Analysis of Procedures for Setting Annual Catch Limits, Including Total Mortality, and Accountability Measures for the Federal Fisheries of the Gulf of Mexico.

MRAG Americas

Introduction

The M-S Act and the 1996 Amendment made progress toward recovery of depleted stocks and sustaining stock health, but many stocks remain overexploited or have not been rebuilt (NOAA 2007, Rosenberg et al. 2006). As a result, the 2007 amendments to the M-S act are designed to improve accountability in management to prevent overfishing and rebuild stocks to levels that will support maximum sustainable yield.

Section 104 (a)(15) of the 2007 Magnuson-Stevens Reauthorization Act (MSRA) establishes "a mechanism for specifying annual catch limits in the plan (including a multiyear plan), implementing regulations, or annual specifications, at a level such that overfishing does not occur in the fishery, including measures to ensure accountability." Congress has set a "no fail" deadline to establish catch limits for all fisheries experiencing overfishing by 2010, and 2011 for all other fisheries.

Aims and Objectives

There are two main aims of this work:

1) Develop an approach for the Gulf of Mexico reef fish fishery to set annual catch limits (ACL) which incorporates total mortality on stocks as required by the Magnuson-Stevens Fishery Conservation and Management Act (M-S Act).

2) Develop accountability measures for maintaining total mortality within the ACL.

Background

The reef fish management system in the Gulf of Mexico currently relies on keeping fishery landings within a total allowable catch (TAC) limit. Bycatch mortality, which is often substantial, is assumed to be a certain amount and is "taken off the top" to calculate a TAC. The bycatch assumptions are not explicit and are not compared to actual bycatch mortality on a regular basis. Bycatch estimates occur in the stock assessment process. It is also unclear exactly how these bycatch assumptions change, based on changes in management measures. If bycatch mortality is not measured against the bycatch limit, how do we know if rebuilding goals are being met?

Catch and bycatch information exists for commercial and recreational fisheries in the Gulf of Mexico. Fishermen and processors must report actual landings on fish receiving tickets; the landings data are considered accurate. Bycatch data for the reef fish fishery is reported under two programs: logbooks and an observer program. The commercial reef fish logbook program requires twenty percent of the fleet to fill in logbooks (although about 10% actually comply), which includes discards per trip. An observer program is also in place for at least 2006-2007 at a 5% coverage level. It currently takes over a year to compile these data after the fishing year has ended. The commercial shrimp fishery has a less than 1% observer program with proxies for bycatch levels of reef fish. For the recreational fishery, the system relies on MRFSS B1 and B2 data for private recreational fisheries, an enhanced charter and head boat survey for these vessels and the Texas Parks and Wildlife recreational fishing data collection system. MRFSS estimates come in waves (six two month periods per year) 2-4 months after the wave has ended. However, the Federal system does not regularly compare bycatch estimated from these systems to bycatch estimated in the stock assessments, and does not compare bycatch estimates to bycatch targets.

Work plan

Develop a methodology using existing data sources to establish and monitor an ACL, which incorporates a total mortality limit (explicitly includes bycatch mortality) and accounts for uncertainty in landings and bycatch. This methodology must be consistent with available data sources and realistic improvements in monitoring capabilities. Required data and monitoring capabilities should be identified for an optimal system. MRAG proposes to conduct a risk-based assessment of fish species in the fishery management plans of the Gulf of Mexico Fishery Management Council (GMFMC); compare the risk-based assessments to results of stock assessments where stock assessments exist; and use simulations to assess the applicability of the risk-based assessments to provide an adequate buffer between the ABC and the ACL. Following the completion of the risk assessment and the simulations steps, MRAG would develop options for interim and longer-term accountability measures for the fisheries.

Methodology

Rosenberg et al. (2007) proposed a precautionary procedure for setting ACLs based on requirements of the M-S Act:

- As a default or starting point, preventing overfishing applies to ALL stocks, therefore, so should ACLs.
- To successfully end and prevent overfishing, OFL > ABC ≥ ACL.
- ACLs should account for uncertainty in stock status and risk of overfishing for each stock.
- Consideration of risk must include some evaluation of the vulnerability of a stock to the fishery.
- The buffer or distance between the ACL and the OFL should be greater when the risk of overfishing is higher (i.e., when uncertainty is greater or the consequences of overfishing as expressed by vulnerability of the resource is higher).

Central to this process is determining the “buffer” needed between the OFL and the ACL to increase the probability that overfishing doesn’t occur and that rebuilding proceeds as needed. That is, the process is designed to determine how far the ACL should be set below the OFL to account for the various sources of uncertainty referred to in the principles above. In general, buffers need to increase as risk of overfishing increases and amount of information decreases; conversely, low risk and more information allows a smaller buffer. This process will require three phases described in more detail below:

1. Conduct risk-based assessment using the procedure of Hobday et al. (2006) for all species,
2. Conduct simulations to develop a basis for relating the size of the buffer to uncertainty and vulnerability for data-poor and data-rich species using the methods of MacCall (unpublished) and Schertzer et al. (2007), and
3. Provide options for interim and long-term accountability measures.

Phase 1: Risk-Based Assessment

The Working Group found that the framework developed by a recent joint Australian CSIRO/AFMA project (Hobday et al. 2006) for Ecological Risk Assessment for the Effects of Fishing (ERAEF) provides a good basis for a precautionary evaluation of vulnerability of fishery resources.

The Working Group recommended Level 2 of the ERA, the Productivity and Susceptibility Analysis (PSA), for this purpose. The Marine Stewardship Council (MSC) also uses the PSA (plus the level 1 Scale Intensity Consequence Analysis) in a pilot program to assess sustainability of data deficient stocks (Hobday 2007). Briefly, productivity and susceptibility tables list attributes for categorization of each fishery stock from high to low productivity and susceptibility. The rankings are based on a combination of susceptibility and productivity that determines the relative vulnerability of the unit of analysis (stock or assemblage) and are given a score (1 to 3 for high to low productivity, respectively; and 1-3 for low to high susceptibility, respectively). The complete PSA requires scoring a large number of susceptibility and productivity attributes (Hobday et al. 2006). However, Hobday (2007) provided the MSC with a simplified version of the full PSA analysis, based on the observation of the ERAEF team that eight productivity and four susceptibility attributes provide nearly all the information needed to conduct an analysis; scoring additional attributes contributes little to the final score.

Productivity Attributes

- Average age at maturity
- Average size at maturity
- Average maximum age
- Productivity
- Average maximum size
- Fecundity
- Reproductive strategy
- Trophic level

Susceptibility Attributes

- Availability (overlap of fishing effort with a species distribution)
- Encounterability (the likelihood that a species will encounter fishing gear that is deployed within the geographic range of that species based on two attributes: adult habitat and bathymetry)
- Selectivity (the potential of the gear to capture or retain species)
- Post capture mortality (the condition and subsequent survival of a species that is captured and released or discarded)

Hobday et al. (2006) developed spreadsheets to calculate PSA scores and to categorize the fishery as low, medium, or high risk. MRAG would populate the spreadsheet with data for the key productivity and susceptibility attributes for selected managed species[1] to develop preliminary scores, and use knowledgeable experts to modify scores as necessary to develop a final consensus score. An ACL would derive from the score and the current catch levels. For fisheries with low risk determined by PSA, the current catch and fishing mortality would serve as a proxy for ACL and F_{ACL}. Fisheries with medium and high risk levels would require progressively decreased catches from the current level to provide additional buffer. Policy makers would need to provide guidance on the level of risk acceptable, which would provide the basis for converting PSA risk into buffers. More information about the PSA methodology and its utility is given in Annex 1.

Phase 2: Risk-based Assessments and Stock Assessments Comparisons

Converting the PSA risk assessment into buffers will require an analysis of how to factor the amount of information available for a fishery into setting the buffer. Species under management will consist of data rich and data poor species. Assessments for data rich species will range from

[1] Red drum, king mackerel, Spanish mackerel, cobia, greater amberjack, lesser amberjack, hogfish, silk snapper, mutton snapper, lane snapper, red snapper, mangrove snapper, yellowtail snapper, vermillion snapper, golden tilefish, red grouper, yellowedge grouper, red hind, goliath grouper, misty grouper, Warsaw grouper, snowy grouper, Nassau grouper, gag, scamp, and black grouper.

low uncertainty to high uncertainty; data poor species often do not have assessments, and are inherently uncertain. A simulation of uncertainty given available information and the vulnerability of a species will inform policy makers on the tradeoff for buffer size. Rosenberg et al. recommend a simulation study of the impacts and consequences of uncertainty and vulnerability on fishery performance along the lines of the work of Shertzer, Prager and Williams, using results from assessments of all the data-rich stocks in the US. This should allow some analysis of the relationship between uncertainty and vulnerability. MRAG will simulate performance of a specific ACL (set a specific distance below OFL, i.e., with various buffers) for several data-rich stock with different levels of uncertainty to develop a basis for relating the size of the buffer to uncertainty and vulnerability. This pattern, which should include stocks across a range of productivities and susceptibilities, will then inform the setting of ACLs for data poor stocks.

Stock assessments for species managed by the GMFMC (and the South Atlantic and Caribbean Fishery Management Councils) are conducted under the SouthEast Data, Assessment, and Review (SEDAR) process. SEDAR uses data, assessment, and review workshops to develop a transparent evaluation leading to a consensus assessment, allowing for minority opinions. The stock assessments with adequate data conducted under SEDAR provide management reference points for species and a determination whether the species is overfished or undergoing overfishing. The SEDAR stock assessments for the GMFMC consist of the following species: king mackerel, Spanish mackerel, greater amberjack, red snapper, yellowtail snapper, vermillion snapper, red grouper, gag, and hogfish. From these species, we would assess which species to include in the simulation. At the conclusion of the simulation, MRAG would apply the vulnerability-uncertainty matrix to the species with no stock assessments.

Phase 3: Synthesis of Accountability Measures

MRAG will use three sources of information to develop options for accountability measures. First, the Working Group convened by Andy Rosenberg will soon have a final report on best practices in US fishery management. Second, a report from a companion project contracted by Ocean Conservancy to Archipelago Marine Research will provide an inventory of data systems and discuss best practices for catch limit management. Third, the first two Phases of this report will recommend a procedure for establishing ACLs, with appropriate buffers below the overfishing level. MRAG, in consultation with Ocean Conservancy staff, will synthesize the information from these sources as a guide for developing options for interim and longer-term accountability measures for management of the ACLs in the Gulf of Mexico.

References

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Annex 1: Overview of the PSA Methodology and its Utility

Premise

The Lenfest Ocean Program convened a working group of national and international fisheries experts, with participation by NOAA Fisheries as technical advisors to the working group, in the summer of 2007 to assess the MSRA requirements for annual catch limits (ACLs) and to recommend a procedure for determining ACLs (Rosenberg *et al*. 2007). Rosenberg *et al*. (2007) developed a methodology that uses existing data sources to establish and monitor an ACL, which incorporates a total mortality limit (explicitly including bycatch mortality) and accounts for uncertainty in landings and bycatch.

Central to the precautionary procedure for setting ACLs proposed by Rosenberg *et al*. (2007) is determining the "buffer" needed between the OFL and the ACL to increase the probability that overfishing doesn't occur and that rebuilding proceeds as needed. That is, the process is designed to determine how far the ACL should be set below the OFL to account for the various sources of uncertainty referred to in the principles above. In general, buffers need to increase as risk of overfishing increases and amount of information decreases; conversely, low risk and more information allow a smaller buffer. Risk-based assessments provide a method that could apply to all stocks, including data deficient. The Working Group found that the framework developed by a recent joint Australian CSIRO/AFMA project (Hobday *et al*. 2006) for Ecological Risk Assessment for the Effects of Fishing (ERAEF) provides a good basis for a precautionary evaluation of vulnerability of fishery resources.

Overview of Productivity Susceptibility Analysis (PSA)

The Productivity and Susceptibility Analysis (PSA) approach is a method of assessment which allows all units within any of the ecological components to be effectively and comprehensively screened for risk. The PSA results measure risk from direct impacts of fishing only, which in all assessments to date has been the hazard with the greatest risks identified at Level 1 (Scale, Intensity and Consequence Analysis, SICA). For our purposes, we will only be conducting the PSA (Level 2 in the ERAEF Methodology).

The PSA approach is based on the assumption that the risk to an ecological component will depend on two characteristics of the component units: (1) the extent of the impact due to the fishing activity, which will be determined by the susceptibility of the unit to the fishing activities (**Susceptibility**) and (2) the productivity of the unit (**Productivity**), which will determine the rate at which the unit can recover after potential depletion or damage by the fishing. It is important to note that the PSA analysis essentially measures potential for risk (hereafter noted as risk). A measure of absolute risk requires some direct measure of abundance or mortality rate for the unit in question, and this information is generally lacking at Level 2.

The PSA approach examines attributes of each unit that contribute to or reflect its productivity or susceptibility to provide a relative measure of risk to the unit (**Table 1**).

Table 1

	Attribute
Productivity	Average age at maturity
	Average size at maturity
	Average maximum age
	Average maximum size
	Fecundity
	Reproductive strategy
	Trophic level
Susceptibility	Availability considers overlap of fishing effort with a species distribution
	Encounterability considers the likelihood that a species will encounter fishing gear that is deployed within the geographic range of that species (based on two attributes: adult habitat and bathymetry)
	Selectivity considers the potential of the gear to capture or retain species
	Post capture mortality considers the condition and subsequent survival of a species that is captured and released (or discarded)

During the Level 2 assessment, each unit of analysis within the ecological component (species, habitat, or community) is scored for risk with regard to attributes in these two classes and the output graphed to produce a PSA plot (**Figure 1**).

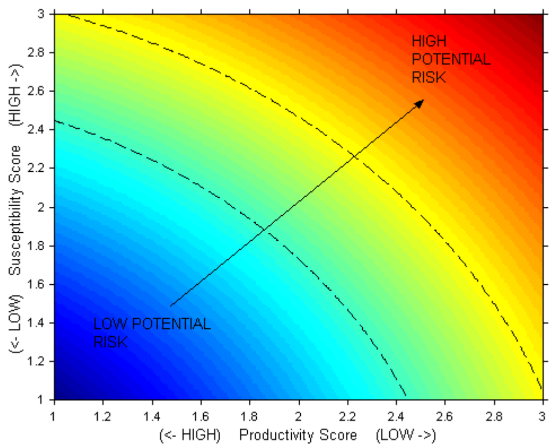

Figure 1. The axes on which risk to the ecological units is plotted. The *x*-axis includes attributes that influence the productivity of a unit, or its ability to recover after impact from fishing. The *y*-axis includes attributes that influence the susceptibility of the unit to impacts from fishing. The combination of susceptibility and productivity determines the relative risk to a unit, i.e. units with high susceptibility and low productivity are at highest risk, while units with low susceptibility and high productivity are at lowest risk. The contour lines divide regions of equal risk and group units of similar risk levels.

PSA Methodology

Risk is measured 1-3, with 1 as the lowest risk, and 3 the highest. For example, if a species is widely available with a large distribution, then is it likely at lower risk than an isolated species. There are also likely to be characteristics that will alter the ranking (1, 2, 3) of an attribute, even if that characteristic is not a specific attribute itself. For example, hermaphroditism will put a species at higher risk, even if it has a large distribution.

The level of fishing impact a unit of analysis (e.g. species, habitat type, or species assemblage) can sustain will depend on the inherent productivity of the unit. The **productivity** determines how rapidly a unit can recover from depletion or impact due to fishing. Susceptibility is estimated as the product of four independent aspects; Availability, Encounterability, Selectivity and Post-capture Mortality (PCM). The level of fishing impact that a unit of analysis can sustain depends on its risk or **susceptibility** to capture or damage by the sub-fishery activities.

Table 2 Populated Attributes.

Productivity Attributes	Susceptibility Attributes
Role in Fishery	Availability (Global Distribution)
Maximum Size (cm)	
Minimum Age at Maturity (years)	Selectivity – values auto-compute based on size in Susceptibility worksheet
Minimum Size at Maturity (years)	Encounterability (Habitat ERA)
Reproductive Strategy	Encounterability (Bathymetry ERA)
Maximum Lifespan Years	Post Capture Mortality
Fecundity (Min and Max estimation number of eggs)	*Stock Structure Proxy
Minimum Trophic Level (from Fishbase, under Ecology link)	*Serves as an over ride to availability; If there are no detailed distribution maps or there are special life history characteristics to consider - refer to Suscep Stock Proxies sheet to rank
[1]if have only one value, fill in under Min Number of eggs (more conservative)	ERA - Ecological Risk Assessment

Productivity cutoff scores for species attributes are have been determined from analysis of species in the ERAEF database, and are intended to divide the attribute values into low, medium and high productivity categories. In the case of reproductive strategy, codes are assigned to the various strategies (i.e. live bearer, broadcast spawner, etc) with associated levels of risk based on those strategies.

Susceptibility Attributes

Availability

Availability considers overlap of the fishing effort with a species distribution. Where a fishery overlaps a large proportion of a species range the risk is high because the species has no refuge, and the potential for impact is high.

Availability scoring
Availability is scored in the PSA spreadsheet using one of two methods based on available data.

Default option for scoring availability
For species without detailed geographic distributional information, availability is scored based on broad categories, reflecting the potential for the fishery to cause impact to the species in question:

Globally distributed – low risk,
Single Hemisphere – medium risk, or
Regional – high risk.

In application, this method is typically applied to species that are data poor, as well as highly migratory fishes such as tunas. Stock structure proxies (**Table 3**) are used to fine tune the availability score; this accounts for details in geographical, temporal and life history barriers not accounted for elsewhere.

Table 3. Stock likelihood scores and rationale types for reviewing availability risk scores for species without detailed distributional maps. Examples are in italic.

Stock Structure Proxy

Stock likelihood scores and rationale types for reviewing availability risk scores for species without detailed distributional maps. Examples are in italic. Coding is automatically completed in the PSA workbook

Rationale: Type of barrier to dispersal	**Score = Low risk (L)** (low chance of local stocks)	**Score = Medium risk (M)** (medium chance of local stocks)	**Score = High risk (H)** (high risk of local stocks)
	1L	**1M**	**1H**
Rationale 1. Geographic barriers	*Deepsea, >650 m: Semi-global water mass - Some depth barriers, too shallow:*	*Pelagic and upper slope: Depth and water temperature barriers -mode water.*	*Restricted to estuaries and or embayments on the shelf: Combination of lat, long, depth, coastal, water temperature barriers*
	2L	**2M**	**2H**
Rational 2. Temporal barriers	*No seasonal peaks in feeding, mating, spawning.*	*Some seasonal peaks but breeding not restricted to a particular season. E.g. batch spawning teleosts, some dogfishes*	*Species forms breeding colonies or <u>breeding aggregations.</u> Fishing is permitted at or near breeding or feeding aggregations*
	3L	**3M**	**3H**
Rationale 3. Ecological barriers (habitat requirements or feeding)	*Occupiable habitat is dispersed through a species range. E.g. pelagics*	*Bycatch species has a preference for a particular type of habitat but habitat occurs across 50% or the range of a fishery. Habitat is different to the habitat of the target species and therefore not targeted*	*<u>Site fidelity;</u> Occupiable habitat is restricted by food availability or bottom topography (reefs, canyons etc). Fishing occurs near restricted habitat*
	4L	**4M**	**4H**
Rationale 4. Behavioral barriers	*No behavior. E.g. algae*	*No social behaviour e.g. sunfish*	*<u>Schooling;</u> Fish/sealion returns to birth place to spawn. Birds remain near rookery to rear chicks. Migrating populations targeted by fishing activity; <u>gonochoristic hermaphrodites</u>*
	5L	**5M**	**5H**
Rationale 5. Life history barriers	*Adult highly migratory, larvae pelagic and dispersed easily, spawning and feeding are dispersed in space and time.*	*Few restrictions to dispersal. E.g. Adult fish species is dispersed through the worlds oceans, female has one million eggs, larvae pelagic, but adults only spawn in the Sargasso Sea; utilize <u>inshore nursary grounds</u>*	*Species can not complete its life history. e.g. salmon returns to spawn in the estuary where it hatched. River mouth is fished annually*

Encounterability

Encounterability considers the likelihood that a species will encounter fishing gear that is deployed within the geographic range of that species.

Encounterability Scoring

The main component of encounterability considered for each species is its adult habitat. This habitat and position in the water column is also checked to determine if it lies within a bathymetric zone where fishing is permitted. Habitat codes and scores for evaluating the encounterability risk for a species provide a check to determine that the fishing gear examined can operate in the same habitat where the species lives. Bathymetry codes and scores for checking the encounterability risk for a species provide a check to determine if fishing is permitted and practical within the bottom depth range of the species examined.

Selectivity

This attribute is automatically computed from size information in the productivity attributes. For species that do encounter fishing gear, selectivity considers the potential of gear to capture or retain the species.

Post Capture Mortality (PCM)

Post capture mortality evaluates the case that, if captured, a species would be released in condition that would permit subsequent survival. The PCM of a species is affected by its biology and fishing practices. Biological factors limit the potential of a species to be captured alive. These biological factors can be assessed using expert judgement. For example, sharks with spiracles, such as Port Jackson sharks can breathe without swimming and can survive on deck for many hours if captured alive. The most important considerations are the time taken to clear discards from the deck. In the absence of expert judgement and independent field observations the default value for the PCM of all species is high.

All species considered dead on capture should have high PCM risk, unless there are observer data or other verified field observations made during commercial fishing operations.