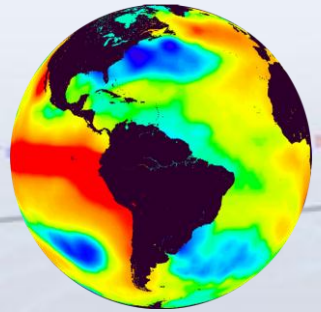




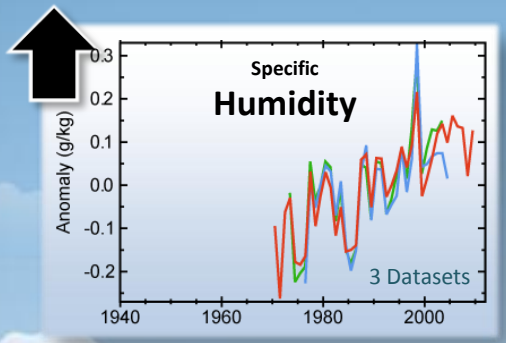


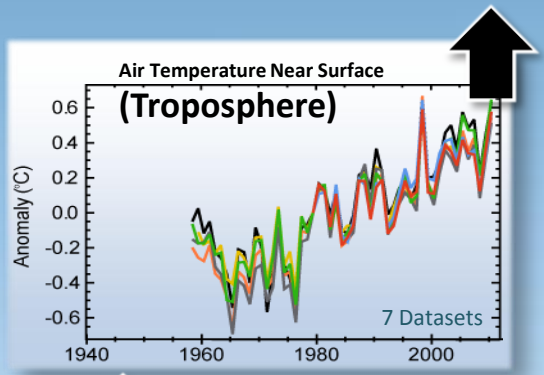
Climate, fisheries and food security

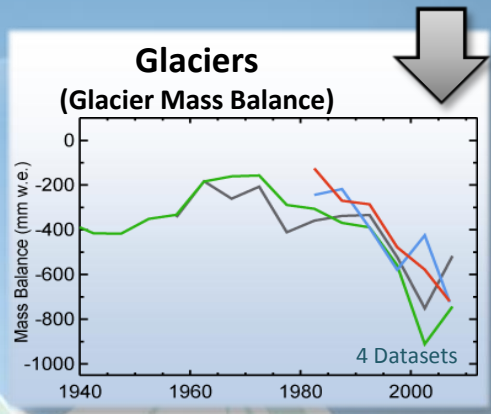
Dr. Roger S. Pulwarty
Climate and Societal Interactions and
National Integrated Drought Information System
NOAA

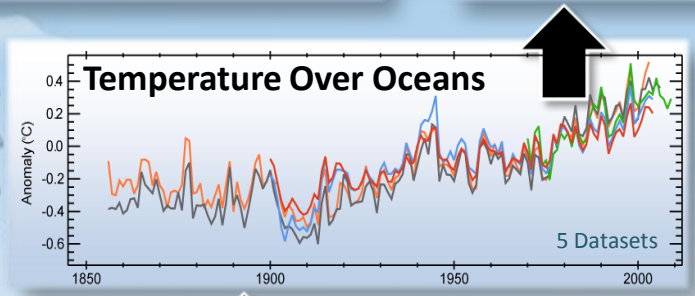


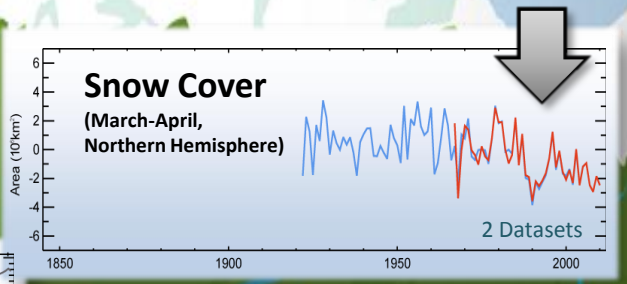
Observed Physical System Changes-What is in the data?

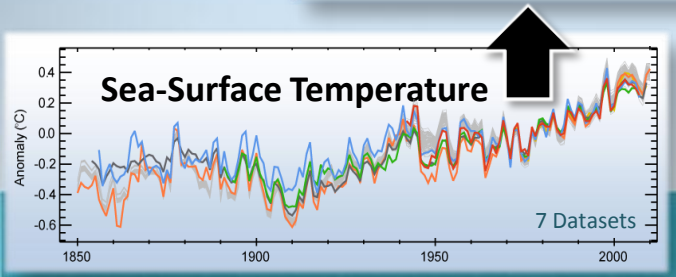


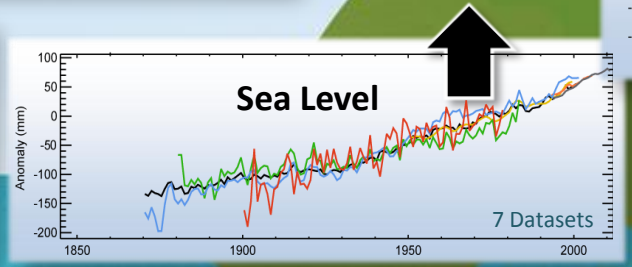


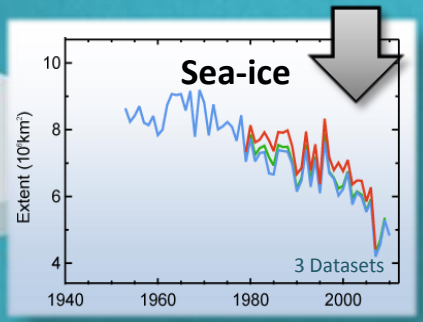


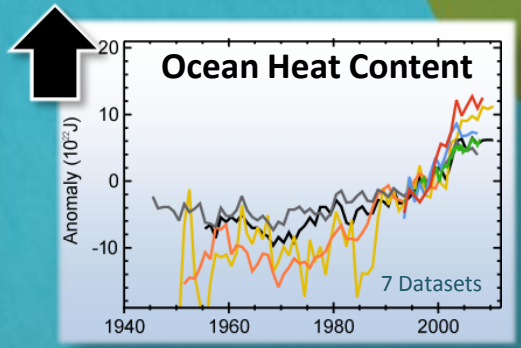


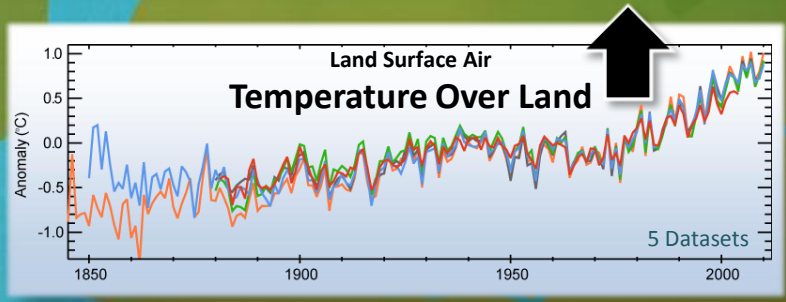


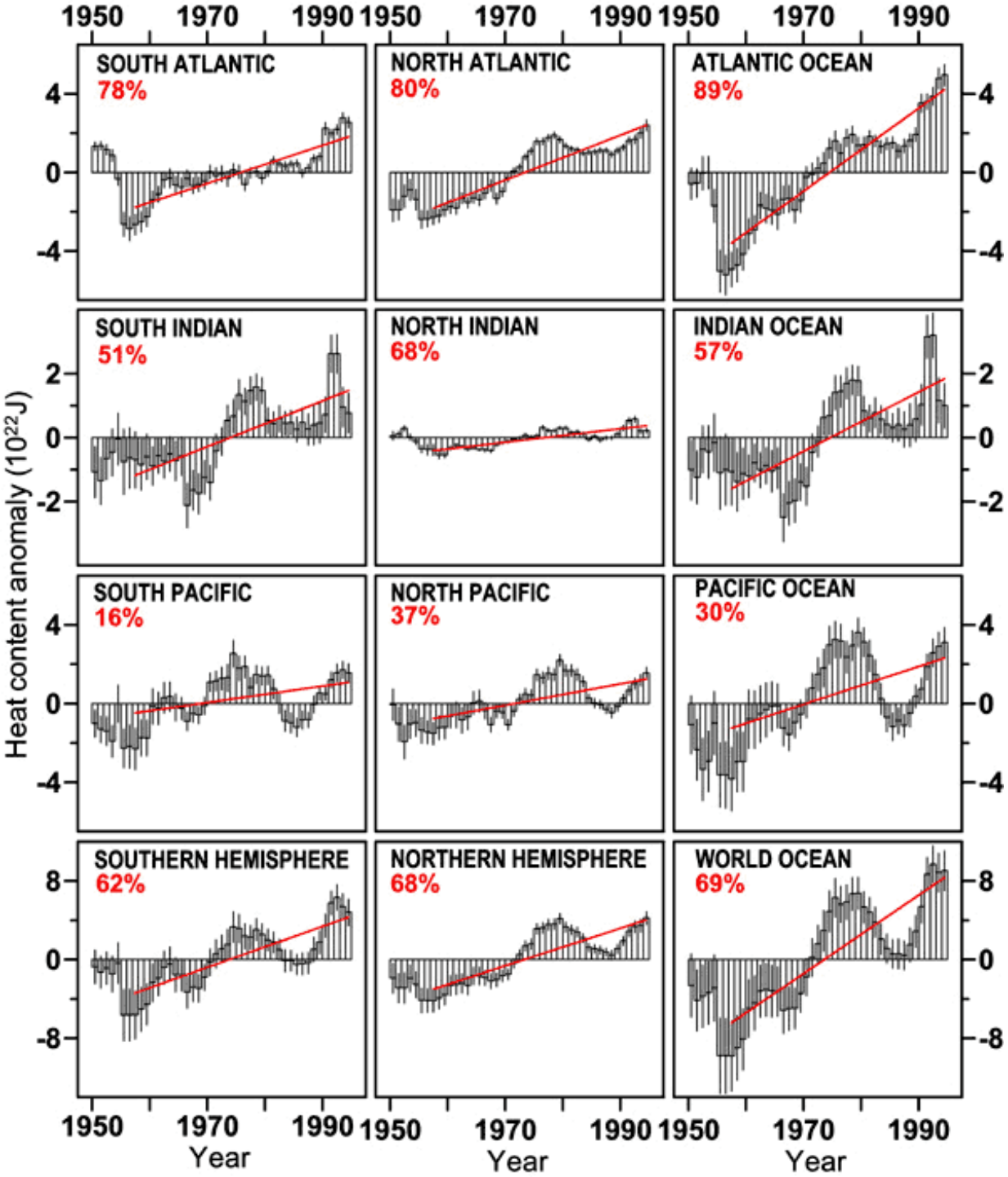











SOUTH ATLANTIC
78%
NORTH ATLANTIC
80%
ATLANTIC OCEAN
89%
SOUTH INDIAN
51%
NORTH INDIAN
68%
INDIAN OCEAN
57%
SOUTH PACIFIC
16%
NORTH PACIFIC
37%
PACIFIC OCEAN
30%
SOUTHERN HEMISPHERE
62%
NORTHERN HEMISPHERE
68%
WORLD OCEAN
69%
Heat content anomaly (10^{22}J)
Year
1950
1970
1990

Warming of as little as 1◦C causes coral bleaching,
What we know about the ocean chemistry of ***…saturation state***

$$CO_2 + CO_3^{2-} + H_2O \Leftrightarrow 2HCO_3^-$$

Saturation State

$$W_{phase} = \frac{[Ca^{2+}][CO_3^{2-}]}{K^*_{sp,phase}}$$

$$Ca^{2+} + CO_3^{2-} \rightarrow CaCO_3$$

calcium carbonate → calcium carbonate

W>1= *precipitation*
W=1= *equilibrium*
W<1= *dissolution*

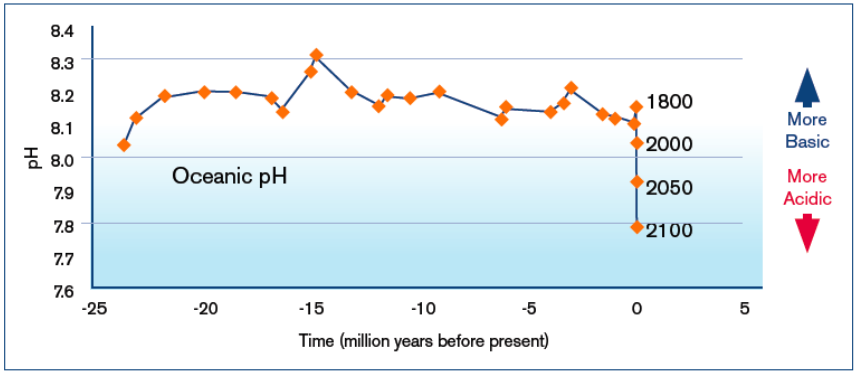
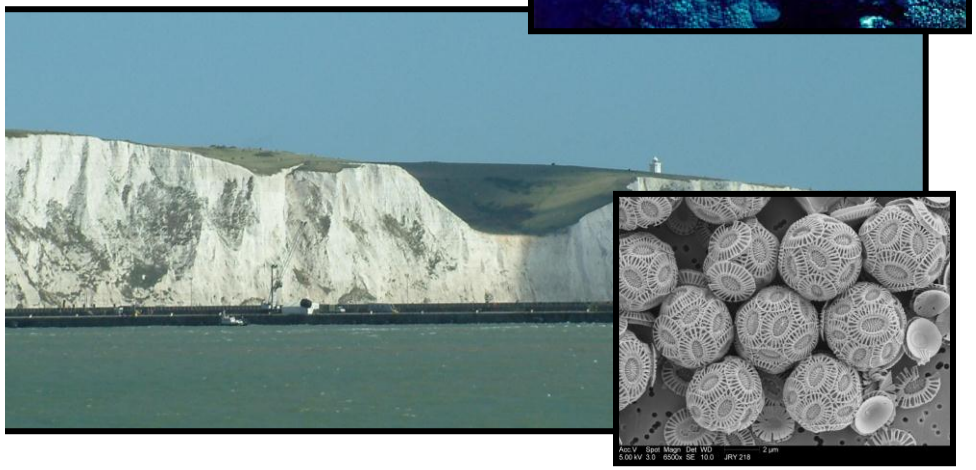
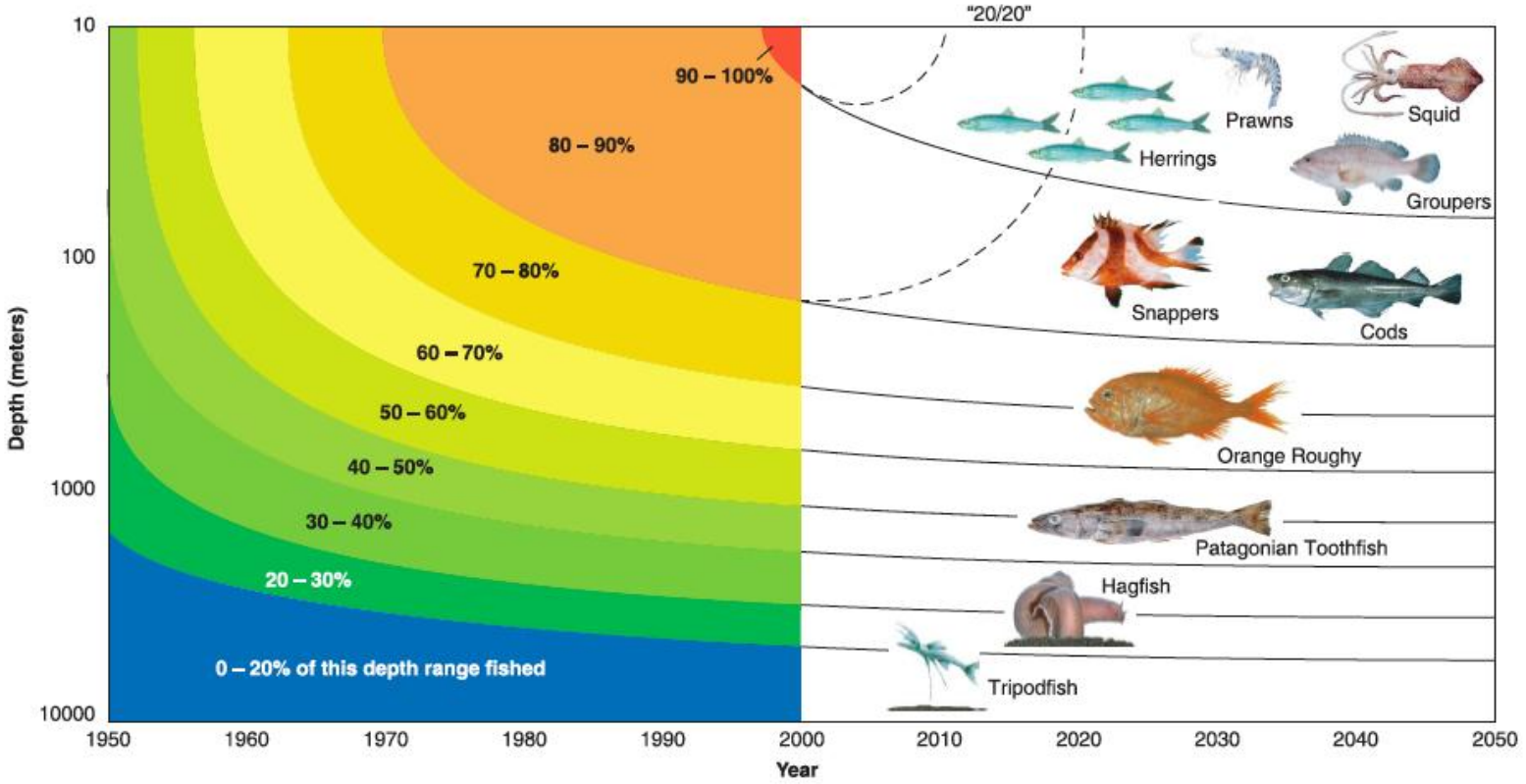


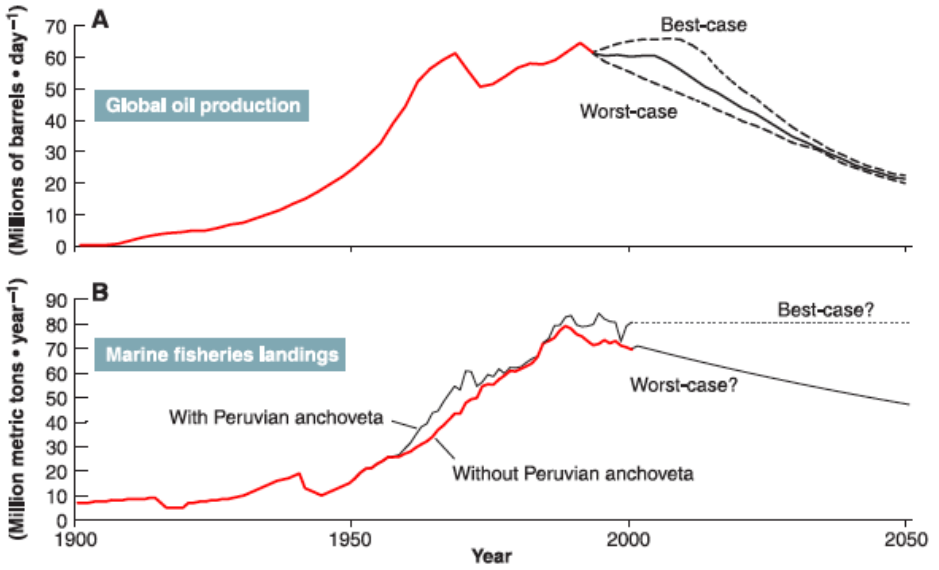
Figure 1. The Rapid Change in Ocean pH since the Industrial Revolution is Likely the Fastest in Earth's History *(Turley, C., et al. 2006[15])*

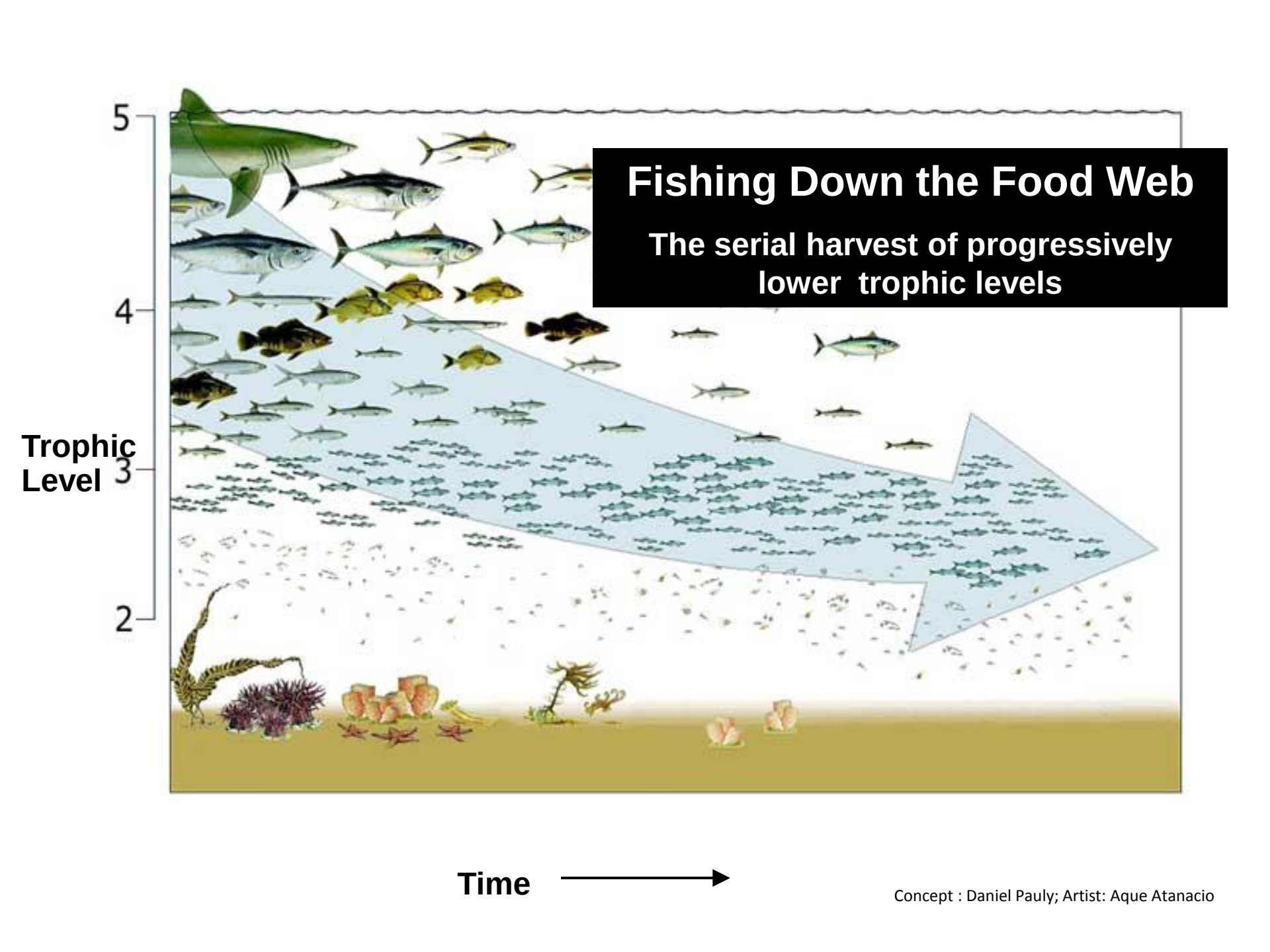


Feely et al



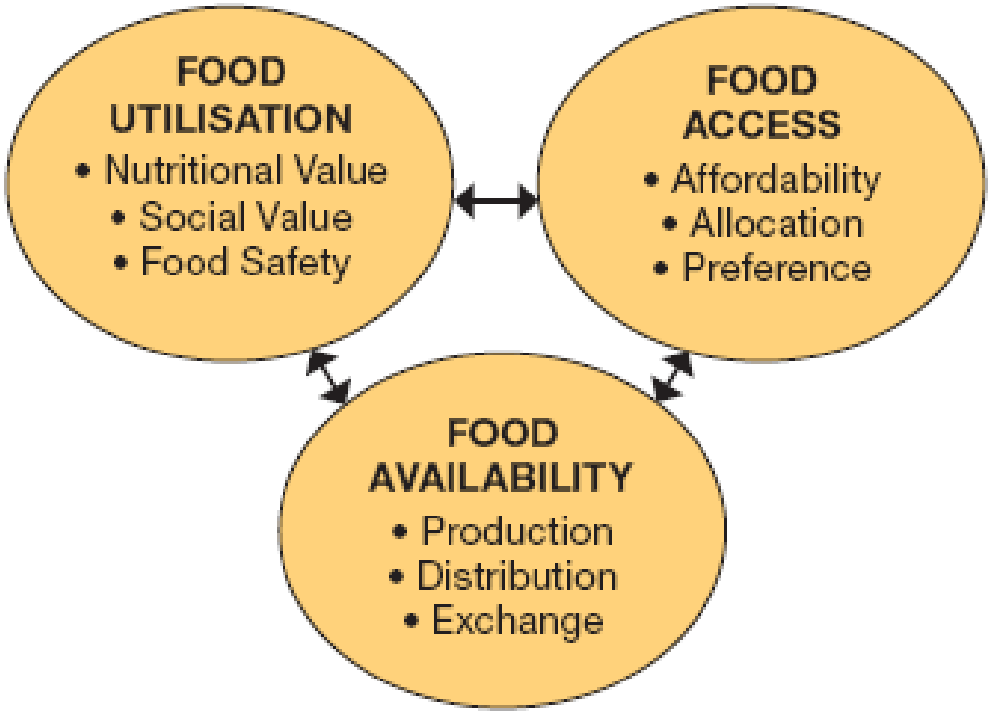
Eighty-four percent of the world's fish stocks are fully exploited, overexploited or depleted, according to the U.N. Food and Agriculture Organization (FAO)





Concept : Daniel Pauly; Artist: Aque Atanacio

Food Security: when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (UN-FAO, 1996)



Indonesia:

Rice, Soybeans
Fisheries contributed 5.2% to GDP in 2010 BUT

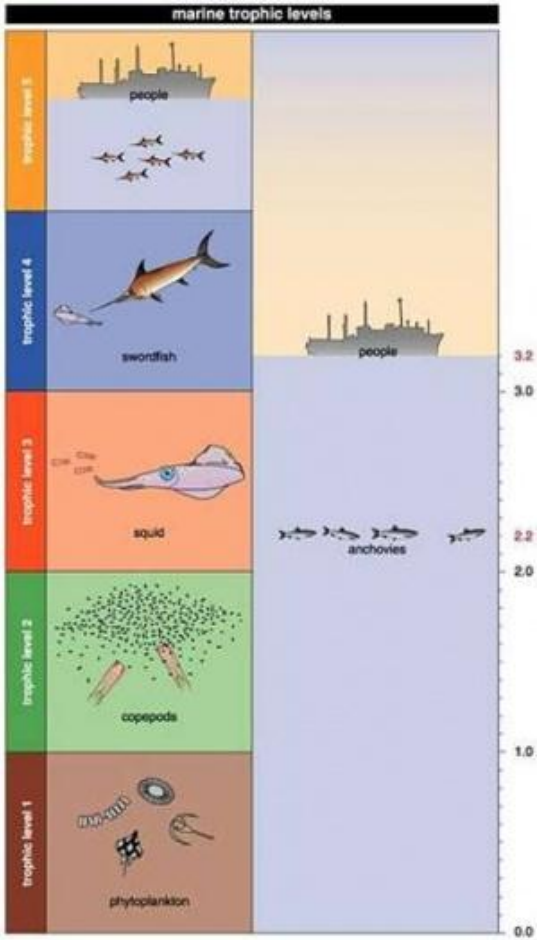
Over 60% of the Indonesia's protein consumption comes from fish-72 percent of animal protein consumption per capita per year

Aquaculture production increased on average 50% from 2007 to 2010

Climate Impacts

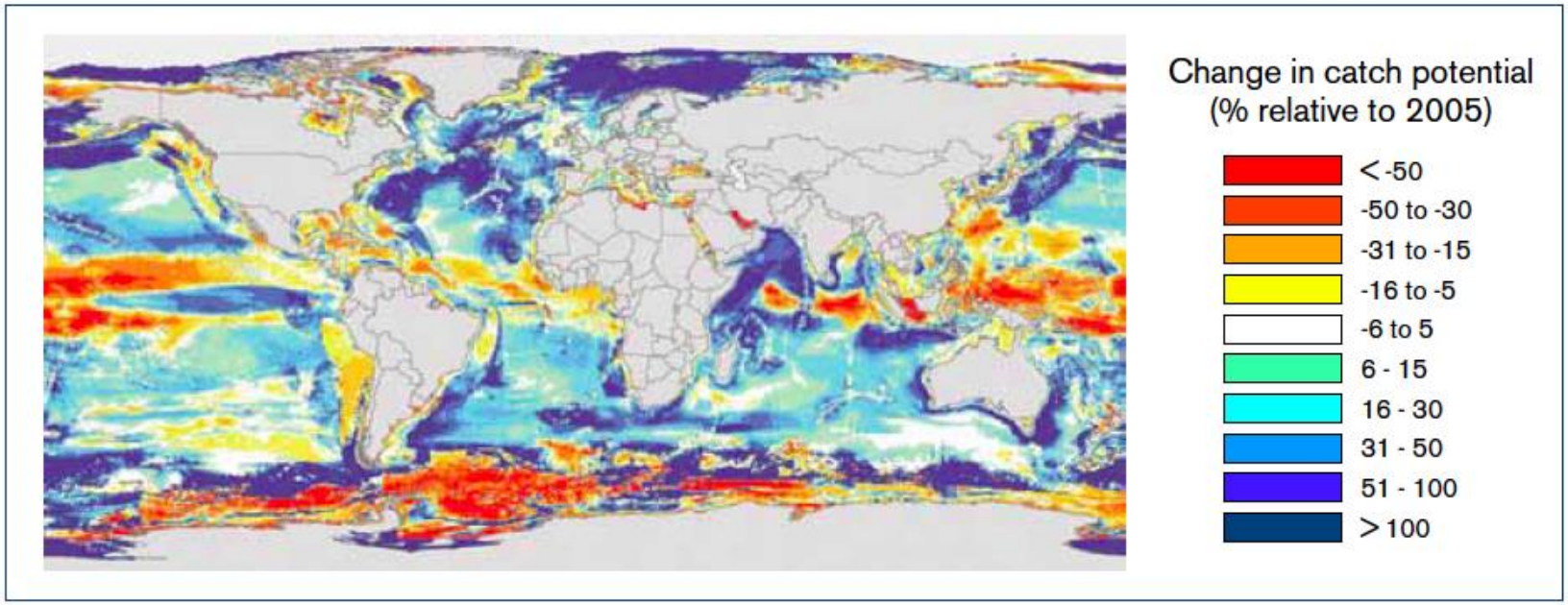
Potential impacts on physical features of oceans:

- Sea surface temperatures
- Sea levels
- Ocean circulation patterns
- Salinity
- pH



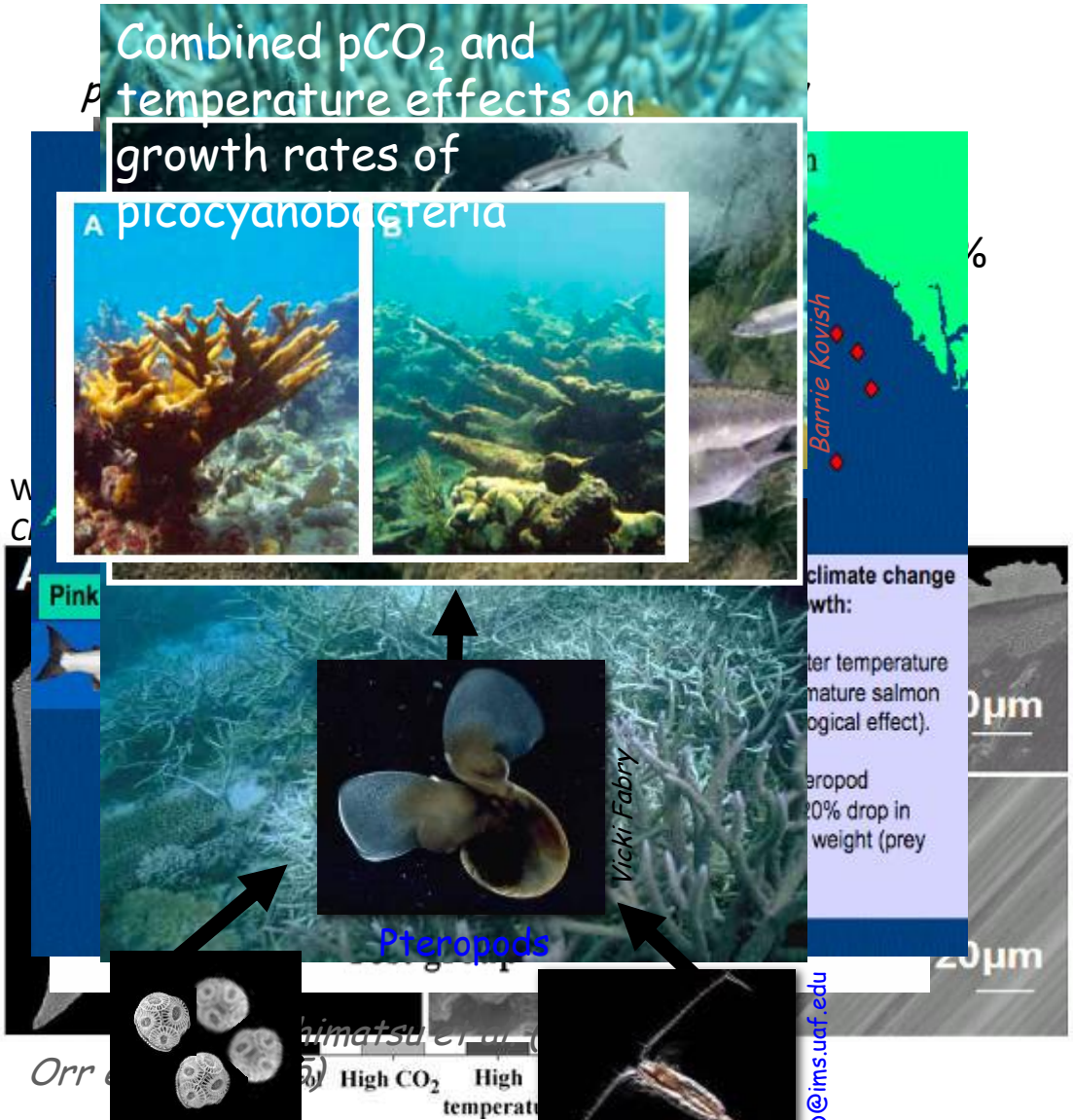
Potential impacts on marine fish:

- Migration patterns
- Changes in reproductive patterns
- Food web effects



- Projections of climate change impacts on global food supply have only recently focused on marine capture fisheries.
- Climate change may lead to large-scale redistribution of global catch potential, with an average of 30–70% increase in high-latitude regions and a drop of up to 40% in the tropics
- Maximum catch potential declines considerably in the southward margins of semi-enclosed seas while it increases in poleward tips of continental shelf margins. Such changes are most apparent in the Pacific Ocean. Among the 20 most important fishing Exclusive Economic Zone (EEZ) regions in terms of their total landings, EEZ regions with the highest increase in catch potential by 2055 include Norway, Greenland, the United States (Alaska) and Russia (Asia).
- EEZ regions with the biggest loss in maximum catch potential include Indonesia, the United States (excluding Alaska and Hawaii), Chile and China. Cheung et al 2009
- Cheung et al

Biological implications of ocean acidification



- Reduced calcification rates
- Shift in phytoplankton diversity
- Reduced tolerance to other environmental fluctuations
- Changes to species survival
- Changes to food webs
- Reduced growth, production and life span of adults, juveniles & larvae
- Changes to species fitness
- *Uncertainties great – research required*

Indonesia's gross national income per capita has steadily risen from $2,200 in the year 2000 to $3,720 in 2009

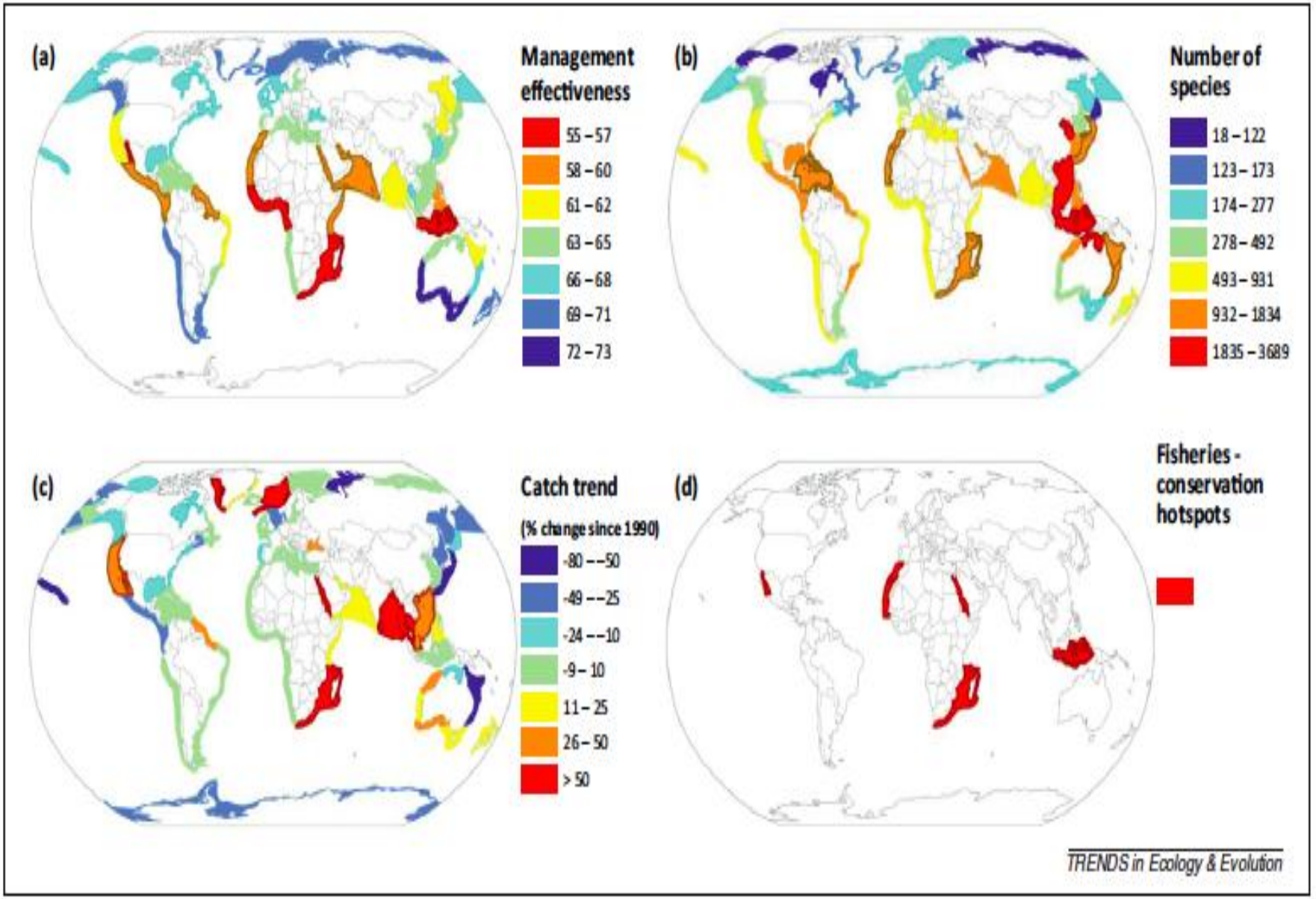
- 17,000 islands, a "maritime continent," home to 240 million people

- Over 60% of the nation's protein consumption comes from fish-72 percent of animal protein consumption per capita per year
- The price of rice is one of the highest in the South East Asia region. Soybean products are important commodity traditional protein staple, especially for low-income people. Indonesia consumes 2.5 million tons of soybeans per year with produced 650,000 tons in 2011

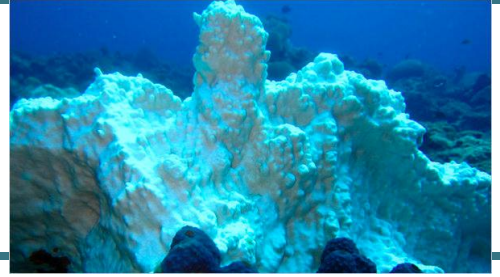
Fisheries contributed 5.2% to GDP in 2010

- The majority in the east of the country, where 40 per cent of the population live below the national poverty line, above the 13 per cent national average
- Capture fisheries production has been increasing at about 5% per year over the last decade

- Indonesia coral reef fisheries are the most vulnerable to collapse



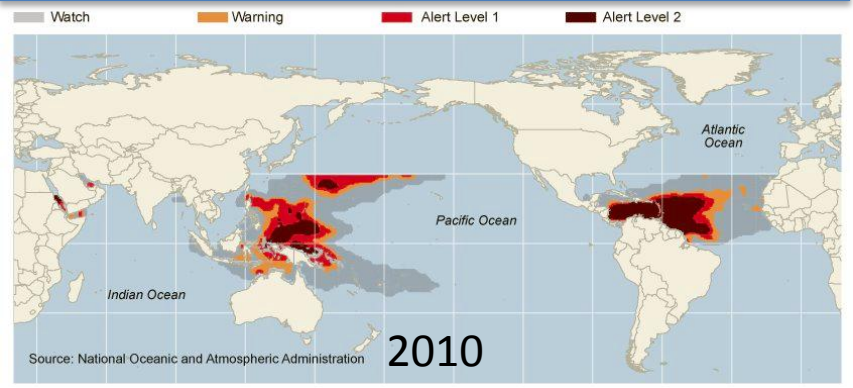
Most of studies predict large distributional shifts and range contractions in high profile species

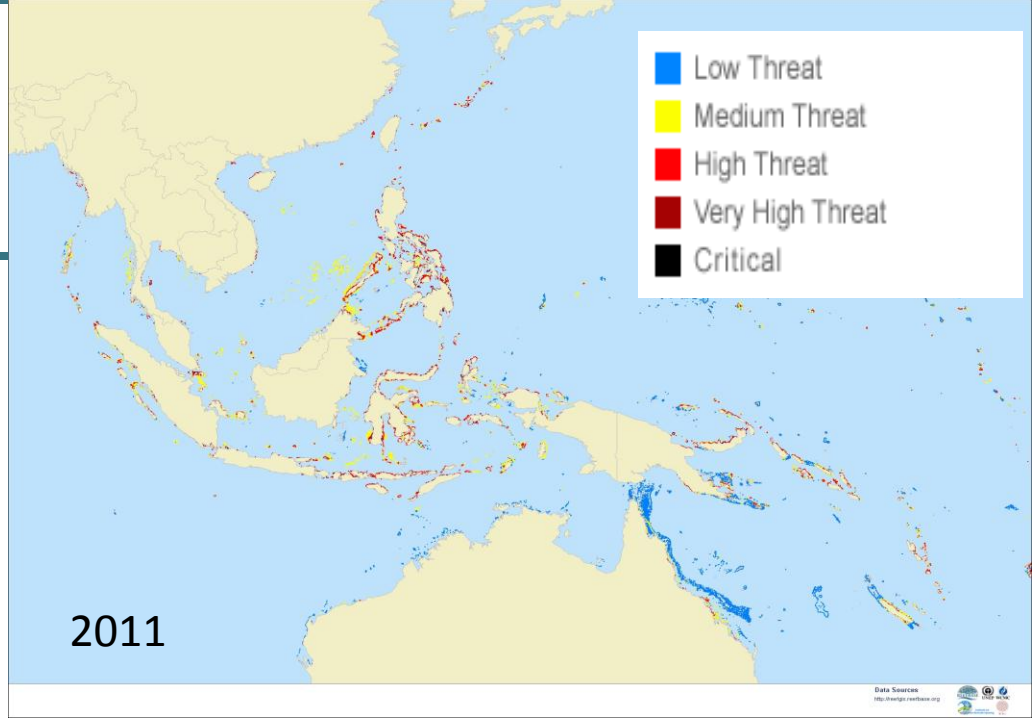


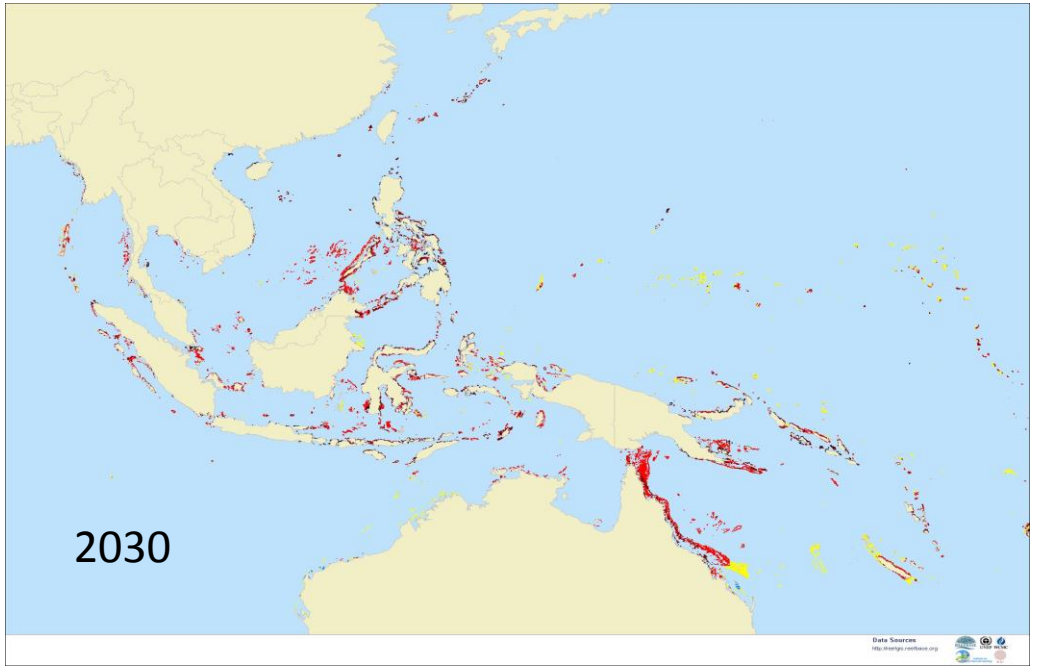
Local threats (present)
Coastal Development Marine Pollution
Overfishing and
Destructive Fishing
Watershed-based Pollution

Indonesia coral reef fisheries are the most vulnerable to collapse

System responses from global climate change will be superimposed on acute and immediate anthropogenic stresses



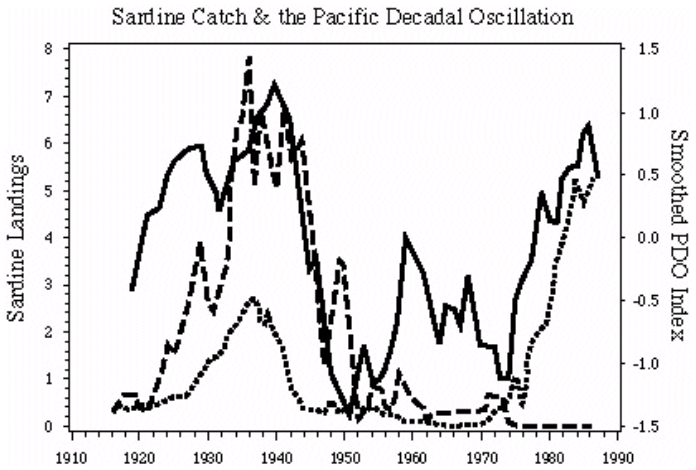


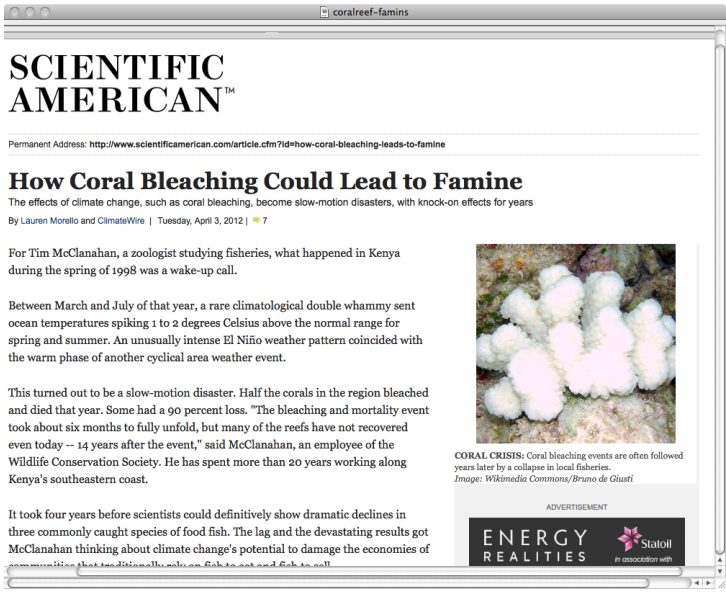


Shifting Baselines and Thresholds

"Fishing has a short memory. If you see twice as many fish as you've seen in the last 10 years, it's still twice as much of not very much."

The perception of what is considered "normal" shifts with each generation





At least 1°C higher than the summer maximum) drives incidence of coral bleaching.

Post card from Census of Marine Life - History of Marine Animal Populations – Glenn Jones

NOAA Fisheries-Cudmore, Stein others

Summary

- Overfishing is the primary cause of marine fishery declines
- New technologies, bycatch and overcapacity contribute to fishery declines
- Global climate change poses an emerging threat but so does present climate
- Fisheries declines have community- and ecosystem-level effects
- Societal factors such as subsidies, increasing demand, shifting baselines and the lack of fisheries data to support management have allowed fishery at all scales declines to occur

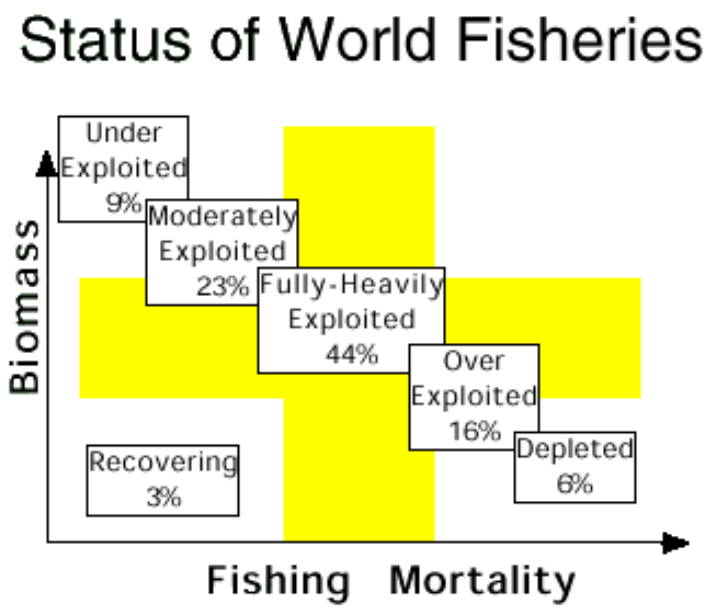


TABLE 1 Summarising observed direct effects of climate change on marine biodiversity

Cause	Effect	Effect on diversity	References
Temperature increase (tropical)	Coral bleaching	↓	[38,39]
Temperature increase (temperate)	Warm-adapted species replace cold-adapted ones	↑	[19,35,45,47,52]
Temperature increase (polar)	Decline of polar endemics invasion of subpolar species	?	[41–44]
Increased climate variability (heat waves)	Increased rates of disturbance	↓	[67,68]
Increased upwelling intensity	Surface water hypoxia	↓	[69–71]
Increasing water column stratification	Lower nutrient supply and productivity	?	[8,11,12]
Sea level rise	Erosion of coastal habitat	↓	[74]
Changes in currents	Changes in larval transport	?	[96]

Connecting Food Security Dimensions in a changing climate:

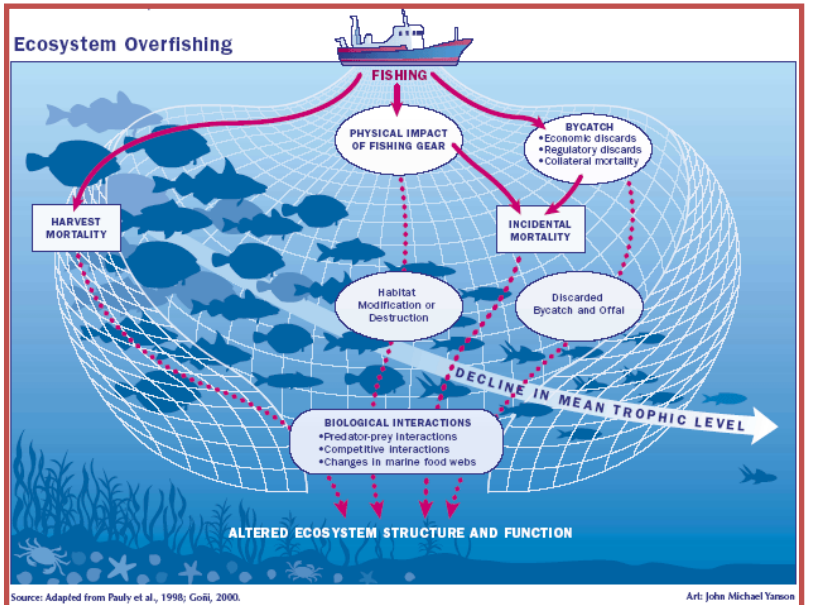
Changes in ocean conditions and key biological interactions can alter the underlying dynamics that govern ecosystem structure and function

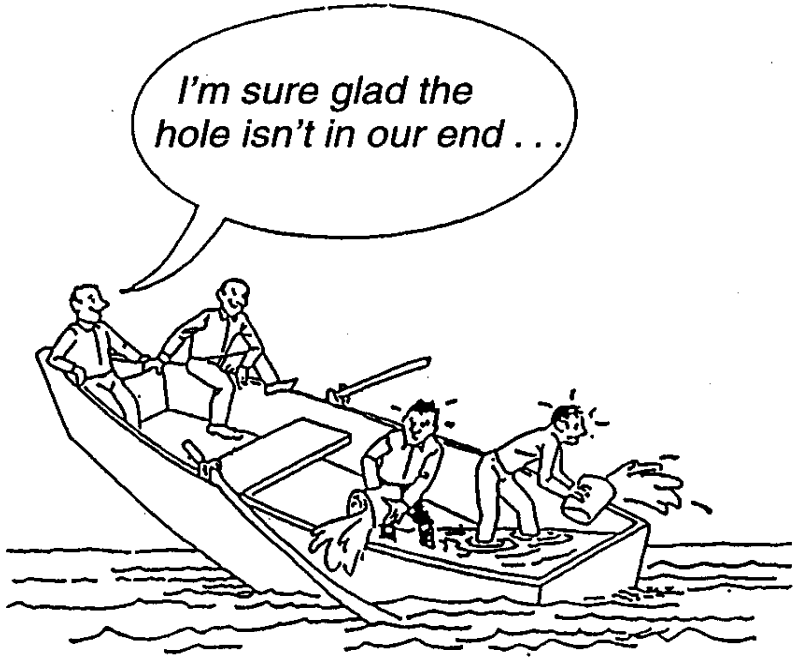
Improving the usefulness and use of climate information

Social protection, financial services and risk-pooling, early warning systems, ecosystem services, biomass production

(Pulwarty, Eilerts, Verdin 2012)

We're all in this together





Socio-Economic Challenges: major current issues and problems associated with development of capture and culture fisheries: access and purchasing power

- lack of economic diversity in coastal communities
- low income and low standard of living for fishers and fish farmers;
- lack of access to credit and other financial tools;
- limited access to technology for better value and sustainable use of resources
- weak practical fisheries management, particularly in monitoring, surveillance and enforcement

Ecosystem Threats:

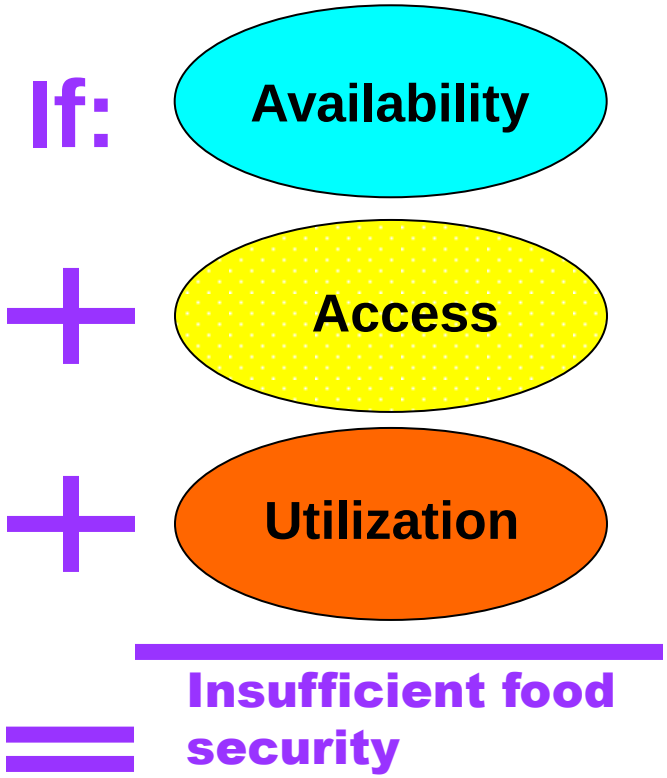
Combined fisheries and conservation objectives merge diverse management actions, including catch restrictions, gear modification, and closed areas, depending on local context.

Nutrient pollution from sewage and runoff.

The most important element of small-scale fisheries success has been community-based management-establishment of spatial management units that had exclusive access by local fishing organizations

Common transactions costs in fisheries co-management

Information costs Knowledge of resource Searching,acquisition Integration Strategic planning	Collective Fisheries/Decision-making costs Participating in meetings Developing policy and rules Communicating decisions Coordinating local and central authorities	Collective operational costs
Monitoring, enforcement, compliance costs Monitoring rules Catch record management Fishing area man.. Fishing inputs Conflict resolution Sanction for violation	Resource maintenance costs Fishing rights protection Stock enhancement Resource evaluation	Resource distribution costs Fishing right distribution Institutional pr participatory costs



No food in market, sufficient purchasing power

Significant food in market, no purchasing power

Food & purchasing power available, but, bad water, disease, poor care practices

Different causes, different responses

- promoting quality of human resources
- development of science and technology
- strengthening economic competitiveness.

On a global scale, a key problem for rebuilding is the movement of fishing effort from industrialized countries to the developing world

On a regional scale- the reduction of quotas, fishing effort, and overcapacity have been shown to affect recovery

Contentious trade-offs between allowable catch and the conservation of vulnerable or collapsed species

Designing incentives to avoid the catch of threatened species. tradable catch and by-catch quotas, has yielded good results in some regions

Improved use of climate information across timescales into planning and decisionmaking

Raja Ampat: Survey Confirms Highest Marine Biodiversity on Earth

Decision Matrix: Priority on labor's access/understanding*

	Labor's welfare matters most	Others' welfare matters most
HIGH Access & Understanding	convenient, low-cost dissemination	convenient, low-cost dissemination
•LOW •Access & Understanding	greater dissemination efforts, and education and training	convenient, low-cost dissemination

*Study results relevant to this table:

1) other societal groups (e.g., the industrial subsector) can increase their expected utility without training

2) wide discrepancies in access, understanding, and distortion of information among different groups.

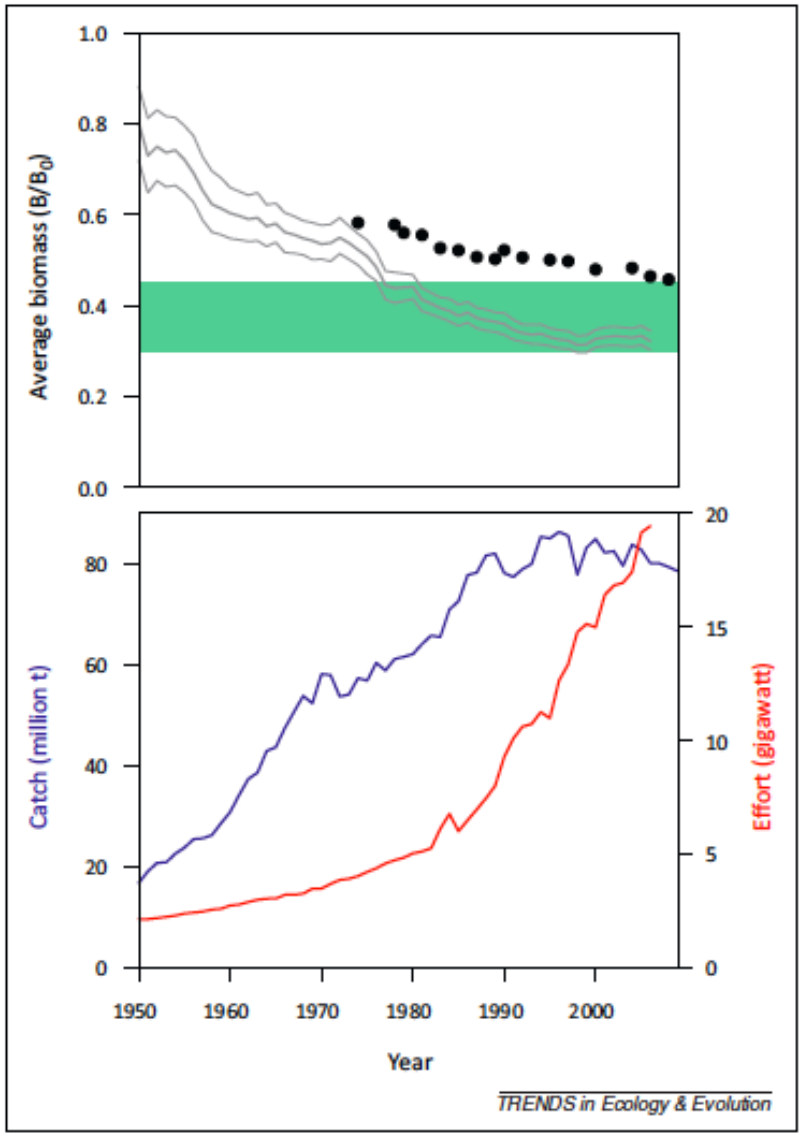
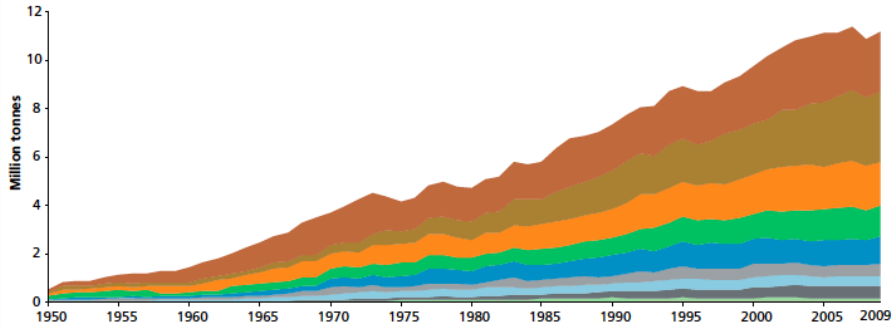


FIGURE B12.2
Annual nominal catches by ISSCAAP species groups in the Western Central Pacific (Area 71)

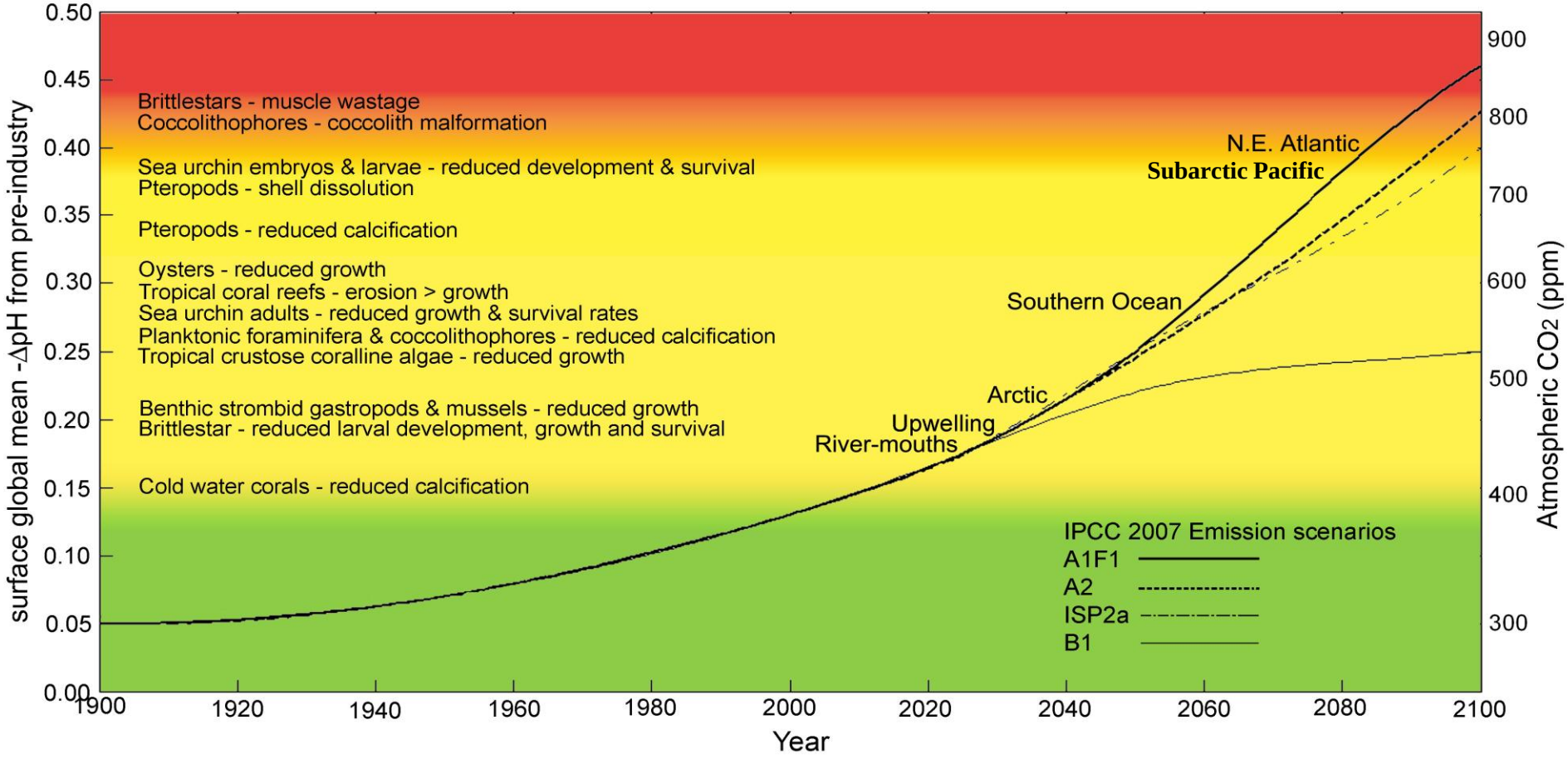


Mariculture and Aquaculture:

About 50% of Indonesia's fish production comes from aquaculture, which has grown significantly from 2.1 million tons in 2005 to 4.7 million tons in 2009. Aquaculture production increased on average 50% from 2007 to 2010

- The problem of food insecurity in this case is not necessarily due to the lack of food supplies in the domestic market, but with the inability of people to access the food that is available
- A key aspect in the food security issue here is the ability of people to generate enough income to purchase adequate food for their consumption

What constitutes a 'dangerous anthropogenic interference' with ocean chemistry?



Turley et al., submitted

Conclusions

- Since the beginning of the industrial age surface ocean pH (~0.1), carbonate ion concentrations (~16%), and aragonite and calcite saturation states (~16%) have been decreasing because of the uptake of anthropogenic CO_2 by the oceans, i.e., ocean acidification. By the end of this century pH could have a further decrease by as much as 0.3-0.4 pH units.

- Possible responses of ecosystems are speculative but could involve changes in species composition & abundances - could affect food webs, biogeochemical cycles. More research on impacts and vulnerabilities is needed.

- An observational network for ocean acidification is under development. Modeling studies need to be expanded into coastal regions. Mitigation and adaptation studies need to be enhanced and integrated with the models.

The severity of biodiversity depletion in the country—and so threats to the sustainability of the marine and coastal ecosystems that produce the fish so essential to the Indonesian diet—is illustrated by:

Overfishing of critical pelagic and coastal fish species from tuna to grouper;

- the rareness or extirpation of many other coastal and marine species (sea turtles, giant clams and some other mollusc species, crustaceans, cetaceans, dugong, and humphead wrasses);
- the destruction of critical coastal habitats, particularly mangroves and coral reefs; and overfishing

- Nutrient pollution from sewage and runoff. Almost all domestic sewage in Indonesia is discharged directly to the sea, or indirectly through rivers, without proper treatment-led to high organic and nutrient loading, resulting in eutrophication manifested by red tides and harmful algal blooms (HAB) in many places.

Enabling and current trends

Differences
Promote diversity by including the widest range of expertise, knowledge and experience that can be brought into the problem solving arena

Exchanges
Meaningful direct interaction and exchanges among all stakeholder entities.

Containers
Stakeholder groups and entities have clear identities. Boundaries of all kinds (geographic, organisational, etc.) are clear and known to all stakeholders..

Getting from Translation?.to…Transfer?…to… Transformation

Transitions from applications

Private vs public

Applied

Benefits and limits of

"co-production"

Social-ecological

Path dependence

Adaptive

Across organizational boundaries

Joint monitoring and joint fact-finding