RECOVERY ASSESSMENT:
THE PROCESS NEEDED AFTER IMPACTS HAVE EXCEEDED SUSTAINABILITY LIMITS

EIANZ Annual Conference

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Dr Bryan Jenkins

Adjunct Professor, University of Adelaide

PRESENTATION

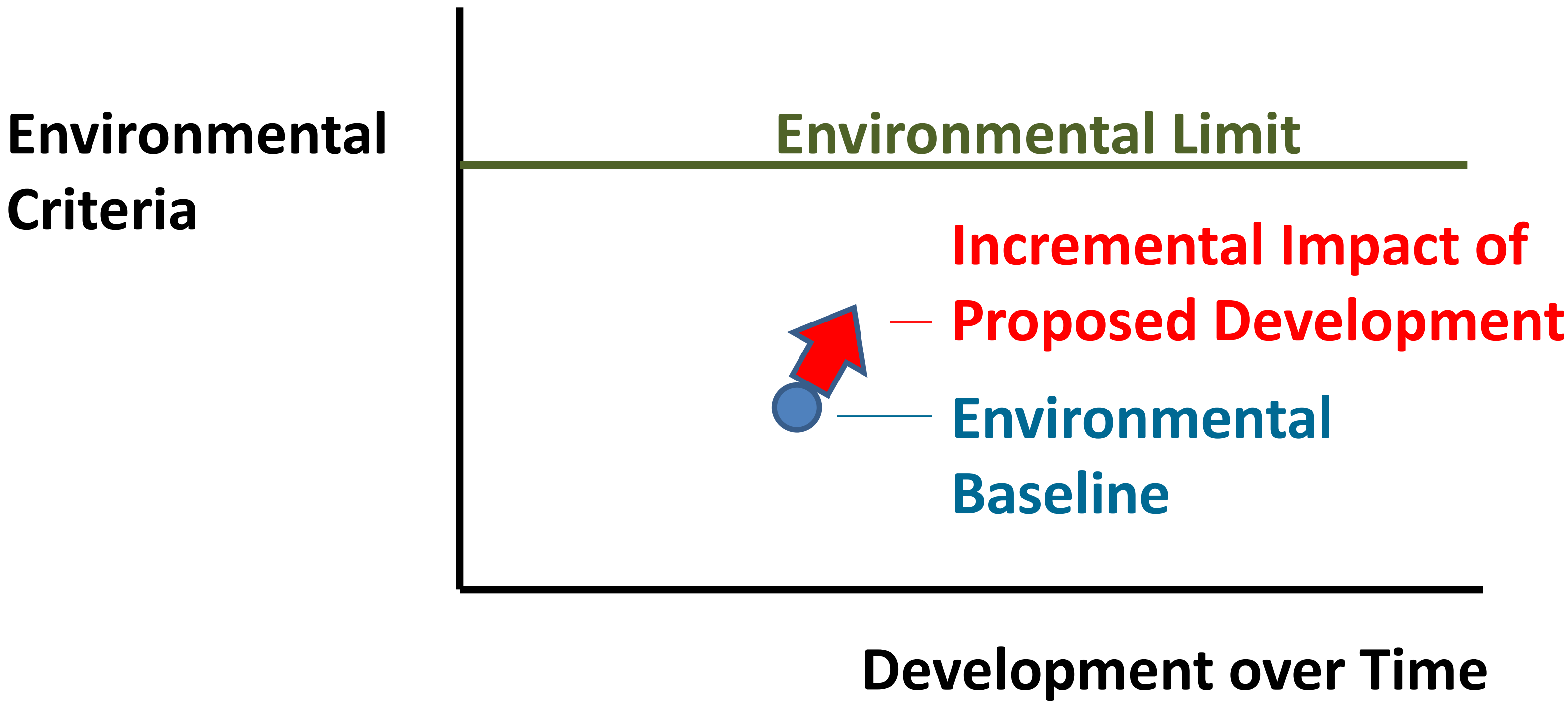
- Recovery Assessment

  - process of developing management interventions to address environmental damage and degradation
  - contrast with impact assessment: process to avoid, minimise or mitigate adverse effects of development
  - focus on different phases of the adaptive cycle in managing socio-ecological systems

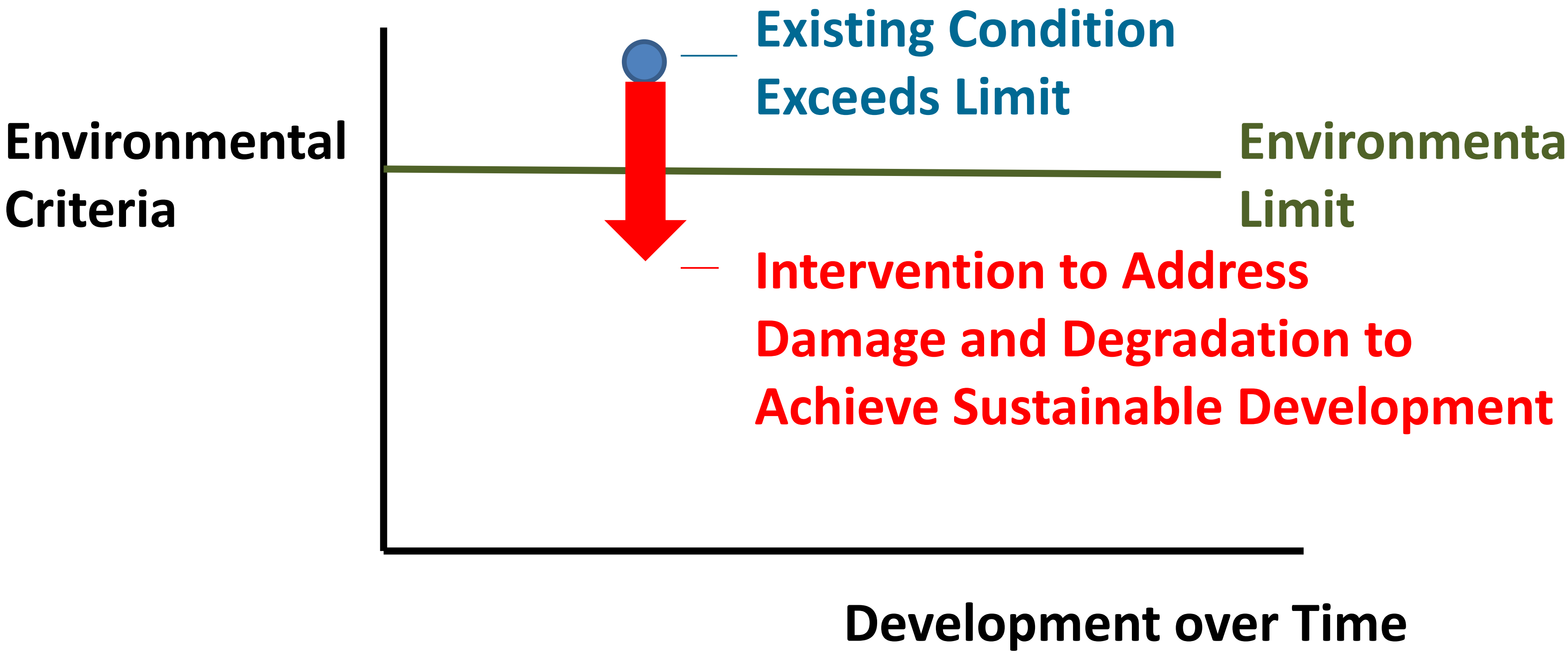
- Case Studies in Recovery Assessment

  - Exxon Valdez oil spill: extensive monitoring of recovery process
  - Fundao tailings dam failure: ecosystem service equivalence analysis
  - Great Barrier Reef: enhanced natural recovery techniques
  - Uluru fire management: indigenous fire regimes for ecological recovery

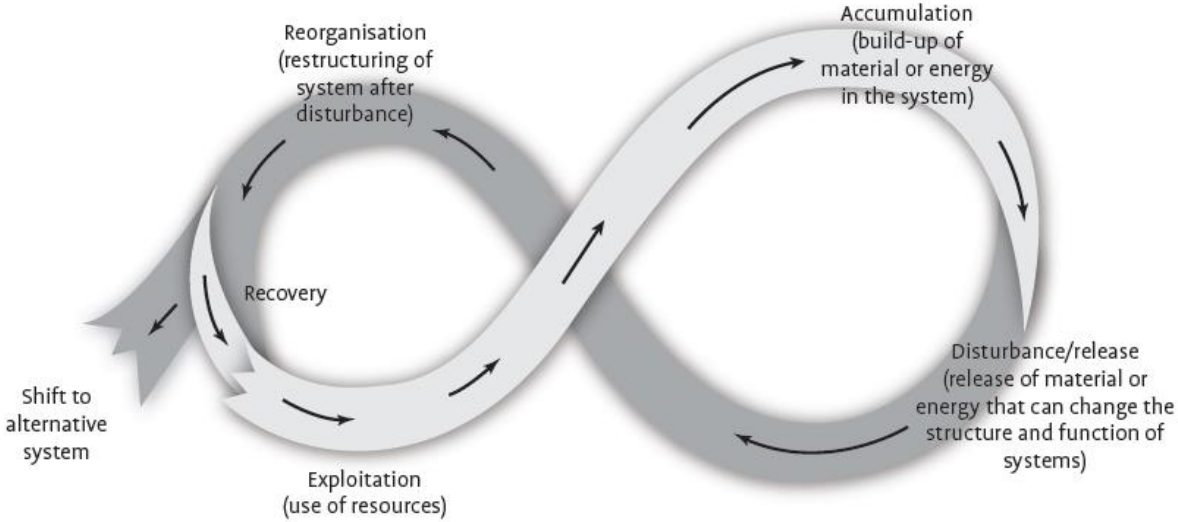
IMPACT MANAGEMENT: INCREMENTAL IMPACTS WITHIN ENVIRONMENTAL LIMITS



RECOVERY ASSESSMENT: INTERVENTIONS WHEN ENVIRONMENTAL LIMITS EXCEEDED



ADAPTIVE CYCLE FOR SUSTAINABLE SOCIO-ECOLOGICAL SYSTEMS



PHASES OF ADAPTIVE CYCLE
Exploitation **- Use of resources**
Accumulation **- Build-up of material or energy**
Disturbance **- Release that can change system**
Reorganisation **- Recovery, or** **- Shift to alternative system**

Adapted from
Gunderson and Holling 2002

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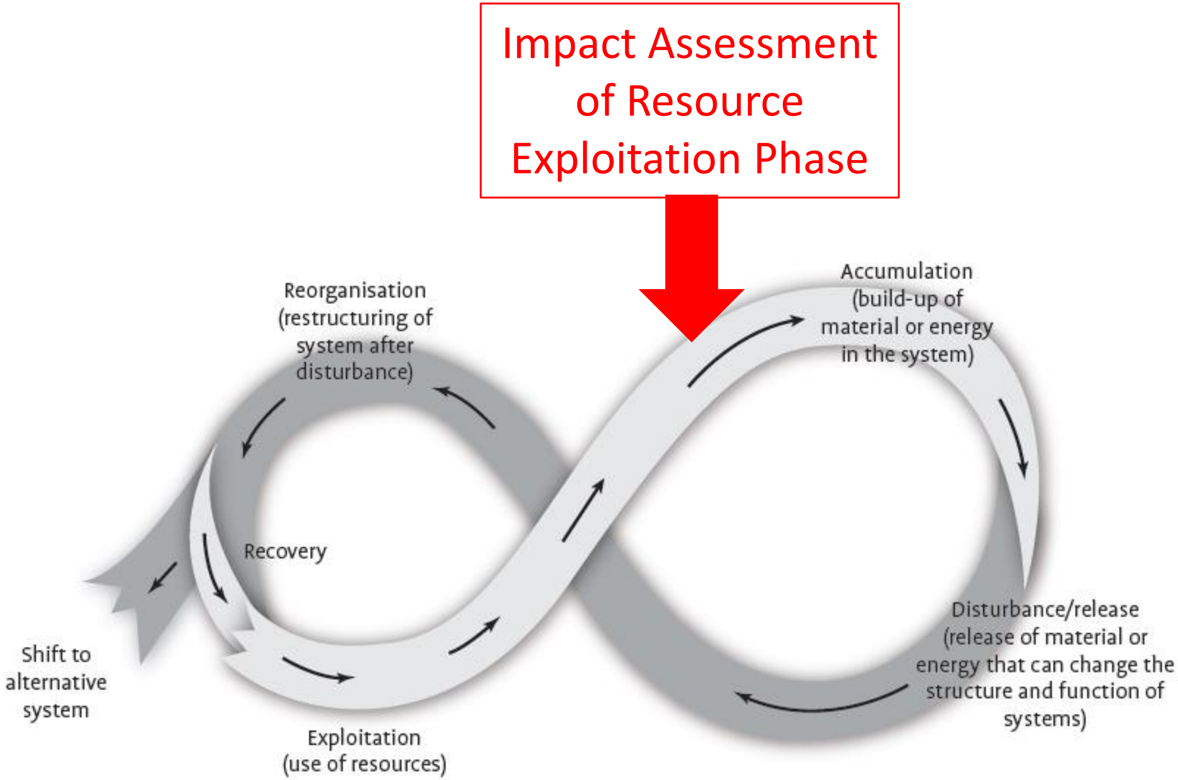

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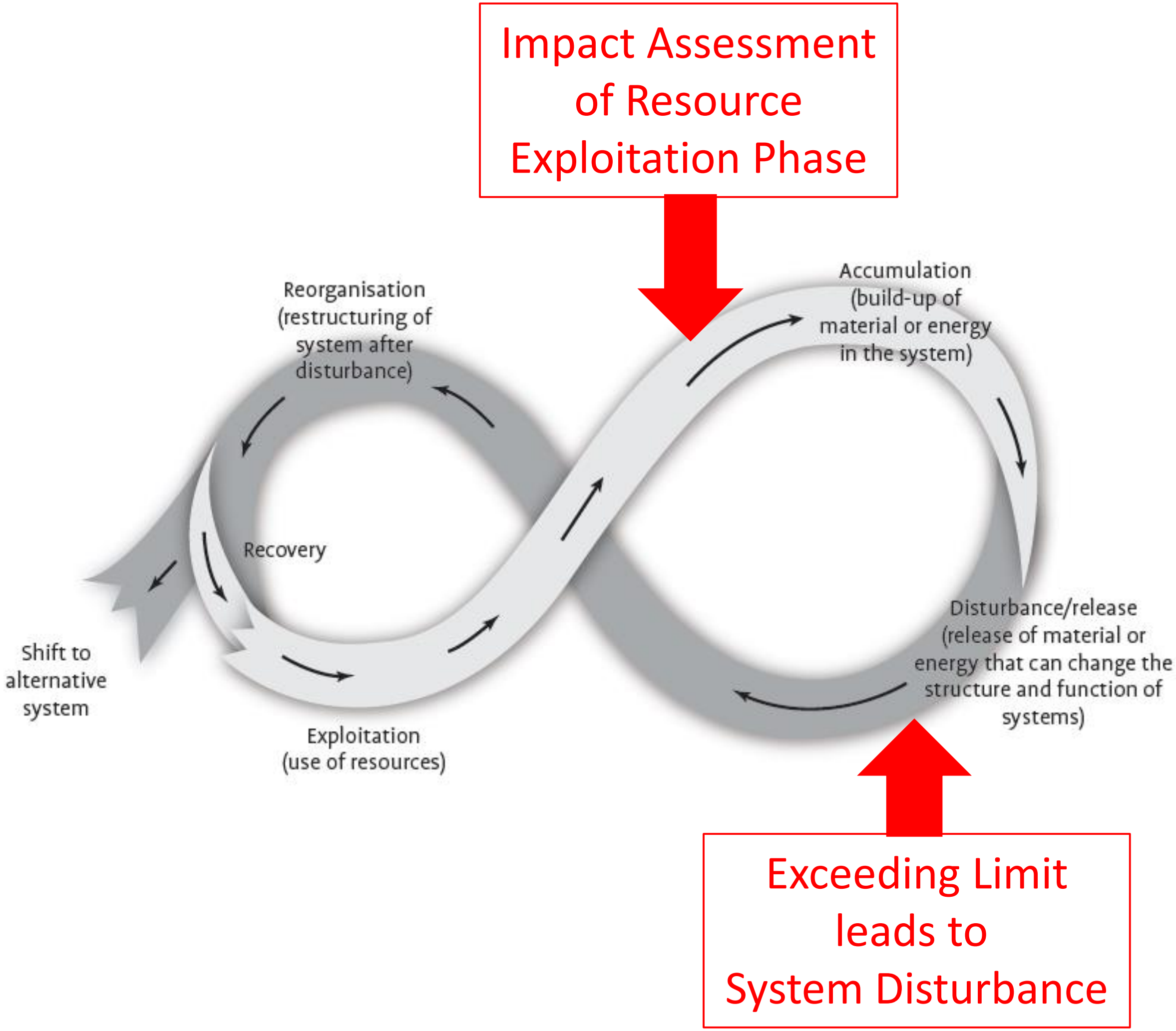

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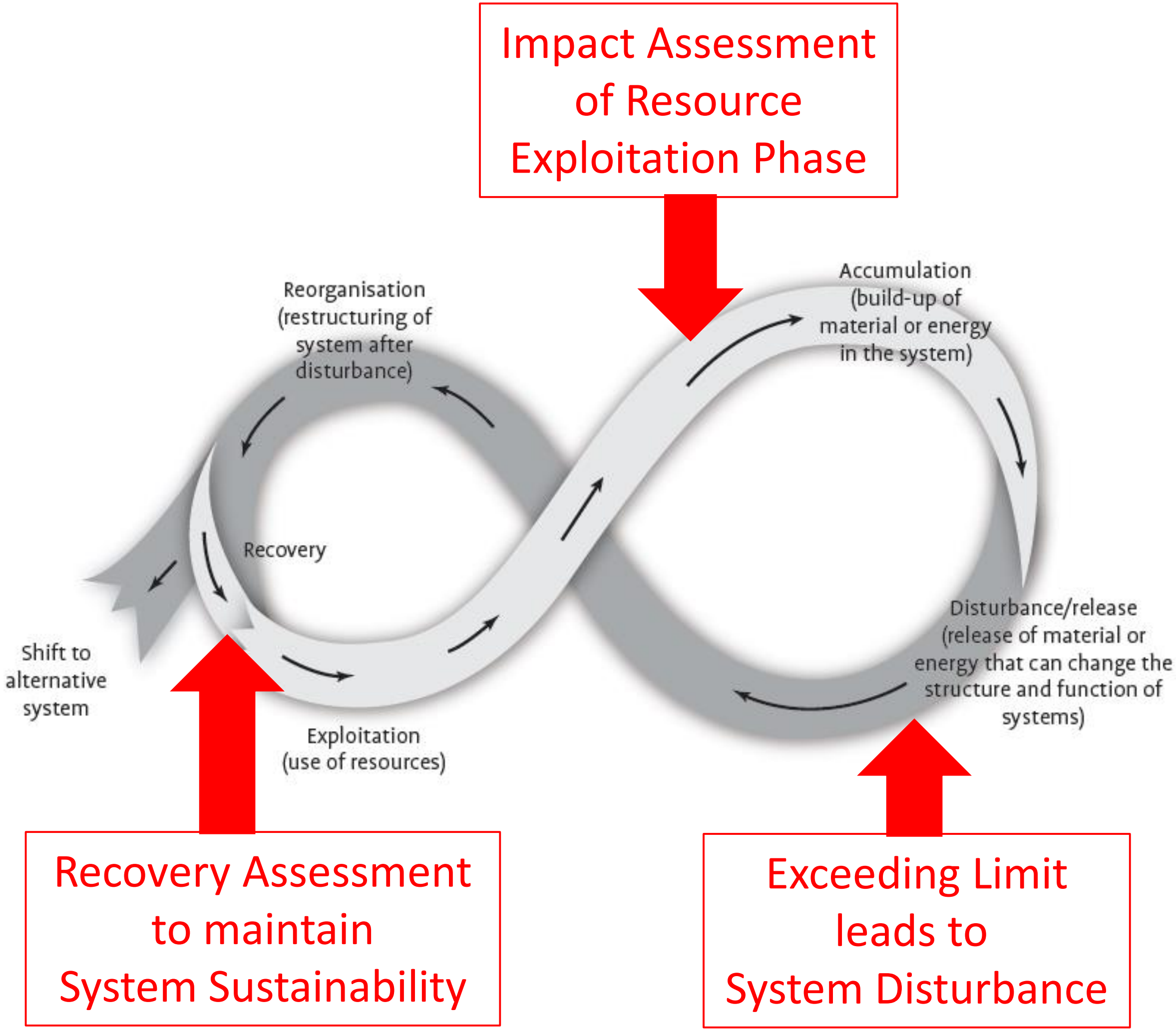

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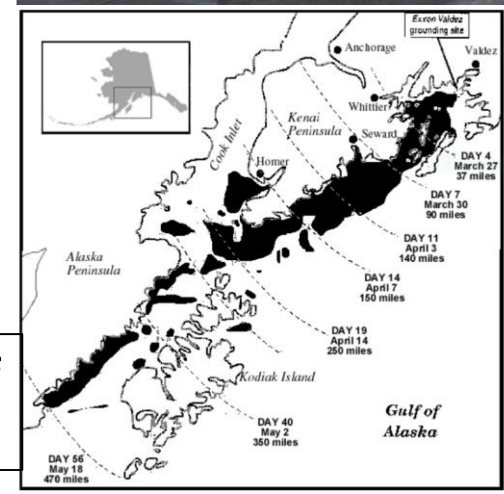
EXXON VALDEZ OIL SPILL

Exxon Valdez on Bligh Reef

- Exxon Valdez struck Bligh Reef in Prince William Sound (24 Mar 1989)
- 11 million gallons of oil spilled
- 43 million gallons diverted to other vessels
- 750 mile oil slick; 3,000 square miles with 350 miles of beaches contaminated
- Estimated 250,000 seabirds, 2,800 sea otters 250 bald eagles and 22 killer whales killed
- Billons of salmon and herring eggs

Offloading Oil



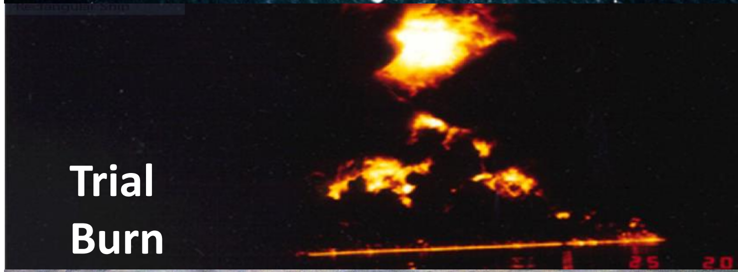
Progress of Oil Slick

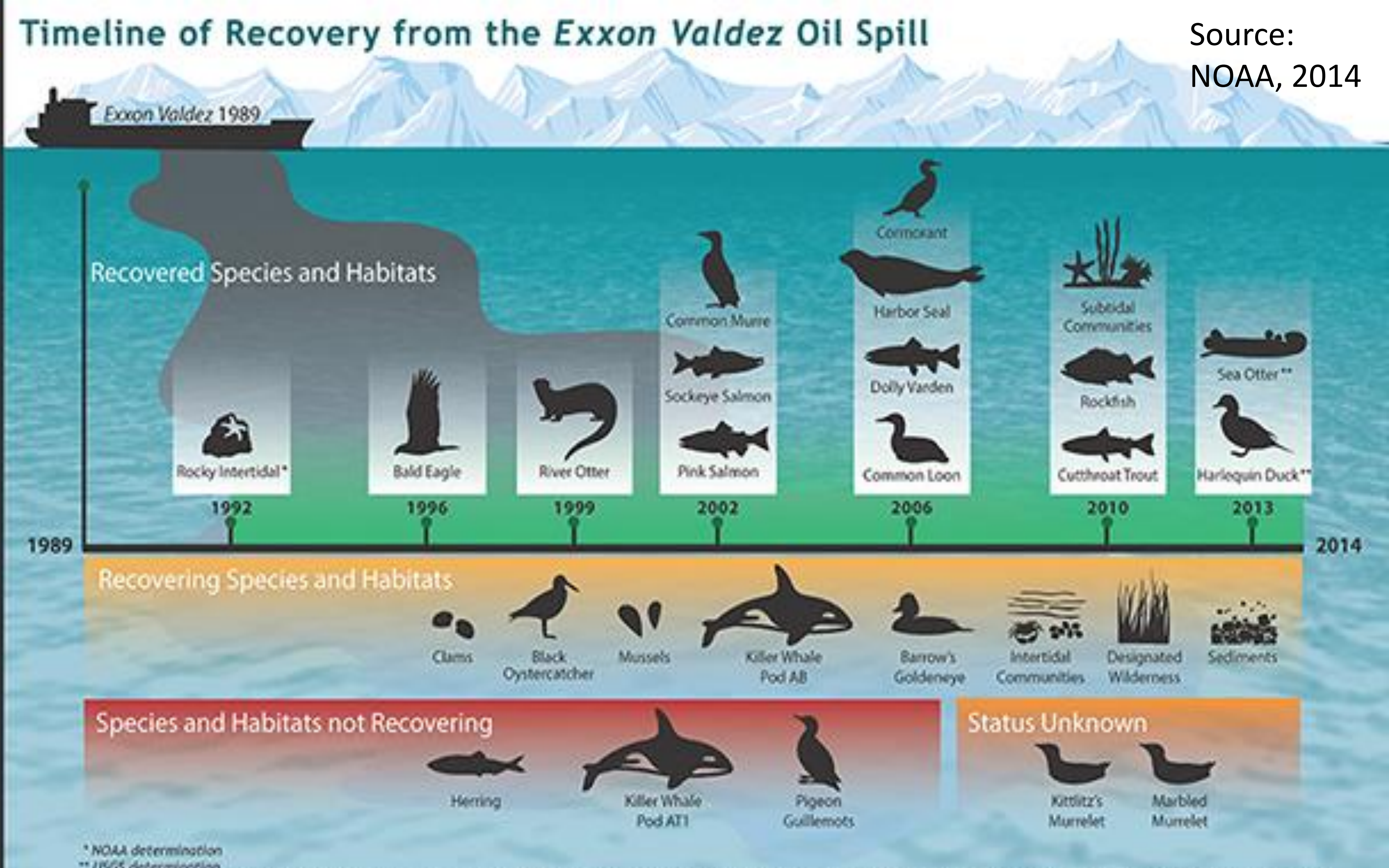
Source: NOAA, 2014

RESPONSE TO OIL SPILL

- Dispersants: ineffective
- In Situ Burning: trial worked them slick dispersed by storm
- Oil Skimming: 10% recovered
- Aggressive Shoreline Clean-Up: high-pressure hoses
- Clean-Up costs: $2.1 billion

Source: NOAA, 2014

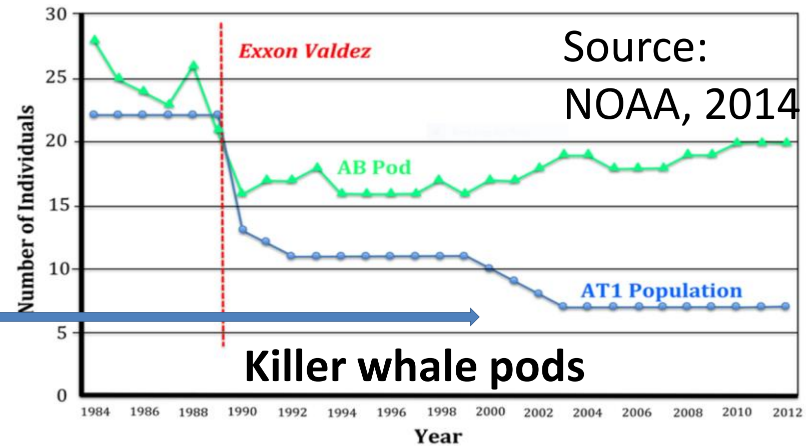


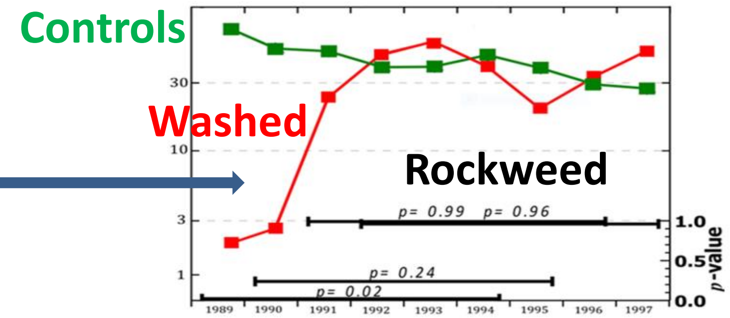


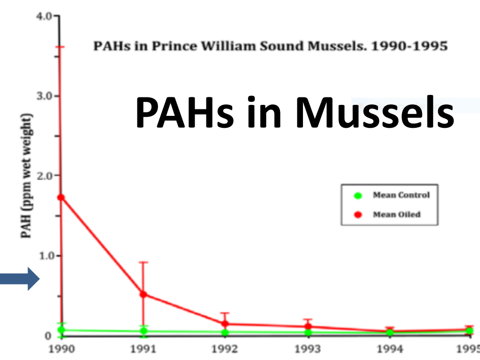
Source: NOAA, 2014

VARIATIONS IN RECOVERY

- Overall ecology has not recovered
  - Herring fishery not recovered
  - Killer whale pod AT1
  - Seabirds: guillemots, murrelets
- Some components recovered
  - Salmon fishery
  - Rocky intertidal communities
  - Birds: bald eagle, cormorant
- Some still recovering
  - clams, mussels
  - sediments
- Contamination reducing
  - PAHs in mussels
  - sediments still retain unweathered oil







NET ENVIRONMENTAL BENEFITS ANALYSIS

- A new form of analysis to assess remedial actions
- Net Environmental Benefits
  - gains in services of resources and processes inherently supplied by natural ecosystems or attained by remedial actions
  - minus the environmental injuries caused by those actions
- Differs from environment impact assessment
  - includes potential impacts of remedial actions
- Involves evaluating clean-up or remediation to determine if remedial proposal is warranted or sufficient
- Applied to shoreline excavation and washing to remove oil but disrupt the environment
  - conclusion: no net environmental benefit gained by shoreline excavation and washing

COLLAPSE OF FUNDAO TAILINGS DAM

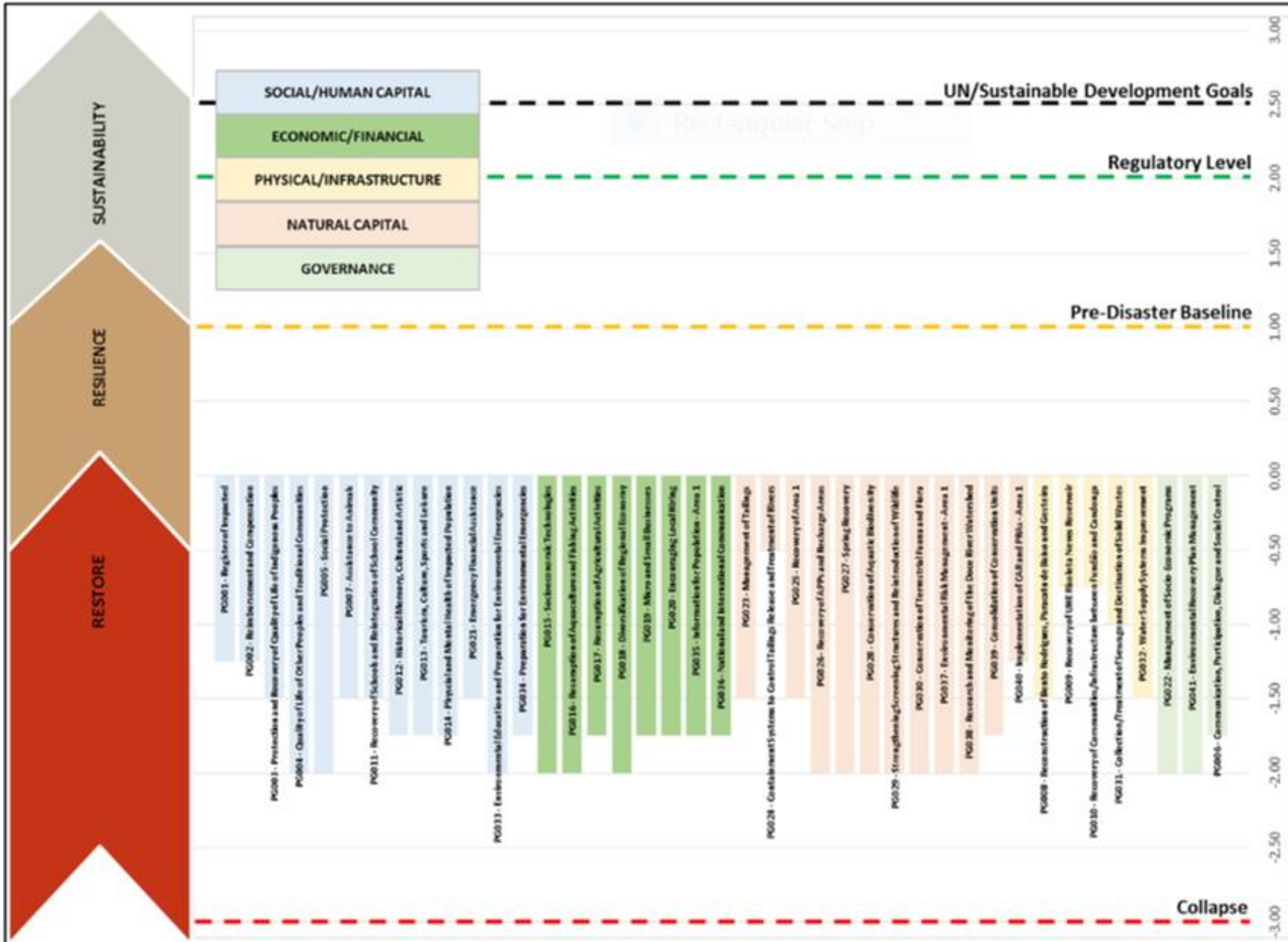
- 48m m^3 of mine tailings spilled into Rio Duce River, Brazil (5 Nov 2015)
- 19 people killed
- 500 homes destroyed
- 7 bridges destroyed
- 650 km of river contaminated
- 11 tons of dead fish
- 1469 ha of damaged river floodplain

Source: Ehrman, 2018

41 ENVIRONMENTAL AND SOCIAL RESTORATION PROGRAMS

- Aquatic and terrestrial ecosystems
- Village and infrastructure reconstruction
- Community relocation and resettlement
- Economic compensation and recovery
- Recovery management and governance

Source: Ehrman, 2018

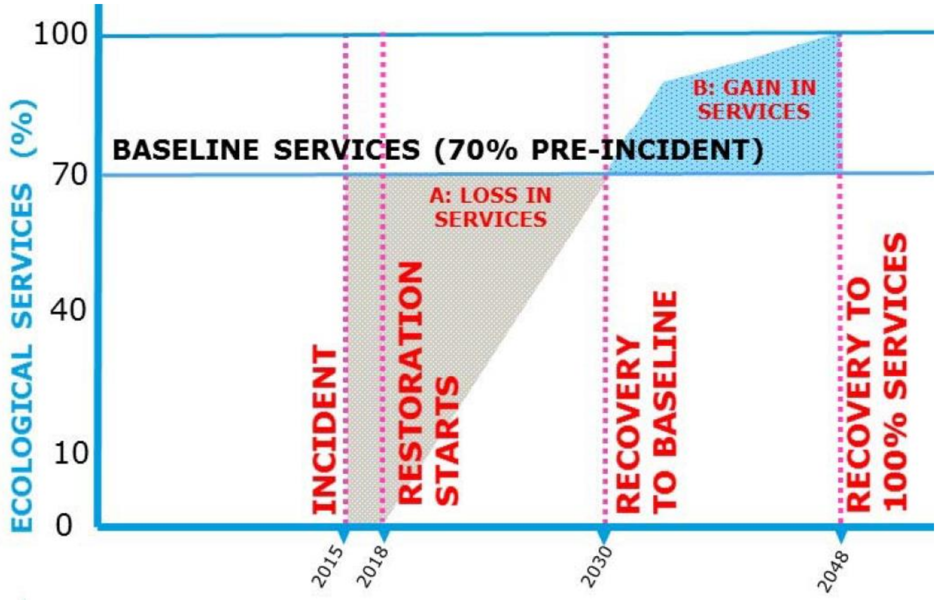


Source: Ehrman, 2018

EXTENSION OF HABITAT EQUIVALENCY ANALYSIS

- **What scale of restoration will compensate for loss of natural resources and services?**
  - estimate extent and duration of loss of ecosystem services
  - estimate ecosystem services provided by restoration project
  - calculate size of restoration project to provide services equal to lost services
  - calculate project cost (for compensation) or performance standards (for implementation)

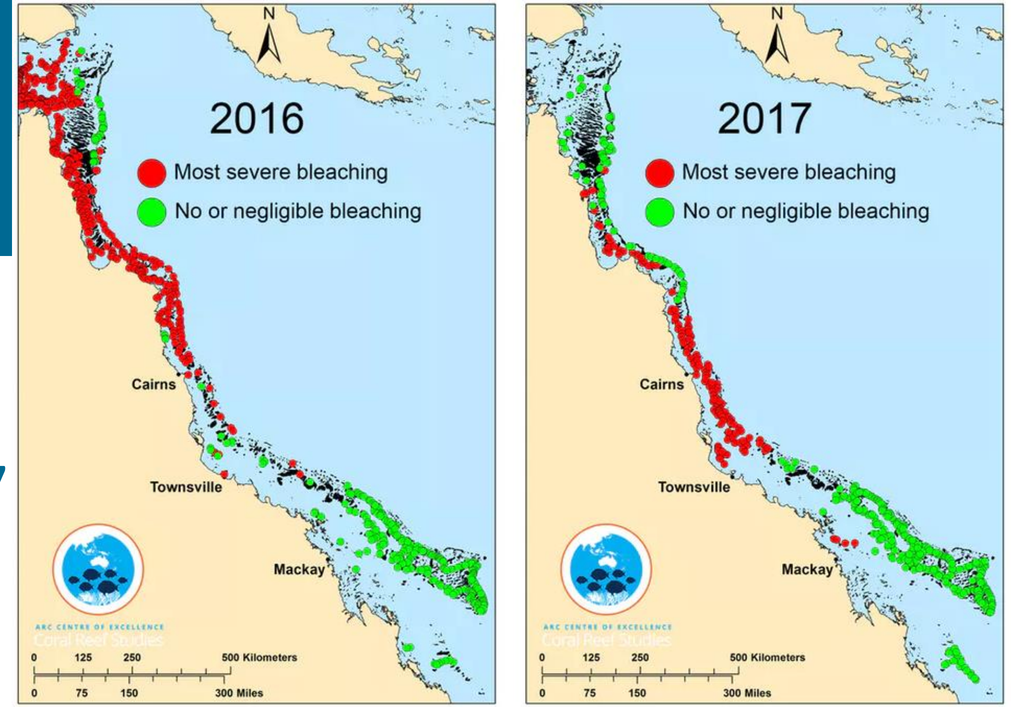
- **Extension of concept if baseline condition unsustainable**
  - calculate restoration project to achieve ecosystem sustainability



Source: Booth, 2018

GREAT BARRIER REEF CORAL BLEACHING

- Climate-driven mass coral bleaching in 2016 and 2017
- Tropical Cyclone Debbie in 2017
- 80% of coral reef area in Marine Park impacted
- 50% of reef's shallow water coral died in bleaching events



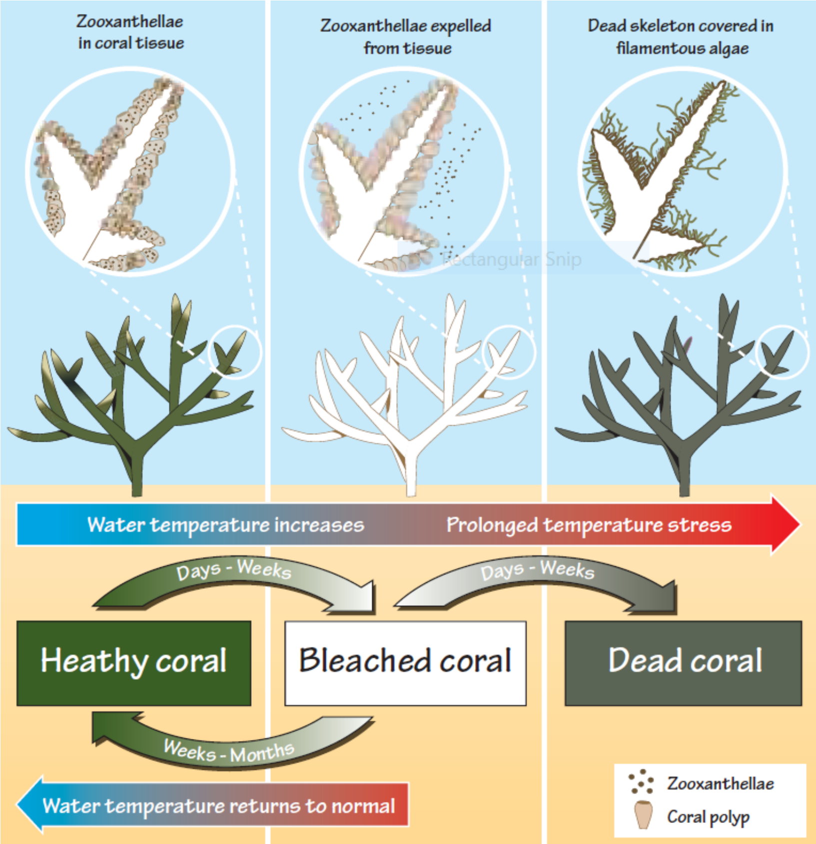
Source: Hughes and Kerry, 2017

- Heat stress increased incidence of coral disease
- Crown of thorns outbreak ongoing since 2010
- IPCC: coral decline by 70-90% at 1.5°C and >99% at 2°C increase

ADAPTIVE CYCLE FOR CORAL BLEACHING

- **Exploitation Phase**
  - zooanthella (symbiotic algae living in coral tissue) performs photosynthesis and provides food source to corals
- **Accumulation Phase**
  - corals store surplus food as lipids
- **Disturbance/Release Phase**
  - increase in sea water temperature zooanthella produce oxygen radicals harmful to corals
  - corals expel zooanthella to avoid tissue damage; leaving white coral skeleton
- **Reorganisation Phase**
  - recovery: temperature reduces and zooanthella repopulate coral
  - shift: prolonged temperature stress; coral without food source and dies

Source: Marshall and Schuttenberg, 2006



MANAGEMENT INTERVENTIONS FOR REEF MANAGER

- **Seawater Temperature**
  - requires global action on greenhouse gas emissions
  - mitigation beyond capacity of reef manager
- **Protect Resistant Coral Reefs**
  - establish refugia of reef areas more resistant to mass bleaching
  - network of refugia with connectivity to reefs more susceptible to bleaching to facilitate reseeding
- **Build Tolerance: Assist or Accelerate Natural Recovery Process**
  - evolution: bleaching-resistant corals make a greater contribution to next generation of corals – coral translocation
  - migration of heat-tolerant genotypes – coral seeding
- **Rehabilitate Adverse Effects to Promote Recovery**
  - improve water quality to reduce phase shift to filamentous algae
  - maintain fishery for grazing of algae
  - control crown-of-thorns outbreaks

DIFFERENT APPROACH TO IMPCT ASSESSMENT

- **Collaborative Approach**
  - Partnership Group: Government, traditional owners, industry, scientists and interest groups
- **Strategic Assessments**
  - marine component
  - coastal / catchment component
- **Reef Strategy for Coordinated Action of All Stakeholders**
  - Reef 2050 Long Term Sustainability Plan with Outcomes, Actions, Targets
- **Investment Framework for Implementation**
  - funding requirements for actions
- **Managing for Resilience of the Coral Ecosystem**
  - GBRMP Blueprint of Resilience

FIRE HISTORY AT ULURU

- Aṉangu conducted **"patch burning"** of spinifex to create a mosaic of burnt and unburnt terrain
- Fires were lit to **regenerate vegetation**, stimulate growth of bush foods and fresh growth for animals like kangaroo

- Stopped in 1930s when **Aboriginal people driven off their lands**
- Spread of pastoral enterprises, **introduction of cattle and feral animals**
- **Spread on introduced grasses** (buffel, couch) increasing fuel load
- **Large high-intensity wildfires** in 1950 (burnt one third of park) and two fires in 1976 (burnt about 76% of park)
- In 1985, **land title returned to Aṉangu** traditional owners with lease back to National Parks
- Reintroduction of **traditional Aboriginal** methods of fire management
- Wildfires in 2002 consisted on many **separate fires of variable intensity**

FIRE ECOLOGY IN ULURU

Source: Pinkerton, 2018

- **Wildfire Risk**
  - infrequent large **rainfall events** drive profuse vegetation growth
  - vegetation dries leaving **large fuel load** and ecosystem prone to massive wildfire
- **Vegetation Response to Fire**
  - **spinifex** grassland: **fire-tolerant** – plants killed but reliably reestablish after fire
  - **mulga** woodland: **fire-sensitive** – killed if canopy burnt; 10 to 20 years before mulga produces seeds; can be eliminated with frequent intense fires
- **Fire Strategy**
  - **patch burning of spinifex** to reduce fuel load and maintain habitats at different stages of succession
  - **fire breaks burnt around mulga** to limit fire frequency and intensity
  - network of **strategic firebreaks** to limit spread of intense wildfires

Source: DoE, 2018

CONCLUDING COMMENTS

RECOVERY ASSESSMENT	IMPACT ASSESSMENT
Proactive environmental improvements to achieve sustainability outcomes	Reactive analysis of actions to mitigate adverse effects
Reorganisation phase of adaptive cycle	Exploitation phase of adaptive cycle
Focus on system recovery	Focus on impact mitigation
Outcome-based approach	Effects-based approach
Managing resilience of socio-ecological systems	Managing effects of proposed actions
Enhancement of natural recovery processes as well as engineered interventions	Changes to proposals to avoid or mitigate adverse effects
Collaborative approach to coordinate actions of multiple stakeholders based on bioregions	Proponent responsibility to reduce impacts of actions based on project footprint