfish-burger?



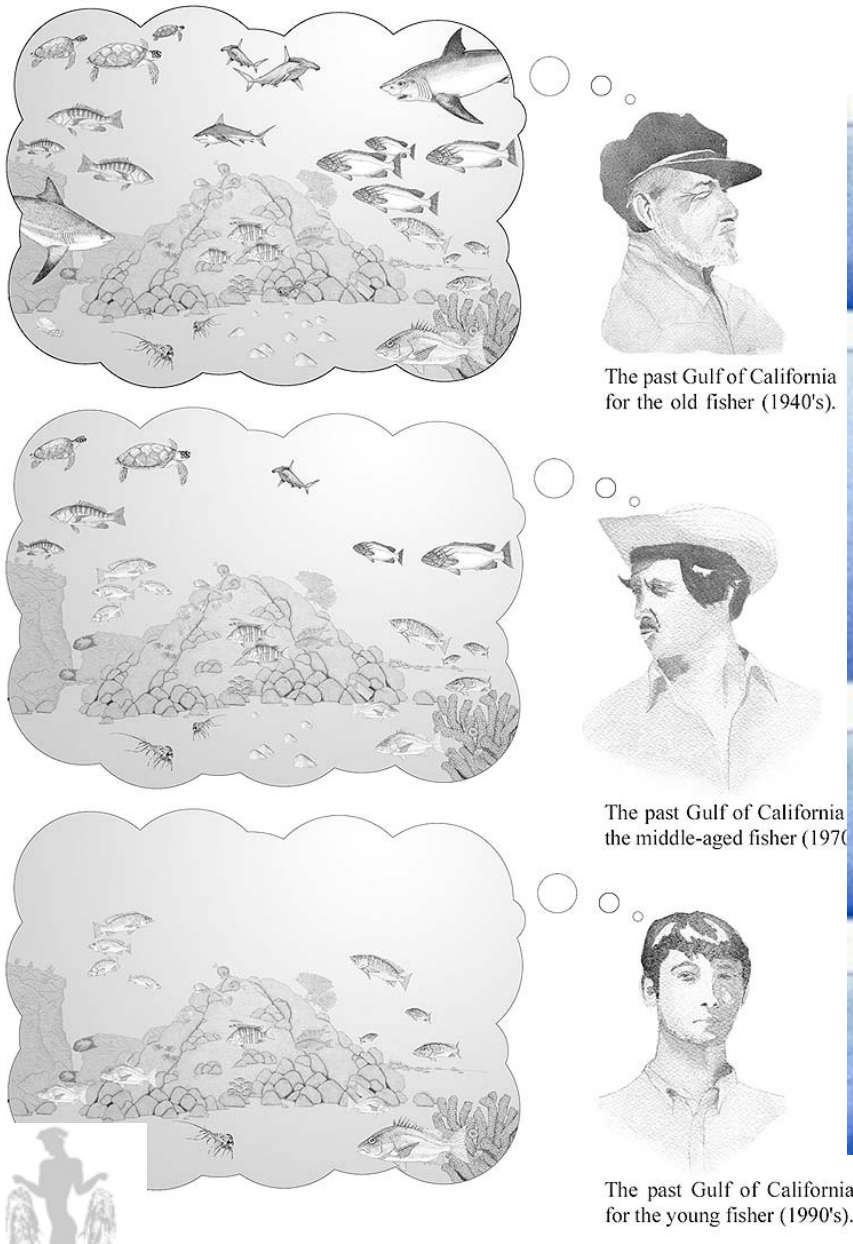
«Η υπεραλίευση έχει μειώσει τους θηρευτές και η αύξηση της θερμοκρασίας έχει αυξήσει την αφθονία των μεδουσών. Αν δεν αλλάξουν οι αλιευτικές πρακτικές, τα jellyfish-burgers δεν απέχουν πολύ από την κοντινή μας καθημερινότητα…»

Science 327, 946-948 (2010)

Fish used to be larger



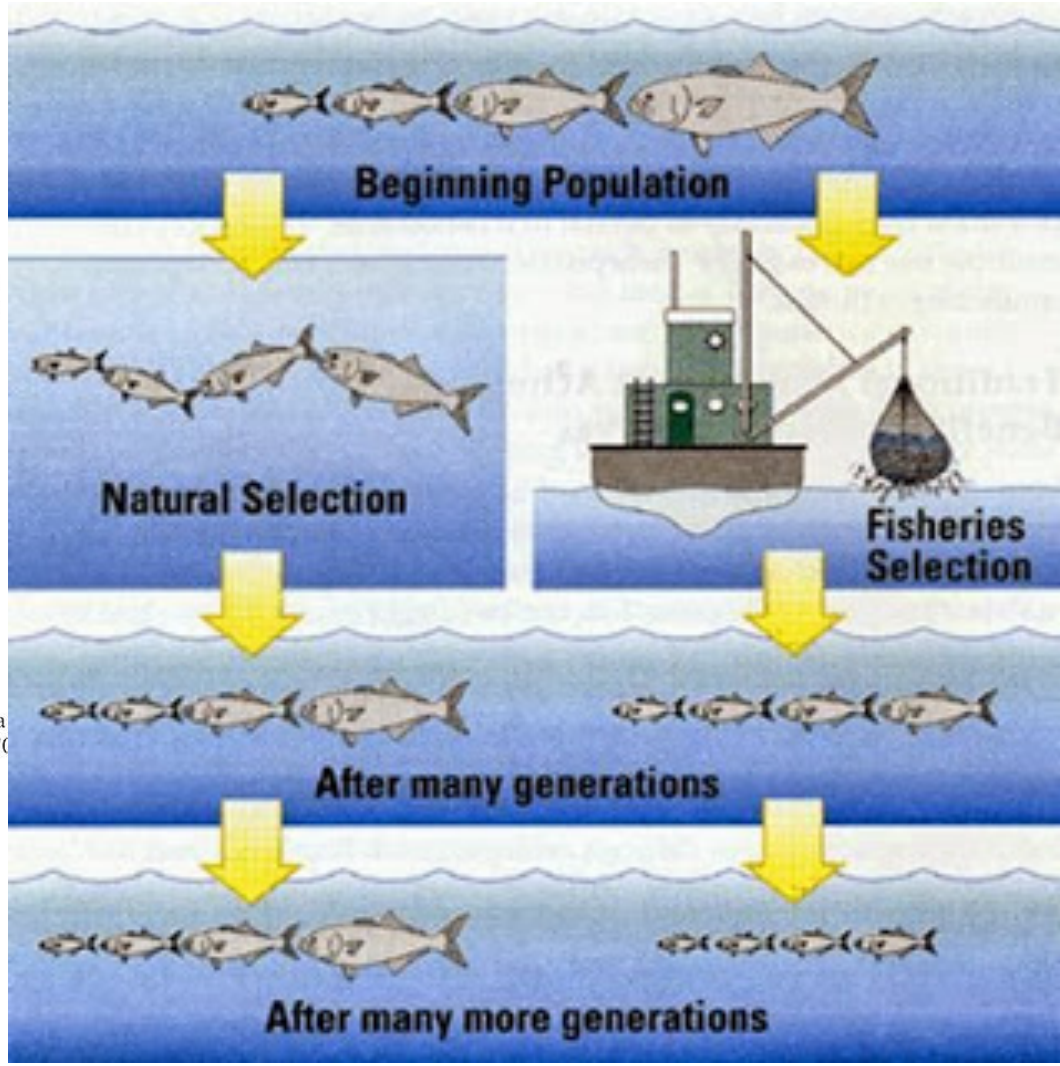
Fish used to be larger



The past Gulf of California for the old fisher (1940's).

The past Gulf of California the middle-aged fisher (197(

The past Gulf of California for the young fisher (1990's).



Toy Tuna MSE

https://puntapps.shinyapps.io/tunamse/

1. Try to find the MSY by adjusting the catch
   - try to save the fishery
   - try to collapse the fishery

2. Use a harvest control rule to manage the fishery
   - try to save the fishery
   - try to collapse the fishery

Questions

What determines the health of the stock?

What is the best approach to fisheries management?

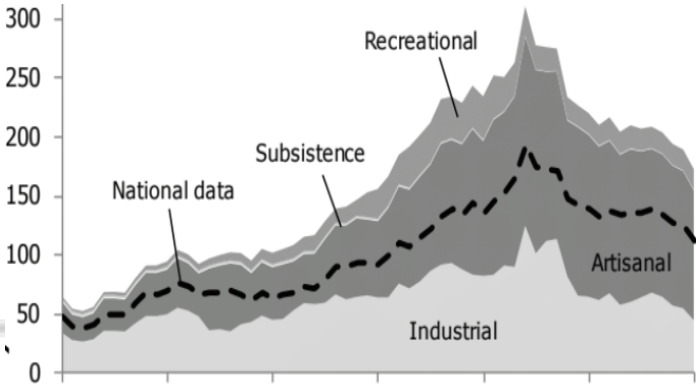
Critical issues with the Greek reconstruction

- Emphasis on **extending** and **correcting** the time series
  (the magnitude changed, trend remained the same)
- Masking effects with too many **aggregated** taxonomic groups
  (no sharks, no lessepsian migrants included)
- **Phantom gears** and **catches** remain unmonitored
  (day purse seine net: does not exist as *métier*)
- **Illegal fishing** practices are well underestimated
  (one needs vivid imagination to reveal the many ways of illegal fishing)
- **Recreational** fishing has become the most **fantastic job** in Greece
  (completely unmonitored, lead groupers and wreck-fish to functional extinction)
- Calculated (?) **mis-reporting** and **mis-management** and their effects on stock assessments

Lessepsian: Allochthonous species migrating (mainly) due to sea warming, find vacant niches and party

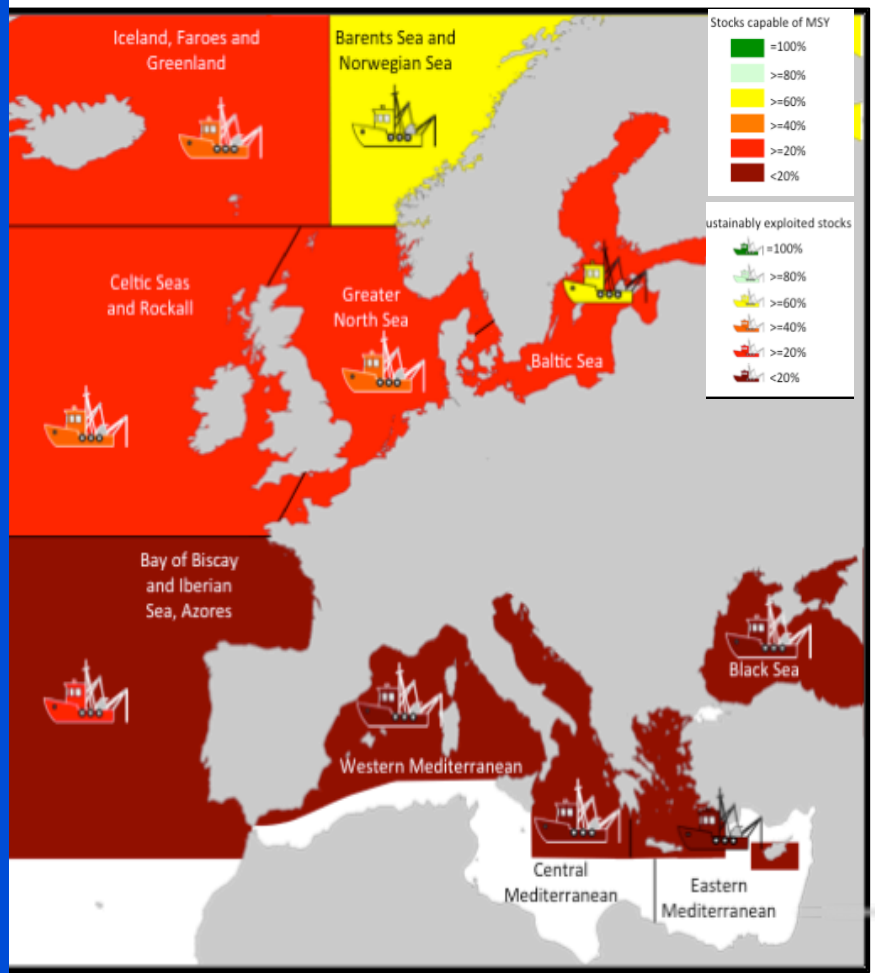
Reconstruction of Greek fishery catches by fishing gear and area (1950-2010)

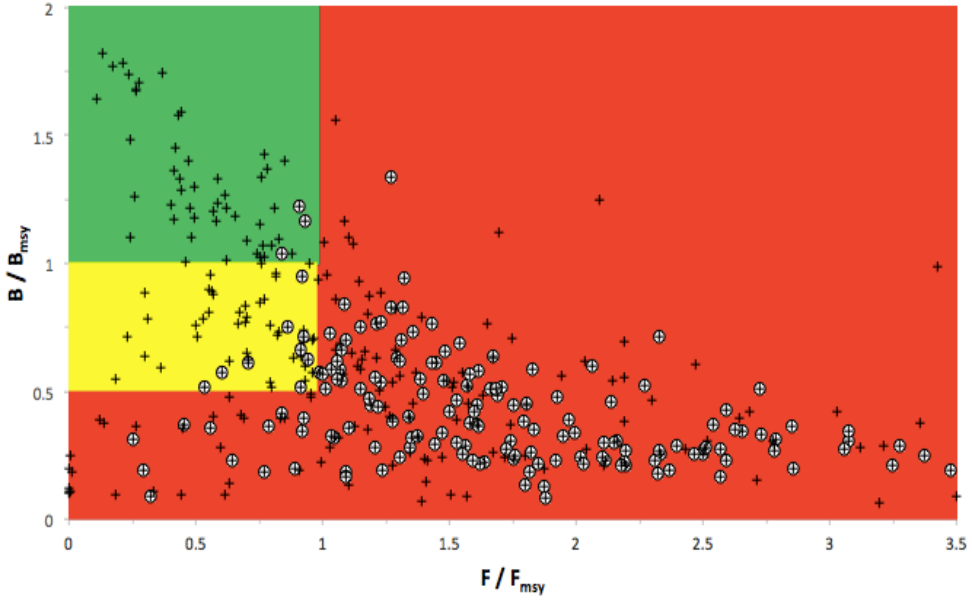
Dimitrios Moutopoulos, Athanassios Tsikliras and Konstantinos Stergiou

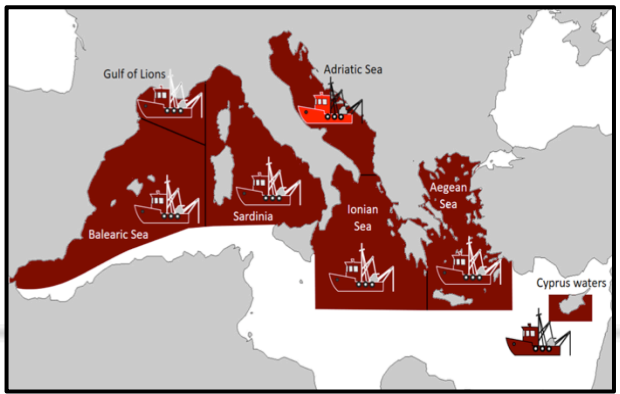


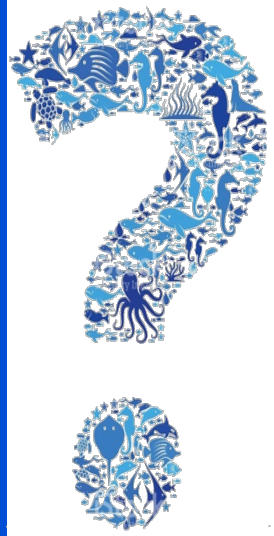
The drama of Mediterranean fisheries

According to the largest assessment ever, the vast majority of fish and invertebrate stocks are in bad shape and subject to ongoing overfishing (Froese et al. 2018 Mar Pol; unpublished data)





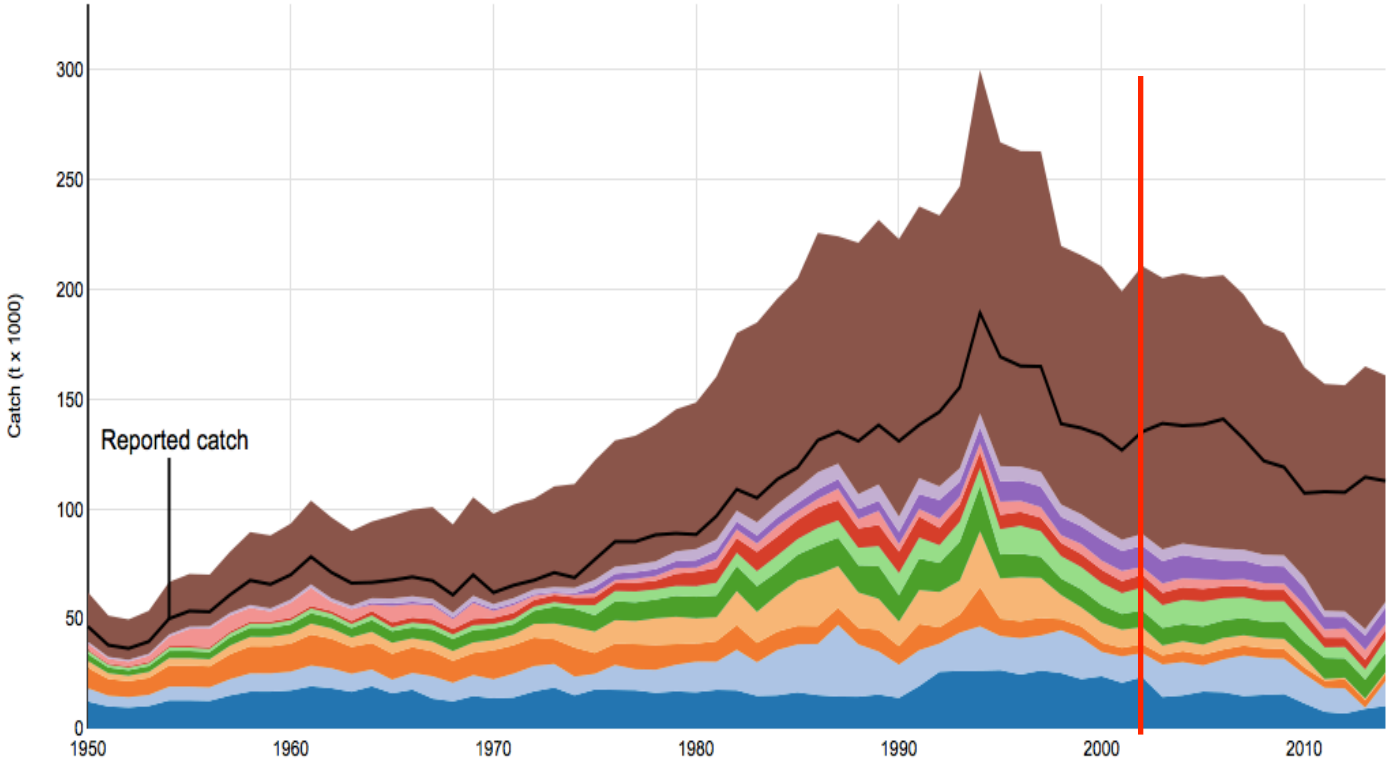




Deliberate shifting of the baseline?

Some scientists consider 2002 (beginning of DCF) as the reference year for their stock assessments and disregard even the MEDITS survey data of 1994-2001

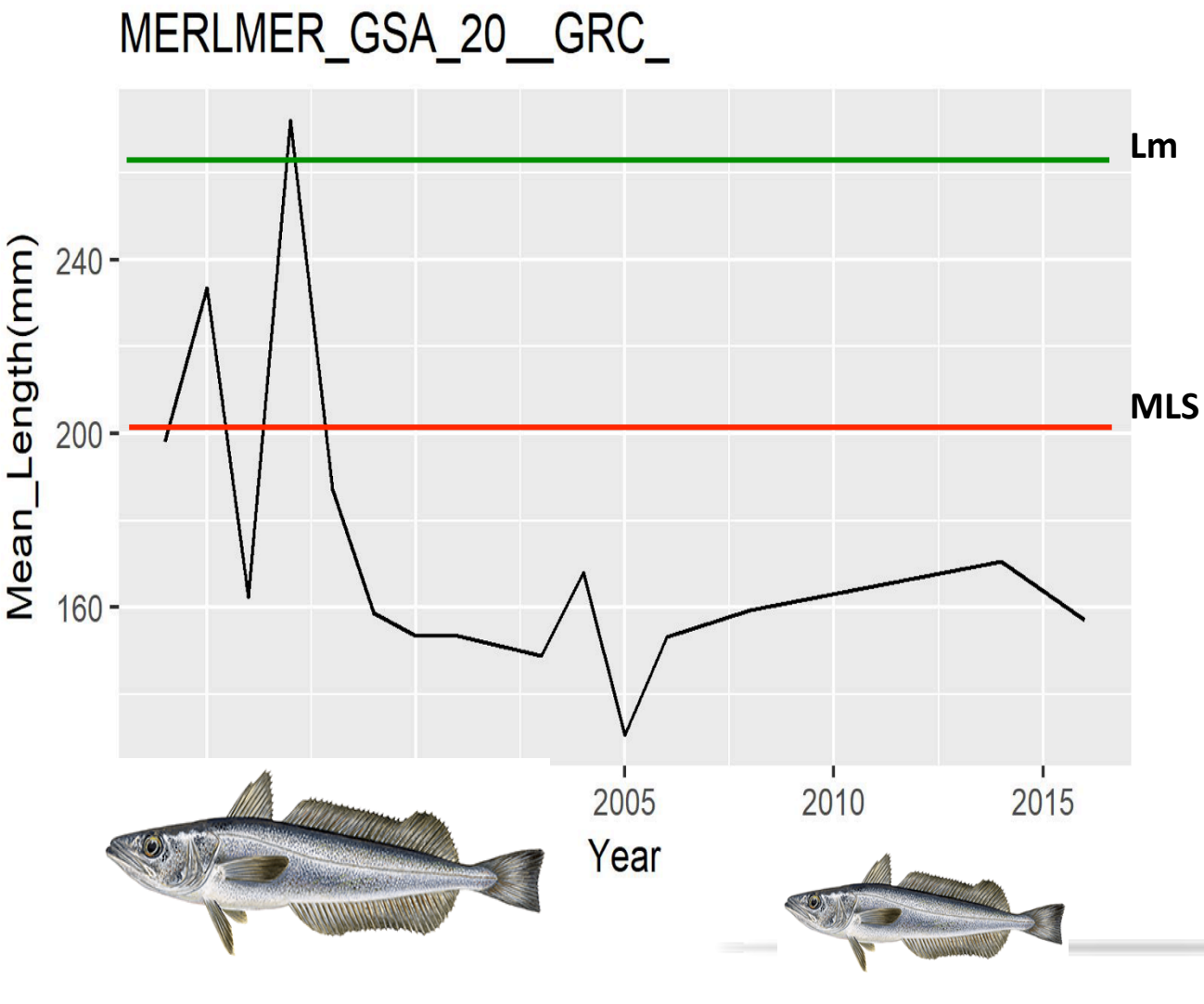
By 2002, most fisheries were already in **bad shape**
(catches at 60% of their historical max: Tsikliras et al. 2015, PLoS One)
and even a slight increase in CPUE/catch will indicate a healthy stock



Greek reconstructed catches: Data from SAUP

Exploiting (and landing) the small ones

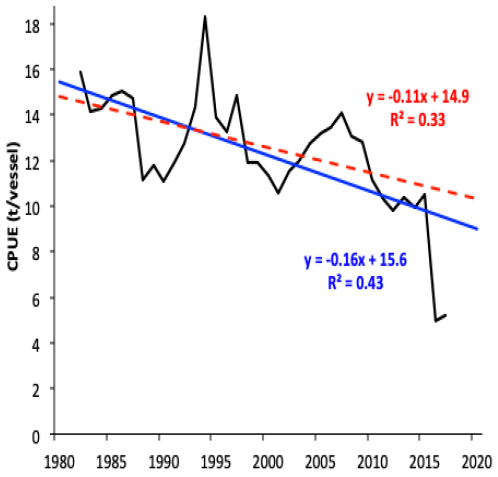
Most Mediterranean fisheries, especially trawling and seining, are today **juvenile based**
Fish decline in length with time and are caught young in high abundances, instead of being discarded or selectively not fished



Greek statistics

This was a joke in European parliament a few years back…

…in economics, but economic and ecological crises have many similarities (Tsikliras et al. 2013, ESEP)



Official misreporting in Greece is worst than anywhere

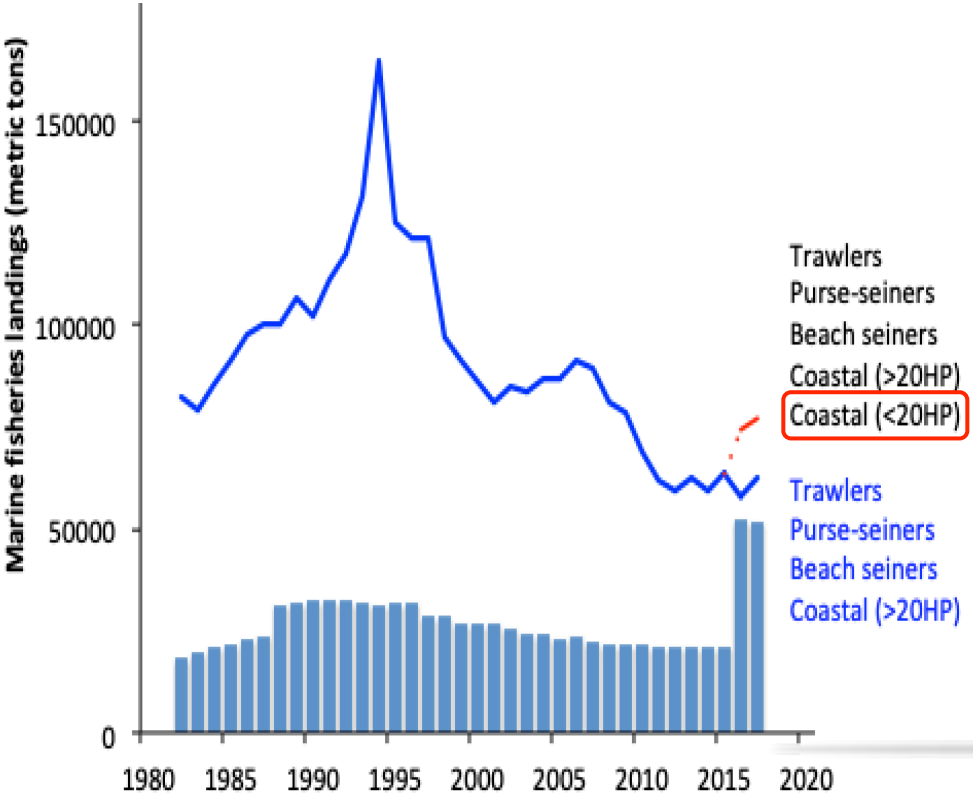
The landings of an extra fleet (**10000 coastal vessel**s) were included in the dataset after 2016

total landings appear increased in GFCM/FAO databases

SPiCT model shows good status

The **ministry** claims perfect management

Everyone is happy!

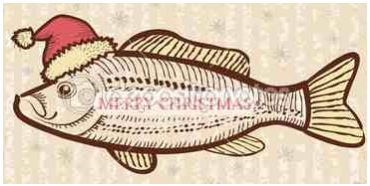


Tsikliras et al. submitted
Declining trends are not reversed in Greek marine fisheries landings

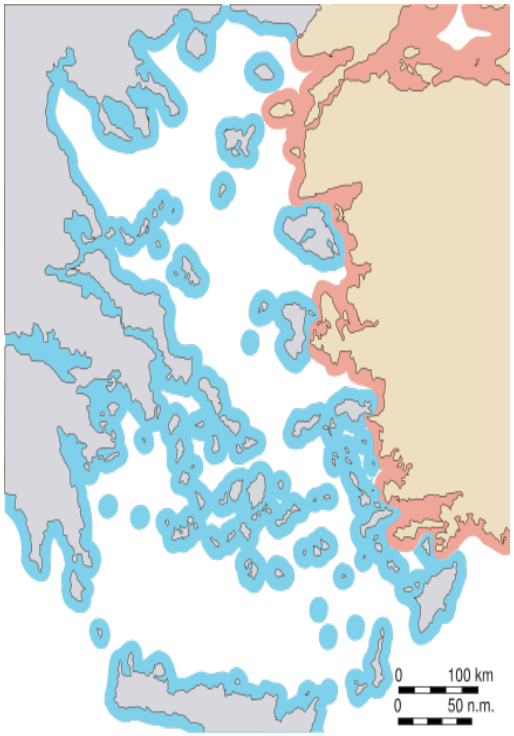
Four cases of mis-management

1. The management plan for Greek trawlers

Hake's Christmas



In an effort to **reduce fishing pressure** it closes the week between **Christmas and New Years Day!!!**
(Tsikliras 2014, Fish Aquac J)



2. Trawling and purse-seining in international waters across the year

In the Aegean Sea the national waters are confined to 6 nautical miles and the fleets **extend their fishing period** and **increase fishing pressure** (but they think they get international fish…)

3. Re-establishment of boat-seining

The gear had been banned in 2006 as it was operating over *Posidonia* beds and collecting all the small fish (90% undersized: Stergiou et al. 2009, Fish Man Ecol)

4. Recreational fishing is free

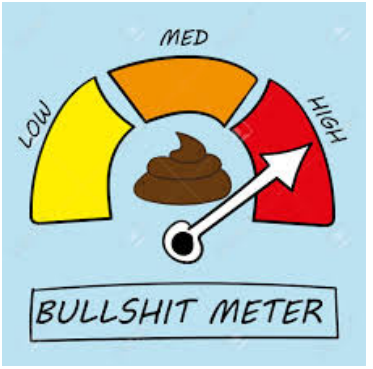
Since 2014 there is no requirement for a license to recreational fishing

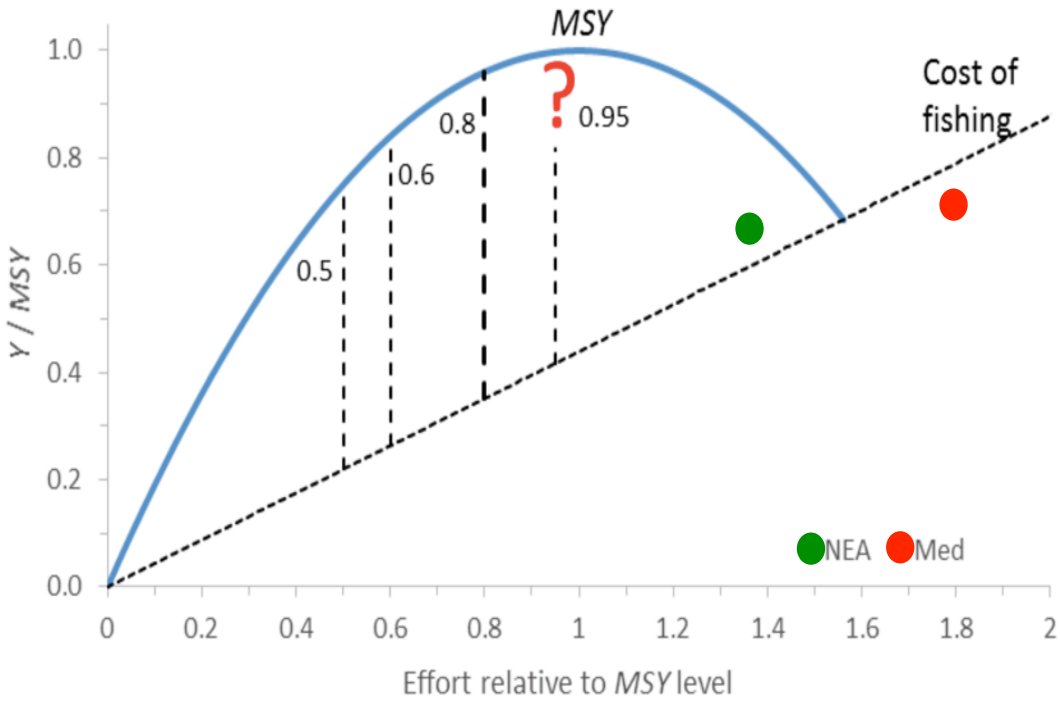
One of the greatest ^@£@%!@ in fisheries science?

The illusion that *higher fishing effort results in higher profits*...

Only **cost** is linearly related to fishing effort

Profit is maximized **ONLY** when stocks are sustainably exploited.





Any obvious solutions to the battle against the dark side?

In terms of human behaviour
all fishers need to step back a bit
and (logic) **managers** to **forget**
anthropocentric views and **yields**

In terms of science
we need **novel methods** and
more assessments but
also **ecosystem** info

Rainer leads the way
(CMSY, LBB, AMSY)
and as he says
"if it works with the Greek data, it can work everywhere"

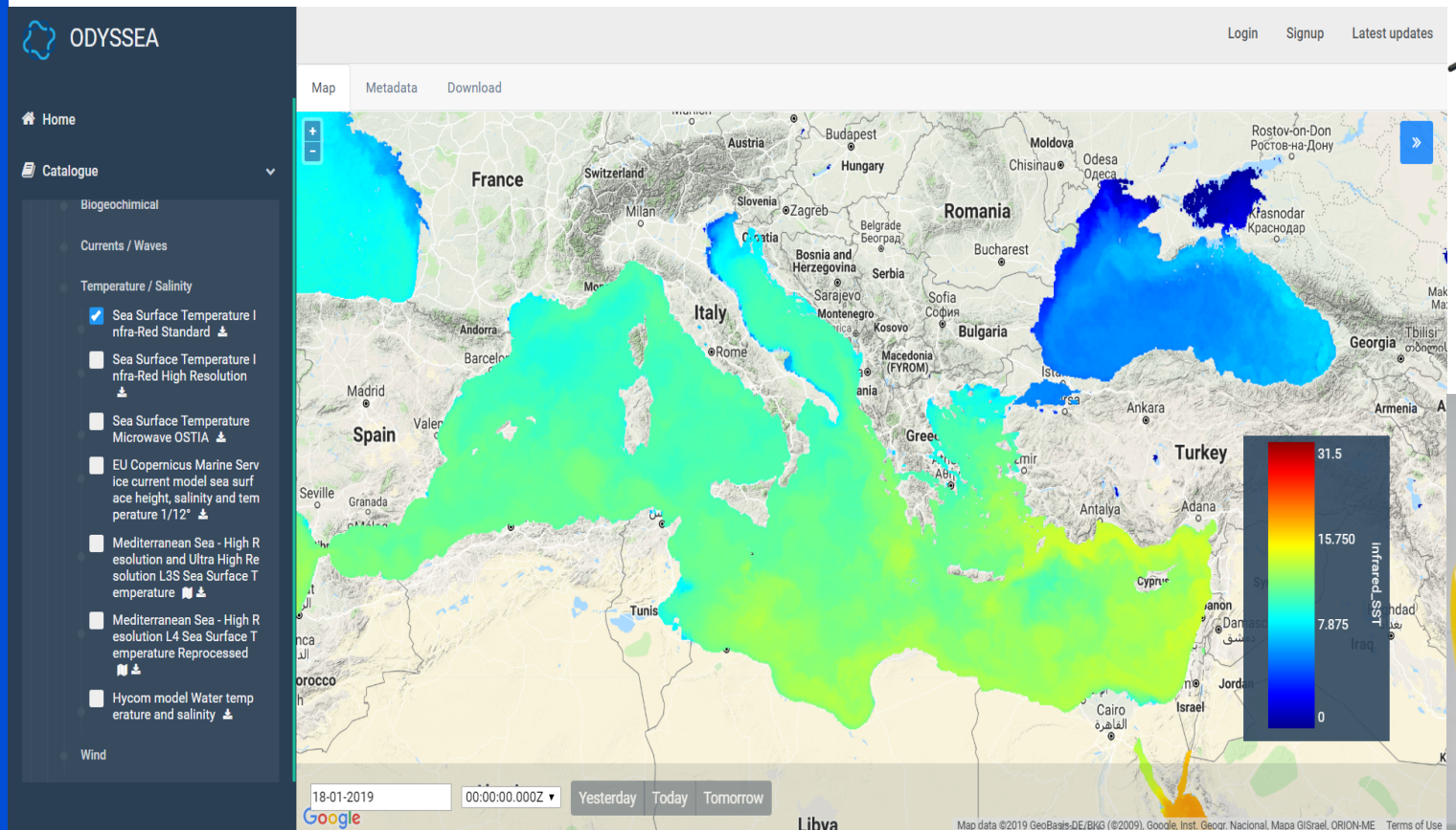
Therapy or utopia?

Harmonize of data collection and improving (and sharing) datasets

ODYSSEA Horizon 2020 Project: a platform to **unify** all biological and oceanographic data (and **collect new data** using static sensors and gliders)

A plethora of data in south Med countries that remain data poorer (Dimarchopoulou et al. 2017, PLoS One)

Aim to include **fisheries** (GFCM, SAUP), **species distributions** (Aquamaps) and **survey data**



The largest electronic encyclopedia for fishes, contains pretty much everything

FishBase

ver. (12/2013)

Mobile options & donations

(32700 Species, 302100 Common names, 53400 Pictures, 49500 References, 2090 Collaborators, 700000 Visits/Month)

FishBase consortium

Home | FishBase Book | Best Photos | Hints | Guest Book | Download | Links | Fish Forum | Fish Quiz | FishWatcher | Ichthyology Course| LarvalBase | Team | Collaborators | Quick Identification | Services

Common Name

is (e.g. rainbow trout) Search

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

中文 العربيّة Русский 日本語 हिन्दी Ελληνικά More scripts...

Scientific Name

Advanced Match

Genus is (e.g. Rhincodon) Search

Species is (e.g. typus) Random Species

Genus + Species Sp. ID Search

Information by Family

Family info. | Identification by pictures | References (FishBase) | Graphs
All fishes | List of pictures | Missing photos | Species Ecology Matrix
Nominal species | Identification keys | Stamps and coins

Note: Lists may be incomplete. Some lists may be very long and will take time to load

Information by Country / Island

Biodiversity	Uses	Tools	Miscellaneous
All fishes	Commercial	Identification by pictures	Country info
Freshwater	Aquaculture	Identification keys	FAO profile
Marine	Aquarium trade	Field guide	ReefBase profile
Introduced	Invasiveness	Occurrences	Treaties & Conv.
Endemic	Game fishes	References	Collaborators
Threatened	FAO aquaculture	Missing data	Fish stamps and coins
Dangerous	FAO catches	Missing photos	Common names
Reef-associated	ICES catch	Ecopath data	Public aquariums
Pelagic	Sea Around Us catch	Species Ecology Matrix	MPA database
Deep-water	Fish Loss	Checklist (extended)	Spawning aggregation

Note: Lists may be incomplete. Some lists may be very long and will take time to load
Note: A new dropdown list will appear if a country has a sub-country (ex. Canada, USA, etc.)

Information by Ecosystem

All fishes | Ecosystem info | Trophic pyramids | Ecopath parameters
Point data | Resilience of fishes | Species Ecology Matrix | Identification by pictures
Deep-water | Identification keys

Note: Lists may be incomplete. Some lists may be very long and will take time to load

Information by Topic

About this page | Languages | User feedbacks | Citation | Uploads | Related species | Like 1

Phycodurus eques (Günther, 1865)
Leafy seadragon

Upload your photos and videos
Pictures | Stamps, Coins | Google image

Phycodurus eques
Picture by Maddern, M.

Add your observation in Fish Watcher
| Native range | All suitable habitat | PointMap | Year 2100 |

This map was computer-generated and has not yet been reviewed.
Phycodurus eques AquaMaps Data sources: GBIF OBIS

Classification / Names Common names | Synonyms | Catalog of Fishes (gen., sp.) | ITIS | CoL | WoRMS | Cloffa

Actinopterygii (ray-finned fishes) > Syngnathiformes (Pipefishes and seahorses) > Syngnathidae (Pipefishes and seahorses) > Syngnathinae
Etymology: *Phycodurus:* Greek, phykon = seaweed + Greek, dora = skin (Ref. 45335).

Environment / Climate / Range Ecology

Marine; reef-associated; non-migratory; depth range 4 - 30 m (Ref. 9002). Temperate; 32°S - 39°S, 115°E - 140°E (Ref. 57011)

Size / Weight / Age

Maturity: L_m ? range ? - ? cm
Max length : 35.0 cm TL male/unsexed; (Ref. 9002)

Distribution Countries | FAO areas | Ecosystems | Occurrences | Introductions | Faunafri

Eastern Indian Ocean: endemic to southern Australia.

Biology Glossary Search (e.g. epibenthic)

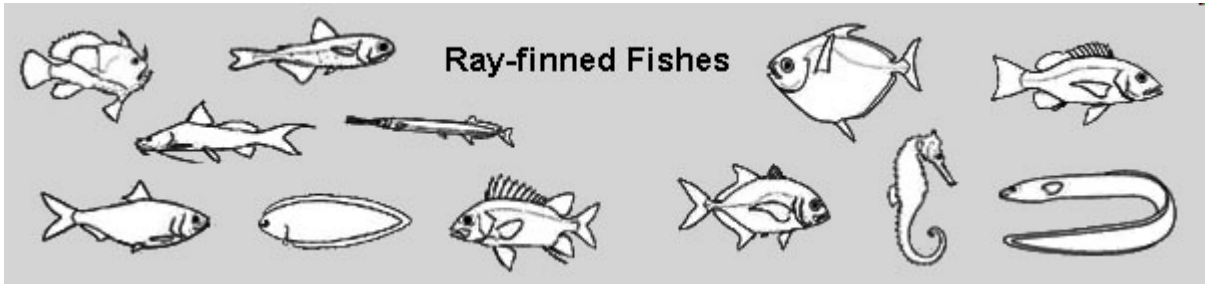
φυλλωτός θαλασσόδρακος

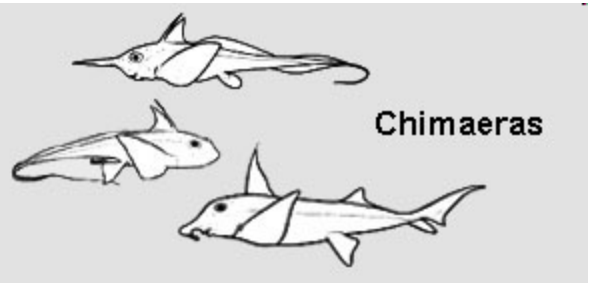
(leafy seadragon)

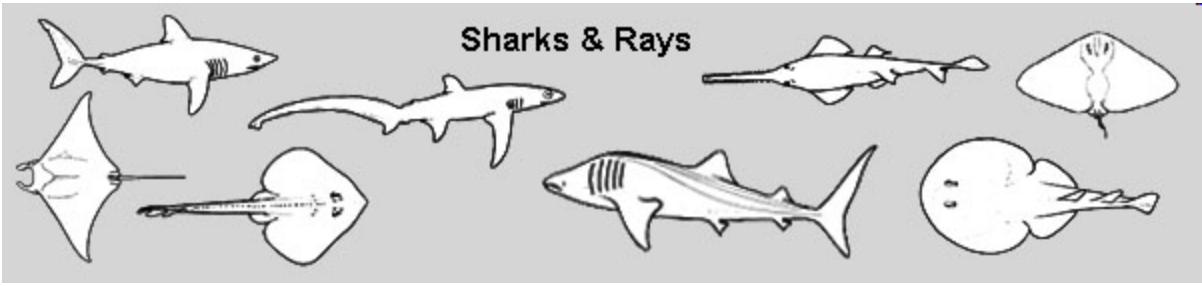
Phycodurus eques

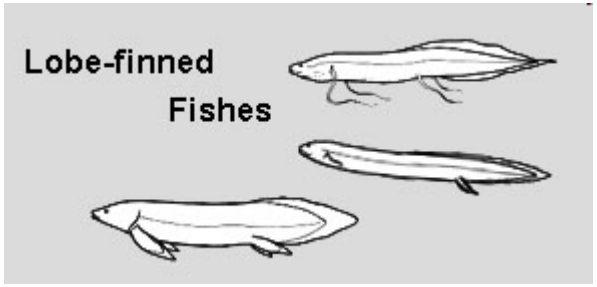
www.fishbase.gr

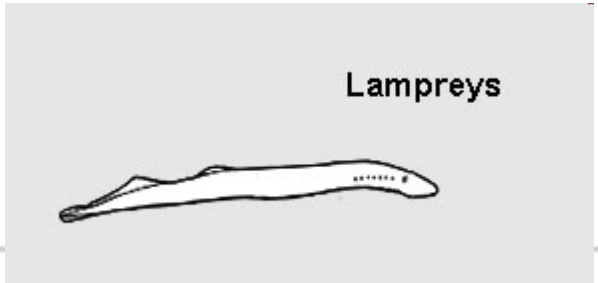
Fish classes

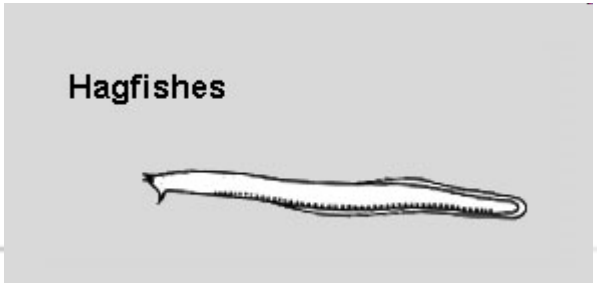












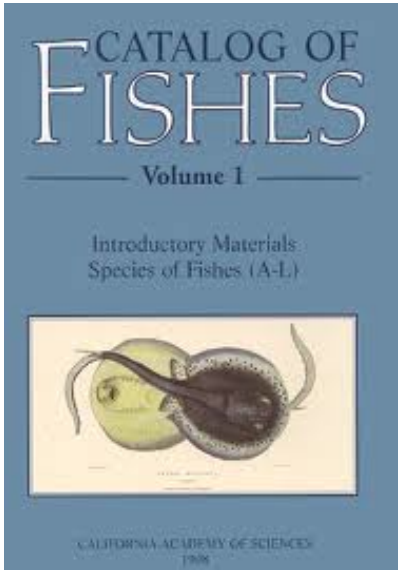
How many fish species in the world?

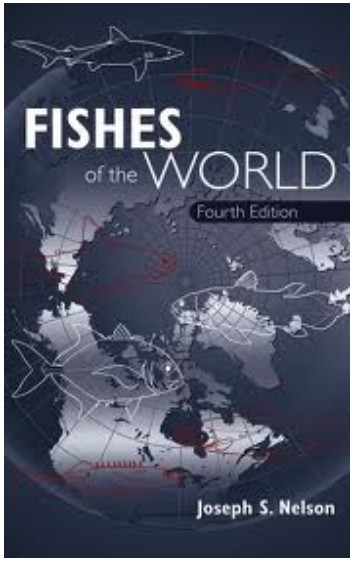
Fishbase (2013)	Eschmeyer (2014)	Nelson (2006)
6 Classes	6 Classes	5 Classes
64 Orders	64 Orders	62 Orders
550 Families	550 Families	515 Families
5 033 Genera	5 000 Genera	4 494 Genera
≈ 32 700 Species	≈ 33 065 Species	≈ 28 000 Species

Mobil

FishBase

ver. (12/2013)





In general, it follows Nelson's Fishes of the World (2006) with the noticeable exception of Elasmobranchii and Holocephali being elevated to class rank.
But at family level, FishBase may follow Eschmeyer's Catalog of Fishes that is updated more frequently to integrate new stable groupings.

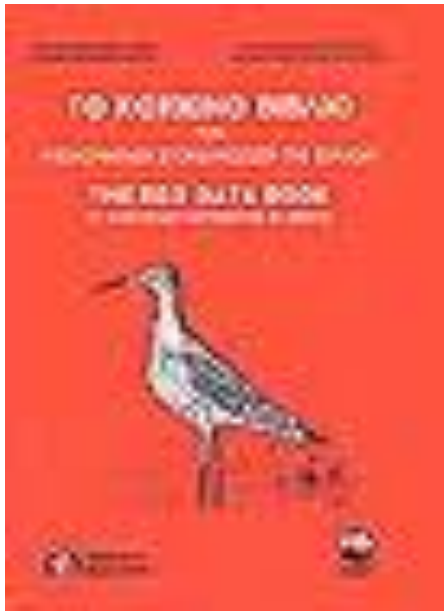
How many fishes in Greek waters?

Over **510 marine species**

(Papaconstantinou 2014)

And around **167**

freshwater species



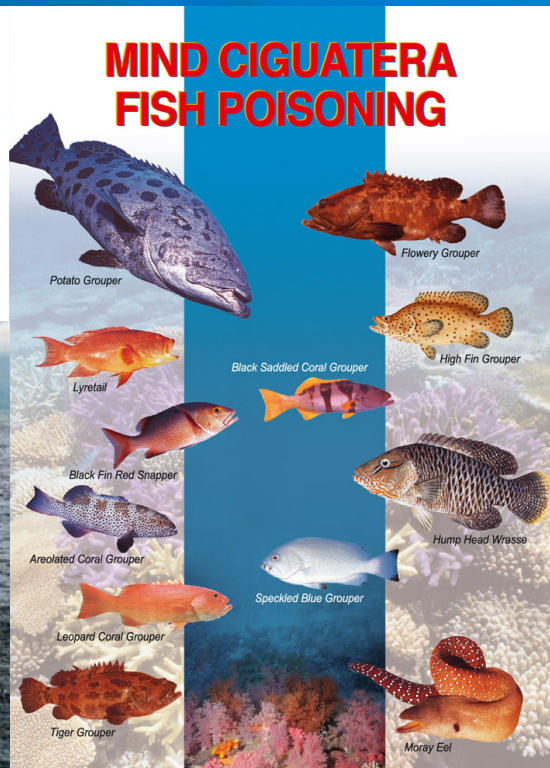
Mobil

FishBase

ver. (12/2013)

How many fish species in the world?

Marine and freshwaters	FishBase 12/2013
Freshwater	14 791
Marine	15 019
Brackish and diadromous	2 982
Threatened and aliens	
Threatened	1 981
Aliens (introduced)	895
Dangerous for humans	
Poisonous, traumatogenic	1 037



Around 7 500 fish species (25%)

Fisheries	4 652
Aquaculture	361
As bait	205
Recreational fishing	1 139
Ornamental	3 234
	7 500

Από www.fishbase.org




Chimaera monstrosa

Nezumia sclerorhynchus

Hygophum benoiti

Coelorhynchus spp.

Trachyrhynchus trachyrhynchus

Hymenocephalus italicus

Giants

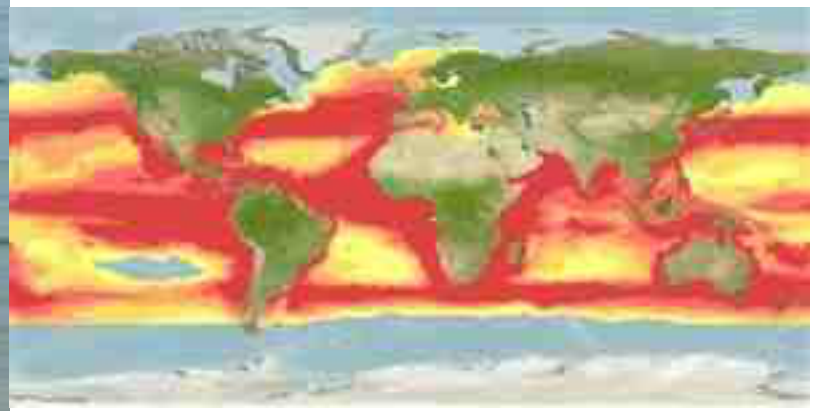
***Rhincodon typus* (Whale shark)**

Largest fish species
length of 20 m
marine, pelagic, 0-700 m depth
Commercial (for fins, skin, liver)
feeds on plankton and small fish
Harmless (εκτός επίθεσης)
Endangered

***Cetorhinus maximus* (Basking shark)**

Second largest
Length of 15 m
marine, pelagic, 0-2000 m depth
Commercial (for fins, skin, liver)
feeds on plankton Harmless (εκτός επίθεσης)
Endangered

Regalecus glesne



Silurus glanis

Istiophorus platypterus (112 km/h)

Tetrapturus audax (80 km/h)

Acanthocybium solandri (77 km/h)

Thunnus maccoyii (76 km/h)

Thunnus albacares (74 km/h)

Prionace glauca (69 km/h)