

Bycatch, discards, and selective fishing: Biological, ecological and fisheries issues

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Anchorage, May 2014

Outline

- Cause of bycatch (and discards)
- Management goals
- Biological, ecological, and fisheries effects
 - Vulnerable species
 - Target species
 - Non-target species
- Ecosystem structure and biodiversity
- Solution

Bycatch and discarded species

1. Vulnerable species--many are megafauna and apex predators.
2. Target species--undersized or wrong sex.
- 3. Non-target species.**



Why bycatch and discards?

Bycatch and discards result from **selective** fishing:

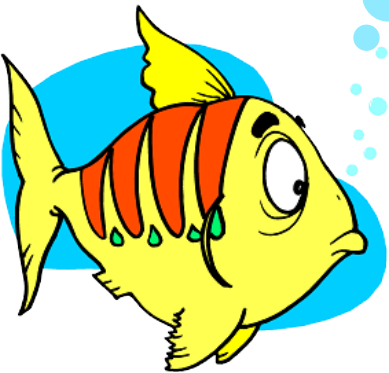
- Gear selection.
- Economic selection.
- Cultural selection.
- Regulatory selection.
-



Goals of fisheries management

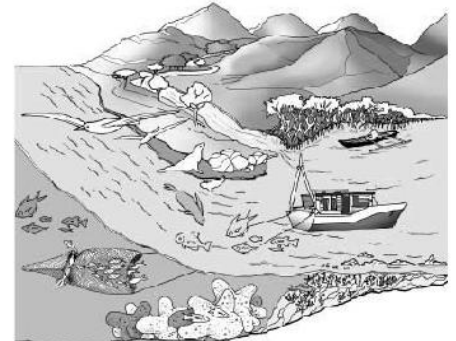
- Sustainable fisheries production.
- Conservation of ecosystem structure and biodiversity.

What is the
problem of
bycatch?



FISHERIES MANAGEMENT

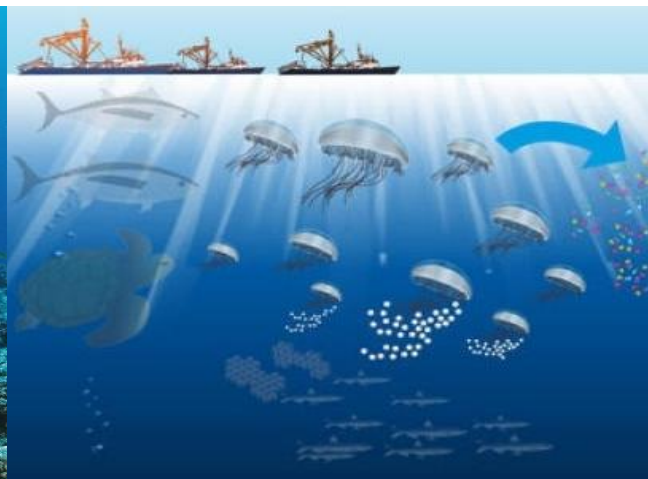
2. The ecosystem approach to fisheries



Ecological effects of bycatch--**vulnerable species**

They are typically long lived, large sized, low productive

- Maintain ecosystem structure by top-down control.
- Maintain healthy prey populations.
- Maintain biodiversity and food web balance.
- Keep habitats healthy (e.g., sea grass beds).



Ecological and fisheries effects of bycatch- **vulnerable species**

Reducing bycatch and over-protection

- Alter community structure and food web.
- Reduce fishery production by increased predation.

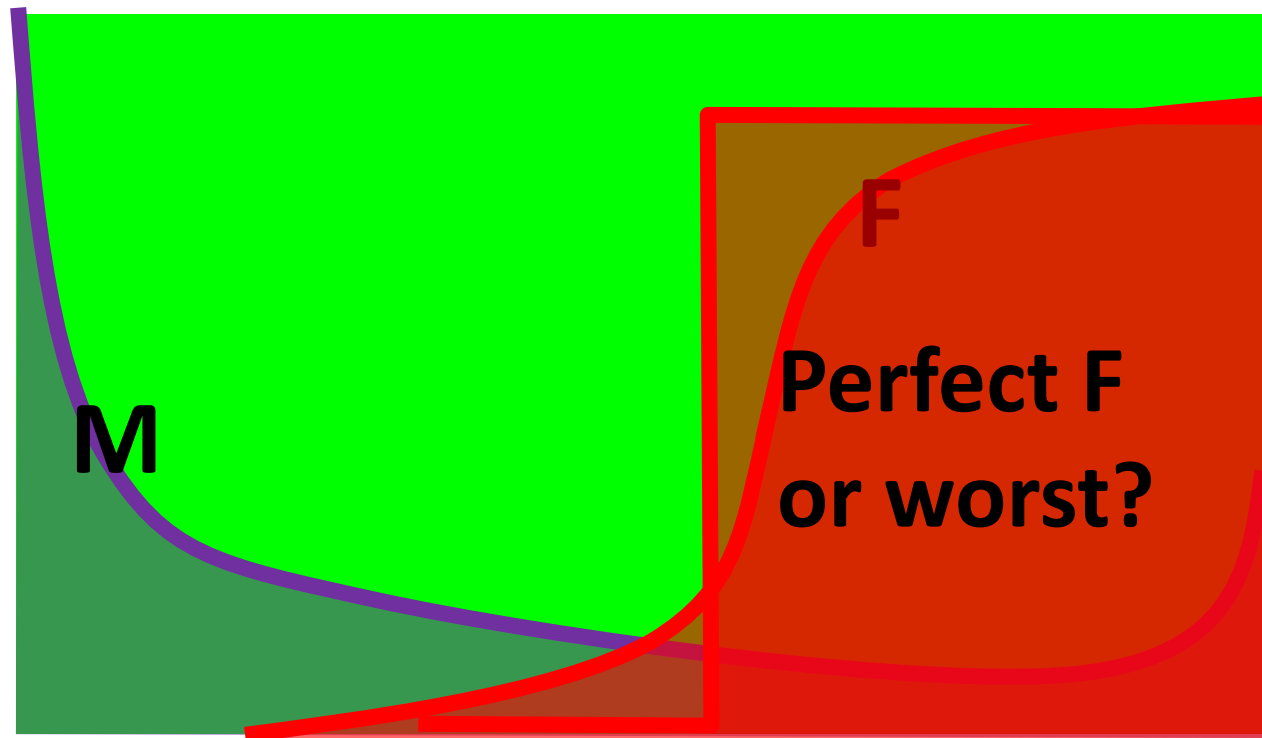


Ecological effects of bycatch--**target species**

Under market size or legal size, illegal sex

- **Negative effect:**
 - Many target species are fully exploited or over-fished.
 - **Additional** fishing mortality on small fish may further reduce population size.
- **Positive effect:**
 - Small fish have a higher growth rate, higher natural mortality, higher abundance.
 - First time spawners produce smaller eggs and low quality juveniles.
 - Sex ratio out of balance results in low fertilisation, poor quality of offspring.

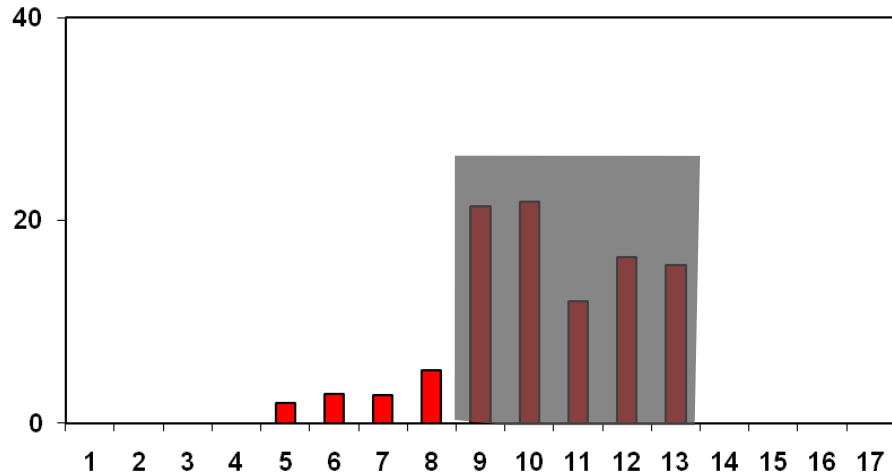
Target species: $F_{msy} \propto M$?



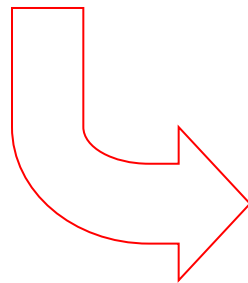
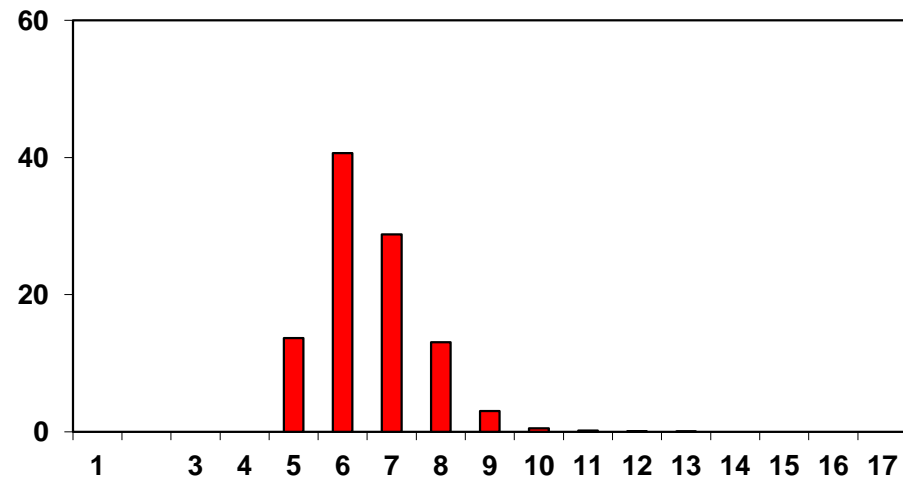
Age or size

Biological effect of size selective fishing

North East Arctic cod 1946

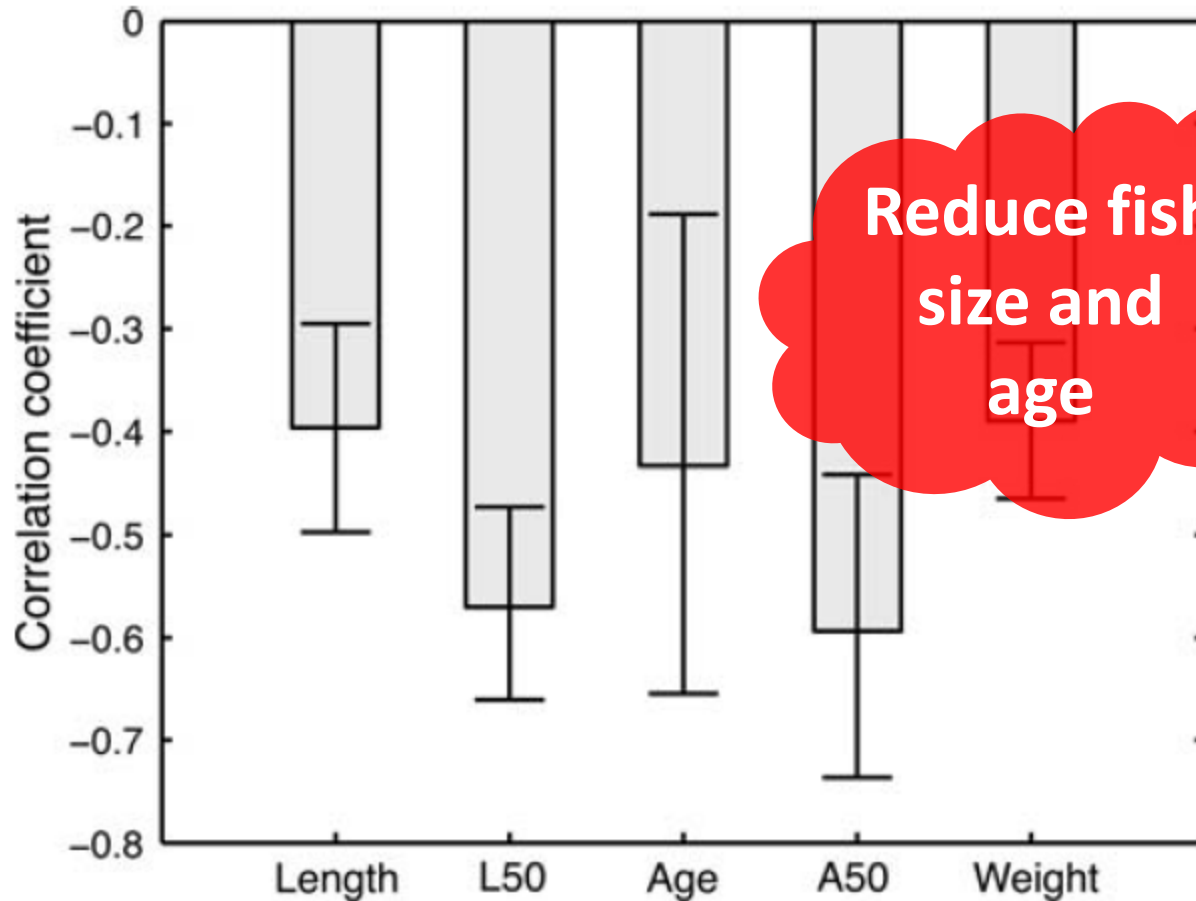


North East Arctic cod 2003



Marteinsdóttir, G., Pardoe, H., and Zhou, S. 2011. Managing intra-specific diversity of marine resources. 2nd International ISEKI_Fooc conference. Milan, Italy, 2011.

Biological effects of size selective fishing



Biological effect of size selective fishing

Change in size and species composition



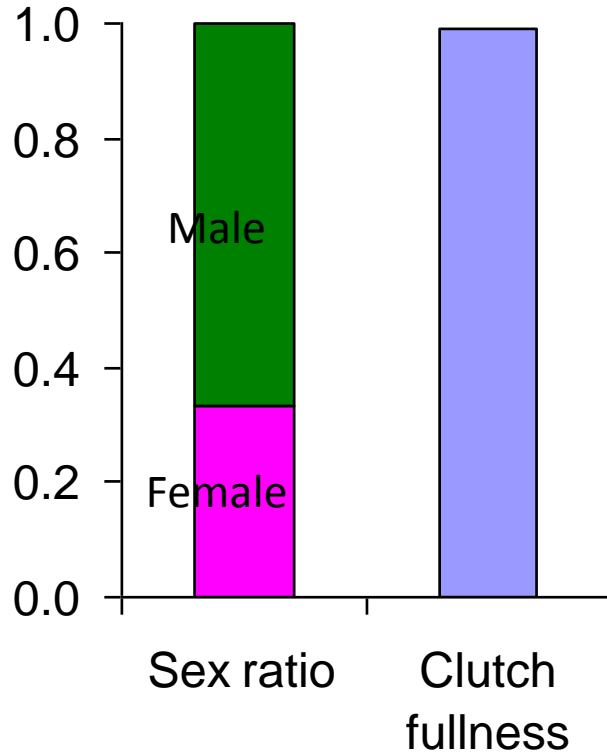
1958



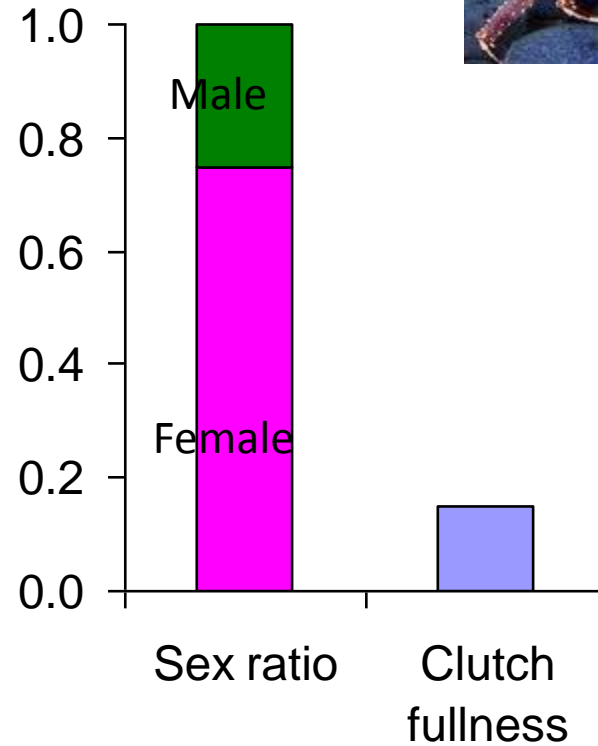
2007

Key West, Florida, same charter enterprise

Sex selective fishing: Kodiak red king crab



1973-75

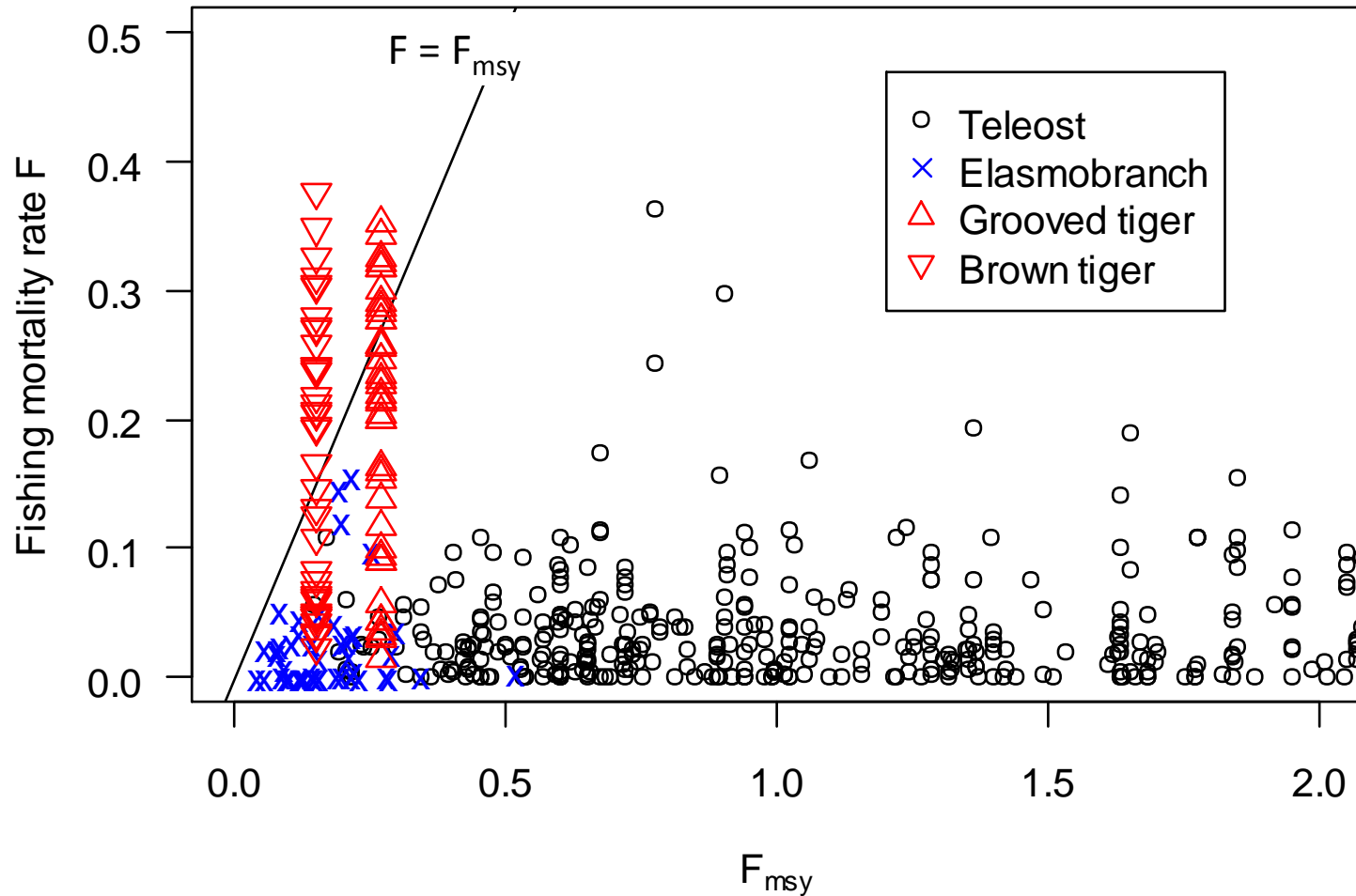


1986

Ecological effects of bycatch—**non-target species**

- There are more than 16,700 valid fish species in the oceans.
- Only about 1,200 species are recorded in FAO Fishery Statistics of various sorts.
- **Majority of bycatch and discards are non-target, low-value 'trash' fish.**

Fishing mortality on target and non-target species: 539 species in Australian Northern Prawn Fishery



Zhou and Griffiths. 2008. Sustainability assessment for fishing effects (SAFE). Fisheries Research 91: 56-68.

Zhou et al. 2009. Sustainability assessment for fishing effects (SAFE) on highly diverse and data-limited fish bycatch in a tropical prawn trawl fishery. Marine and Freshwater Research 60: 563-570.

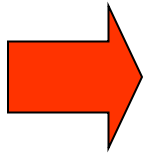
Ecosystem structure and biodiversity conservation



Biodiversity with fisheries

Classical three levels

1. Genetic diversity: at molecular level



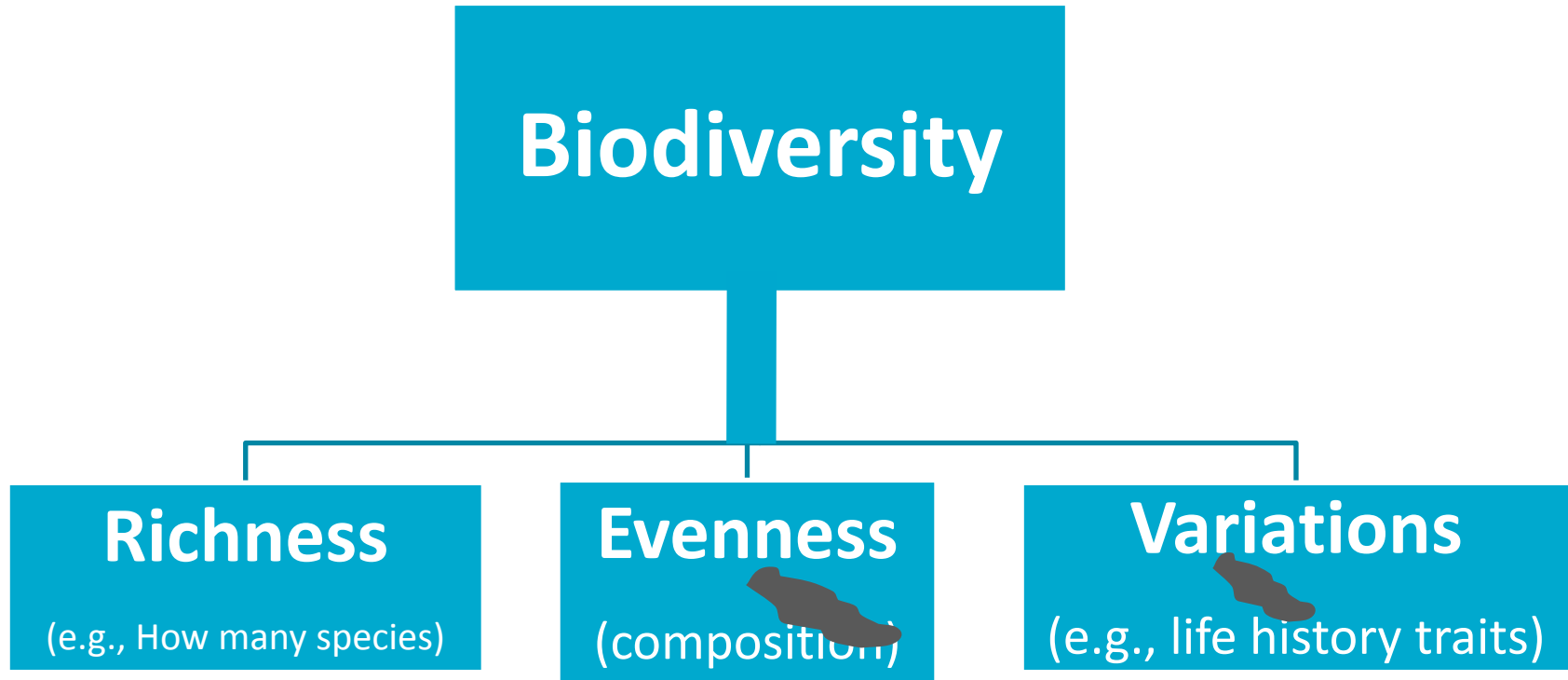
Intra-specific diversity:

Stock, size, age, sex, fecundity, maturity, longevity, behaviour, etc.

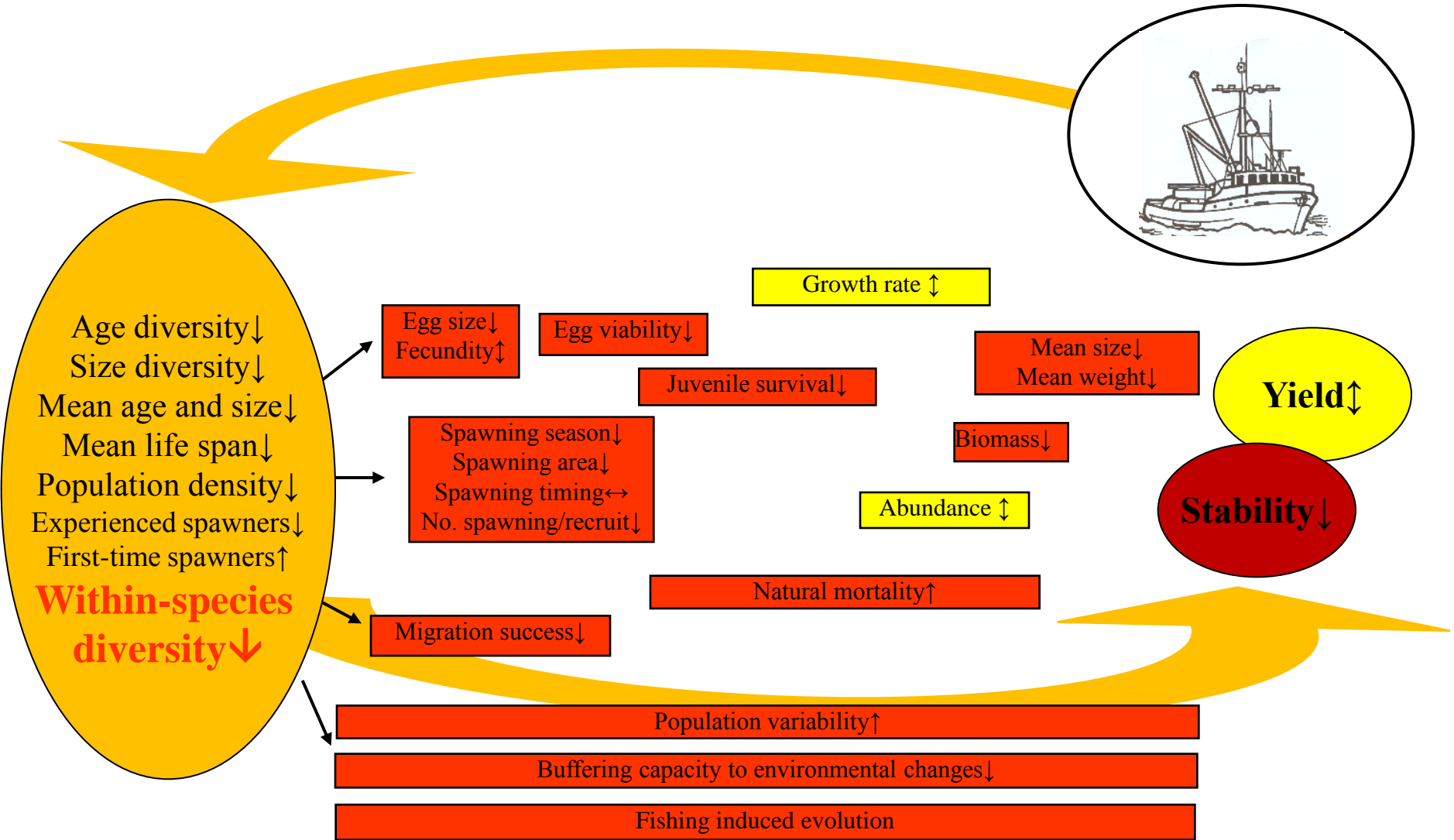
2. Species diversity
≠ species richness

3. Community diversity

Properties of biodiversity



Effects of size-selection on intra-species diversity and fisheries



Selective fishing impacts inter-species diversity

- **Causes diversity loss:**

Reduces richness or evenness or ecological service;

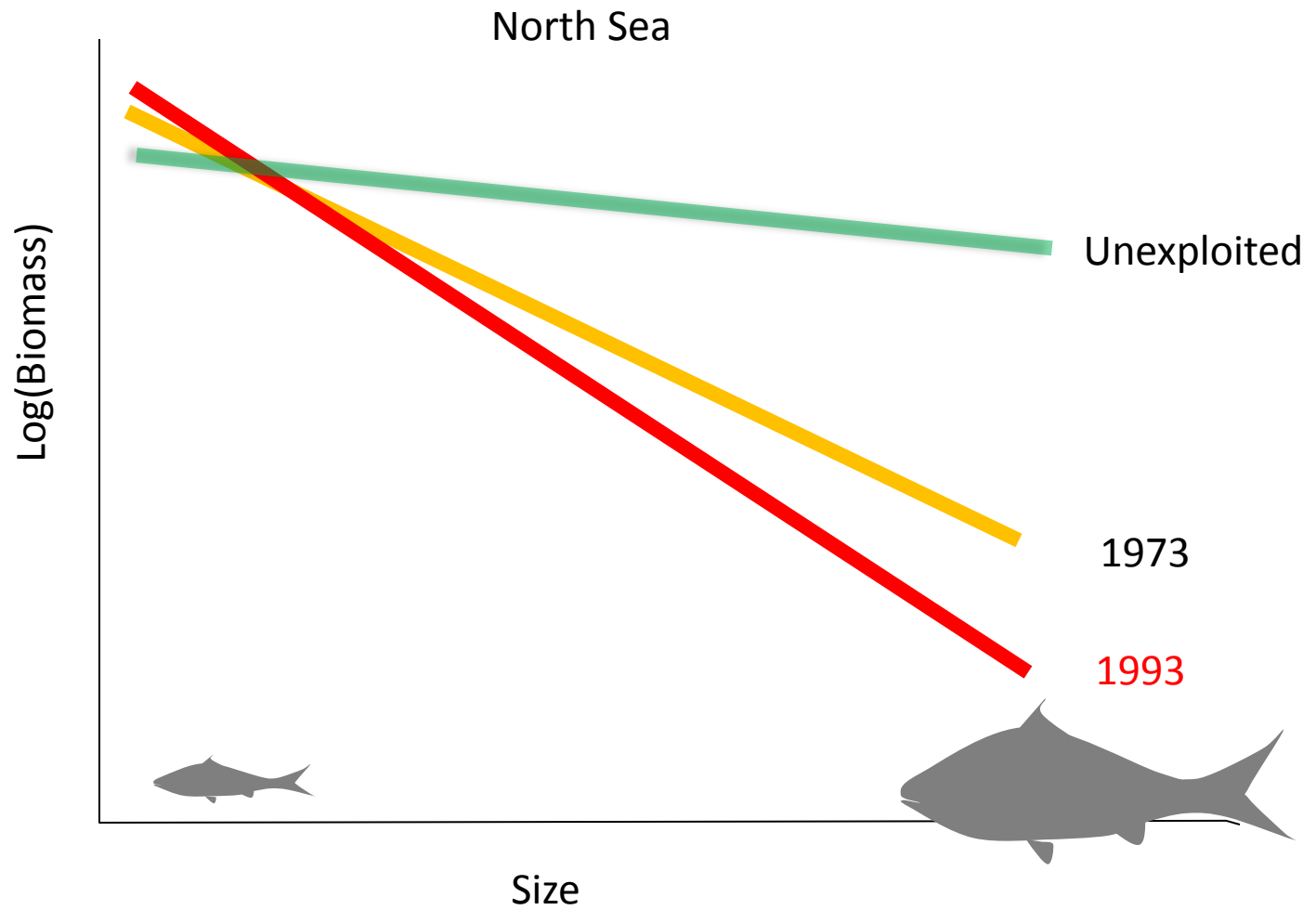
- **Increases diversity:**

Increases **evenness** by removing dominant species;

- **Modifies diversity:**

Changes life history traits for some species more than others.

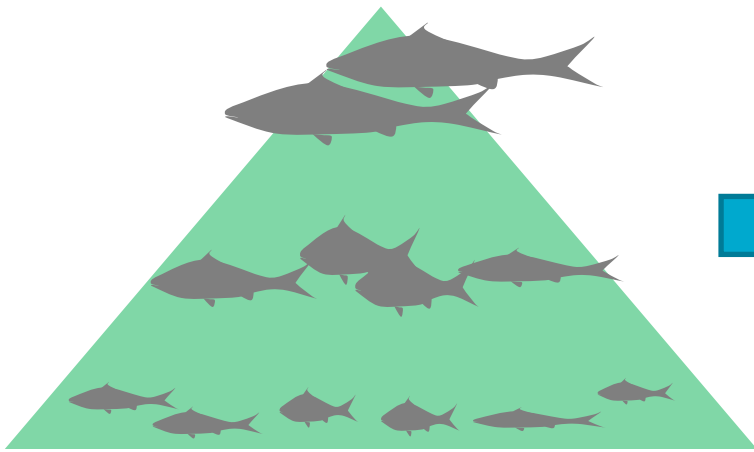
Selective fishing alters ecosystem structure



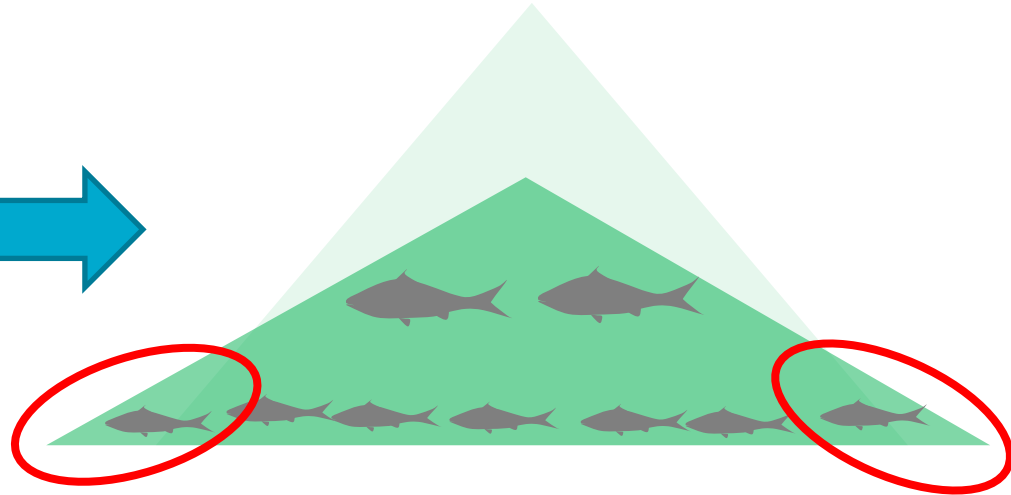
Bianchi et al 2000: Impact of fishing on size composition and diversity of demersal fish communities. ICES JMS 57:558-571.

Jennings and Blanchard 2004. Fish abundance with no fishing: predictions based on macroecological theory. JAE 73: 632-642.

Effect of selective fishing on ecological pyramid



Unexploited



Current

Some consequences of reducing all bycatch

While disproportionately remove target component (species/age/sex) from the community, further reducing bycatch:

1. Alter ecosystem structure
 1. Change species composition (evenness).
 2. Change species relationship and dependency.
 3. Increase abundance of non-target competitors.
 4. Change size, age (and maybe sex) structure.
2. Destabilize stocks and ecosystem.
- 3. Reduce long-term production.**
4. Trigger evolution.

Paradox in current bycatch management

Policies

- More selective fishing
- Toward zero bycatch



Goals

- ✓ Sustainable fisheries
- ✓ Maintain biodiversity

Solution for future fisheries

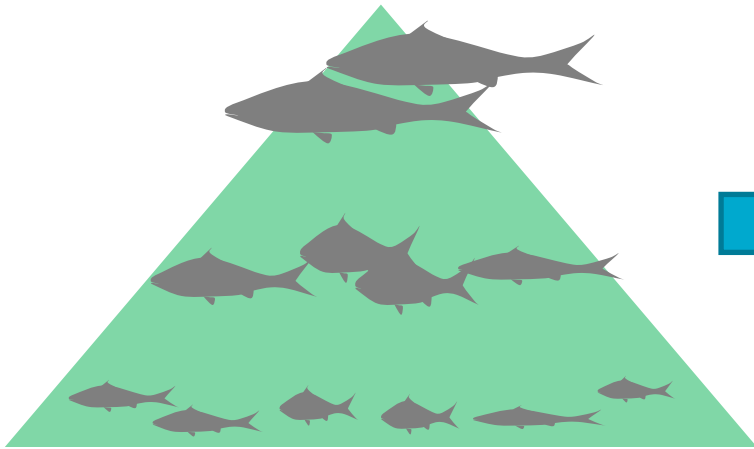
1. Reduce fishing intensity on overfished and highly impacted components
2. Redistribute fishing pressure to increase food production while reducing ecological effects of fishing



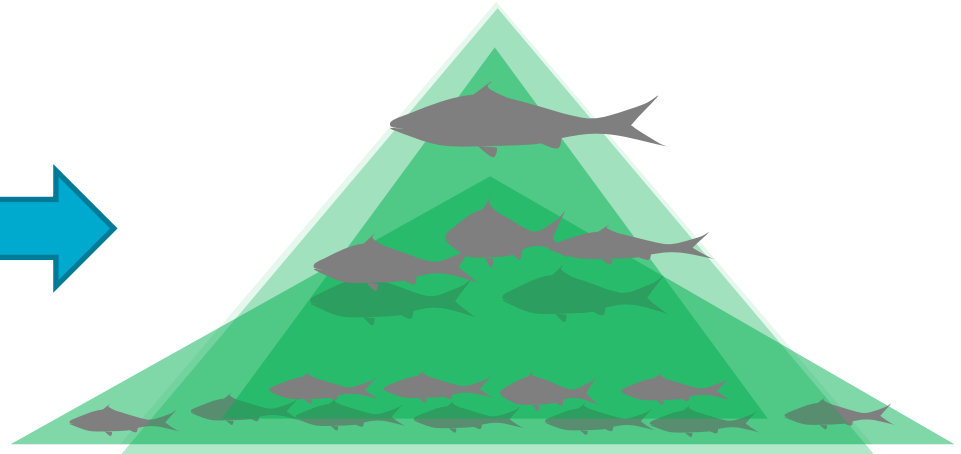
Balanced exploitation

Moderate fishing pressure across a wide range of ecological groups in proportion to their natural productivity.

Balanced exploitation



Unexploited



Current

Reconciling fisheries production and ecosystem conservation

Strategies

- ✓ Less selective fishing
- ✓ Utilize all catch



Goals

- ✓ Sustainable fisheries.
- ✓ Maintain ecosystem structure and biodiversity.

Solving bycatch

**There will be no bycatch
and discards if all catch is
retained and utilized!**



Edible insects

Future prospects for food and feed se



Conclusions

- Selective fishing has many biological and ecological effects which in turn affect fisheries production.
- Consider these effects before reducing bycatch!
- Utilize all catch!

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Are Current Fishing Regulations Misguided?

Selectively harvesting fish by species, size, gender or other traits can knock an ecosystem out of balance, according to a new analysis.

By John Matson

The oceans are in trouble—overfishing has led to depletion of fish stocks around the world and has driven many species to [critically endangered status](#). But what to do about it?

Officials have responded to the collapse of fishery stocks with a slew of regulations, many of them forcing fishing operators to be more selective in their harvest, whether by targeting certain species and regional

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