APPENDIX I

ECONOMIC ANALYSIS AND SUPPLEMENT

TO DRAFT RIR AND IRFA

Economic Analysis and Supplement to the Draft RIR and IRFA for the Fishery Management Plan for Atlantic Billfishes

1.0 INTRODUCTION

Executive Order 12291 "Federal Regulation" established guidelines for promulgating new regulations and reviewing existing regulations. Under these guidelines each agency, to the extent permitted by law, is expected to comply with the following requirements: (1) administrative decisions shall be based on adequate information concerning the need for and consequences of proposed government action; (2) regulatory action shall not be undertaken unless the potential benefit to society for the regulation outweighs the potential costs to society; (3) regulatory objectives shall be chosen to maximize the net benefits to society; (4) among alternative approaches to any given regulatory objective, the alternative involving the least net cost to society shall be chosen; and (5) agencies shall set regulatory priorities with the aim of maximizing the aggregate net benefit to society, taking into account the condition of the particular industries affected by regulations, and the condition of the national economy, and other regulatory actions contemplated for the future.

In compliance with Executive Order 12291, the Department of Commerce (DOC) and the National Oceanic and Atmospheric Administration (NOAA) require the preparation of a Regulatory Impact Review (RIR) for all regulatory actions which either implement a new Fishery Management Plan (FMP) or significantly amend an existing plan, or may be significant in that they reflect important DOC/NOAA policy concerns and are the object of public interest.

The RIR is part of the process of preparing and reviewing fishery management plans. The RIR provides a comprehensive review of the level and incidence of impact associated with the proposed or final regulatory actions. The analysis also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that could be used to solve problems. The purpose of the analysis is to ensure that the regulatory agency systematically and comprehensively considers all available alternatives so that the public welfare can be enhanced in the most efficient and cost effective way.

The RIR serves as the basis for determining whether the proposed regulations implementing the fishery management plan or amendment are major/non-major under Executive Order 12291, and whether or not the proposed regulations will have a significant economic impact on a substantial number of small entities under the Regulatory Flexibility Act (P.L. 96-354).

The purpose of the Regulatory Flexibility Act is to relieve small businesses, small organizations, and small governmental entities from burdensome regulations and recordkeeping requirements. Since small businesses will be affected by the regulations to be promulgated under the FMP, this document also serves as the Regulatory Flexibility Analysis (RFA) for the FMP. In addition to analyses conducted for the RIR, the RFA provides an estimate of the number of small

businesses affected, a description of the small businesses affected and a discussion of the nature and size of impacts.

The Small Business Administration (SBA) defines a small business in the commercial fishing activity, classified and found in the Standard Industrial Classification Code, Major Group, Hunting, Fishing and Trapping (SIC 09), as a firm with receipts up to $2.0 million annually. SBA defines a small business in the charter boat activity to be in the SIC 7999 code, Amusement and Recreational Services, not elsewhere classified as a firm with receipts up to $3.5 million per year.

2.0 PROBLEMS IN THE BILLFISH FISHERY

Problems in the fishery which the management plan addresses are:

1. There is intense competition for the available resource between the recreational fishery for billfish and other fisheries that have a bycatch of billfish.
2. There is a developing commercial market for billfish and an increasing value for the product, thus encouraging directed fishing and/or increased retention of incidentally caught billfish. This situation jeopardizes the economically valuable, traditional recreational fishery and threatens to undermine the conservation ethic developed by this user group.
3. There is a rapidly expanding domestic tuna longline fishery which has a higher billfish bycatch than the historical swordfish fishery.
4. The current statistical and scientific data base is inadequate for stock assessment and is likely to remain so for the foreseeable future. A long term biologically sound management regime, either domestic or international, will not be possible until an adequate and accurate data base is available.

3.0 OBJECTIVES

The following management objectives have been developed for the billfish fishery in the Atlantic, Gulf of Mexico, and Caribbean EEZs:

1. Maintain the highest availability of billfishes to the U.S. recreational fishery.
2. Optimize the social and economic benefits to the nation by reserving the billfish resource for its traditional use, which on the continental U.S. is almost entirely a recreational fishery. In the Caribbean, the fishery is both a recreational and small scale handline fishery where billfishes are used as a source of food.
3. Increase understanding of the condition of billfish stocks and the billfish fishery.

4.0 LISTING OF MANAGEMENT MEASURES CONSIDERED

4.1 Accepted Management Measures

The following management measures form the basis for managing the billfish resource within the U.S. EEZ. The proposed measures apply to the entire management unit:

1. The sale of all billfish is prohibited ("no sale provision") except those from the traditional handline fishery in Puerto Rico.
2. Possession of billfish aboard commercial longline vessels is prohibited.
3. Only billfish (i.e., blue marlin, white marlin, sailfish, and spearfish) having been captured by recreational fishermen using conventional rod and reel may be retained in possession.
4. Only billfish (i.e., blue marlin, white marlin, sailfish, and spearfish) exceeding the following minimum sizes may be retained in possession:

blue marlin:	86 inches from tip of lower jaw to fork of tail
white marlin:	62 inches from tip of lower jaw to fork of tail
sailfish:	57 inches from tip of lower jaw to fork of tail
spearfish:	no minimum size

5. Mandatory reporting of catch and effort data for recreational fishing tournaments.

Foreign fishing management measures: All measures presently implemented and/or approved but held in reserve through the PMP are adopted in their entirety into this FMP. No additional management measures that apply to foreign fishing are proposed in this FMP. These measures and their rationale can be found in the PMP for Atlantic Billfishes and Sharks and in 50 CFR Section 611.61. They will not be discussed further in this FMP.

4.2 Management Measures Considered and Rejected

1a-5a No action was considered as an alternative to each specific management measure considered.

1b. Prohibit sale of all billfish, from the management unit, including those from the traditional handline fishery in Puerto Rico.

2b. Prohibit all possession of billfish from the management area.

3b. Prohibit possession of billfish from the management area by recreational fishermen in excess of certain limits (i.e., recreational bag limit).

3c. Prohibit possession of billfish from the management area during tournaments by participants in the tournament. (i.e., establish that all tournaments would be "no kill" tournaments).

4b. Only billfish exceeding a minimum size based on size at sexual maturity may be retained in possession.

4c. Only billfish exceeding a minimum size in each council area based on the average size distribution of billfish caught in that area may be retained (non-uniform, size limits).

5.0 ANALYSIS OF BENEFITS AND COSTS

5.1 Methodology and Data

5.1.1. Methodology

Three of the five proposed management measures are likely to have larger economic effects on fishermen. These are (in abbreviated fashion): 1) the no-sale provision, 2) minimum size limits and retention of fish caught by rod and reel, and 3) the no-possession provision applying to long-liners and drift netters.

One effect common to these three proposed measures is that fishing mortality will be reduced, hence stocks are expected to rebuild in the future. Another effect common to proposed management measures one and three is to reallocate the incidental commercial harvest to the recreational fishery. As a portion of the incidental commercial harvest that is returned will be live fish, the stock available for recreational harvest will increase. Average size of fish caught may also increase in the future; however, the analysis below does not incorporate this possibility directly.

As the stock rebuilds in the future, the probability of catching a billfish will increase. Thus, the quality of the fishing experience is increased. For purposes of estimating the effects of this quality improvement in the recreational fishery, the improvement is modeled as an outward shift (increase) in recreational demand (see Huppert, 1983)[1]. Such treatment of quality improvement is not only consistent with, and predicted by demand theory, there is also evidence available from survey data suggesting that these shifts will take place. One can then estimate the change in consumer surplus resulting from this demand shift.

The 1986 survey by Brown and Ofiera of New Jersey's big game fishermen posed the following question to vessel owners/operators (and solicited responses by species, including blue and white marlin):

"Considering the amount of fish caught on a typical trip, how much extra would you be willing to pay in trip costs to catch one more fish of the following species?"

Responses to these questions yielded average values of $170 for white marlin; $365 for blue marlin. It should be noted that the values solicited for an additional fish represent values net of other benefits associated with a fishing trip as those benefits are already being realized and paid for. In addition, the demand for trips is employed as it is in this "market" that economic benefits

[1] Huppert, Daniel D., 1983. NMFS Guidelines on Economic Valuation of Marine Recreational Fishing. [illegible] Memorandum, NOAA-TM-NMFS-SWFC-[illegible] 35 p.

are realized, and the question in the New Jersey survey links fishing quality and trip costs. In valuing additional fish made available to the recreational sector by reduced commercial harvests (from no sale and no commercial crew personal use), these survey responses are used as shown below in figure 1 (for the blue marlin). Once these values are generated, they must be adjusted by the probability of catching one more fish per trip. That probability should rise over time as stocks rebuild toward a new bio-economic equilibrium in the fishery.

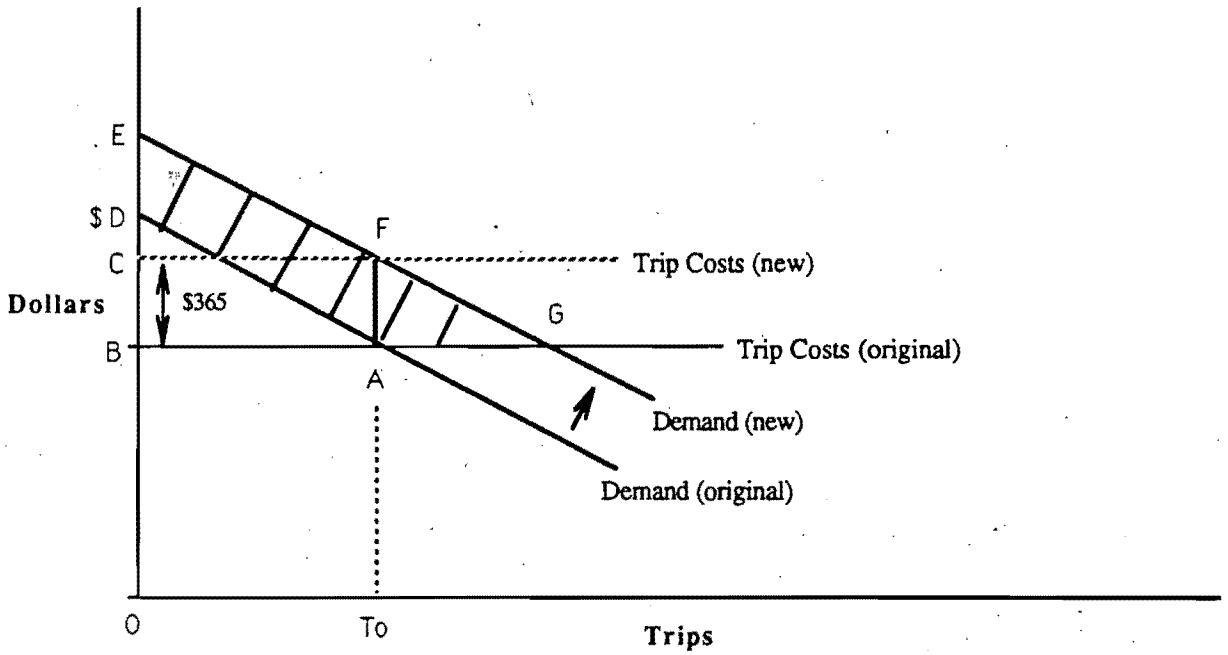

Figure 1. Schematic of Model Used to Value Increased Recreational Catch for a Representative Trip

Trip costs (or the supply function) for billfish trips is assumed to be perfectly elastic (given at least some excess capacity, and the ease with which recreational vessels can switch fisheries). Consumer surplus under the original demand function is area ABD, and is defined as consumer benefits in excess of payment for the good or service (payment = area OBAT).

As posed in the New Jersey survey, the question asks what the vessel operator would pay in additional trip costs for one more fish, i.e., for a higher quality fishing experience. This is modeled as an increase in demand to intersect the (hypothetically higher) trip cost function. The amount of the vertical shift is the $365 response. Thus, the change in consumer surplus is the area under the new demand curve, but above the original one, or area ADEFG. This area can be approximated by treating area ADEF as a rectangle of dimension ($365) (average number of trips), and adding the area of the triangle AFG. To estimate the triangle AFG, we either must know or

assume a value for the own-price elasticity of demand for trips. This elasticity is defined as the percent change in quantity demanded divided by the percent change in price, or

$$n = \frac{\%\Delta Q}{\%\Delta P}.$$

We can estimate the $\%\Delta P$ (the percent change in trip costs) from the New Jersey survey data. As there is no known estimate for billfish own-price demand elasticity, we assume a base value of 1. We can then compute $\%\Delta Q$, the length of AG in the triangle AFG. At this point we can estimate the area between the two demand curves, or the change in consumer surplus.

Once this area is estimated, it must be adjusted by the probability of catching one more fish per trip. It is reasonable to assume that this probability is quite low soon after regulations are imposed, but rises as the cumulative live returns of fish to the stock increase, and as reproduction from those returns also add to the stock. Thus we trace out over a finite time period what we think is a reasonable bound for this probability. This probability times the change in consumer surplus gives the expected value of catching one more fish per trip. To estimate the value for the entire fishery, we multiply by the total number of trips. From these increased annual recreational values, we subtract annual losses to commercial fishermen imposed by the no-sale and no-possession regulations.

The model used to value commercial losses is as follows:

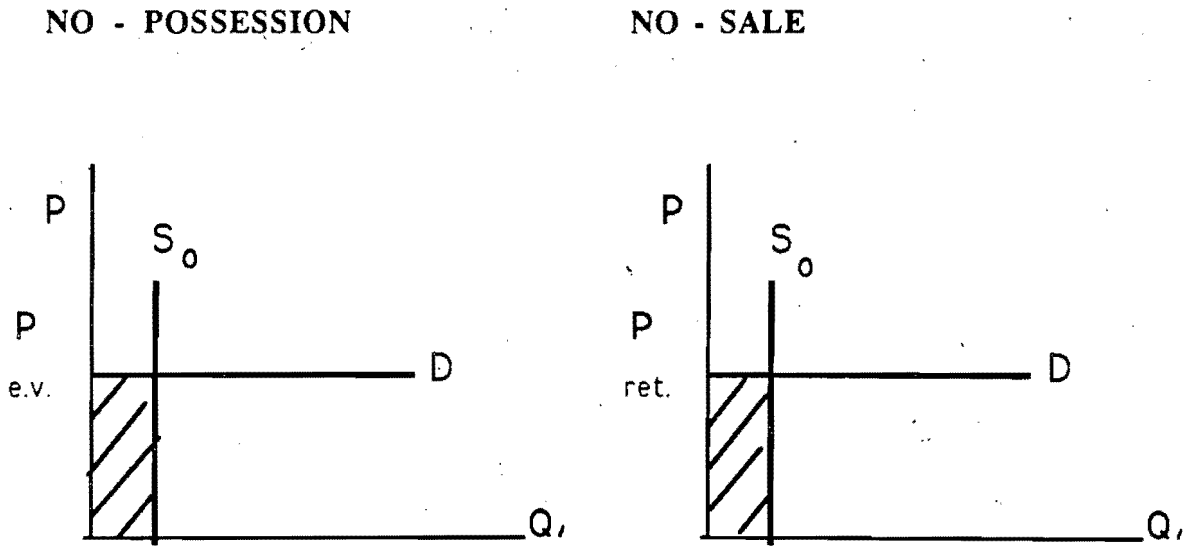

Figure 2. Schematic of Model Used to Value Effects of Regulation on Commercial Fishery

Since catch of billfish by commercial fishermen are incidental catches, there is no reason to believe that the no-sale provision, or the no-possession provision will in any way affect commercial effort. Thus whatever has been caught is illustrated as an inelastic (vertical) supply function. We are also assuming a perfectly elastic demand curve (i.e., consumers have perfect

substitutes for billfish). Thus the total value of landings under the no-sale regulation is viewed as a loss to the commercial sector (valued at retail prices). Similarly, the value of billfish that could have been retained by commercial crewmen for personal use (valued at ex-vessel price--the opportunity cost to the crewman of retaining a fish for personal use) is viewed as a loss to the commercial sector. These losses are illustrated as the cross-hatched areas in Figure 2.

Estimates of gains to recreational fishermen, and losses to commercial fishermen are then summed by year to obtain a net change in benefits to society from the proposed regulation. Future net values to society are then discounted to obtain the present value of those benefits. If net present value is positive, society gains even though there is a redistribution from consumers (and commercial fishermen) of billfish to recreational fishermen for billfish. If net present value is negative, then society loses economic value from the proposed changes.

5.1.2. Data[2]

Data used to estimate components of the recreational analyses from the New Jersey survey are presented below.

	Number Of Trips		Average Number On Board*
Charter	1557		5.60
Private	3921		4.60
Total	5478	Avg.	5.06

*Number of paying customers on board charter vessels; total number on board private vessels.

Average number of big game trips = 7.35

Trip Costs:

	Private	Charter
Lodging, food, land transportation*	$823	$1,002
Vessel costs	202	946
Travel time costs:**land	216	296
water	409	580
	$1,650	$2,824

* Estimated from survey response average of $179 per person for 4.6 on board private; 5.6 paying customers on board charter (captain's presumed to be included in the trip price of $946).

[2] Data used below from the New Jersey survey are from two sources: 1) Douglas Ofiera, personal communications, and forthcoming in D. Ofiera and Bernard Brown, Benefits of Big Game Fishing: A Contingent Valuation Approach, paper in progress, March 1988; and 2)_____. The 1986 Economic Survey of New Jersey's Big Game Fishery, N.J. Maine Fisheries Administration, Sept. 1987.

**Valued at one-half the imputed wage of $39.40 per hour for land travel time for private vessel fishermen, and also applied to paying customers of charter. Captain's (and mate, if any) presumed to be included in trip price charged customers. One-third the imputed wage applied to time spent traveling on water to fishing site (water travel time was approximately three times the land travel time).

Willingness to pay additional trip costs for one more fish (average):

	Willingness to pay
White marlin	$170
Blue marlin	$365

These data, together with assumed values for own-price demand elasticity, were used to generate the amount of consumer surplus created by the demand shift. For the base case (assuming the demand elasticity = 1), the following are the estimated consumer surpluses:

	White Marlin	Blue Marlin
Private trip	$1314	$2978
Charter trip	$1288	$2856

The computation for the white marlin private trip is illustrated below in Figure 3.

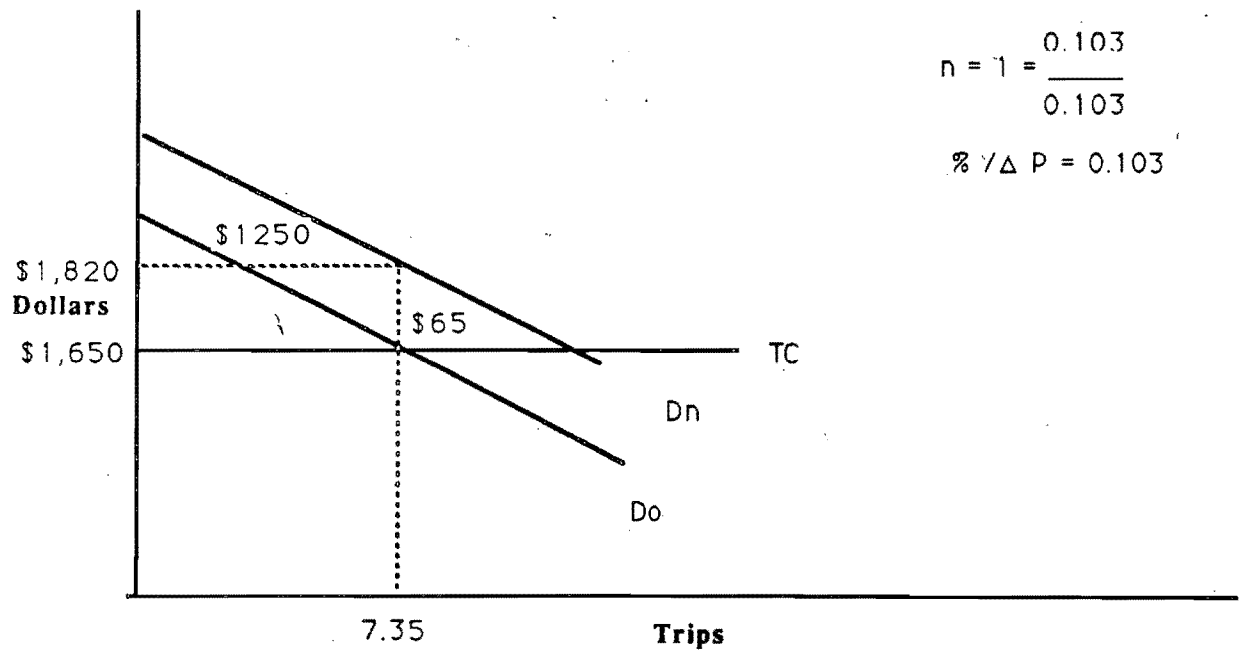

Figure 3. Estimation of Consumer Surplus for a White Marlin, Private Vessel Trip

$$\text{Area} = [170(7.35) + 1/2\{(.103)(7.35)(170)\}]\ \{P\}$$
$$= [1250 + 65]\ \{P\}$$
$$\text{Expected Value} = \$1314\ \{\text{probability of catching one more fish per trip}\}$$

5.1.3 Stock Enhancement From Live Releases From:

5.1.3.1 No Sale, No Retention Regulations

The impact of the no sale, no longline retention regulations will be to reduce the present commercial longline landings to zero. Total reported marlin landings in 1986 was 204,215 pounds. Mean weight was assumed to be 264 pounds for blue marlin and 50 pounds for white marlin (Billfish Source Document).

Based on 21 observer trips, the observed marlin species composition was: 49% Blue Marlin; 51% White Marlin. Assuming these proportions are representative of the total landings, then:

Total Number of Marlin = 204,215 + (.49)(264) + (.51)(50)
= 1319 marlin; of which 646 are blue marlin
and 673 are white marlin

From observer data, 72% of the blue marlin and 52% of the white marlin caught by longliners are alive.

Therefore, of 646 blue marlin caught and sold, 72% = 465 would be released alive each year with the no sale and no longline possession regulations. Likewise, of 673 white marlin released, 52% = 350 would be released alive each year following implementation of the plan.

Since both blue and white marlin are relatively long lived, the annual additions accrue over time, decremented by natural mortality. Natural mortality rates for these species are not known, so we assumed values of M=0.2 for blue marlin and M=0.3 for white marlin, and assumed that additions to the stock will continue to accrue for ten years after which equilibrium is reached at a new level equal to the original population size plus the cumulative additions remaining alive in the population in year 10. These values are shown in Table 1 and Figure 4.

5.1.3.2 Minimum Sizes (see Table 2)

Estimates of the number of live additions to the population that will result from minimum size regulations, were derived from total recreational billfish landings. Two estimates of recreational landings were used - Hamm and Slater, 1979, Survey of the Recreational Billfish and Shark Fisheries; and NMFS 1983, Oceanic Pelagics Program Summary.

Table 1. Additions to Stock From No Sale, No Possession Regulations

Years After Implementation	No. Blue Marlin	Cumulative No. of Blue Marlin	No. White Marlin	Cumulative No. of White Marlin
1	465	465	350	350
2	381	846	259	609
3	312	1158	192	801
4	255	1413	142	943
5	209	1622	105	1048
6	171	1793	78	1126
7	140	1933	58	1184
8	115	2048	43	1227
9	94	2142	32	1259
10	77	2219	24	1283

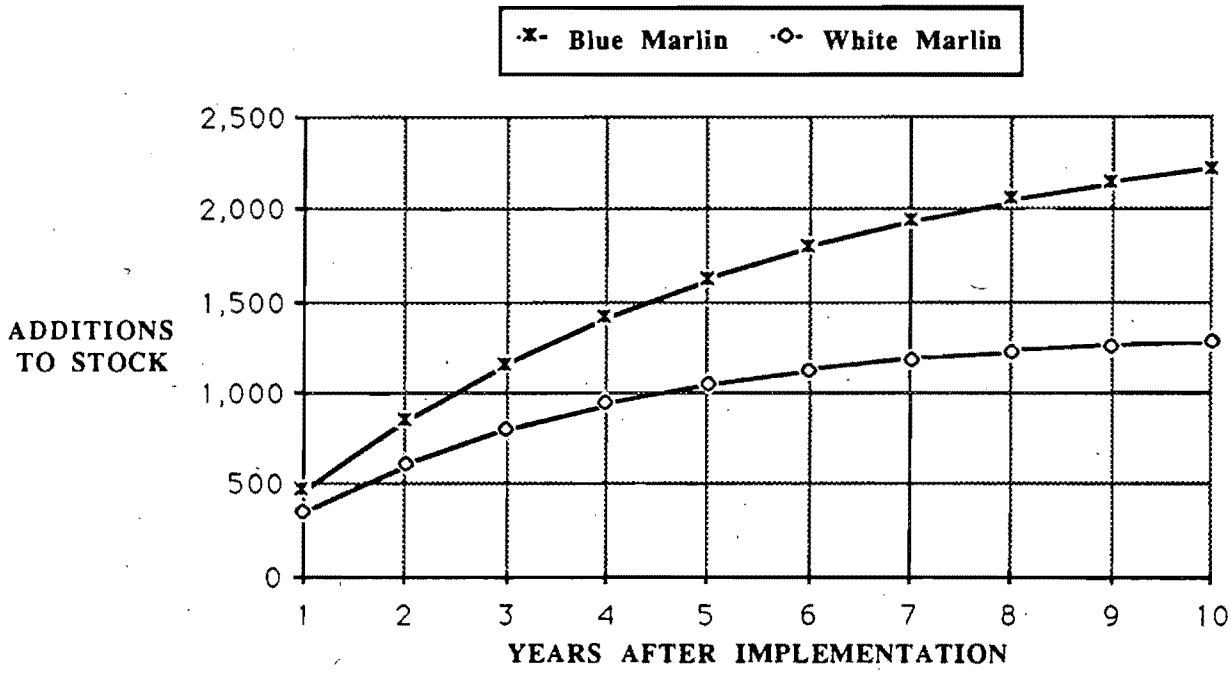

Figure 4. Additions to Blue and White Marlin Stocks From No Sale, No Possession Provisions.

The minimum sizes specified in the management plan were derived from size frequency data and are calculated to reduce retention by 50 percent for blue and white marlin and by 30 percent for sailfish.

Hamm and Slater estimated:

2,452 blue marlin were caught and retained

4,787 white marlin were caught and retained

15,699 sailfish were caught and retained

Of these, the number of fish that will be released with the minimum size regulations are:

(2,452) x (.5) = 1,226 blue marlin

(4,787 x (.5) = 2,394 white marlin

(15,699) x (.3) = 4,710 sailfish

Using the 1983 estimates:

1,513 blue marlin were caught and retained x (.5) = 757 released

3,242 white marlin were caught and retained x (.5) = 1,621 released

no estimate for sailfish caught

Table 2. Projected Additions to Billfish Stocks Resulting From the Imposition of Minimum Sizes

	BLUE MARLIN (M=0.2)				WHITE MARLIN (M=0.3)				SAILFISH (M=0.34)	
Years After	1977 Survey		1983 Census		1977 Survey		1983 Census		1977 Survey	
Implementation	Annual	Cum.	Annual	Cum.	Annual	Cum.	Annual	Cum.	Annual	Cum.
1	1,226	1,226	757	757	2,394	2,394	1,621	1,621	4,710	4,7102
2	1,004	2,230	620	1,377	1,774	4,168	1,201	2,822	3,352	8,062
3	822	3,052	507	1,884	1,314	5,482	890	3,712	2,386	10,448
4	673	3,725	415	2,299	973	6,455	659	4,371	1,698	12,146
5	551	4,276	340	2,639	721	7,176	488	4,859	1,209	13,355
6	451	4,727	278	2,917	534	7,710	362	5,221	860	14,215
7	369	5,096	228	3,145	396	8,106	268	5,489	612	14,827
8	302	5,398	187	3,332	293	8,399	199	5,688	436	15,263
9	248	5,646	153	3,485	217	8,616	147	5,835	310	15,573
10	203	5,849	125	3,610	161	8,777	109	5,944	221	15,794

These numbers were decremented each year for estimated natural mortality rates of M=0.2 for blue marlin; M=0.3 for white marlin; and M=0.34 for sailfish (from Source Document). All fish released by the recreational fishery were assumed to be alive. Resulting additions and cumulative additions to the population are shown in Table 2. Estimated cumulative additions remaining alive in the population after each year up to year ten are shown in Figures 5, 6, and 7.

Because the population has been incremented by the live releases discussed above, the probability of catching a fish will increase. The lower bound on this probability was calculated by assuming the present tag-recapture rate of 1% for blue marlin and 2% for white marlin, and applying these rates to the additions to stock for each year to estimate the number of anticipated recaptures. To simplify the calculation of gains to the recreational fishery, for each species, a weighted average consumer surplus value of charter and private trips (weighted by the proportion

of trips taken by each category) was used and multiplied by the number of anticipated recaptures for that species.

Tag recaptures are believed to be unrealistically low, and not representative of the actual increased probability of catching an additional fish. Thus, to calculate an upper bound on the probability of catching an additional fish, we assumed that the increase would be linear and increase as the stock size increased up to year ten. For blue marlin we assumed a probability in

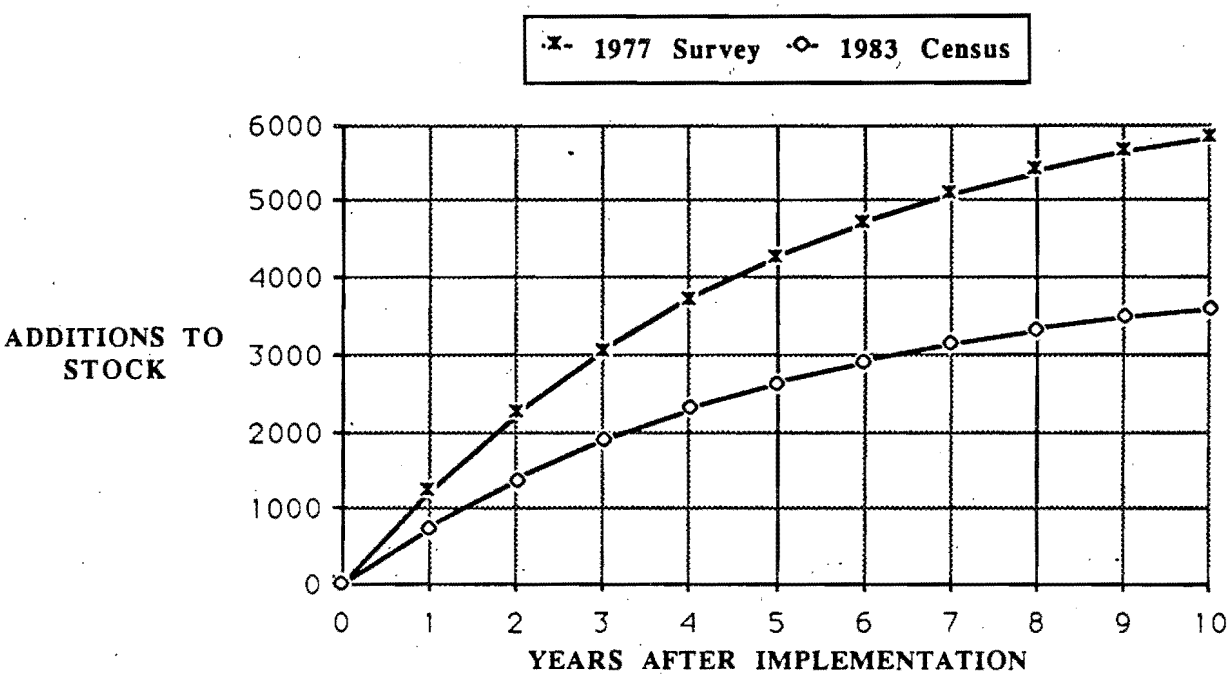

Figure 5. Additions to Blue Marlin Stock from Minimum Sizes

year one of 0.001 which increased (by .001 per year) up to 0.01 in year ten. For white marlin we assumed an initial increase in the probability of recapture of 0.002, increasing linearly to 0.02 in year ten.

These probabilities, and estimated trips, are the final pieces of information necessary to evaluate the economic effects of the proposed major regulations. The number of charter boats that could potentially fish for billfish is unclear. Hamm and Slater (1979, p.87) state that out of all respondents reporting days fished information, 8.5 percent were charter boats. If charter boats reported days fished information in the same proportion as private vessels, then 8.5 percent of the

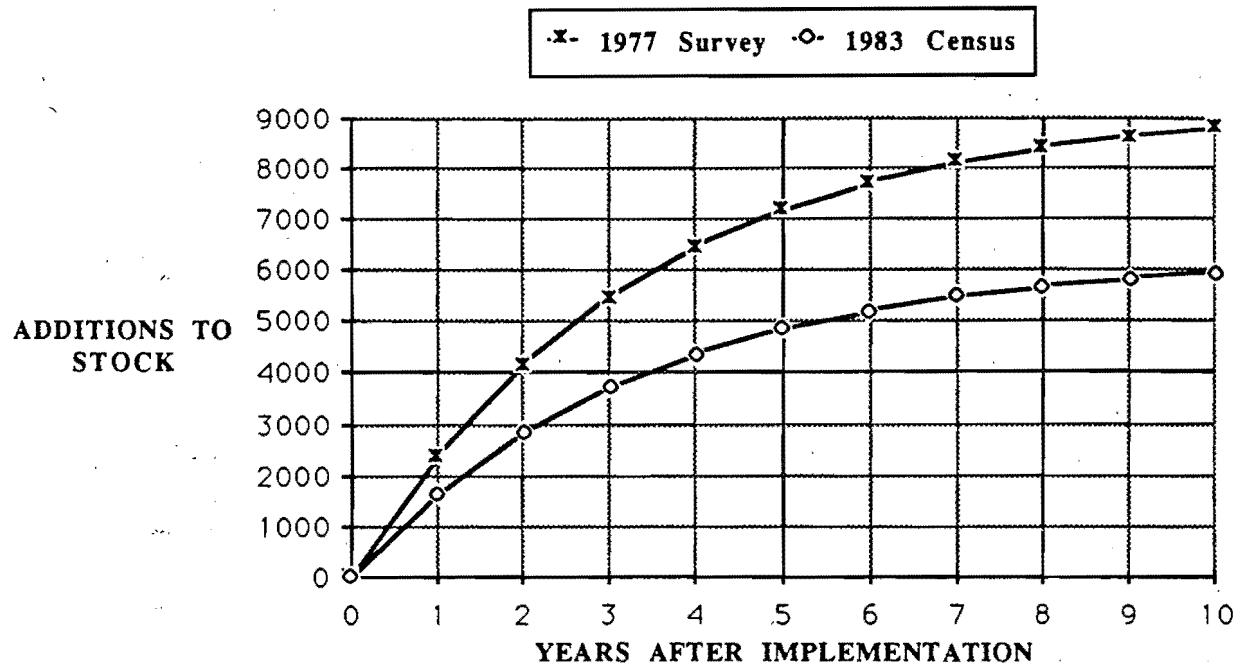

Figure 6. Additions to White Marlin Stock from Minimum Sizes

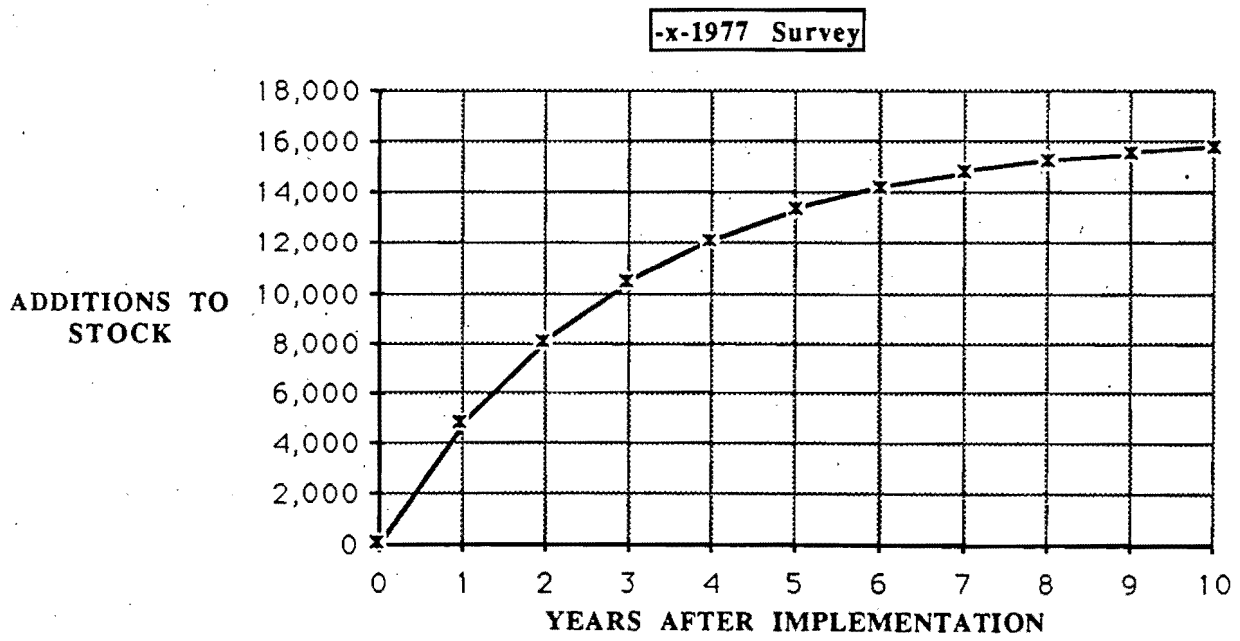

Figure 7. Additions to Sailfish Stock from Minimum Sizes

estimated number of vessels fishing for billfish were charter boats or, using the most conservative estimate in Hamm and Slater (1979, p.78), there could have been 1,477 charter boats involved in the billfish fishery. These boats were reported to account for 18.7 percent of the total days fished or 55,875 days fished for billfish; each day fished represented one trip. Subtracting an estimated 55,875 charter trips from total trips of 296,100 yields an estimated total private vessel trips of 240,225. Charter and private trips are allocated between blue and white marlin as 30 percent blue marlin; 70 percent white marlin. This differs from the blue marlin catch as a percent of total marlins caught (23 percent, from Table 3 in text) in that the success rate of blue-targeted trips is likely to be lower than white-targeted trips. Therefore, the trip summary is as follows:

	Blue Marlin	White Marlin	Total
Number charter	16,763	39,112	55,875
Number private	72,068	168,157	240,225

5.2 Analysis of Accepted Management Measures

5.2.1 Prohibition on Sale of Billfish

Using the methodology detailed above, estimates of annual gains to recreational fishermen and losses to commercial fishermen were generated for the first 10 years after implementation of the plan. Recreational gains were generated for private and charter vessels, for blue and white marlin separately, then aggregated for minimum and maximum estimates of additions to stock. Base own-price recreational demand elasticity was assumed to be one: simulations of .5 and 1.5 were also tested, with results not greatly different form 1. Maximum and minimum estimates correspond to higher or lower estimates of the probability of catching one more fish per trip, as explained earlier.

Computation of net present value for blue marlin charter trips for one year, for example, is

[Value of change in Consumer Surplus]	[Probability of catching one more fish]	[Estimated number of blue marlin charter trips]

For 1 year, using the initial maximum probability of .001, the computation is: [$2,856] [.001] [16,763] = $47,875. By year 10, this value rises to $478,751 because the probability of catching one more fish has risen to 0.01 under the assumed maximum probability bound.

Annual losses to commercial fishermen are deducted from recreational gains, and the net gain discounted over the 10-year period. Commercial losses are computed as follows:

Using consumer level values discussed above and average weights of 264 pounds for blue marlin and 50 pounds for white marlin, the loss in consumer level value is $232,000 per year for blue marlin and $332,000 per year for white marlin or a total loss of $564,000 per year. It is reasonable to assume that these fish would be retained for personal use by the crews of the vessels historically selling fish. The total ex-vessel value of billfish reported landed in 1986 was $134,716 and is an estimate of the annual personal use value. Over 10 years, at a 10 percent discount rate,

the present value would be $827,698. The net annual loss in societal value would be $429,284 = $564,000 - $134,716.

The present value of recreational gains minus commercial losses, each year over 10 years are shown in Table 3. Thus, over 10 years, the range of net present value is:

Net Present Value

Minimum Estimate = - $2.67 million

Maximum Estimate = + $18.71 million

Table 3. Net Gains and Losses From No Sale Provision at Two Probability Levels of Catching an Additional Fish

YEAR	RECREATIONAL GAINS MINIMUM $$	RECREATIONAL GAINS MAXIMUM $$	COMMERCIAL LOSSES $$	NET GAINS MINIMUM $$	NET GAINS MAXIMUM $$	NET DISCOUNTED AT 10% MINIMUM $$	NET DISCOUNTED AT 10% MAXIMUM $$
1	23,826	490,245	500,000	-476,174	-9,755	-432,842	-8,867
2	39,156	1,338,753	500,000	-460,844	838,753	-380,657	692,810
3	56,148	2,143,898	500,000	-443,852	1,643,898	-333,333	1,234,567
4	65,937	2,949,597	500,000	-434,063	2,449,597	-296,465	1,673,075
5	74,433	3,755,074	500,000	-425,567	3,255,074	-264,277	2,021,401
6	82,929	4,559,259	500,000	-417,071	4,059,255	-235,228	2,289,420
7	87,177	5,364,567	500,000	-412,823	4,864,567	-211,778	2,495,523
8	91,425	6,169,713	500,000	-408,575	5,669,713	-189,425	2,647,756
9	94,380	6,975,411	500,000	-405,620	6,475,411	-171,983	2,745,574
10	98,628	8,051,627	500,000	-401,372	7,551,627	-154,930	2,914,928
TOTALS						-2,670,918	18,706,187

5.2.2 Minimum Sizes

A similar procedure for estimating recreational gains to minimum size limits could be employed as that used to estimate gains under the no-sale provision of #1. However, retention of fish is not a necessary condition for a successful recreational trip. Those released will also improve the probability of catching fish in the future. The estimated additions to the stock will exceed those resulting from the no-sale provision by 1.6 to 2.6 times for blue marlin; and by 4.6 to 6.8 times for white marlin. Since there are no commercial losses associated with this measure, the impacts will result in large net gains at both minimum and maximum probabilities of increased catches. Table 4 shows the net gains each year over 10 years at the minimum levels of probability of recapture (i.e., 1% for blue marlin; 2% for white marlin; and 1% for sailfish). Calculations are based on cumulative additions to the stock as shown in Table 2, and weighted mean values of an additional fish for charter and private boats as discussed previously. Values for sailfish consumer surplus are assumed to be the same as those for white marlin. Over the 10 year period, the minimum estimate of net present value is between $2.0 and $2.6 million. At the higher level of probability of recapture, net present value would exceed the maximum estimate discussed under

management measure #1. Therefore, since demand is not likely to be reduced by the minimum size limits, and significant future gains will result, the effect of this policy will be positive and will likely exceed, by a considerable amount, the gains under the no-sale provision. If average size of fish caught begins increasing over time, recreational demand could shift outward even more.

Table 4. Net Gains From Minimum Size Provision at Lowest Level of Probability of Recapture. Two Estimates of Recreational Marlin Catches were Used (1977 and 1983).

	NET GAINS		NET DISCOUNTED AT 10%	
	1983 Data	1977 Data	1983 Data	1977 Data
Year	$$	$$	$$	$$
1	125,787	158,295	114,340	143,890
2	218,511	277,062	180,490	228,853
3	286,299	368,307	215,011	276,599
4	336,909	432,585	230,109	295,456
5	375,513	486,519	233,194	302,128
6	403,773	521,613	227,728	294,190
7	425,199	551,535	218,127	282,937
8	442,746	574,623	206,762	268,349
9	456,414	589,584	193,520	249,984
10	464,541	602,252	179,313	232,855
Totals			$1,998,594	$2,575,241

5.2.3 No Possession

The effect of this measure would be to prohibit commercial longliners from retaining billfish for personal use in addition to eliminating the sale of fish caught from longliners. Considered in conjunction with management measure 1, and assuming that fish historically sold by vessels other than longline would be released, then this measure would, like measure 1, result in live addition to stock. These stock additions have been shown in previous tables and graphs. Considered above, this measure would cost the commercial fishery about $.6 million per year,with recreational gains as computed under measure 1. The net present values under the probability ranges (for 10 years) would be the following:

Minimum Estimate = - $3.27 million

Maximum Estimate = + $18.2 million

5.2.4 Data Reporting Requirements

This management measure has no direct effect on the societal value of billfish as it does not affect the catch, landings, or distribution of catch and landings among user groups. It does have an implementation cost of $1,700 per year for the Federal costs of data collection as well as a respondent cost of $350 per year for 100 burden hours of reporting (per Rod Dalton personal communication, January 19, 1988). Enforcement costs are assumed to be negligible. The present value of perpetual implementation costs is $20,500.

5.2.5 Exemption for Puerto Rican Handline Fishery

The extent of the Puerto Rican handline fishery is not well documented. The reported average Caribbean sales of 23 blue marlin and 16 white marlin in 1985-86 was assumed to be caught by the handline fishery in the analysis of management measures 1 and 2. Banning possession and subsequent sales of these fish by handline boats would represent an incremental loss in consumer level value of $21,000 per year (present value of perpetual loss equal to $210,000) beyond the loss discussed in the analysis of management measures above.

5.3 Rejected Management Measures

1a-5a. No action alternative.

Concern over recent increases in incidental commercial catches, and potential losses of value in the recreational sector were major motivations for this plan. The estimated gains to society under measure 1 above of -$2.67 million to +$18.71 million is one estimate of costs of "no action".

1b. Prohibit sale of all billfish from the management unit, including those from the traditional handline fishery in Puerto Rico.

This measure was considered as an alternative to accepted 1 and 5 above, the difference being that exception to the no-sale provision was made for the small Puerto Rican fishery. These effects were judged insignificant compared to the values associated with accepted measure 1 above, and the small costs associated with accepted measure 5.

2b. Prohibit all possession of billfish from the management unit.

This measure, above, would cost commercial fishermen about $.6 million per year, with gains similar to those reported under accepted measures 1-3 above. The partial effect of no recreational retention was judged to be small compared to 1 and 3 above, as many recreationally caught fish are returned anyway.

3b. Prohibit possession of billfish from the management area by recreational fishermen in excess of certain limits (i.e., recreational bag limit).

The effect of this management measure would be similar to accepted management measure 2 with the addition of an increase in recreational catch release and subsequent recaptures. The size of the increase depends on the increase in recreational releases (i.e., the reduction in retained recreational catch).

3c. Prohibit possession of billfish from the management area during tournaments by participants in the tournaments (i.e., establish that all tournaments would be "no kill" tournaments).

See the discussion for 3b.

4b. Only billfish exceeding a minimum size based on size at sexual maturity may be retained in possession.

The effects of this management measure would be similar to those for accepted management measure 2. The size limits in management measure 2 are smaller than size at sexual maturity, resulting in a larger increase in recreational releases and thus increase in recreational use value than would larger size limits. If this management measure were implemented alone, smaller size limits would result in a larger retained catch to be sold with a correspondingly smaller loss in consumer level value. On balance, smaller size limits will cause a smaller loss in societal value, the amounts depending on the proportional reduction in catch.

4c. Only billfish exceeding a minimum size in each Council area based on the average size distribution of billfish caught in that area may be retained (non-uniform size limits).

See the discussion for 4b. There may be additional enforcement costs as well as "leakages" into bordering areas with smaller size limits.

6.0 IMPACT ON BUSINESSES

The FMP notes that there were approximately 625 swordfish permits issued in 1987. Assuming that those permittees that catch, and sell, swordfish could also catch and sell billfish, then an estimate of the businesses involved is the number of permit holders. Although there are no data, it may be reasonable to assume that most of the permit holders would qualify as small businesses under the Small Business Administration guidelines. The extent of the impact on commercial vessels would be the change in ex-vessel value. This ranges from no change under the no action alternatives to an annual loss of ex-vessel receipts that averaged $116,000 over the 1985-86 years. The per business annual loss estimate is thus $186 or a capitalized revenue loss of $1,860. There are a number of ancillary small businesses that could be affected by the FMP's management measures, including seafood processors and distributors, taxidermists, docks and marinas, boatyards, fishing equipment manufacturers, etc. Data are not readily available to estimate the extent of impacts on these ancillary businesses.

Increasing demand by recreational fishermen due to expected and subsequently, realized increases in catch rather suggest increases in sales by firms supplying this sector. However, these increased sales are transfers from consumers, and are not (if the supply functions are perfectly elastic) increases in producers' or consumers' surplus, which are what we want to measure. If, on the other hand, long-run supplies are less than perfectly elastic, producers' surpluses will be generated, as shown in Figure 8 below. New producers' surplus generated by the demand shift is area P1P2BCA. However, P1P2BA of that is lost consumer surplus, hence is a transfer and should not be counted as a net gain to society. Only triangle BCA would--that part of producers' surplus not transferred from consumers--represent net gains to society (and accruing to suppliers

of imports to recreational fishermen). While we suspect this supply function to be relatively elastic (flat), we do not have estimates of its elasticity. Yet this area is likely to be small relative to changes in consumers surplus from the demand shifts discussed above under methodology.

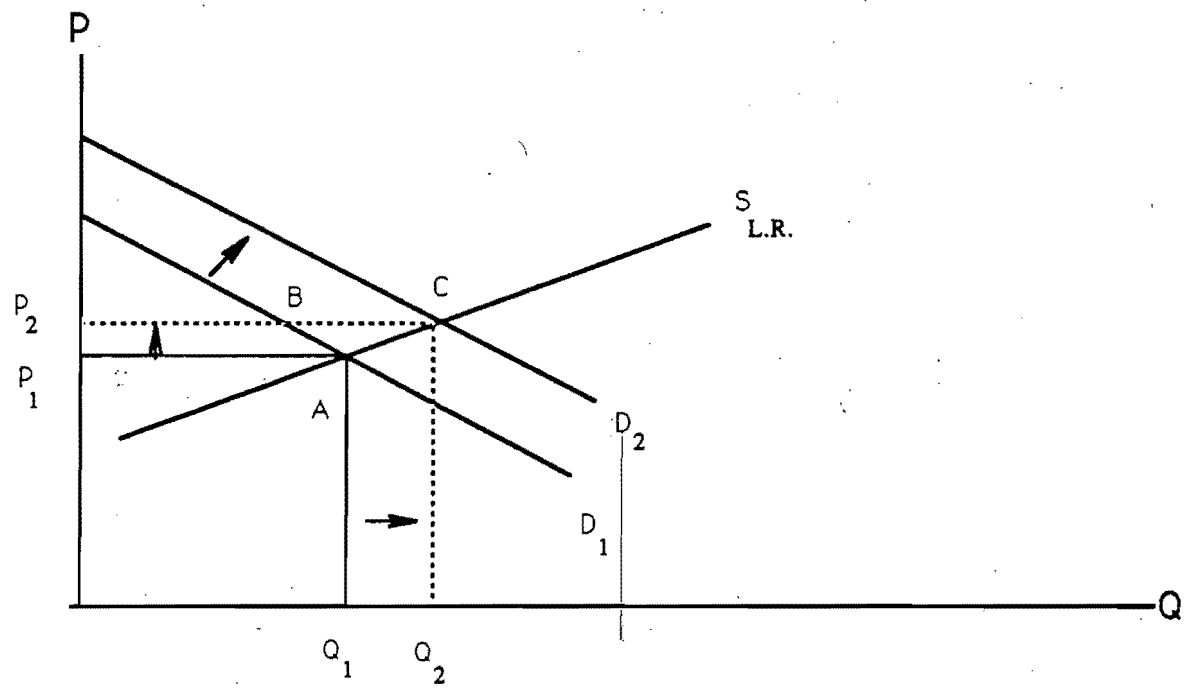

Figure 8.

7.0 SUMMARY

The cumulative effect of the proposed management measures may be as high as $36 million in net gain (present value over the first 10 years). The FMP makes a strong contribution to the objectives, and the accepted management measures are superior to the no action alternative.