Title [5434]: The economic value of fisheries harvest supported from saltmarsh and mangrove productivity in two temperate Australian estuaries

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Definitions:

- 'penaeid' means any prawn of the family Penaeidae, many of which have economic importance.
- 'nekton' refers to aquatic animals that are able to swim and move independently of water currents.
- 'primary producers' refers mainly to plants and relates to the capacity to utilise solar energy directly using photosynthesis. Primary producers are at the base of the 'food chain'.
- 'trophic' relates to feeding and nutrition.

Summary

Estimated values of fisheries harvest supported by habitats within the regions modelled ranged from around AUD100,000 per year to around AUD7,200,000 per year. Saltmarsh in the Clarence River had by far the greatest economic value per-unit-area, with an average estimated Total Economic Output (from fisheries harvest) of AUD25,741 per hectare per year. The value for mangrove was estimated to be AUD5,297 per hectare per year.

Average Total Economic Output in the Hunter River was AUD2,579 per hectare per year for saltmarsh and AUD316 per hectare per year for mangrove habitat.

What prompted the research

The valuation of ecosystem services is increasingly being employed to support an economic case for habitat conservation and repair. Such valuations are usually system specific and there is substantial variation in such estimates across species, systems and habitats, and across different valuation approaches. This variation highlights a need to further refine estimation of economic value across multiple habitats and estuarine ecosystems. The use of trophic relationships may represent an efficient method that can be applied in a consistent fashion across multiple systems. While there is a long history of research that deals with the trophic linkages between various primary producers (such as mangroves and saltmarsh) and exploited species (such as Eastern King Prawn) in estuaries, these studies are rarely extended to estimate the actual fisheries impact of these primary producers.

What we did

We studied the Hunter River estuary and the Clarence River estuary, both in New South Wales. We used stable isotope composition to model the contributions of saltmarsh and mangrove plants to the biomass of estuarine dependent or resident species of fish and crustaceans*. We then looked at the commercial fisheries catch of fish and crustaceans from each of the two estuaries. We were able to match the harvest with the habitats the fish and crustaceans had used when feeding within the estuary. This meant we could estimate the contribution each habitat area made to the commercial catch. By getting the information from the fish markets about the point-of-sale price for these fish and crustaceans we could establish the Gross Value of Production. By using an economic multiplier we could convert the Gross Value of Production to Total Economic Output.

What we found

For fish, the greatest overall value from mangrove and saltmarsh was derived through Yellowfin Bream and Sea Mullet harvest, and the lowest value derived through Luderick. These differences were largely driven by differences in market value and catch volume. Yellowfin Bream, Mulloway and Dusky Flathead are all higher market value species, whereas Luderick and Sea Mullet have lower market values. The lower market value of Sea Mullet, however, was offset by much larger catches; and this was reflected in higher values derived from both saltmarsh and mangrove.

For invertebrates, the patterns among species were also similar between estuaries, with the greatest economic value from saltmarsh consistently derived through harvest of School Prawn. School Prawn harvest from the model region in the Clarence River was still around 3 times that of the Hunter River.

Depending on whether we looked at Gross Value of Production or Total Economic Output, total habitat values (summed across species) estimated within the model regions ranged from around AUD100,000 per year to around AUD7,200,000 per year. As expected, the highest values derived were for Total Economic Output, which reflected the broader impact of harvest derived from the primary producers across the broader supply chain. Taking into account the areal extent of each habitat in which the primary producers dominate resulted in saltmarsh in the Clarence River having by far the greatest economic value per-unit-area, with an average estimated Total Economic Output of AUD25,741 per hectare per year. The greatest economic value derived from mangrove habitats was also in the Clarence River with a Total Economic Output of AUD5,297 per hectare per year.

Our estimates of the economic value of saltmarsh, including value-per-hectare were consistently greater in the Clarence River. The magnitude by which the value of habitats in the Clarence River exceeded that of the Hunter River was surprising. There are several other factors which may underpin both the increased catch and the greater economic values derived per unit habitat in this estuary. Firstly, average temperatures in the Clarence River (26 °C) are warmer than the Hunter River (23 °C), and this may explain improved fisheries productivity through faster growth and concomitant effects on survival. Secondly, the Clarence River has a much larger waterway area (89 km^2 compared with 29 km^2 in the Hunter River), meaning there is greater subtidal habitat available (i.e. more space) to support fishes. Thirdly, the Clarence River also experiences greater freshwater flows and a lower level of flow regulation, which also contributes to increased recruitment and/or catch of many of the species examined here. Finally, species in the Hunter River are exposed to various contaminants not found in the Clarence River catchment, which could adversely affect growth or reproduction. Consequently, it is likely that habitat value depends on a number of these other factors which may contribute to fisheries productivity, in addition to the areal extent of habitat, and these additional factors may have contributed to the inter-estuarine variation observed here.

Implications

Environmental accounting is receiving increasing attention internationally as governments and other organisations endeavour to increase accountability and stimulate investment in environmental management activities. Our approach to establishing habitat-fishery linkages in support of economic evaluation may prove useful in future efforts in this area, but the actual values estimated here also lay the foundation for further consideration of the costs and potential benefits that can be realised from habitat repair in Australian ecosystems. It is important to note, however, that linking fisheries values to habitat rehabilitation does require additional consideration of other ecological processes (such as adequate recruitment), the value of these habitats as a refuge, as well as other economic factors which are not captured here.

Limitations

To our knowledge, there are no other studies that combine stable isotope-derived trophic linkages with fisheries catch and economic data for the purposes of habitat valuation. Thus, it is prudent to highlight the various assumptions and areas of uncertainty inherent in the approach. The market value estimates used were obtained directly from the auction floor at the state's largest fish market and were probably accurate, but taking the value from a single market essentially ignores the potentially enhanced values that might be achieved through other niche markets. Failing to account for these means that our estimates may be on the conservative side.

The proportional contribution of primary producers to the biomass of exploited species used in this model was determined through stable isotope analysis. This parameter was determined using data directly collected from the study systems (see paper ref 4723).

Given the inherent variability in our model parameters, as well as variation in other factors across spatial and temporal scales, it is unlikely that an actual value will ever be known, and consequently we have expressed our model outputs as distributions so the range of potential values and the level of uncertainty in these estimates can be considered. These estimates deal with commercial fisheries outputs only; consideration of recreational harvest and other ecosystem services will ultimately lead to a more holistic valuation, but such estimates will increase the number of underlying assumptions and may rely on relationships that are more difficult to quantify.

* In order to identify nursery habitat, a method using the stable isotope signature of muscle tissue was developed which enables researchers to know where in an estuary an aquatic animal has been feeding. This two part process involves firstly collecting animals from across the estuary (including from what appear to be nursery habitat areas) to develop a library to which animals of "unknown origin" can be assigned. The second part of the process involves collecting animals as they emigrate from the estuary to join the adult population, and matching the muscle stable isotope signature from these individuals to potential nursery habitat areas to derive the most likely area from which they originated. (See the paper 4723 '*A rapid approach to evaluate putative nursery sites for penaeid prawns'* for a detailed description of this method).