Beyond yield: balancing ecosystem services in harvested predator-prey communities

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Abstract

The global overexploitation of fish stocks is endangering many marine food webs. Scientists and managers now call for an ecosystem-based fisheries management, able to take into account the complexity of marine ecosystems and the multiple ecosystem services they provide. Yet, many fishery management plans only focus on maximizing yields, and thus on reaching the maximum sustainable yield (MSY) of harvested stocks. Such practices however have side effects on other ecosystem services, altering the integrity and resilience of natural communities. The compatibility of yield-maximizing strategies with an ecosystem management of marine food webs thus comes into question. Here we show that while MSY policies can be sustainable and resilient in predator-prey communities, they are not optimal in this multi-objective context. We find that maximizing total predator and prey yields can maintain the integrity of the community if the harvest is not focused on prey. In that case, balancing yield and resilience at MSY implies a balanced harvesting between trophic levels. Beyond MSY, when promoting resilience is considered a supplementary management objective, we show that optimal harvesting strategies are located on a yield-resilience trade-off. In this multi-objective context, we find that resilience-maximizing strategies fare better than yield-maximizing strategies. Maintaining resilience is thus compatible with high yields, and should be part of future management policies. Further, our results suggest that the balance between ecosystem services in exploited food webs is dependent on the distribution of harvest between trophic levels.

Keywords: Maximum sustainable yield, resilience, ecosystem based fisheries management, ecosystem services, multi objective optimization, balanced harvesting

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