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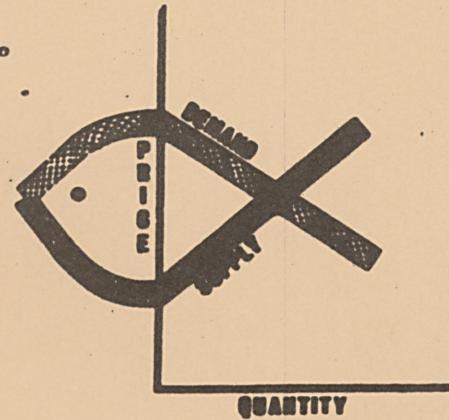
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## A Steady State Bio-Economic Model of a Fishery

by

J. M. Gates

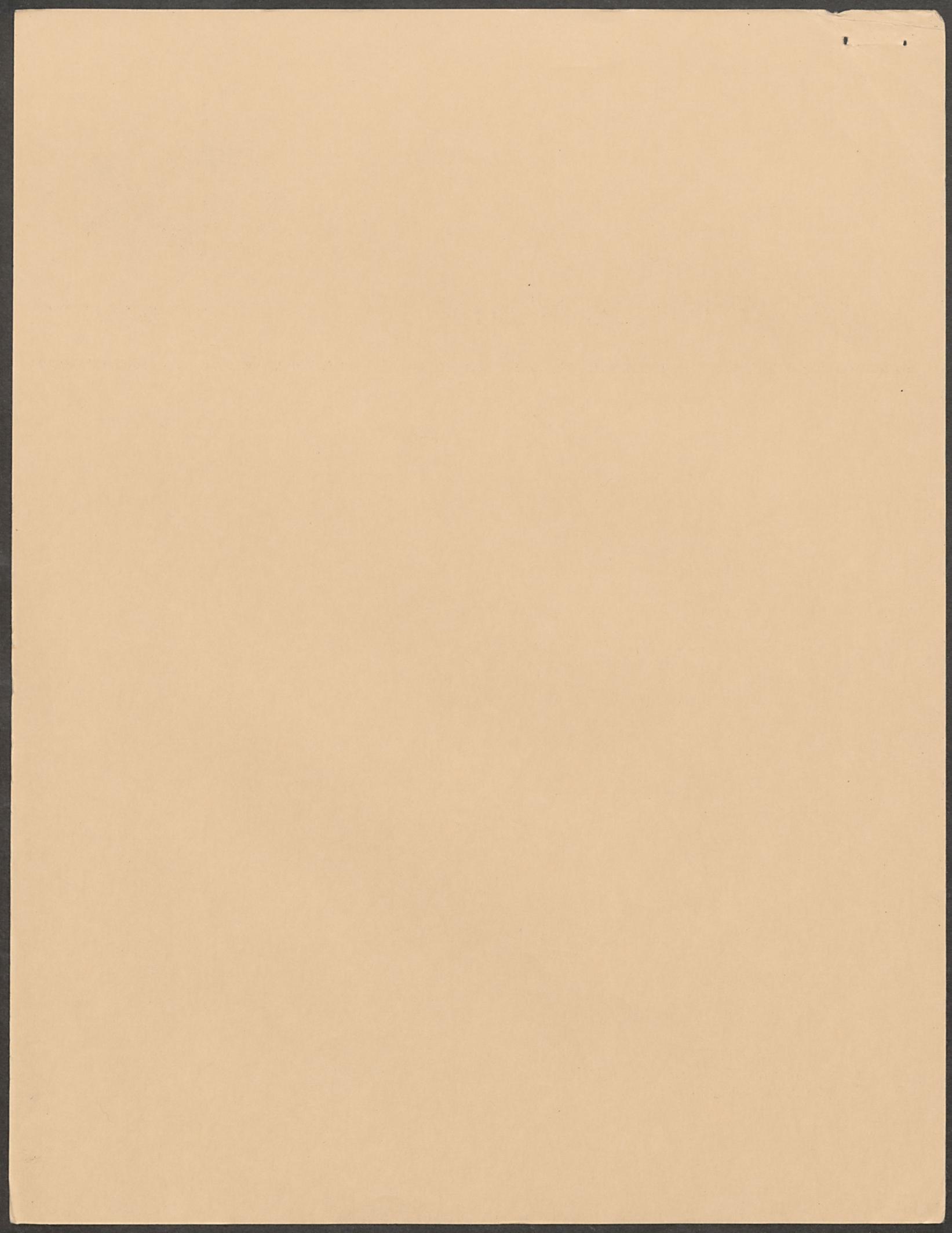
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## INTRODUCTION

During the past two decades, in response to a growing interest in developing national fisheries management plans, there have been numerous "bio-economic" fisheries models proposed. These include Gordon (1954), Scott (1955), Crutchfield & Zellner (1963), Turvey (1964), Lampe (1965), Van Meir (1969), Quirk & Smith (1969), Carlson (1969), Smith (1969) and Bell (1970).

These models have ranged from highly abstract optimization statements to some interesting statistical explorations. Certain of the earliest models were ordinal descriptions of the end result, i.e. steady state cost curves.

In general, these authors have not attempted a thorough theoretical and empirical development beginning from the determinants of the biological yield function. In addition, with the exception of the Carlson paper, there has been little explicit development of distinctions between the production function of an individual vessel and the aggregate or fleet production function inclusive of a "crowding" externality. This paper develops the biological yield functions and the "crowding" externality which exists for a fixed stock of fish explicitly. It improves upon some previous approaches by thoroughly integrating many of the biological and economic factors that affect the fishing industry.

In order to test the implications of mesh regulations, explicit recognition is given to the importance of age class structure for market price as well as for aggregate yield.

Since domestic vs. foreign shares are a significant issue in high seas fisheries, the model permits variations in shares to investigate the effect of country quotas on domestic cost and revenue functions. The model also allows for parametric variations in factors such as import levels, relative size composition of the fleet, and demand coefficients. In addition, the model allows for testing the sensitivity of yield, costs and revenue to changes in certain biological parameters such as natural mortality and recruitment.

It should be noted that the model developed for this study is a "steady state" model and, therefore, permits only comparative statics analyses. It is anticipated that future work will focus on relaxing the steady state nature of the model and on extending it to cope with multiple species fisheries. The authors believe, however, that the comparative statics approach used in this study clearly demonstrates the effects of changes in the political, economic, and biological factors mentioned above. In particular, the approach delineates the economic cost of allowing unrestricted entry into a common property fishery.

The remainder of this report is divided into three chapters. Chapter II develops the steady state biological model. This section is a paraphrasing, with some interpretive comments, of a model in Beverton and Holt (1957). Chapter III develops the economic model and links it with the biological model via the fishing mortality effort equation. Chapter IV comprises

an application of the model to the yellowtail flounder fishery of New England.

The authors suggest that some readers may wish to skip over Chapter II in that it contains some complex and tedious mathematical manipulations but which are presented so that those readers who are interested can fully evaluate the economic model used in this study. The decision to include the mathematical origins of the model was reinforced by the limited availability of the Beverton and Holt book to many potential readers.

## II

### THE BIOLOGICAL MODEL

#### A. Growth of a Representative Fish

The steady state biological model used is that proposed by Beverton and Holt (1957), pp. 34-38. Notation has been chosen to correspond with theirs. The growth of a representative fish is expressed by the following differential equation, first proposed by von Bertalanffy (1938):

$$\frac{dw}{dt} = Hs - kw \quad (2.A.1)$$

where:  $H$  = rate of synthesis of mass per unit of physiological surface.

$k$  = rate of destruction (catabolism) of mass per unit mass.

$w$  = weight of a representative fish.

$t$  = age of fish.

$s$  = effective physiological surface of a fish.

Empirical evidence suggests that  $s$  is approximately proportional to the square of length ( $\ell$ ), while  $w$  is approximately proportional to the cube of length. From these empirical relationships, we may state (2.A.2):

$$\frac{dw}{dt} = 3 a \ell^2 \frac{d\ell}{dt} \quad (2.A.2)$$

where  $a$  is the proportionality factor between  $w$  and  $\ell^3$ .

Substitution for  $dw/dt$  in 2.A.1 yields the following expression for  $d\ell/dt$ :

$$\frac{d\ell}{dt} = \frac{Hr}{3a} - \frac{kl}{3} \quad (2.A.3)$$

where  $r$  is the proportionality factor between  $s$  and  $\ell^2$ .

Define  $H_r = E$  and  $k = K \frac{1}{3}$

Then  $\frac{d\ell}{dt} = E - Kl$ ; the solution of which is  $\ell_t$ :

$$\ell_t = E - \left[ \frac{E - \ell_0}{K} \right] e^{-Kt} \quad (2.A.4)$$

where  $\ell_0$  is the length of a representative fish at  $t=0$ . Taking the limit of 2.A.4.

$\lim_{t \rightarrow \infty} (\ell_t) \rightarrow E \equiv \ell_\infty \equiv$  the maximum length achievable by a representative fish

substitution for  $\ell_\infty$  in 2.A.4 yields 2.A.5:

$$\ell_t = \ell_\infty - (\ell_\infty - \ell_0) e^{-Kt} \quad (2.A.5)$$

substitute for  $\ell_t = \frac{w}{a}^{1/3}$ ; and solve to obtain  $w_t$ :

$$w_t = \left[ w_\infty^{1/3} - (w_\infty^{1/3} - w_0^{1/3}) e^{-Kt} \right]^3 \quad (2.A.6)$$

Let  $w_t = 0$  at  $t = t_0$  and substitute in 2.A.6:

$$0 = \left[ w_\infty^{1/3} (1 - e^{-Kt_0}) + w_0^{1/3} e^{-Kt_0} \right]^3$$

Expand and solve for  $w_0$  to obtain 2.A.7:

$$w_0 = w_\infty (1 - e^{-Kt_0})^3 \quad (2.A.7)$$

substitute for  $w_0$  in 2.A.6 to obtain 2.A.8:

$$w_t = w_\infty (1 - e^{-K(t-t_0)})^3 \quad (2.A.8)$$

similarly, one can derive the following expression for  $\ell_t$ :

$$\ell_t = \ell_\infty (1 - e^{-K(t-t_0)}) \quad (2.A.9)$$

Equation 2.A.8 may be expanded and written as 2.A.10:

$$w_t = w_\infty \sum_{j=0}^3 \gamma_j e^{-jk(t-t_0)} \quad (2.A.10)$$

where  $[\gamma_j] = [1 \ -3 \ 3 \ -1]$

The typical graph of 2.A.8 is a sigmoid curve whose asymptote is  $w_\infty$ . The curve is initially convex to the origin but becomes concave. The inflection point is reached at a weight of 0.296  $w_\infty$ . This is a property of the von Bertalanffy function. The age at which this inflection point is reached depends both on  $w_\infty$  and on the catabolic coefficient  $k \equiv 3K$ . Figure 2.A.1 is a "normalized" plot of the growth curve for a representative fish which survives to age  $t$ . It is normalized by plotting  $w_t/w_\infty$  as the ordinate rather than  $w_t$ . The curve plotted is based on  $K=0.335$  as cited by Brown and Henne-muth (1971) for yellowtail flounder.

#### B. Population Numbers and Sustainable Yields in Numbers

Consider a single year class which enters the exploited area at age  $t_p$ . Let the gear selectivity be such that fishing mortality is zero prior to age  $t_p$ . From age  $t_p$  to  $t_{p^-}$ , the population is subject to natural mortality only. Thus the time path of population numbers is given by 2.B.1:

$$N_t = R e^{-M(t-t_p)} \quad (2.B.1)$$

where:  $R \equiv$  recruitment in numbers of fish at age  $t_p$

$M \equiv$  instantaneous natural mortality coefficient

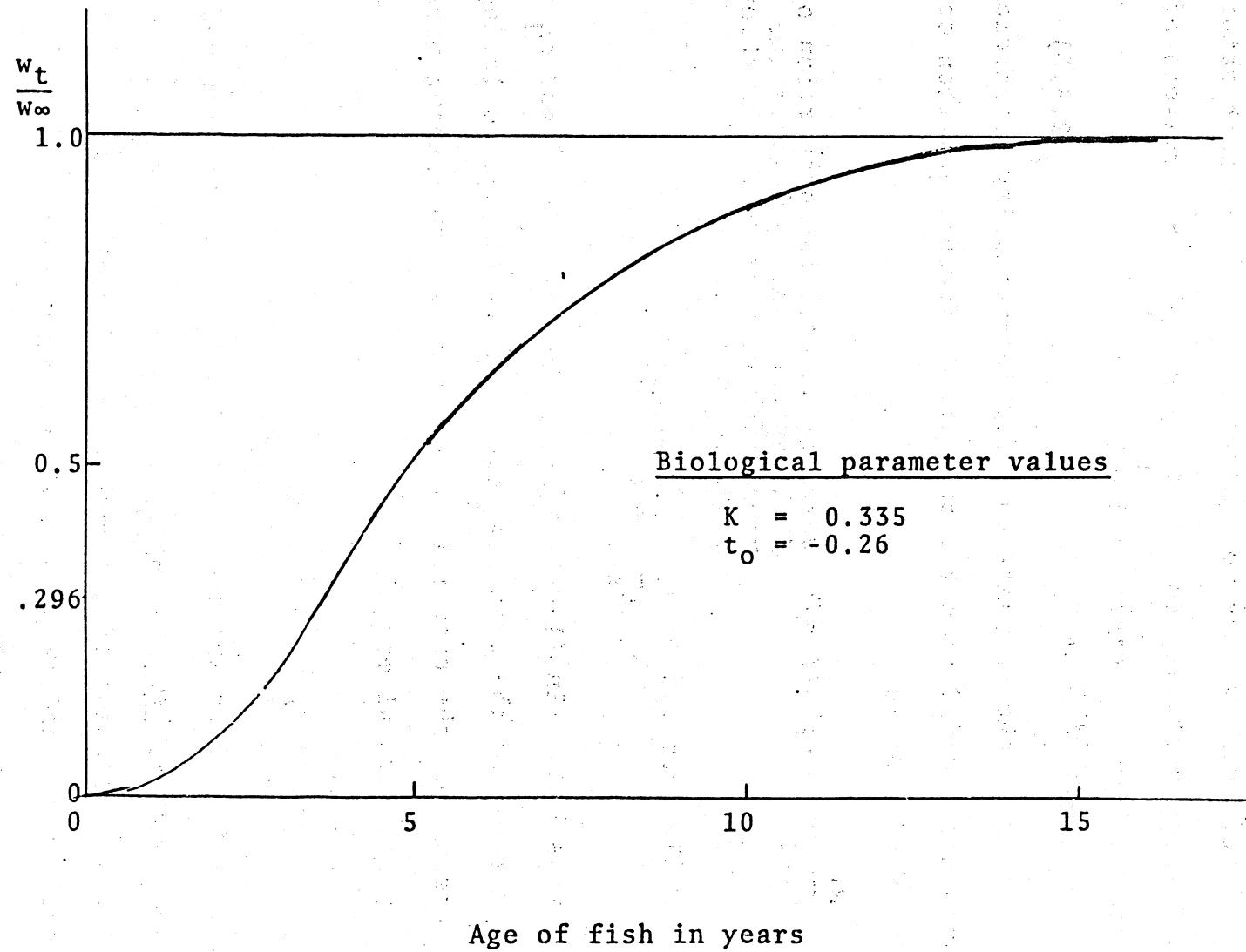
$e \equiv$  base of Naperian logarithms

$N_t \equiv$  population numbers surviving at time  $t$

For the immediate modeling purposes, we have no abiding interest in recruits which die before age  $t_{p^-}$ , and therefore define a recruitment at age  $t_{p^-}$ , instead of at age  $t_p$ .

Weight at age  $t$  relative to  
maximum weight

Figure 2.A.1: The normalized growth curve of a representative fish



$$R' = R e^{-m(t_p - t_p)} = R e^{-mp} \quad (2.B.2)$$

where  $p = t_p - t_p$

After age  $t_p$ , the population is subject to both natural and fishing mortality so that the time path of survivors of a given age class is given by 2.B.3:

$$N_t = R' e^{-(F+M)(t-t_p)} \quad (2.B.3)$$

where  $F$  is the instantaneous fishing mortality coefficient. During time period from  $t-1$  to  $t$  the difference equation counterpart of (2.B.3) is:

$$\frac{N_t}{N_{t-1}} = (1-q_F)(1-q_M) \quad \text{where } q_F \text{ denotes the proportion of fish captured and } q_M \text{ denotes the proportion of fish which die through natural mortality.}$$

while from 2.B.3;  $\frac{N_t}{N_{t-1}} = e^{-(F+M)}$

thus  $F+M = -\ln(1-q_F) - \ln(1-q_M)$ , or,  $q_F = 1-e^{-F}$  and  $q_M = 1-e^{-M}$ . Manipulation of the preceding equations yields the following expression for the proportions of deaths due to fishing mortality and natural mortality:

$$1 - \frac{N_t}{N_{t-1}} = q_F + q_M - q_F \cdot q_M$$

Thus, total deaths are the sum of deaths due to fishing and natural causes, less the product ( $q_F \cdot q_M$ ) which reflects the fact that a portion of the fish captured would have died of natural causes had they not been captured.

Note that the "fishing mortality coefficient"  $-F$  is the natural logarithm of the proportion of fish which survive capture and natural mortality.

Note also, that while  $F$  and  $M$  can be added to obtain a total mortality coefficient, percentages of deaths due to capture and natural mortality cannot be so added, since a portion of fish captured represent fish which would have died of natural causes if capture had not occurred. This interaction effect,  $(q_F \cdot q_M)$ , must be subtracted from the sum of  $q_F$  and  $q_M$  to obtain a total percentage of deaths.

The time path of numbers of fish is  $\frac{dN}{dt}$  in equation 2.B.4:

$$\frac{dN}{dt} = -(F+M)N \quad (2.B.4)$$

This time path contains two components which are analogous to deaths due to fishing ( $-FN$ ) and natural mortalities ( $-MN$ ), respectively. The latter term is of no special interest to the bio-economic model developed here. The former represents the time rate of change (with sign reversed) of yield in numbers over the lifetime of an age class. That is, from 2.B.3 and 2.B.4:

$$\frac{dY_n}{dt} = FN = FR' e^{-(F+M)(t-t_p)} \quad (2.B.5)$$

The yield in number of an age class over its fishable life is obtained by integrating 2.B.5 with respect to  $t$  to obtain 2.B.6:

$$Y_n = \int_{t_p}^{t_\lambda} \frac{dY_n}{dt} dt = \frac{FR'}{F+M} (1 - e^{-(F+M)\lambda}) \quad (2.B.6)$$

### C. Population Biomass

The weight of an individual fish of age class  $t$  was expressed by 2.A.10 as:

$$w_t = w_\infty \sum_{j=0}^3 \gamma_j e^{-jk(t-t_0)}$$

The time path of number of survivors of a given age class was given by 2.B.3 as:

$$N_t = R' e^{-(F+M)(t-t_p)}$$

Thus, the biomass ( $N_t w_t$ ) of a given age class is obtained by multiplication of 2.A.10 and 2.B.3:

$$N_t w_t = R' w_\infty e^{-(F+M)(t-t_p)} \sum_{j=0}^3 \gamma_j e^{-jk(t-t_0)} \quad (2.C.1)$$

The biomass of all age classes subject to exploitation is obtained by integration of 2.C.1 with respect to  $t$  over the time (age class) interval  $t_p'$  to  $t_\lambda$ . This integration yields

2.C.2:

$$W_B \frac{t_\lambda}{t_p'} = - \int_{t_p'}^{t_\lambda} N_t w_t dt = -R' w_\infty \int_{t_p'}^{t_\lambda} \sum_{j=0}^3 \gamma_j e^{-jk(t-t_0)-(F+M)(t-t_p')} dt$$

$$W_B \frac{t_\lambda}{t_p'} = R' w_\infty \sum_{j=0}^3 \left[ \frac{\gamma_j e^{-jk(t_p'-t_0)}}{jk+F+M} \right] \left[ \frac{1 - e^{-(jk+F+M)\lambda}}{1 - e^{-jk(F+M)}} \right] \quad (2.C.2)$$

Similarly, the biomass of the unexploited phase, i.e. of fish younger than age  $t_p'$ , is obtained by integration with

respect to  $t$  over the interval  $(t_p, t_{p'})$ . This integration yields 2.C.3:

$$WB_{t_p}^{t_{p'}} = R' W_\infty \sum_{j=0}^3 \frac{\gamma_j e^{-jk(t_p-t_0)}}{M+jK} \left[ 1 - e^{-M+jK} \right] \quad (2.C.3)$$

Obviously, as  $t_{p'}$  is reduced toward  $t_p$ ,  $p \rightarrow 0$ , and so too does  $WB_{t_p}^{t_{p'}}$ . The total biomass of exploited and pre-exploit phases is the sum of 2.C.2 and 2.C.3:

$$WB = WB_{t_p}^{t\lambda} + WB_{t_p}^{t_{p'}} \quad (2.C.4)$$

Equation 2.C.2 implies a simple relationship between the biomass of the exploited phase, annual yield in weight ( $Y_w$ ) and the fishing mortality coefficient ( $F$ ). Although the functional relationship needed for  $Y_w$  is not developed until the next section, we state here, without proof, the relationship between  $WB_{t_p}^{t\lambda}$ ,  $Y_w$  and  $F$ :

$$Y_w = \frac{WB_{t_p}^{t\lambda}}{F} \quad (2.C.5)$$

Equation 2.C.5 is an estimate of total biomass only if  $p = 0$ ; i.e. if age at recruitment into the fishing grounds ( $t_p$ ) and age at exploitation ( $t_{p'}$ ) are equal. In the more general case of  $t_{p'} > t_p$ , equations 2.C.2, 2.C.3 and 2.C.4 would be necessary to define total biomass. However, the biomass of the unexploited phase is not of interest for the immediate task, and future references to biomass are to  $WB_{t_p}^{t\lambda}$  unless otherwise noted.

#### D. Sustainable Yields in Weight

The time path of yield in weight of an age class is numerically equal, but of opposite sign to the rate at which the fish survive capture:

$$\frac{dY_w}{dt} = F \cdot N_t W_t \quad (2.D.1)$$

where  $Y_w$  = the yield in weight of an age class.

Substitution for  $N_t$  and  $W_t$  in 2.D.1 gives 2.D.2:

$$\frac{dY_w}{dt} = (R' F e^{-(F+M)(t-t_{p^-})}) (W_\infty \sum_{j=0}^3 \gamma_j e^{-jk(t-t_0)})$$

$$\frac{dY_w}{dt} = F R' W_\infty e^{(F+M)t_{p^-}} \sum_{j=0}^3 \gamma_j e^{-jk t_0} e^{-(F+M+jK)t} \quad (2.D.2)$$

Let the fishable life span be denoted by  $\lambda$ . That is, fish are captured, if at all, only between the ages of  $t_{p^-}$  and  $t_\lambda$  so that  $\lambda \equiv t_\lambda - t_{p^-}$ . Then the yield over all age classes is obtained by integrating 2.D.2 with respect to  $t$  over the time interval  $(t_{p^-}, t_\lambda)$ . That is:

$$Y_w = FR' W_\infty e^{(F+M)t_{p^-}} \sum_{j=0}^3 \gamma_j e^{jk t_0} \left[ \int_{t_{p^-}}^{t_\lambda} e^{-(F+M+jK)t} dt \right]$$

$$Y_w = FR' W_\infty e^{(F+M)t_{p^-}} \sum_{j=0}^3 \gamma_j e^{jk t_0} \left[ \frac{-e^{-(F+M+jK)t_\lambda} + e^{-(F+M+jK)t_{p^-}}}{F+M+jK} \right]$$

Factor out  $(e^{-(F+M+jK)t_{p^-}})/F+M+jK$

$$Y_w = FR' W_\infty e^{-(F+M)t_p} \sum_{j=0}^3 \frac{\gamma_j e^{-jk(t_p - t_0)}}{F+M+jK} \left[ 1 - e^{-(F+M+jK)(t_\lambda - t_p)} \right]$$

Substitute for  $\lambda \equiv t_\lambda - t_p$ , and move  $e^{(F+M)t}$  inside the summation sign:

$$Y_w = FR' W_\infty \sum_{j=0}^3 \gamma_j e^{-jk(t_p - t_0)} (1 - e^{-(F+M+jK)\lambda}) \quad (2.D.3)$$

Substituting for  $R' = R e^{-mp}$

$$Y_w = FRW_\infty e^{-Mp} \sum_{j=0}^3 \frac{\gamma_j e^{-jk(t_p - t_0)}}{F+M+jK} \left[ 1 - e^{-(F+M+jK)\lambda} \right] \quad (2.D.4)$$

Substitution, for the biomass from 2.D.2 and for yield from 2.D.4, gives the relationship between  $Y_w$ ,  $F$  and  $WB \frac{t_\lambda}{t_p}$ , which was asserted earlier in 2.C.5:

$$Y_w = F \cdot WB \frac{t_\lambda}{t_p} \quad (2.C.5)$$

Yield per recruit,  $Y_w/R$ , follows readily from 2.D.4. Average weight per fish captured,  $Y_w/Y_n$ , follows readily from 2.B.6 and 2.D.4.

Equation (2.D.4) is the steady state production function where fishing effort has implicitly been converted into the instantaneous fishing mortality coefficient,  $F$ . The conversion between fishing effort and  $F$  is developed in Chapter III, but first some interpretive comments on 2.D.4 are appropriate.

## E. The Steady State Function for Yield in Weight

### The Steady State Parameters

The steady state yield function contains several parameters which vary between fisheries but are assumed fixed for a given fishery in a stable, steady state environment. These include natural mortality ( $M$ ), the catabolic coefficient ( $k=3K$ ), and the maximum fishable age ( $t_\lambda$ ) from which  $\lambda$  is derived by subtraction of age at exploitation ( $t_{p'}$ ). Recruitment ( $R$ ) is treated as a *deux ex machina* although it is possible to reformulate the system with  $R$  being density dependent. The interested reader is referred to Beverton and Holt for this refinement.

The yield function contains two variables which are subject to policy influence. These are fishing mortality ( $F$ ) and age at exploitation ( $t_{p'}$ ). The effects on yield per recruit of varying  $F$  with fixed  $t_{p'}$  will be considered initially followed by a consideration of substitution between  $F$  and  $t_{p'}$ .

### Effect of $F$ on Yield Per Recruit with Fixed $t_{p'}$

Equation 2.D.4 expresses the yield in weight as a function of the fishing mortality coefficient,  $F$ , and several parameters, one of which is the age at exploitation  $t_{p'}$ . If  $t_{p'}$  is fixed at a value, let us say  $t_{p'} = 2.0$ , we can vary  $F$  to trace out a locus of values of yield per recruit. Similarly with  $t_{p'} = 2.75$ , we can trace out another locus of values of yield per recruit for a range of values of  $F$ . These yield per recruit curves, for  $t_{p'} = 2.0$  and  $t_{p'} = 2.75$ , are shown in Figures 2.E.1 and 2.E.2 respectively. These figures are

Figure 2.E.1: Steady state yield per recruit for selected levels of the fishing mortality coefficient when  $t_p = 2.0$

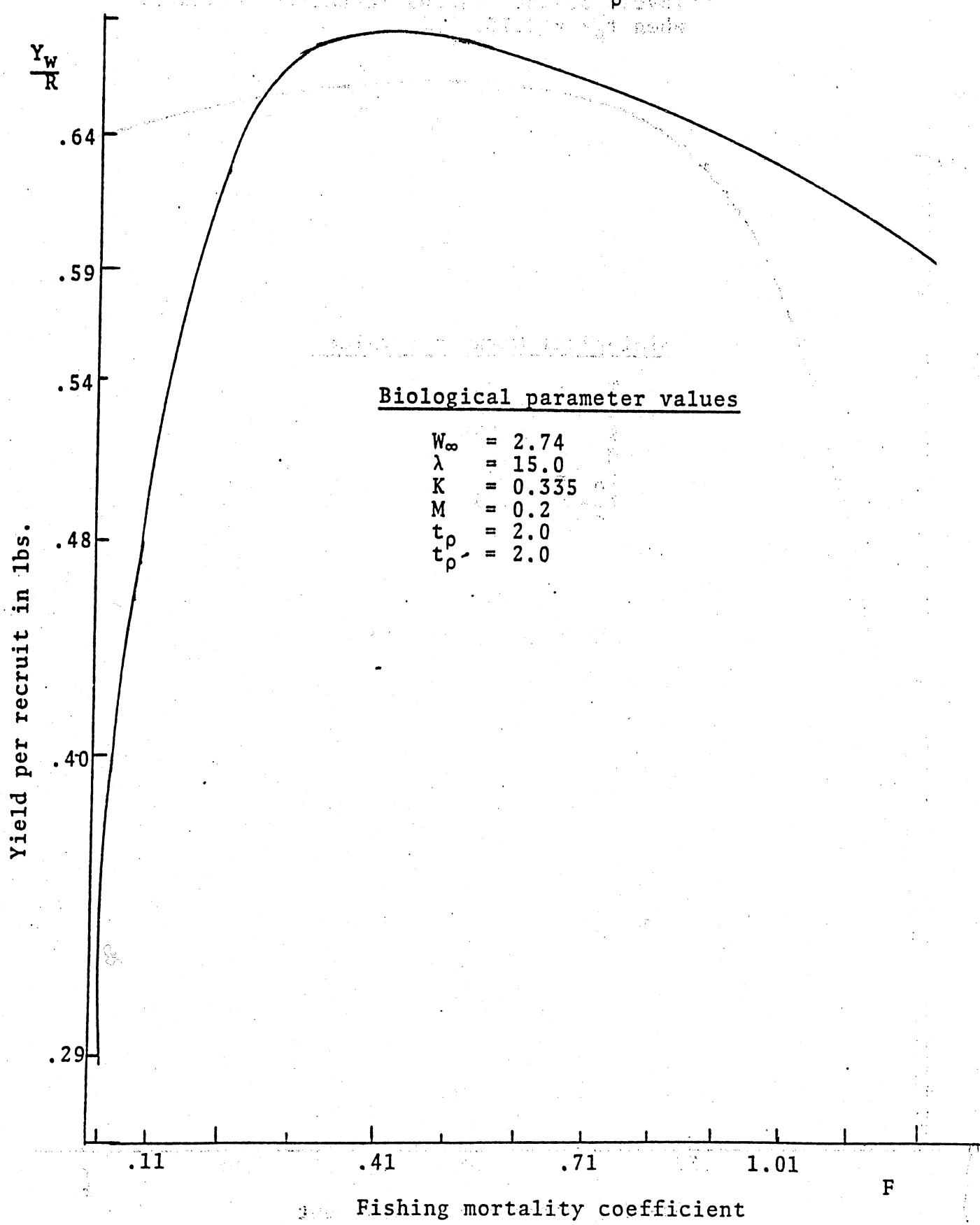
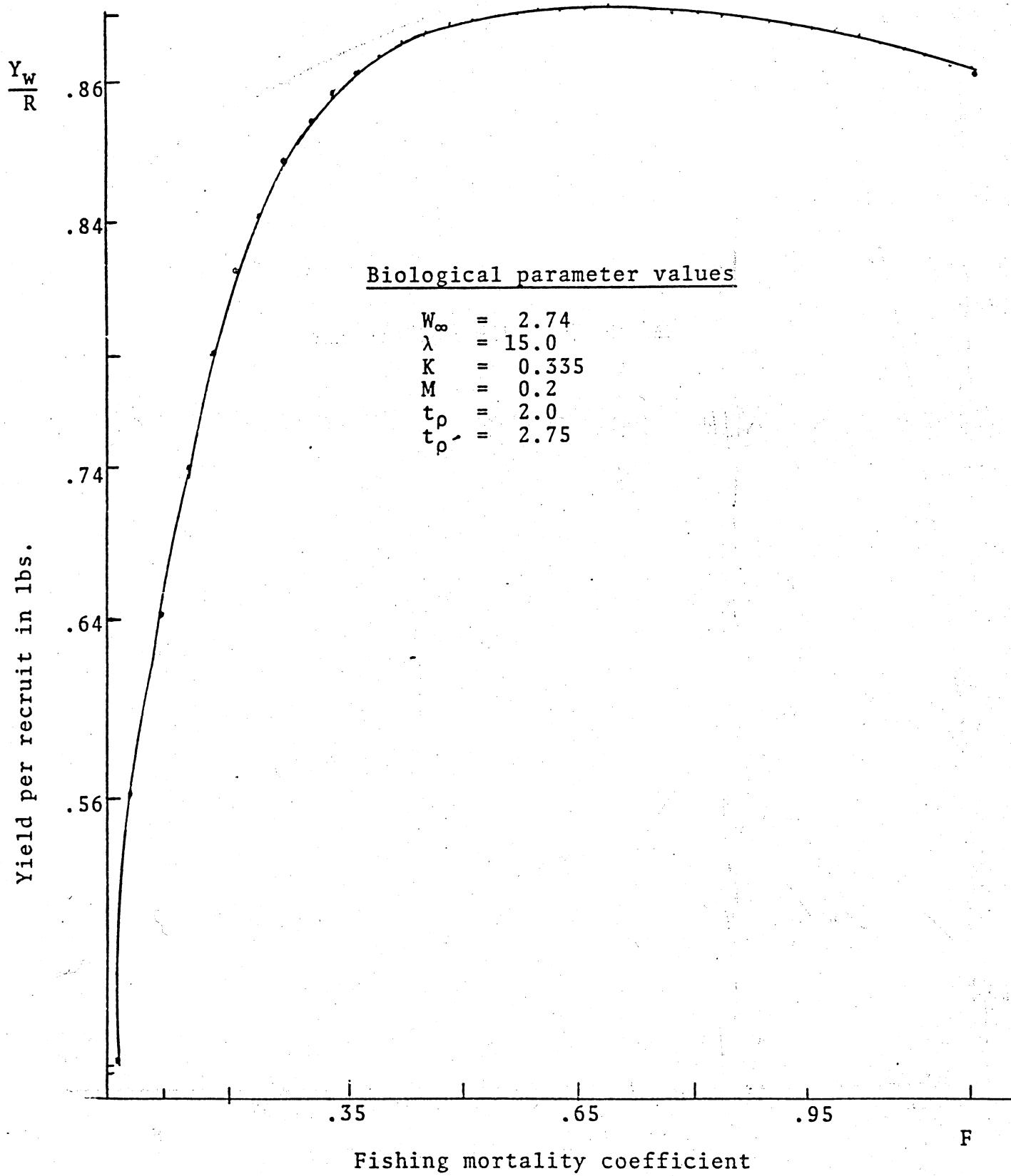


Figure 2.E.2: Steady state yield per recruit for selected levels of the fishing mortality coefficient when  $t_p = 2.75$ .



based on equation 2.D.4, deflated to a yield per recruit basis. The values of parameters in these figures are as follows:

Figure 2.E.1

$W_\infty$	2.74
$\lambda$	15.0
$K$	0.335
$M$	0.2
$t_p$	2.00
$t_{p'}$	2.00
$F$	.005 $\leq F \leq$ 1.16

Figure 2.E.2

$W_\infty$	2.74
$\lambda$	15.0
$K$	0.335
$M$	0.2
$t_p$	2.00
$t_{p'}$	2.75
$F$	.005 $\leq F \leq$ 1.16

An examination of either figure reveals that yield per recruit increases at a decreasing rate, reaches a maximum sustainable yield (MSY) and then declines. The curves are asymmetric about MSY with yield declining relatively slowly to the right of MSY.

The strict concavity in  $F$  of the yield per recruit function implies that the partial elasticity of production with respect to  $F$  is less than unity. If  $F$  is a scalar transformation of fishing effort, then the partial elasticity of production with respect to fishing effort is also less than unity. Furthermore, if the costs of fishing effort are also proportional to effort, this implies that industry average and marginal cost functions are monotonically increasing functions of yield for effort not greater than MSY effort and that

marginal cost is greater than average cost over the effort range from zero to MSY effort.

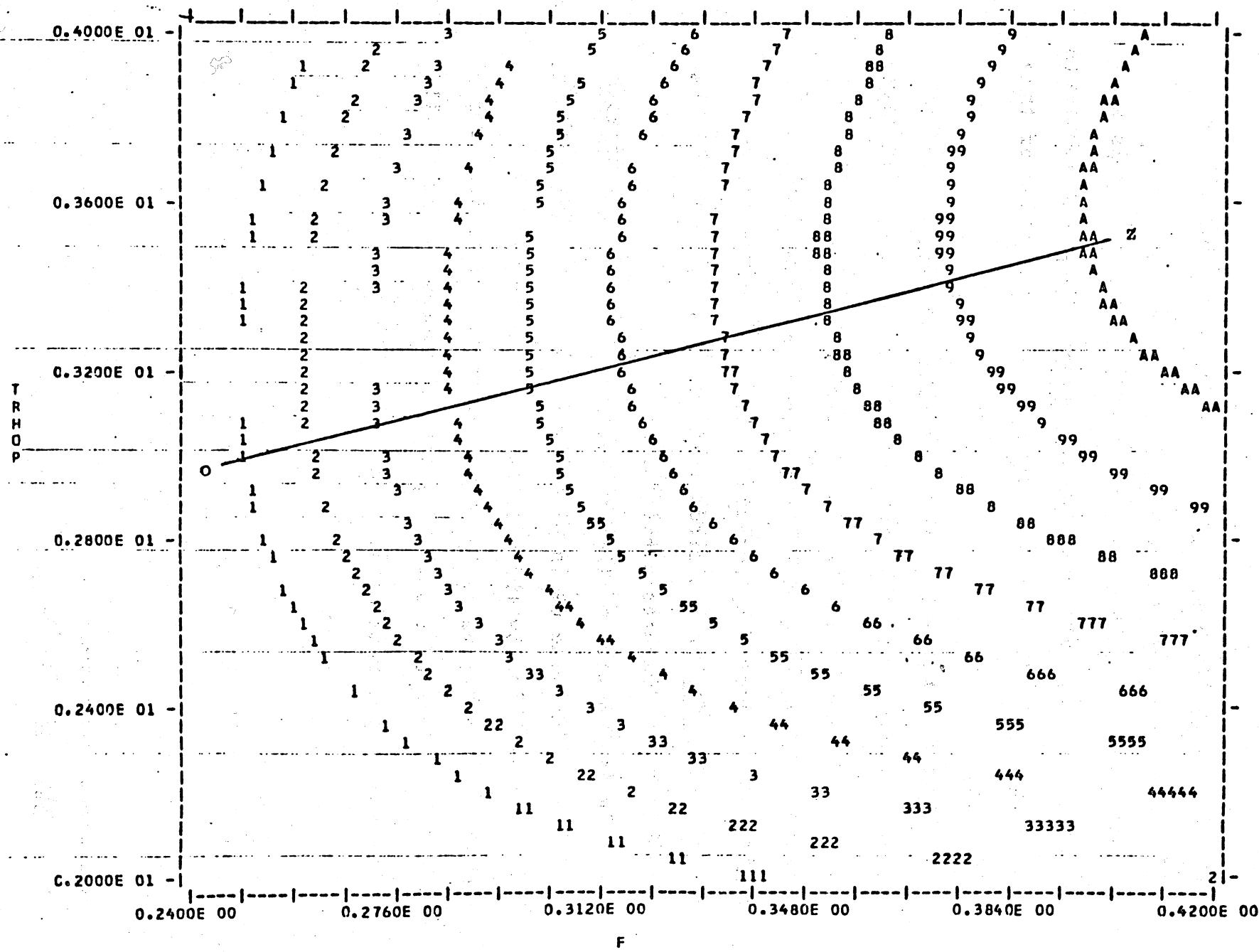
#### Substitution between F and $t_p'$

A comparison of Figures 2.E.1 and 2.E.2 suggests that increases in  $t_p'$ , at least over the range illustrated, tend to effect an upward shift in the yield curve. This proposition can be developed more clearly by considering the relationship between F and  $t_p'$  for a fixed value of  $Y_w$ . The concept involved is that of isopleth, as labelled by fisheries biologists and is similar to the concept of an isoquant as labelled by economists. Figure 2.E.3 illustrated the yield isopleths for a fishery. It is based upon parameters for yellowtail flounder as reported by Brown and Hennemuth (1971).

Movements along an isopleth are substitutions between F and  $t_p'$  for a fixed yield ( $Y_w$ ). For any given point on a yield isopeth, the slope of the isopeth at that point indicates the marginal rate of substitution,  $\frac{\partial t_p'}{\partial F}$ , between  $t_p'$  and F.

The locus of points which minimizes the costs of attaining a given isopeth is the expansion path (Carlson, 1956). If the relative costs of affecting  $t_p'$  and F were known, it would be possible to derive the expansion path; the locus of points for which the inverse ratio of costs equals the marginal rate of substitution. A particular case of interest is that in which variations in  $t_p'$  are essentially costless in the long run. If increases in  $t_p'$  are costless, the relative costs would be infinitely large, and the expansion path would coincide with the ridge line for  $t_p'$ . This line is the locus

Figure 2.E.3: Yield Isopleths for a Fishery



of points for which the slope of the isopleth,  $\partial t_p^- / \partial F$ , is infinitely large (Carlson, 1956).

Graphically, each point on the ridge line for  $t_p^-$  is a point of tangency between a vertical line and a yield isopleth in Figure 2.E.3. Line OZ in Figure 2.E.3 is a portion of the ridge line for  $t_p^-$ .

Although the concepts isoquant and isopleth are mathematically equivalent, the term isoquant is normally used only when there exist quantitative measures of inputs and their relative costs. This is not obviously the case with  $t_p^-$  and it is perhaps more appropriate to treat variations in  $t_p^-$  simply as shifts in the production function (yield curve) as illustrated by Figures 2.E.1 and 2.E.2.

An examination of the isopleths of Figure 2.E.3 suggests that the ridge line OZ involves values of  $t_p^-$  greater than 3. This is supported by the results reported by Brown and Hennemuth.<sup>1</sup> They varied  $t_p^-$  over the range 2.0 to 3.0 for selected values of F and their Table 13 suggests that in all cases yield per recruit was increasing even at  $t_p^- = 3.0$ .

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<sup>1</sup>Op. cit., p. 29.

### III

#### THE ECONOMIC MODEL

##### A. Catch of an Individual Vessel

The annual catch of an individual vessel, if it were operating alone in a fishery, would be influenced by vessel design characteristics, the days fished, the proportion of days fished devoted to capture of the species in question, and the abundance of fish. The catch ( $\ell_j$ ) of an individual vessel operating alone in a fishery may be summarized by 3.A.1:

$$\ell_j = \{\theta \alpha_j d_j WB\} \text{ for } \alpha_j d_j WB > \ell_{j\max} \text{ respectively} \quad (3.A.1)$$

where:  $\ell_j$  = potential annual catch of an individual vessel of type j operating alone.

$\ell_{j\max}$  = maximum catch feasible for a vessel of the  $j^{\text{th}}$  class when  $\theta = 1$ .

$\theta$  = proportion of total days fished devoted to the fishery in question.<sup>1</sup>

$d_j$  = total days fished by a vessel of the  $j^{\text{th}}$  class.

WB = biomass of the fishery (refer to 2.C.2 et seq.)

$\alpha_j$  = potential average catch, per vessel-day fished per unit biomass, of a vessel of the  $j^{\text{th}}$  class operating alone in the fishery in question.

Actual landings per vessel will be less than  $\ell_j$  due to a "crowding" externality as discussed later in this section.

The maximum catch capacity of such a vessel would be expected to bear a close relationship to actual average catch

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<sup>1</sup>It is recognized that in a multiple species fishery,  $\theta$  is determined by relative returns in other species to whose capture the fleet is adaptable. This fact is abstracted from in this paper, but it is an important area for future work (see Lampe, 1965, and Van Meir, 1969).

so that it may be assumed that  $\ell_j^{\max}$  is an effective constraint.

The proportion of the biomass captured by one vessel operating alone is  $q_j$  in 3.A.2:

$$q_j = \frac{\theta \ell_j^{\max}}{WB} \quad (3.A.2)$$

It should be noted that with  $\ell_j = \ell_j^{\max}$ , and WB an increasing function of recruitment (R) it follows that  $q_j$  is a decreasing function of recruitment. Also, vessel design changes which increase  $\ell_j^{\max}$  would increase  $q_j$ . The biomass of equation 3.A.2 is the biomass of the exploited phase ( $WB_{t_p}^{t_\lambda}$ ) as given by equation 2.C.2. The biomass of the unexploited phase,  $WB_{t_p}^{t_p}$ , is not relevant to the economic model except in the case where  $t_p = t_p'$  in which case  $WB_{t_p}^{t_\lambda}$  and  $WB_{t_p'}^{t_\lambda}$  are also equal (equations 2.C.2 through 2.C.5 and associated text).

#### B. Catch of the Fleet

The catch of an individual vessel operating alone in a fishery is expressed by 3.A.1. The proportion of the biomass that would be captured by a single vessel is expressed by 3.A.2. If we define  $\ell_j$  and WB as in 3.A.1 and 2.C.2 except that homogenous vessels are assumed so  $\ell_j$  and q need not be subscripted, and if we assume  $\theta = 1$ , we have 3.B.1:

$$q = \frac{\ell}{WB} \quad (3.B.1)$$

Aggregation to obtain the catch of the fleet as distinct from the catch of an individual vessel operating alone, must reflect a technological diseconomy external to the firm, but

internal to the industry. The specification employed is that suggested by Carlson (1969). The Carlson model recognizes the fact that if one vessel catches a proportion,  $q$ , of the biomass, two vessels cannot catch  $2q$ ; rather they catch a proportion  $q + q(1-q)$ . More generally, if there are  $N$  homogeneous vessels operating, the catch of the fleet denoted by  $C$  is given by 3.B.2:

$$C = WB[1 - (1-q)^N] \quad (3.B.2)$$

But for a steady state equilibrium,  $C = Y_w$ ; hence

$$Y_w = WB[1 - (1-q)^N] \quad (3.B.3)$$

It is convenient to convert 3.B.3 to the alternate but equivalent form of 3.B.4:

$$\ln \left[ \frac{1-Y_w}{WB} \right] = N \ln(1-q) \quad (3.B.4)$$

The left hand side of 3.B.4 is,  $-F$ , the (negative of) instantaneous fishing mortality coefficient which appears in biological model. Hence, by substitution one obtains 3.B.5, which would be the total domestic fishing mortality of a fleet made up of homogeneous vessels.

$$F_d = -N \ln(1-q) \quad (3.B.5)$$

The subscript  $d$  is used to denote that 3.B.5 is a partial expression only; it includes the effect of domestic fishing effort but not foreign effort. The distinction between  $F$  and  $F_d$  is developed in section 3.C.

An obvious generalization of 3.B.5 is to allow for the existence of  $J$  classes of vessels with  $N_j$  homogeneous vessels in class  $j$ . The classes of vessels can reflect differences

such as vessel size, fishing power or cost structure. This generalization of 3.B.5 is expressed by 3.B.6:

$$F_d \equiv - \sum_{j=1}^J N_j \ln (1-q_j) = -N \sum_{j=1}^J b_j \ln (1-q_j) \quad (3.B.6)$$

$$\text{where } N \equiv \sum_{j=1}^J N_j$$

$$b_j \equiv \frac{N_j}{N}$$

$F_d$  = fishing mortality if no foreign fleet exists.

### C. Discrimination between Foreign and Domestic Catch

A further generalization of 3.B.6 is to distinguish between the catches of the domestic and foreign fleets. The relationship between the two catches may be specified in any of a variety of ways. For the purposes of this model, it is assumed that national shares are operative and that the relationship between domestic catch ( $Y_d$ ) and foreign catch ( $Y_f$ ) is given by 3.C.2:

$$Y_f = G Y_d \quad (3.C.2)$$

$$\text{so that } Y_w = Y_d + Y_f = (1+G) Y_d$$

where  $Y_w$  denotes the combined catches of domestic and foreign fleets.

The simplest way to reflect this specification is to redefine the catch capacities  $\ell_{j\max}$  as  $(1+G) \ell_{j\max}$ . The proportion of the biomass capturable by a vessel, together with the catch of its foreign counterpart is  $(1+G) \underline{\ell_j \max}$ . This

specification ensures that the catch of each vessel in the domestic fleet is accompanied by an associated foreign catch which is  $G$  times as great. It also ensures a "crowding" externality between domestic and foreign fleets as well as within the domestic fleet as implied by 3.B.2 and 3.B.5.

It should be noted that 3.C.2 assumes in effect, that  $G$  is not a function of lagged ratios of  $Y_f : Y_d$ . If in fact  $G$  would be determined by lagged shares, then it would become rational for participating nations to adopt any of a number of subsidy measures to increase, or at least maintain, their respective shares in future time periods.

This formulation implies that the total fishing mortality (coefficient)  $F$ , is given by 3.C.3:<sup>1</sup>

$$F = F_d + F_f = -N \sum_{j=1}^J b_j \ln (1-q_j^*) \quad (3.C.3)$$

$$\text{where } q_j^* = \frac{(1+G) \ell_j \max}{WB}$$

<sup>1</sup>If foreign catch were zero, 3.C.3 would reduce to the earlier expression (3.B.5) for domestic fishing mortality ( $F_d$ ):

$$F_d = -N \sum_{j=1}^J b_j \ln (1-q_j) \quad (3.B.5)$$

$$\text{where } q_j = \frac{\ell_j \max}{WB}$$

The calculation of the  $q_j$  may be done as follows. Assume that the fleet consists of one vessel of class one. Then, total catch is  $(1+G) \ell_1 \max$ . Total catch must also be  $R.Y(F)$  where  $Y(F)$  denotes the yield per recruit function evaluated at a fishing mortality coefficient of  $F$ , and  $R$  denotes recruitment

#### D. The Costs of Fishing Effort

The cost of (domestic) fishing effort depends upon the number of units of fishing effort (vessels), their composition, days fished and the opportunity costs of the inputs comprising a unit of effort. Total annual industry cost allocated to the fishery in question, may be expressed algebraically by 3.D.1:

$$TC = FC + VC$$

$$= N \sum_{j=1}^J (b_j \theta_j k_j + b_j \theta_j c_j d_j) \quad (3.D.1)$$

where  $N \equiv$  number of domestic vessels

$b_j \equiv$  proportion of vessels of the  $j^{th}$  class

$\theta_j \equiv$  proportion of days fished devoted to the fishery in question by a vessel of the  $j^{th}$  class.

(fn. cont. from preceeding pg.) Thus, for one vessel of class one, equation 3.C.4 must hold:

$$Y_w = (1+G) \ell_{1max} = R.Y(\hat{F}) \quad (3.C.4)$$

or

$$\frac{Y_w}{R} = (1+G) \frac{\ell_{1max}}{R} = Y(\hat{F}) \quad (3.C.5)$$

Equation 3.C.5 may be solved by iteration for  $\hat{F}$ . The value of  $q_1$  is then obtained by substitution of  $\hat{F}$  in 3.C.6:

$$q_1 = 1 - e^{-\hat{F}} \quad (3.C.6)$$

If the relative catch capacities or fishing power of the  $j^{th}$  class is the index  $FP_j$ , then

$$q_j = q_1 \cdot FP_j \quad (3.C.7)$$

Equations 3.C.5-3.C.7 imply that the percent of biomass capturable by a single vessel of class  $j$  is a decreasing function of recruitment, and that marginal and average products of vessels decline more slowly (with increases in  $N$ ) at a high recruitment than at a low recruitment.

$k_j \equiv$  annual opportunity cost of a vessel of the  $j^{\text{th}}$  type. In a short run analysis this would be the gross stock obtainable in other fisheries to which this class of vessel is adaptable. In a long run analysis, this would represent the acquisition cost of a new vessel of this class. In any short run period, there need be no relationship between these two measures of opportunity cost and it is the former measure which is relevant to fishermen's decisions concerning the allocation of their fishing effort between alternative fisheries. The latter measure (acquisition cost) is relevant to long run entry decisions only.

$c_j \equiv$  variable, or operating costs per day fished for a representative vessel in the  $j^{\text{th}}$  class.

$d_j \equiv$  days fished by a representative vessel in the  $j^{\text{th}}$  class.

For the computer model used in this study, the domestic average total unit cost of domestic landings is not developed as an analytic expression. Instead, it is calculated rather mechanistically from 3.D.2 for a sequence of values of  $N$ , the number of domestic vessels:

$$AC(N) = TC(N) \div Y_d(N) = \frac{TC}{Y_d} \Big|_N = AC(Y_d(N)) \Big|_{Y_d = Y_d(N)} \quad (3.D.2)$$

Similarly, an analytic expression for marginal cost has not been developed. Instead, the following increments were calculated:

$$\Delta TC(N) \equiv TC(N+\epsilon) - TC(N) \quad \epsilon > 0 \quad (3.D.3)$$

$$\Delta Y_d(N) \equiv Y_d(N+\epsilon) - Y_d(N) \quad \epsilon > 0 \quad (3.D.4)$$

where  $\epsilon$  denotes an integer increment in the number of domestic vessels.

An approximate measure of marginal cost of domestic catch is provided by the ratio of finite differences in 3.D.5:

$$MC(Y(N)) \doteq \frac{\Delta TC(N)}{\Delta Y_d(N)} = \frac{TC(N+\epsilon) - TC(N)}{Y_d(N+\epsilon) - Y_d(N)} \quad (3.D.5)$$

This approximate relationship is valid for total yield levels ( $Y_d + Y_f = Y_w$ ) less than a maximum sustainable yield. As effort is increased in the neighborhood of MSY, marginal cost explodes to  $+\infty$  at MSY and AC bends backward. Although MC (3.D.5) is not of interest at effort levels in excess of MSY effort, AC is of interest as the industry supply curve without landing rights. To ensure inclusion of any range of interest, the model can be re-run to include any desired range of values for N simply by changing  $\epsilon$ . However, the larger the value chosen for  $\epsilon$ , the less exact is the expression, 3.D.5, for marginal cost. In the numerical analyses of Chapter IV,  $\epsilon$  was set at 1.0 (see Appendix printout).

#### E. Ex-vessel Demand for Fish

The ex-vessel demand for fish is a derived demand by fish processors and/or distributors. In addition to the usual demand parameters such as quantity, prices of substitutes, population, income levels etc., it appears frequently to be the case that price is affected by the size (age) class distribution of fish landed. Since variations in F alter the age class distribution of fish landed, increases in F ceteris paribus imply shifts in ex-vessel derived demand as well as movements along an industry supply curve. A generalized statement of the ex-vessel price function is provided by 3.E.1:

$$P = D(Y_c, Y_w/Y_n) \quad (3.E.1)$$

where:

$P$  = ex-vessel price

$Y_C$  = domestic consumption in round weight equivalents

$$= Y_d [1 + (G)(GG)]$$

$Y_w/Y_n$  = mean weight per fish captured.

The distinction between consumption in round weight equivalents ( $Y_C$ ) and product equivalents ( $Q$ ) is that the latter is less than the former due to a processing yield percentage which is generally about one-third for flounder but which is an increasing function of fish size. The functional relationship between processing yield and fish size is introduced later.

The "demand function", or more appropriately the price-quantity function, in (3.E.1) is a derived surface for an input whose quality varies with fish size. Since both total weight yield,  $Y_w$ , and yield in numbers,  $Y_n$ , vary with  $F$ , it follows that in general, fish size will be a function of the level of exploitation. This in turn implies that "quality" as measured by fish size cannot remain homogeneous when total yield in weight varies.

The costs of filleting fish are a function of the number of fish processed rather than simply the pounds of product produced. The pounds of product yield per pound of raw fish processed, vary approximately from 0.31 for a one pound flounder to 0.38 for a two pound flounder. The ex-vessel price would, by definition, reflect wholesale price, less processing costs and margins. Excluding consideration of

margin, if processing costs rise with decreases in mean fish size then, ceteris paribus, ex-vessel prices would be expected to fall with decreases in mean fish size. The extent to which changes in processing costs are passed forward to consumers or back to fishermen is influenced by the degree of competition in the processing sector. No!

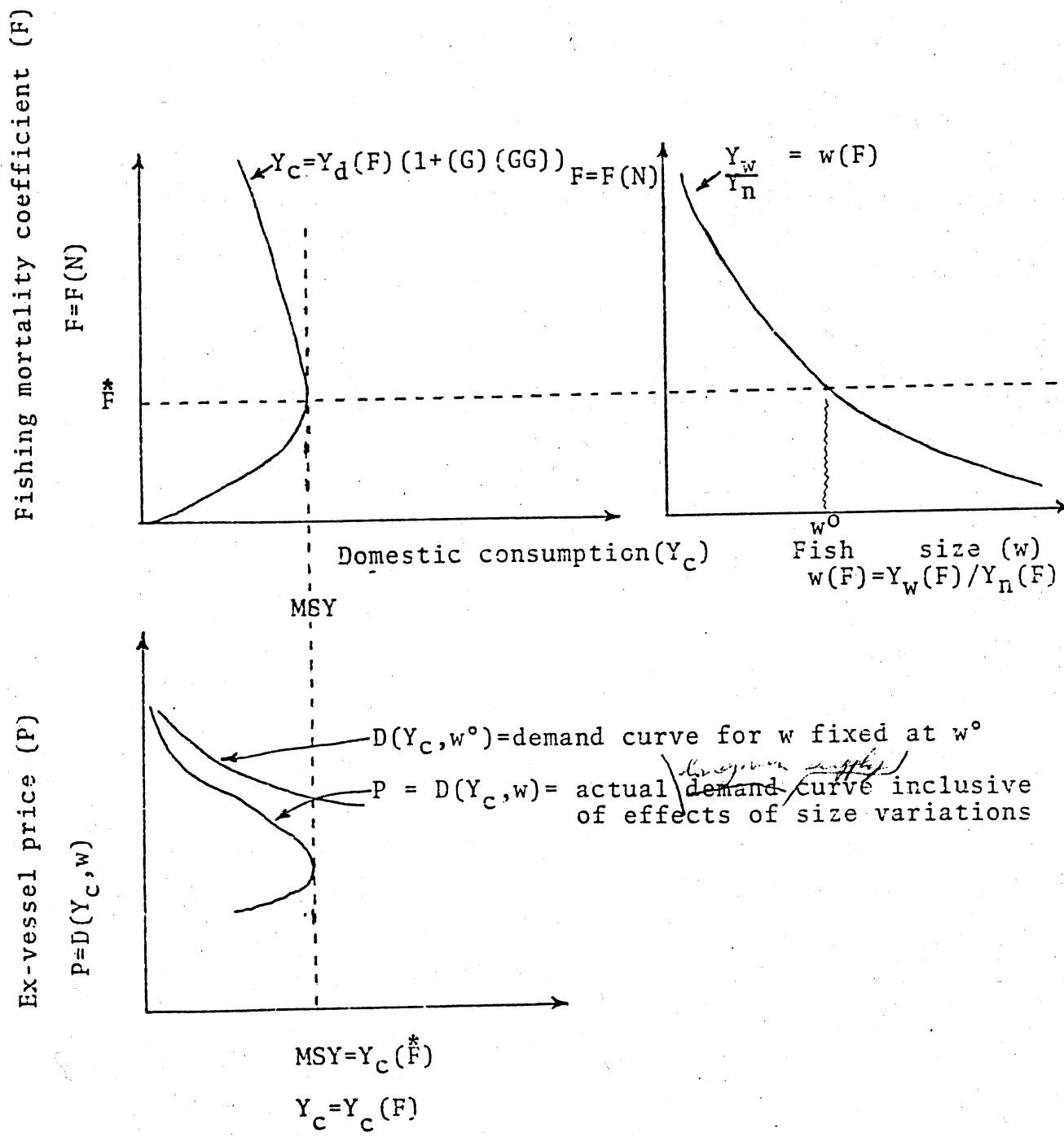
The fact that mean fish size ( $Y_w/Y_n$ ) is a decreasing function of fishing mortality implies that movement along the true demand curve, holding fish size constant, is not a matter of choice. For a fixed value of  $t_p$ , it is a technological (biological) impossibility; one must move simultaneously across the demand surface in two directions. In order to increase aggregate yield,  $Y_w$ , and hence aggregate domestic consumption,  $Y_c$ , one must also accept a smaller fish size ( $Y_w/Y_n$ ) and higher processing costs per unit of product. The implications of this are discussed below.

As effort is increased at levels less than that associated with MSY, landed weight increases and weight per fish landed decreases. Both movements tend to depress price so that the observed price function inclusive of size effects slopes downward to the right more rapidly than it would if fish size were constant.

As effort is increased beyond MSY, landed weight decreases. Weight per fish landed also decreases. The two movements, lower landed weight and size decreases, are now exerting

opposing influences on price with the result that as yield decreases to the right of MSY, one does not move back up the same demand curve down which one moved as yield increased to the left of MSY. As MSY is approached from the left, the equilibrium price curve bends sharply downward and is tangent to a vertical line at MSY. It then curves back. Whether the demand curve then slopes downward to the left or upward to the left depends on whether the quantity effect or the size effect dominates. In either case it would curve backwards for effort levels in excess of MSY and would lie beneath the demand curve which applies for effort levels less than MSY. Figure 3.E.1 depicts these relationships.

Figure 3.E.1. Sustainable yields in weight and derived demand for landings when a price premium exists for larger fish.



## IV

### APPLICATION OF THE MODEL TO THE YELLOWTAIL FLOUNDER FISHERY OF NEW ENGLAND

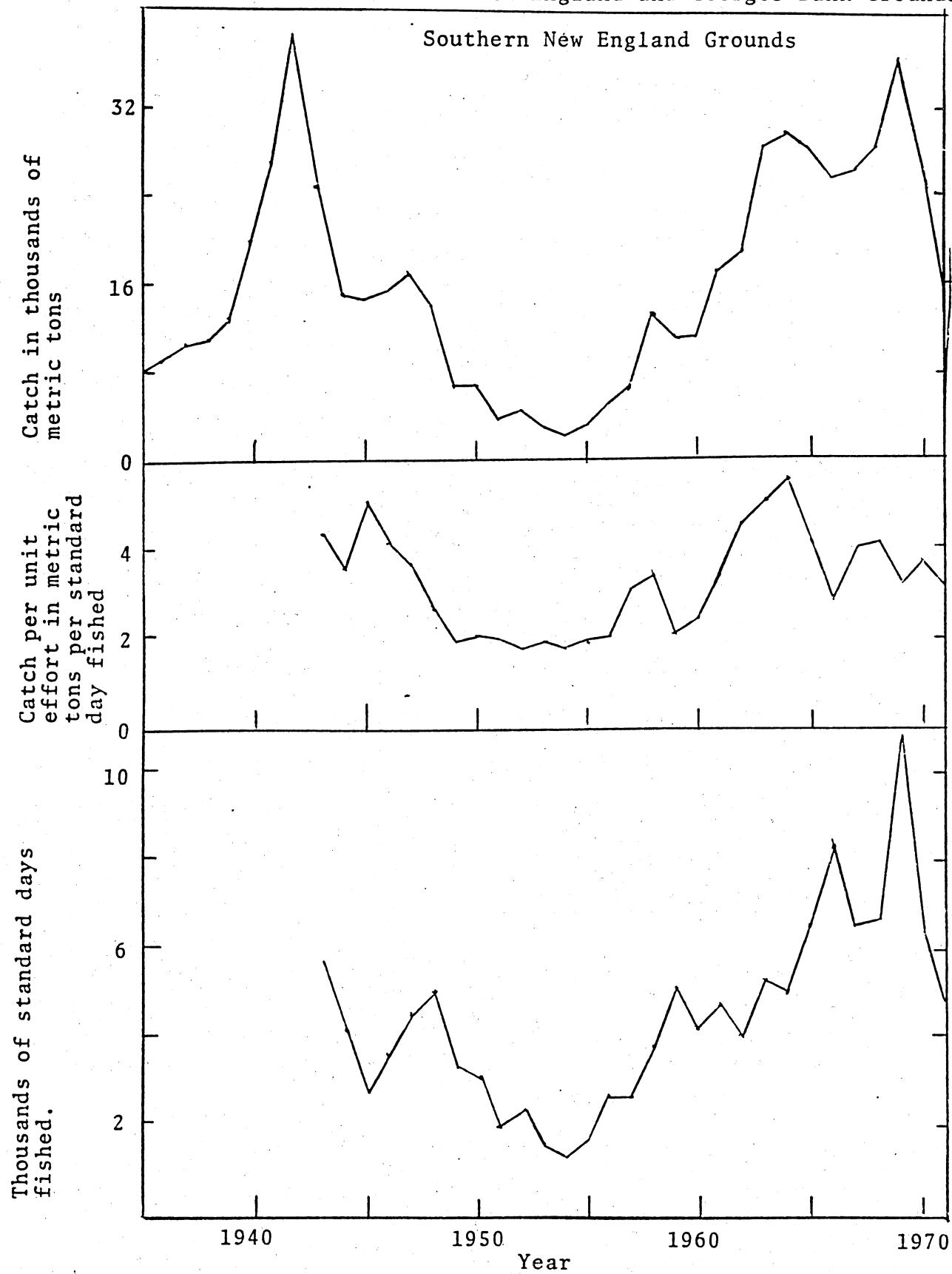
#### A. Descriptive Overview of the Fishery

The Yellowtail flounder fishery is one of the most valuable fin fisheries of the Northeast states. Landings were approximately 63 million pounds in 1971 valued ex-vessel at \$9 million. This comprised about 56 percent of the landed weight and 49 percent of the landed value of fin fish in the region. The trends in landing, fishing effort, and catch per unit of effort are given in Figure 4.A.1.

Table 4.A.1 contains yellowtail landings data for the major landing states for the period 1938-1971. Aggregate domestic landings have been increasing substantially since about 1954. Prior to that year, a substantial decline occurred from a 1942 high of 68.6 million pounds to a low of 12.8 million pounds in 1954. By 1963 the 1942 landings record had been surpassed with catch at approximately 83 million pounds. Since that time some decline has occurred but 1968-1971 landings remained considerably above 1940-1961 levels.

In recent years the average annual ex-vessel price for yellowtail flounder has been in the general range of 12 to 14 cents per pound. The New England industry accounts for most of the U.S. landings of yellowtail flounder. During the past decade New England yellowtail landings ranged from 90.5 percent to 95.7 percent of total U.S. landings (Table 4.A.2).

Figure 4.A.1: Trends in the Yellowtail Flounder Fisheries;  
Southern New England and Georges Bank Grounds



Sources: Brown and Hennemuth (1971), Brown (1972)

Figure 4.A.1 (continued)

35

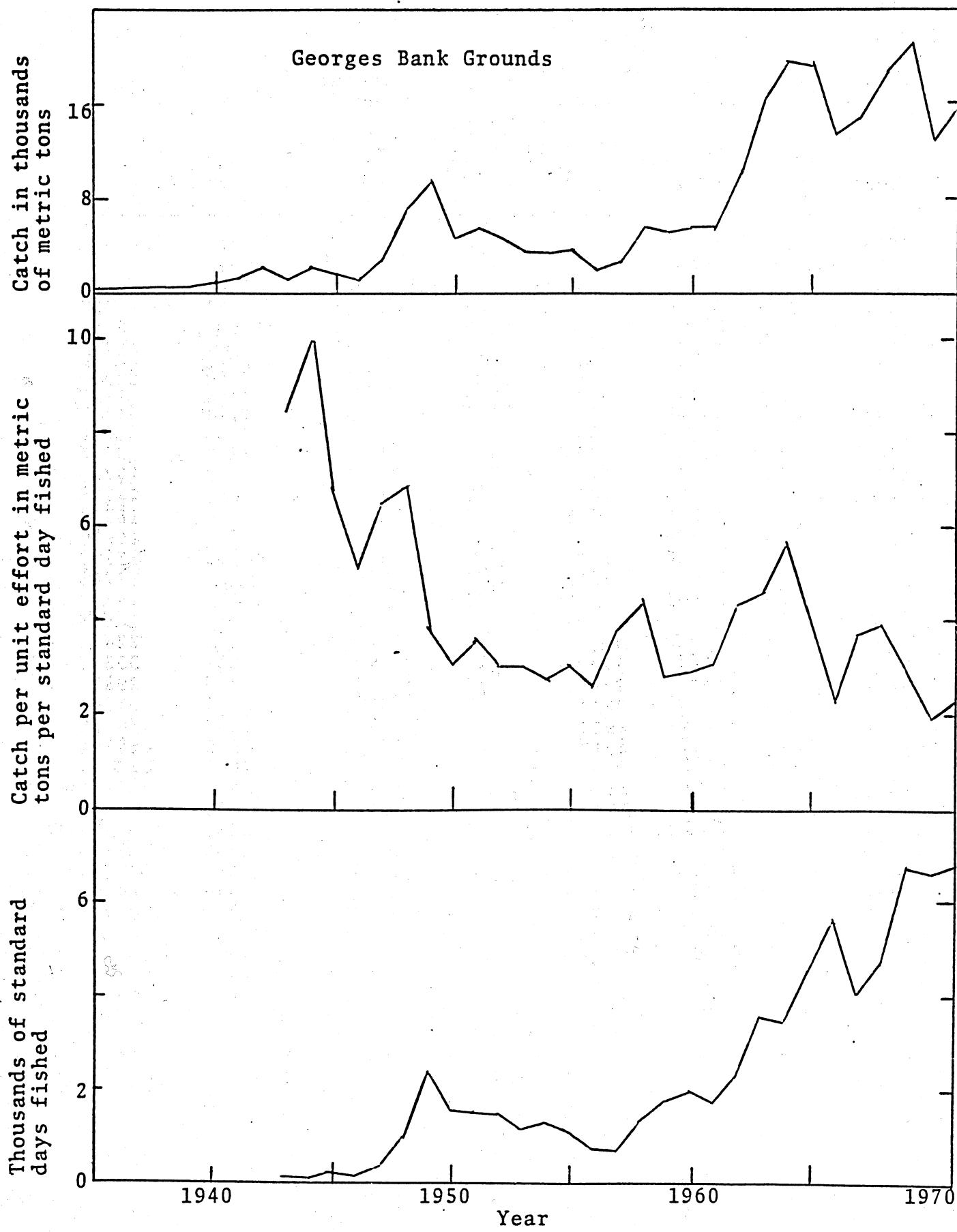


Table 4.A.1: Annual U.S. Landings of Yellowtail Flounder in New England States, New York & New Jersey; 1938-1971  
 (in 000 pounds)

Year	Maine	Mass.	R. I.	Conn.	Total New England	New York & New Jersey	Total
1938	301	16985	364	1781	19431	3384	22815
1939	222	20662	397	3129	24410	4316	28726
1940	827	28352	1059	4096	34334	6544	40872
1941	276	37912	334	4246	42492	8921	51689
1942	26	47932	2420	6193	56571	12007	68578
1943	46	32897	2052	3605	38600	7187	45787
1944	127	19283	3027	3187	25624	5518	31142
1945	73	24358	2852	2801	30084	3085	33169
1946	37	23709	2240	3171	29157	2311	31468
1947	91	27603	2259	3006	32959	3333	36319
1948	118	32087	3293	1352	36850	2778	39628
1949	120	25409	1138	550	27217	1519	28736
1950	145	21399	1029	302	22875	1241	24116
1951	82	16735	723	100	17640	774	18414
1952	55	15306	1334	49	16744	234	16978
1953	58	12627	1014	24	13723	50	13773
1954	24	10972	1681	30	12707	56	12763
1955	30	12661	1448	60	14199	174	14373
1956	52	11756	2444	161	14413	230	14643
1957	41	19910	2230	91	22272	179	22451
1958	64	29519	2984	226	32793	532	33325
1959	113	25932	3012	139	29196	615	29811
1960	65	27701	2110	160	30036	1171	31207
1961	34	34667	2337	107	37146	2082	39228
1962	17	50835	5730	79	56661	3929	60590
1963	---	68875	8998	135	78008	4682	82691
1964	5	70974	8249	49	79277	3573	82850
1965	7	70920	5602	38	76567	3693	80260
1966	22	57471	5855	53	63401	3583	66984
1967	78	46449	5793	67	52387	5503	57890
1968	13	57736	6533	23	64305	5712	70017
1969	76	56270	8375	5	64726	5089	69815
1970	155	57449	8925	691	67220	5895	73115
1971	86	41975	11810	2790	56661	6146	62807

**Table 4.A.2: Annual New England Landings of Yellowtail Flounder as a Percent of Total U.S. Landings of the Species; 1962-1971.**

<u>Year</u>	<u>Percent</u>
1962	93.51
1963	94.33
1964	95.7
1965	95.3
1966	94.7
1967	90.5
1968	91.8
1969	92.7
1970	92.9
1971	90.2

It is apparent from Table 4.A.3 that Massachusetts dominates U.S. as well as New England yellowtail landings. Further, within Massachusetts, New Bedford is the dominant port; accounting for about 80 percent of the New England total and, therefore, approximately 75 percent of total U.S. yellowtail landings.

In view of the relative importance of the port of New Bedford, the data and information used in this study relate primarily to the New Bedford fleet. For this reason, the results of the study should be considered as most nearly characterizing the New Bedford segment of the total yellowtail fleet.

#### B. The Empirical Model

As was indicated in Chapters II and III the model used for this study relies on various types of biological and economic information. The approach was to initially develop a "base" model which, within the constraints of data availability and the limitation of attempting to model a "real world" situation, closely approximates the existing biological and economic characteristics of this fishery. Considering that the yellowtail fishery is, as are most fisheries, a highly variable industry with significant daily, monthly, and annual fluctuation, any "close approximation" must be considered as approximating the general or average fishery conditions. Also, it should be recognized that because this is a steady state or

Table 4.A.3: Percent of U.S. Landings of Yellowtail Flounder by States; 1962-1971.

Year	Maine	Mass.	R. I.	Conn.	New York & New Jersey
1962	.03	83.90	9.46	.13	6.48
1963	--	83.29	10.88	.16	5.66
1964	.006	85.67	9.96	.06	4.31
1965	.009	88.36	6.98	.05	4.60
1966	.033	85.80	8.74	.08	5.35
1967	.13	80.24	10.01	.12	9.51
1968	.019	82.46	9.33	.03	8.15
1969	.11	80.60	12.00	--	7.29
1970	.21	78.57	12.21	.95	8.06
1971	.14	66.83	18.80	4.44	9.79

Table 4.A.4: Annual New Bedford Landings of Yellowtail Flounder; 1962-1971.

Year	Landings (in millions of lbs.)	% New England	% of U.S. (total)
1962	46.5	82.0	74.4
1963	63.8	81.8	77.0
1964	65.8	83.0	79.5
1965	66.1	86.3	82.0
1966	53.3	84.1	79.6
1967	42.5	81.1	73.0
1968	53.7	83.5	77.0
1969	52.5	81.1	75.0
1970	53.8	80.1	74.4
1971	N.A.	-----	-----

static model, the results should be interpreted as the trend or tendency if the particular parametric values were to hold for at least a few years.

Recognizing these limitations, however, the authors believe the results of the study as described in the following sections clearly show the implications of various parametric changes in the bio-economic model, including parameters which are subject to policy manipulation.

The base model and each succeeding alteration of that model are analyzed from the standpoint of three potential industry institutional positions:

- 1) Maximum economic efficiency (Pareto efficient position). This is a position in which price equals marginal cost and is the point where if economic efficiency were the sole consideration, a social optimum would exist. This could be considered as similar to the point economic theory suggests certain regulated monopolies or public utilities such as electric companies should operate. The logic being that the price (or value to society) is at that point just equal to the cost to society of producing the last unit of that product.
- 2) The maximum sustainable yield level. This is the amount of fishing effort where, given certain biological parameters such as natural mortality, recruitment, and age of entry into the fishery (as determined by mesh size) the physical yield derived from the fishery would be maximized.

3) Free entry. This is the position which would tend to be approached when the amount of effort applied to the fishery is determined solely by the market forces. Because the yellowtail industry is characterized by a relatively atomistic structure, free entry (the institutional arrangement that currently exists) automatically assures a tendency toward a zero profit or more precisely, zero economic rent solution.

A qualifying statement is in order regarding the tendency for effort to increase and drive profits to zero. This is true in a static world. In a dynamic world where demand is increasing rapidly, price rises may partially or completely offset the effect of decreasing catch per unit effort. As a consequence, one may observe actual profits decreasing, constant or increasing over time in spite of declining catch per unit effort. This does not in any way vitiate the conclusions of the comparative statics analyses. Indeed, as we shall show, an effect of demand increases is to increase the potential benefits of certain regulatory measures.

For the purpose of this study the Georges Bank and Southern New England fishing areas were combined and considered in total. Biologically, if the two populations are

separate, this implies summation over two biological yield functions. Economically, the combination of the two areas is logical because most vessels are capable of fishing either area, and would be expected to re-allocate fishing effort to approach equal catch per unit effort in the two areas.

### C. Data Sources and Parameter Estimates

The parameter estimates and symbols used in the base model are presented in Table 4.C.1.

Table 4.C.1

#### Parameter Values for the Base Model

<u>Item</u>	<u>Symbol</u>	<u>Value Assigned</u>
<b>Biological Parameters</b>		
Maximum weight per fish	$W_{\infty}$	2.74
Fishable life	$\lambda$	9.0
Catabolic coefficient x 1/3	K	00.335
Natural mortality	m	0.2
Age at zero weight	$t_0$	-0.26
Age at entering fishing ground	$t_p$	2.0
Age at which exploitation begins	$t_p'$	2.75
Recruitment	R	$123 \times 10^6$
<b>Domestic Fleet Parameters</b>		
Proportion of time fished for flounder	$\theta$	0.6
Vessel characteristics	see table 4.C.2	
<b>Foreign Fishing Parameters</b>		
Foreign catch/domestic catch	G	0.5
Proportion of foreign catch imported	GG	0.8
<b>Demand Parameters</b>		
Price/quantity flexibility	$b_1$	-0.6346
Price/processing yield flexibility	$b_3$	0.4726
Price intercept	a	0.3358

The data sources and justification for these parameter estimates are presented in the following sections.

#### Biological Parameters

The parameter  $w_{\infty}$  is the maximum weight achieved by a representative fish. It has been assigned a value of 2.74 lbs. per fish. It was obtained as follows. Lux and Nichy (1969) found the following empirical relationship between weight ( $w$ ) in grams of a representative fish of length ( $L$ ) in millimeters:

$$w = -12.97 + 3.23 \ln (L)$$

They also suggest a maximum length per fish ( $L_{\infty}$ ) of 500 millimeters. Substitution of  $L_{\infty}$  in the weight-length equation gives an estimate of  $w_{\infty}$  in grams which, on conversion from metric to avoirdupois units, is 2.74 lbs.

The parameter,  $\lambda$ , is the probable life of the species. For the base model it was assigned a value of 9. The justification of this value is that Brown and Hennemuth report that essentially no fish are caught beyond the age of 6 or 7. Nine was selected to assure that all potentially catchable age classes would be considered in the model.

The parameter,  $K$ , is  $1/3$  the catabolic coefficient (refer to equation 2.A.3, et seq.). Lux and Nichy suggest an estimate of 0.335 for  $K$ .

The parameter,  $M$ , is the natural mortality coefficient.

It has been assigned a value of 0.2 in the base model. This value is the estimate reported by Lux and Nichy. Alternative models with  $M$  assigned values of 0.175 and 0.225 were also included in the analysis in order to test the effect of changes in this parameter on the fishery.

The parameter,  $t_0$ , is the age of a representative fish at zero weight (refer to equation 2.A.6, et. seq.). It has been assigned a value of -0.26. This is the value reported by Brown and Hennemuth (1971).

The parameter  $t_p$  is the age of a representative fish on entering the fishing grounds. It has been assigned a value of 2.0 (Brown and Hennemuth).

The age at which fishing exploitation begins ( $t_{p^-}$ ) is primarily determined by the mesh size of the trawls used. For the base model  $t_{p^-}$  was set at 2.75. Because of the economic as well as the biological importance of this parameter (i.e.,  $t_{p^-}$  influences the mean size of fish landed) several alternative values for  $t_{p^-}$  were also tested. This parameter is considered as an important policy variable that could be under the control of a management agency.

The parameter  $R$  is the recruitment rate in numbers of fish per year. It has been set for the base model at  $123 \times 10^6$  which is approximately the recruitment rate necessary, given the above parameter values, at maximum sustainable yield per recruit (0.77 lbs.) to generate an MSY of 42,000 metric tons or 92 million lbs., estimated by Brown and Hennemuth.

### Domestic Fleet Parameters

Information and data on the yellowtail fleet were obtained from a variety of sources. Obtaining the most appropriate and reliable data involved directly contacting industry members and certain other individuals familiar with the industry. Also, information was obtained directly or in certain necessary cases, interpolated from secondary sources such as: Carlson (1970), Noetzel & Norton, Rittgers, Holmsen and BCF Working papers. Based on these various data sources and the authors' personal knowledge of the economics of vessel operations, the essential characteristics of the fleet were calculated and are explained below and summarized in Table 4.C.2.

The fleet was considered to have 6 relatively homogeneous vessel groups ( $j$ ). The vessels were categorized into these 6 groups on the basis of gross registered tonnage (Table 4.C.2). For each of these vessel groups the following information was calculated: percent of all vessels in each size class ( $b_j$ ); days fished ( $d_j$ ); relative fishing power ( $FP_j$ ); variable cost per day at sea ( $c_j$ ); and annual fixed cost ( $K_j$ ). The values of these parameters for each vessel size class are presented in Table 4.C.2.

Because the vessels in the fleet do not fish only for yellowtail flounder, it was necessary to determine a value for  $\theta$ ; the proportion of the annual days fished devoted to

Table 4.C.2: Calculated Fleet Characteristics for Base Model

<u>Parameter</u>	<u>Symbol</u>	<u>Vessel Size Group</u>					
Vessel class	j	1	2	3	4	5	6
Gross tonnage range	$g_j$	<50	51-150	151-200	201-250	251-300	<300
Proportion in vessel class	$b_j$	.34	.28	.24	.10	.03	.01
Days fished/year	$d_j$	135	135	140	150	165	173
Relative fishing power	$FP_j$	1.00	1.20	1.38	1.91	1.93	1.98
Variable cost/day	$c_j$	450	686	766	860	1020	1110
Annual fixed costs	$k_j$	10,336	19,788	22,000	27,700	38,000	48,000

yellowtail. Data to calculate the value of this parameter were extremely difficult to obtain, especially by vessel size class. For this reason, one value of  $\theta$  was applied to all vessel classes. Based on examination of data reported by Brown and Hennemuth, relative species landings at New Bedford, conversations with individuals familiar with the industry and the authors' best judgement,  $\theta$  was set at 0.6 for the initial model.

#### Foreign Fishing Parameters

The parameter, G, is the ratio of foreign to domestic catch of yellowtail. For the base model the value of G was set at 0.5. This was estimated through an examination of relative catches which were reported, by Brown and Hennemuth, as ranging up to about 0.7 in 1968. Alternative values of G were tested to analyze the impact of varying levels of foreign fishing on the domestic industry. It is interesting to note that in terms of affecting the domestic industry the value of G is "double edged" in that as foreign catch goes up, not only is the productivity of domestic vessels adversely affected but also there are more fish available for import and hence potential downward pressure on domestic prices. For the purpose of integrating the effect of imports in the

model, it was decided to set imports as a fixed percent (GG) of foreign catches. Because the Bureau of Customs does not report yellowtail fillets and blocks separate from other flat fishes it was necessary to make a rather arbitrary judgment regarding the value of GG. For the base model GG was set at .8. However, in testing alternative models this value was considered as a maximum; in certain models the value was changed to 0.5 and in one model the import parameter, GG, was set at zero.

#### Demand Parameters

Several empirical demand functions were tested to determine the most important factors affecting ex-vessel price in order to develop the best estimate of ex-vessel price flexibility. The function that was selected for use in the study was a log linear form as follows:

$$\log P = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4$$

where:

P = quarterly ex-vessel price at New Bedford

X<sub>1</sub> = per capita quarterly landings of yellowtail flounder in New England

X<sub>2</sub> = per capita quarterly income in the Northeastern states

X<sub>3</sub> = quarterly mean processing yield of yellowtail flounder landed in New England

X<sub>4</sub> = the ratio of per capita imports of flat fish fillets in the current quarter to per capita imports for the past quarter.

Population figures for  $X_1$  and  $X_4$  were for the North-eastern states. Landings, import, and price data were obtained from the Division of Marketing Research and Services, NMFS. Data on per capita income were obtained from Survey of Current Business published by the Department of Commerce. Data on population for the Northeast Region were obtained from Bureau of the Census Current Population Reports "Population Estimates and Projections" Series P25 Nos. 384, 420, and 437. These data were available only on an annual basis. All other data were available on a quarterly basis so intra-year (quarterly) values for population were generated by interpolation using a compound growth relationship.

Processing yield data were calculated from quarterly data on length frequency of yellowtail landings which were obtained from the NMFS Woods Hole Biological Laboratory. These data were converted to quarterly weight frequency distributions using the following relationship between weight in grams (W) and length in millimeters (L).

$$\ln(W) = -12.96813 + 3.233 \ln(L)$$

The means of these quarterly weight frequency distributions were computed and used to calculate processing yields. Information on processing yields were obtained through contacts with fish processing technologists at the University of Rhode Island. The function used was:

$$\text{Processing yield} = -.14 + .45 (\text{mean weight/fish})$$

This function gives for example a 31% fillet yield from a

one pound yellowtail flounder and a 38% fillet yield from a two pound fish. Since the mean weight/fish for the model were generally slightly above one pound, this gives a processing yield in the range of approximately 33%.

As noted above, all variables are expressed on a quarterly basis. The time interval covered by the data are the 38 consecutive quarters beginning with the 3rd quarter, 1962 through 1971 inclusive. Consequently there are 38 observations in the least squares function used for estimating the parameter.

The regression coefficients, their standard errors, and the computed t values are as follows:

	<u>Regression Coefficient</u>	<u>Standard Error</u>	<u>"t"</u>
$b_1$	-.6346	.1716	-3.698
$b_2$	-.9581	.2097	4.570
$b_3$	.4726	.2980	1.586
$b_4$	-.2938	.1026	-2.865

The F value for the equation was 28.76, with a multiple correlation coefficient of .88 and an adjusted multiple correlation coefficient of .78. The Durban-Watson value was 1.45.

All "t" values were significant at the .05 level with the exception of that for  $b_3$ , mean processing yield. This variable, however, was left in the final equation for three reasons:

- 1) It resulted in a substantial improvement in the  $R^2$  value.

2) In alternative estimating equations, especially when income was not included as a variable, the regression coefficient for processing yield was significant.

3) In the models where the three alternative situations (i.e., maximum economic efficiency, maximum sustainable yield, and free entry) were compared, there was more variation in mean fish size and thus processing yield than actually existed during the 1962-71 period. Thus, in view of the effect of processing yield on processing costs it was the judgment of the authors that this variable should be considered in the model. For use in the computer model, the price/quantity coefficient (price flexibility coefficient) was used directly. As indicated, its estimated value was -.6346. The processing yield coefficient (.4726) was also used directly in the model. Rather than specifying a time path for future income increase, the income variable was considered as constant and collapsed into the intercept coefficient. Also, because it was not possible from available statistics to separate yellowtail imports from imports of all flat fish, imports were included with domestic catch to compute total domestic consumption and price effects.

Therefore, the demand parameters utilized in the base model were:

$$\text{Price flexibility} = -.6346$$

$$\text{Processing yield coefficient} = .4726$$

$$\text{Adjusted price intercept} = .3358.$$

## D. Results of the Analysis

### The Base Model

As was indicated earlier, the base model was designed to duplicate as closely as possible the existing situation in the yellowtail flounder fishery. The parameter values for this model are described in Tables 4.C.1 and 4.C.2. Using these parameter values and the bio-economic model described in chapters II and III of this report, various economic measures were calculated. These are summarized in Table 4.D.1 and Figures 4.D.1 and 4.D.2. As can be seen from the table, the free entry situation, which represents the institutional structure as it now is, results in approximately 132 U.S. vessels (fishing 60 percent of their time on yellowtail flounder). This, based on the authors' knowledge of the industry, is relatively close to the actual number of vessels in the fleet.

Operating in this manner these 132 vessels would land slightly over 61 million pounds with total catch (foreign and domestic) being 91.9 million pounds. The catch per vessel would range from 364 thousand pounds to 720 thousand pounds by the smallest and largest size class respectively.

Imports under this situation would be approximately 24.5 million pounds, landed weight. Thus, the total amount (domestic catch plus imports) going on the domestic market would be 85.8 million pounds. This, taking into account the mean size per fish and resultant fillet yield, would be the equivalent of about 27.7 million pounds of product weight.

Table 4.D.1. Summary of Results of the Base Model<sup>1</sup>

<sup>1</sup> See Tables 3.C.1 and 3.C.2 for parameter values for Base Model. All catch, cost, revenue, etc. figures are for the fleet fishing 60 % of the time for yellowtail flounder.

Figure 4.D.1 Cost and Revenue Curves for Model 1; the Base Model

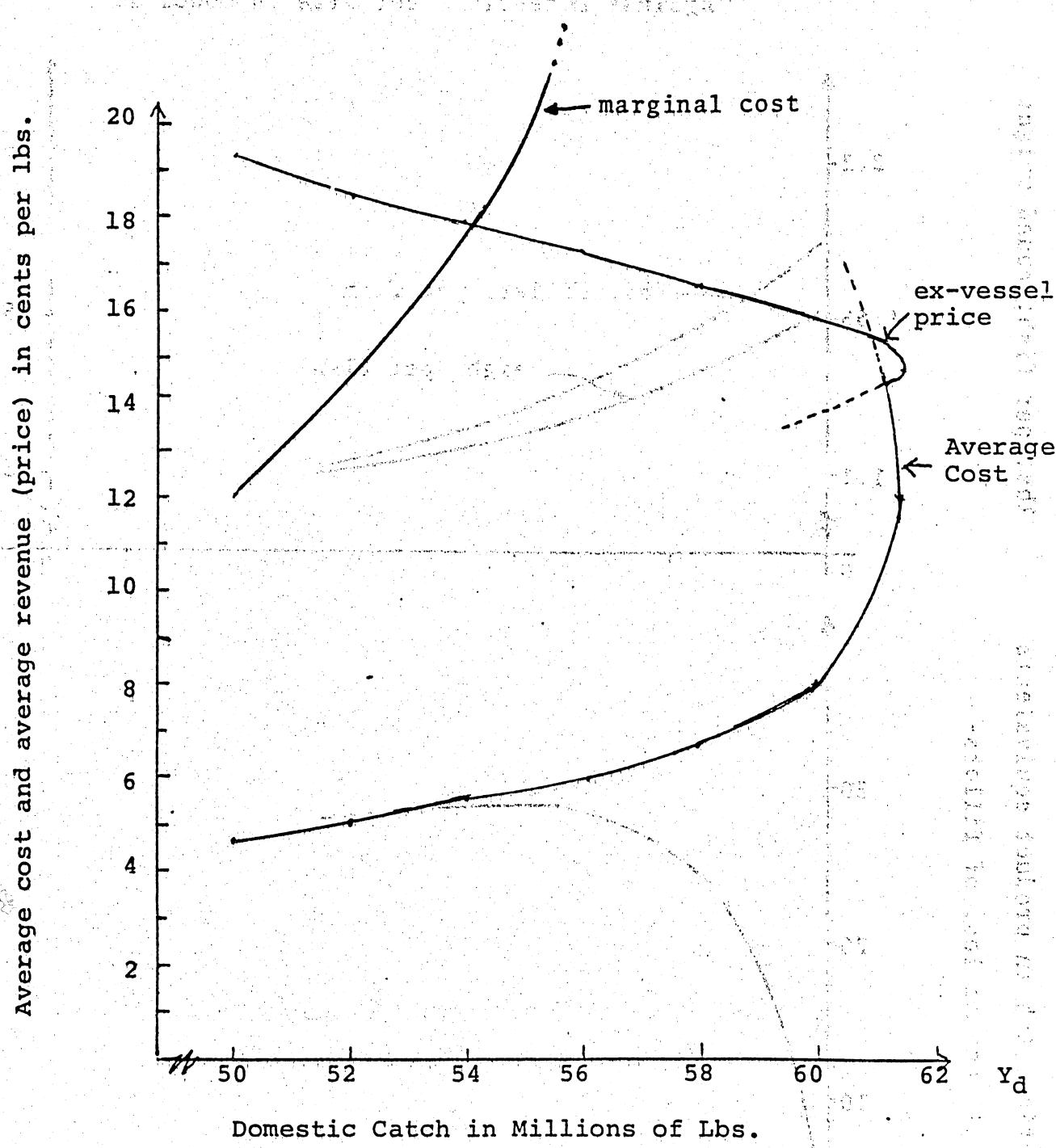
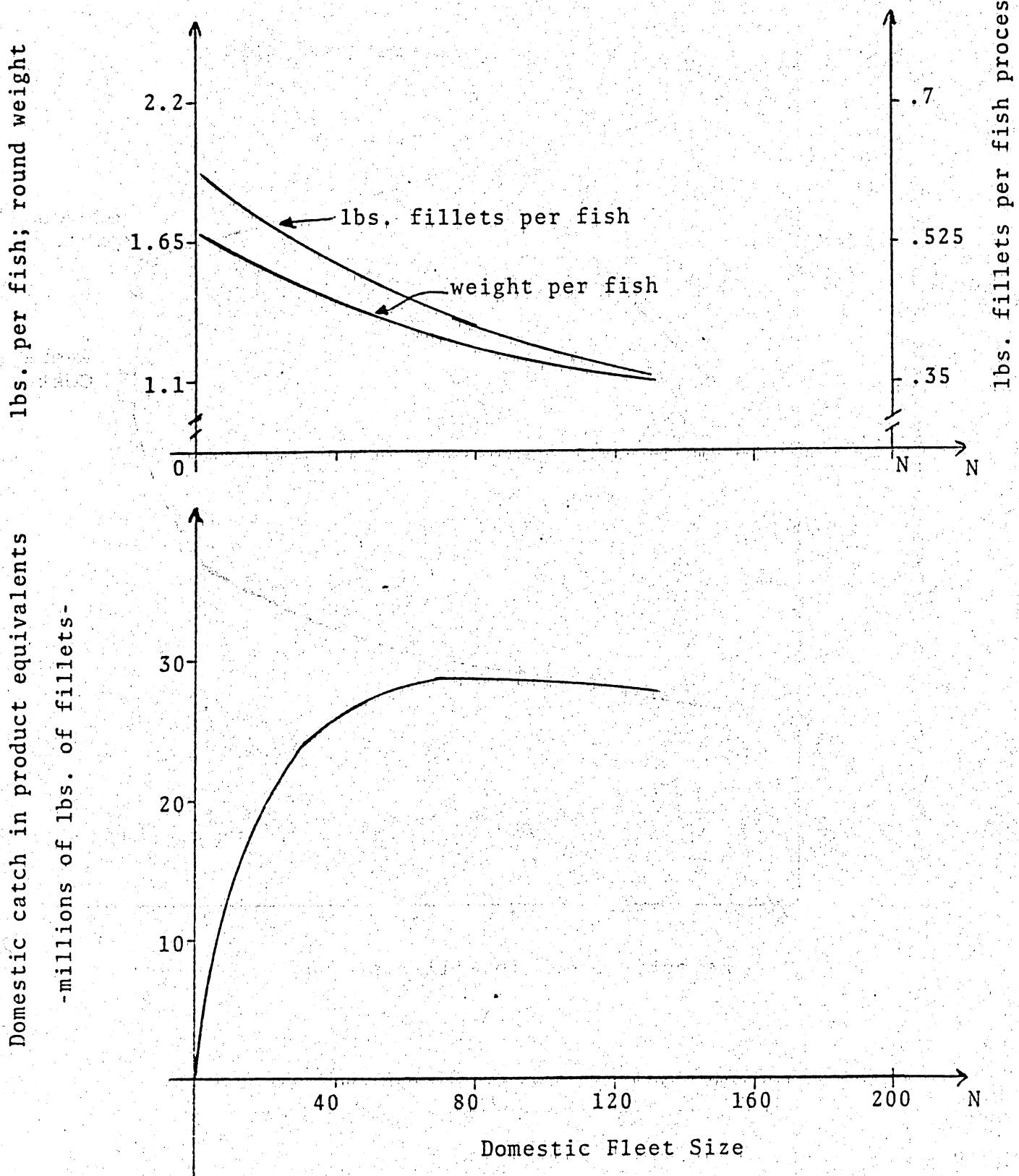


Figure 4.D.2. Weight per Fish Landed, Product Yield in lbs.  
Fillets per Fish Processed, and Domestic  
Catch in Product (Fillet) Equivalents; Plotted  
Against Domestic Fleet Size in Model 1.



The average cost per pound of fish landed would be 14.3 cents, and the price per pound received by the fishermen would also be 14.3 cents.

It is interesting to note that, although the total rent to the fishery is zero, there is substantial variation in the actual net earnings by vessel class. Table 4.D.1 shows that vessel size groups 1 and 4 would actually earn a net profit of 9.4 and 5.4 thousand dollars respectively while the other vessel classes would incur some net losses.

If it were possible, through a management agency, to restrict effort to the point of maximum sustainable yield, 111 vessels could land 61.5 million pounds of fish and total foreign and domestic landings would be 92.2 million pounds. Even though this would bring a greater quantity of fish (28.2 million as compared with 27.7 under the free entry situation) on the market, the price received would be slightly higher.

This is because the average size of fish landed at the MSY would be larger and command a higher price than at the free entry level. In other words, the upward pressure on price as a result of a greater fillet yield per pound of fish more than offsets the downward pressure on price of the slightly greater landings. At this operating point the average cost per pound of fish landed by the domestic fleet would be 12.0 cents compared to 14.3 cents under the free entry point. The reason for this is that with 21 fewer vessels there is actually an increase in landings of about 200 thousand lbs. along with a 0.4 cent per pound higher price under the MSY situation as

compared to the free entry level of fishing. The 111 vessels fishing at the MSY level would generate a total economic rent of 1.63 million dollars for the industry. This is an average of about 14.7 thousand dollars per vessel. Even at this level of operation, however, vessel size classes 5 and 6 show a net loss, indicating that the catch rate is still too low to offset the higher investment and operating costs required for these vessels. It should be remembered here that the average earnings per vessel would be for 60 percent of the fishing time available to the vessels.

An examination of Table 4.D.1 shows that if the management agency decided to restrict effort in this fishery to a level which would be socially optimum from the economic efficiency standpoint, this would imply 45 vessels harvesting 54.2 million pounds of fish at an average cost of only 5.5 cents per pound. This means that with 87 less vessels for this situation as compared to the free entry situation, the domestic fleet would land only about 7 million pounds less. They would receive, however, a price of 17.9 cents per pound, total industry profits of 6.7 million dollars, and average profit of almost 150 thousand dollars per vessel.

Under this situation, the mean size per fish landed would be 1.39 pounds, giving a fillet yield of almost 35 percent. The amount going on the market to consumers would be 26.5 million pounds compared to only slightly more (27.68 million pounds) under the free entry situation. Thus, while landed weight would be 11.4 percent less than at the free entry

position, the amount available to consumers would be reduced by only 4.3 percent.

Although the results of this analysis clearly show the large economic gains to those vessels remaining in the industry if effort were limited to the maximum economic efficiency level, it is important to recognize the political and social implications of eliminating a large number of vessels (87) and crewmen (over 200) from this fishery. Therefore, it is appropriate to examine the compensation possibilities for those vessel owners leaving the fishery.

As indicated earlier, moving from the free entry level of 132 vessels to the MSY level of 111 vessels would require the elimination of 21 vessels, each spending 60 percent of its fishing time on yellowtail flounder. Suppose, for example, the remaining 111 vessel owners would, through the management agency, pay for the fixed costs of these 21 vessels plus an additional amount as compensation for not fishing in the yellowtail fishery. The vessels in the fishery have an average annual fixed cost of about \$25,000. Sixty percent of this would be \$15,000. Assume the vessels eliminated from the fishery would be paid \$15,000 to cover their fixed costs plus an additional \$8,000 for not fishing. This represents a total compensation of \$483,000 and the remaining 111 vessels would have \$1.63 million (the industry net profit) minus \$483,000 or \$1.147 million to divide up. This would be just slightly over \$10,000 pure profit each to the remaining 111 vessels. In this way all vessel owners, those compensated for not

fishing and those remaining in the fishery, would be economically better off than under the free entry situation.

If the management agency would restrict effort to some level below MSY, there is a potential for even greater economic gains to all vessel owners. As an example, if the agency limited the number of vessels to 100 vessels, each fishing 60 percent of their time for yellowtail, a net profit of \$2.5 million would be generated (see computer printout in Appendix). Assume these 100 vessel owners pay \$23,000 (\$15,000 + \$8.000) to each of the 32 vessel owners who are eliminated from the fishery. This is a total payment of \$736,000 and would leave \$1.764 million net profit for the 100 vessels in the fishery; an average profit of \$17,640 per vessel. Therefore, from the economic standpoint there could be substantial gains to the industry if the management agency reduced effort below the MSY level.

It is interesting to note that with 100 vessels operating in the fishery the total product weight of fillets going to the consumer is 28.45 million pounds; more than at either the free entry or MSY levels.

This discussion does not deal with the critical question of how to bring about a management structure that can take the types of action described above. It does seem that, considering the tremendous potential economic gains and the possibility of developing an environment in which fishermen and consumers would both gain, the Federal Government should take some significant leadership and legislative action to attempt

to bring about a rational fishery management plan.

#### Alternative Models

In Table 4.D.2 a summary is given of the various other models that were evaluated through the bio-economic approach used for the base model. Each of these models has some parametric change from the base model. Before discussing the details of the various models, a summary comment seems appropriate.

An examination of the table shows that regardless of restrictions on foreign effort, restrictions on imports, increases in demand, changes in biological parameters, or increases in vessel efficiency, without effort restrictions any potential profit is simply dissipated as new vessels enter the fishery.

#### Changes in Foreign Fishing and Imports

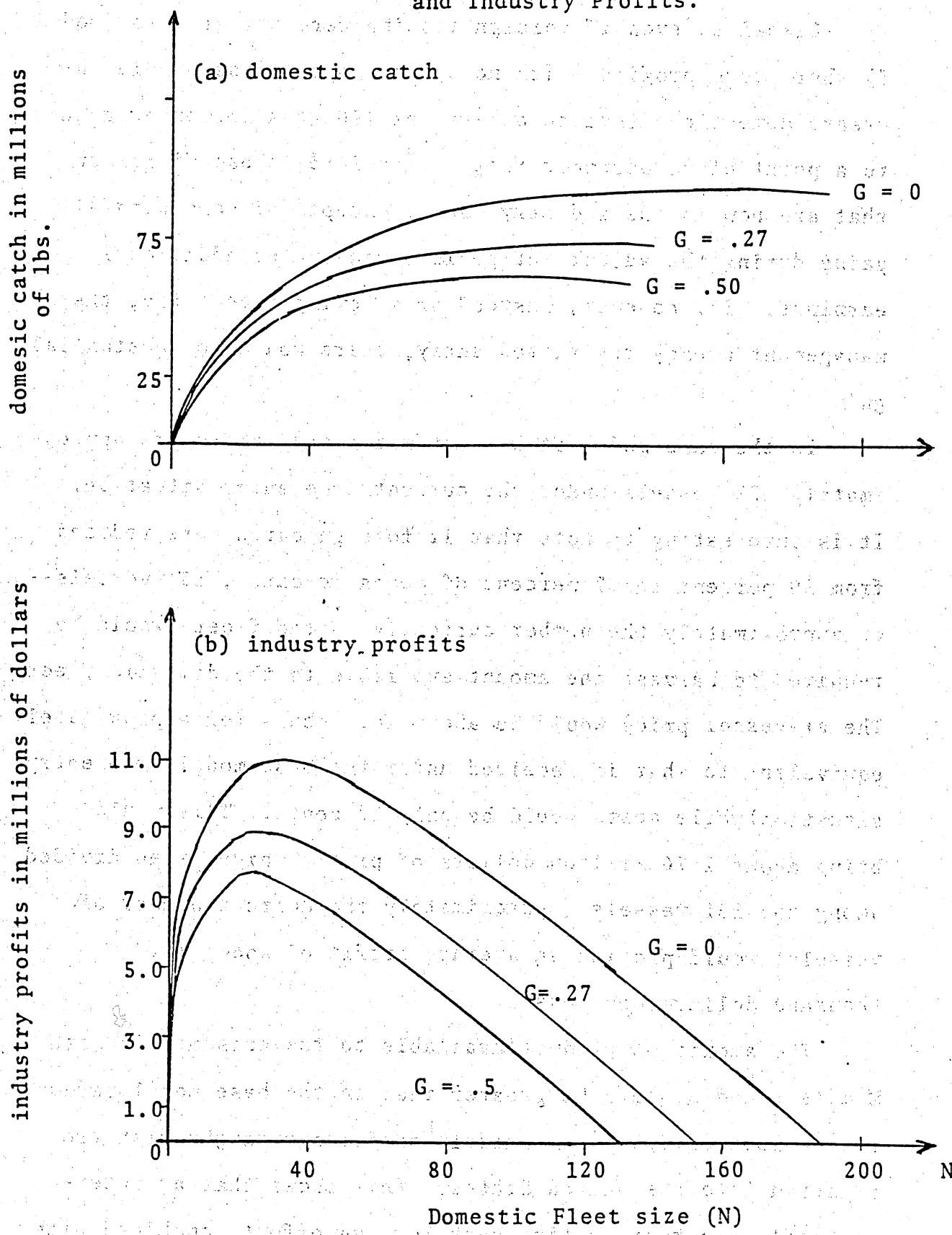
It is evident in examining Table 4.D.2 that domestic earnings were extremely sensitive to changes in foreign fishing activities. For example, in the table under the model number 2, foreign catch as a ratio to domestic catch (G) is set at .27 rather than .50 as was done in the base model. The removal of foreign fishing effort naturally leaves more of the population for capture by the domestic fleet. If free entry is allowed to exist, the reduction in foreign fishing effort would merely encourage additional U.S. vessels to a point where eventually approximately 153 vessels would be operating with no pure profit (Fig. 4.D.3).

Table 4.D.2. Results of Alternative Models Containing Various Parametric Changes as Compared to the Base Model

Variable	Position	Model Number																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
		Base	G=.27	G=0	GG=.5	G=.27	B <sub>1</sub> =.3694	B <sub>1</sub> =.4030	B <sub>1</sub> =.3694	B <sub>1</sub> =.4030	GG=0.5	θ=.5	B <sub>1</sub> =.34	B <sub>1</sub> =.66	M=.175	M=.225	R=R=111	R=R=135	t <sub>p</sub> =2.5
Vessels (#)	Ec.	45	53	66	46	54	47	48	48	50	54	37	47	43	41	48	43	46	48
	MSY	111	131	167	111	131	111	111	111	111	133	88	109	114	100	122	98	126	145
	F.E.	132	153	190	140	159	143	154	152	163	158	113	137	127	126	137	124	139	146
Price (\$/lb.)	Ec.	17.9	17.7	17.3	19.2	18.4	19.5	21.1	20.1	22.4	18.0	17.8	17.5	18.3	19.1	17.1	17.7	18.3	18.6
	MSY	14.7	14.4	14.0	15.8	15.1	16.1	17.6	17.3	18.9	14.7	14.7	14.5	14.8	15.6	13.8	14.5	14.8	15.1
	F.E.	14.3	14.1	13.7	15.2	14.7	15.6	16.8	16.6	17.9	14.3	14.2	14.0	14.5	15.2	13.6	14.0	14.6	15.0
Av. cost (\$/lb.)	Ec.	5.5	5.5	5.5	5.5	5.6	5.7	5.8	5.8	6.0	5.5	5.2	5.4	5.6	5.6	5.4	5.4	5.6	5.7
	MSY	12.0	12.0	12.1	12.0	12.0	12.0	12.0	12.0	12.0	12.0	11.0	11.1	13.1	12.0	12.0	11.0	13.3	14.9
	F.E.	14.3	14.1	13.7	15.2	14.7	15.6	16.8	16.6	17.9	14.3	14.2	14.0	14.5	15.2	13.6	14.0	14.6	15.0
U.S. catch (mil.lbs.)	Ec.	54.17	63.86	80.52	54.53	64.23	54.88	55.22	55.22	55.84	54.12	54.69	57.75	50.94	49.06	58.89	52.68	55.10	56.23
	MSY	61.46	72.59	92.18	61.46	72.59	61.46	61.46	61.46	61.46	61.46	61.46	65.35	58.11	55.46	67.45	59.47	63.23	64.82
	F.E.	61.26	72.41	92.03	61.12	72.31	61.06	60.83	60.87	60.62	61.27	61.08	64.96	58.05	55.16	67.35	59.09	63.18	64.81
Total catch (mil.lbs.)	Ec.	81.25	81.11	80.52	81.80	81.58	82.32	82.82	82.82	83.76	81.17	82.04	86.62	76.41	73.59	88.33	79.02	82.65	84.35
	MSY	92.18	92.18	92.18	92.18	92.18	92.18	92.18	92.18	92.18	92.18	92.18	98.03	87.17	83.19	101.18	89.21	94.85	97.21
	F.E.	91.89	91.96	92.03	91.68	91.84	91.60	91.25	91.31	90.94	91.91	91.63	97.45	87.10	82.74	101.03	88.63	94.77	97.20
Catch/vessel (000 lbs.)	Ec.	1,802	1,803	1,826	1,775	1,781	1,748	1,722	1,722	1,672	1,500	1,764	1,839	1,773	1,791	1,837	1,834	1,793	1,754
	MSY	829	829	826	829	829	829	829	829	829	692	833	898	763	830	828	908	751	669
	F.E.	695	708	725	654	681	639	591	599	557	581	645	710	684	655	736	713	680	665
Total rent (mil. \$)	Ec.	6.72	7.76	9.55	7.38	8.21	7.56	8.47	8.30	9.20	6.72	6.89	7.00	6.47	6.63	6.85	6.46	7.02	7.24
	MSY	1.63	1.76	1.84	2.30	2.23	2.53	3.43	3.27	4.24	1.65	2.29	2.24	1.00	2.08	1.21	2.11	1.00	.82
	F.E.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Rent/vessel (\$1000)	Ec.	149.4	146.5	144.7	160.5	151.9	160.9	176.4	172.8	184.1	124.5	186.1	149.0	150.6	161.8	142.8	150.1	152.7	150.8
	MSY	14.7	13.5	11.0	20.7	17.1	22.8	30.9	29.5	38.2	12.4	26.0	22.4	8.7	20.3	9.9	21.5	8.0	.6
	F.E.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Imports (mil.lbs.)	Ec.	21.67	13.79	---	13.63	8.67	21.95	22.07	13.80	13.96	21.65	21.88	23.10	20.38	19.62	23.55	21.07	22.0	22.49
	MSY	24.58	15.68	---	15.36	9.80	24.58	24.58	15.36	15.36	24.58	24.58	26.14	23.25	22.18	26.98	23.79	25.3	25.92
	F.E.	24.51	15.64	---	15.28	9.76	24.43	24.53	15.22	15.16	24.51	24.43	25.99	23.22	22.01	26.94	23.63	25.3	25.92
Product yield (mil.lbs.)	Ec.	26.50	27.15	28.17	23.80	25.46	26.79	26.92	24.04	24.26	26.48	26.72	28.49	24.72	23.99	28.85	25.38	27.35	28.24
	MSY	28.23	28.97	30.25	25.20	27.04	28.23	28.23	25.20	25.20	28.24	28.24	30.51	26.25	25.47	30.98	26.81	29.54	30.71
	F.E.	27.68	28.48	29.84	24.52	26.45	27.37	27.07	24.22	23.95	27.70	27.41	29.70	25.95	24.78	30.60	25.93	29.23	30.69
Fish size (lbs.)	Ec.	1.39	1.39	1.40	1.39	1.39	1.38	1.38	1.38	1.37	1.39	1.39	1.44	1.35	1.39	1.40	1.32	1.47	1.53
	MSY	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.20	1.10	1.15	1.15	1.09	1.20	1.26
	F.E.	1.10	1.11	1.11	1.09	1.10	1.08	1.06	1.06	1.05	1.10	1.08	1.13	1.07	1.09	1.12	1.03	1.18	1.25
Fishing mort. coef.	Ec.	.255	.253	.248	.261	.258	.266	.272	.272	.283	.254	.263	.236	.274	.258	.247	.241	.264	.279
	MSY	.629	.626	.627	.629	.626	.629	.629	.629	.629	.626	.626	.546	.727	.629	.629	.551	.721	.842
	F.E.	.748	.732	.713	.793	.760	.810	.872	.861	.923	.744	.804	.866	.810	.793	.706	.697	.796	.848

<sup>1</sup>For vessel size 4.

Figure 4.D.3. Effects of the Foreign:Domestic Shares Ratio ( $G$ ) on Domestic Catch and Industry Profits.



Likewise, even if foreign fishing were set at zero (Model 3) short term profits, with no entry restrictions, would increase domestic effort to a level of 190 vessels; once again to a point of no economic rent. Therefore, those fishermen that are now in the industry would, except for some windfall gains during the adjustment period, receive no additional earnings. If, however, instead of allowing free entry, the management agency restricted entry, there would be substantial gains.

In the base model it was estimated that there are approximately 132 vessels under the current free entry situation. It is interesting to note that if foreign catch were reduced from 50 percent to 27 percent of domestic catch, 131 vessels--or approximately the number currently in the fleet--would be required to harvest the amount available to the domestic fleet. The ex-vessel price would be about 14.4 cents (or approximately equivalent to what is received under the base model free entry situation) while costs would be only 12 cents. This would bring about 1.76 million dollars of profit which, when divided among the 131 vessels (approximately the current number of vessels) would provide an average profit of about 13.5 thousand dollars per vessel.

The amount of product available to the consumer in both Models 2 and 3 would be greater than in the base model because only a portion (.8 in the model) of foreign caught fish are imported into the United States. This shows that an international agreement cutting back foreign effort, combined with

a domestic management plan, would result in greater earnings to the fishermen and a greater amount of fish on the market at approximately the same prices consumers now pay.

Because of the generally increasing world demand for fish, it is likely that over the next few years less foreign caught fish will be available at existing prices to U.S. consumers.

More of the foreign caught fish will be either sold in the home country, or exported to other nations in the world. As is indicated by Model 4, if the amount of imports (GG) were reduced from .8 or 80 percent of the foreign catch to 50 percent of the foreign catch, there would be no gain to the fishing industry if free entry were allowed. The decrease in imports would generate higher prices on the domestic market (as is evidenced by a free entry price of 15.2, as compared with 14.3; in the base model), but this would simply attract more vessels, dissipating the potential gain to the fishermen from the higher ex-vessel price.

If, however, the management agency successfully restricted effort to the MSY level, declining imports of yellowtail flounder would generate a higher price and an average profit of almost \$21,000 per vessel for the 111 vessels necessary to catch the domestic share of the maximum sustainable yield.

Model 5 is a combination of Models 2 and 4, showing a decrease in both foreign catch and the percent imported ( $G = .27$  &  $GG = .5$ ). This would generate a situation where 131 U.S. vessels land the MSY level available to the domestic fleet. If U.S. effort were held to current levels, declining

foreign catch and imports would result in over 2 million dollars pure profit to the industry. If the management agency decided to restrict entry to some level below MSY, the gains to the domestic industry would be correspondingly higher. This is evidenced by the fact that under this model the earnings per vessel would be over \$150,000 at the maximum economic efficiency point.

#### Changes in Demand

The demand analysis described earlier indicated a positive relationship between income increases in the U.S. and ex-vessel price increases. If incomes continue to increase in the U.S., there will likely be a tendency for upward pressure on consumption and prices of yellowtail flounder. Models 6 and 7 provide indications of the effect of increases in the demand for yellowtail flounder of 10 percent and 20 percent respectively. If in the face of increasing demand entry is unchecked, higher prices and short-term profits will attract more vessels into the fishery. Under the 10 and 20 percent increases in demand respectively, 143 and 154 vessels would be attracted to this fishery. If vessel numbers were held to the MSY effort level, there would be a potential of generating approximately \$23,000 and \$31,000 profit per vessel under the demand increments of 10 and 20 percent respectively.

Models 8 and 9 show the effects on the industry of simultaneous increases in demand and decreases in imports: a

situation which may very likely occur in the next few years.

If entry is left unchecked, a 20 percent increase in demand and reduction of imports from .8 to .5 of the foreign catch (Model 9) would encourage entry to a level where there would be 163 U.S. vessels. This would move the effort level far beyond the 111 vessels required to harvest the MSY landings. As a result, costs per pound at the free entry level would be 17.9 cents and the domestic industry would earn no net profit.

One possible approach for the management agency would be to hold the effort constant at 132 vessels rather than allowing the increases that would come about under free entry. If this were done, the total profit to the industry would be 2.51 million dollars and the earnings per vessel for the 132 vessels now in the industry would be \$19.000.

#### Reductions in the Proportion of Time Fishing for Yellowtail Flounder

In the base model as well as in all the above described models, the percent time spent fishing for yellowtail ( $\theta$ ) was set at 0.6 for the domestic fleet. One way to reduce effort is to reduce the percent of time the fleet devotes to the capture of yellowtail flounder. This is equivalent to setting a limit on the days fished for yellowtail by each vessel class. To test the implications of this approach, Model 10 was created

in which  $\theta = 0.5$ . The results of this model show that it would be possible to hold the number of vessels to approximately the current level and restrict effort to the MSY level. This would generate net profits of \$12,400 per vessel provided additional vessels were not allowed to enter. The results of this model also show, however, that if restrictions were not put on entry those fishermen who are now in the fishery and upon whom the initial restriction on fishing time would be imposed, gain nothing.

It should be recognized that if  $\theta$  is reduced, a significant transfer of fishing effort from the yellowtail flounder fishery to other species would likely occur. Therefore, this type of management approach should not be considered unless the implication for other fisheries are taken into account.

#### Changes in Vessel Efficiency

As is indicated in Table 4.D.1, the relative profitability of vessels varies substantially from one class size to another. As can be seen by examining the table, vessel size class 4 earned the greatest amount of profit. In order to determine the effect of increased efficiency, through building more profitable vessels, Model 11 was run in which only two size classes of vessels were considered. Size class 1 was considered to make up 34 percent of all vessels. This is the same percentage as for the base model. This size category was left in Model 11 because according to Table 4.D.1 it is a relatively profitable size class, particularly considering the

small investment required. Also, since many of these fishermen operate in family units, there will likely always be a fairly large number of this particular size class of vessels. For the residual 66 percent of the vessels, however, it was considered that all would fall within the size 4 class.

The results in Table 4.D.2 show that this represents a significant increase in efficiency. Only 88 vessels would be required to harvest the 61.46 pounds available to the domestic fleet at the maximum sustainable yield level. The profit to these 88 vessels would be 2.3 million dollars. At the maximum economic efficiency effort of 37 vessels, rent would be \$6.9 million or slightly over 186 thousand dollars per vessel.

In Model 11, as compared to the base model, the same amount of product would be available to U.S. consumers.

Fishermen receive a slightly lower price, but costs are considerably lower. This means improved efficiency can result in significant payoffs, but only if accompanied by some form of management which restricts effort at least to the maximum sustainable yield level. In the absence of such a management scheme, improved vessel efficiency does not result in long term gains either to the fishermen or to consumers.

### Changes in Biological Parameters

In order to test the sensitivity of the model to changes in certain biological parameters, several alternative models were tried. As was indicated in Table 4.C.1, the natural mortality coefficient for the base model was 0.2. In Model 12, natural mortality ( $M$ ) was set at 0.175.

The apparent impact of the change in natural mortality was to make the yield function rise more rapidly and then, once the MSY level is reached, to drop more gradually. As a result, the effort at the MSY level is 109 vessels compared to 111 in the base model. Because a decrease in natural mortality leaves more of the population available for exploitation by man, the MSY under this situation increased from 92.2 to 98.0 million pounds and both domestic and foreign catches are higher than in the base model.

This biological change resulted in a higher catch rate per vessel (898 thousand for vessel size class 4 as compared with 829 under the base model) and larger industry profits at the maximum economic efficiency and MSY levels of effort. Averaging the 2.24 million dollar MSY level profit over 109 vessels gives profits of 22.4 thousand dollars per vessel.

The effect of this change is to bring more fish on the market and downward pressure on price. This was partially offset, however, because the lower natural mortality coefficient resulted in a larger average size per fish and the MSY level price was 14.5 cents per pound as compared to 14.7 in the base model.

In Model 13 which was an example of the effect of an increase in the natural mortality coefficient, the impact was to lower the MSY to 87.2 million pounds. Operation at the MSY level would provide for only 8.7 thousand dollars profit per vessel, and would place much smaller fish on the docks. This would impose higher processing costs on the processors. At the same time, because of the lower yield function, both foreign and domestic catches would be down significantly. Therefore, prices in this model are higher, processing costs are higher and earnings to fishermen lower.

One point that is interesting to mention is that Model 13 with its relatively high natural mortality, implies that if there are pollution problems being generated in the oceans which tend to affect the non-fishing mortality of fish, there could be significant effects on the industry.

Because recruitment is a significant variable in the bio-economic fishery model used in this study, it was considered appropriate to test sensitivity of the model to changes in the recruitment parameter. In the base model recruitment was set at 123 million. In Models 14 and 15 recruitment was set at 111 and 135 million respectively; representing a plus or minus ten percent change from that in the base model. The lower recruitment figure tended to shift the yield curve to the left and down, so that the MSY dropped to 83.2 million pounds. Under these conditions the potential industry profit at the maximum

economic efficiency level of 41 vessels was about 100 thousand dollars less than under the base model.

At the MSY level, the total profit and profit per vessel were somewhat higher than under the base model, although the number of vessels is significantly less.

In contrast, Model 15 shows that a ten percent increase in recruitment would substantially increase the MSY level from 92.2 in the base model to over 100 million pounds, with the result being that 122 vessels would be required to harvest the amount of the MSY yield available to the domestic fleet. This would generate a total profit to the industry of 6.85 million dollars, or a profit of approximately 10 thousand dollars per vessel.

The general implications of these three models with recruitment at 111, 123- and 135 million respectively is that the higher the recruitment the more are the potential gains to the industry by restricting entry below the MSY level of effort.<sup>1</sup>

Additional models were run to test the impact of alternative mesh sizes on the fishery. This was done on the assumption that the effect of the mesh is knife-edged and is a determinant of the age of fish at entry into the fishery. Recognizing that nets are not this selective, the benefits

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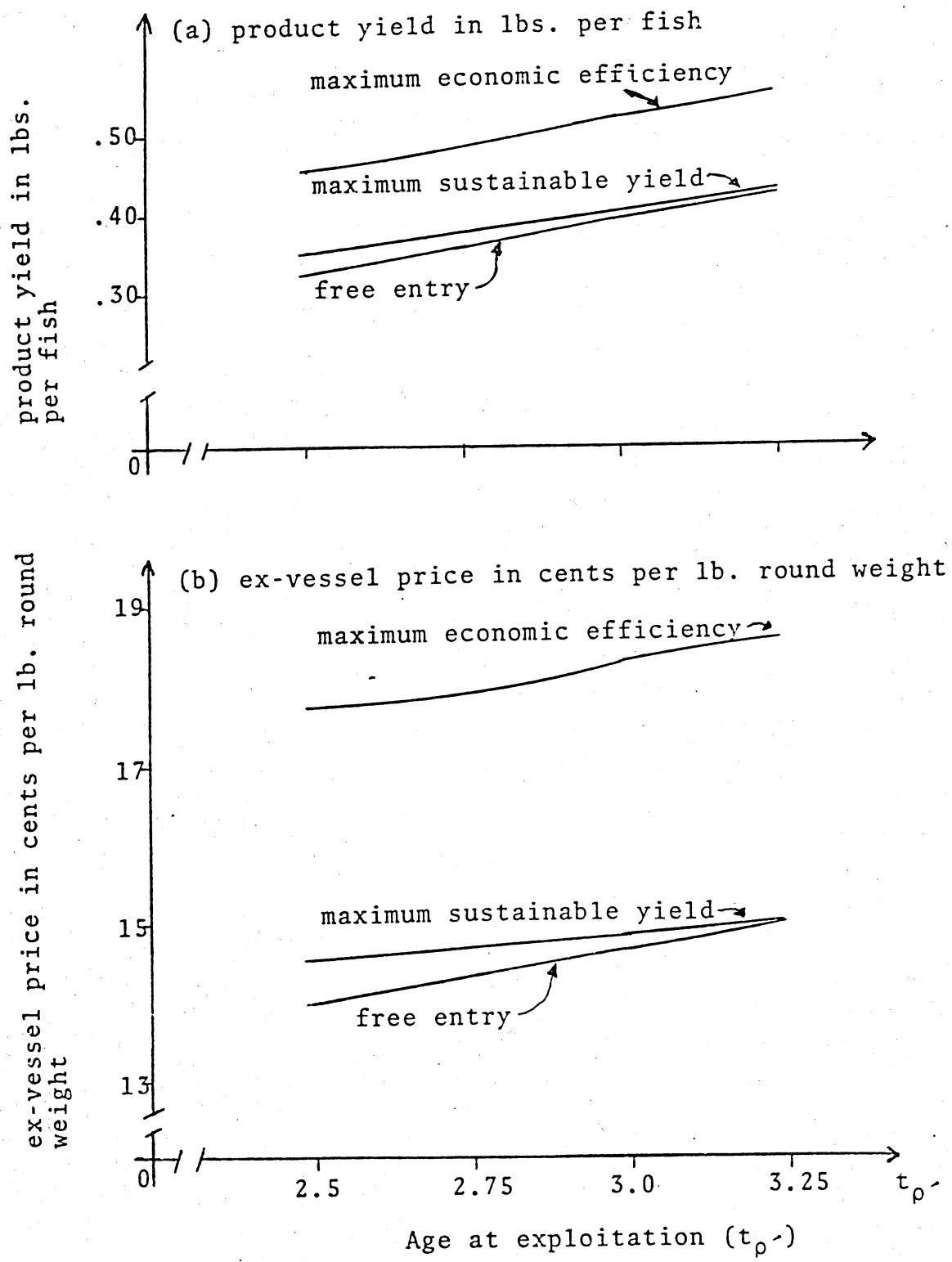
<sup>1</sup>Although beyond the scope of this paper, it is possible that because recruitment is figured at the point of entry into the fishery, changes in recruitment could be used to determine the effect of harvesting undersized fish (for industrial purposes, for example).

from increasing mesh size as are indicated in this analysis, would tend to be somewhat overstated. However, comparing the three alternative models (16, 17, & 18) and the base model, there is clearly an indication that as  $t_p$  (the age at exploitation) increases, there is an increase in the MSY and increase in the total amount of rent generated for any given number of vessels.

It is interesting to note that as mesh size increases the free entry point and the MSY level come closer together. This is because increasing mesh size ( $t_p$ ) shifts the yield function upward and to the right and, therefore, the point at which total costs and total revenue for the fleet become equal is shifted more and more toward the MSY level.

Figure 4.D.4 illustrates the effects of changes in  $t_p$  on product yield and on ex-vessel price.

Figure 4.D.4. Effects of Age at Exploitation ( $t_p$ ) on Product Yield and on Ex-Vessel Price.



## SUMMARY

The results of the base model and the effects of the parametric changes introduced in that model (as described in the previous section) clearly show the tremendous economic waste that will tend to exist in a fishery which is based on common property resource and which lacks entry restrictions.

In most industries increasing productivity, decreasing competition from foreign producers, or increasing demand, tend to lower costs of production, put more of the product on the market, or increase net profits. In fisheries, however, if there are no restrictions on entry, changes such as these tend to generate short term profits that are quickly dissipated as vessels are attracted to the fishery.

These results are certainly not new, especially to those biologists, economists, and others that have been working in the area of fishery management. What this study does do, however, is to quantify the potential economic gains that could be attained if the commercial fishery management agencies --State and Federal--would establish a rational management program for this species. To the authors, as perhaps it will be to others, the magnitude of the potential gains are, if not startling, at least surprising. We believe these results strongly emphasize the need to develop international agreements that will prevent excessive fishing effort in this

fishery. The study also shows that the long term gains to the domestic industry of limiting foreign effort will simply be dissipated unless accompanied by domestic regulations.

The findings reported in this paper quantify and emphasize the strong interrelationships of biological, technical, economic, and institutional factors affecting the fishing industry. This certainly raises the question of how the U.S. can possibly justify continuance of the past fishery policy and also indicates the important economic gains that can be made by the industry if activities such as the NMFS State-Federal fisheries management programs can truly be effective.

The study points out the fact that there is surely no justification for allowing effort to exceed the MSY level--especially if one considers the possibility of compensation for fishermen who leave the fishery from the profit increases which accrue to those who remain.

Beyond consideration of limiting effort to the MSY level, the results of this study clearly imply that limiting effort to the MSY level is not an adequate economic goal of a management agency. Strong economic gains can be made--by those remaining in the fishery as well as those compensated for leaving the fishery--if effort is limited to levels below the MSY level, and over time full consideration should be given to achieving the social economic optimum described in this study as the level of maximum economic efficiency.

Until some rational management scheme is developed, State and Federal agencies and the industry itself can expect little or no long term gains from programs designed to improve efficiency of the fleets, limit foreign catch, limit imports, or increase the demand for fish products. At the same time it is imperative to recognize there will be no domestic benefits if entry restrictions are placed on the domestic fleet unless there is simultaneously an international regime which will prevent foreign fishing effort from increasing as domestic effort is limited.

The study does break new ground by integrating the effects of fishing effort not only on landings in round weight equivalents, but also on fish size, ex-vessel price, and processing yields. It clearly illustrates the complementarity of mesh regulation with effort limitation in increasing yields, decreasing costs and increasing profits. It also illustrates their complementarity via increased fish size, in increasing processing yields, reducing costs per pound of product equivalent and/or increasing ex-vessel price to fishermen.

The authors recognize that this study has many limitations, among these being the use of a fairly simple single species static model. This limitation is also somewhat of an advantage in that it makes the testing of parametric variations in the model relatively easy. Also, the use of a more complex model, when data reliability is questionable, may be

a way to only "make believe" that we really have better answers. On the subject of data reliability, the authors generally have confidence in the various parameter values used. Certainly improvements can be made in any or all of the estimated values used in this study. We believe, however, that even with perfect data, the same general results would be shown. Free entry generates great amounts of economic waste while reduction of effort to the MSY level (and preferably below) will reduce this waste. Potential gains are of such a magnitude that compensation could be given to those leaving the fishery by those remaining in the industry. In the absence of such effort limitations, the U.S. fishing industry will, increasingly, be a marginal economic venture.

It should be noted that for a complete benefit cost analysis of policy measures, one would need, not only profit increments, but also increments in consumer surplus and the cost of implementing regulations. Also, time paths of program implementation and discounted net benefit streams should be considered. These points, along with the development of multi-species models should be an important next step in the general research related to fishery management.

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## **APPENDIX**

### **Description of Program**

#### **- COST -**

- 1. Objectives of COST**
- 2. Variables and Parameters**
- 3. Output Options Available**
- 4. Sample Input Data for COST Program**
- 5. Description of Sample Input Data**
- 6. Sample Output for COST Program**

## 1. Objectives of COST

The objectives of COST are as follows:

- a. To calculate physical yields, prices, revenues, costs and profits, product yield and imports in a fishery for any desired range of fishing effort.
- b. To identify four positions of interest. These positions are those levels of fishing effort at which
  - i. aggregate profits are a maximum (not pertinent to or referred to in this report).
  - ii. price and marginal cost are equal (Pareto efficient position or socially optimum position).
  - iii. sustainable (physical) yield is at a maximum (MSY position).
  - iv. price and average cost are equal (the free entry position).

By appropriate variation of biological and economic parameters it is possible to explore the sensitivity of results and conclusions to estimation errors or secular trends of interest (e.g., secular demand shifts).

## 2. Variables and Parameters

<u>FORTRAN Name</u>	<u>Text Symbol</u>	Description
WINF	$W_\infty$	maximum fish size
ZK	K	catabolic coefficient x 3
LAMBDA	$\lambda$	fishable life
TO	$t_o$	age at zero weight
TRO	$t_p$	age at entry
TRHOP	$t_p'$	age at exploitation
R	R	recruitment
NAMOR	M	natural mortality coefficient
N	N	number of domestic vessels
NO	-	minimum number of vessels of interest
LMAX(J)	$l_{j\max}$	maximum catch capability of a vessel
MC	MC	marginal cost
K(J)	$k_j$	opportunity costs of a vessel
LOLIM	-	lower bound on F used to find fishing mortality (FO) with one vessel by an iterative algorithm
UPLIM	-	upper bound complement of LOLIM
NRUN	-	number of models to be run
IPUNCH	-	parameter controlling punching or printing of output
IAL	-	parameter controlling the calculation of actual catch by vessel class

FORTRAN Name	Text Symbol	Description
IMNMAX	-	parameter controlling the suppression of printing
ALABEL	-	an alpha numeric label card; used to describe a model
DELTA	$\epsilon$	integer variation to be used with fleet size (N)
THETA	$\theta$	proportion of time devoted to fishing the species in question
G	G	ratio of foreign:domestic catch
D(J)	$d_j$	days fished by vessel class
B(J)	$b_j$	proportion of fleet of the $j^{\text{th}}$ vessel class
C(J)	$c_j$	variable costs per day fished
FP(J)	$FP_j$	relative fishing power
CONS1	$B_1$	demand interest
PNE	--	human population in the market demand region
P1Q1	$B_2$	price flexibility coefficient
PMS	$B_3$	demand coefficient associated with processing yield
ERROR	-	tolerance limit in iterative algorithm mentioned in connection with UPLIM, LOLIM
FO	-	fishing mortality coefficient with a fleet of one vessel
FUNC		the steady state yield equation (equation 2. . )

<u>FORTRAN Name</u>	<u>Text Symbol</u>	<u>Description</u>
YT	$Y_w$	total catch in pounds
P(J)	$q_j$	percent fishing mortality; j <sup>th</sup> vessel class.
FM	F	total fishing mortality coefficient
FC	-	weighted average of opportunity costs of vessels for the domestic fleet
YC	-	weighted average of annual variable costs for the domestic fleet
CT	TC	total costs of the domestic fleet
YXN	$Y_n$	total catch in numbers
YDN	-	domestic yield in numbers
WB	$WB_{t_p}^{t_\lambda}$	biomass of the exploited phase
YD	$Y_d$	domestic yield in weight
AL	-	actual or realized catch per vessel by vessel class
YMP	-	imports
YCONS	-	domestic catch and imports
WGT	$Y_w/Y_n$	mean weight per fish
YCN	-	domestic consumption in numbers of fish
YLD	-	processing yield in lbs. of fillets per fish processed
YPROD	-	domestic consumption in lbs. of product equivalents
V	P	ex-vessel price
AC	AC	average harvest cost per lb. captured, for the fleet

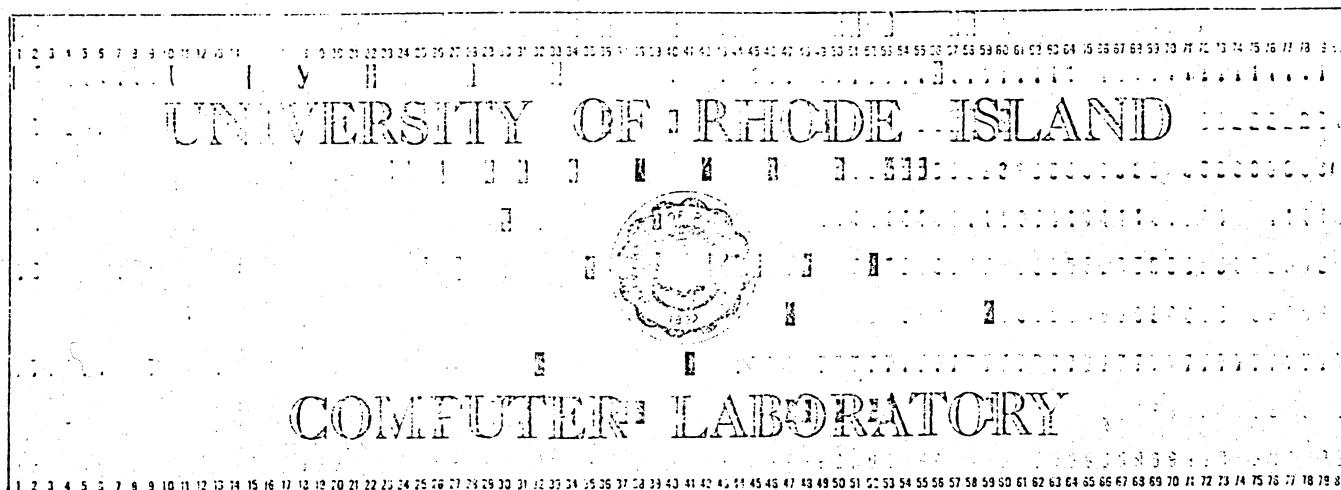
<b>FORTRAN Name</b>	<b>Text Symbol</b>	<b>Description</b>
PRNREV	-	total fleet profits
PNREVV	-	profits per vessel
DELYD	$\Delta Y_d$	yield increment associated with a variation, $\epsilon$ , in number of vessels
DELC	$\Delta T_C$	cost increment associated with a variation, $\epsilon$ , in number of vessels

### 3. Output Options Available

Output may be either printed (if IPUNCH = 0) or punched and printed (if IPUNCH = 1). Output may consist solely of a summary of the four positions of interest (if IMNMAX = 0) or it may also include (if IMNMAX = 1) all values of all variables over the range in fleet size from the beginning number of vessels (NO) to the number of vessels at which profits fall to approximately zero. Since  $\epsilon$  is an integer variable it will be coincidence for profits to ever be exactly zero since profits at N vessels may be "slightly positive" and with  $N + \epsilon$  vessels profits may be "slightly negative".

Sample Input Data for COST Program

IV  
I  
1.0E-01 .1.0E-05 .1.0E-06 9  
.3358 -0.63461 422679000 0.4725900  
.2.74 .335 .9.0 .2 .26 .2.75 .2.00 8  
1.00 .1.20 .1.38 .1.91 .1.93 .1.93  
10336. .19788. .22000. .27700. .38000. .48000. 7  
450.00 .686.00 .766.00 .860.00 .1020.0 .1110.0 6  
0.34 .0.28 .0.24 .0.10 .0.03 .0.01 5  
135. 135. 140. 150. 165. 173. 4  
1.0 .1.0 .123.E6 .0.6 .0.5 .0.8 .0.36E07 3  
THIS IS MODEL 1 ; THE BASE MODEL 2  
001000001000 1  
/GO.SYSIN DD \* 0  
ENRIG POMRUN, LIBUSER, NAME=COST 0  
COST / JOB (JNC100,1,3), 'J.M.GATES', MSGLEVEL=(2,0), CLASS=B 0



## 5. Description of Sample Input Data

Cards I-III and V-VI - system control cards

Card IV - output options

FORMAT (4I3)

- Field 1. NRUN
- 2. IPUNCH
- 3. IAL
- 4. IMNMAX

Card 0 - label card to describe model

FORMAT (40A2)

Card 1 - 1st parameter card

FORMAT (2F10.0, E10.0, 3F10.0, E10.0)

- Field 1. NO
- 2. DELTA
- 3. R
- 4. THETA
- 5. G
- 6. GG
- 7. LMAX(1)

Card 2 - 2nd parameter card

FORMAT (6F10.0)

days fished by vessel class (D(J))

Card 3 - 3rd parameter card

FORMAT (6F10.0)

proportion of vessels by vessel class (B(J))

Card 4 - 4th parameter card

FORMAT (6F10.0)

variable costs per day fished by vessel  
class (C(J))

Card 5 - 5th parameter card

FORMAT (6F10.0)

opportunity costs per year by vessel  
class (K(J))

Card 6 - 6th parameter card

FORMAT (6F10.0)

relative fishing power by vessel class (FP(J))

Card 7 - 7th parameter card

FORMAT (7F10.0)

- Field 1. WINF
- 2. ZK
- 3. LAMBDA
- 4. NAMOR
- 5. TO
- 6. TRHOP
- 7. TRO

**Card 8 - 8th parameter card**

**FORMAT (6F10.0)**

- Field 1.
- 1. CONSI
  - 2. P1Q1
  - 3. PNE
  - 4. PMS
  - 5. unused
  - 6. unused

**Card 9 - 9th parameter card**

**FORMAT (3E10.0)**

- Field 1.
- 1. UPLIM
  - 2. LOLIM
  - 3. ERROR

**6. Sample Output for COST Program**

**(See following pages)**

//COST JOB (JNC100,5,10),'J.M.GATES',MSGLEVEL=(2,0),CLASS=A JOB 141  
// EXEC PGMSAVE,LIB=USER,NAME=COST  
// LANG.SYSIN DD \*  
URI0011 STEP EXECUTION TIME 1.24 MINS.  
IEF283I SYS73080.T075741.RF000.COST.LOADSET NOT DELETED..8  
IEF283I VOL SER NUS= MFTLB2 1.  
URI0011 STEP EXECUTION TIME .06 MINS.

FORTRAN IV G. LEVEL 20

MAIN

DATE = 73080

09/56/25

PAGE 0001

```
0001      DIMENSION OMEGA(4),B(6),P(6),D(6),C( 6),FM(300),YT(300),YCONS(300)
1,DELYT(300),DELC(300),A(6),LMAX(6),WB(300),MC(300),YD(300),YMP(300)
2),DFM(300),FC(300),YC(300),K(6),WGT(300),YDN(300),FP(6),
3CT(300),DELYD(300),AC(300),NI(300),SLOGV(300),AL(300,6),ALABEL(300
*),
4PRNREV(300),PNREVV(300),SNREV(300),YXN(300),V(300),YPROD(300)
5,YLD(300)
0002      COMMON WINF,ZK,LAMDA,NAMOR,TO,TRO,TRHOP,R
0003      REAL NAMUR,LAMDA,MULT,N,NO,LMAX,MC,K,LOLIM
0004      INTEGER OUT
0005      IN=5
0006      OUT=6
0007      READ(IN,100) NRUN,IPUNCH,IAL,IMNMAX
0008      DO 955 II=1,NRUN
0009      READ(IN,98)(ALABEL(I),I=1,40)
0010      98      FORMAT(40A2)
0011      WRITE(OUT,235) II,NRUN
0012      READ(IN,115)NO,DELTA,R,THETA,G,GG,LMAX(1)
0013      WRITE(OUT,240)THETA,G,R,GG,LMAX(1)
0014      READ(IN,120) (D(J),J=1,6)
0015      WRITE(OUT,250) (D(J),J=1,6)
0016      READ(IN,120) (B(J),J=1,6)
0017      WRITE(OUT,260) (B(J),J=1,6)
0018      READ(IN,120) (C(J),J=1,6)
0019      WRITE(OUT,280) (C(J),J=1,6)
0020      READ(IN,120) (K(J),J=1,6)
0021      WRITE(OUT,290) (K(J),J=1,6)
0022      READ(IN,120) (FP(J),J=1,6)
0023      WRITE(OUT,310) (FP(J),J=1,6)
0024      READ(IN,140) WINF,ZK,LAMDA,NAMOR,TO,TRHOP,TRO
0025      WRITE(OUT,200) WINF,ZK,LAMDA,NAMOR,TO,TRHOP,TRO
0026      READ(IN,120)CONS1,P1Q1,PNE,PMS
0027      WRITE(OUT,320)CONS1,PNE,PMS,P1Q1
0028      WRITE(OUT,99)(ALABEL(I),I=1,40)
0029      99      FORMAT(1X,40A2)
0030      READ(IN,299) UPLIM,LOLIM,ERROR
0031      299      FORMAT(3E10.1)
0032      WRITE(OUT,300)UPLIM,LOLIM,ERROR
0033      300      FORMAT('1','UPPER LIMIT ON F0...',E15.7,5X,'LOWER LIMIT ON F0...',,
1E15.7,5X,'PERMISSABLE ERROR...',E15.7//)
0034      LMAX(1)=THETA*(1.0+G)*LMAX(1)
0035      YT(1)=LMAX(1)/R
0036      FO=UPLIM
0037      YT(2)=FUNC(FC)/R
0038      IF(YT(1).LT.YT(2))GO TO 316
0039      WRITE(OUT,311)
0040      311     FORMAT(1X,'UPPER LIMIT TOO LOW!')
0041      STOP
```

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```
0042      316 F0=LOLIM
0043      YT(2)=FUNC(F0)/R
0044      IF(YT(1).GT.YT(2)) GO TO 324
0045      WRITE(OUT,321)
0046      321 FORMAT(1X,'LOWER LIMIT TOO HIGH!')
0047      STOP
0048      324 I=0
0049      325 F0=(UPLIM+LOLIM)/2
0050      I=I+1
0051      YT(2)=FUNC(F0)/R
0052      IF(YT(2).GT.YT(1)) UPLIM=F0
0053      IF(YT(2).LT.YT(1)) LOLIM=F0
0054      DYT=ABS(YT(2)-YT(1))
0055      P(1)=1.0-EXP(-FC)
0056      IF(DYT.GT.ERROR) GO TO 325
0057      WRITE(OUT,330)I,DYT,F0,P(1)
0058      330 FORMAT(1X' ITERATION #          YIELD PER RECRUIT-LMAX(1)
1/R           F0          P(1)'//3X,I5,12X,3(10X
2,E20.7)++)
0059      335 N=NO-DELTA
0060      SUMBJ=0.0
0061      SUMBFP=0.0
0062      DO 40 J=1,6
0063      SUMBJ=SUMBj+B(j)
0064      SUMBFP=SUMBFP+B(j)*FP(j)
0065      IF(B(j).GE.0.0.AND.B(j).LE.1.0) GO TO 20
0066      WRITE(OUT,151B(j)
0067      15 FORMAT(10X,'B(j) DOES NOT LIE BETWEEN ZERO & UNITY ;B(j)=' ,F10.5)
0068      20 CONTINUE
0069      40 LMAX(j)=LMAX(1)*FP(j)
0070      IF(ABS(SUMBj-1.0).LE.0.0001) GO TO 25
0071      WRITE(OUT,21)SUMBJ
0072      21 FORMAT(10X,'SUM OF THE B(j)"S DOES NOT EQUAL UNITY;SUMBJ=' ,F10.4)
0073      25 CONTINUE
0074      DO 4 J=1,6
0075      4 P(j)=P(1)*FP(j)
0076      WRITE(OUT,589)(P(j),J=1,6)
0077      589 FORMAT(1X'THE P(j)'S ARE...'/6E13.6)
0078      WRITE(OUT,99)(ALABEL(i),I=1,40)
0079      DO 600 J=1,6
0080      IF(P(j).LT.1..AND.P(j).GT.0.0) GO TO 600
0081      WRITE(OUT,590)LMAX(1),F0,(P(j),J=1,6)
0082      590 FORMAT(1X'CHECK P(j) LIES BETWEEN ZERO & UNITY;LMAX(1)=' ,E10.3,5X,
1'FZERO=' ,F6.0//1'THE P(j)'S ARE...'/6E13.6)
0083      STOP
0084      600 CONTINUE
0085      6000 CONTINUE
0086      DO 2 I=1,300
```

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```
0087      YC(I)=0.0
0088      FC(I)=0.0
0089      N=N+DELTA
0090      NI(I)=N
0091      IF(NI(I).GT.0) GO TO 605
0092      WRITE(OUT,601)NI(I)
0093      601 FORMAT(10X,'NUMBER OF BOATS IS NON-POSITIVE;NI(I)=',F5.0)
0094      STOP
0095      605 CONTINUE
0096      DFM(I)=0.0
0097      DO 3 J=1,6
0098      YC(I)=YC(I)+B(J)*D(J)*C(J)
0099      FC(I)=FC(I)+K(J)*B(J)
0100      3 DFM(I)=DFM(I)+N*B(J)* ALOG(1.0-P(J))
0101      IF(DFM(I).LT.0) GO TO 8
0102      WRITE(OUT,10)NI(I),DFM(I)
0103      10 FORMAT(4X,'DFM(!,F5.0,)=',E10.4,'PROGRAM TERMINATES')
0104      STOP
0105      8 CONTINUE
0106      FM(I)=-DFM(I)
0107      RHO=TRHOP-TRO
0108      IF(RHO.GE.0) GO TO 7
0109      5 WRITE(OUT,6) RHO
0110      6 FORMAT(10X,'TRHOP EXCEEDS TRO;RHO=',E10.3)
0111      STOP
0112      7 CONTINUE
0113      RP=R*EXP(-NAMOR*RHO)
0114      FC(I)=N*THETA*FC(I)
0115      YC(I)=N*THETA*YC(I)
0116      CT(I)=FC(I)+YC(I)
0117      F=FM(I)
0118      YXN(I)=FM(I)*RP*(1.-EXP(-(FM(I)+NAMOR)*LAMDA))/(FM(I)+NAMOR)
0119      YDN(I)=YXN(I)/(1.+G)
0120      YT(I)=FUNC(F)
0121      IF(YT(I).GT.0..AND.YXN(I).GT.0.)GO TO 12
0122      11 FORMAT(' NUMBER OF VESSELS=',I4,10X,'YT(I)=',E20.8,10X,'YXN(I)=',
1E20.8)
0123      12 CONTINUE
0124      WB(I)=YT(I)/(1.0-EXP(-FM(I)))
0125      YD(I)=YT(I)/(1.0+G)
0126      DU 9 J=1,6
0127      9 AL(I,J)=(YD(I)/N)*(FP(J)/SUMBFP)
0128      YMP(I)=GG*G*YD(I)
0129      YCONS(I)=YD(I)+YMP(I)
0130      WGT(I)=YT(I)/YXN(I)
0131      YLD(I)=-0.14+0.45*WGT(I)
0132      YCN=YCONS(I)/WGT(I)
0133      YPROU(I)=YCN*YLD(I)
```

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```
0134 SLOGV(I)=ALOG(CONS1)+P1Q1*ALOG(YCONS(I)/PNE)+PMS*ALOG(YLD(I))
0135 V(I)=EXP(SLOGV(I))
0136 AC(I)=CT(I)/YD(I)
0137 PRNREV(I)=YD(I)*(V(I)-AC(I))
0138 PNREVV(I)=PRNREV(I)/NI(I)
0139 IF(I.EQ.1) GO TO 2
0140 DELYT(I-1)=YT(I)-YT(I-1)
0141 DELC(I-1)=CT(I)-CT(I-1)
0142 DELYD(I-1)=YD(I)-YD(I-1)
0143 IF(DELYD(I-1).LE.0.)MC(I-1)=1.E75
0144 IF(DELYD(I-1).LE.0.) GO TO 610
0145 MC(I-1)=DELC(I-1)/DELYD(I-1)
0146 610 SNREV(I-1)=V(I-1)-MC(I-1)
0147 IF(PRNREV(I-1).GT.0.)GO TO 2
0148 WRITE(OUT,2001)
0149 2001 FORMAT(IX,'THE VALUE OF I IS ',I10)
0150 GO TO 57
0151 2 CONTINUE
0152 57 IF(IMNMAX.EQ.0.)GO TO 900
0153 LL=I
0154 WRITE(OUT,210)((NI(J),FM(J),YT(J),FC(J),YC(J),CT(J),
1,WB(J)),J=1,LL)
0155 WRITE(OUT,99)(ALABEL(I),I=1,40)
0156 WRITE(OUT,230)((NI(J),YD(J),AC(J),YDN(J),V(J),PRNREV(J),HGT(J)),
1J=1,LL)
0157 WRITE(OUT,99)(ALABEL(I),I=1,40)
0158 LLL=LL-1
0159 WRITE(OUT,220)((NI(J),YMP(J),DELYD(J),YPROD(J),MC(J),PNREVV(J),
1SNREV(J)),J=1,LLL)
0160 WRITE(OUT,99)(ALABEL(I),I=1,40)
0161 IF(IAL.EQ.0) GO TO 63C
0162 WRITE(OUT,620)(NI(I),(AL(I,J),J=1,6),I=1,LL)
0163 620 FORMAT('1',4X,'ACTUAL CATCH PER VESSEL;BY VESSEL CLASS'//
*13X,'BOATS',4X,'CLASSB1',13X,'CLASSB2',13X,'CLASSB3',13X,'CLASSB4',
*13X,'CLASSB5',13X,'CLASSB6'//35(14,6E20.8/))
0164 WRITE(OUT,99)(ALABEL(I),I=1,40)
0165 630 IF(IPUNCH.EQ.0)GO TO 105
0166 WRITE(7,400)((NI(J),FM(J),YT(J),FC(J),YC(J),CT(J),WB(J),
1,YD(J),AC(J),DELYT(J-1),DELYD(J-1),DELC(J-1),MC(J-1)),J=2,LL)
0167 100 FORMAT(4I3)
0168 105 CONTINUE
0169 115 FORMAT(2F10.0,E10.0,3F10.0,E10.0)
0170 120 FORMAT(6F10.0)
0171 140 FORMAT(7F10.0)
0172 200 FORMAT(IX,'WGT. AT INF...',F10.4,' CATABOLIC COEF...',F10.4
1,' LAMBDA...',F10.4,' NATURAL MORT...',F10.4,' TO...',F10.4
2,/1X,' TRHOP...',F10.4,' TRHO...',F10.4//)
0173 210 FORMAT('1','BOATS',1X,'FISHMCRTCUEF',7X,'TOTAL YIELD',8X)
```

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```
1,'FIXED COST',9X,'VARIABLE COST',7X,'TOTAL COST',8X,'BIOMASS'  
2/35(I4,E16.8,5E20.8//)  
0174 220 FORMAT('1','BOATS',4X,' IMPORTS ',7X,'DY(I)-DY(I-1)',7X,'PRODUC  
1T WEIGHT',6X,'MARGINAL COST',6X,'RENT/VESSEL',8X,'PRICE-MARGINAL  
2CUST'/34(I4,6E20.8//)  
0175 230 FURMAT('1',' BOATS',4X,'DOMESTIC WEIGHT',6X,'AVERAGE COST',6X,'DOM  
TESTIC #',10X,'EX-VESSEL PRICE',5X,'TOTAL RENT ',8X,'MEAN WEIGHT/FI  
2SH',/35(I4,6E20.8//)  
0176 235 $FORMAT('1',56X,'THIS IS RUN #',I3,' OF ',I3,' RUNS')//  
0177 240 FURMAT(1X,'% TIME FLounder FISHED...',F10.4,4X,'FOREIGN/DOMESTIC CA  
1TCH..',E10.4,1X,'RECRUITS..',E10.4,/,% FOREIGN CATCH IMPURTED...  
2',F10.4,10X,'LMAX(1)...',F10.0)  
0178 250 FURMAT(/1X,'D(J)...DAYS FISHED PER VESSEL PER YEAR;BY  
1VESSEL CLASS'/10X,6F10.4)  
0179 260 FURMAT(/1X,'B(J)...DISTRIBUTION OF VESSELS BY VESSEL CLASS'  
1/10X,6F10.4)  
0180 280 FURMAT(/1X,'C(J)...VARIABLE COSTS PER VESSEL PER DAYFISHED,  
1BY VESSEL CLASS'/10X,6F10.4)  
0181 290 FURMAT(/1X,'K(J)...OPPORTUNITY COSTS PER VESSEL PER YEAR;  
1BY VESSEL CLASS'/10X,6F10.4)  
0182 310 FURMAT(/1X,'FP(J)...RELATIVE FISHING POWER BY VESSEL CLASS....'  
1/10X,6F10.5//)  
0183 320 FURMAT(4X,'DEMAND INTERCEPT...',E12.5,4X,'POPULATION OF THE NOR  
1THEAST..',E12.5,5X,'PROCESSING YIELD COEFFICIENT...',F10.5//  
28X,'PRICE FLEXIBILITY COEFFICIENT...',F10.5//)  
0184 400 FURMAT(8E10.4/5E10.4)  
0185 900 CONTINUE  
0186 CALL MINMAX(PRNREV,I-1,2,L4,L1)  
0187 CALL MINMAX(SNREV,I-1,1,L2,LOC2)  
0188 CALL MINMAX(YD,I-1,3,LOC1,L3)  
0189 DO 950 M=1,4  
0190 IF(M.NE.1)GO TO 910  
0191 L=L1  
0192 WRITE(OUT,905)NO  
0193 905 FURMAT('1',50X,'POSITION OF MAXIMUM PROFITS :NO=',F10.0//)  
0194 GO TO 940  
0195 910 CONTINUE  
0196 IF(M.NE.2)GO TO 920  
0197 L=L2  
0198 WRITE(OUT,915)  
0199 915 FURMAT('1',50X,'PARETO EFFICIENT POSITION:NO=',F10.0//)  
0200 GO TO 940  
0201 920 CONTINUE  
0202 IF(M.NE.3)GO TO 930  
0203 WRITE(OUT,925)  
0204 925 FURMAT('1',50X,'POSITION OF MAXIMUM SUSTAINABLE YIELD:NO=',F10.0//  
*)  
0205 L=L3
```

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```
0206      GO TO 940
0207      930  CONTINUE
0208      IF(M.NE.4)GO TO 950
0209      WRITE(OUT,935)
0210      935  FORMAT('1',50X,'POSITION OF ZERO PROFITS: NO= ',F10.0//)
0211      L=L4
0212      GO TO 940
0213      940  WRITE(OUT,945) NI(L),FM(L),YT(L),FC(L),YC(L),CT(L),WB(L),NI(L),
*YU(L),AC(L),YDN(L),VL(P),PRNREV(L),WGT(L),NI(L),YMP(L),DELYD(L),
*,YPRUD(L),MC(L),PNREVV(L),SNREV(L),NI(L),(AL(L,J),J=1,6)
0214      945  FORMAT(' BOATS',1X,'FISHMORTCOEF ',7X,'TOTAL YIELD',8X,'FIXED COST'
*,9X,'VARIABLE CUST',7X,'TOTAL COST',8X,'BIOMASS'//14,E16.8,5E20.8/
*/' BOATS',4X,'DOMESTIC WEIGHT',6X,'AVERAGE COST',6X,'DOMESTIC #',1
*0X,'EX-VESSEL PRICE',5X,'TOTAL PROFIT',8X,'MEAN WEIGHT/FISH'//
*14,6E20.8//' BOATS',4X,'IMPORTS',6X,'YIELD INCREMENT',6X,'PRODUCT
* WEIGHT',6X,'MARGINAL COST',6X,'PROFIT/BOAT',8X,'PRICE-MARGINAL
* CUST'//14,6E20.8//' BOATS',40X,'ACTUAL CATCH PER VESSEL; BY VESSEL
* CLASS'//14,6E20.8)
0215      WRITE(OUT,99)(ALABEL(I),I=1,40)
0216      950  CONTINUE
0217      955  CONTINUE
0218      STOP
0219      DEBUG SUBCHK
0220      END
```

THIS IS RUN # 1 OF 1 RUNS

% TIDE FLUNDER FISHED.. 0.6000 FOREIGN/DOMESTIC CATCH..0.8000E 00 RECRUITS..0.1230E 09  
% FOREIGN CATCH IMPORTED... 0.5000 LMAX(1)... 3600000.

D(J)...DAYS FISHED PER VESSEL PER YEAR;BY VESSEL CLASS  
135.0000 135.0000 140.0000 150.0000 165.0000 173.0000

B(J)...DISTRIBUTION OF VESSELS BY VESSEL CLASS  
0.3400 0.2800 0.2400 0.1000 0.0300 0.0100

C(J)...VARIABLE COSTS PER VESSEL PER DAYFISHED, BY VESSEL CLASS  
450.0000 386.0000 766.0000 860.0000 1020.0000 1110.0000

K(J)...OPPORTUNITY COSTS PER VESSEL PER YEAR; BY VESSEL CLASS  
10336.000019788.000022000.00002770.000038000.000048000.0000

F(J)...RELATIVE FISHING POWER BY VESSEL CLASS...

1.00000 1.20000 1.38000 1.91000 1.93000 1.98000

WGT. AT INF... 2.7400 CATABOLIC COEF... 0.3350 LAMBDA... 9.0000 NATURAL MORT... 0.2000 TO... -0.2600  
TRHOP... 2.7500 TRHO... 2.0000

DEMAND INTERCEPT... 0.33580E 00 POPULATION OF THE NOR THEAST.. 0.48267E 08 PROCESSING YIELD COEFFICIENT.. 0.47259

PRICE FLEXIBILITY COEFFICIENT... -0.63461

THIS IS MODEL 1; THE EASE MODEL

4/4

8/4  
14/4

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```
0001 FUNCTION FUNC(FM)
0002 DIMENSION OMEGA(4),QEXP(4),G(4)
0003 DATA OMEGA/1.,-3.,3.,-1./
0004 COMMON WINF,ZK,LAMDA,NAMOR,TO,TRO,TRHOP,R
0005 REAL NAMOR,LAMDA,MULT
0006 DO 30 K=1,4
0007 ZN=FLOAT(K)-1.0
0008 QEXP(K)=NAMOR+ZN*ZK
0009 30 G(K)=OMEGA(K)/EXP(ZN*ZK*(TRHOP-TO))
0010 MULT=FM*R*WINF*(EXP(-(NAMOR*(TRHOP-TRO))))
0011 FIRST=0.0
0012 DO 35 L=1,4
0013 QEXX=FM+QEXP(L)
0014 QEXXL=LAMDA*QEXX
0015 A=EXP(-QEXXL)
0016 35 FIRST=FIRST+G(L)*(1.0-A)/QEXX
0017 FUNC=MULT*FIRST
0018 RETURN
0019 DEBUG_SUBCHK
0020 END
```

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```
0001      SUBROUTINE MINMAX(X,M,N,LOC1,LOC2)
0002      DIMENSION X(M)
0003      REAL MAX
0004      MM=M-1
0005      GU TO (1,1,2),N
0006      1  MAX=ABS(X(1))
0007      LOC1=1
0008      DO 3 I=1,MM
0009      IF(MAX.LT.ABS(X(I+1)))GO TO 3
0010      LOC1=I+1
0011      MAX=ABS(X(I+1))
0012      3  CONTINUE
0013      IF(N.EQ.1)RETURN
0014      2  MAX=X(1)
0015      LOC2=1
0016      DO 4 I=1,MM
0017      IF(MAX.GT.X(I+1))GO TO 4
0018      LOC2=I+1
0019      MAX=X(I+1)
0020      4  CONTINUE
0021      RETURN
0022      END
```

BOATS	FISHMCRTCOEF	TOTAL	YIELD	FIXED COST	VARIABLE COST	TOTAL COST	BIMASS
1	0.6823141E-02	0.49361890E	07	0.11234914E 05	0.55315496E 05	0.66550375E 05	0.72591693E 09
2	0.13646293E-01	0.96098240E	07	0.22469824E 05	0.11063094E 06	0.13310075E 06	0.70902246E 09
3	0.20469431E-01	0.14035144E	08	0.33704730E 05	0.16594638E 06	0.19965106E 06	0.69270520E 09
4	0.27292576E-01	0.18225616E	08	0.44939652E 05	0.22126194E 06	0.26620156E 06	0.67694131E 09
5	0.34115724E-01	0.22194016E	08	0.56174559E 05	0.27657738E 06	0.33275188E 06	0.66171034E 09
6	0.40938873E-01	0.25952272E	08	0.67409438E 05	0.33189294E 06	0.39930238E 06	0.64699187E 09
7	0.47762018E-01	0.29511792E	08	0.78644375E 05	0.38720838E 06	0.46585275E 06	0.63276544E 09
8	0.54585166E-01	0.32883248E	08	0.89879250E 05	0.44252388E 06	0.53240313E 06	0.61901184E 09
9	0.61408319E-01	0.36076768E	08	0.10111419E 06	0.49783944E 06	0.59895363E 06	0.60571290E 09
10	0.68231404E-01	0.391019C4E	08	0.11234913E 06	0.55315488E 06	0.66550400E 06	0.59285094E 09
11	0.75054526E-01	0.41967777E	08	0.12358400E 06	0.60847044E 06	0.73205444E 06	0.58040986E 09
12	0.81877649E-01	0.44682816E	08	0.13481894E 06	0.66379588E 06	0.79860481E 06	0.56837274E 09
13	0.88700831E-01	0.47255136E	08	0.14605388E 06	0.71910138E 06	0.86515525E 06	0.55672397E 09
14	0.95523953E-01	0.4969240UE	08	0.15728875E 06	0.77441688E 06	0.93170563E 06	0.54545024E 09
15	0.10234714E 00	0.52001712E	08	0.16852362E 06	0.82973238E 06	0.99825606E 06	0.53453594E 09
16	0.10917026E 00	0.54189936E	08	0.17975863E 06	0.88504794E 06	1.06480606E 07	0.52396774E 09
17	0.11599338E 00	0.56263456E	08	0.19099350E 06	0.94036338E 06	1.11313560E 07	0.51373286E 09
18	0.12281650E 00	0.50228464E	08	0.20222844E 06	0.99567888E 06	1.1979070E 07	0.50381926E 09
19	0.12963957E 00	0.60090592E	08	0.21346331E 06	0.10509940E 07	1.2644570E 07	0.49421466E 09
20	0.13646275E 00	0.51855320E	08	0.22469825E 06	0.11063090E 07	1.3310070E 07	0.48490711E 09
21	0.14328587E 00	0.63527856E	08	0.23593319E 06	0.11616250E 07	1.3975580E 07	0.47588659E 09
22	0.15010905E 00	0.65112896E	08	0.24716806E 06	0.12169400E 07	1.4641080E 07	0.46714112E 09
23	0.15693218E 00	0.66615184E	08	0.25840300E 06	0.12722560E 07	1.5306590E 07	0.45866214E 09
24	0.16375542E 00	0.68038912E	08	0.26963794E 06	0.13275710E 07	1.5972080E 07	0.45043840E 09
25	0.17057848E 00	0.69388368E	08	0.28087281E 06	0.13828870E 07	1.6637590E 07	0.44246246E 09
26	0.17740172E 00	0.70461264E	08	0.29210775E 06	0.14382020E 07	1.7303090E 07	0.43472358E 09
27	0.18422478E 00	0.7187952CE	08	0.30334263E 06	0.14935180E 07	1.7968600E 07	0.42721536E 09
28	0.19104803E 00	0.73028240E	08	0.31457738E 06	0.15488320E 07	1.8634090E 07	0.41992653E 09
29	0.19787115E 00	0.74117072E	08	0.32581244E 06	0.16041480E 07	1.9299600E 07	0.41285222E 09
30	0.20469433E 00	0.75149024E	08	0.33704713E 06	0.16594630E 07	1.9965100E 07	0.40598323E 09
31	0.21151745E 00	0.76126840E	08	0.34828219E 06	0.17147790E 07	2.0630610E 07	0.39931213E 09
32	0.21834069E 00	0.77053664E	08	0.35951719E 06	0.17700950E 07	2.1296120E 07	0.39283328E 09
33	0.22516370E 00	0.77931808E	08	0.37075194E 06	0.18254100E 07	2.1961610E 07	0.38653850E 09
34	0.23198694E 00	0.78763904E	08	0.38198700E 06	0.18807260E 07	2.2627130E 07	0.38042189E 09
35	0.23880994E 00	0.79552288E	08	0.39322175E 06	0.19360410E 07	2.3292620E 07	0.37447731E 09
36	0.24563318E 00	0.80299320E	08	0.40445675E 06	0.19913570E 07	2.3958130E 07	0.36869914E 09
37	0.25245625E 00	0.81007056E	08	0.41569181E 06	0.20466730E 07	2.4623640E 07	0.36308147E 09
38	0.25927937E 00	0.81677344E	08	0.42692656E 06	0.21019870E 07	2.5289130E 07	0.35761018E 09
39	0.26610255E 00	0.82312304E	08	0.43816156E 06	0.21573030E 07	2.5954640E 07	0.35230464E 09
40	0.27292562E 00	0.82913488E	08	0.44939631E 06	0.22126180E 07	2.6620140E 07	0.24713523E 09
41	0.27974886E 00	0.83482848E	08	0.46063131E 06	0.226797340E 07	2.7285650E 07	0.34210560E 09
42	0.28657198E 00	0.84072032E	08	0.47186638E 06	0.23232500E 07	2.7951160E 07	0.33721165E 09
43	0.29339516E 00	0.84532224E	08	0.48310113E 06	0.23785650E 07	2.8616660E 07	0.33244723E 09
44	0.30021828E 00	0.85015376E	08	0.49433613E 06	0.24338810E 07	2.9282170E 07	0.32780979E 09
45	0.30704147E 00	0.85472256E	08	0.50557088E 06	0.24891960E 07	2.9947660E 07	0.32329318E 09
46	0.31386459E 00	0.85904704E	08	0.51680594E 06	0.25445120E 07	3.0613170E 07	0.31889536E 09
47	0.32068783E 00	0.86313616E	08	0.52804094E 06	0.25998280E 07	3.1278680E 07	0.31461054E 09
48	0.32751089E 00	0.86700288E	08	0.53927569E 06	0.26551420E 07	3.1944170E 07	0.31043712E 09
49	0.33433402E 00	0.87065936E	08	0.55051075E 06	0.27104580E 07	3.2609680E 07	0.30637005E 09
50	0.34115708E 00	0.87411376E	08	0.56174544E 06	0.27657730E 07	3.3275180E 07	0.30240614E 09
51	0.34798038E 00	0.87737776E	08	0.57298050E 06	0.28210890E 07	3.3940690E 07	0.29854208E 09
52	0.35480344E 00	0.88046064E	08	0.58421550E 06	0.28764050E 07	3.4606200E 07	0.29477530E 09
53	0.36162663E 00	0.88337072E	08	0.59545025E 06	0.29317200E 07	3.5271700E 07	0.29110170E 09
54	0.36844975E 00	0.88611648E	08	0.60668531E 06	0.29870360E 07	3.5937210E 07	0.28751898E 09
55	0.37527293E 00	0.88070576E	08	0.61792006E 06	0.30423510E 07	3.6602710E 07	0.28402381E 09
56	0.38209611E 00	0.891148C0E	08	0.62915506E 06	0.30976670E 07	3.7268220E 07	0.28061414E 09
57	0.38891923E 00	0.89344928E	08	0.64039013E 06	0.31529830E 07	3.7933730E 07	0.27728691E 09
58	0.39574230E 00	0.89561696E	08	0.65162488E 06	0.32082970E 07	3.8599210E 07	0.27403981E 09

59	0.40256548E 00	0.897656C0E 08	0.66285988E 06	0.32636130E 07	0.39264720E 07	0.27086976E 09
60	0.40938860E 00	0.89957376E 08	0.67409463E 06	0.33189280E 07	0.39930220E 07	0.26777501E 09
61	0.41621166E 00	0.90137632E 08	0.68532963E 06	0.33742440E 07	0.40595730E 07	0.26475299E 09
62	0.42303491E 00	0.90307056E 08	0.69656469E 06	0.34295600E 07	0.41261240E 07	0.26180189E 09
63	0.42985803E 00	0.90465920E 08	0.70779944E 06	0.34848750E 07	0.41926740E 07	0.25891098E 09
64	0.43668121E 00	0.90614688E 08	0.71903444E 06	0.35401910E 07	0.42592250E 07	0.25610203E 09
65	0.44350439E 00	0.90754112E 08	0.73026919E 06	0.35955060E 07	0.43257750E 07	0.25334982E 09
66	0.45032752E 00	0.90884656E 08	0.74150425E 06	0.36509220E 07	0.43923260E 07	0.25066051E 09
67	0.45715052E 00	0.91006368E 08	0.75273925E 06	0.37061380E 07	0.44588770E 07	0.24803125E 09
68	0.46397382E 00	0.91120176E 08	0.76397400E 06	0.37614520E 07	0.45254260E 07	0.24546138E 09
69	0.47079682E 00	0.91226144E 08	0.77520906E 06	0.38167680E 07	0.45919770E 07	0.24294866E 09
70	0.47762007E 00	0.91324560E 08	0.78644375E 06	0.38720830E 07	0.46585260E 07	0.24049093E 09
71	C.48444319E 00	0.914160CCE 08	0.79767881E 06	0.39273990E 07	0.47250770E 07	C.23808736E 09
72	0.49126631E 00	0.91500896E 08	0.80891381E 06	0.39827150E 07	0.47916280E 07	0.23573658E 09
73	C.49808949E 00	0.91517924E 08	0.82014856E 06	0.40380300E 07	0.48581780E 07	0.23343626E 09
74	0.50491267E 00	0.91651488E 08	0.83138363E 06	0.40933460E 07	0.49247290E 07	0.23118528E 09
75	0.51173568E 00	0.91717952E 08	0.84261838E 06	0.41486610E 07	0.49912790E 07	0.22898243E 09
76	0.51855892E 00	0.91778976E 08	0.85385338E 06	0.42039770E 07	0.50578300E 07	0.22682642E 09
77	C.52538222E 00	0.91834928E 08	0.865C9844E 06	0.42592930E 07	0.51243810E 07	0.22471621E 09
78	0.53220516E 00	0.91885480E 08	0.87632319E 06	0.43146070E 07	0.51909300E 07	0.22264928E 09
79	0.53902847E 00	0.91931424E 08	0.88795819E 06	0.43699230E 07	0.52574810E 07	0.22062552E 09
80	0.545851519E 00	0.919730C0E 08	0.89879294E 06	0.44252380E 07	0.53240300E 07	0.21864403E 09
81	0.55267471E 00	0.92010000E 08	0.91002794E 06	0.44805540E 07	0.53905810E 07	0.2167C250E 09
82	0.55949703E 00	0.92042960E 08	0.92126300E 06	0.45358700E 07	0.54571330E 07	0.21480070E 09
83	0.56632096E 00	0.92071856E 08	0.93249775E 06	0.45911850E 07	0.55236820E 07	0.21293698E 09
84	0.57314414E 00	0.92097216E 08	0.94313275E 06	0.46465010E 07	0.55902330E 07	0.21111117E 09
85	0.57946732E 00	0.92118856E 08	0.95496750E 06	0.47018160E 07	0.56567830E 07	0.20932147E 09
86	0.58679032E 00	0.92137280E 08	0.96620256E 06	0.47571320E 07	0.57233340E 07	0.20756752E 09
87	0.59361356E 00	0.921524E0E 08	0.97743731E 06	0.48124460E 07	0.57898830E 07	0.20584811E 09
88	0.60043669E 00	0.92164240E 08	0.98867231E 06	0.48677620E 07	0.58564340E 07	0.20416154E 09
89	0.60725993E 00	0.92173344E 08	0.99900738E 06	0.49230780E 07	0.59229850E 07	0.20250832E 09
90	0.61408305E 00	0.92179696E 08	0.10111421E 07	0.49783930E 07	0.59895350E 07	0.20088712E 09
91	0.62090617E 00	0.92183200E 08	0.10223771E 07	0.50337090E 07	0.60560860E 07	0.19929656E 09
92	0.62772930E 00	0.92184320E 08	0.10336119E 07	0.50890240E 07	0.61226350E 07	0.19773662E 09
93	0.63455260E 00	0.92182816E 08	0.10448469E 07	0.51443400E 07	0.61891860E 07	0.19620571E 09
94	0.64137560E 00	0.92179120E 08	0.10560810E 07	0.51996560E 07	0.62557370E 07	0.19470386E 09
95	0.64819884E 00	0.92173344E 08	0.10673160E 07	0.52549710E 07	0.63222870E 07	0.1932021E 09
96	0.65502197E 00	0.92165392E 08	0.10785510E 07	0.53102870E 07	0.63888380F 07	0.19178374E 09
97	0.66184491E 00	0.92155344E 08	0.10897860E 07	0.53656010E 07	0.64553870E 07	0.19036373E 09
98	0.66866821E 00	0.92143408E 08	0.11010210E 07	0.54209170E 07	0.65219380E 07	0.18996966E 09
99	0.67549127E 00	0.92129856E 08	0.11122560E 07	0.54762330E 07	0.65884890E 07	0.18760132E 09
100	C.68231440E 00	0.92114416E 08	0.11234910E 07	0.55315489E 07	0.66550390E 07	0.18625749E 09
101	0.68913764E 00	0.92097424E 08	0.11347260E 07	0.55868640E 07	0.67215900E 07	0.18493784E 09
102	0.69596070E 00	0.92078736E 08	0.11459610E 07	0.56421790E 07	0.67881400E 07	0.18364152E 09
103	0.70278388E 00	0.92058672E 08	0.11571960E 07	0.56974950E 07	0.68546910E 07	0.18236835E 09
104	0.70960718E 00	0.92037392E 08	0.11684310E 07	0.57528110E 07	0.69212420E 07	0.18111179E 09
105	0.71643025E 00	0.92014368E 08	0.11796650E 07	0.58081260E 07	0.69877910E 07	0.17988875E 09
106	0.72325345E 00	0.91990336E 08	0.11909000E 07	0.58634420E 07	0.70543420E 07	0.17860141E 09
107	0.73007661E 00	0.91964992E 08	0.12021350E 07	0.59187560E 07	0.71208910E 07	0.17749475E 09
108	0.73689967E 00	0.91938720E 08	0.12133700E 07	0.59740720L 07	0.71874420E 07	0.17632894E 09
109	0.74372280E 00	0.91911120E 08	0.12246050E 07	0.60293880E 07	0.72539930E 07	0.17518259E 09
110	0.75054610E 00	0.91882336E 08	0.12358400E 07	0.60847030E 07	0.73205430E 07	0.17405539E 09
111	0.75736910E 00	0.91852832E 08	0.12470750E 07	0.61400190E 07	0.73870940E 07	0.17294776E 09
112	0.76419228E 00	0.91822320E 08	0.12583100E 07	0.61953340E 07	0.74536440E 07	0.17185854E 09
113	0.77101535E 00	0.91790768E 08	0.12695450E 07	0.62506500E 07	0.75201950E 07	0.17078723E 09
114	0.77778385E 00	0.91758816E 08	0.12007800E 07	0.63059660E 07	0.75067460E 07	0.16973448E 09
115	0.78466171E 00	0.91725584E 08	0.12920150E 07	0.63612810E 07	0.76532960E 07	0.16869818E 09
116	0.79148483E 00	0.91691776E 08	0.13032500E 07	0.64165970L 07	0.77198470E 07	0.16767918E 09

117	0.79830801E 00	0.91657184E 08	0.13144840E 07	0.64719110E 07	0.77863950E 07	0.16667666E 09
118	0.80513126E 00	0.91622144E 08	0.13257190E 07	0.65272270E 07	0.78529460E 07	0.16569075E 09
119	0.81195432E 00	0.91586160E 08	0.13369540E 07	0.65825430E 07	0.79194970E 07	0.16472019E 09
120	0.81877750E 00	0.91549792E 08	0.13481890E 07	0.66378580E 07	0.79860470E 07	0.16376555E 09
121	0.82560068E 00	0.91512800E 08	0.13594240E 07	0.66931740E 07	0.80525980E 07	0.16282600E 09
122	0.83242375E 00	0.91475280E 08	0.13706590E 07	0.67484890E 07	0.81191480E 07	0.16190133E 09

THIS IS MODEL 1; THE BASE MODEL

BOATS	FISHMCRTCOEF	TOTAL YIELD	FIXED COST	VARIABLE COST	TOTAL COST	BIOMASS
1	0.68231411E-02	0.49361890E 07	0.11234914E 05	0.55315496E 05	0.66550375E 05	0.72591693E 09
2	0.13646293E-01	0.96098240E 07	0.22469824E 05	0.11063094E 06	0.13310075E 06	0.70902246E 09
3	0.20469431E-01	0.14035144E 08	0.33704730E 05	0.16594638E 06	0.19965106E 06	0.69270528E 09
4	0.27292576E-01	0.18225616E 08	0.44939652E 05	0.22126194E 06	0.26620156E 06	0.67694131E 09
5	0.34115724E-01	0.22194016E 08	0.56174559E 05	0.27657738E 06	0.33275188E 06	0.66171034E 09
6	0.40938737E-01	0.25952272E 08	0.67409438E 05	0.33189294E 06	0.39930238E 06	0.64699187E 09
7	0.47762018E-01	0.29511792E 08	0.78644375E 05	0.38720830E 06	0.46585275E 06	0.63276544E 09
8	0.54585166E-01	0.32883248E 08	0.89879250E 05	0.44252388E 06	0.53240313E 06	0.61901184E 09
9	0.61408319E-01	0.36076768E 08	0.10111419E 06	0.49783944E 06	0.59895363E 06	0.60571290E 09
10	0.68231404E-01	0.39101904E 08	0.11234913E 06	0.55315488E 06	0.66550400E 06	0.59285094E 09
11	0.75054526E-01	0.41967776E 08	0.12358400E 06	0.60847044E 06	0.73205444E 06	0.58040986E 09
12	0.81877649E-01	0.44682816E 08	0.13481894E 06	0.66378588E 06	0.79860481E 06	0.56837274E 09
13	0.88700831E-01	0.47255136E 08	0.14605388E 06	0.71910138E 06	0.86515525E 06	0.55672397E 09
14	0.95523953E-01	0.49692400E 08	0.15728875E 06	0.77441688E 06	0.93170563E 06	0.54545024E 09
15	0.10234714E 00	0.52001712E 08	0.16852369E 06	0.82973238E 06	0.99825606E 06	0.53453594E 09
16	0.10917026E 00	0.54189936E 08	0.17975863E 06	0.88504794E 06	0.10648060E 07	0.52396774E 09
17	0.11599338E 00	0.56263456E 08	0.19099350E 06	0.94036338E 06	0.11313560E 07	0.51373286E 09
18	0.12281650E 00	0.58228464E 08	0.20222844E 06	0.99567888E 06	0.11979070E 07	0.50381926E 09
19	0.12963957E 00	0.60090592E 08	0.21346331E 06	0.10509940E 07	0.12644570E 07	0.49421466E 09
20	0.13646275E 00	0.61855328E 08	0.22469825E 06	0.11063090E 07	0.13310070E 07	0.48490701E 09
21	0.14328587E 00	0.63527856E 08	0.23593319E 06	0.11616250E 07	0.13975530E 07	0.47588659E 09
22	0.15010905E 00	0.65112896E 08	0.24716806E 06	0.12169400E 07	0.14641080E 07	0.46714112E 09
23	0.15693218E 00	0.66615184E 08	0.25840300E 06	0.12722560E 07	0.15306590E 07	0.45866214E 09
24	0.16375542E 00	0.68038912E 08	0.26963794E 06	0.13275710E 07	0.15972080E 07	0.45043840E 09
25	0.17057848E 00	0.69388368E 08	0.28087281E 06	0.13828870E 07	0.16637590E 07	0.44246246E 09
26	0.17740172E 00	0.70667264E 08	0.29210775E 06	0.14382020E 07	0.17303090E 07	0.43472358E 09
27	0.18422478E 00	0.71879520E 08	0.30334263E 06	0.14935180E 07	0.17968600E 07	0.42721536E 09
28	0.19104803E 00	0.73028240E 08	0.31457738E 06	0.15488320E 07	0.18634090E 07	0.41992653E 09
29	0.19787115E 00	0.74117072E 08	0.32581244E 06	0.16041480E 07	0.19299600E 07	0.41285222E 09
30	0.20469433E 00	0.75149024E 08	0.33704713E 06	0.16594630E 07	0.19965100E 07	0.40598323E 09
31	0.21151745E 00	0.76126848E 08	0.34828219E 06	0.17147790E 07	0.20630610E 07	0.39931213E 09
32	0.21834069E 00	0.77053664E 08	0.35951719E 06	0.17700950E 07	0.21296120E 07	0.39283328E 09
33	0.22516370E 00	0.77931808E 08	0.37075194E 06	0.18254100E 07	0.21961610E 07	0.38653850E 09
34	0.23198694E 00	0.78763904E 08	0.38198700E 06	0.18807260E 07	0.22627130E 07	0.38042189E 09
35	0.23880994E 00	0.79552288E 08	0.39322175E 06	0.19360410E 07	0.23292620E 07	0.37447731E 09
36	0.24563318E 00	0.80299328E 08	0.40445675E 06	0.19913570E 07	0.23958130E 07	0.36869914E 09
37	0.25245625E 00	0.81007056E 08	0.41569181E 06	0.20466730E 07	0.24623640E 07	0.36308147E 09
38	0.25927937E 00	0.81677344E 08	0.42692656E 06	0.21019870E 07	0.25289130E 07	0.35761818E 09
39	0.26610255E 00	0.82312304E 08	0.43816156E 06	0.21513030E 07	0.25994640E 07	0.35230464E 09
40	0.27292562E 00	0.82913488E 08	0.44939631E 06	0.22126180E 07	0.26620140E 07	0.34713523E 09
41	0.27974886E 00	0.83482848E 08	0.46063131E 06	0.22679340E 07	0.27285650E 07	0.34210560E 09
42	0.28657198E 00	0.84022032E 08	0.47186638E 06	0.23232500E 07	0.27951160E 07	0.33721165E 09
43	0.29339516E 00	0.84532224E 08	0.48310113E 06	0.23785650E 07	0.28616660E 07	0.33244723E 09
44	0.30021828E 00	0.85015376E 08	0.49433613E 06	0.24338810E 07	0.29282170E 07	0.32780979E 09
45	0.30704147E 00	0.85472256E 08	0.50557088E 06	0.24891960E 07	0.29947660E 07	0.32329318E 09
46	0.31386459E 00	0.85904704E 08	0.51680594E 06	0.25445120E 07	0.30613170E 07	0.31889536E 09
47	0.32068783E 00	0.86313616E 08	0.52804094E 06	0.25998280E 07	0.31278680E 07	0.31461094E 09
48	0.32751089E 00	0.86700288E 08	0.53927569E 06	0.26551420E 07	0.31944170E 07	0.31043712E 09
49	0.33433402E 00	0.87065936E 08	0.55051075E 06	0.27104580E 07	0.32609680E 07	0.30637005E 09
50	0.34115708E 00	0.87411376E 08	0.56174544E 06	0.27657730E 07	0.33275180E 07	0.30240614E 09
51	0.34798038E 00	0.87737776E 08	0.57298050E 06	0.28210890E 07	0.33940690E 07	0.29854208E 09
52	0.35480344E 00	0.88046064E 08	0.58421550E 06	0.28764050E 07	0.34606200E 07	0.29477530E 09
53	0.36162663E 00	0.88337072E 08	0.59545025E 06	0.29317200E 07	0.35271700E 07	0.29110170E 09
54	0.36844975E 00	0.88611648E 08	0.60668531E 06	0.29870360E 07	0.35937210E 07	0.28751898E 09
55	0.37527293E 00	0.88870576E 08	0.61792006E 06	0.30423510E 07	0.36602710E 07	0.28402381E 09
56	0.38209611E 00	0.89114800E 08	0.62915506E 06	0.30976670E 07	0.37268220E 07	0.28061414E 09
57	0.38891923E 00	0.89344928E 08	0.64039013E 06	0.31529830E 07	0.37933730E 07	0.27728691E 09
58	0.39574230E 00	0.89561696E 08	0.65162488E 06	0.32082970E 07	0.38599210E 07	0.27403981E 09

59	0.40256548E 00	0.897656C0E 08	0.66285988E 06	0.32636130E 07	0.39264720E 07	0.27086976E 09
60	0.40938860E 00	0.89957376E 08	0.67409463E 06	0.33189280E 07	0.39930220E 07	0.26777501E 09
61	0.41621166E 00	0.90137632E 08	0.68532963E 06	0.33742440E 07	0.40595730E 07	0.26475299E 09
62	0.42303491E 00	0.90307056E 08	0.69656469E 06	0.34295600E 07	0.41261240E 07	0.26180189E 09
63	0.42985803E 00	0.90465920E 08	0.70779944E 06	0.34848750E 07	0.41926740E 07	0.25891898E 09
64	0.43668121E 00	0.90614688E 08	0.71903444E 06	0.35401910E 07	0.42592250E 07	0.25610203E 09
65	0.44350439E 00	0.90754112E 08	0.73026919E 06	0.35955060E 07	0.43257750E 07	0.25334982E 09
66	0.45032752E 00	0.90884656E 08	0.74150425E 06	0.36508220E 07	0.43923260E 07	0.25066051E 09
67	0.45715052E 00	0.91006368E 08	0.75273925E 06	0.37061380E 07	0.44588770E 07	0.24803125E 09
68	0.46397382E 00	0.91120176E 08	0.76397400E 06	0.37614520E 07	0.45254260E 07	0.24546138E 09
69	0.47079682E 00	0.91226144E 08	0.77520906E 06	0.38167680E 07	0.45919770E 07	0.24294866E 09
70	0.47762007E 00	0.91324560E 08	0.78644375E 06	0.38720830E 07	0.46585260E 07	0.24049093E 09
71	0.48444319E 00	0.914160CCE 08	0.79767881E 06	0.39273990E 07	0.47250770E 07	0.23808736E 09
72	0.49126631E 00	0.91500896E 08	0.80891381E 06	0.39827150E 07	0.47916280E 07	0.23573658E 09
73	0.49808949E 00	0.91579248E 08	0.82014856E 06	0.40380300E 07	0.48581780E 07	0.23343626E 09
74	0.50491267E 00	0.91651488E 08	0.83138363E 06	0.40933460E 07	0.49247290E 07	0.23118528E 09
75	0.51173568E 00	0.91717952E 08	0.84261838E 06	0.41486610E 07	0.49912790E 07	0.22898243E 09
76	0.51855892E 00	0.91778976E 08	0.85385338E 06	0.42039770E 07	0.50578300E 07	0.22682642E 09
77	0.52538222E 00	0.91834928E 08	0.865C8844E 06	0.42592930E 07	0.51243810E 07	0.22471621E 09
78	0.53220516E 00	0.91885488E 08	0.87632319E 06	0.43146070E 07	0.51909300E 07	0.22264928E 09
79	0.53902847E 00	0.91931424E 08	0.88755819E 06	0.43699230E 07	0.52574810E 07	0.22062552E 09
80	0.54585159E 00	0.919730C8E 08	0.89879294E 06	0.44252380E 07	0.53240300E 07	0.21864403E 09
81	0.55267471E 00	0.920100C0E 08	0.91002794E 06	0.44805540E 07	0.53905810E 07	0.21670250E 09
82	0.55949783E 00	0.92042960E 08	0.92126300E 06	0.45358700E 07	0.54571330E 07	0.21480070E 09
83	0.56632096E 00	0.92071856E 08	0.93249775E 06	0.45911850E 07	0.55236820E 07	0.21293698E 09
84	0.57314414E 00	0.92097216E 08	0.94373275E 06	0.46465010E 07	0.55902330E 07	0.21111117E 09
85	0.57996732E 00	0.92118896E 08	0.95496750E 06	0.47018160E 07	0.56567830E 07	0.20932147E 09
86	0.58679032E 00	0.92137280E 08	0.96620256E 06	0.47571320E 07	0.57233340E 07	0.20756752E 09
87	0.59361356E 00	0.92152480E 08	0.97743731E 06	0.48124460E 07	0.57898830E 07	0.20584811E 09
88	0.60043669E 00	0.92164240E 08	0.98867231E 06	0.48677620E 07	0.58564340E 07	0.20416154E 09
89	0.60725993E 00	0.92173344E 08	0.99990738E 06	0.49230780E 07	0.59229850E 07	0.20250832E 09
90	0.61408305E 00	0.92179696E 08	0.10111421E 07	0.49783930E 07	0.59895350E 07	0.20088712E 09
91	0.62090617E 00	0.92183200E 08	0.10223771E 07	0.50337090E 07	0.60560860E 07	0.19929656E 09
92	0.62772930E 00	0.92184320E 08	0.10336119E 07	0.50890240E 07	0.61226350E 07	0.19773662E 09
93	0.63455260E 00	0.92182816E 08	0.10448469E 07	0.51443400E 07	0.61891860E 07	0.19620571E 09
94	0.64137560E 00	0.92179120E 08	0.10560810E 07	0.51996560E 07	0.62557370E 07	0.19470386E 09
95	0.64819884E 00	0.92173344E 08	0.10673160E 07	0.52549710E 07	0.63222870E 07	0.19323021E 09
96	0.65502197E 00	0.92165392E 08	0.10785510E 07	0.53102870E 07	0.63888380E 07	0.19178374E 09
97	0.66184491E 00	0.92155344E 08	0.10897860E 07	0.53656010E 07	0.64553870E 07	0.19036373E 09
98	0.66866821E 00	0.92143408E 08	0.11010210E 07	0.54209170E 07	0.65219380E 07	0.18896966E 09
99	0.67549127E 00	0.92129856E 08	0.11122560E 07	0.54762330E 07	0.65884890E 07	0.18760139E 09
100	0.68231440E 00	0.92114416E 08	0.11234910E 07	0.55315480E 07	0.66550390E 07	0.18625749E 09
101	0.68913764E 00	0.92097424E 08	0.11347260E 07	0.55868640E 07	0.67215900E 07	0.18493784E 09
102	0.69596070E 00	0.92078736E 08	0.11459610E 07	0.56421790E 07	0.67881400E 07	0.18364152E 09
103	0.70278388E 00	0.92058672E 08	0.11571960E 07	0.56974950E 07	0.68546910E 07	0.18236835E 09
104	0.70960718E 00	0.92037392E 08	0.11684310E 07	0.57528110E 07	0.69212420E 07	0.181111798E 09
105	0.71643025E 00	0.92014368E 08	0.11796650E 07	0.58081260E 07	0.69877910E 07	0.17988875E 09
106	0.72325349E 00	0.91990336E 08	0.11909000E 07	0.58634420E 07	0.70543420E 07	0.17868141E 09
107	0.73007661E 00	0.91964992E 08	0.12021350E 07	0.59187560E 07	0.71208910E 07	0.17749475E 09
108	0.73689967E 00	0.91938720E 08	0.12133700E 07	0.59740720E 07	0.71874420E 07	0.17632894E 09
109	0.74372280E 00	0.91911120E 08	0.12246050E 07	0.60293880E 07	0.72539930E 07	0.17518259E 09
110	0.75054610E 00	0.91882336E 08	0.12358400E 07	0.60847030E 07	0.73205430E 07	0.17405539E 09
111	0.75736910E 00	0.91852832E 08	0.12470750E 07	0.61400190E 07	0.73870940E 07	0.17294776E 09
112	0.76419228E 00	0.91822320E 08	0.12583100E 07	0.61953340E 07	0.74536440E 07	0.17185854E 09
113	0.77101535E 00	0.91790768E 08	0.12649540E 07	0.62506500E 07	0.75201950E 07	0.17078723E 09
114	0.77783859E 00	0.91758816E 08	0.12807800E 07	0.63059660E 07	0.75867460E 07	0.16973448E 09
115	0.78466171E 00	0.91725584E 08	0.12920150E 07	0.63612810E 07	0.76532960E 07	0.16869818E 09
116	0.79148483E 00	0.91691776E 08	0.13032500E 07	0.64165970E 07	0.77198470E 07	0.16767918E 09

117	0.79830801E 00	0.91657184E 08	0.13144840E 07	0.64719110E 07	0.77863950E 07	0.16667666E 09
118	0.80513126E 00	0.9162144E 08	0.13257190E 07	0.65272270E 07	0.78529460E 07	0.16569075E 09
119	0.81195432E 00	0.9158616CE 08	0.13369540E 07	0.65825430E 07	0.79194970E 07	0.16472019E 09
120	0.81877750E 00	0.91549792E 08	0.13481890E 07	0.66378580E 07	0.79860470E 07	0.16376555E 09
121	0.82560068E 00	0.915128COE 08	0.13594240E 07	0.66931740E 07	0.80525980E 07	0.162826COE 09
122	0.83242375E 00	0.91475280E 08	0.13706590E 07	0.67484890E 07	0.81191480E 07	0.16190133E 09

THIS IS MODEL 1; THE BASE MODEL

BOATS	DOMESTIC WEIGHT	AVERAGE COST	DOMESTIC #	EX-VESSEL PRICE	TOTAL RENT	MEAN WEIGHT/FISH
1	0.27423280E 07	0.24267837E-01	0.16386910E 07	0.13284702E 01	0.35765490E 07	0.16734858E 01
2	0.53387930E 07	0.24930868E-01	0.32074990E 07	0.86772376E 00	0.44994960E 07	0.16644716E 01
3	0.77973050E 07	0.25605135E-01	0.47098940E 07	0.68018144E 00	0.51039310E 07	0.16555157E 01
4	0.10125346E 08	0.26259610E-01	0.61491800E 07	0.57445419E 00	0.55503450E 07	0.16466169E 01
5	0.12330014E 08	0.26987143E-01	0.75284610E 07	0.50535953E 00	0.58983370E 07	0.16377859E 01
6	0.14417935E 08	0.27694836E-01	0.88506930E 07	0.45616752E 00	0.61776900E 07	0.16290169E 01
7	0.16395446E 08	0.28413545E-01	0.10118662E 08	0.41912258E 00	0.64058480E 07	0.16203175E 01
8	0.18268464E 08	0.29143289E-01	0.11335027E 08	0.39009440E 00	0.65740210E 07	0.16116829E 01
9	0.20042656E 08	0.29883943E-01	0.12502298E 08	0.36666405E 00	0.67499670E 07	0.16031170E 01
10	0.21723280E 08	0.30635521E-01	0.13622823E 08	0.34731412E 00	0.68792970E 07	0.15946245E 01
11	0.23315440E 08	0.31397838E-01	0.14698877E 08	0.33103800E 00	0.69862410E 07	0.15862055E 01
12	0.24823792E 08	0.32170940E-01	0.15732593E 08	0.31714129E 00	0.70740440E 07	0.15778570E 01
13	0.26252864E 08	0.32954697E-01	0.16725980E 08	0.30512762E 00	0.71453170E 07	0.15695858E 01
14	0.27606896E 08	0.33749014E-01	0.17680944E 08	0.29463238E 00	0.72021780E 07	0.15613909E 01
15	0.28889840E 08	0.34553878E-01	0.18599344E 08	0.28538018E 00	0.72463310E 07	0.15532713E 01
16	0.30105520E 08	0.35369128E-01	0.19482848E 08	0.27716029E 00	0.72792470E 07	0.15452309E 01
17	0.31257480E 08	0.36194716E-01	0.20333120E 08	0.26980680E 00	0.73021260E 07	0.15372686E 01
18	0.32349152E 08	0.37030552E-01	0.21151696E 08	0.26318955E 00	0.73160510E 07	0.15293875E 01
19	0.33383664E 08	0.37876517E-01	0.21940048E 08	0.25720191E 00	0.73218840E 07	0.15215845E 01
20	0.34364080E 08	0.38732506E-01	0.22699584E 08	0.25175804E 00	0.73204250E 07	0.15138636E 01
21	0.35293264E 08	0.39598431E-01	0.23431600E 08	0.24678713E 00	0.73123640E 07	0.15062246E 01
22	0.36173840E 08	0.40474221E-01	0.24137376E 08	0.24223000E 00	0.72982800E 07	0.14986649E 01
23	0.37008448E 08	0.41359715E-01	0.24818080E 08	0.23803741E 00	0.72787350E 07	0.14911890E 01
24	0.37799408E 08	0.42254839E-01	0.25474864E 08	0.23416734E 00	0.72541770E 07	0.14837923E 01
25	0.38549140E 08	0.43159470E-01	0.26108752E 08	0.23058438E 00	0.72250610E 07	0.14764814E 01
26	0.39259600E 08	0.44073526E-01	0.26720832E 08	0.22725779E 00	0.71917380E 07	0.14692497E 01
27	0.39933072E 08	0.44996787E-01	0.27312016E 08	0.22416162E 00	0.71546010E 07	0.14621058E 01
28	0.40571248E 08	0.45929298E-01	0.27883264E 08	0.22127259E 00	0.71138950E 07	0.14550390E 01
29	0.41176160E 08	0.468708C9E-01	0.28435472E 08	0.21857041E 00	0.70699290E 07	0.14480553E 01
30	0.41749472E 08	0.478212C1E-01	0.28969392E 08	0.21603882E 00	0.70229950E 07	0.14411573E 01
31	0.42292704E 08	0.48780538E-01	0.29485856E 08	0.21366143E 00	0.69732570E 07	0.14343376E 01
32	0.42807600E 08	0.49748454E-01	0.29985664E 08	0.21142513E 00	0.69209890E 07	0.14276018E 01
33	0.43295456E 08	0.50724976E-01	0.30469392E 08	0.20931816E 00	0.68663630E 07	0.14209490E 01
34	0.43757728E 08	0.51710017E-01	0.30937888E 08	0.20732886E 00	0.68095240E 07	0.14143734E 01
35	0.44195728E 08	0.52703328E-01	0.31391648E 08	0.20544875E 00	0.67506920E 07	0.14078808E 01
36	0.44610752E 08	0.53704832E-01	0.31831408E 08	0.20366865E 00	0.66899970E 07	0.14014692E 01
37	0.45003936E 08	0.54714411E-01	0.32257664E 08	0.20198101E 00	0.66275750E 07	0.13951387E 01
38	0.45376320E 08	0.55731957E-01	0.32671008E 08	0.20037895E 00	0.65635450E 07	0.13888055E 01
39	0.45729072E 08	0.56757417E-01	0.33071984E 08	0.19885600E 00	0.64980340E 07	0.13827124E 01
40	0.46063056E 08	0.5779C648E-01	0.33461072E 08	0.19740677E 00	0.64311420E 07	0.13766155E 01
41	0.46379376E 08	0.58831427E-01	0.33838784E 08	0.19602597E 00	0.63629950E 07	0.13705978E 01
42	0.46678912E 08	0.59879627E-01	0.34205504E 08	0.19740789E 00	0.62936840E 07	0.13646603E 01
43	0.46962352E 08	0.60535318E-01	0.34561760E 08	0.19345123E 00	0.62232580E 07	0.13587952E 01
44	0.47230784E 08	0.61998058E-01	0.34907888E 08	0.19224918E 00	0.61518620E 07	0.13530111E 01
45	0.47484592E 08	0.63068151E-01	0.35244352E 08	0.19109905E 00	0.60794940E 07	0.13472958E 01
46	0.47724848E 08	0.64145088E-01	0.35571504E 08	0.18999743E 00	0.60062840E 07	0.13416595E 01
47	0.47952016E 08	0.65229118E-01	0.35889696E 08	0.18894166E 00	0.59322650E 07	0.13360939E 01
48	0.48166832E 08	0.66319823E-01	0.36199264E 08	0.18792886E 00	0.58575210E 07	0.13306026E 01
49	0.48365984E 08	0.67417145E-01	0.36500544E 08	0.18695605E 00	0.57820940E 07	0.13251839E 01
50	0.48561888E 08	0.68521142E-01	0.36793856E 08	0.18602145E 00	0.57060360E 07	0.13198366E 01
51	0.48743216E 08	0.69631577E-01	0.37079504E 08	0.18512243E 00	0.56293950E 07	0.13145590E 01
52	0.48914496E 08	0.70748329E-01	0.37357760E 08	0.18425739E 00	0.55522380E 07	0.13093529E 01
53	0.49076160E 08	0.71871340E-01	0.37628800E 08	0.18342412E 00	0.54745810E 07	0.13042145E 01
54	0.49228704E 08	0.73000491E-01	0.37893184E 08	0.18262100E 00	0.53964750E 07	0.12991438E 01
55	0.49372560E 08	0.74135721E-01	0.38150848E 08	0.18184626E 00	0.53179450E 07	0.12941399E 01
56	0.49508240E 08	0.75276792E-01	0.38402144E 08	0.18109846E 00	0.52390440E 07	0.12892046E 01
57	0.49636080E 08	0.76423645E-01	0.38647312E 08	0.18037641E 00	0.51598070E 07	0.12843342E 01
58	0.49756512E 08	0.77576160E-01	0.38886544E 08	0.17967832E 00	0.50802470E 07	0.12795296E 01

59	0.49869792E 08	0.78734457E-01	0.39120064E 08	0.17900324E 00	0.50003830E 07	0.12747869E 01
60	0.49976336E 08	0.79898238E-01	0.39348064E 08	0.17835063E 00	0.49202890E 07	0.12701082E 01
61	0.50076480E 08	0.81067443E-01	0.39570736E 08	0.17771834E 00	0.48399360E 07	0.12654924E 01
62	0.50170592E 08	0.82241833E-01	0.39788256E 08	0.17710602E 00	0.47593920E 07	0.12609396E 01
63	0.50258364E 08	0.83421528E-01	0.40000816E 08	0.17651248E 00	0.46786450E 07	0.12564449E 01
64	0.50341519E 08	0.84606588E-01	0.40208576E 08	0.17593688E 00	0.45977040E 07	0.12520084E 01
65	0.50418960E 08	0.85796535E-01	0.40411648E 08	0.17537874E 00	0.45166410L 07	0.12476339E 01
66	0.50491488E 08	0.86991370E-01	0.40610272E 08	0.17483664E 00	0.44354380E 07	0.12433176E 01
67	0.50559104E 08	0.88191330E-01	0.40804528E 08	0.17431039E 00	0.43541020E 07	0.12390556E 01
68	0.50622336E 08	0.89395821E-01	0.40994576E 08	0.17379898E 00	0.42726840E 07	0.12348537E 01
69	0.5068120JE 08	0.906C5080E-01	0.41180576E 08	0.17330194E 00	0.41911750E 07	0.12307062E 01
70	0.50735888E 08	0.91819108E-01	0.41362608E 08	0.17281836E 00	0.41095690E 07	0.12266111E 01
71	0.50786688E 08	0.93037665E-01	0.41540864E 08	0.17234814E 00	0.40279160E 07	0.12225714E C1
72	0.50833840E 08	0.94260573E-01	0.41715392E 08	0.17189050E 00	0.39462270E 07	0.12185869E 01
73	0.50877376E 08	0.95487952E-01	0.41886352E 08	0.17144471E 00	0.38644800E 07	0.12146521E C1
74	0.50917504E 08	0.96719742E-01	0.42053840E 08	0.17101049E 00	0.37826990E 07	0.12107697E 01
75	0.50954432E 08	0.97955704E-01	0.42217952E 08	0.17058730E 00	0.37009100E 07	C.12069368F 01
76	0.50988336E 08	0.99195778E-01	0.42378800E 08	0.17017478E 00	0.36191010E 07	0.12031565E 01
77	0.51019424E 08	0.10043979E CC	0.42536496E 08	0.16977262E 00	0.35373210E 07	0.11994267E 01
78	0.51047504E 08	0.10168821E OC	0.42691104E 08	0.16938025E 00	0.34555090E 07	0.11957407E 01
79	0.51073024E 08	0.10294044E CC	0.42842736E 08	0.16899705E 00	0.33737100E 07	0.11921043E 01
80	0.51096128E 08	0.10419631E 00	0.42991472E 08	0.16862321E 00	0.32919650E 07	0.11885176E 01
81	0.51116688E 08	0.10545635E CC	0.43137408E 08	0.16825795E 00	0.32120909E 07	C.11849728E 01
82	0.51134992E 03	0.10672009E CC	0.43280576E 08	0.16790116E 00	0.31284930E 07	0.11814756E 01
83	0.51151040E 08	0.10798764E CC	0.43421136E 08	0.16755259E 00	0.30468090E 07	0.11780214E 01
84	0.51165136E 08	0.10925859E CC	0.43555072E 08	0.16721177E 00	0.29651820E 07	C.11746140E 01
85	0.51177184E 08	0.11053330E CC	0.43694528E 08	0.16687852E 00	0.28835890E 07	0.11712434E 01
86	0.51187392E 08	0.11181140E CC	0.43827520E 08	0.16655260E 00	0.28020590E 07	C.11646481E C1
87	0.51195840E 08	0.11309284E CC	0.43958176E 08	0.16623378E 00	0.27205949E 07	0.11614065E 01
88	0.51202368E 08	0.11437815E CC	0.44086496E 08	0.16592163E 00	0.26391470E 07	0.11582088E C1
89	0.51207424E 08	0.11566651E CC	0.44212576E 08	0.16561604E 00	0.25577860E 07	0.11550522E C1
90	0.51210960E 08	0.11695802E CC	0.44336464E 08	0.16531682E 00	0.24765000E 07	0.11519327E 01
91	0.51212896E 08	0.11825311E 00	0.44458208E 08	0.16502386E 00	0.23952650E 07	0.11519327E 01
92	0.51213520E 08	0.11955112E 00	0.445777920E 08	0.16473675E 00	0.23141140E 07	0.11488533E 01
93	0.51212688E 08	0.12085259E CC	0.446956300E 08	0.16445529E 00	0.22330110E 07	0.11458101E 01
94	0.51210640E 08	0.12215092E CC	0.44811280E 08	0.16417944E 00	0.21520000E 07	0.11428061E 01
95	0.51207424E 08	0.12346423E 00	0.44925072E 08	0.16390896E 00	0.20710700E 07	0.11398401E 01
96	0.512030C8E 08	0.12477463E 00	0.45036992E 08	0.16364378E 00	0.19902170E 07	0.11369095E C1
97	0.51197424E 08	0.126088C8E CC	0.45147072E 08	0.16338366E 00	0.19094370E 07	0.11340141E C1
98	0.51190800E 08	0.12740445E CC	0.45255392E 08	0.16312832E 00	0.18287330E 07	0.11311531E C1
99	0.51183264E 08	0.12872350E CC	0.45361968E 08	0.16287792E 00	0.17481340E 07	C.11283293E C1
100	0.51174688E 08	0.13004547E CC	0.454666864E 08	0.16263217E 00	0.16676130E 07	0.11255379E C1
101	0.51165248E 08	0.13137019E CC	0.45570076E 08	0.16239059E 00	0.15871660E 07	0.11227808E C1
102	0.51154864E 08	0.13269782E CC	0.45671728E 08	0.16215378E 00	0.15068150E 07	0.11200552E C1
103	0.51143728E 08	0.13402796E 00	0.45771776E 08	0.16192079E 00	0.14265430E 07	0.11173630E 01
104	0.51131904E 08	0.13536048E CC	0.45870304E 08	0.16169190E 00	0.13463750E 07	0.11147051E 01
105	0.51119104E 08	0.13669622E CC	0.45967328E 08	0.16146725E 00	0.12662730E 07	0.11120739E 01
106	0.51105760E 08	0.13803416E CC	0.46062880E 08	0.16124642E 00	0.11862790E 07	0.11094780E 01
107	0.51091680E 08	0.13937473E 00	0.46156992E 08	0.16102928E 00	0.11063670E 07	0.11069098E 01
108	0.51077088E 08	0.14071751E CC	0.46249712E 08	0.16081583E 00	0.10265641E 07	C.11043750E C1
109	0.51061744E 08	0.14206314E CC	0.46341072E 08	0.16060597E 00	0.94682900E 06	0.11018677E 01
110	0.51045760E 08	0.14341134E CC	0.46431104E 08	0.16039950E 00	0.86717344E 06	0.10993872E 01
111	0.51029360E 08	0.14476162E CC	0.46519808E 08	0.16019648E 00	0.78763106E 06	0.10969381E 01
112	0.51012416E 08	0.14611429E CC	0.466670232E 08	0.15999681E 00	0.70818075E 06	0.10945168E 01
113	0.50994880E 08	0.14746958E CC	0.466793424E 08	0.15980023E 00	0.62880060E 06	0.10921211E 01
114	0.50977136E 08	0.14882642E CC	0.46778400F 08	0.15960664E 00	0.54954444E 06	0.10897579E 01
115	0.50958672E 08	0.1501E635E CC	0.46862160E 08	0.15941632E 00	0.47034944E 06	0.10874157E C1
			0.47024752E 08	0.15922386E 00	0.39125469E 06	0.10851021E 01

117	0.50920672E 08	0.15291226E 00	0.47026208E 08	0.15904433E 00	0.31224888E 06	0.10828142E C1
118	0.50901200E 08	0.15427816E 00	0.47106560E 08	0.15886271E 00	0.23335913E 06	0.10805540E 01
119	0.50881216E 08	0.15564674E 00	0.47185760E 08	0.15868372E 00	0.15452500E 06	0.10783167E 01
120	0.508610C8E 08	0.15701705E 00	0.47263936E 08	0.15850723E 00	0.75791813E 05	0.10761051E C1
121	0.50840464E 08	0.15838951E 00	0.47341024E 08	0.15833378E 00	-0.28333564E 04	0.10739193E 01
122	0.50819616E 08	0.15976405E 00	0.47417120E 08	0.15816247E 00	-0.81391500E 05	0.10717564E 01

THIS IS MODEL I; THE BASE MODEL

BOATS	IMPORTS	DY(I)-DY(I-1)	PRODUCT WEIGHT	MARGINAL COST	RENT/VESSEL	PRICE-MARGINAL COST
1	0.10969310E 07	0.25964650E C7	0.14064820E 07	0.25631145E-01	0.35765490E 07	0.13028383E 01
2	0.21355170E 07	0.24585120E C7	0.27347670E 07	0.27069345E-01	0.22497480E 07	0.84065437E 00
3	0.31189210E 07	0.23280410E C7	0.39891610E 07	0.28586481E-01	0.17013100E 07	0.65159494E 00
4	0.40501380E 07	0.22046680E C7	0.51737270E 07	0.30186091E-01	0.13875860E 07	0.54426807E 00
5	0.49320050E C7	0.20879210E 07	0.62923270E 07	0.31874049E-01	0.11796670E 07	0.47348547E 00
6	0.57671730E 07	0.19775110E 07	0.73485590E 07	0.33653602E-01	0.10296150E 07	0.42251390E 00
7	0.65581780E 07	0.18730180E 07	0.83458680E 07	0.35531089E-01	0.91512113E 06	0.38359147E 00
8	0.73073890E 07	0.17741920E 07	0.92874630E 07	0.37510313E-01	0.82425263E 06	0.35258406E 00
9	0.80170610E 07	0.16806240E C7	0.10176415E 03	0.39598610E-01	0.74999631E 06	0.32706541E C0
10	0.86893110E 07	0.159216C0E 07	0.11015578E 08	0.41798837E-01	0.68792969E 06	0.30551523E 00
11	0.93261750E C7	0.15083520E 07	0.11807739E 08	0.44121247E-01	0.63511281E 06	0.28691673E 00
12	0.99295160E 07	0.14290720E 07	0.12555386E 08	0.46568986E-01	0.58950363E 06	0.27057230E 00
13	0.10501144E C8	0.13540320E 07	0.13261006E 08	0.49149778E-01	0.54963975E 06	0.25597781E 00
14	0.11042757E C8	0.12829440E C7	0.13926872E 08	0.51873218E-01	0.51444125E 06	0.24275911E 00
15	0.11555935E 08	0.121568C0E C7	0.145555113E 08	0.54742970E-01	0.48308869E 06	0.23063719E 00
16	0.12042220E 08	0.11519680E C7	0.15147823E 08	0.57770699E-01	0.45495294E 06	0.21938956E 00
17	0.12502994E 08	0.10916640E 07	0.1570J6921E 08	0.60962897E-01	0.42453681E 06	0.20884389E 00
18	0.12939660E 08	0.10345120E 07	0.16234220E 08	0.64329803E-01	0.40644725E 06	0.19885975E C0
19	0.13353464E 08	0.980416C0E C6	0.16731448E 08	0.67879319E-01	0.38536231E 06	0.18932259E 00
20	0.13745631E 08	0.92918400E C6	0.17200240E 08	0.71623027E-01	0.36602125E 06	0.18013501E 00
21	0.14117304E 08	0.880576C0E C6	0.17642144E 08	0.75755313E-01	0.34820775E 06	0.17121160E 00
22	0.14469535E 08	0.8346C8C0E C6	0.18058576E 08	0.79739213E-01	0.33174000E 06	0.16249079E C0
23	0.14803378E C8	0.79096000E 06	0.18450960E 08	0.84136963E-01	0.31646669E 06	0.15390044E 00
24	0.15119762E 08	0.74969600E 06	0.18820544E 08	0.88770628E-01	0.30225738E 06	0.14539671E 00
25	0.15417640E 08	0.710496C0E C6	0.19169608E 08	0.93666911E-01	0.28900244E 06	0.13691747E 00
26	0.15703839E 08	0.67347200E 06	0.19496240E 08	0.98817766E-01	0.27660525E 06	0.12844002E 00
27	0.15973227E 08	0.638176C0E C6	0.19804656E 08	0.10427999E 00	0.26498519E 06	0.11988163E 00
28	0.16228498E 08	0.604912C0E 06	0.20094752E 08	0.11001760E 00	0.25406763E 06	0.11125499E C0
29	0.16470463E 08	0.57331200E 06	0.20367600E 08	0.11607937E 00	0.24379063E 06	0.10249054E C0
30	0.16699787E 08	0.54323200E C6	0.20624144E 08	0.12250930E 00	0.23409981E 06	0.93529522E-01
31	0.16917072E 08	0.514896C0E 06	0.20865152E 08	0.12925130E 00	0.22494375E 06	0.84410131E-01
32	0.17123024E C8	0.487856C0E 06	0.21091584E 08	0.13641113E 00	0.21628088E 06	0.75013995E-01
33	0.17318176E 08	0.462272C0E C6	0.21304112E 08	0.14396715E 00	0.20807156E 06	0.65351009E-01
34	0.17503088E 08	0.43800000E C6	0.21503536E 08	0.15193832E 00	0.20028006E 06	0.55390537E-01
35	0.17678288E 08	0.41502400E 06	0.21690528E 08	0.16035455E 00	0.19287688E 06	0.45094192E-01
36	0.17844288E 08	0.39318400E 06	0.21865792E 08	0.16926169E 00	0.18533325E 06	0.344C6960E-01
37	0.18001568E 08	0.372384C0E C6	0.22029952E 08	0.17871064E 00	0.17912363E 06	0.23270369E-01
38	0.18150512E 08	0.35275200E C6	0.22183536E 08	0.18662235E 00	0.17272481E 06	0.11716723E-01
39	0.18291616E C8	0.3323984C0E C6	0.22327184E 08	0.19926101E 00	0.16661625E 06	-0.4050I356E-C3
40	0.18425216E 08	0.316320C0E 06	0.22461344E 08	0.21039134E 00	0.16077850E 06	-0.12984574E-01
41	0.18551744E 08	0.29953600E 06	0.22586592E 08	0.22218025E 00	0.15519500E 06	-0.2615428CE-01
42	0.18671552E C8	0.283440C0E C6	0.22703424E 08	0.23479390E 00	0.14984956E 06	-0.40084958E-01
43	0.18784928E 08	0.268432C0E C6	0.22812160E 08	0.24792498E 00	0.14472688E 06	-0.54473758E-C1
44	0.18892304E 08	0.25380800E C6	0.22913424E 08	0.26220208E 00	0.13981500E 06	-0.69952905E-01
45	0.18993824E 08	0.240256C0E 06	0.23007376E 08	0.27700031E 00	0.13509981E 06	-0.85901260E-01
46	0.19089936E 08	0.227168C0E C6	0.23094624E 08	0.29295939E 00	0.13057138E 06	-0.10296196E C0
47	0.19180800E 08	0.21481600E 06	0.23175376E 08	0.30979532E 00	0.12621838E 06	-0.12085366E 00
48	0.19266720E 08	0.203152C0E C6	0.23250032E 08	0.32759213E 00	0.12203169E 06	-0.13966328E 00
49	0.19347984E 08	0.191904C0E 06	0.23318960E 08	0.34678793E 00	0.11800108E 06	-0.15983188E 00
50	0.19424752E C8	0.181328C0E C6	0.23382368E 08	0.36701995E 00	0.11412069E 06	-0.18094850E 00
51	0.19497280E 08	0.171280C0E 06	0.23440624E 08	0.38855088E 00	0.11038025E 06	-0.20342845E 00
52	0.19565792E 08	0.161664C0E 06	0.23494000E 08	0.41165626E 00	0.10677375E 06	-0.22739887E 00
53	0.19630448E 08	0.152544C0E C6	0.23542704E 08	0.43627411E 00	0.10329394E 06	-0.25285000E 00
54	0.19691472E 08	0.143856C0E C6	0.23586992E 08	0.46261537E 00	0.99934688E 05	-0.27999437E 00
55	0.197490C0E 08	0.135680C0E C6	0.23627120E 08	0.49049968E 00	0.96689875E 05	-0.30865341E 00
56	0.19803280E 08	0.127840C0E C6	0.23663344E 08	0.52058041E 00	0.93554313E 05	-0.33948195E 00
57	0.19854416E 08	0.120432C0E C6	0.23695840E 08	0.55257738E 00	0.90522875E 05	-0.37220097E 00
58	0.19902592E 08	0.113280C0E C6	0.23774816E 08	0.58749115E 00	0.87590438E 05	-0.40781283E C0

59	0.19947904E 08	0.106544C0E 06	0.23750416E 08	0.62462455E 00	0.84752250E 05	-0.44562131E 00
60	0.19990520E 08	0.100144C0E 06	0.23772848E 08	0.66455299E 00	0.82004813E 05	-0.48620236E 00
61	0.20030576E 08	0.94112000E 05	0.23792304E 08	0.70714676E 00	0.79343188E 05	-0.52942842E 00
62	0.20068224E 08	0.882720C0E C5	0.23808960E 08	0.75391966E 00	0.76764375E 05	-0.57681364E 00
63	0.20103536E 08	0.82640000E 05	0.23822896E 08	0.80531216E 00	0.74264188E 05	-0.62879968E 00
64	0.20136592E 08	0.77456000E 05	0.23834240E 08	0.85919744E 00	0.71839125E 05	-0.68326056E 00
65	0.20167568E 08	0.725280C0E 05	0.23843248E 08	0.91759044E 00	0.69486750E 05	-0.74221170E 00
66	0.20196592E 08	0.67616000E 05	0.23850016E 08	0.98424923E 00	0.67203563E 05	-0.80941260E 00
67	0.20223632E 08	0.63232000E 05	0.23854528E 08	0.10524569E 01	0.64986594E 05	-0.87814647E 00
68	0.20248928E 08	0.58864000E C5	0.23857120E 08	0.11305885E 01	0.62833586E 05	-0.95678955E 00
69	0.20272464E 08	0.5468E000E C5	0.23857744E 08	0.12168846E 01	0.60741664E 05	-0.10435820E 01
70	0.20294352E 08	0.50800000E C5	0.23856512E 08	0.13100586E 01	0.58708125E 05	-0.11372395E 01
71	0.20314672E 08	0.47152000E 05	0.23853584E 08	0.14114141E 01	0.56731211E 05	-0.12390652E 01
72	0.20333520E 08	0.435360C0E 05	0.23849088E 08	0.15286198E 01	0.54808707E 05	-0.13567286E 01
73	0.20350944E 08	0.401280C0E C5	0.23842992E 08	0.16584673E 01	0.52938082E 05	-0.14870224E 01
74	0.20366992E 08	0.369280C0E C5	0.23835456E 08	0.18021555E 01	0.51117551E 05	-0.16311445E 01
75	0.20381760E 08	0.33904C00E C5	0.23826544E 08	0.19629240E 01	0.49345344E 05	-0.17923365E 01
76	0.20395328E 08	0.31088000E C5	0.23816384E 08	0.21407290E 01	0.47619750E 05	-0.19705534E 01
77	0.20407760E 08	0.28080000E C5	0.23805072E 08	0.23699780E 01	0.45939230E 05	-0.22002048E 01
78	0.20418992E 08	0.25520000E C5	0.23792448E 08	0.26077976E 01	0.44301395E 05	-0.24384165E 01
79	0.20429200E 08	0.23104000E 05	0.23778816E 08	0.28804102E 01	0.42705188E 05	-0.27114124E 01
80	0.20438448E 08	0.20560000E C5	0.23754224E 08	0.32369156E 01	0.41149563E 05	-0.30682917E 01
81	0.20446672E 08	0.18304000E C5	0.2374856CE 08	0.36359262E 01	0.39632207E 05	-0.34676676E 01
82	0.20453984E 08	0.16048000E C5	0.23732032E 08	0.41468716E 01	0.38152352E 05	-0.39785696E 01
83	0.20460400E 08	0.14096000E 05	0.23714592E 08	0.47212677E 01	0.36708539E 05	-0.45537148E 01
84	0.20466048E 08	0.12048000E C5	0.23696432E 08	0.55237379E 01	0.35299785E 05	-0.53565254E 01
85	0.20470864E 08	0.102080C0E C5	0.23677472E 08	0.65194941E 01	0.33924574E 05	-0.63526154E 01
86	0.20474944E 08	0.8448C000E C4	0.23657840E 08	0.78774853E 01	0.32582078E 05	-0.77109318E 01
87	0.20478320E 08	0.65280000E C4	0.23637552E 08	0.10194699E 02	0.31271195E 05	-0.10028465E 02
88	0.20480944E 08	0.505600C0E 04	0.23616528E 08	0.13162776E 02	0.29990305E 05	-0.12996854E 02
89	0.20482967E 08	0.35360C00E C4	0.23594992E 08	0.18820694E 02	0.28739168E 05	-0.18655075E 02
90	0.20484364E 08	0.19360000E C4	0.23572944E 08	0.34375504E 02	0.27516664E 05	-0.34210175E 02
91	0.20485152E 08	0.62400000E 03	0.23550304E 08	0.10664903E 03	0.26321590E 05	-0.10648401E 03
92	0.20485392E 08	-0.832000C0E C3	0.23527216E 08	0.999999964E 75	0.25153410E 05	-0.99999964E 75
93	0.20485072E 08	-0.20480000E 04	0.23503648E 08	0.999999964E 75	0.24010867E 05	-0.99999964E 75
94	0.20484240E 08	-0.321600C0E C4	0.23479664E 08	0.999999964E 75	0.22893613E 05	-0.99999964E 75
95	0.20482960E 08	-0.44160000E 04	0.23455344E 08	0.999999964E 75	0.21800734E 05	-0.99999964E 75
96	0.20481200E 08	-0.55840000E 04	0.23430624E 08	0.999999964E 75	0.20731426E 05	-0.99999964E 75
97	0.20478960E 08	-0.66240000E C4	0.23405536E 08	0.999999964E 75	0.19684914E 05	-0.99999964E 75
98	0.20476344E 08	-0.75360000E C4	0.23380128E 08	0.999999964E 75	0.18660539E 05	-0.99999964E 75
99	0.20473296E 08	-0.85760000E C4	0.23354430E 08	0.999999964E 75	0.17657918E 05	-0.99999964E 75
100	0.20469872E 08	-0.94400000E 04	0.23328528E 08	0.999999964E 75	0.16676129E 05	-0.99999964E 75
101	0.20466096E 08	-0.10384000E C5	0.23302352E 08	0.999999964E 75	0.15714512E 05	-0.99999964E 75
102	0.20461936E 08	-0.11136000E C5	0.23275888E 08	0.999999964E 75	0.14772695E 05	-0.99999964E 75
103	0.20457488E 08	-0.11824000E 05	0.23249264E 08	0.999999964E 75	0.13849930E 05	-0.99999964E 75
104	0.20452752E 08	-0.12800000E C5	0.23222496E 08	0.999999964E 75	0.12945910E 05	-0.99999964E 75
105	0.20447632E 08	-0.13344000E C5	0.23195408E 08	0.999999964E 75	0.12059742E 05	-0.99999964E 75
106	0.20442288E 08	-0.14080000E C5	0.23168288E 08	0.999999964E 75	0.11191309E 05	-0.99999964E 75
107	0.20436656E 08	-0.14592000E C5	0.23140960E 08	0.999999964E 75	0.10339875E 05	-0.99999964E 75
108	0.20430832E 08	-0.15344000E C5	0.23113600E 08	0.999999964E 75	0.95052227E 04	-0.99999964E 75
109	0.20424668E 08	-0.15984000E C5	0.23086032E 08	0.999999964E 75	0.86665039E 04	-0.99999964E 75
110	0.20418288E 08	-0.16400000E C5	0.23058304E 08	0.999999964E 75	0.78833945E 04	-0.99999964E 75
111	0.20411728E 08	-0.16944000E C5	0.23030592E 08	0.999999964E 75	0.70957734E 04	-0.99999964E 75
112	0.20404960E 08	-0.17536000E C5	0.23002784E 08	0.999999964E 75	0.63230391E 04	-0.99999964E 75
113	0.20397936E 08	-0.17744000E C5	0.22974848E 08	0.999999964E 75	0.55646016E 04	-0.99999964E 75
114	0.20390848E 08	-0.18464000E C5	0.22947008E 08	0.999999964E 75	0.48205625E 04	-0.99999964E 75
115	0.20383456E C8	-0.18784000E C5	0.22919960E 08	0.999999964E 75	0.40899949E 04	-0.99999964E 75
116	0.20375952E C8	-0.19216000E C5	0.22890944E 08	0.999999964F 75	0.33728850E 04	-0.99999964E 75

117	0.20368256E 08	-0.19472000E 05	0.22862864E 08	0.99999964E 75	0.26687937E 04	-0.99999964E 75
118	0.20360464E 08	-0.19984000E 05	0.22834848E 08	0.99999964E 75	0.19776196E 04	-0.99999964E 75
119	0.20352480E 08	-0.20208000E 05	0.22806736E 08	0.99999964E 75	0.12985293E 04	-0.99999964E 75
120	0.20344400E 08	-0.20544000E 05	0.22778688E 08	0.99999964E 75	0.63159839E 03	-0.99999964E 75
121	0.20336176E 08	-0.20848000E 05	0.22750624E 08	0.99999964E 75	-0.23416168E 02	-0.99999964E 75

THIS IS MODEL 1; THE BASE MODEL

**ACTUAL CATCH PER VESSEL; BY VESSEL CLASS**

<b>BOATS</b>	<b>CLASSB1</b>	<b>CLASSB2</b>	<b>CLASSB3</b>	<b>CLASSB4</b>	<b>CLASSB5</b>	<b>CLASSB6</b>
1	0.21493330E 07	0.25791990E 07	0.29660760E 07	0.41052250E 07	0.41482090E 07	0.42556770E 07
2	0.20921710E 07	0.25106050E 07	0.28371930E 07	0.39960460E 07	0.40378880E 07	0.41424970E 07
3	0.20370770E 07	0.24444920E 07	0.28111630E 07	0.38908160E 07	0.39315560E 07	0.40334100E 07
4	0.19839650E 07	0.23807580E 07	0.27378690E 07	0.37893730E 07	0.38290500E 07	0.39282490E 07
5	0.19327590E 07	0.23193100E 07	0.26672040E 07	0.36911560E 07	0.37302220E 07	0.38268610E 07
6	0.18833720E 07	0.22600460E 07	0.25990500E 07	0.35972390E 07	0.36349050E 07	0.37290740E 07
7	0.18357320E 07	0.22028780E 07	0.25333080E 07	0.35062480E 07	0.35429610E 07	0.36347480E 07
8	0.17897660E 07	0.21477190E 07	0.24698740E 07	0.34184530E 07	0.34542460E 07	0.35437350E 07
9	0.17454080E 07	0.20944890E 07	0.24086600E 07	0.33337280E 07	0.33686340E 07	0.34559050E 07
10	0.17025880E 07	0.20431060E 07	0.23495690E 07	0.32519430E 07	0.32859930E 07	0.33711230E 07
11	0.16612500E 07	0.19935000E 07	0.22925230E 07	0.31729870E 07	0.32062110E 07	0.32892740E 07
12	0.16213290E 07	0.19455940E 07	0.22374310E 07	0.30967370E 07	0.31291620E 07	0.32102290E 07
13	0.15827690E 07	0.18993230E 07	0.21842190E 07	0.30230880E 07	0.30547420E 07	0.31338810E 07
14	0.15455170E 07	0.18546200E 07	0.21328110E 07	0.29519370E 07	0.29828460E 07	0.30601220E 07
15	0.15095170E 07	0.18114200E 07	0.20831310E 07	0.28831770E 07	0.29133660E 07	0.29888420E 07
16	0.14747230E 07	0.17696670E 07	0.20351150E 07	0.28167200E 07	0.28462130E 07	0.29199500E 07
17	0.14410840E 07	0.17293000E 07	0.19886930E 07	0.27524690E 07	0.27812900E 07	0.28533440E 07
18	0.14085570E 07	0.16902690E 07	0.19438070E 07	0.26903440E 07	0.27185140E 07	0.27889430E 07
19	0.13710960E 07	0.16525160E 07	0.19033910E 07	0.26302540E 07	0.26577950E 07	0.27266500E 07
20	0.13466630E 07	0.16159950E 07	0.18533930E 07	0.25721260E 07	0.25990580E 07	0.26663920E 07
21	0.13172150E 07	0.15806570E 07	0.18177540E 07	0.25158800E 07	0.25422230E 07	0.26080840E 07
22	0.12887120E 07	0.15464550E 07	0.17784210E 07	0.24614400E 07	0.24872130E 07	0.25516500E 07
23	0.12611220E 07	0.15133460E 07	0.17403460E 07	0.24087420E 07	0.24339630E 07	0.24970200E 07
24	0.12344050E 07	0.14812860E 07	0.17034780E 07	0.23577140E 07	0.23824010E 07	0.24441220E 07
25	0.12085330E 07	0.14502390E 07	0.16677730E 07	0.23082970E 07	0.23324670E 07	0.23928940E 07
26	0.11846480E 07	0.14201610E 07	0.16331840E 07	0.22604240E 07	0.22840920F 07	0.23432660E 07
27	0.11591850E 07	0.13910220E 07	0.15996740E 07	0.22140440E 07	0.22372270E 07	0.22951860E 07
28	0.11356500E 07	0.13627800E 07	0.15671950E 07	0.21390910E 07	0.21918030E 07	0.22485860E 07
29	0.11128380E 07	0.13354050E 07	0.15357140E 07	0.21255200E 07	0.21477760E 07	0.22034180E 07
30	0.10907210E 07	0.13088660E 07	0.15051940E 07	0.20832780E 07	0.21050910E 07	0.21596280E 07
31	0.10692710E 07	0.12831250E 07	0.147555920E 07	0.20423070E 07	0.20636910E 07	0.21171550E 07
32	0.10484678E 07	0.12581610E 07	0.14468830E 07	0.20025720E 07	0.20235410E 07	0.20759650E 07
33	0.10282828E 07	0.12339390E 07	0.14190280E 07	0.19640190E 07	0.19845840E 07	0.20359980E 07
34	0.10086958E 07	0.12114340E 07	0.13919980E 07	0.19266080E 07	0.19467810E 07	0.19972160E 07
35	0.98968400E 06	0.11876200E 07	0.13657620E 07	0.18902950E 07	0.19100880E 07	0.19595730E 07
36	0.97122800E 06	0.11654730E 07	0.13402930E 07	0.18550440E 07	0.18744680E 07	0.19230300E 07
37	0.95330725E 06	0.11439680E 07	0.13155620E 07	0.18208160E 07	0.18398810E 07	0.18875470E 07
38	0.93590069E 06	0.11230800E 07	0.12915410E 07	0.17875690E 07	0.18062870E 07	0.18530820E 07
39	0.91899256E 06	0.11027900E 07	0.12682080E 07	0.17552750E 07	0.17736540E 07	0.18196040E 07
40	0.90256181E 06	0.10830740E 07	0.12455330E 07	0.17238920E 07	0.17419420E 07	0.17870710E 07
41	0.88659550E 06	0.10639130E 07	0.12234990E 07	0.16933950E 07	0.17111270E 07	0.17554570E 07
42	0.87107494E 06	0.10452899E 07	0.12020820E 07	0.16637520E 07	0.16811730E 07	0.17247270E 07
43	0.85598356E 06	0.10271801E 07	0.11812550E 07	0.16349280E 07	0.16520470E 07	0.16948460E 07
44	0.84131075E 06	0.10095728E 07	0.11610070E 07	0.16069030E 07	0.16237280E 07	0.16657940E 07
45	0.82703613E 06	0.99243191E 06	0.11413080E 07	0.15796380E 07	0.15961780E 07	0.16375300E 07
46	0.81315075E 06	0.975780C6E 06	0.11221460E 07	0.15531170E 07	0.15693790E 07	0.16100370E 07
47	0.79963781E 06	0.95956525E 06	0.11034980E 07	0.15273070E 07	0.15432990E 07	0.15832820E 07
48	0.78648631E 06	0.94378344E 06	0.10853490E 07	0.15021880E 07	0.15179170E 07	0.15572420E 07
49	0.77368500E 06	0.92842188E 06	0.10676840E 07	0.14777370E 07	0.14932110E 07	0.15318950E 07
50	0.76121950E 06	0.91346319E 06	0.10504810E 07	0.14539280E 07	0.14691520E 07	0.15072130E 07
51	0.74908025E 06	0.89889613E 06	0.10337295E 07	0.14307420E 07	0.14457230E 07	0.14831780E 07
52	0.73725644E 06	0.8847C756E 06	0.10174127E 07	0.14081590E 07	0.14229030E 07	0.14597660E 07
53	0.72573663E 06	0.87088375E 06	0.10015153E 07	0.13851560E 07	0.14006700E 07	0.14369570E 07
54	0.71451106E 06	0.85741313E 06	0.98602413E 06	0.13647150E 07	0.13740050E 07	0.14147310E 07

55	0.70356994E 06	0.84428381E 06	0.97092538E 06	0.13438180E 07	0.13578890E 07	0.13930670E 07
56	0.69290513E 06	0.831486C0E 06	0.95620794E 06	0.13234480E 07	0.13373050E 07	0.13719510E 07
57	0.68250675E 06	0.81900794E 06	0.94185819E 06	0.13035870E 07	0.13172370E 07	0.13513620E 07
58	0.67236481E 06	0.80684000E 06	0.92736506E 06	0.12842200E 07	0.12976660E 07	0.13312850E 07
59	0.66247556E 06	0.79497056E 06	0.91421519E 06	0.12653270E 07	0.12785760E 07	0.13117000E 07
60	0.652826C6E 06	0.78339113E 06	0.90089888E 06	0.12468970E 07	0.12599530E 07	0.12925940E 07
61	0.64341069E 06	0.77209269E 06	0.88790575E 06	0.12289140E 07	0.12417810E 07	0.12739520E 07
62	0.63422281E 06	0.7610C6725E 06	0.87522644E 06	0.12113650E 07	0.12240490E 07	0.12557600E 07
63	0.62525394E 06	0.75030456E 06	0.86284938E 06	0.11942340E 07	0.12067390E 07	0.12380020E 07
64	0.61649638E 06	0.73979556E 06	0.850764C6E 06	0.11775070E 07	0.11898370E 07	0.12206620E 07
65	0.60794575E 06	0.72953475E 06	0.83896413E 06	0.11611760E 07	0.11733340E 07	0.12037310E 07
66	0.59959575E 06	0.71951475E 06	0.82744113E 06	0.11452270E 07	0.11572180E 07	0.11871980E 07
67	0.59143750E 06	0.70972488E 06	0.81618281E 06	0.11296450E 07	0.11414730E 07	0.11710450E 07
68	0.58346869E 06	0.70016231E 06	0.80518588E 06	0.11144240E 07	0.11260930E 07	0.11552670E 07
69	0.57568131E 06	0.69081744E 06	0.79443925E 06	0.10995500E 07	0.11110640E 07	0.11398480E 07
70	0.56806956E 06	0.68168338E 06	0.78393513E 06	0.10850120E 07	0.10963730E 07	0.11247770E 07
71	0.56062938E 06	0.67275513E 06	0.77366763E 06	0.10708010E 07	0.10820130E 07	0.11100450E 07
72	0.55335613E 06	0.66402725E 06	0.76363056E 06	0.10569090E 07	0.10679760E 07	0.10956440E 07
73	0.54624331E 06	0.65549188E 06	0.75381494E 06	0.10433244E 07	0.10542480E 07	0.10815610E 07
74	0.53928669E 06	0.64714394E 06	0.74421475E 06	0.10300373E 07	0.10408226E 07	0.10677870E 07
75	0.53248206E 06	0.63897838E 06	0.73482444E 06	0.10170404E 07	0.10276897E 07	0.10543130E 07
76	0.52582538E 06	0.63099038E 06	0.72563819E 06	0.10043262E 07	0.10148423E 07	0.10411337E 07
77	0.51931294E 06	0.62317538E 06	0.71665100E 06	0.99188738E 06	0.10022732E 07	0.10282390E 07
78	0.51293719E 06	0.61552456E 06	0.70785250E 06	0.97970975E 06	0.989968C6E 06	0.10156151E 07
79	0.50669750E 06	0.60803694E 06	0.69924175E 06	0.96779200E 06	0.97792550E 06	0.10032606E 07
80	0.50059019E 06	0.6007C806E 06	0.69081363E 06	0.95612688E 06	0.96613831E 06	0.99116800E 06
81	0.49460900E 06	0.59353069E 06	0.68255956E 06	0.94470288E 06	0.95459463E 06	0.97932525E 06
82	0.48875215E 06	0.5865C244E 06	0.67447713E 06	0.93351625E 06	0.94329088E 06	0.96772869E 06
83	0.48301506E 06	0.579618C0E 06	0.66656000E 06	0.92255850E 06	0.93221838E 06	0.95636931E 06
84	0.47739644E 06	0.57287563E 06	0.65880631E 06	0.91I82688E 06	0.92137444E 06	0.94524444E 06
85	0.47189100E 06	0.56626919E 06	0.65120894E 06	0.90131169E 06	0.91074913E 06	0.93434381E 06
86	0.46649700E 06	0.55579631E 06	0.643765J6E 06	0.89100900E 06	0.90053850E 06	0.92366356E 06
87	0.46121106E 06	0.55345319E 06	0.63647050E 06	0.88091281E 06	0.89013669E 06	0.91319738E 06
88	0.45602819E 06	0.54723375E 06	0.62931813E 06	0.87101356E 06	0.88013375E 06	0.90293531E 06
89	0.45094881E 06	0.54113850E 06	0.62230836E 06	0.86131194E 06	0.87033056E 06	0.89267819E 06
90	0.445966C6E 06	0.53516275E 06	0.61543656E 06	0.85180056E 06	0.86071963E 06	0.883C1819E 06
91	0.44108494E 06	0.52930188E 06	0.60869656E 06	0.84247200E 06	0.85129338E 06	0.87334775E 06
92	0.43625588E 06	0.52355550E 06	0.60208703E 06	0.83332488E 06	0.84205044E 06	0.863R6538E 06
93	0.43159750E 06	0.51791694E 06	0.59560388E 06	0.82435L00E 06	0.83298263E 06	0.85456263E 06
94	0.42698894E 06	0.51238669E 06	0.58924406E 06	0.81554863E 06	0.82408066E 06	0.84543769E 06
95	0.42246781E 06	0.50696131E 06	0.58300494E 06	0.80691331E 06	0.81536231E 06	0.83648581E 06
96	0.418031C6E 06	0.50163719E 06	0.57688219E 06	0.79843906E 06	0.80679931E 06	0.82770100E 06
97	0.41367631E 06	0.49641150E 06	0.57087263E 06	0.79012150E 06	0.79839469E 06	0.81907863E 06
98	0.40940219E 06	0.49128250E 06	0.56497431E 06	0.78195788E 06	0.79014556E 06	0.81C61581E 06
99	0.40520713E 06	0.48624844E 06	0.55918519E 06	0.77394538E 06	0.78204919E 06	0.80230969E 06
100	0.40108788E 06	0.48130538E 06	0.55350063E 06	0.76607756E 06	0.774099C0E 06	0.79415356E 06
101	0.39704338E 06	0.47645200E 06	0.54791925E 06	0.75835269E 06	0.76629319E 06	0.7861455CE 06
102	0.39307106E 06	0.47168519E 06	0.54243744E 06	0.75076550E 06	0.75362656E 06	0.7782R025E 06
103	0.38917006E 06	0.46700400E 06	0.53705406E 06	0.74331463E 06	0.75109769E 06	0.77055631E 06
104	0.38533894E 06	0.46240669E 06	0.53176713E 06	0.73599719E 06	0.74370363E 06	0.76297069E 06
105	0.38157350E 06	0.45788813E 06	0.52657081E 06	0.72880519E 06	0.73643631E 06	0.75551513E 06
106	0.377875C6E 06	0.45345CC0E 06	0.52146700E 06	0.72174119E 06	0.72929838E 06	0.74819225E 06
107	0.37424044E 06	0.44908844E 06	0.51645119E 06	0.71479900E 06	0.72228350E 06	0.74C99563E 06
108	0.37066938E 06	0.44480319E 06	0.51152313E 06	0.70797825E 06	0.71539138E 06	0.73392494E 06
109	0.36715838E 06	0.44058994E 06	0.50667794E 06	0.70127225E 06	0.70861513E 06	0.72697313E 06
110	0.36370669E 06	0.43644794E 06	0.50191463E 06	0.69467950E 06	0.70195338E 06	0.72013881E 06
111	0.36031425E 06	0.43237700E 06	0.49723306E 06	0.68820000E 06	0.69540600E 06	0.71342181E 06
112	0.35697863E 06	0.42837425E 06	0.49262988E 06	0.683182894E 06	0.68896819E 06	0.70681725E 06

113	0.35369781E 06	0.42443731E 06	0.48810244E 06	0.67556263E 06	0.68263631E 06	0.70032131E 06
114	0.35047325E 06	0.42056781E 06	0.48365250E 06	0.66940369E 06	0.67641288E 06	0.69393663E 06
115	0.34725981E 06	0.41675975E C6	0.47927319E 06	0.66334250E 06	0.67028819E 06	0.68765331E 06
116	0.34417894E 06	0.41301463E 06	0.47496638E 06	0.65738156E 06	0.66426488E 06	0.68147394E 06
117	0.34110850E 06	0.40933013E 06	0.47072919E 06	0.65151706E 06	0.65833894E 06	0.67539444E 06
118	0.33808844E 06	0.405706C6E C6	0.46656150E 06	0.64574869E 06	0.65251019E 06	0.66941469E 06
119	0.33511569E 06	0.40213875E C6	0.46245913E 06	0.64007081E 06	0.64677281E 06	0.66352875E C6
120	0.33219113E 06	0.39862925E C6	0.45842319E 06	0.63448481E 06	0.64112838E 06	0.65773800E 06
121	0.32931263E 06	0.39517506E 06	0.45445088E 06	0.62898694E 06	0.63557294E 06	0.65203869E 06
122	0.32647944E 06	0.39177525E C6	0.45054106E 06	0.62357550E 06	0.63010481E 06	0.64642894E C6

THIS IS MODEL 1; THE BASE MODEL

POSITION OF MAXIMUM PROFITS : NO = 1.

BOATS	FISHMORTCOEF	TOTAL YIELD	FIXED COST	VARIABLE COST	TOTAL COST	BIOMASS
22	0.12461627E 00	0.58729392E 08	0.24716806E 06	0.12169400E 07	0.14641080E 07	0.50125619E 09
BOATS	DOMESTIC WEIGHT	AVERAGE COST	DOMESTIC #	EX-VESSEL PRICE	TOTAL PROFIT	MEAN WEIGHT/FISH
22	0.39152928E 08	0.37394594E-01	0.25635024E 08	0.23297560E 00	0.76575670E 07	0.15273209E 01
BOATS	IMPORTS	YIELD INCREMENT	PRODUCT WEIGHT	MARGINAL COST	PROFIT/BOAT	PRICE-MARGINAL COST
22	0.15661170E 08	0.10207360E 07	0.19641856E 08	0.65199018E-01	0.34807119E 06	0.16777658E 00
BOATS	ACTUAL CATCH PER VESSEL; BY VESSEL CLASS					
22	0.13948440E 07	0.16738130E 07	0.19248830E 07	0.26641520E 07	0.26920470E 07	0.27617900E 07
THIS IS MODEL 1 : THE BASE MODEL.						



POSITION OF MAXIMUM SUSTAINABLE YIELD; NO=						
BOATS	FISHMORTCOEF	TOTAL YIELD	FIXED COST	VARIABLE COST	TOTAL COST	BIOMASS
111	0.62874651E 00	0.92184256E 08	0.12470750E 07	0.61400190E 07	0.73870940E 07	0.19750656E 09
BOATS	DOMESTIC WEIGHT	AVERAGE COST	DOMESTIC #	EX-VESSEL PRICE	TOTAL PROFIT	MEAN WEIGHT/FISH
111	0.61456160E 08	0.12020099E 00	0.53514688E 08	0.14669985E 00	0.16285170E 07	0.11483974E 01
BOATS	IMPORTS	YIELD INCREMENT	PRODUCT WEIGHT	MARGINAL COST	PROFIT/BOAT	PRICE-MARGINAL COST
111	0.24582448E 08	-0.92800000E 03	0.28228480E 08	0.99999964E 75	0.14671324E 05	-0.99999964E 75
BOATS	ACTUAL CATCH PER VESSEL; BY VESSEL CLASS					
111	0.43393706E 06	0.52072438E 06	0.59883244E 06	0.82881950E 06	0.83749788E 06	0.85919488E 06
THIS IS MODEL 1.: THE BASE MODEL						

BOATS FISHMORTCOEF		TOTAL YIELD	POSITION OF ZERO PROFITS; NO=			TOTAL COST	BIO MASS
			FIXED COST	VARIABLE COST			
132	0.74769872E 00	0.91894528E 08	0.14830080E 07	0.73016440E 07	0.87846520E 07	0.17452354E 09	
BOATS	DOMESTIC WEIGHT	AVERAGE COST	DOMESTIC #	EX-VESSEL PRICE	TOTAL PROFIT	MEAN WEIGHT/FISH	
132	0.61263008E 08	0.14339238E 00	0.55672416E 08	0.14295059E 00	-0.27065359E 05	0.11004190E 01	
BOATS	IMPORTS	YIELD INCREMENT	PRODUCT WEIGHT	MARGINAL COST	PROFIT/BOAT	PRICE-MARGINAL COST	
132	0.24505200E 08	-0.16064000E 05	0.27683888E 08	0.99999964E 75	-0.20504059E 03	-0.99999964E 75	
BOATS	ACTUAL CATCH PER VESSEL; BY VESSEL CLASS						
132	0.36375475E 06	0.43650563E 06	0.50198100E 06	0.69477138E 06	0.70204619E 06	0.72023406E 06	
THIS IS MODEL 1 : THE BASE MODEL							



