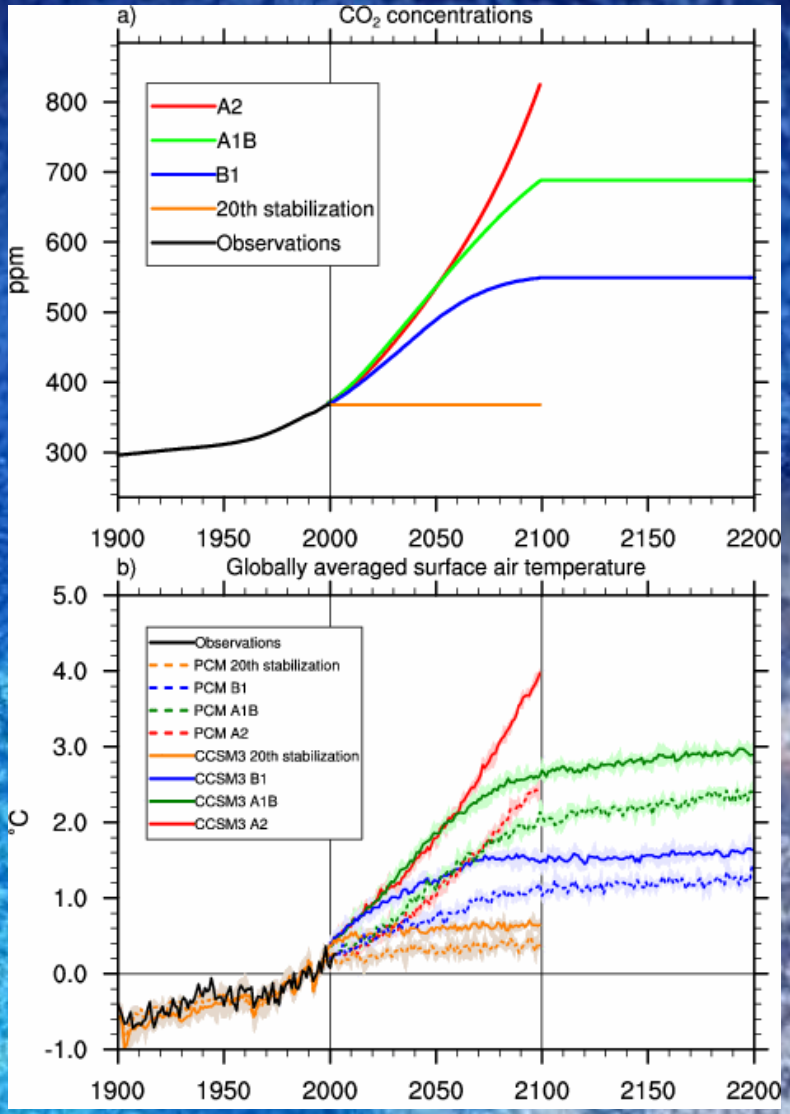
Global Perspectives on Climate Change Effects on Fish and Fisheries: messages from an ICES/PICES/FAO Symposium.

Anne B. Hollowed (NOAA),
Suam Kim (Pukyong Univ.)
+ selected symposium participants

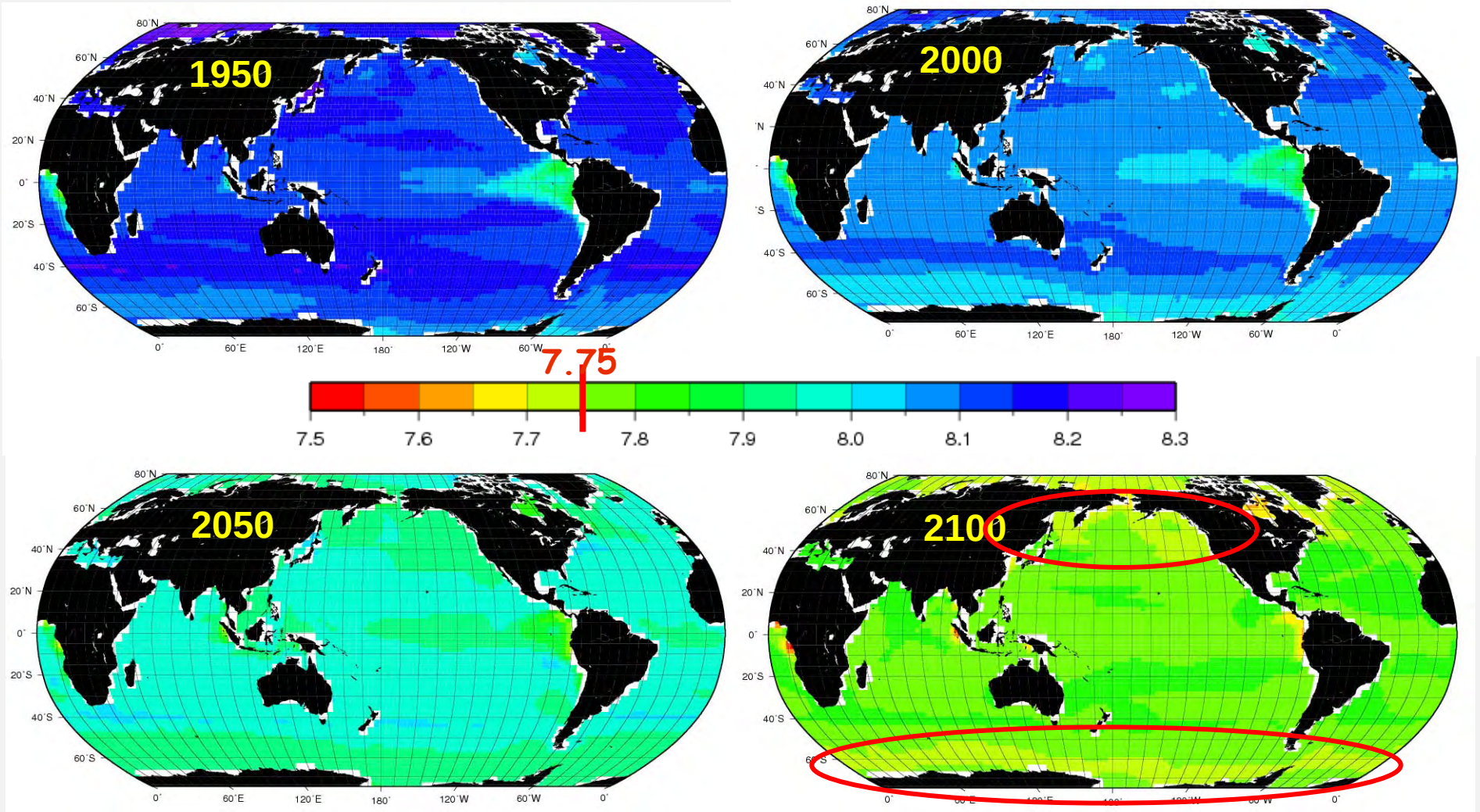
Intergovernmental Panel on Climate Change (IPCC 2007 and others)

CO2

Ocean Surface Air Temperature



The Acidification of the World Ocean



'A2' Scenario from the Canadian Centre for Climate Modelling and Analysis (CCCMA) Earth System Model CanESM1: *Zahariev, Christian & Denman, 2008; Arora et al., 2009, J. Climate; Christian et al., 2010, JGR-Biogeosciences*

ICES/PICES/FAO Symposium

April 26-29, 2010 Sendai, Japan

P1: Forecasting impacts: from Climate to Fish

P2-D1: Forecasting impacts: from fish to markets

A1: Downscaling variables from global models

A2: Species-specific responses: changes in growth, reproductive success, mortality, spatial distribution, and adaptation

B1: Assessing ecosystem responses: impacts on community structure, biodiversity, energy flow, and carrying capacity

B2: Comparing responses to climate variability among nearshore, shelf and oceanic regions

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C1: Impacts on fisheries and coastal communities

C2: Evaluating Human Responses, Management Strategies, and Economic Implications

D2: Contemporary and next generation climate and oceanographic models, technical advances and new approaches

P3: Sustainable strategies in a warming climate.

Six Workshops on April 25

W1: Reducing global and national **vulnerability** to climate change in the fisheries sectors: Policy perspectives post Copenhagen

W2: Potential impacts of **ocean acidification** on marine ecosystems and fisheries

W3: **Coupled climate-to-fish-to-fishers models** for understanding mechanisms underlying low frequency fluctuations in small pelagic fish and projecting its future

W4: **Salmon** workshop on climate change

W5: Networking across global marine "**hotspots**"

W6: Examining the linkages between physics and fish: How do zooplankton and **krill** data sets improve our understanding of the impacts of climate change on fisheries?

Our Global Representation

Participating country

Non-participating country

What we found from the Symposium?

Key finding 1: Shelf Seas Models have already been developed for our region.

Key finding 2: 3 sources of uncertainty in GOMs

Key finding 3: Multiple methods to predicting physics to fish. Each has strengths and weaknesses.

Key finding 4: Fisheries oceanography and laboratory studies are critical

Key finding 5: Considerable work is needed to couple marine so-cial & ecological systems

Key finding 6: Food security and marine conservation issues are going to collide

Key finding 7: two way communication needed with scientists and stakeholders

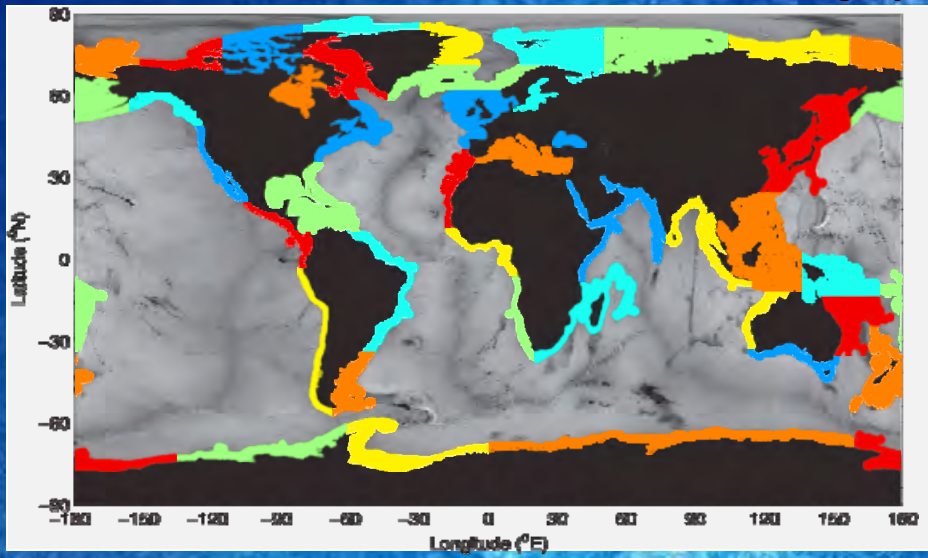
Key finding 1:
Shelf Seas Models have already been developed for our region.

GCOMS (Global Coastal Ocean Modelling System).

Model components:

- —POL-Coastal Ocean Modelling System
- —ERSEM (European Regional Seas Ecosystem Model)

GCOMS Global Coastal Ocean Modelling System



1/10°resolution

Includes important shelf processes: Tides, upwelling, Benthic/pelagic recycling

Geographically linked to LME : ocean governance scale

Although global, the models are regional

Icarus Allen: Plymouth Marine Laboratory

QUEST Quantifying and Understanding the Earth System

Key finding 2:
3 sources of uncertainty in GOMs

- Parameter uncertainty: addressed by series of sensitivity tests that alter parameter values through a reasonable range.

- Structural uncertainty: could be explored, by coupling biological models with differing complexity to the same physical model and examining the range and accuracy of the results.

- Scenario uncertainty: uncertainties in greenhouse gas emissions and can only be addressed by computing ensembles that cover a range of plausible states.

Key finding 3:
Multiple methods to predicting physics to fish. Each has strengths and weaknesses.

- Direct use: Use GCM model output as basis for global predictions of primary production, fish production and/or impacts on fishing communities/nations (e.g. Cheung or Nye)
- Dynamical Downscaling: Regional coupled biophysical models that extend from climate to fish & beyond (End-to-end Nemuro-Fish, Quest Fish, Atlantis, FEAST)
- Statistical Downscaling: "Mechanistically-based" empirical approaches (Species-specific / regional) linked to climate forecasts (Mueter)
- Conceptual models from observations (Hunt)
- Inference from field or laboratory studies

Key finding 4:
Fisheries oceanography and laboratory studies are critical

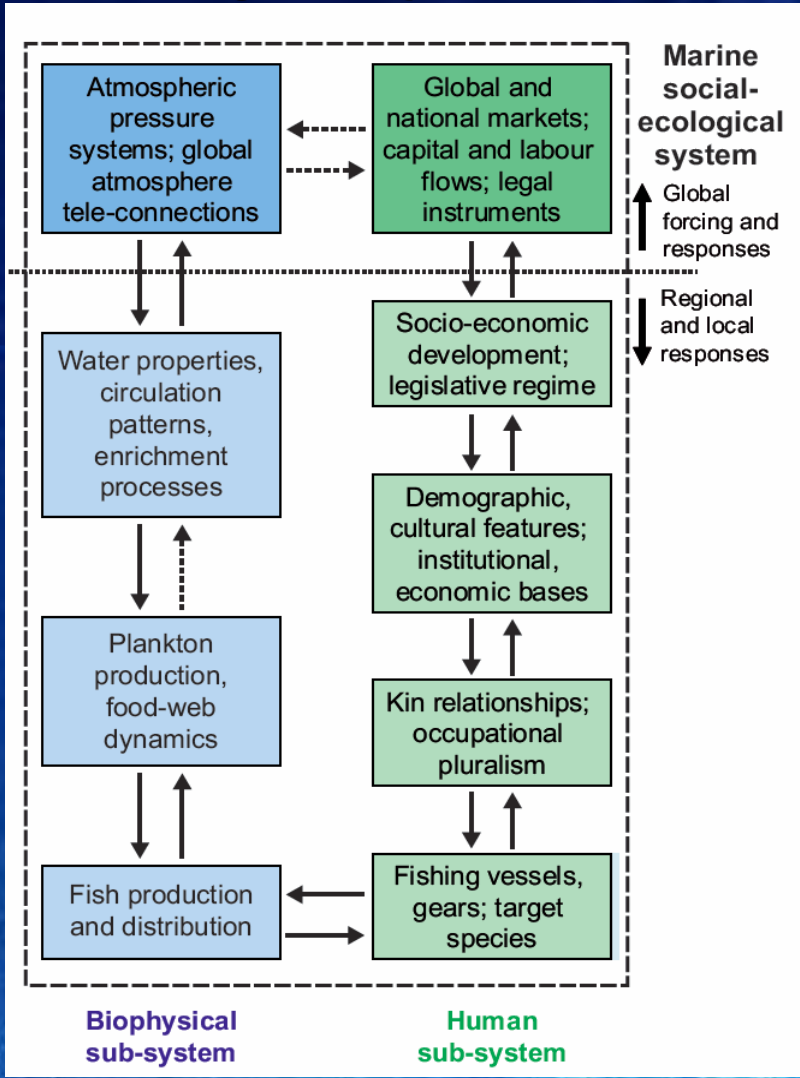
Species	talks
Antartic Krill	1
Atlantic cod	3
Atlantic herring	1
Black rockfish	1
Blue marlin	1
Bluefin tuna	1
Common squid	1
Pacific cod	1
Pacific halibut	1
Pacific herring	2
Plaice	1
Saffron cod	1
Sockeye salmon	1
Sprat	1
Swordfish	1
Yellowfin tuna	2
Yellowtail	1
Interspecific	8

A2 has 69 abstracts in the book...
296 total to sessions (~25% in A2).

Invited Presentations (2)
Oral Presentations (27)
Poster Presentations (40)

Key finding 5:

Considerable work is needed to couple marine social & ecological systems



Perry et al. 2010. In: Barange et al. Marine ecosystems and global change. OUP

Social-ecological systems:

- complex adaptive systems including social (human) and ecological (biophysical) sub-systems in two-way feedback relationships
- integrated concept of humans-in-nature
- delineation between human social and ecological systems is artificial

Berkes. In Press. In: Ommer et al. World Fisheries: a social-ecological analysis. Wiley-Blackwell.

Key finding 6:
Food security and marine conservation issues are going to collide

2006 –

- Capture fisheries stabilized at 85-95 mmt.
- Aquaculture ~ 40 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 = 73 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

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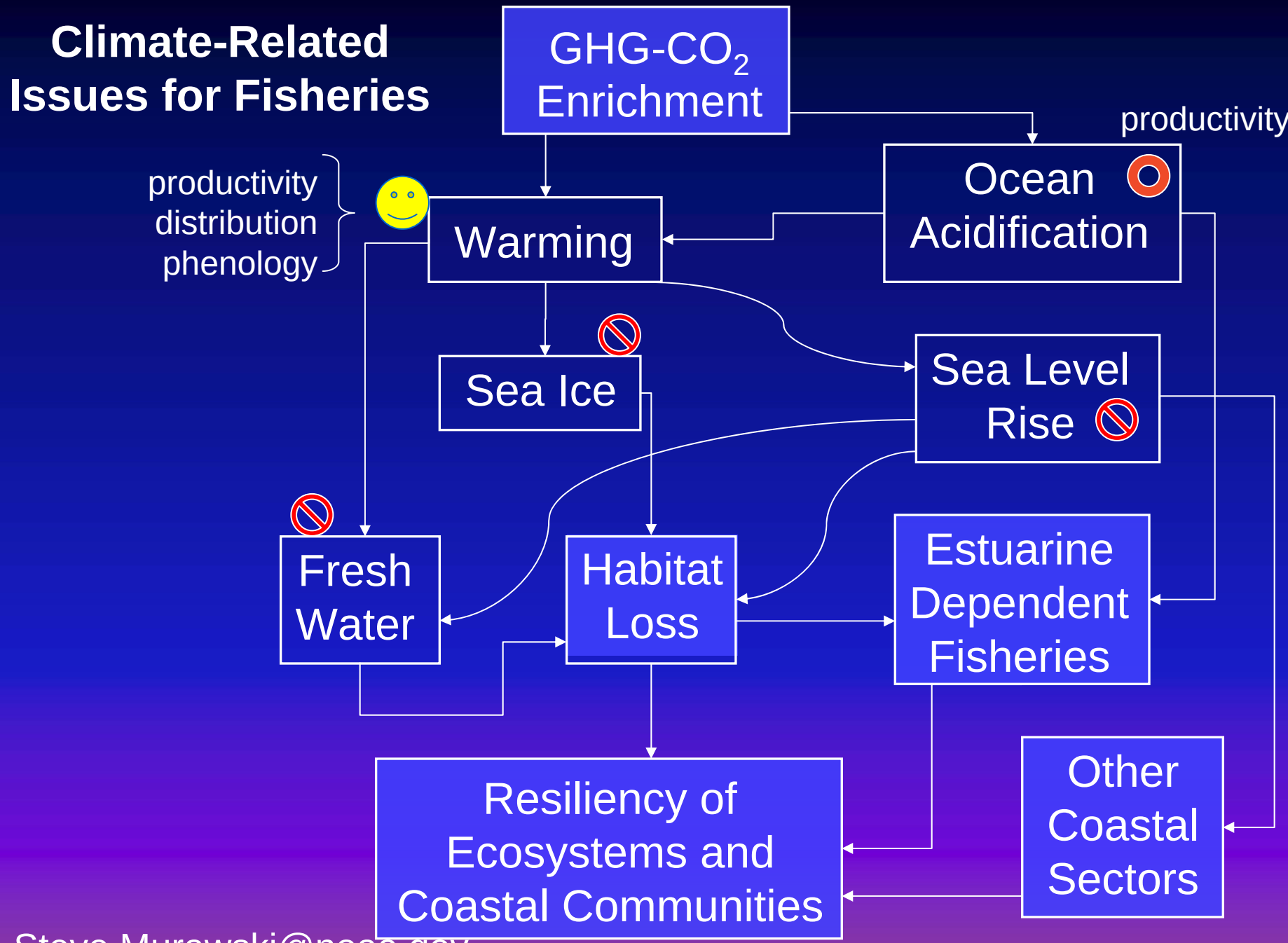
Climate-Related Issues for Fisheries



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Messages

- Research on fundamental question of adaptation and environmental tolerances for marine species is needed.
- Field and laboratory studies are needed to understand the responses of fish and humans to a changing climate.
- Climate, fishing, nutrient enrichment, habitat loss, toxics and other issues are confounded by additive to multiplicative factors. We need an holistic approach to these analytical issues.
- Strategies are needed to project responses of fish and fisheries and social systems to understand ecosystem and community effects.