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

Principles and Practice

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1 Introduction

Under the Magnuson-Stevens Fishery Conservation and Management Act (MSA), a fishing management plan 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 (50 CFR Ch. VI, §600.325(c)(1)). Allocation is at the heart of recent management actions such as the creation of catch shares (NOAA 2010c); the imposition of restrictions on certain types of gear (GMFMC and NMFS 2009); and the consideration of how harvest should be distributed between different sectors of a fishery (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 this last 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 a plan must meet. These standards, reviewed in more detail below, are focused on two general criteria: that the plan consider efficiency in making the allocation and that the allocation be 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 and equitable. Nevertheless, understanding the context in which fairness and equity are considered is important, and so this technical memorandum covers both criteria.

There is a substantial literature on the efficiency of allocation 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, Jr., and Prochaska (1987), Easley, Jr. (1992), and Green (1994).

The literature on fairness and equity (hereafter 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 the fairness of allocations (or distributions of fishing rights) is just as important as efficiency for the practical matter of making real world policy decisions. Similar views are expressed by Loomis and Ditton (1993) and Copes (1997). 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 1) efficiency and 2) 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 and equity but do not attempt to reduce the discussion to a similarly analytical framework.

The final part of the memorandum reviews the allocation decisions that have been made under the MSA for eleven fishery management plans (FMPs). We also review the types of socioeconomic analyses that have been undertaken to support these decisions.

2 Allocation and the Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA) seeks to conserve and manage the fishery resources in the coastal waters of the United States. The MSA established a system of Regional Fishery Management Councils, which were charged with preparing and implementing fishery management plans (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 sections of the MSA 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 fishing management plans (FMPs) under the MSA. National Standard 4 states the following:

> 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, including:

§303(a)(14), Contents of Fishery Management Plans, Required Provisions: "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(b)(6)(F), Contents of Fishery Management Plans, Discretionary Provisions: "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…"

§303A(c)(5)(A), Limited Access Privilege Programs, Requirements for Limited Access Privileges: "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…"

§304(e)(4)(B), Action by the Secretary, Rebuilding for Overfished Fisheries: "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…"

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

While not addressing allocation explicitly, other parts of the MSA touch upon the issue by specifying general requirements for FMPs. These include the following:

> §301(a)(5), National Standards for Fishery Conservation and Management, National Standard 5: "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)(8), National Standards for Fishery Conservation and Management, National Standard 8: "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."

Finally, the regulations implementing the MSA discuss at some length the allocation of fishing privileges in the context of Nation Standard 4 (§600.325, National Standard 4 - 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 and

equity of an allocation, the regulations state that the allocation should be "rationally connected" to the FMPs management objectives, including the achievement of the FMP's optimum yield (OY); 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 and equity 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, National Standard 5 – 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 both in the statute and the 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 conditions of open access, a fisheries harvest is not allocated in any direct or deliberate way. As is well known, 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).

In managed fisheries that impose a limit on harvest, the constraint on fishing creates a situation in which different allocations of the limit will affect the benefits capable of being produced by the fishery. In general, constraints on behavior (such as fishing) are meaningful if individuals subject to the constraint change their behavior when the constraint is relaxed. Such a (potential) change in behavior reveals the value placed on the activity, and so it gives insights into the value.

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, and so the act addressed the allocation of harvest between foreign and domestic harvesters (16 U.S.C. 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 and regions, and so on.

When limits on harvest are imposed on a fishery, then, a multitude of allocation decisions are made, even if the imposition merely uses historical data to create limits that mirror past behavior.

As noted in the previous section, the MSA identifies two criteria to be considered when crafting a management policy that allocates a fishery's harvest: efficiency and fairness. The first criterion 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. The second criterion is central to much public policy and management but is less commonly considered using a formal or quantitative approach. Our discussion below follows these practices, then, and as a result presents the efficiency criterion in greater detail than that of fairness and equity. This disparity does not reflect, however, the relative importance, in theory or practice, of the two criteria.

We begin with a brief discussion of how public policy and management decisions can be evaluated. This discussion provides the basis for separating the two criteria that are relevant for MSA allocation decisions. We then consider each criterion in turn. As noted above, the discussion of efficiency is considerably longer than the discussion of fairness.

3.1 Analyzing fisheries management decisions: a general framework

When promulgating a regulation under the MSA or other statutes, the federal government typically considers a number of alternatives. If the choice among them is not constrained in ways that make only one feasible, the government must address the policy question: Which alternative is the "best" one? A common approach to answering this question is to assess the benefits and costs that accrue to individual members of society, and then aggregate these individual effects to find the social benefits and costs. The "best" alternative is then the one that maximizes the difference between the two, or the net social benefits.

This simple approach includes an important, sometimes under-emphasized step: the aggregation of individual benefits and costs across members of society. This action inherently involves social judgments about the individuals, in the sense that any scheme of aggregation explicitly or implicitly assigns weights to individuals, if only to treat them all equally (Zerbe 2001). These two issues – what is the "best" policy choice, and how should the effects of that policy on any single individual be treated *vis a vis* the effects on other individuals – correspond to the issues of efficiency and fairness, respectively.

Economists have developed different ways of assessing the efficiency of a policy. A particularly stringent approach is known as *Pareto efficiency* (Pareto 1896). In general, a state is *Pareto efficient* if changing the state cannot benefit one or more individuals without harming one or more other individuals. A *Pareto improvement* is a change from a state that is not Pareto efficient to one that is, and is possible if the change makes no one worse off and makes at least one person better off. Referring to these conditions is one way that economists use to analyze social policies. Ideally, a policy that is judged to be socially desirable would be one that is a Pareto improvement.

In practice, however, it is rare that a policy can satisfy the Pareto improvement condition because the effects almost always produce a mixture of winners and losers. This doesn't mean that the status quo is socially preferable over a policy that fails to meet this condition, however. Satisfying the test of a Pareto improvement is often taken as a sufficient condition for identifying a socially preferable change, but it is not a necessary condition. If a policy generates winners and losers, it may be judged as preferable to the status quo if the benefits that accrue to the winners are somehow judged to be "greater" than the costs borne by the losers, in terms of

"social welfare." When a policy generates winners and losers, then, the question becomes how to assess those changes and judge the policy as better or worse from a social perspective.

To address this question, economists have developed what is called the *potential Pareto improvement* criterion, which asks whether the aggregate benefits of a change outweigh the aggregate costs. The important feature of this criterion is that there is no requirement that all individual effects be non-negative and at least one be positive. Instead, the potential Pareto improvement criterion aggregates individual benefits and costs, and requires that the aggregate net effect be positive, even if there are individual winners and losers.[1] Essentially, this criterion considers whether the beneficial fruits of a change could be (costlessly) redistributed in such a way that any loser would be fully compensated for the change while leaving at least one individual better off. The key feature is that the redistribution need not actually take place, and so a change can produce significant redistributions and still be judged an improvement as long as the aggregate effect is positive.

The potential Pareto improvement criterion is therefore one that focuses on efficiency, in the sense that it is capable of identifying policies that achieve the highest aggregate (unweighted) net benefits. Its development was an attempt to separate economic efficiency from the distribution of the benefits and costs of a policy, or the fairness of the policy (Zerbe 2001). This does not mean that the second criterion is irrelevant or less important, only that a policy that is efficient (in the sense of being a potential Pareto improvement) may or may not be a fair and equitable one. Thus, whether an efficient policy in this sense is a socially preferable one depends on an additional consideration of its distributional effects (Farrow 1998). In the next two subsections,

[1] This criterion is embedded in a more technical set of criteria known as the Kaldor-Hicks criteria (Kaldor 1939, Hicks 1939).

we examine these concepts in greater detail, with "efficiency" defined in terms of aggregate (unweighted) benefits and costs.

3.2 The efficiency of harvest allocations

Assessing the efficiency of a harvest allocation 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 based on these measurements is then simple in theory 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 a similar analysis for an actual fishery, taken from Carter *et al*. (2008).

3.2.1 Economic concepts of value

"Economic value" is based on the willingness of individuals to make trade-offs, and applies to both market and non-market settings. As noted in the Lipton *et al*. (1995), "[e]conomic 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)." Focusing on efficiency and adopting a stance of assessing the benefits and costs of a policy change still requires a metric common to both benefits and costs and across all individuals. The standard practice is to use a monetary metric, which is then a measure of an individual's willingness to "trade" other valuable goods for the effects of the policy change. The 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.

In the context of the allocation of a fishery's harvest, the concept of economic value is based on how various individuals or sectors value the harvest. The WTP of an individual harvester depends on the context of that harvest. Broadly speaking, for the commercial harvest sector, WTP is based on market factors such as the consumer demand for seafood; the cost of harvesting, processing, and marketing seafood; and so forth. An important complication 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 determine 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). 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 both in theory and in practice, as discussed later in this subsection.[2] For our purposes here, however, we compress all of the commercial stages from harvest to final retail sale into one, and so a "commercial harvester" represents the full set of commercial enterprises and their corresponding WTPs. The total economic value of harvest in the commercial sector is then the sum of the consumer WTP (or consumer surplus) and the harvesters' WTP (or, more generally, producer surplus).[3]

[2] See Just, Hueth, and Schmitz (2004) for an overview of the theoretical issues involved in measuring these values in a market setting.
[3] Lipton *et al*. (1995) and Edwards (1990) provide more extensive discussions of these concepts in the context of natural resources in general and fisheries in particular, respectively.

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. This case is complicated by the fact that commercial suppliers such as charter boats typically charge for a fishing trip, not by the quantity harvested (which is how allocation occurs). This complication can be overcome, however (see Carter and Liese, 2010), and so this type of recreational harvest can be included as part of a conceptual framework for assessing the efficiency of commercial-recreational harvest allocations. Finally, recreational fishing can take place in a non-market setting, in which case the fisherman is both 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 respect to variation in a trip's harvest amount, and so recreational fishing where there is 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.

3.2.2 Determining the efficiency of harvest allocation

In this section, we examine the question of what conditions make an allocation efficient. From the previous section, 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 re-allocation 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. This rate is the marginal economic value, or the difference in the total economic value for successive amounts of harvest. This assumption means that the marginal economic value is positive but decreasing as the harvest amount increases. Table 3.1 and Figure 1 illustrate these assumptions and form the basis for our numerical example. (Table 3.1 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 3.2 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.

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.

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 and then finding the allocation that equates that marginal

value across all sectors.[4] The particular solution or efficient set of allocations is dependent on the factors that underlie (in this example) 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.

Suppose, for example, Sector A consists of commercial harvesters and the ex-vessel price for commercial harvest increases. 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?[5]

[4] Appendix A treats the general case of efficient allocation of an ACL across *n* harvest sectors.
[5] 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

Suppose the ACL is adjusted upward by 100 units. Table 3.3 lists the increase in the total value for each sector using their current allocation and current total value as a baseline, and the 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 Tables 3.3 and 3.4 (bolded cells). One can also simply conduct the analysis of an efficient allocation *de novo*; Table 3.5 and Figure 6 illustrate the new efficient allocation for an ACL of 350 units.

3.2.3 An example of an analysis of allocation efficiency

In this section, 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 fishery, which is part of the Gulf of Mexico Reef Fish FMP,[6] 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 (GMFMC) implemented the Fishery Management Plan for the Reef Fish Resources (Reef Fish FMP) to protect and rebuild declining reef fish stocks. Through the late 1990s, the Reef Fish FMP was amended several times, including the establishment of quotas covering shallow-water groupers and deep-water groupers.[7] In October 2000, NOAA declared the red grouper resource to be overfished and

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allocation efficiency.

[6] Harvest of red grouper takes place in a multi-species fisheries.

[7] The shallow water grouper complex occurs primarily in the eastern Gulf of Mexico. Red, gag, black, scamp, yellowfin, yellowmouth, rock hind, and red hind grouper comprise the shallow-

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-tiered commercial shallow water grouper quota. Under the two-tiered 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.[8]

For red grouper, the Secretarial 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.

The issue of allocation has come to forefront recently for other fishery management actions considered by the GMFMC. 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

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water grouper complex. Their affinity for reef and hard bottom areas makes them susceptible to fixed gears such as longlines, vertical lines, and traps (Moe 1969; Bullock and Smith 1991). 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 dollars. Red grouper accounted for 65.8% of the landings and 60.2% of the revenues, and gag 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 the 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, yellowedge, speckled hind, warsaw, and misty grouper. The harvesting of Nassau and goliath grouper is banned.

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

stood in 2003. Given an overall TAC of 6.21M lbs., the problem they addressed was to identify the allocation that maximized the aggregate economic value of harvest. As illustrated in the previous section, 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:

- Red grouper is caught in a multi-species fishery, and so the data on fishing efforts covered a set of species, not just red grouper;
- Data on harvest costs were not available; and
- Data on non-harvest commercial sectors (processing, wholesale, etc.) were not available.

Using the data that were available, 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 the 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 re-allocation 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). Re-allocating some of the commercial harvest to the recreational sector would therefore increase the aggregate economic value and so improve efficiency.

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 0.168 MP, given the conditions that existed in 2003.

Caution should be used, however, in drawing conclusions from this example as presented above. The 95 percent 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).[9] 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.

3.2.4 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 typically cover specific species, retail and even wholesale markets for "seafood" may have characteristics that also allow them to be safely excluded from the analysis. Still, the data

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

required to analyze 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.
- If one makes an attempt to find efficient allocation, understanding how factors that underlie that determination change can provide some insights into the desirability and possibly direction of an efficient reallocation.
- 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).

3.3 Fairness and equity for harvest allocation decisions

As noted many times above, the consideration of the second allocation criterion, fairness and equity (fairness), 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 a formal, quantitative framework. It is straightforward, of course, 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. Nevertheless, it is worth recalling why the two criteria are so commonly distinguished in this way.

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 social (i.e., the aggregated, unweighted, individual) benefits? If the answer is Yes, the decision improves the efficiency of the fishery harvest.

In the context of public policy, fairness is part of the broader issue of *social welfare.* Defining this concept must grapple with the fact that dollar or income measures, which are the foundation of efficiency analysis, are not necessarily the same as utility or welfare measures. Two individuals can have the same income yet have different "utility"; or two individuals can attach the different changes in "utility" to the same change in income. Both of these statements require the interpersonal comparison of utility or welfare, which is a much stronger requirement for economic analysis than the usual assumption that utility functions need only be based on an ordinal measure of welfare (Silberberg and Suen 2001).

A social welfare function is a way of transforming a set of individual welfare measures into a social welfare ordering. Such an order gives meaning to the statement, for example, that one distribution of income is "better" (from a social perspective) than another (Boadway and Bruce, 1984). Fairness can be viewed as one element of social welfare. For example, one way of incorporating it into social welfare focuses on the distribution of income and disparities that exist in that distribution. Several measures that combine a measure of income levels (e.g., average income) with a measure of income dispersion (e.g., a Gini coefficient measure) are used as a cardinal measure of social welfare (Boadway and Bruce 1984). Another approach is to assign particular weights to individuals or groups of individuals, and then sum the weighted incomes to achieve a social value (Mishan and Quah 2007). Projects can then be evaluated in terms of how they change income levels (efficiency) and dispersion (fairness).

It is entirely possible, of course, for measures of efficiency and such measures of social welfare to rank projects differently. The most efficient allocation may be deemed unfair and inequitable, at least compared to a different (and feasible) allocation. The allocation that is more fair and equitable, however, will then be less efficient. It can even be the case that the second criterion allows for fairer and more equitable distributions that have lower net social benefits compared to the status quo (Freeman III 2003).

Unlike the theoretical framework for efficiency, however, there is no objective way of assessing social welfare because its definition provides no quantitative framework for its analysis. Creating an explicit social welfare function, which would enable such an analysis, inherently involves "someone making prior value judgments" (Boadway and Bruce 2001; see also Hausman and McPherson 1996). An important consideration here is what exactly to consider in terms of fairness: the 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 one has to achieve various levels of welfare (Arneson 1990); the capabilities one has to achieve various levels of welfare (Sen 1987, 1992); and so forth.

Baumol (1980, 1987) 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 that is 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.

While these treatments provide important insights into the concepts of fairness and equity, as noted before, translating them into a more formal analysis involves value judgments, and so are beyond the scope of this technical memorandum. In each case, however, the distribution of the effects of a policy action is central to the determination of the policy's fairness. Documenting those distribution effects is an obvious way, then, of addressing that issue in the context of making an allocation of fishery harvest.

3.4 Summary

Under the MSA, allocation decisions are expected to address the issues of efficiency and fairness. As seen above, the former is amenable to a formal, quantitative analysis, although gathering the data needed to conduct such an analysis is challenging; the latter 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

As presented in the previous section, the problem of allocating a harvest limit across two or more sectors can be analyzed both in terms of efficiency and fairness. As also discussed above, however, such analyses require copious amounts of data that may have to be gathered on an ongoing basis. Thus, while the analysis of efficiency and fairness is straightforward in theory, it is more difficult 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 for more than three-quarters of the FMPs covered in this technical memorandum, however. Of the New England FMC's eight FMPs, for example, seven do not have a significant recreational fishery and so 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 4.1 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, an FMP can have a recreational sector but management does 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 4.2 lists the FMPs that fall into this category.

The remaining eleven FMPs have an active recreational sector and have allocated allowable harvest between commercial and recreational sectors. These FMPs are listed in Table 4.3.

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 twenty-five regulations completed by the end of 2010 that address fisheries allocations between commercial and recreational fisheries (Table 4.4). Some regulations provide allocations for one species (i.e bluefish), while others allocate across multiple species (Amendment 1 to the Gulf of Mexico Reef Fish Fishery Management Plan (FMP) addresses nine species and two species groups). Overall, we documented allocations for thirty-six different stocks of fish (twenty-nine species).

Of the twenty-five regulations, all but one either created or modified existing allocation ratios. Only one regulation (Amendment 23 to the Gulf of Mexico Reef Fish FMP) removes an allocation. Vermillion snapper 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, and so they approved regulations that did not designate allocations.

For most of the regulations, the rationale for the final decision was similar across all stocks within that regulation. For five of the 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 thirty-one such decisions. As mentioned above, one decision removed an allocation, so is not considered further here. In four cases, we were unable to determine the rationale behind the allocation decision.

Of the twenty-six remaining decisions, most (twenty-three) created allocations that matched historical or current catch ratios. Only three amendments provided a different rationale. Amendments 7 and 9 to the Pacific Salmon FMP both 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 twenty-three allocation decisions that were based on historical or current catch can be further divided into four categories: seven created allocations that match the status quo (retain

current allocations), six were based on the catch ratios averaged across the longest (five decisions) or most recent time period (one decision) with both commercial and recreational catch data available, four were based on historical catch ratios before the implementation of regulations that would impact catch, and the final six 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 above, the Gulf of Mexico vermillion 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 stock was first modified to increase the recreational allocation followed by a later amendment to lower recreational allocation.

The allocations of West Coast coho and chinook salmon have been modified (Amendments 7 and 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 (Amendment 30A of the Reef Fish FMP), they 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 twenty years of historical catch, increasing the recreational percent allocation from 19% to 24%. The Gulf of Mexico Council created a committee to examine future allocation decisions.

The final two fisheries with a change in allocation through time include the king mackerel and Spanish mackerel, 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 the Gulf and Atlantic stocks, and revised allocations with an increased allocation to commercial (decreased allocation to recreational) for both stocks. The allocation decision for the Gulf group 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 the recreational participation was low. They therefore adjusted the allocation to match the limited data they had from the 1970's, creating a 50:50 split between commercial and recreational fisheries. Finally, in 1999, in response to reductions in total catch, allocation was adjusted (55% : 45%) to retain commercial catch at levels close to the 1998 catch. This adjustment moved allocation that was currently not being used by the recreational fishermen to the commercial fishermen.

Recently, two new policy initiatives have created the need for new allocation decisions. First, The Magnuson-Stevens Reauthorization Act of 2006 established new requirements to end and prevent overfishing through the use of annual catch limits (ACLs) and accountability measures (AMs). Federal fishery management plans must establish mechanisms for ACLs and AMs by 2010 for stocks subject to overfishing and by 2011 for all others. This requires managers to specify specific catch limits (rather than managing effort using trip limits or bag limits) for both commercial and recreational fisheries and thus involve making *de facto* allocation decisions.

The second policy initiative is the final catch share policy released in November 2010, which addresses allocation decisions for all fishery management programs, not just those managing with catch shares. The policy states "the underlying harvest allocations to specific fishery sectors (e.g. , commercial and recreational) should be revisited on a regular basis, and the basis for the allocation should include consideration of conservation, economic, and social criteria used in specifying optimum yield and in furtherance of the goals of the underlying FMP" (NMFS 2010). This compilation of historical allocation decisions may benefit managers as they address future allocation decisions.

4.2 Analyses of FMP allocations (examples)

Using the set of allocation decisions listed in Table 4.4, we searched various types of 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/Administrative Effects sections of the regulatory document (such as the Federal Register notice) 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 was insufficient for analysis. The economics sections are usually brief and we therefore have included excerpts of these sections in Appendix C.

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 section 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 ten 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 4.5 lists the analyses we found and tabulates various characteristics of the analyses (if any) that support each decision covered in Section 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 both 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 4.6, we list the management objectives that have the characteristics described above. In Appendix C, we list the management objectives for the eleven FMPs for which we have documented allocation decisions.

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 both establishing an efficient allocation and

considering how that allocation might change in light of changing conditions in a fishery. Fairness and equity are 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 the historical patterns of harvest can be viewed as one way of assessing the distributional effects of harvest restrictions and allocations.

As noted before, this technical memorandum does not offer any 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 provide 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 above. 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.

A.1 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 include 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 in the following way:

$$\max_{\{h_i\}} V(H) = \sum_{i=1}^{n} V^i(h_i) \quad s.t. \quad \sum_{i=1}^{n} h_i = H . \tag{1.1}$$

This problem can be solved by using a Lagrange multiplier framework, standard for problems in microeconomics and mathematical optimization.[10] The Lagrangian, $\mathcal{L}$, for this problem is

$$\mathcal{L} = \sum_{i=1}^{n} V^i(h_i) + \lambda(H - \sum_{i=1}^{n} h_i) \tag{1.2}$$

where λ is the Lagrange multiplier associated with the harvest constraint in (1.1).

The solution to (1.1) is derived by solving the following system of equations, which constitute the first order conditions for a maximum:

$$\frac{\partial \mathcal{L}}{\partial h_i} = \frac{\partial V^i}{\partial h_i} - \lambda = 0 \quad \forall i \tag{1.3}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = H - \sum_{i=1}^{n} h_i = 0\,. \tag{1.4}$$

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 assumptions that $\partial^2 V^i / \partial h_i^2 < 0 \ \ \forall i$ assure that these conditions are met.

The system of equations (1.3) and (1.4) can be solved in principle to give the optimal harvest allocations, $\{h_i^*\}$. This allocation depends on factors that affect the individual valuation functions as well as the total harvest, H. Thus, the optimal individual allocations can be

[10] Silberberg and Suen (2001), pp. 128-150, provides an introduction to the use of this framework in microeconomics.

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 (1.3) can be used to derive the equimarginal principle:

(1.5) $$MV^i = \lambda = MV^j \quad \forall i, j$$

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.

A.2 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, $\alpha^i_j \in \boldsymbol{\alpha}^i$, where we assume that $\partial V^i / \partial \alpha^i_j > 0$, $\partial MV^i / \partial \alpha^i_j > 0$, and $\partial MV^k / \partial \alpha^i_j = 0 \ \ \forall k \neq i$ (the last assumptions is that α^i_j affects the valuation of the i^{th} harvest sector only. It is then straightforward to show that

(1.6) $$\frac{\partial h_i^*}{\partial \alpha^i_j} > 0$$

(1.7) $$\frac{\partial h_k^*}{\partial \alpha^i_j} < 0 \quad \forall k \neq i$$

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

Similarly, it can be shown that

(1.8) $$\frac{\partial h_i^*}{\partial H} > 0 \quad \forall i$$

(1.9) $$\frac{\partial \lambda^*}{\partial H} < 0$$

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 (1.3) and rearrange to get the identity

(1.10) $$MV^i\left(h_i^*(H)\right) \equiv \lambda^*(H)$$

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

(1.11) $$\frac{\partial h_i^*}{\partial H} = \frac{\partial \lambda^* / \partial H}{\partial MV^i / \partial h_i}.$$

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.

A.3 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 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, and 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

$$\max_{\{h_i\}} V(H) = \sum_{i=1}^{n} V^i(h_i) \quad s.t. \quad \sum_{i=1}^{n} h_i = H_1 \quad \text{and} \quad h_i \geq h_i^0 \ \ \forall i \tag{1.12}$$

Because the initial allocation was not efficient, the equimarginal principle, which is the condition for a maximum in (1.3) , will not in general be met for initial allocation, $\{h_i^0\}$, so that

$$MV^i\left(h_i^0\right) \neq MV^j\left(h_j^0\right). \tag{1.13}$$

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

$$MV^1\left(h_1^0\right) > MV^2\left(h_2^0\right) > \cdots > MV^{n-1}\left(h_{n-1}^0\right) > MV^n\left(h_n^0\right) \tag{1.14}$$

Note that this ordering provides a guide to a pattern of "under-" and "over-allocation" of the initial ACL. For some m in the index set, we have

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

where λ* is the value associated with the efficient allocation of H_0 from (1.5). Because $\partial MV^i / \partial h_i < 0$, this sequence implies that $h_j^0 < h_j^*$ (under-allocation) for $j \le m$, and $h_k^0 > h_k^*$ (over-allocation) for $k > m$.

The order established in (1.15) also acts as a guide to the distribution of any increase in the ACL. The condition

(1.16) $$MV^1\left(h_1^0\right) > MV^i\left(h_i^0\right), i > 1$$

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 (1.16) still holds at $h_1 = h_1^0 + \Delta\text{ACL}$, then that allocation is efficient.

For what levels of ΔACL is it efficient to allocate additional harvest to other sectors? Suppose $\Delta\text{ACL} = \Delta\text{ACL}_2$ is just large enough to make $MV^1(h_1^0 + \Delta\text{ACL}_2) = MV^2(h_2^0)$. Any $\Delta\text{ACL} \ge \Delta\text{ACL}_2$ means that some of the additional harvest should also be allocated to sector 2, otherwise $MV^1(h_1^0 + \Delta\text{ACL})$ 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 $\Delta\text{ACL} \ge \Delta\text{ACL}_2$, then, the standard efficiency framework can be applied to these two sectors alone, in terms of allocating the additional harvest, ΔACL:

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

Let $\{\Delta h_i^{(2)}\}$ be the solutions to this maximization problem, where the superscript "(2)" indicates that the maximization takes place over 2 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 (1.15). Suppose $\Delta ACL = \Delta ACL_3$ is just large enough to make

$$MV^1(h_1^0 + \Delta h_1^{(2)}(\Delta ACL_3)) = MV^2(h_2^0 + \Delta h_2^{(2)}(\Delta ACL_3)) = MV^3(h_3^0) \tag{1.18}$$

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 (1.17) 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:

$$MV^1(h_1^0 + \Delta h_1^{(n-1)}(\Delta ACL_n)) = \cdots = MV^{n-1}(h_{n-1}^0 + \Delta h_{n-1}^{(n-1)}(\Delta ACL_n)) = MV^n(h_n^0) \tag{1.19}$$

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 equations (1.3) and (1.4) without any initial allocation constraints.

Figures A1 to A4 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 A1). This equal allocation is inefficient because $MV^B(125) > MV^A(125)$, and so Sector B has an "under-

allocation" and Sector A has an "over-allocation." 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 A2). If ΔACL is at least 75 units, then it becomes efficient to allocate some of the additional harvest to both sectors because $MV^B(125 + 75) = MV^A(125)$, and so using the terminology above, $\Delta ACL_2 = 75$ (Figure A3). If the ΔACL is deemed higher than 75 units, both sectors receive a share and the new allocation will satisfy the equimarginal principle (Figure A4).

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 A1). 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 A1). 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 A1).

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 Section 4.1. These analyses are typically contained within the official documents supporting the 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 Section 4.2 , instead including what we believe is a representative sample.

B1. Gulf of Mexico Fishery Management Council

B1.1 Reef Fish Resources of the Gulf of Mexico, Amendment 1 (1990): Greater Amberjack; Grey Snapper; Groupers in aggregate; Jewfish; Lane Snapper; Mutton Snapper; Red Snapper; Sea basses; Snappers in aggregate; Vermillion Snapper; Yellowtail snapper

This amendment created allocations for several species based on the commercial and recreational catch during the period 1979-87. There was no quantitative analysis of the alternatives considered.

Excerpts:

> "The proposed allocation based on the historical percentage harvested by each user group during 1979-87 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."[11]

B1.2 Reef Fish Resources of the Gulf of Mexico, Secretarial Amendment 1 (2004): Red grouper

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:

"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 thousand pounds or $1.33 million for red grouper only, 130 thousand pounds or $312 thousand for gag only, or 754 thousand 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

[11] GMFMC (1989) at 227.

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.

"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."[12]

B1.3 Reef Fish Resources of the Gulf of Mexico, Amendment 30B (2009): Gag grouper; 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 both 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:

"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 section 5.3.3.1.

"For the recreational sector, the economic value corresponding to each alternative is derived by summing its constituting components, i.e., 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

[12] GMFMC (2004) at 70.

changes in TAC do not affect the relative proportion harvested by each sub-sector. 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."[13]

"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 charterboat 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 (Section 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."[14]

[13] GMFMC (2008) at 230.
[14] GMFMC (2008) at 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."[15]

B2. Gulf of Mexico Fishery Management Council and South Atlantic Fishery Management Council

B2.1 Coastal Migratory Pelagic Resources of the Gulf of Mexico and South Atlantic, Amendment 2 (1987): Spanish Mackerel/Atlantic Group; Spanish Mackerel/Gulf Group

This amendment created an allocation based on the commercial and recreational catch during the period 1979-85. There was no quantitative analysis of the economic effects of the alternatives.

Excerpts:

"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 through 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 TAC's (set in Action 2) between recreational and commercial fishermen. The decrease in T AC to restore the

[15] GMFMC (2008) at 215.

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 .30 per pound as a proxy for average value and a discount rate of 10 percent. This compares favorably with the present value of $18.6 million for the unregulated fishery."[16]

B2.2 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:

"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

[16] GMFMC and SAFMC (1987) at 14.

National Mane Fisheries Services'[…] information as soon as it is available which will greatly assist in the determining the impacts of our regulations."[17]

"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 re-done 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."[18]

"[…] 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."[19]

[17] GMFMC and SAFMC (1989) at 9.
[18] GMFMC and SAFMC (1989) at 11.
[19] GMFMC and SAFMC (1989) at 8.

B3. Mid-Atlantic Fishery Management Council

B3.1 Atlantic Bluefish, Amendment 1 (2000): Bluefish

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 1981-89. No quantitative analysis of the economic effects of the allocation was conducted.

Excerpts:

> "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 both 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."[20]

B4. New England Fishery Management Council

B4.1 Northeast Multispecies Fishery, Amendment 16 (2010): Gulf of Maine Cod; Gulf of Maine Haddock

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.

[20] MAFMC (1998) at 160.

Excerpts:

"The Proposed Action would make an explicit allocation between commercial and recreational user groups for stocks where the 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."[21]

B5. South Atlantic Fishery Management Council

B5.1 Dolphin and Wahoo FMP (2004): Dolphin and Wahoo

The FMP created a *de facto*, non-binding allocation by capping the commercial harvest at 13%, an allocation based on harvest data for the period 1994-97. 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.

[21] NEFMC (2009) at 683.

Excerpts:

> "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."[22]

B5.2 Snapper-Grouper Fishery of the South Atlantic Region, Amendment 15B (2009): Red porgy; Snowy grouper

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 an assumption that "adverse effects are compounded the greater the deviation from the status quo."[23]

Excerpts:

> "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

[22] SAFMC (2003) at lxvi.
[23] SAFMC (2008) at xxxviii.

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 decreases 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 both 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 1999-2003) 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."[24]

B5.3 Snapper-Grouper Fishery of the South Atlantic Region, Amendment 16 (2009): Gag grouper; Vermillion snapper

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 both 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:

"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."[25]

"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

[24] SAFMC (2008a) at 4-2 to 4-4.
[25] SAFMC (2008b) at 4-21.

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."[26]

"In the absence of 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 charterboats 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

[26] SAFMC (2008b) at 4-21 to 4-22.

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 charterboat and headboat to arrive at the change in charterboat 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."[27]

[27] SAFMC (2008b) at 4-25.

B5.4 Snapper-Grouper Fishery of the South Atlantic Region, Amendment 17B (2010): Combined red, black, gag grouper; Golden Tilefish

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

Excerpts:

> "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 both 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."[28]

[28] SAFMC (2010) at 191.

Appendix C: Management Objectives for FMPs with Allocation Decisions

Under the MSA, fishery management councils establish management objectives as part of the process of developing a fishery management plan. 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 C1, we list all of the management objectives for the eleven 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.

Tables

Table 3.1
Total and Marginal Values of Harvest

Harvest	Total Value		Marginal Value	
	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

Table 3.2
Sector and Aggregate Values of Harvest Allocation (ACL=250)

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

Table 3.3
Total and Marginal Values of Additional Harvest

	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**	
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

Table 3.4
Sector and Aggregate Values of Additional Harvest Allocations (ACL=350)

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

Table 4.1 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	Coral and Coral Reefs of the Gulf of Mexico
	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
	Crustaceans Fisheries of the Western Pacific Region
	Pelagic Fisheries of the Western Pacific Region
	Precious Corals Fishery of the Western Pacific Region

Table 4.2 FMPs with recreational harvest but no current allocation	
Council	**FMP**
Caribbean Fishery Management Council	Queen Conch Resources of Puerto Rico and the United States Virgin Islands
	Shallow Water Reeffish 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 Degrees East Longitude
Pacific Fishery Management Council	U.S. West Coast Fisheries for Highly Migratory Species
South Atlantic and Gulf of Mexico Fishery Management Councils Joint Efforts	Spiny Lobster Fishery of the Gulf of Mexico and South Atlantic

Table 4.3 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 Sea Bass 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 4.4
Commercial-Recreational Allocations

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (Commercial% : Recreational%)	Cate-gory[1] /Note[2]	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 1979-87. These years represent the longest time period of documented commercial and recreational annual harvests.
		Grey 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% (this allocation was later removed)	Y/L	
		Yellowtail snapper	55% : 45%	Y/L	
	Secretarial Amendment 1 (2004)	Red grouper	81% : 19% (this allocation was later changed)	Y/SQ	The ratio 1990-00 was 76% : 24%, close to the 1986-89 ratio (75% : 25%). However, in recent years (1999-01) it has shifted to 81% : 19% due to management changes and a strong 1996 year class 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 4.4
Commercial-Recreational Allocations

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (Commercial% : Recreational%)	Cate-gory[1] /Note[2]	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 ratio of 21% : 79%. The proposed rule reduces landings by 60% for both sectors retaining historic ratio. Council created Ad Hoc committee to examine fair and equitable ways to allocate in the future.
		Greater amberjack	27% : 73%	Y/L	Close to historical average 1981-04 (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 sports fish.
	Amendment 30B (2009)	Gag grouper	39% : 61%	Y/L	Interim allocation based on 1986-05 (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	

Table 4.4
Commercial-Recreational Allocations

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (Commercial% : Recreational%)	Cate-gory[1] /Note[2]	Basis for Allocation
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% (this allocation was later changed)	UNK	Allocations (as lbs) 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 temporary allocation and gives method for changing future allocations: use "longest numbers of years beginning in 1979 for which concurrent recreational and commercial data are available."
		King Mackerel/Gulf Group	32% : 68%	Y/NE	Historical catch (1975-79 was 30% : 70%). Moved 2% of allocation from recreational to commercial to account for recreational fish sold. Amendment states this is temporary allocation and gives method for changing future allocations: use "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% (this allocation was later changed)	Y/R	Catch 1979-85 (most recent time period with catch data)
		Spanish Mackerel/Gulf Group	57% : 43%	Y/R	
	Amendment 4 (1989)	Spanish Mackerel/Atlantic Group	50% : 50% (this allocation was later changed)	Y/B	Council noted that the 76% : 24% allocation was from time when resources were overfished and recreational participation was low. Limited data from early 70's 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 4.4
Commercial-Recreational Allocations

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (Commercial% : Recreational%)	Cate-gory[1] /Note[2]	Basis for Allocation
Mid-Atlantic Fishery Management Council					
Atlantic Bluefish	Amendment 1 (2000)	Bluefish	17% : 83%	Y/B	Average Catch 1981-89 (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 M lb, then the quota could be increased up to 10.5 M 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 1997-2007 from MRFSS database times 1.5. Percentage would be: 6.2%, which translates into 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)
Summer Flounder, Scup, and Black Sea Bass Fisheries	Amendment 2 (1993)	Summer Flounder	60% : 40%	Y/B	Average catch 1980-89. 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 and fair and equitable.
	Amendment 8 (1996)	Scup	78% : 22%	Y/NE	Average catch 1988-92. 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 Sea Bass	49% : 51%	Y/NE	Average catch 1983-92. 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.

Table 4.4
Commercial-Recreational Allocations

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (Commercial% : Recreational%)	Cate-gory[1] /Note[2]	Basis for Allocation
New England Fishery Management Council					
Northeast Multispecies Fishery	Amendment 16 (2010)	Gulf of Maine Cod	66.3% : 33.7%	Y/NE	Catch from 2001-06. The allocations were based 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.
		Gulf of Maine Haddock	72.5% : 27.5%	Y/NE	
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.
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 1971-75. 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 1966-78.
		Coho S of Cape Falcon	Varies with TAC (allocation method was later changed)	Y/B	Allocation was based on historic catch between 1966-78 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.

Table 4.4
Commercial-Recreational Allocations

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (Commercial% : Recreational%)	Cate-gory[1] /Note[2]	Basis for Allocation
West Coast Salmon, continued	Amendment 7 (1986)	Coho/S of Cape Falcon	Varies with TAC	N/SR	Determined by group composed of C&R 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.
		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/NE	Based on average 1994-97 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 sea bass	43% : 57%	Y/SQ	Allocations (as lbs) were provided with a 3 year step-down. All 3 yrs contained same 43% : 57% split. Discussion mentions decreasing commercial and recreational catch equally (35% by year 3 based on 2001-03 and 2000-03 for commercial and recreational respectively). Year 1 represents current catch.
	Amendment 15B (2009)	Red porgy	50% : 50%	Y/L	The alternative chosen was closest to status quo (1999-03 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 vs recreational).
		Snowy grouper	95% : 5%	Y/L	Historical landings 1986-05 (longest time series available). Shorter time frames were not utilized because unrealistic spikes in recreational landings overly influenced the results.

Table 4.4
Commercial-Recreational Allocations

Fisheries Management Plan	Regulation	Fishery	Allocation ratio (Commercial% : Recreational%)	Cate-gory[1] /Note[2]	Basis for Allocation
Snapper-Grouper Fishery of the South Atlantic Region, continued	Amendment 16 (2009)	Gag grouper	51% : 49%	Y/SQ	Allocation is based on landings from 1999-03. 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 1986-05 (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/M	Commercial and recreational catch limits provided (in lbs), but no allocation listed. Catch limits equate to allocation of 50.5% : 49.5%. The lbs are expected catch resulting from implementing amendment 16.
		Golden Tilefish	97% : 3%	Y/SQ	Based on formula Sector allocation = (.5 * average catch 1986-08) + (.5 * average catch 2006-08). 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

[1] **Category**:
N= not based on catch history
Y= based on catch history
UNK = Unknown how allocation was decided

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

Table 4.5
Commercial-Recreational Allocation Analyses

Fisheries Management Plan	Regulation	Fishery	Analysis included as a separate document[1]	Analysis of all Alternatives[1]	Quantitative Analysis Performed[1]	Explicit use of Analysis in Decision[1]	Poor Data Availability Cited as reason for incomplete analysis[1]
Gulf of Mexico Fishery Management Council							
Reef Fish Resources of the Gulf of Mexico	Amendment 1 (1990)	Greater amberjack	NF	Y	NF	NF	NF
		Grey snapper, Groupers in aggregate, Jewfish, Lane snapper, Mutton snapper, Red snapper, Sea basses, Snappers in aggregate, Vermillion snapper	NF	Y	NF	NF	NF
		Yellowtail snapper	NF	Y	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[2]	NF	NF	NF	NF	NF
	Amendment 30B (2009)	Gag grouper, Red grouper	NF	Y	Y	NF	NF

Table 4.5
Commercial-Recreational Allocation Analyses

Fisheries Management Plan	Regulation	Fishery	Analysis included as a separate document[1]	Analysis of all Alternatives[1]	Quantitative Analysis Performed[1]	Explicit use of Analysis in Decision[1]	Poor Data Availability Cited as reason for incomplete analysis[1]
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					
	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 specifications (1999)	Spanish mackerel/Atlantic group	NF	NF	NF	NF	NF
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 Sea Bass Fisheries	Amendment 2 (1993)	Summer Flounder	NF	NF	NF	NF	NF
	Amendment 8 (1996)	Scup	NF	NF	NF	NF	NF
	Amendment 9 (1996)	Black Sea Bass	NF	NF	NF	NF	NF

Table 4.5
Commercial-Recreational Allocation Analyses

Fisheries Management Plan	Regulation	Fishery	Analysis included as a separate document[1]	Analysis of all Alternatives[1]	Quantitative Analysis Performed[1]	Explicit use of Analysis in Decision[1]	Poor Data Availability Cited as reason for incomplete analysis[1]
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 Ground fish FMP (Non-biological 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 Chinook / N of Cape Falcon	NF	Y	Y	Y	NF
South Atlantic Fishery Management Council							
Dolphin and Wahoo	FMP (2004)	Dolphin and Wahoo	NF	NF	NF	NF	NF
Snapper-Grouper Fishery of the South Atlantic Region	Amendment 13C (2006)	Black sea bass	Y	Y	Y	NF	Y
	Amendment 15B (2009)	Red porgy and Snowy grouper	Y	Y	Y	NF	Y
	Amendment 16 (2009)	Gag grouper, Vermillion snapper	Y	Y	Y	NF	Y
	Amendment 17B (2010)	Combined red, black, gag grouper, Golden tilefish	Y	Y	Y	NF	Y

[1] NF=Not Found; Y=Yes
[2] The Council removed the actions that addressed allocations for greater amberjack and gray triggerfish.

Table 4.6
FMP Management Objectives that reference
Commercial or Recreational Sectors, Efficiency, or Fairness

FMP	Management Objectives
Gulf of Mexico Fishery Management Council	
Reef Fish Resources of the Gulf of Mexico[1]	Management Objective (FMP/Amendment) 4. Minimize conflicts between user groups of the resource and conflicts for space (Original FMP) 6. To reduce user conflicts and nearshore fishing mortality [modifies Objective 4] (Amendment 1) 11. To maximize net economic benefits from the reef fish fishery (Amendment 1) 15. To 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[2]	The current FMP through Amendment 5 lists seven plan objectives: 4. To minimize gear and user group conflicts. 5. To 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 the development of the deep water run-around gill-net fishery and when the resource was not overfished. 8. To optimize the social and economic benefits of the coastal migratory pelagic fisheries.
Mid-Atlantic Fishery Management Council	
Atlantic Mackerel, Squid, and Butterfish Fisheries[3]	2. Promote the 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 Multispecies Fishery (Amendment 16)[4]	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 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.
NMFS Highly Migratory Species Division	
Atlantic Highly Migratory Species[5]	• Consistent with other objectives of this FMP, to manage Atlantic HMS fisheries for continuing optimum yield 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

Table 4.6
FMP Management Objectives that reference
Commercial or Recreational Sectors, Efficiency, or Fairness

FMP	Management Objectives
Pacific Fishery Management Council	
Pacific Coast Groundfish[6]	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 measures that will affect users equitably.
West Coast Salmon[7]	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 and/or specific coastal communities (e.g., recreational port allocations north of Cape Falcon.)
South Atlantic Fishery Management Council	
Dolphin and Wahoo[8]	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 upon 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: 3. Minimize conflict and/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 and/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.

Table 4.6
FMP Management Objectives that reference
Commercial or Recreational Sectors, Efficiency, or Fairness

FMP	Management Objectives
Sources: [1] GMFMC (2004). [2] GMFMC (1992). [3] MAFMC (2010). [4] NEFMC (2009). [5] NMFS (1999). [6] PFMC (2008). [7] PFMC (2003). [8] SAFMC (2003).	

Table A1
Efficient and Constrained Allocations of ACL

ACL	Efficient Allocation (units)		Constrained Allocation (units)	
	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
ACL	**Efficient Allocation (% share)**		**Constrained Allocation (% share)**	
	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%

Table C1
FMP Management Objectives

FMP	Management Objectives
Gulf of Mexico Fishery Management Council	
Reef Fish Resources of the Gulf of Mexico[1]	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. To reduce user conflicts and nearshore fishing mortality [modifies Objective 4] (Amendment 1) 7. To 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. To revise the definitions of the fishery management unit and fishery to reflect the current species composition of the reef fish fishery (Amendment 1) 9. To revise the definition of optimum yield to allow specification at the species level (Amendment 1) 10. To encourage research on the effects of artificial reefs (Amendment 1) 11. To maximize net economic benefits from the reef fish fishery (Amendment 1) 12. To avoid to the extent practicable the "derby" type of fishing season (Amendment 8 July, 1995) 13. To promote flexibility for the fishermen in their fishing operations (Amendment 8) 14. To provide for cost-effective and enforceable management of the fishery (Amendment 8) 15. To 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[2]	The current FMP through Amendment 5 lists seven 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. To 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. To provide necessary information for effective management and establish a mandatory reporting system for monitoring catch. 4. To minimize gear and user group conflicts. 5. To 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 the development of the deep water run-around gill-net fishery and when the resource was not overfished. 6. To minimize waste and bycatch in the fishery. 7. To provide appropriate management to address specific migratory groups of king mackerel. A new objective (8) is proposed as follows: 8. To optimize the social and economic benefits of the coastal migratory pelagic fisheries.

Table C1
FMP Management Objectives

FMP	Management Objectives
Mid-Atlantic Fishery Management Council	
Atlantic Bluefish[3]	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 the waste in both the commercial and recreational fisheries.
Atlantic Mackerel, Squid, and Butterfish Fisheries[4]	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. 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 Sea Bass Fisheries[5]	The objectives of the FMP are to: 1) reduce fishing mortality in the summer flounder, scup, and black sea bass fisheries to ensure that overfishing does not occur; 2) reduce fishing mortality on immature summer flounder, scup, and black sea bass 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; and 6) minimize regulations to achieve the management objectives stated above.
New England Fishery Management Council	
Northeast Multispecies Fishery (Original FMP)[6]	The objective of the Northeast Region Multi-Species Fishery Management Plan 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.

Table C1
FMP Management Objectives

FMP	Management Objectives
Northeast Multispecies Fishery (Amendment 16)[7]	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 multispecies 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. Goal 6: To promote stewardship within the fishery. Objective 1: Achieve, on a continuing basis, optimum yield (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 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 M-S Act, including identification of EFH 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.

Table C1
FMP Management Objectives

FMP	Management Objectives
NMFS Highly Migratory Species Division	
Atlantic Highly Migratory Species[8]	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. • To prevent or end overfishing of Atlantic tuna, swordfish, and sharks and adopt the precautionary approach to fishery management; • To 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 can be supported on a continuing basis; • To minimize, to the extent practicable, economic displacement and other adverse impacts on fishing communities during the transition from overfished fisheries to healthy ones; • To 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; • To establish a foundation for international negotiation on conservation and management measures to rebuild overfished fisheries and to promote achievement of optimum yield for these species throughout their range, both within and beyond the exclusive economic zone. Optimum yield is the maximum sustainable yield from the fishery, reduced by any relevant social, economic, or ecological factors; • To provide a framework, consistent with other applicable law, to take necessary action under ICCAT compliance recommendations; • To 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, to manage Atlantic HMS fisheries for continuing optimum yield 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; • To better coordinate domestic conservation and management of the fisheries for Atlantic tuna, swordfish, sharks, and billfish, considering the multispecies nature of many HMS fisheries, overlapping regional and individual participation, international management concerns, historical fishing patterns and participation, and other relevant factors; • To simplify and streamline HMS management while actively seeking input from affected constituencies, the general public, and the HMS AP; • To promote protection of areas identified as essential fish habitat for tuna, swordfish, and sharks; • To reduce latent effort and overcapitalization in HMS commercial fisheries; • To 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; and • To 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.

Table C1
FMP Management Objectives

FMP	Management Objectives
Pacific Fishery Management Council	
Pacific Coast Groundfish[9]	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. Objectives. 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. 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 nongroundfish 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 essential fish habitat (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 and/or economic discards through gear research regulated by EFP.

Table C1
FMP Management Objectives

FMP	Management Objectives
Pacific Coast Groundfish, continued	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 multispecies nature of the fishery and establish a concept of managing by species and gear or by groups of interrelated species. Objective 11. Develop management programs that reduce regulations-induced discard and/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[10]	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 ESA 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 and/or specific coastal communities (e.g., recreational port allocations north of Cape Falcon.) 4. Minimize fishery mortalities for those fish not landed from all ocean salmon fisheries as consistent with optimum yield and the bycatch management specifications of Section 3.4. 5. Manage and regulate fisheries so that the optimum yield encompasses the quantity and value of food produced, the recreational value, and the social and economic values of the fisheries.

Table C1
FMP Management Objectives

FMP	Management Objectives
West Coast Salmon, continued	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[11]	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, dependant upon 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. 3. Minimize conflict and/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 and/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.

Table C1
FMP Management Objectives

FMP	Management Objectives
Dolphin and Wahoo, continued	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.
Snapper-Grouper Fishery of the South Atlantic Region[12]	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.

Sources:
[1] GMFMC (2004).
[2] GMFMC (1992).
[3] MAFMC (1998).
[4] MAFMC (2010).
[5] MAFMC (2007).
[6] NEFMC (1985).
[7] NEFMC (2009).
[8] NMFS (1999).
[9] PFMC (2008).
[10] PFMC (2003).
[11] SAFMC (2003).
[12] SAFMC (2008).

Figures

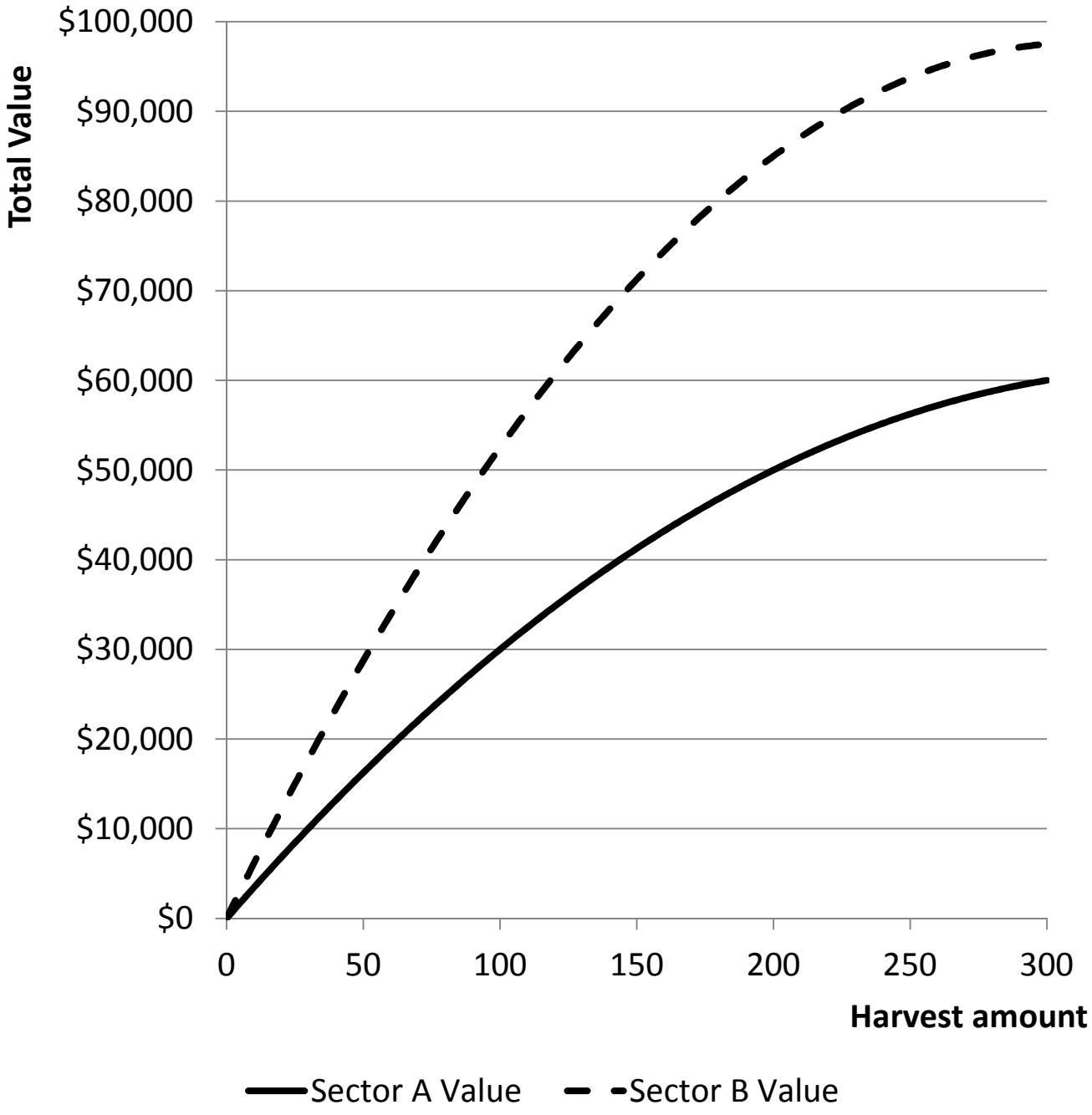

Figure 1: For each sector, the total (net) economic value of harvest increases with an increase in the amount harvested, but at a decreasing rate.

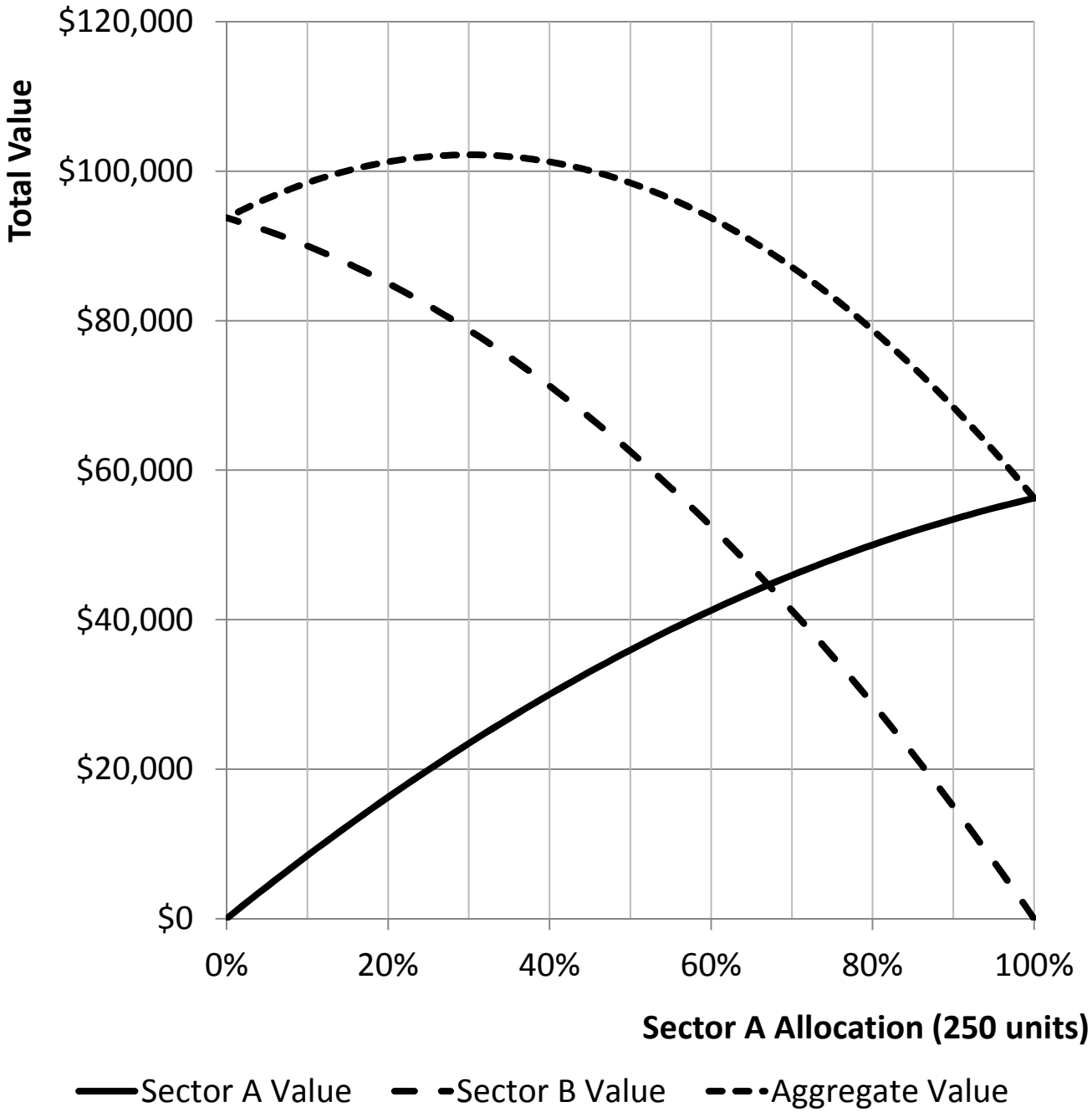

Figure 2: Although a greater value can be achieved by allocating all of the harvest to sector B instead of Sector A, the maximum total value is achieved by allocating 30% of the harvest to Sector A and 70% to sector B.

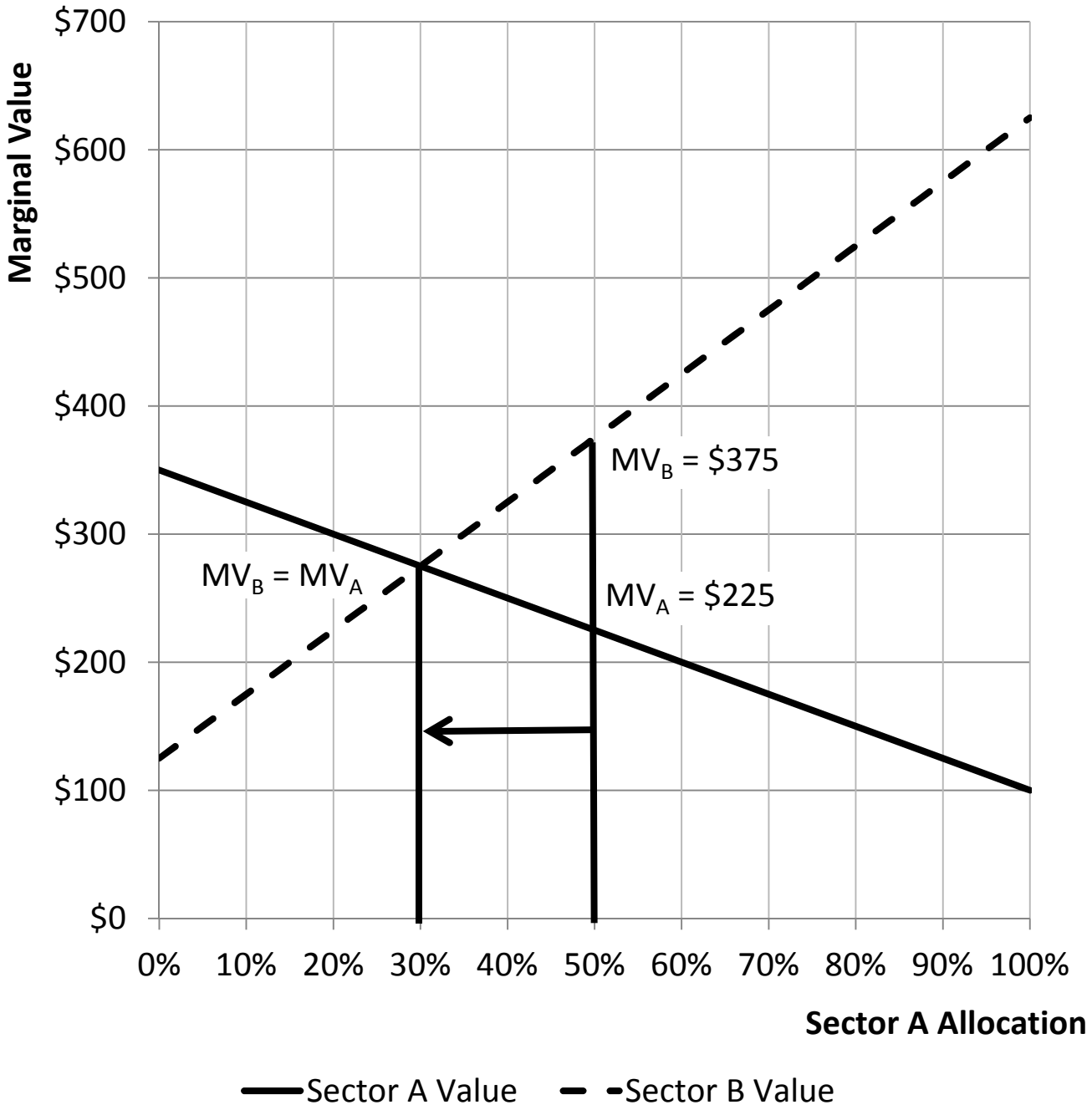

Figure 3: If harvest is allocated equally across Sector A and B, the marginal value of increasing sector B's allocation exceeds the marginal value (cost) of decreasing sector A's allocation. A more efficient allocation can be achieved by transferring harvest from A to B, but the gains from doing so will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

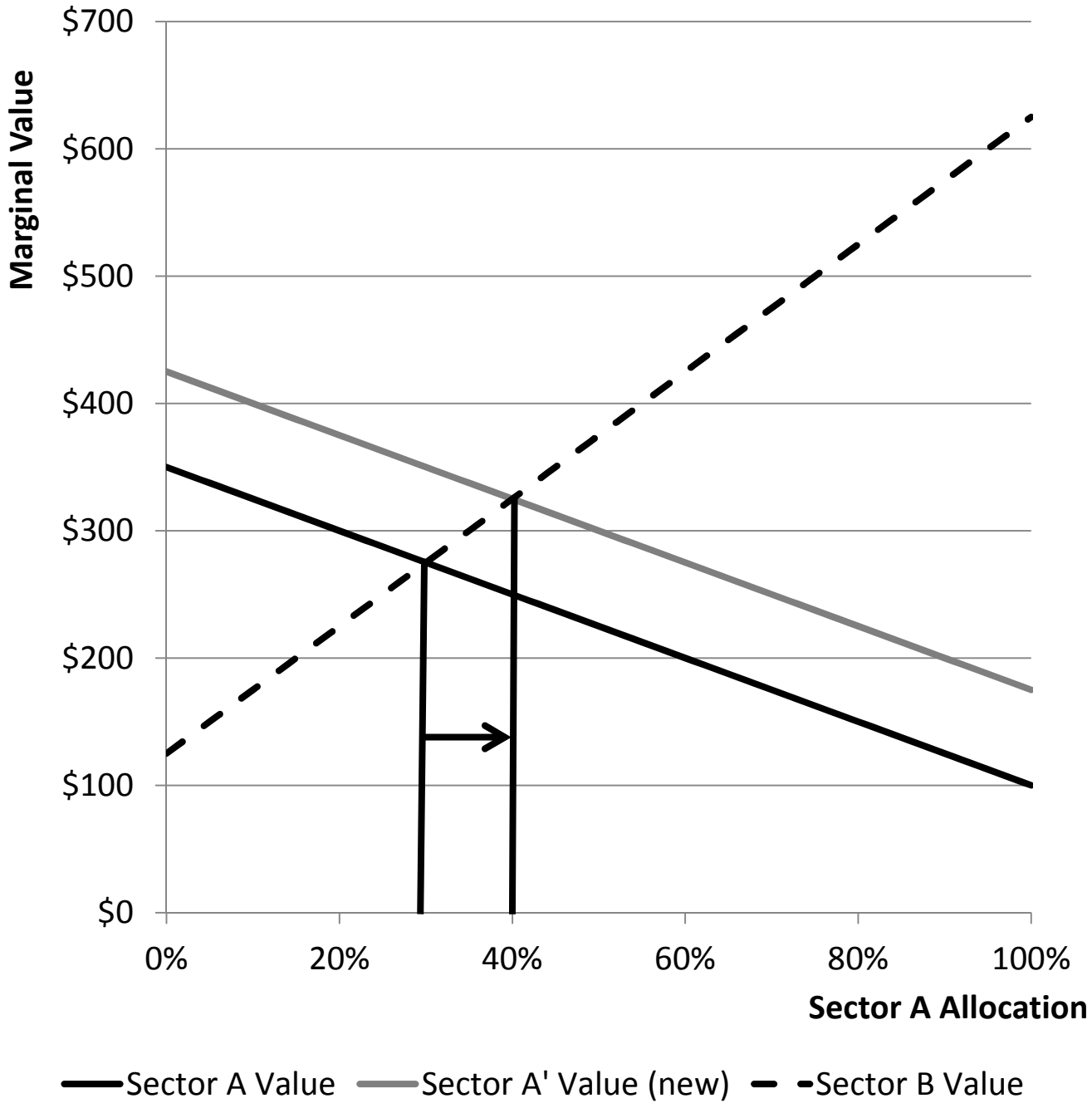

Figure 4: If Sector A is commercial harvesters, an increase in the commercial ex-vessel value could shift the marginal value of that sector's harvest, which would then change the efficient allocation to one that allocated more harvest to sector A and less to Sector B.

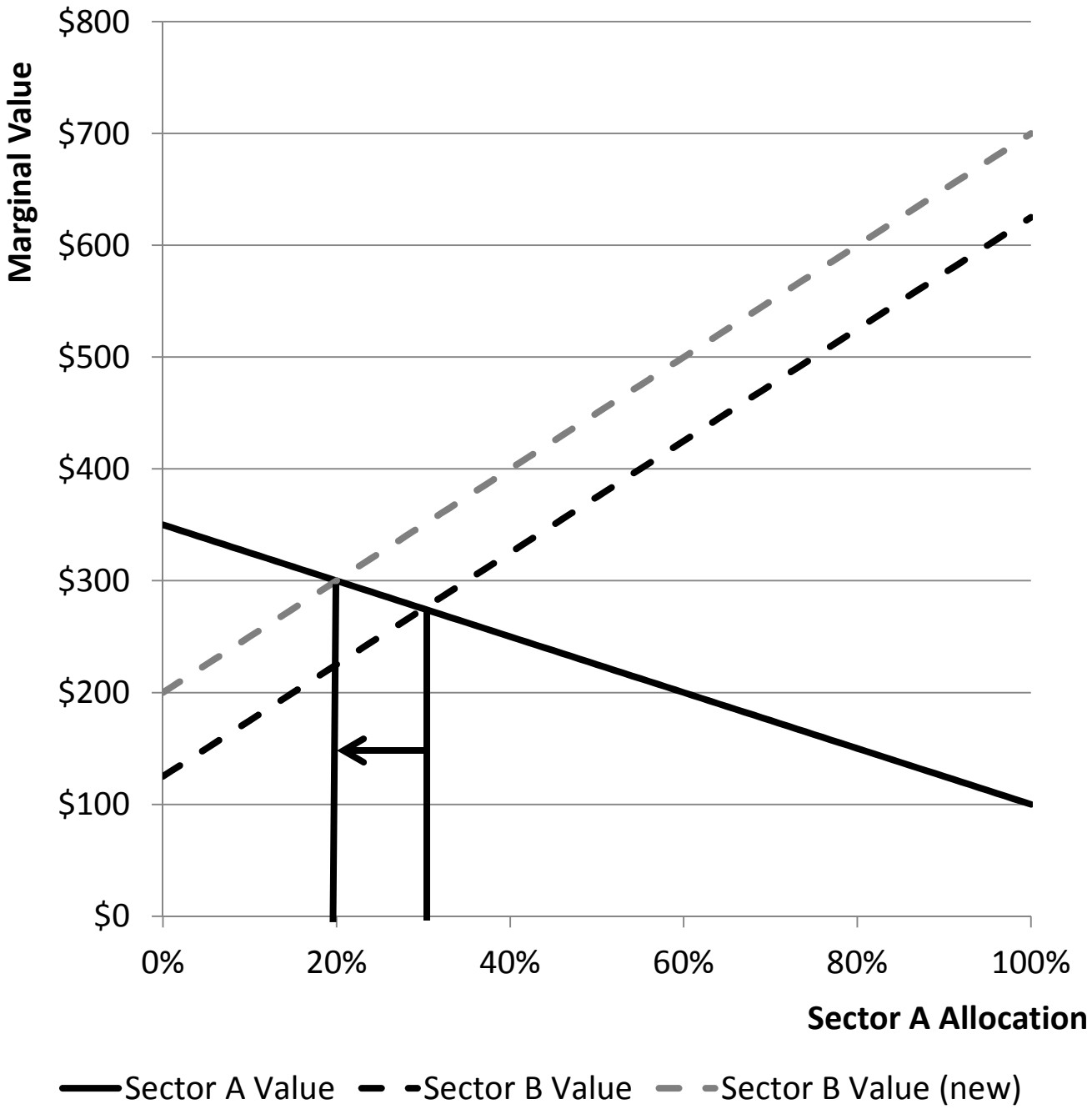

Figure 5: A reallocation of harvest from sector A to sector B is efficient if a factor changes in a way that increases sector B's marginal value of harvest.

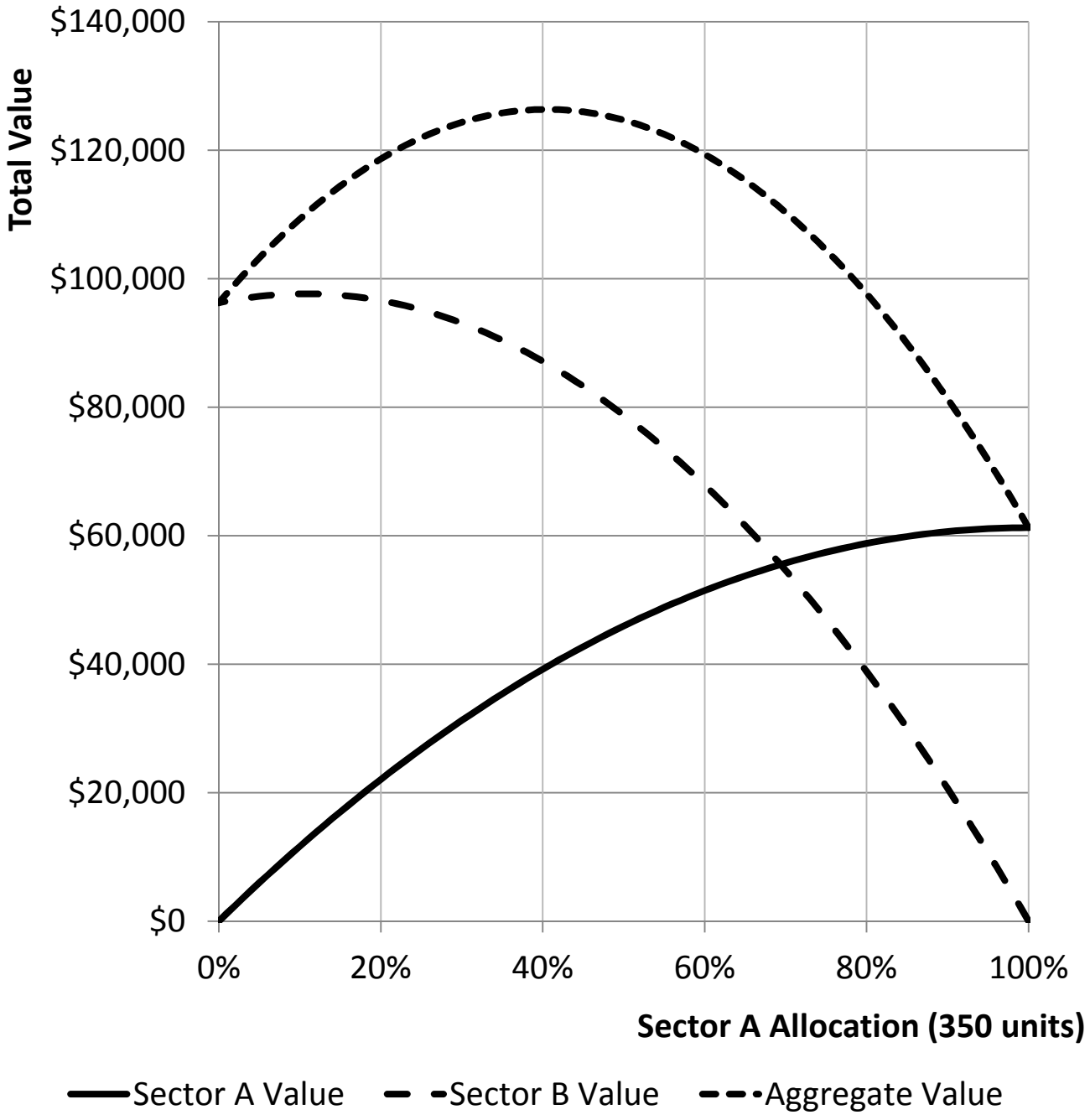

Figure 6: If the ACL is set to at 350 instead of 250, the efficient allocation is one that gives 41% of the harvest to Sector A and 59% to sector B.

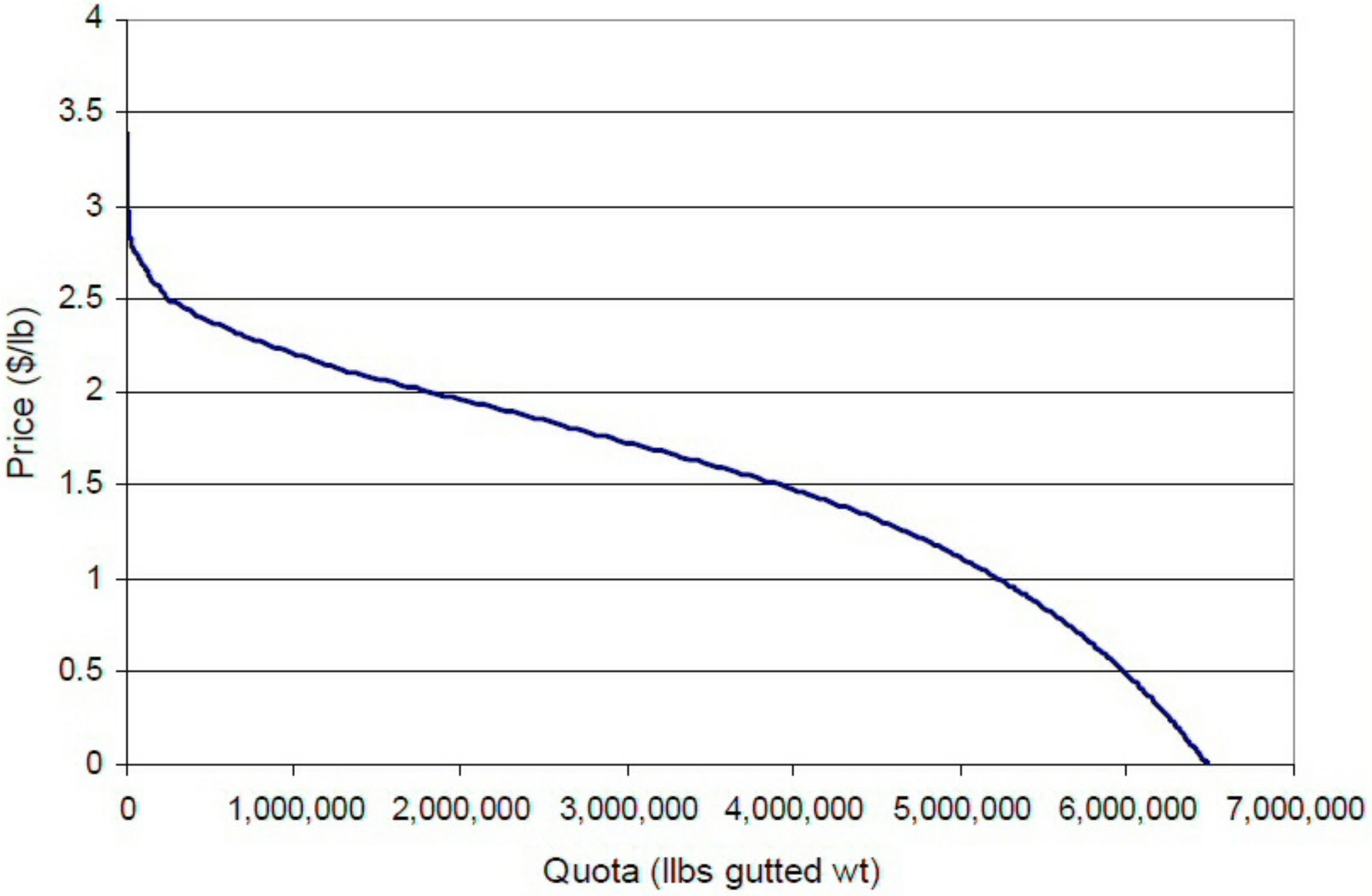

Figure 7: Carter et al. (2008) estimated the commercial sector's marginal value for red grouper harvest.

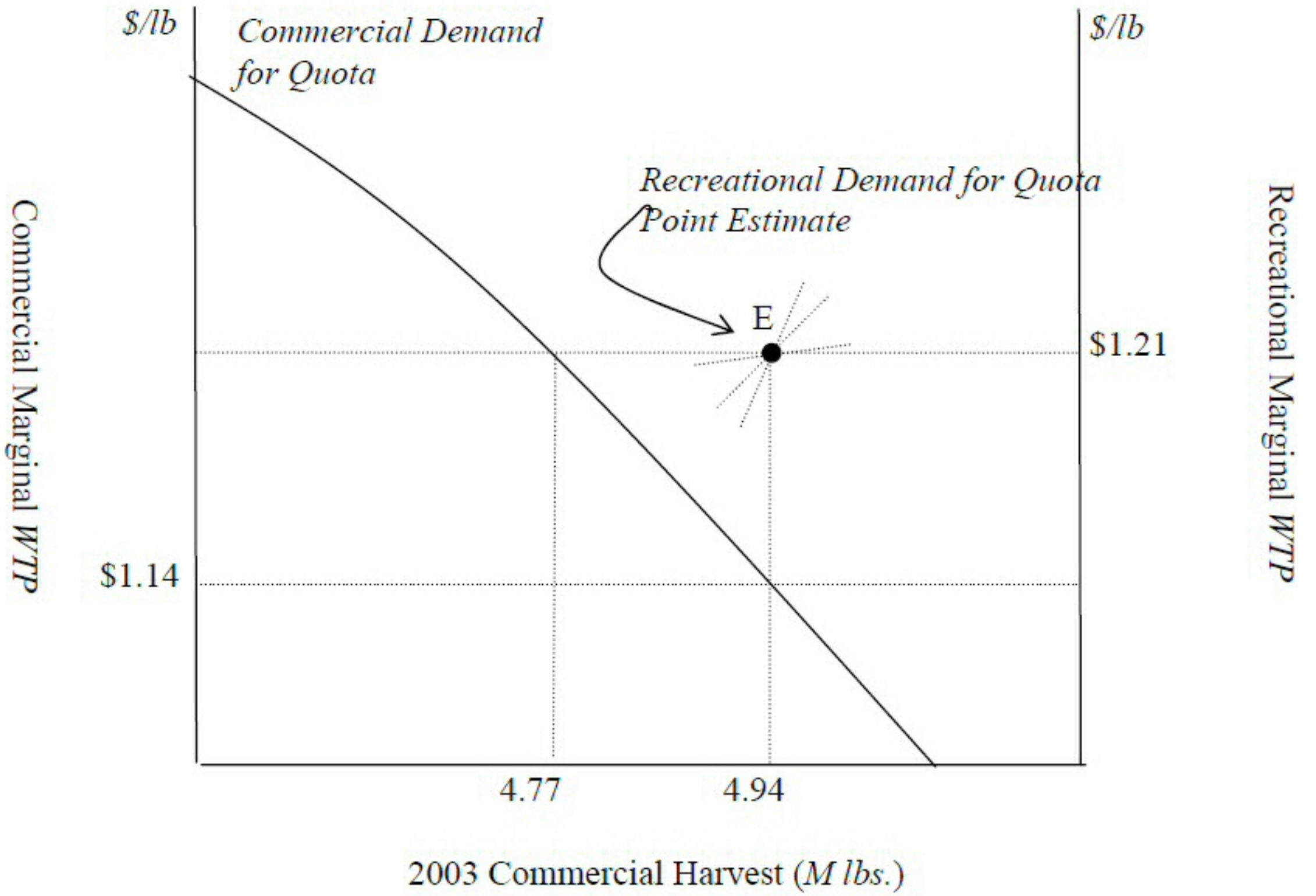

Figure 8: While Carter et al. (2008) estimated the marginal value curve for the commercial sector in their analysis, the marginal value of the recreational sector is represented only by a single point, which is the mean WTP for recreational fisherman.

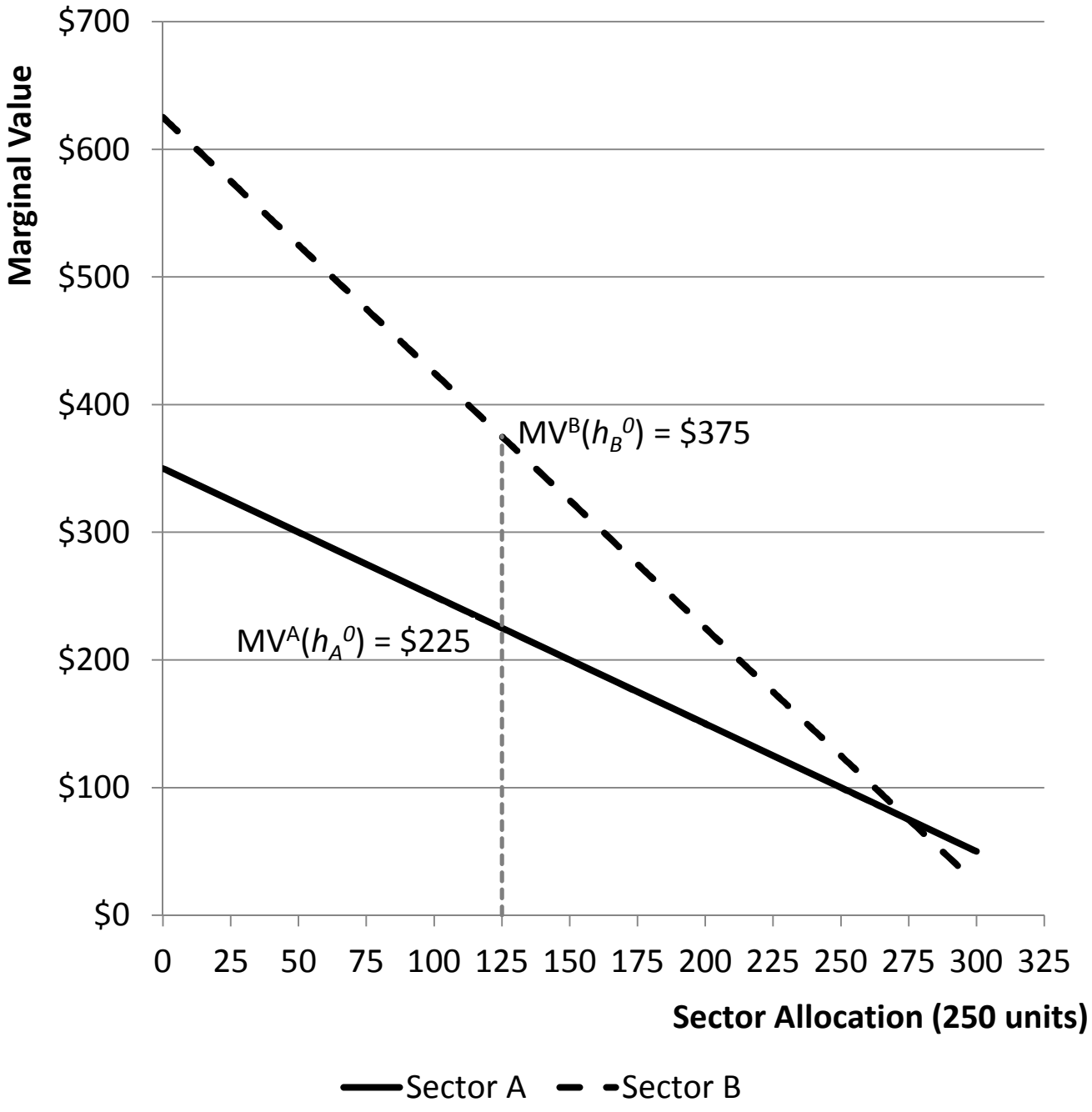

Figure A1: If an ACL is allocated without regard to efficiency, the marginal value of harvest across sectors will likely not be equal. If an ACL is allocated equally across these two sectors, the marginal value of Sector B's harvest is higher than the marginal value of Sector A's harvest.

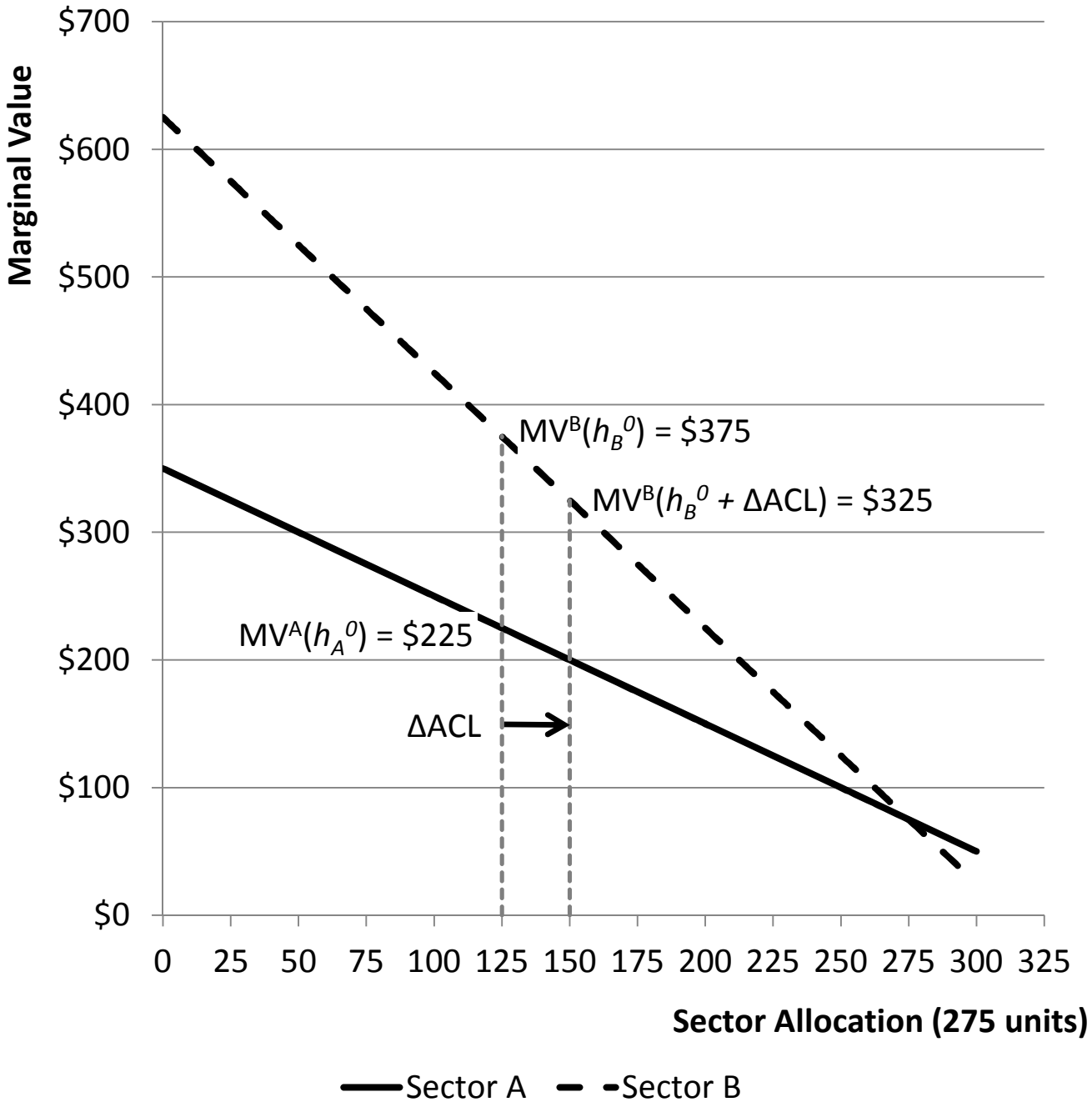

Figure A2: If the initial allocations act as a constraint on efficient allocations of any increase in the ACL, these additional allocations may involve granting 100% of the increase to one sector. In this case, an increase of 25 units is allocated solely to Sector B because that sector's marginal value of harvest is higher than Sector A's even after the new allocation.

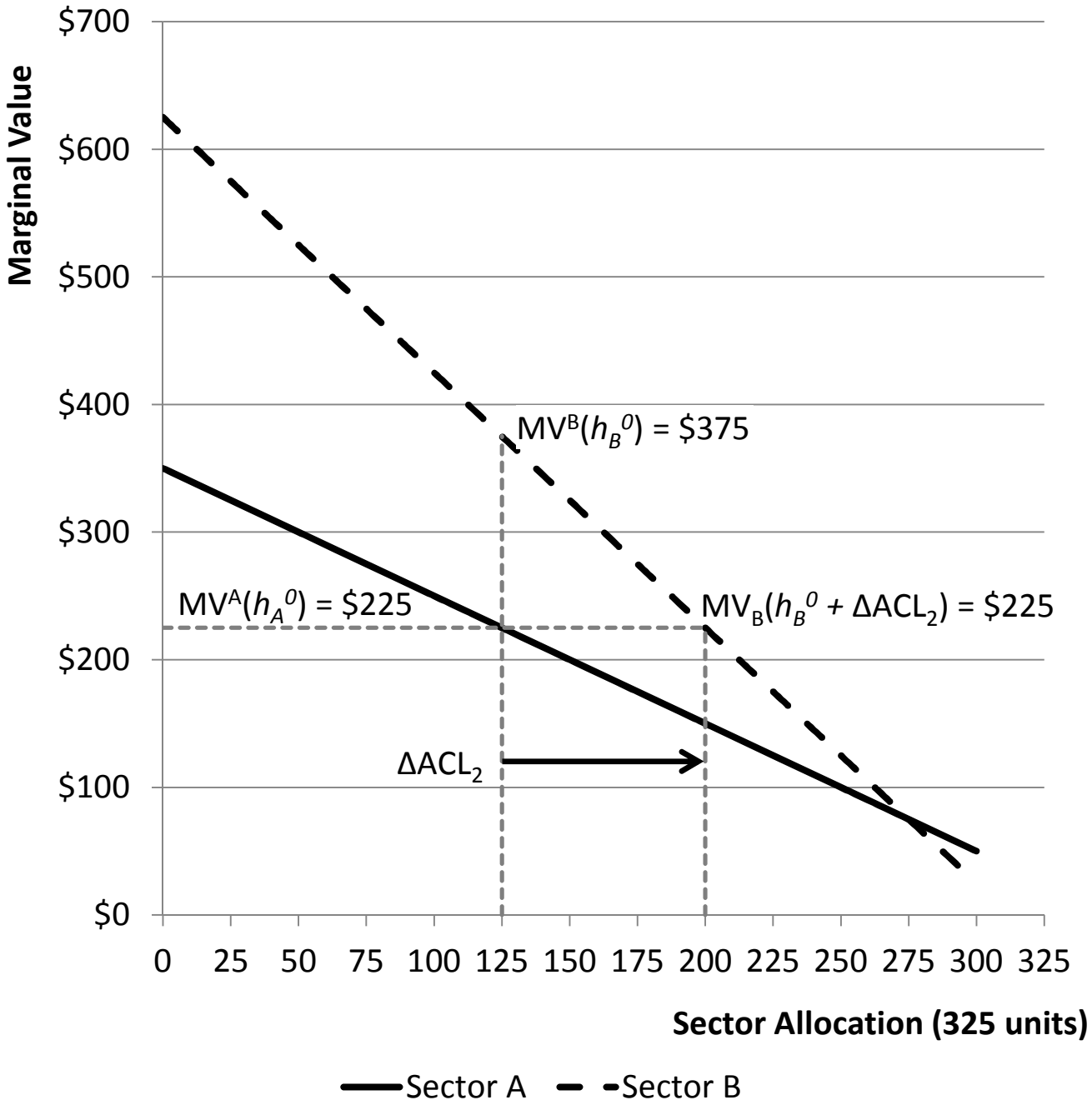

Figure A3: If the additional allocation is as high as 75 units, the marginal value of harvest for Sector B will fall to a level that is just equal to the marginal value of Sector A's harvest. Granting 100% of this increase will produce an allocation that is efficient, in that it satisfies the equimarginal principle.

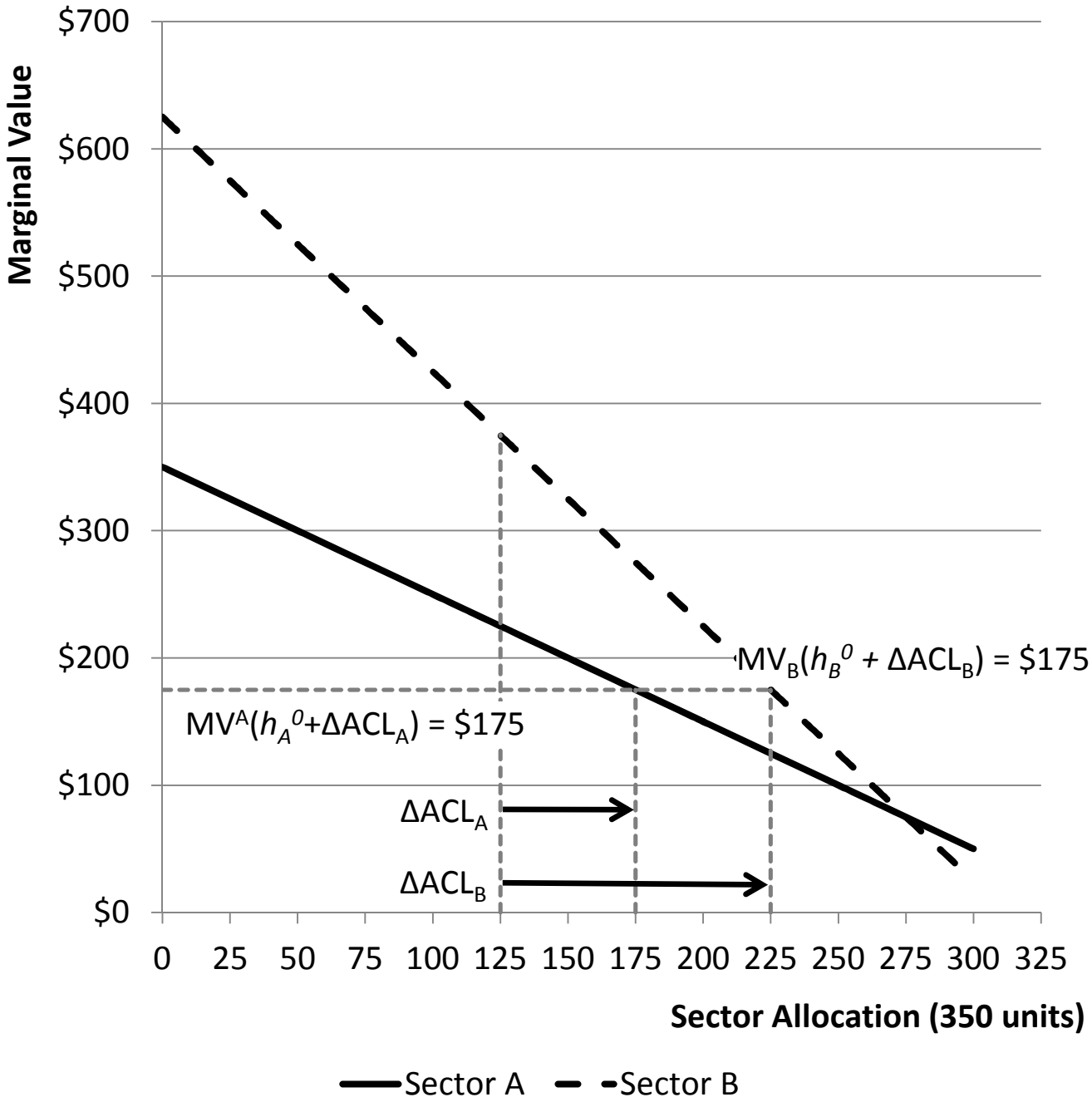

Figure A4: Increases in the ACL above 75 units produce sufficient additional units to enable both sectors to receive increases in their allocation and achieve an efficient overall allocation.