Integrated social and biophysical modelling of marine resources

In Vitro: Agents in a Glass

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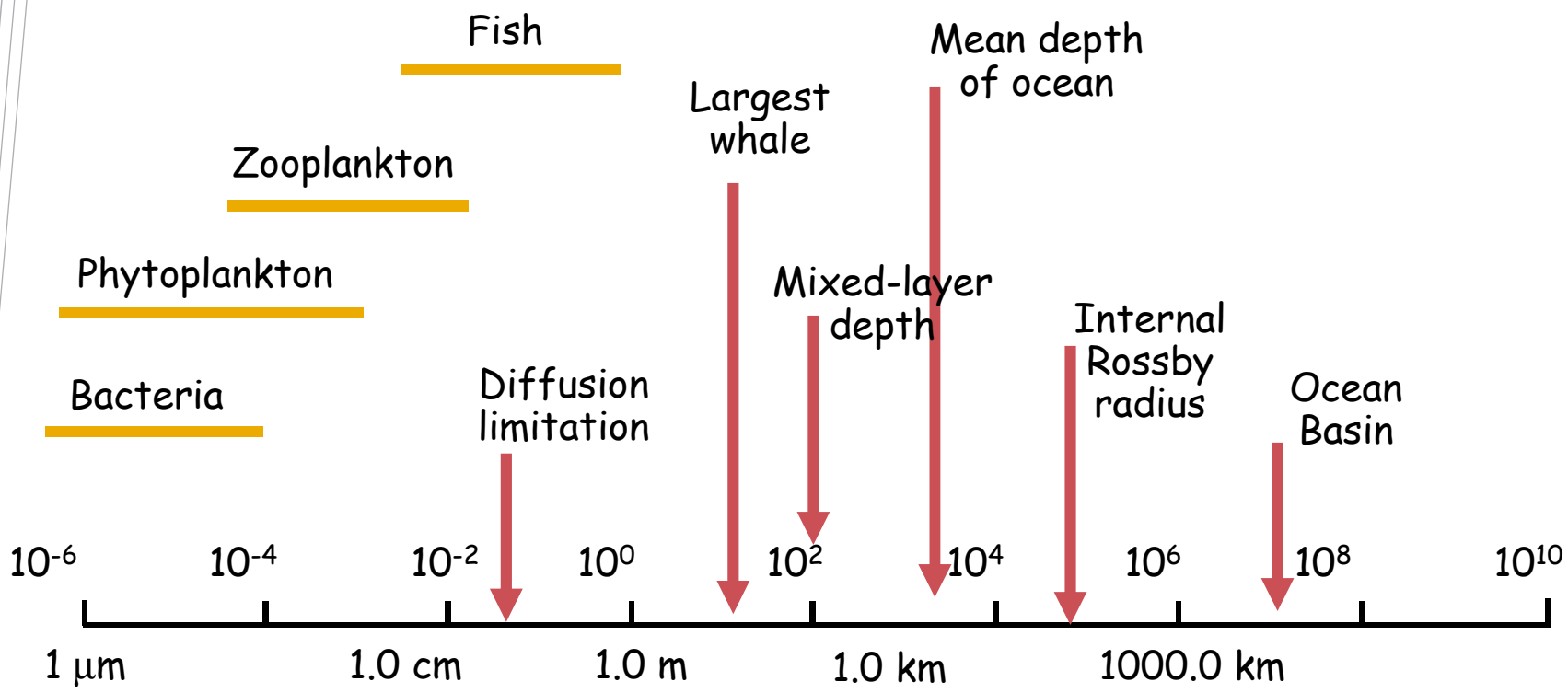
Acknowledgements

- Roger Scott
- Brian Hatfield
- Keith Sainsbury
- Miriana Sporcic

Agent-based models

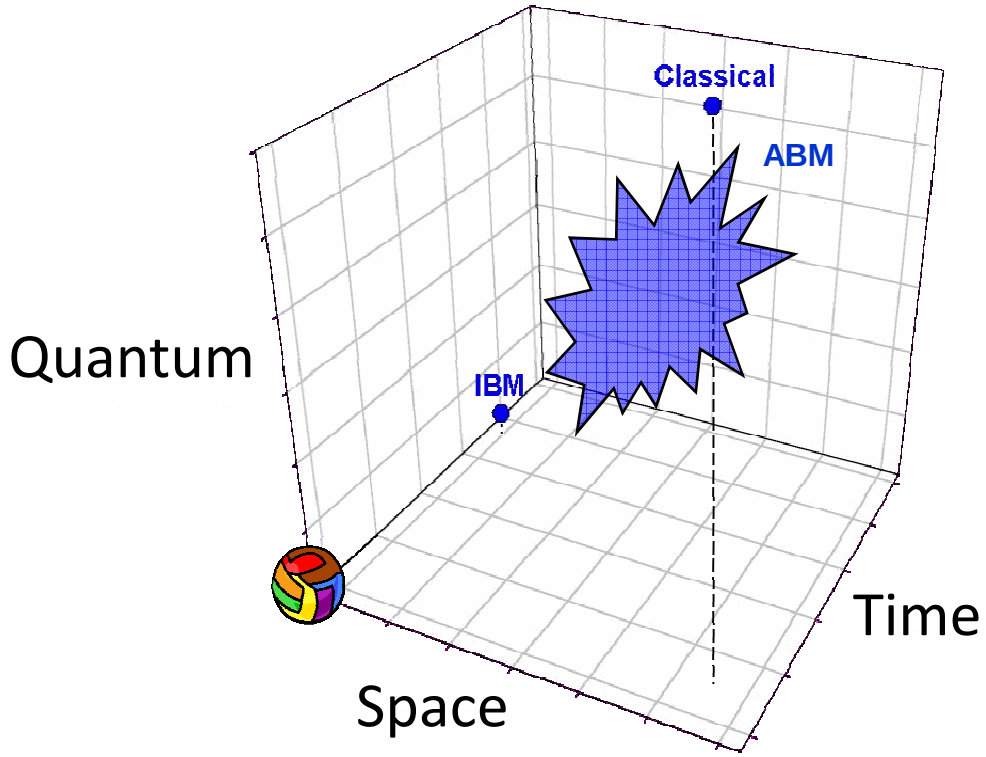
- Composed of autonomously acting individuals (agents)
- Agent characteristics are variable
- Agent actions are defined by the behaviour given to them
- Agent behaviour is conditioned on external information from the agents' environment
- Agents can interact with other agents (social dynamics)

Models must deal with different Scales



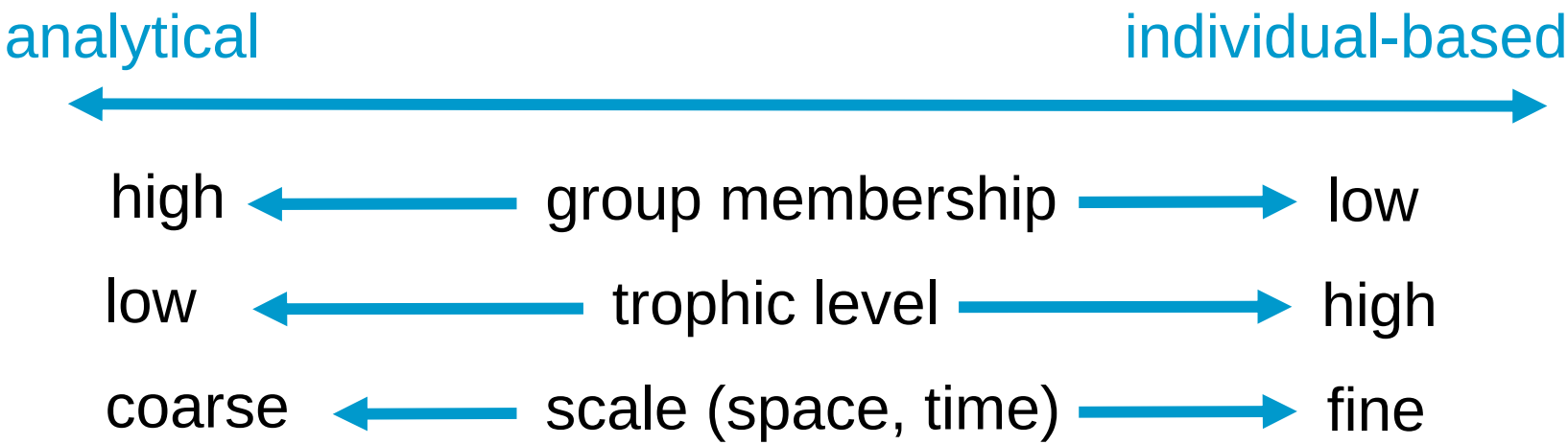
InVitro

- Agent-based
  - process-based
  - mix differential equations and decision trees

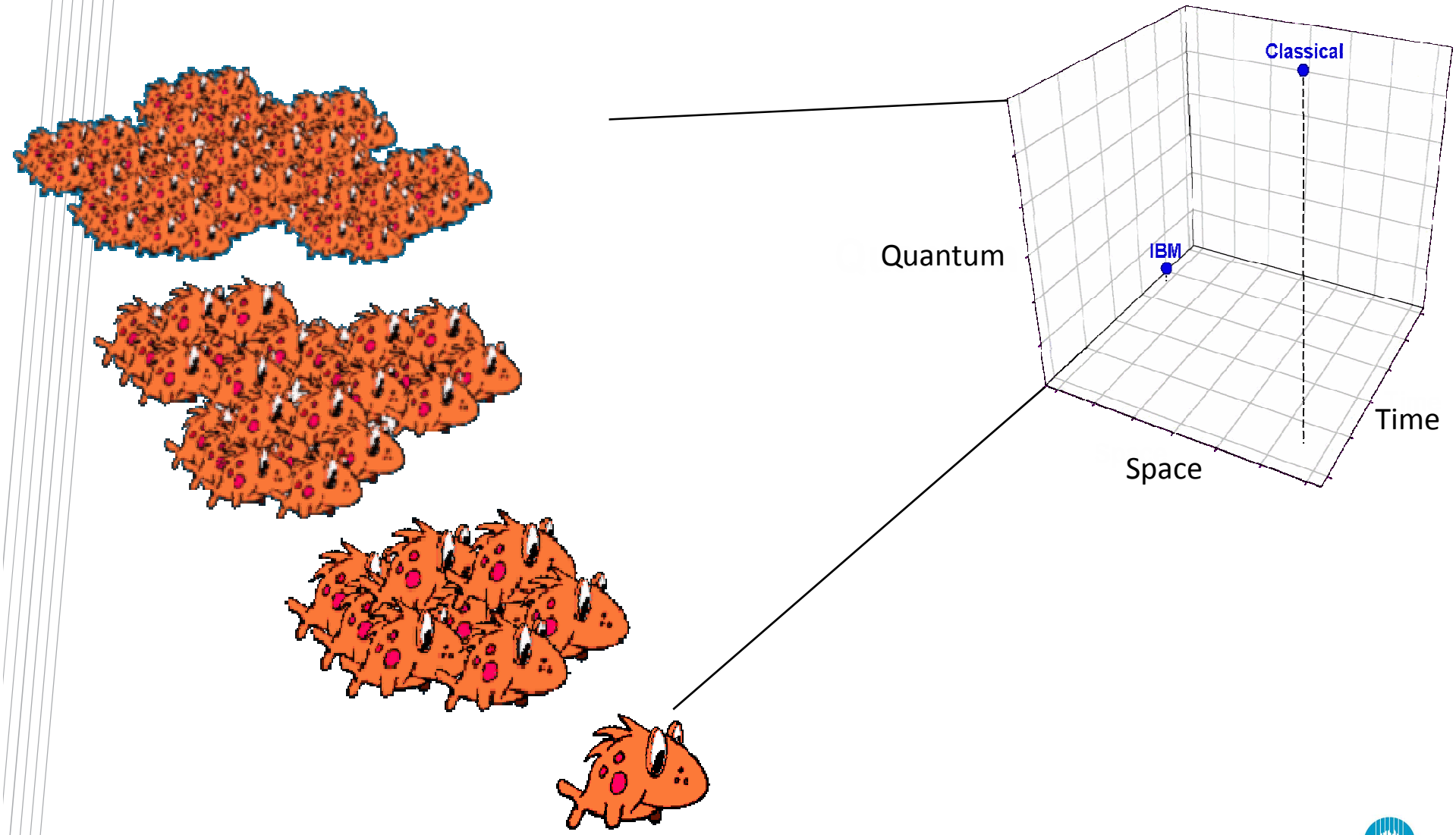


InVitro

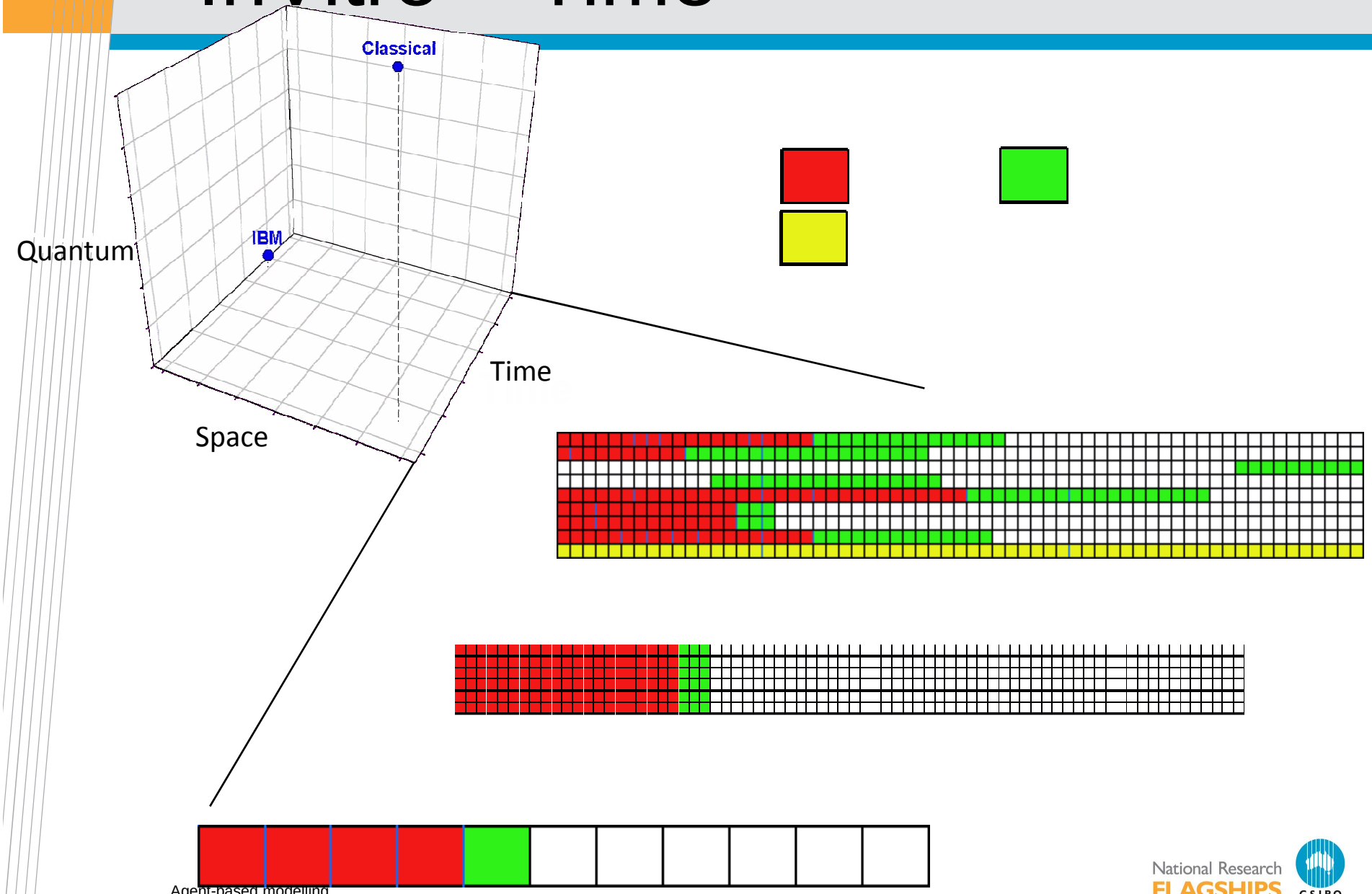
- 3-dimensional
- Variable time
- Many model components (best for each part)



InVitro – Quantum

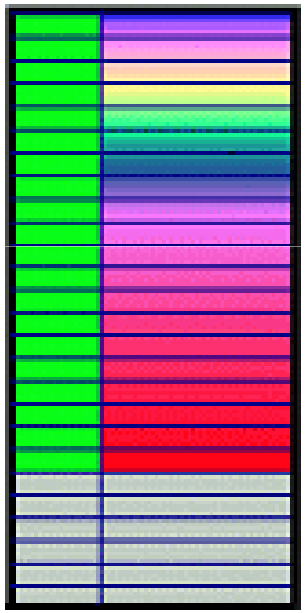


InVitro – Time



Handling Agents - Time

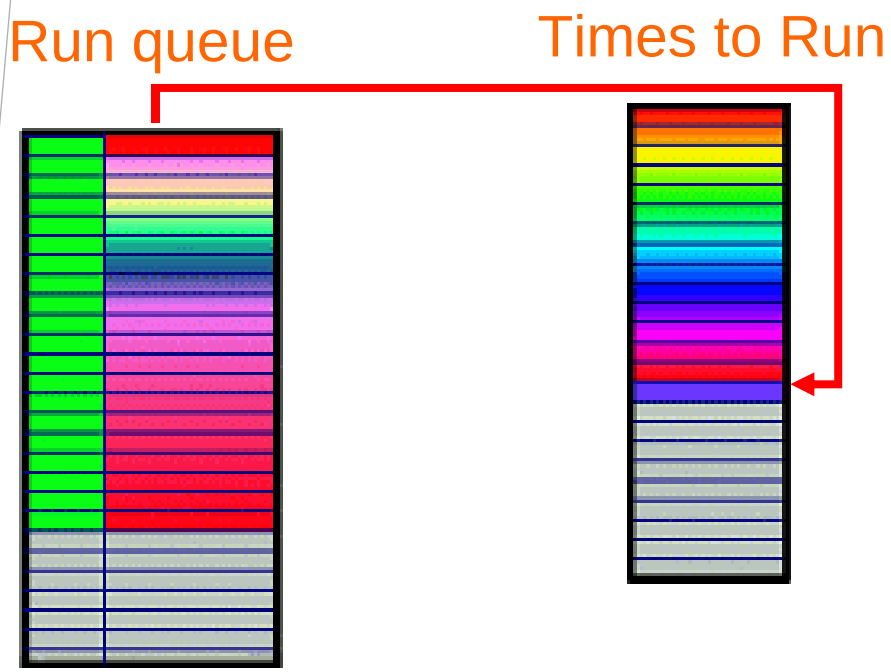
Run queue is a priority queue of agents ready to run



- The queue is sorted by time within each time group. It is further sorted on priority.
- In each of these priority sorted groups, the agents are inserted into the queue in a random order.
- Allows for asynchronous timesteps

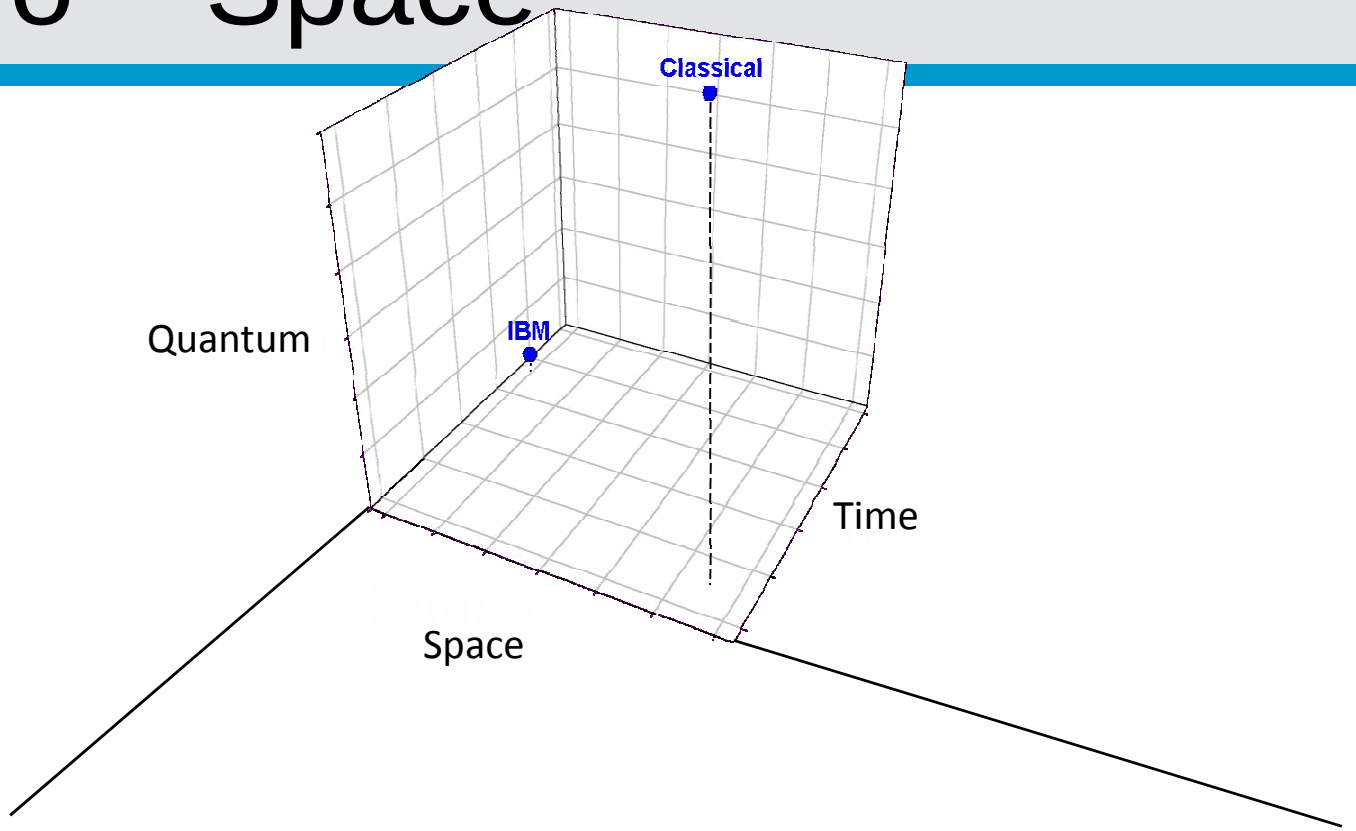
Handling Agents -Time

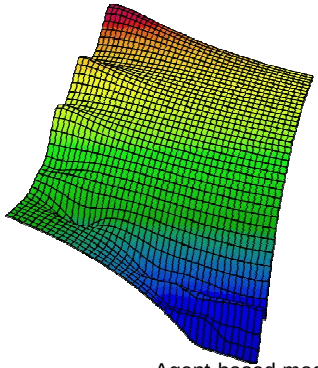
- Run queue plus agent's queue of times to run (timing of executing timesteps)

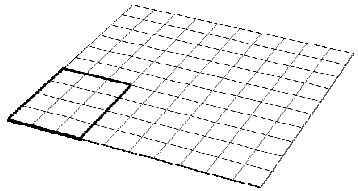


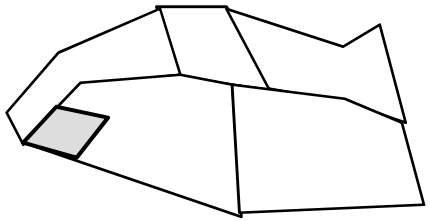
- Scheduler uses agent's "times to run" to determine next time step
- Other agents can introduce times in agent's queue to bring agents into synchrony

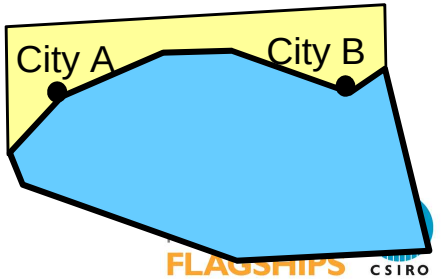
InVitro – Space





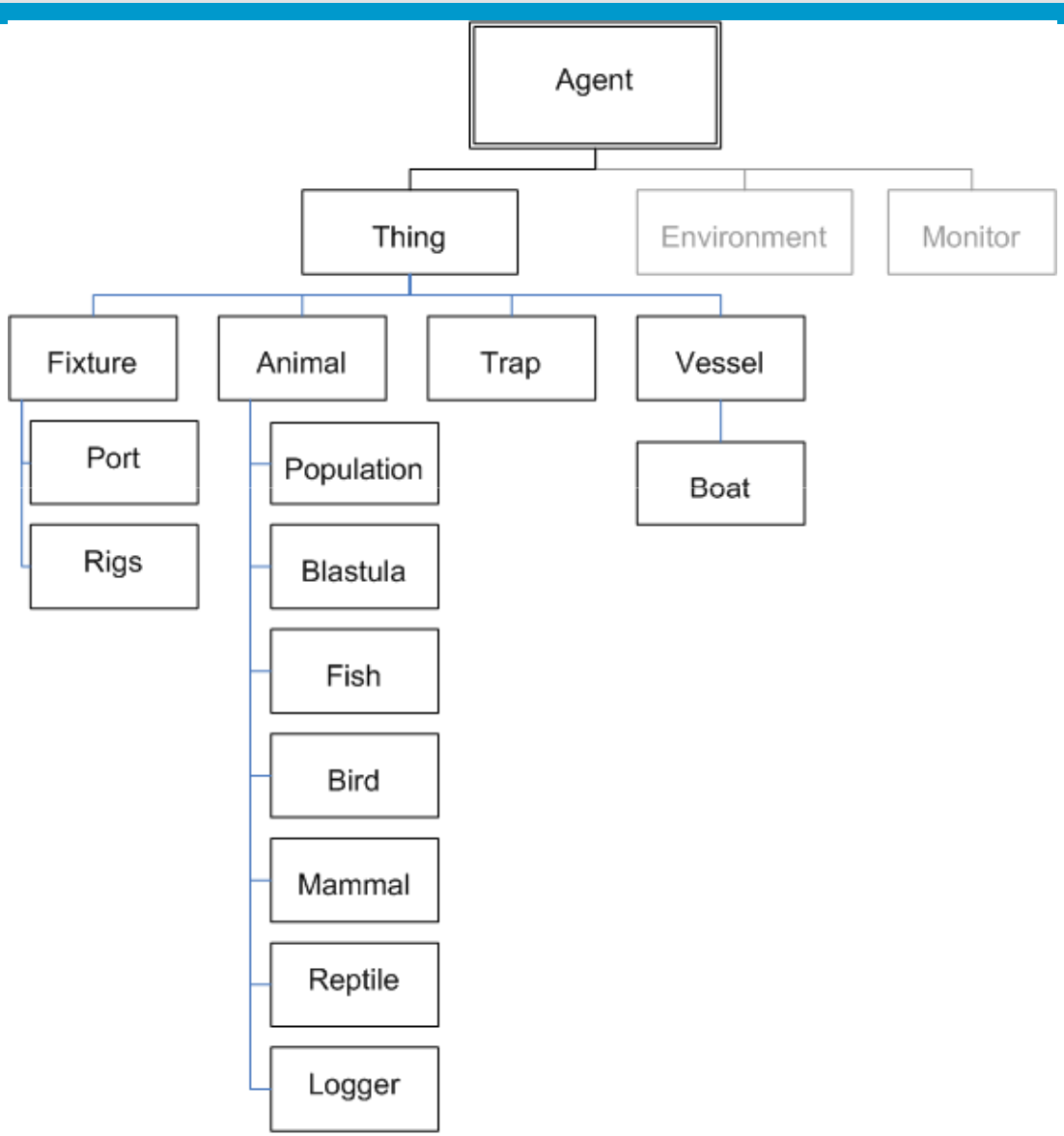




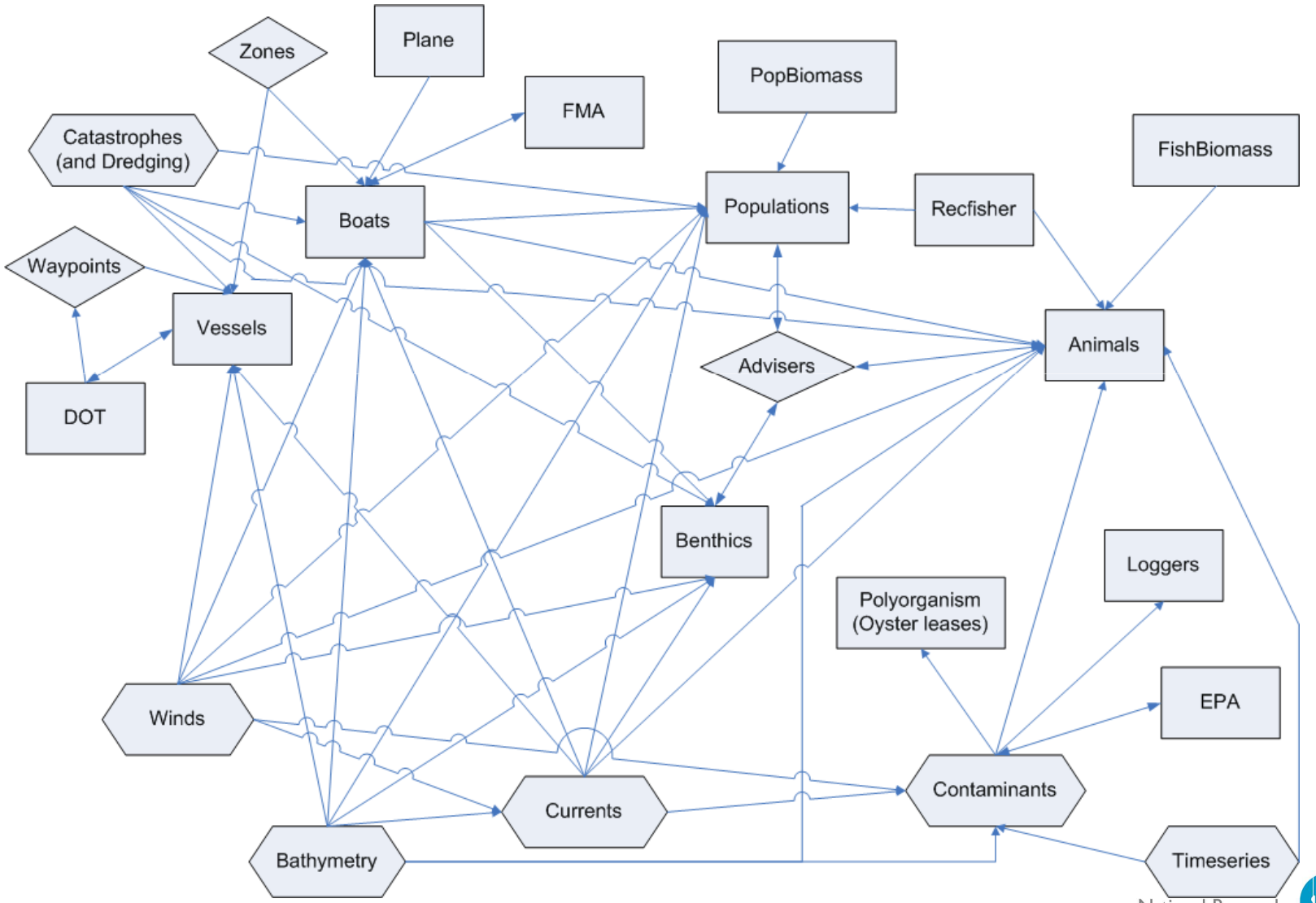


Agent-based modelling

Agent Taxonomy



Agent Connections



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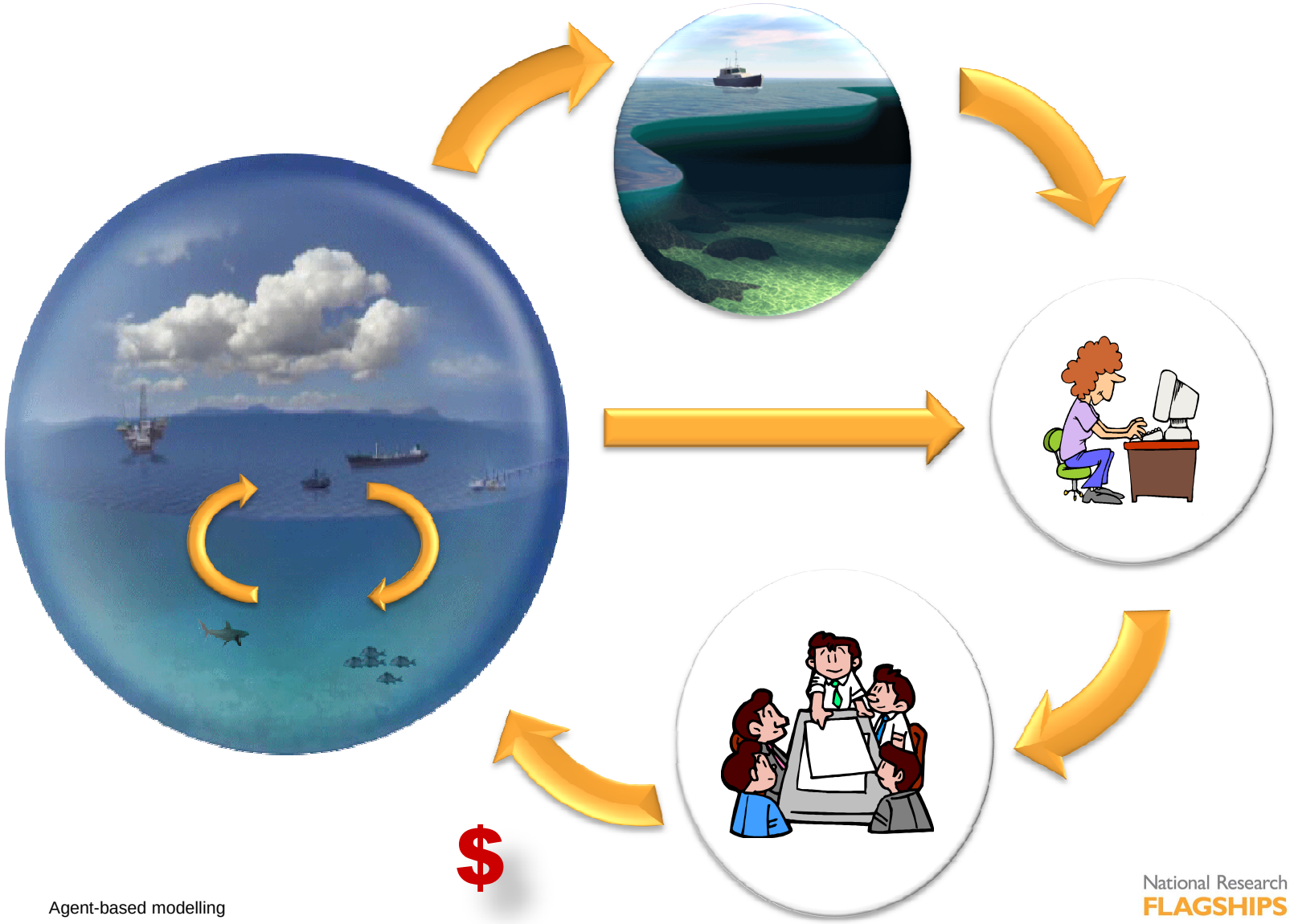
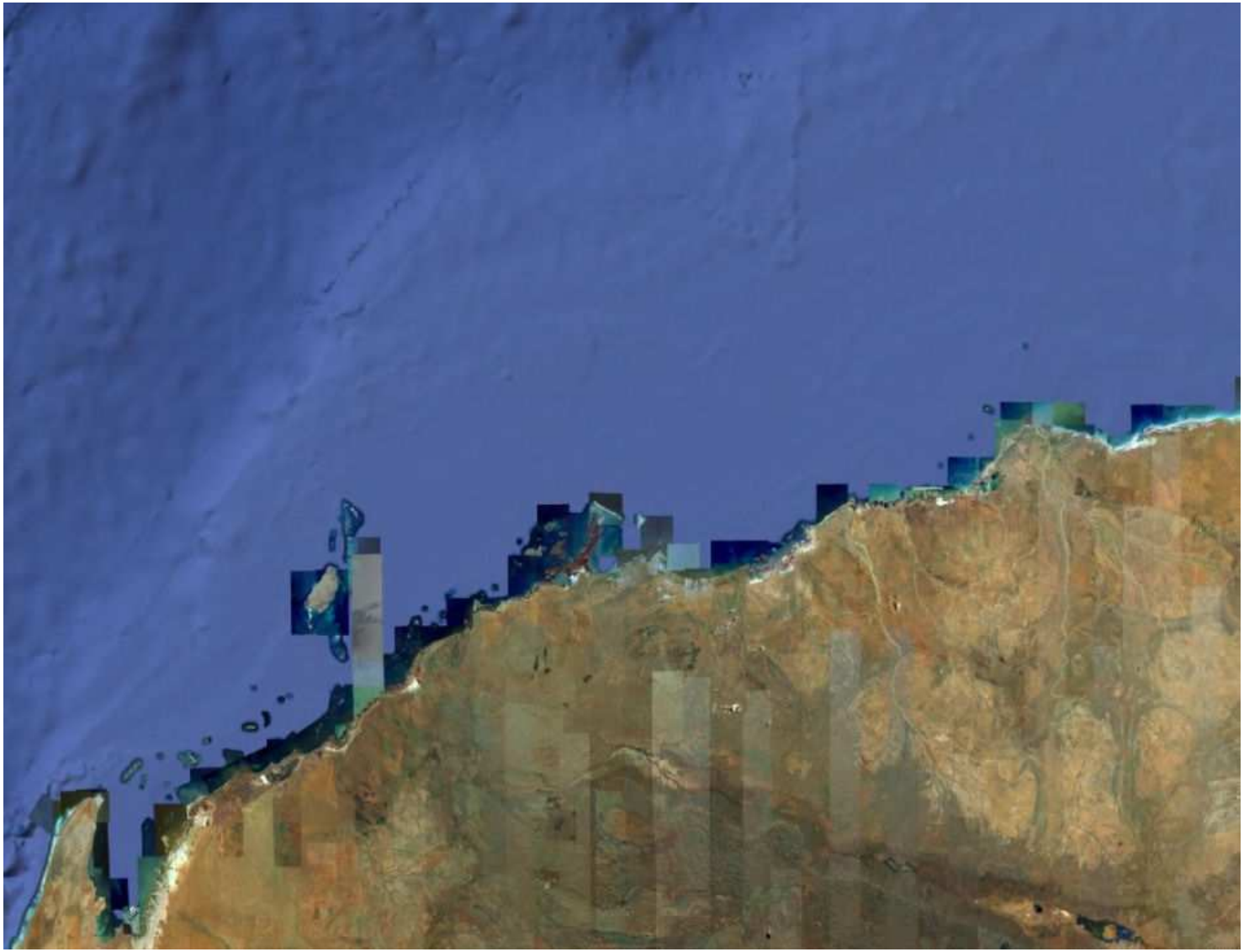
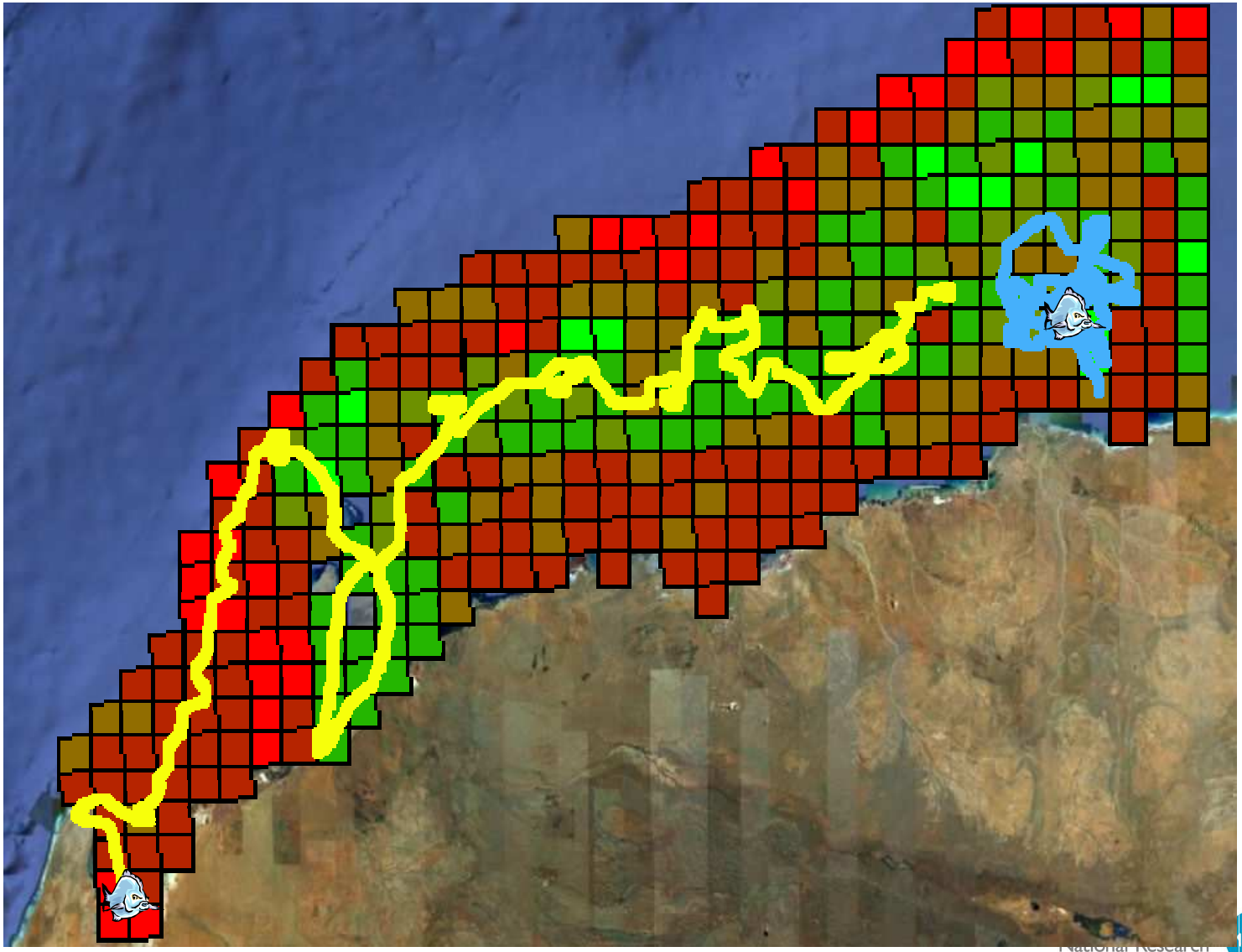
Assessment + Management



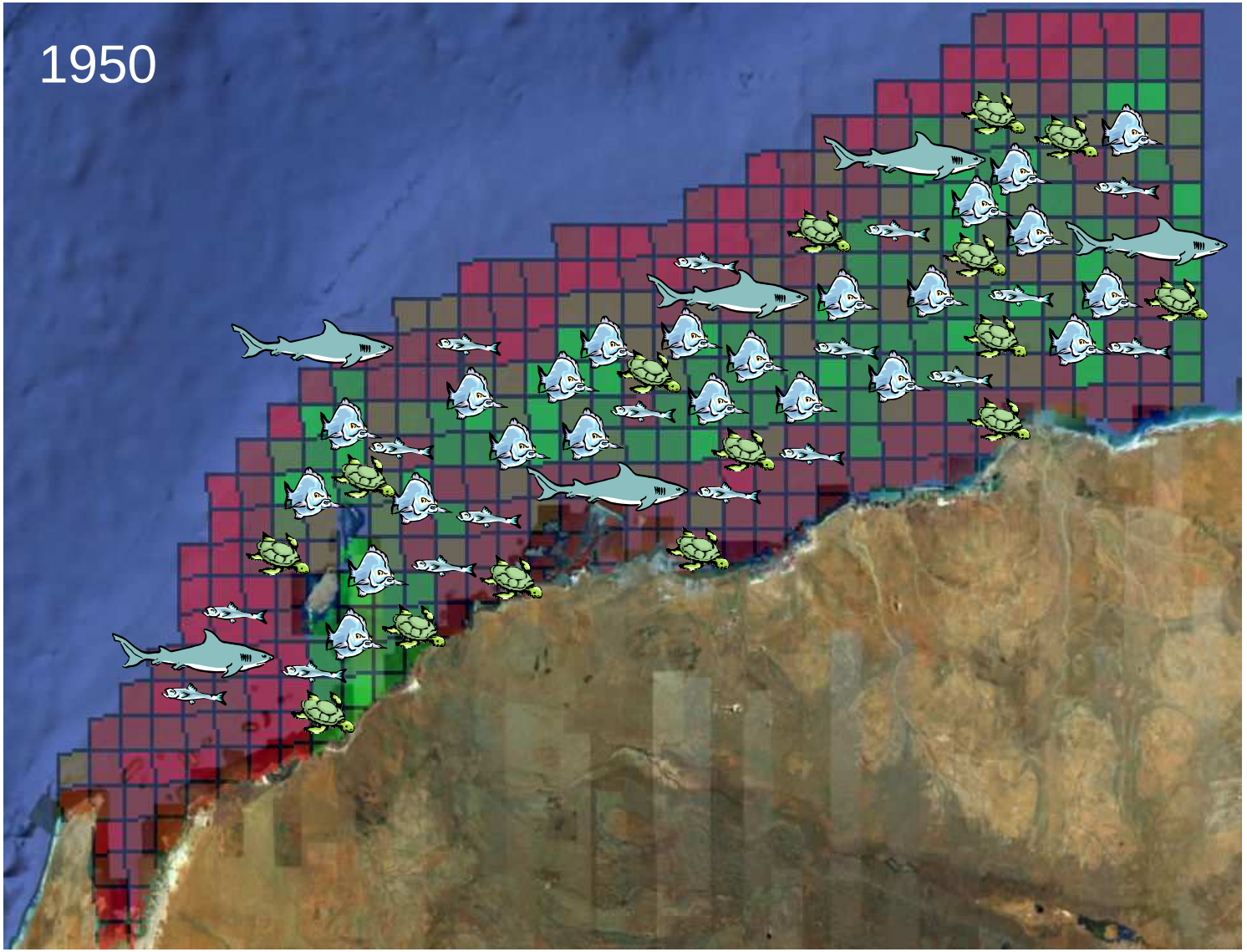
Northwest Shelf Example



Fish habitat association



Historical changes



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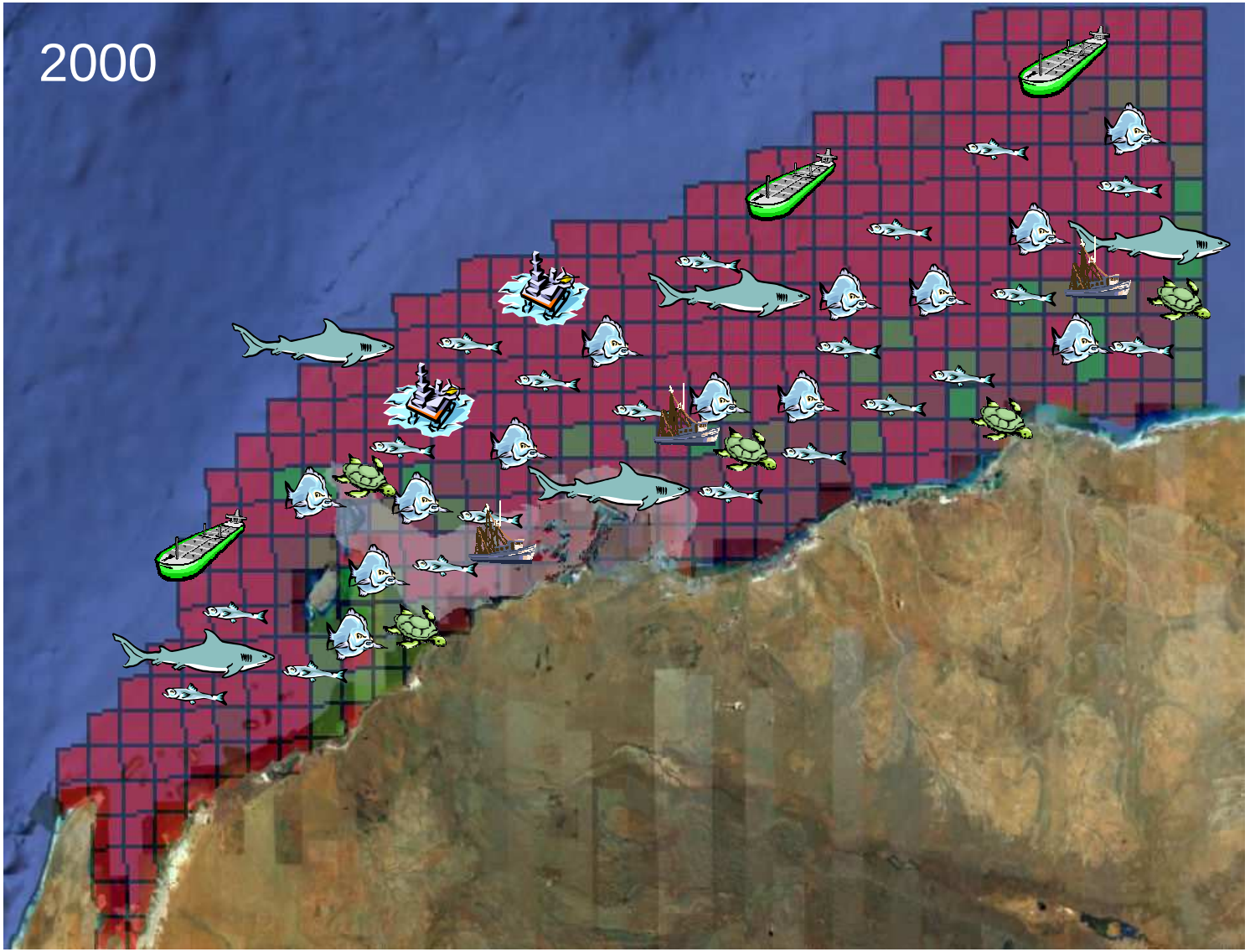

Summary

Attack problems at appropriate scales, with appropriate theories and methods. A universal scale is NOT useful

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Thank you

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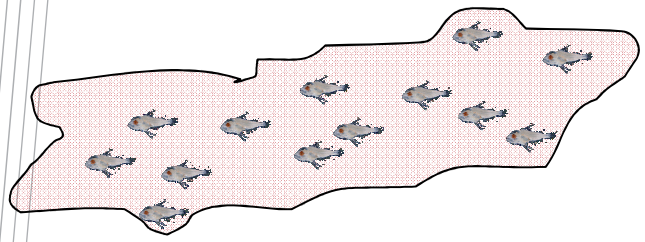
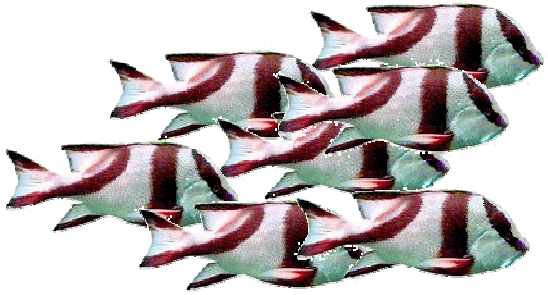
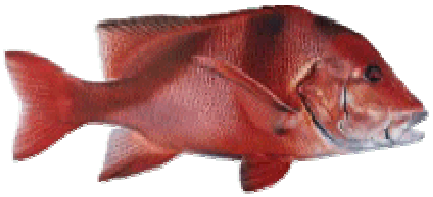
Biophysical

- Physics
- Benthos
- Larvae
- Populations
- Animals

Fish Life Cycle Example







Biophysical + Industries

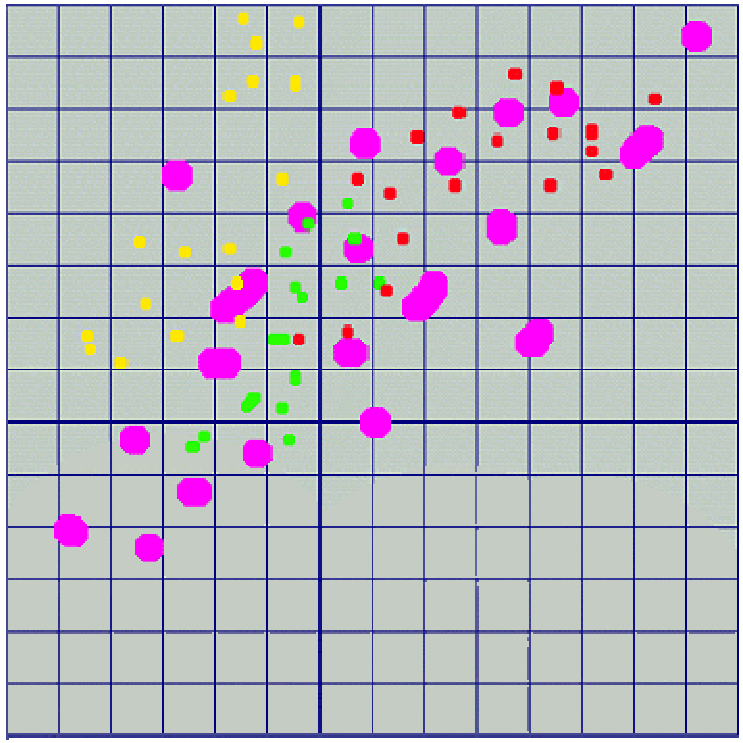
- Physics
- Benthos
- Larvae
- Populations
- Animals

- Fisheries
- Oil-n-gas
- Shipping
- Tourism
- Development

etc….

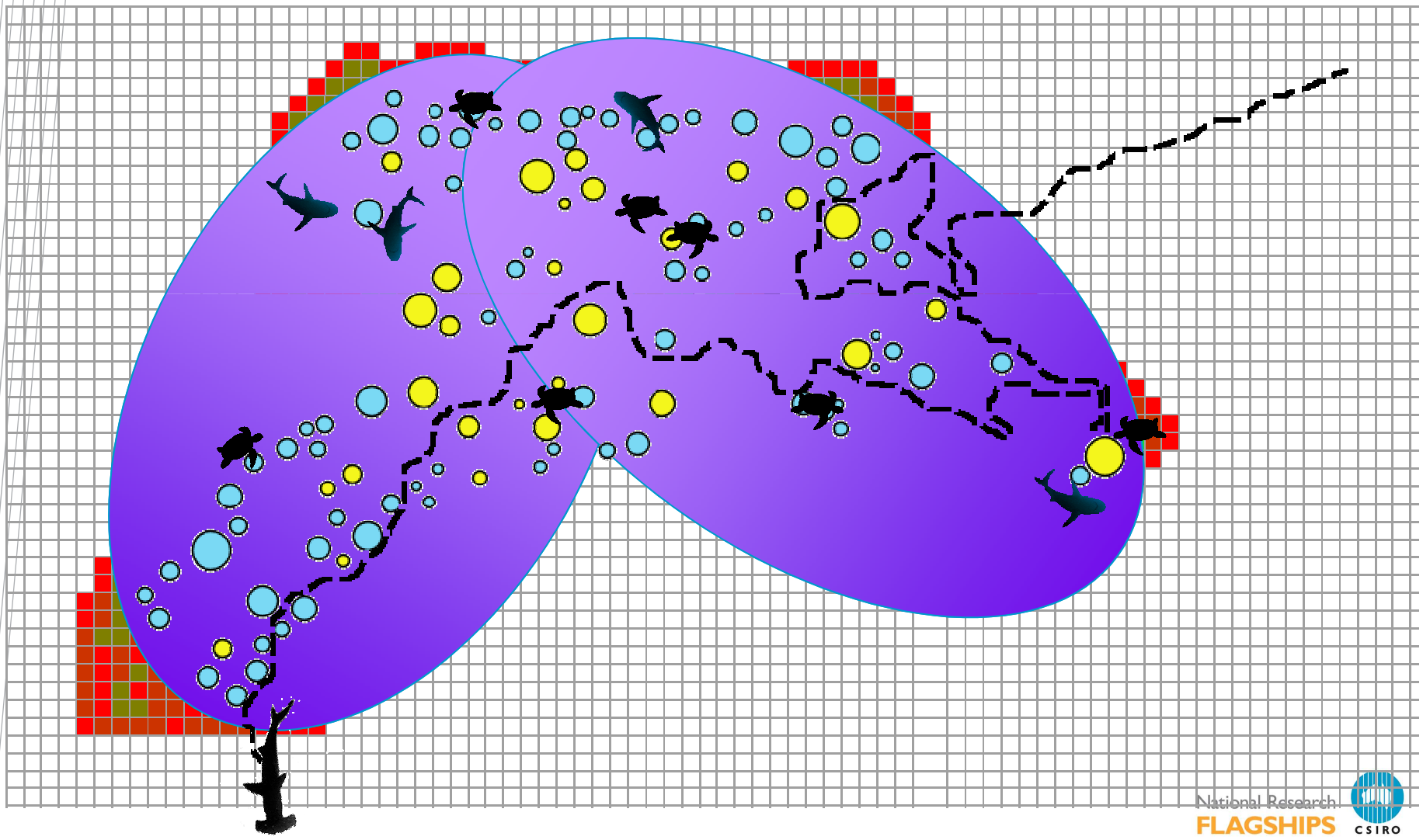
Handling Agents - Space

- Regular grids; continuous 3D; polygons; multiple layers
- Spatial neighbourhoods are used to reduce search space



- Each agent or polygon is represented in a grid of neighbouring cells (facilitates path searches)

Putting It Together



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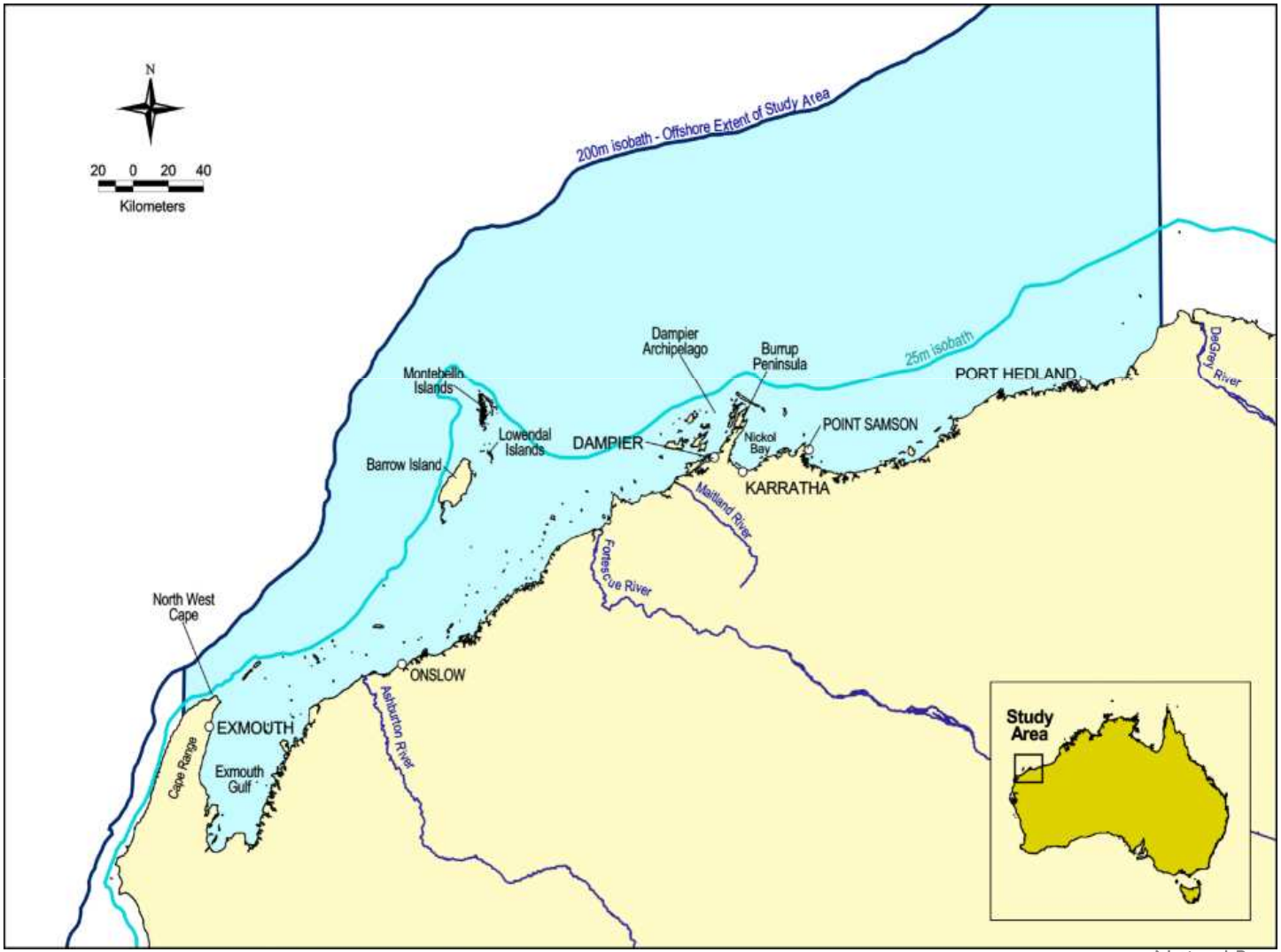
Study Area = NW + Ningaloo



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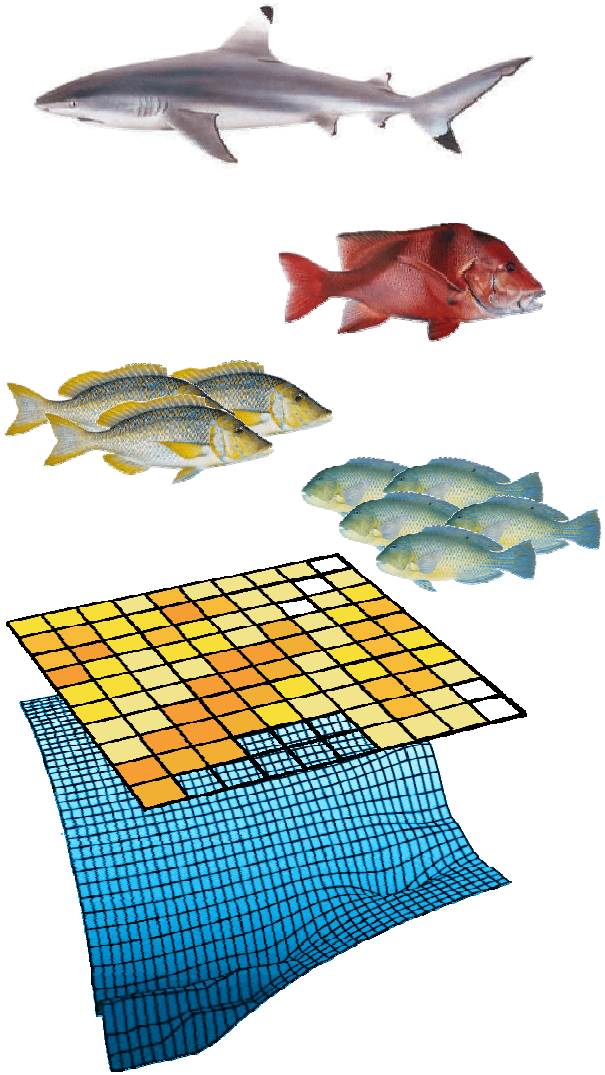
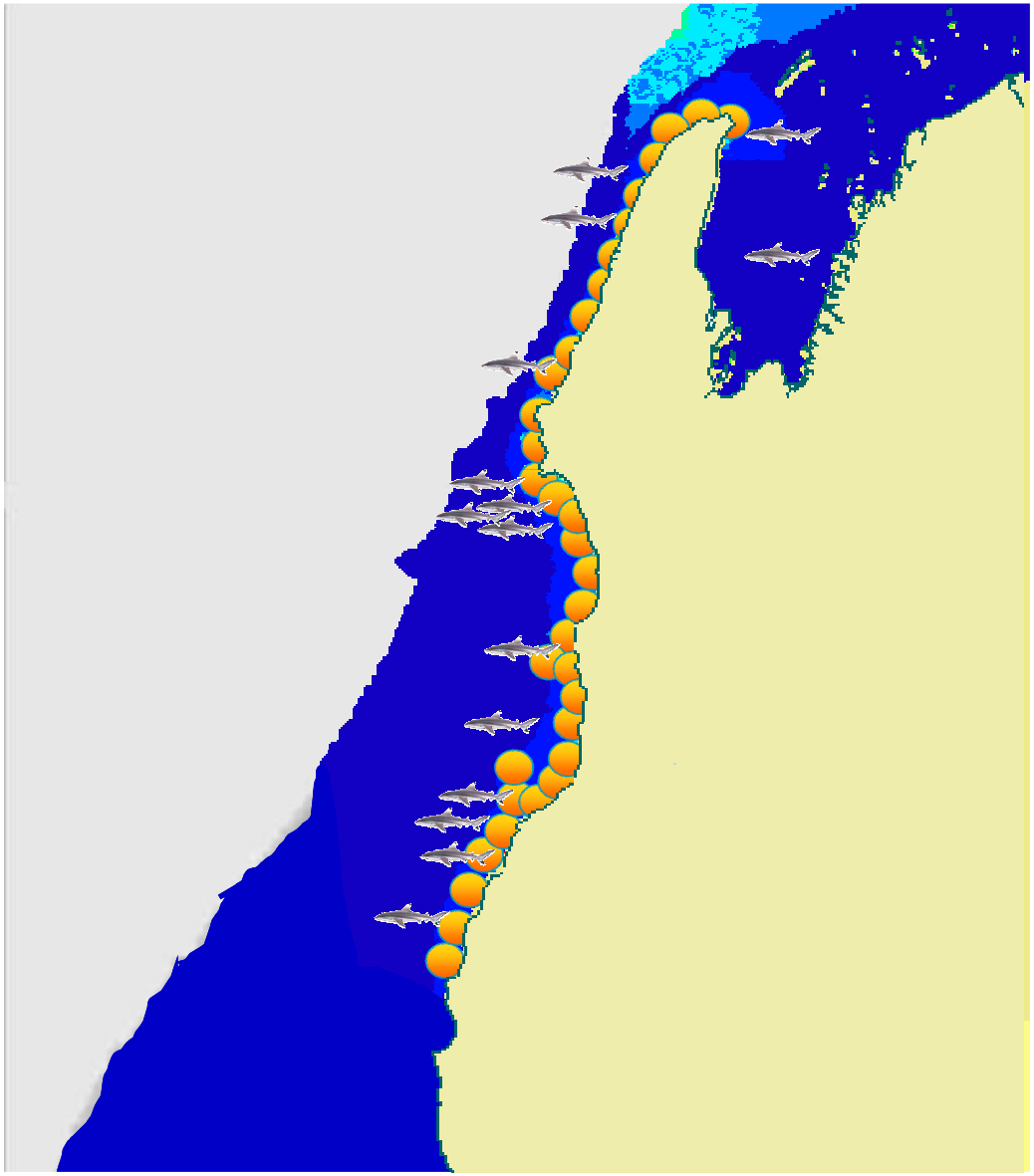
Ningaloo (sketch)

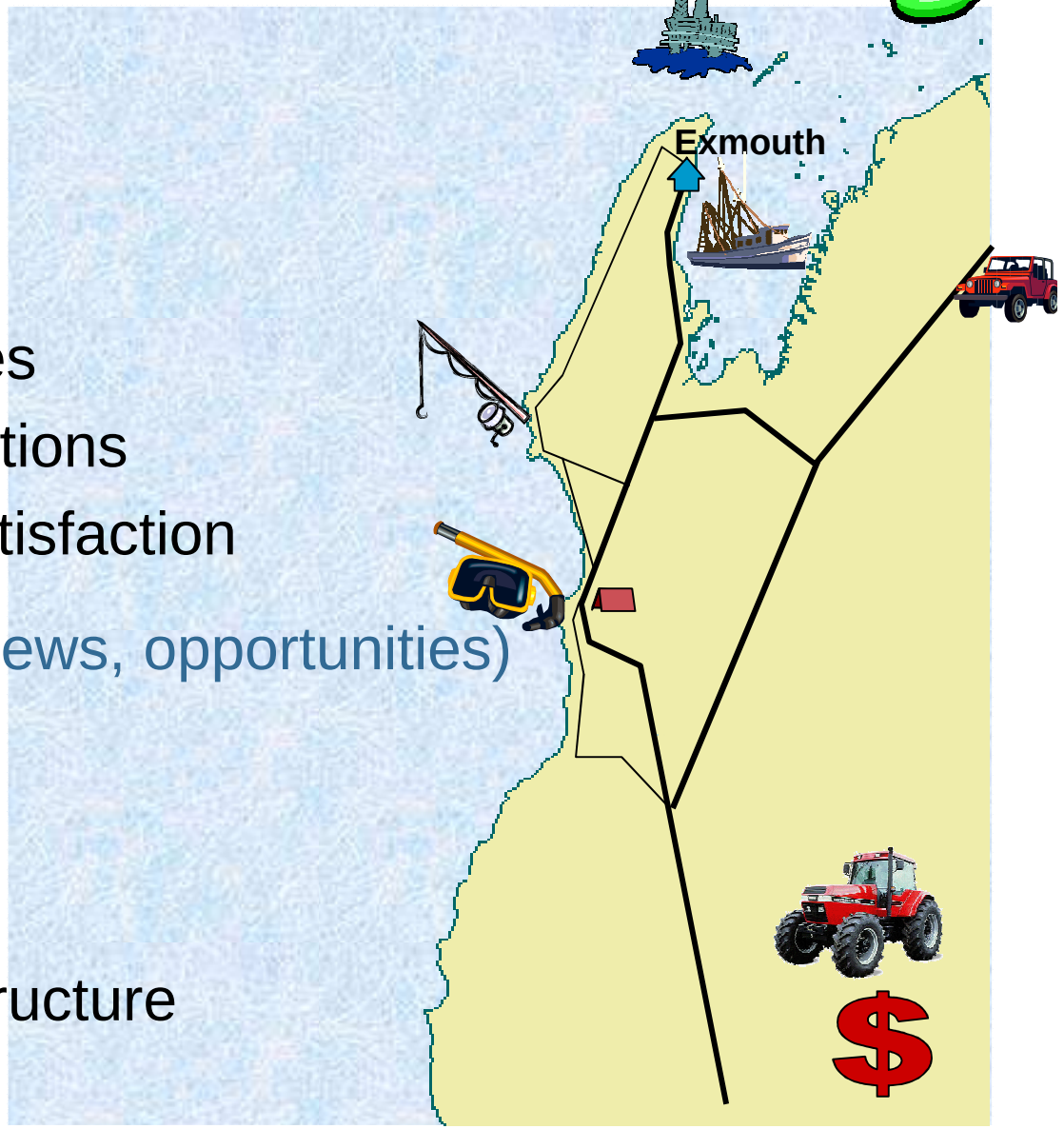


Modelling for Management: News from Ningaloo

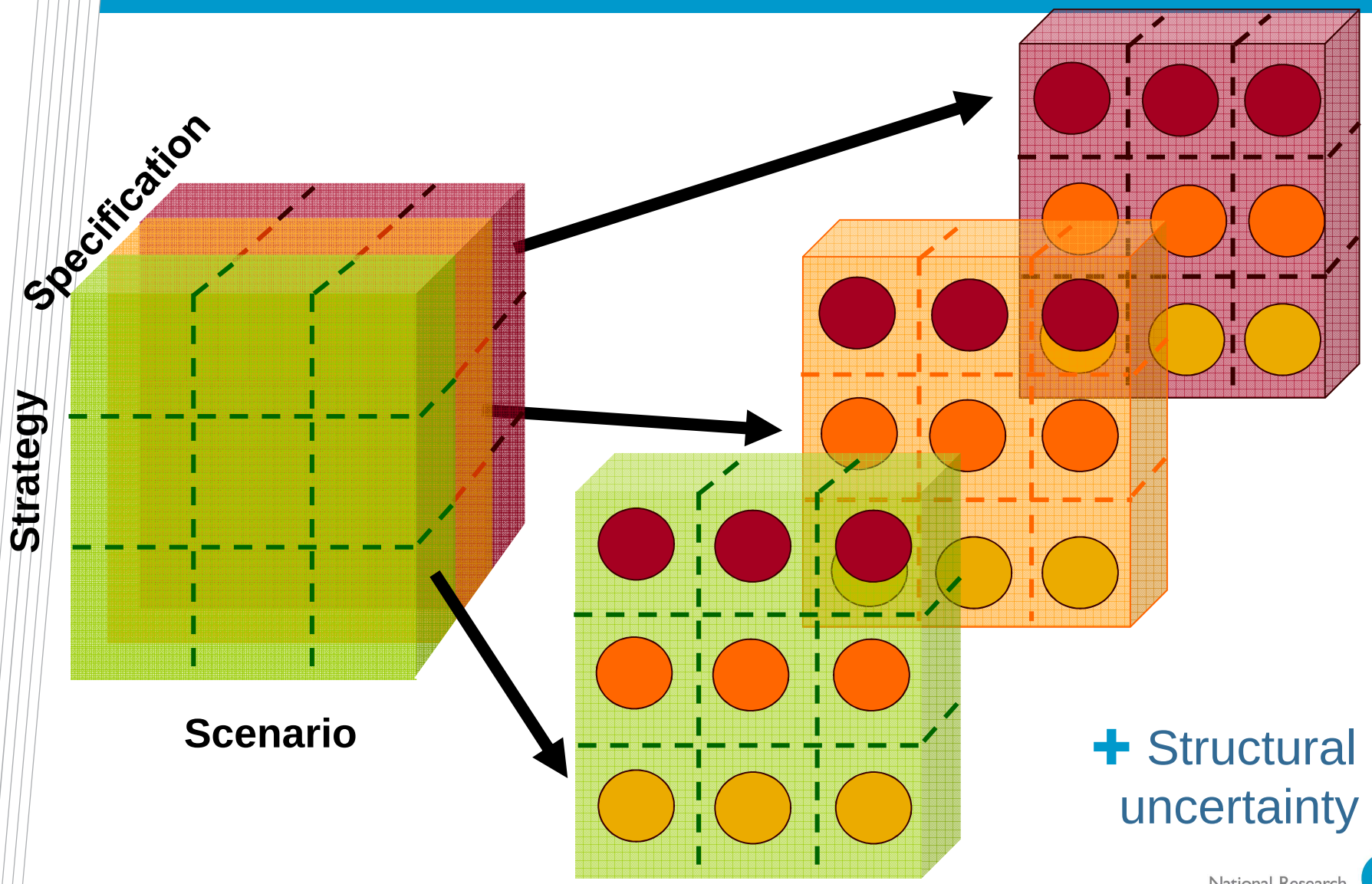


Ningaloo (sketch)

- Accommodation
- Activities
- Visitors
  - types & preferences
  - (updating) expectations
  - compromises & satisfaction
- Residents (choices, views, opportunities)
- Management
  - tourism
  - fisheries
  - planning & infrastructure



Handling Uncertainty

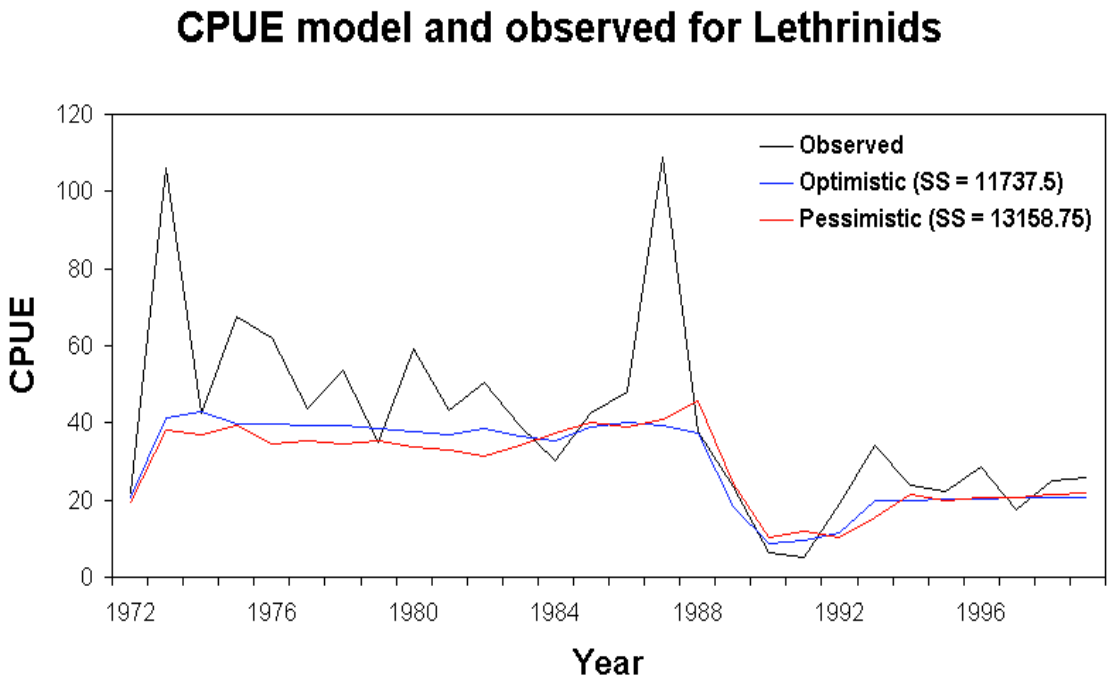


+ Structural uncertainty

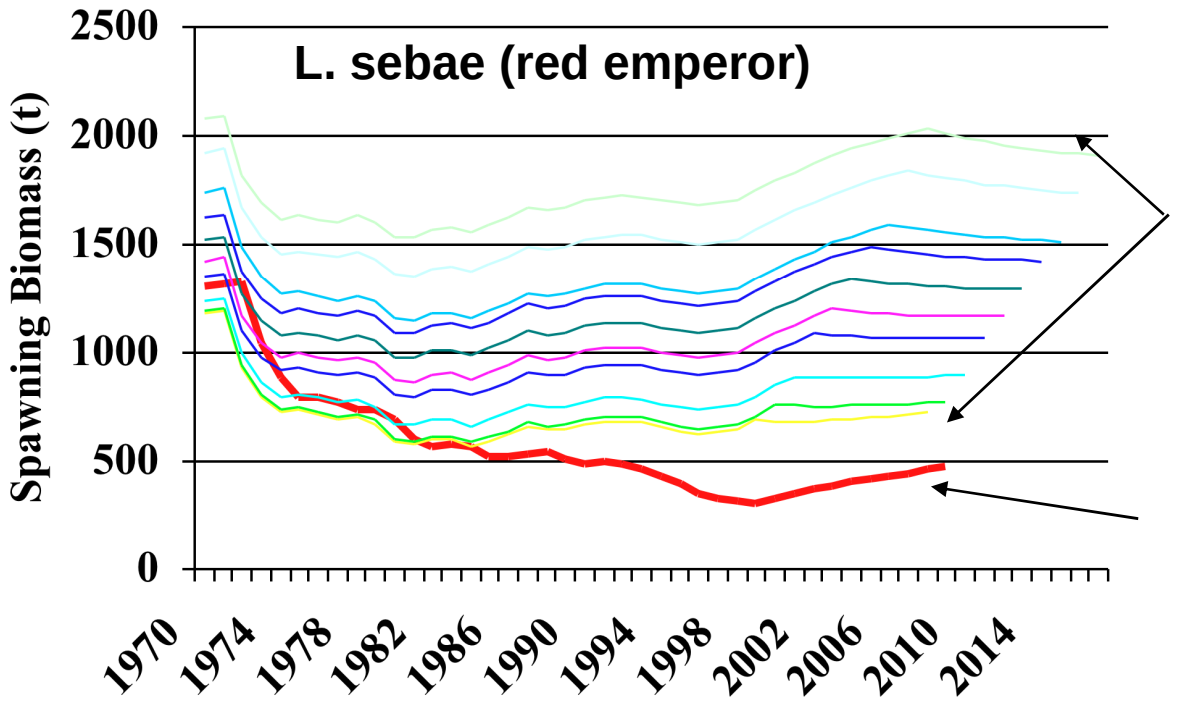
Model Specification

e.g. fish population

- model fitted to catch and effort data



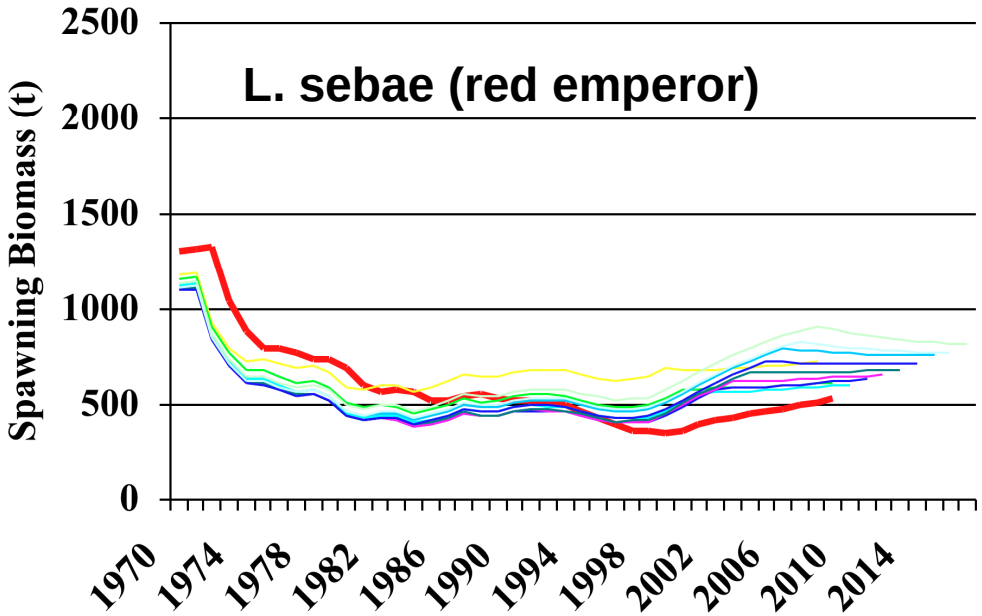
Assessment warning



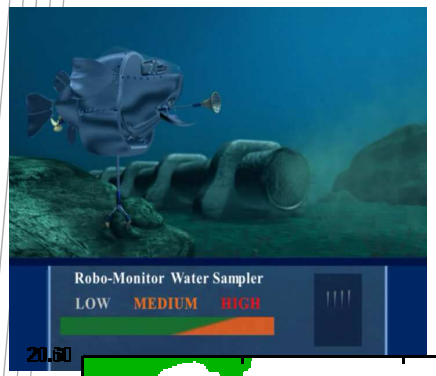
Annually updated assessment and 10y predictions

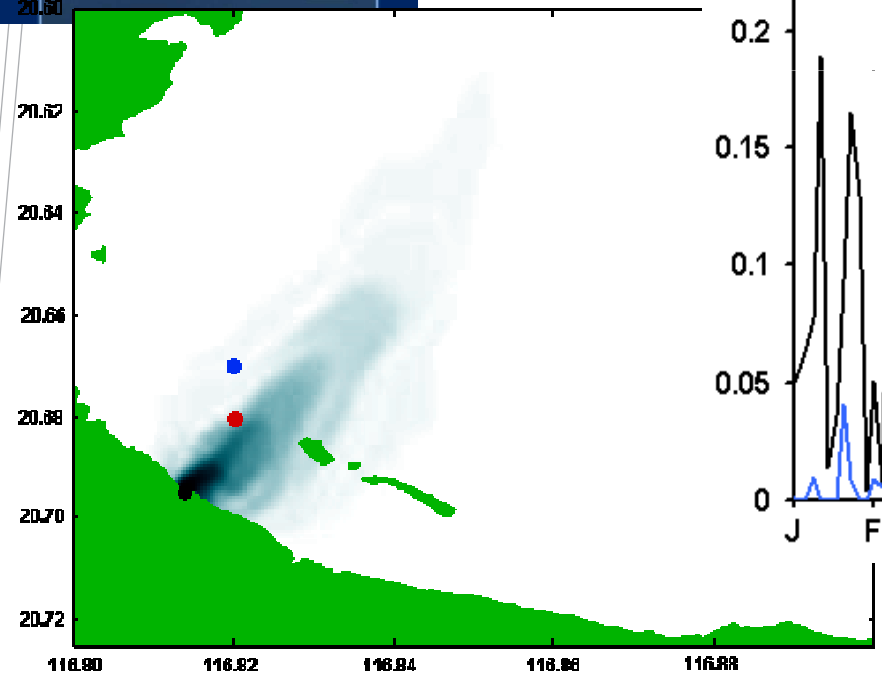
Model ‘truth’

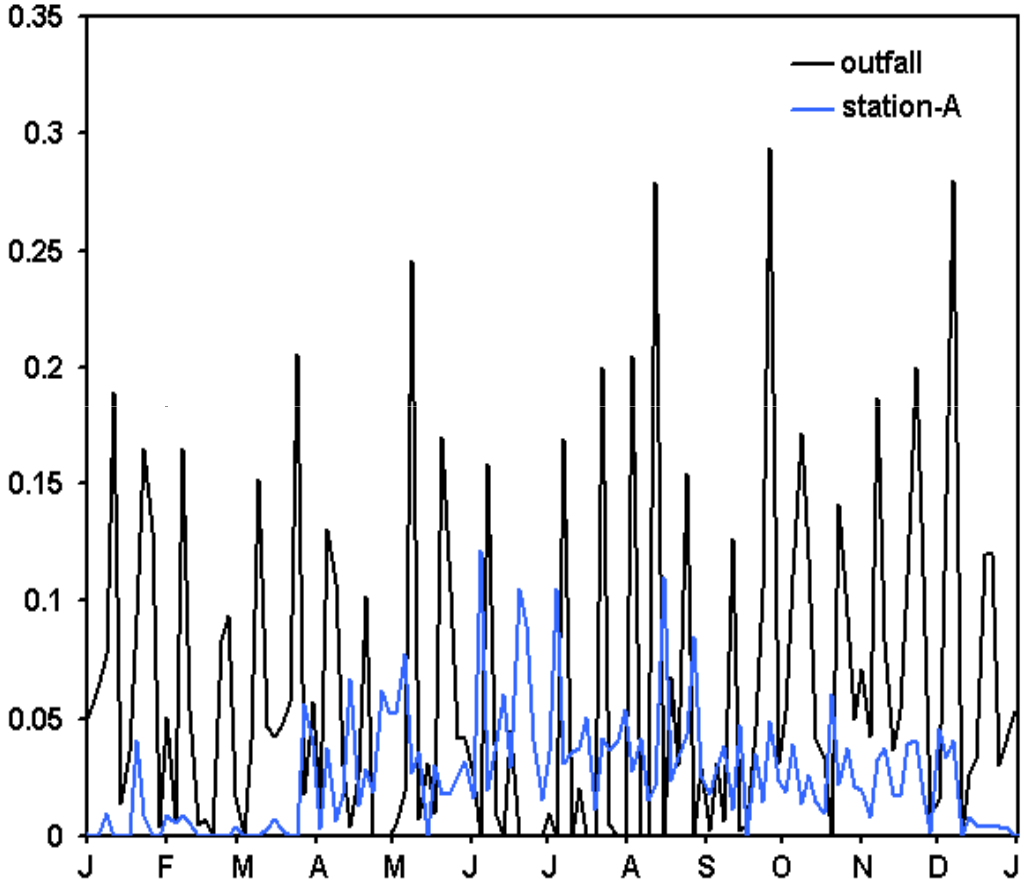
Value of independent surveys



Contaminants (Monitoring)

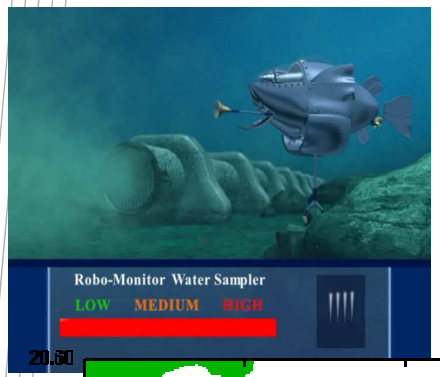


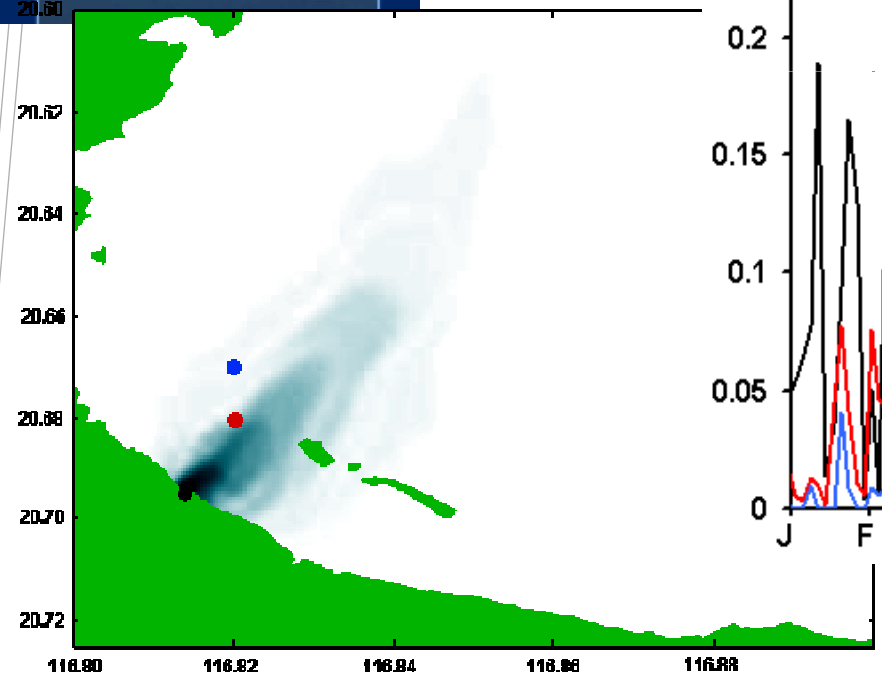


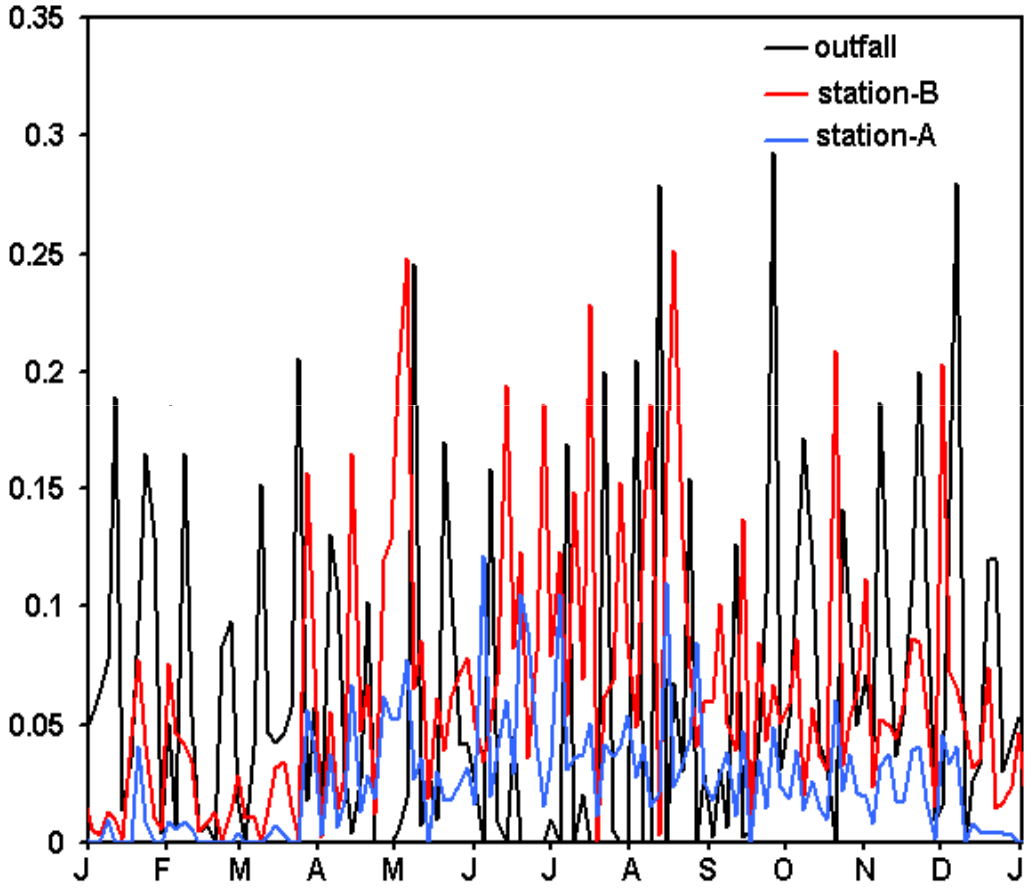


- Poorly placed = ineffective

Contaminants (Monitoring)







- Well placed = effective

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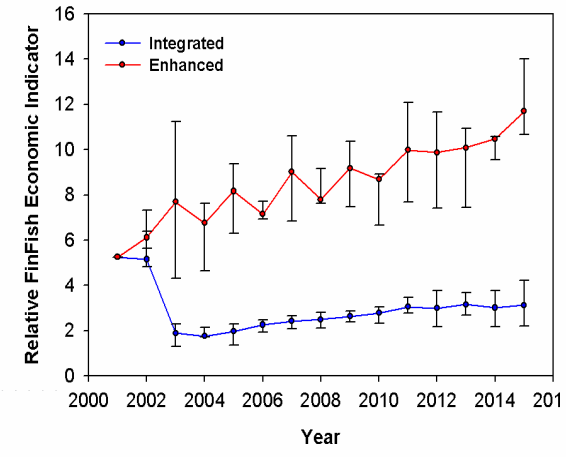
Governance change needed

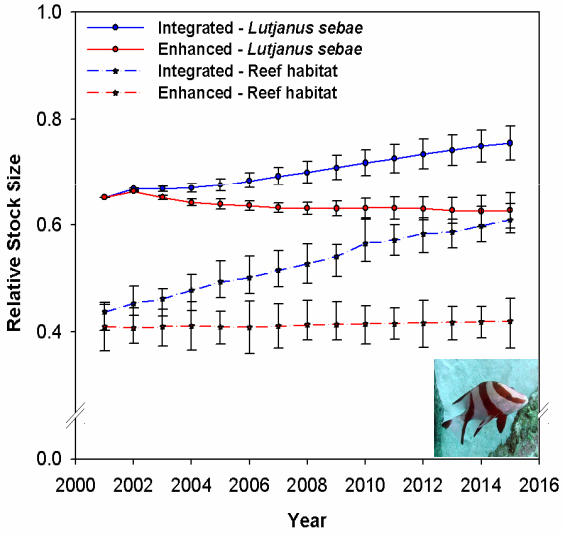
- Status Quo = will bumble you through, but not always the best (very sector specific, e.g. EPA)
- Enhanced = usually more effective
- Integrated = often not much of a step on enhanced (though usually more environmentally conservative)

Tradeoffs

Fisheries Economic Indicators (Medium Specification)



Relative Ecological Indicators (Medium Specifications)



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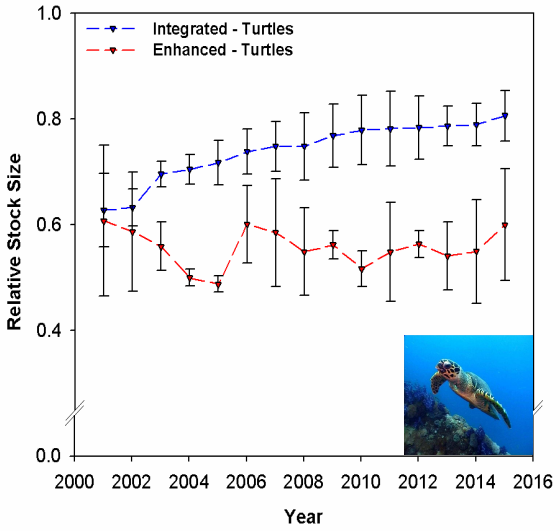

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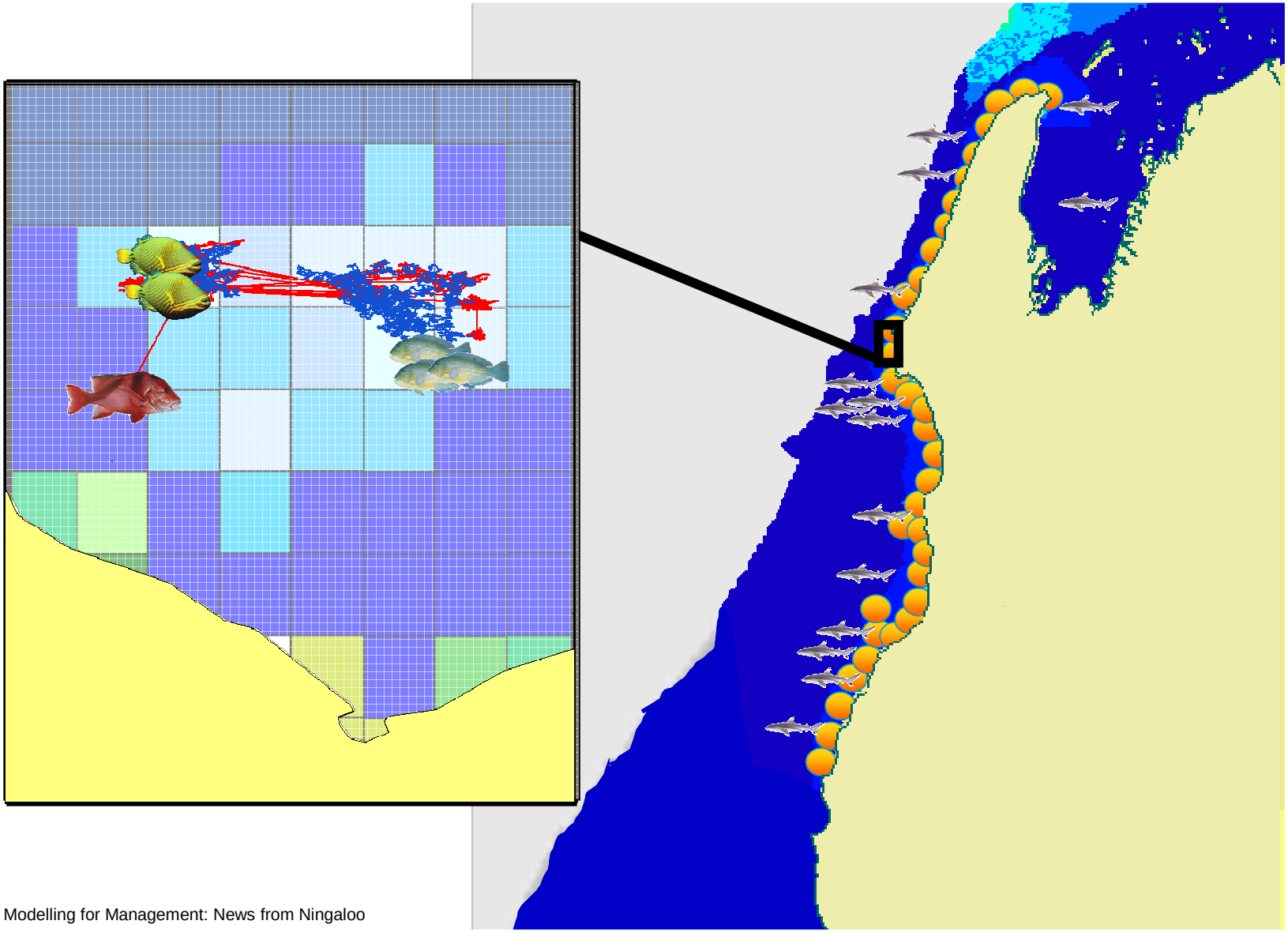
Ningaloo – indirect effects

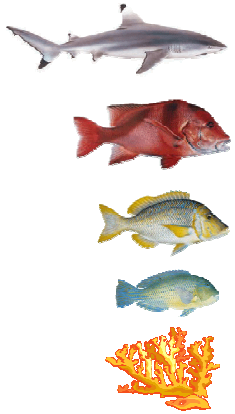


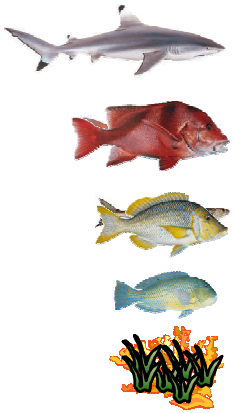
Tourism confusion

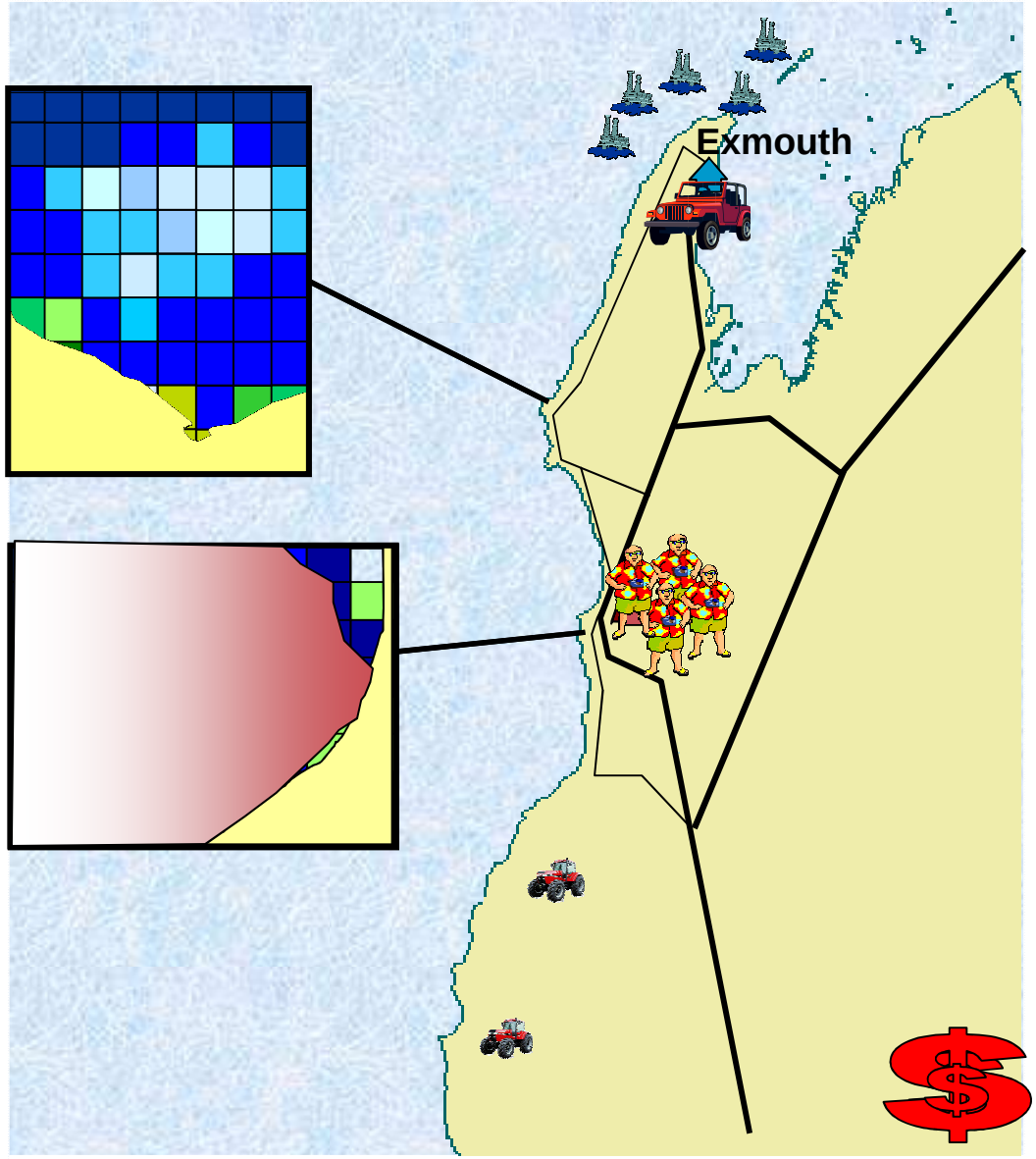
Residents

Captains

Employers







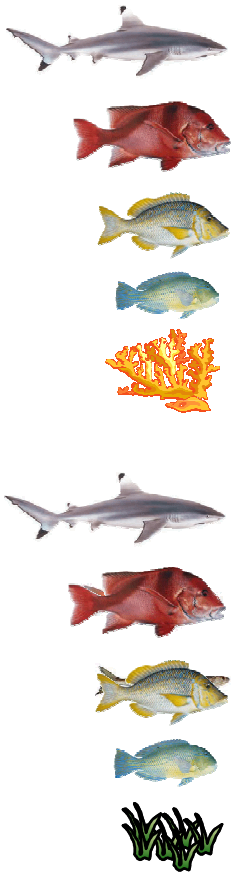
- Impacts
- Sustainability

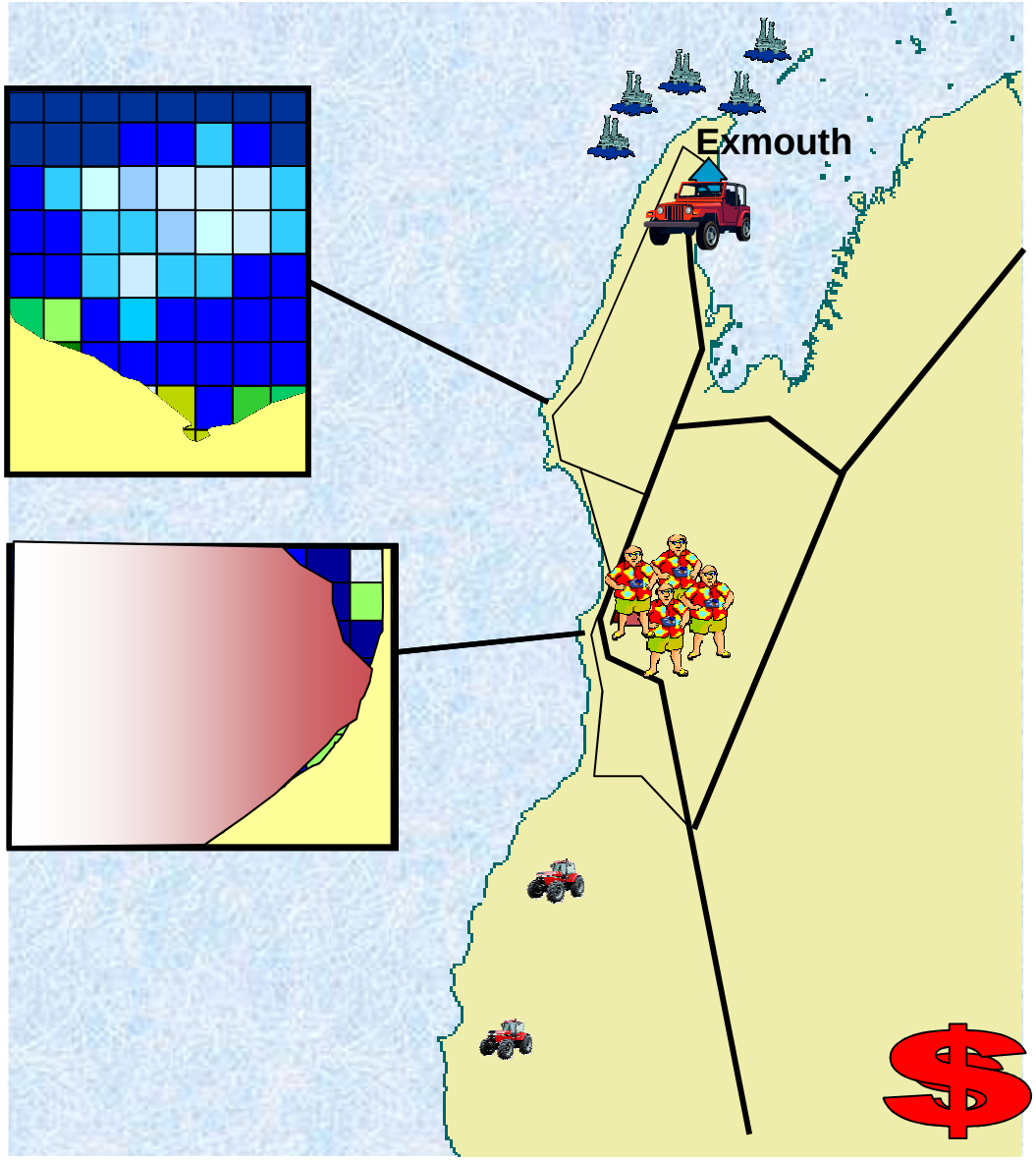
Tourism management

Residents

Captains

Employers





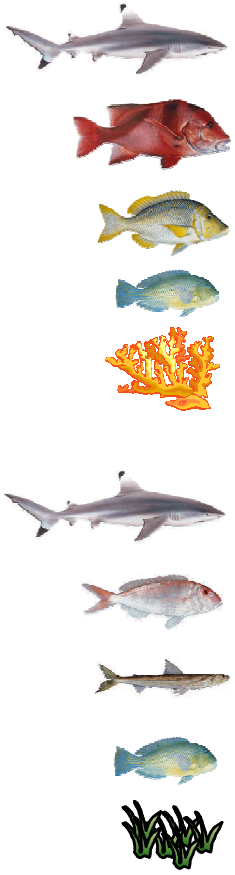
- Management

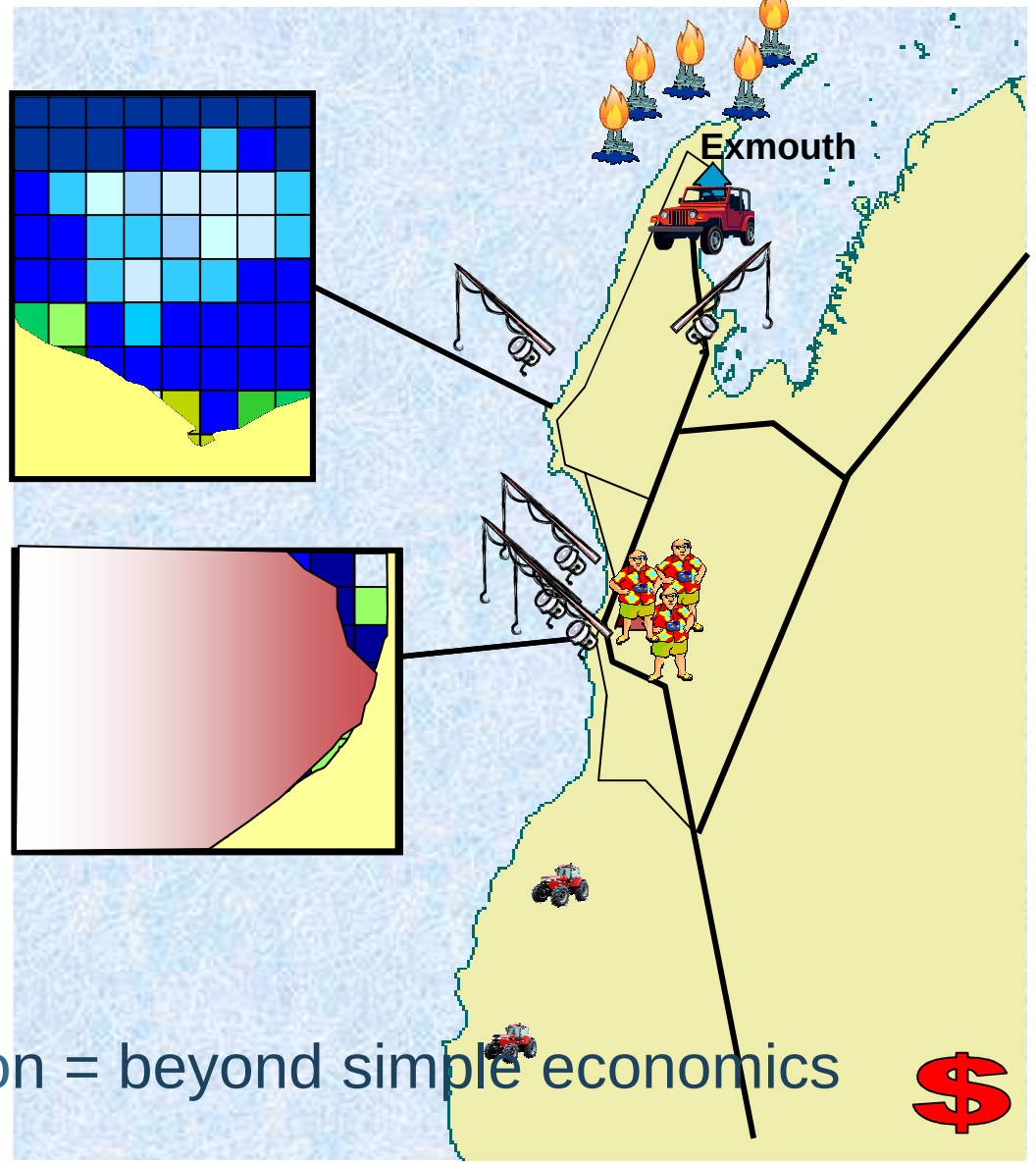
Clash of the titans

Residents

Captains

Employers





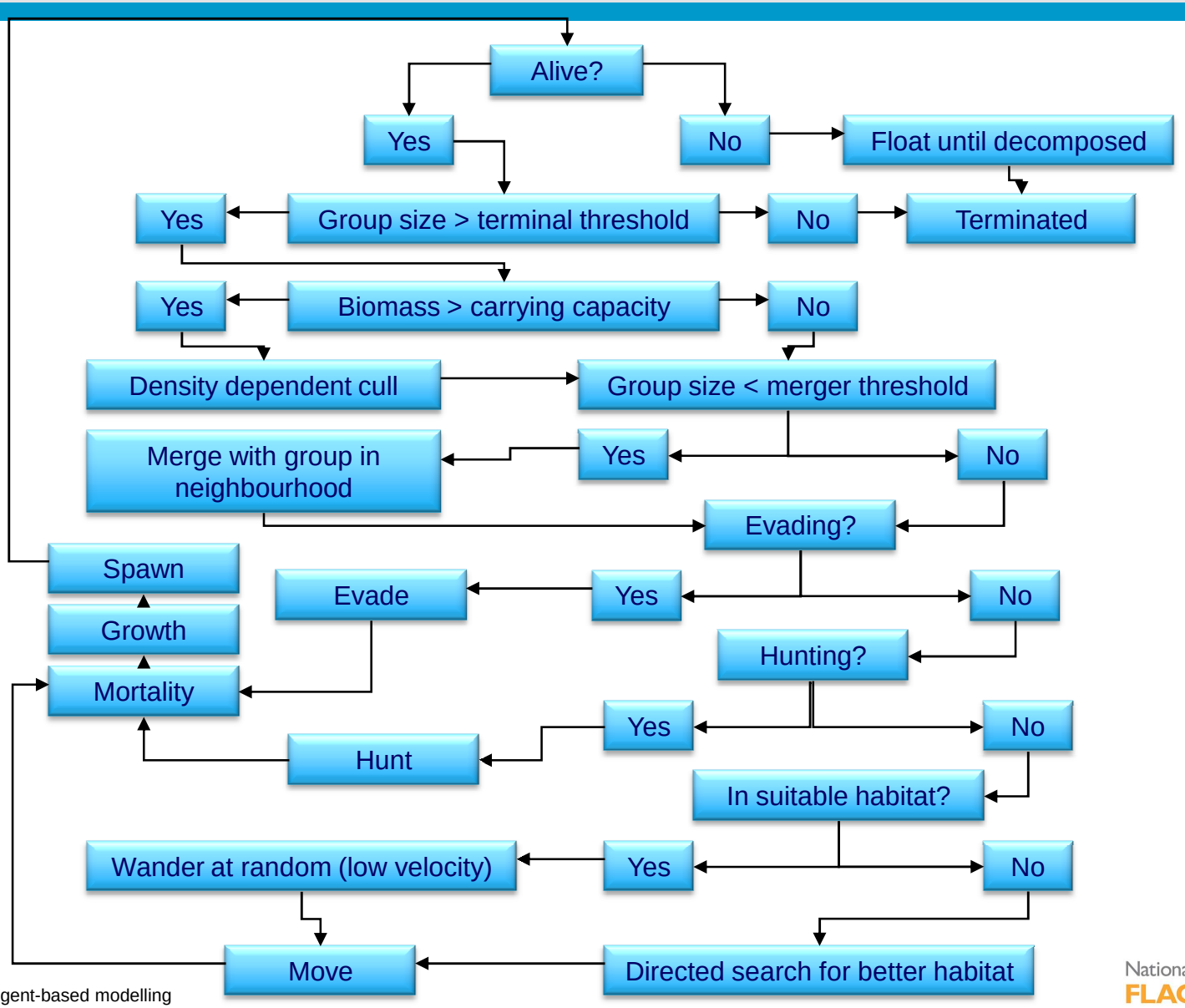
- Competition & motivation = beyond simple economics

Summary

Attack problems at appropriate scales, with appropriate theories and methods. A universal scale is NOT useful

Rudolph Marcus

Formulations – decision trees



Modular Structure

- Representation
  - native currency
  - native scales
  - feedbacks
- Flexible options
  - run-to-run
  - within run
- Understand sensitivity