DEVOTES
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Development of innovative tools for understanding marine biodiversity and assessing good environmental status

Mixed-fisheries and Ecosystem Based Management
trade-offs and the importance of climate

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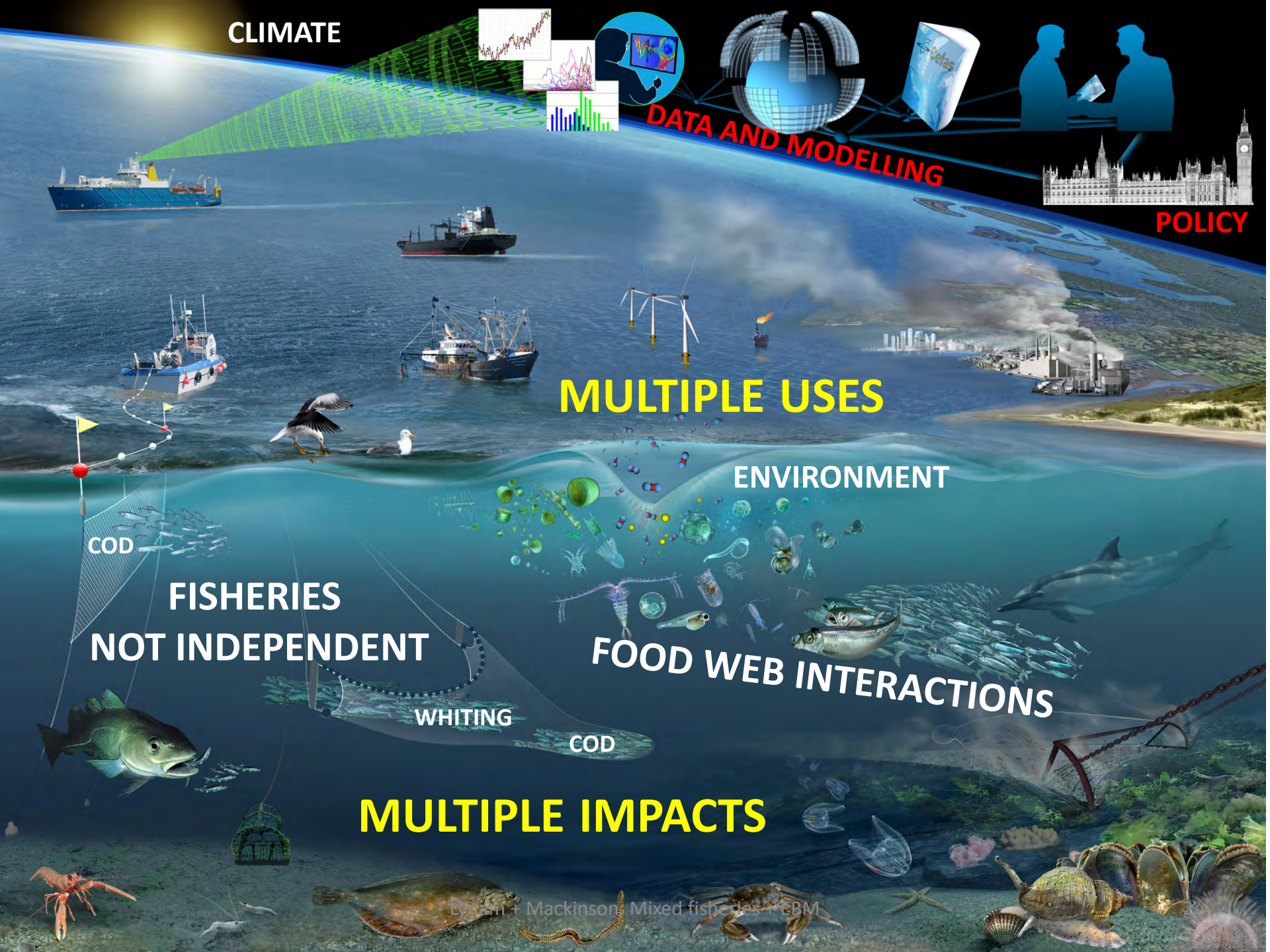
fizzyfish

S12 Linking climate change to marine management objectives
Tuesday 24th March 2015


CLIMATE
DATA AND MODELLING
POLICY
MULTIPLE USES
ENVIRONMENT
COD
FISHERIES
NOT INDEPENDENT
FOOD WEB INTERACTIONS
WHITING
COD
MULTIPLE IMPACTS

Policy arena

Management for European seas required to meet aims of policy:

1. Common Fisheries Policy (CFP; EC 2013)
2. Marine Strategy Framework Directive (MSFD; EC 2010)

Objectives:

1) to achieve maximum sustainable yield for all commercial species by 2020

2) to achieve Good Environmental Status (GES) of marine waters by 2020

Climate is explicitly mentioned …

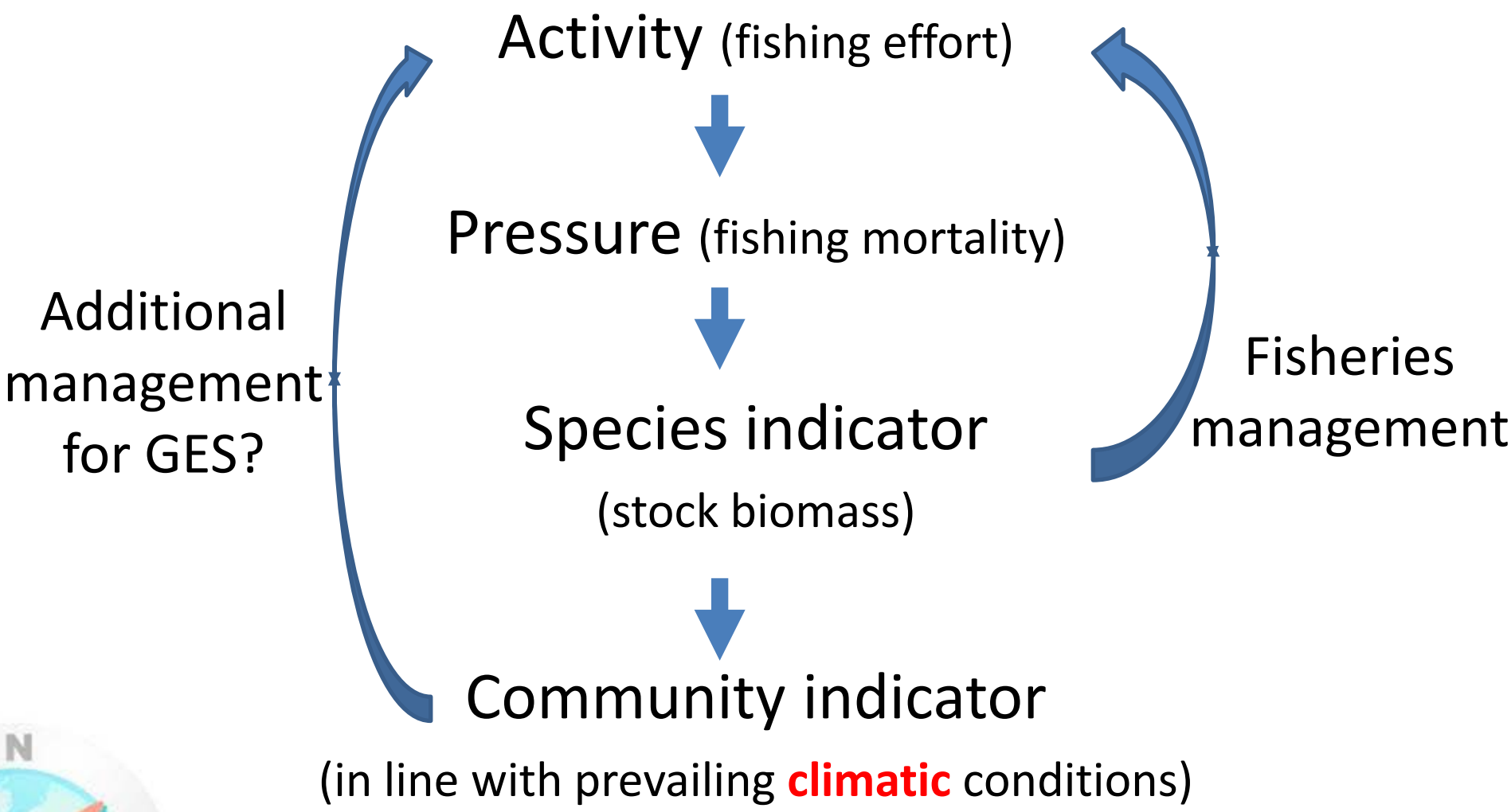
MSFD Descriptor 1: Biodiversity

"The quality and occurrence of habitats and the distribution and abundance of species are in line with **prevailing physiographic, geographic and climatic conditions**."

MSFD Descriptor 4: Food Webs

"All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels **capable of ensuring the long-term abundance of the species** and the retention of their full reproductive capacity"

Extended management cycle



Fisheries and Environmental objectives

CFP: Fisheries management have adopted maximum sustainable yield (MSY) targets for fishing mortality on commercial species

MSFD: GES by 2020, assessment based on ecological indicators, including indicators of Biodiversity and Food webs

Q *How might fisheries management measures contribute towards the attainment of GES*?

Q *How important are the prevailing climatic conditions*?

Which ecological indicators respond to fishing pressure?
What management measures might alter fishing pressure?
Will climate change mean that we can not meet our aims?

MSFD state indicators

Considered by OSPAR and ICES responsive to fisheries impacts:

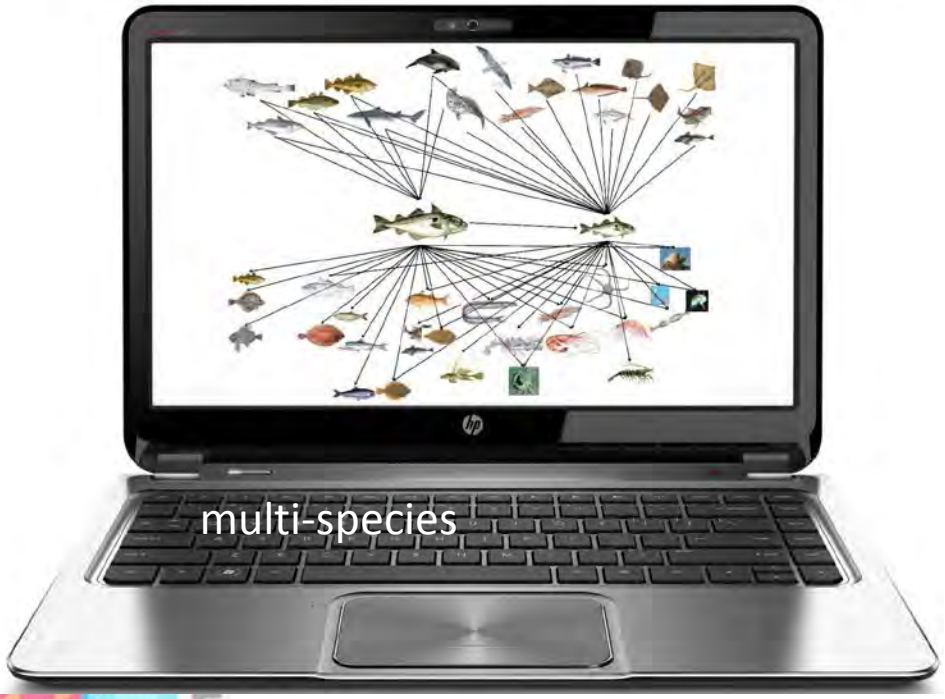
Food webs

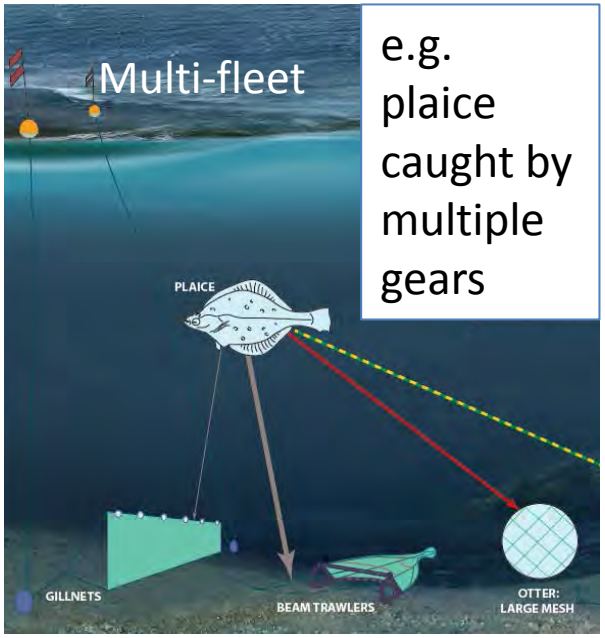
- Mean trophic level of surveyed species
- Abundance of trophic guilds
  (piscivores, planktivores, benthivores, bentho-piscivores)
- Large Fish Indicator (all fish and elasmobranches)

Biodiversity

- Large Fish Indicator (demersal fish and elasmobranchs)
- Mean Maximum Length of demersal fish and elasmobranchs

- ICES (2012) approved "key-run" of North Sea model
- Driven by time series of fishing mortality for assessed stocks and fishing effort for 8 fleets





Includes environmental drivers

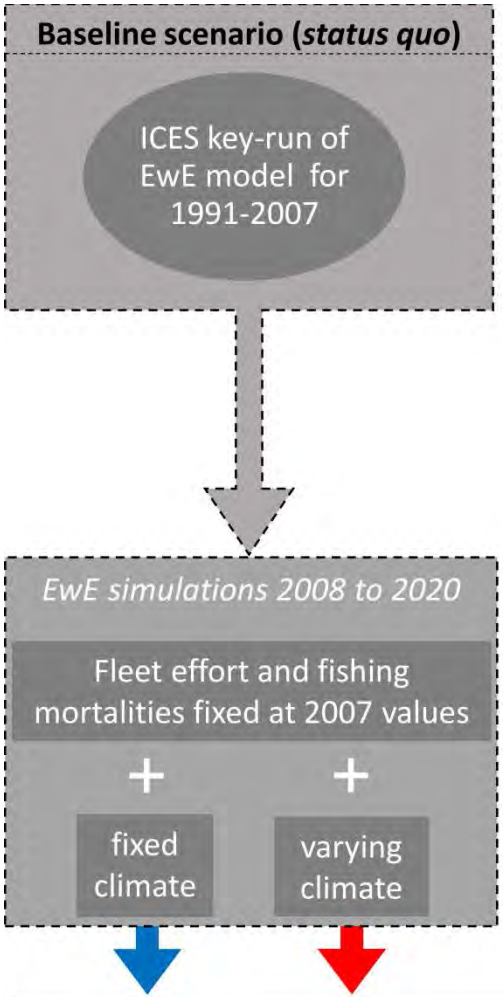
Direct forcing of phytoplankton

Direct forcing on some fish (e.g. cod) following literature

Indirect effects on higher levels

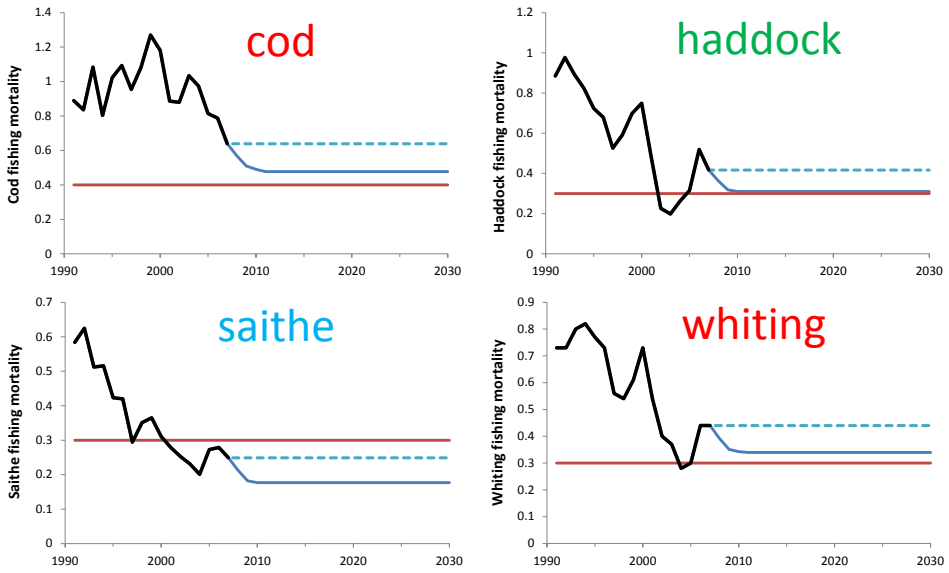
[see Mackinson (2013)]

Scenario developments

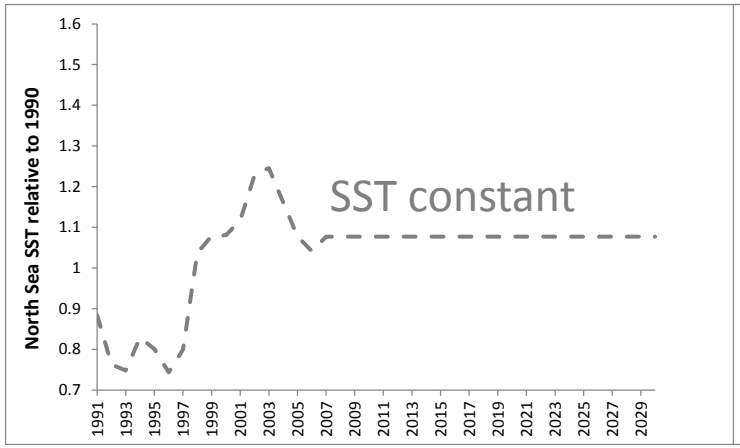


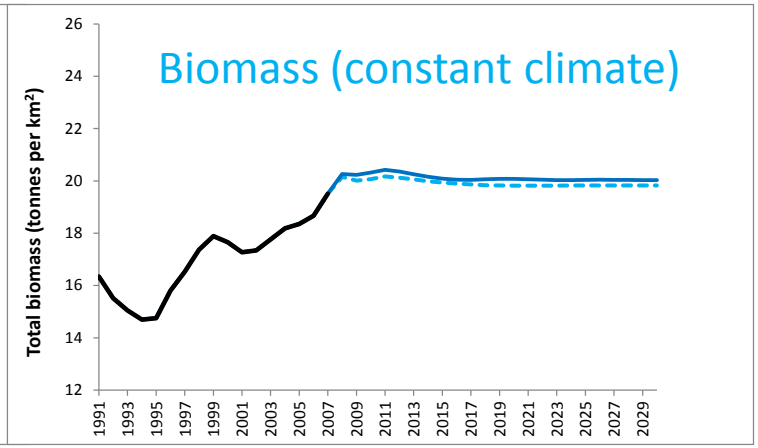
Fishing strategy (for wider effects)

- Benefit of the optimisation approach is that we final a single set of effort for 3 fleets (using ICES *F* targets for 8 stocks)
- Incorporating the effort strategy in EwE we can model the expected *F* on 43 species in a consistent way



Temperature scenario





Total biomass of system follows temperature trajectory

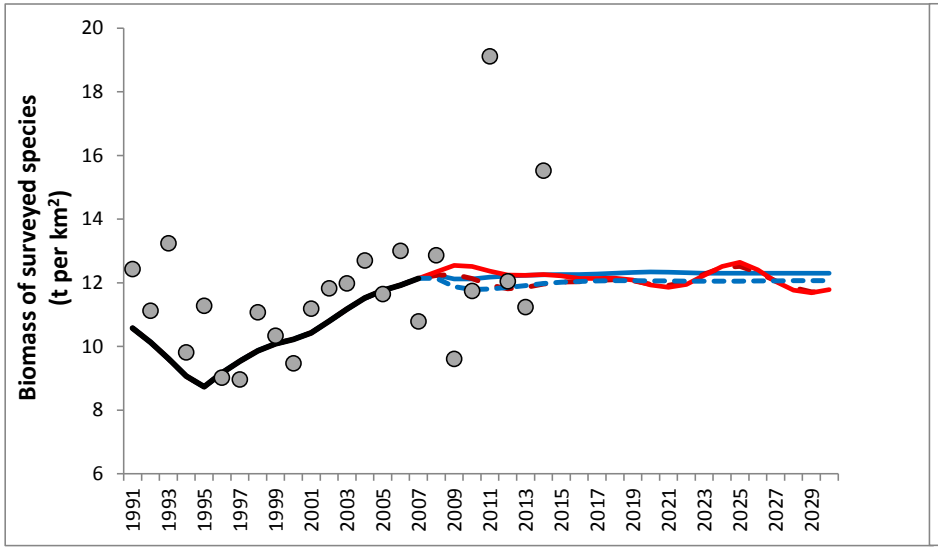
Scenario

- Baseline fishing and constant climate
- Optimised fishing strategy with constant climate
- Baseline fishing plus climate scenario
- Optimised fishing plus climate scenario

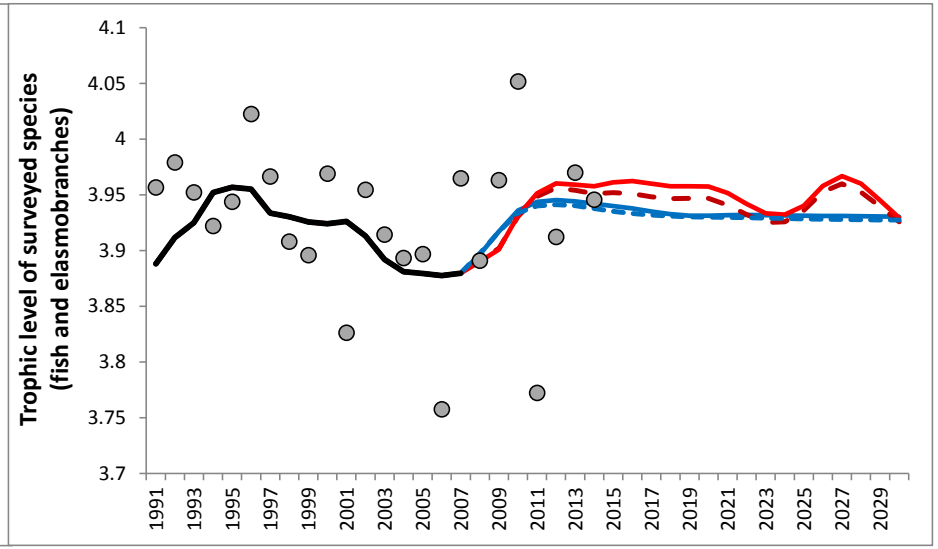
Temperature – little effect on fish ?

Total biomass of fish less sensitive than biomass of entire system
Yet small change in trophic level…

Biomass of fish and elasmobranchs



Trophic level of fish and elasmobranchs



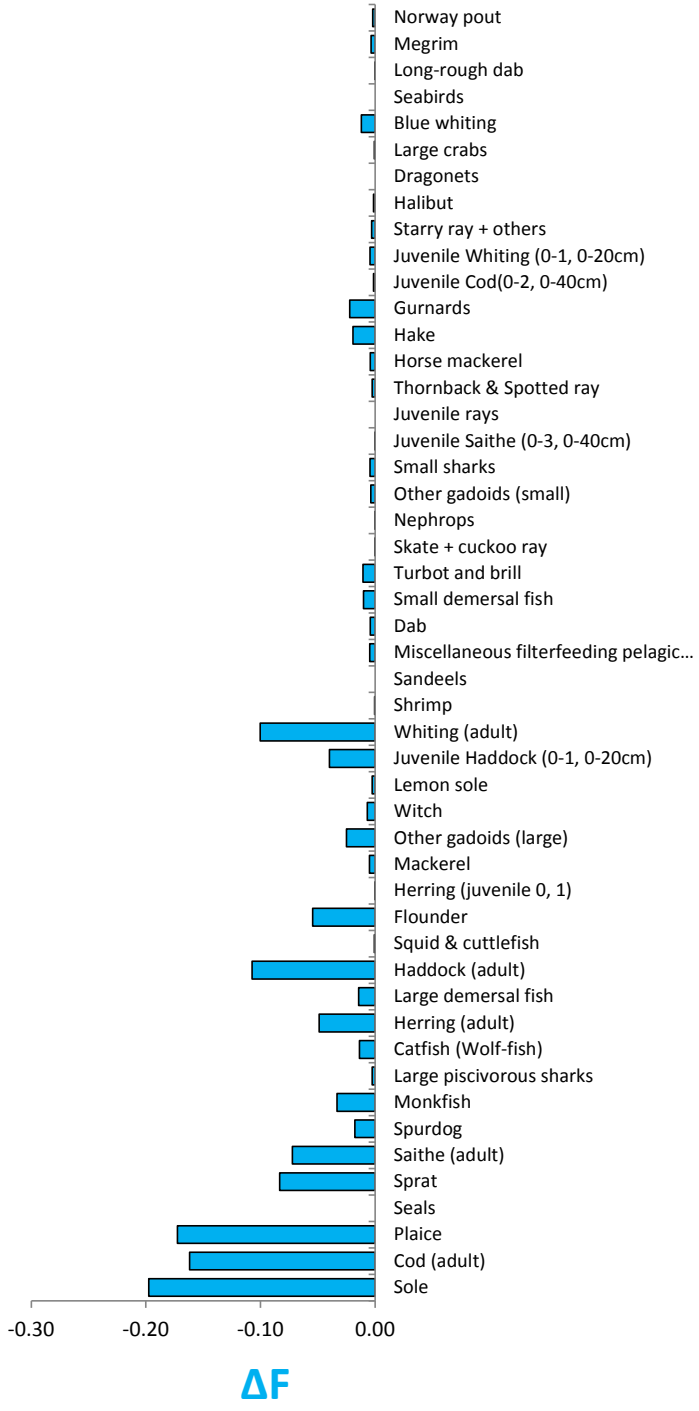
- Baseline fishing and constant climate
- Optimised fishing strategy with constant climate
- Baseline fishing plus climate scenario
- Optimised fishing plus climate scenario
- hindcast period
- Survey

ΔF by species

Without change in climate

Winners and losers

decreases in *F* or no change for every group



ΔF and ΔSST

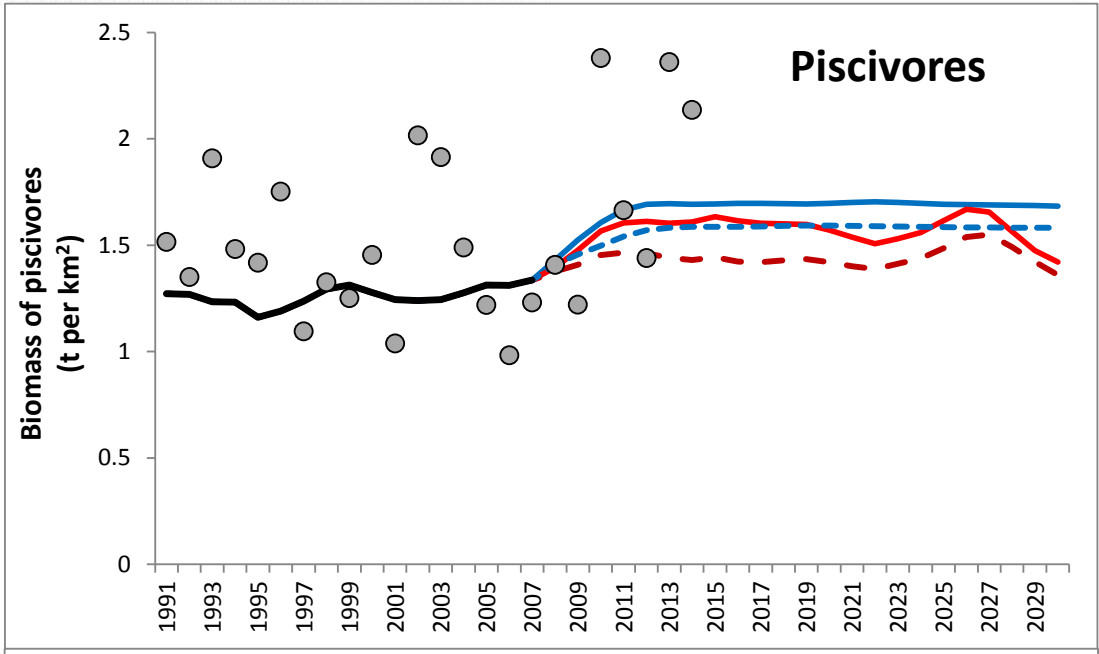
With variability in climate

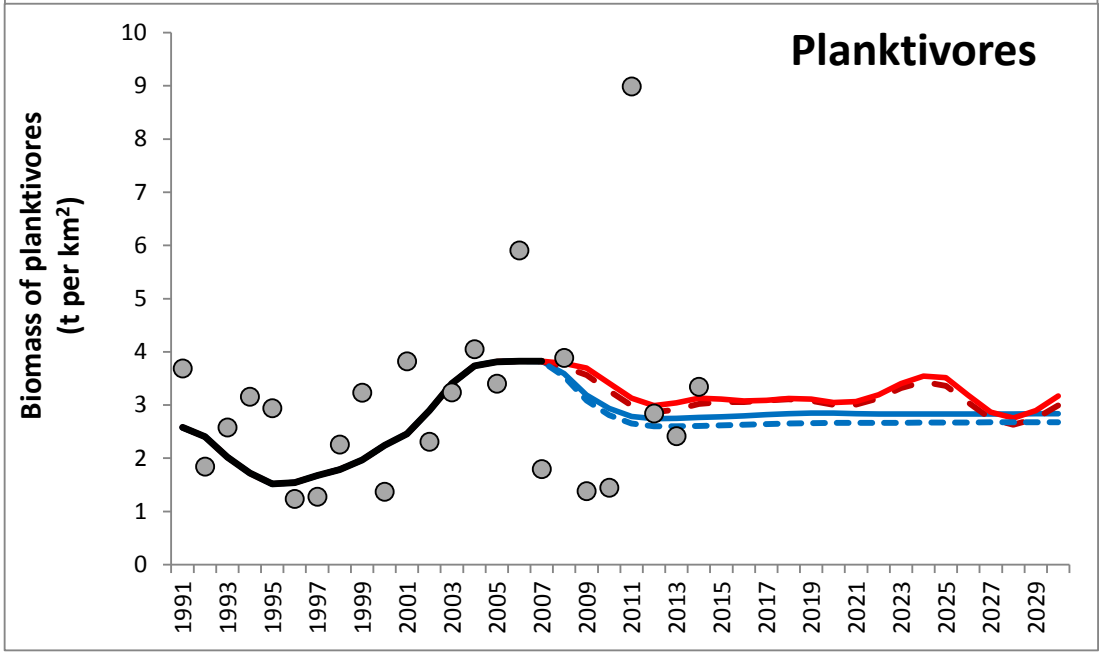
Losers worse off

decreases in *F* or no change for every group

ΔF and ΔSST: food webs

Biomass by trophic guild

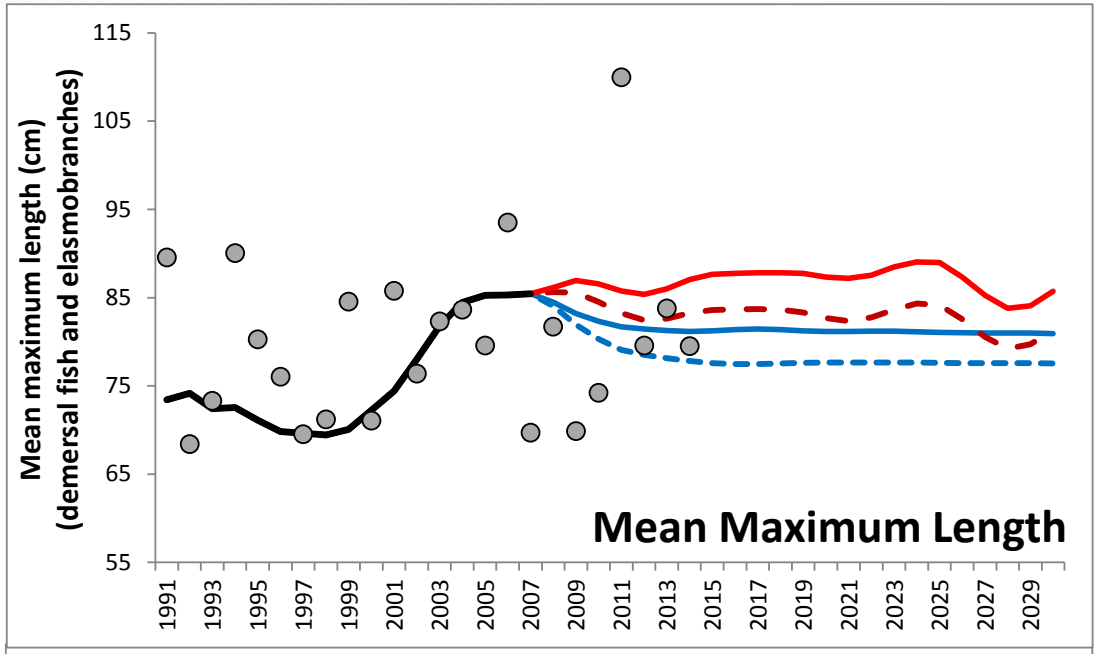


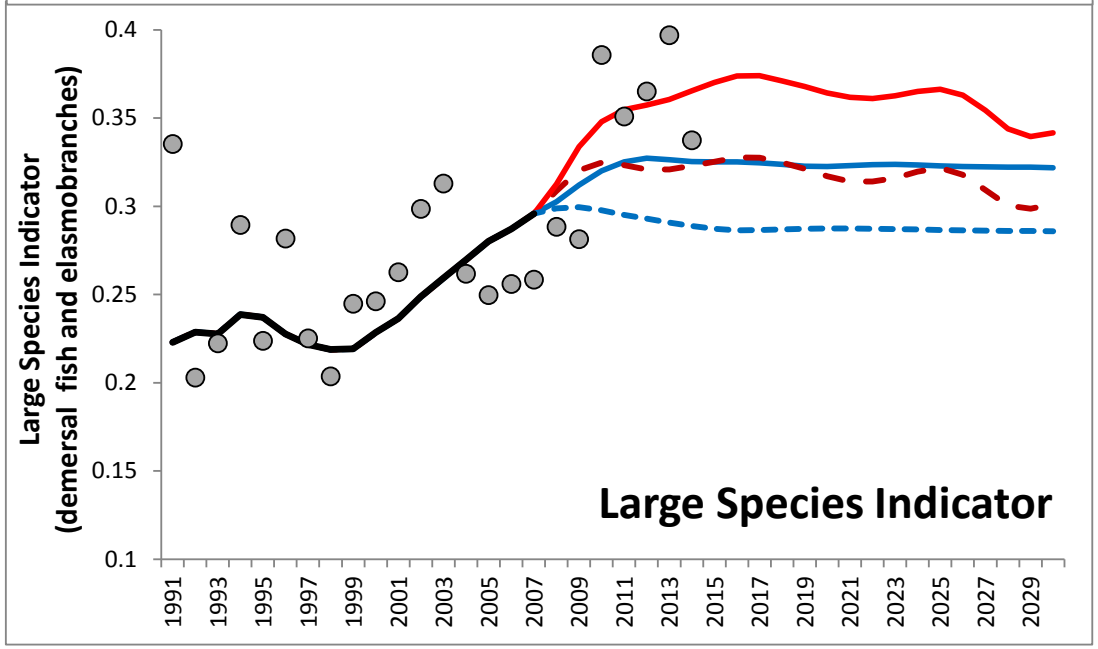


- Survey
- **Baseline fishing and constant climate**
- **Optimised fishing strategy with constant climate**
- **Baseline fishing plus climate scenario**
- **Optimised fishing plus climate scenario**

ΔF and ΔSST: biodiversity

Size structure indicators for demersal guild





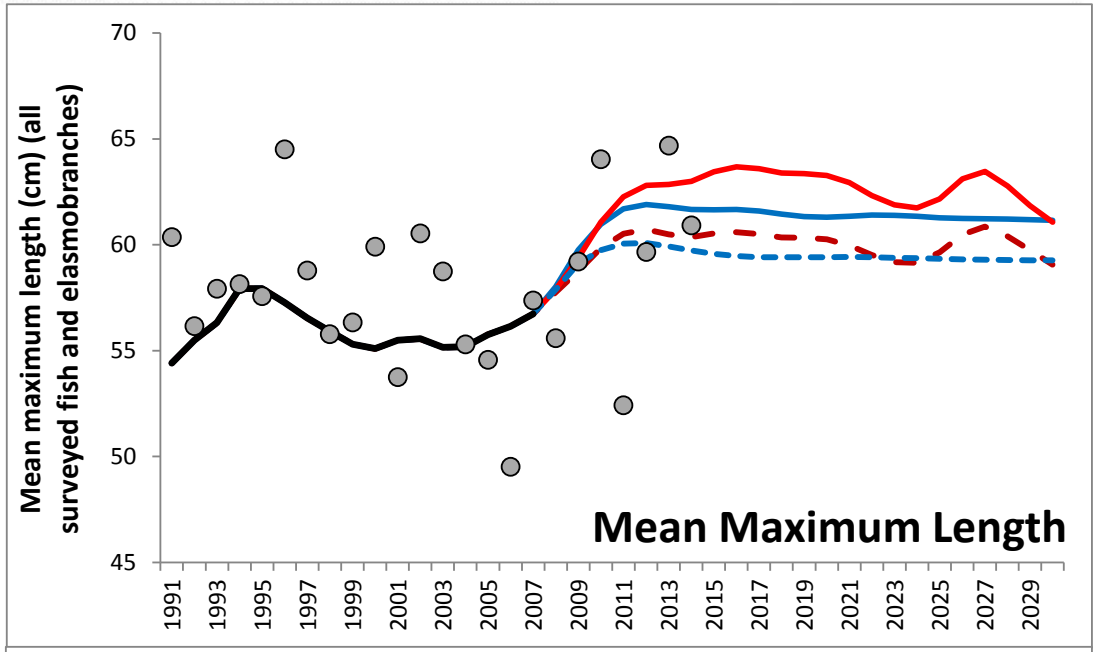
- Survey
- **Baseline fishing and constant climate**
- **Optimised fishing strategy with constant climate**
- **Baseline fishing plus climate scenario**
- **Optimised fishing plus climate scenario**

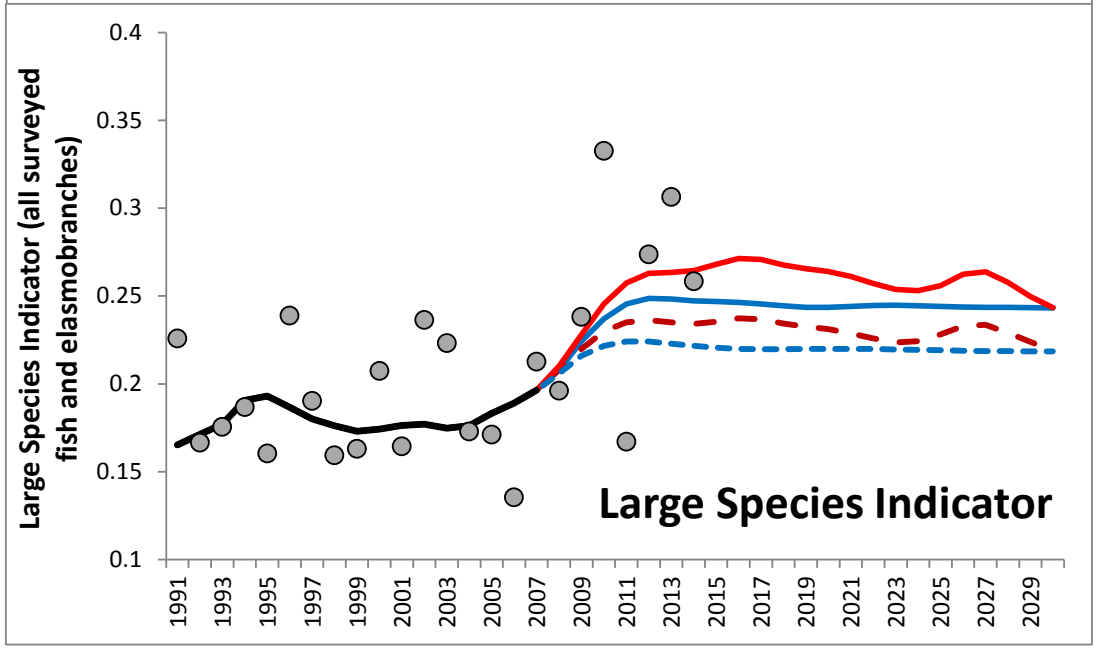
ΔF and ΔSST: food webs

Size structure indicators for all species

Less sensitive to climate than the demersal guild

- Survey
- Baseline fishing and constant climate
- Optimised fishing strategy with constant climate
- Baseline fishing plus climate scenario
- Optimised fishing plus climate scenario





Summary: fishing impacts

Reduced fishing effort will lead to increases in

- size-based indicators and
- biomasses of piscivores, planktivores and benthivores
- *however, predation by piscivores will depress bentho-piscivore biomass*

- Fisheries management measures will contribute to improvements in the biodiversity of the fish community, but food web interactions will mediate changes

Summary: climate impacts

Climate warming may

- increase indicators of size and trophic level
- increase the biomass of planktivores and benthivores
- decrease the biomass of piscivores

- Community indicators are less sensitive to climate as the number of species included in the indicator increase

Implications

- Targets for ecological indicators + targets for fishing mortality (revised to reflect fleet/species interactions) must be set in a coherent manner

- Climate change must be considered such that management targets set are achievable

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