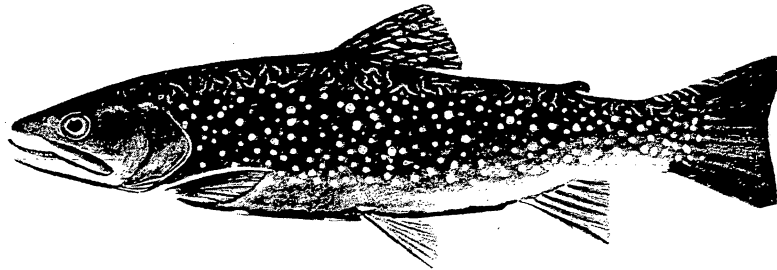


Development and Analysis of an Energetics-Based Model for Trout Populations in Appalachian Streams

Final Report

to

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Forest Service
Southeastern Forest Experiment Station



by

Kelly J. Meyer, Graduate Research Assistant
and
Donald J. Orth, Principal Investigator

Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061

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INTRODUCTION

This report presents a description of an age-structured, bioenergetics-based population model for brook trout *Salvelinus fontinalis* in southern Appalachian streams. Research was funded by the USDA - Forest Service, Southeastern Forest Experiment Station, Cold Water Fisheries Research Unit, Blacksburg, Virginia. Two major problem areas being addressed by the Cold Water Fisheries Research Unit are (1) identify patterns in distribution and abundance of trout across watershed and stream systems in the southern Appalachians, and (2) determine how individual biotic and abiotic factors influence trout productivity. This research contributes to both problem areas.

Three potential insidious threats to brook trout population status (distribution and abundance) and productivity in the southeastern United States include acidic deposition (DeWalle et al. 1987; Winger et al. 1987), global warming (Meisner 1990a, 1990b), and gypsy moth infestations. Impacts of timber management and land use changes are additional factors that affect trout resources; however, management planning can influence future land use and timber management regimes. Future long-term planning efforts will have to consider the constraints that may be imposed due to those potential threats that are more difficult to manage. Previous attempts to integrate trout resource projections

in a planning process have used empirical models to relate watershed land base characteristics and water yields directly to fish abundance (Flebbe et al. 1988; Joyce et al. 1990). Although empirical, site-specific or region-specific models are essential tools, a more mechanistic modeling framework may provide a basis for understanding and predicting effects of novel changes in water quality, prey availability, land management, or fisheries management.

Our objective in this research was to develop and analyze an age-structured, bioenergetics-based population model for trout populations. Although this type of model has not been previously developed for brook trout, a considerable literature exists to describe the bioenergetic relations, on the basis of similar species. Preall and Ringler (1990) used an approach similar to ours to predict potential growth rates of brown trout *Salmo trutta* based on temperature and body size relations (Elliott 1975, 1976). We have attempted to link the growth predictions with a population model, similar to the models of Serchuk et al. (1980) and Swartzman and Beauchamp 1990. Temperature and prey availability are the principal driving variables in the model. The model has thus far been coded in FORTRAN and simulation experiments have been run with parameter estimates derived from available data. A field study of one model component (influence of prey availability on food consumption by brook trout) has been completed and is reported on separately (Meyer 1990).

LITERATURE REVIEW

Characteristics of brook trout streams

Brook trout streams in the southeast are located in the Appalachian Mountains from Maryland to northern Georgia (Seehorn 1978). Brook trout streams in Virginia are located in the Blue Ridge mountains, the Allegheny mountains, and the Blue Ridge plateau area in the southwest (Mohn 1980). The range of brook trout in the southern Appalachians has been fairly stable over the past ten years with some reductions in the most southern range.

Historically, brook trout distribution was reduced by habitat degradation but this is no longer as serious a problem because most brook trout streams in the southeastern U.S. are protected by government agencies. Eighty-three percent of the trout streams in Tennessee are on federal land (Bivens et al. 1985). Some of the brook trout streams and populations are vulnerable to acidic rain (Light 1983; Winger et al. 1987). DeWalle et al. (1987) found brook trout more likely to be absent in acid-sensitive streams. Competition from exotic salmonids is considered the most serious threat to brook trout populations in Tennessee (Bivens et al. 1985).

Brook trout are rarely found in waters with a temperature higher than 20 Celsius (Mohn 1980). Brook trout streams are characterized as having high gradients, coarse substrates, and low nutrients, with most of the nutrients coming from allochthonous sources. The stream is usually bounded on the lower end by a zone of sympatric brook trout and exotic trout species, either brown (*Salmo trutta*) or rainbow (*Oncorhynchus mykiss*), which gradually becomes a zone of only introduced species (Moore 1979; Josephson 1983).

Behnke (1980) has separated brook trout into two ecological groups, the southern brook trout which are found in small streams, and their northern cousins which are larger and live longer. Flick and Webster (1976) substantiated this separation when they found Canadian strains grew better and lived longer in Pennsylvania ponds. Brook trout populations in the southeast have developed characteristics that help them adapt to high summer temperatures. Therefore, we have made generalizations about population characteristic of brook trout in the southern Appalachians. We were interested in how population characteristics such as mortality, fecundity, migration and growth are affected by changes in prey abundance.

Brook trout in the Southeast are short-lived with few individuals living past three years. Konopacky and Estes (1983) found 98% of brook trout to be younger than three years, and Mohn (1980) found annual survival of fish older than three to be 10%. The fish become even more short-lived the further south they exist (Michaels 1978). Most of the adult mortality occurs in the winter (Whitworth and Strange 1983) and may be tied to lipid storage, as larger fish of a year class survive better than smaller fish (Hunt 1969).

Because of their variable environment, these populations are usually dominated by one year class of age-0 or age-1 fish. Michael (1978) found young-of-year were responsible for 82% of production in a Georgia stream. A year class may be reduced from

unusual flood events (Elwood and Waters 1969) or by drought (Lennon 1961, Gray 1979).

Although mortality of older trout in a stream tends to be density independent, the mortality of early life stages is often density dependent (Miller 1987, Elliott 1990). McFadden et al. (1967) found the number of eggs spawned had no relationship to the number of brook trout surviving the first year. However, Gee et al. (1978) found an inverse relationship between fry density and survival of Atlantic salmon *Salmo salar* indicating survival is density dependent for the early life stages. Most mortality in young-of-year brook trout occurs in the first three months (Latta 1961) and is negatively correlated with summer water levels (Latta 1965). Little research has been done on early mortality in southern Appalachia populations of brook trout.

Brook trout fecundity is a function of adult size and food abundance. Fecundity is directly related to length and this relationship is consistent among different parts of North America (Power 1980). In contrast, Robinette (1978) found that the fecundity of large brook trout (> 200 mm) from a stream in the Smoky Mountains less than the fecundity of similar size brook trout from Pennsylvania (Wydoski and Cooper 1966). Typically, low food abundance reduces fecundity (Mann and Mills 1979) and, by affecting growth, can reduce the proportion of fish that mature (McCormick and Naiman 1984). However, if growth is extremely poor for extended periods, fish may be under selective pressure to mature earlier since the additional year of growth would not increase fecundity (Light 1983). Droughts and corresponding low food levels may restrict spawning in certain years (Gray 1979, LaRoche 1979), which may help explain the preponderance of populations with one dominant year-class in the southeastern U.S.

Brook trout do not migrate much in southeastern montane streams (Whitworth and Strange 1983, Harned 1976, Gray 1979). The limited movement that has been seen can be explained by seasonal changes or food limitation. Sadowski (1978) found adult

brook trout tended to head upstream in the fall during spawning but headed downstream and overwintered at low elevations. Droughts may prevent the fish from swimming upstream in the fall (Gray 1979).

Food limitation may also affect migration. Flick and Webster (1975) removed non-trout competitors from a brook trout stream and observed a drastic reduction in migration. Fish that do not get enough food may be displaced downstream (Noakes 1980). However, when food is low throughout the stream, trout may not obtain much benefit from moving, and mortality is presumably higher with migration.

Growth is surprisingly consistent among different populations regardless of the fertility of the stream (Mohn 1980, Robinette 1978, Lucchetti 1983). When density is decreased catastrophically the first one or two year classes may have increased growth (Elwood and Waters 1969), evidence that growth may be density-dependent. Therefore, space or food may be limiting growth. Growth of brook trout in the southeast is generally comparable to the rest of their range for the first year but is slower for older fish (LaRoche 1980, Konopacky and Estes 1983). Seasonally, growth is highest in the spring with low growth during the rest of the year (Lucchetti 1983).

Because growth is consistent among streams, production is normally a function of biomass (Lucchetti 1983). Biomass in the southeastern U.S. is generally low, less than 50 kg/ha, except in highly alkaline streams (Mohn 1980). Kaufman (1985) found biomass was significantly correlated with alkalinity. The production per biomass ratio is fairly consistent and lower than the rest of the brook trout range with two Virginia studies having a ratio of 1.6 (Neves and Pardue 1983, Lucchetti 1983) and a Tennessee study having a ratio from 0.7 to 1.0 for nine months of production (Whitworth and Strange 1983).

Lucchetti (1983) looked at seasonal production of three brook trout streams and found July to October had the lowest production with 1.2% of the yearly total. The

annual production was correlated negatively with water discharge suggesting headwater sections of streams had higher production than sections at lower elevations. This finding was further substantiated when Neves and Pardue (1983) and Josephson (1983) found that production of brook trout was highest in the upper reaches of streams. These findings suggest that high temperatures may limit brook trout production in streams of the southern Appalachians.

Food consumption

Consumption of prey is a complex process, which is a function of abiotic variables, and prey and predator characteristics. Temperature is the most important abiotic variable affecting consumption (Baldwin 1956, Elliott 1975), but light intensity (Wilzbach et al. 1986) and to a lesser extent substrate complexity (Ware 1972, Wilzbach et al. 1986) also affect feeding. Prey characteristics that influence their selection are abundance (Allan 1981), size (Bisson 1978, Meyer 1990), nutritional content (Rozin and Mayer 1961, Grove et al. 1978), dispersion patterns (Ivlev 1961), and spatial availability (Ney 1990). The behavior of the predator determines where the prey are selected (Allan 1978a), what time of day it is selected (Johnson and Johnson 1981), what prey are selected (McNicol et al. 1985) and how flexible the fish is to changing environment or introduced competition (Bisson 1978, Griffith 1974). The size of the fish also determines the quantity (Elliott 1975) and the kind of prey it will consume (Elliott 1970).

The complex process of predation has been simplified and mathematically represented by Ivlev (1961) as:

$$C = C_{\max}(1 - e^{-kp})$$

Where:

C = actual ration

C_{\max} = maximum consumption

p = concentration of prey

k = coefficient of proportionality for a specific prey and predator.

This equation describes the Holling (1959) type-2 functional response of how consumption responds to increasing prey density (Healey 1984). This type-2 response has been found appropriate for both benthic (Ware 1972) and drift (Ringler and Brodowski 1983) feeding of salmonids.

This equation should be modified when prey are clumped because the predators will spend more time in areas of high density (Ivlev 1961). This equation is also modified when predator density is large enough to cause interference among predators or modifications of prey behavior (DeAngelis et al. 1975). However these modifications may not be needed for drift-feeding brook trout populations in the summer.

Ivlev (1961) found that patchy prey distribution increased consumption because the fish swim until they reach the prey patch and concentrated feeding in the location. Drift feeding brook trout do not increase consumption with patchiness because the fish do not search areas for prey but take an optimum position where they maximize the number of prey that float past. Drift is periodic (Waters 1969), so Ivlev's formula may have to be modified with changing diel densities of prey.

Power (1980), in his comprehensive review of brook trout, found only one situation where stream-dwelling brook trout did not feed predominantly on drift. This tendency to feed on drift is more pronounced in the summer (LaRoche 1979, Light 1983, Newman 1987). Warren and Davis (1967) hypothesized that during warmer periods trout maximize (energetic benefit/ cost) ratios by drift feeding. Reeves et al. (1987) supported this

theory when higher temperatures caused rainbow trout to concentrate in riffles instead of throughout the pool. Smith and Li (1983) found additional evidence when they observed steelheads selected significantly higher water velocities with higher temperatures.

Ivlev's formula should still be applicable without modifications for higher densities of brook trout. One reason that predation success changes with more consumers is that prey modify their behavior in the presence of predators. It might be possible that the density of consumers may influence the likelihood to drift (Allan 1978b, Andersson et al. 1986), but it is unlikely that once drifting, the prey will change its behavior because of additional trout. Insects identify predators tactilely or by chemical cues within millimeters (Williams 1987). Terrestrial insects especially are unlikely to modify behavior once drifting and they often make up over half the drift during the summer (Light 1983, Allan 1978a, Cada et al. 1987, Meyer 1990). Agonistic behavior toward other consumers will also reduce consumption efficiency but charrs (genus *Salvelinus*) are usually less aggressive than other salmonids (Power 1980). In addition, the high energetic costs and increased lethargy in the summer reduces salmonid aggression and their likelihood of interfering with consumption of other fish (Reeves et al. 1987).

Competition from other species affects food consumption. Generally, nonsalmonid competitors have little effect on salmonids (Brocksen et al. 1968, Flick and Webster 1975) except in rarer instances when they feed on the drift (Reeves et al. 1987). Brocksen et al. (1968) found benthic feeders may crop insects before drifting but have little effect once the prey enters the drift. Other salmonids directly compete with brook trout by forcing the fish to select slightly different drift (Griffith 1974), displacing them to different stations (Salli 1979), or by becoming dominant and monopolizing the food (Helfrich et al. 1982).

Brook trout are opportunistic feeders that normally select prey in proportion to their abundance (Allan 1981). Size is also a major factor since fish can see larger prey

from a greater distance and therefore scan more area (Bannon and Ringler 1986, Grant and Noakes 1986). Terrestrial insects are seen more easily because they disturb the surface-water interface and are often positively selected (Wilzbach et al. 1986). The prey selected may change with size of fish or time of day. Larger fish have larger territories and feed on larger prey. They also feed on a larger variety of prey and are more likely to feed on the bottom (Elliott 1970). Trout are more likely to select smaller and benthic prey at night (Allan 1978b, Bisson 1978, Johnson and Johnson 1982). Allan (1978b) hypothesized the tendency to select larger prey was reduced at night because of poorer visibility.

The prey available to the fish, encounter rate, depends on the search rate and prey density (Beyer and Laurence 1980). The search rate of the fish depends on fish size, prey size, feeding behavior, water velocity and physical obstructions. A stationary fish scans half a sphere while moving fish, or fish feeding in a current, scan a cylinder (Newman 1987). A cylindrical search rate can be mathematically represented by:

$$\text{search rate} = \frac{1}{2} \pi r^2 v$$

Here v is the current velocity passing by the fish or length of the cylinder. The radius of the scanning area (r) increases with fish size and may vary seasonally. Fausch (1984) used twice the fish length as the radius of the scanning area for his study; he considered it an underestimate of the scanning area. Prey size may increase scanning area because a fish will swim further for larger prey (Dunbrack and Dill 1983, Ware 1972). Physical obstructions may reduce the area the predator is scanning (Dunbrack and Dill 1983). Fausch (1984) stated trout normally feed from only one quarter of semicircle and used $1/8$ instead of $1/2$ to find the area for his search rate.

Our review of the literature suggests a lot of plasticity in the times of feeding. Allan (1981) not only found differences in diel feeding between seasons but within seasons as well. Many studies have indicated or assumed brook trout do not feed at night (Cada et al. 1987, Light 1983, Griffith 1974). Other studies have documented night feeding (Johnson and Johnson 1982, Allan 1978 Meyer 1990). Practically, there is no physiological lower limit where fish are unable to see (Tanaka 1970, as quoted from Elliott 1973). Jenkins (1969) found no significant differences in night feeding of brown trout with different moon phases.

Despite this variation, at least in localized areas, brook trout feed more at certain times of day. Most studies that have shown periodicity in the summer found peaks of feeding in the morning and evening (White 1967, Salli 1979, Elliott 1970). The morning and evening feeding peaks often corresponds to the times when drift is highest (Waters 1969) and stomach contents are lowest. In contrast, Meyer (1990) found that larger brook trout (> 100mm) ate more at night than during the day in July and September. Wilzbach et al. (1986) found that increased canopy cover increased the likelihood that cutthroat trout would feed at midday. Young-of-year brook trout feed throughout the daylight hours (Salli 1979). When food is scarce, trout are less likely to show periodicity when feeding (Smith and Li 1983, Cada et al. 1987, Ensign 1988).

Growth

Growth is estimated from an energy budget where there is an input (food) from which metabolic cost must be subtracted. The leftover energy can be used for reproduction and growth. The energy budget is represented by Webb (1978) as:

$$Q_R - (Q_F + Q_N) = Q_S + Q_L + Q_{SDA} + Q_G + Q_R$$

where:

Q_R = ration (cal)

Q_F = energy egested (cal)

Q_N = energy excreted (cal)

Q_S = standard metabolism (cal)

Q_L = locomotor, activity costs (cal)

Q_{SDA} = energy used for digestion of food (cal)

Q_G = energy for growth (cal)

Q_P = reproductive costs (cal)

Most studies on brook trout energy budgets have been done in the northern part of their range. Walsh et al. (1988) estimated daily ration in two sub-arctic streams and found increased daily ration and growth in the warmer of the two streams. By August, higher temperatures reduced feeding in the warmer stream and the fish in the cooler stream had higher rations. Cunjak and Power (1987) found daily ration was larger than costs during the winter except in November. They hypothesized the fish had a net energy deficit because of acclimation to rapidly declining temperatures. This deficit was more likely for mature brook trout, 4 of 6 instances, than immature trout, 2 of 6 instances (Cunjak et al. 1987).

Studies in Canada may not be easily applied in the southern Appalachians because the brook trout are from different ecological groups (Behnke 1980) and are subjected to a different climate. In Tennessee, Ensign (1988) measured energy budgets using one morning sample and one evening sample to estimate ration. Ensign (1988) found maintenance costs (minimum energy required to maintain weight) were higher than daily ration in every instance during the summer. The young-of-year had less of a deficit, ingesting from 33 to 83% of the maintenance requirement, while the adult fish ingested

only 15 to 33% of the maintenance needs. This energy intake was low despite fairly high prey densities. In contrast to Ensign (1988), Meyer (1990) estimated that brook trout generally met maintenance costs during the summer (30 of 32 instances) in northern Virginia streams. Although, Meyer (1990) calculated trout ate more than maintenance costs throughout the summer, he found that the trout did not grow in late summer. He concluded activity costs contributed greatly to the energy budget of trout, at least in the summer.

MODEL DOCUMENTATION

This section describes the model equations. Figure 1 depicts the relations that will be included in the model. The population will be represented by the number of fish in the i age (N_i) in a 100 meter stream length, and the average weight of an individual fish in the i age class (W_i). The model equations were selected on the basis of empirical relations whenever possible.

Temperature

The model uses empirical data from Guys Run, Virginia, in 1977, (Hornick et al. 1980) to predict the temperature by time of year. Mean temperature in Guys Run ranged from 0 C in the winter months to 19 C in September. Temperature in Guys Run is probably typical or slightly cooler than other brook trout streams in the southern Appalachians. Mohn (1980) observed that most trout streams had summer maxima under 20 C. The model also contains the option to use a sine function to predict temperature.

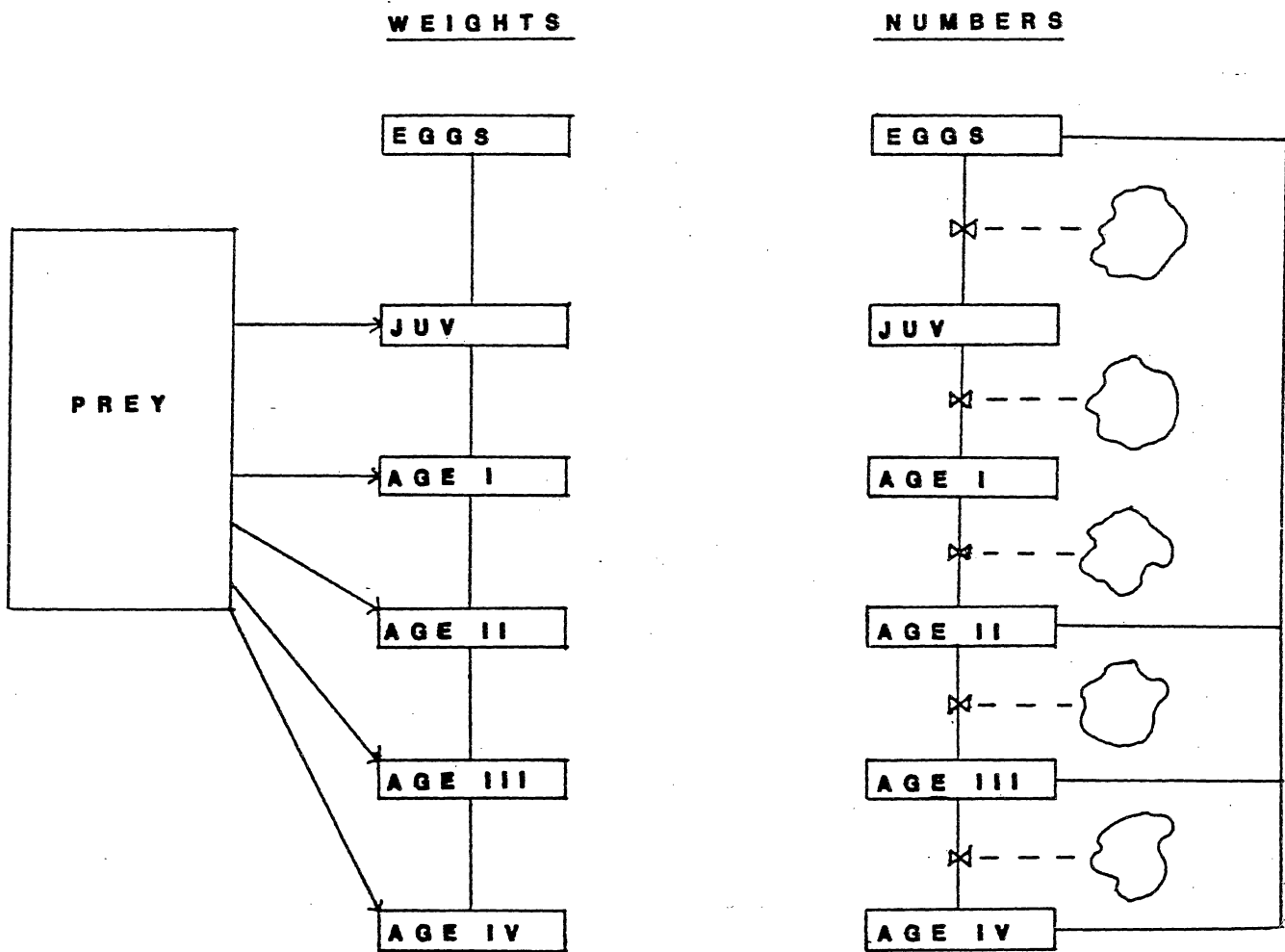


Figure 1. Flow diagram depicting key relations in the model for brook trout populations. Clouds represent mortality rates.

$$\text{Temp} = \text{Mtem} + \text{Sin}(\text{Tr} - 2.926) \text{ Amp}$$

$$\text{Tr} = (\text{Tdy}/365) 6.283$$

Where Temp is the temperature predicted for the specific day, Mtem is the mean yearly temperature, Tr is the time of the year in radians, Amp is the amplitude of the change around the mean, and Tdy is the time during the year in days (where Tdy is equal to 0 on November 1). The equations cause the maximum yearly temperature to occur on July 21 because of the constant 2.926 (in radians); changing the constant would change the temperature timing. The model requires the user to input changes in summer temperature (from May 1 to October 31) before running the model.

Reproduction and recruitment

Timing of spawning

The best estimate of spawning time in the southeast is November 1, estimated by gonadal somatic indexes and direct observations (Gray 1979). This date is supported by Pennsylvania (Wydoski and Cooper 1966) and Wisconsin (McFadden 1961) studies. Power (1980) speculated that spawning should be later for southern populations, but found no data that would support geographic variability in time of spawning. Age-1 trout spawn later than the age-2 trout (Gray 1979) so the spawning date may have to be modified for populations dominated by younger fish.

Fecundity

The number of eggs spawned was estimated from an equation modified from Robinette (1978); Robinette data was used for the fecundity estimates because it was

specific to the southern Appalachians. Fecundity equations for brook trout were also presented by Shetter (1961), Wydoski and Cooper (1966), and Gray (1979).

$$FEC_i(t) = -114.06 + 1.41 L_i(t)$$

$$EGGS = \sum_{i=0}^n FEC_i(t) M_i(t) P_i(t) N_i(t)$$

Where $L_i(t)$ is the average length of age i at time t , $M_i(t)$ is the percent of females at age i that are mature at time t , and $P_i(t)$ is the proportion of females in the population. Average length may be modelled in several ways; our initial approach is based on the average weight for age i and a condition factor (K) of 1.

$$L_i = \sqrt[3]{(100,000 W_i)/K}$$

The proportion of females that are mature $M_i(t)$ is fairly constant for age 0 fish (0%) and fish older than age I (100%). The proportion of females in age I that are mature is more variable. Percent maturation changes from one year to the next (Gray 1979) and from one population to another (Light 1983). McCormick and Naiman (1984) found that a regression of size versus maturation explained 97 % of the variation in maturity of female brook trout (Figure 2). We used a nonlinear regression of their data to obtain the following relationship for the maturation of age I females:

$$M_{(2)} = \frac{0.997}{(1 + 50e^{(-.068 W_{(2)})})}$$

In the model $M_{(2)}$ and $W_{(2)}$ are the maturation rate and weight of age-I trout.

If growth is below a certain threshold the fish are more likely to mature at a earlier age regardless of size. Light (1983) found a population with smaller fish that had sig-

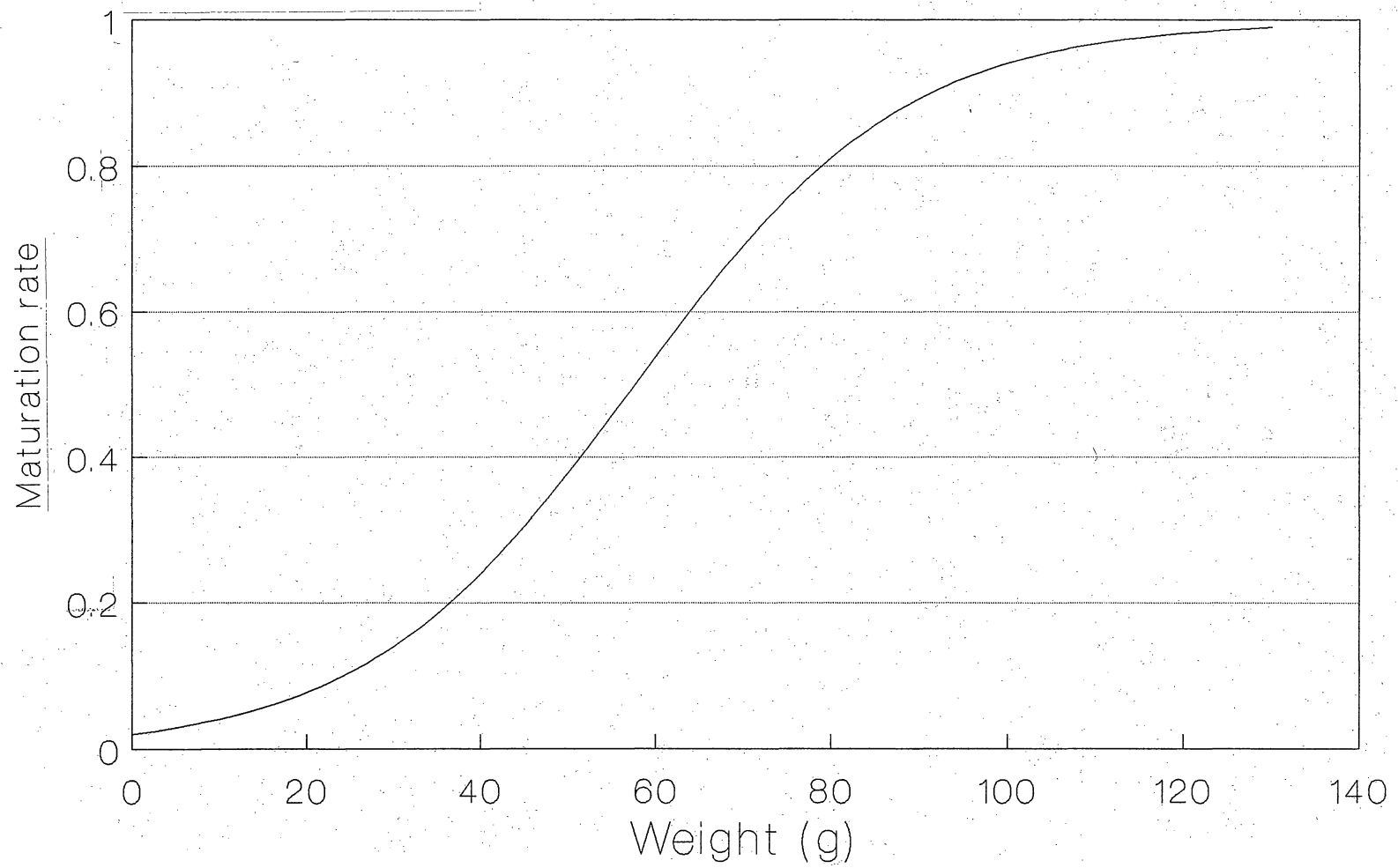


Figure 2. Maturation rate of yearling brook trout versus weight (g). Relation calculated from data on weight and maturation rates (McCormick and Naiman 1984).

nificantly more mature age I females than two populations with larger fish. It is unlikely that this situation applies very often because younger fish grow fairly well in southern Appalachian streams. Age-1 brook trout in Light's study had a median length of 104 mm. Konopacky (1978) measured age-1 trout in twenty-five southeastern streams and the lowest mean he found was 118mm.

We will use a 1:1 female to male sex ratio ($P_i(t)$) as our initial conditions. Konopacky (1978) did extensive work on brook trout sex ratios; of the 24 streams he looked at in the Southeast 9 had more males, 13 had more females, and 2 had an exact 1:1 ratio. Sex ratio was variable between streams, the ratios ranged from 4.0 females per male to 0.286 females per male (Konopacky 1978). Carlander (1969), in a general review of brook trout, stated that females tended to be relatively more abundant as they got older. Lennon (1967) and Robinette (1978) found the opposite in the Southeast. Lennon (1967) speculated the increased mortality of females may have been caused by an ovarian disease, although no verification was done.

Hatching and emergence timing

The time needed for hatching and emergence is temperature driven (Figure 3). In this model we will use data from Embody (1934, cited in Power 1980) to predict the days needed to hatch eggs at specific temperatures.

$$\text{DAYHAT} = e^{5.1823 - 0.13T} \quad (R^2 = 0.99)$$

Where DAYHAT equals days to hatching and T equals the temperature in Celsius. Days to emergence is estimated by multiplying the days to hatching by 1.7 (Crisp 1988) and gives the following relationship.

$$\text{DAYEME} = e^{5.7129 - 0.137T}$$

Where DAYEME is the days needed to emerge and T is the mean temperature in Celsius since spawning (variable AVTEMP in the model).

Hatching and emergence success.

Hatching success of eggs is normally very high, 84% to 91.5% (McFadden 1961, Hausle and Coble 1976). Emergence rate of eggs seems to be more variable than hatching rate. Some studies have found a emergence rate close to 100% (Hobbs 1948 as quoted from Gray 1979). However, Gray (1979) observed that eggs in artificial redds had an emergence success of 36 to 47 %. Brasch (1949) found brook trout eggs had an emergence rate of 79% (as quoted from Shetter 1961). Hausle and Coble (1976) observed that brook trout eggs had emergence rates slightly below Brasch's value but had added sand to increase mortality.

We combined hatching and emergence rates in the model for ease in calculation. Future modification could estimate hatching mortality and emergence mortality separately. The formulas were:

$$N_{\text{eggs}}(t + 1) = N_{\text{eggs}}(t)e^{-Z_{\text{eggs}}}$$

Where $N_{\text{eggs}}(t)$ is the number of eggs at (t) time and Z_{eggs} is the daily instantaneous mortality for eggs from spawning to emergence.

$$Z_{\text{eggs}} = \frac{-\log_e(\text{Surv}_{\text{eggs}})}{\text{days}}$$

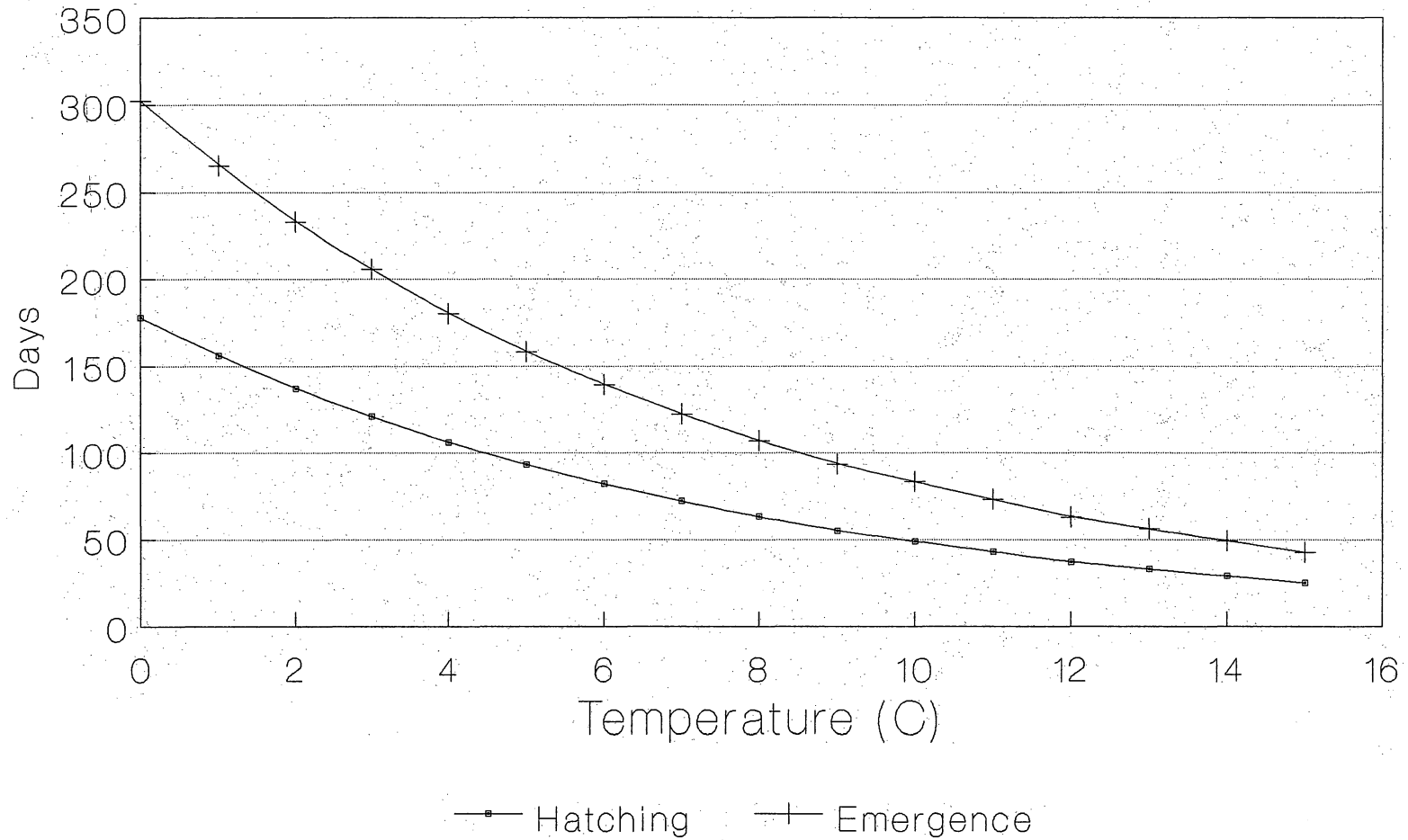


Figure 3. Number of days required for brook trout eggs to hatch and emerge at different temperature (C). Data for relation from Embody (1934) as reported in Power (1980).

Where Sur_{eggs} is the survival of eggs from spawning to emergence. We used a survival of 54% in the model (Hausle and Coble 1976). Survival of eggs may have been underestimated because Hausle and Coble added silt to the eggs in their study which could have increased egg mortality.

Recruitment

Trout in the age classes were recruited to the next age class on December 15 of each year.

Mortality

Mortality was estimated by the instantaneous rate used by Ricker (1975). The number of trout alive at time (t) was estimated by:

$$N_i(t + 1) = N_i(t)e^{-Z_i}$$

Where N_i is the number of fish in the i age class and where Z_i is the daily instantaneous mortality for the i age class.

$$Z_i = \frac{-\log_e(\text{survival of i class})}{\text{days}}$$

Yearly mortality rates used in all model simulations were 70% for age-0 and age-1 trout and 80% for age-2 and age-3 trout. Table 1 contains information on trout survival rates in other studies.

Table 1. Mortality rates (percentage and instantaneous, Z) for brook trout during first year of life (egg to 0+).

<u>Intervals</u>	<u>Percent</u>	<u>Days</u>	<u>Z (d⁻¹)</u>	<u>Reference</u>
Egg to emergence	21	150	1.57×10^{-3}	Brash 1949
	41	150	3.5×10^{-3}	Hausle & Coble 1976
Egg to fingerling	95-97	180	$1.66 \text{ to } 1.95 \times 10^{-2}$	Cooper 1953
	95-97	177	$1.69 \text{ to } 1.98 \times 10^{-2}$	Latta 1961
	95.3	180	$1.40 \text{ to } 2.17 \times 10^{-2}$	Shetter 1961
	92-98	180	$1.40 \text{ to } 2.17 \times 10^{-2}$	Latta 1968
	99			Light 1983
Egg to yearling	96.8	360	9.56×10^{-3}	McFadden et al. 1967
0+ to I+	46	210 ^a	2.93×10^{-3}	Hunt 1969
	76.8	360	4.06×10^{-3}	Alexander 1979
	63.1	360	2.77×10^{-3}	Mohn 1980
	72.1	360	3.55×10^{-3}	Moore 1980
	20-58	360	$0.62 \text{ to } 2.41 \times 10^{-3}$	Light 1983
	84.4	360	5.16×10^{-3}	Lucchetti 1983

^aSeptember to April.

If temperatures reach lethal levels the number of fish in the age class will be set to 0. Lethal limits are 24.5 °C for age-0 trout (McCormick et al. 1972) and 25.3 °C for older fish (Fry et al. 1946).

Size dependent mortality

The purpose of this project is to relate the food base to growth and mortality of the brook trout populations. There is evidence that larger sizes or more lipids improve survival rates. Flick and Webster (1975) removed fish from a stream and fed them, increasing their survival. Hunt (1969) found a direct relationship between length of young of year and over-winter survival. Backcalculated lengths from scales also suggest that larger fish are surviving better than smaller trout (Mohn 1980, Konopacky 1978). Adelman et al. (1955) tested overwinter survival directly by starving different sizes of brook trout for 7 months at 7 °C. He found that 3.5 inch fish were more likely to die than 5.5 inch or larger fish.

This model contains an option to relate growth and mortality. It was difficult to relate size of fish to mortality because the threshold of poor growth changes throughout the year. For example, a ten gram yearling may be in good shape in March but a ten gram yearling would be in poor shape in September. A size dependent mortality rate would assign the ten gram yearling the same mortality rate at both months. Instead of assigning mortality rates on the basis of size we hypothesize that mortality rates are a function of growth in weight. The model increased mortality rates for trout that lost weight (Figure 4). A proportion of the mortality rate was constant and not dependent on growth. Mortality rates were:

$$Z_i = Z_{GD(i)} + Z_{GI(i)}$$

Where Z_i is the total mortality rate of the i age class, $Z_{GD(i)}$ is the growth dependent mortality and $Z_{GI(i)}$ is the growth independent mortality rate. The growth independent rate can be found the same way as Z by using the highest survival rates measured. The growth dependent Z can be estimated from:

$$Z_{GD(i)} = Z_{GD\text{MAX}(i)} e^{-B K(i)}$$

$$K(i) = \text{weight}(i)/\text{maxwei}(i)$$

Where $Z_{GD\text{MAX}(i)}$ is the maximum instantaneous mortality rate, $K(i)$ is a weight gain ratio (ranging from 1 to 0), and maxwei is the maximum weight the fish had reached at any previous time. These equations cause mortality rates to be exponentially higher with larger weight losses. This may not represent the actual relation between weight loss and mortality but the assumptions seem realistic. Parameters of the above equation can be fitted with actual data if mortality and weight loss (may be approximated with condition factors) are known. Further research is needed to test this equation.

Seasonal and angling mortality.

The present version of the model does not contain modifications for seasonal or angling mortality. Increased angling mortality can be added during the summer months. The instantaneous rate will be adjusted so that it is the sum of the angling and natural mortality. Angling mortality has been measured in Michigan (McFadden 1961), Georgia

(Michaels 1980) and Virginia (Mohn 1980, LaRoche 1979). We could use LaRoche's estimate of 20% because he had the best data of southeastern streams.

The model may be improved by the addition of seasonal mortality rates, especially for fry after emergence. Latta (1961) found that most of the age-0 mortality occurs in the first three months. However, the present model calculates the same mortality for age-0 trout throughout the year and underestimates their mortality. The model uses the yearly mortality rate of 70% which is probably accurate after the juveniles survive to the summer. Modifications of the present model could easily increase age-0 mortality for the first three months by tracking the days after emergence. Table 1 contains percentage and instantaneous mortality rates for brook trout streams over an entire year. These rates can be converted to monthly rates by using the seasonal mortality information of Latta (1961) for young of year and Lucchetti (1983) for older fish. Seasonal mortality has also been described for older fish by Moore (1980) and LaRoche (1979).

Mortality may be attributed to winter stress. Most of the Canadian studies on brook trout showed more stress on adults in the early winter. Adult brook trout lose weight over and above the costs of reproduction in the fall (Cunjak and Power 1987, Cunjak et al. 1987). Cunjak (1988) found that glucose levels were greater in the early part of the winter; glucose levels are linked to stress. Conversely, juvenile fish are not as susceptible to mortality in the early winter as they were in late winter. This is probably due to the fact of lower lipid storage capabilities than larger fish.

The coldest streams do not necessarily have the highest mortalities. Fluctuating temperatures may be the key to unraveling the mystery of overwinter mortality. Studies in Convict Creek showed that mortality may be more likely with temperature fluctuations late in the winter (Reimers 1963). The increase in metabolism caused by the higher temperatures was too much stress for the fish in poor condition.

Mortality is affected by factors outside the focus of the model. Floods and droughts have a large influence on year to year variation of trout densities (Lennon 1961). Young-of-year mortality may be affected by predation, water levels (Latta 1965), and density (Gee et al. 1978).

Growth

The growth equations were represented by:

$$\text{gro}_i = (C_i - R_i - F_i)/DC$$

Where gro_i is the growth rate (g/trout), C_i is the consumption rate for the i age class (cal/trout), R_i is the respiration rate for the i age class (cal/trout), F_i is the energy allocated to waste in the i age class (cal/trout) and DC is the constant (1360 cal/gm wet wt) that converts calories to grams (Elliott 1975). The final results of the growth equation were added to the average weight of the year classes.

$$W_i(t + 1) = W_i(t) + \text{gro}_i(t)$$

The separate components of the equation were estimated using formulas from Hewett and Johnson (1987).

Consumption.

The consumption rate is a function of the maximum food a specific sized fish can eat, temperature, and prey availability. The model used the same consumption rate formula as Hewett and Johnson (1987).

$$C = C_{\max} P\text{-value} F(T)$$

$$C_{\max} = 248.9W^{0.8347}$$

Where:

C_{\max} = maximum specific consumption of the i age class (cal/trout).

C = the daily specific consumption (cal/trout).

$F(T)$ = the temperature dependence function where $T = ^\circ C$.

P-value = the proportion of C_{\max} actually consumed.

Maximum consumption

The parameter C_{\max} is the maximum potential consumption of a specific size of brook trout at optimal temperature (temperature at highest consumption). The slope (0.8347) and intercept (248.9) of the C_{\max} weight function were taken from a study on brown trout (Elliott 1976). We assumed brook trout at optimum feeding temperature (15.5) would consume the same amount as brown trout of the same weight at their optimum (17.8).

P-value.

The P-value will be manipulated to see how differing prey densities affect growth.

Initial P-values were estimated by placing growth and temperature data into the model and solving iteratively. However, it was difficult to obtain concurrent growth and temperature data for southern brook trout streams. We were able to locate good growth data for brook trout in Guys Run, Virginia, from 1981 to 1982 (Lucchetti 1983) and temperature data in the same stream for 1977 (Hornick et al. 1980). Data from the two studies were used to estimate P-values for different sizes of trout at different times of the year. Estimates of P-value during the entire year are contained in the model code (Appendix I). Estimates of P-value ranged from 0.42 to 0.8 from December to May, from 0.30 to 0.45 from May to July, from 0.19 to 0.27 from July to October, and from 0.13 to 0.22 from October to December.

Alternatively, the model has the option to estimate P-values as a function of prey density from mid May to mid September. Meyer (1990) presents a formula that estimates P-value from prey density from different ages of fish.

$$P\text{-value} = (1 - e^{-(\pi(i) \text{ preden})})$$

Where P-value is the proportion of possible consumption consumed, $\pi(i)$ is constants that represents an increase in feeding with increasing prey density for the i size trout, and preden is the prey density (number of prey longer than 4mm per m^3).

Temperature

Temperature is the most important factor affecting consumption (Elliott 1975). We will use the Thornton and Lessem (1978) algorithm to describe consumptions dependence on temperature. Hewett and Johnson (1987) found this algorithm to be the most appropriate for cool and coldwater fish. The formula is fairly complex and can be found in Hewett and Johnson (1987) with a more detailed description in Thornton and

Lessem (1978). To use the formula we need to identify the threshold, optimal and maximum temperature of consumption. The threshold temperature is the lower temperature where consumption is 10% of optimal, the optimal temperature is the temperature at maximum consumption, and the maximum temperature is the temperature where consumption ceases.

There is a lot of literature relating temperature with brook trout growth (Baldwin 1956, McCormick et al. 1972, Dwyer et al. 1983) or trout thermal preference (Coutant 1977, Peterson et al. 1979, Power 1980). Unfortunately, there are few studies that relate consumption directly with temperature. Hatchery studies have some information on temperature-related consumption Haskell (1955) but are flawed in that they do not look at higher temperatures and do not take into account increased lethargy and wasted food with higher temperatures. Baldwin (1956) measured consumption directly, but his selected temperatures were widely spaced. He found the optimal temperature at 13 °C but his next highest temperature was 17 °C. It is probable that the optimal temperature is between 13 and 17 °C. Maximum temperature of feeding is probably higher than 21 °C because consumption was 12% of maximum at 21 °C.

Growth studies may be useful in estimating temperature values. Baldwin (1956) also measured growth and his graphs showed growth mirroring consumption. Therefore growth data can be used to approximate the consumption-temperature relation. Optimal growth was at 16°C in two studies (Hokanson 1973, Dwyer 1983); there was good growth from 10 to 19 °C in both studies. Optimal temperature for fry tended to be lower; McCormick et al. (1972) found that optimal temperature for brook trout alvein growth was from 12.4 to 15.4 °C with good growth from 9 to 17.9 °C.

Temperature preference can also be used to find the optimal temperature. Kitchell et al. (1977) noted the optimal temperature for consumption corresponded with the temperature preference for perch *Perca flavescens*. Kitchell also stated that Brett (1956)

found other evidence that temperature preferences and temperature optimum for growth are the same in other fishes. Coutant (1977) compiled information from 12 studies on brook trout and found that temperature preference ranged from 14.8 to 20.3 °C with a median of 16°C

The effect of temperature on maximum consumption $F(T)$ was estimated from laboratory studies on brook trout (Figure 5). The temperature correction factor, $F(T)$, was estimated by fitting Thornton-Lessem (1978) functions to the data in Baldwin (1956) and Coutant (1977). The parameters used in the algorithm were lower threshold = 3.5 C with P-value = 20%, upper threshold = 21 C with P-value = 13%, and optimum temperature = 16.0 C with P-value = 100%.

The optimum temperature may be slightly different for different populations and locations. Temperature optimal may be genetic; hybrids of species have temperature preferences intermediate between the species (Peterson et al. 1979). It is possible that southern populations of brook trout may have a higher optimal feeding temperature than northern populations. Bevelheimer et al. (1985) observed northern pike *Esox lucius* in their southern range had a feeding optimum at a higher temperature than pike in the northern part of their range.

Respiration

Respiration can be divided into three components:

$$R_t = R_s + R_g + R_{sda}$$

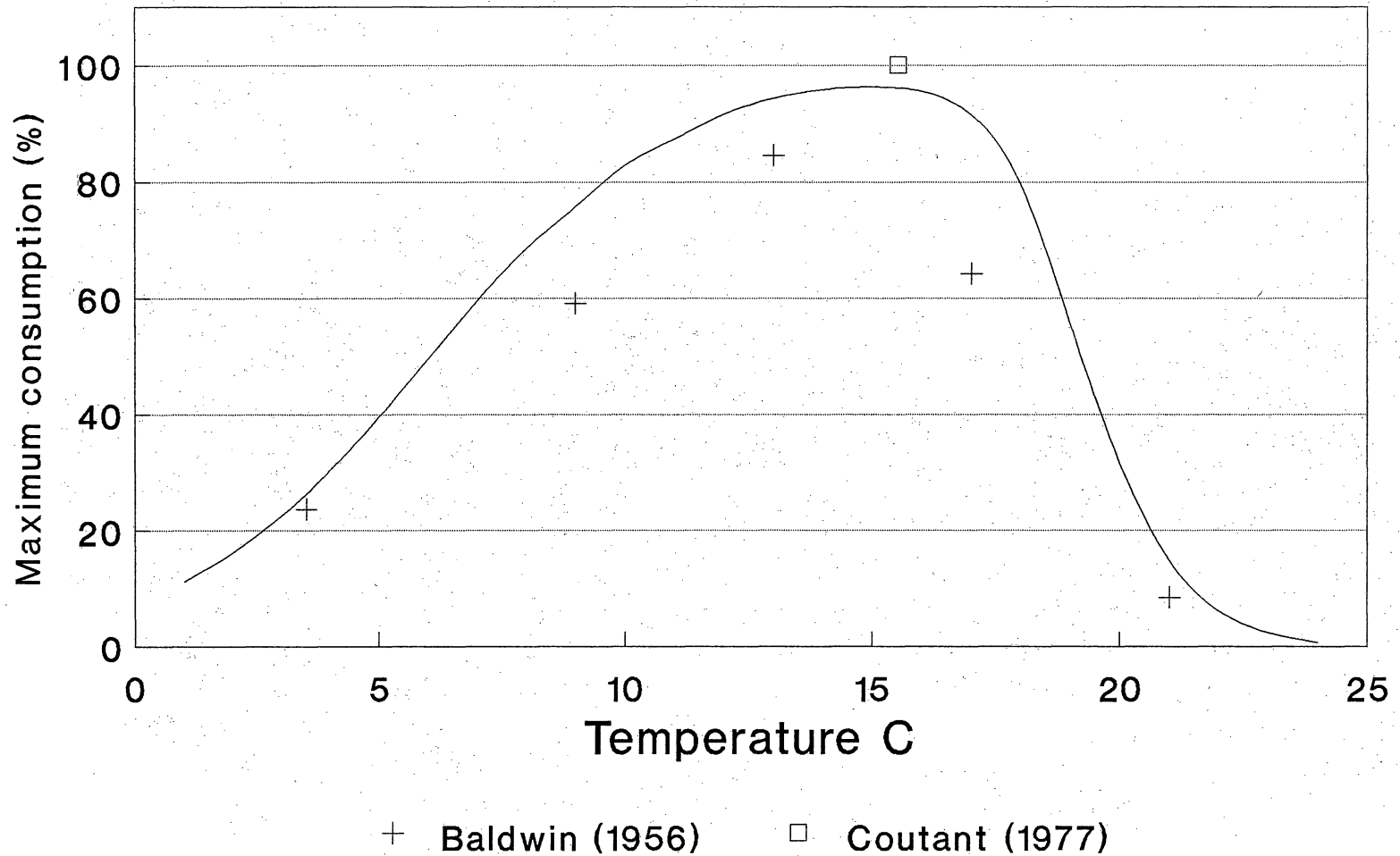


Figure 5. Brook trout feeding as a function of temperature as fitted by a Thornton-Lessem function. Daily rations from Baldwin (1956) was converted to the proportion of maximum consumption (P-value) by dividing by maximum consumption. Maximum consumption was estimated from maximum consumption for brown trout at the optimum temperature (Elliott 1976). Brook trout temperature preferences from Coutant (1977) was used to estimate the temperature at maximum consumption.

Where R_t is the total respiration, R_s is the standard metabolism, R_a is the activity metabolism, and R_{sda} is the respiration due to the digestion of food.

Basal metabolism R_s was estimated by taking the data from Job (1955) for brook trout and using multiple regression to correlate respiration with temperature and fish size. Job (1955) measured basal metabolism for a wide range of trout sizes (5 to 1000g) and temperatures (5 to 20 C). Job (1955) appeared to use 5 to 10 fish to find the mean basal metabolism at specific weights and temperatures. I used the means he reported to correlate respiration with fish size and temperature ($P < 0.0001$, $R^2 = 0.993$). The final equation was:

$$R_s = 4.42611 W^{0.8347} e^{0.0821T}$$

where R_s is basal metabolism (cal/trout), W is fish size (g), and T is temperature in C. Figure 6 shows the data from Job (1955) and the regressions predicted from the equation.

Active metabolism R_a is a difficult parameter to measure accurately in the energy budget (Ney 1990). Active metabolism likely varies among streams and sizes of trout, based on estimates derived from field studies of growth and consumption (Meyer 1990). Active metabolism has previously been treated as a multiple of standard metabolism (Winberg 1956), but this process probably introduces error (Ney 1990). Alternatively, an estimate of swimming speed can be used to determine the activity metabolism. For instance, Rice et al. (1983) multiplies standard metabolism by $e^{g \times S}$ to estimate total respiration due to standard metabolism and swimming activity. The parameter S is the swimming speed and g is the species specific constant. Fausch (1984) used the same formula with data on coho salmon *Oncorhynchus kisutch* and rainbow trout from Stewart (1980) to estimate swim costs for salmonids. I attempted to calculate g for brook trout

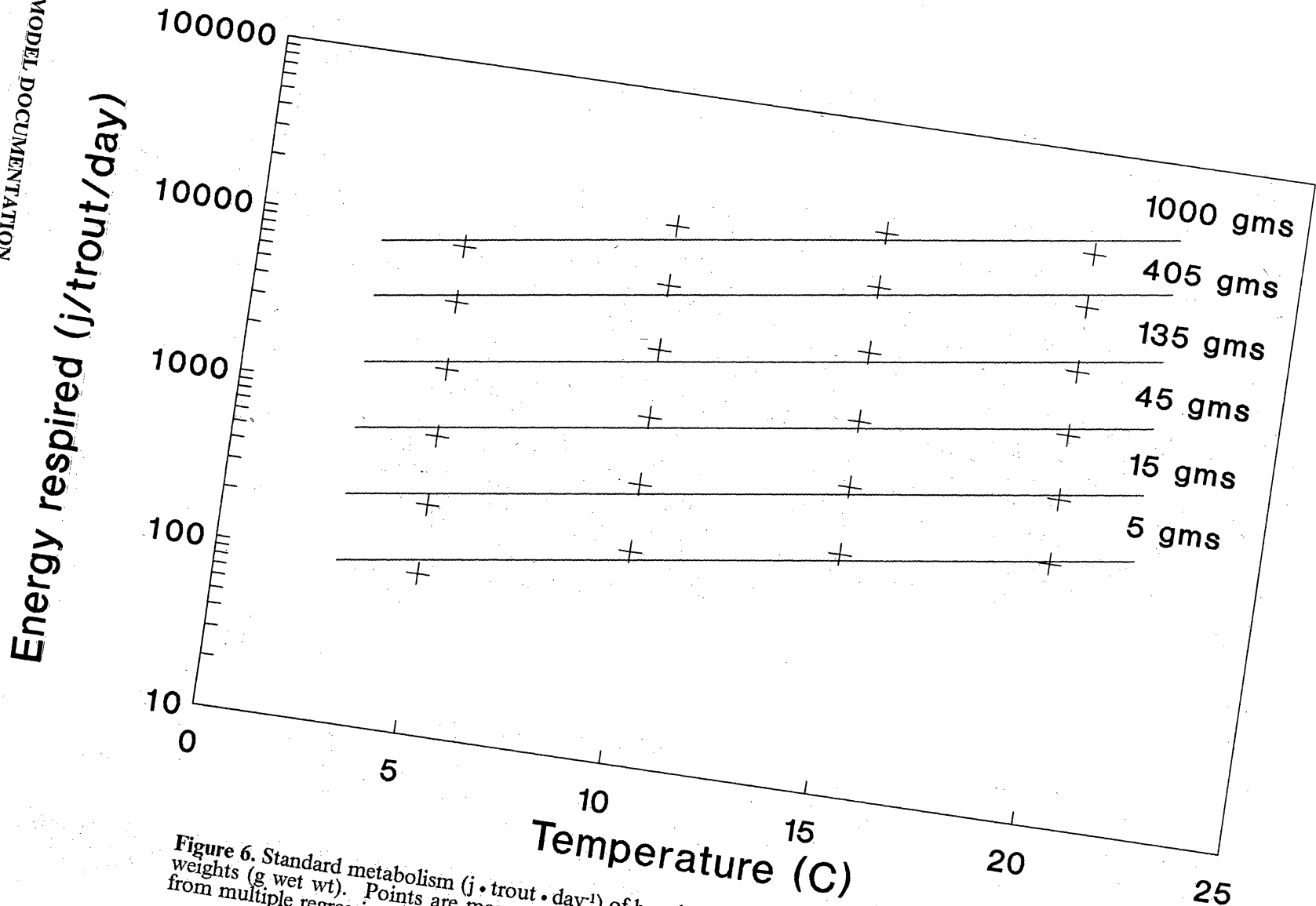


Figure 6. Standard metabolism ($j \cdot \text{trout} \cdot \text{day}^{-1}$) of brook trout at different temperatures (C) and fish weights (g wet wt). Points are means of consumption measured by Job (1955), lines were found from multiple regression of temperature and weight, the formula is $18.532W^{0.8347}e^{T \cdot 0.0821}$

using oxygen consumption and swim speed data from (Beamish 1980). The following formula estimates activity costs.

$$R_a = (R_s e^{vel(i)g}) - R_s$$

Where R_a is active metabolism (cal/trout), R_s is standard metabolism (cal/trout), $vel(i)$ is the swim speed of the i age trout (cm/sec), and g is the species specific constant. The constant g is 0.02600 for swim speeds faster than 25 cm/sec and 0.01356 for swim speeds less than 25 cm/sec. Webb (1978) found log of oxygen consumption was linearly related to swimming speed but this may not necessarily be true for brook trout. I noticed oxygen consumption increased slowly with swim speed at 25 cm/sec when plotting the natural log of oxygen consumption versus swim speed. However, starting at 30 cm/sec, oxygen consumption increased quickly with increases in swim speed. Therefore, the model contains two measures of g . The model assumes trout are swimming at 10 cm/sec (Griffith 1972, Lohr 1985). Fausch and White (1981) observed that the mean velocities at the focal point ranged from 13 to 25 cm/sec depending on whether the trout was feeding or resting. Activity costs in the model are a constant proportion (15%) of standard metabolism because the model assumes a constant swim speed of 10 cm/sec. This may be an underestimate, because Winberg (1956) stated metabolic cost when activity is included is likely to be double standard metabolism. An activity multiplier of two for brook trout would correspond with a swimming speed of 26.7 cm/sec.

The respiration due to feeding is a direct proportion of the food consumed.

$$R_{sda} = C_f \times s$$

Where s is the percent of consumption used to break down and manipulate food. The respiration due to digestion ranges from 5% of consumption for carbohydrates to 30% for proteins (Webb 1978). Hewett and Johnson (1987) used a s of 0.172 for lake trout. This percent may be overestimated because they used fish as the food consumed. Brook trout commonly feed on invertebrates which have a lower protein content. Brett and Groves (1979) examined various energetic studies and concluded carnivorous fish normally spend 14% of consumed energy on digestion.

Waste.

The model lumps both excretion and egestion as waste. Waste is a direct proportion of the food consumed and does not depend on temperature or fish size (Elliott 1976).

$$F_i = C_i \times f$$

Where f is the percent of consumption egested and excreted. The egestion component of waste may be variable depending on the type of food consumed. More wastes are egested with foods high in carbohydrates than with foods high in proteins (Webb 1978). The model uses the f of 0.32 found by Elliott (1976) for brown trout feeding on invertebrates.

Spawning loss

The model contains an equation that subtracts the weight of gonads from mature trout on November 1. The model assumes gonadal weight of females is 12% of total weight and gonadal weight of males is 1.2% of total weight (Gray 1979).

All parameters used to estimate growth in the model are given in Table 2.

Table 2. Parameter values used in the model predicting growth for brook trout. Parameter symbols from Hewett and Johnson 1988 are included in the table.

Hewitt and Johnson	Parameter Description	Value
<u>Consumption</u>		
P	Preparation of Cmax	.0 to .8 ^a
CA	Intercept:Cmax (cal.trout ⁻¹ .d ⁻¹)	248.9
CB	Coefficient:Cmax versus wt	0.8347
CQ	Temp. for K ₁ (lower threshold) (C ^o)	3.5
CTO	Temp. for K ₂ (C ^o)	15.5
CTM	Temp. for K ₃ (C ^o)	15.5
CTL	Temp. for K ₄ (upper threshold) (C ^o)	21
CK1	Proportion of Cmax at K ₁	0.26
CK4	Proportion of Cmax at K ₂	0.133
<u>Respiration (R)</u>		
RA	Intercept R (cal/trout)	4.42611
RB	Coefficient R versus weight	0.8347
RQ	Coefficient R versus temperature	0.0821
RTO	Coefficient R versus swim speed U <25 cm/s >25 cm/s	0.01356 0.02600
U	Swim speed (cm/sec)	10
SDA	Specific dynamic action	0.172
<u>Waste</u>		
F&U	Proportion of food (egestion and excretion)	0.32

^aP values are found in Table 4.

MODEL OUTPUT

Methods

We ran the model at different temperatures and P-values to measure effects on model output (i.e. brook trout growth and recruitment). Temperature was only changed from May 1 to October 1 because changes in temperature from land management practices is more pronounced in the summer (Hewlett and Fortsen 1982, Rishel et al. 1982, Lynch et al. 1984). The model was ran at three temperatures to determine the effects on growth predictions of the model. The three temperatures were: the original temperature of Guys Run in 1977, the original temperature plus 1 C, and the original temperature minus 1 C. The model was ran at three different prey densities (P-value) at the three temperatures to estimate the effect of prey abundance on growth. The three initial P-values were: the original P-value as found iteratively from Lucchetti's (1983) data, the original P-value increased by 50%, and the original P-value decreased by 50%. Decreases in P-value of 50% caused the trout populations to crash at all three temperatures. Thus, we changed the decrease in P-value at the low prey density from 50% to 25%.

Changes in temperature and P-value were probably realistic for southern Appalachian streams. Temperature among streams often differ by more than 1 C (Meyer 1990). In fact, temperature between upstream and downstream reaches may differ by more than 1 C. Measures of P-value are more difficult than temperature to measure. However, Meyer (1990) estimated P-values on a daily basis in Appalachian trout streams. He found that the P-values were variable among streams and months (Table 3). P-values among streams differed by 400% in July, therefore modeling changes in P-value of 50% may not be unreasonable.

The output measure was the growth of yearling trout in May over a two year period. Yearling trout after two years of growth would be the larger trout in the stream because most of the older trout would have died (Lucchetti 1983). We also examined the number of eggs spawned by the entire population after three years of simulation as a measure of the populations ability to sustain it's numbers.

Results

Model output

Seasonal response of growth was generally similar at all prey densities (Figure 7 to 9). Seasonally, growth was greatest from March to July. There was a small dip in growth from August to September when temperatures were warmest. There was a slight pulse in growth during October as temperatures began to cool (from 15 C to 9 C). There was a small drop in weight in November (probably due to the loss of weight at spawning). From November to mid February, the size of trout stayed relatively constant.

Lower temperatures were associated with higher growth rates at all prey densities (Figures 7 to 9). Summer depressions in growth rates were more pronounced for trout at higher temperatures. The loss of weight due to spawning on November 1 was less for

Table 3. Daily ration in percent (g dry wt/g dry wt x 100) and P-value (the percent of maximum consumption) for different sizes of fish in the summer in Shenandoah National Park. Pvalue was only measured on one day within the month.

MODEL OUTPUT

	Juvenile		Yearling		Adult	
	Ration (%)	P-value	Ration (%)	P-value	Ration (%)	P-value
MAY						
Piney	-	-	2.20	24	2.40	35
White oak	-	-	1.22	15	2.88	48
Madison	-	-	4.34	45	3.65	50
Hawksbill	-	-	3.11	32	3.88	55
Average			2.72	29	3.20	47
JULY						
Piney	5.66	39	4.82	52	5.47	79
White oak	7.49	44	5.71	53	8.48	109
Madison	3.22	22	1.72	17	1.14	15
Hawksbill	7.42	46	8.79	79	8.49	98
Average	5.96	38	5.26	50	5.80	75
SEPT						
Piney	3.32	21	2.34	22	1.10	13
White oak	3.83	25	1.72	16	1.56	18
Madison	6.64	45	3.21	31	2.08	26
Hawksbill	7.04	46	4.38	39	5.31	61
Average	5.21	34	2.91	27	2.51	30

Low prey abundance

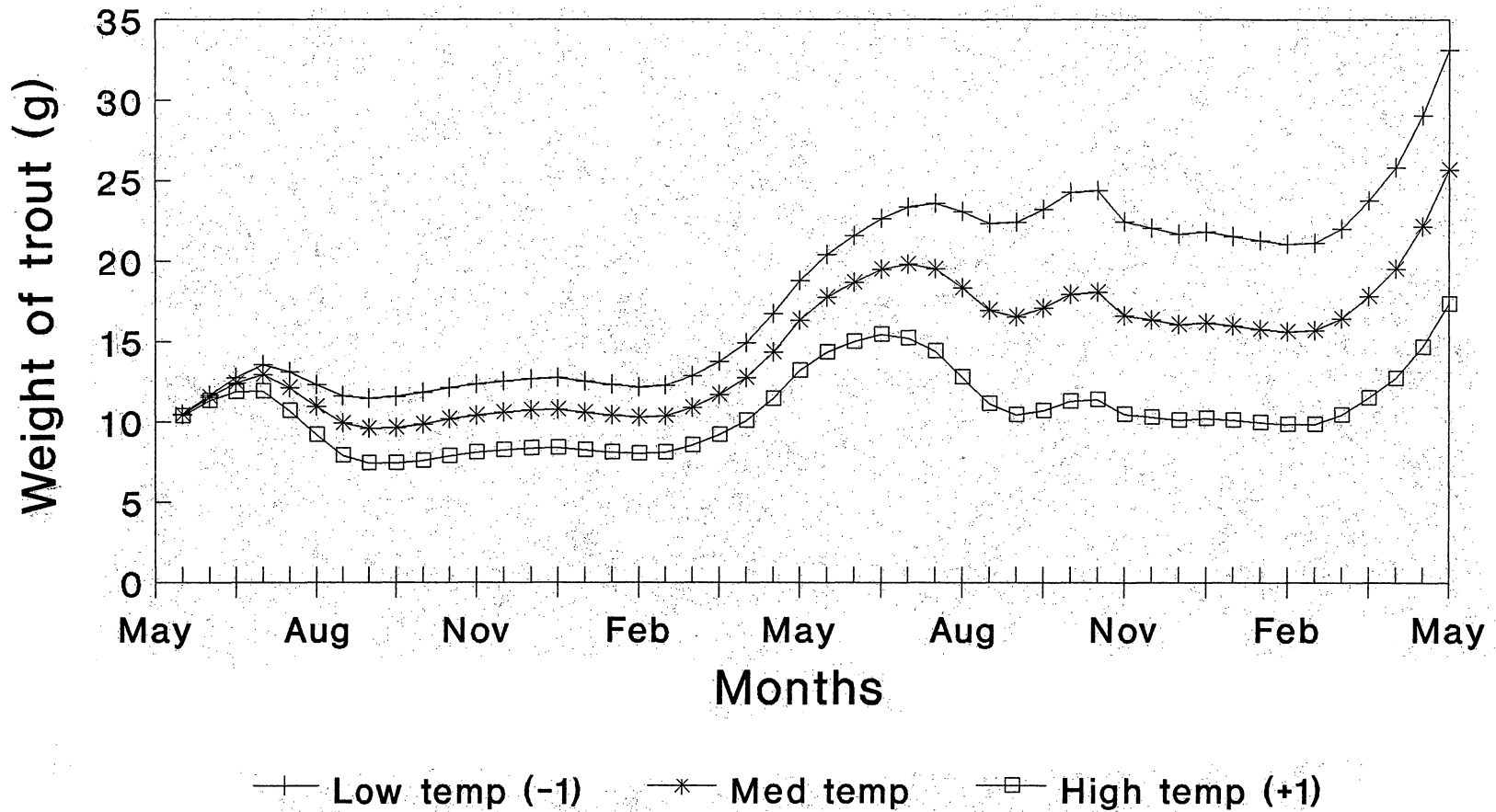


Figure 7. Simulation of two years of growth (g) for yearling trout (initial weight was 9.36 g on May 1) at low prey abundance at three temperatures. Prey abundance was 25% less than the Pvalue found iteratively from Lucchetti (1983).

Baseline prey abundance

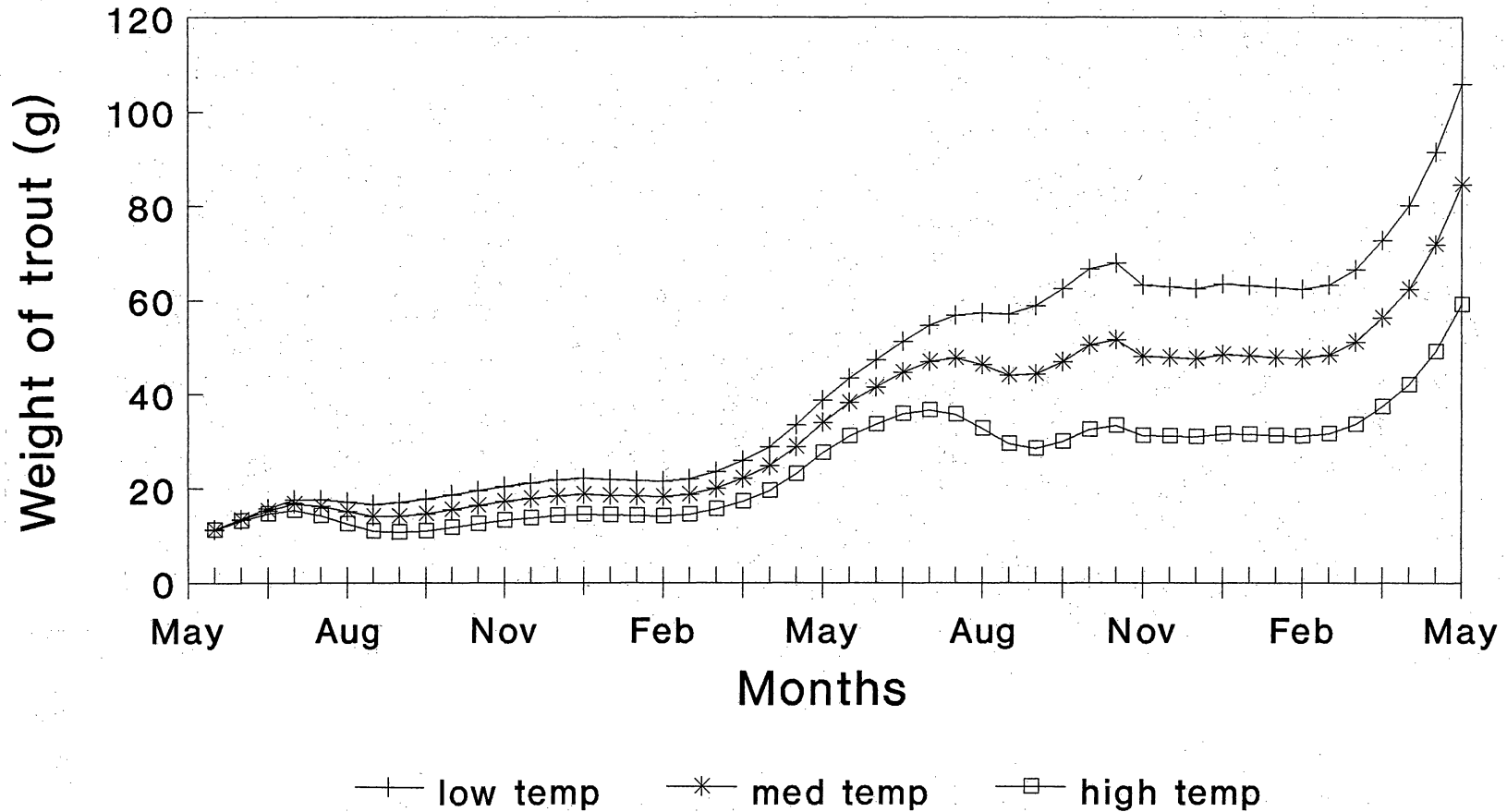


Figure 8. Simulation of two years of growth (g) for yearling trout (initial weight was 9.36 g on May 1) at intermediate prey abundance at three temperatures. Prey abundance was the Pvalue found iteratively from Lucchetti (1983).

High prey abundance

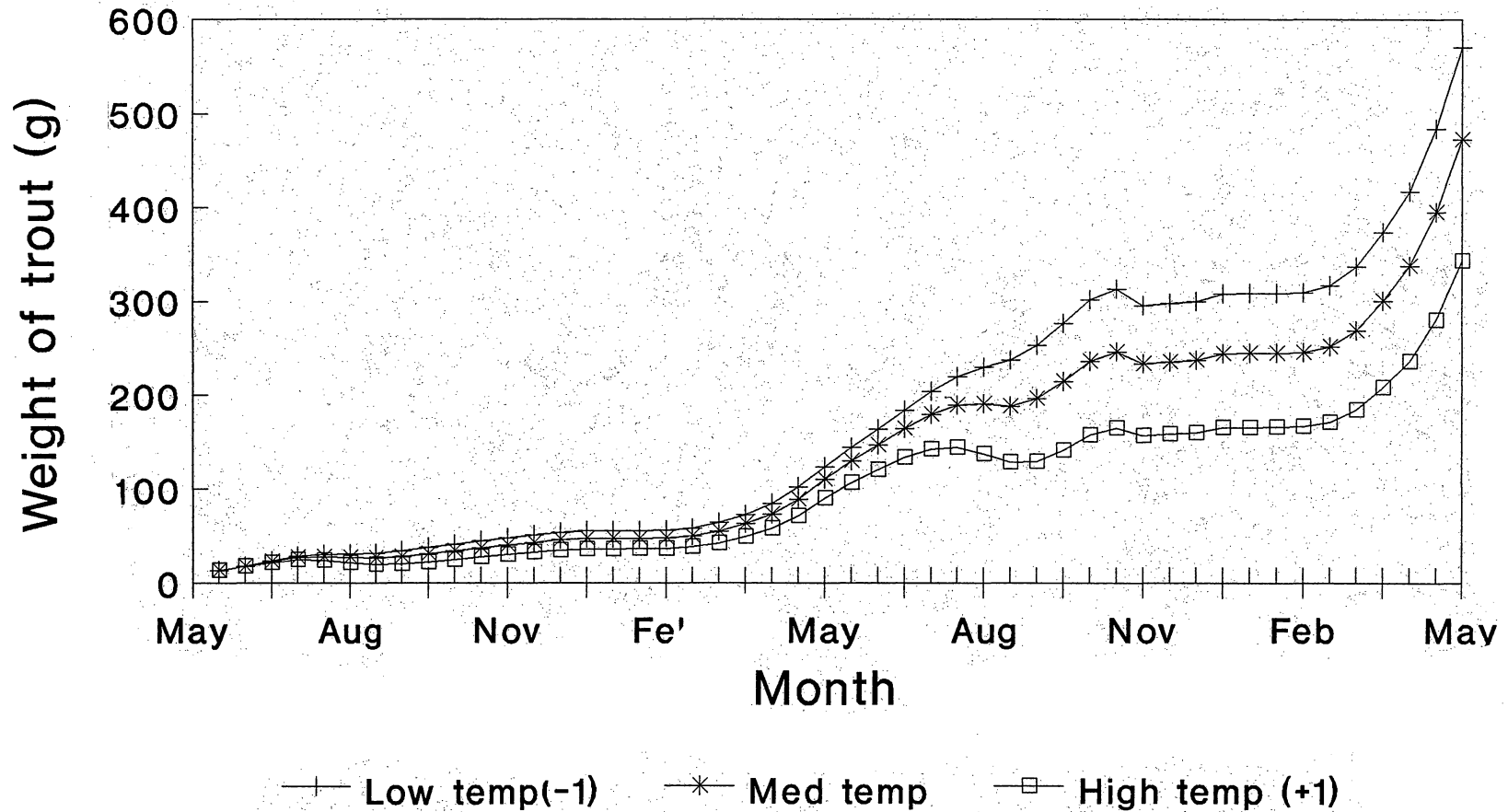


Figure 9. Simulation of two years of growth (g) for yearling trout (initial weight was 9.36 g on May 1) at high prey abundance at three temperatures. Prey abundance was 50% higher than the Pvalue found iteratively from Lucchetti (1983).

trout at higher temperatures. In the simulations, trout lost approximately 7 % of their weight, if all the trout were mature; since trout were smaller at higher temperatures they lost less weight than trout at lower temperatures.

Prey abundance had an obvious effect on trout growth with trout growing substantially more at higher prey abundance. Yearling trout after two years grew to 25 grams at low prey abundance, 90 grams at the original prey abundance, and 500 grams at the high prey abundance at the baseline temperature. Seasonally, trout at the highest prey abundance had the lowest decrease in growth during mid summer at all temperatures. In fact, trout at high prey densities and low temperatures were able to grow throughout the summer (Figure 9).

Recruitment varied substantially among the model output at different prey densities (Figure 10). Recruitment was substantial (800 eggs/ 100 meters of stream), even with warmer temperatures as long as prey densities were high. The model requires trout to spawn 292 eggs/ 100 meters of stream to replace juvenile trout in May; at low prey densities the trout were unable to maintain the population at all three temperatures. Therefore, the model suggests that lower prey availability will have significant consequences for population persistence, especially if summer temperatures are elevated.

Discussion

Model output

Changes in P-value and temperature did not change the timing of growth in the model. This is fairly realistic because trout growth in the southern Appalachians is normally high in Spring and low in the summer (Whitworth and Strange 1983, Cada et al. 1987, Meyer 1990). The slight increase in October may be inaccurate. Although temperature may be better for growth in fall than during the summer, trout may have

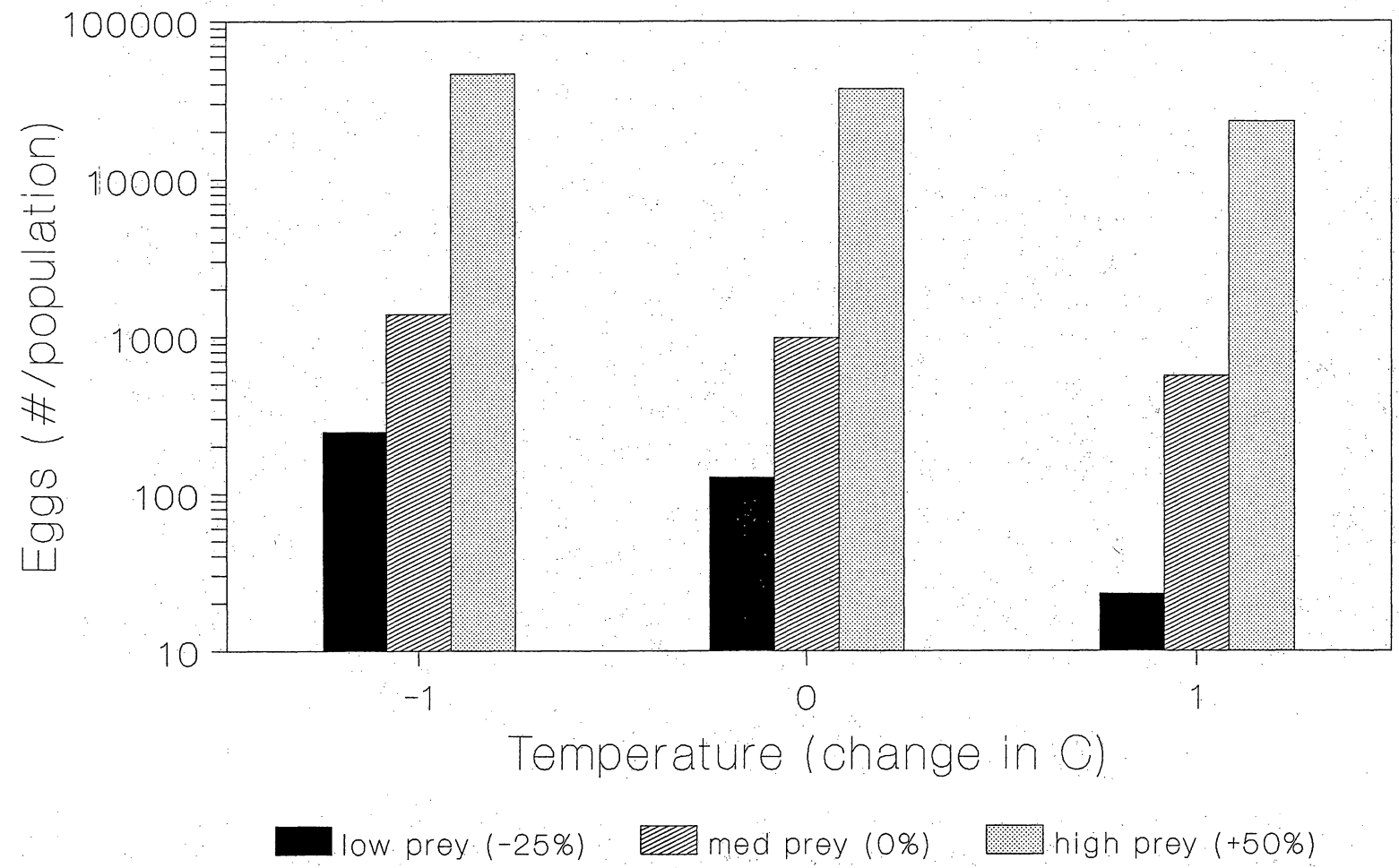


Figure 10. Egg numbers (no population⁻¹ 100m stream length⁻¹) at different temperatures and prey densities.

higher physiological costs. Cunjak (1988) found that brook trout had the steepest drop in lipid contents in autumn and hypothesized brook trout had difficulties adjusting to lower temperatures.

Model output showed large variations in growth with changes in temperature and P-values. These variations were fairly unrealistic: the mean trout size for low prey abundance was 25 grams and the mean trout size for high prey abundance was 500 grams. Individuals could weigh 25 to 500 grams after two years but is unlikely the mean would be that extreme. Magnitudes in change were large even though the change in temperature and P-value may have been realistic, suggesting the model may have been too sensitive to changes in temperature and prey abundance.

There are three reasons the growth simulations may have been inaccurate: lack of a density dependent feedback with changes in trout size, inaccurate estimates of activity costs, and unequal resource partitioning. The model does not contain any form of feedback, if trout are increasing in size and consumption they may eventually reduce prey availability (P-value). Meyer (1990) found significant positive correlations between prey abundance and P-value for yearling and adult brook trout in streams of Shenandoah National Park.

Furthermore, territorial behavior of trout would serve to partition available prey resources unequally. In situations of low prey availability, growth trajectories of individual trout would become highly variable. The effects of unequal resource partitioning and size-selective mortality will require further investigation (Grant and Kramer 1990).

Activity costs are likely underestimated in the model and may contribute to the poor prediction of growth. Activity costs are difficult to measure even in stable systems, yet activity costs contribute greatly to the energy budget. Boisclair and Legget (1989) found activity costs of perch in lakes was quite variable (0-44% of the total energy budget). Activity costs are likely to be more variable in trout streams than in lentic

systems because of social hierarchies, variation in habitat among streams and fluctuating water levels. Meyer (1990) concluded that activity costs varied widely among brook trout streams and sizes of trout in the southern Appalachians.

Validation Meyer (1990) conducted studies on the energy budget and growth of brook trout in Shenandoah National Park, Virginia. We compared the P-values found iteratively in the model with P-values found by Meyer (1990) for two periods, May to July (early summer) and July to September (late summer) (Table 4). Meyer (1990) found that P-values were variable among streams and months. The P-values estimated by Meyer (1990) were consistently higher than P-values found from Lucchetti's data. The difference was less pronounced for yearlings in early summer.

The higher P-values estimated by Meyer (1990) in comparison with the model suggest that the iterative method of estimating P-value from Lucchetti's data may have underestimated P-value. P-value was found iteratively in the model using temperature and growth data. Therefore, any underestimates in metabolic costs would cause P-value to be underestimated. therefore underestimated P-value. Two sources of costs were likely underestimated: activity costs, and increased standard metabolism due to gonadal respiration. We already discussed possible biases in activity costs; standard metabolism increases as trout are getting close to spawning because the gonadal mass also respire (Beamish 1964, Facey and Grossman 1990). Although, this increase in respiration is not normally modelled, it may increase the accuracy of bioenergetic models for brook trout. Beamish (1964) presents empirical data on brook trout respiration due to maturation that can be incorporated in the model.

Mortality versus growth

Perhaps the most promising use of this model is in predicting how feeding is related

Table 4. Seasonal P values found from Meyer (1990) and predicted by the model using seasonal growth data from Lucchetti (1983). Early summer is from May to July and late summer is July to August.

<u>Time/Stream</u>	<u>Juvenile</u>	<u>Yearling</u>	<u>Adult</u>
Early summer			
Lucchetti 1983			
Guys Run	0.45	0.36	0.31
Meyer 1990			
Piney	---	0.36	0.57
White Oak	---	0.38	0.78
Madison	---	0.31	0.32
L. Hawksbill	---	0.55	0.76
Mean		<u>0.40</u>	<u>0.61</u>
Late summer			
Lucchetti 1983			
Guys Run	0.19	0.20	0.27
Meyer 1990			
Piney	0.25	0.37	0.46
White Oak	0.34	0.34	0.63
Madison	0.33	0.24	0.20
L. Hawksbill	0.46	0.59	0.79
Mean	<u>0.35</u>	<u>0.39</u>	<u>0.52</u>

to mortality. Although there is large variations among streams in temperature and prey abundance (Cada et al 1987, Meyer 1990) most trout populations do not have large variations in growth. Growth is fairly consistent among streams in the southern Appalachians (Konopacky 1978, Robinette 1978, Mohn 1980, Lucchetti 1983). If temperature and prey abundance are variable, why are trout not growing? It is possible poor feeding does not cause lower growth rates but increases mortality rates. Ensign (1988) found brook trout in a Smoky Mountain stream fed consistently less than brook trout captured by Meyer (1990) yet both populations had similar growth rates. Ensign (1988) did find low condition factors (0.8) and high mortality rates (up to 50%) over the summer. High summer mortality rates are not typical in the southern Appalachians, based on previous studies. Most mortality in trout populations in the southern Appalachians takes place in winter (Michaels 1980, Whitworth and Strange 1983, Neves et al. 1985). Therefore, it is reasonable to assume the high mortality rates found by Ensign are due to bioenergetic factors.

Conclusions

Model output was accurate in predicting the timing of growth but may be too sensitive to changes in temperatures and prey abundance. Refinements to the model that would reduce sensitivity to temperature and prey abundance would be to include some type of feedback with changes in growth and to improve the estimate of activity costs. Meyer (1990) concluded activity costs of trout populations were variable among streams. If this is true, this model may not be useful in predicting trout growth in streams other than Guys Run. Measurements or predictions of activity costs in other streams would be useful in making this model transferable to other streams.

Historically, there has been relatively small changes in growth among brook trout streams in the southern Appalachians but large differences in numbers among streams. Therefore, this model may be more useful in predicting how changes in prey abundance and temperature affect mortality of brook trout in streams than in predicting changes in trout growth.

Individual-based models currently being developed (Huston et al. 1988; De Angelis and Godbout 1991) may permit better predictions of the effect of temperature and prey abundance changes as additional research questions are answered. This study provides the basis for developing individual-based population models for brook trout.

Future research on the following topics will fill important information gaps.

1. Activity costs among different sizes of brook trout at different times of the year.
2. Range in activity costs among streams and behavioral and physiological explanations for variable activity costs among streams.
3. Relation between growth and mortality for brook trout.
4. Density-dependent feedback mechanisms for predicting consumption under variable prey abundance.
5. Relation between temperature and maximum consumption for brook trout, especially in southern latitudes.
6. Seasonal changes in caloric density of adult male and female brook trout.
7. Mechanics of feeding behavior.

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APPENDIX I: MODEL CODE

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C-----
C
C           BROOK TROUT MODEL
C BIOENERGETIC BASED MODEL OF BROOK TROUT IN SOUTHERN APPALACHIANS
C
C THIS MODEL DETERMINES THE EFFECT OF CHANGES IN TEMPERATURE AND PREY
C DENSITY ON GROWTH OF BROOK TROUT. IT ALSO TRACKS CHANGES IN
C RECRUITMENT WITH CHANGES IN GROWTH AND HAS THE OPTION TO TRACK
C MORTALITY WITH CHANGES IN GROWTH.
C-----
C
C STATE VARIABLES
C NUM (I)= NUMBER OF BROOK TROUT AT AGE I
C WEI (I)= WEIGHT OF BROOK TROUT AT AGE I
C EGGS
C-----
C INPUT VARIABLES
C TCHANG= CHANGES IN TEMPERATURE
C PCHANG= CHANGES IN PREY DENSITY (AS PROPORTION OF CURRENT DENSITY
C       E.G. - .20.
C-----
C
C PARAMETERS (MAIN PROGRAM)
C T= INITIAL TIME (YEAR)
C SEGGS= SUM OF EGGS (NUMBER OF EGGS SPAWNED BY ALL AGE CLASSES)
C TMAX= TIME OF SIMULATION (YEARS)
C TDY= TIME WITHIN YEAR (DAYS, 0 IS EQUAL TO NOVEMBER 1)
C IOUT= THE NUMBER OF DAYS RUN BEFORE PRINTING (START AT 0)
C SUR (I)= YEARLY SURVIVAL OF AGE CLASSES, DEFAULT SURVIVAL VALUES
C       (IF TYING MORTALITY TO GROWTH THESE VALUES WILL BE OVERRIDDEN).
C       (PROPORTION SURVIVING YEAR)
C-----
C       (OPTION)
C PARAMETERS FOR GROWTH DEPENDENT MORTALITY
C MORTALITY VALUES IF TYING MORTALITY TO GROWTH. I AM ASSUMING
C FISH MORTALITY IS A FUNCTION OF THE AMOUNT OF WEIGHT LOST.
C NMOR = NATURAL MORTALITY (PROPORTION OF YEARLY MORT.)
C ZGD (I)= IS GROWTH DEPENDENT MORTALITY
C       (PROPORTION OF YEARLY MORT.) AT AGE I
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C  ZGI (I)= IS GROWTH INDEPENDENT MORTALITY
C  (PROPORTION OF YEARLY MORT.) AT AGE I
C  ZGDMAX (I)= IS MAXIMUM GROWTH DEPENDENT MORTALITY RATE (PROPORTION
C  OF YEARLY MORT.) AT AGE I
C  MAXWEI (I) = THE MAXIMUM MEAN WEIGHT OF A COHORT
C  K (I) = WEIGHT LOSS IN % (WEI/MAXWEI)
C  B = CONSTANT THAT REPRESENTS THE INCREASE IN MORTALITY RATE
C  WITH WEIGHT LOSS
C -----
C  RECRUITMENT PARAMETERS
C  LEN (I)= LENGTH OF BROOK TROUT AT AGE I
C  FEC (I)= AGE SPECIFIC FECUNDITY (EGGS/FISH)
C  MAT (I)= AGE SPECIFIC MATURATION (PROPORTION MATURE)
C  PRO (I)= FEMALES IN THE POPULATION (PROPORTION OF POPULATION).
C  EGGS= EGGS (NUMBER PER AGE CLASS)
C  EGGSUR= EGG SURVIVAL (PROPORTION SURVIVING TO EMERGENCE)
C  GSF= GSI OF FEMALES AT SPAWNING
C  GSM= GSI OF MALES AT SPAWNING
C  WEILF= WEIGHT LOSS OF FEMALES AT SPAWNING
C  WEILM= WEIGHT LOSS OF MALES AT SPAWNING
C  STEMP= SUM OF DAILY TEMPERATURES SINCE SPAWNING (USED TO CALCULATE
C  TIME OF EMERGENCE)
C  AVTEMP= AVERAGE TEMPERATURE SINCE SPAWNING (ALSO USED TO CALCULATE
C  TIME OF EGG EMERGENCE)
C  DAYEME= DAY FRY EMERGE FROM GRAVEL
C  EGWEI= WEI OF FRY AT EMERGENCE (I.E. 0.04 GRAMS)
C -----
C  PARAMETERS FOR GROWTH
C  TEMPDEP= SUBROUTINE THAT ESTIMATES THE EFFECT OF TEMPERATURE ON THE
C  AMOUNT OF FOOD EATEN (PARAMETERS IN SUBROUTINE FROM THORTON
C  LESSEM (1978), OR FOUND FROM LITERATURE).
C  PVAL(I)= PROPRION OF MAXIMUM CONSUMPTION EATEN
C  CMAX(I)= MAXIMUM AMOUNT OF FOOD THAT COULD BE EATEN
C  C(I)= ENERGY CONSUMED
C  R(I)= TOTAL ENERGY RESPIRED
C  RS(I)= ENERGY FOR STANDARD METABOLISM
C  RSDA(I)= ENERGY FOR STANDARD DYNAMIC ACTION
C  RA(I)= ENERGY FOR ACTIVE METABOLISM
C  F(I)= ENERGY FOR EGESTION
C  U(I)= ENERGY FOR EXCRETION
C  VEL(I)= TROUT SWIM SPEED (USED TO CALCULATE RA)
C  G= PARAMETER THAT ESTIMATES HOW SWIM SPEED RELATES TO ACTIVITY COSTS
C  GRO(I)= DAILY GROWTH IN G/FISH
C -----
C  (OPTION)
C  PARAMETERS FOR ESTIMATING PVAL FROM PREY ABUNDANCE DATA (MEYER 1990)
C  INSTEAD OF TROUT GROWTH DATA (LUCCHETTI 1983).
C  PI(I)= COEFFICIENT FOR IVLEV'S EQUATION
C  PREDEN = THE NUMBER OF PREY > 4MM /M3
C -----
C  BEGIN MAIN MODEL
C -----
C  DECLARE VARIABLES
C  REAL WEI(4),PRO(4),NUM(4),SUR(4)

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```

REAL TCHANG,PCHANG
REAL NMOR,ZGD(4),ZGI(4),ZGDMAX(4),MAXWEI(4),K(4),B
INTEGER TDY, DT, T, TMAX
C-----
C
C SET INITIAL CONDITIONS
C
C-----
C INITIALIZE STATE VARIABLES
C-----
DATA NUM/145.,65.,18.,4./
DATA WEI/0.65,9.36,36.42,71.88/
DATA MAXWEI/0.65,9.36,36.42,71.88/
EGGS = 0.
C-----
C INPUT CHANGE IN TEMPERATURE AND CHANGE IN PREY
C-----
WRITE(5,25)
25 FORMAT('ENTER THE TEMPERATURE CHANGE(EG. 2. OR -1. ETC.)')
READ(5,35)TCHANG
35 FORMAT(F8.2)
WRITE(5,45)
45 FORMAT('ENTER THE PVALUE CHANGE AS PROPORTION (E.G. 0.5 OR -.25)')
READ(5,35)PCHANG
C-----
C INITIALIZE VARIABLES
C-----
DATA SUR/.37,.37,.1,.1/
DATA K/1,1,.8,.8/
DATA ZGD/0.,0.,0.,0./
DATA ZGI/0.,0.,0.,0./
DATA ZGDMAX/100.,100.,100.,100./
DATA NMOR = 0.
B = 5.0
T = 0
TMAX = 1460
TDY = 200
IOUT = 0.
EGGSUR = .54
STEMP = 0.
C-----
C WRITE COLUMN HEADINGS
C-----
WRITE(6,3)TCHANG,PCHANG
WRITE(6,1)
3 FORMAT(' ', 'CHANGE SUMMER TEMPERATURE = ',F6.2,' CHANGE PREY = ',
&F6.2)
1 FORMAT('/ ', 'TIME',26X,'EGGS',4X,'AGE 0',4X,'AGE 1',4X,'AGE 2',4X,
&'AGE 3 ')
C-----
C
C BEGIN RUNNING MAIN MODEL
C
C-----
C START MODEL AND TRACK DAYS

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```

50  IF(T.LT.TMAX)THEN
C   DT IS ONE DAY
    DT=1
    TDY=TDY+DT
C   RESET TIME WITHIN YEAR TO 0 AFTER 1 YEAR
C   THE NEW YEAR IS CONSIDER TO START WITH SPAWNING ON NOVEMBER 1.
    IF(TDY.GT.365)THEN
      TDY=1
    END IF
C   ENTER TEMPERATURE DATA FROM HORNICK ET AL, WE CAN ALSO USE AN
C   AVERAGE TEMPERATURE WITH A SINE FUNCTION IF WE PREFER
    IF(TDY.GE.0.AND.TDY.LT.7)TEMP=9.0
    IF(TDY.GE.7.AND.TDY.LT.14)TEMP=7.5
    IF(TDY.GE.14.AND.TDY.LT.21)TEMP=7.0
    IF(TDY.GE.21.AND.TDY.LT.28)TEMP=6.5
    IF(TDY.GE.28.AND.TDY.LT.42)TEMP=7.0
    IF(TDY.GE.42.AND.TDY.LT.49)TEMP=5.0
    IF(TDY.GE.49.AND.TDY.LT.56)TEMP=2.0
    IF(TDY.GE.56.AND.TDY.LT.98)TEMP=0.0
    IF(TDY.GE.98.AND.TDY.LT.105)TEMP=1.0
    IF(TDY.GE.105.AND.TDY.LT.112)TEMP=2.0
    IF(TDY.GE.112.AND.TDY.LT.119)TEMP=3.0
    IF(TDY.GE.119.AND.TDY.LT.126)TEMP=4.0
    IF(TDY.GE.126.AND.TDY.LT.133)TEMP=5.0
    IF(TDY.GE.133.AND.TDY.LT.154)TEMP=6.0
    IF(TDY.GE.154.AND.TDY.LT.161)TEMP=6.5
    IF(TDY.GE.161.AND.TDY.LT.168)TEMP=7.5
    IF(TDY.GE.168.AND.TDY.LT.175)TEMP=8.5
    IF(TDY.GE.175.AND.TDY.LT.182)TEMP=9.5
    IF(TDY.GE.182.AND.TDY.LT.189)TEMP=10.0
    IF(TDY.GE.189.AND.TDY.LT.196)TEMP=10.5
    IF(TDY.GE.196.AND.TDY.LT.203)TEMP=12.5
    IF(TDY.GE.203.AND.TDY.LT.210)TEMP=13.5
    IF(TDY.GE.210.AND.TDY.LT.231)TEMP=14.5
    IF(TDY.GE.231.AND.TDY.LT.238)TEMP=15.5
    IF(TDY.GE.238.AND.TDY.LT.245)TEMP=16.5
    IF(TDY.GE.245.AND.TDY.LT.259)TEMP=17.0
    IF(TDY.GE.259.AND.TDY.LT.266)TEMP=17.5
    IF(TDY.GE.266.AND.TDY.LT.273)TEMP=18.0
    IF(TDY.GE.273.AND.TDY.LT.280)TEMP=18.5
    IF(TDY.GE.280.AND.TDY.LT.301)TEMP=19.0
    IF(TDY.GE.301.AND.TDY.LT.308)TEMP=18.5
    IF(TDY.GE.308.AND.TDY.LT.315)TEMP=17.0
    IF(TDY.GE.315.AND.TDY.LT.322)TEMP=15.5
    IF(TDY.GE.322.AND.TDY.LT.329)TEMP=15.0
    IF(TDY.GE.329.AND.TDY.LT.336)TEMP=13.0
    IF(TDY.GE.336.AND.TDY.LT.343)TEMP=11.5
    IF(TDY.GE.343.AND.TDY.LT.350)TEMP=10.5
    IF(TDY.GE.350.AND.TDY.LT.357)TEMP=10.0
    IF(TDY.GE.357.AND.TDY.LT.364)TEMP=9.0
C   SINE FUNCTION FOR TEMPERATURE
C   CALCULATE TIME DURING YEAR IN RADIANS
C   TR=(TDY/365.)*6.28318
C   CALCULATE TEMPERATURE (MAX OCCURS 29 DAYS AFTER SUMMER SOLSTICES
C   AT JULY 21 (WE ZEROED THE SINE FUNCTION ON APRIL 19 OR TDY=170)
C   EARLIER MODELS HAD IF STATEMENTS FOR INCREASING TEMPERATURES DURING

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C SUMMER MONTHS TO MODEL CLEARCUTTING AND OTHER EFFECTS.
C TEMP = (9.5) + SIN(TR-2.926415075)*9.5
C CHANGE IN SUMMER TEMPERATURE; TEMP ONLY CHANGES FROM MAY 1 TO
C OCTOBER 31
  IF (TDY.GE.181.AND.TDY.LE.365)THEN
    TEMP = TEMP + TCHANG
  ENDIF
C INPUT RECRUITMENT
  CALL RECRU (TDY,TEMP,WEI,NUM,MAXWEI,SEGGS)
C INSERT THE SPECIFIC GROWTH RATE
  CALL GROWTH (TEMP,TDY,WEI,PCHANG)
C-----
C
C INSERT MORTALITY RATES (ANALYTICAL)
C IF YOU DO NOT WANT TO USE FEEDING DEPENDENT MORTALITY THEN COMMENT
C THE FIRST THREE COMMAND LINES AFTER THE 'DO 40' COMMAND.
C MORTALITY RATES FOR EGGS (COMBINED HATCHING AND EMERGENCE RATES)
C
C-----
C TRACK CONDITION OF TROUT (FOR WEIGHT DEPENDENT MORTALITY)
C-----
  DO 30 I = 1,4
    IF(WEI(I).GT.MAXWEI(I)) THEN
      MAXWEI(I) = WEI(I)
    ENDIF
    IF(MAXWEI(I).EQ.0.)THEN
      K(I) = 1.
    ELSE
      K(I) = WEI(I)/MAXWEI(I)
    ENDIF
  30 CONTINUE
C-----
C CALCULATE MORTALITY RATES
C-----
  EGGZ = (-ALOG(EGGSUR))/120.
  SEGGS = SEGGS * EXP(-EGGZ)
  DO 40 I = 1,4
    C ZGD(I) = ZGDMAX(I) * EXP(-B * K(I))
    C NMOR = ZGD(I) + ZGI(I)
    C SUR(I) = 1-NMOR
    Z = (-ALOG(SUR(I)))/364.
  40 NUM(I) = NUM(I) * EXP(-Z)
C CHANGE NUMBERS TO 0 IF TEMPERATURE REACHES LETHAL LEVELS
  IF(TEMP.GE.25.3)THEN
    DO 60 I = 1,4
  60 NUM(I) = 0.
  END IF
C IOUT IS THE COUNTER FOR THE OUTPUT INTERVAL
C WRITE X VALUES EVERY TWO WEEKS
  IF(IOUT.LT.14)THEN
    IOUT = IOUT + 1
  ELSE
    C IF(TDY.EQ.181.OR.TDY.EQ.242.OR.TDY.EQ.334.)THEN
      WRITE(6,2)TDY,SEGGS,(NUM(I),I = 1,4)
      WRITE(6,4)TDY,(WEI(I),I = 1,4)
    C ENDIF

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C   IF(TDY.EQ.30..OR.TDY.EQ.151.)THEN
C   WRITE(6,4)TDY,(WEI(I),I= 1,4)
C   ENDIF
2   FORMAT(/' ',I4,5X,'NUMBERS',4X,5F10.4)
4   FORMAT(' ',I4,5X,'WEIGHTS',19X,5F10.4)
      IOUT = 0
      END IF
      T = T + DT
      GOTO 50
      END IF
      STOP
      END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
SUBROUTINE RECRU(TDY,TEMP,WEI,NUM,MAXWEI,SEGGS)
REAL WEI(4),LEN(4),FEC(4),PRO(4),NUM(4),MAT(4),GSF,GSM,EGGS,WEILF
REAL WEILM,STEMP,TD,AVTEMP,DAYEME,EQWEI,MAXWEI(4),SEGGS
INTEGER TDY
C THIS SUBROUTINE DETERMINES FECUNDITY BY (SIZE AND AGE OF TROUT) AND
C DETERMINES RECRUITMENT OF EGGS AND FISH TO NEW AGE CLASSES.
C-----
C INITIALIZE PARAMETERS
C-----
      DATA LEN/90.,120.,145.,180./
      DATA FEC/0.,0.,1.,1./
      DATA MAT/0.,0.,1.,1./
      DATA PRO/.5.,.5.,.5.,.5/
      GSF = .12
      GSM = .012
C-----
C CALCULATE NUMBER OF EGGS SPAWNED
C-----
      IF(TDY.EQ.1)THEN
      DO 10 I = 1,4
      LEN(I) = (100000. * WEI(I))**.33333
      FEC(I) = (1.41 * LEN(I)) - 114.06
      IF(FEC(I).LE.0.)THEN
      FEC(I) = 0.
      END IF
10  CONTINUE
C CALCULATE MATURATION FOR I+ FISH
      MAT(2) = .997/(1. + 50. * EXP(-.068 * WEI(2)))
C CALCULATE NUMBER OF EGGS
C AND RECALCULATE WEIGHT AFTER SPAWNING,WEILF IS WEIGHT LOSS OF FEMALE
C WEILM IS WEIGHT LOSS OF MALES, EGGS AND SEGGS HAS TO BE INITIALIZED
C AT 0.
      EGGS = 0.
      SEGGS = 0.
      DO 20 I = 1,4
      EGGS = FEC(I) * MAT(I) * PRO(I) * NUM(I)
      WEILF = (MAT(I) * PRO(I) * GSF * WEI(I))
      WEILM = (MAT(I) * (1-PRO(I)) * GSM * WEI(I))
      WEI(I) = WEI(I)-(WEILF + WEILM)
20  SEGGS = SEGGS + EGGS
C INITIALIZE ALL EGG TEMPERATURE DATA TO 0
C STEMP = SUM OF TEMPERATURE AFTER EGGS ARE SPAWNED, AVTEMP = AVERAGE

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C TEMPERATURE AFTER EGGS ARE SPAWNED, DAYEME = DAYS TO EMERGENCE
C EGWEI = BIOMASS OF FRY AT EMERGENCE(LUCCHETTI QUOTES HUNT PER OBS.),
  STEMP = 0.
  AVTEMP = 0.
  DAYEME = 0.
  EGWEI = 0.04
  END IF
C-----
C CALCULATE RECRUITMENT OF FISH AND EGGS
C-----
C GRADUATE ALL THE FISH TO A NEW AGE CLASS ON DECEMBER 15.
  IF(TDY.EQ.46)THEN
    NUM(4) = NUM(3)
    NUM(3) = NUM(2)
    NUM(2) = NUM(1)
    NUM(1) = 0.
    WEI(4) = WEI(3)
    WEI(3) = WEI(2)
    WEI(2) = WEI(1)
    WEI(1) = 0.0
    MAXWEI(4) = MAXWEI(3)
    MAXWEI(3) = MAXWEI(2)
    MAXWEI(2) = MAXWEI(1)
    MAXWEI(1) = 0.0
  ENDIF
C GRADUATE EGGS TO AGE 0 AT HATCHING
  IF(SEGGS.GT.0.)THEN
    STEMP = STEMP + TEMP
    TD = FLOAT(TDY)
    AVTEMP = STEMP/TD
    DAYEME = EXP(5.7129 -(0.13 * AVTEMP))
    IF(TD.GE.DAYEME)THEN
      NUM(1) = NUM(1) + SEGGS
      WEI(1) = WEI(1) + EGWEI
      SEGGS = 0.
    END IF
  END IF
  RETURN
  END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
SUBROUTINE GROWTH(TEMP,TDY,WEI,PCHANG)
REAL WEI(4),TEMDEP, PVAL(4),CMAX(4),C(4),R(4),RS(4),RSDA(4)
REAL RA(4), M, F(4), GRO(4), U(4),VEL(4),PI(4)
INTEGER TDY
C THIS SUBROUTINE CONTAINS THE EQUATIONS FOR GROWTH
C CALCULATE SPECIFIC GROWTH RATES OF BROOK TROUT
C PVALUES FOUND FROM EMPIRICALLY FROM LUCCHETTI (1983) AND HORNICK
C ET AL. (1980).
C-----
C READ IN INITIAL VALUES
C-----
DATA VEL/10.,10.,10.,10./
IF(TDY.GT.45.AND.TDY.LE.200)THEN
  PVAL(1) = .8
  PVAL(2) = .49
  PVAL(3) = .42

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PVAL(4) = .50
END IF
IF(TDY.GT.200.AND.TDY.LE.258)THEN
PVAL(1) = .45
PVAL(2) = .36
PVAL(3) = .30
PVAL(4) = .41
END IF
IF(TDY.GT.258.AND.TDY.LE.350)THEN
PVAL(1) = .19
PVAL(2) = .2
PVAL(3) = .27
PVAL(4) = .27
END IF
IF(TDY.LE.45.OR.TDY.GT.350)THEN
PVAL(1) = .19
PVAL(2) = .22
PVAL(3) = .13
PVAL(4) = .13
END IF
C-----
C
C PVAL IS FOUND IN THIS SECTION FROM THE EMPIRICAL RELATION
C OF PREY DENSITY (NUM PREY > 4MM) TO PVAL (MEYER 1990).
C THIS RELATION IS ONLY APPROPRIATE FROM MAY 1 (AT TDY = 200) TO
C SEPTEMBER 1 (AT TDY = 323)
C-----
CC INITIALIZE DATA
C DATA PI/.5258734,.5773327,1.159615,1.159615/
C PREDEN = .5
C IF(TDY.GT.200.AND.TDY.LE.323)THEN
C DO 70 I = 1,4
C PVAL(I) = (1-EXP(-PI(I)*PREDEN))
C70 CONTINUE
C END IF
C IF(TDY.GT.323.AND.TDY.LE.350)THEN
C PVAL(1) = .19
C PVAL(2) = .2
C PVAL(3) = .27
C PVAL(4) = .27
C END IF
DO 80 I = 1,4
PVAL(I) = PVAL(I) + (PVAL(I) * PCHANG)
80 CONTINUE
C-----
C
C DETERMINE SPECIFIC GROWTH
C VALUES FROM ELLIOTT 1975, THE RESULT OF THE EQUATION IS IN G DRY
C WEIGHT PER DAY. GAMMARUS HAS 4.05CAL/G; AQUATIC INVERTS HAVE 5CAL/G
C DRY WEIGHT. THIS EQUATION ASSUMES 24 HOURS OF DAYLIGHT.
C DRY WT IS 1/4 OF WET WT (ELLIOTT 1976)
C-----
C CALCULATE CONSUMPTION

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C-----
C  START CALCULATING THE TEMPERATURE DEPENDENT FUNCTION
C  CALL TEMPDE(TEMP,TEMDEP)
C  DO 10 I= 1,4
C  CMAX(I)= 248.9 * WEI(I)** 0.767
10  C(I)= CMAX(I) * PVAL(I) * TEMDEP
C-----
C  DETERMINE EGESTION AND EXCRETION
C-----
C  DO 40 I= 1,4
C  F(I)= C(I) * .267
C  U(I)= C(I) * .06
40  CONTINUE
C-----
C  CALCULATE THE COMPONENTS OF RESPIRATION: STANDARD= RS,
C  ACTIVITY= RA, AND STANDARD DYNAMIC ACTION= RSDA
C-----
C  DO 20 I= 1,4
C  RS(I)=(4.42611*WEI(I)** 0.8347) * EXP(0.08212232*TEMP)
C  IF(VEL(I).GT.25)THEN
C  G = .026
C  ELSE
C  G = .013555
C  END IF
C  RA(I)= RS(I) *EXP(VEL(I)*G)-RS(I)
C  RSDA(I)= (C(I)-F(I)) * .172
20  R(I)=(RS(I) + RA(I)) + RSDA(I)
C-----
C  CALCULATE THE SPECIFIC GROWTH RATE FOR EACH AGE CLASS
C  DIVIDING GROO BY 1360J/G DRY WT CONVERTS IT FROM ENERGY TO MASS
C-----
C  DO 30 I= 1,4
C  GRO(I)= C(I) - R(I) - F(I) -U(I)
30  GRO(I)= GRO(I)/1360
C  WEI(1)=(WEI(1) + GRO(1))
C  WEI(2)=(WEI(2) + GRO(2))
C  WEI(3)=(WEI(3) + GRO(3))
C  WEI(4)=(WEI(4) + GRO(4))
100 CONTINUE
C  RETURN
C  END
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
SUBROUTINE TEMPDE(TEMP,TEMDEP)
REAL TEMPO1,TEMPO2
REAL K1, K2,K3,K4,KA,KB,L1,L2,G1,G2,TEMDEP
C  START CALCULATING THE TEMPERATURE DEPENDENT FUNCTION
C  THORTON AND LESSEM CALCULATIONS
C  INITIAL CONDITIONS
C  TEMPL= TEMP AT LOW THRESHOLD,TEMPU= TEMPERATURE AT UPPER THRESHOLD
C  TEMPO1,TEMPO2= TEMPERATURE AT MAXIMUM CONSUMPTION(DON'T HAVE TO BE
C  THE SAME),K1= REACTION RATE AT TEMPL, K4= REACTION RATE AT TEMPU
C  K2, K3= REACTION RATE AT OPTIMUM(DON'T USE 1, ALWAYS USE .98)
C  TEMPL= 3.5
C  TEMPU= 21.
C  TEMPO1= 16.0
C  TEMPO2= 16.0

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K1=.26
K2=.98
K3=.98
K4=.133
C START OF CALCULATING KA DESCRIBES THE RISING PORTION OF THE CURVE
C AND KB DESCRIBES THE FALLING PORTION
G1 = (1./(TEMPO1-TEMPL))*ALOG((K2*(1.-K1))/(K1*(1.-K2)))
L1= EXP(G1 * (TEMP-TEMPL))
KA=(K1 * L1)/(1. + K1 * (L1-1.))
G2 = (1./(TEMPU-TEMPO2))*ALOG((K3*(1.-K4))/(K4*(1.-K3)))
L2= EXP(G2 * (TEMPU-TEMP))
KB=(K4 * L2)/(1. + K4 * (L2-1.))
TEMDEP= KA * KB
20 CONTINUE
RETURN
END

```

APPENDIX II: SIMULATION OUTPUT

Simulation output represents the number and weight of trout in 100 meters of Guys Run, Virginia, during four years. Model runs were begun at initial conditions on May 19 (TDY = 200). All fish were recruited to new age classes on November 1 (TDY = 1).

This appendix contains nine model simulations (three temperatures versus three prey densities). The three prey abundances were: 25% less than, the same as, and 50% more than Pvalues found iteratively throughout the year for data from Lucchetti (1983). The three temperatures were: one degree cooler (Tchange = -1.0), the same temperature (Tchange = 0.0) and one degree warmer (Tchange = 1.0) than the temperature measured in Guys Run (Hornick et al. 1981).

CHANGE SUMMER TEMPERATURE = -1.00 CHANGE PREY = -0.25

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		0.9051	10.4602	38.1798	77.7533
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		1.2264	11.6213	39.8866	83.8134
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		1.6012	12.7186	41.2098	89.4262
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		1.9580	13.5590	42.0896	93.8556
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		1.8971	13.1265	41.9513	93.0777
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		1.7802	12.4260	40.9608	90.7000
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		1.6730	11.7734	40.0342	88.4567
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		1.6646	11.6123	40.5396	88.9385
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		1.7086	11.7185	41.7933	90.8592
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		1.7742	11.9441	43.2942	93.2927
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		1.8259	12.2176	42.5616	91.7291
15	NUMBERS	649.3457	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		1.8760	12.4466	39.0773	84.2341
30	NUMBERS	601.2065	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		1.9056	12.6081	38.3702	82.7610
45	NUMBERS	556.6367	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		1.9287	12.7373	37.6507	81.2717
60	NUMBERS	515.3701	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	1.9793	12.7844	37.9252
75	NUMBERS	477.1636	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	1.9560	12.5872	37.5063
90	NUMBERS	441.7891	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	1.9331	12.3929	37.0919
105	NUMBERS	409.0364	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	1.9251	12.2478	36.8164
120	NUMBERS	378.7122	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	1.9958	12.3576	37.2705
135	NUMBERS	350.6357	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	2.2090	12.9152	39.0015
150	NUMBERS	324.6409	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	2.5391	13.7935	41.6511
165	NUMBERS	300.5730	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	2.9789	14.9241	45.0277
180	NUMBERS	0.0000	281.3569	46.3198	17.8642	3.9154
180	WEIGHTS		0.0643	3.6793	16.6513	50.1217
195	NUMBERS	0.0000	267.7366	44.0777	16.7177	3.6641
195	WEIGHTS		0.1701	4.5397	18.6240	55.9282
210	NUMBERS	0.0000	254.7756	41.9440	15.6449	3.4290
210	WEIGHTS		0.3130	5.3680	20.2054	61.6313
225	NUMBERS	0.0000	242.4434	39.9137	14.6409	3.2089
225	WEIGHTS		0.4659	6.1029	21.3502	66.7978
240	NUMBERS	0.0000	230.7081	37.9816	13.7014	3.0030
240	WEIGHTS		0.6626	6.8598	22.4013	71.9285
255	NUMBERS	0.0000	219.5409	36.1430	12.8221	2.8103
255	WEIGHTS		0.8949	7.5613	23.1765	76.5050
270	NUMBERS	0.0000	208.9142	34.3935	11.9993	2.6299
270	WEIGHTS		0.9329	7.5466	23.4402	77.1913
285	NUMBERS	0.0000	198.8019	32.7286	11.2293	2.4612
285	WEIGHTS		0.8853	7.1882	23.0920	75.6373
300	NUMBERS	0.0000	189.1790	31.1443	10.5087	2.3032
300	WEIGHTS		0.8261	6.7686	22.5090	73.4994
315	NUMBERS	0.0000	180.0219	29.6367	9.8343	2.1554
315	WEIGHTS		0.8107	6.5942	22.6292	73.1900
330	NUMBERS	0.0000	171.3081	28.2021	9.2032	2.0171
330	WEIGHTS		0.8365	6.6554	23.4241	74.6506
345	NUMBERS	0.0000	163.0161	26.8369	8.6126	1.8876
345	WEIGHTS		0.8797	6.8201	24.4717	76.8073
360	NUMBERS	0.0000	155.1254	25.5378	8.0600	1.7665
360	WEIGHTS		0.9201	7.0232	24.5400	76.6492
10	NUMBERS	422.0457	147.6166	24.3015	7.5427	1.6531
10	WEIGHTS		0.9548	7.2040	22.5327	70.3797

25	NUMBERS	390.7571	140.4713	23.1251	7.0587	1.5471
25	WEIGHTS		0.9789	7.3404	22.1256	69.1506
40	NUMBERS	361.7878	133.6719	22.0057	6.6057	1.4478
40	WEIGHTS		1.0034	7.4786	21.7267	67.9444
55	NUMBERS	334.9666	0.0000	127.2016	20.7085	6.1818
55	WEIGHTS		0.0000	1.0424	7.5727	21.8631
70	NUMBERS	310.1331	0.0000	121.0445	19.3795	5.7851
70	WEIGHTS		0.0000	1.0308	7.4516	21.6163
85	NUMBERS	287.1409	0.0000	115.1854	18.1358	5.4139
85	WEIGHTS		0.0000	1.0193	7.3324	21.3722
100	NUMBERS	265.8530	0.0000	109.6099	16.9719	5.0665
100	WEIGHTS		0.0000	1.0108	7.2249	21.1591
115	NUMBERS	246.1443	0.0000	104.3043	15.8827	4.7413
115	WEIGHTS		0.0000	1.0370	7.2399	21.2899
130	NUMBERS	227.8972	0.0000	99.2555	14.8635	4.4371
130	WEIGHTS		0.0000	1.1372	7.5108	22.1374
145	NUMBERS	211.0027	0.0000	94.4510	13.9096	4.1523
145	WEIGHTS		0.0000	1.3348	8.0868	23.8400
160	NUMBERS	195.3607	0.0000	89.8792	13.0170	3.8859
160	WEIGHTS		0.0000	1.5802	8.7657	25.8364
175	NUMBERS	0.0000	181.2091	85.5286	12.1817	3.6365
175	WEIGHTS		0.0435	1.9863	9.8447	28.9604
190	NUMBERS	0.0000	172.4378	81.3886	11.4000	3.4031
190	WEIGHTS		0.1250	2.5394	11.2015	32.8742
205	NUMBERS	0.0000	164.0911	77.4490	10.6684	3.1847
205	WEIGHTS		0.2714	3.1672	12.5541	37.1249
220	NUMBERS	0.0000	156.1483	73.7000	9.9838	2.9804
220	WEIGHTS		0.4100	3.6819	13.4142	40.7979
235	NUMBERS	0.0000	148.5901	70.1326	9.3431	2.7891
235	WEIGHTS		0.5930	4.2385	14.2630	44.6109
250	NUMBERS	0.0000	141.3977	66.7378	8.7436	2.6101
250	WEIGHTS		0.8126	4.7686	14.9207	48.0902
265	NUMBERS	0.0000	134.5534	63.5073	8.1825	2.4426
265	WEIGHTS		0.9414	5.0076	15.3442	49.9670
280	NUMBERS	0.0000	128.0404	60.4332	7.6574	2.2859
280	WEIGHTS		0.9060	4.8209	15.3068	49.4128
295	NUMBERS	0.0000	121.8427	57.5079	7.1660	2.1392
295	WEIGHTS		0.8454	4.5365	14.9480	48.0538

310	NUMBERS	0.0000	115.9449	54.7242	6.7061	2.0019
310	WEIGHTS		0.8092	4.3491	14.8506	47.3703
325	NUMBERS	0.0000	110.3327	52.0753	6.2758	1.8734
325	WEIGHTS		0.8258	4.3737	15.3743	48.2814
340	NUMBERS	0.0000	104.9921	49.5545	5.8731	1.7532
340	WEIGHTS		0.8650	4.4900	16.1454	49.8398
355	NUMBERS	0.0000	99.9100	47.1558	5.4962	1.6407
355	WEIGHTS		0.9080	4.6426	16.5870	50.6513
5	NUMBERS	231.0631	95.0738	44.8732	5.1435	1.5354
5	WEIGHTS		0.9438	4.7935	15.2362	46.5084
20	NUMBERS	213.9339	90.4718	42.7010	4.8134	1.4369
20	WEIGHTS		0.9726	4.9238	14.9726	45.7052
35	NUMBERS	198.0745	86.0925	40.6340	4.5045	1.3446
35	WEIGHTS		0.9949	5.0273	14.6961	44.8831
50	NUMBERS	183.3909	0.0000	81.9252	38.4523	4.2154
50	WEIGHTS		0.0000	1.0343	5.1400	14.6953
65	NUMBERS	169.7957	0.0000	77.9596	35.9847	3.9449
65	WEIGHTS		0.0000	1.0347	5.0876	14.6160
80	NUMBERS	157.2084	0.0000	74.1860	33.6754	3.6918
80	WEIGHTS		0.0000	1.0231	5.0043	14.4493
95	NUMBERS	145.5542	0.0000	70.5950	31.5143	3.4549
95	WEIGHTS		0.0000	1.0117	4.9223	14.2844
110	NUMBERS	134.7640	0.0000	67.1778	29.4919	3.2331
110	WEIGHTS		0.0000	1.0213	4.8960	14.2748
125	NUMBERS	124.7736	0.0000	63.9261	27.5992	3.0257
125	WEIGHTS		0.0000	1.0905	5.0264	14.7020
140	NUMBERS	115.5238	0.0000	60.8317	25.8280	2.8315
140	WEIGHTS		0.0000	1.2640	5.4151	15.8476
155	NUMBERS	106.9598	0.0000	57.8871	24.1705	2.6498
155	WEIGHTS		0.0000	1.4895	5.9021	17.2710
170	NUMBERS	99.0306	0.0000	55.0851	22.6194	2.4797
170	WEIGHTS		0.0000	1.8317	6.6147	19.3264
185	NUMBERS	0.0000	93.5508	52.4186	21.1677	2.3206
185	WEIGHTS		0.0905	2.3437	7.6172	22.1975
200	NUMBERS	0.0000	89.0225	49.8813	19.8093	2.1717
200	WEIGHTS		0.2342	3.0046	8.8111	25.6166
215	NUMBERS	0.0000	84.7133	47.4668	18.5380	2.0323

215	WEIGHTS		0.3591	3.5055	9.5111	28.4836
230	NUMBERS	0.0000	80.6128	45.1691	17.3483	1.9019
230	WEIGHTS		0.5274	4.0535	10.2164	31.5162
245	NUMBERS	0.0000	76.7107	42.9826	16.2349	1.7798
245	WEIGHTS		0.7359	4.5964	10.8174	34.4304
260	NUMBERS	0.0000	72.9975	40.9020	15.1931	1.6656
260	WEIGHTS		0.9455	5.0398	11.2811	36.8476
275	NUMBERS	0.0000	69.4641	38.9221	14.2181	1.5587
275	WEIGHTS		0.9212	4.8964	11.3886	36.7637
290	NUMBERS	0.0000	66.1016	37.0380	13.3057	1.4587
290	WEIGHTS		0.8651	4.6294	11.1924	35.9121
305	NUMBERS	0.0000	62.9020	35.2451	12.4519	1.3651
305	WEIGHTS		0.8139	4.3824	11.0143	35.1169
320	NUMBERS	0.0000	59.8572	33.5390	11.6528	1.2775
320	WEIGHTS		0.8176	4.3544	11.3407	35.6093
335	NUMBERS	0.0000	56.9598	31.9154	10.9050	1.1955
335	WEIGHTS		0.8501	4.4433	11.9300	36.7738
350	NUMBERS	0.0000	54.2026	30.3704	10.2052	1.1188
350	WEIGHTS		0.8941	4.5810	12.5978	38.1577
365	NUMBERS	0.0000	51.5789	28.9003	9.5503	1.0470
365	WEIGHTS		0.9296	4.7391	12.3924	37.5123
15	NUMBERS	216.1754	49.0822	27.5013	8.9375	0.9798
15	WEIGHTS		0.9643	4.8855	11.3848	34.4416
30	NUMBERS	200.1499	46.7063	26.1700	8.3639	0.9169
30	WEIGHTS		0.9865	4.9886	11.1745	33.8158
45	NUMBERS	185.3124	44.4455	24.9032	7.8272	0.8581
45	WEIGHTS		1.0048	5.0759	10.9570	33.1781
60	NUMBERS	171.5748	0.0000	42.2940	23.3050	7.3249
60	WEIGHTS		0.0000	1.0385	5.1157	11.1064
75	NUMBERS	158.8556	0.0000	40.2467	21.8094	6.8549
75	WEIGHTS		0.0000	1.0269	5.0319	10.9792
90	NUMBERS	147.0793	0.0000	38.2985	20.4098	6.4150
90	WEIGHTS		0.0000	1.0155	4.9495	10.8534
105	NUMBERS	136.1760	0.0000	36.4446	19.0999	6.0033
105	WEIGHTS		0.0000	1.0132	4.8919	10.7833
120	NUMBERS	126.0809	0.0000	34.6804	17.8742	5.6181
120	WEIGHTS		0.0000	1.0598	4.9633	11.0053

135	NUMBERS	116.7343	0.0000	33.0016	16.7271	5.2575
135	WEIGHTS		0.0000	1.1959	5.2623	11.7435
150	NUMBERS	108.0805	0.0000	31.4041	15.6536	4.9201
150	WEIGHTS		0.0000	1.4086	5.7300	12.8709
165	NUMBERS	100.0682	0.0000	29.8839	14.6491	4.6044
165	WEIGHTS		0.0000	1.6968	6.3373	14.3275
180	NUMBERS	0.0000	93.6712	28.4373	13.7090	4.3089
180	WEIGHTS		0.0643	2.1646	7.2756	16.5628
195	NUMBERS	0.0000	89.1371	27.0607	12.8293	4.0324
195	WEIGHTS		0.1701	2.7529	8.3692	19.1810

CHANGE SUMMER TEMPERATURE = 0.00 CHANGE PREY = -0.25

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		0.9023	10.4141	38.0081	77.5043
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		1.2143	11.4980	39.4785	83.1650
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		1.5576	12.4313	40.3880	87.9476
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		1.8516	13.0091	40.6519	91.0468
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		1.7304	12.2804	39.5905	88.5251
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		1.5317	11.1689	37.2266	83.5602
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		1.3572	10.1646	35.0479	78.9530
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		1.3224	9.8707	35.0376	78.4863
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		1.3492	9.9041	35.9940	79.8930
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		1.4068	10.1070	37.3917	82.1793
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		1.4636	10.4160	36.7486	80.7554
15	NUMBERS	586.1431	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		1.5082	10.6316	33.7404	74.1532
30	NUMBERS	542.6895	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		1.5353	10.7823	33.1269	72.8479
45	NUMBERS	502.4575	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		1.5570	10.9043	32.5017	71.5270
60	NUMBERS	465.2083	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	1.6013	10.9513	32.7591
75	NUMBERS	430.7200	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	1.5827	10.7805	32.3949
90	NUMBERS	398.7886	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	1.5644	10.6122	32.0347
105	NUMBERS	369.2239	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	1.5588	10.4878	31.7990
120	NUMBERS	341.8508	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	1.6205	10.5906	32.2177
135	NUMBERS	316.5076	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	1.8044	11.0927	33.7819
150	NUMBERS	293.0425	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	2.0900	11.8823	36.1746
165	NUMBERS	271.3171	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	2.4725	12.8999	39.2276
180	NUMBERS	0.0000	253.9722	46.3198	17.8642	3.9154
180	WEIGHTS		0.0643	3.0853	14.4569	43.8409
195	NUMBERS	0.0000	241.6789	44.0777	16.7177	3.6641
195	WEIGHTS		0.1821	3.9089	16.3873	49.5489
210	NUMBERS	0.0000	229.9806	41.9440	15.6449	3.4290
210	WEIGHTS		0.3341	4.6480	17.7885	54.7088
225	NUMBERS	0.0000	218.8486	39.9137	14.6409	3.2089
225	WEIGHTS		0.4905	5.2762	18.7222	59.1814
240	NUMBERS	0.0000	208.2555	37.9816	13.7014	3.0030
240	WEIGHTS		0.6844	5.8991	19.5175	63.4489
255	NUMBERS	0.0000	198.1750	36.1430	12.8221	2.8103
255	WEIGHTS		0.8929	6.4031	19.9273	66.7453
270	NUMBERS	0.0000	188.5825	34.3935	11.9993	2.6299
270	WEIGHTS		0.8978	6.2449	19.7486	66.2466
285	NUMBERS	0.0000	179.4543	32.7286	11.2293	2.4612
285	WEIGHTS		0.8023	5.7070	18.7243	62.9920
300	NUMBERS	0.0000	170.7679	31.1443	10.5087	2.3032
300	WEIGHTS		0.6962	5.1118	17.4277	59.0445
315	NUMBERS	0.0000	162.5020	29.6367	9.8343	2.1554
315	WEIGHTS		0.6570	4.8482	17.1231	57.7077
330	NUMBERS	0.0000	154.6363	28.2021	9.2032	2.0171
330	WEIGHTS		0.6716	4.8614	17.6633	58.6267
345	NUMBERS	0.0000	147.1512	26.8369	8.6126	1.8876
345	WEIGHTS		0.7077	4.9894	18.5225	60.4232
360	NUMBERS	0.0000	140.0284	25.5378	8.0600	1.7665
360	WEIGHTS		0.7470	5.1772	18.6113	60.3472
10	NUMBERS	337.8025	133.2504	24.3015	7.5427	1.6531
10	WEIGHTS		0.7820	5.3530	17.0991	55.4161

25	NUMBERS	312.7590	126.8005	23.1251	7.0587	1.5471
25	WEIGHTS		0.8038	5.4699	16.7894	54.4387
40	NUMBERS	289.5720	120.6628	22.0057	6.6057	1.4478
40	WEIGHTS		0.8260	5.5886	16.4861	53.4798
55	NUMBERS	268.1040	0.0000	114.8222	20.7085	6.1818
55	WEIGHTS		0.0000	0.8605	5.6703	16.6114
70	NUMBERS	248.2283	0.0000	109.2643	19.3795	5.7851
70	WEIGHTS		0.0000	0.8511	5.5780	16.4224
85	NUMBERS	229.8267	0.0000	103.9754	18.1358	5.4139
85	WEIGHTS		0.0000	0.8418	5.4871	16.2355
100	NUMBERS	212.7892	0.0000	98.9425	16.9719	5.0665
100	WEIGHTS		0.0000	0.8351	5.4057	16.0738
115	NUMBERS	197.0147	0.0000	94.1532	15.8827	4.7413
115	WEIGHTS		0.0000	0.8585	5.4230	16.1924
130	NUMBERS	182.4096	0.0000	89.5957	14.8635	4.4371
130	WEIGHTS		0.0000	0.9463	5.6469	16.8954
145	NUMBERS	168.8872	0.0000	85.2589	13.9096	4.1523
145	WEIGHTS		0.0000	1.1196	6.1183	18.3002
160	NUMBERS	156.3672	0.0000	81.1319	13.0170	3.8859
160	WEIGHTS		0.0000	1.3360	6.6761	19.9533
175	NUMBERS	0.0000	145.0401	77.2047	12.1817	3.6365
175	WEIGHTS		0.0435	1.6960	7.5647	22.5474
190	NUMBERS	0.0000	138.0195	73.4677	11.4000	3.4031
190	WEIGHTS		0.1315	2.2203	8.7555	26.0087
205	NUMBERS	0.0000	131.3388	69.9115	10.6684	3.1847
205	WEIGHTS		0.2907	2.8072	9.9126	29.6871
220	NUMBERS	0.0000	124.9814	66.5274	9.9838	2.9804
220	WEIGHTS		0.4334	3.2594	10.5824	32.6823
235	NUMBERS	0.0000	118.9318	63.3071	9.3431	2.7891
235	WEIGHTS		0.6177	3.7386	11.2231	35.7381
250	NUMBERS	0.0000	113.1750	60.2427	8.7436	2.6101
250	WEIGHTS		0.8205	4.1457	11.6181	38.2286
265	NUMBERS	0.0000	107.6968	57.3266	8.1825	2.4426
265	WEIGHTS		0.9188	4.2640	11.7548	39.1993
280	NUMBERS	0.0000	102.4837	54.5517	7.6574	2.2859
280	WEIGHTS		0.8407	3.9537	11.3325	37.7222
295	NUMBERS	0.0000	97.5230	51.9111	7.1660	2.1392
295	WEIGHTS		0.7300	3.5256	10.5193	35.2512

310	NUMBERS	0.0000	92.8025	49.3983	6.7061	2.0019
310	WEIGHTS		0.6606	3.2415	10.0664	33.7236
325	NUMBERS	0.0000	88.3104	47.0071	6.2758	1.8734
325	WEIGHTS		0.6645	3.2257	10.3689	34.1808
340	NUMBERS	0.0000	84.0358	44.7317	5.8731	1.7532
340	WEIGHTS		0.6946	3.3082	10.9313	35.3337
355	NUMBERS	0.0000	79.9680	42.5664	5.4962	1.6407
355	WEIGHTS		0.7344	3.4426	11.2983	36.0344
5	NUMBERS	160.1922	76.0972	40.5060	5.1435	1.5354
5	WEIGHTS		0.7722	3.5941	10.3891	33.0934
20	NUMBERS	148.3168	72.4137	38.5452	4.8134	1.4369
20	WEIGHTS		0.7981	3.7045	10.2114	32.5187
35	NUMBERS	137.3217	68.9084	36.6794	4.5045	1.3446
35	WEIGHTS		0.8183	3.7935	10.0229	31.9268
50	NUMBERS	127.1418	0.0000	65.5729	34.7100	4.2154
50	WEIGHTS		0.0000	0.8533	3.8896	10.0380
65	NUMBERS	117.7165	0.0000	62.3988	32.4825	3.9449
65	WEIGHTS		0.0000	0.8543	3.8508	9.9894
80	NUMBERS	108.9899	0.0000	59.3783	30.3980	3.6918
80	WEIGHTS		0.0000	0.8449	3.7868	9.8748
95	NUMBERS	100.9102	0.0000	56.5041	28.4472	3.4549
95	WEIGHTS		0.0000	0.8357	3.7238	9.7616
110	NUMBERS	93.4294	0.0000	53.7690	26.6216	3.2331
110	WEIGHTS		0.0000	0.8447	3.7060	9.7652
125	NUMBERS	86.5033	0.0000	51.1662	24.9131	3.0257
125	WEIGHTS		0.0000	0.9055	3.8158	10.0980
140	NUMBERS	80.0905	0.0000	48.6895	23.3143	2.8315
140	WEIGHTS		0.0000	1.0574	4.1363	10.9754
155	NUMBERS	74.1532	0.0000	46.3326	21.8181	2.6498
155	WEIGHTS		0.0000	1.2558	4.5391	12.0705
170	NUMBERS	68.6560	0.0000	44.0899	20.4178	2.4797
170	WEIGHTS		0.0000	1.5587	5.1302	13.6594
185	NUMBERS	0.0000	64.8569	41.9557	19.1075	2.3206
185	WEIGHTS		0.0931	2.0298	5.9932	15.9673
200	NUMBERS	0.0000	61.7175	39.9247	17.8812	2.1717
200	WEIGHTS		0.2513	2.6603	7.0512	18.8102
215	NUMBERS	0.0000	58.7300	37.9921	16.7337	2.0323

215	WEIGHTS		0.3814	3.1055	7.6137	21.0456
230	NUMBERS	0.0000	55.8872	36.1531	15.6598	1.9019
230	WEIGHTS		0.5528	3.5829	8.1643	23.3766
245	NUMBERS	0.0000	53.1819	34.4030	14.6548	1.7798
245	WEIGHTS		0.7524	4.0212	8.5759	25.4695
260	NUMBERS	0.0000	50.6076	32.7377	13.7144	1.6656
260	WEIGHTS		0.9328	4.3252	8.8084	26.9775
275	NUMBERS	0.0000	48.1579	31.1529	12.8343	1.5587
275	WEIGHTS		0.8718	4.0749	8.6411	26.3083
290	NUMBERS	0.0000	45.8268	29.6449	12.0107	1.4587
290	WEIGHTS		0.7654	3.6635	8.0758	24.6922
305	NUMBERS	0.0000	43.6085	28.2098	11.2400	1.3651
305	WEIGHTS		0.6728	3.2968	7.5621	23.2081
320	NUMBERS	0.0000	41.4975	26.8443	10.5187	1.2775
320	WEIGHTS		0.6600	3.2191	7.6890	23.2860
335	NUMBERS	0.0000	39.4888	25.5448	9.8437	1.1955
335	WEIGHTS		0.6819	3.2707	8.0979	24.0563
350	NUMBERS	0.0000	37.5773	24.3082	9.2120	1.1188
350	WEIGHTS		0.7210	3.3869	8.6323	25.1391
365	NUMBERS	0.0000	35.7583	23.1315	8.6208	1.0470
365	WEIGHTS		0.7595	3.5473	8.4992	24.7131
15	NUMBERS	114.9073	34.0273	22.0117	8.0676	0.9798
15	WEIGHTS		0.7905	3.6719	7.8118	22.6924
30	NUMBERS	106.3889	32.3802	20.9461	7.5499	0.9169
30	WEIGHTS		0.8107	3.7604	7.6682	22.2755
45	NUMBERS	98.5020	30.8127	19.9322	7.0654	0.8581
45	WEIGHTS		0.8275	3.8364	7.5186	21.8486
60	NUMBERS	91.1998	0.0000	29.3211	18.6530	6.6120
60	WEIGHTS		0.0000	0.8574	3.8723	7.6399
75	NUMBERS	84.4389	0.0000	27.9018	17.4559	6.1877
75	WEIGHTS		0.0000	0.8480	3.8080	7.5522
90	NUMBERS	78.1792	0.0000	26.5511	16.3356	5.7906
90	WEIGHTS		0.0000	0.8387	3.7446	7.4654
105	NUMBERS	72.3836	0.0000	25.2658	15.2873	5.4190
105	WEIGHTS		0.0000	0.8375	3.7015	7.4209
120	NUMBERS	67.0175	0.0000	24.0428	14.3063	5.0713
120	WEIGHTS		0.0000	0.8785	3.7632	7.5974

135	NUMBERS	62.0493	0.0000	22.8789	13.3882	4.7458
135	WEIGHTS		0.0000	0.9977	4.0103	8.1662
150	NUMBERS	57.4494	0.0000	21.7714	12.5291	4.4413
150	WEIGHTS		0.0000	1.1845	4.3965	9.0359
165	NUMBERS	53.1905	0.0000	20.7175	11.7250	4.1563
165	WEIGHTS		0.0000	1.4391	4.8998	10.1660
180	NUMBERS	0.0000	49.7902	19.7146	10.9726	3.8896
180	WEIGHTS		0.0643	1.8549	5.6807	11.9123
195	NUMBERS	0.0000	47.3800	18.7602	10.2685	3.6400
195	WEIGHTS		0.1821	2.4274	6.6739	14.1515

CHANGE SUMMER TEMPERATURE = 1.00 CHANGE PREY = -0.25

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		0.8942	10.3373	37.7618	77.0917
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		1.1887	11.3074	38.9142	82.1624
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		1.4730	11.9705	39.1898	85.5662
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		1.6518	12.0975	38.4346	86.3317
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		1.4535	10.9612	36.0090	81.2421
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		1.1879	9.4539	32.2088	73.5370
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		0.9679	8.1428	28.8107	66.5670
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		0.9102	7.7115	28.1864	64.9496
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		0.9215	7.6779	28.8102	65.7820
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		0.9648	7.8354	29.9855	67.7190
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		1.0127	8.1147	29.3967	66.3791
15	NUMBERS	498.0933	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		1.0492	8.3077	26.9914	60.9485
30	NUMBERS	461.1670	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		1.0723	8.4421	26.4975	59.8655
45	NUMBERS	426.9780	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		1.0912	8.5528	25.9929	58.7678
60	NUMBERS	395.3237	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	1.1267	8.5984	26.2252
75	NUMBERS	366.0161	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	1.1140	8.4621	25.9310
90	NUMBERS	338.8809	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	1.1015	8.3278	25.6400
105	NUMBERS	313.7568	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	1.0988	8.2301	25.4548
120	NUMBERS	290.4958	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	1.1479	8.3223	25.8237
135	NUMBERS	268.9595	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	1.2919	8.7484	27.1647
150	NUMBERS	249.0197	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	1.5167	9.4169	29.2138
165	NUMBERS	230.5594	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	1.8206	10.2802	31.8341
180	NUMBERS	0.0000	215.8208	46.3198	17.8642	3.9154
180	WEIGHTS		0.0643	2.3127	11.6048	35.8041
195	NUMBERS	0.0000	205.3742	44.0777	16.7177	3.6641
195	WEIGHTS		0.1909	3.0168	13.3259	40.9618
210	NUMBERS	0.0000	195.4332	41.9440	15.6449	3.4290
210	WEIGHTS		0.3475	3.6142	14.4676	45.3043
225	NUMBERS	0.0000	185.9734	39.9137	14.6409	3.2089
225	WEIGHTS		0.5007	4.0976	15.1488	48.8718
240	NUMBERS	0.0000	176.9715	37.9816	13.7014	3.0030
240	WEIGHTS		0.6785	4.5405	15.6344	51.9967
255	NUMBERS	0.0000	168.4053	36.1430	12.8221	2.8103
255	WEIGHTS		0.8283	4.7717	15.5643	53.4688
270	NUMBERS	0.0000	160.2538	34.3935	11.9993	2.6299
270	WEIGHTS		0.7816	4.4577	14.8436	51.4648
285	NUMBERS	0.0000	152.4968	32.7286	11.2293	2.4612
285	WEIGHTS		0.6403	3.8228	13.2754	46.7834
300	NUMBERS	0.0000	145.1153	31.1443	10.5087	2.3032
300	WEIGHTS		0.5040	3.1897	11.5874	41.7491
315	NUMBERS	0.0000	138.0911	29.6367	9.8343	2.1554
315	WEIGHTS		0.4453	2.8862	10.9285	39.5115
330	NUMBERS	0.0000	131.4068	28.2021	9.2032	2.0171
330	WEIGHTS		0.4497	2.8692	11.2224	39.9232
345	NUMBERS	0.0000	125.0462	26.8369	8.6126	1.8876
345	WEIGHTS		0.4753	2.9523	11.8278	41.2254
360	NUMBERS	0.0000	118.9934	25.5378	8.0600	1.7665
360	WEIGHTS		0.5069	3.0925	11.9040	41.1779
10	NUMBERS	222.6938	113.2336	24.3015	7.5427	1.6531
10	WEIGHTS		0.5355	3.2273	10.9302	37.7732

25	NUMBERS	206.1851	107.7525	23.1251	7.0587	1.5471
25	WEIGHTS		0.5534	3.3159	10.7327	37.0983
40	NUMBERS	190.9002	102.5368	22.0057	6.6057	1.4478
40	WEIGHTS		0.5716	3.4062	10.5395	36.4365
55	NUMBERS	176.7484	0.0000	97.5735	20.7085	6.1818
55	WEIGHTS		0.0000	0.5990	3.4695	10.6454
70	NUMBERS	163.6456	0.0000	92.8505	19.3795	5.7851
70	WEIGHTS		0.0000	0.5927	3.4115	10.5234
85	NUMBERS	151.5142	0.0000	88.3561	18.1358	5.4139
85	WEIGHTS		0.0000	0.5866	3.3544	10.4027
100	NUMBERS	140.2822	0.0000	84.0792	16.9719	5.0665
100	WEIGHTS		0.0000	0.5824	3.3039	10.3001
115	NUMBERS	129.8827	0.0000	80.0094	15.8827	4.7413
115	WEIGHTS		0.0000	0.6012	3.3218	10.3987
130	NUMBERS	120.2543	0.0000	76.1365	14.8635	4.4371
130	WEIGHTS		0.0000	0.6696	3.4832	10.9176
145	NUMBERS	111.3395	0.0000	72.4511	13.9096	4.1523
145	WEIGHTS		0.0000	0.8049	3.8188	11.9469
160	NUMBERS	103.0857	0.0000	68.9441	13.0170	3.8859
160	WEIGHTS		0.0000	0.9757	4.2186	13.1658
175	NUMBERS	0.0000	95.6182	65.6068	12.1817	3.6365
175	WEIGHTS		0.0435	1.2632	4.8592	15.0892
190	NUMBERS	0.0000	90.9898	62.4311	11.4000	3.4031
190	WEIGHTS		0.1364	1.7042	5.7570	17.7730
205	NUMBERS	0.0000	86.5855	59.4091	10.6684	3.1847
205	WEIGHTS		0.3037	2.1928	6.6110	20.5736
220	NUMBERS	0.0000	82.3943	56.5334	9.9838	2.9804
220	WEIGHTS		0.4451	2.5467	7.0598	22.7271
235	NUMBERS	0.0000	78.4060	53.7968	9.3431	2.7891
235	WEIGHTS		0.6212	2.9106	7.4677	24.8646
250	NUMBERS	0.0000	74.6108	51.1927	8.7436	2.6101
250	WEIGHTS		0.7791	3.1371	7.5720	26.1396
265	NUMBERS	0.0000	70.9993	48.7147	8.1825	2.4426
265	WEIGHTS		0.8192	3.0983	7.4068	26.0621
280	NUMBERS	0.0000	67.5625	46.3566	7.6574	2.2859
280	WEIGHTS		0.6922	2.6978	6.7157	23.9118
295	NUMBERS	0.0000	64.2921	44.1127	7.1660	2.1392
295	WEIGHTS		0.5463	2.2296	5.7832	21.0975

310	NUMBERS	0.0000	61.1800	41.9774	6.7061	2.0019
310	WEIGHTS		0.4535	1.9165	5.1925	19.2108
325	NUMBERS	0.0000	58.2186	39.9454	6.2758	1.8734
325	WEIGHTS		0.4461	1.8757	5.3028	19.2886
340	NUMBERS	0.0000	55.4005	38.0118	5.8731	1.7532
340	WEIGHTS		0.4655	1.9236	5.6343	19.9980
355	NUMBERS	0.0000	52.7188	36.1718	5.4962	1.6407
355	WEIGHTS		0.4962	2.0191	5.8754	20.4873
5	NUMBERS	58.3538	50.1670	34.4208	5.1435	1.5354
5	WEIGHTS		0.5276	2.1349	5.4014	18.7917
20	NUMBERS	54.0278	47.7386	32.7546	4.8134	1.4369
20	WEIGHTS		0.5486	2.2161	5.3126	18.4653
35	NUMBERS	50.0225	45.4277	31.1690	4.5045	1.3446
35	WEIGHTS		0.5653	2.2830	5.2160	18.1249
50	NUMBERS	46.3142	0.0000	43.2287	29.4955	4.2154
50	WEIGHTS		0.0000	0.5931	2.3544	5.2409
65	NUMBERS	42.8808	0.0000	41.1362	27.6026	3.9449
65	WEIGHTS		0.0000	0.5948	2.3321	5.2220
80	NUMBERS	39.7018	0.0000	39.1449	25.8312	3.6918
80	WEIGHTS		0.0000	0.5886	2.2924	5.1622
95	NUMBERS	36.7586	0.0000	37.2501	24.1735	3.4549
95	WEIGHTS		0.0000	0.5825	2.2534	5.1032
110	NUMBERS	34.0335	0.0000	35.4469	22.6221	3.2331
110	WEIGHTS		0.0000	0.5903	2.2456	5.1163
125	NUMBERS	31.5105	0.0000	33.7310	21.1703	3.0257
125	WEIGHTS		0.0000	0.6378	2.3255	5.3326
140	NUMBERS	29.1745	0.0000	32.0982	19.8116	2.8315
140	WEIGHTS		0.0000	0.7561	2.5519	5.8896
155	NUMBERS	27.0116	0.0000	30.5444	18.5402	2.6498
155	WEIGHTS		0.0000	0.9122	2.8383	6.5912
170	NUMBERS	25.0091	0.0000	29.0659	17.3503	2.4797
170	WEIGHTS		0.0000	1.1530	3.2613	7.6197
185	NUMBERS	0.0000	23.6251	27.6589	16.2368	2.3206
185	WEIGHTS		0.0950	1.5410	3.8983	9.1671
200	NUMBERS	0.0000	22.4815	26.3200	15.1948	2.1717
200	WEIGHTS		0.2635	2.0742	4.6941	11.1258
215	NUMBERS	0.0000	21.3932	25.0459	14.2198	2.0323

215	WEIGHTS		0.3941	2.4273	5.0811	12.5924
230	NUMBERS	0.0000	20.3576	23.8334	13.3072	1.9019
230	WEIGHTS		0.5612	2.7976	5.4469	14.1014
245	NUMBERS	0.0000	19.3720	22.6797	12.4533	1.7798
245	WEIGHTS		0.7320	3.0825	5.6425	15.2620
260	NUMBERS	0.0000	18.4342	21.5818	11.6541	1.6656
260	WEIGHTS		0.8473	3.1886	5.6164	15.7660
275	NUMBERS	0.0000	17.5419	20.5371	10.9063	1.5587
275	WEIGHTS		0.7390	2.8454	5.2146	14.7039
290	NUMBERS	0.0000	16.6927	19.5429	10.2064	1.4587
290	WEIGHTS		0.5917	2.3773	4.5124	12.9633
305	NUMBERS	0.0000	15.8846	18.5968	9.5514	1.3651
305	WEIGHTS		0.4720	1.9819	3.9047	11.4288
320	NUMBERS	0.0000	15.1157	17.6965	8.9385	1.2775
320	WEIGHTS		0.4449	1.8774	3.8761	11.2376
335	NUMBERS	0.0000	14.3840	16.8399	8.3649	1.1955
335	WEIGHTS		0.4564	1.8989	4.1016	11.6418
350	NUMBERS	0.0000	13.6878	16.0246	7.8281	1.1188
350	WEIGHTS		0.4856	1.9787	4.4387	12.3059
365	NUMBERS	0.0000	13.0253	15.2490	7.3258	1.0470
365	WEIGHTS		0.5176	2.1002	4.3661	12.0754
15	NUMBERS	17.4876	12.3948	14.5109	6.8557	0.9798
15	WEIGHTS		0.5424	2.1919	4.0181	11.0939
30	NUMBERS	16.1911	11.7948	13.8085	6.4157	0.9169
30	WEIGHTS		0.5591	2.2583	3.9460	10.8890
45	NUMBERS	14.9908	11.2239	13.1401	6.0040	0.8581
45	WEIGHTS		0.5732	2.3164	3.8699	10.6770
60	NUMBERS	13.8795	0.0000	10.6806	12.2969	5.6187
60	WEIGHTS		0.0000	0.5969	2.3455	3.9523
75	NUMBERS	12.8506	0.0000	10.1636	11.5077	5.2581
75	WEIGHTS		0.0000	0.5907	2.3056	3.9073
90	NUMBERS	11.8980	0.0000	9.6717	10.7693	4.9207
90	WEIGHTS		0.0000	0.5845	2.2663	3.8630
105	NUMBERS	11.0159	0.0000	9.2035	10.0782	4.6049
105	WEIGHTS		0.0000	0.5845	2.2410	3.8443
120	NUMBERS	10.1993	0.0000	8.7580	9.4315	4.3094
120	WEIGHTS		0.0000	0.6168	2.2878	3.9611

135	NUMBERS	9.4432	0.0000	8.3341	8.8262	4.0329
135	WEIGHTS		0.0000	0.7095	2.4630	4.3202
150	NUMBERS	8.7432	0.0000	7.9307	8.2598	3.7741
150	WEIGHTS		0.0000	0.8559	2.7367	4.8717
165	NUMBERS	8.0950	0.0000	7.5468	7.7298	3.5319
165	WEIGHTS		0.0000	1.0576	3.0961	5.5970
180	NUMBERS	0.0000	7.5775	7.1815	7.2337	3.3052
180	WEIGHTS		0.0643	1.3912	3.6589	6.7337
195	NUMBERS	0.0000	7.2107	6.8339	6.7695	3.0931
195	WEIGHTS		0.1909	1.8816	4.4178	8.2929

CHANGE SUMMER TEMPERATURE = -1.00 CHANGE PREY = 0.00

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		1.0556	11.2330	39.9080	81.8334
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		1.6288	13.3520	43.5456	92.6869
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		2.3798	15.5860	46.9627	103.7627
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		3.1901	17.6026	49.9830	113.8130
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		3.2414	17.6494	51.6553	116.3093
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		3.1850	17.2700	52.1399	116.5257
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		3.1350	16.9195	52.6795	116.8449
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		3.2636	17.2789	55.2523	120.9949
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		3.4867	18.0081	58.8582	127.0687
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		3.7391	18.8532	62.6601	133.5262
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		3.9523	19.7540	62.3973	132.7320
15	NUMBERS	858.5115	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		4.1662	20.5584	58.0281	123.2235
30	NUMBERS	794.8669	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		4.3251	21.2314	57.6045	122.2007
45	NUMBERS	735.9402	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		4.4688	21.8436	57.1204	121.0789
60	NUMBERS	681.3823	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	4.6588	22.1880	58.2039
75	NUMBERS	630.8687	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	4.6508	21.9962	57.9159
90	NUMBERS	584.0996	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	4.6430	21.8060	57.6295
105	NUMBERS	540.7976	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	4.6764	21.7242	57.6227
120	NUMBERS	500.7053	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	4.9299	22.2129	59.0919
135	NUMBERS	463.5852	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	5.5878	23.7072	63.1562
150	NUMBERS	429.2173	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	6.5966	25.9612	69.1909
165	NUMBERS	397.3970	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	7.9547	28.8586	76.9038
180	NUMBERS	0.0000	371.9915	46.3198	17.8642	3.9154
180	WEIGHTS		0.0758	10.1379	33.2755	88.5710
195	NUMBERS	0.0000	353.9841	44.0777	16.7177	3.6641
195	WEIGHTS		0.2639	12.8826	38.4391	102.1978
210	NUMBERS	0.0000	336.8481	41.9440	15.6449	3.4290
210	WEIGHTS		0.5680	15.7017	43.0500	116.5352
225	NUMBERS	0.0000	320.5413	39.9137	14.6409	3.2089
225	WEIGHTS		0.9395	18.3868	46.8821	130.4905
240	NUMBERS	0.0000	305.0239	37.9816	13.7014	3.0030
240	WEIGHTS		1.4596	21.2821	50.6992	145.0831
255	NUMBERS	0.0000	290.2581	36.1430	12.8221	2.8103
255	WEIGHTS		2.1304	24.1855	54.1115	159.3335
270	NUMBERS	0.0000	276.2065	34.3935	11.9993	2.6299
270	WEIGHTS		2.3394	24.8657	56.3904	165.0329
285	NUMBERS	0.0000	262.8354	32.7286	11.2293	2.4612
285	WEIGHTS		2.3299	24.4500	57.2393	165.7797
300	NUMBERS	0.0000	250.1122	31.1443	10.5087	2.3032
300	WEIGHTS		2.2827	23.7925	57.4826	165.1215
315	NUMBERS	0.0000	238.0058	29.6367	9.8343	2.1554
315	WEIGHTS		2.3442	23.8669	59.4494	168.4431
330	NUMBERS	0.0000	226.4853	28.2021	9.2032	2.0171
330	WEIGHTS		2.5110	24.6441	63.0429	175.5085
345	NUMBERS	0.0000	215.5225	26.8369	8.6126	1.8876
345	WEIGHTS		2.7179	25.6875	67.1400	183.7505
360	NUMBERS	0.0000	205.0903	25.5378	8.0600	1.7665
360	WEIGHTS		2.9114	26.8268	68.2954	185.6533
10	NUMBERS	896.8960	195.1631	24.3015	7.5427	1.6531
10	WEIGHTS		3.0873	27.7280	63.4951	172.2479

25	NUMBERS	830.4058	185.7164	23.1251	7.0587	1.5471
25	WEIGHTS		3.2264	28.5882	63.0534	170.8257
40	NUMBERS	768.8450	176.7269	22.0057	6.6057	1.4478
40	WEIGHTS		3.3697	29.4674	62.6181	169.4224
55	NUMBERS	711.8477	0.0000	168.1726	20.7085	6.1818
55	WEIGHTS		0.0000	3.5513	30.1073	63.6161
70	NUMBERS	659.0752	0.0000	160.0323	19.3795	5.7851
70	WEIGHTS		0.0000	3.5479	29.8453	63.2971
85	NUMBERS	610.2151	0.0000	152.2861	18.1358	5.4139
85	WEIGHTS		0.0000	3.5445	29.5857	62.9799
100	NUMBERS	564.9771	0.0000	144.9148	16.9719	5.0665
100	WEIGHTS		0.0000	3.5518	29.3708	62.7588
115	NUMBERS	523.0925	0.0000	137.9003	15.8827	4.7413
115	WEIGHTS		0.0000	3.6870	29.6654	63.6624
130	NUMBERS	484.3130	0.0000	131.2253	14.8635	4.4371
130	WEIGHTS		0.0000	4.0967	31.0208	66.9007
145	NUMBERS	448.4082	0.0000	124.8734	13.9096	4.1523
145	WEIGHTS		0.0000	4.8742	33.6528	72.9680
160	NUMBERS	415.1653	0.0000	118.8289	13.0170	3.8859
160	WEIGHTS		0.0000	5.8450	36.7443	80.0943
175	NUMBERS	0.0000	385.0894	113.0771	12.1817	3.6365
175	WEIGHTS		0.0448	7.4440	41.5595	91.1109
190	NUMBERS	0.0000	366.4475	107.6036	11.4000	3.4031
190	WEIGHTS		0.1792	9.6396	47.6235	105.0209
205	NUMBERS	0.0000	348.7080	102.3951	10.6684	3.1847
205	WEIGHTS		0.4734	12.2018	53.8808	120.5746
220	NUMBERS	0.0000	331.8276	97.4387	9.9838	2.9804
220	WEIGHTS		0.8001	14.4560	58.3950	134.9245
235	NUMBERS	0.0000	315.7642	92.7222	9.3431	2.7891
235	WEIGHTS		1.2700	16.9597	63.0156	150.2291
250	NUMBERS	0.0000	300.4788	88.2340	8.7436	2.6101
250	WEIGHTS		1.8875	19.5039	67.1157	165.1985
265	NUMBERS	0.0000	285.9326	83.9630	8.1825	2.4426
265	WEIGHTS		2.3233	21.0022	70.3904	175.1745
280	NUMBERS	0.0000	272.0911	79.8988	7.6574	2.2859
280	WEIGHTS		2.3459	20.8586	71.8701	177.1091
295	NUMBERS	0.0000	258.9194	76.0313	7.1660	2.1392
295	WEIGHTS		2.2983	20.3094	72.0271	176.3347

310	NUMBERS	0.0000	246.3863	72.3510	6.7061	2.0019
310	WEIGHTS		2.3067	20.0946	73.2372	177.7047
325	NUMBERS	0.0000	234.4602	68.8488	6.2758	1.8734
325	WEIGHTS		2.4502	20.6704	76.9821	184.2250
340	NUMBERS	0.0000	223.1114	65.5162	5.8731	1.7532
340	WEIGHTS		2.6490	21.5632	81.6515	192.6233
355	NUMBERS	0.0000	212.3119	62.3448	5.4962	1.6407
355	WEIGHTS		2.8520	22.5624	84.6447	197.8302
5	NUMBERS	834.7373	202.0351	59.3270	5.1435	1.5354
5	WEIGHTS		3.0305	23.4411	78.6708	183.5577
20	NUMBERS	772.8555	192.2558	56.4552	4.8134	1.4369
20	WEIGHTS		3.1862	24.3148	78.1803	182.1775
35	NUMBERS	715.5610	182.9498	53.7225	4.5045	1.3446
35	WEIGHTS		3.3204	25.0639	77.5743	180.6019
50	NUMBERS	662.5134	0.0000	174.0942	50.8381	4.2154
50	WEIGHTS		0.0000	3.5093	25.8365	78.2062
65	NUMBERS	613.3987	0.0000	165.6673	47.5756	3.9449
65	WEIGHTS		0.0000	3.5490	25.7690	78.2535
80	NUMBERS	567.9243	0.0000	157.6483	44.5225	3.6918
80	WEIGHTS		0.0000	3.5456	25.5454	77.8500
95	NUMBERS	525.8215	0.0000	150.0175	41.6653	3.4549
95	WEIGHTS		0.0000	3.5422	25.3238	77.4489
110	NUMBERS	486.8401	0.0000	142.7560	38.9915	3.2331
110	WEIGHTS		0.0000	3.6161	25.3783	77.8456
125	NUMBERS	450.7483	0.0000	135.8460	36.4893	3.0257
125	WEIGHTS		0.0000	3.9106	26.2087	80.4758
140	NUMBERS	417.3318	0.0000	129.2704	34.1476	2.8315
140	WEIGHTS		0.0000	4.5949	28.3162	86.7692
155	NUMBERS	386.3926	0.0000	123.0131	31.9562	2.6498
155	WEIGHTS		0.0000	5.4860	30.9255	94.5038
170	NUMBERS	357.7471	0.0000	117.0587	29.9055	2.4797
170	WEIGHTS		0.0000	6.8345	34.6711	105.4866
185	NUMBERS	0.0000	337.9495	111.3926	27.9863	2.3206
185	WEIGHTS		0.1184	8.8600	39.8919	120.6784
200	NUMBERS	0.0000	321.5898	106.0007	26.1903	2.1717
200	WEIGHTS		0.3918	11.5074	46.1246	138.7617
215	NUMBERS	0.0000	306.0215	100.8697	24.5095	2.0323

215	WEIGHTS		0.6766	13.6761	50.2327	154.6800
230	NUMBERS	0.0000	291.2070	95.9872	22.9366	1.9019
230	WEIGHTS		1.0964	16.1115	54.4930	171.7447
245	NUMBERS	0.0000	277.1101	91.3409	21.4646	1.7798
245	WEIGHTS		1.6657	18.6583	58.4605	188.8107
260	NUMBERS	0.0000	263.6946	86.9196	20.0871	1.6656
260	WEIGHTS		2.2971	20.9380	61.9342	203.9581
275	NUMBERS	0.0000	250.9299	82.7122	18.7979	1.5587
275	WEIGHTS		2.3472	20.9584	63.8014	207.1171
290	NUMBERS	0.0000	238.7839	78.7085	17.5915	1.4587
290	WEIGHTS		2.3140	20.4906	64.2606	206.6600
305	NUMBERS	0.0000	227.2258	74.8986	16.4625	1.3651
305	WEIGHTS		2.2853	20.0568	64.7839	206.3697
320	NUMBERS	0.0000	216.2271	71.2732	15.4061	1.2775
320	WEIGHTS		2.3953	20.4377	67.7028	212.1165
335	NUMBERS	0.0000	205.7608	67.8232	14.4174	1.1955
335	WEIGHTS		2.5791	21.2431	71.8340	220.8888
350	NUMBERS	0.0000	195.8012	64.5401	13.4923	1.1188
350	WEIGHTS		2.7857	22.1834	76.1968	230.3045
365	NUMBERS	0.0000	186.3236	61.4160	12.6264	1.0470
365	WEIGHTS		2.9615	23.1868	75.8379	228.7268
15	NUMBERS	1272.6321	177.3047	58.4431	11.8162	0.9798
15	WEIGHTS		3.1387	24.0485	70.4915	212.1517
30	NUMBERS	1178.2883	168.7224	55.6142	11.0579	0.9169
30	WEIGHTS		3.2716	24.7923	69.9555	210.2936
45	NUMBERS	1090.9380	160.5555	52.9221	10.3483	0.8581
45	WEIGHTS		3.3927	25.4669	69.3506	208.2952
60	NUMBERS	1010.0632	0.0000	152.7840	49.5260	9.6842
60	WEIGHTS		0.0000	3.5502	25.8440	70.5777
75	NUMBERS	935.1841	0.0000	145.3885	46.3477	9.0628
75	WEIGHTS		0.0000	3.5467	25.6197	70.2186
90	NUMBERS	865.8560	0.0000	138.3511	43.3734	8.4812
90	WEIGHTS		0.0000	3.5433	25.3975	69.8615
105	NUMBERS	801.6667	0.0000	131.6543	40.5900	7.9369
105	WEIGHTS		0.0000	3.5736	25.2966	69.8273
120	NUMBERS	742.2366	0.0000	125.2816	37.9851	7.4276
120	WEIGHTS		0.0000	3.7840	25.8348	71.4974

135	NUMBERS	687.2119	0.0000	119.2174	35.5475	6.9510
135	WEIGHTS		0.0000	4.3276	27.4980	76.1571
150	NUMBERS	636.2661	0.0000	113.4467	33.2662	6.5049
150	WEIGHTS		0.0000	5.1660	30.0055	83.0686
165	NUMBERS	589.0974	0.0000	107.9554	31.1314	6.0875
165	WEIGHTS		0.0000	6.3036	33.2218	91.8772
180	NUMBERS	0.0000	551.4373	102.7299	29.1336	5.6968
180	WEIGHTS		0.0758	8.1490	38.1121	105.1572
195	NUMBERS	0.0000	524.7441	97.7572	27.2639	5.3312
195	WEIGHTS		0.2639	10.4930	43.8081	120.5970

CHANGE SUMMER TEMPERATURE = 0.00 CHANGE PREY = 0.00

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		1.0558	11.2015	39.7687	81.6653
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		1.6216	13.2472	43.1766	92.1514
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		2.3279	15.2761	46.1060	102.2368
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		3.0298	16.9161	48.3111	110.4895
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		2.9658	16.5034	48.6460	110.4482
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		2.7389	15.4403	47.0051	106.6602
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		2.5354	14.4684	45.5041	103.1580
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		2.5919	14.5623	47.1477	105.6557
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		2.7631	15.1270	50.1628	110.7554
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		2.9869	15.9036	53.7139	116.8706
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		3.2059	16.8569	53.5861	116.3098
15	NUMBERS	771.6267	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		3.3925	17.5989	49.8553	108.0058
30	NUMBERS	714.4226	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		3.5321	18.2081	49.5045	107.1247
45	NUMBERS	661.4600	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		3.6591	18.7639	49.0988	106.1526
60	NUMBERS	612.4233	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	3.8249	19.0784	50.0816
75	NUMBERS	567.0217	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	3.8204	18.9142	49.8399
90	NUMBERS	524.9856	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	3.8159	18.7516	49.5996
105	NUMBERS	486.0654	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	3.8471	18.6857	49.6091
120	NUMBERS	450.0312	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	4.0685	19.1295	50.9382
135	NUMBERS	416.6680	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	4.6413	20.4734	54.5915
150	NUMBERS	385.7778	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	5.5232	22.5020	60.0212
165	NUMBERS	357.1777	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	6.7173	25.1154	66.9769
180	NUMBERS	0.0000	334.3433	46.3198	17.8642	3.9154
180	WEIGHTS		0.0758	8.6495	29.1100	77.5278
195	NUMBERS	0.0000	318.1577	44.0777	16.7177	3.6641
195	WEIGHTS		0.2869	11.3110	34.1914	90.9381
210	NUMBERS	0.0000	302.7561	41.9440	15.6449	3.4290
210	WEIGHTS		0.6163	13.8872	38.3923	104.1248
225	NUMBERS	0.0000	288.1001	39.9137	14.6409	3.2089
225	WEIGHTS		1.0048	16.2660	41.7199	116.5733
240	NUMBERS	0.0000	274.1533	37.9816	13.7014	3.0030
240	WEIGHTS		1.5314	18.7613	44.9032	129.2383
255	NUMBERS	0.0000	260.8811	36.1430	12.8221	2.8103
255	WEIGHTS		2.1574	21.0387	47.3649	140.5122
270	NUMBERS	0.0000	248.2529	34.3935	11.9993	2.6299
270	WEIGHTS		2.2875	21.1985	48.4280	143.2710
285	NUMBERS	0.0000	236.2365	32.7286	11.2293	2.4612
285	WEIGHTS		2.1474	20.0757	47.3372	139.6278
300	NUMBERS	0.0000	224.8016	31.1443	10.5087	2.3032
300	WEIGHTS		1.9603	18.6715	45.4228	134.0956
315	NUMBERS	0.0000	213.9203	29.6367	9.8343	2.1554
315	WEIGHTS		1.9431	18.3086	46.0021	134.4194
330	NUMBERS	0.0000	203.5657	28.2021	9.2032	2.0171
330	WEIGHTS		2.0691	18.8332	48.7277	139.7764
345	NUMBERS	0.0000	193.7122	26.8369	8.6126	1.8876
345	WEIGHTS		2.2503	19.6949	52.1913	146.8591
360	NUMBERS	0.0000	184.3358	25.5378	8.0600	1.7665
360	WEIGHTS		2.4381	20.7479	53.2900	148.7340
10	NUMBERS	747.2253	175.4131	24.3015	7.5427	1.6531
10	WEIGHTS		2.6110	21.6684	49.6310	138.1418

25	NUMBERS	691.8306	166.9224	23.1251	7.0587	1.5471
25	WEIGHTS		2.7359	22.4030	49.3084	137.0316
40	NUMBERS	640.5420	158.8426	22.0057	6.6057	1.4478
40	WEIGHTS		2.8650	23.1551	48.9906	135.9363
55	NUMBERS	593.0562	0.0000	151.1540	20.7085	6.1818
55	WEIGHTS		0.0000	3.0275	23.7048	49.8510
70	NUMBERS	549.0901	0.0000	143.8374	19.3795	5.7851
70	WEIGHTS		0.0000	3.0260	23.4995	49.6106
85	NUMBERS	508.3833	0.0000	136.8751	18.1358	5.4139
85	WEIGHTS		0.0000	3.0245	23.2960	49.3716
100	NUMBERS	470.6941	0.0000	130.2497	16.9719	5.0665
100	WEIGHTS		0.0000	3.0325	23.1299	49.2125
115	NUMBERS	435.7991	0.0000	123.9450	15.8827	4.7413
115	WEIGHTS		0.0000	3.1542	23.3901	49.9911
130	NUMBERS	403.4905	0.0000	117.9455	14.8635	4.4371
130	WEIGHTS		0.0000	3.5205	24.5390	52.7193
145	NUMBERS	373.5774	0.0000	112.2364	13.9096	4.1523
145	WEIGHTS		0.0000	4.2173	26.7636	57.8250
160	NUMBERS	345.8818	0.0000	106.8036	13.0170	3.8859
160	WEIGHTS		0.0000	5.0914	29.3855	63.8447
175	NUMBERS	0.0000	320.8252	101.6339	12.1817	3.6365
175	WEIGHTS		0.0448	6.5386	33.4821	73.1850
190	NUMBERS	0.0000	305.2937	96.7143	11.4000	3.4031
190	WEIGHTS		0.1909	8.6615	38.9753	85.7481
205	NUMBERS	0.0000	290.5144	92.0329	10.6684	3.1847
205	WEIGHTS		0.5153	11.1149	44.5351	99.5800
220	NUMBERS	0.0000	276.4509	87.5781	9.9838	2.9804
220	WEIGHTS		0.8594	13.1677	48.2787	111.7528
235	NUMBERS	0.0000	263.0681	83.3389	9.3431	2.7891
235	WEIGHTS		1.3439	15.4138	52.0343	124.5768
250	NUMBERS	0.0000	250.3335	79.3049	8.7436	2.6101
250	WEIGHTS		1.9348	17.5105	54.9681	136.1421
265	NUMBERS	0.0000	238.2164	75.4661	8.1825	2.4426
265	WEIGHTS		2.3032	18.5274	56.8922	142.7561
280	NUMBERS	0.0000	226.6857	71.8132	7.6574	2.2859
280	WEIGHTS		2.2135	17.8170	56.4275	140.8707
295	NUMBERS	0.0000	215.7132	68.3371	7.1660	2.1392
295	WEIGHTS		2.0209	16.5592	54.1473	135.2910

310	NUMBERS	0.0000	205.2718	65.0292	6.7061	2.0019
310	WEIGHTS		1.9233	15.8169	53.3564	132.7903
325	NUMBERS	0.0000	195.3358	61.8814	6.2758	1.8734
325	WEIGHTS		2.0212	16.1517	55.9105	137.1750
340	NUMBERS	0.0000	185.8807	58.8860	5.8731	1.7532
340	WEIGHTS		2.1875	16.8598	59.5548	143.8000
355	NUMBERS	0.0000	176.8833	56.0356	5.4962	1.6407
355	WEIGHTS		2.3775	17.7628	62.1223	148.3433
5	NUMBERS	650.2410	168.3214	53.3232	5.1435	1.5354
5	WEIGHTS		2.5602	18.6795	57.8620	137.8320
20	NUMBERS	602.0356	160.1739	50.7420	4.8134	1.4369
20	WEIGHTS		2.6997	19.4328	57.5378	136.8460
35	NUMBERS	557.4041	152.4208	48.2858	4.5045	1.3446
35	WEIGHTS		2.8206	20.0820	57.1187	135.6960
50	NUMBERS	516.0811	0.0000	145.0430	45.6933	4.2154
50	WEIGHTS		0.0000	2.9898	20.7508	57.6725
65	NUMBERS	477.8213	0.0000	138.0222	42.7610	3.9449
65	WEIGHTS		0.0000	3.0265	20.7049	57.7463
80	NUMBERS	442.3982	0.0000	131.3413	40.0169	3.6918
80	WEIGHTS		0.0000	3.0250	20.5262	57.4609
95	NUMBERS	409.6003	0.0000	124.9838	37.4488	3.4549
95	WEIGHTS		0.0000	3.0235	20.3492	57.1772
110	NUMBERS	379.2346	0.0000	118.9340	35.0456	3.2331
110	WEIGHTS		0.0000	3.0907	20.4068	57.5294
125	NUMBERS	351.1194	0.0000	113.1771	32.7965	3.0257
125	WEIGHTS		0.0000	3.3542	21.1236	59.6630
140	NUMBERS	325.0886	0.0000	107.6988	30.6918	2.8315
140	WEIGHTS		0.0000	3.9666	22.9297	64.7331
155	NUMBERS	300.9878	0.0000	102.4857	28.7222	2.6498
155	WEIGHTS		0.0000	4.7677	25.1717	70.9879
170	NUMBERS	278.6733	0.0000	97.5249	26.8789	2.4797
170	WEIGHTS		0.0000	5.9860	28.3997	79.9065
185	NUMBERS	0.0000	263.2507	92.8042	25.1540	2.3206
185	WEIGHTS		0.1228	7.8872	33.0625	92.7106
200	NUMBERS	0.0000	250.5074	88.3120	23.5397	2.1717
200	WEIGHTS		0.4273	10.4685	38.8019	108.4786
215	NUMBERS	0.0000	238.3819	84.0373	22.0290	2.0323

215	WEIGHTS		0.7303	12.4613	42.2991	121.5838
230	NUMBERS	0.0000	226.8432	79.9694	20.6153	1.9019
230	WEIGHTS		1.1677	14.6660	45.8524	135.4709
245	NUMBERS	0.0000	215.8631	76.0985	19.2923	1.7798
245	WEIGHTS		1.7294	16.8422	48.8976	148.6374
260	NUMBERS	0.0000	205.4144	72.4149	18.0542	1.6656
260	WEIGHTS		2.3006	18.5915	51.1801	159.2238
275	NUMBERS	0.0000	195.4715	68.9097	16.8955	1.5587
275	WEIGHTS		2.2578	18.1303	51.5046	158.7608
290	NUMBERS	0.0000	186.0099	65.5741	15.8112	1.4587
290	WEIGHTS		2.0833	16.9691	49.7635	153.3243
305	NUMBERS	0.0000	177.0062	62.3999	14.7966	1.3651
305	WEIGHTS		1.9271	15.9066	48.1694	148.2784
320	NUMBERS	0.0000	168.4383	59.3795	13.8470	1.2775
320	WEIGHTS		1.9801	15.9935	49.8642	151.2264
335	NUMBERS	0.0000	160.2852	56.5052	12.9584	1.1955
335	WEIGHTS		2.1256	16.5884	52.9925	157.6416
350	NUMBERS	0.0000	152.5267	53.7700	12.1269	1.1188
350	WEIGHTS		2.3138	17.4123	56.6804	165.4181
365	NUMBERS	0.0000	145.1438	51.1673	11.3487	1.0470
365	WEIGHTS		2.4986	18.4254	56.5345	164.4870
15	NUMBERS	929.6816	138.1182	48.6904	10.6204	0.9798
15	WEIGHTS		2.6570	19.2027	52.5903	152.6450
30	NUMBERS	860.7612	131.4326	46.3335	9.9389	0.9169
30	WEIGHTS		2.7767	19.8469	52.2152	151.3469
45	NUMBERS	796.9504	125.0707	44.0907	9.3011	0.8581
45	WEIGHTS		2.8861	20.4338	51.7834	149.9351
60	NUMBERS	737.8696	0.0000	119.0167	41.2612	8.7042
60	WEIGHTS		0.0000	3.0270	20.7648	52.8006
75	NUMBERS	683.1685	0.0000	113.2558	38.6134	8.1456
75	WEIGHTS		0.0000	3.0255	20.5856	52.5434
90	NUMBERS	632.5225	0.0000	107.7737	36.1354	7.6229
90	WEIGHTS		0.0000	3.0240	20.4081	52.2877
105	NUMBERS	585.6309	0.0000	102.5569	33.8164	7.1337
105	WEIGHTS		0.0000	3.0524	20.3335	52.2919
120	NUMBERS	542.2158	0.0000	97.5927	31.6462	6.6760
120	WEIGHTS		0.0000	3.2410	20.8020	53.6687

135	NUMBERS	502.0188	0.0000	92.8687	29.6154	6.2475
135	WEIGHTS		0.0000	3.7271	22.2283	57.4616
150	NUMBERS	464.8015	0.0000	88.3734	27.7148	5.8466
150	WEIGHTS		0.0000	4.4795	24.3804	63.0968
165	NUMBERS	430.3433	0.0000	84.0957	25.9362	5.4714
165	WEIGHTS		0.0000	5.5056	27.1494	70.3098
180	NUMBERS	0.0000	402.8320	80.0251	24.2717	5.1203
180	WEIGHTS		0.0758	7.1792	31.3756	81.2402
195	NUMBERS	0.0000	383.3320	76.1514	22.7141	4.7917
195	WEIGHTS		0.2869	9.5065	36.7393	95.1139

CHANGE SUMMER TEMPERATURE = 1.00 CHANGE PREY = 0.00

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		1.0485	11.1297	39.5344	81.2849
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		1.5927	13.0482	42.6005	91.1362
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		2.2029	14.7040	44.7171	99.4074
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		2.6896	15.6509	45.4826	104.2837
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		2.4683	14.5780	43.7696	100.3579
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		2.0926	12.8409	39.8823	92.2772
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		1.7731	11.3101	36.3774	84.9177
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		1.7547	11.1021	36.8637	85.3068
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		1.8669	11.4805	39.1403	89.1732
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		2.0376	12.1158	42.1452	94.4425
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		2.2191	12.9650	42.0361	93.9250
15	NUMBERS	651.4421	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		2.3656	13.6043	39.1388	87.2590
30	NUMBERS	603.1479	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		2.4767	14.1202	38.8816	86.5697
45	NUMBERS	558.4341	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		2.5786	14.5933	38.5777	85.8012
60	NUMBERS	517.0344	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	2.7091	14.8636	39.4181
75	NUMBERS	478.7041	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	2.7086	14.7371	39.2364
90	NUMBERS	443.2161	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	2.7082	14.6118	39.0558
105	NUMBERS	410.3579	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	2.7354	14.5668	39.0841
120	NUMBERS	379.9360	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	2.9100	14.9451	40.2164
135	NUMBERS	351.7690	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	3.3598	16.0730	43.2990
150	NUMBERS	325.6899	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	4.0578	17.7775	47.8889
165	NUMBERS	301.5439	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	5.0130	19.9822	53.7917
180	NUMBERS	0.0000	282.2659	46.3198	17.8642	3.9154
180	WEIGHTS		0.0758	6.5772	23.3683	62.7870
195	NUMBERS	0.0000	268.6011	44.0777	16.7177	3.6641
195	WEIGHTS		0.3045	8.8815	27.9158	74.8743
210	NUMBERS	0.0000	255.5977	41.9440	15.6449	3.4290
210	WEIGHTS		0.6490	11.0149	31.4385	86.1275
225	NUMBERS	0.0000	243.2258	39.9137	14.6409	3.2089
225	WEIGHTS		1.0388	12.9196	34.0724	96.3857
240	NUMBERS	0.0000	231.4527	37.9816	13.7014	3.0030
240	WEIGHTS		1.5370	14.8078	36.3857	106.2407
255	NUMBERS	0.0000	220.2494	36.1430	12.8221	2.8103
255	WEIGHTS		2.0220	16.1269	37.4756	112.9611
270	NUMBERS	0.0000	209.5884	34.3935	11.9993	2.6299
270	WEIGHTS		2.0130	15.6334	36.9100	111.6984
285	NUMBERS	0.0000	199.4435	32.7286	11.2293	2.4612
285	WEIGHTS		1.7350	13.9797	34.0538	103.9872
300	NUMBERS	0.0000	189.7896	31.1443	10.5087	2.3032
300	WEIGHTS		1.4415	12.2058	30.6837	95.0284
315	NUMBERS	0.0000	180.6030	29.6367	9.8343	2.1554
315	WEIGHTS		1.3446	11.4967	29.9074	92.3411
330	NUMBERS	0.0000	171.8610	28.2021	9.2032	2.0171
330	WEIGHTS		1.4223	11.7730	31.6477	95.7732
345	NUMBERS	0.0000	163.5422	26.8369	8.6126	1.8876
345	WEIGHTS		1.5578	12.3729	34.1662	101.0852
360	NUMBERS	0.0000	155.6260	25.5378	8.0600	1.7665
360	WEIGHTS		1.7106	13.1765	35.0287	102.6046
10	NUMBERS	555.7791	148.0930	24.3015	7.5427	1.6531
10	WEIGHTS		1.8521	13.9211	32.6592	95.3282

25	NUMBERS	514.5767	140.9247	23.1251	7.0587	1.5471
25	WEIGHTS		1.9523	14.4727	32.4770	94.6051
40	NUMBERS	476.4287	134.1033	22.0057	6.6057	1.4478
40	WEIGHTS		2.0561	15.0396	32.2978	93.8922
55	NUMBERS	441.1089	0.0000	127.6121	20.7085	6.1818
55	WEIGHTS		0.0000	2.1857	15.4570	32.9635
70	NUMBERS	408.4070	0.0000	121.4351	19.3795	5.7851
70	WEIGHTS		0.0000	2.1869	15.3252	32.8177
85	NUMBERS	378.1299	0.0000	115.5571	18.1358	5.4139
85	WEIGHTS		0.0000	2.1881	15.1947	32.6727
100	NUMBERS	350.0969	0.0000	109.9636	16.9719	5.0665
100	WEIGHTS		0.0000	2.1967	15.0911	32.5864
115	NUMBERS	324.1418	0.0000	104.6409	15.8827	4.7413
115	WEIGHTS		0.0000	2.2948	15.2976	33.1888
130	NUMBERS	300.1111	0.0000	99.5757	14.8635	4.4371
130	WEIGHTS		0.0000	2.5863	16.1518	35.2279
145	NUMBERS	277.8618	0.0000	94.7558	13.9096	4.1523
145	WEIGHTS		0.0000	3.1438	17.7992	39.0401
160	NUMBERS	257.2617	0.0000	90.1691	13.0170	3.8859
160	WEIGHTS		0.0000	3.8505	19.7540	43.5664
175	NUMBERS	0.0000	238.6260	85.8045	12.1817	3.6365
175	WEIGHTS		0.0448	5.0333	22.8279	50.6388
190	NUMBERS	0.0000	227.0755	81.6511	11.4000	3.4031
190	WEIGHTS		0.2000	6.8625	27.1438	60.6119
205	NUMBERS	0.0000	216.0841	77.6988	10.6684	3.1847
205	WEIGHTS		0.5453	8.9634	31.4436	71.4632
220	NUMBERS	0.0000	205.6248	73.9378	9.9838	2.9804
220	WEIGHTS		0.8937	10.6398	34.1498	80.6085
235	NUMBERS	0.0000	195.6717	70.3589	9.3431	2.7891
235	WEIGHTS		1.3689	12.4336	36.7803	90.0595
250	NUMBERS	0.0000	186.2003	66.9531	8.7436	2.6101
250	WEIGHTS		1.8573	13.7823	38.2115	96.9691
265	NUMBERS	0.0000	177.1875	63.7123	8.1825	2.4426
265	WEIGHTS		2.0752	14.0817	38.4585	99.2018
280	NUMBERS	0.0000	168.6108	60.6283	7.6574	2.2859
280	WEIGHTS		1.8437	12.8319	36.2275	93.8104
295	NUMBERS	0.0000	160.4493	57.6935	7.1660	2.1392
295	WEIGHTS		1.5342	11.1853	32.6693	85.6225

310	NUMBERS	0.0000	152.6829	54.9008	6.7061	2.0019
310	WEIGHTS		1.3457	10.1052	30.5592	80.4994
325	NUMBERS	0.0000	145.2924	52.2433	6.2758	1.8734
325	WEIGHTS		1.3906	10.2006	31.8476	82.6420
340	NUMBERS	0.0000	138.2596	49.7144	5.8731	1.7532
340	WEIGHTS		1.5092	10.6703	34.1896	87.0315
355	NUMBERS	0.0000	131.5672	47.3079	5.4962	1.6407
355	WEIGHTS		1.6595	11.3440	35.9760	90.3042
5	NUMBERS	431.8794	125.1987	45.0180	5.1435	1.5354
5	WEIGHTS		1.8117	12.0914	33.5601	83.9536
20	NUMBERS	399.8621	119.1386	42.8388	4.8134	1.4369
20	WEIGHTS		1.9231	12.6571	33.4185	83.4199
35	NUMBERS	370.2185	113.3717	40.7651	4.5045	1.3446
35	WEIGHTS		2.0204	13.1495	33.2102	82.7659
50	NUMBERS	342.7722	0.0000	107.8840	38.5764	4.2154
50	WEIGHTS		0.0000	2.1554	13.6559	33.6371
65	NUMBERS	317.3604	0.0000	102.6619	36.1008	3.9449
65	WEIGHTS		0.0000	2.1865	13.6376	33.7273
80	NUMBERS	293.8328	0.0000	97.6926	33.7840	3.6918
80	WEIGHTS		0.0000	2.1877	13.5221	33.5773
95	NUMBERS	272.0488	0.0000	92.9639	31.6160	3.4549
95	WEIGHTS		0.0000	2.1889	13.4077	33.4281
110	NUMBERS	251.8802	0.0000	88.4640	29.5870	3.2331
110	WEIGHTS		0.0000	2.2441	13.4651	33.7047
125	NUMBERS	233.2078	0.0000	84.1819	27.6883	3.0257
125	WEIGHTS		0.0000	2.4540	14.0059	35.1757
140	NUMBERS	215.9197	0.0000	80.1071	25.9114	2.8315
140	WEIGHTS		0.0000	2.9426	15.3516	38.6360
155	NUMBERS	199.9132	0.0000	76.2295	24.2485	2.6498
155	WEIGHTS		0.0000	3.5880	17.0316	42.9379
170	NUMBERS	185.0932	0.0000	72.5396	22.6923	2.4797
170	WEIGHTS		0.0000	4.5799	19.4656	49.1241
185	NUMBERS	0.0000	174.8513	69.0283	21.2360	2.3206
185	WEIGHTS		0.1262	6.1827	23.0869	58.3011
200	NUMBERS	0.0000	166.3877	65.6870	19.8731	2.1717
200	WEIGHTS		0.4536	8.4229	27.6363	69.9005
215	NUMBERS	0.0000	158.3338	62.5074	18.5977	2.0323

215	WEIGHTS		0.7641	10.0665	30.2212	79.1220
230	NUMBERS	0.0000	150.6698	59.4817	17.4042	1.9019
230	WEIGHTS		1.2007	11.8556	32.7869	88.7892
245	NUMBERS	0.0000	143.3767	56.6024	16.2872	1.7798
245	WEIGHTS		1.7023	13.4081	34.5974	96.9160
260	NUMBERS	0.0000	136.4367	53.8626	15.2420	1.6656
260	WEIGHTS		2.1111	14.3047	35.3101	101.7185
275	NUMBERS	0.0000	129.8325	51.2553	14.2639	1.5587
275	WEIGHTS		1.9353	13.3180	33.9875	97.8879
290	NUMBERS	0.0000	123.5480	48.7743	13.3486	1.4587
290	WEIGHTS		1.6319	11.7127	30.8797	89.9824
305	NUMBERS	0.0000	117.5678	46.4133	12.4920	1.3651
305	WEIGHTS		1.3753	10.3002	28.0867	82.7846
320	NUMBERS	0.0000	111.8770	44.1666	11.6903	1.2775
320	WEIGHTS		1.3655	10.1171	28.5541	83.1826
335	NUMBERS	0.0000	106.4615	42.0287	10.9402	1.1955
335	WEIGHTS		1.4626	10.4782	30.4857	86.9889
350	NUMBERS	0.0000	101.3083	39.9942	10.2381	1.1188
350	WEIGHTS		1.6081	11.0775	33.0167	92.1702
365	NUMBERS	0.0000	96.4045	38.0582	9.5811	1.0470
365	WEIGHTS		1.7631	11.8771	32.9673	91.6718
15	NUMBERS	539.1494	91.7381	36.2160	8.9663	0.9798
15	WEIGHTS		1.8889	12.4835	30.7208	85.1705
30	NUMBERS	499.1799	87.2975	34.4629	8.3909	0.9169
30	WEIGHTS		1.9851	12.9714	30.5351	84.5004
45	NUMBERS	462.1731	83.0719	32.7946	7.8524	0.8581
45	WEIGHTS		2.0737	13.4196	30.3098	83.7524
60	NUMBERS	427.9097	0.0000	79.0508	30.6901	7.3485
60	WEIGHTS		0.0000	2.1861	13.6763	31.0275
75	NUMBERS	396.1865	0.0000	75.2243	28.7206	6.8770
75	WEIGHTS		0.0000	2.1873	13.5605	30.8923
90	NUMBERS	366.8152	0.0000	71.5831	26.8774	6.4356
90	WEIGHTS		0.0000	2.1885	13.4457	30.7579
105	NUMBERS	339.6208	0.0000	68.1181	25.1526	6.0227
105	WEIGHTS		0.0000	2.2132	13.4064	30.7982
120	NUMBERS	314.4429	0.0000	64.8208	23.5384	5.6362
120	WEIGHTS		0.0000	2.3639	13.7649	31.7621

135	NUMBERS	291.1309	0.0000	61.6832	22.0278	5.2745
135	WEIGHTS		0.0000	2.7510	14.8287	34.3635
150	NUMBERS	269.5469	0.0000	58.6974	20.6141	4.9360
150	WEIGHTS		0.0000	3.3551	16.4374	38.2450
165	NUMBERS	249.5636	0.0000	55.8561	19.2912	4.6192
165	WEIGHTS		0.0000	4.1875	18.5208	43.2576
180	NUMBERS	0.0000	233.6101	53.1524	18.0531	4.3228
180	WEIGHTS		0.0758	5.5614	21.7260	50.9345
195	NUMBERS	0.0000	222.3024	50.5795	16.8945	4.0454
195	WEIGHTS		0.3045	7.6045	26.0412	61.3225

CHANGE SUMMER TEMPERATURE = -1.00 CHANGE PREY = 0.50

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		1.4093	12.9001	43.5314	90.4510
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		2.7194	17.3800	51.6048	112.5058
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		4.7582	22.7519	60.2580	137.5487
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		7.3291	28.3640	69.0791	163.1950
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		7.9869	30.1560	76.0884	175.7290
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		8.3856	31.1543	81.3316	184.6219
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		8.8088	32.2087	86.9128	193.9968
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		9.7564	34.7467	96.6139	210.9249
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		10.9977	38.0623	108.5341	231.6870
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		12.3031	41.5044	120.6826	252.6565
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		13.4644	45.0816	122.6483	255.5716
15	NUMBERS	1737.0867	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		14.6681	47.8318	116.3813	241.4005
30	NUMBERS	1608.3125	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		15.6540	50.8277	117.5226	242.9373
45	NUMBERS	1489.0835	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		16.5999	53.7066	118.4508	244.1078
60	NUMBERS	1378.6943	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	17.6479	55.5087	122.8552
75	NUMBERS	1276.4885	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	17.8428	55.5797	123.4085
90	NUMBERS	1181.8584	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	18.0390	55.6507	123.9628
105	NUMBERS	1094.2441	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	18.4254	56.0859	125.3427
120	NUMBERS	1013.1245	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	19.8225	58.4468	131.0691
135	NUMBERS	938.0186	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	23.1121	64.2489	144.5629
150	NUMBERS	868.4795	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	28.1525	72.8494	164.4317
165	NUMBERS	804.0962	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	35.0427	84.0364	190.2482
180	NUMBERS	0.0000	752.6926	46.3198	17.8642	3.9154
180	WEIGHTS		0.1026	46.2826	101.2939	229.9897
195	NUMBERS	0.0000	716.2578	44.0777	16.7177	3.6641
195	WEIGHTS		0.5586	60.7906	122.1328	278.0842
210	NUMBERS	0.0000	681.5869	41.9440	15.6449	3.4290
210	WEIGHTS		1.5112	76.6550	142.5975	332.3545
225	NUMBERS	0.0000	648.5942	39.9137	14.6409	3.2089
225	WEIGHTS		2.8863	92.7776	161.4720	388.9573
240	NUMBERS	0.0000	617.1980	37.9816	13.7014	3.0030
240	WEIGHTS		5.0315	110.9337	181.4898	451.3169
255	NUMBERS	0.0000	587.3218	36.1430	12.8221	2.8103
255	WEIGHTS		8.0929	130.3770	201.4627	516.9695
270	NUMBERS	0.0000	558.8916	34.3935	11.9993	2.6299
270	WEIGHTS		9.4753	138.5242	217.9467	554.1375
285	NUMBERS	0.0000	531.8372	32.7286	11.2293	2.4612
285	WEIGHTS		10.0077	141.0734	229.5690	574.9221
300	NUMBERS	0.0000	506.0925	31.1443	10.5087	2.3032
300	WEIGHTS		10.3934	142.3055	239.1117	591.1431
315	NUMBERS	0.0000	481.5940	29.6367	9.8343	2.1554
315	WEIGHTS		11.2548	147.3127	255.8694	621.7717
330	NUMBERS	0.0000	458.2815	28.2021	9.2032	2.0171
330	WEIGHTS		12.5825	155.8359	279.2134	665.3301
345	NUMBERS	0.0000	436.0972	26.8369	8.6126	1.8876
345	WEIGHTS		14.0681	165.3636	304.1172	711.6909
360	NUMBERS	0.0000	414.9868	25.5378	8.0600	1.7665
360	WEIGHTS		15.4752	175.2418	314.5781	730.1516
10	NUMBERS	4653.0937	394.8984	24.3015	7.5427	1.6531
10	WEIGHTS		16.8079	172.8921	296.7871	686.2302

25	NUMBERS	4308.1328	375.7820	23.1251	7.0587	1.5471
25	WEIGHTS		17.9385	180.5775	298.6375	688.4768
40	NUMBERS	3988.7471	357.5913	22.0057	6.6057	1.4478
40	WEIGHTS		19.1233	188.5113	300.5034	690.7476
55	NUMBERS	3693.0540	0.0000	340.2810	20.7085	6.1818
55	WEIGHTS		0.0000	20.4686	194.4957	308.6663
70	NUMBERS	3419.2812	0.0000	323.8076	19.3795	5.7851
70	WEIGHTS		0.0000	20.6800	194.3115	309.3804
85	NUMBERS	3165.8030	0.0000	308.1321	18.1358	5.4139
85	WEIGHTS		0.0000	20.8927	194.1277	310.0945
100	NUMBERS	2931.1155	0.0000	293.2156	16.9719	5.0665
100	WEIGHTS		0.0000	21.1737	194.2399	311.3318
115	NUMBERS	2713.8259	0.0000	279.0217	15.8827	4.7413
115	WEIGHTS		0.0000	22.2577	197.8552	318.7483
130	NUMBERS	2512.6448	0.0000	265.5137	14.8635	4.4371
130	WEIGHTS		0.0000	25.0695	208.7108	338.9395
145	NUMBERS	2326.3772	0.0000	252.6603	13.9096	4.1523
145	WEIGHTS		0.0000	30.2419	228.3762	374.8770
160	NUMBERS	2153.9182	0.0000	240.4305	13.0170	3.8859
160	WEIGHTS		0.0000	36.7395	251.4418	417.2593
175	NUMBERS	0.0000	1997.8901	228.7927	12.1817	3.6365
175	WEIGHTS		0.0475	47.4015	286.7722	482.2507
190	NUMBERS	0.0000	1901.1831	217.7182	11.4000	3.4031
190	WEIGHTS		0.3357	62.1638	331.3938	565.0767
205	NUMBERS	0.0000	1809.1570	207.1797	10.6684	3.1847
205	WEIGHTS		1.1908	79.8598	378.9829	660.3447
220	NUMBERS	0.0000	1721.5857	197.1514	9.9838	2.9804
220	WEIGHTS		2.3525	96.4631	417.0574	753.4907
235	NUMBERS	0.0000	1638.2532	187.6084	9.3431	2.7891
235	WEIGHTS		4.2216	115.3830	457.2300	855.4133
250	NUMBERS	0.0000	1558.9541	178.5274	8.7436	2.6101
250	WEIGHTS		6.9556	135.6995	496.2585	960.9285
265	NUMBERS	0.0000	1483.4934	169.8859	8.1825	2.4426
265	WEIGHTS		9.2281	149.9288	531.1951	1041.4937
280	NUMBERS	0.0000	1411.6851	161.6627	7.6574	2.2859
280	WEIGHTS		9.8806	153.7199	555.3699	1078.4412
295	NUMBERS	0.0000	1343.3533	153.8375	7.1660	2.1392
295	WEIGHTS		10.2640	154.9406	571.2810	1101.1702

310	NUMBERS	0.0000	1278.3289	146.3911	6.7061	2.0019
310	WEIGHTS		10.8932	158.2310	594.5820	1136.0674
325	NUMBERS	0.0000	1216.4512	139.3052	6.2758	1.8734
325	WEIGHTS		12.1155	166.4651	634.7681	1198.9182
340	NUMBERS	0.0000	1157.5693	132.5622	5.8731	1.7532
340	WEIGHTS		13.5765	176.4325	680.2773	1270.3618
355	NUMBERS	0.0000	1101.5369	126.1456	5.4962	1.6407
355	WEIGHTS		15.0345	186.7786	711.7363	1319.0422
5	NUMBERS	17337.9531	1048.2173	120.0396	5.1435	1.5354
5	WEIGHTS		16.3720	184.2550	669.1758	1237.3711
20	NUMBERS	16052.6367	997.4778	114.2291	4.8134	1.4369
20	WEIGHTS		17.5968	193.1212	672.3232	1240.8208
35	NUMBERS	14862.6055	949.1946	108.6999	4.5045	1.3446
35	WEIGHTS		18.7157	201.0780	674.1938	1242.2991
50	NUMBERS	13760.7891	0.0000	903.2485	102.8638	4.2154
50	WEIGHTS		0.0000	20.1377	209.0777	685.1838
65	NUMBERS	12740.6523	0.0000	859.5264	96.2628	3.9449
65	WEIGHTS		0.0000	20.6094	210.1217	689.6360
80	NUMBERS	11796.1406	0.0000	817.9204	90.0854	3.6918
80	WEIGHTS		0.0000	20.8217	209.9010	690.2695
95	NUMBERS	10921.6406	0.0000	778.3286	84.3044	3.4549
95	WEIGHTS		0.0000	21.0350	209.6808	690.9009
110	NUMBERS	10111.9727	0.0000	740.6531	78.8944	3.2331
110	WEIGHTS		0.0000	21.7351	211.7158	698.3826
125	NUMBERS	9362.3281	0.0000	704.8015	73.8315	3.0257
125	WEIGHTS		0.0000	23.8204	220.0320	724.8403
140	NUMBERS	8668.2539	0.0000	670.6851	69.0936	2.8315
140	WEIGHTS		0.0000	28.3805	238.6725	782.2893
155	NUMBERS	8025.6289	0.0000	638.2197	64.6596	2.6498
155	WEIGHTS		0.0000	34.3361	261.5195	852.1960
170	NUMBERS	7430.6523	0.0000	607.3262	60.5102	2.4797
170	WEIGHTS		0.0000	43.3321	293.7644	949.8879
185	NUMBERS	0.0000	7019.4648	577.9277	56.6271	2.3206
185	WEIGHTS		0.1916	56.9038	338.3584	1083.8091
200	NUMBERS	0.0000	6679.6758	549.9521	52.9932	2.1717
200	WEIGHTS		0.9278	74.8650	391.7991	1243.2979
215	NUMBERS	0.0000	6356.3242	523.3306	49.5924	2.0323

215	WEIGHTS		1.8968	90.6691	430.9104	1390.5330	
230	NUMBERS	0.0000	6048.6211	497.9973	46.4099	1.9019	
230	WEIGHTS		3.5069	108.8665	472.4958	1550.4409	
245	NUMBERS	0.0000	5755.8164	473.8904	43.4316	1.7798	
245	WEIGHTS		5.9423	128.8174	513.9011	1716.1868	
260	NUMBERS	0.0000	5477.1914	450.9507	40.6444	1.6656	
260	WEIGHTS		8.9489	148.0211	553.2615	1871.7236	
275	NUMBERS	0.0000	5212.0430	429.1208	38.0361	1.5587	
275	WEIGHTS		9.6948	152.7704	581.4443	1933.4114	
290	NUMBERS	0.0000	4959.7344	408.3484	35.5951	1.4587	
290	WEIGHTS		10.1355	154.5339	599.7109	1968.6025	
305	NUMBERS	0.0000	4719.6406	388.5813	33.3109	1.3651	
305	WEIGHTS		10.6027	156.4407	618.8167	2005.3970	
320	NUMBERS	0.0000	4491.1641	369.7710	31.1731	1.2775	
320	WEIGHTS		11.6742	163.4695	656.3462	2088.3643	
335	NUMBERS	0.0000	4273.7500	351.8711	29.1726	1.1955	
335	WEIGHTS		13.0796	173.0417	702.6946	2192.7820	
350	NUMBERS	0.0000	4066.8618	334.8376	27.3004	1.1188	
350	WEIGHTS		14.5548	182.9944	749.1899	2297.5500	
365	NUMBERS	0.0000	3870.0095	318.6284	25.5484	1.0470	
365	WEIGHTS		15.8620	193.2206	753.9304	2303.6064	
15	NUMBERS	44920.2305	3682.6848	303.2039	23.9088	0.9798	
15	WEIGHTS		17.2125	190.3585	708.5173	2157.0208	
30	NUMBERS	41590.1953	3504.4280	288.5259	22.3745	0.9169	
30	WEIGHTS		18.3144	198.2357	710.3821	2157.1094	
45	NUMBERS	38507.0312	3334.7988	274.5583	20.9386	0.8581	
45	WEIGHTS		19.3687	205.6594	711.4417	2155.4121	
60	NUMBERS	35652.4258	0.0000	3173.3809	256.9380	19.5948	
60	WEIGHTS		0.0000	20.5389	210.1954	726.9482	
75	NUMBERS	33009.4297	0.0000	3019.7761	240.4498	18.3373	
75	WEIGHTS		0.0000	20.7508	209.9745	727.5562	
90	NUMBERS	30562.3672	0.0000	2873.6060	225.0198	17.1604	
90	WEIGHTS		0.0000	20.9638	209.7541	728.1641	
105	NUMBERS	28296.6992	0.0000	2734.5115	210.5799	16.0591	
105	WEIGHTS		0.0000	21.3897	210.5190	731.8884	
120	NUMBERS	26198.9961	0.0000	2602.1492	197.0666	15.0286	
120	WEIGHTS		0.0000	22.9453	216.4740	751.9583	

135	NUMBERS	24256.7930	0.0000	2476.1934	184.4205	14.0642
135	WEIGHTS		0.0000	26.6063	231.5146	800.4441
150	NUMBERS	22458.5742	0.0000	2356.3350	172.5859	13.1617
150	WEIGHTS		0.0000	32.1933	253.4783	870.3586
165	NUMBERS	20793.6562	0.0000	2242.2781	161.5107	12.3170
165	WEIGHTS		0.0000	39.7933	281.3569	958.3413
180	NUMBERS	0.000019464.3945		2133.7417	151.1462	11.5266
180	WEIGHTS		0.1026	52.1223	323.1448	1088.7710
195	NUMBERS	0.000018522.2266		2030.4590	141.4469	10.7870
195	WEIGHTS		0.5586	67.9409	371.8462	1239.5488

CHANGE SUMMER TEMPERATURE = 0.00 CHANGE PREY = 0.50

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		1.4180	12.9032	43.4641	90.4641
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		2.7316	17.3305	51.3378	112.2658
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		4.6940	22.4067	59.3460	135.9792
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		7.0056	27.3322	66.8564	158.6383
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		7.3411	28.1754	71.3960	166.4297
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		7.2074	27.6161	72.3221	167.1530
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		7.0976	27.1307	73.4148	168.1879
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		7.7503	28.9005	80.7431	181.0416
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		8.7624	31.6798	90.9657	199.1191
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		9.9302	34.8512	102.2466	218.9233
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		11.0955	38.5278	104.4569	222.3306
15	NUMBERS	1432.7437	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		12.1459	41.2507	99.2338	210.1691
30	NUMBERS	1326.5310	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		13.0104	43.9499	100.2932	211.6311
45	NUMBERS	1228.1914	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		13.8427	46.5496	101.1636	212.7623
60	NUMBERS	1137.1428	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	14.7628	48.1814	105.1021
75	NUMBERS	1052.8433	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	14.9394	48.2587	105.6220
90	NUMBERS	974.7925	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	15.1172	48.3360	106.1429
105	NUMBERS	902.5278	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	15.4618	48.7411	107.3988
120	NUMBERS	835.6204	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	16.6931	50.8796	112.5259
135	NUMBERS	773.6724	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	19.5944	56.1244	124.5927
150	NUMBERS	716.3167	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	24.0617	63.9154	142.4059
165	NUMBERS	663.2134	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	30.2054	74.0810	165.6334
180	NUMBERS	0.0000	620.8159	46.3198	17.8642	3.9154
180	WEIGHTS		0.1026	40.2947	89.8199	201.5364
195	NUMBERS	0.0000	590.7646	44.0777	16.7177	3.6641
195	WEIGHTS		0.6219	54.5828	110.5501	248.9659
210	NUMBERS	0.0000	562.1677	41.9440	15.6449	3.4290
210	WEIGHTS		1.6762	69.4474	129.7106	299.6384
225	NUMBERS	0.0000	534.9553	39.9137	14.6409	3.2089
225	WEIGHTS		3.1509	84.2213	146.8559	351.3831
240	NUMBERS	0.0000	509.0596	37.9816	13.7014	3.0030
240	WEIGHTS		5.3827	100.5273	164.5840	407.3042
255	NUMBERS	0.0000	484.4175	36.1430	12.8221	2.8103
255	WEIGHTS		8.3450	116.8226	180.8392	462.4146
270	NUMBERS	0.0000	460.9683	34.3935	11.9993	2.6299
270	WEIGHTS		9.4441	122.0089	192.1962	488.3647
285	NUMBERS	0.0000	438.6536	32.7286	11.2293	2.4612
285	WEIGHTS		9.4128	120.1569	195.0612	491.4368
300	NUMBERS	0.0000	417.4187	31.1443	10.5087	2.3032
300	WEIGHTS		9.1279	116.4101	194.2720	487.0046
315	NUMBERS	0.0000	397.2119	29.6367	9.8343	2.1554
315	WEIGHTS		9.5782	118.2743	204.0099	504.0764
330	NUMBERS	0.0000	377.9839	28.2021	9.2032	2.0171
330	WEIGHTS		10.6841	124.9616	222.9118	539.5425
345	NUMBERS	0.0000	359.6863	26.8369	8.6126	1.8876
345	WEIGHTS		12.0348	133.2367	244.6608	580.4043
360	NUMBERS	0.0000	342.2747	25.5378	8.0600	1.7665
360	WEIGHTS		13.4190	142.5534	254.5004	597.9690
10	NUMBERS	4220.4102	325.7058	24.3015	7.5427	1.6531
10	WEIGHTS		14.7321	141.8273	240.8046	563.2156

25	NUMBERS	3907.5291	309.9387	23.1251	7.0587	1.5471
25	WEIGHTS		15.7635	148.5202	242.5201	565.4097
40	NUMBERS	3617.8564	294.9346	22.0057	6.6057	1.4478
40	WEIGHTS		16.8463	155.4425	244.2501	567.6248
55	NUMBERS	3349.6575	0.0000	280.6572	20.7085	6.1818
55	WEIGHTS		0.0000	18.0751	160.6758	251.3264
70	NUMBERS	3101.3411	0.0000	267.0703	19.3795	5.7851
70	WEIGHTS		0.0000	18.2726	160.5672	252.0173
85	NUMBERS	2871.4321	0.0000	254.1416	18.1358	5.4139
85	WEIGHTS		0.0000	18.4714	160.4587	252.7087
100	NUMBERS	2658.5674	0.0000	241.8401	16.9719	5.0665
100	WEIGHTS		0.0000	18.7326	160.6068	253.8489
115	NUMBERS	2461.4822	0.0000	230.1341	15.8827	4.7413
115	WEIGHTS		0.0000	19.7264	163.7924	260.2893
130	NUMBERS	2279.0071	0.0000	218.9947	14.8635	4.4371
130	WEIGHTS		0.0000	22.3010	173.2656	277.7100
145	NUMBERS	2110.0591	0.0000	208.3944	13.9096	4.1523
145	WEIGHTS		0.0000	27.0492	190.4293	308.7515
160	NUMBERS	1953.6357	0.0000	198.3073	13.0170	3.8859
160	WEIGHTS		0.0000	33.0375	210.6227	345.4961
175	NUMBERS	0.0000	1812.1165	188.7084	12.1817	3.6365
175	WEIGHTS		0.0475	42.9056	241.6522	402.0640
190	NUMBERS	0.0000	1724.4014	179.5741	11.4000	3.4031
190	WEIGHTS		0.3650	57.4876	283.3499	478.8518
205	NUMBERS	0.0000	1640.9324	170.8820	10.6684	3.1847
205	WEIGHTS		1.3260	74.8668	327.2275	566.2937
220	NUMBERS	0.0000	1561.5037	162.6105	9.9838	2.9804
220	WEIGHTS		2.5805	90.5275	360.5898	648.6206
235	NUMBERS	0.0000	1485.9197	154.7395	9.3431	2.7891
235	WEIGHTS		4.5572	108.1771	395.3313	737.9336
250	NUMBERS	0.0000	1413.9937	147.2494	8.7436	2.6101
250	WEIGHTS		7.2623	125.9460	426.4756	824.9570
265	NUMBERS	0.0000	1345.5493	140.1219	8.1825	2.4426
265	WEIGHTS		9.3205	137.1496	451.7356	885.8525
280	NUMBERS	0.0000	1280.4180	133.3394	7.6574	2.2859
280	WEIGHTS		9.5101	136.8466	460.8909	897.9316
295	NUMBERS	0.0000	1218.4392	126.8851	7.1660	2.1392
295	WEIGHTS		9.2217	132.5672	456.8635	887.8157

310	NUMBERS	0.0000	1159.4609	120.7433	6.7061	2.0019
310	WEIGHTS		9.3120	131.4951	463.2559	895.2200
325	NUMBERS	0.0000	1103.3367	114.8988	6.2758	1.8734
325	WEIGHTS		10.2871	137.7158	493.8730	943.1223
340	NUMBERS	0.0000	1049.9292	109.3372	5.8731	1.7532
340	WEIGHTS		11.5744	146.2514	531.7383	1002.8899
355	NUMBERS	0.0000	999.1069	104.0448	5.4962	1.6407
355	WEIGHTS		12.9693	155.9474	559.8835	1046.7471
5	NUMBERS	13403.8750	950.7449	99.0085	5.1435	1.5354
5	WEIGHTS		14.3353	155.4268	527.9917	984.3132
20	NUMBERS	12410.1953	904.7236	94.2160	4.8134	1.4369
20	WEIGHTS		15.4514	163.2961	530.9270	987.7119
35	NUMBERS	11490.1836	860.9299	89.6556	4.5045	1.3446
35	WEIGHTS		16.4737	170.3766	532.7830	989.4319
50	NUMBERS	10638.3594	0.0000	819.2561	84.8420	4.2154
50	WEIGHTS		0.0000	17.7723	177.4995	542.2285
65	NUMBERS	9849.6953	0.0000	779.5994	79.3974	3.9449
65	WEIGHTS		0.0000	18.2067	178.4702	546.1301
80	NUMBERS	9119.4922	0.0000	741.8621	74.3023	3.6918
80	WEIGHTS		0.0000	18.4050	178.3225	546.8296
95	NUMBERS	8443.4297	0.0000	705.9514	69.5341	3.4549
95	WEIGHTS		0.0000	18.6045	178.1751	547.5291
110	NUMBERS	7817.4805	0.0000	671.7793	65.0719	3.2331
110	WEIGHTS		0.0000	19.2479	180.0238	553.9812
125	NUMBERS	7237.9258	0.0000	639.2610	60.8961	3.0257
125	WEIGHTS		0.0000	21.1570	187.4352	576.3823
140	NUMBERS	6701.3359	0.0000	608.3167	56.9882	2.8315
140	WEIGHTS		0.0000	25.3383	204.0171	624.9351
155	NUMBERS	6204.5312	0.0000	578.8706	53.3311	2.6498
155	WEIGHTS		0.0000	30.8199	224.3874	684.1995
170	NUMBERS	5744.5625	0.0000	550.8496	49.9087	2.4797
170	WEIGHTS		0.0000	39.1337	253.2102	767.3030
185	NUMBERS	0.0000	5426.6680	524.1843	46.7059	2.3206
185	WEIGHTS		0.2013	52.1505	294.4673	885.3499
200	NUMBERS	0.0000	5163.9648	498.8103	43.7086	2.1717
200	WEIGHTS		1.0354	70.0722	345.5420	1030.8892
215	NUMBERS	0.0000	4913.9844	474.6638	40.9037	2.0323

215	WEIGHTS		2.0917	85.0843	380.6616	1158.6699
230	NUMBERS	0.0000	4676.0977	451.6870	38.2787	1.9019
230	WEIGHTS		3.8115	102.1777	417.4744	1296.1897
245	NUMBERS	0.0000	4449.7305	429.8213	35.8222	1.7798
245	WEIGHTS		6.2878	120.1081	452.1543	1432.9329
260	NUMBERS	0.0000	4234.3125	409.0144	33.5233	1.6656
260	WEIGHTS		9.1266	136.1187	482.2361	1552.5186
275	NUMBERS	0.0000	4029.3389	389.2151	31.3720	1.5587
275	WEIGHTS		9.5092	137.4728	497.3164	1580.7559
290	NUMBERS	0.0000	3834.3018	370.3740	29.3587	1.4587
290	WEIGHTS		9.3167	133.9783	495.6511	1567.4988
305	NUMBERS	0.0000	3648.7053	352.4451	27.4746	1.3651
305	WEIGHTS		9.1542	130.7821	494.7275	1556.1685
320	NUMBERS	0.0000	3472.0930	335.3838	25.7114	1.2775
320	WEIGHTS		9.9212	135.3320	521.1284	1611.7498
335	NUMBERS	0.0000	3304.0293	319.1482	24.0614	1.1955
335	WEIGHTS		11.1197	143.2202	559.1089	1695.0706
350	NUMBERS	0.0000	3144.1001	303.6987	22.5172	1.1188
350	WEIGHTS		12.5007	152.3328	600.6023	1786.5632
365	NUMBERS	0.0000	2991.9121	288.9971	21.0722	1.0470
365	WEIGHTS		13.8717	162.8142	606.3042	1795.2373
15	NUMBERS	37046.6367	2847.0913	275.0068	19.7198	0.9798
15	WEIGHTS		15.1008	160.8413	570.2866	1682.1621
30	NUMBERS	34300.2812	2709.2798	261.6938	18.4543	0.9169
30	WEIGHTS		16.1069	167.8473	572.1528	1683.0508
45	NUMBERS	31757.5195	2578.1392	249.0261	17.2700	0.8581
45	WEIGHTS		17.0717	174.4644	573.3315	1682.4417
60	NUMBERS	29403.2656	0.0000	2453.3459	233.0457	16.1616
60	WEIGHTS		0.0000	18.1408	178.5196	586.6750
75	NUMBERS	27223.5273	0.0000	2334.5933	218.0908	15.1244
75	WEIGHTS		0.0000	18.3388	178.3717	587.3599
90	NUMBERS	25205.3750	0.0000	2221.5889	204.0955	14.1539
90	WEIGHTS		0.0000	18.5379	178.2242	588.0447
105	NUMBERS	23336.8281	0.0000	2114.0542	190.9983	13.2456
105	WEIGHTS		0.0000	18.9312	178.9487	591.3831
120	NUMBERS	21606.8125	0.0000	2011.7244	178.7416	12.3956
120	WEIGHTS		0.0000	20.3558	184.2678	608.6479

135	NUMBERS	20005.0508	0.0000	1914.3479	167.2714	11.6002
135	WEIGHTS		0.0000	23.7099	197.6471	650.1858
150	NUMBERS	18522.0234	0.0000	1821.6843	156.5373	10.8558
150	WEIGHTS		0.0000	28.8453	217.2117	710.1897
165	NUMBERS	17148.9297	0.0000	1733.5063	146.4920	10.1591
165	WEIGHTS		0.0000	35.8590	242.1102	785.9363
180	NUMBERS	0.000016052.6602	1649.5964	137.0913	9.5072	
180	WEIGHTS		0.1026	47.2887	279.5425	898.6462
195	NUMBERS	0.000015275.6211	1569.7483	128.2938	8.8971	
195	WEIGHTS		0.6219	63.3355	327.0381	1040.6069

CHANGE SUMMER TEMPERATURE = 1.00 CHANGE PREY = 0.50

TIME		EGGS	AGE 0	AGE 1	AGE 2	AGE 3
215	NUMBERS	0.0000	137.9814	61.8537	16.8448	3.7433
215	WEIGHTS		1.4134	12.8438	43.2573	90.1580
230	NUMBERS	0.0000	131.3025	58.8596	15.7638	3.5031
230	WEIGHTS		2.6979	17.1187	50.7441	111.2449
245	NUMBERS	0.0000	124.9468	56.0105	14.7522	3.2783
245	WEIGHTS		4.4467	21.5529	57.5090	132.0706
260	NUMBERS	0.0000	118.8988	53.2992	13.8055	3.0679
260	WEIGHTS		6.1750	25.0735	62.4701	148.5201
275	NUMBERS	0.0000	113.1436	50.7192	12.9196	2.8710
275	WEIGHTS		6.0310	24.4654	63.0413	148.6524
290	NUMBERS	0.0000	107.6670	48.2641	12.0905	2.6868
290	WEIGHTS		5.3944	22.3189	59.3372	140.4633
305	NUMBERS	0.0000	102.4554	45.9278	11.3146	2.5144
305	WEIGHTS		4.8353	20.3944	55.9829	132.9767
320	NUMBERS	0.0000	97.4961	43.7047	10.5886	2.3530
320	WEIGHTS		5.1357	21.2072	60.2215	140.3380
335	NUMBERS	0.0000	92.7767	41.5891	9.9091	2.2020
335	WEIGHTS		5.8420	23.2746	68.1027	154.5882
350	NUMBERS	0.0000	88.2859	39.5759	9.2732	2.0607
350	WEIGHTS		6.7344	25.8634	77.4883	171.4695
365	NUMBERS	0.0000	84.0125	37.6601	8.6781	1.9284
365	WEIGHTS		7.6914	29.0775	79.4576	174.5677
15	NUMBERS	1088.0234	79.9458	35.8371	8.1212	1.8047
15	WEIGHTS		8.5026	31.5234	75.6432	165.2603
30	NUMBERS	1007.3645	76.0760	34.1024	7.6001	1.6889
30	WEIGHTS		9.1765	33.7559	76.5710	166.5903
45	NUMBERS	932.6851	72.3936	32.4516	7.1123	1.5805
45	WEIGHTS		9.8296	35.9157	77.3447	167.6435
60	NUMBERS	863.5420	0.0000	68.8894	30.3690	6.6559
60	WEIGHTS		0.0000	10.5494	37.2778	80.5998
75	NUMBERS	799.5247	0.0000	65.5547	28.4201	6.2288
75	WEIGHTS		0.0000	10.6952	37.3614	81.0636
90	NUMBERS	740.2534	0.0000	62.3815	26.5962	5.8291
90	WEIGHTS		0.0000	10.8421	37.4449	81.5286
105	NUMBERS	685.3752	0.0000	59.3619	24.8894	5.4550

105	WEIGHTS		0.0000	11.1193	37.7993	82.5967
120	NUMBERS	634.5659	0.0000	56.4885	23.2921	5.1050
120	WEIGHTS		0.0000	12.0900	39.5865	86.8445
135	NUMBERS	587.5227	0.0000	53.7541	21.7973	4.7774
135	WEIGHTS		0.0000	14.3822	43.9551	96.8252
150	NUMBERS	543.9670	0.0000	51.1521	20.3984	4.4708
150	WEIGHTS		0.0000	17.9465	50.4712	111.6274
165	NUMBERS	503.6399	0.0000	48.6760	19.0893	4.1839
165	WEIGHTS		0.0000	22.9069	59.0240	131.0508
180	NUMBERS	0.0000	471.4431	46.3198	17.8642	3.9154
180	WEIGHTS		0.1026	31.1611	72.3570	161.2934
195	NUMBERS	0.0000	448.6218	44.0777	16.7177	3.6641
195	WEIGHTS		0.6721	43.7143	91.0281	203.8368
210	NUMBERS	0.0000	426.9053	41.9440	15.6449	3.4290
210	WEIGHTS		1.7957	56.3312	107.4867	247.4665
225	NUMBERS	0.0000	406.2395	39.9137	14.6409	3.2089
225	WEIGHTS		3.3114	68.5939	121.7303	291.0305
240	NUMBERS	0.0000	386.5745	37.9816	13.7014	3.0030
240	WEIGHTS		5.4864	81.5789	135.7083	336.2324
255	NUMBERS	0.0000	367.8611	36.1430	12.8221	2.8103
255	WEIGHTS		7.9202	92.3687	145.8322	373.5415
270	NUMBERS	0.0000	350.0537	34.3935	11.9993	2.6299
270	WEIGHTS		8.4216	93.2407	149.4782	382.6387
285	NUMBERS	0.0000	333.1079	32.7286	11.2293	2.4612
285	WEIGHTS		7.7208	87.2674	143.3236	367.5364
300	NUMBERS	0.0000	316.9827	31.1443	10.5087	2.3032
300	WEIGHTS		6.8425	80.0030	134.2765	346.4434
315	NUMBERS	0.0000	301.6372	29.6367	9.8343	2.1554
315	WEIGHTS		6.7967	78.6065	136.1258	348.1443
330	NUMBERS	0.0000	287.0347	28.2021	9.2032	2.0171
330	WEIGHTS		7.5744	82.9909	149.1521	372.9756
345	NUMBERS	0.0000	273.1396	26.8369	8.6126	1.8876
345	WEIGHTS		8.6271	89.1122	165.4903	404.3137
360	NUMBERS	0.0000	259.9170	25.5378	8.0600	1.7665
360	WEIGHTS		9.7793	96.4887	173.2981	418.5317
10	NUMBERS	3371.5498	247.3357	24.3015	7.5427	1.6531
10	WEIGHTS		10.8717	97.3170	164.4404	394.9690

25	NUMBERS	3121.6104	235.3636	23.1251	7.0587	1.5471
25	WEIGHTS		11.7059	102.4584	165.9046	396.9939
40	NUMBERS	2890.1992	223.9710	22.0057	6.6057	1.4478
40	WEIGHTS		12.5857	107.7966	167.3819	399.0364
55	NUMBERS	2675.9426	0.0000	213.1299	20.7085	6.1818
55	WEIGHTS		0.0000	13.5833	111.8508	172.8277
70	NUMBERS	2477.5691	0.0000	202.8135	19.3795	5.7851
70	WEIGHTS		0.0000	13.7518	111.8395	173.4522
85	NUMBERS	2293.9014	0.0000	192.9965	18.1358	5.4139
85	WEIGHTS		0.0000	13.9214	111.8283	174.0774
100	NUMBERS	2123.8496	0.0000	183.6546	16.9719	5.0665
100	WEIGHTS		0.0000	14.1419	112.0127	175.0423
115	NUMBERS	1966.4036	0.0000	174.7650	15.8827	4.7413
115	WEIGHTS		0.0000	14.9560	114.5154	180.0170
130	NUMBERS	1820.6296	0.0000	166.3056	14.8635	4.4371
130	WEIGHTS		0.0000	17.0597	121.8319	193.3334
145	NUMBERS	1685.6621	0.0000	158.2557	13.9096	4.1523
145	WEIGHTS		0.0000	20.9635	135.0993	217.1226
160	NUMBERS	1560.6997	0.0000	150.5954	13.0170	3.8859
160	WEIGHTS		0.0000	25.9340	150.8064	245.4871
175	NUMBERS	0.0000	1447.6436	143.3060	12.1817	3.6365
175	WEIGHTS		0.0475	34.2076	175.0989	289.4893
190	NUMBERS	0.0000	1377.5706	136.3693	11.4000	3.4031
190	WEIGHTS		0.3882	47.0991	209.3146	352.2290
205	NUMBERS	0.0000	1310.8894	129.7684	10.6684	3.1847
205	WEIGHTS		1.4276	62.4302	244.9502	423.2322
220	NUMBERS	0.0000	1247.4358	123.4870	9.9838	2.9804
220	WEIGHTS		2.7279	75.7564	270.7888	487.9341
235	NUMBERS	0.0000	1187.0537	117.5097	9.3431	2.7891
235	WEIGHTS		4.7173	90.5349	297.1584	557.2063
250	NUMBERS	0.0000	1129.5942	111.8217	8.7436	2.6101
250	WEIGHTS		7.0650	103.2338	316.3860	615.2012
265	NUMBERS	0.0000	1074.9160	106.4090	8.1825	2.4426
265	WEIGHTS		8.5069	109.1366	327.5315	646.6567
280	NUMBERS	0.0000	1022.8845	101.2583	7.6574	2.2859
280	WEIGHTS		8.0350	104.0674	320.0715	631.3962
295	NUMBERS	0.0000	973.3713	96.3570	7.1660	2.1392
295	WEIGHTS		7.1249	95.5863	301.4363	597.1980

310	NUMBERS	0.0000	926.2546	91.6928	6.7061	2.0019
310	WEIGHTS		6.6670	90.6157	293.0005	580.3972
325	NUMBERS	0.0000	881.4189	87.2544	6.2758	1.8734
325	WEIGHTS		7.2861	94.2217	311.4780	609.4136
340	NUMBERS	0.0000	838.7532	83.0309	5.8731	1.7532
340	WEIGHTS		8.2593	100.4478	337.9949	651.8757
355	NUMBERS	0.0000	798.1526	79.0117	5.4962	1.6407
355	WEIGHTS		9.3937	108.1046	358.9561	685.0320
5	NUMBERS	8643.6875	759.5176	75.1872	5.1435	1.5354
5	WEIGHTS		10.5524	109.1400	339.4849	645.5549
20	NUMBERS	8002.8906	722.7524	71.5477	4.8134	1.4369
20	WEIGHTS		11.4527	115.2782	341.9810	648.6716
35	NUMBERS	7409.5977	687.7666	68.0845	4.5045	1.3446
35	WEIGHTS		12.2825	120.8321	343.6899	650.5437
50	NUMBERS	6860.2852	0.0000	654.4746	64.4290	4.2154
50	WEIGHTS		0.0000	13.3364	126.4276	350.7920
65	NUMBERS	6351.6992	0.0000	622.7942	60.2944	3.9449
65	WEIGHTS		0.0000	13.6955	127.2543	353.8230
80	NUMBERS	5880.8125	0.0000	592.6472	56.4251	3.6918
80	WEIGHTS		0.0000	13.8648	127.2142	354.5481
95	NUMBERS	5444.8359	0.0000	563.9592	52.8041	3.4549
95	WEIGHTS		0.0000	14.0352	127.1742	355.2732
110	NUMBERS	5041.1758	0.0000	536.6599	49.4155	3.2331
110	WEIGHTS		0.0000	14.5652	128.6844	360.1560
125	NUMBERS	4667.4414	0.0000	510.6816	46.2443	3.0257
125	WEIGHTS		0.0000	16.1244	134.5208	376.5862
140	NUMBERS	4321.4023	0.0000	485.9612	43.2767	2.8315
140	WEIGHTS		0.0000	19.5526	147.5362	412.1074
155	NUMBERS	4001.0276	0.0000	462.4365	40.4995	2.6498
155	WEIGHTS		0.0000	24.0881	163.6063	455.7397
170	NUMBERS	3704.4233	0.0000	440.0510	37.9005	2.4797
170	WEIGHTS		0.0000	31.0342	186.4720	517.3545
185	NUMBERS	0.0000	3499.4426	418.7490	35.4682	2.3206
185	WEIGHTS		0.2089	42.2884	220.1568	607.6113
200	NUMBERS	0.0000	3330.0549	398.4785	33.1921	2.1717
200	WEIGHTS		1.1186	58.2775	262.8086	721.8342
215	NUMBERS	0.0000	3168.8660	379.1892	31.0620	2.0323

215	WEIGHTS		2.2253	71.1445	290.6047	818.2927
230	NUMBERS	0.0000	3015.4800	360.8337	29.0686	1.9019
230	WEIGHTS		3.9840	85.6329	319.2959	921.2529
245	NUMBERS	0.0000	2869.5178	343.3660	27.2031	1.7798
245	WEIGHTS		6.2797	99.4257	343.1680	1014.5312
260	NUMBERS	0.0000	2730.6211	326.7439	25.4574	1.6656
260	WEIGHTS		8.4795	109.4223	358.7231	1081.1912
275	NUMBERS	0.0000	2598.4475	310.9268	23.8236	1.5587
275	WEIGHTS		8.2629	106.2943	356.9124	1070.5303
290	NUMBERS	0.0000	2472.6716	295.8750	22.2947	1.4587
290	WEIGHTS		7.4176	98.3435	338.6731	1021.2900
305	NUMBERS	0.0000	2352.9836	281.5518	20.8639	1.3651
305	WEIGHTS		6.6717	91.0898	321.8525	975.4363
320	NUMBERS	0.0000	2239.0884	267.9219	19.5249	1.2775
320	WEIGHTS		7.0298	92.6394	334.5447	999.5906
335	NUMBERS	0.0000	2130.7065	254.9521	18.2718	1.1955
335	WEIGHTS		7.9031	98.1460	360.6265	1055.0442
350	NUMBERS	0.0000	2027.5708	242.6113	17.0992	1.1188
350	WEIGHTS		9.0060	105.2043	391.5444	1121.3999
365	NUMBERS	0.0000	1929.4272	230.8680	16.0018	1.0470
365	WEIGHTS		10.1806	113.9020	396.3044	1128.8215
15	NUMBERS	24181.2422	1836.0342	219.6930	14.9749	0.9798
15	WEIGHTS		11.1692	113.3589	373.4768	1059.2651
30	NUMBERS	22388.6172	1747.1611	209.0590	14.0140	0.9169
30	WEIGHTS		11.9846	118.8477	375.2244	1060.9255
45	NUMBERS	20728.8906	1662.5903	198.9397	13.1147	0.8581
45	WEIGHTS		12.7708	124.0562	376.4663	1061.5110
60	NUMBERS	19192.1992	0.0000	1582.1130	186.1733	12.2731
60	WEIGHTS		0.0000	13.6393	127.2678	386.4116
75	NUMBERS	17769.4180	0.0000	1505.5312	174.2262	11.4855
75	WEIGHTS		0.0000	13.8082	127.2276	387.1404
90	NUMBERS	16452.1211	0.0000	1432.6562	163.0458	10.7484
90	WEIGHTS		0.0000	13.9783	127.1875	387.8691
105	NUMBERS	15232.4766	0.0000	1363.3086	152.5828	10.0587
105	WEIGHTS		0.0000	14.3057	127.8246	390.5396
120	NUMBERS	14103.2383	0.0000	1297.3174	142.7913	9.4132
120	WEIGHTS		0.0000	15.4699	132.0319	403.4075

135	NUMBERS	13057.7227	0.0000	1234.5203	133.6281	8.8091
135	WEIGHTS		0.0000	18.2143	142.5315	434.1489
150	NUMBERS	12089.7031	0.0000	1174.7634	125.0529	8.2438
150	WEIGHTS		0.0000	22.4494	157.9352	478.7356
165	NUMBERS	11193.4492	0.0000	1117.8989	117.0280	7.7148
165	WEIGHTS		0.0000	28.2898	177.6496	535.3950
180	NUMBERS	0.000010477.8750	1063.7866	109.5181	7.2197	
180	WEIGHTS		0.1026	37.9102	207.4888	620.3701
195	NUMBERS	0.0000 9970.6758	1012.2935	102.4900	6.7564	
195	WEIGHTS		0.6721	52.3727	247.6937	734.2893