



# Living in a world of change: Juggling cumulative impacts and path dependency

Beth Fulton  
2018

CSIRO MARINE & ATMOSPHERIC  
[www.csiro.au](http://www.csiro.au)



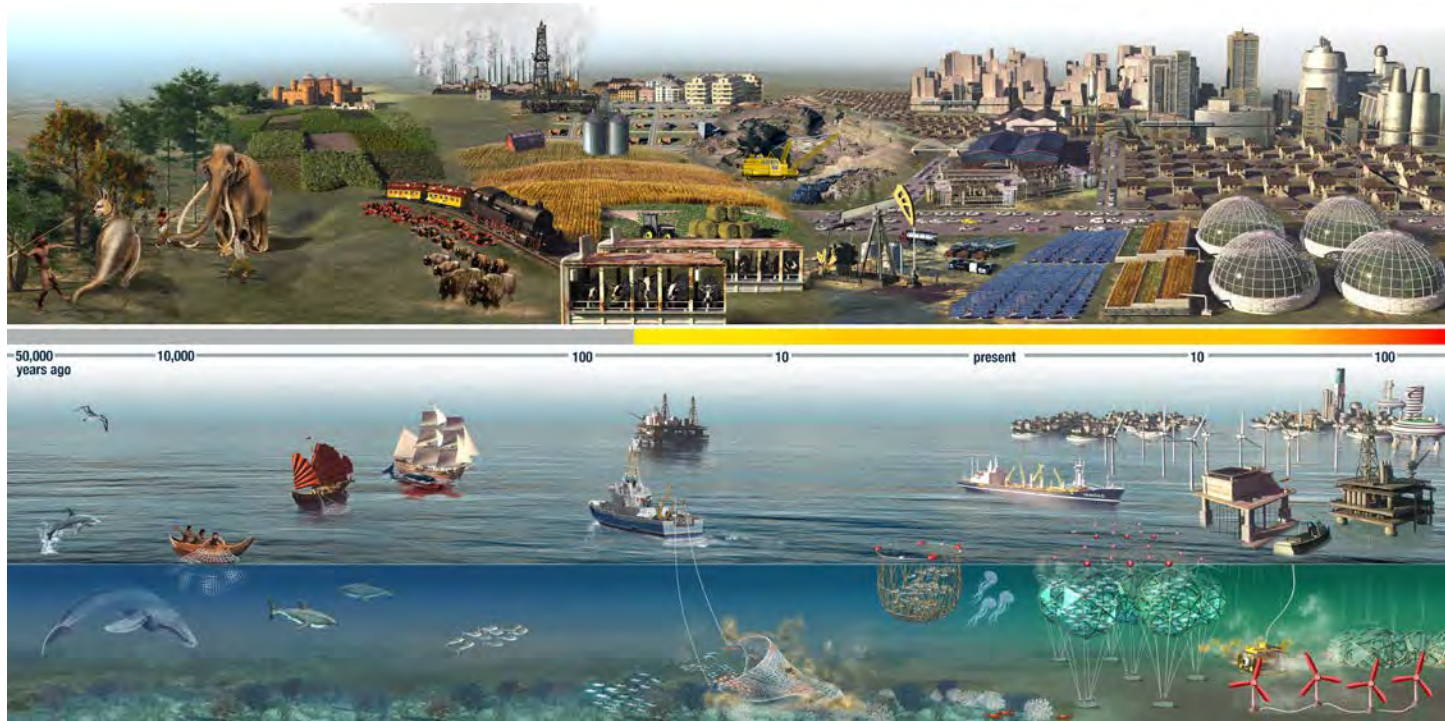
# Old view



# New reality



# Aquatic Revolution



# Expanding Blue Economy



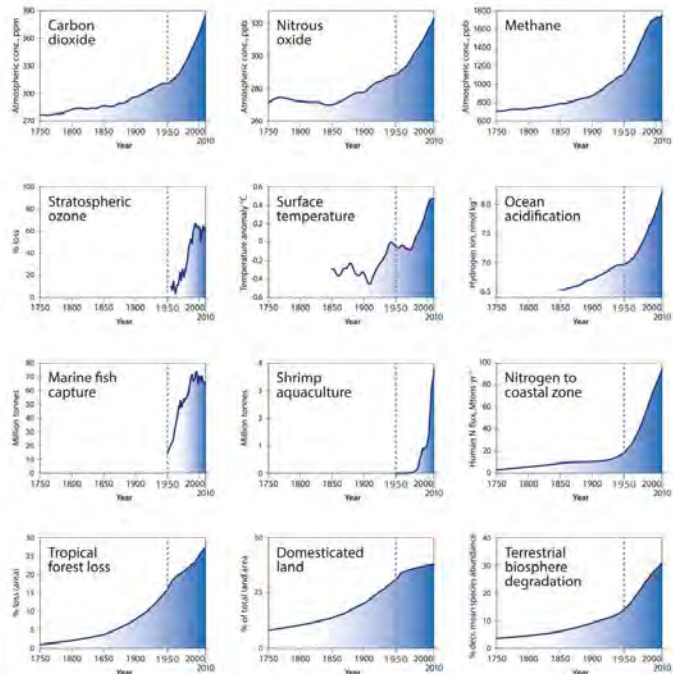
- Ocean “assets” = USD \$24+ trillion
- Annual value = USD \$2.5 trillion (~7<sup>th</sup> largest economy)
- Double (or more) within a decade



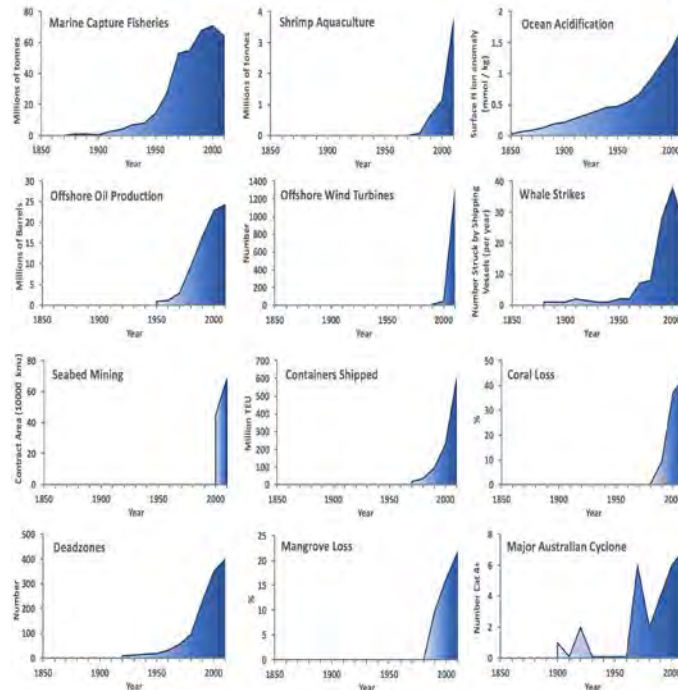
Image: OECD

# The Anthropocene & The Ocean

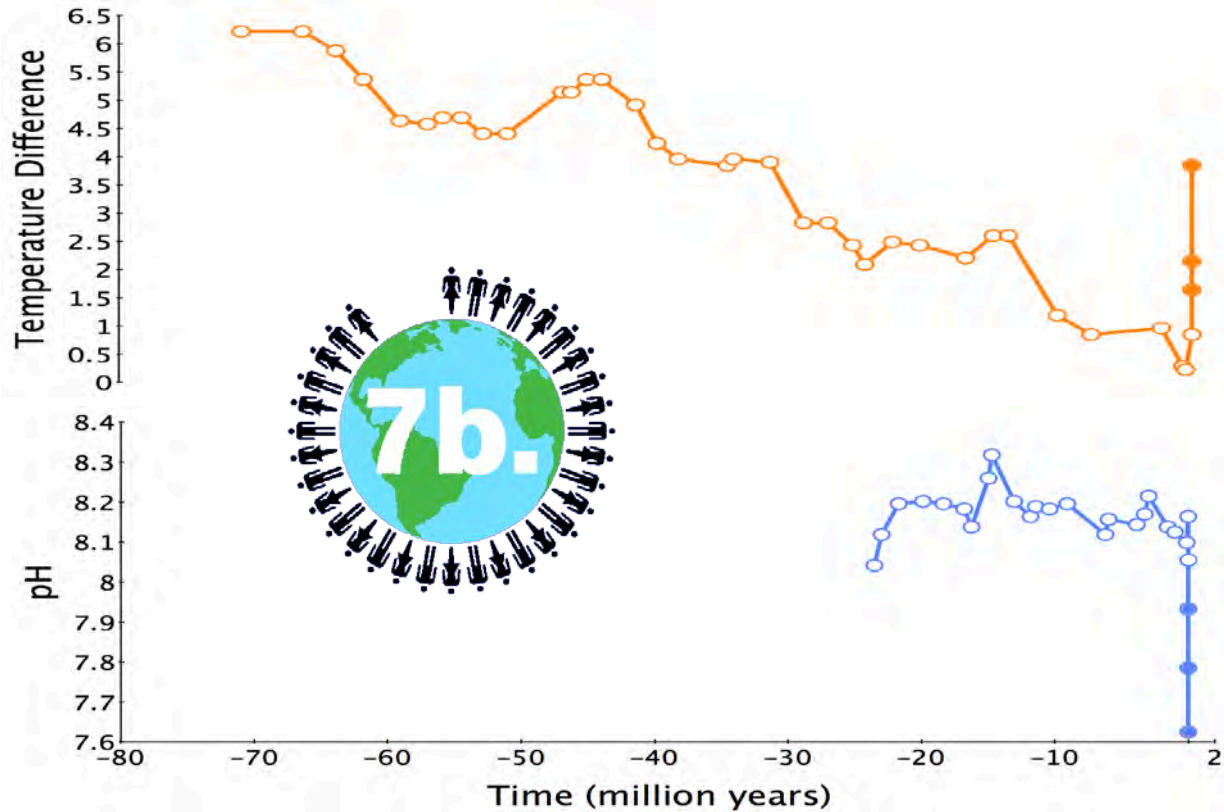
## Earth system trends



## Ocean system trends

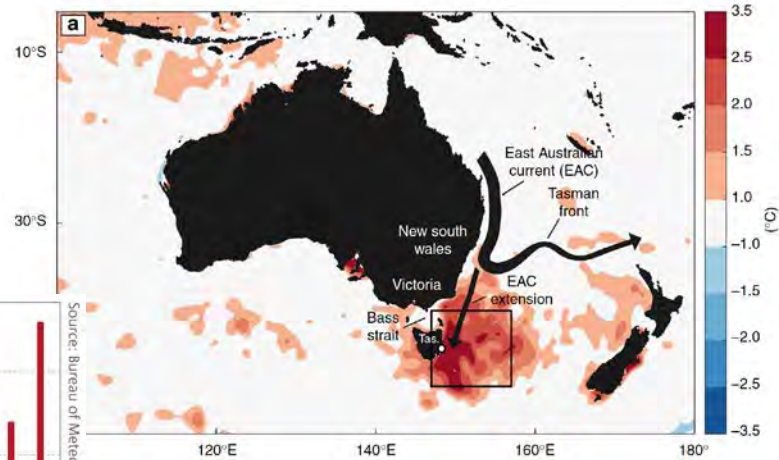
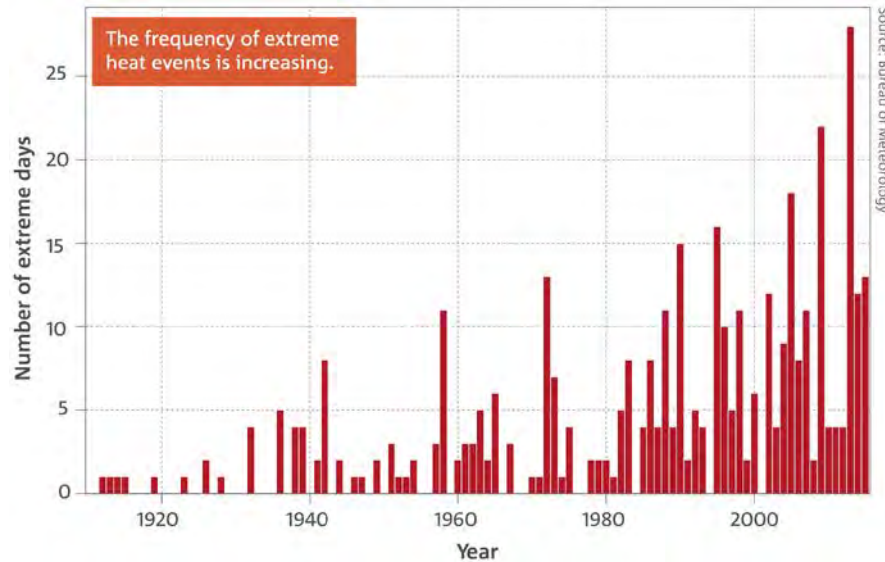


# Climate context



# Extreme Events

- Sept 2015 – May 2016
- $\sim 2-3\text{ }^{\circ}\text{C} >$  climatology

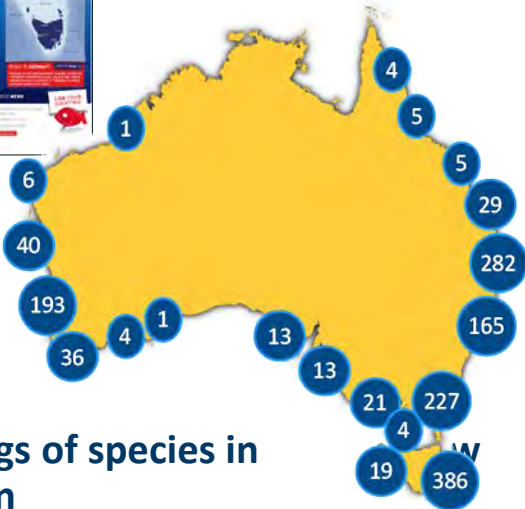


Oliver et al 2017



# Changing Ecosystems

- Marine habitat losses
- Shifting species



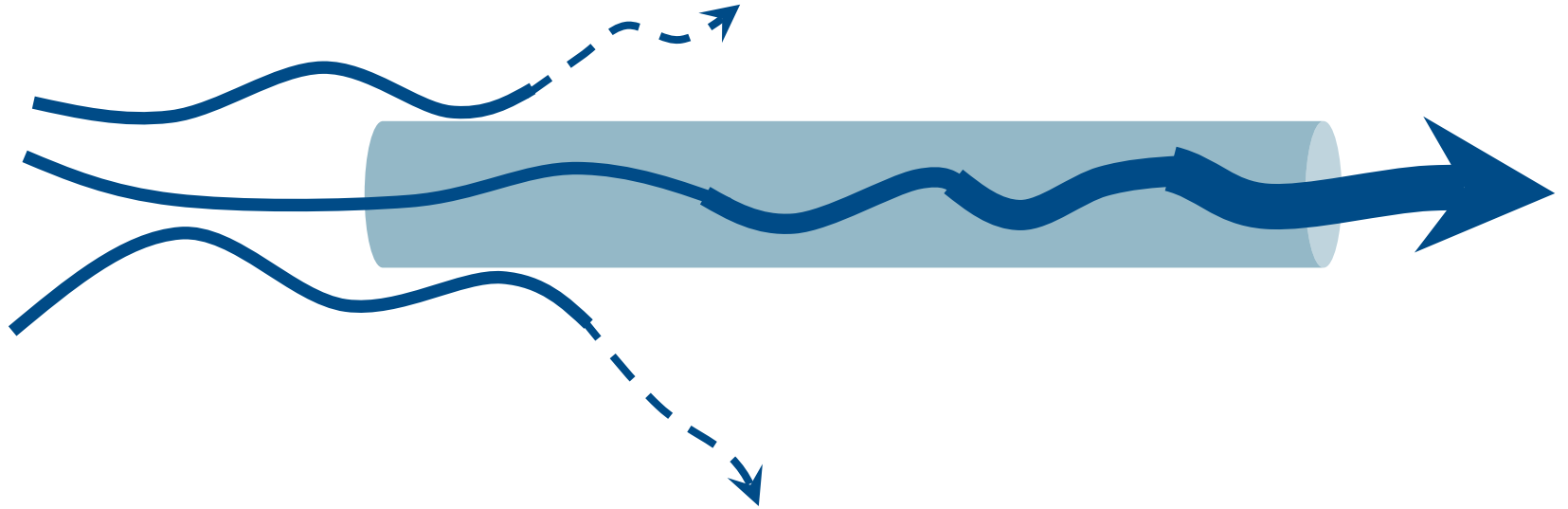
Sightings of species in location

## Climate impacts 2006-2017



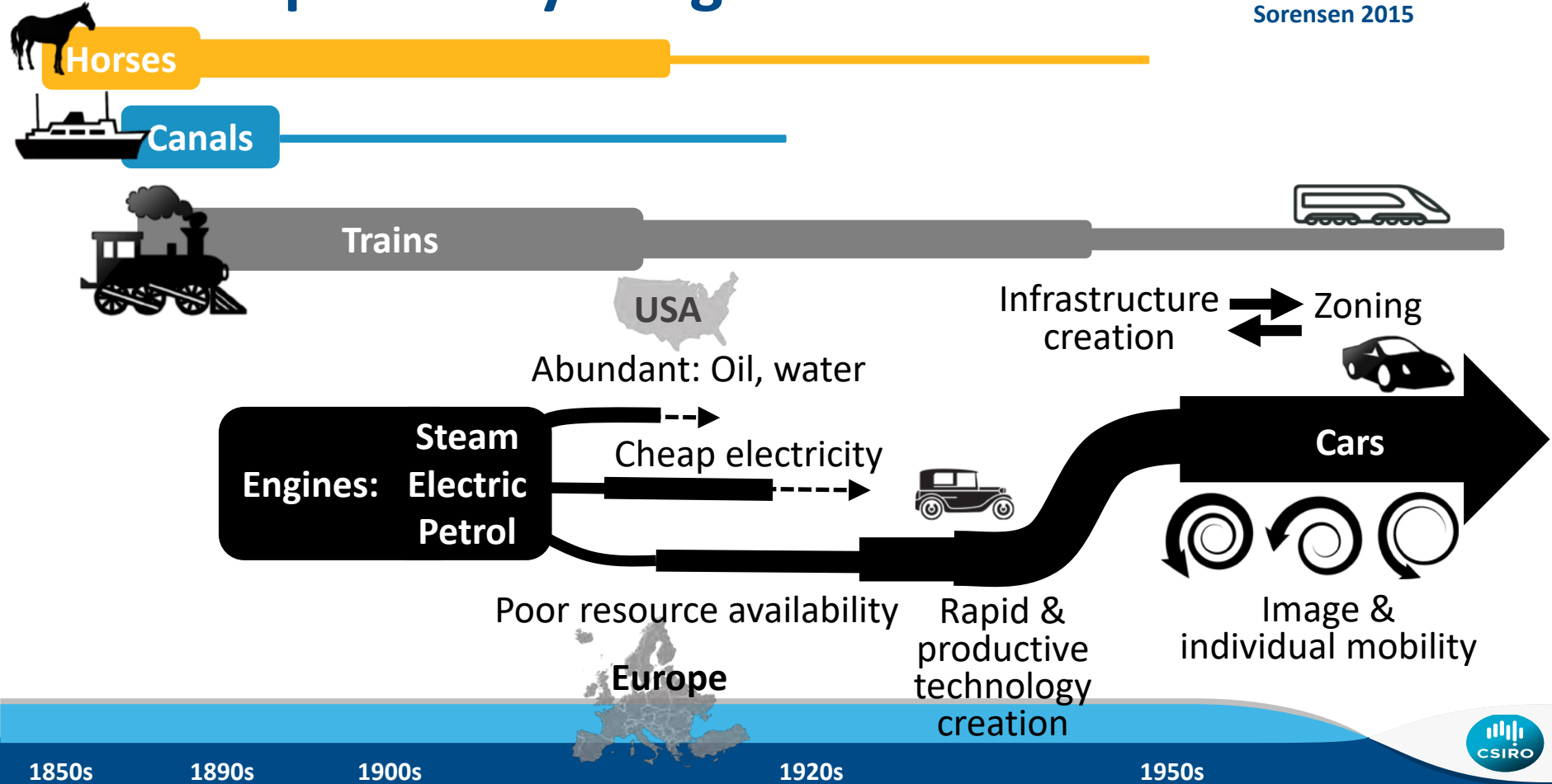
# Path dependency

- Decisions preclude (or increase likelihood) of specific future options



# Path dependency – e.g. Cars

Peck 1996, Windrum 1999,  
Little 2012, Cairns 2014,  
Sorensen 2015



# Path dependency – e.g. Law

1000+ years of  
(Persian &) Roman law

**529:** Corpus Juris Civilis  
(Justinian Code)

**1070:** Pisa library  
discovery



**1100s:** Bologna University  
created, specialises in Law

**1200+:** Roman law spreads  
across Catholic Europe

**1400+:** Europe colonises the world

Evolution of colonized legal codes

- Right of ownership of property
- Right to own a business
- Validity of contracts
- Validity of wills
- Equal treatment under law
- Innocent until proven guilty
- Burden of proof with accuser
- Right of appeal
- Right of legal defense
- Set aside unfair laws

# Path dependency (cascades of consequences)

**Initial decision made**

- **Best given available information / conditions** (political, economic, social compromises)
- **Random or social influence** → preferential conditions for an option
- **Minor heterogeneity in availability of options** (available selected)

**Existing option entrenched**

- **Evolutionary & sequential dependence** (evolve what is available, build on existing knowledge)
- **Increasing returns** (efficiencies of production or process)
- **Switching costs** (transactional & learning, sunk costs)
- **Interrelated & interlocked technologies, infrastructure & institutions** (high inertia & reticence to change)
- **Entrenchment of vested interests** (or based on arguments of moral superiority)
- **Contractual & legal constraints**

**Critical juncture**

- **External shock**
- **Loss of legitimacy**
- **Opportunity for change**

**New option put in place**

**New option entrenched**

# Global Vision for Fisheries Management

## Social and Economic



- **Convention on Biodiversity:** “the objectives of management are a matter of societal choice”



- **Law of the Sea:** “optimum utilization”

THE LAW  
OF THE SEA

## Environmental

- **Convention on Biodiversity:** “conservation of ecosystem structure & function”
- **Law of the Sea:** “preserve rare or fragile ecosystems as well as the habitat of... marine life”  
“associated and dependent species above levels at which their reproduction may become seriously threatened”

# Operational Reality = MSY

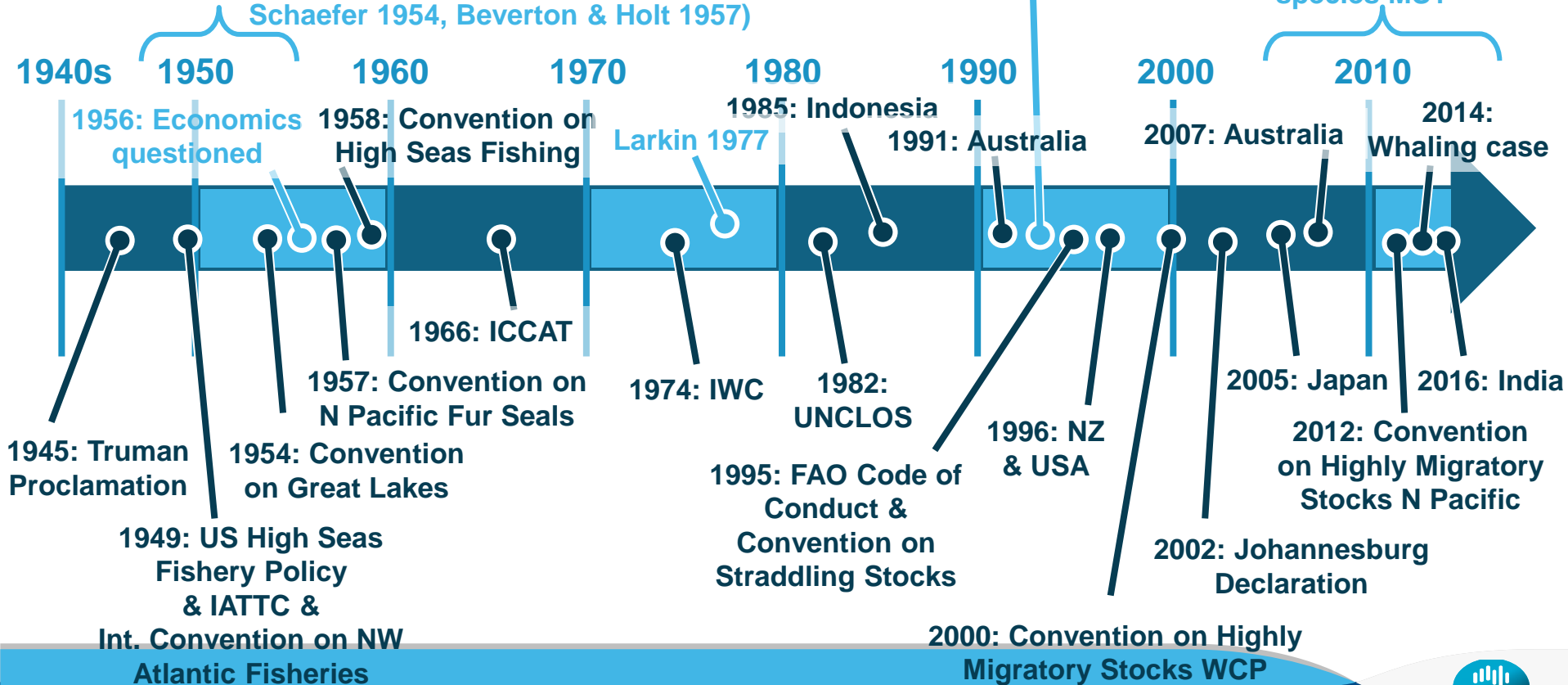
...restore fish stocks in the shortest time feasible at least to levels that can produce maximum sustainable yield...

UN Oceans Conference 2017 Call to Action

- **Legal focus** = MSY and avoiding recruitment overfishing
- **Multiple single species fisheries:** all species at  $B_{MSY}$  (basis of national & international agreements)
- **Mixed species fisheries:** caught together (manage for choke species or optimum output across all species; no species  $< B_{LIM}$ )
- **Multispecies fisheries:** biological & technological interactions (need new approaches; MMSY)
- All at MSY not possible (or desirable)

# Operational Reality = MSY

Science basis (Russell 1931, Hjort et al 1933, Graham 1935, Schaefer 1954, Beverton & Holt 1957)



1850s: MSY concept created as an economic ideal (Germany)

Arif 2017, Link 2018





# Psychology – dual modes of thinking

Intuitive



Continuous scan



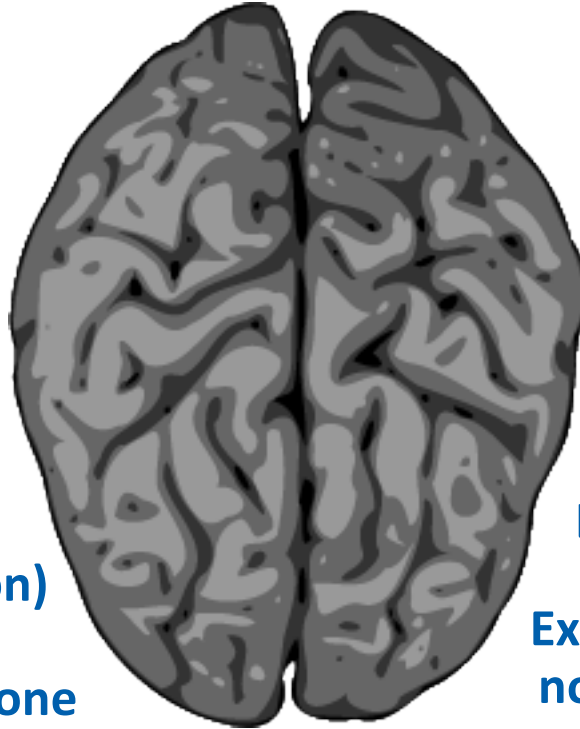
Rapid (unconscious) assessment



Heuristic rules  
(impulses & intuition)



Error prone



Rational

Conscious process



Slow, deliberate,  
automatic







Logical, evidence based



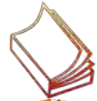
Extra effort to engage so  
not automatic response



# Psychology – Heuristics

-  ❖ **Associations & Priming:** Exposure primes following intuitions
  - $X \therefore Y$  ❖ **Judgements:** Single assessment applied across all dimensions
  - $\frac{AB}{a}$  ❖ **Substitution:** Swap in an easier question
  -  ❖ **Cognitive Ease:** Trust concepts that comfortable, easy to recall
  -  ❖ **Emotions:** Generate pleasing emotional outcomes
  -  ❖ **Causal Narratives:** Experiences couched in stories
- Rely on associations, stories & approximations, confuse causality & correlation, jump to (erroneous) conclusions

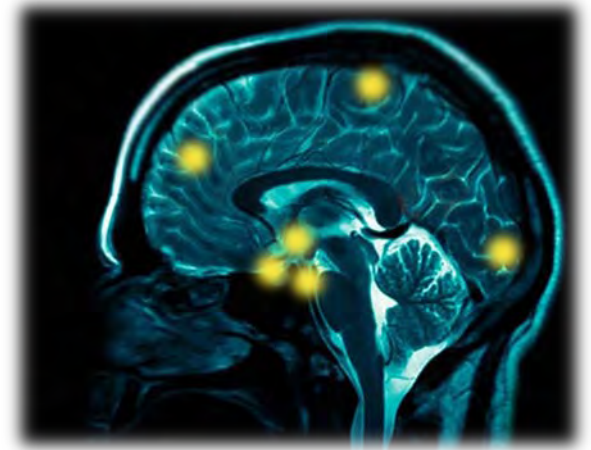
# Psychology – Typical Errors & Oddities



- ❖ **Belief bias:** Personally believable (especially if it “feels right”)
- ❖ **Narrative fallacy:** Good stories assumed true
- ❖ **Frequency (availability) bias:** Commonly heard = believable & likely
- ❖ **Confirmation bias:** Confirm preconceptions
- ❖ **Optimism bias:** Overestimate favourable / pleasing outcomes
- ❖ **Planning fallacy & bias:** Overestimate benefits, underestimate costs
- ❖ **Framing bias:** Way information presented changes thinking (anchoring)
- ❖ **Regression bias:** Ignore stochasticity
- ❖ **Extrapolation fallacy:** Generalise off small N
- ❖ **Representativeness fallacy:** Seems similar, must have similar likelihood
- ❖ **Out of sight out of mind:** Ignore unknowns & uncertainty
- ❖ **Hindsight illusion:** We knew then what we know now
- ❖ **Loss aversion:** Eliminate risk of loss > Increase chance of success
- ❖ **Endowment effect:** If invested stick with it
- ❖ **Halo effect:** One outcome extended to all aspects

# Translation time

- Adoption of new knowledge: 13-23+ years
- Communication pathways
- Declarative knowledge  $\neq$  Procedural knowledge
- Frequency fallacy (intuitively think what we hear often is true, so change is slow)
- Confirmation bias



# Operational Reality = MSY

- **Familiar:** Already used (ignorant of other options)
- **Easy to communicate:** thus accepted
- **Better than intuitive judgement:** less long term losses than intuitive experience as considers some feedbacks (both ignore complexity)
- **Operational:** Practical alternatives hard to find... supplement don't displace (much invested in current management & assessment)



# Chasing the Silver Bullet

- Despite recognising the complexity we still chase simple solutions

**Gear Control**

**Effort Control & Seasonal closures**

**Catch Quota**

**User rights**

**Co-management**

**Portfolio management**

**Spatial management**

- This is why policy makers continue to substitute in MSY

# Nudge theory

- Framing means can **Nudge** behaviour  
e.g. recreational fishing compliance



It might be to size but  
do you really want it?

Not bad!

Impressive!

Worth bragging  
about!

Officially  
a monster



**Trout fish  
Tasmania**  
www.ifs.tas.gov.au



Know the rules when  
and where you fish.  
Download the Infish app

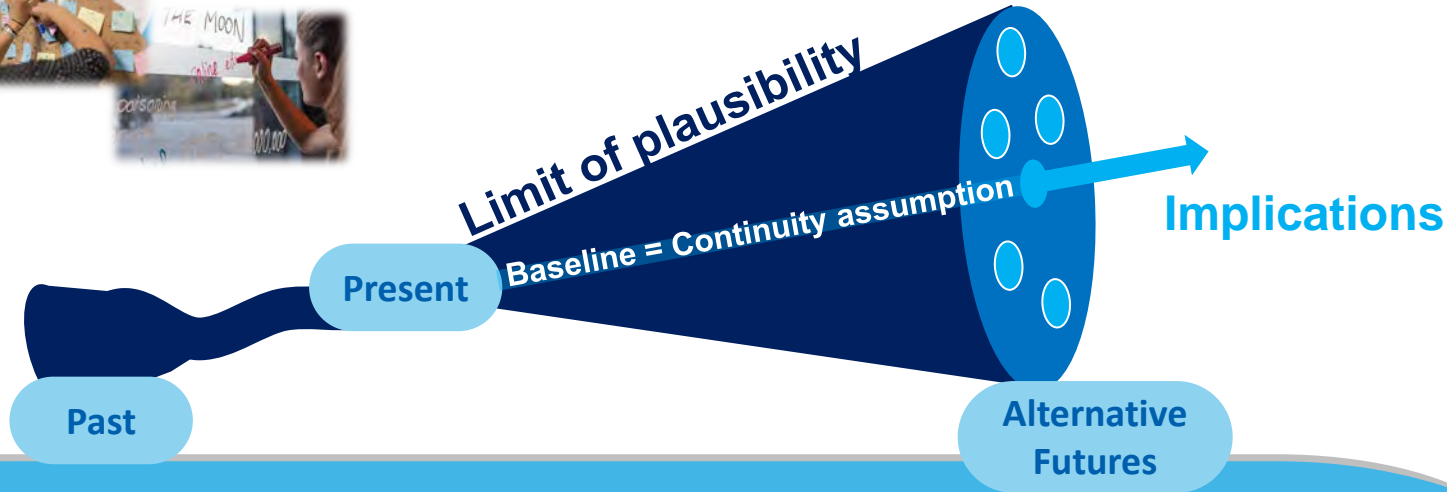


# Exploring future options

- What are the (feasible) possibilities?
- What is likely? Bifurcations? What is desired?
- Indicators? Implications?



## Foresight broadened vision



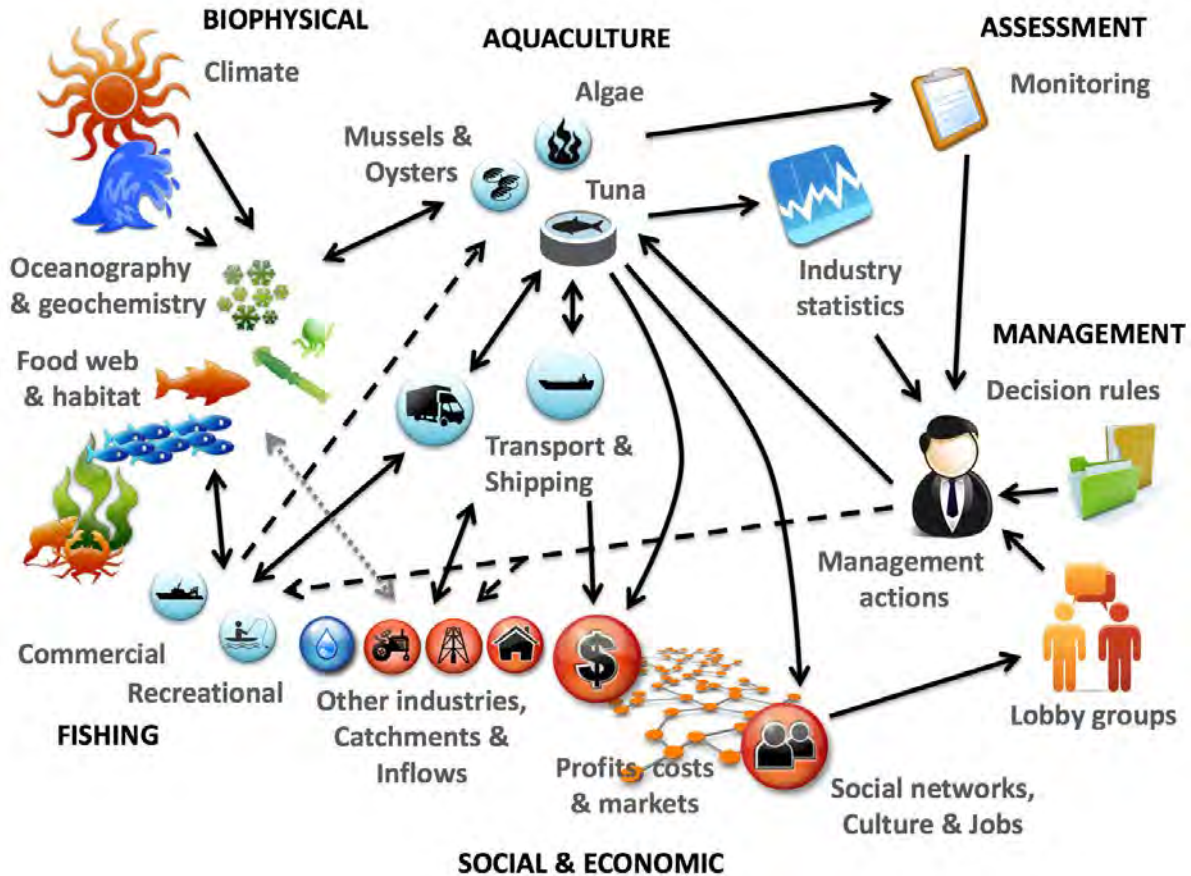
### Scenario Forces

	Barbarism	Markets	Sustainability
Population			
Economy			
Environment			
Equity			
Technology			
Conflict			
	Worst Case	Business-as-usual	Best Case

from "Great Transition," Global Scenario Group



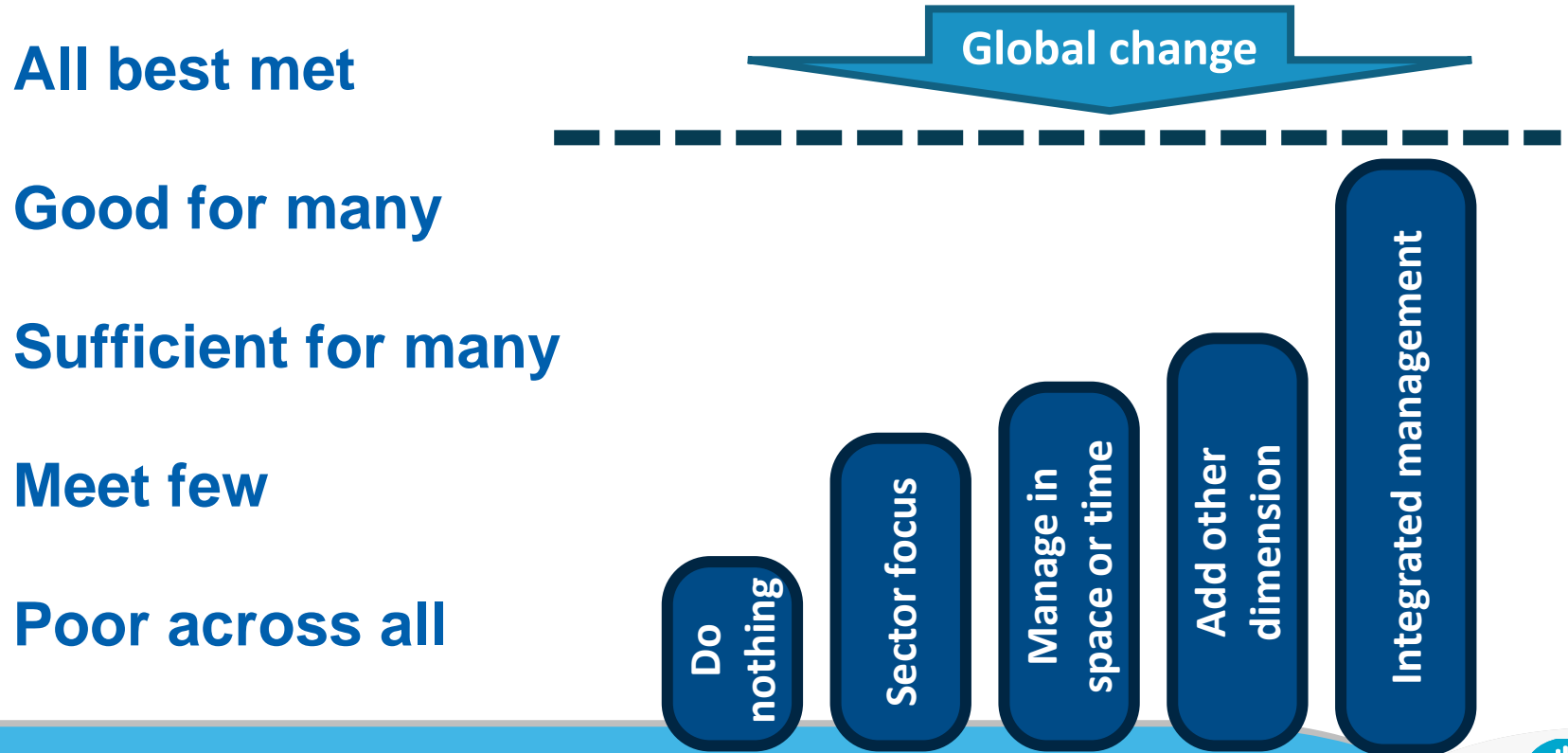
# Exploring future options



- Varied climate & development scenarios
- Alternative management forms
- Implications for economic, social ecological & outcomes

# Without integration systems will suffer

Ecological, Economic, Social objectives

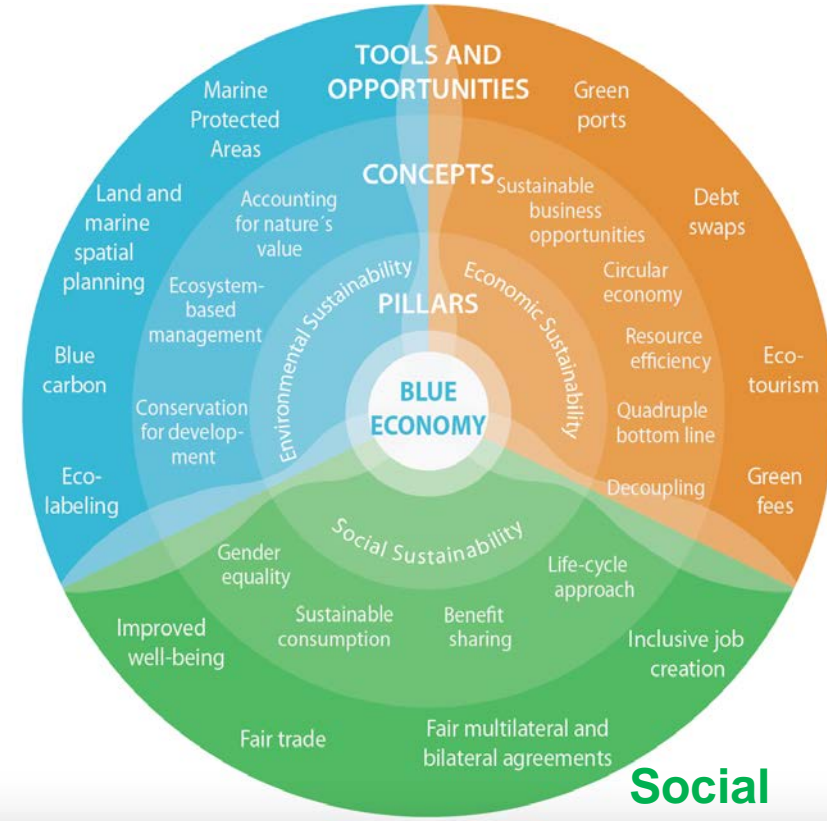


# History of integration

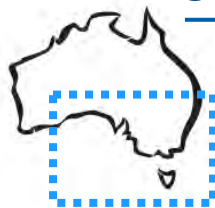
- **Millenia:** Eastern & indigenous faiths
- **1930s:** US environmental discourse
- **1960s-1970s:** Systems thinking influence
- **1980s - 1990s:** ICZM & Ecosystem Approach
- **2000s:** Ecosystem Based Management (increasingly multi-sector)
  
- Doing it has proven much harder than discussing it

Environment

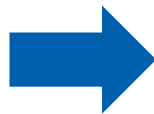
Economic



# Addressing cumulative impacts



Scoping



**Really cumulative ?**  
Multiple pressures, events,  
components

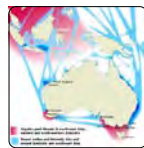
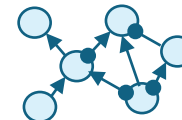
Management Phase



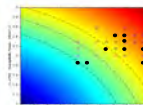
Analysis



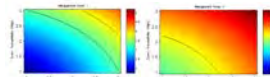
Qualitative



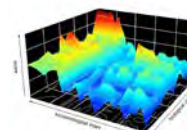
Semi-quantitative  
Evaluations



Semi-quantitative  
Validation & testing



Quantitative  
Assess & Test

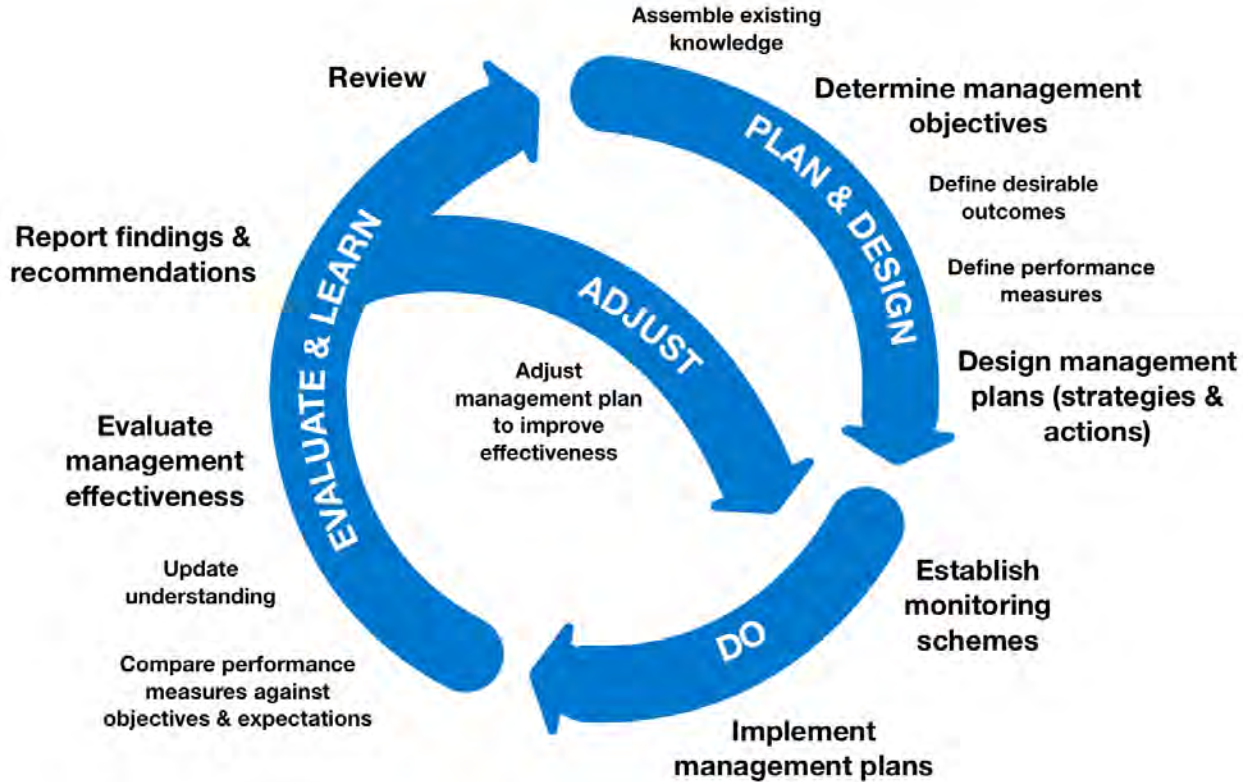


Rated as  
High Risk

Rated as  
High Risk

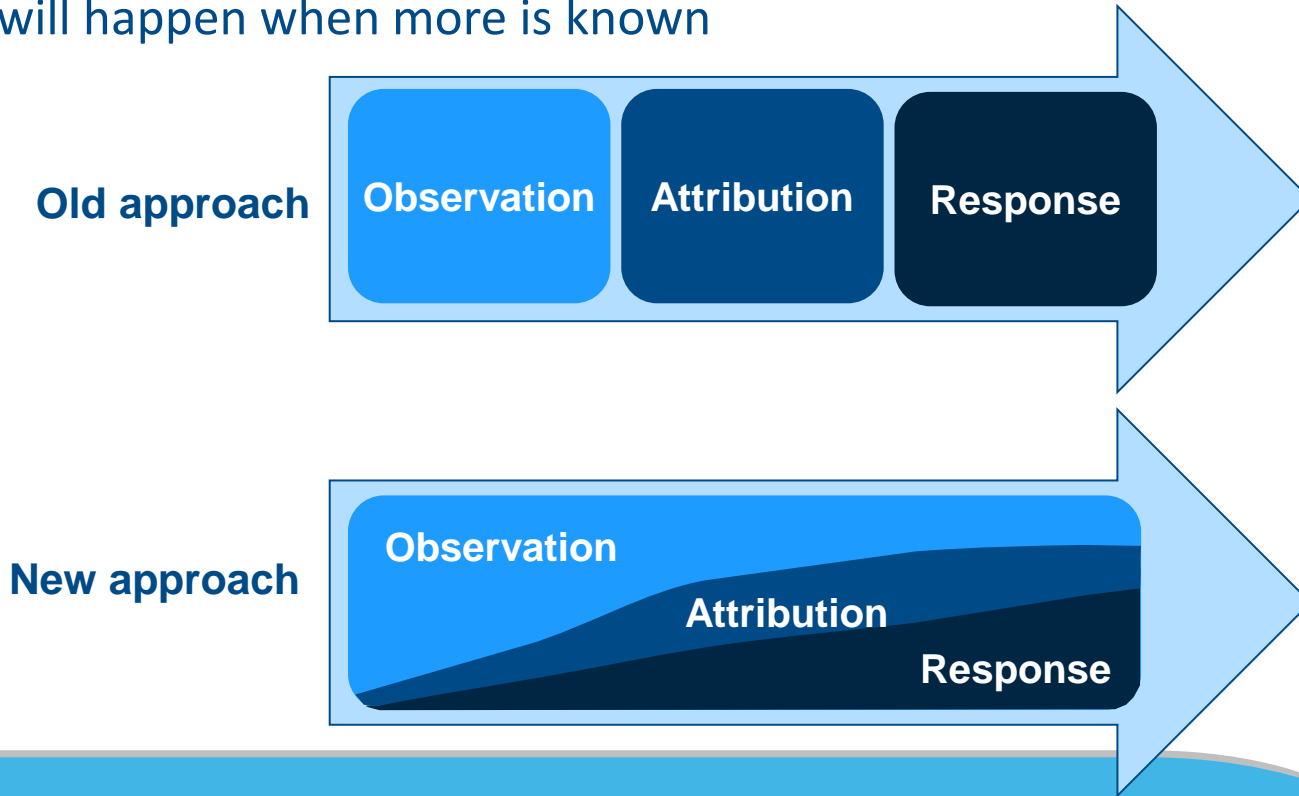
Rated as  
High Risk

# Adaptive management remains key



# Changing science & management

- No time for systematic steps – instead make no regret decisions & acknowledge change will happen when more is known



# Grappling with future options



1. **Use climate change as a “critical juncture”:** trigger useful change
2. **Provide short, medium & long term implications:** & describe how delivery now may constrain future options
3. **Flexibility:** Don’t give up diversity of options too early or easily
  - don’t try and predict winner (co-evolution difficult to predict)
  - (if possible) don’t block alternatives
4. **Decisions:** Not just what is in, but why something is explicitly out
  - this helps with multi-objective reality across stakeholders too (less likely to get surprise that one groups objective lost)

# Summary

- Ocean Anthropocene underway
- Path dependency constrains future options
  - Has already embedded some management concepts (MSY, selective harvesting)
- Human cognition has many biases: 'exploit' for change & push for conscious engagement
- As approach (pass) planetary boundaries integration is crucial
- Nested approaches to handle complexity
- Make conscious (no-regrets) decisions, be adaptive & diverse





# Thanks

**CSIRO Oceans & Atmosphere**

Beth Fulton

Ecosystem Modelling & Risk Assessment

**t** +61 3 6232 5018

**e** [beth.fulton@csiro.au](mailto:beth.fulton@csiro.au)

**w** [www.csiro.au](http://www.csiro.au)

