# Building scenarios for marine ecosystems under anthropogenic and natural forcing in the XXI Century

*ENVIM*
*January 2016*

Institut de recherche pour le développement

Photo: Philippe Cury


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# Building scenarios : should we do it ?

1. Scenarios: Hollywood business or scientific issue?
2. Several (very) good reasons to build scenarios
3. Scenarios to build ‘real-world’ answers : towards a (more) predictive science
4. Towards good modelling practice
5. Towards a scientific strategy for developing scenarios
6. Communicating scenarios : moving towards SimOceans™?
7. Conclusion: virtual pathways for real marine ecosystems


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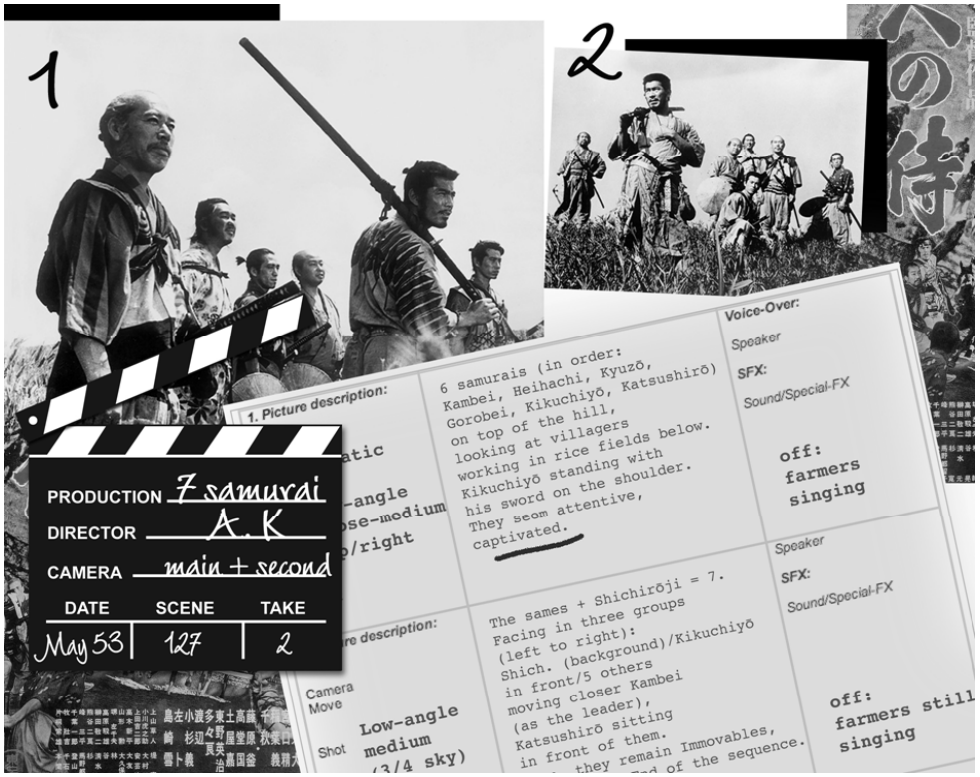
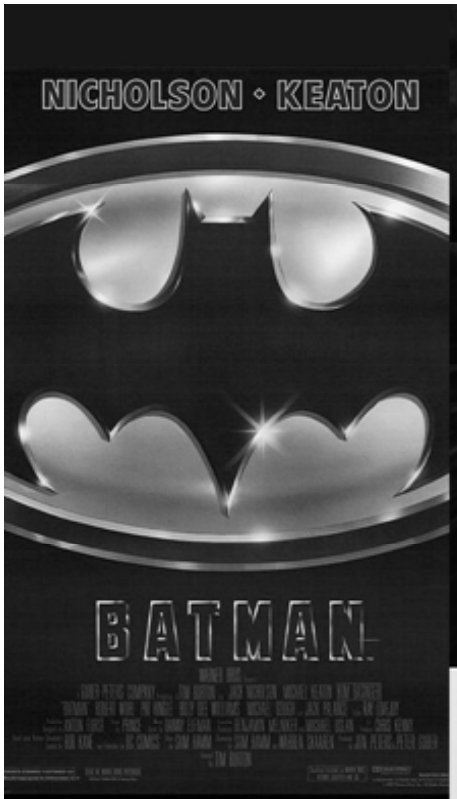
# 1. Scenarios: Hollywood business or scientific matter?

‘Scenarios’
are about stories,
not really
about science !



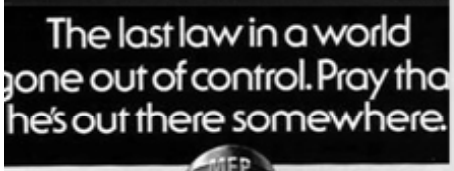

NICHOLSON • KEATON
BATMAN


STAR TREK
FERENGINAR RISING
IN THEATERS DECEMBER 2010


2012


JURASSIC PARK
Il a fallu 65 millions d'années
pour que cette aventure devienne possible.


WE WERE WARNED


The last law in a world
gone out of control. Pray tha
he's out there somewhere.


MFP
MAD
MAX


His brain came from a genius. His body came from a
His soul came from hell!
Your blood will run cold when the monster rises.


FRANKENSTEIN
AND THE
MONSTER FROM HELL
Peter Cushing Shane Briant


THE DAY AFTER
TOMORROW


2012

# Almost real life, but not really!

“Scenarios are plausible, provocative, and relevant stories about how the future might unfold. They can be told in both words and numbers”

“Scenarios are not forecasts, projections, predictions, or recommendations, though model projections may be used to quantify some aspects of the scenarios”

(MA - Millennium Ecosystem Assessment 2005)

# Scenarios as pathways for our future : how can we get there ?

“A set of coherent, plausible stories designed to address complex questions about our uncertain future …that can be used to consider what we want for our future, about envisioning future pathways and accounting for critical uncertainties”

(MA - Millennium Ecosystem Assessment 2005)

Scenarios are about our responsibility towards the future generations

by assessing future changes in world ecosystems over the next 50 years and beyond (up to 100 years)

# Scenarios for building our ‘not preordained’ future

Scenarios reflect the modern worldview that the future is not preordained but rather is subject to human actions and choices

The process of building scenarios is about asking questions and providing answers and guidance for action (to widen perspectives and illuminate key issues)

(adapted from MA - Millennium Ecosystem Assessment 2005)

# Scientific challenges of building scenarios

- Pluridisciplinary approach is a requisite: scenarios address ‘real-world’ questions of systems dynamics, policy choices, technological evolution, and consumption and production patterns

- Complex dynamics need to be explored: scenarios explore the response of marine ecosystems to global change, but also on how humankind will respond through changes in technology, economies, lifestyle and policy (i.e., importance of feed-backs: mitigation, adaptation)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# 2. Several (very) good reasons to build scenarios

# Gobal change: what is worrying with our future?

- Ecosystems are always changing, but the rate and magnitude of change have not been experienced before

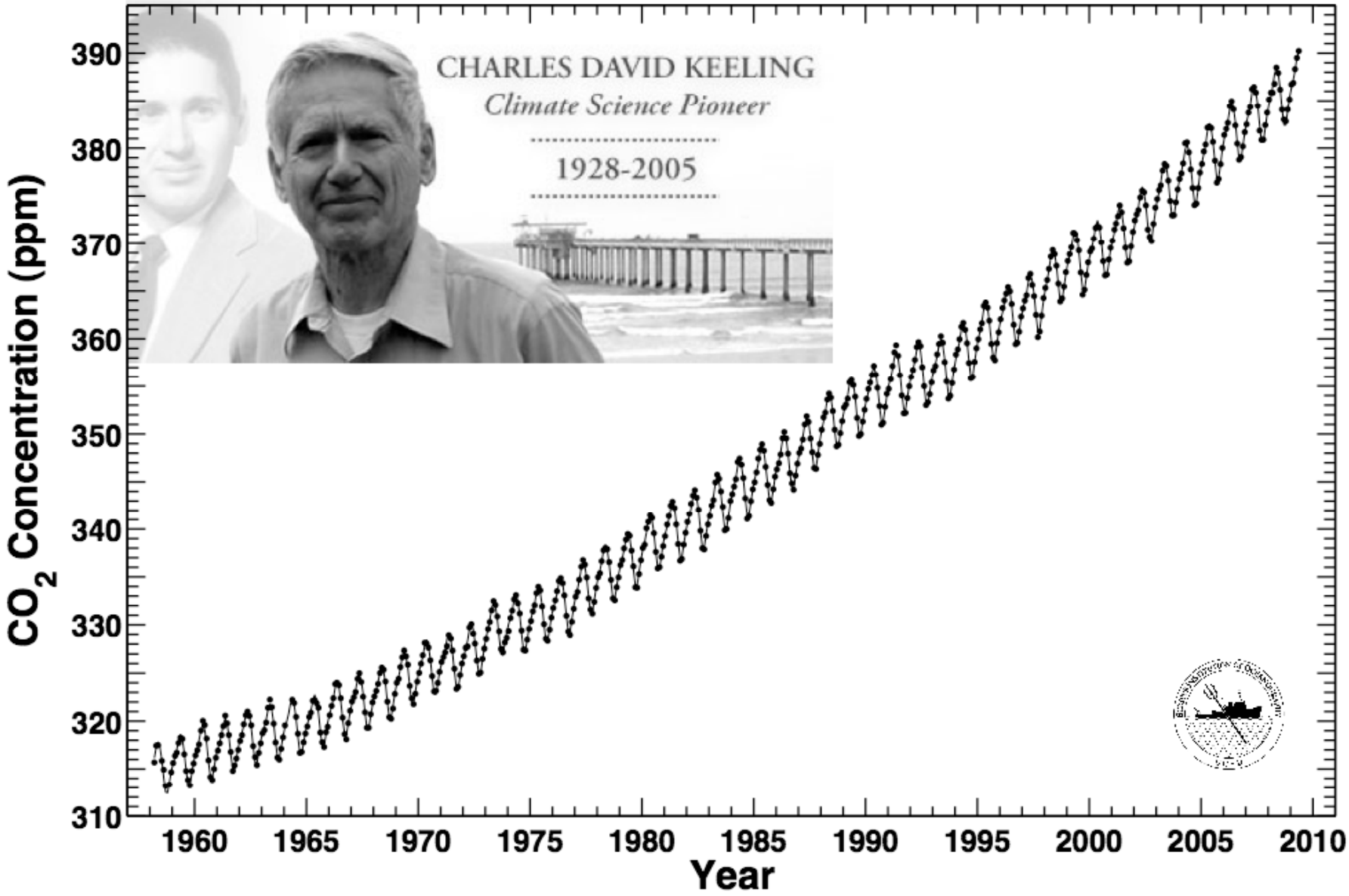
- Those changes seem bewildering because of their complexity, speed, surprises and demands on human ingenuity

- Some changes in marine ecosystems and services appear to be large in magnitude, expensive, or impossible to reverse

(MA - Millennium Ecosystem Assessment 2005)

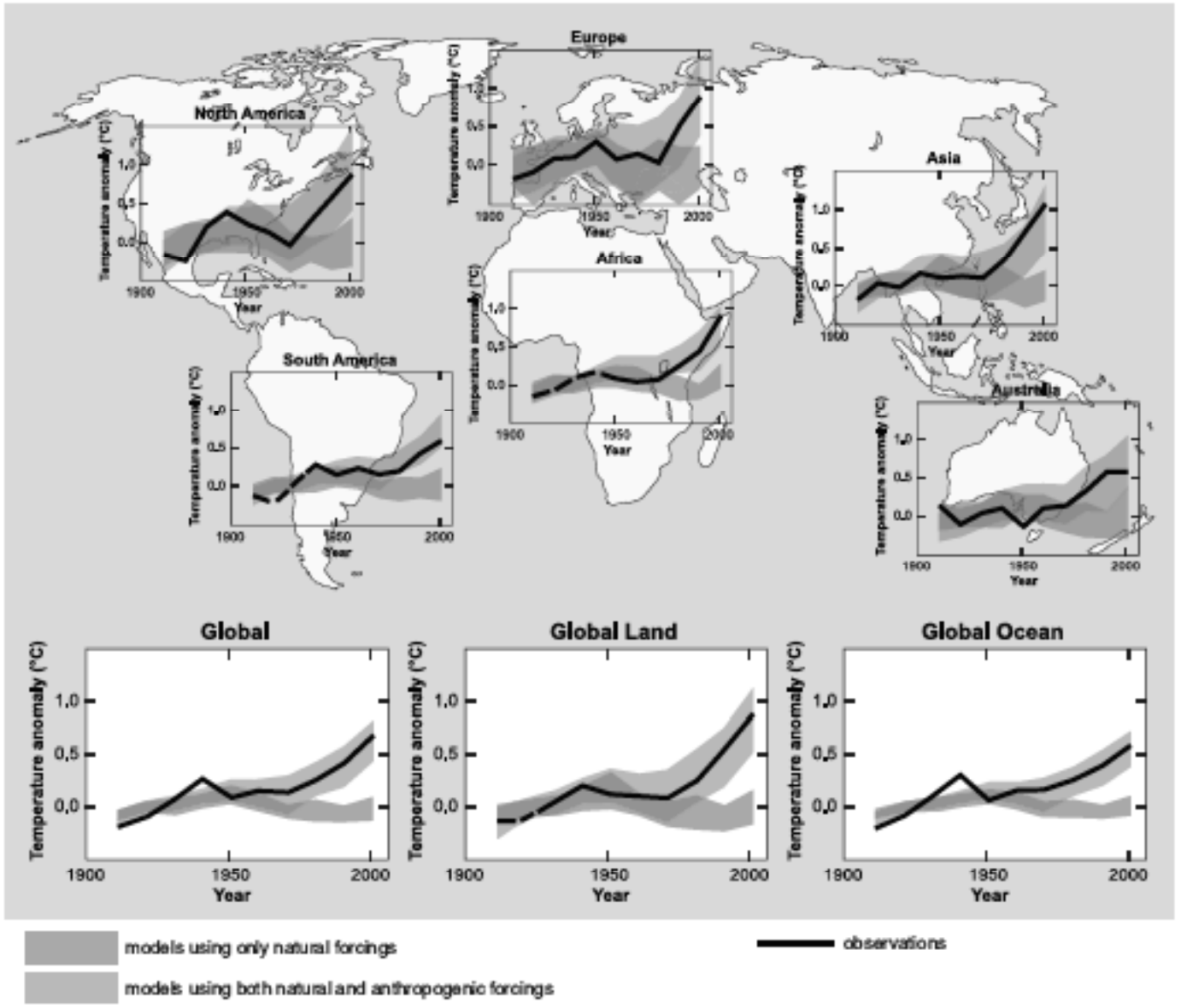
# Mauna Loa Observatory, Hawaii
# Monthly Average Carbon Dioxide Concentration

Data from Scripps $CO_2$ Program  Last updated May 2009



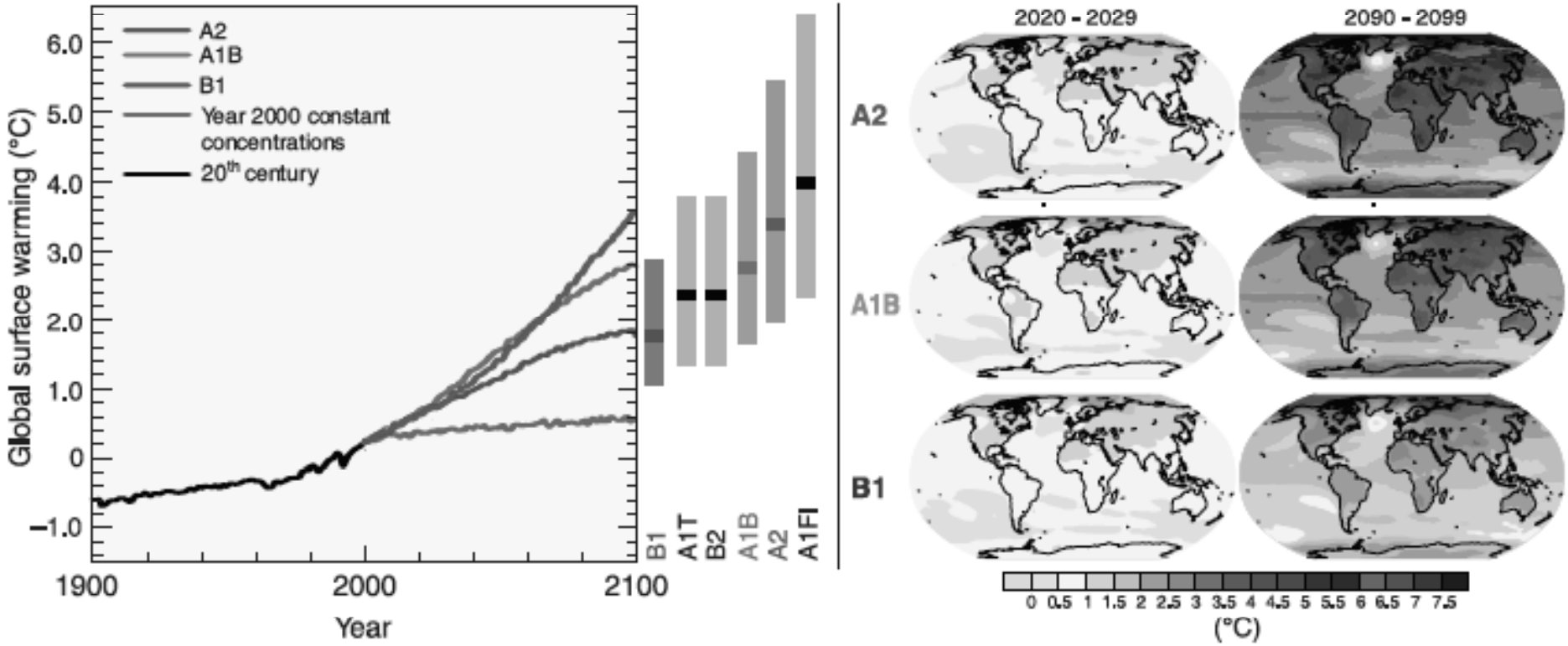
# Retrospective scenarios of global climatic change : What would have been the environment without anthropogenic forcing?

(IPCC -Intergovernmental Panel on Climat Change – AR 4 - 2007)



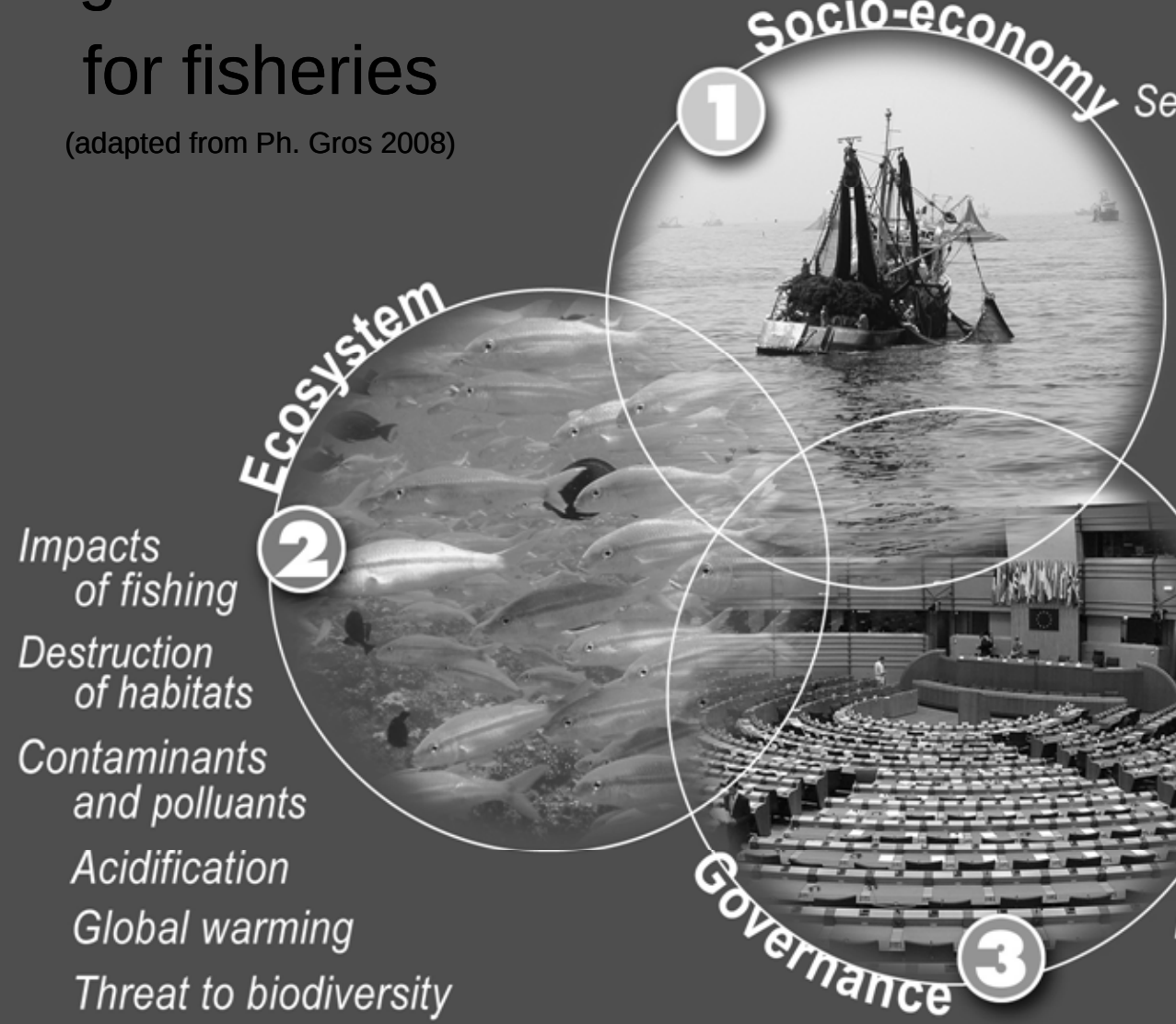
# What will be our future environment in 2030 & 2100 under different emission scenarios

(IPCC -Intergovernmental Panel on Climat Change – AR 4 - 2007)



# A global context for fisheries

(adapted from Ph. Gros 2008)




*Seafood demand*

*Globalization of trade*

*Overcapacity / Overexploitation*

*Evolution of subsidies*

*Profitability of fisheries*

*Impacts of fishing*

*Destruction of habitats*

*Contaminants and polluants*

*Acidification*

*Global warming*

*Threat to biodiversity*

*Reform of the CFP*

*MPA's*

*Multilateral agreements: UNCLOS, UNCED, FAO*


# IPBES: Busan, 11 June 2010

## UN body will assess ecosystems and biodiversity

‘History was made today in South Korea when governments gave the green light to an Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES)’

# IPBES : an ‘IPCC’ for biodiversity

(*Intergovernmental Platform on Biodiversity and Ecosystem Services*)

- Single, credible, recognized and independent international scientific expertise in the field of biodiversity

- Scientists would form the core of the IPBES (developed and developing countries) and Governments wanted to be reassured that it would be lean and mean and streamlined (not become a huge bureaucracy)

- Provide the stimulus to evaluate and improve models and assessments made from global to sub-regional scales

- Provide political leaders with scenarios enabling them to cope effectively with the crisis (“policy relevant” rather than “policy prescriptive”)

- Formal relations with CBD (Convention on Biological Diversity) , FAO, MA, GEO BON (Group on Earth Observations Biodiversity Observation Network)….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# 3. Scenarios to build ‘real-world’ answers: towards a (more) predictive science

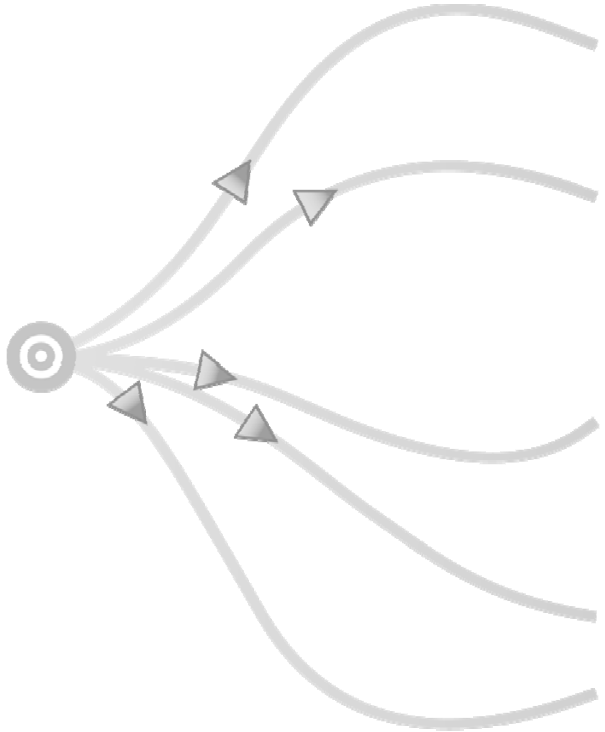
# Building Scenarios

1. Projections models: identification and extrapolation of fundamental trends

1. Decision models : integrated & multi-disciplinary exploratory scenarios to envision alternative futures (with a strong policy dimension)

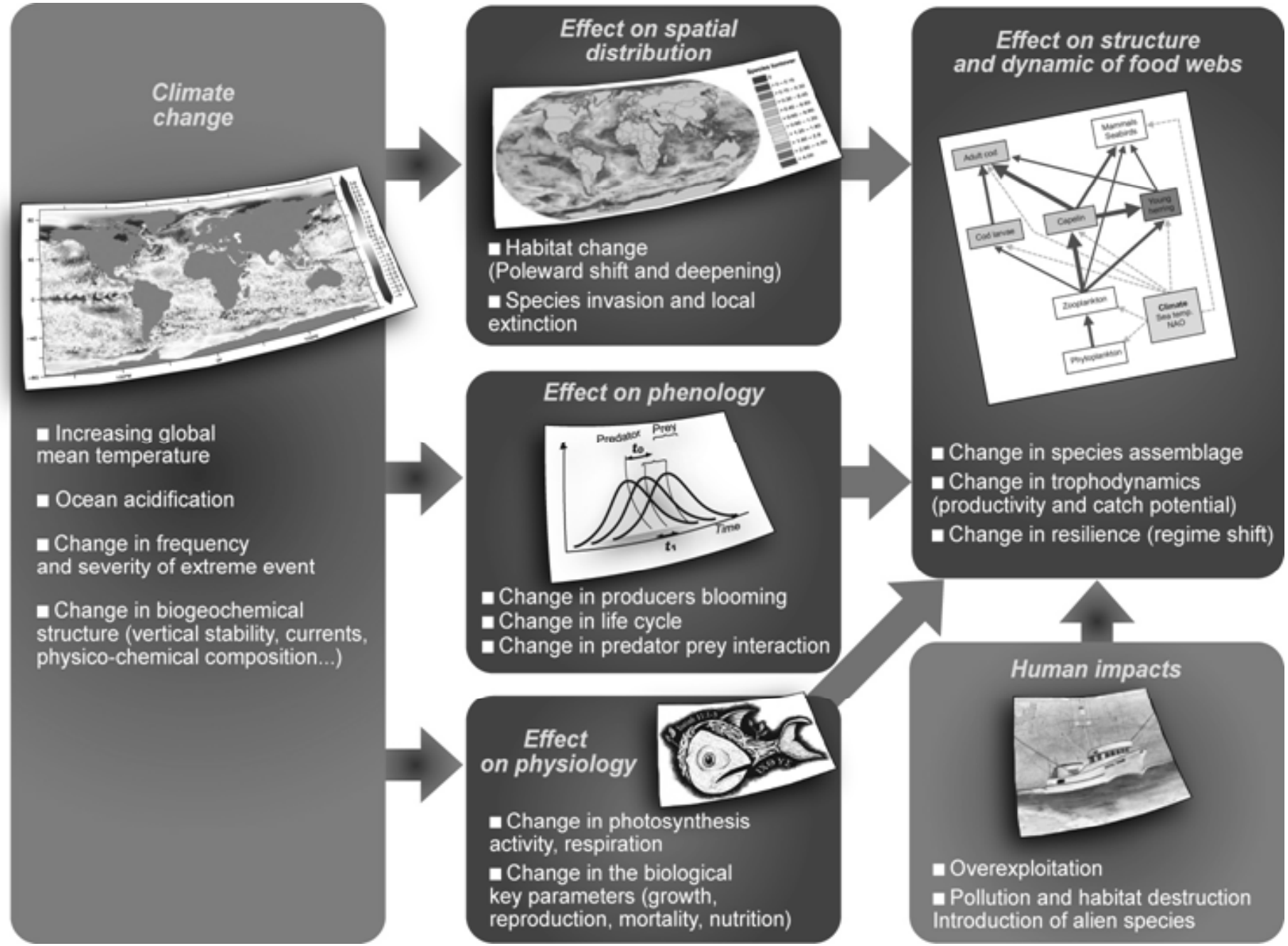
# 1. Projections models

Present

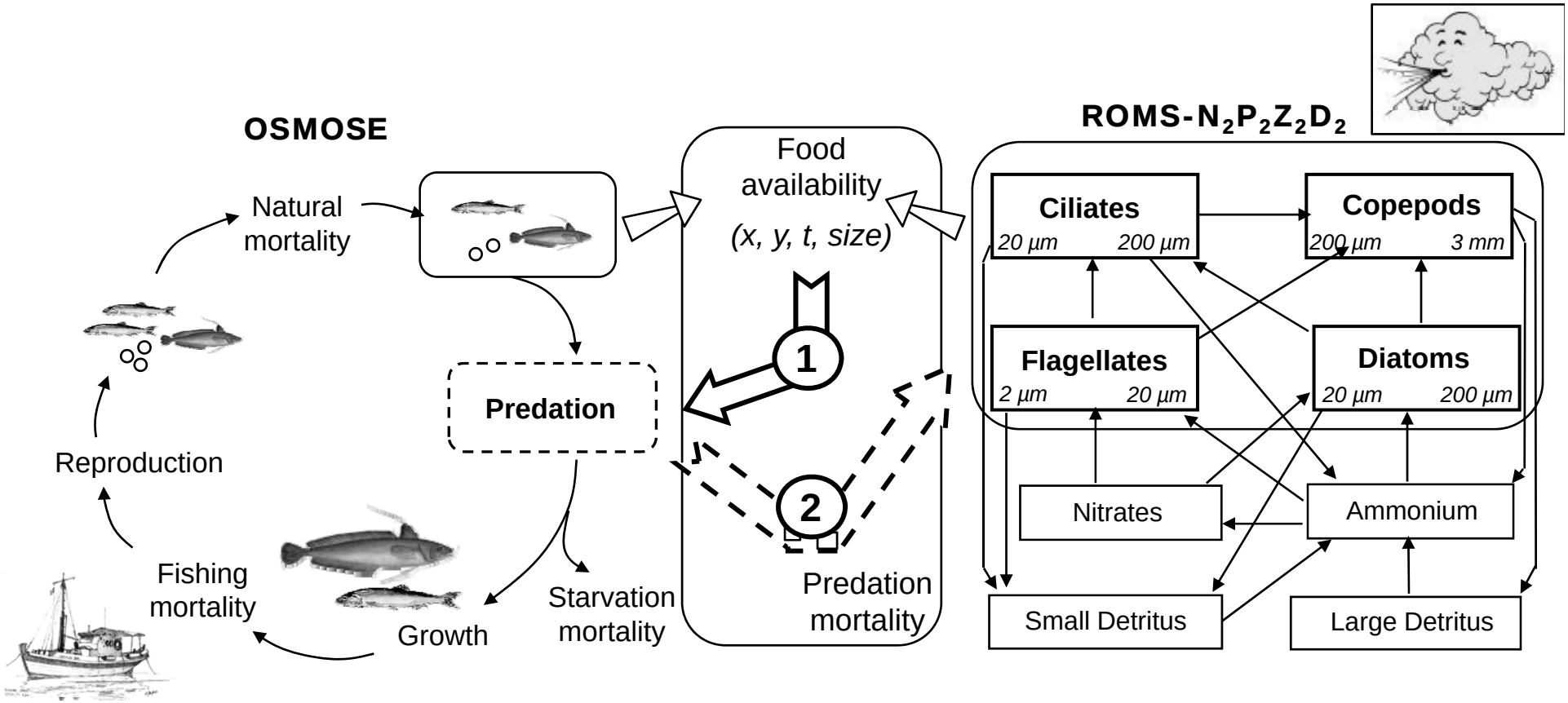


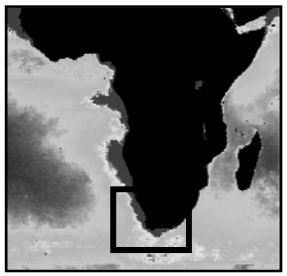
Future

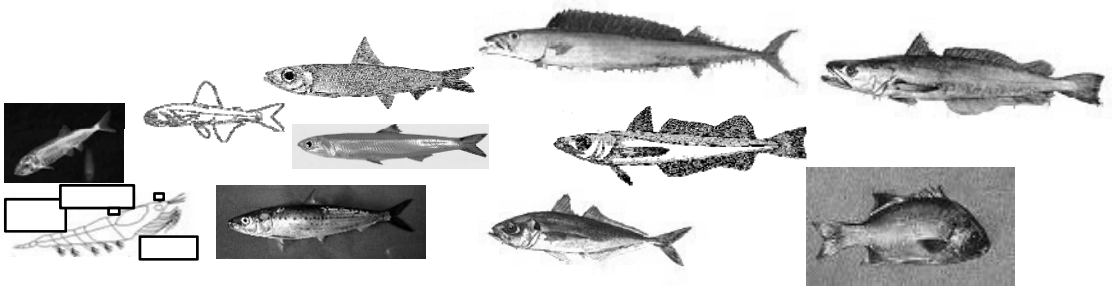
# A. Scenarios of climate change impacts



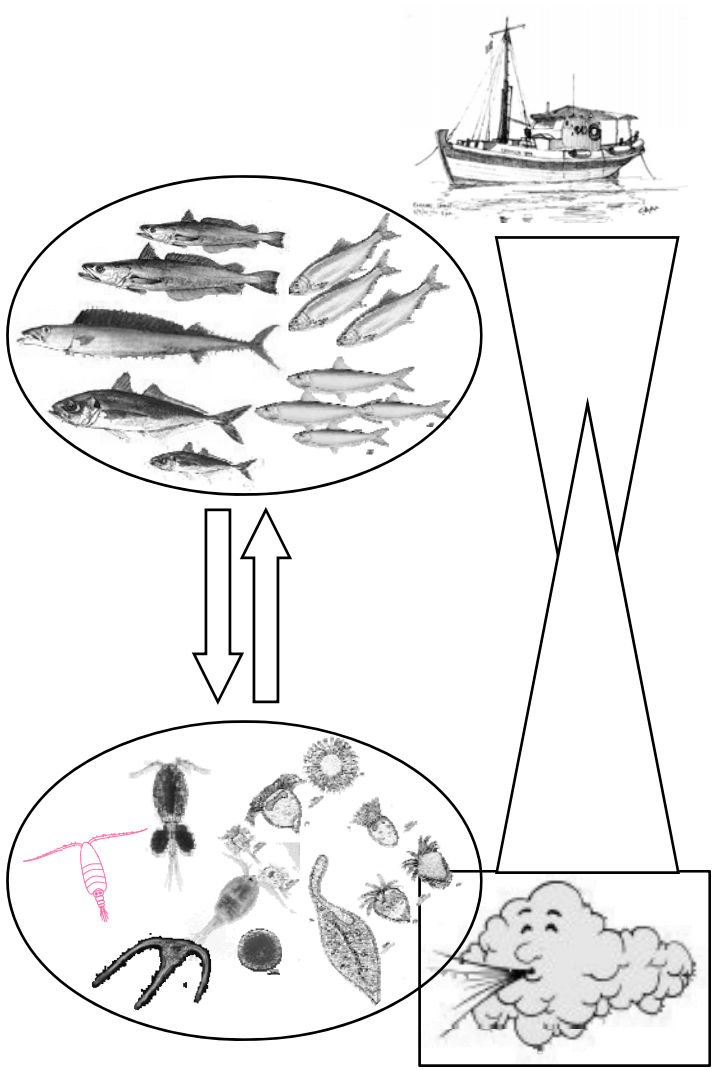
- To address the combined effects of overfishing and climate change with an end-to-end model





*(Travers and Shin submitted)*



## Effects of forcing factors

- Fishing: mortality on recruited fish
- Climate: temperature, currents, wind, salinity, mixed depth layer…

+ indirect effects: propagation of these effects up and down the food web

**What are the combined effects ?**

3 scenarios:

1. Environmental variation
2. Change of fishing mortality
3. Environmental variation + Change of fishing mortality

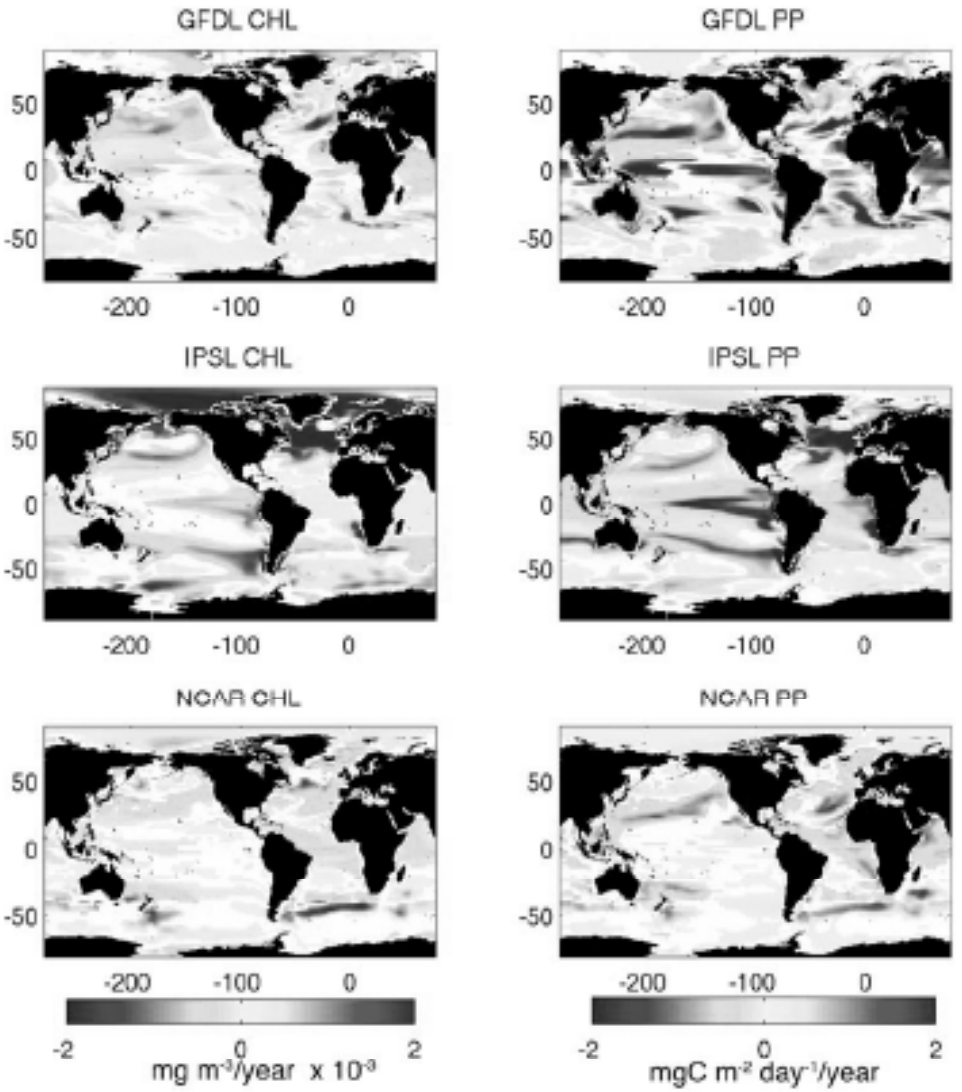
# Change in the Primary Producer activity

Linear trend in Chl. conc. and Primary prod.

2001–2100 under the A2 IPCC scenario, calculated for

the GFDL, IPSL and NCAR biogeochemical models

(Henson et al. Biogeosciences 2009)

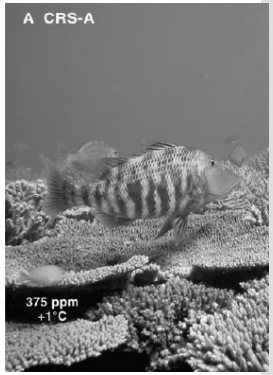


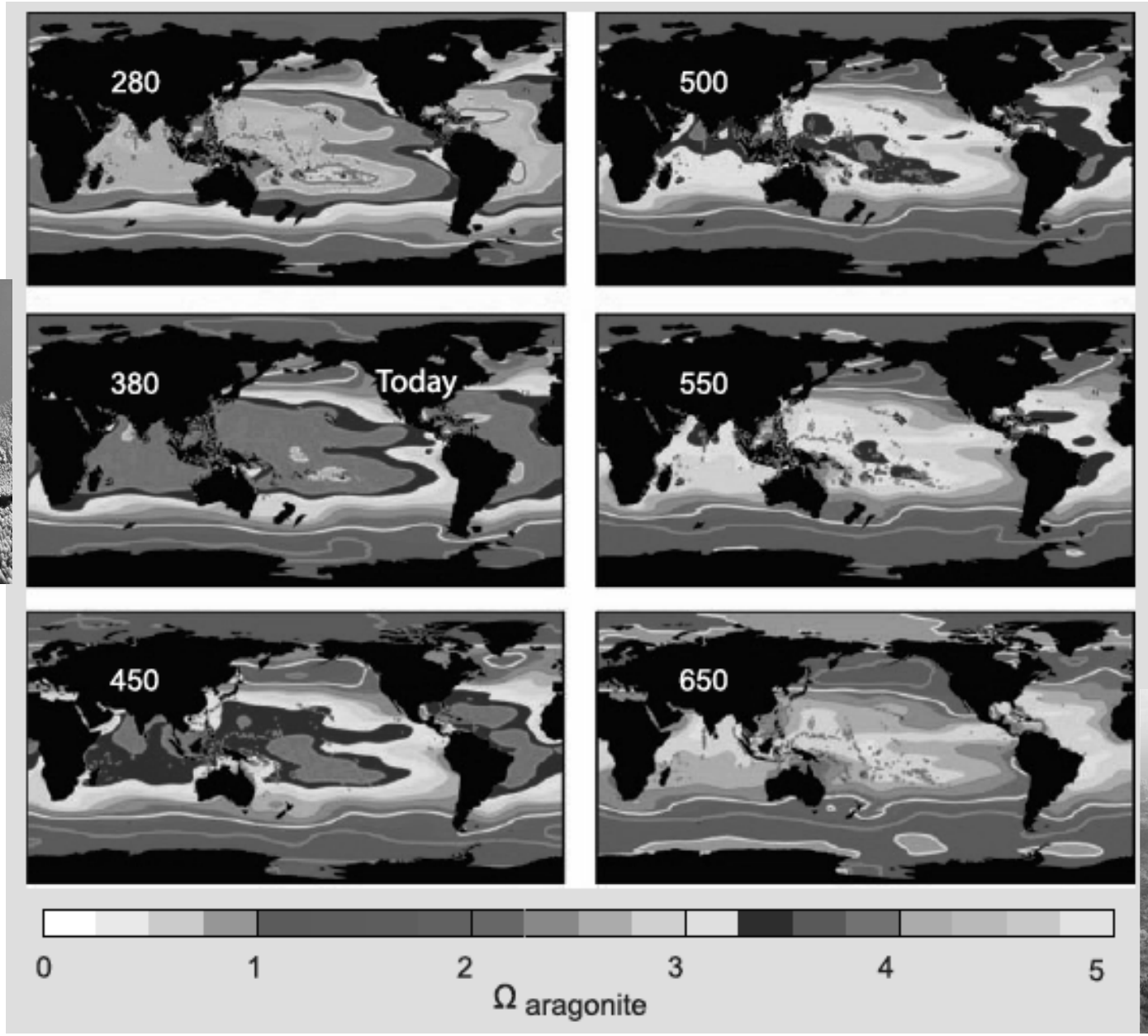

[Chlorophyll a]

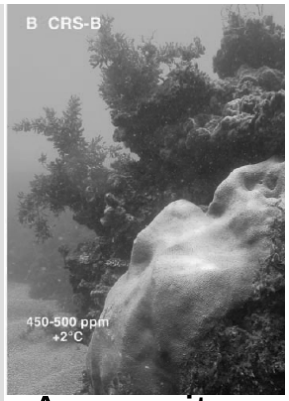
Primary Production

# Scenario of coral reefs with warming & acidification

*(Hoegh-Guldberg et al. Science 2010)*

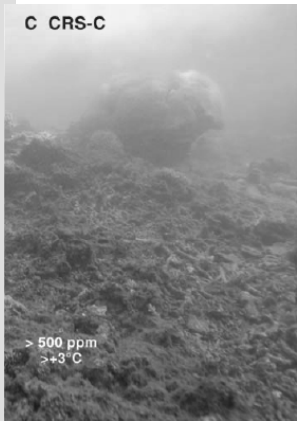



Aragonite saturation predicted

- IPPC Scenarios
- model



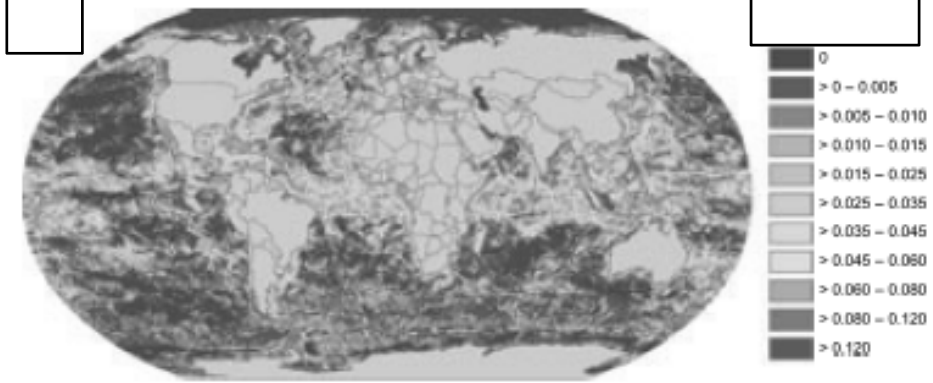
# Global Marine biodiversity and Climate Change

*(Cheung et al. Fish & Fisheries 2009)*

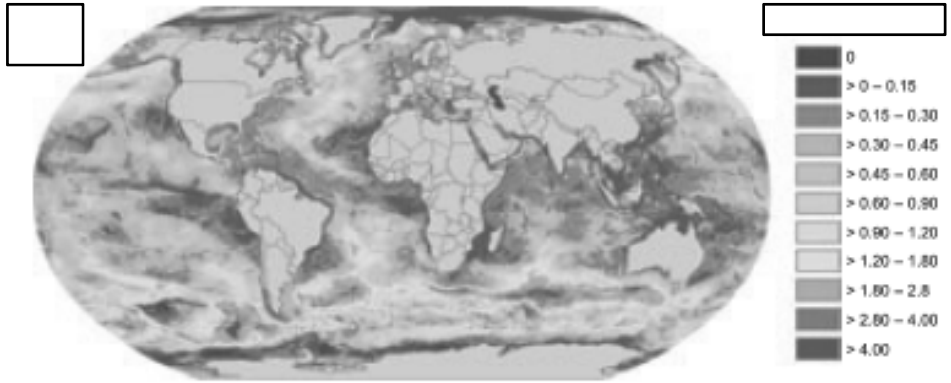
*Method: 3 Climatic scenarios GFDL's CM 2.1 - bioclimate envelope model of 1066 fish and invertebrate species*

Species invasion


Local Extinction




Species Turnover



# B. Global change impacts on fisheries & human welfare

- Food security & vulnerability
- World markets dynamics
- Catches, Catch (landed) values, Cost of fishing
- Profits to fishing companies, income to fishers & economic rent to resource owners
- Costs & benefits to different countries, regions and groups

# Current literature

Ocean acidification impacts on US commercial mollusks fishery (Cooley & Doney, 2009):

• Found potential declines in revenue, jobs, indirect & impact on the whole economy.

Sardines

European Sardine fisheries (Garaza-Gil et al., 2010):

• Found that profits could decrease by 1.4% annually with an increase in SST.

- existing work centered on local & regional studies;
- no study at global scale.

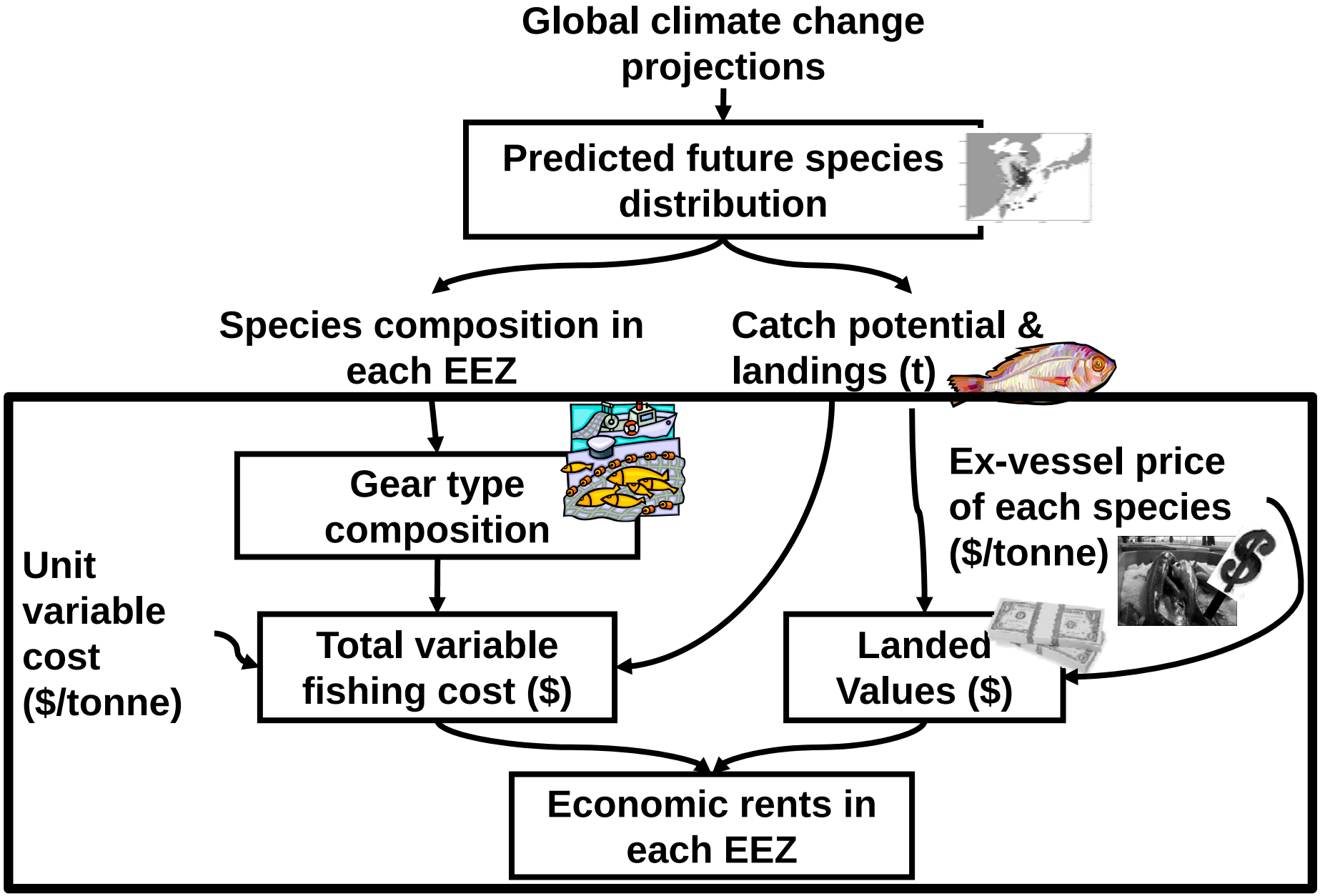
# Methods

**Scenarios:**

1. SRES A1B (atmospheric carbon dioxide ($CO_2$) stabilization at 720 ppm by year 2100) – high range GHG emission;

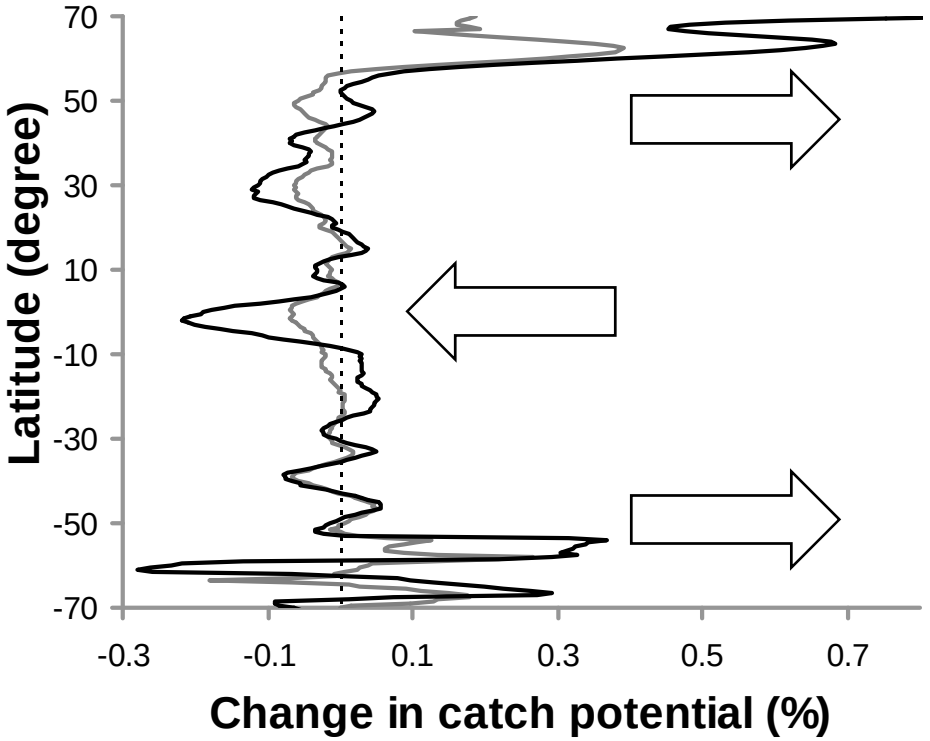
2. A1B, ocean acidification, deoxygenation & body size change – high range GHG emission + change in ocean chemistry & body size.

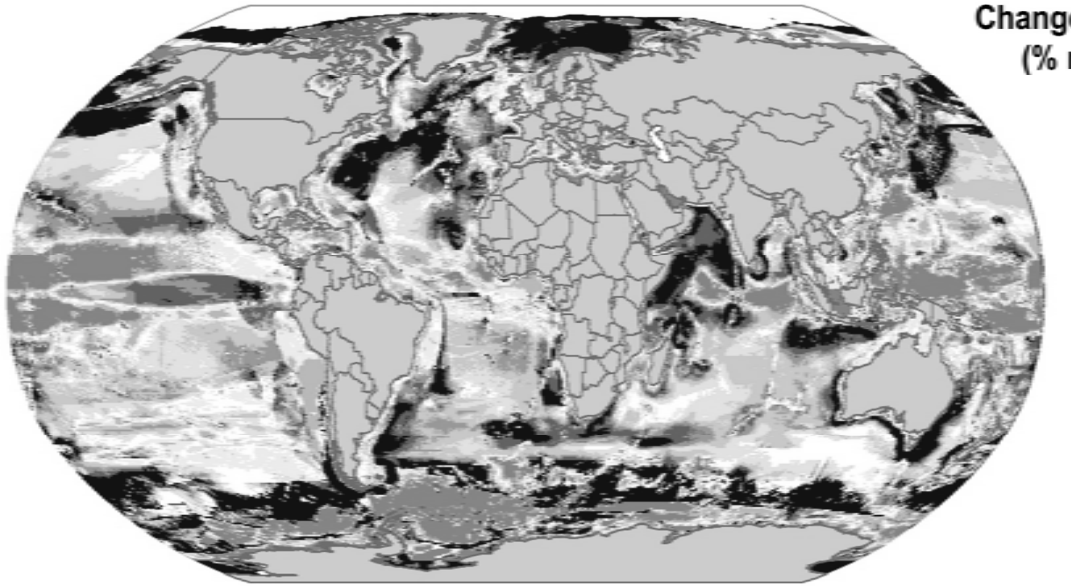
# Methods


Global climate change projections
Predicted future species distribution
Species composition in each EEZ
Catch potential & landings (t)
Gear type composition
Ex-vessel price of each species ($/tonne)
Unit variable cost ($/tonne)
Total variable fishing cost ($)
Landed Values ($)
Economic rents in each EEZ

# Climate Change Impacts on catch potential in 2050

*(Cheung et al. Global Change Biology, 2009)*



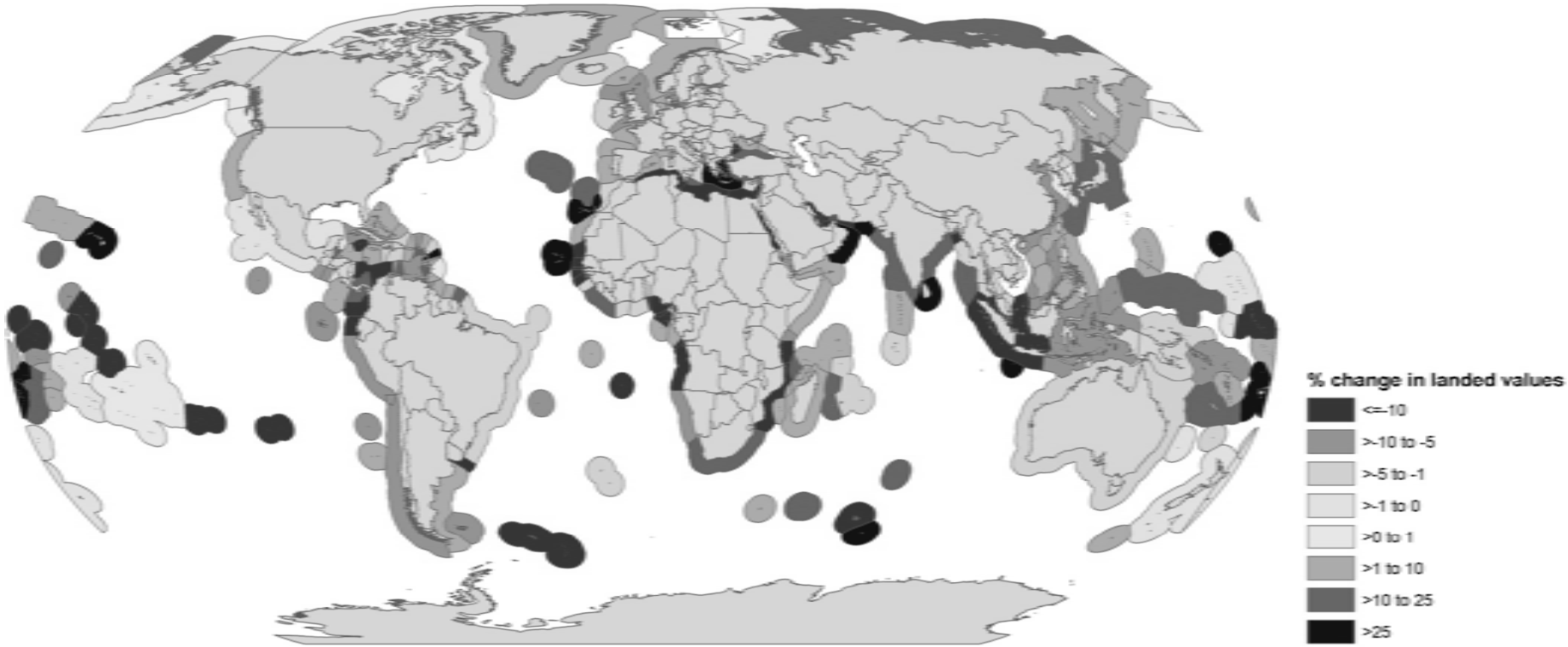
Change in catch potential
(% relative to 2005)

- < -50
- > -50 - -30
- > -30 - -15
- > -15 - -5
- > -5 - 5
- > 5 - 15
- > 15 - 30
- > 30 - 50
- > 50 - 100
- > 100

# Impacts on fisheries economics

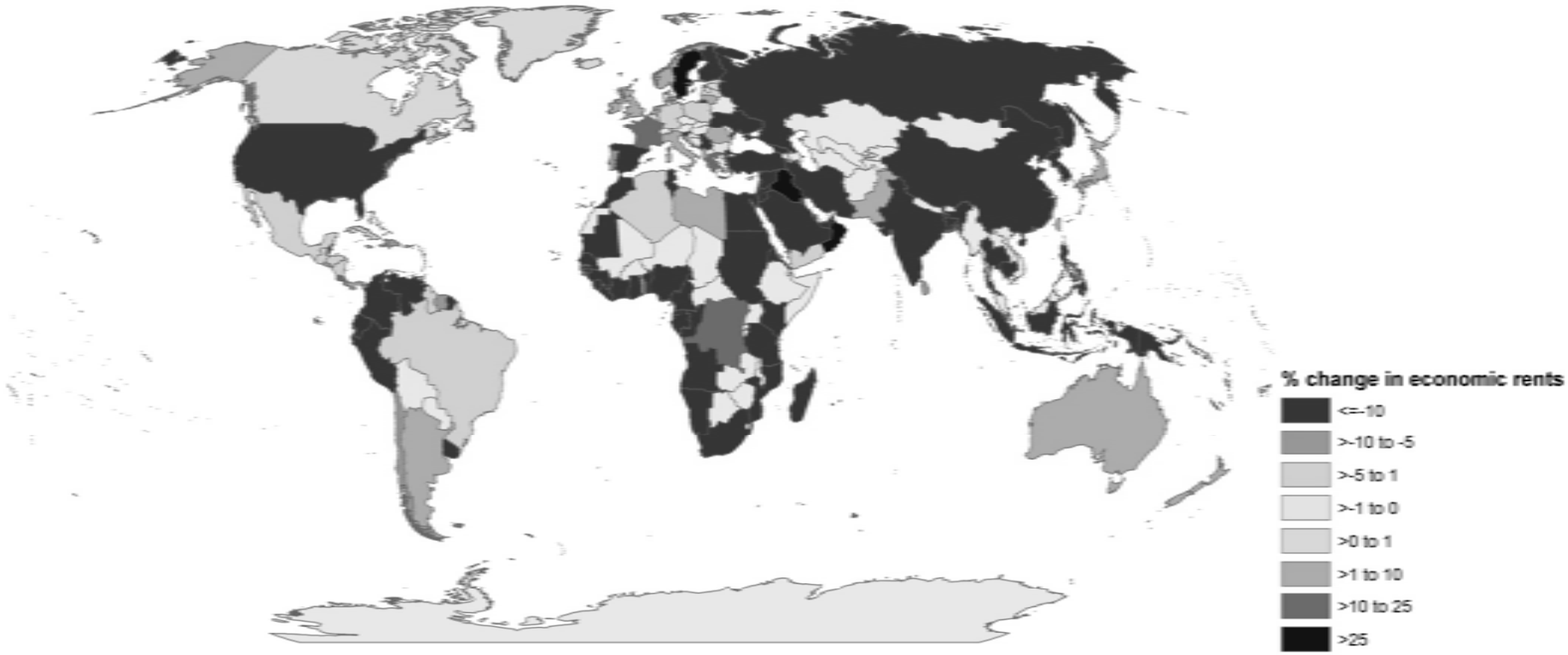
- We use the model to predict changes of the following indicators under the two climate change scenarios:
  - Resource rents:
    - Landed values;
    - Fishing costs.
  - Fish protein supply.

# Predicted change in landed values by EEZ in the 2050s under high GHG emission scenario



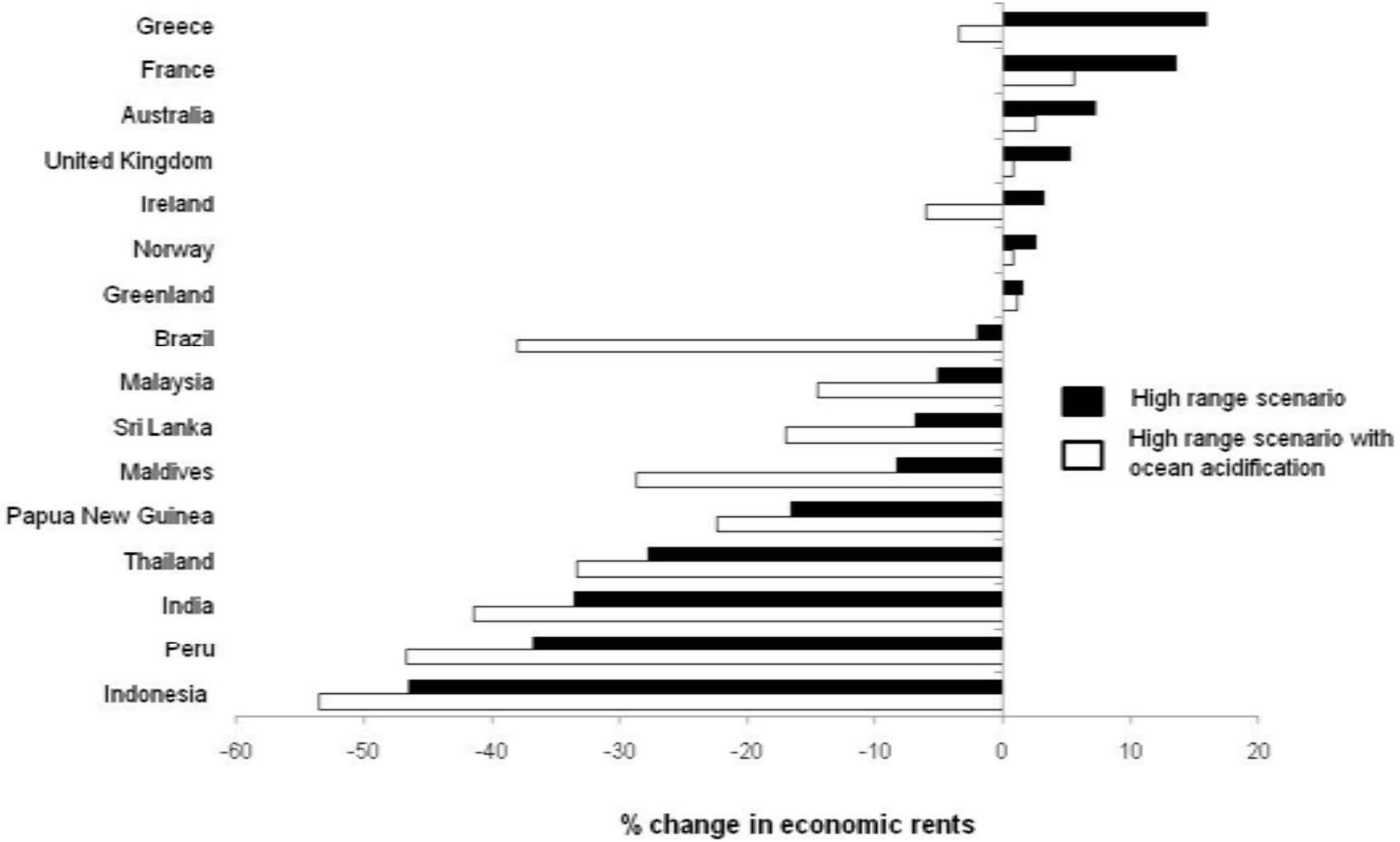

Lam *et al*. (in prep.)

# Predicted change in economic rents by fishing country in the 2050s under high GHG emission scenario



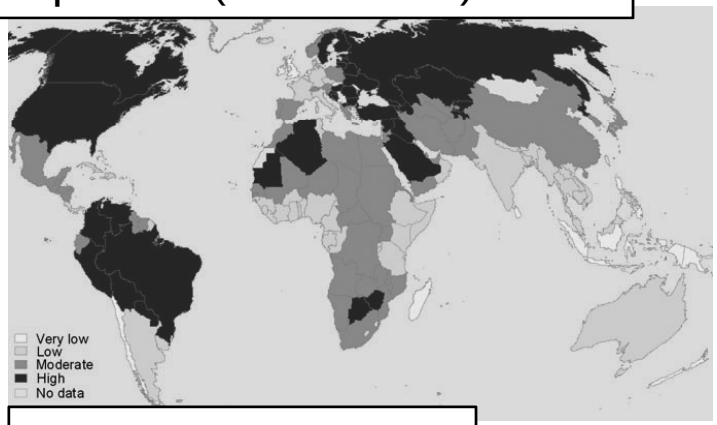

Lam *et al*. (in prep.)

# Predicted change in economic rents under different climate change scenarios

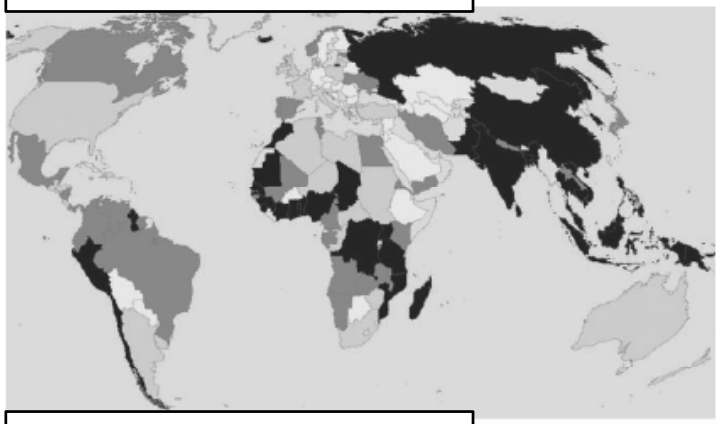



**Lam *et al*. (in prep.)**

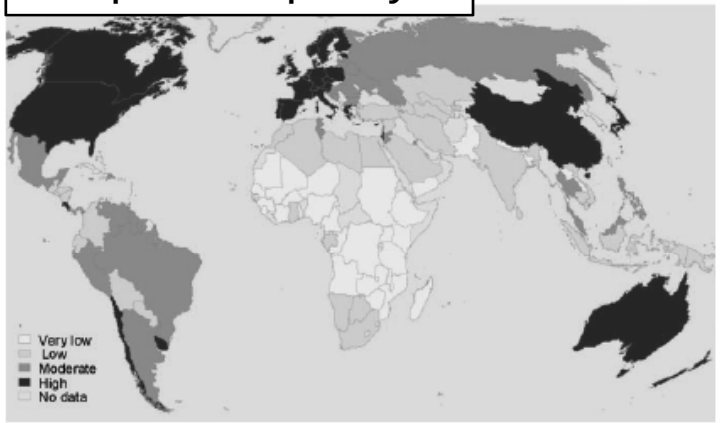
Exposure (SST in 2050)




Fisheries Sensitivity



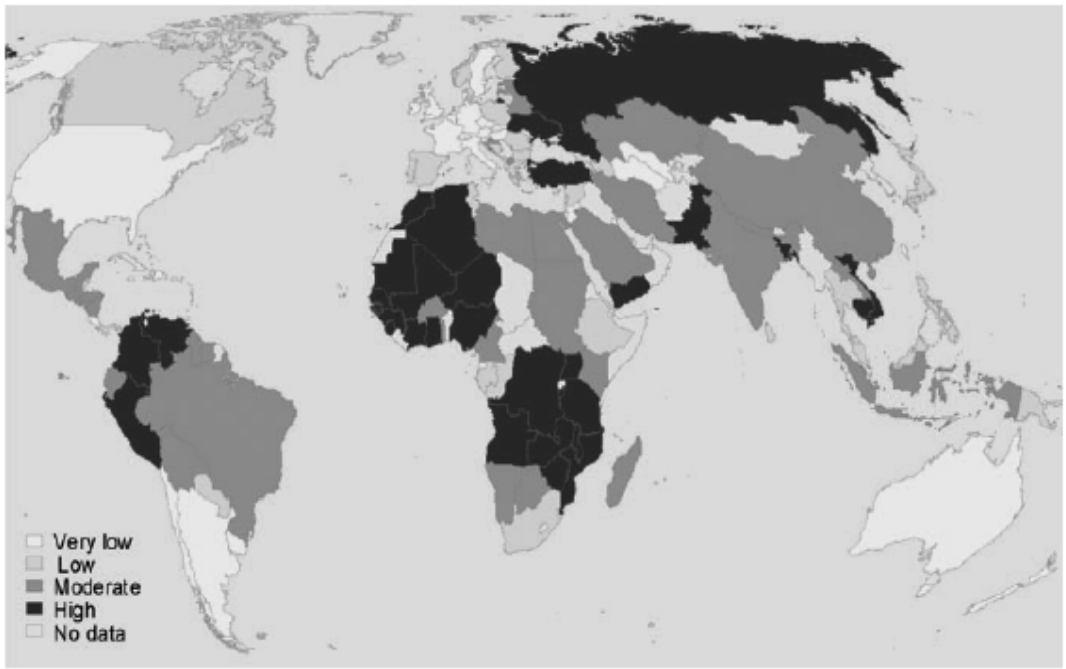
Adaptive Capacity




# Vulnerability of 132 national economies of climate change impacts on fisheries under IPCC scenario B2

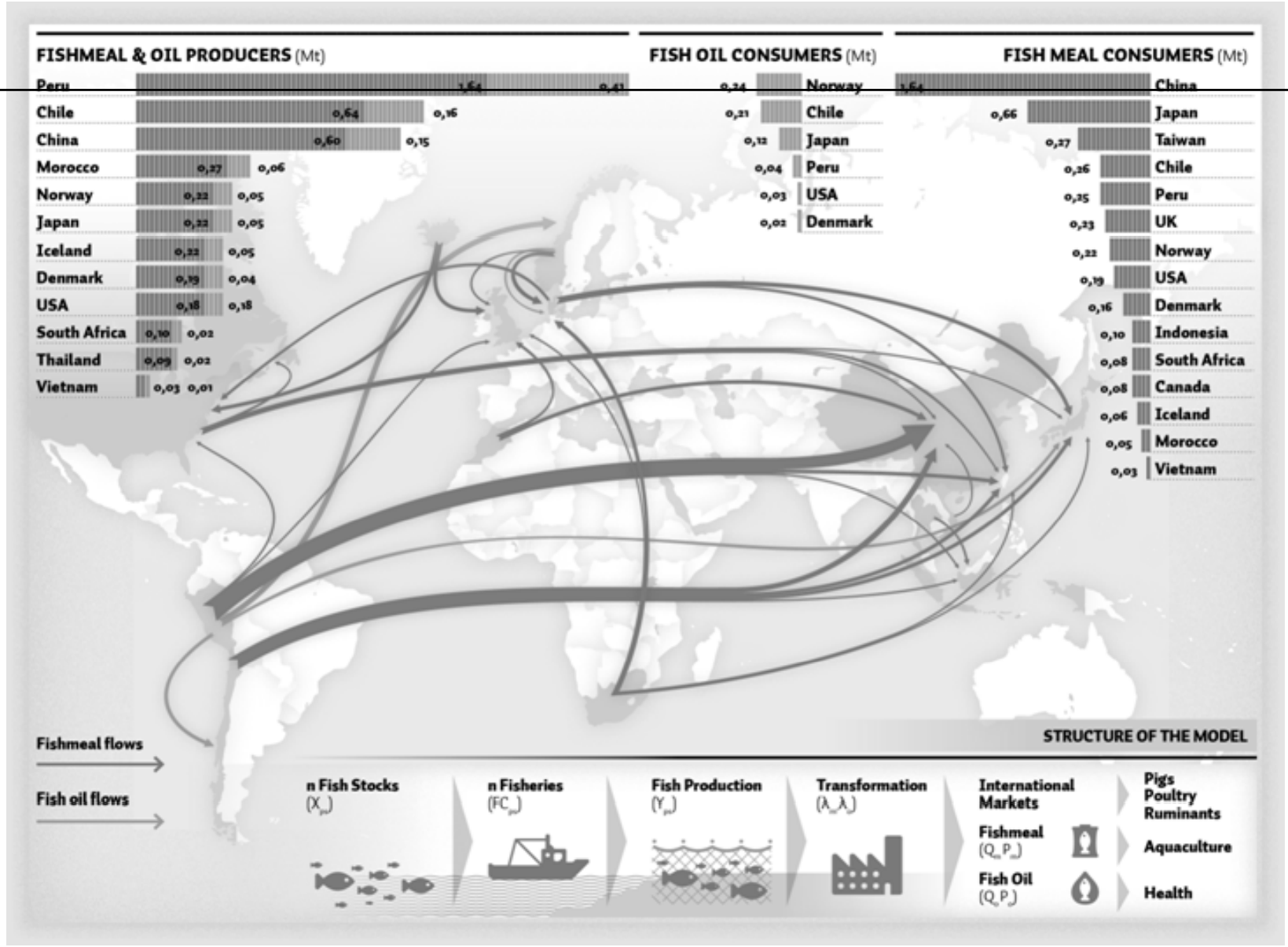
*(Allison et al. Fish & Fisheries 2009)*

Vulnerability scenario



# Fishmeal and fishoil markets scenarios: coupling producers and consumers dynamics

*(Mullon et al. 2009)*

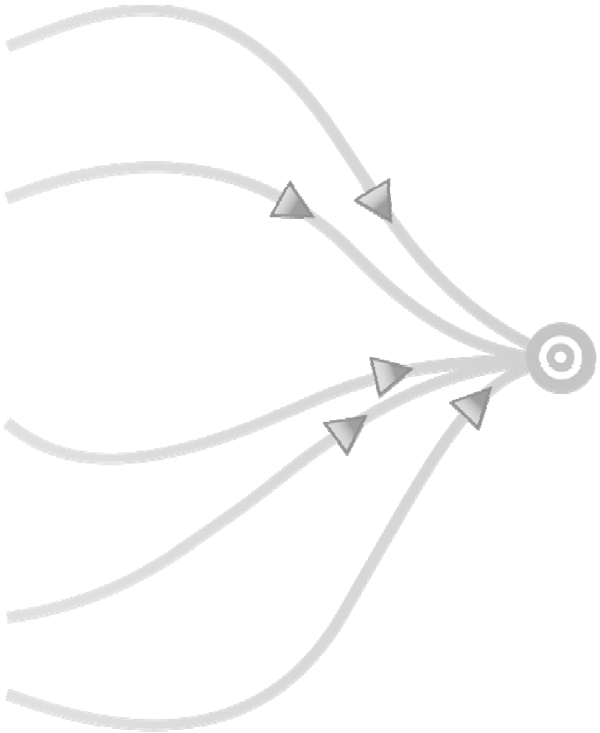


Tremendous progress is under way and global models are making astonishing progress, but this is a daunting task to include a broader range of ecosystem services, especially cultural services, and social and economic adaptation…

…moving towards exploratory scenarios
to envision alternative futures …

# 2. Pathways Scenarios

Present



Future

# What should we do? : Quotes from MA interviews

1. ‘There is tangible evidence that natural systems are stressed to the limits of tolerance’

2. ‘Governments must work together – we can’t save half the planet’

3. ‘there is unequal distribution of resources, population, and trade, leading to a vicious circle of environmental degradation’

4. ‘Business leaders understand that surprise is the rule and flexibility is key to surviving the surprises’

(MA - Millennium Ecosystem Assessment 2005)

# The 4 Pathways Scenarios to change our future

(MA, CBD, $GEO_4$)

1. Market First (Techno Garden): maximum economic growth to improve environment and human well-being (globalized, technology driven)

2. Policy First (Global orchestration): strong policy to improve environment and human well-being (effort to implement Rio, WSSD, Millennium Summit recommendations) (socially conscious globalization & equity)

3. Security First (Order from Strength): efforts to improve (maintain!) humain well-being for mainly the rich and powerful in society (*Me First*) (UN role is suspect!)

4. Sustainability First (Adapting Mosaic): improve the environment and human well-being with a strong emphasis on equity (regionalized, proactive approach to ecosystems)

# Future Scenarios

- Models should integrate across social, economic, environmental and ecosystem dimensions using the 4 scenarios and quantify interaction and trade-offs among ecosystem services

- Daunting task to include a broader range of ecosystem services, especially cultural services, and social and economic adaptation

- Disaggregating across multiple scales from global patterns down to regional scale

- Consider the long time horizons (50 to 100 years) and global perspectives that are required to understand complex interactions between human and ecological systems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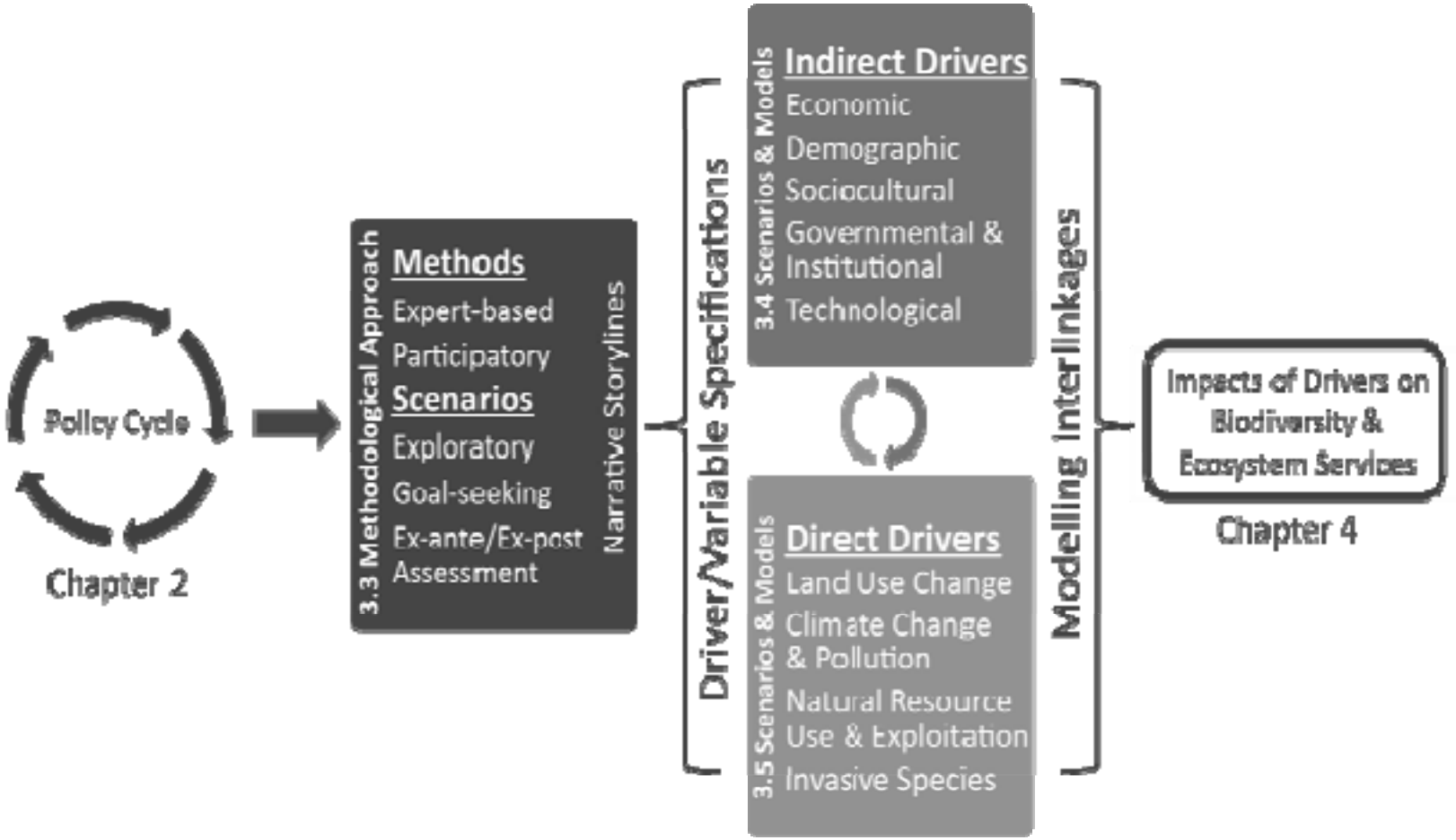
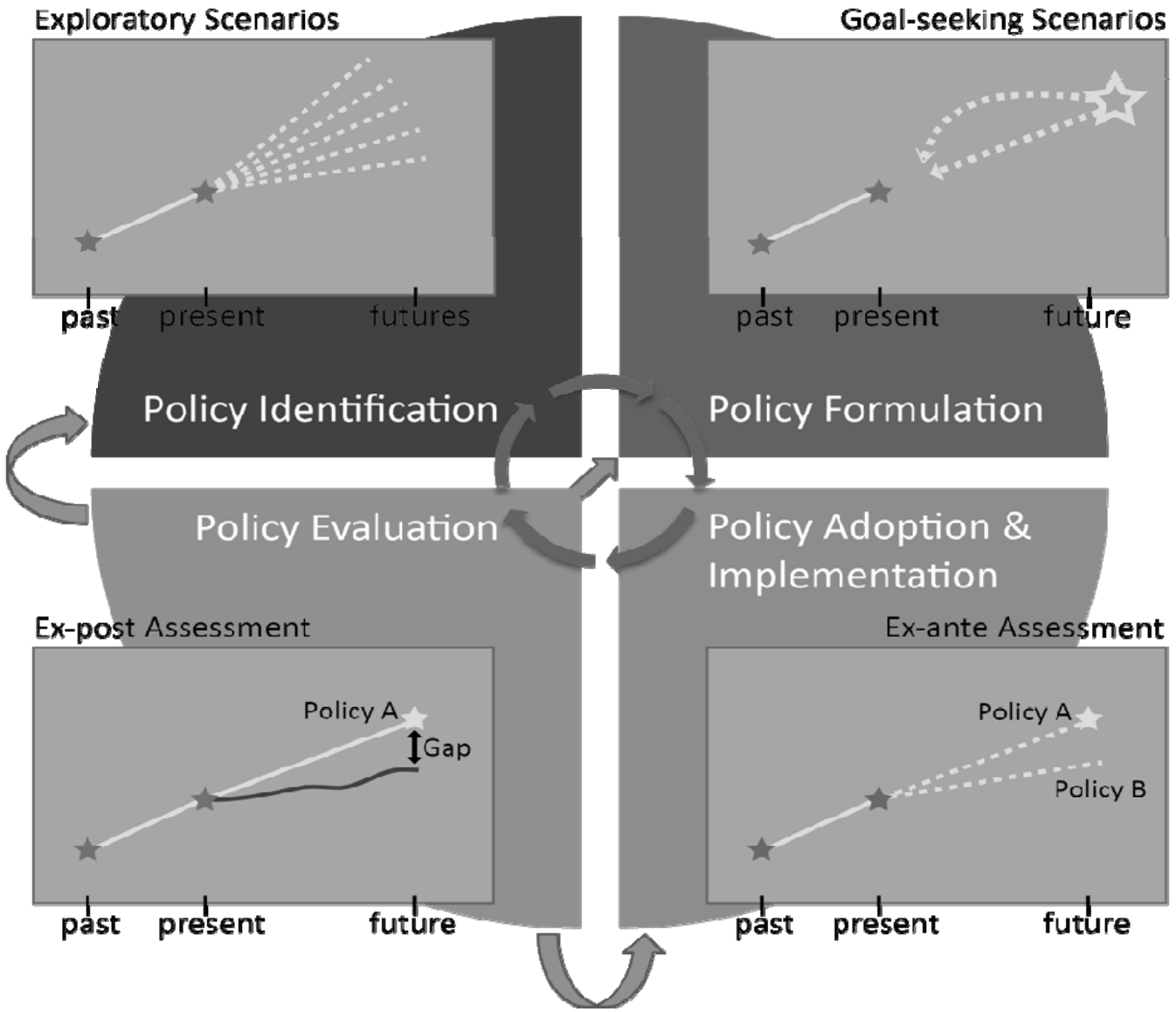
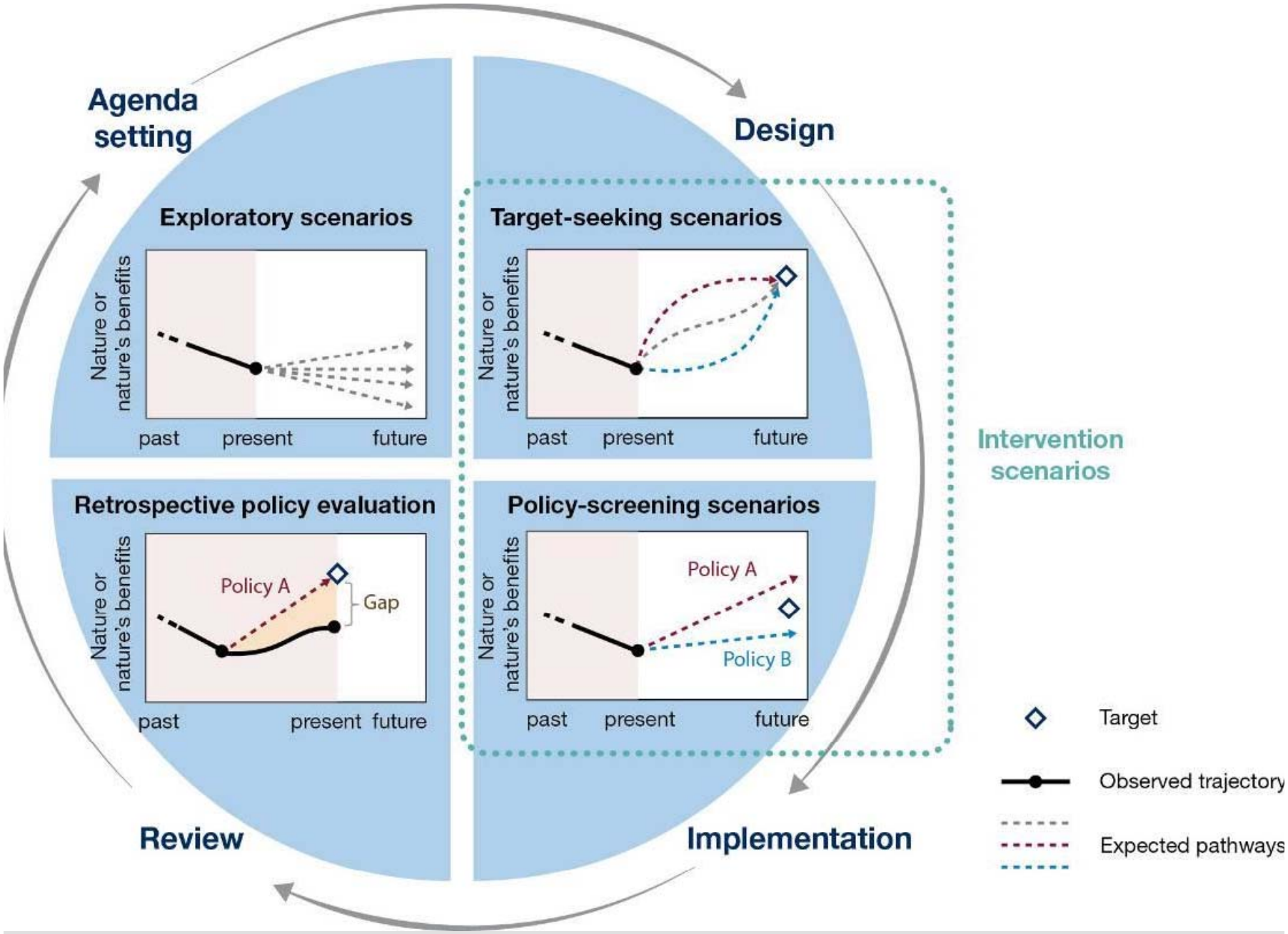
# 5. Scientific strategy for developing scenarios

# Buiding scenarios

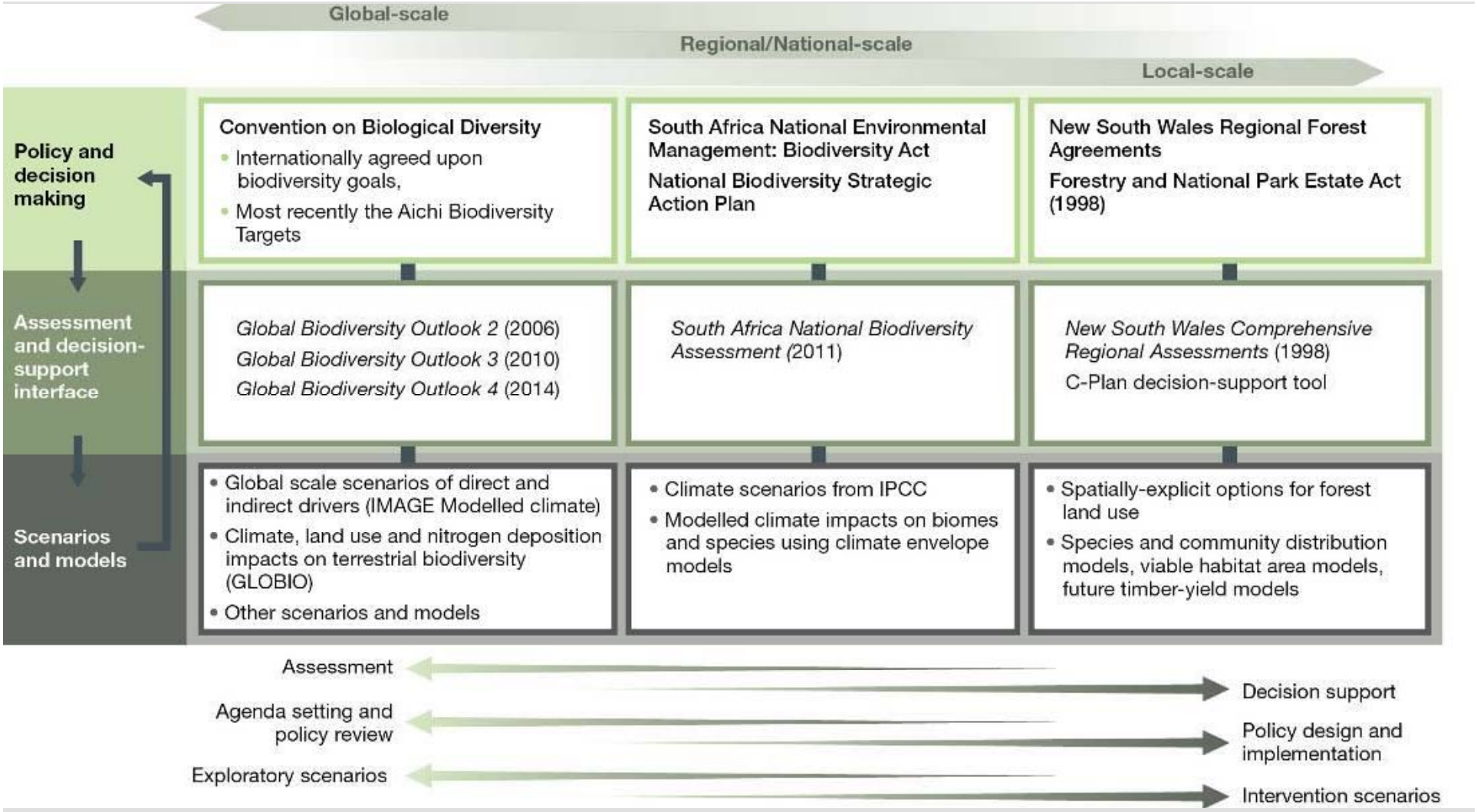


# Scenario Approach According to Policy Cycle Context – IPBES 2016




Agenda setting
Design
Implementation
Review
Exploratory scenarios
Target-seeking scenarios
Retrospective policy evaluation
Policy-screening scenarios
Nature or nature's benefits
past
present
future
Policy A
Gap
Policy B
Intervention scenarios
Target
Observed trajectory
Expected pathways


Policy review
Engaging actors and stakeholders
Linking policy options to scenarios
Communicating results
From scenarios to decision-making
Data
Models
Steps
Information flow
Influence


Global-scale
Regional/National-scale
Local-scale
Policy and decision making
Assessment and decision-support interface
Scenarios and models
Convention on Biological Diversity
• Internationally agreed upon biodiversity goals,
• Most recently the Aichi Biodiversity Targets
South Africa National Environmental Management: Biodiversity Act
National Biodiversity Strategic Action Plan
New South Wales Regional Forest Agreements
Forestry and National Park Estate Act (1998)
Global Biodiversity Outlook 2 (2006)
Global Biodiversity Outlook 3 (2010)
Global Biodiversity Outlook 4 (2014)
South Africa National Biodiversity Assessment (2011)
New South Wales Comprehensive Regional Assessments (1998)
C-Plan decision-support tool
• Global scale scenarios of direct and indirect drivers (IMAGE Modelled climate)
• Climate, land use and nitrogen deposition impacts on terrestrial biodiversity (GLOBIO)
• Other scenarios and models
• Climate scenarios from IPCC
• Modelled climate impacts on biomes and species using climate envelope models
• Spatially-explicit options for forest land use
• Species and community distribution models, viable habitat area models, future timber-yield models
Assessment
Decision support
Agenda setting and policy review
Policy design and implementation
Exploratory scenarios
Intervention scenarios


***26 Core members***

***11 Core Countries***

**Pierre-François Baisnée (Executive Director)**
**Philippe Cury, Scientific Coordinator**

**(CRH/IRD, Sète, France)**

**www.eur-oceans.eu**

EUROMARINE
INTEGRATION OF EUROPEAN MARINE RESEARCH NETWORKS OF EXCELLENCE

**FP7 Coordination Action for the integration of three FP6 NoEs**

**www.euromarineconsortium.eu**

**⇨Launch of new durable EuroMarine+ network (as a consortium) in 2013/14**

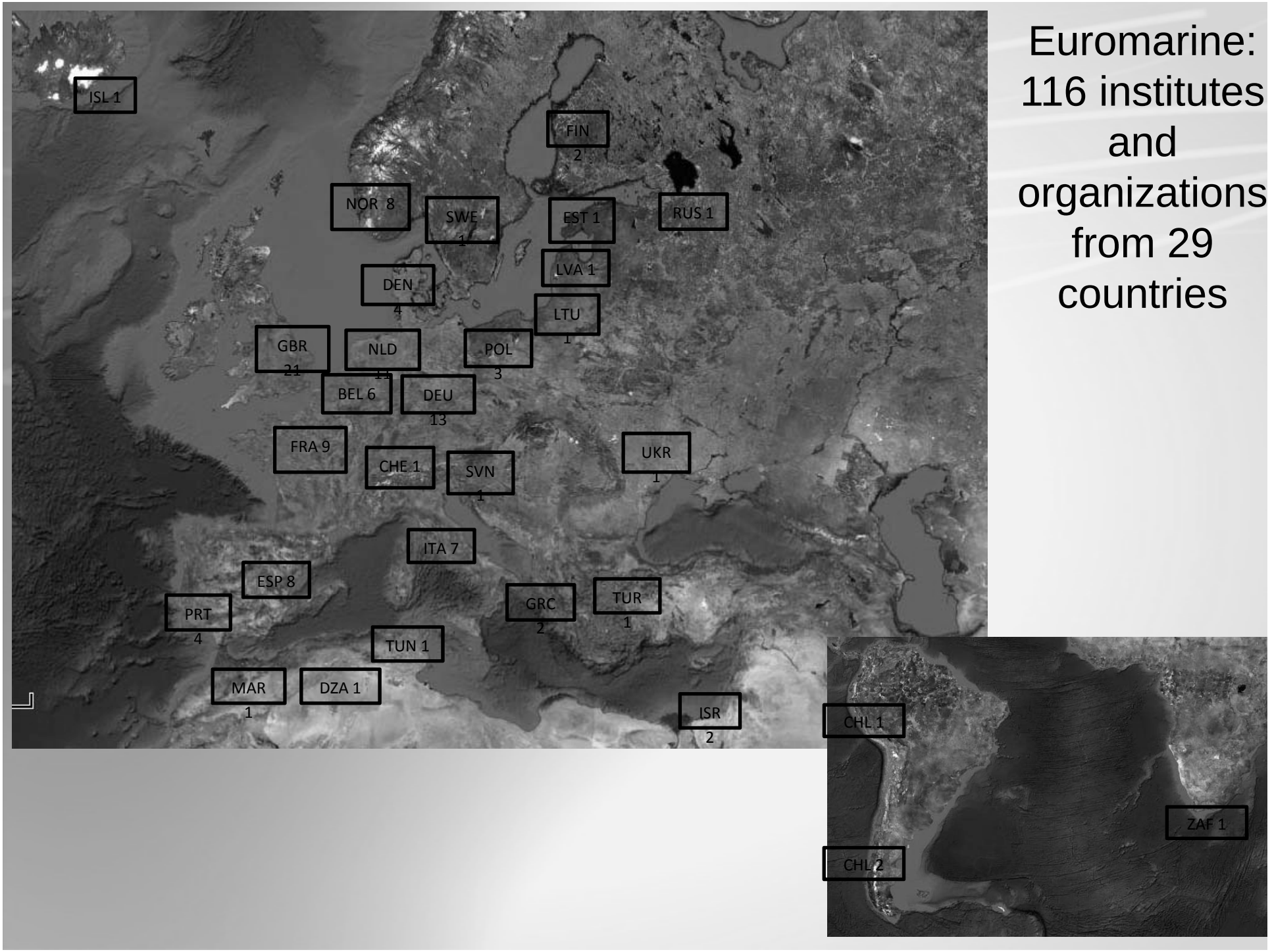
# *From Genes to Ecosystems … in a changing Ocean*

**Three key areas:**

- **Understanding Marine Ecosystems for Healthy Oceans**
- **Building scenarios for changing oceans**
- **Marine science as a provider of new concepts and as a driver for innovation**

**Focus on emerging fields in 'trading zones'**


**⇨Possible European marine focal point for the *Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES)**




Euromarine: 116 institutes and organizations from 29 countries

Scientific vision for **EuroMarine+** now published

EUROMARINE
INTEGRATION OF EUROPEAN MARINE RESEARCH NETWORKS OF EXCELLENCE

# EUROMARINE RESEARCH STRATEGY REPORT

EuroMarine Deliverable 3.2.

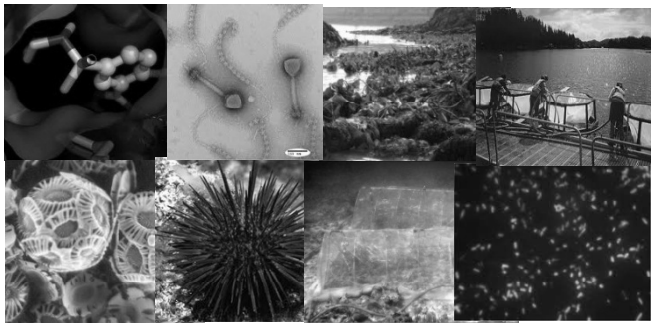
*Catherine Boyen, Carlo Heip, Philippe Cury, Pierre-François Baisnée, Colin Brownlee, Kristin Tessmar-Raible, et al.*

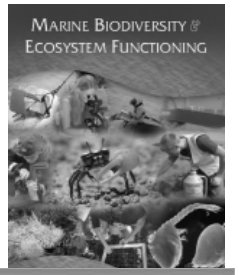
***”From genes to ecosystems in changing Oceans”***

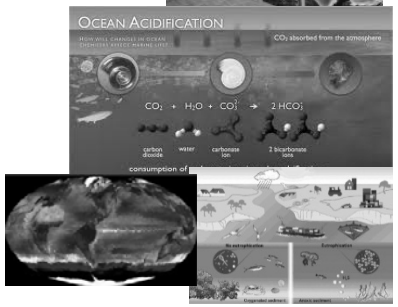
Develop knowledge

Understand, modeling

New concepts in Biology and Ecology

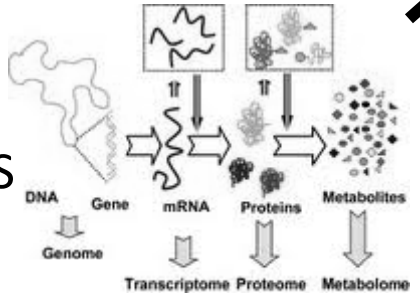




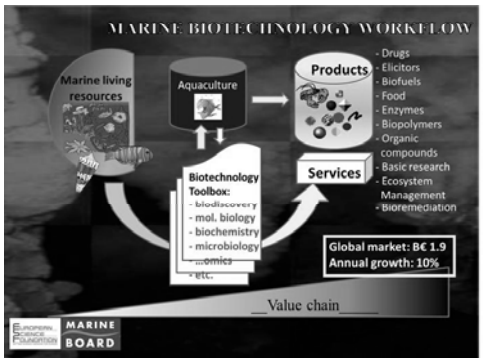




Conserve, restore, plan and manage

OMICS



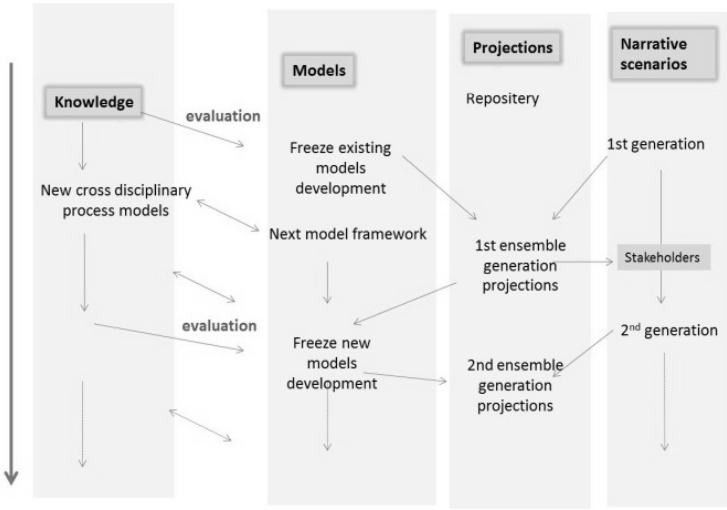

Innovation




EUROMARINE
INTEGRATION OF EUROPEAN MARINE RESEARCH NETWORKS OF EXCELLENCE

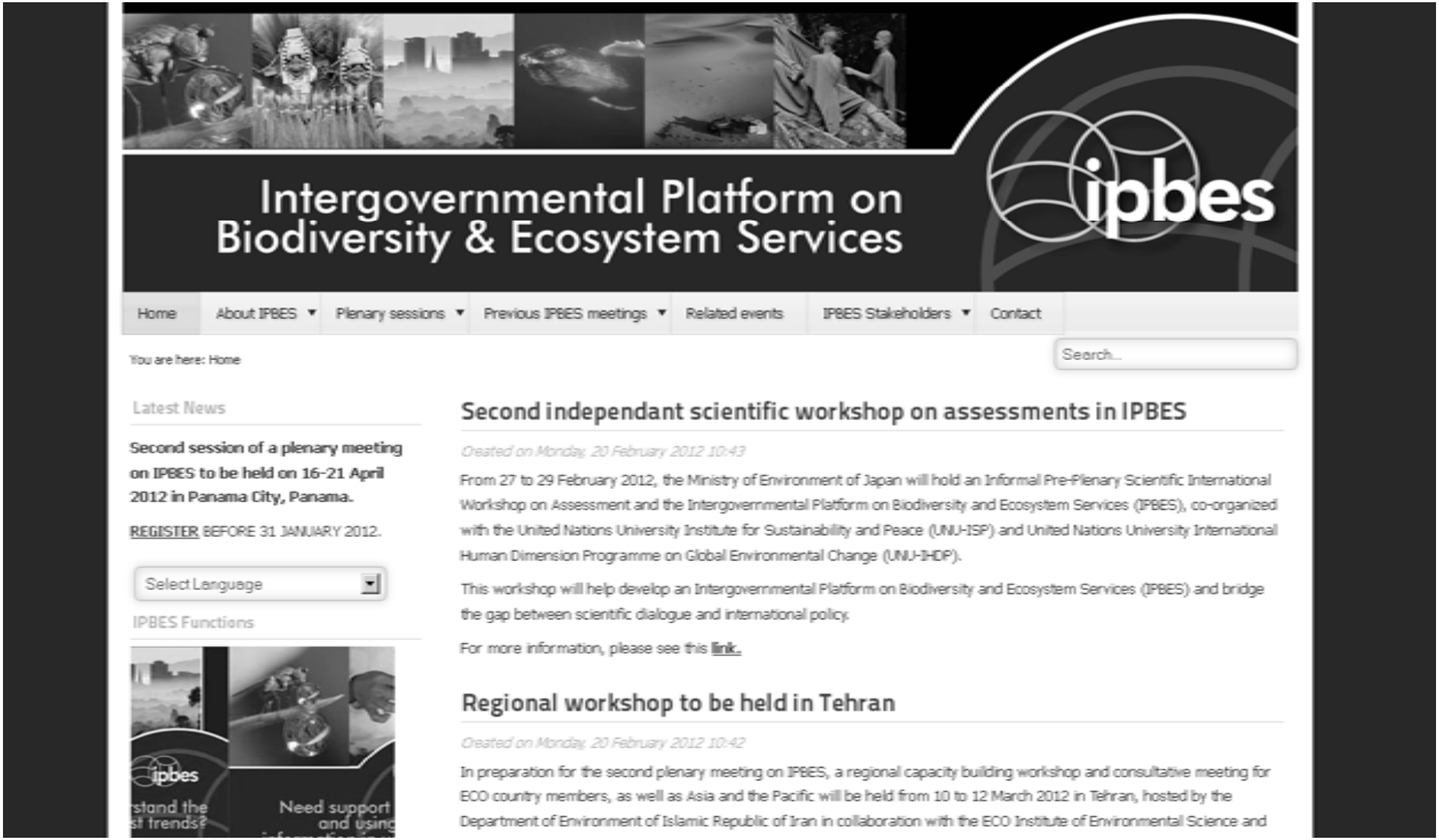
ipbes

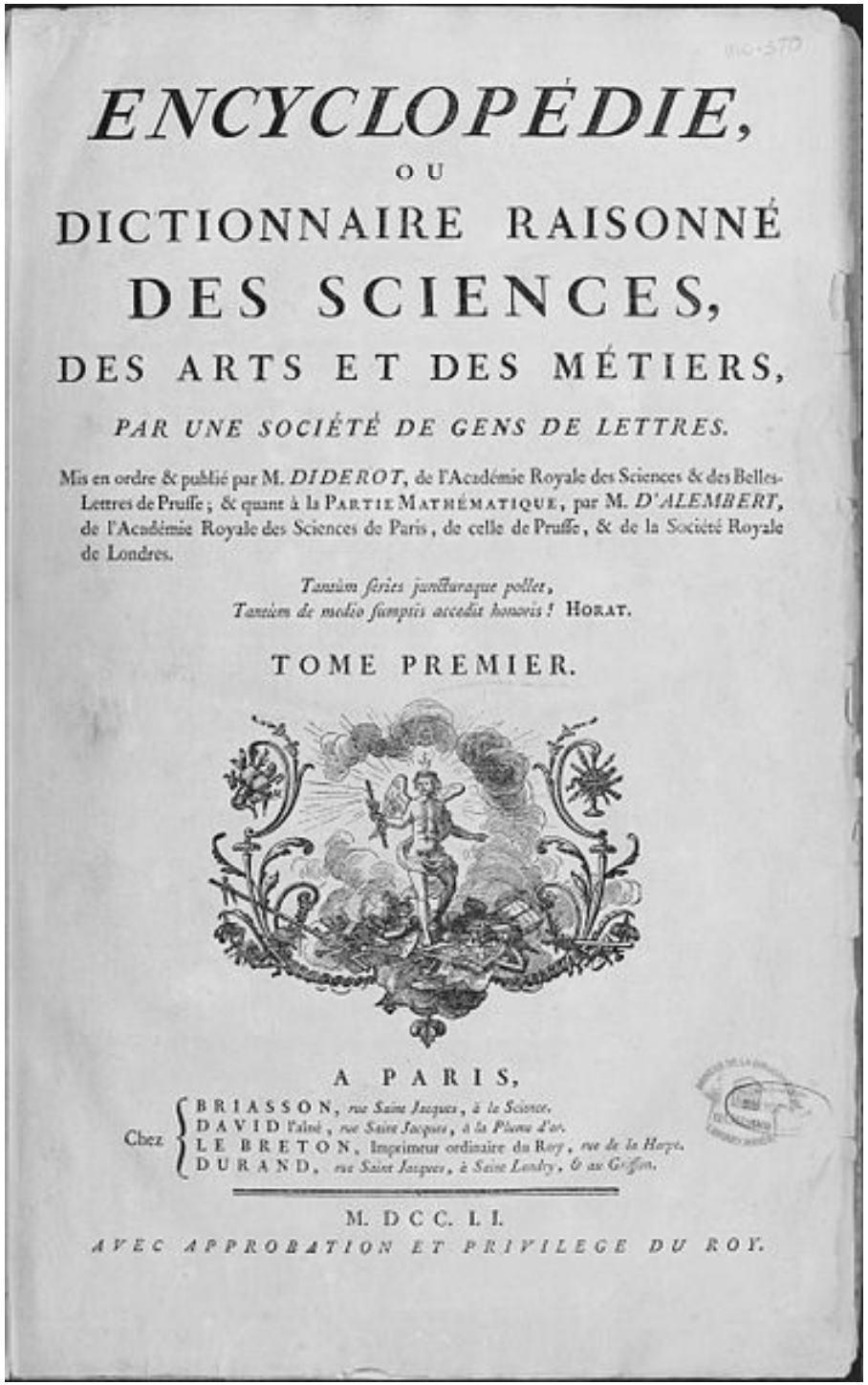
Build Scenarios




EUROMARINE+ : THE FOCAL POINT FOR IPBES

# Ipbes: the future of marine ecosystems in a global change context (Building scenarios)





ENCYCLOPÉDIE,

OU

DICTIONNAIRE RAISONNÉ

DES SCIENCES,

DES ARTS ET DES MÉTIERS,

PAR UNE SOCIÉTÉ DE GENS DE LETTRES.

Mis en ordre & publié par M. DIDEROT, de l'Académie Royale des Sciences & des Belles-Lettres de Prusse; & quant à la PARTIE MATHÉMATIQUE, par M. D'ALEMBERT, de l'Académie Royale des Sciences de Paris, de celle de Prusse, & de la Société Royale de Londres.

*Tantùm series juncturaque pollet,*
*Tantùm de medio sumptis accedit honoris!* HORAT.

TOME PREMIER.

A PARIS,

Chez BRIASSON, *rue Saint Jacques, à la Science.*
DAVID l'aîné, *rue Saint Jacques, à la Plume d'or.*
LE BRETON, Imprimeur ordinaire du Roy, *rue de la Harpe.*
DURAND, *rue Saint Jacques, à Saint Landry, & au Griffon.*

M. DCC. LI.

*AVEC APPROBATION ET PRIVILEGE DU ROY.*

**L e siècle des Lumières**

**Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers est une encyclopédie française, éditée de 1751 à 1772 sous la direction de Diderot et D'Alembert**

**La genèse et la publication de l'Encyclopédie se développent dans un contexte de complet renouveau des connaissances**

**Le but est de mettre le savoir scientifique au centre des décisions publiques**


# 6. Communicating scenarios :

# Moving towards SimOceans™?

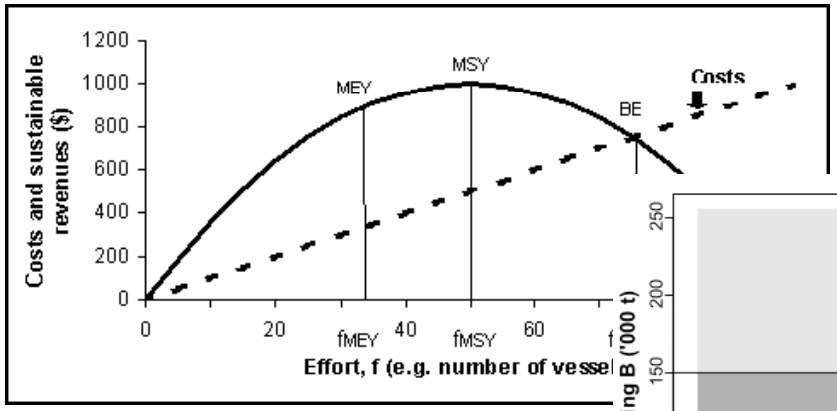
# Scenarios and acceptance of forecasts : self-realization

(Gregory & Duran 2001)

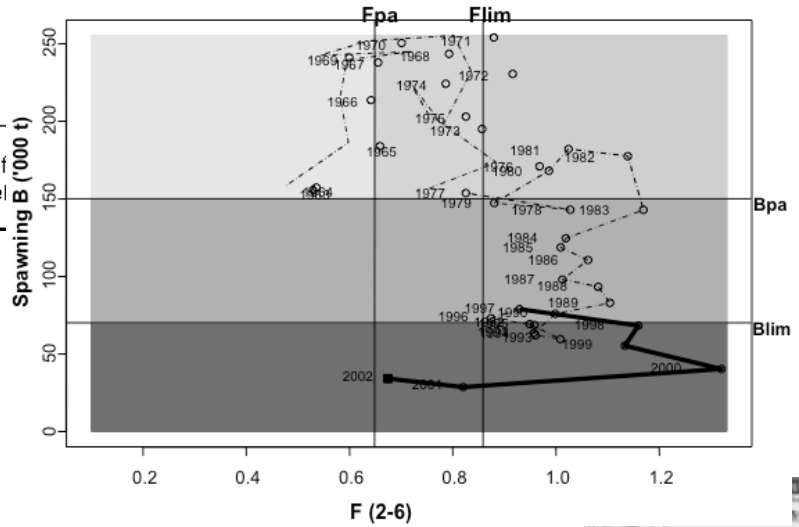
…Vivid scenarios distort people's perceptions of the likelihood of the events they describe.

Scenarios can therefore be used to overcome resistance to unpopular forecasts

# Moving from TRP (*Target Reference Point*), to LRPs (*Limit Reference Point*) and to scenarios !

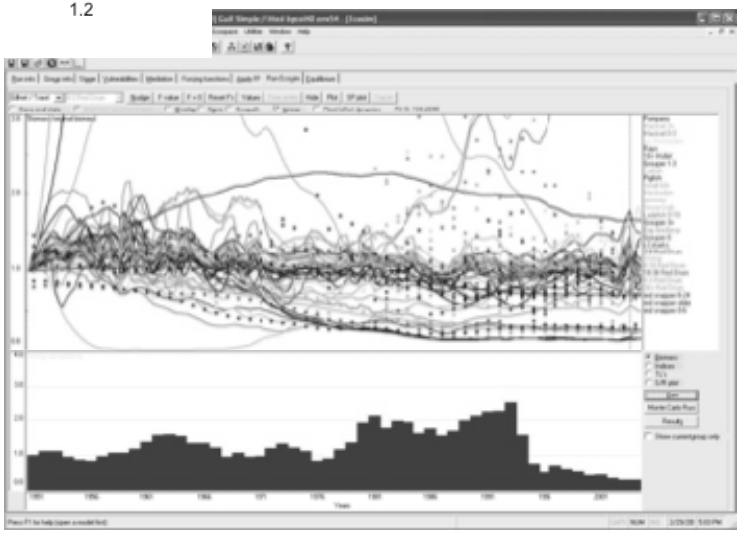



TRP : MSY - MEY

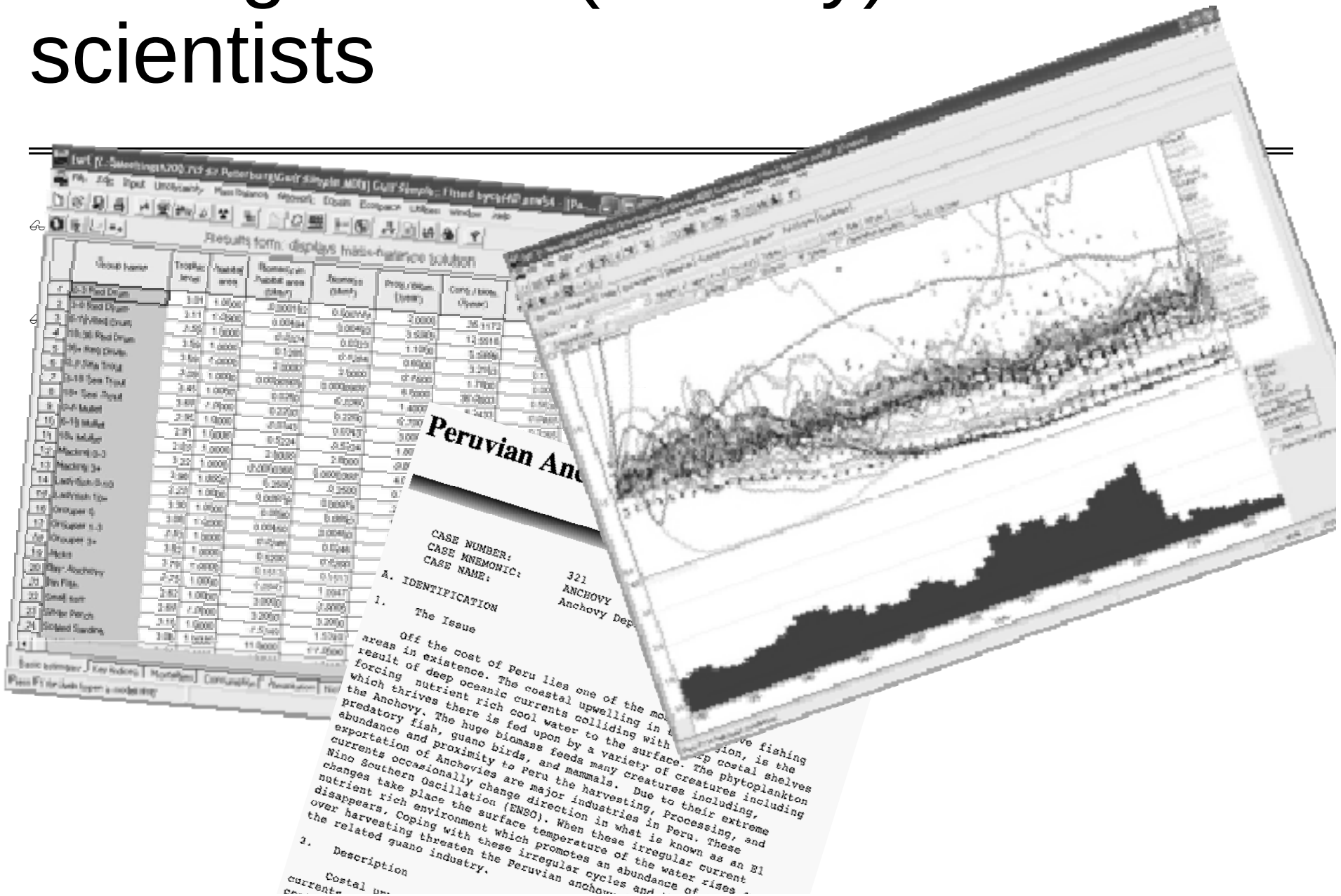



Scenarios

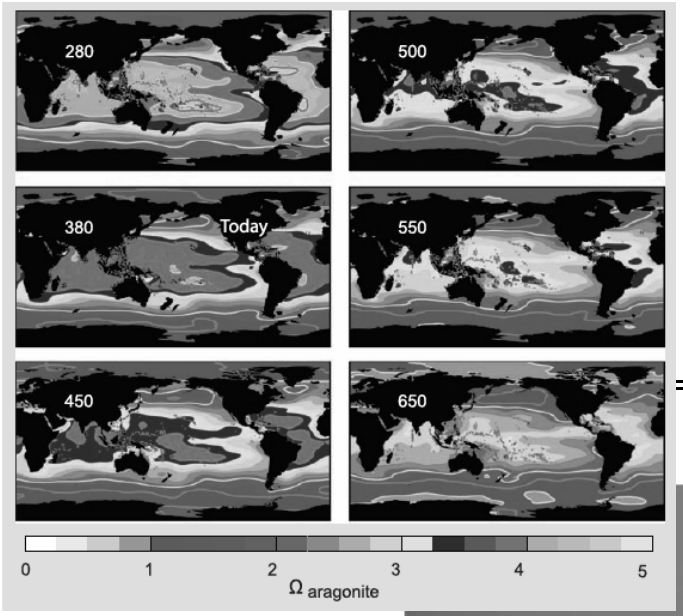
LRP : F & B lim or pa

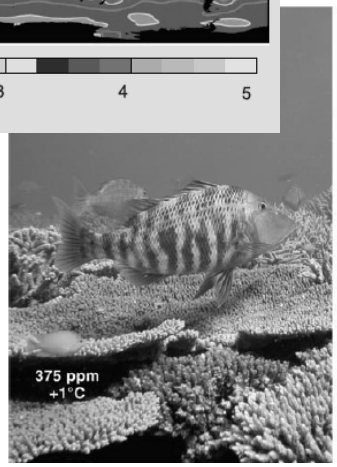


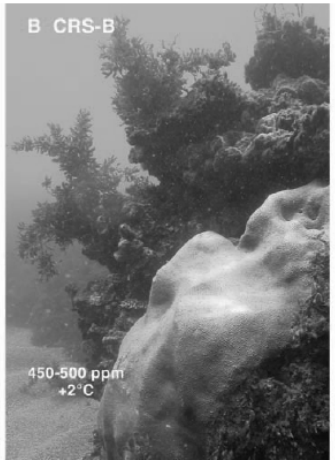
# Managers are (usually) not scientists

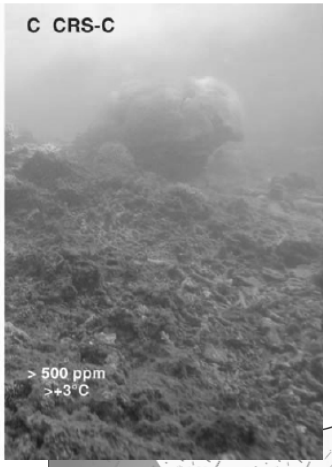


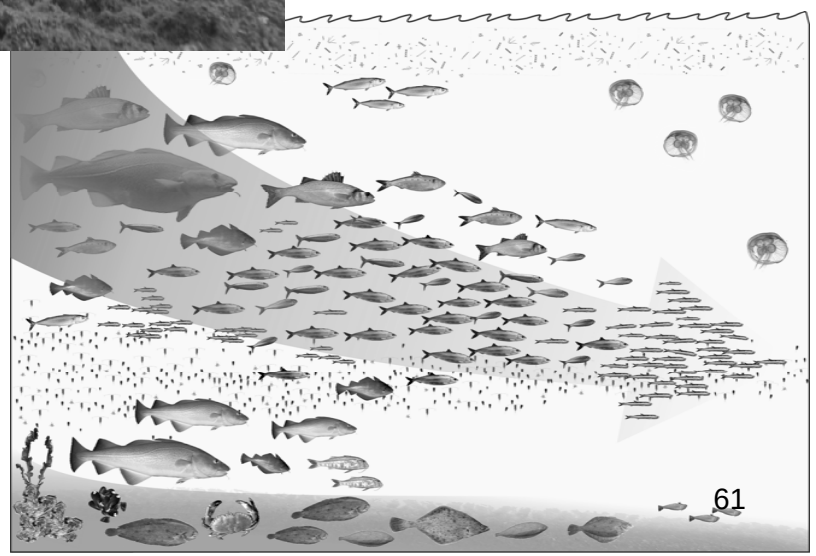
# Communicating through maps, pictures, cartoons….



# Knowledge-based web sites

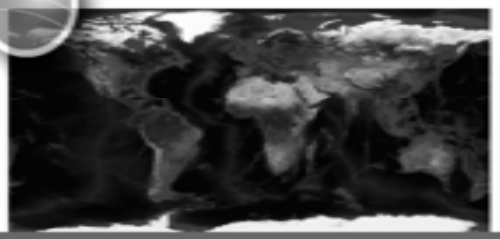
Base de connaissances sur les écosystèmes marins exploités

Ecoscope

Informations sur le projet

Accueil
Recherche avancée
Représentations graphiques
Collaborateurs
Ressources
Liens

## Explorer Par Éco-régions



Eco-régions : ***LME***, ***ZEE***, ***ZET***, ***Longhurst***

## Explorer Par Composants Des Écosystèmes

élements abiotiques
**Océan Atlantique**

élements biotiques
**Lestrolepis intermedia**

élements humains
**Photo d'observateurs embarqués non indexée**

## Ecosystème de Humboldt

Le système du courant de Humboldt avec ses cellules d'upwelling permanent au Pérou, ou saisonnier, le long des côtes chiliennes, est de loin le plus productif en poisson. Avec moins de 1% de la surface de l'océan mondial il fournit 15 à 20% des captures maritimes mondiales (jusqu'à près de 20 millions de tonnes par an pour le Pérou et le Chili réunis). Une seconde particularité réside dans la...[suite]

L'océan Atlantique est l'un des cinq océans de la Terre. Sa superficie de 106 000 000 km² en fait le deuxième par la surface derrière l'océan...[suite]

L'espèce Lestrolepis intermedia est étudiée au CRHMT en tant que proie possible des espèces ciblées par les pêcheries à la seine ou à la palangre... [suite]

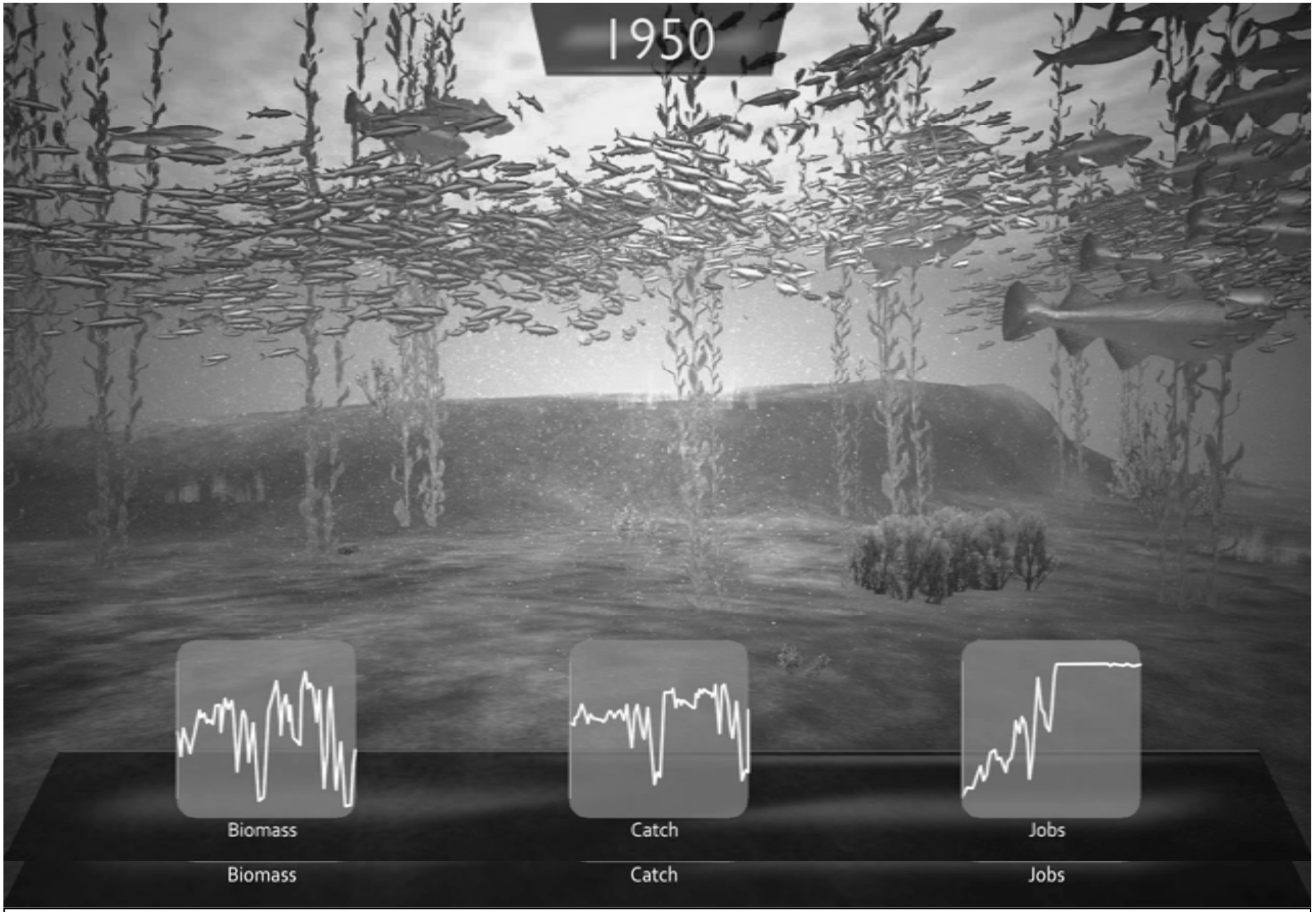
{}[suite]

⚠ Le contenu de ce site n'a pas encore été validé scientifiquement

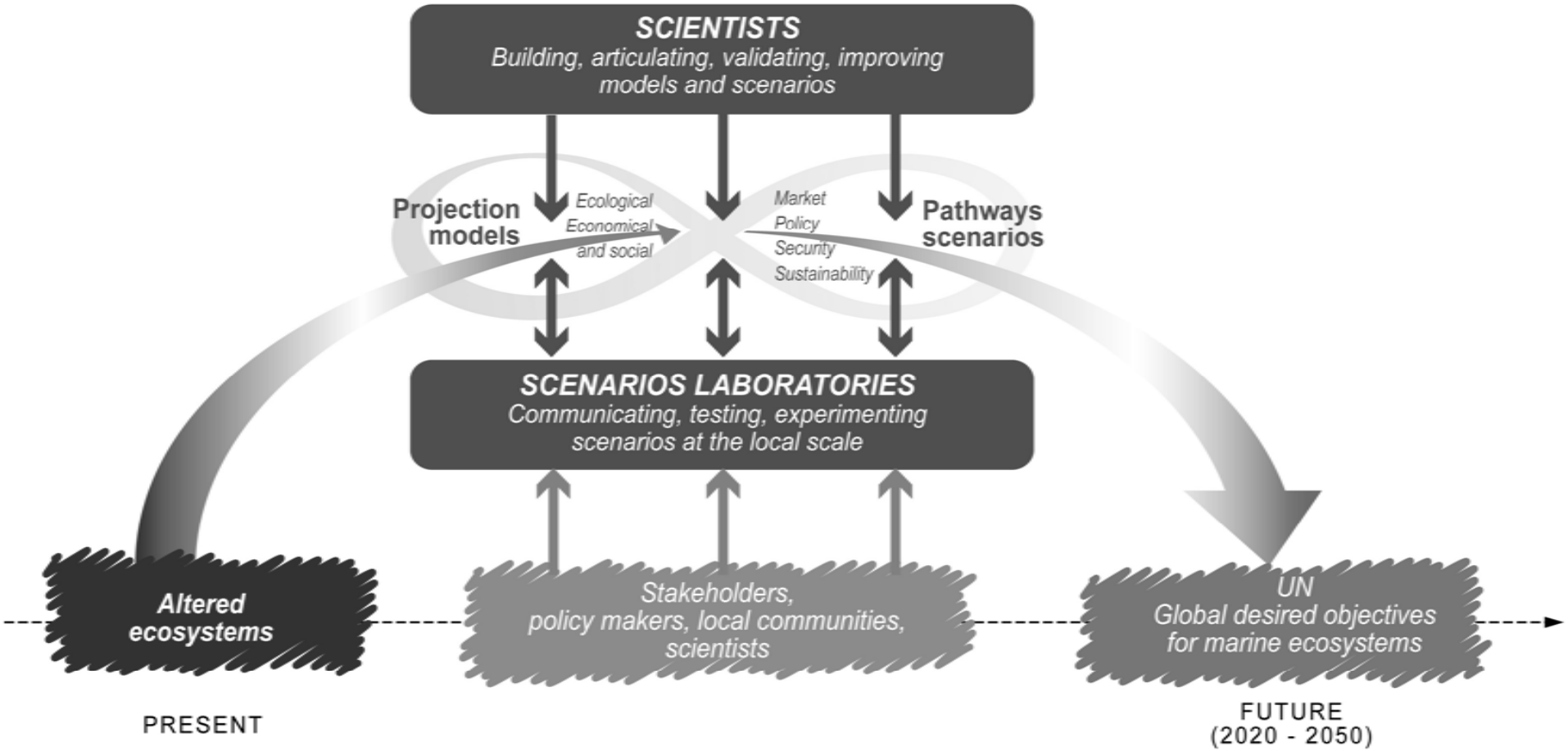
Partenariats Mentions légales Contacts

# *Scenarios Laboratory*

Ocean Futures Project by Villy Christensen (Fisheries Center , Vancouver)

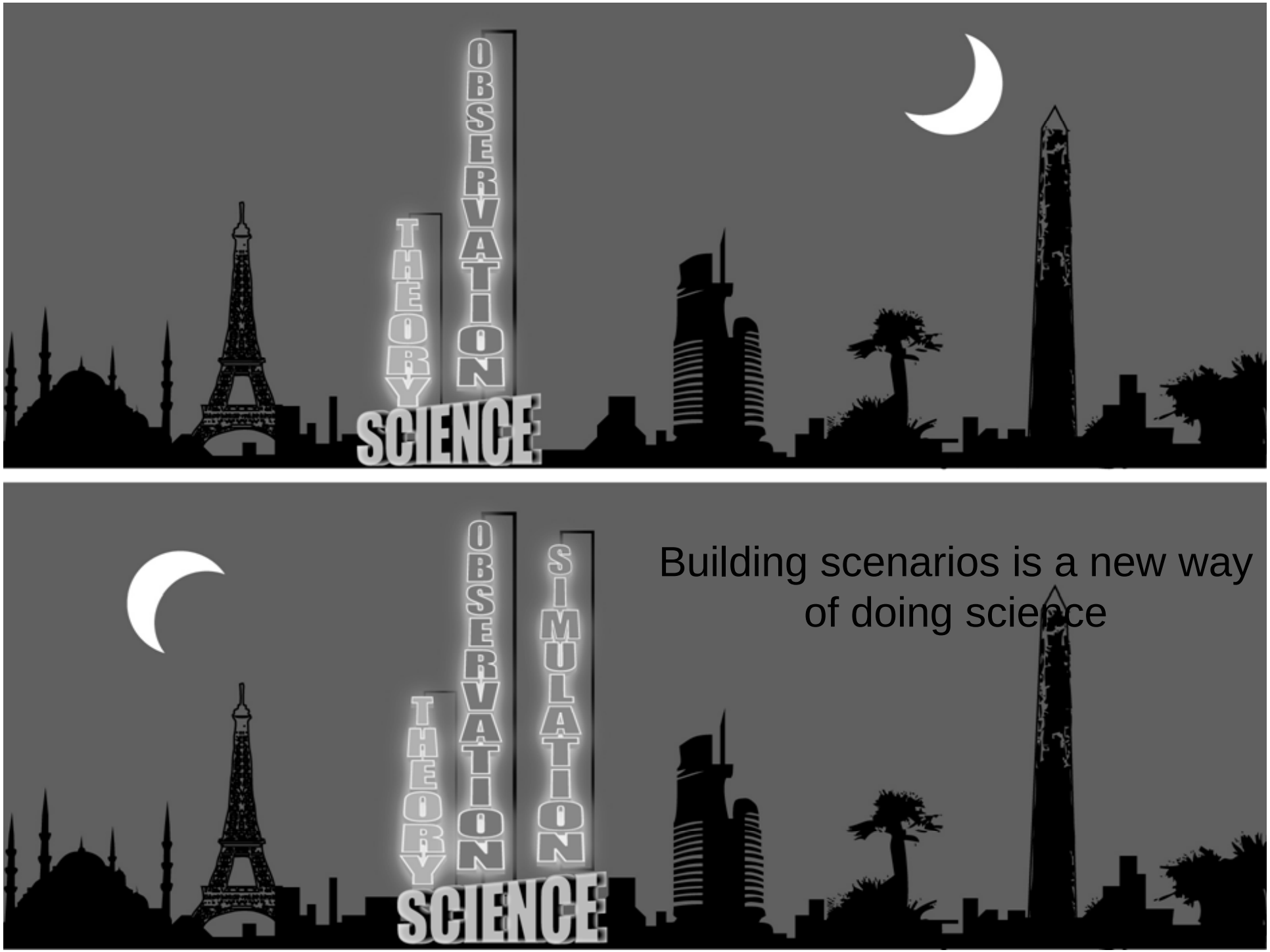



Lenfest Ocean Futures (V. Christensen UBC)
First use of a 3D gaming engine to real-time visualization of scientific simulations


SCIENTISTS
Building, articulating, validating, improving models and scenarios
Projection models
Ecological
Economical
and social
Market
Policy
Security
Sustainability
Pathways scenarios
SCENARIOS LABORATORIES
Communicating, testing, experimenting scenarios at the local scale
Altered ecosystems
Stakeholders, policy makers, local communities, scientists
UN
Global desired objectives for marine ecosystems
PRESENT
FUTURE
(2020 - 2050)


© IRD, C. Peignon

# 7. Conclusion : virtual pathways for real marine ecosystems


THEORY
OBSERVATION
SCIENCE
THEORY
OBSERVATION
SIMULATION
SCIENCE
Building scenarios is a new way of doing science


© IRD, C. Peignon

# Building scenarios will require:

• the involvement of a large scientific community that will discuss and adopt a global scientific strategy with IPBES

• the development of community models with common currencies

• the contribution and links to the emerging and relevant initiatives (GEO5, CBD, FRB, Eur-Oceans, Euromarine….)

• the communication and dissemination of scenarios to stakeholders in an appropriate and innovative manner



*‘If you don’t know where you’re going, you end up somewhere else’*

*Yogi Berra, baseball player*

# *Thank you for your attention*