Integrating Climate and Ocean Change Vulnerability into Conservation Planning

May 14-17, 2013
AGU Meeting of the Americas

Dr. Lizzie Mcleod
The Nature Conservancy

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Challenges

- Planners lack access to climate experts or models
- Mismatch of scales (regional projections vs. site-based planning)
- Uncertainty of climate data/ecological response
- Efficacy of MPAs to protect ecosystems in face of CC
- Lack of guidance on how models/data can be applied

Establish resilient networks of MPAs

Resilience Model

Representation and Replication

Habitat Types
Multiples → Risk Spreading

Critical Areas

Refuges
Spawning Aggregations → Secure Sources of Seed

Connectivity

Transport → Replenishment

Effective Management

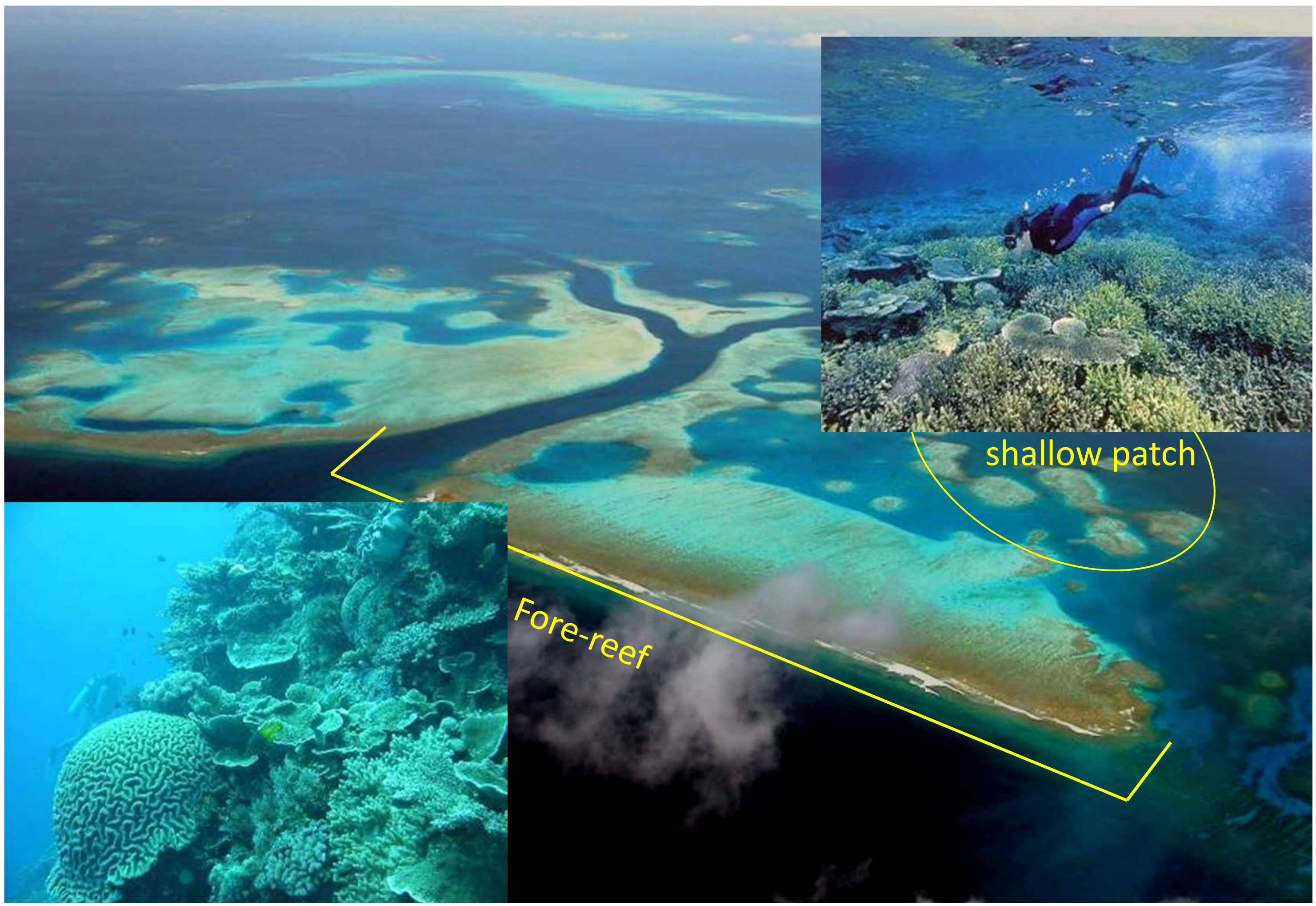
Threat Abatement
Adaptive Strategies → Strong Recruitment
Enhanced Recovery

Representation and Replication

Habitat Types Multiples → **Risk Spreading**

Spread risk

- ID/protect areas likely to be less vulnerable
- ID variety of ocean chemistry regimes
  - high variability
  - high/low Ωarag



Critical Areas

Refuges
Spawning Aggregations → → → **Secure Sources of Seed**

Protect refugia

- ID/protect areas likely to be resilient/resistant to OA
  - buffering effects (biological, physical and chemical processes)
- Prioritize areas with > natural Ωarag variability

Connectivity

Transport → **Replenishment**

Link refuges – recovery

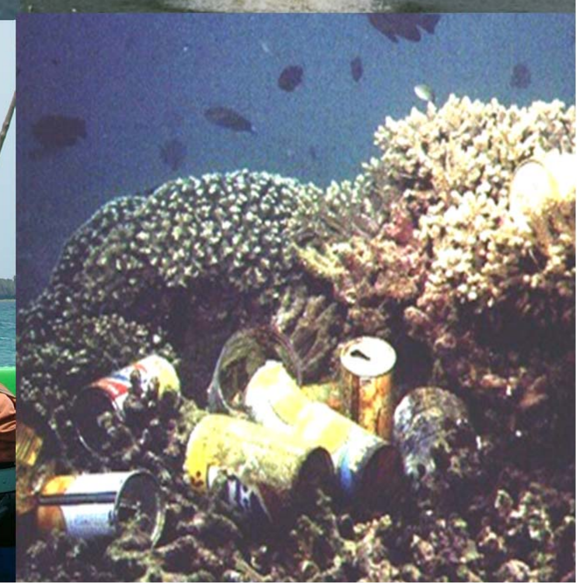
- OA impacts on life stages/ connnectivity

Effective Management

Threat Abatement Adaptive Strategies	→	Strong Recruitment Enhanced Recovery

Abate threats – reduce stress

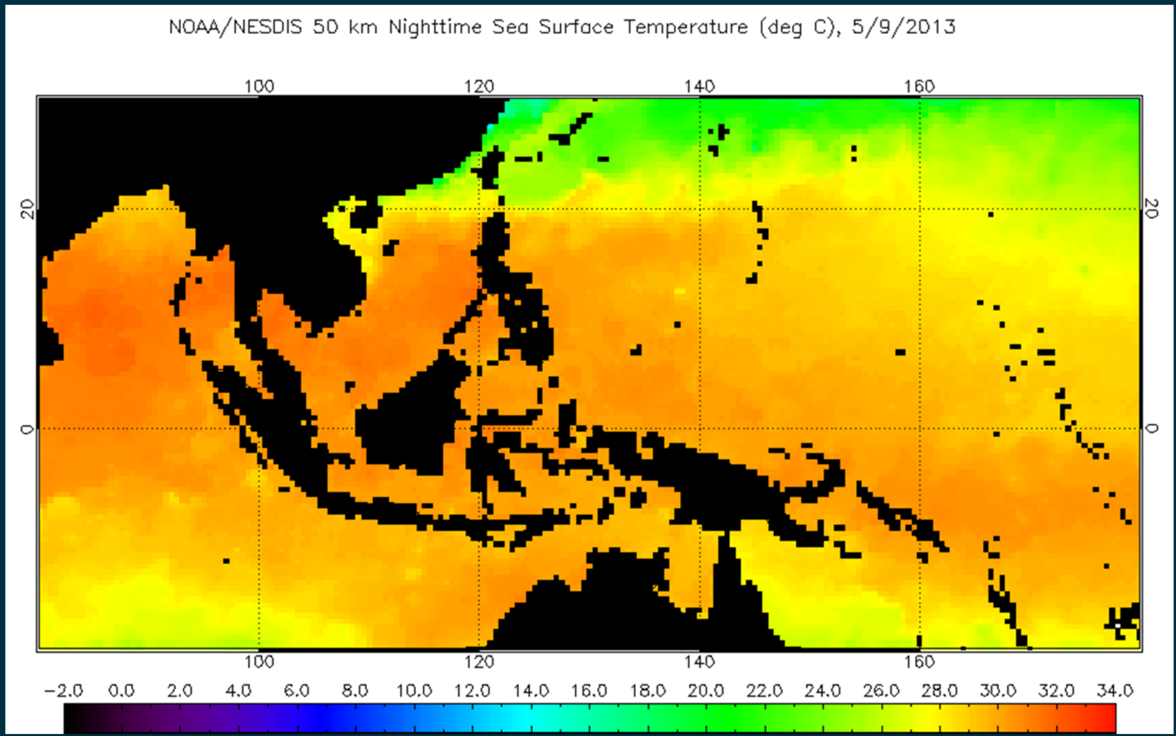
- Control coastal run-off (e.g., nitrogen & sulfur oxides)
- Overfishing of herbivores



Research Priorities for SSTs

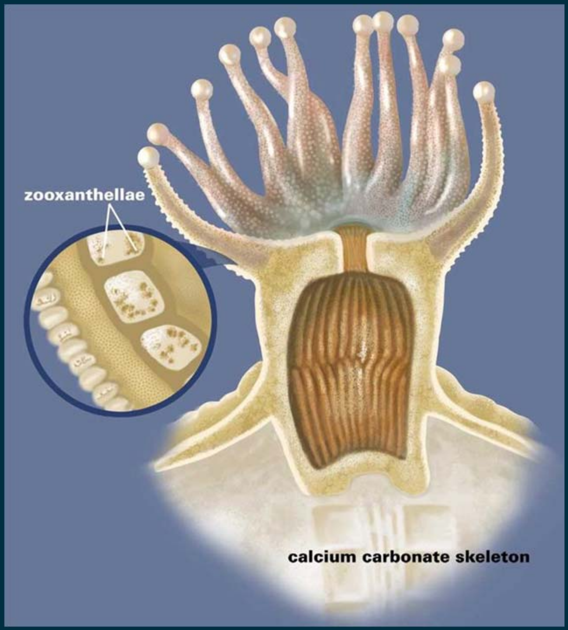
1) Improve tools

- finer scale SST data
- thermal stress patterns nearshore



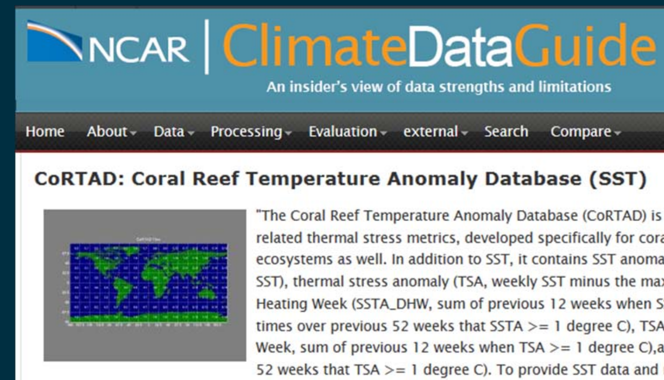
2) Ecological gaps

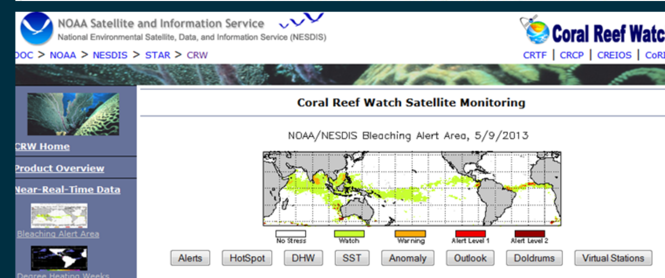
- Local factors affecting bleaching susceptibility
- Corals’ adaptation potential



3) Decision support

- Agreement on thermal stress metrics/datasets
- Combining historical SSTs/projections
- Scales of thermal variability
- Integration of socioeconomic factors





Research Priorities for OA

1) Ocean chemistry baseline

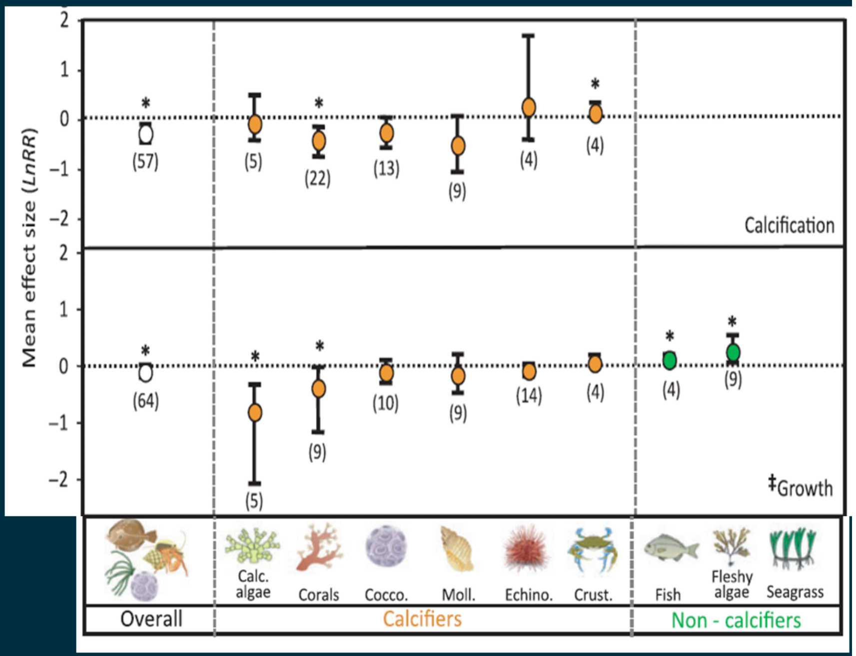
- Understand natural spatial/temporal variability of ocean carbon system
- Explore areas with high variability in pH and Ω_a
- Explore areas with naturally low pH and Ω_a

2) Establish ecological baseline

- Better understand reef health and resilience potential
- Assess carbonate chemistry of reefs/adjacent habitats
- Assess ocean current patterns

3) Determine species/habitat/community sensitivity

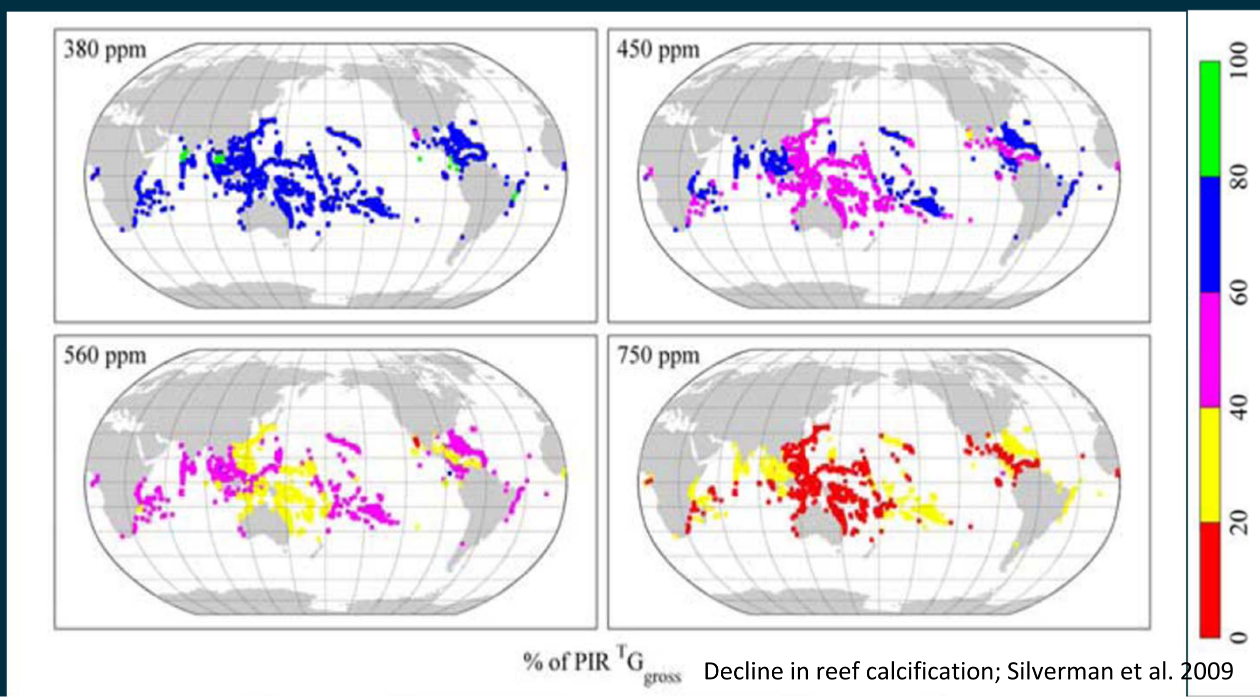
- sensitivity varies within & across reefs



Kroeker et al. 2010

4) Projecting changes in seawater carbonate chemistry

- Projections of seawater carbonate chemistry - robust at broad spatial/temporal scales of open ocean



Decline in reef calcification; Silverman et al. 2009

5) Identify potential synergistic effects of multiple stressors

- Many threats affect vulnerability
- OA can support macroalgal growth; major implications for reef resilience




Integrating SST/OA into Planning

- ID/protect refuges (vs. bleaching refuge)
  - Areas likely to experience less change in seawater chemistry/lower thermal stress
  - Resistant species/communities
  - Ameliorating factors
  - Adaptation/Acclimation potential

- Apply “bet-hedging approach”
  - – high variability in temp and Ω_a/pH
  - – high/low Ω_a/pH

Integrating OA/SST into Planning/Mngt

- Maps of reef vulnerability to SST & OA - MPA network design
  - factors conferring resilience/resistance
  - coral's adaptation potential
  - how OA/temp affect connectivity, recruitment, and recovery

- Links between land-based pollution and chemistry of coastal waters to inform ICZM

Moving forward

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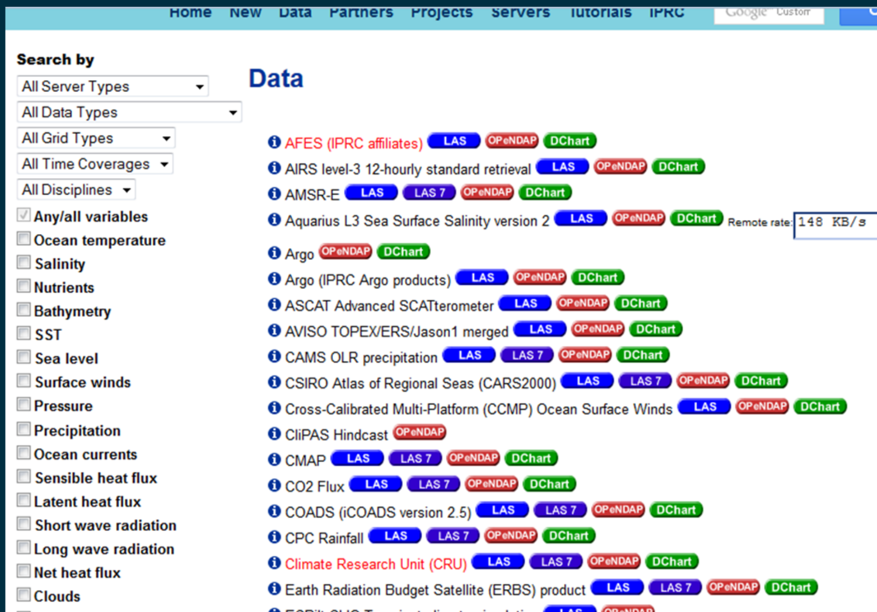

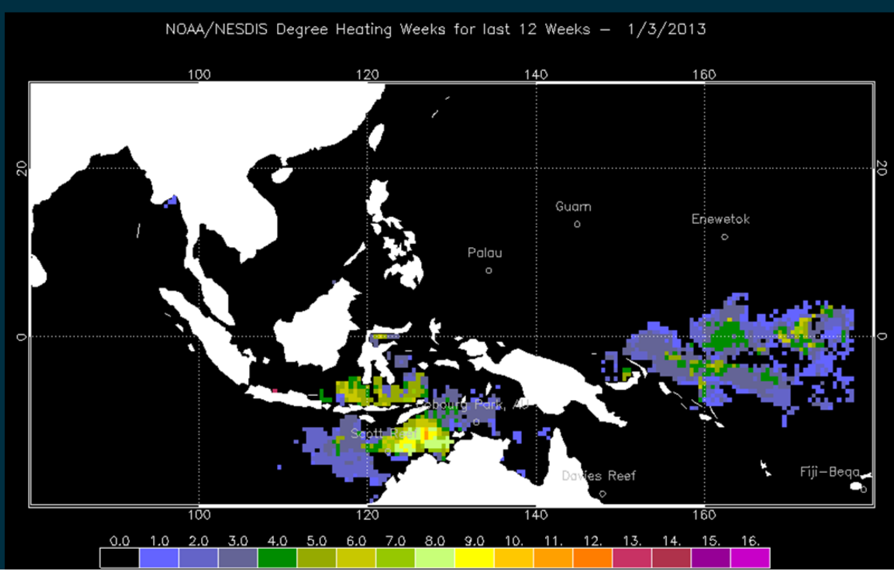

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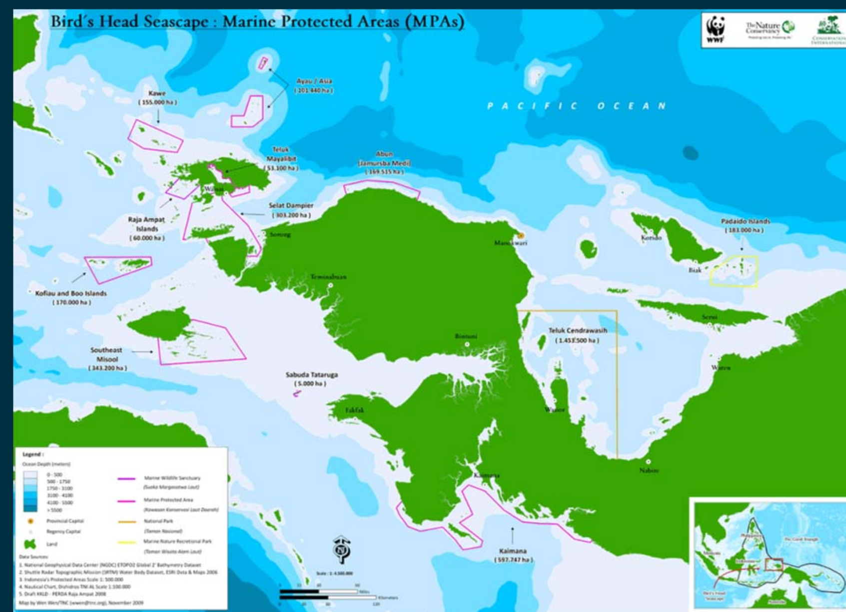

If the perils of our time are unprecedented,
then so are the opportunities. – Anonymous