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

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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

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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 YS, the equilibrium standing crop, and most sensitive to changes in KXO, 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 KXO and for values of YS 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:

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:

$$K = K_E + (K_E - K_o) \left(\frac{N - N_s}{N_s}\right)^3 \quad \ldots\ldots\ (1)$$

in which:

$K$ = generalized unit mortality rate, day$^{-1}$

$K_E$ = conventional first order or "equilibrium" rate, day$^{-1}$

$K_o$ = 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.

---

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

[b] Nicholson, A. J., "An Outline of the Dynamics of Animal Populations," Australian Journal of Zoology, 2:9-65, 1954.

[c] Smith, F. E., "Population Dynamics in Daphnia magna and a New Model for Population Growth," Ecology 44:651-663, 1963.

[d] Errington, P. L., "Factors Limiting Higher Vertebrate Populations," Quart. Rev. Biol. 21:144-177, 1946.

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

[f] Patten, B. C., "System Analysis and Simulation in Ecology," Academic Press, New York, pages 275 through 278, 1971.

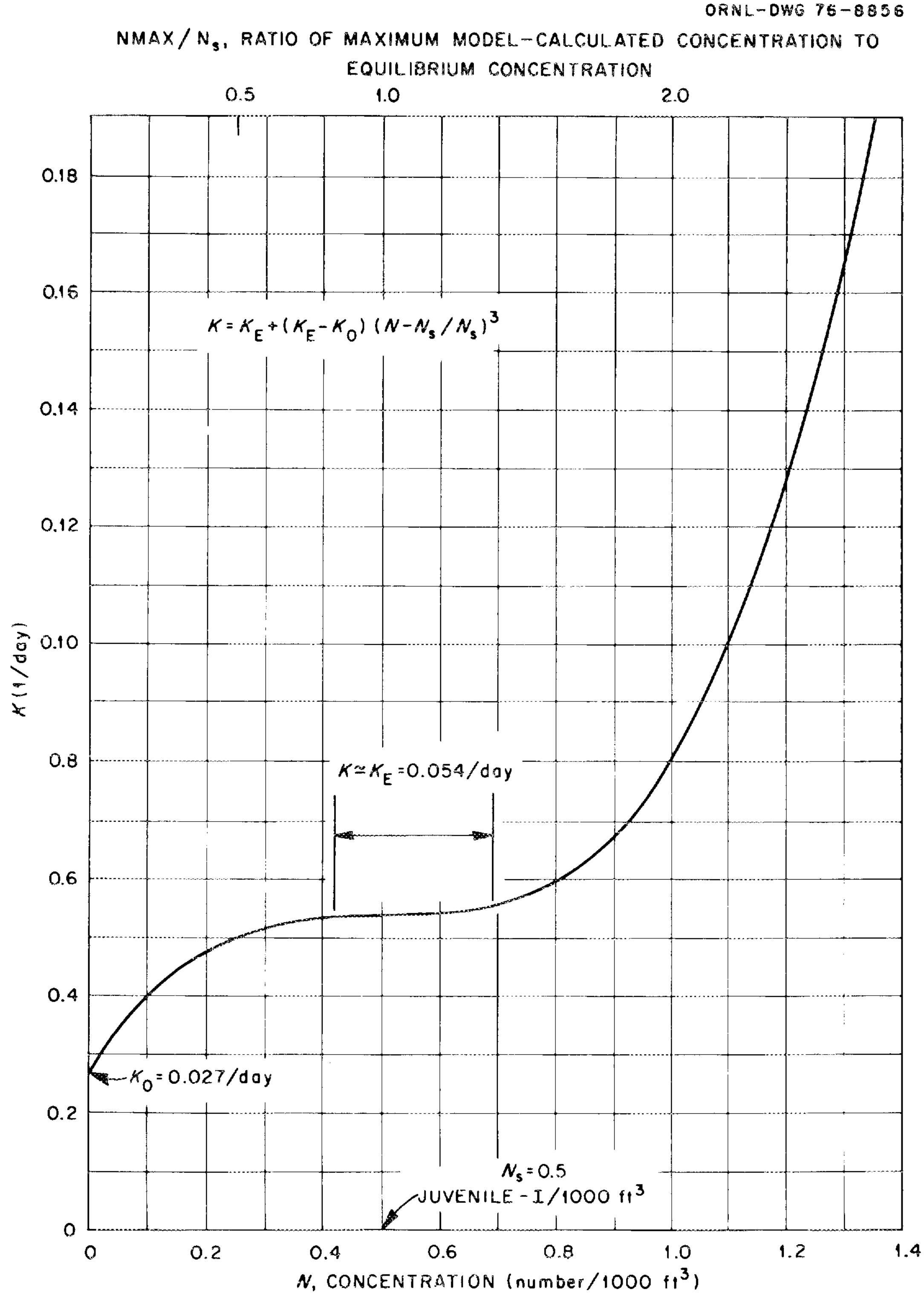


Fig. 1. Exponential mortality coefficient vs concentration (Juvenile 1) (modified from Fig. 9 of ref. 2). Equivalent symbols used elsewhere in this report: YS = $N_S$; KX = $K_E$; KXO = $K_0$.

"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 $day^{-1}$, 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

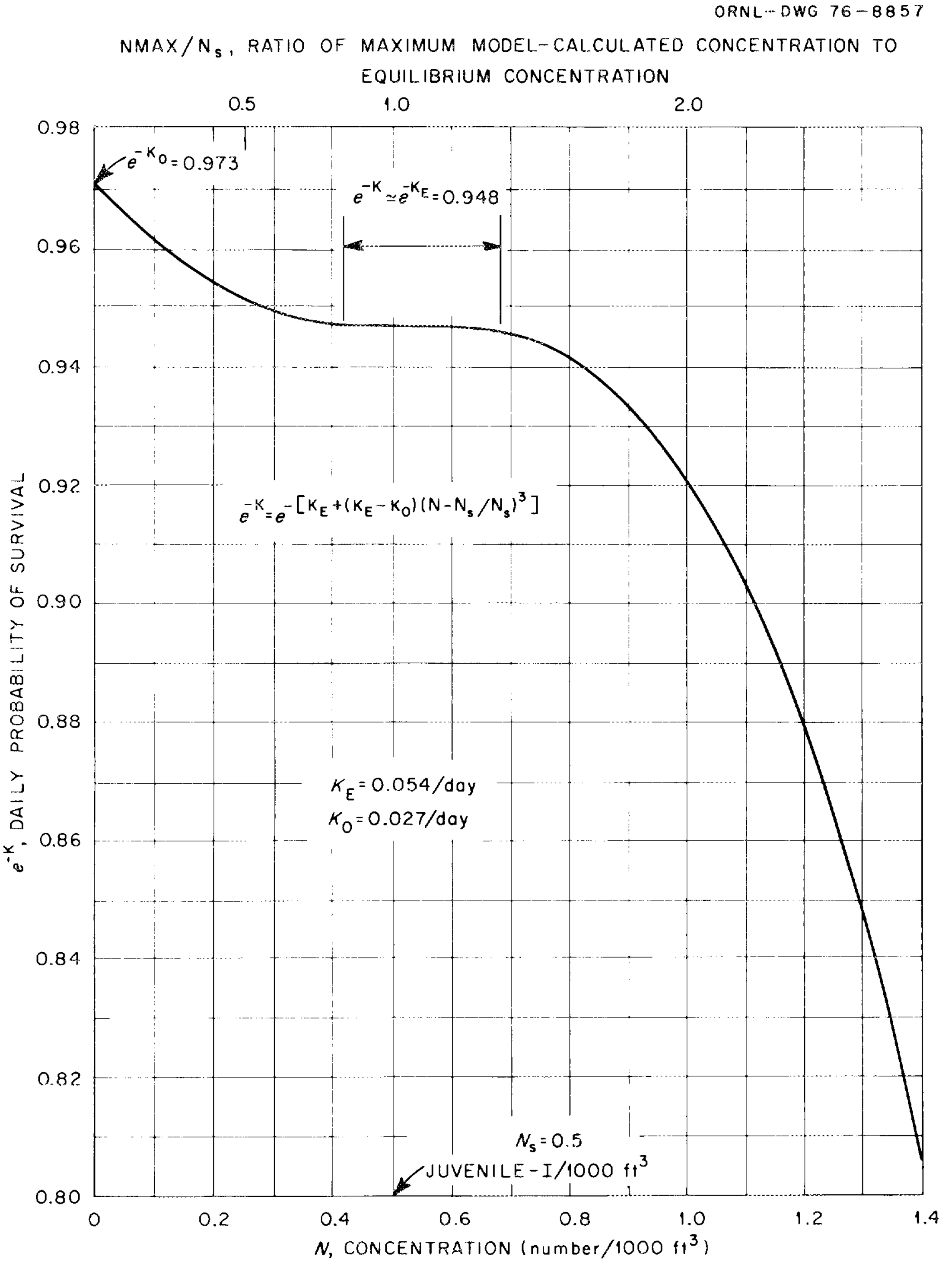


Fig. 2. Probability of survival vs concentration (Juvenile 1) (modified from Fig. 10 of ref. 2). Equivalent symbols used elsewhere in this report: YS = $N_S$; KX = $K_E$; KXO = $K_0$.

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 YS, 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 supplied[5] and documented[6] 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 KXO($\equiv K_0$), 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 KXO = 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 KXO 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 (KXO) were obtained by using the multiplicative constants (denoted AYS, AKX, and AKXO, respectively) in Table 1(b). Note that level 4 of AYS, level 4 of AKX, and level 3 of AKXO (i.e., KXO=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 |
| KXO($\equiv K_0$)[d] | $Day^{-1}$ | ---- | 0.132 | 0.0409 | 0.00996 | 0.00778 |

[a]PS = probability of survival through the life stage; DTE = duration of the life stage; YS = saturation or equilibrium standing crop; KX = equilibrium mortality rate coefficient; KXO = minimum mortality rate coefficient.

[b]ORNL and LMS assume no compensation occurs in the egg stage.

[c]Fortran exponential notation; e.g., 1.47E9 = $1.47 \times 10^9$.

[d]For each life stage, KXO = 0.8 KX; e.g., for larvae 0.132 = 0.8 (0.164).

(b) Multiplicative constants[e]

| Level | AYS | AKX[f] | AKXO[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 | |

[e]For a given parameter (i.e., YS, KX or KXO) and model run, the same multiplicative constant (value of AYO, AKX or AKXO, 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).

[f]In the sensitivity analysis for KX, KXO 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 KXO value used in the model is 0.8 (0.082) = 0.0656.

[g]The AKXO multiplicative constants were applied to the baseline KX values (Table 1(a)). The approach was to specify a value for the ratio KXO/KX($\equiv$ AKXO) (e.g., 0.3), and then given the baseline KX value (e.g., 0.164 for larvae) to calculate KXO as KXO = AKXO·KX for the different levels of AKXO given in Table 1(b) (e.g., KXO = 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 AKXO = 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.

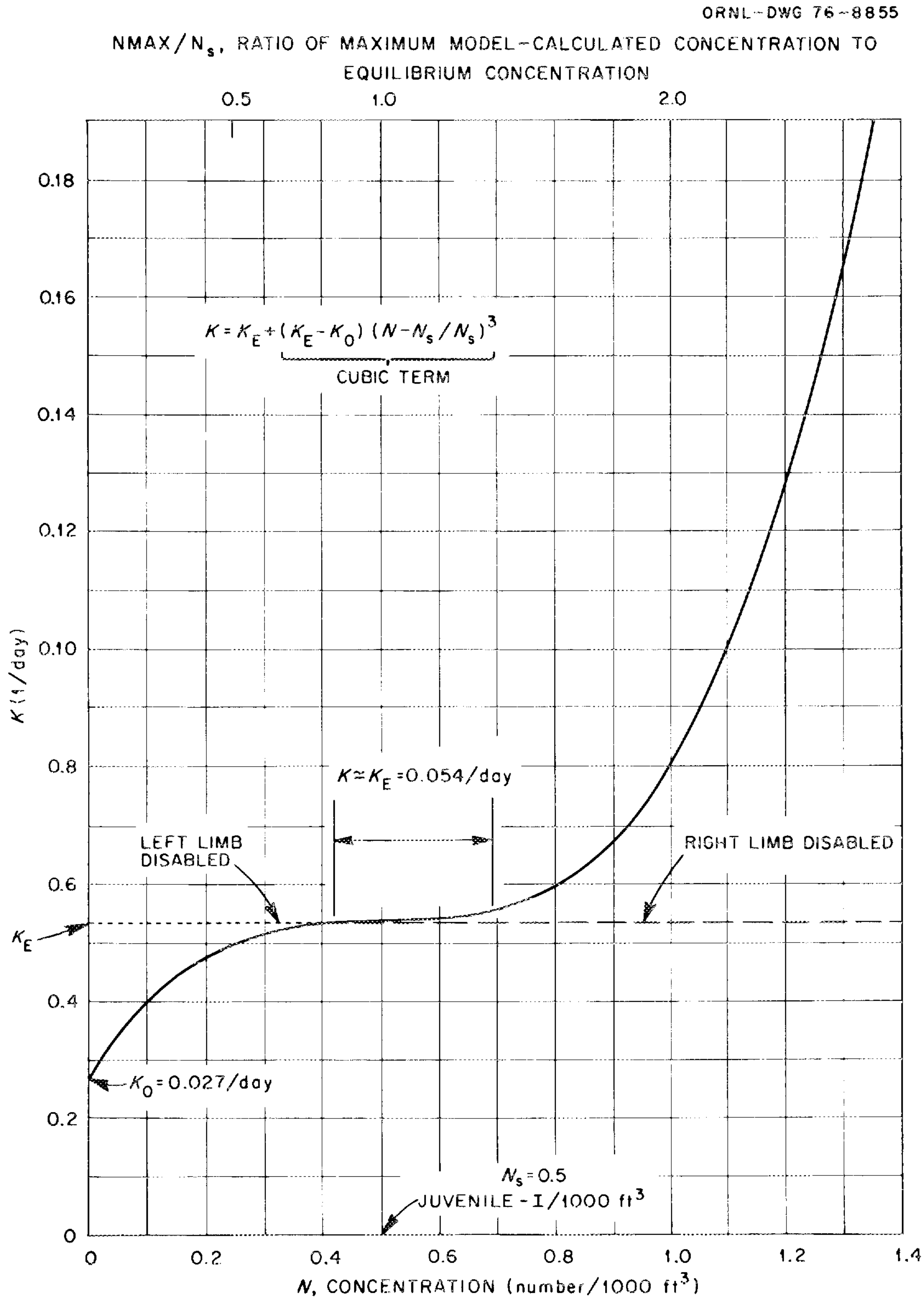


Fig. 3. Exponential mortality coefficient vs concentration (Juvenile 1) (modified from Fig. 9 of ref. 2), showing the effect on the curve of disabling the left or right limb of the compensation function. Equivalent symbols used elsewhere in this report: YS = $N_S$; KX = $K_E$; KXO = $K_0$.

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:

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

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] |
| | Impact Variables |
| 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 |

[a]Variables 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.

[b]NMAX 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.

[c]Variable 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 multicative 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 ≤ 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 ≤ 2.0), NMAX

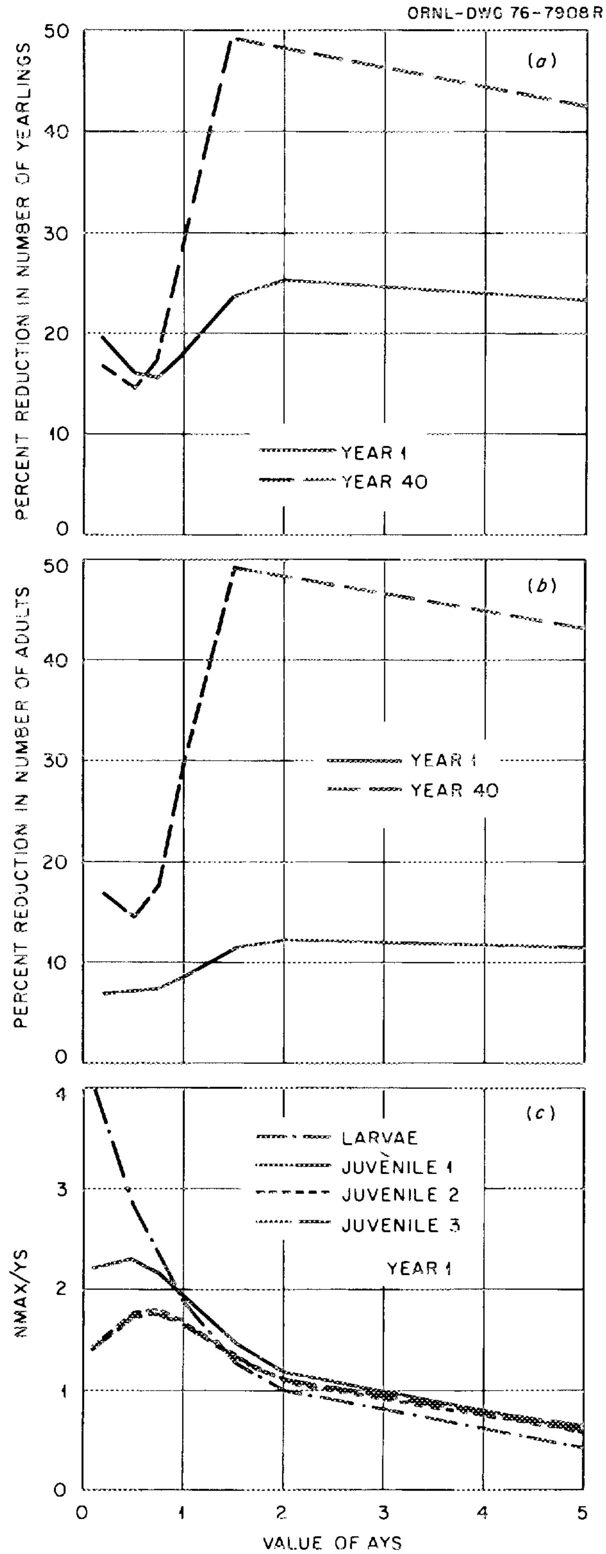


Fig. 4. Sensitivity of (a) percent reduction of yearlings, (b) percent reduction of adults, and (c) NMAX/YS to changes in YS values.

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

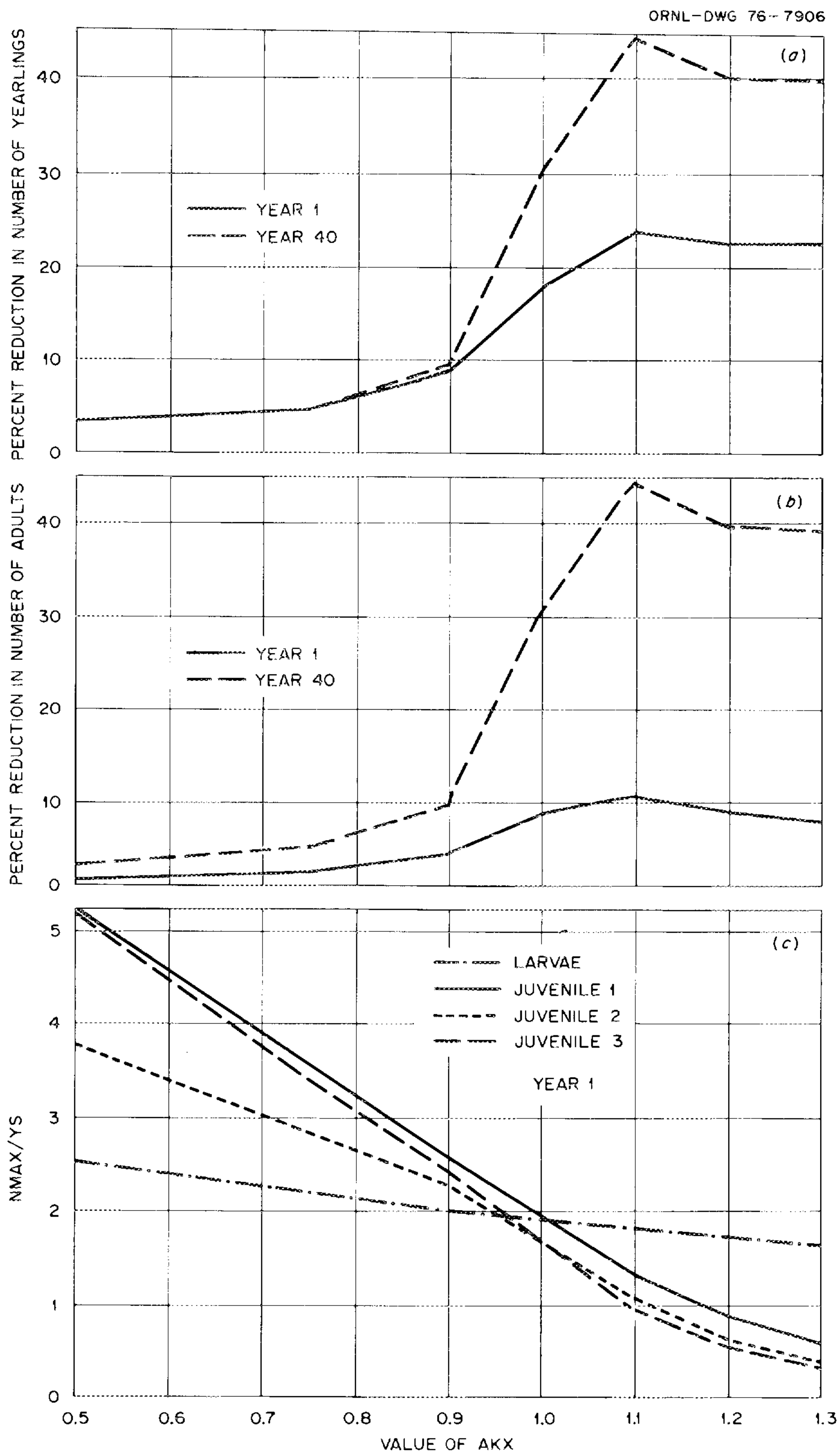


Fig. 5. Sensitivity of (a) percent reduction of yearlings, (b) percent reduction of adults, and (c) NMAX/YS to changes in KX values.

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 KX0, the minimum mortality rate coefficient

The dependence of percent reduction in number of yearlings and number of adults on KX0 ($K_0$ of Eq. 1) is illustrated in Fig. 6. Values of KX0 less than the baseline values (that is, where the multiplicative constant AKX0 $\leq$ 0.8) result in lower percent reductions than the baseline case. Values of KX0 greater than the baseline values (AKX0 > 0.8) result in higher percent reductions. Once again, these trends are more ovbious 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 KX0 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 KX0, while holding YS and KX constant, is to increase (AKX0 > 0.8) or decrease (AKX0 > 0.8) the steepness of both the left and right limbs. When AKX0 = 1.0, a horizontal straight line at KX0 = KK results; this case corresponds to no compensation. Values of KX0 greater than KK (AKX0 > 1.0) are theoretically possible, but they have not been used in the present study; such cases correspond to depensatory mortality, i.e., a decrease in the mortality rate as standing crop increases.

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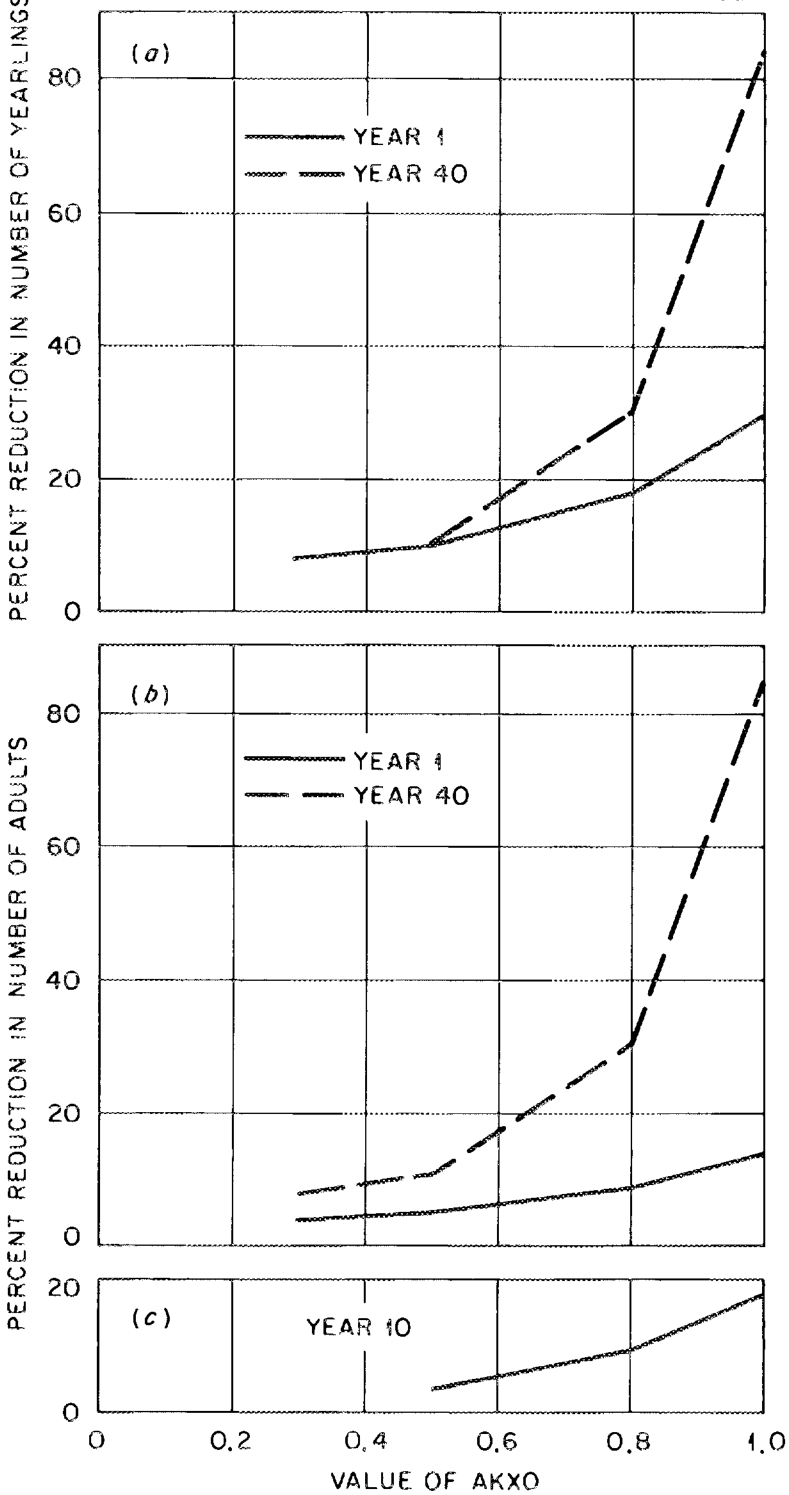


Fig. 6. Sensitivity of (a) percent reduction of yearlings and (b) and (c) percent reduction of adults to changes in KXO values. Fig. 6c is a plot of results from model runs by the applicant (Ref. 7).

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 results[7] (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(AYX $>$ 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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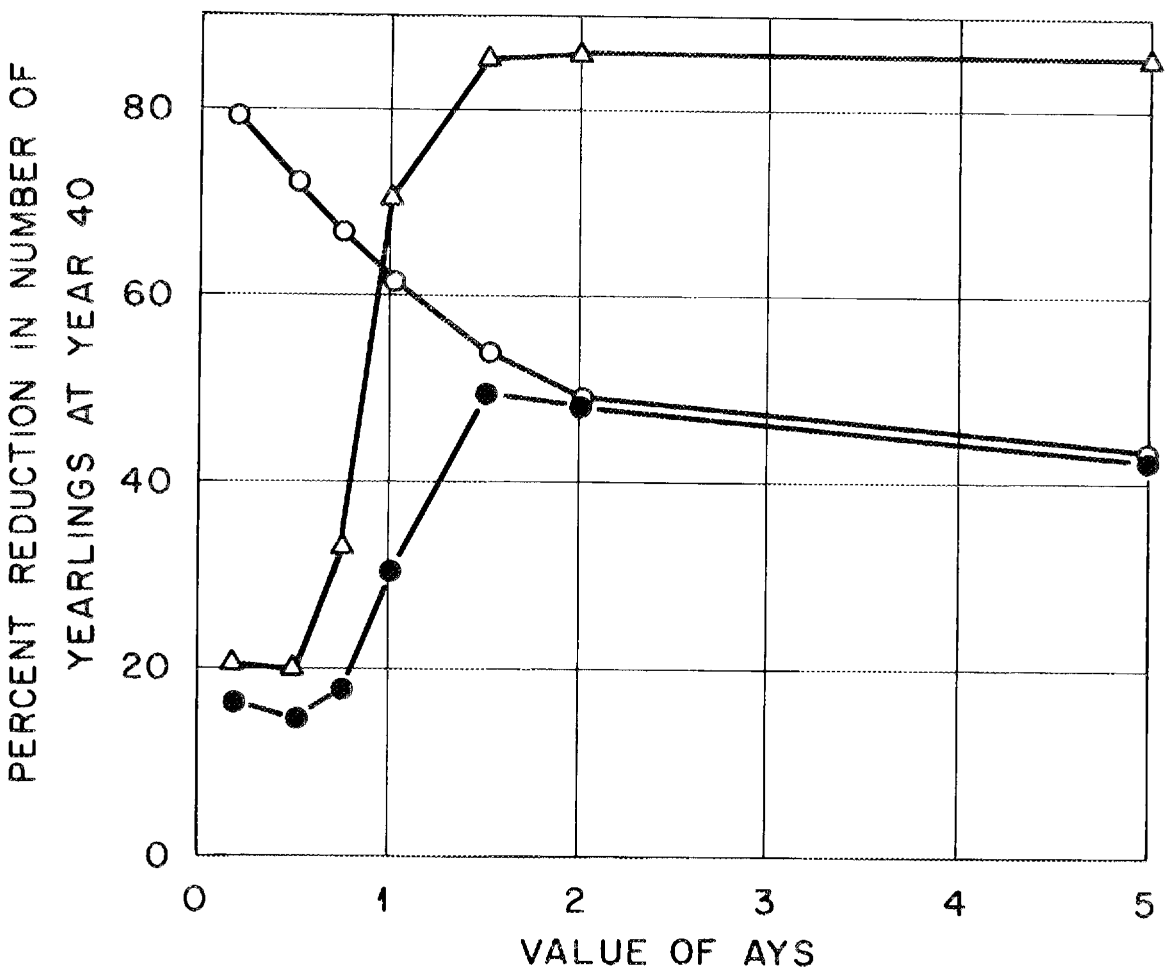


Fig. 7. Dependence of percent reduction in number of yearlings at year 40 on the value of YS with neither limb of the compensation function disabled (●———●), left limb disabled (△———△), and right limb disabled (○———○).

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.

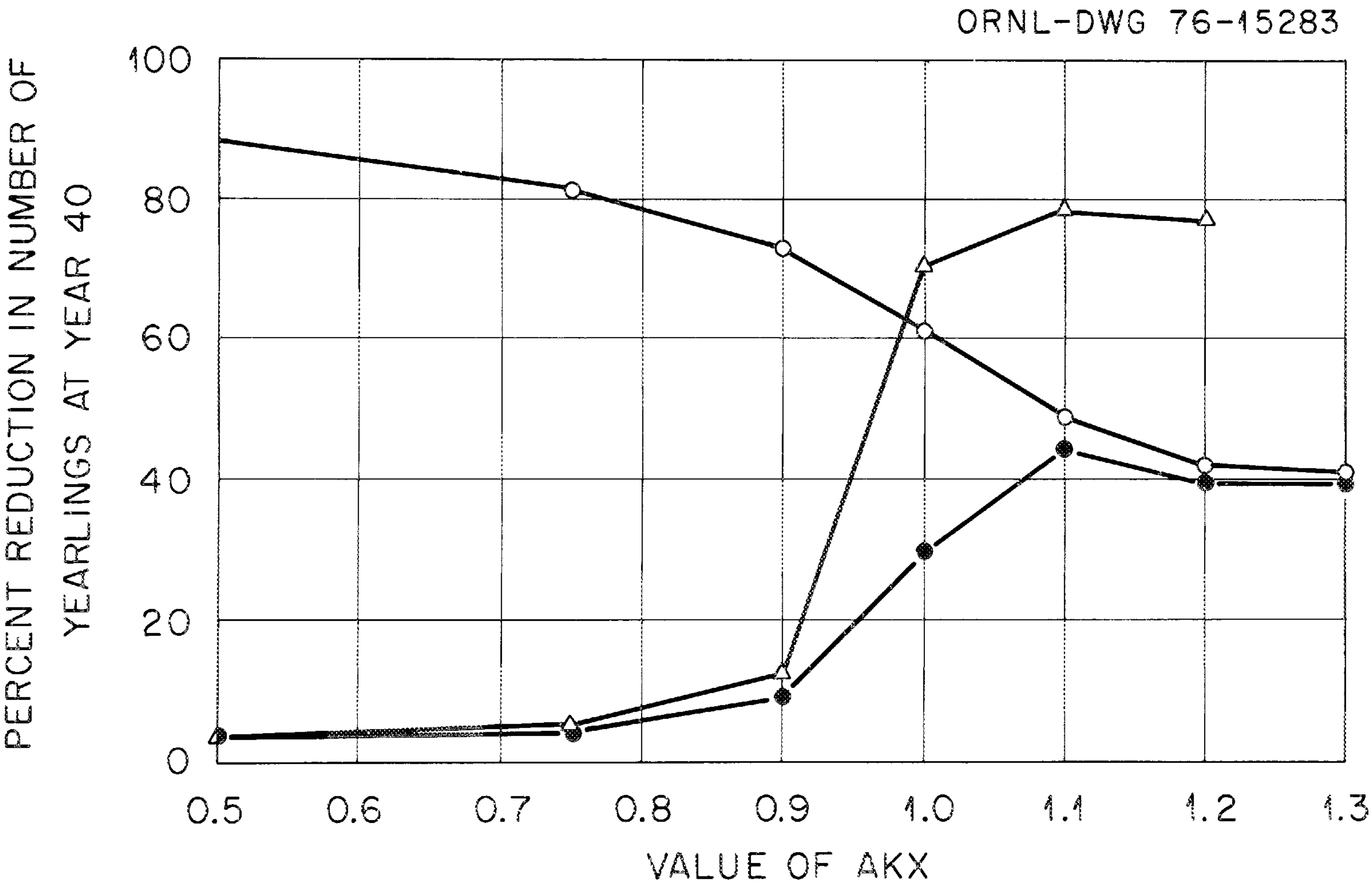


Fig. 8. Dependence of percent reduction in number of yearlings at year 40 on the value of KX with neither limb of the compensation function disabled (●——●), left limb disabled (Δ——Δ), and right limb disabled (o——o).

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 KXO. The dependence of percent reduction in number of yearlings at year 40 on KXO 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 KXO at and below the baseline value (AKXO $\leq$ 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 KXO 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

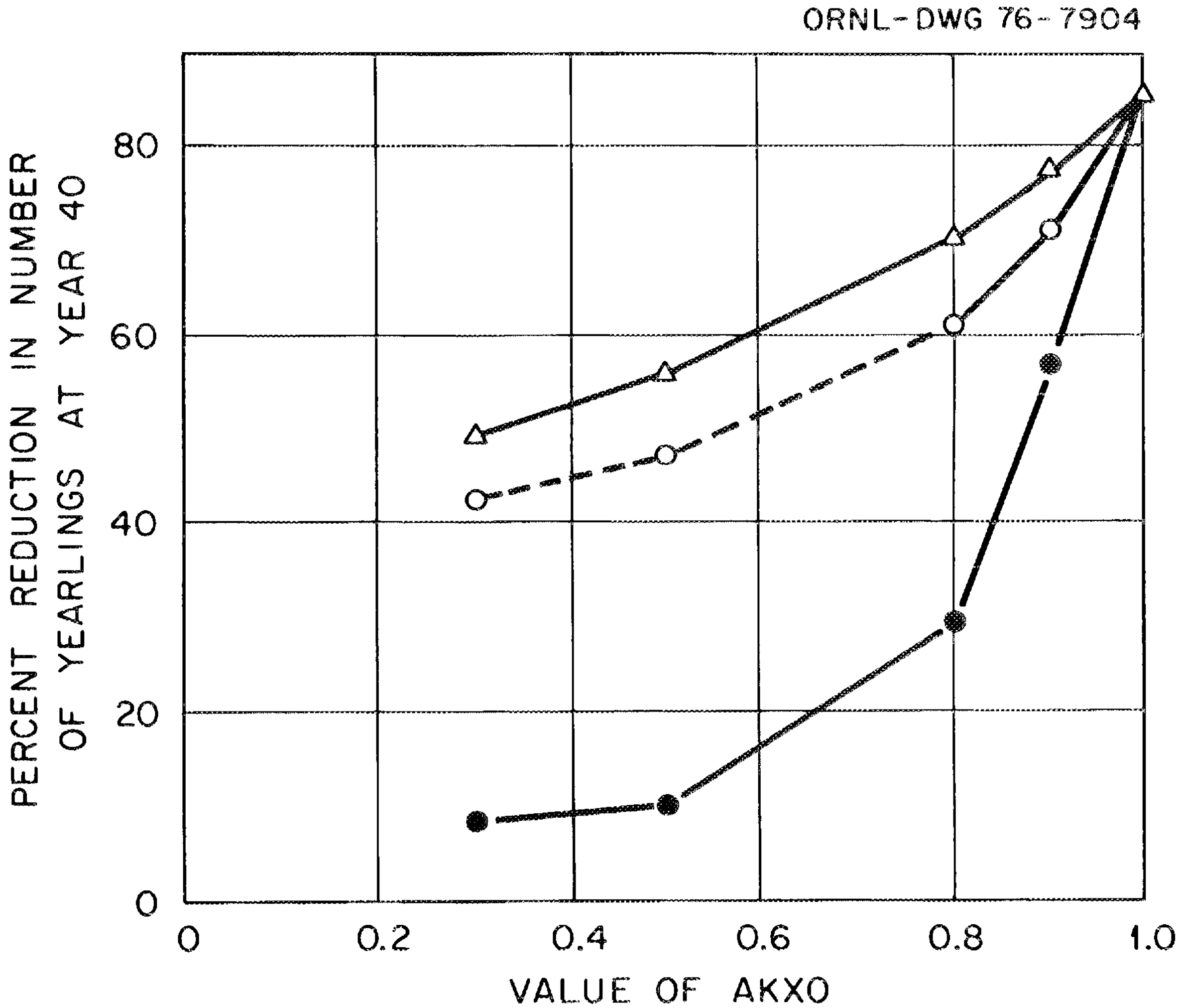


Fig. 9. Dependence of percent reduction in number of yearlings at year 40 on the value of KXO with neither limb of the compensation function disabled (●———●), left limb disabled (Δ———Δ), and right limb disabled (○———○).

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 KXO, but that the left limb is the more important of the two.

<u>Summary</u>

(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 KXO, 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 KXO.

(5) Disabling either limb of the compensation function results in higher estimates of percent reduction. For all values of KXO 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

[a]For 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 model[10] and our life cycle model[11] 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.

<u>YS</u>

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

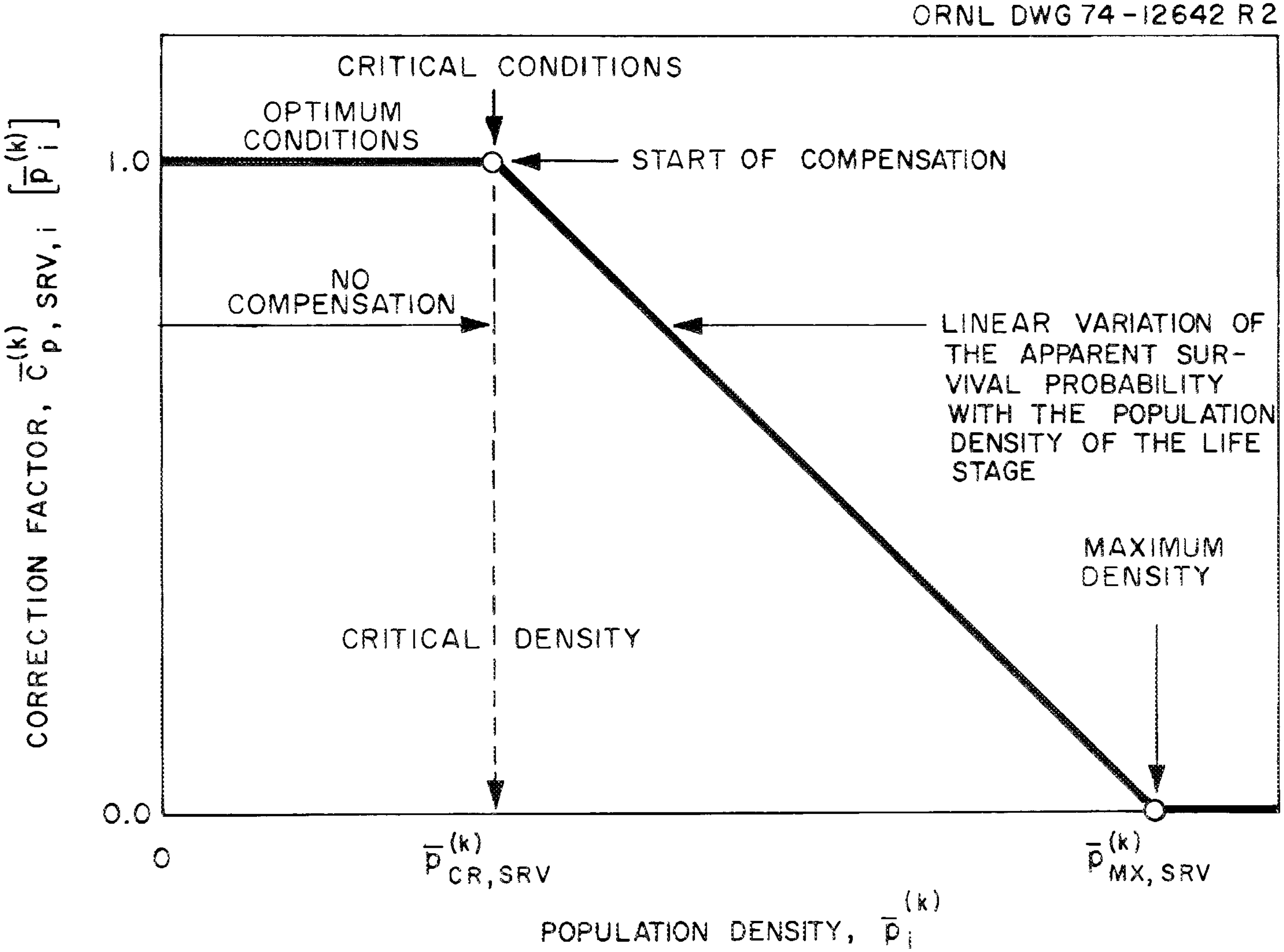


Fig. 10. Schematic representation of the population density correction factor for the apparent survival probability used in the ORNL computer simulation model for the striped bass young-of-the-year population in the Hudson River.

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.

KXO

The parameter KXO 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 KXO is that the values selected by LMS commonly correspond to unrealistic probabilities of survival (Table 3). The PSO values for AKXO = 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 AKXO = 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 KXO, 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 KXO. 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 KXO.

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 |

[a]DTE 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)

[b]Values 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

```
COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,XREF
          CHIST
          C...
          C     JANUARY 1976.  COMPUTER CODE FOR THE COMPLETELY MIXED MODEL
          C      DEVELOPED BY LAWLER, MATUSKY & SKELLY, AS MODIFIED BY
          C     VAN WINKLE.
          C...
          C...THIS IS THE MAIN PROGRAM FOR THE COMPLETELY MIXED MODEL.
          C...IT WAS FORMERLY IDENTIFIED AS SUBROUTINE HISTG.
          C...
ISN 0002        COMMON/ADULTT/DCY(20),FEC(20),SRAT(20),SMAT(20)
ISN 0003        COMMON/LSTAGE/AKX(5),AKX0(5),AYS(5),DE(5),DTE(5),FKILL(5),ILEFT(5)
               1  ,IRIGHT(5),KX(5),KX0(5),YS(5)
ISN 0004        COMMON/PAR/IEND,ISKP,ISW,KSTP,NN,P,QP,TE,V
ISN 0005        COMMON /RKTIA/ NX,DNXDT,AUX(16,1)
ISN 0006        COMMON/WGHT/TIM(10),TIMW(10)
ISN 0007        COMMON/WYY/W(5000),YY(5000)
ISN 0008        DIMENSION ADULT(20),ADULTS(20),DCYU(20),PAD(20),PADE(20),RMF(20)
ISN 0009        DIMENSION CHAR(6,5),JLEFT(5),JRIGHT(5),PNDAY(4),ASUM(4),REF(6)
ISN 0010        DIMENSION R(100),S(100),R3(100),SR(100),RR(100),R3R(100), R3S(100)
               1  ,R3RSR(100)
ISN 0011        REAL*8 ISW1,JLEFT,JRIGHT,NO,YES
ISN 0012        REAL IMPJ2,IMPJ3,IMPTOT,KX,KX0,NEC,NMAX,NMAXYS,NTOT,NX,KPLANT
ISN 0013        DATA NC/6H     NO/, YES/6H   YES/
ISN 0014        DATA J,K,L,M,N/5*0/
ISN 0015        DATA IK,IN,IQ,IX,JJ,IL,MM/7*0/
ISN 0016        DATA IAD,IEN,III,IPL,IPT,IST,IVY,IYR,LPT,LYR/10*0/
ISN 0017        DATA KSWT,KTYO/2*0/
ISN 0018        DATA IKTYO,ITEST,KSPAN,NSPAN/4*0/
ISN 0019        DATA INCRMT,ISTAGE/2*0/
ISN 0020        DATA R,S,R3,SR,RR,R3R,R3S,R3RSR/800*0./
ISN 0021        DATA AA,AM,BB,E2,R0,SM,SP,TF/8*0./
ISN 0022        DATA AVG,NEC,REF,SPE,SSF/10*0./
ISN 0023        DATA ASUM,NMAX,NTOT,PSPP,RATE,SUMA,SURV,TEND,TOT1/12*0./
ISN 0024        DATA FRACT,PNDAY,PTIME/6*0./
ISN 0025        DATA NMAXYS,PEQUAL,TSTART/3*0./
ISN 0026        DATA ADULT, ADULTS, DCYU,PAD,PADE,RMF/120*0./
ISN 0027        INTEGER OF1,OF2
          C...
          C...INITIALIZATION STATEMENTS.
          C...
ISN 0028        OF1=6
ISN 0029        OF2=12
ISN 0030        IF1=5
ISN 0031        ISW1 = NO
ISN 0032        TIM(1)=0.
ISN 0033        TIM(9) = 56.
ISN 0034        DO 10 I=1,5000
ISN 0035     10    YY(I)=0.
          C...
          C...READ INPUT PARAMETERS AND WRITE THOSE INPUT PARAMETERS REQUESTED.
          C...
ISN 0036        READ(IF1,10000) ISW,IEND,LYR,KSTP,TSTART,TEND,ISKP
ISN 0037        LYR=LYR-1
ISN 0038        IF (ISW.EQ.1) ISW1=YES
ISN 0040        TF=TEND-TSTART
ISN 0041        READ(IF1,10100)IST,IK,IEN,NN
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ISN 0042          READ(IF1,10200) QP
ISN 0043          READ(IF1,10300) V,(FKILL(L),L=1,5),IPL
ISN 0044          IF (ISW.EQ.1) LYR=LYR+ISW
ISN 0046          QPCFS = 1703680*QP
ISN 0047          WRITE(OF1,13000)
ISN 0048          WRITE(OF1,13900) IEND,LYR,ISW1,IPL
ISN 0049          WRITE(OF1,13000)
ISN 0050          IF (NN.EQ.1) WRITE(OF2,13100)
ISN 0052          IF (NN.EQ.1) WRITE(OF2,13200) QP,QPCFS,V,(FKILL(JJ),JJ=1,5)
ISN 0054          KSWT = 1
ISN 0055          ISTAGE=1
ISN 0056          IYR=0
ISN 0057          READ(IF1,10400)P,TE,(DE(JJ),JJ=1,5)
ISN 0058          PEQUAL=P
ISN 0059          READ(IF1,10500)NSPAN,(TIM(J),J=2,NSPAN)
ISN 0060          READ(IF1,10600)(TIMW(J),J=1,NSPAN)
ISN 0061          IF (NN.EQ.1) WRITE(12,14000) (DE(J),J=1,5)
ISN 0063          IF (NN.EQ.1) WRITE(OF2,14100) TE
ISN 0065          KSPAN=NSPAN-1
ISN 0066          DO 20 K=1,KSPAN
ISN 0067             IF (NN.EQ.1) WRITE(OF2,14200)TIM(K),TIM(K+1),TIMW(K)
ISN 0069       20    CONTINUE
ISN 0070          READ(IF1,10700)(DCY(J),J=1,IEND)
ISN 0071          READ(IF1,10800)(SRAT(J),J=1,IEND)
ISN 0072          READ(IF1,10800)(SMAT(J),J=1,IEND)
ISN 0073          READ(IF1,10900)(FEC(J),J=1,IEND)
ISN 0074          READ(IF1,11000) (PNDAY(J),J=1,4)
ISN 0075          PTIME=0.
ISN 0076       30 FRACT=DE(1)*TIMW(1)/TIM(2)
ISN 0077          NEO=P*FRACT
ISN 0078          ITEST=MOD(IYR,IK)
ISN 0079          IN=0
ISN 0080          IF (ITEST.EQ.0) IN=1
ISN 0082          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,11400) IYR
ISN 0084       40 IF (IYR.GT.0) GO TO 50
              C ..................
ISN 0086          READ(IF1,11100) (CHAR(I,ISTAGE),I=1,6)
ISN 0087          READ(IF1,11200) KX(ISTAGE),YS(ISTAGE),DTE(ISTAGE)
ISN 0088          READ(IF1,11300) AKX(ISTAGE),AKXO(ISTAGE),AYS(ISTAGE),
                 1 ILEFT(ISTAGE),IRIGHT(ISTAGE)
ISN 0089          JLEFT(ISTAGE) = NO
ISN 0090          JRIGHT(ISTAGE) = NO
ISN 0091          IF (ILEFT(ISTAGE).EQ.1) JLEFT(ISTAGE) = YES
ISN 0093          IF (IRIGHT(ISTAGE).EQ.1) JRIGHT(ISTAGE) = YES
ISN 0095          KX(ISTAGE) = AKX(ISTAGE)*KX(ISTAGE)
ISN 0096          KXO(ISTAGE) = AKXO(ISTAGE)*KX(ISTAGE)
ISN 0097          YS(ISTAGE) = AYS(ISTAGE)*YS(ISTAGE)
ISN 0098       50 IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,13000)
ISN 0100          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,11500) ISTAGE, (CHAR(I,ISTAGE),
                 1 I=1,6)
ISN 0102          IF (NN.EQ.1.AND.IN.EQ.1.OR.NN.EQ.1.AND.IYR.EQ.1) WRITE(OF1,13300)
                 1 KX(ISTAGE),KXO(ISTAGE),YS(ISTAGE),DTE(ISTAGE), AKX(ISTAGE),
                 1 AKXO(ISTAGE),AYS(ISTAGE),JLEFT(ISTAGE),JRIGHT(ISTAGE)
              C...
              C...AVERAGE THE VALUES IN THE PRODUCTION TABLE WHEN DIFFERENT
              C...MODEL TIME STEPS ARE USED FOR VARIOUS LIFE STAGES.
              C...
ISN 0104          IF (ISTAGE.NE.1) ASUM(ISTAGE)=DE(ISTAGE)/DE(ISTAGE-1)
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ISN 0106          IF (ISTAGE.EQ.1) MM = (DTE(ISTAGE)/DE(1) + 0.0001)
ISN 0108          IF (ISTAGE.EQ.1) IPT = ((0.0-DTE(ISTAGE))/DE(1)) + SIGN(0.0001,
                 1 (0.0-DTE(ISTAGE)))
ISN 0110          IF (ISTAGE.EQ.1) III=IPT+MM
ISN 0112          IF (III.EQ.0) IPT=0
ISN 0114          IF (IPT.NE.0) IPT=IABS(IPT)
ISN 0116          IF (ISTAGE.EQ.1.AND.IPT.LE.0) IPT=0
ISN 0118          IF (KFIRST.EQ.0) LPT=IPT
ISN 0120          IF (ISTAGE.EQ.1.OR.ISTAGE.EQ.5) GO TO 160
ISN 0122          AA=ABS(PNDAY(ISTAGE)-PNDAY(ISTAGE-1))
ISN 0123          BB=ABS(DE(ISTAGE)-DE(ISTAGE-1))
ISN 0124          IF ((AA.LT..0001).AND.(BB.LT..0001)) GO TO 160
ISN 0126          L=1
ISN 0127          INCRMT=ASUM(ISTAGE)+.001
ISN 0128          IF (INCRMT.LE.0) GO TO 120
ISN 0130          IX=0
ISN 0131          IPT=FLOAT(IPT)/FLOAT(INCRMT)
ISN 0132          DO 70 I=1,KTYO,INCRMT
ISN 0133             AVG=0.
ISN 0134             IX=IX+INCRMT
ISN 0135             DO 60 J=I,IX
ISN 0136                AVG=AVG+YY(J)
ISN 0137       60       YY(J)=0.
ISN 0138             YY(L)=AVG
ISN 0139             L=L+1
ISN 0140       70    CONTINUE
ISN 0141          KTYO=L
ISN 0142       80 IAD=PNDAY(ISTAGE)/DE(ISTAGE)+.001
ISN 0143          IF (IAD.EQ.1) GO TO 160
ISN 0145          DO 110 K=1,KTYO,IAD
ISN 0146             L=K
ISN 0147             LL=K+IAD-1
ISN 0148             AVG=0.
ISN 0149             DO 90 N=L,LL
ISN 0150       90       AVG=AVG+YY(N)
ISN 0151             DO 100 N=L,LL
ISN 0152      100       YY(N)=AVG/IAD
ISN 0153      110    CONTINUE
ISN 0154          GO TO (160,170),KSWT
ISN 0155      120 IQ=1.0/ASUM(ISTAGE)+.001
ISN 0156          IVY=-IQ
ISN 0157          MM=KTYO
ISN 0158          IKTYO=KTYO*IQ
ISN 0159          DO 130 M=1,IKTYO,IQ
ISN 0160             K=IKTYO-M+1
ISN 0161             YY(K+IVY+1)=YY(MM)
ISN 0162             YY(MM)=0.
ISN 0163      130    MM=MM-1
ISN 0164          DO 150 K=1,IKTYO,IQ
ISN 0165             J=K
ISN 0166             JJ=K+IQ-1
ISN 0167             AM=YY(K)/IQ
ISN 0168             DO 140 N=J,JJ
ISN 0169      140       YY(N)=AM
ISN 0170      150    CONTINUE
ISN 0171          KTYO=IKTYO
ISN 0172          GO TO 80
            C...
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              C...CALL SUBROUTINE GROWTH FOR THE SPECIFIED LIFE STAGE.
              C...
ISN 0173        160 CALL GROWTH (IN,ISTAGE,IYR,KTYO,NEO,NMAX,PTIME,KPLANT)
              C...
              C...CALCULATE AND WRITE TOTAL PRODUCTION, TOTAL TRANSFER, % SURVIVAL
              C...AND MAXIMUM STANDING CROP 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,KTYO
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) REF(ISTAGE) = P
ISN 0187            CHANGN = REF(ISTAGE) - P
ISN 0188            CHANGP = 100*CHANGN/REF(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) REF(ISTAGE) = NTOT
ISN 0203            CHANGN = REF(ISTAGE) - NTOT
ISN 0204            CHANGP = 100*CHANGN/REF(ISTAGE)
ISN 0205            IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(6,11600)NTOT,TOT1,RATE,NMAX,NMAXYS,
                   1 CHANGN,CHANGE
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*P
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(NSPAN)
ISN 0226            NEO=YY(1)
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ISN 0227          IF (ISTAGE.LE.5) GO TO 40
ISN 0229          IF (IYR.GT.0) GO TO 230
            C...
            C...CALL SUBROUTINE EQUAL FOR YEAR ZERO.
            C...
ISN 0231          CALL EQUAL (ADULT,ADULTS,DCYU,NEO,PEQUAL,FMF,R0)
ISN 0232          APS = EXP(-DCYU(4)*365.)
ISN 0233          IF (NN.EQ.1) WRITE(12,13600) APS
ISN 0235          IF (NN.EQ.1) WRITE(OF2,13400)
ISN 0237          IF (NN.EQ.1) WRITE(OF2,13500) (J,DCYU(J),SRAT(J),SMAT(J),FEC(J),J=
                 1 1,IEND)
            C...
            C...GENERATE ADULT CLASSES FOR YEAR ZERC.
            C...
ISN 0239          ADULT(1)=NEO
ISN 0240          REF(6) = ADULT(1)
ISN 0241          DO 220 J=2,IEND
ISN 0242             SURV=EXP(-DCYU(J-1)*365.)
ISN 0243             ADULT(J)=ADULT(J-1)*SURV
ISN 0244      220    CCNTINUE
ISN 0245          GO TO 250
            C...
            C...CALCULATE ADULT CLASSES FOR ALL YEARS OTHER THAN YEAR ZERO.
            C...
ISN 0246      230 DO 240 IX1=2,IEND
ISN 0247             J=IEND-IX1+2
ISN 0248      240    ADULT(J)=ADULT(J-1)*EXP(-DCYU(J-1)*365.)
ISN 0249          ADULT(1)=NEO
ISN 0250      250 CONTINUE
            C...
            C...CALCULATE EGG PRODUCTION FOR THE UPCOMING YEAR.
            C...
ISN 0251          P=0.
ISN 0252          I = IYR + 1
ISN 0253          S(I) = C.
ISN 0254          DO 260 J=1,IEND
ISN 0255             SSP=ADULT(J)*SRAT(J)*SMAT(J)*FEC(J)
ISN 0256             SPAWN = ADUIT(J)*SRAT(J)*SMAT(J)
ISN 0257             S(I) = S(I) + SPAWN
ISN 0258             R(I) = ADULT(3)
ISN 0259      260    P=P+SSP
            C...
            C...CALCULATE RELATIVE ADULT AGE DISTRIBUTION IN TWO WAYS.
            C...
ISN 0260          SP=0.
ISN 0261          DC 270 J=1,IEND
ISN 0262      270    SP=SP+ADULT(J)
ISN 0263          IF (IYR.GT.0) GO TO 290
ISN 0265          DC 280 K=1,IEND
ISN 0266             PADE(K) = 100.*ADULT(K)/SP
ISN 0267      280    PAD(K)=100.*ADULT(K)/SP
ISN 0268          SPE=SP
ISN 0269          GO TO 310
ISN 0270      290 IF (IYR.EQ.0) GO TO 310
ISN 0272          DO 300 K=1,IEND
ISN 0273             PADE(K) = 100.*ADULT(K)/SP
ISN 0274      300    PAD(K)=100.*ADULT(K)/SPE
ISN 0275      310 PSPP = SP/SPE
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ISN 0276          CHAGN1 = REF(6) - ADULT(1)
ISN 0277          CHAGP1 = 100*CHAGN1/REF(6)
ISN 0278          CHAGNT = SPE - SP
ISN 0279          CHAGPT = 100*CHAGNT/SPE
            C...
            C...PRINT ADULT AGE DISTRIBUTION AND RELATIVE ADULT AGE DISTRIBUTION.
            C...
ISN 0280          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12000)
ISN 0282          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12100) (J,ADULT(J),J=1,IEND)
ISN 0284          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12200) SP
ISN 0286          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12300)
ISN 0288          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12400)  (K,PAD(K),K=1,IEND)
ISN 0290          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12500)
ISN 0292          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12400)  (K,PADE(K),K=1,IEND)
ISN 0294          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12600) PSPP
ISN 0296          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12700) CHAGN1,CHAGP1, CHAGNT,
                 1 CHAGPT
ISN 0298          E2=1.
ISN 0299          SUMA=0.
ISN 0300          DO 320 K=1,IEND
ISN 0301             IF (K.NE.1) E2=E2*EXP(-DCYU(K-1)*365.)
ISN 0303      320    SUMA=SUMA+E2*RMF(K)
ISN 0304          SM=SUMA*(NEO/PEQUAL)
ISN 0305          IF (IN.EQ.1.OR.IYR.EQ.1) WRITE(OF1,12800) SM
            C...
            C...CYCLE TO NEXT YEAR.
            C...
ISN 0307          IF (ISW.EQ.1.AND.IYR.EQ.IPL) QP = 0.
ISN 0309          IF (IYR.EQ.LYR) GO TO 330
ISN 0311          IYR=IYR+1
ISN 0312          ISTAGE=1
ISN 0313          PTIME=0.
ISN 0314          GO TO 30
ISN 0315      330 IF (IN.EQ.1) WRITE(OF1,12900)
ISN 0317          LYR1 = LYR + 1
ISN 0318          DO 340 I = 1,LYR1
ISN 0319             R3(I) = R(I+3)
ISN 0320             R3S(I) = R3(I)/S(I)
ISN 0321             SR(I) = S(I)/S(1)
ISN 0322             RR(I) = R(I)/R(1)
ISN 0323             R3R(I) = R3(I)/R3(1)
ISN 0324             R3RSR(I) = R3R(I)/SR(I)
ISN 0325      340    CONTINUE
ISN 0326          IF (NN.EQ.1) WRITE(12,13700)
ISN 0328          IF (NN.EQ.1) WRITE(12,13800) (I,S(I),R(I),R3(I),R3S(I), SR(I),
                 1 RR(I),R3R(I),R3RSR(I),I=1,LYR1)
ISN 0330          STOP
            C
            C       INPUT FORMAT CARDS
            C
            C
            C       OUTPUT FORMAT CARDS
            C
ISN 0331    10000 FORMAT (I1,1X,I2,1X,I3,1X,I4,1X,2(F4.0,1X),I1)
ISN 0332    10100 FORMAT (4(I2,1X))
ISN 0333    10200 FORMAT (E16.8)
ISN 0334    10300 FORMAT(6F10.0,I2)
ISN 0335    10400 FORMAT(E15.8,F5.0,5F5.2)
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ISN 0336      10500 FORMAT(I2,1X,15F5.0)
ISN 0337      10600 FORMAT (10F8.0)
ISN 0338      10700 FORMAT (3E10.6,10F5.2)
ISN 0339      10800 FORMAT(13F6.0)
ISN 0340      10900 FORMAT(8F10.0)
ISN 0341      11000 FORMAT (4F6.0)
ISN 0342      11100 FORMAT(20A4)
ISN 0343      11200 FORMAT (2(E12.7,3X),F5.1)
ISN 0344      11300 FORMAT (3F5.2,2(4X,I1))
ISN 0345      11400 FORMAT(1H1,1X,'.................................'/ 1X,
                    1 '..CURRENT YEAR.......',' - ',I3,'- ','..'/ 1X,
                    1 '.................................'//)
ISN 0346      11500 FORMAT (//,' STAGE',I3,3X,10A4)
ISN 0347      11600 FORMAT (/,' TOTAL PRODUCTICN INTO THIS LIFE STAGE = ',E20.10/
                    1 ' TOTAL TRANSFER INTO THE NEXT LIFE STAGE = ',E20.10/
                    1 ' % SURVIVAL THROUGH THIS LIFE STAGE = ',5X,F4.1/
                    1 ' MAXIMUM STANDING CROP FOR THIS LIFE STAGE = ',E20.10/
                    1 ' RATIO OF MAXIMUM STANDING CROP TC EQUILIBRIUM STANDING',
                    1 ' CROP (NMAX/YS) = ',F7.4/
                    1 ' REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE',
                    1 ' DUE TO THE POWER PLANT...',E20.10/
                    1 ' % REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE',
                    1 ' STAGE DUE TC THE POWER PLANT...',F5.2)
ISN 0348      11700 FORMAT (//' CUMULATIVE PROBABILITY OF SURVIVAL FROM EGG',
                    1 ' THROUGH JUVENILE 3 = ',E15.8/
                    1 ' EXPECTED NUMBER OF YEARLINGS = ',E15.8)
ISN 0349      11800 FORMAT (/' NUMBER OF JUVENILE 2 KILIED BY IMPINGEMENT...',E12.6)
ISN 0350      11900 FORMAT (/' NUMBER OF JUVENILE 3 KILLED BY IMPINGEMENT...',E12.6/
                    1 ' TOTAL NUMBER OF JUVENILES KILLED BY IMPINGEMENT...',E12.6)
ISN 0351      12000 FORMAT(///' ADULT DISTRIBUTION BY AGE CLASS',//, 5(
                    1 13H AGE NUMBERS  ))
ISN 0352      12100 FORMAT(5(1X,I3,1X,F8.0))
ISN 0353      12200 FORMAT(1X,'TOTAL ADULTS ',F15.0/)
ISN 0354      12300 FORMAT (//' PERCENT AGE DISTRIBUTION RELATIVE TO YEAR ZERO'/ 1X,5(
                    1  12HAGE PERCENT  )/)
ISN 0355      12400 FORMAT(5(1X,I3,1X,F7.3))
ISN 0356      12500 FORMAT (//' PERCENT AGE DISTRIBUTION RELATIVE TC CURRENT YEAR'/
                    1 1X,5(12HAGE PERCENT  )/)
ISN 0357      12600 FORMAT (/,' SIZE OF POPULATION (YEAR CLASSES 1-13) FOR THE', /,
                    1 ' CURRENT YEAR AS A PERCENTAGE OF THE SIZE OF THE ', /,
                    1 ' POPULATION IN YEAR ZERO...', F6.3)
ISN 0358      12700 FORMAT(//' REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT...',F9.0/
                    1  ' % REDUCTION IN NUMBER OF YEARLINGS DUE TO PLANT...',F5.2/
                    1 ' REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT...',F9.0/
                    1 ' % REDUCTION IN TOTAL NUMBER OF ADULTS DUE TO PLANT...',F5.2)
ISN 0359      12800 FORMAT (/,' NUMBER OF EGGS EXPECTED TO BE PRODUCED BY',
                    1 /,' THE NUMBER OF ONE-YEAR OLD STRIPED BASS FOR THE CURRENT',
                    1 /,' YEAR DURING THEIR LIFE TIME AS A PERCENTAGE OF THE NUMBER',
                    1 /,' OF EGGS PRODUCED IN YEAR ZERO.....',F6.3//)
ISN 0360      12900 FORMAT(//' END HISTG........')
ISN 0361      13000 FORMAT(///, '****************************************')
ISN 0362      13100 FORMAT(1H1,' TRACING LIFE HISTORY OF STRIPED BASS FISH ', /,
                    1 ' IN HUDSON RIVER, WITH MORTALITY IN EACH ',/,
                    1 ' STAGE GIVEN BY:',// 5X,
                    1 ' D(NX)/DT=-(KX+(KX-KX0)*((NX-YS)/YS)**3)*NX')
ISN 0363      13200 FORMAT(16X,'-FKILL*QP*NX/V',//,' WHERE, QP(MI**3/DAY)= ', E10.4,/,
                    1  ' WHICH IS EQUIVALENT TO AN INTAKE FLOW OF... ',E10.4,'(CFS)',/,
                    1  7X,'V(MI**3)= ',E10.4// 2X,
```

```
                1 'FRACTIONAL KILL (I.E., COMPOSITE F-FACTOR) FOR:',/ 2X,
                1 ' EGGS                ',F10.4/ 2X,' LARVAE               ',F10.4/ 2X,
                1 ' JUVENILE 1          ',F10.4/ 2X,' JUVENILE 2           ',F10.4/ 2X,
                1 ' JUVENILE 3          ',F10.4)
ISN 0364   13300 FORMAT(//,' KX(1/DAY)= ',E20.10,/,' KXO(1/DAY)= ',
                1 E20.10,/,' YS(NUMBER)= ',E20.10,/,' LIFE PERIOD(DAY)= ',
                1 F10.4,/,
                1 ' RATIO OF THE KX VALUE USED IN THIS RUN TO THE "STANDARD" KX',
                1 ' VALUE GIVEN ABOVE = ',F6.3,/,
                1 ' RATIO OF THE KXO VALUE USED IN THIS RUN TO THE KX VALUE',
                1 ' USED IN THIS RUN = ',F6.3,/,
                1 ' RATIO OF THE YS VALUE USED IN THIS RUN TO THE "STANDARD" YS',
                1 ' VALUE GIVEN ABOVE = ',F6.3,/,
                1 ' LEFT LIMB OF COMPENSATION FUNCTION DISABLED...',A6,/,
                1 ' RIGHT LIMB OF COMPENSATION FUNCTION DISABLED...',A6,/)
ISN 0365   13400 FORMAT (///,T10,'AGE',T15,'DECAY COEFF.',T31,'SEX RATIO',T45,
                1 'FRACTION',T60,'FECUNDITY',/, T17,'(1/DAY)',T31,'(FEM/TOT)',T46,
                1 'MATURE',T58,'(EGGS/FEMALE)',/)
ISN 0366   13500 FORMAT (T10,I2,T15,F10.6,T33,F4.2,T47,F4.2,T58,E12.4)
ISN 0367   13600 FORMAT(//' ANNUAL PROBABILITY OF SURVIVAL FOR ADULTS (4-13) = ',
                1 F5.3)
ISN 0368   13700 FORMAT (1H1,20X,'STOCK RECRUITMENT TABLE'//
                1 ' DEFINITIONS OF COLUMN HEADINGS'/
                1 ' I = YEAR + 1'/
                1 ' S(I) = NUMBER OF SPAWNERS'/
                1 ' R(I) = NUMBER OF RECRUITS (3-YEAR OLDS)'/
                1 ' R3(I) = NUMBER OF RECRUITS AT I+3 SPAWNED AT I'/
                1 ' R3S(I) = RECRUITMENT RATE (RECRUITS PER SPAWNER)'/
                1 ' SR(I) = NUMBER OF SPAWNERS RELATIVE TO NUMBER OF SPAWNERS',
                1 ' AT I=1'/
                1 ' RR(I) = NUMBER OF RECRUITS RELATIVE TO NUMBER OF RECRUITS',
                1 ' AT I=1'/
                1 ' R3R(I) = NUMBER OF RECRUITS AT I+3 RELATIVE TO THE NUMBER OF',
                1 ' RECRUITS AT I=4 (R3(I)/R3(1))'/
                1 ' R3RSR(I) = RELATIVE RECRUITMENT RATE (R3R(I)/SR(I))'//
                1 T4,'I',T10,'S(I)',T20,'R(I)',T30,'R3(I)',T40,'R3S(I)',T60,
                1 'SR(I)',T70,'RR(I)',T80,'R3R(I)',T90,'R3RSR(I)'//)
ISN 0369   13800 FORMAT (T2,I3,T7,F8.0,T17,F8.0,T27,F8.0,T37,F8.4,T57,F8.4, T67,
                1 F8.4,T77,F8.4,T87,F8.4)
ISN 0370   13900 FORMAT(' NO. ADULT AGE CLASSES - ',I2/ ' MODEL SIMULATES - ',I3,
                1 1X,'YEARS'/ ' PLANT OPERATING...',A6/ ' FOR ..............',I3,
                1 ' YEARS.')
ISN 0371   14000 FORMAT (//' MODEL TIME STEP SIZE (DAYS)'/ 4X,'EGG',5X,'LARV',5X,
                1 'JUV1',5X,'JUV2',5X,'JUV3'/ 5(3X,F4.2,2X)/)
ISN 0372   14100 FORMAT(//' TOTAL PRODUCTION PERIOD (DAYS) = ',F3.0/
                1 ' SUBPRODUCTION PERIODS AND ASSOCIATED FRACTIONS OF TOTAL EGG',
                1 ' PRODUCTION'/
                1 T5,'PERIOD (DAY)',T20,'FRACTION')
ISN 0373   14200 FORMAT (T5,2(1X,F4.1),T22,F6.4)
ISN 0374         END
```

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                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

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
        0328 0328 0328
J       0014 0059 0059 0059 0060 0060 0060 0061 0061 0061 0070 0070 0070 0071 0071 0071 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 0292 0300 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
EZ      0021 0298 0301 0301 0303
IK      0015 0041 0078
IN      0015 0079 0080 0082 0098 0100 0102 0173 0190 0205 0213 0215 0219 0280 0282 0284 0286 0288 0290
        0292 0294 0296 0305 0315
IQ      0015 0155 0156 0158 0159 0164 0166 0167
IX      0015 0130 0134 0134 0135
JJ      0015 0052 0052 0052 0057 0057 0057 0166 0168
KX      0003 0012 0087 0095 0095 0096 0102 0207 0209
LL      0015 0147 0149 0151
MM      0015 0106 0110 0157 0161 0162 0163 0163
NN      0004 0041 0050 0052 0061 0063 0067 0102 0102 0233 0235 0237 0326 0328
NO      0011 0013 0031 0089 0090
NX      0005 0012
QP      0004 0042 0046 0052 0307
RR      0010 0020 0322 0328
RO      0021 0231
R3      0010 0020 0319 0320 0323 0323 0328
SM      0021 0304 0305
SP      0021 0260 0262 0262 0266 0267 0268 0273 0275 0278 0284
SR      0010 0020 0321 0324 0328
TE      0004 0057 0063
TF      0021 0040
YS      0003 0087 0097 0097 0102 0199
YY      0007 0035 0136 0137 0138 0150 0152 0161 0161 0162 0167 0169 0181 0196 0226
ABS     0122 0123
AKX     0003 0088 0095 0102
APS     0232 0233
AUX     0005
AVG     0022 0133 0136 0136 0138 0148 0150 0150 0152
AYS     0003 0088 0097 0102
DCY     0002 0070
DTE     0003 0087 0102 0106 0108 0108 0222
EXP     0232 0242 0248 0301
FBC     0002 0073 0237 0255
IAD     0016 0142 0143 0145 0147 0152
IBN     0016 0041
```

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

SYMBOL   INTERNAL STATEMENT NUMBERS
IP1      0030  0036  0041  0042  0043  0057  0059  0060  0070  0071  0072  0073  0074  0086  0087  0088
III      0016  0110  0112
IPL      0016  0043  0048  0307
IPT      0016  0108  0110  0112  0114  0114  0114  0116  0116  0118  0131  0131
IST      0016  0041
ISW      0004  0036  0038  0044  0044  0307
IVY      0016  0156  0161
IX1      0246  0247
IYR      0016  0056  0078  0082  0082  0084  0098  0100  0102  0173  0185  0190  0201  0205  0213  0215  0219  0229  0252
         0263  0270  0280  0282  0284  0286  0288  0290  0292  0294  0296  0305  0307  0309  0311  0311
KXO      0003  0012  0096  0102
LPT      0016  0118
LYR      0016  0036  0037  0037  0044  0044  0048  0309  0317
MOD      0078
NXO      0012  0022  0077  0173  0226  0231  0239  0249  0304
OP1      0027  0028  0047  0048  0049  0082  0098  0100  0102  0190  0280  0282  0284  0286  0288  0290  0292  0294  0296
         0305  0315
OP2      0027  0029  0050  0052  0063  0067  0235  0237
PAD      0006  0026  0267  0274  0288
REF      0009  0022  0185  0187  0188  0201  0203  0204  0240  0276  0277
RSF      0008  0026  0231  0303
R3R      0010  0020  0323  0324  0328
R3S      0010  0020  0320  0328
SPE      0022  0268  0274  0275  0278  0279
SSF      0022  0255  0259
TIM      0006  0032  0033  0059  0,067 0067  0076  0224
YES      0011  0013  0038  0091  0093
AKXO     0003  0088  0096  0102
ASUM     0009  0023  0104  0127  0155
CHAR     0009  0086  0100
DCYU     0008  0026  0231  0232  0237  0242  0248  0301
IABS     0114
IEND     0004  0036  0048  0070  0071  0072  0073  0237  0241  0246  0247  0254  0261  0265  0272  0282  0288  0292  0300
ISKP     0004  0036
ISW1     0011  0031  0038  0048
KSTP     0004  0036
KSWT     0017  0054  0154  0176  0179
KTYO     0017  0132  0141  0145  0157  0158  0171  0173  0180  0195
LYR1     0317  0318  0328
NMAX     0012  0023  0173  0190  0199  0205
NTOT     0012  0023  0193  0198  0200  0201  0203  0205  0207  0209
PADE     0006  0026  0266  0273  0292
PSPP     0023  0275  0294
RATE     0023  0183  0190  0198  0205
SIGN     0108
SMAT     0002  0072  0237  0255  0256
SRAT     0002  0071  0237  0255  0256
SUMA     0023  0299  0303  0303  0304
SURV     0023  0242  0243
TEND     0023  0036  0040
TIMW     0006  0060  0067  0076
TOT1     0023  0178  0181  0181  0183  0184  0190  0193  0194  0196  0196  0198  0200  0205  0207  0209
ADULT    0008  0026  0231  0239  0240  0243  0243  0248  0248  0249  0255  0256  0258  0262  0266  0267  0273  0274  0276
         0282
COMPS    0184  0200  0200  0217  0219
```

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                         *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

SYMBOL  INTERNAL STATEMENT NUMBERS
DNXDT   0005
EQUAL   0231
FKILL   0003  CC43  0052
FLOAT   0131  0131
FRACT   0024  0076  0077
IKTYO   0018  0158  0159  0160  0164  0171
ILEFT   C003  C088  0091
IMPJ2   0012  0207  0211  0213
IMPJ3   0012  0209  0211  0215
ITEST   0018  0078  0080
JLEFT   0009  C011  0089  C091  0102
KSPAN   0018  0065  0C66
NSPAN   0018  0059  0059  0060  0065  0224
PNDAY   0009  0024  0074  0122  0122  0142
PTIME   0024  C075  0173  0222  0222  0224  0224  0313
QPCPS   0046  0052
RMRSR   0010  0020  0324  0328
SPAWN   0256  C257
YEAR1   0217  C219
ADULTS  0008  0026  0231
CHAGNT  0278  C279  0296
CHAGN1  0276  0277  0296
CHAGPT  C279  C296
CHAGP1  0277  0296
CHANGN  0187  0188  0190  0203  0204  0205
CHANGP  0188  0190  0204  0205
GROWTH  0173
IMPTOT  0012  0211  0215
INCRMT  0019  0127  0128  0131  0132  0134
IRIGHT  0003  0088  0093
ISTAGE  0019  C055  0086  0087  0087  0087  0088  0088  0C88  0C88  0088  0089  0090  0091  0091  0093  0093  0095  0095
        0095  0096  0096  0096  0097  0097  0097  0100  0100  0102  0102  0102  0102  0102  0102  0102  0102  0102  0104
        0104  0104  0104  0106  0106  0108  01C8  0108  0110  0116  0120  0120  0122  0122  0123  0123  0127  0142  0142
        0155  C173  0174  0185  0187  0188  C199  0201  0203  0204  0207  0207  0209  0209  0211  0213  0213  0215  0215
        0217  0219  0219  0222  0223  0223  C224  0227  0312
JRIGHT  0009  0011  0090  0093  0102
KFIRST  0118
KPLANT  0012  C173  0207  0207  0209  0209
NMAXYS  0012  0025  0189  0190  0199  0205
PEQUAL  0025  0058  0231  0304
ISTART  0025  0036  0040
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

| 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 | | |

```
        COMPILER OPTIONS - NAME=   MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,XREF
              CGROW
              C...
              C...SUBROUTINE GROWTH CALCUIATES THE GROWTH OF EACH YOUNG OF THE
              C...YEAR LIFE STAGE. IT IS CALLED BY MAIN ONCE FOR EACH LIFE STAGE.
              C...
ISN 0002            SUBROUTINE GROWTH (IN,ISTAGE,IYR,KTYO,NXO,NMAX,PTIME,KPLANT)
ISN 0003            COMMON/LSTAGE/AKX(5),AKXO(5),AYS(5),DE(5),DTE(5),FKILL(5),ILEFT(5)
                   1  ,IRIGHT(5),KX(5),KXO(5),YS(5)
ISN 0004            COMMON/PAR/IEND,ISKP,ISW,KSTP,NN,P,QP,TE,V
ISN 0005            COMMON /RKTTA/ NX,DNXDT
ISN 0006            COMMON/WGHT/TIM(10),TIMW(10)
ISN 0007            COMMON/WYY/W(5000),YY(5000)
ISN 0008            REAL NXO,NX,KX,KXO,KNATL,KPLANT,KTOTAL,NMAX
ISN 0009            INTEGER OP1
              C
              C       INITIALIZATION
              C
ISN 0010            IND = 0
ISN 0011            KOUNTY = 0
ISN 0012            NDT = 0
ISN 0013            NMAX = 0.
ISN 0014            OLDNX = 0.
ISN 0015            T = 0.
ISN 0016            YYY = 0.
ISN 0017            OP1=6
ISN 0018            ISTP=KSTP
ISN 0019            J4=2
ISN 0020            ISTART=2
ISN 0021            W(1)=1.
ISN 0022            IS = ISTAGE
ISN 0023            PTIME = PTIME + DTE(IS) + TE
ISN 0024            TT=PTIME+T
ISN 0025            NX=NXO
ISN 0026            KOUNTX=1
ISN 0027            IF (ISKP.EQ.1.AND.IN.EQ.1.OR.ISKP.EQ.1.AND.IYR.EQ.1) WRITE(OP1,
                   1 10000)
ISN 0029            IF (ISKP.EQ.1.AND.IN.EQ.1.OR.ISKP.EQ.1.AND.IYR.EQ.1) WRITE(OP1,
                   1 10100) TT,OLDNX,YYY,NXO,NX
ISN 0031         10 IF (ISTAGE.EQ.5) GO TO 40
ISN 0033            IF (NX.GT.NMAX) NMAX = NX
              C...
              C...CALL SUBROUTINE DELTA.
              C...
ISN 0035            CALL DELTA (1,IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,PST)
ISN 0036            NDT=NDT+1
ISN 0037            TT = PTIME + NDT*DE(IS)
ISN 0038            OLDNX=NX
              C
              C       COMPUTE GROWTH HISTORY OF PRESENT STAGE AND
              C       RECORD HISTORY OF NEXT-STAGE INPUT IMPULSES..
              C
ISN 0039            IF (T+0.001+DE(IS).GE.TE) GO TO 30
ISN 0041            IF (T+0.001+DE(IS).GE.DTE(IS)) GO TO 20
ISN 0043            KOUNTX=KOUNTX+1
ISN 0044            IF (ISTAGE.NE.1) NXO=YY(KOUNTX)
              C ***** A---ONLY PRODUCTION OCCURS
```

```
ISN 0046          NX=NX+NXO
ISN 0047          YYY=0.
ISN 0048          GO TO 100
            C ***** B---PRODUCTION AND TRANSFER OCCUR
ISN 0049       20 KOUNTY=KOUNTY+1
ISN 0050          IF (ISTAGE.NE.1) NXO=YY(KOUNTX+KOUNTY)
ISN 0052          YY(KOUNTY)=NX*W(KOUNTX)
ISN 0053          NX=NX-YY(KOUNTY)+NXO
ISN 0054          YYY=YY(KOUNTY)
ISN 0055          GO TO 100
            C ***** C---ONLY TRANSFER OCCURS
ISN 0056       30 KOUNTY=KOUNTY+1
ISN 0057          NXO=0.
ISN 0058          IF (ISTAGE.NE.1) NXO=YY(KOUNTX+KOUNTY)
            C          FROM JUVENILE II STAGE ON, NO TRANSFER EXCEPT SURVIVAL...
ISN 0060       40 IF (ISTAGE.LT.4) GO TO 90
ISN 0062          IF (NX.GT.NMAX) NMAX = NX
ISN 0064          NXO=0.
ISN 0065          NDT=0
ISN 0066          YYY=0.
ISN 0067       50 BUF=0.
ISN 0068          IF (YS(IS).LT.1.) GO TO 60
ISN 0070          BUF = (KX(IS)-KXO(IS))*((NX-YS(IS))/YS(IS))**3
ISN 0071          IF (NX.LT.YS(IS).AND.ILEFT(IS).EQ.1) BUF = 0.
ISN 0073          IF (NX.GT.YS(IS).AND.IRIGHT(IS).EQ.1) BUF = 0.
ISN 0075       60 KNATL = KX(IS) + BUF
ISN 0076          KPLANT = ISW*FKILL(IS)*QP/V
ISN 0077          IF (IYR.EQ.0) KPLANT = 0.
ISN 0079          KTOTAL = KNATL + KPLANT
ISN 0080          RATIO = KPLANT/KTOTAL
ISN 0081          PSN = EXP(-KNATL*DTE(IS))
ISN 0082          PSP = EXP(-KPLANT*DTE(IS))
ISN 0083          PST = EXP(-KTOTAL*DTE(IS))
ISN 0084          OLDNX=NX
ISN 0085          NX = NX*EXP(-KTOTAL*DE(IS))
ISN 0086          NDT=NDT+1
ISN 0087          T = TT + NDT*DE(IS)
ISN 0088          IF (T.GE.FTIME.OR.T.GT.365.) GO TO 70
ISN 0090          IF (MOD(NDT,ISTP).GT.0) GO TO 50
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,NXO,NX, KNATL,KPLANT,RATIO,PSN,PSP,PST
ISN 0094          GO TO 50
ISN 0095       70 NXO=NX
ISN 0096          YY(1)=NX
ISN 0097          DO 80 J=2,5000
ISN 0098       80    YY(J)=0.
ISN 0099          RETURN
ISN 0100       90 IF (IND.EQ.0) ISTART=1
ISN 0102          IND=1
ISN 0103          YY(KOUNTY)=NX*W(KOUNTX)
ISN 0104          NX=NX-YY(KOUNTY)
ISN 0105          YYY=YY(KOUNTY)
ISN 0106          ISTART=ISTART+1
ISN 0107      100 IF (MOD(NDT,ISTP).GT.0) GO TO 110
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,NXO,NX, KNATL,KPLANT,RATIO,PSN,PSP,PST
ISN 0111      110 IF (ISTAGE.GE.4) GO TO 130
ISN 0113          SUM=0.
```

```
ISN 0114          DO 120 I=ISTART,KOUNTX
ISN 0115             II=KOUNTX+ISTART-I
ISN 0116             W(II)=0.
ISN 0117             IF (NX.EQ.0.) GO TO 120
ISN 0119             W(II)=OLDNX*W(II-1)/NX
ISN 0120             SUM=SUM+W(II)
ISN 0121      120    CONTINUE
ISN 0122          W(ISTART-1)=1.-SUM
ISN 0123      130 IF (TT.GE.FTIME) GO TO 140
ISN 0125          T = NDT*DE(IS)
ISN 0126          IF (ISTAGE.NE.1) GO TO 10
ISN 0128          AA=ABS(T-TIM(J4))
ISN 0129          IF (AA.GT.0.001) GO TO 10
ISN 0131          NXO = P*DE(IS)*TIMW(J4)/(TIM(J4+1)-TIM(J4))
ISN 0132          J4=J4+1
ISN 0133          GO TO 10
            C
            C       QUIT FOR EXIT
            C
ISN 0134      140 IF (ISTAGE.EQ.1) GO TO 160
            C       ZERO UNUSED PART OF YY(I) TO SHOW NO PRODUCTION THEREON
ISN 0136          KTY1=KOUNTY+1
ISN 0137          DO 150 I=KTY1,KTYO
ISN 0138      150    YY(I)=0.
            C       STORE # OF ELEMENTS USED IN YY(I)
ISN 0139      160 KTYO=KOUNTY+1
ISN 0140          RETURN
ISN 0141    10000 FORMAT(//,T4,'TIME( )',T15,'POPULATION(-)',T30,'TRANSFER',T45,
                 1 'PRODUCTION',T60,'POPULATION(+)',T75,'KNATL',T85,'KPLANT',T95,
                 1 'RATIO',T105,'PSN',T115,'ESP',T125,'PST'/)
ISN 0142    10100 FORMAT (T4,F6.2,T15,E9.4,T30,E9.4,T45,E9.4,T60,E9.4,T75, E9.4,T85,
                 1  E9.4,T95,F6.4,T105,F6.4,T115,F6.4,T125,F6.4)
ISN 0143          END
```

```
                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

SYMBOL  INTERNAL STATEMENT NUMBERS
I       0114  0115  0137  0138
J       0097  0098
P       0004  0131
T       0015  0024  0039  0041  0087  0088  0088  0092  0125  0128
V       0004  0076
W       0007  0021  0052  0103  0116  0119  0119  0120  0122
AA      0128  0129
DE      0003  0037  0039  0041  0085  0087  0125  0131
II      0115  0116  0119  0119  0120
IN      0002  0027  0029  0035  0092  0109
IS      0022  0023  0037  0039  0041  0041  0068  0070  0070  0070  0070  0071  0071  0073  0073  0075  0076  0081  0082
        0083  0085  0087  0125  0131
JM      0019  0128  0131  0131  0131  0132  0132
KX      0003  0008  0070  0075
NN      0004
NX      0005  0008  0025  0029  0033  0033  0038  0046  0046  0052  0053  0053  0062  0062  0070  0071  0073  0084  0085
        0085  0092  0095  0096  0103  0104  0104  0109  0117  0119
QP      0004  0076
TE      0004  0023  0039
TT      0024  0029  0037  0087  0109  0123
YS      0003  0068  0070  0070  0071  0073
YY      0007  0044  0050  0052  0053  0054  0058  0096  0098  0103  0104  0105  0138
ABS     0126
AKX     0003
AYS     0003
BUF     0067  0070  0071  0073  0075
DYE     0003  0023  0041  0081  0082  0083
EXP     0081  0082  0083  0085
IND     0010  0100  0102
ISW     0004  0076
IYR     0002  0027  0029  0035  0077  0092  0109
KXO     0003  0008  0070
MOD     0090  0107
NDT     0012  0036  0036  0037  0065  0086  0086  0087  0090  0107  0125
NXO     0002  0008  0025  0029  0044  0046  0050  0053  0057  0058  0064  0092  0095  0109  0131
OP1     0009  0017  0027  0029  0092  0109
PSM     0035  0081  0092  0109
PSP     0035  0082  0092  0109
PST     0035  0083  0092  0109
SUM     0113  0120  0120  0122
TIM     0006  0128  0131  0131
TYY     0016  0029  0047  0054  0066  0092  0105  0109
AKXO    0003
IEND    0004
ISKP    0004  0027  0027  0029  0029  0092  0092  0109  0109
ISTP    0018  0090  0107
NSTP    0004  0018
KTYO    0002  0137  0139
KTY1    0136  0137
NMAX    0002  0008  0013  0033  0033  0062  0062
TIMW    0006  0131
DELTA   0035
DMXDF   0005
FKILL   0003  0076
FTIME   0023  0088  0123
JLEFT   0003  0071
KHATL   0008  0035  0075  0079  0081  0092  0109
```

*****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

| SYMBOL | INTERNAL STATEMENT NUMBERS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| OLDNX | 0014 | 0029 | 0038 | 0084 | 0092 | 0109 | 0119 | | | | | | | |
| PTIME | 0002 | 0023 | 0024 | 0037 | | | | | | | | | | |
| RATIO | 0035 | 0080 | 0092 | 0109 | | | | | | | | | | |
| GROWTH | 0002 | | | | | | | | | | | | | |
| IRIGHT | 0003 | 0073 | | | | | | | | | | | | |
| ISTAGE | 0002 | 0022 | 0031 | 0035 | 0044 | 0050 | 0058 | 0060 | 0111 | 0126 | 0134 | | | |
| ISTART | 0020 | 0100 | 0106 | 0106 | 0114 | 0115 | 0122 | | | | | | | |
| KOUNTX | 0026 | 0043 | 0043 | 0044 | 0050 | 0052 | 0058 | 0103 | 0114 | 0115 | | | | |
| KOUNTY | 0011 | 0049 | 0049 | 0050 | 0052 | 0053 | 0054 | 0056 | 0056 | 0058 | 0103 | 0104 | 0105 | 0136 | 0139 |
| KPLANT | 0002 | 0008 | 0035 | 0076 | 0077 | 0079 | 0080 | 0082 | 0092 | 0109 | | | | |
| KTOTAL | 0008 | 0079 | 0080 | 0083 | 0085 | | | | | | | | | |

| LABEL | DEFINED | 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 |

```
          COMPIIER OPTIONS - NAME=   MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                                SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,XREF
                  CDELT
                  C...
                  C...SUBROUTINE DELTA IS THE RUNGE KUTTA EQUATIONS USED TO ADVANCE
                  C...ONE TIME STEP FOR THE SPECIFIED LIFE STAGE. IT IS CALLED BY
                  C...SUBROUTINE GROWTH. SUBROUTINE DELTA CALLS SUBROUTINE FUNC AT
                  C...FOUR POINTS.
                  C...
ISN 0002                SUBROUTINE DELTA(NDIM,IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,
                       1 PST)
ISN 0003                COMMON/LSTAGE/AKX(5),AKX0(5),AYS(5),DE(5),DTE(5),FKILL(5),ILEFT(5)
                       1  ,IRIGHT(5),KX(5),KX0(5),YS(5)
ISN 0004                COMMON /RKTTA/Y(1),DERY(1),AUX(16,1)
ISN 0005                REAL KNATL,KPLANT
                  C THIS ROUTINE PERFORMS THE RUNGE KUTTA CALCULATIONS.
ISN 0006                H = DE(ISTAGE)
ISN 0007                CALL FUNC (IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,PST)
ISN 0008                DO 10 I=1,NDIM
ISN 0009                   AUX(1,I)=Y(I)
ISN 0010             10    AUX(8,I)=DERY(I)
ISN 0011             20 CONTINUE
                  C RUNGE-KUTTA EQUATIONS FOLLOW
ISN 0012             30 DO 40 I=1,NDIM
ISN 0013                   Z=H*AUX(8,I)
ISN 0014                   AUX(5,I)=Z
ISN 0015                   Y(I)=AUX(1,I)+.4*Z
ISN 0016                   IF (Y(I).LT.0.) Y(I)=0.
ISN 0018             40    CONTINUE
                  C     Z=X+.4*H
ISN 0019                CALL FUNC (IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,PST)
ISN 0020                DO 50 I=1,NDIM
ISN 0021                   Z=H*DERY(I)
ISN 0022                   AUX(6,I)=Z
ISN 0023                   Y(I)=AUX(1,I)+.2969776*AUX(5,I)+.1587596*Z
ISN 0024                   IF (Y(I).LT.0.) Y(I)=0.
ISN 0026             50    CONTINUE
                  C
                  C     Z=X+.4557372*H
ISN 0027                CALL FUNC (IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,PST)
ISN 0028                DO 60 I=1,NDIM
ISN 0029                   Z=H*DERY(I)
ISN 0030                   AUX(7,I)=Z
ISN 0031                   Y(I)=AUX(1,I)+.2181004*AUX(5,I)-3.050965*AUX(6,I) +3.832865*Z
ISN 0032                   IF (Y(I).LT.0.) Y(I)=0.
ISN 0034             60    CONTINUE
                  C     Z=X+H
ISN 0035                CALL FUNC (IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,PST)
ISN 0036                DO 70 I=1,NDIM
ISN 0037                   Y(I)=AUX(1,I)+.1747603*AUX(5,I)-.5514807*AUX(6,I) +1.205536*
                       1    AUX(7,I)+.1711848*H*DERY(I)
ISN 0038                   IF (Y(I).LT.0.) Y(I)=0.
ISN 0040             70    CONTINUE
ISN 0041             80 RETURN
ISN 0042                END
```

```
                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

SYMBOL  INTERNAL STATEMENT NUMBERS
H       0006 0013 0021 0029 0037
I       0008 C009 0009 0010 0010 0012 0013 0014 0C15 0C15 0016 0016 0020 0021 0022 0023 C023 0023 0024
        0024 0028 0029 003C 0031 0031 0031 0031 0C32 0C32 0036 0037 0037 0037 0037 0037 0037 0038 0038
Y       0004 0009 0015 0016 0016 0023 0024 0024 0031 0032 0032 0037 0038 0038
Z       0013 C014 0015 0021 0022 0023 0029 0030 0031
DB      0003 0006
IN      0002 0007 0019 0027 0035
KX      0003
YS      0003
AKX     0003
AUX     0004 0009 0010 0013 0014 0015 0022 0023 0023 0C30 0031 0031 0031 0037 0037 0037 C037
AYS     0003
DTE     0003
IYR     0002 0007 0019 0027 0035
KXO     0003
PSN     0002 0007 0019 0027 0035
PSP     0002 C007 0019 0027 0035
PST     0002 0007 0019 0027 0035
AKXO    0003
DERY    0004 0010 0021 0029 0037
FUNC    0007 C019 0027 0035
NDIM    0002 0008 0012 0020 0028 0036
DELTA   0002
FKILL   0003
ILEFT   0003
KMATL   0002 0005 0007 0019 0027 0035
RATIO   0002 0007 0019 0027 0035
IRIGHT  0003
ISTAGE  0002 C006 0007 0019 0027 0035
KPLANT  0002 0005 0007 0019 0C27 0035
```

| 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,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,XREF
              CFUNC
              C...
              C...SUBROUTINE FUNC CALCULATES THE CHANGE IN STANDING CROP FOR
              C...THE SPECIFIED LIFE STAGE DUE TO NATURAL MORTALITY AND, IF THE
              C...POWER PLANT IS "ON" IN THE MODEL, DUE TO PLANT MORTALITY.
              C...
ISN 0002            SUBROUTINE FUNC(IN,ISTAGE,IYR,KNATL,KPLANT,RATIO,PSN,PSP,PST)
ISN 0003            COMMON/ISTAGE/AKX(5),AKXO(5),AYS(5),DE(5),DTE(5),FKILL(5),ILEFT(5)
                  1  ,IRIGHT(5),KX(5),KXO(5),YS(5)
ISN 0004            COMMON/PAR/IEND,ISKP,ISW,KSTP,NN,F,QP,TE,V
ISN 0005            COMMON /BKTTA/ NX,DNXDT
ISN 0006            REAL KNATL,KPLANT,KTOTAL
ISN 0007            REAL KX,KXO,NX
ISN 0008            IS = ISTAGE
ISN 0009            BUF = 0.
ISN 0010            IF (YS(IS).LT.1.) GO TO 10
ISN 0012            BUF = (KX(IS)-KXO(IS))*((NX-YS(IS))/YS(IS))**3
ISN 0013            IF (NX.LT.YS(IS).AND.ILEFT(IS).EQ.1) BUF = 0.
ISN 0015            IF (NX.GT.YS(IS).AND.IRIGHT(IS).EQ.1) BUF = 0.
ISN 0017         10 KNATL = KX(IS) + BUF
ISN 0018            KPLANT = ISW*FKILL(IS)*QP/V
ISN 0019            IF (IYR.EQ.0) KPLANT = 0.
ISN 0021            KTOTAL = KNATL + KPLANT
ISN 0022            RATIO = KPLANT/KTOTAL
ISN 0023            PSN = EXP(-KNATL*DTE(IS))
ISN 0024            PSP = EXP(-KPLANT*DTE(IS))
ISN 0025            PST = EXP(-KTOTAL*DTE(IS))
ISN 0026            DNXDT = -KTOTAL*NX
ISN 0027            RETURN
ISN 0028            END
```

```
                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

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
NX      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
ISKP    0004
KSTP    0004
DNXDT   0005  0026
FKILL   0003  0018
ILEFT   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 |

```
COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,NOID,XREF
          CEQUA
          C...
          C...SUBROUTINE EQUAL CALCULATES A FIRST ORDER MORTALITY RATE
          C...COEFFICIENT FOR ADULT CLASSES 4-13 FOR YEAR ZERO. THIS
          C...CALCULATION IS DONE USING A NEWTON RHAPHSON TECHNIQUE AND
          C...IS DESIGNED TO GENERATE AN ADULT AGE DISTRIBUTION THAT WILL
          C...PRODUCTION THE SAME NUMBER OF EGGS AS SPECIFIED BY ONE OF
          C...THE INPUT PARAMETERS.
          C...
ISN 0002        SUBROUTINE EQUAL (ADULT,ADULTS,DCYU,NEO,PEQUAL,RMF,R0)
ISN 0003        COMMON/ADULTT/DCY(20),FEC(20),SRAT(20),SMAT(20)
ISN 0004        COMMON/PAR/IEND,ISKP,ISW,KSTP,NN,P,QP,TE,V
ISN 0005        DIMENSION ADULT(20),ADULTS(20),DCYU(20),RMF(20)
ISN 0006        REAL NEO,NS,K0,KN
ISN 0007        DO 10 K=1,3
ISN 0008     10    DCYU(K)=DCY(K)
ISN 0009        R0=PEQUAL/NEO
ISN 0010        DO 20 K=1,IEND
ISN 0011     20    RMF(K)=SRAT(K)*SMAT(K)*FEC(K)
ISN 0012        S1=RMF(1)
ISN 0013        AXP=1.
ISN 0014        DO 30 K=2,4
ISN 0015           AXP=AXP*EXP(-DCYU(K-1)*365.)
ISN 0016     30    S1=S1+RMF(K)*AXP
ISN 0017        D=(R0-S1)/AXP
ISN 0018        WRITE(12,10000)
ISN 0019        WRITE(12,10100)R0,S1,AXP,D
ISN 0020        DTEST=.1E-7
ISN 0021        ITERX=20
ISN 0022        ITER=1
ISN 0023        K0=1.89903E-3
          C...
          C...START ITERATION LOOP
          C...
ISN 0024     40 FPK=0.
ISN 0025        FK=D
ISN 0026        PX=1.
ISN 0027        DO 50 K=5,IEND
ISN 0028           AK=K
ISN 0029           PX=EXP(-K0*(AK-4.)*365.)
ISN 0030           FK=FK-RMF(K)*PX
ISN 0031     50    FPK=FPK+365.*(AK-4.)*RMF(K)*PX
ISN 0032        QUOT=FK/FPK
ISN 0033        KN=K0-QUOT
ISN 0034        DF=ABS(KN-K0)
ISN 0035        WRITE(12,10200)K0,KN,DF,ITER
ISN 0036        ITER=ITER+1
ISN 0037        IF (ITER.EQ.ITERX) GO TO 60
ISN 0039        IF (DF.LE.DTEST) GO TO 60
ISN 0041        IF (KN.LT.0.) KN=.5*K0
ISN 0043        K0=KN
ISN 0044        GO TO 40
ISN 0045     60 KK=4
ISN 0046        DO 70 K=KK,IEND
ISN 0047     70    DCYU(K)=KN
ISN 0048        WRITE(12,10200)K0,KN,DF,ITER
```

```
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 YEAR 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
```

```
                    *****F O R T R A N   C R O S S   R E F E R E N C E   L I S T I N G*****

SYMBOL  INTERNAL STATEMENT NUMBERS
D       0017  0019  0025
K       0007  0008  0008  0010  0011  0011  0011  0011  0014  0015  0016  0027  0028  0030  0031  0046  0047
P       0004
V       0004
AK      0028  0029  0031
DF      0034  0035  0039  0048
FK      0025  0030  0030  0032
KK      0045  0046
KN      0006  0033  0034  0035  0041  0041  0043  0047  0048
KO      0006  0023  0029  0033  0034  0035  0041  0043  0048
NN      0004
NS      C006
PK      0026  0029  0030  0031
QP      0004
RO      0002  0009  0017  0019
S1      0012  0016  0016  0017  0019
TE      0004
ABS     0034
AXP     0013  0015  0015  0016  0017  0019
DCY     0003  C008
EXP     0015  0029
FBC     0003  0011
FPK     0024  0031  0031  0032
ISM     C004
NBO     0002  0006  0009
NMP     0002  0005  0011  0012  0016  0030  0031
DCYU    0002  0005  0C08  0015  0047
ISND    0004  C010  0027  0046
ISKP    0004
ITER    0022  0035  0036  0036  0037  0048
KSTP    0004
QUOT    C032  0033
SMAT    0003  0011
SRAT    0003  0011
ADULT   0002  0005
DTEST   002C  0039
EQUAL   0002
ITERX   0021  0037
ADULTS  0002  0005
PEQUAL  C002  0009
```

| LABEL | DEFINED | 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   .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
```

# APPENDIX C
# OUTPUT FROM SAMPLE RUN

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

STAGE 1 EGG STAGE

KX(1/DAY)= 0.1150999069E 01
KXO(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 KXO 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

| 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 | .2952E 10 | .1151E 01 | .0 | 0.0 | 0.1001 | 1.0000 | 0.1001 |
| 18.00 | .2345E 10 | .6750E 08 | .6746E 09 | .2952E 10 | .1151E 01 | .0 | 0.0 | 0.1001 | 1.0000 | 0.1001 |
| 20.00 | .2345E 10 | .6750E 08 | .6746E 09 | .2952E 10 | .1151E 01 | .0 | 0.0 | 0.1001 | 1.0000 | 0.1001 |
| 22.00 | .3754E 10 | .6750E 08 | .1281E 10 | .4967E 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 |

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.9999994061E 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)= 0.1644999981E 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 | .1532E 08 | .1532E 08 | | | | | | |
| 9.00 | .2639E 09 | .0 | .4597E 08 | .3099E 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

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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 | .2179E 06 | .2179E 06 | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 37.00 | .4573E 07 | .0 | .5095E 06 | .5082E 07 | .4535E-01 | .0 | 0.0 | 0.2565 | 1.0000 | 0.2565 |
| 44.00 | .5536E 07 | .0 | .2005E 06 | .5736E 07 | .4609E-01 | .0 | 0.0 | 0.2509 | 1.0000 | 0.2509 |
| 51.00 | .1478E 08 | .0 | .1854E 07 | .1663E 08 | .5026E-01 | .0 | 0.0 | 0.2214 | 1.0000 | 0.2214 |
| 58.00 | .3397E 08 | .0 | .3975E 07 | .3795E 08 | .5138E-01 | .0 | 0.0 | 0.2141 | 1.0000 | 0.2141 |
| 65.00 | .5199E 08 | .1197E 06 | .2769E 07 | .5464E 08 | .6026E-01 | .0 | 0.0 | 0.1640 | 1.0000 | 0.1640 |
| 72.00 | .5294E 08 | .4058E 05 | .8258E 01 | .5290E 08 | .6132E-01 | .0 | 0.0 | 0.1589 | 1.0000 | 0.1589 |
| 79.00 | .3489E 08 | .3378E 06 | .0 | .3456E 08 | .5148E-01 | .0 | 0.0 | 0.2135 | 1.0000 | 0.2135 |
| 86.00 | .2101E 08 | .6939E 06 | .0 | .2032E 08 | .5106E-01 | .0 | 0.0 | 0.2162 | 1.0000 | 0.2162 |
| 93.00 | .8510E 07 | .5667E 06 | .0 | .7943E 07 | .4795E-01 | .0 | 0.0 | 0.2373 | 1.0000 | 0.2373 |
| 100.00 | .1218E 07 | .7037E 06 | .0 | .5144E 06 | .4227E-01 | .0 | 0.0 | 0.2814 | 1.0000 | 0.2814 |
| 107.00 | .1916E 02 | .2857E 01 | .0 | .1630E 02 | .4092E-01 | .0 | 0.0 | 0.2930 | 1.0000 | 0.2930 |

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.1126106560E 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

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STAGE 4 JUVENILE 2 STAGE

KX(1/DAY)= 0.1244999841E-01
KXO(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 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| 60.00 | .0 | .0 | .5208E 05 | .5208E 05 | | | | | | |
| 74.00 | .1479E 07 | .0 | .7526E 05 | .1555E 07 | .1100E-01 | .0 | 0.0 | 0.3329 | 1.0000 | 0.3329 |
| 88.00 | .8153E 07 | .0 | .1476E 07 | .9629E 07 | .1245E-01 | .0 | 0.0 | 0.2880 | 1.0000 | 0.2880 |
| 102.00 | .1789E 08 | .0 | .4258E 01 | .1789E 08 | .1488E-01 | .0 | 0.0 | 0.2258 | 1.0000 | 0.2258 |
| 123.00 | .1370E 08 | .0 | .0 | .1346E 08 | .1281E-01 | .0 | 0.0 | 0.2777 | 1.0000 | 0.2777 |
| 137.00 | .1148E 08 | .0 | .0 | .1128E 08 | .1250E-01 | .0 | 0.0 | 0.2864 | 1.0000 | 0.2864 |
| 151.00 | .9642E 07 | .0 | .0 | .9475E 07 | .1245E-01 | .0 | 0.0 | 0.2879 | 1.0000 | 0.2879 |
| 165.00 | .8099E 07 | .0 | .0 | .7959E 07 | .1245E-01 | .0 | 0.0 | 0.2880 | 1.0000 | 0.2880 |
| 179.00 | .6805E 07 | .0 | .0 | .6688E 07 | .1241E-01 | .0 | 0.0 | 0.2890 | 1.0000 | 0.2890 |
| 193.00 | .5722E 07 | .0 | .0 | .5624E 07 | .1233E-01 | .0 | 0.0 | 0.2914 | 1.0000 | 0.2914 |
| 207.00 | .4818E 07 | .0 | .0 | .4737E 07 | .1220E-01 | .0 | 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 = 0.1827156800E 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

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KX(1/DAY)=       0.9719997644E-02
KKO (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 KKO 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
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| TIME( ) | POPULATION(-) | TRANSFER | PRODUCTION | POPULATION(+) | KNATL | KPLANT | RATIO | PSN | PSF | 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 | .2587E 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 |

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TOTAL PRODUCTION INTO THIS LIFE STAGE =      0.4578047000E 07
TOTAL TRANSFER INTO THE NEXT LIFE STAGE =      0.9808884375E 06
% SURVIVAL THROUGH THIS LIFE STAGE =       21.4
MAXIMUM STANDING CROP FOR THIS LIFE STAGE =      0.4578047000E 07
RATIO OF MAXIMUM STANDING CROP TO EQUILIBRIUM STANDING CROP (NMAX/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  980888.   2  392411.   3  235405.   4  188348.   5  117871.
  6   73766.   7   46164.   8   28890.   9   18080.  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

KX(1/DAY)= 0.1150999069E 01
KXO(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 KXO 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

| 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 | .6685E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 4.00 | .5306E 09 | .1518E 08 | .1531E 09 | .6685E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 6.00 | .5306E 09 | .1518E 08 | .1531E 09 | .6685E 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 | .6746E 09 | .2945E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 18.00 | .2337E 10 | .6687E 08 | .6746E 09 | .2945E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 20.00 | .2337E 10 | .6687E 08 | .6746E 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 = 0.9999961293E 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 (NMAX/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 | .4696E-02 | 0.0311 | 0.0167 | 0.8768 | 0.0147 |
| 16.00 | .2290E 09 | .0 | .2065E 08 | .2496E 09 | .1447E 00 | .4696E-02 | 0.0314 | 0.0174 | 0.8768 | 0.0152 |
| 23.00 | .9493E 09 | .0 | .2006E 09 | .1150E 10 | .1630E 00 | .4696E-02 | 0.0280 | 0.0104 | 0.8768 | 0.0091 |
| 30.00 | .1997E 10 | .1906E 06 | .3808E 09 | .2378E 10 | .1660E 00 | .4696E-02 | 0.0275 | 0.0096 | 0.8768 | 0.0084 |
| 37.00 | .2180E 10 | .4512E 06 | .2009E 09 | .2381E 10 | .1682E 00 | .4696E-02 | 0.0272 | 0.0090 | 0.8768 | 0.0079 |
| 44.00 | .1535E 10 | .1779E 06 | .0 | .1535E 10 | .1645E 00 | .4696E-02 | 0.0278 | 0.0100 | 0.8768 | 0.0088 |
| 51.00 | .4738E 09 | .1647E 07 | .8837E 06 | .4722E 09 | .1543E 00 | .4696E-02 | 0.0295 | 0.0133 | 0.8768 | 0.0117 |
| 58.00 | .1482E 09 | .3549E 07 | .1105E 07 | .1446E 09 | .1406E 00 | .4696E-02 | 0.0323 | 0.0195 | 0.8768 | 0.0171 |
| 65.00 | .3544E 08 | .2447E 07 | .0 | .3299E 08 | .1339E 00 | .4696E-02 | 0.0339 | 0.0235 | 0.8768 | 0.0206 |
| 72.00 | .1250E 03 | .1414E 01 | .0 | .1236E 03 | .1316E 00 | .4696E-02 | 0.0345 | 0.0251 | 0.8768 | 0.0220 |
| 79.00 | .3134E 02 | .0 | .0 | .3134E 02 | .1316E 00 | .4696E-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 = 0.9994761600E 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... 0.9360998400E 08
% REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT... 0.93

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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 | C.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 08
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

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STAGE 4 JUVENILE 2 STAGE

KX(1/DAY)= 0.1244999841E-01
KXO(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 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 | PSE | 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 = 0.1520892000E 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
KXO (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 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 | PSF | 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 = 0.3805681000E 07
TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.8054810625E 06
% SURVIVAL THROUGH THIS LIFE STAGE = 21.2
MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.3805681000E 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...0.371781E 06

CUMULATIVE PROBABILITY OF SURVIVAL FROM EGG THROUGH JUVENILE 3 = 0.80548316E-05
EXPECTED NUMBER OF 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 | 18080. | 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 | 8.937 | 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 | 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... NO
RIGHT LIMB OF COMPENSATION FUNCTION DISABLED... NO

| TIME( ) | POPULATION(-) | TRANSFER | PRODUCTION | POPULATION(+) | KNATL | KPLANT | RATIO | PSN | PSF | PST |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | .0 | .0 | .1086E 09 | .1086E 09 | | | | | | |
| 2.00 | .3762E 09 | .1076E 08 | .1086E 09 | .4740E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 4.00 | .3762E 09 | .1076E 08 | .1086E 09 | .4740E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 6.00 | .3762E 09 | .1076E 08 | .1086E 09 | .4740E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 8.00 | .2385E 09 | .1076E 08 | .4923E 08 | .2770E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 10.00 | .1706E 09 | .4880E 07 | .4923E 08 | .2149E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 12.00 | .1706E 09 | .4880E 07 | .4923E 08 | .2149E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 14.00 | .1706E 09 | .4880E 07 | .4923E 08 | .2149E 09 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 16.00 | .1615E 10 | .4880E 07 | .4783E 09 | .2088E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 18.00 | .1657E 10 | .4742E 08 | .4783E 09 | .2088E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 20.00 | .1657E 10 | .4742E 08 | .4783E 09 | .2088E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 22.00 | .2654E 10 | .4742E 08 | .9080E 09 | .3515E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 24.00 | .3146E 10 | .9001E 08 | .9080E 09 | .3964E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 26.00 | .3146E 10 | .9001E 08 | .9080E 09 | .3964E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 28.00 | .3146E 10 | .9001E 08 | .9080E 09 | .3964E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 30.00 | .1703E 10 | .9001E 08 | .4791E 09 | .2092E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 32.00 | .1660E 10 | .4750E 08 | .4791E 09 | .2092E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 34.00 | .1660E 10 | .4750E 08 | .4791E 09 | .2092E 10 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 36.00 | .5484E 09 | .4750E 08 | .0 | .5009E 09 | .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 06 | .2634E 07 | .1150E 08 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 48.00 | .9125E 07 | .2611E 06 | .2634E 07 | .1150E 08 | .1151E 01 | .4696E-02 | 0.0041 | 0.1001 | 0.9907 | 0.0991 |
| 50.00 | .2185E 07 | .2611E 06 | .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 = 0.7039401984E 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

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 | .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 (NMAX/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

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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 | .1465E 06 | .1465E 06 | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 37.00 | .3134E 07 | .0 | .3656E 06 | .3500E 07 | .4414E-01 | .4696E-02 | 0.0962 | 0.2660 | 0.8686 | 0.2311 |
| 44.00 | .3789E 07 | .0 | .1426E 06 | .3931E 07 | .4471E-01 | .4696E-02 | 0.0950 | 0.2615 | 0.8686 | 0.2271 |
| 51.00 | .1023E 08 | .0 | .1313E 07 | .1155E 08 | .4878E-01 | .4696E-02 | 0.0878 | 0.2314 | 0.8686 | 0.2010 |
| 58.00 | .2366E 08 | .0 | .2859E 07 | .2651E 08 | .5114E-01 | .4696E-02 | 0.0841 | 0.2156 | 0.8686 | 0.1873 |
| 65.00 | .3666E 08 | .7859E 05 | .1855E 07 | .3844E 08 | .5173E-01 | .4696E-02 | 0.0832 | 0.2119 | 0.8686 | 0.1840 |
| 72.00 | .3809E 08 | .2899E 05 | .3268E 01 | .3806E 08 | .5201E-01 | .4696E-02 | 0.0828 | 0.2101 | 0.8686 | 0.1825 |
| 79.00 | .2485E 08 | .2413E 06 | .0 | .2461E 08 | .5115E-01 | .4696E-02 | 0.0841 | 0.2156 | 0.8686 | 0.1873 |
| 86.00 | .1446E 08 | .5009E 06 | .0 | .1396E 08 | .5019E-01 | .4696E-02 | 0.0856 | 0.2219 | 0.8686 | 0.1927 |
| 93.00 | .5516E 07 | .3859E 06 | .0 | .5131E 07 | .4607E-01 | .4696E-02 | 0.0925 | 0.2510 | 0.8686 | 0.2181 |
| 100.00 | .7469E 06 | .4332E 06 | .0 | .3137E 06 | .4176E-01 | .4696E-02 | 0.1011 | 0.2857 | 0.8686 | 0.2482 |
| 107.00 | .0 | .0 | .0 | .0 | .4092E-01 | .4696E-02 | 0.1029 | 0.2930 | 0.8686 | 0.2545 |

TOTAL PRODUCTION INTO THIS LIFE STAGE = 0.7842804800E 08
TOTAL TRANSFER INTO THE NEXT LIFE STAGE = 0.1486779900E 08
% SURVIVAL THROUGH THIS LIFE STAGE = 19.0
MAXIMUM STANDING CROP FOR THIS LIFE STAGE = 0.4143772800E 08
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... 0.3418260800E 08
% REDUCTION IN NUMBER OF ORGANISMS ENTERING THIS LIFE STAGE DUE TO THE POWER PLANT...30.35

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STAGE 4 JUVENILE 2 STAGE

KX(1/DAY)= 0.1244999841E-01
KXO(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 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 | PSF | PST |
|---|---|---|---|---|---|---|---|---|---|---|
| 60.00 | .0 | .0 | .3144E 05 | .3144E 05 | | | | | | |
| 74.00 | .9756E 06 | .0 | .5400E 05 | .1030E 07 | .1069E-01 | .2630E-03 | 0.0240 | 0.3435 | 0.9740 | 0.3346 |
| 88.00 | .5783E 07 | .0 | .1069E 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 | .9635E 07 | .0 | .0 | .9465E 07 | .1245E-01 | .2630E-03 | 0.0207 | 0.2879 | 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 | 0.2890 | 0.9740 | 0.2815 |
| 165.00 | .5656E 07 | .0 | .0 | .5557E 07 | .1232E-01 | .2630E-03 | 0.0209 | 0.2916 | 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 | 0.3005 | 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 = 0.1486779900E 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
KXO (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 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 | PSE | 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 | .2100E 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 = 0.3197542000E 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 | | | | |

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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 YEARLINGS DUE TO PLANT...  293637.
% 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
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 TRACING LIFE HISTORY OF STRIPED BASS FISH
IN HUDSON RIVER, WITH MORTALITY IN EACH
STAGE GIVEN BY:

     D(NX)/DT=-(KX+(KX-KXO)*((NX-YS)/YS)**3)*NX
               -FKILL*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 F-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      LARV      JUV1      JUV2      JUV3
  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
KO=0.18990298E-02 KN=0.84374728E-03 D= 0.10552825E-02 I=  1
KO=0.84374728E-03 KN=0.11321306E-02 D= 0.28838334E-03 I=  2
KO=0.11321306E-02 KN=0.12636880E-02 D= 0.13155746E-03 I=  3
KO=0.12636880E-02 KN=0.12837220E-02 D= 0.20033913E-04 I=  4
KO=0.12837220E-02 KN=0.12841103E-02 D= 0.38836151E-06 I=  5
KO=0.12841103E-02 KN=0.12841105E-02 D= 0.23283064E-09 I=  6
KO=0.12841103E-02 KN=0.12841105E-02 D= 0.23283064E-09 I=  7
END OF EQUAL......



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


        AGE  DECAY COEFF.    SEX RATIO     FRACTION      FECUNDITY
               (1/DAY)       (FEM/TOT)      MATURE     (EGGS/FEMALE)
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| | | | | |
|---|---|---|---|---|
| 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 | 0.2050E 06 |
| 5 | 0.001284 | 0.58 | 0.80 | 0.2970E 06 |
| 6 | 0.001284 | 0.60 | 1.00 | 0.4200E 06 |
| 7 | 0.001284 | 0.62 | 1.00 | 0.5720E 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 HEADINGS
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. | 1.2809 | 0.7784 | 0.7542 | 0.9061 | 1.1641 |
| 18 | 135561. | 176813. | 174301. | 1.2858 | 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 |

# 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 Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on 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 | 1.72 | 1.43 | 1.49 | 2.06 | 1.76 | 1.79 | 2.11 | 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 E4 | 2.9 E4 | | 7.9 E4 | 7.3 E4 | | 1.2 E5 | 1.34 E5 | | 1.76 E5 | 2.94 E5 | | 3.1 E5 | 6.42 E5 | | 3.7 E5 | 7.06 E5 | | 4.9 E5 | 9.1 E5 |
| 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 Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on Year 40 | Plant off, year 0 | Plant on Year 1 | Plant on 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% | 58.5% | 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: AKXO = 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 E8 | 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 | 45-18-11 | 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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