Considerations for Developing a Risk Policy Underlying Annual Catch Limits

Discussion paper

Prepared for the New England Fishery Management Council's Risk Policy Workshop Steering Committee

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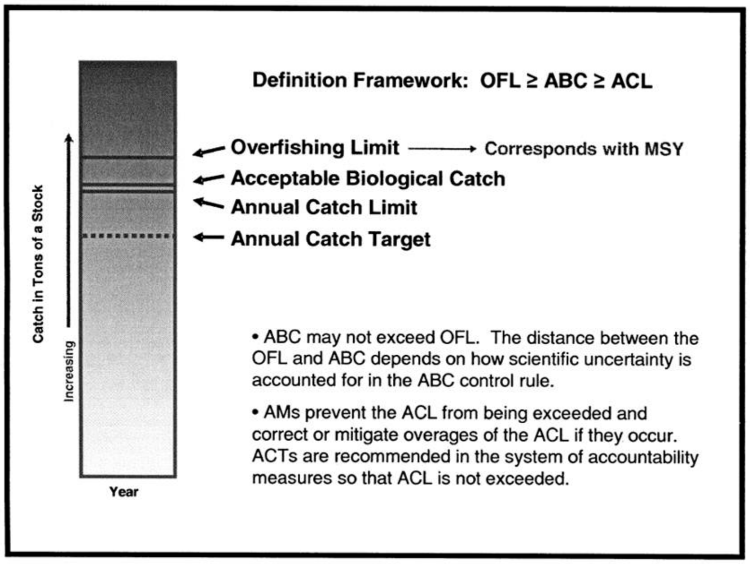
Prologue

This paper outlines key issues and concepts that need to be considered in order to develop a more transparent and better informed risk policy for setting annual catch limits. Members of the Steering Committee established to organize the New England Fishery Management Council's Risk Policy workshop contributed to this paper, which aims to propose ideas and generate discussion, rather than reach conclusions. This paper does not necessarily represent endorsement of its content by the Steering Committee as a whole or any of its members. The workshop and processes arising from it will aim to reach more firm conclusions about the definition of risk, its key elements, methods for evaluation, and processes for determining and implementing policy.

Annual catch limits

The 2007 re-authorization of the Magnuson-Stevens Act (MSRA) and subsequent development of the National Standard 1 (NS1) guidelines created a new system for establishing annual catch limits (ACLs) in federally managed fisheries. The new system includes two important changes. Firstly, ACLs now reflect buffers that account for both scientific and management uncertainty (Fig. 1). The scientific uncertainty buffer reduces the risk-neutral overfishing limit (OFL) to an acceptable biological catch (ABC). The ABC effectively becomes a risk-averse OFL. Given the likelihood of uncertainty in the capacity for management to keep catch at or below the ABC, a second buffer that accounts for management uncertainty is then added to reduce the ABC to the final ACL. The line between scientific uncertainty and management uncertainty is not always clear-cut, however. For example, the speed with which the overall fisheries science/management system is able to detect effects of management measures (e.g., ACLs) on the stock and respond is rooted in management uncertainty, but also affects scientific uncertainty because different response times will have different effects on stock dynamics.



- ABC may not exceed OFL. The distance between the OFL and ABC depends on how scientific uncertainty is accounted for in the ABC control rule.
- AMs prevent the ACL from being exceeded and correct or mitigate overages of the ACL if they occur. ACTs are recommended in the system of accountability measures so that ACL is not exceeded.

Figure 1. Relationship among the overfishing limit (OFL), acceptable biological catch (ABC), and annual catch limit (ACL), as well as the optional annual catch target (ACT). Scientific uncertainty is incorporated in the ABC buffer and management uncertainty is incorporated in the ACL buffer, although some aspects of uncertainty do not fit neatly into one or the other (e.g., response time of the management system). (From the Federal Register, vol. 74, no. 11, 16 January 2009)

The second major change was that the responsibility for determining the ABC, and therefore the maximum potential value of an ACL (if management uncertainty is assumed to be zero), was explicitly given to the Scientific and Statistical Committees (SSCs) of the Regional Fishery Management Councils. SSCs might also advise on management uncertainty buffers chosen to set the ACL, but the Councils retain the authority to determine management uncertainty buffers. In fact, the Councils also decide the control rules used to set ABCs, although typically the control rule is also developed by the SSC at the request of the Council.

Roles of science and management in establishing buffers

Developing a control rule and then specifying the scientific uncertainty buffer that adjusts the OFL to the ABC is not a straightforward process. Although a scientific endeavor, selecting an appropriate buffer should be done to meet policy goals. Specifically, the buffer added to determine the ABC should strive to meet a chosen level of risk tolerance. MSRA and NS1 require that the risk of overfishing be less than 50%, but there is considerable room for different levels of risk tolerance within that limit.

The decision about risk tolerance should not happen in the scientific arena. After all, although a scientific process can produce as an outcome, for example, our best estimate of stock size or fishing mortality rate, determining acceptable risk is not a scientific judgment. In other words, although there can be an objectively “best” estimate for a given biological trait, there is no comparable objectively “best” level of risk tolerance. Instead, science should provide decision-makers with the guidance needed to set an informed risk policy, and then provide the analyses needed to set management strategies aimed at achieving that policy through the ABC, ACL and other management measures (Fig. 2).

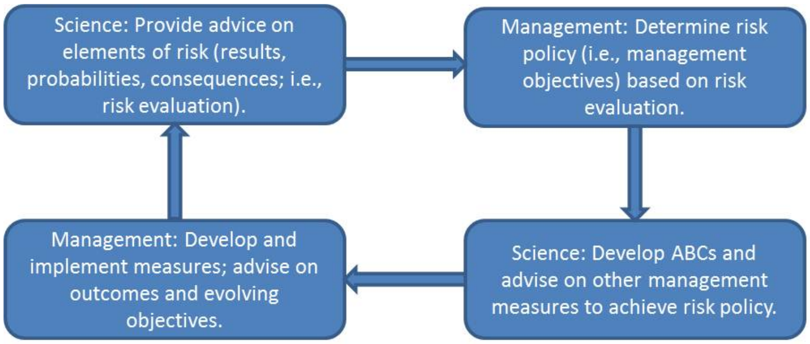


Figure 2. Proposed science-management feedback loop for developing, implementing and adapting a risk policy for federally-managed fisheries in the United States. Scientific bodies primarily include the SSC and PDTs, as well as others. Management bodies primarily include the Council, FMP Oversight Committees and NOAA, as well as others such as different levels of government.

Unfortunately, explicit risk policies have been largely absent from the early iterations of the new ABC-setting process. Instead, Councils have for the most part simply asked SSCs to provide ABCs, with no guidance from the SSCs and other scientific bodies on the elements of risk, and no guidance to the SSCs on the policy goals the ABC is intended to achieve. The SSCs have then provided ABC values to the Councils, values that result in part from a transparent and explicit discussion of scientific uncertainty in the information used to manage a given fishery (i.e., stock assessment model outputs, survey indices, estimate of age and life history parameters, etc.). But the ABC decisions also reflect the implicit but generally unspoken tendencies toward risk tolerance of SSC members, averaged (roughly) across the membership.

Complications

This de facto establishment of unspoken and implicit risk policies by the SSCs led to complications in the management arena in the early years of the new ABC/ACL system. Complaints about ACLs that are overly “precautionary” or “conservative” have been common, and those complaints usually address the magnitude of the scientific uncertainty buffer implemented to set the ABC. Some unease and discomfort was probably inevitable, given that we were changing a system in which it was common to fish right up against uncertain reference points, with too little respect for that uncertainty. In many cases, this was going to mean reductions in short-term catch in order to reduce the probability of overfishing, rebuild depleted stocks, and move more quickly toward realizing greater benefits from rebuilt fisheries.

Apart from transitional effects, the process would benefit from an explicit discussion of risk and subsequent determination of risk policies that the ABCs should be aiming to achieve. Debates have centered on the motivations, performance and suitability of SSCs in making the very important decisions about ABCs. If an explicit risk policy existed, any debates that emerge in response to ABC decisions would focus on whether the outcome reflects responsible and objective scientific judgment of how best to meet that policy.

For example, in 2009 NEFMC tasked its SSC with setting an ABC for the Atlantic herring fishery. The SSC deliberated and delivered an ABC set approximately 40% below the OFL due to a considerable retrospective bias in the assessment, as well as other worrisome trends (e.g., low recruitment in recent years), uncertainty about whether herring were adequately serving their important ecosystem function as forage fish, and other issues such as absence of spatial structure in the assessment. The decision was met with considerable dissatisfaction within the Council, which then voted to ask the SSC to consider whether a 17% buffer would adequately capture scientific uncertainty. In passing that motion, it is unlikely that the Council was truly questioning the scientific merits of its SSC's decision. Rather, the Council was more likely conveying that the SSC was being more risk-averse than the Council felt warranted. A debate between the Council and the SSC that on the surface seemed to be about science was more likely really about risk.

Understanding risk

Box 1 proposed a working definition of "risk", which includes three primary components: the possible results of a given action, the probability that each result will occur, and the consequences if it does. To date, most considerations of risk in fisheries management focus on two major results of ACL decision – the possibility of imposing an exploitation rate that represent overfishing and the possibility of the stock declining to an overfished state. The probabilities of either or both of those results also receive some attention to the extent that analytical capabilities allow. Other results and their consequences receive far less attention. One exception is consideration of the likely time it will take to rebuild from overfishing based on the inherent productivity of the stock (more on this below).

Box 1. Proposed working definition of "risk".

Risk is the likelihood and the severity of adverse consequences of an action.

Risk assessment entails defining:

a) The possible results from the action.
b) The probability that each result will occur.
c) The set of possible consequences from each result and its probabilities.

Overfishing (i.e., imposing a fishing mortality rate, *F*, that exceeds the *F* required to achieve OFL) should be far less of a concern than a stock becoming overfished (i.e., spawning stock biomass, *B*, falling below a threshold level) because the latter carries with it important biological and ecological consequences and triggers a rebuilding plan than can be costly and contentious. In fact, for any *F* chosen to determine the ABC we will expect overfishing to occur in some years, with the probability of overfishing in at least on year increasing through time due to the accumulation of each annual probability. For example, if the annual probability of overfishing is 25%, then there is a 25% probability that overfishing will occur in year 1 or year 2, but a 44% probability that overfishing will have occurred in at least one of the two years. Whether or not overfishing is problematic depends on the status and inherent vulnerability and productivity of the stock.

Imposing an overfishing *F* is a much more serious concern for a stock close to its threshold biomass than one at a much higher level, for the latter case is less likely to result in the stock becoming overfished before the problem can be identified and corrected. Of course, we should never knowingly impose an overfishing *F*, but we cannot completely ensure that we will not do so as long as fishing takes place. So, we must gauge how likely we are to be overfishing for a candidate *F* and determine whether that risk is acceptable in light of what will happen if overfishing does occur and especially if we reach an overfished *B*.

Evaluating the consequences of a given result has not been entirely absent from ABC-setting. Several control rules either in place or being considered include stock status as one criterion in establishing the buffer. Stock status is a key determinant of the consequences of imposing an overfishing *F* because it determines the likelihood that overfishing will lead to the stock being overfished. That is far less likely for a stock near or above the biomass target than it is for one near or below the biomass threshold.

The consequences of a stock becoming overfished are in part a function of its capacity for growth and recovery. This capacity is the focus of Productivity and Susceptibility Analysis (PSA), which weighs a variety of biological metrics to a stock's likelihood of becoming overfished in the first place (i.e., susceptibility, or vulnerability) and its potential to recover (productivity). Control rules linked to stock status and PSA represent important steps toward considering the consequences of a stock becoming overfished. However, other important consequences have not been considered as thoroughly and explicitly.

Factors determining the consequences of becoming overfished

Risk policy should be set with an understanding of the consequences of a stock becoming overfished in four broad areas: biological, ecological, economic and social consequences. At present, the consideration of these four areas is far from equal. Whether or not some warrant greater consideration or weight than others, there is considerable scope for bringing more balance to the risk evaluation process. An important limitation is the extent of available data and current understanding of each category of consequences, which is driven in part by the potential of each to be quantified.

Biological factors

To the extent that the consequences from overfishing are addressed at present, the focus far and away is on the ability to rebuild to target biomass based on the biological attributes of the target species. The extent of depletion is an important factor. An abundant stock might allow us to be more risk-tolerant (e.g., if a fleet is more dependent on the stock due to rebuilding of others), whereas a stock at lower biomass should engender greater risk aversion. Other important attributes include, but are not necessarily limited to:

- Longevity and natural mortality rate.
- Growth rate.
- Maturation schedules.
- Fecundity, especially age- or size-specific patterns.
- Complexity of spawning behavior and social systems.
- Habitat specificity.
- Natural range relative to the fishing grounds.
- Capacity for replenishment due to larval dispersal and post-larval movements.
- Genetic and life history diversity.

Ecological factors
Biological consequences of risk relate to the target species specifically, whereas ecological consequences relate to the role of that species in the ecosystem. Ecological functions that might be compromised by overfishing include, but are not necessarily limited to:

- Importance as prey for other species.
- Effects of predation in structuring fish and invertebrate communities.
- Structure-forming behaviors, such as creating feeding pits or burrows.
- Serving as vectors for carbon, energy, nutrients and symbionts among areas through migrations.

The consequences from overfishing for any of these roles are due to removal of the target species, which is controlled by catch limit decisions. Other effects of fishing on the ecosystem can include alteration of habitat and bycatch. However, these impacts should not be part of the risk evaluation phase of ABC-setting, and should not aim to be mitigated indirectly through the ABC. Rather, these impacts should be addressed directly through appropriate assessment, monitoring and management strategies. Implementation of those strategies might compromise the ability of a fleet to reach the ACL, and analysis and design of overall management systems should strive to limit such compromises.

Economic factors
Social and economic consequences from overfishing are closely intertwined in many respects. However, economic consequences currently receive much more attention than social consequences. This is likely due in part to the fact that economic factors can be more readily quantified (i.e., in dollar terms), and in part due to the political weight carried by economics.

Factors that define and determine the economic consequences from overfishing include, but are not limited to:

- Overall financial value of the fishery.
- Total employment in the fishery, distinguishing full-time and part-time.
- Proportion of revenue of vessels, ports and/or individuals provided by the stock (similarly, opportunities for alternative income).
- Nature, extent and value of shoreside and supply-chain businesses, also considering the proportion of revenue provided by the stock.

Social factors
Overfishing can adversely affect human institutions beyond the economic realm. Fishing, and therefore fish stocks, makes contributions to:

- History and heritage of both pre- and post-Colonial societies.
- Architecture and the character of coastal regions.
- Culture, including cuisine, literature, music, art, etc.
- Pride, identity and cohesion.

Social consequences from overfishing are the extent to which those attributes are compromised when a stock becomes overfished. The nature of those consequences are determined by factors including, but not limited to:

- Relative age of the fishery.
- Size of the fleet and associated services relative to the surrounding community.
- Size and type of vessels.
- Nature of ownership.

Identifying these factors does not imply that any attributes are inherently better or more preferable than others. Furthermore, the effects of these attributes might differ widely among communities.

ACLs that are too high versus ACLs that are too low

Legal requirements to end overfishing and rebuild depleted stocks are linked to the risk associated with setting ACLs that are too high. There are also, however, risks associated with ACLs set lower than necessary to achieve a chosen level of risk tolerance. ACLs set lower than would otherwise be set with a transparent and well-informed risk policy represent foregone value and associated economic and social benefits. One important difference between ACLs set too high and those set too low is that the latter can be corrected immediately at any time due to scientific improvements and policy responses. The 2010 mid-season Atlantic pollock ACL adjustment is an example of the potential rapid response to an underfishing problem. In contrast, when a stock becomes overfished due to ACLs set too high, the fishery is largely at the mercy of biology and the environment in rebuilding from the overexploited state.

Often, debates about the socio-economic costs of low ACLs take place after a stock has become overfished. In those circumstances, the debate centers on how much short-term cost and sacrifice is acceptable in order to achieve greater benefits after rebuilding more quickly. In any case, the challenges associated with determining policy priorities when faced with low stock biomass and therefore potentially low ACLs can be minimized by more purposeful risk evaluation, establishment of a transparent risk policy, and implementation of effective management strategies that reduce the likelihood of being in that predicament in the first place.

Case study: A straw-man risk evaluation for the Atlantic deep-sea red crab fishery

Following is a cursory and largely qualitative risk evaluation for one of the smaller and generally less contentious fisheries in New England. This is intended to illustrate in a more tangible way how the issues outlined above might be characterized and evaluated, but the conclusions reached along the way would need much deeper analysis and scrutiny were this to be applied to development of management measures.

Biological factors

Scientific uncertainty is fairly high for the species, and we lack an analytical assessment with which to determine reference points and status. The fishery targets almost exclusively males, with a small incidental allowance of female harvest, so egg-production is protected. However, there are important questions about whether harvest focused on males is reducing their abundance and size structure to a point where successful fertilization and hatching are compromised, given that reproductive behavior of the species involves larger males forming a protective "cage" around berried females. Still, crustacean fisheries generally show high resilience to population declines, and red crabs are not subject to significant non-fishing impacts like other commercially important crustaceans (e.g., lobsters in Long Island Sound; blue crabs in Chesapeake Bay). The fleet invests time and funding into collaborative research, efforts that should reduce uncertainty and might increase estimates of sustainable yield, and reducing the level of biological risk while increasing catch limits.

<u>Biological risk level</u>: Medium

Ecological factors

Even less is known about the ecological role of red crabs, such as whether they are important prey for higher level predators, or whether they play an important trophic role structuring shelf break ecosystems due to their own predation activity. Furthermore, red crabs build burrows, which might create structural complexity and habitat for other species, or contribute to sediment and nutrient dynamics in deep, low energy waters. Regardless, any ecosystem function compromised by red crab harvest likely has minimal effects of ecosystem services for humankind, given that their ecosystem seems largely disconnected from the shallower areas of the shelf, ledges and banks, and coastal areas upon which humans are most heavily dependent.

Ecological risk level: Low

Economic factors
The red crab fishery is rather small, at least compared to its regional cousins such as herring, sea scallops, groundfish or lobster. There are only four active vessels in the fleet, which work as a cooperative linked by a common co-owner. The cooperative has recently made a significant investment in a shoreside receiving and processing facility in New Bedford, and expanded its business model to serve newer and more diverse markets than it has in the past. This facility provides on the order of 100 jobs for the New Bedford community. Although this is a valuable addition to the local economy, it still represents relatively small employment and economic activity compared with other fisheries, even on a local scale and certainly on a state or regional scale. If scientific improvements allow the fishery to increase its catch, which in turn allow the workforce to grow, then the economic risk profile might change as well.

Economic risk level: Low

Social factors
The red crab fishery is very new by New England standards, having begun as an experimental fishery in the 1970s, with a more dedicated directed fishery only developing in the 1990s. For much of its history, red crab was largely an anonymous product, being sold as generic crab meat for a single dish served by a single restaurant chain. Therefore, its historical and cultural significance is very low. The cooperative has begun an effort to develop new uses for their product, access new consumers, and build a red crab brand. This could lead to red crab becoming a more recognizable product with a more established place in public perception of what defines New England seafood. But that evolution will take time, and the small scale of the fishery might always limit its status (although Nantucket bay scallops and other fisheries with low volume but high prestige and value might challenge that conclusion).

Social risk level: Low

All in all, a risk evaluation of the red crab fishery might suggest that a high degree of risk tolerance would be justifiable if industry members were willing to accept those risks. If the stock became overfished, the potential for biological recovery is moderate, or perhaps uncertain, but the likely ecological, economic and social consequences are comparatively low. The industry might still choose to be risk-averse and advise decision-makers accordingly, but if the fleet wanted to be more risk-tolerant, the broader impacts seem tolerable. Therefore, ABC-setting for this fishery could justifiably err on the side of a higher catch level, greater risks, and fishing closer to the OFL (or proceeding with comparatively limited caution in the face of an unknown OFL). The red crab fishery might prove to be an interesting case study in how the different dimensions of risk can evolve through time in light of the scientific and business planning developments underway that could change its biological, ecological, economic and social attributes.