



# Complexity Science in Action

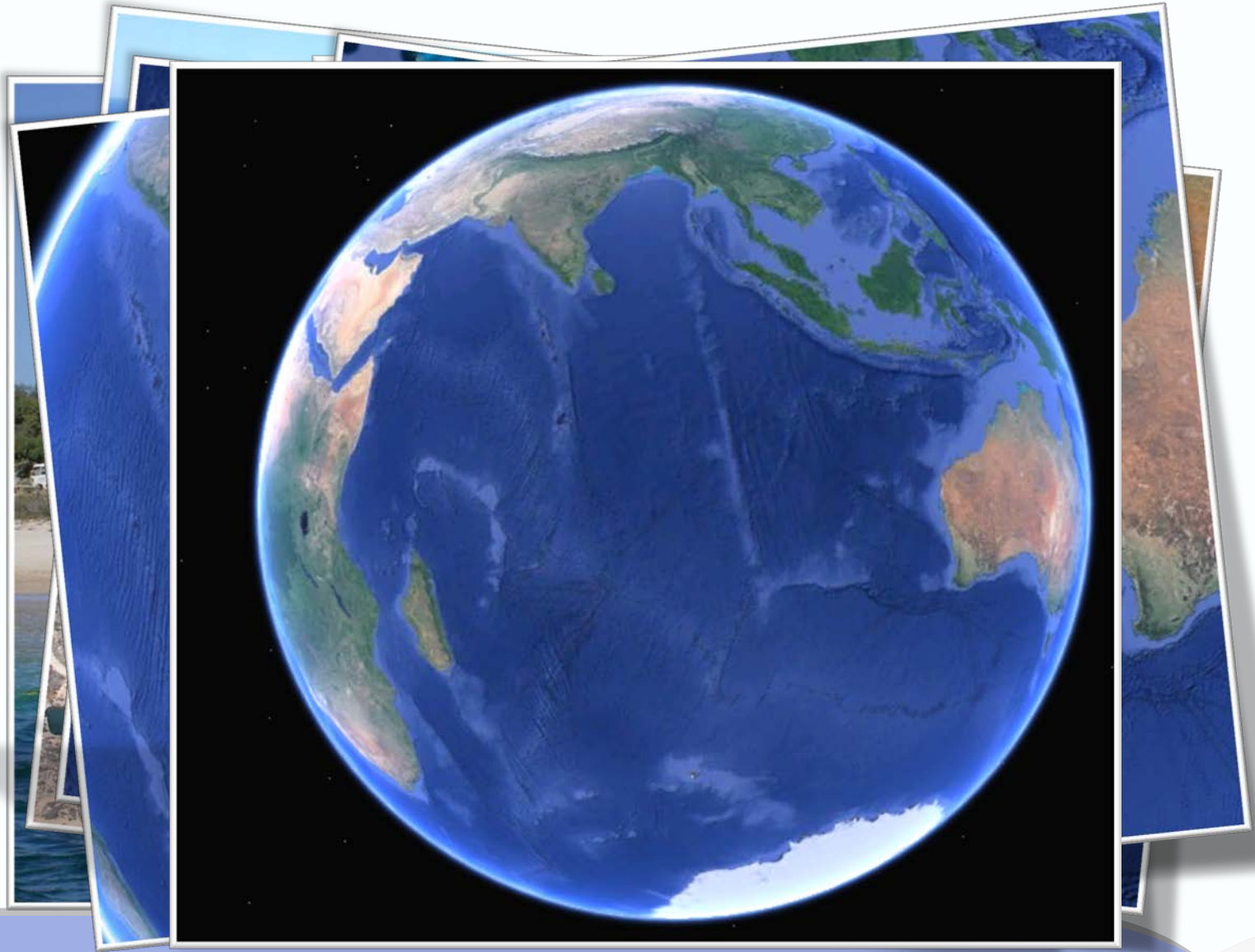
**Beth Fulton**, Fabio Boschetti, Randall Gray, Miriana Sporcic, Bec Gorton, Linda Thomas, Hector Lozano-Montes, Roger Scott, Jeff Dambacher, Tod Jones

September 2013

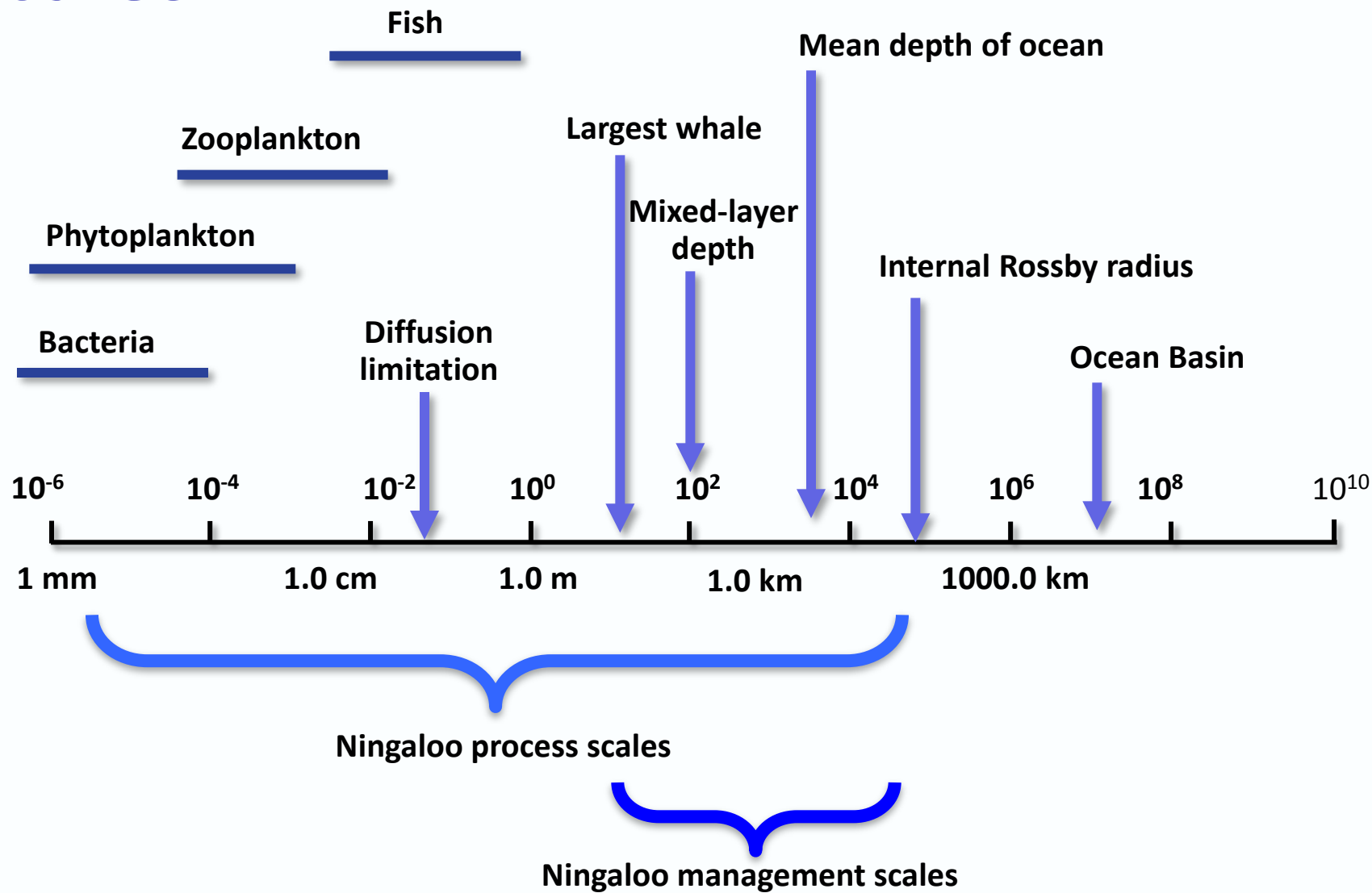
CSIRO WEALTH FROM OCEANS FLAGSHIP  
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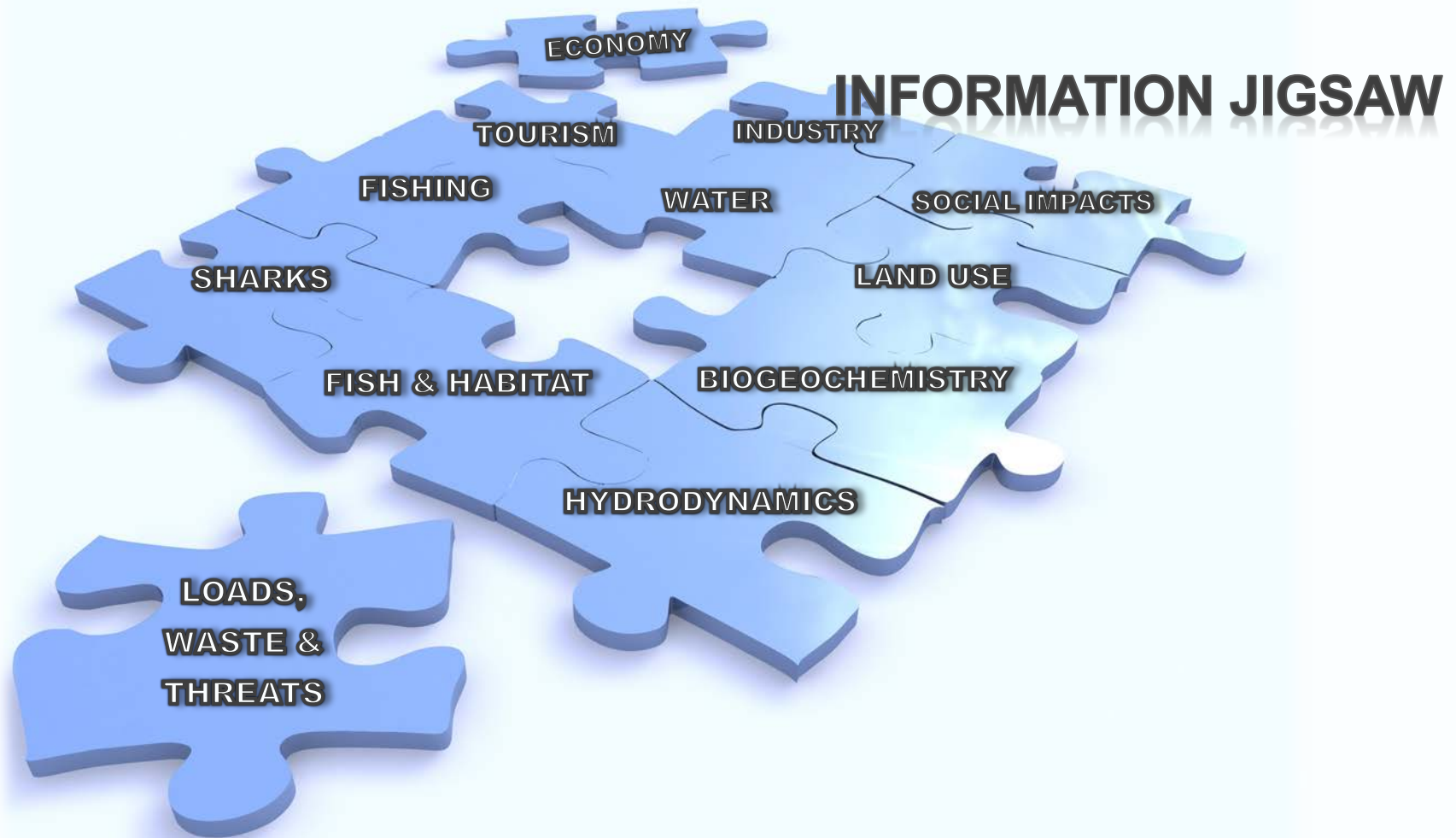
# Nested Scales



# Scales



# Regulatory Jigsaw



# Regulatory Focus





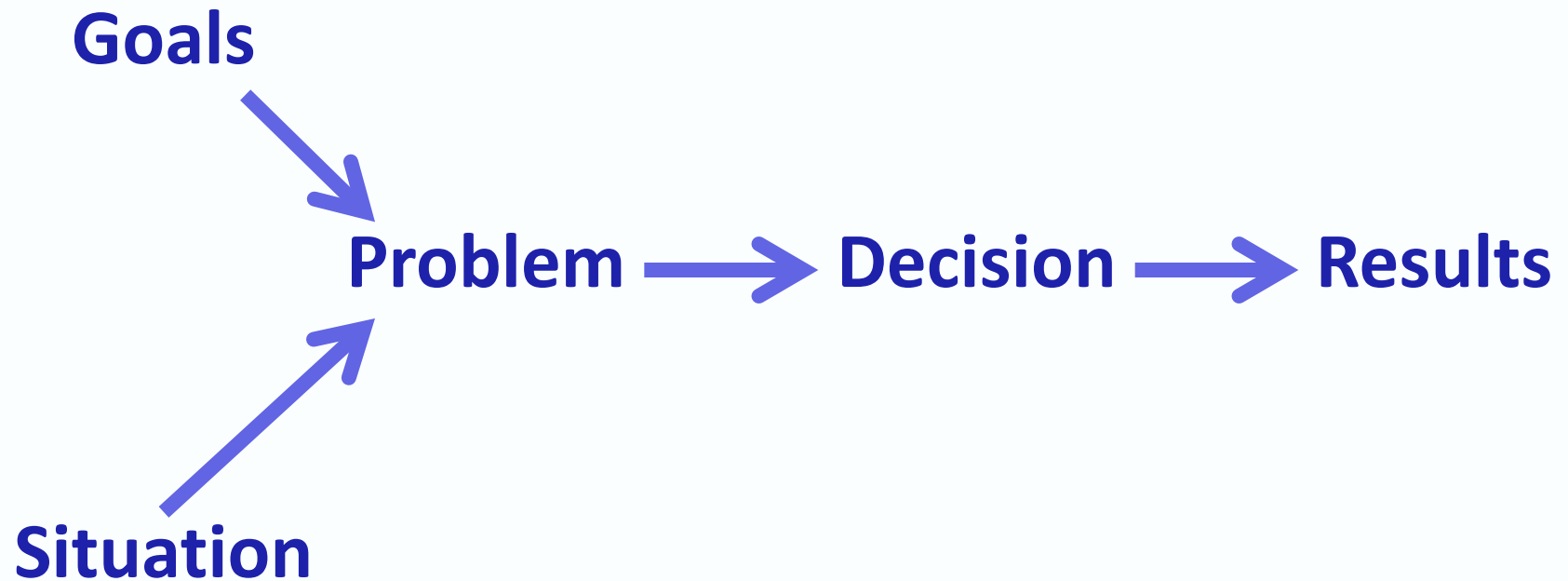
# Northwest – Multiple Use



# Marine multiple use management



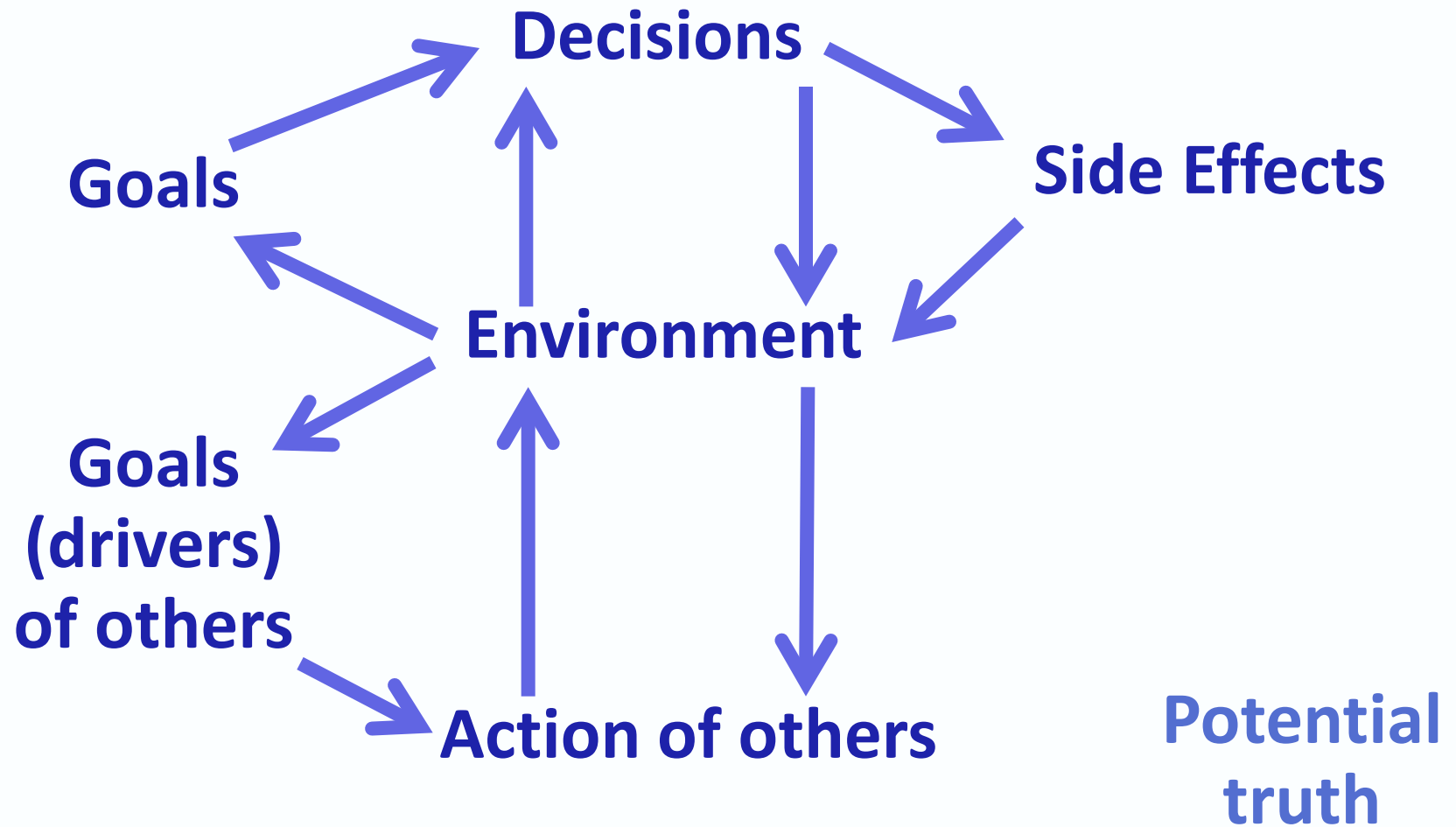
# Decision Processes



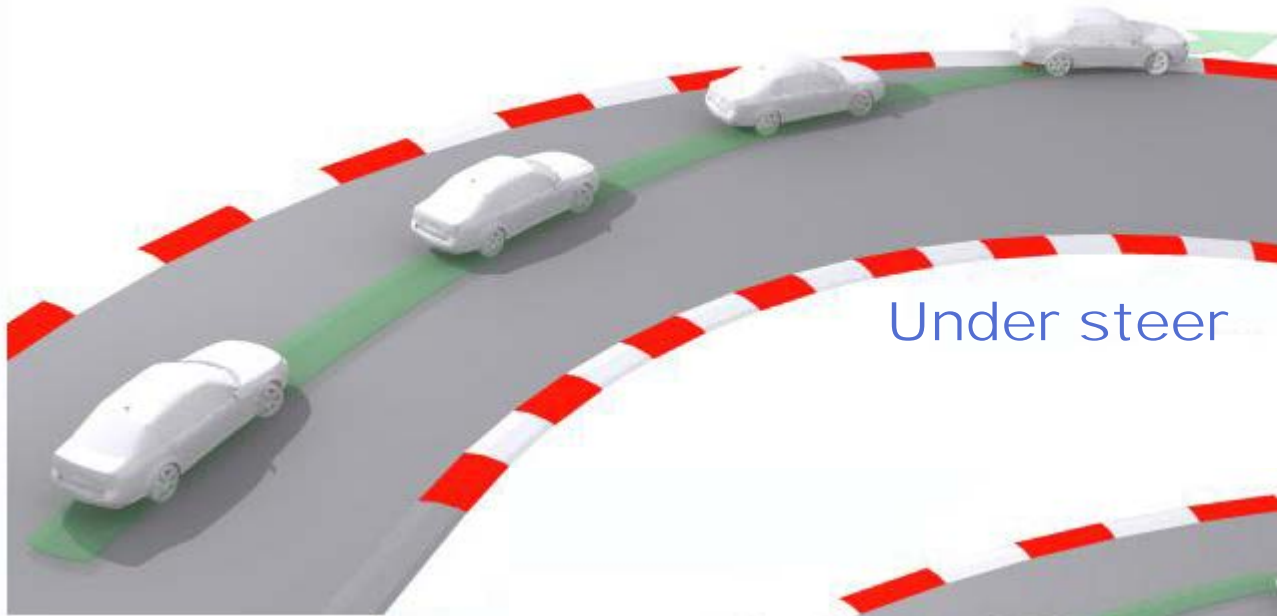
Assumed



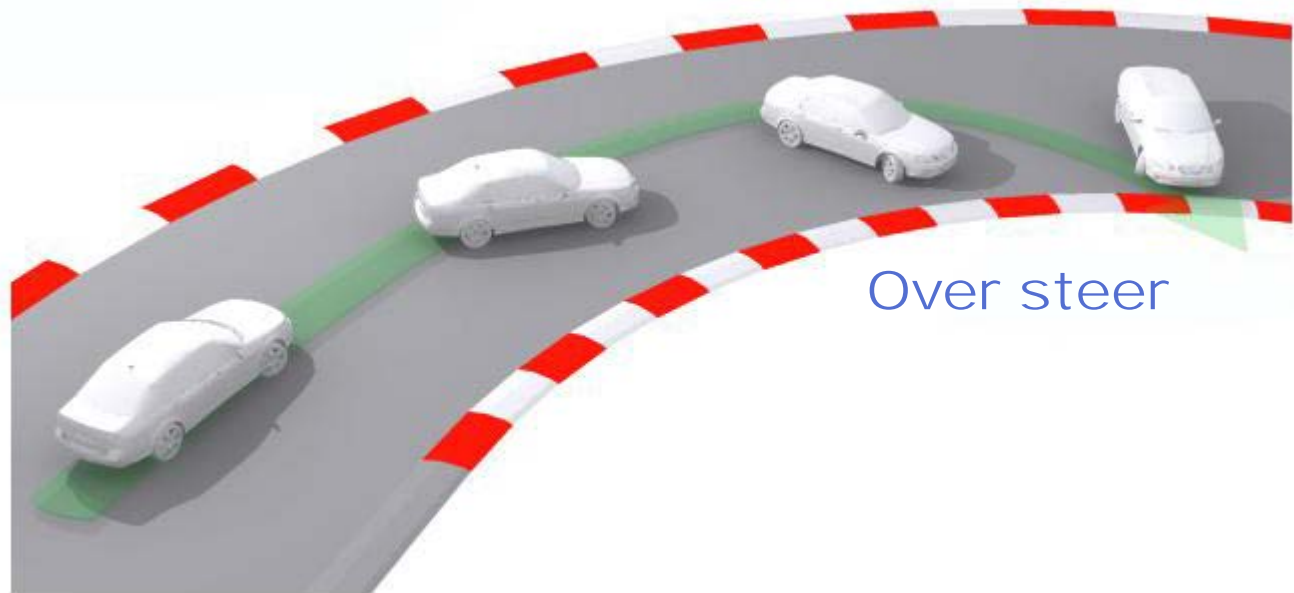
# Decision Processes



# Mis-judging feedback



Under steer

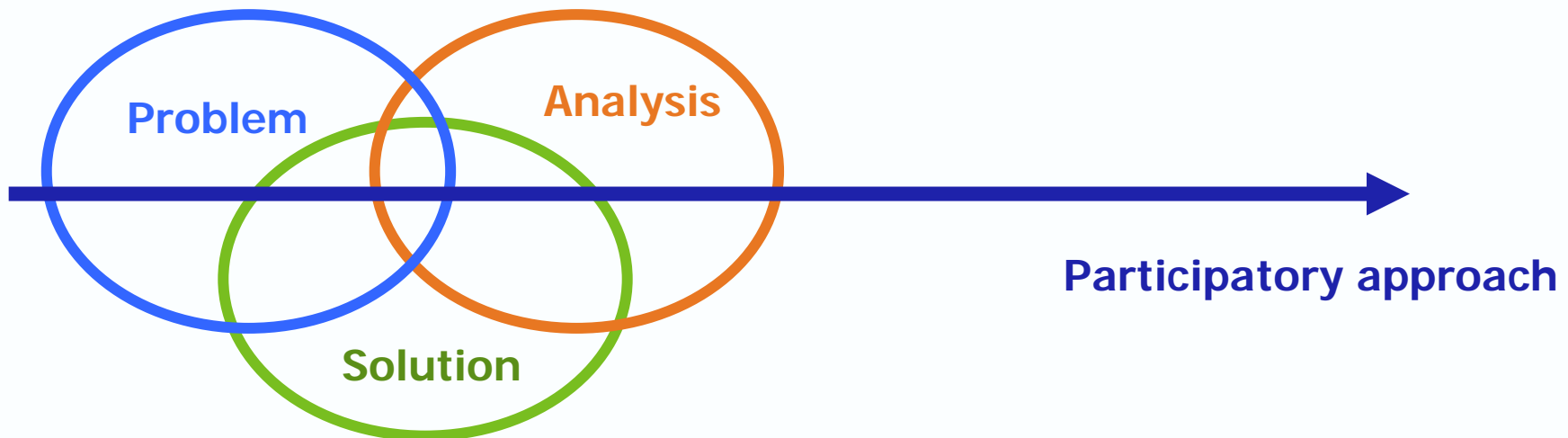
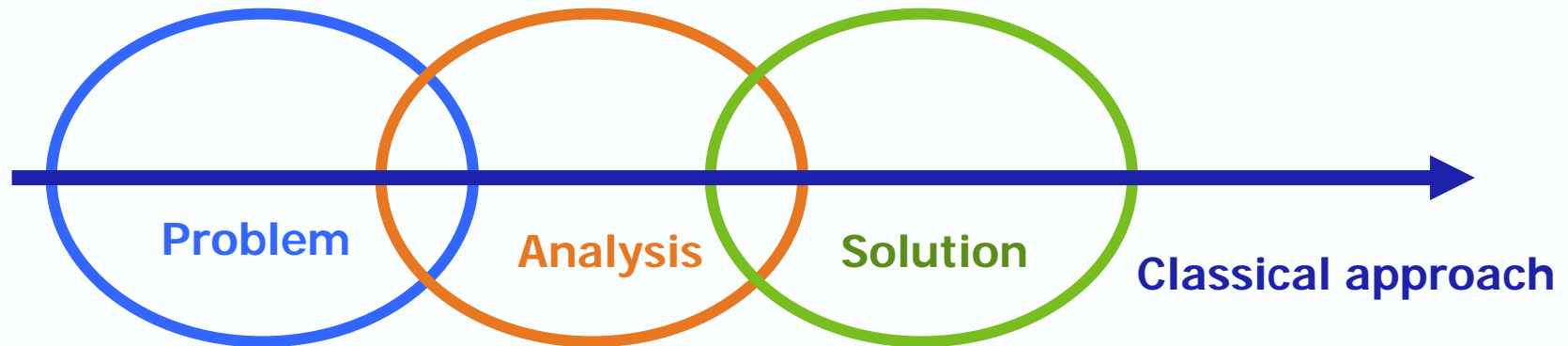


Over steer

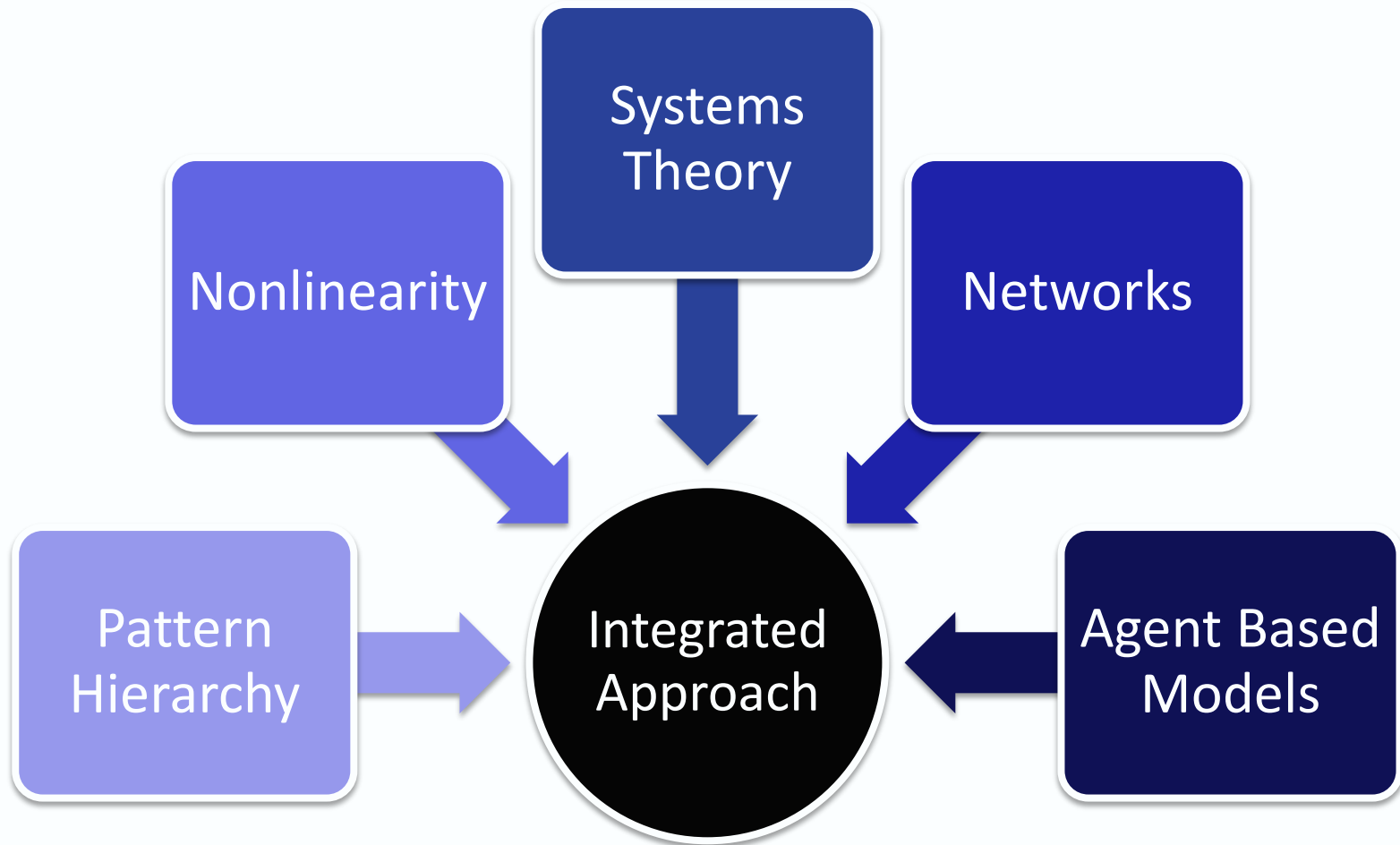
# Training (brain)



# 1. Participatory Modelling



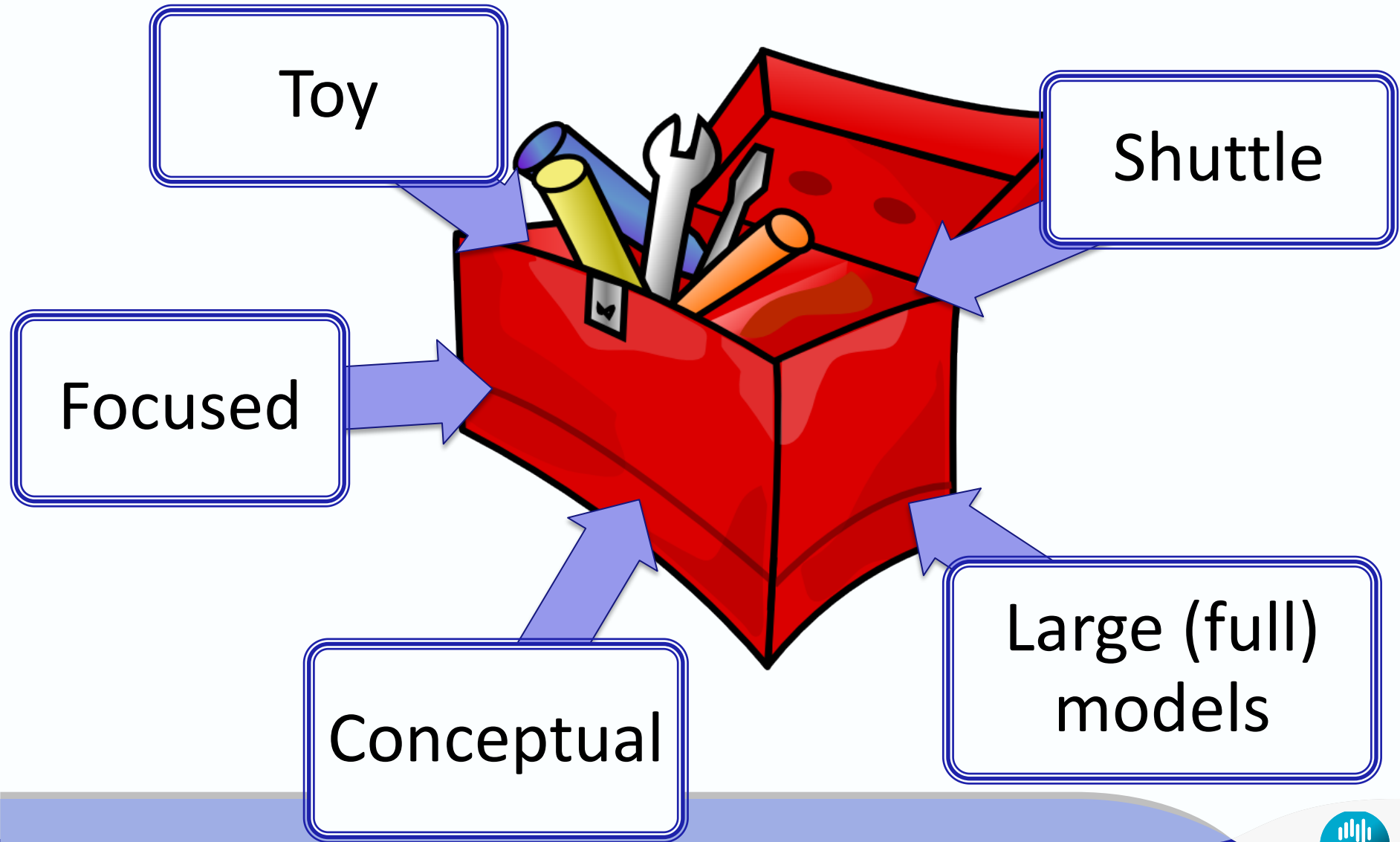
## 2. Complexity science



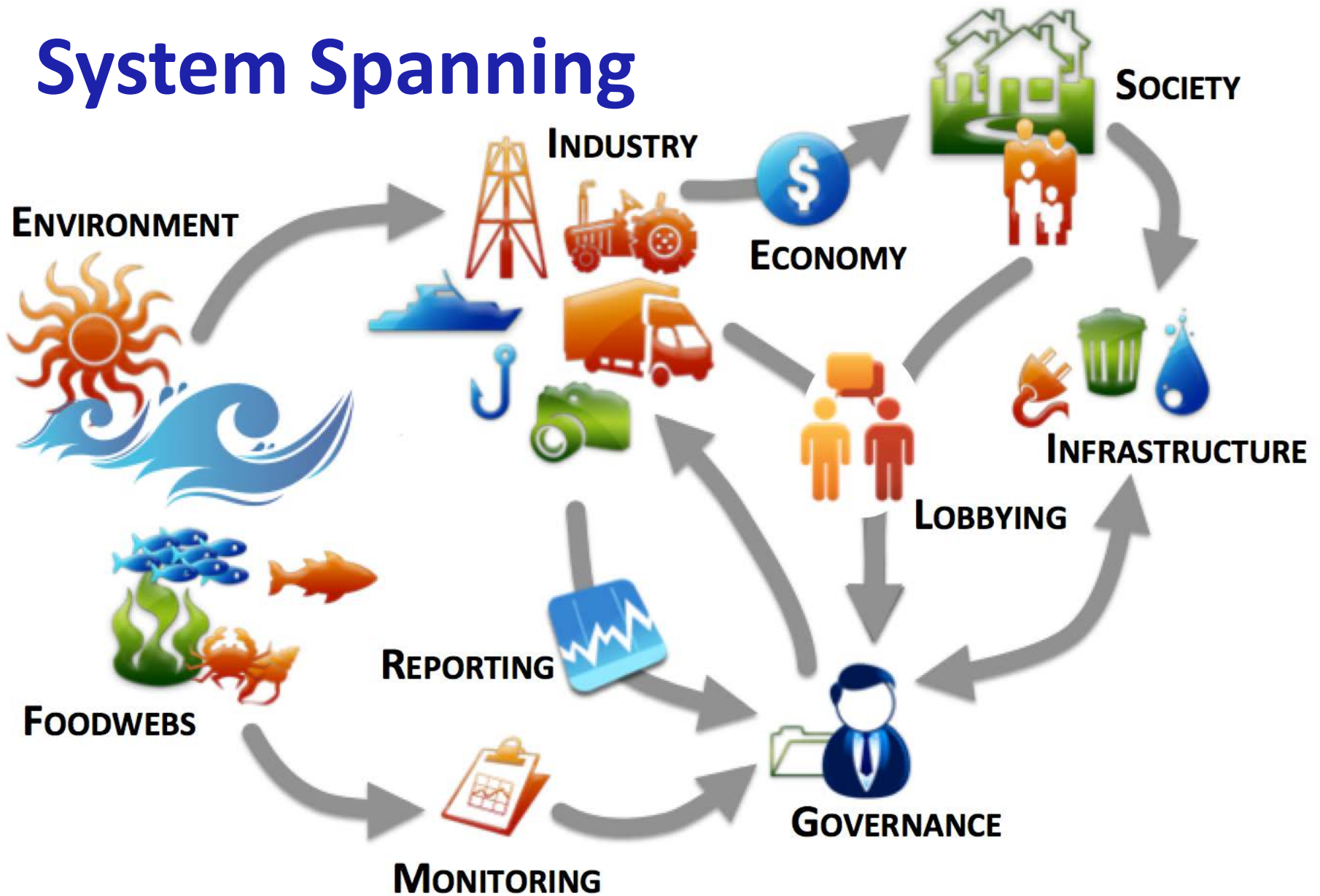


# Multiple models

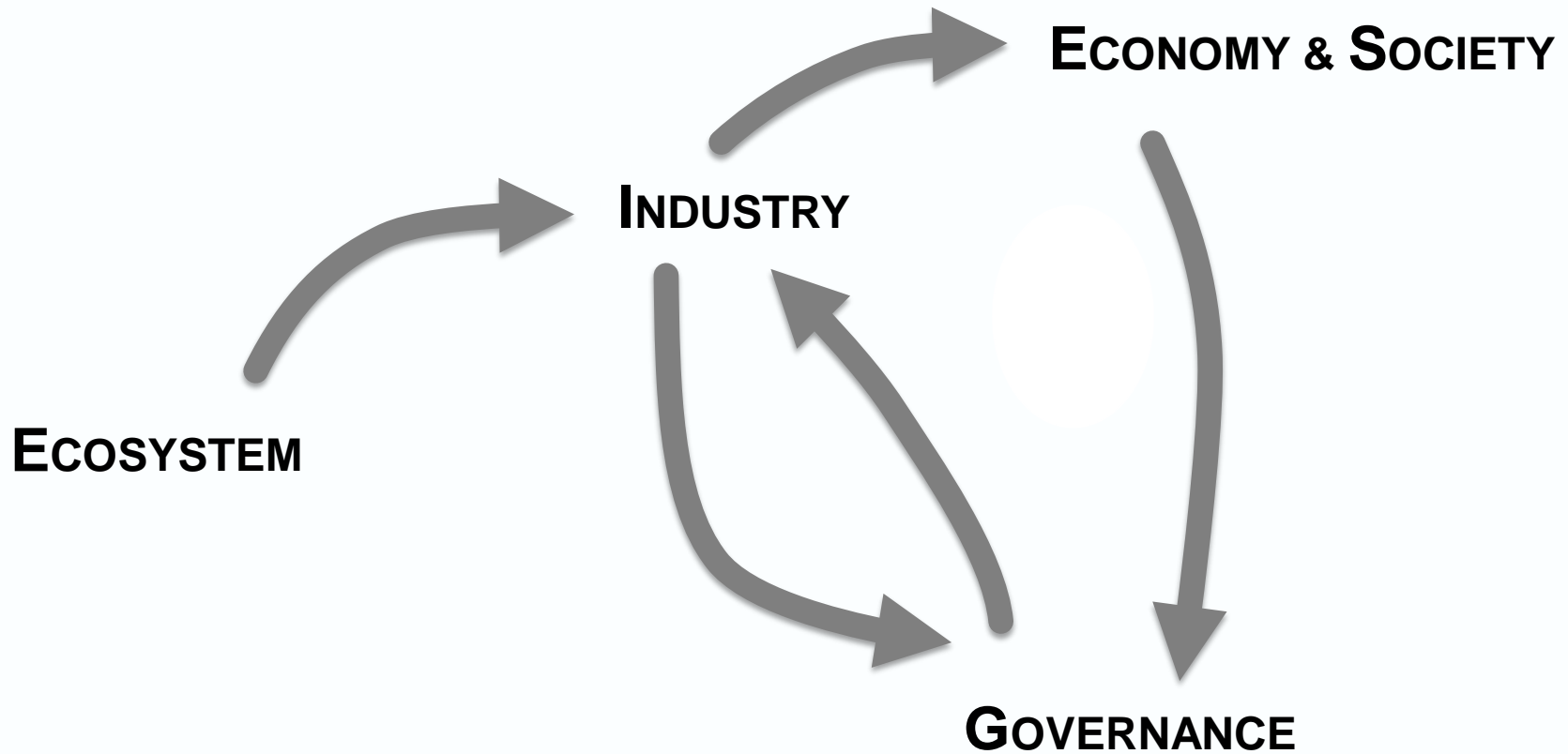
- All individually useful
- Don't always need the set



# System Spanning



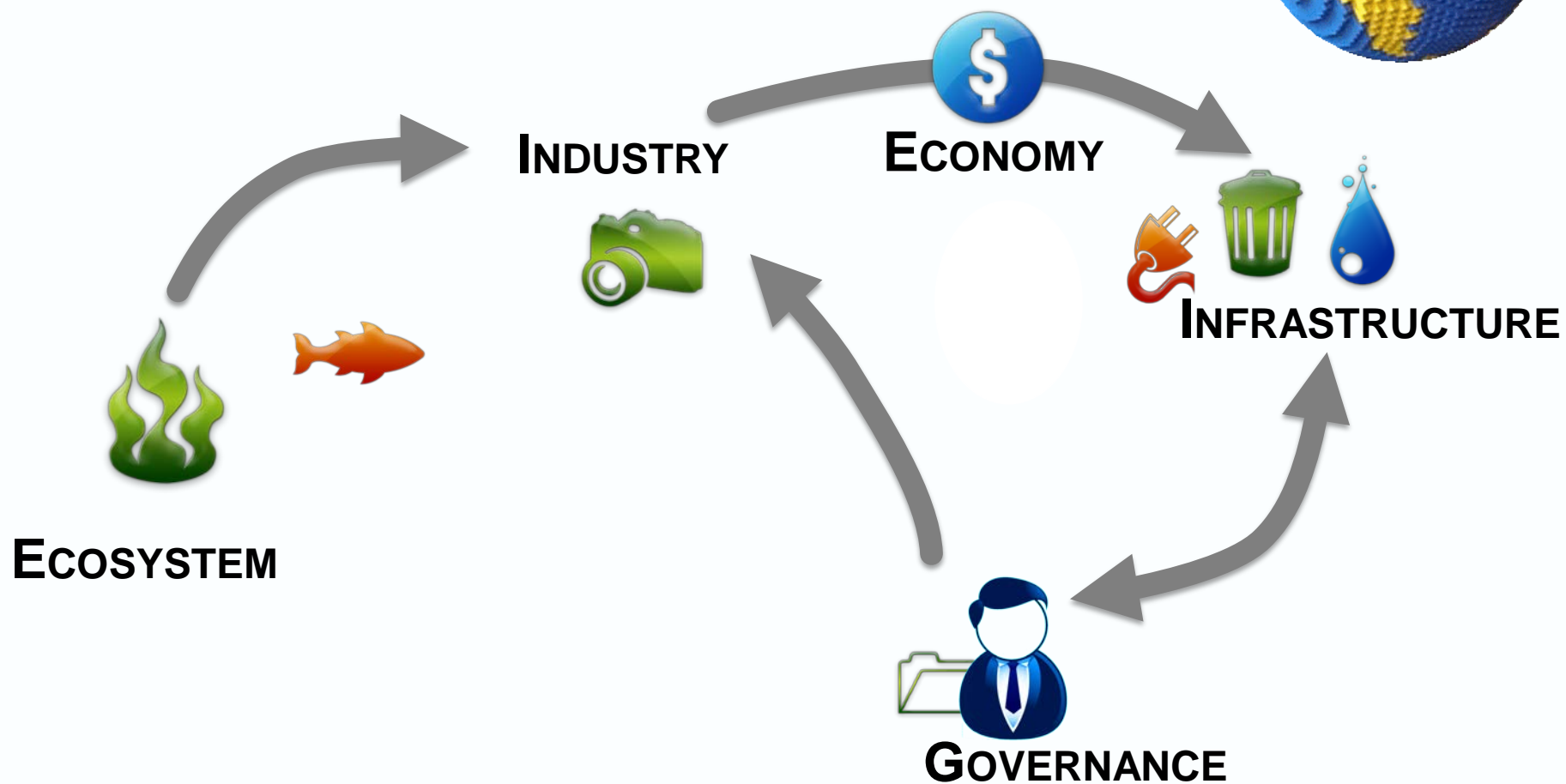
# Qualitative



# Empirical & Focused

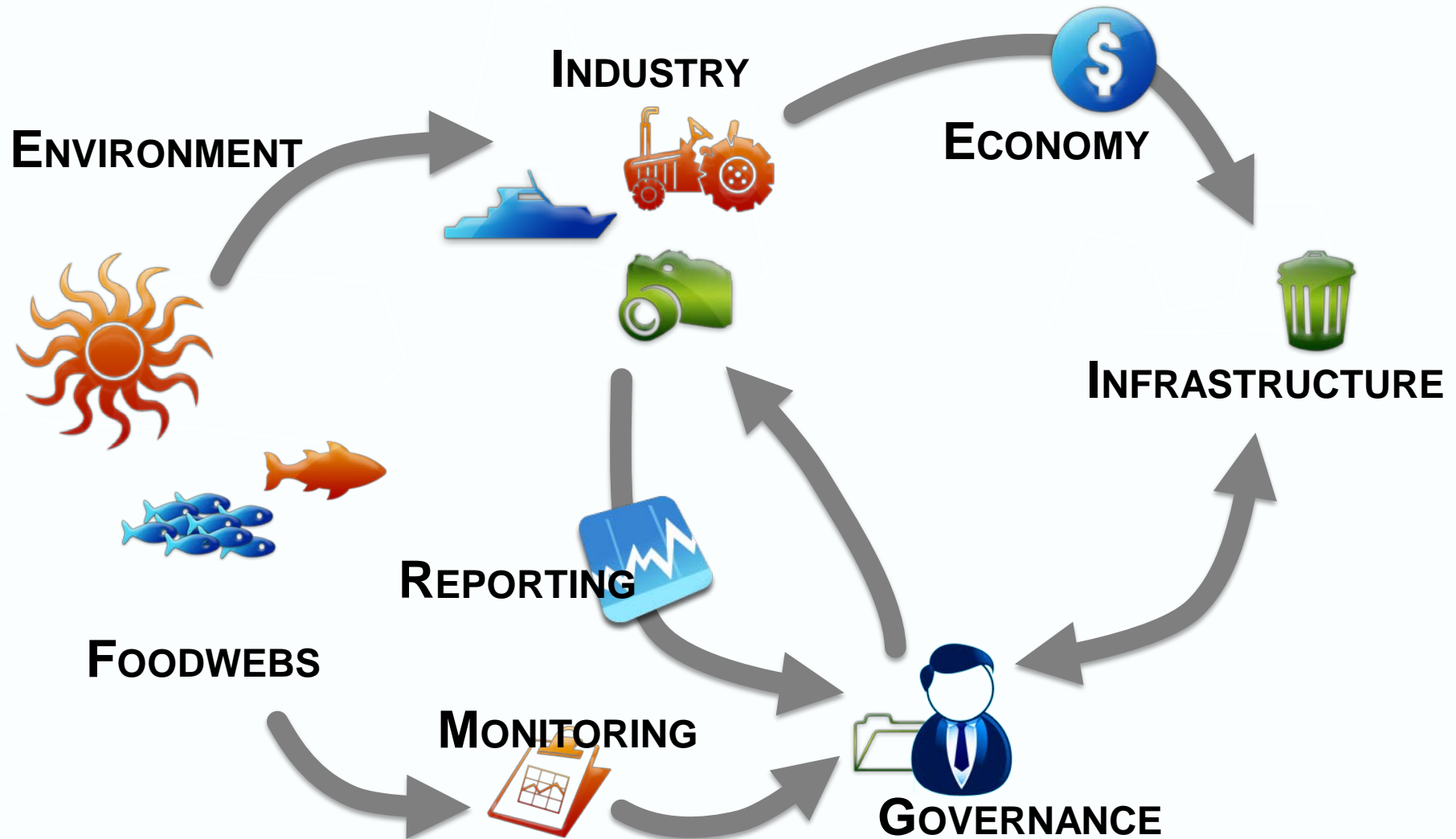


# Toy models

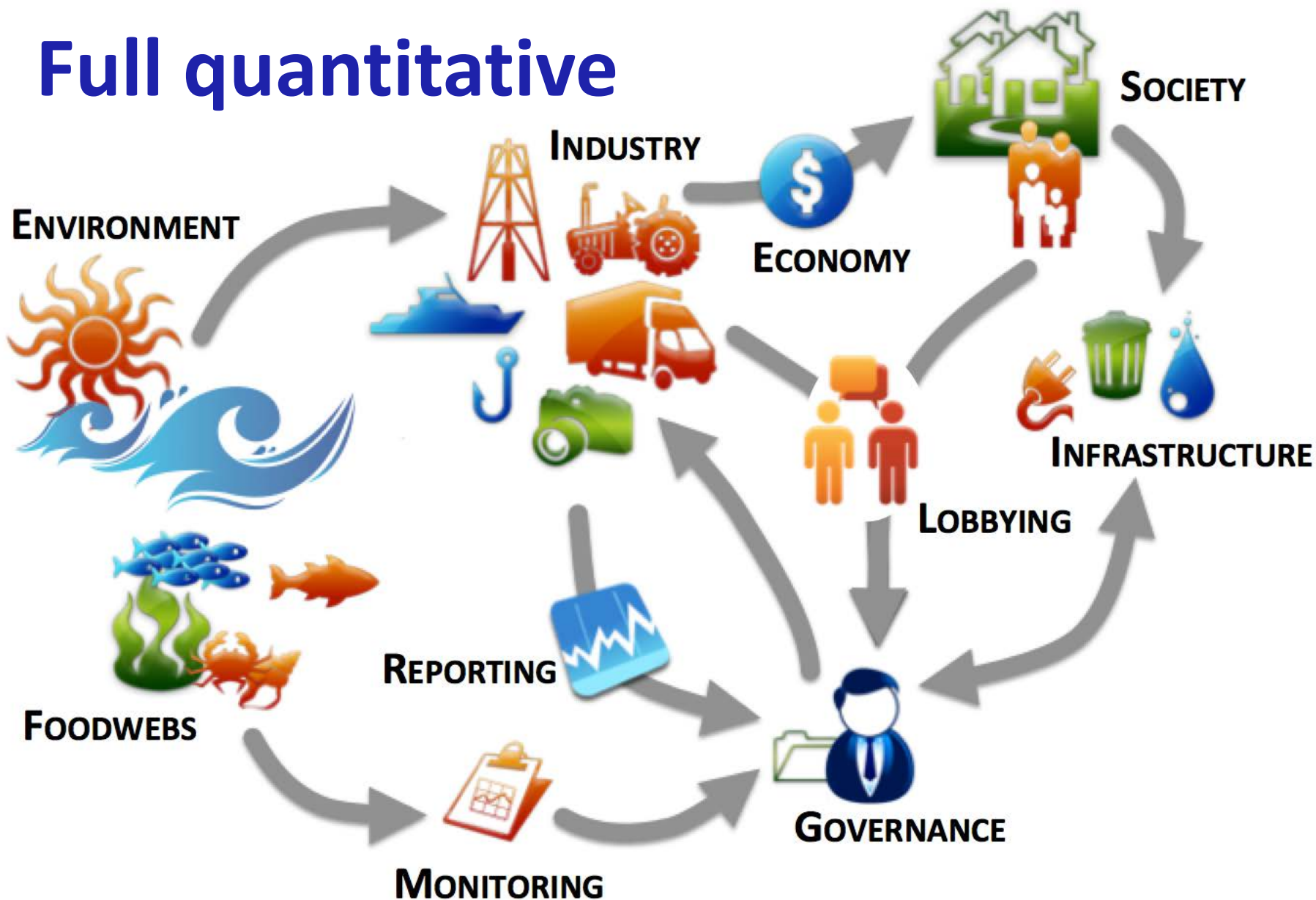




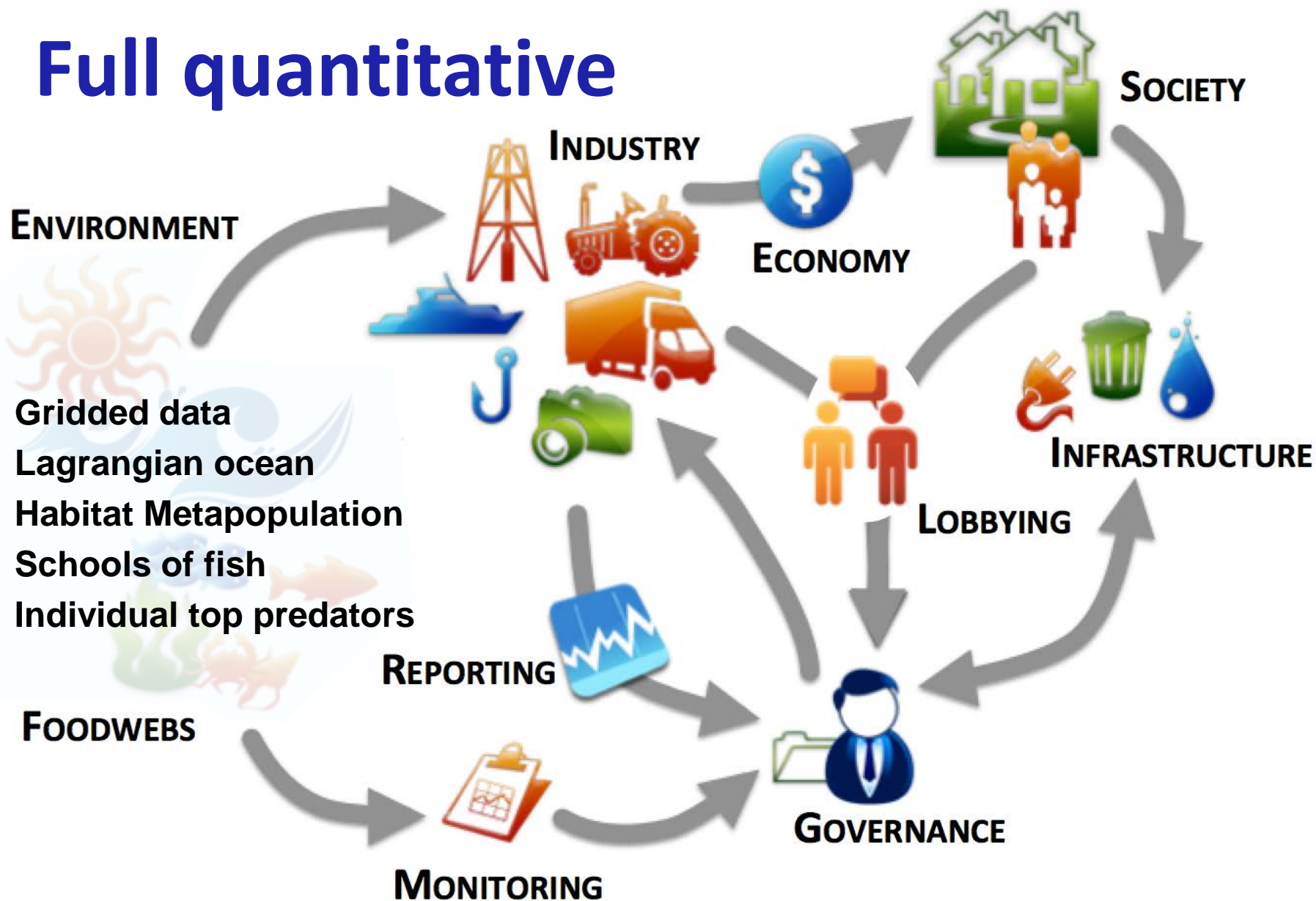
# Minimum realistic (shuttle ideas)



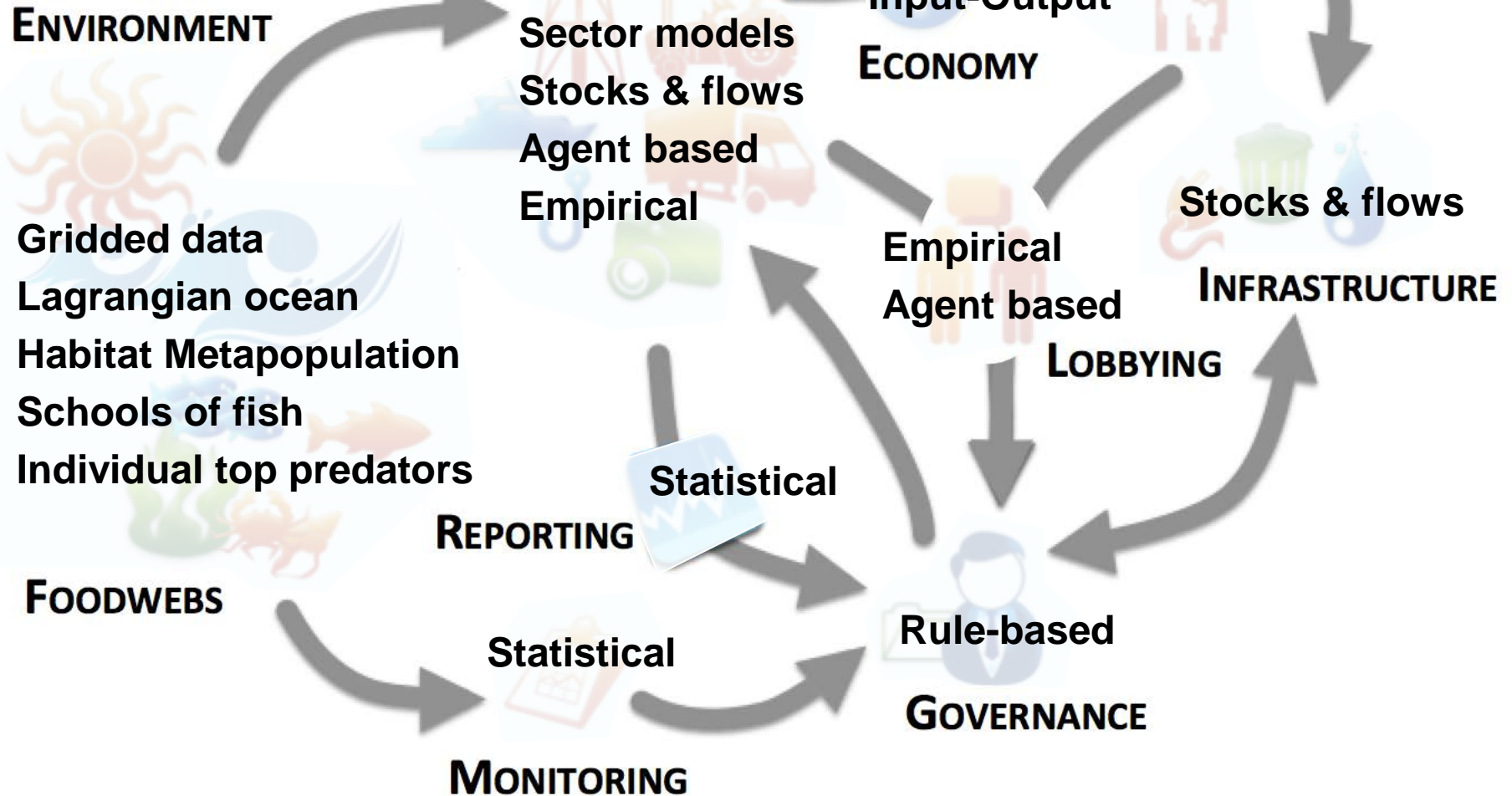
# Full quantitative



# Full quantitative

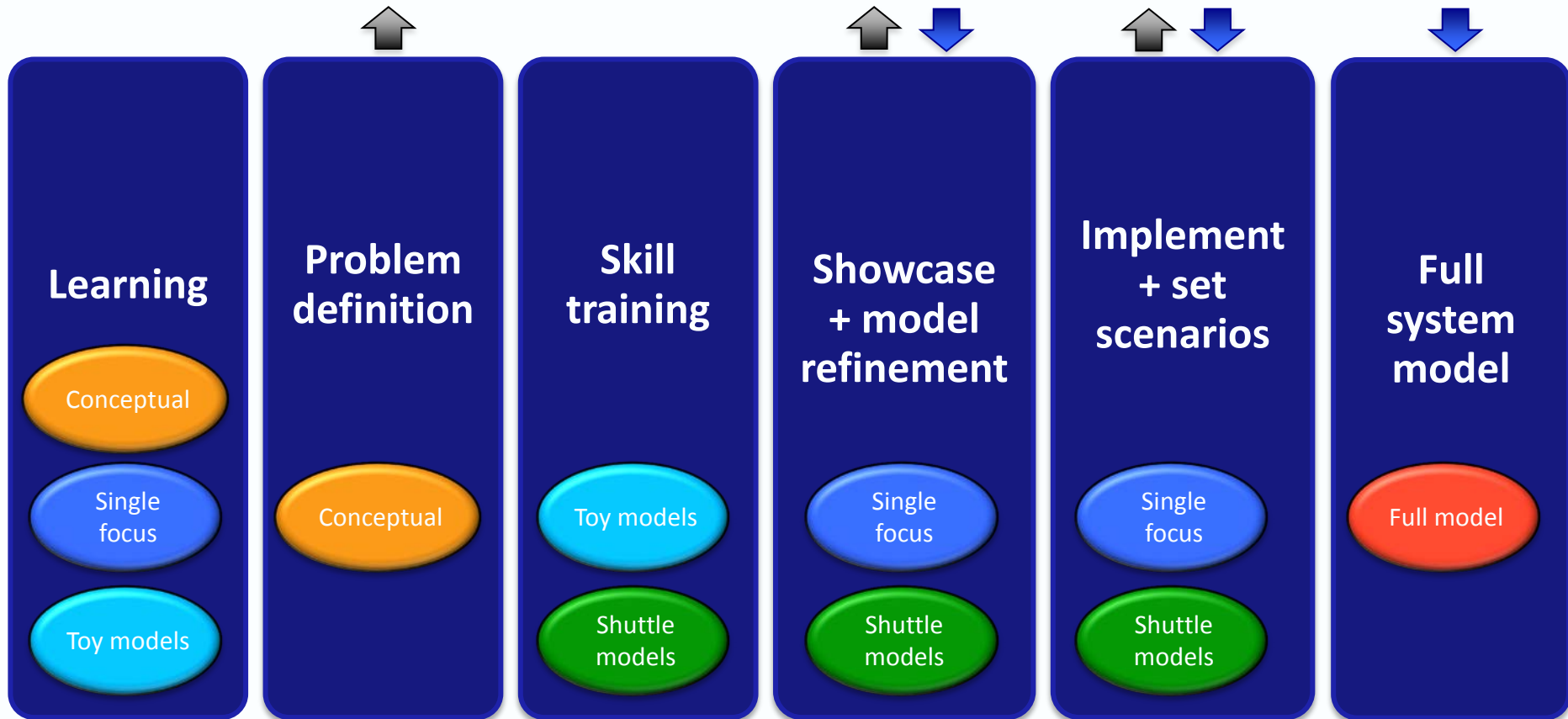


# Full quantitative



# Multiple models

Full study (and model development)





# Australian Example: SE Fishery

- Multi-everything fishery
- Highly diverse and variable
- Solutions needed



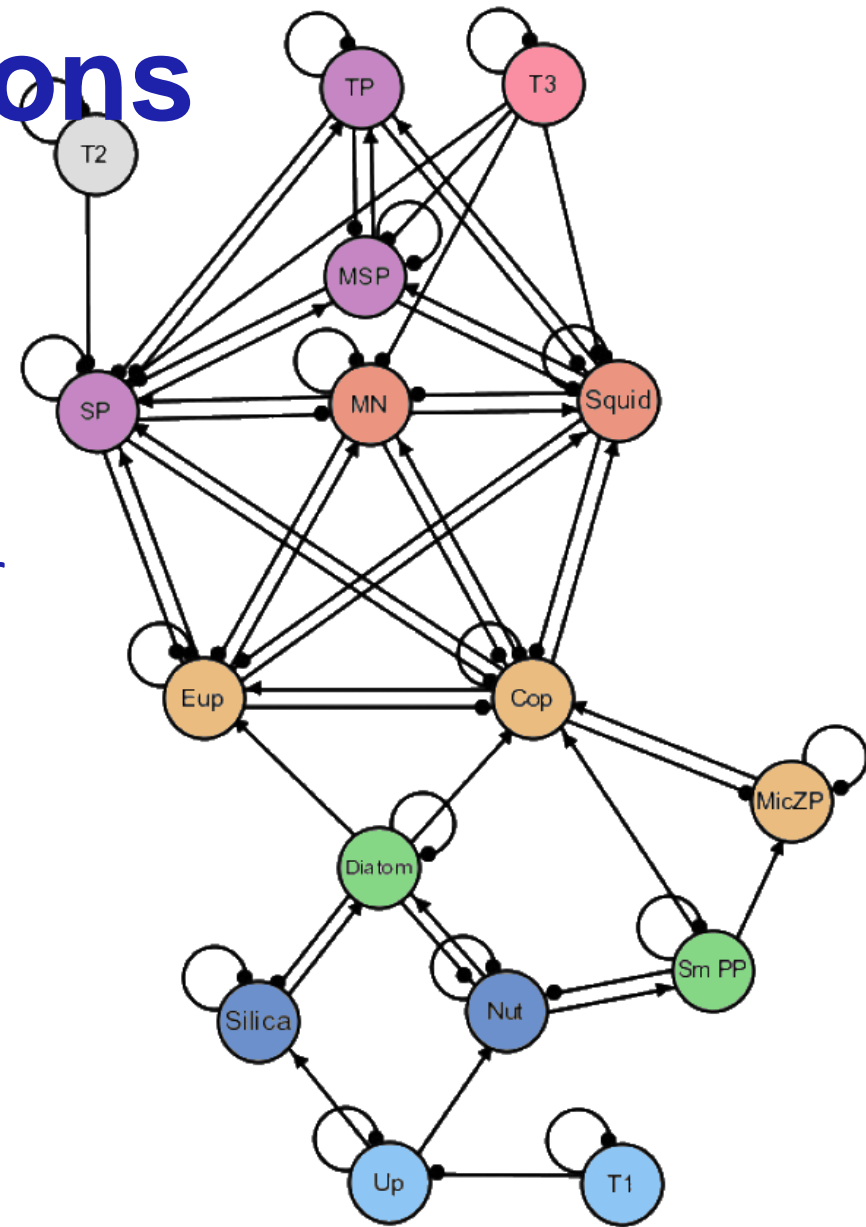
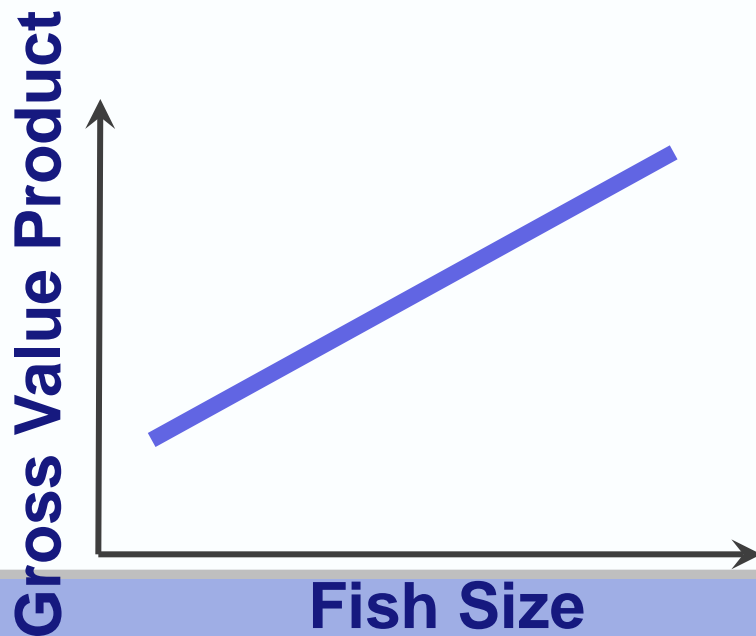
# Desired Outcome

*Find small interventions  
with large returns*

*Avoid large interventions  
with small returns*

# Expert Assumptions

- Each concentrate on focus topic
  - Stock assessments, economics
  - Assumed linear relations
  - Miss interactions
  - Miss dynamic human behaviour



# Scenarios

Status quo (quota management & not that effective)

Quotas on everything of value

Integrated management (zoning; gear restrictions; quotas)

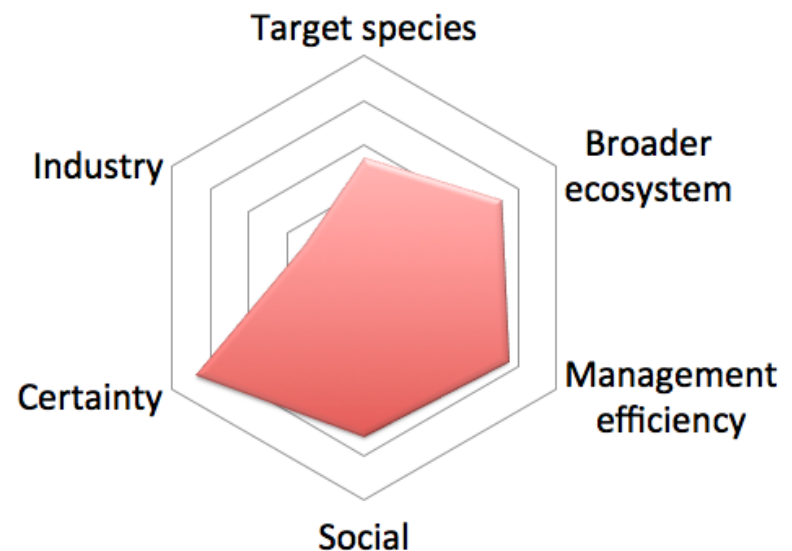
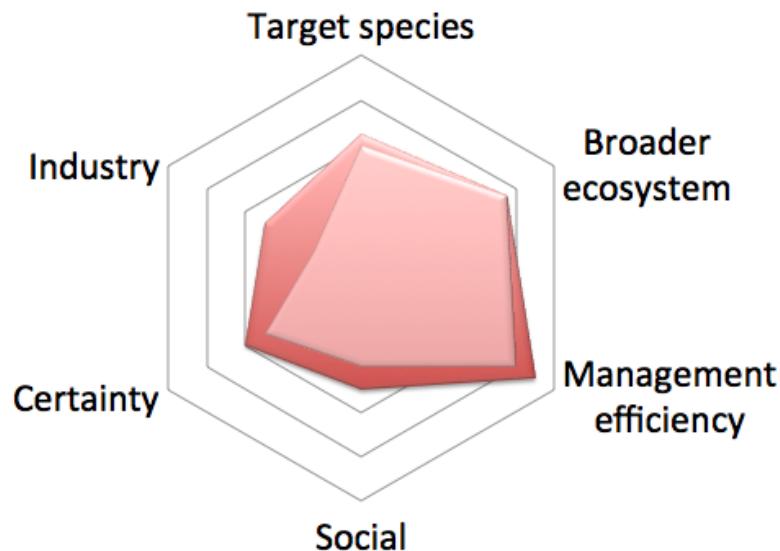
Conservation driven (open paddocks, closed world)

# Assumed vs Reactive Responses

## Status quo (2006)

- Qualitative analysis
  - pessimistic
  - optimistic

- Quantitative analysis



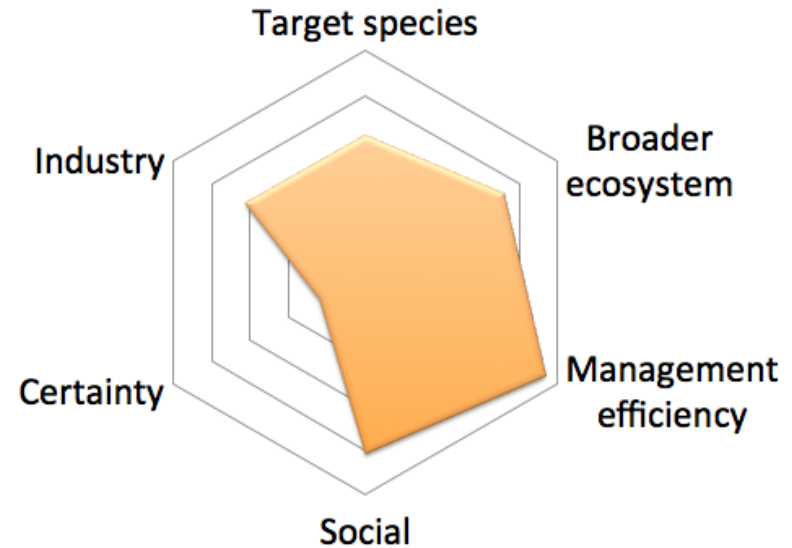
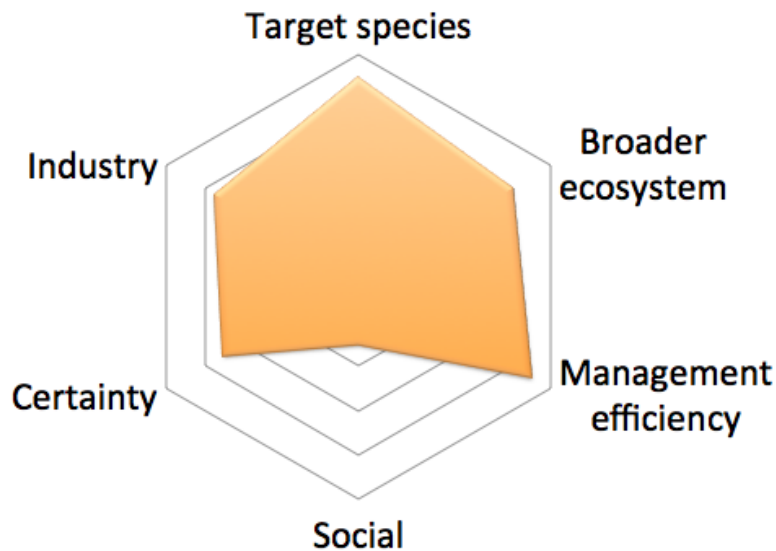


# Assumed vs Reactive Responses

Lots of quotas

- Qualitative analysis

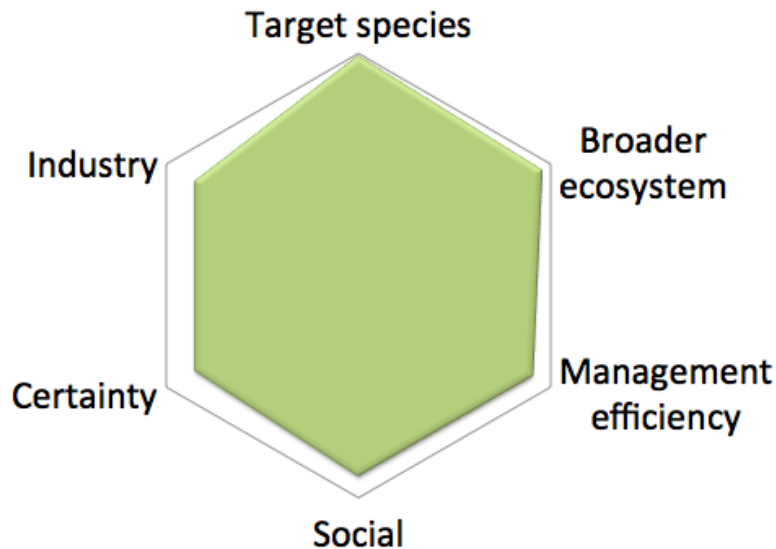
- Quantitative analysis



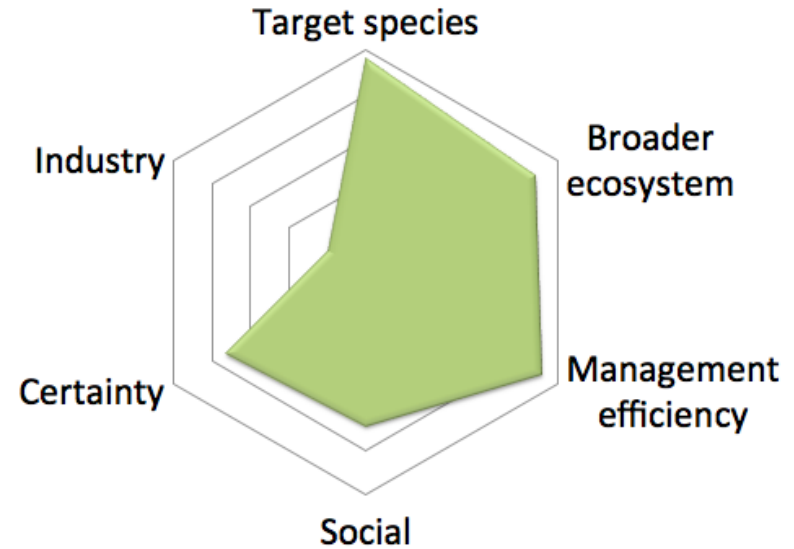
# Assumed vs Reactive Responses

## Conservation

- Qualitative analysis



- Quantitative analysis

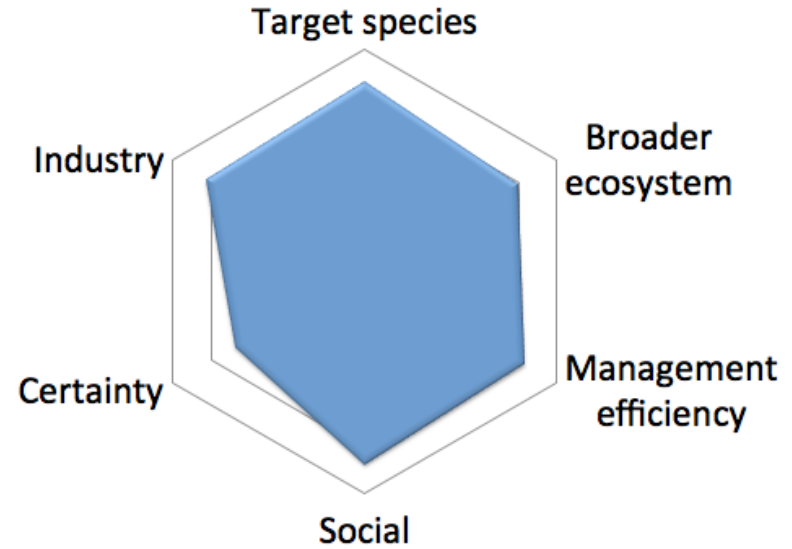
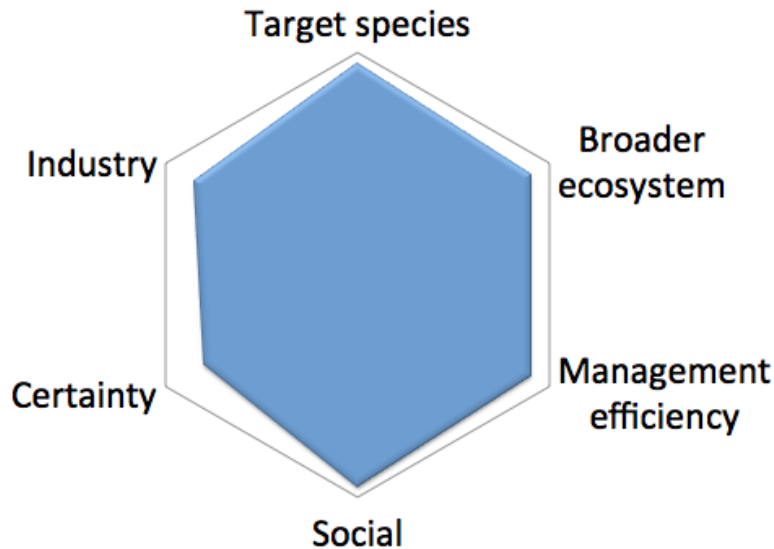


# Assumed vs Reactive Responses

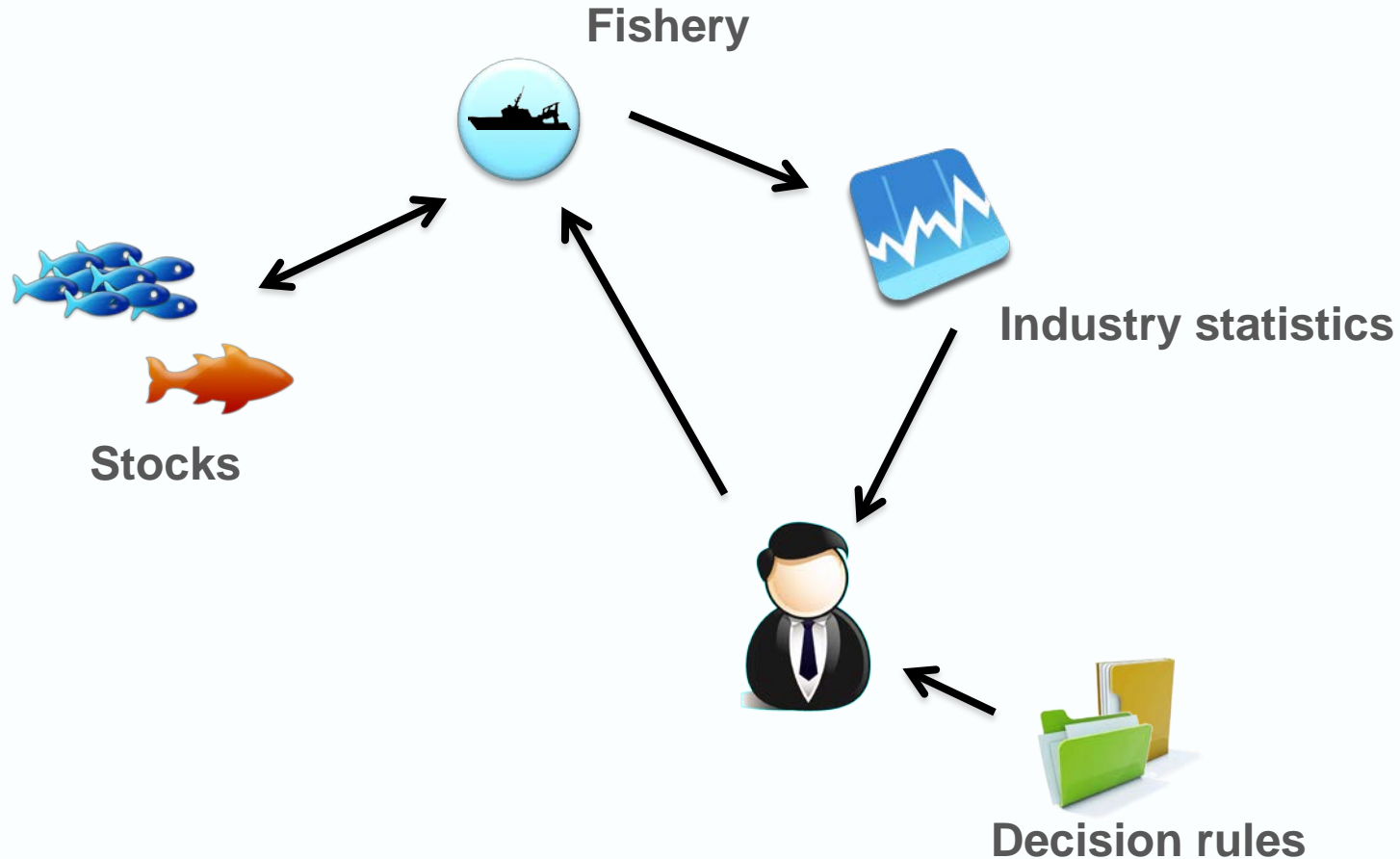
## Integrated

- Qualitative analysis

- Quantitative analysis

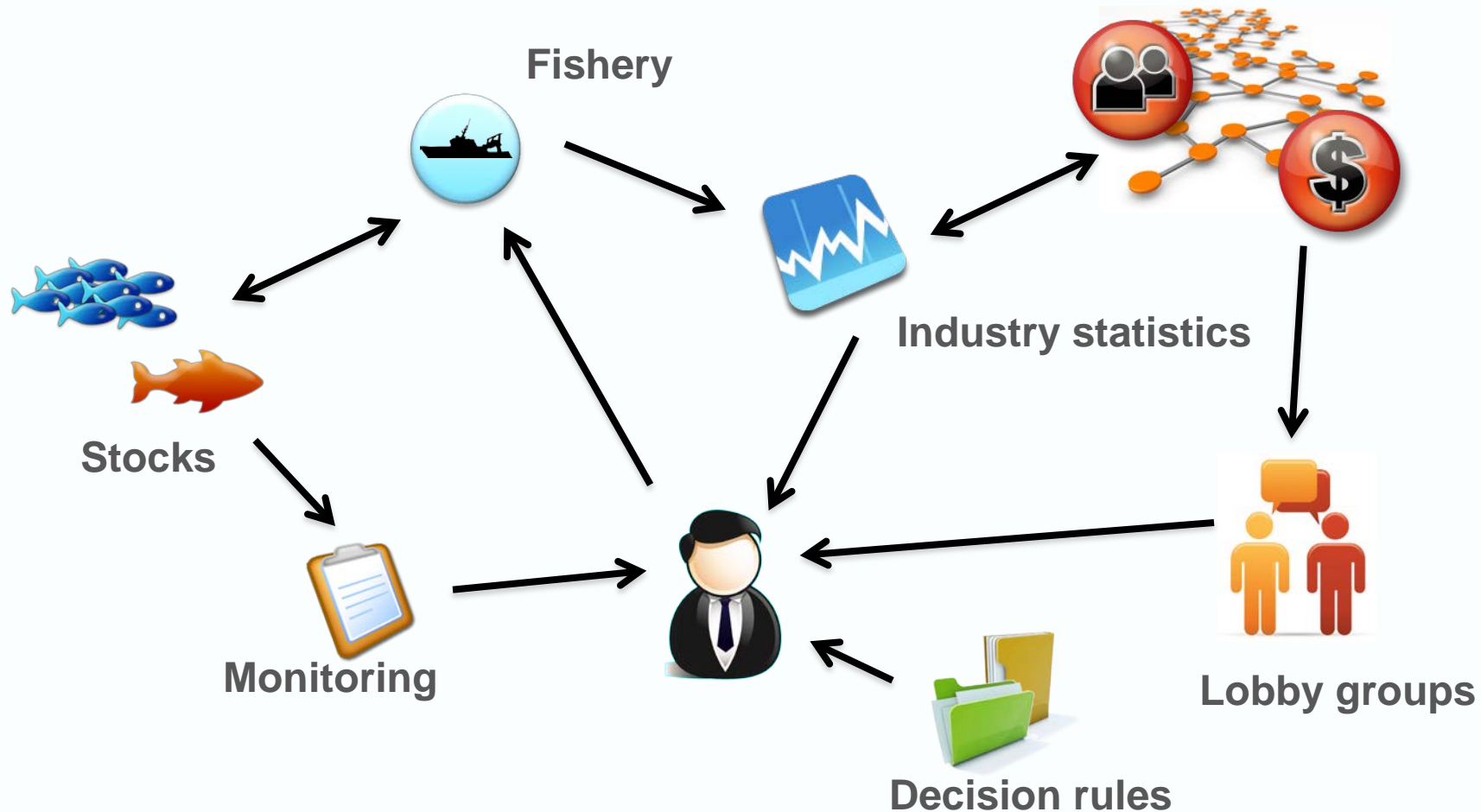


# Disciplinary Focus



- Best management = quotas (mostly)

# Cross-disciplinary Links



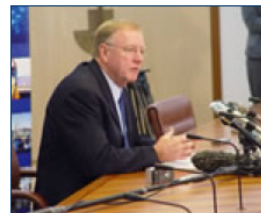
- Best management = quotas + spatial + gear restrictions
- Similarly for coastal zone management

# General Finding & Outcomes

- Trade-offs
  - Sectors (small and large)
  - Timescales  
(short-term costs vs long-term risk)
  - Conservation vs economic objectives
- Fishery restructured



## \$220m to secure Australia's fishing future



Fisheries Minister Ian Macdonald announces the \$220m adjustment package earlier today.

The Minister for Fisheries, Senator Ian Macdonald today announced a \$220 million adjustment package to help secure Commonwealth fish stocks and a profitable future for the fishing industry. The *Securing our Fishing Future* package follows concerns about the state of Australia's fish stocks, and the sustainability and profitability of the industry.

The Government will provide a major package of one-off structural adjustment and improved management measures for those fisheries managed by the Australian Government. As part of the measures, AFMA has today released new catch limits for the SESS and effort limits in the ETBF (further information follows).



# Conclusions

- Integrated adaptive management = most effective management option
- Coasts & oceans (& society of users) = complex systems
- Complexity science-based toolbox
  - explore alternative futures (feedbacks & uncertainty)
  - can be transformative
  - industry & biophysical usage becoming more common
  - inclusion of social aspects rarer (often critical though)
  - transdisciplinarity is key (especially being participatory)



**Networks**

**Chaos**

**Agent based  
modelling**

**Complexity  
Self-organisation  
Emergence**

**Bayes**

**Systems  
Theory**

**Non-  
linearity**



# **Taking a systems approach to systems**



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# Thank you

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