A Socioeconomic Evaluation of a Network of Deepwater Marine Protected Areas

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Introduction

As defined by Marine Protected Areas Executive Order 13158, a marine protected area (MPA) is "any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein" (EOP, 2000).

The South Atlantic Fishery Management Council (Council) is responsible for the conservation and management of fish stocks within the Federal Exclusive Economic Zone (EEZ) off the southeastern U.S. coast. The EEZ begins 3 nmi off the coasts of North Carolina, South Carolina, Georgia, and the east coast of Florida, including the Florida Keys, and extends offshore to 200 nmi.[1] The Council further defines MPA's within its jurisdiction as "a network of specific areas of marine environments reserved and managed for the primary purpose of aiding in the recovery of overfished stocks and to ensure the persistence of healthy fish stocks, fisheries, and associated habitats. Such areas may include naturally occurring or artificial bottom and water column habitats, and may include prohibition of harvest on seasonal or permanent time periods to achieve desired fishery conservation and management goals."[2]

As part of the federal regulatory process when establishing MPA's in the U.S. EEZ, the net socioeconomic impact to fishery stakeholders must be valued ex ante, using the best scientific information available (NOAA, 2009). In this study, we evaluate net socioeconomic impact with a traditional benefit-cost framework in which the potential benefits of protection are compared to the potential costs when evaluated over different time frames. Effects in the form of socioeconomic benefits (i.e., advantages) and costs (i.e., disadvantages) are expected to arise due to the implementation of a network of MPA's.

The collective of these negative and positive forces and their relative influence over time result in a net socioeconomic impact to fishery stakeholders. In many instances these concepts are very hard to define and should be viewed as positive or negative effects with varying and unknown degrees of influence on an overall prediction of net socioeconomic impact associated with a particular MPA alternative.

This study presents a Delphi[3] approach that engages stakeholders in the public domain and produces semi-quantitative forecasts of the type and incidence of socioeconomic effects, associated with implementing a network of Type 2 MPA's[4] in the deepwater component of the snapper-grouper (SG) fishery in the EEZ off the southeastern U.S. coast. The cumulative weighted influence of these socioeconomic effects results in a net socioeconomic impact to fishery stakeholders. The Delphi method employed in this study quantifies this impact and allows comparison of alternative MPA sites based on the resulting metric.

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[1]Outer boundaries of the U.S. EEZ off the southeastern coast vary according to areas where jurisdictional boundaries meet with Bermuda, the Bahamas, and Cuba.

[2]Available online at http://safmc.net/managed-areas/marine-protected-areas.

[3]See Linstone and Turoff (1975) for a seminal discussion of the Delphi technique and applications.

[4]A Type 2 MPA allows some level of fishing effort within the protected areas.

ABSTRACT—Marine protected areas (MPA's) are spatially defined fishery management strategies designed to allow overfished species to recover by excluding fishing effort from certain fishing grounds and essential habitats. When MPA's are established in federal waters, the net socioeconomic impact to fishery stakeholders must be forecast. In many cases, conducting a quantitative impact analysis is not possible due to poor spatial resolution of available data. This study implements a semi-quantitative impact assessment based on Delphi methodology to evaluate the net socioeconomic impact of alternative MPA sites proposed for the deepwater component of the snapper-grouper fishery off the southeastern coast of the United States. The results suggest that the approach is tractable and useful to fishery managers when assessing alternative MPA sites in a data-poor environment.

The Council implemented its "Fishery Management Plan for the Snapper-Grouper Fishery of the South Atlantic Region" to protect SG resources, which generally are site-specific, relatively long-lived, slow-growing, and vulnerable to depletion (SAFMC, 1983).[5] The Council first investigated the potential of MPA's to protect SG species through its Snapper-Grouper Plan Development Team (PDT, 1990). Over the next decade, the Council initiated public scoping meetings and a scientific review of the 1990 PDT report, while also establishing the Experimental Oculina Research Reserve off Ft. Pierce, Fla., and implementing MPA's associated with the Florida Keys Marine Sanctuary.

In 2000, the Council began discussions regarding implementation of MPA's from North Carolina to the Florida Keys to protect deepwater species susceptible to overfishing (i.e., speckled hind, *Epinephelus drummondhayi*; golden tilefish, *Lopholatilus chamaeleonticeps*; blueline tilefish, *Caulolatilus microps*; snowy grouper, *Hyporthodus niveatus*; Warsaw grouper, *Hyporthodus nigritus*; misty grouper, *Hyporthodus mystacinus*; and yellowedge grouper, *Hyporthodus flavolimbatus*). The process culminated in the development of Amendment 14 to the Snapper-Grouper FMP.[6] This amendment augments traditional methods of management with permanently closed Type 2 MPA's in an effort to improve the biological health of SG deepwater resources and mitigate negative socioeconomic consequences resulting from spatial closures.[7]

Table 1.—Proposed Amendment 14 MPA's off the Carolinas and Georgia.

MPA	Location and description
Snowy Grouper Wreck	Two alternatives, 10 nmi × 15 nmi each, located 55 nmi SE of Southport, N.C. Both sited on a known snowy grouper aggregation. Alternative 1 may protect more mid-shelf species than Alternative 2.
Northern South Carolina	Three alternatives, 5 nmi × 10 nmi each, located 55 nmi SE of Murrells Inlet, S.C. All three sited on an area of low relief containing significant hardbottom. All three sited on shelf edge which is a popular spot for deepwater and mid-shelf SG species.
Edisto	Two alternatives, 5 nmi × 10 nmi each, located 45 nmi SE of Charleston, S.C. Both sited in an area of upwelling holding snowy grouper and speckled hind. Both sited on shelf edge which is a popular spot for deepwater and mid-shelf SG species.
Charleston Deep Reef	One alternative, 3.5 nmi × 6 nmi, located 50 nmi E of Charleston Harbor, S.C. Artificial reef MPA to study effects associated with implementation of MPA's sited in a depth range preferred by deepwater SG species.
Georgia	Two alternatives, 10 nmi × 10 nmi each, located 65–69 nmi SE off the mouth of Wassaw Sound, Ga. Both sited on known golden tilefish habitat and active trolling grounds for pelagic species.

Descriptions of the proposed MPA's were developed based on the Council's Public Hearing Draft for Amendment 14, published research, and expert testimony (Tables 1, 2). Several alternate locations were considered for many of the proposed MPA's. Amendment 14 proposed five MPA's off the coasts of North Carolina, South Carolina, and Georgia: Snowy Grouper Wreck, Northern South Carolina, Edisto, Charleston Deep Artificial Reef, and Georgia (Table 1; Fig. 1). Three MPA's were proposed off the Florida coast: North Florida, St. Lucie Hump, and East Hump/Un-Named Hump (Table 2; Fig. 2). Each proposed MPA also included a no-action alternative, omitted from the descriptions in the tables.

Empirical data, such as logbook trip reports, are typically used to conduct quantitative analyses of the socioeconomic impacts generated by fishery management actions in the SG fishery. However, these data are reported at a larger spatial scale than that of the MPA sites proposed in Amendment 14. It was therefore not possible to construct the needed data for a quantitative analysis to assess the socioeconomic effects that may arise due to the implementation of the proposed MPA's. As a result, a Delphi approach was adopted to develop a semi-quantitative ranking system for forecasting the type and extent of socioeconomic effects that might result. The Delphi approach uses the magnitude of these effects to compute a net socioeconomic impact to fishery stakeholders which is comparable across alternative sites of the proposed MPA network.

Forecasting Net Socioeconomic Impact

The Delphi Method

The Delphi method involves repetitive response, discussion, and judgment among a panel of diverse experts and aims to result in sound collective opinion. Experts participate in a structured forum of communication so that they may systematically address a complex social problem where relevant empirical data are lacking, eventually making forecasts and sometimes supporting policy decisions (Linstone and Turoff, 1975).

Since the first applications sponsored by the U.S. Air Force and carried out at the RAND Corporation[8] in the post-World War II era, the Delphi method has evolved; however, core traits have remained intact. Foremost, individual responses are summarized and presented back to the panel, enabling the experts to review all responses and clarify or change their own position based on their perception of the collective views of the panel.

[5]The Snapper-Grouper Management Complex is composed of ten species units: groupers, *Epinephelidae*; grunts, *Haemulidae*; jacks, *Carangidae*; porgies, *Sparidae*; sea basses, *Serranidae*; snappers, *Lutjanidae*; spadefishes, *Ephippidae*; tilefishes, *Malacanthidae*; triggerfishes, *Balistidae*; and wrasses, *Labridae*.

[6]Amendment 14 (see Appendix E for the complete Delphi report) was adopted and published in the Federal Register on 13 January 2009 and available online as of 1 March 2009 at http://www.safmc.net/Library/pdf/FinalAmend14_071807.pdf.

[7]Within the Type 2 MPA's, fishing for any snapper-grouper species is not allowed. Vessels may transit through the MPA's with snapper-grouper species onboard, but fishing gear must be appropriately stowed. Shark bottom longline gear is not allowed. Trolling for pelagic species, such as tuna, dolphin, mackerel, and billfish, is allowed within the MPA's.

[8]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

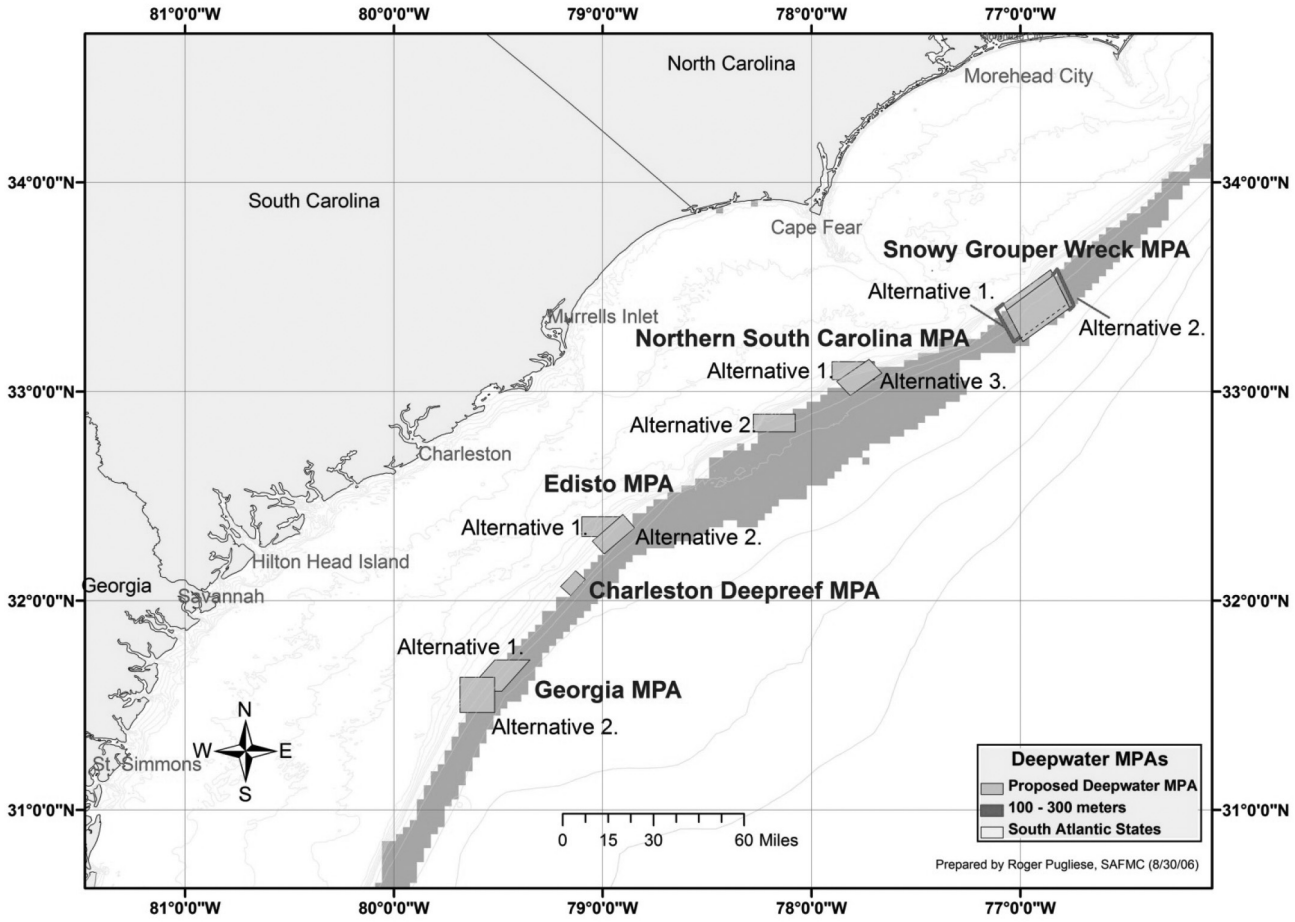

Figure 1.—Proposed Amendment 14 MPA's off the Carolinas and Georgia.

Table 2.—Proposed Amendment 14 MPA's off Florida.

MPA	Location and description
North Florida	Six alternatives, ranging from 10 nmi × 10 nmi to 22 nmi x 23 nmi, located from 43–60 nmi off the coast of northeast Florida. Alternatives 1, 2, and 4 are fished more heavily for mid-shelf SG species than Alternatives 3, 5, and 6. All six are sited in an area where significant rock and royal red shrimp trawling takes place.
St. Lucie Hump	One alternative, 2 nmi × 4 nmi, located 9 nmi SE of St. Lucie Inlet, Fla. Anecdotal information indicates site is habitat rich with deepwater species. Sited on active trolling grounds for pelagic species.
East Hump/Un-named Hump	One alternative, 5 nmi × 10 nmi, located 13 nmi off Long Key, Fla. Sited in an area that is habitat rich and heavily trolled for pelagic species.

This process is repeated until some level of group consensus is reached regarding the designated problem. Essential characteristics of the Delphi include anonymity, repetition, controlled feedback, and statistical summaries of group opinion.

The Delphi technique has many strengths relative to other decision-making processes. Anonymity allows participants to freely communicate their opinions without fear of reprisal or alienation. Anonymity also helps to prevent situations where a dominant voice or position overly influences the responses of other panel members. The structured nature of the process allows a diverse group of experts to communicate, posit subjective judgements, and come to a consensus lending credence to controversial solutions to complex problems which may not be attainable by analytical methods (Linstone and Turoff, 1975).

Another advantage is that a panel with a range of expertise, perspectives, and cognitive abilities can contribute individually at appropriate times when their particular input can be efficiently processed leading to a group solution to a problem that may have more complex facets than just their area of expertise (Stitt-Gohdes and Crews, 2004). With recent technological developments in communications and computing, a Delphi Conference (Linstone and Turoff, 1975) may allow a larger number of participants to contribute than face to face or tra-

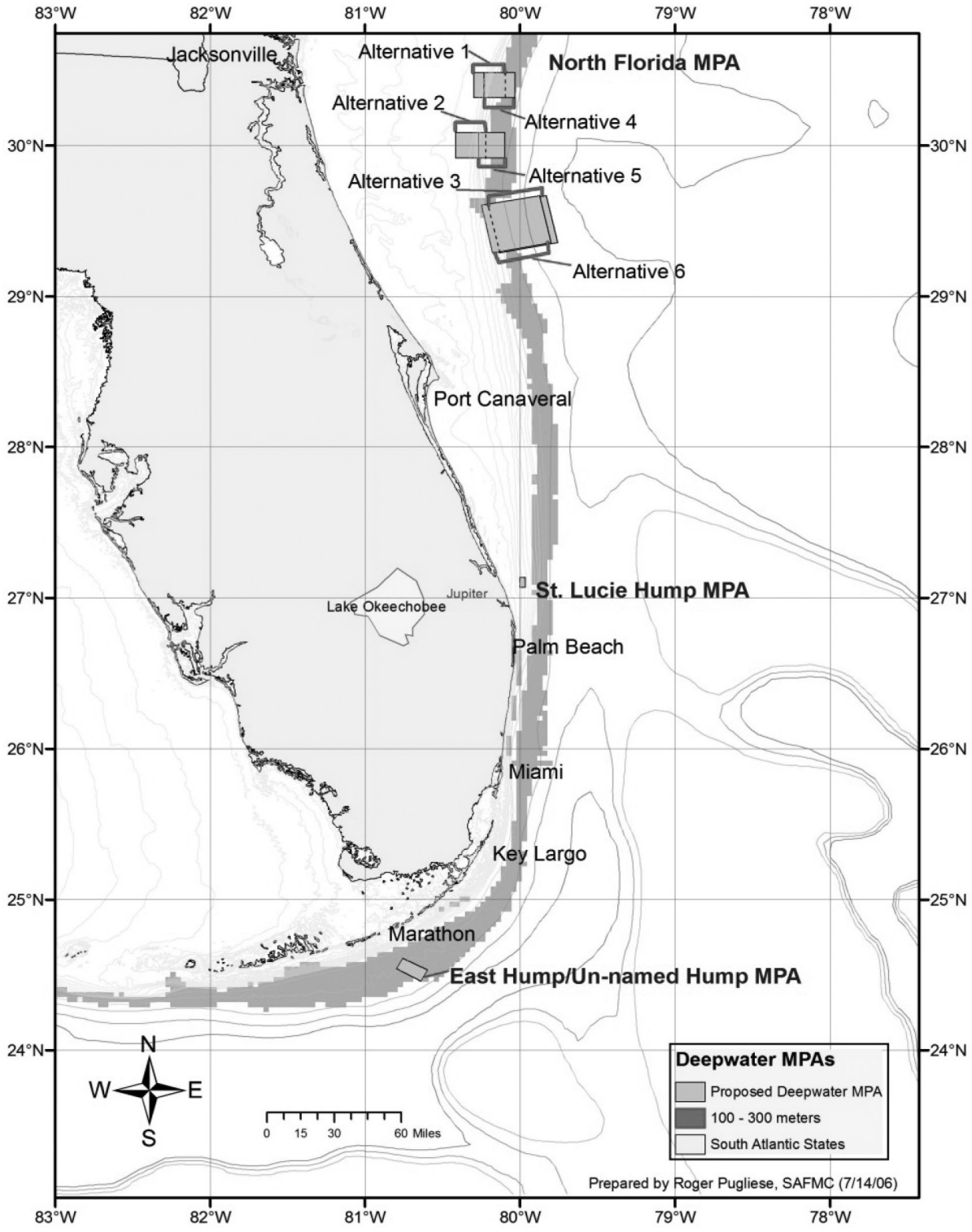

Figure 2.—Proposed Amendment 14 MPA's off Florida.

ditional conference and panel settings while also reducing the time needed to administer questionnaires and summarize feedback.

On the other hand, the Delphi technique does have weaknesses. Administrators wield considerable power and may inject personal biases into the process. For example, experts may be picked such that the panel is stacked towards a particular position of the issue at hand, while questionnaires, feedback summaries, and scoring methods can be engineered to steer results towards a predetermined consensus point. Failure to adequately explore disagreements and to allow each participant to appropriately present their feedback could lead to drop outs and an artificial consensus (Linstone and Turoff, 1975).

The possibility of groupthink leading to an irrational consensus should be of concern. While anonymity is an advantage of Delphi, the associated lack of accountability for panelists may lead to hasty or uninformed responses (Goodman, 1987). Though technological progress has led to advantages for Delphi in some situations, a traditional multi-round Delphi still takes considerable time and effort from administrators and participants; thus, full and active participation by the panel throughout the entire process may be difficult to attain.

The lack of refined spatial data relevant to the MPA's proposed in Amendment 14 offered a unique opportunity to apply the Delphi method in fisheries management. It was considered experimental, as no Delphi or consensus-oriented studies had at that time been carried out specifically to forecast net socioeconomic impact resulting from implementation of MPA's. However, since the completion of this Delphi study, economic valuations associated with alternative MPA sites in California state waters were calculated using a short-run comparative static model and a long-run dynamic bioeconomic model and were subsequently used in an iterative evaluation process to help determine preferred MPA's (White et al., 2012).

The Southeast Delphi Expert Panel

The name given to our Delphi experiment was the Southeast Delphi Expert Panel (SEDEP). SEDEP was conducted anonymously by email from 17 July 2006 to 30 Sept. 2006. For this panel, we recruited stakeholders with commercial and recreational (i.e., for-hire) fishing interests, as well as others with expertise covering biology, economics, and anthropology. Experts in these fields were initially identified and invited to participate based on years of active fishing experience (fishermen), published research (academics), and management experience (fishery managers) associated with the areas and species of interest in Amendment 14.

Experts initially targeted were also invited to suggest other colleagues within their own social network to participate in the study. Seventeen panelists, geographically dispersed from the Carolinas to the Florida Keys, agreed to participate. This group included five fishermen, three academics, and nine fishery managers. Of the original seventeen, twelve panelists participated in at least one round of SEDEP. This group included four fishermen, three academics, and five fishery managers.

Of the twelve, six self-identified as biologists, including three NMFS employees and three academics, four identified as fishermen, including two commercial and two for-hire, one identified as an anthropologist (NMFS employee), and one identified as an economist (state employee). Most had significant cross-knowledge about the biology associated with the proposed sites in Amendment 14 and the socioeconomic situations of dependent fishermen and their communities, as well as general knowledge of MPA's.

The majority of the participating experts also had experience with at least one of the sites, whether it was through actual fishing, biological research, or interaction with fishery stakeholders. These insights were treated as expert testimony and were systematically disseminated to the rest of the panel, so that each panelist had some fundamental information about each of the proposed sites.

For the most part, all communication with the panelists and the moderation team was done through a third-party administrator via email. All emails sent to panelists used blind carbon copy, which is an email option which hides recipients' email addresses, and experts were assigned a random respondent number. This insured anonymity among panel members as well as between the panel and the moderation team. This was done to insure that there was no bias among the moderators as they evaluated qualitative responses from panelists.

Due to the complexity of quantifying socioeconomic effects, the moderation team did conduct telephone calls with individual panelists to aid in responses. Care was taken not to influence any responses, and since the impact analysis was purely quantitative, there was no opportunity to amend a respondent's impact scores due to mediator bias. Updates and final results were distributed in the same manner to the panel, using Word, Adobe Portable Document (PDF), and Excel formats.

SEDEP was conducted in three stages or rounds (Fig. 3). Round One was a Policy Delphi in which the panelists identified a comprehensive list of socioeconomic effects that potentially could be associated with the kinds of Type 2 MPA's that would be implemented by Amendment 14. This was a brainstorming session designed to produce strongly opposing views among the panelists. A Policy Delphi differs from a traditional Delphi, in that its final goal is to elicit differing viewpoints regarding some contentious issue, rather than to reach a consensus (Turoff, 1970). Thus, the role of Round One pertained more to policy analysis than decision making.

Round Two followed a more traditional Delphi approach. Its primary objective was to group and rank the most important of the socioeconomic effects identified in Round One. First,

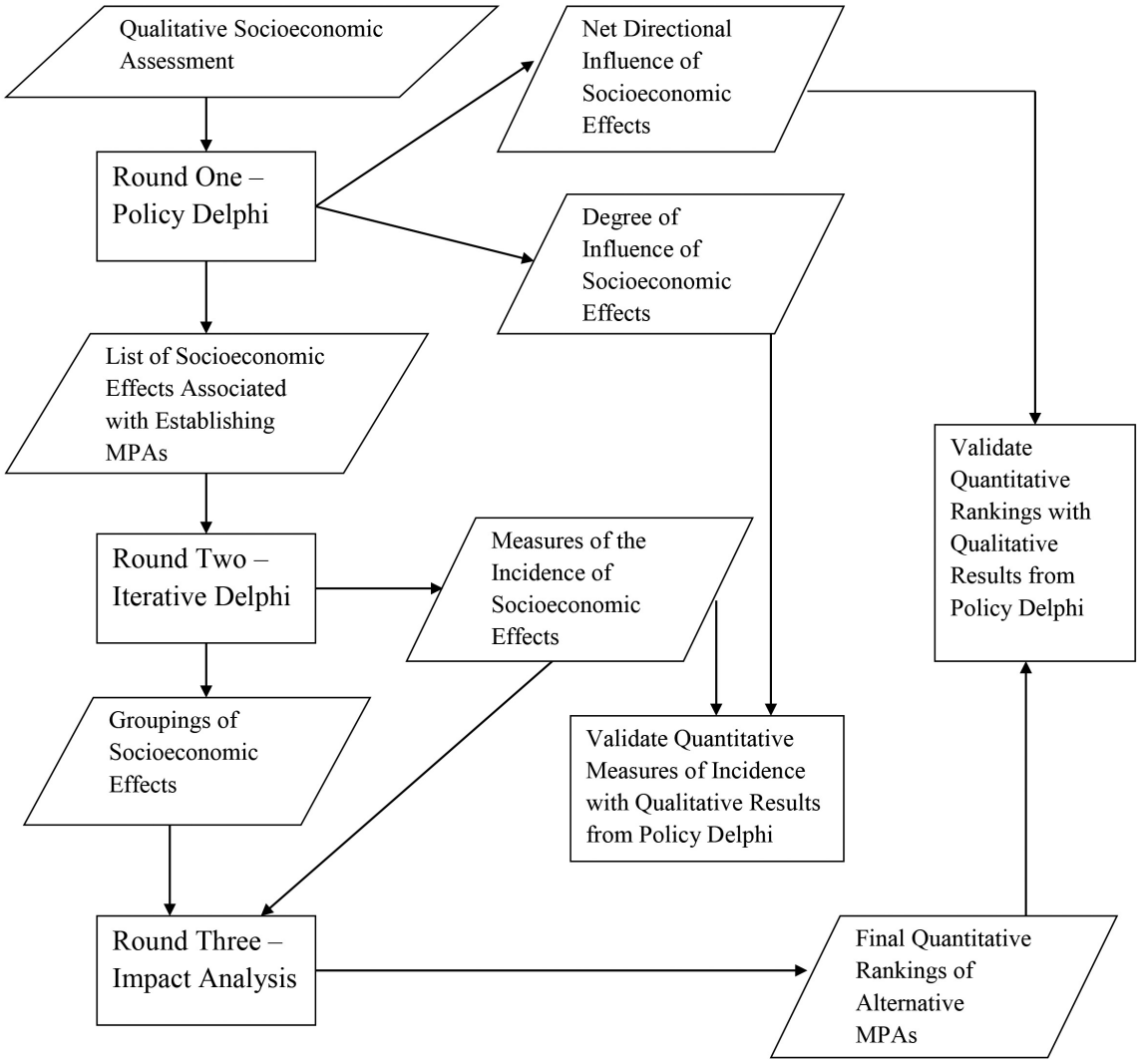

Figure 3.—Flowchart of the processes, inputs, and outputs associated with SEDEP.

panelists were asked to group individual effects on the basis of common characteristics. Four groupings of socioeconomic effects were identified based on the following common characteristics: management and administration of MPA's, influence of MPA's on commercial and recreational fishermen, community and regional effects, and influences on the ecosystem associated with future resource use. A time dimension was then introduced to distinguish short-term (<1 yr) effects of implementing a network of Type 2 MPA's from effects that would arise in the medium term (1–5 yr) and long term (>5 yr).[9] Finally, groups of effects were ranked in importance based on their expected overall impacts during each of the three time periods after implementation.

The primary objective of Round Three was to differentiate among alternative sites for each proposed MPA in Amendment 14, according to their socioeconomic impact on fishery stakeholders. We used a weighted scoring system based on the results from Rounds One and Two to achieve this objective. In Delphi terminology, this is considered an impact analysis.

Each panelist was asked to estimate the impact of each group of effects in each time period on a scale of -3 to 3, with a score of zero representing a neutral impact[10] (Table 3). Overall impact scores for each grouping of effects in each time period were calculated with a probabilistic consensus model (PCM) that enabled us to test

[9]The length of the time frames was defined by the moderators and was not a product of panel consensus.

[10]Another reason for a score of zero could have been that the positive and negative impacts associated with the different effects within a group canceled each other out. This was very possible, since the groupings were broadly defined.

Table 3.—Scoring of the Impact of Group Effects.

Score	Effect
–3	High negative impact
–2	Moderate negative impact
–1	Minimal negative impact
0	Neutral impact
+1	Minimal positive impact
+2	Moderate positive impact
+3	High positive impact

for agreement in responses among panelists (Romney et al., 1986).

We utilize PCM to reconstruct an "answer key" based on patterns of agreement among our expert panelists. The "answer key" represents forecasted socioeconomic impacts for groupings of effects in different time periods and is produced by the consensus model based on correlations among the original impact scores submitted by the panel and Bayesian statistical theory. The cultural consensus model is based on the premise that variation in knowledge among individuals can be attributed to cultural differentials, and allows us to test for differences in responses for subcultures of knowledge within the Delphi panel based on professional affiliation: biologists and nonbiologists.

Relative weights based on the rankings of effects from Round Two were used to calculate the overall weighted impact scores in each time period derived from PCM that were employed to compare the alternatives associated with the Amendment 14 MPA sites. The Wilcoxin Signed-Rank Test produces a nonparametric statistic that was used to formally test for differences in scores among the alternatives for each MPA site while we employed a Wilcoxin-Mann-Whitney nonparametric estimator to test differences between two independent samples from among Delphi subgroups (i.e., biologists and nonbiologists). The no-action alternative was not explicitly evaluated by the panelists and was defined to have a score of zero.

SEDEP Results

Submissions from all panelists were used in Round Three to rank the alternatives associated with each of the individual MPA sites. However, a more detailed analysis of the results from all rounds shows cultural differences among these experts. Throughout SEDEP, we focused on two main stakeholder groups: biologists and nonbiologists. By comparing differences among these groups throughout the Delphi process, we were able to identify significant cultural differences among these stakeholders with respect to the proposed MPA's over time as well as changes in individual positions over the course of the experiment.

Round One Results

Eleven experts participated in Round One. Effects with potential socioeconomic implications that would have a negative net directional influence identified by majority support on the panel included

- decreased catch levels;
- increased trip, search, and gear costs;
- increased costs to learn new fishing practices;
- redirected effort toward unprotected species;
- congestion effects and user conflicts;
- decreased personal safety;
- adverse community and social effects;
- income loss to local and regional economies;
- costs to maintain and enforce MPA's; and
- costs for public outreach and education.

Effects with potential socioeconomic implications that would have a positive net directional influence identified by majority support on the panel included

- increased biomass and health of stocks;
- increased future catch levels and yields;
- replenishment, recruitment, and spillover in open areas;
- reduced variability in landings and revenue;
- hedge against future stock collapses;
- realized option and existence values;
- beneficial human community effects from stock reliability;
- improved environmental and habitat quality;
- ecosystem protection;
- reduced risk associated with stock assessments; and
- control areas for experimental biological research.

As expected, early in this round experts chose to comment primarily on their areas of expertise. Nonbiologists, mostly comprised of fishing interests, focused on the economic and social implications of MPA's on the fishing industry and their communities, while the biologists generally focused on socioeconomic effects relating to stock conditions and ecosystem services.

As Round One progressed the panel began to refine and consolidate their views while focusing on the Amendment 14 MPA's with the following conclusions receiving majority support from the panel:

- Displacement costs will be minimal or neutral due to the small size of the MPA's and close proximity and knowledge of similar fishing grounds.
- Risks to personal safety will be neutral.
- Biological and ecosystem benefits will be minimal due to the small size of the MPA's.
- Public resource management benefits will be minimal and will only be realized with adequate compliance and enforcement.

The following insights relative to the Amendment 14 MPA's received strong minority support from experts on the panel:

- Sites that encroach into mid-shelf regions will inflict greater displacement costs to fishermen than those which encompass deep water only.
- As displaced commercial vessels move closer to shore, conflict with recreational vessels will increase.
- Unprotected species will be negatively impacted by displaced effort.
- A time dimension should be introduced to the analysis.

Table 4.—Groupings of socioeconomic effects resulting from the establishment of a network of Type 2 MPA's.

Administrative	Commercial, for-hire, and recreational	Community and social	Ecosystem
Conservation and fishery management goals	Catch levels and landings variation	Local economic and social effects	Ecosystem and habitat effects
Enforcement and monitoring	Trip-level search and other costs	Regional economic and social effects	Option and existence values
Education and awareness	Crowding and congestion	Associated employment (e.g. fish houses, dealers, bait and tackle shops)	Bycatch mortality
Improved stock assessments	Personal safety		Non-consumptive (non-use) opportunities
Insurance against stock collapse	Commercial and for-hire profitability and recreational enjoyment		Replenishment, abundance, and other stock effects
Improved knowledge of marine systems and effectiveness of MPA's	Replenishment, abundance, and other stock effects		Catch levels and landings variation
Ecosystem and habitat effects	Industry employment		

- Lack of baseline data on the habitat of the MPA's will hinder ex post evaluations.
- Non-use values will be positive but minimal.

As expected, the diversity of the experts resulted in an exhaustive list of potential effects with a fair degree of divergence regarding the influence of these effects. Negative effects would be realized mainly in the form of displacement effects on fishermen, and their families and communities that depend on them, with the possibility of management incurring some costs. However, due to the small size of the Amendment 14 MPA's and the availability of alternative fishing opportunities for displaced fishermen, displacement effects were likely to be minimal and observed only in the short term. Benefits were thought to be possible due to increases in longer-term catch levels, quality increases in the MPA and ecosystem, option and existence values, and management benefits. These benefits also were deemed to be minimal due to the small size of the Amendment 14 MPA's.

In general, both cultural subgroups consistently displayed majority support regarding the net directional influence of individual effects although conclusions about the level of influence of these effects specific to the Amendment 14 MPA's were mixed with nonbiologists concluding that the potential economic and social consequences of MPA's to be more influential than biologists. The results alluded to cultural differences that would be revealed in later rounds. In general, consensus among the experts on most of the potential effects added validity to the qualitative responses elicited in this round and quantitative rankings derived in later rounds.

Round Two Results

At the end of Round One, the panel was fully engaged with the evaluation of the Amendment 14 MPA's; however, the comprehensive list of socioeconomic effects produced by the Policy Delphi was not compatible with a quantitative impact analysis. Therefore, the initial objective of Round Two was to organize the socioeconomic benefits and costs associated with spatial management into a manageable number of categories that could be used as criteria to compare alternative MPA's, while maintaining meaningful distinctions among the categories. The moderators offered four initial groupings of effects to the panel at the beginning of Round Two: Administrative; Commercial, For-Hire, and Recreational; Community and Social; and, Ecosystem. The classification of the effects identified by the Policy Delphi is summarized in Table 4. Note that individual effects may be included under more than one group heading.

The ultimate objective of Round Two was to rank the most important of the socioeconomic effects based on their expected overall impact. To do so, panelists were asked to rank the groups listed in Table 4 based on their relative socioeconomic impact in the immediate, medium, and long terms. The rankings were then used to derive relative weights for each grouping of socioeconomic effects over time. The final rankings and weights of the groups by nine panelists are presented in Table 5.

Groups were ranked in importance on a one to four scale and were assigned points that corresponded to the ordered nature of the ranking system. Weights were calculated and interpreted as the relative importance that the panel attributed to each grouping of effects when determining the net socioeconomic impact of the implementation of a network of Type 2 MPA's. For example, one group of effects may be the most important determinant of socioeconomic impacts immediately after implementation; however, over time the socioeconomic implications of these effects may diminish as other factors become more consequential.

Weighting also implies that some groups of effects are more influential than others on the final determination of net socioeconomic impact. For instance, Table 5 suggests that within 1 year of implementation, community and social effects would be 60% as

Table 5.—Ranks and relative weights of four groupings of socioeconomic effects associated with the establishment of a network of Type 2 MPA's.

	Short term		Medium term		Long term	
Group heading	Rank	Weight	Rank	Weight	Rank	Weight
Administrative	2	0.95	1	1.00	2	0.84
Commercial, for-hire, and recreational	1	1.00	2	0.89	3	0.81
Community and social	4	0.60	4	0.64	4	0.59
Ecosystem	3	0.71	2	0.89	1	1.00

important as effects on the commercial, recreational, and for-hire sectors. Consequently, in the immediate term, socioeconomic effects associated with the commercial, for-hire, and recreational fishing sectors were deemed most influential; whereas, socioeconomic effects associated with public administrative issues and ecosystem changes were considered most dominant in the medium term and long term, respectively.

When analyzed over time the relative weights in Table 4 represent a forecast of the incidence of the groupings of socioeconomic effects associated with establishing MPA's. Some interesting trends were observed by comparing the incidence of the groups. First, community and social effects were considered less important than all other groups in all time periods. Second, as time goes on, the importance of effects on commercial, for-hire, and recreational fishermen becomes less relevant. Third, over time ecosystem effects become more important. Lastly, administrative effects were viewed as relatively important throughout all time periods. The weights, which are constant across MPA alternatives, also serve as a constraint by reducing variability in the calculated impact scores used for alternative site comparisons. For instance, if one expert feels strongly about a particular MPA, the constant weights will buffer individual prejudices.

In Round Two, changes in the perceptions of some of the panel members became evident. Nonbiologists explicitly took into account the small size of the proposed MPA's and generally merged to the consensus point that the overall financial impact, especially outside of the short term on fishermen and their communities, would be minimal. Biologists generally held onto their initial perspectives outlined in Round One that MPA's have significant socioeconomic impacts on stakeholders related to biological and ecosystem outcomes that outweigh the potential negative economic and social effects generated by protection throughout all time periods.

Round Three Results

In Round Three, the panel was asked to estimate the socioeconomic impact of each grouping produced in Round Two, on a scale of –3 to 3, for alternative MPA sites. Estimates were made for the short, medium, and long terms following MPA implementation. Given the small sample sizes, nonparametric estimators were used in conjunction with PCM to investigate cultural differences among biologists and nonbiologists regarding individual MPA options.

- Snowy Grouper Wreck MPA: In the short and medium terms, no-action scored higher than both alternatives. In the long term, both alternatives scored higher than no-action. Alternative 2 scored higher than Alternative 1 in all time periods. The differences in impact scores arose from one biologist and two nonbiologists forecasting larger negative impacts realized by the fishing sector for Alternative 1 relative to Alternative 2. Subcultures in knowledge regarding the socioeconomic consequences realized by the fishing sector in the short run were statistically significant for this MPA. Nonbiologists generally forecasted greater negative impacts than did biologists for both alternatives in the near term.
- Northern South Carolina MPA: In the short and medium terms, no-action scored higher than all three alternatives. In the long term, all three alternatives scored higher than no-action. Alternative 3 ranked lower than Alternatives 1 and 2 in all three time periods. Alternative 1 scored higher than Alternative 2 in the short and medium terms, while Alternative 2 scored higher than Alternative 1 in the long term. Nonparametric tests did not identify any significant cultural differences among biologists and nonbiologists for any of the alternatives for this MPA.
- Edisto MPA: In the short and medium terms, no-action scored higher than either alternative. In the long term, both Alternatives 1 and 2 scored higher than no-action. Alternative 1 scored higher than Alternative 2 in all time periods. Nonparametric tests suggest cultural differences regarding long-term impacts for administrative, fishing, ecosystem, and community effects may exist. Specifically, results suggest subcultures exist regarding knowledge about the long-term socioeconomic effects on the fishing sector for both alternatives as well as effects on communities associated with Alternative 1.
- Charleston Deep Reef MPA: In the short and medium terms, no-action scored higher than the alternative, but the alternative scored higher than no-action in the long term. Cultural differences related to Alternative 1 were not significant for any time periods.
- Georgia MPA: In the short and medium terms, no-action scored higher than both alternatives. In the long term, both alternatives scored higher than no-action. Alternative 1 scored higher than Alternative 2 in all time periods. Nonparametric tests suggest that subcultures in knowledge may exist in the long run for Alternative 1. Nonbiologists generally forecasted greater negative impacts than did biologists for both alternatives.
- Northern Florida MPA: In the short and medium terms, no-action scored higher than all six of the proposed sites. In the long term, Alternatives 2, 3, 4, and 6 scored higher than no-action. Alternatives 3 and 6 ranked higher than all other alternatives in the short and medium terms, while Alternative 2 scored higher than all other alternatives in the long term. Nonparametric tests suggest that subcultures in knowledge regarding the socioeconomic consequences associated with Alternatives 1 and 4 may exist for all time periods. Nonbiologists generally forecasted greater negative impacts than did biologists. In

the long term all weighted impact scores for members of the biological subculture were positive. However, only one non-biologist had a positive weighted impact score for both alternatives, due mainly to his/her forecast of high ecosystem benefits in the long term. Further tests suggest that subcultures associated with Alternative 2 may exist for all time periods, and subcultures may exist in the short and medium terms for Alternative 3. Nonbiologists generally forecasted greater negative impacts than did biologists for both alternatives.

- St. Lucie Hump MPA: In the short term, no-action scored higher than Alternative 1, but Alternative 1 scored higher in the medium and long terms. Subcultures in knowledge regarding the socioeconomic consequences associated with Alternative 1 may exist in the short and medium terms. Nonbiologists generally forecasted greater negative impacts than did biologists for Alternative 1. However, the nonbiologists' responses tended to be closer to the final weighted impact scores derived by the consensus model.
- East Hump MPA/Un-Named Hump: In the short term, no-action scored higher than Alternative 1, but Alternative 1 scored higher than no-action in the medium and long terms. Differences in cultural knowledge for Alternative 1 were not significant for any time periods.

The final rankings of alternative MPA sites from the Delphi experiment must be interpreted with caution, however. First, our response sizes for each impact analysis were relatively small and may not represent a true cross-section of knowledge regarding the Amendment 14 MPA's. Although our panel consisted of 12 individuals, usually only 7 or 8 responded regarding any specific MPA, with the identities of respondents differing among MPA's based on their local knowledge.

Also, it is important to realize that the panel reported impact scores for the short, medium, and long term, and in most cases, it was not discernible whether they incorporated aspects of risk or other dynamic attributes into their scoring system. Consequently, each score for each alternative in a particular time period should be viewed independently of scores for the other time periods. We cannot justify or advocate a process of comparing alternatives by adding impact scores over time periods.

Conclusion

From a scientific perspective, we believe that the Delphi approach was superior to a simple, qualitative analysis of potential socioeconomic impacts from MPA's. The varied backgrounds of the panelists generated an extensive list of potential economic, community, ecosystem, and administrative effects which could arise due to the implementation of MPA's, demonstrating that the socioeconomic consequences associated with spatial closures are extensive, complicated to measure, and interconnected. However, there was a high degree of consensus among respondents in their scoring of the potential impacts, despite their varied backgrounds. In general, the panel concluded that in the near term the negative socioeconomic consequences impacted on the fishing industry and dependent communities would outweigh the short-term benefits of marine protection; thus, the no-action alternative usually was preferable to all alternatives. However, as the time frame increased, benefits from biological and ecosystem effects and mitigation of negative industry and community effects favored adoption of at least one alternative over no-action in the long term. It is likely that the diversity of the panel precluded a dominant bias from being systematically injected into the analysis.

Although a high degree of consensus was reached by the panel, differences in the cultural knowledge of the potential socioeconomic net impact on stakeholders was uncovered in a number of instances. Even though our sample sizes were small, biologists and nonbiologists exhibited cultural differences for a few of the MPA options. Mainly, these differences centered on immediate-term negative effects on fishermen and their communities. This difference was identified subjectively in Rounds One and Two and statistically verified in Round Three for the following MPA's: Snowy Grouper Wreck, Edisto, Georgia, Northern Florida, and St. Lucie Hump.

It appears that by the end of the Delphi, nonbiologists had changed their perspective on the long-term benefits of MPA's by agreeing that the benefits in the future would outweigh the short-term displacement costs to industry and dependent communities. In general, biologists did not change their main positions during the process.

Of course, if data had been available, a quantitative comparison of the benefits and costs associated with each proposed MPA would have been preferred. However, the semi-quantitative Delphi approach represents a suitable alternative when data are not available. In addition, the Policy Delphi of Round One could be employed in other aspects of fishery management, for example, during discussion of the Council's Advisory Panels for future amendments. A Policy Delphi of this sort may be used as a precursor to committee activity, not so much to gain consensus on an issue, as to expose differing positions among varied constituents.

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