DRAFT

Implications of Recreational Harvest Control Rules on ABC Specification

SSC HCR Workgroup

Introduction

The Mid-Atlantic Fishery Management Council (MAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC) jointly manage several important fish species in the Mid-Atlantic region. A combination of biological reference points that specify maximum sustainable catch levels, and harvest control rules that specify the actual catch quota based on the current stock biomass is used to manage these species. Within the joint MAFMC / ASMFC process, the MAFMC Statistical and Scientific Committee (SSC) is mandated to consider sources of scientific uncertainty to specify an acceptable biological catch (ABC) by applying the Council's risk policy. The Council's risk policy is a harvest control rule because it results in a catch, the ABC, specified as an amount in weight. Subsequently, Council and Commission staff, supported by Management Committees, develop catch quotas reflecting predetermined allocation decisions for the commercial (annual catch target, ACT) and recreational sectors (recreational harvest limit, RHL). In all cases, the combined ACT, RHL and dead discards must be equal to or less than the ABC.

In fulfilling their joint responsibility, the MAFMC and the ASMFC recently considered a number of proposed approaches to managing four key recreationally important species: Black Sea Bass, Bluefish, Scup and Summer Flounder. The approaches proposed in the Addendum / Framework seek to prevent overfishing, be reflective of stock status, appropriately account for uncertainty in the recreational data, take into consideration angler preferences, and provide an appropriate level of stability and predictability in changes from year to year. The proposed Addendum / Framework presents five options (including one of no action or status quo) for how recreational harvest levels could be specified in a harvest control rule. In discussing the proposed approaches, a joint resolution was passed that sought input from the SSC to help Council and Commission members understand how the proposed approaches would affect catch levels before a final vote was taken. Specifically, the Council and Commission adopted the following motion:

> *"Request that the SSC provide a qualitative evaluation, in time for final action at the June 2022 Council/Policy Board meeting, regarding the potential effect of each of the five primary alternatives in the Harvest Control Rule Addendum/Framework on the SSC's assessment and application of risk and uncertainty in determining ABCs. The intent is to provide the Council and Policy Board with information to consider the tradeoffs among the different alternatives with respect to the relative risk of overfishing, increasing uncertainty, fishery stability, and the likelihood of reaching/remaining at BMSY for each approach at different biomass levels (e.g., for ½ BMSY < B < BMSY, the relative risk among alternatives is (highest to lowest) E > C > B > A>D)."*

In response to this motion, the SSC created an ad hoc sub-committee comprising Drs. Lee Anderson, Cynthia Jones, Thomas Miller (chair), Paul Rago, Brian Rothschild and Alexei Sharov. To fulfill the Council / Commission request, the sub-committee held three webinars (3/25, 4/13, 4/29). The webinars were public meetings. At each meeting, the sub-committee invited questions and comments from Council and Commission members and other stakeholders. The sub-committee extends its gratitude to Brandon Muffley and Julia Beatty (MAFMC staff) who supported the sub-committee, organizing meetings, providing relevant data and answering queries from members of the sub-committee.

The sub-committee through shared authorship and editing prepared this report. The sub-committee's report was presented to the entire MAFMC SSC at their May 10th, 2022 meeting. Responses from the entire SSC were incorporated into the final report, and as such, this report represents the consensus view of the SSC.

The report is structured to address four key questions:
(I) What is the impact of the proposed Addendum / Framework on the SSC's assessment and application of risk and uncertainty in determining ABCs?
(II) Does the proposed Addendum / Framework represent a Harvest Control Rule?
(III) What are some of the implications of the proposed Addendum / Framework?
(IV) What are the benefits and challenges of each proposed action within the proposed Addendum / Framework?

We answer each question in subsequent sections of this report.

(I) What is the impact of the proposed Addendum / Framework on the SSC's assessment and application of risk and uncertainty in determining ABCs?

The SSC operates under the Magnuson Stevens Fishery Conservation and Management Reauthorization Act (2007, as amended). The SSC is mandated to provide the Council (and Commission, for jointly managed species), an ABC. An accepted stock assessment exists for each of the four species covered by the proposed Addendum / Framework that provides an estimate of the catch associated with the overfishing limit (OFL). The SSC uses a structured decision making process that identifies key sources of scientific uncertainty and the Council's risk policy, termed as the p* approach, to determine the ABC. The MAFMC SSC's structured decision-making process involves consideration of scientific uncertainty in nine categories (Table 1).

Table 1. Categories of scientific uncertainty used by the SSC in developing ABCs. The principal considerations are provided for each decision criteria, but the list of considerations is not comprehensive.

Decision criteria	Considerations
Data quality	Accuracy and precision of catch Availability of age/length data External data for key parameters (e.g., M)
Model appropriateness and identification	Comparison with alternative models Match with life history
Retrospective analysis	Model misspecification, often due to undetected temporal trend
Comparison with empirical measures	External measure of population scale
Ecosystem factors	Stationarity of model parameters
Trends in recruitment	Evaluation of stanzas and trends
Prediction error	Validation of predictions with subsequent estimates
Assessment accuracy	Function of historical exploitation patterns
Simulation / MSE	Measures of robustness of assessment

The proposed Addendum / Framework is triggered by determination of the ABC, and as such, the actual ACTs and RHLs are determined only once the ABC has been specified. Consequently, the proposed Addendum / Framework does not affect the structured decision making process the SSC uses to specify the ABC. *Neither the no action option, nor any of the alternative approaches proposed in the Addendum / Framework directly affect the SSC's perception of scientific uncertainty and hence cannot directly affect the ABC the SSC develops*. If implementation of any of the alternatives described in the Addendum / Framework subsequently degrades or improves the quality of assessment data, these impacts would be addressed in future specifications through assessment of the accuracy and precision of the catch data and potentially through assessment of prediction error.

(II) Does the proposed Addendum / Framework represent a Harvest Control Rule?

Harvest control rules are quantitative relationships that specify how harvest should vary with stock biomass. In the commercial sector, the ABC (an actual catch weight, developed by application of the SSC structured decision process and the Council's risk policy or harvest control rule) is buffered to reflect management uncertainty to provide an ACT. Because the ABC is determined through application of a harvest control rule, the ACT is also based on a harvest control rule. In contrast, the alternatives described in the Addendum / Framework for the recreational fishery do not specify harvest. Instead, the alternatives provide a suite of principles that will be used to determine whether the current regulations that determine recreational harvest, principally specifications of season length, size limits and bag limits, should be maintained, liberalized or reduced. They do not specify how catch should change, but are assumed to result in the removals that are close to earlier specified RHL. *Neither the no action option, nor any of the alternatives described in the Addendum / Framework represent harvest control rules. The alternatives define target catch adjustments depending on recent landings and population status but fall short of specifying how season length, size limits and bag limits should be altered, and thus cannot be considered harvest control rules.*

Indeed, the sub-committee felt that the proposed alternatives failed to address explicitly the complexity of the problem of specifying a vector of how regulations around season, size and bag limits would change. The expected resultant harvest depends upon the relative contributions of the different specifications as well as host of biological and socioeconomic parameters. The current ABC process that uses the Council's risk policy, involves control of a single variable, the allowable harvest limit. However, there are at least three specifications that have to be set simultaneously for the proposed alternatives to be implemented. The sub-committee notes that this increases substantially the complexity and the difficulty of the challenge. The sub-committee believes that this should be explicitly stated so Council and Commission members have a solid grip on the decision they are being asked to make.

Marine recreational fisheries present significant management challenges because the relationships between regulatory decisions regarding season length, size limits and bag limits and the realized catch are not simple. Figure 1 presents plots of the relationships between catch limits and landings for the commercial and recreational sectors for the four species included in the Addendum / Framework. As indicated by the solid blue lines in Figure 1, there are significant relationships between catch limits and landings in the commercial sector for three of the four species. In contrast, only one of the four relationships between catch limit and landings is significant in the recreational sector. The dashed line in each panel is the 1:1 line expected if landings were exactly equal to the catch limit. By comparing data to this expected line, only the fisheries for Summer Flounder appear to be well controlled in both sectors. Inspection of the four panels suggests greater variation around the 1:1 line for the recreational sector in three of the four species. Indeed these data could be taken as motivating a need for improved harvest controls in the recreational sector, or a broader acceptance that recreational fisheries cannot achieve the same level of control as that achieved through in-season catch monitoring in the commercial sector. These patterns suggest that even if policies may be well designed from a conceptual point of view, compliance with the policy may lead to substantial differences between specified and realized harvests. This potential is not discussed in the Addendum / Framework.

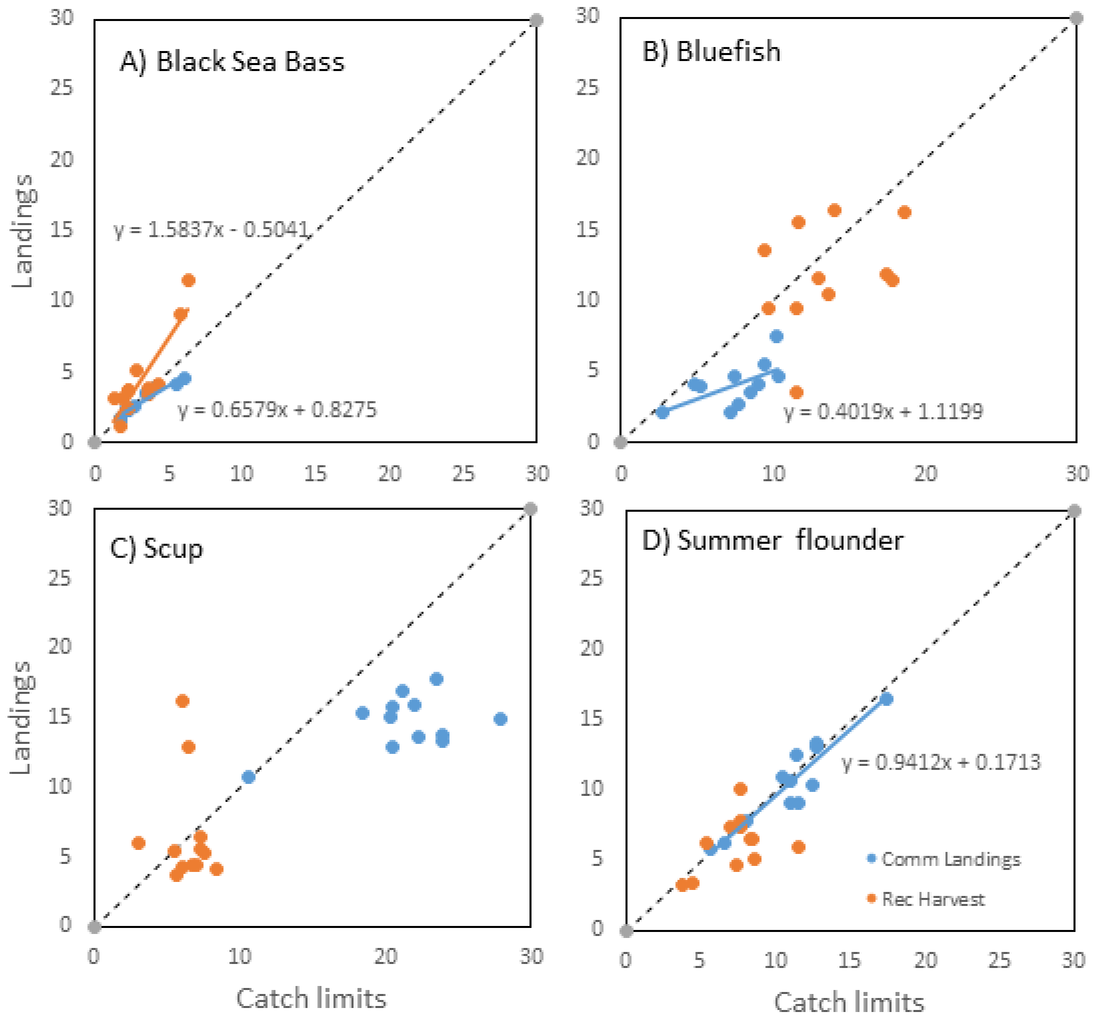

Figure 1. Comparisons of catch limit and subsequent landings for the commercial (blue) and recreational sectors (orange) for A) Black Sea Bass, B) Bluefish, C) Scup and D) Summer Flounder. All figures are plotted on the same scale. Regression lines are plotted for significant ($P < 0.05$) linear relationships between catch limit and subsequent landings by sector. Regression relationships are given for significant regressions. The expected 1:1 line is shown as a dashed line in each figure.

There is a significant impact of angler behavior on the relationships shown in Figure 1. Angler behavior can be affected by many factors, causing deviations away from expected relationships in both directions. High fuel prices can cause angler participation to decline, leading to lower than expected catches. Reports of good catches in traditional and social media can produce positive feedbacks that can lead to higher than expected catches. As a result, we understand why the workgroup who produced the alternatives described in the Addendum / Framework consciously chose not to produce recreational harvest control rules - and rather focused on directional rules that indicated how catches should change relative to a number of easily measurable stock characteristics. However, Council and Commission members should recognize that the proposed Addendum / Framework does not solve the problem of marine recreational fisheries management in the Mid-Atlantic, despite the apparent quantitative and sophisticated alternatives brought forward. The need for an approach to understanding how angler behavior and motivation affects angler avidity and ultimately catch remains. This is a significant social and natural science challenge.

(III) What are some of the implications of the proposed Addendum / Framework?

The proposed alternatives in the Addendum / Framework use a number of biological, stock and fisheries characteristics of the target species to define a process aimed at catch adjustment. Five alternatives are presented (Table 2)

Table 2. Summary of the alternatives proposed in the Addendum / Framework.

Alternative	Approach
Status Quo	Compares MRIP to RHL, and recommends change in regulations based on expert judgment.
% Change	Maintains and MRIP vs RHL comparison. Bands or bins of % change defined based on magnitude of difference between MRIP and RHL as well as B/B_{MSY} ratio. 15 different categories of action suggested.
Fishery Score	Applied multi-criteria decision making to fishery management. Action is the weighted average of multiple criteria, which weights based on “importance”. Result in a continuous “aggregated” response variable, which is then binned into four categories of action.
Biological Reference Points	Use B/B_{MSY} and F/F_{MSY} to define bands or bins based on multiples of the reference point. Incorporates secondary measures, such as trends in recruitment or biomass to refine action. Current proposal has 34 different categories of action.
Biomass-based Matrix	Combines information on trends in biomass and stock status (B/B_{MSY}) to define 7 different categories of action.

We identify the following generic concerns with the proposed alternatives that are inherent to the status quo approach also.

1) Indirect effects on ABCs
   Recently, the Council has requested the SSC provide multiyear, often three-year, specifications of ABC. In most cases, the SSC assumes that the ABC will be fully caught in the first year to estimate stock biomass in the second year. This stock biomass is used in the Council's risk policy to calculate the ABC for the second year. The SSC then assumes that the year-2 ABC will be fully caught to estimate stock biomass in year-3, applying once again the Council's risk policy to estimate the year-3 ABC. In most cases, the SSC has not had to consider circumstances in which the ABC is exceeded. However, recreational overages in recreational Black Sea Bass catches have been significant. To account for this the SSC has provided projections in which it assumes the ABC will be exceeded, thereby further reducing stock biomass, leading to a reduction in subsequent ABCs. Any policy that leads to harvests that are substantially above the quota will likely lead to a similar approach from the SSC of reducing ABCs in multiyear projections.

   There are structural issues in several of the alternatives related to time lags in the availability and uncertainty in the level of recreational catches, and related the binning of responses that may lead to increased uncertainty in whether ABCs may be exceeded, which could lead to the SSC setting lower ABCs than it otherwise would in multi-year specifications.

   We note that biennial stock assessments are expected for each of the four species involved in the proposed Addendum / Framework which would be expected to ameliorate this challenge, as 3-year ABC will likely be superseded by new assessment-derived ABCs

2) The Council risk policy assumes a continuous relationship between stock status and fishery responses, whereas many of the alternatives in the proposed Addendum / Framework presume a discrete, binned approach that may not be compatible with the risk policy.

   Fisheries management is an example of process control, and there is an extensive body of literature that considers the response characteristics of both sensors (inputs - in fisheries, the inputs are catches, recruitments and stock biomasses) and process changes (outputs - in fisheries, the outputs are catch limits). For example, a room thermostat is a simple example of process control. Appropriate matching of the sensitivity of the sensors (accuracy of the thermostat), the size of the signal that triggers a responses and the latency in the response (size of the room, capacity of the HVAC system) are all factors that determine the degree to which the process is well controlled.

For HVAC systems, thermostats, HVAC capacity both have to be specified appropriately to operate efficiently and effectively to obtain a comfortable room.

The sub-committee explored how a fishery operates as a process control, considering variability in recruitment (inputs), and control rules of the fishery management process on the performance of the fishery (Appendix A - Rago, MS). Preliminary conclusions from this simulation are that the impacts of binning and random recruitment lead to a marked increase in the likelihood that OFLs would be exceeded. Moreover, populations were not rebuilt as frequently as occurred with population specific optimal fishing mortality rates. Perhaps more importantly, a greater fraction of populations that were previously above B_{msy} fell below ½ B_{msy} when controlled with a binned HCR.

The subcommittee does not conclude from these simulations that binned approaches should be abandoned; rather we wish Council and Commission members to be aware of the uncertainty that may be introduced by the mismatch between the harvest control rule (Council risk policy) and the binned approach.

3) Impact of time lags in estimates of recreational catch on management decisions

MRIP estimates are most precise at the annual level for a whole stock. Real-time estimates of recreational catch can be problematic for many species (NASEM 2017, 2021) because of the reduced precision of small-area estimation.

4) Angler compliance.

As noted previously, angler compliance is a challenge in marine recreational fishery management generally. We define compliance here not to imply intentional illegal harvest, but rather to refer to how well changes in regulations map to changes in angler behavior. We re-emphasize the highly uncertain relationship between specific regulatory tools (i.e., season, size and bag limits) and the resultant catch we have noted already. This challenge is exacerbated by trying to determine such relationships when regulations change frequently. Another important aspect of angler compliance is the extent to which anglers accept, believe in, and follow regulations. The committee discussed whether the complexity of some of the proposed alternatives might lead to reduced compliance because of the challenge of communicating some of the specific binned options that result in multiple contingent outcomes.

5) Limited control in one sector leads to “borrowing” of quota from other sectors, and given the role of historical data in determining allocation, this may lead to unintended management-driven shifts in allocation.

The joint Council / Commission management process includes policy decisions about the allocation of catch between the principal sectors involved in the fishery. Allocation decisions are always the most controversial aspect of fishery management because they involve statements of economic and social value, about which simple dollar values are an insufficient foundation for decision-making.

The sub-committee discussed the impacts of the performance of marine recreational fishery management on the allocation. Ideally, levels of under and overharvesting should be small and approximately equal in both sectors (e.g. Figure 1D). Under this scenario, realized catches will lead to patterns of allocation that are close to those adopted in policy. In contrast, if constraining one sector is more challenging, and leads to larger deviations from the specified catch targets, the patterns of allocation may be substantially different to those specified in the policy (e.g. Figure 1A). This can lead to effective "borrowing" of quota from the more controlled sector. This leads to increased levels of contention in the fishery management process. The sub-committee recommends this aspect be evaluated in considering the adoption of the proposed Addendum / Framework.

(IV) What are the benefits and challenges of each proposed action within the proposed Addendum / Framework?

The sub-committee provides its consensus summary of the benefits and challenges associated with each of the five options in Table 3

Alternative	Benefits	Challenges
Status Quo	• Immediate corrective action to avoid exceeding RHL and overall overfishing of the stock. • Continuous response	• Expectation of recreational catch in the upcoming year being equal to the one observed in one or two most recent years or their average is not supported by the experience. • Angler groups and recreational anglers have expressed frustration with the current methods of setting harvest quotas.
% Change	• Uses data readily available already. Broad categories of B/B_{MSY}. • Easily understandable by stakeholders/anglers. • This and other new options are expected to provide more stability by employing a buffer concept, where an action is	• May suggest finer control of recreational catches than has been achieved historically • Duplicating use of B/B_{MSY} at this level may imply more precision than actually available. • Allows liberalization of rec.catch in some circumstances when $B/B_{MSY} < 1$

	triggered only if the recent catch exceeds threshold values defined by specific alternatives.	• If stock size is increasing and effort in year t+1 is the same as in year t, then the expected harvest will increase in year t+1. When you boost effort by 10, 20 or 40% you are likely to overshoot the RHL because you are increasing E(t+1) while B(t+1) is also increasing. The only way this makes sense is if the overall fishing mortality target for the recreational fishery is inappropriate. • Competition with commercial fleets underscores this challenge. Increasing E(t+1) inappropriately (e.g., + 40%) without a commensurate decrease in quota allocation to commercial will result in increased probability of overfishing. • Potential to induce instability - constantly under or over-shooting targets. The degree to which this occurs is related to the magnitude of the restrictions or liberalizations
Fishery Score	• Combines multiple sources of information - both data and performance. • Fishery score approach is an example of a simple additive weighting multi-attribute decision-making. Selection of weights (expert opinion, optimal, eigenvalue weights, fuzzy) is important and is unspecified.	• We are unaware of examples of where a scoring system has been shown to control a population trajectory. • Mapping multiple factors to one scalar may preclude necessary actions or forgo catch. • Not clear if information is available to inform weights. Identifying a priori relative importance of various factors and appropriate selection of weights is difficult. Empirical adjustment based on multiple

		years of observations will be required for tuning, ● Strong correlation that is expected in B/B_{MSY} and F/F_{MSY} may lead to strong influence of this single measure. Such collinearity breaches assumption of preferential independence. ● We are unclear whether all values of Fishery Score are likely/ possible when this appears not to be the case from consideration of the input value distributions (e.g. distribution of B/B_{MSY} that is under management control).
Biological Reference Points	● Information readily available (B/B_{MSY} & F/F_{MSY}) as primary determinants.	● High number of categories might suggest a level of precision in data and management systems that appears unlikely. ● Within each bin of stock size and overfishing condition, regulations will be adjusted based on trends in biomass and recruitment. Apart from knowledge about year classes, how will such trends be evaluated? How many years needed to identify a trend? ● Does the averaging approach capture strong year classes? ● The stock assessment process used to derive the ABC already includes actions suggested in this Option. Biomass status determination separates the top 3 rows of Table 3 from the bottom row. F status determination separates the two columns. The top 3 rows in

		Table 3 are defined by the Council's Risk Policy. The projection process, imperfect as it is, accounts for the expected effects of historical recruitment and variation in future recruitment to develop an expected biomass trajectory. ● This option compares recent harvests performance to determine whether regulation should be liberalized or restricted. The decision variable should instead be a comparison of recent F due to recreational harvest with target F. This is particularly important in situations where a subsequent stock assessment revealed that biomass was underestimated. Under these conditions, the poor performance was in part due to an increase in abundance rather than an increase in F. Regulations are designed to control fishing mortality; decisions to adjust regulations should therefore rely on comparison between target and realized Fs.
Biomass-based Matrix	● Uses existing data (B trend and B/B_{MSY})	● Not clear how this leads to stability ● Does not explicitly consider overfishing as a basis for action. Does this violate MSA? ● As the SEC requires for mutual fund ads, "past performance does not necessarily predict future results"

Conclusions and Recommendations

We conclude that the proposed Addendum / Framework options are unlikely to increase directly the uncertainty in the current SSC process of ABC determination in the short term. The current process for determining ABC is based on a structured decision making process that results in a preselected level of variability (CV) that is applied to the most recent estimates of OFL and stock biomass through the Council's risk policy (an HCR). The ABC specification process is not directly influenced by the level of the subsequent catches in any sector.

The sub-committee also notes that the performance of the proposed alternatives in the Addendum / Framework will likely be limited in scope temporarily if biennial stock assessments continue to be available for the four target species. At this frequency of stock assessment, we expect adjustments of OFLs through the stock assessment process, and subsequent adjustments in ABCs through the SSC process will likely limit the impacts of poor performance by any proposed specification process.

At the same time, the sub-committee notes that the actual efficacy of the proposed alternatives in the Addendum / Framework is unknown. Preliminary modeling conducted by the sub-committee to evaluate the impacts of the binning of population states, reliance on various metrics of stock condition and recent catch history, and implications of recruitment variability could result in an increased risk of overfishing and becoming overfished. This suggests that the appearance of precision in the process that leads to regulatory specifications does not necessarily translate into precision in catch performance and compliance. The sub-committee expresses the concern that some of the overly complex, contingent decision-making processes included in the proposed alternatives do not reflect the actual level of control likely achieved in marine recreational fishery management.

Finally, the sub-committee caution that stability of regulations is not the same as stability of catch. If regulations are properly set to achieve a target F, then catches and CPUE will be expected to fluctuate with stock biomass. This is an inherent feature of exploited populations. It is entirely possible to set a constant catch policy. However, such a constant catch policy would likely have to be substantially lower than the ABC (and its attendant RHL) to account for interannual variability in population processes and angler avidity.