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Commonwealth Environment Research Facilities
Marine Biodiversity Hub

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Are spatial incentives more cost effective than marine protected areas for conserving biodiversity?

1. Problem/Background

The incidental capture of seabirds has been an issue of concern in the Australian pelagic longline fishery, resulting in closures driven by a threat abatement plan established under Australia's Environmental Protection and Biodiversity Conservation Act. The tuna fishery management plan has the option of reducing the effort allocation that a fishing operator receives based on where they fish.

While intended for spatial management of fishing on commercial species, we evaluated whether this effort incentive tool could be extended to reduce capture of threatened species like seabirds as a cost efficient alternative to the current policy of fisheries closures. In this example, the area in which we apply the incentives corresponds to one in which closures, in the form of prohibited day settings, have been recently utilised by AFMA.

2. Aim

- Demonstrate a method for predicting the costs of marine spatial management
- Compare the economic cost of a marine reserve with spatial incentives
- Evaluate the conservation effectiveness of spatial incentives

3. Consultative process

- Stakeholders include DEWHA, AFMA, commercial fishers, conservation NGOs and tourism operators.
- Objectives include:
  - Ecological: e.g. protection of Threatened Endangered and Protected (TEP) species
  - Social: maintenance of recreational values
  - Economic: ranging from single trip profits to effects on regional communities supported by the fishing industry.
- BUT low coherence of objectives within stakeholder groups, → management decision making is a function more of the set of individuals than the stakeholder groups they represent.

4. Approach

- We use a fleet dynamics model to evaluate the economic effects of using spatial incentives versus a marine reserve (aka a spatial closure) for reducing the catch of seabirds, predicting the costs of the two methods, and their effectiveness for conservation.
- Two effort decrement rates (the amount a fisher's effort allocation is reduced for each unit of fishing activity in a given area) were considered: 1.66 and 3.00 units of effort per unit spent in the region. These were imposed on two simulated fishery regimes, corresponding approximately to years that embraced two of the main historical targeting practices (in terms of set types and catch compositions).
- We used statistical models to predict seabird encounters per shot from historical data: these suggested that the highest predicted encounter rates are outside of the management area
- We used stakeholder weightings (based on the relative perceived importance of economic, social, and ecological objectives) to evaluate the overall utility of the outcomes of the two management approaches.

5. Are incentives cheaper than closures?

- Low relative difference in overall $ profit; greatest decrease 20% with 3.00 incentive for "2003" (Figure 1)
- Low incentives generally cheaper than closure; higher incentives generally more expensive
- Difference between years in direction and magnitude of profit change – "2007" shows increased profit with incentives and closures
- Figures 2 and 3 illustrate differences in catch patterns between "years" and management scenarios

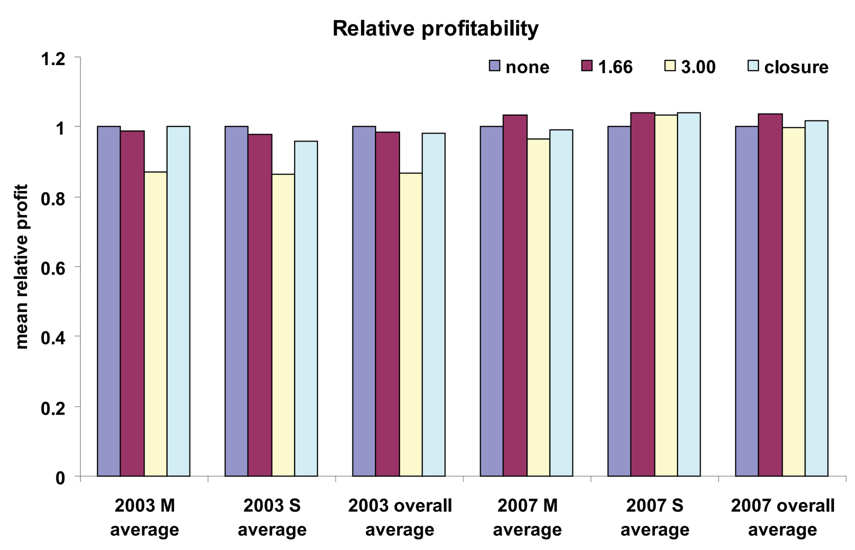

Figure 1. Relative profitability of different home ports (M = Mooloolaba; S = Sydney) (average across difference vessel types) across a range of management scenarios for two different "years" (incorporating differences in relative availability and price between the three main target species)

- Difference in catch composition and distributions between years
- Vessels shift differently according to the fish distribution and targeting practices

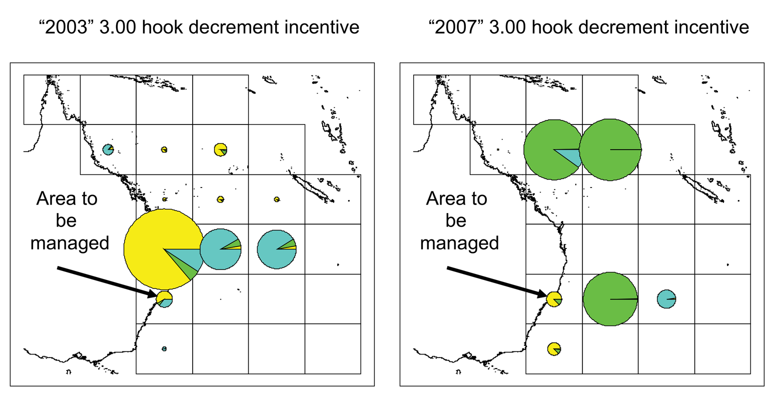

Figure 2: The distribution of catch at a given incentive for two of the simulated fishing regimes: "2003" and "2007". Circle size is proportional to catch in a cell, colours represent target species catches (yellow – yellowfin tuna, blue - swordfish, green – albacore tuna).

- Timing of landings drives differences in price and profit: outcomes depend on competition between fishers
- Management scenarios can have unanticipated effects on some subsets of the fishery by giving them a competitive advantage

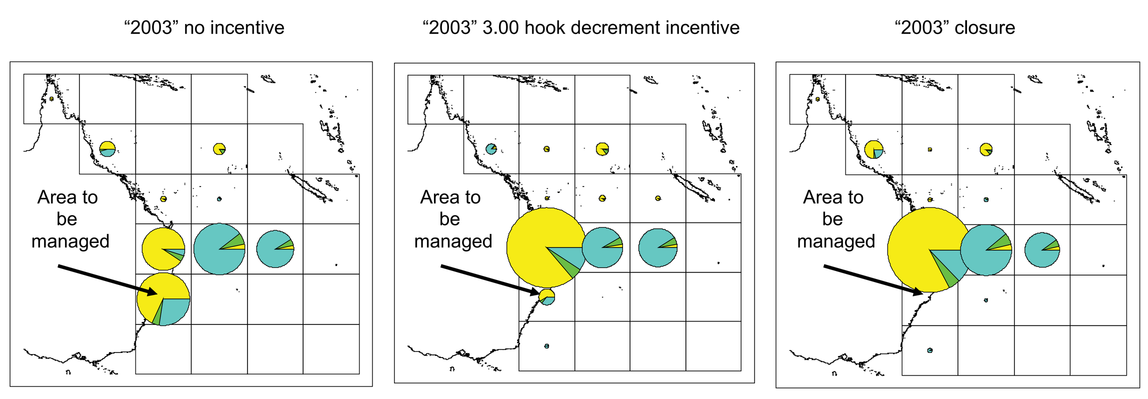

Figure 3: The distribution of catch with i) no incentives, ii) a 3.00 hook decrement incentive and iii) area closure for the "2003" simulated fishing regime. Circle size is proportional to catch in a cell, colours represent target species catches (yellow – yellowfin tuna, blue - swordfish, green – albacore tuna).

6. Do incentives save as many seabirds as closures?

- Seabird encounter rate decreases with increasing strength of the management measure in "2003" scenario, but encounter rates increase with low incentives and with closure for "2007" scenario (different effort redistributions and fish distributions between "years")

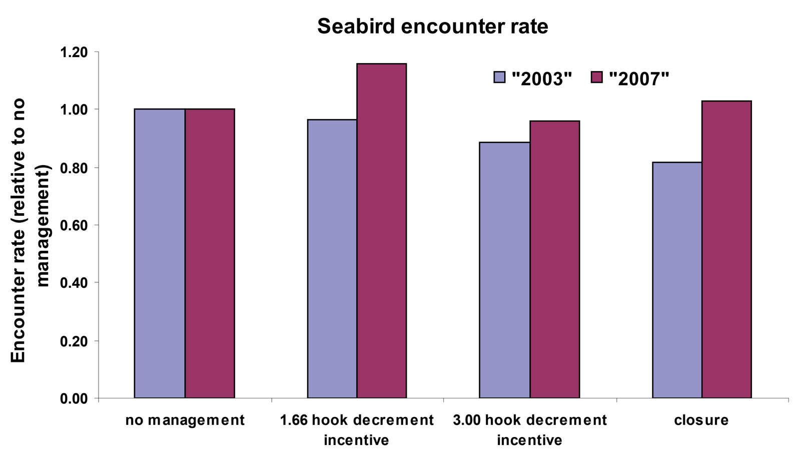

Figure 4: Relavive overall seabird encounter rate by management and "year" scenarios

7. What is the relative biodiversity per unit cost?

- Closures results in best trade off between biodiversity and minimal cost for "2003"
- A weak incentive performs worse than the status quo for "2007"
- Stronger incentive measures result in the best trade off between biodiversity and minimal cost for "2007"

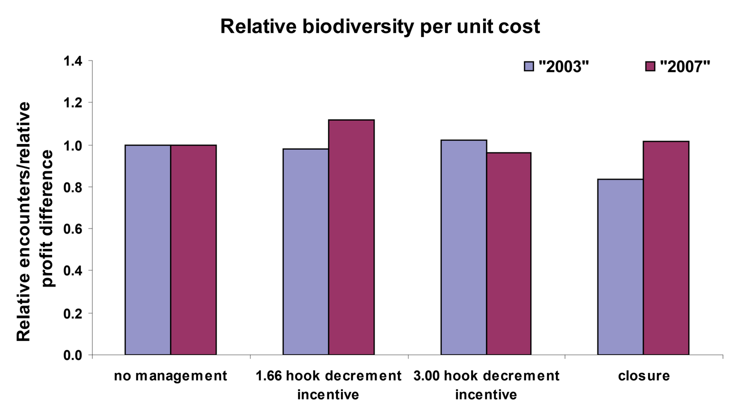

Figure 5: Relative gain in terms of reduction in overall seabird encounter rate, divided by profit, by management and "year" scenarios. Lower values are optimal as these indicate lowest encounter rate and lowest cost (or highest profit).

Fleet dynamics model detail

In designing marine reserves or spatial incentives it is of critical importance to understand how fishing effort will be redistributed in response to management. The pattern of redistribution will determine the economic losses due to management, and will be essential for predicting other undesirable outcomes such as increased bycatch of species that were not previously encountered.

We use dynamic state variable models to predict how spatial incentives will affect profit and location choice across different sizes of vessels operating from the various ports (Mooloolaba and Sydney in this example). These models have their basis in ecological theory and enable constraints, risks and trade-offs to be represented, and can include features such as the spatial-temporal distribution of the target species, the effect of supply on the price of fish, along with effort quotas and other management structures. We use expected profit to predict location choice, assuming that fishers maximise their overall profit via their location choice throughout the season, given the effort quota they have remaining.

8. How do industry vs environmental stakeholders value the issues?

Table 1: Subset of average management objective weights by industry and environmental stakeholder group expressed as percentages (Pascoe et al., 2008)

Objective	Industry weighting	Environmental weighting
Economics: Industry profit	29%	3%
Environment: TEP Species	4%	14%

- These represent the two most extreme stakeholder groups with respect to these objectives

9. What is the utility score across the scenarios?

Table 2: Weightings applied to outcomes (relative profit, relative gain in terms of reduced seabird encounter) and summed to give overall score.

	Industry weighting		Environmental weighting	
	"2003"	"2007"	"2003"	"2007"
none	0.330	0.330	0.170	0.170
1.66	0.327	0.335	0.174	0.152
3.00	0.296	0.331	0.184	0.175
closure	0.333	0.333	0.201	0.166

- Scores are variable between "year" scenarios and management measures
- "2003" shows higher scores to environmental stakeholders with increased stringency of the management measure, but with little change to industry scores
- **Overall, stronger incentives and closures appear to yield higher overall scores than the flexibility conferred by lower incentives**
- **Next stage is to incorporate other objectives into the process to assess how well alternative management practices perform.**

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The Marine Biodiversity Hub is funded through the Commonwealth Environment Research Facilities Program (CERF), administered through the Australian Government's Department of the Environment, Water, Heritage and the Arts. The key aim of CERF is to provide sound advice to inform environmental public policy objectives and to better the management of Australia's unique environment. (Our stakeholder partners are: AFMA, APPEA, CFA, DAFF, DEWHA, DAFF, the Tourism CRC, and WWF Australia)

Further information

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