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A SIMULATION STUDY OF JOLLY'S ESTIMATES FOR ANIMAL POPULATIONS WHEN SAMPLING INTENSITY IS LOW

by

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ABSTRACT

The Jolly estimation equations do not yield reliable estimates of the population parameters when sampling intensity is low. Criteria to aid the experimenter in determining whether or not his results from the Jolly model are reliable, are developed. Using these criteria, the parameter sets of survival rate and capture probability, for which unreliable estimates result, are determined.

Two methods of pooling are suggested which may allow the experimenter to salvage some information from this experiment when the Jolly estimation equations produce unreliable estimates. The two pooling methods are the method of pooled statistics and the method of reduced capture histories. Both pooling methods are simulated using the parameter sets which resulted in unreliable estimates. The criteria developed previously are again applied to these results to determine if there has been any improvement with either pooling method. It is shown, that in certain cases, there is a very great improvement in the estimates from both pooling methods. Variance formulae for the pooled estimates are proposed and shown to give reliable estimates of the precision of the pooled estimates.

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TABLE OF CONTENTS

Chapter 1

1.1 General Introduction

Over periods of time the size of an animal population changes due to variation caused by births, deaths, immigration and emigration. What are mainly of interest to the biologist are trends in the population such as: is the population steadily increasing over time, is the population decreasing and heading for extinction or are there significant fluctuations in the population throughout the year? This type of study is called "monitoring" a population.

The mark-recapture or multiple-recapture experiment is one method of estimating these trends. The mark-recapture experiment is described as follows: The population is sampled at a number of discrete (but not necessarily equally spaced) sampling times $i = 1, 2, \ldots, L$. Any unmarked animals in the sample are given a unique identifying mark. The capture of each animal and the sampling period is recorded and it is returned to the population. Some animals may not survive the capture and these animals are called losses on capture. Other animals may be detained and returned to the population at a later sampling occasion. Each of the animals released from the sample has some probability of surviving to the next sampling period. Thus, some animals may die between sampling periods. Others may permanently leave the population but are included in the deaths. However, the experimenter is unaware of which animals die or when they die or which animals leave the population since he may never see them again. Between successive sampling periods there are new arrivals to the population, which are termed births and which increase the pool of unmarked individuals. The term births is meant in the general sense to include any new entries to the population due either to birth or immigration.

The model used to estimate population parameters such as population size, survival rate or number of births was developed by Jolly (1965). To derive the estimation equations he made the following assumptions:

(1) Sampling is random. Each animal has the same probability of capture at time i, p_i, although p_i may vary over the different sampling times. In particular, capture must not affect future catchability. Out of the s_i released from a sample of size n_i, p_j is the same for the s_i and the $N_i - n_i$ (the number not captured in the ith sample) for all $j > i$.

(2) The probaility that an animal survives from time i to i + 1, ϕ_i, is assumed to be the same regardless of age, size, capture history, etc. If the experimenter thinks that survival or capture rate differs among various age or size groups, the Jolly analysis can be applied to the stratified population. This analysis can be done, providing there is no transfer of individuals among the strata in the course of the experiment. In this study I consider only

the case of a single stratum.

(3) Only permanent migration occurs. That is, an animal that leaves the population at any time does not return to the population. This does not apply to animals detained upon capture which may be returned to the population as part of a later s_i.

(4) Aside from animals detained upon capture, the period of time required to mark and return a sample is assumed to be small compared to the time between samples.

1.2 Notation

The notation is taken from Jolly (1965) and is consistent with the general notation proposed by Cormack (1968) and is as follows:

$N_i \equiv$ the total population size at the time of the ith sample.

$n_i \equiv$ the number of individuals captured in the ith sample.

$M_i \equiv$ the total number of marked animals in the population at the time of the ith sample.

$m_i \equiv$ the number of marked animals in the ith sample.

$s_i \equiv$ the number in the ith sample returned to the population after marking.

$B_i \equiv$ the number of new arrivals to the population between the ith and i + 1st samples.

z_i ≡ the number in the population at time i that were caught and marked before and after time i, but were not caught at time i.

r_i ≡ the number of animals caught at time i which are seen again at some later sampling time.

$\alpha_i = M_i/N_i$ ≡ the proportion of marked animals in the population at time i.

ϕ_i ≡ the probability that an animal alive at time i survives to time i + 1.

P_i ≡ the probability that an animal alive at time i is caught in the ith sample.

η_i ≡ the probability than an animal caught in the ith sample is released. i.e. that the animal is not lost on capture.

L ≡ the total number of samples.

The n_i, m_i, s_i, r_i and z_i all represent random variables. N_i and M_i are called conditional parameters by Jolly because they are parameters of the model but they are also affected by random variation in numbers surviving prior to time i. They are usually called unobservable random variables. The parameters p_i, ϕ_i, η_i and B_i are considered to be fixed but unknown quantities. Parameter estimates are denoted in the usual way. For example, $\hat{N}_i$ is an estimate of N_i.

1.3 Purpose and Scope

This thesis is an analysis of the multiple-recapture experiment described in 1.1. The model is the one proposed by

Jolly (1965) and Seber (1965). The notation is the same as Jolly's and in certain cases is taken from Cormack (1968) to standardize notation. It will be shown that, provided the assumptions hold, the Jolly model yields satisfactory results in most cases. However, there are cases, such as when sampling intensity is low or when the population is small, that result in poor estimates of the population parameters. These cases will be determined and a method of pooling the observations is suggested which will produce reliable estimates. A reliable estimate is defined as one which is fairly precise and not badly biased as defined by the criteria for reliability that are developed.

If estimates of the parameters at each sampling time are unreliable, it may be possible to assume that the parameters change only slowly over time, so that the parameters over several adjacent sampling periods are approximately the same. One may then wish to combine or pool the information from several adjacent sampling periods to produce more reliable estimates of the average parameter sizes within each pooled interval.

If unreliable estimates are produced from an experiment, it may be due to low sampling intensity; that is, p_i may be low resulting in small samples and/or few recaptures. An experimenter may wish to increase his number of trapping stations but for various reasons such as manpower shortage or lack of suitable trap sites it may not be possible. In such cases he may consider pooling as a method of increasing the acceptability of his estimates. He may also consider extending his sampling chain. However, if his sampling intensity is low or, if the animals are subject to a relatively low survival rate the number of recaptures may still be small. Again, pooling may allow the experimenter to accept the new estimates, whereas he may have rejected the unpooled estimates.

As a starting point, the simulations deal with a stable population. In my simulations a stable population is produced by keeping the parameters p, ϕ and η constant over the sampling chain. As well, the births are made to compensate for the total expected losses. Thus, $E(N_i)=N_0$ for all i, where N_0 is the initial population size in the simulation. A more general definition of stability, allowing the parameters p, ϕ and η to vary over the sampling sequence, but compensating for any losses by new entries, and still keeping the population stable was not used.

Stable populations are not unrealistic especially over short periods of time. Also, if pooling methods do not work on stable populations they are not likely to work on populations changing gradually or erratically over time. In order to keep the thesis to manageable proportions the main part of the investigation involved stable populations. Unstable populations were also looked at to determine the effect of pooling on the estimates. More work must be done in the area of unstable populations, and the results given here are intended only as a basis for a more comprehensive study of the properties of the Jolly estimates and pooling methods in an unstable population. In chapter 5 I outline how such a study might be carried out.

The Jolly estimates are calculated over the stable population for a large number of parameter sets. From the results of these simulations criteria for determing reliability of estimates are developed using bias, relative bias, coefficient of variation and comparison of the r_i to the estimate for N_i. Using the criteria, those parameter sets from which unreliable estimates result are determined.

The criteria used in this simulation study can also be used by the experimenter on his estimates. The experimenter will not be able to get a measure of the bias in his estimates and the coefficient of variation can not always be reliably estimated from the results of a single experiment. However, the criterion which uses the average r_i across i can be used. If the experimenter's estimates of N_i are fairly stable, he can compare the r_i's to the estimate of N_i. If the r_i's are fairly high, say greater than 5 percent of the estimate then, his results are probably fairly good.

Two of the methods of pooling described below are investigated using the parameter sets which yield unreliable estimates. The problem is to determine if the pooling methods improve the estimates sufficiently to allow the experimenter to accept them. If the pooling methods yield good estimates is one method better than the other? Also, what is the effect of increasing the number of sample times pooled? What is the optimal pooling rule? Since the variance of the estimate gives an indication of the precision of the estimate, another purpose of the simulations is to form variance formulae for the pooled estimates and determine the validity of these variance formulae.

There are a number of possible methods of pooling that can be used when the Jolly model yields unsatisfactory results. Information is pooled in groups of s sample periods each. Instead of getting the $\hat{N}_i$, $\hat{\phi}_i$, $\hat{B}_i$, etc. for i = 1, 2, ..., L the experimenter gets $\hat{N}_J$, $\hat{\phi}_J$, $\hat{B}_J$ etc. for J = 1, 2, ..., P. $P \simeq L/S$ and the Jth period is called the Jth grouping interval. Thus, for example, when J = 1, $\hat{N}_J$ is an estimate of the population size over the first s sampling periods.

The first method involves pooling the statistics n_i, m_i, s_i, r_i and z_i over the pooling interval. From these pooled statistics estimates of the parameter values at the beginning of each grouping interval can be formed. In particular, the estimates are formed for i = 1, s + 1, s + 2, etc. By shifting the interval one sample period and pooling over the new interval, the experimenter can get estimates for i = 2, s + 2, 2s + 2, etc. By shifting the interval s times the experimenter can get estimates for all the sample periods except the last s - 1. If he wishes, the experimenter may then average the estimates within grouped intervals to derive the $\hat{N}_J$, etc. as described above. This process, then, involves forming estimates from the pooled statistics and then taking a moving average within grouping intervals. This method will be called the pooled statistics method. A more detained justification and explanation of this method is given in chapter 4.

The second pooling method may be called the method of reduced capture histories. For each individual the capture history data within a grouping interval are treated as if they were collected at a single point in time; the midpoint of each period. In this method recaptures within a grouping interval are ignored. Each capture history is grouped and the n_i, m_i, s_i, r_i and z_i are collected from the reduced capture histories of each individual. The Jolly equations are then used to form the estimates. A moving average is also used on the capture histories to get a moving average of estimates. This method of reduced capture histories is discussed in detail in chapter 4.

A third method of pooling, called the method of pooled estimates, was suggested by Jolly (1969). This method involves weighting the estimates $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$. The estimates are calculated using the original Jolly model and are then pooled within periods by a weighted average of the estimates. The weights are taken in inverse proportion to the estimated variance. The methods of pooled statistics and reduced capture histories were simulated and are discussed further in chapters 4 and 5. However, due to the complexity of the method of pooled estimates it was not investigated.

1.4 Chapter Outlines

In chapter 2 I discuss the Jolly model giving the Jolly estimation equations and the estimation equations corrected for small sample bias as suggested by Seber (1965). In the second part of the chapter I describe the simulation program which generates the capture histories for the population, calculates the observed values n_i, m_i, s_i, r_i and z_i and calculates the estimates $\hat{N}_i$, $\hat{M}_i$, $\hat{\alpha}_i$, $\hat{\phi}_i$, $\hat{B}_i$, $\hat{V}(\hat{N}_i)$, $\hat{V}(\hat{\phi}_i)$, $\hat{V}(\hat{B}_i)$, $\hat{V}(\hat{N}_i|N_i)$ and $\hat{V}(\hat{\phi}_i) - \hat{\phi}_i^2(1 - \hat{\phi}_i)/\hat{M}_{i+i}$. Also included is a discussion of problems encountered during the simulation.

In chapter 3 I discuss the results of the simulation of a single experiment as described in chapter 2. Following the discussion is the next step of the simulation; running the simulation over multiple replications of a single experiment. The reasons for multiple replications are given as well as what analysis can be done on the results in terms of bias, relative bias and coefficient of variation. From the results of the multiple replications I derive criteria for determining whether or not an estimate is reliable. The last section of this chapter gives the parameter sets over which the simulations were run as well as the parameter sets which yield reliable estimates according to the criteria developed in this chapter.

In chapter 4 I describe the two methods of pooling which were investigated; the method of pooled statistics and the method of reduced capture histories. The estimation equations which result from both methods of pooling are given as well as the methods of implementing both pooling methods into the simulating program.

In chapter 5 I give the results of both pooling methods described in chapter 4. Included in this chapter is a discussion of the variance formulae used in the pooling methods, a discussion of the effect of changing the grouping interval length, a comparison of the two pooling methods and some results of simulations done on a nonstable population.

Chapter 6 is the concluding chapter of the thesis. The conclusions made throughout the thesis are summarized in this chapter.

Chapter 2

2.1 Introduction

The Jolly estimation equations are given in this chapter as well as the estimation equations corrected for small sample bias which were used in the simulation. After this, the simulation program is described, giving a discussion of the methods used and a description of problems which arose during the course of the simulation.

2.2 The Jolly Estimation Equations

(1) α_i is the proportion of marked animals in the population and is estimated by $\hat{\alpha}_i = m_i/n_i$.

(2) $\hat{M}_i = (s_i z_i/r_i) + m_i$

The total number of marked animals in the population is made up of the m_i daptured in the ith sample and the M_i-m_i not captured in the ith sample. At the time of release of the ith sample there are two groups of marked animals. These two groups are the s_i and the M_i-m_i. The number caught before, and after, but not at time i is z_i. The M_i-m_i are the number caught before the ith sample but not in the ith sample. Therefore, z_i of the M_i-m_i are caught after the ith sample. The number caught at and after the ith sample is r_i. Therefore, of the s_i released from the ith sample, r_i are caught subsequently. Hence, because of assumptions (1) and (2) from 1.1, namely, that probability of recapture is the same for the M_i-m_i and the s_i,

$$\frac{z_i}{M_i-m_i} \approx \frac{r_i}{s_i}.$$

That is, the proportion of the marked animals not caught at time i but caught after time i should be approximately the same as the proportion of marked animals released at time i and subsequently recaptured. Therefore, these proportions yield the estimate $\hat{M}_i$ given above.

(3) Since capture does not affect future catchability the proportion of marked animals in the sample, m_i/n_i, should be the same as the proportion of marked animals in the population, M_i/N_i. Therefore, it follows from $m_i/n_i \simeq M_i/N_i$, that $\hat{N}_i = (n_i/m_i)\hat{M}_i$.

(4) $\hat{\phi}_i = \hat{M}_{i+1}/(\hat{M}_i - m_i + s_i)$

At the time of release of the ith sample the two groups of marked animals are the M_i-m_i and the s_i. The total number of marked animals known to be alive at time i is $M_i-m_i+s_i$. Of these, M_{i+1} are alive at the time of the i+1st sample. Therefore, the probability of survival from the ith to the i+1st sample is the proportion of the number of animals marked and alive at time i, still alive at time i+1, which is $M_{i+1}/(M_i-m_i+s_i)$.

(5) $\hat{B}_i = \hat{N}_{i+1} - \hat{\phi}_i(\hat{N}_i - n_i + s_i)$

At the time of release of the ith sample the total number in the population is $N_i-n_i+s_i$. Of these, $\phi_i(N_i-n_i+s_i)$ will survive to the i+1st sampling period. At time i+1 there are N_{i+1} animals in the population, so the number of arrivals between i and i+1 is the difference, $N_{i+1}-\phi_i(N_i-n_i+s_i)$.

While the samples are taken over the L sampling periods, the estimates $\hat{M}_i$, $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ do not exist for all i. The range of $\hat{\alpha}_i$ is over the complete sampling chain, since both m_i and n_i are defined for all i. The range of $\hat{M}_i$ is restricted to 1 to L-1, because at i=L neither r_i nor z_i are defined and therefore, $\hat{M}_L$ is undefined. The range of $\hat{N}_i$ is also restricted to 1 to L-1. This is because $\hat{N}_i$ is a function of $\hat{M}_i$, which as shown does not exist for i=L. Therefore, $\hat{N}_i$ does not exist at i=L. $\hat{N}_i$ also does not exist for i=1 since m_i=0. However, $\hat{N}_i$ is calculated by averaging the N_i, for i=2, 3, ..., L-1. This average value is then assigned to $\hat{N}_i$.

The range of $\hat{\phi}_i$ is further restricted to 1 to L-2 because $\hat{\phi}_i$ is a function of $\hat{M}_{i+1}$. Thus, for i=L, $\hat{\phi}_i$ does not exist because there is no $\hat{M}_{L+1}$ and for i=L-1, $\hat{\phi}_i$ does not exist because $\hat{M}_L$ does not exist. Similarily, $\hat{B}_i$ exists in the range 1 to L-2 because it is a function of $\hat{\phi}_i$. Since neither $\hat{\phi}_L$ nor $\hat{\phi}_{L-1}$ exist neither B_L nor B_{L-1} exist.

Also of importance to the experimenter are the variances for $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$. These aid him in determining how reliable his estimates are. The variance formulae given below are from Jolly (1965). These formulae are asympototic formulae, valid when the n_i, m_i, s_i, r_i and z_i are large.

$$V(\hat{N}_i)=\{N_i(N_i-n_i)(((M_i-m_i+s_i)/M_i)(1/r_i-1/s_i)+(1-\alpha_i)/m_i)\}$$
$$+\{N_i-\sum_{j=0}^{i-1}(N_i^2(j)/B_j)\}$$

$$V(\hat{\phi}_i)=\phi_i^2\{((M_{i+1}-m_{i+1})(M_{i+1}-m_{i+1}+s_{i+1})/(M_{i+1}^2))(1/r_{i+1}-1/s_{i+1})$$
$$+((M_i-m_i)/(M_i-m_i+s_i))(1/r_i-1/s_i)+(1-\phi_i)/M_{i+1}\}$$

$$V(\hat{B}_i)=\{B_i^2(M_{i+1}-m_{i+1})(M_{i+1}-m_{i+1}+s_{i+1})/M_{i+1}^2)(1/r_{i+1}-1/s_{i+1})\}$$
$$+(M_i-m_i)/(M_i-m_i+s_i)\}\{\phi_i s_i(1-\alpha_i)/\alpha_i\}^2(1/r_i-1/s_i)$$
$$+(N_i-n_i)(N_{i+1}-B_i)(1-\alpha_i)(1-\phi_i)/(M_i-m_i+s_i)+N_{i+1}(N_{i+1}-n_{i+1})$$
$$(1-\alpha_{i+1})/m_{i+1}+\phi_i^2 N_i(N_i-n_i)(1-\alpha_i)/m_i$$

Since the parameter N_i is affected by survival and immigration prior to time i, it is not considered as a fixed parameter of the model. The number surviving to time i has random variation and the total variation from sampling periods before i produces random variation in N_i. The estimate of N_i, $\hat{N}_i$, has variance consisting of errors in estimation and the variability of N_i. The term in the first set of braces represents errors in estimation, while the terms $N_i - \sum_{j=0}^{i-1} (N_i^2(j)/B_j)$ represent the variance of the conditional estimate, $\hat{N}_i | N_i$. The $N_i(j)$ used in the formula of $V(\hat{N}_i)$ refers to the expected number in the population at time i that first joined the population between times j and j+1. The $N_i(j)$ are obtained from the recursive formula, $N_{i+1}(j) = \{(N_{i+1}-B_j)/N_i\}N_i(j)$, for $i > j$, and $N_{i+1}(i) = B_i$.

In Jolly's formulae for the variances each symbol refers to the expected value. However, since these are unobtainable each symbol is replaced by its observed or estimated value. Only observed or estimated values are used in the variance formulae; therefore, the results are only estimated values of the asymptotic variances and are denoted $\hat{V}(\hat{N}_i)$, etc.

2.3 The Unbiased Estimation Equations

The estimates from the Jolly model are subject to bias either from failure of one of the assumptions of the model or, if all assumptions are met, from some inherent property of the model, which may be termed as small sample bias. In order to reduce small sample bias, the estimation equations used in the simulation are those given by Seber (1965) and discussed by Carothers (1973). They are as follows:

$$\hat{\alpha}_i = (m_i+1)/(n_i+1)$$

$$\hat{M}_i = (s_i+1)z_i/(r_i+1) + m_i$$

The formulae for $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ remain the same as in 2.2 and use $\hat{\alpha}_i$ and $\hat{M}_i$ from above.

2.4 The Simulation

The simulation consists of taking N_o individuals and generating capture histories over the L sampling periods for sets of the parameters ϕ, p and η. The parameters N_o, ϕ, p, η and L are read into the program, with ϕ, p and η constant for all i, i=1, 2, ..., L. The parameters ϕ, p and η need not be constant over i and in many real-life situations they are not. However, as a matter of convenience they were constant over i. The simulation program can be easily modified to allow for varying these parameters.

Each of the N_o individuals is either caught and released, caught and lost on capture, or not caught at each of the L sample periods. Also, any individual that is caught and released, or not caught, may not survive between trapping periods. As well as the N_o individuals at the beginning of the simulation, there are new arrivals to the population between sample times in the form of births. This simulation deals with a stable population and hence, the expected number of births was chosen so as to replace the expected number of deaths or losses.

The expected number of losses between any sample times i and i+1 is $N_i p_i(1-\eta_i) + (N_i-n_i+s_i)(1-\phi_i)$. These losses represent the number of animals caught at time i, $N_i p_i$, but lost on capture, plus the number of animals caught and released at time i, $N_i-n_i+s_i$, that did not survive to time i+1. Since for given N_i,

$E(N_i-n_i+s_i) = N_i-N_ip_i+N_ip_i\eta_i$, therefore,

$$E\{N_ip_i(1-\eta_i)+(N_i-n_i+s_i)(1-\phi_i)\} = N_ip_i(1-\eta_i)+(N_i-N_ip_i+N_ip_i\eta_i)(1-\phi_i)$$

$$= N_i\{p_i(1-\eta_i)+(1-p_i+p_i\eta_i)(1-\phi_i)\}$$

$$= N_i\{1-\phi_i(1-p_i+p_i\eta_i)\}$$

$$= N_i\rho_i.$$

Therefore, $N_i\rho_i$ is the expected number of losses between i and i+1, and the number of births between i and i+1, B_i, is $N_i\rho_i$. Since N_i is a random variable, and because the population is stable over the L sampling periods, I use $N_i=N_0$ in calculating the number of births.

The following is the mechanism by which the capture history of each individual is produced for each sample, i, and for each parameter set of N_0, p_i, ϕ_i, and η_i and L:

(1) A uniformly distributed random number, U_1, is generated between 0 and 1 for each sample for which the individual is in the population. It is captured if U_1 is less than the probability of capture, p_i.

(2) If it is captured, a second uniformly distributed random number, U_2, is generated between 0 and 1. If U_2 is less than η_i, the probability of no loss on capture, then the individual survives until release.

(3) If the individual is alive at the time of release of the ith sample, then a third uniformly distributed random number, U_3, is generated between 0 and 1. If U_3 is less than ϕ_i, the probability

of survival from i to i+1, then the individual survives until the time of the next sample.

A capture history is produced in this way for each of the N_o individuals, as well as for the $N_o\rho_i$ new arrivals between times i and i+1.

There is a second method by which the capture histories can be produced which was not used, but is more efficient. When sampling begins, there are five mutually exclusive and exhaustive events. These events and their corresponding probabilities are listed below. An individual could be

(i) not captured at i and does not survive to i+1, with probability $(1-p_i)(1-\phi_i)$

(ii) not captured at i and survives to i+1, with probability $(1-p_i)\phi_i$

(iii) captured at i and lost on capture with probability $p_i(1-\eta_i)$

(iv) captured at i, released and does not survive to i+1, with probability $p_i\eta_i(1-\phi_i)$

(v) captured at i, released and survives to i+1, with probability $p_i\eta_i\phi_i$.

The sum of the five probabilities is 1. The interval between 0 and 1 is divided into 5 sub-intervals. Each sub-interval has a length corresponding to the value of one of the 5 probabilities. A uniformly distributed random number, U_1 is generated between 0 and 1. U_1 will fall into one of the sub-intervals and the corresponding event is the one which occurs.

The capture history of each of the N_o individuals, and each of the B_i individuals, $i=1, 2, \ldots, L-1$, is stored in a vector, X, of length L. The following notation is used:

$X_i=0$ implies the individual was not captured at time i.

$X_i=1$ implies the individual was captured at time i and was returned to the population at time i.

$X_i=-1$ implies the individual was captured at time i but was lost on capture.

$X_i=2$ implies the individual died before time i.

Thus, as soon as an individual has died, the remainder of the capture history for that individual is set to 2.

In order to calculate the estimates from the Jolly model-the simulation requires the observations n_i, m_i, s_i, r_i and z_i. These are calculated from all the capture histories in the subroutine STATS (see appendix B). Each time an individual's capture history is completed, the STATS routine is called. For each individual's capture history, STATS forms a cumulative sum vector, C, of length L defined by:

$C_i = \sum_{j=1}^{i} |x_j|$ for all x_j, $x_j \neq 2$. If $x_j=2$ then add zero to the sum.

The following algorithm uses the X_i and C_i to calculate the required observations:

if $|X_i|=1$ then $n_i=n_i+1$, where n_i is the number captured in the ith sample.

if $|X_i|=1$ and $c_i > 1$ then $m_i=m_i+1$, where m_i is the number of marked individuals in the ith sample.

if $X_i=1$ then $s_i=s_i+1$, where s_i is the number released from the ith sample.

if $X_i=0$ and $0 < C_i < C_L$ then $z_i=z_i+1$, where z_i is the number marked before and after, but not at time i.

if $X_i=1$ and $C_i < C_L$ then $r_i=r_i+1$, where r_i is the number marked at and after time i.

if $X_i \neq 2$ then $N_i=N_i+1$, where N_i is the total number in the population at time i.

if $X_{i-1} \neq 2$ and $C_{i-1} > 0$ then $M_i=M_i+1$, where M_i is the total number of marked individuals in the population at time i.

This algorithm (suggested by A.D. Carothers in a private communication) can also be used to form the n_i, m_i, s_i, r_i and z_i from actual data. All that is required is that the data be coded as shown previously. However, the experimenter will not be able to calculate the N_i and M_i from actual data, since he won't know when an individual dies. Thus, with the exception of those individuals lost on capture, none of the X_i for the population will have the value of 2. The algorithm given above is suitable for forming the statistics from actual data, if the last two steps of the algorithm are omitted.

When the n_i, m_i, s_i, r_i and z_i have been calculated from all the capture histories, the subroutine ESTMT (See appendix B) is called to calculate the estimates $\hat{\alpha}_i$, $\hat{N}_i$, $\hat{M}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, as well as the estimates of the variance of the estimates $\hat{V}(\hat{N}_i)$, $\hat{V}(\hat{\phi}_i)$, $\hat{V}(\hat{B}_i)$, $\hat{V}(\hat{N}_i|N_i)$ and $\hat{V}(\hat{\phi}_i)-\hat{\phi}_i^2(1-\hat{\phi}_i)|\hat{M}_{i+1}$. These are the results of a single replication of the simulation. The results of a single replication correspond exactly to the results that an experimenter could derive from an actual set of data.

In the course of the simulation a number of problems arose, which either gave poor estimates, or produced problems in the simulation program. The problems and the solutions adopted were:

(1) In calculating $\hat{\phi}_i$, it is possible to get values which are less than zero or greater than one. Not only are such estimates inadmissable, but they also lead to problems when using the variance formulae. For instance: $V(\hat{N}_i|N_i) = V(\hat{N}_i) + \hat{N}_i - \sum_{j=0}^{i-1}(N_i^2(j)/B_j)$. B_j is a function of ϕ_j and if $\phi_j > 1.0$, the values of B_j may be negative. With B_j negative, the term $\sum_{j=0}^{i-1}(N_i^2(j)/B_j)$ may be negative, which makes $\hat{V}(\hat{N}_i|N_i) > \hat{V}(\hat{N}_i)$, which should not be the case. Therefore, any $\hat{\phi}_i \leq 0.0$ were adjusted to a small positive number, 0.000001, and any $\phi_i > 1.0$ were adjusted to 1.0.

(2) If any $\hat{B}_i$ were less than zero, they produced unacceptable values for $\hat{V}(\hat{B}_i)$. Accordingly, any $\hat{B}_i < 0.0$ were adjusted to zero .

(3) In calculating $\sum_{j=0}^{i-1}(N_i^2(j)/B_j)$, if any B_j=0.0, then the term is undefined and the jth row in the triangular matrix for $N_i(j)$ ($N_i(j)$ is the expected number in the population at time i, that first joined the population between times j and j+1; i.e. which are members of B_j) is undefined. Since B_j has

been set to zero, $N_i(j)$ should also be zero. Therefore, the jth row in the triangular matrix for $N_i(j)$ contributes no information to the term and the row is left out.

(4) In calculating the variance estimates, if any variable in the denominator is zero then the variance is set to zero. For example: $\hat{V}(\hat{N}_i) = \hat{N}_i(\hat{N}_i-n_i)\{((\hat{M}_i-m_i+s_i)/\hat{M}_i)(1/r_i-1/s_i) +(1-\hat{\alpha}_i)/m_i\} + \hat{N}_i-\sum_{j=0}^{i-1}(N_i^2(j)/B_j)$. If any of the r_i, s_i or M_i equlas zero, then $\hat{V}(\hat{N}_i)$ is set to zero. In such cases the variance should logically be infinite. However, in practice an experimenter encountering such a situation would not be able to form a variance estimate (although using Seber's formulae with correction for small sample bias he could form estimates). Setting the variance estimate to zero and reducing the number of replications by one, eliminates the offending data set when calculating the mean and variance of the variance estimate over replications. Thus, such means and variances for the variance estimates are conditional on the m_i, s_i and r_i being greater than zero.

Chapter 3

3.1 Introduction

In Chapter 3, I discuss the results of a single experiment as well as the results from repetition of a single experiment during a simulation. From these results I derive a criterion for a "good" experiment and determine the parameter sets of N_o, ϕ_i, and p_i which produce acceptable results.

3.2 Results of a Single Experiment

The simulation of a single experiment produces results such as those in tables 3.2.1 and 3.2.2, for the parameter set of p_i, ϕ_i, η_i, N_o and L equal to 0.50, 0.90, 1.00, 200 and 50, respectively. Table 3.2.1 gives the true values of the observations M_i, m_i, N_i, n_i, B_i, s_i, r_i and z_i from columns two to nine, respectively. and table 3.2.2 give the estimates $\hat{\alpha}_i$, $\hat{M}_i$, $\hat{N}_i$, $\hat{\phi}_i$, $\hat{B}_i$, $\hat{V}(\hat{N}_i)$, $\hat{V}(\hat{\phi}_i)$, $\hat{V}(\hat{B}_i)$, $\hat{V}(\hat{N}_i|N_i)$, $\hat{V}(\hat{\phi}_i)-\hat{\phi}_i^2(1-\hat{\phi}_i)/\hat{M}_{i+1}$ and bias of $\hat{N}_i$ from columns two to twelve, respectively.

The results from a single experiment are extremely variable across i, as can be seen from the column labelled CN(I) (which represents N_i in the notation from 1.2) in table 3.2.1. This column represents the total number of animals in the population at time i. The values of CN(I) begin at 200 for I=1, reach a low of 174 at I=20 and climb to a high of 219 at I=49. Since the simulation deals with a stable population, the expected value of N_i is 200 for all i. The variability in the N_i is due to the effect of the (stochastically occurring) deaths and losses on capture.

Another example of the variability over a single experiment occurs in the column NN(I) in table 3.2.1 which, from the notation in 1.2, is n_i the number in the ith sample. With the probability of capture equal to 0.50 and N_0 equal to 200, the expected size of each sample is 200(0.50) = 100. However, the variability is due to the variability in CN(I), as well as the variability contributed by the capture mechanism. While the expected population size at any sampling time is 200, the true population size at the ith sample is CN(I). $\hat{N}_i$, NEST(I) in table 3.2.2, is an estimate of the true population size. N_i is an unobserveable random variable and the error of the estimate of N_i, $\hat{N}_i - N_i$, should be small if the results from this simulation are to be acceptable. Since $\hat{N}_i$ is an estimate of CN(I), and CN(I) fluctuates over i, you expect $\hat{N}_i$ to fluctuate over I as well. $\hat{N}_i$ does vary over i and the error of $\hat{N}_i$ remains relatively constant over i as well.

In this set of simulations the estimates which appear to give the best results over one experiment are PHIEST(I) ($\hat{\phi}_i$) and BEST(I) ($\hat{B}_i$), however, this is generally not the case. The true survival rate is 0.90 and the average estimate of survival is close to that, with a low estimated standard deviation. The estimates ϕ_i for i=6, 12 and 42 equals 1.0. The calculated estimate for those values if ϕ_i was greater than 1.0, but as was discussed in 2.4, any such estimates were reset to 1.0. The average value across i of $\hat{B}_i$ is close to 20, the true value from table 3.2.1, with the average estimate of the standard deviation across i of $\hat{B}_i$ approximately equal to 8.5.

Although the estimates in the above example fluctuate, they are still relatively close to their true values. The probable conclusion from this experiment is that the estimates are reliable. However, the results in the next example, shown in tables 3.2.3 and 3.2.4, are clearly the opposite case. The results are for the parameter set of N_o, ϕ_i, p_i and η_i equal to 200, 0.93, 0.04 and 1.00, respectively.

From table 3.2.3, the column labelled M(I) which corresponds to m_i, has several zero entries. Thus, in these zero entries there were no recaptures, which will show up in the r_i (R(I) in table 3.2.3). Several entries in the r_i are zero as well, and since the Jolly model requires non zero r_i for good estimates, the indication is that the results will be poor.

The conclusion of poor estimates is further asserted by the results in table 3.2.4. The column lablelled NEST(I) ($\hat{N}_i$) has a very wide range of values, which are significant overestimates and underestimates. The fifth column, $\hat{\phi}_i$, has a number of entries equal to 1.0, indicating several inadmissable estimates of ϕ_i were obtained. The same is true for BEST(I) ($\hat{B}_i$), SDN(I) ($\hat{V}(\hat{N}_i)$), SDP(I) ($\hat{V}(\hat{\phi}_i)$) and SDB(I) ($\hat{V}(\hat{B}_i)$). All have several zero entries, showing that inadmissable results were obtained. Thus, this example of a poor experiment over a single replication contrasts with the previous example of a good experiment over a single replication.

3.3 Multiple Replications

In order to investigate the variability of the estimates at each sampling time, the simulation was performed over 36 replications. Replications meant that the experiment was repeated 36 times using the same parameter values, but different generated capture histories. In particular, a different set of random numbers was generated for each replication, which generated different capture histories.

The number of replications was not chosen to be a much larger number, such as 100 for two reasons. Firstly, a smaller number was chosen because of a "diminishing returns" effect for the estimation of the mean. Replicating produces means of the estimates over the 36 replications. According to the central limit theorem, if $\bar{X}$ is the mean of an estimate, then $\bar{X}$ is approximately normally distributed with mean μ and variance σ^2/n. Thus, the precision, as measured by the standard deviation, increases with $\sqrt{n}$ and the gain in precision for a unit increase in n, diminishes as n becomes larger. Secondly, because of the "diminishing returns" effect and the cost of computing for more than 36 replications the simulations were run over 36 replications. Now, instead of results over only one experiment, the observations and estimates were averaged over 36 replications. From the replicated results, sample standard deviations of the estimates can also be calculated.

The purpose of averaging the estimates over 36 replications is to be able to analyze the estimates and to determine their reliability. The estimates of parameters are analyzed as to their bias and to their variability, and the estimates of the variances are investigated to see if the variance formulae estimate the variance of an estimate reliably. This investigation applies to the Jolly estimates without pooling, in order to determine what parameter values allow reliable estimates. The investigation also applies to the study of pooled estimates which allows you to determine if pooling reduces bias, improves precision and to see empirically if the variance formulae have any applicability when pooled statistics are substituted into the formulae.

There are two types of estimates which can be distinquished from the Jolly model. One type is estimates of a fixed parameter or property of the model. For example, the fixed parameters are p_i, ϕ_i, B_i, n_i, $V(\hat{N}_i|N_i)$, $V(B_i)$ and $V(\phi_i)$. The second type are estimates of conditional parameters and properties of the model such as N_i, M_i and $V(N_i)$.

Two properties of both types of estimates are of interest; namely, precision and bias. Precision and bias cannot be easily derived analytically and so they are estimated from the replicated data for particular parameter sets. The methods of analyzing precision and bias for the two methods are discussed separately.

A single replication of an experiment yields an estimate, e, of a true value, Θ. In my simulations e corresponds to p_i, $\hat{\phi}_i$, $\hat{B}_i$, etc. and Θ corresponds to the fixed parameters p_i, ϕ_i, B_i, etc. Since e is a function of observeable random variables, e is a random variable and has an expected value. The expected value of e $E(e)$, is μ_e, and the variance of e, var(e), is σ_e^2. If $\mu_e = \Theta$, then e is said to be an unbiased estimate of Θ.

Neither μ_e nor σ_e^2 are known. However, both μ_e and σ_e^2 were estimated by replicating the experiment 36 times, which gives e_1, e_2, ..., e_{36}. The average of the e_i over the 36 replications is $\bar{e}$, and $\bar{e}$ is an estimate of μ_e. Since each e_i is a random variable, its expected value, $E(\bar{e})$, is μ_e and its variance, $var(\bar{e})$, is $\sigma_e^2/\sqrt{(36)}$. By the central limit theorem, $\bar{e}$ is approximately $N(\mu_e, \sigma_e^2/6)$.

The estimate of the bias, $\hat{b}$, is $\bar{e}-\Theta$ and since $E(\bar{e})=\mu_e$, $E(\hat{b})=\mu_e-\Theta$. Therefore, $\hat{b}$ is approximately $N(\mu_e-\Theta, \sigma_e^2/6)$. The sample variance of the e_i over the 36 replications is s_e^2, which is an estimate of σ_e^2. A test of significance can be performed on $\hat{b}$. In particular, if $\mu_e-\Theta = 0$, then $\hat{b}/s_b$ is approximately t_{36}, and t_{36} is approximately $N(0, 1)$, where $s_b=\sqrt{(s_e^2/36)}$. This allows you to test if the observed bias is significantly different from zero. Thus, if $\hat{b} < 0$ and $|\hat{b}| > 1.96s_b$, then we say e is a significant underestimate of Θ, and if $\hat{b} > 0$ and $\hat{b} > 1.96s_b$, then we say is a significant overestimate of Θ. In this example significance is at the 95% level.

A measure of precision of an estimate e is the coefficient of variation. The coefficient of variation of e is defined as σ_e/μ_e. If e is unbiased and normally distributed, a coeffcient of variation of less than 1/2 indicates that the 95% confidence interval for the true parameter Θ does not include zero. The coefficient of variation is not known but can be estimated by $s_e/\bar{e}$. Moreover, the distribution of e for most estimates is far from a normal distribution (Manly 1971), so the estimate of the coefficient of variation gives only a very approximate and not very stringent measure of precision.

According to Gilbert (1972), if the coefficient of variation is relatively low, below .25, then the bias is small and the estimate is good. However, the experimenter may not be able to use the coefficient of variation. Both the estimate and the estimated variance of the estimate are highly variable and therefore, the coefficient of variation is highly variable as well. Thus, the coefficient of variation is only a rough measure of precision.

The preceding discussion of bias and precision holds only if e is an estimate of a fixed parameter. However, if e is an estimate of an unobserveable random variable, t, then another analysis must be used. Instead of looking at the bias, $b=E(e)-E(t)$, you look at the error of the estimate which is denoted ε, and $\varepsilon=e-t$. ε is a random variable with $E(\varepsilon)=E(E(e|t=T)-T)=E(E(e|t=T)-E(t))=E(e)-E(t)$. Also, $var(\varepsilon)=var(e)+var(t)-2\ cov(et)$.

However, rather than estimate the covariance of e and t, it is easier to estimate the variance of ε from the sample standard deviations of ε over the 36 replications. The estimate of the variance is denoted s_e^2. Now $\bar{\varepsilon}$, the sample mean of the error over the 36 replications, is a measure of the accuracy of the estimate and, by the central limit theorem, $var(\bar{\varepsilon})=s_e^2/36$. Thus, if t is N_i, then e is $\hat{N}_i$and $\bar{\varepsilon}$ is given in the last column in table 3.3.3, and $\sqrt{(var(\varepsilon))}$ is given in the last column of table 3.3.4. Therefore, we say that an estimate is accurate if the interval $\varepsilon\pm1.96$ $(s_e/6)$ includes zero. For example, in table 3.3.3, $\bar{\varepsilon}$ for i=25 is 1.42 and in table 3.3.4 s_e for i=25 is 10.89. Therefore, at the 95% level of significance, $\bar{\varepsilon}\pm1.96(s_e/6) = 1.42\pm1.96(10.89/6)$

= 1.42 ± 3.55, which includes zero and the estimate is unbiased. The use of bias, error of an estimate and coefficient of variation in determining criteria for a reliable estimate is discussed in 3.4.

The output from a simulation of multiple replications is now four tables for each parameter set of N_o, ϕ_i, p_i and η_i. The first table (table 3.3.1) is one of means of the true values of the observations M_i, m_i, N_i, n_i, B_i, s_i, r_i and z_i. From this table the N_i are compared with the $\hat{N}_i$ to determine how closely the $\hat{N}_i$ follow the true population size. The r_i are used to develop a criterion for a reliable estimate. The second table (table 3.3.2) is one of sample standard deviations of the observations from table 3.3.1, which are used to look at the variability of the observations over the 36 replications.

The third table (table 3.3.4) contains the sample means over the replications of the estimates $\hat{\alpha}_i$, $\hat{M}_i$, $\hat{N}_i$, $\hat{\phi}_i$, $\hat{B}_i$, $\hat{V}(\hat{N}_i)$, $\hat{V}(\hat{N}_i|\hat{N}_i)$, $\hat{V}(\hat{\phi}_i)-\hat{\phi}_i^2(1-\hat{\phi}_i)/\hat{M}_{i+1}$ and $\hat{b}(\hat{N}_i)$. From this table the pairs $\hat{N}_i$ and $\hat{V}(\hat{N}_i)$, $\hat{\phi}_i$ and $\hat{V}(\hat{\phi}_i)$ and $\hat{B}_i$ and $\hat{V}(\hat{B}_i)$ are used to develop a criterion for a reliable estimate. The estimate $\hat{b}(\hat{N}_i)$ is also used to develop another criterion for a reliable estimate. The fourth table (table 3.3.4) contains the sample standard deviations of the estimates in table 3.3.3 over the 36 replications.

The entries in the columns labelled SDN(I), SDP(I) and SDB(I) from table 3.3.3 are compared to the entries in the columns labelled NEST(I), PHIEST(I) and BEST(I), respectively from table 3.3.4 (the table of sample standard deviations of the estimates) to see if the variance formulae estimate the variance of an estimate reliably. SDN(I), SDP(I) and SDB(I) are the mean estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, respectively and NEST(I), PHIEST(I) and BEST(I) are the samples standard deviations over the 36 replications of $\hat{N}_i$, $\hat{\phi}_i$, and $\hat{B}_i$, respectively. The entries in table 3.3.4 also indicate the variability of the corresponding entries in table 3.3.3 over the 36 replications.

Also included in table 3.3.3, in the last row of the table, are the number of inadmissable estimates of ϕ and B that were calculated during the simulation. These totals are the first two numbers in the last row, respectively. Any estimate of ϕ that is less than or equal to zero or greater than 1.0 is inadmissable, and any estimate of B that is less than zero is inadmissable. The number of inadmissable estimates of ϕ and B may provide a criterion for reliability of an estimate. When the number of inadmissable estimates of ϕ and B becomes too large when compared with the total number of estimates of ϕ and B that are calculated, then the estimates may be unreliable.

The third number in the last row of table 3.3.3 corresponds to the total number of zero r_i values over the 36 replications. The number of zero r_i may provide another criterion for the reliability of the estimates of an experiment.

3.4 Criterion for a "Good" Experiment

As can be seen from table 3.3.3, the Jolly model gives good estimates for the given parameter set. The accuracy of these estimates can be seen by looking at the bias. The average bias across i, in absolute value, is about 2.0. An estimate of the relative bias is about 2.0/200, which is .01. Thus, the relative bias is very low indicating accurate results. The average estimated standard deviation across i is about 16.0, and an estimate of the coefficient of variation across i is about 16.0/200 = .08. Again, this estimate is very low, indicating the acceptability of the estimates.

The coefficients of variation of $\hat{\phi}_i$ and $\hat{B}_i$ are also low. The former is .05/.90 = .055 and the latter is 9.0/20.0 = .45. Both values indicate reliable estimates. When the estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ from table 3.3.3 are compared with the samples standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ from table 3.3.4, the results are again favorable. For example, for i=25, $\sqrt{(\hat{V}(\hat{N}_i)}=17.57$, $\sqrt{(\hat{V}(\hat{\phi}_i))}=0.482$ and $\sqrt{(\hat{V}(\hat{B}_i))}=9.28$ from table 3.3.3, and the average sample standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are 15.42, .0492 and 7.94, respectively. Again, the indication is that the estimates are acceptable.

While the Jolly model produces results which are obviously good estimates in this case, the model also yields results which are clearly poor estimates. For example, tables 3.4.1, 3.4.2, 3.4.3 and 3.4.4 are the results of a simulation with the parameter set of N_o, ϕ_i, p_i and η_i equal to 200, 0.93, 0.04 and 1.00, respectively. In this case, the relative bias of $\hat{N}_i$ across i is between .20 and .30, significantly higher than the previous example, but on this information alone it is not possible to determine the reliability of the estimates. However, the coefficients of variation across i of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are now approximately .60, .75 and .95, respectively, all of which are too large to indicate reliable estimates. Comparing the estimated standard deviations and the sample standard deviations shows again that the estimates are unreliable. For example, for i=25, $\sqrt{(\hat{V}(\hat{N}_i))} = 116.87$, $\sqrt{(\hat{V}(\hat{\phi}_i))} = .5736$ and $\sqrt{(V(B_i))} = 108.32$ from table 3.4.3, and the average sample standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are 179.08, .2500 and 74.36, respectively.

While it is not difficult to determine the acceptability of the results in the above two examples, there are cases where the answer is not quite as obvious. It is for this reason that a criterion for a "good" estimate is required. It is difficult choosing a test for acceptability, because you do not want to be too restrictive. On the other hand, you do not want to allow results which would mislead the experimenter into believing his results are more reliable than they actually are.

The Jolly estimates are subject to small sample bias as discussed in 2.3. Seber's corrections reduce small sample bias but do not eliminate it. If there is a large small sample bias, $\hat{N}_i$ is an overestimate of N_i (Carothers (1973)). The estimated variance of $\hat{N}_i$, SDN(I) in table 3.4.3, is highly correlated with $\hat{N}_i$ (Manley (1971)) and is an overestimate of the true variance of $\hat{N}_i$, NEST(I) in table 3.4.4. Therefore, an estimate with significant small sample bias, not only has a large actual variance, but also has a large estimated variance. It is from this large estimated variance that an estimate of N_i is found unreliable.

In order to establish a criterion I compared the mean estimated standard deviation of $\hat{N}_i$ over the 36 replications, SDN(I), with the mean estimate of N_i over the 36 replications, NN(I). In statistical terms the comparison is a test of the coefficient of variation, which is defined as SDN(I)/N(I). Thus, I accepted the estimates as reliable if the coefficient of variation of $\hat{N}_i$ was less than 0.50. Choosing 0.50 was arbitrary and any fraction of $\hat{N}_i$ could be chosen. However, when the SDN(I) are greater than $\hat{N}_i/2$, they approach the same order of magnitude as the estimates, implying that the experimenter has received "more noise than signal". That is, his results are too variable to be of much use. A smaller fraction of $\hat{N}_i$, of about .20, is more desireable, but it makes the criterion more restrictive and reduces the parameter space of possible reliable estimates. As pointed out in the previous section the coefficient of variation is strictly meaningful only on the assumption that the estimates are approximately normally distributed. However, the coefficient of variation can be used as a rough measure of precision.

Carothers (1973) infers that small sample biases and variances are functions of $1/m_i$ and $1/r_i$, and that small sample biases are small if m_i and r_i are sufficiently large to produce low variances. Therefore, a second criterion that was investigated was a comparison of the r_i with the population size. I found that when the average value of the r_i across i fell below 3-4 per cent of N_o, the simulation produced unreliable estimates. Thus, for an initial poulation size of 200, when the average value of r_i across i fell below 6 or 7, the resulting estimate of N_i was unsatisfactory. For a simulation with an initial population size of 400 the average r_i across i approximately doubled before poor estimates were obtained. This method corresponded very well with the first criterion. When the average r_i fell below 4 per cent of N_o, the coefficient of variation of $\hat{N}_i$ also rose to greater than 0.50.

A third criterion that was investigated compared the average estimated standard deviation of $\hat{N}_i$ over the 36 replications and the sample standard deviation of $\hat{N}_i$ over the 36 replications. If small sample bias is low, then according to Gilbert (1972), these two values will also be small and will have values that are "close". The problem is in defining what "close" is. The definition chosen was that, if the two values were within 20 per cent of each other the estimate of N_i was good. When the standard deviations were low this criterion proved to be satisfactory and concurred with the first two criteria. However, when the standard deviations became large, and applying the first two criteria resulted in accepting the estimates as reliable, the third criterion resulted in rejecting the estimates as unreliable. That is, the variance estimates are probably more variable than the estimates of the parameters.

3.5 Simulated Parameter Sets

Table 3.5.1 shows the parameter sets of L, N_o, ϕ, p and η for which the simulation was run. All simulations were run over 50 sampling periods and with η_i, the probability of no loss on capture, equal to .99. Also, the simulations were run with two initial population sizes of 200 and 400. For each value of ϕ the simulations were run for each value of p.

For each value of ϕ there is at least one value of p which has an asterix beside it. The entries in the columns labelled p, that have an asterix beside them are the values of p, for the given value of ϕ, that produced unreliable estimates, according to the criteria given in 3.4. Thus, the first value of p, for a given value of ϕ, with an asterix, is the first value of p that produced unreliable estimates. The preceding value of p was the last value that produced reliable estimates.

There are several possible criteria that an experimenter can use in order to determine the reliability of his estimates. In order of importance they are the following:

(1) the average number of r_i across i compared with the expected population size; r_i should be approximately 3-4 per cent of the expected population size.

(2) the coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ should be less than .50.

(3) the estimates of variance for $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ should be close to the sample variances of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$. The experimenter will not be able to apply this criterion because the sample variances are obtained through replication, which the experimenter cannot do.

(4) the bias of $\hat{N}_i$ should be small if his results are reliable.

(5) the number of inadmissable estimates of ϕ and B that are calculated may be related to the reliability of the estimates. As well, the numbers of zero r_i values obtained may be another indication as to the reliability of the estimates.

Table 3.5.2 gives the results of applying the criteria, listed above, to the last good and first bad values of p, for given ϕ, shown in table 3.5.1, for $N_o = 200$. Table 3.5.3 gives the results for $N_o = 400$. Column 3 is the per centage of the average value of r_i across i out of N_o. Columns 4, 5 and 6 are the average coefficients of variation, across i, for $\hat{N}_i$, $\hat{\phi}_i$, and $\hat{B}_i$, respectively. Columns 7, 8 and 9 tell if the estimated variances of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, respectively, adequately estimate the true variances. Adequate meant that the estimated standard deviations were within 20 per cent of the sample standard deviations. Column 10 tells if the estimate $\hat{N}_i$ was significantly biased. Columns 11, 12 and 13 give the percentage of inadmissable estimates of $\hat{\phi}_i$ and $\hat{B}_i$ that were calculated and the number of zero r_i values obtained over the simulation, respectively.

The results in the tables show that in most cases the bias of $\hat{N}_i$ is not significant. Also, the criterion of zero r_i only applies in very bad experiments and cannot be applied in marginal experiments. Another result shown in the tables is that the number of inadmissable values of $\hat{\phi}_i$ is a function of the true survival rate. If the true survival rate is high, say about .80, the number of inadmissable vaues of $\hat{\phi}_i$ will also be high. If the true survival rate is low, say below .20, again the number of inadmissable values of $\hat{\phi}_i$ will be high. If the true number of new arrivals to the population is low, say below 30, then the number of inadmissable values of $\hat{B}_i$ will be large.

From the high values of the coefficient of variation of $\hat{B}_i$, it can be seen that the estimate of B_i is generally unreliable, even in a good experiment. However, both $\hat{N}_i$ and $\hat{\phi}_i$ generally provide good estimates of N_i and ϕ_i, respectively. Although the largest value of p_i simulated for ϕ_i equal to .90, .70 and .50 was .30, and for ϕ_i equal to .30 and .10 was .60 any larger values of p_i, for the corresponding value of ϕ_i, would also produce reliable estimates.

Chapter 4

4.1 Introduction

In chapter 3 it was shown that the Jolly formulae produce reliable estimates, as long as there is a reasonably large number of recaptures. However, when the number of recaptures is low, the results are unacceptable. In this chapter I describe two methods of pooling which can be used to increase the reliability of the estimates, when the Jolly model results in poor estimates. Both methods are described and the resultant estimation equations and method of implementation of both methods is given.

4.2 Pooling Sampling Periods to Increase Precision

When using the Jolly method the experimenter may have a large number of samples usually equally spaced from which he wants to monitor the population. If the population is small, or if the sampling intensity is low (small p_i), or if survival is low the data resulting from his trapping sequence has few recaptures. As seen in the previous chapter, low recapture rates result in poor estimates. The pooling methods which were used in the simulation attempt to salvage the data and produce more dependable estimates, by pooling information across sampling periods.

The method is based on pooling several adjacent samples together. Now, instead of getting N_i, ϕ_i, M_i, etc. for $i=1,2,\ldots,$ L, one hopes to get N_J, ϕ_J, M_J, etc. for $J=1,2,\ldots,$ P, where P is the number of periods resulting by pooling adjacent samples.

The assumptions for the pooling method are the same as for the Jolly estimates, as stated in 1.1, with one addition. It is, that in the hope of getting more precise estimates, you pool data assuming that the parameters within a pooled group do not change significantly, but may change from group to group. Thus, if an experimenter has collected data several times a month over several months, he may pool his data within months. He does this assuming there is no great difference in his population parameters within any given month, but there may be significant differences from month to month.

4.3 The Method of Pooled Statistics

This method of pooling uses the ovservations n_i, m_i, s_i, r_i and z_i that were gathered in forming the original Jolly esimates. Since the main reason for the poor estimates from the Jolly formulae is low r_i values, you want to pool the r_i so that the pooled result is large enough to ensure good estimates. The method of pooling is as follows:

Divide the L sampling periods into P groups of s sample times each. s must be chosen large ehough so that

$R_1 + R_2 + \ldots + R_s$

$R_{s+1} + R_{s+2} + \ldots + R_{2s}$

$R_{(P-1)s+1} + R_{(P-1)s+2} + \ldots + R_{Ps}$

are sufficiently large to produce reliable estimates. Thus, the first pooled interval group consists of samples 1, 2, ..., s. The second pooled interval group consists of samples s+1, s+2, ..., Ps, etc. It is not necessary for all groups to be of the same length, but in this simulation all groups are of the same length.

Instead of L sample periods there are now P sample groups, each of length s. For each i=1, 2, ..., P, where i denotes a group interval, k_i is the first sampling time within the ith grouped interval and is defined by $k_i = (i-1)s+1$.

In the following equations i represents unless otherwise noted, a group interval, s is the length of each group interval and $j = k_i$, is the first sampling period of the ith group interval.

(1) The Jolly equation for $\hat{\alpha}_i$, the proportion of marked individuals in the single ith sample, is m_i/n_i. The number of recaptures is low and thus, the number of marked individuals in the ith sample, m_i, is low. If only one trapping period was used in calculating $\hat{\alpha}_i$, the estimate would be poor. However, on the average it is expected that adjacent proportions within a group interval, namely m_{k_i}/n_{k_i}, m_{k_i+1}/n_{k_i+1}, ..., m_{k_i+s-1}/n_{k_i+s-1} would be approximately the same. Therefore, to obtain a better estimate the sum of the m_{k_i}'s is divided by the sum of n_{k_i}'s and the estimation equation is

$$\hat{\alpha}_i = (m_{k_i} + m_{k_i+1} + \ldots + m_{k_i+s-1})/(n_{k_i} + n_{k_i+1} + \ldots + n_{k_i+s-1})$$

In the original formula for $\hat{\alpha}_i$, corrected for small sample bias, unity was added to both the numerator and denominator. In the above formula for $\hat{\alpha}_i$ unity was not added to the numerator and denominator. If m_{k_i} and n_{k_i} after pooling were still very low, say below 5, then adding one might make a significant difference in the proportion m_{k_i}/n_{k_i}. If after pooling, the m_{k_i} and n_{k_i} were large adding one will not make a significant difference in the proportion. This modification was recommended by D. Platt (private communication) from his experience with actual data. Use of the small sample correction for bias in the pooled estimate of α_i seemed, in practice, to introduce large bias, rather than removing it. Whether or not this is actually the case might be investigated by simulation, but this was not studied in this thesis.

(2) $\hat{M}_{k_i}$ is an estimate of the total number of individuals marked and alive at the beginning of interval i, i.e. at sampling time k_i, and is defined by

$M_{k_i} = (s_{k_i} + s_{k_i+1} + \ldots + s_{k_i+s-1} + 1)\ z_{k_i}/(r_{k_i} + r_{k_i+1}$
$+ \ldots + r_{k_i+s-1} + 1) + m_{k_i}$.

The Jolly estimate for M_i, where is is a single sampling period, is $m_i + z_i/(r_i/s_i)$. This expression represents the number of marked individuals known to be in the population at time i, m_i, plus z_i divided by the proportion of the unknown number of marked individuals, M_i-m_i, expected to be subsequently captured. When the proportion r_i/s_i refers to only one sample, and is very small or zero, a better estimate of this proportion is required. The assumption made is that adjacent proportions within a group interval, namely r_{k_i}/s_{k_i}, r_{k_i+1}/s_{k_i+1}, ..., $r_{k_i=s-1}/s_{k_i+s-1}$, are expected, on the average, to have approximately the same value. Therefore, a better estimate of the proportion would be $(\Sigma\ r_{k_i})/(\Sigma\ s_{k_i})$. As with the original Jolly estimates, even pooling the data may still result in small numbers, which would bias $\hat{M}_{k_i}$ appreciably. Therefore, to reduce the small sample bias, unity is added to the sum of the r_{k_i}'s and to the sum of the s_{k_i}'s. Toward the end of the sampling chain, the assumption that the ratios r_{k_i}/s_{k_i}, r_{k_i+1}/s_{k_i+1}, etc. are approximately equal is not valid. The assumption is not valid, because toward the end of the sampling chain, there are fewer recaptures, while the s_{k_i} remain approximately the same. The animals alive near the end of the sampling chain are not exposed to as long a sampling time as those animals alive at the beginning or the middle of the experiment. Therefore, there are fewer recaptures near the termination of the experiment. The result is an upward bias in the $\hat{M}_i$, towards the end of the experiment and consequently, an upward bias in the $\hat{N}_i$ towards the end of the experiment. This effect was observed over the last three or four estimates of $\hat{N}_i$, where there was a large positive bias. The large positive bias at the end of the sampling chain seems to be mainly a function of survival, and is greatest for high survival rates.

(3) $\hat{N}_{k_i}$ is an estimate of the total number of individuals in the population at the time of the k_ith sample and is defined by $\hat{N}_{k_i} = \hat{M}_{k_i}/\hat{\alpha}$, where $\hat{\alpha}_i$ and $\hat{M}_{k_i}$ are calculated from (1) and (2) above, respectively.

(4) $\hat{\phi}_i$ is an estimate of the probability that an individual

survives the ith grouped interval, that is, from sample period j to sample period j+s where $j=k_i$, and j+s is the first sampling occasion in the i+1 st interval. An extension of the Jolly estimate would give $\hat{M}_{j+s}/(M_j-m_j+s_j)$ as the estimate of $\hat{\phi}_i$. However, this would be incorrect. The quantity M_{j+s} includes newly marked individuals that are first caught in trapping periods j+1, ..., j+s-1 and so may not have been included in the $M_j-m_j+s_j$ animals. The $M_j-m_j+s_j$ only account for those individuals marked on or before sampling period j. Since $\hat{\phi}_i$ is the proportion of marked individuals immediately after time j that survive to time j+s, any individuals marked for the first time in periods j+1, j+2, ..., j+s-1 are counted as unmarked, for the purposes of estimating ϕ_i. Therefore, an adjusted estimate of M_{j+s}, denoted $\hat{M}'_{j+s}$, is used, which removes those individuals marked for the first time from j+1 to j+s-1 and is defined by:

$$\hat{M}'_{j+s}=\{(s'_{j+s}+s'_{j+s+1} + \dots +s'_{j+2s-1}+1)z'_{j+s}/(r'_{j+s} + r'_{j+2s-1}+1)\} + m_j$$

The definitions of s', r' and z' are as follows:

$s'_{j+s}=s_{j+s}$ - those out of the s_{j+s} that were first marked at times j+1, j+2, ..., j+s-1

$r'_{j+s} = r_{j+s}$ - those out of the r_{j+s} that were first marked at times j+1, j+2, ..., j+s+1

$z'_{j+s} = z_{j+s}$ - those out of the z_{j+s} that were first marked at times j+1, j+2, ..., j+s-1

Thus, $\hat{M}'_{j+s}$ is the estimated number of marked individuals alive at sample period j+s, that were marked from the first time at time j or before. Therefore, the estimate of $\hat{\phi}_i$, is $\hat{M}'_{j+s}/(\hat{M}_j-m_j+s_j)$, where $j = k_i$.

(5) $\hat{B}_i$ is an estimate of the number of new arrivals over the ith interval; that is, from sample period k_i to sample period k_i+s. $\hat{B}_i$ is estimated by $\hat{N}_{k_i+s} - \hat{\phi}_i(\hat{N}_i-n_{k_i}+s_{k_i})$, which is the difference of the estimate of the total population at time k_i+s and of the number in the population at time k_i that survive to time k_i+s.

The subscripts of the estimates are important to the interpretation of what the estimates actually estimate. The subscripts of the estimates of N and M are k_i, which refers to a point estimate. That is, they are estimates of class sizes existing at sample time k_i only. However, the subscripts of the estimates of α, ϕ and B are i, which is used to indicate an estimate of a parameter defined over the ith interval.

4.3.1 Variance Estimation Equations for the Method of Pooled Statistics

Whereas the Jolly variance estimation equations pertained to a single sampling period, the variance estimation equations for the pooled estimates must consider a group of several sampling periods. In this way, it is difficult to determine exactly what the variances represent. At best, an interpretation of what the variances mean can be given. The following are used in the variance formulae:

$$\rho_i = r_{k_i} + r_{k_i+1} + \dots + r_{k_i+s-1}$$

$r_i = s_{k_i} + s_{k_i+1} + \ldots + s_{k_i+s-1}$

$\mu_i = m_{k_i} + m_{k_i+1} + \ldots + m_{k_i+s-1}$

In the above relations, i represents the ith interval, k_i is the first sampling period in the ith interval and s in the subscripts is the interval length. In the original Jolly variance formulae, any occurances of r_i, s_i and m_i in the denominator of an expression are replaced by ρ_i, r_i and μ_i respectively. Similarly, any occurances of r_{i+1}, s_{i+1} and m_{i+1} in the denominator of an expression are replaced by ρ_{i+1}, r_{i+1} and μ_{i+1} respectively. However, neither m_i nor s_i are replaced when they occur in the expression $M_i-m_i+s_i$. For example, $V(\hat{N}_j) = N_j(N_j-m_j)\{((M_j-m_j+s_j)/M_j)(1/\rho_i-1/r_i)+(1-\alpha_i)/\mu_i\}$ The variance formula for $\hat{N}_j$ excludes the term $N_i - \sum_{j=0}^{i-1}(N_i^2(j)/B_j)$, because the contribution made by this term to $V(\hat{N}_i)$ is generally very small, compared to the variance due to sampling. That is, $\hat{V}(\hat{N}_i)$ was found to be very close to $\hat{V}(\hat{N}_i/N_i)$, and the above term can be omitted.

Since $\hat{N}_{k_i}$ is an estimate of the population size at sampling time k_i, $\hat{V}(\hat{N}_{k_i})$ is interpreted as an estimate of the variance of $\hat{N}_{k_i}$ at time k_i. Also, because the estimates $\hat{\phi}_i$ and $\hat{B}_i$ refer to estimates over the ith interval, $\hat{V}(\hat{\phi}_i)$ and $\hat{V}(\hat{B}_i)$ are interpreted as estimates of the variances of $\hat{\phi}_i$ and $\hat{B}_i$, respectively, over the ith interval.

4.4 Implementation of the Method of Pooled Statistics: Single Replication

The simulation of the pooled estimates makes use of the data from capture histories generated as in the simulations of

Section 2.4. The capture histories of the N_0 individuals, as well as all the B_i are generated and stored in a vector, X, of length L (using the same notation as described in 2.4). The observations, n_i, m_i, s_i, r_i and z_i are collected using the same algorithm as described in 2.4. In particular, a cumulative sum vector, C, of length L, is used to calculate the n_i, m_i, s_i, r_i and z_i (see section 2.4), from which the pooled statistics, used in calculating the estimates, are formed. In particular, if k_i is the first sampling period in the ith interval, then $r_{k_i} = r_{k_i} + r_{k_i+1} + \ldots + r_{k_i+s-1}$ is the pooled statistic used in calculating $\hat{M}_{k_i}$. The same is true for the pooled statistics s_{k_i}, used in $\hat{M}_{k_i}$, and m_{k_i} and n_{k_i}, used in calculating $\hat{\alpha}_{k_i}$.

The method of pooling described in 4.3 yields estimates for i=1, 2, ..., P, where i is grouped interval of length s. The estimates on these intervals correspond to estimates at k_i=1, s+1, 2s + 1, ..., (P-1)s+1, where k_i is the first sample period in the ith interval. By shifting over one sample period and reforming the pooled statistics, you get the pooled statistics for k_i=2, s+2, 2s+2, ..., (P-1)s+2. Thus, the estimates can be calculated at these points. Shifting through s sample periods, s gbeing the group interval length, gives pooled statistics, and consequently estimates, for all k_i=1, 2, ..., s. However, the pooled statistics for the Pth interval require the n_i, m_i, s_i, r_i and z_i past the Lth sampling period. Since these do not exist, only estimates for the first L-s sampling times can be obtained.

When all the capture histories have been generated, and the statistics n_i, m_i, s_i, r_i and z_i have collected, the subroutine, GROUP 2 (see appendix B), forms the pooled statistics, n_{k_i}, m_{k_i}, s_{k_i} and r_{k_i}, by the following algorithm:

For $k_i = 1, 2, \ldots, L-s$

$$n_{k_i} = n_{k_i} + n_{k_i+1} + \ldots + n_{k_i+s-1}$$

$$m_{k_i} = m_{k_i} + m_{k_i+1} + \ldots + m_{k_i+s-1}$$

$$s_{k_i} = s_{k_i} + s_{k_i+1} + \ldots + s_{k_i+s-1}$$

$$r_{k_i} = r_{k_i} + r_{k_i+1} + \ldots + r_{k_i+s-1}$$

The s'_{k_i}, r'_{k_i} and z'_{k_i} must also be formed. From the definitions given in section 4.2, in order for an individual to be a member of the s'_{k_i}, r'_{k_i} or z'_{k_i} it must be a member of the s_{k_i}, r_{k_i} or z_{k_i}, respectively. The following algorithm is used to calculate these quantities:

> Initially set $s'_{k_i} = s_{k_i}$, $r'_{k_i} = r_{k_i}$ and $z'_{k_i} = z_{k_i}$.
>
> Then each capture history is scanned for $k_i = s+1, s+2, \ldots, L$. For given k_i,
>
> if for any value of $j=k_i-s+1, k_i-s+2, \ldots, k_i-1$,
>
> if an animal is a member of s_{k_i} and $X_j=1$ and $C_j=1$,
>
> then $s'_{k_i} \leftarrow s'_{k_i}-1$
>
> if an animal is a member of r_{k_i} and $X_j=1$ and $C_j=1$,
>
> then $r'_{k_i} \leftarrow r'_{k_i}-1$
>
> if an animal is a member of the z_{k_i} and $X_j=1$ and $C_j=1$,
>
> then $z'_{k_i} \leftarrow z'_{k_i}-1$

The estimates are then calculated in the subroutine ESTMT2 (see Appendix B). These estimates correspond to the results an experimenter would get on an actual set of data.

In calculating the unpooled estimates from the original Jolly equations, all that the experimenter requires is the n_{i_j} matrix (n_{i_j} is the number in the ith sample last caught in the jth sample). From the n_{i_j} the experimenter can obtain the n_i, m_i, s_i, r_i and z_i, from which the estimates are calculated. However, in the method of pooled statistics, the experimenter cannot obtain the s', r' or z' from the n_{i_j}. To get these quantities, the complete capture history of each animal is required.

The results of a single replication are given in tables 4.4.1 and 4.4.2. The parameter set of N_0, ϕ_i, p_i and η_i and L used in this simulation is 200, 0.93, 0.04, 1.00 and 50, respectively, for pooling interval length equal to 5. The results from this simulation, using the pooled statistics method of pooling, correspond to the results in tables 3.2.3 and 3.2.4, for the same parameter set. In particular, the same starting value for the random number generator was used in both simulations, thus producing the same capture histories in both cases. Tables 3.2.3 and 3.2.4 are the results of the estimates calculated from the Jolly equations.

Columns 2 to 9 of table 4.4.1 correspond to M_i, m_i, N_i, n_i, B_i, s_i, r_i and z_i, respectively. The m_i, n_i, s_i and r_i given, are the pooled statistics.

Columns 2 to 12 of table 4.4.2 correspond to $\hat{\alpha}_i$, $\hat{M}_i$, $\hat{N}_i$, $\hat{\phi}_i$, $\hat{B}_i$, $\hat{V}(\hat{N}_i)$, $\hat{V}(\hat{\phi}_i)$, $\hat{V}(\hat{B}_i)$, $\hat{V}(\hat{N}_i|N_i)$, $\hat{V}(\hat{\phi}_i)-\hat{\phi}_i^2(1-\hat{\phi}_i)/\hat{M}_{i+1}$ and bias $(\hat{N}_i)$, respectively, which are the estimates resulting from the equations discussed in 4.3 and 4.3.1. The $\hat{V}(\hat{N}_i|N_i)$ were set to zero because $\hat{V}(\hat{N}_i|N_i) = \hat{V}(\hat{N}_i)$. The last row of table 4.4.2 gives the number of inadmissable estimates of ϕ_i and B_i that were calculated and the number of zero r_i values. The number of zero r_i are not the number of zero r_i after pooling, but are the number before pooling and therefore, is the same as the number of zero r_i values given in the last row of table 3.2.4.

The estimate of ϕ_i, for the pooling method, was defined as survival over the ith grouping interval. Therefore, if ϕ_{k_i} is the probability of surviving from sampling time k_i to sampling time k_i+s, and there are s sampling periods within the ith grouped interval, then $(\phi)^s$ is the probability of survival over the ith grouped interval. In this example, ϕ equals 0.93 and therefore, the probability of survival over the ith grouped interval is $(0.93)^5$=.6957. Thus, the entries in the fifth column of table 4.4.2 are estimates of $\phi^5 \simeq .70$.

The estimate of B_i was also defined over the ith grouped interval. Therefore, if B_{k_i} is the number of births between sampling times k_i and k_i+s, and the group interval length is s, then the number of births over the ith grouped interval is s * B. Therefore, the entries in column six of table 4.4.2, should be close to 5(14) = 70.

At the end of each column in table 4.4.2 there are several zero entries. These are zero because the estimates are not obtainable at these points. In particular, since the pooled n_i, m_i, s_i and r_i are defined for only the first L-s sampling times, where s is the grouping size, the estimates $\hat{\alpha}_i$ and $\hat{M}_i$ are defined for only the first L-s sampling periods. Consequently, $\hat{N}_i$ is defined over this range as well. The estimate of ϕ_i requires $\hat{M}_{i+s}$, which is not defined for i=L-2s 1, L-2s 2, ..., L. Thus, $\hat{\phi}_i$ is not defined for these values of i. Consequently, $\hat{B}_i$ is not defined for the same values of i as well. The ranges of the estimated variances correspond to the ranges of the corresponding estimates.

In order to determine if any improvement has occured, by using the pooled statistics method, tables 3.2.4 and 4.4.2 can be compared. The reader should keep in mind, that these tables correspond exactly to the estimates, which an experimenter could form from actual data (except for the last column, labelled BIASN(I)). One comparison that can be made is between the errors of the estimate of N_i, given in the last column of both tables. A line by line comparison of both columns shows that the pooled statistics method has produced 33 out of 45 errors of $\hat{N}_i$, which are lower than for the unpooled method, which is a noteable difference. This result indicated that, in this example, the estimates of N_i are better for the method of pooled statistics. Whether or not the error of $\hat{N}_i$ is significant, will be determined by replicating the experiment, and is discussed in section 4.4.2. The experimenter, however, will not be able to obtain the error of $\hat{N}_i$, because he does not have N_i, from which the error is calculated.

The estimates of N_i, ϕ_i and B_i from table 3.2.4 were judged to be unreliable, by looking at their coefficients of variation. The coefficients of variation were only estimated, because the true standard deviations are not available. The estimated coefficient of variation is the estimate, divided by the estimated standard deviation of the estimate, which is all an experimenter has. Using columns four and seven to calculate the coefficient of variation of $\hat{N}_i$, shows that the estimated coefficient of variation of $\hat{N}_i$ is greater than 0.50 and often is close to 1.0. Thus, the estimate of N_i is considered unreliable. The coefficient of variation of $\hat{\phi}_i$, calculated from the entries in columns five and eight, is greater than 0.50 and generally is close to 1.0. Again, the $\hat{\phi}_i$ are considered unreliable. In this case, the $\hat{\phi}_i$ in column five should be close to 0.93. The $\hat{B}_i$ are also judged to be unreliable, because the coefficient of variation of B_i, calculated from the entries in columns six and nine, is generally close to 1.0. The estimate of B_i, given in column six, should be close to 14.

The reliability of the estimate of N_i, ϕ_i and B_i, in table 4.4.2, is also determined using their coefficients of variation. Again, all the experimenter has are the estimates and the estimated standard deviation of the estimates. Therefore, all that can be calculated are the estimated coefficients of variation. The coefficient of variation of $\hat{N}_i$, calculated from columns four and seven, is less than 0.50 and is often close to 0.35, which is a substantial improvement over the results in table 3.2.4. The estimates of N_i near the end of the experiment are low, and the experimenter would know that these estimates are not as reliable as the earlier estimates, because their coefficients of variation are close to 0.50. The estimate $\hat{N}_1$ is calculated by averaging the

$\hat{N}_i$, for i=2, 3, ..., 45.

The coefficient of variation of $\hat{\phi}_i$, calcualted from the entries in columns five and eight, is less than 0.50 for $i < 37$. Notice the sharp decrease in $\hat{\phi}_i$, for i=38, 39 and 40. The coefficient of variation is about 0.50 for these estimates, but we shall see from the multiple replications, that sudden changes or trends in the estimates, towards the end of the sampling chain, should be regarded as spurious. Therefore, the experimenter would accept the ϕ_i for $i < 37$, but would not accept the remaining 3 estimates. In this case, the $\hat{\phi}_i$ are all estimates of $(\phi)^5 \simeq .70$.

The estimate of $\hat{B}_i$, given in column six, should be close to 70, which generally they are not. The coefficient of variation of $\hat{B}_i$, calculated from the entries in columns six and nine, is close to 1.0, and the experimenter would not accept these estimates. He would, however, realize that there is a substantial number of births over the grouped intervals.

The number of inadmissable estimates of $\hat{\phi}_i$ and $\hat{B}_i$ has decreased by using the pooled statistics method, and are now 1/3 and 1/6, respectively, of the number from the method without pooling. It is not known whether or not the estimated standard deviations, in columns seven, eight and nine of table 4.4.2, are considered valid. Therefore, the discussion of the estimated coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, in table 4.4.2, is valid if the estimated standard deviations are considered valid. The validity of the estimated standard deviations is determined by performing multiple replications and is discussed in section 4.4.2.

The experimenter, however, cannot replicate his experiment and all he has are the results in tables 3.2.3 and 3.2.4 and in tables 4.4.1 and 4.4.2. The experimenter can see, by comparing coefficients of variation and error of the estimate, that $\hat{N}_i$ has been improved by using the pooled statistics method. By comparing the coefficients of variation, he can also tell that the $\hat{\phi}_i$ have also improved, although there appears to be some bias at the end of the experiment. He is also aware that there are a significant number of new arrivals to the population, although he does not know the precise magnitude of these arrivals. Therefore, the experimenter would conclude, that the method of pooled statistics improves his estimates.

Another way in which the experimenter can see if his estimates are reliable, is to compare the r_i to the population size. This criterion was discussed in section 3.4. In that discussion, the r_i were compared to N_o. If r_i/N_o was greater than about .05, the estimates were considered reliable. The experimenter does not have N_o, but he can compare the r_i to the $\hat{N}_i$, and if $r_i/\hat{N}_i$ is greater than .05, the estimate can be considered reliable. The pooled statistics method uses the pooled n_i, m_i, s_i and r_i to form the estimates. Since these will be larger than the corresponding unpooled statistics, it is expected that there will be an improvement in the estimates.

For example, for i=25, the r_i used to calculate the unpooled estimates is 2.00, from column eight of table 3.2.3. The r_i, for i=25, used to calculate the estimates from pooling is

9.00, from column eight of table 4.4.1. Therefore, the experimenter can tell that his estimates will probably be acceptable, when using the pooled statistics method.

4.4.1 Averaging Within Grouping Intervals

In order to pool the statistics n_i, m_i, s_i and r_i over the grouping interval, the experimenter makes the assumption that adjacent proportions of the pooled statistics will be approximately the same. In particular, the proportions m_{k_i}/n_{k_i}, m_{k_i+1}/n_{k_i+1}, ..., m_{k_i+s-1}/n_{k_i+s-1}, as well as the proportions r_{k_i}/s_{k_i}, r_{k_i+1}/s_{k_i+1}, ..., r_{k_i+s-1}/s_{k_i+s-1}, should be about equal over the ith interval. If this assumption is correct, then $(\sum_{k_i=1}^{s} m_{k_i})/(\sum_{k_i=1}^{s} n_{k_i})$ can replace $\sum_{k_i=1}^{s}(m_{k_i}/n_{k_i})$. The same result will be true for the r_{k_i} and s_{k_i}. Furthermore, if the experimenter assumes that N_i, M_i, ϕ_i, etc. are approximately constant over the grouping interval, then he may average his estimates over the interval.

Thus, if there are L sampling periods, the experimenter will have estimates for $k_i = 1, 2, \ldots, L-s$. By averaging over grouping intervals of length s, he will now have estimates for $i=1, 2, \ldots, P$, where $P \approx L/s$. The estimates given in tables 4.4.3 and 4.4.4 are the results of the estimates in tables 4.4.1 and 4.4.2, using this averaging process. For example, NEST(1) in table 4.4.2 represents $(\hat{N}_1 + \hat{N}_2 + \ldots + \hat{N}_5)/5$, which will be denoted $\bar{\hat{N}}_{j=1}$, where $\bar{\hat{N}}_j$ is the average of the pooled estimates over the jth interval. In general, $\bar{\hat{N}}_j = \sum_{k_i=s(j-1)+1}^{sj} N_{k_i}/s$. The true statistics, in table 4.4.3, are the results from averaging the true statistics over the grouping interval as well.

The true variance of $\bar{\hat{N}}_j$, over a single replication, is $(1/s^2)\{\sum_{i=1}^{s} \text{var}(\hat{N}_i) + \sum_{i=j} \text{cov}(\hat{N}_i \hat{N}_j)\}$. Since I do not have the true variances or covariances, a logical estimate of the true variance is $\hat{V}(\hat{N}_j) = (1/s^2)\{\sum_{i=1}^{s} \hat{V}(\hat{N}_i) + 2 \sum_{i \neq j} \widehat{\text{cov}}(\hat{N}_i \hat{N}_j)\}$. However, I do not have the estimated covariances either, and I assumed that $\sqrt{(\hat{V}(\bar{\hat{N}}_j))} = (1/s) \sum_{i=1}^{s} \sqrt{(\hat{V}(\hat{N}_i))}$, which is given as the average estimated standard deviation of $\hat{N}_i$ over the grouping interval in table 4.4.4. This discussion also holds for $\hat{V}(\hat{\phi}_i)$ and $\hat{V}(\bar{\hat{B}}_i)$.

The formula for the logical estimated of the true variance reduces to the actual formula used, if all correlations among the $\hat{N}_{k_i}$ are 1. Although this is not the case, the correlations are undoubtedly positive and close to 1, since most of the data used to form $\hat{N}_{k_i}$ is also used to form $\hat{N}_{k_i+1}$.

By using the averaging process, the experimenter hopes that he can further improve his estimates. The averaging process does have a stabilizing effect on the estimates over the grouped interval, which can be seen in the $\hat{N}_i$, from column four of table 4.4.4. All the estimates of $\hat{N}_i$ are within one standard deviation of 200, indicating there is no detectable bias in $\hat{N}_i$. The coefficients of variation of the $\hat{N}_i$ are slightly lower than without averaging. The estimate of $\hat{N}_9$ is low, however, the coefficient of variation of $\hat{N}_9$ is close to 0.50, indicating the estimate may not be reliable.

The same stabilizing effect is seen in the $\hat{\phi}_i$, from column five of table 4.4.4. The coeffcient of variation of $\hat{\phi}_i$ is close to 0.40 for all but the last estimate. The last estimate of ϕ_i is is an underestimate and its unreliability is seen from its coefficient of variation, which is greater than 0.50.

The stabilizing effect is seen again in the $\hat{B}_i$. However, if the experimenter assumes that the estimated standard deviations of the $\hat{B}_i$ are valid, then he still will not accept the $\hat{B}_i$, although he will note that there are a large number of new entries to the population. The variability, across i, of the estimated standard deviation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, given in columns seven, eight and nine, respectively, of table 4.4.4, has also decreased, although it is still not known if these standard deviation estimates are to be considered valid.

The averaging of pooled estimates will frequently be done by the experimenter, not only because of the additional stability gained for the estimates, but also because he may only be interested in average parameter values over the grouped interval. For example, even though an experimenter samples his population twice weekly, he may be interested only in the parameters relating to bi-weekly or monthly intervals. Averaging allows him to form these estimates.

4.4.2 Multiple Replications

The method of pooled statistics was simulated over 36 replications. As discussed in section 3.3, the purpose of multiple replications is to analyze the estimates and to determine their reliability. The estimates of parameters are investigated for bias and reliability. The variance estimates are investigated to see if the variance formulae adequately estimate the true variances.

The purpose of this analysis, on the results of the pooling methods, is to determine if pooling reduces bias, improves precision and to determine if the variance formulae are reliable, when pooled statistics are substituted into the formulae.

As with unpooled estimates, there are two types of estimates that result from the pooling methods. The first type is estimates of a fixed parameter or property of the model and includes, p_i, ϕ_i, B_i, n_i, $V(\hat{N}_i|N_i)$, $V(B_i)$ and $V(\phi_i)$. The second type is estimates of conditional parameters and includes N_i, M_i and $V(N_i)$. The properties of both types of estimates, that are of interest, are precision and bias. A detailed discussion of analyzing precision and bias, for both types of estimates, is given in section 3.3.

An example of the results of the method of pooled statistics is given in tables 4.4.5, 4.4.6, 4.4.7 and 4.4.8. These estimates are the result of replicating the experiment 36 times, over the same parameter set as in tables 4.4.1 and 4.4.2. Table 4.4.5 is one of means of the true values of the observations M_i, m_i, N_i, n_i, B_i, s_i, r_i and z_i (unpooled statistics). Table 4.4.6 is one of sample standard deviations of the observations in table 4.4.5, and indicates the variability of the observations over the 36 replications. Table 4.4.7 contains the sample means, over the replications, of $\hat{\alpha}_i$, $\hat{M}_i$, $\hat{N}_i$, $\hat{\phi}_i$, $\hat{B}_i$, $\hat{V}(\hat{N}_i)$, $\hat{V}(\hat{B}_i)$, $\hat{V}(\hat{N}_i|N_i)$, $\hat{V}(\hat{\phi}_i) - \hat{\phi}_i^2(1-\hat{\phi}_i)/\hat{M}_{i+1}$ and bias $(\hat{N}_i)$. Table 4.4.8 contains the sample standard deviations of the estimates in table 4.4.7, over the 36 replications. The estimates in table 4.4.7 and the sample standard deviations in table 4.4.8 are used to determine if the method of pooled statistics improves bias and precision, and to determine if the variance formulae are reliable. The last row of table 4.4.7 give the number of inadmissable estimates of ϕ_i and B_i and the number of zero r_i values, over the 36 replications.

Tables 4.4.7 and 4.4.8 should be examined (and compared to table 4.4.2) as an example of the additonal knowledge that can be gained by (simulated) replication of the experiment. In section 3.3 it was shown how a test of significance can be performed on the bias of $\hat{N}_i$, given in the last column of table 4.4.7. $\hat{N}_i$ is an estimate of a conditional parameter. The sample mean of the error of $\hat{N}_i$, over the 36 replications, is given in the last column of table 4.4.7 and is denoted $\bar{\varepsilon}$. The sample standard deviation of the bias of $\hat{N}_i$ is given in the last column of table 4.4.7 and is denoted s_e. Thus, the bias is not significant if $\varepsilon \pm 1.96(s_e/6)$ includes zero. For example, for i=25, $\bar{\varepsilon}$ is -7.83, from table 4.4.7, and s_e, for i=25, is 63.77, from table 4.4.8. Therefore, at the 95% level of significance, $\bar{\varepsilon} \pm 1.96(s_e/6) = -7.83 \pm 1.96(10.63)$, which includes zero and hence, there is no detectable bias.

This result is true for all the $\hat{N}_i$ except the last two. In those cases there is a significant positive bias, which is due to the end effects of the experiment. That is, there were fewer recaptures at the end of the sampling chain. The positive bias was not evident in the single replication, given in table 4.4.2, only by chance. The last two sample standard deviations of the bias (last column of table 4.4.8) are large and indicate further, the large positive bias.

The estimate of ϕ_i is an estimate of a fixed parameter of the model. The estimate is detectably unbiased, at the 95% level of significance, if $\bar{e} \pm 1.96(s_e/6)$ includes the true value of ϕ. In this case, the true value of ϕ is $(0.93)^5 \simeq 0.70$. Column five of tables 4.4.7 and 4.4.8 give $\bar{e}$ and s_e, respectively. Thus, for i=25, $\bar{e}$ is 0.6756 and s_e is .2402. Therefore, at the 95% level of significance, $\bar{e} \pm 1.96(s_e/6) = 0.6756 \pm 1.96(.0400)$, which includes the true value of ϕ. Significant bias shows up only in the last estimate of ϕ_i, which is due, again, to the end effects of the experiment. Note that the bias of $\hat{\phi}_{40}$ is significant, despite the increased sample standard deviation of $\hat{\phi}_{40}$.

The estimate of B_i is also an estimate of a fixed parameter of the model. Therefore, the same discussion is true for $\hat{B}_i$ as for $\hat{\phi}_i$. Thus, $\bar{e}$ and s_e are given in column six of tables 4.4.7 and 4.4.8. If $\hat{B}_i$ is unbiased, then $\bar{e} \pm 1.96(s_e/6)$ will include the true value of B_i, which is 70. For example, for i=25, $\bar{e}$ is 83.70, from table 4.4.7 and s_e is 67.25, from table 4.4.8. Therefore, $\bar{e} \pm 1.96(s_e/6) = 83.70 \pm 1.96(11.21)$, which does include the true value of B_i. Therefore, the estimate of B_i, for i=25, is not detectably biased. This result is true for all the estimates but the last three, where there is a large positive bias.

The precision of the $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ can be investigated by looking at their coefficients of variation. In a single replication, given in table 4.4.2, the experimenter can only calculate the estimated coefficient of variation. The estimated coefficient of variation of an estimate, is the estimate, divided by its estimated standard deviation. However, since he does not know if his estimated standard deviations are valid, he does not know if the estimated coefficient of variation is valid.

By performing multiple replications, you can get a better estimate of the coefficient of variation. The coefficient of variation is now calculated by dividing the estimate, by the sample standard deviation of the estimate, given in table 4.4.8. The coefficient of variation of $\hat{N}_i$, calculated from column four of tables 4.4.7 and 4.4.8, is generally between 0.35 and 0.50. The coefficient of variation of $\hat{N}_i$ rises above 0.50 for the last four estimates, which is mainly due to the end effects of the experiment. These results are much the same as the results obtained in the single simulation.

The coefficient of variation of $\hat{\phi}_i$, calculated from column five of tables 4.4.7 and 4.4.8, is less than 0.50, for all but the first two estimates and the last estimate. The same effect was noticed in the single replication, given in table 4.4.2. The coefficient of variation of $\hat{B}_i$, calculated from column six of tables 4.4.7 and 4.4.8, is above 0.50 and often approaches 1.0. These results were also seen in the results of the single replication. Since the results are the same in both the single and multiple replications, the experimenter can be satisfied that the estimated coefficient of variation, which he is able to calculate, is a reasonable guide for judging precision.

One of the major reasons for performing multiple replications is to determine if the variance formulae are valid. To do this, the average estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, given in columns seven, eight and nine, respectively, of table 4.4.7, are compared to their sample standard deviations, given in columns four, five and six, respectively, of table 4.4.8. If the average estimated standard deviations and the sample standard deviations do not differ by more than, say, 20 per cent, of the average estimated standard deviations, then the variance formulae were considered valid.

Comparing the estimated standard deviations of $\hat{N}_i$, with the sample standard deviations of $\hat{N}_i$, shows that this criterion holds for all but the last two estimates. Again, the last two estimates are unreliable because of the end effects of the experiment. Using the criterion on the estimated standard deviations of $\hat{\phi}_i$, shows that all but the first two and last estimates of $\hat{V}(\hat{\phi}_i)$ are valid. Applying the criterion to $\hat{V}(\hat{B}_i)$ results in rejecting almost all the estimates as invalid. Therefore, the variance formulae for $\hat{N}_i$ and $\hat{\phi}_i$ are valid, but the variance formula for $\hat{B}_i$ is not particularily good in this example. The discrepancy between the average estimated standard deviations and the sample standard deviations was usually less than 30 to 40 per cent of the former.

The estimates that result from multiple replications can be averaged over the grouping intervals, in the same way as the estimates from a single replication. On each replication, the average of the estimates over each grouping interval is calculated. For example, if you consider $\hat{N}_i$, then $\bar{\hat{N}}_j$, for j=1, 2, ..., P, is the average of the $\hat{N}_i$, over the jth interval, on a single replication (see section 4.4.1). The $\bar{\hat{N}}_j$ from each replication are then averaged over the 36 replications, which give means over the 36 replications, of the average of the estimate over each grouping interval.

The sample standard deviations of the $\bar{\hat{N}}_j$, over the 36 replications, are also calculated. The $\bar{\hat{N}}_j$, on each replication, are accumulated over the 36 replications, as well as the $\bar{\hat{N}}_j^2$. After the 36 replications the sample standard deviations are calculated using the usual sum and sum of squares formula for variance. An example of averaging over grouping intervals, over multiple replications is shown is tables 4.4.9, 4.4.10, 4.4.11 and 4.4.12. The parameter set is the same as in the previous example, therefore, the estimates in both examples are the same.

As with the results of a single replication, shown in table 4.4.4, it is hoped that the averaging process improves the estimates. The same stabilizing effect, seen in table 4.4.4, is also seen in tables 4.4.11 and 4.4.12. The $\hat{N}_i$, given in column four of table 4.4.11, are now not as variable as in table 4.4.7. However, the end effect is still seen in the last estimate, which shows up also in the sample standard deviation of $\hat{N}_i$, given in column four of table 4.4.12.

In table 4.4.7, the last estimate of ϕ_i (column five) was seen to be biased. However, this unbiased estimate has been averaged with the remaining estimates, in the eighth grouping interval and the result, given for i=8 in column five of table 4.4.11, is an unbiased estimate, over the grouped interval. An improvement in the $\hat{B}_i$ is also produced by averaging. Many of the estimates of B_i, in table 4.4.7, were biased. While the estimates of B_i, in table 4.4.11 are still biased, for i=1, 2, 4, 6 and 8, the bias has been reduced by averaging.

A significant improvement has occured in the estimated variance of $\hat{N}_i$. Comparing $\hat{V}(\hat{N}_i)$ (column seven of table 4.4.11) to the sample standard deviations of $\hat{N}_i$ (column four of table 4.4.12) shows that these two values are very close. The coefficient of variation of $\hat{\phi}_i$, calculated by dividing $\hat{\phi}_i$ by its sample standard deviation, in column five of tables 4.4.11 and 4.4.12, respectively has fallen below 0.25, which is a significant improvement. No improvement has been achieved in the estimated standard deviation of $\hat{B}_i$, which are still unreliable. What is worse, the $\hat{V}(\hat{B}_i)$ appear to be underestimates of $V(\hat{B}_i)$, which might mislead the experimenter into believing his estimates were more precise than they, in fact, are. However, the variability of the $\hat{B}_i$ were such that, despite this, in the single replication of the experiment (table 4.4.2), the $\hat{B}_i$ were nevertheless judged to be unreliable.

4.5 The Method of Reduced Capture Histories

The second method of pooling which was tested is less complex and easier to implement than the first. It involves pooling over the individual capture histories, rather than over the n_i, m_i, s_i, r_i and z_i.

The capture histories are generated the same way as described in section 2.4, for the original Jolly estimates, and are stored in a vector, X, of length L. The vector, X, is divided into P groups, each group consisting of s sample periods. All the data in the ith group are treated as if they were collected at a single point in time; the midpoint of each grouping interval. That is, the data in each grouping interval is combined, so as to give the best capture record at the midpoint of each of the P grouping intervals. The n_i, m_i, s_i, r_i and z_i, where i represents the midpoint of each grouping interval, are calculated using the same algorithm as in section 2.4.

When these statistics have been collected, the estimates are calculated, using the original Jolly estimation equations, discussed in sections 2.2 and 2.3 except for $\hat{\phi}_i$ and $\hat{B}_i$. Since $\hat{\phi}_i$ estimates the survival across a grouping interval, the estimation equation for $\hat{\phi}$ is

$$\hat{\phi}_i = \hat{M}_{i+s}/(\hat{M}_i - m_i + s_i).$$

$\hat{B}_i$ also estimates the number of births across the grouping interval and the estimation equation for $\hat{B}_i$ is

$$\hat{B}_i = (\hat{M}_{i+s}/\hat{\alpha}_{i+s}) - \hat{\phi}_i(\hat{N}_i - n_i + s_i).$$

4.6 Implementation of the Method of Reduced Capture Histories: Single Replication

The following algorithm transforms the original vector of capture histories, X, into a reduced vector. This is done in the subroutine STATS 3 (see Appendix B). If i=1, 2, ..., P are the group interval numbers, then $k_i = (i-1)s+s/2+1$ is the middle sample period in the ith group, of length s, and $\ell = (i-1)s+1$ is the first sample period in the ith interval. The algorithm is as follows;

For any grouping interval $i=1, 2, \ldots, P$

if all $X_j=0$, for all $j=\ell, \ell+1, \ldots, \ell+s-1$, then $X_{k_i}=0$

if $X_j = -1$, for any $j = \ell, \ell+1, \ldots, \ell+s-1$, then $X_{k_i}=-1$

if $X_j = 1$, for any $j = \ell, \ell+1, \ldots, \ell+s-1$

and if $X_j \neq -1$ for all $j=\ell, \ell+1, \ldots, \ell+s-1$,

then $X_{k_i} = 1$.

if all $X_j = 2$, for all $j=\ell, \ell+1, \ldots, \ell+s-1$, then $X_{k_i}=2$.

For example, if the original capture history is

00000|10110|01000|00-122|22222

then the capture history after pooling in groups of 5 is 0 1 1 -1 2, for $k_i = 3, 8, 13, 18, 23$, respectively.

This method of pooling gives entries in X_i, for $i=1, 2, \ldots, P$, where i is a grouped interval of length s. These entries correspond to $k_i = \ell, s+\ell, 2s+\ell, \ldots, (P-1)s+\ell$, where k_i is the middle sample period of the ith interval of length, s and $\ell = s/2+1$. Now, the n_{k_i}, m_{k_i}, s_{k_i}, r_{k_i} and z_{k_i} are formed from the reduced capture histories, as shown above. If you shift over one sample period to the right, and use the algorithm on the new intervals, you get entries, in X corresponding to $k_i = \ell+1, s+\ell+1, 2s+\ell+1, \ldots, (P-1)s+\ell+1$. Again, the n_{k_i}, m_{k_i}, s_{k_i}, r_{k_i} and z_{k_i} are formed from the reduced capture histories. If you shift through s sample periods, one by one, you get all the reduced capture histories for $k_i = \ell, \ell+1, \ldots, (P-1)s+\ell$, from which all the n_{k_i}, m_{k_i}, s_{k_i}, r_{k_i} and z_{k_i} are formed. Consequently, the estimates for these k_i are calculated.

As with the first method of pooling the ranges of the estimates are restricted within the sampling chain. Since the reduced capture history refers to midpoints of the intervals, n_i, s_i and r_i are not defined for $i=1, 2, \ldots, \ell-1$, where $\ell = s/2+1$. Also, n_i and s_i are not defined for $i=L-\ell+1, L-\ell+2, \ldots, L$ and r_i is not defined for $i=L-s-\ell+1, L-s-\ell+2, \ldots, L$. The ranges of m_i and z_i are not defined for $i=1, 2, \ldots, s+\ell-1$, at the beginning of the sampling chain. At the end of the sampling chain m_i is not defined for $i=L-\ell+1, L-\ell+2, \ldots, L$, and z_i is not defined for $i=L-s+\ell+1, L-s+\ell+2, \ldots, L$.

Thus, the ranges of the estimates are also restricted. At the beginning of the sampling chain $\hat{\alpha}_i$, $\hat{M}_i$, $\hat{N}_i$, $\hat{V}(\hat{N}_i)$, $\hat{V}(\hat{\phi}_i)$, $\hat{V}(\hat{B}_i)$ and $\hat{V}(\hat{N}_i|N_i)$ are not defined for $i=1, 2, \ldots, s+\ell-1$, and $\hat{\phi}_i$ and $\hat{B}_i$ are defined for $i = 1, 2, \ldots, \ell-1$. At the end of the sampling chain $\hat{\alpha}_i$ and $\hat{N}_i$ are not defined for $i=L-\ell+1, L-\ell+2, \ldots, L$, $\hat{M}_i$, $\hat{V}(\hat{N}_i)$ and $\hat{V}(\hat{N}_i|N_i)$ are not defined for $i=L-s-\ell+1, L-s-\ell+2, \ldots, L$ and $\hat{\phi}_i$, $\hat{B}_i$, $\hat{V}(\hat{\phi}_i)$ and $\hat{V}(\hat{B}_i)$ are not defined for $i=L-2s-\ell+1, L-2s-\ell+2, \ldots, L$.

An example of the reduced capture method of pooling, over a single replication, is shown in tables 4.6.1 and 4.6.2. The simulation used the same parameter set as in the simulation for tables 4.4.1 and 4.4.2. In particular, the same capture histories were generated in both pooling methods.

The coefficient of variation of $\hat{\phi}_i$, calculated from columns five and eight of table 4.6.2, is generally less than 0.50, except for the last four estimates, and the experimenter would reject, these last estimates. The estimates of ϕ_i should be close to $(\phi)^5 \simeq 0.70$. The estimates of $\hat{B}_i$, given in column six of table 4.6.2, should be close to the true value of B_i across the interval, which is 70. The $\hat{B}_i$ are extremely variable, across i, and it seems that they are not close to the true value. The coefficient of variation of $\hat{B}_i$, calculated from columns six and nine of table 4.6.2, is greater then 0.50 and is often close to 1.0, and supports the observation that the $\hat{B}_i$ are unreliable. However, as in the pooled statistics method, the experimenter would realize that there was a significant number of new arrivals to the population. The number of inadmissable estimates of ϕ_i and B_i has been reduced considerably, indicating that the reduced capture history method does improve the estimates.

It is not known whether or not the estimated standard deviations, given in columns seven, eight and nine of table 4.6.2, are to be considered valid. The validity of these estimates is determined by performing multiple replications, which is discussed in section 4.6.2.

How the reduced capture history method improves the estimates, can be seen by looking at the n_i and r_i, given in columns five and eight of table 4.6.1. The expected size of any sample is $0.04(200) = 8$. The reduced capture history method has increased the sample size to between 30 and 40. The increased sample size also has the effect of increasing the r_i. The r_i in table 3.2.3 are between 1 and 5, but the r_i in table 4.6.1 have increased and are between 5 and 10. The larger r_i values improve the estimates.

4.6.1 Averaging Within Grouping Intervals

The estimates, that are produced over a single replication of the experiment, can be averaged over the grouping interval. The discussion of averaging over the grouping intervals, given in section 4.4.1, is also true for the method of reduced capture histories. Tables 4.6.3 and 4.6.4 show the results in tables 4.6.1 and 4.6.2 after the estimates have been averaged over the grouping intervals. These four tables correspond to the results that an experimenter would get with actual data, and tables 4.6.3 and 4.6.4 correspond to tables 4.4.3 and 4.4.4.

The averaging process, performed on the estimates from the reduced capture history method, has the same stabilizing effect as with the previous method. The error of the estimate of N_i, given in the last column of table 4.6.4, shows a general decrease, by averaging across grouped intervals. However, it is still not known whether or not these errors are significant. The last estimate of $\hat{N}_i$, given in column four of table 4.6.4, is a large underestimate, which is substantiated by the large error of the estimate. The coefficient of variation of $\hat{N}_i$ appear to be about the same as without averaging.

The $\hat{\phi}_i$, given in column five of table 4.6.4, have also been stabilized, as have the $\hat{V}(\hat{\phi}_i)$, given in column eight of table 4.6.4. The coefficient of variation of $\hat{\phi}_i$ is the same as without averaging. The same effect of a bad last estimate of $\hat{\phi}_i$ is still observed with averaging. The $\hat{B}_i$ are also not as variable, across i, as without averaging, but they are still considered unreliable, as seen by the large coefficient of variation of $\hat{B}_i$, calculated from columns six and nine of table 4.6.4

4.6.2 Multiple Replications

The method of reduced capture histories was simulated over 36 replications, in order to determine the reliability of the estimates and the adequacy of the variance formulae. The discussion of replications, given in section 4.4.2 holds for both methods of pooling. Tables 4.6.5, 4.6.6, 4.6.7 and 4.6.8 are the results of performing the simulation over 36 replications, and correspond to tables 4.4.5, 4.4.6, 4.4.7 and 4.4.8, respectively. The same parameter set and the same set of capture histories was used in both cases.

Tables 4.6.7 and 4.6.8 can be examined to determine the bias and precision of the estimates, and to determine the validity of the variance formulae. The discussions in sections 3.3 and 4.4.2, concerning the methods of analyzing the estimates, are true for the estimates derived from the method of reduced capture histories as well. The sample mean of the error of $\hat{N}_i$, given in the last column of table 4.6.7, are denoted $\bar{\varepsilon}$, and the sample standard deviations of the error, given in the last column of table 4.6.8, is denoted s_e. For i=25, $\bar{\varepsilon} \pm 1.96(s_e/6) = -9.37 \pm 1.96(77.61/6) = -9.37 \pm 1.96(12.93)$, which includes zero. Therefore, at the 95% level of significance, $\hat{N}_i$, for i=25 has no detectable bias. This result is true for all i.

If the estimate of ϕ_i has no detectable bias, then the 95% confidence interval for $\hat{\phi}_i$ will contain the true value of ϕ_i, which is 0.70. For i=25, the 95% confidence interval for $\hat{\phi}_i$ is $0.6517 \pm 1.96(0.2040/6) = 0.6517 \pm 1.96(0.0340)$, which includes the true value of ϕ_i. Again, no detectable bias is found in the $\hat{\phi}_i$. The estimate of $\hat{B}_i$ also has no detectable bias, if the 95% confidence interval for $\hat{B}_i$ includes the true value of B_i, which is 70. For i=25, the 95% confidence interval for $\hat{B}_i$ is $63.14 \pm 1.96(63.57/6) = 63.14 \pm 1.96(10.59)$, which includes the true value of B_i. Almost all the estimates of B_i have no detectable bias, but taken over all i, there seems to be a tendency in the $\hat{B}_i$ to overestimate the true B_i.

The precision of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ is investigated, by calculating their coefficients of variation. As discussed in section 4.4.2, multiple replications allow you to calculate the best estimated coefficient of variation, which is the estimate, divided by the sample standard deviation of the estimate. The coefficient of variation of $\hat{N}_i$ is greater than 0.50 for about half of the estimates indicating that the $\hat{N}_i$ are considered unreliable. However, the estimates in the middle of the experiment are generally considered reliable.

The coefficient of variation of ϕ_i, calculated from column five of tables 4.6.7 and 4.6.8, is below 0.50 and is generally about 0.35. No unusual trends in the $\hat{\phi}_i$ can be seen. The coefficient of variation of $\hat{B}_i$, calculated from column six of tables 4.6.7 and 4.6.8, are generally close to 1.0, indicating that the $\hat{B}_i$ are not at all reliable. The results from the multiple replication, thus confirm the judgement made, of the estimates from a single experiment.

Multiple replications allow you to test the adequacy of the variance formulae. The average estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, given in columns seven, eight and nine of table 4.6.7, are compared to their sample standard deviations, given in columns four, five and six of table 4.6.8, respectively. If they do not differ by more than 20 per cent of the former, then the variance formulae are considered to be valid. Using these comparisons show that the formulae for variances of $\hat{N}_i$ and $\hat{\phi}_i$ are reliable, while the variance formula for the $\hat{B}_i$ is not reliable.

The estimates that result from multiple replications on the reduced capture history method, can also be averaged over the grouping interval, in the same way as discussed in section 4.4.2. The results of averaging are shown in tables 4.6.9, 4.6.10, 4.6.11 and 4.6.12. These are the results of using the same parameter set in tables 4.6.5, 4.6.6, 4.6.7 and 4.6.8, and correspond to tables 4.4.9, 4.4.10, 4.4.11 and 4.4.12 for the pooled statistics method.

Again, the purpose of averaging is to improve the estimates from the method without averaging. A considerable improvement is seen in the $\hat{N}_i$, given in column four of table 4.6.11. The estimates are close to the true value of about 200, and the coefficient of variation of $\hat{N}_i$, is less than 0.50 for most of the estimates. Little improvement is seen in the $\hat{\phi}_i$, except that the estimates have stabilized. The coefficient of variation of $\hat{\phi}_i$ is about the same as without pooling. Some improvement is seen in the $\hat{B}_i$, where the larger overestimates have been averaged out. However, the $\hat{B}_i$ still overestimate the true B_i.

The best improvement by averaging is seen in the average estimated standard deviation of $\hat{N}_i$, given in column seven of table 4.6.11. Comparing these estimates with the sample standard deviations of $\hat{N}_i$, given in column four of table 4.6.12, shows these two values are very close, and differ by about 10 per cent, for about half the comparisons. The average estimated standard deviation of $\hat{B}_i$ has not improved, and, although it has stabilized, the variance formula for $\hat{B}_i$ is still not considered valid.

4.7 Comparison of Both Pooling Methods for the Given Parameter Set

The two pooling methods can be compared, by looking at the tables produced by each method, for the same parameter set. In particular, the results of the method of pooled statistics, for 36 replications, given in tables 4.4.5, 4.4.6, 4.4.7 and 4.4.8, are compared with the results of the method of reduced capture histories, for 36 replications, given in tables 4.6.5, 4.6.6, 4.6.7 and 4.6.8. The same parameter set was used to derive both sets of tables.

From the single replications of both methods, it was difficult to determine which pooling method showed a greater improvement over the unpooled estimates. However, from multiple replications it can be seen that there is a difference. The range of the estimates for the reduced capture history method is shorter than the range for the pooled statistics method. This is especially true for $\hat{N}_i$, where there are no estimates for the first s+s/2 grouping intervals (s is the number of sampling occasions in each grouping interval). One comparison that does not show a noteable difference in the two methods, is between the biases of $\hat{N}_i$, given in the last column of tables 4.4.7 and 4.6.7. There is no significant difference in the magnitude of the biases from both methods, and the biases in both methods are not significant.

Looking at the number of inadmissable estimates of ϕ_i and B_i also show not significant difference in both methods. The reduced capture history method produced less inadmissable estimates of ϕ_i, but more inadmissable estimates of B_i, than the pooled statistics method.

The precision of the estimates shows the most noteable difference. In this example, the variance formulae for both pooling methods gave valid estimates. The precision of $\hat{\phi}_i$ was approximately the same for both methods. However, the precision of $\hat{N}_i$ was better for the method of pooled statistics and the precision of $\hat{B}_i$ was better still, for the method of pooled statistics.

The results are not surprising, when you consider the r_i values that are used in calculating the estimates. The r_i values used in the reduced capture history method are as shown in column eight of table 4.6.5. That is, to calculate $\hat{V}(\hat{N}_{25})$, r_{25} is used. However, in calculating $\hat{V}(\hat{N}_{25})$ in the method of pooled statistics, the value of r_{25} pooled is $r_{25}+r_{26}+r_{27}+r_{28}+r_{29}$, from column nine of table 4.4.5. The r_{25} pooled are consistently larger, for the method of pooled statistics than the r_{25} used for the method of reduced capture histories.

The results, given in this chapter, are for a particular parameter set. The same tables were produced for both methods, in order that a comparison be made. Thus, any conclusions drawn in this chapter, pertain only to this parameter set, and are not general conclusions. In chapter five, several parameter sets are considered, from which more general conclusions can be drawn.

Chapter 5

5.1 Introduction

In chapter 4 the results of simulations of the pooled statistics method and the reduced capture history method were discussed for a particular parameter set. The discussion concerned bias of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, the precision of these estimates and the adequacy of the variance formulae.

In chapter 5 the same analysis is applied to simulations over several parameter sets, from which general conclusions about pooling methods are drawn. Both pooling methods were run for several grouping interval lengths, and the effect of changing the grouping interval length is discussed. From these results both pooling methods are compared. The final section of this chapter is a discussion of non stable populations.

5.2 Results of the Pooled Statistics Method

Tables 3.5.2 and 3.5.3 summarize the results of the estimates, obtained without pooling, for the smallest value of p_i that gave good estimates, and for the largest value of p_i that gave bad estimates for the given value of ϕ_i. Table 5.2.1 summarizes the results of the simulations, using the pooled statistics method, for those first values of p_i, in table 3.5.2, that gave bad estimates. The detailed simulation results (of which table 5.2.1 is a summary) are given in tables 5.2.2 to 5.2.11.

Column one is the initial population size and columns two and three are ϕ_i and p_i, respectively. Column four is the proportion of pooled r_i, in the population, at the ith grouping interval (calculated by r_i pooled, divided, by N_0). Columns five, six and seven are the average coefficients of variation, across i, of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, respectively, which are calculated by dividing the average of the estimate across i, by the average sample standard deviation of the estimate across i. columns eight and nine are the true value of survival and birth, respectively, across the grouped interval.

Columns ten, eleven and twelve show if the variance formulae, given in section 4.3, are considered valid. If the variance formula is considered valid, then the column entry is "YES", otherwise the entry is "under" if the formula yields an underestimate of the true variance, or the entry is "over" if the formula yields an overestimate. The variance formulae are considered valid, if the average estimated standard deviations and the sample standard deviations do not differ by more than 20 per cent of the former. Columns thirteen, fourteen and fifteen show if there is any detectable bias in $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, respectively, where the bias is detectable, if the 95% confidence interval for the estimated bias of $\hat{N}_i$ $(\hat{b}(\hat{N}_i))$ does not include zero or the true value of ϕ_i or B_i. Column sixteen gives the table references of the results of the particular parameter sets. All the simulations had η_i, L and grouping interval size set to 1.00, 50 and 5, respectively.

The simulations with $\phi_i = 0.99$ and $p_i = 0.03$, without pooling, produced estimates which were very poor. The estimates of $\hat{N}_i$ were significantly biased, both postively and negatively. The same result is true for $\hat{\phi}_i$ and $\hat{B}_i$ for which there were several inadmissable values. Since the estimates were highly biased the coefficients of variation were very high. Also, the average estimated standard deviations did not adequately estimate the true standard deviations.

Tables 5.2.2 and 5.2.3 are the results of a simulation using the pooled statistics method, for $\phi_i = 0.99$ and $p_i = 0.03$. The discussions in sections 3.3 and 4.4.1, concerning the analysis of bias and precision of the estimates, can be applied in this case and in the subsequent examples in this chapter. In particular, $\hat{N}_i$ is an estimate of a conditional parameter and $\hat{\phi}_i$ and $\hat{B}_i$ are estimates of fixed parameters. Pooling, in this case produced satisfactory parameter and variance estimates along with substantial improvements in precision.

Forming the confidence intervals for the bias of $\hat{N}_i$, from column twelve of tables 5.2.2 and 5.2.3, it can be seen that, in general, the $\hat{N}_i$ have no detectable bias. A significant positive bias is seen only in the last seven estimates of $\hat{N}_i$. This large bias is attributable to the fewer recaptures at the end of the experiment, which causes overestimates in the last seven estimates of $\hat{N}_i$.

The true survival rate over a grouped interval is $(0.99)^5 = 0.9510$. The confidence interval for the true survival rate formed from column five of tables 5.2.2 and 5.2.3 do not include the true value. The negative bias is apparent in all the estimates of survival which, when taken together, underestimate the true rate of survival by about 5 per cent. The largest underestimates are seen in the last four estimates which are due to the end effects of the experiment.

The true number of births over a grouped interval is $5(2) = 10$. It can be seen, by looking at column six of tables 5.2.2 and 5.2.3, that the $\hat{B}_i$ have a large positive bias and hence, the $\hat{B}_i$ significantly overestimate the true B_i. Again, the end effects are seen in the last three estimates of B_i, which are even larger overestimates than the rest of the $\hat{B}_i$.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are given in columns five, six and seven, respectively, of table 5.2.1. The coefficients of variation are calculated by dividing the average estimate, by the average sample standard deviation of the estimate. Since it is not known if the average estimated standard deviations can be considered valid, the coefficients of variation were calculated in this way.

The low coefficient of variation of $\hat{N}_i$ indicates that the estimates of population size are reliable. The large sample standard deviations for the last seven estimates resulted in larger coefficients of variation at these points, which is a further indication that these estimates should be considered unreliable. The very small coefficient of variation of $\hat{\phi}_i$ is misleading. The estimates were found to have a detectable negative bias. The low coefficient of variation means that, although the estimates were biased, the sample standard deviations were low enough to lower the coefficient of variation. The coefficient of variation of $\hat{B}_i$ is too large to accept the estimates of birth. The large coefficient of variation substantiates the conclusion that the $\hat{B}_i$ are biased.

A line by line comparison of the average estimated standard deviations, given in column seven of table 5.2.2, with the sample standard deviations, given in column four of table 5.2.3, shows that they differ by less than 20 per cent and often by less than 10 per cent of the former. Therefore, the variance formula for $\hat{V}(\hat{N}_i)$ can, in this case, be considered valid.

The variance formula for $\hat{V}(\hat{\phi}_i)$ cannot be considered valid. The average estimated standard deviations (column eight of table 5.2.2) and the sample standard deviations (column five of table 5.2.3) usually differ by about 35-50 per cent of the former. Similarily the variance formula for $\hat{V}(\hat{B}_i)$ is not considered valid.

Note, however, that both $\hat{V}(\hat{\phi}_i)$ and $\hat{V}(\hat{B}_i)$ are consistently overestimates of the true variances. Thus, an experimenter would not be misled into thinking that his estimates of survival and birth are more precise than they actually are, as he would if the estimated variances were underestimates.

Both $\hat{\phi}_i$ and $\hat{B}_i$ were subject to inadmissable estimates, as discussed in section 2.4. When an inadmissable estimate was calculated, it was reset to an admissable value. Thus, the sample variances would be smaller than if the inadmissable estimates were allowed. The estimated variance is not affected by resetting the inadmissable value and hence, will be larger than the sample standard deviations. Note that the $\hat{N}_i$ were not subject to inadmissable values and that the $\hat{V}(\hat{N}_i)$ are considered valid.

The results for $\phi_i = 0.90$ and $p_i = 0.05$ are given in tables 5.2.4 and 5.2.5. Again, we see that the pooled statistics method gives excellent results. In general, almost all of the $\hat{N}_i$, given in column four of table 5.2.4, have no detectable bias. The exceptions occur in the last four estimates which are also affected by the fewer recaptures at the end of the experiment. The last four estimates are significant overestimates which is seen in the large positive bias of these estimates given in column twelve.

The true survival rate over a grouped interval is $(0.90)^5 = 0.5840$. Forming the confidence intervals from column five of tables 5.2.4 and 5.2.5, shows that they include the true survival rate. Thus, the $\hat{\phi}_i$ have no detectable bias, but they do appear to overestimate the true survival rate when looked at together. The $\hat{\phi}_i$ do not appear to be affected by any end effects of the experiment.

The true number of births over a grouped interval is $5(20) = 100$. The confidence intervals for the $\hat{B}_i$ do include the true number of births and hence, they are not detectably biased. The estimates of B_i (column six of table 5.2.4) for which there is any detectable bias are the last three. Again, the positive bias is attributable to the end effects of the experiment, which can be seen in the large corresponding standard deviations (column six of table 5.2.5). The $\hat{B}_i$ appear, generally, to underestimate the true number of births when looked at across i.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are given in columns five, six and seven, respectively, of table 5.2.1. The coefficient of variation of $\hat{N}_i$ indicates acceptable results for the estimates of population size. The larger coefficient of variation for i=44 and 45 again indicates the unreliability of these estimates due to the end effects of the experiment. The coefficient of variation of $\hat{\phi}_i$ is also well within the acceptable limits, while the coefficient of variation of $\hat{B}_i$ lies outside the acceptable limits. The trend of underestimation of the true number of births is too significant to accept the $\hat{B}_i$, according to the test on the coefficient of variation.

The variance formula for $\hat{V}(\hat{N}_i)$ estimates the true variation extremely well. A line by line comparison of the average estimated standard deviations, given in column seven of table 5.2.4, with the sample standard deviations, given in column four of table 5.2.5, shows that they differ by less than 20 per cent and frequently by less than 10 per cent of the former. The variance formula is even considered adequate for the estimates at the end of the sampling chain.

A similar comparison of columns eight and five of tables 5.2.4 and 5.2.5, respectively shows that the variance formula for $\hat{V}(\hat{\phi}_i)$ adequately estimates the true variance. However, in this case the comparisons generally show differences of close to 20 per cent of the average estimated standard deviations. The trend in the average estimated standard deviations is that they underestimate the true standard deviation, when looked at across i.

The same comparison of $\hat{V}(\hat{B}_i)$, given in column nine of table 5.2.4, and the sample standard deviations of $\hat{B}_i$, given in column six of table 5.2.5, shows that the standard deviation estimates are very good, and they usually differ by less than 10 per cent of $\hat{V}(\hat{B}_i)$.

The results for $\phi_i = 0.80$ and $p_i = 0.10$ are given in tables 5.2.6 and 5.2.6. It will be shown that, in this case, the estimates of population size are considered valid, as are $\hat{V}(\hat{N}_i)$ and $\hat{V}(\hat{B}_i)$. However, both $\hat{\phi}_i$ and $\hat{B}_i$ are unreliable estimates.

When the confidence intervals are formed for the bias of $\hat{N}_i$ from column twelve of both tables, it is seen that the estimates of population size have no detectable bias. A large positive bias is seen only in the last estimate of N_i, which is due to the end effects of the experiment.

As can be seen from column five of both tables, the $\hat{\phi}_i$ are detectably biased. Furthermore, they are overestimates of the true survival rate over a grouped interval of $(0.80)^5 = 0.3269$. The true number of births over a grouped interval is $5(40) = 200$. It is evident from column six of both tables that the $\hat{B}_i$ are detectably biased and that they underestimate the true number of births. Only the last estimate is detectably unbiased, but this is due to the end effects of the experiment which have caused a sudden increase in this estimate. This sudden increase is also seen in the sample standard deviation which also has increased significantly.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are given in columns four, five and six, respectively, of table 5.2.1. The coefficient of variation of $\hat{N}_i$ is low indicating that these estimates can be considered reliable. The coefficients of variation of $\hat{\phi}_i$ and $\hat{B}_i$ are both well below 0.50 which would indicate that both sets of estimates can be considered reliable. However, both the $\hat{\phi}_i$ and the $\hat{B}_i$ were found to be detectably biased. Thus, the low coefficients of variation mislead you into thinking that the $\hat{\phi}_i$ and $\hat{B}_i$ are more reliable than they actually are.

The estimated standard deviations of $\hat{N}_i$, given in column seven of table 5.2.6, are considered valid when compared to the sample standard deviations of $\hat{N}_i$, given in column four of table 5.2.7. In general, they differ by about 10 per cent of the former. The estimated standard deviations of $\hat{B}_i$, given in column nine of table 5.2.6, are also considered valid. In this case the estimated standard deviations of $\hat{\phi}_i$, given in column eight of table 5.2.6, are compared to the sample standard deviations, given in column five of table 5.2.7, the difference is about 80-90 per cent of the former. Furthermore, the estimated standard deviations of $\hat{\phi}_i$ are significant underestimates of the true standard deviations and hence, are not considered valid for this parameter set.

The results for ϕ_i and p_i equal to 0.70 and 0.15, respectively, are given in tables 5.2.8 and 5.2.9. In this experiment we shall see that pooling gives substantial improvement in the $\hat{N}_i$, but gives misleading estimates for $\hat{V}(\hat{N}_i)$. The estimates for ϕ_i and B_i and their variances are not at all reliable.

Looking at column twelve of both tables indicates that the $\hat{N}_i$ are not detectably biased. The overestimates of $\hat{N}_i$ for the last four estimates, seen in the three previous examples, have disappeared and only the last estimate is a significant overestimate.

The confidence intervals for the $\hat{\phi}_i$ do not include the true survival rate of $(0.70)^5=0.1681$ and hence they have a detectable bias. The positive bias can be seen by taking all the estimates together, which are overestimates by about 50 per cent of the true survival rate. By looking at the entries in column six of table 5.2.9, it is evident that the $\hat{B}_i$ are significant underestimates of the true number of births, which is 5(60) = 300.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ for this parameter set are given in columns five, six and seven, respectively, of table 5.2.1. The low coefficient of variation of $\hat{N}_i$ indicates the estimates of population size are reasonably precise. The same conclusion is drawn for the $\hat{\phi}_i$ and the $\hat{B}_i$ since the coefficients of variation for both estimates are well below 0.50. However, both the $\hat{\phi}_i$ and $\hat{B}_i$ were found to be significantly biased and hence, the low coefficients of variation are misleading. Since the experimenter cannot replicate his experiment, he cannot determine whether or not his estimates are biased. Thus, he will assume a larger rate and a lower number of births than actually holds.

Looking at the average estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, given in columns seven, eight and nine, respectively, of table 5.2.8, and the sample standard deviations, given in columns four, five and six, respectively, of table 5.2.9, shows that none of the variance formulae can be considered valid. Furthermore, the average estimated standard deviations are all overestimates of the sample standard deviations.

The results for $\phi_i = 0.50$ and $p_i = 0.20$ are given in tables 5.2.10 and 5.2.11. This experiment gives barely acceptable estimates of N_i and totally unacceptable results for $\hat{\phi}_i$ and $\hat{B}_i$

and all the variances.

The bias of $\hat{N}_i$, given in column twelve of table 5.2.10, is not significant. The end effects are seen only in the last two estimates, where again there is a significant positive bias.

The true survival rate over a grouped interval is $(0.50)^5$ = 0.0313. Looking at the $\hat{\phi}_i$, given in column five of table 5.2.10, it is obvious that they are large overestimates. The true number of births over a grouped interval is 5(100) = 500. Again, it is obvious that the $\hat{B}_i$, given in column six of table 5.2.10, are significant underestimates of the true number of births.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ for this parameter set are given in columns five, six and seven, respectively, of table 5.2.1. As with the previous examples, the coefficient of variation of $\hat{N}_i$ is below 0.50, indicating that the estimates of N_i are reliable. Since there was no detectable bias in $\hat{N}_i$ this conclusion is substantiated. The coefficients of variation of $\hat{\phi}_i$ and $\hat{B}_i$ are too large to allow you to accept the estimates, which were seen to be significantly biased. This result contrasts with the previous example, where the estimates were significantly biased, but the coefficients of variation were low enough to accept the results.

The analysis of the estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, given in columns seven, eight and nine of table 5.2.10, yields the same result as in the previous example. That is, none of the variance formulae can be regarded as valid. Again, the average estimated standard deviations are all underestimates of the true standard deviations.

The method of pooled statistics was simulated for one parameter set with N_o=400. The results are given in the last row of table 5.2.1 for ϕ_i=0.90 and p_i=0.05. The results are almost identical with the results for the same parameter set for N_o=200 (in the second row of table 5.2.1).

The bias of $\hat{N}_i$ is generally not significant, except for the last few estimates which are large overestimates due to the end effects of the experiment. Also, there is no detectable bias in the $\hat{\phi}_i$, although when considered together, the $\hat{\phi}_i$ generally overestimate the true survival rate. There are several estimates of $\hat{B}_i$ in the middle of the sampling chain which have a detectable bias but, in general, the $\hat{B}_i$ are not detectably biased. The end effects are also seen in the last two estimates of B_i, as was seen in the corresponding simulation with N_o=200.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ yield the same conclusions as the simulation with N_o=200 for the same parameter set. However, the coefficient of variation of $\hat{B}_i$ are almost acceptable. However, the $\hat{B}_i$ are still considered to be unacceptable. The average estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are all considered to estimate the true standard deviations adequately. This result is the same as the corresponding simulation with N_o=200.

Note that although the pooled r_i values are greater when N_o=400 than when N_o=200, the proportions r_i/N_o are virtually identical in the two cases. As a consequence, the reliability of the pooled estimates in the two cases is virtually the same.

In section 4.4.2 it was shown that averaging the estimates across the grouping interval does have a limited effect. With ϕ_i=0.93 and p_i=0.04 the primary effect on the estimates was that with averaging they stabilized. That is, they were not as variable across i with averaging. There was a slight improvement in the coefficient of variation and almost no improvement in the variance estimates.

The same results are derived when ϕ_i=0.99 and p_i=0.03. The estimates of population size have stabilized but the end effects of the experiment are still seen in the last estimate. The estimates of survival rate and birth still have a large negative and positive bias, respectively, and the end effects are seen in the last estimate of B_i. The coefficients of variation from averaging are very close to those without averaging (table 5.2.1) and hence, there is no gain in precision. The standard deviation estimates also have not improved significatnly. They are slightly lower than without averaging but the estimated standard deviations of $\hat{\phi}_i$ and $\hat{B}_i$ are still large overestimates.

Similar results occur when ϕ_i=0.70 and p_i=0.15. The estimates of population size are detectably unbiased and are less variable across i. The $\hat{\phi}_i$ still have significant postive bias which has decreased slightly with averaging. Also, the $\hat{B}_i$ still have a significant negative bias which shows no improvement by averaging. The coefficients of variation of the estimates are very close to what they were without averaging and hence, there is no improvement in precision. Also, the estimated standard deviations of the estimates are all considered valid and are all overestimates of the true standard deviations. Thus, from the three examples given above it appears that very little is gained by averaging over the grouping interval.

5.3 Results of the Reduced Capture History Method

The same analysis that is applied to the estimates derived from the pooled statistics method, discussed in section 5.2, can also be applied to the estimates derived from the reduced capture history method. Table 5.3.1 summarizes the results of the simulations using the reduced capture history method. The entries in this table represent the same quantities as in table 5.2.1, except that column four is now just the proportion of the r_i in the population at time i, rather than the pooled r_i. The parameter sets used in the simulations for the reduced capture history method are the same as those used for the simulations for the pooled statistics method. Furthermore, both sets of simulations deal with exactly the same sets of capture histories. The detailed simulation results are given in tables 5.3.2 to 5.3.11.

Tables 5.3.2 and 5.3.3 are the results of a simulation with ϕ_i=0.99 and p_i=0.03. We shall see that the $\hat{N}_i$ and $\hat{V}(\hat{N}_i)$ are acceptable, but the $\hat{\phi}_i$ and $\hat{B}_i$ and their estimated variances are not reliable.

From column twelve of both tables it can be seen that there is no detectable bias in the estimates of population size. In constrast with the results from the pooled statistics method, no overestimates are observed at the last four sampling occasions.

From column five of tables 5.3.2 and 5.3.3, it can be seen that the $\hat{\phi}_i$ have a detectable bias and when looked at across i, the $\hat{\phi}_i$ underestimate the true survival rate. The $\hat{B}_i$ do have a detectable bias, as seen from column six of both tables. Also, when looked at across i, the $\hat{B}_i$ overestimate the true B_i. Again, the last few estimates of ϕ_i and B_i are not affected by any end effects of the experiment.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, given in columns five, six and seven of table 5.3.1, indicate that both the $\hat{N}_i$ and $\hat{\phi}_i$ can be considered reliable but the $\hat{B}_i$ cannot. However, the $\hat{\phi}_i$ were found to be negatively biased and hence, the low coefficient of variation is misleading.

The variance formula for $\hat{V}(\hat{N}_i)$ produces results which are considered valid. The average estimated standard deviations (column seven of table 5.3.2) and the sample standard deviations (column four of table 5.3.3) differ by about 20 per cent of the former. The variance formulae for $\hat{V}(\hat{\phi}_i)$ and $\hat{V}(\hat{B}_i)$ are not considered to give good estimates. The differences for the $\hat{\phi}_i$ are about 35-50 per cent, while the differences for the $\hat{B}_i$ are about 25-40 per cent. Both the $\hat{V}(\hat{\phi}_i)$ and $\hat{V}(\hat{B}_i)$ overestimate the true variances. This result was also seen in the standard deviation estimates from the pooled statistics method. As suggested for those results, the overestimates of variance for the reduced capture history method are probably due to the inadmissable $\hat{\phi}_i$ and $\hat{B}_i$ that are calculated, which lower the sample standard deviations, but have no effect on the estimated standard deviations.

The results for ϕ_i=0.90 and p_i=0.05 are given in tables 5.3.4 and 5.3.5. We see that, in this experiment, pooling gives excellent results. The $\hat{N}_i$ have no detectable bias as seen from column twelve of both tables. The $\hat{\phi}_i$ and $\hat{B}_i$ also have no detectable bias and there is no trend in any of the three estimates. Also, none of the estimates are affected by the end effects of the experiment.

The precision of the $\hat{N}_i$, given in column five of table 5.3.1, shows that the estimates of population size are barely considered accpetable. If the sample standard deviations of $\hat{N}_i$ were any larger, the $\hat{N}_i$ would not be considered reliable. The coefficient of variation of $\hat{\phi}_i$, given in column six of table 5.3.1, indicates that $\hat{\phi}_i$ can be considered reliable, while the coefficient of variation of $\hat{B}_i$, given in column seven of table 5.3.1, indicates the estimates of birth cannot be considered reliable.

The differences between the average estimated standard deviations of the $\hat{N}_i$ (column seven of table 5.3.4) and the sample standard deviations of the $\hat{N}_i$ (column four of table 5.3.5) are generally about 15-20 per cent of the former. The corresponding differences for the $\hat{\phi}_i$ are about 10-20 per cent and the differences for the $\hat{B}_i$ are less than 20 per cent about half the time and up to 35 per cent for the other half. Thus, all the variance formulae are considered valid for this parameter set.

The results for ϕ_i=0.80 and p_i=0.10 are given in tables 5.3.6 and 5.3.7. In this case, the $\hat{N}_i$ and $\hat{\phi}_i$ and their variance estimates are reliable. The $\hat{B}_i$ are not reliable but the $\hat{V}(\hat{B}_i)$ are considered acceptable.

It is evident from column twelve of both tables that there is no detectable bias in the $\hat{N}_i$ although they do underestimate the true population size. For this parameter set the $\hat{\phi}_i$ are very close to the true survival rate of 0.3269 and hence, they are detectably unbiased. However, they do tend to overestimate the true ϕ_i. From column six of both tables it can be seen that the $\hat{B}_i$ do have a detectable negative bias.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are given in columns five, six and seven, respectively, of table 5.3.1. The coefficients of variation of $\hat{N}_i$ and $\hat{\phi}_i$ are both below 0.50 which indicates that the $\hat{N}_i$ and the $\hat{\phi}_i$ can be considered reliable. However, the coefficient of variation of $\hat{B}_i$ is very close to 0.50 and since the $\hat{B}_i$ were found to be detectably biased, they are not considered reliable.

The average estimated standard deviations of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, given in columns seven, eight and nine of table 5.3.6, are all considered valid estimates of the true standard deviations. The differences between them and the sample standard deviations, given in columns four, five and six, respectively, are below 20 per cent of the former. In the case of the $\hat{\phi}_i$ the differences are less than 10 per cent.

The results for ϕ_i=0.70 and p_i= 0.15 are given in tables 5.3.8 and 5.3.9. We shall see that the $\hat{N}_i$ and the $\hat{\phi}_i$ and their variance estimates are considered valid, but the $\hat{B}_i$ and $\hat{V}(\hat{B}_i)$ are not.

Almost 1/3 of the estimates of population size (column four of table 5.3.10) have a detectable bias. Furthermore, as can be seen from the biases of $\hat{N}_i$ (column twelve of table 5.3.10), which are almost all negative, the $\hat{N}_i$ are underestimates of the true population size. However, in general the $\hat{N}_i$ will be considered to have no dectable bias.

When the confidence intervals for $\hat{\phi}_i$ are formed, it is seen that they include the true rate of survival and hence, the $\hat{\phi}_i$ have no detectable bias. The $\hat{B}_i$ do have a detectable bias and the bias is negative indicating that the $\hat{B}_i$ are significant underestimates of the true B_i.

The coefficient of variation of $\hat{N}_i$ indicates that the estimates of population size can be considered reliable. However, the results are marginal and if the sample standard deviations were any larger the $\hat{N}_i$ would not be considered reliable. The coefficient of variation of $\hat{\phi}_i$ indicates that the estimates of survival rate can be considered acceptable, while the coefficient of variation of $\hat{B}_i$ indicates that the estimates of birth cannot be considered reliable.

The estimated standard deviations of $\hat{N}_i$ and $\hat{\phi}_i$, given in columns seven and eight, respectively, of table 5.3.10, are considered valid, while those of $\hat{B}_i$ are not. However, the validity of the estimated standard deviations of $\hat{N}_i$ is marginal because almost half the differences between them and the sample standard deviations are greater than 20 per cent of the former. All the standard deviation estimates tend to underestimate the true standard deviations.

The results for ϕ_i=0.50 and p_i=0.20 are given in tables 5.3.10 and 5.3.11. We shall see that the $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are all unacceptable as are their estimated variances.

The $\hat{N}_i$ (column four of table 5.3.10) are detectably biased and are consistent underestimates of the true population size. The estimates of survival (column five of table 5.3.10) are also detectably biased and are consistent overestimates of the true rate of survival. The $\hat{B}_i$ (column six of table 5.3.10) have a detectable negative bias.

The coefficients of variation of $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ are consistent with the conclusions on the bias of these estimates. All of the estimates are considered unreliable because the coefficients of variation are well above 0.50.

The variance formulae for $\hat{V}(\hat{N}_i)$ and $\hat{V}(\hat{B}_i)$ are not considered valid for this parameter set. Even a rough estimate of differences between the average estimated standard deviations and the sample standard deviations of $\hat{N}_i$ and $\hat{\phi}_i$ cannot be determined because the latter are too variable. The variance formula for $\hat{V}(\hat{\phi}_i)$ is not considered valid, as well, with the differences between the two standard deviations estimated at 100 per cent.

As with the method of pooled statistics, the method of reduced capture histories was simulated for one parameter set for N_o=400. The results are given in the last row of table 5.3.1. The results are about the same as the results for the same parameter set with N_o=200 (row two of table 5.3.1).

The bias of $\hat{N}_i$ is generally not significant with the same result true for the $\hat{B}_i$. The $\hat{B}_i$ appear to give better estimates of the true B_i than in the simulation with N_o=200, although they are generally slight underestimates. A detectable bias is seen in some of the $\hat{\phi}_i$, but on the whole they are not detectably biased. However, they do tend to underestimate the true survival rate.

The coefficient of variation of $\hat{N}_i$ shows a slight improvement than with N_o=200 and the coefficient of variation of $\hat{B}_i$ shows a much larger improvement, to the point where the $\hat{B}_i$ may be considered acceptable. The precision in the $\hat{\phi}_i$ is about the same. As with the simulation with N_o=200, the variance formulae are all considered valid. Thus, it seems from this example at least, that a larger population size has little effect.

The process of averaging also has little effect on the estimates derived from the reduced capture history method. In section 4.6.2 it was shown that the main improvement is in the $\hat{N}_i$ and the estimated standard deviations of $\hat{N}_i$. Otherwise, the results are about the same with averaging as without.

For ϕ_i=0.99 and p_i=0.03 the results with averaging are about the same as in the previous example. The $\hat{N}_i$ are detectably unbiased without averaging and still are. No improvement is seen in the $\hat{\phi}_i$ or the $\hat{B}_i$ which are still large underestimates and overestimates, respectively. There is a slight improvement in the coefficients of variation of $\hat{N}_i$ and $\hat{B}_i$, but the improvement is not significant. Also, the standard deviation estimates of $\hat{\phi}_i$ and $\hat{B}_i$ are still large overestimates of the true standard deviations and show no significant decrease.

Similar results are obtained for ϕ_i=0.70 and p_i=0.15. Both the $\hat{N}_i$ and $\hat{\phi}_i$ are detectably unbiased as they were without averaging and the $\hat{B}_i$ are again significant underestimates of the true number of births. There is no improvement in the coefficients of variation of these estimates and the estimated standard deviations of $\hat{N}_i$ and $\hat{\phi}_i$ are considered valid, while the estimated standard deviation of $\hat{B}_i$ is still considered invalid. As with the method of pooled statistics, averaging does not give any significant improvements.

5.4 Effect of Changing Interval Length

In order to determine the effects of pooling over different interval lengths, both pooling methods were simulated for a low and a high probability of survival, over increasing interval lengths. The effect of increasing interval length is determined by examining the average sample standard deviation of $\hat{N}_i$ across i.

Figure 5.4.1 is a graph of interval length versus the average standard deviation across i, of $\hat{N}_i$. The parameter set of N_o, ϕ_i, p_i, η_i and L is 200, 0.99, 0.03, 1.00 and 50, respectively. The upper curve is the result from the reduced capture history method and the lower curve is the result from the pooled statistics method. Also given below the interval length are the average r_i and r_i/N_o for the reduced capture history method and the average pooled r_i and the average pooled r_i/N_o for the pooled statistics method. Figure 5.4.2 is the graph for the parameter set of N_o, ϕ_i, p_i, η_i and L equal to 200, 0.70, 0.10, 1.00 and 50, respectively. Again the upper and lower curves are the results from the reduced capture history and pooled statistics methods, respectively.

The results in the two graphs are as expected. In all four cases the average standard deviation decrease with an increase in grouping interval length. This result is expected since with an increase in the grouping interval length, the r_i over the interval are expected to increase. Since the estimates are an inverse function of the r_i, an increase in r_i yields a decrease in the sample variance of the estimates. The figures show a general increase in r_i as the grouping interval length increases.

While both methods of pooling show an increase in precision with an increase in interval length, the two methods differ in degree of improvement. Figure 5.4.1 shows that the method of pooled statistics yields a better improvement in precision than the method of reduced capture histories. While the r_i's do not differ by much for interval lengths 3 and 5 there is a significant difference for interval lengths greater than 5. For the method of pooled statistics, the average pooled r_i for interval length 11 is almost double the average r_i for the method of reduced capture histories for interval length 10. A significant difference in the r_i used in both methods, shows up in a significant difference in the samples standard deviation. The average estimated standard deviations are significantly lower for the method of pooled statistics.

The same result is seen in figure 5.4.2. However, with a lower survival rate the difference in precision is even greater. The average pooled r_i for the pooled statistics method are 2 to 13 times larger than the average r_i for the reduced capture history method. The result is that the sample standard deviations from the latter method.

Note that the curves for the reduced capture history method appear almost linear. The curves for the pooled statistics method is parabolic, with little improvement in the estimated variances for interval lengths greater than about 7.

In comparing the two methods the average pooled r_i have been compared to the average r_i. In the method of pooled statistics the pooled r_i are used to derive the estimates, rather than the unpooled r_i. In the method of reduced capture histories the opposite is the case. Only the unpooled r_i are used to calculate the estimates. Thus, while both methods increase the precision of the estimates with an increase in grouping interval length, the method of pooled statistics results in a significantly larger increase in precision.

5.5 Comparison of the Pooling Methods

The results of the simulations of both methods of pooling over several parameter sets were analyzed as to bias, precision and adequacy of the variance formulae. In this section the results of the analyses for both pooling methods are compared.

Table 5.5.1 summarizes the analyses of the bias of the $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ performed in sections 5.2 and 5.3 for the two pooling methods. Column one is the pooling method and columns two and three are the survival and capture rates, respectively. Columns four, five and six tell if there were any detectable biases in the $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$, respectively, at the 95% level of significance. The entries in these three columns will be either "none", "positive" or "negative" depending on whether or not there was a detectable bias. If there was detectable bias then the entries depend on whether the biases were significant overestimates (positive bias) or significant underestimates (negative bias).

The pooled statistics method appears to give the most reliable estimates of N_i. None of the parameter sets that were simulated for the pooled statistics method yielded $\hat{N}_i$ that had any detectable bias. However, the results for the reduced capture history method show that a detectable negative bias in $\hat{N}_i$ occurs for $\phi_i=0.50$ and $p_i=0.20$. Furthermore, for $\phi_i=0.70$ the results for the reduced capture history method indicate that the $\hat{N}_i$ are underestimates of the true population size, so that some bias is beginning to be seen in the $\hat{N}_i$.

The opposite result is the case when the biases of the $\hat{\phi}_i$ are considered. A significant positive bias is detected in the $\hat{\phi}_i$ from the pooled statistics method for $\phi_i=0.70$ as well as for $\phi_i=0.50$. Also, while the estimates of survival for $\phi_i=0.90$ are not detectably biased, the trend in these $\hat{\phi}_i$ is to overestimate the true survival rate. This trend of overestimating the true survival rate is not seen until a much lower ϕ_i, for the reduced capture history method. It is not until ϕ_i drops to 0.50 that a detectable bias in the $\hat{\phi}_i$, for the reduced capture history method, is evident. While there is a detectable bias for this parameter set, it is a much smaller bias than in the $\hat{\phi}_i$ derived from the pooled statistics method.

Although a positive bias is detected in the $\hat{\phi}_i$ from both pooling methods for lower survival rates it appears that when the true survival rate over single sampling occasions is very high, say 0.95 and larger, the $\hat{\phi}_i$ for both pooling methods will be negatively biased. This bias is small and is almost certainly due to the adjustment of inadmissable estimates ($\hat{\phi}_i > 1.0$) and so is only artifically introduced by the simulation. Thus, it need not be considered a shortcoming of the pooling methods.

There is not much difference in the biases of the $\hat{B}_i$ for the two pooling methods. In both methods the $\hat{B}_i$ are negatively biased beginning at ϕ_i=0.70. However, the pooled statistics method results in $\hat{B}_i$ which tend to underestimate the true number of births for ϕ=0.90. When there are a small number of births over a grouped interval (less than about 30) both pooling methods give $\hat{B}_i$ which have a significant positive bias. When there are a large number of births over a grouped interval (greater than about 100) both pooling methods give $\hat{B}_i$ which have a significant negative bias.

The estimates of N_i, ϕ_i and B_i from the pooled statistics method were affected by the fewer number of recaptures at the end of the sampling chain. That is, the estimates at the end of the experiment were overestimates of the true parameter values. This effect diminished as the survival rate decreased. The estimates of N_i, ϕ_i and B_i from the reduced capture history method were not affected by the fewer number of recpatures at the end of the experiment.

The precision of the $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ for both pooling methods is given in columns five, six and seven, respectively, of tables 5.2.1 and 5.3.1. The precision of the estimates derived from the reduced capture history method is better. The most significant difference is precision is seen in the coefficients of variation for $\hat{B}_i$, where the estimates of birth from the pooled statistics method are much more precise than the estimates of birth from the reduced capture history method.

The adequacy of the variance formulae is given in columns ten, eleven and twelve of tables 5.2.1 and 5.3.1. The variance formulae from the pooled statistics method give better estimates. However, the variance formulae for $\hat{V}(\hat{B}_i)$ from neither method give estimates which can be considered valid. The variance estimates from both methods for very high survival rates are significant over-estimates, while those for lower survival rates are significant underestimates. The overestimates were shown in sections 5.2 and 5.3 to be caused by inadmissable estimates. When an inadmissable estimate is calculated it is reset to an admissable value. This procedure reduces the sample variance but has no effect on the estimated variance thus, producing overestimates.

For low survival rates neither method yields estimates which can be considered valid. When the survival rate is low there is a large turnover of animals between sampling occasisons. Thus, many animals do not remain in the population long enough to be recaptured several times. Therefore, the total number of recaptures at any sampling occasion is lowered, producing unreliable estimates.

The process of averaging over the grouping intervals gives very little improvement. The bias and precision of the estimates as well as the adequacy of the variance formulae are approximately the same with pooling as without. The only improvement seen is that the estimates are less variable across i with averaging.

5.6 Non Stable Populations

Two types of non stable populations were simulated. In the first type, the expected number of births was $(1-\phi_i)\ N_o$ for sampling times 1 to 25. From times 26 to 50 the expected number of births was doubled. The expected number of losses was now less than the expected number of births and hence, a monotone increasing population was the result.

Figure 5.6.1 is a graph of sampling time versus the estimated population size from the pooled statistics method. The smooth curve is the estimated population size and the broken curve is the expected population size. Although the estimate of N_i is an overestimate of the expected population size, the difference does not seem to be significant. However, a large positive bias occurs at the end of the sampling chain. This overestimate at the end of the chain is due to the fewer number of recaptures during the last several sampling occasions.

The estimates of population size at the end of the experiment are based on fewer recaptures than those estimates in the middle. In the middle of the sampling chain the ratios r_i/s_i, r_{i+1}/s_{i+1}, etc. are approximately equal. Therefore, over a grouped interval of length s $(r_i+r_{i+1}+\ldots+r_{i+s-1})/(s_i+s_{i+1}+\ldots s_{i+s-1})$ is approximately the same as $(r_i/s_i) + (r_{i+1}/s_{i+1}) + \ldots + (r_{i+s-1}/s_{i+s-1})$. However, at the end of the sampling chain there are fewer recaptures because the marked animals alive in the population are exposed to fewer sampling times. Therefore, $(r_i/s_i) < (r_{i+1}/s_{i+1}) < (r_{i+2}/s_{i+2})$, etc. near the end of the chain, which gives and underestimate of

$(\Sigma\ r_i)/(\Sigma\ s_i)$. Since the inverse of this expression is used to calculate $\hat{M}_i$, the result is an overestimate of $\hat{M}_i$, which in turn results in an overestimate of $\hat{N}_i$.

The second type of non stable population simulated was one with a large influx of individuals at one sampling period. For sampling periods 1 to 25 the expected population size was 200. Between times 25 and 26 the population size doubled to 400 and remains there up to the end of the experiment. The values of p_i and ϕ_i used in the simulation were 0.10 and 0.50, respectively.

Figure 5.6.2 is a graph of the sampling time versus the estimated population size. The broken line represents the expected population size. The pooled statistics method used in this example smooths out the sudden jump in the population size. The grouping interval lenth in this case is 5. The effects of the population increase are felt 3 or 4 periods before the actual increase and the estimated population size does not reach the expected population size until 6 to 8 sampling periods after the actual increase.

With the survival rate at 0.50 an individual is expected to survive only two sampling occasions. Therefore, the number of recaptures will be approximately the same at the end of the sampling chain as in the middle. Therefore, the estimates at the end of the chain should not become too large. From the graph it can be seen that the estimates at the end of the chain do not become significant overestimates.

Chapter 6

6.1 Conclusions

The following conclusions have been substantiated in previous chapters and are the result of this thesis:

(1) When an experimenter should pool and why.

1.1 When the estimated coefficient of variation of an estimate is below 0.50 the estimate can be considered reliable. The estimated coefficient of variation is calculated by dividing the estimate by its estimated standard deviation.

1.2 If the experimenter believes that the estimated variances are invalid or if he believes that the $\hat{N}_i$ are reasonably accurate and stable, then if the average number of recaptures is greater than about 5 per cent of the average $\hat{N}_i$, then the estimates of N_i, ϕ_i and B_i can be considered reliable. However, the experimenter may still want to pool in order to increase precision, or to derive estimates that relate to a time interval which is longer than his actual time between sampling times.

1.3 If there is a large number of zero r_i values or a large number of values of $\hat{\phi}_i$ and $\hat{B}_i$ which are inadmissable, then this may be an indication that the estimates are unreliable. Note that this is not a very stringent criterion and should not be the main one.

1.4 The proportion, the average r_i divided by the average $\hat{N}_i$, is approximately the same for different population sizes, for the same paramter set.

1.5 Whenever one or both of 1.1 and 1.2 do not hold, the experimenter should pool his results. The purpose of pooling is to salvage the data and to produce more dependable and precise estimates.

(2) What grouping interval should be chosen.

2.1 When choosing a grouping interval, the experimenter should keep in mind the assumption that the parameters within a pooled group should not change significantly, but may change from group to group. Thus, if the population parameters change from month to month, the experimenter may pool over monthly periods.

2.2 The criterion, that the average r_i should be greater than 5 per cent of the average $\hat{N}_i$, should be adhered to whenever possible. Thus, if after pooling over the chosen interval the average r_i are still less than 5 per cent of the average $\hat{N}_i$, then a new interval to increase the r_i should be chosen, if possible.

2.3 Also, if the estimated coefficients of variation of the pooled estimates are still greater than 0.50, then the estimates are still unreliable and a new pooling interval should be chosen.

2.4 As the grouping interval becomes larger, the true rate of survival over the grouping interval decreases. When the survival over a grouped interval falls below about

0.40, the estimates and their estimated variances are no longer reliable. Thus, the experimenter may increase the grouping interval length in order to increase the r_i over the interval, as long as the true survival rate over the grouped interval remains larger than 0.40.

2.5 As the grouping interval length increase, the precision of the estimates increases, but with a corresponding in the bias of the estimates. The increase in bias is seen mainly in the $\hat{\phi}_i$ and the $\hat{B}_i$ which are both estimates over the grouped interval.

(3) Properties of pooled estimates, given a valid grouping interval. A valid grouping interval is one for which the estimated coefficients of variation of the estimates is less than 0.50, the average r_i is greater than 5 per cent of the average $\hat{N}_i$ and the survival rate over the grouped interval is greater than o.40.

Bias of the Estimates:

3.1 The estimates of population size derived from either pooling method do not have any significant bias.

3.2 The method of reduced capture histories gives slightly less biased estimates of survival rates than the pooled statistics method.

3.3 When the true survival rate over a grouped interval is greater than about 0.90, the estimated survival rate derived from either pooling method is slightly negatively biased. For true survival rates lower than about 0.50 both pooling methods give estimated survival rates which are positively biased.

3.4 In general, the estimates of the number of births over a grouped interval from either pooling method are unreliable.

3.5 A large positive bias is seen in the last few estimates of N_i, ϕ_i and B_i for high survival rates. This large positive bias is due to the fewer number of recaptures at the end of the experiment.

Precision of the Estimates

3.6 In general, the coefficients of variation of the estimates of N_i and ϕ_i are less than 0.50 for both pooling methods. Although an experimenter may have an estimated coefficient of variation greater than 0.50, it is probably due to random fluctuations in a single experiment. The true coefficient of variation, when a valid grouping is used, is seen to be less than 0.50 for N_i and ϕ_i.

3.7 The estimated coefficients of variation of the $\hat{B}_i$ from both pooling methods are generally greater than 0.50 and hence, an experimenter should not apply this criterion to the $\hat{B}_i$.

3.8 In general, the precision of the $\hat{N}_i$, $\hat{\phi}_i$ and $\hat{B}_i$ is greater with the pooled statistics method than with the reduced capture history method.

The Variance Estimates

3.9 The variance formulae for both pooling methods can be considered valid as long as the true survival rate over the grouped interval is greater than about 0.30.

3.10 When the true survival rate over the grouped interval is greater than about 0.95, the variance estimates for $\hat{\phi}_i$ and $\hat{B}_i$ are positively biased. The bias is due to resetting inadmissable $\hat{\phi}_i$ and B_i to admissable values. The positive bias in the variance estimates gives the experimenter a conservative estimate of the precision. A negative bias in the variance estimates would mislead him into thinking his estimates are more precise than they actually are.

Further Properties

3.11 Averaging the estimates over the grouping interval has little effect other than stabilizing the estimates.

3.12 When choosing a grouping interval, the increase in precision for larger intervals is greatest for the pooled statistics method. However, for interval lengths greater than about 8-10 there is very little increase in precision.

3.13 In both the unpooled method and the pooled statistics method any sudden increase in the $\hat{N}_i$, $\hat{\phi}_i$ or $\hat{B}_i$ near the end of the sampling chain should be regarded as spurious, unless the experimenter has reason to believe they are valid. Increases are also seen in the last few estimates of variance. These increases are due to the fewer number of recaptures at the end of the chain. The end effects decrease as the survival rate decreases.

3.14 No end effects are seen in the estimates derived from the reduced capture history method. However, estimates from this method are available over a shorter range of sampling times and thus, fewer end results are given. Therefore, there is little to choose between the two methods when this situation arises.

3.15 Pooling appears to make sudden large changes in population size more gradual.

6.2 Further Hypotheses

(1) In this thesis I determined which parameter sets give unreliable estimates and used the pooling methods on them. The parameter sets which gave good estimates were not considered and even in these situations it may be advantageous to use one of the pooling methods. There may be a significant improvement in the estimates by pooling. A second reason for pooling over good experiments would be standardize the estimates over say, weeks or months. Note, however, that if the sampling occasions are unequally spaced, then pooling will not be satisfactory because the estimated survival rate will refer to different interval lengths. However, it is possible to adopt the pooling methods to unequal sample times by assigning weights to the estimates.

(2) Only stable populations were mainly of concern in this thesis. In order to obtain a stable population, the p_i, ϕ_i and η_i were constant over the sampling chain. A further area of study would be to determine the effects of varying these parameters over the sampling chain.

(3) Pooling amy be subject to failure of one or more of the assumptions of the Jolly model. Another area of study would be to determine the effects of failure of the assumptions on the pooled estimates. It may well happen that the pooled estimates are more "robust" than the unpooled estimates to failure of the assumptions (equal catchability, homogeneity of survival, only permanent migration). Therefore, by pooling one may not only increase the precision of the estimates, but may also reduce bias due to failure of the assumptions.

APPENDIX A

TABLES AND GRAPHS

TABLE 3.5.1

PARAMETER SETS USED

$L = 50 \quad n_i = 0.99$

ϕ_i	$N_0 = 200$ P_i	$N_0 = 400$ P_i
0.90	0.30 0.25 0.20 0.15 0.10 0.05 *	0.30 0.25 0.20 0.15 0.10 0.05 *
0.70	0.30 0.25 0.20 0.15 * 0.10 * 0.05 *	0.30 0.25 0.20 0.15 0.10 * 0.05 *
0.50	0.30 0.25 0.20 * 0.15 * 0.10 * 0.05 *	0.30 0.25 0.20 0.15 * 0.10 * 0.05 *
0.30	0.60 0.55 0.50 0.45 0.40 0.35 * 0.30 * 0.25 *	0.60 0.55 0.50 0.45 0.40 0.35 0.30 0.25 *
0.10	0.60 0.55 * 0.50 * 0.45 * 0.40 * 0.35 *	0.60 0.55 0.50 0.45 * 0.40 * 0.35 *

TABLE 3.5.2 $N_0 = 200$ $L = 50$ $\eta_1 = 0.99$

ϕ	P	r_1/N_0	AVERAGE COEFFICIENT OF VARIATION OF $\hat{N}_1$	AVERAGE COEFFICIENT OF VARIATION OF $\hat{\phi}_1$	AVERAGE COEFFICIENT OF VARIATION OF $\hat{B}_1$	ADEQUACY OF THE V FOR V OF $\hat{N}_1$	ADEQUACY OF THE V FOR V OF $\hat{\phi}_1$	ADEQUACY OF THE V FOR V OF $\hat{B}_1$	BIAS IN $\hat{N}_1$	PROPORTION OF INADMISSABLE $\hat{\phi}_1$	PROPORTION OF INADMISSABLE $\hat{B}_1$	# OF ZERO r_1
0.90	0.10	0.04	0.40	0.37	1.5	YES	NO	YES	NO	0.37	0.31	—
	0.05	0.04	0.80	0.60	1.7	YES	NO	NO	NO	0.40	0.39	—
0.70	0.20	0.06	0.36	0.31	0.86	YES	YES	YES	NO	0.13	0.10	0
	0.15	0.04	0.52	0.36	1.2	YES	NO	NO	NO	0.18	0.15	2
0.50	0.25	0.05	0.46	0.43	0.65	YES	YES	YES	NO	0.05	0.02	1
	0.20	0.03	0.52	0.66	0.55	YES	NO	NO	NO	0.08	0.07	3
0.30	0.40	0.06	0.46	0.42	0.42	YES	YES	NO	NO	0.02	0.00	0
	0.35	0.04	0.56	0.52	0.54	NO	NO	NO	NO	0.02	0.00	0
0.10	0.60	0.05	0.42	0.41	0.47	YES	YES	NO	NO	0.18	0.00	0
	0.55	0.03	0.59	0.56	0.61	NO	NO	NO	NO	0.19	0.00	0

TABLE 3.5.3 $N_0 = 400$ $L = 50$ $\eta_1 = 0.99$

ϕ	P	r_1/N_0	AVERAGE COEFFICIENT OF VARIATION OF $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	ADEQUACY OF THE V FOR V OF $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	BIAS IN $\hat{N}_1$	PROPORTION OF INADMISSABLE $\hat{\phi}_1$	$\hat{B}_1$	# OF ZERO r_1
0.90	0.10	0.04	0.29	0.26	1.3	YES	YES	YES	NO	0.34	0.11	—
	0.05	0.01	0.70	0.56	1.7	YES	NO	NO	NO	0.37	0.34	—
0.70	0.15	0.04	0.33	0.31	0.81	YES	YES	YES	NO	0.13	0.10	0
	0.10	0.02	0.57	0.50	1.2	YES	NO	NO	NO	0.19	0.16	4
0.50	0.20	0.04	0.41	0.37	0.61	YES	YES	YES	NO	0.04	0.02	0
	0.15	0.02	0.60	0.52	0.86	YES	NO	NO	NO	0.07	0.05	1
0.30	0.30	0.04	0.46	0.43	0.45	YES	NO	NO	NO	0.02	0.00	0
	0.25	0.03	0.58	0.54	0.57	NO	NO	NO	NO	0.02	0.00	0
0.10	0.50	0.02	0.46	0.53	0.32	YES	NO	NO	NO	0.02	0.00	1
	0.45	0.02	0.64	0.69	0.41	NO	NO	NO	NO	0.02	0.00	0

TABLE 3.2.1

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.50
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.90
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 1

MEANS OVER 1 REPLICATIONS

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	200.00	96.00	20.00	96.00	77.00	0.0
2	96.00	45.00	198.00	106.00	20.00	106.00	83.00	32.00
3	146.00	61.00	193.00	92.00	20.00	92.00	74.00	54.00
4	156.00	77.00	193.00	104.00	20.00	104.00	86.00	51.00
5	167.00	84.00	195.00	106.00	20.00	106.00	89.00	53.00
6	172.00	85.00	196.00	102.00	20.00	102.00	85.00	57.00
7	175.00	77.00	195.00	97.00	20.00	97.00	72.00	65.00
8	179.00	81.00	191.00	96.00	20.00	96.00	76.00	56.00
9	172.00	77.00	187.00	87.00	20.00	87.00	72.00	55.00
10	160.00	68.00	185.00	89.00	20.00	89.00	74.00	59.00
11	163.00	79.00	185.00	98.00	20.00	98.00	78.00	54.00
12	165.00	81.00	187.00	106.00	20.00	106.00	85.00	51.00
13	175.00	70.00	187.00	84.00	20.00	84.00	71.00	66.00
14	171.00	72.00	183.00	91.00	20.00	91.00	71.00	65.00
15	168.00	82.00	186.00	96.00	20.00	96.00	75.00	54.00
16	166.00	74.00	190.00	94.00	20.00	94.00	68.00	55.00
17	171.00	68.00	184.00	84.00	20.00	84.00	64.00	55.00
18	162.00	69.00	179.00	90.00	20.00	90.00	74.00	50.00
19	160.00	70.00	180.00	89.00	20.00	89.00	73.00	54.00
20	160.00	67.00	174.00	83.00	20.00	83.00	66.00	60.00
21	153.00	74.00	180.00	91.00	20.00	91.00	70.00	52.00
22	157.00	69.00	182.00	92.00	20.00	92.00	83.00	53.00
23	164.00	73.00	184.00	89.00	20.00	89.00	77.00	63.00
24	163.00	76.00	192.00	93.00	20.00	93.00	72.00	64.00
25	168.00	80.00	198.00	99.00	20.00	99.00	78.00	56.00
26	174.00	65.00	202.00	88.00	20.00	88.00	71.00	69.00
27	183.00	75.00	187.00	91.00	20.00	91.00	72.00	65.00
28	165.00	78.00	192.00	96.00	20.00	96.00	78.00	59.00
29	171.00	81.00	195.00	100.00	20.00	100.00	88.00	56.00
30	175.00	84.00	197.00	97.00	20.00	97.00	79.00	60.00
31	173.00	83.00	199.00	105.00	20.00	105.00	80.00	56.00
32	181.00	66.00	197.00	84.00	20.00	84.00	69.00	70.00
33	179.00	82.00	196.00	99.00	20.00	99.00	82.00	57.00
34	177.00	76.00	196.00	92.00	20.00	92.00	84.00	63.00
35	174.00	82.00	204.00	100.00	20.00	100.00	87.00	65.00
36	181.00	91.00	209.00	107.00	20.00	107.00	87.00	61.00
37	184.00	88.00	206.00	111.00	20.00	111.00	88.00	60.00
38	188.00	87.00	202.00	101.00	20.00	101.00	85.00	61.00
39	182.00	75.00	203.00	98.00	20.00	98.00	85.00	71.00
40	189.00	88.00	205.00	106.00	20.00	106.00	91.00	68.00
41	190.00	90.00	206.00	101.00	20.00	101.00	85.00	69.00
42	184.00	87.00	204.00	102.00	20.00	102.00	85.00	67.00
43	178.00	73.00	204.00	93.00	20.00	93.00	76.00	79.00
44	184.00	79.00	207.00	99.00	20.00	99.00	81.00	76.00
45	188.00	90.00	207.00	112.00	20.00	112.00	91.00	67.00
46	191.00	79.00	213.00	93.00	20.00	93.00	75.00	79.00
47	191.00	84.00	214.00	105.00	20.00	105.00	84.00	70.00
48	198.00	88.00	217.00	102.00	20.00	102.00	65.00	66.00
49	197.00	82.00	219.00	102.00	20.00	102.00	50.00	49.00
50	201.00	99.00	218.00	111.00	0.0	111.00	0.0	0.0

TABLE 3.2.2

MEANS OVER 1 REPLICATIONS

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	190.29	0.8924	29.45	0.0	0.0567	0.0	0.0	0.0022	-9.71
2	0.4299	85.76	199.49	0.8719	18.01	19.17	0.0525	17.13	17.88	0.0020	1.49
3	0.6667	127.96	191.94	0.8716	19.21	15.63	0.0494	11.65	12.95	0.0017	-1.06
4	0.7429	138.55	186.51	0.8880	19.44	13.68	0.0438	8.87	9.40	0.0013	-6.49
5	0.7944	147.01	185.06	0.9068	15.74	13.49	0.0431	7.75	8.13	0.0014	-9.94
6	0.8350	153.27	183.56	0.9647	29.29	13.72	0.0532	9.35	7.85	0.0026	-12.44
7	0.7959	164.26	206.38	0.8225	9.53	17.43	0.0539	8.52	12.27	0.0021	11.38
8	0.8454	151.55	179.27	0.8604	7.43	14.73	0.0493	6.37	8.57	0.0017	-11.73
9	0.8864	143.30	161.67	0.9054	34.66	13.56	0.0494	8.52	6.98	0.0019	-25.33
10	0.7667	138.80	181.04	0.9178	15.34	16.13	0.0505	9.32	10.04	0.0021	-3.96
11	0.8081	146.67	181.51	0.8719	30.23	15.65	0.0491	8.65	9.03	0.0017	-3.49
12	0.7664	144.45	188.49	0.8729	12.55	16.18	0.0470	8.68	9.35	0.0016	1.49
13	0.8353	147.92	177.08	0.9576	25.83	15.64	0.0542	9.74	8.84	0.0027	-9.92
14	0.7935	155.06	195.41	0.8671	6.94	17.75	0.0542	8.47	11.38	0.0023	12.41
15	0.8557	150.92	176.38	0.9079	29.53	15.47	0.0578	8.56	8.37	0.0028	-9.62
16	0.7995	149.72	185.65	0.8244	16.02	17.86	0.0590	8.97	11.63	0.0026	-0.35
17	0.8118	139.92	172.37	0.8316	25.22	16.54	0.0547	8.72	10.26	0.0021	-11.63
18	0.7692	129.67	168.57	0.9005	20.19	15.72	0.0499	8.99	9.01	0.0019	-10.43
19	0.7989	135.68	171.98	0.9195	17.55	15.90	0.0536	9.17	9.12	0.0024	-8.02
20	0.8095	142.22	175.69	0.8935	16.44	16.62	0.0570	8.63	10.12	0.0026	1.69
21	0.8152	141.38	173.43	0.8062	29.82	16.14	0.0480	8.55	9.41	0.0013	-6.57
22	0.7527	127.68	169.63	0.9669	13.18	15.30	0.0396	9.10	8.09	0.0014	-12.37
23	0.8222	145.69	177.19	0.9797	19.79	15.64	0.0514	9.11	8.27	0.0025	-6.81
24	0.8191	158.41	193.38	0.8602	19.93	17.50	0.0535	8.67	10.66	0.0022	1.38
25	0.8100	150.89	186.28	0.9847	37.87	16.55	0.0525	11.16	9.40	0.0022	-11.72
26	0.7416	150.29	202.67	0.9055	6.44	19.17	0.0551	11.06	12.86	0.0025	0.67
27	0.8261	156.92	189.95	0.8700	19.46	17.12	0.0519	8.61	10.18	0.0020	2.95
28	0.8144	150.44	184.72	0.8582	19.52	16.36	0.0446	7.95	9.12	0.0013	-7.28
29	0.8119	144.55	178.04	0.9630	10.13	15.22	0.0428	7.40	7.33	0.0016	-16.96
30	0.8673	157.50	181.59	0.9166	30.77	15.64	0.0513	8.17	7.96	0.0022	-15.41
31	0.7925	156.28	197.22	0.8470	24.53	17.44	0.0515	10.08	10.35	0.0019	-1.78
32	0.7882	151.00	191.57	0.8916	10.74	17.81	0.0503	9.28	11.22	0.0020	-5.43
33	0.8300	150.67	181.54	0.8643	18.13	15.73	0.0416	7.61	8.12	0.0010	-14.46
34	0.8280	144.93	175.04	0.9731	20.23	14.99	0.0369	8.31	7.04	0.0012	-20.96
35	0.8218	156.60	190.56	0.9500	13.68	16.02	0.0431	7.91	8.14	0.0016	-13.44
36	0.8519	165.86	194.71	0.8991	30.71	16.21	0.0469	8.32	8.25	0.0017	-14.29
37	0.7946	163.51	205.76	0.8544	8.90	17.42	0.0451	7.76	9.89	0.0014	-0.24
38	0.9627	159.35	184.70	0.9041	37.17	15.50	0.0430	9.39	7.47	0.0013	-17.30
39	0.7677	156.73	204.16	0.9296	11.08	17.61	0.0416	9.81	10.29	0.0014	1.16
40	0.8318	167.09	200.88	0.9284	6.11	16.44	0.0419	7.33	8.32	0.0014	-4.12
41	0.8922	171.84	192.61	0.9147	19.57	15.77	0.0444	7.02	7.49	0.0015	-13.39
42	0.8544	167.24	195.75	0.9298	33.24	16.30	0.0483	10.21	8.36	0.0020	-8.25
43	0.7872	169.44	215.24	0.9063	19.54	19.04	0.0510	11.33	12.14	0.0022	11.24
44	0.8000	171.68	214.60	0.8988	21.05	18.43	0.0479	10.02	11.18	0.0018	7.60
45	0.8053	172.29	213.95	0.9095	13.05	17.66	0.0484	9.26	9.89	0.0019	6.95
46	0.8511	176.71	207.63	0.8982	27.12	17.85	0.0517	9.62	10.54	0.0022	-5.37
47	0.8019	171.29	213.61	0.9933	8.87	18.18	0.0660	9.74	10.80	0.0043	-0.39
48	0.8641	191.00	221.04	0.8827	29.44	20.48	0.0859	9.94	14.08	0.0069	4.04
49	0.8058	180.96	224.57	0.0000	0.0	24.52	0.0	0.0	0.0	0.0	5.57
50	0.8929	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 3.2.3

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

MEANS OVER 1 REPLICATIONS

I	CM(I)	M(I)	CN(I)	MN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	200.00	11.00	14.00	11.00	3.00	0.0
2	11.00	0.0	197.00	9.00	14.00	9.00	4.00	3.00
3	19.00	2.00	199.00	9.00	14.00	9.00	5.00	5.00
4	23.00	1.00	199.00	8.00	14.00	8.00	4.00	9.00
5	30.00	2.00	195.00	11.00	14.00	11.00	5.00	11.00
6	36.00	2.00	193.00	7.00	14.00	7.00	2.00	14.00
7	40.00	1.00	192.00	5.00	14.00	5.00	3.00	15.00
8	43.00	1.00	197.00	7.00	14.00	7.00	3.00	17.00
9	49.00	2.00	201.00	5.00	14.00	5.00	1.00	18.00
10	50.00	2.00	206.00	8.00	14.00	8.00	4.00	17.00
11	54.00	0.0	206.00	5.00	14.00	5.00	1.00	21.00
12	58.00	3.00	199.00	16.00	14.00	16.00	2.00	19.00
13	66.00	1.00	197.00	5.00	14.00	5.00	2.00	20.00
14	64.00	2.00	189.00	6.00	14.00	6.00	4.00	20.00
15	60.00	1.00	191.00	5.00	14.00	5.00	1.00	23.00
16	62.00	3.00	192.00	9.00	14.00	9.00	3.00	21.00
17	64.00	1.00	187.00	6.00	14.00	6.00	3.00	23.00
18	63.00	5.00	191.00	10.00	14.00	10.00	3.00	21.00
19	65.00	1.00	194.00	6.00	14.00	6.00	0.0	23.00
20	66.00	0.0	192.00	9.00	14.00	9.00	3.00	23.00
21	67.00	4.00	189.00	7.00	14.00	7.00	2.00	22.00
22	64.00	3.00	177.00	6.00	14.00	6.00	4.00	21.00
23	62.00	3.00	177.00	7.00	14.00	7.00	2.00	22.00
24	61.00	2.00	181.00	6.00	14.00	6.00	2.00	22.00
25	62.00	4.00	180.00	8.00	14.00	8.00	2.00	20.00
26	61.00	1.00	176.00	6.00	14.00	6.00	3.00	21.00
27	57.00	3.00	179.00	8.00	14.00	8.00	2.00	21.00
28	58.00	6.00	183.00	12.00	14.00	12.00	1.00	17.00
29	61.00	2.00	183.00	3.00	14.00	3.00	1.00	16.00
30	60.00	3.00	192.00	8.00	14.00	8.00	2.00	14.00
31	63.00	3.00	189.00	6.00	14.00	6.00	1.00	13.00
32	60.00	3.00	191.00	13.00	14.00	13.00	3.00	11.00
33	65.00	3.00	190.00	9.00	14.00	9.00	4.00	11.00
34	68.00	1.00	194.00	9.00	14.00	9.00	1.00	14.00
35	71.00	2.00	191.00	6.00	14.00	6.00	0.0	13.00
36	69.00	2.00	189.00	9.00	14.00	9.00	2.00	11.00
37	70.00	4.00	196.00	14.00	14.00	14.00	3.00	9.00
38	76.00	1.00	200.00	4.00	14.00	4.00	1.00	11.00
39	76.00	1.00	200.00	5.00	14.00	5.00	0.0	11.00
40	71.00	3.00	199.00	10.00	14.00	10.00	1.00	8.00
41	73.00	4.00	198.00	8.00	14.00	8.00	2.00	5.00
42	70.00	0.0	200.00	8.00	14.00	8.00	1.00	7.00
43	74.00	2.00	196.00	9.00	14.00	9.00	0.0	6.00
44	73.00	1.00	200.00	4.00	14.00	4.00	2.00	5.00
45	74.00	2.00	203.00	8.00	14.00	8.00	0.0	5.00
46	77.00	4.00	203.00	11.00	14.00	11.00	3.00	1.00
47	77.00	1.00	201.00	8.00	14.00	8.00	1.00	3.00
48	73.00	2.00	200.00	7.00	14.00	7.00	1.00	2.00
49	76.00	3.00	202.00	9.00	14.00	9.00	0.0	0.0
50	77.00	0.0	207.00	9.00	0.0	9.00	0.0	0.0

TABLE 3.2.4 MEANS OVER 1 REPLICATIONS

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	147.11	0.5455	0.0	0.0	0.3547	0.0	0.0	0.1033	-52.89
2	0.1000	6.00	60.00	0.6899	0.0	0.0	0.3230	0.0	0.0	0.0900	-137.00
3	0.3000	10.33	34.44	0.9923	43.22	21.72	0.4460	66.96	20.91	0.1984	-164.56
4	0.2222	17.20	77.40	0.9917	19.24	71.10	0.4711	84.69	71.57	0.2216	-121.60
5	0.2500	24.00	96.00	1.0000	8.89	64.79	0.6744	79.17	65.45	0.4548	-99.00
6	0.3750	39.33	104.89	0.5301	14.90	85.17	0.3613	63.50	85.68	0.1250	-88.11
7	0.2333	23.50	70.50	1.0000	69.50	61.76	0.5708	130.55	61.64	0.3259	-121.50
8	0.2500	35.00	140.00	1.0000	0.0	134.92	0.9922	130.23	134.61	0.9845	-57.00
9	0.5000	56.00	112.00	0.5525	35.92	114.93	0.5198	62.54	114.44	0.2660	-89.00
10	0.3333	32.60	97.80	1.0000	280.20	65.76	0.9681	0.0	65.02	0.9372	-109.20
11	0.1667	63.00	378.00	1.0000	92.33	0.0	1.1083	0.0	0.0	1.2284	172.00
12	0.2353	110.67	470.33	0.3315	0.0	399.26	0.2782	126.30	398.67	0.0756	271.33
13	0.3333	41.00	123.00	0.6667	0.0	120.74	0.4047	75.00	120.23	0.1598	-74.00
14	0.4286	30.00	70.00	1.0000	140.00	42.11	0.9439	173.15	41.27	0.8910	-119.00
15	0.3333	70.00	210.00	0.7500	0.0	255.57	0.7466	140.79	255.16	0.5549	19.00
16	0.4000	55.50	138.75	0.6707	51.31	90.40	0.4092	126.79	89.63	0.1638	-53.25
17	0.2857	41.25	144.38	1.0000	0.0	134.71	0.6250	123.97	134.18	0.3906	-42.63
18	0.5455	62.75	115.04	1.0000	451.96	65.25	0.0	0.0	64.37	0.0	-75.56
19	0.2857	162.00	567.00	0.3443	370.78	0.0	0.0	0.0	0.0	-0.0014	373.00
20	0.1000	57.50	575.00	0.9424	0.0	0.0	0.7082	0.0	0.0	0.5007	393.00
21	0.6250	62.67	100.27	0.4934	7.23	66.91	0.3178	25.26	66.15	0.0972	-87.73
22	0.5714	32.40	56.70	1.0000	66.63	27.00	0.6565	52.93	25.93	0.4310	-120.30
23	0.5000	61.67	123.33	0.8122	24.28	89.28	0.6606	76.39	88.59	0.4340	-53.67
24	0.4286	53.33	124.44	1.0000	0.0	98.07	0.8264	74.72	97.43	0.6830	-56.56
25	0.5556	64.00	115.20	0.5551	68.17	80.05	0.3978	111.83	79.33	0.1546	-64.80
26	0.2857	37.75	132.13	1.0000	16.38	123.21	0.7343	125.57	122.67	0.5392	-43.88
27	0.4444	66.00	148.50	1.0000	67.86	111.49	1.1267	85.23	110.82	1.2694	-30.50
28	0.5385	116.50	216.36	0.2776	0.0	215.02	0.3308	22.98	214.52	0.1078	33.36
29	0.7500	34.00	45.33	1.0000	55.92	40.03	1.0031	44.59	39.46	1.0062	-137.67
30	0.4444	45.00	101.25	0.5700	0.0	76.05	1.0383	51.04	75.38	1.0775	-90.75
31	0.5714	48.50	84.88	0.8058	76.86	83.46	0.8202	73.47	82.95	0.6698	-104.13
32	0.2857	41.50	145.25	0.4854	0.0	104.07	0.2928	42.74	103.37	0.0809	-45.75
33	0.4000	25.00	62.50	1.0000	292.50	36.15	1.0242	314.54	35.28	1.0490	-127.50
34	0.2000	71.00	355.00	1.0000	0.0	469.15	0.0	0.0	468.77	0.0	161.00
35	0.4286	93.00	217.00	0.3986	42.39	0.0	0.0	0.0	0.0	-0.0025	26.00
36	0.3000	38.67	128.89	0.8266	6.70	112.40	0.6537	75.06	111.83	0.4242	-60.11
37	0.3333	37.75	113.25	0.5969	3.66	75.57	0.5734	60.03	74.81	0.3238	-82.75
38	0.4000	28.50	71.25	1.0000	129.75	83.18	0.0	0.0	82.75	0.0	-128.75
39	0.3333	67.00	201.00	0.6620	0.0	0.0	0.0	0.0	0.0	-0.0032	1.00
40	0.3636	47.00	129.25	0.3519	0.0	139.06	0.3759	23.30	138.59	0.1371	-69.75
41	0.5556	19.00	34.20	1.0000	249.30	23.25	1.1094	0.0	22.50	1.2307	-163.80
42	0.1111	31.50	283.50	1.0000	0.0	0.0	0.0	0.0	0.0	0.0	93.50
43	0.3000	62.00	206.67	0.1353	0.0	0.0	0.0	0.0	0.0	-0.0017	10.67
44	0.4000	9.33	23.33	1.0000	117.67	21.05	0.0	0.0	20.49	0.0	-176.67
45	0.3333	47.00	141.00	0.1321	0.0	0.0	0.0	0.0	0.0	-0.0022	-62.00
46	0.4167	7.00	16.80	1.0000	48.45	8.85	1.0447	54.03	7.84	1.0913	-186.20
47	0.2222	14.50	65.25	0.4651	0.0	88.42	0.6064	29.50	88.05	0.3562	-135.75
48	0.3750	10.00	26.67	0.2000	2.17	29.41	0.0	0.0	28.95	-0.0107	-173.33
49	0.4000	3.00	7.50	0.0000	0.0	0.0	0.0	0.0	0.0	0.0	-194.50
50	0.1000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 21 19 7

TABLE 3.3.1

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.50
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.90
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 1

MEANS OVER 36 REPLICATIONS

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	200.00	99.42	20.00	99.42	81.25	0.0
2	99.42	44.19	199.89	100.11	20.00	100.11	81.97	37.06
3	145.72	64.50	199.89	99.11	20.00	99.11	80.53	54.53
4	165.69	73.58	199.83	99.28	20.00	99.28	81.28	61.47
5	175.42	78.44	198.92	99.33	20.00	99.33	81.17	64.31
6	177.94	79.14	198.75	98.39	20.00	98.39	79.19	66.33
7	179.44	79.03	198.72	98.94	20.00	98.94	81.44	66.50
8	180.81	80.19	199.00	98.53	20.00	98.53	79.14	67.75
9	181.06	79.31	199.36	96.67	20.00	96.67	79.25	67.58
10	180.58	80.08	198.75	99.42	20.00	99.42	81.03	66.75
11	181.36	80.50	198.64	97.94	20.00	97.94	80.42	67.28
12	180.50	83.08	198.86	101.28	20.00	101.28	83.58	64.61
13	180.47	81.47	198.72	100.00	20.00	100.00	81.17	66.72
14	180.64	79.72	198.19	97.92	20.00	97.92	80.42	68.17
15	179.72	81.53	198.28	98.94	20.00	98.94	80.08	67.06
16	179.19	79.39	198.64	98.03	20.00	98.03	79.81	67.75
17	179.92	78.86	199.58	97.44	20.00	97.44	79.22	68.69
18	181.44	82.36	200.36	100.75	20.00	100.75	82.19	65.56
19	182.31	80.44	199.11	98.11	20.00	98.11	79.53	67.31
20	180.39	81.06	199.94	98.97	20.00	98.97	81.75	65.78
21	180.00	79.69	199.19	97.92	20.00	97.92	80.78	67.83
22	180.42	81.14	200.08	99.89	20.00	99.89	81.75	67.47
23	181.72	83.69	200.19	100.64	20.00	100.64	83.11	65.53
24	180.64	82.03	201.17	100.81	20.00	100.81	82.86	66.61
25	181.94	80.36	201.78	98.89	20.00	98.89	80.61	69.11
26	182.64	82.33	201.81	100.39	20.00	100.39	82.64	67.39
27	182.44	83.81	201.06	102.61	20.00	102.61	84.67	66.22
28	182.92	81.61	201.42	100.78	20.00	100.78	82.28	69.28
29	183.92	85.03	202.36	103.53	20.00	103.53	85.94	66.53
30	185.03	83.67	202.72	101.53	20.00	101.53	83.44	68.81
31	184.92	83.25	202.53	101.69	20.00	101.69	82.03	69.00
32	184.89	81.75	201.44	100.39	20.00	100.39	82.11	69.28
33	184.47	83.31	201.53	101.44	20.00	101.44	83.25	68.08
34	184.42	81.39	201.22	99.31	20.00	99.31	81.17	69.94
35	184.03	83.06	200.81	100.67	20.00	100.67	82.22	68.06
36	182.89	82.00	200.03	99.81	20.00	99.81	81.44	68.28
37	182.03	81.14	201.39	100.22	20.00	100.22	81.83	68.58
38	184.28	83.83	200.33	101.50	20.00	101.50	83.61	66.58
39	182.92	81.25	200.17	98.86	20.00	98.86	80.39	68.94
40	181.94	81.64	200.58	99.72	20.00	99.72	81.69	67.69
41	182.28	83.56	200.94	101.94	20.00	101.94	83.56	65.83
42	183.28	83.78	200.61	101.47	20.00	101.47	83.89	65.61
43	182.36	81.81	200.72	100.06	20.00	100.06	81.08	67.69
44	182.72	81.61	200.78	100.14	20.00	100.14	81.69	67.17
45	182.86	82.61	200.94	100.72	20.00	100.72	80.72	66.25
46	182.97	81.44	200.39	98.81	20.00	98.81	78.06	65.53
47	181.89	83.67	200.39	102.17	20.00	102.17	76.92	59.92
48	182.36	81.58	201.19	99.86	20.00	99.86	65.31	55.25
49	183.22	81.83	201.75	100.19	20.00	100.19	45.00	38.72
50	183.61	83.72	201.56	101.78	0.0	101.78	0.0	0.0

TABLE 3.3.2 STANDARD DEVIATIONS OVER 36 REPLICATIONS

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	0.05	7.56	0.0	7.56	7.02	0.0
2	7.56	4.53	3.66	7.04	0.0	7.04	6.07	5.46
3	7.05	6.98	6.14	8.08	0.0	8.08	8.05	5.94
4	7.18	8.19	7.55	8.53	0.0	8.53	7.65	8.58
5	7.52	6.37	9.08	7.22	0.0	7.22	6.02	6.63
6	8.93	5.76	9.30	5.81	0.0	5.81	5.35	7.33
7	8.70	6.54	9.55	7.60	0.0	7.60	7.84	5.35
8	9.84	8.30	10.68	8.20	0.0	8.20	7.66	7.96
9	10.13	8.29	10.55	8.78	0.0	8.78	7.81	7.15
10	10.64	8.11	11.65	8.54	0.0	8.54	8.29	6.26
11	11.57	6.37	11.18	7.12	0.0	7.12	7.29	7.48
12	10.57	9.37	12.17	10.07	0.0	10.07	9.45	6.85
13	12.44	6.47	12.27	7.01	0.0	7.01	7.22	7.97
14	12.33	7.56	11.39	7.49	0.0	7.49	7.17	8.43
15	11.92	6.98	10.46	7.93	0.0	7.93	8.09	7.65
16	11.62	8.57	10.65	8.13	0.0	8.13	8.87	7.71
17	10.31	9.07	10.48	9.26	0.0	9.26	7.87	6.93
18	11.30	7.67	10.20	7.90	0.0	7.90	8.03	8.44
19	10.64	8.26	10.65	8.41	0.0	8.41	7.61	6.78
20	9.68	7.41	9.85	8.08	0.0	8.08	7.50	7.50
21	9.68	8.61	9.77	9.22	0.0	9.22	7.05	8.08
22	9.82	8.81	9.72	9.66	0.0	9.66	8.98	7.46
23	10.74	8.10	10.29	9.09	0.0	9.09	9.25	7.40
24	11.42	8.23	9.46	8.93	0.0	8.93	8.60	7.59
25	10.40	8.14	10.91	8.41	0.0	8.41	8.59	7.62
26	11.43	8.18	9.95	8.48	0.0	8.48	7.22	8.85
27	10.58	6.55	11.14	7.37	0.0	7.37	7.40	9.17
28	12.02	8.17	10.80	8.57	0.0	8.57	7.92	8.62
29	12.09	9.90	10.31	8.72	0.0	8.72	6.92	6.52
30	11.43	7.36	8.41	7.66	0.0	7.66	7.20	8.37
31	9.42	6.70	7.71	7.12	0.0	7.12	7.00	7.20
32	8.63	8.72	8.38	10.31	0.0	10.31	9.11	7.82
33	9.36	8.80	8.87	9.42	0.0	9.42	7.34	7.99
34	10.09	7.24	6.97	7.57	0.0	7.57	6.91	7.29
35	7.59	9.28	7.29	10.00	0.0	10.00	8.36	6.97
36	8.65	7.46	6.89	7.02	0.0	7.02	7.14	6.80
37	6.48	7.77	6.91	8.17	0.0	8.17	7.17	7.31
38	6.61	7.64	8.11	8.94	0.0	8.94	7.28	7.59
39	8.77	8.60	7.82	8.92	0.0	8.92	7.50	7.90
40	8.57	6.55	7.39	7.79	0.0	7.79	7.44	8.27
41	7.57	6.74	7.00	8.28	0.0	8.28	7.64	7.98
42	6.63	8.92	6.70	9.56	0.0	9.56	9.16	6.13
43	7.98	8.07	8.30	8.07	0.0	8.07	6.78	7.70
44	8.01	6.91	9.21	6.49	0.0	6.49	7.01	7.15
45	9.97	7.74	9.09	7.96	0.0	7.96	7.47	8.25
46	8.77	8.77	9.31	9.14	0.0	9.14	8.27	7.63
47	8.71	7.71	10.55	8.68	0.0	8.68	8.78	6.10
48	10.85	9.05	11.13	8.51	0.0	8.51	7.08	7.27
49	11.30	8.89	10.19	8.80	0.0	8.80	6.90	7.17
50	10.83	9.44	10.74	9.54	0.0	9.54	0.0	0.0

TABLE 3.3.3

MEANS OVER 36 REPLICATIONS

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	200.64	0.8966	20.70	0.0	0.0531	0.0	0.0	0.0019	0.64
2	0.4473	89.34	200.21	0.9065	21.08	19.60	0.0503	18.24	18.08	0.0020	0.33
3	0.6547	131.60	201.54	0.8942	20.27	15.76	0.0494	13.03	13.22	0.0019	1.65
4	0.7430	148.58	200.27	0.9015	18.17	14.71	0.0486	10.75	11.24	0.0019	0.54
5	0.7919	157.05	198.48	0.9086	20.43	14.61	0.0495	9.82	10.16	0.0020	-0.44
6	0.8061	161.54	200.55	0.8852	22.54	15.11	0.0492	9.69	10.39	0.0019	1.80
7	0.8008	159.75	199.71	0.9161	19.04	15.46	0.0496	9.71	10.06	0.0021	0.99
8	0.8150	164.48	201.86	0.8854	18.56	16.05	0.0496	9.30	10.36	0.0019	2.86
9	0.8220	161.73	197.06	0.9052	22.59	15.98	0.0491	9.45	9.79	0.0020	-2.30
10	0.8070	161.88	200.66	0.8960	17.42	16.48	0.0486	9.22	10.11	0.0019	1.92
11	0.8239	162.31	196.59	0.8979	19.68	16.25	0.0474	8.80	9.55	0.0018	-1.65
12	0.8216	161.39	196.53	0.9118	21.63	16.20	0.0481	9.06	9.23	0.0019	-2.33
13	0.8166	163.97	200.86	0.8943	20.76	16.88	0.0484	9.35	9.98	0.0019	2.14
14	0.8153	162.76	199.85	0.9096	17.71	16.94	0.0494	9.23	9.96	0.0020	1.65
15	0.8258	164.40	199.24	0.8958	22.45	16.91	0.0497	9.33	9.83	0.0020	0.96
16	0.8107	162.77	200.77	0.8969	21.05	17.28	0.0495	9.74	10.25	0.0020	2.13
17	0.8102	163.09	201.42	0.8962	18.35	17.38	0.0493	9.36	10.33	0.0019	1.84
18	0.8188	162.88	198.88	0.9019	19.99	16.97	0.0489	9.07	9.65	0.0019	-1.48
19	0.8209	163.36	198.56	0.8387	19.29	17.16	0.0485	8.98	9.94	0.0018	-0.15
20	0.8207	160.66	195.87	0.9054	21.15	16.77	0.0474	9.17	9.38	0.0018	-3.08
21	0.8152	161.54	198.30	0.9105	20.84	17.06	0.0481	9.46	9.73	0.0019	-0.89
22	0.8140	163.62	201.26	0.8955	16.09	17.30	0.0476	8.85	9.95	0.0018	1.17
23	0.8335	163.22	196.01	0.9061	22.67	16.66	0.0471	8.83	9.07	0.0018	-4.18
24	0.8153	163.11	200.05	0.9085	21.80	17.12	0.0485	9.45	9.67	0.0019	-1.11
25	0.9143	165.29	203.19	0.8929	18.45	17.57	0.0482	9.28	10.26	0.0018	1.42
26	0.8216	163.99	199.69	0.9017	20.48	17.04	0.0469	8.98	9.53	0.0017	-2.11
27	0.8185	164.07	200.51	0.9099	23.23	17.00	0.0475	9.41	9.41	0.0018	-1.35
28	0.8111	166.55	205.53	0.8900	18.34	17.66	0.0468	9.20	10.26	0.0017	4.11
29	0.8222	165.11	200.56	0.9128	19.84	16.93	0.0463	8.98	9.22	0.0017	-1.41
30	0.8258	167.47	203.04	0.9110	21.18	17.24	0.0485	9.22	9.66	0.0019	0.32
31	0.8205	168.77	205.86	0.8899	21.28	17.61	0.0488	9.40	10.18	0.0019	3.33
32	0.8163	166.48	204.18	0.8980	18.99	17.52	0.0478	9.28	10.09	0.0018	2.73
33	0.8226	166.13	202.15	0.9072	20.44	17.21	0.0479	9.29	9.65	0.0019	0.62
34	0.8212	166.97	203.47	0.9003	18.52	17.47	0.0483	9.19	10.04	0.0019	2.25
35	0.8266	166.26	201.45	0.9025	20.00	17.23	0.0483	9.12	9.69	0.0019	0.64
36	0.8227	165.71	201.54	0.8999	22.66	17.33	0.0484	9.45	9.87	0.0019	1.51
37	0.8112	165.02	203.65	0.8946	17.06	17.54	0.0476	9.13	10.16	0.0018	2.27
38	0.8277	164.61	199.07	0.9112	20.82	16.92	0.0479	9.06	9.29	0.0019	-1.26
39	0.8232	166.02	201.88	0.8960	19.83	17.43	0.0486	9.19	10.02	0.0019	1.71
40	0.8205	164.28	200.41	0.8990	19.56	17.23	0.0478	8.97	9.77	0.0018	-0.17
41	0.8219	163.89	199.54	0.8955	19.00	17.02	0.0466	8.69	9.45	0.0017	-1.41
42	0.8269	162.99	197.23	0.9139	21.24	16.79	0.0478	9.03	9.15	0.0019	-3.28
43	0.8190	165.16	201.63	0.8951	20.81	17.37	0.0489	9.28	9.96	0.0019	0.91
44	0.8162	164.12	201.24	0.9066	19.16	17.36	0.0493	9.23	9.94	0.0020	0.46
45	0.8216	165.32	201.33	0.8972	18.84	17.42	0.0510	9.05	10.04	0.0021	0.38
46	0.8254	164.38	199.26	0.8998	20.17	17.47	0.0545	8.95	10.23	0.0025	-1.12
47	0.8207	163.35	199.27	0.9094	22.22	17.71	0.0644	9.25	10.64	0.0038	-1.12
48	0.8177	166.09	203.29	0.9040	22.47	19.49	0.0919	9.62	13.22	0.0083	2.09
49	0.8175	168.08	205.89	0.0000	0.0	23.85	0.0	0.0	0.0	0.0	4.14
50	0.8237	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 70 33 36

TABLE 3.3.4

STANDARD DEVIATIONS OVER 36 REPLICATIONS

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	5.61	0.0408	14.87	0.0	0.0052	0.0	0.0	0.0006	5.58
2	0.0365	7.91	15.67	0.0423	16.34	2.52	0.0052	1.99	2.81	0.0005	15.13
3	0.0491	8.71	12.73	0.0451	13.38	2.04	0.0046	1.84	2.11	0.0005	11.90
4	0.0374	9.79	15.42	0.0429	8.88	1.94	0.0041	1.66	2.24	0.0004	12.88
5	0.0299	11.06	14.08	0.0477	8.03	1.67	0.0035	1.26	1.49	0.0004	10.29
6	0.0298	11.13	14.36	0.0417	8.44	1.65	0.0042	1.09	1.68	0.0005	10.75
7	0.0290	8.15	12.02	0.0554	8.58	1.26	0.0049	1.17	1.41	0.0005	8.83
8	0.0352	11.90	12.68	0.0457	9.38	1.16	0.0042	1.29	1.63	0.0004	8.75
9	0.0343	11.69	16.13	0.0371	9.34	1.36	0.0049	0.91	1.82	0.0005	11.98
10	0.0309	10.08	11.39	0.0433	8.07	1.04	0.0050	0.80	1.38	0.0005	8.80
11	0.0325	11.25	11.31	0.0454	8.62	0.84	0.0044	0.99	1.20	0.0004	8.35
12	0.0333	12.33	14.47	0.0471	9.94	1.12	0.0050	1.03	1.45	0.0005	8.35
13	0.0326	15.72	17.58	0.0587	9.19	1.55	0.0044	1.17	1.94	0.0004	9.65
14	0.0301	12.32	16.35	0.0430	7.64	1.43	0.0043	1.21	1.82	0.0005	10.05
15	0.0269	11.61	14.57	0.0460	10.07	1.22	0.0054	1.09	1.57	0.0005	8.62
16	0.0391	12.90	12.72	0.0457	10.10	1.31	0.0051	1.17	1.83	0.0004	9.23
17	0.0354	11.24	13.12	0.0420	8.80	1.05	0.0047	1.13	1.38	0.0005	7.33
18	0.0307	13.53	14.67	0.0522	7.67	1.29	0.0043	1.03	1.70	0.0005	8.38
19	0.0308	11.33	11.03	0.0553	8.35	1.02	0.0040	1.09	1.45	0.0005	8.87
20	0.0308	11.24	13.15	0.0403	8.56	1.12	0.0042	1.09	1.46	0.0004	9.56
21	0.0310	10.19	12.51	0.0444	9.74	0.99	0.0046	1.18	1.31	0.0005	9.05
22	0.0345	11.81	15.50	0.0428	8.66	1.32	0.0057	1.34	1.73	0.0006	10.02
23	0.0373	12.64	15.10	0.0512	8.70	1.36	0.0050	0.98	1.78	0.0005	11.12
24	0.0309	12.89	13.81	0.0553	10.53	1.11	0.0049	1.24	1.48	0.0005	9.69
25	0.0391	12.89	15.42	0.0433	10.19	1.46	0.0047	1.19	1.91	0.0004	10.89
26	0.0340	11.95	13.39	0.0492	7.94	1.05	0.0041	1.08	1.38	0.0004	8.62
27	0.0255	12.93	15.45	0.0462	9.64	1.15	0.0037	1.22	1.43	0.0004	7.96
28	0.0318	13.84	17.39	0.0421	9.40	1.60	0.0042	1.33	2.00	0.0004	11.51
29	0.0359	12.80	15.04	0.0435	10.47	1.21	0.0033	1.29	1.57	0.0004	9.93
30	0.0372	11.56	14.59	0.0448	8.88	1.40	0.0041	1.33	1.83	0.0005	10.17
31	0.0343	10.02	12.13	0.0456	9.38	1.20	0.0038	1.25	1.57	0.0004	9.85
32	0.0331	10.24	13.81	0.0354	9.93	1.33	0.0042	1.03	1.80	0.0004	10.76
33	0.0298	10.76	13.87	0.0518	9.80	1.26	0.0048	1.10	1.65	0.0005	10.31
34	0.0327	10.35	12.65	0.0442	10.75	1.25	0.0046	1.28	1.65	0.0005	10.11
35	0.0388	9.19	12.76	0.0508	9.74	1.35	0.0048	1.29	1.84	0.0005	11.72
36	0.0339	9.15	10.51	0.0419	9.99	1.31	0.0047	0.98	1.79	0.0004	9.62
37	0.0343	8.80	11.65	0.0432	8.17	1.18	0.0037	1.07	1.59	0.0004	9.36
38	0.0238	9.98	13.97	0.0511	9.37	1.33	0.0039	1.14	1.71	0.0005	10.13
39	0.0306	10.00	13.26	0.0493	8.25	1.45	0.0046	1.25	1.92	0.0005	11.25
40	0.0282	9.16	12.69	0.0475	7.35	1.26	0.0040	1.11	1.66	0.0004	10.02
41	0.0266	9.85	12.46	0.0437	7.73	1.17	0.0044	1.06	1.53	0.0004	9.89
42	0.0304	6.94	10.33	0.0444	9.77	0.93	0.0045	0.97	1.37	0.0004	7.82
43	0.0354	11.94	10.61	0.0460	9.55	0.94	0.0045	0.99	1.30	0.0005	8.42
44	0.0318	11.81	14.71	0.0545	8.55	1.40	0.0056	1.24	1.83	0.0006	9.19
45	0.0303	11.50	13.43	0.0463	8.29	1.38	0.0050	1.33	1.79	0.0005	9.66
46	0.0340	10.51	11.60	0.0496	9.23	1.33	0.0062	1.28	1.80	0.0008	8.83
47	0.0315	9.81	13.51	0.0640	11.27	1.40	0.0073	1.36	1.85	0.0011	11.52
48	0.0382	14.80	17.28	0.0792	12.71	2.08	0.0161	1.90	2.51	0.0034	13.47
49	0.0327	16.32	21.32	0.0000	0.0	4.21	0.0	0.0	0.0	0.0	19.69
50	0.0386	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 3.4.1

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 1

MEANS OVER 36 REPLICATIONS

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	200.00	7.69	14.00	7.69	2.81	0.0
2	7.69	0.36	200.61	8.28	14.00	8.28	2.78	2.44
3	15.08	0.72	200.50	7.86	14.00	7.86	2.78	4.50
4	21.28	0.94	201.25	7.89	14.00	7.89	2.36	6.33
5	26.53	0.83	201.22	7.61	14.00	7.61	2.86	7.86
6	31.33	1.08	200.78	7.61	14.00	7.61	2.28	9.64
7	35.94	1.25	200.72	7.86	14.00	7.86	2.69	10.67
8	39.69	1.42	200.89	8.00	14.00	8.00	2.53	11.94
9	43.44	1.39	200.28	7.61	14.00	7.61	2.61	13.08
10	46.53	1.31	200.72	7.42	14.00	7.42	2.86	14.39
11	49.92	1.47	201.17	8.03	14.00	8.03	3.03	15.78
12	52.86	2.28	200.25	8.28	14.00	8.28	2.78	16.53
13	54.92	2.08	201.61	7.83	14.00	7.83	2.56	17.22
14	57.08	2.17	201.69	7.47	14.00	7.47	2.50	17.61
15	58.67	1.94	201.36	7.94	14.00	7.94	2.53	18.17
16	60.19	1.92	201.42	7.89	14.00	7.89	2.56	18.78
17	62.36	2.39	201.92	8.03	14.00	8.03	2.33	18.94
18	64.14	2.29	202.06	7.61	14.00	7.61	2.33	19.00
19	64.39	2.58	203.00	8.00	14.00	8.00	2.28	18.75
20	65.69	2.14	202.42	7.94	14.00	7.94	3.11	18.89
21	66.56	2.28	202.44	7.86	14.00	7.86	2.75	19.72
22	67.50	2.19	202.89	7.75	14.00	7.75	2.50	20.28
23	68.44	2.61	201.36	7.83	14.00	7.83	2.69	20.17
24	68.56	3.03	202.42	8.11	14.00	8.11	2.83	19.83
25	69.19	2.61	201.61	7.53	14.00	7.53	2.25	20.06
26	69.11	2.39	201.47	8.31	14.00	8.31	3.00	19.92
27	70.14	2.75	201.39	7.69	14.00	7.69	2.61	20.17
28	70.81	2.81	200.81	8.36	14.00	8.36	2.67	19.97
29	71.56	3.28	200.19	8.36	14.00	8.36	2.42	19.36
30	71.47	2.64	200.78	8.03	14.00	8.03	2.72	19.14
31	72.00	2.78	201.00	7.89	14.00	7.89	2.69	19.08
32	71.92	2.61	201.03	7.89	14.00	7.89	2.53	19.17
33	72.08	2.42	201.44	7.89	14.00	7.89	2.17	19.28
34	72.92	2.92	201.64	8.50	14.00	8.50	2.42	18.53
35	73.42	2.39	201.08	8.08	14.00	8.08	1.94	18.56
36	73.86	2.94	201.28	8.67	14.00	8.67	2.50	17.56
37	75.00	2.64	200.28	7.92	14.00	7.92	2.14	17.42
38	75.00	2.58	201.31	8.00	14.00	8.00	2.31	16.97
39	75.53	2.94	200.39	7.94	14.00	7.94	1.89	16.33
40	74.89	2.42	200.39	7.75	14.00	7.75	1.78	15.81
41	75.25	2.72	200.61	8.00	14.00	8.00	1.92	14.86
42	75.50	2.78	201.31	8.28	14.00	8.28	2.11	14.00
43	76.14	3.31	201.67	8.19	14.00	8.19	1.81	12.81
44	75.61	2.86	201.58	8.42	14.00	8.42	1.44	11.75
45	75.72	3.11	201.97	8.31	14.00	8.31	1.00	10.08
46	75.86	3.00	202.06	8.08	14.00	8.08	1.39	8.08
47	74.67	2.75	201.97	7.67	14.00	7.67	0.81	6.72
48	74.36	2.94	202.58	7.97	14.00	7.97	0.69	4.58
49	73.89	2.67	202.47	8.28	14.00	8.28	0.39	2.61
50	74.72	3.00	202.75	8.78	0.0	8.78	0.0	0.0

TABLE 3.4.2

STANDARD DEVIATIONS OVER 36 REPLICATIONS

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	0.09	2.53	0.01	2.53	1.79	0.0
2	2.53	0.64	3.34	2.54	0.01	2.54	1.73	1.48
3	3.58	0.78	4.86	2.52	0.01	2.52	1.71	2.32
4	4.14	0.98	5.96	2.69	0.01	2.69	1.53	2.53
5	4.72	0.94	6.78	2.68	0.01	2.68	1.48	3.06
6	5.52	1.11	7.40	2.58	0.01	2.58	1.49	3.42
7	5.77	0.94	7.79	3.24	0.01	3.24	1.64	3.30
8	6.36	1.00	8.41	2.53	0.01	2.53	1.65	3.79
9	7.18	1.23	8.91	2.26	0.01	2.26	1.34	3.72
10	6.50	1.19	9.43	2.73	0.01	2.73	1.31	3.52
11	7.29	1.21	9.01	2.13	0.01	2.13	1.76	3.43
12	7.01	1.16	9.55	2.91	0.01	2.91	1.71	3.80
13	6.95	1.42	10.73	3.20	0.01	3.20	1.56	3.74
14	7.21	1.52	11.01	2.36	0.01	2.36	1.40	3.92
15	7.03	1.24	10.93	2.25	0.01	2.25	1.30	3.48
16	7.03	1.54	11.06	2.97	0.01	2.97	1.70	3.49
17	7.43	1.59	11.19	3.01	0.01	3.01	1.55	3.82
18	7.26	1.45	10.26	2.48	0.01	2.48	1.53	4.05
19	6.96	1.59	10.74	2.88	0.01	2.88	1.63	3.30
20	7.82	1.33	10.62	2.62	0.01	2.62	1.56	3.93
21	6.84	1.49	10.53	2.57	0.01	2.57	1.57	3.94
22	7.37	1.43	11.40	3.17	0.01	3.17	1.32	3.74
23	8.09	1.52	11.42	2.56	0.01	2.56	1.51	4.14
24	7.90	1.68	11.14	2.78	0.01	2.78	1.36	4.15
25	8.13	1.46	12.16	2.42	0.01	2.42	1.34	4.92
26	8.53	1.61	12.31	2.59	0.01	2.59	1.41	4.38
27	8.63	1.95	11.79	2.89	0.01	2.89	1.32	4.36
28	8.78	1.35	11.92	2.37	0.01	2.37	1.55	3.93
29	9.13	1.70	10.30	2.34	0.01	2.34	1.92	4.59
30	7.93	1.61	9.99	2.75	0.01	2.75	1.80	4.78
31	8.57	1.64	10.04	3.13	0.01	3.13	1.51	4.47
32	8.64	1.54	10.27	2.59	0.01	2.59	1.70	4.18
33	8.53	1.27	10.60	2.58	0.01	2.58	1.46	4.93
34	8.08	1.89	9.76	2.70	0.01	2.70	1.40	4.29
35	8.25	1.46	8.74	3.02	0.01	3.02	1.45	4.38
36	8.72	1.51	8.72	2.57	0.01	2.57	1.34	4.48
37	9.15	1.61	8.29	2.76	0.01	2.76	1.20	4.59
38	9.80	1.76	8.91	2.55	0.01	2.55	1.64	4.20
39	9.92	1.60	8.82	2.64	0.01	2.64	1.26	4.34
40	9.04	1.42	8.59	2.47	0.01	2.47	1.07	4.37
41	9.37	1.41	8.29	2.69	0.01	2.69	1.54	4.24
42	9.49	1.77	8.68	2.67	0.01	2.67	1.35	3.82
43	9.76	1.47	8.53	2.39	0.01	2.39	1.35	3.87
44	9.39	2.02	7.94	3.07	0.01	3.07	1.05	3.52
45	9.40	1.74	7.96	2.24	0.01	2.24	0.93	3.36
46	9.60	1.82	7.79	2.72	0.01	2.72	1.42	2.58
47	9.43	1.65	8.21	2.81	0.01	2.81	0.89	2.05
48	9.57	1.69	8.51	2.67	0.01	2.67	0.86	1.92
49	9.30	1.67	8.44	3.02	0.01	3.02	0.55	1.50
50	9.53	1.60	9.60	2.53	0.0	2.53	0.0	0.0

TABLE 3.4.3

MEANS OVER 36 REPLICATIONS

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	157.13	0.7681	0.20	0.0	0.5585	0.0	0.0	0.4037	-42.87
2	0.1566	6.89	50.80	0.7099	44.55	12.72	0.3873	8.32	12.58	0.2307	-149.53
3	0.2058	14.51	78.42	0.7895	64.17	21.51	0.5089	23.12	21.58	0.3968	-121.66
4	0.2261	19.91	112.89	0.6745	60.03	48.99	0.4796	24.02	48.85	0.3120	-87.77
5	0.2165	21.11	115.89	0.8579	80.37	33.94	0.5012	23.05	33.75	0.4424	-84.83
6	0.2543	31.68	158.59	0.7362	77.24	58.69	0.5063	44.59	58.45	0.3438	-41.63
7	0.2702	30.98	155.24	0.8249	73.51	64.04	0.5689	60.15	63.66	0.4452	-44.76
8	0.2820	36.22	156.41	0.7735	62.39	93.89	0.5363	50.06	93.52	0.3584	-43.75
9	0.2919	35.13	156.48	0.7872	59.49	73.65	0.5272	46.72	73.24	0.3198	-43.10
10	0.2325	35.61	161.24	0.8336	75.55	52.40	0.5956	60.18	52.08	0.4391	-38.87
11	0.2678	43.31	179.25	0.8032	69.20	116.72	0.5402	87.45	116.26	0.3832	-21.22
12	0.3719	49.92	173.94	0.8035	56.92	111.13	0.5755	88.69	110.51	0.4399	-25.42
13	0.3517	50.17	157.35	0.8023	65.79	111.93	0.5495	72.64	111.37	0.3998	-43.45
14	0.3784	54.71	176.46	0.8016	72.72	91.38	0.5799	85.61	90.82	0.4209	-24.43
15	0.3342	52.97	175.08	0.8215	110.99	119.50	0.6009	102.21	118.98	0.4737	-25.45
16	0.3345	58.32	231.64	0.8197	65.99	117.47	0.5926	99.74	116.97	0.4639	30.92
17	0.3397	61.39	192.60	0.7829	67.71	138.46	0.5523	98.61	137.92	0.4104	-8.45
18	0.3771	60.42	193.67	0.8203	56.09	118.90	0.6074	92.29	118.32	0.4970	-17.52
19	0.3990	63.50	172.62	0.6936	76.77	120.27	0.4735	77.98	119.68	0.2933	-29.50
20	0.3651	48.19	172.49	0.8510	91.83	82.82	0.5133	69.84	82.20	0.3539	-29.12
21	0.3795	57.61	192.95	0.7928	73.42	87.06	0.5657	106.13	86.49	0.4081	-8.72
22	0.3957	56.65	174.52	0.8300	44.32	149.64	0.5606	117.37	149.03	0.3975	-27.59
23	0.4187	56.93	162.32	0.7658	49.17	110.26	0.5198	81.94	109.62	0.3405	-38.70
24	0.4484	54.34	138.27	0.8450	91.86	92.04	0.5797	93.48	91.30	0.4151	-63.37
25	0.4442	63.42	183.83	0.7746	68.24	116.87	0.5736	108.32	116.26	0.4186	-16.95
26	0.3621	51.48	159.49	0.8309	39.08	123.71	0.5576	86.86	123.06	0.3596	-41.18
27	0.4241	57.51	144.27	0.8651	74.57	91.13	0.5866	80.64	90.51	0.4144	-56.31
28	0.4151	61.95	177.79	0.8142	95.04	104.77	0.5647	84.57	104.11	0.4390	-22.13
29	0.4619	74.62	192.75	0.7246	80.69	107.53	0.5310	77.54	106.88	0.3921	-6.72
30	0.4200	59.33	175.68	0.8045	28.95	105.33	0.5530	73.56	104.70	0.4008	-24.32
31	0.4400	54.92	135.22	0.8391	67.93	98.74	0.5055	76.87	98.11	0.3571	-64.89
32	0.4099	59.52	160.09	0.8250	89.30	88.03	0.5271	80.68	87.44	0.4095	-40.22
33	0.4334	66.74	194.06	0.7644	91.27	117.99	0.5493	86.75	117.43	0.4352	-6.55
34	0.4146	65.34	199.06	0.8454	81.52	107.07	0.5862	89.42	106.46	0.4807	-1.81
35	0.3865	65.95	200.37	0.7503	44.80	122.33	0.5739	95.50	121.81	0.4549	0.33
36	0.4278	57.13	156.17	0.7856	79.42	126.51	0.5660	87.23	125.84	0.4145	-44.19
37	0.4231	59.07	176.52	0.7813	76.04	105.11	0.5511	72.26	104.54	0.4469	-22.98
38	0.4040	57.47	171.23	0.8095	53.57	118.22	0.4993	60.35	117.66	0.3928	-29.38
39	0.4484	62.01	155.24	0.7771	79.34	91.70	0.5690	67.36	91.15	0.4707	-44.40
40	0.3961	58.60	170.94	0.7992	41.03	106.26	0.6850	71.03	105.75	0.6255	-28.64
41	0.4189	56.64	147.16	0.7532	57.96	112.95	0.6854	67.72	112.39	0.5601	-52.64
42	0.4171	47.42	143.35	0.7977	40.57	95.13	0.5669	56.02	94.56	0.4587	-57.15
43	0.4744	53.22	124.32	0.7729	129.32	79.75	0.5675	53.55	79.18	0.5121	-76.56
44	0.4158	59.23	204.72	0.8042	55.55	85.06	0.4571	24.68	84.62	0.4425	3.83
45	0.4429	62.93	169.35	0.6372	36.97	61.44	0.2493	15.99	61.05	0.1685	-31.98
46	0.4403	45.76	117.02	0.7383	44.52	30.91	0.3075	14.64	30.47	0.2823	-84.48
47	0.4368	40.27	106.65	0.6648	27.59	39.68	0.1959	6.57	39.38	0.1614	-94.77
48	0.4443	31.95	84.94	0.5559	26.86	24.31	0.0884	4.75	24.04	0.0606	-117.17
49	0.4059	21.29	62.91	0.0000	0.0	16.72	0.0	0.0	0.0	0.0	-139.25
50	0.4241	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 727 600 242

TABLE 3.4.4 STANDARD DEVIATIONS OVER 36 REPLICATIONS

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	24.98	0.2951	0.89	0.0	0.3283	0.0	0.0	0.4712	24.98
2	0.0796	4.07	37.01	0.2757	48.90	22.71	0.3046	24.74	22.52	0.3141	1775.43
3	0.0984	11.82	58.79	0.2560	93.51	33.51	0.3825	46.45	33.51	0.4324	1752.26
4	0.0988	12.90	109.45	0.2749	90.77	61.99	0.3005	43.24	61.96	0.3305	1538.99
5	0.0953	15.36	101.26	0.2002	119.10	52.54	0.3332	40.54	52.48	0.4001	1395.65
6	0.1361	21.10	137.52	0.2536	157.63	77.51	0.3062	65.85	77.41	0.3266	843.55
7	0.1254	19.94	173.91	0.2245	89.96	62.74	0.3574	85.26	62.66	0.4132	831.64
8	0.1323	15.89	102.64	0.2151	109.73	117.15	0.2757	72.06	117.13	0.3091	911.17
9	0.1316	14.14	114.34	0.1878	70.51	77.19	0.2156	62.35	77.09	0.2336	803.11
10	0.1364	18.88	115.65	0.1878	83.85	59.03	0.2988	84.60	58.87	0.3785	615.37
11	0.1046	21.32	94.74	0.2460	139.34	129.00	0.3093	109.63	128.96	0.3852	354.97
12	0.1511	25.42	155.68	0.2512	71.74	146.95	0.3371	95.29	147.00	0.3571	489.27
13	0.1160	24.49	90.16	0.2332	130.80	107.38	0.3205	78.42	107.38	0.3490	712.65
14	0.1476	37.55	158.05	0.2279	83.76	83.78	0.2981	78.07	83.76	0.3376	472.62
15	0.1241	22.82	72.53	0.2059	193.62	87.10	0.3431	141.38	87.05	0.4278	553.70
16	0.1422	33.79	212.27	0.2267	127.04	167.03	0.3427	102.49	167.00	0.3924	828.83
17	0.1531	31.13	172.02	0.2318	104.79	125.44	0.3317	98.76	125.44	0.3599	355.07
18	0.1746	28.98	122.75	0.2319	89.58	121.43	0.3648	81.34	121.46	0.4174	298.18
19	0.1161	34.46	104.22	0.2441	152.44	82.34	0.2709	57.99	82.37	0.2777	497.64
20	0.1499	24.51	188.67	0.2069	139.41	64.10	0.3061	70.46	64.07	0.3753	566.38
21	0.1670	31.59	157.40	0.2395	89.58	94.95	0.3036	107.09	94.90	0.3595	582.24
22	0.1577	22.17	97.18	0.1928	66.98	124.33	0.2955	114.93	124.42	0.3507	506.06
23	0.1698	27.28	105.64	0.2405	95.27	108.93	0.2722	60.72	108.98	0.3074	615.35
24	0.1389	24.78	101.50	0.2337	163.10	69.10	0.2871	86.92	69.21	0.3098	1433.15
25	0.1710	39.60	179.08	0.2500	74.36	126.47	0.3063	77.72	126.50	0.3852	357.16
26	0.1385	17.89	73.76	0.2245	66.01	91.83	0.2275	63.15	91.93	0.2399	875.51
27	0.1301	30.98	75.57	0.1621	170.56	67.42	0.2717	62.98	67.41	0.3191	1305.21
28	0.1304	33.11	194.74	0.2317	199.39	86.16	0.3535	77.84	86.19	0.3954	542.95
29	0.1515	54.16	207.75	0.2750	115.72	103.45	0.3395	77.16	103.54	0.3689	590.85
30	0.1737	41.71	152.64	0.2059	37.29	112.12	0.3156	64.75	112.15	0.3682	613.66
31	0.1699	29.99	70.82	0.2271	81.44	70.82	0.3251	67.13	70.82	0.3567	1479.34
32	0.1415	28.33	82.65	0.2439	128.60	77.95	0.3695	76.92	77.92	0.3865	704.44
33	0.1570	36.72	135.80	0.2560	178.76	93.00	0.3727	92.00	92.99	0.4224	255.87
34	0.1788	41.93	185.86	0.2318	109.29	106.45	0.3768	82.15	106.48	0.4075	382.88
35	0.1398	25.56	125.42	0.2543	77.06	96.83	0.3617	85.06	96.75	0.4119	351.18
36	0.1672	23.42	93.97	0.2276	146.38	113.68	0.3138	72.90	113.78	0.3382	954.58
37	0.1606	32.49	154.68	0.2558	102.21	94.89	0.3856	105.84	94.91	0.4607	682.52
38	0.1689	27.93	123.68	0.2360	97.87	162.11	0.3861	77.60	162.13	0.4095	462.38
39	0.1429	33.57	112.70	0.2666	118.75	87.18	0.3907	70.31	87.15	0.4292	868.25
40	0.1433	31.60	119.54	0.2478	49.61	90.60	0.4028	64.00	90.56	0.4848	536.71
41	0.1376	31.05	92.18	0.2349	102.39	91.80	0.3083	70.21	91.84	0.3861	1047.13
42	0.1746	18.44	103.00	0.2445	67.93	95.61	0.3783	69.17	95.62	0.4364	991.41
43	0.1235	26.84	83.82	0.2738	262.44	91.64	0.4440	69.84	91.65	0.5116	1377.51
44	0.1951	45.74	267.10	0.2453	107.94	98.57	0.4921	38.74	98.50	0.5601	617.25
45	0.1461	38.84	145.13	0.2966	57.16	68.91	0.3350	25.87	68.79	0.3046	865.74
46	0.1396	29.93	91.70	0.2925	76.38	33.76	0.4416	25.20	33.59	0.4563	1265.29
47	0.1674	22.46	88.48	0.2867	44.95	45.45	0.3609	13.59	45.27	0.3726	1501.99
48	0.1625	18.38	66.21	0.3072	39.42	37.19	0.2432	13.22	37.03	0.2334	1524.74
49	0.1645	14.48	51.21	0.0000	0.0	30.57	0.0	0.0	0.0	0.0	1641.28
50	0.1763	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 3.5.1

PARAMETER SETS USED

$L = 50 \quad \eta_1 = 0.99$

ϕ_1	$N_0 = 200$ P_1	$N_0 = 400$ P_1
0.90	0.30 0.25 0.20 0.15 0.10 0.05 *	0.30 0.25 0.20 0.15 0.10 0.05 *
0.70	0.30 0.25 0.20 0.15 * 0.10 * 0.05 *	0.30 0.25 0.20 0.15 0.10 * 0.05 *
0.50	0.30 0.25 0.20 * 0.15 * 0.10 * 0.05 *	0.30 0.25 0.20 0.15 * 0.10 * 0.05 *
0.30	0.60 0.55 0.50 0.45 0.40 0.35 * 0.30 * 0.25 *	0.60 0.55 0.50 0.45 0.40 0.35 0.30 0.25 *
0.10	0.60 0.55 * 0.50 * 0.45 * 0.40 * 0.35 *	0.60 0.55 0.50 0.45 * 0.40 * 0.35 *

TABLE 4.4.9

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

MEANS OVER 1 REPLICATIONS
POOLED STATISTICS METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	5.00	200.00	48.00	14.00	48.00	21.00	0.0
2	11.00	7.00	197.00	44.00	14.00	44.00	20.00	3.00
3	19.00	8.00	199.00	40.00	14.00	40.00	19.00	5.00
4	23.00	7.00	199.00	38.00	14.00	38.00	17.00	9.00
5	30.00	8.00	195.00	35.00	14.00	35.00	14.00	11.00
6	36.00	8.00	193.00	32.00	14.00	32.00	13.00	14.00
7	40.00	6.00	192.00	30.00	14.00	30.00	12.00	15.00
8	43.00	8.00	197.00	41.00	14.00	41.00	11.00	17.00
9	49.00	8.00	201.00	39.00	14.00	39.00	10.00	18.00
10	50.00	8.00	206.00	40.00	14.00	40.00	13.00	17.00
11	54.00	7.00	206.00	37.00	14.00	37.00	10.00	21.00
12	58.00	10.00	199.00	41.00	14.00	41.00	12.00	19.00
13	66.00	8.00	197.00	31.00	14.00	31.00	13.00	20.00
14	64.00	12.00	189.00	36.00	14.00	36.00	14.00	20.00
15	60.00	11.00	191.00	36.00	14.00	36.00	10.00	23.00
16	62.00	10.00	192.00	40.00	14.00	40.00	12.00	21.00
17	64.00	11.00	187.00	38.00	14.00	38.00	11.00	23.00
18	63.00	13.00	191.00	38.00	14.00	38.00	12.00	21.00
19	65.00	11.00	194.00	35.00	14.00	35.00	11.00	23.00
20	66.00	12.00	192.00	35.00	14.00	35.00	13.00	23.00
21	67.00	16.00	188.00	34.00	14.00	34.00	12.00	22.00
22	64.00	13.00	177.00	33.00	14.00	33.00	13.00	21.00
23	62.00	13.00	177.00	35.00	14.00	35.00	11.00	22.00
24	61.00	16.00	181.00	40.00	14.00	40.00	10.00	22.00
25	62.00	16.00	180.00	37.00	14.00	37.00	9.00	20.00
26	61.00	15.00	176.00	37.00	14.00	37.00	9.00	21.00
27	57.00	17.00	179.00	37.00	14.00	37.00	7.00	21.00
28	58.00	17.00	183.00	42.00	14.00	42.00	8.00	17.00
29	61.00	14.00	183.00	39.00	14.00	39.00	11.00	16.00
30	60.00	13.00	192.00	45.00	14.00	45.00	11.00	14.00
31	63.00	12.00	189.00	43.00	14.00	43.00	9.00	13.00
32	60.00	11.00	191.00	46.00	14.00	46.00	10.00	11.00
33	65.00	12.00	190.00	47.00	14.00	47.00	10.00	11.00
34	68.00	10.00	194.00	42.00	14.00	42.00	7.00	14.00
35	71.00	10.00	191.00	38.00	14.00	38.00	6.00	13.00
36	68.00	11.00	189.00	42.00	14.00	42.00	7.00	11.00
37	70.00	13.00	196.00	41.00	14.00	41.00	7.00	9.00
38	76.00	9.00	200.00	35.00	14.00	35.00	5.00	11.00
39	76.00	10.00	200.00	40.00	14.00	40.00	4.00	11.00
40	71.00	10.00	199.00	39.00	14.00	39.00	6.00	8.00
41	73.00	9.00	198.00	37.00	14.00	37.00	5.00	5.00
42	70.00	9.00	200.00	40.00	14.00	40.00	6.00	7.00
43	74.00	10.00	196.00	40.00	14.00	40.00	6.00	6.00
44	78.00	10.00	200.00	38.00	14.00	38.00	7.00	5.00
45	74.00	12.00	203.00	43.00	14.00	43.00	5.00	5.00
46	77.00	10.00	203.00	44.00	14.00	44.00	5.00	1.00
47	77.00	0.0	201.00	0.0	14.00	0.0	0.0	3.00
48	78.00	0.0	200.00	0.0	14.00	0.0	0.0	2.00
49	76.00	0.0	202.00	0.0	14.00	0.0	0.0	0.0
50	77.00	0.0	207.00	0.0	0.0	0.0	0.0	0.0

TABLE 4.4.2

MEANS OVER 1 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.1042	0.0	202.77	0.7364	0.0	0.0	0.2403	0.0	0.0	0.0355	2.77
2	0.1591	6.43	40.41	1.0000	143.44	15.35	0.2269	35.29	0.0	0.0515	-156.59
3	0.2000	12.25	61.25	1.0000	248.81	21.42	0.2338	65.17	0.0	0.0547	-137.75
4	0.1842	20.50	111.29	1.0000	217.56	42.90	0.2773	72.17	0.0	0.0769	-87.71
5	0.2286	28.40	124.25	1.0000	134.68	46.38	0.2319	63.54	0.0	0.0795	-70.75
6	0.2500	35.00	140.00	1.0000	243.45	52.13	0.3005	96.66	0.0	0.0903	-53.00
7	0.2000	36.77	183.85	1.0000	80.13	78.78	0.3403	119.66	0.0	0.1158	-8.15
8	0.1951	60.50	310.06	0.5965	0.0	127.77	0.2247	120.20	0.0	0.0484	113.06
9	0.2051	67.45	328.84	0.5110	0.0	137.30	0.1872	98.64	0.0	0.0326	127.84
10	0.2000	51.79	258.93	0.9760	3.74	101.30	0.3396	151.90	0.0	0.1150	52.93
11	0.1892	72.55	383.45	0.6125	42.04	167.72	0.2328	108.30	0.0	0.0519	177.45
12	0.2439	64.38	263.98	0.8000	50.50	97.91	0.2487	79.88	0.0	0.0591	64.98
13	0.2581	46.71	181.02	0.8615	42.82	67.08	0.2570	59.90	0.0	0.0641	-15.98
14	0.3333	51.33	154.00	0.9322	79.16	48.36	0.3145	75.28	0.0	0.0982	-35.00
15	0.3056	78.36	256.46	0.5837	22.80	94.69	0.2153	84.91	0.0	0.0443	65.46
16	0.2500	69.23	276.92	0.6613	0.0	101.33	0.2311	83.72	0.0	0.0514	84.92
17	0.2895	75.75	261.68	0.5154	2.22	94.49	0.1335	57.14	0.0	0.0318	74.68
18	0.3421	68.00	198.77	0.7036	45.91	64.77	0.2394	64.70	0.0	0.0552	7.77
19	0.3143	70.00	222.73	0.7227	49.04	78.95	0.2471	57.65	0.0	0.0586	28.73
20	0.3429	59.14	172.50	0.6868	66.53	55.82	0.2204	39.60	0.0	0.0463	-19.50
21	0.4706	63.23	134.37	0.8214	88.94	39.15	0.2561	39.98	0.0	0.0633	-53.63
22	0.3939	54.00	137.08	1.0000	86.56	41.50	0.3237	54.03	0.0	0.1048	-39.92
23	0.3714	69.00	185.77	0.9315	42.44	61.61	0.3397	56.24	0.0	0.1147	8.77
24	0.4000	84.00	210.00	0.5331	42.20	70.52	0.2143	43.15	0.0	0.0443	29.00
25	0.4324	80.00	185.00	0.5714	90.44	63.66	0.2332	51.83	0.0	0.0526	5.00
26	0.4054	80.80	199.31	0.5556	104.99	70.48	0.2501	58.11	0.0	0.0612	23.31
27	0.4595	102.75	223.63	0.3991	119.85	85.97	0.1864	57.36	0.0	0.0336	44.63
28	0.4048	87.22	215.49	0.4232	108.55	79.23	0.1683	46.21	0.0	0.0265	32.49
29	0.3590	55.33	154.14	0.7456	205.33	51.14	0.2772	74.79	0.0	0.0743	-28.86
30	0.2889	56.67	196.15	0.6324	158.77	69.12	0.2478	76.09	0.0	0.0590	4.15
31	0.2791	60.20	215.72	0.5736	109.66	83.01	0.2408	70.00	0.0	0.0552	26.72
32	0.2391	50.00	209.09	0.4458	68.41	81.77	0.1755	59.31	0.0	0.0286	18.09
33	0.2553	51.00	199.75	0.8947	81.83	75.61	0.3945	102.25	0.0	0.1545	9.75
34	0.2381	76.25	320.25	0.7145	135.97	143.90	0.3615	111.67	0.0	0.1287	126.25
35	0.2632	74.43	282.83	0.4845	52.95	131.71	0.2501	74.02	0.0	0.0606	91.83
36	0.2619	61.13	233.39	0.4697	37.00	102.29	0.2341	48.82	0.0	0.0525	44.39
37	0.3171	51.25	161.63	0.5085	100.04	68.06	0.2630	88.08	0.0	0.0673	-34.37
38	0.2571	67.00	260.56	0.2905	72.89	132.25	0.1841	110.04	0.0	0.0332	60.56
39	0.2500	91.20	364.80	0.1155	54.27	201.67	0.0720	58.83	0.0	0.0049	164.80
40	0.2564	48.71	189.99	0.1167	116.39	89.77	0.0655	64.21	0.0	0.0040	-9.01
41	0.2432	35.67	146.63	0.0	0.0	74.96	0.0	0.0	0.0	0.0	-51.37
42	0.2250	41.00	182.22	0.0	0.0	90.05	0.0	0.0	0.0	0.0	-17.78
43	0.2500	37.14	148.57	0.0	0.0	71.04	0.0	0.0	0.0	0.0	-47.43
44	0.2632	25.38	96.43	0.0	0.0	42.64	0.0	0.0	0.0	0.0	-103.57
45	0.2791	38.67	138.56	0.0	0.0	69.14	0.0	0.0	0.0	0.0	-64.44
46	0.2273	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 7 3 7

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

TABLE 4.4.3

MEANS OVER 1 REPLICATIONS
POOLED STATISTICS METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	16.60	7.00	198.00	41.00	14.00	41.00	18.00	5.60
2	43.60	7.00	197.80	36.00	14.00	36.00	11.00	16.20
3	60.40	9.00	196.40	36.00	14.00	36.00	11.00	20.60
4	64.00	11.00	191.20	37.00	14.00	37.00	11.00	22.20
5	63.20	14.00	180.60	35.00	14.00	35.00	11.00	21.40
6	59.40	15.00	182.60	40.00	14.00	40.00	9.00	17.80
7	65.40	11.00	191.00	43.00	14.00	43.00	8.00	12.40
8	72.20	10.00	196.80	39.00	14.00	39.00	5.00	10.00
9	73.80	10.00	199.40	39.00	14.00	39.00	5.00	5.60
10	77.00	2.00	202.60	8.00	11.20	8.00	1.00	1.20

TABLE 4.4.4

MEANS OVER 1 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0208	0.0	107.99	0.9473	148.90	0.0	0.2520	0.0	0.0	0.0596	0.55
2	0.2100	50.30	244.34	0.8167	65.47	99.46	0.2784	117.41	0.0	0.0804	46.54
3	0.2660	62.67	247.78	0.7580	47.46	95.15	0.2537	81.65	0.0	0.0635	51.38
4	0.3977	68.42	226.52	0.6579	32.74	79.07	0.2243	60.56	0.0	0.0487	35.32
5	0.4137	70.05	170.44	C.7715	70.12	55.29	0.2734	49.04	0.0	0.0759	-10.16
6	0.3835	76.55	197.75	0.5512	139.50	71.19	0.2259	62.51	0.0	0.0509	15.15
7	0.2550	62.38	245.53	0.6226	89.76	103.20	0.2845	83.45	0.0	0.0855	54.53
8	0.2685	63.86	242.07	0.3002	76.12	118.81	0.1638	0.0	0.0	0.0324	45.27
9	0.2521	35.57	142.48	0.0	0.0	69.57	0.0	0.0	0.0	0.0	-56.92
10	0.0455	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 7 3 7

TABLE 4.4.5

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	CM(I)	M(I)	CN(I)	N(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	2.86	200.00	39.33	14.00	39.33	13.58	0.0
2	7.69	3.94	200.61	39.25	14.00	39.25	13.06	2.44
3	15.03	4.83	200.50	38.83	14.00	38.83	12.97	4.50
4	21.23	5.53	201.25	38.97	14.00	38.97	12.72	6.33
5	26.53	5.97	201.22	38.69	14.00	38.69	12.97	7.86
6	31.33	6.44	200.78	38.50	14.00	38.50	12.97	9.64
7	35.94	6.83	200.72	38.92	14.00	38.92	13.72	10.67
8	39.69	7.86	200.89	39.33	14.00	39.33	13.81	11.94
9	43.44	8.53	200.28	39.17	14.00	39.17	13.83	13.08
10	46.53	9.31	200.72	39.03	14.00	39.03	13.72	14.39
11	49.92	9.94	201.17	39.56	14.00	39.56	13.39	15.78
12	52.36	10.39	200.25	39.42	14.00	39.42	12.92	16.53
13	54.92	10.50	201.61	39.17	14.00	39.17	12.47	17.22
14	57.08	10.69	201.69	38.94	14.00	38.94	12.25	17.61
15	58.67	11.11	201.36	39.47	14.00	39.47	12.03	18.17
16	60.19	11.31	201.42	39.47	14.00	39.47	12.61	18.78
17	62.36	11.67	201.92	39.44	14.00	39.44	12.81	18.94
18	64.14	11.47	202.06	39.17	14.00	39.17	12.97	19.00
19	64.39	11.81	203.00	39.39	14.00	39.39	13.33	18.75
20	65.69	12.25	202.42	39.50	14.00	39.50	13.89	18.89
21	66.56	12.72	202.44	39.08	14.00	39.08	13.03	19.72
22	67.50	12.83	202.89	39.53	14.00	39.53	13.28	20.28
23	68.44	13.39	201.86	39.47	14.00	39.47	13.39	20.17
24	68.56	13.58	202.42	40.00	14.00	40.00	13.36	19.83
25	69.19	13.83	201.61	40.25	14.00	40.25	12.94	20.06
26	69.11	13.86	201.47	40.75	14.00	40.75	13.42	19.92
27	70.14	14.25	201.39	40.33	14.00	40.33	13.11	20.17
28	70.81	14.11	200.81	40.53	14.00	40.53	13.03	19.97
29	71.56	13.72	200.19	40.06	14.00	40.06	12.53	19.36
30	71.47	13.36	200.78	40.19	14.00	40.19	12.53	19.14
31	72.00	13.11	201.00	40.25	14.00	40.25	11.75	19.08
32	71.92	13.28	201.03	41.03	14.00	41.03	11.56	19.17
33	72.09	13.31	201.44	41.06	14.00	41.06	11.17	19.28
34	72.92	13.47	201.64	41.17	14.00	41.17	11.31	18.53
35	73.42	13.50	201.08	40.61	14.00	40.61	10.78	18.56
36	73.86	13.53	201.28	40.28	14.00	40.28	10.61	17.56
37	75.00	13.31	200.28	39.61	14.00	39.61	10.03	17.42
38	75.00	13.44	201.31	39.97	14.00	39.97	10.00	16.97
39	75.53	14.17	200.39	40.17	14.00	40.17	9.50	16.33
40	74.39	14.08	200.39	40.64	14.00	40.64	9.06	15.81
41	75.25	14.78	200.61	41.19	14.00	41.19	8.28	14.86
42	75.50	15.06	201.31	41.28	14.00	41.28	7.75	14.00
43	76.14	15.03	201.67	40.67	14.00	40.67	6.44	12.81
44	75.61	14.67	201.58	40.44	14.00	40.44	5.33	11.75
45	75.72	14.47	201.97	40.31	14.00	40.31	4.28	10.08
46	75.06	14.36	202.06	40.78	14.00	40.78	3.28	8.08
47	74.67	0.0	201.97	0.0	14.00	0.0	0.0	6.72
48	74.36	0.0	202.58	0.0	14.00	0.0	0.0	4.58
49	73.89	0.0	202.47	0.0	14.00	0.0	0.0	2.61
50	74.72	0.0	202.75	0.0	0.0	0.0	0.0	0.0

TABLE 4.4.6

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	1.88	0.09	6.35	0.01	6.35	4.33	0.0
2	2.53	2.15	3.34	5.44	0.01	5.44	3.32	1.48
3	3.58	2.17	4.86	6.18	0.01	6.18	3.41	2.32
4	4.14	2.20	5.96	6.13	0.01	6.13	3.58	2.53
5	4.72	2.47	6.78	5.58	0.01	5.58	3.26	3.06
6	5.52	2.51	7.40	5.43	0.01	5.43	3.53	3.42
7	5.77	2.27	7.79	5.08	0.01	5.08	3.32	3.30
8	6.36	2.53	8.41	5.24	0.01	5.24	3.58	3.79
9	7.18	3.18	8.91	6.15	0.01	6.15	3.42	3.72
10	6.50	3.30	9.43	6.14	0.01	6.14	3.04	3.52
11	7.29	3.37	9.01	5.83	0.01	5.83	3.22	3.43
12	7.01	3.46	9.55	6.57	0.01	6.57	3.23	3.80
13	6.95	3.43	10.73	6.22	0.01	6.22	3.81	3.74
14	7.21	3.29	11.01	5.96	0.01	5.96	3.52	3.92
15	7.03	3.29	10.93	6.93	0.01	6.93	3.64	3.48
16	7.03	3.45	11.06	6.88	0.01	6.88	3.86	3.49
17	7.43	3.81	11.19	7.21	0.01	7.21	3.85	3.82
18	7.26	3.53	10.26	6.98	0.01	6.98	3.58	4.05
19	6.96	3.46	10.74	6.73	0.01	6.73	3.42	3.30
20	7.32	3.57	10.62	6.79	0.01	6.79	3.86	3.93
21	6.84	3.98	10.53	7.00	0.01	7.00	3.40	3.94
22	7.37	3.81	11.40	7.11	0.01	7.11	3.56	3.74
23	8.09	3.95	11.42	6.51	0.01	6.51	3.16	4.14
24	7.70	3.89	11.14	6.37	0.01	6.37	3.37	4.15
25	8.13	3.87	12.16	6.45	0.01	6.45	3.55	4.92
26	8.53	3.41	12.31	5.82	0.01	5.82	3.93	4.38
27	8.63	3.30	11.79	6.86	0.01	6.86	4.13	4.36
28	8.78	2.65	11.02	5.69	0.01	5.69	4.37	3.93
29	9.13	2.69	10.30	5.45	0.01	5.45	4.08	4.59
30	7.93	3.57	9.99	6.07	0.01	6.07	3.40	4.78
31	8.57	3.58	10.04	6.24	0.01	6.24	3.52	4.47
32	8.64	3.71	10.27	6.70	0.01	6.70	3.38	4.18
33	8.53	3.79	10.60	7.22	0.01	7.22	3.27	4.93
34	8.08	4.27	9.76	7.43	0.01	7.43	3.11	4.29
35	8.25	3.91	8.74	6.61	0.01	6.61	3.55	4.38
36	8.72	3.60	8.72	5.29	0.01	5.29	2.83	4.48
37	9.15	3.54	8.29	5.43	0.01	5.43	3.10	4.59
38	9.80	4.03	8.91	6.21	0.01	6.21	3.45	4.20
39	9.92	3.62	8.82	5.92	0.01	5.92	3.27	4.34
40	9.04	4.20	8.59	6.86	0.01	6.86	2.52	4.37
41	9.37	4.09	8.29	6.97	0.01	6.97	2.48	4.24
42	9.49	4.17	8.68	6.31	0.01	6.31	2.55	3.82
43	9.76	4.23	8.53	6.12	0.01	6.12	2.67	3.87
44	9.39	4.64	7.94	6.07	0.01	6.07	2.47	3.52
45	9.40	3.88	7.96	6.16	0.01	6.16	2.13	3.36
46	9.60	3.94	7.79	6.33	0.01	6.33	1.92	2.58
47	9.43	0.0	8.21	0.0	0.01	0.0	0.0	2.05
48	9.57	0.0	8.51	0.0	0.01	0.0	0.0	1.92
49	9.30	0.0	8.44	0.0	0.01	0.0	0.0	1.50
50	9.53	0.0	9.60	0.0	0.0	0.0	0.0	0.0

TABLE 4.4.7

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0701	0.0	208.03	0.5874	32.52	0.0	0.2202	0.0	0.0	0.0504	8.03
2	0.0992	7.50	106.32	0.6019	131.59	81.14	0.2097	108.96	0.0	0.0434	-94.29
3	0.1252	13.88	130.64	0.6683	98.16	76.26	0.2294	106.14	0.0	0.0534	-69.66
4	0.1419	20.57	171.90	0.6384	90.77	95.31	0.2162	107.77	0.0	0.0452	-29.35
5	0.1531	24.13	182.02	0.6630	73.07	95.11	0.2241	114.87	0.0	0.0512	-19.20
6	0.1664	30.52	210.15	0.6937	91.41	106.68	0.2233	100.33	0.0	0.0491	14.71
7	0.1739	31.46	200.74	0.7356	89.35	96.10	0.2353	96.47	0.0	0.0550	0.02
8	0.1977	35.51	198.93	0.7433	97.29	80.90	0.2330	83.48	0.0	0.0540	-11.96
9	0.2141	37.95	196.28	0.7493	99.69	76.30	0.2336	80.37	0.0	0.0544	-13.99
10	0.2360	41.12	184.89	0.7638	93.10	72.42	0.2436	84.07	0.0	0.0606	-15.83
11	0.2492	47.39	204.56	0.7137	92.10	81.28	0.2318	86.90	0.0	0.0557	3.39
12	0.2620	51.50	216.08	0.7114	87.23	85.90	0.2379	88.55	0.0	0.0589	15.83
13	0.2669	56.36	226.22	0.6687	70.92	88.26	0.2261	86.21	0.0	0.0520	24.61
14	0.2723	59.02	231.01	0.6714	61.48	92.15	0.2293	82.51	0.0	0.0557	29.32
15	0.2808	61.75	228.00	0.6260	59.71	86.43	0.2172	76.36	0.0	0.0534	26.64
16	0.2853	62.29	228.03	0.6617	63.37	87.10	0.2209	77.32	0.0	0.0505	26.61
17	0.2926	62.75	227.75	0.7109	58.10	88.34	0.2358	71.28	0.0	0.0624	25.83
18	0.2901	59.75	212.41	0.6914	48.24	78.21	0.2234	66.96	0.0	0.0514	10.36
19	0.2978	57.68	200.77	0.7059	55.06	72.10	0.2218	64.86	0.0	0.0511	-2.23
20	0.3085	55.89	191.18	0.7314	68.78	68.65	0.2289	65.51	0.0	0.0543	-11.24
21	0.3236	60.42	198.86	0.7104	64.34	71.18	0.2247	63.03	0.0	0.0518	-3.58
22	0.3227	61.40	196.90	0.7015	58.22	68.30	0.2219	57.04	0.0	0.0513	-5.99
23	0.3349	60.81	184.49	0.7365	59.02	61.27	0.2348	55.90	0.0	0.0576	-17.37
24	0.3352	62.24	186.19	0.6873	76.64	61.48	0.2205	58.11	0.0	0.0494	-16.22
25	0.3399	65.62	193.78	0.6756	83.70	65.36	0.2171	57.68	0.0	0.0499	-7.83
26	0.3401	63.62	190.51	0.7239	89.88	63.62	0.2326	58.43	0.0	0.0567	-10.96
27	0.3532	66.33	189.06	0.7136	94.97	62.93	0.2331	59.34	0.0	0.0560	-12.33
28	0.3484	66.58	192.49	0.7108	100.92	64.87	0.2339	62.21	0.0	0.0570	-8.32
29	0.3430	65.95	201.05	0.7023	84.07	69.92	0.2359	64.24	0.0	0.0578	0.85
30	0.3312	64.83	205.60	0.7345	84.69	73.29	0.2509	71.90	0.0	0.0658	4.82
31	0.3254	67.54	218.57	0.6983	73.08	80.09	0.2488	73.01	0.0	0.0660	17.58
32	0.3233	69.56	224.21	0.6953	82.28	81.76	0.2503	73.26	0.0	0.0682	23.18
33	0.3261	71.86	230.33	0.6850	77.90	83.52	0.2508	70.49	0.0	0.0700	28.89
34	0.3256	67.66	215.71	0.7039	58.30	77.96	0.2631	69.77	0.0	0.0735	14.07
35	0.3327	71.31	223.47	0.6749	69.98	84.11	0.2490	66.93	0.0	0.0654	22.39
36	0.3385	67.56	211.21	0.7268	71.45	79.27	0.2738	70.24	0.0	0.0791	9.93
37	0.3365	69.76	221.88	0.7204	76.91	86.50	0.2756	72.02	0.0	0.0807	21.60
38	0.3345	69.30	217.54	0.6954	104.05	83.95	0.2738	71.18	0.0	0.0830	16.24
39	0.3524	70.19	204.72	0.6596	180.99	78.42	0.2660	86.45	0.0	0.0837	4.33
40	0.3467	70.06	207.43	0.5603	203.00	80.05	0.2435	95.70	0.0	0.0792	7.04
41	0.3589	74.09	213.41	0.0	0.0	86.32	0.0	0.0	0.0	0.0	12.80
42	0.3640	76.85	222.16	0.0	0.0	96.13	0.0	0.0	0.0	0.0	20.86
43	0.3683	85.56	244.74	0.0	0.0	121.44	0.0	0.0	0.0	0.0	43.07
44	0.3558	99.14	309.79	0.0	0.0	205.90	0.0	0.0	0.0	0.0	108.21
45	0.3580	108.64	321.12	0.0	0.0	230.30	0.0	0.0	0.0	0.0	119.15
46	0.3499	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 276 156 242

TABLE 4.4.8

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0398	0.0	39.69	0.3585	78.55	0.0	0.1187	0.0	0.0	0.0403	39.69
2	0.0509	4.39	120.80	0.3025	87.50	129.02	0.0814	121.12	0.0	0.0313	120.89
3	0.0525	7.19	89.09	0.2684	62.00	68.47	0.0788	96.00	0.0	0.0374	89.00
4	0.0536	9.27	120.29	0.2482	73.68	87.36	0.0618	95.08	0.0	0.0268	119.02
5	0.0568	10.11	120.48	0.2197	77.17	86.74	0.0729	117.85	0.0	0.0401	118.49
6	0.0617	15.53	177.16	0.2214	86.05	125.68	0.0541	88.77	0.0	0.0253	172.71
7	0.0507	12.19	119.91	0.1861	92.06	85.40	0.0566	65.77	0.0	0.0297	118.74
8	0.0512	13.27	98.37	0.1899	82.70	61.43	0.0500	42.22	0.0	0.0254	97.52
9	0.0583	12.66	76.82	0.1938	84.28	44.66	0.0487	45.33	0.0	0.0243	77.11
10	0.0644	11.42	69.92	0.1948	67.82	39.06	0.0591	48.81	0.0	0.0303	68.96
11	0.0693	12.90	81.27	0.2172	93.06	52.55	0.0649	63.10	0.0	0.0309	80.66
12	0.0720	13.46	101.09	0.2054	129.40	63.92	0.0674	56.82	0.0	0.0346	100.25
13	0.0704	13.70	96.87	0.1905	64.82	49.80	0.0543	58.45	0.0	0.0264	94.43
14	0.0702	22.81	106.47	0.2315	52.26	63.43	0.0700	47.26	0.0	0.0361	103.31
15	0.0655	20.60	80.48	0.2296	55.25	39.21	0.0903	43.26	0.0	0.0576	78.15
16	0.0603	22.28	110.87	0.2064	59.08	62.64	0.0607	60.80	0.0	0.0291	107.56
17	0.0645	27.25	154.93	0.2270	35.75	98.60	0.0942	35.16	0.0	0.0656	152.32
18	0.0633	18.98	78.64	0.2001	33.98	44.61	0.0597	29.59	0.0	0.0286	76.64
19	0.0648	15.61	67.49	0.2217	37.74	37.66	0.0615	36.92	0.0	0.0291	67.54
20	0.0711	15.13	74.20	0.2312	56.77	45.68	0.0581	35.67	0.0	0.0276	73.40
21	0.0773	14.28	74.97	0.2265	51.55	42.82	0.0544	24.34	0.0	0.0254	73.91
22	0.0689	13.16	54.54	0.2348	44.42	32.43	0.0619	18.59	0.0	0.0272	54.43
23	0.0642	15.33	44.00	0.2124	46.10	21.53	0.0645	16.22	0.0	0.0315	46.80
24	0.0562	19.33	48.68	0.2038	83.13	21.42	0.0512	21.20	0.0	0.0231	48.03
25	0.0575	24.15	65.12	0.2402	67.25	29.77	0.0675	21.87	0.0	0.0339	63.77
26	0.0668	21.40	63.67	0.2198	79.22	28.44	0.0657	23.15	0.0	0.0338	62.73
27	0.0534	23.66	64.99	0.2064	71.82	27.46	0.0584	19.77	0.0	0.0273	64.54
28	0.0440	22.09	64.04	0.2309	84.30	29.68	0.0619	29.33	0.0	0.0286	62.25
29	0.0534	27.00	95.48	0.1981	57.41	45.17	0.0647	29.05	0.0	0.0342	93.61
30	0.0759	24.94	88.28	0.2131	64.46	43.60	0.0662	42.45	0.0	0.0360	86.87
31	0.0762	19.99	89.50	0.2038	74.34	50.40	0.0763	41.50	0.0	0.0445	88.92
32	0.0707	19.75	81.18	0.2353	86.05	42.33	0.0841	33.80	0.0	0.0451	79.92
33	0.0770	24.27	96.12	0.2435	78.72	42.27	0.0933	30.86	0.0	0.0506	94.11
34	0.0794	16.47	58.71	0.1918	59.48	30.39	0.0779	29.83	0.0	0.0413	56.87
35	0.0827	22.25	70.70	0.2428	57.04	37.54	0.0702	30.30	0.0	0.0362	70.59
36	0.0897	19.35	74.39	0.2332	69.16	41.18	0.0756	37.81	0.0	0.0446	74.07
37	0.0801	21.50	97.52	0.2461	83.32	53.93	0.0789	34.50	0.0	0.0454	95.71
38	0.0800	23.94	86.05	0.2691	110.53	43.15	0.0982	33.50	0.0	0.0559	84.26
39	0.0658	23.68	75.40	0.3185	242.00	39.26	0.1193	69.22	0.0	0.0634	73.73
40	0.0789	24.96	72.95	0.3348	261.34	34.17	0.1466	100.19	0.0	0.0812	70.36
41	0.0731	31.34	97.06	0.0	0.0	50.95	0.0	0.0	0.0	0.0	95.54
42	0.0760	34.02	116.95	0.0	0.0	69.10	0.0	0.0	0.0	0.0	116.00
43	0.0798	43.89	144.07	0.0	0.0	134.84	0.0	0.0	0.0	0.0	143.91
44	0.0954	65.69	281.68	0.0	0.0	308.88	0.0	0.0	0.0	0.0	281.09
45	0.0743	89.94	306.41	0.0	0.0	337.68	0.0	0.0	0.0	0.0	306.66
46	0.0667	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4.4.9

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	14.12	4.28	200.72	38.64	14.00	38.64	12.72	4.23
2	39.39	7.36	200.68	38.58	14.00	38.58	13.17	11.94
3	54.69	10.11	201.22	38.94	14.00	38.94	12.14	17.06
4	63.36	11.28	202.16	39.03	14.00	39.03	12.72	18.87
5	68.05	12.92	202.24	39.22	14.00	39.22	12.81	20.01
6	70.62	13.44	200.93	40.03	14.00	40.03	12.53	19.71
7	72.47	13.03	201.24	40.44	14.00	40.44	10.92	18.92
8	74.85	13.28	200.73	39.72	14.00	39.72	9.44	16.82
9	75.64	14.36	201.43	40.36	14.00	40.36	6.11	12.70
10	74.70	2.50	202.37	7.69	11.20	7.69	0.22	4.40

TABLE 4.4.10

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	2.62	1.86	3.63	5.02	0.00	5.02	2.74	1.70
2	5.84	2.21	7.73	4.54	0.00	4.54	2.83	3.27
3	6.63	2.92	9.81	5.36	0.00	5.36	2.99	3.34
4	6.82	3.09	10.39	5.89	0.00	5.89	3.04	3.25
5	7.24	3.27	10.79	5.74	0.00	5.74	2.84	3.84
6	8.31	2.36	10.45	5.02	0.00	5.02	3.48	4.07
7	7.91	3.33	9.37	5.95	0.00	5.95	2.87	4.10
8	8.89	3.26	7.96	4.90	0.00	4.90	2.65	4.12
9	9.13	3.64	7.76	5.11	0.00	5.11	2.01	3.49
10	9.12	0.88	7.94	1.39	0.01	1.39	0.42	1.29

TABLE 4.4.11

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0140	0.0	159.82	0.6318	86.42	0.0	0.2199	0.0	0.0	0.0487	1.61
2	0.1976	35.31	194.20	0.7371	94.17	86.48	0.2339	88.94	0.0	0.0546	-5.48
3	0.2662	55.21	221.17	0.6782	74.29	86.80	0.2285	84.11	0.0	0.0551	19.96
4	0.2949	59.67	212.03	0.7002	58.71	78.88	0.2262	69.18	0.0	0.0540	9.87
5	0.3313	62.10	192.04	0.7023	68.39	65.52	0.2238	58.35	0.0	0.0520	-10.20
6	0.3432	65.66	195.74	0.7170	90.90	66.93	0.2373	63.22	0.0	0.0587	-5.19
7	0.3266	69.59	222.46	0.6915	72.31	81.49	0.2524	70.69	0.0	0.0686	21.22
8	0.3417	69.38	212.55	0.6725	127.28	81.64	0.2665	0.0	0.0	0.0812	11.83
9	0.3618	88.86	262.25	0.0	0.0	148.02	0.0	0.0	0.0	0.0	60.82
10	0.0700	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 276 156 242

TABLE 4.4.12

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0080	0.0	81.04	0.2105	40.67	0.0	0.0598	0.0	0.0	0.0258	7.94
2	0.0447	11.23	91.54	0.1353	55.45	57.29	0.0393	45.50	0.0	0.0198	90.20
3	0.0585	14.51	73.30	0.1394	58.14	42.44	0.0510	44.77	0.0	0.0273	71.11
4	0.0520	15.96	79.08	0.1505	22.41	47.38	0.0534	31.71	0.0	0.0297	76.88
5	0.0500	13.21	38.94	0.1570	44.37	20.19	0.0445	14.31	0.0	0.0208	38.76
6	0.0408	20.52	63.93	0.1592	49.24	28.44	0.0465	24.14	0.0	0.0228	62.34
7	0.0621	15.88	62.36	0.1536	53.84	29.78	0.0610	26.18	0.0	0.0334	60.74
8	0.0673	17.95	66.20	0.2345	134.85	33.91	0.0870	0.0	0.0	0.0488	64.53
9	0.0707	47.57	173.32	0.0	0.0	160.96	0.0	0.0	0.0	0.0	172.85
10	0.0133	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4.6.1

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

MEANS OVER 1 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	200.00	0.0	14.00	0.0	0.0	0.0
2	0.0	0.0	197.00	0.0	14.00	0.0	0.0	0.0
3	0.0	0.0	199.00	39.00	14.00	39.00	16.00	0.0
4	0.0	0.0	199.00	37.00	14.00	37.00	15.00	0.0
5	0.0	0.0	195.00	34.00	14.00	34.00	13.00	0.0
6	0.0	0.0	193.00	31.00	14.00	31.00	10.00	0.0
7	0.0	0.0	192.00	29.00	14.00	29.00	8.00	0.0
8	39.00	4.00	197.00	27.00	14.00	27.00	9.00	12.00
9	37.00	4.00	201.00	27.00	14.00	27.00	10.00	11.00
10	34.00	4.00	206.00	36.00	14.00	36.00	8.00	9.00
11	31.00	3.00	206.00	36.00	14.00	36.00	8.00	7.00
12	29.00	3.00	199.00	35.00	14.00	35.00	10.00	5.00
13	51.00	7.00	197.00	35.00	14.00	35.00	10.00	14.00
14	52.00	9.00	189.00	38.00	14.00	38.00	11.00	12.00
15	60.00	5.00	191.00	27.00	14.00	27.00	10.00	12.00
16	58.00	5.00	192.00	30.00	14.00	30.00	10.00	10.00
17	53.00	5.00	187.00	31.00	14.00	31.00	7.00	10.00
18	64.00	7.00	191.00	36.00	14.00	36.00	9.00	17.00
19	67.00	9.00	194.00	35.00	14.00	35.00	8.00	14.00
20	58.00	10.00	192.00	35.00	14.00	35.00	9.00	12.00
21	60.00	10.00	188.00	32.00	14.00	32.00	9.00	10.00
22	61.00	11.00	177.00	32.00	14.00	32.00	11.00	6.00
23	67.00	15.00	177.00	30.00	14.00	30.00	10.00	11.00
24	64.00	11.00	181.00	31.00	14.00	31.00	13.00	11.00
25	65.00	10.00	180.00	33.00	14.00	33.00	9.00	11.00
26	59.00	10.00	176.00	37.00	14.00	37.00	8.00	9.00
27	58.00	8.00	179.00	34.00	14.00	34.00	6.00	9.00
28	62.00	13.00	183.00	34.00	14.00	34.00	7.00	8.00
29	59.00	15.00	183.00	35.00	14.00	35.00	5.00	9.00
30	62.00	12.00	192.00	38.00	14.00	38.00	5.00	8.00
31	65.00	11.00	189.00	33.00	14.00	33.00	7.00	6.00
32	62.00	11.00	191.00	40.00	14.00	40.00	9.00	4.00
33	62.00	11.00	190.00	40.00	14.00	40.00	9.00	4.00
34	64.00	9.00	194.00	42.00	14.00	42.00	8.00	5.00
35	70.00	8.00	191.00	42.00	14.00	42.00	7.00	5.00
36	66.00	7.00	189.00	40.00	14.00	40.00	5.00	6.00
37	72.00	9.00	196.00	36.00	14.00	36.00	5.00	4.00
38	68.00	8.00	200.00	38.00	14.00	38.00	4.00	5.00
39	73.00	9.00	200.00	37.00	14.00	37.00	3.00	4.00
40	77.00	7.00	199.00	33.00	14.00	33.00	2.00	5.00
41	76.00	8.00	198.00	36.00	14.00	36.00	2.00	3.00
42	72.00	8.00	200.00	35.00	14.00	35.00	4.00	1.00
43	74.00	8.00	196.00	34.00	14.00	34.00	4.00	1.00
44	75.00	7.00	200.00	37.00	14.00	37.00	0.0	0.0
45	77.00	7.00	203.00	35.00	14.00	35.00	0.0	0.0
46	80.00	5.00	203.00	32.00	14.00	32.00	0.0	0.0
47	73.00	5.00	201.00	34.00	14.00	34.00	0.0	0.0
48	75.00	5.00	200.00	33.00	14.00	33.00	0.0	0.0
49	0.0	0.0	202.00	0.0	14.00	0.0	0.0	0.0
50	0.0	0.0	207.00	0.0	0.0	0.0	0.0	0.0

TABLE 4.6.2

MEANS OVER 1 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDVGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	169.39	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-30.61
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.9641	XXXXXX	0.0	0.1827	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.8649	XXXXXX	0.0	0.3179	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	1.0000	XXXXXX	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	1.0000	XXXXXX	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.6677	XXXXXX	0.0	0.2338	0.0	0.0	0.0507	0.0
8	0.1481	37.60	253.80	0.6716	42.88	138.31	0.3259	137.85	138.31	0.1031	56.80
9	0.1481	32.00	216.00	0.8727	14.16	114.51	0.3818	186.23	114.51	0.1434	15.00
10	0.1111	41.00	369.00	0.4869	12.27	220.40	0.2396	220.17	220.40	0.0536	163.00
11	0.0833	31.78	381.33	0.5122	3.76	257.56	0.2449	161.28	257.56	0.0533	175.33
12	0.0857	19.36	225.91	0.8761	81.08	146.00	0.3093	141.91	146.00	0.0938	26.91
13	0.2000	52.82	264.09	0.8649	131.07	116.30	0.3115	100.32	116.30	0.0949	67.09
14	0.2368	48.00	202.67	0.8442	81.70	79.30	0.2907	90.21	79.30	0.0814	13.67
15	0.1852	35.55	191.95	0.9245	8.75	91.58	0.3396	102.30	91.58	0.1134	0.95
16	0.1667	33.18	199.09	0.7391	0.0	97.70	0.3249	123.47	97.70	0.1024	7.09
17	0.1613	45.00	279.00	0.3873	0.0	153.88	0.1640	126.54	153.88	0.0256	92.00
18	0.1944	69.90	359.49	0.4651	0.0	164.60	0.1974	89.72	164.60	0.0372	168.49
19	0.2571	65.00	252.78	0.3972	1.46	109.43	0.1640	54.97	109.43	0.0251	58.78
20	0.2857	53.20	186.20	0.6061	43.56	73.67	0.2327	45.75	73.67	0.0508	-5.80
21	0.3125	43.00	137.60	0.7385	75.99	52.47	0.2499	35.34	52.47	0.0572	-50.40
22	0.3438	27.50	80.00	1.0000	145.25	25.16	0.2894	41.86	25.16	0.0838	-97.00
23	0.5000	46.00	92.00	0.7869	53.15	26.35	0.2289	26.49	26.35	0.0487	-85.00
24	0.3548	36.14	101.86	1.0000	59.14	30.40	0.3367	46.51	30.40	0.1134	-79.14
25	0.3030	47.40	156.42	0.9091	60.47	60.52	0.3704	59.96	60.52	0.1356	-23.58
26	0.2703	48.00	177.60	0.4867	23.07	75.13	0.2327	70.01	75.13	0.0519	1.60
27	0.2353	53.00	225.25	0.3468	21.51	113.72	0.1624	36.56	113.72	0.0247	46.25
28	0.3824	48.00	125.54	0.3971	49.78	49.19	0.1958	37.02	49.19	0.0370	-57.46
29	0.4286	69.00	161.00	0.3695	93.99	72.51	0.2043	62.03	72.51	0.0404	-22.00
30	0.3158	64.00	202.67	0.3875	104.56	100.27	0.1902	47.72	100.27	0.0337	10.67
31	0.3333	36.50	109.50	0.8205	184.44	44.93	0.3299	66.88	44.93	0.1045	-79.50
32	0.2750	27.40	99.64	0.5969	75.19	38.01	0.2280	35.18	38.01	0.0467	-91.36
33	0.2750	27.40	99.64	0.8333	140.22	38.01	0.3465	69.68	38.01	0.1165	-90.36
34	0.2143	32.89	153.48	0.7133	83.74	70.44	0.3372	71.59	70.44	0.1095	-40.52
35	0.1905	34.88	183.09	0.9244	130.89	93.21	0.5039	174.14	93.21	0.2526	-7.91
36	0.1750	48.00	274.29	0.5556	59.12	162.94	0.3223	71.26	162.94	0.0998	85.29
37	0.2500	33.67	134.67	0.2505	32.76	72.32	0.1557	68.58	72.32	0.0232	-61.33
38	0.2105	47.00	223.25	0.1948	20.26	138.70	0.1419	56.63	138.70	0.0195	23.25
39	0.2432	47.00	193.22	0.0	0.0	131.50	0.0	0.0	131.50	0.0	-6.78
40	0.2121	63.67	300.14	0.0	0.0	249.13	0.0	0.0	249.13	0.0	101.14
41	0.2222	45.00	202.50	0.0	0.0	170.61	0.0	0.0	170.61	0.0	4.50
42	0.2286	15.20	66.50	0.0	0.0	38.60	0.0	0.0	38.60	0.0	-133.50
43	0.2353	15.00	63.75	0.0	0.0	36.40	0.0	0.0	36.40	0.0	-132.25
44	0.1892	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
45	0.2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
46	0.1563	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
47	0.1471	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
48	0.1515	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 4 3 9

TABLE 4.6.3

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

MEANS OVER 1 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	198.00	36.67	17.49	36.67	14.67	0.0
2	36.67	4.00	197.80	30.00	17.49	30.00	9.00	10.67
3	44.60	5.40	196.40	34.20	17.49	34.20	9.80	10.00
4	60.00	7.20	191.20	33.40	17.49	33.40	8.60	12.60
5	63.40	11.40	180.60	31.60	17.49	31.60	10.40	9.80
6	60.00	11.60	182.60	35.60	17.49	35.60	6.20	8.60
7	64.60	10.00	191.00	39.40	17.49	39.40	8.00	4.80
8	71.20	8.00	196.80	36.80	17.49	36.80	3.80	4.80
9	74.80	7.60	199.40	35.40	17.49	35.40	3.33	1.67
10	76.33	5.00	202.60	33.00	3.49	33.00	0.0	0.0

TABLE 4.6.8

MEANS OVER 1 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	33.88	0.5430	XXXXXX	0.0	0.1669	0.0	0.0	0.0	-6.12
2	0.1358	36.87	279.60	0.7798	135.31	157.74	0.2362	108.85	157.74	0.0702	78.27
3	0.1582	37.50	253.19	0.8044	61.27	138.15	0.2992	119.20	138.15	0.0874	56.79
4	0.2131	53.26	255.21	0.5150	9.00	119.86	0.2166	88.09	119.86	0.0482	64.11
5	0.3628	40.01	113.58	0.8869	78.80	38.98	0.2951	42.03	38.98	0.0878	-67.02
6	0.3265	56.40	178.41	0.3975	58.58	82.16	0.1971	50.67	82.16	0.0375	-4.19
7	0.2576	31.81	129.07	0.7777	122.90	56.92	0.3491	73.50	56.92	0.1260	-61.93
8	0.2182	47.87	225.11	0.3336	34.38	150.92	0.2067	65.49	150.92	0.0475	28.31
9	0.2151	25.07	66.55	0.0	0.0	49.12	0.0	0.0	49.12	0.0	-132.85
10	0.1516	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX

NUMBER OF INADMISSABLE ESTIMATES 0 0 9

TABLE 4.6.5

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	200.00	0.0	14.00	0.0	0.0	0.0
2	0.0	0.0	200.61	0.0	14.00	0.0	0.0	0.0
3	0.0	0.0	200.50	34.72	14.00	34.72	10.33	0.0
4	0.0	0.0	201.25	34.97	14.00	34.97	9.94	0.0
5	0.0	0.0	201.22	34.78	14.00	34.78	9.89	0.0
6	0.0	0.0	200.78	34.86	14.00	34.86	9.64	0.0
7	0.0	0.0	200.72	34.81	14.00	34.81	9.94	0.0
8	34.72	4.14	200.99	34.94	14.00	34.94	10.36	6.19
9	34.97	3.78	200.28	35.00	14.00	35.00	11.00	6.17
10	34.78	4.17	200.72	34.94	14.00	34.94	10.72	5.72
11	34.86	4.17	201.17	34.56	14.00	34.56	10.50	5.47
12	34.81	4.33	200.25	34.78	14.00	34.78	10.50	5.61
13	52.33	7.17	201.61	35.31	14.00	35.31	10.42	9.39
14	52.36	7.56	201.69	35.28	14.00	35.28	9.83	9.61
15	52.03	6.94	201.36	35.14	14.00	35.14	9.22	9.50
16	52.17	6.83	201.42	35.25	14.00	35.25	9.56	9.14
17	52.36	7.03	201.92	35.56	14.00	35.56	9.36	9.08
18	63.06	9.53	202.06	35.56	14.00	35.56	9.69	11.28
19	62.81	8.69	203.00	35.50	14.00	35.50	9.72	10.75
20	62.72	8.17	202.42	35.36	14.00	35.36	10.22	10.56
21	62.19	8.39	202.44	35.06	14.00	35.06	10.39	10.31
22	62.78	8.08	202.89	34.92	14.00	34.92	10.14	10.36
23	68.83	9.03	201.86	34.25	14.00	34.25	9.33	11.94
24	69.06	9.03	202.42	34.94	14.00	34.94	9.64	11.44
25	69.11	9.56	201.61	34.92	14.00	34.92	9.53	11.22
26	68.14	9.42	201.47	35.33	14.00	35.33	9.67	11.28
27	68.19	9.50	201.39	35.56	14.00	35.56	9.25	11.00
28	71.33	10.25	200.81	36.06	14.00	36.06	9.81	11.03
29	71.81	10.86	200.19	35.97	14.00	35.97	9.00	10.22
30	71.31	10.58	200.78	36.31	14.00	36.31	9.58	10.17
31	71.81	10.36	201.00	35.75	14.00	35.75	9.06	10.58
32	72.03	9.89	201.03	35.78	14.00	35.78	8.83	10.36
33	73.03	10.03	201.44	35.94	14.00	35.94	8.58	10.81
34	74.06	10.11	201.64	36.64	14.00	36.64	7.31	9.11
35	74.25	10.44	201.08	36.89	14.00	36.89	7.28	9.21
36	73.67	10.36	201.28	37.47	14.00	37.47	7.86	9.28
37	73.83	10.25	200.28	36.64	14.00	36.64	7.39	8.94
38	74.83	10.36	201.31	35.97	14.00	35.97	7.50	9.03
39	76.47	10.31	200.39	35.19	14.00	35.19	5.03	6.11
40	76.42	10.31	200.39	35.31	14.00	35.31	5.31	6.28
41	77.08	10.92	200.61	35.64	14.00	35.64	5.17	6.22
42	76.72	10.50	201.31	36.03	14.00	36.03	5.22	5.83
43	76.78	10.69	201.67	36.25	14.00	36.25	4.94	5.83
44	76.44	11.14	201.58	36.39	14.00	36.39	0.0	0.0
45	76.61	11.58	201.97	36.42	14.00	36.42	0.0	0.0
46	77.06	11.39	202.06	36.58	14.00	36.58	0.0	0.0
47	77.03	11.06	201.97	34.81	14.00	34.81	0.0	0.0
48	76.89	10.78	202.58	32.33	14.00	32.33	0.0	0.0
49	0.0	0.0	202.47	0.0	14.00	0.0	0.0	0.0
50	0.0	0.0	202.75	0.0	0.0	0.0	0.0	0.0

TABLE 4.6.6

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	0.09	0.0	0.01	0.0	0.0	0.0
2	0.0	0.0	3.34	0.0	0.01	0.0	0.0	0.0
3	0.0	0.0	4.86	5.09	0.01	5.09	3.31	0.0
4	0.0	0.0	5.96	5.03	0.01	5.03	2.94	0.0
5	0.0	0.0	6.78	5.59	0.01	5.59	2.83	0.0
6	0.0	0.0	7.40	5.62	0.01	5.62	2.93	0.0
7	0.0	0.0	7.79	4.89	0.01	4.89	2.32	0.0
8	5.09	1.85	8.41	4.88	0.01	4.88	2.89	3.21
9	5.03	1.71	8.91	4.50	0.01	4.50	2.63	2.52
10	5.59	1.40	9.43	4.88	0.01	4.88	3.16	2.47
11	5.62	1.95	9.01	5.19	0.01	5.19	2.63	2.22
12	4.89	1.64	9.55	5.23	0.01	5.23	2.76	2.13
13	7.61	2.72	10.73	4.95	0.01	4.95	2.80	3.03
14	7.26	3.01	11.01	5.95	0.01	5.95	2.61	2.95
15	6.30	2.61	10.93	5.69	0.01	5.69	3.14	3.44
16	6.48	2.30	11.06	5.82	0.01	5.82	3.15	2.89
17	6.11	2.13	11.19	6.60	0.01	6.60	2.87	2.52
18	6.87	2.63	10.26	5.91	0.01	5.91	3.12	2.85
19	7.22	3.21	10.74	6.43	0.01	6.43	3.08	2.99
20	7.31	3.23	10.62	6.63	0.01	6.63	3.32	3.20
21	7.27	2.93	10.53	6.45	0.01	6.45	3.01	3.22
22	7.84	2.67	11.40	5.73	0.01	5.73	3.19	3.06
23	7.58	3.07	11.42	6.17	0.01	6.17	2.93	3.27
24	8.02	2.46	11.14	6.05	0.01	6.05	3.15	2.50
25	8.01	2.67	12.16	5.32	0.01	5.32	2.82	2.65
26	8.16	3.06	12.31	5.78	0.01	5.78	3.00	3.20
27	7.99	2.84	11.79	5.51	0.01	5.51	3.05	3.49
28	8.74	3.07	11.02	5.44	0.01	5.44	3.06	3.61
29	8.74	2.98	10.30	5.94	0.01	5.94	3.01	3.55
30	8.06	2.49	9.99	4.82	0.01	4.82	3.32	3.46
31	8.32	2.42	10.04	4.53	0.01	4.53	3.29	4.00
32	8.01	2.84	10.27	5.11	0.01	5.11	2.54	3.77
33	7.99	2.77	10.60	5.09	0.01	5.09	2.36	3.54
34	8.36	2.94	9.76	5.88	0.01	5.88	2.39	3.43
35	8.43	2.94	9.74	6.02	0.01	6.02	2.33	3.26
36	8.17	3.61	8.72	6.42	0.01	6.42	2.74	2.95
37	8.10	3.01	8.29	6.22	0.01	6.22	3.05	2.83
38	8.39	3.34	8.91	5.08	0.01	5.08	2.17	2.71
39	8.52	3.00	9.82	4.64	0.01	4.64	2.04	2.54
40	9.65	2.96	8.59	5.51	0.01	5.51	1.80	2.08
41	9.61	2.73	8.29	5.59	0.01	5.59	2.06	2.64
42	9.51	3.21	8.68	5.91	0.01	5.91	1.68	2.71
43	9.35	3.12	8.53	5.32	0.01	5.32	1.77	2.70
44	8.77	3.07	7.94	5.08	0.01	5.08	0.0	0.0
45	9.63	2.98	7.96	5.24	0.01	5.24	0.0	0.0
46	9.28	3.67	7.79	5.75	0.01	5.75	0.0	0.0
47	9.33	3.19	9.21	5.43	0.01	5.43	0.0	0.0
48	9.47	3.12	8.51	5.63	0.01	5.63	0.0	0.0
49	0.0	0.0	8.44	0.0	0.01	0.0	0.0	0.0
50	0.0	0.0	9.60	0.0	0.0	0.0	0.0	0.0

TABLE 4.6.7

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERP(I)	BIASN(I)
1	0.0	0.0	183.46	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-16.54
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.6534	XXXXXX	0.0	0.2816	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.6414	XXXXXX	0.0	0.3042	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.6380	XXXXXX	0.0	0.3058	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.6193	XXXXXX	0.0	0.3015	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.6346	XXXXXX	0.0	0.2511	0.0	0.0	0.0	0.0
8	0.1196	25.43	236.11	0.6962	93.14	152.20	0.2827	201.56	152.20	0.0606	0.0
9	0.1081	23.19	291.42	0.7470	87.77	222.43	0.3078	200.03	222.43	0.0780	45.19
10	0.1196	22.84	209.40	0.7516	120.19	124.74	0.3035	158.05	124.74	0.0938	95.20
11	0.1201	21.93	214.39	0.7332	83.01	142.20	0.2939	150.73	142.20	0.0918	7.68
12	0.1258	22.74	213.82	0.7300	83.42	130.77	0.2624	120.25	130.77	0.0856	18.45
13	0.2015	38.76	222.67	0.7295	88.49	115.07	0.2721	117.34	115.07	0.0680	13.57
14	0.2129	40.87	226.48	0.6859	88.91	115.75	0.2721	136.00	115.75	0.0749	21.05
15	0.1977	43.75	262.36	0.6345	77.54	145.69	0.2539	101.77	145.69	0.0746	24.78
16	0.1928	40.71	215.57	0.6245	73.98	105.52	0.2494	93.61	105.52	0.0655	61.00
17	0.1971	40.77	215.97	0.6353	107.95	105.21	0.2465	112.74	105.21	0.0645	17.90
18	0.2403	50.08	225.34	0.6804	87.89	103.36	0.2635	99.97	103.36	0.0673	14.05
19	0.2416	49.18	223.45	0.6790	74.06	107.59	0.2582	92.67	107.59	0.0740	23.28
20	0.2274	44.85	214.45	0.6891	60.28	102.73	0.2517	86.19	102.73	0.0729	20.45
21	0.2369	42.95	194.06	0.7050	75.96	88.98	0.2552	120.42	88.98	0.0639	12.04
22	0.2317	44.08	235.54	0.7004	77.84	135.64	0.2572	98.99	135.64	0.0660	-8.38
23	0.2640	51.85	221.65	0.6457	67.76	107.89	0.2450	78.87	107.89	0.0685	32.66
24	0.2607	49.80	201.51	0.6702	55.51	88.14	0.2516	71.14	88.14	0.0620	19.79
25	0.2735	50.69	192.24	0.6517	63.14	82.72	0.2459	71.87	82.72	0.0649	-0.91
26	0.2629	50.67	199.27	0.6727	80.38	86.23	0.2540	78.00	86.23	0.0619	-9.37
27	0.2553	52.17	201.87	0.6541	83.22	88.92	0.2424	72.88	88.92	0.0660	-2.20
28	0.2830	50.77	187.97	0.6939	94.53	79.04	0.2632	70.35	79.04	0.0610	0.49
29	0.3013	51.40	176.92	0.7079	96.49	75.21	0.2676	68.43	75.21	0.0708	-12.84
30	0.2923	49.76	177.65	0.7011	92.98	74.37	0.2667	74.77	74.37	0.0766	-23.27
31	0.2911	54.80	203.22	0.6846	89.41	95.81	0.2714	81.38	95.81	0.0743	-23.13
32	0.2754	52.39	203.73	0.7003	81.96	93.34	0.2808	84.26	93.34	0.0775	2.32
33	0.2810	53.76	210.69	0.6515	78.92	94.47	0.2900	87.64	94.47	0.0832	2.79
34	0.2763	54.35	213.99	0.6235	79.72	105.13	0.2793	77.96	105.13	0.0882	9.25
35	0.2845	56.91	208.99	0.5958	74.40	99.10	0.2641	77.92	99.10	0.0852	12.35
36	0.2755	54.73	212.67	0.6260	55.55	104.37	0.2763	75.90	104.37	0.0742	7.90
37	0.2827	55.22	207.11	0.5850	61.38	104.16	0.2540	71.80	104.16	0.0814	11.40
38	0.2915	51.78	197.99	0.6445	70.37	96.12	0.3489	83.13	96.12	0.0698	6.84
39	0.2943	51.76	190.36	0.0	0.0	112.75	0.0	0.0	112.75	0.1391	-3.32
40	0.2930	49.18	182.65	0.0	0.0	103.10	0.0	0.0	103.10	0.0	-10.03
41	0.3077	51.41	173.52	0.0	0.0	96.97	0.0	0.0	96.97	0.0	-17.74
42	0.2922	48.20	170.16	0.0	0.0	94.90	0.0	0.0	94.90	0.0	-27.09
43	0.2954	50.57	187.77	0.0	0.0	108.47	0.0	0.0	108.47	0.0	-31.15
44	0.3074	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-13.90
45	0.3195	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
46	0.3098	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
47	0.3163	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
48	0.3329	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 171 196 324

TABLE 4.6.8

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	35.50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.50
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.2288	XXXXXX	0.0	0.1403	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.2250	XXXXXX	0.0	0.1078	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.2205	XXXXXX	0.0	0.1140	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.2089	XXXXXX	0.0	0.1215	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.1841	XXXXXX	0.0	0.0645	0.0	0.0	0.0359	0.0
8	0.0549	15.48	247.14	0.1963	165.05	211.84	0.0622	312.25	211.84	0.0366	238.98
9	0.0483	9.94	352.15	0.1655	117.44	388.36	0.0748	242.11	388.36	0.0485	347.87
10	0.0381	9.52	113.48	0.2082	154.88	81.88	0.0709	140.64	81.88	0.0458	112.91
11	0.0537	8.69	144.65	0.1939	101.17	145.51	0.0661	128.28	145.51	0.0419	140.68
12	0.0475	8.84	138.00	0.1856	80.36	105.38	0.0461	124.16	105.38	0.0256	136.08
13	0.0663	13.69	171.26	0.2038	104.73	141.73	0.0601	104.25	141.73	0.0352	169.52
14	0.0744	12.19	130.11	0.1794	156.15	97.29	0.0619	140.33	97.29	0.0355	128.50
15	0.0671	19.15	170.38	0.1905	94.77	146.76	0.0662	58.56	146.76	0.0383	167.53
16	0.0608	15.77	114.99	0.2061	84.28	67.66	0.0726	42.24	67.66	0.0446	106.08
17	0.0499	13.78	80.34	0.2108	227.70	48.73	0.0950	129.62	48.73	0.0701	78.63
18	0.0639	17.47	115.92	0.1965	105.85	72.31	0.0851	85.24	72.31	0.0605	114.36
19	0.0653	24.36	175.34	0.2121	72.78	131.93	0.0950	58.17	131.93	0.0669	173.97
20	0.0691	15.08	99.54	0.1987	73.20	77.29	0.0595	50.55	77.29	0.0326	99.57
21	0.0672	14.46	89.92	0.2123	69.70	66.63	0.0600	239.72	66.63	0.0335	89.00
22	0.0720	14.29	241.73	0.2390	72.99	284.47	0.0656	115.97	284.47	0.0372	241.89
23	0.0815	14.30	127.09	0.2211	74.07	124.35	0.0652	35.38	124.35	0.0371	127.18
24	0.0660	13.70	71.45	0.2189	56.30	44.41	0.0628	34.32	44.41	0.0324	69.93
25	0.0616	18.46	75.61	0.2040	63.57	47.47	0.0624	38.83	47.47	0.0323	77.61
26	0.0555	19.12	82.69	0.2239	162.93	51.30	0.0616	44.57	51.30	0.0328	83.95
27	0.0577	21.16	83.27	0.2319	100.25	51.35	0.0679	35.90	51.35	0.0359	84.42
28	0.0695	18.97	79.99	0.2182	119.14	49.47	0.0611	41.18	49.47	0.0349	79.82
29	0.0666	18.31	73.94	0.2403	102.12	49.18	0.0844	33.55	49.18	0.0529	71.06
30	0.0600	18.94	81.44	0.2261	88.11	48.08	0.0734	63.29	48.08	0.0439	80.31
31	0.0643	34.11	170.56	0.2141	95.65	139.43	0.0807	48.53	139.43	0.0494	168.51
32	0.0715	26.51	120.30	0.2151	76.82	81.03	0.0810	64.29	81.03	0.0488	119.08
33	0.0763	19.41	125.61	0.1813	85.33	79.51	0.0817	55.31	79.51	0.0519	125.51
34	0.0721	20.07	115.69	0.2545	83.11	76.26	0.0959	40.71	76.26	0.0572	116.12
35	0.0712	25.22	102.83	0.2106	89.92	60.96	0.0833	42.20	60.96	0.0525	103.41
36	0.0799	24.19	107.91	0.2399	67.34	84.68	0.0854	37.40	84.68	0.0493	107.72
37	0.0791	25.10	91.08	0.2610	44.77	69.11	0.0852	40.42	69.11	0.0477	99.83
38	0.0959	15.28	85.99	0.2517	83.56	60.82	0.1420	52.23	60.82	0.1026	83.79
39	0.0831	23.68	104.39	0.0	0.0	87.08	0.0	0.0	87.08	0.0	100.54
40	0.0904	21.36	100.97	0.0	0.0	82.10	0.0	0.0	82.10	0.0	97.65
41	0.0839	27.47	98.66	0.0	0.0	77.99	0.0	0.0	77.99	0.0	95.83
42	0.0787	25.20	81.46	0.0	0.0	62.01	0.0	0.0	62.01	0.0	83.02
43	0.0713	21.94	118.40	0.0	0.0	89.79	0.0	0.0	89.79	0.0	119.30
44	0.0775	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
45	0.0743	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
46	0.0947	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
47	0.0735	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
48	0.0731	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 4.6.9

PARAMETERS FOR THE SIMULATION
CAPTURE PROBABILITY AT TIME I=0.04
SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =0.93
PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =1.00
INITIAL POPULATION SIZE = 200
NUMBER OF SAMPLING PERIODS = 50
GROUPING INTERVAL= 5

SURVIVAL OVER 5 SAMPLING PERIODS =0.6955
BIRTHS OVER 5 SAMPLING PERIODS =70

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	200.72	34.82	17.49	34.82	10.06	0.0
2	34.82	4.03	200.68	34.91	17.49	34.91	10.33	6.03
3	45.28	6.03	201.22	35.01	17.49	35.01	10.09	7.92
4	58.62	7.85	202.16	35.44	17.49	35.44	9.71	10.16
5	66.39	8.82	202.24	34.82	17.49	34.82	9.81	11.06
6	70.16	10.12	200.93	35.84	17.49	35.84	9.46	10.74
7	73.19	10.17	201.24	36.20	17.49	36.20	8.21	10.03
8	75.04	10.32	200.73	36.12	17.49	36.12	6.62	7.93
9	76.73	10.97	201.43	36.14	17.49	36.14	5.11	5.56
10	76.99	11.07	202.37	34.57	3.49	34.57	0.0	0.0

TABLE 4.6.10

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	CM(I)	M(I)	CN(I)	NN(I)	B(I)	S(I)	R(I)	Z(I)
1	0.0	0.0	3.63	4.78	0.04	4.78	2.71	0.0
2	4.78	1.30	7.73	3.84	0.04	3.84	2.10	2.51
3	5.44	1.95	9.81	4.62	0.04	4.62	2.28	2.29
4	6.19	2.16	10.39	5.24	0.04	5.24	2.60	2.51
5	7.06	2.25	10.79	5.12	0.04	5.12	2.50	2.62
6	7.89	2.12	10.45	4.52	0.04	4.52	2.48	3.09
7	7.64	2.12	9.37	4.31	0.04	4.31	1.93	3.29
8	7.96	2.68	7.96	4.30	0.04	4.30	1.94	2.26
9	8.83	2.63	7.76	4.65	0.04	4.65	1.51	2.34
10	8.74	3.03	7.94	5.09	0.01	5.09	0.0	0.0

TABLE 4.6.11

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	36.69	0.6443	XXXXXX	0.0	0.2972	0.0	0.0	0.0	-3.31
2	0.1157	23.82	245.31	0.6897	145.86	166.45	0.2893	111.93	166.45	0.0648	47.36
3	C.1716	33.61	227.94	0.7026	84.27	129.90	0.2709	126.82	129.90	0.0737	27.77
4	0.2199	45.12	218.55	0.6617	80.83	104.88	0.2539	97.03	104.88	0.0685	17.54
5	C.2534	47.87	209.C0	0.6754	68.04	100.68	0.2510	88.26	100.68	0.0647	6.76
6	C.2810	50.95	188.74	0.6859	89.52	80.75	0.2588	72.88	80.75	0.C697	-12.19
7	C.2819	54.44	208.14	0.6511	80.88	97.57	0.2771	81.83	97.57	0.0817	6.91
8	C.2874	52.53	198.16	0.6185	62.43	104.10	0.2930	76.95	104.10	0.0968	-2.57
9	0.3C45	50.06	106.29	0.C	0.0	60.07	0.0	0.0	60.07	0.0	-95.14
10	0.3197	0.0	0.C	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX

NUMBER OF INADMISSABLE ESTIMATES 0 0 324

TABLE 4.6.12

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	C.0	0.0	7.10	0.2023	XXXXXX	0.0	0.0990	0.0	0.0	0.0	7.10
2	0.C387	10.67	207.C7	0.1333	107.93	201.47	0.0407	105.37	201.47	0.0236	211.37
3	C.C486	9.69	124.64	0.1359	81.25	105.37	0.0417	93.34	105.37	0.0241	122.65
4	C.C445	14.76	94.22	C.1498	83.92	61.52	0.0677	62.29	61.52	0.C479	92.50
5	0.C561	11.29	95.86	0.1699	37.83	99.61	0.0430	76.64	99.61	0.0227	96.02
6	0.C413	15.07	49.59	0.1747	86.79	27.66	0.0515	33.20	27.66	0.0296	48.86
7	0.C525	19.96	101.42	0.14C3	59.26	67.34	0.0561	40.54	67.34	0.0334	1C0.60
8	0.C723	14.95	66.69	0.2048	44.02	50.28	0.0767	37.78	50.28	0.0477	63.81
9	C.C614	20.37	43.73	0.C	0.0	32.42	0.0	0.0	32.42	0.C	43.81
10	0.C694	0.0	C.C	0.C	0.0	0.0	0.0	0.0	0.0	0.0	XXXX

TABLE 5.2.1

POOLED STATISTICS METHOD

N_0	ϕ	p	POOLED r_1/N_0	AVERAGE COEFFICIENT OF VARIATION OF $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	TRUE VALUE ϕ_1	B_1	ADEQUACY OF $\hat{V}$ FOR V OF $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	BIAS IN $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	TABLE REF.
200	0.99	0.03	0.07	55/202 =0.27	0.148/0.880 =0.17	40/52 =0.77	0.9510	10	YES	OVER	OVER	NO	YES	YES	5.2.2 5.2.3
200	0.93	0.04	0.06	83/204 =0.41	0.224/0.696 =0.32	63/79 =0.80	0.6955	70	YES	YES	OVER	NO	NO	NO	4.4.7 4.4.8
200	0.90	0.05	0.07	73/207 =0.35	0.224/0.610 =0.37	57/91 =0.63	0.5840	100	YES	YES	YES	NO	NO	NO	5.2.4 5.2.5
200	0.80	0.10	0.14	48/202 =0.24	0.150/0.389 =0.39	43/130 =0.33	0.3269	200	YES	UNDER	YES	NO	YES	YES	5.2.6 5.2.7
200	0.70	0.15	0.19	55/201 =0.27	0.103/0.250 =0.41	48/153 =0.31	0.1681	300	UNDER	UNDER	UNDER	NO	YES	YES	5.2.8 5.2.9
200	0.50	0.20	0.16	84/200 =0.43	0.075/0.131 =0.57	91/180 =0.51	0.0313	500	UNDER	UNDER	UNDER	NO	YES	YES	5.2.10 5.2.11
400	0.90	0.05	0.07	100/407 =0.24	0.152/0.627 =0.24	91/172 =0.53	0.5840	200	YES	YES	YES	NO	NO	NO	—

TABLE 5.2.2

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

PROBABILITY OF CAPTURE =0.03
SURVIVAL OVER 5 SAMPLING PERIODS =0.9510
BIRTHS OVER 5 SAMPLING PERIODS =10

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SNI(I)	SOP(I)	SDB(I)	SONGN(I)	PHIERR(I)	BIASN(I)
1	0.0605	0.0	291.70	0.8548	1.85	0.0	0.2084	0.0	0.0	0.0318	1.70
2	0.0796	6.02	75.07	0.8497	105.61	51.77	0.1934	89.52	0.0	0.0299	-116.92
3	0.1073	11.33	121.90	0.9716	81.95	79.84	0.1364	103.43	0.0	0.0316	-76.06
4	0.1444	17.20	148.71	0.9002	81.86	87.44	0.1848	116.61	0.0	0.0320	-51.37
5	0.1725	21.79	157.14	0.8389	71.03	84.69	0.1336	108.09	0.0	0.0322	-42.74
6	0.2000	27.14	160.60	0.9143	72.19	79.87	0.1394	100.71	0.0	0.0352	-39.29
7	0.2409	33.10	166.90	0.8352	70.25	77.64	0.1392	98.36	0.0	0.0350	-34.16
8	0.2439	37.57	174.88	0.9123	65.43	76.80	0.1996	102.65	0.0	0.0399	-25.40
9	0.2574	42.96	188.50	0.9035	71.71	81.50	0.2007	99.28	0.0	0.0409	-11.54
10	0.2640	47.50	190.40	0.8791	69.93	71.50	0.2045	88.24	0.0	0.0420	-9.76
11	0.2809	51.41	194.33	0.8952	57.91	70.43	0.2072	81.47	0.0	0.0432	-5.03
12	0.3023	55.53	194.37	0.9097	54.32	67.43	0.2142	81.34	0.0	0.0468	-5.63
13	0.3196	61.03	205.25	0.9719	43.83	71.31	0.2037	85.12	0.0	0.0445	4.95
14	0.3294	64.09	216.71	0.8955	45.46	77.28	0.2153	90.66	0.0	0.0475	15.60
15	0.3450	67.58	222.58	0.8910	34.35	80.50	0.2152	81.90	0.0	0.0473	22.36
16	0.3433	70.73	214.30	0.8770	29.92	71.37	0.2131	77.09	0.0	0.0462	14.02
17	0.3593	73.16	214.11	0.8737	35.13	69.79	0.2142	71.20	0.0	0.0462	13.84
18	0.3779	74.33	209.93	0.9194	33.68	62.53	0.2293	70.91	0.0	0.0533	0.90
19	0.3891	79.41	210.16	0.8760	31.90	67.25	0.2253	65.79	0.0	0.0512	10.13
20	0.4197	80.62	198.12	0.9130	35.38	57.54	0.2362	58.52	0.0	0.0564	-1.77
21	0.4597	84.50	190.12	0.9029	40.66	55.11	0.2453	57.59	0.0	0.0612	-9.91
22	0.4700	89.41	198.59	0.8625	33.56	58.60	0.2422	56.96	0.0	0.0600	-1.03
23	0.4805	95.42	204.55	0.8369	31.34	59.67	0.2409	53.17	0.0	0.0597	4.61
24	0.4976	94.03	195.95	0.8686	35.90	56.36	0.2512	52.40	0.0	0.0655	-3.72
25	0.5058	97.27	193.72	0.8572	36.59	53.62	0.2569	51.79	0.0	0.0687	-1.23
26	0.5132	102.27	202.32	0.8516	35.38	60.48	0.2533	48.89	0.0	0.0662	2.55
27	0.5227	98.23	191.01	0.9029	45.12	55.72	0.2718	48.28	0.0	0.0772	-8.71
28	0.5361	102.39	191.29	0.8772	43.75	56.72	0.2751	48.21	0.0	0.0783	-8.57
29	0.5431	105.93	197.39	0.8755	44.00	59.41	0.2834	46.99	0.0	0.0834	-2.69
30	0.5485	105.84	194.18	0.8750	51.01	59.45	0.2371	46.57	0.0	0.0846	-5.60
31	0.5594	105.71	191.91	0.8810	62.23	59.49	0.3054	49.10	0.0	0.0979	-7.40
32	0.5623	112.70	203.27	0.8869	59.16	64.73	0.3223	50.09	0.0	0.1086	4.30
33	0.5648	112.00	203.42	0.8659	55.44	66.11	0.3275	49.57	0.0	0.1132	4.39
34	0.5684	112.96	203.07	0.8809	66.63	63.85	0.3533	54.28	0.0	0.1276	3.60
35	0.5552	116.24	219.70	0.9123	58.43	73.01	0.3370	55.31	0.0	0.1579	10.98
36	0.5846	126.13	221.96	0.9419	73.64	81.71	0.3798	58.26	0.0	0.1540	22.07
37	0.5893	133.95	231.84	0.7363	78.05	91.25	0.3741	58.65	0.0	0.1518	32.20
38	0.6013	133.20	224.42	0.7872	116.08	90.52	0.3910	70.22	0.0	0.1637	24.75
39	0.6035	141.37	233.09	0.6940	111.60	104.70	0.3703	69.12	0.0	0.1608	38.23
40	0.6006	141.39	240.40	0.5319	130.19	109.37	0.3437	75.56	0.0	0.1518	40.57
41	0.5963	145.93	246.88	0.0	0.0	131.88	0.0	0.0	0.0	0.0	46.99
42	0.5892	142.71	247.19	0.0	0.0	141.12	0.0	0.0	0.0	0.0	47.35
43	0.5825	153.07	277.75	0.0	0.0	183.02	0.0	0.0	0.0	0.0	78.96
44	0.5831	149.22	257.16	0.0	0.0	175.04	0.0	0.0	0.0	0.0	57.77
45	0.5925	153.96	258.43	0.0	0.0	195.59	0.0	0.0	0.0	0.0	59.07
46	0.6068	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 597 332 200

TABLE 5.2.3

STANDARD DEVIATIONS OVER 35 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0416	0.0	25.30	0.1820	7.55	0.0	0.0392	0.0	0.0	0.0184	25.29
2	0.0423	2.59	52.12	0.1589	128.89	47.78	0.0308	78.87	0.0	0.0131	50.23
3	0.0575	4.12	73.04	0.1537	100.09	74.42	0.0356	88.32	0.0	0.0146	70.67
4	0.0656	4.95	97.40	0.1273	97.47	99.97	0.0309	113.09	0.0	0.0120	97.23
5	0.0732	5.93	97.01	0.1206	65.47	93.14	0.0340	147.01	0.0	0.0141	96.37
6	0.0682	7.01	115.82	0.1253	78.37	121.13	0.0287	157.50	0.0	0.0105	115.18
7	0.0790	7.54	122.09	0.1433	79.52	131.72	0.0309	144.16	0.0	0.0129	121.74
8	0.0740	7.60	95.39	0.1348	75.35	100.51	0.0339	141.98	0.0	0.0174	94.69
9	0.0831	9.81	99.61	0.1555	97.29	105.48	0.0413	103.12	0.0	0.0185	99.93
10	0.0745	11.53	60.61	0.1347	139.05	31.22	0.0399	40.30	0.0	0.0183	61.13
11	0.0694	14.16	84.03	0.1190	64.12	42.50	0.0373	37.94	0.0	0.0171	84.07
12	0.0792	14.77	71.22	0.1373	42.73	33.03	0.0412	37.36	0.0	0.0182	71.30
13	0.0900	15.35	73.11	0.1305	46.37	37.34	0.0418	53.73	0.0	0.0186	79.07
14	0.0934	15.45	99.61	0.1192	65.62	56.19	0.0467	89.31	0.0	0.0230	93.73
15	0.1045	17.62	139.66	0.1443	51.23	88.69	0.0421	56.96	0.0	0.0201	138.78
16	0.0942	15.72	66.14	0.1564	46.09	33.55	0.0398	36.74	0.0	0.0187	65.77
17	0.0922	12.81	55.41	0.1467	43.89	34.15	0.0347	25.39	0.0	0.0156	55.82
18	0.0739	16.10	45.54	0.1431	37.96	25.14	0.0417	32.20	0.0	0.0191	45.68
19	0.0786	15.90	63.17	0.1418	41.86	34.09	0.0352	30.96	0.0	0.0163	63.81
20	0.0794	15.89	49.90	0.1234	45.45	23.79	0.0371	23.37	0.0	0.0179	50.05
21	0.0919	17.80	49.20	0.1240	43.05	21.14	0.0410	25.68	0.0	0.0208	48.74
22	0.1093	21.75	56.62	0.1591	45.70	24.91	0.0452	24.77	0.0	0.0231	56.01
23	0.0992	23.14	56.71	0.1809	37.50	22.64	0.0546	22.42	0.0	0.0268	55.33
24	0.1050	24.64	52.39	0.1471	33.75	23.19	0.0565	25.17	0.0	0.0319	51.59
25	0.0981	23.79	58.29	0.1636	40.90	27.89	0.0595	22.66	0.0	0.0316	56.82
26	0.0899	29.30	56.08	0.1718	43.08	28.17	0.0532	17.97	0.0	0.0289	54.54
27	0.0771	27.01	56.14	0.1594	46.15	25.71	0.0615	15.09	0.0	0.0347	54.81
28	0.0922	32.30	53.46	0.1867	52.33	24.61	0.0604	15.26	0.0	0.0323	52.39
29	0.0898	28.44	49.18	0.1736	40.55	23.77	0.0607	15.25	0.0	0.0343	49.21
30	0.0913	35.57	57.43	0.1730	48.85	29.54	0.0517	14.83	0.0	0.0302	59.00
31	0.0914	35.64	53.50	0.1843	61.11	31.86	0.0719	16.85	0.0	0.0467	59.71
32	0.0875	29.55	54.63	0.1572	57.52	28.58	0.0732	19.15	0.0	0.0538	57.94
33	0.1060	27.21	57.69	0.1562	58.32	29.26	0.0819	17.54	0.0	0.0628	58.74
34	0.0905	26.48	54.91	0.1463	76.73	33.71	0.0759	20.91	0.0	0.0566	55.02
35	0.0809	29.34	59.79	0.1466	73.04	29.74	0.0940	21.05	0.0	0.0714	58.51
36	0.1017	40.54	76.71	0.1392	90.29	30.77	0.1025	24.93	0.0	0.0882	75.59
37	0.0975	44.47	81.16	0.2184	135.50	47.27	0.1130	35.12	0.0	0.0959	80.69
38	0.0930	50.47	80.21	0.2318	144.79	51.74	0.1081	47.97	0.0	0.0977	81.10
39	0.0909	51.57	87.65	0.2932	94.51	57.38	0.1577	34.22	0.0	0.1224	88.55
40	0.0909	45.44	89.93	0.2717	98.14	56.41	0.1379	39.53	0.0	0.1974	81.64
41	0.0846	57.50	109.31	0.0	0.0	111.59	0.0	0.0	0.0	0.0	99.95
42	0.0847	72.22	133.51	0.0	0.0	154.30	0.0	0.0	0.0	0.0	133.77
43	0.0817	90.37	156.58	0.0	0.0	185.26	0.0	0.0	0.0	0.0	156.46
44	0.0755	73.05	122.38	0.0	0.0	143.06	0.0	0.0	0.0	0.0	121.14
45	0.0846	89.34	129.87	0.0	0.0	153.63	0.0	0.0	0.0	0.0	128.17
46	0.0319	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.2.8

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

PROBABILITY OF CAPTURE =0.05
SURVIVAL OVER 5 SAMPLING PERIODS =0.5840
BIRTHS OVER 5 SAMPLING PERIODS =100

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SON(I)	SDP(I)	SOB(I)	SONGN(I)	PHIERR(I)	BIASN(I)
1	0.0822	0.0	207.82	0.5240	43.58	0.0	0.1874	0.0	0.0	0.0386	7.82
2	0.1177	10.70	114.92	0.5405	117.70	74.60	0.1831	75.56	0.0	0.0359	-85.47
3	0.1503	17.64	127.02	0.5913	102.77	59.16	0.1943	72.28	0.0	0.0385	-73.34
4	0.1653	23.31	153.87	0.5831	99.23	67.37	0.1925	68.48	0.0	0.0370	-45.63
5	0.1791	27.25	154.13	0.5797	99.32	61.34	0.1358	63.06	0.0	0.0349	-45.10
6	0.2027	31.05	152.91	0.6347	120.73	57.12	0.1385	64.36	0.0	0.0404	-47.20
7	0.2074	33.74	165.51	0.6173	108.23	61.53	0.1966	64.70	0.0	0.0397	-34.63
8	0.2195	37.94	175.32	0.6173	103.39	64.65	0.1956	65.92	0.0	0.0378	-24.73
9	0.2360	43.24	184.47	0.5802	113.71	67.83	0.1782	66.68	0.0	0.0326	-14.56
10	0.2455	44.03	187.33	0.6291	101.10	67.16	0.1994	71.56	0.0	0.0431	-12.14
11	0.2401	49.22	213.72	0.5971	86.53	73.64	0.1361	69.18	0.0	0.0352	13.45
12	0.2502	48.81	205.88	0.6424	85.55	73.06	0.2000	69.09	0.0	0.0424	6.99
13	0.2527	51.14	211.30	0.6637	95.85	74.83	0.2051	71.97	0.0	0.0443	12.85
14	0.2496	52.07	217.66	0.6219	84.14	73.91	0.1940	70.09	0.0	0.0385	18.99
15	0.2659	54.94	212.44	0.6001	91.48	73.72	0.1903	63.93	0.0	0.0385	14.02
16	0.2832	56.77	205.38	0.5934	94.53	69.67	0.1994	63.18	0.0	0.0386	6.02
17	0.2982	59.44	208.39	0.6200	95.41	70.77	0.2047	64.96	0.0	0.0445	9.42
18	0.3013	62.30	217.10	0.6180	99.51	74.37	0.2057	66.29	0.0	0.0442	18.94
19	0.3149	64.96	214.44	0.6257	104.76	74.31	0.2029	64.04	0.0	0.0418	16.69
20	0.2987	63.41	214.77	0.6093	99.43	73.65	0.1931	63.50	0.0	0.0400	15.33
21	0.2944	61.80	214.12	0.6308	95.06	73.72	0.1996	68.39	0.0	0.0412	14.06
22	0.2835	61.63	222.01	0.5664	92.42	77.39	0.1953	69.67	0.0	0.0415	21.84
23	0.2696	59.19	222.26	0.5988	82.52	79.81	0.1959	68.07	0.0	0.0415	22.73
24	0.2791	58.78	222.11	0.6029	74.72	77.80	0.1978	67.12	0.0	0.0421	22.30
25	0.2858	57.89	213.67	0.6118	71.09	74.34	0.2023	65.89	0.0	0.0440	13.81
26	0.2903	61.39	219.48	0.5338	83.11	76.38	0.1804	60.87	0.0	0.0345	18.76
27	0.2939	59.29	202.32	0.5725	91.59	68.68	0.1857	60.82	0.0	0.0368	1.57
28	0.2941	58.66	203.24	0.5763	101.93	70.13	0.1835	61.12	0.0	0.0350	2.52
29	0.3002	59.91	203.36	0.5694	105.13	70.71	0.1319	59.65	0.0	0.0341	2.79
30	0.2584	57.79	197.24	0.5678	91.78	66.50	0.1826	59.30	0.0	0.0349	-4.26
31	0.2929	55.26	197.87	0.6163	88.42	67.52	0.1947	60.27	0.0	0.0404	-4.38
32	0.2896	55.38	200.68	0.6665	89.78	68.17	0.2118	65.43	0.0	0.0486	-2.09
33	0.2517	56.53	211.15	0.6204	90.27	71.07	0.1994	65.24	0.0	0.0415	7.73
34	0.2862	56.03	209.80	0.6620	87.88	73.21	0.2131	60.63	0.0	0.0461	8.41
35	0.2955	56.95	197.64	0.6878	92.45	65.17	0.2220	59.92	0.0	0.0518	-3.75
36	0.3048	61.16	203.09	0.6741	99.23	67.88	0.2247	63.36	0.0	0.0548	1.37
37	0.3077	64.69	215.83	0.6607	115.03	74.77	0.2240	64.57	0.0	0.0566	14.69
38	0.3158	63.26	205.18	0.6799	164.13	69.46	0.2348	73.22	0.0	0.0613	5.26
39	0.3101	64.86	216.59	0.6131	173.09	76.08	0.2257	79.50	0.0	0.0597	16.51
40	0.3124	67.30	222.98	0.5120	215.49	80.12	0.1989	89.59	0.0	0.0456	23.37
41	0.3044	67.91	224.39	0.0	0.0	86.79	0.0	0.0	0.0	0.0	28.92
42	0.3031	74.37	250.40	0.0	0.0	102.77	0.0	0.0	0.0	0.0	51.35
43	0.3073	87.74	295.51	0.0	0.0	132.58	0.0	0.0	0.0	0.0	95.99
44	0.3145	91.15	303.66	0.0	0.0	150.30	0.0	0.0	0.0	0.0	102.35
45	0.3118	97.14	327.25	0.0	0.0	193.36	0.0	0.0	0.0	0.0	125.11
46	0.3157	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 166 57 192

TABLE 5.2.5

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SON(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0339	0.0	24.73	0.3559	141.06	0.0	0.1105	0.0	0.0	0.0332	24.72
2	0.0414	7.83	164.40	0.2917	59.42	172.25	0.0852	86.27	0.0	0.0376	164.79
3	0.0436	6.97	63.52	0.2602	60.74	42.77	0.0730	44.90	0.0	0.0295	64.81
4	0.0498	8.80	78.48	0.2349	59.46	47.23	0.0666	38.26	0.0	0.0282	77.16
5	0.0482	10.11	69.47	0.2268	73.56	33.64	0.0651	22.46	0.0	0.0263	69.23
6	0.0518	12.47	54.16	0.2409	73.61	22.91	0.0660	23.45	0.0	0.0253	54.80
7	0.0489	11.49	53.17	0.2238	65.45	25.83	0.0661	25.27	0.0	0.0284	53.79
8	0.0564	13.91	65.69	0.1929	75.53	31.91	0.0533	23.54	0.0	0.0228	65.47
9	0.0517	17.18	58.86	0.2389	78.83	29.84	0.0594	30.19	0.0	0.0213	59.38
10	0.0634	13.10	67.90	0.2257	53.49	36.28	0.0754	30.40	0.0	0.0409	70.04
11	0.0535	15.17	82.35	0.2078	61.99	44.85	0.0529	29.08	0.0	0.0206	83.32
12	0.0597	10.60	68.44	0.2322	62.52	35.57	0.0676	31.23	0.0	0.0294	70.70
13	0.0526	14.95	84.94	0.2412	73.71	45.64	0.0667	37.68	0.0	0.0309	86.24
14	0.0577	17.58	89.97	0.2019	80.25	46.66	0.0561	28.19	0.0	0.0231	83.15
15	0.0569	15.06	64.45	0.2300	61.49	30.68	0.0646	24.53	0.0	0.0265	65.08
16	0.0585	17.01	69.20	0.2211	62.36	32.34	0.0652	25.86	0.0	0.0292	63.73
17	0.0641	17.49	77.32	0.2078	56.07	34.24	0.0681	29.69	0.0	0.0317	74.89
18	0.0571	22.79	99.84	0.1828	96.71	43.50	0.0644	34.18	0.0	0.0323	95.99
19	0.0542	25.97	99.50	0.2092	65.28	47.48	0.0501	21.35	0.0	0.0217	96.39
20	0.0492	24.26	84.64	0.2533	65.02	39.29	0.0660	22.75	0.0	0.0271	80.45
21	0.0614	23.54	84.79	0.2481	80.71	39.64	0.0543	24.20	0.0	0.0223	82.05
22	0.0520	21.37	81.53	0.2683	58.82	35.74	0.0700	46.90	0.0	0.0284	79.43
23	0.0725	11.53	102.76	0.2494	51.72	60.05	0.0696	29.32	0.0	0.0296	103.87
24	0.0655	11.67	67.57	0.2346	55.64	34.88	0.0699	30.23	0.0	0.0315	67.58
25	0.0661	13.82	71.27	0.2116	46.56	38.01	0.0714	37.70	0.0	0.0325	69.17
26	0.0645	19.09	86.49	0.1319	61.55	44.43	0.0646	31.53	0.0	0.0289	84.33
27	0.0562	21.75	74.41	0.2238	67.57	34.95	0.0657	27.97	0.0	0.0295	72.32
28	0.0614	21.62	71.97	0.2349	67.66	35.20	0.0572	24.49	0.0	0.0204	70.00
29	0.0613	22.62	78.43	0.2254	99.95	39.56	0.0552	25.73	0.0	0.0212	77.96
30	0.0519	18.81	68.74	0.2063	53.24	33.59	0.0621	30.53	0.0	0.0247	67.52
31	0.0576	16.19	82.83	0.2416	45.23	43.36	0.0680	34.77	0.0	0.0278	82.28
32	0.0595	17.18	86.85	0.2410	61.19	46.63	0.0751	31.48	0.0	0.0369	97.57
33	0.0604	17.27	83.23	0.1909	51.96	40.93	0.0630	47.89	0.0	0.0282	83.51
34	0.0616	17.66	116.46	0.1782	53.02	66.20	0.0548	28.76	0.0	0.0251	117.64
35	0.0511	16.78	70.30	0.2264	53.90	33.33	0.0670	19.59	0.0	0.0322	71.05
36	0.0557	22.49	67.47	0.2512	50.99	23.95	0.0765	23.61	0.0	0.0374	68.14
37	0.0663	20.84	72.41	0.2806	95.46	34.48	0.0938	25.56	0.0	0.0416	73.15
38	0.0612	19.43	67.16	0.2711	103.27	23.94	0.0869	26.21	0.0	0.0453	67.70
39	0.0574	16.85	72.41	0.2875	161.19	35.98	0.1011	41.96	0.0	0.0494	73.27
40	0.0575	19.34	74.99	0.2466	203.07	30.47	0.0876	56.09	0.0	0.0397	74.38
41	0.0582	22.54	81.65	0.0	0.0	44.38	0.0	0.0	0.0	0.0	80.25
42	0.0705	32.03	122.13	0.0	0.0	72.94	0.0	0.0	0.0	0.0	110.89
43	0.0717	35.65	136.24	0.0	0.0	80.20	0.0	0.0	0.0	0.0	133.23
44	0.0661	45.90	183.97	0.0	0.0	125.35	0.0	0.0	0.0	0.0	181.63
45	0.0596	55.27	235.85	0.0	0.0	244.68	0.0	0.0	0.0	0.0	235.16
46	0.0601	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.2.6

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

PROBABILITY OF CAPTURE =0.10
SURVIVAL OVER 5 SAMPLING PERIODS =0.3269
BIRTHS OVER 5 SAMPLING PERIODS =200

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDR(I)	SDNGN(I)	PHIFRR(I)	BIASN(I)
1	0.1191	0.0	198.08	0.3485	51.28	0.0	0.0975	0.0	0.0	0.0086	-1.92
2	0.1666	17.92	111.89	0.3565	156.45	34.37	0.0947	45.36	0.0	0.0076	-88.88
3	0.1924	28.07	149.36	0.3851	133.54	41.74	0.0973	42.47	0.0	0.0085	-50.00
4	0.2165	34.49	161.41	0.3740	138.20	42.05	0.0917	42.74	0.0	0.0076	-39.11
5	0.2366	41.11	175.82	0.3275	142.06	43.95	0.0822	42.27	0.0	0.0057	-24.76
6	0.2545	46.76	184.60	0.3337	136.62	44.85	0.0832	42.53	0.0	0.0060	-17.34
7	0.2636	51.62	194.04	0.3342	130.11	46.99	0.0813	39.70	0.0	0.0056	-6.05
8	0.2724	50.86	186.73	0.3937	128.69	44.10	0.0922	41.54	0.0	0.0075	-13.83
9	0.2672	51.23	193.02	0.4154	127.02	46.69	0.0950	42.82	0.0	0.0080	-7.37
10	0.2680	51.94	196.59	0.4325	139.45	47.03	0.0993	43.36	0.0	0.0090	-3.08
11	0.2650	50.67	194.54	0.4152	140.48	46.00	0.0959	42.29	0.0	0.0081	-3.68
12	0.2700	51.36	191.46	0.3958	127.83	44.53	0.0910	40.68	0.0	0.0072	-6.18
13	0.2853	55.70	197.47	0.3874	125.75	45.23	0.0907	40.59	0.0	0.0070	-1.47
14	0.2921	58.91	203.19	0.3776	120.83	45.08	0.0881	42.53	0.0	0.0074	1.78
15	0.2899	62.73	219.02	0.3704	120.26	50.19	0.0869	42.75	0.0	0.0070	17.38
16	0.2934	62.83	218.30	0.3716	119.61	50.00	0.0856	39.46	0.0	0.0065	16.24
17	0.2974	59.39	201.14	0.3660	122.46	45.04	0.0852	39.13	0.0	0.0063	-1.30
18	0.2954	58.30	199.25	0.3661	125.73	45.10	0.0857	38.88	0.0	0.0068	-3.64
19	0.2922	56.34	193.79	0.3702	126.76	43.69	0.0857	39.84	0.0	0.0069	-8.04
20	0.2945	58.26	199.45	0.3833	125.56	45.46	0.0895	39.19	0.0	0.0077	-1.91
21	0.2977	57.88	196.19	0.3806	140.44	44.52	0.0897	40.59	0.0	0.0071	-5.23
22	0.2936	57.36	193.95	0.4149	142.74	43.77	0.0982	41.97	0.0	0.0088	-8.22
23	0.2852	56.03	195.80	0.3825	139.20	44.98	0.0925	41.70	0.0	0.0076	-5.34
24	0.2865	56.37	195.79	0.3745	134.69	45.73	0.0907	42.45	0.0	0.0075	-4.57
25	0.2780	55.38	198.93	0.3979	129.21	47.27	0.0967	44.96	0.0	0.0086	-1.96
26	0.2779	58.48	212.67	0.4100	119.68	51.92	0.0993	45.48	0.0	0.0089	11.14
27	0.2755	60.02	220.56	0.3797	126.29	53.51	0.0922	44.64	0.0	0.0078	20.90
28	0.2750	58.37	213.33	0.3736	115.93	51.15	0.0916	42.18	0.0	0.0075	13.08
29	0.2735	56.07	205.31	0.3822	125.86	48.44	0.0927	42.68	0.0	0.0078	5.20
30	0.2772	56.89	206.37	0.3772	117.87	48.02	0.0912	41.47	0.0	0.0075	5.90
31	0.2756	56.12	203.00	0.3788	126.35	47.26	0.0907	42.31	0.0	0.0074	2.33
32	0.2800	57.21	205.45	0.3617	128.60	48.00	0.0864	40.00	0.0	0.0065	4.89
33	0.2862	55.13	193.08	0.4045	125.46	44.55	0.0958	41.20	0.0	0.0084	-6.89
34	0.2845	57.39	202.99	0.3944	126.96	47.04	0.0919	40.03	0.0	0.0079	3.47
35	0.2875	55.78	194.42	0.3943	123.62	44.34	0.0939	40.97	0.0	0.0078	-5.86
36	0.2955	59.73	202.09	0.3842	116.69	46.66	0.0902	40.12	0.0	0.0071	2.45
37	0.2949	58.52	200.97	0.3714	116.98	46.12	0.0879	39.79	0.0	0.0070	0.70
38	0.2946	58.50	200.63	0.4037	137.32	45.73	0.0946	41.57	0.0	0.0083	0.86
39	0.3011	60.60	203.01	0.3756	148.41	46.46	0.0893	42.36	0.0	0.0078	3.87
40	0.3065	60.40	199.64	0.3701	210.32	45.99	0.0905	49.44	0.0	0.0078	-0.03
41	0.3051	57.88	191.35	0.0	0.0	44.49	0.0	0.0	0.0	0.0	-9.04
42	0.3080	58.89	191.10	0.0	0.0	44.73	0.0	0.0	0.0	0.0	-9.07
43	0.3021	65.18	215.71	0.0	0.0	53.31	0.0	0.0	0.0	0.0	14.43
44	0.2941	64.96	221.60	0.0	0.0	58.16	0.0	0.0	0.0	0.0	22.18
45	0.2880	79.93	280.71	0.0	0.0	83.62	0.0	0.0	0.0	0.0	80.99
46	0.2871	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 8 0 51

TABLE 5.2.7

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0362	0.0	17.60	0.2382	52.45	0.0	0.0530	0.0	0.0	0.0110	17.60
2	0.0373	9.12	60.84	0.1856	66.97	21.56	0.0410	17.67	0.0	0.0069	60.79
3	0.0396	10.70	66.95	0.1960	58.09	22.65	0.0426	14.42	0.0	0.0076	69.19
4	0.0373	12.52	62.52	0.1812	56.07	19.48	0.0379	12.68	0.0	0.0067	62.04
5	0.0362	13.83	61.87	0.1180	55.10	19.23	0.0263	12.33	0.0	0.0039	60.45
6	0.0387	16.12	64.84	0.1146	44.80	19.18	0.0280	12.66	0.0	0.0055	62.23
7	0.0431	22.61	73.02	0.1301	44.43	20.55	0.0267	11.09	0.0	0.0040	68.31
8	0.0415	19.25	64.89	0.1643	46.20	19.49	0.0277	12.32	0.0	0.0049	63.23
9	0.0429	18.33	65.22	0.1712	47.93	22.33	0.0311	11.86	0.0	0.0049	64.63
10	0.0421	14.43	56.36	0.1823	44.79	18.42	0.0330	12.26	0.0	0.0062	58.23
11	0.0427	10.46	47.41	0.1638	53.55	16.08	0.0291	11.93	0.0	0.0056	49.07
12	0.0464	15.21	50.78	0.1334	36.88	15.29	0.0243	11.10	0.0	0.0038	49.77
13	0.0506	14.39	50.01	0.1125	41.98	15.76	0.0209	9.63	0.0	0.0031	49.45
14	0.0483	14.08	47.77	0.1644	41.07	14.10	0.0317	11.08	0.0	0.0065	47.82
15	0.0541	15.09	50.63	0.1426	47.87	16.56	0.0286	13.49	0.0	0.0052	48.18
16	0.0512	15.98	61.47	0.1440	44.50	19.99	0.0251	9.07	0.0	0.0039	60.53
17	0.0453	12.64	40.51	0.1250	37.15	13.01	0.0226	8.58	0.0	0.0035	41.71
18	0.0418	12.17	43.17	0.1574	39.35	13.45	0.0311	8.19	0.0	0.0060	44.66
19	0.0369	13.99	46.31	0.1692	31.96	12.68	0.0330	9.69	0.0	0.0051	46.44
20	0.0421	14.63	52.79	0.1662	38.20	15.56	0.0339	10.19	0.0	0.0065	51.26
21	0.0332	13.34	48.35	0.1301	64.18	14.35	0.0261	9.26	0.0	0.0042	47.21
22	0.0384	17.25	46.48	0.1549	54.87	12.11	0.0326	11.22	0.0	0.0061	44.32
23	0.0409	17.51	49.89	0.1294	46.29	13.68	0.0276	9.37	0.0	0.0046	48.37
24	0.0428	16.60	46.90	0.1455	41.69	13.91	0.0305	9.56	0.0	0.0059	44.74
25	0.0455	14.94	45.98	0.1529	32.20	14.78	0.0307	15.83	0.0	0.0054	45.86
26	0.0434	18.75	69.36	0.1471	35.10	24.30	0.0281	12.73	0.0	0.0052	70.68
27	0.0381	18.23	69.10	0.1511	49.11	22.01	0.0284	11.72	0.0	0.0064	68.80
28	0.0428	16.44	56.53	0.1250	41.17	16.83	0.0264	10.47	0.0	0.0046	53.88
29	0.0405	15.41	49.75	0.1245	48.07	14.17	0.0296	8.86	0.0	0.0047	48.25
30	0.0433	13.81	42.24	0.1303	40.97	11.91	0.0294	7.00	0.0	0.0053	39.77
31	0.0397	14.41	40.68	0.1302	51.89	11.52	0.0279	11.57	0.0	0.0051	38.70
32	0.0363	17.86	62.02	0.1203	43.31	18.95	0.0267	9.96	0.0	0.0040	61.29
33	0.0300	15.43	51.10	0.1470	42.56	15.53	0.0317	11.60	0.0	0.0052	51.88
34	0.0337	15.32	56.06	0.1680	39.35	16.24	0.0337	9.13	0.0	0.0064	55.88
35	0.0395	13.27	41.87	0.1136	48.02	12.46	0.0242	13.13	0.0	0.0048	42.83
36	0.0408	15.40	62.70	0.1322	45.00	19.32	0.0233	10.92	0.0	0.0036	63.48
37	0.0388	13.33	53.65	0.1453	45.79	16.76	0.0274	11.06	0.0	0.0049	55.01
38	0.0470	16.60	60.49	0.1608	47.08	17.26	0.0304	8.44	0.0	0.0052	59.76
39	0.0471	14.54	47.34	0.1744	56.79	14.85	0.0354	11.52	0.0	0.0076	46.40
40	0.0483	15.64	52.90	0.1592	106.73	17.43	0.0341	15.89	0.0	0.0062	51.81
41	0.0439	15.66	50.17	0.0	0.0	15.29	0.0	0.0	0.0	0.0	48.94
42	0.0522	18.08	48.95	0.0	0.0	13.37	0.0	0.0	0.0	0.0	48.86
43	0.0457	21.09	61.22	0.0	0.0	17.46	0.0	0.0	0.0	0.0	57.63
44	0.0472	19.97	62.36	0.0	0.0	21.04	0.0	0.0	0.0	0.0	60.44
45	0.0463	31.08	111.44	0.0	0.0	48.30	0.0	0.0	0.0	0.0	112.49
46	0.0500	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.2.8

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

PROBABILITY OF CAPTURE =0.15
SURVIVAL OVER 5 SAMPLING PERIODS =0.1681
BIRTHS OVER 5 SAMPLING PERIODS =300

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.1462	0.0	197.55	0.1594	87.51	0.0	0.0391	0.0	0.0	0.0017	-2.44
2	0.1941	23.19	119.93	0.2339	178.13	27.00	0.0570	36.52	0.0	0.0023	-79.02
3	0.2203	33.34	148.81	0.2536	170.40	31.58	0.0589	36.48	0.0	0.0027	-50.80
4	0.2359	39.73	167.51	0.2563	153.91	34.92	0.0563	35.15	0.0	0.0024	-31.55
5	0.2495	45.58	182.72	0.2558	156.86	36.91	0.0558	36.90	0.0	0.0025	-17.64
6	0.2555	50.87	198.15	0.2270	157.83	39.67	0.0499	37.48	0.0	0.0020	-2.07
7	0.2622	53.48	203.95	0.2411	146.64	40.93	0.0523	36.95	0.0	0.0023	1.51
8	0.2632	54.63	207.36	0.2354	156.18	41.39	0.0525	36.36	0.0	0.0022	3.69
9	0.2615	50.62	193.78	0.2633	167.55	38.66	0.0573	38.63	0.0	0.0026	-8.08
10	0.2610	52.30	199.66	0.2826	154.66	40.23	0.0621	37.16	0.0	0.0029	-1.48
11	0.2631	53.14	201.68	0.2540	158.15	40.35	0.0568	36.41	0.0	0.0025	1.54
12	0.2619	50.63	193.90	0.2709	145.47	39.92	0.0597	37.10	0.0	0.0029	-6.35
13	0.2608	52.51	203.95	0.2465	140.36	41.58	0.0545	38.29	0.0	0.0023	3.00
14	0.2641	56.34	216.43	0.2436	154.31	43.92	0.0543	38.45	0.0	0.0025	18.66
15	0.2619	54.27	210.49	0.2380	146.48	42.68	0.0527	37.80	0.0	0.0022	10.85
16	0.2593	53.57	203.79	0.2316	155.72	42.41	0.0508	36.69	0.0	0.0022	9.71
17	0.2609	51.32	196.70	0.2392	158.84	39.56	0.0526	35.90	0.0	0.0021	-2.35
18	0.2620	43.95	188.77	0.2652	153.90	39.08	0.0579	37.82	0.0	0.0026	-9.90
19	0.2592	52.55	204.64	0.2563	150.60	41.56	0.0562	36.05	0.0	0.0024	5.62
20	0.2615	50.71	195.30	0.2761	155.10	39.08	0.0592	37.14	0.0	0.0028	-4.75
21	0.2634	52.79	202.09	0.2496	147.78	40.26	0.0540	36.23	0.0	0.0023	3.70
22	0.2667	54.43	204.07	0.2589	142.74	40.40	0.0563	36.03	0.0	0.0027	5.04
23	0.2703	54.92	203.08	0.2391	138.39	40.09	0.0522	34.76	0.0	0.0022	2.58
24	0.2697	54.10	201.41	0.2436	153.00	39.50	0.0525	36.97	0.0	0.0022	0.02
25	0.2673	55.73	208.68	0.2668	162.50	41.28	0.0577	36.65	0.0	0.0026	7.48
26	0.2646	52.13	196.88	0.2647	162.34	38.92	0.0587	37.28	0.0	0.0026	-3.76
27	0.2616	50.07	193.78	0.2652	150.50	39.18	0.0592	35.57	0.0	0.0027	-6.58
28	0.2556	47.20	186.11	0.2558	159.39	37.58	0.0576	39.03	0.0	0.0026	-15.72
29	0.2553	51.06	201.21	0.2233	165.52	41.67	0.0505	41.17	0.0	0.0022	2.18
30	0.2555	54.64	215.60	0.2153	153.79	45.03	0.0491	39.64	0.0	0.0021	18.11
31	0.2561	53.92	212.76	0.2423	139.20	44.84	0.0557	37.40	0.0	0.0024	13.10
32	0.2508	49.90	209.27	0.2623	146.31	42.24	0.0592	39.05	0.0	0.0028	0.16
33	0.2477	50.35	206.65	0.2270	145.26	44.41	0.0510	38.98	0.0	0.0021	6.81
34	0.2478	50.54	207.95	0.2323	154.20	44.28	0.0524	38.23	0.0	0.0021	8.95
35	0.2472	48.43	177.72	0.2439	141.06	41.30	0.0541	35.63	0.0	0.0026	-0.89
36	0.2519	46.87	189.19	0.2658	162.98	38.92	0.0582	38.51	0.0	0.0028	-7.92
37	0.2568	49.91	195.32	0.2481	154.71	39.77	0.0549	36.23	0.0	0.0025	-4.93
38	0.2624	49.47	190.65	0.2680	149.26	38.40	0.0585	37.38	0.0	0.0029	-9.59
39	0.2615	52.37	200.55	0.2258	153.99	40.93	0.0511	37.04	0.0	0.0022	0.52
40	0.2703	50.15	187.63	0.2540	134.86	38.24	0.0565	43.01	0.0	0.0032	-10.67
41	0.2695	54.33	211.84	0.0	0.0	44.73	0.0	0.0	0.0	0.0	13.18
42	0.2622	51.97	200.68	0.0	0.0	42.16	0.0	0.0	0.0	0.0	0.90
43	0.2655	52.32	197.63	0.0	0.0	41.74	0.0	0.0	0.0	0.0	-0.39
44	0.2670	55.31	203.84	0.0	0.0	45.44	0.0	0.0	0.0	0.0	10.06
45	0.2645	59.19	230.50	0.0	0.0	53.45	0.0	0.0	0.0	0.0	31.23
46	0.2710	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 11 0 38

TABLE 5.2.9

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SON(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0269	0.0	12.03	0.1698	50.90	0.0	0.0375	0.0	0.0	0.0032	12.02
2	0.0343	10.14	52.89	0.1339	50.86	14.55	0.0283	6.80	0.0	0.0022	52.80
3	0.0386	14.44	51.75	0.1261	47.16	12.12	0.0268	8.43	0.0	0.0028	51.73
4	0.0381	16.38	53.50	0.1201	46.46	14.28	0.0227	9.32	0.0	0.0022	57.00
5	0.0369	16.78	60.19	0.1190	48.42	13.67	0.0236	8.42	0.0	0.0023	60.03
6	0.0353	16.46	57.21	0.0963	46.33	14.00	0.0185	8.10	0.0	0.0015	54.89
7	0.0354	15.16	50.49	0.1208	47.83	12.35	0.0227	7.56	0.0	0.0022	49.92
8	0.0370	14.30	45.92	0.0818	59.54	11.77	0.0194	10.04	0.0	0.0017	44.16
9	0.0434	15.30	50.37	0.1088	63.35	12.66	0.0212	9.79	0.0	0.0021	49.92
10	0.0435	16.87	53.65	0.0703	51.63	12.75	0.0153	9.05	0.0	0.0015	52.66
11	0.0361	13.01	45.15	0.0827	48.08	10.72	0.0184	8.65	0.0	0.0019	45.10
12	0.0347	14.24	49.49	0.1057	44.23	12.08	0.0217	9.47	0.0	0.0023	49.43
13	0.0377	15.18	60.68	0.0813	47.71	15.64	0.0170	10.79	0.0	0.0015	59.72
14	0.0303	16.57	69.63	0.1218	42.70	17.14	0.0233	8.64	0.0	0.0022	68.07
15	0.0358	14.45	58.24	0.0932	47.22	14.44	0.0198	9.08	0.0	0.0018	56.19
16	0.0418	14.54	52.45	0.1239	41.67	13.63	0.0235	8.33	0.0	0.0022	49.77
17	0.0393	13.90	45.26	0.0968	43.46	11.58	0.0181	8.87	0.0	0.0014	44.50
18	0.0322	11.93	49.11	0.0902	42.48	13.44	0.0166	8.75	0.0	0.0015	47.51
19	0.0303	12.44	47.86	0.0764	41.70	13.26	0.0177	8.97	0.0	0.0015	45.33
20	0.0372	14.37	52.03	0.1085	52.38	12.80	0.0204	9.46	0.0	0.0019	49.80
21	0.0327	13.41	51.84	0.0975	38.18	12.85	0.0182	8.17	0.0	0.0016	48.35
22	0.0338	14.90	49.32	0.1182	50.50	11.19	0.0239	8.03	0.0	0.0023	48.74
23	0.0342	13.18	49.02	0.0983	45.33	10.08	0.0191	7.87	0.0	0.0017	38.00
24	0.0318	12.53	44.28	0.1069	48.14	10.64	0.0202	9.84	0.0	0.0018	41.59
25	0.0275	16.72	59.74	0.1298	46.85	14.81	0.0208	8.52	0.0	0.0020	53.57
26	0.0315	13.85	47.54	0.0834	52.90	11.04	0.0179	12.36	0.0	0.0016	45.62
27	0.0366	14.98	61.99	0.1026	56.14	17.48	0.0207	10.68	0.0	0.0018	62.39
28	0.0347	13.62	53.11	0.0873	65.34	13.40	0.0200	11.35	0.0	0.0018	50.11
29	0.0397	15.04	50.68	0.0969	61.23	15.59	0.0227	11.73	0.0	0.0024	59.05
30	0.0379	14.00	58.13	0.0374	43.01	16.18	0.0208	10.97	0.0	0.0016	59.21
31	0.0383	10.99	50.21	0.0903	47.05	16.53	0.0184	10.86	0.0	0.0019	50.57
32	0.0329	15.77	64.83	0.1024	51.91	17.99	0.0214	11.76	0.0	0.0020	67.57
33	0.0377	14.23	64.46	0.1063	50.25	19.21	0.0203	12.42	0.0	0.0015	65.34
34	0.0369	13.98	64.99	0.0939	48.46	19.60	0.0177	9.15	0.0	0.0016	65.93
35	0.0414	12.97	48.04	0.1301	46.80	13.62	0.0268	10.92	0.0	0.0029	50.34
36	0.0417	12.07	52.19	0.1274	58.23	15.65	0.0250	9.56	0.0	0.0024	50.40
37	0.0429	16.41	57.03	0.1257	58.55	13.80	0.0245	10.24	0.0	0.0024	55.13
38	0.0415	15.52	58.65	0.1215	65.52	14.40	0.0227	10.63	0.0	0.0025	57.96
39	0.0365	15.13	53.55	0.1050	61.00	13.39	0.0221	11.24	0.0	0.0021	52.76
40	0.0350	13.86	53.78	0.1442	80.21	14.25	0.0321	14.35	0.0	0.0049	54.15
41	0.0313	14.45	64.69	0.0	0.0	13.17	0.0	0.0	0.0	0.0	64.31
42	0.0355	16.57	69.63	0.0	0.0	13.69	0.0	0.0	0.0	0.0	66.48
43	0.0433	19.66	73.38	0.0	0.0	19.49	0.0	0.0	0.0	0.0	71.17
44	0.0434	17.83	65.45	0.0	0.0	19.14	0.0	0.0	0.0	0.0	64.32
45	0.0439	16.07	79.05	0.0	0.0	26.28	0.0	0.0	0.0	0.0	79.79
46	0.0359	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.2.10

MEANS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

PROBABILITY OF CAPTURE =0.20
SURVIVAL OVER 5 SAMPLING PERIODS =0.0313
BIRTHS OVER 5 SAMPLING PERIODS =500

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SON(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.1140	0.0	205.53	0.0348	126.16	0.0	0.0124	0.0	0.0	0.0003	5.53
2	0.1477	19.68	132.71	0.1064	231.57	33.57	0.0316	57.03	0.0	0.0010	-68.07
3	0.1617	28.44	176.64	0.1135	230.05	44.03	0.0314	52.31	0.0	0.0008	-25.58
4	0.1696	34.00	205.73	0.1099	176.36	50.93	0.0303	46.73	0.0	0.0007	4.87
5	0.1719	34.43	201.92	0.1462	154.50	49.33	0.0414	48.27	0.0	0.0013	0.61
6	0.1668	35.65	217.24	0.1259	157.94	56.02	0.0348	54.53	0.0	0.0009	16.08
7	0.1616	38.05	244.74	0.1313	204.47	64.23	0.0363	56.17	0.0	0.0011	42.41
8	0.1569	33.96	213.45	0.1340	130.25	56.49	0.0381	50.15	0.0	0.0010	17.28
9	0.1572	31.70	197.55	0.1352	132.96	48.38	0.0390	49.83	0.0	0.0011	-3.29
10	0.1607	29.57	182.25	0.1276	130.40	45.84	0.0365	47.79	0.0	0.0010	-18.86
11	0.1544	29.77	181.74	0.1169	147.22	45.20	0.0315	50.40	0.0	0.0008	-18.23
12	0.1680	38.78	231.91	0.1099	178.52	57.33	0.0300	49.37	0.0	0.0008	31.63
13	0.1701	36.76	216.63	0.1255	180.28	52.77	0.0347	50.21	0.0	0.0009	14.75
14	0.1706	36.97	218.80	0.1290	177.43	53.96	0.0356	48.86	0.0	0.0010	16.22
15	0.1696	34.20	203.21	0.1339	191.30	50.16	0.0377	49.61	0.0	0.0010	2.69
16	0.1657	31.99	187.62	0.1221	173.70	46.43	0.0341	48.31	0.0	0.0009	-13.01
17	0.1694	34.29	201.65	0.1148	169.50	49.23	0.0325	48.22	0.0	0.0009	2.66
18	0.1731	35.70	207.24	0.1328	142.97	50.79	0.0369	44.05	0.0	0.0011	7.55
19	0.1703	34.45	202.80	0.1271	151.97	50.20	0.0356	47.39	0.0	0.0009	3.33
20	0.1695	35.83	216.11	0.1281	167.04	53.71	0.0351	45.60	0.0	0.0010	16.22
21	0.1743	34.35	199.78	0.1497	175.37	43.35	0.0403	46.87	0.0	0.0012	-0.38
22	0.1755	32.91	191.55	0.1255	179.66	46.32	0.0359	44.99	0.0	0.0008	-3.11
23	0.1743	29.07	168.95	0.1230	199.86	41.01	0.0347	48.93	0.0	0.0008	-30.91
24	0.1747	30.32	176.31	0.1298	202.59	43.17	0.0353	48.53	0.0	0.0009	-24.52
25	0.1745	33.63	189.86	0.1365	134.82	45.36	0.0381	49.56	0.0	0.0011	-9.56
26	0.1634	34.11	202.26	0.1512	192.20	50.57	0.0427	52.53	0.0	0.0017	1.62
27	0.1620	32.44	201.84	0.1447	170.00	51.46	0.0403	51.70	0.0	0.0016	3.07
28	0.1623	35.15	213.98	0.1204	159.96	55.42	0.0344	51.74	0.0	0.0009	19.73
29	0.1631	35.40	223.62	0.1313	175.80	58.36	0.0339	50.87	0.0	0.0011	23.59
30	0.1608	32.97	210.02	0.1371	195.23	54.69	0.0389	54.07	0.0	0.0014	11.91
31	0.1618	35.35	218.97	0.1287	192.21	55.38	0.0368	50.45	0.0	0.0010	20.36
32	0.1642	31.43	196.65	0.1572	191.79	50.11	0.0438	48.56	0.0	0.0013	-3.74
33	0.1645	31.99	194.92	0.1313	184.07	48.28	0.0369	50.32	0.0	0.0010	-4.52
34	0.1644	32.68	202.04	0.1399	176.25	50.23	0.0373	50.72	0.0	0.0012	1.68
35	0.1679	36.32	221.98	0.1247	177.61	55.05	0.0341	49.34	0.0	0.0010	22.65
36	0.1710	36.75	217.85	0.1256	198.01	52.91	0.0341	50.77	0.0	0.0010	18.69
37	0.1723	37.35	219.23	0.1171	163.85	53.01	0.0323	46.39	0.0	0.0007	18.04
38	0.1733	35.62	203.44	0.1371	202.00	50.56	0.0381	48.74	0.0	0.0010	6.47
39	0.1691	34.36	203.53	0.1443	214.21	48.66	0.0398	52.20	0.0	0.0012	2.72
40	0.1696	34.45	203.78	0.1243	235.21	49.39	0.0343	57.78	0.0	0.0009	2.31
41	0.1726	36.58	212.62	0.0	0.0	51.91	0.0	0.0	0.0	0.0	13.95
42	0.1739	32.57	188.01	0.0	0.0	46.03	0.0	0.0	0.0	0.0	-13.24
43	0.1728	38.40	227.02	0.0	0.0	57.64	0.0	0.0	0.0	0.0	26.80
44	0.1725	40.98	240.80	0.0	0.0	61.55	0.0	0.0	0.0	0.0	40.22
45	0.1637	41.99	258.89	0.0	0.0	71.21	0.0	0.0	0.0	0.0	59.39
46	0.1636	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 31 0 49

TABLE 5.2.11

STANDARD DEVIATIONS OVER 36 REPLICATIONS
POOLED STATISTICS METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0219	0.0	17.21	0.0760	65.20	0.0	0.0247	0.0	0.0	0.0010	17.20
2	0.0254	9.70	64.33	0.0793	123.52	19.92	0.0239	24.71	0.0	0.0015	64.30
3	0.0241	10.91	59.64	0.0652	80.67	17.60	0.0180	18.32	0.0	0.0008	59.36
4	0.0269	10.57	71.34	0.0558	68.48	20.85	0.0144	15.48	0.0	0.0007	68.03
5	0.0255	13.72	77.20	0.0684	63.77	22.40	0.0191	19.16	0.0	0.0013	77.03
6	0.0254	17.69	110.41	0.0637	94.81	33.51	0.0173	25.50	0.0	0.0007	110.11
7	0.0232	16.54	121.03	0.0776	97.16	38.79	0.0188	20.27	0.0	0.0012	120.15
8	0.0252	13.43	87.83	0.0920	75.87	26.59	0.0207	14.24	0.0	0.0011	88.46
9	0.0278	13.95	72.28	0.0684	88.77	18.61	0.0171	19.73	0.0	0.0012	71.97
10	0.0251	12.77	67.60	0.0719	87.13	18.46	0.0183	21.15	0.0	0.0009	69.03
11	0.0260	14.08	93.86	0.0663	73.94	25.69	0.0163	18.83	0.0	0.0008	93.27
12	0.0245	17.17	101.21	0.0631	77.46	28.41	0.0162	12.79	0.0	0.0009	99.76
13	0.0249	13.34	78.29	0.0480	81.18	21.22	0.0142	17.40	0.0	0.0008	76.38
14	0.0257	15.75	93.87	0.0646	92.56	26.13	0.0175	15.61	0.0	0.0009	91.82
15	0.0255	15.68	91.16	0.0656	112.14	26.53	0.0170	21.29	0.0	0.0009	87.19
16	0.0195	12.68	75.91	0.0624	88.46	21.77	0.0184	14.70	0.0	0.0011	73.13
17	0.0242	13.93	77.82	0.0698	73.47	20.71	0.0197	15.87	0.0	0.0015	76.10
18	0.0247	14.52	81.66	0.0750	61.10	22.14	0.0189	16.00	0.0	0.0016	78.25
19	0.0235	15.83	91.03	0.0491	77.64	24.85	0.0139	20.65	0.0	0.0008	90.18
20	0.0214	16.50	112.25	0.0901	65.76	32.54	0.0213	14.86	0.0	0.0015	111.26
21	0.0250	14.68	87.28	0.0812	78.93	24.34	0.0197	14.96	0.0	0.0016	84.97
22	0.0218	11.89	77.63	0.0577	85.88	21.50	0.0163	16.08	0.0	0.0007	76.23
23	0.0261	10.49	65.07	0.0542	107.26	19.31	0.0148	19.70	0.0	0.0007	64.80
24	0.0287	10.39	74.41	0.0641	125.85	25.78	0.0155	20.73	0.0	0.0008	73.16
25	0.0261	13.39	67.25	0.0683	93.27	17.35	0.0190	19.38	0.0	0.0012	65.87
26	0.0252	14.64	82.41	0.1083	100.13	23.83	0.0282	19.48	0.0	0.0038	81.32
27	0.0250	13.51	82.64	0.1002	90.39	22.92	0.0252	22.78	0.0	0.0030	81.37
28	0.0188	15.87	105.55	0.0529	75.75	32.44	0.0137	25.38	0.0	0.0008	106.80
29	0.0212	13.33	129.57	0.0700	93.87	41.65	0.0215	25.13	0.0	0.0012	129.42
30	0.0269	13.65	97.89	0.0825	83.61	32.76	0.0238	23.03	0.0	0.0019	98.62
31	0.0297	15.63	103.78	0.0541	90.28	34.80	0.0156	21.55	0.0	0.0008	103.74
32	0.0291	12.30	95.89	0.0942	80.68	33.24	0.0268	18.04	0.0	0.0012	96.94
33	0.0280	13.56	81.36	0.0608	99.30	24.15	0.0153	22.51	0.0	0.0007	80.15
34	0.0254	14.90	99.55	0.0709	76.31	28.67	0.0179	17.90	0.0	0.0011	97.44
35	0.0259	12.07	85.13	0.0715	71.00	25.85	0.0188	18.53	0.0	0.0013	85.94
36	0.0251	14.26	89.24	0.0720	95.95	24.47	0.0189	18.14	0.0	0.0010	83.89
37	0.0239	13.67	80.74	0.0492	66.80	21.72	0.0133	17.73	0.0	0.0005	79.66
38	0.0239	15.51	93.21	0.0697	87.68	27.42	0.0194	20.99	0.0	0.0009	97.89
39	0.0269	14.22	83.12	0.0705	94.84	22.36	0.0201	21.29	0.0	0.0012	81.27
40	0.0236	13.09	76.27	0.0619	113.81	20.82	0.0161	23.68	0.0	0.0009	74.03
41	0.0253	16.75	95.75	0.0	0.0	26.50	0.0	0.0	0.0	0.0	93.75
42	0.0261	12.57	68.42	0.0	0.0	11.34	0.0	0.0	0.0	0.0	65.91
43	0.0289	13.34	85.70	0.0	0.0	27.07	0.0	0.0	0.0	0.0	84.09
44	0.0310	15.63	95.31	0.0	0.0	29.78	0.0	0.0	0.0	0.0	92.38
45	0.0327	15.81	116.62	0.0	0.0	44.62	0.0	0.0	0.0	0.0	115.31
46	0.0284	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
47	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.3.1

REDUCED CAPTURE HISTORY METHOD

N_0	ϕ	p	r_1/N_0	AVERAGE COEFFICIENT OF VARIATION OF $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	TRUE VALUE ϕ_1	B_1	ADEQUACY OF $\hat{V}$ FOR V OF $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	BIAS IN $\hat{N}_1$	$\hat{\phi}_1$	$\hat{B}_1$	TABLE REF.
200	0.99	0.03	0.05	91/214 =0.43	.154/0.841 =0.18	80/49 =1.60	0.9510	10	YES	OVER	OVER	NO	YES	YES	5.3.2 5.3.3
200	0.93	0.04	0.04	105/206 =0.51	.206/0.671 =0.31	85/81 =1.1	0.6955	70	YES	YES	YES	NO	NO	NO	4.6.7 4.6.8
200	0.90	0.05	0.05	100/209 =0.48	.224/0.590 =0.38	82/88 =0.93	0.5840	100	YES	YES	YES	NO	NO	NO	5.3.4 5.3.5
200	0.80	0.10	0.07	69/179 =0.39	.124/0.340 =0.37	60/122 =0.49	0.3269	200	YES	YES	YES	NO	NO	YES	5.3.6 5.3.7
200	0.70	0.15	0.06	87/181 =0.48	.074/0.170 =0.44	84/155 =0.54	0.1681	300	YES	YES	UNDER	NO	NO	YES	5.3.8 5.3.9
200	0.50	0.20	0.02	190/176 =1.08	.046/0.046 =1.00	149/162 =0.92	0.0313	500	UNDER	UNDER	UNDER	YES	YES	YES	5.3.10 5.3.11
400	0.90	0.05	0.05	119/383 =0.31	.137/0.528 =0.26	92/185 =0.50	0.5840	200	YES	YES	YES	N)	NO	NO	—

TABLE 5.3.2

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

PROBABILITY OF CAPTURE =0.03
SURVIVAL OVER 5 SAMPLING PERIODS =0.9510
BIRTHS OVER 5 SAMPLING PERIODS =10

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	EIASN(I)
1	0.0	0.0	185.07	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-14.93
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.8653	XXXXXX	0.0	0.2291	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.8853	XXXXXX	0.0	0.1973	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.8952	XXXXXX	0.0	0.2217	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.8896	XXXXXX	0.0	0.2004	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.8876	XXXXXX	0.0	0.1958	0.0	0.0	0.0369	0.0
8	0.1335	26.28	209.66	0.8956	58.56	116.13	0.2236	150.61	116.13	0.0489	15.64
9	0.1518	27.34	221.00	0.8802	68.78	132.36	0.2216	129.48	132.36	0.0476	20.86
10	0.1552	26.81	183.41	0.9083	73.19	93.03	0.2325	165.51	93.03	0.0544	-7.36
11	0.1441	27.40	232.64	0.8810	86.78	147.83	0.2301	195.03	147.83	0.0528	44.81
12	0.1388	27.08	230.42	0.8771	100.71	144.29	0.2079	150.06	144.29	0.0435	42.61
13	0.2475	48.60	215.95	0.8933	56.89	88.14	0.2263	108.74	88.14	0.0515	15.65
14	0.2522	48.75	218.04	0.8960	59.83	92.82	0.2345	110.13	92.82	0.0558	17.93
15	0.2461	49.86	226.46	0.8573	45.19	97.13	0.2253	126.75	97.13	0.0512	26.24
16	0.2385	48.67	247.69	0.8528	53.33	116.82	0.2297	147.40	116.82	0.0540	47.42
17	0.2418	47.89	253.43	0.8874	54.03	125.44	0.2169	124.18	125.44	0.0478	53.16
18	0.3179	65.96	225.39	0.8929	36.77	80.24	0.2349	91.05	80.24	0.0559	25.36
19	0.3116	64.17	222.88	0.8774	40.52	82.67	0.2370	85.04	82.67	0.0566	22.85
20	0.3220	63.87	204.57	0.9001	46.16	72.11	0.2464	86.26	72.11	0.0625	4.68
21	0.3030	65.19	221.70	0.8936	32.38	83.01	0.2508	87.70	83.01	0.0640	21.67
22	0.3193	65.61	216.06	0.8960	44.06	79.85	0.2509	76.44	79.85	0.0641	16.34
23	0.4151	80.26	203.88	0.8960	37.95	66.59	0.2751	67.23	66.59	0.0776	3.93
24	0.4246	82.60	205.60	0.8656	45.54	72.13	0.2784	69.98	72.13	0.0803	5.93
25	0.4132	83.60	211.79	0.8247	35.97	74.20	0.2662	63.52	74.20	0.0743	11.85
26	0.4217	82.19	201.16	0.8639	30.91	68.65	0.2756	64.82	68.65	0.0782	1.38
27	0.4208	81.95	207.15	0.8504	40.54	73.19	0.2756	61.08	73.19	0.0804	7.43
28	0.4782	95.74	205.21	0.8459	39.22	67.83	0.3020	60.23	67.83	0.0995	5.35
29	0.4738	92.83	206.27	0.8788	56.62	81.22	0.3282	61.89	81.22	0.1198	6.50
30	0.4911	90.87	188.23	0.8450	61.71	67.87	0.3140	56.12	67.87	0.1049	-11.55
31	0.4843	89.72	191.26	0.8400	48.01	67.80	0.3128	55.84	67.80	0.1042	-8.04
32	0.4838	91.78	195.09	0.8289	44.08	72.08	0.3049	51.54	72.08	0.0968	-3.89
33	0.5241	99.31	195.53	0.8535	48.36	69.44	0.3530	54.37	69.44	0.1336	-3.50
34	0.5160	111.23	224.46	0.8228	44.88	94.24	0.3777	54.70	94.24	0.1571	24.99
35	0.5090	101.10	208.20	0.7976	34.68	95.31	0.3620	52.21	95.31	0.1387	8.48
36	0.5113	97.35	197.90	0.8336	67.65	87.52	0.3839	61.05	87.52	0.1576	-1.99
37	0.5119	95.57	193.38	0.8190	84.37	80.22	0.3927	60.87	80.22	0.1700	-6.26
38	0.5613	111.73	203.15	0.7836	44.92	87.75	0.5033	56.62	87.75	0.2823	3.49
39	0.5619	109.76	201.51	0.0	0.0	134.61	0.0	0.0	134.61	0.0	1.65
40	0.5679	101.90	181.80	0.0	0.0	112.58	0.0	0.0	112.58	0.0	-18.03
41	0.5738	121.77	218.30	0.0	0.0	133.31	0.0	0.0	133.31	0.0	18.41
42	0.5615	122.29	231.51	0.0	0.0	119.14	0.0	0.0	119.14	0.0	31.67
43	0.5785	106.07	187.11	0.0	0.0	113.69	0.0	0.0	113.69	0.0	-12.59
44	0.5632	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
45	0.5560	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
46	0.5444	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
47	0.5565	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
48	0.5896	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 514 380 325

TABLE 5.3.3

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	29.40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.39
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.1292	XXXXXX	0.0	0.1563	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.1263	XXXXXX	0.0	0.1665	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.1127	XXXXXX	0.0	0.1475	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1210	XXXXXX	0.0	0.1598	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.1249	XXXXXX	0.0	0.0343	0.0	0.0	0.0154	0.0
8	0.0567	6.92	93.63	0.1291	79.28	72.89	0.0328	104.86	72.89	0.0151	86.55
9	0.0617	6.70	140.19	0.1445	108.52	150.55	0.0344	89.35	150.55	0.0155	138.69
10	0.0641	6.79	76.70	0.1362	86.43	55.13	0.0474	159.20	55.13	0.0238	73.31
11	0.0710	7.83	160.11	0.1371	158.97	165.96	0.0503	207.64	165.96	0.0266	158.25
12	0.0619	7.94	169.03	0.1184	195.10	176.22	0.0434	127.88	176.22	0.0202	166.20
13	0.0751	12.96	95.73	0.1259	68.86	57.74	0.0401	78.46	57.74	0.0197	95.84
14	0.0926	13.01	120.82	0.1352	62.62	84.53	0.0443	85.46	84.53	0.0211	120.16
15	0.0824	13.19	103.95	0.1346	53.95	74.67	0.0460	117.32	74.67	0.0225	104.01
16	0.0537	11.28	161.60	0.1297	73.55	122.86	0.0505	177.11	122.86	0.0268	160.30
17	0.1040	12.37	190.49	0.1430	76.62	162.36	0.0410	126.57	162.36	0.0196	189.60
18	0.0930	13.54	79.62	0.1372	53.86	42.57	0.0413	46.00	42.57	0.0203	79.20
19	0.0942	10.84	68.20	0.1384	67.13	41.44	0.0390	35.59	41.44	0.0191	69.96
20	0.0688	14.84	51.27	0.1519	64.48	28.41	0.0509	34.80	28.41	0.0275	51.61
21	0.0666	14.78	71.88	0.1246	45.45	41.21	0.0456	39.28	41.21	0.0243	72.30
22	0.0737	15.03	72.12	0.1211	67.80	41.77	0.0449	34.09	41.77	0.0240	72.52
23	0.0977	16.22	61.44	0.1280	42.08	32.14	0.0516	38.23	32.14	0.0298	61.48
24	0.1089	25.44	73.13	0.1631	102.48	39.28	0.0607	41.34	39.28	0.0376	73.25
25	0.0993	25.26	75.89	0.1782	43.14	39.67	0.0673	30.63	39.67	0.0390	74.92
26	0.1030	23.41	51.82	0.1475	32.56	28.48	0.0561	37.75	28.48	0.0337	50.83
27	0.1047	22.80	76.72	0.1819	55.00	45.99	0.0729	32.68	45.99	0.0433	76.19
28	0.0951	26.84	60.63	0.1698	53.63	32.98	0.0970	41.56	32.98	0.0831	59.28
29	0.0870	31.20	101.86	0.1750	89.40	84.73	0.1143	46.82	84.73	0.1023	101.87
30	0.0896	28.42	59.08	0.1978	73.20	33.06	0.0846	25.55	33.06	0.0599	58.50
31	0.0973	20.93	53.54	0.1785	67.49	29.76	0.0853	25.49	29.76	0.0597	54.02
32	0.0979	33.65	69.86	0.1900	51.81	43.15	0.0685	23.04	43.15	0.0438	71.05
33	0.1077	32.99	70.00	0.1944	53.16	41.98	0.0995	27.96	41.98	0.0623	70.67
34	0.1052	56.31	133.27	0.2432	64.62	109.32	0.1246	31.22	109.32	0.0908	133.95
35	0.1120	35.47	92.60	0.2275	46.38	84.47	0.0931	23.91	84.47	0.0746	92.90
36	0.1022	38.02	87.07	0.2032	99.69	71.96	0.1062	34.74	71.96	0.0879	85.89
37	0.0917	29.91	72.61	0.1930	216.97	42.25	0.1305	49.81	42.25	0.1111	70.89
38	0.0998	43.97	76.97	0.2332	67.21	50.81	0.1746	36.78	50.81	0.2087	75.97
39	0.0954	52.13	108.44	0.0	0.0	121.80	0.0	0.0	121.80	0.0	106.86
40	0.0939	45.55	80.77	0.0	0.0	90.21	0.0	0.0	90.21	0.0	80.01
41	0.1066	65.87	119.02	0.0	0.0	123.99	0.0	0.0	123.99	0.0	119.24
42	0.0907	92.07	222.95	0.0	0.0	96.99	0.0	0.0	96.99	0.0	223.10
43	0.0882	39.51	76.06	0.0	0.0	81.66	0.0	0.0	81.66	0.0	75.93
44	0.0875	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
45	0.0862	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
46	0.0793	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
47	0.0932	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
48	0.0924	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.3.8

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

PROBABILITY OF CAPTURE =0.05
SURVIVAL OVER 5 SAMPLING PERIODS =0.5840
BIRTHS OVER 5 SAMPLING PERIODS =100

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SON(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	177.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-22.48
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.5155	XXXXXX	0.0	0.3151	0.0	0.0	-0.0000	0.0
4	0.0	0.0	0.0	0.5121	XXXXXX	0.0	0.3230	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.5751	XXXXXX	0.0	0.2949	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.5539	XXXXXX	0.0	0.2973	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.5357	XXXXXX	0.0	0.2206	0.0	0.0	0.0469	0.0
8	0.1363	22.81	182.96	0.5384	120.27	102.31	0.2585	128.73	102.31	0.0686	-12.75
9	0.1194	22.00	212.53	0.5813	95.07	129.87	0.2573	166.32	129.87	0.0655	13.51
10	0.1183	24.57	249.00	0.6016	94.38	170.07	0.2585	148.78	170.07	0.0657	49.53
11	0.1333	23.92	207.47	0.6209	103.59	130.01	0.2543	115.90	130.01	0.0663	7.19
12	0.1428	23.03	174.08	0.6260	96.76	91.28	0.2442	100.48	91.28	0.0640	-24.81
13	0.1374	37.24	222.46	0.5865	91.16	123.93	0.2248	92.91	123.93	0.0504	24.02
14	0.1377	34.57	203.69	0.5975	72.59	101.91	0.2333	86.18	101.91	0.0569	5.02
15	0.1795	36.26	210.65	0.6082	73.07	100.78	0.2368	96.02	100.78	0.0587	12.24
16	0.1733	36.05	219.65	0.6482	84.29	107.10	0.2490	89.27	107.10	0.0639	19.69
17	0.1929	37.20	199.68	0.6365	87.06	91.57	0.2402	79.94	91.57	0.0604	0.71
18	0.2231	40.96	194.77	0.5891	71.18	85.32	0.2276	69.36	85.32	0.0533	-3.40
19	0.2386	41.11	182.29	0.6307	100.82	79.94	0.2366	80.15	79.94	0.0565	-15.46
20	0.2340	43.17	200.37	0.6263	117.66	91.38	0.2510	90.02	91.38	0.0666	0.92
21	0.2390	43.24	215.57	0.5734	112.33	102.47	0.2303	84.42	102.47	0.0563	15.51
22	0.2340	48.09	213.10	0.5658	95.65	102.19	0.2161	68.31	102.19	0.0479	12.93
23	0.2439	44.37	182.45	0.6318	105.98	79.28	0.2440	83.16	79.28	0.0623	-17.07
24	0.2243	43.48	206.19	0.5821	80.10	95.24	0.2341	91.49	95.24	0.0588	6.39
25	0.2267	44.25	227.76	0.5396	73.01	110.71	0.2144	88.36	110.71	0.0466	27.90
26	0.2181	42.48	219.44	0.5512	76.90	103.66	0.2180	78.69	103.66	0.0486	19.72
27	0.2232	41.35	198.55	0.5682	76.89	89.26	0.2332	80.22	89.26	0.0563	-2.20
28	0.2262	44.31	214.38	0.5311	78.65	100.78	0.2197	73.40	100.78	0.0495	14.16
29	0.2360	44.34	192.19	0.5340	105.01	89.87	0.2128	72.61	89.87	0.0478	-8.98
30	0.2401	43.62	183.62	0.5909	121.35	87.08	0.2364	77.75	87.08	0.0567	-17.88
31	0.2391	42.94	195.17	0.5906	118.91	86.91	0.2343	76.91	86.91	0.0580	-17.08
32	0.2379	42.21	183.00	0.5688	95.14	80.97	0.2259	70.19	80.97	0.0523	-19.78
33	0.2339	40.93	185.40	0.6262	92.81	82.37	0.2537	77.93	82.37	0.0685	-13.02
34	0.2232	40.26	196.54	0.6159	83.47	94.54	0.2479	87.35	94.54	0.0656	-4.85
35	0.2074	42.99	220.49	0.5739	57.66	108.27	0.2452	86.16	108.27	0.0685	19.10
36	0.2129	43.17	222.11	0.5561	86.74	109.83	0.2331	92.34	109.83	0.0561	20.39
37	0.2250	42.68	198.50	0.5782	71.89	90.58	0.2425	72.60	90.58	0.0621	-2.64
38	0.2342	45.57	201.78	0.6186	104.09	94.07	0.3194	87.27	94.07	0.1216	1.86
39	0.2455	47.73	193.56	0.0	0.0	113.09	0.0	0.0	113.09	0.0	-1.12
40	0.2520	44.18	174.51	0.0	0.0	93.37	0.0	0.0	93.37	0.0	-25.10
41	0.2463	44.42	195.33	0.0	0.0	118.75	0.0	0.0	118.75	0.0	-4.09
42	0.2529	44.35	182.33	0.0	0.0	99.98	0.0	0.0	99.98	0.0	-16.73
43	0.2427	50.66	221.30	0.0	0.0	139.98	0.0	0.0	139.98	0.0	20.77
44	0.2482	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
45	0.2579	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
46	0.2607	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
47	0.2769	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
48	0.2947	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 92 99 325

TABLE 5.3.5

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	28.78	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.78
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.1998	XXXXXX	0.0	0.0914	0.0	0.0	0.0000	0.0
4	0.0	0.0	0.0	0.1918	XXXXXX	0.0	0.0713	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.2492	XXXXXX	0.0	0.0957	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.2398	XXXXXX	0.0	0.0991	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.2178	XXXXXX	0.0	0.0751	0.0	0.0	0.0354	0.0
8	0.0595	19.13	101.77	0.2133	154.93	73.75	0.0900	111.54	73.75	0.0552	97.40
9	0.0429	8.77	136.35	0.1838	124.51	119.66	0.0762	189.07	119.66	0.0475	137.08
10	0.0488	11.81	199.73	0.2026	81.40	212.93	0.0747	153.50	212.93	0.0440	200.96
11	0.0484	12.33	147.81	0.2316	76.30	143.44	0.0840	98.18	143.44	0.0472	146.83
12	0.0470	10.46	91.13	0.1949	67.23	61.38	0.0909	77.66	61.38	0.0659	99.85
13	0.0605	23.91	177.54	0.1943	67.50	200.30	0.0610	74.44	200.30	0.0294	177.06
14	0.0561	11.72	130.02	0.2150	73.01	113.55	0.0764	39.76	113.55	0.0428	132.58
15	0.0361	10.79	79.92	0.2258	80.24	56.80	0.0776	41.09	56.80	0.0409	81.57
16	0.0518	11.36	75.20	0.2293	84.76	52.91	0.0695	31.32	52.91	0.0364	75.54
17	0.0446	10.12	62.78	0.2222	82.42	36.54	0.0741	37.13	36.64	0.0399	65.81
18	0.0622	14.97	80.76	0.1945	44.84	47.67	0.0639	38.78	47.67	0.0362	90.70
19	0.0634	15.13	82.59	0.1598	74.01	48.24	0.0632	46.74	48.24	0.0322	79.47
20	0.0606	15.94	103.18	0.2169	123.19	66.14	0.0778	51.79	66.14	0.0465	103.48
21	0.0574	19.95	104.96	0.2405	94.18	64.75	0.0744	43.44	64.75	0.0399	102.30
22	0.0550	24.24	107.36	0.2377	72.48	73.08	0.0614	24.48	73.08	0.0263	105.73
23	0.0614	16.24	63.27	0.2436	81.99	37.48	0.0716	40.18	37.48	0.0362	61.36
24	0.0590	13.50	81.39	0.2391	62.33	50.80	0.0909	74.16	50.80	0.0422	80.73
25	0.0745	11.50	136.46	0.2082	84.06	96.53	0.0581	54.59	96.53	0.0252	137.00
26	0.0622	13.13	116.40	0.1957	69.35	72.25	0.0619	42.34	72.25	0.0311	115.03
27	0.0525	11.61	83.57	0.1793	56.42	48.75	0.0690	42.10	48.75	0.0363	80.13
28	0.0562	17.16	95.08	0.1940	61.49	61.94	0.0663	40.03	61.94	0.0328	92.67
29	0.0519	20.23	85.93	0.2383	104.56	53.70	0.0745	34.15	58.70	0.0384	84.59
30	0.0542	25.39	90.78	0.2318	91.01	70.77	0.0770	34.25	70.77	0.0377	89.12
31	0.0693	20.44	79.69	0.2340	102.11	58.16	0.0774	35.87	58.16	0.0368	77.28
32	0.0516	15.93	62.41	0.1903	65.65	36.47	0.0674	32.48	36.47	0.0319	63.19
33	0.0631	16.07	82.25	0.2314	68.67	49.94	0.0855	44.94	49.94	0.0503	80.56
34	0.0575	19.28	119.62	0.2676	84.45	77.44	0.0810	48.44	77.44	0.0468	120.43
35	0.0534	17.79	108.71	0.2559	43.48	69.47	0.1058	55.75	69.47	0.0590	108.57
36	0.0599	17.80	121.37	0.1774	126.30	79.96	0.0721	50.12	79.96	0.0412	122.53
37	0.0492	18.60	95.22	0.1994	56.29	56.04	0.0749	35.73	56.04	0.0437	95.75
38	0.0499	18.54	93.46	0.2642	93.46	57.20	0.1499	55.34	57.20	0.1234	92.40
39	0.0589	25.92	110.64	0.0	0.0	84.94	0.0	0.0	84.94	0.0	108.05
40	0.0633	22.44	70.04	0.0	0.0	54.80	0.0	0.0	54.80	0.0	68.93
41	0.0597	21.33	140.64	0.0	0.0	166.05	0.0	0.0	166.05	0.0	143.17
42	0.0564	17.29	86.19	0.0	0.0	75.30	0.0	0.0	75.30	0.0	89.60
43	0.0554	27.82	142.09	0.0	0.0	142.31	0.0	0.0	142.81	0.0	140.45
44	0.0540	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
45	0.0662	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
46	0.0641	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
47	0.0706	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
48	0.0746	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.3.6

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

PROBABILITY OF CAPTURE =0.10
SURVIVAL OVER 5 SAMPLING PERIODS =0.3269
BIRTHS OVER 5 SAMPLING PERIODS =200

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SON(I)	SDP(I)	SDB(I)	SONGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	163.42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-36.58
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.3501	XXXXXX	0.0	0.2701	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.3192	XXXXXX	0.0	0.2485	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.3004	XXXXXX	0.0	0.2429	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.3090	XXXXXX	0.0	0.2301	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.3163	XXXXXX	0.0	0.1252	0.0	0.0	0.0137	0.0
8	0.1402	26.04	190.52	0.3224	141.95	82.68	0.1349	80.29	82.68	0.0187	-10.03
9	0.1406	24.01	183.01	0.3279	139.36	88.08	0.1258	68.35	88.08	0.0140	-17.38
10	0.1522	23.51	159.77	0.3461	130.73	65.99	0.1346	70.06	65.99	0.0156	-39.90
11	0.1353	24.50	185.06	0.3605	122.37	85.76	0.1321	68.38	85.76	0.0162	-13.17
12	0.1357	24.97	188.68	0.3532	111.30	76.66	0.1209	64.81	76.66	0.0128	-8.96
13	0.1605	29.83	201.01	0.3644	111.71	77.61	0.1278	64.82	77.61	0.0143	2.07
14	0.1564	29.30	198.31	0.3585	111.74	79.06	0.1291	61.62	79.06	0.0159	-3.10
15	0.1705	30.75	185.40	0.3581	123.79	72.39	0.1262	60.47	72.39	0.0145	-16.24
16	0.1761	31.94	186.04	0.3233	117.23	72.73	0.1170	56.29	72.73	0.0130	-16.01
17	0.1835	31.87	178.26	0.3191	120.30	67.17	0.1116	54.52	67.17	0.0118	-24.18
18	0.1911	34.39	184.80	0.3494	130.92	65.80	0.1211	57.47	65.80	0.0135	-18.09
19	0.1905	33.48	182.76	0.3325	118.32	67.91	0.1158	57.86	67.91	0.0123	-19.07
20	0.1862	33.47	189.33	0.3244	119.07	73.91	0.1149	56.10	73.91	0.0119	-12.03
21	0.1820	30.93	176.35	0.3466	132.31	67.36	0.1228	59.37	67.36	0.0137	-25.07
22	0.1814	30.78	176.90	0.3601	136.27	66.40	0.1295	66.90	66.40	0.0180	-25.36
23	0.1856	34.43	194.12	0.3412	137.76	77.45	0.1228	59.81	77.45	0.0142	-7.02
24	0.1866	32.08	175.96	0.3378	127.91	66.31	0.1231	58.25	66.31	0.0139	-24.40
25	0.1810	31.19	176.81	0.3283	121.24	67.12	0.1239	62.76	67.12	0.0146	-24.08
26	0.1764	32.86	192.70	0.3203	123.24	77.77	0.1192	63.72	77.77	0.0133	-8.83
27	0.1754	33.35	196.84	0.3474	127.27	81.00	0.1315	70.86	81.00	0.0166	-2.83
28	0.1741	32.37	198.88	0.3570	146.74	83.94	0.1349	71.28	83.94	0.0176	-1.37
29	0.1710	31.22	185.20	0.3367	127.77	73.05	0.1244	60.48	73.05	0.0146	-14.91
30	0.1748	30.84	180.28	0.3228	111.94	69.28	0.1199	57.29	69.28	0.0133	-20.19
31	0.1671	30.33	184.45	0.3320	118.40	71.74	0.1227	60.51	71.74	0.0137	-16.22
32	0.1760	32.47	193.65	0.3009	103.44	77.40	0.1078	63.97	77.40	0.0104	-6.91
33	0.1674	33.23	217.83	0.3378	114.03	91.51	0.1215	60.21	91.51	0.0137	17.85
34	0.1736	31.42	183.86	0.3519	121.28	73.30	0.1200	52.34	73.30	0.0120	-10.67
35	0.1749	30.10	171.68	0.3594	128.90	62.03	0.1247	56.75	62.03	0.0150	-28.59
36	0.1755	31.41	180.62	0.3876	132.82	66.20	0.1326	55.77	66.20	0.0175	-19.02
37	0.1833	28.61	159.72	0.3633	119.77	56.80	0.1314	57.79	56.80	0.0165	-40.55
38	0.1846	32.82	184.11	0.3676	133.13	71.14	0.1406	64.77	71.14	0.0205	-15.66
39	0.1838	32.86	184.20	0.0	0.0	75.29	0.0	0.0	75.29	0.0	-14.94
40	0.1829	33.44	190.14	0.0	0.0	78.23	0.0	0.0	78.23	0.0	-9.53
41	0.1862	36.29	201.67	0.0	0.0	92.59	0.0	0.0	92.59	0.0	1.28
42	0.1936	32.95	178.45	0.0	0.0	72.82	0.0	0.0	72.82	0.0	-21.72
43	0.1814	34.51	197.98	0.0	0.0	86.63	0.0	0.0	86.63	0.0	-3.30
44	0.1870	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
45	0.1910	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
46	0.1821	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
47	0.2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
48	0.2346	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 2 1 324

TABLE 5.3.7

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	17.29	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.28
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.1302	[illegible]	0.0	0.0703	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.1443	[illegible]	0.0	0.0797	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.1083	[illegible]	0.0	0.0577	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1573	[illegible]	0.0	0.0760	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.1105	[illegible]	0.0	0.0380	0.0	0.0	0.0	0.0
8	0.0338	9.71	69.14	0.1188	90.92	51.25	0.0666	0.0	0.0	0.0088	0.0
9	0.0450	10.31	82.79	0.1184	67.66	87.79	0.0423	74.79	51.25	0.0232	65.68
10	0.0502	9.09	49.26	0.1160	53.18	35.36	0.0374	43.60	87.79	0.0099	82.91
11	0.0390	14.91	89.96	0.1488	59.91	74.75	0.0498	41.45	35.36	0.0093	50.27
12	0.0361	9.65	70.01	0.1056	47.89	39.17	0.0347	32.20	74.75	0.0142	91.43
13	0.0430	10.75	103.88	0.1167	52.36	64.10	0.0364	43.21	39.17	0.0082	68.39
14	0.0415	10.67	82.61	0.1392	62.89	50.20	0.0458	35.43	64.10	0.0089	104.26
15	0.0411	10.45	63.69	0.1253	71.44	37.55	0.0426	29.77	50.20	0.0143	81.12
16	0.0450	12.28	68.44	0.1174	57.70	48.26	0.0431	37.93	37.55	0.0130	62.69
17	0.0489	9.82	45.00	0.1079	58.10	29.04	0.0398	27.67	48.26	0.0117	70.47
18	0.0499	11.37	56.89	0.1214	69.84	30.99	0.0387	20.54	29.04	0.0090	46.14
19	0.0458	12.72	77.90	0.1367	52.41	46.41	0.0366	24.63	30.99	0.0096	56.63
20	0.0505	11.87	96.18	0.1221	54.31	56.79	0.0360	30.52	46.41	0.0078	77.52
21	0.0412	10.60	68.55	0.1243	61.18	42.43	0.0399	24.32	56.79	0.0076	85.73
22	0.0399	10.54	71.93	0.1662	77.86	37.10	0.0620	23.85	42.43	0.0093	67.32
23	0.0356	12.46	85.48	0.1284	80.33	49.29	0.0433	31.82	37.10	0.0237	70.68
24	0.0441	12.72	64.74	0.1240	52.30	34.91	0.0396	26.31	49.29	0.0120	84.02
25	0.0461	11.87	62.28	0.1031	49.56	31.94	0.0434	21.62	34.91	0.0098	62.13
26	0.0433	12.52	74.32	0.1126	50.44	44.22	0.0419	31.00	31.94	0.0115	61.32
27	0.0490	14.67	88.74	0.1281	57.08	55.33	0.0459	33.07	44.22	0.0102	76.70
28	0.0520	11.56	86.27	0.1314	78.83	58.62	0.0478	42.77	55.33	0.0132	88.82
29	0.0338	10.67	61.35	0.1238	60.64	34.72	0.0411	35.57	58.62	0.0142	87.24
30	0.0415	10.24	56.55	0.1121	40.45	33.29	0.0387	28.47	34.72	0.0102	60.81
31	0.0424	11.08	65.49	0.0951	45.18	34.12	0.0332	22.88	33.29	0.0082	54.42
32	0.0477	11.75	70.71	0.1053	46.32	41.80	0.0314	24.05	34.12	0.0075	63.31
33	0.0490	11.67	95.22	0.1160	63.14	63.63	0.0402	36.96	41.80	0.0082	70.98
34	0.0367	11.23	76.74	0.1262	64.94	44.57	0.0320	31.36	63.63	0.0119	97.24
35	0.0383	10.91	54.61	0.1647	91.37	30.94	0.0471	20.47	44.57	0.0073	77.99
36	0.0360	10.34	59.39	0.1798	69.20	33.27	0.0528	26.32	30.94	0.0122	53.87
37	0.0400	9.68	52.33	0.1195	53.53	30.43	0.0449	26.40	33.27	0.0168	55.59
38	0.0387	12.51	73.93	0.1568	76.86	39.83	0.0591	25.79	30.43	0.0126	52.64
39	0.0401	10.72	70.13	0.0	0.0	43.24	0.0	34.53	39.83	0.0225	75.89
40	0.0465	15.95	109.31	0.0	0.0	70.70	0.0	0.0	43.24	0.0	69.11
41	0.0454	15.33	88.97	0.0	0.0	72.44	0.0	0.0	70.70	0.0	108.61
42	0.0437	11.48	74.87	0.0	0.0	45.20	0.0	0.0	72.44	0.0	89.70
43	0.0398	14.53	93.53	0.0	0.0	56.71	0.0	0.0	45.20	0.0	75.82
44	0.0458	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.71	0.0	92.52
45	0.0503	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
46	0.0576	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
47	0.0525	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
48	0.0535	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.3.8

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

PROBABILITY OF CAPTURE =0.15
SURVIVAL OVER 5 SAMPLING PERIODS =0.1681
BIRTHS OVER 5 SAMPLING PERIODS =300

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	160.11	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-39.89
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.1938	[illegible]	0.0	0.1701	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.2038	[illegible]	0.0	0.1765	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.1925	[illegible]	0.0	0.1678	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.1827	[illegible]	0.0	0.1608	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.1852	[illegible]	0.0	0.0790	0.0	0.0	0.0061	0.0
8	0.1086	20.48	194.25	0.1995	154.09	83.27	0.0781	60.45	83.27	0.0056	-9.42
9	0.1146	21.55	194.51	0.1917	153.49	76.55	0.0719	50.27	76.55	0.0044	-7.35
10	0.1205	20.84	173.93	0.2089	174.12	59.15	0.0829	66.77	59.15	0.0072	-27.21
11	0.1103	19.68	187.94	0.1961	148.24	78.92	0.0724	58.25	78.92	0.0041	-12.20
12	0.1118	19.77	189.35	0.1843	138.09	74.44	0.0735	57.53	74.44	0.0054	-10.90
13	0.1243	23.21	191.61	0.1758	143.46	80.29	0.0727	66.82	80.29	0.0049	-9.33
14	0.1225	22.25	189.45	0.1751	139.92	81.80	0.0700	62.82	81.80	0.0040	-8.33
15	0.1173	23.64	209.11	0.1718	130.56	90.70	0.0661	50.26	90.70	0.0034	9.47
16	0.1215	22.06	192.81	0.1708	135.73	71.59	0.0591	41.98	71.59	0.0025	-16.27
17	0.1230	20.58	172.08	0.1944	153.99	58.27	0.0715	48.27	58.27	0.0046	-26.97
18	0.1196	20.00	175.12	0.2048	173.02	67.59	0.0731	46.06	67.59	0.0046	-23.54
19	0.1192	19.76	170.90	0.1835	139.27	56.62	0.0687	44.13	56.62	0.0043	-27.51
20	0.1195	19.36	162.84	0.1962	155.53	52.84	0.0739	51.96	52.84	0.0049	-37.22
21	0.1171	19.19	165.16	0.1985	150.70	53.59	0.0765	57.06	53.59	0.0055	-33.23
22	0.1209	21.57	184.47	0.2092	156.14	69.93	0.0765	65.55	69.93	0.0049	-14.56
23	0.1216	22.94	206.44	0.1996	150.52	85.35	0.0759	49.67	85.35	0.0056	5.94
24	0.1201	20.90	172.22	0.1811	160.84	59.92	0.0702	60.39	59.92	0.0046	-29.16
25	0.1235	22.12	189.24	0.1802	160.00	74.60	0.0663	55.60	74.60	0.0037	-11.95
26	0.1251	22.42	185.21	0.1779	157.11	73.65	0.0665	57.76	73.65	0.0041	-15.43
27	0.1252	23.58	193.65	0.1624	146.68	77.21	0.0678	63.74	77.21	0.0042	-6.71
28	0.1154	22.99	187.87	0.1597	133.75	78.93	0.0659	53.37	78.93	0.0041	-13.96
29	0.1130	20.97	192.61	0.1645	136.94	80.32	0.0656	50.99	80.32	0.0041	-6.42
30	0.1114	21.00	193.16	0.1802	152.70	73.59	0.0713	54.26	73.59	0.0043	-4.34
31	0.1103	20.77	188.55	0.1537	134.69	74.65	0.0603	49.70	74.65	0.0034	-11.12
32	0.1144	18.85	176.40	0.1588	146.78	71.04	0.0608	44.27	71.04	0.0038	-23.71
33	0.1173	19.25	162.11	0.1542	139.03	57.16	0.0578	42.86	57.16	0.0029	-37.73
34	0.1172	19.01	166.36	0.1713	163.75	60.81	0.0707	67.92	60.81	0.0051	-32.64
35	0.1123	20.93	188.88	0.1878	160.77	83.98	0.0705	45.66	83.98	0.0045	-9.73
36	0.1091	17.53	163.19	0.1852	156.00	57.73	0.0687	49.42	57.73	0.0039	-33.92
37	0.1077	17.77	172.98	0.1843	136.74	62.07	0.0679	41.87	62.07	0.0037	-27.27
38	0.1090	17.55	164.34	0.1772	151.59	52.56	0.0648	55.24	52.56	0.0034	-35.30
39	0.1058	19.19	190.11	0.0	0.0	69.08	0.0	0.0	69.08	0.0	-9.91
40	0.1096	21.13	193.28	0.0	0.0	73.13	0.0	0.0	73.13	0.0	-5.02
41	0.1130	20.56	195.85	0.0	0.0	75.93	0.0	0.0	75.93	0.0	-12.82
42	0.1249	20.78	169.33	0.0	0.0	66.17	0.0	0.0	66.17	0.0	-30.45
43	0.1212	19.65	179.06	0.0	0.0	71.25	0.0	0.0	71.25	0.0	-18.96
44	0.1190	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
45	0.1212	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
46	0.1225	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
47	0.1357	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
48	0.1544	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	[illegible]
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

NUMBER OF INADMISSABLE ESTIMATES 0 0 324

TABLE 5.3.9

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	19.19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	19.18
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0812	XXXXX	0.0	0.0608	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0943	XXXXX	0.0	0.0673	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0935	XXXXX	0.0	0.0682	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0863	10XXXX	0.0	0.0642	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0527	1XXXXX	0.0	0.0410	0.0	0.0	0.0073	0.0
8	0.0345	9.11	77.57	0.0858	73.39	70.61	0.0386	45.17	70.61	0.0068	79.54
9	0.0316	9.96	91.43	0.0785	75.96	75.89	0.0353	44.07	75.89	0.0053	91.05
10	0.0304	10.18	77.54	0.1298	110.09	61.09	0.0525	70.98	61.09	0.0111	77.22
11	0.0335	9.13	103.50	0.0999	73.35	98.01	0.0351	78.87	98.01	0.0059	100.87
12	0.0374	10.19	134.07	0.1037	93.58	113.76	0.0421	44.49	113.76	0.0098	131.99
13	0.0392	10.05	79.56	0.0655	69.82	69.64	0.0330	65.21	69.64	0.0051	78.08
14	0.0362	9.12	80.99	0.0760	72.39	81.12	0.0304	55.69	81.12	0.0043	81.60
15	0.0338	13.62	123.89	0.0832	54.29	90.55	0.0289	41.43	90.55	0.0040	124.96
16	0.0300	10.41	83.72	0.0750	59.26	69.10	0.0257	42.82	69.10	0.0034	85.48
17	0.0289	11.29	101.83	0.1026	85.41	80.66	0.0399	46.94	80.66	0.0081	104.55
18	0.0337	7.90	75.07	0.1154	168.40	79.29	0.0391	46.19	79.29	0.0060	77.69
19	0.0331	8.70	80.69	0.0817	54.38	65.28	0.0370	40.22	65.28	0.0058	78.63
20	0.0296	8.72	62.53	0.0754	80.74	52.11	0.0375	49.68	52.11	0.0062	61.58
21	0.0224	8.04	68.07	0.0815	72.63	53.07	0.0389	49.50	53.07	0.0066	65.57
22	0.0299	10.99	93.89	0.0996	91.67	73.55	0.0338	77.63	73.55	0.0057	95.46
23	0.0354	12.58	177.63	0.1000	62.73	138.23	0.0420	40.30	138.23	0.0084	176.64
24	0.0277	9.73	67.24	0.0703	73.66	53.82	0.0343	60.65	53.82	0.0057	66.09
25	0.0335	9.02	93.52	0.0852	84.87	77.32	0.0288	45.21	77.32	0.0042	94.70
26	0.0364	10.37	87.12	0.0809	70.94	79.32	0.0334	58.37	79.32	0.0052	87.15
27	0.0276	11.77	107.87	0.0632	84.58	92.86	0.0311	67.05	92.86	0.0044	107.83
28	0.0273	12.23	74.97	0.0661	58.42	74.29	0.0339	48.38	74.29	0.0061	73.74
29	0.0336	9.44	84.45	0.0732	75.00	80.95	0.0362	49.52	80.95	0.0057	85.23
30	0.0319	10.70	96.11	0.0851	82.35	72.58	0.0343	49.49	72.58	0.0061	96.98
31	0.0282	9.92	83.95	0.0809	69.06	71.07	0.0345	58.58	71.07	0.0061	85.88
32	0.0341	7.23	92.68	0.0986	83.94	95.83	0.0400	47.46	95.83	0.0079	96.29
33	0.0330	6.94	66.39	0.0727	69.57	70.99	0.0310	46.41	70.99	0.0046	68.50
34	0.0322	8.53	78.90	0.1086	137.14	80.13	0.0426	71.02	80.13	0.0090	81.40
35	0.0291	9.65	92.34	0.1083	95.38	76.39	0.0438	44.87	76.39	0.0089	93.29
36	0.0291	8.62	77.06	0.0850	78.28	67.86	0.0374	53.76	67.86	0.0068	77.63
37	0.0364	10.41	92.45	0.0665	52.80	74.35	0.0338	46.20	74.35	0.0052	52.34
38	0.0277	8.94	82.51	0.0793	131.63	69.24	0.0367	98.28	69.24	0.0067	81.41
39	0.0257	12.95	149.39	0.0	0.0	105.76	0.0	0.0	105.76	0.0	147.86
40	0.0334	13.01	107.02	0.0	0.0	78.18	0.0	0.0	78.18	0.0	104.11
41	0.0296	9.77	87.41	0.0	0.0	79.29	0.0	0.0	79.29	0.0	87.47
42	0.0290	8.04	67.00	0.0	0.0	59.87	0.0	0.0	59.87	0.0	69.32
43	0.0289	9.52	135.94	0.0	0.0	118.57	0.0	0.0	118.57	0.0	138.41
44	0.0294	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
45	0.0334	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
46	0.0341	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
47	0.0414	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
48	0.0522	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TABLE 5.3.10

MEANS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

PROBABILITY OF CAPTURE =0.20
SURVIVAL OVER 5 SAMPLING PERIODS =0.0313
BIRTHS OVER 5 SAMPLING PERIODS =500

I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	152.52	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-46.08
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0431	XXXXXX	0.0	0.0417	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0388	XXXXXX	0.0	0.0377	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0495	XXXXXX	0.0	0.0474	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0516	XXXXXX	0.0	0.0465	0.0	0.0	-0.0000	0.0
7	0.0	0.0	0.0	0.0413	XXXXXX	0.0	0.0190	0.0	0.0	0.0000	0.0
8	0.0386	5.73	148.22	0.0482	183.64	19.55	0.0260	30.06	19.55	0.0029	-52.94
9	0.0359	5.10	139.11	0.0847	298.81	8.80	0.0299	108.29	8.80	0.0019	-61.73
10	0.0381	6.54	239.67	0.0513	159.42	160.06	0.0288	58.88	160.06	0.0010	38.56
11	0.0349	6.74	207.44	0.0606	202.22	108.02	0.0370	32.24	108.02	0.0005	7.47
12	0.0313	5.45	163.55	0.0468	204.33	54.50	0.0254	27.24	54.50	0.0001	-26.42
13	0.0302	6.50	190.81	0.0425	153.80	64.30	0.0222	31.76	64.30	0.0001	-11.08
14	0.0364	11.93	312.07	0.0337	123.48	107.34	0.0165	7.94	107.34	0.0000	109.48
15	0.0403	6.90	172.29	0.0425	136.20	52.39	0.0222	46.21	52.39	0.0002	-28.29
16	0.0399	8.01	213.85	0.0502	170.70	114.28	0.0236	74.31	114.28	0.0001	13.02
17	0.0373	6.38	211.80	0.0429	160.36	121.11	0.0216	18.66	121.11	0.0000	12.60
18	0.0349	5.77	161.13	0.0462	179.70	44.39	0.0231	0.70	44.39	0.0000	-38.56
19	0.0350	4.56	129.81	0.0354	123.19	0.02	0.0186	6.42	0.02	0.0000	-69.67
20	0.0378	5.63	142.99	0.0439	146.36	16.68	0.0226	26.71	16.68	0.0001	-56.90
21	0.0366	6.63	179.66	0.0337	121.98	65.43	0.0168	34.85	65.43	0.0001	-20.50
22	0.0386	5.62	169.14	0.0375	119.86	62.47	0.0196	39.46	62.47	0.0001	-27.13
23	0.0393	6.13	186.35	0.0428	134.64	75.22	0.0204	3.37	75.22	0.0000	-13.51
24	0.0365	4.64	127.83	0.0434	138.87	0.03	0.0219	14.31	0.03	0.0001	-73.00
25	0.0397	5.76	152.52	0.0534	167.93	27.94	0.0263	1.76	27.94	-0.0000	-46.89
26	0.0342	4.39	128.19	0.0599	178.59	0.01	0.0254	0.00	0.01	-0.0000	-72.44
27	0.0376	4.86	126.03	0.0622	188.74	0.02	0.0313	11.82	0.02	0.0013	-69.25
28	0.0382	5.60	142.87	0.0512	223.20	17.81	0.0266	12.06	17.81	0.0001	-56.38
29	0.0369	5.58	144.45	0.0450	155.55	26.46	0.0241	27.41	26.46	0.0001	-52.36
30	0.0379	6.83	176.24	0.0507	206.94	56.08	0.0309	79.18	56.08	0.0015	-18.29
31	0.0354	7.10	185.68	0.0368	148.64	75.34	0.0197	36.16	75.34	0.0002	-8.40
32	0.0372	8.01	196.12	0.0382	147.21	88.91	0.0207	65.74	88.91	0.0001	-0.74
33	0.0337	6.75	232.18	0.0420	139.09	143.48	0.0214	18.75	143.48	0.0000	32.74
34	0.0334	5.76	161.71	0.0666	229.00	40.37	0.0390	72.13	40.37	0.0017	-38.65
35	0.0371	6.63	215.34	0.0429	130.21	113.16	0.0227	18.28	113.16	0.0002	16.01
36	0.0313	4.88	155.81	0.0549	159.64	29.43	0.0251	15.05	29.43	0.0001	-43.36
37	0.0345	5.08	154.55	0.0543	179.09	28.87	0.0241	9.60	28.87	0.0001	-46.64
38	0.0380	5.65	147.73	0.0514	153.96	19.20	0.0255	59.83	19.20	0.0003	-54.24
39	0.0383	8.84	238.91	0.0	0.0	137.92	0.0	0.0	137.92	0.0	38.10
40	0.0404	5.69	139.19	0.0	0.0	9.12	0.0	0.0	9.12	0.0	-62.28
41	0.0399	7.49	168.74	0.0	0.0	67.38	0.0	0.0	67.38	0.0	-26.01
42	0.0390	7.30	187.43	0.0	0.0	79.53	0.0	0.0	79.53	0.0	-9.82
43	0.0392	6.79	161.33	0.0	0.0	43.47	0.0	0.0	43.47	0.0	-38.89
44	0.0420	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
45	0.0386	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
46	0.0402	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
47	0.0529	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
48	0.0759	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

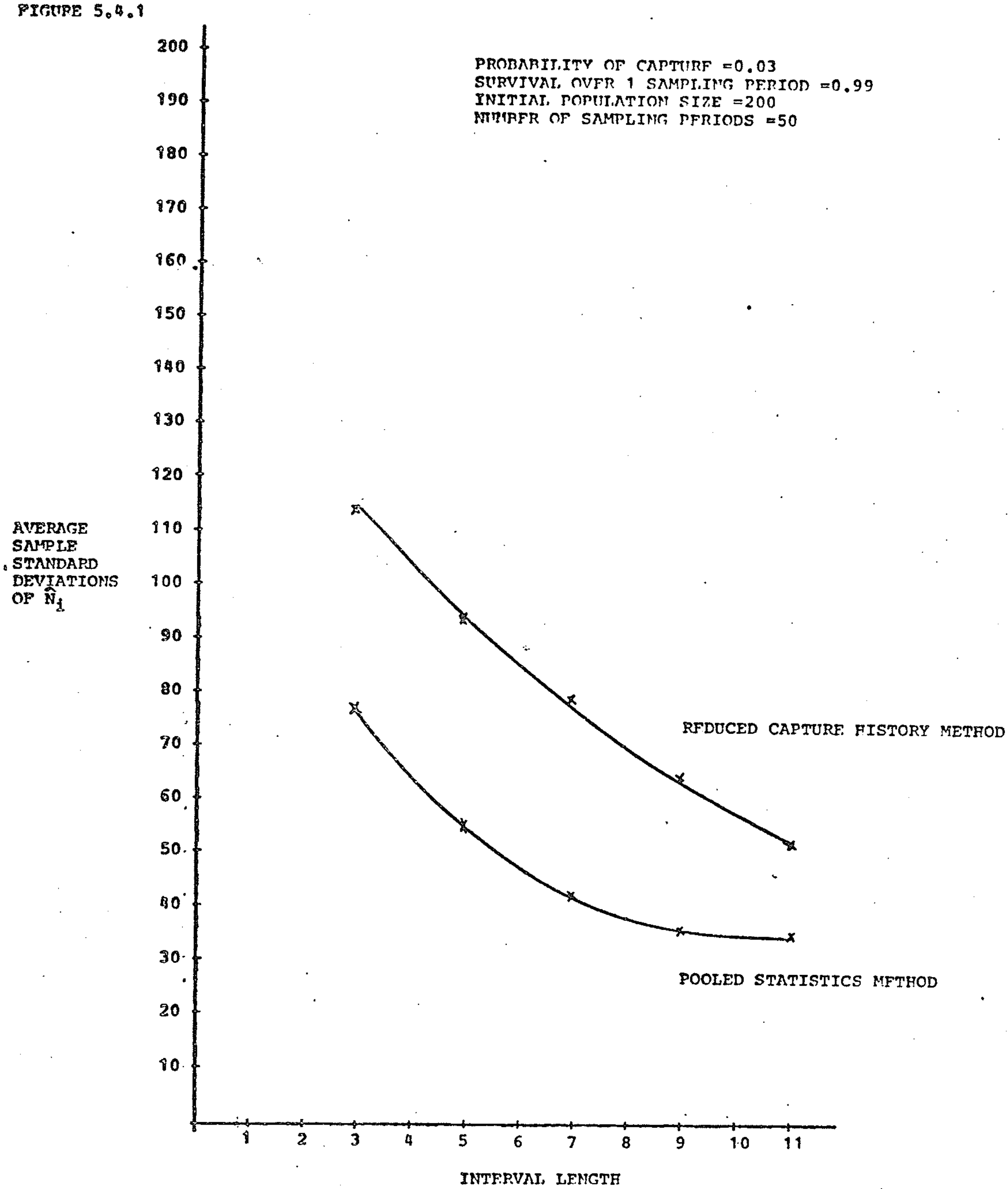
NUMBER OF INADMISSABLE ESTIMATES 12 0 336

TABLE 5.3.11

STANDARD DEVIATIONS OVER 36 REPLICATIONS
REDUCED CAPTURE HISTORY METHOD

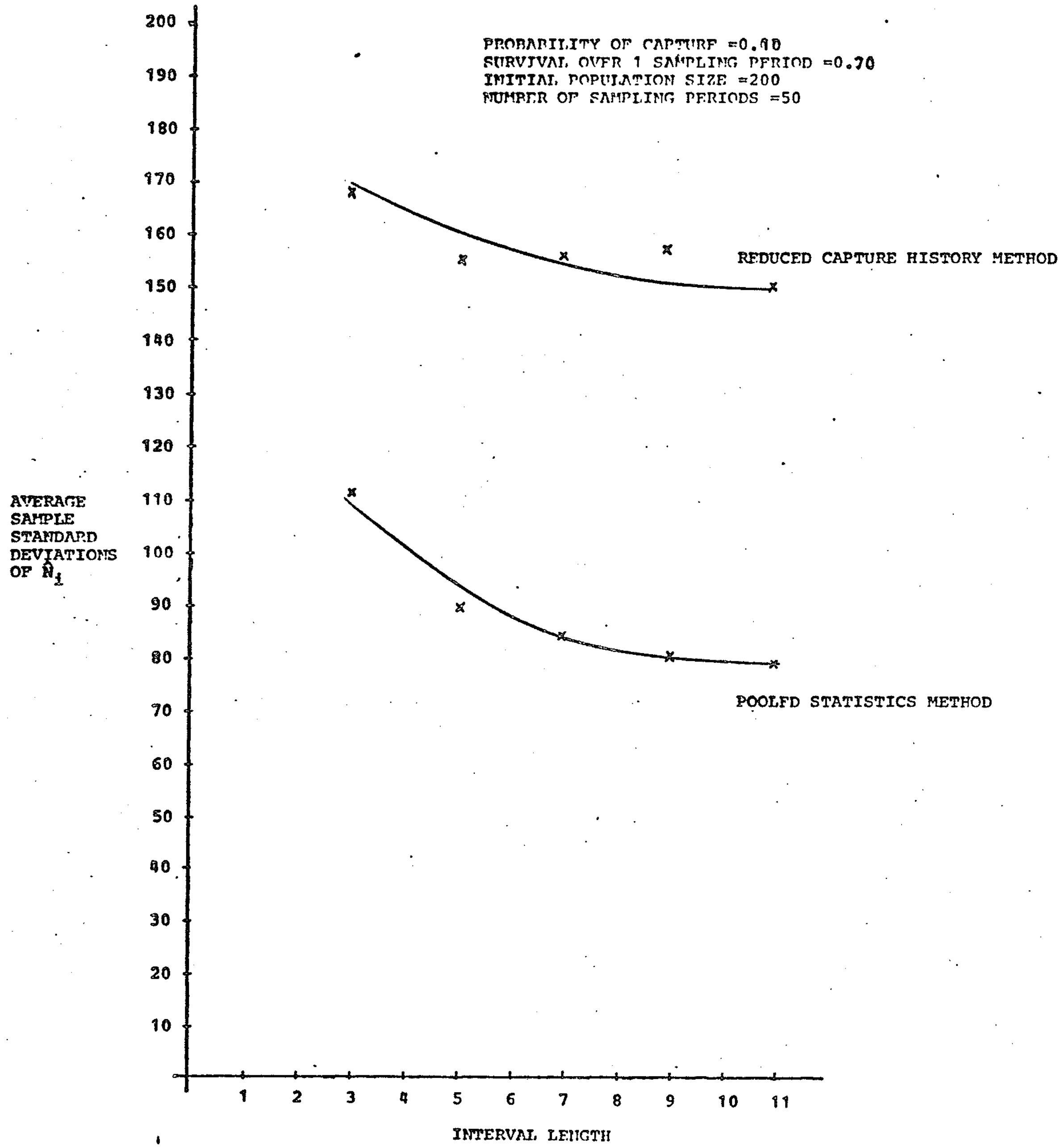
I	AEST(I)	MEST(I)	NEST(I)	PHIEST(I)	BEST(I)	SDN(I)	SDP(I)	SDB(I)	SDNGN(I)	PHIERR(I)	BIASN(I)
1	0.0	0.0	51.26	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51.36
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0288	XXXXX	0.0	0.0260	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0263	XXXXX	0.0	0.0243	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0400	XXXXX	0.0	0.0359	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0609	XXXXX	0.0	0.0517	0.0	0.0	0.0002	0.0
7	0.0	0.0	0.0	0.0487	XXXXX	0.0	0.0214	0.0	0.0	0.0002	0.0
8	0.0131	3.86	97.41	0.0842	253.48	117.12	0.0547	175.59	117.12	0.0173	96.94
9	0.0163	3.34	50.59	0.1800	701.68	52.62	0.0460	550.03	52.62	0.0085	51.37
10	0.0154	5.40	537.59	0.0522	167.73	823.16	0.0343	157.42	823.16	0.0051	537.31
11	0.0141	7.97	306.19	0.0686	269.58	456.33	0.0467	137.14	456.33	0.0030	304.46
12	0.0208	6.50	212.13	0.0486	383.70	274.55	0.0229	114.80	274.55	0.0005	207.16
13	0.0145	11.65	264.69	0.0527	173.26	280.07	0.0311	133.91	280.07	0.0004	263.69
14	0.0161	26.66	724.32	0.0153	9.61	491.84	0.0084	39.34	491.84	0.0001	724.47
15	0.0213	7.32	177.72	0.0402	74.44	228.94	0.0195	165.01	228.94	0.0007	176.17
16	0.0172	9.84	279.28	0.0591	177.37	414.55	0.0226	387.41	414.55	0.0002	279.88
17	0.0184	6.92	387.28	0.0344	265.16	594.64	0.0157	90.10	594.64	0.0002	387.97
18	0.0130	7.39	180.08	0.0335	235.81	266.17	0.0172	4.17	266.17	0.0000	180.66
19	0.0163	2.12	7.96	0.0142	10.27	0.06	0.0121	38.48	0.06	0.0001	10.52
20	0.0173	5.17	78.59	0.0258	98.91	99.93	0.0147	94.50	99.93	0.0006	77.51
21	0.0136	7.11	183.38	0.0145	11.03	240.41	0.0098	195.63	240.41	0.0003	180.64
22	0.0178	4.31	267.93	0.0165	23.22	374.67	0.0131	166.40	374.67	0.0004	266.43
23	0.0186	4.56	239.50	0.0358	79.47	314.67	0.0157	14.42	314.67	0.0000	238.66
24	0.0154	1.99	10.17	0.0413	113.03	0.07	0.0256	65.12	0.07	0.0005	11.80
25	0.0131	3.62	101.67	0.0605	181.59	125.38	0.0270	7.91	125.38	0.0000	102.76
26	0.0141	1.87	9.61	0.0653	171.17	0.05	0.0288	0.01	0.05	0.0000	12.26
27	0.0172	2.22	23.28	0.0703	189.21	0.06	0.0423	70.87	0.06	0.0080	8.59
28	0.0158	4.81	82.47	0.0597	352.17	106.69	0.0265	60.18	106.69	0.0007	83.91
29	0.0214	5.69	118.08	0.0509	125.25	158.60	0.0324	100.95	158.60	0.0003	117.45
30	0.0171	7.33	187.80	0.0474	327.10	200.25	0.0412	329.86	200.25	0.0079	186.85
31	0.0145	8.18	178.29	0.0260	98.06	226.09	0.0142	100.86	226.09	0.0005	175.57
32	0.0158	9.03	197.01	0.0263	132.68	257.68	0.0137	234.23	257.68	0.0005	194.77
33	0.0156	8.20	362.92	0.0299	88.73	532.99	0.0120	67.49	532.99	0.0001	363.14
34	0.0131	6.39	131.08	0.0681	256.98	168.85	0.0529	284.81	168.85	0.0068	130.20
35	0.0171	5.99	329.78	0.0235	46.93	440.39	0.0159	65.43	440.39	0.0009	327.55
36	0.0121	3.50	100.34	0.0802	198.58	124.31	0.0274	85.40	124.31	0.0008	101.31
37	0.0124	3.28	135.07	0.0632	210.65	173.14	0.0209	50.36	173.14	0.0003	135.80
38	0.0153	4.12	91.35	0.0695	147.42	115.06	0.0239	147.50	115.06	0.0008	90.89
39	0.0150	9.23	264.93	0.0	0.0	349.69	0.0	0.0	349.69	0.0	265.79
40	0.0164	3.31	46.49	0.0	0.0	54.55	0.0	0.0	54.55	0.0	45.64
41	0.0195	11.89	209.74	0.0	0.0	364.27	0.0	0.0	364.27	0.0	207.69
42	0.0164	8.64	219.18	0.0	0.0	295.97	0.0	0.0	295.97	0.0	217.99
43	0.0182	9.05	155.41	0.0	0.0	225.59	0.0	0.0	225.59	0.0	154.82
44	0.0134	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
45	0.0144	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
46	0.0153	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
47	0.0231	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
48	0.0315	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	XXXXX
49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

FIGURE 5.4.1



REDUCED CAPTURE HISTORY METHOD	7.70	12.10	13.60	14.60	17.10	AVERAGE r_i
	3.75	6.05	6.80	7.30	8.55	% of N_0
POOLED STATISTICS METHOD	9.00	14.20	21.80	30.00	34.00	AVERAGE POOLED r_i
	8.50	7.10	10.90	15.00	17.00	% of N_0

FIGURE 5.4.2

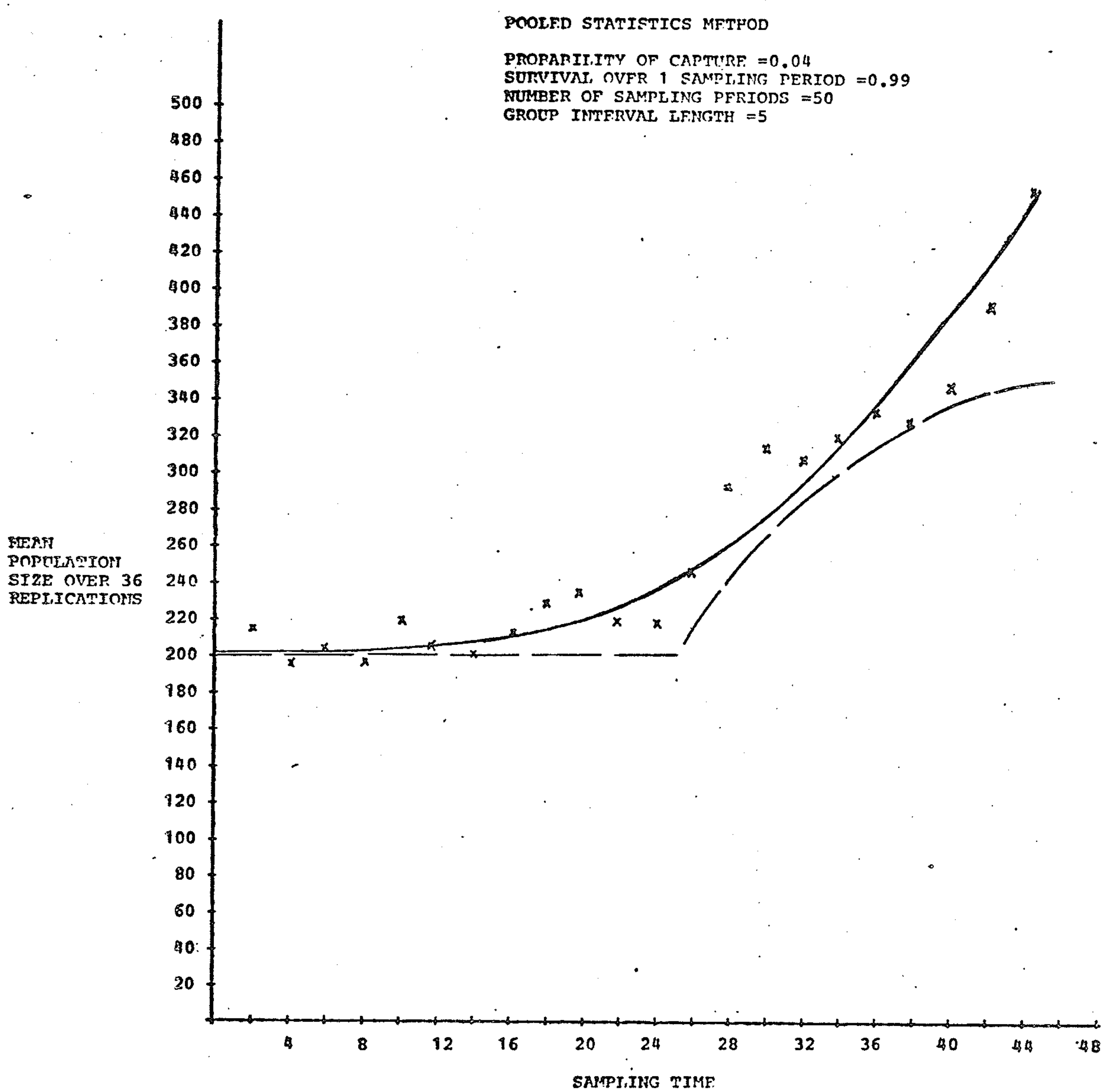


REDUCED CAPTURE HISTORY METHOD	5.00	6.00	5.00	4.00	3.00	AVERAGE r_i
	2.50	3.00	2.50	2.00	1.50	% of N_0
POOLED STATISTICS METHOD	12.00	19.10	26.50	37.00	41.00	AVERAGE POOLED r_i
	6.00	9.55	13.25	18.50	20.50	% of N_0

TABLE 5.5.1

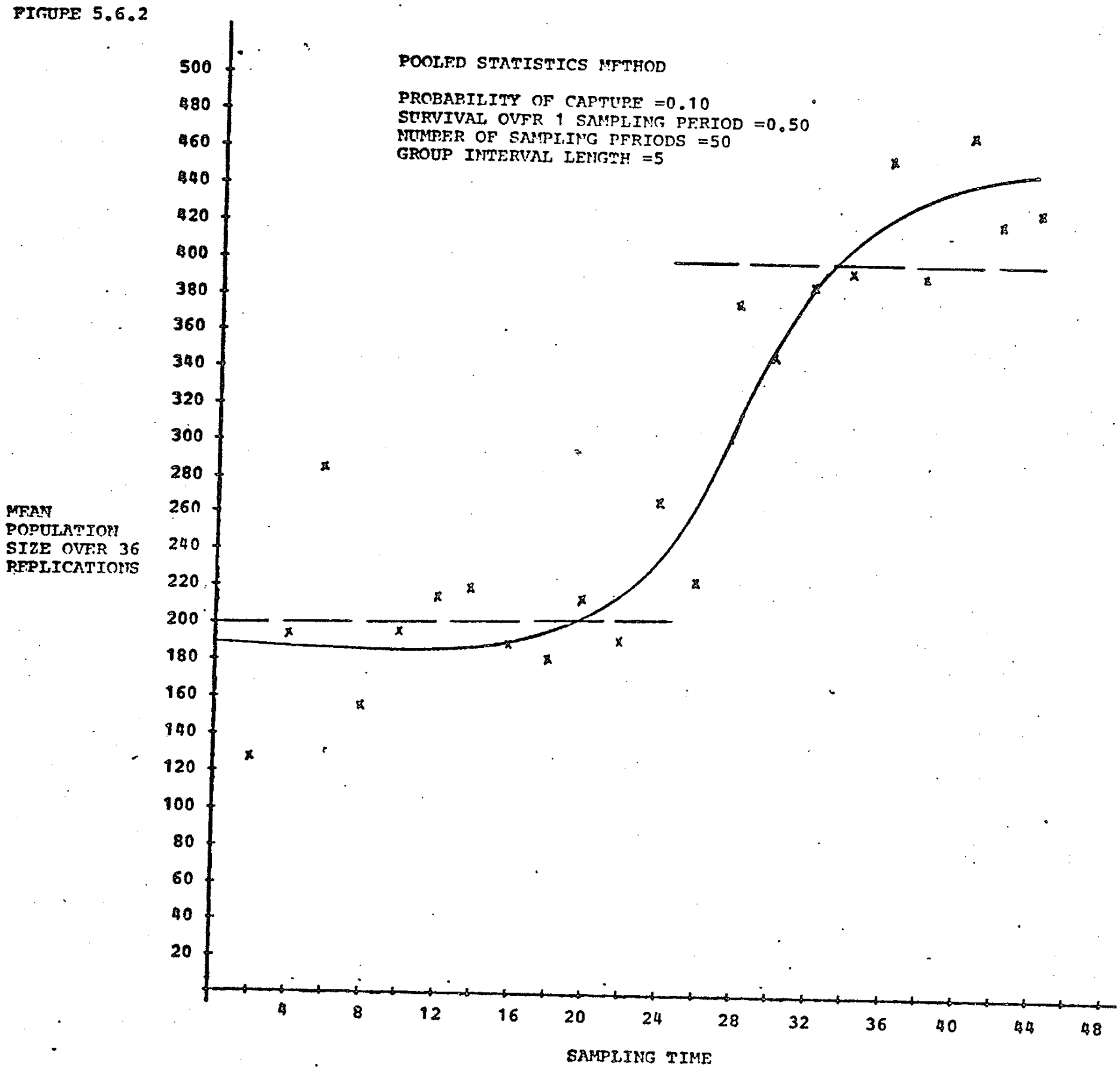
POOLING METHOD	ϕ	P	BIAS IN $\hat{N}_i$	BIAS IN $\hat{\phi}_i$	BIAS IN $\hat{B}_i$
POOLED STATISTICS METHOD	0.99	0.03	NONE	NEGATIVE	POSITIVE
	0.90	0.05	NONE	NONE	NONE
	0.70	0.15	NONE	POSITIVE	NEGATIVE
	0.50	0.20	NONE	POSITIVE	NEGATIVE
REDUCED CAPTURE HISTORY METHOD	0.99	0.03	NONE	NEGATIVE	POSITIVE
	0.90	0.05	NONE	NONE	NONE
	0.70	0.15	NONE	NONE	NEGATIVE
	0.50	0.20	NEGATIVE	POSITIVE	NEGATIVE

FIGURE 5.6.1



POOLED STATISTICS METHOD
PROBABILITY OF CAPTURE =0.04
SURVIVAL OVER 1 SAMPLING PERIOD =0.99
NUMBER OF SAMPLING PERIODS =50
GROUP INTERVAL LENGTH =5
MEAN POPULATION SIZE OVER 36 REPLICATIONS
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
4
8
12
16
20
24
28
32
36
40
44
48
SAMPLING TIME

FIGURE 5.6.2


POOLED STATISTICS METHOD
PROBABILITY OF CAPTURE =0.10
SURVIVAL OVER 1 SAMPLING PERIOD =0.50
NUMBER OF SAMPLING PERIODS =50
GROUP INTERVAL LENGTH =5
MEAN POPULATION SIZE OVER 36 REPLICATIONS
500
480
460
440
420
400
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
4
8
12
16
20
24
28
32
36
40
44
48
SAMPLING TIME

APPENDIX B

THE SIMULATION PROGRAM

```
  LOC  OBJECT CODE    ADDR1 ADDR2  STMT   SOURCE STATEMENT

000000                               1 RAND CSECT
000000                               2    USING *,15
000000 9025 D01C            0001C    3    STM  2,5,28(13)
000004 9823 1000            00000    4    LM   2,3,0(1)
000008 585C F030            00030    5    L    5,A
00000C 5C42 0000            00000    6    M    4,0(2)
000010 5D4C F034            00034    7    D    4,P
000014 5042 0000            00000    8    ST   4,0(2)
000018 884C 0007            00007    9    SRL  4,7
00001C 5A4C F02C            0002C   10    A    4,CHAR
000020 5043 0000            00000   11    ST   4,0(3)
000024 9825 D01C            0001C   12    LM   2,5,28(13)
000028 07FE                         13    BR   14
00002A 0000
00002C 40000000                     14 CHAR  DC  F'1073741824'
000030 000041A7                     15 A     DC  F'16807'
000034 7FFFFFFF                     16 P     DC  F'2147483647'
                                    17    END
```

```
         COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                          SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
   ISN 0002          INTEGER X(50),SPOOL(50),RPOOL(50),MPOOL(50),NPOOL(50),ZMOD(50),
                    &RMOD(50),SMOD(50)
   ISN 0003          REAL          NN(50),M(50),S(50),R(50),Z(50),P(50),CM(50),CN(50)
   ISN 0004          REAL SNN(50),SM(50),SS(50),SR(50),SZ(50),SP(50),SCN(50),SCM(50)
   ISN 0005          REAL AEST(50),MEST(50),NEST(50),PHIEST(50),BEST(50),SDN(50),
                    &  SDB(50),SDP(50),PHIERR(50),SDNGN(50)
   ISN 0006          REAL SP(50),PC(50),NL(50),RHO(50),
                    &SSNN(50),SSM(50),SSS(50),SSR(50),SSR(50),SSZ(50),SSCN(50),SSCM(50)
                    &,SAEST(50),SMEST(50),SNEST(50),SPH(50),SBEST(50),SSDN(50),SSDB(50)
                    &,  SSDP(50),SPHER(50),SSNGN(50),BIASN(50),SSBSN(50),
                    &SSAEST(50),SSMEST(50),SSNEST(50),SSPH(50),SSBEST(50),SSSDN(50),
                    &   SSSDB(50),SSSDP(50),SSPHER(50),SSSNGN(50),SBIASN(50)
   ISN 0007          REAL MMOD(50)
   ISN 0008          COMMON /AREA1/X
   ISN 0009          COMMON /AREA2/NN,M,Z,R,S,CM,CN
   ISN 0010          COMMON /AREA3/SSNN,SSM,SSS,SSB,SSR,SSZ,SSCN,SSCM,
                    &  SAEST,SMEST,SNEST,SPH,SBEST,SSDN,SSDB,SSDP,SPHER,SSNGN,BIASN,
                    &  SSAEST,SSMEST,SSNEST,SSPH,SSBEST,SSSDN,SSSDB,SSSDP,SSPHER,
                    &    SSSNGN,SBIASN,SSBSN,
                    &  SNN,SM,SS,SR,SZ,SB,SCNN,SCM
   ISN 0011          COMMON /AREA4/AEST,MEST,NEST,PHIEST,BEST,SDN,SDB,SDP,PHIERR,SDNGN
   ISN 0012          COMMON /AREA5/B
   ISN 0013          COMMON /AREA6/SPOOL,RPOOL,NPOOL,MPOOL
   ISN 0014          COMMON /AREA8/MMOD
   ISN 0015          COMMON /AREA7/ZMOD,RMOD,SMOD
   ISN 0016          CALL ERRSET(207,300,-5,0,0,0)
   ISN 0017          CALL ERRSET(208,300,-5,0,0,0)
   ISN 0018          CALL ERRSET(209,300,-5,0,0,0)
   ISN 0019          CALL ERRSET(251,300,-5,0,0,0)
               C
               C      THE INPUT PARAMETERS IN THE ORDER THEY ARE READ IN ARE:
               C        ISTART - THE INITIAL VALUE FOR THE RANDOM NUMBER GENERATOR
               C        IGR - IS 1 IF AVERAGING OVER THE GROUPED INTERVALS IS REQUIRED,
               C              0 OTHERWISE
               C        NREP - THE NUMBER OF REPLICATIONS OVER WHICH THE SIMULATION IS RUN
               C        LEN - THE NUMBER OF SAMPLING PERIODS
               C        NO - IS THE INITIAL POPULATION SIZE
               C        NDATA - THE NUMBER OF PARAMETER SETS OVER THE SIMULATION IS TO BE RUN
               C        INSIZE - THE GROUPING INTERVAL LENGTH.  IF NO POOLING THEN INSIZE=1
   ISN 0020          READ2, ISTART
   ISN 0021          READ2,IGR
   ISN 0022          READ2, NREP
   ISN 0023          READ2, LEN
   ISN 0024          READ2, NO
   ISN 0025          READ2, NDATA
   ISN 0026          READ2, INSIZE
   ISN 0027        2 FORMAT(I10)
   ISN 0028          IAP=0
   ISN 0029          IAB=0
   ISN 0030          IRZ=0
               C
   ISN 0031          DO 64 JJM=1,NDATA
               C        CPC - THE PROBABILITY OF CAPTURE
               C        CLP - THE PROBABILITY OF NO LOSS ON CAPTURE
               C        CSP - THE PROBABILITY OF SURVIVAL
   ISN 0032          READ4, CPC,CLP,CSP
```

```
ISN 0033          4 FORMAT(3F4.2)
                C
ISN 0034            DO 62 JM=1,1
ISN 0035            L=LEN
ISN 0036            DO 6 I=1,L
ISN 0037              SP(I)=CSP
ISN 0038              NU(I)=1.-CLF
ISN 0039              PC(I)=CPC
ISN 0040              RHO(I)=1.-SP(I)*(1.-PC(I)+PC(I)*NU(I))
ISN 0041          6 CONTINUE
                C
ISN 0042            DO 8 I=1,L
ISN 0043            SNN(I)=0
ISN 0044            SM(I)=0
ISN 0045            SB(I)=0
ISN 0046            SS(I)=0
ISN 0047            SR(I)=0
ISN 0048            SZ(I)=0
ISN 0049            SCNN(I)=0
ISN 0050            SCM(I)=0
ISN 0051            BIASN(I)=0.
ISN 0052            SSNN(I)=0.
ISN 0053            SSZ(I)=0.
ISN 0054            SSR(I)=0.
ISN 0055            SSB(I)=0.
ISN 0056            SSS(I)=0.
ISN 0057            SSM(I)=0.
ISN 0058            SSCN(I)=0.
ISN 0059            SSCM(I)=0.
ISN 0060            SMEST(I)=0.
ISN 0061            SAEST(I)=0.
ISN 0062            SPH(I)=0.
ISN 0063            SNEST(I)=0.
ISN 0064            SBEST(I)=0.
ISN 0065            SSOP(I)=0.
ISN 0066            SSON(I)=0.
ISN 0067            SSOB(I)=0.
ISN 0068            SPHER(I)=0.
ISN 0069            SSSDN(I)=0.
ISN 0070            SSSCB(I)=0.
ISN 0071            SSSCP(I)=0.
ISN 0072            SSPHEP(I)=0.
ISN 0073            SSMEST(I)=0.
ISN 0074            SSBSN(I)=0.
ISN 0075            SSAEST(I)=0.
ISN 0076            SSPH(I)=0.
ISN 0077            SSNEST(I)=0.
ISN 0078            SSBEST(I)=0.
ISN 0079            SSNGN(I)=0.
ISN 0080            SSSNGN(I)=0.
ISN 0081            SBIASN(I)=0.
ISN 0082          8 CONTINUE
                C
ISN 0083            DO 48 IJK=1,NREP
                C
ISN 0084            DO 10 I=1,L
ISN 0085            NN(I)=0
ISN 0086            Z(I)=0
```

```
ISN 0087                M(I)=0
ISN 0088                R(I)=0
ISN 0089                S(I)=0
ISN 0090                CM(I)=0
ISN 0091                CN(I)=0
ISN 0092                ZMOD(I)=0
ISN 0093                RMOD(I)=0
ISN 0094                SMOD(I)=0
ISN 0095                SDN(I)=0.
ISN 0096                SDP(I)=0.
ISN 0097                PHIEOR(I)=0.
ISN 0098                SCR(I)=0.
ISN 0099                SDNGN(I)=0.
ISN 0100                MEST(I)=0.
ISN 0101                AEST(I)=0.
ISN 0102                NEST(I)=0.
ISN 0103                PHIEST(I)=0.
ISN 0104                BEST(I)=0.
ISN 0105             10 CONTINUE
               C
ISN 0106                IX=1
ISN 0107                DO 24 J=1,NC
ISN 0108                DO 20 I=1,L
ISN 0109                CALL RAND(ISTART,YFL)
ISN 0110                IF(YFL.GT.PC(I)) GO TO 14
ISN 0112                  X(I)=1
               C
ISN 0113                  CALL RAND(ISTART,YFL)
ISN 0114                  IF(YFL.LT.NC(I)) GO TO 16
ISN 0116                    X(I)=-1
ISN 0117                IF(I.EQ.L) GO TO 22
ISN 0119                    II=I+1
ISN 0120                    DO 12 K=II,L
ISN 0121             12     X(K)=2
ISN 0122                    GO TO 22
ISN 0123             14   X(I)=0
ISN 0124             16   CALL RAND(ISTART,YFL)
ISN 0125                IF(YFL.LT.SP(I)) GO TO 20
ISN 0127                    IF(I.EQ.L) GO TO 22
ISN 0129                    II=I+1
ISN 0130                    DO 13 K=II,L
ISN 0131             18     X(K)=2
ISN 0132                    GO TO 22
ISN 0133             20 CONTINUE
               C          THE NEXT STATEMENT IS AS FOLLOWS:
               C            IF NO POOLING IS REQUIRED THEN
               C     22 CALL STATS(L,IX,INSIZE)
               C            IF THE POOLED STATISTICS METHOD IS REQUIRED THEN
               C     22 CALL STATS2(L,IX,INSIZE)
               C            IF THE REDUCED CAPTURE HISTORY METHOD IS REQUIRED THEN
               C     22 CALL STATS3(L,IX,INSIZE)
ISN 0134             22 CALL STATS3(L,IX,INSIZE)
ISN 0135             24 CONTINUE
               C
ISN 0136                B(L)=0
ISN 0137                LL=L-1
ISN 0138                DO 44 I=1,LL
ISN 0139                B(I)=PHO(I)*NC
```

```
ISN 0140          IB=B(I)
ISN 0141          IF(IB.EQ.0) GO TO 46
            C
ISN 0143          KK=I+1
ISN 0144          DO 42 K=1,IB
            C
ISN 0145          DO 26 L2=1,T
ISN 0146       26 X(L2)=0
ISN 0147          DO 33 J=KK,L
ISN 0148          CALL RAND(ISTART,YFL)
ISN 0149          IF(YFL.GT.PC(J)) GO TO 32
ISN 0151            X(J)=1
            C
ISN 0152       28   CALL RAND(ISTART,YFL)
ISN 0153            IF(YFL.LT.SU(J)) GO TO 34
ISN 0155              X(J)=-1
ISN 0156              IF(J.EQ.L) GO TO 40
ISN 0158              JJ=J+1
ISN 0159              DO 30 II=JJ,L
ISN 0160       30     X(II)=2
ISN 0161              GO TO 40
            C
ISN 0162       32   X(J)=0
ISN 0163       34   CALL RAND(ISTART,YFL)
ISN 0164            IF(YFL.LT.SP(J)) GO TO 38
ISN 0166              IF(J.EQ.L) GO TO 40
ISN 0168              JJ=J+1
ISN 0169              DO 36 II=JJ,L
ISN 0170       36     X(II)=2
ISN 0171              GO TO 40
            C
ISN 0172       38 CONTINUE
            C          FOR THE CORRECT CALL TO A SUBROUTINE SEE COMMENTS FOR
            C          STATEMENT LABEL 22
ISN 0173       40 CALL ST TS3(L,[illegible],INSIZE)
ISN 0174       42 CONTINUE
ISN 0175       44 CONTINUE
ISN 0176          DO 45 III=1,L
ISN 0177          IF(R(III).EQ.0.) IRZ=IRZ+1
ISN 0179       45 CONTINUE
            C
ISN 0180       46 LEN2=L
ISN 0181          IF(INSIZE.GT.1) LEN2=LEN2/INSIZE
            C          THE NEXT STATEMENT IS AS FOLLOWS:
            C           IF NO POOLING IS REQUIRED THEN
            C         CALL ESTMT(LEN2,NREP,INSIZE,IAP,IAB,IGR)
            C           IF THE POOLED STATISTICS METHOD IS REQUIRED THEN
            C         CALL GROUP2(LEN2,INSIZE)
            C           AND
            C         CALL ESTMT2(LEN2,NREP,INSIZE,IAP,IAP,IGR)
            C           IF THE REDUCED CAPTURE HISTORY METHOD IS REQUIRED THEN
            C         CALL ESTMT3(LEN2,NREP,INSIZE,IAP,IAP,IGR)
ISN 0183          CALL ESTMT3(LEN2,N[illegible],INSIZ[illegible],IA[illegible],IA[illegible],I[illegible])
ISN 0184       48 CONTINUE
ISN 0185          L=LEN2
ISN 0186          IF(IGR.EQ.1) GO TO 49
ISN 0188          L=LEN
ISN 0189       49 CALL AVG(L,NREP)
```

```
ISN 0190          CCLP=1.-CLP
ISN 0191          PRINT90, CPC,CSP,CCLP,NO,LEN,INSIZE,NREP
ISN 0192          PRINT91
ISN 0193          DO 50 I=1,L
ISN 0194       50 PRINT92, I,SCM(I),SM(I),SCNN(I),SNN(I),SB(I),SS(I),SF(I),SZ(I)
ISN 0195          IF(NREP.EQ.1) GO TO 54
ISN 0197          PRINT95, NREP
ISN 0198          PRINT91
              C
ISN 0199          DO 52 I=1,L
ISN 0200       52 PRINT96, I,SSCM(I),SSM(I),SSCN(I),SSNN(I),SSB(I),SSS(I),SSE(I),
                 &   SSZ(I)
              C
ISN 0201       54 PRINT97, NREP
ISN 0202          PRINT93
ISN 0203          DO 56 I=1,L
ISN 0204       56 PRINT94, I,SAEST(I),SMEST(I),SNEST(I),SPH(I),SBEST(I),SSDN(I),
                 &   SSDP(I),SSDB(I),SSNGN(I),SPHER(I),SBIASN(I)
ISN 0205          PRINT98, IAP,IAB,IRZ
              C
ISN 0206          IF(NREP.EQ.1) GO TO 60
ISN 0208          PRINT95, NREP
ISN 0209          PRINT93
ISN 0210          DO 58 I=1,L
ISN 0211       58 PRINT94, I,SSAEST(I),SSMEST(I),SSNEST(I),SSPH(I),SSBEST(I),
                 &   SSSDN(I),SSSDP(I),SSSDB(I),SSSNGN(I),SSPHER(I),SSBSN(I)
              C
ISN 0212       60 CSP=CSP-0.02
              C
ISN 0213       62 CONTINUE
ISN 0214       64 CONTINUE
              C
ISN 0215       90 FORMAT(1H1,       51X,'PARAMETERS FOR THE SIMULATION',
                 &          /,45X,'CAPTURE PROBABILITY AT TIME I=',F4.2, /,45X,
                 &'SURVIVAL PROBABILITY BETWEEN TIME I, I+1 =',F4.2, /,45X,
                 &'PROBABILITY OF NO LOSS ON CAPTURE AT TIME I =',F4.2, /,45X,
                 &'INITIAL POPULATION SIZE =',I4, /,45X,'NUMBER OF SAMPLING PERIODS
                 &=',I3,/,45X,'GROUPING INTERVAL=',I3,//,53X,'MEANS OVER',I3,
                 &' REPLICATIONS',/)
ISN 0216       91 FORMAT( /, 7X,'I', 9X,'CM(I)',10X,'M(I)', 9X,'CN(I)', 9X,'NN(I)',
                 &   10X,'B(I)',10X,'S(I)',10X,'R(I)',10X,'Z(I)',/)
ISN 0217       92 FORMAT(3X,I5,9(8X,F6.2))
ISN 0218       93 FORMAT(     ///   ,4X,'I',4X,'AEST(I)',4X,'MEST(I)',4X,'NEST(I)',
                 &   2X,'PHIEST(I)',4X,'BEST(I)',5X,'SDN(I)',5X,'SDP(I)',5X,
                 &   'SDB(I)',3X,'SDNGN(I)',2X,'PHIERR(I)',2X,'BIASN(I)',/)
ISN 0219       94 FORMAT(2X,I3,4X,F7.4,4X,F7.2,4X,F7.2,4X,F7.4,2X,F9.2,4X,F7.2,4X,
                 &   F7.4,2X,F9.2,4X,F7.2,4X,F7.4,3X,F7.2)
ISN 0220       95 FORMAT(1H1,//,46X,'STANDARD DEVIATIONS OVER',I3,' REPLICATIONS',
                 &   //)
ISN 0221       96 FORMAT(3X,I5,8(7X,F7.2))
ISN 0222       97 FORMAT(1H1,   //,53X,'MEANS OVER',I3,' REPLICATIONS')
ISN 0223       98 FORMAT(/,' NUMBER OF INADMISSABLE ESTIMATES',3I10)
              C
ISN 0224          STOP
ISN 0225          END
```

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          COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                            SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
ISN 0002          SUBROUTINE AVC(L,NREP)
ISN 0003          REAL    SNN(50),SM(50),SS(50),SR(50),SZ(50),SB(50),SCNN(50),
                 &  SCM(50)
ISN 0004          REAL SSNN(50),SSM(50),SSS(50),SSR(50),SSR(50),SSZ(50),SSCN(50),
                 &  SSCM(50),
                 &SAEST(50),SMEST(50),SNEST(50),SPH(50),SBEST(50),SSDN(50),SSDB(50),
                 &  SSDP(50),SPHER(50),SSNGN(50),BIASN(50),SSBSN(50),
                 &SSAEST(50),SSMEST(50),SSNEST(50),SSPH(50),SSBEST(50),SSSDN(50),
                 &  SSSDB(50),SSSDP(50),SSPHER(50),SSSNGN(50),SBIASN(50)
ISN 0005          COMMON /AREA3/SSNN,SSM,SSS,SSR,SSP,SSZ,SSCN,SSCM,
                 &  SAEST,SMEST,SNEST,SPH,SBEST,SSDN,SSDB,SSDP,SPHER,SSNGN,BIASN,
                 &  SSAEST,SSMEST,SSNEST,SSPH,SSBEST,SSSDN,SSSDB,SSSDP,SSPHER,
                 &     SSSNGN,SBIASN,SSBSN,
                 &  SNN,SM,SS,SR,SZ,SB,SCNN,SCM
ISN 0006          T=NREP-1.
ISN 0007          Y=FLOAT(NREP)
           C
ISN 0008          DO 5 I=1,L
ISN 0009          IF(NREP.EQ.1) GO TO 3
ISN 0011          SSNN(I)=SQRT(SSNN(I)/T-1./(NREP*T)*SNN(I)*SNN(I))
ISN 0012          SSM(I)=SQRT(SSM(I)/T-1./(NREP*T)*SM(I)*SM(I))
ISN 0013          SSS(I)=SQRT(SSS(I)/T-1./(NREP*T)*SS(I)*SS(I))
ISN 0014          SSR(I)=SQRT(SSR(I)/T-1./(NREP*T)*SR(I)*SR(I))
ISN 0015          SSZ(I)=SQRT(SSZ(I)/T-1./(NREP*T)*SZ(I)*SZ(I))
ISN 0016          SSB(I)=SQRT(SSB(I)/T-1./(NREP*T)*SB(I)*SB(I))
ISN 0017          SSCN(I)=SQRT(SSCN(I)/T-1./(NREP*T)*SCNN(I)*SCNN(I))
ISN 0018          SSCM(I)=SQRT(SSCM(I)/T-1./(NREP*T)*SCM(I)*SCM(I))
ISN 0019          SSAEST(I)=SQRT(SSAEST(I)/T-1./(NREP*T)*SAEST(I)*SAEST(I))
ISN 0020          SSMEST(I)=SQRT(SSMEST(I)/T-1./(NREP*T)*SMEST(I)*SMEST(I))
ISN 0021          SSNEST(I)=SQRT(SSNEST(I)/T-1./(NREP*T)*SNEST(I)*SNEST(I))
ISN 0022          SSPH(I)=SQRT(SSPH(I)/T-1./(NREP*T)*SPH(I)*SPH(I))
ISN 0023          SSBEST(I)=SQRT(SSBEST(I)/T-1./(NREP*T)*SBEST(I)*SBEST(I))
ISN 0024          SSSDN(I)=SQRT(SSSDN(I)/T-1./(NREP*T)*SSDN(I)*SSDN(I))
ISN 0025          SSSDP(I)=SQRT(SSSDP(I)/T-1./(NREP*T)*SSDP(I)*SSDP(I))
ISN 0026          SSSDB(I)=SQRT(SSSDB(I)/T-1./(NREP*T)*SSDB(I)*SSDB(I))
ISN 0027          SSSNGN(I)=SQRT(SSSNGN(I)/T-1./(NREP*T)*SSNGN(I)*SSNGN(I))
ISN 0028          SSPHER(I)=SQRT(SSPHER(I)/T-1./(NREP*T)*SPHER(I)*SPHER(I))
ISN 0029          SSBSN(I)=SQRT(SSBSN(I)/T-1./(NREP*T)*SBIASN(I)*SBIASN(I))
ISN 0030        3 SNN(I)=SNN(I)/Y
ISN 0031          SM(I)=SM(I)/Y
ISN 0032          SS(I)=SS(I)/Y
ISN 0033          SR(I)=SR(I)/Y
ISN 0034          SZ(I)=SZ(I)/Y
ISN 0035          SB(I)=SB(I)/Y
ISN 0036          SCNN(I)=SCNN(I)/Y
ISN 0037          SCM(I)=SCM(I)/Y
ISN 0038          SAEST(I)=SAEST(I)/Y
ISN 0039          SMEST(I)=SMEST(I)/Y
ISN 0040          SNEST(I)=SNEST(I)/Y
ISN 0041          SPH(I)=SPH(I)/Y
ISN 0042          SBEST(I)=SBEST(I)/Y
ISN 0043          SSDN(I)=SSDN(I)/Y
ISN 0044          SSDP(I)=SSDP(I)/Y
ISN 0045          SSDB(I)=SSDB(I)/Y
ISN 0046          SSNGN(I)=SSNGN(I)/Y
ISN 0047          SPHER(I)=SPHER(I)/Y
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ISN 0048          SBIASN(I)=SBIASN(I)/Y
ISN 0049        5 CONTINUE
ISN 0050          RETURN
ISN 0051          END
```

LEVEL 21.6 (MAY 72)   OS/360 FORTRAN H   DATE 72...

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COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
ISN 0002          SUBROUTINE STATS(L,J)
ISN 0003          INTEGER X(50),C(50)
ISN 0004          REAL NN(50),M(50),Z(50),R(50),S(50),CM(50),CN(50)
ISN 0005          COMMON /AREA1/X
ISN 0006          COMMON /AREA2/NN,M,Z,R,S,CM,CN
ISN 0007          IF(J.EQ.1) GO TO 101
ISN 0009          C(J-1)=0
ISN 0010          X(J-1)=0
ISN 0011      101 DO 92 I=J,L
ISN 0012          IF(IABS(X(I)).EQ.1) GO TO 93
ISN 0014          IF(X(I).EQ.2) GO TO 94
ISN 0016          IF(I.EQ.1) GO TO 95
ISN 0018          C(I)=C(I-1)
ISN 0019          GO TO 92
ISN 0020       95 C(1)=0
ISN 0021          GO TO 92
ISN 0022       93 IF(I.EQ.1) GO TO 96
ISN 0024          C(I)=C(I-1)+1
ISN 0025          GO TO 92
ISN 0026       96 C(1)=1
ISN 0027          GO TO 92
ISN 0028       94 IF(I.NE.1) GO TO 97
ISN 0030          IC=0
ISN 0031          GO TO 98
ISN 0032       97 IC=C(I-1)
ISN 0033       98 DO 99 K=I,L
ISN 0034       99 C(K)=IC
ISN 0035          GO TO 100
ISN 0036       92 CONTINUE
ISN 0037      100 DO 90 I=J,L
ISN 0038          IF(IABS(X(I)).EQ.1) NN(I)=NN(I)+1
ISN 0040          IF(I.EQ.1) GO TO 91
ISN 0042          IF(IABS(X(I)).EQ.1.AND.C(I-1).GT.0) M(I)=M(I)+1
ISN 0044          IF(X(I-1).NE.2.AND.C(I-1).GT.0) CM(I)=CM(I)+1
ISN 0046       91 IF(X(I).EQ.0.AND.(C(I).GT.0.AND.C(I).LT.C(L))) Z(I)=Z(I)+1
ISN 0048          IF(X(I).EQ.1.AND.C(I).LT.C(L)) R(I)=R(I)+1
ISN 0050          IF(X(I).NE.2) CN(I)=CN(I)+1
ISN 0052          IF(X(I).NE.1) GO TO 90
ISN 0054          S(I)=S(I)+1
ISN 0055       90 CONTINUE
ISN 0056          RETURN
ISN 0057          END
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                  COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                             SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
      ISN 0002          SUBROUTINE ESTMIT(L,IAP,IAB,NREP)
      ISN 0003          REAL     NN(50),M(50),Z(50),R(50),S(50),CM(50),CN(50),B(50),
                       &SNN(50),SM(50),SS(50),SR(50),SZ(50),SB(50),SCMN(50),SCM(50)
      ISN 0004          REAL SSNN(50),SSM(50),SSS(50),SSB(50),SSR(50),SSZ(50),SSCN(50),
                       & SSCM(50),
                       &SAEST(50),SMEST(50),SNEST(50),SPH(50),SBEST(50),SSDN(50),SSDB(50),
                       & SSDP(50),SPHER(50),SSNGN(50),BIASN(50),SSBSN(50),
                       &SSAEST(50),SSMEST(50),SSNEST(50),SSPH(50),SSBEST(50),SSSDN(50),
                       & SSSDB(50),SSSDP(50),SSPHER(50),SSSNGN(50),SBIASN(50)
      ISN 0005          REAL AEST(50),MEST(50),NEST(50),PHIEST(50),BEST(50),SDN(50),
                       & SDB(50),SDP(50),PHIERR(50),SDNGN(50)
      ISN 0006          REAL VP(50),VCONC(50)
      ISN 0007          COMMON /AREA2/NN,M,Z,R,S,CM,CN
      ISN 0008          COMMON /AREA3/SSNN,SSM,SSS,SSB,SSR,SSZ,SSCN,SSCM,
                       & SAEST,SMEST,SNEST,SPH,SBEST,SSDN,SSDB,SSDP,SPHER,SSNGN,BIASN,
                       & SSAEST,SSMEST,SSNEST,SSPH,SSBEST,SSSDN,SSSDB,SSSDP,SSPHER,
                       &    SSSNGN,SBIASN,SSBSN,
                       & SNN,SM,SS,SR,SZ,SB,SCMN,SCM
      ISN 0009          COMMON /AREA4/AEST,MEST,NEST,PHIEST,BEST,SDN,SDB,SDP,PHIERR,SDNGN
      ISN 0010          COMMON /AREA5/B
      ISN 0011          AEST(1)=0
      ISN 0012          MEST(1)=0
      ISN 0013          MEST(L)=0
      ISN 0014          NEST(L)=0
      ISN 0015          PHIEST(L-1)=0
      ISN 0016          PHIEST(L)=0
      ISN 0017          BEST(L-1)=0
      ISN 0018          BEST(L)=0
      ISN 0019          SDN(1)=0
      ISN 0020          SDN(L)=0
      ISN 0021          SDP(L-1)=0
      ISN 0022          SDP(L)=0
      ISN 0023          SDB(1)=0
      ISN 0024          SDB(L-1)=0
      ISN 0025          SDB(L)=0
      ISN 0026          SDNGN(1)=0
      ISN 0027          SDNGN(L-1)=0
      ISN 0028          SDNGN(L)=0
      ISN 0029          PHIERR(L-1)=0
      ISN 0030          PHIERR(L)=0
                  C
      ISN 0031          DO 24 I=2,L
      ISN 0032          IF(I.EQ.L) GO TO 93
      ISN 0034          MEST(I)=(((S(I)+1.)*Z(I)/(R(I)+1.))+M(I))
      ISN 0035       93 IF(NN(I).NE.0) GO TO 74
      ISN 0037          AEST(I)=0.
      ISN 0038          GO TO 24
      ISN 0039       74 AEST(I)=(M(I)+1.)/(NN(I)+1.)
      ISN 0040       24 CONTINUE
                  C
      ISN 0041          LL=L-1
      ISN 0042          IC=0
      ISN 0043          SUM=0.
      ISN 0044          DO 25 I=1,LL
      ISN 0045          IF(I.LT.L-1) PHIEST(I)=MEST(I+1)/(MEST(I)-M(I)+S(I))
      ISN 0047          IF(PHIEST(I).GT.0.) GO TO 78
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ISN 0049             PHIEST(I)=0.000001
ISN 0050             IAP=IAP+1
ISN 0051             GO TO 79
ISN 0052          78 IF(PHIEST(I).LE.1.0) GO TO 79
ISN 0054             PHIEST(I)=1.0
ISN 0055             IAP=IAP+1
ISN 0056          79 IF(I.EQ.L) GO TO 40
ISN 0058             IF(AEST(I).NE.0) GO TO 64
ISN 0060             NEST(I)=0.
ISN 0061             GO TO 65
               C
ISN 0062          64 NEST(I)=MEST(I)/AEST(I)
ISN 0063             SUM=SUM+NEST(I)
ISN 0064             BIASN(I)=NEST(I)-CN(I)
               C
ISN 0065          65 IC=IC+1
ISN 0066             IF(I.EQ.L) GO TO 99
ISN 0068          99 IF(AEST(I+1).NE.0) GO TO 40
ISN 0070             BEST(I)=0
ISN 0071             GO TO 25
ISN 0072          40 IF(I.EQ.1.OR.I.GE.L-1) GO TO 25
ISN 0074              BEST(I)=(MEST(I+1)/AEST(I+1))-PHIEST(I)*(NEST(I)-NN(I)+S(I))
ISN 0075             IF(BEST(I).GE.0.0) GO TO 25
ISN 0077             BEST(I)=0.
ISN 0078             IAB=IAB+1
ISN 0079          25 CONTINUE
               C
ISN 0080             NEST(1)=SUM/IC
ISN 0081             BIASN(1)=NEST(1)-CN(1)
ISN 0082             B0=NEST(1)
ISN 0083             BEST(1)=NEST(2)-PHIEST(1)*(NEST(1)-NN(1)+S(1))
ISN 0084             IF(BEST(1).GE.0.0) GO TO 95
ISN 0086             BEST(1)=0.0
               C
ISN 0087             IAB=IAB+1
ISN 0088          95 LL=L-1
ISN 0089             DO 41 I=1,LL
ISN 0090          41 VCOND(I)=0
               C
ISN 0091             JJ=L-2
ISN 0092             DO 42 I=1,JJ
ISN 0093             IF(I.NE.1) GO TO 43
ISN 0095             TEMP=B0
ISN 0096             VCOND(1)=VCOND(1)+TEMP
               C
ISN 0097          43 II=I+1
ISN 0098             DO 44 J=II,LL
ISN 0099             IF(NEST(J-1).NE.0) GO TO 69
ISN 0101             TEMP=0
ISN 0102             GO TO 70
ISN 0103          69 IF(BEST(J-1).LE.0) GO TO 42
ISN 0105             TEMP=(NEST(J)-BEST(J-1))**2/(NEST(J-1)**2)*TEMP
ISN 0106          70 VCOND(J)=VCOND(J)+TEMP
ISN 0107             KK=J
ISN 0108          44 CONTINUE
ISN 0109             K=I
ISN 0110          42 CONTINUE
ISN 0111             IF(NEST(KK).EQ.0 .OR.BEST(KK).LE.0) GO TO 75
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ISN 0113          VCOND(K)=VCOND(K)+(NEST(KK+1)-BEST(KK))**2/(NEST(KK)**2)*TEMP
              C
ISN 0114        75 DO 46 I=1,L
ISN 0115          IF(R(I).NE.0.AND.M(I).NE.0) GO TO 66
ISN 0117          SDN(I)=0
ISN 0118          GO TO 81
              C
ISN 0119        66 IF(I.EQ.1.OR.I.EQ.L) GO TO 81
              C
ISN 0121                    SDN(I)=     NEST(I)*(NEST(I)-NN(I))*((MEST(I)-M(I)
               &    +S(I))/MEST(I)*(1./R(I)-1./S(I))+(1.-AEST(I))/M(I))+NEST(I)
               &  . -VCOND(I)
ISN 0122          IF(SDN(I).LT.0) SDN(I)=0
ISN 0124          SDN(I)=SQRT(SDN(I))
              C
ISN 0125        81 IF(I.GT.L-2) GO TO 94
ISN 0127          IF(R(I+1).NE.0.AND.R(I).NE.0) GO TO 67
ISN 0129          SDP(I)=0
ISN 0130          PHIERR(I)=(-(PHIEST(I)**2)*(1.-PHIEST(I))/MEST(I+1))
ISN 0131          VP(I)=0.
ISN 0132          GO TO 94
              C
ISN 0133        67 VP(I)=     (PHIEST(I)**2)*((MEST(I+1)-M(I+1))*(MEST(I+1)-M(I)
               &    +S(I+1))/(MEST(I+1)**2)*(1./R(I+1)-1./S(I+1))+(MEST(I)-M(I))
               &    /(MEST(I)-M(I)+S(I))*(1./R(I)-1./S(I))+(1.-PHIEST(I))
               &    /MEST(I+1))
ISN 0134          IF(VP(I).LT.0) VP(I)=0.
ISN 0136          SDP(I)=SQRT(VP(I))
ISN 0137          PHIERR(I)=VP(I)-(PHIEST(I)**2)*(1.-PHIEST(I))/MEST(I+1)
              C
ISN 0138        94 IF(I.EQ.1.OR.I.GE.L-1) GO TO 63
ISN 0140          IF(M(I).NE.0.AND.R(I).NE.0.AND.R(I+1).NE.0.AND.M(I+1).NE.0.
               &    AND.AEST(I).NE.0) GO TO 68
ISN 0142          SDB(I)=0
ISN 0143          GO TO 63
              C
ISN 0144        68              SDB(I)=     (BEST(I)**2)*(MEST(I+1)-M(I+1))
               &    *(MEST(I+1)-M(I+1)+S(I+1))/MEST(I+1)**2*(1./R(I+1)-1./S(I+1))
               &    +(MEST(I)-M(I))/(MEST(I)-M(I)+S(I))*((PHIEST(I)*S(I)
               &    *(1.-AEST(I)))/AEST(I))**2*(1./R(I)-1./S(I))+(NEST(I)-NN(I))
ISN 0145          SDB(I)=SDB(I)
               &    *(NEST(I+1)-BEST(I))*(1.-AEST(I))*(1.-PHIEST(I))/(MEST(I)-M(I)
               &    +S(I))+NEST(I+1)*(NEST(I+1)-NN(I+1))*(1.-AEST(I+1))/M(I+1)+
               &    (PHIEST(I)**2)*NEST(I)*(NEST(I)-NN(I))*(1.-AEST(I))/M(I)
ISN 0146          IF(SDB(I).LT.0) SDB(I)=0
ISN 0148          SDB(I)=SQRT(SDB(I))
              C
ISN 0149        63 IF(I.EQ.1.OR.I.GE.L-1) GO TO 46
              C
ISN 0151          IF(R(I).NE.0.AND.M(I).NE.0) GO TO 71
ISN 0153          SDNGN(I)=0
ISN 0154          GO TO 46
ISN 0155        71     SDNGN(I)=     NEST(I)*(NEST(I)-NN(I))*((MEST(I)-M(I)
               &    +S(I))/MEST(I)*(1./R(I)-1./S(I))+(1.-AEST(I))/M(I))
ISN 0156          IF(SDNGN(I).LT.0) SDNGN(I)=0
ISN 0158          SDNGN(I)=SQRT(SDNGN(I))
              C
ISN 0159        46 CONTINUE
```

```
      C
ISN 0160          DO 83 I=1,L
ISN 0161          SNN(I)=SNN(I)+NN(I)
ISN 0162          SM(I)=SM(I)+M(I)
ISN 0163          SS(I)=SS(I)+S(I)
ISN 0164          SR(I)=SR(I)+R(I)
ISN 0165          SZ(I)=SZ(I)+Z(I)
ISN 0166          SB(I)=SB(I)+B(I)
ISN 0167          SCNN(I)=SCNN(I)+CN(I)
ISN 0168          SCM(I)=SCM(I)+CM(I)
ISN 0169          SMEST(I)=SMEST(I)+MEST(I)
ISN 0170          SAEST(I)=SAEST(I)+AEST(I)
ISN 0171          SNEST(I)=SNEST(I)+NEST(I)
ISN 0172          SBEST(I)=SBEST(I)+BEST(I)
ISN 0173          SPH(I)=SPH(I)+PHIEST(I)
ISN 0174          SSDN(I)=SSDN(I)+SDN(I)
ISN 0175          SSDP(I)=SSDP(I)+SDP(I)
ISN 0176          SPHER(I)=SPHER(I)+PHIERR(I)
ISN 0177          SSDB(I)=SSDB(I)+SDB(I)
ISN 0178          SSNGN(I)=SSNGN(I)+SDNGN(I)
ISN 0179          SBIASN(I)=SBIASN(I)+BIASN(I)
ISN 0180          IF(NREP.EQ.1) GO TO 83
ISN 0182          SSNN(I)=SSNN(I)+NN(I)*NN(I)
ISN 0183          SSM(I)=SSM(I)+M(I)*M(I)
ISN 0184          SSS(I)=SSS(I)+S(I)*S(I)
ISN 0185          SSP(I)=SSR(I)+R(I)*R(I)
ISN 0186          SSZ(I)=SSZ(I)+Z(I)*Z(I)
ISN 0187          SSB(I)=SSB(I)+B(I)*B(I)
ISN 0188          SSCN(I)=SSCN(I)+CN(I)*CN(I)
ISN 0189          SSCM(I)=SSCM(I)+CM(I)*CM(I)
ISN 0190          SSMEST(I)=SSMEST(I)+MEST(I)*MEST(I)
ISN 0191          SSAEST(I)=SSAEST(I)+AEST(I)*AEST(I)
ISN 0192          SSNEST(I)=SSNEST(I)+NEST(I)*NEST(I)
ISN 0193          SSBEST(I)=SSBEST(I)+BEST(I)*BEST(I)
ISN 0194          SSPH(I)=SSPH(I)+PHIEST(I)*PHIEST(I)
ISN 0195          SSSDN(I)=SSSDN(I)+SDN(I)*SDN(I)
ISN 0196          SSSDP(I)=SSSDP(I)+SDP(I)*SDP(I)
ISN 0197          SSPHER(I)=SSPHER(I)+PHIERR(I)*PHIERR(I)
ISN 0198          SSSDB(I)=SSSDB(I)+SDB(I)*SDB(I)
ISN 0199          SSSNGN(I)=SSSNGN(I)+SDNGN(I)*SDNGN(I)
ISN 0200          SSBSN(I)=SSBSN(I)+BIASN(I)*BIASN(I)
ISN 0201       83 CONTINUE
      C
ISN 0202          RETURN
ISN 0203          END
```

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LEVEL 21.6 ( MAY 72 )                    OS/360  FORTRAN H                    DATE  72.1?

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
  ISN 0002            SUBROUTINE ESTMT2(L,NREP,INSIZE,IAP,IAB,IGR)
  ISN 0003            INTEGER SPOOL(50),RPOOL(50),NPOOL(50),MPOOL(50),ZMOD(50),RMOD(50),
                     &  SMOD(50)
  ISN 0004            REAL     NN(50),M(50),Z(50),R(50),S(50),CM(50),CN(50),B(50)
  ISN 0005            REAL SNN(50),SM(50),SS(50),SR(50),SZ(50),SB(50),SCNN(50),SCM(50)
  ISN 0006            REAL SSNN(50),SSM(50),SSS(50),SSB(50),SSR(50),SSZ(50),SSCN(50),
                     &  SSCM(50),
                     &SAEST(50),SMEST(50),SNEST(50),SPH(50),SBEST(50),SSON(50),SSOB(50),
                     &  SSOP(50),SPHER(50),SSNON(50),BIASN(50),SSBSN(50),
                     &SSAEST(50),SSMEST(50),SSNEST(50),SSPH(50),SSBEST(50),SSSON(50),
                     &  SSSOB(50),SSSOP(50),SSPHER(50),SSSNON(50),SBIASN(50)
  ISN 0007            REAL AEST(50),MEST(50),NEST(50),PHIEST(50),BEST(50),SON(50),
                     &  SOB(50),SOP(50),PHIERR(50),SONGN(50)
  ISN 0008            REAL VP(50),VCOND(50)
  ISN 0009            REAL MMOD(50)
  ISN 0010            COMMON /AREA2/NN,M,Z,R,S,CM,CN
  ISN 0011            COMMON /AREA3/SSNN,SSM,SSS,SSB,SSR,SSZ,SSCN,SSCM,
                     &  SAEST,SMEST,SNEST,SPH,SBEST,SSON,SSOB,SSOP,SPHER,SSNON,BIASN,
                     &  SSAEST,SSMEST,SSNEST,SSPH,SSBEST,SSSON,SSSOB,SSSOP,SSPHER,
                     &     SSSNON,SBIASN,SSBSN,
                     &  SNN,SM,SS,SR,SZ,SB,SCNN,SCM
  ISN 0012            COMMON /AREA4/AEST,MEST,NEST,PHIEST,BEST,SON,SOB,SOP,PHIERR,SONGN
  ISN 0013            COMMON /AREA5/B
  ISN 0014            COMMON /AREA6/SPOOL,RPOOL,NPOOL,MPOOL
  ISN 0015            COMMON /AREA7/ZMOD,RMOD,SMOD
  ISN 0016            COMMON /AREA8/MMOD
  ISN 0017            L1=L*INSIZE
                C
  ISN 0018            LC=L1-INSIZE
  ISN 0019            DO 15 I3=1,L1
  ISN 0020            IF(I3.GT.LC) GO TO 5
  ISN 0022            MEST(I3)=(((SPOOL(I3)+1.)*Z(I3)/(RPOOL(I3)+1.))+M(I3))
  ISN 0023          5 IF(NPOOL(I3).NE.0) GO TO 10
  ISN 0025            AEST(I3)=0.
  ISN 0026            GO TO 15
                C
  ISN 0027         10 AEST(I3)=FLOAT(MPOOL(I3))/FLOAT(NPOOL(I3))
  ISN 0028         15 CONTINUE
                C
  ISN 0029            IC=0
  ISN 0030            SUM=0
  ISN 0031            LC1=L1-2*INSIZE
  ISN 0032            DO 45 I3=1,LC
  ISN 0033            IF(I3.GT.LC1) GO TO 25
  ISN 0035            PHIEST(I3)=MMOD(I3+INSIZE)/(MEST(I3)-M(I3)+S(I3))
  ISN 0036            IF(PHIEST(I3).GT.0) GO TO 20
  ISN 0038            PHIEST(I3)=0.000001
  ISN 0039            IAP=IAP+1
  ISN 0040            GO TO 25
                C
  ISN 0041         20 IF(PHIEST(I3).LE.1.0) GO TO 25
  ISN 0043            PHIEST(I3)=1.0
  ISN 0044            IAP=IAP+1
                C
  ISN 0045         25 IF(I3.EQ.1) GO TO 40
  ISN 0047            IF(AEST(I3).NE.0) GO TO 30
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ISN 0049          NEST(I3)=0.
ISN 0050          GO TO 35
              C
ISN 0051       30 NEST(I3)=MEST(I3)/AEST(I3)
ISN 0052          SUM=SUM+NEST(I3)
ISN 0053          BIASN(I3)=NEST(I3)-CN(I3)
              C
ISN 0054       35 IC=IC+1
ISN 0055          IF(AEST(I3+INSIZE).NE.0.) GO TO 40
ISN 0057          BEST(I3)=0.
ISN 0058          GO TO 45
              C
ISN 0059       40 IF(I3.EQ.1.OR.I3.GT.LC1) GO TO 45
ISN 0061          BEST(I3)=(MEST(I3+INSIZE)/AEST(I3+INSIZE))-PHIEST(I3)
                &  *(NEST(I3)-NN(I3)+S(I3))
ISN 0062          IF(BEST(I3).GE.0.0) GO TO 45
ISN 0064          BEST(I3)=0.
ISN 0065          IAB=IAB+1
ISN 0066       45 CONTINUE
              C
ISN 0067          NEST(1)=SUM/IC
ISN 0068          BIASN(1)=NEST(1)-CN(1)
ISN 0069          B0=NEST(1)
ISN 0070          BEST(1)=NEST(2)-PHIEST(1)*(NEST(1)-NN(1)+S(1))
ISN 0071          IF(BEST(1).GE.0.) GO TO 70
ISN 0073          BEST(1)=0.
              C
ISN 0074       70 DO 100 I=1,L1
ISN 0075          IF(I.EQ.1.OR.I.GT.L1-INSIZE) GO TO 75
ISN 0077          IF(SPOOL(I).EQ.0.OR.MPOOL(I).EQ.0) GO TO 75
ISN 0079          SDN(I)=NEST(I)*(NEST(I)-NN(I))*((MEST(I)-M(I)+S(I))/MEST(I)
                &  *(1./RPOOL(I)-1./SPOOL(I))+(1.-AEST(I))/MPOOL(I))
ISN 0080          IF(SDN(I).LT.0.) SDN(I)=0.
ISN 0082          SDN(I)=SQRT(SDN(I))
ISN 0083       75 IF(I.GT.LC1) GO TO 90
ISN 0085          IF(RPOOL(I).NE.0.AND.RPOOL(I+1).NE.0) GO TO 80
ISN 0087          SDP(I)=0.
ISN 0088          VP(I)=0.
ISN 0089          GO TO 85
ISN 0090       80 VP(I)=(PHIEST(I)**2)*((MEST(I+1)-M(I+1))*(MEST(I+1)-M(I)+S(I+1))
                &  /(MEST(I+1)**2)*(1./RPOOL(I+1)-1./SPOOL(I+1))+(MEST(I)-M(I))
                &  /(MEST(I)-M(I)+S(I))*(1./RPOOL(I)-1./SPOOL(I))+(1.-PHIEST(I))
                &  /MEST(I+1))
ISN 0091          IF(VP(I).LT.0.) VP(I)=0.
ISN 0093          SDP(I)=SQRT(VP(I))
ISN 0094       85 PHIERR(I)=VP(I)-(PHIEST(I)**2)*(1.-PHIEST(I))/MEST(I+1)
ISN 0095       90 IF(I.EQ.1.OR.I.GT.L1-2*INSIZE) GO TO 100
ISN 0097          SDB(I)=0.
ISN 0098          IF(MPOOL(I).EQ.0.OR.RPOOL(I).EQ.0.OR.RPOOL(I+1).EQ.0.OR.
                &  MPOOL(I+1).EQ.0.OR.AEST(I).EQ.0.) GO TO 100
ISN 0100          SDB(I)=(BEST(I)**2)*(MEST(I+1)-M(I+1))*(MEST(I+1)-M(I+1)+S(I+1))
                &  /MEST(I+1)**2*(1./RPOOL(I+1)-1./SPOOL(I+1))+(MEST(I)-M(I))
                &  /(MEST(I)-M(I)+S(I))*((PHIEST(I)*S(I)*(1.-AEST(I)))/AEST(I))**2
                &  *(1./RPOOL(I)-1./SPOOL(I))
ISN 0101          SDB(I)=SDB(I)+(NEST(I)-NN(I))
                &              *(NEST(I+1)-BEST(I))*(1.-AEST(I))*(1.-PHIEST(I))
                &  /(MEST(I)-M(I)+S(I))+NEST(I+1)*(NEST(I+1)-NN(I+1))*(1.-AEST(I+1)
                &  )/MPOOL(I+1)+(PHIEST(I)**2)*NEST(I)*(NEST(I)-NN(I))*(1.-AEST(I))
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                        &  /MPOOL(I)
ISN 0102                   IF(SDB(I).LT.0.) SDB(I)=0.
ISN 0104                   SDB(I)=SQRT(SDB(I))
ISN 0105               100 CONTINUE
ISN 0106                   INS=INSIZE
ISN 0107                   LZ=L
ISN 0108                   IF(ISP.EQ.1) GO TO 113
ISN 0110                   L=50
ISN 0111                   INSIZE=1
ISN 0112                   IF(INSIZE.EQ.1) GO TO 127
ISN 0114               113 DO 125 I=1,L
ISN 0115                   K=(I-1)*INSIZE+1
ISN 0116                   KK=K+INSIZE-1
ISN 0117                   IF(I.NE.1) GO TO 110
ISN 0119                   K=K+1
ISN 0120                   GO TO 115
ISN 0121               110 CM(I)=0.
ISN 0122                   MPOOL(I)=0
ISN 0123                   CN(I)=0.
ISN 0124                   NPOOL(I)=0
ISN 0125                   B(I)=0.
ISN 0126                   SPOOL(I)=0
ISN 0127                   RPOOL(I)=0
ISN 0128                   Z(I)=0.
ISN 0129                   MEST(I)=0.
ISN 0130                   AEST(I)=0.
ISN 0131                   PHIEST(I)=0.
ISN 0132                   NEST(I)=0.
ISN 0133                   BEST(I)=0.
ISN 0134                   SDNGN(I)=0.
ISN 0135                   SDP(I)=0.
ISN 0136                   PHIERR(I)=0.
ISN 0137                   SDB(I)=0.
ISN 0138                   SDN(I)=0.
ISN 0139                   BIASN(I)=0.
ISN 0140               115 DO 120 I3=K,KK
ISN 0141                   CM(I)=CM(I)+CM(I3)
ISN 0142                   MPOOL(I)=MPOOL(I)+MPOOL(I3)
ISN 0143                   CN(I)=CN(I)+CN(I3)
ISN 0144                   NPOOL(I)=NPOOL(I)+NPOOL(I3)
ISN 0145                   B(I)=B(I)+B(I3)
ISN 0146                   SPOOL(I)=SPOOL(I)+SPOOL(I3)
ISN 0147                   RPOOL(I)=RPOOL(I)+RPOOL(I3)
ISN 0148                   Z(I)=Z(I)+Z(I3)
ISN 0149                   IF(I.GT.1.AND.I.LT.L) MEST(I)=MEST(I)+MEST(I3)
ISN 0151                   IF(I.GT.1) AEST(I)=AEST(I)+AEST(I3)
ISN 0153                   IF(I.LT.L-1) PHIEST(I)=PHIEST(I)+PHIEST(I3)
ISN 0155                   IF(I.LE.L-1) NEST(I)=NEST(I)+NEST(I3)
ISN 0157                   IF(I.LT.L-1) BEST(I)=BEST(I)+BEST(I3)
ISN 0159                   IF(I.GT.1.AND.I.LT.L) SDN(I)=SDN(I)+SDN(I3)
ISN 0161                   IF(I.LE.L-2) SDP(I)=SDP(I)+SDP(I3)
ISN 0163                   IF(I.LE.L-2) PHIERR(I)=PHIERR(I)+PHIERR(I3)
ISN 0165                   IF(I.GT.1.AND.I.LT.L-2) SDB(I)=SDB(I)+SDB(I3)
ISN 0167                   IF(I.GT.1.AND.I.LT.L) SDNGN(I)=SDNGN(I)+SDNGN(I3)
ISN 0169                   IF(I.GT.1) BIASN(I)=BIASN(I)+BIASN(I3)
ISN 0171               120 CONTINUE
                 C
ISN 0172                   CM(I)=CM(I)/INSIZE
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ISN 0173          MPOOL(I)=MPOOL(I)/INSIZE
ISN 0174          CN(I)=CN(I)/INSIZE
ISN 0175          NPOOL(I)=NPOOL(I)/INSIZE
ISN 0176          B(I)=B(I)/INSIZE
ISN 0177          SPOOL(I)=SPOOL(I)/INSIZE
ISN 0178          RPOOL(I)=RPOOL(I)/INSIZE
ISN 0179          Z(I)=Z(I)/INSIZE
ISN 0180          MEST(I)=MEST(I)/INSIZE
ISN 0181          AEST(I)=AEST(I)/INSIZE
ISN 0182          PHIEST(I)=PHIEST(I)/INSIZE
ISN 0183          NEST(I)=NEST(I)/INSIZE
ISN 0184          BEST(I)=BEST(I)/INSIZE
ISN 0185          SDN(I)=SDN(I)/INSIZE
ISN 0186          SDP(I)=SDP(I)/INSIZE
ISN 0187          PHIERR(I)=PHIERR(I)/INSIZE
ISN 0188          SDB(I)=SDB(I)/INSIZE
ISN 0189          SDNGN(I)=SDNGN(I)/INSIZE
ISN 0190          BIASN(I)=BIASN(I)/INSIZE
ISN 0191      125 CONTINUE
            C
ISN 0192      127 DO 130 I=1,L
ISN 0193          SNN(I)=SNN(I)+NPOOL(I)
ISN 0194          SM(I)=SM(I)+MPOOL(I)
ISN 0195          SS(I)=SS(I)+SPOOL(I)
ISN 0196          SR(I)=SR(I)+RPOOL(I)
ISN 0197          SZ(I)=SZ(I)+Z(I)
ISN 0198          SB(I)=SB(I)+B(I)
ISN 0199          SCNN(I)=SCNN(I)+CN(I)
ISN 0200          SCM(I)=SCM(I)+CM(I)
ISN 0201          SMEST(I)=SMEST(I)+MEST(I)
ISN 0202          SAEST(I)=SAEST(I)+AEST(I)
ISN 0203          SNEST(I)=SNEST(I)+NEST(I)
ISN 0204          SBEST(I)=SBEST(I)+BEST(I)
ISN 0205          SPH(I)=SPH(I)+PHIEST(I)
ISN 0206          SSDN(I)=SSDN(I)+SDN(I)
ISN 0207          SSDP(I)=SSDP(I)+SDP(I)
ISN 0208          SPHER(I)=SPHER(I)+PHIERR(I)
ISN 0209          SSDB(I)=SSDB(I)+SDB(I)
ISN 0210          SSNGN(I)=SSNGN(I)+SDNGN(I)
ISN 0211          SBIASN(I)=SBIASN(I)+BIASN(I)
ISN 0212          IF(NREP.EQ.1) GO TO 130
ISN 0214          SSNN(I)=SSNN(I)+NPOOL(I)*NPOOL(I)
ISN 0215          SSM(I)=SSM(I)+MPOOL(I)*MPOOL(I)
ISN 0216          SSS(I)=SSS(I)+SPOOL(I)*SPOOL(I)
ISN 0217          SSR(I)=SSR(I)+RPOOL(I)*RPOOL(I)
ISN 0218          SSZ(I)=SSZ(I)+Z(I)*Z(I)
ISN 0219          SSB(I)=SSB(I)+B(I)*B(I)
ISN 0220          SSCN(I)=SSCN(I)+CN(I)*CN(I)
ISN 0221          SSCM(I)=SSCM(I)+CM(I)*CM(I)
ISN 0222          SSMEST(I)=SSMEST(I)+MEST(I)*MEST(I)
ISN 0223          SSAEST(I)=SSAEST(I)+AEST(I)*AEST(I)
ISN 0224          SSNEST(I)=SSNEST(I)+NEST(I)*NEST(I)
ISN 0225          SSBEST(I)=SSBEST(I)+BEST(I)*BEST(I)
ISN 0226          SSPH(I)=SSPH(I)+PHIEST(I)*PHIEST(I)
ISN 0227          SSSDN(I)=SSSDN(I)+SDN(I)*SDN(I)
ISN 0228          SSSDP(I)=SSSDP(I)+SDP(I)*SDP(I)
ISN 0229          SSPHER(I)=SSPHER(I)+PHIERR(I)*PHIERR(I)
ISN 0230          SSSDB(I)=SSSDB(I)+SDB(I)*SDB(I)
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ISN 0231          SSSNGN(I)=SSSNGN(I)+SDNGN(I)*SDNGN(I)
ISN 0232          SSBSN(I)=SSBSN(I)+BIASN(I)*BIASN(I)
ISN 0233      130 CONTINUE
ISN 0234          INSIZE=INS
ISN 0235          L=LZ
ISN 0236          RETURN
ISN 0237          END
```

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                COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                                   SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
      ISN 0002             SUBROUTINE GROUP2(L,INSIZE)
      ISN 0003             INTEGER SPOOL(50),RPOOL(50),MPOOL(50),NPOOL(50),SMOD(50),RMOD(50),
                          & ZMOD(50)
      ISN 0004             REAL   MN(50),M(50),S(50),R(50),Z(50),CM(50),CN(50)
      ISN 0005             REAL MMOD(50)
      ISN 0006             COMMON /AREA2/MN,M,Z,R,S,CM,CN
      ISN 0007             COMMON /AREA6/SPOOL,RPOOL,NPOOL,MPOOL
      ISN 0008             COMMON /AREA7/ZMOD,RMOD,SMOD
      ISN 0009             COMMON /AREA8/MMOD
      ISN 0010             LL=L*INSIZE
      ISN 0011             DO 5 J=1,LL
      ISN 0012             SPOOL(J)=0
      ISN 0013             RPOOL(J)=0
      ISN 0014             NPOOL(J)=0
      ISN 0015             MPOOL(J)=0
      ISN 0016           5 CONTINUE
                     C
      ISN 0017             K=0
      ISN 0018             KK=INSIZE-1
      ISN 0019             L2=LL-INSIZE+1
      ISN 0020             DO 20 J=1,L2
      ISN 0021             K=K+1
      ISN 0022             KK=KK+1
                     C
      ISN 0023             DO 10 I=K,KK
      ISN 0024             SPOOL(K)=SPOOL(K)+S(I)
      ISN 0025             RPOOL(K)=RPOOL(K)+R(I)
      ISN 0026             MPOOL(K)=MPOOL(K)+M(I)
      ISN 0027             NPOOL(K)=NPOOL(K)+MN(I)
      ISN 0028          10 CONTINUE
      ISN 0029          20 CONTINUE
                     C
      ISN 0030             I1=INSIZE+1
      ISN 0031             DO 22 I=I1,L2
      ISN 0032             SMOD(I)=SMOD(I)+S(I)
      ISN 0033             RMOD(I)=RMOD(I)+R(I)
      ISN 0034             ZMOD(I)=ZMOD(I)+Z(I)
      ISN 0035          22 CONTINUE
                     C
      ISN 0036             K=INSIZE
      ISN 0037             KK=K+INSIZE-1
      ISN 0038             DO 25 J=1,L2
      ISN 0039             T1=0.
      ISN 0040             T2=0.
      ISN 0041             K=K+1
      ISN 0042             KK=KK+1
      ISN 0043             DO 24 I=K,KK
      ISN 0044             T1=T1+SMOD(I)
      ISN 0045             T2=T2+RMOD(I)
      ISN 0046          24 CONTINUE
      ISN 0047             MMOD(K)=((T1+1)/(T2+1))*ZMOD(K)+M(K-INSIZE)
      ISN 0048          25 CONTINUE
      ISN 0049             RETURN
      ISN 0050             END
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        COMPILER OPTIONS - NAME=  MAIN,OPT=00,LINECNT=60,SIZE=0000K,
                           SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
ISN 0002        SUBROUTINE STATS2(L,J,INSIZE)
ISN 0003        INTEGER X(50),ZMOD(50),RMOD(50),SMOD(50),C(50)
ISN 0004        REAL NN(50),M(50),Z(50),S(50),R(50),CM(50),CN(50)
ISN 0005        COMMON /AREA1/X
ISN 0006        COMMON /AREA2/NN,M,Z,R,S,CM,CN
ISN 0007        COMMON /AREA7/ZMOD,RMOD,SMOD
ISN 0008        IF(J.EQ.1) GO TO 101
ISN 0010        C(J-1)=0
ISN 0011        X(J-1)=0
          C
ISN 0012        IF(J.LT.INSIZE+1) GO TO 101
ISN 0014        K=J-INSIZE+1
ISN 0015        KK=J-1
ISN 0016        DO 5 I=K,KK
ISN 0017        X(I)=0
ISN 0018      5 C(I)=0
          C
ISN 0019    101 DO 92 I=J,L
ISN 0020        IF(IABS(X(I)).EQ.1) GO TO 93
ISN 0022        IF(X(I).EQ.2) GO TO 94
ISN 0024        IF(I.EQ.1) GO TO 95
ISN 0026        C(I)=C(I-1)
ISN 0027        GO TO 92
ISN 0028     95 C(I)=0
ISN 0029        GO TO 92
ISN 0030     93 IF(I.EQ.1) GO TO 96
ISN 0032        C(I)=C(I-1)+1
ISN 0033        GO TO 92
ISN 0034     96 C(I)=1
ISN 0035        GO TO 92
ISN 0036     94 IF(I.NE.1) GO TO 97
ISN 0038        IC=0
ISN 0039        GO TO 98
ISN 0040     97 IC=C(I-1)
ISN 0041     98 DO 99 K=I,L
ISN 0042     99 C(K)=IC
ISN 0043        GO TO 100
ISN 0044     92 CONTINUE
ISN 0045    100 DO 90 I=J,L
ISN 0046        IF(I.LT.INSIZE+1) GO TO 105
ISN 0048        K=I-INSIZE+1
ISN 0049        KK=I-1
ISN 0050    105 IF(IABS(X(I)).EQ.1) NN(I)=NN(I)+1
ISN 0052        IF(I.EQ.1) GO TO 91
ISN 0054        IF(IABS(X(I)).EQ.1.AND.C(I-1).GT.0) M(I)=M(I)+1
ISN 0056        IF(X(I-1).NE.2.AND.C(I-1).GT.0) CM(I)=CM(I)+1
ISN 0058     91 IF(.NOT.(X(I).EQ.0.AND.(C(I).GT.0.AND.C(I).LT.C(L)))) GO TO 115
ISN 0060        Z(I)=Z(I)+1
ISN 0061        IF(I.LT.INSIZE+1) GO TO 115
ISN 0063        DO 110 MM=K,KK
ISN 0064        IF(X(MM).EQ.1.AND.C(MM).EQ.1) ZMOD(I)=ZMOD(I)-1
ISN 0066    110 CONTINUE
ISN 0067    115 IF(.NOT.(X(I).EQ.1.AND.C(I).LT.C(L)))  GO TO 125
ISN 0069        R(I)=R(I)+1
ISN 0070        IF(I.LT.INSIZE+1) GO TO 125
ISN 0072        DO 120 MM=K,KK
```

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ISN 0073            IF(X(MM).EQ.1.AND.C(MM).EQ.1) RMOD(I)=RMOD(I)-1
ISN 0075        120 CONTINUE
ISN 0076        125 IF(.NOT.(X(I).EQ.1)) GO TO 135
ISN 0078            S(I)=S(I)+1
ISN 0079            IF(I.LT.INSIZE+1) GO TO 135
ISN 0081            DO 130 MM=K,KK
ISN 0082            IF(X(MM).EQ.1.AND.C(MM).EQ.1)  SMOD(I)=SMOD(I)-1
ISN 0084        130 CONTINUE
ISN 0085        135 IF(X(I).NE.2) CN(I)=CN(I)+1
ISN 0087         90 CONTINUE
ISN 0088            RETURN
ISN 0089            END
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LEVEL 21.6 ( MAY 72 )                    OS/360  FORTRAN H                                DATE

            COMPILER OPTIONS - NAME=  MAIN,OPT=02,LINECNT=60,SIZE=0000K,
                               SOURCE,EBCDIC,NOLIST,NODECK,LOAD,MAP,NOEDIT,ID,NOXREF
  ISN 0002           SUBROUTINE ESTMT3(L,NREP,INSIZE,IAP,IAB,IGP)
  ISN 0003           REAL    NN(50),M(50),Z(50),R(50),S(50),CP(50),CN(50),B(50)
  ISN 0004           REAL SNN(50),SM(50),SS(50),SP(50),SZ(50),SB(50),SCNN(50),SCM(50)
  ISN 0005           REAL SSNN(50),SSM(50),SSS(50),SSP(50),SSB(50),SSZ(50),SSCN(50).
                    &  SSCM(50),
                    &SAEST(50),SMEST(50),SNEST(50),SPH(50),SPEST(50),SSDN(50),SSDB(50),
                    &  SSDP(50),SPHER(50),SSNGN(50),BIASN(50),SSBSN(50),
                    &SSAEST(50),SSMEST(50),SSNEST(50),SSPH(50),SSPEST(50),SSSDN(50).
                    &  SSSDB(50),SSSDP(50),SSPHER(50),SSSNGN(50),SBIASN(50)
  ISN 0006           REAL AEST(50),MEST(50),NEST(50),PHIEST(50),PEST(50),SDN(50),
                    &  SDB(50),SDP(50),PHIERR(50),SDNGN(50)
  ISN 0007           REAL VP(50),VCONC(50)
  ISN 0008           COMMON /AREA2/NN,M,Z,R,S,CM,CN
  ISN 0009           COMMON /AREA3/SSNN,SSM,SSS,SSB,SSP,SSZ,SSCN,SSCM,
                    &  SAEST,SMEST,SNEST,SPH,SPEST,SSDN,SSDB,SSDP,SPHER,SSNGN,BIASN.
                    &  SSAEST,SSMEST,SSNEST,SSPH,SSPEST,SSSDN,SSSDB,SSSDP,SSPHER,
                    &     SSSNGN,SBIASN,SSBSN,
                    &  SNN,SM,SS,SP,SZ,SB,SCNN,SCM
  ISN 0010           COMMON /AREA4/AEST,MEST,NEST,PHIEST,PEST,SDN,SDB,SDP,PHIERR,SDNGN
  ISN 0011           COMMON /AREA5/B
  ISN 0012           L1=L*INSIZE
  ISN 0013           I5=INSIZE/2
  ISN 0014           I6=INSIZE+I5
  ISN 0015           I7=L1-I5
  ISN 0016           I8=I5+1
  ISN 0017           I9=I6+1
               C
  ISN 0018           DO 15 I3=I9,I7
  ISN 0019           IF(I3.GT.L1-I6) GO TO 5
  ISN 0021           MEST(I3)=(((S(I3)+1.)*Z(I3)/(R(I3)+1.))+M(I3))
  ISN 0022         5 IF(NN(I3).NE.0) GO TO 10
  ISN 0024           AEST(I3)=0.
  ISN 0025           GO TO 15
  ISN 0026        10 AEST(I3)=M(I3)/NN(I3)
  ISN 0027        15 CONTINUE
  ISN 0028           IC=0
  ISN 0029           SUM=0
  ISN 0030           DO 45 I3=I8,I7
  ISN 0031           IF(I3.GT.L1-2*INSIZE-I5) GO TO 25
  ISN 0033           PHIEST(I3)=MEST(I3+INSIZE)/(MEST(I3)-M(I3)+S(I3))
  ISN 0034           IF(PHIEST(I3).GT.0.) GO TO 20
  ISN 0036           PHIEST(I3)=0.000001
  ISN 0037           IAP=IAP+1
  ISN 0038           GO TO 25
  ISN 0039        20 IF(PHIEST(I3).LE.1.0) GO TO 25
  ISN 0041           PHIEST(I3)=1.0
  ISN 0042           IAP=IAP+1
  ISN 0043        25 IF(I3.LE.I6) GO TO 36
  ISN 0045           IF(AEST(I3).NE.0.) GO TO 30
  ISN 0047           NEST(I3)=0.
  ISN 0048           GO TO 35
  ISN 0049        30 NEST(I3)=MEST(I3)/AEST(I3)
  ISN 0050           SUM=SUM+NEST(I3)
  ISN 0051           BIASN(I3)=NEST(I3)-CN(I3)
  ISN 0052        35 IC=IC+1
  ISN 0053        36 IF(AEST(I3+INSIZE).NE.0.) GO TO 40
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ISN 0055          BEST(I3)=0.
ISN 0056          GO TO 45
ISN 0057       40 IF(I3.EQ.1.OR.I3.GT.L1-2*INSIZE-I5) GO TO 45
ISN 0059                            BEST(I3)=MEST(I3+INSIZE)/AEST(I3+INSIZE)
        &  -PHIEST(I3)*(NEST(I3)-NN(I3)+S(I3))
ISN 0060          IF(BEST(I3).GT.0.) GO TO 45
ISN 0062          BEST(I3)=0.
ISN 0063          IAB=IAB+1
ISN 0064       45 CONTINUE
ISN 0065          NEST(1)=SUM/IC
ISN 0066          BIASN(1)=NEST(1)-CN(1)
ISN 0067          PO=NEST(1)
ISN 0068          BEST(1)=NEST(2)-PHIEST(1)*(NEST(1)-NN(1)+S(1))
ISN 0069          IF(BEST(1).GE.0.) GO TO 46
ISN 0071          BEST(1)=0.
ISN 0072       46 L2=L1
ISN 0073          DO 47 I=1,L2
ISN 0074       47 VCOND(I)=0
ISN 0075       70 DO 100 I=I8,I7
ISN 0076          SDNGN(I)=0.
ISN 0077          IF(I.LE.INSIZE+I5) GO TO 75
ISN 0079          IF(R(I).EQ.0.OR.M(I).EQ.0) GO TO 75
ISN 0081          TEMP=NEST(I)*(NEST(I)-NN(I))*((MEST(I)-M(I)+S(I))/MEST(I)*(1./R(I)
        &  -1./S(I))+(1.-AEST(I))/M(I))
ISN 0082          IF(TEMP.LT.0.) TEMP=0.
ISN 0084          SDNGN(I)=SQRT(TEMP)
ISN 0085       75 IF(I.GT.L1-2*INSIZE-I5) GO TO 95
ISN 0087          IF(R(I).NE.0.AND.R(I+1).NE.0) GO TO 80
ISN 0089          SDP(I)=0.
ISN 0090          VP(I)=0.
ISN 0091          GO TO 85
ISN 0092       80 VP(I)=(PHIEST(I)**2)*((MEST(I+1)-M(I+1))*(MEST(I+1)-M(I)+S(I+1))
        &  /(MEST(I+1)**2)*(1./R(I+1)-1./S(I+1))+(MEST(I)-M(I))
        &  /(MEST(I)-M(I)+S(I))*(1./R(I)-1./S(I))+(1.-PHIEST(I))/MEST(I+1))
ISN 0093          IF(VP(I).LT.0.) VP(I)=0.
ISN 0095          SDP(I)=SQRT(VP(I))
ISN 0096       85 PHIERR(I)=VP(I)-(PHIEST(I)**2)*(1.-PHIEST(I))/MEST(I+1)
ISN 0097          SDB(I)=0.
ISN 0098          IF(M(I).EQ.0.OR.R(I).EQ.0.OR.R(I+1).EQ.0.OR.M(I+1).EQ.0.OR.
        &  AEST(I).EQ.0) GO TO 95
ISN 0100          SDB(I)=(BEST(I)**2)*(MEST(I+1)-M(I+1))*(MEST(I+1)-M(I+1)+S(I+1))
        &  /MEST(I+1)**2*(1./R(I+1)-1./S(I+1))+(MEST(I)-M(I))/(MEST(I)
        &  -M(I)+S(I))*((PHIEST(I)*S(I)     *(1.-AEST(I)))/AEST(I))**2
        &  *(1./R(I)-1./S(I))
ISN 0101          SDB(I)=SDB(I)+(NEST(I)-NN(I))
        &              *(NEST(I+1)-BEST(I))*(1.-AEST(I))*(1.-PHIEST(I))
        &  /(MEST(I)-M(I)+S(I))+NEST(I+1)*(NEST(I+1)-NN(I+1))*(1.-AEST(I+1)
        &  )/M(I+1)+(PHIEST(I)**2)*NEST(I)*(NEST(I)-NN(I))*(1.-AEST(I))
        &  /M(I)
ISN 0102          IF(SDB(I).LT.0.) SDB(I)=0.
ISN 0104          SDB(I)=SQRT(SDB(I))
ISN 0105       95 SDN(I)=SDNGN(I)
ISN 0106      100 CONTINUE
ISN 0107          INS=INSIZE
ISN 0108          LZ=L
ISN 0109          IF(IGR.EQ.1) GO TO 113
ISN 0111          L=50
ISN 0112          INSIZE=1
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ISN C113          IF(INSIZE.EQ.1) GO TO 127
ISN C115      113 DO 125 I=1,L
ISN C116          K=(I-1)*INSIZE+1
ISN C117          KK=K+INSIZE-1
ISN C118          IF(I.NE.1) GO TO 110
ISN C120          K=K+1
ISN C121          GO TO 115
ISN C122      110 CM(I)=0.
ISN C123          M(I)=0.
ISN C124          CN(I)=0.
ISN C125          NN(I)=0.
ISN C126          B(I)=0.
ISN C127          S(I)=0.
ISN C128          R(I)=0.
ISN C129          Z(I)=0.
ISN C130          MEST(I)=0.
ISN 0131          AEST(I)=0.
ISN C132          PHIEST(I)=0.
ISN C133          NEST(I)=0.
ISN C134          BEST(I)=0.
ISN C135          SDNGN(I)=0.
ISN C136          SDP(I)=0.
ISN C137          PHIERR(I)=0.
ISN C138          SDB(I)=0.
ISN C139          SDN(I)=0.
ISN C140          BIASN(I)=0.
ISN C141      115 DO 120 I3=K,KK
ISN C142          CM(I)=CM(I)+CM(I3)
ISN C143          M(I)=M(I)+M(I3)
ISN C144          B(I)=B(I)/INSIZE
ISN C145          CN(I)=CN(I)+CN(I3)
ISN C146          NN(I)=NN(I)+NN(I3)
ISN C147          B(I)=B(I)+B(I3)
ISN C148          S(I)=S(I)+S(I3)
ISN C149          R(I)=R(I)+R(I3)
ISN C150          Z(I)=Z(I)+Z(I3)
ISN C151          IF(I.GT.1) BIASN(I)=BIASN(I)+BIASN(I3)
ISN C153          IF(I.GT.1.AND.I.LT.L) MEST(I)=MEST(I)+MEST(I3)
ISN C155          IF(I.GT.1) AEST(I)=AEST(I)+AEST(I3)
ISN C157          IF(I.LT.L-1) PHIEST(I)=PHIEST(I)+PHIEST(I3)
ISN C159          IF(I.GT.1) NEST(I)=NEST(I)+NEST(I3)
ISN 0161          IF(I.LT.L-1) BEST(I)=BEST(I)+BEST(I3)
ISN C163          IF(I.GT.1.AND.I.LT.L) SDN(I)=SDN(I)+SDN(I3)
ISN C165          IF(I.LE.L-2) SDP(I)=SDP(I)+SDP(I3)
ISN C167          IF(I.LE.L-2) PHIERR(I)=PHIERR(I)+PHIERR(I3)
ISN C169          IF(I.LT.L-1) SDB(I)=SDB(I)+SDB(I3)
ISN C171          IF(I.GT.1) SDNGN(I)=SDNGN(I)+SDNGN(I3)
ISN C173      120 CONTINUE
ISN C174          CN(I)=CN(I)/INSIZE
ISN C175          INS1=INSIZE/2+1
ISN C176          INS2=INSIZE
ISN C177          IF(I.EQ.2.OR.I.EQ.L) INSIZE=INS1
ISN C179          CM(I)=CM(I)/INSIZE
ISN 0180          M(I)=M(I)/INSIZE
ISN C181          AEST(I)=AEST(I)/INSIZE
ISN 0182          NEST(I)=NEST(I)/INSIZE
ISN 0183          SDN(I)=SDN(I)/INSIZE
ISN C184          SDNGN(I)=SDNGN(I)/INSIZE
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ISN 0185          BIASN(I)=BIASN(I)/INSIZE
ISN 0186          INSIZE=INS2
ISN 0187          IF(I.EQ.1.OR.I.EQ.L-2) INSIZE=INS1
ISN 0189          PHIEST(I)=PHIEST(I)/INSIZE
ISN 0190          BEST(I)=BEST(I)/INSIZE
ISN 0191          SDP(I)=SDP(I)/INSIZE
ISN 0192          PHIERR(I)=PHIERR(I)/INSIZE
ISN 0193          SDB(I)=SDB(I)/INSIZE
ISN 0194          INSIZE=INS2
ISN 0195          IF(I.EQ.2.OR.I.EQ.L-1) INSIZE=INS1
ISN 0197          MEST(I)=MEST(I)/INSIZE
ISN 0198          Z(I)=Z(I)/INSIZE
ISN 0199          INSIZE=INS2
ISN 0200          IF(I.EQ.1.OR.I.EQ.L-1) INSIZE=INS1
ISN 0202          R(I)=R(I)/INSIZE
ISN 0203          INSIZE=INS2
ISN 0204          IF(I.EQ.1.OR.I.EQ.L) INSIZE=INS1
ISN 0206          NN(I)=NN(I)/INSIZE
ISN 0207          S(I)=S(I)/INSIZE
ISN 0208          INSIZE=INS2
ISN 0209      125 CONTINUE
ISN 0210      127 DO 130 I=1,L
ISN 0211          SNN(I)=SNN(I)+NN(I)
ISN 0212          SM(I)=SM(I)+M(I)
ISN 0213          SS(I)=SS(I)+S(I)
ISN 0214          SR(I)=SR(I)+R(I)
ISN 0215          SZ(I)=SZ(I)+Z(I)
ISN 0216          SB(I)=SB(I)+B(I)
ISN 0217          SCNN(I)=SCNN(I)+CN(I)
ISN 0218          SCM(I)=SCM(I)+CM(I)
ISN 0219          SMEST(I)=SMEST(I)+MEST(I)
ISN 0220          SAEST(I)=SAEST(I)+AEST(I)
ISN 0221          SNEST(I)=SNEST(I)+NEST(I)
ISN 0222          SBEST(I)=SBEST(I)+BEST(I)
ISN 0223          SPH(I)=SPH(I)+PHIEST(I)
ISN 0224          SSDN(I)=SSDN(I)+SDN(I)
ISN 0225          SSDP(I)=SSDP(I)+SDP(I)
ISN 0226          SPHER(I)=SPHER(I)+PHIERR(I)
ISN 0227          SSDB(I)=SSDB(I)+SDB(I)
ISN 0228          SSNGN(I)=SSNGN(I)+SDNGN(I)
ISN 0229          SBIASN(I)=SBIASN(I)+BIASN(I)
ISN 0230          IF(NREP.EQ.1) GO TO 130
ISN 0232          SSNN(I)=SSNN(I)+NN(I)*NN(I)
ISN 0233          SSM(I)=SSM(I)+M(I)*M(I)
ISN 0234          SSS(I)=SSS(I)+S(I)*S(I)
ISN 0235          SSR(I)=SSR(I)+R(I)*R(I)
ISN 0236          SSZ(I)=SSZ(I)+Z(I)*Z(I)
ISN 0237          SSB(I)=SSB(I)+B(I)*B(I)
ISN 0238          SSCN(I)=SSCN(I)+CN(I)*CN(I)
ISN 0239          SSCM(I)=SSCM(I)+CM(I)*CM(I)
ISN 0240          SSMEST(I)=SSMEST(I)+MEST(I)*MEST(I)
ISN 0241          SSAEST(I)=SSAEST(I)+AEST(I)*AEST(I)
ISN 0242          SSNEST(I)=SSNEST(I)+NEST(I)*NEST(I)
ISN 0243          SSBEST(I)=SSBEST(I)+BEST(I)*BEST(I)
ISN 0244          SSPH(I)=SSPH(I)+PHIEST(I)*PHIEST(I)
ISN 0245          SSSDN(I)=SSSDN(I)+SDN(I)*SDN(I)
ISN 0246          SSSDP(I)=SSSDP(I)+SDP(I)*SDP(I)
ISN 0247          SSPHER(I)=SSPHER(I)+PHIERR(I)*PHIERR(I)
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ISN 0248          SSSDB(I)=SSSDB(I)+SDB(I)*SDB(I)
ISN 0249          SSSNGN(I)=SSSNGN(I)+SDNGN(I)*SDNGN(I)
ISN 0250          SSBSN(I)=SSBSN(I)+BIASN(I)*BIASN(I)
ISN 0251      130 CONTINUE
ISN 0252          L=LZ
ISN 0253          INSIZE=INS
ISN 0254          RETURN
```

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