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

Presentation Structure

- Overview of the fisheries of the Pacific Ocean
  - Food Security
  - Economic Prosperity
- Evidence of impacts on Pelagic Ecosystems
- Impacts on pelagic ecosystems for SIDS
  - Economic
  - Social considerations

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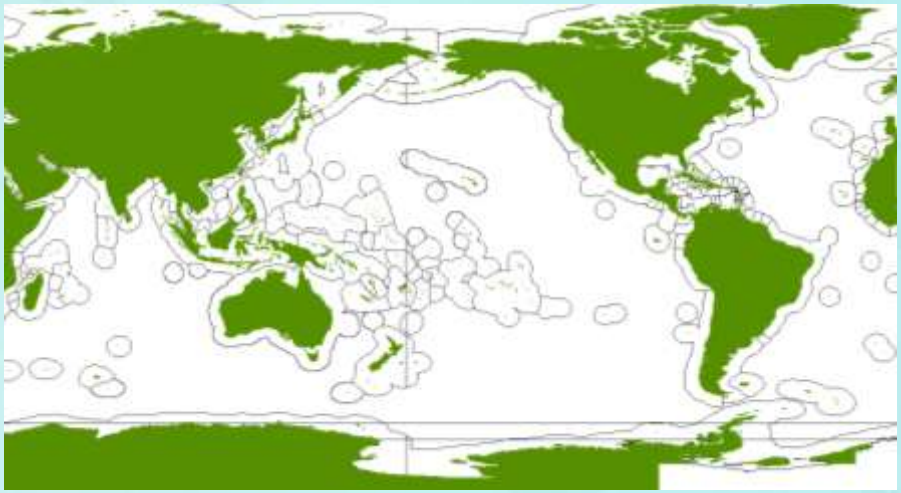
Western Pacific SIDS

- Dominated by Islands and Atolls
- 27,116,382 km^2 of Exclusive Economic Zones
- 98% coastal and oceanic habitats



Western Pacific SIDS

- Many are Remote and Isolated
- Mix of high and low density populations

Marshall Islands

- 29 Atolls and 5 Islands
- 181 km^2 land area (<1% of EEZ (2,131,000 km^2))
- 24 inhabited
- Est. population = 53,158
- ~50% living on Majuro Atoll

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Papua New Guinea

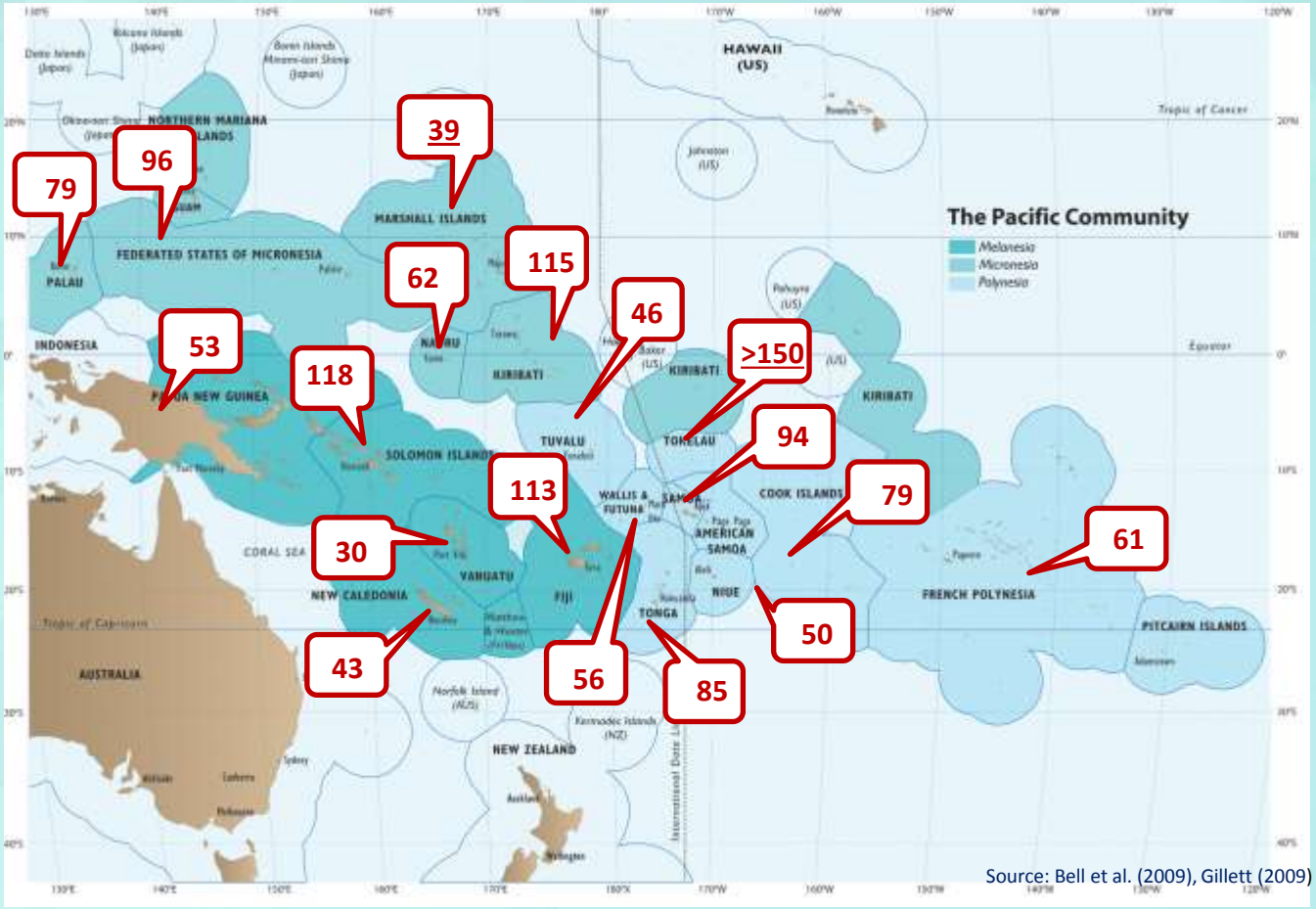
- 5 main Islands, 139 small islands
- 462,840 km^2 land area (~15% of EEZ (3,120,000 km^2))
- All inhabited
- Est. Population = 7,059,553 (~50% on coastline)
- ~13% living in urban centres

Western Pacific SIDS

- All Pacific SIDS are unique but have many similarities and dependencies
  - Government revenue
    - Kiribati derives >50% of its foreign revenue from the sale of fishing licenses to foreign fleets
    - typically around 20% for most Pacific Island Nations
    - 3% for larger SIDS like PNG & Solomon Islands
  - Health
    - world's highest levels of diabetes and obesity driven by changes in lifestyle and increasing imports of inexpensive, nutritionally-poor, energy dense food
  - Food security
    - Priorities to increase fish in diet to combat deteriorating health
    - Over-exploited coastal fisheries resources that are not able to support the food requirements in urban centres

How much fish do we eat?

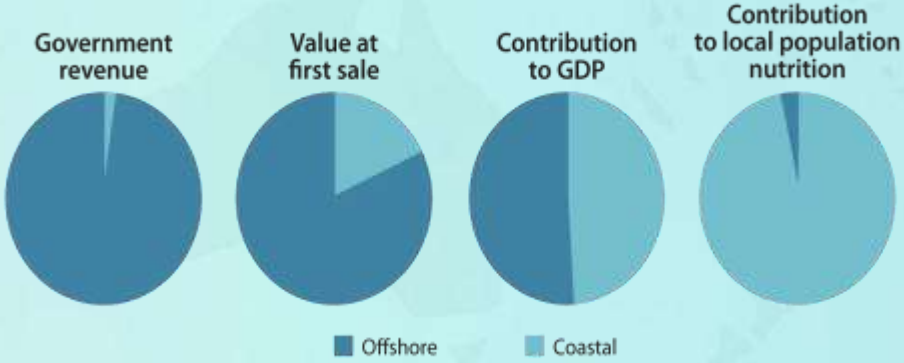
- Fish consumption in coastal communities (kg/person/year)



Source: Bell et al. (2009), Gillett (2009)

- **Coastal fisheries:** coral reefs, mangroves and sea-grass habitats provide the bulk of subsistence animal protein
  - Supports a combination of subsistence fishing, local market, commercial operations, marine tourism
- **Oceanic fisheries:** industrial tuna fisheries, small scale artisanal fisheries for domestic markets

- Coastal fisheries provides 50% - 90% of protein intake for coastal communities
- Very important for local incomes (provides around 50% of coastal households with 1st or 2nd source of income)



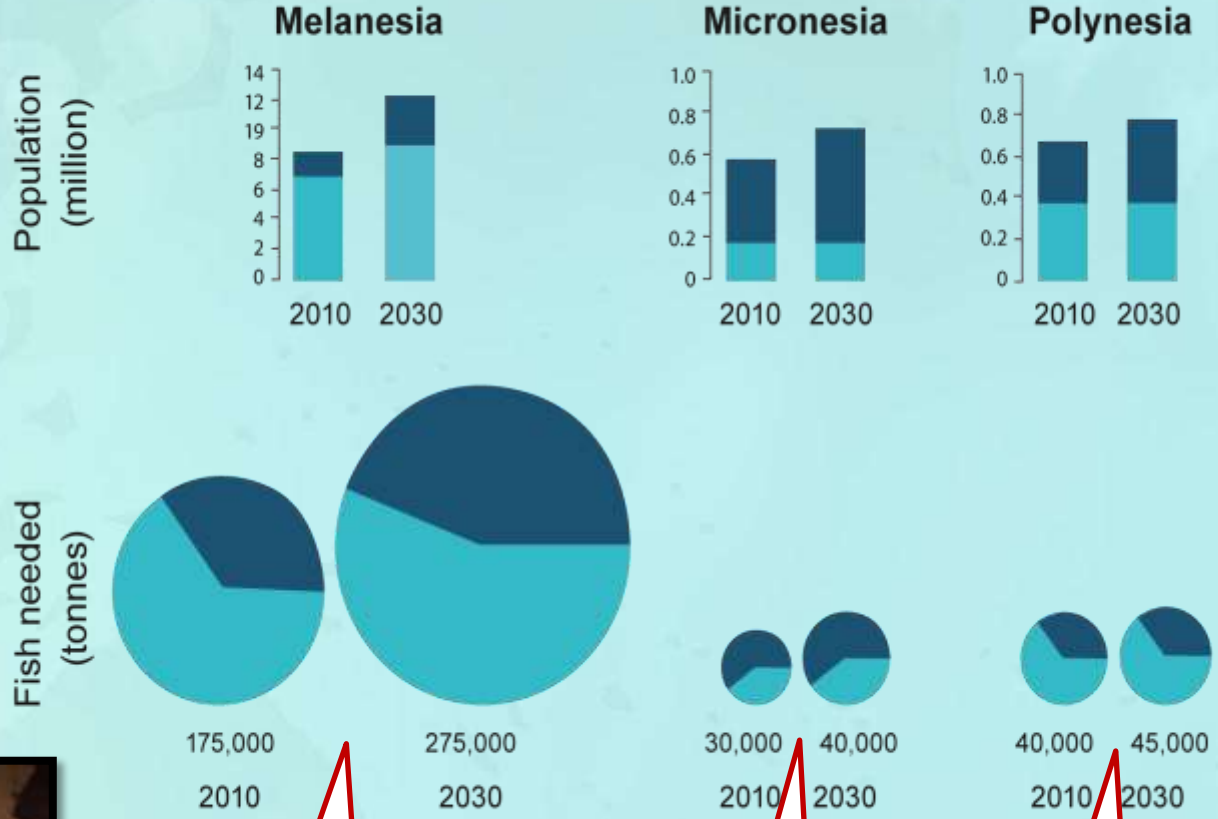
Industrial Tuna Fisheries

- Currently valued (ex-vessel) at USD5.62 Billion
- One stock over-fished
- One stock probably fished above economic sustainability
- Two stocks fully exploited
- 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)



100,000 t
400,000,000 pieces

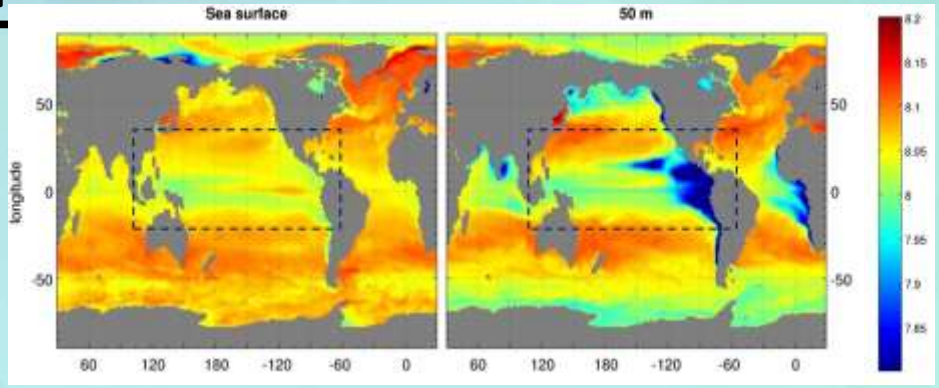
10,000 t
40,000,000 pieces

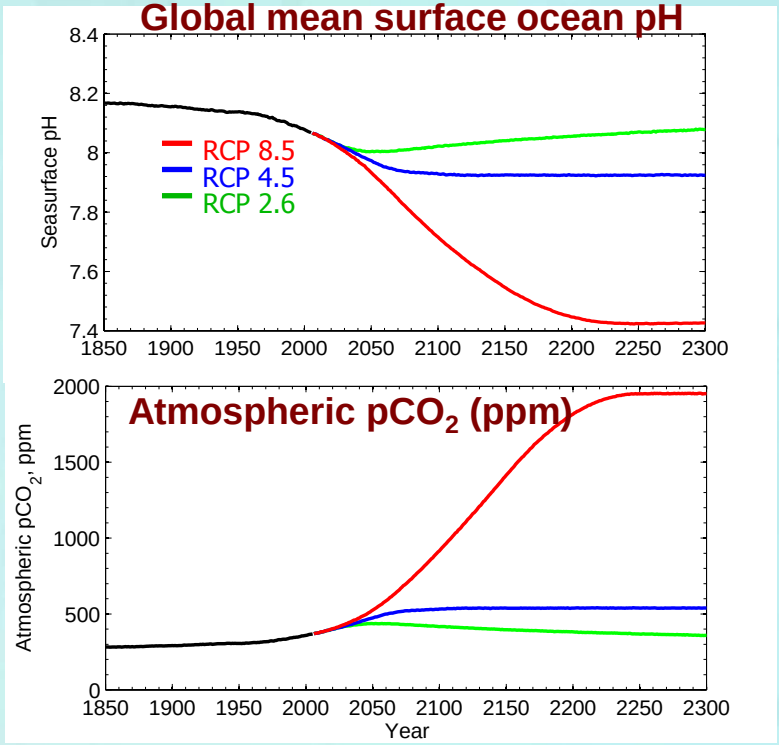
5,000 t
20,000,000 pieces

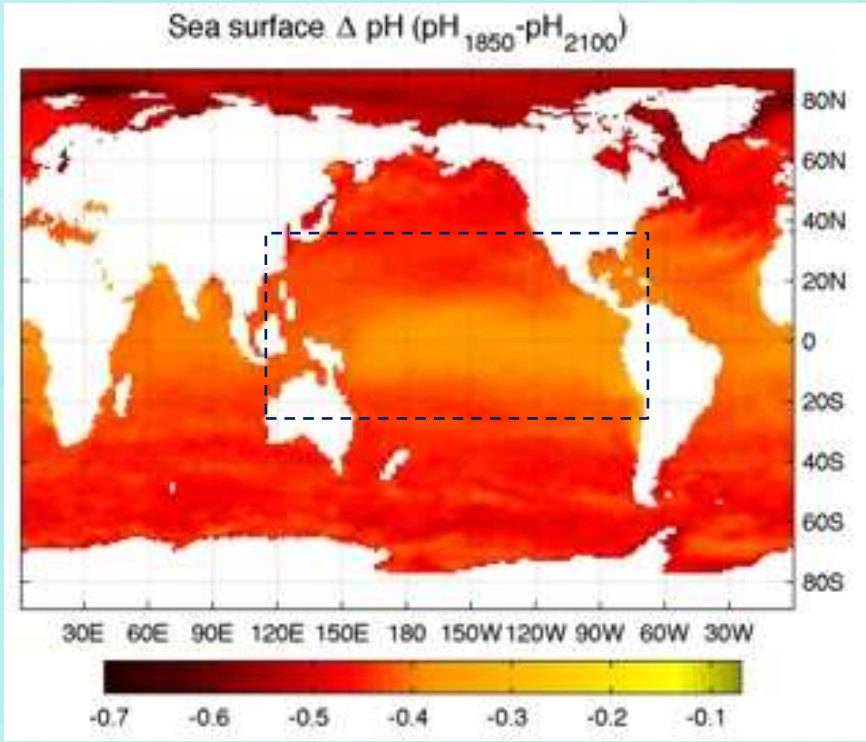
Source: Bell et al. (2011)

Ocean Acidification

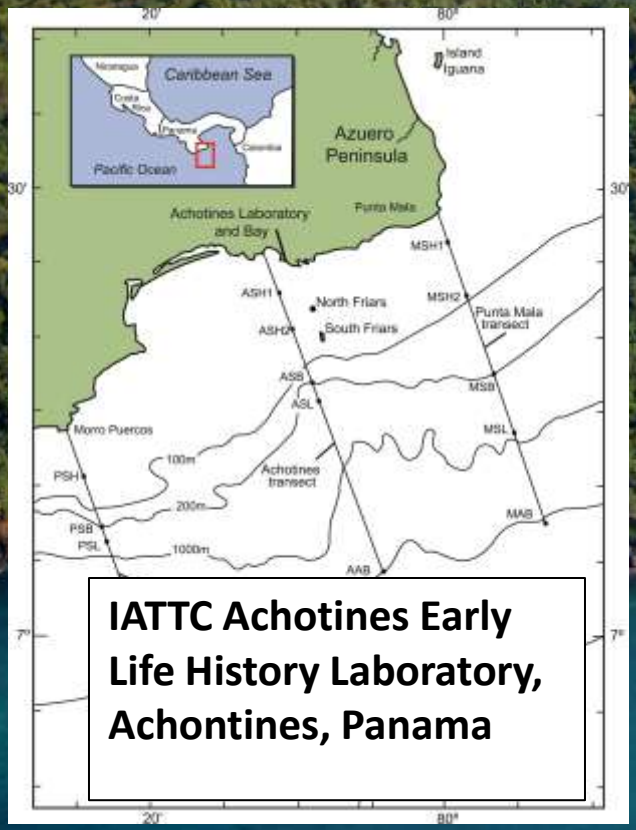
IPCC based RCP 8.5 projections estimate that while oceans will acidify (lower pH, higher pCO2) the degree of change will vary spatially in surface waters







Ocean Acidification effects on Pelagic Fisheries



IATTC Achotines Early Life History Laboratory, Achontines, Panama

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	Genetic^
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

What do these results mean

- Preliminary but suggest that direct and indirect effects on tuna are likely
  - Increase in natural mortality rates (i.e. less tuna)
  - Consequences for food security & government revenues
- Potential for genetic adaptation to future acidity levels
  - Need to assess the likely time gap to adaptation
- Combined effects of increasing ocean temperatures and decreasing pH could be stronger
  - Additional trials would address this uncertainty.

Where to from here

- Need to include Acidity effects in population dynamics models (e.g. SEAPODYM) to forecast how the direct and indirect effects on natural mortality are likely to manifest themselves.
- Need to identify the communities that are most likely to 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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