UCDAVIS AGRICULTURAL & RESOURCE ECONOMICS

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Fields of Interest

Environmental and Natural Resource Economics

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Balancing Conservation and Commerce

A shadow value viability approach for handling bycatch in a multi-species fishery

Chair: Michael Springborn

Abstract

The benefits from avoiding [irreversible] extinction events are often not well-known, which makes an expected net benefits approach to conservation problems difficult to justify. A viable control strategy instead focuses on limiting the risk of extinction to some acceptable level, at minimal management cost. In my job market paper, I use a social [fishery] planner's shadow value of leatherback turtle extinction to set market-based instruments for managing turtle bycatch that incentivize socially-optimal fishing behavior among decentralized fishers. My work is the first to tackle the setting of market-based instruments for bycatch when the benefits of preservation are unknown.

Shadow Value Viability

The standard economic approach to natural resource management involves maximizing the difference between the present value of long-run benefits and costs, whether we are thinking about live species, water, or fossil fuels. This is effective when the payoffs are predictable and easy to measure. But many disastrous and irreversible events are difficult to value, such as the extinction of a species.

Viability objectives entail ensuring survival over an extended time horizon with a given likelihood. We can imagine trading off effort across this horizon, opting to act only when things look bleak, or when action has the most bite, or when it is cheapest. But concern for a joint probabilistic outcome spanning an extended horizon creates a methodological challenge: the joint-chance constraint removes the Markov property essential for typical optimization methods.

A new method developed in my dissertation allows a decision-maker to proceed without explicit information on the benefits of taking preemptive action. This involves estimating the loss from disaster that drives enough effort to ensure viability. With this loss I construct a function that tracks the implied value of the system as it moves towards or away from extinction (see left figure). This function replaces the explicit viability constraint, allowing conventional dynamic programming methods to solve the management problem.

Management objectives that aim to avoid key thresholds over time with a margin of safety are abundant. Examples include maintaining safe endangered species populations, global temperatures below a maximum increase, and disease prevalence away from outbreak levels. Shadow value viability translates the implied value of avoiding these thresholds to the benefits of reducing risk on the margin, which enables all of these urgent issues to be investigated through an economic lens.

Turtles and Swordfish

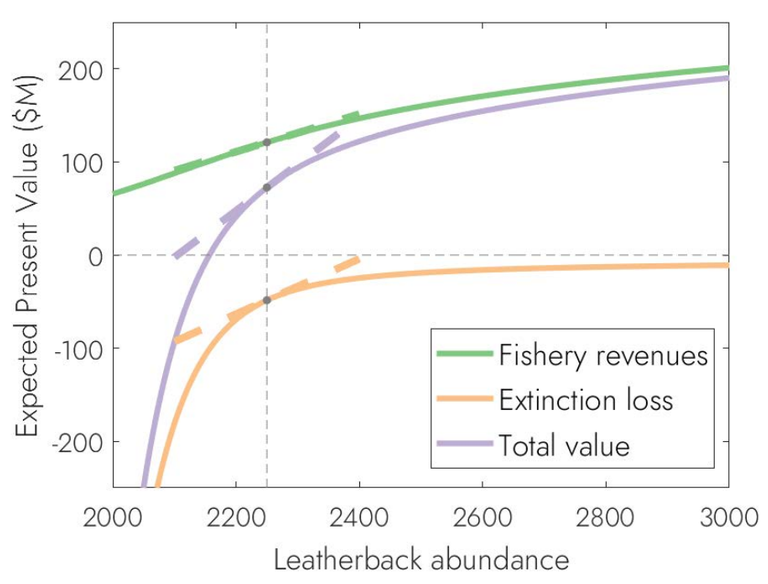
The Pacific leatherback turtle population co-mingles with the California gillnet swordfish fishery, and the risk of bycatch threatens both turtle survival and swordfish revenues. The current approach to protecting leatherbacks uses inflexible management tools like marine protected areas and gear requirements, which are very effective but pose unnecessarily high costs to the fishery. Before a large spatial closure was put into place, incidental take of leatherbacks rarely exceeded 30 individuals–less than 1% of the total population. Now this has been eliminated, along with a bountiful swordfish fishery.

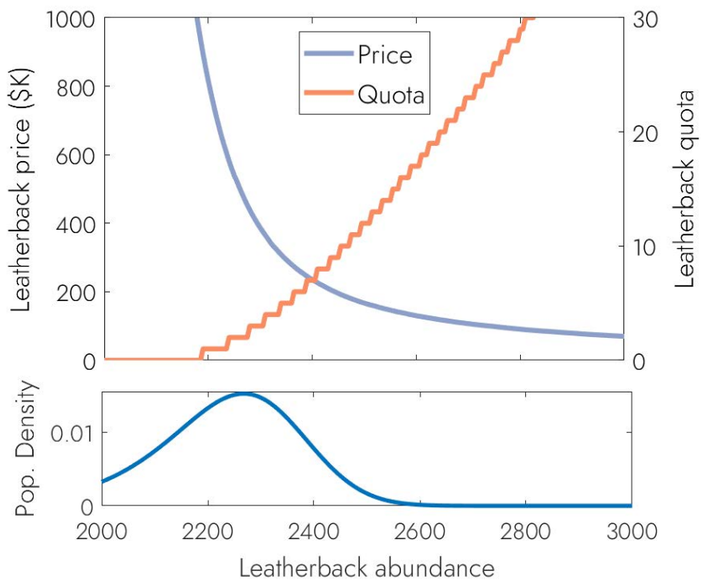
Market-based instruments–calibrated to the implied benefits of leatherback conservation–can enable greater flexibility for how fishers choose to avoid bycatch and allow for the de-implementation of more costly management methods. I use shadow value viability to set these instruments to reflect the implied value of changes in the risk of leatherback extinction.

Regulating Bycatch

Ideally, instruments for regulating bycatch would account for both economic and biological factors concerning multiple species. My work weighs leatherback turtle viability against potential swordfish fishery rents. The tradeoff of these two "goods" can be captured by market-based instruments. Prices can capture more value via inter-season flexibility, but quantities can be more politically-favorable because the magnitude of the price instrument is relative to the avoidance costs of bycatch. If there are not many margins for adjustment regarding fishing behavior, prices will be higher.

In the long run, the fishery achieves a present value of $125M, which equates to $4M in seasonal revenues. This is 5 times larger than under current management. The leatherback population is expected to fall an additional 400 turtles compared to current management, but this abundance is still stable enough to avoid extinction.





Left: The value of the swordfish fishery is decomposed into ex-vessel revenues and the loss due to potential future leatherback extinction. As populations degrade, the threat of extinction becomes more salient (orange) and tightened regulations further hinder the fishery's future revenues (green). Both of these phenomena contribute marginal values (tangent lines) which provide conservation incentives that weigh against today's economic benefits.

Right: I translate this marginal valuation of the leatherbacks to price and quota instruments, conditional on the current population. Under either of these policies, leatherback abundances tend to lie in a region where prices per turtle are quite high or where quota fall between 0-10 turtles.

Summary of Job Market Paper