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Critique and Sensitivity Analysis of the Compensation Function Used in the LMS Hudson River Striped Bass Models

W. Van Winkle
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Environmental Sciences Division Publication No. 944

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CRITIQUE AND SENSITIVITY ANALYSIS OF THE
COMPENSATION FUNCTION USED IN THE LMS
HUDSON RIVER STRIPED BASS MODELS

W. Van Winkle, S. W. Christensen, and G. Kauffman¹

ENVIRONMENTAL SCIENCES DIVISION

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ABSTRACT

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The description and justification for the compensation function developed and used by Lawler, Matusky & Skelly Engineers (LMS) (under contract to Consolidated Edison Company of New York) in their Hudson River striped bass models is presented. A sensitivity analysis of this compensation function is reported, based on computer runs with a modified version of the LMS completely mixed (spatially homogeneous) model. Two types of sensitivity analysis were performed: (1) a parametric study involving at least five levels for each of the three parameters in the compensation function, and (2) a study of the form of the compensation function itself, involving comparison of the LMS function with functions having no compensation at standing crops either less than or greater than the equilibrium standing crops. For the range of parameter values used in this study, estimates of percent reduction are least sensitive to changes in Y_S , the equilibrium standing crop, and most sensitive to changes in KX_0 , the minimum mortality rate coefficient. Eliminating compensation at standing crops either less than or greater than the equilibrium standing crops results in higher estimates of percent reduction. For all values of KX_0 and for values of Y_S and KX at and above the baseline values, eliminating compensation at standing crops less than the equilibrium standing crops results in a greater increase in percent reduction than eliminating compensation at standing crops greater than the equilibrium standing crops.

The conceptual basis for the LMS compensation function is criticized, particularly the lack of a sound biological basis for the left limb of the function. An alternative functional form is presented. The lack of a relationship between any of the three parameters in the LMS compensation function and measureable biological phenomena is also criticized.

Together, the critique and sensitivity analysis of the compensation function used in the LMS Hudson River striped bass models highlight the need for caution in relying on these models to reach a reasoned decision on the potential impact of the Hudson River power plants on the striped bass population.

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INTRODUCTION

The primary issue in controversy with respect to estimating the effects of entrainment and impingement on the Hudson River striped bass population is the extent to which regulatory agencies, utilities, and society should rely on compensatory decreases in natural mortality to offset the increased mortality due to the power plants. This issue is of particular importance in terms of how compensation is included in striped bass simulation models, because the handling of compensation appears to account for the major part of the difference among estimates of percent reduction in the striped bass population.

The objectives of this report are (1) to present the description and justification for the compensation function developed and used by Lawler, Matusky & Skelly Engineers (LMS) (under contract to Consolidated Edison Company of New York), and (2) to present a sensitivity analysis and critique of the LMS compensation function.

LMS FORMULATION OF COMPENSATION^{1,2,3}

LMS describes and justifies the mathematical formulation for density-dependent mortality of early life stages, which is used in all three of the LMS striped bass models to estimate the percent reduction due to power plant operation, as follows:²

"Quantitative accounting for compensation in biological systems is simply a recognition that, as in other physical systems, first order kinetics cannot be employed to describe survival kinetics over the whole range of population. This recognition requires that rather than using the simple first order decay function exclusively to describe natural survival behavior, a more complex expression must be employed.

"This expression should reduce to the first order function over the range of populations where such is appropriate, but should also recognize the tendency of the system to compensate itself when driven substantially beyond this range in either the direction of increased populations or in the direction of decreased populations. This is the concept of homeostasis or 'biofeedback', that is, that a living system tends to be self-stabilizing.

"The first order decay expression is written:

$$\text{Rate of mortality, fish/unit volume/day} = K_E N$$

in which:

N = number of fish per unit volume of water

K_E = unit first order decay rate, a constant having the units of days⁻¹.

"This expression was used in the early modeling [1] to describe the natural mortality behavior in any life stage. The numerical value of K_E is obtained when the duration of the stage in days and the percent survival for that stage are known.

"The kinetic expression employed in the transport model was developed by employing the first order form, in which a general rate coefficient K , rather than the constant K_E , is introduced and is allowed to vary with fish concentration.

"For any stage, K is varied with the prevailing concentration so that the rate of mortality in that stage increases with increasing concentration (due to crowding, less food per unit number of fish, more food [fish] for predators, etc.) and decreases with decreasing concentration for the converse reasons. Thus, the concept of homeostasis is preserved in the model.

"The functional form chosen for variation of K is:

$$K = K_E + (K_E - K_0) \left(\frac{N - N_s}{N_s} \right)^3 \dots \dots \dots (1)$$

in which:

K = generalized unit mortality rate, day⁻¹

K_E = conventional first order or "equilibrium" rate, day⁻¹

K_0 = minimum unit mortality rate consistent with system biology, day⁻¹

N_s = "saturation" or equilibrium population level, fish per unit volume

N = actual fish concentration at any point in time (week and year) and space (river location)

"This kinetic model has been developed after extensive review of population dynamics literature ([a] through [f]). Many of the concepts described herein are presented in these earlier references in a largely qualitative fashion; they have been quantified here.

"Figure [1], which is a graphical representation of the behavior of Equation 1 for a given set of rate constants (K_E , K_O , N_S), shows how the generalized rate coefficient, K , varies with population density. Explanation of the behavior of Equation 1 and Figure [1] follows. [The Figure 1 in this report is a modified version of the original LMS Figure 9 of Ref. 2.]

"Consideration of Equation 1 shows that when the actual population, N , is equal to the "saturation" population, the K rate reduces to the constant K_E , signifying normal first order behavior.

"What we are saying is that, on a long-term basis, exclusive of the plant's effect, we are considering the estuary juvenile striped bass population to have reached some "saturation" or "equilibrium" level. This does not imply that the estuary can never support more life - it simply says that for the existing set of background conditions, i.e., conditions both natural and man-made that exist prior to the operation of the plant, the river is "in balance" or is supporting that level of life which it is capable of supporting, considering all the external factors, both good and bad, that presently exist.

^aNicholson, A. J., "The Self Adjustment of Population to Change," Cold Spring Harbor Symposium, 1957, Quant. Biol. 22:153-172.

^bNicholson, A. J., "An Outline of the Dynamics of Animal Populations," Australian Journal of Zoology, 2:9-65, 1954.

^cSmith, F. E., "Population Dynamics in Daphnia magna and a New Model for Population Growth," Ecology 44:651-663, 1963.

^dErrington, P. L., "Factors Limiting Higher Vertebrate Populations," Quart. Rev. Biol. 21:144-177, 1946.

^eWangersky, P. J., Cunningham, W. J., "Time Lag in Population Models," Cold Spring Harbor Symposium, 1957, Quant. Biol. 22:329-338.

^fPatten, B. C., "System Analysis and Simulation in Ecology," Academic Press, New York, pages 275 through 278, 1971.

Fig. 1. Exponential mortality coefficient vs concentration (Juvenile 1) (modified from Fig. 9 of ref. 2). Equivalent symbols used elsewhere in this report: YS = N_s; KX = K_E; KX0 = K₀.

"These include, for example; the possibility that railroad construction before the turn of the century on both sides of the river may have cut off some natural nursery areas, that the Sacandaga and Indian Lake Reservoirs in the Adirondack Mountains near the headwaters of the Hudson are probably posing a different freshwater regime than once existed, etc.

"Whether we are close or far from the theoretical ultimate saturation that might be reached under the best of conditions is beside the point. We are only interested in saying that before a specific new influence enters the river, the river is probably not in a state in which significant departure from a balanced population exists.

"The mathematics chosen represent this notion quite well. The plateau shown in Figure [1], extending over a concentration range of .42 [per one thousand] cubic feet to .68 [per one thousand] cubic feet of juvenile I's, and in an approximate sense over an even broader range, corresponds to the saturation level. The decay rate is constant at $.0536 \text{ day}^{-1}$, the chosen value of K_E . Note that this corresponds to 20% survival over 30 days of life of any juvenile I complement. The kinetics over this relatively broad range are essentially first order, the system is in relative balance or at relative equilibrium, and there is little active compensation. The important point is that this numerically apparent non-compensatory behavior is occurring over a relatively broad range centered about "existing" conditions in the river.

"This notion is shown again in Figure [2] where survival rate versus concentration is plotted. [The Figure 2 in this report is a modified version of the original LMS Figure 10 of Ref. 2.]. The daily survival rate at which relative equilibrium is attained for this stage is .948. Note that the carrying capacity concentration satisfying this plateau is in the range .42 to .68 per one thousand cubic feet for given values. On either side of this plateau, we observe either an increase or decrease in survival of existing concentration. Survival increases to compensate for lower concentration and decreases to compensate for higher concentration.

"Now, Equation 1 also indicates that as the fish concentration drops off, because of induced population-draining effects, the rate of mortality, K , continues to decrease until a minimum rate of mortality, K_0 , is reached. K approaches K_0 as the population decreases

Fig. 2. Probability of survival vs concentration (Juvenile I) (modified from Fig. 10 of ref. 2). Equivalent symbols used elsewhere in this report: YS = N_s; KX = K_E; KX0 = K₀.

toward zero. Thus, K_0 may be interpreted as the minimum rate of mortality that will exist in the system when population influences on mortality (competition for food, availability to predators, etc.) are eliminated.

"In this sense, K_0 has the same system interpretation as does K_E and N_S , i.e., it is representative of the "now" condition in the estuary, taking into account all positive and negative, natural and man-made influences on the system.

"Equation 1, therefore, shows that, as concentrations are reduced by plant effects, the mortality rate due to other effects will decrease, thereby compensating partially for the smaller numbers by allowing a larger fraction of the fish that remain to advance to the next stage. This will only partially offset the effects of the plant, since each early stage is subjected to either entrainment or impingement by the plant.

"Note that in the presence of a factor which will tend to increase population, such as a year in which "everything is right," the mortality rate, K , will exceed K_E and the tendency to increase the population will be controlled. Thus, compensation can be seen to be the mechanism which keeps a fluctuating population under control. The fate of a fluctuating non-compensating feed back system is discussed in detail in the early testimony.[1]

"In summary, then, Equation 1 was chosen to represent background or existing survival kinetics in the model because it operates in a normal first order fashion about existing concentrations and will permit partial compensation if significant departures from existing levels occur upon introduction of new influences."

LMS uses exactly the same compensation function in its real-time, two dimensional model.³ With one modification, LMS also uses the same compensation function in its completely (totally) mixed model (i.e., spatially homogeneous model).¹ The one modification is that N_S , the "saturation" or equilibrium population density (fish per unit volume) used in the two transport models, is replaced by Y_S , the "saturation" or equilibrium standing crop for the entire Hudson River estuary.

SENSITIVITY ANALYSIS OF THE COMPENSATION FUNCTION USING THE LMS COMPLETELY MIXED STRIPED BASS MODEL

Justification for Using the Completely Mixed Model

As indicated in the preceding section, LMS uses essentially the same compensation function in all three of its striped bass models. We selected the completely mixed model for the detailed sensitivity analysis of this function because it is the easiest and least expensive of the three models to run. We have also performed a sensitivity analysis of the LMS compensation function using the LMS tidal-averaged, one dimensional model.⁴

Methods

We started with the deck of computer cards for the transport and completely mixed models as supplied⁵ and documented⁶ by LMS and Con Edison. These two models consist of subroutines of a main program, with the main program calling whichever model is specified. We modified the main program to call only the completely mixed model and left only those few subroutines required for the completely mixed model. Additional changes were made in the program, relating primarily to input and output. The basic mathematical formulation of the model was not altered except in one part of the investigation [the flattening out horizontally (i.e., disabling) of the right or left limb of the compensation function]. A listing of the computer program as used by ORNL is given in Appendix A. Input data cards for a sample run are given in Appendix B, and output from the sample run is given in Appendix C.

We performed two types of sensitivity analysis: (1) a parametric study involving a range of values for each of the three parameters in the compensation function, and (2) a study of the form of the compensation function itself involving disabling the left or right limb.

The LMS compensation function has three parameters for each life stage: $YS(\equiv N_s)$, the saturation or equilibrium standing crop; $KX(\equiv K_E)$,

the corresponding equilibrium mortality rate coefficient; and $KX_0 (\equiv K_0)$, the minimum mortality rate coefficient (see Figs. 1 and 2). (The variables in all capital letters are the computer variable names, which are used throughout the remainder of this report. The variables in parentheses are the mathematical symbols used by Lawler, Matusky & Skelly Engineers as quoted earlier in this report.) For each of these three parameters we carried out a separate sensitivity analysis using at least five different values for the parameter. The values of the remaining two parameters were held constant at the baseline values.

The baseline parameter values [Table 1(a)] were selected as follows. The probability of survival (PS) and duration (DTE) were specified for each life stage. The PS values were selected so that the probability of survival from egg to yearling was 0.00001 and the probability of survival from Juvenile 1 through Juvenile 3 was 0.01, with the probability of survival the same for each of the three juvenile life stages. The DTE values are those used by LMS except for eggs (2.0 vs 1.5 days) and Juvenile 2 (100 days vs 100.5 days). Baseline KX values were calculated as $-\ln(PS)/DTE$. The model was run using these KX values and $KX_0 = KX$ for each life stage (i.e., no compensation) without the power plant in operation. The program was modified to select and print NMAX, the maximum standing crop calculated for each life stage during the simulation. Then baseline YS values were taken as one-half of these maximum standing crop values. The choice of one-half was designed to assure that both limbs, as well as the plateau, of each compensation function would be utilized. Baseline KX_0 values were calculated as 0.8 KX. Additional levels for the values of the equilibrium standing crop (YS), the equilibrium mortality rate coefficient (KX), and the minimum mortality rate coefficient (KX_0) were obtained by using the multiplicative constants (denoted AYS, AKX, and AKX₀, respectively) in Table 1(b). Note that level 4 of AYS, level 4 of AKX, and level 3 of AKX₀ (i.e., $KX_0 = 0.8 KX$) correspond to the baseline set of parameter values.

Table 1. Parameter values used by ORNL in its sensitivity analysis of the LMS compensation function

(a) Baseline values

Parameter		Life stage				
Symbol ^a	Units	Egg ^b	Larva	Juvenile 1	Juvenile 2	Juvenile 3
PS		0.1	0.01	0.215	0.215	0.215
DTE	Days	2	28	30	100	158
YS($\equiv N_s$)	No. of organisms	----	1.47E9 ^c	2.65E7 ^c	8.98E6 ^c	2.29E6 ^c
KX($\equiv K_E$)	Day ⁻¹	1.15	0.164	0.0511	0.0124	0.00972
KX0($\equiv K_0$) ^d	Day ⁻¹	----	0.132	0.0409	0.00996	0.00778

^aPS = probability of survival through the life stage; DTE = duration of the life stage; YS = saturation or equilibrium standing crop; KX = equilibrium mortality rate coefficient; KX0 = minimum mortality rate coefficient.

^bORNL and LMS assume no compensation occurs in the egg stage.

^cFortran exponential notation; e.g., 1.47E9 = 1.47×10^9 .

^dFor each life stage, KX0 = 0.8 KX; e.g., for larvae $0.132 = 0.8 (0.164)$.

(b) Multiplicative constants^e

Level	AYS	AKX ^f	AKX0 ^g
1	0.2	0.5	0.3
2	0.5	0.75	0.5
3	0.75	0.9	0.8
4	1.0	1.0	0.9
5	1.5	1.1	1.0
6	2.0	1.2	
7	5.0	1.3	

^eFor a given parameter (i.e., YS, KX or KX0) and model run, the same multiplicative constant (value of AYS, AKX or AKX0, respectively) was used for all four life stages. Parameter values are calculated in the computer program by multiplying the baseline values in Table 1(a) by multiplicative constants selected from Table 1(b).

^fIn the sensitivity analysis for KX, KX0 values were always calculated as 0.8 times the KX value being used. For example, for larvae and AKX = 0.5, the KX value used in the model is $0.5 (0.164) = 0.082$. Then the KX0 value used in the model is $0.8 (0.082) = 0.0656$.

^gThe AKX0 multiplicative constants were applied to the baseline KX values (Table 1(a)). The approach was to specify a value for the ratio KX0/KX($\equiv$ AKX0) (e.g., 0.3), and then given the baseline KX value (e.g., 0.164 for larvae) to calculate KX0 as $KX0 = AKX0 \cdot KX$ for the different levels of AKX0 given in Table 1(b) (e.g., $KX0 = 0.3 (0.164) = 0.0492$).

The range of values used for each parameter was large enough to evaluate the sensitivity of the model to parameter variations in the neighborhood of the baseline values. We have not included results for what we consider to be extreme variations in parameter values. Extreme variations around the baseline values do provide further insight into the operation of the LMS compensation function, but they tend to be inconsistent with the LMS conceptual justification for the function of controlling population levels about an equilibrium point.

In addition to the above parametric study of the LMS compensation function, we examined the sensitivity of the results to the form of the function itself by disabling either the left limb or the right limb (see Figs. 1 and 2). Again, when values of one parameter were changed, the values of the remaining two parameters were held constant at the baseline values. Note that disabling both arms simultaneously eliminates compensation from the model and is equivalent to the case with $AKX0 = 1.0$.

The left limb was disabled for each life stage by setting the cubic term in Eq. (1) equal to zero whenever the standing crop at time t , $N(t)$, was less than the equilibrium standing crop, YS ; i.e., whenever $N(t) < YS$. The right limb was disabled in a similar manner, but based on the test condition $N(t) > YS$. Figure 3 provides an example of the resulting shapes of the LMS compensation function when the left limb or right limb is disabled. The effects of disabling the left limb or the right limb were compared with each other and with the case of neither arm disabled.

The model was run for 41 years (year 0 through year 40) for each parameter combination and form of the compensation function. The output for year 0 provided results with no power plant; the output for year 1 provided results with the power plant operating for 1 year; and the output for year 40 provided results with the power plant operating for 40 years. The hypothetical power plant considered in these model runs had an intake flow of 8000 cubic feet per second (cfs), which is more than the combined intake flows of Indian Point Units.

Fig. 3. Exponential mortality coefficient vs concentration (Juvenile 1) (modified from Fig. 9 of ref. 2), showing the effect on the curve of disabling the left or right limb of the compensation function. Equivalent symbols used elsewhere in this report: YS = N_s; KX = K_E; KX0 = K₀.

1, 2, and 3 (4585 cfs) and less than the combined intake flows at Indian Point plus Bowline, Lovett, Roseton, and Danskammer (9150 cfs). A composite f-factor value of 0.5 was used for each of the three entrainable life stages (eggs, larvae, and Juvenile 1). (We have also performed a combined sensitivity analysis for compensation parameters and f-factors using the LMS tidal-averaged, one dimensional transport model.⁴)

The code number and description of output variables we have tabulated for each model run are given in Table 2. Variables 1-15 are for production into a life stage, ratio of maximum standing crop to equilibrium standing crop (NMAX/YS), and percent survival through the life stage for each of the five young-of-the-year life stages. In addition, there are variables for number of yearlings produced (16), total number of adults in the population (17), relative number of adults in age classes 1, 2, and 3 (18), and annual probability of survival for adults in each of age classes 4 through 13 (19). Values of variables 1-19 were tabulated for years 0, 1, and 40. Variables 62-74 are the "impact variables." The percent reduction caused by the power plant is calculated for each young-of-the-year life stage and for yearlings and total number of adults. As an example, percent reduction in the number of young-of-the-year striped bass surviving to become yearlings after one year of power plant operation is calculated as:

$$100 \times \frac{(\text{Number of yearlings produced in year 0} - \text{Number of yearlings produced in year 1})}{\text{Number of yearlings produced in year 0}}$$

Values of variables 62-74 were tabulated for years 1 and 40, with year 0 (no power plant) as the reference condition in both cases.

Results

Detailed results corresponding to the variables in Table 2 are given in Appendix D, Tables D1-D6. Graphs in this Results section are based on values from these tables.

Table 2. Code number and description of output variables
tabulated by ORNL

Output variable code ^a	Description of output variable ^b
01	Number of eggs produced
03	Percent survival through the egg life stage
04	Number of larvae produced
05	NMAX/YS for larvae
06	Percent survival through the larval life stage
07	Number of J1 produced
08	NMAX/YS for larvae
09	Percent survival through J1
10	Number of J2 produced
11	NMAX/YS for J2
12	Percent survival through J2
13	Number of J3 produced
14	NMAX/YS for J3
15	Percent survival through J3
16	Number of yearlings produced
17	Total number of adults
18	Relative age composition in the first three age classes
19	Annual probability of survival for adult age classes 4-13 ^c
<u>Impact Variables</u>	
62	Percent reduction in number of eggs produced
64	Percent reduction in number of larvae produced
66	Percent reduction in number of J1 produced
68	Percent reduction in number of J2 produced
70	Percent reduction in number of J3 produced
71	Reduction in number of yearlings produced
72	Percent reduction in number of yearlings produced
73	Reduction in total number of adults
74	Percent reduction in total number of adults

^aVariables 1-18 are used for each of year 0 (power plant off) and years 1 and 40 (power plant on); variables 62-74 are used for each of years 1 and 40 and refer to percent or number reductions at year 1 and year 40 relative to year 0. See text for definition of percent reduction.

^bNMAX is the maximum standing crop occurring in a given model run for the indicated life stage; YS is the saturation or equilibrium standing crop for the indicated life stage and is an input parameter; J1 denotes the Juvenile 1 life stage; J2 denotes the Juvenile 2 life stage; J3 denotes the Juvenile 3 life stage.

^cVariable 19, the annual probability of survival for adults in each of age classes 4 through 13, is calculated during year 0 using an iteration scheme. It is calculated to satisfy the constraint that, given the values for all of the other parameters in the model, this is the annual probability of survival for adults that results in a constant adult population with no power plant. This parameter is then held constant for years 1 through 40.

Sensitivity analysis for YS, the equilibrium standing crop

The dependence of percent reduction in number of yearlings (age class 1) and number of adults (age classes 1-13) on YS (N_s of Eq. 1) is quite complicated (Figs. 4a and 4b), although two basic trends stand out and merit comment. Values of YS less than the baseline values (that is, where the multiplicative constant $AYS < 1.0$) result in lower percent reductions than for the baseline case. Values of YS greater than the baseline values ($AYS > 1.0$) result in higher percent reductions. As would be expected, these trends are more obvious at year 40 than at year 1. For example, at year 40 the percent reduction in number of adults ranges from 15 to 49%, while at year 1 the percent reduction ranges from 7 to 12% (Fig. 4b). It is important to note that these variations are due to relatively small changes in YS from one-half ($AYS = 0.5$) to twice ($AYS = 2.0$) the baseline values.

The curves in Figs. 4a and 4b may be explained, in part, by the shape of the curves in Fig. 4c. Again YS is the equilibrium standing crop for a given life stage, which was varied over seven levels by means of the multiplicative constant AYS; the value of YS fixes the location of the plateau of the compensation function along the abscissa (Figs. 1 and 2). NMAX is the maximum standing crop calculated for a given life stage during each simulation. Thus, the ratio $NMAX/YS$ is an indicator of the right-most point on the compensation curve actually used in a given model run (Figs. 1 and 2; note the X-axis scale at the top of these figures). For example, if $NMAX/YS = 1.0$ for a given life stage, this means that the simulated standing crop reached a maximum value of YS; thus, only the left limb of the compensation function was used at all. As indicated in Fig. 4c and as would be expected, increasing YS ($AYS > 1.0$) causes $NMAX/YS$ to decrease, eventually to less than 1.0. Decreasing YS ($AYS < 1.0$) causes $NMAX/YS$ to increase, although for $AYS \leq 0.5$ the value of $NMAX/YS$ ultimately decreases for the juvenile life stages.

Considered together, Figs. 4a, 4b, and 4c indicate that at YS values slightly above the baseline levels ($1.0 < AYS \leq 2.0$), NMAX

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Fig. 4. Sensitivity of (a) percent reduction of yearlings, (b) percent reduction of adults, and (c) N_{MAX}/Y_S to changes in Y_S values.

and YS approach each other and the populations spend more time on the plateau (region of no compensation) and left limb of the compensation function, with the result that percent reduction increases. At YS values greater than NMAX ($AYS > 2.0$), the populations are restricted to the left limb (which is compensatory at all points), with the result that percent reduction decreases slightly. As YS decreases below the baseline levels ($AYS < 1.0$), the model tends to operate more on the right limb of the compensation function, which gets progressively steeper (i.e., stronger compensation), with the result that percent reduction decreases.

Sensitivity analysis for KX, the first order mortality rate coefficient

The dependence of percent reduction in number of yearlings and number of adults on KX (K_E of Eq. 1) is illustrated in Fig. 5. Values of KX less than the baseline values (that is, where the multiplicative constant $AKX < 1.0$) result in lower percent reductions than the baseline case. Values of KX greater than the baseline values ($AKX > 1.0$) result in higher percent reductions. Again, these trends are more obvious at year 40 than year 1. For example, at year 40 the percent reduction in number of adults ranges from 3 to 44%, while at year 1 the percent reduction ranges from 2 to 10% (Fig. 5b). Estimates of percent reduction are particularly sensitive to changes in KX in the neighborhood of the baseline values ($0.75 \leq AKX \leq 1.1$).

The curves in Figs. 5a and 5b may be explained by the curves in Fig. 5c, which is analogous in derivation to Fig. 4c. Again, the ratio NMAX/YS is an indicator of the right-most point on the compensation curve used in a given model run (Figs. 1 and 2; note the X-axis scale at the top of these figures). Increasing KX ($AKX > 1.0$) causes NMAX/YS to decrease, eventually to less than 1.0 for all three juvenile life stages. Decreasing KX ($AKX < 1.0$) causes NMAX/YS to increase to values considerably greater than 2.0, which is the approximate baseline ratio for all four life stages.

Considered together, Figs. 5a, 5b, and 5c indicate that at KX slightly above the baseline levels ($1.0 < AKX \leq 1.1$), natural mortality

Fig. 5. Sensitivity of (a) percent reduction of yearlings, (b) percent reduction of adults, and (c) NMAX/YS to changes in KX values.

increases, and thus, NMAX decreases and approaches YS as the populations spend more time on the plateau (region of no compensation) and left limb of the compensation function. As a result percent reduction increases. At still higher KX values ($AKX > 1.1$), NMAX becomes less than YS and the populations are restricted to the left limb which is compensatory at all points. As a result percent reduction decreases slightly. As KX decreases below the baseline levels, natural mortality decreases and thus NMAX increases and the populations spend more time on the right limb of the compensation function, which gets progressively steeper (i.e., stronger compensation), with the result that percent reduction decreases.

Sensitivity analysis of KX_0 , the minimum mortality rate coefficient

The dependence of percent reduction in number of yearlings and number of adults on KX_0 (K_0 of Eq. 1) is illustrated in Fig. 6. Values of KX_0 less than the baseline values (that is, where the multiplicative constant $AKX_0 \leq 0.8$) result in lower percent reductions than the baseline case. Values of KX_0 greater than the baseline values ($AKX_0 > 0.8$) result in higher percent reductions. Once again, these trends are more obvious at year 40 than year 1. For example, at year 40 the percent reduction in number of adults ranges from 8 to 85%, while at year 1 the percent reduction ranges from 4 to 14% (Fig. 6b). Estimates of percent reduction are particularly sensitive to changes in KX_0 above the baseline values, but become progressively less sensitive below the baseline values.

The curves in Figs. 6a and 6b may be explained as follows. The major effect on the compensation curves (Figs. 1 and 2) of changing KX_0 , while holding YS and KX constant, is to increase ($AKX_0 > 0.8$) or decrease ($AKX_0 < 0.8$) the steepness of both the left and right limbs. When $AKX_0 = 1.0$, a horizontal straight line at $KX_0 = KK$ results; this case corresponds to no compensation. Values of KX_0 greater than KK ($AKX_0 > 1.0$) are theoretically possible, but they have not been used in the present study; such cases correspond to compensatory mortality, i.e., a decrease in the mortality rate as standing crop increases.

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Fig. 6. Sensitivity of (a) percent reduction of yearlings and (b) and (c) percent reduction of adults to changes in KX0 values. Fig. 6c is a plot of results from model runs by the applicant (Ref. 7).

As the limbs of the compensation function become steeper, the effectiveness of compensatory changes in mortality in the model increases, and estimates of percent reduction decrease.

This aspect of our sensitivity analysis has also been performed by LMS with similar results⁷ (Fig. 6c). The major difference between the two analyses is that the LMS curve is shifted downwards and covers a narrower range of percent reduction values. This difference is due primarily to the use by LMS of: (1) lower f-factors (for discussion of f-factors, see Ref. 8, pp. V-87 to V-101) for eggs, larvae, and Juvenile I [(0.4, 0.4, 0.2) versus (0.5, 0.5, 0.5)]; (2) lower total power plant intake flow [2642 cfs (Indian Point Units 1 and 2 with once-through cooling) versus 8000 cfs (hypothetical power plant)]; and (3) a 10-year versus a 40-year simulation.

Disablement of the left or right limb of the compensation function

Dependence on YS. The dependence of percent reduction in number of yearlings at year 40 on YS with neither limb of the compensation function disabled, left limb disabled, and right limb disabled is illustrated in Fig. 7. The curve for neither limb disabled is the same as the curve for year 40 in Fig. 4a. Disabling the left limb results in higher percent reductions, especially for YS at and above the baseline values ($AYS \geq 1.0$). Disabling the right limb also results in higher percent reductions, especially for YS at and below the baseline values ($AYS \leq 1.0$).

The curves in Fig. 7 may be explained as follows. Disabling either limb decreases the range of standing crops over which compensatory changes in mortality can occur (Fig. 3). In addition, decreasing YS ($AYS < 1.0$) accentuates the importance of the right limb of the compensation function in offsetting power plant mortality, while increasing YS ($AYS > 1.0$) accentuates the importance of the left limb (Fig. 3). Thus, disabling the left limb in combination with AYS values > 1.0 markedly increases percent reductions (Fig. 7). Likewise, disabling the right limb in combination with AYS values < 1.0 markedly increases percent reductions.

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Fig. 7. Dependence of percent reduction in number of yearlings at year 40 on the value of AYS with neither limb of the compensation function disabled (●—●), left limb disabled (Δ—Δ), and right limb disabled (○—○).

Dependence on KX. The dependence of percent reduction in number of yearlings at year 40 on KX with neither limb of the compensation function disabled, left limb disabled, and right limb disabled is illustrated in Fig. 8. The curve for neither limb disabled is the same as the curve for year 40 in Fig. 5a. The curve for the left limb disabled is similar in shape to that for neither limb disabled. However, the percent reduction values with the left limb disabled are approximately double the values with neither limb disabled for KX at and above the baseline KX values ($AKX \geq 1.0$). With the right limb disabled the dependence of percent reduction on KX is the reverse of that with neither limb disabled or the left limb disabled. Percent reduction is highest for small KX values ($AKX < 1.0$) and decreases for large KX values ($AKX > 1.0$) to approach the curve for neither limb disabled.

The curves in Fig. 8 may be explained as follows. Again, disabling either limb decreases the range of standing crops over which compensatory changes in mortality can occur. Decreasing KX ($AKX < 1.0$) decreases mortality, and thus increases standing crops and NMAX values (Table D5). As a result the left limbs of the compensation functions become relatively unimportant, and consequently, disabling the left limbs does not have much effect on percent reduction at low AKX values. On the other hand, because of the increases in standing crops and NMAX values, the right limbs of the compensation functions are of greater importance; consequently, disabling the right limbs at low KX values results in tremendous increases in percent reduction (Fig. 8).

Increasing KX increases mortality, and thus decreases standing crops and NMAX values (Table D5). As a result the right limbs of the compensation functions become relatively unimportant, and consequently, disabling the right limbs does not have much effect on percent reduction at high AKX values (Fig. 8). On the other hand, because of the decreases in standing crops and NMAX values, left limbs of the compensation functions are of greater importance. Consequently, disabling the left limbs at high KX values increases percent reduction.

Fig. 8. Dependence of percent reduction in number of yearlings at year 40 on the value of KX with neither limb of the compensation function disabled (●—●), left limb disabled (Δ—Δ), and right limb disabled (○—○).

The slight decrease in percent reduction at $AKX = 1.2$ (the model is unstable at $AKX = 1.3$) from the apparent maximum percent reduction at $AKX = 1.1$ for the case of the left limb disabled merits comment because this result reflects a subtle balancing of opposing effects. As AKX increases from 1.1 to 1.2, the resulting higher mortality rates have the effect of decreasing standing crops and $NMAX$ values and of driving the life stage populations off the right limbs of the compensation functions. In fact, as indicated in Table D5, by year 40 $NMAX$ is considerably less than YS for each life stage, and because the left limbs of the compensation functions are disabled in this case, there is no compensation in effect during the latter years of these model runs. As AKX increases from 1.1 to 1.2, however, the right limbs of the compensation functions become steeper (i.e., stronger compensation). During the earlier years of the model run when the $NMAX$ values are still larger than the YS values, percent reduction decreases as AKX increases from 1.1 to 1.2, due to the increasingly strong compensation. This trend during the earlier years carries over to year 40 and accounts for the decrease in percent reduction at $AKX = 1.2$.

Dependence on $KX0$. The dependence of percent reduction in number of yearlings at year 40 on $KX0$ with neither limb of the compensation function disabled, left limb disabled, and right limb disabled is illustrated in Fig. 9. The curve for neither limb disabled is the same as the curve for year 40 in Fig. 6a. Disabling either the left or right limb of the compensation function results in higher percent reductions, especially for $KX0$ at and below the baseline value ($AKX0 \leq 0.8$). Disabling the left limb, as compared to the right limb, results in somewhat higher percent reductions. The relative steepness of the three curves in Fig. 8 indicates that the sensitivity of the model to the value of $KX0$ is greatest when neither limb is disabled and is least when the left limb is disabled.

The curves in Fig. 9 may be explained as follows. Disabling either limb decreases the range of standing crops over which compensatory changes in mortality can occur. In particular, disabling the left limb eliminates compensatory changes in mortality for standing crops

Fig. 9. Dependence of percent reduction in number of yearlings at year 40 on the value of KX0 with neither limb of the compensation function disabled (●—●), left limb disabled (Δ—Δ), and right limb disabled (○—○).

less than YS, while disabling the right limb eliminates compensatory changes for standing crops greater than YS (Fig. 3). Figure 9 indicates that both limbs of the compensation function are important in offsetting power plant mortality for all values of KX0, but that the left limb is the more important of the two.

Summary

(1) Two types of sensitivity analysis were performed: (a) a parametric study involving at least five levels for each of the three parameters in the compensation function, (b) a study of the form of the compensation function itself involving disabling the left or right limb.

(2) The model was run for 41 years (year 0 through year 40) for each parameter combination and form of the compensation function--year 0 with no power plant and years 1 through 40 with a power plant. The hypothetical power plant had an intake flow of 8000 cfs. A composite f-factor value of 0.5 was assumed for each of the entrainable life stages (eggs, larvae, and Juvenile 1).

(3) Output variables, including production, percent survival, and population size, were tabulated for years 0, 1, and 40. Values for percent reduction due to power plant mortality were tabulated for years 1 and 40, with year 0 as the reference case.

(4) For the range of parameter values used in this study, estimates of percent reduction are least sensitive to changes in YS, the equilibrium standing crop, and most sensitive to changes in KX0, the minimum mortality rate coefficient. Estimates of percent reduction in number of adults at year 40 range from 15 to 49% for YS, 3 to 44% for KX, and 8 to 85% for KX0.

(5) Disabling either limb of the compensation function results in higher estimates of percent reduction. For all values of KX0 and for values of YS and KX at and above the baseline values, disabling the left limb resulted in a greater increase in percent reduction than did disabling the right limb.

DISCUSSION

Conceptual Basis for the LMS Compensation Function^a

We feel that the LMS mathematical formulation, as described under LMS formulation of compensation, is not conceptually sound. As implemented in the three LMS striped bass models,^{1,2,3} the assumption is made that without the new power plants (Indian Point Units 2 and 3, Bowline, and Roseton), "the system is in relative balance or at relative equilibrium, and there is little active compensation." For young-of-the-year life stages of striped bass, it is difficult to visualize a source of mortality that (1) is a minimum near zero density, (2) increases (although at a decreasing rate) at low densities to reach a plateau over a range of intermediate densities (0.42 to 0.68 in Figs. 1 and 2 for the Juvenile 1 life stage), and then (3) increases again (but now at an increasing rate) at a high density. For example, it is not reasonable to hypothesize a curve with this entire shape due solely to crowding or less food per unit number of fish as density increases.

In particular, there is not a sound biological basis for the left limb of the curves in Figs. 1 and 2 for fish species such as striped bass. Much of the theory of compensation in animal populations is based on experience with terrestrial and higher vertebrate populations. In these populations there may be sound biological bases for hypothesizing the left half of the curves in Figs. 1 and 2, which show a decreasing mortality coefficient and an increasing probability of survival as density decreases to very low values. The biological bases for this type of curve involve refugia, territoriality, food preferences of predators on target species (e.g., young-of-the-year striped bass as the target species), and other behavioral phenomena that tend to be more highly developed in terrestrial and higher vertebrate species than in nonterritorial fish species such as the striped bass. Based on model results LMS has presented to date, it is not clear which half

^aFor a previous discussion of some of the points mentioned below, see reference 7, pages 134-135.

of the curves in Figs. 1 and 2 is the more important in offsetting the power plant impact. However, because the density in each river segment initially starts at zero and finally drops back down to zero, the left limbs of these curves are certainly utilized.

In our opinion, a mathematical formulation for compensation for striped bass with a more sound biological basis is one that has a plateau extending from zero to some critical density. Above this critical density the density-dependent parameter increases (e.g., mortality rate coefficient and duration) or decreases (e.g., growth rate coefficient and probability of survival) with further increases in density due to resource limitations or selective predation.⁹ The compensation functions used in both our young-of-the-year model¹⁰ and our life cycle model¹¹ have this property.

As an example, Fig. 10 is a schematic representation of the population density correction factor for the apparent survival probability used in the ORNL computer simulation model for the striped bass young-of-the-year population in the Hudson River.¹⁰ This type of function is analogous to the plateau and right limb of the compensation function used by LMS (cf. Figs. 2 and 10). Given this formulation, the major issue (i.e., the extent to which regulatory agencies, utilities, and society should rely on compensatory changes in mortality to offset the increased mortality due to the power plants) reduces to choosing: (a) critical densities, (b) steepness of the right limbs of curves, and (c) where to assume the population would exist on the curve without the additional power plant mortality.

We are also concerned about the conceptual relationship between the three parameters in the LMS compensation function and actual biological phenomena.

YS

The parameter YS for a given life stage is defined as the equilibrium population level in the Hudson River. In our opinion the entire

Fig. 10. Schematic representation of the population density correction factor for the apparent survival probability used in the ORNL computer simulation model for the striped bass young-of-the-year population in the Hudson River.

concept of an equilibrium population level for any of the young-of-the-year life stages is inappropriate. Within a year, the young-of-the-year population consists of a series of linked transients, with one life stage overlapping with both the preceding and succeeding life stages. To speak of an equilibrium population level for each life stage in such a system is meaningless. In dealing with comparisons among years, only the concepts of an average maximum standing crop and an average transient curve for a given life stage have operational meaning. In summary, it is our opinion that the parameter YS has no operational meaning for the transient dynamics of the young-of-the-year life stages, and it cannot be based directly or indirectly on observed standing-crop or density data.

KX

The parameter KX is defined by LMS as the equilibrium first order mortality rate coefficient.^{1,2} LMS calculates this parameter as $-\ln(PS)/DTE$ for each life stage, where DTE is the time required to pass through a given life stage under equilibrium conditions and PS is the probability of survival through that life stage under equilibrium conditions. However, all that can be estimated from field and/or laboratory data are DTE', an average time required to pass through a given life stage, and PS', an average probability of survival through that life stage. DTE' and PS' could then be used to calculate an average first order mortality rate coefficient (KX') as $KX' = -\ln(PS')/DTE'$, assuming exponential mortality. Only by chance would DTE' = DTE, PS' = PS, and/or KX' = KX, because the average values will reflect biological phenomena occurring over the full range of population densities achieved in the natural system, and not just at an "equilibrium" standing crop or density (however defined). Thus, the parameters necessary to calculate KX cannot be directly estimated from observable data.

KX0

The parameter KX0 is defined as the minimum mortality rate coefficient, which is approached at population levels near zero. We

already have implicitly criticized the biological basis for this parameter in the previous discussion about the left limb of the curves in Figs. 1 and 2 for fish species such as striped bass (page 28). Another point to be made about $KX0$ is that the values selected by LMS commonly correspond to unrealistic probabilities of survival (Table 3). The $PS0$ values for $AKX0 = 0.25$ are completely unrealistic biologically. Even in a hatchery under optimal conditions, it is difficult to obtain survivals greater than 50% for the juvenile stages and impossible for larvae.¹² The values for $AKX0 = 0.5$ are also high, certainly for conditions in the natural environment.

Sensitivity Analysis

Sensitivity analysis, involving systematic variation of parameters through a range of values, is a standard way of evaluating and even validating simulation models. On the basis of examining model output, one can answer such questions as: (a) what is the relative sensitivity of the model to changes in certain parameters, and (b) is the model output reasonable or even plausible for a given parameter combination?

With respect to the three parameters in the LMS compensation function and the output variable of primary interest (viz., percent reduction in the striped bass population due to power plant operation), and given the range of parameter values used in this study, the model is least sensitive to changes in YS , the equilibrium standing crop, and most sensitive to changes in $KX0$, the minimum mortality rate coefficient. For example, estimates of percent reduction in number of adults at year 40 range from 15 to 49% for YS , 3 to 44% for KX , and 8 to 85% for $KX0$. Variations of this magnitude obviously must be considered in reaching a reasoned decision on the potential impact of the Hudson River power plants on the striped bass population. This concern is accentuated by the lack of a sound biological basis for the parameters YS , KX , and $KX0$.

A more fundamental type of sensitivity analysis involves comparing alternative forms for a function in a simulation model, where each form of the function reflects a somewhat different set of assumptions and

Table 3. Values of maximum probability of survival (PSO) corresponding to the KXO values used by LMS

Life stage	DTE ^a (days)	PS ^a	PSO ^b		
			AKXO = 0.8	AKXO = 0.5	AKXO = 0.25
Larva	28	0.15	0.22	0.39	0.62
Juvenile 1	30	0.20	0.28	0.45	0.67
Juvenile 2	123	0.50	0.57	0.71	0.84
Juvenile 3	158	0.19	0.27	0.44	0.66

^aDTE is the average number of days required to pass through the specified life stage. PS is the average probability of survival through the specified life stage. (See reference 2, table 4, page 40a; and reference 13, Table 7, page 13c)

^bValues for maximum probability of survival through the life stage are calculated as

$$PSO = e^{-AKXO \cdot KX \cdot DTE} = e^{-KXO \cdot DTE}, \text{ where } KX = \frac{-\ln(PS)}{DTE}$$

understanding about how the real-world system may operate. We have been critical in this report of the conceptual basis for the left limb of the LMS compensation function, and we have shown that disabling the left limb results in appreciably higher estimates of percent reduction. Thus, again, results of this type must be considered in reaching a reasoned decision on the potential impact of the Hudson River power plants on the striped bass population.

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APPENDIX A
CROSS REFERENCE LISTING OF THE LAWLER, MATUSKY & SKELLY
ENGINEERS COMPLETELY MIXED MODEL FOR THE HUDSON RIVER
STRIPED BASS POPULATION AS MODIFIED BY
OAK RIDGE NATIONAL LABORATORY

COMPILE OPTIONS - NAME= MAIN,OPT=02,LINECNT=60,SIZE=0000K,
SOURCE,EBCDIC,NOLIST,NOLECK,LOAD,MAP,NOEDIT,NOID,XREF

CHIST		HIST	0
C...		HIST	5
C	JANUARY 1976. COMPUTER CODE FOR THE COMPLETELY MIXED MODEL	HIST	10
C	DEVELOPED BY LAWLER, MATUSKY & SKELLY, AS MODIFIED BY	HIST	15
C	VAN WINKLE.	HIST	20
C...		HIST	25
C...	THIS IS THE MAIN PROGRAM FOR THE COMPLETELY MIXED MODEL.	HIST	30
C...	IT WAS FORMERLY IDENTIFIED AS SUBROUTINE HISTG.	HIST	35
C...		HIST	40
ISN 0002	COMMON/ADULTT/DCY(20),PEC(20),SBAT(20),SMAT(20)	HIST	45
ISN 0003	COMMON/LSTAGE/AKX(5),AKX0(5),AYS(5),DE(5),DTE(5),PKILL(5),JLEFT(5)	HIST	50
	1, JRIGHT(5),AL(5),AL0(5),AL(5)	HIST	55
ISN 0004	COMMON/PAR/IEND,ISKP,ISW,KSTP,NN,P,CP,TE,V	HIST	60
ISN 0005	COMMON/RKTTA/NX,DNDXT,AUX(16,1)	HIST	65
ISN 0006	COMMON/NGHT/TIM(10),TIMW(10)	HIST	70
ISN 0007	COMMON/WYY/W(5000),YY(5000)	HIST	75
ISN 0008	DIMENSION ADULT(20),ADULTS(20),DCYU(20),PAD(20),PADE(20),RMP(20)	HIST	80
ISN 0009	DIMENSION CHAR(6,5),JLEFT(5),JRIGHT(5),PNCAY(4),ASUM(4),REF(6)	HIST	85
ISN 0010	DIMENSION R(100),S(100),R3(100),SR(100),RE(100),R3R(100),R3S(100)	HIST	90
	1,R3RSR(100)	HIST	95
ISN 0011	REAL*8 ISW1,JLEFT,JRIGHT,NO,YES	HIST	100
ISN 0012	REAL IMPJ2,IMPJ3,IMPTOT,KX,KX0,NEC,NMAX,NMAXYS,NTOT,NX,KPLANT	HIST	105
ISN 0013	DATA NC/6H NO/,YES/6H YES/	HIST	110
ISN 0014	DATA J,K,L,M,N/5*0/	HIST	115
ISN 0015	DATA IK,IN,IQ,IX,JJ,IL,MM/7*0/	HIST	120
ISN 0016	DATA IAD,IEN,III,IPL,IPT,IST,IVY,IYF,LPT,LYR/10*0/	HIST	125
ISN 0017	DATA KSWT,KTYO/2*0/	HIST	130
ISN 0018	DATA IKTYO,ITEST,KSPAN,NSPAN/4*0/	HIST	135
ISN 0019	DATA INCRMT,ISTAGE/2*0/	HIST	140
ISN 0020	DATA R,S,R3,SR,RR,R3R,R3S,R3RSR/800*0./	HIST	145
ISN 0021	DATA AA,AM,BB,E2,R0,SM,SP,TP/8*0./	HIST	150
ISN 0022	DATA AVG,NEO,REF,SPE,SSP/1C*0./	HIST	155
ISN 0023	DATA ASUM,NMAX,NTOT,PSPP,RATE,SUMA,SURV,TEND,TOT1/12*0./	HIST	160
ISN 0024	DATA PRACT,PNDAY,PTIME/6*0./	HIST	165
ISN 0025	DATA NMAXYS,PEQUAL,TSTART/3*0./	HIST	170
ISN 0026	DATA ADULT,ADULTS,DCYU,PAD,PADE,RMP/120*0./	HIST	175
ISN 0027	INTEGER OF1,OF2	HIST	180
C...		HIST	185
C...	INITIALIZATION STATEMENTS.	HIST	190
C...		HIST	195
ISN 0028	OF1=6	HIST	200
ISN 0029	OF2=12	HIST	205
ISN 0030	IF1=5	HIST	210
ISN 0031	ISW1 = NO	HIST	215
ISN 0032	TIM(1) = 0.	HIST	220
ISN 0033	TIM(9) = 56.	HIST	225
ISN 0034	DO 10 I=1,5000	HIST	230
ISN 0035	10 YY(I)=0.	HIST	235
C...		HIST	240
C...	READ INPUT PARAMETERS AND WRITE THOSE INPUT PARAMETERS REQUESTED.	HIST	245
C...		HIST	250
ISN 0036	READ(IF1,10000) ISW,IEND,LYR,KSTP,TSTART,TEND,ISKP	HIST	255
ISN 0037	LYR=LYR-1	HIST	260
ISN 0038	IF (ISW.EQ.1) ISW1=YES	HIST	265
ISN 0040	TP=TEND-TSTART	HIST	270
ISN 0041	READ(IF1,10100) IST,IK,IEN,NN	HIST	275

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ISN 0042      READ(IF1,10200) QP                                HIST 280
ISN 0043      READ(IF1,10300) V, (FKILL(L),L=1,5), IPL          HIST 285
ISN 0044      IF (ISW.EQ.1) LYR=LYR+ISW                          HIST 290
ISN 0046      QPCFS = 1703680*QP                                HIST 295
ISN 0047      WRITE(OF1,13000)                                  HIST 300
ISN 0048      WRITE(OF1,13900) IEND,LYR,ISW1,IPI               HIST 305
ISN 0049      WRITE(CF1,13000)                                  HIST 310
ISN 0050      IF (NN.EQ.1) WRITE(OF2,13100)                     HIST 315
ISN 0052      IF (NN.EQ.1) WRITE(OF2,13200) QF,QPCFS,V, (FKILL(JJ),JJ=1,5) HIST 320
ISN 0054      KSWT = 1                                          HIST 325
ISN 0055      ISTAGE=1                                          HIST 330
ISN 0056      IYR=0                                             HIST 335
ISN 0057      READ(IF1,10400) P,TE, (DE(JJ),JJ=1,5)           HIST 340
ISN 0058      PEQUAL=P                                          HIST 345
ISN 0059      READ(IF1,10500) NSPAN, (TIM(J),J=2,NSPAN)        HIST 350
ISN 0060      READ(IF1,10600) (TIMW(J),J=1,NSPAN)              HIST 355
ISN 0061      IF (NN.EQ.1) WRITE(12,14000) (DE(J),J=1,5)      HIST 360
ISN 0063      IF (NN.EQ.1) WRITE(OF2,14100) TE                 HIST 365
ISN 0065      KSPAN=NSPAN-1                                     HIST 370
ISN 0066      DO 20 K=1,KSPAN                                   HIST 375
ISN 0067      IF (NN.EQ.1) WRITE(OF2,14200) TIM(K),TIM(K+1),TIMW(K) HIST 380
ISN 0069      20 CONTINUE                                       HIST 385
ISN 0070      READ(IF1,10700) (DCY(J),J=1,IEND)                HIST 390
ISN 0071      READ(IF1,10800) (SRAT(J),J=1,IEND)               HIST 395
ISN 0072      READ(IF1,10800) (SMAT(J),J=1,IEND)               HIST 400
ISN 0073      READ(IF1,10900) (PEC(J),J=1,IEND)               HIST 405
ISN 0074      READ(IF1,11000) (PNDAY(J),J=1,4)                HIST 410
ISN 0075      PTIME=C.                                          HIST 415
ISN 0076      30 FRACT=LE(1)*TIMW(1)/TIM(2)                    HIST 420
ISN 0077      NFO=F*FRACT                                       HIST 425
ISN 0078      ITEST=MOD(IYR,IK)                                 HIST 430
ISN 0079      IN=0                                              HIST 435
ISN 0080      IF (ITEST.EQ.0) IN=1                              HIST 440
ISN 0082      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,11400) IYR   HIST 445
ISN 0084      40 IF (IYR.GT.0) GO TO 50                         HIST 450
C .....                                                       HIST 455
ISN 0086      READ(IF1,11100) (CHAR(I,ISTAGE),I=1,6)           HIST 460
ISN 0087      READ(IF1,11200) KX(ISTAGE),YS(ISTAGE),DTE(ISTAGE) HIST 465
ISN 0088      READ(IF1,11300) AKX(ISTAGE),AKX0(ISTAGE),AYS(ISTAGE), HIST 470
1 JLEFT(ISTAGE),IRIGHT(ISTAGE)                                HIST 475
ISN 0089      JLEFT(ISTAGE) = NO                                HIST 480
ISN 0090      JRIGHT(ISTAGE) = NO                               HIST 485
ISN 0091      IF (JLEFT(ISTAGE).EQ.1) JLEFT(ISTAGE) = YES     HIST 490
ISN 0093      IF (JRIGHT(ISTAGE).EQ.1) JRIGHT(ISTAGE) = YES   HIST 495
ISN 0095      KX(ISTAGE) = AKX(ISTAGE)*KX(ISTAGE)              HIST 500
ISN 0096      KX0(ISTAGE) = AKX0(ISTAGE)*KX(ISTAGE)            HIST 505
ISN 0097      YS(ISTAGE) = AYS(ISTAGE)*YS(ISTAGE)              HIST 510
ISN 0098      50 IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,13000)    HIST 515
ISN 0100      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,11500) ISTAGE, (CHAR(I,ISTAGE), HIST 520
1 I=1,6)                                                       HIST 525
ISN 0102      IF (NN.EQ.1.AND.IN.EQ.1.OR.NN.EQ.1.AND.IYR.EQ.1) WRITE(OF1,13300) HIST 530
1 KX(ISTAGE),KX0(ISTAGE),YS(ISTAGE),DTE(ISTAGE), AKX(ISTAGE), HIST 535
1 AKX0(ISTAGE),AYS(ISTAGE),JLEFT(ISTAGE),JRIGHT(ISTAGE)       HIST 540
C...                                                           HIST 545
C...AVERAGE THE VALUES IN THE PRODUCTION TABLE WHEN DIFFERENT HIST 550
C...MODEL TIME STEPS ARE USED FOR VARIOUS LIFE STAGES.       HIST 555
C...                                                           HIST 560
ISN 0104      IF (ISTAGE.NE.1) ASUM(ISTAGE)=DE(ISTAGE)/LE(ISTAGE-1) HIST 565

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ISN 0106	IF (ISTAGE.EQ.1) MM = (DTE(ISTAGE)/DE(1) + 0.0001)	HIST 570
ISN 0108	IF (ISTAGE.EQ.1) IPT = ((0.0-DTE(ISTAGE))/DE(1)) + SIGN(0.0001,	HIST 575
	1 (0.0-DTE(ISTAGE)))	HIST 580
ISN 0110	IF (ISTAGE.EQ.1) III=IPT+MM	HIST 585
ISN 0112	IF (III.EQ.0) IPT=0	HIST 590
ISN 0114	IF (IPT.NE.0) IPT=IABS(IPT)	HIST 595
ISN 0116	IF (ISTAGE.EQ.1.AND.IPT.LE.0) IPT=0	HIST 600
ISN 0118	IF (KFIRST.EQ.0) LPT=IPT	HIST 605
ISN 0120	IF (ISTAGE.EQ.1.OR.ISTAGE.EQ.5) GC TO 160	HIST 610
ISN 0122	AA=ABS(PNDAY(ISTAGE)-PNDAY(ISTAGE-1))	HIST 615
ISN 0123	BB=ABS(DE(ISTAGE)-DE(ISTAGE-1))	HIST 620
ISN 0124	IF ((AA.IT..0001).AND.(BB.IT..0001)) GO TO 160	HIST 625
ISN 0126	L=1	HIST 630
ISN 0127	INCRMT=ASUM(ISTAGE)+.001	HIST 635
ISN 0128	IF (INCRMT.LE.0) GO TO 120	HIST 640
ISN 0130	IX=0	HIST 645
ISN 0131	IFT=FLOAT(IPT)/FLOAT(INCRMT)	HIST 650
ISN 0132	DO 70 I=1,KTYO,INCRMT	HIST 655
ISN 0133	AVG=0.	HIST 660
ISN 0134	IX=IX+INCRMT	HIST 665
ISN 0135	DO 60 J=1,IX	HIST 670
ISN 0136	AVG=AVG+YY(J)	HIST 675
ISN 0137	60 YY(J)=0.	HIST 680
ISN 0138	YY(L)-AVG	HIST 685
ISN 0139	L=L+1	HIST 690
ISN 0140	70 CONTINUE	HIST 695
ISN 0141	KTYO=L	HIST 700
ISN 0142	80 IAD=PNDAY(ISTAGE)/DE(ISTAGE)+.001	HIST 705
ISN 0143	IF (IAD.EQ.1) GO TO 160	HIST 710
ISN 0145	DO 110 K=1,KTYO,IAD	HIST 715
ISN 0146	L=K	HIST 720
ISN 0147	LL=K+IAD-1	HIST 725
ISN 0148	AVG=0.	HIST 730
ISN 0149	DO 90 N=L,LL	HIST 735
ISN 0150	90 AVG=AVG+YY(N)	HIST 740
ISN 0151	DO 100 N=L,LL	HIST 745
ISN 0152	100 YY(N)=AVG/IAD	HIST 750
ISN 0153	110 CONTINUE	HIST 755
ISN 0154	GO TO (160,170),KSWT	HIST 760
ISN 0155	120 IQ=1.0/ASUM(ISTAGE)+.001	HIST 765
ISN 0156	IVY=-IQ	HIST 770
ISN 0157	MM=KTYO	HIST 775
ISN 0158	IKTYO=KTYO*IQ	HIST 780
ISN 0159	DO 130 M=1,IKTYO,IQ	HIST 785
ISN 0160	K=IKTYO-M+1	HIST 790
ISN 0161	YY(K+IVY+1)=YY(MM)	HIST 795
ISN 0162	YY(MM)=0.	HIST 800
ISN 0163	130 MM=MM-1	HIST 805
ISN 0164	DO 150 K=1,IKTYO,IQ	HIST 810
ISN 0165	J=K	HIST 815
ISN 0166	JJ=K+IQ-1	HIST 820
ISN 0167	AM=YY(K)/IQ	HIST 825
ISN 0168	DO 140 N=J,JJ	HIST 830
ISN 0169	140 YY(N)=AM	HIST 835
ISN 0170	150 CONTINUE	HIST 840
ISN 0171	KTYO=IKTYO	HIST 845
ISN 0172	GO TO 80	HIST 850
		HIST 855

C...

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C...CALL SUBROUTINE GROWTH FOR THE SPECIFIED LIFE STAGE.
C...
160 CALL GROWTH (IN,ISTAGE,IYR,KTYO,NEO,NMAX,ETIME,KPLANT)
C...
C...CALCULATE AND WRITE TOTAL PRODUCTION, TOTAL TRANSFER, % SURVIVAL
C...AND MAXIMUM STANDING CRCP FOR THE SPECIFIED LIFE STAGE.
C...
ISN 0174      IF (ISTAGE.GT.1) GO TO 190
ISN 0176      KSWT = 2
ISN 0177      GO TO 80
ISN 0178      170 TOT1=0.
ISN 0179      KSWT = 1
ISN 0180      DO 180 J=1,KTYC
ISN 0181      TOT1 = TOT1 + YY(J)
ISN 0182      180 CONTINUE
ISN 0183      RATE = 100.*TOT1/P
ISN 0184      CUMPS = TOT1/P
ISN 0185      IF (IYR.EQ.0) REP(ISTAGE) = P
ISN 0187      CHANGN = REP(ISTAGE) - P
ISN 0188      CHANGP = 100*CHANGN/REP(ISTAGE)
ISN 0189      NMAXYS = 0.0
ISN 0190      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,11600) P,TOT1,RATE,NMAX,NMAXYS,
1 CHANGN,CHANGP
ISN 0192      GO TO 210
ISN 0193      190 NTOT=TOT1
ISN 0194      TOT1=0.
ISN 0195      DO 200 J=1,KTYO
ISN 0196      TOT1 = TOT1 + YY(J)
ISN 0197      200 CONTINUE
ISN 0198      RATE=100.*TOT1/NTOT
ISN 0199      NMAXYS = NMAX/YS(ISTAGE)
ISN 0200      CUMPS = (TOT1/NTOT)*CUMPS
ISN 0201      IF (IYR.EQ.0) REP(ISTAGE) = NTOT
ISN 0203      CHANGN = REP(ISTAGE) - NTOT
ISN 0204      CHANGP = 100*CHANGN/REP(ISTAGE)
ISN 0205      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(6,11600) NTCT,TOT1,RATE,NMAX,NMAXYS,
1 CHANGN,CHANGP
ISN 0207      IF (ISTAGE.EQ.4) IMPJ2=(KPLANT/(KPLANT+KX(ISTAGE)))*(NTOT-TOT1)
ISN 0209      IF (ISTAGE.EQ.5) IMPJ3=(KPLANT/(KPLANT+KX(ISTAGE)))*(NTOT-TOT1)
ISN 0211      IF (ISTAGE.EQ.5) IMPTOT = IMPJ2 + IMPJ3
ISN 0213      IF (ISTAGE.EQ.4.AND.IN.EQ.1.OR.ISTAGE.EQ.4.AND.IYR.EQ.1) WRITE(6,
1 11800) IMPJ2
ISN 0215      IF (ISTAGE.EQ.5.AND.IN.EQ.1.OR.ISTAGE.EQ.5.AND.IYR.EQ.1) WRITE(6,
1 11900) IMPJ3,IMPTOT
ISN 0217      IF (ISTAGE.EQ.5) YEAR1 = CUMPS*F
ISN 0219      IF (ISTAGE.EQ.5.AND.IN.EQ.1.OR.ISTAGE.EQ.5.AND.IYR.EQ.1) WRITE(6,
1 11700) CUMPS,YEAR1
ISN 0221      210 CONTINUE
C
C...CYCLE TO THE NEXT LIFE STAGE.
C...
C .... STAGE 2=LARVAE
C .... STAGE 3-5=JUVENILE I-III
C .....
ISN 0222      PTIME = PTIME + DTE(ISTAGE)
ISN 0223      ISTAGE=ISTAGE+1
ISN 0224      IF (ISTAGE.EQ.5) PTIME=PTIME+TIM(NSFAN)
ISN 0226      NEO=YY(1)

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ISN 0227	IF (ISTAGE.LE.5) GO TO 40	HIST1150
ISN 0229	IF (IYR.GT.0) GO TO 230	HIST1155
	C...	HIST1160
	C...CALL SUBROUTINE EQUAL FOR YEAR ZERO.	HIST1165
	C...	HIST1170
ISN 0231	CALL EQUAL (ADULT,ADULTS,DCYU,NEO,PEQUAL,EMP,RO)	HIST1175
ISN 0232	APS = EXP(-DCYU(4)*365.)	HIST1180
ISN 0233	IF (NN.EQ.1) WRITE(12,13600) APS	HIST1185
ISN 0235	IF (NN.EQ.1) WRITE(OF2,13400)	HIST1190
ISN 0237	IF (NN.EQ.1) WRITE(OF2,13500) (J,DCYU(J),SRAT(J),SMAT(J),PEC(J),J=	HIST1195
	1 1,IEND)	HIST1200
	C...	HIST1205
	C...GENERATE ADULT CLASSES FOR YEAR ZERO.	HIST1210
	C...	HIST1215
ISN 0239	ADULT(1)=NEO	HIST1220
ISN 0240	REF(6) = ADULT(1)	HIST1225
ISN 0241	DO 220 J=2,IEND	HIST1230
ISN 0242	SURV=EXP(-DCYU(J-1)*365.)	HIST1235
ISN 0243	ADULT(J)=ADULT(J-1)*SURV	HIST1240
ISN 0244	220 CONTINUE	HIST1245
ISN 0245	GO TO 250	HIST1250
	C...	HIST1255
	C...CALCULATE ADULT CLASSES FOR ALL YEARS OTHER THAN YEAR ZERO.	HIST1260
	C...	HIST1265
ISN 0246	230 DO 240 IX1=2,IEND	HIST1270
ISN 0247	J=IEND-IX1+2	HIST1275
ISN 0248	240 ADULT(J)=ADULT(J-1)*EXP(-DCYU(J-1)*365.)	HIST1280
ISN 0249	ADULT(1)=NEO	HIST1285
ISN 0250	250 CONTINUE	HIST1290
	C...	HIST1295
	C...CALCULATE EGG PRODUCTION FOR THE UPCOMING YEAR.	HIST1300
	C...	HIST1305
ISN 0251	P=0.	HIST1310
ISN 0252	I = IYR + 1	HIST1315
ISN 0253	S(I) = 0.	HIST1320
ISN 0254	DO 260 J=1,IEND	HIST1325
ISN 0255	SSF=ADULT(J)*SRAT(J)*SMAT(J)*PEC(J)	HIST1330
ISN 0256	SPAWN = ADULT(J)*SRAT(J)*SMAT(J)	HIST1335
ISN 0257	S(I) = S(I) + SPAWN	HIST1340
ISN 0258	R(I) = ADULT(3)	HIST1345
ISN 0259	260 P=P+SSF	HIST1350
	C...	HIST1355
	C...CALCULATE RELATIVE ADULT AGE DISTRIBUTION IN TWO WAYS.	HIST1360
	C...	HIST1365
ISN 0260	SP=0.	HIST1370
ISN 0261	DO 270 J=1,IEND	HIST1375
ISN 0262	270 SP=SP+ADULT(J)	HIST1380
ISN 0263	IF (IYR.GT.0) GO TO 290	HIST1385
ISN 0265	DO 280 K=1,IEND	HIST1390
ISN 0266	PAD(K) = 100.*ADULT(K)/SP	HIST1395
ISN 0267	280 PAD(K)=100.*ADULT(K)/SF	HIST1400
ISN 0268	SPE=SP	HIST1405
ISN 0269	GO TO 310	HIST1410
ISN 0270	290 IF (IYR.EQ.0) GO TO 310	HIST1415
ISN 0272	DO 300 K=1,IEND	HIST1420
ISN 0273	PAD(K) = 100.*ADULT(K)/SP	HIST1425
ISN 0274	300 PAD(K)=100.*ADULT(K)/SFE	HIST1430
ISN 0275	310 PSPP = SP/SPE	HIST1435

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ISN 0276      CHAGN1 = REF(6) - ADULT(1)      HIST1440
ISN 0277      CHAGP1 = 100*CHAGN1/REF(6)      HIST1445
ISN 0278      CHAGNT = SPE - SP              HIST1450
ISN 0279      CHAGPT = 100*CHAGNT/SPE        HIST1455
C...          HIST1460
C...PRINT ADULT AGE DISTRIBUTION AND RELATIVE ADULT AGE DISTRIBUTION. HIST1465
C...          HIST1470
ISN 0280      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12000)      HIST1475
ISN 0282      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12100) (J,ADULT(J),J=1,IEND) HIST1480
ISN 0284      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12200) SP    HIST1485
ISN 0286      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12300)      HIST1490
ISN 0288      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12400) (K,PAD(K),K=1,IEND) HIST1495
ISN 0290      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12500)      HIST1500
ISN 0292      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12400) (K,PADE(K),K=1,IEND) HIST1505
ISN 0294      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12600) ESPP  HIST1510
ISN 0296      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12700) CHAGN1,CHAGP1, CHAGNT, HIST1515
1 CHAGPT      HIST1520
ISN 0298      E2=1.      HIST1525
ISN 0299      SUMA=0.    HIST1530
ISN 0300      DO 320 K=1,IEND      HIST1535
ISN 0301      IF (K.NE.1) E2=E2*EXP(-DCYU(K-1)*365.)      HIST1540
ISN 0303      320 SUMA=SUMA+E2*RMP(K)      HIST1545
ISN 0304      SM=SUMA*(NEO/PEQUAL)      HIST1550
ISN 0305      IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OP1,12800) SM    HIST1555
C...          HIST1560
C...CYCLE TO NEXT YEAR.      HIST1565
C...          HIST1570
ISN 0307      IF (ISW.EQ.1.AND.IYR.EQ.IPL) QP = 0.      HIST1575
ISN 0309      IF (IYR.EQ.LYR) GO TO 330      HIST1580
ISN 0311      IYR=IYR+1      HIST1585
ISN 0312      ISTAGE=1      HIST1590
ISN 0313      PTIME=C.      HIST1595
ISN 0314      GO TO 30      HIST1600
ISN 0315      330 IF (IN.EQ.1) WRITE(OP1,12900)      HIST1605
ISN 0317      LYR1 = LYR + 1      HIST1610
ISN 0318      DC 340 I = 1,LYR1      HIST1615
ISN 0319      R3(I) = R(I+3)      HIST1620
ISN 0320      R3S(I) = R3(I)/S(I)      HIST1625
ISN 0321      SR(I) = S(I)/S(1)      HIST1630
ISN 0322      RR(I) = R(I)/R(1)      HIST1635
ISN 0323      R3R(I) = R3(I)/R3(1)      HIST1640
ISN 0324      R3RSR(I) = R3R(I)/SR(I)      HIST1645
ISN 0325      340 CONTINUE      HIST1650
ISN 0326      IF (NN.EQ.1) WRITE(12,13700)      HIST1655
ISN 0328      IF (NN.EQ.1) WRITE(12,13800) (I,S(I),R(I),R3(I),R3S(I), SR(I), HIST1660
1 RR(I),R3R(I),R3RSR(I),I=1,LYR1)      HIST1665
ISN 0330      STOP      HIST1670
C          HIST1675
C      INPUT FORMAT CARDS      HIST1680
C          HIST1685
C          HIST1690
C      OUTPUT FORMAT CARDS      HIST1695
C          HIST1700
ISN 0331      10000 FORMAT (I1,1X,I2,1X,I3,1X,I4,1X,2(F4.0,1X),I1)      HIST1705
ISN 0332      10100 FORMAT (4(I2,1X))      HIST1710
ISN 0333      10200 FORMAT (E16.8)      HIST1715
ISN 0334      10300 FORMAT (6P10.0,I2)      HIST1720
ISN 0335      10400 FORMAT (E15.8,F5.0,5F5.2)      HIST1725

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ISN 0336 10500 FORMAT (I2,1X,15F5.0) HIST1730
ISN 0337 10600 FORMAT (10F8.0) HIST1735
ISN 0338 10700 FORMAT (3E10.6,10F5.2) HIST1740
ISN 0339 10800 FORMAT (13F6.0) HIST1745
ISN 0340 10900 FORMAT (8F10.0) HIST1750
ISN 0341 11000 FORMAT (4F6.0) HIST1755
ISN 0342 11100 FORMAT (20A4) HIST1760
ISN 0343 11200 FORMAT (2(E12.7,3X),F5.1) HIST1765
ISN 0344 11300 FORMAT (3F5.2,2(4X,I1)) HIST1770
ISN 0345 11400 FORMAT (1H1,1X,'.....' / 1X, HIST1775
1 '...CURRENT YEAR.....', ' - ', I3, ' - ', '...' / 1X, HIST1780
1 '.....' //) HIST1785
ISN 0346 11500 FORMAT (//, ' STAGE', I3, 3X, 10A4) HIST1790
ISN 0347 11600 FORMAT (//, ' TOTAL PRODUCTION INTO THIS LIFE STAGE = ', E20.10/ HIST1795
1 ' TOTAL TRANSFER INTO THE NEXT LIFE STAGE = ', E20.10/ HIST1800
1 ' % SURVIVAL THROUGH THIS LIFE STAGE = ', 5X, F4.1/ HIST1805
1 ' MAXIMUM STANDING CROP FOR THIS LIFE STAGE = ', E20.10/ HIST1810
1 ' RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING', HIST1815
1 ' CROP (NMAX/YS) = ', F7.4/ HIST1820
1 ' REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE', HIST1825
1 ' DUE TO THE POWER PLANT...', E20.10/ HIST1830
1 ' % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE', HIST1835
1 ' STAGE DUE TO THE POWER PLANT...', F5.2) HIST1840
ISN 0348 11700 FORMAT (//, ' CUMULATIVE PROBABILITY OF SURVIVAL FROM EGG', HIST1845
1 ' THROUGH JUVENILE 3 = ', E15.8/ HIST1850
1 ' EXPECTED NUMBER OF YEARLINGS = ', E15.8) HIST1855
ISN 0349 11800 FORMAT (//, ' NUMBER OF JUVENILE 2 KILLED BY IMPINGEMENT...', E12.6) HIST1860
ISN 0350 11900 FORMAT (//, ' NUMBER OF JUVENILE 3 KILLED BY IMPINGEMENT...', E12.6/ HIST1865
1 ' TOTAL NUMBER OF JUVENILES KILLED BY IMPINGEMENT...', E12.6) HIST1870
ISN 0351 12000 FORMAT (///, ' ADULT DISTRIBUTION BY AGE CLASS', //, 5( HIST1875
1 13H AGE NUMBERS )) HIST1880
ISN 0352 12100 FORMAT (5(1X, I3, 1X, F8.0)) HIST1885
ISN 0353 12200 FORMAT (1X, 'TOTAL ADULTS ', F15.0/) HIST1890
ISN 0354 12300 FORMAT (//, ' PERCENT AGE DISTRIBUTION RELATIVE TO YEAR ZERO' / 1X, 5( HIST1895
1 12HAGE PERCENT )) HIST1900
ISN 0355 12400 FORMAT (5(1X, I3, 1X, F7.3)) HIST1905
ISN 0356 12500 FORMAT (///, ' PERCENT AGE DISTRIBUTION RELATIVE TO CURRENT YEAR' / HIST1910
1 1X, 5(12HAGE PERCENT )) HIST1915
ISN 0357 12600 FORMAT (//, ' SIZE OF POPULATION (YEAR CLASSES 1-13) FOR THE', //, HIST1920
1 ' CURRENT YEAR AS A PERCENTAGE OF THE SIZE OF THE ', //, HIST1925
1 ' POPULATION IN YEAR ZERO...', F6.3) HIST1930
ISN 0358 12700 FORMAT (///, ' REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT...', F9.0/ HIST1935
1 ' % REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT...', F5.2/ HIST1940
1 ' REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT...', F9.0/ HIST1945
1 ' % REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT...', F5.2) HIST1950
ISN 0359 12800 FORMAT (//, ' NUMBER OF EGGS EXPECTED TO BE PRODUCED BY', HIST1955
1 //, ' THE NUMBER OF ONE-YEAR OLD STRIPED BASS FOR THE CURRENT', HIST1960
1 //, ' YEAR DURING THEIR LIFE TIME AS A PERCENTAGE OF THE NUMBER', HIST1965
1 //, ' OF EGGS PRODUCED IN YEAR ZERO.....', F6.3//) HIST1970
ISN 0360 12900 FORMAT (///, ' END HISTG.....') HIST1975
ISN 0361 13000 FORMAT (///, '*****') HIST1980
ISN 0362 13100 FORMAT (1H1, ' TRACING LIFE HISTORY OF STRIPED BASS FISH ', //, HIST1985
1 ' IN HUDSON RIVER, WITH MORTALITY IN EACH ', //, HIST1990
1 ' STAGE GIVEN BY:', //, 5X, HIST1995
1 ' D(NX)/DT = (KX + (KX - KX0) * ((NX - YS) / YS) ** 3) * NX' ) HIST2000
ISN 0363 13200 FORMAT (16X, ' - PKILL * QP * NY / V', //, ' WHERE, QP (MT**3/DAY) = ', E10.4, //, HIST2005
1 ' WHICH IS EQUIVALENT TO AN INTAKE FLOW OF... ', E10.4, ' (CPS) ', //, HIST2010
1 7X, ' V (MT**3) = ', E10.4 // 2X, HIST2015

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1 'FRACTIONAL KILL (I.E., COMPOSITE F-FACTOR) FOR: ',/ 2X, HIST2020
1 ' EGGS ',P10.4/ 2X, ' LARVAE ',P10.4/ 2X, HIST2025
1 ' JUVENILE 1 ',P10.4/ 2X, ' JUVENILE 2 ',P10.4/ 2X, HIST2030
1 ' JUVENILE 3 ',P10.4) HIST2035
ISN 0364 13300 FORMAT (///, ' KX (1/DAY) = ',E20.10,/, ' KX0 (1/DAY) = ', HIST2040
1 E20.10,/, ' YS (NUMBER) = ',E20.10,/, ' LIFE PERIOD (DAY) = ', HIST2045
1 F10.4,/, HIST2050
1 ' RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX', HIST2055
1 ' VALUE GIVEN ABOVE = ',F6.3,/, HIST2060
1 ' RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE', HIST2065
1 ' USED IN THIS RUN = ',F6.3,/, HIST2070
1 ' RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS', HIST2075
1 ' VALUE GIVEN ABOVE = ',F6.3,/, HIST2080
1 ' LEFT LIMB OF COMPENSATION FUNCTION DISABLED...',A6,/, HIST2085
1 ' RIGHT LIMB OF COMPENSATION FUNCTION DISABLED...',A6,/) HIST2090
ISN 0365 13400 FORMAT (///,T10,'AGE',T15,'DECAY COEFF.',T31,'SEX RATIO',T45, HIST2095
1 'FRACTION',T60,'FECUNDITY',/, T17,'(1/DAY)',T31,'(FEM/TOT)',T46, HIST2100
1 'MATURE',T58,'(EGGS/FEMALE)',/) HIST2105
ISN 0366 13500 FORMAT (T10,I2,T15,F10.6,T33,F4.2,T47,F4.2,T58,E12.4) HIST2110
ISN 0367 13600 FORMAT (//, ' ANNUAL PROBABILITY OF SURVIVAL FOR ADULTS (4-13) = ', HIST2115
1 F5.3) HIST2120
ISN 0368 13700 FORMAT (1H1,20X,'STOCK RECRUITMENT TABLE'// HIST2125
1 ' DEFINITIONS OF COLUMN HEADINGS'// HIST2130
1 ' I = YEAR + 1'// HIST2135
1 ' S(I) = NUMBER OF SPAWNERS'// HIST2140
1 ' R(I) = NUMBER OF RECRUITS (3-YEAR OLDS)'// HIST2145
1 ' R3(I) = NUMBER OF RECRUITS AT I+3 SPAWNED AT I'// HIST2150
1 ' R3S(I) = RECRUITMENT RATE (RECRUITS PER SPAWNER)'// HIST2155
1 ' SR(I) = NUMBER OF SPAWNERS RELATIVE TO NUMBER OF SPAWNERS', HIST2160
1 ' AT I=1'// HIST2165
1 ' RR(I) = NUMBER OF RECRUITS RELATIVE TO NUMBER OF RECRUITS', HIST2170
1 ' AT I=1'// HIST2175
1 ' R3R(I) = NUMBER OF RECRUITS AT I+3 RELATIVE TO THE NUMBER OF', HIST2180
1 ' RECRUITS AT I=4 (R3(I)/R3(1))'// HIST2185
1 ' R3RSR(I) = RELATIVE RECRUITMENT RATE (R3R(I)/SR(I))'// HIST2190
1 T4,'I',T10,'S(I)',T20,'R(I)',T30,'R3(I)',T40,'R3S(I)',T60, HIST2195
1 'SR(I)',T70,'RR(I)',T80,'R3R(I)',T90,'R3RSR(I)'//) HIST2200
ISN 0369 13800 FORMAT (T2,I3,T7,F8.0,T17,F8.0,T27,F8.0,T37,F8.4,T57,F8.4, T67, HIST2205
1 F8.4,T77,F8.4,I87,F8.4) HIST2210
ISN 0370 13900 FORMAT (' NO. ADULT AGE CLASSES - ',I2/ ' MODEL SIMULATES - ',I3, HIST2215
1 1X,'YEARS'/' PLANT OPERATING...',A6/ ' FOR .....',I3, HIST2220
1 ' YEARS.') HIST2225
ISN 0371 14000 FORMAT (///, ' MODEL TIME STEP SIZE (DAYS)'// 4X,'EGG',5X,'LARV',5X, HIST2230
1 'JUV1',5X,'JUV2',5X,'JUV3'// 5(3X,P4.2,2X)/) HIST2235
ISN 0372 14100 FORMAT (//, ' TOTAL PRODUCTION PERIOD (DAYS) = ',F3.0/ HIST2240
1 ' SUBPRODUCTION PERIODS AND ASSOCIATED FRACTIONS OF TOTAL EGG', HIST2245
1 ' PRODUCTION'// HIST2250
1 T5,'PERIOD (DAY)',T20,'FRACTION') HIST2255
ISN 0373 14200 FORMAT (T5,2(1X,P4.1),T22,F6.4) HIST2260
ISN 0374 END HIST2265

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*****FORTRAN CROSS REFERENCE LISTING*****

SYMBOL	INTERNAL STATEMENT NUMBERS
I	0034 0035 0086 0086 0086 0100 0100 0100 0132 0135 0252 0253 0257 0257 0258 0318 0319 0319 0320 0320 0320 0321 0321 0322 0322 0323 0323 0324 0324 0324 0328 0328 0328 0328 0328 0328 0328 0328
J	0014 0059 0059 0059 0060 0060 0060 0061 0061 0061 0070 0070 0070 0071 0071 0071 0072 0072 0072 0072 0073 0073 0073 0074 0074 0074 0135 0136 0137 0165 0168 0180 0181 0195 0196 0237 0237 0237 0237 0237 0237 0237 0241 0242 0243 0243 0247 0248 0248 0248 0254 0255 0255 0255 0255 0256 0256 0256 0261 0262 0282 0282 0282 0282
K	0014 0066 0067 0067 0067 0145 0146 0147 0160 0161 0164 0165 0166 0167 0265 0266 0266 0267 0267 0272 0273 0273 0274 0274 0288 0288 0288 0288 0292 0292 0292 0300 0301 0301 0301 0303
L	0014 0043 0043 0043 0126 0138 0139 0139 0141 0146 0149 0151
M	0014 0159 0160
N	0014 0149 0150 0151 0152 0168 0169
P	0004 0057 0058 0077 0183 0184 0185 0187 0190 0217 0251 0259 0259
R	0010 0020 0258 0319 0322 0322 0328
S	0010 0020 0253 0257 0257 0320 0321 0321 0328
V	0004 0043 0052
W	0007
AA	0021 0122 0124
AM	0021 0167 0169
BB	0021 0123 0124
DE	0003 0057 0061 0076 0104 0104 0106 0108 0123 0123 0142
E2	0021 0298 0301 0301 0303
IK	0015 0041 0078
IN	0015 0079 0080 0082 0098 0100 0102 0113 0190 0205 0213 0213 0219 0200 0202 0204 0205 0208 0200
IQ	0292 0294 0296 0305 0315
IX	0015 0155 0156 0158 0159 0164 0166 0167
JJ	0015 0130 0134 0134 0135
KX	0015 0052 0052 0052 0057 0057 0166 0168
LL	0003 0012 0087 0095 0095 0096 0102 0201 0204
MM	0015 0147 0149 0151
NN	0015 0106 0110 0157 0161 0162 0163 0163
NO	0004 0041 0050 0052 0061 0063 0067 0102 0102 0233 0235 0237 0326 0328
XX	0011 0013 0031 0089 0090
QP	0005 0012
RR	0004 0042 0046 0052 0307
RO	0010 0020 0322 0328
RJ	0021 0231
SM	0010 0020 0319 0320 0323 0323 0328
SP	0021 0304 0305
SR	0021 0260 0262 0262 0266 0267 0268 0273 0275 0278 0284
TE	0010 0020 0321 0324 0328
TF	0004 0057 0063
YS	0021 0040
YY	0003 0087 0097 0097 0102 0199
ABS	0007 0035 0136 0137 0138 0150 0152 0161 0161 0162 0167 0169 0181 0196 0226
AKK	0122 0123
APS	0003 0088 0095 0102
AUX	0232 0233
AVG	0005
AYS	0022 0133 0136 0136 0138 0148 0150 0150 0152
DCY	0003 0088 0097 0102
DEE	0002 0070
EKF	0003 0007 0102 0106 0108 0108 0222
FEC	0232 0242 0248 0301
IAD	0002 0073 0237 0255
IBN	0016 0142 0143 0145 0147 0152
	0016 0041

[illegible]

SYMBOL	INTERNAL STATEMENT NUMBERS																							
DNXDT	0005																							
EQUAL	0231																							
PKILL	0003	0043	0052																					
FLOAT	0131	0131																						
FRACT	0024	0076	0077																					
INTIO	0018	0158	0159	0160	0164	0171																		
ILEPT	0003	0088	0091																					
IMPJ2	0012	0207	0211	0213																				
IMPJ3	0012	0209	0211	0215																				
ITEST	0018	0078	0080																					
JLEPT	0005	0011	0089	0091	0102																			
KSPAN	0018	0065	0066																					
NSPAN	0018	0059	0059	0060	0065	0224																		
PNDAY	0009	0024	0074	0122	0122	0142																		
PTIME	0024	0075	0173	0222	0222	0224	0224	0313																
QPCPS	0046	0052																						
RJRSR	0010	0020	0324	0328																				
SPAWN	0256	0257																						
YEAR1	0217	0219																						
AUULTS	0008	0026	0231																					
CHRGHT	0278	0279	0296																					
CHAGM1	0276	0277	0296																					
CHAGP2	0275	0296																						
CHAGP1	0277	0296																						
CHANGH	0187	0188	0190	0203	0204	0205																		
CHANGP	0188	0190	0204	0205																				
GROWTH	0173																							
INPTOT	0012	0211	0215																					
INCRNT	0019	0127	0128	0131	0132	0134																		
INIGHT	0003	0088	0093																					
ISTAGE	0019	0055	0086	0087	0087	00																		

*****FORTRAN CROSS REFERENCE LISTING*****

LABEL	DEFINED	REFERENCES
10	0035	0034
20	0069	0066
30	0076	0314
40	0084	0227
50	0098	0084
60	0137	0135
70	0140	0132
80	0142	0172 0177
90	0150	0149
100	0152	0151
110	0153	0145
120	0155	0128
130	0163	0159
140	0169	0168
150	0170	0164
160	0173	0120 0124 0143 0154
170	0178	0154
180	0182	0180
190	0193	0174
200	0197	0195
210	0221	0192
220	0244	0241
230	0246	0229
240	0248	0246
250	0250	0245
260	0259	0254
270	0262	0261
280	0267	0265
290	0270	0263
300	0274	0272
310	0275	0269 0270
320	0303	0300
330	0315	0309
340	0325	0318
10000	0331	0036
10100	0332	0041
10200	0333	0042
10300	0334	0043
10400	0335	0057
10500	0336	0059
10600	0337	0060
10700	0338	0070
10800	0339	0071 0072
10900	0340	0073
11000	0341	0074
11100	0342	0086
11200	0343	0087
11300	0344	0088
11400	0345	0082
11500	0346	0100
11600	0347	0190 0205
11700	0348	0219
11800	0349	0213
11900	0350	0215
12000	0351	0280
12100	0352	0282
12200	0353	0284

12300	0354	0286		
12400	0355	0288	0292	
12500	0356	0290		
12600	0357	0294		
12700	0358	0296		
12800	0359	0305		
12900	0360	0315		
13000	0361	0047	0049	0098
13100	0362	0050		
13200	0363	0052		
13300	0364	0102		
13400	0365	0235		
13500	0366	0237		
13600	0367	0233		
13700	0368	0326		
13800	0369	0328		
13900	0370	0048		
14000	0371	0061		
14100	0372	0063		
14200	0373	0067		

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COMPIER OPTIONS - NAME= MAIN,CFT=02,LINECNT=60,SIZE=0000K,
                  SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,XREF
CGROW
C...
C...SUBROUTINE GROWTH CALCULATES THE GROWTH OF EACH YOUNG OF THE
C...YEAR LIFE STAGE. IT IS CALLED BY MAIN ONCE FOR EACH LIFE STAGE.
C...
ISN 0002      SUBRCUTINE GROWTH (IN,ISTAGE,IYE,KTYO,NX0,NMAX,PTIME,KPLANT)
ISN 0003      COMMON/LSTAGE/AKX(5),AKX0(5),AYS(5),DE(5),DTE(5),FKILL(5),ILEPT(5)
ISN 0004      1 ,IRIGHT(5),KX(5),KX0(5),YS(5)
ISN 0005      COMMON/PAR/LEND,ISKP,ISW,KSTP,NN,P,QP,TE,V
ISN 0006      COMMON /BKTTA/ NX,DNXTD
ISN 0007      COMMON/WGHT/TIM(10),TIMW(10)
ISN 0008      COMMON/WYY/W(5000),YY(5000)
ISN 0009      REAL NX0,NX,KX,KX0,KNATL,KPLANT,KTOTAL,NMAX
ISN 0010      INTEGER OF1
ISN 0011      C
ISN 0012      C      INITIALIZATION
ISN 0013      C
ISN 0014      IND = 0
ISN 0015      KOUNTY = 0
ISN 0016      NDT = 0
ISN 0017      NMAX = 0.
ISN 0018      OLDNX = 0.
ISN 0019      T = 0.
ISN 0020      YYY = C.
ISN 0021      OF1=6
ISN 0022      ISTP=KSTP
ISN 0023      J4=2
ISN 0024      ISTART=2
ISN 0025      W(1)=1.
ISN 0026      IS = ISTAGE
ISN 0027      PTIME = PTIME + DTE (IS) + TE
ISN 0028      TT=PTIME+T
ISN 0029      NX=NX0
ISN 0030      KOUNTX=1
ISN 0031      IF (ISRP.EQ.1.AND.IN.EQ.1.OR.ISKP.EQ.1.AND.IYR.EQ.1) WRITE(OF1,
ISN 0032      1 10000)
ISN 0033      IF (ISKP.EQ.1.AND.IN.EQ.1.OR.ISKP.EQ.1.AND.IYR.EQ.1) WRITE(CF1,
ISN 0034      1 10100) TT,OLDNX,YYY,NX0,NX
ISN 0035      10 IF (ISTAGE.EQ.5) GO TO 40
ISN 0036      IF (NX.GT.NMAX) NMAX = NX
ISN 0037      C...
ISN 0038      C...CALL SUBROUTINE DELTA.
ISN 0039      C...
ISN 0040      CALL DELTA (1,IN,ISTAGE,IYR,KNATL,KPLANT,BATIO,PSN,PSP,PST)
ISN 0041      NDT=NDT+1
ISN 0042      TT = PTIME + NDT*DE (IS)
ISN 0043      OLDNX=NX
ISN 0044      C
ISN 0045      C      COMPUTE GROWTH HISTORY OF PRESENT STAGE AND
ISN 0046      C      RECORD HISTORY OF NEXT-STAGE INPUT IMPULSES..
ISN 0047      C
ISN 0048      IF (T+0.001*DE (IS).GE.TE) GO TO 30
ISN 0049      IF (T+0.001*DE (IS).GE.DTE (IS)) GO TO 20
ISN 0050      KOUNTX=KOUNTX+1
ISN 0051      IF (ISTAGE.NE.1) NX0=YY (KOUNTX)
ISN 0052      C ***** A---ONLY PRODUCTION OCCURS

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ISN 0046	NX=NX+NX0	GROW 280
ISN 0047	YYY=0.	GROW 285
ISN 0048	GO TO 100	GROW 290
	C ***** B---PRODUCTION AND TRANSFER OCCUR	GROW 295
ISN 0049	20 KOUNTY=KOUNTY+1	GROW 300
ISN 0050	IF (ISTAGE.NE.1) NX0=YY(KOUNTX+KOUNTY)	GROW 305
ISN 0052	YY(KOUNTY)=NX*W(KOUNTY)	GROW 310
ISN 0053	NX=NX-YY(KOUNTY)+NX0	GROW 315
ISN 0054	YYY=YY(KOUNTY)	GROW 320
ISN 0055	GO TO 100	GROW 325
	C ***** C---ONLY TRANSFER OCCURS	GROW 330
ISN 0056	30 KOUNTY=KOUNTY+1	GROW 335
ISN 0057	NX0=0.	GROW 340
ISN 0058	IF (ISTAGE.NE.1) NX0=YY(KOUNTX+KOUNTY)	GROW 345
	C FROM JUVENILE II STAGE ON, NO TRANSFER EXCEPT SURVIVAL...	GROW 350
ISN 0060	40 IF (ISTAGE.LT.4) GO TO 90	GROW 355
ISN 0062	IF (NX.GT.NMAX) NMAX = NX	GROW 360
ISN 0064	NX0=0.	GROW 365
ISN 0065	NDT=0	GROW 370
ISN 0066	YYY=0.	GROW 375
ISN 0067	50 BUF=0.	GROW 380
ISN 0068	IF (YS(IS).LT.1.) GO TO 60	GROW 385
ISN 0070	BUF = (KX(IS)-KX0(IS))*((NX-YS(IS))/YS(IS))**3	GROW 390
ISN 0071	IF (NX.LT.YS(IS).AND.ILEFT(IS).EQ.1) BUF = 0.	GROW 395
ISN 0073	IF (NX.GT.YS(IS).AND.IRIGHT(IS).EQ.1) BUF = 0.	GROW 400
ISN 0075	60 KNATL = KX(IS) + BUF	GROW 405
ISN 0076	KPLANT = ISW*PKILL(IS)*QP/V	GROW 410
ISN 0077	IF (IYB.EQ.0) KPLANT = 0.	GROW 415
ISN 0079	KTOTAL = KNATL + KPLANT	GROW 420
ISN 0080	RATIO = KPLANT/KTOTAL	GROW 425
ISN 0081	PSN = EXP(-KNATL*DTE(IS))	GROW 430
ISN 0082	PSP = EXP(-KPLANT*DTE(IS))	GROW 435
ISN 0083	PST = EXP(-KTOTAL*DTE(IS))	GROW 440
ISN 0084	OLDNX=NX	GROW 445
ISN 0085	NX = NX*EXP(-KTOTAL*DE(IS))	GROW 450
ISN 0086	NDT=NDT+1	GROW 455
ISN 0087	T = TT + NDT*DE(IS)	GROW 460
ISN 0088	IF (T.GE.PTIME.OR.T.GI.365.) GO TO 70	GROW 465
ISN 0090	IF (MOD(NDT,ISTP).GT.0) GO TO 50	GROW 470
ISN 0092	IF (ISKP.EQ.1.AND.IN.EQ.1.OR.ISKP.EQ.1.AND.IYR.EQ.1) WRITE(OP1, 1 10100) T,OLDNX,YYY,NX0,NX, KNATL,KPLANT,RATIO,PSN,PSP,PST	GROW 475 GROW 480
ISN 0094	GO TO 50	GROW 485
ISN 0095	70 NX0=NX	GROW 490
ISN 0096	YY(1)=NX	GROW 495
ISN 0097	DO 80 J=2,5000	GROW 500
ISN 0098	80 YY(J)=0.	GROW 505
ISN 0099	RETURN	GROW 510
ISN 0100	90 IF (IND.EQ.0) ISTART=1	GROW 515
ISN 0102	IND=1	GROW 520
ISN 0103	YY(KOUNTY)=NX*W(KOUNTY)	GROW 525
ISN 0104	NX=NX-YY(KOUNTY)	GROW 530
ISN 0105	YYY=YY(KOUNTY)	GROW 535
ISN 0106	ISTART=ISTART+1	GROW 540
ISN 0107	100 IF (MOD(NDT,ISTP).GT.0) GO TO 110	GROW 545
ISN 0109	IF (ISKP.EQ.1.AND.IN.EQ.1.OR.ISKP.EQ.1.AND.IYR.EQ.1) WRITE(OP1, 1 10100) TT,OLDNX,YYY,NX0,NX, KNATL,KPLANT,RATIO,PSN,PSP,PST	GROW 550 GROW 555
ISN 0111	110 IF (ISTAGE.GE.4) GO TO 130	GROW 560
ISN 0113	SUM=0.	GROW 565

ISN 0114	DO 120 I=ISTART,KOUNTX	GROW 570
ISN 0115	II=KOUNTX+ISTART-I	GROW 575
ISN 0116	W(II)=0.	GROW 580
ISN 0117	IF (NX.EQ.0.) GO TO 120	GROW 585
ISN 0119	W(II)=OLDNX*W(II-1)/NX	GROW 590
ISN 0120	SUM=SUM+W(II)	GROW 595
ISN 0121	120 CONTINUE	GROW 600
ISN 0122	W(ISTART-1)=1.-SUM	GROW 605
ISN 0123	130 IF (TT.GE.PTIME) GO TO 140	GROW 610
ISN 0125	T = NDT*DE(IS)	GROW 615
ISN 0126	IF (ISTAGE.NE.1) GO TO 10	GROW 620
ISN 0128	AA=ABS(T-TIM(J4))	GROW 625
ISN 0129	IF (AA.GT.0.001) GO TO 10	GROW 630
ISN 0131	NX0 = P*DE(IS)*TIMW(J4)/(TIM(J4+1)-TIM(J4))	GROW 635
ISN 0132	J4=J4+1	GROW 640
ISN 0133	GO TO 10	GROW 645
	C	GROW 650
	C QUIT FOR EXIT	GROW 655
	C	GROW 660
ISN 0134	140 IF (ISTAGE.EQ.1) GO TO 160	GROW 665
	C ZERO UNUSED PART OF YY(I) TO SHOW NO PRODUCTION THEREON	GROW 670
ISN 0136	KTY1=KCUNTY+1	GROW 675
ISN 0137	DO 150 I=KTY1,KTYO	GROW 680
ISN 0138	150 YY(I)=0.	GROW 685
	C STORE # OF ELEMENTS USED IN YY(I)	GROW 690
ISN 0139	160 KTYO=KOUNTY+1	GROW 695
ISN 0140	RETURN	GROW 700
ISN 0141	10000 FORMAT (//,T4,'TIME ()',T15,'POPULATION(-)',T30,'TRANSFER',T45,	GROW 705
	1 'PRODUCTION',T60,'POPULATION(+)',T75,'KNATL',T85,'KPLANT',T95,	GROW 710
	1 'RATIC',T105,'PSN',T115,'ESP',T125,'PST'//)	GROW 715
ISN 0142	10100 FORMAT (T4,F6.2,T15,E9.4,T30,E9.4,T45,E9.4,T60,E9.4,T75, E9.4,T85,	GROW 720
	1 E9.4,T95,F6.4,T105,F6.4,T115,F6.4,T125,F6.4)	GROW 725
ISN 0143	END	GROW 730

[illegible]

LABEL	DEFINITION	REFERENCES
10	0031	0126 0129 0133
20	0049	0041
30	0056	0039
40	0060	0031
50	0067	0090 0094
60	0075	0068
70	0095	0088
80	0098	0097
90	0100	0060
100	0107	0048 0055
110	0111	0107
120	0121	0114 0117
130	0123	0111
140	0134	0123
150	0138	0137
160	0139	0134
10000	0141	0027
10100	0142	0029 0092 0109

COMPIER OPTIONS - NAME= MAIN,OPT=02,LINECNT=60,SIZE=0000K,
SOURCE,EBCDIC,NOLIST,NO CHECK,LOAD,MAP,NOEDIT,NOID,XREF

	CDELT		DELT	0
	C...		DELT	5
	C...SUBROUTINE DELTA IS THE RUNGE KUTIA EQUATIONS USED TO ADVANCE		DELT	10
	C...ONE TIME STEP FOR THE SPECIFIED LIFE STAGE. IT IS CALLED BY		DELT	15
	C...SUBROUTINE GROWTH. SUBROUTINE DELTA CALLS SUBROUTINE PUNC AT		DELT	20
	C...FOUR POINTS.		DELT	25
	C...		DELT	30
ISN 0002	SUBROUTINE DELTA (NDIM,IN,ISTAGE,IYR,KNATI,KPLANT,RATIO,PSN,PSP,		DELT	35
	1 FST)		DELT	40
ISN 0003	COMMON/LSTAGE/AXX(5),AKX(5),AYS(5),DE(5),DTE(5),PKILL(5),ILEFT(5)		DELT	45
	1 ,IRIGHT(5),KX(5),KXO(5),YS(5)		DELT	50
ISN 0004	COMMON /BKTTA/Y(1),DERY(1),AUX(16,1)		DELT	55
ISN 0005	REAL KNATI,KPLANT		DELT	60
	C THIS ROUTINE PERFORMS THE RUNGE KUTIA CALCULATIONS.		DELT	65
ISN 0006	H = DE(ISTAGE)		DELT	70
ISN 0007	CALL PUNC (IN,ISTAGE,IYR,KNATI,KPLANT,RATIO,PSN,PSP,PST)		DELT	75
ISN 0008	DO 10 I=1,NDIM		DELT	80
ISN 0009	AUX(1,I)=Y(I)		DELT	85
ISN 0010	10 AUX(2,I)=DERY(I)		DELT	90
ISN 0011	20 CONTINUE		DELT	95
	C RUNGE-KUTIA EQUATIONS FOLLOW		DELT	100
ISN 0012	30 DO 40 I=1,NDIM		DELT	105
ISN 0013	Z=H*AUX(8,I)		DELT	110
ISN 0014	AUX(5,I)=Z		DELT	115
ISN 0015	Y(I)=AUX(1,I)+.4*Z		DELT	120
ISN 0016	IF (Y(I).LT.0.) Y(I)=0.		DELT	125
ISN 0018	40 CONTINUE		DELT	130
	C Z=Y+.4*H		DELT	135
ISN 0019	CALL PUNC (IN,ISTAGE,IYR,KNATI,KPLANT,RATIO,PSN,PSP,PST)		DELT	140
ISN 0020	DO 50 I=1,NDIM		DELT	145
ISN 0021	Z=H*DERY(I)		DELT	150
ISN 0022	AUX(6,I)=Z		DELT	155
ISN 0023	Y(I)=AUX(1,I)+.2969776*AUX(5,I)+.1587596*Z		DELT	160
ISN 0024	IF (Y(I).LT.0.) Y(I)=0.		DELT	165
ISN 0026	50 CONTINUE		DELT	170
	C Z=Y+.4557372*H		DELT	175
ISN 0027	CALL PUNC (IN,ISTAGE,IYR,KNATI,KPLANT,RATIO,PSN,PSP,PST)		DELT	180
ISN 0028	DO 60 I=1,NDIM		DELT	185
ISN 0029	Z=H*DERY(I)		DELT	190
ISN 0030	AUX(7,I)=Z		DELT	195
ISN 0031	Y(I)=AUX(1,I)+.2181004*AUX(5,I)-3.050965*AUX(6,I) +3.832865*Z		DELT	200
ISN 0032	IF (Y(I).LT.0.) Y(I)=0.		DELT	205
ISN 0034	60 CONTINUE		DELT	210
	C Z=Y+H		DELT	215
ISN 0035	CALL PUNC (IN,ISTAGE,IYR,KNATI,KPLANT,RATIO,PSN,PSP,PST)		DELT	220
ISN 0036	DO 70 I=1,NDIM		DELT	225
ISN 0037	Y(I)=AUX(1,I)+.1747603*AUX(5,I)-.5514867*AUX(6,I) +1.205536*		DELT	230
	1 AUX(7,I)+.1711048*H*DERY(I)		DELT	235
ISN 0038	IF (Y(I).LT.0.) Y(I)=0.		DELT	240
ISN 0040	70 CONTINUE		DELT	245
ISN 0041	80 RETURN		DELT	250
ISN 0042	END		DELT	255
			DELT	260

LABEL	DEFINED	REFERENCES
10	0010	0008
20	0011	
30	0012	
40	0018	0012
50	0026	0020
60	0034	0028
70	0040	0036
80	0041	

COMPILER OPTIONS - NAME= MAIN,OPT=02,LINECNT=60,SIZE=0000K,
SOURCE,FBCDIC,NOLIST,MODECK,LOAD,MAP,NOEDIT,NOID,XREF

CPUNC		PUNC	0
C...		PUNC	5
C...SUBROUTINE PUNC CALCULATES THE CHANGE IN STANDING CROP FOR		PUNC	10
C...THE SPECIFIED LIFE STAGE DUE TO NATURAL MORTALITY AND, IF THE		PUNC	15
C...POWER PLANT IS "CN" IN THE MODEL, DUE TO PLANT MORTALITY.		PUNC	20
C...		PUNC	25
ISN 0002 SUBROUTINE PUNC(IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,PST)		PUNC	30
ISN 0003 COMMON/ISTAGE/AXI(5),AKX(5),AYS(5),DE(5),DTE(5),PKILL(5),ILEPT(5)		PUNC	35
1 ,IRIGHT(5),KI(5),KXO(5),YS(5)		PUNC	40
COMMON/PAR/IEND,ISKP,ISW,KSTP,NH,F,CP,TE,V		PUNC	45
ISN 0004 COMMON /BKTTA/ NX,DNXT		PUNC	50
ISN 0005 REAL KNATL,KPLANT,KTOTAL		PUNC	55
ISN 0007 REAL KI,KXO,NX		PUNC	60
ISN 0008 IS = ISTAGE		PUNC	65
ISN 0009 BUF = 0.		PUNC	70
ISN 0010 IF (YS(IS).LT.1.) GO TO 10		PUNC	75
ISN 0012 BUF = (KI(IS)-KXO(IS))*((NX-YS(IS))/YS(IS))**3		PUNC	80
ISN 0013 IF (NX.LT.YS(IS).AND.ILEPT(IS).EQ.1) BUF = 0.		PUNC	85
ISN 0015 IF (NX.GT.YS(IS).AND.IRIGHT(IS).EQ.1) BUF = 0.		PUNC	90
ISN 0017 10 KNATL = KI(IS) + BUF		PUNC	95
ISN 0018 KPLANT = ISW*PKILL(IG)*QP/V		PUNC	100
ISN 0019 IF (IYR.EQ.0) KPLANT = 0.		PUNC	105
ISN 0021 KTOTAL = KNATL + KPLANT		PUNC	110
ISN 0022 RATIO = KPLANT/KTOTAL		PUNC	115
ISN 0023 PSN = EXP(-KNATL*DTE(IS))		PUNC	120
ISN 0024 PSP = EXP(-KPLANT*DTE(IS))		PUNC	125
ISN 0025 PST = EXP(-KTOTAL*DTE(IS))		PUNC	130
ISN 0026 DNXT = -KTOTAL*NX		PUNC	135
ISN 0027 RETURN		PUNC	140
ISN 0028 END		PUNC	145

*****FORTRAN CROSS REFERENCE LISTING*****

SYMBOL	INTERNAL STATEMENT NUMBERS
P	0004
V	0004 0018
DE	0003
IN	0002
IS	0008 0010 0012 0012 0012 0012 0013 0013 0015 0015 0017 0018 0023 0024 0025
KX	0003 0007 0012 0017
NN	0004
NI	0005 0007 0012 0013 0015 0026
QP	0004 0018
TE	0004
YS	0003 0010 0012 0012 0013 0015
AKX	0003
AYS	0003
BUF	0005 0012 0013 0015 0017
DTE	0003 0023 0024 0025
EXP	0023 0024 0025
ISW	0004 0018
IYR	0002 0019
KXO	0003 0007 0012
PSN	0002 0023
PSP	0002 0024
PST	0002 0025
AKXO	0003
FUNC	0002
IEND	0004
ISK P	0004
KST P	0004
DNIDT	0005 0026
PKILL	0003 0018
ILEPT	0003 0013
KMATL	0002 0006 0017 0021 0023
RATIO	0002 0022
IRIGHT	0003 0015
ISTAGE	0002 0008
KPLANT	0002 0006 0018 0019 0021 0022 0024
KTOTAL	0006 0021 0022 0025 0026

LABEL	DEFINED	REFERENCES
10	0017	0010

COMPILE OPTIONS - NAME= MAIN,OPT=02,LINECNT=60,SIZE=0000K,
SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,XREF

CEQUA		EQUA	0
C...		EQUA	5
C...SUBROUTINE EQUAL CALCULATES A FIRST ORDER MORTALITY RATE		EQUA	10
C...COEFFICIENT FOR ADULT CLASSES 4-13 FOR YEAR ZERO. THIS		EQUA	15
C...CALCULATION IS DONE USING A NEWTON RHAPHSON TECHNIQUE AND		EQUA	20
C...IS DESIGNED TO GENERATE AN ADULT AGE DISTRIBUTION THAT WILL		EQUA	25
C...PRODUCE THE SAME NUMBER OF EGGS AS SPECIFIED BY ONE OF		EQUA	30
C...THE INPUT PARAMETERS.		EQUA	35
C...		EQUA	40
ISN 0002 SUBROUTINE EQUAL (ADULT,ADULTS,DCYU,NEO,PEQUAL,RMP,RO)		EQUA	45
ISN 0003 COMMON/ADULTT/DCY(20),FEC(20),SEAT(20),SMAT(20)		EQUA	50
ISN 0004 COMMON/PAR/IEND,ISKP,ISW,KSTP,NN,F,QP,TE,V		EQUA	55
ISN 0005 DIMENSION ADULT(20),ADULTS(20),DCYU(20),RMP(20)		EQUA	60
ISN 0006 REAL NEO,NS,KO,KN		EQUA	65
ISN 0007 DO 10 K=1,3		EQUA	70
ISN 0008 10 DCYU(K)=DCY(K)		EQUA	75
ISN 0009 RO=PEQUAL/NEO		EQUA	80
ISN 0010 DO 20 K=1,IEND		EQUA	85
ISN 0011 20 RMP(K)=SEAT(K)*SMAT(K)*FEC(K)		EQUA	90
ISN 0012 S1=RMP(1)		EQUA	95
ISN 0013 AXP=1.		EQUA	100
ISN 0014 DO 30 K=2,4		EQUA	105
ISN 0015 AXP=AXP*EXP(-DCYU(K-1)*365.)		EQUA	110
ISN 0016 30 S1=S1+RMP(K)*AXP		EQUA	115
ISN 0017 D=(RO-S1)/AXP		EQUA	120
ISN 0018 WRITE(12,10000)		EQUA	125
ISN 0019 WRITE(12,10100)RO,S1,AXP,D		EQUA	130
ISN 0020 DTEST=.1E-7		EQUA	135
ISN 0021 ITERX=20		EQUA	140
ISN 0022 ITER=1		EQUA	145
ISN 0023 KO=1.89903E-3		EQUA	150
C...		EQUA	155
C...START ITERATION LOOP		EQUA	160
C...		EQUA	165
ISN 0024 40 PPK=0.		EQUA	170
ISN 0025 PK=D		EQUA	175
ISN 0026 PX=1.		EQUA	180
ISN 0027 DO 50 K=5,IEND		EQUA	185
ISN 0028 AK=K		EQUA	190
ISN 0029 PX=EXP(-KO*(AK-4.)*365.)		EQUA	195
ISN 0030 PK=PK-RMP(K)*PX		EQUA	200
ISN 0031 50 PPK=PPK+365.*(AK-4.)*RMP(K)*PX		EQUA	205
ISN 0032 QUOT=PK/PPK		EQUA	210
ISN 0033 KN=KO-QUOT		EQUA	215
ISN 0034 DP=ABS(KN-KO)		EQUA	220
ISN 0035 WRITE(12,10200)KO,KN,DP,ITER		EQUA	225
ISN 0036 ITER=ITER+1		EQUA	230
ISN 0037 IF (ITER.EQ.ITERX) GO TO 60		EQUA	235
ISN 0039 IF (DP.LE.DTEST) GO TO 60		EQUA	240
ISN 0041 IF (KN.LT.0.) KN=.5*KO		EQUA	245
ISN 0043 KO=KN		EQUA	250
ISN 0044 GC TO 40		EQUA	255
ISN 0045 60 KK=4		EQUA	260
ISN 0046 DO 70 K=KK,IEND		EQUA	265
ISN 0047 70 DCYU(K)=KN		EQUA	270
ISN 0048 WRITE(12,10200)KO,KN,DP,ITER		EQUA	275

ISN 0049	WRITE(12,10300)	EQUA 280
ISN 0050	RETURN	EQUA 285
ISN 0051	10000 FORMAT (////' ITERATE TO EQUILIBRIUM BY ADJUSTING THE FIRST ORDER'	EQUA 290
	1 ,/, ' DECAY RATE COEFFICIENT USED FOR YEAB CLASSES 4 AND OLDER',/)	EQUA 295
ISN 0052	10100 FORMAT (' R0=',E15.8,' S1=',E15.8,' AXP=',E15.8,' D=',E15.8)	EQUA 300
ISN 0053	10200 FORMAT (' K0=',E15.9,' KN=',E15.9,' C=',E15.8,' I=',I3)	EQUA 305
ISN 0054	10300 FORMAT (' END OF EQUAL.....'////)	EQUA 310
ISN 0055	END	EQUA 315

*****PORTRAN CROSS REFERENCE LISTING*****

[illegible]

LABEL	DEFINEL	REFERENCES
10	0008	0007
20	0011	0010
30	0016	0014
40	0024	0044
50	0031	0027
60	0045	0037 0039
70	0047	0046
10000	0051	0018
10100	0052	0019
10200	0053	0035 0048
10300	0054	0049

APPENDIX B INPUT DATA CARDS FOR SAMPLE RUN

```

1 13 040 0010 128. 335. 1
01 40 01 01
    4.6957E-3
    .5      .5      .5      .5      .028      .028  40
      100.0E9 49.  0.2  0.7  0.7  1.4  1.4
08  7.  14.  21.  28.  35.  42.  49.
    .0536  .0243  .2361  .4482  .2365  .0000  .0013  .0000
    .002510 .001400 .000611  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
    .50  .52  .54  .56  .58  .60  .62  .64  .66  .68  .70  .70  .70
    .0  .0  .0  .0  .8  1.0  1.  1.  1.  1.  1.  1.  1.
      .0      .0      .0      .0      .205E6  .297E6  .420E6  .572E6  .747E6
    .940E6  1.14E6  1.36E6  1.56E6  1.76E6
1.  1.  1.  2.
EGG STAGE
1.151      0.00E0  2.
  1.0  1.0  1.0  0  0
LARVAL STAGE
0.1645      1.47E9  28.
  1.0  0.8  1.0  0  0
JUVENILE 1 STAGE
0.05115      2.65E7  30.
  1.0  0.8  1.0  0  0
JUVENILE 2 STAGE
0.01245      8.98E6  100.
  1.0  0.8  1.0  0  0
JUVENILE 3 STAGE
0.009720      2.29E6  158.
  1.0  0.8  1.0  0  0

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APPENDIX C
OUTPUT FROM SAMPLE RUN

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.....
..CURRENT YEAR..... - 0- ..
.....

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STAGE 1 EGG STAGE

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KK(1/DAY)=      0.1150999069E 01
KX0(1/DAY)=      0.1150999069E 01
YS(NUMBER)=      0.0
LIFE PERIOD(DAY)= 2.0000
RATIO OF THE KK VALUE USED IN THIS RUN TO THE "STANDARD" KK VALUE GIVEN ABOVE = 1.000
RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 1.000
RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

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TIME ()	POPULATION (-)	TRANSFER	PRODUCTION	POPULATION (+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
0.0	.0	.0	.1531E 09	.1531E 09						
2.00	.5324E 09	.1532E 08	.1531E 09	.6703E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
4.00	.5324E 09	.1532E 08	.1531E 09	.6703E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
6.00	.5324E 09	.1532E 08	.1531E 09	.6703E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
8.00	.3378E 09	.1532E 08	.6943E 08	.3919E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
10.00	.2414E 09	.6947E 07	.6943E 08	.3039E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
12.00	.2414E 09	.6947E 07	.6943E 08	.3039E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
14.00	.2414E 09	.6947E 07	.6943E 08	.3039E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
16.00	.2285E 10	.6947E 07	.6746E 09	.2552E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
18.00	.2345E 10	.6750E 08	.6746E 09	.2552E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
20.00	.2345E 10	.6750E 08	.6746E 09	.2552E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
22.00	.3754E 10	.6750E 08	.1281E 10	.4567E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
24.00	.4452E 10	.1281E 09	.1281E 10	.5605E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
26.00	.4452E 10	.1281E 09	.1281E 10	.5605E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
28.00	.4452E 10	.1281E 09	.1281E 10	.5605E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
30.00	.2410E 10	.1281E 09	.6757E 09	.2957E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
32.00	.2349E 10	.6762E 08	.6757E 09	.2957E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
34.00	.2349E 10	.6762E 08	.6757E 09	.2957E 10	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
36.00	.7783E 09	.6762E 08	.0	.7107E 09	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
38.00	.4621E 01	.4239E 01	.0	.3827E 00	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
40.00	.0	.0	.0	.0	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
42.00	.0	.0	.0	.0	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
44.00	.1254E 08	.0	.3714E 07	.1626E 08	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
46.00	.1291E 08	.3717E 06	.3714E 07	.1626E 08	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
48.00	.1291E 08	.3717E 06	.3714E 07	.1626E 08	.1151E 01 .0		0.0	0.1001	1.0000	0.1001
50.00	.3103E 07	.3717E 06	.0	.2732E 07	.1151E 01 .0		0.0	0.1001	1.0000	0.1001

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TOTAL PRODUCTION INTO THIS LIFE STAGE =      0.9959994061E 11
TOTAL TRANSFER INTO THE NEXT LIFE STAGE =      0.1002105651E 11
% SURVIVAL THROUGH THIS LIFE STAGE =      10.0
MAXIMUM STANDING CROP FOR THIS LIFE STAGE =      0.5604630528E 10
RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 0.0
REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0
% REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0

```

STAGE 2 LARVAL STAGE

KX(1/DAY)= 0.1644999961E 00
 KX0(1/DAY)= 0.1385999627E 00
 YS(NUMBER)= 0.1459999872E 10
 LIFE PERIOD(DAY)= 28.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NC
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
2.00	.0	.0	.1532E 08	.1532E 08						
9.00	.2639E 09	.0	.4597E 08	.3093E 09	.1463E 00	.0	0.0	0.0166	1.0000	0.0166
16.00	.2375E 09	.0	.2084E 08	.2584E 09	.1451E 00	.0	0.0	0.0172	1.0000	0.0172
23.00	.9725E 09	.0	.2025E 09	.1175E 10	.1632E 00	.0	0.0	0.0104	1.0000	0.0104
30.00	.2050E 10	.2179E 06	.3844E 09	.2435E 10	.1665E 00	.0	0.0	0.0094	1.0000	0.0094
37.00	.2238E 10	.5095E 06	.2028E 09	.2440E 10	.1692E 00	.0	0.0	0.0088	1.0000	0.0088
44.00	.1594E 10	.2005E 06	.6100E 01	.1594E 10	.1645E 00	.0	0.0	0.0100	1.0000	0.0100
51.00	.5063E 09	.1854E 07	.8920E 06	.5044E 09	.1552E 00	.0	0.0	0.0130	1.0000	0.0130
58.00	.1620E 09	.3975E 07	.1115E 07	.1580E 09	.1413E 00	.0	0.0	0.0191	1.0000	0.0191
65.00	.3959E 08	.2769E 07	.0	.3682E 08	.1342E 00	.0	0.0	0.0233	1.0000	0.0233
72.00	.1357E 03	.8258E 01	.0	.1274E 03	.1316E 00	.0	0.0	0.0251	1.0000	0.0251
79.00	.2913E 02	.0	.0	.2913E 02	.1316E 00	.0	0.0	0.0251	1.0000	0.0251

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.1002105651E 11
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.1126106560E 09
 % SURVIVAL THROUGH THIS LIFE STAGE = 1.1
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.2836734976E 10
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.9298
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0

STAGE 3 JUVENILE 1 STAGE

KX(1/DAY)= 0.5114999786E-01
 KX0(1/DAY)= 0.4091999307E-01
 YS(NUMBER)= 0.2650000000E 08
 LIFE PERIOD(DAY)= 30.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NC
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
30.00	.0	.0	.2179E 06	.2179E 06						

37.00	.4573E 07	.0	.5095E 06	.5082E 07	.4535E-01 .0	0.0	.2565	1.0000	0.2565
44.00	.5536E 07	.0	.2005E 06	.5736E 07	.4609E-01 .0	0.0	.2509	1.0000	0.2509
51.00	.1478E 08	.0	.1854E 07	.1663E 08	.5026E-01 .0	0.0	.2214	1.0000	0.2214
58.00	.3397E 08	.0	.3975E 07	.3795E 08	.5138E-01 .0	0.0	.2141	1.0000	0.2141
65.00	.5199E 08	.1197E 05	.2769E 07	.5464E 08	.6026E-01 .0	0.0	.1640	1.0000	0.1640
72.00	.5294E 08	.4058E 05	.8258E 01	.5290E 08	.6132E-01 .0	0.0	.1589	1.0000	0.1589
79.00	.3489E 08	.3378E 05	.0	.3456E 08	.5148E-01 .0	0.0	.2135	1.0000	0.2135
86.00	.2101E 08	.6939E 05	.0	.2032E 08	.5106E-01 .0	0.0	.2162	1.0000	0.2162
93.00	.3510E 07	.5667E 05	.0	.7943E 07	.4795E-01 .0	0.0	.2373	1.0000	0.2373
100.00	.1218E 07	.7037E 05	.0	.5144E 06	.4227E-01 .0	0.0	.2814	1.0000	0.2814
107.00	.1916E 02	.2857E 01	.0	.1630E 02	.4092E-01 .0	0.0	.2930	1.0000	0.2930

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.1126166540E 09
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.2165459200E 08
 % SURVIVAL THROUGH THIS LIFE STAGE = 19.2
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.5835945600E 08
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 2.2022
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0

STAGE 4 JUVENILE 2 STAGE

KX(1/DAY)= 0.1244999841E-01
 KX0(1/DAY)= 0.9959995747E-02
 YS(NUMBER)= 0.8980000000E 07
 LIFE PERIOD (DAY)= 100.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION (-)	TRANSFER	PRODUCTION	POPULATION (+)	KNATL	KPLANT	RATIO	ESN	PSP	PST
60.00	.0	.0	.5208E 05	.5208E 05						
74.00	.1479E 07	.0	.7526E 05	.1555E 07	.1100E-01 .0	0.0	.3329	1.0000	0.3329	
88.00	.8153E 07	.0	.1476E 07	.9629E 07	.1245E-01 .0	0.0	.2880	1.0000	0.2880	
102.00	.1789E 08	.0	.4258E 01	.1789E 08	.1488E-01 .0	0.0	.2258	1.0000	0.2258	
123.00	.1370E 08	.0	.0	.1346E 08	.1281E-01 .0	0.0	.2777	1.0000	0.2777	
137.00	.1148E 08	.0	.0	.1128E 08	.1250E-01 .0	0.0	.2864	1.0000	0.2864	
151.00	.9642E 07	.0	.0	.9475E 07	.1245E-01 .0	0.0	.2879	1.0000	0.2879	
165.00	.8099E 07	.0	.0	.7959E 07	.1245E-01 .0	0.0	.2880	1.0000	0.2880	
179.00	.6805E 07	.0	.0	.6688E 07	.1241E-01 .0	0.0	.2890	1.0000	0.2890	
193.00	.5722E 07	.0	.0	.5624E 07	.1233E-01 .0	0.0	.2914	1.0000	0.2914	
207.00	.4818E 07	.0	.0	.4737E 07	.1220E-01 .0	0.0	.2952	1.0000	0.2952	

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.2165459200E 08
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.4578047000E 07
 % SURVIVAL THROUGH THIS LIFE STAGE = 21.1
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.1827156200E 08
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 2.0347
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0

NUMBER OF JUVENILE 2 KILLED BY IMPINGEMENT...0.0

STAGE 5 JUVENILE 3 STAGE

KI(1/DAY)= 0.9719997644E-02
 KJO(1/DAY)= 0.7775995880E-02
 KS(NUMBER)= 0.2290000000E 07
 LIFE PERIOD(DAY)= 158.0000
 RATIO OF THE KI VALUE USED IN THIS RUN TO THE "STANDARD" KI VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KJO VALUE USED IN THIS RUN TO THE KI VALUE USED IN THIS RUN = 0.800
 RATIO OF THE KS VALUE USED IN THIS RUN TO THE "STANDARD" KS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	FSF	PST
209.00	.0	.0	.4578E 07	.4578E 07						
223.00	.3982E 07	.0	.0	.3924E 07	.1050E-01	.0	0.0	0.1902	1.0000	0.1902
237.00	.3451E 07	.0	.0	.3403E 07	.9973E-02	.0	0.0	0.2068	1.0000	0.2068
251.00	.3006E 07	.0	.0	.2965E 07	.9779E-02	.0	0.0	0.2133	1.0000	0.2133
265.00	.2622E 07	.0	.0	.2597E 07	.9726E-02	.0	0.0	0.2151	1.0000	0.2151
279.00	.2289E 07	.0	.0	.2258E 07	.9720E-02	.0	0.0	0.2153	1.0000	0.2153
293.00	.1997E 07	.0	.0	.1970E 07	.9716E-02	.0	0.0	0.2154	1.0000	0.2154
307.00	.1744E 07	.0	.0	.1720E 07	.9694E-02	.0	0.0	0.2162	1.0000	0.2162
321.00	.1523E 07	.0	.0	.1502E 07	.9647E-02	.0	0.0	0.2178	1.0000	0.2178
335.00	.1331E 07	.0	.0	.1313E 07	.9577E-02	.0	0.0	0.2202	1.0000	0.2202
349.00	.1165E 07	.0	.0	.1149E 07	.9489E-02	.0	0.0	0.2233	1.0000	0.2233
363.00	.1020E 07	.0	.0	.1007E 07	.9389E-02	.0	0.0	0.2269	1.0000	0.2269

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.4578047000E 07
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.9808884375E 06
 % SUBVIVAL THROUGH THIS LIFE STAGE = 21.4
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.4578047000E 07
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CRCP (WMAX/YS) = 1.9991
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.0.

NUMBER OF JUVENILE 3 KILLED BY IMPINGEMENT...0.0
 TOTAL NUMBER OF JUVENILES KILLED BY IMPINGEMENT...0.0

CUMULATIVE PROBABILITY OF SURVIVAL FROM EGG THROUGH JUVENILE 3 = 0.98088749E-05
 EXPECTED NUMBER OF YEARLINGS = 0.98088688E 06

ADULT DISTRIBUTION BY AGE CLASS

AGE NUMBERS	AGE NUMBERS	AGE NUMBERS	AGE NUMBERS	AGE NUMBERS
1 980688.	2 392411.	3 235405.	4 188348.	5 117871.
6 73766.	7 46164.	8 28890.	9 18020.	10 11315.
11 7081.	12 4431.	13 2773.		
TOTAL ADULTS	2107417.			

PERCENT AGE DISTRIBUTION RELATIVE TO YEAR ZERO
 AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT

1 46.545	2 18.620	3 11.170	4 8.937	5 5.593
6 3.500	7 2.191	8 1.371	9 0.858	10 0.537
11 0.336	12 0.210	13 0.132		

PERCENT AGE DISTRIBUTION RELATIVE TO CURRENT YEAR
 AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT

1	46.545	2	18.620	3	11.170	4	8.937	5	5.593
6	3.500	7	2.191	8	1.371	9	0.858	10	0.537
11	0.336	12	0.210	13	0.132				

SIZE OF POPULATION (YEAR CLASSES 1-13) FOR THE
 CURRENT YEAR AS A PERCENTAGE OF THE SIZE OF THE
 POPULATION IN YEAR ZERO... 1.000

REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT... 0.
 % REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT... 0.0
 REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT... 0.
 % REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT... 0.0

NUMBER OF EGGS EXPECTED TO BE PRODUCED BY
 THE NUMBER OF ONE-YEAR OLD STRIPED BASS FOR THE CURRENT
 YEAR DURING THEIR LIFE TIME AS A PERCENTAGE OF THE NUMBER
 OF EGGS PRODUCED IN YEAR ZERO..... 1.000

.....
 ..CURRENT YEAR..... - 1- ..

STAGE 1 STAGE 2

KX(1/DAY)= 0.1150999069E 01
 KYC(1/DAY)= 0.1150999069E 01
 YS(NUMBER)= 0.0
 LIFE PERIOD(DAY)= 2.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KYC VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 1.000
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NC
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
0.0	.0	.0	.1531E 09	.1531E 09						
2.00	.5306E 09	.1518E 08	.1531E 09	.66E5E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
4.00	.5306E 09	.1518E 08	.1531E 09	.66E5E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
6.00	.5306E 09	.1518E 08	.1531E 09	.66E5E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
8.00	.3363E 09	.1518E 08	.6943E 08	.3906E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
10.00	.2405E 09	.6882E 07	.6943E 08	.3031E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
12.00	.2405E 09	.6882E 07	.6943E 08	.3031E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
14.00	.2405E 09	.6882E 07	.6943E 08	.3031E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
16.00	.2277E 10	.6882E 07	.5746E 09	.2945E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
18.00	.2337E 10	.6687E 08	.5746E 09	.2945E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
20.00	.2337E 10	.6687E 08	.5746E 09	.2945E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
22.00	.3743E 10	.6687E 08	.1281E 10	.4957E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
24.00	.4437E 10	.1269E 09	.1281E 10	.5590E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
26.00	.4437E 10	.1269E 09	.1281E 10	.5590E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
28.00	.4437E 10	.1269E 09	.1281E 10	.5590E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
30.00	.2401E 10	.1269E 09	.6757E 09	.2950E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
32.00	.2341E 10	.6698E 08	.6757E 09	.2950E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
34.00	.2341E 10	.6698E 08	.6757E 09	.2950E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
36.00	.7733E 09	.6698E 08	.0	.7063E 09	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
38.00	.0	.0	.0	.0	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
40.00	.0	.0	.0	.0	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
42.00	.0	.0	.0	.0	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
44.00	.1250E 08	.0	.3714E 07	.1621E 08	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
46.00	.1287E 08	.3682E 06	.3714E 07	.1621E 08	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
48.00	.1287E 08	.3682E 06	.3714E 07	.1621E 08	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
50.00	.3081E 07	.3682E 06	.0	.2713E 07	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991

TOTAL PRODUCTION INTO THIS LIFE STAGE = (.9999961293E 11
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.9927446528E 10
 % SURVIVAL THROUGH THIS LIFE STAGE = 9.9
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.5590171648E 10
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NRAX/YS) = 0.0
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.3276800000E 06
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.00

STAGE 2 LARVAL STAGE

KX(1/DAY)= 0.1644999981E 00
 KXO(1/DAY)= 0.1315999627E 00
 YS(NUMBER)= 0.1469999872E 10
 LIFE PERIOD(DAY)= 28.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KXO VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
2.00	.0	.0	.1518E 08	.1518E 08						
9.00	.2578E 09	.0	.4554E 08	.3034E 09	.1461E 00	.4E96E-02	0.0311	0.0167	0.8768	0.0147
16.00	.2290E 09	.0	.2065E 08	.2496E 09	.1447E 00	.4E96E-02	0.0314	0.0174	0.8768	0.0152
23.00	.5493E 09	.0	.2006E 09	.1150E 10	.1630E 00	.4E96E-02	0.0280	0.0104	0.8768	0.0091
30.00	.1997E 10	.1906E 06	.3808E 09	.2378E 10	.1660E 00	.4E96E-02	0.0275	0.0096	0.8768	0.0084
37.00	.1180E 10	.4512E 06	.2009E 09	.2381E 10	.1682E 00	.4E96E-02	0.0272	0.0090	0.8768	0.0079
44.00	.1535E 10	.1779E 06	.0	.1535E 10	.1645E 00	.4E96E-02	0.0278	0.0100	0.8768	0.0088
51.00	.4738E 09	.1647E 07	.8837E 06	.4722E 09	.1543E 00	.4E96E-02	0.0295	0.0133	0.8768	0.0117
58.00	.1482E 09	.3549E 07	.1105E 07	.1446E 09	.1406E 00	.4E96E-02	0.0323	0.0195	0.8768	0.0171
65.00	.3544E 08	.2447E 07	.0	.3299E 06	.1339E 00	.4E96E-02	0.0339	0.0235	0.8768	0.0206
72.00	.1250E 03	.1414E 07	.0	.1236E 03	.1316E 00	.4E96E-02	0.0345	0.0251	0.8768	0.0220
79.00	.3134E 02	.0	.0	.3134E 02	.1316E 00	.4E96E-02	0.0345	0.0251	0.8768	0.0220

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.9927446528E 10
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.999476600E 08
 % SURVIVAL THROUGH THIS LIFE STAGE = 1.0
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.2774163456E 10
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.8872
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.9360938400E 08
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.93

STAGE 3 JUVENILE 1 STAGE

KX(1/DAY)= 0.5114999786E-01
 KXO(1/DAY)= 0.4091999307E-01
 YS(NUMBER)= 0.2650000000E 08
 LIFE PERIOD(DAY)= 30.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KXO VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
30.00	.0	.0	.1906E 06	.1906E 06						

37.00	.3962E 07	.0	.4512E 06	.4413E 07	.4486E-01	.4696E-02	0.0948	0.2604	0.8686	0.2261
44.00	.4726E 07	.0	.1779E 06	.4904E 07	.4548E-01	.4696E-02	0.0936	0.2556	0.8686	0.2220
51.00	.1277E 08	.0	.1647E 07	.1442E 08	.4973E-01	.4696E-02	0.0863	0.2250	0.8686	0.1954
58.00	.2944E 08	.0	.3549E 07	.3299E 08	.5116E-01	.4696E-02	0.0841	0.2155	0.8686	0.1872
65.00	.4565E 08	.9512E 05	.2447E 07	.4800E 08	.5501E-01	.4696E-02	0.0786	0.1920	0.8686	0.1668
72.00	.4720E 08	.3387E 05	.1414E 01	.4716E 08	.5603E-01	.4696E-02	0.0773	0.1862	0.8686	0.1618
79.00	.3058E 08	.2845E 06	.0	.3029E 08	.5119E-01	.4696E-02	0.0840	0.2153	0.8686	0.1870
86.00	.1789E 08	.5868E 06	.0	.1730E 08	.5080E-01	.4696E-02	0.0846	0.2178	0.8686	0.1892
93.00	.7013E 07	.4720E 06	.0	.6541E 07	.4708E-01	.4696E-02	0.0907	0.2435	0.8686	0.2115
100.00	.9671E 06	.5595E 06	.0	.4076E 06	.4200E-01	.4696E-02	0.1006	0.2837	0.8686	0.2464
107.00	.3683E 01	.0	.0	.3683E 01	.4092E-01	.4696E-02	0.1029	0.2930	0.8686	0.2545

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.9994761600E 08
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.1795907200E 08
 % SURVIVAL THROUGH THIS LIFE STAGE = 18.0
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.5179577600E 06
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.9546
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.1266304000E 08
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...11.24

STAGE 4 JUVENILE 2 STAGE

KI(1/DAY)= 0.1244999841E-01
 KIO(1/DAY)= 0.9959995747E-02
 YS(NUMBER)= 0.8980000000E 07
 LIFE PERIOD(DAY)= 100.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KIO VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	PSF	PST
60.00	.0	.0	.4012E 05	.4012E 05						
74.00	.1181E 07	.0	.6325E 05	.1244E 07	.1082E-01	.2630E-03	0.0237	0.3390	0.9740	0.3302
88.00	.6817E 07	.0	.1250E 07	.8067E 07	.1242E-01	.2630E-03	0.0207	0.2889	0.9740	0.2814
102.00	.1492E 08	.0	.4410E 01	.1492E 08	.1317E-01	.2630E-03	0.0196	0.2679	0.9740	0.2609
123.00	.1156E 08	.0	.0	.1136E 08	.1251E-01	.2630E-03	0.0206	0.2862	0.9740	0.2788
137.00	.9676E 07	.0	.0	.9505E 07	.1245E-01	.2630E-03	0.0207	0.2879	0.9740	0.2804
151.00	.8098E 07	.0	.0	.7955E 07	.1245E-01	.2630E-03	0.0207	0.2880	0.9740	0.2805
165.00	.6779E 07	.0	.0	.6660E 07	.1241E-01	.2630E-03	0.0207	0.2890	0.9740	0.2815
179.00	.5679E 07	.0	.0	.5580E 07	.1233E-01	.2630E-03	0.0209	0.2915	0.9740	0.2840
193.00	.4766E 07	.0	.0	.4683E 07	.1219E-01	.2630E-03	0.0211	0.2954	0.9740	0.2878
207.00	.4007E 07	.0	.0	.3939E 07	.1203E-01	.2630E-03	0.0214	0.3004	0.9740	0.2926

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.1795907200E 08
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.3805681000E 07
 % SURVIVAL THROUGH THIS LIFE STAGE = 21.2
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.1520692000E 08
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.6936
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.3695520000E 07
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...17.07

NUMBER OF JUVENILE 2 KILLED BY IMPINGEMENT...0.292753E 06

STAGE 5 JUVENILE 3 STAGE

KX(1/DAY)= 0.9719997644E-02
 KX0(1/DAY)= 0.777599588CE-02
 YS(NUMBER)= 0.229000000CE 07
 LIFE PERIOD(DAY)= 158.000C
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB CP COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION (-)	TRANSFER	REPRODUCTION	POPULATION (+)	KNATL	KPLANT	RATIO	PEN	ESF	PST
209.00	.0	.0	.3806E 07	.3806E 07						
223.00	.3340E 07	.0	.0	.3293E 07	.9908E-02	.2630E-03	0.0259	0.2090	0.9593	0.2005
237.00	.2900E 07	.0	.0	.2860E 07	.9757E-02	.2630E-03	0.0262	0.2140	0.9593	0.2053
251.00	.2521E 07	.0	.0	.2486E 07	.9722E-02	.2630E-03	0.0263	0.2152	0.9593	0.2065
265.00	.2193E 07	.0	.0	.2162E 07	.9720E-02	.2630E-03	0.0263	0.2153	0.9593	0.2065
279.00	.1907E 07	.0	.0	.1880E 07	.9711E-02	.2630E-03	0.0264	0.2156	0.9593	0.2068
293.00	.1658E 07	.0	.0	.1636E 07	.9679E-02	.2630E-03	0.0264	0.2167	0.9593	0.2079
307.00	.1443E 07	.0	.0	.1424E 07	.9622E-02	.2630E-03	0.0266	0.2187	0.9593	0.2098
321.00	.1257E 07	.0	.0	.1240E 07	.9542E-02	.2630E-03	0.0268	0.2214	0.9593	0.2124
335.00	.1097E 07	.0	.0	.1082E 07	.9445E-02	.2630E-03	0.0271	0.2249	0.9593	0.2157
349.00	.9581E 06	.0	.0	.9453E 06	.9338E-02	.2630E-03	0.0274	0.2287	0.9593	0.2194
363.00	.8382E 06	.0	.0	.8271E 06	.9225E-02	.2630E-03	0.0277	0.2328	0.9593	0.2233

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.380568100CE 07
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.80548100CE 06
 % SURVIVAL THROUGH THIS LIFE STAGE = 21.2
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.380568100CE 07
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.6619
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.7723660000E 06
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...16.87

NUMBER OF JUVENILE 3 KILLED BY IMPINGEMENT...0.790276E 05
 TOTAL NUMBER OF JUVENILES KILLED BY IMPINGEMENT...0.3778E 06

CUMULATIVE PROBABILITY OF SURVIVAL FROM EGG THROUGH JUVENILE 3 = 0.80548316E-05
 EXPECTED NUMBER CP YEARLINGS = 0.80548000E 06

ADULT DISTRIBUTION BY AGE CLASS

AGE NUMBERS	AGE NUMBERS	AGE NUMBERS	AGE NUMBERS	AGE NUMBERS
1 805481.	2 392411.	3 235405.	4 188348.	5 117871.
6 73766.	7 46164.	8 28890.	9 18060.	10 11315.
11 7081.	12 4431.	13 2773.		
TOTAL ADULTS	1932009.			

PERCENT AGE DISTRIBUTION RELATIVE TO YEAR ZERO
 AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT

1 38.221	2 18.620	3 11.170	4 8.917	5 5.593
6 3.500	7 2.191	8 1.371	9 0.858	10 0.517
11 0.336	12 0.210	13 0.132		

PERCENT AGE DISTRIBUTION RELATIVE TO CURRENT YEAR
 AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT

1	41.691	2	20.311	3	12.184	4	9.749	5	6.101
6	3.818	7	2.389	8	1.495	9	0.936	10	0.586
11	0.367	12	0.229	13	0.144				

SIZE OF POPULATION [YEAR CLASSES 1-13] FOR THE
 CURRENT YEAR AS A PERCENTAGE OF THE SIZE OF THE
 POPULATION IN YEAR ZERO... 0.917

REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT... 175407.
 % REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT...17.88
 REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT... 175408.
 % REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT... 8.32

NUMBER OF EGGS EXPECTED TO BE PRODUCED BY
 THE NUMBER OF ONE-YEAR OLD STRIPED BASS FOR THE CURRENT
 YEAR DURING THEIR LIFE TIME AS A PERCENTAGE OF THE NUMBER
 OF EGGS PRODUCED IN YEAR ZERO..... 0.821

.....
 ..CURRENT YEAR..... - 40- ..

STAGE 1 STAGE

KX(1/DAY)= 0.1150999069E 01
 KX0(1/DAY)= 0.1150999069E 01
 YS(NUMBER)= 0.0
 LIFE PERIOD(DAY)= 2.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 1.000
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NC
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION (-)	TRANSFER	PRODUCTION	POPULATION (+)	KNATL	KFLANT	RATIO	PSN	PSP	PST
0.00	.0	.0	.1086E 09	.1086E 09						
2.00	.3762E 09	.1076E C8	.1086E 09	.4740E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
4.00	.3762E 09	.1076E C8	.1086E 09	.4740E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
6.00	.3762E 09	.1076E C8	.1086E 09	.4740E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
8.00	.2385E 09	.1076E C8	.4923E 08	.2770E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
10.00	.1706E 09	.4880E C7	.4923E 08	.2149E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
12.00	.1706E 09	.4880E C7	.4923E 08	.2149E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
14.00	.1706E 09	.4880E C7	.4923E 08	.2149E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
16.00	.1615E 10	.4880E C7	.4783E 09	.2088E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
18.00	.1657E 10	.4742E C8	.4783E 09	.2088E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
20.00	.1657E 10	.4742E C8	.4783E 09	.2088E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
22.00	.2654E 10	.4742E C8	.9080E 09	.3515E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
24.00	.3146E 10	.9001E C8	.9080E 09	.3964E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
26.00	.3146E 10	.9001E C8	.9080E 09	.3964E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
28.00	.3146E 10	.9001E C8	.9080E 09	.3964E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
30.00	.1703E 10	.9001E C8	.4791E 09	.2092E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
32.00	.1660E 10	.4750E C8	.4791E 09	.2092E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
34.00	.1660E 10	.4750E C8	.4791E 09	.2092E 10	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
36.00	.5484E 09	.4750E C8	.0	.5009E C9	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
38.00	.1406E 02	.0	.0	.1406E 02	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
40.00	.0	.0	.0	.0	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
42.00	.0	.0	.0	.0	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
44.00	.8864E 07	.0	.2634E 07	.1150E 08	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
46.00	.9125E 07	.2611E C6	.2634E 07	.1150E 08	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
48.00	.9125E 07	.2611E C6	.2634E 07	.1150E 08	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991
50.00	.2185E 07	.2611E C6	.0	.1924E 07	.1151E 01	.4696E-02	0.0041	0.1001	0.9907	0.0991

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.7090883789E 11
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.7039401934E 10
 % SURVIVAL THROUGH THIS LIFE STAGE = 9.9
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.3963955456E 10
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 0.0
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.2909110272E 11
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...29.09

STAGE 2 LARVAL STAGE

KI(1/DAY)= 0.1644999981E 00
 KX(1/DAY)= 0.1315999627E 00
 YS(NUMBER)= 0.1469999872E 10
 LIFE PERIOD(DAY)= 28.0000
 RATIO OF THE KI VALUE USED IN THIS RUN TO THE "STANDARD" KI VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE KI VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION (-)	TRANSFER	PRODUCTION	POPULATION (+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
2.00	.0	.0	.1076E 08	.1076E 08						
9.00	.1846E 09	.0	.3229E 08	.2169E 09	.1425E 00	.4696E-02	0.0319	0.0185	0.8768	0.0162
16.00	.1659E 09	.0	.1464E 08	.1806E 09	.1415E 00	.4696E-02	0.0321	0.0190	0.8768	0.0167
23.00	.6819E 09	.0	.1423E 09	.8241E 09	.1594E 00	.4696E-02	0.0286	0.0115	0.8768	0.0101
30.00	.1427E 10	.1465E 06	.2700E 09	.1696E 10	.1645E 00	.4696E-02	0.0278	0.0100	0.8768	0.0088
37.00	.1621E 10	.3656E 06	.1425E 09	.1764E 10	.1645E 00	.4696E-02	0.0277	0.0100	0.8768	0.0088
44.00	.1121E 10	.1426E 06	.4220E 01	.1120E 10	.1641E 00	.4696E-02	0.0278	0.0101	0.8768	0.0089
51.00	.3534E 09	.1313E 07	.6266E 06	.3521E 09	.1501E 00	.4696E-02	0.0303	0.0150	0.8768	0.0131
58.00	.1122E 09	.2859E 07	.7833E 06	.1093E 09	.1386E 00	.4696E-02	0.0328	0.0206	0.8768	0.0181
65.00	.2661E 08	.1855E 07	.0	.2475E 08	.1334E 00	.4696E-02	0.0340	0.0239	0.8768	0.0210
72.00	.9709E 02	.3268E 01	.0	.9382E 02	.1316E 00	.4696E-02	0.0345	0.0251	0.8768	0.0220
79.00	.2197E 02	.0	.0	.2197E 02	.1316E 00	.4696E-02	0.0345	0.0251	0.8768	0.0220

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.7039401984E 10
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.7842804800E 08
 % SURVIVAL THROUGH THIS LIFE STAGE = 1.1
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.2025001472E 10
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (EMAX/YS) = 1.3776
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.2981654528E 10
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...29.75

STAGE 3 JUVENILE 1 STAGE

KI(1/DAY)= 0.5114999786E-01
 KX(1/DAY)= 0.4091999307E-01
 YS(NUMBER)= 0.2650000000E 08
 LIFE PERIOD(DAY)= 30.0000
 RATIO OF THE KI VALUE USED IN THIS RUN TO THE "STANDARD" KI VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE KI VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION (-)	TRANSFER	PRODUCTION	POPULATION (+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
30.00	.0	.0	.1465E 06	.1465E 06						

37.00	.3134E 07	.0	.3656E 06	.3500E 07	.4414E-01	.4596E-02	0.0962	.2660	0.8686	0.2311
44.00	.3789E 07	.0	.1426E 06	.3931E 07	.4471E-01	.4596E-02	0.0950	.2615	0.8686	0.2271
51.00	.1023E 08	.0	.1313E 07	.1155E 08	.4878E-01	.4596E-02	0.0878	.2314	0.8686	0.2010
58.00	.2366E 08	.0	.2859E 07	.2651E 08	.5114E-01	.4596E-02	0.0841	.2156	0.8686	0.1873
65.00	.3666E 08	.7E59E 05	.1855E 07	.3844E 08	.5173E-01	.4596E-02	0.0832	.2119	0.8686	0.1840
72.00	.3809E 08	.2899E 05	.3268E 01	.3806E 08	.5201E-01	.4596E-02	0.0828	.2101	0.8686	0.1825
79.00	.2485E 08	.2413E 06	.0	.2461E 08	.5115E-01	.4596E-02	0.0841	.2156	0.8686	0.1873
86.00	.1446E 08	.5009E 06	.0	.396E 08	.5019E-01	.4596E-02	0.0856	.2219	0.8686	0.1927
93.00	.5516E 07	.3859E 06	.0	.5131E 07	.4607E-01	.4596E-02	0.0925	.2510	0.8686	0.2181
100.00	.7469E 06	.4332E 06	.0	.3137E 06	.4176E-01	.4596E-02	0.1011	.2857	0.8686	0.2482
107.00	.0	.0	.0	.0	.4092E-01	.4596E-02	0.1029	.2930	0.8686	0.2545

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.7842804800E 08
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.1486779500E 08
 % SURVIVAL THROUGH THIS LIFE STAGE = 19.0
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.4143712600E 06
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.5637
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.3418250800E 08
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...30.35

STAGE 4 JUVENILE 2 STAGE

KX(1/DAY)= 0.1244999841E-04
 KX0(1/DAY)= 0.9959995747E-02
 YS(NUMBER)= 0.8980000000E 07
 LIFE PERIOD(DAY)= 100.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME ()	POPULATION(-)	TRANSFER	PRODUCTION	POPULATION(+)	KNATL	KPLANT	RATIO	PSN	PSP	PST
60.00	.0	.0	.3144E 05	.3144E 05						
74.00	.9756E 06	.0	.5400E 05	.1030E 07	.1069E-01	.2630E-03	0.0240	.23435	0.9740	0.3346
88.00	.5783E 07	.0	.1065E 07	.6852E 07	.1234E-01	.2630E-03	0.0209	0.2912	0.9740	0.2836
102.00	.1237E 08	.0	.4549E 01	.1237E 08	.1258E-01	.2630E-03	0.0205	0.2841	0.9740	0.2767
123.00	.3635E 07	.0	.0	.9465E 07	.1245E-01	.2630E-03	0.0207	.2879	0.9740	0.2804
137.00	.8064E 07	.0	.0	.7922E 07	.1245E-01	.2630E-03	0.0207	0.2880	0.9740	0.2805
151.00	.6751E 07	.0	.0	.6632E 07	.1241E-01	.2630E-03	0.0207	.2890	0.9740	0.2815
165.00	.5656E 07	.0	.0	.5557E 07	.1232E-01	.2630E-03	0.0209	.2916	0.9740	0.2840
179.00	.4746E 07	.0	.0	.4664E 07	.1219E-01	.2630E-03	0.0211	0.2956	0.9740	0.2879
193.00	.3991E 07	.0	.0	.3923E 07	.1202E-01	.2630E-03	0.0214	.3005	0.9740	0.2927
207.00	.3364E 07	.0	.0	.3308E 07	.1184E-01	.2630E-03	0.0217	0.3060	0.9740	0.2981

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.1486779500E 08
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.3197542000E 07
 % SURVIVAL THROUGH THIS LIFE STAGE = 21.5
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.1259646500E 08
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.4027
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.6786793000E 07
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...31.34

NUMBER OF JUVENILE 2 KILLED BY IMPINGEMENT...0.241391E 06

STAGE 5 JUVENILE 3 STAGE

KX(1/DAY)= 0.9719997644E-02
 KX0(1/DAY)= 0.7775995880E-02
 YS(NUMBER)= 0.2290000000E 07
 LIFE PERIOD(DAY)= 158.0000
 RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX VALUE GIVEN ABOVE = 1.000
 RATIO OF THE KX0 VALUE USED IN THIS RUN TO THE KX VALUE USED IN THIS RUN = 0.800
 RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS VALUE GIVEN ABOVE = 1.000
 LEFT LIMB OF COMPENSATION FUNCTION DISABLED... NO
 RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

TIME()	POPULATION (-)	TRANSFER	PRODUCTION	POPULATION (+)	KNATL	KPLANT	RATIO	PSN	FSF	PST
209.00	.0	.0	.3198E 07	.3198E 07						
223.00	.2817E 07	.0	.0	.2778E 07	.9744E-02	.2630E-03	0.0263	0.2145	0.9593	0.2058
237.00	.2449E 07	.0	.0	.2415E 07	.9721E-02	.2630E-03	0.0263	0.2153	0.9593	0.2065
251.00	.2130E 07	.0	.0	.2103E 07	.9719E-02	.2630E-03	0.0263	0.2153	0.9593	0.2066
265.00	.1852E 07	.0	.0	.1827E 07	.9706E-02	.2630E-03	0.0264	0.2158	0.9593	0.2070
279.00	.1611E 07	.0	.0	.1589E 07	.9669E-02	.2630E-03	0.0265	0.2170	0.9593	0.2082
293.00	.1403E 07	.0	.0	.1383E 07	.9607E-02	.2630E-03	0.0266	0.2192	0.9593	0.2103
307.00	.1222E 07	.0	.0	.1206E 07	.9523E-02	.2630E-03	0.0269	0.2221	0.9593	0.2131
321.00	.1066E 07	.0	.0	.1052E 07	.9423E-02	.2630E-03	0.0271	0.2256	0.9593	0.2164
335.00	.9318E 06	.0	.0	.9193E 06	.9314E-02	.2630E-03	0.0275	0.2295	0.9593	0.2202
349.00	.8154E 06	.0	.0	.8047E 06	.9201E-02	.2630E-03	0.0278	0.2337	0.9593	0.2242
363.00	.7147E 06	.0	.0	.7054E 06	.9087E-02	.2630E-03	0.0281	0.2379	0.9593	0.2282

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.3157542000E 07
 TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.6872511875E 06
 % SURVIVAL THROUGH THIS LIFE STAGE = 21.5
 MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.3197542000E 07
 RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/YS) = 1.3963
 REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.1380505000E 07
 % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...30.15

NUMBER OF JUVENILE 3 KILLED BY IMPINGEMENT...0.661230E 05
 TOTAL NUMBER OF JUVENILES KILLED BY IMPINGEMENT...0.307514E 06

CUMULATIVE PROBABILITY OF SURVIVAL FROM EGG THROUGH JUVENILE 3 = 0.96920257E-05
 EXPECTED NUMBER OF YEARLINGS = 0.68725025E 06

ADULT DISTRIBUTION BY AGE CLASS

AGE NUMBERS	AGE NUMBERS	AGE NUMBERS	AGE NUMBERS	AGE NUMBERS
1 687251.	2 275272.	3 165345.	4 132473.	5 83023.
6 52037.	7 32618.	8 20448.	9 12820.	10 8039.
11 5041.	12 3162.	13 1983.		
TOTAL ADULTS	1479506.			

PERCENT AGE DISTRIBUTION RELATIVE TO YEAR ZERO

AGE	PERCENT	AGE	PERCENT	AGE	PERCENT	AGE	PERCENT	AGE	PERCENT
1	32.611	2	13.062	3	7.846	4	6.286	5	3.940
6	2.469	7	1.548	8	0.970	9	0.608	10	0.381
11	0.239	12	0.150	13	0.094				

PERCENT AGE DISTRIBUTION RELATIVE TO CURRENT YEAR
 AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT AGE PERCENT

1	46.451	2	18.606	3	11.176	4	8.954	5	5.612
6	3.517	7	2.205	8	1.382	9	0.867	10	0.543
11	0.341	12	0.214	13	0.134				

SIZE OF POPULATION (YEAR CLASSES 1-13) FOR THE
 CURRENT YEAR AS A PERCENTAGE OF THE SIZE OF THE
 POPULATION IN YEAR ZERO... 0.702

REDUCTION IN NUMBER OF YEARLENGS DUE TO PLANT... 293631.
 % REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT...29.94
 REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT... 627911.
 % REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT...29.80

NUMBER OF EGGS EXPECTED TO BE PRODUCED BY
 THE NUMBER OF ONE-YEAR OLD STRIPED BASS FOR THE CURRENT
 YEAR DURING THEIR LIFE TIME AS A PERCENTAGE OF THE NUMBER
 OF EGGS PRODUCED IN YEAR ZERO..... 0.701

TRACING LIFE HISTORY OF STRIPED BASS FISH
IN HUDSON RIVER, WITH MORTALITY IN EACH
STAGE GIVEN BY:

$$D(NX)/LT = -(KX + (KX - KX0) * ((NX - YS)/YS)**3) * NX \\ - PKILL * QP * NX / V$$

WHERE, $QP(MI**3/DAY) = 0.4696E-02$
WHICH IS EQUIVALENT TO AN INTAKE FLOW OF... $0.8000E 04(CFS)$
 $V(MI**3) = 0.5000E 00$

FRACTIONAL KILL (I.E., COMPOSITE P-FACTOR) FOR:

EGGS	0.5000
LARVAE	0.5000
JUVENILE 1	0.5000
JUVENILE 2	0.0280
JUVENILE 3	0.0280

MODEL TIME STEP SIZE (DAYS)

EGG	LAEV	JUV 1	JUV 2	JUV 3
0.20	0.70	0.70	1.40	1.40

TOTAL PRODUCTION PERIOD (DAYS) = 49.

SUBPRODUCTION PERIODS AND ASSOCIATED FRACTIONS OF TOTAL EGG PRODUCTION

PERIOD (DAY)	FRACTION
0.0 7.0	0.0536
7.0 14.0	0.0243
14.0 21.0	0.2361
21.0 28.0	0.4482
28.0 35.0	0.2365
35.0 42.0	0.0
42.0 49.0	0.0013

ITERATE TO EQUILIBRIUM BY ADJUSTING THE FIRST ORDER
DECAY RATE COEFFICIENT USED FOR YEAR CLASSES 4 AND OLDER

R0= 0.10194831E 06 S1= 0.0 AXP= 0.19201821E 00 D= 0.53093038E 06
K0=0.189902983E-02 FN=0.843747286E-03 C= 0.10552825E-02 I= 1
K0=0.843747286E-03 FN=0.113213062E-02 C= 0.28838334E-03 I= 2
K0=0.113213062E-02 FN=0.126368809E-02 C= 0.13155746E-03 I= 3
K0=0.126368809E-02 FN=0.128372200E-02 D= 0.20033913E-04 I= 4
K0=0.128372200E-02 FN=0.128411036E-02 C= 0.38836151E-06 I= 5
K0=0.128411036E-02 FN=0.128411059E-02 D= 0.23283064E-09 I= 6
K0=0.128411036E-02 FN=0.128411059E-02 D= 0.23283064E-09 I= 7
END CP EQUAL.....

ANNUAL PROBABILITY OF SURVIVAL FOR ADULTS (4-13) = 0.626

AGE	DECAY COEFF. (1/DAY)	SEX RATIO (FEM/TOT)	FRACTION MATURE	FECONILITY (EGGS/FEMALE)
-----	-------------------------	------------------------	--------------------	-----------------------------

1	0.002510	0.50	0.0	0.0
2	0.001400	0.52	0.0	0.0
3	0.000611	0.54	0.0	0.0
4	0.001284	0.56	0.0	0.2052E 06
5	0.001284	0.58	0.80	0.2973E 06
6	0.001284	0.60	1.00	0.4203E 06
7	0.001284	0.62	1.00	0.5723E 06
8	0.001284	0.64	1.00	0.7470E 06
9	0.001284	0.66	1.00	0.9400E 06
10	0.001284	0.68	1.00	0.1140E 07
11	0.001284	0.70	1.00	0.1360E 07
12	0.001284	0.70	1.00	0.1560E 07
13	0.001284	0.70	1.00	0.1760E 07

STOCK RECRUITMENT TABLE

DEFINITIONS OF COLUMN READINGS

I = YEAR + 1

S(I) = NUMBER OF SPAWNERS

R(I) = NUMBER OF RECRUITS (3-YEAR OLDS)

R3(I) = NUMBER OF RECRUITS AT I+3, SPAWNED AT I

R3S(I) = RECRUITMENT RATE (RECRUITS PER SPAWNER)

SR(I) = NUMBER OF SPAWNERS RELATIVE TO NUMBER OF SPAWNERS AT I=1

RR(I) = NUMBER OF RECRUITS RELATIVE TO NUMBER OF RECRUITS AT I=1

R3R(I) = NUMBER OF RECRUITS AT I+3 RELATIVE TO THE NUMBER OF RECRUITS AT I=4 (R3(I)/R3(1))

R3RSR(I) = RELATIVE RECRUITMENT RATE (R3R(I)/SR(I))

I	S(I)	R(I)	R3(I)	R3S(I)	SR(I)	RR(I)	R3R(I)	R3RSR(I)
1	175689.	235405.	193309.	1.1003	1.0000	1.0000	1.0000	1.0000
2	175689.	235405.	193309.	1.1003	1.0000	1.0000	1.0000	1.0000
3	175689.	235405.	193309.	1.1003	1.0000	1.0000	1.0000	1.0000
4	175689.	193309.	193309.	1.1003	1.0000	0.8212	1.0000	1.0000
5	175689.	193309.	193309.	1.1003	1.0000	0.8212	1.0000	1.0000
6	165908.	193309.	191632.	1.1551	0.9443	0.8212	0.9913	1.0498
7	157994.	193309.	189442.	1.1990	0.8993	0.8212	0.9800	1.0898
8	152875.	193309.	187251.	1.2249	0.8701	0.8212	0.9687	1.1132
9	149569.	191632.	185199.	1.2382	0.8513	0.8141	0.9580	1.1254
10	147435.	189442.	183387.	1.2438	0.8392	0.8047	0.9487	1.1305
11	145670.	187251.	181762.	1.2478	0.8291	0.7954	0.9403	1.1340
12	143959.	185199.	180246.	1.2521	0.8194	0.7867	0.9324	1.1379
13	142280.	183387.	178854.	1.2571	0.8098	0.7790	0.9252	1.1425
14	140646.	181762.	177551.	1.2624	0.8005	0.7721	0.9185	1.1473
15	139316.	180246.	176813.	1.2692	0.7930	0.7657	0.9147	1.1535
16	138010.	178854.	176007.	1.2753	0.7855	0.7598	0.9105	1.1591
17	136753.	177551.	175162.	1.2309	0.7784	0.7542	0.9061	1.1641
18	135561.	176813.	174301.	1.2958	0.7716	0.7511	0.9017	1.1686
19	134437.	176007.	173445.	1.2902	0.7652	0.7477	0.8972	1.1726
20	133500.	175162.	172667.	1.2934	0.7599	0.7441	0.8932	1.1755
21	132693.	174301.	171973.	1.2960	0.7553	0.7404	0.8896	1.1779
22	131958.	173445.	171348.	1.2985	0.7511	0.7368	0.8864	1.1801
23	131263.	172667.	170770.	1.3010	0.7471	0.7335	0.8834	1.1824
24	130594.	171973.	170229.	1.3035	0.7433	0.7305	0.8806	1.1847
25	129958.	171348.	169717.	1.3059	0.7397	0.7279	0.8780	1.1869
26	129365.	170770.	169237.	1.3082	0.7363	0.7254	0.8755	1.1890
27	128819.	170229.	168789.	1.3103	0.7332	0.7231	0.8732	1.1908
28	128316.	169717.	168371.	1.3122	0.7304	0.7210	0.8710	1.1926
29	127848.	169237.	167974.	1.3139	0.7277	0.7189	0.8689	1.1941
30	127411.	168789.	167601.	1.3154	0.7252	0.7170	0.8670	1.1955
31	127003.	168371.	167251.	1.3169	0.7229	0.7152	0.8652	1.1969
32	126622.	167974.	166922.	1.3183	0.7207	0.7136	0.8635	1.1981
33	126267.	167601.	166617.	1.3196	0.7187	0.7120	0.8619	1.1993
34	125934.	167251.	166330.	1.3208	0.7168	0.7105	0.8604	1.2004
35	125622.	166922.	166062.	1.3219	0.7150	0.7091	0.8591	1.2014
36	125328.	166617.	165809.	1.3230	0.7134	0.7078	0.8577	1.2024
37	125052.	166330.	165570.	1.3240	0.7118	0.7066	0.8565	1.2033
38	124794.	166062.	165345.	1.3249	0.7103	0.7054	0.8553	1.2042
39	124552.	165809.	0.	0.0	0.7089	0.7044	0.0	0.0
40	124325.	165570.	0.	0.0	0.7076	0.7033	0.0	0.0
41	124113.	165345.	0.	0.0	0.7064	0.7024	0.0	0.0

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APPENDIX D
TABULATION OF DETAILED RESULTS FROM THE VARIOUS SENSITIVITY ANALYSES

Table D1. Summary of model runs for the sensitivity analysis for YS, the equilibrium standing crop

Output variable code	Life Stage	Level 1: AYS = 0.20			Level 2: AYS = 0.50			Level 3: AYS = 0.75			Level 4: AYS = 1.00			Level 5: AYS = 1.50			Level 6: AYS = 2.00			Level 7: AYS = 5.00		
		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on	
			Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40
1	Egg	1.00 E11	1.00 E11	8.31 E10	1.00 E11	1.00 E11	8.52 E10	1.00 E11	1.00 E11	8.22 E10	1.00 E11	1.00 E11	7.09 E10	1.00 E11	1.00 E11	5.20 E10	1.00 E11	1.00 E11	5.26 E10	1.00 E11	1.00 E11	5.75 E10
3	Egg	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%
4	Larvae	1.00 E10	9.93 E9	8.25 E9	1.00 E10	9.93 E9	8.46 E9	1.00 E10	9.93 E9	8.16 E9	1.00 E10	9.93 E9	7.04 E9	1.00 E10	9.93 E9	5.16 E9	1.00 E10	9.93 E9	5.22 E9	1.00 E10	9.93 E10	5.71 E9
5	Larvae	4.05	4.03	3.74	2.84	2.81	2.63	2.35	2.32	2.03	1.93	1.89	1.38	1.33	1.30	0.68	1.00	0.98	0.53	0.42	0.41	0.24
6	Larvae	0.2%	0.2%	0.2%	0.6%	0.5%	0.6%	0.9%	0.8%	1.0%	1.1%	1.0%	1.1%	1.3%	1.1%	1.3%	1.3%	1.2%	1.4%	1.7%	1.5%	1.7%
7	Juvenile 1	1.69 E7	1.53 E7	1.62 E7	5.80 E7	5.27 E7	5.45 E7	9.14 E7	8.21 E7	7.82 E7	1.13 E8	9.99 E7	7.84 E7	1.27 E8	1.12 E8	6.65 E7	1.34 E8	1.18 E8	7.21 E7	1.67 E8	1.47 E8	9.60 E7
8	Juvenile 1	2.46	2.21	2.24	2.55	2.30	2.27	2.40	2.17	2.04	2.20	1.95	1.56	1.75	1.49	0.89	1.40	1.18	0.72	0.70	0.59	0.39
9	Juvenile 1	19.4%	17.8%	17.7%	18.3%	17.2%	17.1%	18.3%	17.3%	17.7%	19.2%	18.0%	19.0%	21.4%	19.1%	19.7%	22.0%	19.4%	20.0%	23.1%	20.5%	21.4%
10	Juvenile 2	3.27 E6	2.73 E6	2.87 E6	1.06 E7	9.04 E6	9.32 E6	1.67 E7	1.42 E7	1.38 E7	2.17 E7	1.80 E7	1.49 E7	2.72 E7	2.13 E7	1.31 E7	2.95 E7	2.28 E7	1.45 E7	3.87 E7	3.01 E7	2.06 E7
11	Juvenile 2	1.73	1.43	1.49	3.06	1.76	1.79	3.11	1.79	1.74	2.03	1.69	1.40	1.71	1.34	0.83	1.40	1.08	0.68	0.73	0.57	0.39
12	Juvenile 2	24.2%	23.9%	23.5%	21.8%	21.7%	21.4%	21.1%	21.2%	21.2%	21.1%	21.2%	21.5%	21.8%	21.6%	22.4%	22.2%	21.9%	22.8%	23.3%	23.3%	24.3%
13	Juvenile 3	7.93 E5	6.51 E5	6.76 E5	2.31 E6	1.97 E6	2.00 E6	3.53 E6	3.00 E6	2.92 E6	4.58 E6	3.81 E6	3.20 E6	5.93 E6	4.60 E6	2.94 E6	6.54 E6	4.99 E6	3.30 E6	9.02 E6	7.01 E6	4.99 E6
14	Juvenile 3	1.73	1.42	1.48	2.02	1.72	1.75	2.05	1.75	1.70	2.00	1.66	1.40	1.72	1.34	0.85	1.43	1.09	0.72	0.79	0.61	0.44
15	Juvenile 3	21.9%	21.5%	21.4%	21.4%	21.1%	21.0%	21.3%	21.0%	21.1%	21.4%	21.2%	21.5%	21.9%	21.6%	22.4%	22.3%	21.9%	22.8%	23.5%	23.3%	24.2%
16	Yearlings and adults	1.74 E5	1.40 E5	1.45 E5	4.94 E5	4.15 E5	4.21 E5	7.51 E5	6.32 E5	6.17 E5	9.81 E5	8.05 E5	6.87 E5	1.30 E6	9.91 E5	6.58 E5	1.46 E6	1.09 E6	7.54 E5	2.12 E6	1.63 E6	1.21 E6
17	Yearlings and adults	4.99 E5	4.65 E5	4.15 E5	1.15 E6	1.07 E6	9.81 E5	1.66 E6	1.54 E6	1.36 E6	2.11 E6	1.93 E6	1.48 E6	2.72 E6	2.41 E6	1.38 E6	3.03 E6	2.66 E6	1.57 E6	4.29 E6	3.79 E6	2.44 E6
18	Yearlings and adults	35-14-8	30-15-9	13-14-8	43-17-10	39-18-11	43-17-10	45-18-11	41-20-12	45-18-11	47-19-11	42-20-12	46-19-11	48-19-11	41-22-13	48-19-11	48-19-12	41-22-13	48-19-12	49-20-12	43-22-13	49-20-12
19	Yearlings and adults	0.896			0.735			0.669			0.626			0.579			0.560			0.496		
Impact variables																						
62	Eggs		0%	16.9%		0%	14.8%		0%	17.8%		0%	29.1%		0%	48.0%		0%	47.4%		0%	42.5%
64	Larvae		0.7%	17.5%		0.7%	15.4%		0.7%	18.4%		0.7%	29.6%		0.7%	48.4%		0.7%	47.8%		0.7%	42.9%
66	Juvenile 1		9.5%	4.1%		9.1%	6.0%		10.2%	14.4%		11.6%	30.6%		11.81%	47.6%		11.9%	46.2%		12.0%	42.5%
68	Juvenile 2		16.5%	12.2%		14.7%	12.1%		15.0%	17.2%		17.1%	31.3%		21.7%	51.8%		22.7%	50.8%		22.2%	46.8%
70	Juvenile 3		17.9%	14.8%		14.7%	13.4%		15.0%	17.0%		16.8%	30.1%		22.4%	50.42%		23.7%	49.5%		22.3%	44.7%
71	Yearlings		3.4 F4	2.9 F4		7.9 F4	7.3 F4		1.2 F5	1.34 F5		1.76 F5	2.94 F5		3.1 F5	6.42 F5		3.7 F5	7.06 F5		4.9 F5	9.1 F5
72	Yearlings		19.5%	16.7%		16.0%	14.8%		15.8%	17.8%		17.9%	30.0%		23.8%	49.4%		25.3%	48.4%		23.1%	42.9%
73	Adults		3.4 E4	8.4 E4		7.9 E4	1.7 E5		1.2 E5	3.0 E5		1.80 E5	6.30 E5		3.1 E5	1.34 E6		3.7 E5	1.46 E6		4.9 E5	1.85 E6
74	Adults		6.8%	16.8%		7.0%	14.7%		7.2%	17.8%		8.5%	29.9%		11.4%	49.3%		12.2%	48.2%		11.6%	43.1%

Table D2. Summary of model runs for the sensitivity analysis for KX, the first order mortality rate coefficient

Output variable code	Life stage	Level 1: AKX = 0.5			Level 2: AKX = 0.75			Level 3: AKX = 0.9			Level 4: AKX = 1.00			Level 5: AKX = 1.1			Level 6: AKX = 1.2			Level 7: AKX = 1.3		
		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on	
			Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40
1	Egg	1.00 E11	1.00 E11	9.67 E10	1.00 E11	1.00 E11	9.51 E10	1.00 E11	1.00 E11	9.06 E10	1.00 E11	1.00 E11	7.09 E10	1.00 E11	1.00 E11	5.72 E10	1.00 E11	1.00 E11	6.18 E10	1.00 E11	1.00 E11	6.23 E10
3	Egg	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%
4	Larvae	1.00 E10	9.93 E9	9.60 E9	1.00 E10	9.93 E9	9.44 E9	1.0 E10	9.93 E9	8.99 E9	1.00 E10	9.93 E9	7.04 E9	1.00 E10	9.93 E9	5.68 E9	1.00 E10	1.00 E10	6.13 E9	1.00 E10	9.93 E9	6.19 E9
5	Larvae	2.56	2.51	2.47	2.21	2.17	2.09	2.04	1.99	1.84	1.93	1.89	1.38	1.83	1.79	1.05	1.74	1.70	1.07	1.65	1.62	1.02
6	Larvae	7.4%	6.7%	6.9%	2.9%	2.6%	2.7%	1.6%	1.5%	1.6%	1.1%	1.0%	1.1%	0.8%	0.7%	0.8%	0.5%	0.5%	0.5%	0.4%	0.3%	0.3%
7	Juvenile 1	7.37 E8	6.67 E8	6.63 E8	2.91 E8	2.61 E8	2.56 E8	1.65 E8	1.47 E8	1.40 E8	1.13 E8	9.99 E7	7.84 E7	7.66 E7	6.78 E7	4.41 E7	5.19 E7	4.58 E7	3.16 E7	3.51 E7	3.10 E7	2.15 E7
8	Juvenile 1	5.40	5.21	5.20	3.72	3.55	3.54	2.78	2.57	2.49	2.20	1.95	1.56	1.55	1.32	0.86	1.02	0.87	0.60	0.67	0.57	0.40
9	Juvenile 1	5.3%	5.4%	5.5%	11.0%	11.3%	11.5%	16.4%	16.3%	17.0%	19.2%	18.0%	19.0%	18.0%	16.6%	17.1%	16.8%	14.8%	15.4%	15.2%	13.5%	14.2%
10	Juvenile 2	3.93 E7	3.63 E7	3.63 E7	3.20 E7	2.95 E7	2.95 E7	2.70 E7	2.40 E7	2.38 E7	2.17 E7	1.80 E7	1.49 E7	1.44 E7	1.13 E7	7.55 E6	8.71 E6	6.79 E6	4.87 E6	5.34 E6	4.18 E6	3.05 E6
11	Juvenile 2	4.06	3.75	3.75	3.09	2.85	2.85	2.54	2.27	2.25	2.03	1.69	1.40	1.35	1.05	0.71	0.81	0.63	0.45	0.49	0.39	0.28
12	Juvenile 2	31.2%	32.6%	32.5%	25.5%	26.2%	26.1%	22.6%	23.0%	23.1%	21.1%	21.2%	21.5%	19.4%	19.2%	20.0%	17.8%	17.8%	18.5%	16.7%	16.7%	17.3%
13	Juvenile 3	1.22 E7	1.18 E7	1.18 E7	8.17 E6	7.71 E6	7.71 E6	6.10 E6	5.53 E6	5.48 E6	4.58 E6	3.81 E6	3.20 E6	2.79 E6	2.16 E6	1.51 E6	1.55 E6	1.21 E6	9.04 E5	8.89 E5	6.99 E5	5.28 E5
14	Juvenile 3	5.35	5.16	5.16	3.57	3.37	3.37	2.66	2.42	2.39	2.00	1.66	1.40	1.22	0.94	0.66	0.68	0.53	0.39	0.39	0.31	0.23
15	Juvenile 3	24.0%	24.0%	24.0%	23.4%	23.6%	23.6%	22.6%	22.7%	22.7%	21.4%	21.2%	21.5%	19.6%	19.4%	20.2%	18.3%	18.2%	18.8%	17.3%	17.1%	17.6%
16	Yearlings and adults	2.94 E6	2.84 E6	2.84 E6	1.91 E6	1.82 E6	1.82 E6	1.38 E6	1.25 E6	1.25 E6	9.81 E5	8.05 E5	6.87 E5	5.47 E5	4.18 E5	3.04 E5	2.83 E5	2.20 E5	1.70 E5	1.54 E5	1.19 E5	9.28 E4
17	Yearlings and adults	5.82 E6	5.72 E6	5.63 E6	3.89 E6	3.80 E6	3.70 E6	2.87 E6	2.74 E6	2.60 E6	2.11 E6	1.93 E6	1.48 E6	1.26 E6	1.13 E6	7.03 E5	7.26 E5	6.62 E5	4.39 E5	4.56 E5	4.22 E5	2.78 E5
18	Yearlings and adults	50-20-12	50-21-12	50-20-12	49-20-12	48-20-12	49-20-12	48-19-12	46-20-12	48-19-12	47-19-11	42-20-12	46-19-11	44-17-10	37-19-12	43-17-10	39-16-9	33-17-10	39-16-9	34-13-8	28-15-9	33-13-8
19	Yearlings and adults	0.439			0.514			0.570			0.626			0.719			0.821			0.915		
Impact variables																						
62	Eggs		0%	3.3%		0%	4.9%		0%	9.0%		0%	29.1%		0%	42.8%		0%	38.2%		0%	37.6%
64	Larvae		0.7%	4.0%		0.7%	5.6%		0.7%	10.0%		0.7%	29.6%		0.7%	43.2%		0.9%	38.8%		0.9%	38.2%
66	Juvenile 1		9.5%	10.0%		10.3%	12.0%		10.6%	15.3%		11.6%	30.6%		11.5%	42.4%		11.7%	39.2%		11.9%	38.9%
68	Juvenile 2		7.6%	7.6%		7.8%	7.8%		11.1%	12.0%		17.1%	31.3%		21.9%	47.6%		22.0%	44.0%		21.6%	42.8%
70	Juvenile 3		3.3%	3.3%		5.6%	5.6%		9.3%	10.1%		16.8%	30.1%		22.6%	46.0%		21.9%	41.6%		21.4%	40.6%
71	Yearlings		1.0 E5	1.0 E5		9.0 E4	9.0 E4		1.2 E5	1.3 E5		1.76 E5	2.94 E4		1.30 E5	2.43 E5		6.35 E4	1.13 E5		3.42 E4	6.08 E4
72	Yearlings		3.4%	3.4%		4.7%	4.7%		8.9%	9.4%		17.9%	30.0%		23.7%	44.4%		22.4%	39.8%		22.3%	39.6%
73	Adults		1.0 E5	1.9 E5		9.0 E4	1.9 E5		1.2 E5	2.7 E5		1.80 E5	6.30 E5		1.30 E5	5.55 E5		6.35 E4	2.87 E5		3.42 E4	1.78 E5
74	Adults		1.7%	3.3%		2.3%	4.9%		4.3%	9.4%		8.5%	29.9%		10.3%	44.1%		8.8%	39.5%		7.5%	39.0%

Table D3. Summary of model runs for the sensitivity analysis for KXO, the minimum mortality rate coefficient

Output variable code	Life stage	Level 1: AKXO = 0.3			Level 2: AKXO = 0.5			Level 3: AKXO = 0.8			Level 4: AKXO = 0.9			Level 5: AKXO = 1.00		
		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on		Plant off, year 0	Plant on	
			Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40		Year 1	Year 40
1	Egg	1.00 E11	1.00 E11	9.16 E10	1.00 E11	1.00 E11	8.99 E10	1.00 E11	1.00 E11	7.09 E10	1.00 E11	1.00 E11	4.64 E10	1.00 E11	1.00 E11	2.01 E10
3	Egg	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%	10.0%	10.0%	9.9%	10.0%	9.9%	9.9%	10.0%	9.9%	9.9%
4	Larvae	1.00 E10	9.93 E9	9.09 E9	1.00 E10	9.93 E9	8.92 E9	1.00 E10	9.93 E9	7.04 E9	1.00 E10	9.93 E9	4.60 E9	1.00 E10	9.93 E9	1.99 E9
5	Larvae	1.84	1.81	1.71	1.87	1.84	1.70	1.93	1.89	1.38	1.96	1.91	0.90	2.00	1.94	0.39
6	Larvae	1.7%	1.6%	1.7%	1.4%	1.3%	1.4%	1.1%	1.0%	1.1%	1.0%	0.9%	1.0%	1.0%	0.9%	0.9%
7	Juvenile 1	1.75 E8	1.60 E8	1.58 E8	1.45 E8	1.31 E8	1.27 E8	1.13 E8	9.99 E7	7.84 E7	1.05 E8	9.25 E7	4.72 E7	9.97 E7	8.66 E7	1.74 E7
8	Juvenile 1	2.72	2.62	2.58	2.52	2.38	2.33	2.20	1.95	1.56	2.09	1.80	0.93	2.00	1.66	0.33
9	Juvenile 1	11.1%	11.0%	11.3%	14.2%	14.1%	14.5%	19.2%	18.0%	19.0%	20.5%	18.5%	19.1%	21.4%	18.6%	18.6%
10	Juvenile 2	1.94 E7	1.77 E7	1.78 E7	2.06 E7	1.85 E7	1.85 E7	2.17 E7	1.80 E7	1.49 E7	2.16 E7	1.71 E7	9.02 E6	2.14 E7	1.61 E7	3.23 E6
11	Juvenile 2	1.89	1.72	1.73	1.97	1.77	1.77	2.03	1.69	1.40	2.02	1.60	0.85	2.00	1.51	0.30
12	Juvenile 2	21.8%	22.0%	21.9%	21.3%	21.4%	21.4%	21.1%	21.2%	21.5%	21.3%	21.1%	21.6%	21.6%	20.9%	20.9%
13	Juvenile 3	4.23 E6	3.89 E6	3.90 E6	4.36 E6	3.96 E6	3.96 E6	4.58 E6	3.81 E6	3.20 E6	4.60 E6	3.61 E6	1.95 E6	4.61 E6	3.37 E6	6.76 E5
14	Juvenile 3	1.85	1.70	1.70	1.91	1.73	1.73	2.00	1.66	1.40	2.01	1.57	0.85	2.01	1.47	0.30
15	Juvenile 3	21.8%	21.7%	21.7%	21.5%	21.4%	21.4%	21.4%	21.2%	21.5%	21.6%	21.1%	21.7%	21.8%	20.9%	20.9%
16	Yearlings and adults	9.22 E5	8.44 E5	8.45 E5	9.40 E5	8.46 E5	8.45 E5	9.81 E5	8.05 E5	6.87 E5	9.92 E5	7.60 E5	4.23 E5	1.00 E6	7.04 E5	1.41 E5
17	Yearlings and adults	1.99 E6	1.91 E6	1.83 E6	2.03 E6	1.93 E6	1.82 E6	2.11 E6	1.93 E6	1.48 E6	2.13 E6	1.90 E6	9.21 E5	2.15 E6	1.85 E6	3.25 E5
18	Yearlings and adults	46-19-11	44-19-12	46-19-11	46-19-11	44-19-12	46-19-11	47-19-11	42-20-12	46-19-11	47-19-11	40-21-13	46-19-11	47-19-11	38-22-13	43-18-11
19	Yearlings and adults	0.636			0.633			0.626			0.624			0.622		
Impact variables																
62	Eggs		0%	8.4%		0%	10.1%		0%	29.1%		0%	53.6%		0%	79.9%
64	Larvae		0.7%	9.1%		0.7%	10.8%		0.7%	29.6%		0.7%	54.0%		0.7%	80.1%
66	Juvenile 1		8.6%	9.7%		9.7%	12.4%		11.6%	30.6%		11.9%	55.0%		13.1%	82.5%
68	Juvenile 2		8.8%	8.2%		10.2%	10.2%		17.1%	31.3%		20.8%	58.2%		24.8%	84.9%
70	Juvenile 3		8.0%	7.8%		9.2%	9.2%		16.8%	30.1%		21.5%	57.6%		26.9%	85.3%
71	Yearlings		7.8 E4	7.7 E4		9.4 E4	9.5 E4		1.8 E5	2.9 E5		2.3 E5	5.7 E5		3.0 E5	8.6 E5
72	Yearlings		8.4%	8.4%		10.0%	10.1%		17.9%	30.0%		23.4%	57.4%		29.6%	85.9%
73	Adults		8.0 E4	1.6 E5		1.0 E5	2.1 E5		1.8 E5	6.3 E5		2.3 E5	1.2 E6		3.0 E5	1.8 E6
74	Adults		4.0%	8.0%		4.9%	10.3%		8.5%	29.9%		10.8%	56.8%		14.0%	84.9%

Table D4. Summary of model runs for left limb and right limb of the compensation function disabled at different levels of AYS at year 40

Output variable code	Life stage	Level 1: AYS = 0.2			Level 2: AYS = 0.5			Level 3: AYS = 0.75			Level 4: AYS = 1.00			Level 5: AYS = 1.50			Level 6: AYS = 2.00			Level 7: AYS = 5.00		
		Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled
1	Egg	8.31 E10	7.91 E10	2.54 E10	8.52 E10	8.02 E10	3.13 E10	8.22 E10	6.83 E10	3.61 E10	7.09 E10	3.66 E10	4.05 E10	5.20 E10	2.05 E10	4.74 E10	5.26 E10	2.01 E10	5.21 E10	5.75 E10	2.01 E10	5.75 E10
3	Egg	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%
4	Larvae	8.25 E9	7.85 E9	2.53 E9	8.46 E9	7.96 E9	3.11 E9	8.16 E9	6.78 E9	3.59 E9	7.04 E9	3.63 E9	4.02 E9	5.16 E9	2.04 E9	4.70 E9	5.22 E9	1.99 E9	2.17 E9	5.71 E9	1.99 E9	5.71 E9
5	Larvae	3.74	3.67	2.47	2.63	2.56	1.22	2.03	1.74	0.94	1.38	0.71	0.79	0.68	0.27	0.6255	0.53	0.19	0.52	0.24	0.08	0.24
6	Larvae	0.2%	0.2%	1.0%	0.6%	0.6%	1.1%	1.0%	0.8%	1.2%	1.1%	0.9%	1.2%	1.3%	0.9%	1.3%	1.4%	0.9%	1.4%	1.7%	0.9%	1.7%
7	Juvenile 1	1.62 E7	1.28 E7	2.60 E7	5.45 E7	4.53 E7	3.54 E7	7.82 E7	5.73 E7	4.28 E7	7.84 E7	3.17 E7	4.99 E7	6.65 E7	1.78 E7	6.20 E7	7.21	1.74 E7	7.16 E7	9.60 E7	1.74 E7	9.60 E7
8	Juvenile 1	2.24	1.73	2.60	2.27	1.84	1.42	2.04	1.47	1.15	1.56	0.61	1.00	0.89	0.23	0.83	0.72	0.17	0.72	0.39	0.07	0.39
9	Juvenile 1	17.7%	18.4%	18.9%	17.1%	18.0%	19.2%	17.7%	18.5%	19.4%	19.0%	18.6%	19.5%	19.7%	18.6%	19.8%	20.0%	18.6%	20.1%	21.4%	18.6%	21.4%
10	Juvenile 2	2.87 E6	2.36 E6	4.92 E6	9.32 E6	8.17 E6	6.80 E6	1.38 E7	1.06 E7	8.31 E6	1.49 E7	5.90 E6	9.75 E6	1.31 E7	3.31 E6	1.23 E7	1.45 E7	3.23 E6	1.44 E7	2.06 E7	3.23 E6	2.06 E7
11	Juvenile 2	1.49	1.21	2.32	1.79	1.55	1.28	1.74	1.32	1.05	1.40	0.55	0.92	0.83	0.21	0.77	0.68	0.15	0.68	0.39	0.06	0.39
12	Juvenile 2	23.5%	22.9%	21.2%	21.4%	21.2%	21.6%	21.2%	20.9%	22.0%	21.5%	20.9%	22.2%	22.4%	20.9%	22.6%	22.8%	20.9%	22.9%	24.3%	20.9%	24.3%
13	Juvenile 3	6.76 E5	5.42 E5	1.04 E6	2.00 E6	1.73 E6	1.47 E6	2.92 E6	2.21 E6	1.82 E6	3.20 E6	1.23 E6	2.16 E6	2.94 E6	6.91 E5	2.77 E6	3.30 E6	6.76 E5	3.28 E6	4.99 E6	6.76 E5	4.99 E6
14	Juvenile 3	1.48	1.18	2.27	1.75	1.51	1.29	1.70	1.29	1.06	1.40	0.54	0.94	0.85	0.20	0.81	0.72	0.15	0.72	0.44	0.06	0.44
15	Juvenile 3	21.4%	20.9%	21.0%	21.0%	20.8%	21.6%	21.1%	20.9%	22.0%	21.5%	20.9%	22.2%	22.4%	20.9%	22.6%	22.8%	20.9%	22.9%	24.2%	20.9%	24.2%
16	Yearlings and adults	1.45 E5	1.13 E5	2.19 E5	4.21 E5	3.61 E5	3.18 E5	6.17 E5	4.62 E5	4.01 E5	6.87 E5	2.56 E5	4.80 E5	6.58 E5	1.44 E5	6.25 E5	7.54 E5	1.41 E5	7.50 E5	1.21 E6	1.41 E5	1.21 E6
17	Yearlings and adults	4.15 E5	3.43 E5	4.85 E5	9.81 E5	8.52 E5	6.88 E5	1.36 E6	1.04 E6	8.56 E5	1.48 E6	5.84 E5	1.02 E6	1.38 E6	3.32 E5	1.31 E6	1.57 E6	3.25 E5	1.56 E6	2.44 E6	3.25 E5	2.44 E6
18	Yearlings and adults	35-14-8	33-13-8	45-18-11	43-17-10	42-17-10	46-19-11	45-18-11	45-18-11	47-19-11	46-19-11	44-18-11	47-19-11	48-19-11	43-18-11	48-19-12	48-19-12	43-18-11	48-19-12	49-20-12	43-18-11	49-20-12
Impact variables																						
62	Eggs	16.9%	20.9%	74.6%	14.8%	19.8%	68.7%	17.8%	31.7%	63.9%	29.1%	64.3%	59.5%	48.0%	79.5%	52.6%	47.4%	79.9%	47.9%	42.5%	79.9%	42.4%
64	Larvae	17.5%	21.6%	74.8%	15.4%	20.6%	69.0%	18.4%	32.3%	64.2%	29.6%	63.8%	59.9%	48.4%	79.7%	53.1%	47.8%	80.1%	48.4%	42.9%	80.1%	43.0%
66	Juvenile 1	4.1%	1.3%	75.1%	6.0%	5.3%	68.2%	14.4%	24.6%	63.1%	30.6%	65.8%	58.6%	47.6%	82.2%	51.4%	46.2%	82.6%	46.6%	42.5%	82.6%	42.6%
68	Juvenile 2	12.2%	13.6%	78.1%	12.1%	14.6%	71.7%	17.2%	29.8%	67.0%	31.3%	68.9%	62.7%	51.8%	84.5%	56.1%	50.8%	84.9%	51.5%	46.8%	84.9%	46.8%
70	Juvenile 3	14.8%	17.3%	78.6%	13.4%	17.4%	71.8%	17.0%	31.1%	66.7%	30.1%	69.5%	62.1%	50.42%	85.0%	54.9%	49.5%	85.4%	50.4%	44.7%	85.4%	44.7%
71	Yearlings	2.9 E4	2.9 E4	8.4 E4	7.3 E4	8.92 E4	8.19 E5	1.34 E5	2.25 E5	7.92 E5	2.94 E5	6.1 E5	7.7 E5	6.42 E5	8.55 E5	7.31 E5	7.06 E5	8.63 E5	7.17 E5	9.1 E5	8.63 E5	9.16 E5
72	Yearlings	16.7%	20.5%	79.3%	14.8%	19.8%	72.0%	17.8%	32.8%	66.4%	30.0%	70.4%	61.5%	49.4%	85.6%	53.9%	48.4%	85.9%	48.9%	42.9%	85.9%	43.2%
73	Adults	8.4 E4	8.9 E4	1.78 E6	1.7 E5	2.11 E5	1.72 E6	3.0 E5	5.00 E5	1.66 E5	6.30 E5	1.3 E6	1.6 E6	1.34 E6	1.81 E6	1.52 E6	1.46 E6	1.83 E6	1.48 E6	1.85 E6	1.83 E6	1.85 E6
74	Adults	16.8%	20.6%	78.5%	14.7%	19.8%	71.5%	17.8%	32.6%	66.0%	29.9%	69.1%	61.2%	49.3%	84.5%	53.7%	48.2%	84.9%	48.8%	43.1%	84.9%	43.1%

Table D5. Summary of model runs for left limb or right limb of the compensation function disabled at different levels of AKX at year 40

Output variable code	Life stage	Level 1: AKX = 0.5			Level 2: AKX = 0.75			Level 3: AKX = 0.9			Level 4: AKX = 1.00			Level 5: AKX = 1.1			Level 6: AKX = 1.2			Level 7: AKX = 1.3		
		Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled
1	Egg	9.67E10	9.67E10	1.38E10	9.51E10	9.50E10	2.06E10	9.06E10	8.76E10	2.90E10	7.09E10	3.66E10	4.05E10	5.72E10	2.97E10	5.27E10	6.18E10	3.21E10	5.97E10	6.23E10	4.60E10	6.12E10
3	Egg	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%
4	Larvae	9.60E9	9.60E9	1.37E9	9.44E9	9.43E9	2.04E9	8.99E9	8.70E9	2.88E9	7.04E9	3.63E9	4.02E9	5.68E9	2.95E9	5.23E9	6.13E9	3.19E9	5.93E9	6.19E9	4.57E9	6.08E9
5	Larvae	2.47	2.47	0.40	2.09	2.09	0.49	1.84	1.79	0.61	1.38	0.71	0.79	1.05	0.54	0.97	1.07	0.55	1.03	1.02	0.75	1.00
6	Larvae	6.9%	6.7%	10.8%	2.7%	2.4%	3.8%	1.6%	1.3%	2.0%	1.1%	0.9%	1.2%	0.8%	0.6%	0.8%	0.5%	0.3%	0.5%	0.3%	0.2%	0.3%
7	Juvenile 1	6.63E8	6.39E8	1.49E8	2.56E8	2.31E8	7.80E7	1.40E8	1.16E8	5.70E7	7.84E7	3.17E7	4.99E7	4.41E7	1.62E7	4.13E7	3.16E7	1.11E7	3.07E7	2.15E7	1.00E7	2.12E7
8	Juvenile 1	5.20	5.16	3.71	3.54	3.43	1.72	2.49	2.19	1.18	1.56	0.61	1.00	0.86	0.30	0.80	0.60	0.20	0.58	0.40	0.17	0.40
9	Juvenile 1	5.5%	5.7%	40.3%	11.5%	12.7%	27.8%	17.0%	19.0%	22.4%	19.0%	18.6%	19.5%	17.1%	16.0%	17.2%	15.4%	13.7%	15.5%	14.2%	11.7%	14.2%
10	Juvenile 2	3.63E7	3.64E7	6.01E7	2.95E7	2.94E7	2.17E7	2.38E7	2.19E7	1.28E7	1.49E7	5.90E6	9.75E6	7.55E6	2.59E6	7.11E6	4.87E6	1.52E6	4.76E6	3.05E6	1.17E6	3.01E6
11	Juvenile 2	3.75	3.74	6.09	2.85	2.80	2.11	2.25	2.06	1.22	1.40	0.55	0.92	0.71	0.24	0.67	0.45	0.14	0.44	0.28	0.10	0.28
12	Juvenile 2	32.5%	32.4%	44.8%	26.1%	26.1%	30.7%	23.1%	23.4%	25.0%	21.5%	20.9%	22.2%	20.0%	17.9%	20.1%	18.5%	15.4%	18.6%	17.3%	13.2%	17.3%
13	Juvenile 3	1.18E7	1.18E7	2.69E7	7.71E6	7.66E6	6.65E6	5.48E6	5.12E6	3.19E6	3.20E6	1.23E6	2.16E6	1.51E6	4.65E5	1.43E6	9.04E5	2.34E5	8.85E5	5.28E5	1.55E5	5.23E5
14	Juvenile 3	5.16	5.16	11.8	3.37	3.34	2.90	2.39	2.24	1.39	1.40	0.54	0.94	0.66	0.20	0.62	0.39	0.10	0.39	0.23	0.07	0.23
15	Juvenile 3	24.0%	24.0%	44.8%	23.6%	23.7%	30.6%	22.7%	23.1%	24.8%	21.5%	20.9%	22.2%	20.2%	17.9%	20.3%	18.8%	15.4%	18.9%	17.6%	13.2%	17.6%
16	Yearlings and adults	2.84E6	2.84E6	1.21E7	1.82E6	1.82E6	2.03E6	1.25E6	1.19E6	7.93E5	6.87E5	2.58E5	4.80E5	3.04E5	8.34E4	2.90E5	1.70E5	3.60E4	1.67E5	9.28E4	2.06E4	9.19E4
17	Yearlings and adults	5.63E6	5.63E6	2.22E7	3.70E6	3.69E6	3.90E6	2.60E6	2.48E6	1.59E6	1.48E6	5.84E5	1.02E6	7.03E5	2.19E5	6.67E5	4.39E5	1.19E5	4.30E5	2.78E5	9.98E4	2.75E5
18	Yearlings and adults	50-20-12	50-20-12	54-22-13	49-20-12	49-20-12	52-21-13	48-19-12	48-19-11	50-20-12	46-19-11	44-18-11	47-19-11	43-17-10	38-16-10	43-17-10	39-16-9	30-12-8	39-16-9	33-13-8	21-8-5	33-13-8
19		0.439	0.439	0.035	0.514	0.514	0.220	0.570	0.572	0.439	0.626	0.645	0.586	0.719	0.775	0.713	0.821	0.913	0.818	0.915	1.067	0.913
Impact Variables																						
62	Eggs	3.3%	3.3%	86.2%	4.9%	5.0%	79.4%	9.0%	12.4%	71.0%	29.1%	63.4%	59.5%	42.8%	70.3%	47.3%	38.2%	67.9%	40.3%	37.6%	54.0%	38.8%
64	Larvae	4.0%	4.2%	86.3%	5.6%	5.8%	79.6%	10.0%	13.2%	71.3%	29.7%	63.8%	59.9%	43.2%	70.6%	47.8%	38.8%	68.2%	40.8%	38.2%	54.4%	39.4%
66	Juvenile 1	10.0%	10.3%	85.4%	12.0%	12.7%	77.2%	15.3%	18.5%	68.7%	30.3%	65.8%	38.5%	42.4%	72.9%	48.4%	39.2%	71.2%	42.4%	38.9%	59.2%	40.8%
68	Juvenile 2	7.6%	7.5%	87.3%	7.8%	8.1%	79.9%	12.0%	16.0%	72.1%	31.3%	68.9%	62.7%	47.6%	76.5%	53.1%	44.0%	75.0%	46.7%	42.8%	64.6%	44.4%
70	Juvenile 3	3.3%	3.5%	87.7%	5.6%	5.8%	80.6%	10.1%	13.6%	72.4%	30.1%	69.5%	62.1%	46.0%	77.2%	51.0%	41.6%	75.8%	43.9%	40.6%	65.7%	41.9%
71	Yearlings	1.0E5	9.7E4	9.01E7	9.0E4	9.5E4	8.9E6	1.3E5	1.7E5	2.1E6	2.9E5	6.1E5	7.7E5	2.43E5	2.98E5	2.80E5	1.13E5	1.19E5	1.21E5	6.08E4	4.19E4	6.33E4
72	Yearlings	3.4%	3.3%	88.2%	4.7%	5.0%	81.3%	9.4%	12.4%	73.0%	30.0%	70.4%	61.5%	44.4%	78.2%	49.1%	39.8%	76.8%	42.0%	39.6%	67.1%	40.8%
73	Adults	1.9E5	1.9E5	1.66E8	1.9E5	1.9E5	1.7E7	2.7E5	3.5E5	4.2E6	6.3E5	1.3E6	1.6E6	5.55E5	7.08E5	6.37E5	2.87E5	3.39E5	3.07E5	1.78E5	1.66E5	1.85E5
74	Adults	3.3%	3.3%	88.2%	4.9%	5.0%	81.1%	9.4%	12.4%	72.7%	29.9%	69.1%	61.2%	44.1%	76.4%	48.8%	39.5%	74.0%	41.6%	39.0%	62.4%	40.2%

Table D6. Summary of model runs for left limb and right limb of the compensation function disabled at different levels of AKX0 at year 40

Output variable code	Life stage	Level 1: AKX0 = 0.3			Level 2: AKX0 = 0.5			Level 3: AKX0 = 0.8			Level 4: AKX0 = 0.9		
		Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled	Neither limb disabled	Left limb disabled	Right limb disabled
1	Egg	9.16 E10	5.58 E10	5.77 E10	8.99 E10	5.00 E10	5.32 E10	7.09 E10	3.66 E10	4.05 E10	4.64 E10	2.96 E10	3.21 E10
3	Egg	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%	9.9%
4	Larvae	9.09 E9	5.54 E9	5.73 E9	8.92 E9	4.96 E9	5.28 E9	7.04 E9	3.63 E9	4.02 E9	4.60 E9	2.94 E9	3.19 E9
5	Larvae	1.71	1.08	1.13	1.70	0.97	1.04	1.38	0.71	0.79	0.90	0.58	0.63
6	Larvae	1.7%	0.9%	2.3%	1.4%	0.9%	1.8%	1.1%	0.9%	1.2%	1.0%	0.9%	1.1%
7	Juvenile 1	1.58 E8	4.83 E7	1.31 E8	1.27 E3	4.33 E7	9.58 E7	7.84 E7	3.17 E7	4.99 E7	4.72 E7	2.57 E7	3.42 E7
8	Juvenile 1	2.58	0.93	2.90	2.33	0.83	2.03	1.56	0.61	1.00	0.93	0.49	0.67
9	Juvenile 1	11.3%	18.6%	19.5%	14.5%	18.6%	19.6%	19.0%	18.6%	19.5%	19.1%	18.6%	19.4%
10	Juvenile 2	1.78 E7	8.99 E6	2.56 E7	1.85 E7	8.06 E6	1.88 E7	1.49 E7	5.90 E6	9.75 E6	9.02 E6	4.78 E6	6.62 E6
11	Juvenile 2	1.73	0.84	2.48	1.77	0.75	1.80	1.40	0.55	0.92	0.85	0.45	0.62
12	Juvenile 2	21.9%	20.9%	21.8%	21.4%	20.9%	21.9%	21.5%	20.9%	22.2%	21.6%	20.9%	22.0%
13	Juvenile 3	3.90 E6	1.88 E6	5.58 E6	3.96 E6	1.68 E6	4.12 E6	3.20 E6	1.23 E6	2.16 E6	1.95 E6	9.98 E5	1.46 E6
14	Juvenile 3	1.70	0.82	2.44	1.73	0.74	1.80	1.40	0.54	0.94	0.85	0.44	0.64
15	Juvenile 3	21.7%	20.9%	21.2%	21.4%	20.9%	21.7%	21.5%	20.9%	22.2%	21.7%	20.9%	22.0%
16	Yearlings and adults	8.45 E5	3.93 E5	1.18 E6	8.45 E5	3.52 E5	8.92 E5	6.87 E5	2.56 E5	4.80 E5	4.23 E5	2.09 E5	3.21 E5
17	Yearlings and adults	1.83 E6	8.81 E5	2.40 E6	1.82 E6	7.93 E5	1.83 E6	1.48 E6	5.84 E5	1.02 E6	9.21 E5	4.76 E5	6.94 E5
18	Yearlings and adults	46-19-11	45-13-11	49-20-12	46-19-11	44-18-11	49-19-12	46-19-11	44-18-11	47-19-11	46-19-11	44-18-11	46-19-11
Impact variables													
62	Eggs	8.4%	44.2%	42.2%	10.1%	50.0%	46.8%	29.1%	64.3%	59.5%	53.6%	70.4%	67.9%
64	Larvae	9.1%	44.8%	42.8%	10.8%	50.5%	47.3%	29.6%	63.8%	59.9%	54.0%	70.6%	68.2%
66	Juvenile 1	9.7%	42.6%	32.1%	12.4%	50.0%	40.2%	30.6%	65.8%	58.6%	55.0%	73.1%	68.8%
68	Juvenile 2	8.2%	46.6%	39.5%	10.2%	53.8%	46.4%	31.3%	68.9%	62.7%	58.2%	75.9%	72.0%
70	Juvenile 3	7.8%	47.7%	41.0%	9.2%	54.6%	46.9%	30.1%	69.5%	62.1%	57.6%	76.5%	71.7%
71	Yearlings	7.7 E4	3.8 E5	8.7 E5	9.5 E4	4.5 E5	8.0 E5	2.9 E5	6.1 E5	7.7 E5	5.7 E5	7.1 E5	8.0 E5
72	Yearlings	8.4%	49.2%	42.5%	10.1%	55.9%	47.3%	30.0%	70.4%	61.5%	57.4%	77.2%	71.4%
73	Adults	1.6 E5	8.2 E5	1.77 E6	2.1 E5	9.6 E5	1.64 E6	6.3 E5	1.3 E6	1.6 E6	1.2 E6	1.5 E6	1.7 E6
74	Adults	8.0%	48.2%	42.4%	10.3%	54.8%	47.2%	29.9%	69.1%	61.2%	56.8%	76.0%	70.8%

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