"Shared Socioeconomic Pathways (SSPs) for fisheries and aquaculture in Europe"

CERES

Climate change and European aquatic RESources

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Sunday 3rd June - Workshop 10 - (Room Columbia 10)

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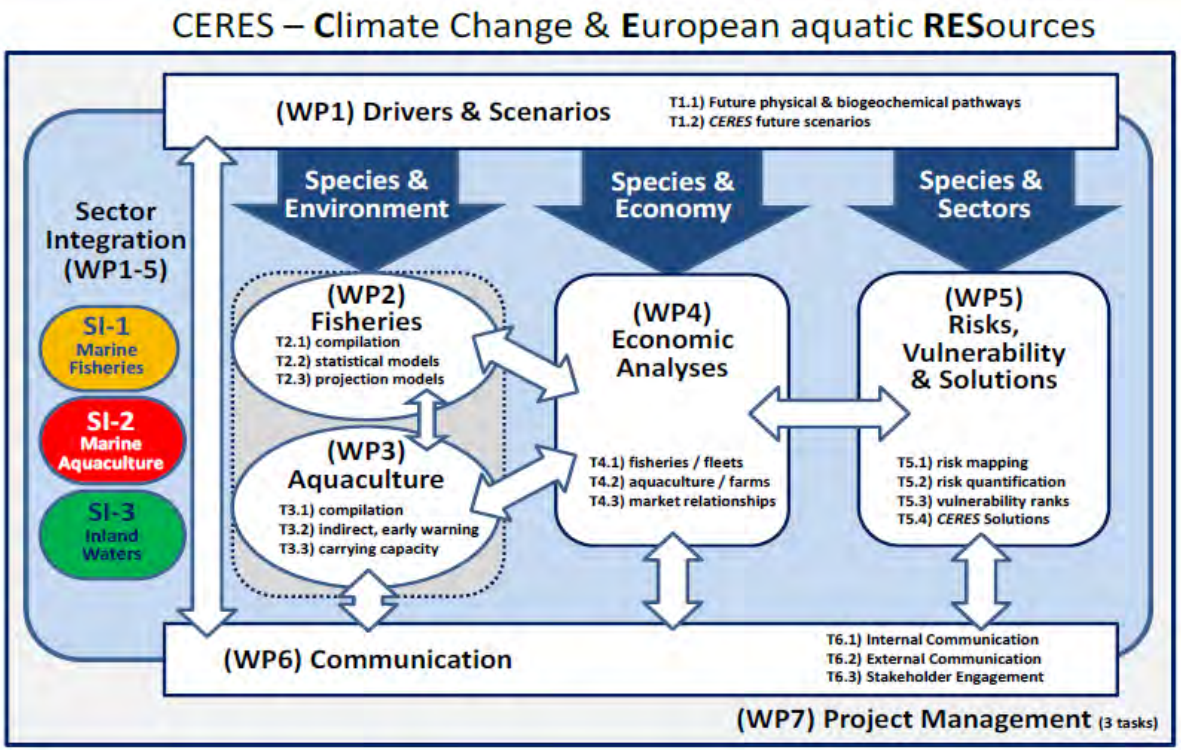
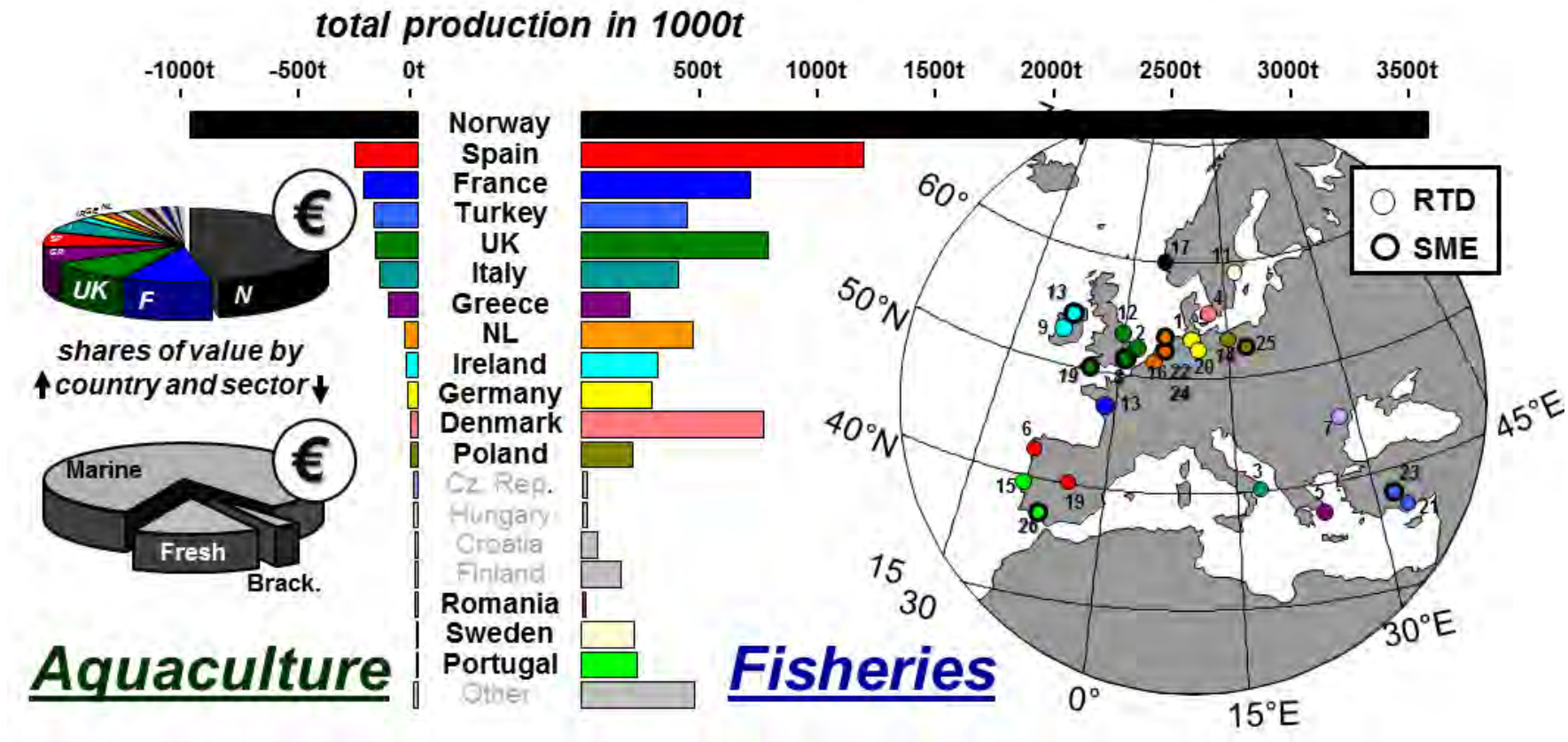


The CERES project is named after the Roman goddess of agriculture and fertility

The total budget for CERES will be €5.58 million and the project will run over 48 months (2016-2019).

The EU funded a parallel projected called ClimeFish

ClimeFish


total production in 1000t
-1000t
-500t
0t
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1000t
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2000t
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3000t
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Norway
Spain
France
Turkey
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Italy
Greece
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Ireland
Germany
Denmark
Poland
Cz. Rep.
Hungary
Croatia
Finland
Romania
Sweden
Portugal
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shares of value by
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Marine
Fresh
Brack.
Aquaculture
Fisheries
RTD
SME
60°
50°N
40°N
15
30
0°
15°E
30°E
45°E

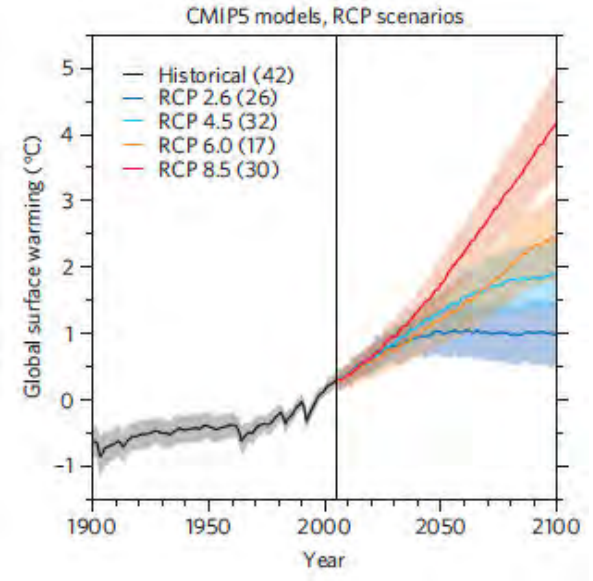
IPCC Scenarios

CERES will aim to make a significant contribution in the next assessment report of the **Intergovernmental Panel on Climate Change (IPCC)** in 2020.

In order to do this CERES participants must use climate change scenarios and socio-economic **storylines that are compatible** with those of the IPCC.

Representative Concentration Pathways (RCPs) are four greenhouse gas concentration (not emission) trajectories adopted by the IPCC.

Global warming (in °C) expected under each RCP



In **CERES task 1.1** modellers will create spatially and temporally detailed projections of **future marine and freshwater conditions** under **RCP 8.5** and **RCP 4.5.**

Physical Modelling

1. POLCOMS-ERSEM projections for the North East Atlantic and Mediterranean.
   - one GCM (MPI-ESM-LR), RCPs 4.5 and 8.5
   - 1960-2099
   - also a run driven by observation-based data, for validation purposes.
2. RCO-SCOBI projections for the Baltic.
   - 11-member ensemble, with four GCMs, RCPs 4.5 and 8.5, three nutrient scenarios
   - 1970-2099
3. NORWECOM projections for the Norwegian and Barents Seas
   - One GCM, RCP4.5
   - 2006-2070
4. E-HYPE projections for European rivers
   - Four GCMs, three RCPs
   - 1970-2099

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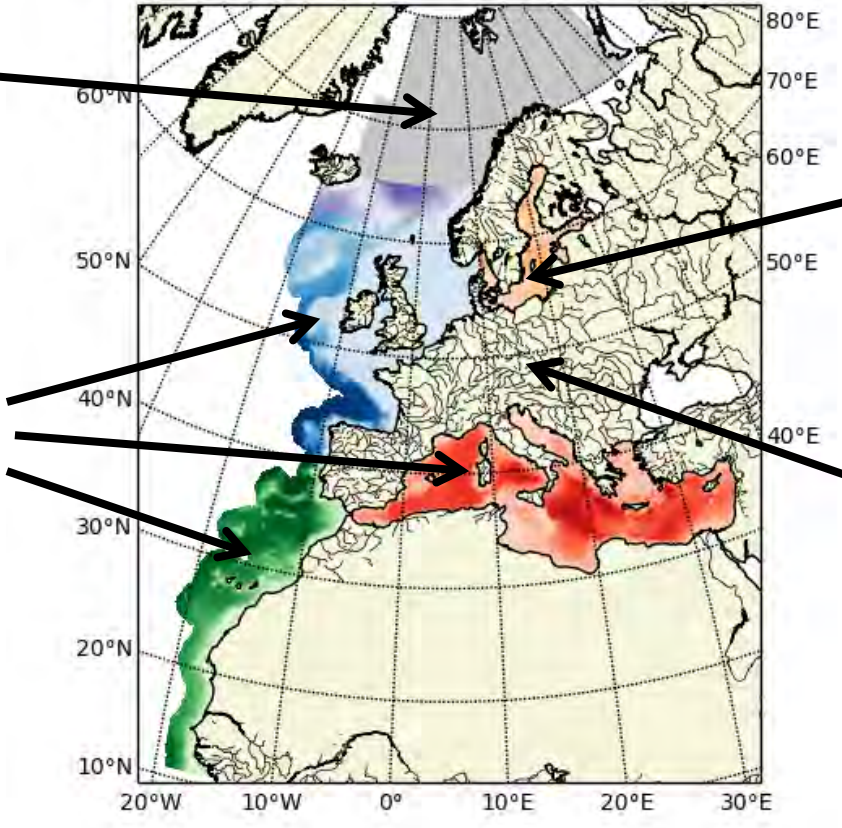
NORWECOM
RCP 4.5
2006 to 2069
Driving model: NorESM1-M

POLCOMS-ERSEM
RCPs 4.5 and 8.5
1960 to 2099
Driving model: MPI - ESM-LR



RCO-SCOBI
RCPs 4.5 and 8.5
1970 to 2100
Driving models MPI - ESM-LR, EC-EARTH, HadGEM2-ES, IPSL-CM5A-MR (RCP 4.5 only)

Freshwater rivers E-HYPE
RCPs 4.5 and 8.5
1970 to 2100
Driving models MPI - ESM-LR, EC-EARTH, HadGEM2-ES, IPSL-CM5A-MR (RCP 4.5 only)

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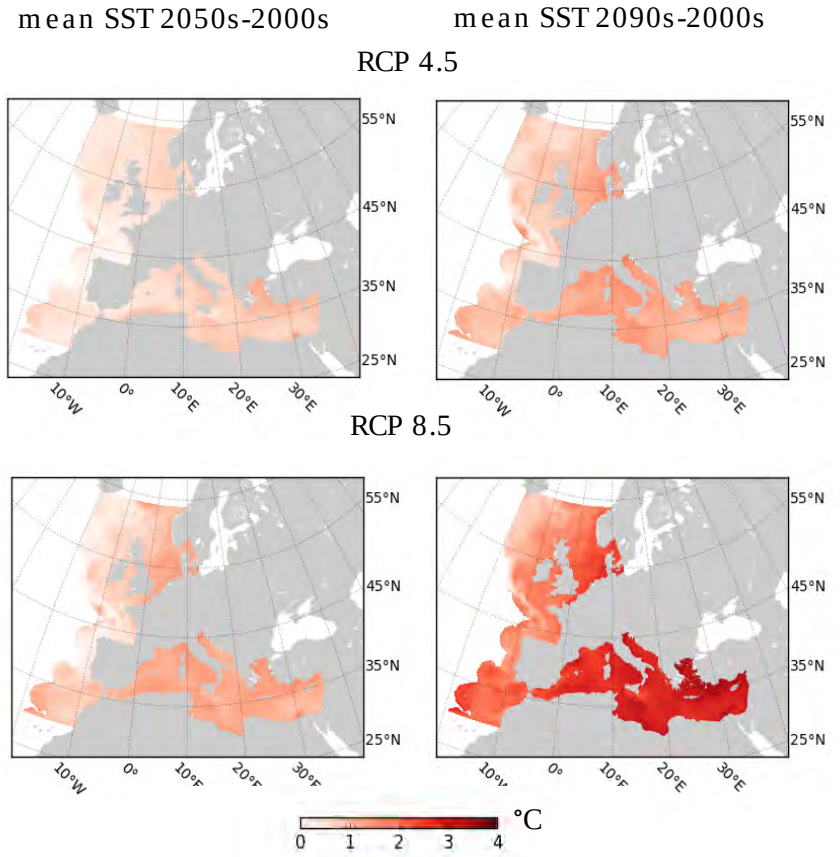
Key findings: North East Atlantic and Mediterranean

- Sea surface temperatures increase by up to 4°C during the century.
- Greater increases in the south and east of the region than the north west.
- Increases under RCP 4.5 are roughly half those under RCP 8.5.
- Differences between RCPs only start to emerge after about 2040.



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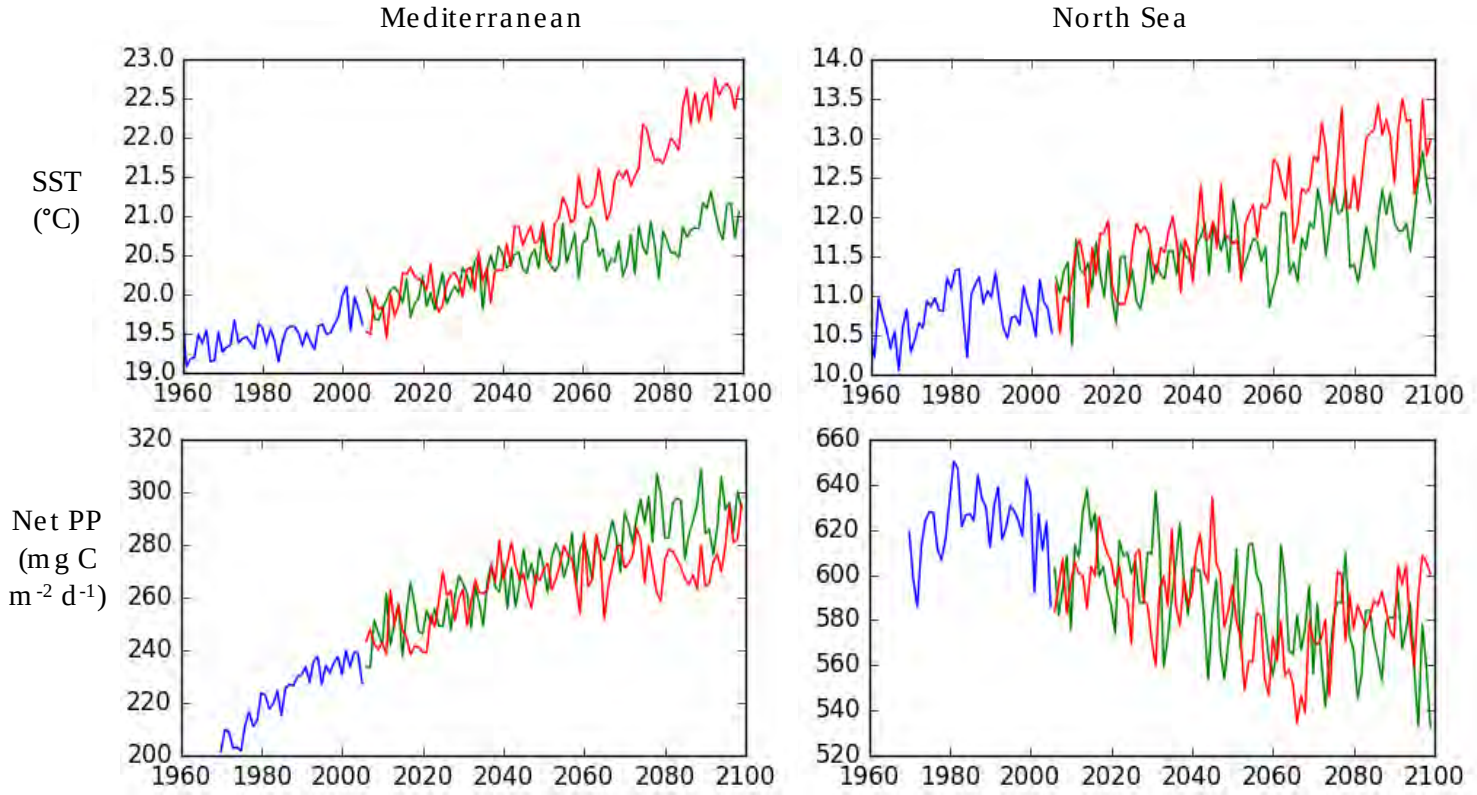
Key findings: North East Atlantic and Mediterranean



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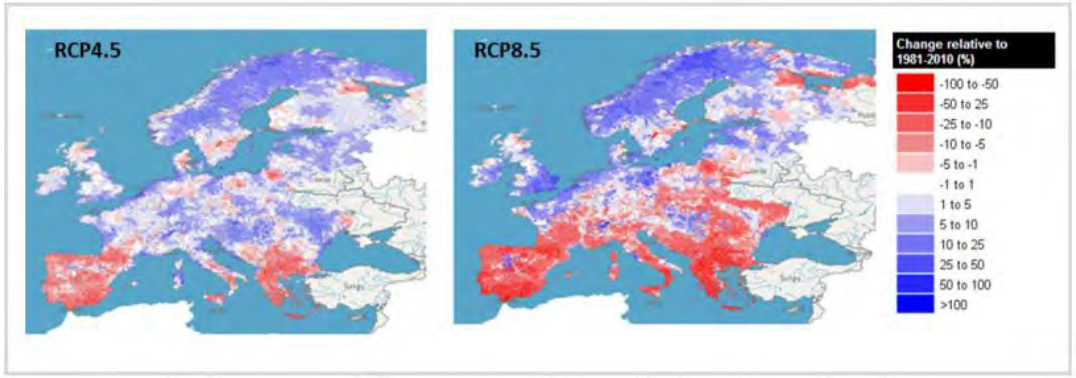
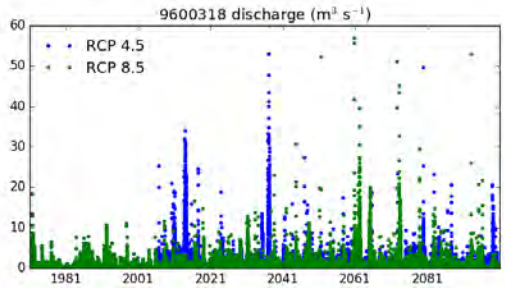
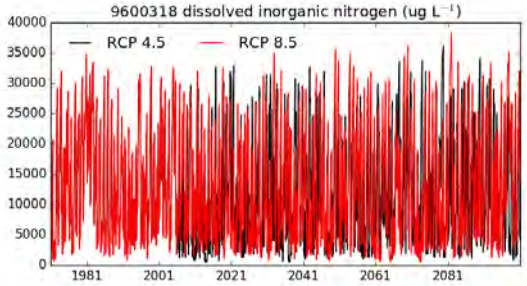
Task 1.1 projections for European rivers







- Projected change in flow across Europe – reported in D1.4
  - Increasing flow in northern Europe, decreasing in the south, but high uncertainty.
- Projections of discharge, N and P for individual basins, used by WP2/3 partners.

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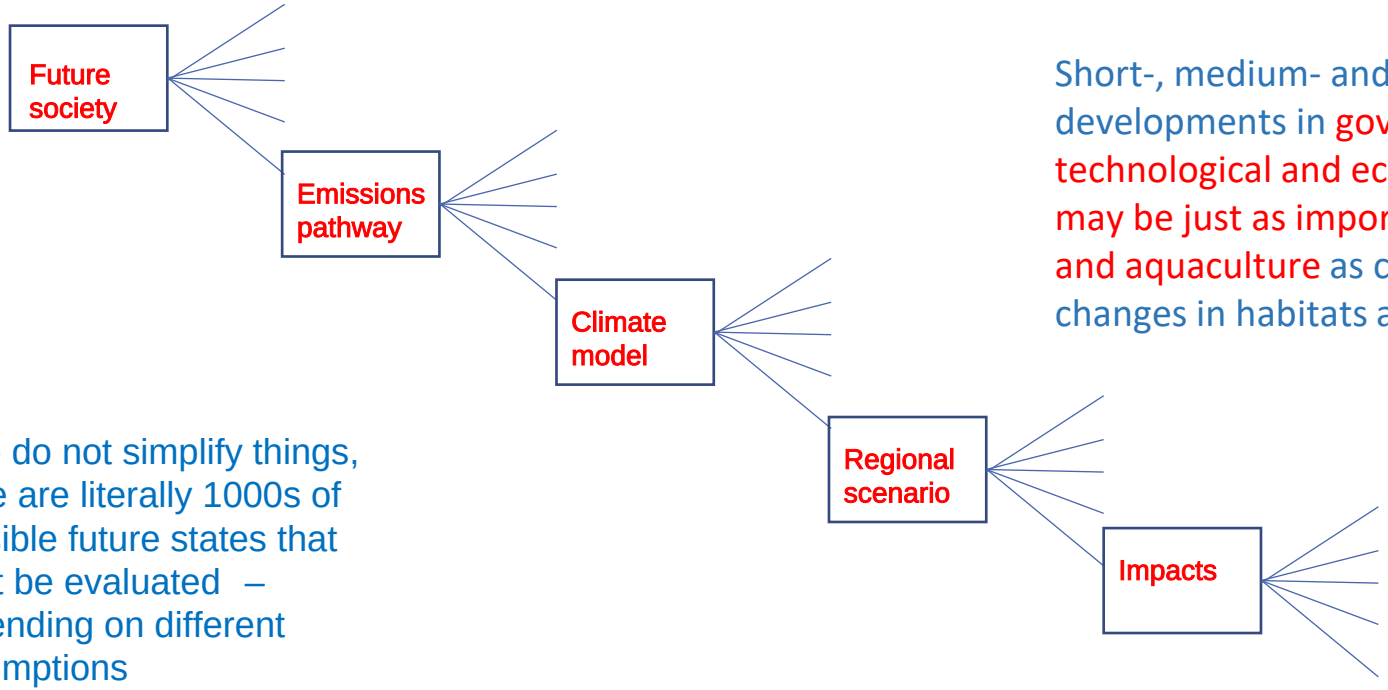
SMHI

The permutation problem …



Short-, medium- and long-term developments in governance, social, technological and economic drivers may be just as important to fisheries and aquaculture as climate-driven changes in habitats and species.

If we do not simplify things, there are literally 1000s of possible future states that must be evaluated – depending on different assumptions

Shared Socioeconomic Pathways (SSPs)

Shared Socio-economic Pathways (SSPs) have been designed by the IPCC to be used alongside the Representative Concentration Pathways (RCPs) to analyse **feedbacks between climate change and socioeconomic factors**.

Certain model outputs are available 'off the shelf' for each Shared Socio-economic Pathway (SSP).

Vuuren & Carter (2014) provided a suggestion for mapping the previous generation of IPCC SRES (Special Report on Emission Scenarios) storylines onto the new framework of RCPs and SSPs.

What are scenarios???

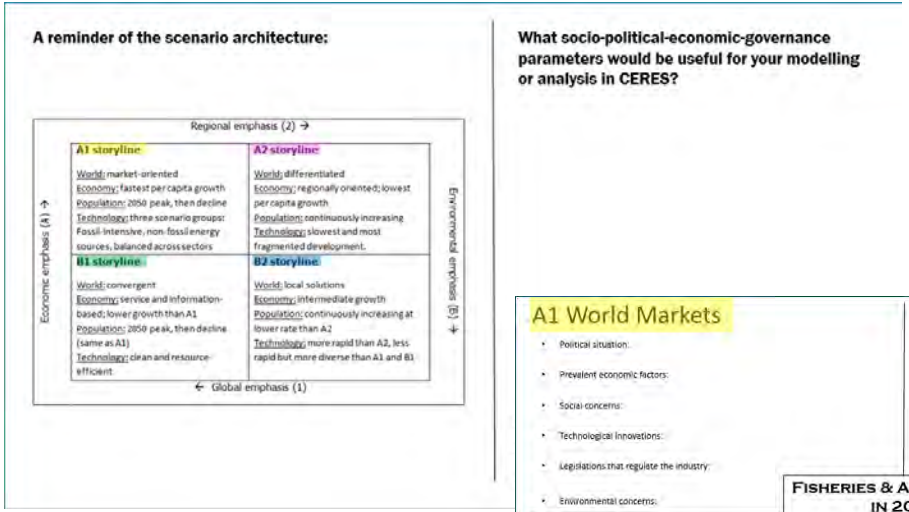
Scenarios are **imagined 'futures'.**

They do not come singly, as a forecast would, but in sets of alternatives. Scenarios are not necessarily "visions" or "plans", but they can help to guide strategy. They describe both **optimistic and problematic futures.**

For scenarios to be a useful tool, they must all be **possible, plausible and credible.**

Plausibility is a necessary criterion, otherwise it simply becomes science-fiction

Template handed out to participants at the CERES ‘kick off’ meeting on 6th April 2016 to gather their own personal views about how the future might unfold under each of the four CERES prototype scenarios.



A reminder of the scenario architecture:

Regional emphasis (2) →

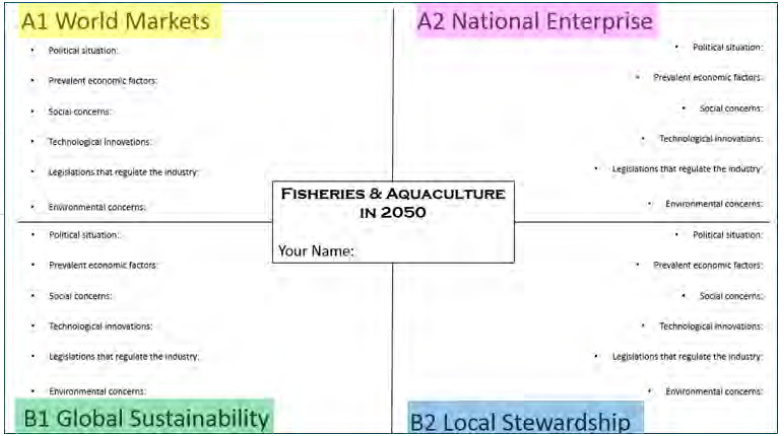
A1 storyline World: market-oriented Economy: fastest per capita growth Population: 2050 peak, then decline Technology: three scenario groups: Fossil-intensive, non-fossil energy sources, balanced across sectors	**A2 storyline** World: differentiated Economy: regionally oriented; lowest per capita growth Population: continuously increasing Technology: slowest and most fragmented development.
B1 storyline World: convergent Economy: service and information-based; lower growth than A1 Population: 2050 peak, then decline (same as A1) Technology: clean and resource-efficient	**B2 storyline** World: local solutions Economy: intermediate growth Population: continuously increasing at lower rate than A2 Technology: more rapid than A2, less rapid but more diverse than A1 and B1

Economic emphasis (A) →

Environmental emphasis (B) →

← Global emphasis (1)

What socio-political-economic-governance parameters would be useful for your modelling or analysis in CERES?



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Results

The CERES 'report card' communicating our new scenarios was launched at a stakeholder event in The Hague (Netherlands) on 21-22nd November

World Markets [RCP 8.5, SSP5]

"Growth is good"!

"We've got the whole world in our hands"!

National Enterprise [RCP 8.5, SSP3]

"Pull up the drawbridge"

"Think local, act local"

Global Sustainability [RCP 4.5, SSP1]

Local Stewardship [RCP 6.0, SSP2]

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What could this mean for Europe?

Western and eastern Europe (36 countries)

World Markets – RCP 8.5 and SSP5 (A1F1)

	2010	2050	2100
Population (millions)	609	748	846
Urban population (%)	72.7	89.5	96.2
Education (number yrs)	12.0	13.7	14.5
GDP/per capita (bill US$)*	25.4	57.8	152.9
Renewable energy (%)‡	15.8	7.7	16.7

National Enterprise – RCP 8.5 and SSP3 (A2)

	2010	2050	2100
Population (millions)	609	606	493
Urban population (%)	72.7	77.9	80.1
Education (number yrs)	12.0	13.0	12.8
GDP/per capita (bill US$)*	25.4	39.3	53.4
Renewable energy (%)‡	15.8	20.5	18.0

Global Sustainability – RCP 4.5 and SSP1 (B1)

	2010	2050	2100
Population (millions)	609	679	600
Urban population (%)	72.7	89.4	96.1
Education (number yrs)	12.0	13.7	14.5
GDP/per capita (bill US$)*	25.4	50.0	96.9
Renewable energy (%)‡	15.8	23.5	46.7

Local Stewardship – RCP 6.0 and SSP2 (B2)

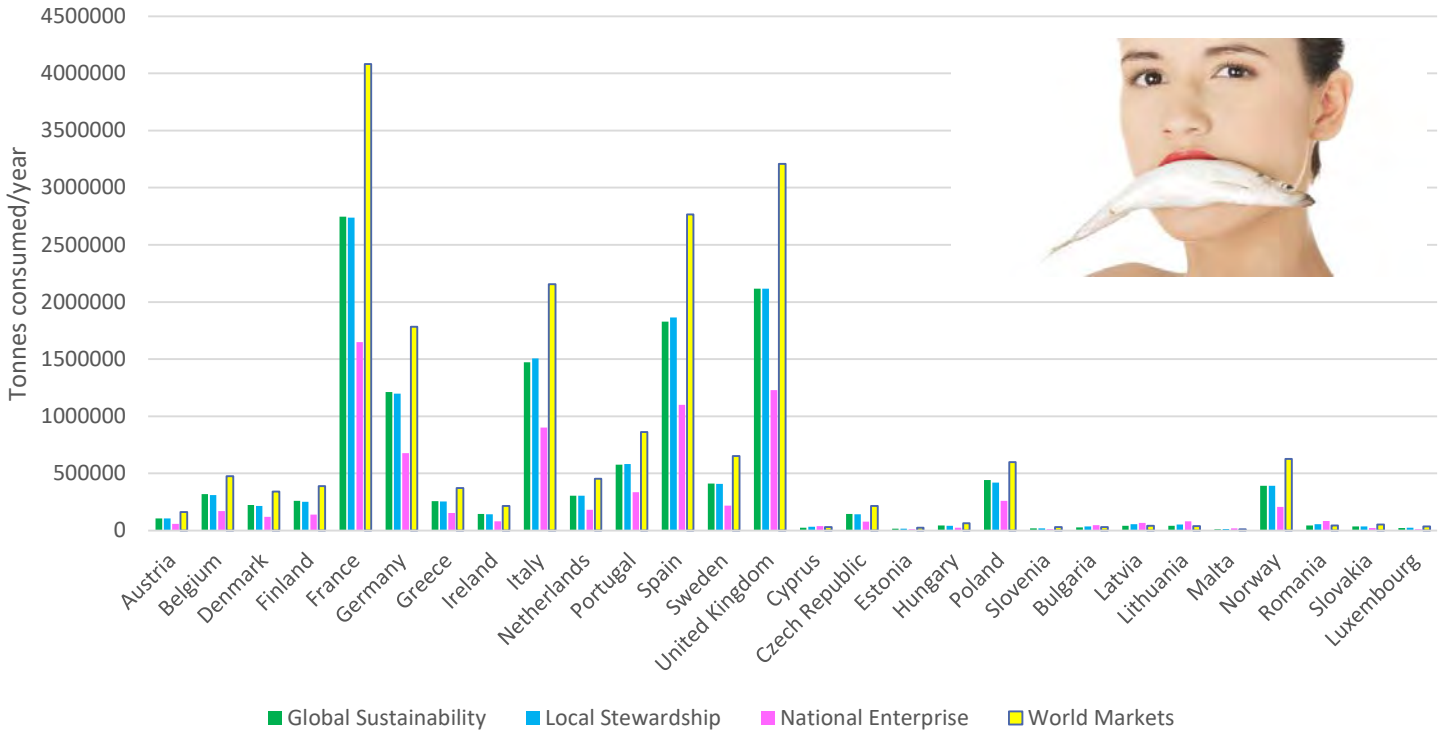
	2010	2050	2100
Population (millions)	609	672	630
Urban population (%)	72.7	84.5	91.8
Education (number yrs)	12.0	13.5	14.1
GDP/per capita (bill US$)*	25.4	45.9	91.5
Renewable energy (%)‡	15.8	16.2	22.8

‡based on global estimates

*billion US$/million people

- **CERES World Markets Scenario (RCP 8.5 and SSP5 - A1F1):** technology and markets fail to deliver sustainable solutions
- **CERES National Enterprise Scenario (RCP 8.5 and SSP3 - A2):** national identity gets in the way of global sustainability.
- **CERES Global Sustainability Scenario (RCP 4.5 and SSP1 - B1):** international co-operation towards global sustainability.
- **CERES Local Stewardship Scenario (RCP 6.0 and SSP2 – B2):** tailored solutions for local problems.

Fish & shellfish consumption (tonnes) – by country…



What could it mean for Marine Fisheries?

These draft socio-political storylines were elaborated by CERES partners and stakeholders

World Markets – RCP 8.5 and SSP5 (A1F1)

- Fish obtained from the cheapest sources
- Decommissioning subsidies reduced
- Few legal and technical restrictions
- Only a few high-tech boats
- Sequentially depleted fish stocks
- More competition for resources globally
- Low taxes, strong private sector
- Europe outcompeted by Asia/China
- Use of cheap immigrant labour

National Enterprise – RCP 8.5 and SSP3 (A2)

- Maintaining national supply important
- Frequent 'cod wars'
- Decline in fish imports (import tariffs)
- Sport fisheries 'squeezed out'
- Higher fish prices and taxes
- Little new technology
- Food security more important than MPAs
- Individual Transferrable Quotas (ITQs)
- Increased disparity – rich and poor countries

Global Sustainability – RCP 4.5 and SSP1 (B1)

- Fish from sustainable sources worldwide
- Equitable and ethical are important
- EU/international marine strategy
- Lower meat and fish consumption per capita
- Ecolabel certification schemes
- EIA required for new fisheries
- Traceability and quality standards
- Fisheries displaced by windfarms and MPAs
- Sustainable, low impact fishing gears

Local Stewardship – RCP 6.0 and SSP2 (B2)

- 'Bottom up' local/regional governance
- Self sufficiency viewed as important
- Large number of small/traditional vessels
- Improved opportunities for 'sport fisheries'
- Mosaic of different management measures
- Not worried about downstream impacts
- Equity and ownership are important
- Traceability standards important

What could it mean for Marine Aquaculture?

These draft socio-political storylines were elaborated by CERES partners and stakeholders

World Markets – RCP 8.5 and SSP5 (A1F1)

- Huge expansion of offshore fish farming
- Luxury product vs anonymous fish protein
- *Pangasius* dominated aquaculture markets
- Extensive use of cheap immigrant labour
- Big businesses strive for value-for-money
- Frequent fish kills due to pathogens & jellyfish
- Global trading of aquaculture products
- Technology/automation important
- Low seafood prices, low energy prices

National Enterprise – RCP 8.5 and SSP3 (A2)

- High seafood prices, high energy prices
- Less technology, more labour
- Regional production with public subsidies
- Genetic engineering of aquaculture species
- Aquaculture to feed domestic tastes
- Some countries adopt new tech., others not
- Local certification and marketing schemes
- Food security dominates over environment

Global Sustainability – RCP 4.5 and SSP1 (B1)

- Tight regulation of inputs and outputs
- EIA required for new farms
- Traceability and quality standards
- Organic and fair-trade ecolabel schemes
- Technology transfer to poorer countries
- Carbon footprint considered
- Inland, closed systems more common
- Renewable energy powering most farms
- Expansion of offshore production

Local Stewardship – RCP 6.0 and SSP2 (B2)

- Local/regional governance – high autonomy
- Self sufficiency viewed as important
- Small scale, low-impact fish farming
- EIA required for all new farms
- Quality and traceability important
- Sale/marketing of locally produced products
- Greater variety of organisms farmed
- Strong incentives to recycle waste materials

Exploitation of results

All partners had intended some sort of face-to-face stakeholder outreach activity under T1.2, but the exact form that that this might take and the timing were not known when the engagement strategy was first drafted.

21-22nd November 2016 CERES Stakeholder Engagement Workshop in The Hague (Netherlands).

NUIG (**Ireland**) carried out face-to-face interviews with aquaculture stakeholders.

DLO-IMARES (**Netherlands**) hosted a meeting for shellfish farmers on the 23rd of June 2017, glossy report card widely circulated.

MEU (**Turkey**) organised two focus-group meetings during May 2017 to share and discuss the socio-political scenarios.

IPMAR (**Portugal**) provided a presentation on the CERES scenarios to industry (Portuguese Association of Fish Farmers).

INCDDD (**Romania**) identified a list of regional stakeholders and translated the ‘glossy report card’ into Romanian.

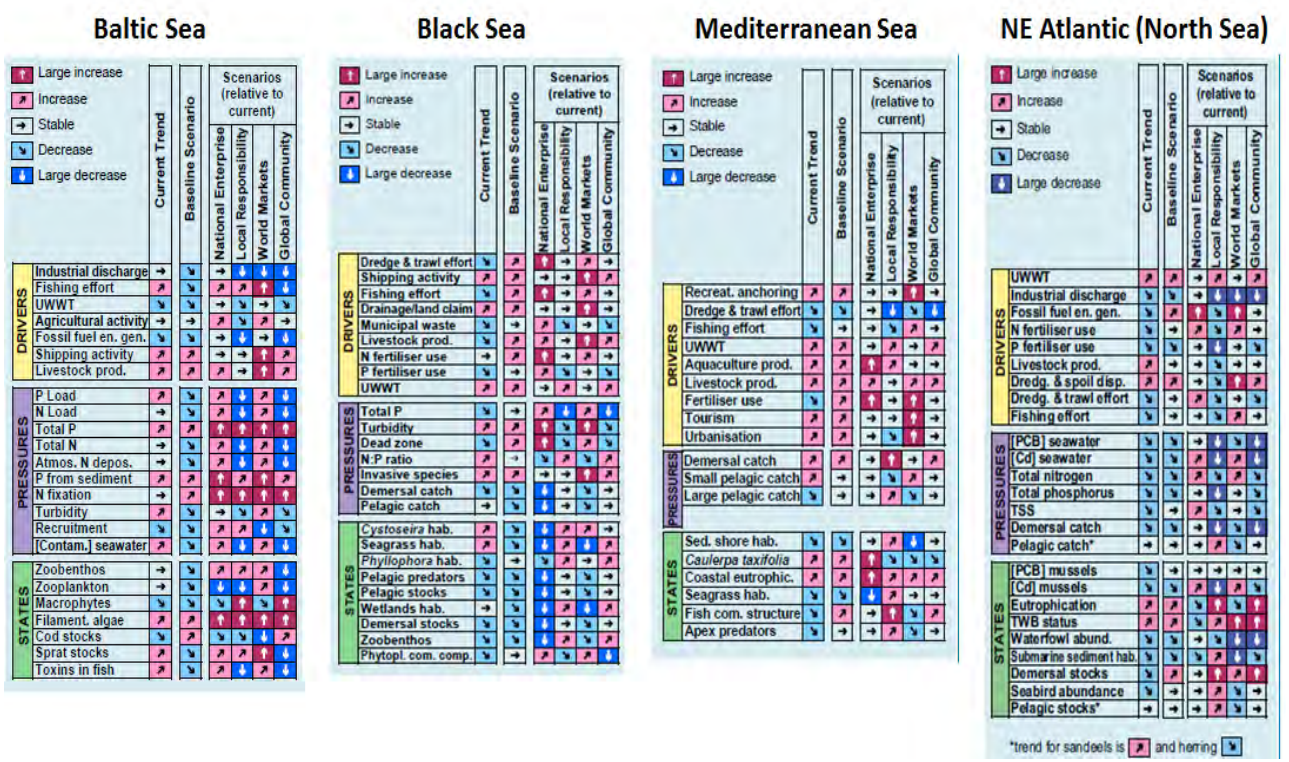
ZUT (**Poland**) translated the Glossy Report Card into Polish to be used in future stakeholder engagement events.

CSIC (**Spain**) translated the glossy report card into Spanish and has now begun full-scale interviews with stakeholders (under WP6).

CEFAS (**UK**) event on 22nd June 2017 in London, organised by 'Seafish‘ the UK seafood industry authority and attended by 50+ representatives from the fisheries, aquaculture and processing sectors.

Regionalisation of the CERES scenarios

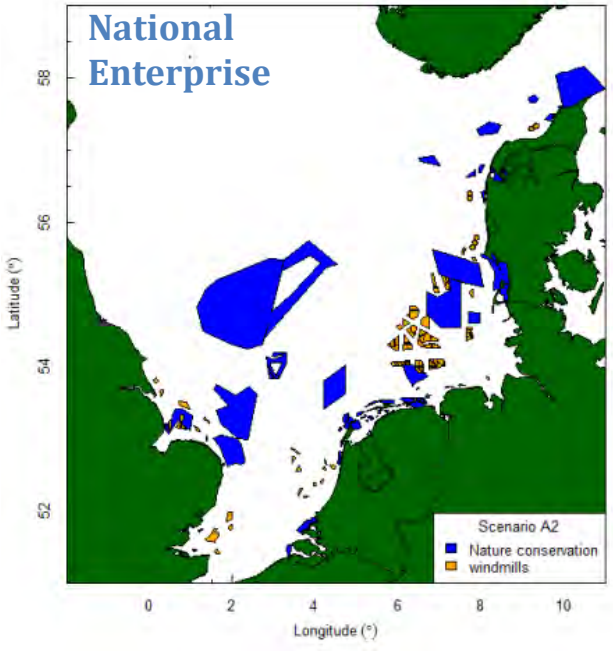
The EU Project ELME has already provided holistic scenarios for each European Sea using a similar common framework

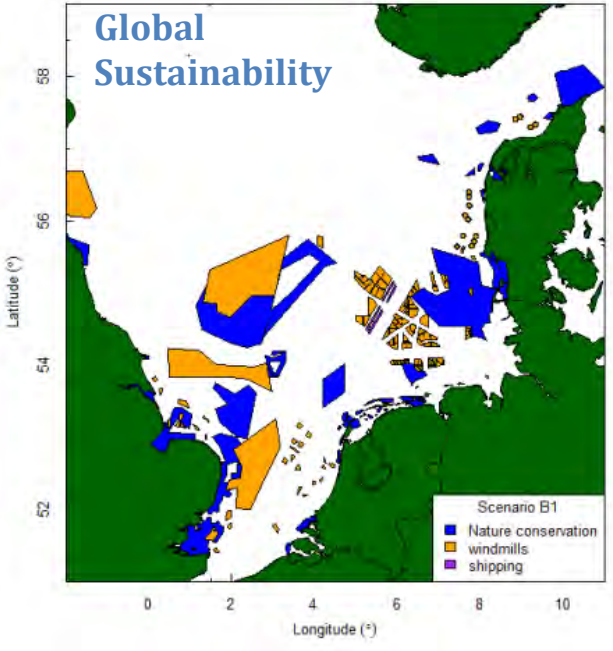


Standardised – for all cases

		World Markets [RCP 8.5, SSP5]	National Enterprise [RCP 8.5, SSP3]	Global Sustainability [RCP 4.5, SSP1]	Local Stewardship [RCP 6.0, SSP2]
Technological	Fuel efficiency	++ (decrease 60% fuel use – based on the MDV vessel)	+ (HALF OF MAX CASE)	++ (decrease 60% fuel use – based on the MDV vessel)	+ (HALF OF MAX CASE)
	Selectivity/survival of discards	Discards would have a value 0	Incentive to use everything caught nationally – Discards would have a value 0	Very selective gears ++	Increased selectivity to protect local assets +
	Catch efficiency	High tech innovation Less restrictions on fishing grounds ++	Little technological innovation but make the most of local resources +	EU rules do not allow increase of catch efficiency No increase 0	Similar to global sustainability with local rules 0
Management	Exploitation rate/TAC related to MSY	MEY	>MSY maximum social yield (employment)	M ecological Y – MSY for all species including vulnerable species	MSY for target species
	Access to other nations waters (Brexit)	Open ++	Restricted to National waters/national fleets (but possibility to flag vessels?) +	Open to sustainable practices ++	Less interest in international waters. High restrictions on where you can fish Participatory co-management +
	Quota trading (international, national)	International open market	IQs barriers on trading to maintain large fleet (of small vessels)	International open market. Even accessible to NGOs (buy out by NGOs would decrease available TACs)	ITQs trading nationally
	Quota redistribution (relative stability or new key of distribution?)	RS used for initial allocation of quota, then traded on market	RS Needs to be revisited. Quota should match what is in national waters. Then applied strictly	Quota distributed to less damaging gears (through EIA)	Relative stability revisited but important. Equitable allocation to local people within a country. Participatory process

Regional – example North Sea (spatial fishery closures)





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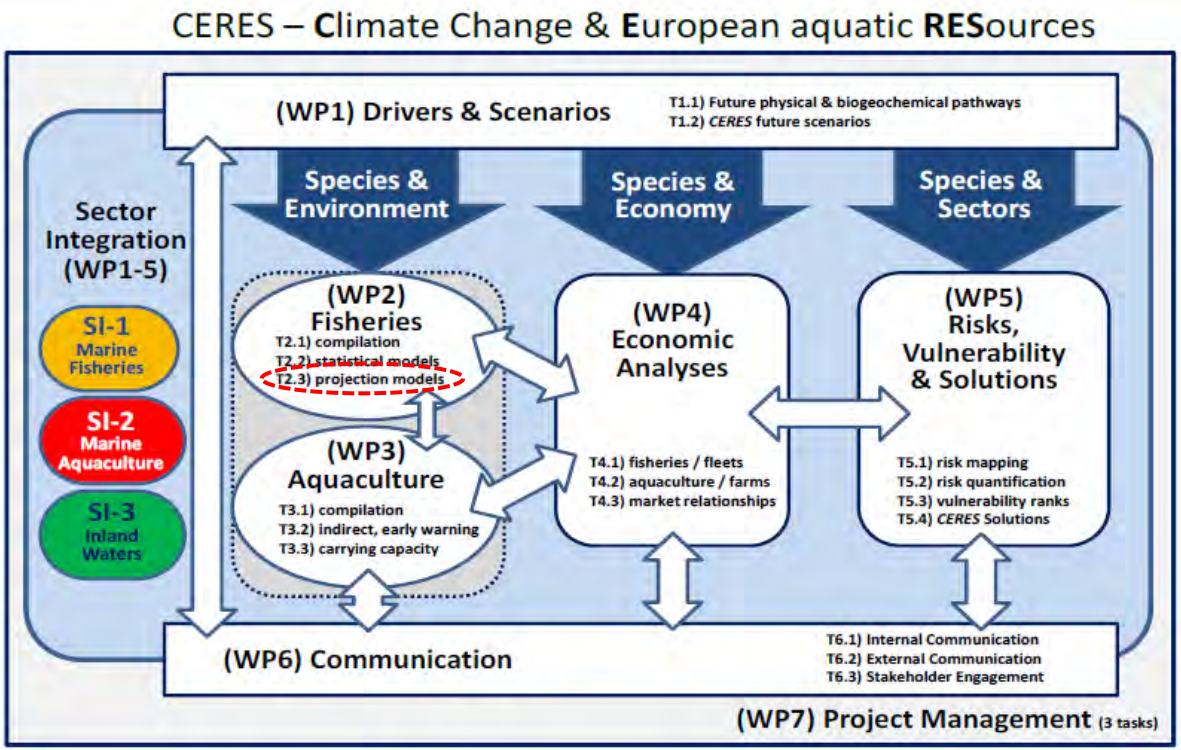
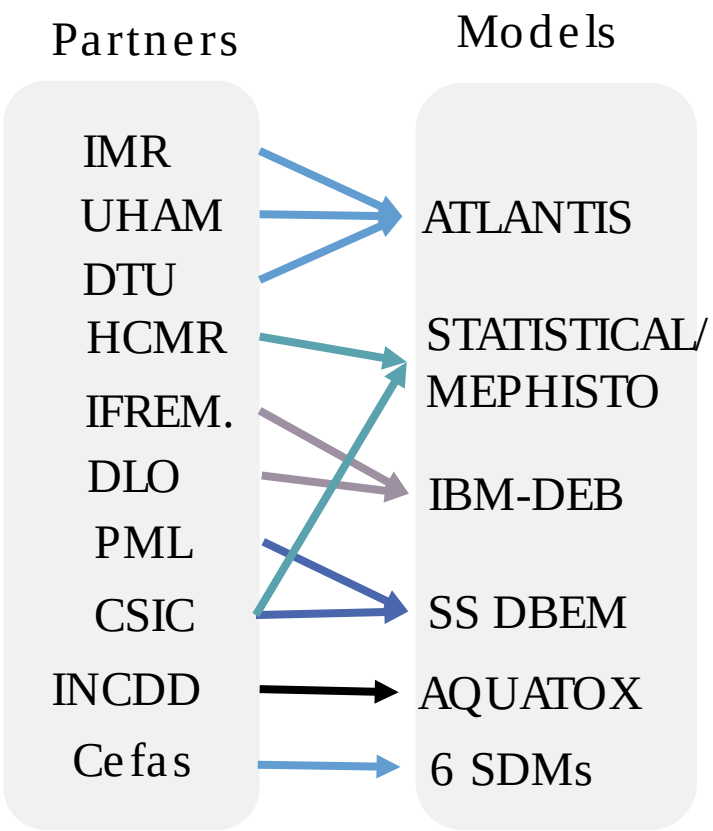


In Task 2.3 a wide diversity of modelling activities focussed on fish and fisheries are underway:

- **UHAM:** Work on the North Sea Atlantis model
- **DTU:** Baltic ecosystem Atlantis modelling
- **IMR:** Barents Sea (arctic) ecosystem Atlantis modelling
- **Cefas:** Work to create an 'ensemble' of relatively simple species distribution models (SDMs)
- **IFREMER:** DEB model for anchovy and sardine in Biscay
- **DLO:** DEB model for North Sea flatfish
- **CSIC:** SSD-DBEM distribution models for dolphinfish

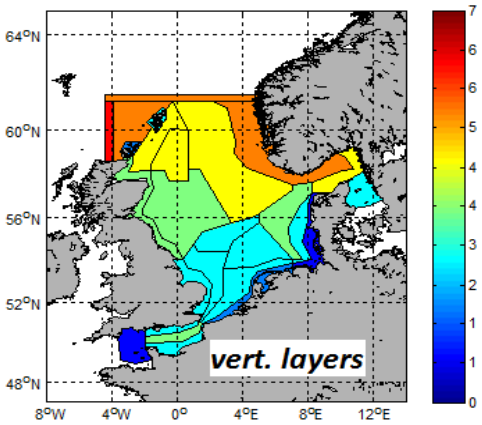


Models from large (e.g. Atlantis) to low (e.g., statistical) complexity have been tested and tuned with historical environmental data.

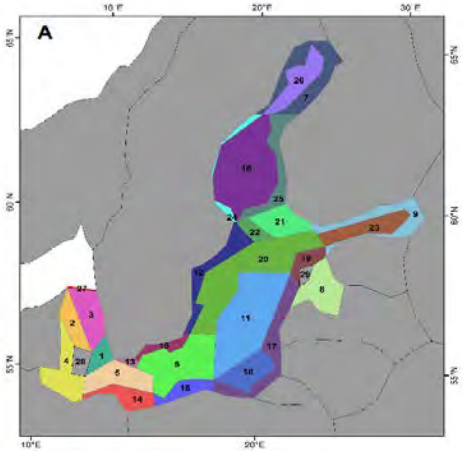
ATLANTIS Models

3 Atlantis Models

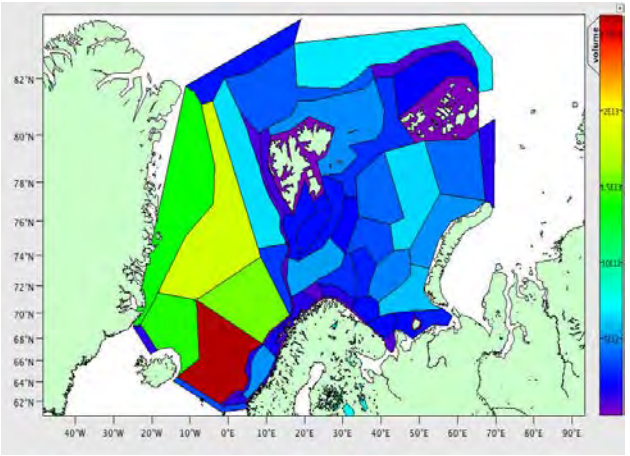
North Sea



Baltic Sea

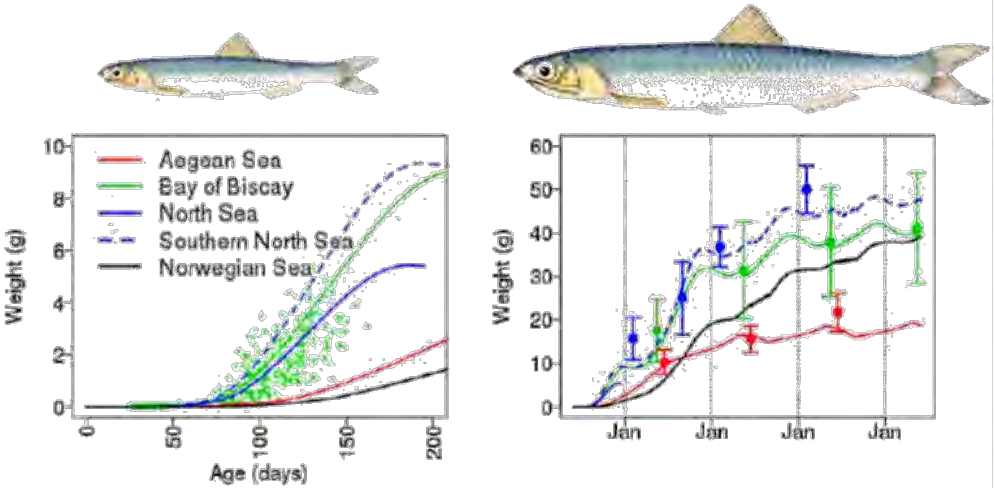


Barents/Norwegian Sea



	North Sea	Baltic Sea	Nordic/Barents Sea
Number of Polygons	26	29	60
Spatial Domain	570,000 km^2	415,000 km^2	4 million km^2
Hydrodynamics	HAMSOM model	HBM-ERGOM	NORWECOM-ROMS model
Functional groups	53	33	52

Bio-energetics Models

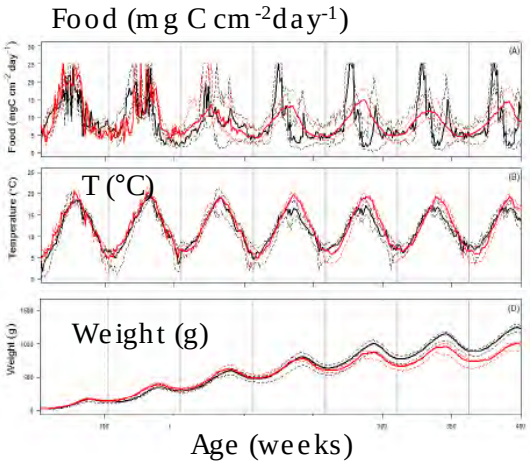


Anchovy growth in different European regions, DEB-IBM, IFREMER.

Results

- Several papers are in preparation or published, based on the updated models (e.g. DEB-IBM, Statistical)

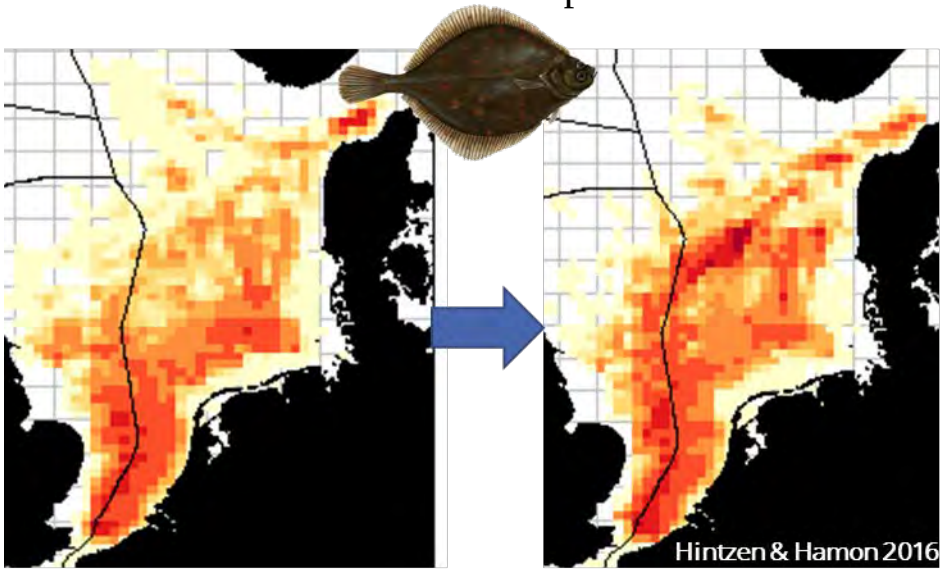
Growth of North Sea plaice as a function of migration, temperature and food, DEB+ERSEM, DLO



Future spatial distribution of fish

- Based on DEB model
  - Use seasonal migration model, applied to ERSEM forecasts
  - Requires obtaining ERSEM results from PML (T1.1)
  - Results can be used in bio-economic models

- Based on INLA model
  - Forecast distribution based on current fit of model, with forecasted temperatures



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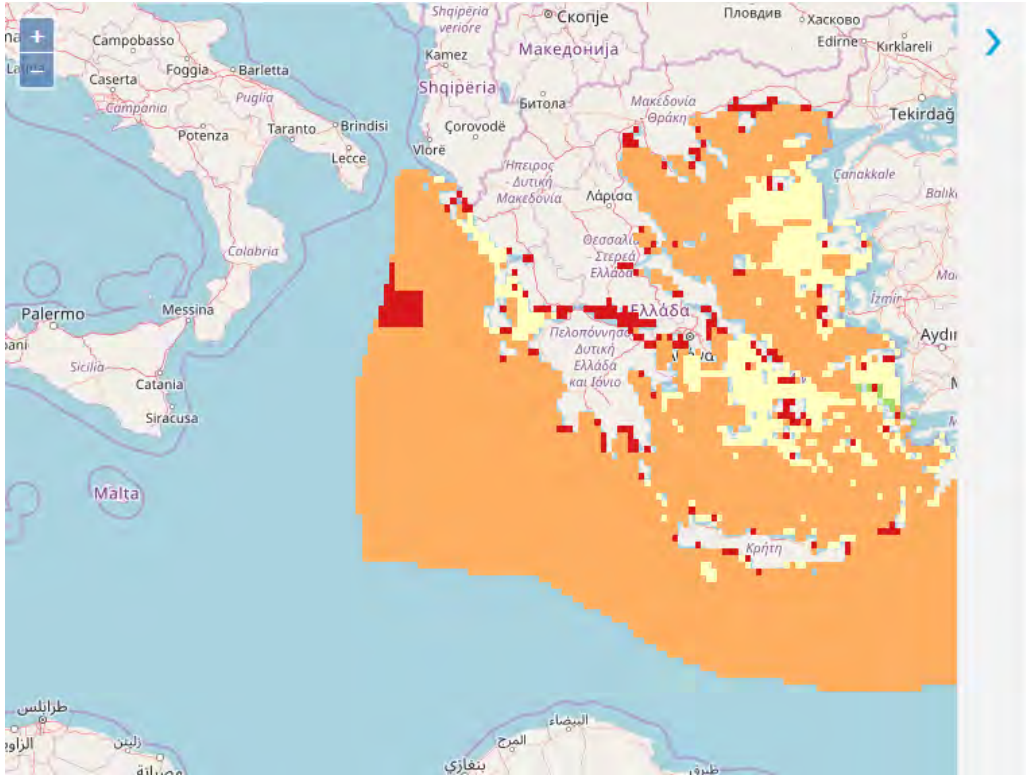
WATER – Gilthead in the Greek EEZ

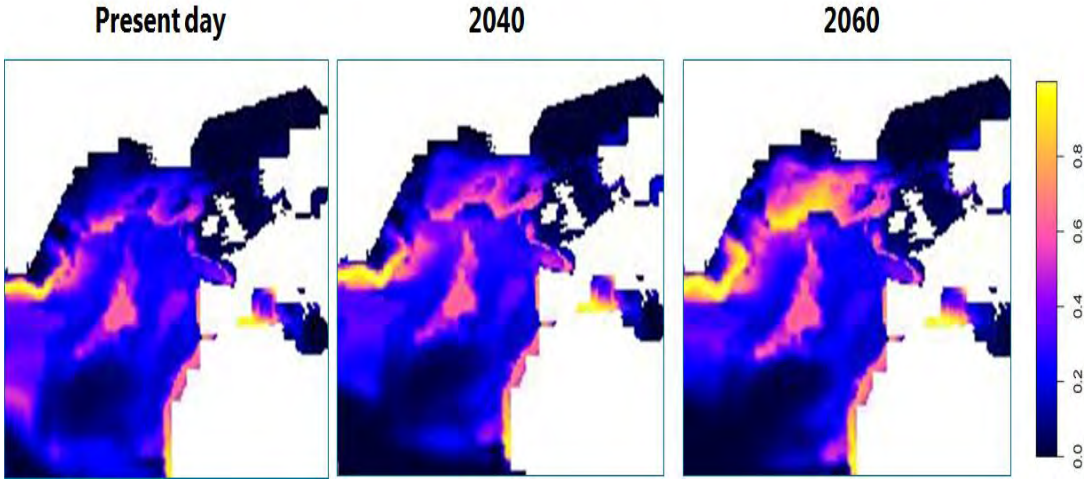
Ignacio Catalán
CSIC

Gilthead suitability shows the best areas are fairly close inshore – the coastal zone is a complex multi-user seascape.



Task 2.3 - Bioclimate Envelope modelling for the NE Atlantic

We have run 6 biological models (Maxent, Bioclim, GAMs, Random Forest, support vector machines - SVMs), for 49 commercial fish species and an ensemble of 11 variants of a future climate model (SRES A2B) [3234 runs]

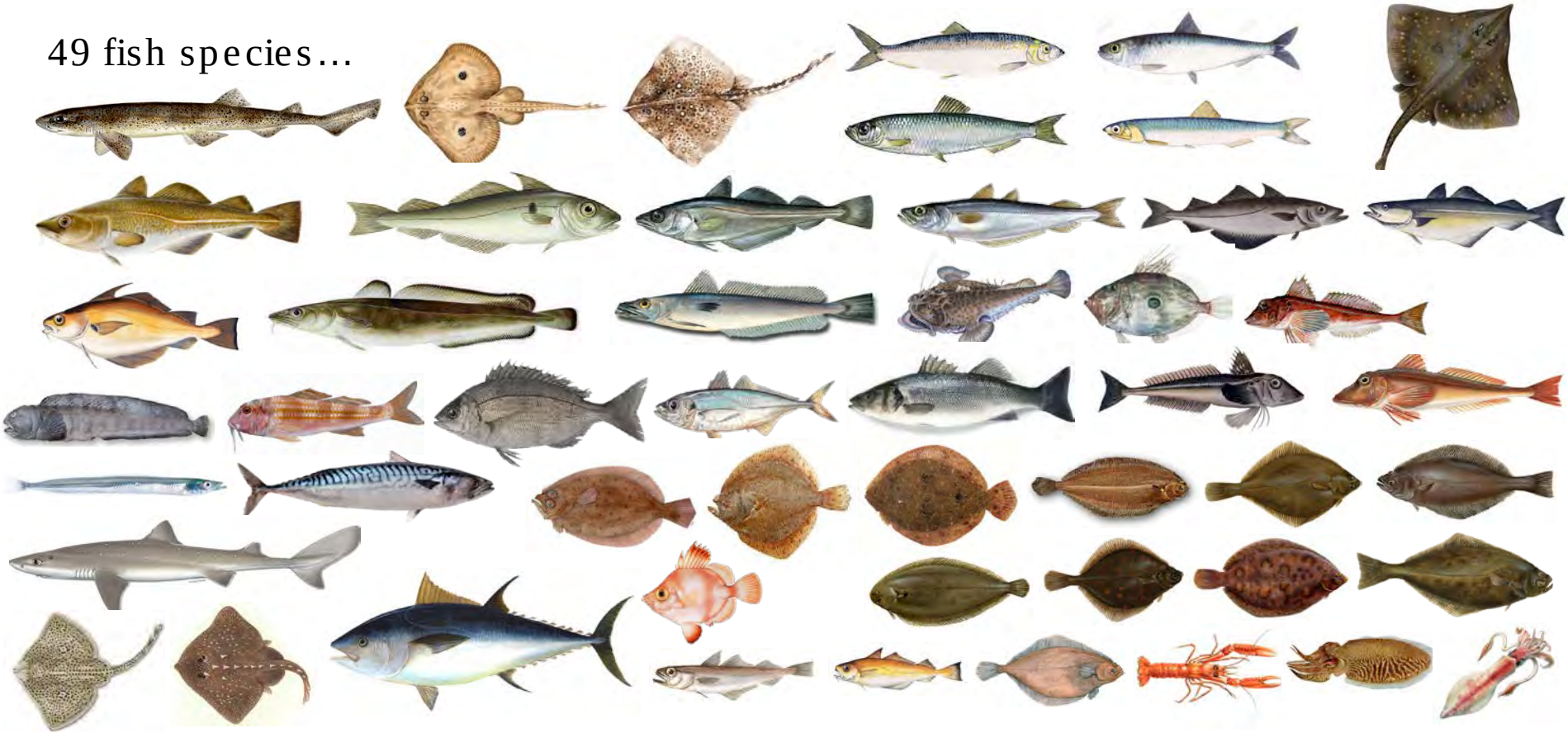


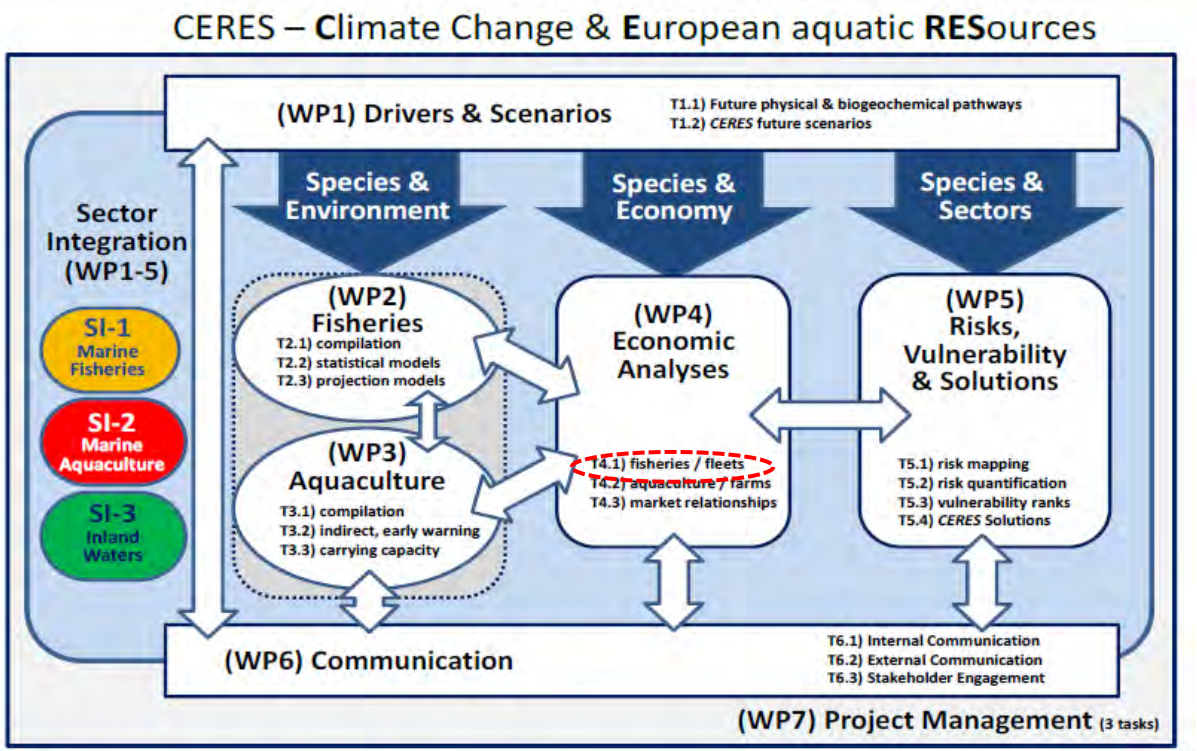
Projected changes in habitat suitability for bluefin tuna (*Thunnus thynnus*) as determined by the Maxent Species Distribution Model (SRES A2b scenario)

In 2018 we will repeat the modelling using the CERES T1.1 outputs (RCP 4.5 and 8.5) [392 runs]

CERES

Climate change and European aquatic RESources

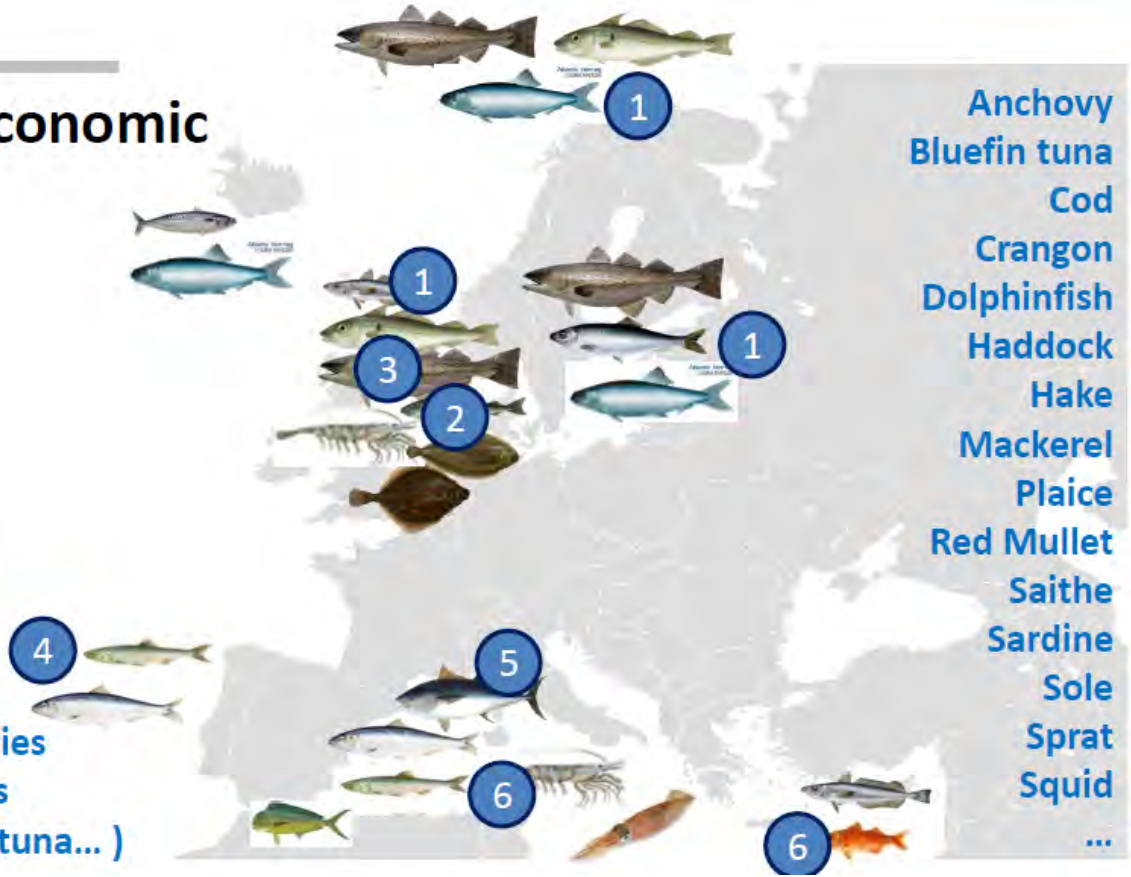




Task 4.1 Spatially-explicit bio - economic estimates of climate - driven changes in fishery access, resources, and effort (DLO (WR), Katell Hamon/Erik Buisman, M6 -36).

Fisheries Bioeconomic Projections

1) Atlantis
2) FishRent
3) SIMFISH/RUM
4) ISISFISH
5) FLBEIA
6) MEFISTO

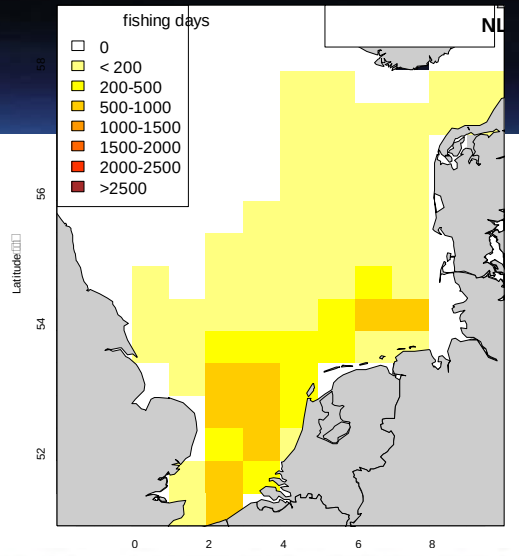


Mixed demersal fisheries
Mixed pelagic fisheries
Single species (buefin tuna…)

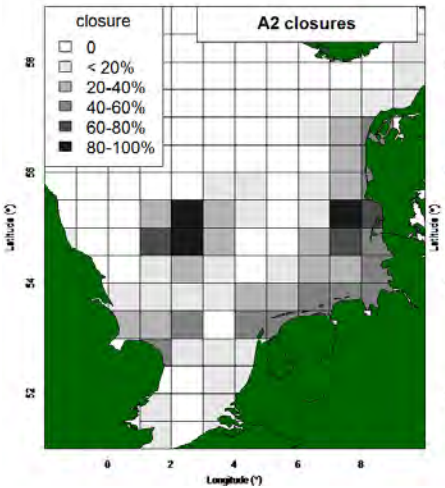
Anchovy
Bluefin tuna
Cod
Crangon
Dolphinfish
Haddock
Hake
Mackerel
Plaice
Red Mullet
Saithe
Sardine
Sole
Sprat
Squid
…

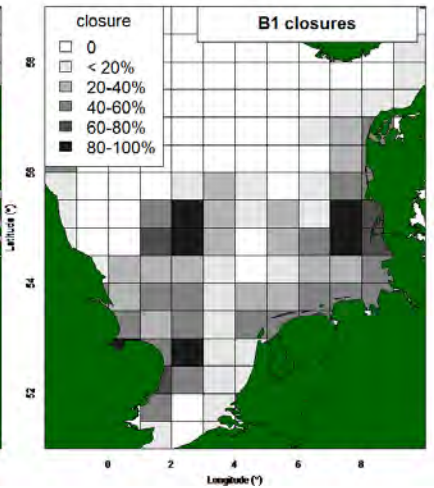
SIMFISH– North Sea

North Sea Flatfish fishery



- Using SIMFISH model
  - Beam-trawler fleets (NL, UK?, DE?)
  - Projection 2015-2050
  - Resolution: ICES rect / quarterly
  - Using socio-political scenarios





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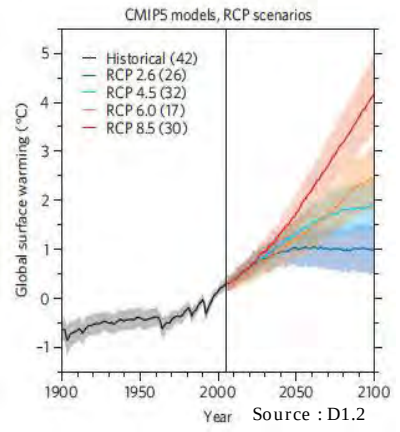
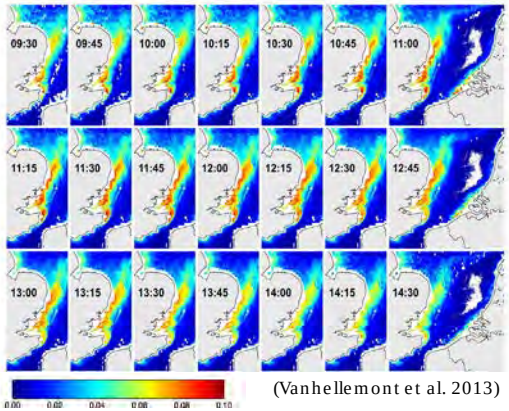
SIMFISH- Data needs & gaps

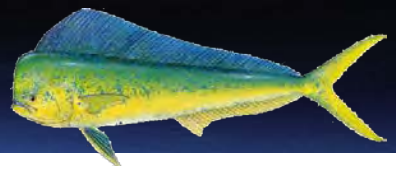
- T1.1 current & RCP 4.5 & 8.5
  - Available forecasted variables?
  - Spatial & temporal resolution?
- Plaice and sole future distribution
- Other species?
  - Interest from Stakeholders (turbot & brill?)
  - Data availability?
- Fleet data UK, Germany
- Final socio-political scenarios (incl. spatial closures)



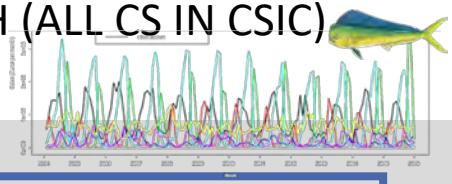
Source : D1.2



(Vanhellemont et al. 2013)



BIOECONOMIC MODEL: 2-STAGE MODELLING APPROACH (ALL CS IN CSIC)



WP4 Economy

WP1 scenarios

WP2

within-season availability to fishermen (extended period?)

Mean initial size at the onset of fishery

Size-progression (growth)within the season

CERES

t+1

F

BIOLOGICAL MODULE (Depletion model)

Management. Effort, selectivity, New? (CC-induced)

Economic controls: taxes,subsidies, decomissions

ECONOMIC SUB-MODEL

Catch

Costs

Revenues

Fishermen behavioural rules

Secondary species

Fish price

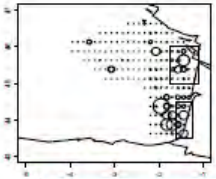
outcome

T0 *Initial conditions*

ISIS-fish – Bay of Biscay

T 4.1 Spatially-explicit bioeconomic estimates of CC changes in fishery access, resources and effort

- Pelagic fishery in Biscay
- Impact of changes in fish distributions on economic viability of current fishing activity



Survey data

Models

Biophysical model

Early life stages and Recruitment

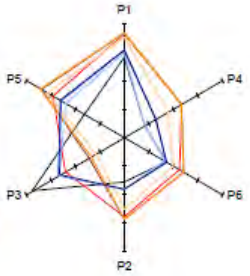
Spatial/ seasonal distributions of fish populations

Spatial/ seasonal distributions of effort

Spatially-explicit modelling plateform

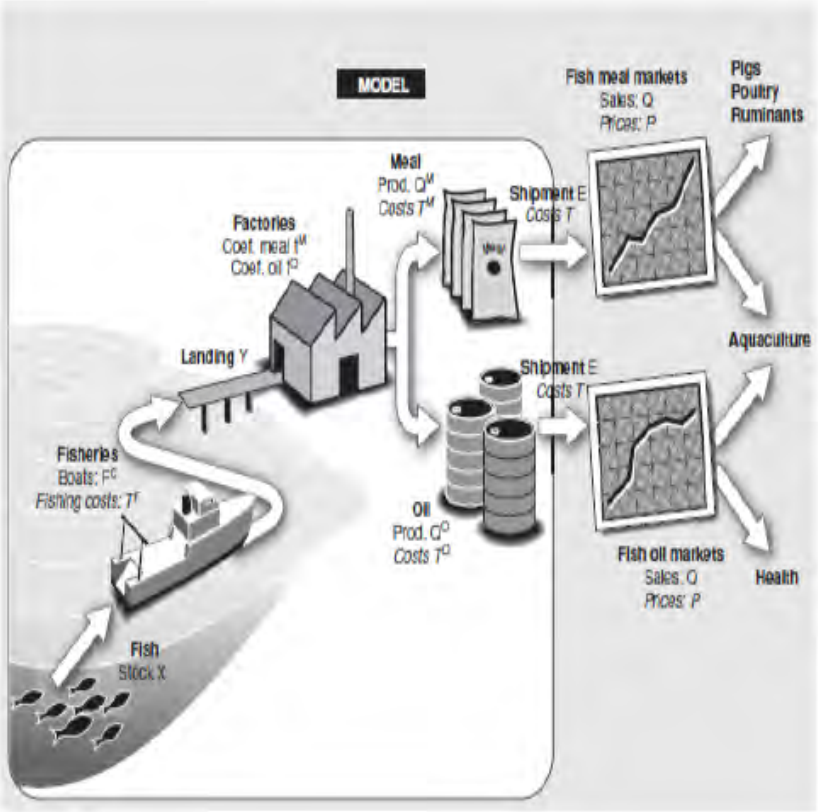
ISIS-fish

Fishing activity



Economic viability

CERES Global Fishmeal model



- Links production and consumption for fishmeal and fish oil globally
- Supply-chain analysis
- Small pelagic fish: sardine, anchovy, sandeel, capelin, blue whiting, menhaden, herring
- Short term (10 years) and long term (80 years)

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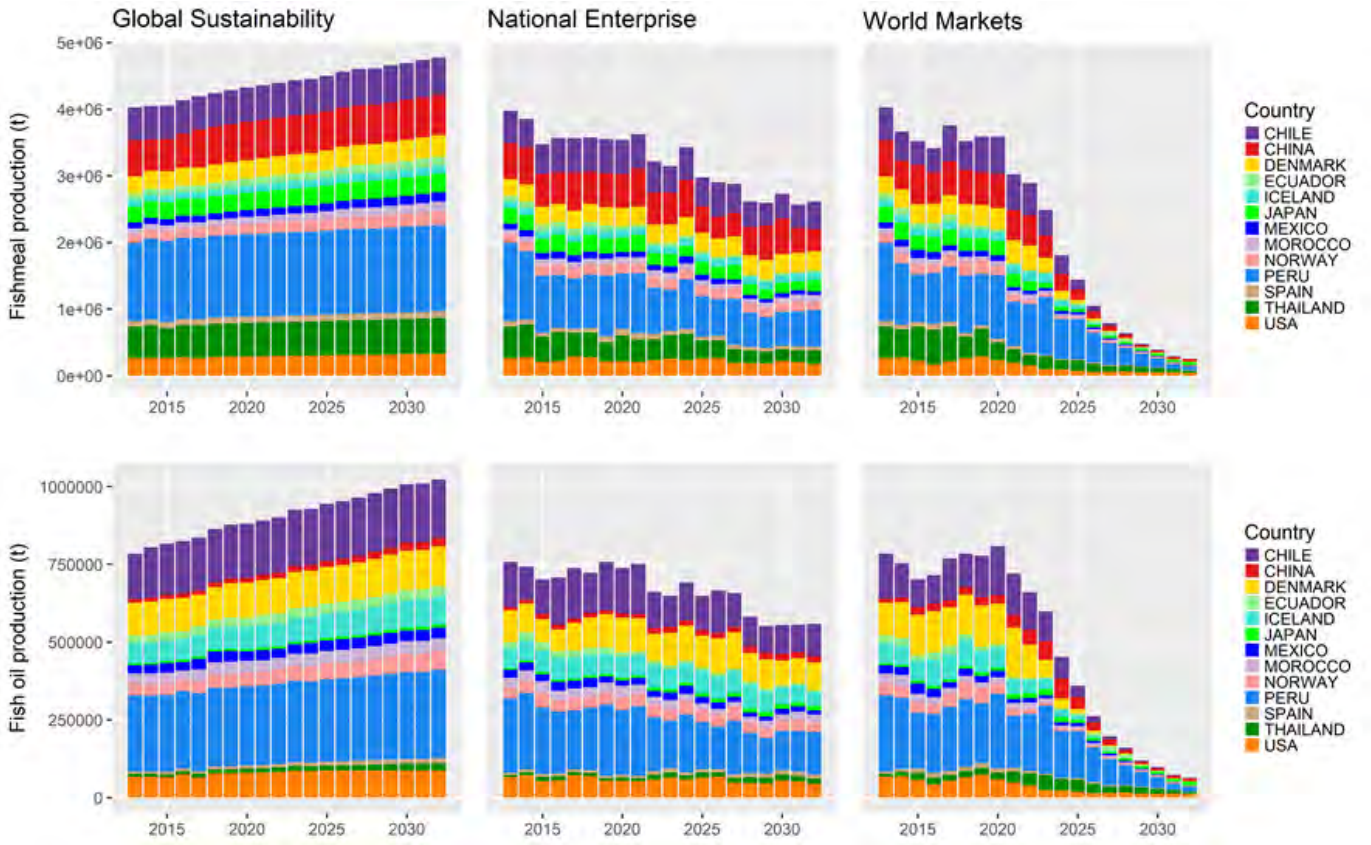
Preparing for trade analysis: socio-economic parameters

	National Enterprise [RCP 8.5, SSP3]	World Markets [RCP 8.5, SSP5]	Global Sustainability [RCP 4.5, SSP1]	Local Stewardship [RCP 6.0, SPP2]
Demand in EU*	+ (moderate population growth)	++ (high popl. growth, competitive pricing)	0 (moderate popl. growth; reduced meat consumption)	0 (moderate popl. growth)
Demand outside of EU*	-/+ (resource distribution)	++ (competitive markets)	+ (redistribution of food)	+ (relatively low due to low per capita consumption)
Trade costs	++ (trade barriers enforced)	- (free trade)	- (co-operation)	+ (local agenda restricts free trade)
FMFO demand	+ (slow increase from national sources)	++ (fast increase of aquaculture globally)	+ (moderate increase for healthier foods)	0 (self sufficiency important)
Farming efficiency	+ (restricted resource availability)	+ (competitive markets)	- (falling fish production)	+ (technological advancement, trimmings)

Preliminary FMFO results under CERES scenarios



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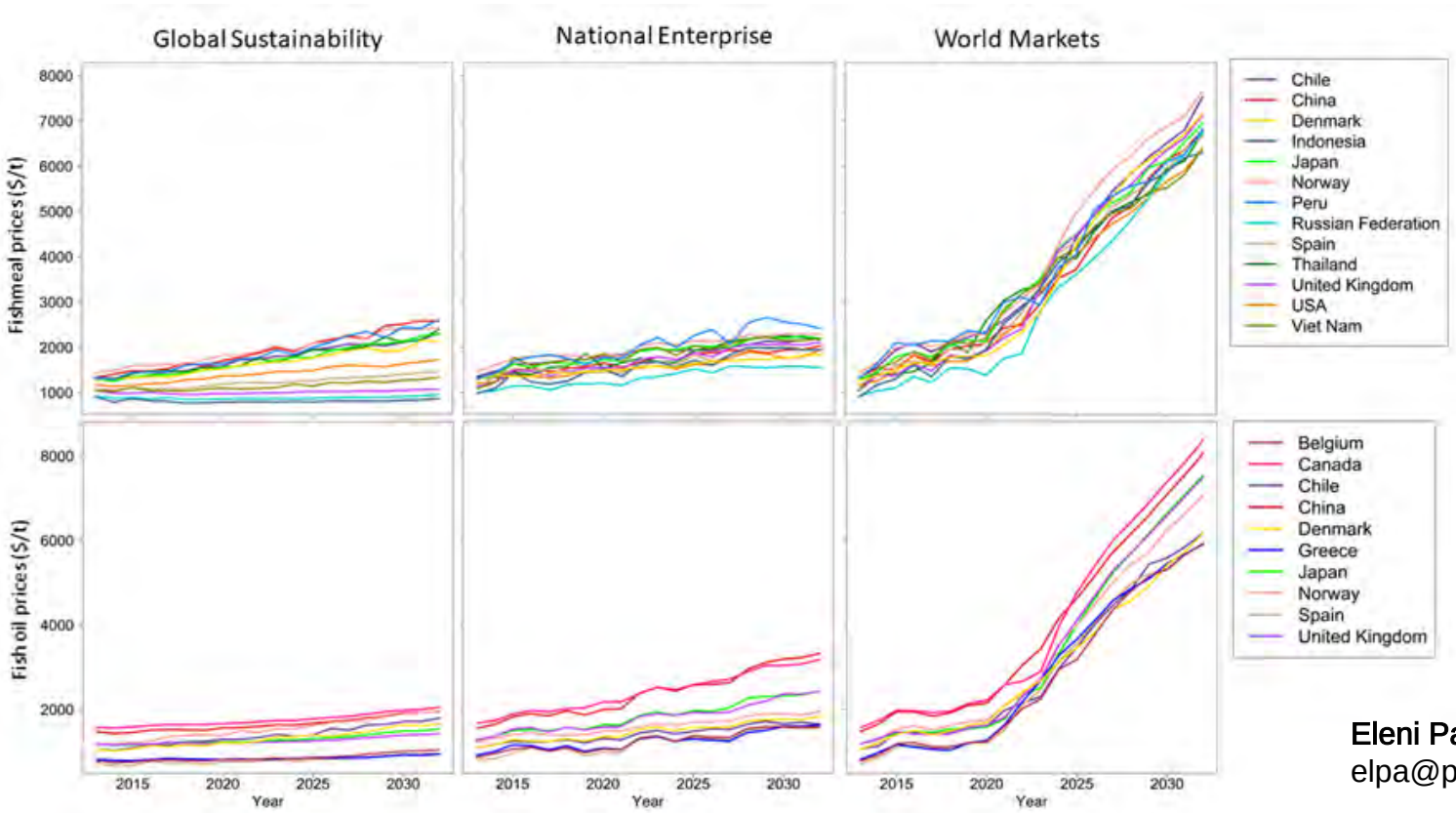
Source: Genevier et al, in prep.

Preliminary FMFO results under CERES scenarios



Eleni Papathanasopoulou - elpa@pml.ac.uk

Source: Genevier et al, in prep.

Conclusions …

- In order to reduce the total number of model runs across all European seas, species, fleets etc. we have chosen to use **a common set of socio-economic scenarios**

- We have based these on the **Shared Socio-economic Pathways (SSPs) that** have been designed by the IPCC to be used alongside the Representative Concentration Pathways (RCPs)

- We have attempted to 'regionalise' these scenarios – with specific assumptions about **MSY and spatial fishery closures**

- **We are now evaluating these scenarios with a wide diversity of biological and economic models**

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