

# Climate change impacts on the west of Scotland demersal fisheries: past and future changes

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**NWWAC webinar – November 2020**

# The ClimeFish project

**Co-creating a decision support framework to ensure sustainable fish production in Europe under climate change**

❑ H2020 EU project

❑ April 1<sup>st</sup> 2016 – 31<sup>st</sup> March 2020

<https://climefish.eu/>



## **ClimeFish – Adapting to a changing world**

“ClimeFish will support sustainable fisheries, enable an increase in European aquaculture production, facilitate employment and regional development in the sectors, and develop forecasting and management tools for adapting to climate change; all in co-creation with stakeholders”

## **Objectives**

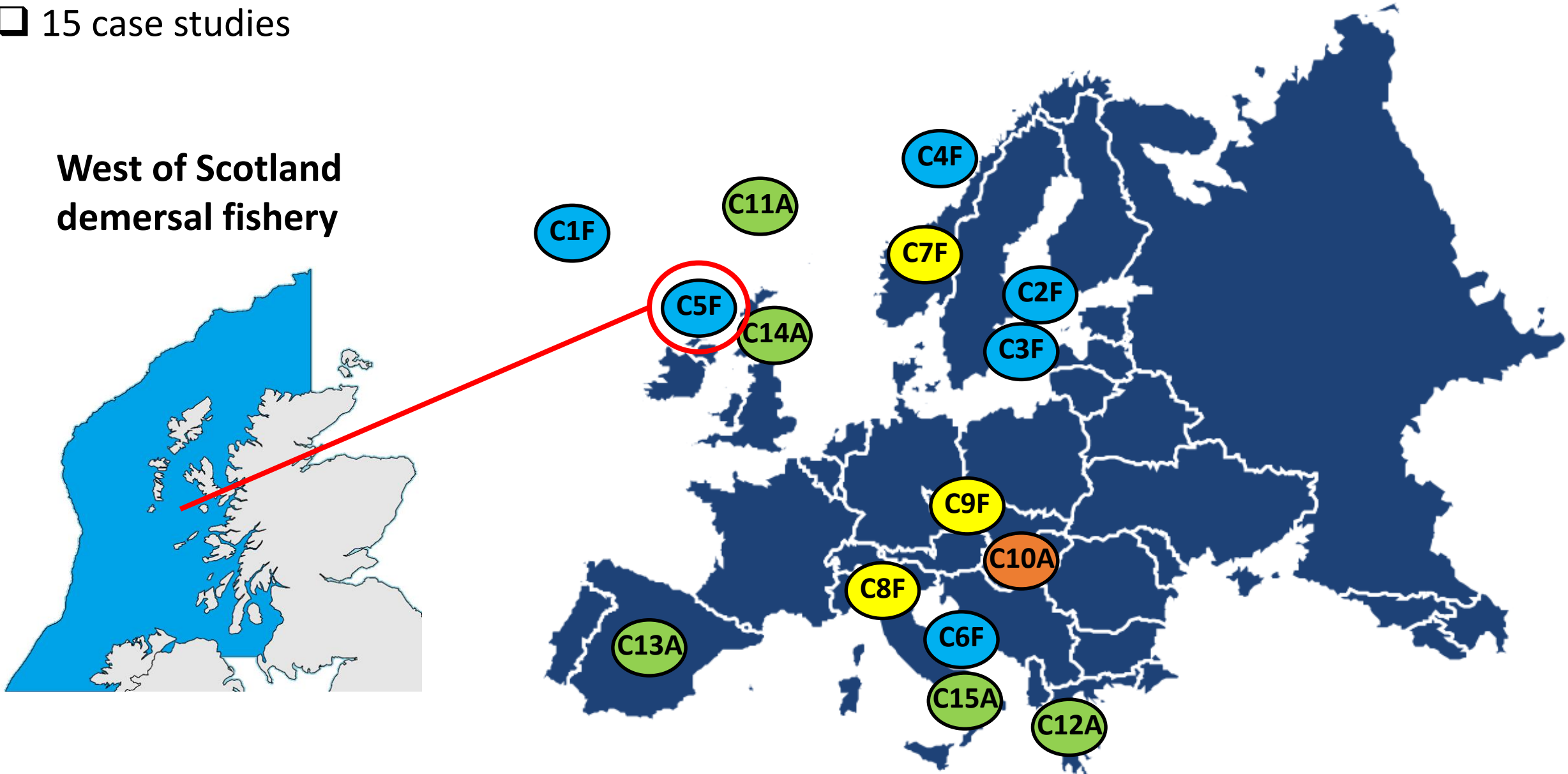
❑ Assess and forecast the greatest threats and opportunities for EU aquatic food production

❑ Develop management plans to mitigate threats and utilise opportunities

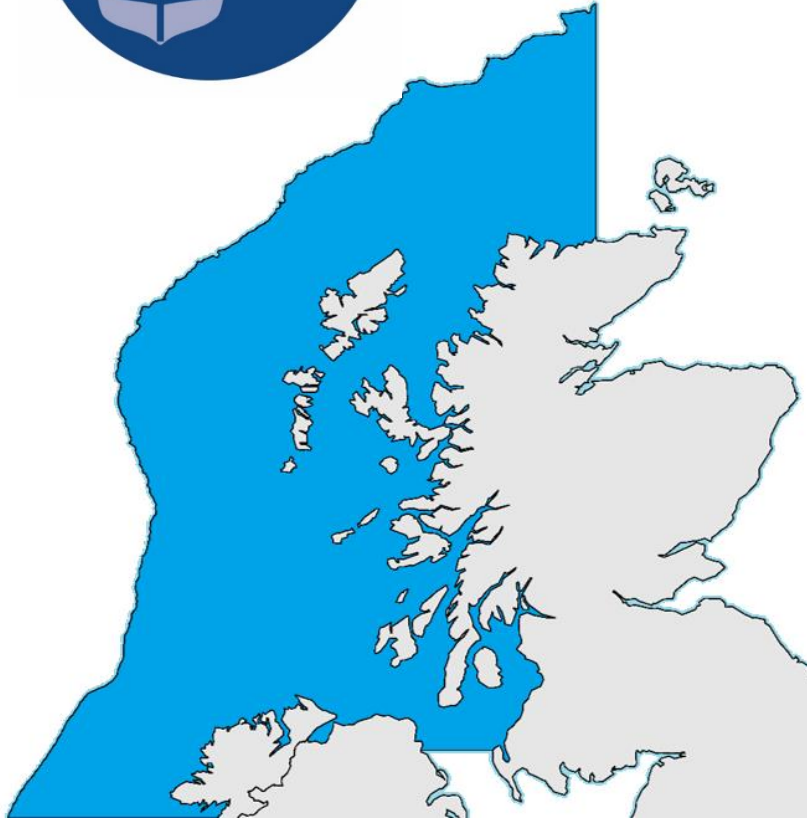
# The ClimeFish project

□ 15 case studies

West of Scotland  
demersal fishery



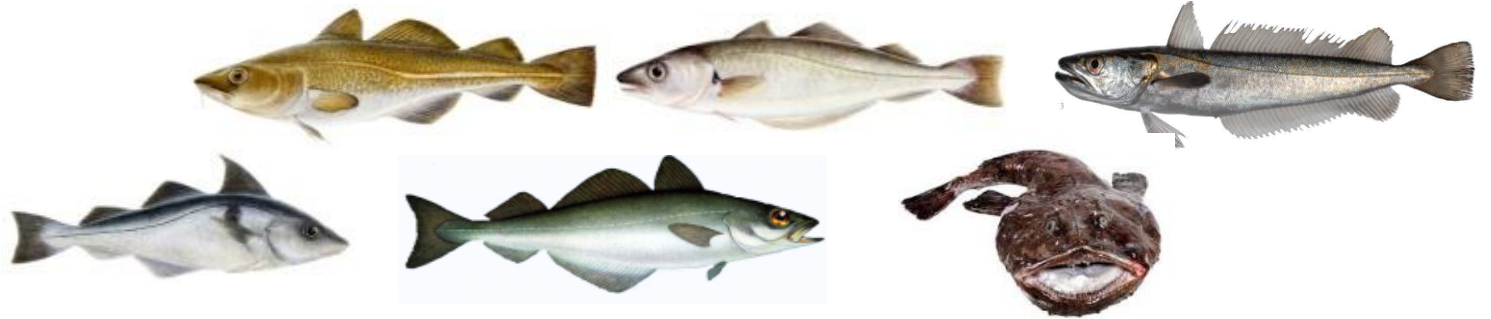
# West of Scotland demersal fishery



Cold-water species



Warm-water species

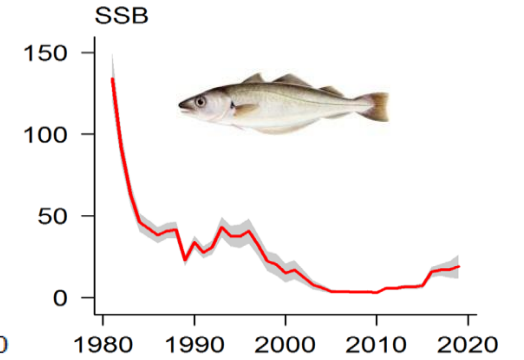
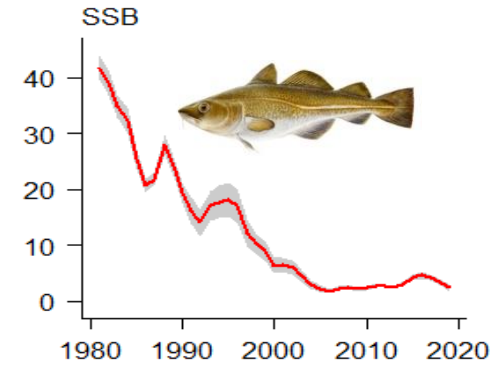


- ❑ A mixed fishery targeting multiple species
- ❑ Main stakeholders:

# West of Scotland demersal fishery

## A fishery already facing numerous challenges

❑ Depleted stocks of cod and whiting



❑ Bycatch by Nephrops fishery



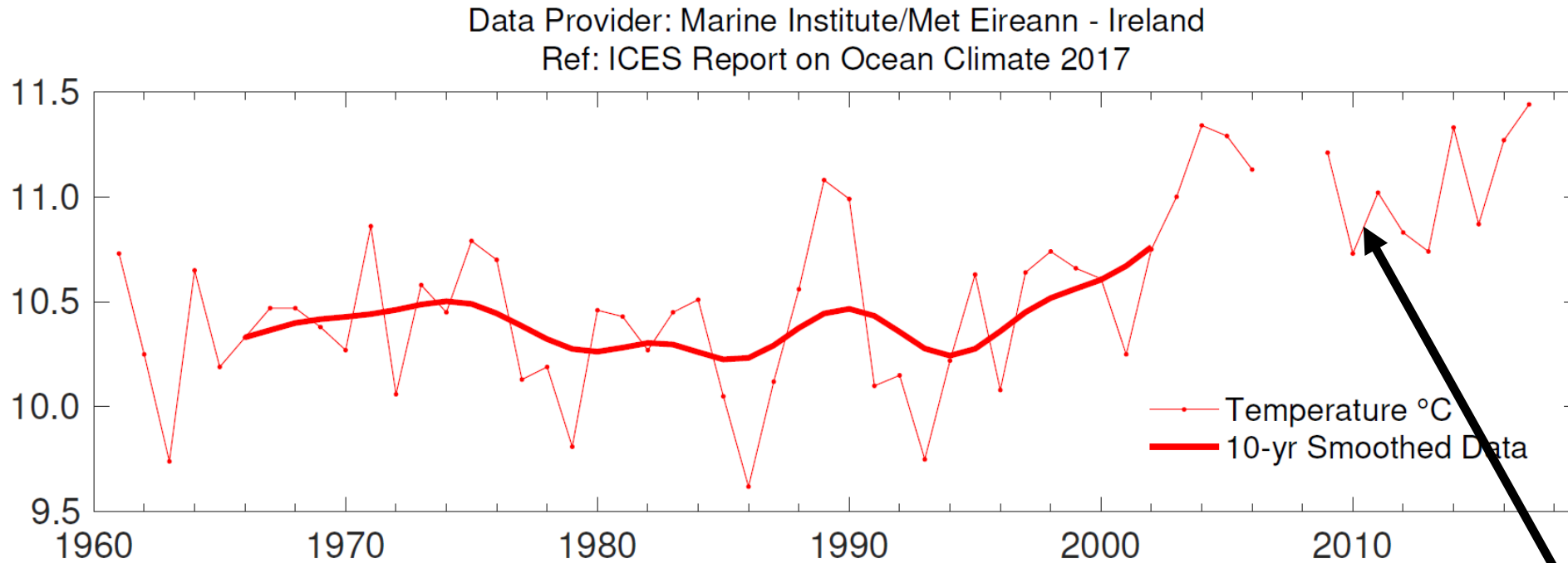
ICES WGCSE  
REPORT 2018  
ICES ADVISORY COMMITTEE  
ICES CM 2018/ACOM:13

❑ Predation from grey seals on cod

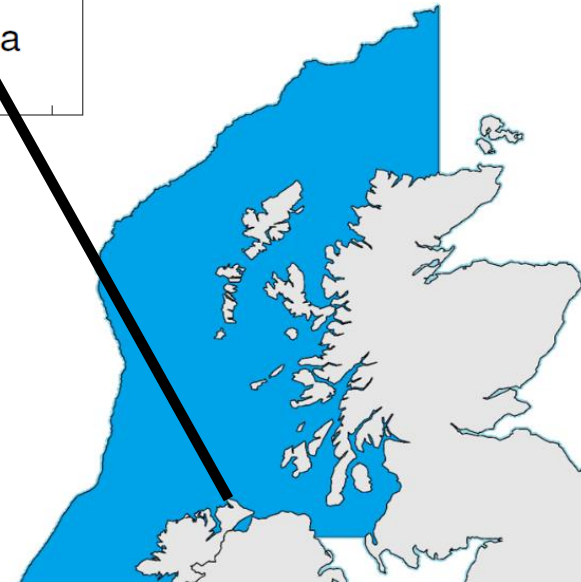


# West Scotland waters are warming

□ Sea temperature measured at Malin Head

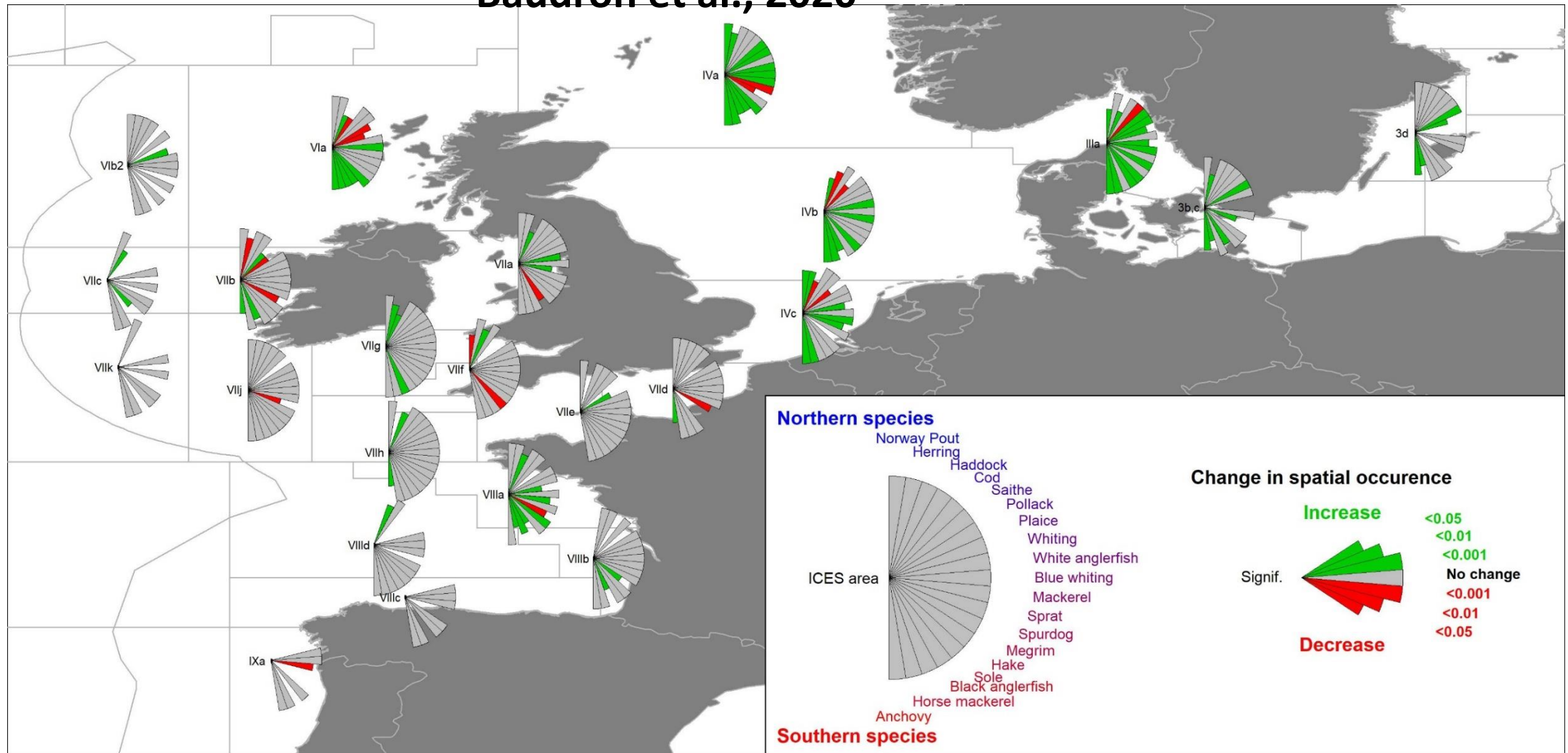


**González-Pola et al., 2018**



# Warming is causing fish distributions to change

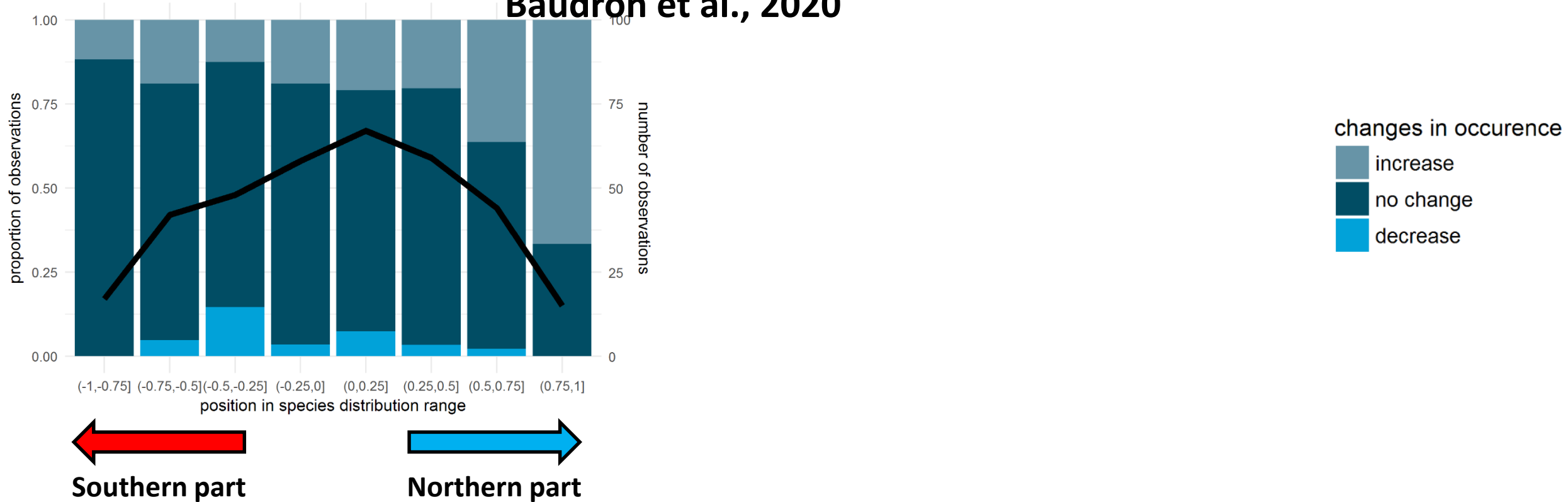
Baudron et al., 2020



- ❑ Expansion of southern species, especially in northern areas
- ❑ Some expansion of northern species in the north, but contractions in mid- and southern areas

# Warming is causing fish distributions to change

Baudron et al., 2020



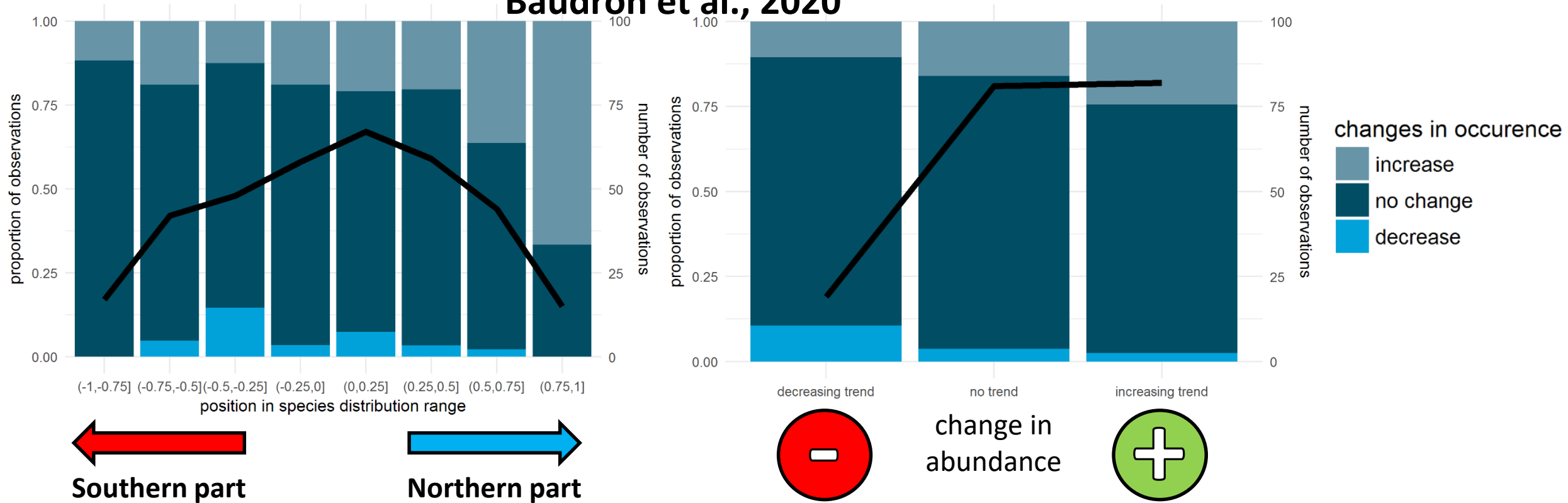
❑ More expansions at northern end of species' ranges

❑ More contractions at southern end

❑ **Changes in suitable habitat areas**

# Warming is causing fish distributions to change

Baudron et al., 2020



❑ More expansions at northern end of species' ranges

❑ More contractions at southern end

❑ **Changes in suitable habitat areas**

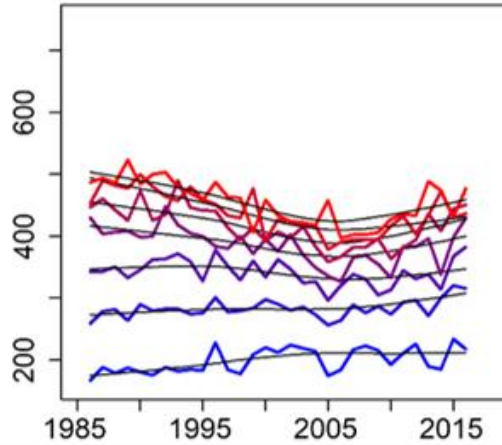
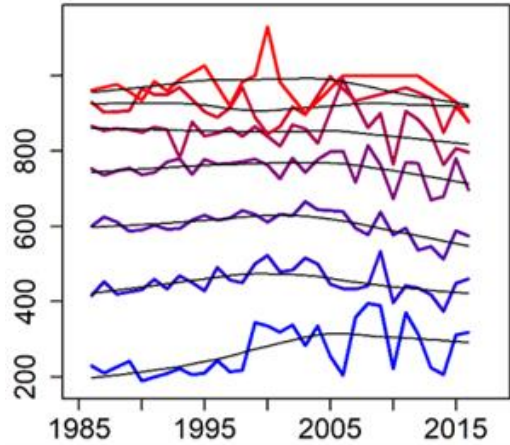
❑ More expansions for species with increasing stock abundance

❑ More contractions for decreasing abundance

❑ **Density-dependent habitat selection**

# Warming is affecting fish body sizes

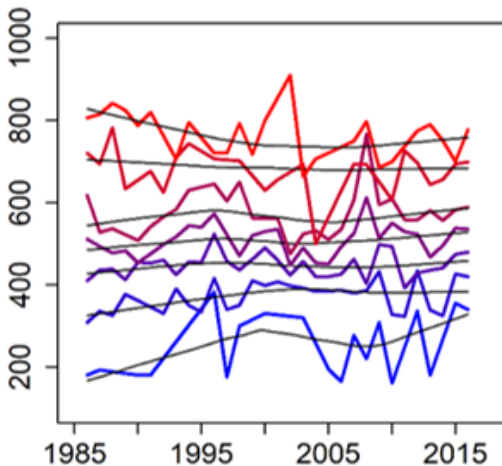
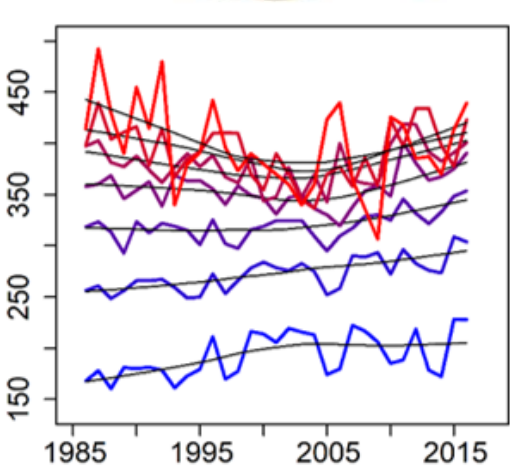
Ikpewe et al., in press



## Change in mean length-at-age

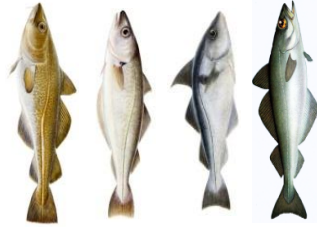
▣ Increase in juvenile length

▣ Decrease in adult length



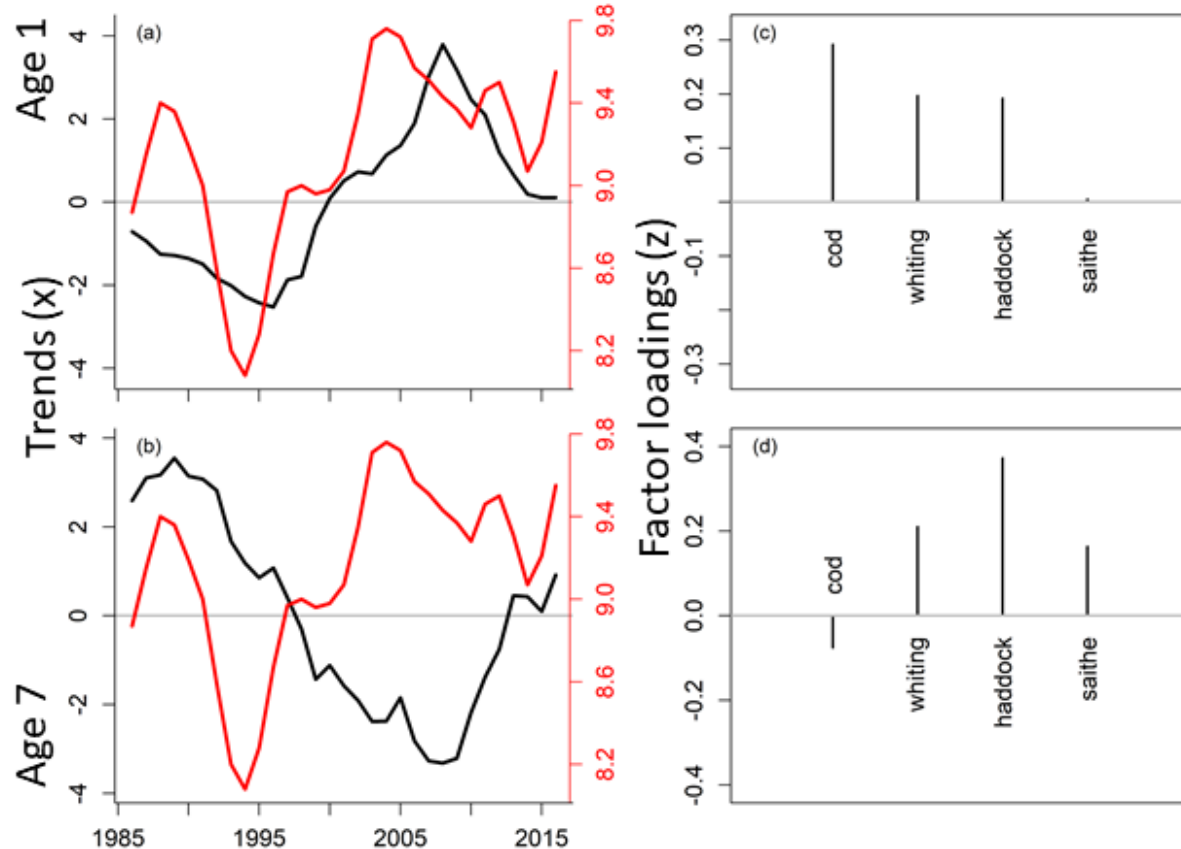
# Warming is affecting fish body sizes

Ikpewe et al., in press

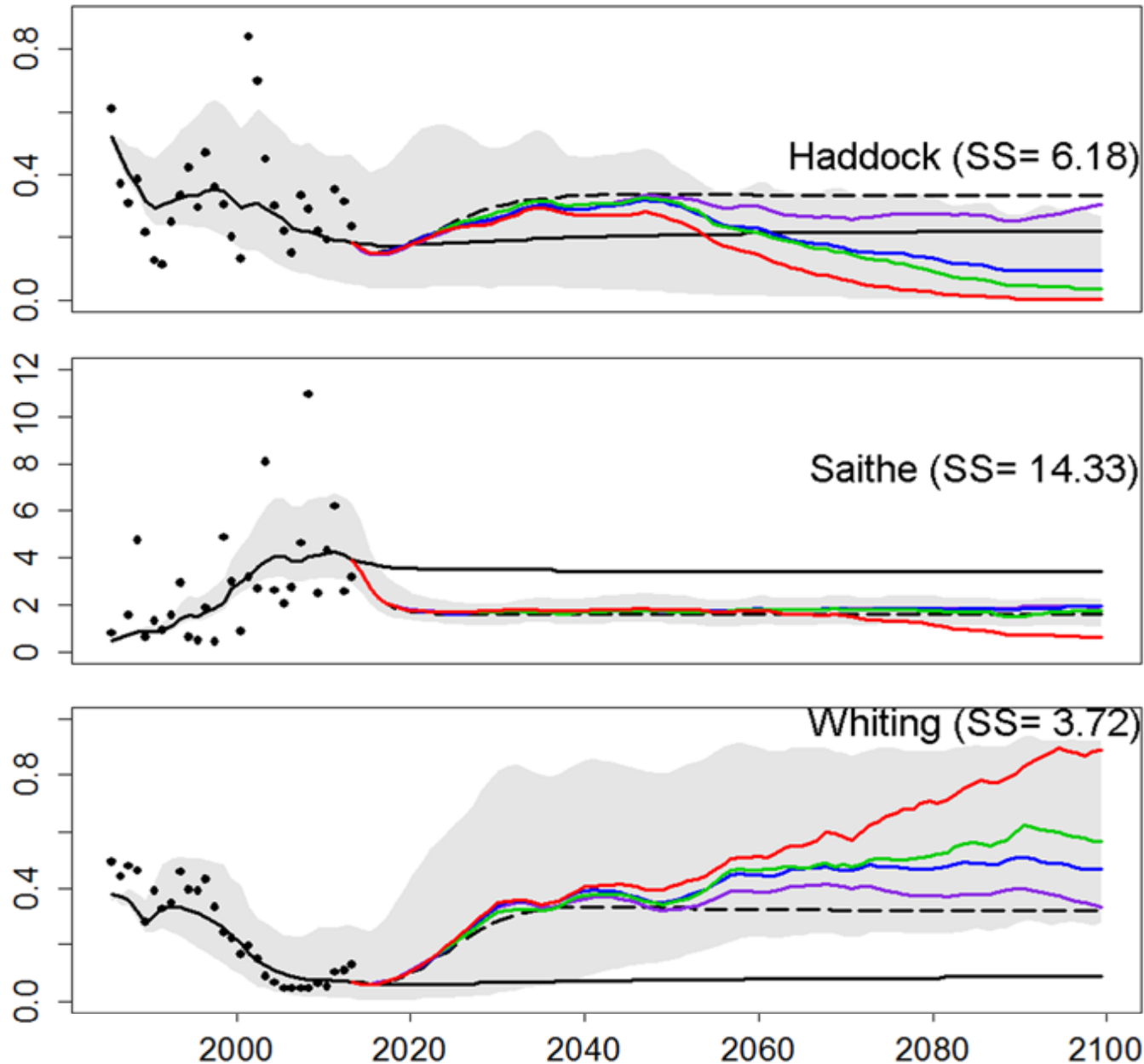


## Change in mean length-at-age

- ☐ Increase in juvenile length
- ☐ Decrease in adult length
- ☐ Concomitant with temperature increase
- ☐ Consistent with Temperature-Size Rule



# Warming will likely affect species composition



## Impact of ocean warming on sustainable fisheries management informs the Ecosystem Approach to Fisheries

N. Serpetti<sup>1</sup>, A. R. Baudron<sup>2</sup>, M. T. Burrows<sup>1</sup>, B. L. Payne<sup>1</sup>, P. Helaouët<sup>3</sup>, P. G. Fernandes<sup>2</sup> & J. J. Heymans<sup>1</sup>

**Serpetti et al., 2017**

- ☐ Decline in biomass of cold-water species
- ☐ Increase in biomass of warm-water species

# Future changes: can we mitigate the impact of warming?

## Stakeholders' objectives:

☐ Recover cod



☐ Maximise landings of emerging species

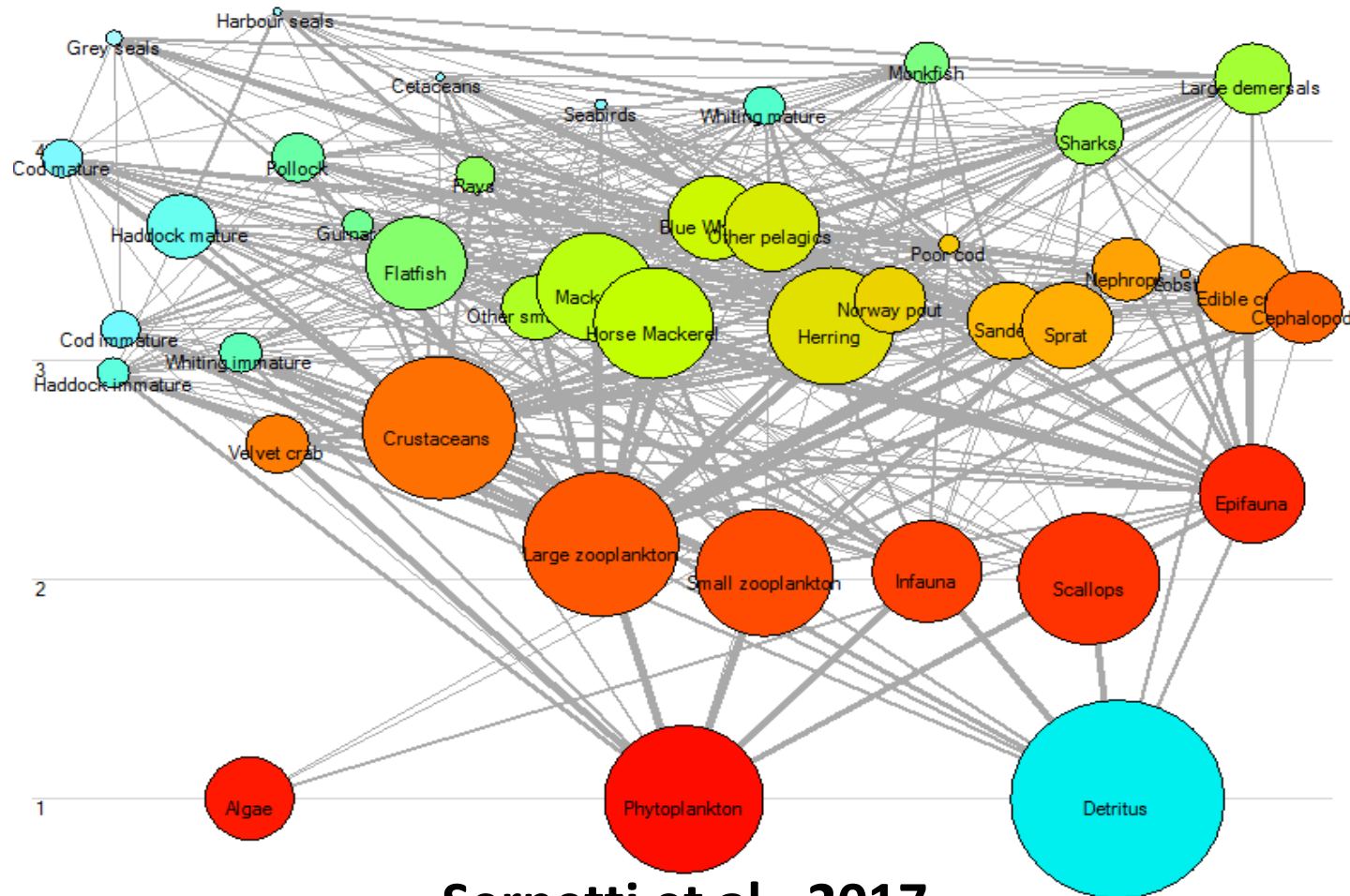


☐ Maximise landings of whiting post-recovery

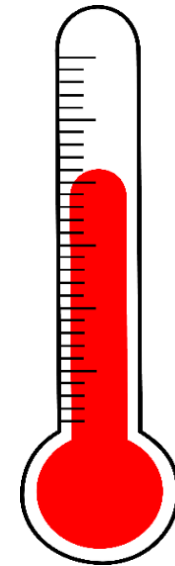


# Biological forecasting

- ❑ Explore alternative fishing strategies under climate change
- ❑ Food web ecosystem model, temperature included



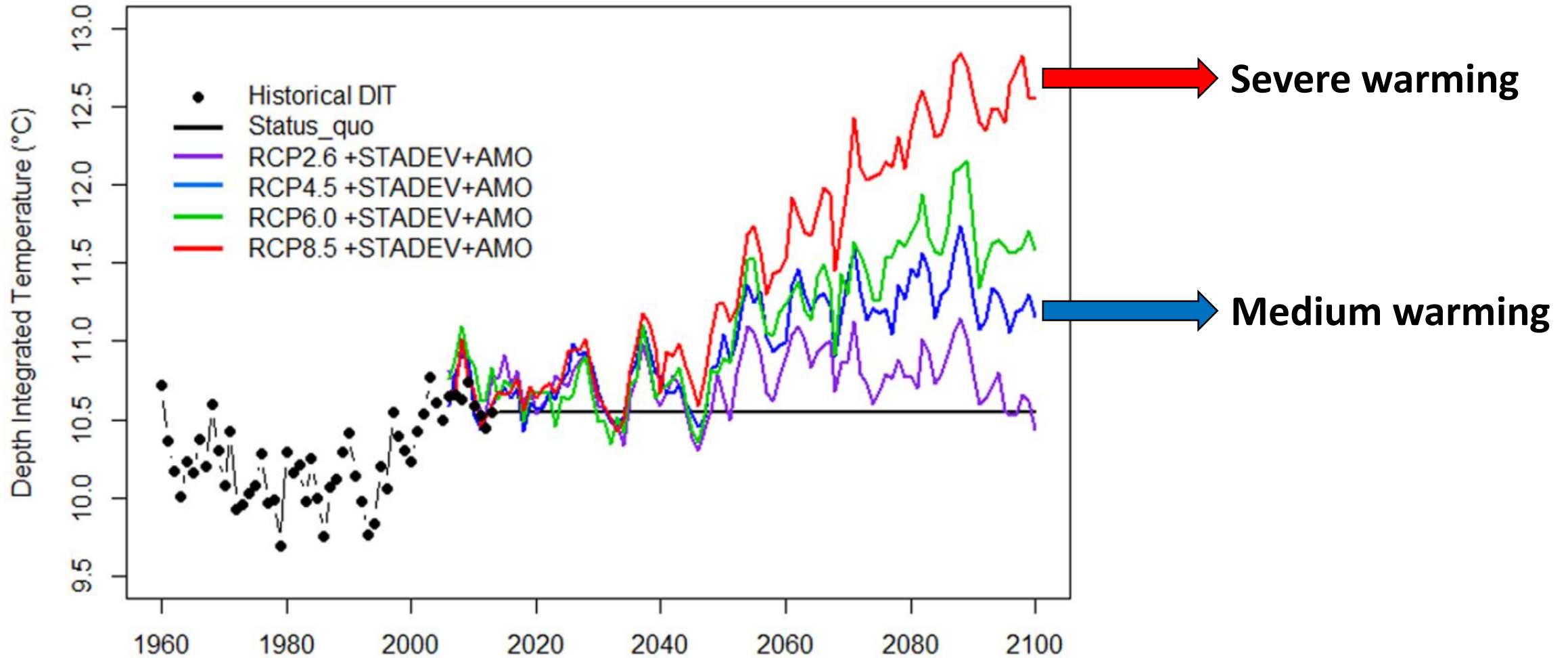
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Serpetti et al., 2017

# Biological forecasting: methods

- Forward simulations under medium (4.5) and severe (8.5) warming



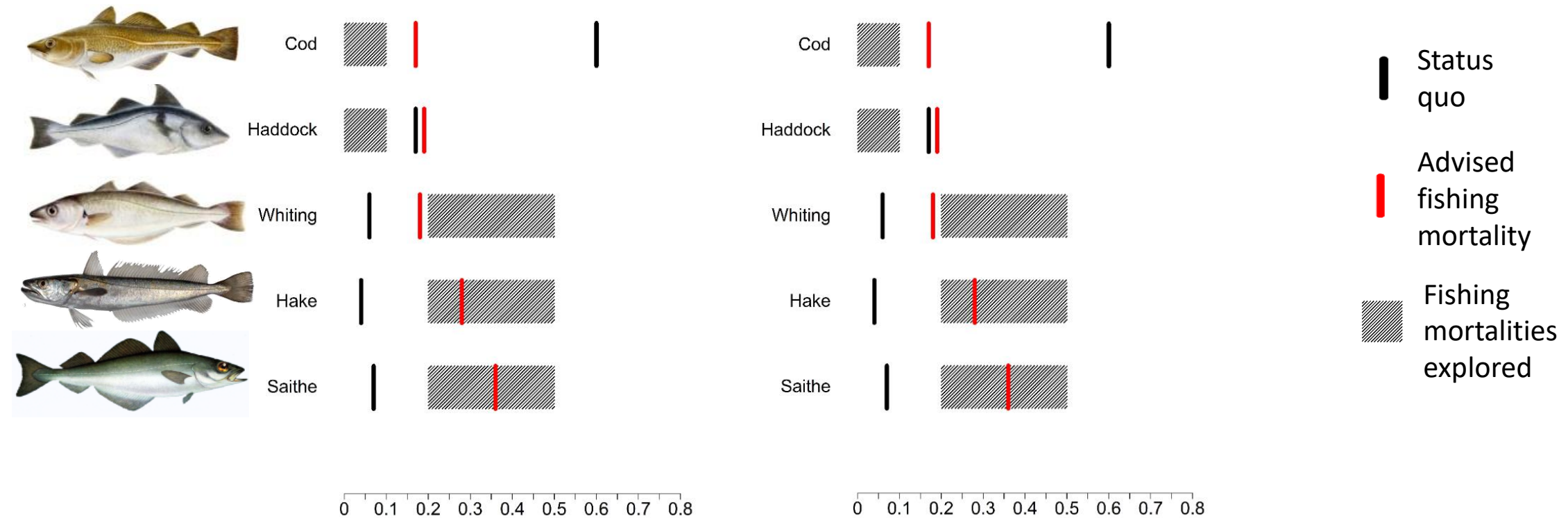
Serpetti et al., 2017

# Biological forecasting: methods

- ❑ Simulations from 2014 to 2050
- ❑ Alternative fishing mortalities at medium and long term

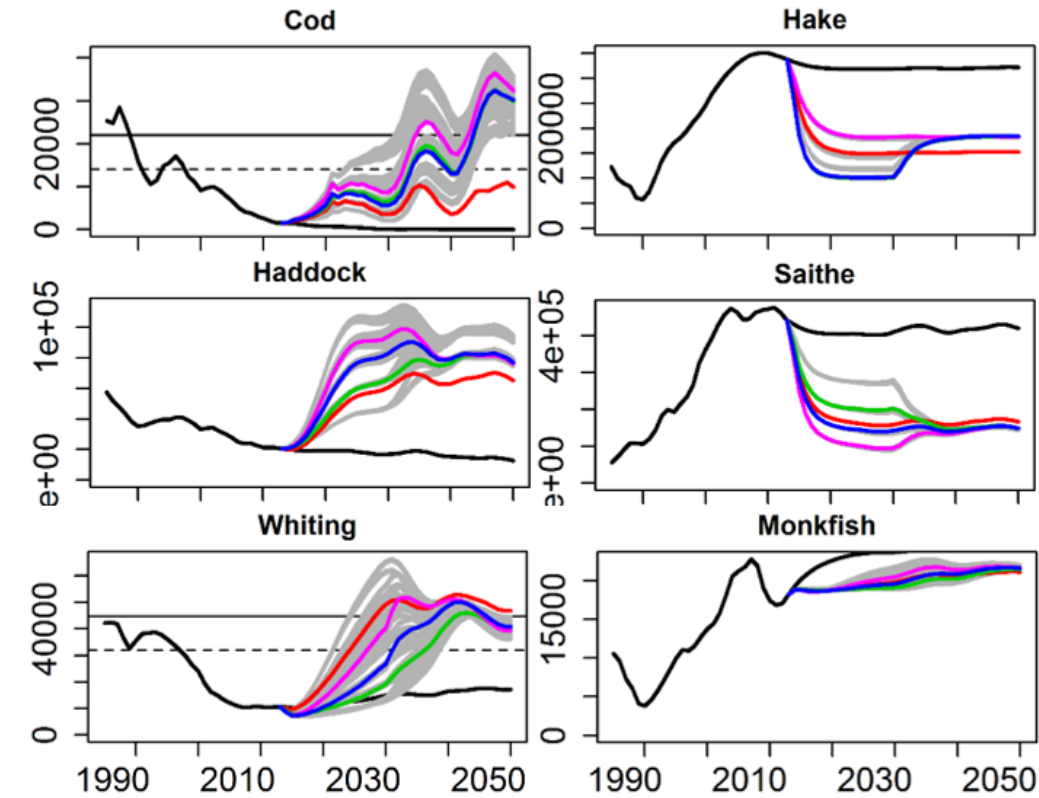
## Short to medium term 2014 to 2030

## Medium to long term 2031 to 2050

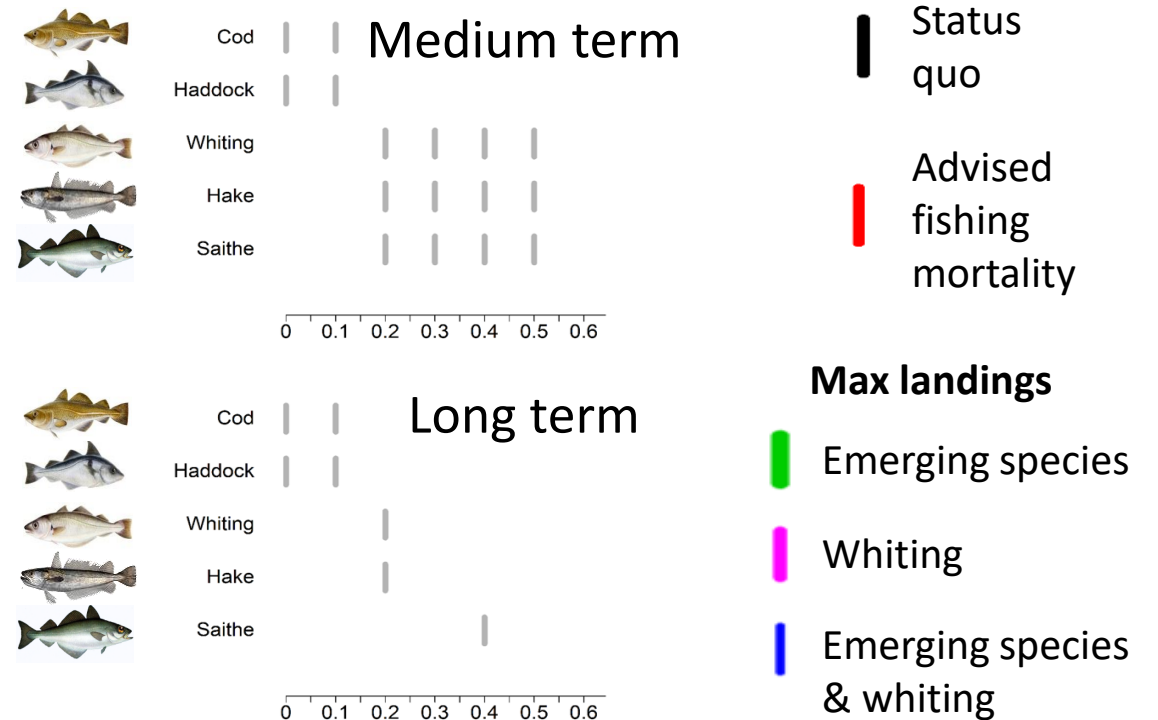


# Biological forecasting: results

☐ Medium warming (IPCC 4.5) – Biomass

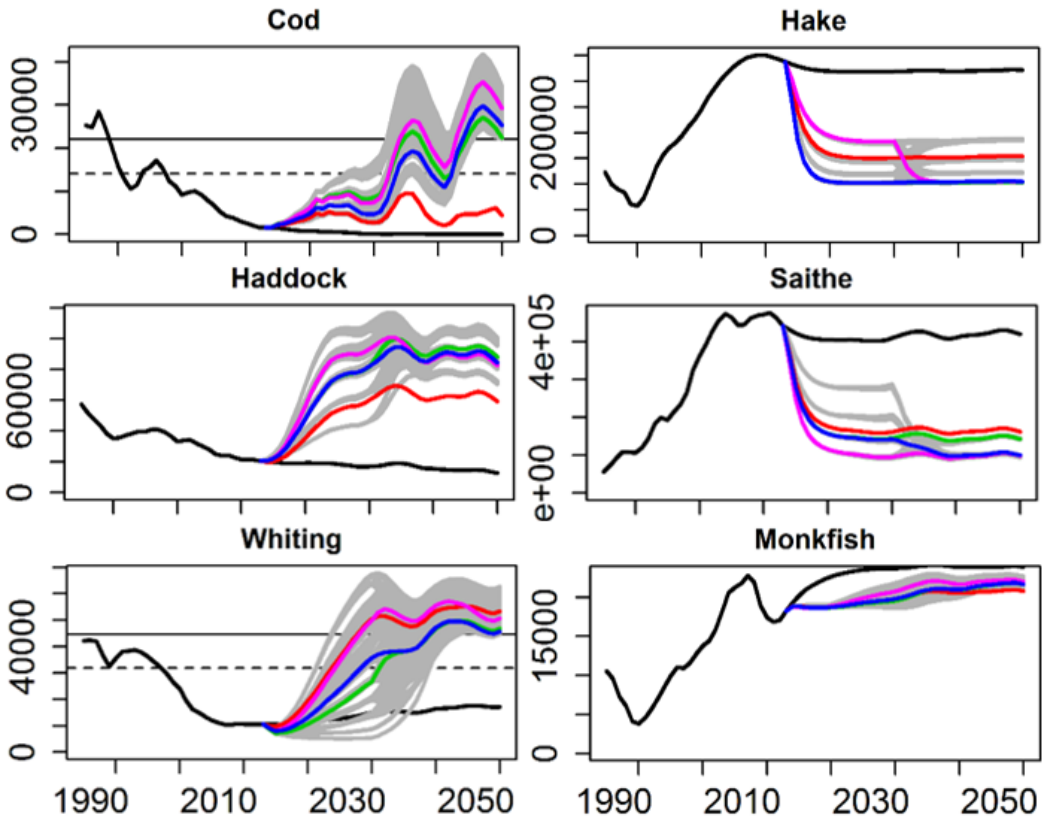


## Fishing mortalities

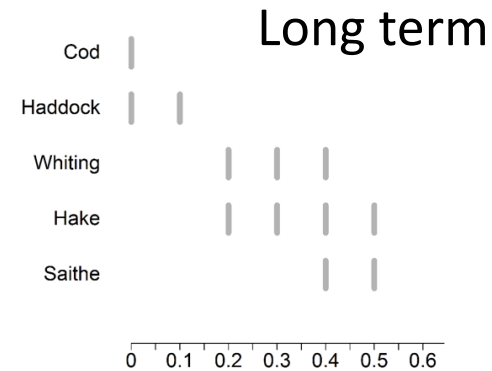
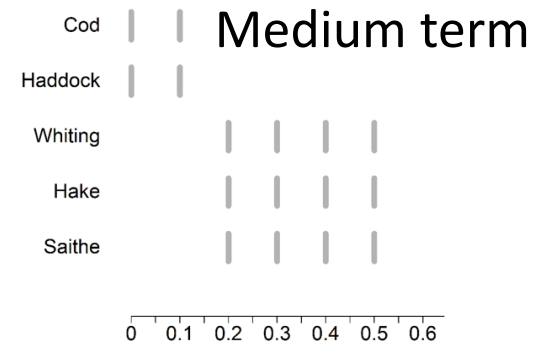


# Biological forecasting: results

Severe warming (IPCC 8.5) – Biomass



## Fishing mortalities

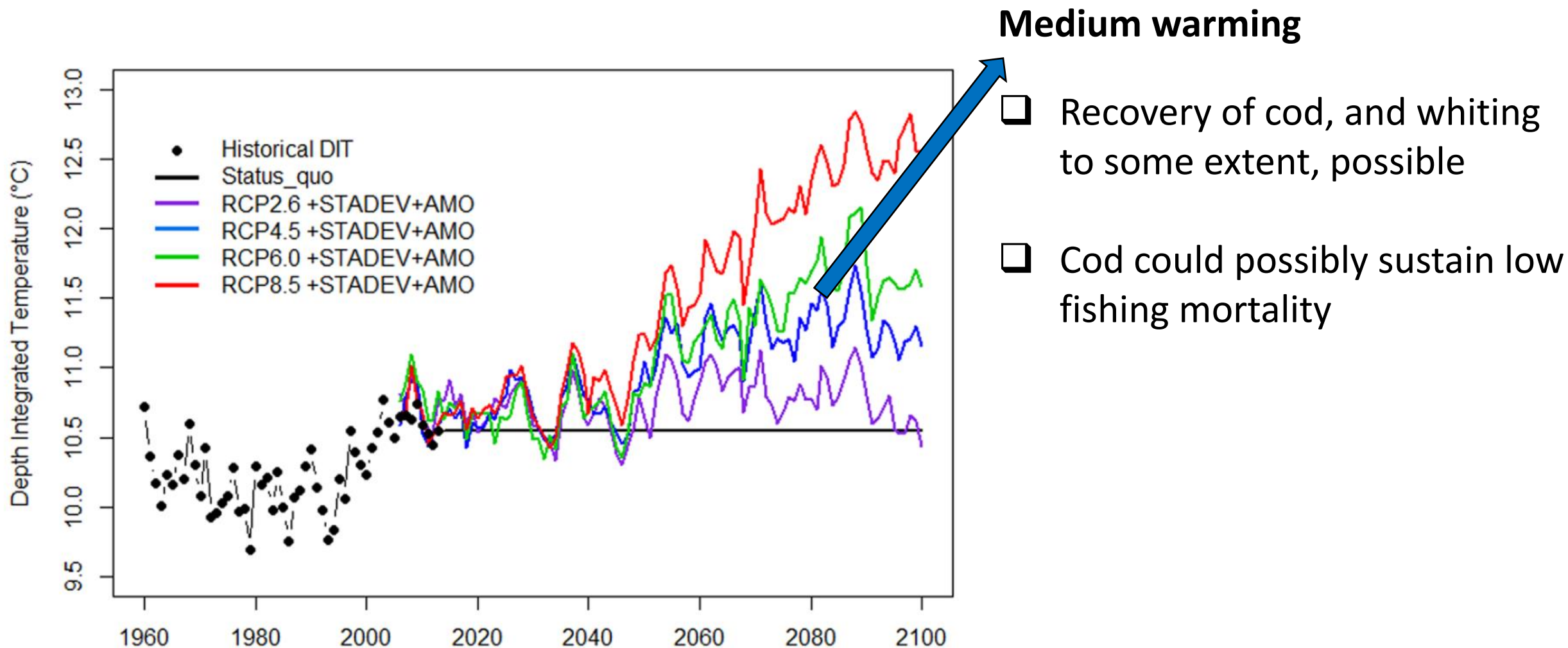


Status quo  
Advised fishing mortality

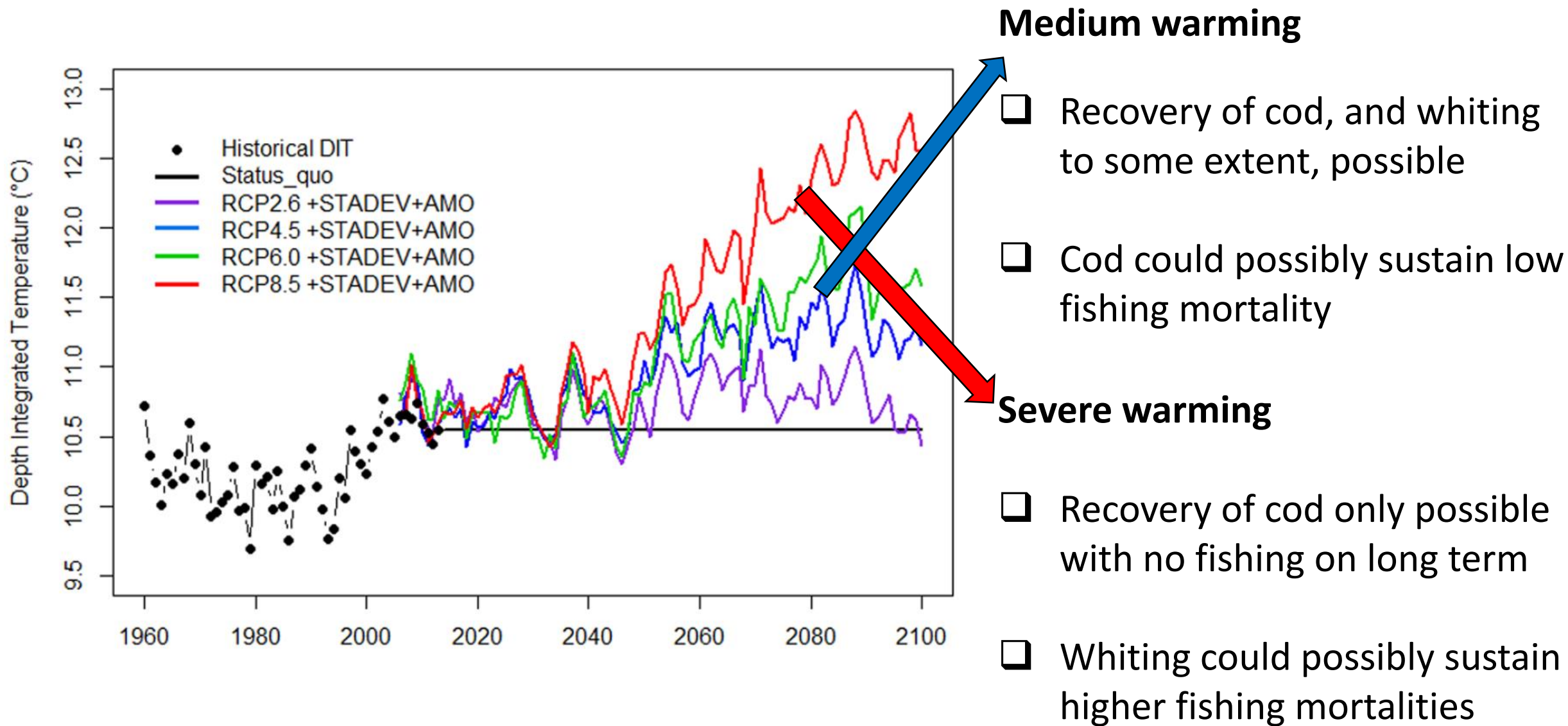
### Max landings

Emerging species  
Whiting  
Emerging species & whiting

# Biological forecasting: main findings



# Biological forecasting: main findings



# Risk Assessment: some threats...

Information from literature, analyses & stakeholders input



- ☐ Extreme weather = poor working conditions
- ☐ Recruitment = collapse of cold water species
- ☐ Distribution changes = reduction in cold water species biomass
- ☐ Changes in catch composition = lack of quotas

4	EXTREME	Greatly affects/damages the industry
3	HIGH	Major damages to the industry
2	MODERATE	Challenges for the industry
1	MINOR	Small/reparable damage to the industry

# Risk Assessment: & some opportunities

Information from literature, analyses & stakeholders input



- ❑ Shift in species' distribution = increase in warm-water species biomass
- ❑ Higher biomass for some species = new catch potential
- ❑ Rise in emerging species biomass = access to new markets

1	MINOR	Limited improvement to present conditions
2	MODERATE	Favourable change for the industry
3	MAJOR	Significant improvements to present conditions
4	EXTREME TRANSFORMATIVE	Transformative benefits to the industry

# Mitigate risks and utilise opportunities?

15 climate adaptation measures identified



## Industry level (8)

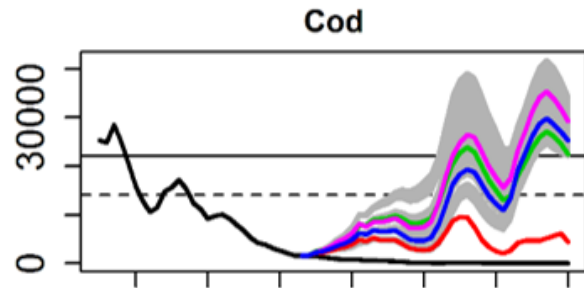
- ☐ Avoid cod bycatch
- ☐ Target emerging species
- ☐ Improve safety

## Policy level (7)

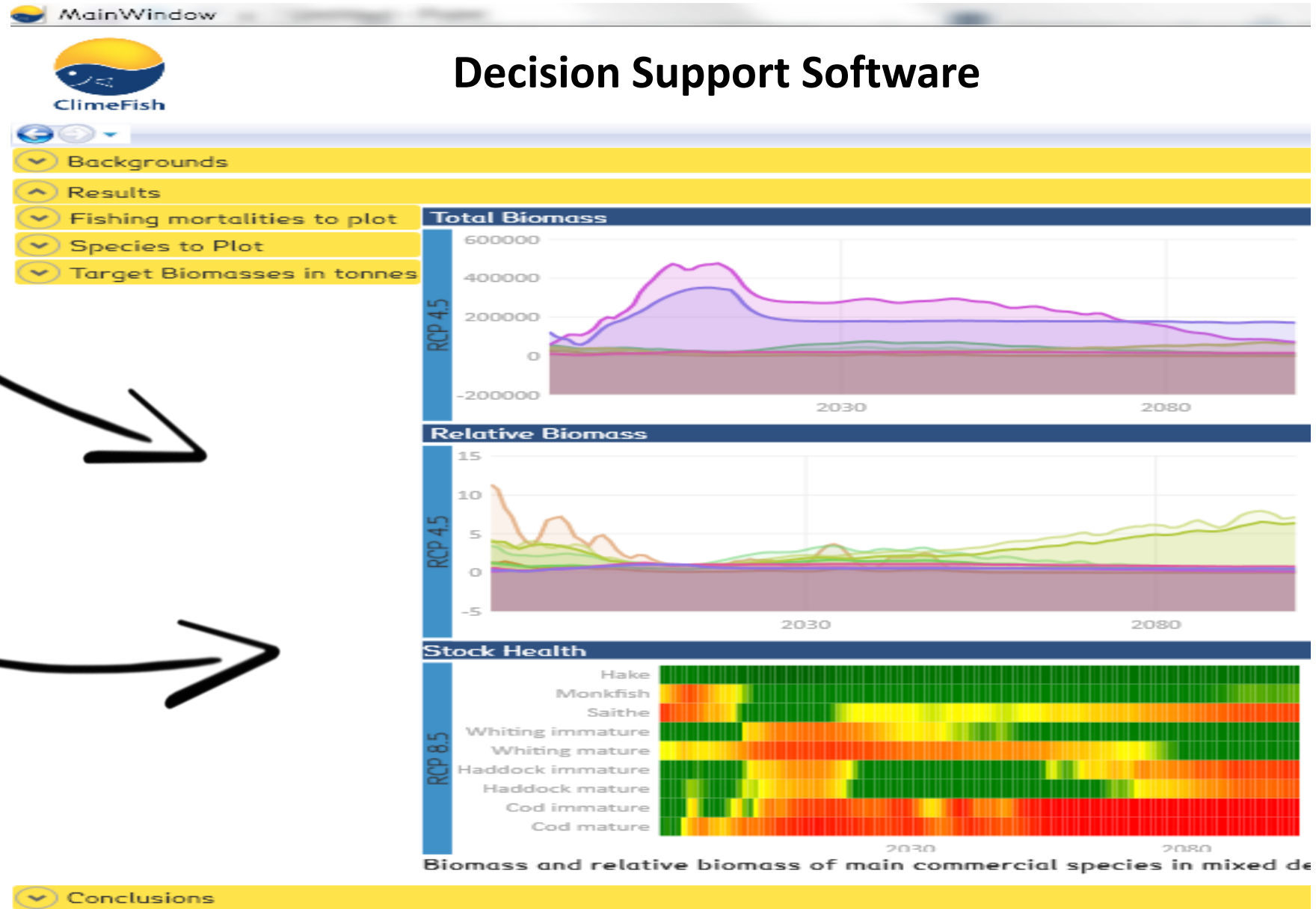
- ☐ Access to quotas & markets for emerging species
- ☐ Flexible management to account for changes
- ☐ Improve monitoring & infrastructure

# Helping stakeholders make decisions

## Model simulations



Climate Risk  
Assessment

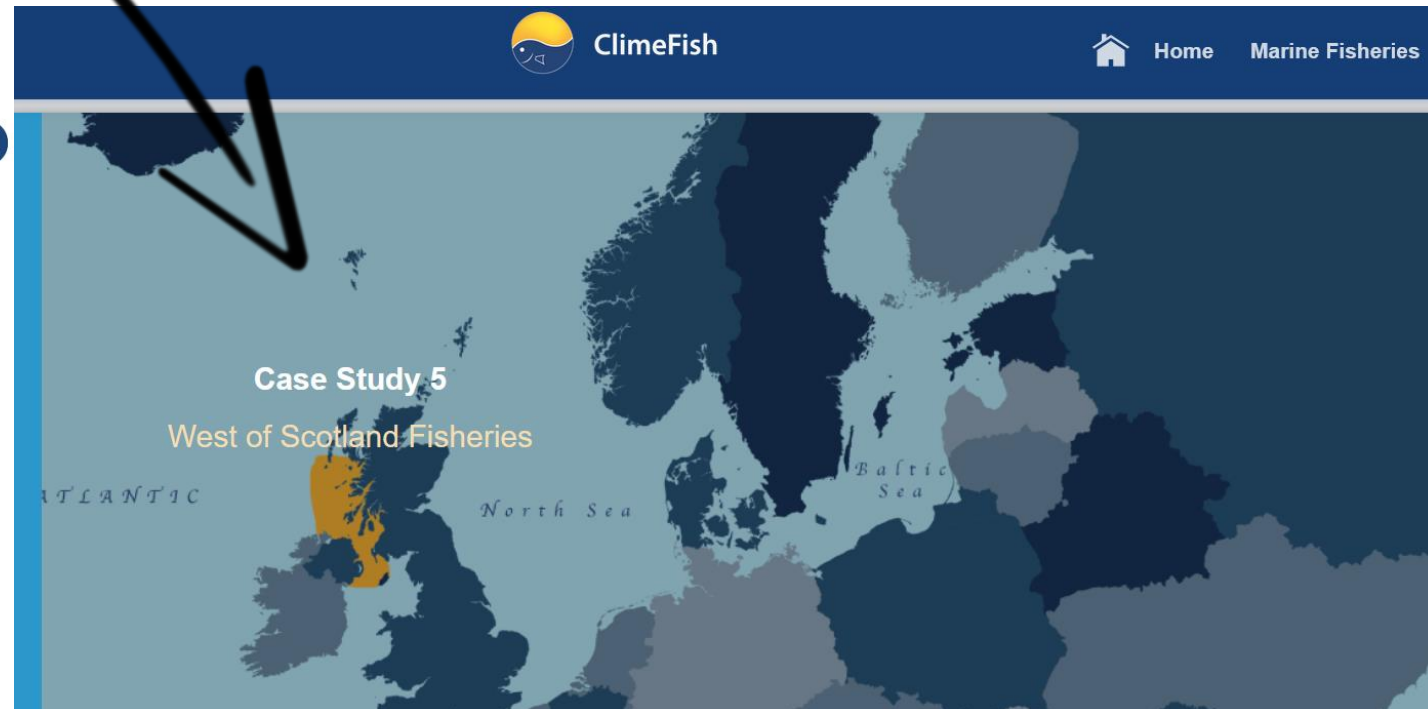


# The ClimeFish legacy

<https://climefish.eu/>





## Case Study Fact Sheets



# The ClimeFish legacy

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Marine Fisheries

Lakes & Ponds

Aquaculture

 Visualization

 DSS

### Risks & Opportunities

Show Further Results

The risks associated with warming temperatures include a loss of catch potential due to species relocation and/or collapse. Aside from warming sea temperatures, the climate-induced increase in storms and extreme weather event is also a risk, with potential reduction in fishing days, damage of fishing infrastructure, and concerns for crew safety.

### Adaptation Strategies

Show Further Results

The simulation of alternative fishing management scenarios showed that it may be possible restore the cod biomass if both fishing pressure and predation mortality are reduced.

The adaptation measures proposed therefore include the reduction of cod bycatches through a real-time information system. In addition, targeting other demersal species such as hake and saithe to both reduce predation on juvenile cod, and compensate for the lack of cod catches, ought to be considered.

Other measures include marketing to promote the sale of catches of merging species. Measure tacking safety at sea include an incident reporting system and safety courses.

### Socio-Economic Outcomes

Show Further Results

The future socio-economic Figure 1: Impact of climate change for the west of Scotland demersal fisheries is difficult to gauge. The fishing industry could potentially mitigate the loss of catch potential of traditional species such as cod by exploiting emerging species.

However, such opportunity would require new markets yielding similar profit which is not guaranteed.

Most importantly, catching emerging species will only be possible if fishing quotas are granted.


Given these two conditions, whether the fishing industry will be able to successfully adapt under future climate change effects remains uncertain.


Download Software

Download DSS

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Risks & Opportunities

Show Further Results

Adaptation Strategies

Show Further Results

Socio-Economic Outcomes

Show Further Results

Risks & Opportunities: C5F - West of Scotland

Main Results

Opportunities

Highest Scoring Risks

The risks associated with warming temperatures include a loss of catch potential due to species relocation and/or collapse.

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in climate change effects remains uncertain

Identified climate-related risks in West of Scotland Demersal Fisheries				RCP4.5			RCP8.5			Overall Risk
Category	Climate Change Drivers	Potential Impact	Modelled?	Risk Rating						All scenarios and timescales
			Yes/No	2020	2030	2050	2020	2030	2050	
Ecosystem	Temperature	Reduction of cod biomass/No recovery of cod biomass	Yes	Severe	Severe	Severe	Severe	Severe	Severe	Severe
Fishery	Temperature	Lack of TACs	No	Major	Severe	Severe	Major	Severe	Severe	Severe
Ecosystem	Temperature	Alterations to year-class strengths incl. larval survival	Yes	Major	Major	Severe	Major	Severe	Severe	Severe
Ecosystem	Temperature	New emerging species due to expanding northwards limits	No	Major	Major	Severe	Major	Severe	Severe	Severe
Fishery	Temperature	Change in catch composition	Yes	Major	Major	Major	Major	Major	Major	Major
Ecosystem	Temperature	Changes in species phenology, including timing of spawning	No	Major	Major	Major	Major	Major	Major	Major
Ecosystem	Temperature	Northward shift in species, e.g. cod	No	Major	Major	Major	Major	Major	Major	Major
<u>Socio-economics</u>	Storminess and Waves	No fisheries due to storminess (economic consequences)	No	Major	Major	Major	Major	Major	Major	Major
Ecosystem	Temperature	Increased biomass of Whiting and Hake	Yes	Major	Major	Major	Major	Major	Major	Major

Given these two conditions, whether the fishing industry will be able to successfully adapt under future climate change effects remains uncertain.

Download Software

Download DSS

# A few key points

- ❑ Climate change is impacting the West Scotland demersal fishery in numerous ways, and likely to keep on doing so
- ❑ Some threats (e.g., storms) but also some opportunities (e.g., emerging species)
- ❑ Some obstacles in adapting? E.g., lack of flexible management to keep pace with changes
- ❑ Climate change still perceived as 'low priority' relative to more pressing issues (e.g., depleted stocks & discards)



# Thank you

## ClimeFish publications:

- ❑ Audzijonyte, A, Barneche, DR, Baudron, AR, Belmaker, J, Clark, TD, Marshall, CT, Morrongiello, JR et al. 2018. **Is oxygen limitation in warming waters a valid mechanism to explain decreased body sizes in aquatic ectotherms?** Global Ecology and Biogeography 28:64–77.  
<https://doi.org/10.1111/geb.12847>
- ❑ Baudron, AR, Brunel, T, Blanchet, M-A, Hidalgo, M, Chust, G, Brown, E, Kleisner, KM, Millar, C, MacKenzie, BR, Nikolioudakis, N, Fernandes, J & Fernandes, PG. 2020. **Changing fish distributions challenge the effective management of European fisheries.** Ecography 42: 1–12.  
<https://doi.org/10.1111/ecog.04864>
- ❑ Baudron, AR, Pecl, G, Gardner, C, Fernandes, PG & Audzijonyte, A. 2019. **Ontogenetic deepening of Northeast Atlantic fish stocks is not driven by fishing exploitation.** Proceedings of the National Academy of Sciences, 116, 2390– 2392. <https://doi.org/10.1073/pnas.1817295116>
- ❑ Ikpewe, IE, Baudron, AR, Ponchon, A & Fernandes, PG. **Bigger juveniles and smaller adults: changes in fish size correlate with warming seas.** In press.
- ❑ Serpetti, N, Baudron, AR, Burrows, MT et al. 2017. **Impact of ocean warming on sustainable fisheries management informs the Ecosystem Approach to Fisheries.** Sci Rep 7, 13438. <https://doi.org/10.1038/s41598-017-13220-7>