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Allocation of Fishery Harvests under the Magnuson-Stevens Fishery Conservation and Management Act

Principles and Practice

February 2012

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Principles and Practice

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Executive Summary

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), a fishery management plan (FMP) may restrict harvest below the level that would occur in the absence of active management. In such a case, the allocation or the distribution of fishing privileges among identifiable, discrete user groups or individuals becomes an important consideration in the development of the plan. Allocation is at the heart of recent management actions such as the creation of catch shares, the imposition of restrictions on certain types of gear, and the consideration of how harvest should be distributed between different sectors of a fishery. In particular, allocation is an active policy issue when limited harvests must be divided between commercial and recreational fishing sectors. This technical memorandum focuses on the latter case, although the general descriptions of how allocation can be analyzed systematically apply to any of the cases mentioned.

The MSA addresses allocation by setting certain standards that a FMP must meet. These standards highlight two general criteria: that the plan considers efficiency in making the allocation and that the allocation is fair and equitable. These two criteria draw on very different aspects of social science. While economics provides a precise technical framework for analyzing the efficiency of the allocation of fishery harvest or any other resource, a similarly precise framework does not exist to answer the question of whether an allocation is fair. Nevertheless, understanding the context in which fairness can be considered is important, so we discuss how efficiency and fairness can be analyzed in principle.

While the analysis of efficiency and fairness is straightforward in theory, it is difficult in practice. We document the allocation of harvest limits between commercial and recreational sectors as practiced by the fishery management councils that operate under the MSA. More than three-fourths of the FMPs promulgated by the councils have no relevant allocation decisions because both commercial and recreational do not play a significant role in the fishery or are not actively managed by the plan. For example, of the New England Fishery Management Council's eight plans, seven do not have a significant recreational fishery; thus allocation between commercial and recreational sectors is not (at present) an important issue for those plans. Similarly, the Western Pacific Fishery Management Council has no FMPs that actively manage a recreational sector. We do not consider these fisheries in this memorandum, nor do we consider plans that have a significant recreational sector but do not have (at this time) what we have defined as an allocation for that sector.

Instead we focus on the 11 plans that have an active recreational sector and have allocated allowable harvest between commercial and recreational sectors. For these plans, we document the council decisions that created allocations between commercial and recreational sectors in the fishery, and review the analyses that have been conducted to support the council's decision-making process. Finally, we briefly discuss the management objectives that govern the

FMPs covered here. These objectives provide a context within which allocation and other management decisions are made.

This technical memorandum offers no recommendations regarding the practice of making an allocation decision under the MSA or analyzing such a decision. Instead, our discussion of the principles of efficiency and fairness, as well as the many other documents and articles that have similar discussions, can be viewed as resources for future considerations of fishery harvest allocations. Similarly, the compilation of FMP allocations and analyses is a useful documentation of past and current practices, which can provide a basis for assessing the desirability of any potential changes in these practices or the need for broader data gathering or research to support future decisions.

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1. Introduction

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), a fishery management plan (FMP) may restrict harvest below the level that would occur in the absence of active management. In such a case, the allocation or distribution of fishing privileges among identifiable, discrete user groups or individuals becomes an important consideration in plan development (50 CFR Ch. VI, §600.325(c)(1)). Allocation is at the heart of recent management actions such as the creation of catch shares (e.g., NOAA 2010), the imposition of restrictions on certain types of gear (e.g., GMFMC and NMFS 2009), and the consideration of how harvest should be distributed between different sectors of a fishery (e.g., NPFMC 2010). In particular, allocation is an active policy issue when limited harvests must be divided between commercial and recreational fishing sectors. This technical memorandum focuses on the latter case, although the general descriptions of how allocation can be analyzed systematically apply to any of the cases mentioned.

The MSA addresses allocation by setting certain standards that a plan must meet. These standards, reviewed in more detail below, focus on two general criteria: that the plan considers efficiency in making the allocation and that the allocation is fair and equitable. These two criteria draw on very different aspects of social science. While economics provides a precise technical framework for analyzing the efficiency of the fishery harvest allocation or any other resource, a similarly precise framework does not exist to address whether an allocation is fair and equitable. Nevertheless, understanding the context in which fairness and equity (hereafter fairness) are considered is important, so this technical memorandum covers both criteria.

There is substantial literature on allocation efficiency in the context of fisheries. Edwards (1990) provides a guide to how economists analyze the efficiency of harvest allocations, focusing on the division between commercial and recreational fisheries. His guide also discusses the differences between economic values and economic impacts. Economic values are the foundation for the benefits and costs of making management decisions such as harvest allocations, while economic impacts are a more restricted way of assessing particular effects (e.g., changes in employment and income) of management decisions. Edwards (1991) covers similar material, in the same context of commercial and recreational harvest allocations, as do Bishop and Samples (1980), Sutinen (1980), Easley and Prochaska (1987), Easley (1992), and Green (1994).

The literature on fairness in the allocation of fisheries harvests is less substantial, but several discussions provide a good background. Bromley (1977) points out that the issue of allocation fairness (or distributions of fishing rights) is just as important as efficiency for the practical matter of making real world policy decisions. Loomis and Ditton (1993) and Copes (1997) express similar views. More general but useful treatments of the issue are in Hausman and McPherson (1996) and Dietz and Atkinson (2010).

This technical memorandum is broadly divided into three parts. In the first part, we discuss the management context of allocation decisions—that is, under what circumstances does

an allocation decision take place and which parts of the MSA govern such a decision. In the second part, we discuss the theoretical basis for considering allocation decisions using the criteria of efficiency and fairness. As noted above, the first is amenable to a technical approach, and so we present an extended analytical framework for assessing the efficiency of an allocation decision. For the second, we discuss the issues relevant to an allocation's fairness, but do not attempt to reduce the discussion to a similarly analytical framework. The third part of the memorandum reviews allocation decisions that have been made under the MSA for 11 FMPs. We also review the types of socioeconomic analyses that have been undertaken to support these decisions.

2. Allocation and the MSA

The MSA seeks to conserve and manage fishery resources in U.S. coastal waters. The act established a system of regional fishery management councils that were charged with preparing and implementing FMPs (16 U.S.C. 1852−1853). A common feature of these plans is a restriction on the allowable harvest for a fishery below the level that would occur in the absence of active management. Such a restriction creates an important management question: How should the allowable harvest be allocated across potential harvesters? Here, we review the MSA sections that address this question.

The issue of allocation is most prominently addressed in National Standard 4, one of 10 standards that govern the development of FMPs under the MSA. National Standard 4 states:

> Conservation and management measures shall not discriminate between residents of different states. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (A) fair and equitable to all such fishermen; (B) reasonably calculated to promote conservation; and (C) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges (16 U.S.C. 1851, §301(a)(4)).

The issue of allocation is also directly covered by other parts of the MSA. Contents of Fishery Management Plans, Required Provisions states:

> Any fishery management plan … shall … allocate … any harvest restrictions or recovery benefits fairly and equitably among the commercial, recreational, and charter fishing sectors in the fishery (§303(a)(14)).

Contents of Fishery Management Plans, Discretionary Provisions states:

> Any fishery management plan … may … establish a limited access system for the fishery in order to achieve optimum yield if, in developing such system, the council and the secretary take into account … the fair and equitable distribution of access privileges in the fishery (§303(b)(6)(F)).

Limited Access Privilege Programs, Requirements for Limited Access Privileges states:

> In developing a limited access privilege program to harvest fish, a council or the secretary shall establish procedures to ensure fair and equitable initial allocations, including consideration of (i) current and historical harvests; (ii) employment in the harvesting and processing sectors; (iii) investments in, and dependence upon, the fishery; and (iv) the current and historical participation of fishing communities (§303A(c)(5)(A)).

And Action by the Secretary, Rebuilding for Overfished Fisheries states:

> For a fishery that is overfished, any fishery management plan, amendment, or proposed regulations … shall … allocate both overfishing restrictions and

> recovery benefits fairly and equitably among sectors of the fishery (§304(e)(4)(B)).

In each case, while the MSA requires that allocations be fair, the statute does not specify further how allocations should be made nor does it prescribe how the fairness of an allocation should be assessed.

While not addressing allocation explicitly, other parts of the MSA touch on the issue by specifying general requirements for FMPs. For example, National Standard 5 states:

> Conservation and management measures shall, where practicable, consider efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose (§301(a)(5)).

National Standard 8 states:

> Conservation and management measures shall, consistent with the conservation requirements of this Act (including the prevention of overfishing and rebuilding of overfished stocks), take into account the importance of fishery resources to fishing communities by utilizing economic and social data that meet the requirements of paragraph (2), in order to (A) provide for the sustained participation of such communities, and (B) to the extent practicable, minimize adverse economic impacts on such communities (§301(a)(8)).

Finally, the regulations implementing the MSA discuss at some length the allocation of fishing privileges in the context of National Standard 4 (§600.325, Allocations). The regulations recommend that a FMP contain a description of existing allocations in a fishery and any allocations made in the FMP as well as an analysis of any such allocations, but without defining the nature of the analysis that should be conducted. In addressing the fairness of an allocation, the regulations state that the allocation should be "rationally connected" to the FMP's management objectives, including achievement of the FMP's optimum yield, and may impose a hardship on one group if it is outweighed by the total benefits received by another group or groups. The regulations also state that the preservation of the status quo is not a prerequisite of satisfying the standard of "fair and equitable" if a new allocation would "maximize overall benefits" (§600.325(c)(3)(i)(B)).

In addition to the fairness of the allocation, the regulations for National Standard 4 list "promotion of conservation" (§600.325(c)(3)(ii)) and "avoidance of excessive shares" (§600.325(c)(3)(iii)) as factors to be considered, as well as other factors such as (but not limited to) "economic and social consequences of the scheme, food production, consumer interest, dependence on the fishery by present participants and coastal communities, efficiency of various types of gear used in the fishery, transferability of effort to and impact on other fisheries, opportunity for new participants to enter the fishery, and enhancement of opportunities for recreational fishing" (§600.325(c)(3)(iv)).

The regulations covering National Standard 5 address allocation in the context of considering an efficient utilization of fishery resources (§600.330, Efficiency). Creating or amending an allocation purely for economic reasons is prohibited, as the need for such an action must be connected to the broader objectives of the FMP. Given the satisfaction of these broader

objectives, however, the regulations support management measures (including allocations) that "result in as efficient a fishery as is practicable or desirable" (§600.350(b)(1)).

In summary, the allocation issue is an important element of developing and amending FMPs under the MSA. The two criteria addressed in this memorandum, efficiency and fairness, are cited in the statute and regulations implementing the MSA. Two national standards (4 and 5) cover the two criteria, suggesting that addressing and analyzing these issues should play an important role in setting allocations for fishery harvests.

3. Allocation Decisions in Theory

Under open access conditions, a fisheries harvest is not allocated in any direct or deliberate way. Open access conditions provide no incentive to adjust effort across or within various sectors to achieve a globally efficient outcome because there is no means of capturing the potential benefits of such adjustments (Anderson 2004). For fisheries that have overall limits on harvest, a variety of allocation decisions must be addressed. The impetus for the original MSA was controversy over foreign fishing, thus the act addressed the allocation of harvest between foreign and domestic harvesters (16 USC 1853, §303(a)). Within the domestic harvesting sector, there is the broad division between recreation and commercial harvesters; within these sectors, there is further division based on gear types, states, regions, and so on.

When harvest limits are imposed on a fishery, a multitude of allocation decisions are made, even if the imposition merely uses historical data to create limits that mirror past behavior. These types of decisions are similar to other government policy decisions. Promulgating a regulation under the MSA or other statutes involves such a policy decision, in which case the federal government typically considers a number of alternatives. If the choice among them is not constrained in ways that make only one feasible, an important policy question is then: Which alternative is best? A common approach to answering this question is to assess the benefits and costs that accrue to individual members of society, and aggregate these individual effects. Then the best alternative is the one that maximizes the difference between the two, or the net aggregate benefits.

Because this simple approach includes the aggregation of individual benefits and costs across members of society, it inherently involves social judgments about those individuals. A simple unweighted aggregation effectively treats each individual as equal from a social perspective. Other aggregation schemes are possible, however, which address the issue of social "weights" for individual members of society more explicitly and consider the distribution of a policy's effects. These considerations then become part of the policy decision making process.

In the context of analyzing a policy such as a harvest allocation, the issues of efficiency and fairness can be divided along the lines expressed above. Efficiency concerns the aggregate benefits and costs of a policy while fairness concerns the individual effects and the distribution across individuals of those benefits and costs. In general and for the MSA in particular, both issues play a role in determining from a social perspective which policy among several alternatives is best (Zerbe 2001).

In this section, we consider how the efficiency and fairness of a harvest allocation can be analyzed in principle. Efficiency is the foundation for benefit-cost analysis, the standard approach economists use to analyze policy actions. As such, it is often considered in a formal framework. Below we present such an approach by way of a series of examples. Fairness is central to much public policy and management, but is less commonly considered using a formal or quantitative approach. Our discussion follows those practices and as a result presents the

efficiency criterion in greater detail than that of fairness. This disparity does not reflect, however, the relative importance—in theory or practice—of the two criteria.

3.1. Efficiency of Harvest Allocations

In general, efficiency refers to how well resources are utilized in production or consumption. An efficient allocation of resources is one that maximizes the value of those resources (again, in production or consumption). The efficiency of a policy can be assessed in terms of how the policy changes the state of the world in ways that affect the allocation of resources and whether those changes increase the value of the resources affected.

Economists have developed different ways of conducting such an assessment. A particularly stringent approach is to apply a criterion known as Pareto efficiency (Pareto 1896). In general, a state of the world is Pareto efficient if there is no potential change (i.e., a policy that changes the state of the world) that will benefit one or more individuals without harming one or more other individuals. A Pareto improvement is a change to an existing state that makes at least one person better off and makes no one worse off (Hausman and McPherson 1996).

Because the effects of government policies almost always produce a mixture of winners and losers, it is rare that a policy can satisfy the Pareto improvement condition. Such a failure does not mean the policy is inefficient, however. If a policy generates winners and losers, the problem is then how to weigh the winners' benefits against the losers' costs. If the benefits that accrue to the winners are somehow judged to be greater than the costs borne by the losers, the policy will then be more efficient than the status quo.

To address this case, economists use what is called the potential Pareto improvement criterion. This criterion adds up individual benefits and costs, and asks whether the net aggregate effect is positive. Unlike the stricter Pareto improvement criterion, a potential Pareto improvement can judge a policy to be more efficient than the current state of the world even if there are individual winners and losers.[1] From its perspective, the distribution of benefits and costs lies outside the analysis. Only efficiency is judged by this criterion, so a simple approach—calculate a simple, unweighted aggregation of individual benefits and costs—is usually adopted.

Assessing the efficiency of a harvest allocation, then, is based on measuring the benefits and costs that accrue to individuals. We begin by presenting a brief review of the basis for such a measurement. Determining the efficiency of harvest allocations is simple in principle but difficult in practice. We illustrate this distinction first with a simple theoretical example of harvest allocation between two sectors; following this, we present an example of conducting such an analysis for an actual fishery, taken from Carter et al. (2008).

[1] This criterion is embedded in a more technical set of criteria known as the Kaldor-Hicks criteria (Kaldor 1939, Hicks 1939). Its development was an attempt to separate the aggregate value of benefits and costs (the economic efficiency of a policy) from the distribution of those benefits and costs (the fairness of the policy) (Zerbe 2001).

3.1.1. Economic Concepts of Value

Focusing on efficiency and adopting a stance of assessing the benefits and costs of a policy change require a metric common to benefits and costs and across all individuals. The standard practice is to use a monetary metric that captures the economic value of the policy's effects. Economic value is based on the willingness of individuals to make trade-offs and applies to market and nonmarket settings. As noted in Lipton et al. (1995), "economic value is a measure of what the maximum amount an individual is willing to forgo in other goods and services in order to obtain some good, service, or state of the world. This measure of welfare is formally expressed in a concept called willingness-to-pay (WTP)." For analyzing the efficiency of a policy such as a harvest allocation, WTP is a measure of an individual's willingness to trade other valuable goods for the effects of the policy change. The WTP monetary metric creates an accounting framework for assessing the net social benefits of a policy, one in which individual effects can be aggregated simply by adding them together.[2]

For analyzing the allocation of a fishery's harvest, economic value reflects how various individuals or sectors place a monetary value on their share of the harvest. For the commercial harvest sector, WTP is based on market factors such as the consumer demand for seafood, the cost of harvesting, processing, marketing seafood, and so forth.[3] An important consideration is the fact that seafood passes through a series of potentially independent stages from harvest to final consumption. The economic value of allocating harvest to the commercial sector then depends on the value or WTP at each of these stages. For harvesters, processors, wholesale and retail seafood firms, and other stages of supply, WTP is determined broadly by producer surplus, or "the excess of what producers earn over their production costs for the total quantity of a good sold" (Lipton et al. 1995).[4] At the final stage in which seafood products are consumed, WTP is also determined by consumer surplus, or "the excess of what consumers are willing to pay over what they actually do pay for the total quantity of a good purchased" (Lipton et al. 1995).

The measurement of these values is difficult in theory and in practice, as discussed later in this subsection.[5] For our purposes here, however, we compress all the commercial stages from harvest to final retail sale into one, thus a commercial harvester represents the full set of commercial enterprises and their corresponding WTPs. The total economic value of harvest in

[2] In most cases, WTP is determined in part by income, with higher levels of income associated with higher WTP, other determinants being equal. Income distribution can therefore affect the levels of WTP across individuals, thus using WTP as a metric to measure efficiency does not entirely escape judgments about fairness (Hausman and McPherson 1996).

[3] A fishery sometimes encompasses multiple species, which can complicate the estimation of economic values for the purpose of allocating one of those species. In such a case, and especially if harvest effort captures those species simultaneously, some or all of the costs of harvesting will be impossible (or at least not easy) to allocate to individual species.

[4] Individuals who participate in commercial fisheries can enjoy what is known as a worker satisfaction bonus, or a nonmonetary benefit from their participation in the fishery, a phenomenon not unique to fisheries (Anderson 1980b, Pollnac and Poggie 1988, Smith 1981). This benefit may be part of the WTP for commercial harvest, which complicates estimating that value from market data.

[5] See Just et al. (2004) for an overview of the theoretical issues involved in measuring these values in a market setting.

the commercial sector is then the sum of the consumer WTP (or consumer surplus) and the harvesters' WTP (or, more generally, producer surplus).[6]

For recreational fishing, there may in fact be a commercial aspect if fishing occurs through charter boats or other commercial ventures that supply a recreational fishing experience. In this case, these commercial operators can be treated as part of the supply chain, while their customers are the "final consumers" for the recreational harvest.[7] Recreational fishing can take place in a nonmarket setting, in which case the fisherman is the producer and the consumer. The concept of WTP still applies, again with the complication that its measurement often takes place for a recreational fishing trip rather than by unit of harvest. Nevertheless, it is possible to gauge how WTP varies with a trip's harvest amount, so the value of recreational fishing where there are no market transactions can still be incorporated into an efficiency analysis of allocation.

An important assumption implicit to this discussion is that the economic values in play are limited to the sectors that harvest the fishery resource. If the fish population has value in situ and harvest somehow affects this value, or if the harvest itself affects other resources with economic value, then a broader consideration that includes these other sectors is necessary. Harvest levels that threaten the viability of a species or harvesting techniques that damage the habitat of nonharvested species are examples where such considerations may be warranted.

3.1.2. Determining the Efficiency of Harvest Allocation

In this subsection, we examine the question of what conditions make an allocation efficient. From the previous subsection, we note that economic value is the basis for assessing efficiency, measured by WTP (which we hereafter call economic value). Here we use an extended numerical and graphical example of allocating a harvest between two fishery sectors to illustrate how an efficient allocation is achieved. We then extend the example to show how reallocation may be warranted when the conditions that underlie the initial allocation change. Appendix A provides a more formal treatment of these conditions.

For the purposes of this example, we assume there are two distinct types of harvesters (simply, Sector A and Sector B) and that the fishery has an annual catch limit (ACL) that will be allocated between the two sectors. We also assume that the net economic value for varying amounts of harvest by each sector has been determined (later, we discuss the data needed to make this statement come true). An important additional assumption, common for any type of economic analysis, is that each sector's total economic value increases with an increase in its harvest level, but at a decreasing rate.[8] This rate is the marginal economic value, or the difference in the total economic value for successive amounts of harvest. This assumption

[6] Edwards (1990) and Lipton et al. (1995) provide more extensive discussions of these concepts in the context of natural resources in general and fisheries in particular, respectively.

[7] Commercial operations such as charter boats typically charge for a fishing trip, not by a quantity of fish harvested, which is how allocation occurs. This complicates the estimation of the WTP for a recreational harvest amount. Carter and Liese (2010) overcame this problem by using market prices for charter trips and estimating how those prices varied with changes in harvest rates and fish sizes. Their analysis produced an estimate of the WTP of charter customers for an additional harvest amount.

[8] This assumption is not necessary, as it may be that the marginal value of harvest for one or more of the sectors is constant (or, although much less likely, increasing). In such a case, the efficient allocation may be more extreme and may even produce a result that allocates all of a harvest to one sector.

means that the marginal economic value is positive but decreasing as the harvest amount increases. Table 1 and Figure 1 illustrate these assumptions and form the basis for our numerical example. (Table 1 lists the total and marginal economic value in increments of 10 units of harvest, but the marginal economic value is based on single unit increments.)

Now suppose the ACL is set at 250 units of harvest. What is the most efficient allocation of that ACL? The most efficient allocation is that which maximizes the total net benefits, or for this example, the sum of the total economic value for the two sectors. Table 2 lists the individual sector and aggregate values as the allocation ranges from 100% for Sector B to 100% for Sector A. At the extremes, a 100% allocation to Sector B generates more value than a 100% allocation to Sector A, but the maximum aggregate value is achieved when the allocation between A and B is 30%:70%. Figure 2 illustrates these results.

Table 1. Total and marginal values of harvest.

	Total value ($)		**Marginal value ($)**	
Harvest	**Sector A**	**Sector B**	**Sector A**	**Sector B**
10	3,450	6,150	341	606
20	6,800	12,100	331	586
30	10,050	17,850	321	566
40	13,200	23,400	311	546
50	16,250	28,750	301	526
60	19,200	33,900	291	506
70	22,050	38,850	281	486
80	24,800	43,600	271	466
90	27,450	48,150	261	446
100	30,000	52,500	251	426
110	32,450	56,650	241	406
120	34,800	60,600	231	386
130	37,050	64,350	221	366
140	39,200	67,900	211	346
150	41,250	71,250	201	326
160	43,200	74,400	191	306
170	45,050	77,350	181	286
180	46,800	80,100	171	266
190	48,450	82,650	161	246
200	50,000	85,000	151	226
210	51,450	87,150	141	206
220	52,800	89,100	131	186
230	54,050	90,850	121	166
240	55,200	92,400	111	146
250	56,250	93,750	101	126
260	57,200	94,900	91	106
270	58,050	95,850	81	86
280	58,800	96,600	71	66
290	59,450	97,150	61	46
300	60,000	97,500	51	26

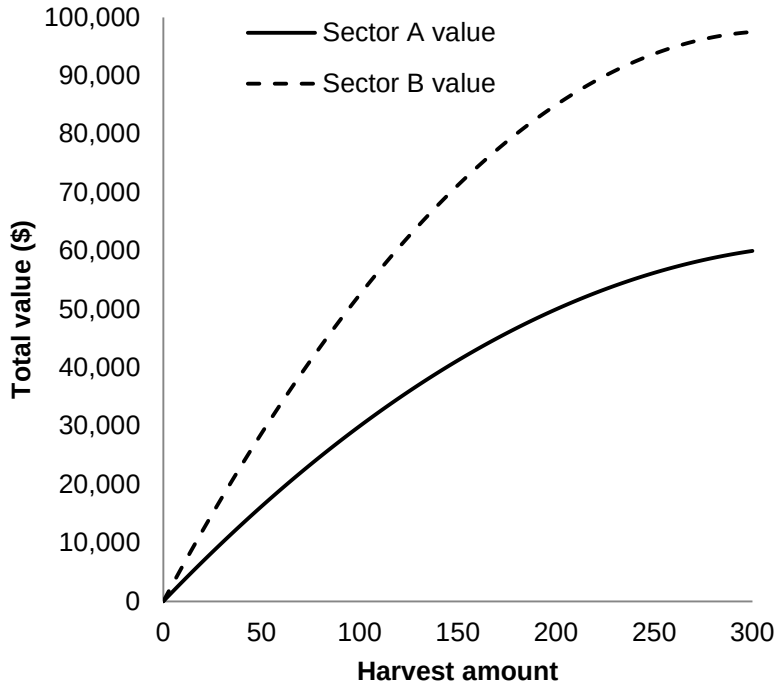

Figure 1. For each sector, the total (net) economic value of harvest increases with an increase in the amount harvested, but at a decreasing rate.

Table 2. Sector and aggregate values of harvest allocation (ACL = 250). Boldface indicates the most efficient allocation.

A:B allocation of ACL (%)	Sector A value ($)	Sector B value ($)	Aggregate value ($)
0:100	0	93,750	93,750
10:90	8,437	90,000	98,438
20:80	16,250	85,000	101,250
30:70	**23,438**	**78,750**	**102,188**
40:60	30,000	71,250	101,250
50:50	35,938	62,500	98,438
60:40	41,250	52,500	93,750
70:30	45,938	41,250	87,188
80:20	50,000	28,750	78,750
90:10	53,438	15,000	68,438
100:0	56,250	0	56,250

What are the conditions that make this allocation efficient? The answer lies in what economists sometimes refer to as the equimarginal principle. Simply, the equimarginal principle considers the change in aggregate economic value that occurs when a small amount of the harvest allocation is transferred from one sector to another, say, from A to B. If the value of that transfer for sector A (which counts as a cost) is less than it is for sector B (which counts as a benefit), the reallocation will increase the aggregate economic value and therefore produce a more efficient allocation.

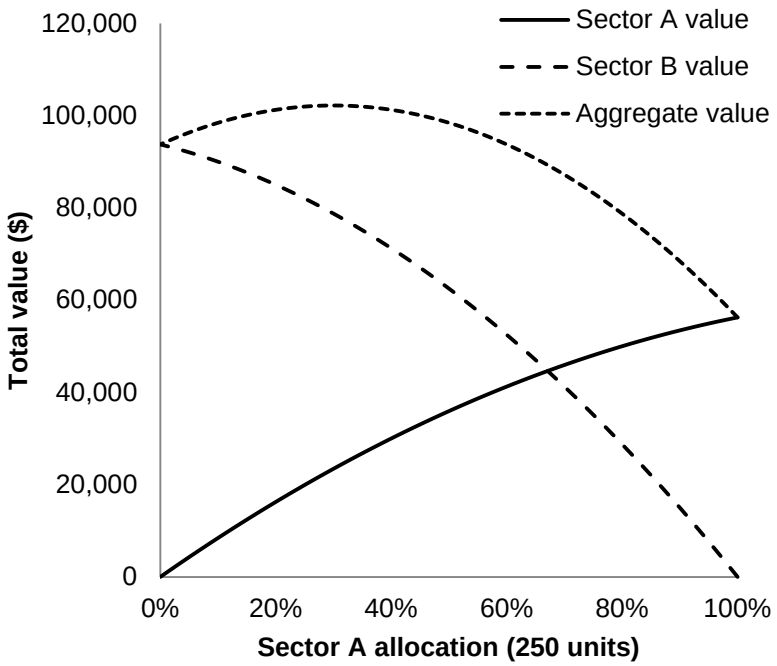

Figure 2. Although a greater value can be achieved by allocating all of the harvest to Sector B instead of Sector A, the maximum total value is achieved by allocating 30% of the harvest to Sector A and 70% to Sector B.

Does this mean that all of sector A's allocation should be transferred to sector B? In general, the answer is no. To see this, suppose harvest is initially allocated 50%:50% (Figure 3). The marginal value of harvest for sector A and B is $225 and $375, respectively. Moving one unit from A to B would then have a benefit of $375 (Sector B's marginal gain) and a cost of $225 (Sector A's marginal loss). This change in the allocation would therefore produce an increase in the aggregate total value of $150. Further changes in the same direction would continue to increase the aggregate total value as long as the benefit (sector B's marginal value) exceeded the cost (sector A's marginal value). Because the former decreases as more is transferred while the latter increases, these transfers will eventually have a negative effect on the aggregate total value. Where this point is just reached—that is, where the net change just reaches zero—the aggregate total value will be maximized. This point is where the marginal value for sector B is equal to the marginal value for sector A.

In principle then, the efficient allocation of an ACL can be determined by deriving each sector's marginal economic value for harvest, then finding the allocation that equates that marginal value across all sectors.[9] The particular solution or efficient set of allocations is dependent on the factors that underlie the economic value of each sector's harvest. These factors include commercial prices and harvest costs when the sector is commercial, determinants of recreational fishermen's WTP for their trips and catch, and so forth. When these factors change, the efficient allocation of harvest also changes, often in a predictable fashion.

[9] Appendix A treats the general case of efficient allocation of an ACL across *n* harvest sectors.

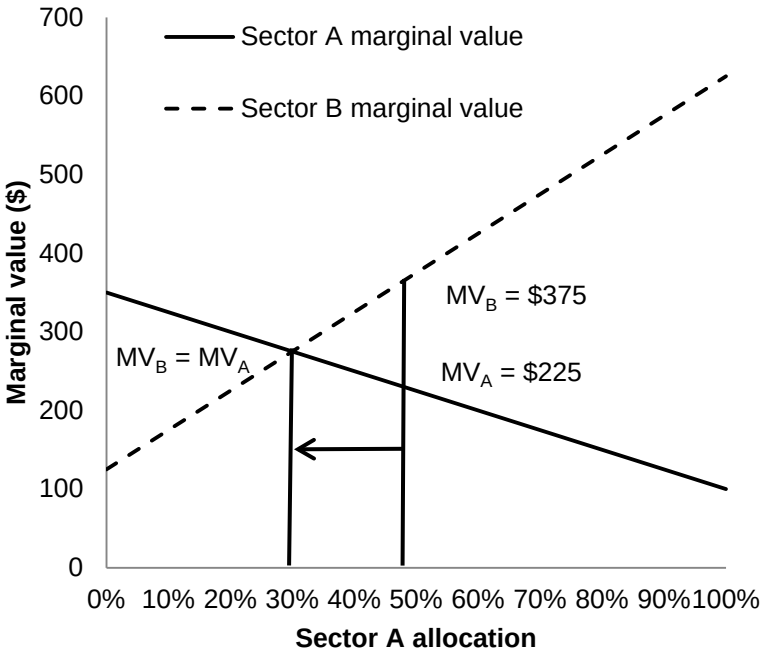

Figure 3. If harvest is allocated equally across Sector A and Sector B, the marginal value of increasing Sector B's allocation exceeds the marginal value (cost) of decreasing Sector A's allocation. A more efficient allocation can be achieved by transferring harvest from A to B, but the gains from doing so will diminish. The most efficient allocation is achieved at 30%:70% allocation.

Suppose, for example, Sector A consists of commercial harvesters and the cost of fuel decreases, decreasing the cost of commercial harvest. This would increase the value of sector A's harvest for any given amount, and so the efficient allocation between sector A and B would change in a predictable direction, say, from 30%:70% to 40%:60% as illustrated in Figure 4. Now suppose Sector B consists of recreational harvesters and the opportunities for participating in other recreational fisheries become more limited. In that case, recreational fishing in the fishery under consideration would likely become more valuable in the sense that the marginal and total WTP for any level of recreational harvest would increase. This would consequently increase the efficient share for Sector B, say, from 30%:70% to 20%:80% as illustrated in Figure 5.

Finally, an increase in the ACL will, under almost any circumstances, increase the amount of harvest allocated to each sector, but the allocation shares in percentage terms are likely to change, depending on how the marginal values in each sector respond to an increase in harvest. A simple way of viewing this is to focus on the additional ACL, and ask the question: Given an efficient allocation of the original ACL, what is the efficient allocation of ΔACL, the increase in the ACL?[10]

Suppose the ACL is adjusted upward by 100 units. Table 3 lists the increase in the total value for each sector using their current allocation and current total value as a baseline, and the

[10] Appendix A considers this case more formally, as well as the case where the original allocation of an ACL is not efficient but a change in the ACL presents an opportunity to improve the allocation efficiency.

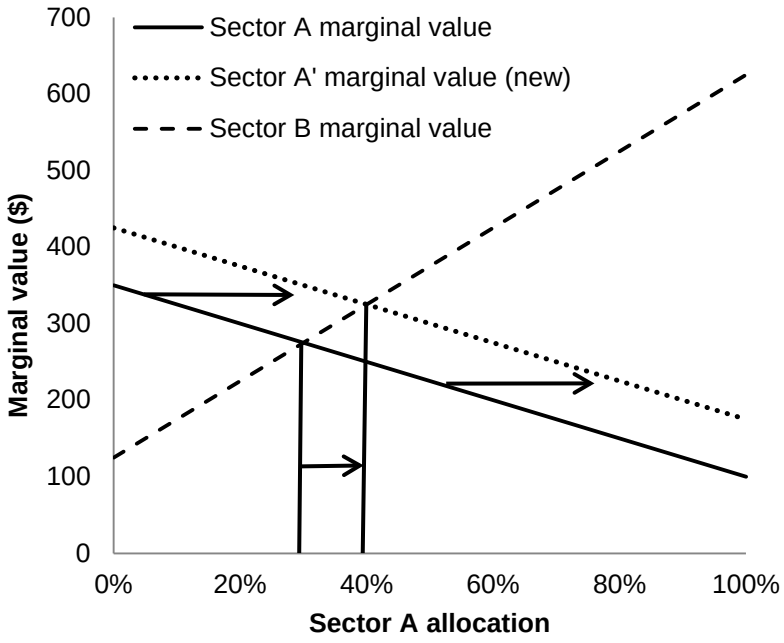

Figure 4. If Sector A is commercial harvesters, a decrease in the cost of harvest could increase the marginal value of that sector's harvest, which would then change the efficient allocation to one that allocated more harvest to Sector A and less to Sector B.

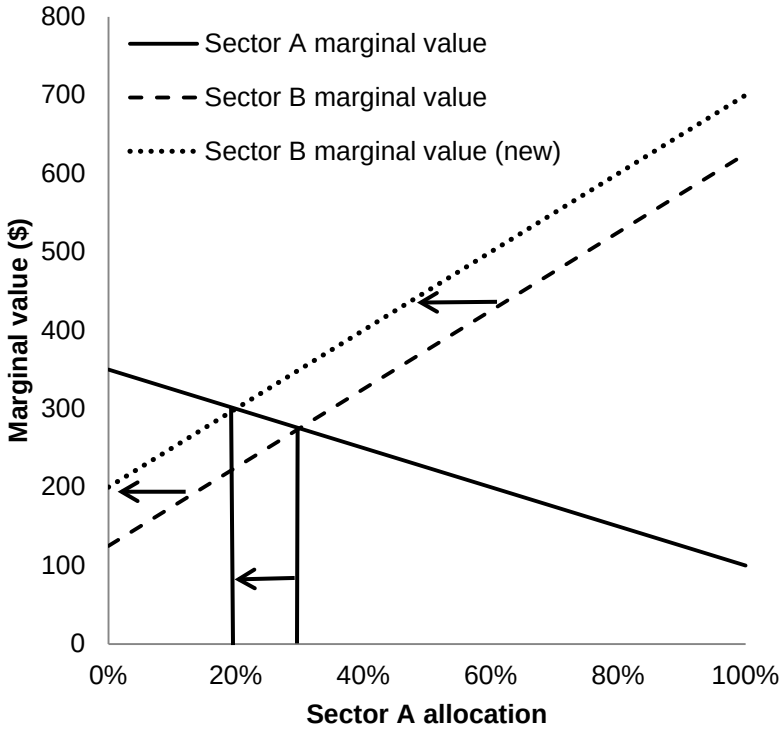

Figure 5. A reallocation of harvest from Sector A to Sector B is efficient if a factor changes in a way that increases Sector B's marginal value of harvest.

Table 3. Total and marginal values of additional harvest. Boldface indicates the most efficient allocation.

	Total value ($)		**Marginal value ($)**	
	Sector A	**Sector B**	**Sector A**	**Sector B**
Value of initial harvest	**23,438**	**78,750**	**—**	**—**
Value of additional harvest	**Total additional value ($)**		**Marginal value of additional harvest ($)**	
	Sector A	**Sector B**	**Sector A**	**Sector B**
1	274	274	274	274
5	1,362	1,350	271	266
10	2,700	2,650	266	256
15	4,012	3,900	261	246
20	5,300	5,100	256	236
25	6,562	6,250	251	226
30	7,800	7,350	246	216
33	8,530	**7,986**	243	**209**
35	9,012	8,400	241	206
40	10,200	9,400	236	196
45	11,362	10,350	231	186
50	12,500	11,250	226	176
55	13,612	12,100	221	166
60	14,700	12,900	216	156
65	15,762	13,650	211	146
67	**16,180**	13,936	**209**	142
70	16,800	14,350	206	136
75	17,812	15,000	201	126
80	18,800	15,600	196	116
85	19,762	16,150	191	106
90	20,700	16,650	186	96
95	21,612	17,100	181	86
100	22,500	17,500	176	76

marginal value at each increased amount of harvest. Increasing the harvest in each sector produces an increase in the total value above the initial harvest levels, but the marginal values are different. In this example, giving 100% of the additional harvest to Sector A produces more value than giving 100% to Sector B. But using the equimarginal principle, the most efficient allocation is found by dividing the additional harvest (67%:33%), as shown in Table 3 and Table 4 (boldfaced cells). One can also simply conduct the analysis of an efficient allocation over again; Table 5 and Figure 6 illustrate the new efficient allocation for an ACL of 350 units.

3.1.3. An Example of an Analysis of Allocation Efficiency

In this subsection, we present an example of an analysis that addresses the economic efficiency of a commercial-recreational harvest allocation. The example covers the Gulf of Mexico red grouper (*Epinephelus morio*) fishery, which is part of the Gulf of Mexico FMP for

Table 4. Sector and aggregate values of additional harvest allocation (ACL = 350). Boldface indicates the most efficient allocation.

A:B allocation of additional ACL (%)	Sector A value ($)	Sector B value ($)	Aggregate value($)
0:100	0	17,500	17,500
10:90	2,700	16,650	19,350
20:80	5,300	15,600	20,900
30:70	7,800	14,350	22,150
40:60	10,200	12,900	23,100
50:50	12,500	11,250	23,750
60:40	14,700	9,400	24,100
67:33	**16,180**	**7,986**	**24,166**
70:30	16,800	7,350	24,150
80:20	18,800	5,100	23,900
90:10	20,700	2,650	23,350
100:0	22,500	0	22,500

Table 5. Sector and aggregate values of harvest allocation (ACL = 350). Boldface indicates the most efficient allocation.

A:B allocation of additional ACL (%)	Sector A value ($)	Sector B value ($)	Aggregate value ($)
0:100	0	96,250	96,250
10:90	11,638	97,650	109,288
20:80	22,050	96,600	118,650
30:70	31,238	93,100	124,338
40:60	39,200	87,150	126,350
41:59	**39,168**	**68,586**	**126,354**
50:50	45,938	78,750	124,688
60:40	51,450	67,900	119,350
70:30	55,738	54,600	110,338
80:20	58,800	38,850	97,650
90:10	60,638	20,650	81,288
100:0	61,250	0	61,250

Reef Fish (Reef Fish FMP),[11] and is taken from Carter et al. (2008). The example replicates the basic approach outlined in the previous section, but underscores the challenges in bringing even a simple theoretical framework to life with data.

In 1984 the Gulf of Mexico Fishery Management Council implemented the Reef Fish FMP to protect and rebuild declining reef fish stocks. Through the late 1990s, the Reef Fish FMP was amended several times, including establishment of quotas covering shallow water groupers and deep water groupers.[12] In October 2000 NOAA declared the red grouper resource

[11] The harvest of red grouper takes place in a multispecies fishery.

[12] The shallow water grouper complex occurs primarily in the eastern Gulf of Mexico. Red, gag (*Mycteroperca microlepis*), black (*M. bonaci*), scamp (*M. phenax*), yellowfin (*M. venenosa*), yellowmouth (*M. interstitialis*), rock hind (*Epinephelus adscensionis*), and red hind (*E. guttatus*) groupers comprise the shallow water grouper complex.

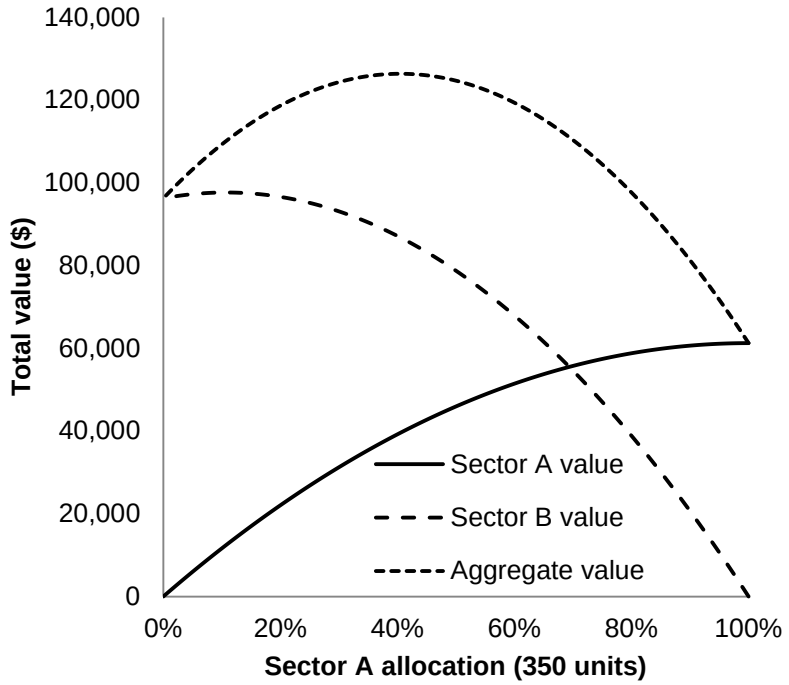

Figure 6. If the ACL is set at 350 instead of 250, the efficient allocation is one that gives 41% of the harvest to Sector A and 59% to Sector B.

to be overfished and undergoing overfishing, which resulted in the development of Secretarial Amendment 1. This amendment became effective in July 2004 and established a rebuilding plan for red grouper that relied on a two-tier commercial shallow water grouper quota. Under the two-tier quota system, the shallow water grouper fishery (which includes red grouper) would close when either the aggregate shallow water grouper quota of 8.8 million pounds or the red grouper quota of 5.31 million pounds was reached.[13]

For red grouper, the amendment used the then recent catch history for the commercial and recreational sectors as a baseline from which to set harvest reductions. For the period 1999–2001, the commercial-to-recreational harvest ratio was 81%:19%. Using this as a baseline, the council decided to reduce each sector's allocation by the same percentage. Since Secretarial Amendment 1, subsequent amendments have further constrained red grouper and other Gulf of Mexico reef fish harvests.

[Footnote 12 continued.] Their affinity for reef and hard bottom areas makes them susceptible to fixed gears such as longlines, vertical lines, and traps. Red grouper is the most important component of the shallow water grouper complex, followed by gag and black grouper. In 2004 the commercial fleet landed about 10.3 million pounds of shallow water groupers (whole weight) with a dockside value of $22.1 million. Red grouper accounted for 65.8% of the landings and 60.2% of the revenues, and gag grouper accounted for 29.6% of the landings and 34.5% of the revenues. Black grouper accounted for approximately 5% of the landings and revenues. Longlines alone accounted for about 60% of total red grouper landings. Vertical line and traps were responsible for about 25% and 13% of red grouper landings, respectively. The deep water grouper complex consists of snowy (*Epinephelus niveatus*), yellowedge (*E. flavolimbatus*), speckled hind (*E. drummondhayi*), warsaw (*E. nigritus*), and misty (*E. mystacinus*) groupers. Harvesting Nassau (*E. striatus*) and goliath (*E. itajara*) groupers is banned.

[13] All quotas are expressed as gutted weight (pounds).

The issue of allocation has come to the forefront recently for other fishery management actions considered by the Gulf of Mexico Fishery Management Council. To address this issue, Carter et al. (2008) developed a framework for analyzing allocation efficiency, using red grouper as a case study. Their approach was to apply the equimarginal principle to commercial and recreational fisheries for red grouper as they stood in 2003. Given an overall total allowable catch of 6.21 million pounds, the problem they addressed was to identify the allocation that maximized the aggregate economic value of harvest. As illustrated in the previous subsection, each sector ideally would be represented by schedules of total and marginal economic values associated with varying levels of harvest. The efficient allocation would then occur where the marginal value of harvest is equal across sectors.

For the commercial sector, the estimation of economic values faced several challenges:

- Because the grouper is jointly caught with several other species, the estimation of economic benefits had to explicitly consider how the allocation of red grouper would also affect the economic benefits derived from the suite of other jointly caught species, not simply the grouper;
- Data on harvest costs were not available; and
- Data on nonharvest commercial sectors (processing, wholesale, etc.) were not available.

Using available data, they were able to estimate commercial harvest values for the vertical and longline fleets with trip level data that included landings and prices by species, area fished, area of landing, and fishing effort. Ideally, the economic value of commercial harvest would also include estimates of values up the supply chain, including consumer surplus for final consumer demand, but data were insufficient to create a full set of such estimates. In the case of final consumer demand, this seems less problematic, as they found that seafood demand for red grouper at that wholesale level was very elastic, which means that potential changes in consumer surplus from changes in commercial harvest would be small (Just and Hueth 1979). Given these limitations, they were able to estimate a marginal economic value curve for commercial harvest (Figure 7).

For recreational fishing, Carter et al. (2008) used data on charter boat pricing and recreational harvest rates and other characteristics of recreational fishing sites to estimate recreational WTP for additional catch (see also Carter and Liese 2010). Their method and available data limited the results to a single point, however, reflecting a mean WTP (across all recreational anglers) of the current harvest level.

Using the estimated marginal value schedule for commercial harvesters and the single estimated marginal WTP for recreational harvesters, Figure 8 illustrates how a reallocation of the red grouper harvest could increase efficiency. Using 2003 as the base year, the overall harvest of 6.21 million pounds was approximately divided between commercial and recreational harvesters in the ratio 79.5%:20.5%, or 4.94 million pounds and 1.28 million pounds, respectively. Taking the two curves as exact representations of the respective economic values, the marginal economic value is higher for recreational fishing ($1.21) than for commercial fishing ($1.14). Reallocating some of the commercial harvest to the recreational sector would therefore increase the aggregate economic value and so improve efficiency.

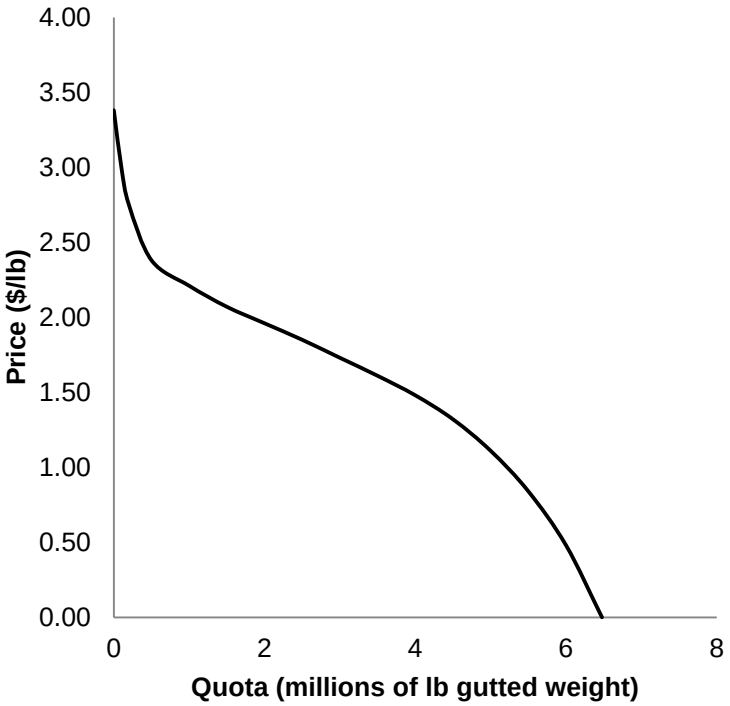

Figure 7. Carter et al. (2008) estimated the commercial sector's marginal value for red grouper harvest.

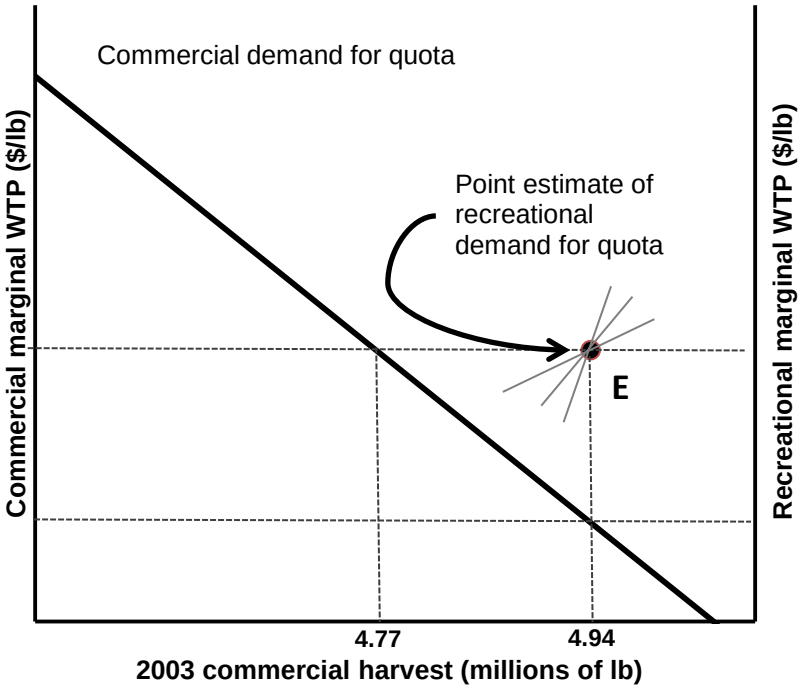

Figure 8. While Carter et al. (2008) estimated the marginal value curve for the commercial sector in their analysis, the marginal value of the recreational sector is represented only by a single point, which is the mean WTP for recreational fishermen.

Because the recreational sector's economic value is only estimated for the base case (a single point), however, the precise amount to reallocate to maximize efficiency cannot be known, as it depends on the shape and the slope of the marginal economic value curve for the recreational sector. A number of linear possibilities are shown in light shading around point E in Figure 8. The maximum reallocation would correspond to the case of a flat marginal economic value curve. Based on the estimated commercial marginal economic value curve, a flat recreational curve implies that the most that would be efficiently reallocated from the commercial to the recreational sector would be about 168,000 pounds, given the conditions that existed in 2003. Caution should be used, however, in drawing conclusions from this example as presented above. The 95% confidence interval for estimated recreational marginal economic value point ranges from \$0.30 to \$2.12, which spans the estimated marginal economic value for the commercial sector at its current allocation (\$1.14).[14] For that reason, it is difficult to draw strong conclusions about whether a reallocation would be justified in this case on the grounds of efficiency.

3.1.4. Conclusions Regarding the Analysis of Efficiency

Identifying the precise, efficient harvest allocation that achieves the maximum aggregate economic value is easy to demonstrate in principle, but difficult in practice. Nevertheless, a few important points are salient:

- The data requirements for a fully realized analysis of allocation efficiency are daunting. As noted above, both commercial and recreational sectors consist of multiple stages from harvest to final consumption. In principle, data sufficient to estimate producer surplus at each stage and consumer surplus at the final stage are needed to capture the economic values being generated across all these stages. These requirements can be eased if a few assumptions common for this type of economic analysis are made. For example, an increase in commercial harvest will typically produce changes in the amounts of labor, fuel, ice, fishing equipment, and so forth. The subsequent changes in producer surplus in those markets, however, are typically viewed as negligible as long as they are competitive markets (Edwards 1990). And because harvest allocations are typically species specific, changes in the commercial harvest of one species may have modest effects in the retail and even wholesale markets for seafood if other species or products are good substitutes for that species. In that case, those markets can be excluded from the analysis. Even with these possibilities, the data requirements for analyzing just the primary commercial and recreational harvest stages are substantial.
- Whether data are rich or sparse, the equimarginal principle for an efficient allocation of harvest limits is still relevant. Using that principle and whatever data are available, it may be possible to conclude that a current allocation is inefficient and know which direction one should move, but it may also be difficult to identify the new, efficient allocation precisely.
- A change in ACL will move allocated harvest amounts for all sectors in the same direction, but keeping harvest shares the same may or may not be efficient (assuming the initial allocation was efficient).

[14] Similar confidence intervals could not be calculated for the estimates of marginal WTP in the commercial sector.

3.2. Fairness for Harvest Allocation Decisions

Efficiency considerations impose a common, unweighted, monetary metric on all consequences stemming from an allocation decision. This enables an analysis to reach a bottom line: Does the decision increase net aggregate benefits? If the answer is yes, the decision improves the efficiency of the fishery harvest. Consideration of the fairness of an allocation decision does not entail a similar objective analysis. Identifying the types of information that inform a determination of fairness is straightforward, but how a decision maker uses that information and assesses fairness is ultimately a policy issue.

In the context of public policy, fairness inherently involves considering the welfare of individuals vis-à-vis the welfare of other individuals. For efficiency, the WTP of each individual is taken as an accurate accounting of that individual's welfare and weight in the broader calculation of social welfare. For a consideration of fairness, however, a WTP measure is not necessarily the same as a measure of an individual's welfare (Farrow 1998). Two individuals can have the same income or experience the same change in income yet have different levels or subsequent changes in welfare. Incorporating fairness into an analysis of a policy's effects must therefore account for the difference between the WTP and the more general welfare of a policy.

A social welfare function is a way of accounting for individual welfare measures and analyzing the fairness of an allocation policy. Such a function can give meaning to the statement, for example, that one distribution of income is better (from a social perspective) than another (Boadway and Bruce 1984). One way of incorporating fairness into an analysis of social welfare focuses on the distribution of income and disparities that exist in that distribution. A social welfare function could, for example, combine a measure of income levels such as average income with a measure of income disparities such as the dispersion of incomes (Boadway and Bruce 1984).[15] Another approach is to assign particular weights to individuals or groups of individuals, then sum the weighted incomes to produce a measure of the social value of a particular income distribution or distribution of incomes changes (Mishan and Quah 2007). Combining income levels or changes and the dispersion of income or income changes in a social welfare function then enables a decision maker to assess which policy is "best" while explicitly accounting for the policy's effects on efficiency and fairness.

Because a social welfare function accounts for the possibility of trade-offs between efficiency and fairness, it is entirely possible for measures of efficiency and measures of social welfare to rank projects differently. The most efficient allocation may be deemed unfair, at least compared to a different (and feasible) allocation. The allocation that is fairer, however, will then be less efficient. It can even be the case that a social welfare function's allowance for the fairness of a policy's distribution results in a best policy being one that has negative net aggregate benefits compared to the status quo (Freeman 2003).

[15] An example commonly used in the analysis of poverty and other aspects of income inequality is the Gini coefficient (Gini 1921). The coefficient reflects the difference between the actual distribution of income and one in which every individual has the same income. It ranges between zero (each individual has an equal income) and one (one individual has all the income while all others have none). The Gini coefficient can also be used as an index of the inequality of changes in income.

Unlike the theoretical framework for efficiency, however, there is no objective way of assessing social welfare and constructing a social welfare function because these tasks inherently involve "someone making prior value judgments" (Boadway and Bruce 1984, see also Hausman and McPherson 1996). Moreover, even the components of a social welfare function are a matter of policy choice. Possibilities include the individual welfare generated by an actual bundle of resources (Dworkin 1981a); the bundle of resources itself, independent of differences across individuals in the welfare associated with those bundles (Dworkin 1981b); the opportunities an individual has to achieve various levels of welfare (Arneson 1990); the capabilities an individual has to achieve various levels of welfare (Sen 1987, 1992); and so forth.

Baumol (1980, 1986) has developed a formal framework for incorporating fairness considerations into economic analysis. He introduced the concept of "superfairness," a distribution of resources such that each group with a share of the resource prefers its own share to that received by any other group (Baumol 1980). He also defined the concept of "incremental superfairness," a change in the distribution of a resource such that each group affected by the change prefers its own increment to that of any other group. This latter concept is intended to address the fairness of changes in distribution independent of the fairness of the initial distribution. This is an important qualification for actions such as harvest allocations, for the management of fisheries cannot (in most cases) address the broader social fairness of the distribution of income unaffected by those actions.

In conclusion, the consideration of the second allocation criterion, fairness, is difficult to place in an objective, formal framework, thus our treatment of this criterion is significantly briefer than the treatment of efficiency. The disparity does not reflect the relative importance of the two criteria, only the ease with which each is examined in such a framework. Because the distribution of a policy action's effects is central to the determination of the policy's fairness, however, documenting those distribution effects is an obvious way of addressing that issue in the context of making an allocation of fishery harvest. It is straightforward, then, to describe the distribution of a given allocation and so pose the question: Is this particular distribution fair and equitable? Answering that question is fundamentally a policy task, however, not a scientific one.

3.3. Summary

Under the MSA, allocation decisions are expected to address the issues of efficiency and fairness. As seen above, efficiency is amenable to a formal, quantitative analysis, although gathering the data needed to conduct such an analysis is challenging; fairness is more difficult to analyze in that way, but can at least be addressed by documenting how a decision affects a fishery's individual sectors.

It is not within the purview of this technical memorandum to recommend particular approaches to considering efficiency and fairness and incorporating these considerations into a particular council's allocation decisions. In the following section, we document how they have been considered in practice.

4. Allocation Decisions in Practice

In this section, we document the practice of allocating harvest limits between commercial and recreational sectors. This issue is relevant, of course, only when both sectors play a significant role in a fishery and are actively managed by an FMP. This is not the case, however, for more than three-fourths of the FMPs covered in this technical memorandum. Of the New England Fishery Management Council's eight FMPs, for example, seven do not have a significant recreational fishery, thus allocation between commercial and recreational sectors is not at present an important issue for these FMPs. Similarly, the Western Pacific Fishery Management Council has no FMPs that actively manage a recreational sector. Table 6 lists the FMPs that do not have a significant recreational fishery, which means the issue of commercial-recreational allocation is not an active one.

In other cases, a FMP can have a recreational sector but management might not at this time involve what we have defined as an allocation for that sector. In most cases, limits on recreational per trip harvests, size of harvest, or other constraints are in place, but the FMP does not attempt to assess total recreational harvest and allocate some proportion of an overall allowable harvest to the recreational sector. Table 7 lists the FMPs that fall into this category. The remaining 11 FMPs have an active recreational sector and have allocated allowable harvest between commercial and recreational sectors. These FMPs are listed in Table 8.

Below, we first give an overview of the allocation decisions we have compiled. We gathered information from publicly available documents on all regulatory actions that constituted what we defined as a commercial-recreational allocation decision: a regulation establishing or amending a FMP that 1) created or continued a limit on allowable harvest and 2) allocated that limit to commercial and recreational sectors either explicitly (e.g., by specifying a commercial-recreational ratio or sector-specific limits) or implicitly (e.g., by specifying a limit on one sector). We then discuss the types of analyses that have supported these decisions. (In Appendix B we give excerpts of several of these analyses.) For our purposes, we defined analysis as a calculation that demonstrated a change in an economic characteristic of the fishery. Finally, we briefly discuss the management objectives that govern the FMPs that are included in our set of allocation decisions. These objectives provide a context within which allocation and other management decisions are made. In particular, we note where an FMP explicitly contains an objective that references the commercial or recreational sector.

4.1. FMP Allocations Among Commercial and Recreational Fisheries

We documented 26 regulations that address fisheries allocations between commercial and recreational fisheries, 25 of which were completed between 1983 and the end of 2010, and one of which is in progress as of this writing (Table 9). Some regulations provide allocations for one species (i.e., Atlantic bluefish [*Pomatomus saltatrix*]), while others allocate across multiple

Table 6. FMPs without a significant recreational fishery.

Council	FMP
Caribbean Fishery Management Council	Corals and reef associated invertebrates of Puerto Rico and the U.S. Virgin Islands
Gulf of Mexico Fishery Management Council	Gulf of Mexico coral and coral reefs Red drum fishery of the Gulf of Mexico
Mid-Atlantic Fishery Management Council	Atlantic surfclam and ocean quahog fisheries Spiny dogfish
New England Fishery Management Council	Atlantic deep sea red crab Atlantic herring fishery Atlantic salmon fishery Atlantic sea scallops Monkfish fishery Skates Small mesh multispecies fishery
North Pacific Fishery Management Council	Arctic fisheries Bering Sea/Aleutian Islands king and tanner crab Groundfish fishery of the Bering Sea and Aleutian Islands area Scallop fishery off Alaska
Pacific Fishery Management Council	Coastal pelagic species
South Atlantic Fishery Management Council	Comprehensive ecosystem based FMP Coral, coral reefs, and live/hard bottom habitats of the South Atlantic region Golden crab fishery of the South Atlantic region Pelagic sargassum habitat of South Atlantic region Shrimp fishery of the South Atlantic region
Western Pacific Regional Fishery Management Council	Bottomfish and seamount groundfish fisheries of the Western Pacific region Coral reef ecosystem of the Western Pacific Crustacean fisheries of the Western Pacific region Pelagic fisheries of the Western Pacific region Precious corals fishery of the Western Pacific region

species (Amendment 1 to the Gulf of Mexico Reef Fish FMP addresses nine species and two species groups). Overall, we documented allocations for 36 different stocks of fish (30 species).

Of the 26 regulations, all but one either created or modified existing allocation ratios. Only one regulation (Amendment 23 to the Reef Fish FMP) rescinded a commercial-recreational allocation in its entirety. Vermilion snapper (*Rhomboplites aurorubens*) was originally allocated 67%:33% to the commercial and recreational sectors, respectively, in Amendment 1. Through time, however, the catch evolved to a ratio of 79%:21%. The council decided that returning to the original allocation would have too much of an impact on the commercial fishery, so they approved regulations that did not designate allocations.

Table 7. FMPs with recreational harvest but no current allocation.

Council	FMP
Caribbean Fishery Management Council	Queen conch resources of Puerto Rico and the U.S. Virgin Islands Shallow water reef fish fishery of Puerto Rico and the U.S. Virgin Islands Spiny lobster fishery of Puerto Rico and the U.S. Virgin Islands
Gulf of Mexico Fishery Management Council	Shrimp fishery of the Gulf of Mexico Stone crab fishery of the Gulf of Mexico
International Pacific Halibut Commission	Pacific halibut
Mid-Atlantic Fishery Management Council	Tilefish
North Pacific Fishery Management Council	Groundfish fishery of the Gulf of Alaska High seas salmon fishery off the coast of Alaska, east of 175° east longitude
Pacific Fishery Management Council	U.S. West Coast fisheries for highly migratory species
South Atlantic and Gulf of Mexico fishery management council joint efforts	Spiny lobster fishery of the Gulf of Mexico and South Atlantic

Table 8. FMPs with recreational allocations for at least some species.

Council	FMP
Gulf of Mexico Fishery Management Council	Reef fish resources of the Gulf of Mexico
Mid-Atlantic Fishery Management Council	Atlantic bluefish Atlantic mackerel, squid, and butterfish fisheries Summer flounder, scup, and black seabass fisheries
New England Fishery Management Council	Northeast multispecies fishery
NMFS Highly Migratory Species Division	Atlantic highly migratory species
Pacific Fishery Management Council	Pacific coast groundfish West Coast salmon
South Atlantic and Gulf of Mexico fishery management councils joint efforts	Coastal migratory pelagic resources of the Gulf of Mexico and South Atlantic
South Atlantic Fishery Management Council	Dolphin and wahoo Snapper-grouper fishery of the South Atlantic region

Table 9. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
Gulf of Mexico Fishery Management Council					
Reef fish resources of the Gulf of Mexico	Amendment 1 (1990)	Greater amberjack	14:86	Y/L	Historical catch 1979–1987. These years represent the longest time period of documented commercial and recreational annual harvests.
		Gray snapper	32:68	Y/L	
		Groupers in aggregate	65:35	Y/L	
		Jewfish	36:64	Y/L	
		Lane snapper	25:75	Y/L	
		Mutton snapper	43:57	Y/L	
		Red Snapper	51:49	Y/L	
		Sea basses	3:97	Y/L	
		Snappers in aggregate	49:51	Y/L	
		Vermillion snapper	67:33 (allocation later removed)	Y/L	
		Yellowtail snapper	55:45	Y/L	
	Secretarial Amendment 1 (2004)	Red grouper	81:19 (allocation later changed)	Y/SQ	The ratio 1900–2000 was 76%:24%, close to the 1986–1989 ratio (75%:24%). In recent years (1999–2001), however, it has shifted to 81%:19% due to management changes and a strong 1996 class year that boosted commercial catch more than recreational harvest. The current amendment does not attempt to address the question of single-species grouper allocations. Instead, it applies the same percentage reductions to each sector, thus effectively maintaining allocations at current levels.
	Amendment 23 (2004)	Vermillion snapper	Removed allocations	RE	Current catch 79%:21%. Returning to allocation from Amendment 1 would reduce commercial catch by 37%. Options chosen by the council do not designate commercial and recreational allocations.

Table 9 continued. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
Reef fish resources of the Gulf of Mexico continued	Amendment 30A (2008)	Gray trigger	21:79	Y/SQ	This is not an official allocation. Historic landings (2000–2004) had a ratio of 21%:79%. The proposed rule reduces landings by 60% for both sectors retaining the historic ratio. Council created an ad hoc committee to examine fair and equitable ways to allocate in the future.
		Greater amberjack	27:73	Y/L	Close to historical average 1981–2004 (was 29%:71%). The council reduced recreational landings proportionally less than commercial landings because of perceived inequities in the effects of previous management decisions and greater amberjack's value as a recreational sport fish.
	Amendment 30B (2009)	Gag grouper	39:61	Y/L	Interim allocation based on 1986–2005 (the longest and most robust time series available). In addition, these data show how the fishery has been shared over time. The council created a committee to examine future allocation issues.
		Red grouper	76:24	Y/L	
Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council					
Coastal migratory pelagic resources of the Gulf of Mexico and south Atlantic	FMP (1983)	King mackerel	24:76 (allocation later changed)	Unk	Allocations (as pounds) were provided. Catch was set for above the current harvest. No detail provided on how the allocations were determined.
	Amendment 1 (1985)	King mackerel, Atlantic group	37.1:62.9	Unk	No discussion provided on how the initial allocations were determined. The amendment states this is a temporary allocation and gives the method for changing future allocations: use the "longest numbers of years beginning in 1979 for which concurrent recreational and commercial data are available."

Table 9 continued. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
Coastal migratory pelagic resources of the Gulf of Mexico and south Atlantic continued		King mackerel, Gulf group	32:68	Y/NE	Historical catch (1975–1979 was 30%:70%). Moved 2% of allocation from recreational to commercial to account for recreational fish sold. Amendment states this is a temporary allocation and gives the method for changing future allocations: use the "longest number of years beginning in 1979 for which concurrent recreational and commercial data are available."
	Amendment 2 (1987)	Spanish mackerel, Atlantic group	76:24 (allocation later changed)	Y/R	Catch 1979–1985 (most recent time period with catch data).
		Spanish mackerel, Gulf group	57:43	Y/R	
	Amendment 4 (1989)	Spanish mackerel, Atlantic group	50:50 (allocation later changed)	Y/B	Council noted that the 76%:24% allocation was from a time when resources were overfished and recreational participation was low. Limited data from early 1970s suggests 50%:50% split.
	Catch specifications (1999)	Spanish mackerel, Atlantic group	55:45	Y/SQ	TAC was decreased. Allocation changed to allow commercial to catch similar amount as last year since recreational does not use full allocation.

Table 9 continued. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
Mid-Atlantic Fishery Management Council					
Atlantic bluefish	Amendment 1 (2000)	Bluefish	17:83	Y/B	Average catch 1981–1989 (most recent years prior to regulations that may have impacted landings). Note: if 17% of the total allowable landings (TAL) was less than 10.5 million lb, then the quota could be increased up to 10.5 million lb if the recreational sector was projected to land less than 83% of the TAL for the upcoming year. The transfer stipulation is intended to provide higher commercial fishing opportunities when possible.
Atlantic mackerel, squid, and butterfish fisheries	Amendment 11 (proposed)	Atlantic mackerel	93.8:6.2	Y/NE	Amendment 11 will designate an allocation for the recreational mackerel fishery that would form the basis of ACL/AM measures in the future. The recreational fishery would be allocated the percentage of the ABC that corresponds to the proportion of total U.S. landings that was accounted for by the recreational fishery from 1997 to 2007 from MRFSS database times 1.5. Percentage would be 6.2%, which translates to an allocation of 9,672 mt under the current ABC (6.2% of 156,000 = 9,672), and an allocation of 2,938 mt under the council's recommended 2011 mackerel ABC (47,395 mt).

Table 9 continued. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
Summer flounder, scup, and black seabass fisheries	Amendment 2 (1993)	Summer flounder	60:40	Y/B	Average catch 1980–1989. The time period for allocation purposes was bounded by reliable recreational landings data availability (1980) and before stock and landings declined to lowest historical levels (1990). The states deemed the years used for allocation purposes fair and equitable.
	Amendment 8 (1996)	Scup	78:22	Y/B	Average catch 1988–1992. Years prior to 1988 were not used because of problems with the data, while changes in regulations in early 1993 suggested not using that year's data.
	Amendment 9 (1996)	Black seabass	49:51	Y/B	Average catch 1983–1992. Years prior to 1983 were not used because of problems with the data, while changes in regulations in early 1993 suggested not using that year's data.
New England Fishery Management Council					
Northeast multispecies fishery	Amendment 16 (2010)	Gulf of Maine cod Gulf of Maine haddock	66.3:33.7 72.5:27.5	Y/SQ Y/SQ	Catch from 2001–2006. The allocations were set in order to maintain the (then) current catch ratios, which the council said would not unduly burden either sector. The allocations were also based on the recommendation of the recreational advisory council and assessments by the Groundfish Assessment Review Meeting. Framework 44 specified the amounts of harvest based on this ratio for the years 2010–2012.
NMFS Highly Migratory Species Division					
Atlantic highly migratory species	FMP (1999)	Bluefin tuna	≈80:20	Unk	FMP assigns 19.7% and 77.8% of allocation to recreational and commercial fishing, respectively. This leaves 2.5% in reserve that can be transferred to any category if needed.

Table 9 continued. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
Pacific Fishery Management Council					
Pacific coast groundfish	Ongoing	Pacific coast groundfish	Determined biennially	Unk	Determined biennially.
West Coast salmon	1984 framework adjustment	Chinook (N of Cape Falcon)	Varies with TAC (allocation method was later changed)	Y/B	Allocation was based on historic catch between 1971–1975. This time period was selected because it is the base period used for comparisons in the previous FMP analyses and it avoids the impacts of the change in the sport (1976) and troll (1977) Chinook size limits.
		Coho (N of Cape Falcon)	Varies with TAC (allocation method was later changed)	Unk	Cannot determine how this allocation was calculated. The allocation gives more fish to commercial than allocation based on historic catch between 1966 and 1978.
		Coho (S of Cape Falcon)	Varies with TAC (allocation method was later changed)	Y/B	Allocation was based on historic catch between 1966 and 1978 for TAC > 700,000. Below 700,000 allocations deviate from historical catch. This time period was chosen because it was prior to the period of increased regulation which altered historic patterns. It also encompasses the period of increased effort and significant contribution of hatchery fish to the catch.
	Amendment 7 (1986)	Coho (S of Cape Falcon)	Varies with TAC	N/SR	Determined by group composed of commercial and recreational fishermen. Change needed to "provide a more stable recreational season."
	Amendment 9 (1988)	Chinook (N of Cape Falcon)	Varies with TAC	N/SR	Working group from council's SAS created the alternatives. Council's emphasis was on increasing the stability of the recreational fishery.

Table 9 continued. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
West Coast salmon continued		Coho (N of Cape Falcon)	Varies with TAC	N/SR	Working group from council's SAS created the alternatives. Council's emphasis was on increasing the stability of the recreational fishery.
South Atlantic Fishery Management Council					
Dolphin and wahoo	FMP (2004)	Dolphin and wahoo	13:87 but non-binding	Y/M	Based on average 1994–1997 catch. This period accurately captured the relatively recent commercial participation in the fishery and addressed the goals and objectives of the FMP. Cap on commercial fishery at 13% was non-binding.
Snapper-grouper fishery of the south Atlantic region	Amendment 13C (2006)	Black seabass	43:57	Y/SQ	Allocations (as pounds) were provided with a 3-year step down. All 3 years contained same 43%:57% split. Discussion mentions decreasing commercial and recreational catch equally (35% by year 3 based on 2001–2003 and 2000–2003 for commercial and recreational, respectively). Year 1 represents current catch.
	Amendment 15B (2009)	Red porgy	50:50	Y/SQ	The alternative chosen was closest to status quo (1999–2003 landings were 49%:51%). Council mentioned that the TAC may have to be adjusted if commercial were allocated > 50% (due to higher discard mortality in commercial versus recreational).
		Snowy grouper	95:5	Y/L	Historical landings 1986–2005 (longest time series available). Shorter time frames were not utilized because unrealistic spikes in recreational landings overly influenced the results.

Table 9 continued. Commercial and recreational allocations.

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (commercial % to recreational %)	Category[a]/Note[b]	Basis for allocation
Snapper-grouper fishery of the south Atlantic region continued	Amendment 16 (2009)	Gag grouper	51:49	Y/SQ	Allocation was based on landings from 1999 to 2003. This time period was chosen because it reflects recent catch. In addition, reductions are equal (35% and 37% for commercial and recreational, respectively).
		Vermillion snapper	68:32	Y/L	Historical landings 1986–2005 (longest time series available). Council noted that results did not change much if different time frames were analyzed.
	Amendment 17B (2010)	Combined red, black, gag grouper	50.5:49.5	N/C	Commercial and recreational catch limits provided (in pounds), but no allocation listed. Catch limits equate to allocation of 50.5%:49.5%. Pounds are expected catch resulting from implementing amendment 16.
		Golden tilefish	97:3	Y/SQ	Based on formula sector allocation = (0.5 × average catch 1986–2008) + (0.5 × average catch 2006–2008). Allocation would mirror historic harvest. Allocation of 50%:50% was also considered, but would adversely impact commercial and provide limits above what could be caught recreational.

[a]Category:
N = not based on catch history,
Unk = unknown how allocation was decided, and
Y = based on catch history.

[b]Note:
B = based on time before regulations impacted catch,
C = based on expected catch,
L = based on longest time period,
M = met objectives of fishery,
NE = based on a time period but no explanation provided as to why those were years chosen,
R = based on most recent time period,
RE = removed allocations,
SQ = retain current allocations (status quo), and
SR = increased stability of recreational fishery.

For most of the regulations, the rationale for the final decision was similar across all stocks within that regulation. For six regulations, however, the reason behind the allocation decision differed for the different stocks covered in the regulation. Therefore, we consider each part of these regulations as a different allocation decision, creating in total 32 such decisions. As mentioned, one decision removed an allocation, so is not considered further here. In five cases, we were unable to determine the rationale behind the allocation decision.

Of the 26 remaining decisions, most (23) created allocations that matched historical or current catch ratios. Only three amendments provided a different rationale. Amendment 7 and Amendment 9 to the Pacific Salmon FMP provide allocations that were designed to provide more stability to the recreational fishery. The allocation (in pounds) of the combined catch of red, black, and gag grouper (Amendment 17B to the South Atlantic Snapper Grouper FMP) was created to match the expected catch resulting from management measures implemented in Amendment 16.

The 23 allocation decisions that were based on historical or current catch can be further divided into 5 categories: 8 created allocations that match the status quo (retain current allocations), 6 were based on the catch ratios averaged across the longest (5 decisions) or most recent time period (1 decision) with commercial and recreational catch data available, 6 were based on historical catch ratios before the implementation of regulations that would impact catch, 1 was based on the years that best met the objectives of the fishery, and 2 were based on a specific historical catch ratio but with no explanation of why that time period was utilized.

Only seven fish stocks had an official change in allocation through time (five from the Gulf of Mexico and two on the West Coast). As mentioned, Gulf of Mexico vermilion snapper had its official allocation removed. Of the other six fish stocks, four contained changes that increased the allocation to the recreational fishermen. Only one increased the allocation to commercial fishermen at the expense of recreational fishermen. The final allocation was first modified to increase the recreational allocation, followed by a later amendment to lower recreational allocation.

The allocations of West Coast coho salmon (*Oncorhynchus kisutch*) and Chinook salmon (*O. tshawytscha*) have been modified (Amendment 7 and Amendment 9 to the Pacific Salmon FMP) to increase the allocations to recreational fishermen. For both of these stocks, a working group composed of both commercial and recreational fishermen was formed to determine the best allocation. Both groups agreed to increase the recreational allocation in order to provide a more stable recreational season. When the Gulf of Mexico Fishery Management Council was forced to reduce catch on greater amberjack (*Seriola dumerili*) (Amendment 30A of the Reef Fish FMP), it chose to reduce recreational landings proportionally less than commercial landings (increasing the recreational percent allocation), because of perceived inequities in the effects of previous management decisions. Red grouper was initially allocated in a 2004 secretarial amendment that applied the same percent reduction to commercial and recreational fishermen and subsequently maintained the status quo. Five years later, Amendment 30B created an interim allocation based on 20 years of historical catch, increasing the recreational allocation from 19% to 24%. The Gulf of Mexico Fishery Management Council created a committee to examine future allocation decisions.

The final two fisheries with a change in allocation through time include king mackerel (*Scomberomorus cavalla*) and Spanish mackerel (*S. maculatus*), both managed within the Coastal Migratory Pelagics FMP. In the original FMP, king mackerel was considered one stock across the south Atlantic and Gulf of Mexico. Allocations were provided (in pounds), but we could find no information detailing how these numbers were determined. Amendment 1 to the FMP split king mackerel into gulf and Atlantic stocks and revised allocations with an increased share to commercial (decreased allocation to recreational) for both stocks. The allocation decision for the gulf stock was based on historical catch, but no information was found on how the allocation for the Atlantic stock was determined.

The allocation for the Atlantic stock of Spanish mackerel has been changed twice. The original allocation (76%:24%) was created in 1987 and based on the most recent time period with catch data (1979–1985). In 1989 the council determined that 1979–1985 represented a time period when the resources were overfished and recreational participation was low. The allocation was therefore adjusted to match the limited data available from the 1970s, creating a 50:50 split between commercial and recreational fisheries. Finally in 1999 in response to reductions in total catch, the allocation was adjusted (55%:45%) to retain commercial catch at levels close to the 1998 catch. This adjustment moved the allocation that was currently not being used by the recreational fishermen to commercial fishermen.

4.2. Analyses of FMP Allocations (Examples)

Using the set of allocation decisions listed in Table 9, we searched the documentation pertaining to a specific amendment or other regulatory action for some form of analysis in support of the decision. In most cases, we found information that we could characterize as an analysis in the biological, economic, social, and administrative effects sections of the regulatory document (such as the FMP and its amendments) that contained the allocation action or some other type of council document. Occasionally we found a reference to an analysis in an appendix, but in general the economic piece of the effects section indicated that the available data were insufficient for analysis. The economics sections are usually brief and we therefore have included excerpts of these sections in Appendix B.

In general, the regulatory documentation provides few formal considerations of efficiency or fairness and few examples of a quantitative analysis of efficiency. As noted in subsection 4.1, most allocation decisions we documented have been based on historical catch levels rather than on an explicit analysis of efficiency or fairness. Still, we found 10 examples of a quantitative analysis covering some aspect of the allocation decision, most of which we have excerpted below. In these cases, although analyses were often performed using measures such as net present value for the commercial allocation alternatives and consumer and producer surplus for the recreational allocation alternatives, we found no occasion where the two separate analyses were brought together to provide a recommendation for the most efficient allocation.

Table 10 lists the analyses we found and tabulates various characteristics of the analyses (if any) that support each decision covered in subsection 4.2. In each case, we considered the following:

- Was an analysis included as a separate document?
- Was an analysis conducted of all the alternatives considered in the regulatory action?
- Was a quantitative analysis performed?
- Did the regulatory action explicitly use the analysis in the decision for selecting a preferred alternative?
- Was poor data availability cited as reason for incomplete analysis?

4.3. FMP Allocations in the Context of FMP Objectives

Under the MSA, fishery management councils establish management objectives as part of the process of developing a FMP (50 CFR Ch. VI, §600.325(b)). The process of establishing these objectives should "balance biological constraints with human needs, reconcile present and future costs and benefits, and integrate the diversity of public and private interests" (50 CFR Ch. VI, §600.325(b)(1)). The objectives are used as a context with which to "judge the consistency of an FMP's conservation and management measures with the national standards" (50 CFR Ch. VI, §600.325(b)(2)).

A few of the FMPs have an objective that covers commercial and recreational sectors (in the same objective), but almost always in the context of reducing or minimizing potential conflicts between the two sectors. Nearly all FMPs contain at least one objective that covers one sector or the other separately, and most contain one or more objectives that address efficiency (usually in terms of optimizing or maximizing economic or other values) or fairness.

In Table 11 we list the management objectives that have the characteristics described above. In Appendix C we list the management objectives for the 11 FMPs for which we have documented allocation decisions.

Table 10. Commercial and recreational allocation analyses.

Fisheries Management Plan	Regulation	Fishery	Analysis included as a separate document	Analysis of all alternatives	Quantitative analysis performed	Explicit use of analysis in decision	Poor data availability cited as reason for incomplete analysis
Gulf of Mexico Fishery Management Council							
Gulf of Mexico reef fish resources	Amendment 1 (1990)	Greater amberjack, gray snapper, groupers in aggregate, jewfish, lane snapper, mutton snapper, red snapper, sea basses, snappers in aggregate, vermillion snapper, yellowtail snapper	NF[a] NF NF	Y[b] Y Y	NF NF NF	NF NF NF	NF NF NF
	Secretarial amendment 1 (2004)	Red grouper	NF	NF	NF	NF	NF
	Amendment 23 (2004)	Vermillion snapper	NF	Y	NF	NF	NF
	Amendment 30A (2008)	Gray trigger and greater amberjack[c]	NF	NF	NF	NF	NF
	Amendment 30B (2009)	Gag grouper and red grouper	NF	NF	Y	NF	NF
Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council							
Coastal migratory pelagic resources of the Gulf of Mexico and south Atlantic	Amendment 1 (1985)	King mackerel, Atlantic group	NF	NF	Y	NF	Y
	Amendment 1 (1985)	King mackerel, Gulf group	NF	NF	Y	NF	Y
	Amendment 2 (1987)	Spanish mackerel, Atlantic and Gulf groups	NF	Y	Y	NF	NF
	Amendment 4 (1989)	Spanish mackerel, Atlantic group	NF	NF	NF	NF	Y
	Catch specifi-cations (1999)	Spanish mackerel, Atlantic group	NF	NF	NF	NF	NF

Table 10 continued. Commercial and recreational allocation analyses.

Fisheries Management Plan	Regulation	Fishery	Analysis included as a separate document	Analysis of all alternatives	Quantitative analysis performed	Explicit use of analysis in decision	Poor data availability cited as reason for incomplete analysis
Mid-Atlantic Fishery Management Council							
Atlantic bluefish	Amendment 1 (2000)	Bluefish	NF	NF	NF	NF	NF
Atlantic mackerel, squid, and butterfish fisheries	Amendment 11 (2010)	Atlantic mackerel	NF	NF	NF	NF	Y
Summer flounder, scup, and black seabass fisheries	Amendment 2 (1993)	Summer flounder	NF	NF	NF	NF	NF
	Amendment 8 (1996)	Scup	NF	NF	NF	NF	NF
	Amendment 9 (1996)	Black seabass	NF	NF	NF	NF	NF
New England Fishery Management Council							
Northeast multispecies fishery	Amendment 16 (2010)	Gulf of Maine cod and haddock	NF	Y	NF	NF	Y
NMFS Highly Migratory Species Division							
Atlantic highly migratory species	FMP (1999)	Bluefin tuna	NF	Y	Y	NF	NF
Pacific Fishery Management Council							
Pacific coast groundfish	Biennial decision	Pacific coast groundfish	Section 6.2.3 of the Pacific Coast Groundfish FMP (nonbiological issues—the socioeconomic framework) describes the types of analyses that are expected to support a management action that addresses allocation decisions.				
West Coast salmon	1984 framework adjustment	Chinook (N of Cape Falcon), coho (N and S of Cape Falcon)	NF	Y	NF	NF	NF
	Amendment 7 (1986)	Coho (S of Cape Falcon)	NF	Y	NF	NF	NF
	Amendment 9 (1988)	Chinook and coho (N of Cape Falcon)	NF	Y	Y	Y	NF

Table 10 continued. Commercial and recreational allocation analyses.

Fisheries Management Plan	Regulation	Fishery	Analysis included as a separate document	Analysis of all alternatives	Quantitative analysis performed	Explicit use of analysis in decision	Poor data availability cited as reason for incomplete analysis
South Atlantic Fishery Management Council							
Dolphin and wahoo	FMP (2004)	Dolphin and wahoo	NF	NF	NF	NF	NF
South Atlantic region snapper-grouper fishery	Amendment 13C (2006)	Black seabass	Y	Y	Y	NF	Y
	Amendment 15B (2009)	Red porgy and snowy grouper	Y	Y	Y	NF	Y
	Amendment 16 (2009)	Gag grouper and vermillion snapper	Y	Y	Y	NF	Y
	Amendment 17B (2010)	Combined red, black, gag grouper, and golden tilefish	Y	Y	Y	NF	Y

[a] NF = not found.
[b] Y = yes.
[c] Council removed the actions that addressed allocations for greater amberjack and gray triggerfish.

Table 11. FMP management objectives that reference commercial or recreational sectors, efficiency, or fairness.

FMP	Management objectives
Gulf of Mexico Fishery Management Council	
Gulf of Mexico reef fish resources (GMFMC 2004)	Management Objective (FMP/amendment) 4. Minimize conflicts between user groups of the resource and conflicts for space (original FMP). 6. Reduce user conflicts and nearshore fishing mortality (modified Objective 4) (Amendment 1). 11. Maximize net economic benefits from the reef fish fishery (Amendment 1). 15. Optimize net benefits to the fishery (modified Objective 11) (Amendment 8).
Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council	
Coastal migratory pelagic resources of the Gulf of Mexico and south Atlantic (GMFMC 1992)	The current FMP through Amendment 5 lists 7 plan objectives: 4. Minimize gear and user group conflicts. 5. Distribute the TAC of Atlantic migratory group Spanish mackerel between recreational and commercial user groups based on the catches that occurred during the early to mid 1970s, which is prior to the development of the deep water run-around gill net fishery and when the resource was not overfished. 8. Optimize social and economic benefits of the coastal migratory pelagic fisheries.
Mid-Atlantic Fishery Management Council	
Atlantic mackerel, squid, and butterfish fisheries (MAFMC 2010)	2. Promote growth of the U.S. commercial fishery, including the fishery for export. 4. Provide marine recreational fishing opportunities, recognizing the contribution of recreational fishing to the national economy. 6. Minimize harvesting conflicts among U.S. commercial, U.S. recreational, and foreign fishermen.
New England Fishery Management Council	
Northeast multi-species fishery (Amendment 16) (NEFMC 2009)	Goal 2: Create a management system so that fleet capacity will be commensurate with resource status so as to achieve goals of economic efficiency and biological conservation and that encourages diversity within the fishery. Goal 3: Maintain a directed commercial and recreational fishery for northeast multispecies. Goal 5: Provide reasonable and regulated access to the groundfish species covered in this plan to all members of the U.S. public for seafood consumption and recreational purposes during the stock rebuilding period without compromising the Amendment 13 objectives or timetable. If necessary, management measures could be modified in the future to insure that the overall plan objectives are met.
NMFS Highly Migratory Species Division	
Atlantic highly migratory species (NMFS 1999)	Consistent with other objectives of this FMP, manage Atlantic HMS fisheries for continuing optimum yield to provide the greatest overall benefit to the nation, particularly with respect to food production, preserving traditional fisheries, providing recreational opportunities, and taking into account marine ecosystem protection.
Pacific Fishery Management Council	
Pacific coast groundfish (PFMC 2008)	Goal 2: Economics. Maximize the value of the groundfish resource as a whole. Objective 6. Within the constraints of the conservation goals and objectives of the FMP, attempt to achieve the greatest possible net economic benefit to the nation from the managed fisheries. Objective 12. When conservation actions are necessary to protect a stock or stock assemblage, attempt to develop management resources that will affect users equitably.

Table 11 continued. FMP management objectives that reference commercial or recreational sectors, efficiency, or fairness.

FMP	Management objectives
Pacific Fishery Management Council (continued)	
West Coast salmon (PFMC 2003)	1. Establish ocean exploitation rates for commercial and recreational salmon fisheries that are consistent with requirements for stock conservation objectives within Section 3.1, specified ESA consultation or recovery standards, or council adopted rebuilding plans. 3. Seek to maintain ocean salmon fishing seasons which support the continuance of established recreational and commercial fisheries while meeting salmon harvest allocation objectives among ocean and inside recreational and commercial fisheries that are fair and equitable, and in which fishing interests shall equitably share the obligations of fulfilling any treaty or other legal requirements for harvest opportunities. Note: In its effort to maintain the continuance of established ocean fisheries, the council includes consideration of maintaining established fishing communities. In addition, a significant factor in the council's allocation objectives in Section 5.3 is aimed at preserving the economic viability of local ports or specific coastal communities (e.g., recreational port allocations north of Cape Falcon).
South Atlantic Fishery Management Council	
Dolphin and wahoo (SAFMC 2003)	The overall goal of the fishery management plan for the South Atlantic, Mid-Atlantic, and New England councils' areas of jurisdiction is to adopt a precautionary and risk-averse approach to management which in the first instance attempts to maintain the status quo. This will require that current catch levels not be exceeded and that recent conflict between sectors of the fishery (commercial longliners and recreational fishermen) be resolved. Status quo should reflect trends (average catch and effort levels) in the fishery over the last five years 1993 through 1997. Owing to the significant importance of the dolphin/wahoo fishery to the recreational fishing community in the Atlantic, the goal of this fishery management plan is to maintain the current harvest level of dolphin and insure that no new fisheries develop. With the potential for effort shifts in the historical longline fisheries for sharks, tunas, and swordfish, these shifts or expansions into nearshore coastal waters to target dolphin could compromise the current allocation of the dolphin resource between recreational and commercial user groups. Further, these shifts in effort in the commercial fishery, dependent on the magnitude (knowing that some dolphin trips may land more than 25,000 pounds in a single trip) could result in user conflict and localized depletion in abundance. Objectives identified by the councils and addressed by this fishery management plan are as follows: 3. Minimize conflict or competition between recreational and commercial user groups. If commercial longlining effort increases, either directing on dolphin and wahoo or targeting these species as a significant bycatch, conflict or competition may arise if effort shifts to areas traditionally used by recreational fishermen. 4. Optimize the social and economic benefits of the dolphin and wahoo fishery. Given the significant importance of dolphin and wahoo to the recreational sector throughout the range of these species and management unit, manage the resources to achieve optimum yield on a continuing basis.

5. Conclusions

Allocation decisions invoke considerations of both efficiency and fairness. While the effects of a decision can be documented in ways that inform each of these issues, the former is more easily analyzed in principle than the latter, at least in terms of widely accepted and formal frameworks. What is easy in principle is far more difficult in practice, however, as the data needed to analyze efficiency are extensive and costly to gather.

Still, even without the necessary data, the equimarginal principle, which is at the heart of an efficiency analysis, can provide some insights into establishing an efficient allocation and considering how that allocation might change in light of changing conditions in a fishery. Fairness is more difficult to analyze formally, of course, but the close connection between the distribution of policy effects and the fairness of a policy suggest some ways of gathering information that can inform an allocation decision on this issue as well. At the very least, assessing historical patterns of harvest can be viewed as one way of assessing the distributional effects of harvest restrictions and allocations.

As noted, this technical memorandum offers no recommendations regarding the practice of making an allocation decision under the MSA or analyzing such a decision. Instead, our discussion of the principles of efficiency and fairness, as well as the many other documents and articles that have similar discussions including those listed in Appendix D, Bibliography of Additional Sources, can be viewed as resources for future considerations of fishery harvest allocations. Similarly, the compilation of FMP allocations and analyses provides a useful documentation of past and current practices, which can provide a basis for assessing the desirability of any potential changes in these practices or the need for broader data gathering or research to support future decisions.

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Appendix A: The Formal Analysis of Allocative Efficiency

The problem of efficiently allocating a fixed amount of harvest, *H*, can be expressed as a constrained maximization problem. In this appendix, we explore this problem with a more formal framework than the one presented in the text. We first lay out the formal problem of allocating harvest. We then consider how the solution to this initial problem is affected by changes in the underlying conditions that produced that solution. Finally, we illustrate how an initial allocation that is inefficient affects the problem of efficiently allocating an increase in the allowable harvest.

The Efficient Allocation of Allowable Harvest

A decision maker allocates *H* with the objective of maximizing the social value, *V*(*H*), of the harvest. The allocation is across *n* possible harvesters, with h_i the amount allocated to the i^{th} harvester, and $V^i(h_i)$ the value placed on that amount by that harvester. We assume that $\partial V^i / \partial h_i > 0$ and $\partial^2 V^i / \partial h_i^2 < 0 \ \ \forall i$. Because we treat each harvester as equal, we have $V(H) = \sum_{i=1}^{n} V^i(h_i)$, where $\sum_{i=1}^{n} h_i = H$. (Alternatively, we could address the issue of fairness by assigning individual weights, w_i, to each harvester or including a measure of dispersion as a direct argument in the social value function.) The problem is then one of choosing an allocation, $\{h_i\}$, to maximize *V*(*H*).

Formally, the constrained maximization can be expressed thusly:

$$\max_{\{h_i\}} V(H) = \sum_{i=1}^{n} V^i(h_i) \quad s.t. \quad \sum_{i=1}^{n} h_i = H \tag{1}$$

This problem can be solved by using a Lagrange multiplier framework, standard for problems in microeconomics and mathematical optimization.[16] The Lagrangian, $\mathcal{L}$, for this problem is

$$\mathcal{L} = \sum_{i=1}^{n} V^i(h_i) + \lambda(H - \sum_{i=1}^{n} h_i) \tag{2}$$

where λ is the Lagrange multiplier associated with the harvest constraint in equation 1.

The solution to equation 1 is derived by solving the following system of equations, which constitute the first order conditions for a maximum:

[16] Silberberg and Suen (2001), p. 128−150, provide an introduction to the use of this framework in microeconomics.

$$\frac{\partial \mathcal{L}}{\partial h_i} = \frac{\partial V^i}{\partial h_i} - \lambda = 0 \quad \forall i \tag{3}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = H - \sum_{i=1}^{n} h_i = 0 \tag{4}$$

The sufficient second-order conditions for a maximum are met if the second derivatives of the Lagrangian satisfy certain conditions on their signs. In this case, the additively separable form of the value function, $V(H)$, and the assumption that $\partial^2 V^i / \partial h_i^2 < 0 \ \ \forall i$ assure that these conditions are met.

The system of equation 3 and equation 4 can be solved in principle to give the optimal harvest allocations, $\{h_i^*\}$. This allocation depends on factors that affect the individual harvest value functions as well as the total harvest, H. Thus the optimal individual allocations can be expressed as a function of these factors, or $h_i^* = h_i^*(\boldsymbol{\alpha}^i, H)$, where $\boldsymbol{\alpha}^i$ is a vector of factors that affect the i^{th} sector's harvest value, $V^i(h_i)$, or $V^i(h_i, \boldsymbol{\alpha}^i)$.

Equation 3 can be used to derive the equimarginal principle:

$$MV^i = \lambda = MV^j \quad \forall i, j \tag{5}$$

where $MV^i = \partial V^i / \partial h_i$. This corresponds to the condition described above, where the efficient allocation equates the marginal value of harvest across all sectors.

Changes in the Efficient Allocation

We can use this framework to illustrate how a reallocation of harvest can be analyzed should the circumstances that supported the original (efficient) allocation change. First, consider a factor, $\alpha_j^i \in \boldsymbol{\alpha}^i$, that affects an individual's value function, where we assume that $\partial V^i / \partial \alpha_j^i > 0$, $\partial MV^i / \partial \alpha_j^i > 0$, and $\partial MV^k / \partial \alpha_j^i = 0 \ \ \forall k \neq i$ (the last assumption is that α_j^i affects the value of the i^{th} individual harvester only. It is then straightforward to show that

$$\frac{\partial h_i^*}{\partial \alpha_j^i} > 0 \tag{6}$$

$$\frac{\partial h_k^*}{\partial \alpha_j^i} < 0 \quad \forall k \neq i \tag{7}$$

Because H is fixed, this translates into a larger percentage share for sector i and a smaller percentage share for other sectors.

Similarly, it can be shown that

$$\frac{\partial h_i^*}{\partial H} > 0 \quad \forall i \tag{8}$$

$$\frac{\partial \lambda^*}{\partial H} < 0 \tag{9}$$

This implies that an increase in the allowable harvest should be allocated to all sectors (assuming the initial allocation was efficient). To see how individual shares of the allowable harvest change in percentage terms, substitute h_i* and λ* into equation 3 and rearrange to get the identity

$$MV^i\left(h_i^*(H)\right) \equiv \lambda^*(H) \tag{10}$$

Now differentiate both sides with respect to *H* and rearrange to get

$$\frac{\partial h_i^*}{\partial H} = \frac{\partial \lambda^* / \partial H}{\partial MV^i / \partial h_i} \tag{11}$$

Note that $\partial h_i^* / \partial H$, or the rate at which the additional harvest allocated to sector *i* changes with respect to a change in *H*, is negatively related to $\left|\partial MV^i / \partial h_i\right|$, or the absolute value of the slope of the marginal value curve for sector *i*.

Reallocation when the Initial Allocation is Inefficient

Finally, consider the case where an existing allocation was made in a way that produces a set of inefficient shares. If the allowable catch limit (ACL) is increased, say, as the result of a rebuilding effort, one approach would be to consider the allocation problem anew and simply create an efficient set of harvest allocations without regard to the previous set. This could result in a decreased allocation for some sectors, however, so we consider the case where the initial set of allocations acts as a constraint on the reallocation. In essence, we use a strict Pareto improvement standard in that we examine allocations of the additional ACL that make at least one sector better off and no sector worse off.

For this case, start with the initial ACL, H_0, and the initial (inefficient) allocation, $\{h_i^0\}$, where $\sum_{i=1}^{n} h_i^0 = H_0$. Now suppose an increase in allowable harvest is proposed from H_0 to H_1. How should this increase be distributed if efficiency is the goal but the strict Pareto improvement standard acts as a constraint? In such a case, the allocation problem becomes

$$\max_{\{h_i\}} V(H) = \sum_{i=1}^{n} V^i(h_i) \quad s.t. \quad \sum_{i=1}^{n} h_i = H_1 \quad \text{and} \quad h_i \geq h_i^0 \ \forall i \tag{12}$$

Because the initial allocation, $\{h_i^0\}$, was not efficient, the equimarginal principle, which is the condition for a maximum in equation 3, will not in general be met for initial allocation, so that

$$MV^i\left(h_i^0\right) \neq MV^j\left(h_j^0\right) \tag{13}$$

Assuming that such an equality does not exist by happenstance, the index of *n* sectors can be ordered by the marginal value of the sector's current allocation so that sector *1* has the highest *MV* and sector *n* has the lowest *MV*, or

$$MV^1\left(h_1^0\right) > MV^2\left(h_2^0\right) > \cdots > MV^{n-1}\left(h_{n-1}^0\right) > MV^n\left(h_n^0\right) \tag{14}$$

Note that this ordering provides a guide to a pattern of underallocation and overallocation of the initial ACL. For some *m* in the index set, we have

$$MV^1\left(h_1^0\right) > \cdots > MV^m\left(h_m^0\right) > \lambda^* > MV^{m+1}\left(h_{m+1}^0\right) > \cdots > MV^n\left(h_n^0\right) \tag{15}$$

where λ* is the value associated with the efficient allocation of H_0 from equation 5. Because $\partial MV^i / \partial h_i < 0$, this sequence implies that $h_j{}^0 < h_j{}^*$ (underallocation) for $j \leq m$, and $h_k{}^0 > h_k{}^*$ (overallocation) for $k > m$.

The order established in equation 15 also acts as a guide to the distribution of any increase in the ACL. The condition

$$MV^1\left(h_1^0\right) > MV^i\left(h_i^0\right), i > 1 \tag{16}$$

implies that it is efficient to allocate at least some of the additional ACL, ΔACL, to sector 1, and that it may be efficient to allocate all of ΔACL to that sector. To see this, consider what happens if all of ΔACL is given to sector 1. If the inequality in equation 16 still holds at $h_1 = h_1{}^0 +$ ΔACL, then that allocation is efficient.

For what levels of ΔACL is it efficient to allocate additional harvest to other sectors? Suppose $\Delta ACL = \Delta ACL_2$ is just large enough to make $MV^1(h_1{}^0 + \Delta ACL_2) = MV^2(h_2{}^0)$. Any $\Delta ACL \geq \Delta ACL_2$ means that some of the additional harvest should also be allocated to sector 2, otherwise $MV^1(h_1{}^0 + \Delta ACL)$ would fall below $MV^2(h_2{}^0)$ and transferring harvest from sector 1 to sector 2 would increase the value of the total harvest.

For $\Delta ACL \geq \Delta ACL_2$, then, the standard efficiency framework can be applied to these two sectors alone, in terms of allocating the additional harvest, ΔACL:

$$\max_{\Delta h_1, \Delta h_2} V = V_1(h_1^0 + \Delta h_1) + V_2(h_2^0 + \Delta h_2) \quad s.t. \quad \Delta ACL = \Delta h_1 + \Delta h_2 \tag{17}$$

Let $\{\Delta h_i^{(2)}\}$ be the solutions to this maximization problem, where the superscript "2" indicates that the maximization takes place over two sectors, and let $h_i^{(2)} = h_i{}^0 + \Delta h_i^{(2)}$ be the optimal total harvest allocation in each of the two sector that receives additional harvest.

As higher levels of ΔACL are considered, the pattern of expanding the set of sectors that receive additional harvest allocations can be derived inductively, following the order established in equation 15. Suppose $\Delta ACL = \Delta ACL_3$ is just large enough to make

$$MV^1(h_1^0 + \Delta h_1^{(2)}(\Delta ACL_3)) = MV^2(h_2^0 + \Delta h_2^{(2)}(\Delta ACL_3)) = MV^3(h_3^0) \quad (18)$$

For $\Delta ACL \geq \Delta ACL_3$, some of the additional ACL should then also go to sector 3, and the maximization problem in equation 17 expands to cover the third sector.

Eventually, as higher levels of the additional allowable harvest are considered, the maximization problem will eventually encompass all *n* sectors. Let $\Delta ACL = \Delta ACL_n$ be the additional harvest needed to achieve the following set of equalities:

$$MV^1(h_1^0 + \Delta h_1^{(n-1)}(\Delta ACL_n)) = \cdots = MV^{n-1}(h_{n-1}^0 + \Delta h_{n-1}^{(n-1)}(\Delta ACL_n)) = MV^n(h_n^0) \quad (19)$$

Then for $\Delta ACL \geq \Delta ACL_n$, all *n* sectors receive at least some of the additional harvest. This is because the initial set of allocations no longer constrains the choice of an efficient allocation for the new, total ACL. In that case, the efficient set of allocations is identical to that produced by solving equation 3 and equation 4 without any initial allocation constraints.

Figure A-1 through Figure A-4 present an example for the simple case of two sectors. Initially, the ACL = 250, which is distributed equally across Sector A and Sector B (Figure A-1). This equal allocation is inefficient because $MV^B(125) > MV^A(125)$, so Sector B has an underallocation and Sector A has an overallocation. Now suppose a rebuilding effort enables the ACL to be increased by 25 units. If the initial allocations are treated as a constraint, allocating all of the additional 25 units to Sector B is the most efficient action, because $MV^B(150) > MV^A(125)$ (Figure A-2). If ΔACL is at least 75 units, then it becomes efficient to allocate some of the additional harvest to both sectors because $MV^B(125 + 75) = MV^A(125)$, thus using the terminology above, $\Delta ACL_2 = 75$ (Figure A-3). If ΔACL is deemed higher than 75 units, both sectors receive a share and the new allocation will satisfy the equimarginal principle (Figure A-4).

In the case of an initial (inefficient) allocation that acts as a constraint, then the allocation of an increase in the ACL can vary dramatically from the allocation that occurs when it takes place de novo (Table A-1). If the initial ACL of 250 units had been allocated efficiently, the allocation ratio would be 30%:70%. For higher levels of the ACL, the ratio would continuously shift in favor of Sector A because MV^A falls less rapidly than MV^B, reaching 41%:59% for an ACL of 350 units. If the initial ACL had been allocated equally (and inefficiently) and this distribution was deemed a constraint on future allocations, the allocation ratio would move in the opposite direction. From an initial allocation of 50%:50%, Sector B would receive 100% of any increase in the ACL, pushing the ratio to 45%:55% for an ACL of 275 and 42%:58% for an ACL of 300. At an ACL of 325, allocating 100% of the increase to Sector B would in fact achieve an overall efficient allocation of 38%:52% (Table A-1). Beyond this point, the allocation of the increase in the ACL returns to the pattern established by the overall efficient allocation, and Sector A would receive higher shares (Table A-1).

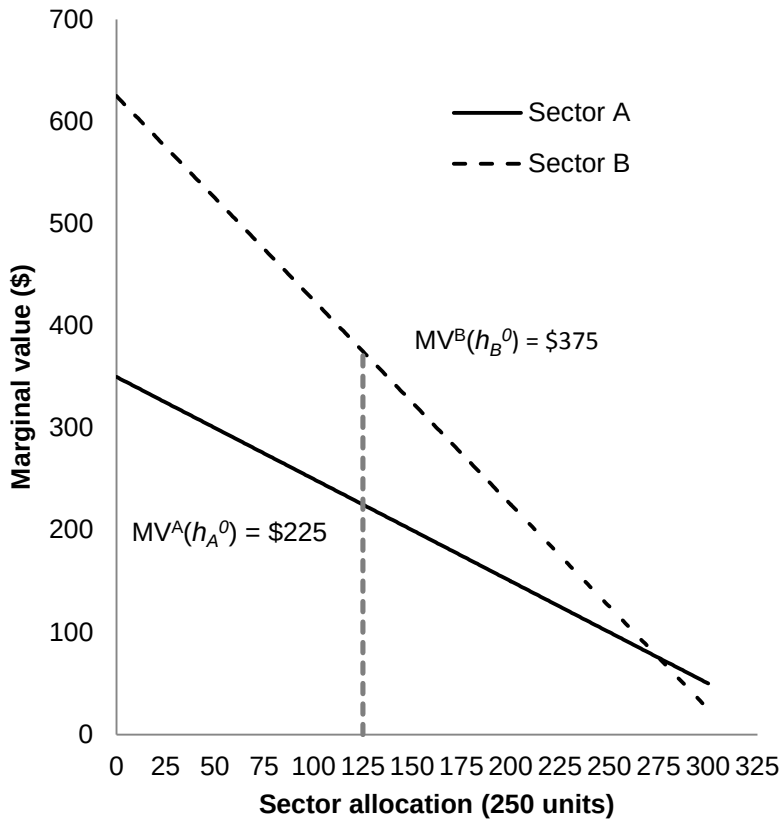

Figure A-1. If an ACL is allocated without regard to efficiency, the marginal value of harvest across sectors will likely not be equal. If an ACL is allocated equally across these two sectors, the marginal value of Sector B's harvest is higher than the marginal value of Sector A's harvest.

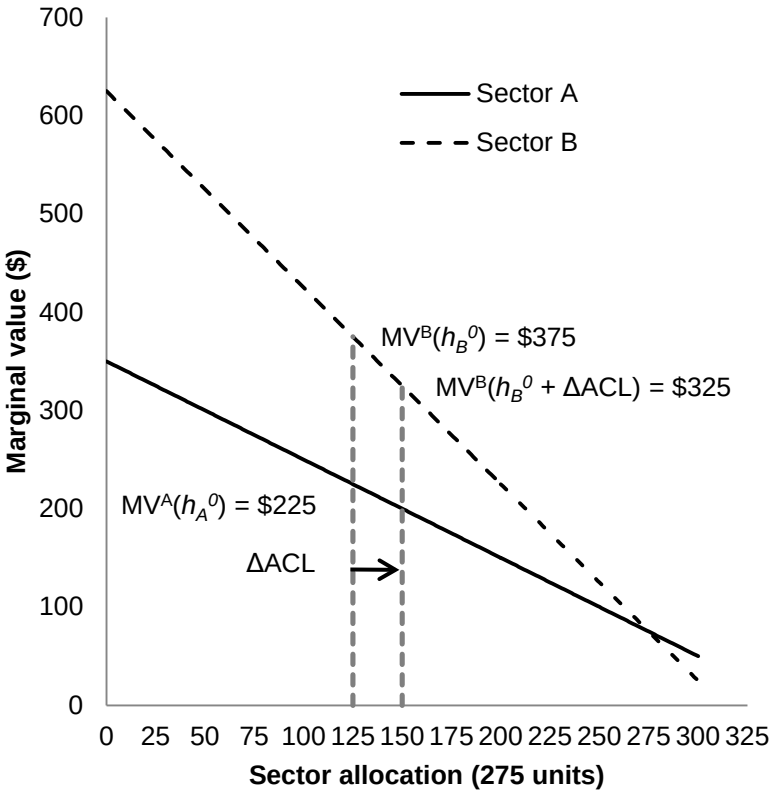

Figure A-2. If the initial allocations act as a constraint on efficient allocations of any increase in the ACL, these additional allocations may involve granting 100% of the increase to one sector. In this case, an increase of 25 units is allocated solely to Sector B because that sector's marginal value of harvest is higher than Sector A's even after the new allocation.

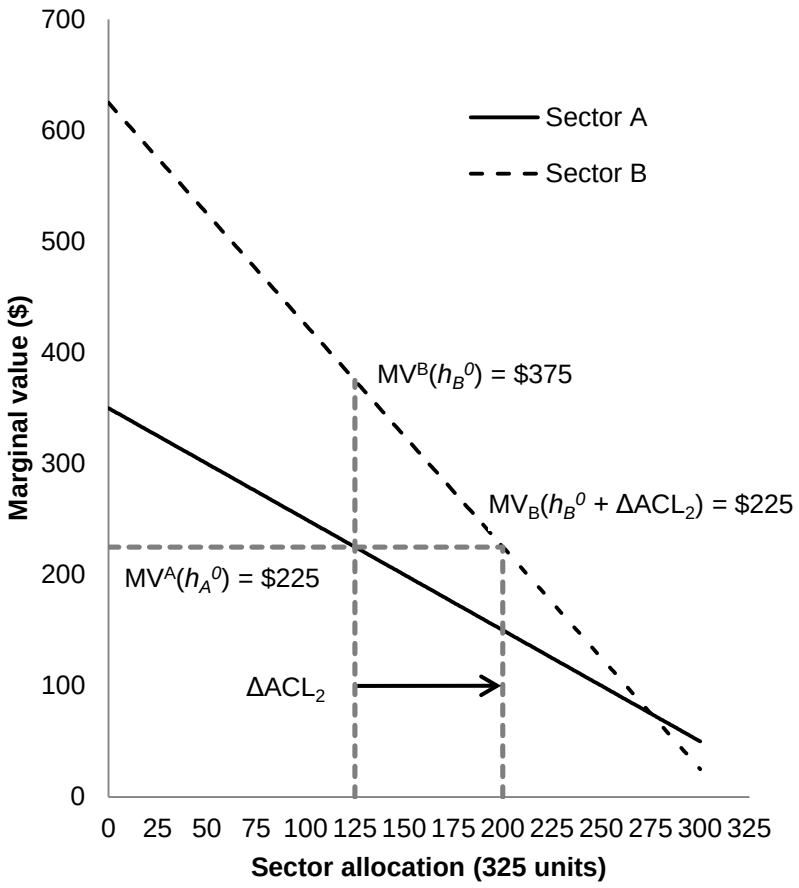

Figure A-3. If the additional allocation is as high as 75 units, the marginal value of harvest for Sector B will fall to a level that is just equal to the marginal value of Sector A's harvest. Granting 100% of this increase will produce an allocation that is efficient, in that it satisfies the equimarginal principle.

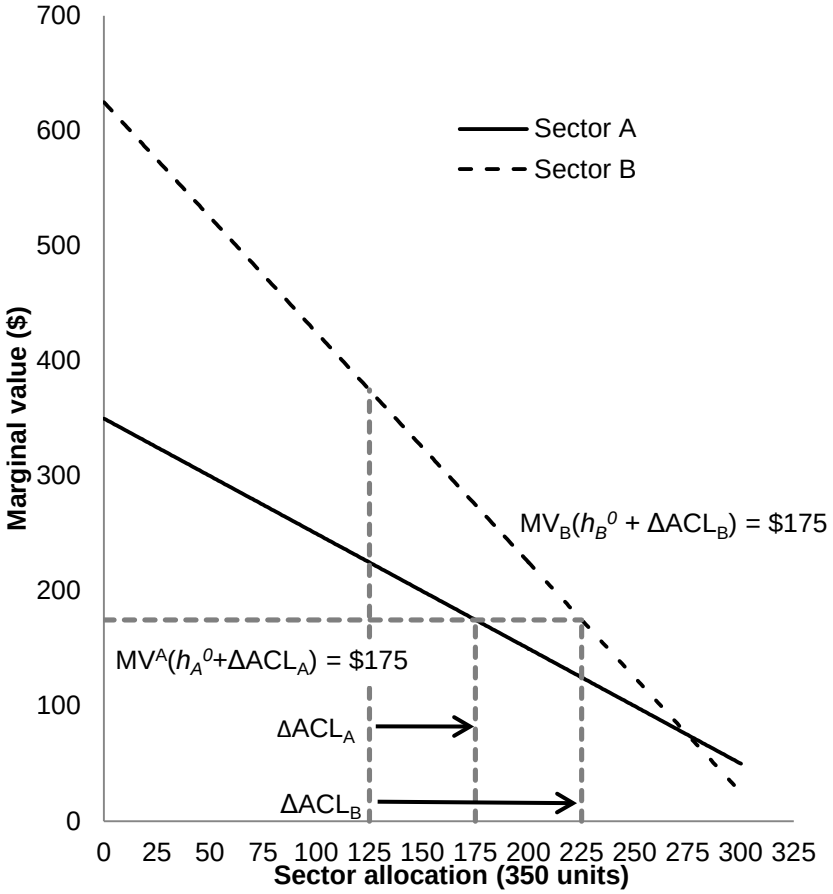

Figure A-4. Increases in the ACL above 75 units produce sufficient additional units to enable both sectors to receive increases in their allocation and achieve an efficient overall allocation.

Table A-1. Efficient and constrained allocations of ACL.

	Efficient allocation (units)		**Constrained allocation (units)**	
ACL	**Sector A**	**Sector B**	**Sector A**	**Sector B**
250	75	175	125	125
275	92	183	125	150
300	108	192	125	175
325	125	200	125	200
350	142	208	142	208
	Efficient allocation (% share)		**Constrained allocation (% share)**	
ACL	**Sector A**	**Sector B**	**Sector A**	**Sector B**
250	30	70	50	50
275	33	67	45	55
300	36	64	42	58
325	38	62	38	62
350	41	59	41	59

Appendix B: Analyses in Support of Allocation Decisions (Excerpts)

In this appendix, we present examples of how fishery management councils have analyzed the allocations described in subsection 4.1, FMP Allocations Among Commercial and Recreational Fisheries. These analyses are typically contained within the official documents supporting the fishery management plan (FMP) amendment or other regulatory action, rather than presented as a stand-alone document. The purpose of these excerpts is to provide examples of the types of approaches taken by the councils. We do not include all of the allocation decisions covered in subsection 4.2, Analysis of FMP Allocations (Examples), instead including what we think is a representative sample.

Gulf of Mexico Fishery Management Council

Reef Fish Resources of the Gulf of Mexico, Amendment 1 (1990): greater amberjack (*Seriola dumerili*), gray snapper (*Lutjanus griseus*), groupers in aggregate, goliath grouper fka jewfish (*Epinephelus itajara*), lane snapper (*Lutjanus synagris*), mutton snapper (*L. analis*), red snapper (*L. campechanus*), sea basses, snappers in aggregate, vermilion snapper (*Rhomboplites aurorubens*), yellowtail snapper (*Ocyurus chrysurus*).

This amendment created allocations for several species based on the commercial and recreational catch during the period 1979–1987. There was no quantitative analysis of the alternatives considered. An excerpt follows.

> The proposed allocation based on the historical percentage harvested by each user group during 1979–1987 provides the best available basis for allocating reef resources because it represents the longest time period of documented commercial and recreational annual harvests. It is the goal of the council to allocate reef resources so that the net benefits to the nation are maximized. Therefore alternative allocation procedures will be regularly reviewed relative to the goal to maximize net benefits. Other allocation methods may be developed in subsequent years based on other periods or criteria, but since they may involve significant impacts on the respective user groups, the council intends that such allocation changes be made only by plan amendment, thus affording the fullest possible public review (GMFMC 1989, p. 227).

Reef Fish Resources of the Gulf of Mexico, Secretarial Amendment 1 (2004): red grouper (*Epinephelus morio*).

This amendment involved a reduction in the harvest level for red grouper, which was accomplished by applying an approximately equal percentage reduction to commercial and recreational allocations at their then current levels (81% commercial, 19% recreational). A

quantitative analysis of the total effects of the harvest reduction was provided (see excerpt below), but not of the marginal effects for the given allocation. Excerpts follow.

> The Proposed Commercial Scenario reduces the overall shallow water grouper commercial quota to account for the required reduction in the red grouper component of the overall quota. Additionally, the proposed quota reduction alternative is estimated to result in a 9.4% reduction in red grouper landings and 6% reduction in gag and black grouper landings, or 8.5% reduction in shallow water grouper landings. Based on 1999–2001 average landings, these percent reductions translate to reductions of 556,000 pounds or $1.33 million for red grouper only, 130,000 pounds or $312,000 for gag only, or 754,000 pounds or $1.8 million for the entire shallow water grouper fishery. Assuming the 1999–2001 average distribution of catches by gear type remains the same, longline vessels would bear approximately 90% of red grouper reductions and 83% of gag reductions, or 89% of all shallow water grouper reductions. Vertical line vessels would bear none of the red grouper reductions and 17% of the gag reductions, or 5.5% of all shallow water grouper reductions. Fish trap vessels would bear 10% of red grouper reductions and none of the gag reductions, or 5.5% of all shallow water grouper reductions.
>
> The Proposed Recreational Scenario reduces the allowable bag limit for red grouper to two fish of the five fish grouper aggregate and is expected to reduce recreational harvest by 9%. This alternative is specific to red grouper such that the reaction of anglers to potential reduction in red grouper harvest may not be in terms of outright trip cancellations. Anglers can switch to other species on a trip once the bag limit is met. In any event certain reductions in consumer surplus may arise from this management action, since angler flexibility is being constrained (GMFMC and NMFS 2004b).
>
> For the purpose of determining some general estimates on the magnitude of impacts of this scenario, it is assumed that the reduction in harvest due to the reduced bag limit is comparable to reductions in target trips. Considering, however, that trip cancellations are unlikely, the consumer surplus reduction under a bag limit change may be deemed less than that under closed seasons, even if the amount of harvest reduction happens to be the same. If a 9% reduction in red grouper harvest were to translate to the same percent reduction in red grouper target trips, losses in consumer surplus would amount to $2.2 million. This amount is likely to be an overestimate, since as shown in Table 6.14 a two fish red grouper bag limit would affect only 6,100 catch trips and catch trips generally exceed target trips as shown in Table 6.8. If the $213 per trip consumer surplus were applied to catch trips affected by the two fish bag limit for red grouper, consumer surplus loss would only amount to $1.3 million. A comparable reduction in for-hire vessel revenues cannot be estimated for the reason that the bag limit change may not result in trip cancellations. Anglers may lose some benefits from the bag limit change but are still likely to take charter or headboat trips (GMFMC and NMFS 2004b, p. 70).

Reef Fish Resources of the Gulf of Mexico, Amendment 30B (2009): gag grouper (*Mycteroperca microlepis*), red grouper.

This amendment established an interim allocation based on commercial and recreational catch over the period 1986–2005. The council created a committee to examine future allocation issues. A quantitative analysis of the alternatives was conducted for the commercial and recreational sectors. This analysis utilized a simulation model for the commercial sector and estimates of economic values for the recreational sector. Excerpts follow.

> The aggregate economic value associated with each alternative is determined by summing estimated commercial and recreational economic values. For the commercial sector, the economic value corresponding to each alternative was derived based on a simulation model developed by Waters. The simulation model is detailed in subsection 5.3.3.1.
>
> For the recreational sector, the economic value corresponding to each alternative is derived by summing its constituting components, that is, the producer surplus derived by charter operators, the producer surplus enjoyed by headboat operators, and consumer surpluses derived by anglers on headboats, private, and charter vessels. It is assumed that changes in total allowable catch (TAC) do not affect the relative proportion harvested by each subsector. In other terms, when expressed in percentage points, harvest levels for anglers on headboats, private, and charter vessels remain constant, regardless of the recreational TAC. Based on a 2001–2005 average, private anglers, anglers on charter vessels, and anglers on headboats harvested 73.2 percent, 24.3 percent, and 2.5 percent of the red grouper recreational quota, respectively. Relative proportions of gag grouper harvested in the recreational sector by private anglers, anglers on charter vessels, and anglers on headboats are estimated at 74.3 percent, 22.5 percent, and 3.2 percent, respectively (GMFMC and NMFS 2008b, p. 230).
>
> The evaluation of economic impacts expected to result from recreational management measures considered in this amendment relies on computed changes in economic values. Changes in economic values resulting from recreational management measures are composed of producer surplus changes affecting charter boat and headboat operators, consumer surplus changes experienced by for-hire consumers, and consumer surplus changes in the private recreational sector. Expected changes in consumer and producer surpluses were estimated based on methods and assumptions detailed in the evaluation of alternative gag and red grouper allocations (subsection 5.5.3.1). Therefore, the same limitations apply. However, it is worth reemphasizing that these estimated changes in economic value are approximations for the welfare changes expected to result from management alternatives considered. These estimates are exclusively presented for the purpose of ranking the management alternatives under consideration (GMFMC and NMFS 2008b, p. 272).
>
> It should be noted that this analytical approach may overestimate or underestimate actual impacts. The analysis relies on actual historic trip records. Models of how fishing behavior might change in response to increased restrictions for individual species are not available for shallow water grouper or other gulf species. As a

result, while changes in grouper harvests and revenues on historic trips can be examined to identify which trips would remain profitable, it is not currently possible to identify how fishing behavior might change, targeting substitute species in order to maintain revenues. In essence, the current model can only eliminate trips, or allow them to occur with decreased revenues, but neither more trips nor trips with substituted revenues can be modeled at this time. The model can also underestimate impacts if observed fishing activities reflect more restrictive regulations than what are proposed. For example, the quota for red grouper was filled and the fishery closed during the latter months of 2004 and 2005. Observed trips during the closure would not have recorded landings of red grouper, and there may have been fewer recorded trips than if the red grouper fishery were open. Therefore, the full benefits of a proposed larger quota would not be calculated in the model because there would not be observed trips to harvest the larger quota during these months. Since this limitation applies to all of the management measures on the commercial sector, it is not expected to affect ranking of the alternatives. Caution is necessary, however, if an attempt is made to compare these values with those generated for the recreational sector.

For each management alternative considered including the baseline, discounted net operating revenues were calculated and summed over the policy period. For purposes of economic analysis, policy period is defined as the years 2008–2013. Most provisions in this amendment consider this timeframe as the period during which management measures affecting harvest and participation would apply. Those measures could last longer or shorter depending on future council decisions, but for this amendment the years 2008–2013 compose the relevant period. The model used logbook records, including the economic add-on survey, supplemented by ALS ex-vessel price information and Bureau of Labor Statistics data on price indices. The baseline scenario refers to the model run using the no action alternative for all actions in this amendment (GMFMC and NMFS 2008b, p. 215).

Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council

Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic, Amendment 2 (1987): Spanish mackerel (*Scomberomorus maculatus*)/Atlantic group; Spanish mackerel/Gulf group.

This amendment created an allocation based on the commercial and recreational catch during the period 1979–1985. There was no quantitative analysis of the economic effects of the alternatives. Excerpts follow.

Allocation of TAC within each migratory group of Spanish mackerel is to be divided between commercial and recreational fishermen based on the average ratio of the catch for the period 1979−1985.

This allocation uses the average ratio of catches from 1979–1985, the most recent period for which comparable catch statistics are available, to allocate the TACs

(set in Action 2) between recreational and commercial fishermen. The decrease in TAC to restore the fishery requires a limitation of catch. In order to distribute the catch fairly, allocations are made for recreational and commercial users.

The allocations are to be revised with TAC adjustments using fixed ratios to assure that each group receives its fair share. The present value of the commercial fishery under this action is $29.45 million using an ex-vessel price of $0.30 per pound as a proxy for average value and a discount rate of 10%. This compares favorably with the present value of $18.6 million for the unregulated fishery (GMFMC and SAFMC 1987, p. 14).

Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic, Amendment 4 (1989): Spanish mackerel/Atlantic group.

This amendment revised the previous allocation based on more recent commercial and recreational catch data. There was no quantitative analysis of the economic effects of the alternatives due to the absence of readily available economic data. Excerpts follow.

The councils know of no economic data readily available with which to quantitatively evaluate the benefits and costs of the proposed change in allocation. Recent work on the Gulf of Mexico king mackerel fishery provides information on the impacts of increased catches and changes to bag limits for Gulf king mackerel, and more importantly develops a methodology which can now be used to conduct the same type of analyses for Gulf and Atlantic migratory groups of Spanish mackerel and Atlantic migratory group king mackerel. The councils strongly recommend that these analyses be conducted by the National Marine Fisheries Services … information as soon as it is available which will greatly assist in the determining the impacts of our regulations (GMFMC and SAFMC 1989, p. 9).

An economic assessment of the king and Spanish mackerel fisheries was prepared in March 1987 by NMFS. While this document presents some general economic information about Spanish mackerel it does not provide an analysis of the impacts of quota and bag limits. The councils strongly recommend that these analyses be redone by the NMFS Southeast Region economists as soon as possible. The councils will of course make use of this information as soon as it is available, which will greatly assist in the determining the impacts of our regulations.

On the recreational side, the methodology to analyze benefits from doubling their allocation has been developed but work in this area has not been conducted (GMFMC and SAFMC 1989, p. 11).

The councils concluded that the 50/50 allocation results in benefits greater than costs and maximizes the net socioeconomic benefits available from the Atlantic migratory group Spanish mackerel resource (GMFMC and SAFMC 1989, p. 8).

Mid-Atlantic Fishery Management Council

Atlantic Bluefish, Amendment 1 (2000): bluefish (*Pomatomus saltatrix*).

This amendment established a de facto allocation by limiting the commercial catch to 20% of the allowable harvest, a figure based on harvest data during the period 1981–1989. No quantitative analysis of the economic effects of the allocation was conducted. An excerpt follows.

> The base period, 1981 to 1989, was chosen by the council and commission as the preferred allocation period because it represents the years prior to the regulations that may have affected recreational and commercial landings (i.e., prior to the approval of the Bluefish FMP in 1990). Given these considerations, the council and commission considered that this period would result in the most fair allocation of the resource (MAFMC 1998, p. 160).

New England Fishery Management Council

Northeast Multispecies Fishery, Amendment 16 (2010): Gulf of Maine cod (*Gadus morhua*); Gulf of Maine haddock (*Melanogrammus aeglefinus*).

This action established an allocation for two fisheries based on commercial and recreational catch data from the period 2001–2006. While no quantitative analysis was conducted, a qualitative assessment of the alternatives was presented. Excerpts follow.

> The Proposed Action would make an explicit allocation between commercial and recreational user groups for stocks where the allowable catch limit (ACL) was not fully harvested and where the recreational catches exceeded 5% of total catch. Based on available data these two criteria would be met for only GOM cod and for GOM haddock. The resulting ACL would depend on the selected years used to calculate commercial and recreational shares. The economic impacts of the proposed option are difficult to assess. For this reason, a qualitative assessment is offered below.
>
> The proposal to create a specific allocation of groundfish for the recreational and commercial components of the groundfish fishery may prove to constrain catches of each of those user groups. The economic impacts, when compared to No Action, depend in larger measure on which time period is used to determine the allocations. If the period used is FY 1996–2006, the share for the commercial component is larger than if the period used is FY 2001–2006. Obviously, the reverse is true for the recreational fishery. Choosing the longer period means that recreational fishing harvest will need to be reduced when compared to recent activity, resulting in a decline in benefits (both monetary and otherwise) for this component when compared to No Action.
>
> The economic impacts on the recreational groundfish fishery will depend on the likelihood that recreational catches will trigger accountability measures and on the nature of the accountability measures themselves. Given a set of management measures, the likelihood that an AM would be triggered would be lower the larger

the ACL. Thus economic benefits to the recreational fishery would be largest if the years selected for calculating the share are 2001–2006. These years would result in the largest recreational share which would also mean a higher ACL and a lower probability that accountability measures would be needed.

One advantage to choosing an allocation period—regardless which specific period is chosen—is that each component can be individually evaluated for compliance with catch limits. If a component exceeds its catch limit, appropriate measures can be introduced to control catch with less likelihood that the other component will also be subject to more restrictive measures. A disadvantage is that if a component does not catch its allocation, the only benefit is the contribution of the uncaught catch to rebuilding as there are no provisions to transfer the uncaught catch between components. This would be difficult in any case because of the delays in catch reporting for recreational fishermen (NEFMC 2010, p. 683).

South Atlantic Fishery Management Council

Dolphin and Wahoo FMP (2004): mahi mahi, fka dolphin (*Coryphaena hippurus*) and wahoo (*Acanthocybium solandri*).

The FMP created a de facto, nonbinding allocation by capping the commercial harvest at 13%, an allocation based on harvest data for the period 1994–1997. No quantitative analysis of the economic effects of the allocation was conducted. The council noted that maintaining the current allocation would have a "possible positive social impact" by reducing potential conflicts between the commercial and recreational sectors. An excerpt follows.

> Setting commercial and recreational sector allocations at levels that are reflective of historical landings will have no negative social impact on either the commercial or recreational participants. A possible positive social impact is that the potential conflict between the two sectors will be reduced, as this action does not change the status quo (SAFMC 2003, p. lxvi).

Snapper-Grouper Fishery of the South Atlantic Region, Amendment 15B (2009): red porgy (*Pagrus pagrus*), snowy grouper (*Epinephelus niveatus*).

This amendment established an allocation for two fisheries based on commercial and recreational catch for the periods 1986–2005 (snowy grouper) and 1999–2003 (red porgy). No quantitative analysis of the economic effects was conducted because data and other limitations were judged to make such an analysis unfeasible. The council operated under the assumption that "adverse effects are compounded the greater the deviation from the status quo" (SAFMC and NMFS 2008a, p. xxxviii). Excerpts follow.

> The alternative allocation ratios for snowy grouper were generated through the examination of sector harvests for different harvest years rather than an attempt to identify the allocation that maximized net benefits because application of the maximum benefit analysis is not possible at this time with available data. Because the alternatives are not the result of benefit maximization analyses, comparison of the alternatives is reduced to a simple benefit-cost analysis which,

since any reallocation to one sector occurs at the expense of the other, consists of comparing the costs to the sector receiving the reduced allocation with the benefits to the sector receiving the increased allocation. The benefits of a new allocation would consist of the increase in consumer surplus to recreational anglers or consumers of purchased fish and increased profits for the suppliers of recreational access (for-hire vessels, gear suppliers, etc.), and entities in the commercial sector production chain (commercial vessels, distributors, retailers, etc.) that accrue to the sector that receives an increased allocation. The costs of a new allocation would consist of the decrease in these variables to the sector that receives a decreased allocation.

Current economic models of the snapper-grouper fisheries, as used and discussed in Amendment 15A, produce estimates of consumer surplus to recreational anglers and net operating revenue (returns to owner and captain/labor) to for-hire and commercial vessels. Due to data deficiencies, however, these models generate estimates of the potential costs and benefits of reallocation that inadequately characterize the potential impacts. For the recreational sector, a demand curve for snowy grouper or appropriate similar species does not exist due to insufficient data. A demand curve demonstrates how the value of each subsequent fish or pound of fish harvested (or any product/service consumed/used by an individual) is reduced relative to the previous fish or pound. This is referred to as the concept of declining marginal value. Because a demand curve has not been estimated, a fixed value must be used, resulting in overestimation of the consumer surplus. In addition to the absence of a demand curve, insufficient information on angler behavioral change exists to accurately model how trip demand would change with changes in fish biomass. The model currently allows unfettered behavioral change by allowing effort to increase with increased catch rates or harvest quotas as biomass improves under the snowy grouper rebuilding plan. Operationally, allowing effort to increase in this manner functionally assumes the relationship "provide the fish and they will come." While such behavior is expected to be true to a point, effort expansion would not be expected to be continuous. Further, it is logical to expect that as catch rates and biomass increases, catch limits, specifically bag limits, would be increased such that some of the increased allowable harvest, and possibly a significant portion, would be harvested by base effort rather than new effort. Thus, while the value to base trips would still increase, resulting in increased benefits, due to improved fishing quality, the increase in value would not be as great as if these fish were harvested on new trips since new trips would generate increases in consumer surplus to anglers and producer surplus for for-hire operators and others in the recreational industry. Because the model assumes linear expansion of recreational effort, the estimates of changes in net recreational benefits overstate what is likely to occur.

Similar problems exist for the commercial sector. Theoretically, changes in consumer surplus also occur as product supply to the market changes. However, the commercial reef fish market is dominated by species substitution and imports, such that market prices for domestic harvests are generally assumed to remain unchanged with changing harvest quantities. If this assumption is not correct, an impact assessment would underestimate the costs of reduced commercial

allocation. Information on the profit situation for distributors and retailers of commercially caught fish is not currently available, so impacts of any reallocation on this sector cannot be quantified. Additionally, behavioral changes in the commercial sector cannot be modeled. The commercial model uses only the records of actual trips taken and does not allow fishermen to change fishing patterns (take more trips or target different species) in response to management changes or increased/decreased availability of catch. The model only allows a given trip to be taken, with historic, reduced, or increased harvests, or be cancelled entirely, with the loss of all harvests for that trip (as well as cancellation of associated trip costs). No new trips can be generated, however, nor can target behavior be shifted to increase the harvest of other species in response to greater restrictions on a given species. Absent the ability of adaptive behavior in the commercial sector, the quantitative results likely understate benefits and overstate losses.

In light of these issues, quantitative assessment of the expected impacts of the allocation alternatives has not been attempted. Qualitatively, it is difficult to identify the best allocation alternative. No alternative to the status quo would benefit one sector while having no impact on the other sector. In fact, since each alternative to the status quo would increase the recreational snowy grouper allocation at the expense of the commercial sector, in all instances the recreational sector would be expected to gain economic benefits while the commercial sector would lose benefits. If it is believed that adverse effects are compounded the greater the deviation from status quo, large changes in the allocation from the status quo would not be recommended. As such, Preferred Alternative 2 and Alternative 3 may be preferable to Alternative 4 since they would result in only marginal changes in the allocation, 1 and 3 percentage points, respectively, whereas Alternative 4 would impose an 8 percentage point change (8.33% total change) in the allocation. While none of the allocation alternatives to the status quo (96% commercial/4% recreational based on landings between 1999 and 2003) would be neutral to either sector, lower overall adverse social impacts to the affected sectors and associated industries and communities may be expected to accrue to those alternatives that result in the lowest allocation away any individual sector (SAFMC and NMFS 2008a, p. 4-2 to 4-4).

Snapper-Grouper Fishery of the South Atlantic Region, Amendment 16 (2009): gag grouper.

This amendment established an allocation to accommodate a reduction in catch, with the allocation based on commercial and recreational catch during the period 1999–2003. A quantitative analysis of the economic effects was conducted for the commercial and recreational sectors and for all alternatives, although the council noted that the set of alternatives did not necessarily contain the allocation that maximized net benefits. Excerpts follow.

These alternatives were generated through an examination of sector harvests for different harvest years rather than an attempt to identify the allocation that maximized net benefits, or in the present case minimized net losses, because

application of the maximum benefit analysis is not possible at this time with available data (SAFMC and NMFS 2008b, p. 4-21).

Estimates of economic effects on the commercial sector were derived using a simulation model developed by Waters. A more detailed description of the model can be found in Appendix H. Estimates of net operating revenues were generated by subtracting trip costs from total revenues. Trip costs were predicted based on gear specific cost functions. If trip revenues exceeded trip costs after accounting for the expected effects of proposed regulations on trip-level harvests, then short-term economic losses were measured as the resulting reduction in trip revenues. Conversely, if the combination of proposed alternatives would cause trip revenues to fall below trip costs, then the trip was recorded as not taken and losses were measured as a reduction in net operating revenues, which included the loss in revenues from all species minus the savings of trip costs not incurred (SAFMC and NMFS 2008b, p. 4-21 to 4-22).

In the absence of a recreational fishery model comparable to that for the commercial sector, estimates of economic impacts on the recreational sector were generated by measuring potential changes in producer and consumer surplus using available information. Some of this information was taken from other fisheries outside of the South Atlantic council's area of jurisdiction. The major parameters used in calculating producer surplus are for-hire net revenues per angler per trip to captain and crew of $150 for charter boats and $67 for headboats. These values are based on the for-hire survey conducted in the Gulf of Mexico. Another parameter used in calculating producer surplus is a keep elasticity of 1.46 that is taken to represent the percent change in target trip demand relative to the percent change in the keep rate. This value was generated by a study of the gulf red snapper fishery. For consumer surplus estimation, the major parameter used is the value of a one fish change in the harvest per target trip of $3.03. This value is based on a recreational demand study conducted for reef fish in the Southeast.

The focal point of estimating consumer and producer surpluses is the 2001–2006 average target trips for gag and other species. It should be pointed out at this stage that for the 2001–2006 period, target effort differed substantially from catch effort, as noted in the discussion of the affected environment. In fact, target effort for gag and other species registered at very low levels especially when taking into account area distribution. At any rate, target effort is used since it presents a more reasonable proxy for demand for gag trips than catch effort. Target effort was represented by target trips for gag and other species.

Producer surplus was proxied by the net operating revenue of for-hire vessels, or more specifically by the net revenue to captain and crew per individual passenger trip. The estimated value of one fish was used to calculate consumer surplus. To estimate a change in producer surplus, the projected percent change in catch rate was first translated into a percent change for target trip demand via the keep rate elasticity. The percent change in target trip demand was then applied to target trips to arrive at the change in target trips. This latter value was subsequently multiplied by the corresponding producer surplus for charter boat and headboat to arrive at the change in charter boat and headboat producer surplus. Estimating the

> change in consumer surplus followed a similar procedure except that the estimation proceeded in determining the change if demand for fish with the latter multiplied by consumer surplus per fish. To do this, catches in pounds were converted to catches in number of fish using the 2001–2006 gag average weight. For more details on the estimation of consumer and producer surplus, please see Appendix I (SAFMC and NMFS 2008b, p. 4-25).

Snapper-Grouper Fishery of the South Atlantic Region, Amendment 17B (2010): golden tilefish (*Lapholatilus chamaeleonticeps*).

This amendment established an allocation based on the average commercial and recreational catch during two periods, 1986–2008 and 2006–2008. An excerpt follows.

> The council concluded balancing long-term catch history with recent catch history is the most fair and equitable way to allocate golden tilefish. Specifying allocations for recreational and commercial sectors allows the council to meet the new Magnuson-Stevens Act requirements. The council also concluded the preferred alternative best meets the goals and objectives of the Snapper Grouper FMP as amended (SAFMC and NMFS 2010, p. 191).

Appendix C: Management Objectives for FMPs with Allocation Decisions

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), fishery management councils establish management objectives as part of the process of developing a fishery management plan (FMP). In establishing these objectives, a council is expected to balance the biological and human interests in the fishery, address the costs and benefits of management over time, and integrate the diversity of public and private interests. The council can then use the management objectives to judge management measures under consideration in light of the national standards listed in the MSA.

In Table C-1, we list all of the management objectives for the 11 FMPs that have allocation decisions discussed in this technical memorandum. The table provides a complete listing even though not all of the FMPs have objectives that relate directly to the issue of commercial-recreational allocation.

Table C-1. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Gulf of Mexico Fishery Management Council	
Reef fish resources of the Gulf of Mexico (GMFMC 2004)	Management objective (FMP/Amendment) 1. Rebuild the declining reef fish stocks wherever they occur within the fishery (original FMP November 1984). 2. Establish a fishery reporting system for monitoring the reef fish fishery (original FMP). 3. Conserve reef fish habitats and increase reef fish habitats in appropriate areas and provide protection for juveniles while protecting existing and new habitats (original FMP). 4. Minimize conflicts between user groups of the resource and conflicts for space (original FMP). 5. Stabilize long-term population levels of all reef fish species by establishing a certain survival rate of biomass into the stock of spawning age to achieve at least 20 percent spawning stock biomass per recruit* (Amendment 1 January, 1990. Identified as the primary objective of the Reef Fish FMP). 6. Reduce user conflicts and nearshore fishing mortality (modifies Objective 4) (Amendment 1). 7. Respecify the reporting requirements necessary to establish a database for monitoring the reef fish fishery and evaluating management actions (modifies Objective 2) (Amendment 1). 8. Revise the definitions of the fishery management unit and fishery to reflect the current species composition of the reef fish fishery (Amendment 1). 9. Revise the definition of optimum yield (OY) to allow specification at the species level (Amendment 1). 10. Encourage research on the effects of artificial reefs (Amendment 1).

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Reef fish resources of the Gulf of Mexico (GMFMC 2004) continued	11. Maximize net economic benefits from the reef fish fishery (Amendment 1). 12. Avoid to the extent practicable the derby type of fishing season (Amendment 8, July 1995). 13. Promote flexibility for the fishermen in their fishing operations (Amendment 8). 14. Provide for cost-effective and enforceable management of the fishery (Amendment 8). 15. Optimize net benefits to the fishery (modifies Objective 11) (Amendment 8).
Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council	
Coastal migratory pelagic resources of the Gulf of Mexico and south Atlantic (GMFMC 1992)	The current FMP through Amendment 5 lists 7 plan objectives: 1. The primary objective of this FMP is to stabilize yield at MSY, allow recovery of overfished populations, and maintain population levels sufficient to ensure adequate recruitment. 2. Provide a flexible management system for the resource which minimizes regulatory delay while retaining substantial council and public input in management decisions and which can rapidly adapt to changes in resource abundance, new scientific information, and changes in fishing patterns among user groups or by areas. 3. Provide necessary information for effective management and establish a mandatory reporting system for monitoring catch. 4. Minimize gear and user group conflicts. 5. Distribute the total allowable catch of Atlantic migratory group Spanish mackerel between recreational and commercial user groups based on the catches that occurred during the early to mid 1970s, which is prior to development of the deep water run-around gill net fishery and when the resource was not overfished. 6. Minimize waste and bycatch in the fishery. 7. Provide appropriate management to address specific migratory groups of king mackerel. 8. A new objective is proposed as follows: Optimize the social and economic benefits of the coastal migratory pelagic fisheries.
Mid-Atlantic Fishery Management Council	
Atlantic bluefish (MAFMC 1998)	The major goal of the management plan is to conserve the bluefish resource along the Atlantic coast. The council and commission have adopted five major objectives to achieve this goal: 1. Increase understanding of the stock and of the fishery. 2. Provide the highest availability of bluefish to U.S. fishermen while maintaining, within limits, traditional uses of bluefish. 3. Provide for cooperation among the coastal states, the various regional marine fishery management councils, and federal agencies involved along the coast to enhance the management of bluefish throughout its range. 4. Prevent recruitment overfishing. 5. Reduce waste in both the commercial and recreational fisheries.
Atlantic mackerel, squid, and butterfish fisheries (MAFMC 2009)	The objectives, as described in the FMP as currently amended, are listed below. The purposes of Amendment 11 described above (4.1) primarily serve FMP general management objectives/goals 3, 4, and 6. 1. Enhance the probability of successful (i.e., the historical average) recruitment to the fisheries.

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Atlantic mackerel, squid, and butterfish fisheries (MAFMC 2009) continued	2. Promote the growth of the U.S. commercial fishery, including the fishery for export. 3. Provide the greatest degree of freedom and flexibility to all harvesters of these resources consistent with the attainment of the other objectives of this FMP. 4. Provide marine recreational fishing opportunities, recognizing the contribution of recreational fishing to the national economy. 5. Increase understanding of the conditions of the stocks and fisheries. 6. Minimize harvesting conflicts among U.S. commercial, U.S. recreational, and foreign fishermen.
Summer flounder, scup, and black seabass fisheries (MAFMC 2007)	The objectives of the FMP are to: 1. Reduce fishing mortality in the summer flounder, scup, and black seabass fisheries to ensure that overfishing does not occur. 2. Reduce fishing mortality on immature summer flounder, scup, and black seabass to increase spawning stock biomass. 3. Improve the yield from the fishery. 4. Promote compatible management regulations between state and federal jurisdictions. 5. Promote uniform and effective enforcement of regulations. 6. Minimize regulations to achieve the management objectives stated above.
New England Fishery Management Council	
Northeast multi-species fishery (original FMP) (NEFMC 1985)	The objective of the Northeast Region Multi-species FMP is to control fishing mortality on juveniles (primarily) and on adults (secondarily) of selected finfish stocks within the management unit for the purpose of maintaining sufficient spawning potential so that year classes replace themselves in the stock on a long-term average basis; and to similarly reduce fishing mortality for the purpose of rebuilding those stocks where it has been demonstrated that the spawning potential of the stock is insufficient to maintain a viable fishery resource; and further to promote the collection of data and information on the nature, behavior and activity of the multi-species fishery, and on the effectiveness of the management program.
Northeast multi-species fishery (Amendment 16) (NEFMC 2010)	The goals and objectives of this amendment remain as described in Amendment 13: Goal 1: Consistent with the national standards and other required provisions of the Magnuson-Stevens Fishery Conservation and Management Act and other applicable law, manage the northeast multi-species complex at sustainable levels. Goal 2: Create a management system so that fleet capacity will be commensurate with resource status so as to achieve goals of economic efficiency and biological conservation and that encourages diversity within the fishery. Goal 3: Maintain a directed commercial and recreational fishery for northeast multispecies. Goal 4: Minimize, to the extent practicable, adverse impacts on fishing communities and shoreside infrastructure. Goal 5: Provide reasonable and regulated access to the groundfish species covered in this plan to all members of the public of the United States for seafood consumption and recreational purposes during the stock rebuilding period without compromising the Amendment 13 objectives or timetable. If necessary, management measures could be modified in the future to insure that the overall plan objectives are met.

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Northeast multi-species fishery (Amendment 16) (NEFMC 2010) continued	Goal 6: To promote stewardship within the fishery. Objective 1: Achieve, on a continuing basis, OY for the U.S. fishing industry. Objective 2: Clarify the status determination criteria (biological reference points and control rules) for groundfish stocks so they are consistent with the national standard guidelines and applicable law. Objective 3: Adopt fishery management measures that constrain fishing mortality to levels that are compliant with the U.S. Sustainable Fisheries Act. Objective 4: Implement rebuilding schedules for overfished stocks and prevent overfishing. Objective 5: Adopt measures as appropriate to support international transboundary management of resources. Objective 6: Promote research and improve the collection of information to better understand groundfish population dynamics, biology and ecology, and to improve assessment procedures in cooperation with the industry. Objective 7: To the extent possible, maintain a diverse groundfish fishery, including different gear types, vessel sizes, geographic locations, and levels of participation. Objective 8: Develop biological, economic and social measures of success for the groundfish fishery and resource that insure accountability in achieving fishery management objectives. Objective 9: Adopt measures consistent with the habitat provisions of the Magnuson-Stevens Act, including identification of essential fish habitat and minimizing impacts on habitat to the extent practicable. Objective 10: Identify and minimize bycatch, which include regulatory discards, to the extent practicable, and to the extent bycatch cannot be avoided, minimize the mortality of such bycatch.
NMFS Highly Migratory Species (HMS) Division	
Atlantic HMS (NMFS 1999)	The management objectives of the FMP for Atlantic HMS are described below. They apply to tuna, swordfish, and sharks. They are not listed in any particular order. • Prevent or end overfishing of Atlantic tuna, swordfish, and sharks and adopt the precautionary approach to fishery management. • Rebuild overfished fisheries in as short a time as possible and control all components of fishing mortality, both directed and incidental, so as to ensure the long-term sustainability of the stocks and promote stock recovery of the management unit to the level at which the maximum sustainable yield (MSY) can be supported on a continuing basis. • Minimize, to the extent practicable, economic displacement and other adverse impacts on fishing communities during the transition from overfished fisheries to healthy ones. • Minimize, to the extent practicable, bycatch of living marine resources and the mortality of such bycatch that cannot be avoided in the fisheries for Atlantic tuna, swordfish, and sharks. • Establish a foundation for international negotiation on conservation and management measures to rebuild overfished fisheries and to promote achievement of OY for these species throughout their range, both within and beyond the exclusive economic zone. OY is the MSY from the fishery, reduced by any relevant social, economic, or ecological factors.

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Atlantic HMS (NMFS 1999) continued	• Provide a framework, consistent with other applicable law, to take necessary action under International Commission for the Conservation of Atlantic Tunas compliance recommendations. • Provide the data necessary for assessing the fish stocks and managing the fisheries, including addressing inadequacies in current collection and ongoing collection of social, economic, and bycatch data about HMS fisheries. • Consistent with other objectives of this FMP, manage Atlantic HMS fisheries for continuing OY so as to provide the greatest overall benefit to the nation, particularly with respect to food production, providing recreational opportunities, preserving traditional fisheries, and taking into account the protection of marine ecosystems. • Better coordinate domestic conservation and management of the fisheries for Atlantic tuna, swordfish, sharks, and billfish, considering the multi-species nature of many HMS fisheries, overlapping regional and individual participation, international management concerns, historical fishing patterns and participation, and other relevant factors. • Simplify and streamline HMS management while actively seeking input from affected constituencies, the general public, and the HMS advisory panel. • Promote protection of areas identified as essential fish habitat for tuna, swordfish, and sharks. • Reduce latent effort and overcapitalization in HMS commercial fisheries. • Develop eligibility criteria for participation in the commercial shark and swordfish fisheries based on historical participation, including access for traditional swordfish handgear fishermen to participate fully as the stock recovers. • Create a management system to make fleet capacity commensurate with resource status so as to achieve the dual goals of economic efficiency and biological conservation.
Pacific Fishery Management Council	
Pacific coast groundfish (PFMC 2008)	Management goals Goal 1: Conservation. Prevent overfishing and rebuild overfished stocks by managing for appropriate harvest levels and prevent, to the extent practicable, any net loss of the habitat of living marine resources. Goal 2: Economics. Maximize the value of the groundfish resource as a whole. Goal 3: Utilization. Within the constraints of overfished species rebuilding requirements, achieve the maximum biological yield of the overall groundfish fishery, promote year-round availability of quality seafood to the consumer, and promote recreational fishing opportunities. To accomplish these management goals, a number of objectives will be considered and followed as closely as practicable: Conservation Objective 1. Maintain an information flow on the status of the fishery and the fishery resource which allows for informed management decisions as the fishery occurs.

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Pacific coast groundfish (PFMC 2008) continued	Objective 2. Adopt harvest specifications and management measures consistent with resource stewardship responsibilities for each groundfish species or species group. Achieve a level of harvest capacity in the fishery that is appropriate for a sustainable harvest and low discard rates, and which results in a fishery that is diverse, stable, and profitable. This reduced capacity should lead to more effective management for many other fishery problems. Objective 3. For species or species groups that are overfished, develop a plan to rebuild the stock as soon as possible, taking into account the status and biology of the stock, the needs of fishing communities, recommendations by international organizations in which the United States participates, and the interaction of the overfished stock within the marine ecosystem. Objective 4. Where conservation problems have been identified for non-groundfish species and the best scientific information shows that the groundfish fishery has a direct impact on the ability of that species to maintain its long-term reproductive health, the council may consider establishing management measures to control the impacts of groundfish fishing on those species. Management measures may be imposed on the groundfish fishery to reduce fishing mortality of a non-groundfish species for documented conservation reasons. The action will be designed to minimize disruption of the groundfish fishery, in so far as consistent with the goal to minimize the bycatch of non-groundfish species, and will not preclude achievement of a quota, harvest guideline, or allocation of groundfish, if any, unless such action is required by other applicable law. Objective 5. Describe and identify EFH, adverse impacts on EFH, and other actions to conserve and enhance EFH, and adopt management measures that minimize, to the extent practicable, adverse impacts from fishing on EFH. Economics Objective 6. Within the constraints of the conservation goals and objectives of the FMP, attempt to achieve the greatest possible net economic benefit to the nation from the managed fisheries. Objective 7. Identify those sectors of the groundfish fishery for which it is beneficial to promote year-round marketing opportunities and establish management policies that extend those sectors' fishing and marketing opportunities as long as practicable during the fishing year. Objective 8. Gear restrictions to minimize the necessity for other management measures will be used whenever practicable. Encourage development of practicable gear restrictions intended to reduce regulatory or economic discards through gear research regulated by exempted fishing permit. Utilization Objective 9. Develop management measures and policies that foster and encourage full utilization (harvesting and processing), in accordance with conservation goals, of the Pacific coast groundfish resources by domestic fisheries. Objective 10. Recognizing the multi-species nature of the fishery and establish a concept of managing by species and gear or by groups of interrelated species.

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Pacific coast groundfish (PFMC 2008) continued	Objective 11. Develop management programs that reduce regulations-induced discard or which reduce economic incentives to discard fish. Develop management measures that minimize bycatch to the extent practicable and, to the extent that bycatch cannot be avoided, minimize the mortality of such bycatch. Promote and support monitoring programs to improve estimates of total fishing-related mortality and bycatch, as well as those to improve other information necessary to determine the extent to which it is practicable to reduce bycatch and bycatch mortality. Social factors. Objective 12. When conservation actions are necessary to protect a stock or stock assemblage, attempt to develop management measures that will affect users equitably. Objective 13. Minimize gear conflicts among resource users. Objective 14. When considering alternative management measures to resolve an issue, choose the measure that best accomplishes the change with the least disruption of current domestic fishing practices, marketing procedures, and the environment. Objective 15. Avoid unnecessary adverse impacts on small entities. Objective 16. Consider the importance of groundfish resources to fishing communities, provide for the sustained participation of fishing communities, and minimize adverse economic impacts on fishing communities to the extent practicable. Objective 17. Promote the safety of human life at sea.
West Coast salmon (PFMC 2003)	Fishery objectives The following objectives guide the council in establishing fisheries against a framework of ecological, social, and economic considerations: 1. Establish ocean exploitation rates for commercial and recreational salmon fisheries that are consistent with requirements for stock conservation objectives within Section 3.1, specified U.S. Endangered Species Act consultation or recovery standards, or council adopted rebuilding plans. 2. Fulfill obligations to provide for Indian harvest opportunity as provided in treaties with the United States, as mandated by applicable decisions of the federal courts, and as specified in the October 4, 1993 opinion of the Solicitor, Department of Interior, with regard to federally recognized Indian fishing rights of Klamath River tribes. 3. Seek to maintain ocean salmon fishing seasons which support the continuance of established recreational and commercial fisheries while meeting salmon harvest allocation objectives among ocean and inside recreational and commercial fisheries that are fair and equitable, and in which fishing interests shall equitably share the obligations of fulfilling any treaty or other legal requirements for harvest opportunities. (Note: In its effort to maintain the continuance of established ocean fisheries, the council includes consideration of maintaining established fishing communities. In addition, a significant factor in the council's allocation objectives in Section 5.3 is aimed at preserving the economic viability of local ports or specific coastal communities (e.g., recreational port allocations north of Cape Falcon.)

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
West Coast salmon (PFMC 2003) continued	4. Minimize fishery mortalities for those fish not landed from all ocean salmon fisheries as consistent with OY and the bycatch management specifications of Section 3.4. 5. Manage and regulate fisheries so that the OY encompasses the quantity and value of food produced, the recreational value, and the social and economic values of the fisheries. 6. Develop fair and creative approaches to managing fishing effort and evaluate and apply effort management systems as appropriate to achieve these management objectives. 7. Support the enhancement of salmon stock abundance in conjunction with fishing effort management programs to facilitate economically viable and socially acceptable commercial, recreational, and tribal seasons. 8. Achieve long-term coordination with the member states of the council, Indian tribes with federally recognized fishing rights, Canada, the North Pacific Fishery Management Council, Alaska, and other management entities which are responsible for salmon habitat or production. Manage consistent with the Pacific Salmon Treaty and other international treaty obligations. 9. In recommending seasons, to the extent practicable, promote the safety of human life at sea. Conservation objectives: see Table 3-1 from document.
South Atlantic Fishery Management Council	
Dolphin and wahoo (SAFMC 2003)	The overall goal of the fishery management plan for the South Atlantic, Mid-Atlantic, and New England councils' areas of jurisdiction is to adopt a precautionary and risk-averse approach to management which in the first instance attempts to maintain the status quo. This will require that current catch levels not be exceeded and that recent conflict between sectors of the fishery (commercial longliners and recreational fishermen) be resolved. Status quo should reflect trends (average catch and effort levels) in the fishery over the last five years 1993 through 1997. Owing to the significant importance of the dolphin/wahoo fishery to the recreational fishing community in the Atlantic, the goal of this fishery management plan is to maintain the current harvest level of dolphin and insure that no new fisheries develop. With the potential for effort shifts in the historical longline fisheries for sharks, tunas, and swordfish, these shifts or expansions into nearshore coastal waters to target dolphin could compromise the current allocation of the dolphin resource between recreational and commercial user groups. Further, these shifts in effort in the commercial fishery, dependent on the magnitude (knowing that some dolphin trips may land over 25,000 pounds in a single trip), could result in user conflict and localized depletion in abundance. Objectives identified by the councils and addressed by this fishery management plan are as follows: 1. Address localized reduction in fish abundance. The Councils remain concerned over the potential shift of effort by longline vessels to traditional recreational fishing grounds and the resulting reduction in local availability if commercial harvest intensifies. 2. Minimize market disruption. Commercial markets (mainly local) may be disrupted if large quantities of dolphin are landed from intense commercial harvest or unregulated catch and landing by charter or other components of the recreational sector.

Table C-1 continued. Fisheries Management Plan (FMP) management objectives.

FMP	Management objectives
Dolphin and wahoo (SAFMC 2003) continued	3. Minimize conflict or competition between recreational and commercial user groups. If commercial longlining effort increases, either directing on dolphin and wahoo or targeting these species as a significant bycatch, conflict or competition may arise if effort shifts to areas traditionally used by recreational fishermen. 4. Optimize the social and economic benefits of the dolphin and wahoo fishery. Given the significant importance of dolphin and wahoo to the recreational sector throughout the range of these species and management unit, manage the resources to achieve OY on a continuing basis. 5. Reduce bycatch of the dolphin fishery. Bycatch is a problem in the pelagic longline fishery for highly migratory species. Any increase in overall effort, and more specifically shifts of effort into nearer shore, non-traditional fishing grounds by swordfish and tuna vessels, may result in increased bycatch of non-target species. In addition, National Standard 9 requires that: "Conservation and management measures shall, to the extent practicable, A) minimize bycatch and B) to the extent bycatch cannot be avoided, minimize the mortality of such bycatch." Therefore, bycatch of the directed dolphin fishery must be addressed. Appendix C (FSEIS for HMS Regulatory Amendment 1) contains data on dolphin-wahoo pelagic longline fishery analysis. The data presented on page C-66 and in Table C-4 indicate that pelagic longlines targeting dolphin do in fact result in a bycatch of HMS species. 6. Direct research to evaluate the role of dolphin and wahoo as predator and prey in the pelagic ecosystem. 7. Direct research to enhance collection of biological, habitat, social, and economic data on dolphin and wahoo stocks and fisheries.
South Atlantic region snapper-grouper fishery (SAFMC and NMFS 2008b)	The council's objectives for the snapper-grouper fishery are shown below. These were last updated in Snapper Grouper FMP Amendment 8 (SAFMC 1997). 1. Prevent overfishing. 2. Collect necessary data. 3. Promote orderly utilization of the resource. 4. Provide for a flexible management system. 5. Minimize habitat damage. 6. Promote public compliance and enforcement. 7. Mechanism to vest participants. 8. Promote stability and facilitate long-rub planning. 9. Create market-driven harvest pace and increase product continuity. 10. Minimize gear and area conflicts among fishermen. 11. Decrease incentives for overcapitalization. 12. Prevent continual dissipation of returns from fishing through open access. 13. Evaluate and minimize localized depletion.

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