Draft Action Plan for Fish Release Mortality Science

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U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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U.S. Department of Commerce
Penny S. Pritzker, Secretary

National Oceanic and Atmospheric Administration
Kathryn D. Sullivan, Administrator

National Marine Fisheries Service
Eileen Sobeck, Assistant Administrator for Fisheries

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Introduction

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) and its fishery management partners are committed to rebuilding overfished marine and anadromous fish stocks. Regional Fishery Management Councils (Councils), Interstate Marine Fisheries Commissions (Commissions), and regional fishery management organizations, such as the International Pacific Halibut Commission, have implemented a variety of measures to rebuild or maintain fish populations (e.g., reduced fishing seasons, closed areas, species-specific non-retention measures, temporal and/or spatial fisheries closures, and size limits). Under these management systems, release mortality can occur due to a variety of factors, including how a fish is handled, how long it is exposed to air, whether it is injured during the fishing process, or whether it experiences thermal shock and/or pressure changes during ascent. Release mortality occurs in a wide variety commercial and recreational fisheries, as well as through the use of a wide variety of fishing gears (e.g., trawls, gillnets, hook and lines).

Release mortality is important to NMFS because the degree to which scientists have accurate estimates of release mortality can affect estimates of fishing mortality used in stock assessments to set reference points that are the basis for determining whether a fish stock is overfished or undergoing overfishing. More accurate release mortality rates will also help estimate total catch and more accurately compare total catch to annual catch limits, which are required by the Magnuson-Stevens Fishery Conservation and Management Act. Annual catch limits, designed to prevent or end overfishing, can be assigned to groups of fishermen or entire fleets and are impacted by release mortality assumptions. Release mortality estimates also can be important for accounting for accurate estimates of approved take of fish that are protected under the Endangered Species Act (ESA), such as some populations of Pacific salmon.

This Action Plan focuses on fish release mortality. Release mortality also is a concern for protected species such as sea turtles, marine mammals, and seabirds. However, release mortality challenges for protected species can differ from those for fish, and NMFS has attempted to, and continues to, address protected species release mortality (e.g., Swimmer and Gilman 2012).

Although release mortality can be a useful management method to focus fishing effort on certain stocks (for example, salmon hatchery fish), release mortality is viewed by some stakeholders as a less-than-optimal use of fishery resources in other situations. That is, release of a fish that is dead or dying does not allow that fish to contribute to an enjoyable angling experience in the future. The ecosystem impacts of release mortality are equally important. NMFS strives to accurately estimate the extent to which released fish will reproduce and contribute to future fish populations.

Release mortality generally is used to describe seemingly live animals of varying condition at capture that subsequently die when released. "Release mortality" will be used throughout this Action Plan, although it is referred to in the literature by other descriptors such as delayed, discard, fatigue, hooking, and post-release mortality. Release mortality can occur soon after discarding or release, due to severe injury or immediate post-release predation.

Release mortality also can occur later as a delayed response to stress or injury sustained during capture or handling. This delayed release mortality can result from an acute injury or one that leads to a chronic condition and eventual death. An example of the latter could be damage to a fish's internal organs during the interaction, which renders it unable to forage or metabolize food effectively, ultimately resulting in its death. Another example is damage to a fish's body while it is caught in a trawl net, prior to being dumped on a boat's deck and subsequently discarded.

Barotrauma is an example of acute physiological stress and has been recognized in recent years as a leading cause of release mortality for certain types of fish. Barotrauma results from a change in pressure that occurs when some deep-water fish, especially fish with physoclistous gas bladders, are rapidly brought to the surface. The symptoms of barotrauma, including stomach eversion and bulging eyes, have been described extensively in the literature, especially for Pacific rockfish (for example, Jarvis and Lowe 2008, Hannah et al. 2012). Fish suffering from barotrauma can recover if they are handled properly.

The recreational fishing community has raised the issue of barotrauma and recreational release mortality as a concern over the past few years. Fishermen and managers have developed and promulgated best practices designed to reduce release mortality (e.g., see the FishSmart website at www.fishsmart.org). Fishermen have adopted various fishing practices, especially the use of descending devices, which are designed to minimize the effects of barotrauma. These methods have been tested for success or ease of use for only a handful of species to date. Barotrauma and release mortality also are concerns in commercial fisheries.

In August 2014, NMFS published a Technical Memorandum entitled *Fisheries Release Mortality*, which summarized NMFS-funded fish release mortality research over the past 15 years, identified release mortality data gaps, compiled mortality estimates used by NMFS, and identified criteria to help scientists and managers focus release mortality resources (Benaka et al. 2014). When this report was published, NMFS announced that it would develop—in partnership with fishing communities, scientists, and managers—an Action Plan for Fish Release Mortality Science.

In late 2014, NMFS assembled an Action Plan Steering Committee (see Appendix 1). The Steering Committee developed a simple multi-attribute rating technique (SMART) tool that can be used by managers, scientists, and other fishery stakeholders to identify high-priority release mortality estimate needs. The Steering Committee brought together experts from NMFS, state agencies, academia, industry groups, non-governmental organizations, and Councils (see Appendix 1) to meet at an April 2015 workshop at the NMFS Northwest Fisheries Science Center in Seattle. Workshop participants tested the SMART tool, discussed issues related to data gaps suggested by the SMART tool, and discussed a variety of release mortality science topics including mismatches between catch data and discard mortality data and conflicting results from multiple release mortality studies. After the workshop, the Steering Committee developed this draft Action Plan.

Purposes and Goals

The purpose of the Action Plan is to:

> *Guide NMFS science efforts related to reducing fish release mortality, improve estimates of release mortality, and better incorporate improved release mortality estimates into stock assessments and management processes.*

The goals of the Action Plan are to:

1. Enable the use of planning tools such as the SMART tool to help managers, scientists, and other stakeholders determine which fish species, complexes, and/or fisheries would benefit most from improved mortality rate estimates.
2. Facilitate the development of improved fish mortality rate estimates.
3. Support effective and efficient research that leads to reduced release mortality for high-priority species, complexes, and/or fisheries.
4. Ensure that improved fish mortality rate estimates are incorporated effectively into stock assessments and existing management processes.

Each of these goals is supported by specific objectives. The following objective relates to **Goal 1** (Enable the use of planning tools such as the SMART tool to help managers, scientists, and other stakeholders determine which fish species, complexes, and/or fisheries would benefit most from improved mortality rate estimates.):

1.1 Support Councils, Commissions, and management entities in their use of the simple multi-attribute rating technique (SMART) tool to identify high-priority release mortality estimate needs (see Appendix 2 for a summary of the SMART tool and preliminary results).

- Provide in-person training to management entities so that the entities and their partners can customize the SMART tool and use it to evaluate a wide variety of species/complexes/fisheries on an ongoing basis.
- Collect results of SMART tool evaluations and make them available to grant programs and other parties that might be interested in identifying priorities based on SMART tool results.

Challenge Addressed: NMFS has limited resources available for the improvement of release mortality rate estimates, and NMFS and its management partners currently do not have a standard approach to identifying high-priority release mortality estimate needs.
Potential Partners: NMFS Office of Science and Technology (ST), NMFS Office of Sustainable Fisheries (SF), NMFS Atlantic Highly Migratory Species Management Division (Atlantic HMS), Councils, Commissions, regional fishery management organizations.
Products: One or more in-person training sessions, lists of regional priorities.

The following objectives relate to **Goal 2** (Facilitate the development of improved fish mortality rate estimates.):

2.1 Support the identification of requirements for improved mortality rate estimates.

- Use Council, Commission, and other management entity research priority documents and related documents (e.g., Southeast Data, Assessment, and Review research recommendations) to identify data gaps for species/complexes/fisheries that receive high SMART tool scores in each region.
- Work with observer programs and other monitoring programs to identify opportunities to collect data that would help inform release mortality estimates for high-priority species.
- Ensure that any new release mortality research initiatives include opportunities to obtain relevant baseline information (e.g., effects of air exposure, gear type, temperature) where that information is missing, as well as opportunities to evaluate release mortality by sector (commercial versus recreational, nearshore versus offshore, wild versus hatchery, and/or deep-water versus shallow-water) as necessary.

Challenge Addressed: NMFS and its partners will continue to identify release mortality data gaps, and some of these gaps can be addressed through refinement of monitoring programs and research that focuses on obtaining baseline information and evaluating release mortality by sector.
Potential Partners: ST, SF, NMFS Science Centers, NMFS Regional Offices, National Fish and Wildlife Foundation (NFWF).
Products: Lists of identified data gaps, recommendations for monitoring programs.

2.2 Support the development of best practices related to the creation of improved mortality rate estimates.

- Identify, possibly as part of a national workshop, best practices for condition evaluation programs (e.g., reflex action mortality predictors) to be used in NMFS-funded research, especially simplification of such programs.
- Identify, possibly as part of a national workshop, best practices for the development of reliable and robust proxies for short- and long-term mortality where such proxies would be helpful.

Challenge Addressed: Experts have identified areas of release mortality research, including condition evaluation programs and short- and long-term proxies for mortality that could benefit from the establishment of best practices.
Potential Partners: ST, Atlantic HMS, NMFS Science Centers, NMFS Regional Offices, Sea Grant, other external stakeholders.
Products: One or more national workshops on best practices.

2.3 Support new observer data-collection efforts that could inform and improve release mortality estimates.

- Explore the development of procedures that would facilitate observer collection of data on air temperature, time on deck, condition, and other factors that could be related to release methods for high-priority species.

- Ensure that observer program discard condition data fields are as consistent as possible among U.S. observer programs and among U.S. and international observer programs such as the Western and Central Pacific Fisheries Commission.
- Improve observer identification of challenging species that are discarded often, including skates and sharks.

Challenge Addressed: NMFS is better able to identify release mortality challenges when discard data generated from domestic and international observer programs are consistent, and when discarded species are accurately identified by observers.
Potential Partners: ST, Atlantic HMS, NMFS Science Centers, NMFS Regional Offices, regional fishery management organizations.
Products: Revised observer forms that feature more consistent condition data fields; additional training and/or identification guides for hard-to-identify species.

The following objectives relate to **Goal 3** (Support effective and efficient research that leads to reduced release mortality for high-priority species, complexes, and/or fisheries.):

3.1 Identify how release mortality rates are affected by descending devices and other methods.

- Incorporate additional factors such as time on deck in a standardized manner for descending device studies.
- Focus descending device studies on improving the ability of head boats and charter boats to descend multiple fish at once.
- Support and improve observer data collection about type, use, and efficacy of descending devices.
- Support additional efforts to develop guidelines for reducing release mortality in commercial and recreational fisheries targeting marine and anadromous species, and communicate to stakeholders about methods to reduce release mortality.

Challenge Addressed: Descending devices have shown great promise in reducing barotrauma and release mortality in some fisheries, especially on the West Coast, but descending devices have not been adequately tested in a variety of fisheries in other regions.
Potential Partners: ST, SF, Atlantic HMS, NMFS Office of Communications, NMFS Science Centers, NMFS Regional Offices, NFWF, Sea Grant, other external stakeholders.
Products: Additional research projects focusing on descending devices, additional release mortality reduction guidelines, additional release mortality reduction communication efforts.

3.2 Explore the creation of an acoustic tagging–related device loaner program (which might include pop-up satellite archival tags, acoustic arrays, hook times, and/or acceleration data loggers) for researchers funded by NMFS.

- Evaluate the cost of such a loaner program in light of savings that should result from researchers not having to include such devices in their budgets.
- If the program is created, provide mandatory training in the use of such devices, and ensure that insurance and recovery costs are built into project budgets.

Challenge Addressed: Release mortality grant applications often include requests for expensive acoustic tagging equipment, and amounts requested would be lower if NMFS were able to loan out equipment through a program similar to its underwater video camera loaner program.
Potential Partners: ST, SF, NMFS Office of Protected Resources, NMFS Science Centers, Atlantic States Marine Fisheries Commission.
Products: Memo evaluating the feasibility of an acoustic tagging-related device loaner program.

3.3 Ensure that relevant existing NMFS grant programs (including programs that receive funding from NMFS) support high-priority release mortality research needs through effective research projects.

- Facilitate contacts between NMFS stock assessment scientists and release mortality researchers, so that researchers can increase their chances of producing results that will be useful to stock assessment scientists.
- For grant programs that include specific release mortality priorities, explore ways to modify release mortality priority language to ensure that funded projects are most likely to produce useful results (e.g., possibly requiring an overview of historic literature, and/or power analysis if appropriate).

Challenge Addressed: NMFS grant programs, and NMFS-supported programs, fund release mortality research, but program priorities are often broad and lacking in specific guidance that could help improve proposals and make them more relevant to NMFS' high-priority release mortality science needs.
Potential Partners: ST, SF, NMFS Office of Management and Budget, NMFS Science Centers, NMFS Regional Offices, NMFS Office of Management and Budget, NFWF, external partners.
Products: Consideration of refined release mortality priorities in existing grant programs, new processes for communication between stock assessment scientists and release mortality researchers.

3.4 Create an online clearing house for release mortality estimation research and priorities.

- Develop a public database (to be maintained by the NMFS Office of Science and Technology) of release mortality research, including published research, ongoing and unpublished research (as appropriate), gray literature (where available), and raw data (where available).
- Identify and implement a procedure to dynamically update discard and release mortality research priorities and document where and how research priorities have been addressed over time.

Challenge Addressed: Release mortality researchers applying for NMFS grants may not have ready access to recently completed or ongoing research, as well as current Council or NMFS region-specific research priorities.
Potential Partners: ST, NMFS Science Centers, Sea Grant, external stakeholders.
Products: Public release mortality research and priorities database.

The following objectives relate to **Goal 4** (Ensure that improved fish mortality rate estimates are incorporated effectively into existing management processes.):

4.1 Organize a session as part of the next National Stock Assessment Workshop (NSAW) or other national meetings that focuses on best practices for the incorporation of new release mortality estimates into stock assessments.

- Explore the development of procedures or best practices for how new estimates can be effectively incorporated, through Council Scientific and Statistical Committees (SSCs) and other means, into existing assessment processes.
- Consider the development of a symposium at a regularly occurring national meeting (e.g., the American Fisheries Society, the American Sportfishing Association, the Association of Fish & Wildlife Agencies) on the same or a similar topic, involving additional stakeholders from outside NMFS.

Challenge Addressed: As scientists continue to carry out release mortality research through internal NMFS funding or external grant funding, NMFS and its management partners will benefit from workshops and symposia that examine how to make best use of these findings.

Potential Partners: ST, SF, NOAA's Recreational Fishing Initiative, HMS, NMFS Science Centers, NMFS Regional Offices, Councils, Commissions, Sea Grant, external stakeholders.

Products: An NSAW session, a symposium at a meeting of a national association.

4.2 Improve communications to recreational and commercial fishing communities targeting marine and anadromous fish species regarding how release mortality estimates are created and used, as well as how such estimates can impact stock assessments, catch limits, and other management processes.

- Develop fact sheets and other communication methods to educate fishing communities regarding various aspects of release mortality estimates.
- Explore the development of additional videos as necessary to explain to stakeholders how release mortality estimates are used by scientists and managers and communicate release mortality success stories.

Challenge Addressed: If recreational and commercial fishing communities do not understand how release mortality estimates are created and used, and how they might impact management, they may not be effective partners with NMFS in reducing release mortality and developing improved release mortality estimates.

Potential Partners: ST, SF, NOAA's Recreational Fishing Initiative, NMFS Science Centers, NMFS Regional Offices, Sea Grant, NMFS Office of Communications, external stakeholders (including FishSmart network).

Products: Fact sheets, online videos, presentations and demonstrations at national and/or regional fishing shows.

Action Plan Objectives Timeline (shaded cells represent the time frame when an objective will be carried out)

Objective	2016	2017	2018	2019	2020
1.1. Support use of SMART tool.					
2.1. Support identification of requirements for improved release mortality estimates.					
2.2. Support development of best practices for the creation of improved release mortality estimates.					
2.3. Strengthen observer programs to obtain improved release mortality estimates.					
3.1. Identify how release mortality rates are affected by descending devices etc.					
3.2. Explore creation of an acoustic tagging-related device loaner program.					
3.3. Modify practices among NMFS external grant programs.					
3.4. Create an online clearing house.					
4.1. Organize a session(s) at the NSAW and other national meetings.					
4.2. Improve communications to fishing communities.					

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Swimmer, Y., and E. Gilman. 2012. Report of the Sea Turtle Longline Fishery Post-release Mortality Workshop, November 15−16, 2011. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-PIFSC-34, 31 p.

Appendix 1. Action Plan Steering Committee and Workshop Attendees

Steering Committee
Lee Benaka, Leah Sharpe—NMFS Office of Science and Technology
Karen Abrams, Randy Blankinship, Danielle Rioux—NMFS Office of Sustainable Fisheries
Forbes Darby—NMFS Office of Communications
Brian Linton— NMFS Northeast Fisheries Science Center
Matthew Campbell— NMFS Southeast Fisheries Science Center
John Hyde— NMFS Southwest Fisheries Science Center
E.J. Dick— NMFS Southwest Fisheries Science Center
Jason Cope— NMFS Northwest Fisheries Science Center
Chris Lunsford— NMFS Alaska Fisheries Science Center
Yonat Swimmer—NMFS Pacific Islands Fisheries Science Center
Scott Baker—North Carolina Sea Grant
Bruce Leaman—International Pacific Halibut Commission

Workshop Attendees
Bill Hoffman—Massachusetts Department of Marine Fisheries
Michael Musyl—Pelagic Research Group, LLC (Honolulu)
John Mandelman—New England Aquarium
Andrew Loftus—Andrew Loftus Consulting (Annapolis, MD)
Heather Reed—Washington Department of Fish and Wildlife
Theresa Tsou—Washington Department of Fish and Wildlife
Beverly Sauls—Florida Fish and Wildlife Commission
Chip Collier—South Atlantic Fishery Management Council
Greg Stunz—Texas A&M University
Scott Meyer—Alaska Department of Fish and Game
Melanie Hutchinson—University of Hawaii
Craig Rose—FishNext Research (Seattle)
John Gauvin—Alaska Seafood Cooperative (Seattle)

Appendix 2. Mortality Workshop SMART Tool Results

Background

In July 2014, NMFS published a technical memorandum on release mortality in fisheries (Benaka et al. 2014). Release mortality generally is used to describe ostensibly live animals of varying condition at capture that subsequently die when released. "Release mortality" will be used throughout this summary, although it is referred to in the literature by other descriptors such as delayed, discard, fatigue, hooking, and post-release mortality.

The 2014 technical memorandum described research projects addressing release mortality that were funded by NMFS from 1999 to 2013. The report also described several important data gaps in understanding and methodology used to determine release mortality. In addition, the technical memorandum identified criteria that could help scientists and managers prioritize species for release mortality research efforts.

When this technical memorandum was published, NMFS announced that it would develop—in partnership with fishing communities, industry, scientists, and managers—an Action Plan to guide agency science, improve estimates of release mortality, and better incorporate release mortality estimates into stock assessments. NMFS staff charged with developing the Action Plan decided to use a simple multi-attribute rating technique (SMART) tool. This tool could use the criteria identified in the technical memorandum to prioritize species for which improved release mortality estimates would significantly alter fishing opportunities or practices.

NMFS identified a Steering Committee charged with organizing an April 2015 workshop involving state researchers and managers, academics, Regional Fishery Management Council staff and members, and industry representatives (see Appendix 1). The workshop participants helped the Steering Committee to explore prioritization options for important U.S. fish species that might be in need of improved release mortality rate estimates (e.g., species with very low or high assumed mortality rates supported by only a single study, few data, and/or myriad assumptions, or species subject to "no-retention" management policies). Workshop participants focused especially on instances where improved estimates of release mortality rates would likely directly affect the results of a stock assessment and/or fishing opportunities or practices.

The SMART Tool

The SMART tool is designed to be an objective, repeatable, and fairly quick assessment of the need for improved release mortality estimates for certain species. Results of the SMART tool are not meant to be prescriptive but rather are intended to provide a starting point for discussions of release mortality research priorities.

The tool first applies a "management sensitivity filter" to each species, which asks experts to answer, using their professional judgement, two questions:

1. Will a new release mortality estimate likely significantly alter fishing opportunities?
2. Will a new release mortality estimate likely significantly alter fishing practices?

If either question receives a "yes" answer, the species should be evaluated using the SMART tool. If both questions receive a "no" answer, then the species should not be evaluated. This

filter is meant to address issues such as the extent to which the species in question has already been studied. For example, if a dozen published studies have estimated release mortality to be 15 to 20 percent for a particular species, an additional study likely will not result in a significantly revised release mortality estimate that would alter fishing opportunities or practices.

The SMART tool, which was used by Steering Committee members prior to the 2015 workshop, included five criteria:

1. Restricted or rare
2. Vulnerability
3. Economic impact
4. Political sensitivity and stakeholder engagement
5. Discard ratio

The following sections describe how each of these criteria was scored.

Restricted or Rare

The restricted or rare criterion was a binary option that asked simply whether the species was considered to be restricted or rare. If the answer to the question was “yes” for either restricted or rare, then the criterion received a score of 100. If the answer was “no” to both questions, then the criterion received a score of 0. The Steering Committee defined “restricted” to mean that the species was commonly considered to be a limiting or "choke" species in relation to other target species in a mixed-species fishery. The Steering Committee defined “rare” to mean that the species was listed as threatened or endangered under the Endangered Species Act.

Vulnerability

The vulnerability criterion was a quantitative approach based on stock status and /or productivity and susceptibility indices. If a species stock status is unknown, or if the stock assessment results are uncertain, experts should use the productivity-susceptibility analysis (PSA) tool developed by NMFS (http://nft.nefsc.noaa.gov/PSA.html). The PSA tool should result in categorization of a species productivity and susceptibility as low, medium, or high. Based on those categories, the species would receive scores based on the matrix shown below:

Susceptibility			
	100	75	50
	75	50	25
	50	25	0
		Productivity	

If the species in question has a related stock assessment, and that stock assessment addresses uncertainty, then SMART tool users should assign the following scores for this criterion, based on the stock status in the assessment:

- Overfishing and overfished = 100
- Overfishing and not overfished (substantial uncertainty) = 70
- Not overfishing but overfished (substantial uncertainty) = 70
- Overfishing but not overfished (little uncertainty) = 50
- Not overfishing but overfished (little uncertainty) = 50
- Not overfishing and not overfished = 0

In addition, if the species in question suffered a decline in status from 2004 to 2014 (i.e., moved from not overfished to overfished, and/or from not undergoing overfishing to undergoing overfishing), the assessors should add a 10-point bonus to the score. This bonus score was designed to highlight variability and susceptibility in a species stock status.

Economic Impact

The economic impact criterion asked experts to consider the impacts of a hypothetical situation in which uncertainty about release mortality led to the unexpected closure of a fishery or fisheries. The following types of impacts received various scores:

- The regional economy would suffer significant and immediately measurable economic consequences (e.g., impact could lead to a request for a fishery disaster declaration) = 100
- The regional economy would suffer some measurable economic consequences = 60
- The regional economy would suffer minor economic consequences = 20
- The regional economy would suffer no measureable economic consequences = 0

Political Sensitivity and Stakeholder Engagement

This criterion used a matrix approach that could result in a range of scores from 0 to 100, based on level of political sensitivity and stakeholder engagement. Experts were asked to categorize sensitivity and engagement related to the species in question as high, moderate, or low.

High sensitivity/engagement could be characterized by lawsuits involving the species, efforts to certify/ecolabel the species, or large involvement of stakeholders including anglers/fishermen in cooperative release mortality research. Moderate sensitivity/engagement could be characterized by infrequent or no lawsuits, moderate levels of public comment on rulemaking, some discussion of certification/ecolabeling for the species, and some angler/fisherman involvement in cooperative research. Low sensitivity/engagement could by characterized by either low levels of public comment on rulemaking or low levels of angler/fisherman involvement in cooperative research.

Based on those categories, the species would receive scores based on the matrix shown below:

Political sensitivity	None	Low	Moderate	High
High	60	60	80	100
Moderate	40	40	60	80
Low	20	40	40	60
None	0	20	40	60

Stakeholder engagement

Discard Ratio

This criterion also used a matrix approach that could result in a range of scores from 0 to 100, based on the magnitude of the discard estimate (e.g., high, medium, low) and the uncertainty in the discard estimate (e.g., high, medium, low). For magnitude of the discard rate, if ratio of discards to landings was unknown or more than 1.5 times landings, experts were asked to assign a score of "high." If discards were between 0.5 and 1.5 times landings, experts were asked to assign a score of "moderate." If discards were less than 0.5 times landings, experts were asked to assign a score of "low."

For uncertainty, if the coefficient of variation (CV) of the discard estimate was unknown or above 50 percent, experts were asked to assign a score of high. If the CV of the discard estimate was from 30 to 50 percent, experts were asked to assign a score of medium. If the CV of the discard estimate was less than 30 percent, experts were asked to assign a score of low.

Based on those categories, the species would receive scores based on the matrix shown below:

Magnitude	Low	Moderate	High
High	50	75	100
Moderate	25	50	75
Low	0	25	50

Uncertainty

Each of the criteria received a weight that reflected the importance of the criterion in relation to the other criteria. The weights, which can be easily adjusted within the SMART tool, were as follows for the analyses conducted prior to and during the expert workshop:

1. Restricted or rare = 20
2. Vulnerability = 100
3. Economic impact = 100
4. Political sensitivity and stakeholder engagement = 20
5. Discard ratio = 60

Species Evaluated with the SMART Tool

Prior to the April 21–22, 2015, workshop, the Acting Director of the Office of Science and Technology sent an email message to Regional Fishery Management Council and Marine Fisheries Commission Executive Directors, as well as the Division Chief for Atlantic HMS, asking for lists of the top-10 species under their jurisdiction that would benefit from improved

release mortality rates. Steering Committee members and workshop participants participated in a series of conference calls prior to the workshop to evaluate the top-10 species using the SMART tool. Table 1 lists the species submitted for consideration. It is important to note that the species evaluated by the Steering Committee and workshop participants may not represent the full suite of species requiring evaluation in a particular region. In addition, it is important to note that a small number of experts conducted these evaluations. The SMART tool should produce more useful results if a larger number of experts evaluate a more extensive list of regional species.

New England Fishery Management Council (NEFMC) Species Preliminary Results

The experts who evaluated the NEFMC species used the management sensitivity filter to rule out an evaluation of Atlantic herring and river herring. The experts felt that the Atlantic herring discard rate was very low, and that it would be difficult to design a study to identify an improved release mortality rate estimate for this species. The experts felt that more information was needed regarding the magnitude of river herring discards before a new release mortality rate would have a significant impact on management. The experts also decided to evaluate the skate complex as separate species. Figure 1 shows the scores for these species.

Workshop participants felt that some of the higher scores for the NEFMC species reflected the species position as a choke species that constrains other fisheries (e.g., flounder species). Vulnerability also influenced high scores for some of the species, especially windowpane flounder and thorny skate. For the two species that scored the highest (windowpane flounder and Atlantic halibut), the NEFMC cited an unknown release mortality rate and the fact that the annual catch limit for these species could constrain other fisheries. Workshop participants suggested some additional species for consideration by the SMART tool, including Atlantic cod (especially as encountered in lobster fisheries), haddock, pollock, wolfish, and cusk (especially as released through the use of recreational gear).

Mid-Atlantic Fishery Management Council (MAFMC) Species Preliminary Results

The experts who evaluated the MAFMC species used the management sensitivity filter to rule out an evaluation of several species, including the six species submitted by the MAFMC that were not identified as species of concern by the Council (i.e., Atlantic mackerel, tilefish, surfclam, ocean quahog, Loligo, and Illex). In addition, the experts decided not to evaluate spiny dogfish, at least initially, because numerous studies already have focused on this species. In addition, the experts decided not to evaluate summer flounder because that species also has been the subject of many recreational fishery studies. Summer flounder may warrant SMART tool evaluation if commercial fishery release mortality estimates could possibly change substantially in response to additional research. Figure 2 shows the scores for these species.

Economic impact scores were major drivers for the MAFMC species scores, with the exception of butterfish, whose score was driven by the discard ratio criterion. None of the species were considered to be restricted or rare, and the species scored low in terms of vulnerability and political sensitivity/stakeholder interest.

The MAFMC included some comments on the species it suggested for evaluation. For butterfish, the MAFMC commented, “Discards are a large part of catch (sometimes greater than

50%); discard mortality assumed=100%.... Most probably do die either immediately or indirectly, so I wouldn't think this would be a high priority for research on this topic."

Table 1. Species submitted for consideration by the Regional Fishery Management Councils, the Atlantic States Marine Fisheries Commission, and expert opinion in the case of the West Coast (the Pacific Fishery Management Council was unable to provide a species list due to schedule conflicts). Species with an asterisk were considered but not evaluated by workshop participants.

NEFMC	MAFMC	ASMFC	SAFMC	GFMC	West Coast	NPFMC	WPFMC	Atlantic HMS
Georges Bank winter flounder	Butterfish	Black sea bass	Red snapper	Red snapper	Black rockfish	Pacific halibut	Main Hawaiian Islands Deep-7 bottomfish species	Dusky shark
Windowpane flounder	Scup	Scup	Gag grouper	Gag grouper	Blue rockfish	Bering Sea red, blue, golden king crab	Bigeye tuna	Sandbar shark
Atlantic halibut	Black sea bass	Spanish mackerel	Vermillion snapper	Vermillion snapper	Bocaccio	Bering Sea Tanner crab	Striped marlin	Porbeagle shark
Northern red hake	Bluefish	Bluefish	Warsaw grouper	Greater amberjack	Brown rockfish	Bering Sea Bairdi crab	Oceanic whitetip shark	Scalloped hammerhead shark
Silver hake	Spiny dogfish*	Black drum	Speckled hind	Goliath grouper	Copper rockfish	Longnose skate	Silky shark	Common thresher shark
Southern New England winter flounder	Summer flounder*	Atlantic sturgeon	Gray triggerfish	Gray triggerfish	Cowcod	Big skate	Blue shark	Yellowfin tuna
Gulf of Maine winter flounder	Atlantic mackerel*	Shad*	Red porgy	Mutton snapper	Canary rockfish	Alaska skate	Bigeye thresher shark	Blacktip shark (Atlantic)
Northeast skate complex	Tilefish*	Red drum*	Red grouper	Red grouper	Quillback rockfish	Sleeper shark	Shortfin mako shark	Blacktip shark (Gulf of Mexico
Ocean pout	Surf clam*	Spotted seatrout*	Scamp grouper	Scamp grouper	Vermillion / sunset rockfish	Spiny dogfish	Blue marlin	Blacknose shark (Atlantic)
Atlantic herring*	Ocean quahog*	Weakfish*	Black sea bass	Yellowtail snapper	Yelloweye rockfish	Yelloweye rockfish	South Pacific albacore	Blacknose shark (Gulf of Mexico)
River herring*	Loligo*	Summer flounder*	Snowy grouper	King mackerel	Sablefish (fixed gear)	Shortraker rockfish		
	Illex*	Tautog*	Blueline tilefish		Sablefish (trawl gear)	Rougheye rockfish		
		Striped bass*			Lingcod	Sablefish		
					Spiny dogfish			
					Skates (big and longnose)			

Figure 1. Preliminary SMART Tool Scores for NEFMC Species

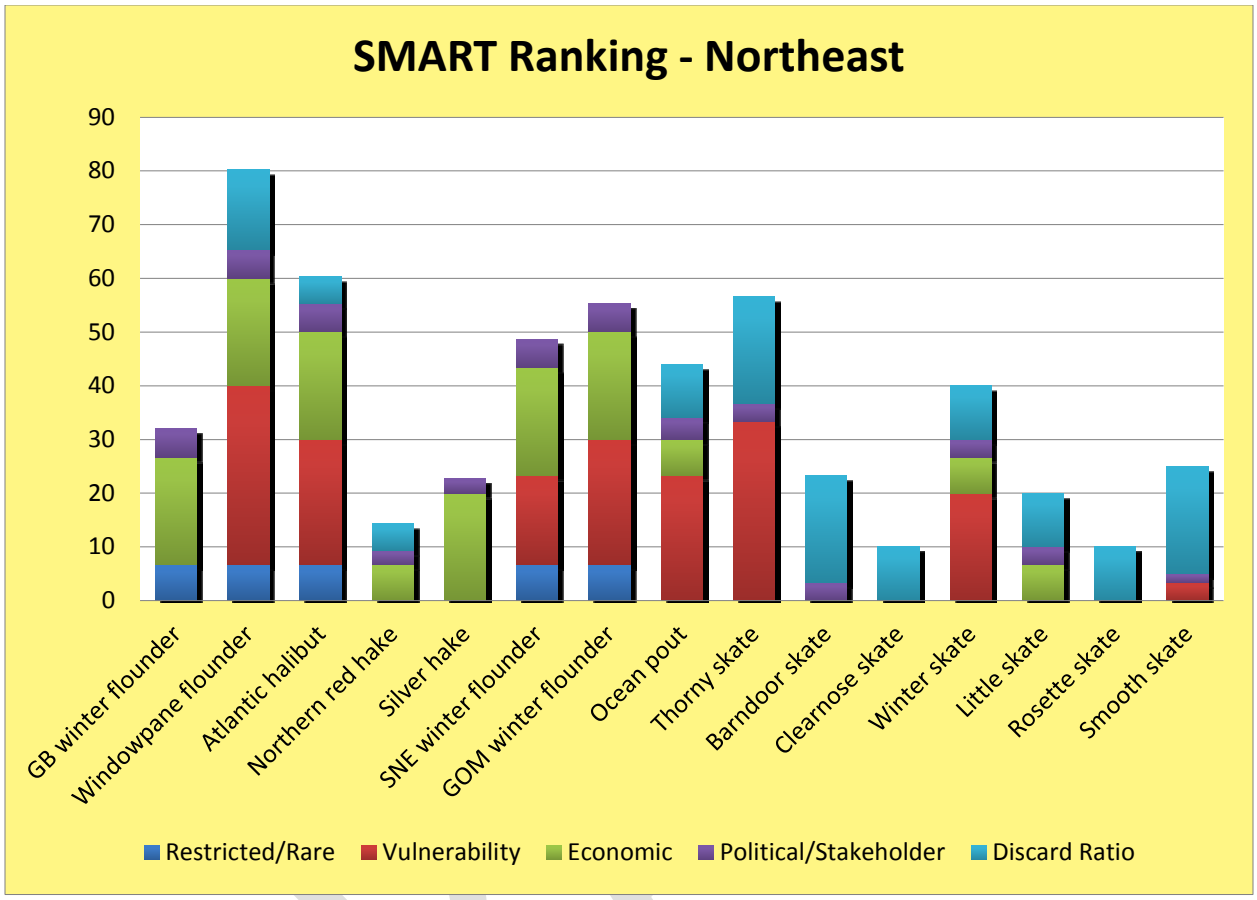
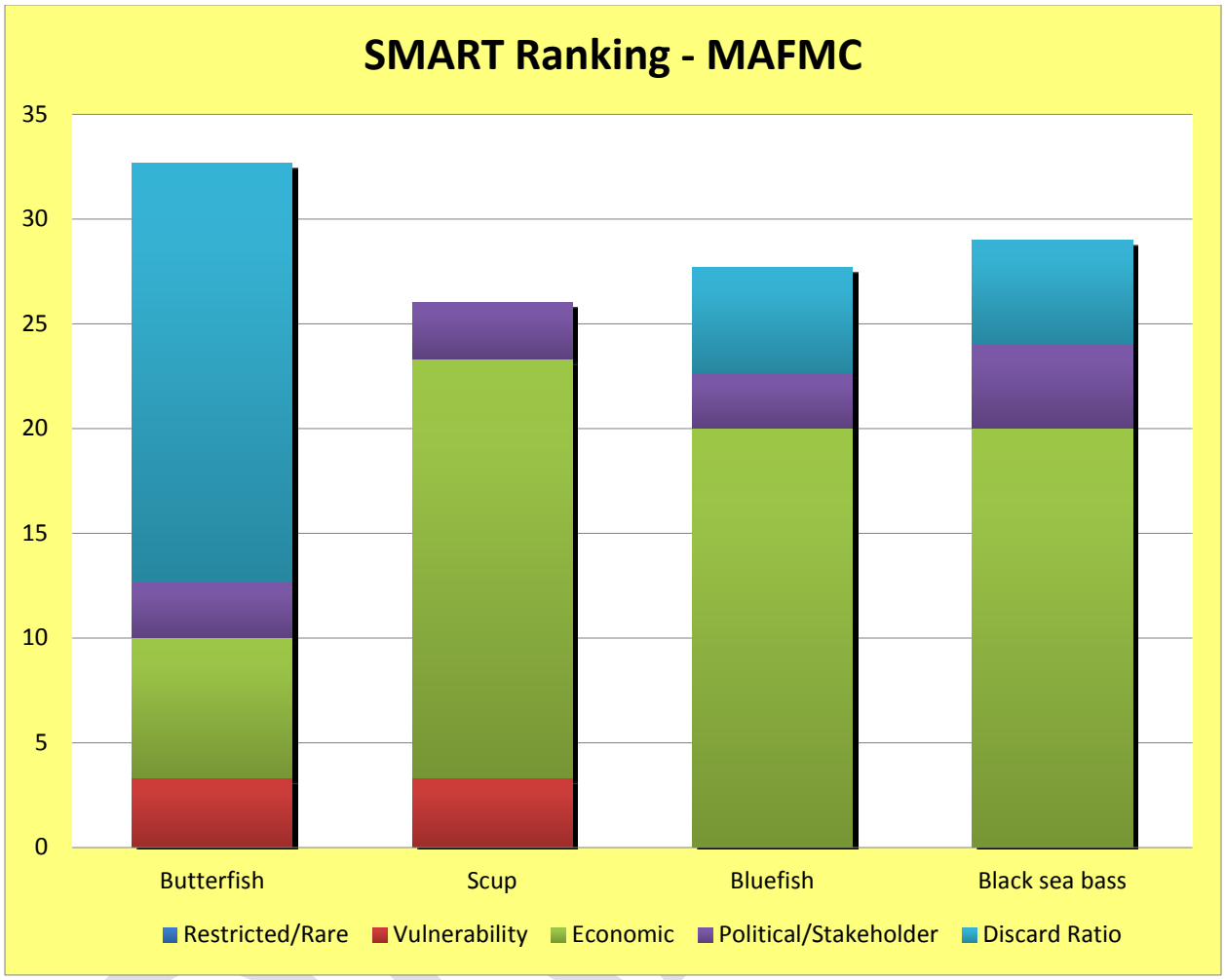


Figure 2. Preliminary SMART Tool Scores for MAFMC Species

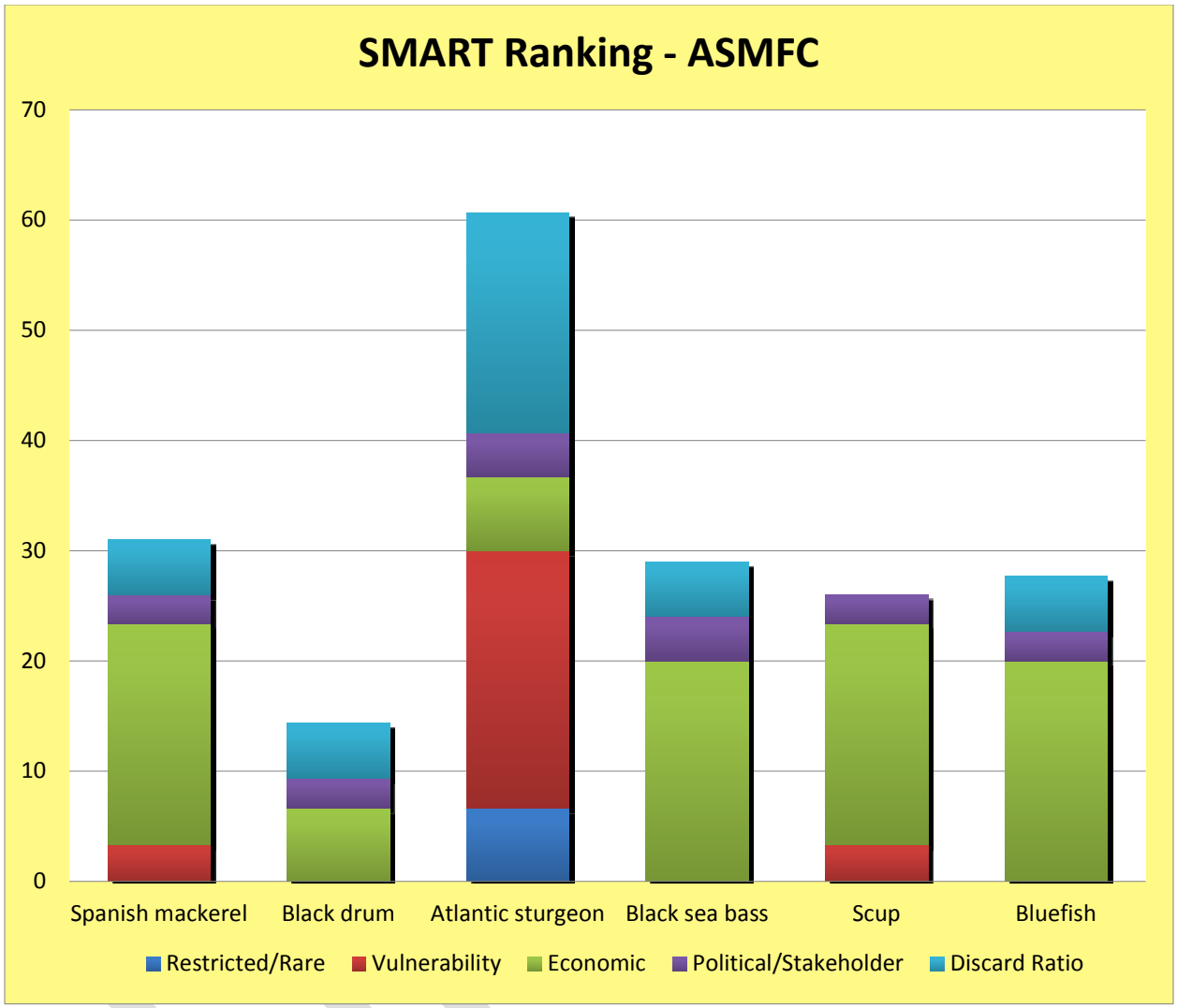


Atlantic States Marine Fisheries Commission (ASMFC) Species Preliminary Results

The experts who evaluated the MAFMC species used the management sensitivity filter to rule out an evaluation of several species. These species (shad, red drum, spotted seatrout, weakfish, summer flounder, tautog, and striped bass) were identified by the ASMFC as species that have been the subject of multiple release mortality studies, and/or species whose release mortality rates are not debated in assessment processes.

Figure 3 shows the scores for the six ASMFC-suggested species that were evaluated. Atlantic sturgeon received an overall score that was twice that of the next highest-scoring group of species. This high score was due to the vulnerability and discard ratio criterion scores assigned to Atlantic sturgeon. In addition, according to ASMFC comments, the release mortality rate used for Spanish mackerel, the second highest-scoring species, is based on a couple of studies, although release mortality rates identified in those studies were highly variable (10–35%).

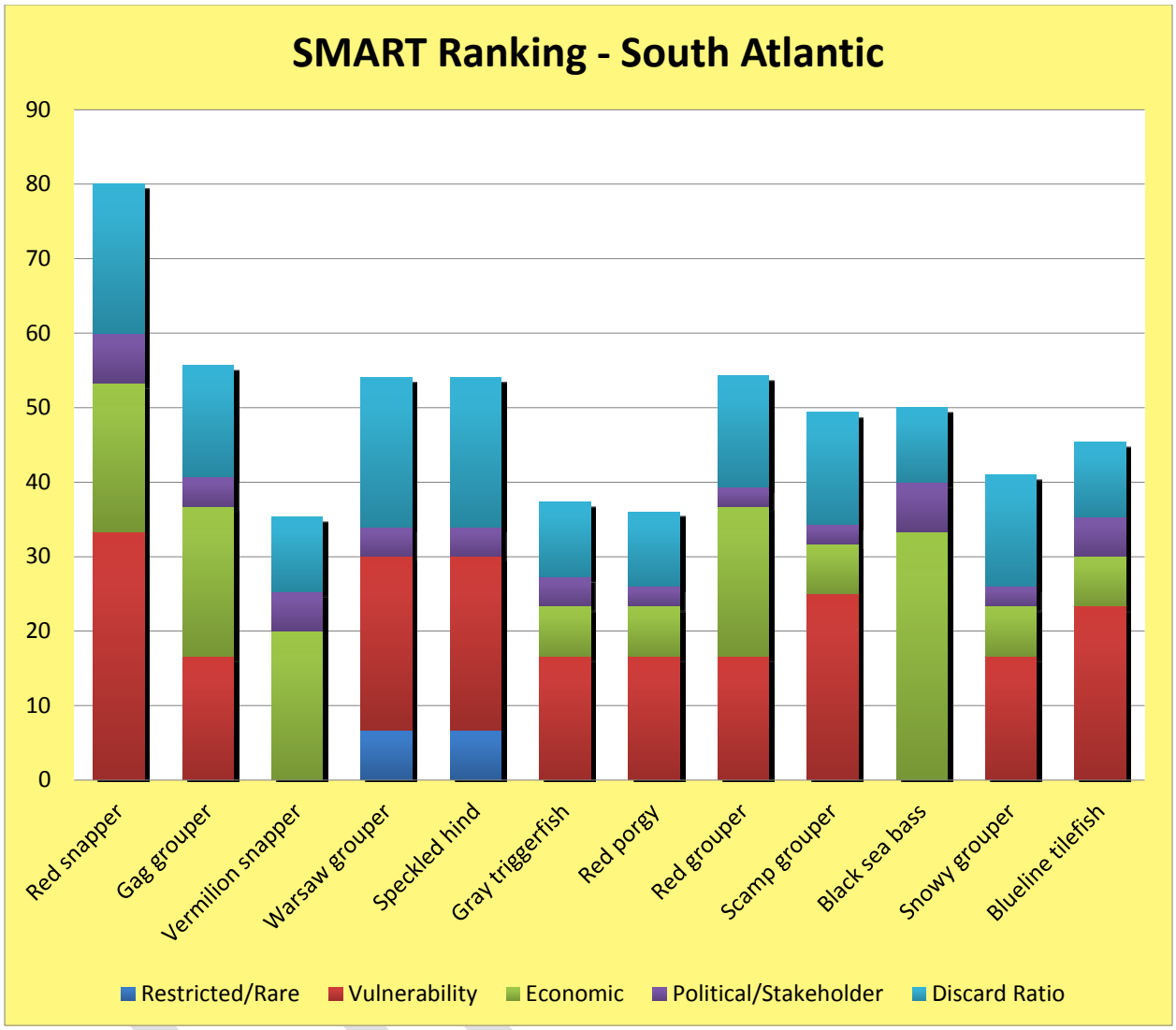
Figure 3. Preliminary SMART Tool Scores for ASMFC Species



South Atlantic Fishery Management Council (SAFMC) Species Preliminary Results

Experts evaluated all 12 species that were suggested by the SAFMC. Figure 4 shows the results for these species. Although red snapper received the highest score due to its stock status and high discard quantities, the experts felt that Warsaw grouper and speckled hind should have received the highest scores, in part because retention of these species is not allowed, as well as because of stock status. However, these two species received lower scores because no directed fishery for these species has existed for a few decades, which impacted the species points under the economic criterion. The experts also commented that a release mortality study focusing on Warsaw grouper and speckled hind would be difficult because the species are rarely encountered. This challenge led workshop participants to suggest that the Action Plan should focus on complexes of species that are caught by a certain gear type (e.g., hook-and-line, gillnet, trawl).

Figure 4. Preliminary SMART Tool Scores for SAFMC Species



Gulf of Mexico Fishery Management Council (GFMC) Species Preliminary Results

Experts evaluated all 11 species that were suggested by the GFMC. Figure 5 shows the results for these species. The experts were surprised to see that red snapper received the highest scores, because that species has been studied so extensively. This surprising result led to some discussion of the possible need for an additional SMART tool criterion that would evaluate the extent to which release mortality has been studied for a species. In addition, the experts commented that if red snapper had been separated into recreational and commercial sectors, the recreational sector may not have been evaluated due to the management sensitivity filter. Workshop participants felt it would be worthwhile to consider separation of certain species into recreational and commercial sectors for SMART tool evaluation purposes.

West Coast Species Preliminary Results

Because the timing of the top-10 species request conflicted with a meeting of the Pacific Fishery Management Council (PFMC), the PFMC was unable to provide a list of species. Instead, experts invited to the workshop, as well as Steering Committee members, identified a list of 15 species to be evaluated with the SMART tool. Figure 6 shows the results for these species.

Workshop attendees commented that some of the West Coast species have important regional differences due to distribution. For example, cowcod, which received a high score, is found mostly off Southern California. Sector differences (i.e., commercial versus recreational) also were cited as important by the workshop attendees. Similar differences might occur for nearshore fisheries as opposed to offshore fisheries for the same species. Workshop attendees also concluded that highly migratory species were underrepresented in the West Coast SMART tool analysis due to a lack of input from experts familiar with those species.

Although all Regional Fishery Management Councils may want to revisit these SMART tool analyses using a more complete set of species and expert opinions, it will be especially important for the PFMC to spend some time with the SMART tool as it was unable to fully engage with the analytical process that occurred prior to the workshop.

Figure 5. Preliminary SMART Tool Scores for GFMC Species

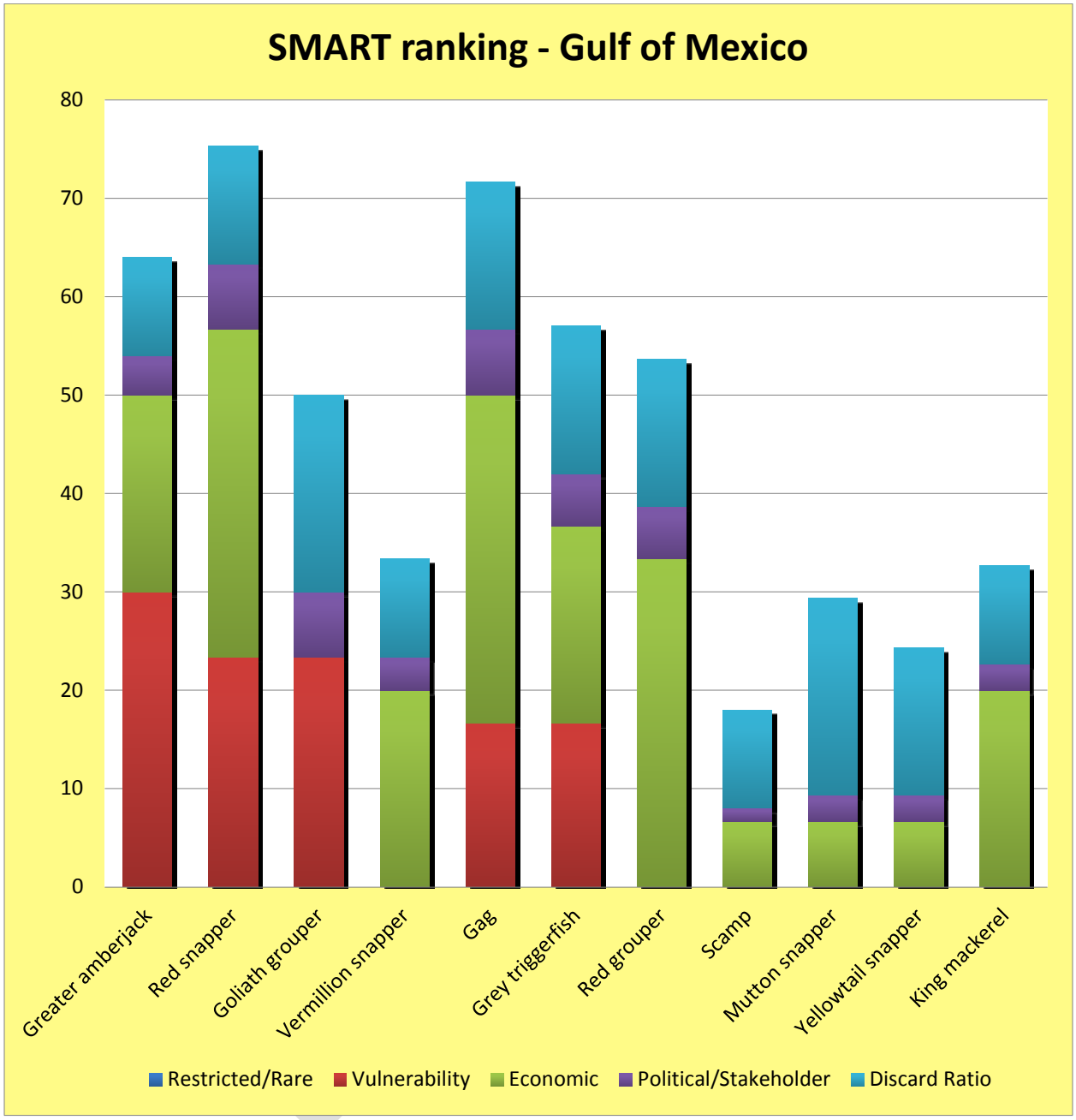


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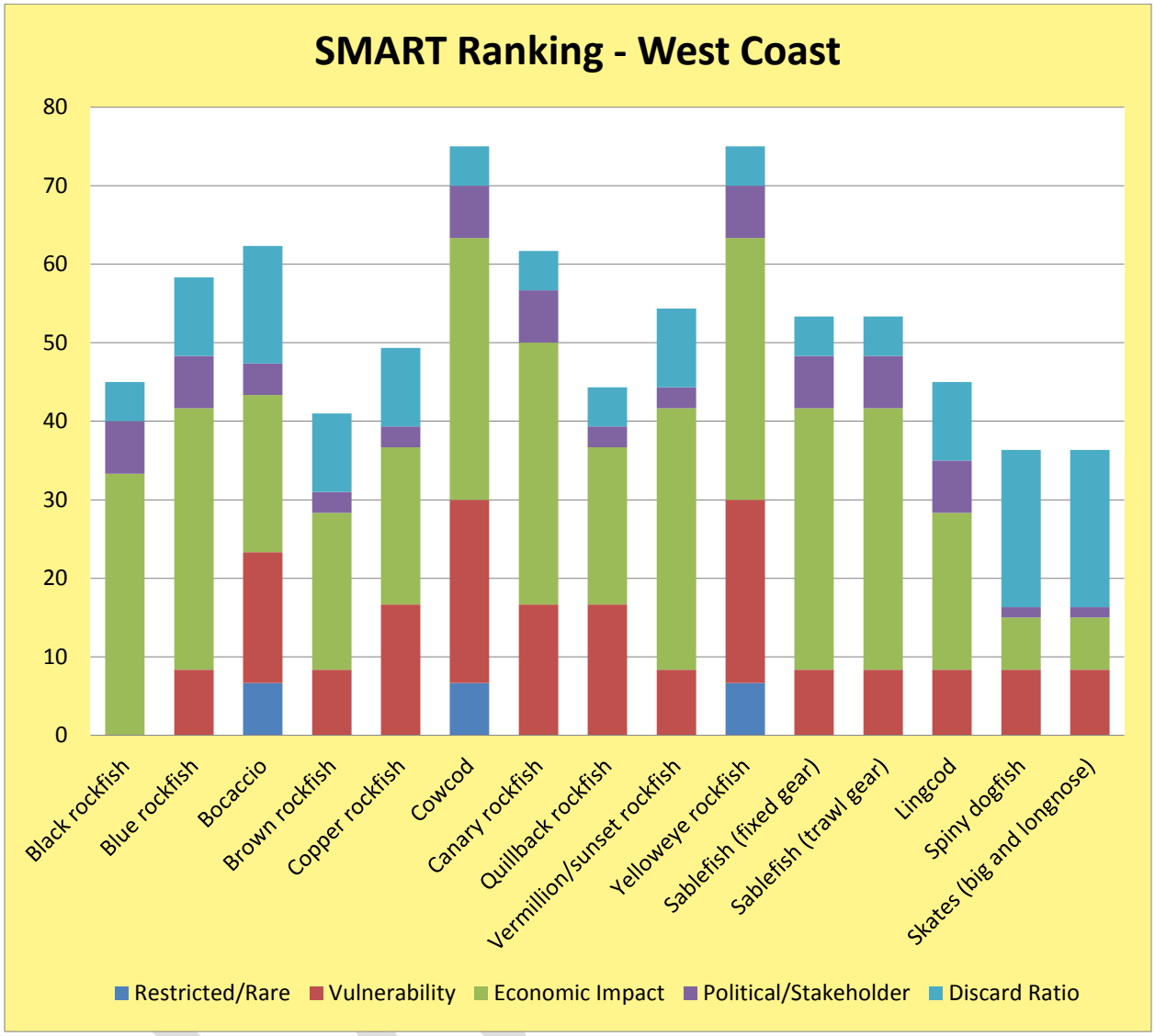
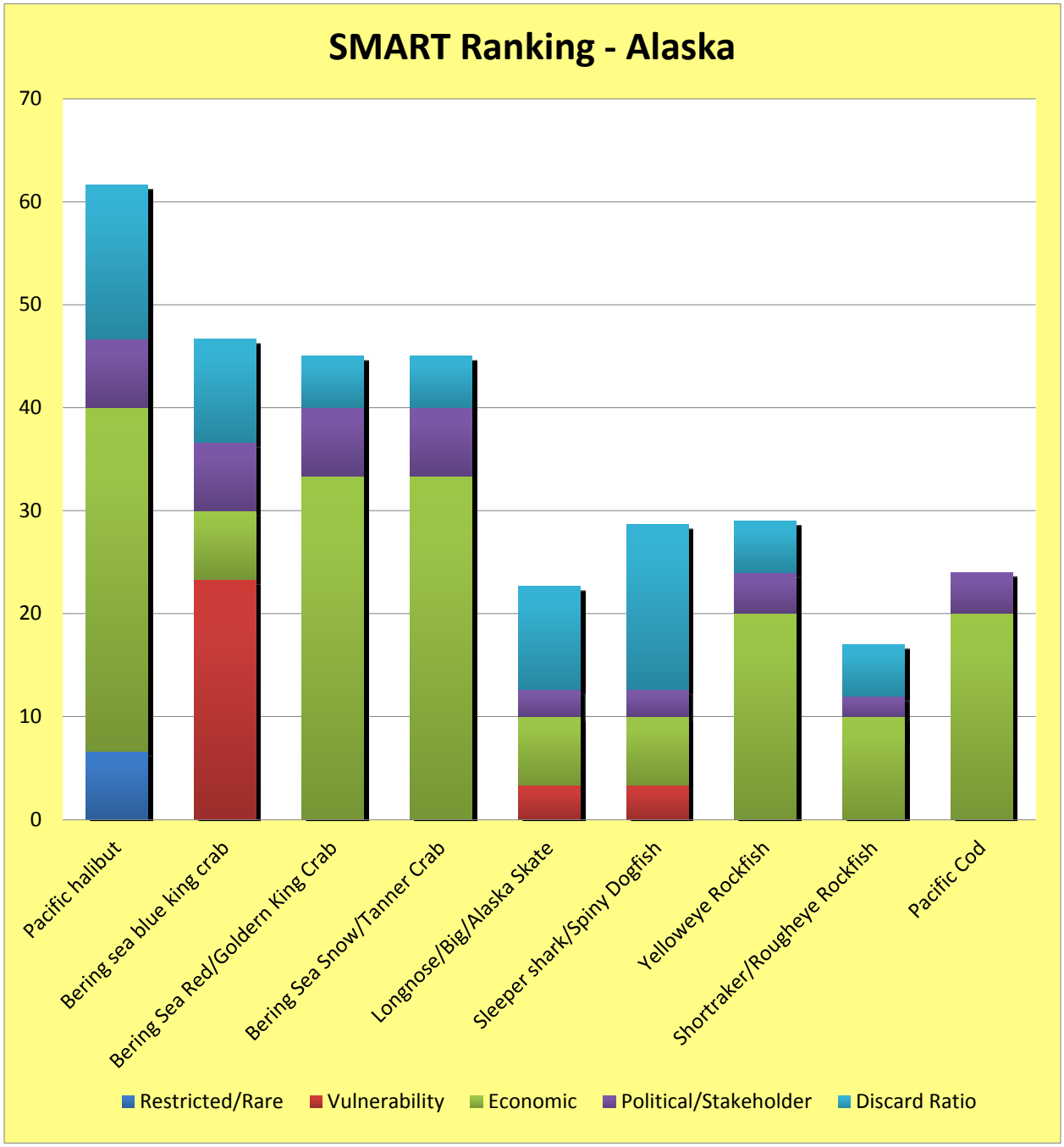
Figure 6. Preliminary SMART Tool Scores for West Coast Species



North Pacific Fishery Management Council (NPFMC) Species Preliminary Results

Experts evaluated all 13 species or species groups that were suggested by the NPFMC. However, the experts combined some of the species for evaluation purposes, and they evaluated an additional species, Pacific cod. The experts added Pacific cod because quotas for that are limited (which leads to additional discards when limits are close to being met), even though it is a valuable commercial species. Figure 7 shows the results for these species. Pacific halibut scored highest due to its economic value, its discard ratio, and its ability to limit groundfish trawl fisheries. Workshop participants felt that skates could receive a higher score as a restricted species if more were known about their biology and release mortality rates. Workshop participants also felt that rockfish species may have been scored too low in terms of the restricted criterion. In addition, participants felt that it is important to note when species are managed under multiple jurisdictions, for example, Pacific halibut and some highly migratory species.

Figure 7. Preliminary SMART Tool Scores for NPFMC Species



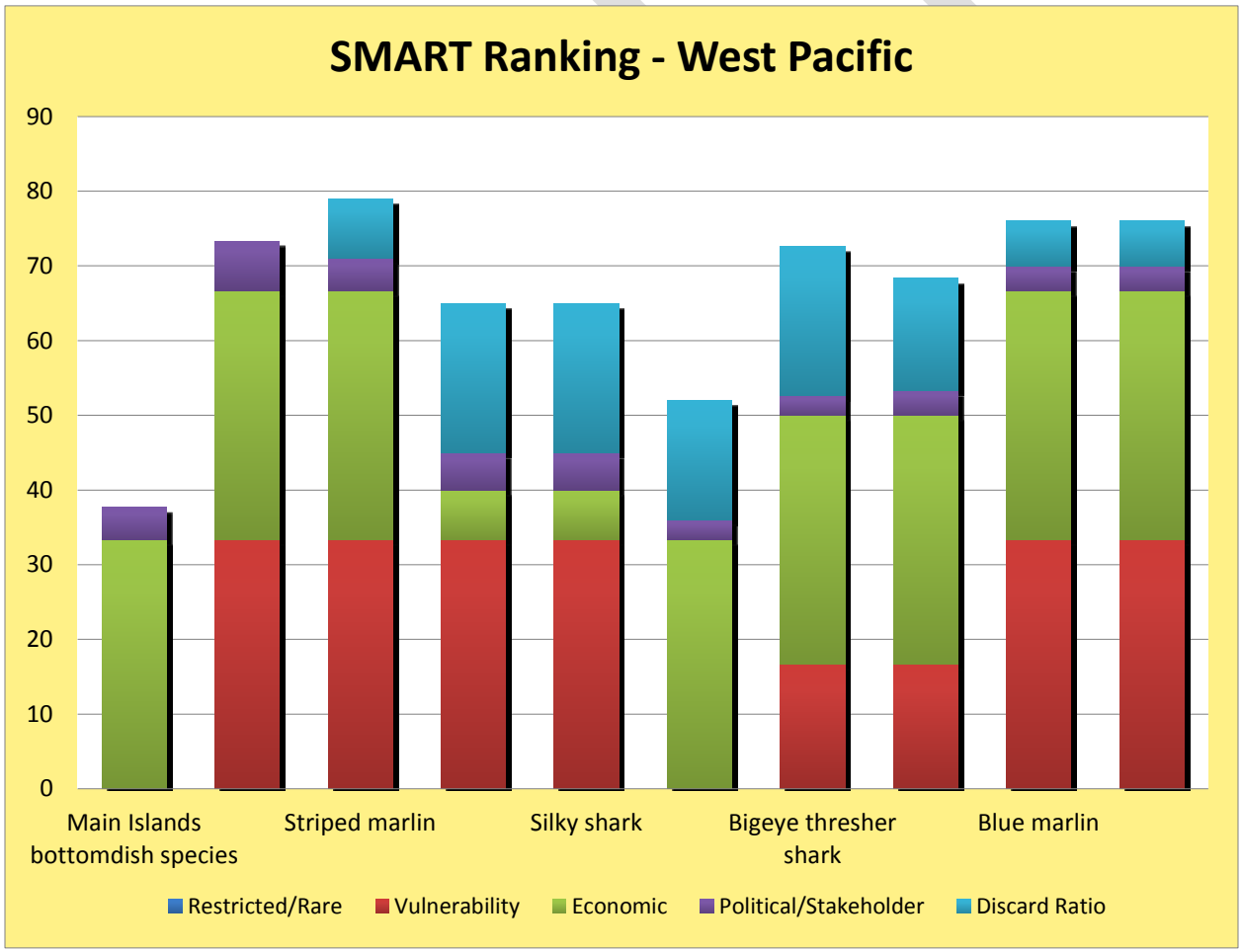
Western Pacific Fishery Management Council (WPFMC) Species Preliminary Results

Experts evaluated all 10 species or species groups that were suggested by the WPFMC. Figure 8 shows the results for these species. Several species, including some tunas and sharks, received high scores due to the economic and vulnerability criteria receiving high scores. This scoring inspired some discussion at the workshop regarding the need to ensure there is a consistent understanding of the criteria definitions by various parties from different parts of the country

who use the SMART tools. When it submitted its list of top species, the WPFMC commented that release mortality rates for small cetaceans (such as false killer whales and pilot whales), as well as other protected species (such as sea turtles and albatrosses), are of high interest to the Council.

Workshop attendees expressed some confusion over why particular species were submitted for evaluation, and why some species were not. It appears that the species submitted by the WPFMC were chosen due to a combination of factors including population status, stock assessment results, and conservation and management measures that include a no-retention policy. Subsequent use of the SMART tool by Councils should involve a wider variety of experts and species than were possible for the limited time and participants allowed for the 2015 workshop. In the case of Western Pacific species, additional SMART tool evaluations might include species for which managers have little release mortality information, such as louvar or oilfish.

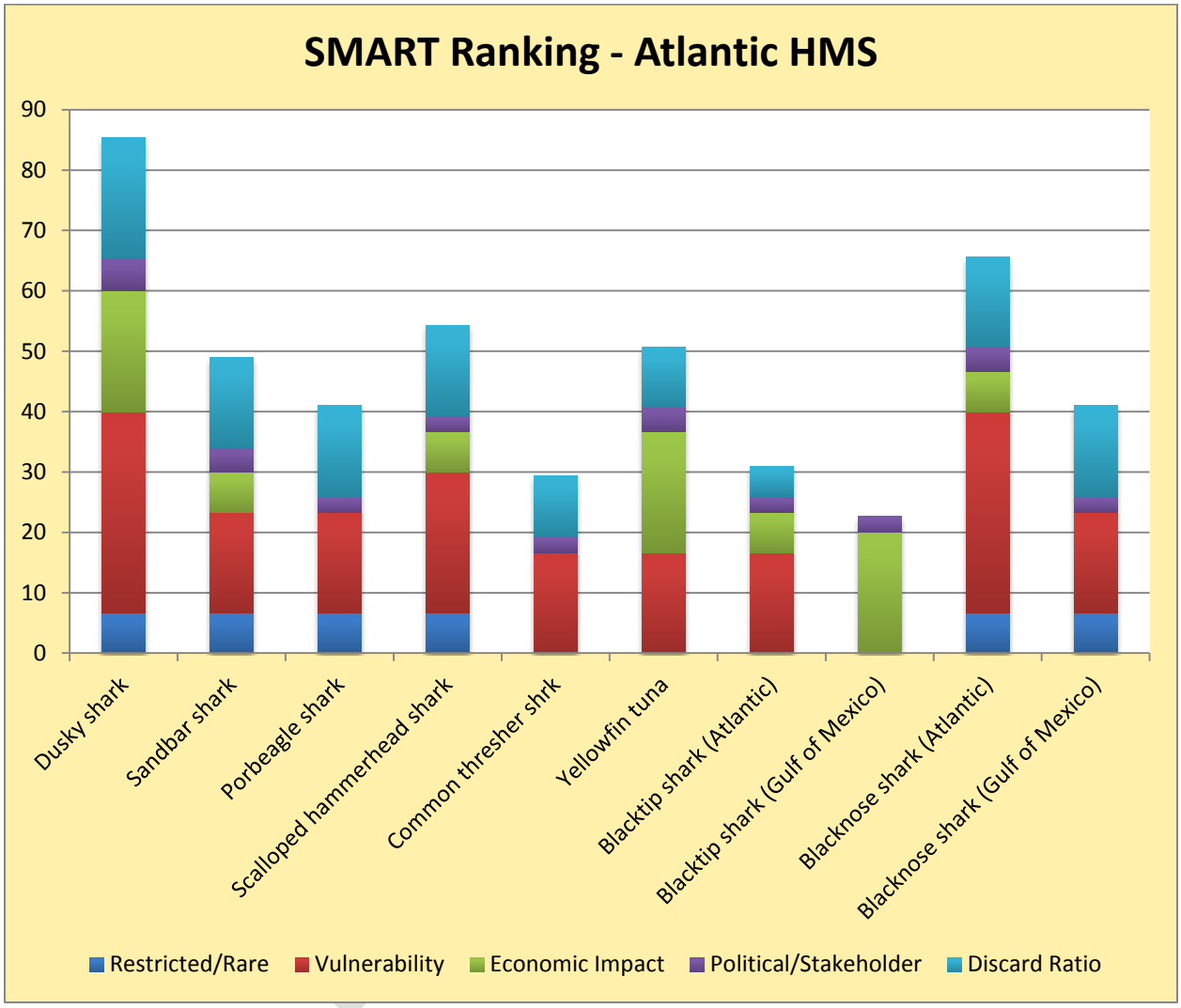
Figure 8. Preliminary SMART Tool Scores for WPFMC Species



Atlantic Highly Migratory Species (Atlantic HMS) Preliminary Results

After the 2015 workshop, experts from the NOAA Fisheries Atlantic HMS Management Division, working with some Steering Committee members, evaluated eight species, and included separate evaluations for Atlantic and Gulf of Mexico populations of two of those species (blacktip and blacknose shark). Figure 9 shows the results for these species.

Figure 9. Preliminary SMART Tool Scores for Atlantic HMS Species



The Atlantic HMS analysis highlighted differences in scoring that can occur for species that are managed domestically as well as internationally. Specifically, yellowfin tuna is a major species caught in the Atlantic HMS recreational and commercial fisheries and is assessed internationally by the International Commission for the Conservation of Atlantic Tunas. Due to different stock assessment thresholds, yellowfin tuna is considered to be overfished internationally, but not

domestically, where the yellowfin tuna population is above the minimum stock size threshold identified for the species (NMFS 2014).

Atlantic HMS experts applied the SMART tool's management sensitivity filter to exclude bluefin tuna and billfish because those species have been the subject of several release mortality estimation studies (for example, see Musyl et al. 2015). Atlantic HMS experts also excluded sea turtles from consideration in light of separate ongoing efforts involving NMFS and other stakeholders to answer release mortality questions involving those species.

Shark species, especially dusky shark and blacknose shark (Atlantic), received the highest scores due to their vulnerability, restricted and rare, and discard as a ratio of landings scores. Yellowfin tuna also received a relatively high score due to its economic importance and political and stakeholder interest.

General Thoughts on the SMART Tool

Workshop participants generally found the SMART tool to be useful in figuring out which species should be prioritized for release mortality research. However, participants did have some ideas to improve the tool.

One possible improvement would be to make the vulnerability criterion more nuanced. For example, this criterion could award additional points if a species is making good progress with its rebuilding plan. Without such nuances, a stock that is declining steadily toward an overfished status would score higher than a stock that is overfished but rebuilding nicely. In addition, progress in ending overfishing might make this criterion less meaningful if most species evaluated are no longer undergoing overfishing.

As was mentioned above, the SMART tool might be improved by introducing a new criterion that provides a score based on how much data on release mortality is available for a species. This score could be based on a simple scheme of low, medium, or high levels of data being available. Another criterion, or perhaps a related criterion, could try to capture the complexity of the fishery related to the fish species. For example, does the fishery involve multiple sectors, multiple jurisdictions, and/or multiple gears?

The discard ratio criterion could be more meaningful if it included information about whether the estimates are derived from observer data as opposed to self-reported data. Workshop participants also felt that the scoring matrix used for the PSA option under the vulnerability criterion should more closely reflect the scoring system used in the actual PSA tool. Species with rich datasets and for which detailed analytic assessments exist could further elaborate the discard mortality criterion by detailing the proportion of fishing mortality composed of discard mortality. This additional metric would help inform managers about the relative importance of discard mortality.

Workshop participants strongly felt that the SMART tool should be refined a bit and then used by a wider group of regional stakeholders, including Regional Fishery Management Council Scientific and Statistical Committees, in order to apply a wider range of expertise to the SMART tool analysis, as well as to evaluate additional species and help identify additional data gaps. A

wider group of regional stakeholders also could explore ways to adapt the SMART tool—for example, to use it to evaluate individual species, species complexes, sectors, or even gear types—or revise the weighting scheme to more accurate reflect regional concerns.

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Musyl, M. K., C. D. Moyes, R. W. Brill, B. L. Mourato, A. West, L. M. McNaughton, W. Chiang, and C. Sun. 2015. Postrelease mortality in istiophorid billfish. Canadian Journal of Fisheries and Aquatic Sciences. 72(4):538-556.

NMFS. 2014. Stock Assessment and Fishery Evaluation (SAFE) Report for Atlantic Highly Migratory Species. U.S. Dept. of Commer., NOAA. Silver Spring, MD, 195 p.