THE POTENTIAL IMPACT OF OCEAN ACIDIFICATION ON PELAGIC ECOSYSTEMS IN THE PACIFIC OCEAN

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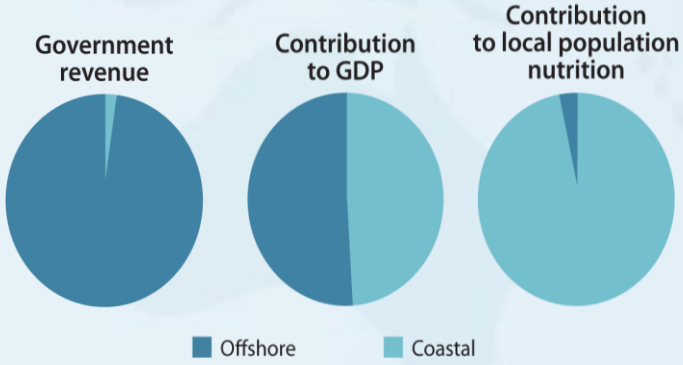
Photo: Jeff Muir

Presentation Structure

- The importance of oceanic fisheries in the WCPO
- The ecosystem is complex
- The ecosystem is based on the primary production
- The direct and indirect effects of OA
- Direct impact of OA on phytoplankton
- Direct impact of OA on zooplankton
- Direct impact of OA on tuna
- Uncertainties and adaptability to OA
- What does it mean for the tuna fisheries?
- Next steps

Industrial Tuna Fisheries

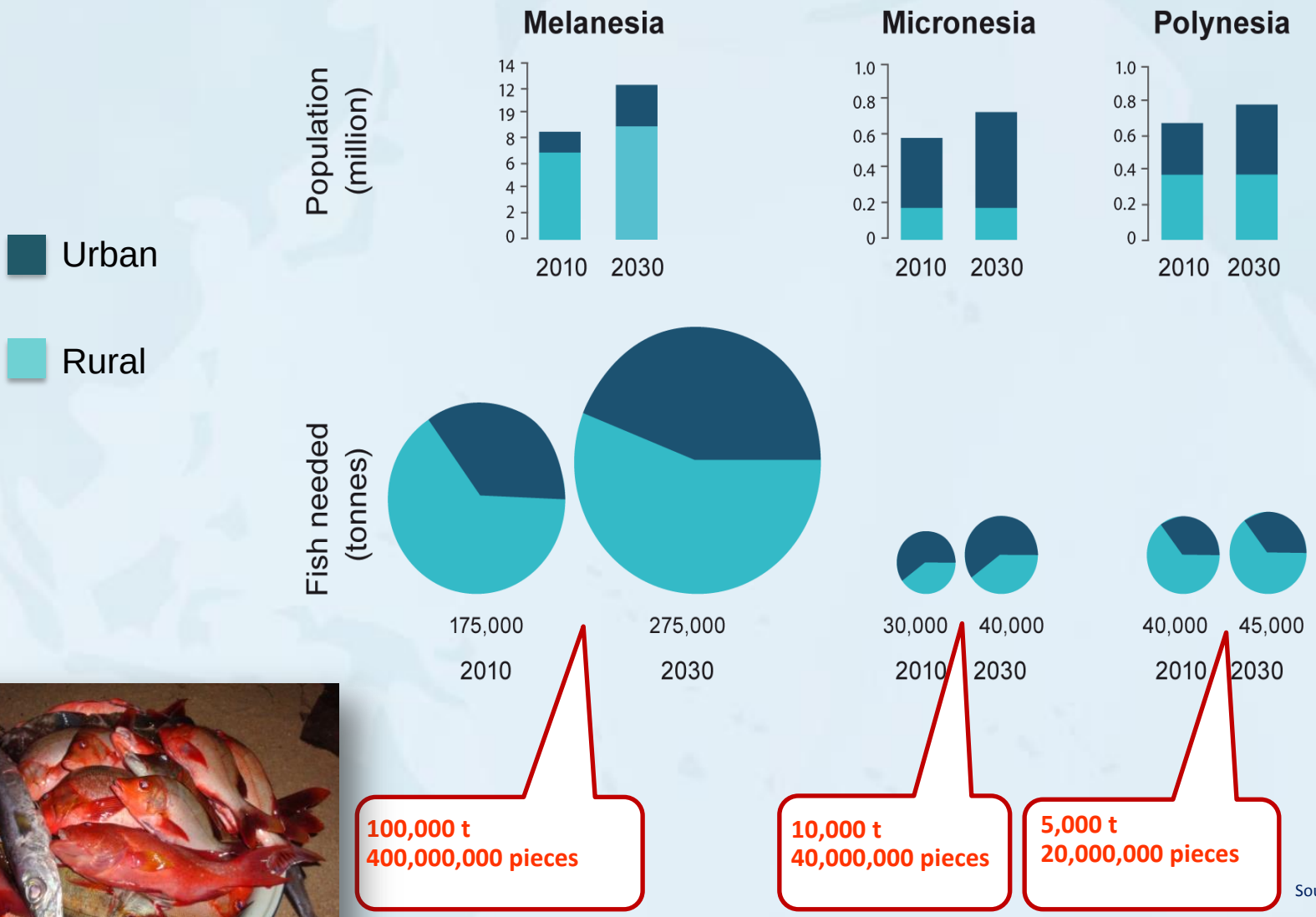
- Currently valued at ~USD 6 Billion
- One stock over-fished (bigeye)
- One stock probably fished above economic sustainability (albacore)
- Two stocks fully exploited (yellowfin, skipjack)
- Increasing need to supplement urban communities with industrial tuna catch
- Potential for negative effects of industrial fisheries on artisanal fisheries



Pacific SIDS Fisheries Dilemma

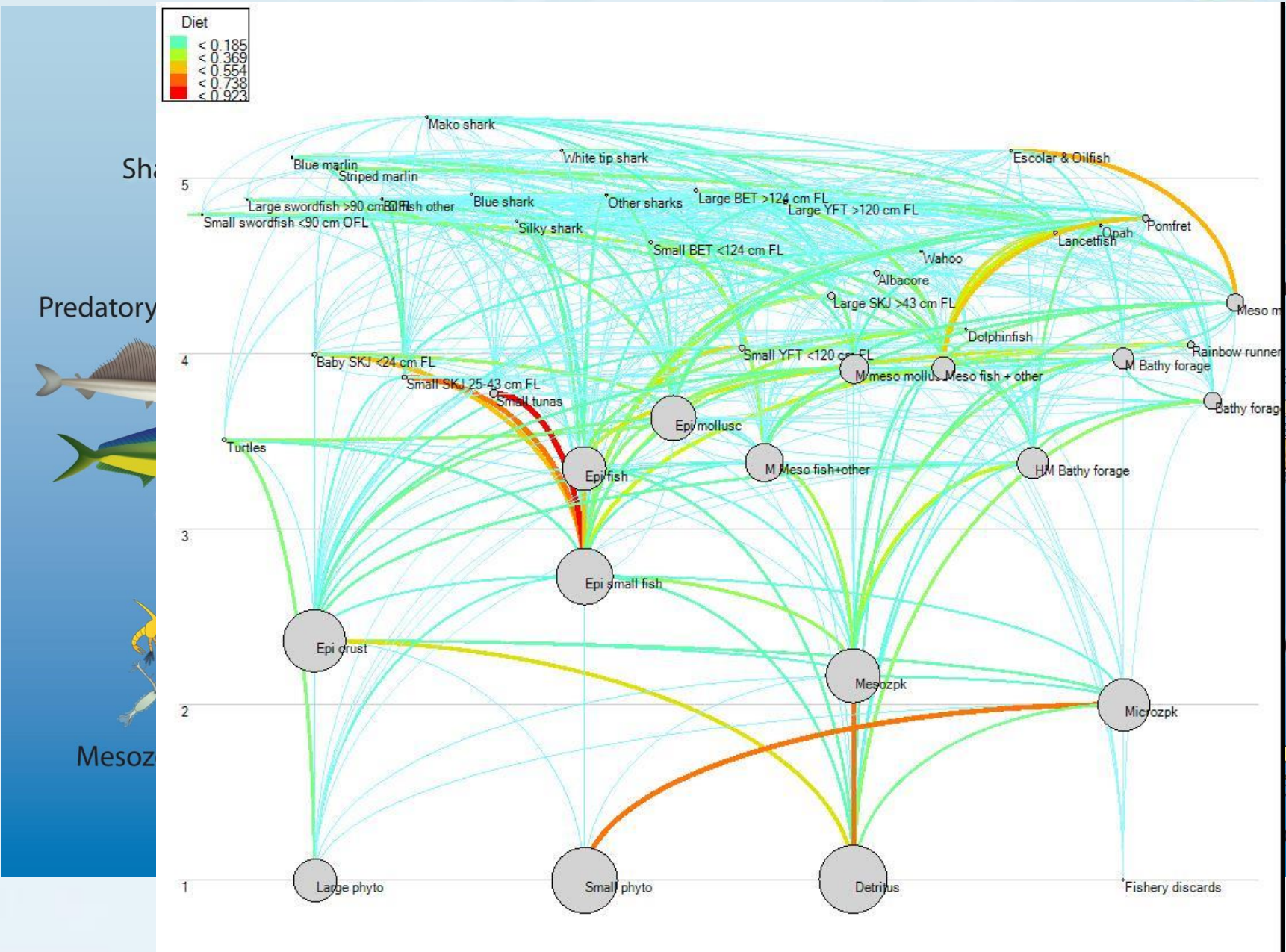
- Highly dependent on fisheries
- Many coastal fisheries over-exploited or at limits of sustainability
- Pelagic fisheries fully exploited
- Need to supplement food demands with pelagic fish
- Gain for food security = potential loss for government revenue
- Changes in tuna distribution and declines in abundance (e.g. Ocean Acidification) are likely to exacerbate this dilemma
- Increases in Pacific populations will further exacerbate this dilemma

Future fish needs (to 2030)

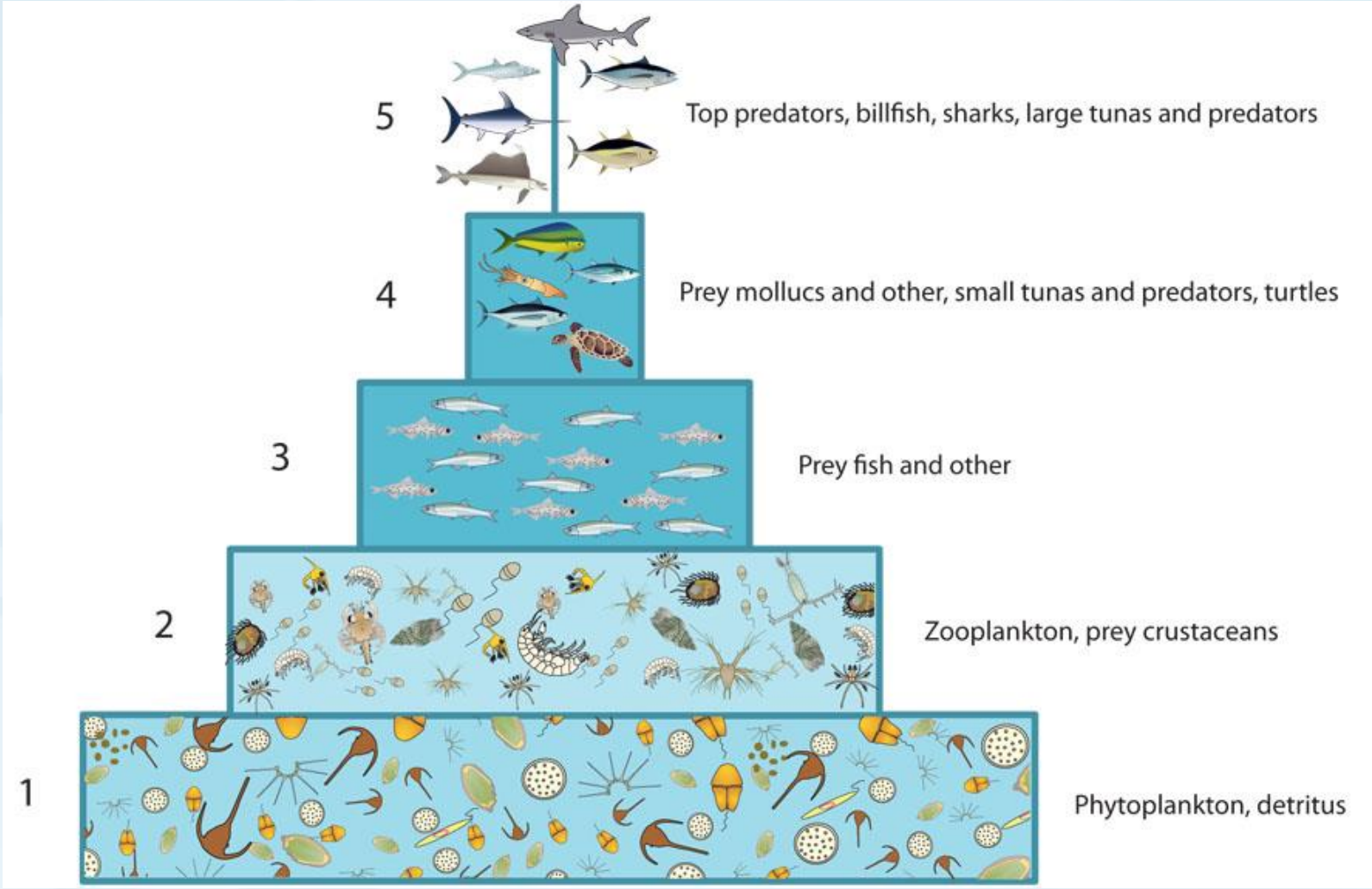


Source: Bell et al. (2011)

The pelagic ecosystem is complex



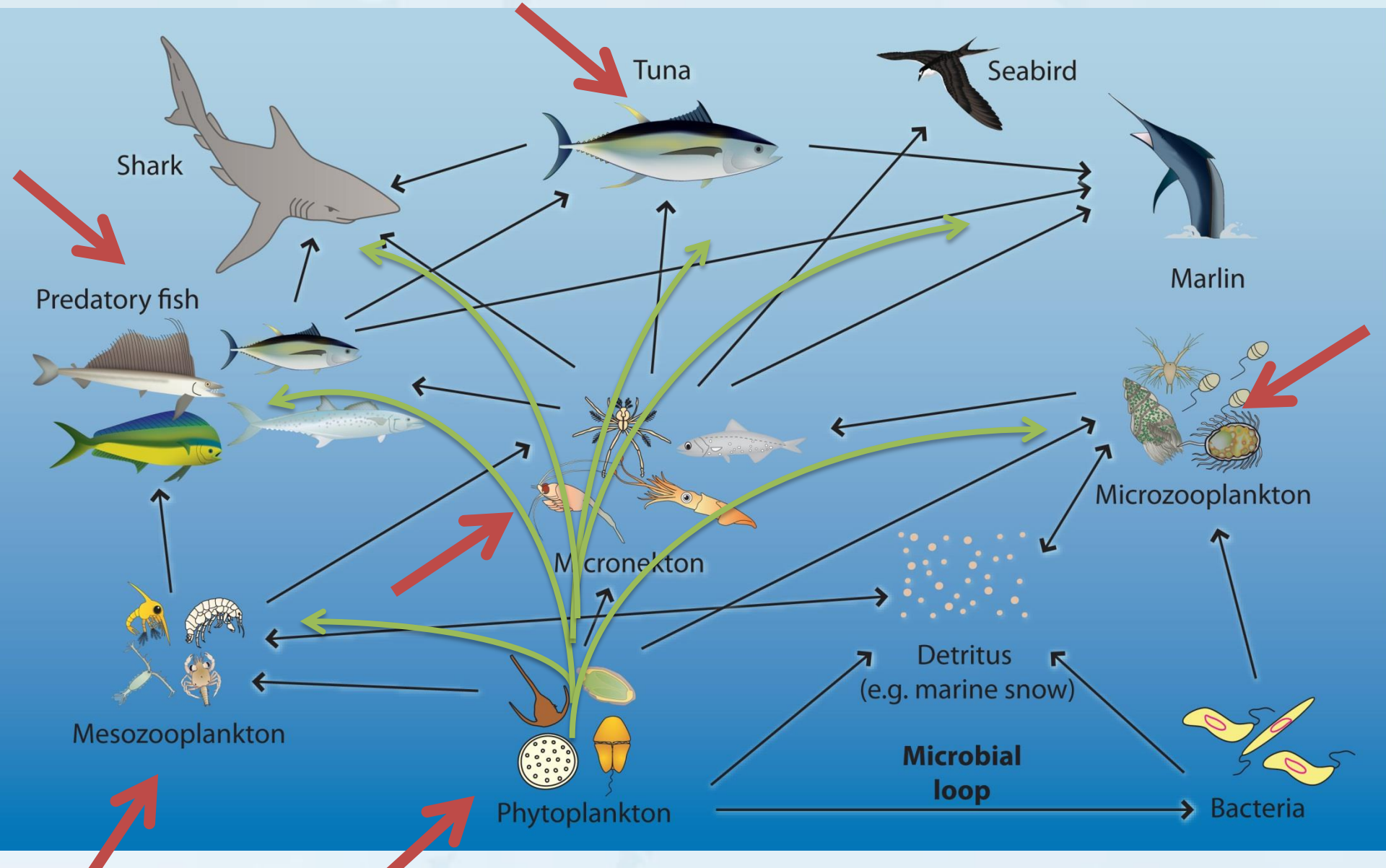
The productivity of the pelagic ecosystem is based on the phytoplankton production



Expected impact of OA on the pelagic ecosystem:

Direct impact

Indirect impact through the food web



Phytoplankton (Microalgae)

The calcifying microalga *Calcidiscus leptoporus* – these tiny cells each about 0.01mm diameter represent a key component at the base of the marine food web. Inset: *Calcidiscus leptoporus* after experimental exposure to a CO_2 level of 700 ppm as projected for the year 2100.

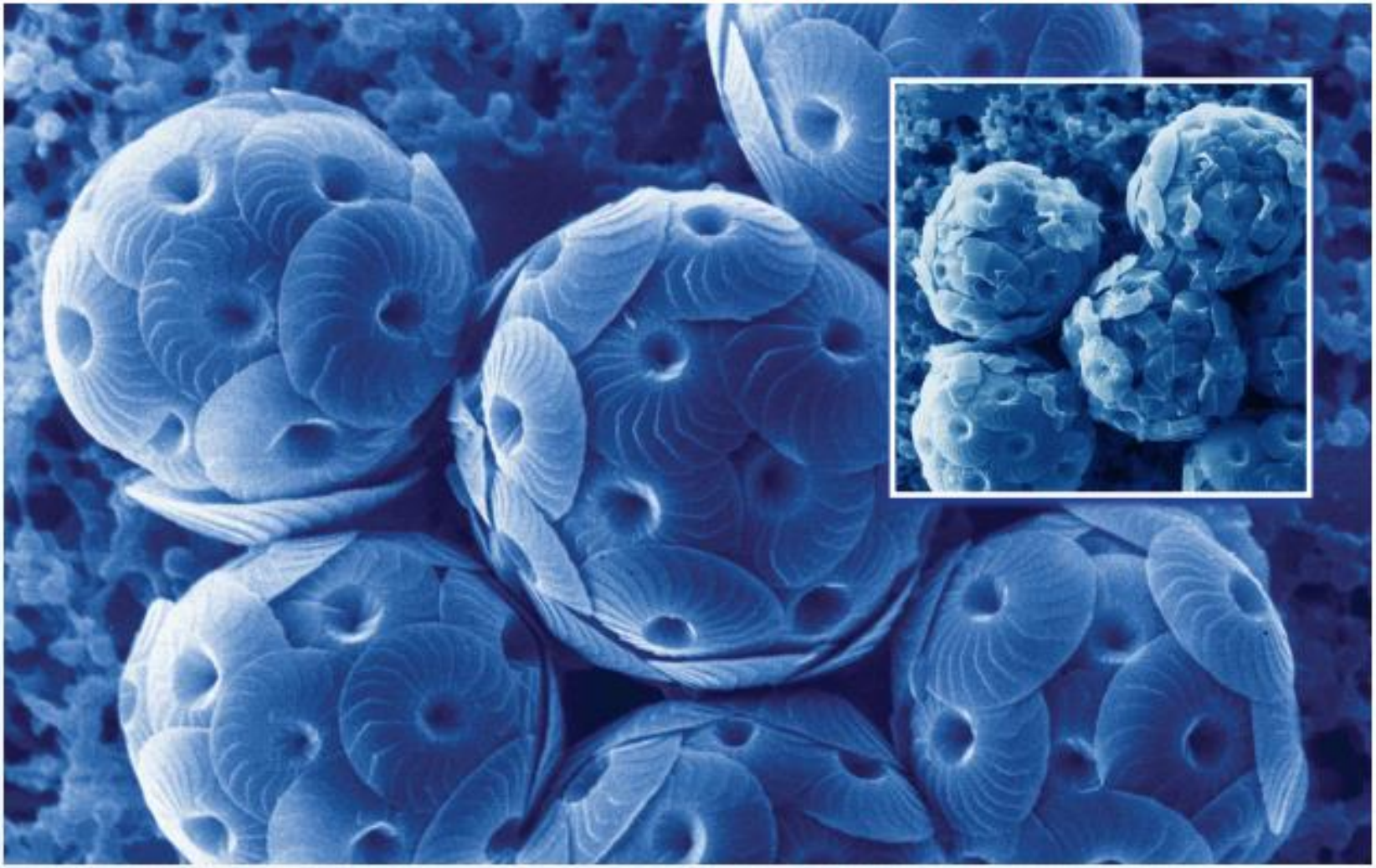


Photo © L.W. Richardson, BPA-GEOMAR

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http://www.epoca-project.eu/dmdocuments/OA.TF.English.pdf

Zooplankton Pteropod, or “sea butterfly”,

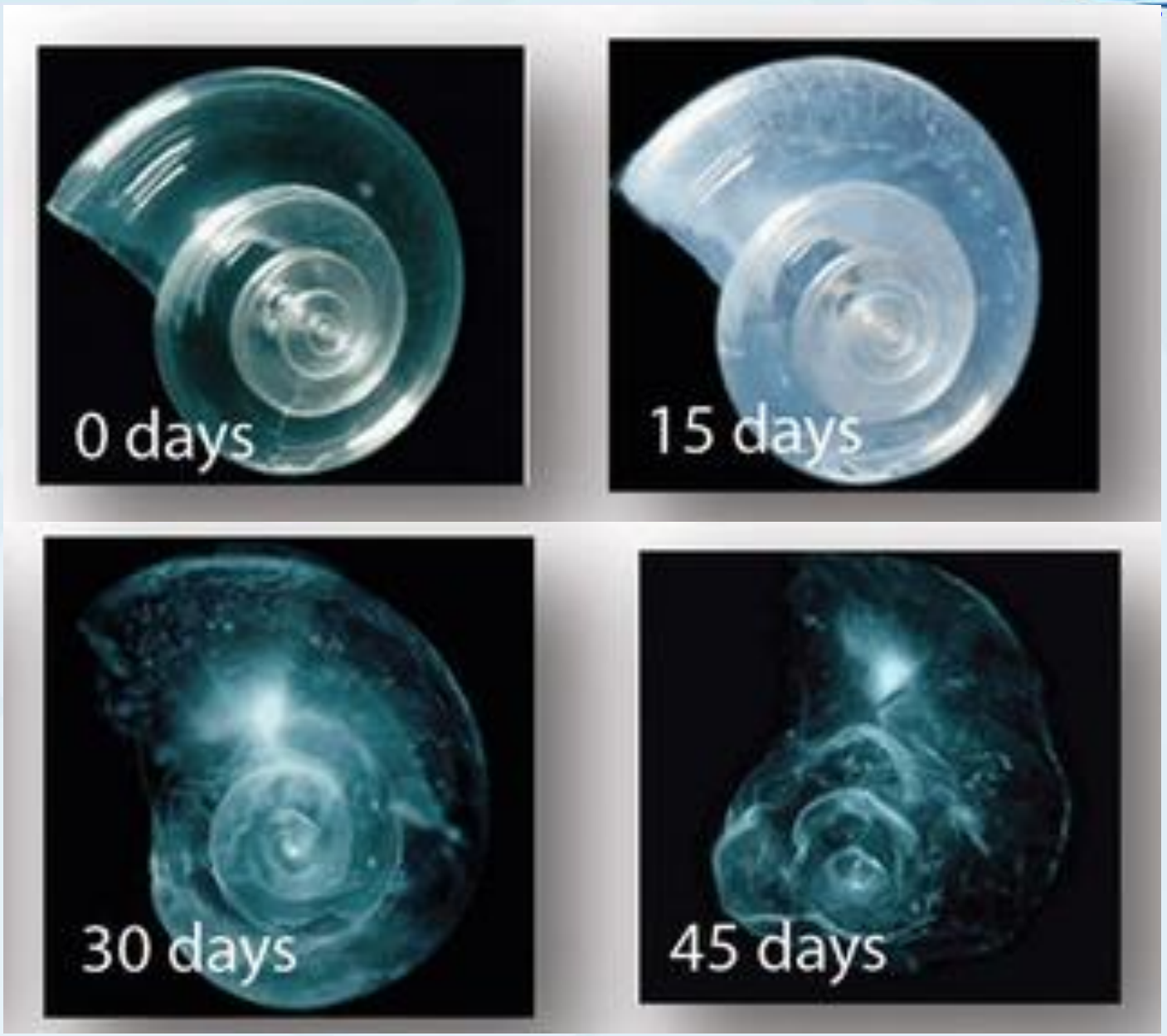

Photo credit: David Littschwager/National Geographic Stock. ***National Geographic***

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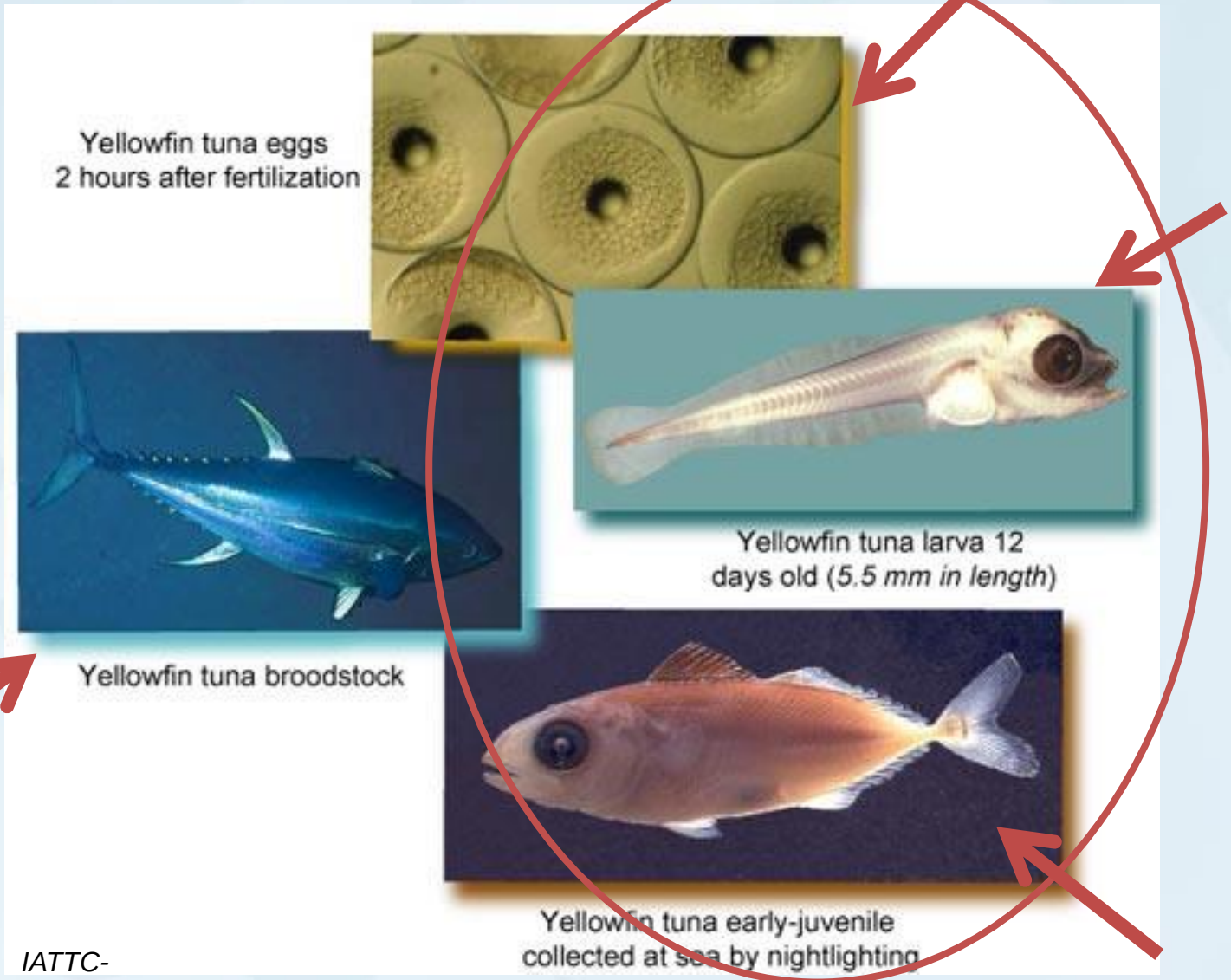
http://www.pmel.noaa.gov/co2/story/What+is+Ocean+Acidification%3F

Tuna

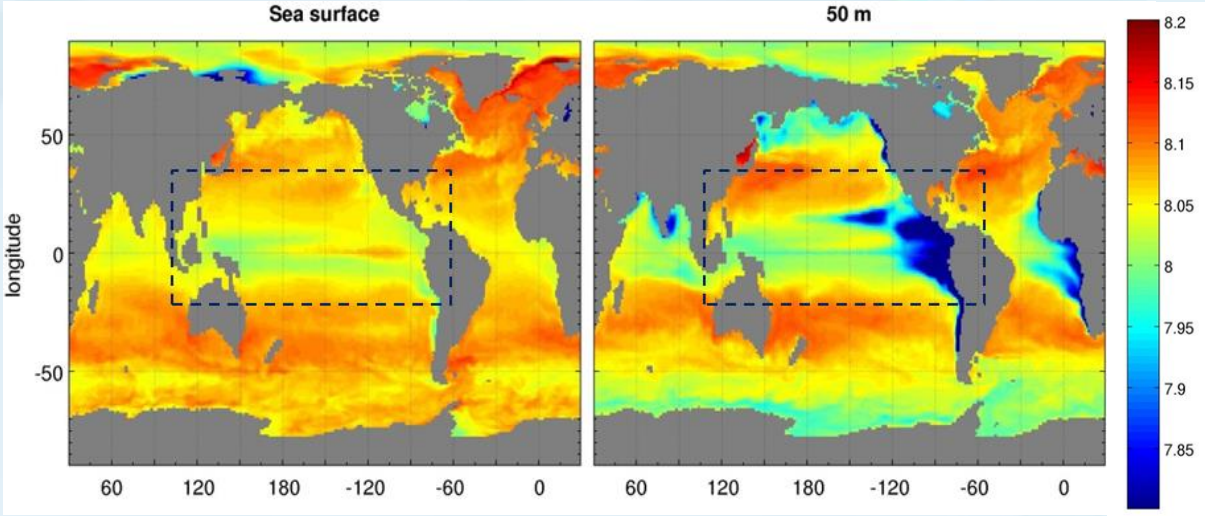


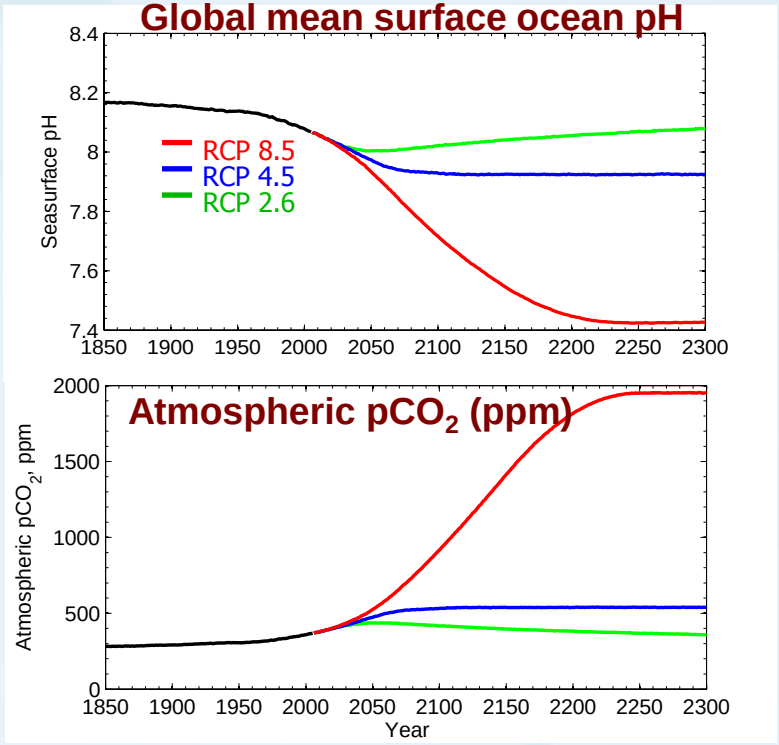
IATTC-
Achotines Lab

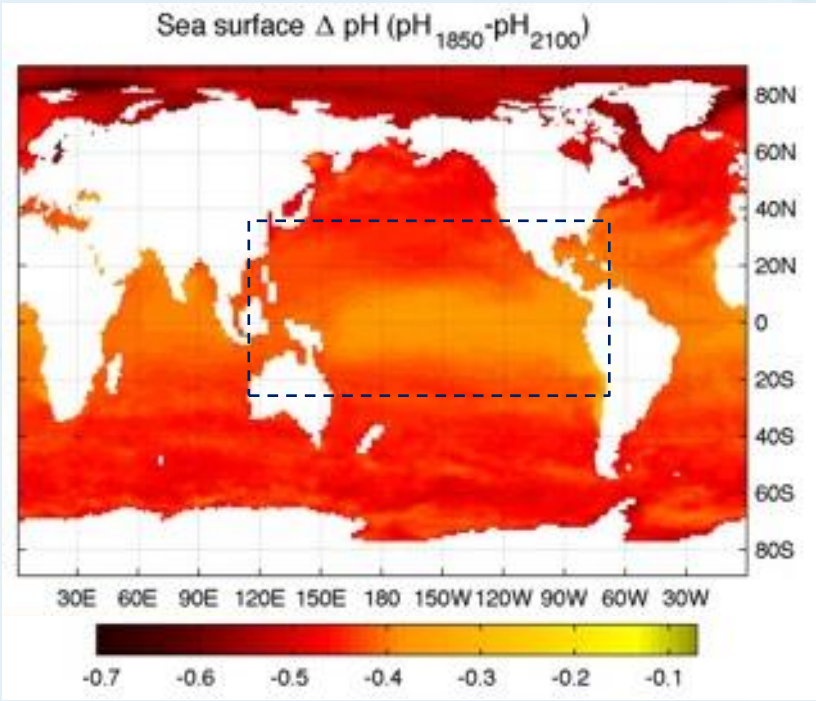
Tuna larvae

Ocean Acidification

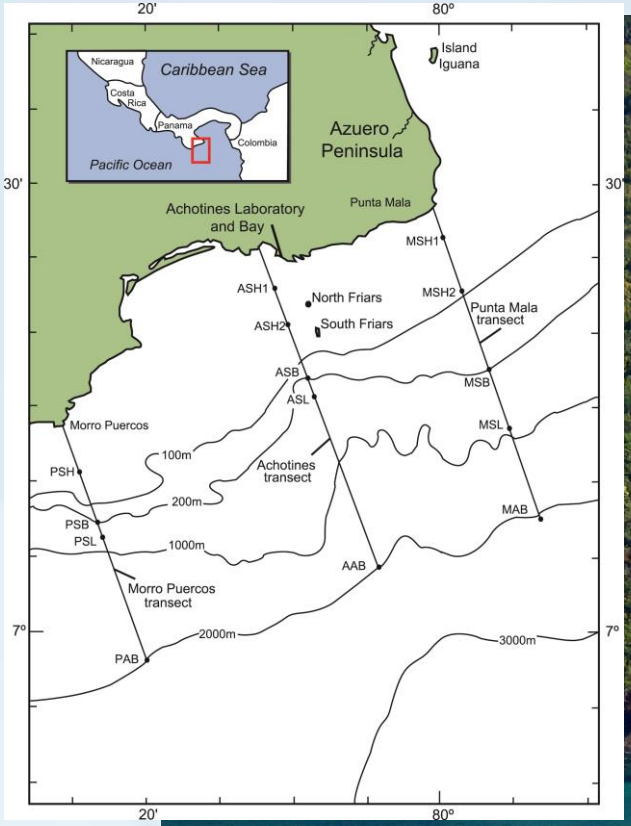
- IPCC based RCP 8.5 projections estimate that while oceans will acidify (lower pH, higher pCO2) the degree of change will vary spatially in surface waters



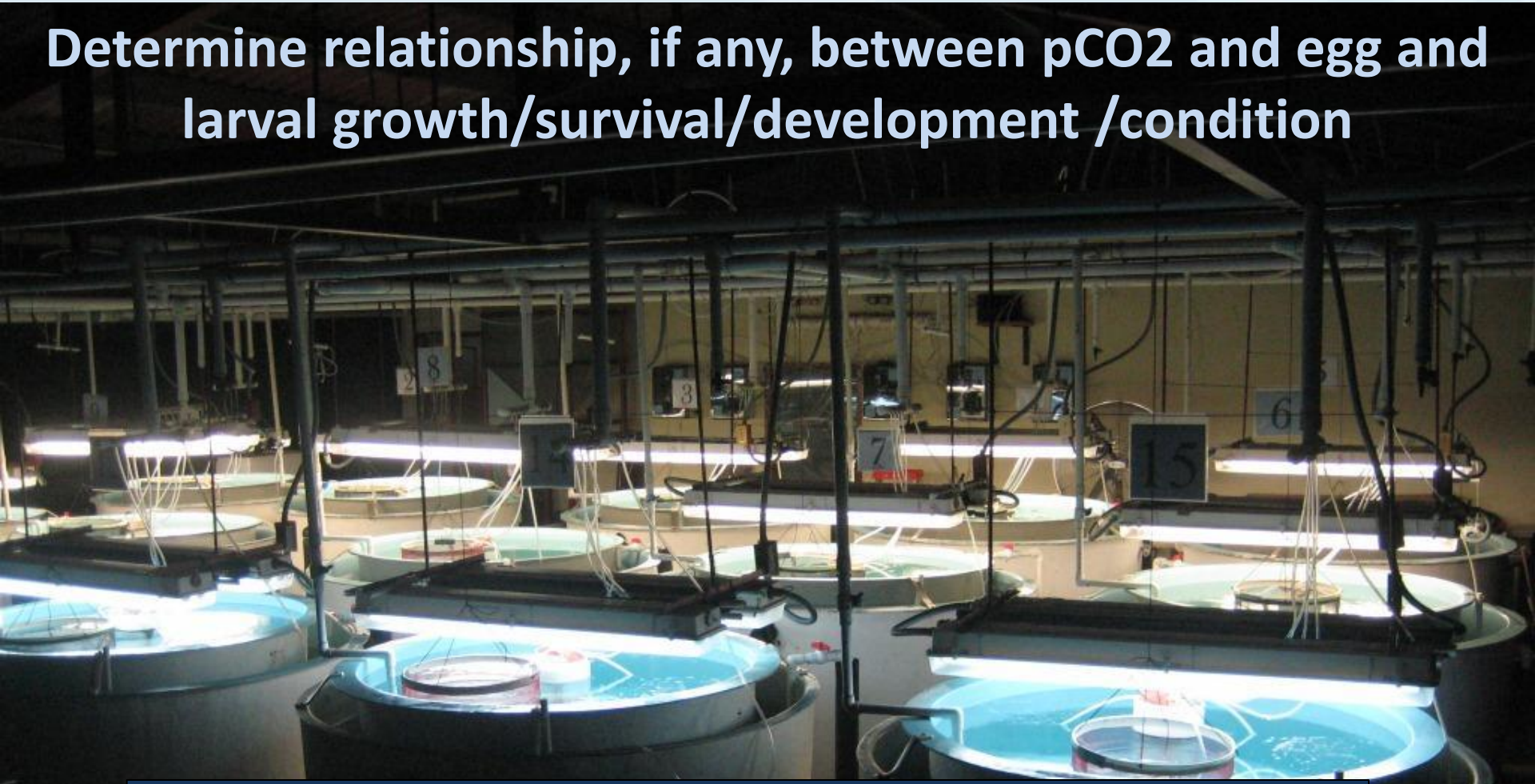




Ocean Acidification effects on Pelagic Fisheries



Determine relationship, if any, between pCO2 and egg and larval growth/survival/development /condition



- 2 Trials (October and November 2011)
- Continuous duration: Eggs>>Larvae>>Post feeding larvae
- 12 x 840L tanks with egg incubator nets
- Each trial: 3 replicates of 4 target treatment pHs (pCO2s)
- Target pHs 6.9, 7.3, 7.7, 8.1
- Modelled pCO2 (estimated via CO2Sys Excel)
- Sampling: every 2-3 days

Results

- Effects detected within the plausible ocean acidities forecasted over the next 100 years.

pCO2	Survival	Growth	*cellular damage**	Skeletal deformity	Otolith deformity
368 (8.1)					
2108 (7.6)#					
4732 (7.4)†					

* liver, kidney, and pancreas tissues
^ evidence for adaptation
#pCO2 projected for 2100
†pCO2 projected for 2200

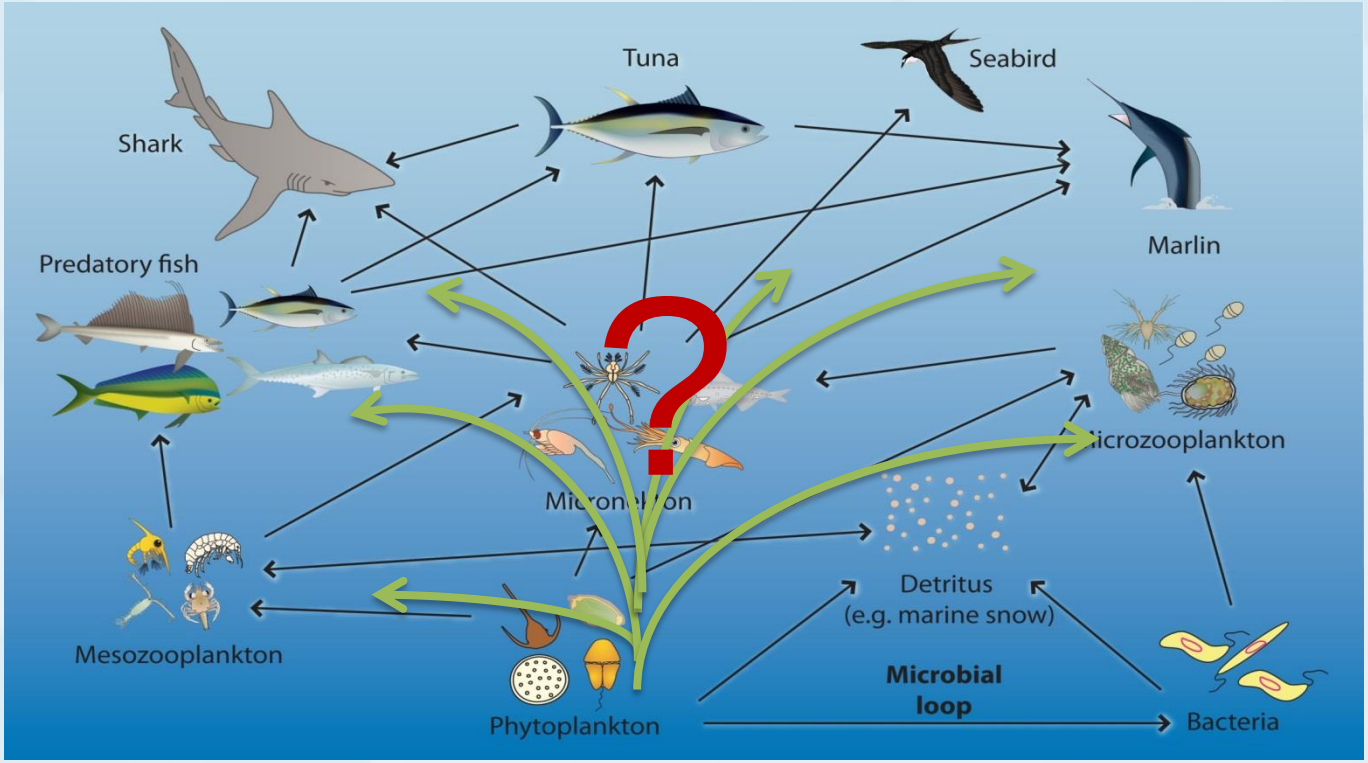
Uncertainties and adaptation

? Potential for genetic adaptation to future acidity levels

- Need to assess the likely time needed for adaptation

? Combined effects of increasing ocean temperatures and decreasing pH could be stronger

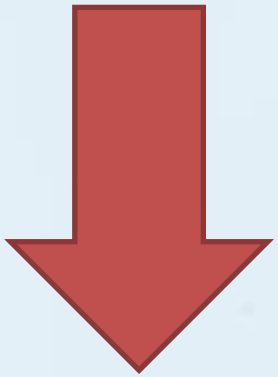
- Additional trials would address this uncertainty.



? Difficult to predict how OA impacts will cascade throughout the marine food web and affect the overall structure of marine ecosystems

What do these results mean

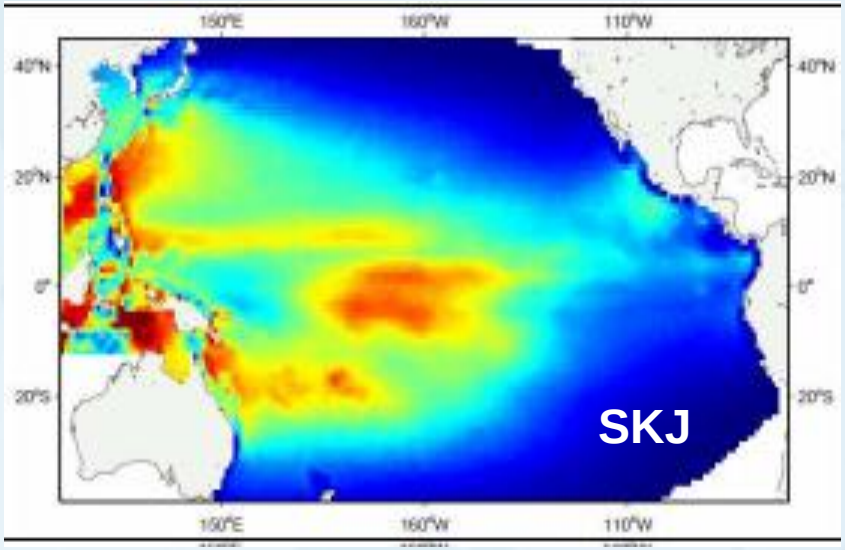
- Increase in natural mortality rates and lower growth rate of tuna (i.e. less tuna)
- Changes in the food web

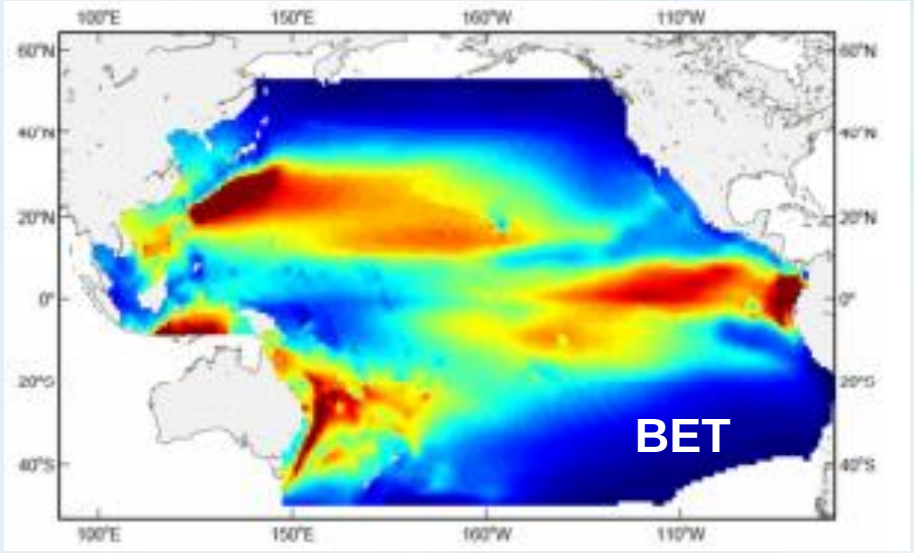


Consequences for food security & government revenues

Where to from here

- Need to include Acidity effects in population dynamics models (e.g. SEAPODYM) to forecast how effects on natural mortality are likely to manifest themselves.





Where to from here

- Need to include Acidity effects in population dynamics models (e.g. SEAPODYM) to forecast how effects on natural mortality are likely to manifest themselves.

- Need to identify the communities that are most likely to be impacted by a change in Pelagic species abundances
  - Rural; supplement with aquaculture & near shore large pelagics
  - Urban; consequences upon licensing arrangements of further supplementation with large pelagics

- Continue to reduce uncertainties in the empirical evidence on acidity effects.

- Monitoring to forewarn when adaptations should be implemented

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MORE INFORMATION

http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/FishNews/142/FishNews142_43_Bromhead.pdf

http://cdn.spc.int/climate-change/fisheries/assessment/e-book/#/1/