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

Beth Fulton
2018
Old view
New reality
Aquatic Revolution

McCauley et al 2015 Science
Expanding Blue Economy

- Ocean “assets” = USD $24+ trillion
- Annual value = USD $2.5 trillion (~7th largest economy)
- Double (or more) within a decade
The Anthropocene & The Ocean

Earth system trends

- Carbon dioxide
- Nitrous oxide
- Methane
- Stratospheric ozone
- Surface temperature
- Ocean acidification

Ocean system trends

- Marine Capture Fisheries
- Shrimp Aquaculture
- Ocean Acidification
- Offshore Oil Production
- Offshore Wind Turbines
- Whale Strikes
- Seabed Mining
- Coral Loss
- Deindorism
Extreme Events

- Sept 2015 – May 2016
- \(~2-3 \, ^\circ\text{C} > \) climatology

Oliver et al 2017
Changing Ecosystems

- Marine habitat loses
- Shifting species

Sightings of species in location

Climate impacts 2006-2017

Key
- Range extension
- Mangrove deaths
- Kelp loss
- Coral bleaching
- Seagrass loss
- Invertebrate fishery decline
Path dependency

- Decisions preclude (or increase likelihood) of specific future options
Path dependency – e.g. Cars

Horses

Canals

Trains

USA

Abundant: Oil, water

Poor resource availability

Infrastructure creation

Zoning

Cars

Image & individual mobility

Rapid & productive technology creation

Cheap electricity

Steam Engines:

Electric

Petrol

1850s

1890s

1900s

1920s

1950s

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

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

Evolution of colonized legal codes
Path dependency (cascades of consequences)

Initial decision made

- Best given available information / conditions (political, economic, social compromises)
- Random or social influence $\Rightarrow$ prefential 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”

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 $B_{\text{MSY}}$ (basis of national & international agreements)

• **Mixed species fisheries**: caught together (manage for choke species or optimum output across all species; no species $< B_{\text{LIM}}$)

• **Multispecies fisheries**: biological & technological interactions (need new approaches; MMSY)

• All at MSY not possible (or desirable)
Operational Reality = MSY


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

1945: Truman Proclamation

1949: US High Seas Fishery Policy & IATTC & Int. Convention on NW Atlantic Fisheries

1950

1956: Economics questioned

1958: Convention on High Seas Fishing

1957: Convention on N Pacific Fur Seals

1960

1966: ICCAT

1966: Larkin 1977

1970

1974: IWC

1974: Identification of ecosystem degradation risks. Aggregate vs single species MSY

1977

1980

1982: UNCLOS

1985: Indonesia

1991: Australia

1994: Practicality first questioned


1996: NZ & USA

1997

2000

2002: Johannesburg Declaration

2005: Japan

2007: Australia

2009

2012: Convention on Highly Migratory Stocks N Pacific

2014: Whaling case

2016: India

2018

2020

2022

2012: Convention on Highly Migratory Stocks WCP

1954: Convention on Great Lakes

1956: Economies questioned

1985: Convention on Great Lakes Fur Seals

2000: Convention on Highly Migratory Stocks WCP

1991: Australia

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

Kahneman 2011
Psychology – Heuristics

- **Associations & Priming**: Exposure primes following intuitions
- **Judgements**: Single assessment applied across all dimensions
- **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 believeable (especially if it “feels right”)
- **Narrative fallacy:** Good stories assumed true
- **Frequency (availability) bias:** Commonly heard = believeable & 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 ≠ Procedural knowledge
- Frequency fallacy (intuitively think what we hear often is true, so change is slow)
- Confirmation bias

Green & Seifert 2004, Morris et al 2011
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)

Barber 1988, Holden & Ellner 2016
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

---

Mackay et al 2018
Exploring future options

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

Foresight broadened vision

Limit of plausibility

Baseline = Continuity assumption

Implications

Past

Present

Alternative Futures

Scenario Forces

<table>
<thead>
<tr>
<th>Barbarism</th>
<th>Markets</th>
<th>Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflict</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

from “Great Transition,” Global Scenario Group

CSIRO
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

All best met

Good for many

Sufficient for many

Meet few

Poor across all

Global change

Do nothing
Sector focus
Manage in space or time
Add other dimension
Integrated management

Fulton and Gorton 2014
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

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

Fulton et al
Adaptive management remains key

Jones 2009
Changing science & management

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

Old approach

- Observation
- Attribution
- Response

New approach

- Observation
- Attribution
- Response
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
w www.csiro.au