Maximizing conservation benefits

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Overexploitation and population collapse pose significant threats to marine fish stocks across the globe. While certain fish populations have already collapsed, research indicates that nearly one third of fisheries worldwide are currently impacted by overharvesting.

In "Meeting Yield and Conservation Objectives by Harvesting Both Juveniles and Adults," published in *The American Naturalist*, Niklas L.P. Lundström, Nicolas Loeuille, Xinzhu Meng, Mats Bodin, and Åke Br?nnström emphasize the urgent need to refine fishery management practices in order to mitigate these trends and preserve fish populations. In the article, the authors investigate whether shifts in harvesting practices possess the potential to optimize yields while still prioritizing sustainability.

The study aims to determine whether reducing fishery harvests slightly from the maximum sustainable yield, or MSY, will produce high yields while also aiding conservation efforts. Introduced by MacCall and Hillborn, these reduced sustainable yields are known as "pretty good yields," or PGY, and contain 20% fewer fish than the quantity that is typically harvested in the maximum sustainable yield.

Drawing upon scientific literature, the authors argue that while the MSY exhibits clear economic benefits, the concept is challenging to estimate accurately and to properly implement as a harvesting practice. Additionally, relying upon MSY harvesting strategies has done little to protect fisheries from collapse.

"In contrast to MSY harvesting management objectives, PGY can be realized by a range of harvesting strategies and therefore leaves room to account for other desirable objectives in addition to the maximization of yield," the authors write.

Utilizing both an age-structured population model and a stage-structured population model, the authors conducted a stability analysis to illustrate how yield and conservation measures change when different harvesting strategies are used. In particular, the authors use the models to assess whether selectively harvesting greater quantities of juvenile fish—or conversely, greater quantities of adult fish—impacted the overall stability of the population.

The authors measured four different characteristics to gauge the ecological stability of a fishery: biomass, size structure, basic reproduction ratio, and resilience. The authors denote biomass and population size structure as "impact measures" that directly affect fish populations. Resilience and reproduction ratio, on the other hand, serve as "risk measures" that assess a population's likelihood of facing extinction.

To examine discrepancies between conservation and yield, the authors examined adult harvesting, juvenile harvesting, and equal harvesting as three separate functions. In order to determine the efficiency of the individual strategies, the authors then accounted for an economic concept known as Pareto efficiency. According to this concept, a strategy reaches maximum efficiency when no further enhancements can be made without adversely altering one variable.

The Pareto front—a curve representing the most efficient harvesting strategies—was plotted against the three functions. This step was repeated for each of the four conservation measures.

Results reveal that employing PGY harvesting strategies instead of MSY strategies offers significant conservation advantages. Additionally, the authors find that, in the majority of cases, harvesting equal quantities of juveniles and adults efficiently supports both yield and population stability.

More information: Niklas L. P. Lundström et al, Meeting Yield and Conservation Objectives by Harvesting Both Juveniles and Adults, *The American Naturalist* (2019). DOI: 10.1086/701631

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