Antarctic Affairs. Vol 2 (2015) 1-8
ISSN: 2451-7755 (Print) - Journal homepage: www.antarticaffairs.org

BALANCED HARVESTING – AN EMERGING CONCEPT IN FISHERIES MANAGEMENT

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ABSTRACT

Over the past few decades, many fish populations have declined while pressure to increase catches has grown. In response, a number of alternatives to traditional fisheries management have emerged, with the goal of maintaining ecosystem health while still allowing fishing. One such strategy is called balanced harvesting (BH), which advocates fishing a wider range of species and sizes of fish. BH proponents claim that their methods will reduce impacts on marine ecosystems while resulting in comparable or even higher catches. However, critics have noted a number of problems with BH that indicate it would not achieve these aims. Additionally, even proponents concede that BH would likely produce lower value harvests dominated by small forage fish. Within an Antarctic context, BH, as an apparently ecosystem-based approach, might seem attractive to those seeking to increase catch limits. However, we conclude that BH is also unlikely to work in Antarctica for a number of reasons, including the many scientific uncertainties relating to marine species and the requirements to catch species with potentially minimal market value. Instead of seeking alternatives to standard fisheries management practices, a more promising approach is to implement proven strategies, such as reducing fishing levels and mitigating bycatch and habitat damage to ensure healthy environments and sustained catches for the long term.

Keywords

Balanced harvesting, fisheries, marine environment, ecosystem management, Antarctica

Introduction

Over the past few decades, we have learned a lot about the declining state of global fish stocks. This knowledge has prompted many re-examinations of the central assumptions of fisheries management, as well as calls for new approaches such as ecosystem-based fisheries management (EBFM), marine spatial planning (MSP) or marine protected areas (MPAs). Another new approach, balanced harvesting (BH), has received somewhat less attention than the others, but has received some support from high-profile scientists and was the subject of a workshop co-hosted by the International Union for the Conservation of Nature (IUCN). The scientists supporting balanced harvesting (BH) make the intriguing claim that we can fish at the same or greater levels while having a reduced impact on marine ecosystems. Moreover, because in theory BH provides ecosystem protection, it could challenge other ecosystem-based approaches to management.

Fishery managers have not implemented BH in many places. Nevertheless, two groups of scientists have recently published detailed critiques of the concept, indicating that it is to some extent being taken seriously (Burgess et al. 2015; Froese et al. 2015). It is therefore important to understand this idea and the potential environmental impacts it might have. Some countries have been open about their desire to expand fishing in places like the Southern Ocean (Neslen 2013.; Niiler 2015), so there could be pressure to increase catch limits and open up new fishing grounds. Balanced harvesting principles could be appealing to those seeking to justify such changes.

Currently, responsibility for managing the Southern Ocean around Antarctica falls to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), an international organization formed in 1982 with the goal of conserving Antarctic marine ecosystems. CCAMLR uses an ecosystem-based, precautionary approach to management. This approach is mandated by Article II of the convention or treaty that established CCAMLR. There are currently 25 signatories to this convention, which requires that:

(a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;

(b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above; and

(c) prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.[CITE]

Balanced harvesting claims to be able to accomplish similar goals. The basic concept of BH is to fish all species in proportion to their reproductive rates and their role in the food chain, thereby keeping the ecosystem in balance while still catching enough fish for human consumption . However, critics have charged that there is little evidence indicating that it can do so. They have additionally noted that implementation might involve harvesting of species not currently targeted, such as whales, seals and seabirds(Froese et al. 2015). This has troubling implications for the Antarctic with its iconic penguin, whale and seal species, many of which are dependent on krill, a low trophic level (LTL) species.

"Traditional" fisheries management

One of the main critiques of traditional fisheries science is that it is overly focused on individual species without considering the full ecosystem. For the purposes of this article, "traditional" fisheries science refers to the concepts and principles for fisheries science that emerged in the post-World War II period. The basic assumptions of traditional fisheries science focus on the biology of the target species, which is used to guide the development of management regulations, including catch limits. Understanding the role of a species in the broader ecosystem and incorporating that into management was thus not always prioritized. However, these deficiencies were recognized early on, even by proponents, who warned that catch limits generated by this science were likely too high for most species (Larkin 1977 quoting Gulland 1969). Significant attention has since been paid to reforming fisheries science and management to protect ecosystems and the marine environment more effectively. But implementing new policies has been slow, and many fish stocks and bycatch species are still in decline.

To fully understand the challenges of BH and other efforts to reform fisheries management, we will quickly review the basics of traditional fisheries science. Perhaps the most famous is maximum sustainable yield (MSY). MSY is the level of catch that fisheries science determines could be taken annually without harming the ability of the population to reproduce its numbers. MSY was for a time a revolutionary concept. It is almost a cliché in environmental circles to note that for centuries, few believed humans had the capacity to influence fish populations. The sea was thought to be inexhaustible, despite evidence to the contrary. In the early twentieth century as fishing technology improved, scientists and managers began to realize that fishing was in fact having a serious impact, and that catches needed to be controlled (Finley 2011). Scientists began studying fish population dynamics and biology and used the results to develop mathematical equations and models that could help managers calculate MSY and thus avoid overfishing.

One key conclusion of this research was that fish populations produce a certain amount of "surplus" every year. Under this surplus production model, harvesting a certain number of adult fish will have minimal long-term impact, because removing them from the ecosystem will merely clear the way for more juvenile fish to survive to maturity and reproduction. By studying the biology of targeted species, data can be gathered and plugged into mathematical models to produce a series of indicators to guide management. Other indicators include fishing mortality, or F, which refers to the proportion of the mortality in a population caused specifically by fishing.

This scientific approach to fishing was an important step towards ending the dangerous unregulated exploitation that threatened to collapse many of the world's fisheries. Even so, the approach clearly had some drawbacks. Fish are part of ecosystems, and MSY may not account for the complex interactions as predator and prey that a species might have in its particular food web, or as one of several species in the same area that are being fished. Hence even proponents of this new mathematical approach to management warned against using MSY as a goal. But in practice few recognized that "maximum" meant just that – the outer limit of what could be harvested safely – and that lower than MSY catches would better protect fish populations and the environment.

Over the next several decades, the limitations of MSY became increasingly clear. Yet it had become thoroughly entrenched in management, an idea which was more of a religious belief or policy goal than it was sound science (Larkin 1977; Finley 2011). Calls for new management systems or even modifications to the MSY regime have proved difficult to implement successfully even though many commercial stocks are in decline. Balanced harvesting was conceived as a way forward.

Balanced harvesting – an overview

Balanced harvesting originates from the idea that the oceans can support a much higher rate of sustainable harvest if, instead of the selective fishing currently favored, a broader array of species are targeted (Zhou 2012). The ecosystem remains intact, meaning that the basic relationships between species remain unchanged. Selective fishing in this context relates to the preference in most regions of the world for fishing only some of the species in a particular area, often because only certain species are profitable. In theory, by fishing unselectively across all species at a moderate rate, the structure of the ecosystem is less impacted, and fishing natural ecosystem predation dynamics. Under a traditional fisheries management regime, for example, species A might be fished while species B and C, predators of species A, might not be fished at all because they are not commercially valuable. There will thus be a significant impact on species A from the combined impact of fishing and predation, and the population may begin to decline. Implementation of BH principles would result in fishing a smaller proportion of species A but beginning to fish species B and C as well. The predation pressure on Species A is reduced, yet by fishing new species B and C, overall catches will not decrease.

Nevertheless, this unselective fishing must be carefully managed. As the name suggests, the goal of BH is to fish in such a manner that the ecosystem remains intact and the relationships between species within it remain unchanged. To do this, all ecosystem components must be harvested at levels that maintain the relationships between species that would occur in an intact ecosystem otherwise the ecological relationships between species could shift or even be severed (Garcia et al. 2012). Depending on the region, a truly balanced harvest would include far more than just fish and invertebrates as many birds and marine mammals make up important components of the marine ecosystem as well. Another outcome of BH is that catches of small forage fish will increase, something that would need to be reconciled with consumer habits (Jacobsen et al. 2014). These species are typically considered low-value by the standards of most world markets making BH a less viable proposition from a financial standpoint.

So far, balanced harvesting remains a largely untested proposition, with its proponents relying on computer and mathematical models to demonstrate its potential effectiveness. These models showed that theoretically, BH could lead to increases in overall yields while preserving ecosystem structure. As a result, empirical evidence for balanced fishing has been gathered by studying unregulated fisheries on some African lakes. These fisheries were unselective and focused primarily on small species yet, according to the proponents of BH, the indiscriminate fishing had little effect on the structure of the fish communities found there (Jacobsen 2014).

Critiques of balanced harvesting

Balanced harvesting presents itself as a clear solution with few downsides, but there have been some recent critiques that cast doubt on its ability to be implemented. BH requires extensive knowledge of the target ecosystem so that species can be fished in proportion to their productivity and so that ecosystem functions can be maintained (Froese 2015). Single species fisheries have had difficulties in attaining the level of knowledge to manage just one species, let alone all of the species in an ecosystem. As it stands, implementing a BH scheme would require a much higher degree of knowledge than currently exists and enacting the regulatory policies and changes to fishing gear are well beyond what is currently possible (Froese 2015).

Also problematic is the lack of empirical evidence supporting balanced harvesting. Advocates of the strategy point to several inland fisheries in Africa where, despite a lack or regulation and a focus on forage fish, the structure of the ecosystem remained intact (Garcia et al. 2012). Setting aside the fact that small inland fisheries (enclosed systems) are unlikely to be a good analog for large marine fisheries (unenclosed systems), the African fisheries used as evidence of BH's viability were actually in a state of collapse, having been overexploited by unselective nets in the years prior (Froese 2015). Furthermore, fish biomass was depleted by an astonishing 80%, and while this may not be a representative case, Burgess et al. (2015) note that new research has found that fish play a role in deepwater carbon storage. Increasing the overall yields taken from an ecosystem could reduce the sequestration of carbon and the availability of nutrients to benthic organisms. Balanced harvesting could therefore produce a situation in which ecosystem structure is technically maintained, but causes damage to other important marine ecosystem services. BH proponents clearly need to examine these kinds of unintended consequences further.

Although BH proponents claim that fishing practices like taking older fish and being selective about which species are harvested causes populations to decline over time, many scientists point out that fisheries that caught mostly large, older fish were sustainable for centuries. To use a well-known example, the infamous collapse of the North Sea cod (Gadus morhua) fisheries in the 20th century occurred only once the fishing level became unsustainable and began targeting smaller individuals. Until then, the cod fishery, a selective unbalanced fishery, had been viable for centuries without reducing the average size of the catch (Froese 2015). The key was that fishing mortality was kept at a lower level, allowing the population to replace individuals lost to fishing.

This problem leads to another risky element of the BH approach: fishing for juveniles, which is often prohibited under traditional fisheries management because it harms the population's reproductive capacity. BH assumes that appropriate management measures could prevent this because fishing of juveniles will be balanced by fishing of their predators, leaving approximately the same number to reach maturity as would be found in an unfished system (Froese et al. 2015). Unfortunately, there is little evidence to support this, and much greater evidence to support that fishing only mature adults at reduced levels helps many depleted populations to recover and rebuild (Froese et al. 2015). Yet again, the problem is not the way that fishing is distributed in an ecosystem, it is that too many fish are being removed.

Consumer habits are another barrier for BH. Currently, consumers in the global north prefer fish that are higher on the food chain, like tuna, cod, salmon, or toothfish and are willing to pay more for these species. In a BH model, a smaller number of these high value species would be harvested, meaning the market for forage fish would need to expand. If consumers could not be convinced to directly consume these species, it is likely they would be used for fishmeal for aquaculture of high value species (Jacobsen 2014). The feasibility and environmental friendliness of such a scheme would depend greatly on the economic realities of conducting BH in remote locations while reducing the GHG emissions associated with the increased fuel use (Burgess 2015). Otherwise, procuring this fishmeal could become too costly both in a financial and environmental sense.

In sum, BH raises a number of concerns. Not only are its basic assumptions contrary to the available evidence on how fish populations and ecosystems respond to fishing (Froese et al. 2015), but the changes in fishing practices it requires might entail higher costs, making fishing unprofitable (Burgess et al. 2015). Thus, additional analysis and testing must occur before BH principles are incorporated into fisheries management. Or, we could simply implement the proven strategy of reducing fishing mortality.

Balanced harvesting in an Antarctic context

Some BH skeptics concede that it might work in some locations (Burgess et al. 2015). Its call to fish more lower trophic level species might resonate with those seeking to increase krill (Euphausia superba) catches in the Southern Ocean, for example. Also, the Southern Ocean's relatively short food chain might simplify the calculations needed to evenly distribute fishing impact across the ecosystem. In Antarctica, many species are primarily reliant on krill (Euphausia superba), so there are fewer trophic interactions to understand and incorporate into a management strategy. Nevertheless, Antarctic food webs, while perhaps less complicated than that of a coral reef, can vary spatially and temporally depending on prevailing conditions and whether krill, salps or copepods are the primary species of zooplankton acting as the base of the food chain (Murphy et al. 2012).

Additionally, the requirements of BH to harvest non-traditional species as part of maintaining a balance will not fit in well with the current protection of Antarctic species such as seabirds and marine mammals. Were these restrictions lifted, it is still unlikely that people would be eager to consume penguins, or that commercial fishing companies would be eager to travel to Antarctica to hunt them. Given the high costs associated with operating in such a remote location, few might be willing to even expand efforts to include other fish species, which are unlikely to attract the same high prices as toothfish (Dissostichus eleginoides and Dissostichus mawsoni).

Economic and environmental considerations aside, there are still many question marks hanging over the lifecycles of various Antarctic species and their role within the greater ecosystems of the Southern Ocean. Scientists are still trying to understand the lifecycle of toothfish, and the impacts of climate change on Antarctic krill. Even less is known about many species not currently fished. By necessity, a BH scheme requires a robust understanding of all components of an ecosystem so that any change to a species within the ecosystem can be predicted.

While the goal of BH is laudable- to increase fishing yields while preserving ecosystems- it does not seem to be a promising alternative to current methods for protecting the marine environment. Unfortunately "moderate harvesting of resilient species for human consumption, with least possible impact on stocks and ecosystems, is still the most promising approach for sustainable use of the living ocean" (Froese et al. 2015), even though this often entails making difficult alterations to current practices. Proponents of BH want to help solve the problem of declining fisheries yields in the face of global population increases, due to presumed future food security issues.

BH and other solutions to future food security problems are often premised on the idea that growing populations will want more animal protein and that the market must meet this demand. This assumption misses two key points. The world already produces enough food to feed everyone, yet hunger and malnutrition persist. Distribution of food and financial resources may therefore ultimately matter more than sheer quantity. Increasing supply thus will not necessarily solve such problems. Moreover, we should not necessarily accept that current animal protein consumption patterns in wealthy nations must be replicated throughout the world. Rather than trying, under a BH approach, to convince people to eat new species of fish, we could reduce the demand for meat and fish (Burgess 2015). Though a challenging task, this would likely improve human health and help shrink the carbon footprint of the food supply (Burgess 2015).

BH is an appealing, but incredibly risky idea. If a BH scheme is poorly managed, it has the potential to do far greater harm than the current methods of managed selective harvest. On the other hand, reducing catches on fish populations and allowing them to rebuild is much less likely to result in significant environmental harm. Rather than reinventing the wheel on fisheries management, we must instead undertake the difficult but necessary work of understanding marine ecosystems, and developing appropriate regulations to protect targeted species and their ecosystems. CCAMLR has pioneered this approach in the Southern Ocean. As pressure to increase catches of Antarctic marine species builds, CCAMLR would do well to remember its past successes and remain firmly on the proven course of precautionary, ecosystem-based management.

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