

Acidification and fisheries and aquaculture: understanding impacts, economics and adaptation

IAEA-CSM
Principality of Monaco
November 11-13 2012

Cassandra De Young
cassandra.deyoung@fao.org



What is at stake?

- Over **500 million** people depend – directly or indirectly – on fisheries and aquaculture for their livelihoods
- Aquatic foods provide essential nutrition for **4 billion people** and at least 50% of animal protein and minerals to 400 million people in the poorest countries.
- Fish products are among the most **widely-traded foods**, with more than 37% by volume of world production traded internationally.



Drivers of change

Affecting biological processes

Pollution/Water quality

Climate

Acidification

Overfishing

Altered habitats

Etc...

Affecting human choices

Governance and politics

Legal systems

Technological change

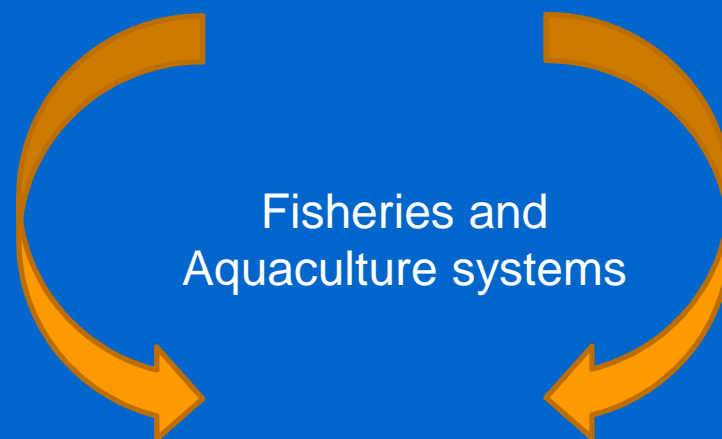
Markets

Capital/labor flows

Demographics

Culture

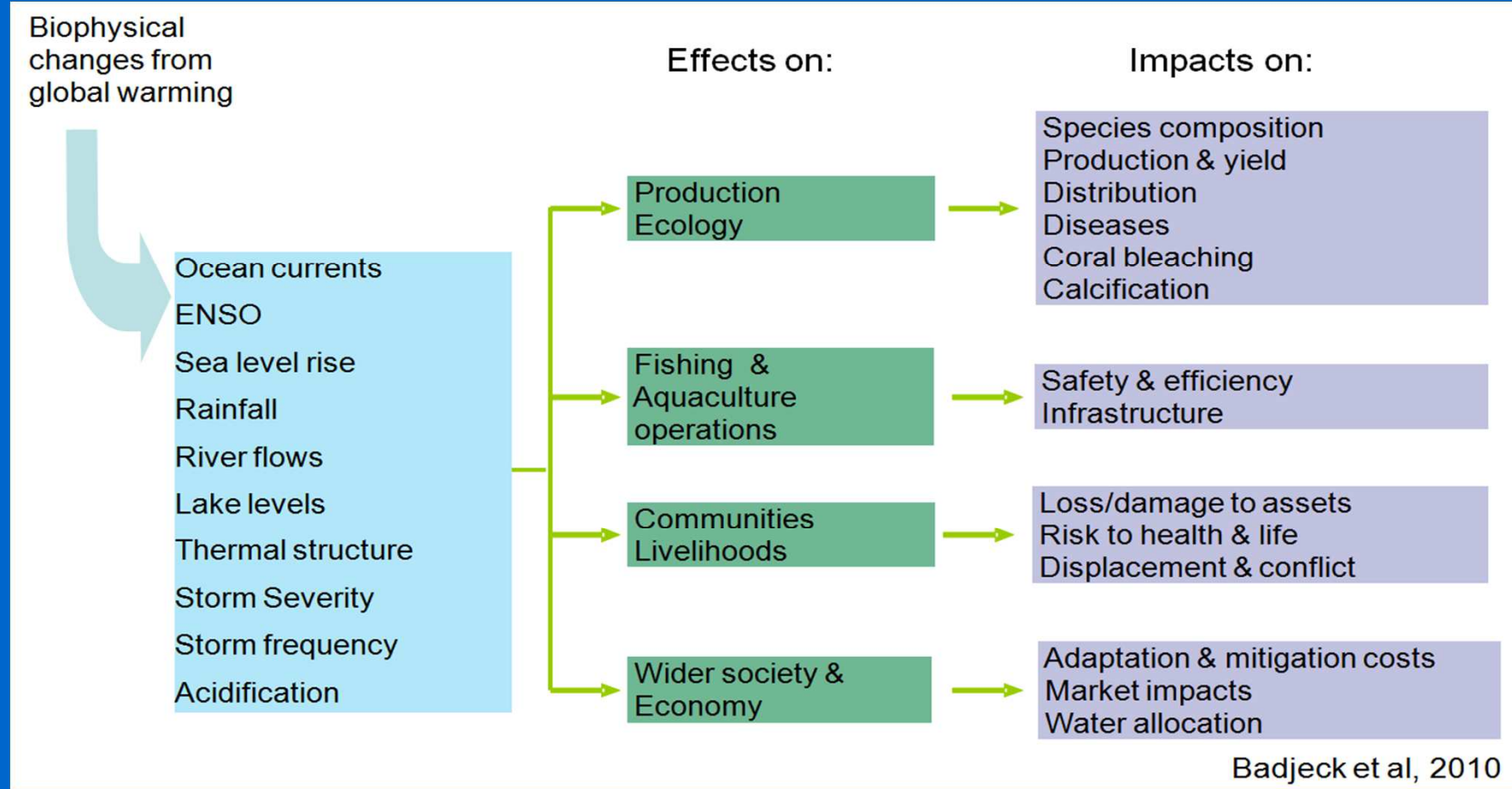
Etc...



Fisheries and
Aquaculture systems



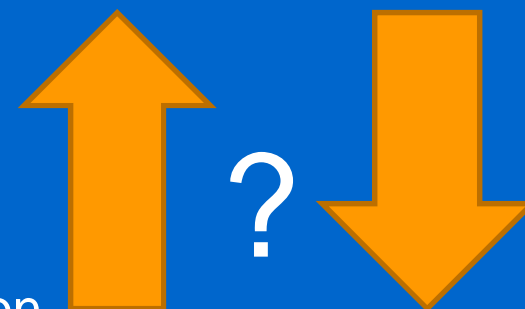
CC impacts on fisheries and aquaculture



Acidification impacts on FI&AQ species

Direct physiological effects

- Alteration, reduction/inhibition of growth of calcified structures (adult and larvae)
- Acid-base balance
- Otolith development
- Basal metabolic costs
- Aerobic scope
- O₂ consumption
- Thermal tolerance
- Gamete maturation and activation
- Fertilization success
- Egg hatching
- Embryonic development
- Olfactory behavioral responses



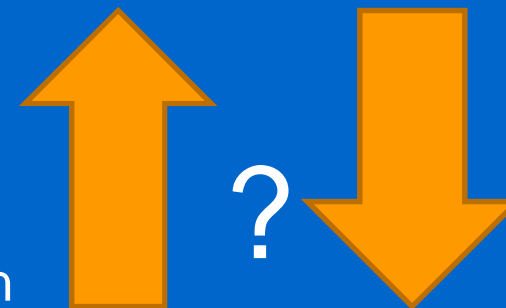
Le Quesne and Pinnengar 2011



Acidification impacts on FI&AQ systems

Indirect effects

- predator or prey abundance
- habitats (esp coral reefs)
- nutrient recycling
- benthic-pelagic coupling
- primary production by phytoplankton



Impacts on food and livelihood security, economies

- ability to respond to changes in demand
- coastal protection from reef systems (and mangroves?)
- changes in fishing ranges
- changes in micronutrients?
- increased risks to aquaculture investments (e.g. decreased productivity and growth rates, increased mortality)
- local decrease in production may not mean increase in prices, etc

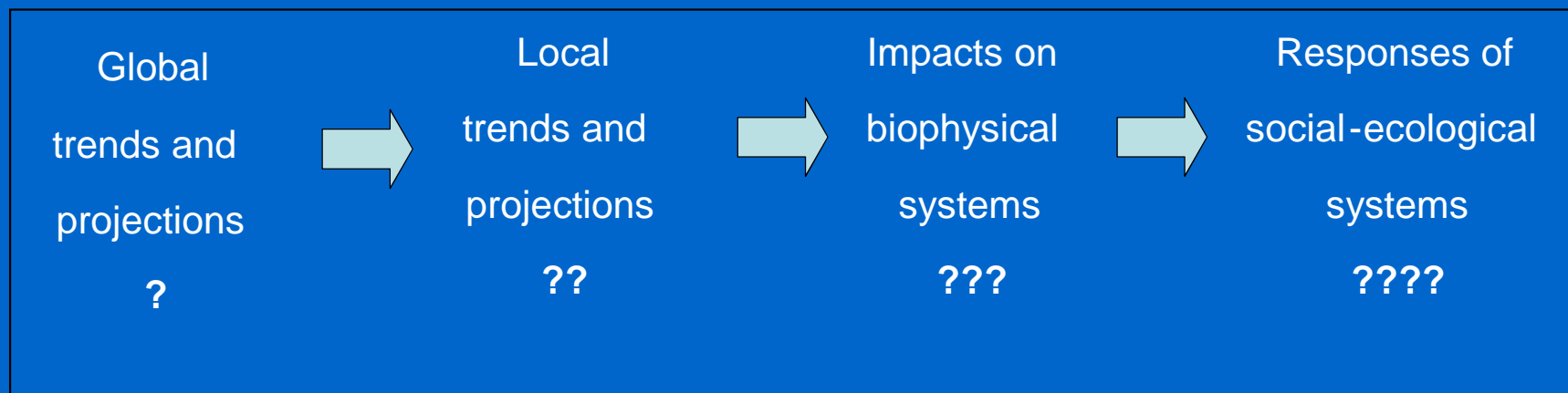


What do we know about social and economic impacts of acidification?

- OA not included in most climate change economic impacts studies
- Few economic studies but number growing
- High uncertainty in biophysical and socioeconomic systems
 - Variability in organism responses, ecosystem responses,
 - Variability in development pathways and responses in both developing and developed countries



A note on the uncertainty of impacts



Daw et al, 2009



Mollusk fisheries examples

- Increasing demand, especially developing countries
- Global mollusc fishery (capture and aquaculture) could loose up to 6 billion USD by 2100 (Narita et al. 2012)
- Other studies have different results due to different OA impacts on calcification, survival, etc. (e.g. Cooley & Doney 2009)
- Already seeing impacts (Whiskey Creek oyster hatchery, Oregon, USA, Barton et al. 2012)



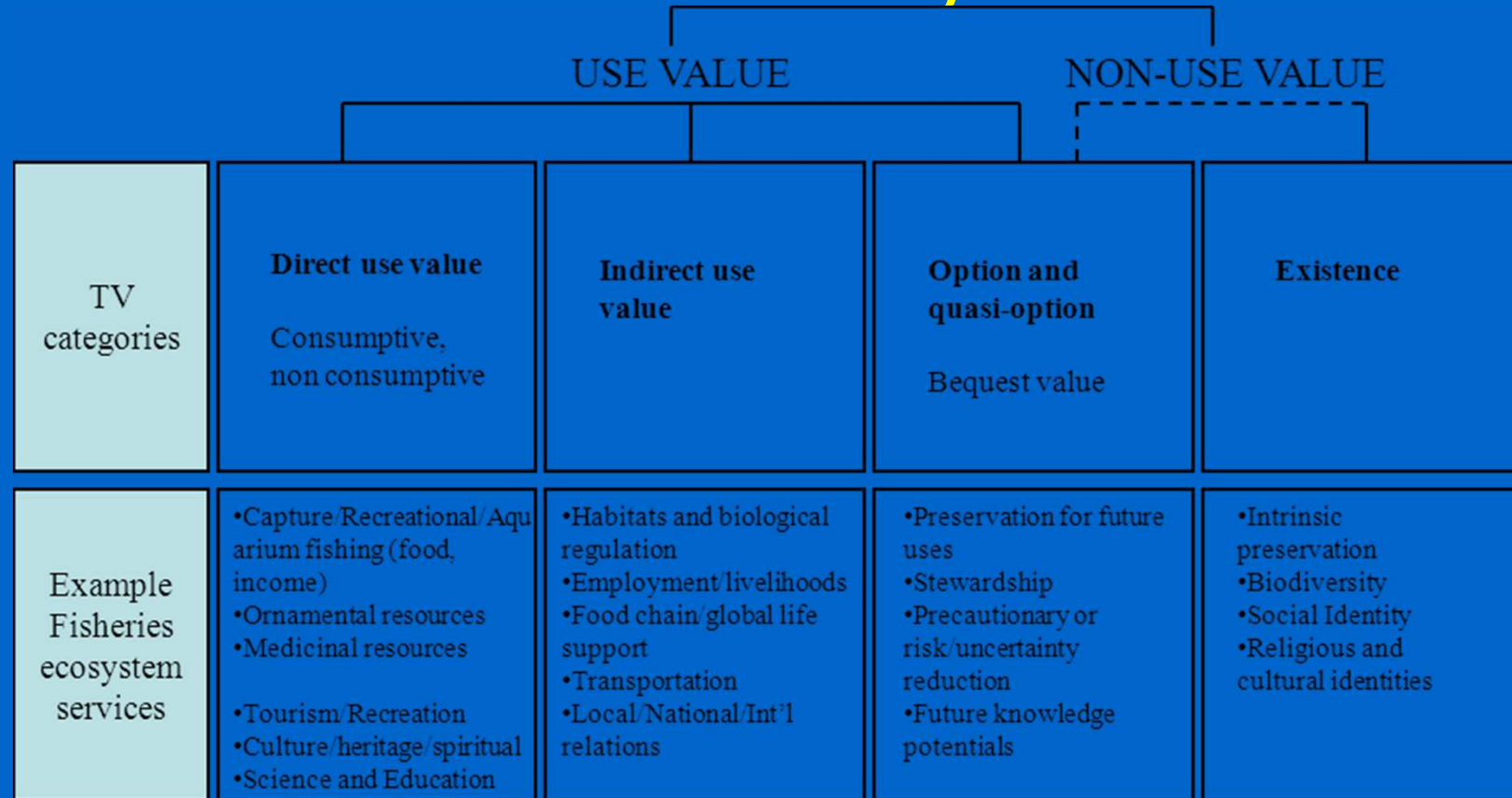
Mollusk fisheries example (cont'd)

Social and economic impact estimations will depend on, e.g.:

- Uneven impacts on production systems
 - Ratio of capture to aquaculture in production
- Existing governance, socioeconomic and market conditions
 - Ability of producers to pass on costs to consumer
 - Dependency of community and adaptive capacity
 - Impacts along value chain



Issues related to broadened scope of impact valuation to other ecosystem services



So, what can we do?

In addition to cutting CO₂
emissions, that is....



Adaptation of aquatic systems to acidification

Organism responses:

- Organism acclimatisation as OA will be gradual shifts as opposed to sudden changes in most experimental designs
 - Transgenerational coping abilities
 - Selection and genetic adaptation
- Species already living at extremes



Adaptation of aquatic systems to acidification

Human responses:

- Reduce land-based pollution and other pressures (e.g. over and destructive fishing) on vulnerable aquatic systems
- Marine spatial planning to preserve refugia areas (e.g. kelp forest systems)
- Phytoremediation - seagrass meadow, macroalgae on coral reefs, kelp forests
- Encourage these habitats near sensitive areas, short-term buffers



Adaptation of fisheries systems to acidification

CCRF and ecosystem approach, including:

- Encourage good governance and adaptive management (e.g. stable but flexible access)
- Encourage monitoring and sharing of information by all stakeholders including researchers, industry, communities
- Undertake OA adaptive capacity assessments for fisheries socio-ecological systems and reduce food and livelihood vulnerability via diversification, insurance schemes, DRM, etc



Adaptation of aquaculture systems to acidification

In addition to EAA, some technical adaptations:

- Species selection (higher tolerance, etc.)
- Shift hatcheries to less impacted areas (if possible)
- Monitor and work around chemical changes
 - e.g. Whiskey Creek hatchery times oyster spawning with pumping higher pH water
- Regulate seawater chemistry
 - e.g. seeding mud flats with calcium carbonate (crushed shell) (Green et al. 2009)



Some acidification questions

Impact pathways (ecological processes potentially at risk and interactions with human-social systems).

- Direct and indirect impacts on commercial species?
- Impacts on relative composition of species in a given system?
- Impacts on overall system productivity (substitutes in habitats and species?; changes along food webs?)
- Relative impacts of acidification among multiple drivers (additive/cumulative effects) and where and in what processes might it be a more important driver of change?
- What are the predicted social and economic effects?
 - What do we risk losing? Yields/production, costs, profits, access to food, income, social values, security nets, etc? Will substitutes suffice?
 - Market impacts - global price changes versus local prices?



Some acidification questions

- Capture fisheries and aquaculture
- Time scales
- Small-scale versus large scale
- Estuaries, coastal, out to open ocean and high seas
- Fishers/farmers, processors, or traders, global markets
- Gender, age, marginalized groups



- Vulnerabilities? - mappings to identify social-ecological systems especially exposed to and sensitive to acidification or with low adaptive capacities - Again, looking at different scales and groups
- Adaptation options? – social, economic, technical, governance (who and how?)
 - anything specific to acidification in capture fisheries? What is good in general is good for acidification?
 - aquaculture examples?
 - Farmers, traders, government
 - Insurance schemes (risk management)
 - Technological change, etc
 - What costs to adaptation? To whom?



Some final, broader acidification questions

- How to improve the science to policy bridge, esp. under uncertainty?
- How can we support the transition to durable and resilient FI&AQ facing acidification?
- What changes will acidification require of decision-making and information processes?
- What changes will acidification require in FI&AQ management and ocean governance?
- How to communicate and advocate to decision-makers and other stakeholders?



Thanks on behalf of the Global Partnership for Climate, Fisheries and Aquaculture (PaCFA)!

Clare Shelton, Tim Daw, Eddie Allison, Ian Perry, Doris Soto provided their thoughts and references (but are in no way responsible for errors!)

