

Monitoring for Resilience

Acknowledgement: David Obura (CORDIO)

The Nature
Conservancy 
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Selecting / designing a protocol

There is no single best protocol

Situation-specific protocols

Manuals/Protocols are guides only

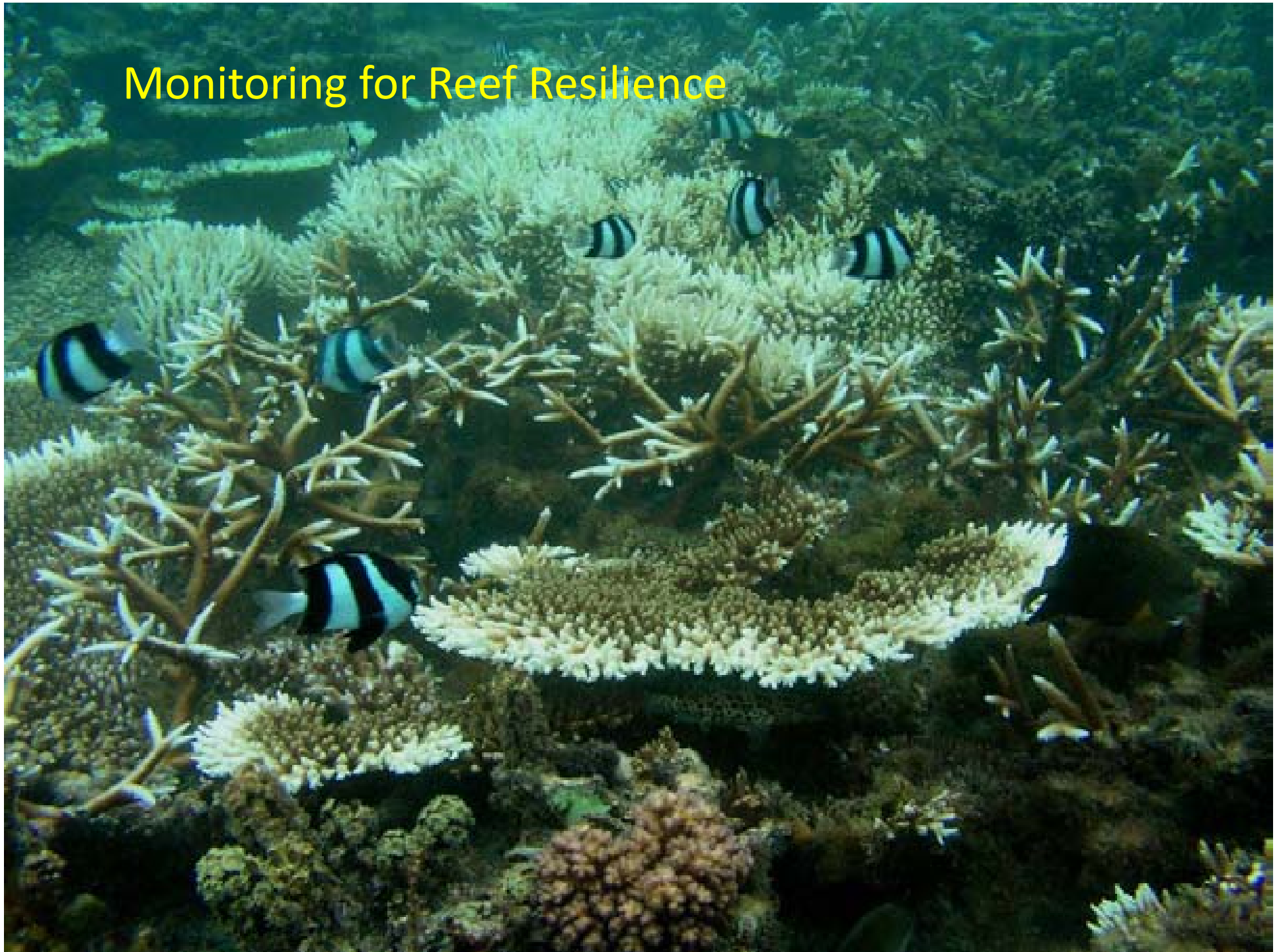
Use standard bleaching & resilience methods

The ideal protocol will depend on:

- specific objectives and goals
- skills and experience
- resources



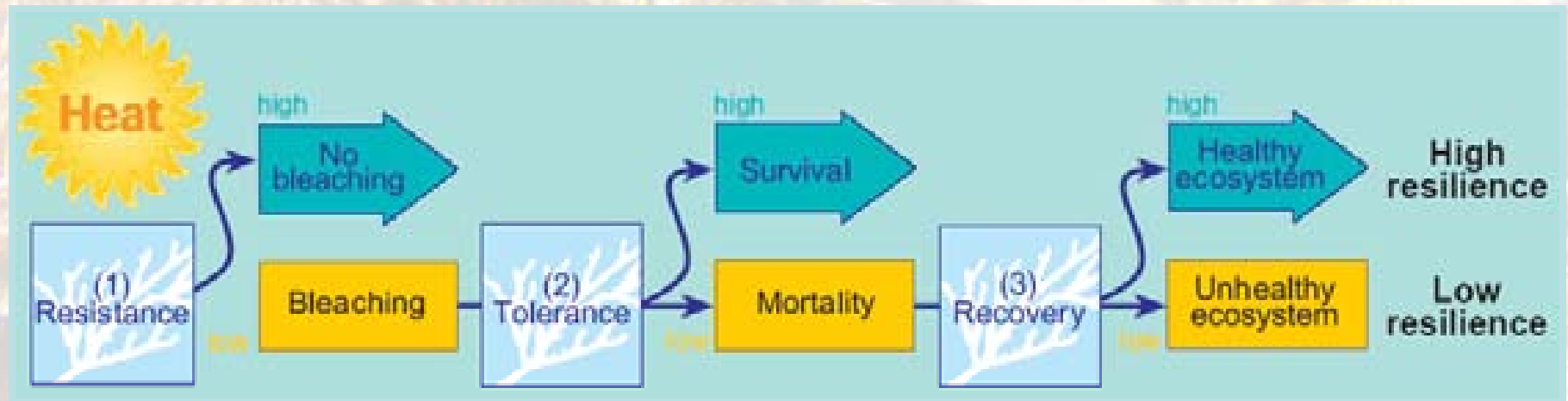
Monitoring for Reef Resilience



Review: What makes a reef resilient?

Resilience to bleaching is determined by:

1. The ability of corals to resist bleaching
2. The ability of corals to tolerate bleaching
3. The potential for recovery following mortality



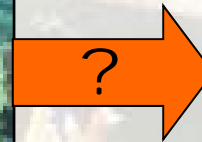
Review: Resistance

Internal factors


- Abundance of bleaching resistant species
- Areas of high coral cover
- Diversity
- History of survival
- Acclimatization

External factors

- Cooling
- Flushing
- Shading



Review: Generalized resistance hierarchy

Growth form	Coral family	Examples	Resistance
Fine branching	Pocilloporidae	<i>Seriatopora</i> <i>Stylophora</i> <i>Pocillopora</i>	 Low Medium High
Branching, tabulate, encrusting/foliose	Acroporidae	<i>Acropora</i> <i>Montipora</i>	
Massive, brain	Faviidae	<i>Favia</i> <i>Favities</i> <i>Leptoria</i> <i>Goniastrea</i> <i>Platygyra</i>	
Massive, boulder	Poritidae	<i>Porites</i> <i>Goniopora</i>	
Various	Various	<i>Turbinaria</i> <i>Cyphastrea</i>	

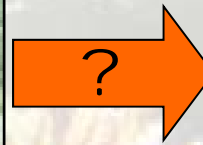
Review: Tolerance

Internal factors

- Abundance of bleaching tolerant species
- History of bleaching (adaptation)
- Acclimatization

External factors

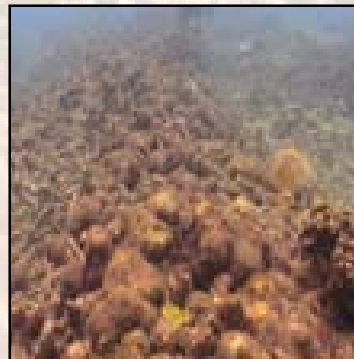
- Cooling
- Flushing
- Shading



Review: Recovery potential

Internal factors

- High remaining coral cover & diversity
- Abundance of larvae & good recruitment
- 'Healthy' population of herbivores
- Low abundance of bioeroders, corallivores, & coral disease



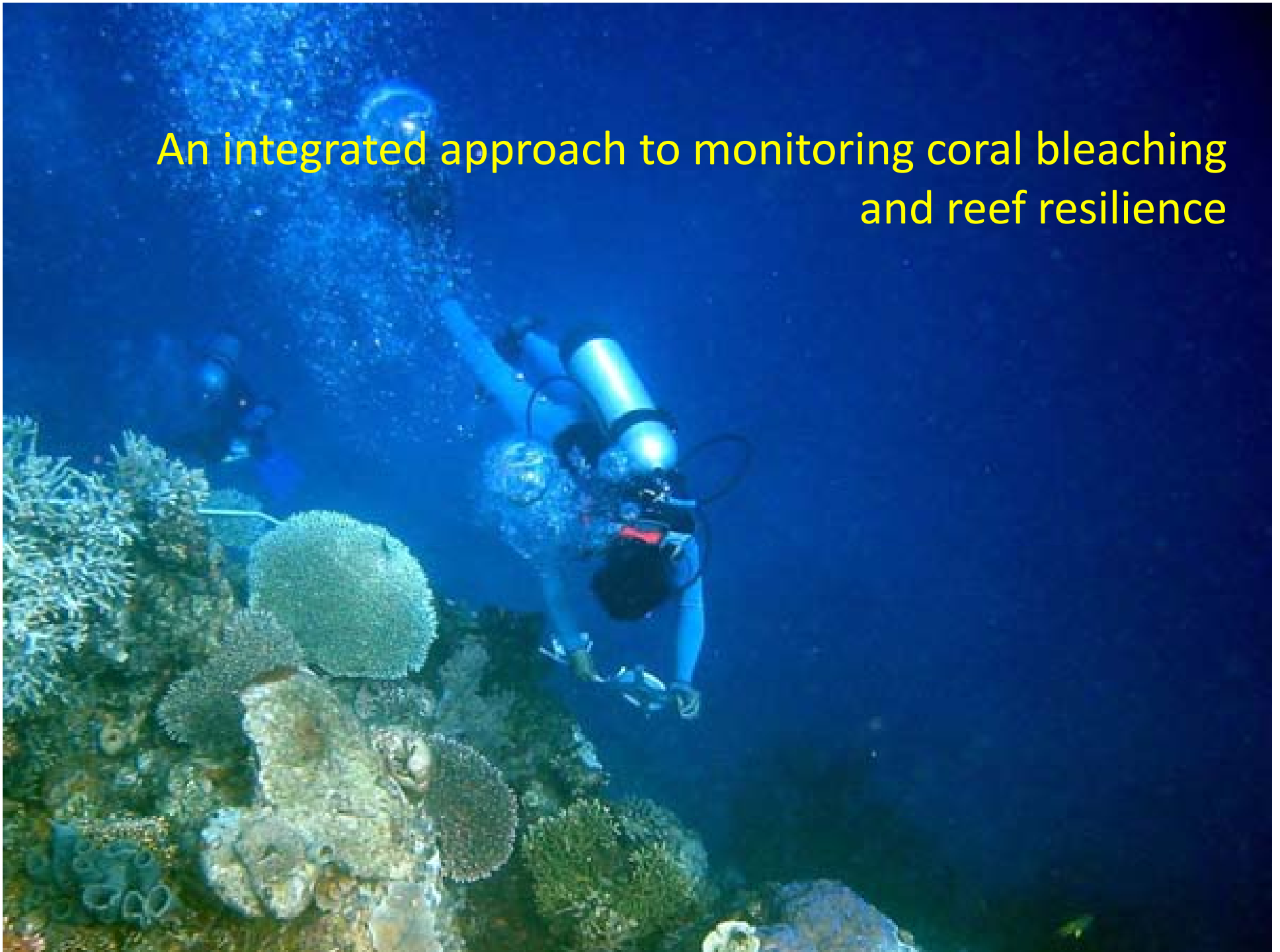
Review: Recovery potential

External factors

- Effective management
- Good water quality
- Natural disturbance regime
- Good connectivity
- Factors that concentrate larval supply

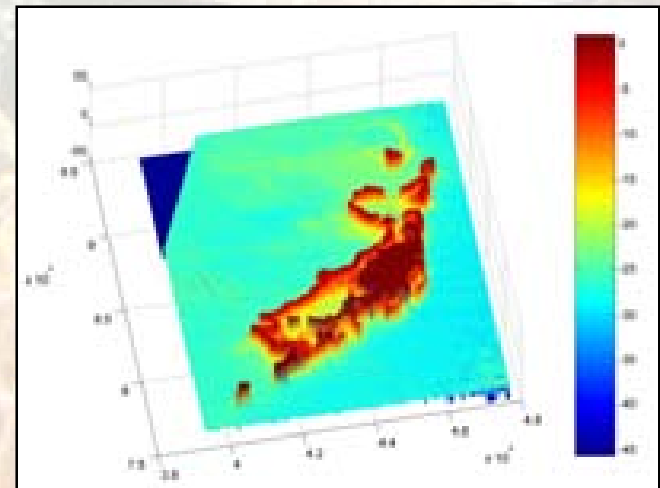


An integrated approach to monitoring coral bleaching
and reef resilience



Design process

- Set goal
- Assess Resources, Training and Funding
- Collate background data and mapping
- Clarify monitoring objectives
- Determine monitoring variables & methods
- Identify and select survey sites
- Implementation plan



Identifying the question

- What is the overall monitoring goal?
- Understanding bleaching resistance
- Predicting bleaching risk
- Estimating impacts / costs
- Quantifying extent & severity
- Raising awareness



1. Assess Resources, Training and Funding

1.1 Personnel

1.2 Equipment

1.3 Training

1.4 Funding

2. Collate background data and mapping

2.1 Compile data

2.2 Map data

3. Clarify monitoring objectives, variables & methods

3.1 Review bleaching resistance & resilience factors

3.2 Collect additional data

4. Identify and select survey sites

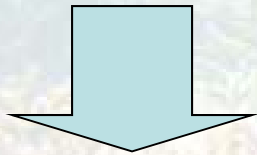
4.1 Stratify Area

4.2 Select representative sites

4.3 Review site selection

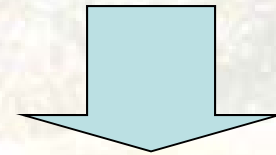
Integrated Monitoring Approach

Routine/Long term Monitoring

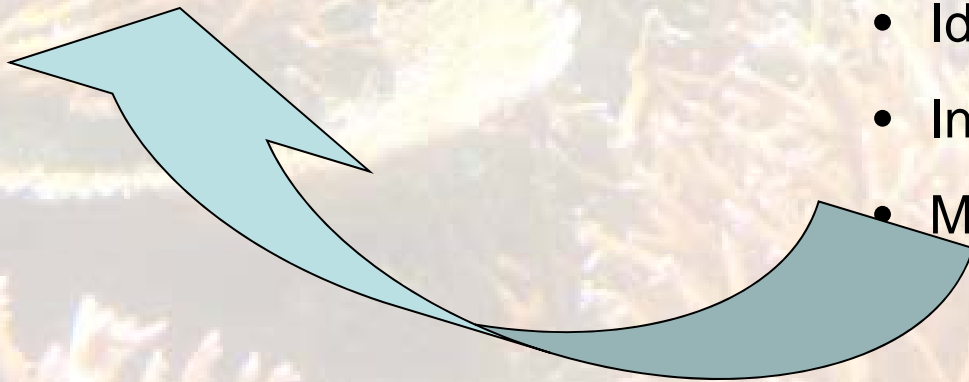


- Establish baselines
- Demonstrates trends
- Informs management decisions

Coral Bleaching Monitoring



- Detect impact
- Determine level of impact
- Detect spatial extent
- Identify patterns
- Informs management decisions
- Modify long term monitoring



Integrated monitoring

Routine monitoring program

- Based on routine/baseline monitoring program
- Developed/adapted to measure resilience variables
- Fixed sites
- Regular surveys

Bleaching monitoring program

- Detect & assess coral bleaching impacts
- Fixed (routine) sites
- Plus targeted sites at severely bleached sites
- Plus broad-scale surveys
- Survey during bleaching events only

Building Resilience Principles into routine monitoring: What to look for

Coral cover & community composition: coral cover, bleaching resistant species, taxonomic diversity, broad size & age distribution, genetic diversity

Acclimatization: previous exposure, large natural temperature variability (diurnal – seasonal), reef exposed at low tide, ponding/pooling

Localized cooling: tidal flushing of warm/cool, upwelling, adjacent to continental shelf, wind driven mixing

Flushing: fast currents, points/peninsulas/channels, high wave energy, large tidal range, strong winds

Building Resilience Principles into routine monitoring: What to look for

Shading: rock overhangs/cliffs, aspect of the sun, slope, turbidity, depth

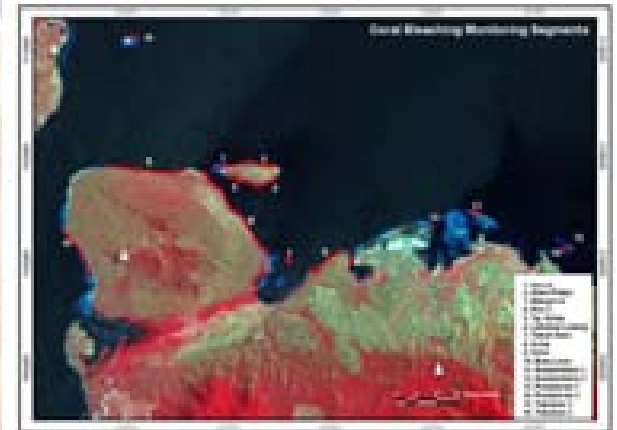
Recruitment: high coral cover, abundance of mature colonies, abundance of young colonies, clean & stable substrate, low bioerosion, low sedimentation, good larval supply

Herbivory: abundance of herbivorous fish & urchins, low fishing pressure on key herbivores, low macroalgal cover

Bioeroders, Corallivores, Disease: low abundance of bioeroders on live or dead coral, low abundance of corallivores on live coral, low levels of coral disease

Building Resilience Principles into routine monitoring: Site selection

- **Ideally:** select replicate sites that span range of resilience characteristics
- **Minimum:** replicate sites with low/high resilience
- **Aim:** compare bleaching response between different resilience levels (test resilience predictions)
- Refine management approaches & design to maximize future resilience



In Summary

- Monitoring is important at the local, regional, & global scale
- Various approaches to monitoring
 - it doesn't have to be expensive
- Adapt existing protocols to fit the needs and conditions at your site
- Best value from integrating existing/routine monitoring with bleaching and resilience monitoring
- Report bleaching monitoring results to Resilience partners and on Coral_List, Reefbase



Application Exercise: Integrated Response Plan

1. Assess capacity (*personnel, equipment, funding*)
2. Develop a list of known available data
3. What variables are you already measuring?
4. Complete resilience monitoring table
 - a. Assess relevance of *resilience / resistance* variables for your site
 - b. Evaluate your capacity to include these variables in your monitoring program
 - c. What method would you use to measure each variable?
5. Identify suitable monitoring sites on your site map or outline criteria for site selection (*ensure representation and replication*)
6. Determine frequency / timing of routine surveys