



# Balanced Harvest: Issues and economic insights

A. Charles and S. M. GARCIA  
IUCN-CEM-FEG

**A Multidisciplinary Workshop To Address Ecosystem-Level Impacts of Fisheries Bycatch on  
Marine Megafauna**

*Biodiversity Conservation through Mitigation, Policy, Economic Instruments, and Technical Change*  
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# Outline

1. The problem
2. The BH Concept
3. Policy and management implications
4. Economic insights
5. Conclusions

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## 1

# Co-existing norms

1. **«Stocks should be kept at biomass levels that can produce MSY»** UNCLOS (1982) and – WSSD ( 2002) Declaration § 31 (a). The concept has been criticized by scientists since early 1970s but recognized in all summits.
2. **«A key feature of the ecosystem approach includes conservation of ecosystem structure and functioning»** CBD. 1998. Malawi principles for Ecosystem Approach: FAO adopted EAF in 2001.

To what extent are these norms compatible? Could species-based rationality lead to ecosystemic rationality?

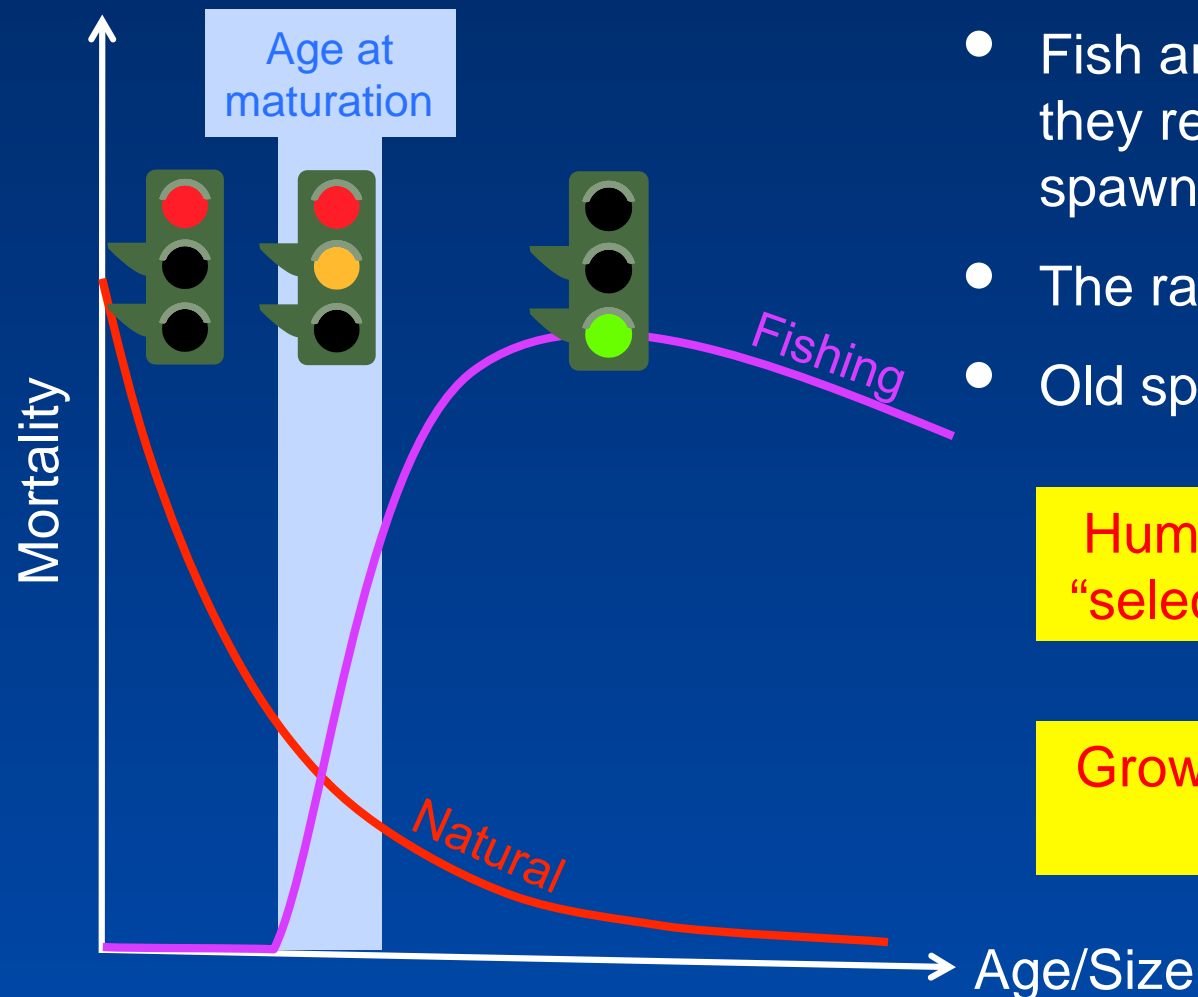
## 1

# Overall selectivity

- Selectivity is the process through which fishing obtains a catch with a composition (in size, sex, or species) that differs from that of the natural habitat on which it operates. It is the probability of a species, sex, size or age to be caught
- It results from the appropriate selection of: (i) the fishing area and depth, (2) the fishing season and time, and (3) the fishing gear, its characteristics and operation
- Theoretically defined at gear level, it displays operational realities at the level of the vessel, the fishery, the species assemblage and the ecosystem
- Selectivity is conventionally regulated to: (i) maximize long-term yield from each recruit of the target species and (ii) reduce catch of unwanted or protected species
- It is also used by fishers to maximize short-term economic returns
- Conventional selectivity regulations ignore trophic relations.

## 1

# Pressure pattern on sizes



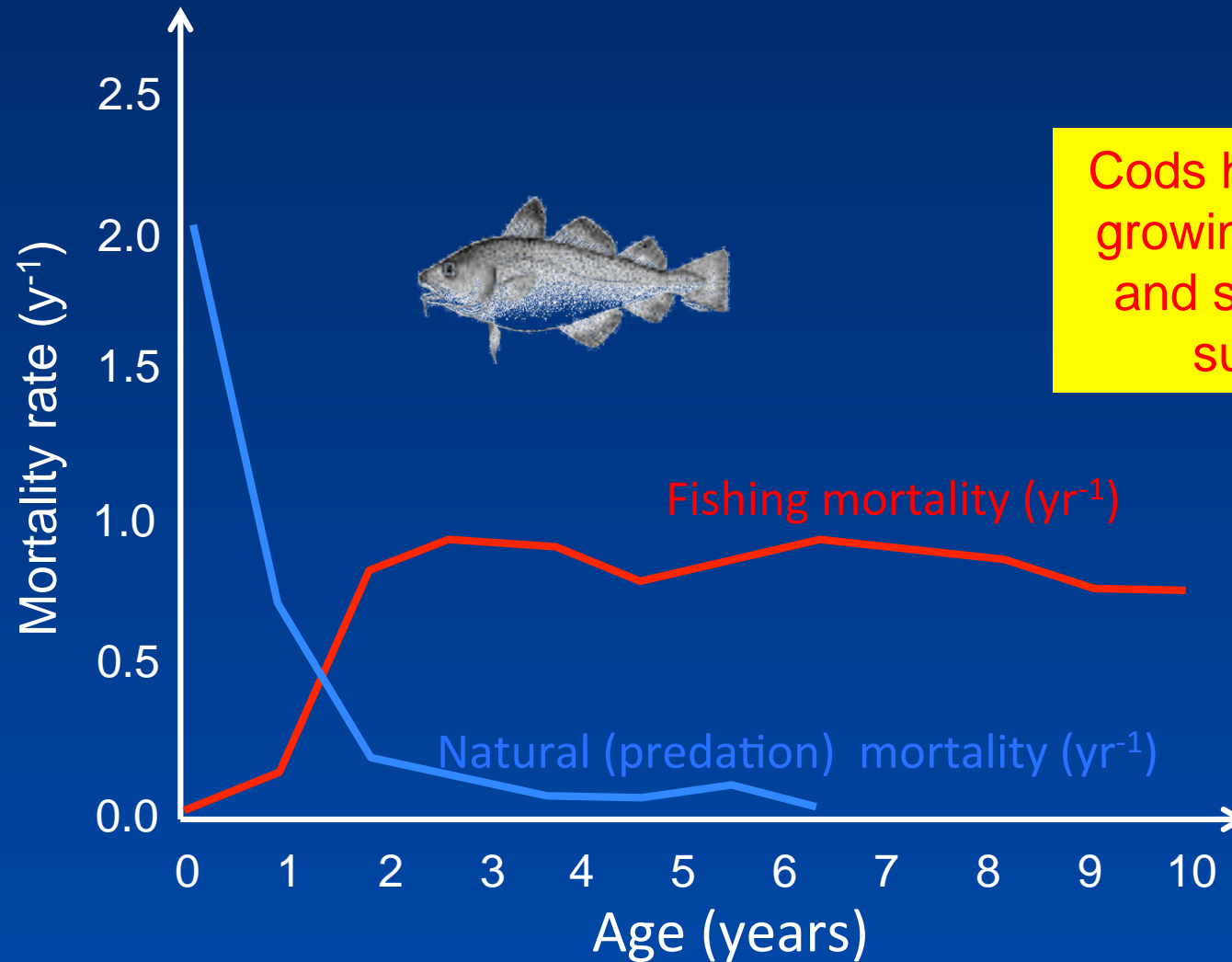
- Fish are theoretically protected until they reach sexual maturity and spawn once
- The race is opened after that
- Old spawners are not protected

Human and natural predators  
“select” their sizes differently !!

Growing big is not any more a  
good strategy!!!

1

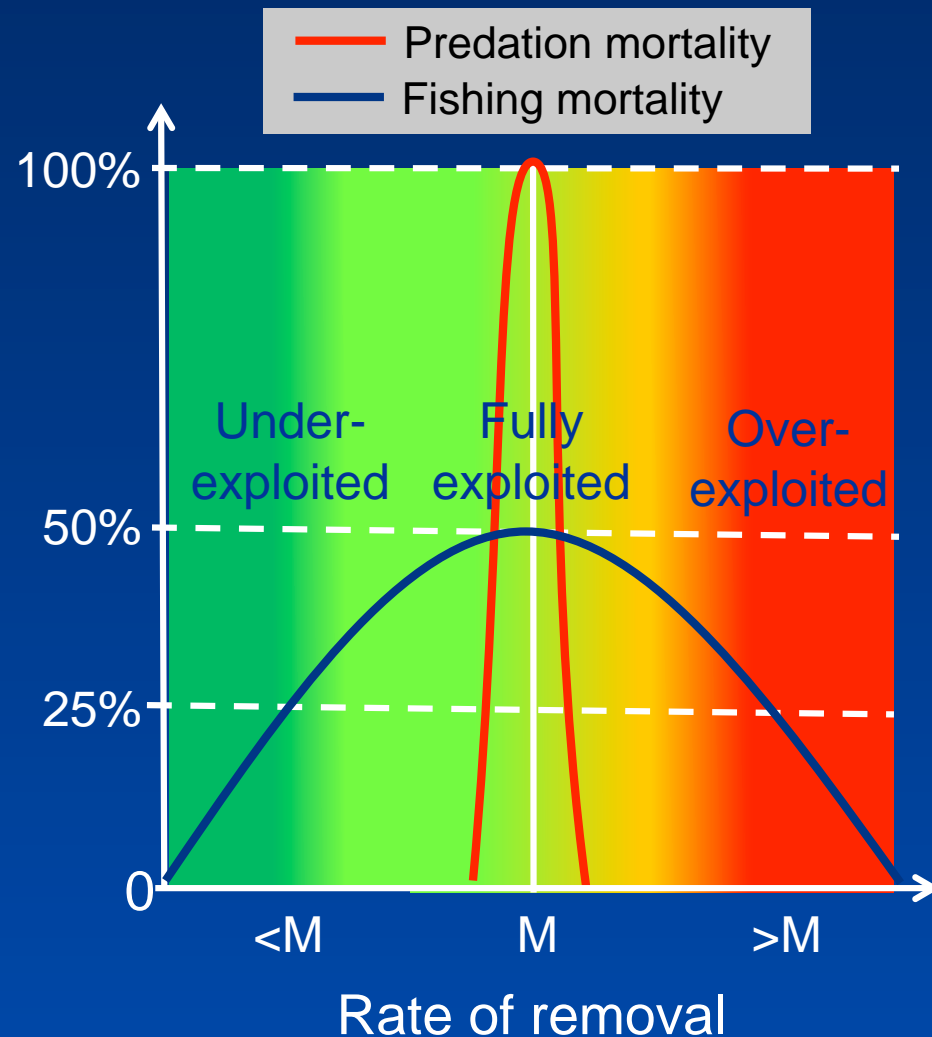
# A typical example



Cods have been growing smaller and smaller to survive

1

# Pressure pattern on species



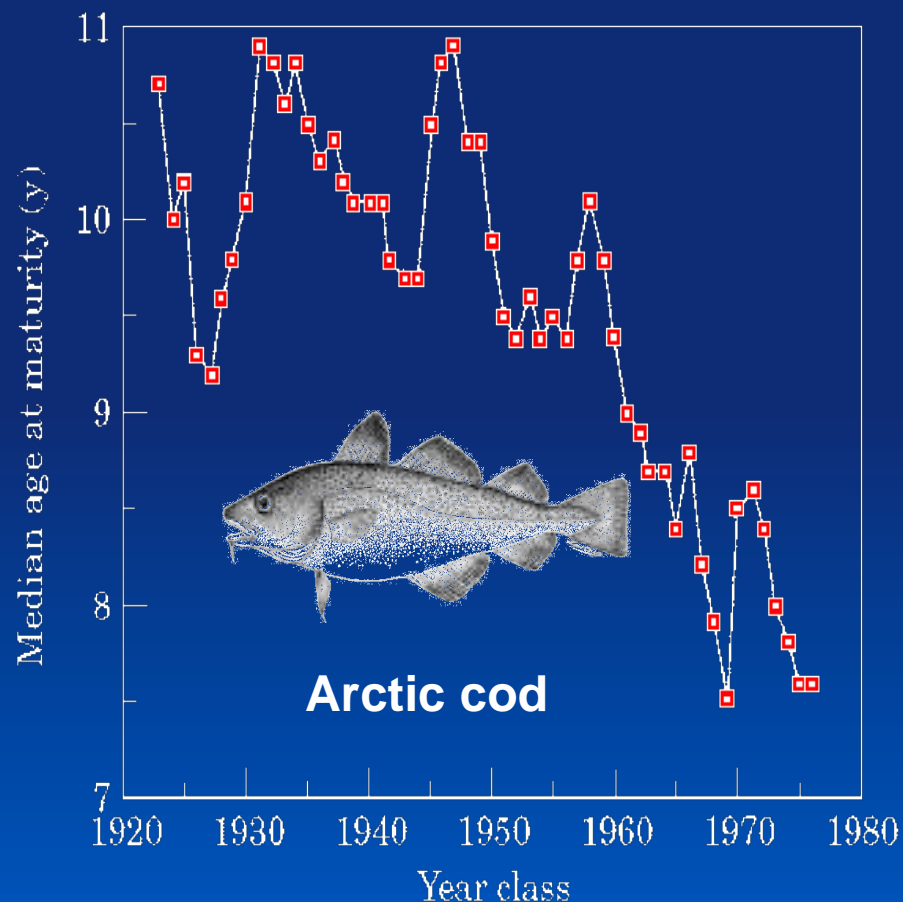
Human and natural predators “pressurize” species differently

Fishing mortality can be lower or higher than predation mortality



## 1

# Consequences



- Total disappearance of largest individuals
- Reduced size at age
- Reduced age and size at maturity
- Reduced maximum body size
- Increased reproductive investment
- Increased resilience to high fishing
- Reduced resilience to environment
- Reduced resource productivity
- Reduced N° of subpopulations
- Reduced genetic variability
- Possible selection of genotypes
- Modification of species dominance

These are substantial modifications of ecosystem structure and function!!

# Outline

1. Background
- 2. The BH concept**
3. Policy and management implications
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## 2

# Utopian solutions?

1. **“In theory a food web could be maintained “in balance” by fishing each component in proportion to the rate of natural predation it is subjected to”**. Caddy and Sharp (1986) optimal, albeit ‘utopian’ strategy
2. Modeling shows that a reduction of fishing pressure at both ends of the size spectrum reduces genetic evolutionary response in a population (e.g. BOFFFs) (M. Heino.)



# Origin of BH

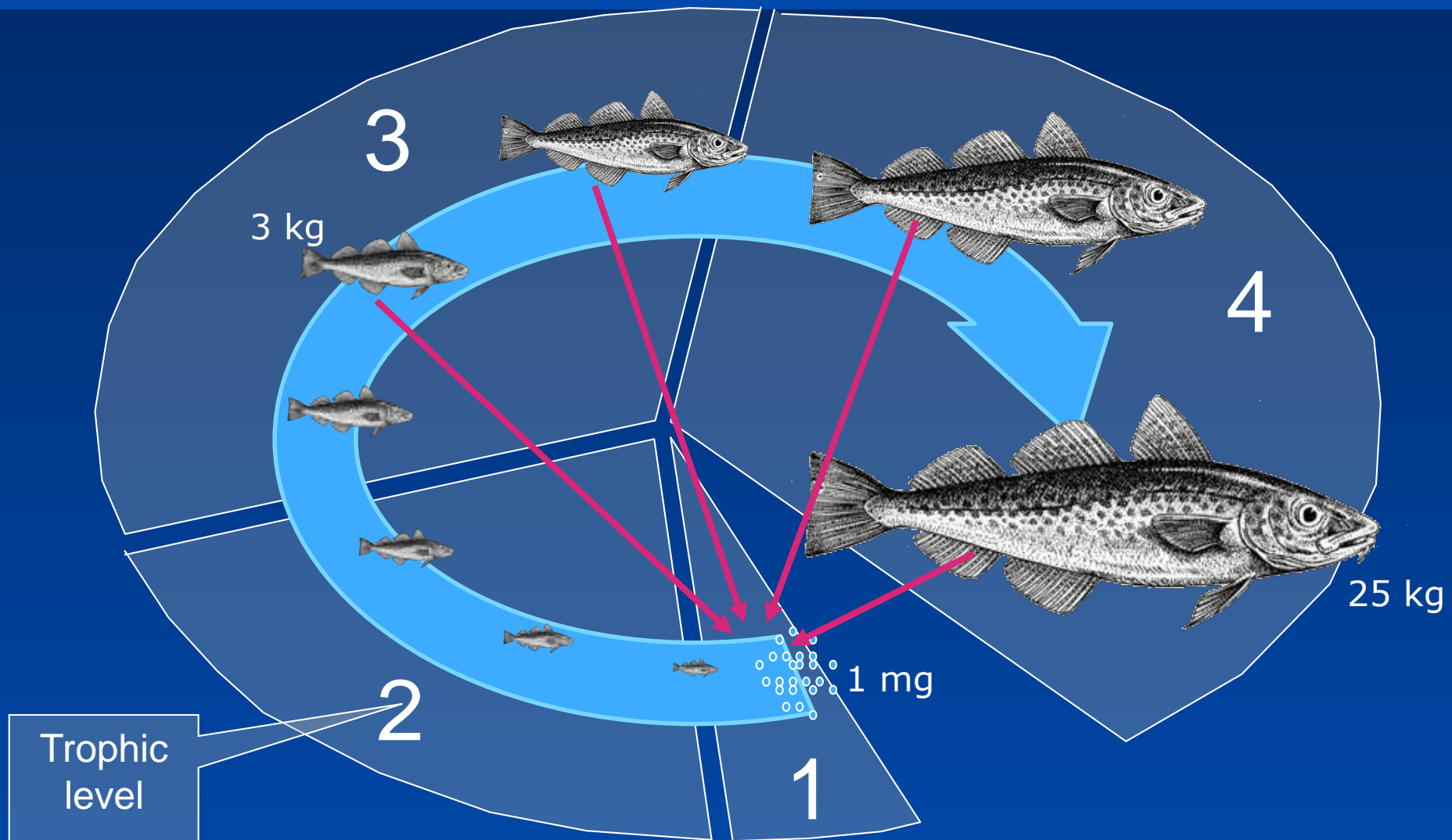


- Zhou, S. et al. 2010. Ecosystem-based fishery management requires a change to the selective fishing philosophy. PNAS, 107: 9485-9489
- **Selective Fishing and Balanced Exploitation in Relation to Fisheries and Ecosystem Sustainability.** A workshop of the IUCN-CEM Fisheries Expert Group (FEG) in Nagoya (Japan) 14-16 October 2010;
- **Reconsidering the consequences of selective fisheries conservation.** A paper in Science Policy Forum (335, March 2012).
- Since then, a small number of papers have explored further and confirmed the behavior of models used and looked for empirical evidence.

Insufficient analyses of implications for operational management, conservation and economics

2

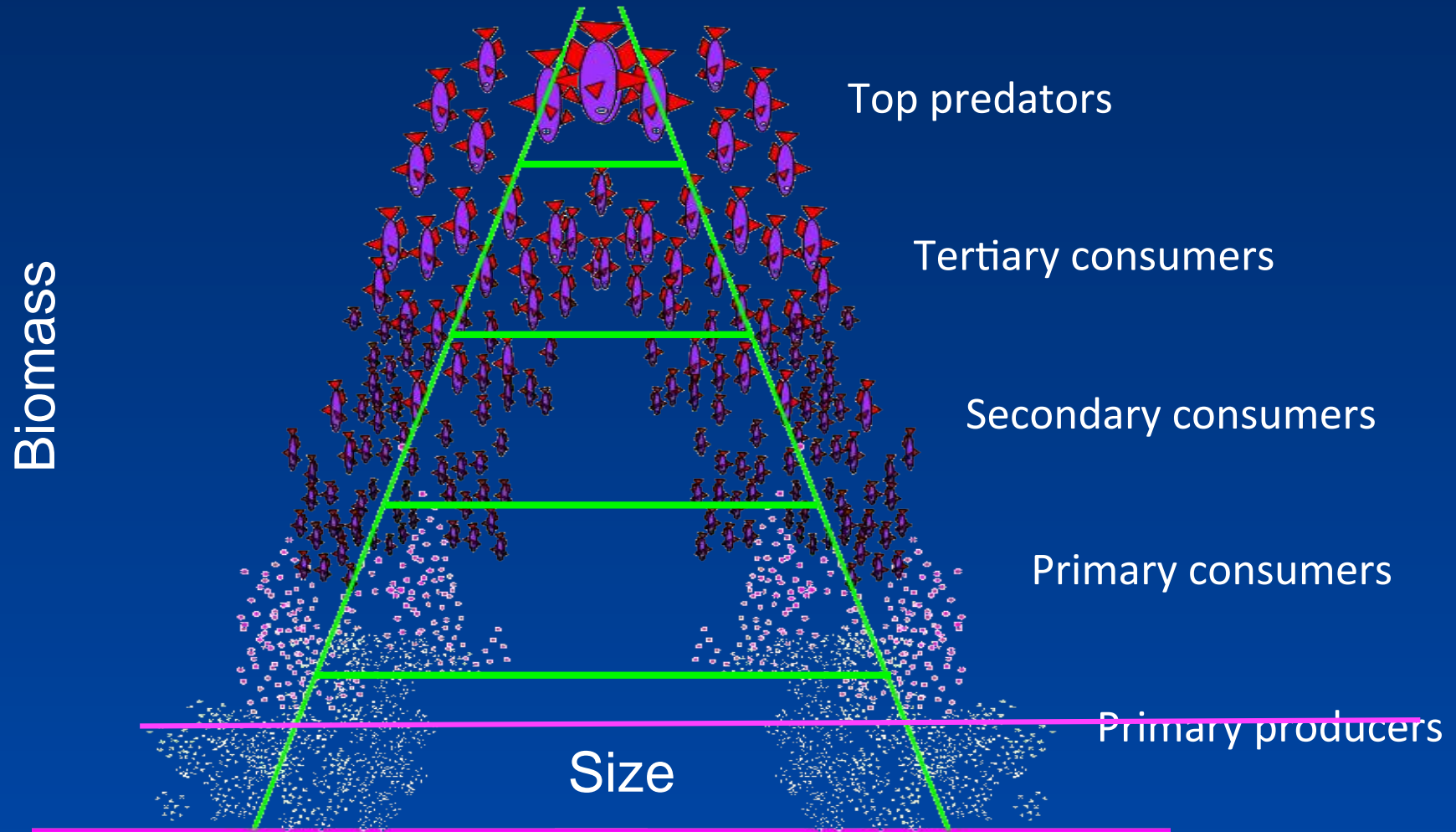
# The ontogenetic shift



Source: Jan Beyer. Nagoya FEG meeting presentation 2010

2

# The food web structure

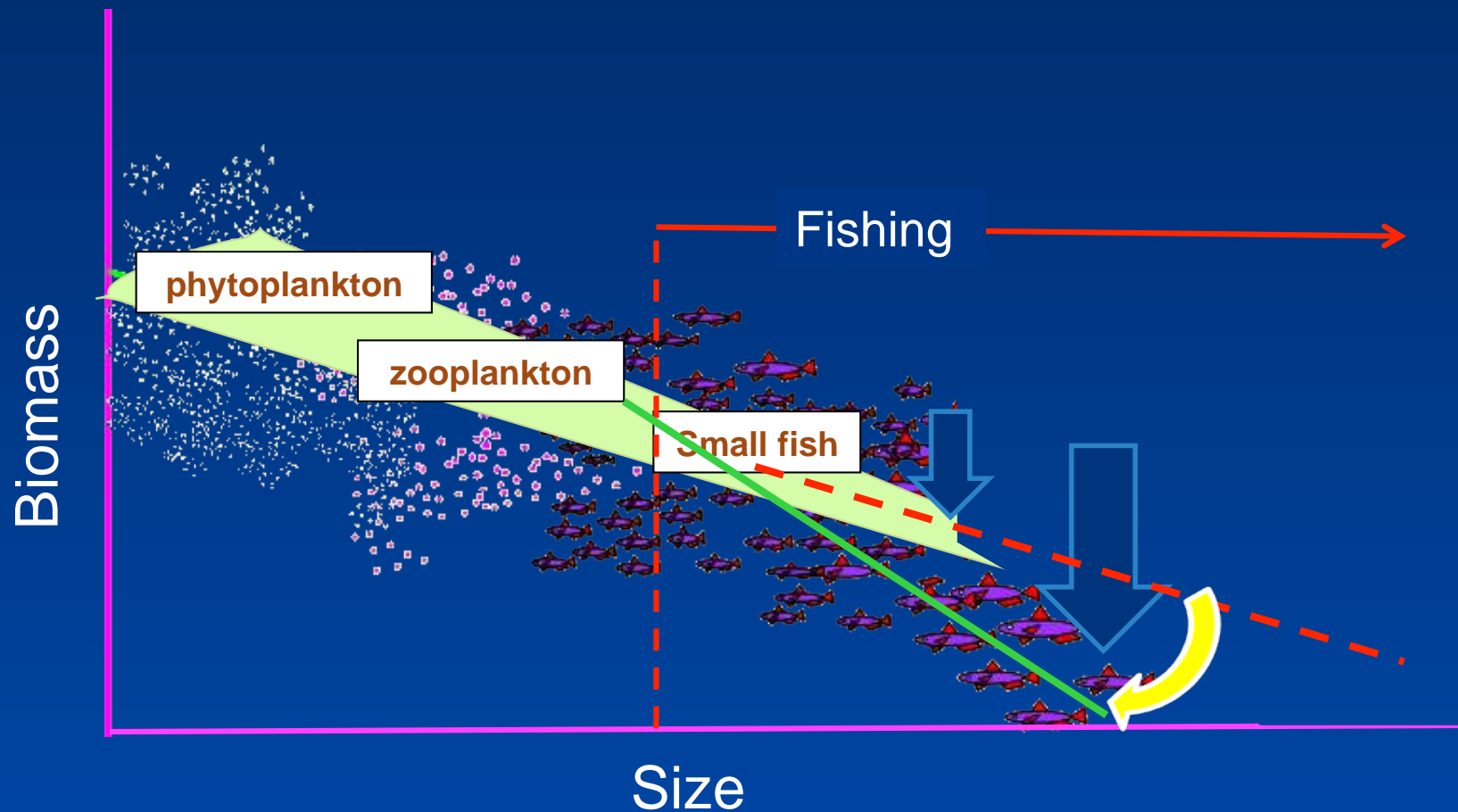


... Abundance is inversely correlated with size

## 2

# Community size spectrum

1. The distribution of biomass by body size follows regular patterns

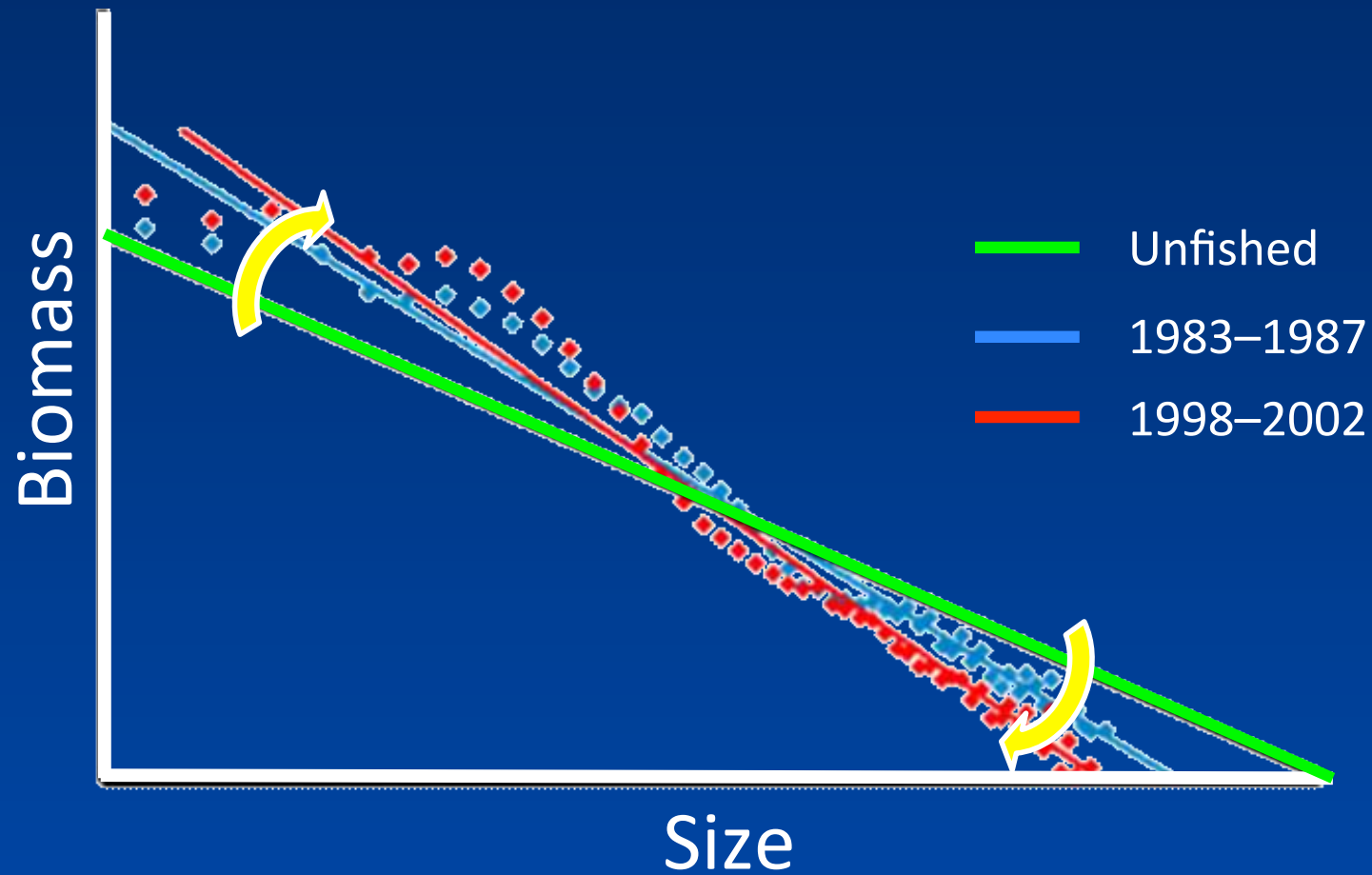


2. Under conventional selective fishing slope and intercept will change



# 2

## Changes in the North Sea

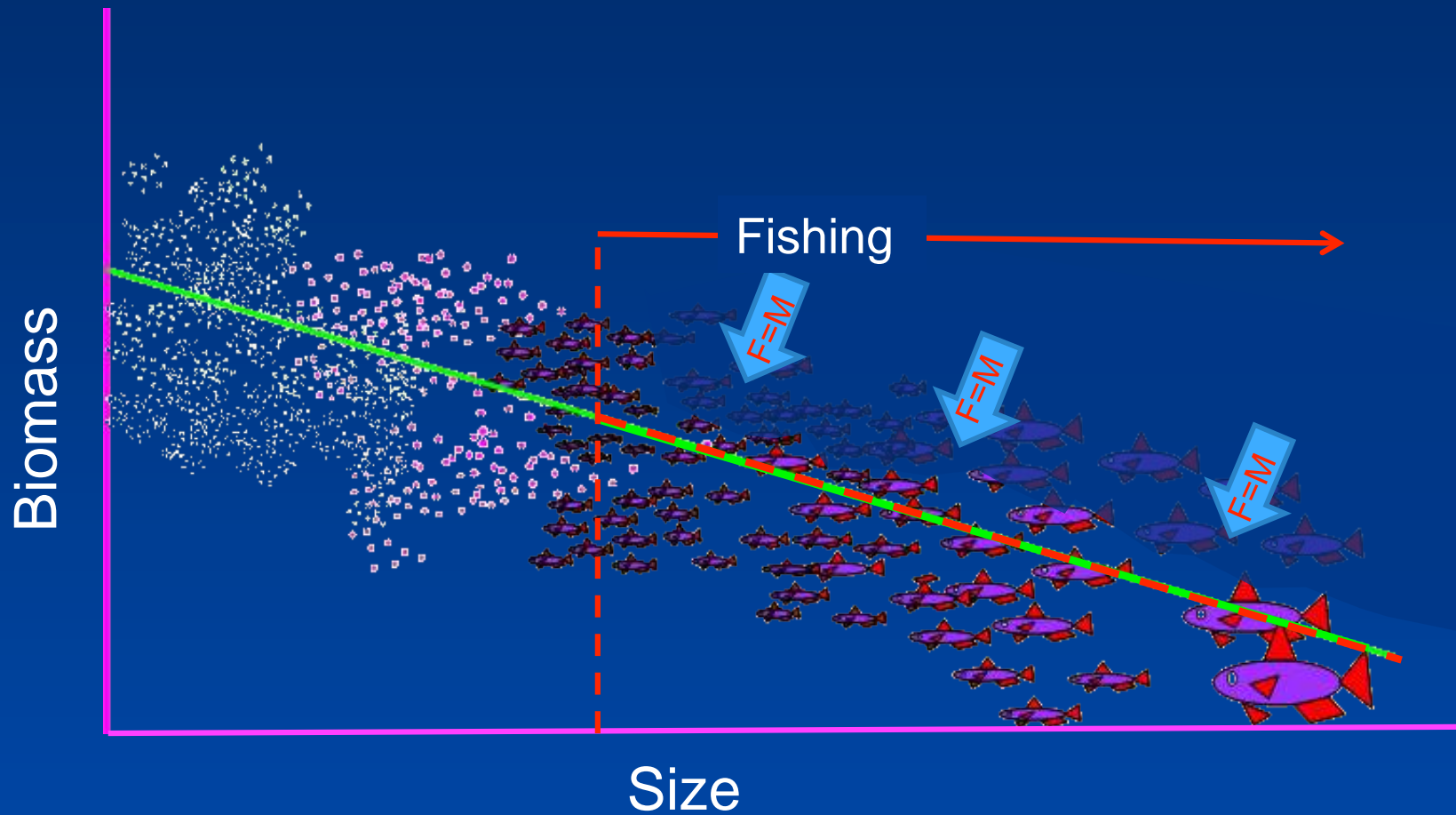




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# Balanced harvesting

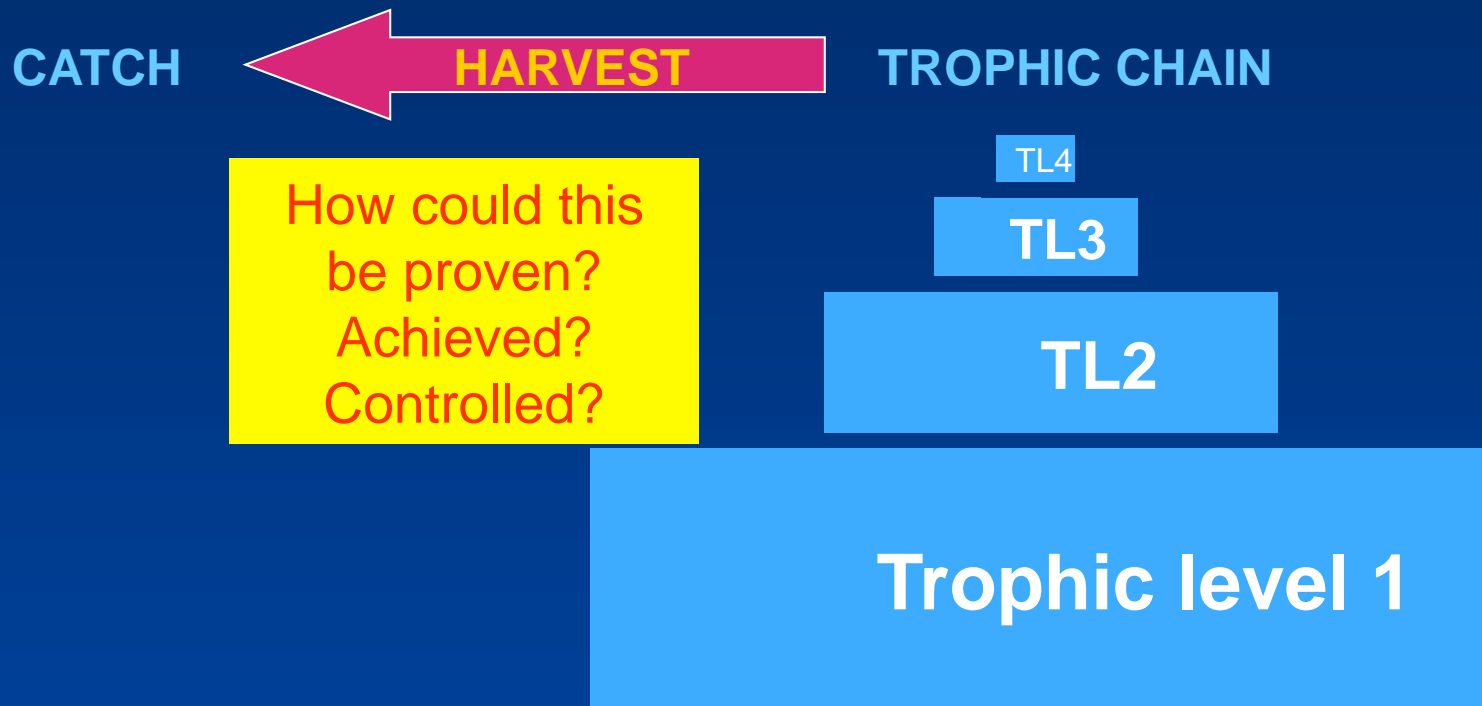
Fishing “all” sizes and species in proportion to their natural productivity



Reconciles objectives: maintains community structure; returns highest yields

## 2

# The eco-fishing challenge



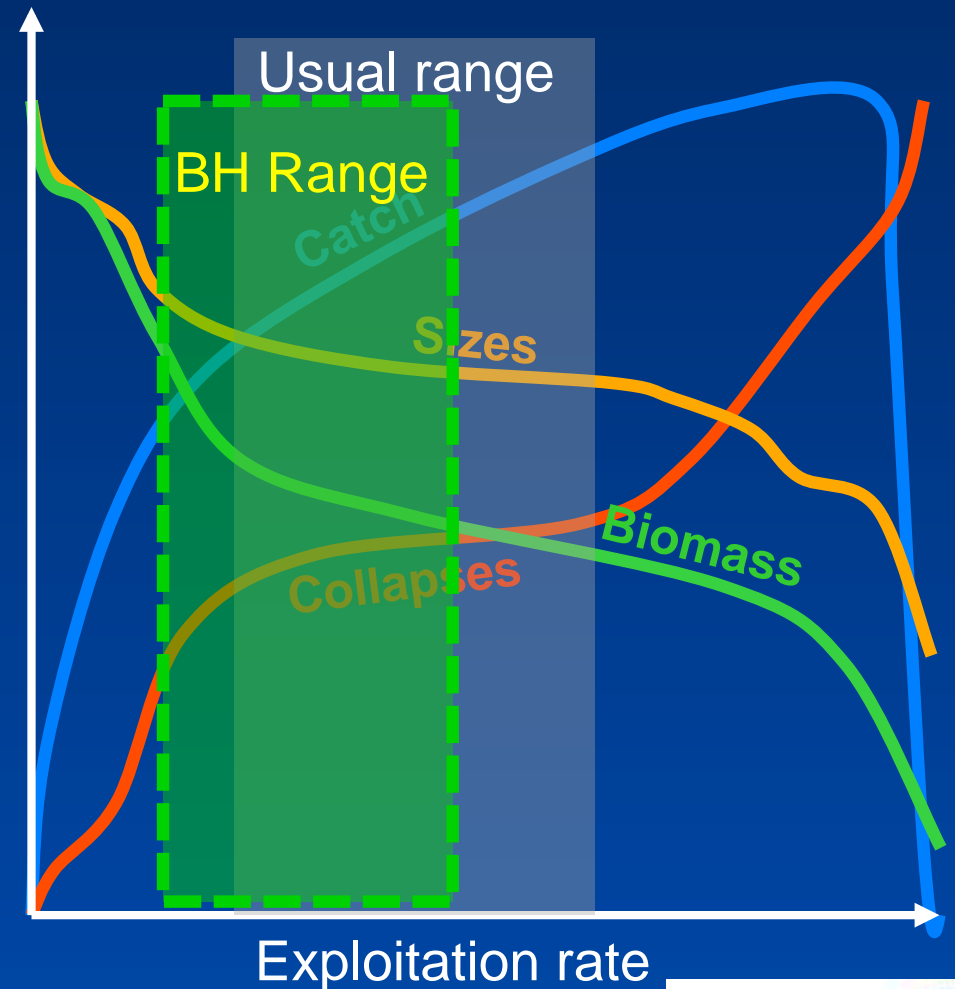
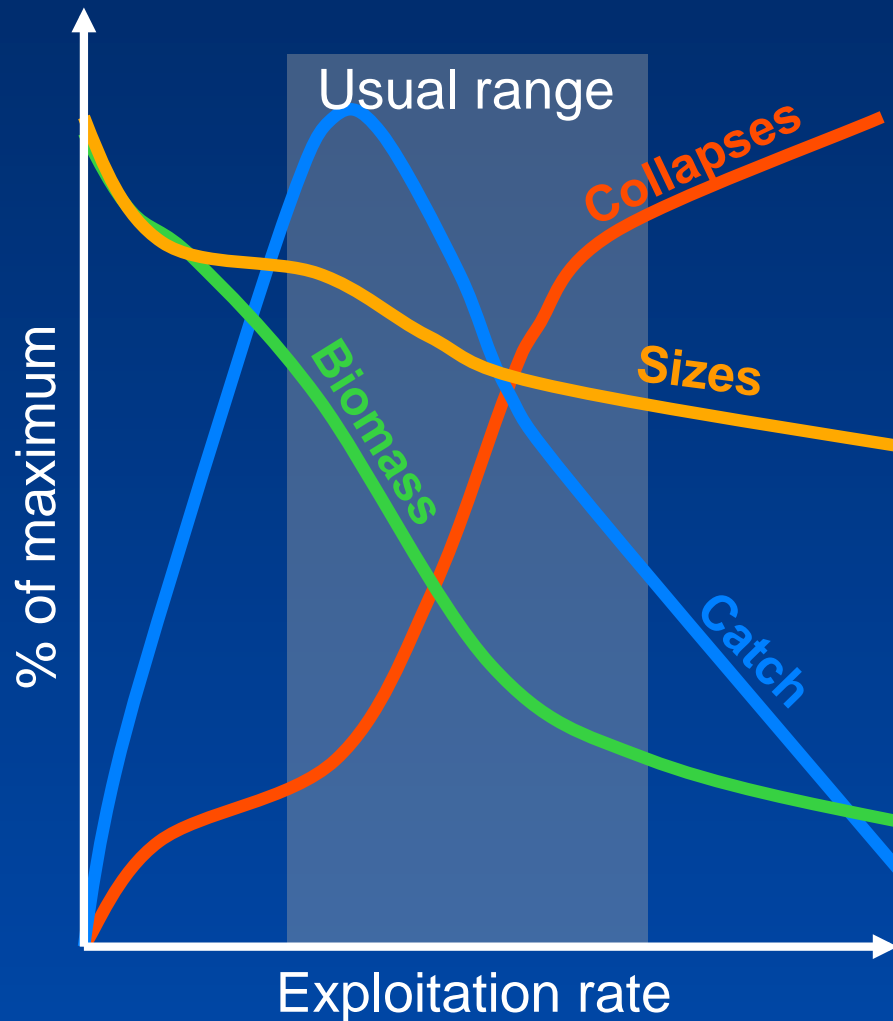
Balanced harvesting: a fishing strategy that maintains ecosystem structure by keeping fishing pressure moderate and distributing it across ecosystem components (species, sizes, and trophic levels) in proportion to their productivities

# 2

# Ecosystem models

## Concentrated fishing

## Widespread fishing



Source: Fulton et al.

## 2

## Empirical evidence

Lake Kariba ecosystem structure: 1980-1994