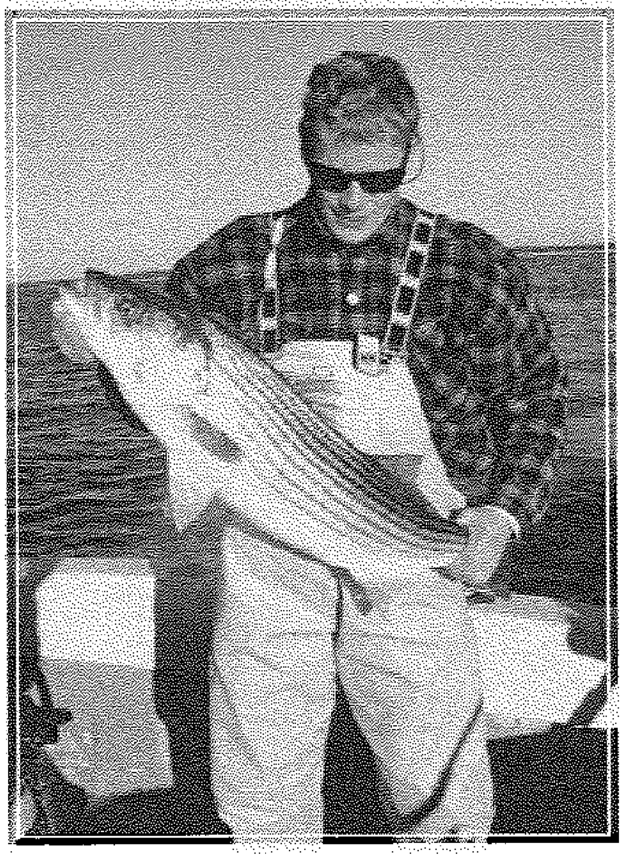
VSGCP-T-00-003 C2

Economic Aspects of Allocating Striped Bass

— Among Competing User Groups in Virginia —



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April 2000

VIRGINIA GRADUATE MARINE SCIENCE CONSORTIUM
University of Virginia 170 Rugby Road, Madison House P.O. Box 400146 Charlottesville, VA 22904-4146

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VSG-00-08

This work is a result of research sponsored in part by NOAA Office of Sea Grant, U.S. Department of Commerce, under Grant No. NA56RG0141 to the Virginia Graduate Marine Science Consortium and Virginia Sea Grant College Program. The U.S. Government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notation that may appear hereon.

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Funding for this project was provided by the Virginia Saltwater Recreational Development Fund and the Commercial Fisheries Improvement Fund, Virginia Marine Resources Commission, the College of William and Mary, Virginia Institute of Marine Science, School of Marine Science; and the Virginia Sea Grant Marine Advisory Program.

Virginia Marine Resources Report No. 2000-05

VSG-00-08

Executive Summary

Competition between commercial and recreational fishers has substantially intensified during the past ten years. The increased competition has subsequently manifest itself in the form of increasingly restrictive regulations on the commercial and recreational harvesting of species. More apparent, however, of the increasing conflict has been the prohibition on the commercial harvesting of certain species or severe restrictions on certain types of fishing gear. Florida imposed a ban on nets and the commercial harvesting of red fish, red drum, *Sciaenops ocellaturs*, or channel bass. South Carolina also prohibited the commercial sale of red drum. South Carolina has also declared "gamefish only" status for spotted seatrout, *Cynoscion nebulosus*. In the past five years, six states or jurisdictions imposed regulations which prohibit the commercial harvest and sale of Atlantic striped bass, *Morone saxatilis*. The six states or jurisdictions are Maine, New Hampshire, Connecticut, New Jersey, Pennsylvania, and the District of Columbia. It is expected that there will be increasing competition among recreational anglers and commercial harvesters for access to fish stocks and subsequent fishery allocations.

In Virginia, mounting competition among commercial watermen and recreational anglers to be allowed greater harvests of Atlantic striped bass can be expected during the next few years. Prior to the mid-1970s, striped bass was a major commercial and recreational species in Virginia and the Chesapeake Bay region. Between 1950 and 1976, the average annual commercial harvest in Virginia was 1.8 million pounds per year; from 1977 through 1998, the average annual commercial harvest was 0.5 million pounds per year. Between 1985 and 1998 (years for which recreational harvest information is available), the average annual commercial and recreational harvest equaled, respectively, 0.5 million pounds and 0.7 million pounds. During the 1970s and early1980s, however, the abundance of striped bass declined to extremely low levels. The decline in abundance led to extremely restrictive commercial and recreational regulations throughout the Chesapeake Bay area. By 1989, however, the regulations had helped restore the abundance of striped bass to relatively high levels. In 1996, the abundance of striped bass was at an all time high, and commercial and recreational harvests were subsequently allowed to increase. Since 1996, both user groups have harvested (caught and retained) in excess of 1.0 million pounds per year.

Given the potential economic importance of striped bass and increased competition for access, there is a need to examine the potential economic impacts and benefits to society from allocating the resource among the two user groups. The Virginia Marine Resources Commission (VMRC) approved a study of the economic impacts and benefits of allocating resources among the two user groups. Funding was provided by the Virginia Saltwater Recreational Fishing Development Fund and the Virginia Commercial Fisheries Improvement Fund.

Using information obtained from various surveys of commercial watermen and recreational anglers in 1998 and 1999, a combination of input-output or economic impact models and statistical models were used to estimate the impacts (i.e., total sales, total income, and total full-time employment generated for the economy of Virginia) and benefits (measured in terms of consumer surplus which is the dollar amount an individual receives from a good or service in excess of what was actually paid for the good or service, and producer surplus or the amount received by producers in excess of what it actually cost to produce the good or service or payments to value added inputs such as labor and owners of capital and land) to society from different allocations of striped bass. The different allocations examined were as follows: (1) 100% and 0.0% for each user group; (2) 75% and 25% for each group; and (3) 50% and 50% for each group. It was the intent of the study to also determine an optimum mix of the allocation (i.e., a certain non-zero percent allocation to each user group). Early analysis of the economic impacts and societal benefits, however, revealed the optimum allocation should be 100 percent to the recreational sector. That is, maximum social benefits and potential sales, income, and employment were associated with a 100% allocation of the 1998 total allowable catch to the recreational sector. As a consequence, there was no need to further examine an optimum allocation.

Based on results obtained for 1998, a 100 percent allocation to the recreational sector has the potential to generate $181.1 million (measured in year 2000 constant dollar value) in total sales, $101.3 million in total income, and 3,738 full time equivalent employees (person-years of employment) to the economy of Virginia. A 100% allocation to the commercial sector has the potential to generate a total sales value of $23.9 million, $17.6 million in total income, and total employment of 517 full time equivalent employees to the economy of Virginia.

In terms of benefits to society, a 100% allocation to the recreational sector, after deducting for expenditures and travel costs, generates approximately $27.6 million in benefits to recreational anglers. In comparison, a 100% allocation to the commercial sector generates approximately $5.6 million in net benefits to watermen, processors, wholesales, distributors, restaurants, retail outlets, and consumers. The commercial benefits include consumer surplus and producer surplus, and the recreational benefits exclude profit or producers' surplus in the commercial-recreational fishery (e.g., party and charter boats and commercial fishing piers).

There are, however, several limitations or problems with the present study. A most important limitation is the use of economic impacts to make decisions about allocation. Economists have long argued that economic impacts should not be the basis upon which to make allocation decisions. There are several reasons for not basing allocation decisions on economic impacts. Edwards (1990) provides a comprehensive listing of reasons why allocation decisions should not be based on economic impacts.

First, input-output or economic impact analysis does not examine economic efficiency (i.e., whether or not production is at least cost and whether or not resources are optimally allocated). That is, it is possible that recreational anglers might be able to engage in some other recreational or leisure activity and actually generate more sales, income, and employment than possible from recreationally fishing striped bass; it also is true that consumers of striped bass might generate more economic activity (impacts) by consuming other fish species or poultry.

To better understand why economic impacts may provide an incomplete picture, consider the cases of smoking and an oil spill. Larger economic impacts might come from smoking more cigarettes than purchasing striped bass or recreationally fishing for striped bass. Tobacco is grown and cured in Virginia, and there are likely less economic leakages (dollars leaving the state) associated with consuming tobacco. Also, since tobacco likely contributes to cancer and heart disease, in-state economic impacts might be quite large from smoking tobacco since individuals with cancer or heart disease would spend considerable money on treatment, and those expenditures would likely have high in-state impacts. Another example of why impacts should not be used to make allocative decisions is the Exxon Valdez oil spill. The spill generated phenomenal economic activity in terms of expenditures, sales, income, and employment. An oil spill, however, is not something the Commonwealth or its citizens would desire.

Second, economic impact analysis does not assess changes in net economic value. Impacts represent financial exchanges that are transfer payments. If the commercial or recreational sector gains money, the other sector and possibly other sectors will lose money. The overall effect will be zero (Edwards 1990). More important, however, is that economic impacts do not provide any information or measure of the net benefits to consumers or users of goods and services. That is, the impacts measure financial transactions of what was paid and received. Economic impacts do not provide any measure of the true economic value of a good or service to an individual.

Third, economic impacts do not provide adequate information about producer surplus. Some economists have suggested that income payments can, in principle, be used to estimate changes in producer surplus (Harris and Norton 1978; Hushak 1987). Edwards (1990) demonstrated, however, that it is clearly inappropriate to examine producer surplus in terms of total income payments generated from economic activity. In the present analysis, even if total income payments are considered to equal producer surplus, it is still concluded that the maximum benefits to society are realized with a 100% allocation to the recreational sector. A 100% allocation to the recreational sector generates approximately $27.6 million in net benefits, while a 100% allocation to the commercial sector generates $18.1 million in consumer surplus and total generated income. There is no mixed allocation that generates higher net benefits than the 100% allocation to the recreational sector. If generated income were added to the recreational benefits, estimated net benefits for the recreational striped bass fishery increase to $128.9 million.

Input-output analysis or impact analysis, even with the known limitations, is still a very useful framework for assessing economic impacts. It is particularly useful for assessing the impacts of enhanced or new economic activity as well as the status quo. It is an extremely useful framework for assessing how regulations might affect economic activity. It offers limited information, however, when used to assess contracted or reduced economic activity (e.g., reducing commercial landings by 25%). Estimates relative to contracted activity may be correct but are restricted to that sector. Estimates of the impacts on the total economy may be incorrect unless it can be determined how producers and consumers in other sectors will respond.

Although the economic analysis concludes society receives the maximum net benefits by allocating 100% of the available catch to recreational anglers, many important aspects which might lead to different allocations were not examined in the present study. The present study examined the allocation of striped bass only with respect to economic impacts and benefits or economic value to society. An important aspect that was not examined is the potential social cost that might occur because of a reallocation of the resource (e.g., the social impact on watermen from loss of harvest rights). The study also did not examine the potential costs that might occur from labor displacement. The potential social impacts on communities and families were also not examined. The study did not attempt to address how the citizens of the Commonwealth might desire to allocate the resource. In essence, the social, cultural, and anthropological costs and impacts were not examined. The study also did not examine the potential costs of different allocations relative to the current individual transferable tag program for the commercial fishery. That is, a change in the present allocation that would favor the recreational sector would impose a cost on the state and society if it was necessary to eliminate the present management regime for the commercial fishery; these latter potential costs cannot be assessed given the present information.

An additional major limitation of the study was the researchers' inability to adequately consider the apparent increasing nature of the recreational fishery to be a catch and release fishery. The analyses focused on resource allocation relative to the harvesting (catching and retaining) of striped bass. Analysis suggests that approximately 43 percent of all striped bass trips were purely catch and release. What is not known, however, are the reasons for catch and release. Were the fish illegal relative to seasonal, size, and creel restrictions? It also is not known how anglers might respond to a catch and release only fishery. It is possible that anglers might not seek striped bass if they do not at least have the option to retain or release fish.

For analytical purposes, it was assumed that anglers would still take trips even if they could not retain striped bass. The number of trips was assumed to equal the number of trips that anglers engaged in catch and release or 43% of all trips. Economic impacts and net benefits were subsequently estimated based only on those trips for which striped bass were harvested (caught and retained). The conclusion that a 100% allocation to the recreational sector provided maximum economic impacts and net benefits, however, remained unchanged.

The study also did not fully consider the substitution possibilities for recreational anglers. That is, the same expenditures or economic impacts and benefits obtained for the striped bass recreational fishery could be obtained if anglers targeted and caught other species (e.g., anglers switch from targeting striped bass to targeting bluefish). Additional analysis, however, suggested that the expected catch per outing would have to substantially increase relative to their 1998 levels. The expected catch of bluefish, for example, would have to increase 340 percent. The expected catch per trip for summer flounder would have to increase 366 percent. The expected catch per trip for spot and croaker and other bottom fish would have to increase by about 639 percent.

Another limitation was the possibility of watermen receiving benefits or income in excess of what they could earn by doing something else. Payments in excess of what must be paid to watermen to have them fish for striped bass represent rents or benefits to labor. Based on survey work and other information, surplus payments were calculated and added to different resource allocations. Even considering these surplus payments to labor as benefits, it was still concluded that a 100% allocation to the recreational sector provided maximum economic impacts and net benefits to the citizens of the Commonwealth.

Another problem and potentially serious limitation was the problem of estimating consumer surplus for commercially harvested striped bass. Data on food store and fish market sales of striped bass were inadequate to precisely estimate consumer surplus or benefits for at-home consumption of commercially distributed striped bass. There was even less information available for estimating the benefits for away-from-home consumption of striped bass. Limited information was subsequently obtained on retail prices, and consumer surplus was estimated based on the assumption that final demand could be adequately represented by a scalar valued function of the commercial ex-vessel demand model; that is, final demand could be approximately by scaling the ex-vessel demand with the retail to ex-vessel price ratio. If the ratio of retail prices to ex-vessel prices were nearly constant, final consumer demand would be very similar to ex-vessel demand.

Out of concern about the imprecision of estimates, the consumer surplus required to equalize the net benefits or economic value between the commercial and recreational sectors was also calculated. Given a zero retention allocation to the recreational sector or 100% to the commercial sector, which assumes a catch and release only recreational fishery, the sum of consumers' and producers' surplus for the commercial fishery would have to equal $8.04 per pound (round or whole weight product) to equal the consumer surplus for a catch and release only fishery. Relative to the maximum benefits possible from the resource, commercially caught striped bass would have to generate a consumer surplus between $14.89 and $32.15 per pound (whole or round weight). Consumers would have to be willing to pay more per pound than the consumer surplus values. It is doubtful that many consumers would be willing to pay more than $14.89 per pound for striped bass. A remaining sensitivity analysis of economic value was also conducted by assuming the retail price to ex-vessel price ratio equaled 20.00; imposing the statistically-determined minimum number of trips for recreational anglers; and assuming that all income generated from the commercial sectors (harvesting, wholesaling, etc) was profit; alternatively, we assumed that labor would work for free. In this case, total net economic value for the commercial sector with a 100% allocation equaled $22.8 million; consumers' surplus for recreational angling, under the assumption of minimum benefits and 100% allocation to the recreational fishery, equaled $18.7 million.

Another limitation or concern was the possibility of imprecision in the estimates. To address this potential problem, all the statistical and mathematical models were subject to a Monte Carlo analysis. With the Monte Carlo analysis, the estimated parameters of various models were allowed to randomly change according to a normal distribution and the mean values and standard errors of the parameters. Estimates were based on 10,000 iterations. The overall conclusion that the economic impacts and benefits are highest with a 100 percent allocation to the recreational sector remained the same. There was a 0.03% probability that the commercial fishery would generate high consumers' surplus than the recreational fishery.

An additional sensitivity analysis on possible errors in estimation was also conducted. In this analysis, it was assumed that the economic value of the commercial fishery had been underestimated while the economic value of the recreational fishery had been overestimated. Estimates were subsequently adjusted to inflate the economic value of the commercial sector and decrease the economic value of the recreational sector. Estimation errors were allowed to range from 1 to 50% of the original estimates. There was no change in the conclusion that economic benefits would be maximized with a 100% allocation to the recreational sector until a 40% estimation error for both sectors (i.e., the economic value of the commercial sector had been underestimated by 40% and the economic value of the recreational sector had been overestimated by 40%).

The analyses indicate that benefits to society would be maximized with a 100% allocation to the recreational sector. That conclusion, however, should not be surprising. In 1998, Virginia anglers took an estimated 870,253 angler trips to catch striped bass. The total number of angler trips for all species in Virginia equaled 2.96 million which were taken by 630,940 anglers. Estimates based on the surveys suggested that approximately 230 thousand individuals caught or attempted to catch striped bass in Virginia in 1998. Last, estimates indicated that about 46% of all striped bass anglers owned some type of pleasure craft. Given the large number of anglers and trips, it is not surprising that the analyses suggest that the economic impacts and net benefits to society would be maximized by a 100% allocation to the recreational sector. It is important, however, to again point out that the analysis of different allocations did not consider the potential social and economic costs of community impacts and labor displacement.

There is a remaining important aspect of the analysis which needs to be considered if the Virginia Marine Resources Commission is considering changes in the striped bass regulations. The time-series data used in the assessment of the commercial and recreational fisheries pertained to a major transition period for striped bass. Between 1973 and 1995, the resource substantially declined and increasing regulations were imposed on striped bass. Between 1981 and 1993, U.S. commercial landings of striped bass fell to all time lows It was not until 1997 that commercial landings started to substantially increase over landings during the past ten years; even in 1997 and 1998, U.S. landings were only about the level of landings in 1976 which equaled only 56 percent of the high 1973 landings. In more recent years, the commercial sale of striped bass in the New York Fulton market has been highly restricted; in 1996, the New York Fulton Market again permitted the sale of striped bass but on a very restrictive basis. In 1998, Virginia striped bass were sold at the market only during two months of the year. In 1999, Virginia product was sold through the market during five months of the year.

The previously described events and changes have important ramifications for the analysis. During the periods of declining resource levels and highly restrictive fishing, commercial markets and their supporting infrastructure declined. Consumers and buyers substituted other species for striped bass. It is extremely difficult to restore lost markets for fishery products. As a consequence, the analysis conducted for the report may not adequately reflect the potential future economic value of the commercial fishery. That is, the present value may be understated relative to the future potential value.

The analysis of the recreational fishery also does not adequately consider the potential future economic value. Recreational fishing for striped bass was highly restricted between 1985 and 1995. During this same period, the abundance of other highly desired gamefish also declined (e.g., bluefish). There was a large pent-up demand by recreational anglers. As the recreational regulations were relaxed, anglers increasingly targeted striped bass. In 1997 and 1998, the recreational harvests, in terms of both number and weight of fish caught, were the highest observed between 1981 and 1998 (the time period of the National Marine Fisheries Service Marine Recreational Fishing Statistics Survey). It is possible that recreational activity in 1997 and 1998 was abnormal. Alternatively, it may be possible that the analysis overestimates the economic value and importance of the recreational fishery relative to the future.

The various sensitivity analyses conducted for this study do incorporate uncertainty about the future. The overall conclusion that benefits to society would be maximized with a 100% allocation to the recreational sector remains unchanged. Statistical analysis, however, only reflects the central tendency of the data. The commercial data depict an overall declining trend in landings and demand. The recreational data depict an overall increasing trend in landings and demand. The statistical analysis, therefore, reflects the central tendency of these two trends. Our overall analysis, therefore, also reflects the two trends which may or may not be indicative of the future potential economic value of the two fisheries.

Given the potential uncertainty about the future value of the two fisheries, we pose the question "Should the Virginia Marine Resources Commission (VMRC) change the current striped bass regulations?" If the Commonwealth has a short planning horizon (e.g., they are only concerned about the fishery as far into the future as year 2002) and desires to maximize the economic value from the resource, then a 100% allocation to the recreational sector is appropriate. If the Commonwealth, however, has a long planning horizon (e.g., from year 2000 to year 2010) and desires to adequately deal with uncertainty about the future, it is advised that they use considerable caution in contemplating changes in the regulations; the VMRC should at least adopt a precautionary approach for considering changes in the regulations. Alternatively, VMRC may want to closely monitor the commercial and recreational fishery during the next two years to detect whether or not the present patterns for the commercial and recreational fisheries are truly indicative of future trends, and then, subsequently change the regulations.

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1. Introduction and Background

1.1 Introduction

Of the many species of finfish exploited along the eastern United States, striped bass, *Morone saxatilis*, has been one of the most important species to both recreational anglers and consumers. During the 1970s and 1980s, however, storms, loss of habitat, and overharvesting resulted in a serious decline of the population. In an effort to rebuild the resource, the Atlantic State Marine Fisheries Commission adopted the Atlantic Coast Striped Bass Interstate Fisheries Management Plan.

Under the plan, extremely restrictive regulations, including an outright moratorium on retention, were implemented. Congress passed additional legislation, the Atlantic Striped Bass Conservation Act, in 1984 and 1988, with amendments in 1986 and 1991, that allowed Federal imposition of a moratorium on striped bass fishing in those states which failed to comply with the ASMFC striped bass plan. States have management authority over striped bass within the territorial sea (out to three miles), and the federal government has management authority over striped bass fishing in the exclusive economic zone (3 to 200 miles). Regulations vary by state but generally involve quotas and size and seasonal restrictions.

By 1997, the resource had apparently recovered to its highest level since 1880 (Schmitten, 1997). As a result of the recovery, anglers and commercial fishermen began to request changes in the existing regulations to allow more fish to be harvested or a decrease in the minimum legal size limit. In those states, particularly New Jersey and Connecticut, that prohibited the commercial harvesting and sale of striped bass, representatives of the commercial industry have increasingly requested the opening of the striped bass fishery to commercial interests.

Despite the apparent increase in the resource, there is an increasing conflict between commercial and recreational interests. Some individuals from each interest group are arguing for an increasing share of striped bass; in New Jersey, some recreational groups are arguing against ever opening the fishery to commercial harvesters. In Virginia, which manages the commercial fishery with an individual transferable quota (ITQ) program and the recreational fishery with size, creel, and seasonal restrictions, the conflict between the two user groups may be anticipated to increase in the future.

Out of concern about the possible economic impacts of changing regulations and a desire to assess the economic value of potential alternative allocations of striped bass among the two sectors, the Recreational License Board and the Commercial Board provided funds to assess the economic impacts and value of different allocations of the resource among the two competing user groups. This report provides the results of the examination of the potential economic values and impacts of alternative allocations of striped bass among the commercial and recreational user groups. The analyses of the economic impacts and societal benefits are restricted to commercial and recreational activities occurring in 1998, the year for which the most complete data are available.

Analyses were based on information obtained from four basic types of surveys. A mail survey of the watermen and recreational anglers was conducted during 1998 and 1999 to obtain information necessary to estimate the economic impacts. An intercept or field survey of recreational anglers was conducted during 1998 to obtain information necessary for estimating the economic value of saltwater striped bass angling. The intercept survey was accomplished as an "add-on" to the National Marine Fisheries Service Marine Recreational Fisheries and Statistics Survey (MRFSS). By adding on to the existing survey, it was possible to expand the survey coverage and obtain more detailed information specific to striped bass. It also facilitates routine assessments of recreational angling at minimum cost since NMFS does the recreational survey on an annual basis. A random digit dial survey was done to assess participation in recreational fishing throughout the state. Last, a follow-up telephone survey of individuals contacted during the intercept survey was done to obtain detailed social and economic information about angling for striped bass in Virginia.

Using data obtained from the surveys, various mathematical and statistical models were formulated. These models are explained in Chapter IV of this report. The statistical models primarily explain relationships between behavior and economic performance and other variables. The mathematical models are of two basic types: (1) input-output which is used to determine the economic impacts, and (2) behavioral and responses models which are used to estimate the economic impacts and benefits of different allocations among the two user groups

2. Striped Bass and the Commercial And Recreational Fisheries

2.1 The Commercial and Recreational Fisheries

Striped bass, *Morone saxatilis*, rock, rockfish, or striper has traditionally been the most popular gamefish of Virginia and the Chesapeake Bay region. Until recent years, striped bass were regularly caught from Maine through North Carolina by commercial and recreational anglers and was considered to be an important and popular commercial and recreational species. Its importance as a commercial species in Virginia, however, has widely varied over time. For example, in 1935, commercial landings of striped bass equaled 375,000 pounds; in comparison, landings of Atlantic croaker equaled 23 million pounds in 1935. Between 1950 and 1998, commercial landings of striped bass in Virginia ranged between 0 in 1989 and a high of 2.9 million pounds in 1973 (Table 2.1). Total commercial landings of all finfish (including menhaden), respectively, equaled 246.9 million pounds in 1950 and 549.0 million pounds in 1998. As a percent of ex-vessel sales value, commercial landings of striped bass equaled 4.96 and 5.20% of the total landed value of finfish in 1950 and 1998. In 1998, reported commercial and recreational landings (caught and retained) equaled, respectively, 1.9 and 1.6 million pounds.

2.1.1 The Commercial Fishery

Relative to total Atlantic coastal state commercial production, the Chesapeake Bay states of Maryland and Virginia produced 65% of the catch of striped bass in the commercial fishery between 1929 and 1965 (Norton et al. 1984). From 1974 to 1980, the respective percentage for these states dropped to 48 percent. Of the Chesapeake states, Maryland produced 63% of the striped bass catch from 1929 to 1974; Virginia produced the remaining 37%. From 1974 to 1980, however, Virginia's share of the Chesapeake catch dropped to 33 % while the Maryland share increased to 67%. Since striped bass are anadromous, the catch is highly seasonal. Landings occur primarily between October and May.

The major gear type used for fishing in Maryland has been gill nets which are anchored, drift, or stake. The Virginia fishery is concentrated in the northern Chesapeake Bay counties of the Northern Neck, with the eastern shore contributing substantially less. Gill nets again predominate as the major commercial gear for Virginia, but pound nets, otter trawls, and handlines either have been historically used or are currently in use. Trawls are presently prohibited in the Chesapeake Bay. Fish from the commercial fishery are sold either to northern or southern wholesalers on the Chesapeake, with final destinations ranging from local restaurants to markets up and down the eastern seaboard (Norton et al. 1984).

Between 1950 and 1995, striped bass were routinely landed in nine states:

(1) Connecticut, (2) Delaware, (3) Maryland, (4) Massachusetts, (5) New Jersey, (6) New York, (7) North Carolina, (8) Rhode island, and (9) Virginia. Intermittent landings also occurred in Maine and New Hampshire. Maryland and Virginia have traditionally accounted for 50% or more of the total US landings of striped bass. For some years between 1950 and 1998, however, Massachusetts, New York, or North Carolina had the highest level of landings.

Table 2.1 Commercial and Recreational Landings of Striped Bass, 1950-1998

Year	Maryland			Virginia			All Other States		
	Commercial Fishery		Sport Fishery	Commercial Fishery		Sport Fishery	Commercial Fishery		Sport Fishery
	Landings	Value	Harvest	Landings	Value	Harvest	Landings	Value	Harvest
1950	3,037,700	578,155		2,796,200	370,276		1,849,800	420,750	
1955	2,572,300	642,998		893,800	177,286		1,498,200	294,100	
1960	1,108,700	674,849		2,278,400	315,552		1,893,700	347,035	
1965	2,949,200	541,866		2,213,400	432,588		6,790,800	484,476	
1970	3,977,500	869,782		1,781,500	371,450		5,427,100	1,286,801	
1975	2,896,800	1,146,185		1,331,300	641,901		4,622,600	2,361,154	
1980	2,100,800	1,824,235		503,000	512,574		2,046,612	3,082,213	
1981	1,640,900	1,651,216	376,530	394,700	455,995	0	2,280,124	3,564,000	0
1982	5,182,000	859,336	0	146,900	229,273	0	1,742,646	3,089,828	891
1983	445,900	858,173	149,351	151,200	271,519	0	1,112,609	1,969,942	432
1984	1,108,500	1,419,560	44,262	508,100	478,370	0	1,313,090	2,199,725	1,982
1985	42,908	45,715	8,825	241,000	258,847	3,585	947,980	1,383,082	12,978
1986	7,600	8,421	3,104	23,700	28,189	5,362	296,421	302,858	19,800
1987	32,500	45,042	40,818	53,300	65,242	19,976	338,993	367,619	4,788
1988	39,800	54,171	1,058	165,677	203,652	178,626	232,256	318,688	38,151
1989	0	0	0	0	0	0	221,230	324,190	1,100
1990	88,470	96,476	12,967	346,778	367,225	443,751	356,240	704,303	68,852
1991	151,389	278,010	456,954	262,405	248,756	333,743	513,865	1,006,274	61,231
1992	559,310	906,282	613,174	280,364	355,100	187,852	686,669	1,306,712	12,879
1993	853,536	1,729,614	794,853	291,407	517,847	505,742	716,970	1,283,702	106,952
1994	977,182	1,696,351	1,096,409	283,681	464,324	870,140	7,102,246	1,300,807	111,337
1995	46,853	76,171	2,057,450	662,463	890,596	955,822	1,852,651	2,856,329	381,303
1996	18,486	31,430	1,560,389	1,608,898	2,775,045	1,340,414	1,501,073	2,665,653	377,447
1997	2,485,714	3,412,371	1,962,947	1,573,669	2,106,531	2,813,471	2,096,082	3,433,153	340,928
1998	2,883,360	3,716,949	1,908,344	1,855,055	2,558,869	1,581,560	1,980,735	3,444,545	559,384

Source of Data: National Marine Fisheries Service (Personal Communication), Latest Catch Statistics. Recreational series available only for 1981 through current period. All Values are in nominal dollars (unadjusted for inflation).

Maine has had no reported commercial landings of striped bass since 1985. Commencing in 1996, Connecticut and New Jersey prohibited the capture and commercial sale of striped bass. As of 1998, the following states or areas had no striped bass commercial fisheries: (1) Connecticut, (2) Maine, (3) New Jersey, (4) New Hampshire, (5) Pennsylvania, and (6) the District of Columbia.

Although the Virginia commercial fishery for striped bass has a long history, it has also experienced many ups and downs since 1950. During the 1950s, average annual landings equaled 1.4 million pounds; the average annual price (in terms of year 2000 constant dollar value) received by Virginia watermen equaled $0.99 per pound. During the 1960s, average annual landings increased to 2.2 million pounds and price declined to $0.86 per pound. In the 1970s, the average annual landings declined relative to the level of the 60s but slightly above the level observed during the 1950s; average annual landings equaled 1.5 million pounds. The average annual price received (in terms of 2000 constant dollar value) was $1.40 per pound. During the 1980s, average annual landings declined to only 243 thousand pounds per year, but price increased to $2.07 per pound. In 1983, the ex-vessel price equaled $3.03 per pound, which was the highest price observed between 1950 and 1998. Between 1990 and 1998, average annual landings equaled 793 thousand pounds; the average ex-vessel price was $1.59 per pound. Since 1994, landings have been increasing while prices have been declining. In 1998, Virginia commercial landings were 1.9 million pounds; the ex-vessel price (year 2000 constant dollar value) was $1.42 per pound.

2.1.2 The Recreational Fishery

The recreational fishery has been considerably different than the commercial fishery. In fact, the latest Marine Recreational Fisheries Statistics Survey Striped Bass Report by the National Marine Fisheries Service (NMFS) indicates that the recreational fishery is increasingly becoming a catch and release fishery (NMFS 1999). Since 1991, over 91% of the striped bass caught by recreational anglers along the Atlantic Coast have been released alive. Between 1982 and 1990, striped bass was relatively unimportant as a recreational species in the United States. Drastic reductions in resource abundance and strigent regulations on recreational anglers are believed to have been major factors why anglers did not exploit striped bass. Between 1990 and 1998, however, the number of directed trips for striped bass increased by approximately 380 percent. In 1998, anglers made slightly more than 6.6 million trips for striped bass. According to the MRFSS Striped Bass Report, approximately 1 in 4 trips made from Maine to North Carolina in 1997 and 1998 were directed at striped bass. NMFS estimates that many avid anglers and charterboat captains now consider striped bass to be exclusive a "catch and release" fishery.

From Maine to North Carolina, there has been a rapid expansion in striped bass recreational fishing since 1981. The U.S. recreational catch (fish caught as opposed to only fish retained which is the harvest), as measured by number of fish caught, increased 1,842.2 percent between 1981 and 1998. The recreational harvest (fish caught and retained), measured by number of fish caught, increased 92.11 percent between 1981 and 1998. In terms of weight, the U.S. recreational harvest increased 589.24 percent between 1981 and 1998; the commercial harvest increased 132.78 percent during the same period.

Until the Norton et al. study of 1984, the striped bass recreational fishery had not been extensively examined. Very little information had been obtained on the recreational fishery. It was not until the National Marine Fisheries Service (NMFS) began its annual Marine Recreational Fishing Statistics Survey program in 1981 that adequate information on recreational activities became available. It is believed, however, that the recreational fishery accounts for a large share of the total harvest of striped bass; Field (1997), in fact, suggests that the recreational catch of striped bass throughout its range may have equaled or exceeded the commercial catch in several states. Since 1981, Virginia saltwater anglers have harvested (that is, caught and retained) approximately 9.24 million pounds of striped bass; Virginia commercial watermen have caught and retained approximately 8.82 million pounds.

Annual data on Virginia's recreational catch have been routinely available since 1981. Between 1981 and 1984, however, there was no recreational fishery for striped bass in Virginia. Since 1985 and up through 1998, the recreational harvest, respectively, in terms of number of fish harvested and weight landed has increased more than 72,000 percent and 44,000 percent. During the same period, the commercial harvest in terms of landed weight has increased only 669.7 percent. In terms of fish caught (included retained and released), there was a 36,234 percent increase. The number of fish released increased by 30,565 percent between 1985 and 1998. In 1998, Virginia anglers released 73.04 percent of all striped bass caught.

2.2 Natural History of the Striped Bass

2.2.1 Description of the Fish

Robins *et al.* (1986) describe the striped bass (*Morone saxatilis)* as a silver colored fish with seven or eight black longitudinal stripes on its side, the center-most being the longest. Its back color can deviate between an olive-green shade in nearshore waters to a blue shade in offshore waters. The fish can attain a length of six feet and can weigh up to 125 pounds. Despite this often cited maximum size, the current record weight of a striped bass recognized by IGFA, the International Gamefish Association, is 78 pounds, 8 ounces. The record fish was caught by Albert McReynolds surfcasting in New Jersey in late September of 1982.

2.2.2 Geographic Range and Major Spawning Locations

The geographic range of the striped bass is wide. Its marine and estuarine range encompasses an area from the St. Lawrence River in Canada to northern Florida and the northern Gulf of Mexico from Western Florida to Louisiana for the Atlantic (Robins et al. 1986). In addition to its Atlantic range, the striped bass has been introduced into large reservoirs in several states after recognition that some of the native fishes survived in land-locked freshwater areas. The fish was further seen as being such a beneficial species that it was also transported and introduced into the Pacific Ocean beginning in the San Francisco Bay area in the late 1800s. Since then, the Pacific population range has extended northward into Washington State.

The striped bass is anadromous moving into estuaries and rivers to spawn and spend its early years, then migrating offshore into more saline waters, but remaining near the coasts except during migrations. Despite its wide Atlantic range, the most prolific spawning grounds for the striped bass are the Chesapeake Bay and the Hudson River. These areas may be the origin for some of the population throughout the northern portion of its range (Richards and Rago 1999).

2.2.3 Reproduction and Growth

Striped bass in the Chesapeake undergo a somewhat sexually dependent growth rate. Females attain less length with age than males until they are approximately three years old, then they grow at more rapid rates than the males (see Table 2.2 for more detailed information). Added to this is the factor that females can have longer life spans than the males, and one then discovers that the largest fish are female.

Table 2.2 Age and Growth of Chesapeake Striped Bass (Karas 1993)

Age of Striped Bass (years)	Fork Length of Males (inches)	Fork Length of Females (inches)
1	5.3	4.9
2	11.7	11.5
3	15.0	15.3
4	17.0	18.4
5	19.7	21.9
6	23.4	25.4
7	27.7	28.5
8	29.7	30.0
9	32.7	33.7
10	34.0	35.4
11	35.7	36.8

Females are thought to reproductively mature at about age 3 to 4 (Norton *et al.* 1984), while males are thought to mature a bit earlier. The spawning season in the Chesapeake spans the period from April to June, when water temperatures are between 57 and 70° F in reaches of the rivers with salinities between approximately 8 to 15 ppt. Females may undergo multiple spawning episodes over the course of several years. The larger the female, the more eggs produced. For example a 4-pound female may produce 426 thousand eggs, while a 55-pound female may produce over 4 million. In recognition of this fact, Maryland began in 1929 protecting females over 15 pounds, with Virginia and Delaware also adopting the regulation shortly thereafter. This regulation was in effect until 1962 when fishermen were allowed to keep one fish in excess of 15 pounds, except during spawning season.

2.3 History of the Striped Bass Fishery

2.3.1 Prehistoric Period

People of the Chesapeake Bay region have been eating striped bass for something on the order of two thousand years. An archaeological site, in this case a shell midden, on a tributary of the Potomac has yielded bones that could be identified as striped bass bones from a Middle Woodland component that was dated between 400 B.C. and 300 A. D. This may be the earliest date for fishing of striped bass because there are remains of fishes of the same genus (*Morone)*, but without sufficient characteristics to be classified to the species level from Early Woodland components dating to maximum ages of approximately 1160 B. C. (Waselkov 1982).

2.3.2 Historic Period

In the earliest historical period, the Colonial period, not only were the Native Americans taking striped bass from this area, the Euro-Americans were also exploiting the resource. One of the earliest colonists from England, Captain John Smith (1629), wrote back to the English monarch that the Dutch, French, and Spanish were gaining "treasure" from the seas (wealth from the catch of fish), especially in the region of "Newfound Land," and that he felt the English should also capture some of that treasure. Once he and his men had established what was referred to as the plantation in Virginia, he wrote of the natives' fishing in addition to their other activities, and described the natural resources of Virginia.

Concerning fish, Smith (1629) writes:

> "Of fish we were best acquainted with Sturgeon, Grampus, Porpus, Seales, *Stingraies*, whose tailes are very dangerous, Bretts, Mullets, white Salmonds, Trowts, Soles, Plaice, Herrings, Conyfish, Rockfish, Eeles, Lampreys, Catfish, Shade Pearch of three sorts, Crabs, Shrimps, Crevises, Oyster, Cocles, and Muscles."

While one may debate over whether the "white Salmonds," or "Rockfish" are in fact what we now call striped bass, they are surely within the fishes of the

Colonists' acquaintance.

In addition to the fish themselves, Smith describes the methods utilized by the natives in the capture and preservation of fish. Fishing equipment for the tribes of which he had familiarity were bow and arrow and dugout canoes. "For fishing, hunting, and warres they vse much of their bow and arrowes as well as their fishing is much in Boats. These they make of one tree by burning and scratching away the coales with stones and shels, till the haue made it in the form of Trough. Some of them are an elne deepe, and fortie or fiftie foot in length, and some will beare 40 men. Once the fish were caught, some were preserved as well as eaten fresh. *Powhatan* their great King, and some others that are provident, rost their fish and flesh vpon hurdles . . ., and keepe it till scarce times."

While the native people used bow and arrow for fishing, Smith had among his supplies for fishing hooks, lines, and nets. Both the native people and the Colonists were at the time participating in a commercial fishery, as the natives used fish in trade while the Colonists were drawn to the New World in part to exploit this natural resource. In addition to the commercial fishery, both the native peoples and the Colonists were eating fish fresh, salting and drying fish for their own subsistence and for fertilizing fields.

Into the 1800s, fishing continued much as it did in the earlier periods. The methods used included nets of various types including pound nets, gill nets, and seine nets, as well as hand lines. In the 1800s, the catch of striped bass still seemed prodigious. Newspaper reports throughout the earlier 1800s are cited by Goode (1884) regarding large, if not enormous, single hauls. Toward the end of the century, a new fishing method had been developed; this new method was used by the upper classes of the day--angling with rod and reel. So popular was this method of fishing that clubs were formed, and in addition to club houses the clubs built piers to place the fishermen further out upon the waters. The fishermen also hired others to chum the waters with menhaden to induce the striped bass to feed and make them less wary of the hooks. The fishing clubs due to the construction costs and the costs of labor of others was the province of the well-to-do, and while one could consider this a recreational fishery, the fish caught by club members were also sold (Goode 1884, Cole 1978, Karas 1993).

Late in the 19th Century, there was a decline in the population of striped bass. This led to the eventual decline of the fishing clubs, and when in the late 1920s, the stock market depleted the population of well-to-do humans, the clubs met their final demise. Despite the loss of one type of fisher, the commercial sector was still continuing. In the 1930s, populations of fish rose again, thanks to the appearance of the 1934 year-class into the Chesapeake Bay (Richards and Rago 1999). With World War II, fisheries saw declines due to lack of available laborers and increased danger to fishermen due to the war. Subsequent to World War II, with the return of soldiers and the increasing availability of mechanical devices such as outboard motors, hydraulic winches, and new materials for net-making, there were advances in the commercial fishery. In addition to changes improving the commercial fishery, similar strides were made in the recreational fishery. While the use of lures began earlier with the use of "tin squid," soon after World War II the use of spinning reels with lures became popular, and many of the recreational fishermen occupying their time off from the factories that were rebuilding the US in the post-war period used this method (Karas 1993). In addition to the newer lures and reels available, outboard motors also became available to the recreational fisherman.

The outcome of these advances was to have a negative effect on the population of fish as fishing capacity was increased with the new technology (Karas 1993, Cole 1978). Commensurate with the decline in the fish population, the fishery also was strongly restricted.

Not only was there an increase in fishing capacity in the postwar era, but other developments and changing land uses are also thought to have an effect on the fishery. Runoff of pollutants from land, habitat destruction due to damming of rivers and episodic climatic events have also been investigated as to their contribution to the decline of striped bass in the 1970s and 1980s. In the mid 1990s, populations of striped bass rebounded and interstate restrictions due to the limited abundance of fish were rescinded in 1995.

2.4 History of Striped Bass Regulations and Management

2.4.1 Historical Management

By the 1700s, there were already concerns regarding protection of the fishery. Laws concerning the use of striped bass were created in both New York and Massachusetts. In early years, all fish, including potentially valuable food fish, were used to manure crops in Massachusetts. This led to the prohibition in 1639 in the use of striped bass for manuring crops (Karas 1993). In New York in the 1700s, fish were prohibited from being taken for sale during the winter months; there were stiff penalties for ignoring the prohibition (Goode 1884).

2.4.2 Management and Recent Years

More recently, the decline of available fish in the 1970s and 1980s brought an interstate focus and national concern to the regulation of the striped bass fishery. The response was first seen in the state management decisions. Although size limits on the fish were set in the 1940s, spawning stock was not protected as the portion of the range north of New Jersey had a larger minimum size limit that the area south of New Jersey, and the smaller minimum size did not assure that 50% of the females of the minimum were sexually mature. Additionally, there was the issue of a wide area involved due to the migration of the fish so that protection in one portion of the range may be circumvented as the fish moved into an area with fewer restrictions on the fishers. To overcome these problems, the 1981 Atlantic States Marine Fisheries Commission (ASMFC) developed an interstate striped bass management plan. The plan dictated both minimum and maximum size limits, area closures, and a series of data collecting and monitoring programs (ASMFC 1981; Field 1997; Richards and Rago 1999). At the inception of the plan, Maryland, Virginia and the Potomac River had regulation as shown in Table 2.3.

In addition to the ASMFC plan, Congress enacted the Atlantic Striped Bass Conservation Act in 1984. The Act provided for a federally imposed moratorium on states that did not adhere to the measures of the interstate plan (Field 1997, FWS 2000).

Despite the efforts of the 1981 plan and the Striped Bass Act, striped bass stocks continued to decline. Further restrictions were implemented at the state level in Maryland in 1985 with a closure of the fishery which extended until 1989 (Field 1997). Additionally, amendments were made to the 1981 striped bass plan. In 1984, Amendments 1 through 3 were approved to increase the effectiveness of the plan. Amendment 1 allowed states to approve management measures equivalent or better than those of the original plan. Amendment 2 set long- and short-term objectives for the plan, and first included the Maryland young-of-the-year index to average over a three year period of 8.0. Amendment 3 was approved to insure no fishing mortality on targeted year classes.

In 1985, an emergency study was also produced by the National Marine Fisheries Service and the U. S. Fish and Wildlife Service. The conclusions of the emergency study were as follows: (1) that juvenile production was low but that the protection of the 1982 year class was succeeding in maintaining a high population of that year class; (2) that there was some negative effects due to chemical contamination; (3) that growth overfishing and recruitment overfishing had occurred; (4) that the increased size limits under Amendment 3 to the 1981 plan, if fully implemented should be effective in rebuilding stocks; (5) that commercial landings were no longer the best representation of abundance and fishery independent monitoring should be used; and (6). that the stocking of striped bass as had already begun should be monitored to determine its effectiveness (USFWS and NMFS 1985).

In 1990, Amendment 4 to the plan was released in response to the needed revisions of the plan by the first three Amendments and in response to the Emergency Study. Amendment 4 was designed to set relaxation of the restrictions of Amendment 3 with the trigger being the attainment of the appropriate 3-year running average of the young-of-the-year index. From this, a transitional fishery was opened which remained in effect for five years. In 1995, the spawning stock biomass reached health levels as determined by fishery-independent gill-net surveys. Amendment 5, allowing increased state fisheries on the recovered population was approved.

Table 2.3 - Fishing Regulations for Maryland and Virginia from before the ASMFC plan to the present[a]

Date	Minimum size	Maximum size	By-Catch	Creel Limit	Season	Area Restriction	Gear Restrictions
MD 1979 (pre-ASMFC Plan)	12" with 14" in Upper Bay June 1- Oct 31	32" TL	Sport catch- 1 fish over 15 lbs May 1 - Mar.1	None	None	None	No purse nets in Chesapeake Bay, no otter trawl in Chesapeake Bay
MD 1982	24" (ocean)	32" TL	Sport Catch- 1 fish over 15 lbs May 1- Mar. 1	10 fish/day sport. 1 fish/day>32" F, caught by hook and line May 1-Mar 1 and not for sale	none	spawning reaches closed Apr 10- Jun 1, including Susquehanna Flats and River. Atlantic Ocean and coastal bays closed Mar 1-May31	Anchor nets prohibited in large area March 1-May 31. Pound net capture prohibited Mar 1-May 11. Gill net mesh size minimum of 4".
MD 1985							Moratorium no possession
MD 1991	Rec: Bay and river-18" Trophy 36", Ocean 28" Commercial: Bay and River - 18" Ocean - 28"	Rec: Bay and river-36" Commercial: Bay and River - 36'		Rec: 2/season 2 for charters (Bay and River), 1 Trophy/season, 1 Ocean/season Commercial cap: 455,000 pounds	Rec: Bay and river-Oct9-Oct 26, three 3-day weekends in Nov, Bay and river charter-Oct 9-Oct 27, Trophy May ll-May 27, Ocean- Oct 11- Oct 27 Comm: haul seine, pound net Sept 2-Oct 18 hook & line Dec2 - Dec 31 Drift gill net Jan2-Feb 28		
MD 1999	Bay: 28" Apr 23-May 31, 18" Jun 1 to Jun 31 (+ 1 > 28"), 118" Jun 14-Nov 30 Ocean: 28"	only 1 larger than 28" /day (Jun 1-Jun 13)		varies by date and location (Ocean versus Bay)	Ocean-year round, Bay Apr 23-Nov 30 except Potomac River and MD tribs Jul 1-Dec. 31		Bait restriction- no eels (mainstem of the the bay), reporting requirements for fish >28" from Apr 24-May 16, also >28' $2 permits required
VA 1970 (pre-ASMFC plan)	14"	2>40"					Trawling prohibited in Chesapeake Bay. Pound net mesh 2"
VA 1982	14" Bay, 24" Ocean		4 fish between 14"-24"(hook and line) 5% of catch between 14"-24" (net)			spawning grounds closed Apr 10- May 21	

Table 2.3--Continued

Date	Minimum size	Maximum size	By-Catch	Creel Limit	Season	Area Restriction	Gear Restrictions
VA 1984				5 fish		Extended closed spawning ground downstream Apr 1-May 31	
VA 1985	18" Bay	40"	No by-catch in ocean	5 fish/day, 2 fish/day>40"	closed statewide Dec 1-May 31	spawning reaches in the James, Pamunky, Mattaponi, and Rappahannock Rivers may be fished only with attended drift nets	no trawl or drag nets
VA 1986	24" Bay, 30" Ocean		Eliminate all by-catch				
VA 1988	24" Bay, 33" Ocean						
VA 1989	-						Moratorium on harvest
VA 1991	Rec: Bay and River 18", Ocean 28" Commercial: Bay and river 18", Ocean 28"	Rec: Bay and River 36", Ocean 36" Commercial: Bay and river 36"		Rec: 2 Commercial cap: 211,000 pounds	Rec: Oct 11-Oct 27 & Nov 21-Dec 5 Commercial: gill nets Nov 5- 8 pound nets Nov 5 -18 haul seine Nov 5 - 18 fyke Nov5 - Dec 5		
VA 2000	28" Ocean, 32" Trophy season, 18" Bay	34" Ocean, 28" Bay for 1 of the 2 allowed for Spring season, 34" for 1 of 2 allowed for Fall season		2 fish /person	Ocean- Jan 1- Mar 31 & May 16- Dec 31, Bay- Spring May 16-Jun 15, Fall October 4-Dec 31, Potomac & Tribs Summer/Fall-June 1-Dec 31, Trophy Ocean May 1-May 15, Trophy Bay May 15-June 15	No possession of 32" or larger fish in the Spawning Reaches May 1 -June 15	

[a]Data prior to 1990 from ASMFC (1990); for 1991 from Karas (1993); for 1999 Maryland from Maryland Department of Natural Resources; and for Virginia 2000, from Virginia Marine Resources commission.

Overlaid upon the population decrease and concerns with overall fishing mortality, the two modern sectors of the striped bass fishery, the recreational sector and the commercial sector, have been competitive with regard to allocation. The recreational sector has been seeking game fish status for striped bass to assure that they have control of the fishery (Walters 1990; Karas 1993).

2.4.3 Fisheries Management in Virginia: 1998-1999

The commercial and recreational fisheries are both regulated in Virginia. Regulations are primarily in the form of a quota to each user group, size limits, temporal or seasonal limitations, and daily catch limitations. In 1998, the commercial and recreational fisheries were restricted by an overall portion of a 10.5 million bay-wide quota, seasonal limits, size limits, and/or creel limits. The commercial fishery had an 18-inch minimum size limit for the Bay and rivers and an ocean minimun size limit of 28-inches. The commercial fishery was open from February 1 until the quota was reached.

The commercial fishery has been managed with several regulations and an individual transferable quota regime. Watermen, as commercial fishers in Virginia are called, must possess a commercial registration license and a gear license. In 1999, watermen received an annual quota of 1,701,748 pounds or the same TAC allocated to recreational anglers. All striped bass in possession had to be identified with a tamper evident sealed tag issued by VMRC. Quota tags could be transferred to any individual who was a licensed commercial fisherman. The open commercial season was February 1 through December 23. There was a minimum size limit of 18 inches for the entire period. There was also a maximum size limit of 28 inches from March 26 through June 15. There was a coastal area fishery which ran from February 1 through December 23, and the minimum size was 28 inches in total length.

There were additional restrictions on the transferability of the tags: (1) tags could not be transferred in any quantity less than 20 tags; (2) no licensed commercial waterman could hold shares totaling more than two percent of the total annual commercial harvest quota; and (3) transfers of tags had to be documented by the Virginia Marine Resources Commission, notarized by a notary public, and approved by the VMRC Commissioner before they are authorized. Transfers of tags could be permanent or temporary. All tags were issued prior to the start of the fishing season. Last, tags that were not used were to be returned to the VMRC within 15 days after the close of the commercial fishery for the year.

In Virginia, saltwater recreational anglers must possess a saltwater fishing license. In 1998 and 1999, the recreational fishery had a combination of seasonal and spatial regulations, daily creel limits, and an overall quota. In 1998, there were two basic quotas: (1) a spring/fall quota which equals a portion of the 10.5 million pound bay-wide quota, and (2) a trophy quota which equals a portion of a 30,000 fish cap. The spring season was from 16 May through 15 June; the fall season was from 4 October through 31 December. The trophy season was 1 through 15 May. There was also an ocean season from 16 May through 31 December. During the spring season of 1998, the allowable size range was 18 to 28 inches; two fish per day were allowed per angler. During the trophy season, one fish per day over 32 inches in length was allowed. During the fall season of 1998, two fish per day over 18-inches were allowed per angler. Relative to the ocean fishery, an angler could retain two fish per day over 28-inches in total length.

The 1999 regulations were similar to those of 1998. In 1999, the total allowable catch (TAC) for both user groups was 3,403,496 pounds. The TAC was equally divided between the commercial and recreational sectors. Remaining regulations are divided into three categories: (1) general prohibitions and requirements; (2) recreational fishing; and (3) commercial fishing.

In 1999, recreational anglers were subject to a quota of 1,701,748 pounds and numerous other restrictions. First, all anglers had to possess a saltwater fishing license to catch and retain striped bass within the Bay or tributaries. Anglers were allowed to catch striped bass using only a hook and line, rod and reel, or hand line. They could not fish in an area or season when there was not an open recreational striped bass season. The Bay Trophy-size striped bass recreational fishery season was between May 1 and June 15. During this trophy season, striped bass had to be at lease 32 inches in length. There was a possession limit of one fish per day. There was also a Bay spring/summer recreational fishery. The time period for this fishery was May 16 through June 15. Fish caught in this fishery had to be at least 18 inches in length and could not exceed 28 inches in total length. There also was a fall striped bass recreational fishery. The fall fishery restricted minimum size to 18 inches and a maximum size of 34 inches. Anglers were permitted to retain two fish per day and one of those could be larger than 34 inches in length. Last, there was a coastal striped bass recreational fishery. This fishery was open from January 1 through March 31 and May 16 through December 31. Anglers were restricted to two fish per person per day, and the fish had to be between 28 and 34 inches in fork length. An angler could retain one fish larger than 34 inches.

3. Issues of Allocation and Competing User Groups

3.1 The Allocation Issue

Allocation of scarce marine resources between commercial and recreational anglers is becoming an increasing concern throughout the nation and the world. As the number of anglers and leisure time increase, the demand for fish products increases, and resources become increasingly limited, commercial harvesters and recreational anglers have increasingly competed for a larger share of the resource. As a consequence, there is increasing pressure placed on resource managers throughout the United States and world to allocate fish stocks between the two user groups.

In the United States, federal Regional Fishery Management Councils have allocated redfish in the Gulf of Mexico, coho and chinook salmon in the pacific, and billfish species in the northwest Atlantic to the two user groups. At the state level and under the auspices of the Atlantic States Marine Fisheries Commission, numerous states have implemented extremely restrictive bans on commercial activities. For example, Florida imposed a net ban on commercial fishing. Florida and South Carolina have both declared red drum, *Sciaenops ocellatus*, to be strictly a "gamefish." Six states or jurisdictions prohibit the commercial harvesting of Atlantic striped bass, *Morone saxatilis*: (1) Maine, (2) New Hampshire, (3) Connecticut, (4) New Jersey, (5) Pennsylvania, and (6) the District of Columbia. Other states such as Maryland and Virginia have allocations for the commercial and recreational striped bass anglers. There is mounting pressure by commercial harvesters to allow commercial fishing for striped bass in New Jersey and Connecticut. The commercial fishery for bluefish has a catch quota equal to 20% of the total catch (recreational catch plus commercial landings). The scup fishery has a proposed allocation of 5.7 million pounds for the commercial sector and 1.6 million pounds for the recreational anglers.

The issue of resource allocation is not likely to dissipate in the near future. In fact, given the increased number of angler clubs and increased demand for access by recreational anglers and commercial fishermen, it is likely that state and federal management agencies will be forced to increasingly consider the allocation of resources between commercial and recreational interests. The allocation of resources, however, raises numerous issues about what should be the basis for allocation. That is, how should allocations be determined?

3.2 A Framework for Allocating Resources

3.2.1 Determining the Optimum Allocation

Economics offers considerable guidance for determining resource allocations. In theory, an optimum economic allocation is one that maximizes net benefits or economic value to society. Any allocation different than the one that maximizes net benefits will be inefficient and generate benefits less than the potential maximum. Determining that optimum point, however, is another story.

It is quite typical of state-level resource managers to determine an optimum allocation relative to resource considerations and economic impacts. That is, which sector will likely lose or gain the most in terms of sales, income, and employment from an allocation constrained by some underlying total allowable catch (TAC). These economic impacts are certainly important considerations. They are not, however, appropriate criteria for determining the optimum economic allocation.

3.2.2 Economic Impacts

Economic impacts are typically assessed or estimated using input-output analysis. Input-output (I/O) analysis is "a systematic method that both describes the financial linkages and the network of input supplies and production which connect industries in a regional economy, and predicts changes in regional output, income, and employment" (Edwards 1990, p. 23).

In general, I/O is little more than an accounting matrix of financial transactions. Individuals make purchases in one sector of the economy. Those purchases generate other purchases or sales, employment, and income. Similarly, producers manufacture goods and services. In order to do so, however, they must purchase other goods and services. They have a payroll. Workers related to the manufacturing of goods and services as well as those from which other goods and services are purchased receive income. They subsequently spend their income on food, utilities, recreation, homes, and other goods and services, which generates even more economic activity. At some point, the economic impacts or activity approach zero in value. The I/O attempts to capture all these linkages in terms of sales or output generated, income, and employment; for additional information on input-output analysis, see Edwards (1990) and Kirkley (1997).

Admittedly, economic activity does appear to be a reasonable basis upon which to determine resource allocations. State and local governments are concerned about sales and production, income, and employment. The federal government also must consider the economic impacts which implementing regulations. Regulations and allocations, however, are not and should not be based on economic impact analysis or the magnitudes of the economic impacts. Such information, however, is required in order to assess the magnitude of the potential impacts.

Consider the recreational saltwater striped bass fishery in Virginia. In 1998, anglers spent approximately $89.5 million to catch striped bass. These expenditures were spread across numerous items (e.g., restaurants, groceries, tackle, fuel, lodging, boat repair and related expenses, ice, and bait). The $89.5 million generated 3,132 full time employment units. If that same $89.5 million had been spent only on dining out, it would have generated full-time employment opportunities for 7,010 individuals. Total sales generated by angler expenditures equaled $135.6 million; if those anglers had spent the same level on dining out rather than sport fishing, total sales would have been $276.3 million. Why are the impacts so different? A major reason for the difference is that many of the items which must be purchased by anglers actually generate large impacts out of the state (i.e., leakage's). In contrast, many of the services and materials required for dining out at restaurants are purchased in-state and have considerably less leakage.

Edwards (1990) provides an extensive listing and discussion of reasons why impact analysis should not be used to determine an optimum allocation of resources between commercial fishermen and recreational anglers. Foremost among the list is that economic impacts are not indicative of economic value to society (i.e., the value society receives in excess of what it cost to purchase and produce a good or service). Another major criticism of using economic impacts as a basis for decisions about allocation is that the impacts represent simply financial transactions or transfers. The economic impacts also convey no information about economic efficiency of the allocation; that is, does the allocation generate the maximum net benefits to society?

Nevertheless, economic impacts do have an important role in determining resource allocations. The impacts are estimates of the potential magnitude of changes in for sales, income, and employment that might occur because of different levels of allocation. Impact analyses is extremely useful for assessing the ramifications of new or expanded economic activity as well as assessing how an economic activity contributes to the economy. Managers have a definite need to know the potential impacts.

3.2.3 Economic Value

If economic impacts are inappropriate for determining the optimum allocation, what is the appropriate framework? Fortunately, economics offers a well-established and accepted framework for providing information for determining the optimum allocation of a resource. That framework is benefit-cost analysis or economic valuation.

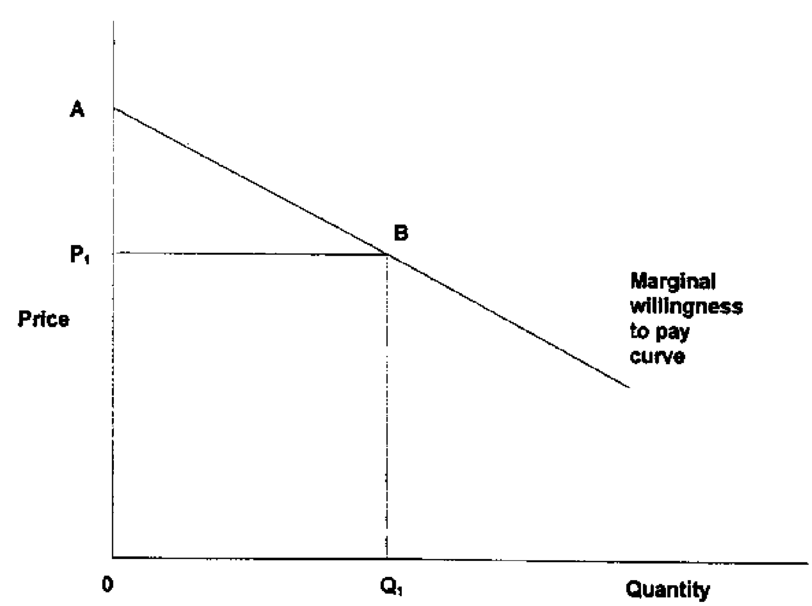
In the case of fisheries and particularly relative to striped bass, the economic valuation requires consideration of several aspects. In terms of economic value, we must consider what is called consumer surplus and producer surplus. We next have to consider these economic values relative to different user groups or other industries which make fish available to consumers or provide commercial services to anglers such as party and charter boats.

3.2.3.1 Consumers' Surplus

Consumer surplus is a measure of the net worth of a good such as seafood or a day of angling to the consumer after expenditures are deducted. A consumer receives economic value from either purchasing a pound of striped bass or catching a pound of striped bass. The economic value of fish is measured in terms of what an individual would be willing to pay for fish—either as food or for sport—rather than spending the same level of money of other goods and services. Because of market conditions and tastes and preferences, however, the consumer may be able to pay considerably less than what they were willing to pay to either acquire the fish or recreationally catch the fish. The difference between what they were willing to pay and what they actually paid is called consumer surplus.

Economic value is an anthropocentric concept (Kahn 1998). Value is determined by people and not by law or government. Economic value is determined by individuals' willingness to make trade-offs. Consider a good sold through conventional markets (e.g., fish sold at a grocery store). Individuals express their willingness to make trade-offs through their willingness to pay a monetary price for fish. Given that a certain quantity, say Q_1, is already being consumed, there is a marginal willingness to pay function which indicates how much individuals are will to pay for an additional unit of fish (Figure 3.1). The total willingness to pay or total economic value is represented by the area $0ABQ_1$ in Figure 3.1. Because of market demand, however, consumers may pay less than their willingness to pay (e.g., P_1 in Figure 3.1). Total expenditures for Q_1 equal P_1 Q_1. The expenditures must be deducted from the total economic value in order to obtain an appropriate measure of net worth of fish. The expenditures are transfer costs and could be spent on other goods and services. The difference between total willingness to pay and the amount actually paid for fish equals consumers' surplus—area ABP_1.

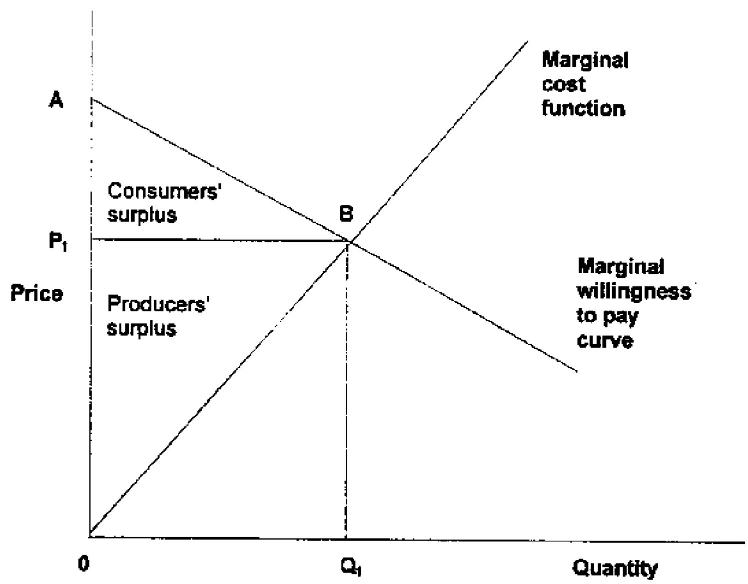
Figure 3.1 Marginal and Total Willingness to Pay and Consumers' Surplus



3.2.3.2 Producers' Surplus and Net Economic Value

Resources were used to capture and market the fish, however, and the costs of these resources also must be deducted from the total value in order to properly assess the true net worth of fish. The reason these resource costs must be deducted is that they could have been used to produce other goods that would benefit society. We have a marginal cost function which depicts the cost, in terms of opportunity cost, of producing one more unit of fish. The opportunity cost equals the productivity of the resources in their next most productive application. The opportunity cost is subtracted from the total value received by producers to yield what is called producers'surplus $0P_1B$ (Figure 3.2). This also is frequently called rent. Resource rent or producers' surplus represents the benefit gained by society from using productive resources in their most productive application. The sum of consumers' and producers' surplus equals net economic value. In Figure 3.2, net economic value equals area 0AB.

Figure 3.2 Producers' Surplus and Net Economic Value



3.3 The Full Economic Assessment

Edwards (1990) provides a convenient framework for what should be assessed to determine an optimum allocation between commercial and recreational anglers. Edwards demonstrates that consumer surplus for final consumption of the commercial product and producer surpluses from all related commercial producing sectors should be added together to obtain the total net economic value of the commercial sector (Table 3.1). Relative to the recreational sector, Edwards argues that consumer surplus for anglers should be added to producer surplus for all commercial recreational activities (e.g., head boats and charter boats). The sum of consumer and producer surplus for each user group represents the total net worth to each respective user group. The sum of the two net worth's equal net benefits to society of the fishery resource.

Table 3.1. Framework for Assessing Economic Value[a]

Seafood Sector	Angler Sector
Consumer surplus in retail markets	Angler consumer surplus
Producer surplus in retail markets	Commercial recreational producer surplus
Produce surplus in wholesale markets	
Producer surplus in distribution and processing	
Producer surplus in harvesting sector	

[a]Adopted from Edwards (1990). Retail markets include grocer stores, seafood markets, restaurants, etc. Producer surplus for commercial recreational activities include party boats, rental boats, private peers which charge for access, and charter boats.

3.4 Remaining Concerns

From a theoretical perspective, the social costs associated with any allocation should also be considered. These would be costs of labor displacement, community disruption, and any social changes imposed on communities because of an allocation. For example, consider a 100% allocation of striped bass to the recreational sector. Individuals who depend upon striped bass will lose income. That loss will be included in the measures of producers' surplus. Individuals, however, will also lose the opportunity to commercially harvest striped bass. The individual may experience a variety of social problems (e.g., loss of self worth). These are social costs that should be included in an economic valuation but typically cannot because of inadequate data.

In essence, the proposed framework does not consider the concept of fairness or superfairness proposed in Baumol (1987). Zajac (1985) suggests that any act, policy, or allocation is unfair if it deprives any individuals of their basic rights to adequate food, shelter, heat, clothing, healthy care, and education in the United States. Zajac also proposes that the retention of a benefit that accrues to an individual under the status quo is considered a right whose removal is considered unjust.

Baumol (1987) has taken a different approach than Zajac to fairness. Baumol argues that allocative efficiency can only properly be determined together with fairness in the allocation. In order to properly consider fairness, it is necessary to access all social costs of any allocation. That is, the costs to individuals who might lose from the allocation must be considered. These costs might include loss of self-worth, reduced employment opportunities, family displacement, increased crime rates, reduced educational opportunities, and numerous other social, cultural, and anthropological factors.

Unfortunately, it is not possible to consider all the social costs that might arise because of allocating striped bass. The analyses contained in this report examined only the allocation that maximizes net benefits to society void of all social costs. The analysis also does not consider the laws that guarantee the right to work or to engage and commerce but not necessarily the right to recreation or leisure.

4. Allocations and Economic Impacts and Values

4.1 Allocations, Assessment Framework, and Study Limitations

Since 1998 was the year having the most complete data and the year for which survey information was collected, the analysis of the economic impacts and values were restricted to 1998. In this study, six allocations were considered (Table 4.1). First, the status quo was examined to assess the relative magnitude of most recent complete fishing season—1998. In 1998, Virginia commercial watermen harvested 1,855,055 pounds of striped bass or 54% of the total harvest by commercial and recreational anglers. Recreational anglers harvested (retained) 1,581,560 pounds or 46% of the total harvest. The next allocation considered was 100% to one sector and 0.0 percent to the other sector. Then, an allocation of 75% to one sector and 25% to the other sector was examined. Last, an equal allocation of 50% to each sector was examined. The allocations were examined with respect to economic impacts and economic values.

Table 4.1 Allocations to the Commercial and Recreational Users, 1998 Activity

Allocation Percent		Allocation Pounds	
Commercial	Recreational	Commercial	Recreational
Status Quo	Status Quo	1,855,055	1,581,560
100%	0%	3,436,615	0
75%	25%	2,577,461	859,154
50%	50%	1,718,308	1,718,308
25%	75%	859,154	2,577,461
0%	100%	0	3,436,615

Assessment of the 1998 activities by commercial watermen and recreational anglers and potential resource allocations was accomplished using input-output (I/O) analysis to assess the impacts (sales, income, and employment) and several statistical models to assess the economic value or benefits of the two activities. Data for the analysis of the recreational sector were obtained from phone, mail, and intercept surveys. Data for the analysis of the commercial sector were obtained from mail surveys of watermen, processors, and distributors. No surveys were conducted of food markets or restaurants to obtain information on final consumption and expenditures by consumers.

The analysis does have several limitations. Major limitations were as follows: (1) inadequate information on final consumer demand for the commercial product; (2) statistical problems caused by a highly-regulated fishery and loss of markets during the 1980s; (3) difficulty of calculating producer benefits or producer surplus or profits; (4) the apparent existence of a large catch and release recreational fishery; and (5) the need to conduct a non-parametric analysis of the expected catch and harvest per striped bass recreational angler trip.

Foremost among the limitations was the absence of adequate information on final consumption. The estimation of economic value requires information on retail prices, retail consumption, restaurant prices, and restaurant consumption. This information was not available and could not be obtained in a cost-effective manner. To address this limitation, several approaches were used. An ex-vessel demand model for striped bass was estimated and modified for final consumption using retail to ex-vessel margins calculated for several years; the subsequent modified demand curve was used to approximate final consumer demand at the retail level. The ex-vessel demand curve was also modified to reflect away from home or restaurant consumption by using restaurant meal price margins and estimates of value added obtained from the input-output model. Based on survey results and the input-output model, it was estimated that at-home and away from home sales were nearly equal (49.4% of the commercial landings were consumed away from home or at restaurants and 50.6% of the landings were purchased for at-home consumption). In addition, the level of consumer surplus (net economic value) on a per pound basis required to equate the commercial product to a pound of recreationally-caught striped bass was estimated relative to consumer willingness to pay for commercial product. Last, Monte Carlo and sensitivity analyses were conducted to assess the statistical precision of the estimates.

The striped bass fishery of Virginia as well as those of other Atlantic coastal states, has been widely regulated. The regulations on commercial and recreational activities have included moratoriums, size limits, creel limits, area limits, and seasonal restrictions. Striped bass have also been plagued with a variety of problems associated with severe water pollution in the northern states; these problems restricted sales and likely reduced consumer demand at the national level. During the 1980s, commercial vendors lost markets for striped bass because of the various restrictions and other limitations. There has been a growing aquaculture production of hybrid striped bass and the expansion and importation of numerous farm raised species (e.g., increased production of red snapper, talapia, and catfish and the importation of farm raised salmon). These products very likely displaced striped bass in the commercial market. The combination of increased regulations and increased supplies of likely substitute consumer products caused substantial statistical problems for the analysis.

Ex-vessel demand was found to be highly unstable over time. The coefficients relating ex-vessel prices to per capita consumption and per capital food expenditures widely varied over time. The price series was highly non-stationary. Preliminary analysis indicated a substantial downward shift in demand over time, particularly between 1985 and 1990; the coefficient for per capita food expenditures was negative. Since the regulations frequently changed, it was not possible to apply conventional regression methods that specifically deal with censored variables (e.g., supply in a given year must be less than or equal to a total allowable catch or quota). To deal with the various problems, a restricted Bayesian approach that allowed price to positively respond to per capita food expenditures was applied. This approach forced the coefficient for per capita expenditures to be positive while allowing for a downward shift in demand during the late 1980s and early 1990s.

Normally, producer benefits or producer surplus would be estimated by an econometric model of supply. The difference between revenues received by producers (watermen, distributors, processors, food stores, and restaurants) and costs provides an estimate of producer surplus. Because of highly regulated production activities, it was not possible to estimate supply. Instead, an alternative, but widely accepted, method was used to estimate producer surplus. Actually, two approaches were used. First, information obtained from the survey data and the input-output model was used to determine a profit margin. These estimates were used to estimate producer surplus at all market levels; as such they likely overstate producer surplus. Next, the framework of Harris and Norton (1978) and Hushak (1987) which suggests that producer surplus can be estimated from the total income generated by economic activities was used to estimate producer surplus. That is, the income estimates obtained from the input-output model were used as measures of profit or producer surplus. Edwards (1990), however, has illustrated that these estimates are excessive or over biased (i.e., they are higher than the actual producer surplus). A remaining issue was that of rent to labor. If labor receives income higher than they could from their next best alternative employment, they receive benefits or what is called rent. Examination of harvesters' net returns suggested that profit for harvesting activities was zero but crew and captain received substantial rent. An analysis of survey responses and other information indicated the crew and captain received rent of approximately $0.54 per pound. In essence, estimates of producer benefits are likely excessive relative to actual rents realized by the commercial sectors.

The catch and release fishery also posed considerable analytical difficulties relative to assessing the economic impacts and value of potential resource allocations. On the one hand, it is clear that some anglers receive benefits even when they do not retain the catch. What is not known, however, is how would anglers respond to not being allowed to retain any striped bass, particularly if the commercial sector received a 100% allocation? That is, anglers may participate in a catch and release fishery because they have the option of releasing fish and may believe they are helping conserve the resource. If they do not have the option of voluntarily releasing striped bass, they may not be willing to engage in catch and release trips. If a substantial number of anglers do receive such benefits from purely catch and release, then changing allocations will have no effect on the overall net benefits except for the potential impacts of reduced availability to recreational anglers. That is, increased harvests by the commercial sector may reduce resource abundance for recreational anglers, and subsequently, reduce their demand for trips and economic value or benefits. To address this problem, the potential relationship between the number of directed Atlantic coast (all Atlantic coast states) striped bass trips, time trends, number of bass retained, and number of bass released was examined. Conventional regression, however, could not determine a precise relationship. Subsequently, a non-parametric regression analysis was conducted. The analysis determined that anglers would still make some trips even if they were prohibited from retaining striped bass. Estimated trips obtained from the non-parametric analysis were next used to estimate expected catch rates for individual anglers in Virginia. This analysis, however, suggested that anglers would make fewer trips than might be realistic given zero retention. Alternatively, the social cost or loss in benefits to recreational anglers from not being allowed to retain striped bass would be substantial. This conclusion would lead one to over estimate the benefits of different allocations. It was subsequently decided to overstate the number of catch and release trips for each allocation and compare those benefit measures to the commercial benefit measures.

4.2 Economic Impacts

4.2.1 Overview of Impacts

Although the previous chapters stressed that allocation decisions should not be based on economic impact analysis, a requirement of the current study was to assess the economic impacts of different allocations. In 1998, commercial anglers harvested 1,855,055 pounds of striped bass. Recreational anglers caught more than 1 million striped bass but retained only 294,008 fish or 1,581,560 pounds (Personal Communication, NMFS, Marine Recreational Fisheries Statistics Survey (MRFSS) data). Commercial anglers received $2.6 million dollars (measured in terms of year 2000 dollars; in nominal or 1998 dollars, Virginia watermen received $2,558,869 in ex-vessel revenue). Processors generated $3.7 million in value added; distributors added another $.2 million in valued added; restaurants and away-from home eating establishments generated $1.9 million in value added; and grocery stores and seafood markets added $0.3 million in value added. For the remainder of this report and unless other stated, all dollar values are reported in terms of year 2000 dollars. In comparison, recreational anglers spent more than $100 million ($101,156,107) (adjusted to year 2000 value) catching or trying to catch striped bass in 1998.

In terms of the total economic impacts of each sector in 1998 relative to the status quo, commercial fishing activities generated total sales of $13.6 million, total income of $10.0 million, and total full-time employment opportunities for 295 individuals. The total impacts include direct, indirect, and induced impacts. Direct impacts are those impacts in the sector for which an expenditure was initially made. The indirect effects measure the economic impacts in the specified sectors providing goods and services to the directly affected sector. The induced effects represent the economic activity generated in turn by personal consumption expenditures due to income generated by employees in the directly and indirectly affected sectors (e.g., workers in wholesaling and accounting spend their paychecks). This report does not separately present the direct, indirect, or induced impacts (these impacts are, however, from the authors in table form). The commercial impacts include all sectors from harvesting through at-home (retail sales) and away-from-home (food service) consumption in Virginia. In contrast, saltwater recreational angling for striped bass generated total sales of $152.0 million, total income of $85.2 million, and total full-time employment opportunities for 3,132 individuals.

In terms of the various allocations, the allocation that generated the largest economic impacts was a 100% allocation to the recreational sector (Table 4.2). A 100% allocation to the commercial sector would generate approximately $23.9 million in total sales in Virginia, $17.6 million in total income, and full-time employment opportunities for 517 individuals. In contrast, a 100% allocation to the recreational user group has the potential to generate up to $181.1 million in total sales in Virginia, $101.4 million in total income, and full-time employment opportunities for up to 3,738 individuals. As previously discussed, however, the economic impacts may be misleading.

Catch and release trips posed considerable problems for the impact analysis. According the National Marine Fisheries Service, there is a growing popularity for catch and release trips (MRFSS Striped Bass Report 1999). What is not known, however, is how anglers would respond to being prohibited from keeping any striped bass. If anglers did not have the voluntary option to release striped bass, would they reduce their trips to zero or near zero. In the present analysis, we assume that the same number of catch and release trips would be taken regardless of the harvest allocations. We subsequently deduct or subtract these impacts from the total impacts of recreational anglers on the basis that the impacts should reflect harvest allocations. Even after subtracting the economic impacts for the catch and release striped bass fishery, the maximum economic impacts occur for a 100% allocation to the recreational user (Tables 4.3 and 4.4).

The recreational assessment was complicated by uncertainty about the demand for recreational trips in response to different allocations. Statistical models failed to provide a relationship between the expected catch and harvest and retention levels. In fact, statistical results suggested large responses to retention. Given the large catch and release fishery, it was thought that the estimates over stated the potential expected catch in response to different allocations. As a consequence, it was assumed that the number of anglers would not change in response to different allocations, and two models were used to estimate total trips. A non-parametric model relating the total number of Atlantic coast striped bass angler trips to a trend variable, number of fish retained, and number of fish released was used to estimate the potential expected catch. It was also assumed that Virginia striped bass anglers would follow the same relationship as would Atlantic coast striped bass anglers. The total number of trips was then used to construct an expected harvest (number of fish per trip) per Virginia angler variable. Total trips were estimated for each allocation by multiplying the number of anglers times the number of expected trips (Table 4.5); the individual Virginia angler trip demand model allows for trips with zero expected catch per outing.

Table 4.2 Economic Impacts of 1998 Commercial and Recreational Striped Bass Fisheries

Allocation		Landings Pounds		Total Sales Year 2000 Dollars		Total Income Year 2000 Dollars		Person Years of Employment	
Commercial	Recreational	Commercial	Recreational	Commercial	Recreational[a]	Commercial	Recreational	Commercial	Recreational
Status Quo	Status Quo	1,855,055	1,581,560	13,638,527	152,006,719	10,039,134	85,176,392	295	3,132
100%	0%	3,436,615	0	23,939,202	67,886,898	17,592,173	38,055,991	517	1,398
75%	25%	2,577,461	859,154	18,470,940	138,481,523	13,580,307	77,591,265	399	2,854
50%	50%	1,718,308	1,718,308	12,699,009	155,395,297	9,350,222	87,061,590	275	3,203
25%	75%	859,154	2,577,461	6,624,277	167,004,479	4,895,831	93,515,118	144	3,445
0%	100%	0	3,436,615	0	181,071,669	0	101,337,066	0	3,738

[a]Assumes continuation of catch and release trips. Based on survey data and information available from the National Marine Fisheries Service, it is estimated that anglers took 334,582 catch and release angler trips in 1998. Alternatively, 38% of the total angler trips for striped bass were catch and release trips.

Table 4.3 Economic Impacts of 1998 Commercial and Recreational Striped Bass Fisheries (subtracting impacts of catch and release trips)[a]

Allocation		Landings Pounds		Total Sales Year 2000 Dollars		Total Income Year 2000 Dollars		Person Years of Employment	
Commercial	Recreational	Commercial	Recreational	Commercial	Recreational[b]	Commercial	Recreational	Commercial	Recreational
Status Quo	Status Quo	1,855,055	1,581,560	13,638,527	84,119,821	10,039,134	47,120,941	295	1,734
100%	0%	3,436,615	0	23,939,202	0	17,592,173	0	517	0
75%	25%	2,577,461	859,154	18,470,940	70,594,625	13,580,307	39,535,274	399	1,456
50%	50%	1,718,308	1,718,308	12,699,009	87,508,399	9,350,222	49,005,599	275	1,805
25%	75%	859,154	2,577,461	6,624,277	99,117,581	4,895,831	55,459,127	144	2,047
0%	100%	0	3,436,615	0	113,184,770	0	63,281,075	0	2,340

[a]The recreational assessment excludes the economic impacts generated from the catch and release striped bass fishery.

[b]Assumes catch and release trips are unimportant relative to the harvest allocation. Based on survey data and information available from the National Marine Fisheries Service, it is estimated that anglers took 372,729 catch and release angler trips in 1998. Alternatively, 42.8% of the total angler trips for striped bass were catch and release trips.

Table 4.4 Economic Impacts of 1998 Commercial and Recreational Striped Bass Fisheries and Alternative Resource Allocations

Allocation		Sales—Total Output 2000 Dolars			Total Income 2000 Dollars			Total Employment Full-time Equivalent		
Commercial	Recreational	Commercial	Recreational	Total	Commercial	Recreational	Total	Commercial	Recreational	Total
Includes All Angler Trips: Harvest and Catch and Release Trips										
Status Quo	Status Quo	13,638,527	152,006,719	165,645,246	10,039,134	85,176,392	95,216,066	295	3,132	3,427
100%	0%	23,939,202	67,886,898	91,826,100	17,592,173	38,055,991	55,648,164	517	1,398	1,915
75%	25%	18,470,940	138,481,523	156,952,463	13,580,307	77,591,265	91,171,572	399	2,854	3,253
50%	50%	12,699,009	155,395,297	168,094,306	9,350,222	87,061,590	96,411,812	275	3,203	3,478
25%	75%	6,624,277	167,004,479	173,628,756	4,895,831	93,515,118	98,410,949	144	3,445	3,589
0%	100%	0	181,071,669	181,071,669	0	101,337,066	101,337,066	0	3,738	3,738
Excludes Catch and Release Trips: Harvest or Retention Only										
Status Quo	Status Quo	13,638,527	84,119,821	97,758,348	10,039,134	47,120,941	57,160,075	295	1734	2,029
100%	0%	23,939,202	0	23,939,202	17,592,173	0	17,592,173	517	0	517
75%	25%	18,470,940	70,594,625	89,065,565	13,580,307	39,535,274	53,115,581	399	1456	1,855
50%	50%	12,699,009	87,508,399	100,207,408	9,350,222	49,005,599	58,355,821	275	1805	2,080
25%	75%	6,624,277	99,117,581	105,741,858	4,895,831	55,459,127	60,354,958	144	2047	2,191
0%	100%	0	113,184,770	113,184,770	0	63,281,075	63,281,075	0	2340	2,340

Table 4.5 Estimated Number of Angler Trips Given Resource Allocations, 1998[a]

Allocation	Private Boat	Charter Boat	Head Boat	Rental Boat	Shore & Pier	Total Trips
Status Quo	696,243	20,644	11,782	1,359	140,225	870,253
100%	908,188	26,928	15,369	1,773	142,952	1095,209
75%	805,637	23,888	13,633	1,573	141,411	986,142
50%	720,943	21,376	12,200	1,407	140,640	896,567
25%	633,198	18,775	10,715	1,236	139,009	803,022
0%	319,111	9,462	5,400	623	38,146	372,742

[a]Estimated trips based on non-parametric model relating number of Atlantic Coast striped bass angler trips for boats and shore to number of striped bass retained, number of striped bass released, and a time trend. It was assumed that all types of boat trips would follow the same pattern as estimated for all boats and Virginia anglers would have the same relationship as did that determined for all Atlantic coast striped bass anglers.

Recreational expenditures by anglers, however, were not assumed to proportionally change with number of trips. For example, at a 100% allocation, it is doubtful that additional boat purchases would be generated. The same assumption was imposed on equipment and tackle purchases. In essence, only trip level or expenses that would likely vary with the number of trips were changed in the analysis in response to different allocations. For allocations less than the status quo, however, new boat purchases were proportionally decreased relative to number of striped bass angler trips. It is thus likely that the economic impacts for allocations in excess of the status quo are seriously underestimated.

The economic impacts indicate contributions to the economy of Virginia. They do not indicate the most efficient level of economic activity for the state. They also only indicate impacts relative to the sectors examined. Consider a reduced allocation of striped bass to the recreational sector. The number of recreational trips and associated expenditures would decrease. Those businesses traditionally dependent upon recreational striped bass fisheries would experience economic impacts in terms of reduced sales and income, and might subsequently lay off workers. Anglers, however, would likely spend their money pursuing other recreational species or other leisure activities. The net result might be no change in the level of economic impacts, an overall decrease in economic activity, or an actual increase in overall economic activity. It is, therefore, difficult to adequately assess the economic impacts on the economy of Virginia of reduced allocations to either the commercial or recreational user.

In the case of increased allocations to either sector, however, the economic impact analysis does generate appropriate estimates of sales, income, and employment. An increased allocation represents new or enhanced economic activity. Additional resources would be required to support the enhanced activity given all other economic activity remains status quo. In this case, the economic impacts provide adequate estimates of changes in economic activity.

Relative to economic efficiency, the economic impact analysis does not provide appropriate information. That is, economic changes estimated from the impact assessment are not necessarily indicative of the best use of Virginia's resources. Consider total angler expenditures of $100.2 million (year 2000 dollars) in 1998. These expenditures generated total sales of $152 million, total income of $85.2 million, and full-time employment opportunities for 3,132 individuals. What if anglers had instead spent their money on dining out or lodging? If the entire $100 million had been spent on dining out, total sales in Virginia from the dining out expenditures would equal $309.3 million; total income generated from the expenditures would equal $164.1 million; and total employment would equal 7,010 full time employees. Alternatively, if the entire $100 million were spent on lodging, total sales from those expenditures in Virginia would equal $238.6 million; total income generated would be $155.4 million; and total full-time employment would equal 6,426 individuals.

A remaining aspect of the impact analysis that must be considered is leakages. Leakages represent dollar amounts leaving the state. For example, commercial and recreational anglers purchase fuel for their activities. Fuel available to anglers and watermen, however, is refined and processed out of state. Expenditures on fuel, therefore, do not generate large in-state impacts. The same is true of recreational pleasure craft and fishing tackle. At the other end of the spectrum and specific to striped bass is that commercial activities relative to striped bass do not generate large in-state economic impacts because a lot of the fish harvested in Virginia are sold out of state (e.g., the Fulton Market). Available data suggest that approximately 60% of commercial landings or processed product was shipped or sold out-of-state in 1998.

4.2.2 The Economic Impacts of the Commercial Sector

This section presents a more detailed examination of the economic impacts of the commercial sector. The impacts are presented in terms of year 2000 dollars and relative to all purchasing and consuming sectors of Virginia. In addition, the impacts are presented relative to the status quo of 1998 and the potential allocations of 100%, 75%, 50%, and 25% [Table 4.6]

In 1998, commercial watermen spent (excluding crew and captain receipts) approximately $2.2 million harvesting striped bass. Watermen received $2.6 million in total revenues—the difference between total receipts and expenditures represents profit and payments to labor. The total economic impacts on the economy of Virginia was as follows: (1) $23.6 million in total sales; (2) $10.0 million in total income; and (3) total full-time employment opportunities for 295 individuals.

Table 4.6 Distribution of Impacts of Commercial Striped Bass Fishery[a]

Allocation	Sector	Sales Year 2000 Dollars	Income Year 2000 Dollars	Employment Full-Time
Status Quo	Harvesting	4,698,964	1,561,432	45
	Processing	4,897,361	4,844,122	139
	Distribution	343,084	319,327	9
	Food Service	3,282,376	2,921,411	91
	Retail Markets	416,741	390,604	12
Total[b]		13,638,527	10,039,134	295
100%	Harvesting	8,311,516	2,760,794	79
	Processing	8,663,763	8,569,757	246
	Distribution	607,084	569,007	16
	Food Service	5,619,420	5,001,447	155
	Retail Markets	737,419	691,168	21
Total		23,939,202	17,592,173	517
75%	Harvesting	6,393,892	2,124,258	61
	Processing	6,664,316	6,591,940	189
	Distribution	466,922	437,636	13
	Food Service	4,378,644	1,764,445	121
	Retail Markets	567,166	531,594	16
Total		18,470,940	13,580,307	399
50%	Harvesting	4,369,405	1,451,974	42
	Processing	4,553,828	4,504,314	129
	Distribution	319,011	299,002	9
	Food Service	3,069,267	2,731,737	85
	Retail Markets	387,499	363,196	11
Total		12,699,009	9,350,222	275
25%	Harvesting	2,238,303	743,972	21
	Processing	2,332,586	2,307,186	61
	Distribution	163,380	153,133	4
	Food Service	1,691,552	1,505,531	47
	Retail Markets	198,457	186,009	6
Total		6,624,277	4,895,831	144

[a]Output or sales of all sectors other than the harvesting sector excludes the value of output for that sector and instead measures the value added by that sector.

[b]Totals may not equal sum of sector values because of round-off error.

In terms of total generated sales, processing activities accounted for the largest percentage of total generated sales. Harvesting and food service or restaurant sales accounted for the second and third largest percentages of total sales generated. Retail market sale activities accounted for only 3.05% of total generate sales.

Allocating the entire total observed catch of 3,436,615 pounds to the commercial sector in 1998 would have nearly doubled total output or sales, income, and person years of employment. Ex-vessel prices relative to the status quo would have decreased by 4.48%, but total ex-vessel revenues would have increased by 76.95 percent. A 100% allocation to the commercial sector in 1998 would have generated $23.9 million in total sales, $17.6 million in income, and 517 person-years of employment.

An allocation of 25% would be accompanied by a 2.82% increase in ex-vessel price but a 52.4% decline in total ex-vessel revenue. Total sales generated from striped bass commercial activity would decrease to $6.6 million; total income would decline to $4.9 million; and total person-years of employment would decline to 144.

There are, however, several important caveats to the preceding results. First, it must be remembered that slightly more than 60% of striped bass and associated products are shipped out of the state of Virginia. The potential importance of striped bass to the economy of Virginia is thus reduced. It also is unlikely that the total sales, income, and employment would actually decline as much as projected by the analysis. Harvesters and consumers might switch over to other products. For example, watermen might attempt to harvest more of certain species such as croaker and spot. Alternatively, watermen might take work in other occupations such as carpentry or home construction. Consumers might substitute flounder, salmon, or sea trout for striped bass. Alternatively, diners might switch from seafood restaurants to Italian or other speciality restaurants.

4.2.3 The Economic Impacts of the Recreational Striped Bass Fishery

In 1998, recreational anglers took approximately 870,253 trips for striped bass. They spent a total of $100.2 million catching or trying to catch striped bass in Virginia waters. The largest expenditures were related to boats. Anglers spent approximately $38.3 million on boat and boat related expenditures catching or trying to catch striped bass in Virginia [Table 4.7]. Many of the boat related expenditures, such as fuel expenditures and boat purchases, however, have low impacts on total sales, income, and employment in Virginia. For example, anglers spent more than $19 million on new and used boats in 1998 so that they could fish for striped bass; the total sales impact throughout the entire economy, however, was $5.7 million.

In 1998, recreational striped bass angling activity generated total sales of $152 million; $85.2 million in total income; and 3,132 person-years of employment. Private boat trips generated the largest sales, income, and person-years of employment [Table 4.8]. The second major mode, in terms of economic impacts, was charter boats. In 1998, charter boat trips for striped bass generated over $22 million in total sales (year 2000 constant dollar value), $11.7 million in income, and 449 person-years of employment. Although the economic impacts or importance of rental boats are included, they should be viewed with caution. There were few respondents indicating the use of rental boats.

Table 4.7 Expenditures and Economic Impacts of Recreational Fishery, 1998

Expenditure Category	Expenditures Year 2000 Dollars Thousand Dollars	Economic Impacts		
		Sales Thousand Dollars	Income Thousand Dollars	Employment Person-years
Restaurant Meals	$7,513	$23,199	$12306	526
Groceries	8,316	13,603	7,639	277
Lodging	5,266	14,042	9,148	338
Bait	3,919	4,608	2,617	106
Ice	2,148	5,100	2,979	101
Head Boat Fees	781	1,939	1,087	38
Charter Boat Fees	6,417	15,724	7,858	310
Rental Boat Fees	185	391	226	6
Equipment Rental	24	0	0	0
Public Transportation	35	42	19	1
Rental Automobile	1,607	2,290	1,258	40
Private Automobile	8,414	8,062	4,205	141
Other Fees	2,629	5,310	2,936	98
Total Trip Expenses	$47,231	$94,309	$52,309	1,980
Fishing Equipment Purchase				
Fishing Rods	$4,366	$5,502	$3,289	127
Fishing Reels	3,292	4,149	2,480	96
Special Fishing Clothing	364	822	429	10
Other Fishing Tackle	6,662	8,395	5,018	194
Total Equipment Purchases	$14,685	$18,868	$11,215	434
Boat Expenses				
Boat Fuel and Oil	$6,613	$3,901	$2,226	70
Docking and Launching Fees	2,652	7,202	3,881	142
Dry Storage Fees	1,636	4,442	2,394	87
Haul Out and Bottom Paint	872	2,212	1,352	42
Engine Repair and Maintenance	546	1,072	499	18
Other Hull and Electronic Repairs	1,032	2,183	1,006	30
New Electronic Equipment	409	512	324	14
New Accessories	993	1,396	809	34
Trailer Maintenance	246	483	225	8
New Trailer	194	160	93	3
Insurance	1,205	2,075	1,096	31
Taxes and Registration	205	422	317	12
Boat Loan	2,667	5,910	3,360	89
New Boat	19,004	6,859	4,073	138
Total Boat Expenditures	$38,275	38,829	21,653	718
Total Striped Bass Expenditures	$100,191	$152,006	$85,177	3,132

Table 4.8 Economic Impacts of Saltwater Striped Bass Angling Trips, by Mode

Mode	Sales (Total Output)[a]	Total Income	Person-Years Of Employment
Private Boat			
Expenditures	$68,380,673		
Direct	$37,744,681	$2,1293393	940
Indirect	10,801,792	6,548,712	180
Induced	46,154,535	26,070,549	82
Total	$94,701,008	$53,912,654	1,943
Friend's Boat			
Expenditures	$10,672,969		
Direct	$6,726,764	$3,711,086	185
Indirect	1,669,653	937,290	26
Induced	8,968,645	5,066,069	161
Total	$17,365,062	$9,714,446	372
Head Boat			
Expenditures	$1,590,252		
Direct	$1,279,955	$693,169	31
Indirect	421,053	248,600	8
Induced	1,508,399	852,184	26
Total	$3,210,526	$1,793,953	65
Charter Boat			
Expenditures	$10,182,409		
Direct	$9,165,733	$4,108,623	212
Indirect	3,709,966	2,144,457	71
Induced	9,572,228	5,407,615	166
Total	$22,447,928	$11,660,694	449
Rental Boat			
Expenditures	$373,299		
Direct	$29,153	$164,614	5
Indirect	96,305	63,830	2
Induced	264,278	148,936	5
Total	$651,736	$377,380	11
Shore-based			
Expenditures	$8,991,187		
Direct	$5,415,454	$3,072,788	145
Indirect	1,250,840	711,086	20
Induced	6,964,166	3,933,931	126
Total	$13,630,460	$7,717,805	291

[a]Sales and income are presented in terms of year 2000 constant dollar values.

At the maximum possible allocation of 100% of the total 1998 catch or 3,436,615 pounds, the recreational sector has the potential to generate $181.1 million in total sales in Virginia; $101.3 million in total income; and 3,738 person years of employment. Although the total allocation would increase by slightly more than 50%, we estimate that the total number of trips would increase by only 25.8%, from 870,253 to 1,095,170 angler trips. At zero retention and assuming the same number of catch and release trips as were taken in 1998, the estimated economic contributions of the recreational fishery are $67.9 million in total sales, $38.1 million in total income, and 1,398 person-years of employment.

A particular difficulty of the impact analysis for striped bass is what appears to be a relatively large catch and release fishery. Based on information obtained from the surveys and from the MRFSS, it appears that approximately 372,729 catch and release trips were made by anglers in 1998. NMFS notes that for the Atlantic Coast Marine striped bass fishery, there has been an increasing tendency by anglers to engage in catch and release. NMFS estimates that over 91% of all striped bass caught since 1991 have been released alive. The catch and release nature of the fishery complicates the assessment of economic impacts because it is not known how anglers would respond to regulations that restrict their catch below current levels. The economic impacts including and excluding catch and release trips were therefore estimated (Table 4.4). Even after subtracting the impacts of catch and release trips, total sales, income, and person-years of employment are largest for the 100% allocation to the recreational user group.

4.3 Economic Values or Net Value Assessment

4.3.1 Overview of Methodology

As stated throughout this report, economic impacts should not provide the primary basis for making allocative decisions. Economists have long argued and demonstrated that allocations should be based on the economic value society receives from goods and services or a particular state of the environment. In the simplest explanation, economic value is a measure of what the maximum amount an individual is willing to forego in other goods and services in order to obtain some good, service, or state of the world (Lipton et al. 1995). More formally, this is the concept of willingness to pay (WTP). Since there are costs of acquiring goods and services, however, economic value must be adjusted to reflect the net willingness to pay. In essence, a measure of net benefits requires measures of net consumer benefits and net producer benefits or consumers' surplus and producers' surplus. The sum of these two surpluses provides an estimate of economic value or net benefit to society.

Consumers' surplus is a measure of what consumers are willing to pay in excess of what they actually have to pay to acquire a good or service, state of the environment, or access to a natural resource. The total economic value to a consumer is the total benefit the consumer or individual receives. The cost of acquiring the good or service, however, must be deducted to obtain a measure of net value or consumer surplus to the consumer or individual.

Producers also may receive a surplus; this is referred to as producer surplus and it is a benefit to producers. Producers' surplus is a measure of what producers earn over their production costs for the total quantity of a good sold. This is a net benefit to producers.

A remaining aspect of value for fisheries is that of rent to labor. That is, if labor, captain and crew, receive payments in excess of what they would be willing to work for, they receive economic rents or surplus payments. Typically, this is calculated by taking the difference between the actual amount of earnings received and what is called the opportunity cost of labor or the amount that workers could receive in their next best alternative form of employment. In this study, it was determined that captain and crew received about $0.54 per pound of surplus payments relative to striped bass activities in 1998.

In this study, consumers' surplus for the commercial sector was estimated using an inverse ex-vessel demand for striped bass. The inverse demand expressed prices as a function of per capita demand for striped bass and per capita food expenditures; prices and income were deflated with the food and beverage price index (1994=100). The inverse demand allows prices to vary with changes in demand. The mathematical area underneath a demand is an estimate of total economic value. Consumers' surplus is estimated by deducting total expenditures from total economic value. Final consumer level benefits were determined by modifying the ex-vessel demand to reflect final consumer demand and the calculated at-home and away-from-home consumption percentages of striped bass. Consumers' surplus for recreational anglers was estimated using a recreational demand model for angling trips. The mathematical and statistical models are described in the technical appendix to this report.

Producers' surplus for all of the related commercial sectors was initially estimated using survey data. Producers' surplus for the commercial sector was also estimated using the profit margins obtained from the input-output analysis applied to value added estimates for each commercial sector. It was subsequently estimated using estimates of total income generated by all commercial activities; this latter estimation substantially overstates producers' surplus for the commercial fishery and related sectors. Edwards (1990) has demonstrated, however, that estimates of producers' surplus based on income generated with an input/output model are substantially overestimated. In addition, if estimates of generated income for the commercial sector are to be used as estimates of commercial producers' surplus, then estimates of income generated by recreational angling should be used as estimates for producers' surplus in the recreational sector. Estimates of the income generated for the commercial and recreational sectors in 1998, respectively, equaled $10.0 million and $85.2 million.

Producers' surplus for the recreational sectors that might generate profits, such as party and charter boats, however, was not included in the assessment because the necessary data for an accurate estimate were not available. Estimated income generated from recreational angling expenditures also was not further considered relative to estimating producers' surplus; inclusion of income as an estimate of producers' surplus would yield an economic value in excess of any value for the commercial fishery. As such, the net economic value for the recreational sector is likely underestimated. Estimates of the economic value of the recreational fishery based on less restrictive assumptions are available from the authors in table form. These latter estimates are less conservative relative to the recreational sector and suggest even greater benefits for recreational anglers than presented in this report.

Although a wide variety of estimates could be presented, we focus on those estimates that are likely to substantially overstate the economic value of the commercial fishery and understate the economic value of the recreational fishery. This was done because the economic value of the recreational fishery exceeded the economic value of the commercial fishery, and it is a common analytical procedure to conduct a least-most conservative analysis as a form of sensitivity analysis. In the commercial assessment, we use 50.6% of the total Virginia commercial landings to approximate at-home consumption, and 49.4% of the total landings to approximate the restaurant or away-from home consumption. The fish and food market retail price was approximated by using the mark-up coefficients from the input-output model and several years of data for which retail and ex-vessel prices were available. Grocery and fish market stores and restaurant retail prices were in terms of whole or round weight (i.e., undressed striped bass).

Retail market prices for fish and food markets were approximated by multiplying the ex-vessel price by a factor of 1.94. Subsequently, consumers' surplus for at-home consumption was estimated using the ex-vessel price model adjusted to reflect retail prices and a constant retail to ex-vessel price ratio of 1.94. The factor 1.94 was determined based on information obtained from surveys, previous data on retail prices, and mark-up coefficients used in the input/output model. For prices for away-from-home consumption, mark-up coefficients were obtained from the input-output model and information from sales relative to expenditures by restaurants to acquire striped bass. This yielded a coefficient of 5.29 which was multiplied by the ex-vessel prices corresponding to each allocation. The 5.29 coefficient reflects only the striped bass portion of the meal; it does not include the values of the various side dishes such as baked potatoes and salads. The analysis assumes that the final consumer demand is a scalar multiple of the ex-vessel demand; that is, all market prices respond to changes in per capita demand and food expenditures in the same way but differ by a constant (i.e., the ratio of upper market level prices to ex-vessel prices).

Consumer surplus for the recreational sector was calculated from a demand for trips model. The model expresses angler demand for trips as a function of travel and other costs, mean or expected catch per outing for several species, and variables related to type or mode of fishing (e.g., boat or shore). The model yields estimates of the demand for recreational trips by an individual angler. Consumers' surplus is subsequently calculated on an angler and per trip basis using the recreational demand for trips model.

Out of concern about the uncertainty of the retail store sales and away-from-home striped bass consumption, consumers' surplus was calculated by modifying the ex-vessel price demand model to reflect a retail price to ex-vessel price ratio of 20.00. It was then assumed that the entire consumption of striped bass would be away-from home. Last, the level of consumers' and producers' surplus, on a per pound basis, required to equate the net value of the commercial sector to that of the recreational sector was calculated. These values indicated that consumers would have had to be willing to pay more than $14.89 per pound of whole or round fish (undressed) relative to observed commercial production in 1998 to generate the same level of consumers' surplus generated by the recreational sector. If the commercial sector received 100% of the allocation, final consumers would have to be willing to pay more than $8.04 per pound (whole fish or round weight) to generate the maximum economic value or net benefits generated by the recreational fishery; producers' surplus for the commercial-recreational sector is excluded. These latter numbers far exceed any values obtained from available information.

4.3.2 Economic Value of the Commercial and Recreational Sectors

In this section, summary estimates of the economic value or net benefits of the various allocations are presented. Additional estimates and analysis may be obtained from the authors. The commercial sector is presented in the most favorable status while the recreational sector is presented using the most conservative estimates. This was done because the value estimates for the recreational sector were considerably larger than those for the commercial sector, and when the estimated value of one sector or outcome is considerably higher than that of the other sector, the least-most conservative analysis offers a form of sensitivity analysis. Estimates are presented relative to the three measures of producers' surplus, including and excluding the benefits from the catch and release fishery, and with respect to the surplus values per pound required for the economic value of the commercial sector to equal the value of the recreational sector.

Estimates of net economic benefits or the sum of consumers' and producers' surplus are presented in Tables 4.9 and 4.10. Table 4.9 presents estimates of economic value given the 49.4% away from home consumption and the 50.6% at-home consumption and producers' surplus estimated from survey information and detailed economic analysis. It also includes the consumer surplus measures with and without the benefits of catch and release trips. Table 4.10 provides the same assessment but uses the higher income values estimated from the input-output model to equal producers' surplus. Table 4.11 provides estimates of the net benefits (consumer plus producer surplus) on a per pound basis that would be necessary for the economic value of the commercial sector to equal the economic value of the recreational sector. In Tables 4.12 and 4.13, we present estimates of the economic values corresponding to the least conservative valuation for the commercial sector and most conservative valuation for the recreational sector.

Table 4.9 Net Economic Values of Commercial and Recreational Striped Bass Fisheries, 1998 Reference Year[a]

Allocation				Economic Value			Consumers' and Producers' Surplus	
Commercial		Recreational		Commercial	Recreational[b]	Recreational[c]	Total[b]	Total[c]
Percent	Pounds	Percent	Pounds	Year 2000 Dollars			Year 2000 Dollars	
Status Quo	1,855,055	Status Quo	1,581,560	$2,533,988	$21,615,794	$12,085,143	$24,149,782	$14,619,131
100%	3,436,615	0%	0	5,626,841	9,530,651	0	15,157,492	5,626,841
75%	2,577,461	25%	859,154	3,847,994	19,824,693	10,294,041	23,672,687	14,142,035
50%	1,718,308	50%	1,718,308	2,318,496	22,316,503	12,785,852	24,634,999	15,104,348
25%	859,154	75%	2,577,461	1,041,691	24,711,242	15,180,591	25,752,933	16,222,282
0.0%	0	100%	3,436,615	0	27,619,605	18,088,954	27,619,605	18,088,954

[a]Net Economic value equals sum of consumers' and producers' surplus. Allocations assessed relative to observed harvests in 1998. Economic values are presented in terms of year 2000 dollars. Assessment based on 49.4% consumption away-from-home, 50.6% consumption at-home, and producers' surplus for the commercial sector estimated from survey data. The economic values for the recreational sector does not include producers' surplus for commercial-recreational activities.
[b]Consumers' surplus with catch and release trips included.
[c]Consumers' surplus with catch and release trips excluded.

Table 4.10 Net Economic Values of Commercial and Recreational Striped Bass Fisheries, 1998 Reference Year[a]

Allocation				Economic Value			Consumers' and Producers' Surplus	
Commercial		Recreational		Commercial	Recreational[b]	Recreational[c]	Total[b]	Total[c]
Percent	Pounds	Percent	Pounds	Year 2000 Dollars			Year 2000 Dollars	
Status Quo	1,855,055	Status Quo	1,581,560	$10,663,420	$21,615,794	$12,085,143	$32,279,214	$22,748,563
100%	3,436,615	0%	0	19,772,777	9,530,651	0	29,303,428	19,772,777
75%	2,577,461	25%	859,154	14,806,862	19,824,693	10,294,041	34,631,555	25,100,903
50%	1,718,308	50%	1,718,308	9,895,369	22,316,503	12,785,852	32,211,872	22,681,221
25%	859,154	75%	2,577,461	5,032,118	24,711,242	15,180,591	29,743,360	20,212,709
0.0%	0	100%	3,436,615	0	27,619,605	18,088,954	27,619,605	18,088,954

[a]Net Economic value equals sum of consumers' and producers' surplus. Allocations assessed relative to observed harvests in 1998. Economic values are presented in terms of year 2000 dollars. Assessment based on 49.4% consumption away-from-home, 50.6% consumption at-home, and assuming that income (wages, salaries, and profits) generated equal producers' surplus. Producers' surplus for the commercial-recreational sector is not included in the economic value of the recreational sector.
[b]Consumers' surplus with catch and release trips included.
[c]Consumers' surplus with catch and release trips excluded.

Table 4.11 Net Economic Value Per Pound Required for Commercial Value to Equal Recreational Value, 1998 Reference Year[a]

Allocation				Economic Value		Value Required			
Commercial		Recreational		Recreational	Recreational	To Equal Maximum[b]		To Equal Allocation[c]	
						With[d]	Without[e]	With[d]	Without[e]
Percent	Pounds	Percent	Pounds	Year 2000 Dollars		Year 2000 Dollars		Year 2000 Dollars	
Status Quo	1,855,055	Status Quo	1,581,560	$21,615,794	$12,085,143	$14.89	$9.75	$11.65	$6.51
100%	3,436,615	0%	0	9,530,651	0	8.04	5.26	2.77	0.00
75%	2,577,461	25%	859,154	19,824,693	10,294,041	10.72	7.02	7.69	3.99
50%	1,718,308	50%	1,718,308	22,316,503	12,785,852	16.07	10.53	12.99	7.44
25%	859,154	75%	2,577,461	24,711,242	15,180,591	32.15	21.05	28.76	17.67
0%	0	100%	3,436,615	27,619,605	18,088,954				

[a]Consumer plus producer surplus required of commercial product on a per pound basis to equal consumer surplus of recreational fishery. Producer surplus values of recreational sector are not included. Consumers of the commercial product would have to be willing to pay in excess of the sum of producers' and consumers' surplus. For example, the price for final consumption relative to the commercial status quo of landings (1,855,055) would have be high enough to generate $14.89 in consumers' and producers' surplus. Presently, retail grocery store prices for round or whole striped bass range from $2.29 per pound in the local Tidewater area up to nearly $5.00 per pound in the Baltimore, Maryland area. That means, consumers would have to be willing to pay between $17.18 and $19.19 per pound to generate $14.89 per pound in net economic value.
[b]Maximum economic value is the value corresponding to a 100% allocation to the recreational sector.
[c]Allocation economic value is the value corresponding to each of the allocations.
[d]With is the economic value including catch and release trips.
[e]Without is the economic value excluding catch and release trips.

Table 4.12 Commercial Consumer and Producer Surplus: Retail Price to Ex-vessel Price Ratio Equals 20.00, 1998 Reference Year

Allocation		Commercial Values						Recreational Values	
Commercial	Recreational	Retail Price Per Pound	Consumers' Surplus	Producers' Surplus[a]	Producers' Surplus[b]	Net Benefits[c]	Net Benefits[v]	Recreational Value (With)[e]	Recreational Value (Without)[f]
Status Quo	Status Quo	$31.03	$1,294,000	$1,909,702	$10,039,134	$3,203,702	$11,333,134	$14,589,425	$8,122,001
100%	0%	29.64	4,519,700	3,446,237	17,592,173	7,965,937	22,111,873	6,467,423	0
75%	25%	30.60	2,542,300	2,621,439	13,580,307	5,163,739	16,122,607	13,365,172	6,897,748
50%	50%	31.15	1,129,900	1,773,349	9,350,222	2,903,249	10,480,122	15,068,471	8,601,048
25%	75%	31.92	282,480	905,404	4,895,831	1,187,884	5,178,311	16,706,460	10,239,037
0%	100%							18,694,877	12,227,453

[a]Producers' surplus estimated using survey information. Recreational values exclude producers' surplus for commercial-recreational fishery. If all market level prices other than the ex-vessel sector are allowed to increase in accordance with market-level price ratios and there only thos costs determined by sales value are allowed to change, producers' surplus for each allocation would be as follows: (1) status quo--$2,638,563; (2) 100% allocation to commercial sector--$4,728,459; (3) 75% allocation to commercial sector--$3,609,738; (4) 50% allocation to commercial sector--$2,452,075; and (5) 25% allocation to commercial sector--$1,259,025.

[b]Producers' surplus estimated from input-output model and assuming income (wages, salaries, and profits) generated equals producers' surplus; the analysis does not consider increased income generated corresponding to the higher retail prices.

[c]Consumer's plus producers' surplus based on survey information.

[d] Consumer's plus producers' surplus assuming producerss' surplus equals income generated from angler expenditures.

[e]Consumers' surplus for recreational angling includes catch and release trips and assumes minimum value per trip based on 95% confidence interval.

[f]Consumers' surplus for recreational angling excludes catch and release trips and assumes minimum value per trip based on 95% confidence interval.

Table 4.13 Commercial and Recreational Net Benefits Assuming Retail to Ex-vessel Price Ratio of 20.00, 1998 Reference Year

Allocation		Commercial Fishery			Recreational Fishery		Net Economic Value of Striped Bass Fishery			
Commercial	Recreational	Retail Price Per Pound	Net Benefits[a]	Net Benefits[b]	Recreational Value (With)[c]	Recreational Value (Without)[d]	Net Value[e] (With)	Net Value[f] (With)	Net Value[g] (Without)	Net Value[h] (Without)
Status Quo	Status Quo	$31.03	$3,397,058	$11,526,490	$14,589,425	$8,122,001	$17,793,127	$25,922,559	$11,325,703	$19,455,135
100%	0%	29.64	8,641,294	22,787,230	6,467,423	0	14,433,360	28,579,296	7,965,937	22,111,873
75%	25%	30.60	5,543,623	16,502,491	13,365,172	6,897,748	18,528,911	29,487,779	12,061,487	23,020,355
50%	50%	31.15	3,072,085	10,648,958	15,068,471	8,601,048	17,971,720	25,548,593	11,504,297	19,081,170
25%	75%	31.92	1,230,094	5,220,521	16,706,460	10,239,037	17,894,344	21,884,771	11,426,921	15,417,348
0%	100%				18,694,877	12,227,453	18,694,877	18,694,877	12,227,453	12,227,453

[a]Sum of consumers' and producers' surplus (estimated from survey data) for commercial fishery when the retail to ex-vessel price ratio equals 20.00.

[b]Sum of consumers' and producers' surplus when income generated is assumed to equal producers' surplus and the retail to ex-vessel price ratio equals 20.00.

[c]Consumers' surplus for recreational fishery when the value of catch and release trips are included and minimum value per trip is assumed; minimum values statistically derived from the derived trip demand equation based on 95% confidence interval. Recreational values exclude producers' surplus for commercial-recreational fishery.

[d] Consumers' surplus for recreational fishery when the value of catch and release trips are excluded and minimum value per trip is assumed.

[e]Net Economic Value of commercial and recreational fishery when producers' surplus estimated using survey data; minimum value per recreational trip is assumed; the ex-vessel to retail price ratio equals 20.00; and catch and release trips are included.

[f]Net Economic Value of commercial and recreational fishery when producers' surplus assumed to equal income generated; minimum value per recreational trip is assumed; the ex-vessel to retail price ratio equals 20.00; and catch and release trips are included.

[g]Net Economic Value of commercial and recreational fishery when producers' surplus estimated using survey data; minimum value per recreational trip is assumed; the ex-vessel to retail price ratio equals 20.00; and catch and release trips are excluded.

[h]Net Economic Value of commercial and recreational fishery when producers' surplus assumed to equal income generated; minimum value per recreational trip is assumed; the ex-vessel to retail price ratio equals 20.00; and catch and release trips are excluded.

Initial estimates of economic values suggested that the commercial fishery generated approximately $2.5 million in net social benefits in 1998 (Table 4.9). The recreational fishery generated approximately $21.6 million in net benefits. Combined, the two sectors generated approximately $24.1 million in net benefits. Based on the information in Table 4.9, which depicts economic values based on estimates of producers' surplus for each commercial sector, society receives maximum economic benefits when 100% of the striped bass allowable catch is allocated to the recreational sector. A 50/50 allocation, however, generates only $3 million less in net economic value to society.

If income (i.e., wages, salaries, bonuses, and profits) generated from all commercial sectors is used to estimate producers' surplus, an allocation of 75% to the commercial sector and 25% to the recreational sector generates the maximum net economic value (Table 4.10). As Edwards (1990), however, has clearly illustrated, total income generated is an inappropriate measure of producers' surplus, and at best, provides an upper bound from which to estimate producers' surplus (i.e., the opportunity costs must be subtracted from the income and additional adjustments must be made for induced income). If income generated in the recreational sector was assumed to equal producers' surplus for the recreational sector, net benefits are maximized with a 100% allocation to the recreation sector.

4.3.3 Sensitivity Analysis and Results

A major aspect of economic valuation, particularly when statistical models are used to make the valuations, is how sensitive are the results to changes in values. If there are major changes in the overall conclusions, there may be serious problems with the analysis and subsequent conclusions. In the information contained in Tables 4.10 and 4.11, there is sufficient uncertainty about the optimum allocation. A 100% allocation to the recreational sector generates $27.6 million net benefits, while a 50/50 allocation generates $24.6 million. A difference of $3.0 million could be little more than a result of statistical errors. Because of the small difference, a sensitivity analysis was necessary to further evaluate the results.

One type of analysis used to assess the sensitivity of results was to highly inflate the value of the commercial fishery and scale down the value of the recreational fishery. Producers' surplus was estimated using information collected from the survey and profit margins from the input-output model and from the income generated and was added to consumers' surplus to obtain estimates of the net economic benefit of the commercial sector. The economic value of the commercial fishery was also scaled up by imposing the assumption that the final demand price was 20 times the ex-vessel price in 1998 (inflated to year 2000 values). It was assumed that the price spread for the different market level prices remained the same as for the status quo, and thus, there was no change in producers' surplus because of higher market level prices. That is, buyers of striped bass at higher market levels had to pay higher prices for striped bass from suppliers. If all market levels prices were scaled up to reflect the higher retail prices at each allocation and the only cost changes were associated with value changes, producers' surplus would considerably increase. Under this scenario, the retail price ranged between $29.64 and nearly $32.00 per pound of whole or round weight product (Tables 4.12 and 4.13). At the same time, consumers' surplus for the recreational sector was scaled back by using the value of the 95% confidence interval of the recreational demand model coefficients that yielded the minimum consumers' surplus estimates for the recreational sector.

The preceding sensitivity analysis suggested that the optimum allocation or the allocation that maximized net benefits to society was one that allocated 75% of the total allowable quota to the commercial fishery and 25% to the recreational fishery. It is, however, highly unlikely that consumer prices would ever exceed $29.00 per pound (whole or undressed weight), which was the estimated retail price required to generate an allocation to the commercial fishery.

Another sensitivity analysis focused on errors in estimating the number of trips and benefits of recreational angling and the consumer and producer surplus estimates for the commercial sector. Of the various sensitivity analysis, this particularly analysis is probably the most useful because it explicitly incorporates the possibility of errors in the estimates. It was assumed that the recreational trips were overestimated by errors ranging from 1% to 50% and the commercial values were underestimated by the same range of errors (1-50%) (Table 4.14). The net result was to scale up the commercial values and scale down the recreational values. When the consumer and producer surpluses are underestimated for the commercial sector by 40% and the demand for recreational trips is overestimated by 40%, the net benefits to society are maximized with approximately a 75% allocation to the commercial sector and a 25% allocation to the recreational sector. If both the commercial and recreational estimates are subject to a 35% error (i.e., the commercial benefits were underestimated by 35% and the recreational benefits were overestimated by 25%), net benefits are maximized for a 100% allocation to the recreational sector.

There is a multitude of errors for each estimate that might generate different allocations. The National Marine Fisheries Service, however, reports a percent standard error of 11.4% for number of angler trips in Virginia. Using a 35% error is thus excessive, but still suggests that net benefits are maximized with a 100% allocation to the recreational sector. Moreover, the estimates of angler benefits for the recreational sector are in line with estimates presented in previous studies (e.g., McConnell and Strand 1994; Kirkley et al. 1998).

It is, however, difficult to assess the potential estimation errors for the commercial sector. Adequate retail demand information was not available, and thus, it was difficult to assess the possible errors relative to consumer demand for striped bass. To a large extent, the errors considered in the previous sensitivity analysis should compensate for potential problems with estimating the retail food store and restaurant demand for striped bass. We nevertheless, consider a Monte Carlo analysis. With this framework, the parameter estimates for the inverse demand and recreational demand for trips were allowed to vary according to a normal distribution of each parameter having mean values and standard deviations consistent with the estimates. Then, 10,000 observations were generated and consumers' surpluses were calculated for each sector using observed prices and per capita demands, trip level costs, and estimated expected catches per recreational outing. The commercial sector yielded higher net benefits for only 0.03% of the 10,000 observations. It is thus unlikely that errors in the estimates of the final consumer demand would lead one to conclude that any allocation other than 100% to the recreational sector would generate maximum net benefits.

For all reasonable sensitivity assumption as well as the mean analysis, net benefits to society are maximized by allocating the entire allowable catch to the recreational sector. For the least-most conservative analysis, net benefits to society are maximized by allocating approximately 74% to the commercial sector and 26% to the recreational sector. The least-most conservative case, however, requires that retail prices exceed $29.00 per pound (round weight) for striped bass, and producers' surplus equals the sum of profits, wages, salaries, and bonuses in all commercial sectors (e.g., harvesting, wholesaling, distributing, and retail stores and restaurants), and the opportunity costs of capital and labor equals zero. This latter assumption imposes the condition that individuals would be willing to work for free, and all alternative investments would yield a zero rate of return.. In addition, the least-most conservative case requires that profits or producers' surplus in the commercial-recreational sector equal zero. It also requires recreational anglers to receive the statistical minimum net benefits per trip.

If income is assumed to equal producers' surplus for the commercial sector and potential producers' surplus for the commercial-recreational fishery is assumed to equal zero, net benefits would be maximized if 75% of the allowable catch was allocated to the commercial sector and 25% was allocated to the recreational sector. As previously stated, however, these assumptions are unrealistic and substantially overstate the net value of the commercial fishery. In addition, a more appropriate framework would be to also include producers' surplus for the recreational fishery.

Regardless of the framework used to assess the economic values of the commercial and recreational sectors, only the results for the least-most conservative analysis, overstated producers' surplus, and estimation errors of 40% or higher results in an allocation to the commercial sector that generates the highest economic value. Even based on the extreme assumptions, analyses suggest that, at lease, 25-26% of the total allowable catch should be allocated to the recreational sector, and that allocation completely ignores the profits of the commercial-recreational sector.

Table 4.14 Consumers' and Producers' Surpluses and Net Benefits Assuming Different Estimation Errors[a]

Allocation			Percent Error							
Commercial	Recreational		1%	5%	10%	20%	25%	35%	40%	50%
Status Quo	Status Quo	Net Value	$23,961,360	$23,253,826	$22,466,264	$21,180,647	$20,671,286	$19,910,142	$19,716,626	$19,478,505
100%	0%	Commercial Value	5,683,678	5,922,991	6,252,046	7,033,551	7,502,455	8,656,678	9,378,068	11,253,682
		Recreational Value	9,446,831	9,086,952	8,673,909	7,951,083	7,633,040	7,067,629	6,845,214	6,360,866
		Net Value	15,130,509	15,009,943	14,925,955	14,984,634	15,135,495	15,724,307	16,223,282	17,614,548
75%	25%	Commercial Value	3,886,863	4,050,520	4,275,549	4,809,993	5,130,659	5,919,991	6,413,323	7,695,988
		Recreational Value	19,268,403	18,880,654	18,022,443	16,520,572	15,859,750	14,213,510	14,160,491	13,216,458
		Net Value	23,515,266	22,931,174	22,297,992	21,330,565	20,990,409	20,133,501	20,573,814	20,912,446
50%	50%	Commercial Value	2,341,915	2,440,522	2,576,107	2,898,120	3,091,328	3,566,917	3,864,160	4,636,992
		Recreational Value	22,095,558	21,253,822	20,287,739	18,597,094	17,853,211	16,530,750	15,940,367	14,877,675
		Net Value	24,437,473	23,694,344	22,863,846	21,495,214	20,944,539	20,097,667	19,804,527	19,514,667
25%	75%	Commercial Value	1,052,213	1,096,517	1,157,434	1,302,114	1,388,921	1,602,602	1,736,152	2,083,382
		Recreational Value	24,466,567	23,534,507	22,464,757	20,592,694	19,768,986	18,304,617	17,650,880	16,474,155
		Net Value	25,518,780	24,631,024	23,622,191	21,894,808	21,157,907	19,907,219	19,387,032	18,557,537
0%	100%	Recreational Value	27,436,140	26,304,382	25,108,728	23,016,334	22,095,681	20,458,964	19,782,775	18,413,068
		Net Value	27,436,140	26,304,382	25,108,728	23,016,334	22,095,681	20,458,964	19,782,775	18,413,068

[a]Each level of error assumes that the commercial sector values were underestimated by that error, and the recreational sector trips or economic values per trip were overestimated by that error. For example, under the 1% error column, we assumed that the commercial value was underestimated by 1% and subsequently inflated the commercial value to reflect the error by dividing the estimated values by 1 minus the level of the error. The corrected recreational sector values are calculated by dividing the original estimated value by 1 plus the level of the error.

If only the catch and release fishery is considered, final consumers of commercial products would have to be willing to pay in excess of $2.77 per pound to obtain the same level of only consumers' surplus received by catch and release anglers. If ex-vessel prices are considered a minimum purchase price by retailers or restaurants and only the economic value of the catch and release fishery is considered, consumers would have to be willing to pay at least $4.09 per pound for whole or undressed striped bass. There is little evidence to support a consumer willingness to pay $4.09 or more per pound. The wholesale price for Virginia striped bass (round or whole fish weight) at the Fulton Market (March 29, 2000) equaled $2.50 per pound. This would increase the retail price to approximately $5.27 per pound to generate a net benefit of $2.77 per pound; and that assumes the only cost to the wholesaler is the purchasing of striped bass.

4.3.4 The Optimum Allocation

The final issue is that of allocation. Assessing the economic ramifications of various allocations was the primary objective of this study. What is the optimum or best use of striped bass? Economic analysis, based on realistic assumptions, indicates that a 100% allocation to the recreational sector generates maximum net benefits to society, even after considering estimation errors and data problems. At the same time, however, there was no information available for assessing the social impacts of different allocations (e.g., the social costs of community, family, and labor displacement). There also was insufficient information to assess the ramifications of eliminating the transferable tag program which is essentially what would happen with a 100% allocation to the recreational sector. Relative to expected value or mean value assessments, a 100% allocation to the recreational sector would generate $27.6 million in consumers surplus (producers' surplus for the commercial-recreational sector was not included); a 100% allocation to the commercial sector would generate an approximate total net value of $10.6 million. There was no non-zero allocation to both sectors that generated a higher net economic value than the 100% allocation to the recreational fishery.

Even though the economic assessment and sensitivity analysis supports a 100% allocation to the recreational sector if the Commonwealth desires to maximize net economic value, there are sufficient reasons to consider a different allocation. First, individuals have a right to work and commerce; they do not necessarily have a right to leisure and recreation. Second, a 50/50 allocation generates only $3.0 million less in net benefits than does a 100% allocation to the recreational sector. It is possible that the social cost of a 100% allocation to the recreational sector could equal $3.0 million; this cannot, however, be determined with available information. Third, both fisheries were in a major transition period. The commercial fishery was just beginning to reestablish a market in 1998 while the recreational fishery was rapidly expanding. In addition, the time-series data available for assessing the consumer benefits of the commercial fishery reflected periods during which the demand for striped bass was considerably low.

Numerous regulations restricted the sale and harvesting of striped bass and consumers substituted other species for striped bass. In essence, the commercial market outlets for striped bass weakened. The statistical analyses reflect the central tendency of the transition. As such, the analysis may understate the potential value of the commercial fishery and overstate the potential value of the recreational fishery relative to the future.

The possible level of uncertainty about the future value and importance of the two fisheries suggests a precautionary approach to making major changes in either the regulations or the allocations that might differentially affect the two sectors. To some extent, however, the uncertainty was addressed by the sensitivity analysis. Moreover, in order for the commercial fishery to generate the same level of benefits as the recreational fishery, consumers would have to be willing to pay more than $8.04 per pound (round weight) to justify a commercial only fishery. At lower allocations to the commercial fishery, the willingness to pay for commercial product would have to increase. It is highly unlikely that consumers would be willing to pay more than $8.04 per pound for striped bass, particularly given the prices and availability of substitute species (e.g., flounder, swordfish, halibut, sea bass, and salmon).

5. Summary and Conclusions

This report provided analyses of the economic impacts and economic values of allocating striped bass to Virginia commercial watermen and saltwater anglers. Initially, the impacts and benefits from the status quo were assessed. Next, the economic impacts and benefits for a 100% allocation to one sector while allocating zero to the other sector were assessed. The remaining allocations examined were as follows: (1) 50% to each sector, and (2) a 75% allocation to one sector and a 25% allocation to the other sector. The analyses were based on commercial and recreational activities in 1998.

Economic impacts were expressed in terms of total sales, income, and person-years of employment generated from commercial and recreational activities. An IMPLAN input-output model, modified specifically for commercial and recreational fisheries, was used for the economic impact assessment. Additional models had to be developed, however, to assess changes in prices and revenues for the commercial sector and changes in the demand for trips by recreational anglers. Net economic values or net benefits were expressed in terms of the sum of consumers' and producers' surplus for the commercial sector and consumers' surplus for the recreational sector. Information for assessing producers' surplus in the recreational sector was not available. Benefits for the recreational sector are very likely, therefore, to be substantially understated or underestimated.

The largest potential economic impacts and net benefit values were realized with the 100% allocation to the recreational sector. It was estimated that a 100% allocation to the recreational sector had the potential to generate $181.1 million in total sales, $101.3 million in total income, and 3,738 person years of employment. A 100% allocation to the commercial sector has the potential to generate $23.9 million (year 2000 constant dollar value) in total sales, $17.6 million in total income, and 517 person years of employment.

It is important to realize, however, that allocations should not be based on the magnitude of economic impacts. Impacts involve transfer payments and reflect financial accounting. They do not necessarily indicate anything about economic efficiency. For example, if striped bass anglers spent the same level of money on dining out as they did catching or trying to catch striped bass, total sales, income, and person-years of employment would be more than double the maximum potential associated with a 100% allocation to the recreational sector.

If an allocation is to be based on economic aspects, it should be based on net economic value or net social benefits. Net benefits equal the sum of consumers' and producers' surplus or the net worth of a good or service to consumers and producers. The present study assessed net economic benefits for different resource allocations to the two user groups. It was concluded that benefits would be maximized for a 100% allocation to the recreational sector. Net benefits associated with a 100% allocation to the commercial sector ranged between $5.6 and $22.8 million; the $22.8 million, however, was considered to be a substantially over-estimated amount. It was based on retail prices exceeding $29.00 per pound; all labor willing to work for free (i.e.. the opportunity cost of labor was zero); producers' surplus or profits for the commercial-recreational sector equaling zero; and minimum economic value per recreational angler trip. It was estimated that just the catch and release recreational fishery generated $6.5 million in net benefits under the most conservative economic value assessment; at mean values, the economic net value of the catch and release fishery was estimated to equal $9.5 million. Producers' surplus for the recreational sector was not included in the valuation of the recreational fishery.

There are, however, several important caveats that should be considered when reviewing the estimates. First, retail demand and price information was extremely limited. Second, producers' surplus for the recreational fishery could not be estimated because of inadequate data (e.g., insufficient information on profit margins for charter boats). Third, there were major structural changes in the ex-vessel demand and marketing of striped bass which could not be adequately incorporated into any model (e.g., the demand for striped bass apparently shifted downward during the 1980s and early 1990s). Fourth, there is an expanding catch and release recreational fishery, and information for assessing how anglers in this fishery might respond to a zero retention allowance was inadequate to more precisely estimate the economic impacts and values of a zero retention restriction. Fifth, there appears to be a growing market for Atlantic coast striped bass; there was inadequate information to adequately assess recent changes in final demand for striped bass. Sixth, the time period over which the analysis was conducted reflected a major transition period for both fisheries. The market for striped bass was just beginning to develop after many years of being seriously depressed. At the same time, the recreational fishery was beginning to substantially expand after many years of extremely restrictive regulations. It is quite possible that the analysis seriously understates the potential economic value of the commercial fishery and overstates the potential importance of the recreational fishery relative to the future.

To deal with the various limitations, several procedures were employed. The most common approach, however, was to overstate the commercial impacts and economic value and understate the recreational impacts and value. That is, we attempted to extract the highest impacts and economic value for the commercial fishery and the least impacts and value for the recreational fishery. While seemingly biased, this is a common assessment framework when one product, allocation, or environmental state is clearly preferred to the other. If any one analysis indicated a change in the conclusion, additional analysis would be necessary. In the present study, the 100% allocation to the recreational sector generated potential higher economic impacts and net benefits to society than any other allocation for all assessment assumptions, except the case when retail prices exceeded $29.00 per pound (whole or round weight) or the benefits from the commercial sector were underestimated by at least 40% and benefits for the commercial sector were overestimated by at least 40%. Both of the above two cases represents cases of unrealistic extremes. A $29.00 per pound retail price is highly unrealistic. Estimations errors is excess of 35-40% are excessive and inconsistent with results of other studies and the National Marine Fisheries Service Marine Recreational Fisheries Statistics Survey.

What is missing from the present study, however, is an assessment of the social costs of changing the allocation or regulations to favor the recreational sector. There simply is no information to estimate the social costs associated with community displacement and problems, family displacement, or labor displacement. Information for evaluating the social costs of changes in self-worth is not available. There also is no information to assess the private and social costs of changing from a transferable tag program for the commercial sector to a recreational-only fishery. Individuals have purchased tags on the premise that they will forever own these tags, even though the Virginia Code indicates that the regulations may be changed. Eliminating or severely reducing the commercial fishery could have long-term ramifications for the Virginia Marine Resources Commission just in terms of lost "good-will."

Relative to an optimum allocation, the analysis indicates that net benefits to society are maximized with a 100% allocation to the recreational sector. The analysis, however, was conducted using data from a time period during which both fisheries were experiencing substantial transitions. The commercial fishery had been depressed for many years because of loss of markets and restrictive regulations. It takes considerable time to recover a market for fish and seafood products after losing a market, particularly when consumers and buyers had obtained numerous substitute species and product. The recreational fishery had also been tightly regulated for many years, and as the regulations for catching and retention were relaxed and the abundance increased, anglers increasingly targeted striped bass. Increased recreational activity would be expected as a rational response to several years of extremely restrictive regulation and sudden increased abundance. It is not known if the level of striped bass recreational activity will continue in the future. Because of the possible uncertainty about the future potential economic value of the two fisheries, it is suggested that any considerations by the Virginia Marine Resources Commission for changing the current regulations or allocations adhere to a precautionary approach.

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Technical Appendix

Overview of Appendix

The assessment of economic impacts and consumers' and producers' surplus required a variety of parametric (statistical) and non-parametric (mathematical) methodologies. This section of the report provides a technical discussion of the various methodologies, the statistical and non-statistical results. and the various assumptions used in the analysis.

The Analytical Framework

The analysis contained in this report was based on two types of analysis: (1) economic impact assessment or input/output (I/O) analysis, and (2) economic valuation or benefit-cost analysis. The economic valuation analysis is primarily statistical.

The I/O analysis is primarily an accounting framework that facilitates estimation of the contributions of economic activity in terms of sales or output generated, income generated, and total person-years of employment. For example, if commercial harvesters spend a certain amount of money to catch striped bass and receive a certain amount of money, the I/O analysis would enable us to know how much that harvesting activity generated in total sales, income, and person-years of employment. As such, I/O is a very useful analytical tool. It is not, however, an approach upon which economic allocation decisions should be based.

The other analysis conducted for this report was that of economic valuation or benefit-cost analysis. Within this framework, analysis is conducted to determine the true value to society of various goods and services. That is, what are the actual benefits and costs. Net economic value is measure of the value of a good or service in excess of what was paid to acquire the good or spent to produce the good. There are two components to net economic value—consumers' surplus and producers' surplus. The sum of the two yields net economic value. A variety of statistical or econometric models and analyses are necessary to estimate consumers' surplus. Statistical models may also be used to estimate producers' surplus, but other approaches were used in the analysis of this report. We specifically used profit margins obtained from surveys and the existing I/O model. These margins were used to estimate producers' surplus. Consumers' surplus for the commercial sector was estimated using the model subsequently discussed. Consumers' surplus for the recreational angler was estimated based on a recreational demand model which is discussed following the discussion of the consumer demand model.

The Analysis of Ex-vessel and Final Consumer Demand: Commercial Sector

In order to estimate the economic impacts (sales, income, and person-years of employment) and net benefits, it was necessary to estimate the ex-vessel and final consumer demand. The input/output model is driven by revenues or values and consumers' surplus requires price response information. Different allocations would result in different prices, sales, and consumers' surplus values. Subsequently, the economic impacts and economic values of the commercial fishery would change in response to different allocations.

Ex-vessel Demand

Although economic theory requires the specification of a demand and supply function to assess market prices, we specified a simple inverse or price dependent ex-vessel demand. The initial model specified ex-vessel price (in 1994 constant dollars) to be a function of the per capita demand for Virginia striped bass, the per capita demand for striped bass from other states, and per capita food expenditures. Inverse demand models are widely used to assess changes in prices, revenues, and consumers' surplus. All dollar values were deflated to 1994 values using the consumer price index for food:

$$\mathbf{PRICE}_t = \alpha + \beta_1 \mathbf{PCLANDVA}_t + \beta_2 \mathbf{PCLANDOS}_t + \beta_3 \mathbf{PCFOODEXP}_t$$

where PRICE is the ex-vessel price, PCLANDVA AND PCLANDOS, respectively, represent per capita demand for Virginia and other states striped bass, PCFOODEXP is per capita expenditures on food, and t is the t^{th} time period.

Additional structure or variables were also considered in the price specification. These included dummy variables to pick up major structural changes, price levels from other states, and a trend variable. Preliminary analysis, however, indicated that the Virginia price responded primarily to Virginia per capita demand and per capita food expenditures. Additional testing resulted in the final model specification:

$$\mathbf{PRICE}_t = \alpha_0 + \alpha_1 \mathbf{D}_1 + \beta_1 \mathbf{PCLANDVA}_t + \beta_2 \mathbf{PCLANDOS}_t + \beta_3 \mathbf{PCFOODEXP}_t + \beta_4 \mathbf{D}_1 * \mathbf{PCLANDVA}_t$$

where D_1 is a dummy variable to reflect structural changes between two time periods--1970 and 1989 and 1990 and 1998. The variable D_1 is set equal to one for the observations corresponding to 1990 through 1998 and zero otherwise.

Estimation and analysis of the price model, however, indicated several potential problems: (1) the data were non-stationary or had changing means and variables; (2) they were integrated of order one which means after taking first differences, the series became stationary; (3) the parameter estimates were highly unstable (i.e., changing over time); and (4) the coefficient for per capita food expenditures was negative (the coefficient should be positive rather than negative). To address the variables problems numerous approaches were used. First, tests for co-integration were conducted but were rejected. Next, causality tests were conducted on various variables and impulse response functions were estimated. Observations contributing to extreme instability were removed from the data set and the equation was reestimated. An error correction model was also estimated to deal with the instability and the non-stationarity of the series. None of the above approaches corrected the problem of an incorrect sign for food expenditures.

The negative sign poses problems because it would be expected that as individuals decided to spend more money on food, the demand for striped bass would increase. Alternatively, it would not decrease. The negative sign implies that as food expenditures increased over time, the demand for striped bass decreased. In actuality, the data also reflect this pattern. The pattern, however, is likely to have been the result of extremely restrictive regulations which reduced the supply of striped bass. It was believed that restricting the coefficient for food expenditures to be positive would best facilitate the estimation and analysis of demand for striped bass.

To deal with the problem of a negative sign for food expenditures, the inverse demand equation was estimated subject to the restriction that the coefficient for food expenditures was positive. This requires imposing an inequality restriction on the coefficient and estimating using a Bayesian approach (for additional information on Bayes estimation, see Geweke (1986)). The approach amounts to a Monte Carlo numerical integration procedure that is implemented by generating replications from a multivariate t distribution (Shazam 1997). The procedures takes the parameters and variance-covariance estimates from the unrestricted estimates and randomly generates new observations based on a chi-squared distribution.

The final demand model was as follows:

$$\mathbf{PRICE_t = 0.96 - .43D_1 - 86.40 * PCLANDVA_t + .0004 * PCFOODEXP_t + 76.07\ D_1 * PCLANDVA_t}$$

The coefficient of determination or adjusted R-squared equaled 0.79. The t statistics for the estimated coefficients were, respectively, as follows: (1) 1.90, (2) 2.16, (3) 16.98, (4) 15.68, and (5) 5.29. Additional examination revealed no serious problems with instability or serial correlation. Even with this approach, the probability that the coefficient for food expenditures was positive was only 15.6 percent.

The preceding estimated equation was used to assess changes in prices and consumer benefits given different commercial allocations. As the allocation to the commercial sector increases, the model predicts a decrease in price. Alternatively, as the allocation decreases, the model predicts an increase in price.

Based on the estimated model, percentage changes in prices and revenues were estimated. The estimated percentages were applied to the observed prices and revenues to estimate changes in actual prices. For example, the model predicted the ex-vessel prices would decline by 4.48 percent given that 100% of the allowable catch was allocated to the commercial sector. The 4.48% estimate was applied to the original observed price to estimate changes in prices and revenues. Consumers' surplus was calculated in a similar manner.

The inverse demand model was also used to assess final demand or consumer demand at the retail and restaurant levels. Prices were increased by a factor of 1.94 for the at-home consumption and 5.29 for the away from home consumption. It was further assumed that at-home and away from home demand would be the same as the ex-vessel demand but simply scaled by retail and restaurant prices. Analysis determine that retail to ex-vessel prices were relative constant between 1990 and 1998.

The Demand for Recreational Trips

In order to estimate benefits for recreational anglers, a travel cost demand function was estimated. The basic premise behind a travel cost model is that angler benefits on a per trip basis are related to travel and fishing costs, expected catch of given species per outing, whether or not an angler is targeting a specific species, whether or not it is a boat trip, and whether or not the angler owns a boat. Since the recreational demand model uses count data (i.e., the number of trips per angler in a given time period), a Poisson model is specified. A Poisson model specifically accommodates the discrete count nature of the data.

A variety of models, based on survey data collected for 1998, were specified and estimated. It was concluded after careful review, however, that the recreational demand models estimated for 1996 provided better estimates (Kirkley et al. 1998). It was, therefore, decided to use the model estimated for 1996, but use the 1998 survey information deflated to 1996 values to estimate angler benefits. The 1996 estimates were found to be highly stable and consistent with previously estimated models for recreational angling. The parameter estimates and associated statistics appear in Table A.1. The recreational demand model was used to estimate angler benefits and changes in the demand for trips.

Table A.1 Parameter Estimates and Statistical Results: Boat and Shore Fishing

Variables	Private Boats and Party/Charter Demand	Shore Demand
Travel/Fishing Costs	-.0073 (-3.55)[a]	-0.0136 (-2.38)
Expected Catch-Gamefish	0.572 (8.45)	0.216 (1.29)
Expected Catch—Bottom Fish	0.077 (1.45)	-0.090 (1.45(
Expected Catch—Flounder	0.131 (3.62)	-
Expected Catch—Any Species	0.049 (0.58)	-
Anglers not Targeting a Species	-0.398 (-0.99_	-0.174 (1.73)
Angler Targeting Croaker	-1.219 (-3.95)	-
Boat Ownership	0.806 (4.96)	-
Rods owned	-	0.081 (5.03)
Constant	0.355 (2.82)	1.28 (4.89)
Variance Estimate	Not significant[b]	Not significant

[a]T-statistics are in parentheses.
[b]The test for a non-zero variance is a test for the negative binomial.

Expected Catch Rates and Trips

An important aspect of the analysis of the recreational sector was how anglers might change their expectations about catch rates per outing given different allocations. The expected catch rate is an important variable in the angler trip demand analysis. We specified the expected catch per outing as a function of previous recreational harvests (weight) and unretained catches (number of fish caught and discarded) and a time trend variable (i.e., expected catch per outing at time t is a function of total recreational harvest at time t minus 1 and total recreational catch at time t minus 1. A time series on striped bass angler just for Virginia striped bass anglers and trips was not available. We thus used data for all Atlantic coast striped bass anglers, which was available from the National Marine Fisheries Service.

Preliminary estimates, however, indicated that anglers were highly responsive to changes in retained catches and unretained catches (discard). That is, anglers would more than proportionally increase their angler trips in response to higher expected catches. More important, however, was that the statistical results were not highly desirable (i.e., the explanatory power was low and numerous coefficients were not statistically significant). After additional analysis, it was decided to estimate expected catch by using nonparametric regression or a kernel estimator. The method is described in detail in Härdle (1990). It basically amounts to using a series of weights to smooth the data and then estimating parameters that minimize the generalized cross validation statistic.

Because the results of the nonparametric regression are quite lengthy, we present estimates only for the last eight observations (Table A.2). There are estimated coefficients for each observation plus all the smoothed values. The adjusted R-square was 0.85. Slope coefficients for each observation are generated with the nonparamateric model. The evaluation or estimation of expected catch per outing was based on inserting the various allocations (retained catch levels assuming that anglers retain all that is allowed) into the nonparametric model (values for lagged harvests) and assuming no changes in unretained catches.

Table A.2 Parameter Estimates of Nonparametric Regression Relating Expected Catch per Trip to Retained Catch, Discards, and Time

Retained Weight[a]--10^{-8}	Discards[a]--10^{-8}	Year[a]--10^{-3}
0.89	-2.13	0.40
-4.94	-8.32	33.56
3.19	-30.03	53.91
-12.98	21.29	25.80
-9.05	16.47	10.71
-22.13	36.84	44.43
-4.99	10.78	5.75
0.013	0.0093	-0.01

[a]Coefficient estimates are expressed in terms of 10 to the negative eighth or third power.

The expected catches per outing were inserted into the recreational demand models for trips, and the number of trips was estimated given travel costs and expenditures and other factors. This provided the basis for assessing how anglers would respond to different allocations.

Uncertainties about Estimates

Given the uncertainties or potential imprecision of the estimates, all estimates were subjected to a Monte Carlo analysis, a sensitivity analysis, and a risk analysis. For these analyses, estimates of the commercial sector were presented in the most positive light while those for the recreational sector were considered in a least favorable view. That is, we intentionally overestimated the impacts and benefits of the commercial fishery and underestimated the impacts and benefits of the recreational fishery.

Initially, results of the ex-vessel demand model were analyzed by generating 10,000 observations having the same mean and standard errors of the estimated price model and assuming a normal distribution. This is standard practice for a Monte Carlo analysis. We then compared commercial benefits to recreational benefits and found that there was only a 0.03% chance that the commercial benefits would equal the recreational benefits.

We next inflated the ex-vessel price by a factor of 20 and compared commercial impacts and benefits to substantially underestimated recreational impacts and values. The recreational values were estimated by assuming statistically minimum benefits per trip (i.e., benefits were derived by taking lower 95% confidence interval estimates of benfits per trip).Even with the extreme bias imposed on both sectors, it was still concluded a 75% commercial allocation and a 25% recreational allocation would maximize net benefits.

Last, we subjected the net benefit estimates to arbitrary errors in estimation. We allowed the commercial benefits to be underestimated by 1 to 50% and the recreational benefits to be overestimated by 1 to 50%. We subsequently corrected the estimates by dividing the original estimates by 1 minus the error for an underestimate and 1 plus the error for an overestimate. It was concluded that a 100% allocation to the recreational sector provided the maximum net benefits for all error levels between 1 and 39%. Given previous estimates and the estimated percent standard errors for the National Marine Fisheries Service Recreational Statistics Survey, an error in excess of 20% would be excessive.