Scenarios for the Future Ocean: A FishMIP Approach

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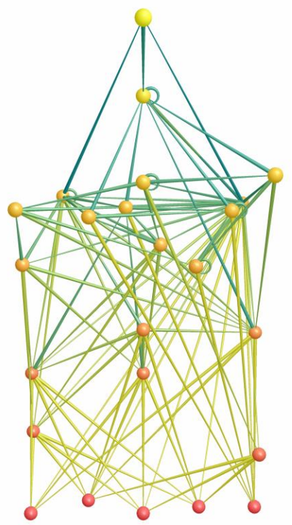
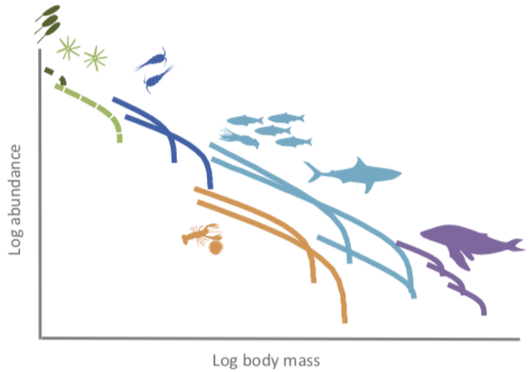
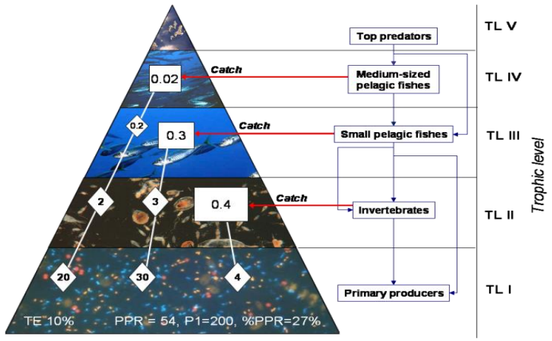
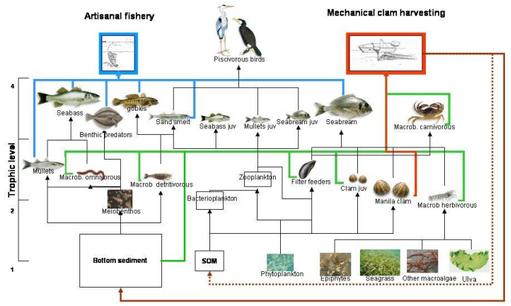
FishMIP









Network of >100 global & regional marine ecosystem modellers

Large Model Diversity

- Size or age-based
- Food-web
- Species distribution
- Hybrid models

Aim

- Develop a common protocol that all models can follow to make climate change projections

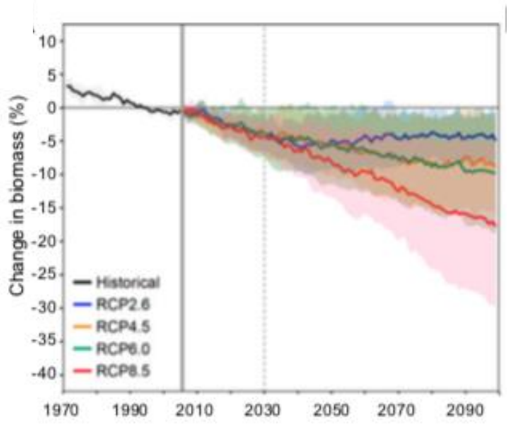
FishMIP
Fisheries & Marine Ecosystem Model Intercomparison Project

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

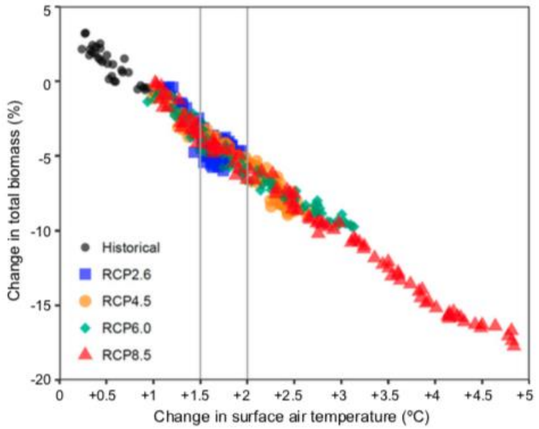
Tittensor et al. 2018 Geoscientific Model Developmer

Global ensemble projections reveal trophic amplification of ocean biomass declines with climate change

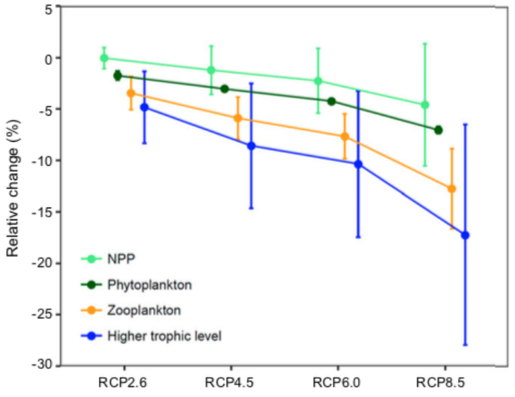
Heike K. Lotze[a,1], Derek P. Tittensor[a,b], Andrea Bryndum-Buchholz[a], Tyler D. Eddy[a,c], William W. L. Cheung[c], Eric D. Galbraith[d,e], Manuel Barange[f], Nicolas Barrier[g], Daniele Bianchi[h], Julia L. Blanchard[i,j], Laurent Bopp[k], Matthias Büchner[l], Catherine M. Bulman[m], David A. Carozza[n], Villy Christensen[o], Marta Coll[g,p], John P. Dunne[q], Elizabeth A. Fulton[j,m], Simon Jennings[r,s,t], Miranda C. Jones[c], Steve Mackinson[u], Olivier Maury[g,v], Susa Niiranen[w], Ricardo Oliveros-Ramos[x], Tilla Roy[i,y], José A. Fernandes[z,aa], Jacob Schewe[l], Yunne-Jai Shin[g,bb], Tiago A. M. Silva[r], Jeroen Steenbeek[p], Charles A. Stock[q], Philippe Verley[cc], Jan Volkholz[l], Nicola D. Walker[r], and Boris Worm[a]



- Large amount of variability in projected biomass declines among climate scenarios



- 5% loss of ocean biomass with every 1 °C of global warming



- Biggest losses at top of the food web (predators)

Lotze et al. 2019 PNAS

nature climate change

ARTICLES

https://doi.org/10.1038/s41558-021-01173-9

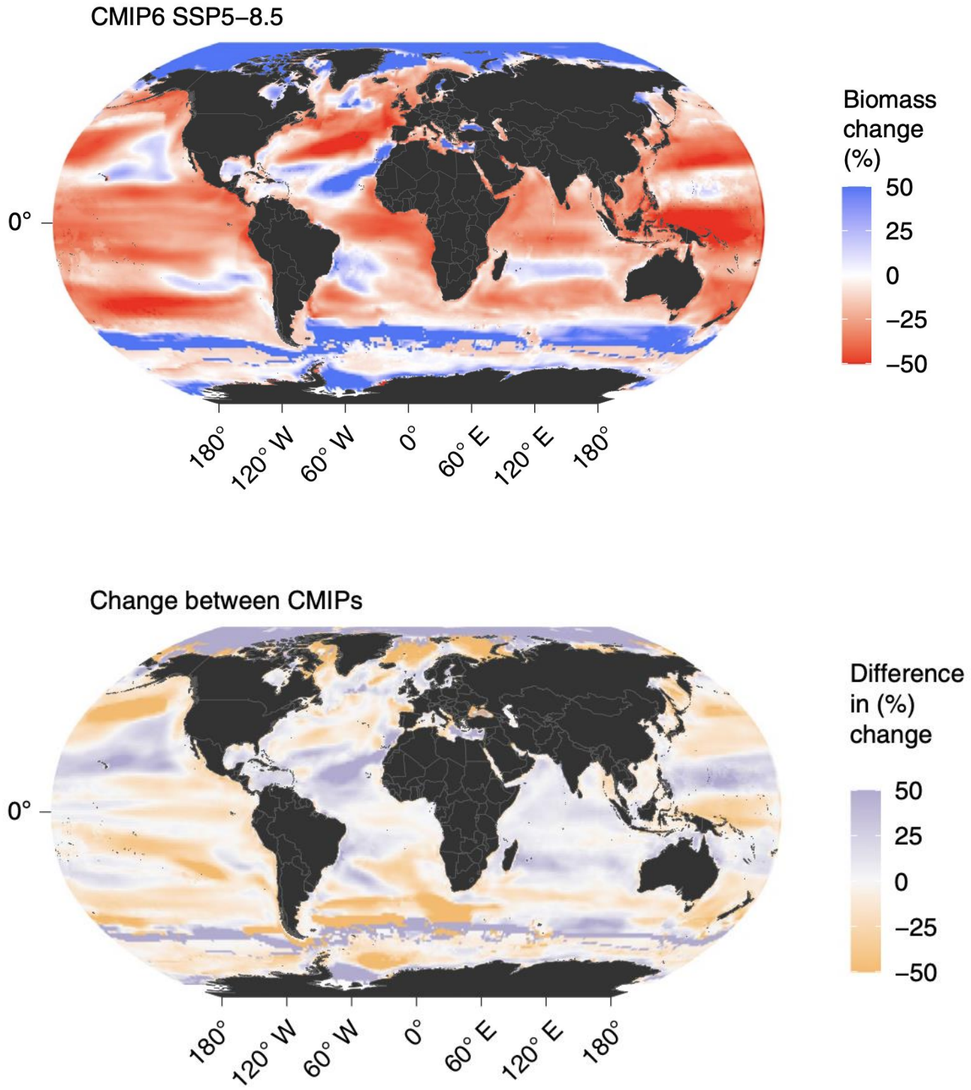
Check for updates

OPEN

Next-generation ensemble projections reveal higher climate risks for marine ecosystems

Derek P. Tittensor[1,2]✉, Camilla Novaglio[3,4], Cheryl S. Harrison[5,6], Ryan F. Heneghan[7], Nicolas Barrier[8], Daniele Bianchi[9], Laurent Bopp[10], Andrea Bryndum-Buchholz[1], Gregory L. Britten[11], Matthias Büchner[12], William W. L. Cheung[13], Villy Christensen[13], Marta Coll[14,15], John P. Dunne[16], Tyler D. Eddy[17], Jason D. Everett[18,19,20], Jose A. Fernandes-Salvador[21], Elizabeth A. Fulton[4,22], Eric D. Galbraith[23], Didier Gascuel[24], Jerome Guiet[9], Jasmin G. John[16], Jason S. Link[25], Heike K. Lotze[1], Olivier Maury[8], Kelly Ortega-Cisneros[26], Juliano Palacios-Abrantes[13,27], Colleen M. Petrik[28], Hubert du Pontavice[24,29], Jonathan Rault[8], Anthony J. Richardson[18,19], Lynne Shannon[26], Yunne-Jai Shin[8], Jeroen Steenbeek[15], Charles A. Stock[16] and Julia L. Blanchard[3,4]

- Greater climate risks in CMIP6 than CMIP5
- Large regional uncertainty in biomass projections between CMIPs



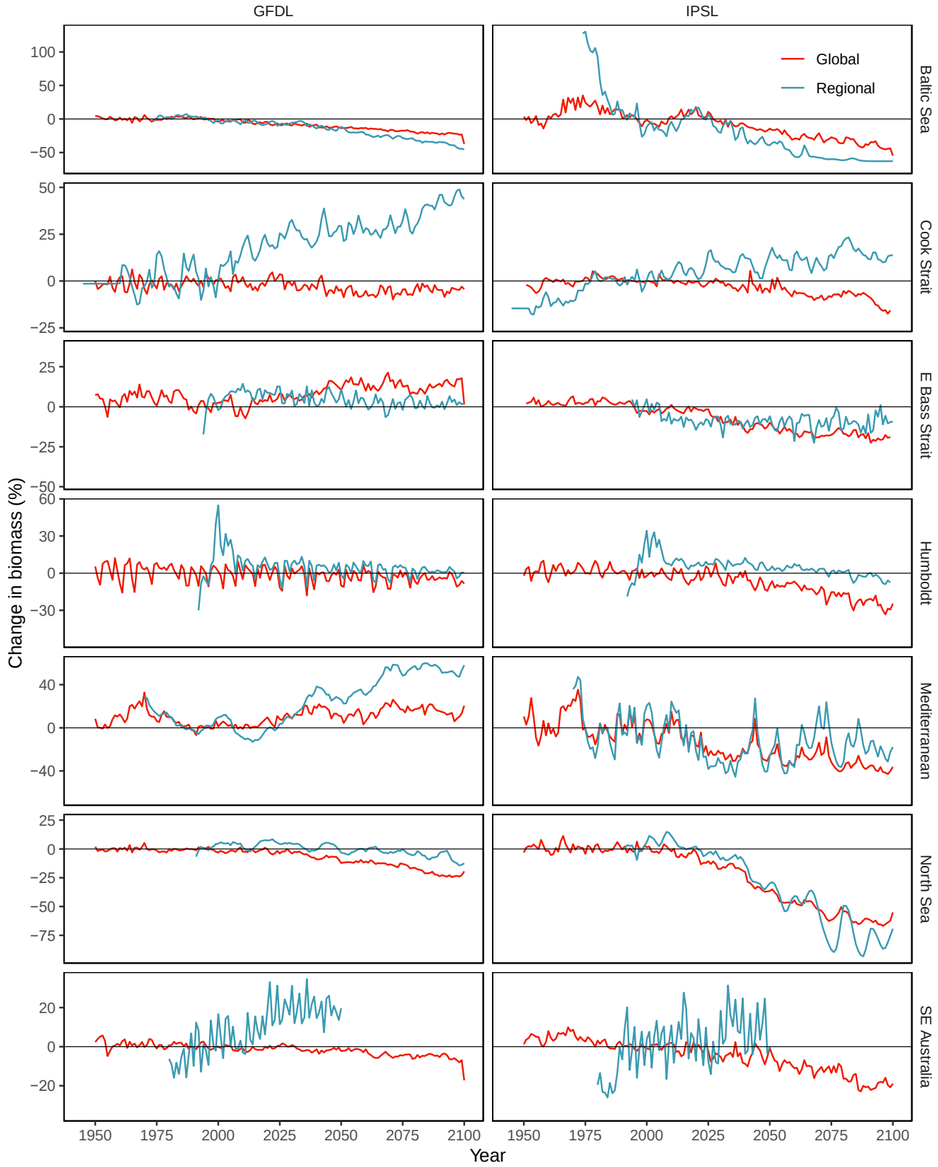
Tittensor et al. 2021 Nature Climate Change

Global and regional marine ecosystem model climate change projections reveal key uncertainties

Tyler Eddy[1], Ryan Heneghan[2], Andrea Bryndum-Buchholz[3], Beth Fulton[4], Cheryl Shannon Harrison[5], Derek Tittensor[6], Heike K Lotze[6], Kelly Ortega-Cisneros[7], Camilla Novaglio[8], Daniele Bianchi[9], Matthias Büchner[10], Catherine M Bulman[11], William Cheung[12], Villy Christensen[13], Marta Coll[14], Jason D Everett[15], L. Denisse Fierro Arcos[16], Eric D. Galbraith[17], Didier Gascuel[18], Jerome Guiet[19], Steve Mackinson[20], Olivier Maury[21], Susa Niiranen[22], Ricardo Oliveros-Ramos[21], Juliano Palacios-Abrantes[23], Chiara Piroddi[24], Hubert du Pontavice[25], Jonathan Charles Reum[26], Anthony Richardson[27], Jacob Schewe[10], Lynne Shannon[28], Yunne-Jai Shin[29], Jeroen Gerhard Steenbeek[30], Jan Volkholz[31], Nicola Walker[32], Phoebe Woodworth-Jefcoats[33], and Julia L. Blanchard[8]

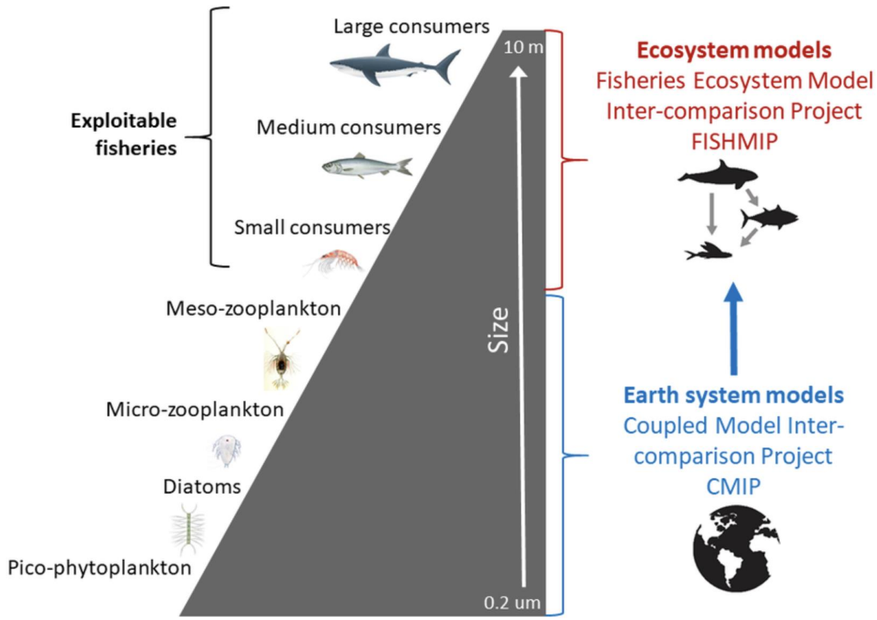
- Mismatches in climate change projections from global and regional marine ecosystem models

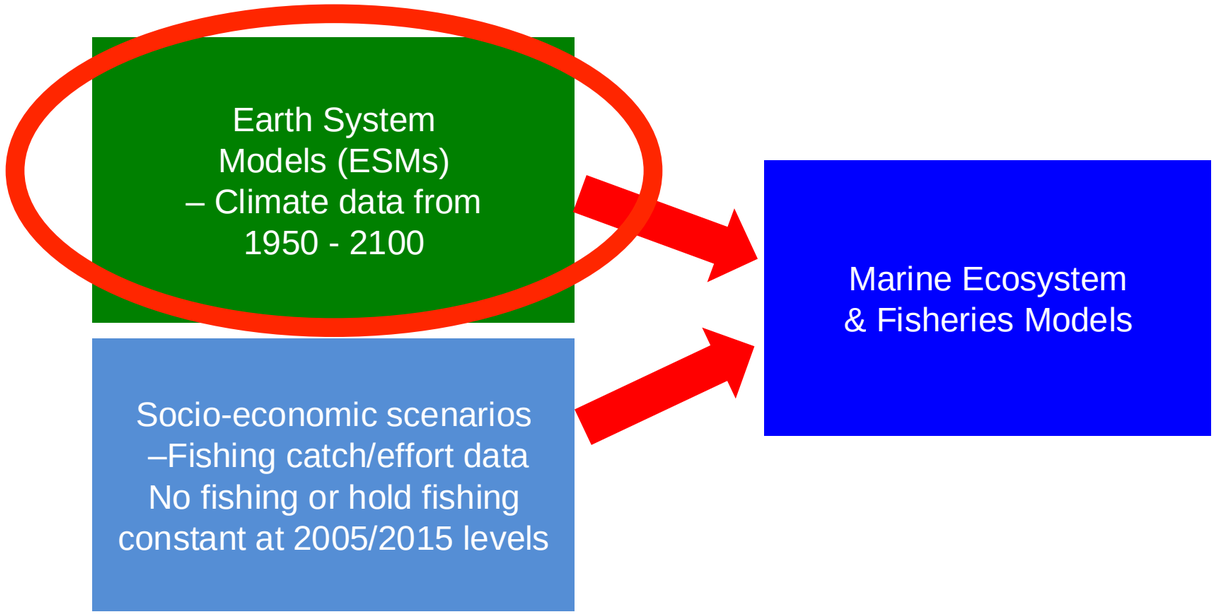
- Global marine ecosystem models produce greater declines than regional models



Eddy et al. In review ESS Open Archive

FishMIP



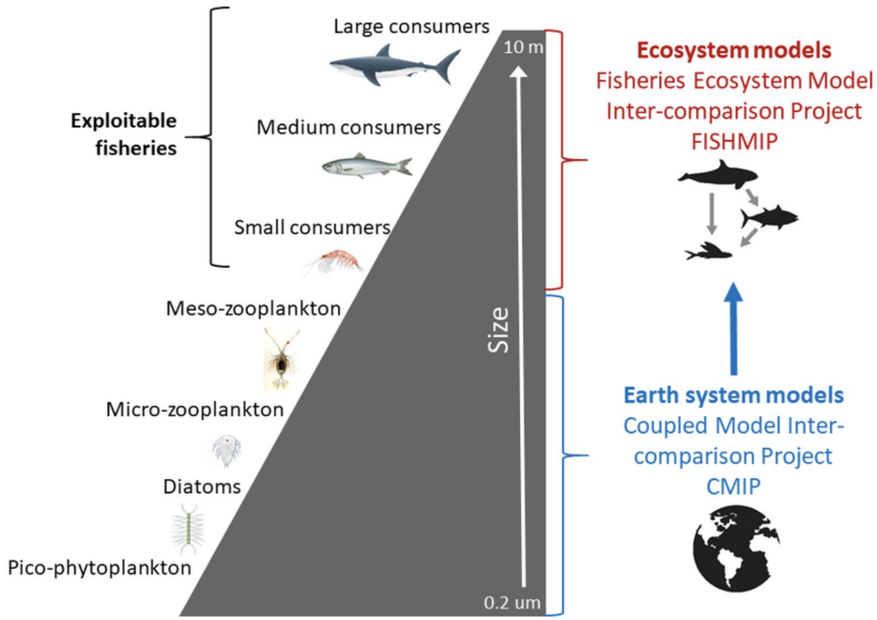


FishMIP
Fisheries & Marine Ecosystem Model Intercomparison Project

ipcc climate change

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

FishMIP



Earth System Models (ESMs) – Climate data from 1950 - 2100

Socio-economic scenarios –Fishing catch/effort data No fishing or hold fishing constant at 2005/2015 levels

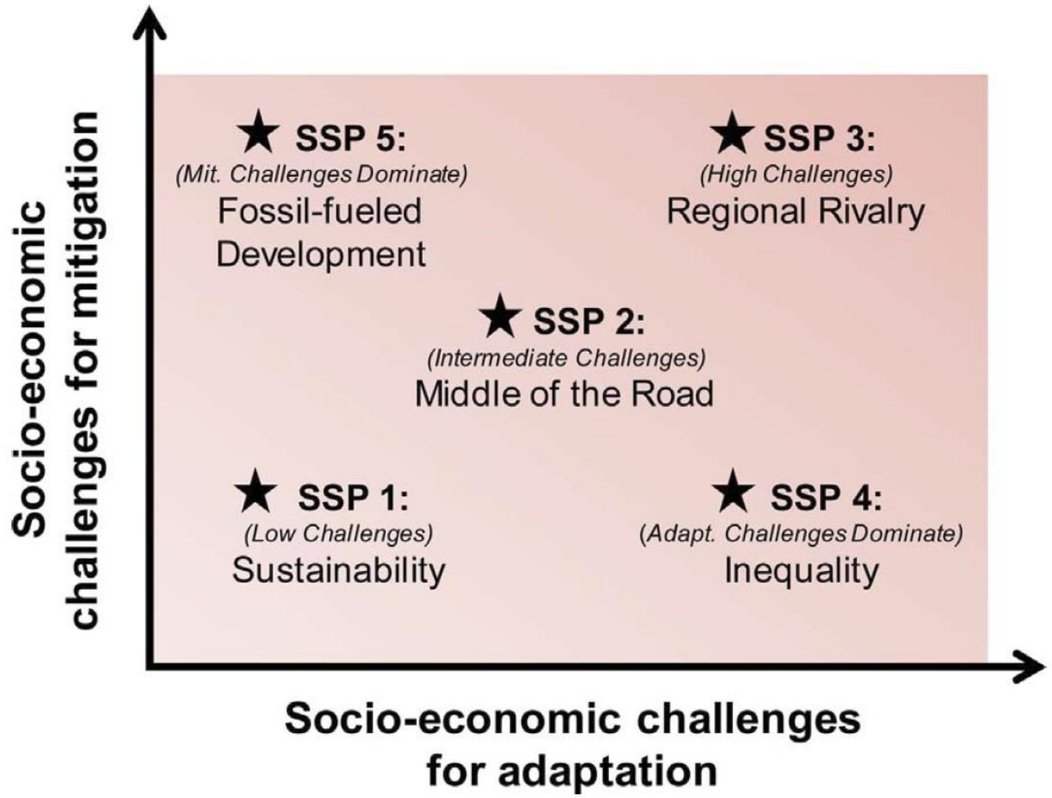
Marine Ecosystem & Fisheries Models

FishMIP Fisheries & Marine Ecosystem Model Intercomparison Project

ipcc climate change

ISIMIP Inter-Sectoral Impact Model Intercomparison Project

Shared Socio-economic Pathways (SSPs)



ipcc climate change

O'Neill et al. 2016 Geoscientific Model Development

Oceanic System Pathways (OSPs)

Global Environmental Change 45 (2017) 203–216

Contents lists available at ScienceDirect

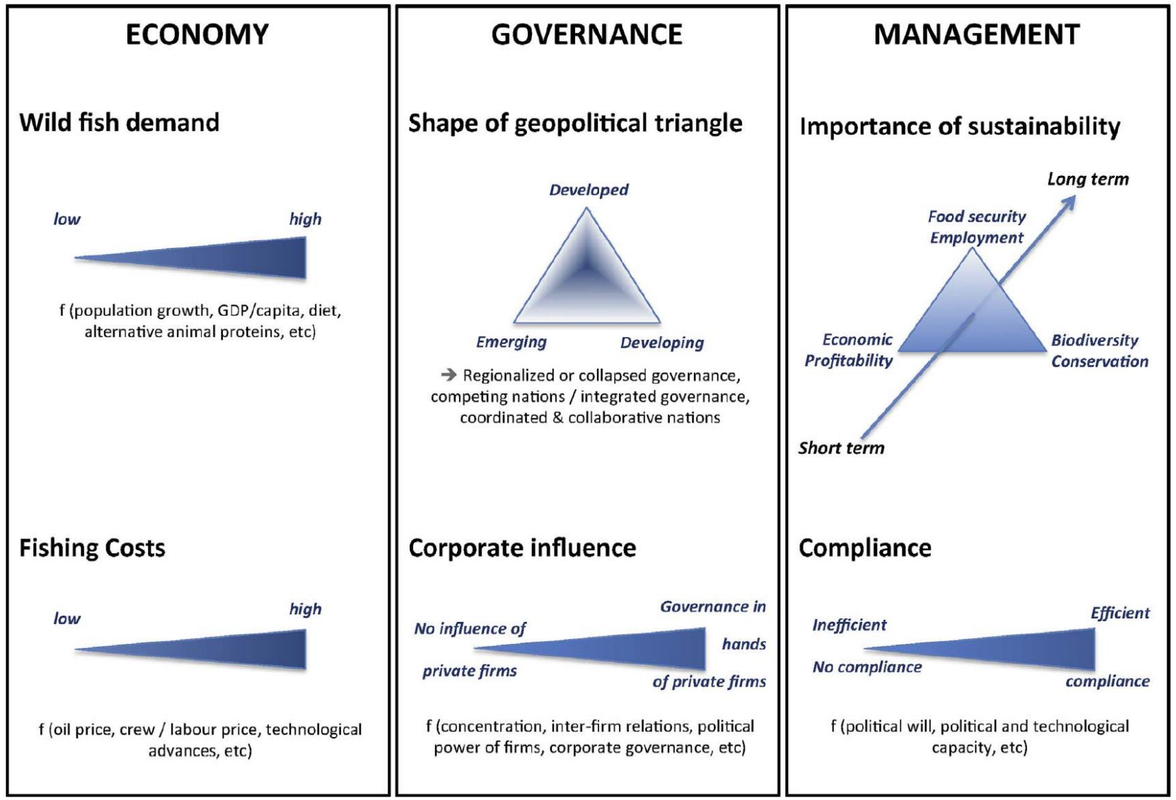
Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

From shared socio-economic pathways (SSPs) to oceanic system pathways (OSPs): Building policy-relevant scenarios for global oceanic ecosystems and fisheries

O. Maury[a,b,*], L. Campling[c], H. Arrizabalaga[d], O. Aumont[e], L. Bopp[f,g], G. Merino[d], D. Squires[h], W. Cheung[i], M. Goujon[j], C. Guivarch[k], S. Lefort[f], F. Marsac[a,b], P. Monteagudo[l], R. Murtugudde[m], H. Österblom[n], J.F. Pulvenis[o], Y. Ye[p], B.J. van Ruijven[q]

Domains & drivers structuring the OSPs



Maury et al. 2017 Global Environmental Change

Regional Scenarios

What could it mean for European Fisheries?

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

World Markets – RCP 8.5 and SSP5 (A1F1)

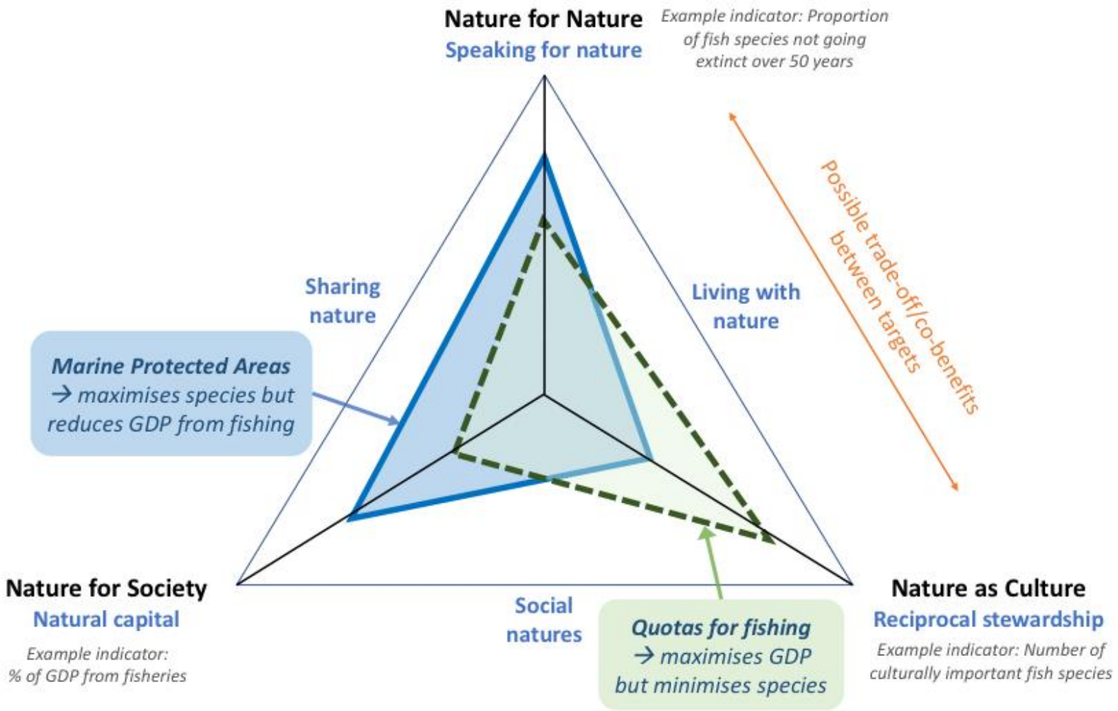
- Fish obtained from the cheapest sources
- Decommissioning subsidies reduced
- Few legal and technical restrictions
- Only a few high-tech boats
- Sequentially depleted fish stocks
- More competition for resources globally
- Low taxes, strong private sector
- Europe outcompeted by Asia/China
- Use of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

CERES

Pinnegar et al. 2021 Frontiers in Marine Science

IPBES
Nature Futures Scenarios

- Nature for nature - biodiversity priority
- Nature for society - ecosystem services priority
- Nature for culture - Indigenous and rural community priority



Kim et al. 2023 Global Environmental Change

The Gaps

- Global scenarios for all fisheries
- Quantitative forcings for FishMIP marine ecosystem models

FishMIP
Scenarios Working Group

- Marine ecosystem modellers
- Earth system modellers
- Integrated assessment modellers
- Economists
- Legal experts
- Social scientists
- FAO representatives

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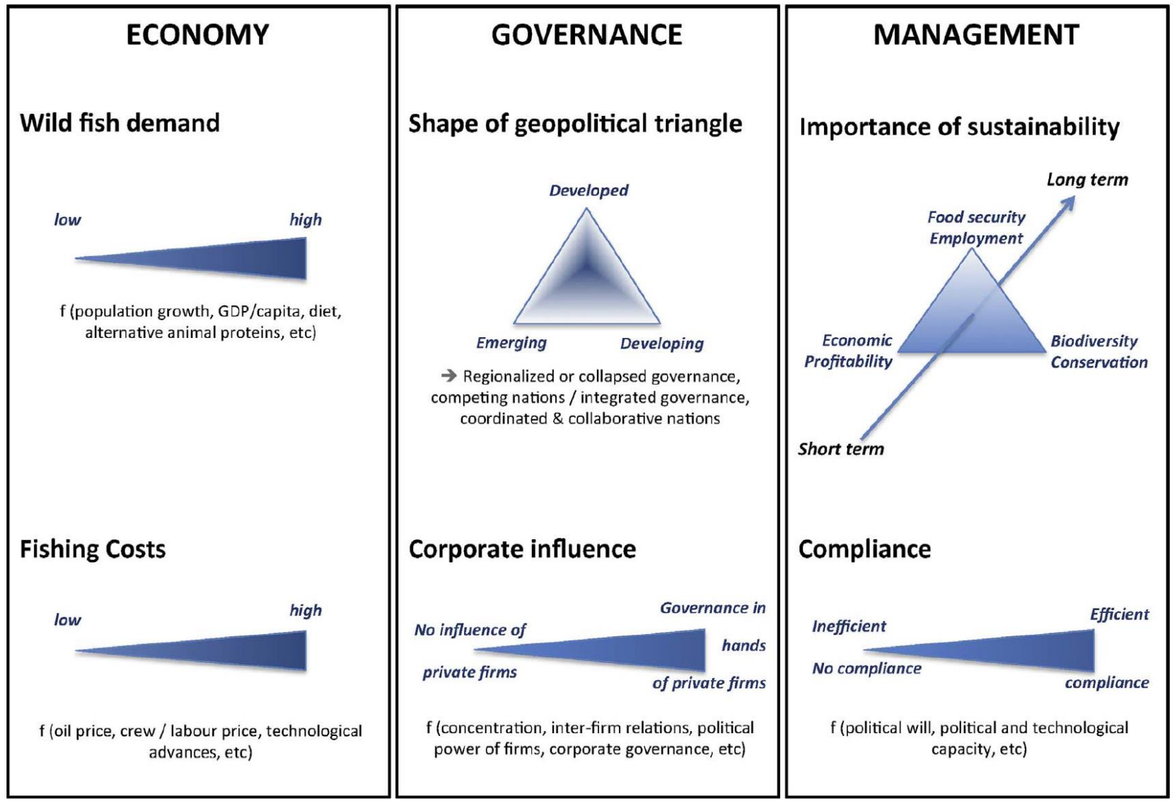
FAO FIAT PANIS

ISIMIP
Inter-Sectoral Impact Model Intercomparison Project

Ocean System Pathways (OSPs)

- Develop OSP storylines based on SSP storylines
- Translate OSP storylines into quantitative model drivers for FishMIP models (spatially resolved fishing mortality/effort)
- Create OSP protocols and model projections under fishing and climate change

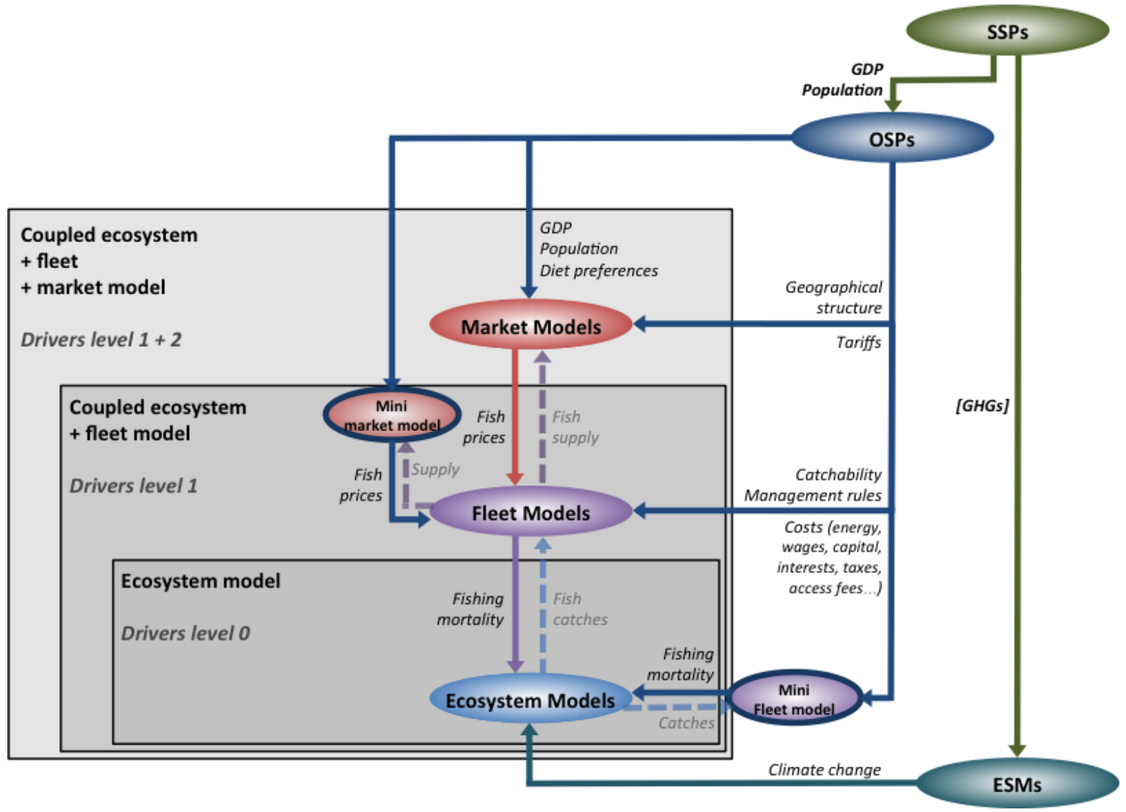
Domains & drivers structuring the OSPs



Maury et al. In review ESS Open Archive

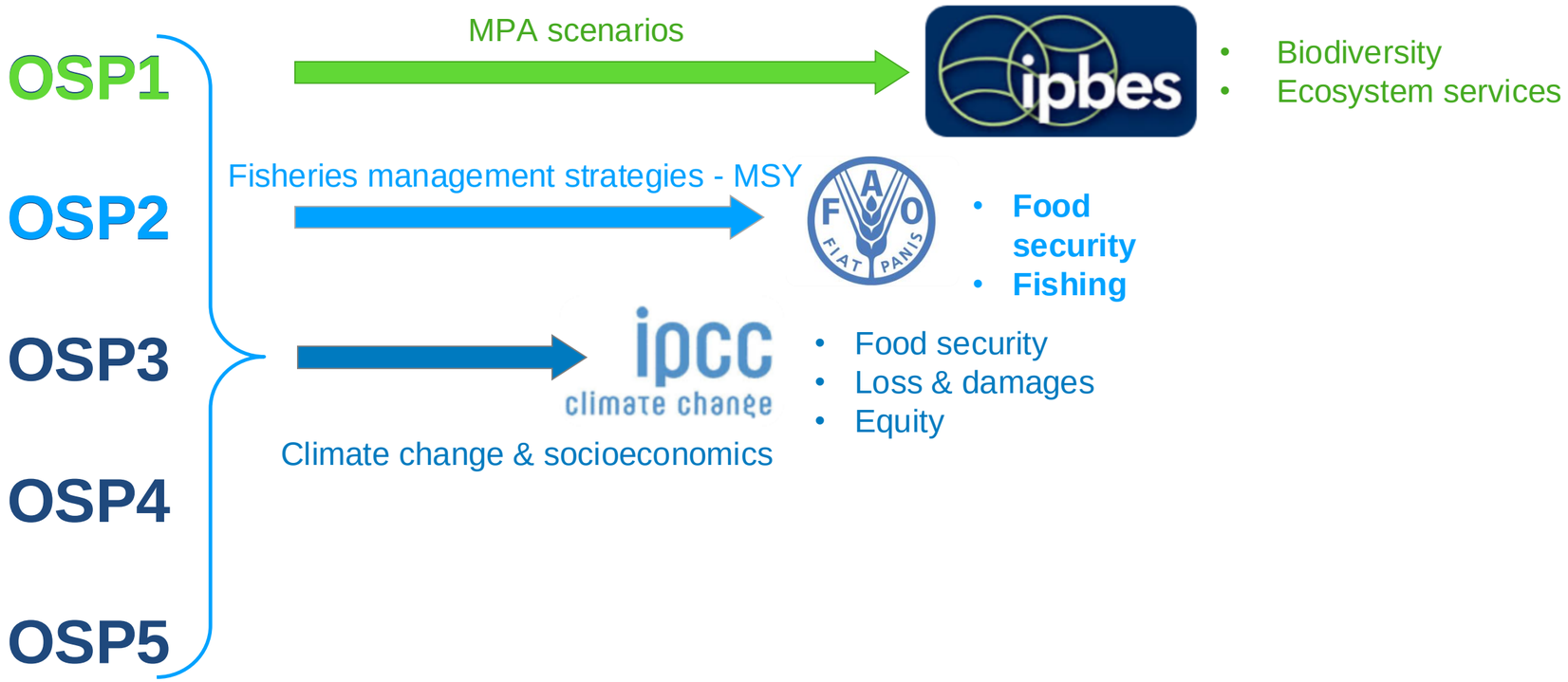
Ocean System Pathways (OSPs)

- Drivers: Country level GDP, human population, market demand
- Multiple scales: national, regional, and global
- Multiple fleets: large pelagic, small pelagic, benthic-demersal, emerging fisheries, mariculture



Maury et al. In review ESS Open Archive

OSP Simulation Protocols



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Maury et al. In review ESS Open Archive
Blanchard et al. In review ESS Open Archive

Acknowledgements

- All contributors to FishMIP
  - Modellers
  - Data providers
  - Coordinators
  - ESM community
  - ISIMIP
- FishMIP is community coordinated and anyone can join

fishmip.org

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THANK-YOU!

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MARINE INSTITUTE

MEMORIAL UNIVERSITY

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NSERC CRSNG

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THE LIFE AQUATIC

OSP Storylines

- The OSP1 “Sustainability first” ➔ SSP1: Sustainable practices across multiple sectors
  - Preferences for high quality wild fish
  - Low-income populations consume small pelagic species, aquaculture transitions to non-fish food sources
  - Prominence of regional and sub-regional markets.
  - Precautionary and efficient fisheries management based on the extensive use of MPAs

- The OSP2 “Conventional Trends” ➔ SSP2: Continuation on current trajectory
  - Demand for fisheries products continues to increase
  - Globalized fish markets
  - Fisheries management, largely based on quotas is unevenly effective

- The OSP3 “Dislocation” ➔ SSP3: Nationalism, rivalries, geopolitical conflicts, regional disparities
  - Local capture and local consumption of fish, fragmentation of markets for aquatic products
  - Failure of fisheries management, breakdown of international cooperation
  - Demand remains high because fish is a primary source of protein and other essential nutrients
  - Food security challenges common due to lack of cooperation, failure of management, non-compliance

- The OSP4 “Global elite and inequalities” ➔ SSP4: Techno-optimism, economic growth, inequalities
  - High-value fisheries and aquaculture products reserved for an elite, low quality products supply aquaculture
  - Vast majority of the population rely on cheap industrial animal products
  - Multinational corporations govern global economics, developing countries are excluded from decision-making
  - Corporate profits drive fisheries management, using advanced technologies to ensure compliance

- The OSP5 “High technology and market” ➔ SSP5: Economic growth, technologies, cheap fossil energy
  - Low fishing costs and growing global fish consumption
  - Wild-caught fish for the wealthy, aquaculture products for low- and middle-income consumers.
  - Emerging fisheries on mesopelagic resources develop to supply fishmeal to the aquaculture industry
  - Geopolitical tensions over increasingly limited natural resources block international governance
  - Technologies improve compliance, but market-driven solutions hinders effective fisheries management