

The Science of Climate Change and Fisheries

Excerpts from the ICES/PICES/IOC Symposium,
25-29 April 2010, Sendai, Japan

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International Council for the Exploration of the Sea (ICES)

Climate Change Effects on Fish and Fisheries: Forecasting impacts, assessing ecosystem responses, and evaluating management strategies

- more than 300 participants from 36 countries
- six workshops
- 210 oral presentations in 10 sessions
- 115 posters



Climate Change Effects on Fish and Fisheries: Forecasting impacts, assessing ecosystem responses, and evaluating management strategies

Forecasting impacts: from climate to fish, from fish to markets

Sustainable strategies in a warming climate

Downscaling variables from global models

Species-specific responses, ecosystem responses

Geographical gradients of responses (near-shore, shelf, oceanic; latitudinal)

Impacts on coastal communities and evaluating human responses

Contemporary and next generation models, advance and approaches

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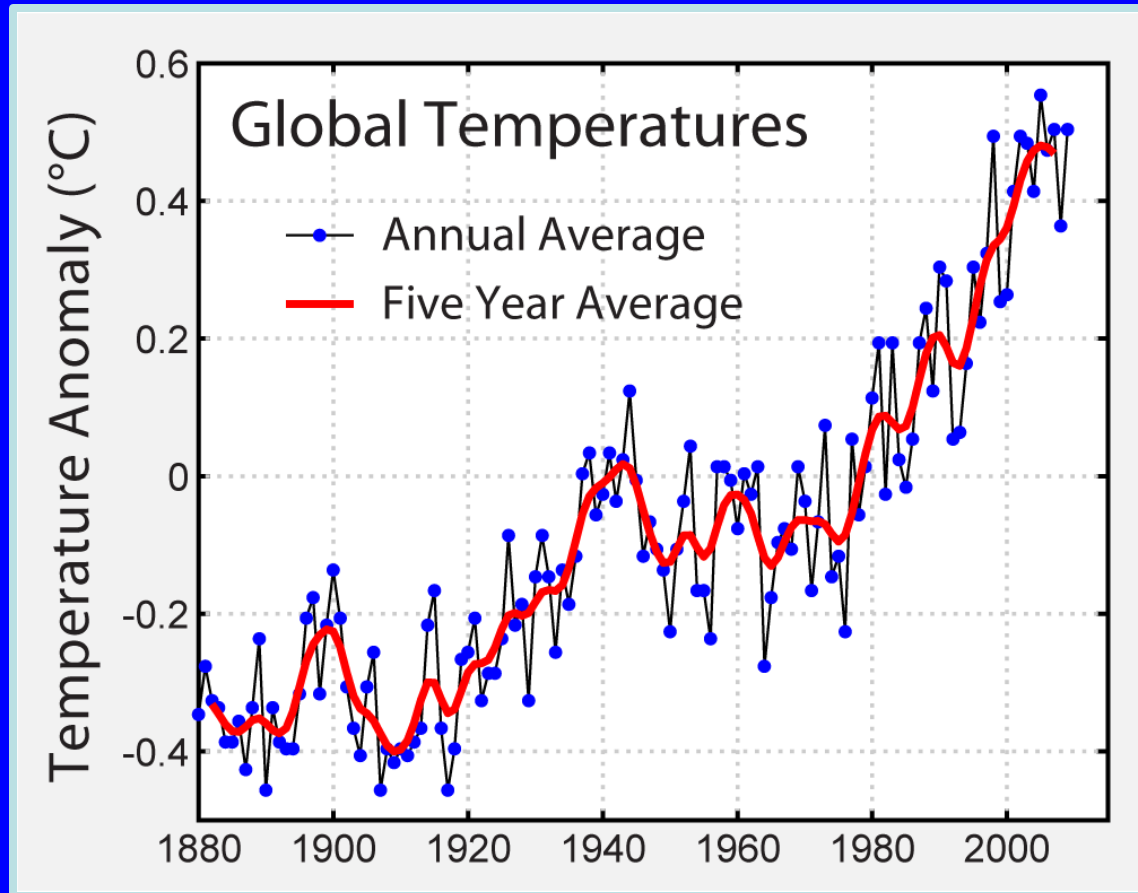
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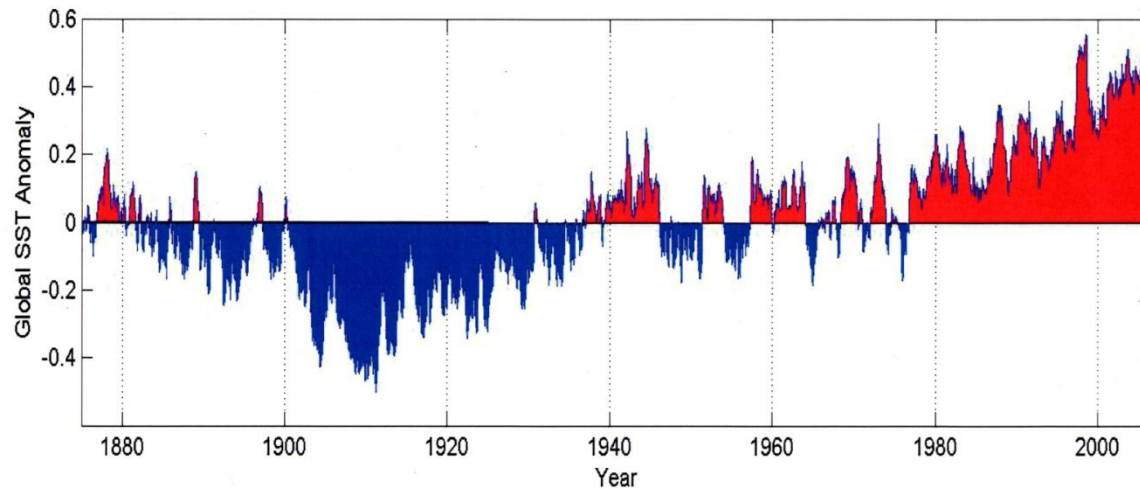
Contemporary and next generation models, advance and approaches

Environment is Changing Rapidly



IPCC (2007) anticipated increase of 1.1 °C to 6.4 °C by 2100

Global Sea Surface Temperature Anomaly, 1880-2005

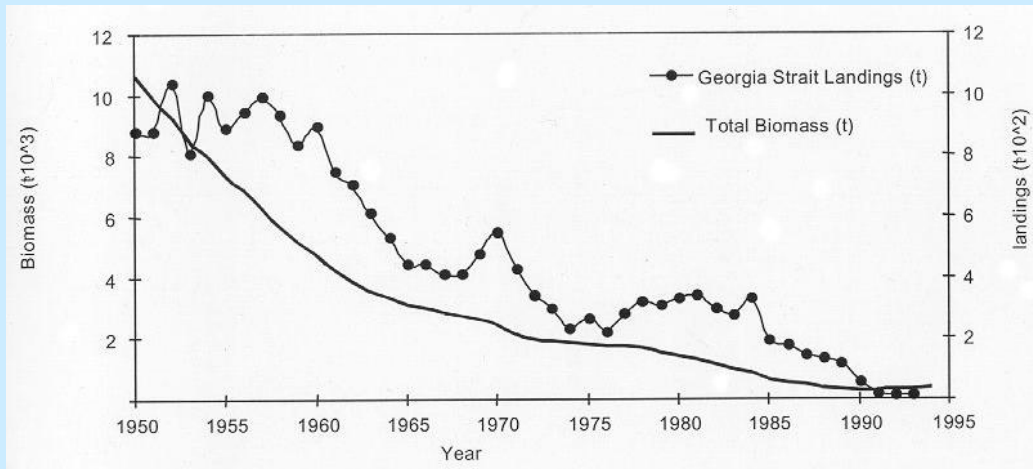
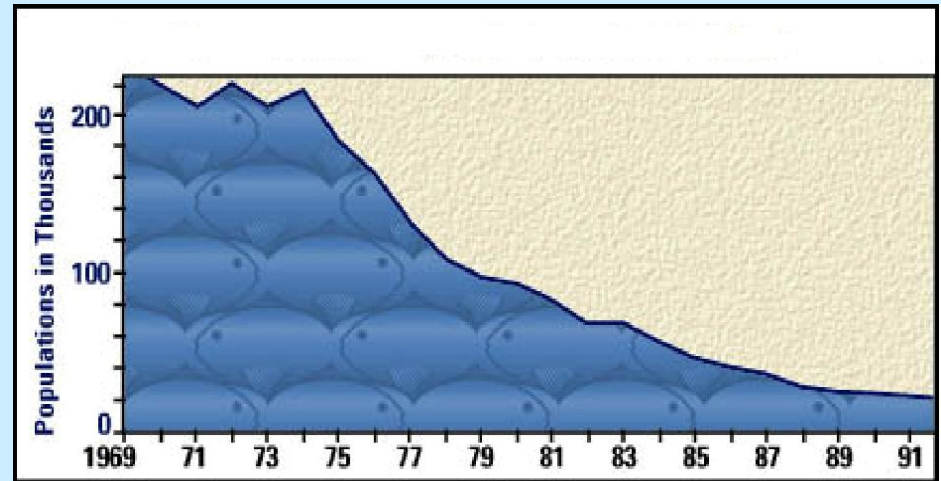


Courtesy Francisco Chavez, MBARI

Nielsen@Sendai 2010

Even without factoring in climate change fisheries are in trouble

Bluefin tuna in the Atlantic ...



Lingcod in British Columbia ...

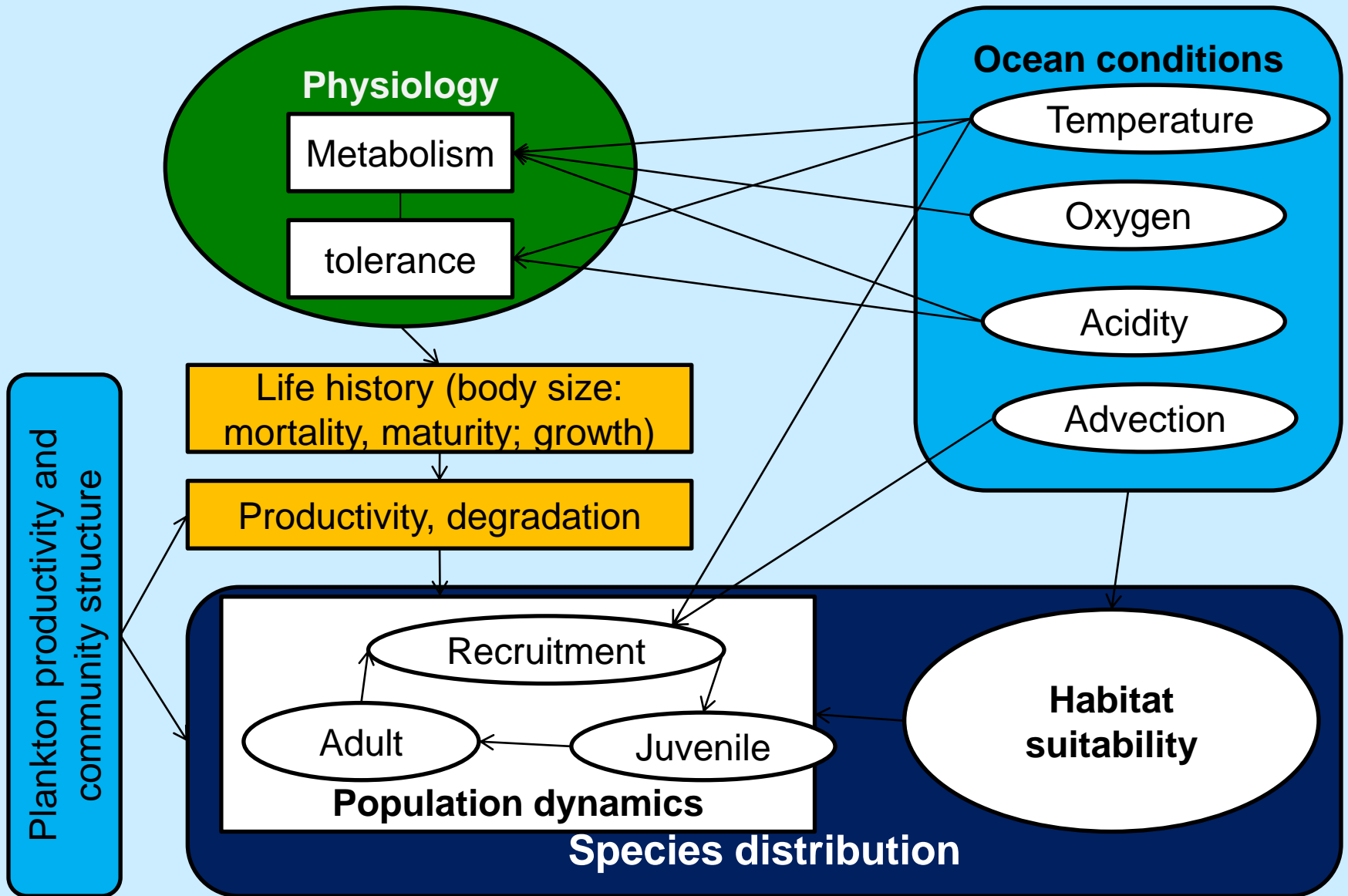
What are the climate change impacts?

- Productivity and distribution of fish biomass in the global ocean will be affected:
 - Shifts in distributional ranges of marine species;
 - Changes in ocean primary productivity;
 - Shifts in timing of peak abundance and migration of biological communities;
 - Mortalities and physiological stress by expansion of oxygen minimum zones and hypoxia areas;
 - Ocean acidification, which affects calcification, other physiological processes and growth of marine species.

Impact of climate change on fisheries

- Climate change will impact human welfare:
 - Catches;
 - Food security;
 - Catch (landed) values;
 - Cost of fishing;
 - Profits to fishing companies;
 - Income to fishers;
 - Economic rent to resource owners;
 - The distribution of benefits to different countries, regions and groups.

Forecasting impacts: physics to fish, ecosystems



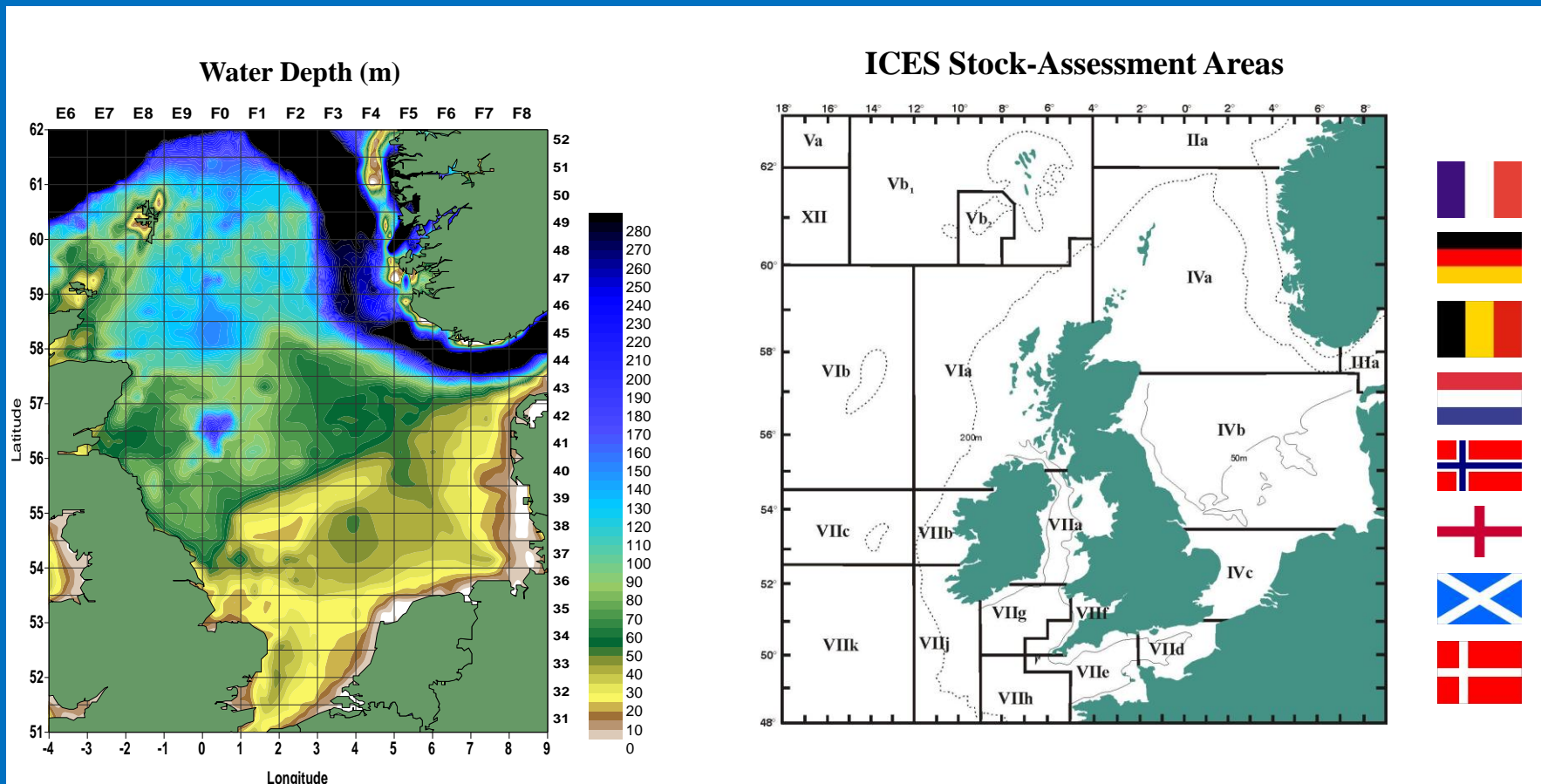
How has climate change impacted marine food-webs in the past, and how might we predict changes in the future?



John K. Pinnegar, Georg Engelhard, Julia Blanchard, Joe Scutt-Phillips, William Cheung

International Symposium: Climate Change Effects on Fish & Fisheries, Sendai, Japan. Session A2

Monday 26th April, 2010



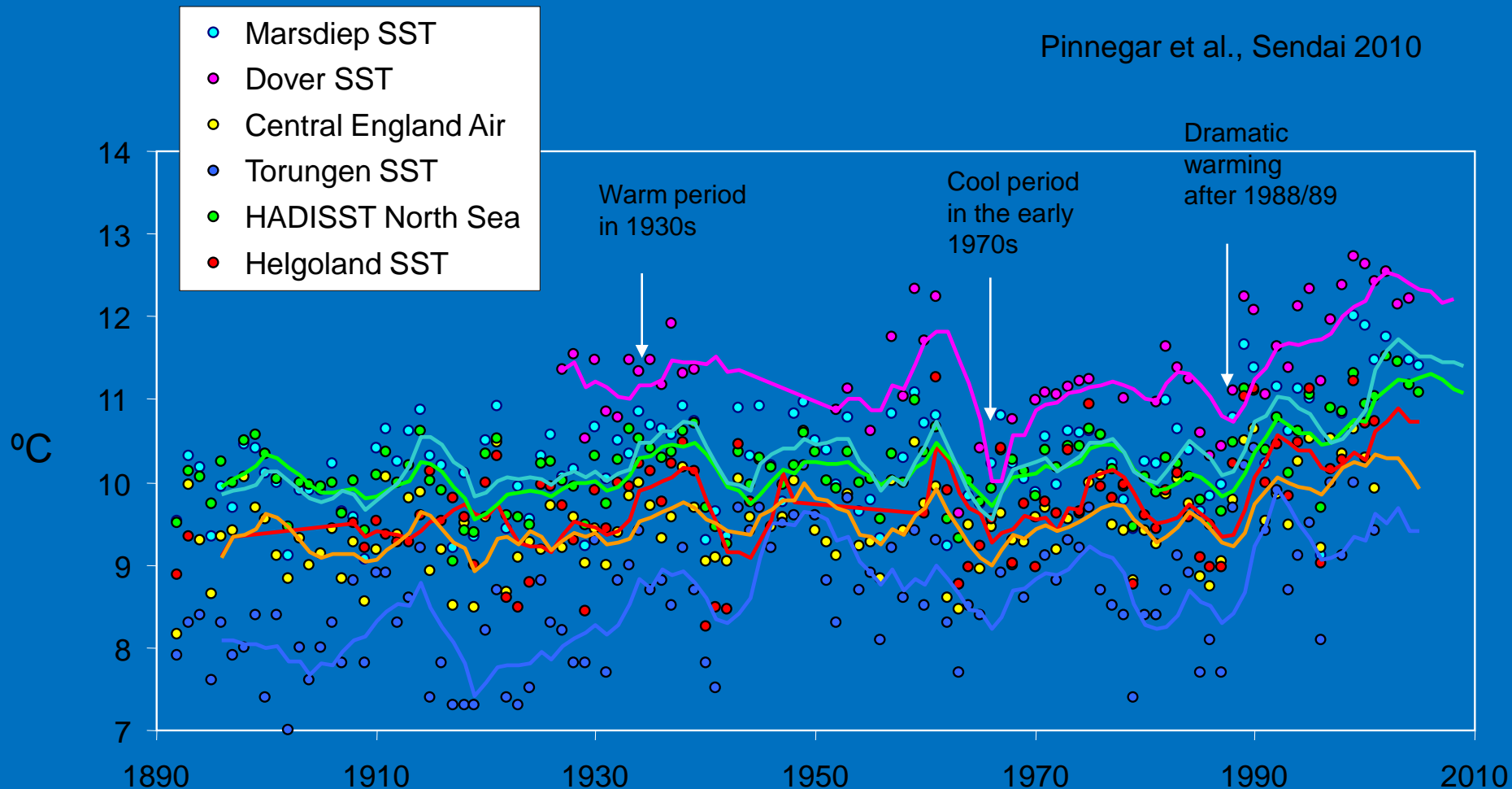
- The North Sea is a semi-enclosed basin with a depth ranging from 30m – 200m
- The ecosystem is dominated by soft-bottom habitats (sand, mud, gravel)

The north Sea harbours a wide range of fish stocks exploited mainly by: France, Germany, Belgium, Netherlands, Norway, England, Scotland, Denmark.

There have been big changes in sea surface temperature (SST)

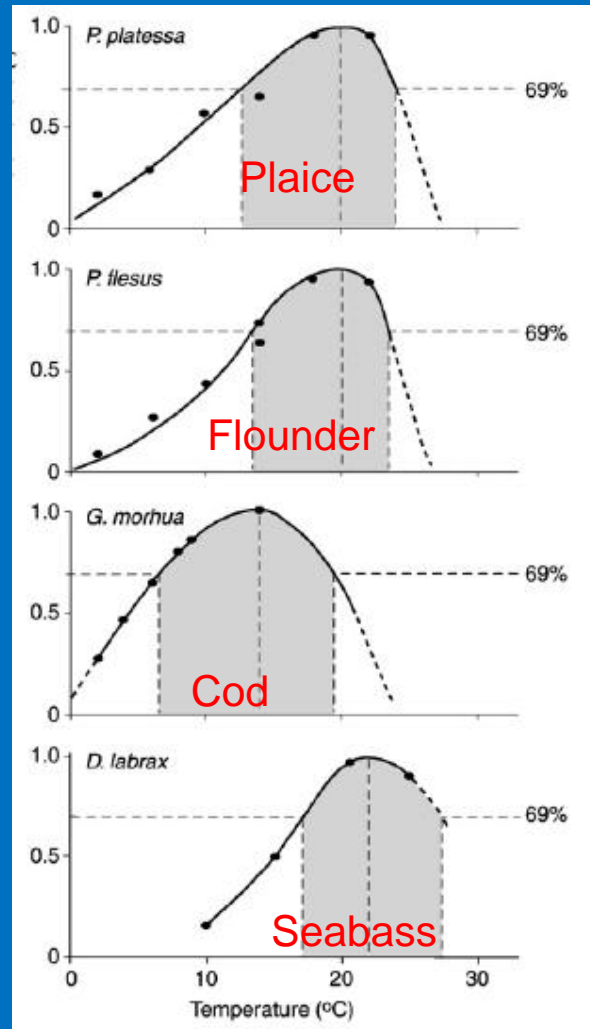
Note the generally close correlation between time series & the overall warming trend during the 20th Century

Pinnegar et al., Sendai 2010



Changes in fish distribution (across Europe)

Thermal performance



Temperature is one of the primary factors, together with food availability and suitable spawning grounds that determine the large-scale distribution patterns of fish.

Because most fish species prefer a specific temperature range, an expansion or contraction of the distribution range often coincides with long-term changes in temperature and/or climate.

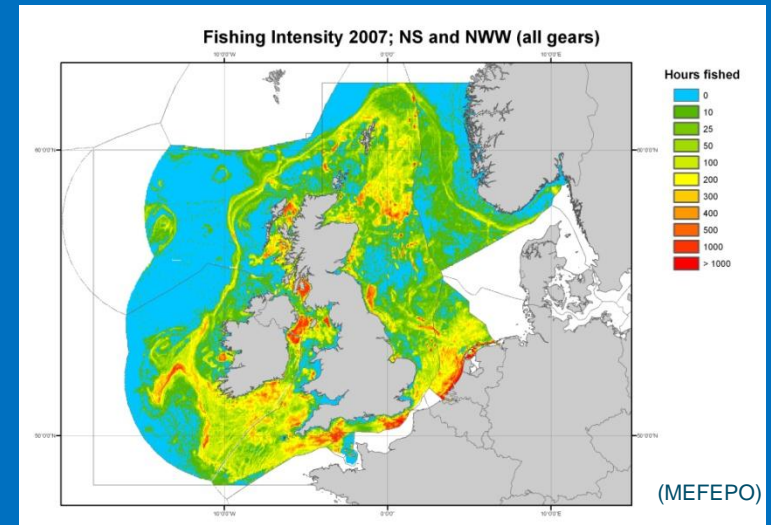
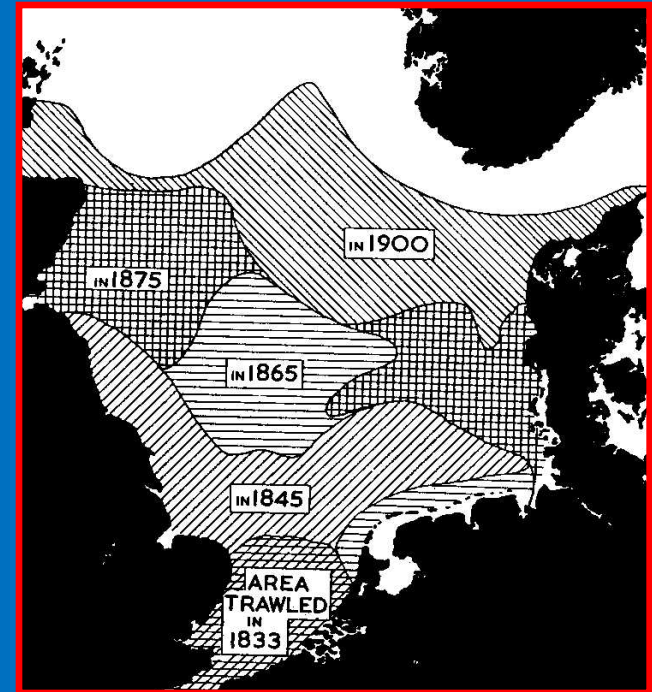
The recent warming trend in the northeast Atlantic has coincided with an apparent northward shift in the distribution of fish species from southerly latitudes

However there have also been big changes fishing pressure.....

Fishing mortality rates have been higher in the southern North Sea than in the north (Heath et al., 2003, Heath et al., 2007).

Apparent changes in distribution (as indicated by Perry et al. 2005) could simply be a consequence of **local patterns of fishing pressure and different rates of depletion** in spatially segregated sub-stocks.

Pinnegar et al., Sendai 2010



What will distribution shifts mean for fisheries?

- Populations may move away from (or towards) the area where fishing fleets operate.
- Distribution changes may have significant consequences for the **distance that must be travelled by fishing boats** to reach the target resources with implications for **fuel usage and time at sea**.
- Also species distributions may migrate across **the boundaries where quotas belong to different nations**.
- Species may move outside the boundaries of **marine protected areas / fishery closure areas**
- Incoming species may be commercially exploitable and therefore offer **new opportunities for fisheries**.



Climate change, fisheries and aquaculture in the Pacific:

Implications for food security,
livelihoods & economic
growth

Johann Bell

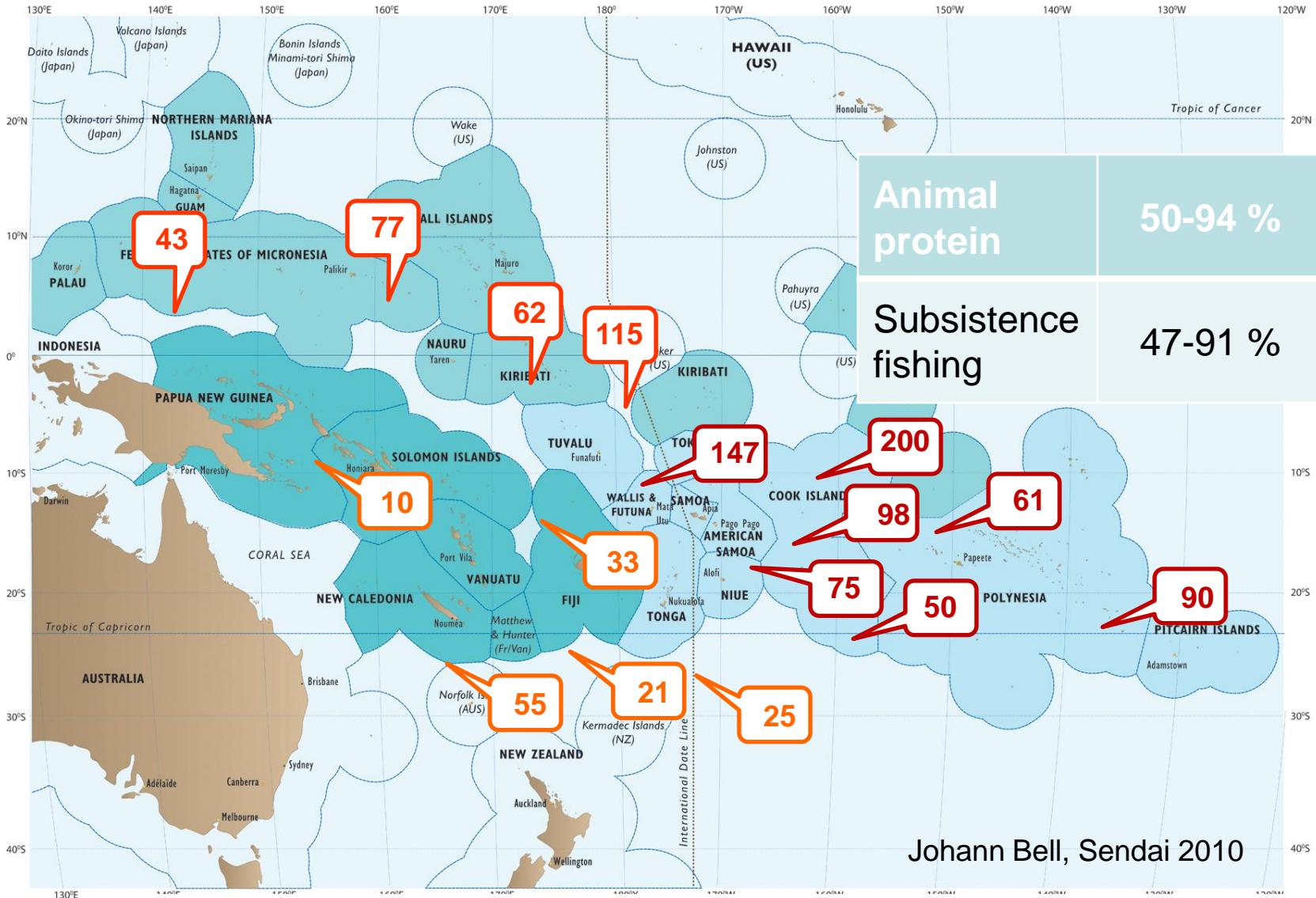
Roles of fisheries and aquaculture



- Food security
- Livelihoods
- Economic growth and government revenue

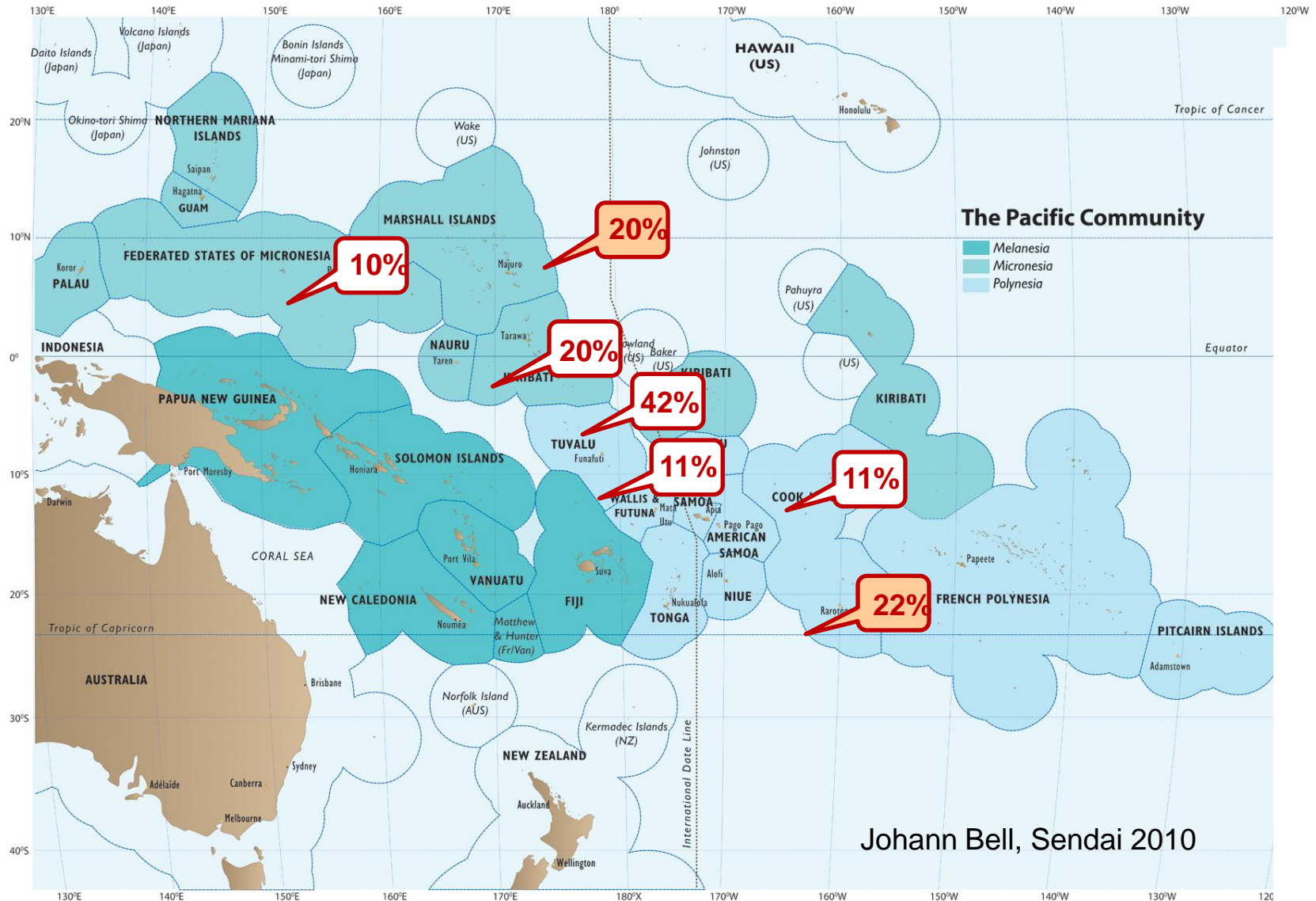
Food security

- Per capita fish consumption - rural (kg)



Economic contributions

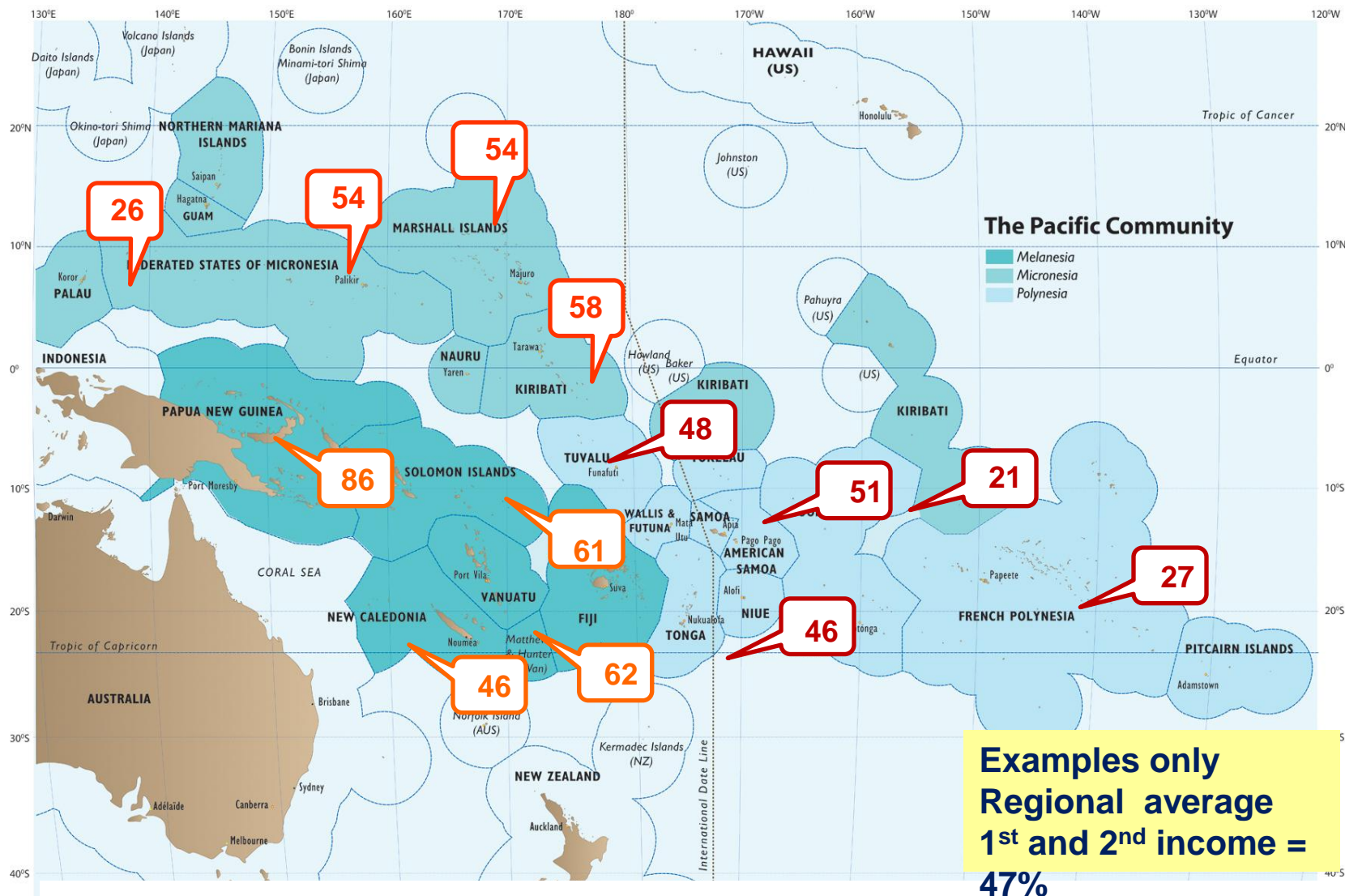
- Government revenue  GDP 



Livelihoods

Johann Bell, Sendai 2010

- Coastal households selling fish (%)





Socio-Economic Impacts of Climate Change on Coastal Communities: The Case of the north coast of java small-pelagic fisheries

Akhmad Fauzi

Bogor Agricultural University (IPB)

Subandono Dipoastono

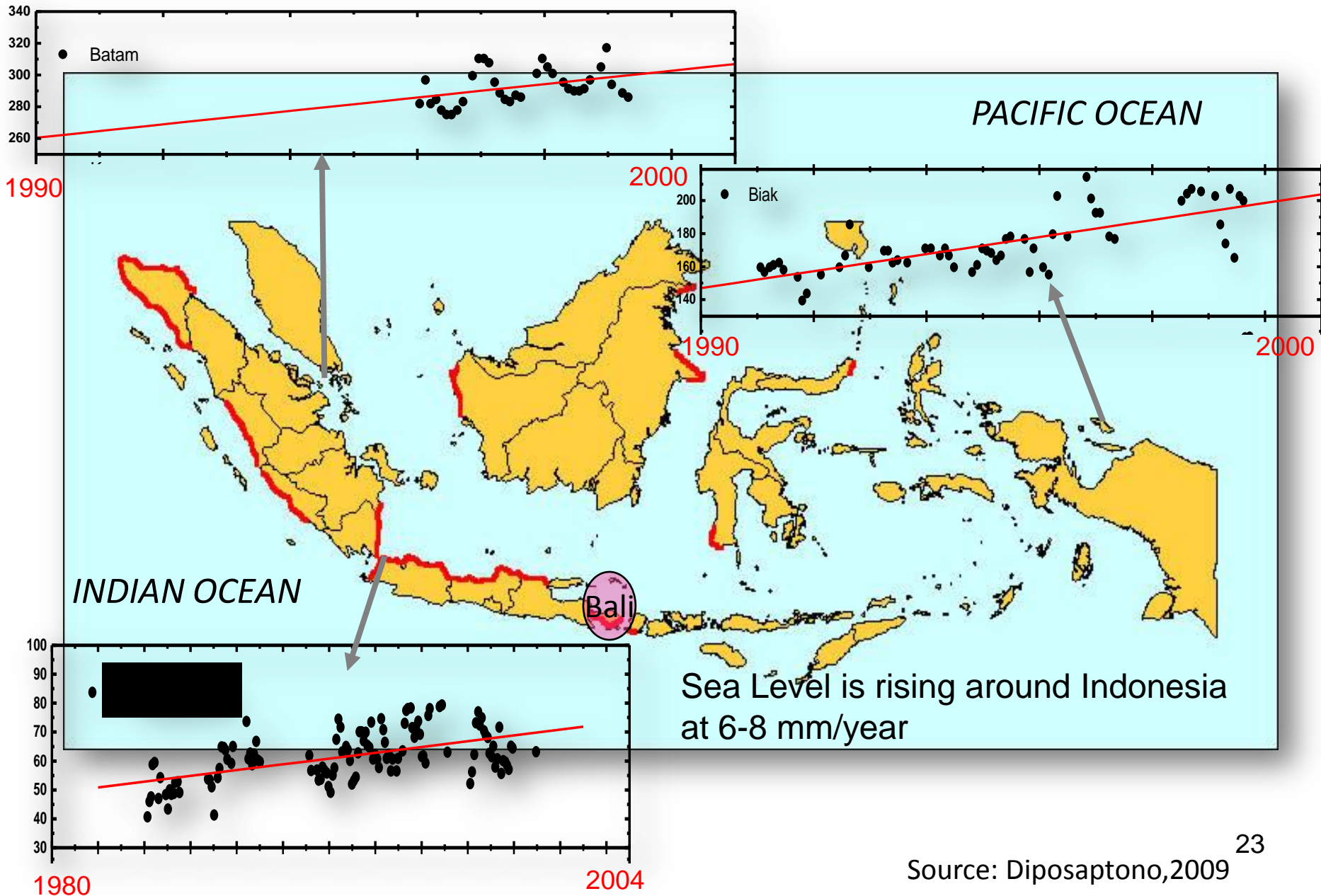
Ministry of Marine Affairs and Fisheries, Republic of Indonesia

Suzy Anna

Padjajaran University, Bandung Indonesia

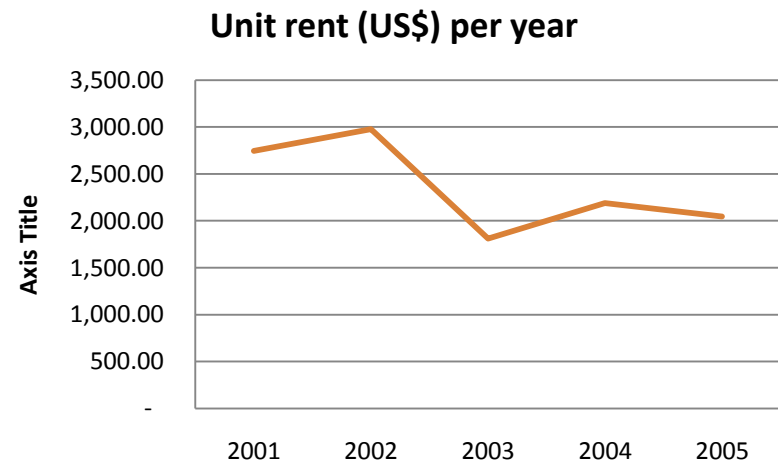
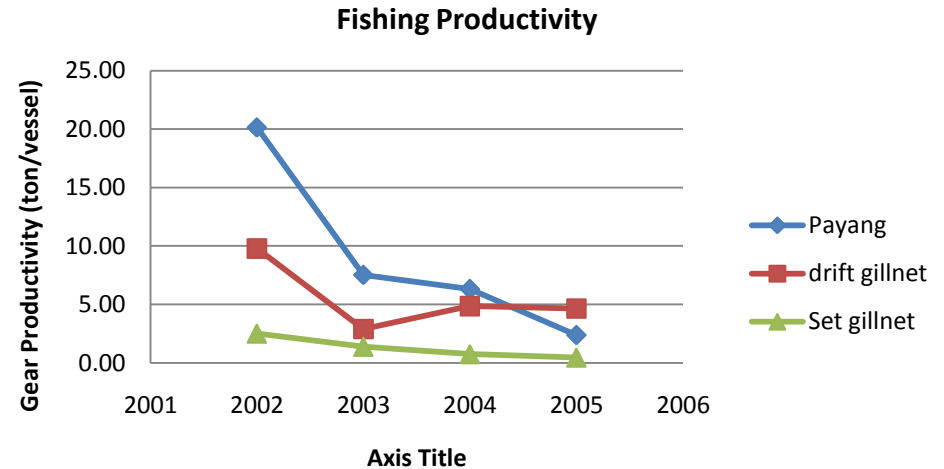


SEA LEVEL RISE IN INDONESIA



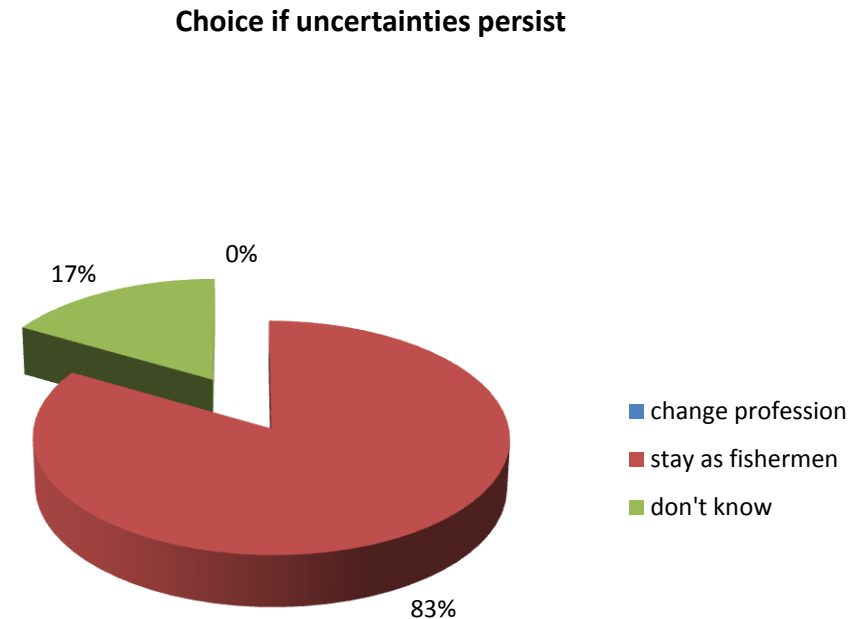
Impacts of climate variability on small-scale fisheries

- Productivity declines on average around 80%
- Unit rent (proxy for gross incomes) declines from US\$ 3000 to US\$ 2000 per gear per year
- Per capita income declines between US\$ 1.4 and US\$ 0.6 per capita per day
- In 2005 rising fuel price adds to “double jeopardy” of poverty



What if uncertainties due to climate variability persist?

- Stay as fishers no matter what
- Fishermen is the employment of the last resort
- Fishing is life style preference
- Reluctant to move out
- Develop strategies to deal with uncertainties



Summary (1/2)

- Climate Change impacts on marine ecosystems, including fisheries, now a **major area of research**,
- particular advancements in the area of Earth System **modeling**, in linking climate, ecosystems and socio-economics;
- however, the global view of climate impacts on fish and fisheries is **patchy** and still **emerging**
- Validating **higher trophic level** outputs, and social, economic and behavioral mechanisms is still difficult, given the limited amount of comparable data
- Shelf **models** are starting to be developed, but there are technical issues to be resolved on the boundary conditions between shelf models and global models, particularly in continental shelves and upwelling areas (where fishery productivity is greatest)
- Climate, fishing, nutrient enrichment, habitat loss, toxics and other human-driven issues are confounded by **additive** to **multiplicative** factors. Understanding their relative **knock-on** impacts is of interest to society

Summary (2/2)

- The **latitudinal** response to climate change (by both species and ecosystems) is inverse to the adaptive capacity of societies- **access** to science and adaptation resources must be **facilitated** so as to contribute to environmental justice issues
- Impacts to fishing sector in **developing countries** may be **2-3 times higher** than in developed countries, requiring a higher adaptation costs than developed countries under all the scenarios considered;

Thank you for listening!