Food Security, Climate Change and Oceans as a Source of Food

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Purpose of Talk

- Bring separate lines of science-policy dialogue together
- Many setting where there are pair-wise discussions of:
  - Climate Change & Global Food Security
  - Climate Change & Conservation of Biodiversity
  - Climate Change & Fisheries
  - Fisheries & Global Food Security
  - Fisheries & Conservation of Biodiversity
- **What are considered *solutions* to problems in one setting are considered *sources of problems* in others**
- GOAL IS TO OPEN DISCUSSION OF THE INTERSECTION OF THESE CRUCIAL ISSUES

Sources

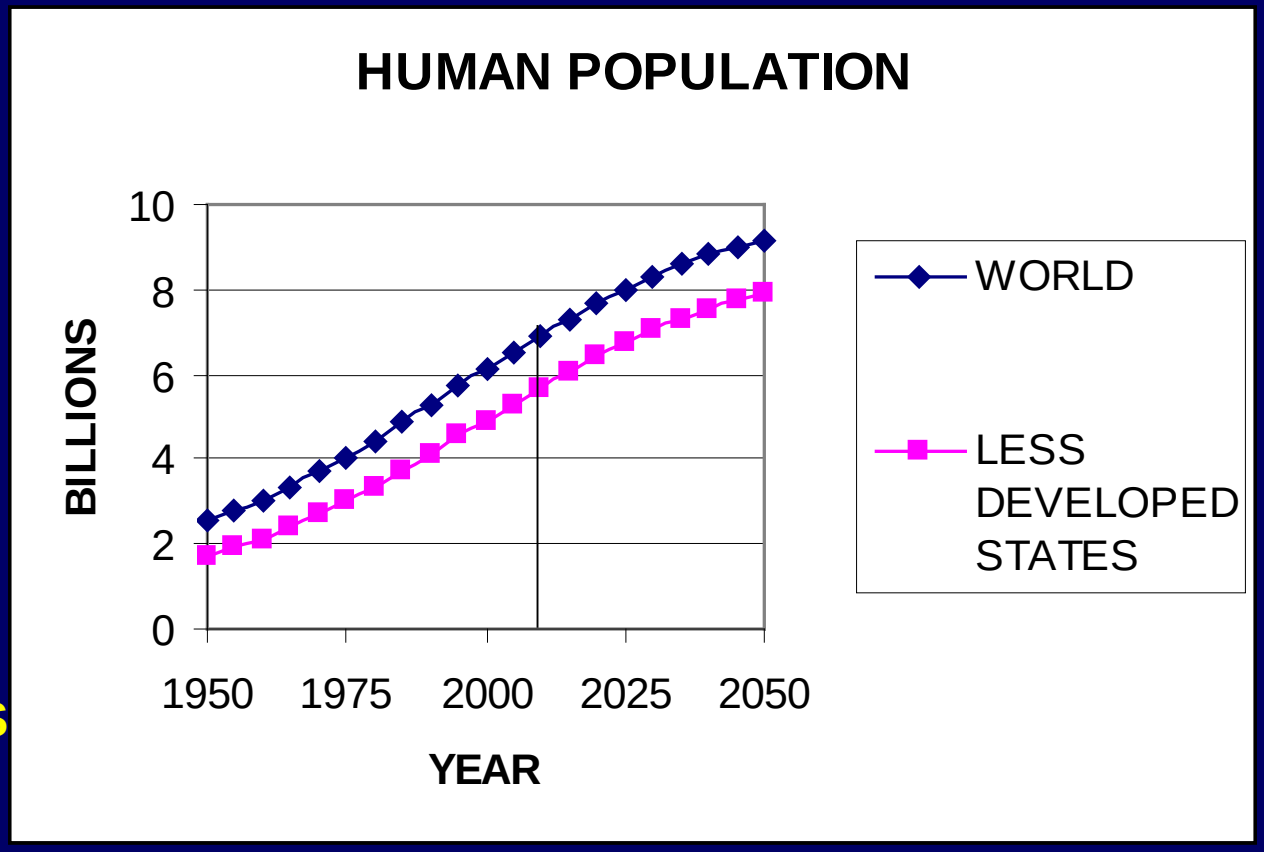
- Largely based on Rice and Garcia 2010 and Garcia, Rice and Charlies 2014
- Relied heavily on FAO and OECD reports on climate change, food security, and IPCC 5th Assessment report (adaptation AND mitigation).
- Consequently some details nearly a decade out of date
- Illustrative not definitive, but from talks in this Symposium no breakthroughs have occurred to make the situation much better.

Sequence of Points Addressed

- Scale of the challenge of meeting food security needs from the ocean
- Scale of the ecosystem challenge of addressing food security in the ocean
- Alternatives like mari-culture, Balanced Harvesting
- Food Security, the Oceans and Trade
- Do we have the Governance processes to find a pathway that deals with the WHOLE challenge that we face (?)

What is expected for human population growth?

FROM UN HUMAN POPULATION PROSPECTS



70 % IN URBAN AREAS / MEGA-CITIES

Percent in coastal areas increases from ~50 to ~ 70 %

WHAT DOES THIS MEAN FOR FOOD REQUIREMENTS

W.H.O. human nutritional requirements

- Calories needs largely from grains (and vegetables ?)
- PROTEIN from grains, livestock & FISH
  - Fish provides more than 1.5 billion people with at least 20 % of non-grain protein
  - In poorer island and coastal states fish provides around 50% of the total non-grain protein
  - Also provide essential micro-nutrients & amino acids
- Individual requirements vary with age, gender
  - Assume 60 kg adult (younger = smaller but need more per kg)
- **NEED 3.65×10^8 t OF DIETARY PROTEIN BY 2050 for population increase**

Forecasts for GRAIN production

Status – quo conditions

- Land in cultivation –
  - will increase at slower rate than 1990-2005 (~ 13%);
  - more marginal lands going into production
- Percent dependent on irrigation –
  - Will increase faster than rain-dependent farming
  - With better technology 11% increase in water use
  - "Green Revolution" of genetic improvements, fertilization will continue, but at 50% of earlier rate
- **NET EFFECT – CROP PRODUCTION INCREASES SLIGHTLY FASTER THAN HUMAN POPULATION (and larger ecosystem footprint from agriculture)**

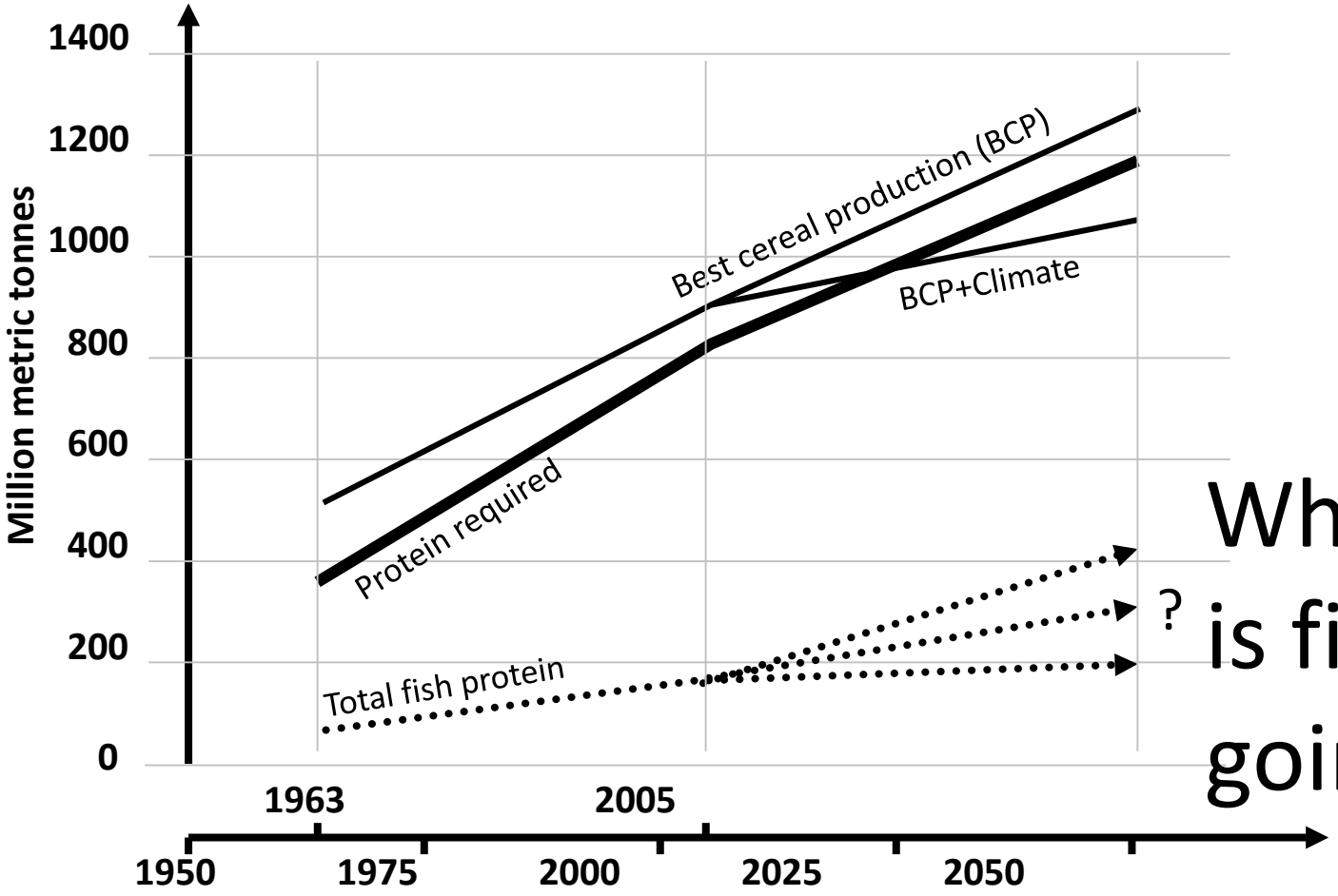
What does climate change do to terrestrial food production?

- Grains (OECD & FAO, Agro-Biodiversity)
  - WHEAT– Irrigaiton allows stable in NA & Europe - **Down** 43 to 57% CA & SA; 44 to 97% Africa; 43 to 58% Asia
  - RICE – no %age projection; threat is increasing number and intensity of severe storms. FAO-AgroBiv project **1 in 4 crops lost.**
  - MAIZE – *increase* usually 20-30% in Africa, Asia, Europe, but is lowest protein content grain
- Livestock (OECD)
  - Cattle and swine – “moderate reduction” in temperate; ”larger” reductions in tropics –
  - Poultry - ?????

Additional Complicatiosns since projections made

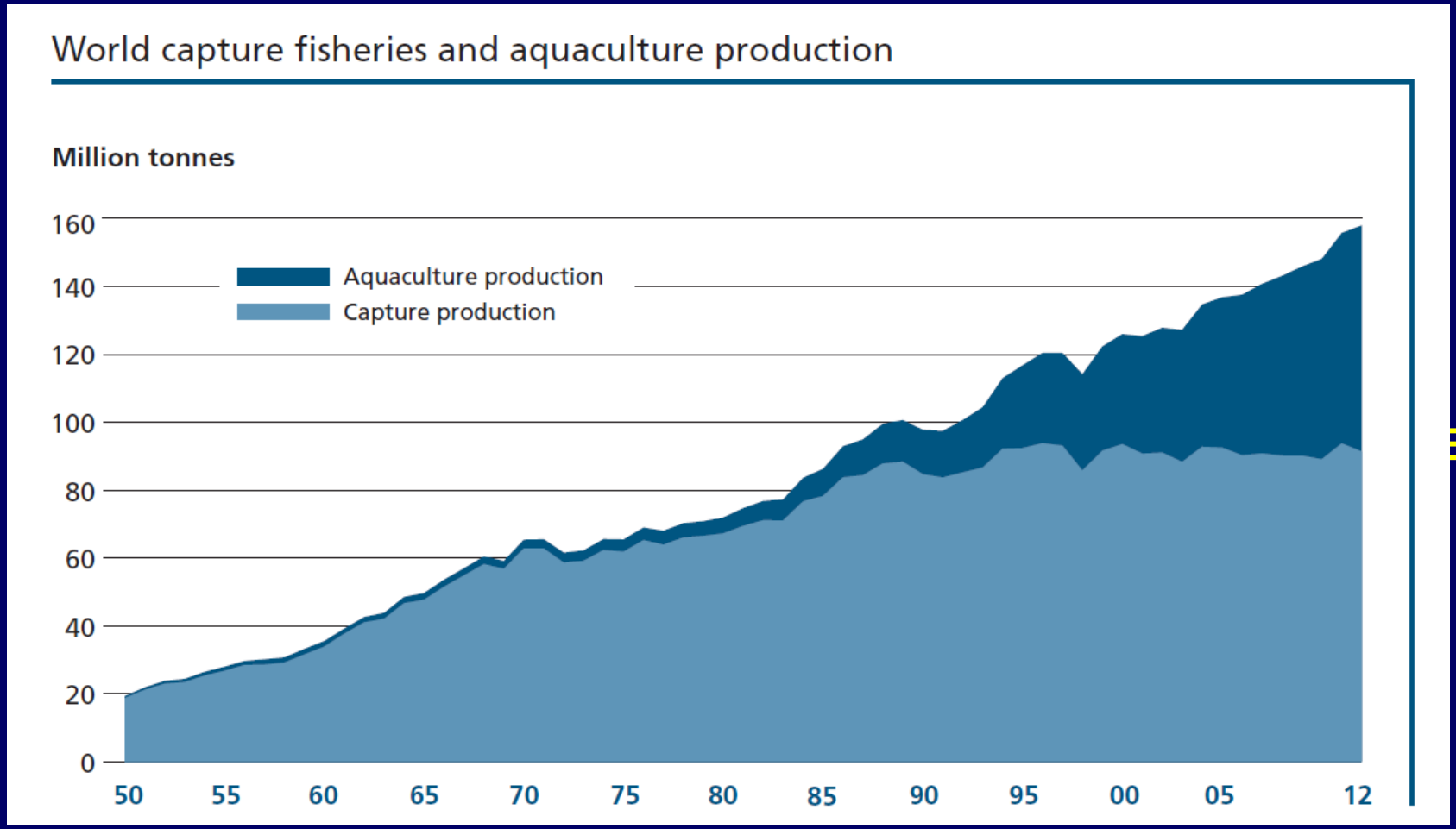
- Growing concerns over
  - What the Green Revolution really changed and how the benefits were distributed.
  - Need to decrease rate of native ecosystem conversion and land alienation,
  - So if SDGs and IPBES ecosystem sustainability concerns are addressed, then status quo projections would be *optimistic.*

Are FISH the solution? Some think so.



Where is fishing going?

Trends from SOFIA 2014



How much fish in the future

2014 –

- Capture fisheries stabilized at 85-90 mmt.
- Aquaculture ~50 mmt and increasing
- 33 mmt used for oil and animal feed, rest consumed.

- 2050 –
  - If fish stays 20% percent of dietary protein, 20% of 365 mmt = >**70 mmt tonnes MORE fish**
- If it has to replace decreasing grain–**MORE**
- With most of population growth in parts of world where fish is greater % of protein- **EVEN MORE**

Where can we get 75 – 100 mmt more fish protein?

- INCREASE CAPTURE FISHERIES?
  - SOFIA concluded 100 mmt was unsustainable when reached in 1990s
  - Could fish lower trophic levels to get greater yield from primary production (10-fold gains)
- INCREASE AQUACULTURE?
  - More intensive mariculture in coastal areas
  - Community-based integrated pond culture
    - Use of specialize strains and species adapted for pond culture and low-protein diets.

Catches stable, what about stocks?

- Could be stable because just addiing more over exploited stocks to globe OR
- Measures actually limiting catches at levels that are allowing recovery
- Looked at 300 stocks up to 2015
- Results incomplete but soi far
  - 2/3 of stocks reached record low spawning biomass within last 20 years
  - BUT 3/4 of those stocks now trending upward

Is aquaculture the solution?

Released
June 2014

At the bi-annual Committee on Fisheries

Main findings – Aquaculture Growth

11. In the last three decades, farmed fish production has increased 12 times at an average annual growth of over 8 percent, making it the fastest growing food production sector….

It is now widely agreed that the foreseen future increase in demand for fish will have to be satisfied through aquaculture production.

13. [Growth expected to continue in future with greater private – public sector interactions]]

Main Findings – Aquaculture vs other protein alternativess

- 12. Aquaculture fish convert more of their feed into body mass than terrestrial animals. [Beef : Pork : Fish = 5: 3 : 1] Moreover, aquatic animal production systems also have a lower carbon footprint per kilogram of output compared with other terrestrial animal production systems. Nitrogen and phosphorous emissions from aquaculture production systems are much lower compared to beef and pork production systems though they are slightly higher than those of poultry

Encouraging BUT

22. For aquaculture, whether scale of operation is neutral or not with respect to food security and nutrition outcomes is less clear. ….Some claims that medium-scale enterprises are more effective at addressing poverty reduction and food security, but ,,, 70–80 percent of aquaculture production has come so far from small-scale farming.

CONCERNS LED TO FAO HIGH-LEVEL PANEL ON AQUACULTURE SUSTAINABILITY

FAO High-Level Panel 2014

Conclusions on Aquaculture

14. ,,, aquaculture experts are now more confident that the era of severe environmental problems has passed and that aquaculture is on the road of being more environmentally sustainable.

15. Often, previously existing land and water uses have been disturbed by the development of aquaculture… . As more space is progressively allocated to aquaculture operations … along the coast, . Conflicts are common when aquaculture is introduced into a region where fishery activities are already established,.. .

16. As for livestock production, fish diseases … are a constant threat to production .. . The use of antibiotics and chemicals in intensive systems are also sources of concern ..

What do these conclusions mean?

- Most information is from medium & large scale operations
- Few projections of how much SUSTAINABLE aquaculture can expand
  - Concerns include cultivated strains as invasive species, disease vectors, antibiotics -
  - How will production be split between community nutrition and trade for other commodities? (will return)

What about the ecosystem being used?

Ecosystem effects of fishing and aquaculture

- Not time for treatment of large and complex field but CBD Aichi Biodiversity Target 6 sets targets for
  - Bycatches of all species
  - Impacts on seabed & associated biota
  - Special attention to endangered species and vulnerable habitats
  - Impacts on Ecosystem Structure & Function
- MOST COUNTRIES HAVE LITTLE ABILITY TO REPORT ON PROGRESS

For Aquaculture consider classical Pathways of Effects Analysis

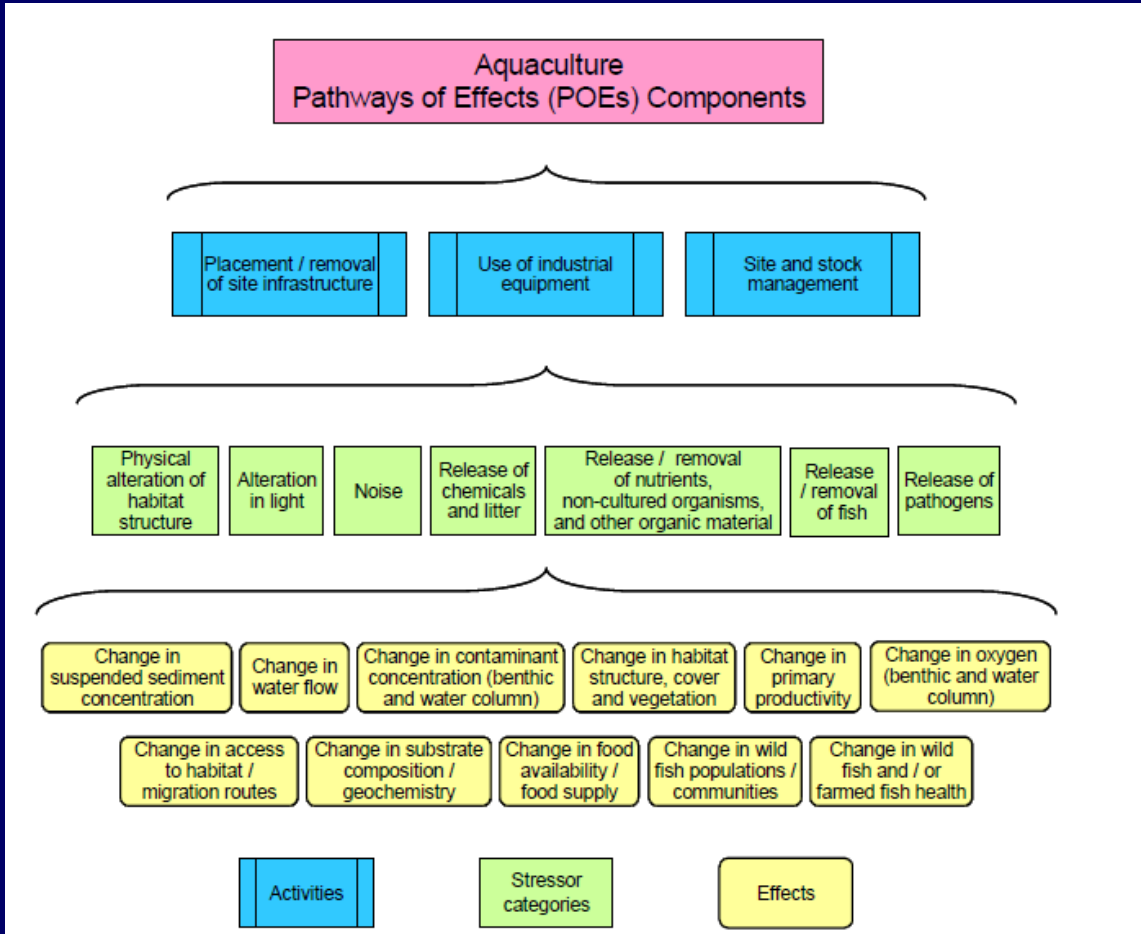


Figure 1: Aquaculture Pathways of Effects components: activities, stressor categories and effects.

Challenges to Conservation of Marine Biodiversity now priority issue

All the world's oceans under some stress; often multiple stresses (Halpern et al 2007)

Special Attention to Seamounts, corals etc (FAO DSF etc)

Major declines in all large fish, invertebrates, elasmobranches etc (Myers and co-authors)

Many Policy Settings for dialogue and action

- UN Biodiversity Beyond National Jurisdiction
- CBD bi-annual Ocean and Coastal Resolution – Doubled in length 2008-10
- IUCN – 35% of Resolutions on marine issues

Gaps from International policy to Domestic policy to implementation are all growing

Illustration of types of choices to be made - CONFLICTS

- Activity Food Security Biodiversity

- Harvest rate Max Sustainable Reduce
- Lower trophic level Fish More Fish Less
- High productivity Areas Fish More Extra Protection
- Mariculture Change species & increase Reduce
- Freshwater culture Increase Only local species
- Freshwater - use of strains
  bred for aquaculture Increase Reduce

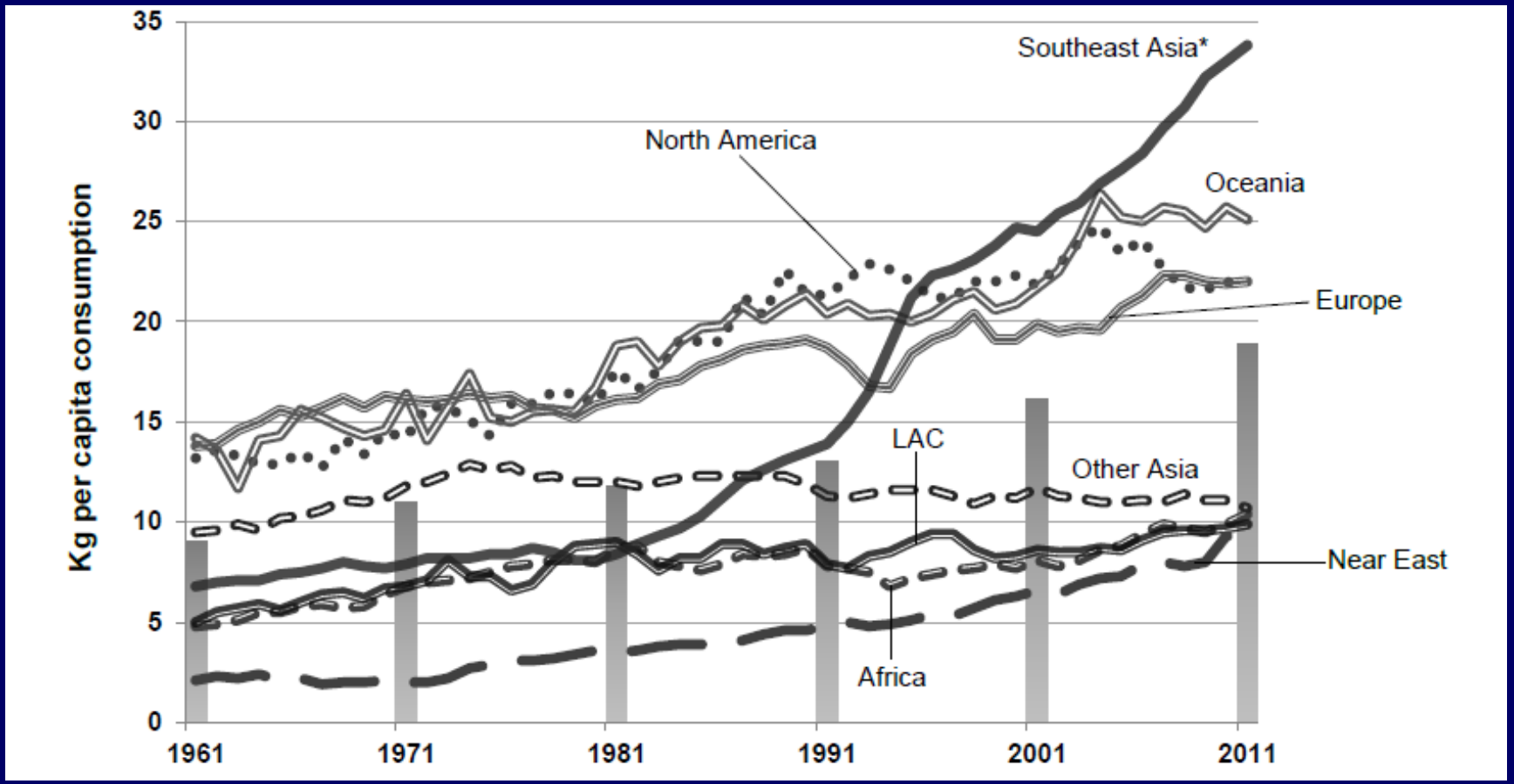
Now Combine Climate Change and Biodiversity Conservation

- Major Messages from science community:
  1. Some species ranges will change in response to changes in oceanographic conditions
  2. Productivities will change as transport mechanisms and larval development conditions change
  3. Community structure will change from 1 & 2
  4. Ocean acidification may reduce abundance and productivity of species with shells & exo-skeletons
  5. Specialized habitats like corals and estuaries face multiple stresses
  6. Coastal habitats face more severe storm stress, but service of coastal protection will be more important

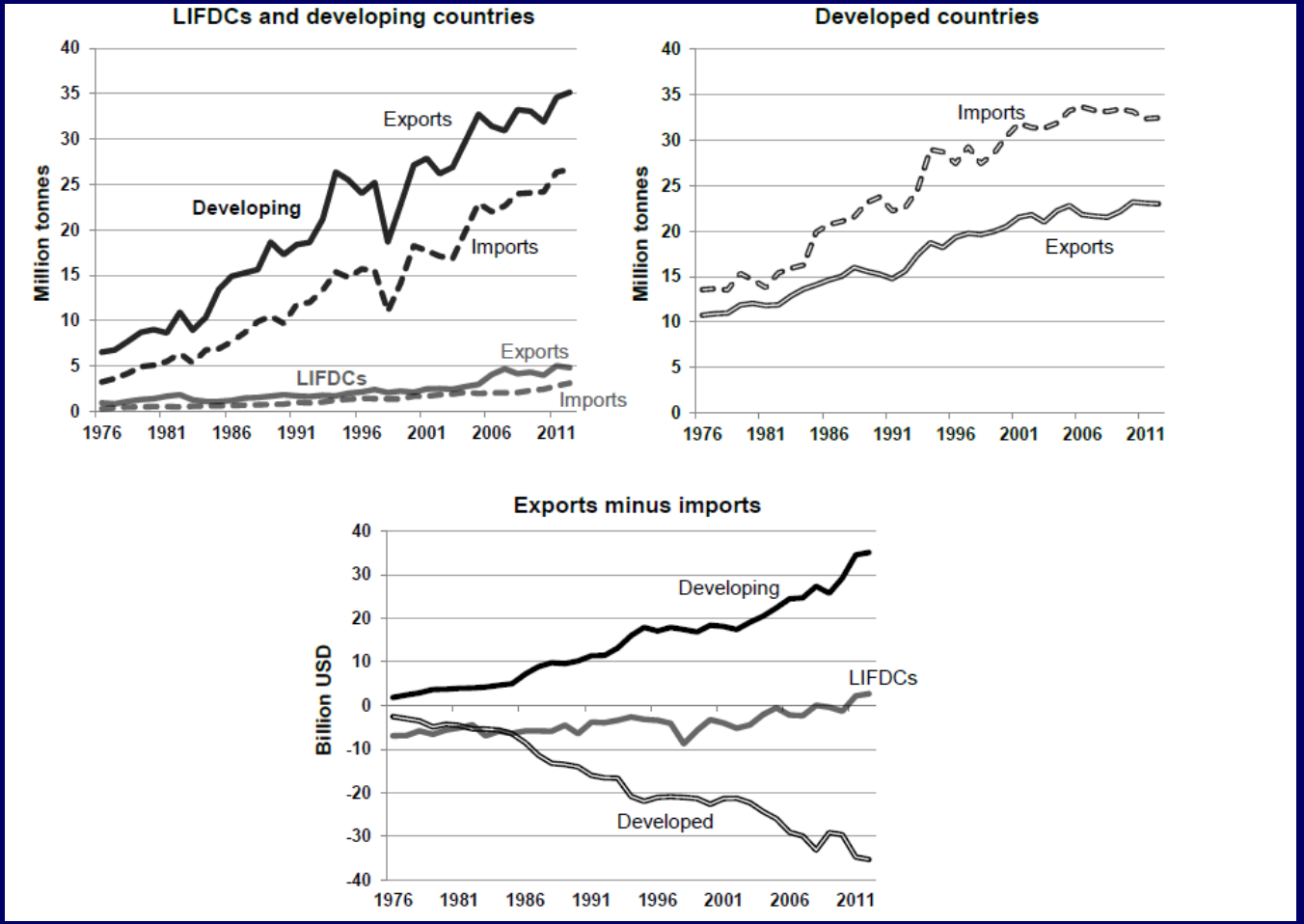
All these factors have implications for fisheries

- Assessment tools used to improve harvest advice can be undone –
- Reference Points for management can change up to 50%.
- Many forecasts of how range of fisheries may move with “thermal envelopes”
  - Predictions (mis-)focused on increased cost of large scale capture fisheries
  - Food security needs forecasts of what will change in fishing grounds of small-scale fishers

TRADE - The Regional picture on consumption



So are the food insecure places fishing for money or food?

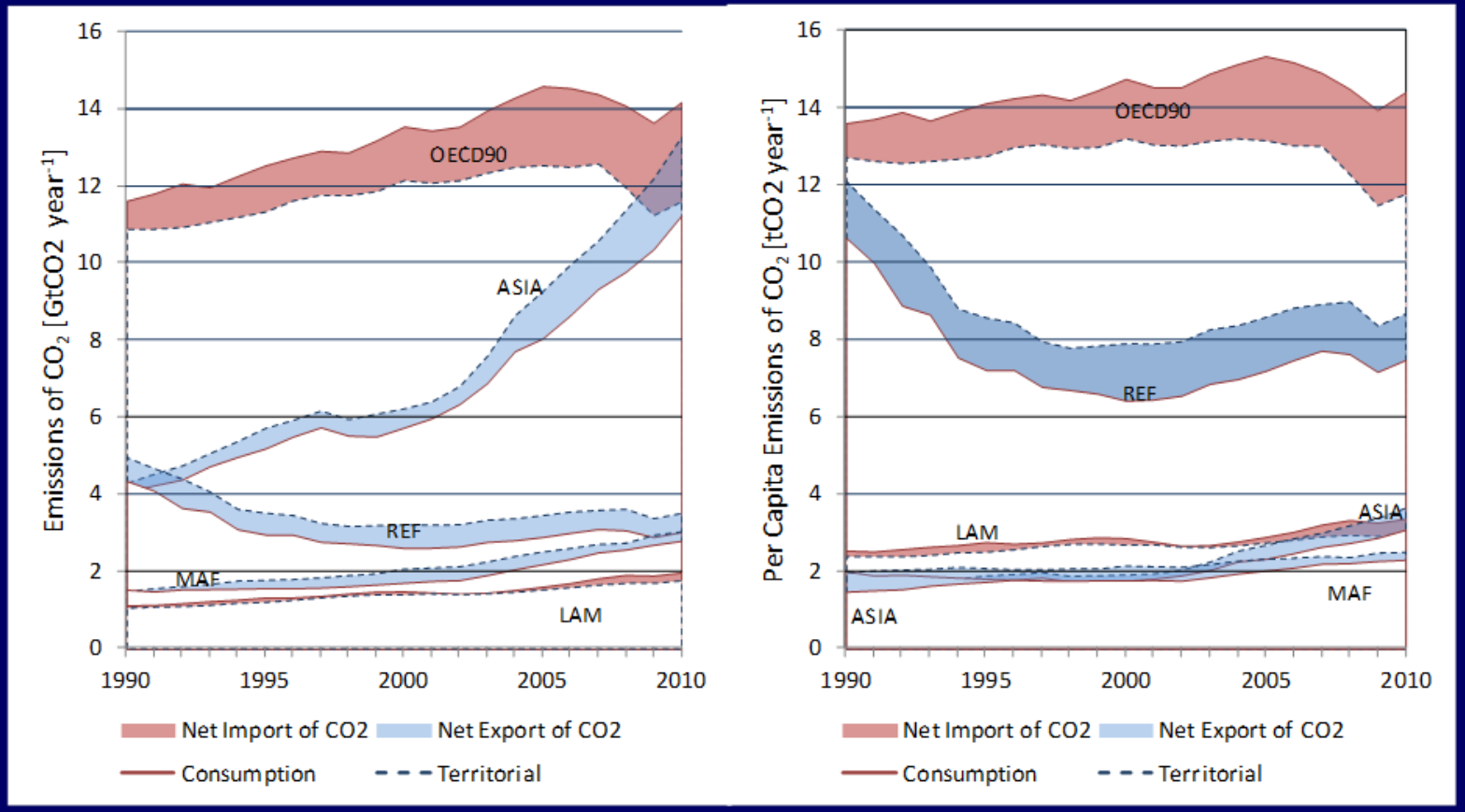


Why bring in trade, isn't it complicated enough?

- Necessary to take trade into account in order to correctly diagnose the problem AND to correctly evaluate effects of policy actions to address the problem

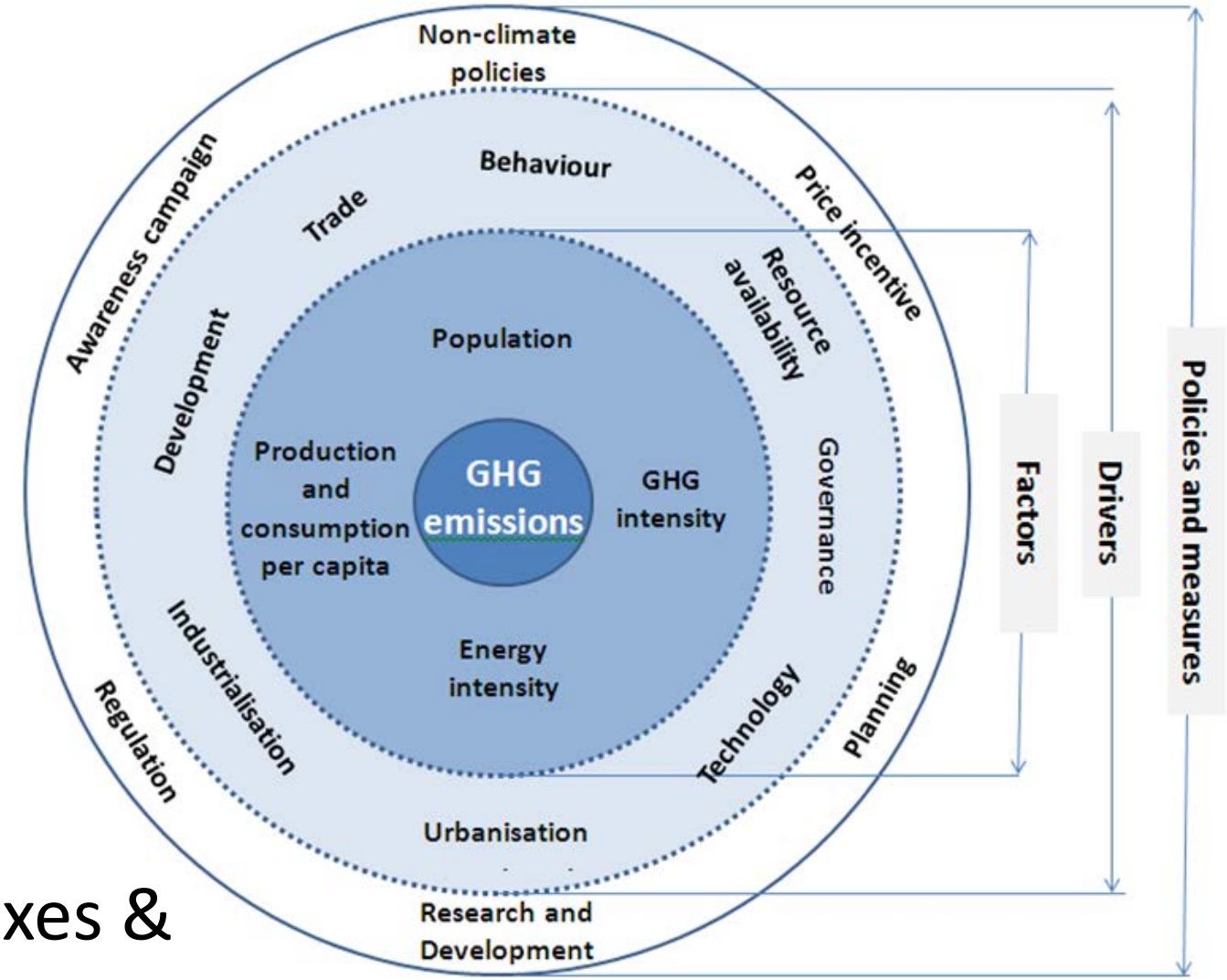
- Consider trade and carbon emissions -

Role of trade in emissions ACCOUNTING



THESE ARE NOT INTERACTIONS THAT CAN BE CONSIDERED SEPARATELY

Figure from IPCC 5th AR WG 3, ch 5



It is NOT boxes & arrows. EVERY CIRCLE SPINS

We need to think about these problems in a different way

- Conventional harvesting (ax cutting a log)
  - Choose economically profitable or culturally preferred species/stocks
  - Fish ages and sizes most attractive to markets
  - Fish them as close to MSY as possible (maybe back off on forage species)
- Serious ecosystem problems from waste, bycatch, habitat impacts.
- CREATES wealth but distribution is ???

Balanced harvesting – a plane peeling layers off the log

- Fish all species in the system at the same %age of their respective productivities
- Spread harvesting in space and across all interacting species and sizes in the area
- Considered to have maximum harvest for regulated degree of perturbation of ecosystem - OR
- Have minimal achievable impact on ecosystem structure and function for a given total yield that is needed.

On log scale these "ripples" are bad, and . Truncation on X axis also bad

Unmanaged subsistence fishery performed much better

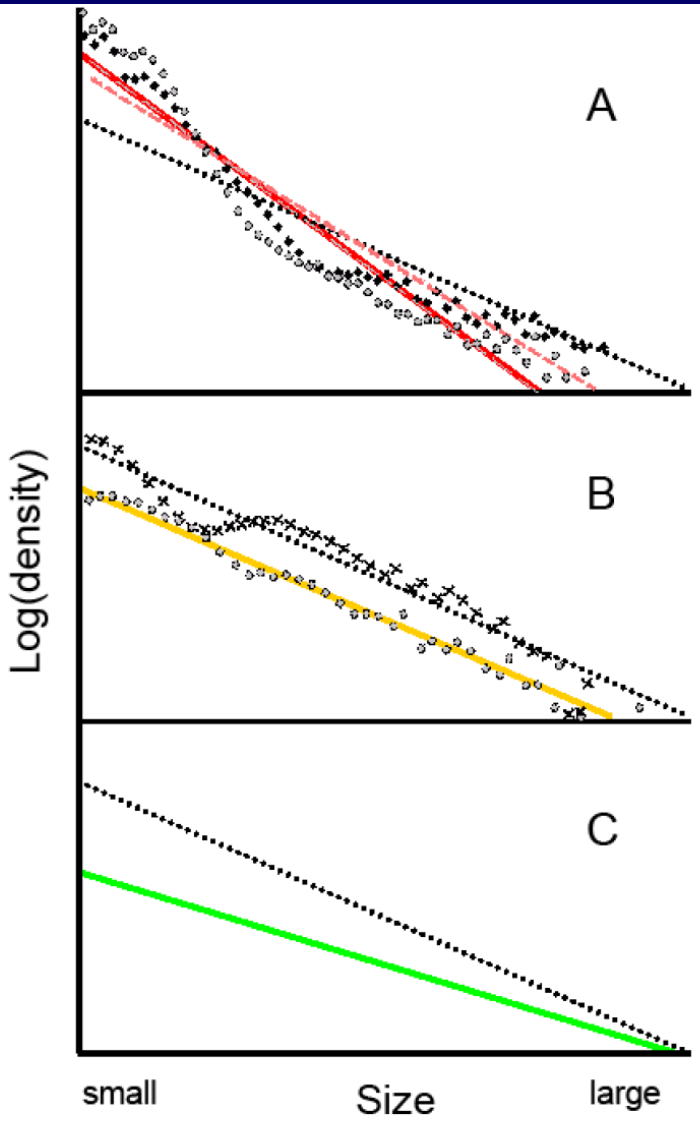


Figure 1: Alternative harvesting strategies on a fish community and the resulting size spectra[17]. Dotted lines are before fishing. A) Conventional selective fishing: superimposed are North Sea data from two periods, 1983–1987 (black diamonds and dashed regression line), and after more accumulated fishing impact, 1998–

But BH brings NEW problems

- Runs counter to market based harvesting
- Runs counter to many cultures in the world
- Allows some take of “Iconic” species
- Don’t have productivity estimates for many stocks
- Need new technologies to spread the harvesting in more targetted was.
- These are NOT harder challenges than fisheries met in the 1950’s (at the time)

We don’t have the governance structures to even start this type of dialogue

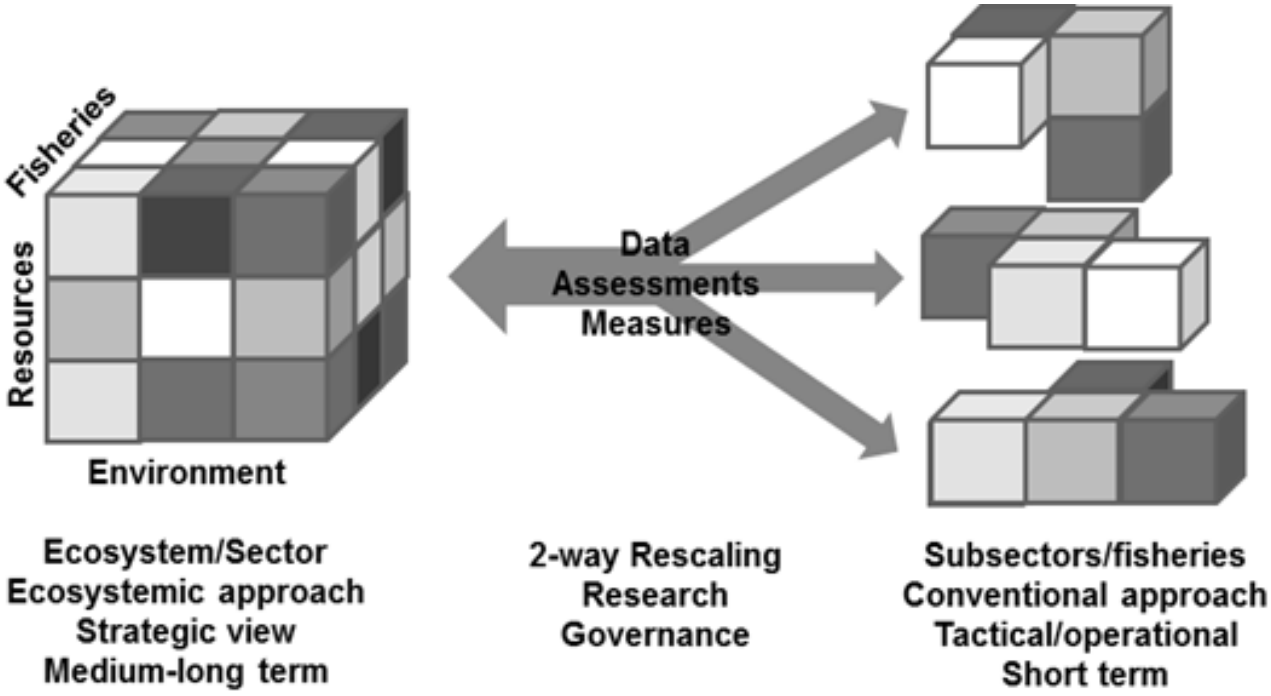
BUT THAT IS ANOTHER TALK

Overarching thesis:

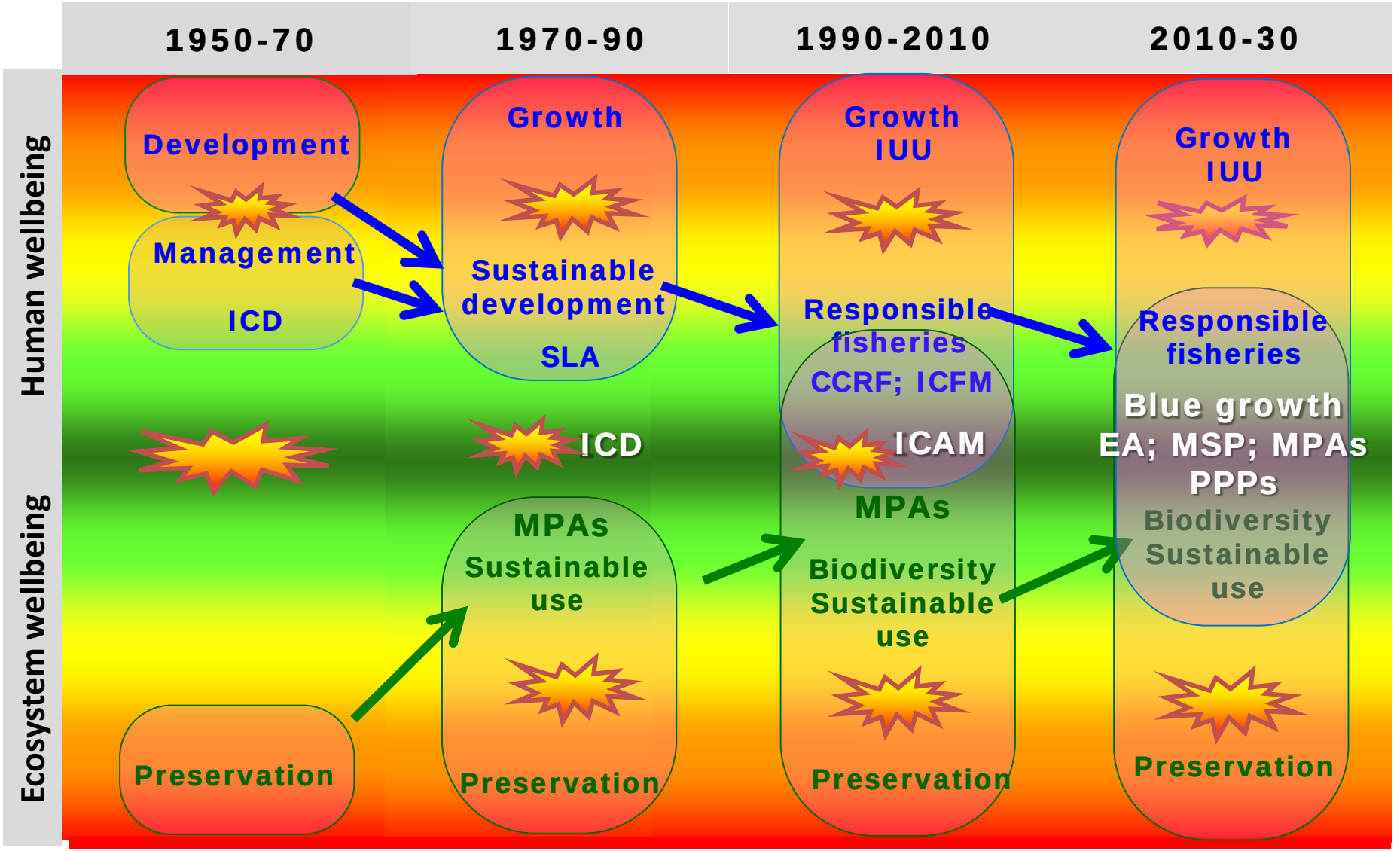
For any policies and management measures for food security, conservation of biodiversity, and sustainability of fisheries to succeed, they all have to be coherent across institutions.

What are the challenges to policy coherence across issues?

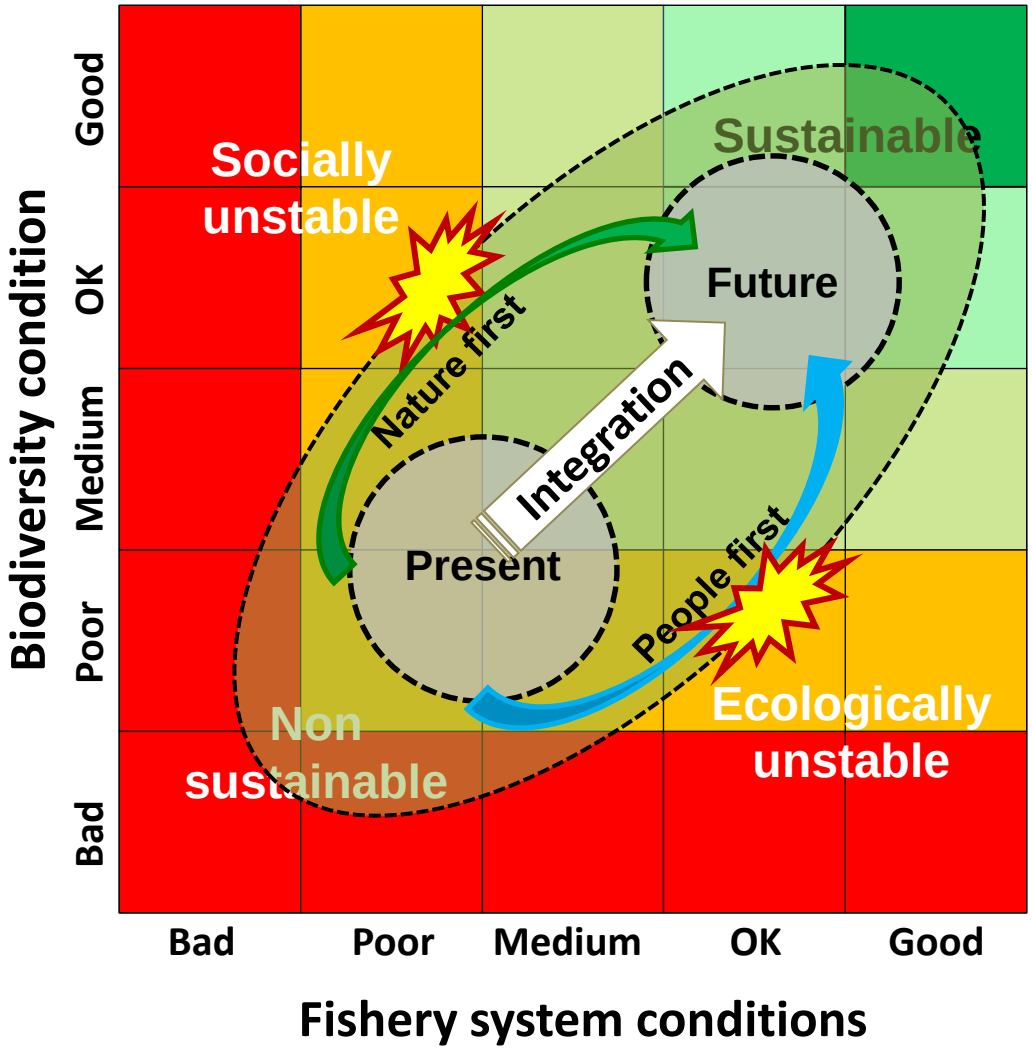
Some success at integrating sectoral governance at local level,



Some actual government institutions actually show convergence



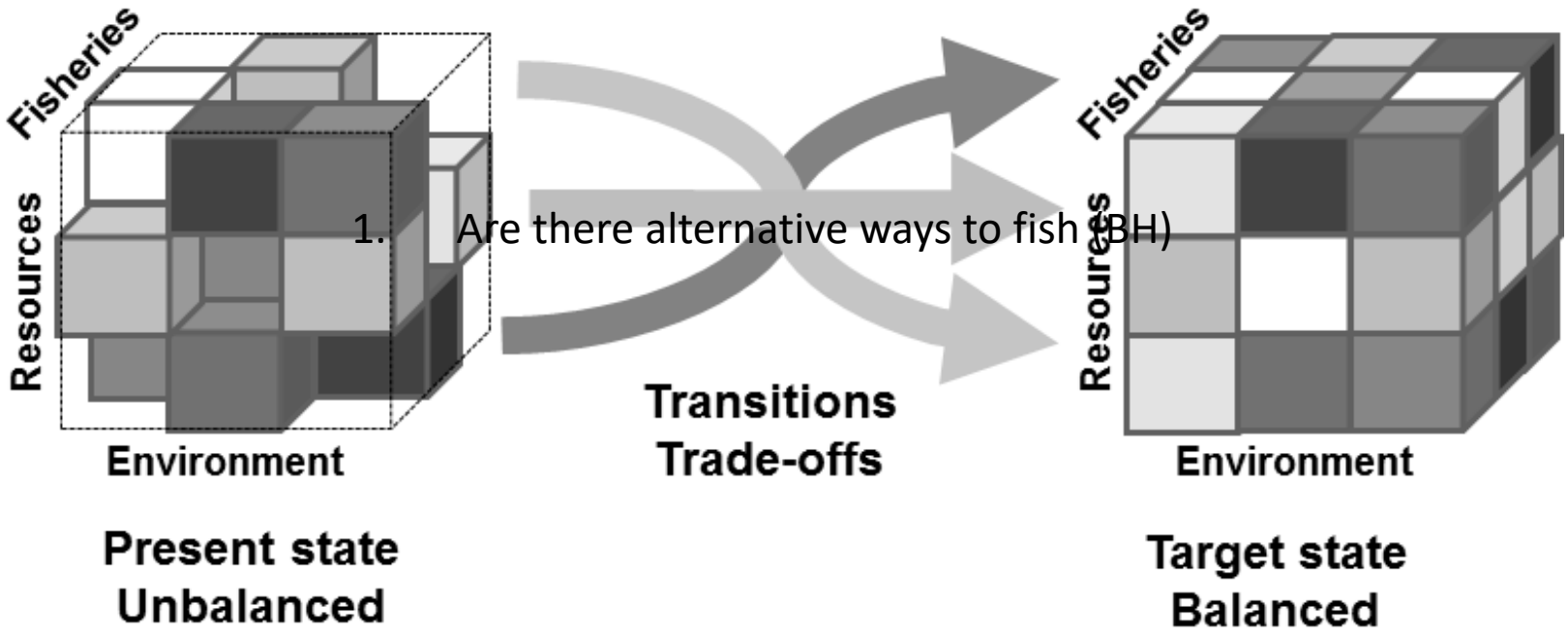
But little Trust among actors, and there are multiple Pathways



Without a better integration of assessment, decision and performance evaluation processes, both streams are likely to fail to achieve their main goals

Redrawn and modified from Garcia (1997) based on Prescott-Allen (1996)

Trade-offs and Pathways can lead to BH – but takes patience and creativity
BOTH patience and creativity suffer under totally top-down policy



1. Are there alternative ways to fish (BH)

Messages

- We do not have the “right” society choices
- We are concerned:
  - Science - policy dialogues about climate change and food security and climate change and biodiversity are proceeding in parallel
  - Likely outcomes of dialogues are NOT COHERENT
  - Tension of “Fascist” vs “Socialist” environmentalism

Without a merger of these policy discussions, likely outcome is **failure on both pathways**

OLD problems of fisheries governance – climate change gives new urgency