ISSN 1327-8231

ECONOMICS, ECOLOGY AND THE ENVIRONMENT

Working Paper No. 17

A Review of Reports on Optimal Australian Dugong Populations and Proposed Action/Conservation Plans: An Economic Perspective

by

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SCIENTIA AC LABORE

THE UNIVERSITY OF QUEENSLAND

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Clement A. Tisdell†

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* This is a revised and extended version of *Economics, Ecology and the Environment* Working Paper No. 111.

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WORKING PAPERS IN THE SERIES, *Economics, Ecology and the Environment* are published by the School of Economics, University of Queensland, 4072, Australia, as follow up to the Australian Centre for International Agricultural Research Project 40 of which Professor Clem Tisdell was the Project Leader. Views expressed in these working papers are those of their authors and not necessarily of any of the organisations associated with the Project. They should not be reproduced in whole or in part without the written permission of the Project Leader. It is planned to publish contributions to this series over the next few years.

Research for ACIAR project 40, *Economic impact and rural adjustments to nature conservation (biodiversity) programmes: A case study of Xishuangbanna Dai Autonomous Prefecture, Yunnan, China* was sponsored by the Australian Centre for International Agricultural Research (ACIAR), GPO Box 1571, Canberra, ACT, 2601, Australia.

The research for ACIAR project 40 has led in part, to the research being carried out in this current series.

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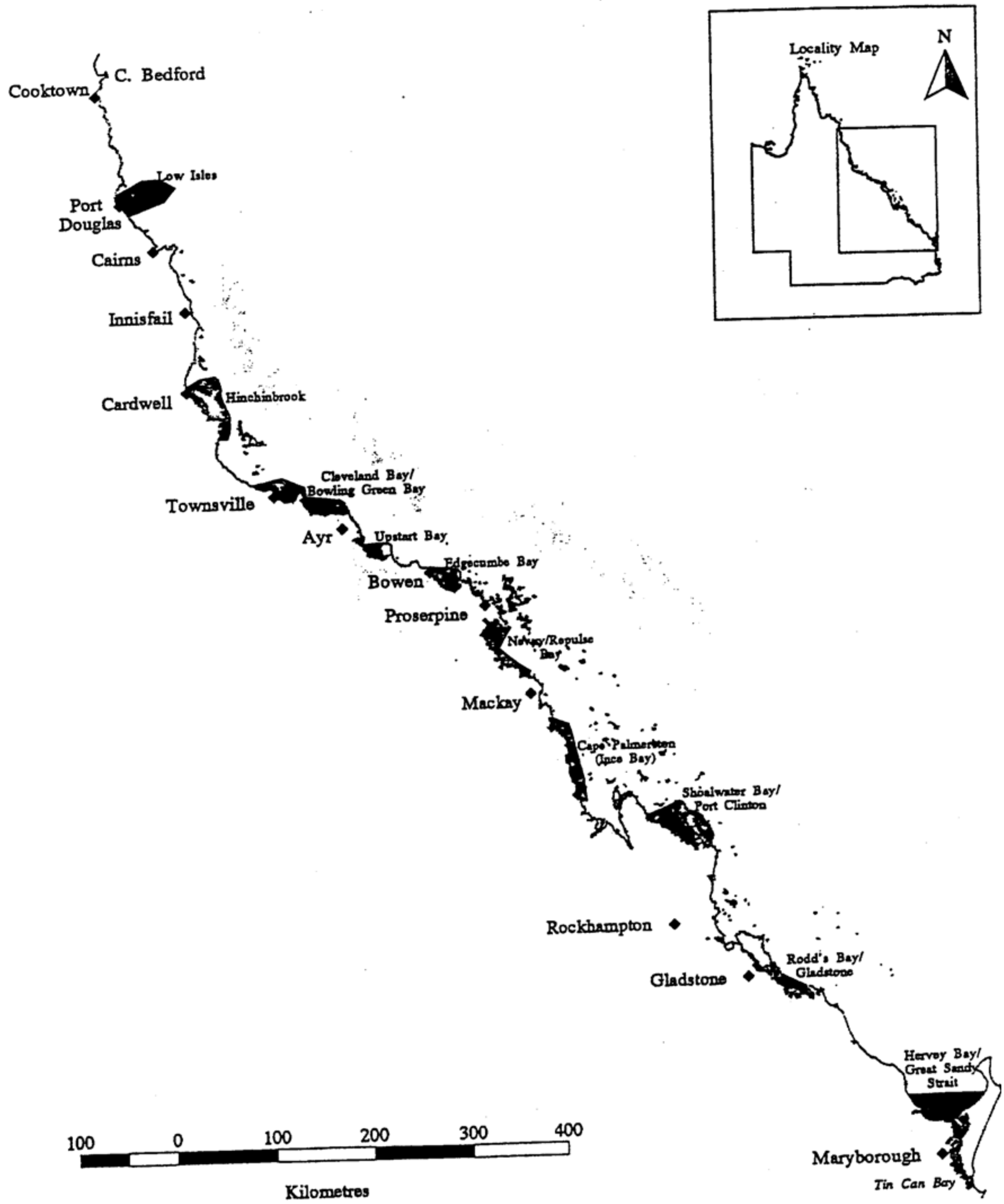
A REVIEW OF REPORTS ON OPTIMAL AUSTRALIAN DUGONG POPULATIONS AND PROPOSED ACTION/CONSERVATION PLANS: AN ECONOMIC PERSPECTIVE

1. Introduction

Two important ecological reports, *The Dugong* ***Dugong dugon****: An Action Plan for its Conservation* (Marsh *et al., n.d.*) and *A System of Dugong Sanctuaries for the Recovery and Conservation of Dugong Populations in the Great Barrier Reef World Heritage Area* (Preen and Morissette, 1997) have been prepared in recent times on the status of the dugong in Australia. Each is accompanied by proposals to foster conservation of populations of dugong. The latter report proposes ten dugong sanctuaries for the southern Great Barrier Reef and Hervey Bay (see Figure 1). Gill nets are recommended to be banned in these sanctuaries.

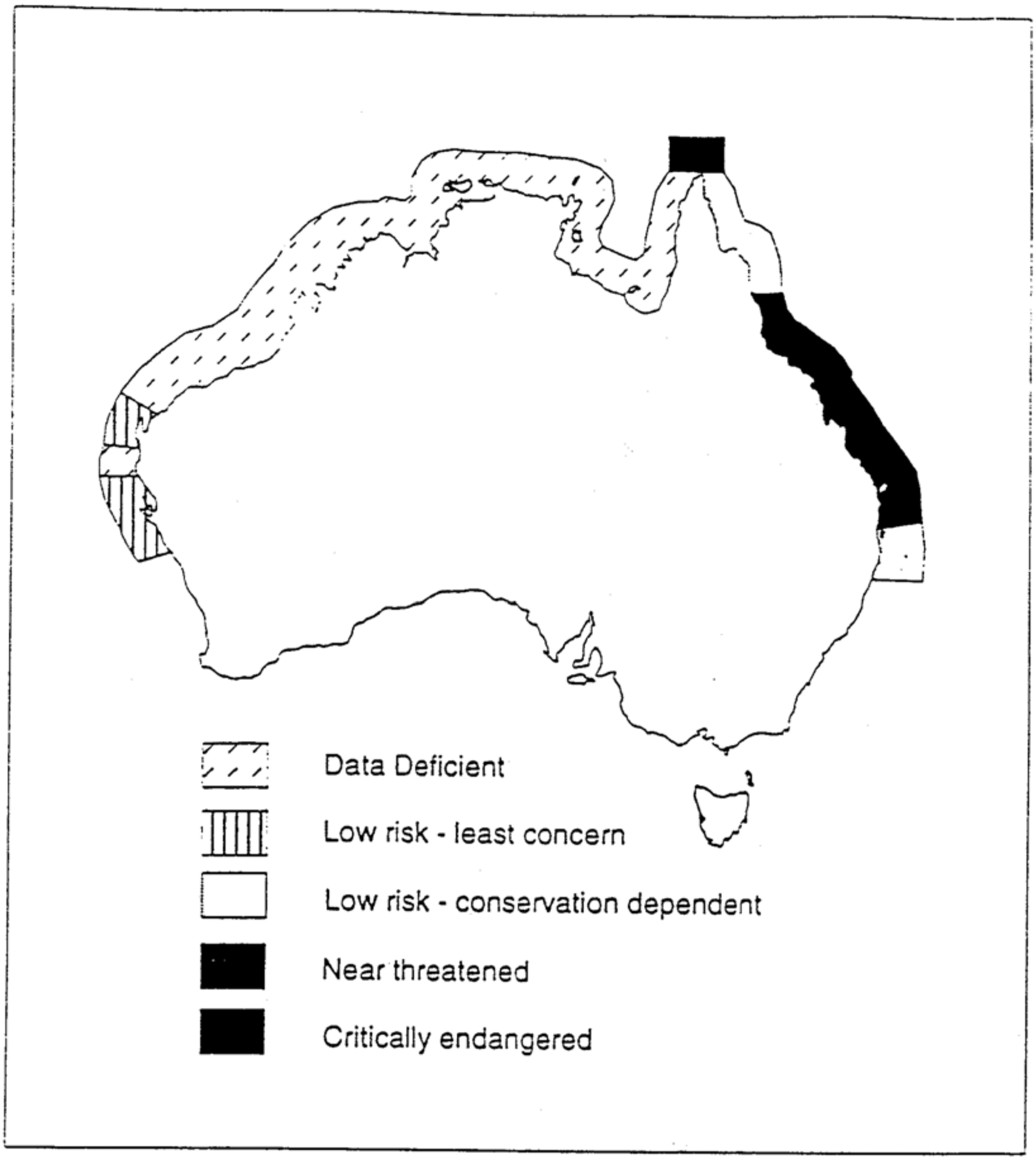
Of the two reports, that by Marsh *et al. (n.d.)* is the least categorical. It points out that while dugong numbers have declined in The Great Barrier Reef (GBR) region south of Cooktown, 'the causes of the decline are unknown, but could include habitat loss, incidental drowning in commercial gill nets and indigenous hunting', (p. 2). It states that 'apart from dugongs drowned in shark nets in Queensland, there are *no* quantitative data on anthropogenic impacts' (pp. 1-2). A well thought out list of research priorities essential for informed management of dugong populations are set out (Marsh *et al., n.d.,* pp. 5-6).


Locality Map
N
C. Bedford
Cooktown
Low Isles
Port Douglas
Cairns
Innisfail
Hinchinbrook
Cardwell
Cleveland Bay/ Bowling Green Bay
Townsville
Ayr
Upstart Bay
Edgecumbe Bay
Bowen
Proserpine
Newry/Repulse Bay
Mackay
Cape Palmerston (Ince Bay)
Shoalwater Bay/ Port Clinton
Rockhampton
Rodd's Bay/ Gladstone
Gladstone
Hervey Bay/ Great Sandy Strait
Maryborough
Tin Can Bay
100 0 100 200 300 400
Kilometres

Despite the fact that this research has not been completed, Preen and Morissette (1997) make major policy recommendations for a system of dugong sanctuaries which are expected to impact adversely on the livelihood of a large number of fishermen in Queensland, as well as resulting in displacement of fishermen and possible crowding of fishermen in areas not set aside as dugong sanctuaries. Flow-on adverse economic consequences for local communities in regional coastal Queensland are anticipated. They make these recommendations with a view to achieving an optimal population of dugongs. For them this seems to imply the requirement that dugongs be not critically endangered locally anywhere within their current population range in Australia. This however, begs the question of how the 'optimal' population of dugongs is to be determined.

2. The Optimal Population of Dugongs

Figures given by Marsh *et al.,* indicate that Australia's total dugong population is of the order of 83,245 head. Most of this population is located in the 'top' of Australia from the north of Cape Bedford in Queensland around to Shark Bay in Western Australia. The population in southern Great Barrier Reef region is estimated to be relatively low at about 1,642 head and in *this region* dugong is listed by Marsh *et al. (n.d)* as a critically endangered species (not IUCN). The IUCN Red book describes a critically endangered species as a one 'facing extremely high risk of extinction in the wild in the immediate future'. Because dugongs in the southern GBR probably do not form an isolated described population, they are unlikely to achieve separate classification as critically endangered under IUCN criteria. In any case, the dugong is not endangered throughout the whole of its population range in Australia according to Marsh *et al. (n.d.)* (see Figure 2). The exact contributors to low numbers of dugong in the southern GBR region are not clear as yet, although a cyclone in the Hervey Bay area significantly lowered dugong numbers there by reducing the extent of seagrass meadows. Periodic destruction of seagrass meadows by cyclones and then their subsequent recovery along with that of the size of local dugong populations appears to be normal.


Data Deficient
Low risk - least concern
Low risk - conservation dependent
Near threatened
Critically endangered

Preen and Morissette (1997, p. 8) state 'To allow dugong populations to recover to their optimum sustainable level all significant dugong habitat, both past and present, should be protected in sanctuaries. Protection of only a subset of dugong habitats, like those that contain substantial dugong numbers may prevent dugong extinction in the southern GBR, but will not allow for recovery'. Elsewhere they also speak of the optimum sustainable population of dugong, but nowhere does their concept of the optimum population appear to be defined.

From their text, it is clear that Preen and Morissette want not just to maintain the minimum population of dugong required to ensure the reasonable probability of survival of dugong in Australian waters as a whole, but at least the minimum populations of dugong throughout their whole range in Australia considered necessary for their survival in every region where they now occur. Their aim is to try to *prevent any local* extinctions. Whether or not their proposals are sufficient or more than sufficient to prevent local extinctions is a matter for ecologists. What is the probability that local extinctions will occur without the DPAs proposed and where? What difference do the restrictions make to these probabilities? Could similar reductions in probabilities be obtained by alternative means and more cheaply? No specific information seems to be available in relation to these questions.

Preen and Morissette (1997) *seem to* waiver between two ideas about optimum populations of dugong in the southern GBR region, which is the main focus of their attention and policy recommendations. These are:

(1) The minimum populations of dugong required to ensure the survival of dugong throughout their range in the southern GBR region, taking into account the mobility of these animals.

(2) The (maximum sustainable) population which would emerge in the absence of anthropogenic disturbance.

(3) A dugong population somewhere in between these.

What we are not told is what criterion is used to decide that these populations are optimal. From what point of view or points of view are they optimal? From the point of view of dugongs? How is the human interest factored in? Are humans to be considered as part of the ecological system or not? What human values should be factored into the optimisation problem and how? Without account being taken on these factors, proposals for optimisation of dugong populations are very narrowly based and unclear. Economic and social evaluation is not included in the problem by Preen and Morissette unless they assume that saving of dugongs is of infinite value.

It is true that some appeal is made to Australia's obligations under international conventions but there is no discussion of how legally binding they are and how these are to be interpreted. In any case, it is doubtful if the international Convention on Biodiversity Conservation obligates nations to 'save' species *throughout their entire range*.

It should furthermore be noted that there is usually no minimum population of a species that guarantees its future existence (Hohl and Tisdell, 1993). All that one can conclude is that the probability of survival of a species can be expected to rise as its habitats and its population are more fully protected. So we have to ask what probability of survival of a species, in this case dugong, are we aiming for and why? In addition, the above theory implies that application of the *precautionary principle* requires an assessment of the weighted risk of various management options. No attempt to do this has been made in the policy recommendation of Preen and Morissette.

3. Economics and the Optimal Population of Species, in this case, Dugong

Economics, not considered in the reports mentioned above, can be factored into decisions about optimal population or conservation of species in two different ways. These are:

(1) *Cost minimisation* in relation to some standard or target for population of a species and,

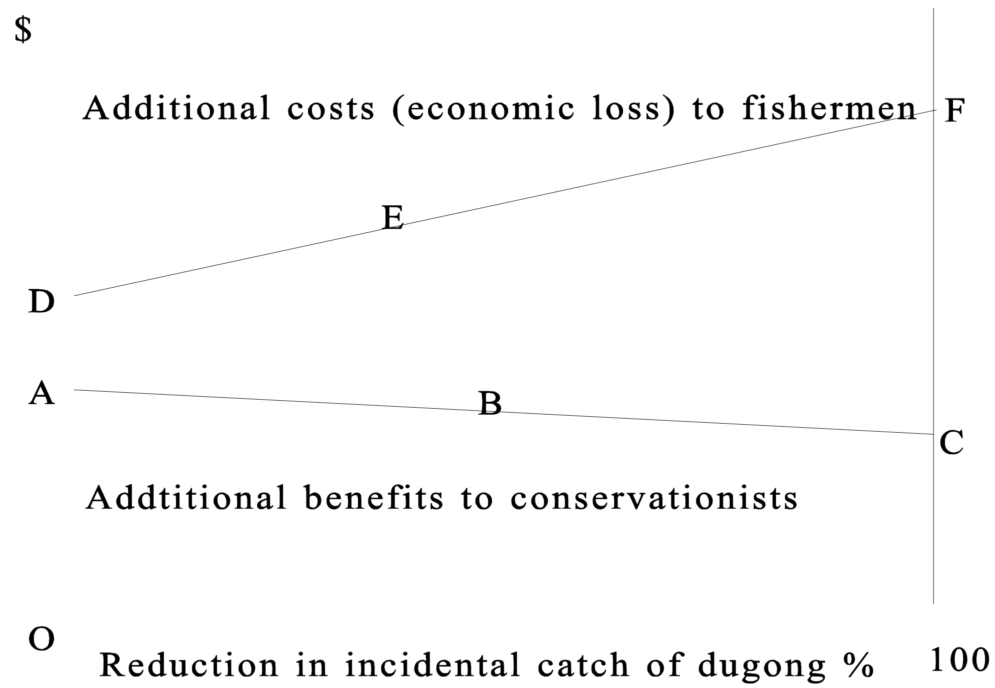
(2) *economic optimisation* of the population of the species.

Neither of these approaches have been applied in determining the optimal population of dugong in Australia or in the GBR region.

Cost minimisation involves searching for strategies which will minimise the cost of achieving the population of dugong aspired to. This for example, would involve search for conservation strategies which would minimise costs imposed on fishermen. Has for example, the best configuration of DPAs been proposed to achieve protection of dugong populations and minimise the cost imposed on fishermen? Should research be undertaken to search for effective methods to deter dugong from entering the area of gill nets? Are there techniques available or which could be developed to reduce unwanted incidental catch? Why is such research not being funded and why is there not a programme for such research? The incidental catch problem is a widespread problem and more attention needs to be given to it from a scientific research point of view.

The second approach to this type of problem adopted by some economists is to treat it as an economic optimisation problem using social cost-benefit analysis (Cf. Campbell *et al.*, 1997). For this method to be applied, it is ideal if all social costs and benefits can be expressed in monetary units. If this is not possible, then one goes as far as is practical in quantifying social costs and benefits in monetary terms and makes a list of the ‘intangibles’ that cannot be quantified so these can be taken into account in the final judgement.

This approach is illustrated by diagrams which look at *possible* costs and benefits of reducing the incidental catch of dugong by fishermen. There are several possibilities to consider. Firstly, it is possible that the economic costs imposed on fishermen in terms of



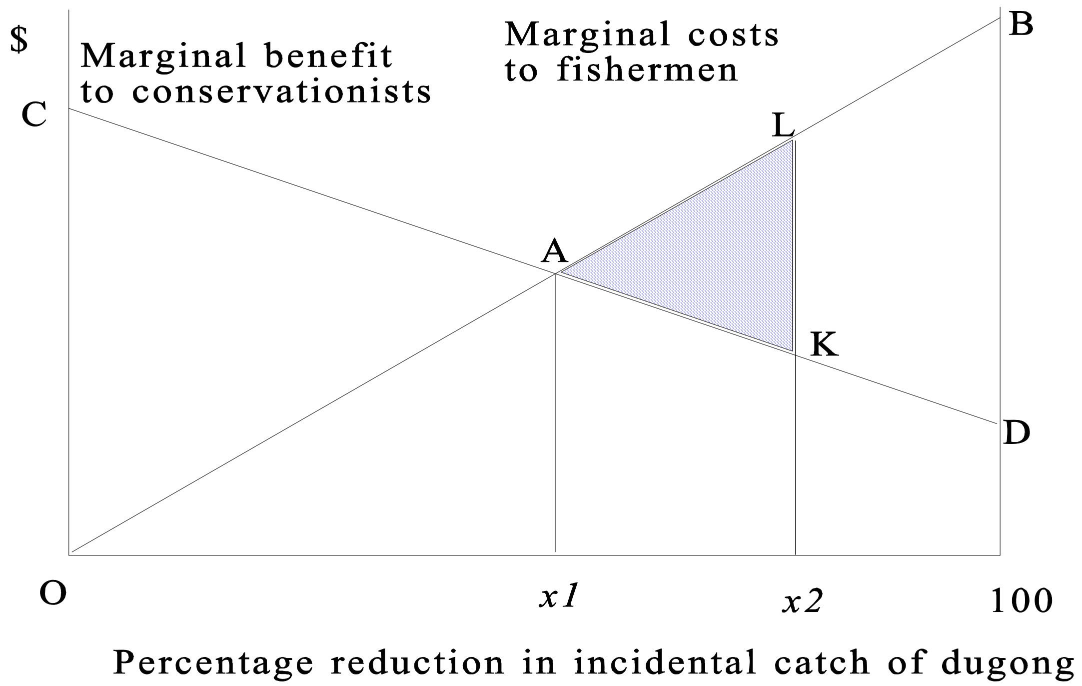
reduced profit, income and so on exceeds the willingness of conservationists to pay for any reduction in the incidental catch of dugong in an area. This would imply that on purely economic grounds that no reduction in the incidental catch of dugong would be justified. This case is illustrated in Figure 3. Line DEF represents the additional costs imposed on fishermen of having to reduce their incidental catch of dugong and line ABC represents the additional benefits to conservationists (e.g., their marginal willingness to pay) for a reduction in the incidental catch of dugong. In this case, it is not economic to reduce their incidental catch of dugong. This is because the cost imposed to fishermen always exceeds the *economic* benefit to conservationists.

Although in the case shown in Figure 3 no reduction in the incidental take of dugong is economic, if a new method of reducing the incidental take of dugong happened to be developed, this could reduce the cost to fishermen of reducing the incidental catch of dugong. Consequently, it may become economic to reduce the incidental catch of dugong. Such a new method would move the line DEF downward possibly sufficiently far to intersect line ABC, other things constant. Its an intersection point would correspond to the optimal economic reduction in the incidental catch of dugong after the introduction of the technique. A reduction in the incidental catch of dugong would then be economic. New techniques of this kind result in a 'win-win' situation, that is benefit both conservationists and fishermen. However, little or no sustained research appears to have been undertaken to find such methods.

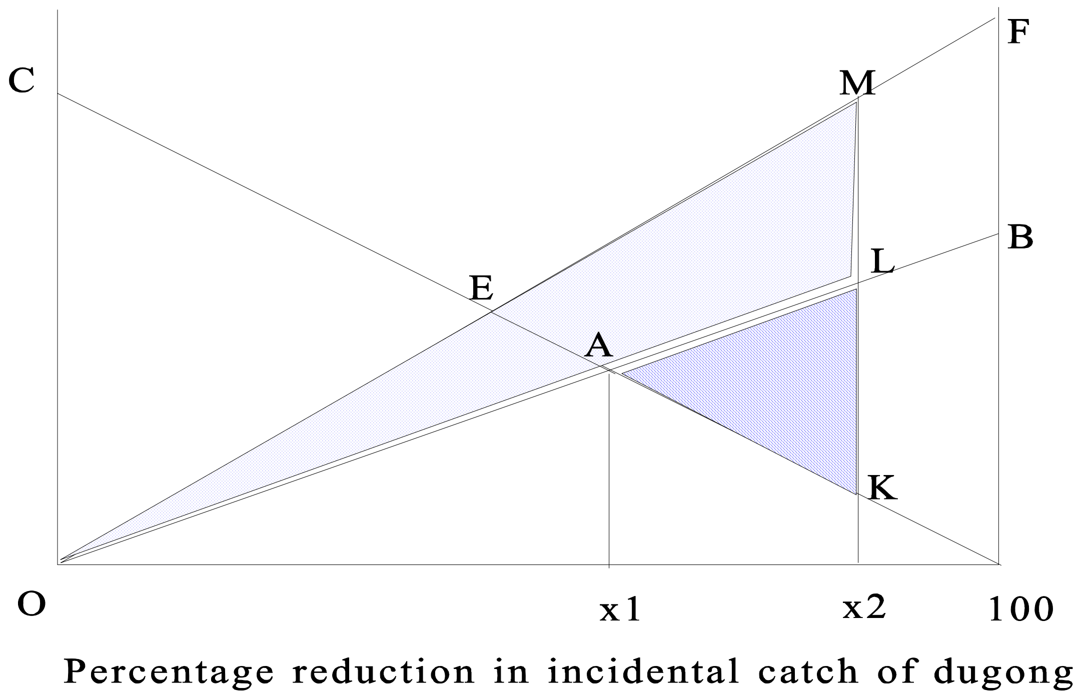
Figure 4 illustrates a case in which it is economic from a social point of view to reduce the incidental catch of dugong. Line OAB represents the additional costs to fishermen of reducing their incidental catch of dugong and line CAD represents the additional benefit to conservastionists of doing this. In this case, a reduction in the incidental catch of dugong by x_1

per cent maximises social net economic benefit: for this reduction the marginal benefit to conservationists equals the marginal cost imposed on fishermen[i]. If the incidental catch of dugong is reduced further, a social deadweight economic loss occurs. If, for example, authorities require and achieve a reduction in the incidental catch of x_2 per cent, the social deadweight loss is equal to the equivalent of area of triangle AKL, the hatched area in Figure 4. It is clear from the above discussion that without proper attention to the costs and benefits of reducing the incidental catch of dugongs, a social economic loss can occur. It is even possible for regulation to be socially less favourable than no regulations from an economic standpoint.

In addition, if the measures, means and techniques for reducing the incidental catch are *prescribed, they* may not be the most efficient or cost-effective ones from an economic



point of view. For example, the prescribed methods may, in relation to the case shown in Figure 4, result in higher extra costs being imposed on fishermen so that their additional



(marginal) cost is than those shown by line OAB. For ease of illustration a similar diagram to Figure 4 is shown as Figure 5. The prescribed methods may result in extra costs being imposed on fishermen. When these are accounted for, their marginal costs might be as shown by line OEF. If this is so and authorities reduce the incidental catch by x_2 per cent, the deadweight economic loss from regulation is equal to the equivalent of the dotted area, the area of triangle OLM, plus the equivalent of the area of the hatched triangle AKL[ii]. Consequently, 'social loss' is raised by even more than the area of triangle AKL due to cost-effective methods not being prescribed. There is a high risk of this occurring as far as the present policy recommendations for attaining 'optimal' population of dugongs is concerned.

Observe that the steeper is the additional cost imposed on fishermen of having to reduce the incidental catch of dugong, the smaller is the optimal reduction in the by-catch of dugong.

If an economic approach to optimality is adopted, it is important to evaluate the social economic costs and benefits of reducing the incidental catch of dugongs. Policy measures must be formulated by weighing up these two components; costs and benefits. It is clear from a social economic standpoint that too much reduction in the by-catch can be forced on fishermen and that excessive costs can be imposed upon them if strategies or policies are proposed without economic assessment. These type of assessments are missing in the reports prepared by Marsh, *et al.,* and Preen and Morissette.

4. Concluding Comments

From the above, it seems that *not* even the *precautionary principle* requires that hasty emergency action is needed to save dugongs from imminent extinction in Australian waters. Even the likelihood of local extinctions could be a subject for serious debate. Note also that proper attention to the precautionary principle requires an assessment of the weighted risks of alternative management options; something which has not been done by policy-makers in this case.

A decision to create or extend DPAs and tighten controls on fishing effort is bound to have major economic repercussions regionally. Therefore, there is a need and time to assess economic factors, take these into account and gather further ecological evidence before coming to policy conclusions. This appears not to have been done in most cases by those making recommendations for management of dugong.

While economics cannot be the sole arbiter on social decisions, it is nevertheless unreasonable to ignore it, especially given that many of the impacts of regulations are likely to have irreversible economic consequences. The economic issues should be explored further, more ecological research is needed and in particular research is needed to find cost-effective methods of maintaining populations of dugong. Hasty decision-making in this area seems both unwise and unnecessary.

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7. Notes

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[i]. The optimality condition can easily be outlined in mathematical terms. If *h(x)* represents the costs imposed on fishermen of reducing the incidental catch of dugong and if *g(x)* represents the benefit to conservationists, then the net social benefit (NSB) of reducing the incidental catch of dugong is NSB = $g(x) - h(x) = f(x)$. The necessary condition for a maximisation of this (given an interior solution) is $\frac{df}{dx} = \frac{dg}{dx} - \frac{dh}{dx} = 0.$

The rate of change of benefits to conservationists should be equal to the rate of increase in costs imposed on fishermen.

The second order condition for the maximum is that $f'' < 0$. Since $g'(x)$ is downward sloping and $h'(x)$ has a positive slope, this condition will be automatically satisfied if the first order condition is met.

Mathematically the optimisation problem is straightforward. In practice, the main problem that is likely to occur is to estimate the functions accurately from an empirical point of view. Furthermore, there is scope for philosophical argument about how best to specify benefits to conservationists. Should for example willingness to pay form the basis of such estimates or should willingness to accept compensation be used for specification (Tisdell, 1991). Observe that deadweight social loss (DSL) shown by the hatched area in Figure 4 would mathematically be obtained as follows:

$$DSL = \int_{0}^{x_2} h'(x)dx - \int_{0}^{x_2} g'(x)dx \, .$$

[ii]. Let *r(x)* represent the extra cost imposed on fishermen by regulation, that is costs in excess of the efficient ones. Then the total economic loss from regulation equals

$$\int_{0}^{x_2} r(x)dx$$

plus DSL as specified in note 1.