Marine Policy 93 (2018) 55–61

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Fisheries bycatch reduction within the least-cost biodiversity mitigation hierarchy: Conservatory offsets with an application to sea turtles

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A R T I C L E I N F O

Keywords:
Fisheries
Bycatch
Sea turtles
Biodiversity mitigation hierarchy
Offsets
Least-cost conservation

A B S T R A C T

This paper considers fisheries bycatch reduction within the least-cost biodiversity impact mitigation hierarchy. It introduces conservatory offsets that are implemented earlier in the biodiversity impact mitigation hierarchy than conventional compensatory offsets used as instruments of last resort. The paper illustrates implementation in an on-going sea turtle conservation programme by the International Seafood Sustainability Foundation.

1. Introduction

How should fisheries bycatch reduction be achieved?[1] This paper discusses three concepts that address this issue. First, it places fisheries bycatch reduction within the least-cost biodiversity impact mitigation hierarchy (BIMH) to achieve the maximum bycatch impact reduction, especially when faced with budgetary limits. Second, this paper develops conservatory offsets, used off-site in the first three steps of the BIMH (unlike conventional compensatory offsets used in the last step), as a voluntary, incentive-based, least-cost, and off-site complement or substitute for other, on-site mitigation measures of the first three steps. They yield benefits ranging from partial recovery to over-recovery (above the baseline) of the stock or habitat depending upon scheme and context. Third, this paper posits incentive-based bycatch policy to price bycatch and alter consumer and producer behavior and decision-making to achieve cost-effective bycatch reduction within and across BIMH steps and all bycatch reduction channels and create dynamic incentives for bycatch-reducing technological change. This paper illustrates these three propositions through fisheries examples.

The following sections discuss successively: least-cost BIMH; BIMH and compensation; conservatory offsets in fisheries; and conservatory offsets in sea turtle conservation.

2. Least-cost biodiversity impact mitigation hierarchy

The BIMH [1,2,21] provides an overarching conservation framework that can be used to achieve bycatch reduction, and more generally marine biodiversity conservation [13,15,19,20]. Its application aims to: (1) *avoid* any impact, (2) *minimize* unavoidable impact, (3) *restore* biodiversity, in that order and as much as practicable, before considering (4) to *compensate* the residual impact, aiming at No Net Loss.[2] The first three steps are *conservatory* and applied *onsite.* The fourth step is *compensatory,* applied *off-site* and on different albeit comparable (`like-for-like' or `in-kind') biodiversity, and entails offsets.

Fisheries management is similar in function and approach to the BIMH *conservatory* steps (Fig. 1): avoid and minimize overfishing on-site, and as appropriate restore/rebuild depleted stocks [20]. The BIMH, never referred to in fisheries, is used in practice. Nothing in the United Nations Law of the Sea Convention (LOSC) impedes fishery managers from simultaneously addressing the three steps even though, logically, stocks cannot be “restored” before having fallen below the maximum sustainable yield (MSY) level (No Net Loss equivalent).

Avoidance of bycatch is on-site and uses: (i) risk-based spatial and temporal planning of fishing, notably zoning, closed areas (including Marine Protected Areas) to protect habitats, nurseries, endangered species and biodiversity `hotspots'; (ii) moratoria in the case of deep

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[1] Bycatch may consist of: (1) target species of non-commercial or prohibited landing size, or of catch inadvertently taken above quota; (2) protected species (e.g. emblematic or under mandatory rebuilding), with contributions to biodiversity and ecosystem, but without market price; and (3) species constituting living habitat (e.g. corals, sponges, seagrass, kelp) the contribution of which to biodiversity and ecosystem is most often poorly known and underpriced or unpriced.

[2] In principle or at the project development stages, steps may be applied sequentially, but at implementation, one or more may be simultaneously applied.

https://doi.org/10.1016/j.marpol.2018.03.018
Received 8 May 2017; Received in revised form 17 March 2018; Accepted 18 March 2018
0308-597X/ Published by Elsevier Ltd.

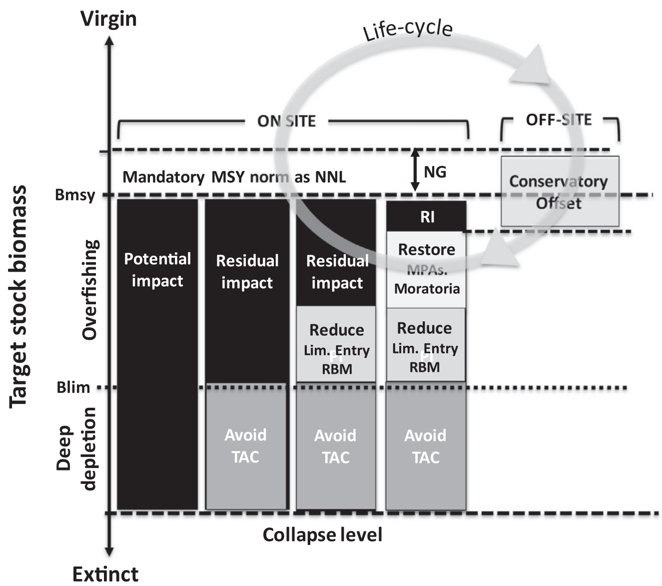

Fig. 1. *BIM hierarchy as applied in fisheries management.* Bmsy, Maximum Sustainable Yield Biomass, is the NNL biomass level imposed by the LOSC. Blim is a precautionary biomass limit. TACs, Limited Entry and Rights-Based Management (RBM) were introduced sequentially. Conservatory offsets are recent and applied offsite but within the life cycle. Modified after BBOP [1].

depletion; and (iii) bycatch-reducing technological innovation, e.g. when information technology, such as satellite imaging, allows detection of biodiversity `hotspots' or areas of unacceptable ratios of bycatch to target catch,[3] or skill and experience gained over time (learning-by-doing) of areas to avoid to reduce bycatch.

Minimization, one of the main tasks of conventional fisheries management, reduces the ongoing on-site impact of fisheries. Performance standards, such as individual catch and effort quotas, trip limits, Total Allowable Catch, and technology standards, such as prescribed gear and operating standards, are the primary means of minimization under direct or `command-and-control' regulation. Bycatch-reducing technological change also minimizes bycatch and post-bycatch mortality. Examples include: circle hooks that replaced J hooks and mackerel-type bait that replaced squid for pelagic longlines harvesting swordfish; Tori lines to minimize seabird bycatch on longliners; Turtle Excluder Devices for shrimp trawls; and sorting grids and altered mesh sizes and designs for groundfish trawls.

Restoration or *rebuilding* of a stock is necessary and mandatory when overfishing or depletion has reduced the stock to or below the minimum authorized by the LOSC (i.e. the MSY level) and, *a fortiori*, the minimum safe biological limit below which the species reproduction is threatened (according to the LOSC and Convention on Biological Diversity or CBD). They aim at halting and reversing negative trends and rebuilding stocks of target and non-target resources as well as critical habitats. Conventional fisheries conservation measures are used, coordinated in rebuilding plans, e.g. reduction of capacity, effort or removals, as a priority; restocking (introductions of reared juveniles); habitat restoration; and technological change, just as in the preceding steps but more stringently due to higher risk of collapse. More specific measures may be used under deep depletion, well below the MSY level, including no-take-zones, moratoria and international trade controls (Convention on International Trade in Endangered Species listing).

Least-cost implementation of the BIMH yields bycatch reduction per dollar expended less than that achieved by direct regulation [13,15,19,20]. By imposing the same standards upon all vessels and bycatch reduction channels within and across the BIM steps, irrespective of their specific level of bycatch, avoidance, minimization, and restoration methods and costs, direct regulation imposes a uniform `one-size-fits-all' approach. Direct regulation faces diminishing returns in effectiveness, does not incentivize vessels to use all bycatch reduction channels across and within BIMH steps, and can face increasing amounts of foregone target catches and revenues (opportunity costs) per dollar expended in mitigation. Direct regulation increases the average cost of continued `dirty' production of target species, creating a crude incentive to reduce bycatch through reducing the scale of production of both catch and bycatch. But because remaining (residual) bycatch is not given a price and cost, so that vessels do not bear the full social-ecological costs of fishing, the scale of production of both bycatch and target catch and the ratio of bycatch to target catch do not decline to the optimum.

Least-cost application of the BIMH intends to achieve the maximum possible bycatch reduction for a limited budget [13,15,19,20]. In principle, it results in the incremental cost from the last unit of bycatch reduction (the marginal cost) to equalize across and within BIMH steps. In practice, however, the average cost per unit of bycatch reduction is typically equated.

Incentive-based policy instruments, which price bycatch, are increasingly used to avoid and minimize bycatch and restore bycatch stocks in a least-cost way [5,7,8,13,15–17,19,20]. Instruments, such as fishing rights for bycatch, effort or capacity caps, bycatch credits, assurance bonds, and bycatch taxes, could be combined and progressively stacked to incentivize the BIMH, making it least-cost (cost-effective) [13,15,16,19,20].

One of the most promising avenues is through incentivizing real-time spatial management (dynamic ocean management) [9]. For example, bycatch credits in the Eastern Bering Sea Pollock fishery incentivize real-time spatial management to avoid salmon bycatch [14]. They price and thereby increase the cost of residual bycatch and hence target species cost. The increased cost incentivizes producers to reduce the bycatch to target catch ratio and to reduce effort and hence catch of both bycatch and target species.

3. Mitigation hierarchy and compensation

Compensation, the fourth step of the BIMH, is used when a residual impact cannot be further reduced or restored and uses *compensatory offsets* [1,2,21]. This section discusses compensatory offsets' potential role in marine fisheries, where their application is complicated by coexistence of the LOSC and CBD.

The LOSC framework requires managing <u>all</u> target fishery stocks *to maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield [MSY], as qualified by relevant environmental and economic factors* (Article 61.3). This paper argues that the LOSC, the UN Fish Stocks Agreement, and FAO Code of Conduct for Responsible Fisheries do not foresee compensatory offsets, applied elsewhere (off-site) on some other stock or meta-population (out-of-kind), even for the same species, for rebuilding depleted target stocks that all should be maintained or rebuilt at MSY (as NNL level) [19,20]. The LOSC also requires *maintaining or restoring populations [of dependent and associated species] above levels at which their reproduction may become seriously threatened* (Article 5e) without further specification. For these species, the MSY norm may not be relevant, but a No Net Loss level is nonetheless *de facto* defined, based on a reproduction criterion, above which all such stocks <u>must</u> be maintained. For living habitats, only the general environmental provisions calling *to protect and preserve the marine environment* (Article 192) may be used, *a priori* allowing any management measure, including presumably offsets.

The CBD must be implemented *consistent with the LOSC* (Art. 22.2). It stresses inter alia the need for *maintenance <u>and recovery</u> of viable populations* (Preamble, emphasis added) and defines *sustainable use* as a

[3] For example, acoustic devices on buoys attached to Floating Aggregator Devices (FADs) detect unacceptable bycatch levels under FADs, signaling tropical tuna purse seiners to avoid setting the net.