Draft MAFMC Research Prioritization Process

Under the Magnuson-Stevens Act, each Council is to develop a 5-year Research Plan for submission to and consideration by the National Marine Fisheries Service. A draft 2012-2016 Research plan has been prepared by Council staff and includes dozens of important projects that range from relatively simple short-term single species activities to long-term ecosystem modeling and assessment programs. The Mid Atlantic Council requested the assistance of its Scientific and Statistical Committee to suggest a process to help the Council identify its priorities within the list of proposed research and information needs.

A work group of the SCC met by teleconference on February 8th to discuss the task and suggest preliminary criteria to use in evaluating projects. Those results have been incorporated into a draft prioritization process described below for further consideration by the SSC. Basic assumptions going into the process included that there are more proposed projects than there is funding available, and that not all projects have equal priority for funding. Therefore a process was needed to prioritize the MAFMC research proposals in a way that maximizes net benefits from the available funds.

The process includes six steps outlined in more detail in the following pages:

Step 1: Compare species criteria to species criteria
Step 2: Compare species (vertical) to species criteria (horizontal) in an L-shaped matrix
Step 3: Identify additional criteria against which to evaluate research proposals
Step 4: Assign weights to the importance of criteria by comparing them in an L-shaped matrix
Step 5: Construct the final L-shaped matrix
Step 6: Cost-benefit analysis

Step 1: Compare species criteria to species criteria

(See Step 1 Spreadsheet.xls)
All species are not created equal, and we may want to give deference to research on some species in lieu of others. What criteria would make us prefer one species over another? We identified five species criteria.

Species criteria

1. High commercial value (annual dollar value of fishery)
   The higher the dollar value (in the case of a commercial fishery), the more important the species.
2. Recreational value (landings, weight)
   The higher number of annual landings or gross weight (in the case of a recreational fishery), the more important the species.
3. The stock is overfished
   The more overfished the stock, the more important the species (as it is important for research to be conducted on this stock).

4. Overfishing is occurring on the species
   The more overfishing of the stock, the more important the species (as it is important for research to be conducted on this stock).
5. Impact on other species (Ex. Forage fish and choke species)
   The more impact a species has on other species (whether positive or negative), the more important the species.

**Remember that each of these species criteria is being judged in reference to which species are the most important from the standpoint of funding research proposals. That means that while overfishing is generally not considered a good thing, the criteria is being applied in the context of giving more deference to funding a fishery where overfishing is occurring.

We do not want to assume that each of the five criteria have equal weights, so we assign weights to the relative importance of these criteria by comparing them pair-wise in an L-shaped matrix. (Step 1 Spreadsheet.xls)

- Reading across the vertical axis, compare each species criteria to those on the horizontal axis (place an "x" in the boxes where the same two criteria are being compared).
- Each time a weight (e.g. 1, 5, 10) is recorded in a row cell, its reciprocal value (e.g. 0.1, 0.2) must be recorded in the corresponding cell.
  - 1 = species criteria equally important
  - 5 = species criterion is more important
  - 10 = species criterion is much more important
  - .2 = species criterion is less important
  - .1 = species criterion is much less important
- Total each horizontal row and convert to a relative decimal value known as the "species criterion weighting."

- If individual judgments are sought (versus taking a group consensus) these judgments will be compiled group-wide by taking a geometric mean to come up with a final rating which will be used in step 2.

Step 2: Compare species (vertical) to species criteria (horizontal) in an L-shaped matrix

(See Step 2 Spreadsheet.xls)

Each species criterion now has a weighted value. In the context of funding research proposals for MAFMC, how do we determine species importance relative to the species criteria?

- Reading across the vertical axis, compare each species to the species criteria on the horizontal axis. Assign a rating by how much each species is in alignment with the criterion. The maximum number that can be assigned is equal to the species criterion weighting for that criterion found in step 1 after adding up the group totals. The species will be assigned the full weight if the species perfectly meets the species criterion. The lowest number is 0 (the species does not meet that criterion at all). A table was developed based on facts from the NMFS databases. Recommendations on what percentage of the species criterion weight should be attributed to each species are below:

Species	Commercial value $ (2010)	Recreational value (# fish 2010)	Overfished (Stock size relative to biological reference points)	Overfishing (F current/Fmsy)	Spillover?
Bluefish	1,075,604	2,559,736	95%	~0.75	neither
Tilefish	5,106,306	~0	104%	~0.35	neither
Surfclams	17,718,858	~0	162%	~0.20	neither
Ocean quahog	7,878,102	~0	162%	~0.25	neither
Summer flounder	8,125,838	1,225,669	100%	~0.75	neither
Black sea bass	1,613,590	1,317,458	111%	~1.00	neither
Scup	2,935,522	2,735,543	202%	~0.25	neither
Atlantic mackerel	912,426	3,914,000	midpoint*	0.50*	forage
Butterfish	329,021	~0	Yes; exact data not available but <50%	0.50*	choke
Illex	5,676,703	~0	Midpoint*	0.50*	forage
Loligo	6,088,431	~0	128%	0.50*	forage
Spiny dogfish	228,607	~0	106%	~0.35	neither
* no data- use midpoint 50% error rate each way					

For commercial value:

Surfclams (100% of species criterion weighting)

Ocean quahog, Tilefish, Summer flounder, Illex, Loligo (75% of species criterion weighting)

Scup (50% of species criterion weighting)

Bluefish, Black sea bass, Atlantic mackerel (25% of species criterion weighting)

Butterfish, Spiny dogfish (0% of species criterion weighting)

For recreational value:

Atlantic mackerel (100% of species criterion weighting)

Bluefish, Scup (66.67% of species criterion weighting)

Black sea bass, summer flounder (33.33% of species criterion weighting)

Tilefish, Surfclams, Ocean quahog, Butterfish, Illex, Loligo, Spiny dogfish (0% of species criterion weighting)

Note the use of "number of fish" for a proxy of recreational importance is imperfect and undervalues species such as summer flounder where low bag limits affect landings. Better proxies such as MRIP data on directed trips were not yet available nor were willingness to pay values for recreational species. We can check sensitivity of this value on the outcome and/or adjust accordingly.

For Overfished:

Normalized cumulative data for overfished (numbers in second column (red) are 1 minus the normalized cumulative data because those species that are overfished should get a greater percentage of the criterion weighting): *=no data so they were assigned the median 50%

Bluefish	0.265605	0.734395	73% of species criterion
Tilefish	0.338178	0.661822	66% of species criterion
Surfclams	0.823204	0.176796	18% of species criterion
Ocean Quahog	0.823204	0.176796	18% of species criterion
Summer flounder	0.304954	0.695046	70% of species criterion
Black sea bass	0.399322	0.600678	60% of species criterion
Scup	0.968222	0.031778	3% of species criterion
Atlantic mackerel	.5*	0.5	50% of species criterion
Butterfish	0.047484	0.952516	95% of species criterion
Illex	.5*	0.5	50% of species criterion
Loligo	0.555333	0.444667	44% of species criterion
Spiny dogfish	0.355297	0.644703	64% of species criterion

Numbers in the second column are the percentages each species will get of the overfished criterion

For Overfishing:

Use the same proportions in above table (Fcurrent/Fmsy) as the proportions of the species criterion

Bluefish	~0.75	75% of species criterion
Tilefish	~0.35	35% of species criterion

Surfclams	~0.20	20% of species criterion
Ocean Quahog	~0.25	25% of species criterion
Summer flounder	~0.75	75% of species criterion
Black sea bass	~1.00	100% of species criterion
Scup	~0.25	25% of species criterion
Atlantic mackerel	0.50*	50% of species criterion
Butterfish	0.50*	50% of species criterion
Illex	0.50*	50% of species criterion
Loligo	0.50*	50% of species criterion
Spiny dogfish	~0.35	35% of speceis criterion

For Spillover:
Species that are both choke and forage (100% of species criterion weighting)
Species that are one or the other (50% of species criterion weighting)
Species that are neither (0% of species criterion weighting)

THEN…

- Total each horizontal row and convert to a relative decimal value known as the "species weighting."
- Now we know the relative importance of each species (in reference to needing research conducted) and can start on the main part of the process for comparing research proposals to criteria.

Step 3: Identify other criteria besides species against which to evaluate research proposals

In the previous steps we've already determined why research on one species might be more important to fund than research on another species. In step 3 we need to identify other criteria besides species importance to use in rating research proposals. Based on SSC conference call results and further reflection, we've identified a total of eight criteria, including species importance. We can easily add or subtract criteria if these are not to everyone's liking. We define the meaning of the different criteria below.

1) Species is important

   We need to simply evaluate the need to pick research projects benefiting important species compared to the other criteria.

2) Decreases scientific and/or management uncertainty and risk

   Species are put into various tiers based on how much information is available. In this way, tier 3 species have a lot of uncertainty, while tier 1 species have the least uncertainty related to their stock assessments. When addressing this criterion, the ability of a particular project to decrease uncertainty and move the species from a higher tier to a more desirable lower tier should be taken into account. The same process can be used to evaluate the importance of a project to reducing management uncertainty, i.e., it lowers risk to Councils associated with achieving the chosen ACL. If a research project lowers the risk of not achieving the chosen ACL (and the repercussions to the Council and fish stocks that go along with that) by increasing the accuracy of scientific data or creating a new management mechanism that has a higher likelihood of success, then the project is more desirable.

3) Positive social impacts

Social considerations must be taken into account when evaluating any research proposal, as coastal and fishing communities are major stakeholders. These include the research's benefit to these communities, whether it is through increased access to jobs, recreational fishing, artisanal fishing, etc., with a particular emphasis on sustainability.

4) Positive economic impacts

Economic considerations also must be taken into account when evaluating research proposals. This includes the potential the research has for increasing net economic values over time with a particular emphasis on sustainability.

5) Is widely applicable

If a research project contributes results that are widely applicable to the greater understanding of multiple species or attributes it is to be rated highly as "applicable." For instance, if developing a new method for assessing the length at age of a mackerel can be applied to other species, this research will be considered highly applicable. Data collection on a single species may not be considered highly applicable, while analytical and assessment tasks may be more so.

6) Contributes to a better understanding of the big-picture ecosystem

It should be considered whether research projects may be beneficial to the larger ecosystem—not only to a specific species. For example research that helps sustain forage fish would help sustain other fish that eat these fish. Important ecosystem attributes to consider when evaluating research proposals include: bottleneck species, bycatch, and ecosystem indicators. This is similar in concept to criteria 6 but is not identical. Given the special interest in ecosystem based fishery management of the Council we kept this separate.

7) Quick achievement of an outcome

Research projects require different amounts of time before the achievement of an outcome is expected. Some projects may be implemented and expected to achieve an outcome within the year (a one-shot deal), while others may need to be conducted over a much longer period of time with several trials before results can be conclusive. Projects that are valuable to fisheries management and achieve an outcome quickly should have priority over slower projects.

8) Has elements of applied research (as opposed to basic)

Projects may either be basic or applied. The goal of basic research is to improve scientific understanding, while applied research builds off of basic research and is used to solve practical problems. Applied research is often much easier to implement because it already has tools and technologies available to tackle an issue. Much of the Council's focus is on decisions hinging on applied research so we give deference to applied research.

Step 4: Assign weights to the importance of criteria by comparing them in an L-shaped matrix

(See Step 4 Spreadsheet.xls)

Now that we have our final criteria, through a pair-wise comparison we determine weights for the eight criteria since we do not want assume they are all equally important. The process is similar to Step 1. We can either use a mean of individual judgments or simply accept a group consensus response for the relative importance of different criteria. Our goal in this step is to ask "In the context of funding research proposals for MAFMC, how important each of the eight criteria compared to each other?"

- Reading across the vertical axis, compare each criteria to those on the horizontal axis (place an "x" in the boxes where the same two criteria are being compared).
- Each time a weight (e.g. 1, 5, 10) is recorded in a row cell, its reciprocal value (e.g. .1, .2) must be recorded in the corresponding cell.
    - 1 = species equally important
    - 5 = species is more important
    - 10 = species is much more important
    - .2 = species is less important
    - .1 = species is much less important
- Total each horizontal row and convert to a relative decimal value known as the "criteria weighting."

Step 5: Construct the final L-shaped matrix

(See Step 5 Spreadsheet.xls)

Now the fun part.

Compare, i.e., rate each research proposal (vertical) against the criteria (horizontal) in an L-shaped matrix.

- First we must explain how to evaluate the species criterion. This criterion in the matrix is subdivided into each species. The proportion assigned to each species in step 2 (after group consensus) must be re-proportioned based on the weighted value of species importance from step 4. So if the proportional value for bluefish from step 2 was 0.2 and the value of species importance from step 4 was 0.3 then the final value of importance for bluefish is the product of these two numbers, 0.06. For the purpose of the species columns in this matrix, the research proposal will be rated based on how closely it targets/supports/aligns with one or more species.

- Now for the other criteria. Each criterion has a weighted value. Reading across the vertical axis, compare each research proposal to the criteria on the horizontal axis. Assign a number by how much each research proposal is in alignment with the criterion. The maximum number that can be assigned is equal to the criterion weighted value (that is if the research proposal perfectly meets the criterion). The lowest number is 0 (the research proposal does not meet that criterion at all). Use the scale below:

    - 0% of criterion weighting= doesn't meet criterion at all
    - 25% of criterion weighting = slightly meets criterion
    - 50% of criterion weighting = somewhat meets criterion
    - 75% of criterion weighting = mostly meets criterion
    - 100% of criterion weighting = fully meets criterion

- Total each horizontal row and convert to a relative decimal and then compare. Those research proposals with the highest numbers have the highest amount of benefits to pursuing them.

These relative decimals will be used as the value for benefits for each research proposal, and can be used in step 6.

Step 6: Cost-benefit analysis

- We left out cost as a criterion for a reason. We don’t have a total budget constraint and don’t have specific costs for each proposal. If we did we could simply convert the cost into a rating score, compute the benefit cost ratio for each proposal, sort them from highest to lowest score and apply the budget constraint. We could also get into optimization and program the frontier of projects that give us the greatest return for our budget.

- For now we can only compare the benefits of a research proposal to some proxy for the cost of the proposal to see which research projects maximize benefits and minimize cost. Each project could be assigned a cost ratings value (e.g., score of 1 = under $250K, 2 = $250-500K, etc) by guesstimate/expert knowledge. We know the benefit value from step 5. Create a chart with the research proposals on the vertical axis and “benefit,” “cost,” “benefit/cost,” “cumulative cost” and “cumulative benefit” on the horizontal axis. After dividing benefit by cost, re-rank the options with the highest number at the top of the list and the lowest at the bottom. Then calculate the cumulative cost and cumulative benefit. This easily shows you where you must cut off the projects based on how much money you have available and the cumulative benefits associated with this set of projects. Thus, you will be able to maximize the benefits for the amount of money you have with which to pursue research projects.

Note: All factors that go into cost must be considered including the cost of labor and equipment. Whether the research would be funded through appropriations or industry (through grant set-aside programs) could be considered either as a criteria in ranking the benefits or as a discounted cost. For example, a project funded by industry would be considered low cost for this purpose (as it wouldn't cost the government money), and thus more desirable if our accounting stance was government dollars.