Good Practices for DSTs:
Using Marxan to Include Community Socio-Economic Values in Conservation Planning

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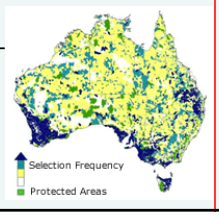
What is systematic conservation planning?

- Guides decisions about the location, configuration, and management of *conservation areas*
- Efficient, repeatable, transparent, and equitable process for making conservation decisions
- By explicitly incorporating socio-economic costs into SCP, we can avoid costly conservation mistakes



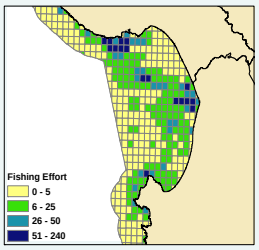
Systematic conservation planning

Comprehensive

Adequate

Representative

Efficient



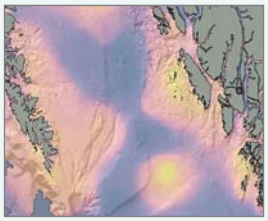
Selecting conservation areas

Objective Function of the Minimum Set Problem:

- Minimise the overall "cost"
- Subject to the constraint that all conservation feature targets are met (e.g., 20% of each habitat type in the analysis)

Why use a decision support tool?

- There are many different site selection configuration possibilities – hard to find by hand
- Tools find many possible solutions, more quickly
- Consider multiple factors (costs, biodiversity, spatial constraints)
- Systematic, repeatable, transparent



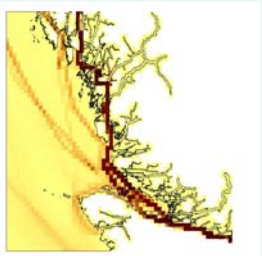
Marxan is a DST that is capable of:

- Addressing core SCP principles
  - representation, cost efficiency, spatial constraints, complementarity, etc.
- Identifying multiple good solutions, even to very large problems
- Systematic, repeatable and transparent area selection
- Easy to use
- **FREE**

Decision-support tool, not a decision-maker!

Socio-economic "cost"

- Including socio-economic costs minimises impacts on resource users, reduces conflicts
- For use in planning, cost data have to be spatially explicit at a scale fine enough to differentiate areas
- Does not necessarily refer to dollar values

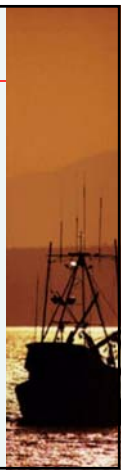


Socio-economic "cost" inclusion

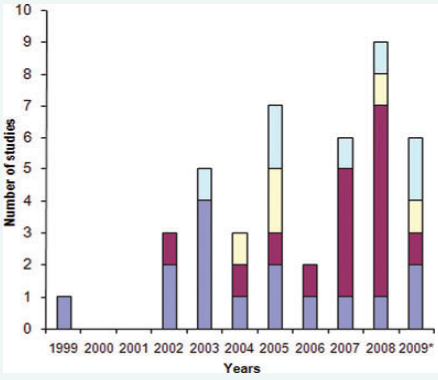
Basic approaches to developing a cost layer:

1. Uniform cost / area
2. Single measure (acquisition, management, transaction, damage, or opportunity costs) – focus on fisheries as cost
3. Multiple socio-economic costs
4. Measures of naturalness or ecological impact of human activities

(Ban & Klein 2009 Conservation Letters)

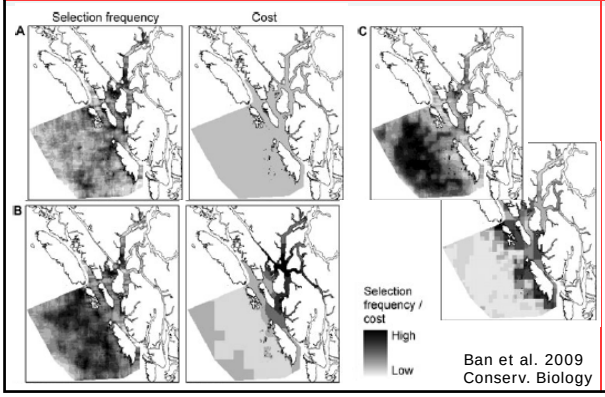


Socio-economic "cost" inclusion



Ban & Klein 2009 Conserv. Letters

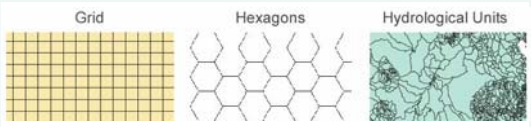
Socio-economic "cost" inclusion



Ban et al. 2009 Conserv. Biology

Socio-economic "cost" inclusion

1. Uniform cost / area
   - Simplest and crudest approach to considering socio-economic factors – proxy for human use
   - Most common approach until recently
   - Assumes minimal area = minimal user impact

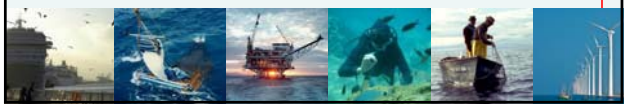


Socio-economic "cost" inclusion

2. Fisheries as cost
   - Opportunity costs commonly used (commercial / recreational catch, effort, value, boat density, number of trips, planning unit importance, etc.)
   - Areas with more catch or effort = higher cost
   - Could also consider acquisition, management, transaction, damage or other opportunity costs

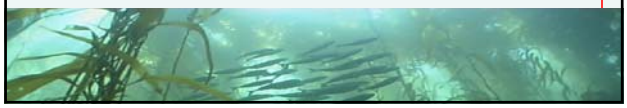
Socio-economic "cost" inclusion

3. Multiple socio-economic costs
   - Representing many different human uses into one cost layer
   - Feasible where human uses can measure cost in comparable units
   - Wherever multiple human uses are combined into one layer, Marxan cannot achieve equity



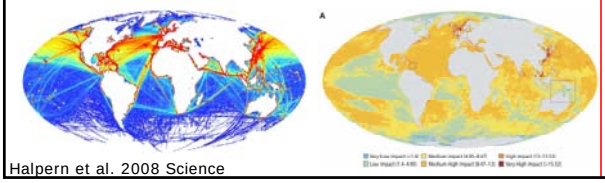
Socio-economic "cost" inclusion

4. Measures of naturalness or ecological impact
   - Rather than directly mapping human activities, the ecological impact of each activity is mapped
   - Conservation is easier or more effective where there has been less human impact
   - Marxan minimises the ecological impact (all else being equal)



Socio-economic "cost" inclusion

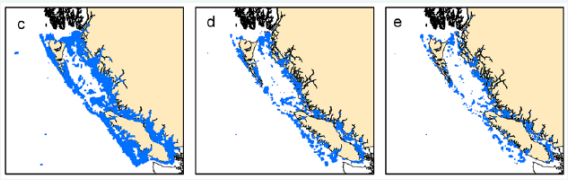
5. Other options
   - Separate scenarios with each human use as the cost, so that each user group has a scenario that directly relates to their interests
   - Surrogates (e.g., coastal population density)



Halpern et al. 2008 Science

Socio-economic "cost" inclusion

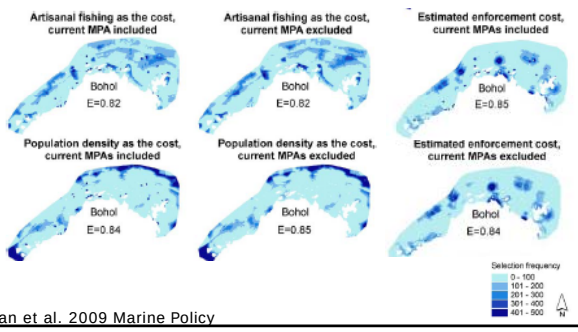
5. Other options
   - Set targets for the inclusion of human use areas in Marxan scenarios, rather than casting human uses as costs



Ban & Vincent 2009 PLoS One

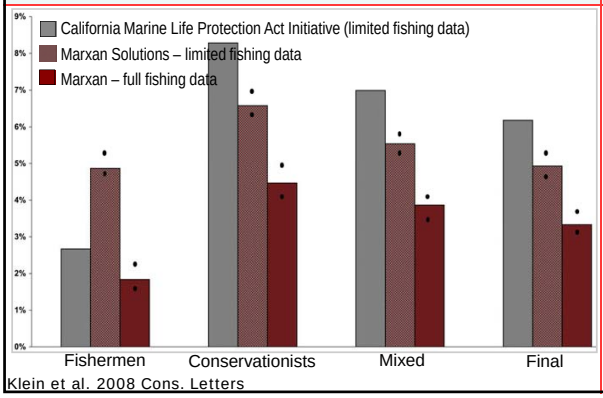
Socio-economic "cost" inclusion

- Examples



Ban et al. 2009 Marine Policy

Socio-economic "cost" inclusion



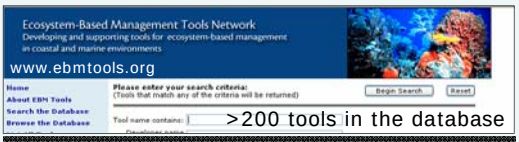
Klein et al. 2008 Cons. Letters

Areas for improvement

- Marxan with Zones allows multiple cost layers
- Static vs. Dynamic
  - Assumes cost is uniform through time and that an activity has the same effects on all features

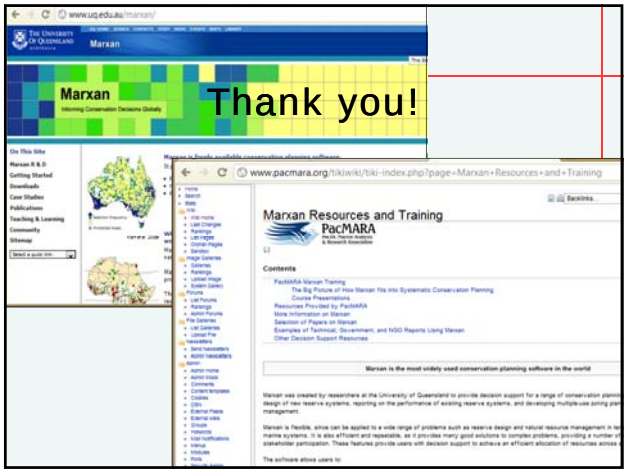
Klein et al. 2009 Front. Ecol. Env.

Other tools…



>200 tools in the database

1. Decision Support Tools
2. Conservation and Restoration Site Selection Tools
3. Land Use Planning, Urban Planning, and Smart Growth
4. Watershed and Marine Ecosystem Models
5. Dispersal and Habitat Models
6. Hazard Assessment and Resiliency Planning Tools
7. Socioeconomic Tools
8. Stakeholder Engagement, Communication, & Visualization
9. Fisheries Management Tools
10. Model Development Tools
11. Data and Project Management Tools



The "score" in Marxan

Combined planning unit cost

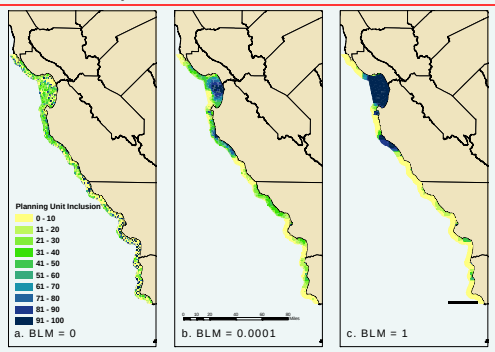
+

Combined boundary cost * BLM

+

Combined species penalty factors

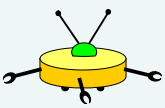
Spatial Compactness of Reserves



BLM = Boundary Length Modifier

Searching for life on Mars: a simulated annealing analogy

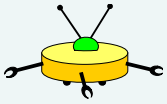
- Life will most likely to be found in low-lying areas
- Problem of finding the lowest-lying area on Mars using a robot is similar to finding the most efficient set of conservation areas (a lot of alternatives)
- How can simulated annealing help solve this problem?



Source: Bob Smith (DICE)

Simulated Annealing

1) Measure the elevation of the ground directly beneath the robot body.
2) Randomly choose an arm and measure the elevation of the ground beneath the arm.
3) If the ground beneath the arm is lower than the robot base then move to the point measured by the arm.



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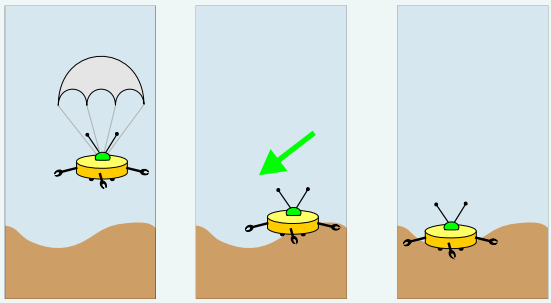
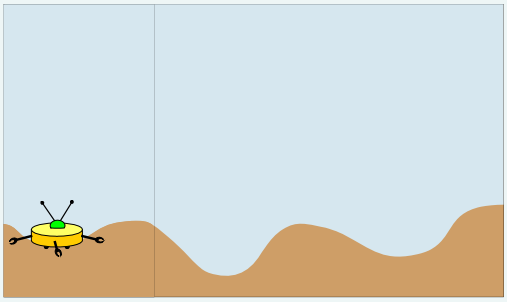


Source: Bob Smith (DICE)

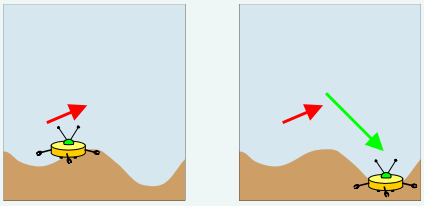
But…this is a flawed strategy as there are lower areas



Source: Bob Smith (DICE)

Random backward steps

- Moves up a slope to try to move into neighbouring, lower-lying valleys
- Backward steps are more common at the beginning of the simulated annealing process



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