

SampleSize 1.1

Sample Size Calculations for Fish and Wildlife Survival Studies

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About This Manual

This manual describes the use of Program SampleSize to calculate the required release sizes for fish and wildlife survival studies. Options are available to calculate release sizes for single release-recapture, paired release-recapture and transport-inriver ratio studies. The program determines anticipated precision (i.e., half-width of 90% and 95% confidence intervals) as a function of release size(s), detection probabilities, and anticipated survival. Precision curves are generated as a function of the user's choice of design variables.

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The SampleSize software, along with an electronic version (PDF) of this document is available for download at:

<http://www.cbr.washington.edu/paramEst/SampleSize/>.

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1.0 Introduction

Release-recapture studies are commonly used to estimate survival-related parameters of fish and wildlife resources. In designing such a study, one must determine how many tagged individuals are needed to achieve the desired precision of the estimates without wasting resources by using larger release sizes than necessary. The SampleSize program was developed to fill this need. It allows the user to enter a range of values for a given parameter or release size, resulting in a graphical display showing the sensitivity of the precision of the parameters to the range of values.

SampleSize can be used to calculate release sizes for the following types of release-recaptures studies:

- Single release-recapture studies (Section 3.0)
- Paired release-recapture studies (Section 4.0)
- Transport-inriver ratio studies (Section 5.0)

Section 2.0 describes the common features of the SampleSize program for all study types.

2.0 General Interface Description

The SampleSize program has a unique dialog window for each of the release-recapture models available:

- Single release-recapture design
- Paired release-recapture design
- Transport-inriver ratio design

Figure 2.1 shows the dialog window for a single-release model, illustrating the types of editable fields in the dialog window for all model types.

Release sizes are entered as positive integers. In Figure 2.1, the release sizes “R0” and “R1” are set to 400 and 0, respectively.

Survival parameters that are to be estimated in the planned study. The model for Figure 2.1 has one survival parameter, “S1”.

Detection parameters that are associated with recapture or detection of an animal given it is alive at the recapture event. Capture probabilities (i.e., P) must be supplied for each recapture event except for the last occasion; for the last occasion the joint probability of survival and being detected (i.e., the final $S * P$) must be specified.

Removal proportions are entered as a proportion between 0.0 and 1.0. Unlike the parameters, these are treated as fixed values in the model and are not estimated. Figure 2.1 contains one removal proportion: “d1”. These specify the proportion of animals that are removed from the study at each occasion.

Note the “Run the analysis” icon in the upper left corner. It appears in all dialog windows. Clicking on it will cause the sample size analysis to be run and the resulting report or graph to appear on the screen.

2.1 Using Fixed Values in All Fields

The dialog window in Figure 2.1 shows fixed values in all of the editable fields. Figure 2.2 is the resulting analysis output for the dialog window shown in Figure 2.1. It consists of four sections:

1. The specified release size
2. The specified parameter values
3. The resulting variance-covariance matrix
4. The resulting precision table with a column for each parameter and the following three rows of information:
 - (a) The standard error,
 - (b) The value for 1/2 width of a 90% confidence interval
 - (c) The value for 1/2 width of a 95% confidence interval

2.2 Using a Range Specification

Figure 2.3 shows the same dialog window as Figure 2.1 except that a range of values has been specified for the release size “R0”. The syntax for a range specification is *minimum-value:maximum-value* where the colon (“:”) is required. In Figure 2.3, a range of values between 300 and 500 is specified for the initial release “R0”.

A range specification can be entered for the release size, survival, detection or final $S * P$ parameters. A range may **not** be specified for the removal proportions. Only one field in any dialog window can have a range specified; all the rest of the fields must have fixed values specified.

Figure 2.4 shows the resulting output when a range is specified for a release size or parameter. The specified range is always on the X axis. The drop-down selection box on the lower left allows the user to select any one of the estimable parameters to be displayed on the Y axis. The upper line of the graph (in blue) indicates the half-width of a 95% confidence interval, and the lower line (in red) indicates the half-width of a 90% confidence interval.

If the user clicks the mouse inside the graph, a vertical indicator line appears as shown in Figure 2.5. This line can be dragged along the X axis in order to view specific values.

2.3 Modifying Model Assumptions

Both the single release-recapture and the paired release-recapture models allow the user to modify the assumptions of the release-recapture model. Models can be specified which are reduced cases of the fully parameterized models (this does not apply to the transport-inriver ratio model). Figure 2.6 illustrates this concept for a single-release model with three periods. Note the drop-down menu for the survival probability parameter for the second reach, allowing the user to set the parameter to “S2” (the default) or “S1”. The default setting is a unique survival parameters for each period. If the user sets the parameter to “S1” for period two, the same parameter will be estimated for both reaches. The same capability exists for “P2” in this example. In general, we do not recommend using less than the fully parameterized models unless there is a strong *a priori* reason to do so.

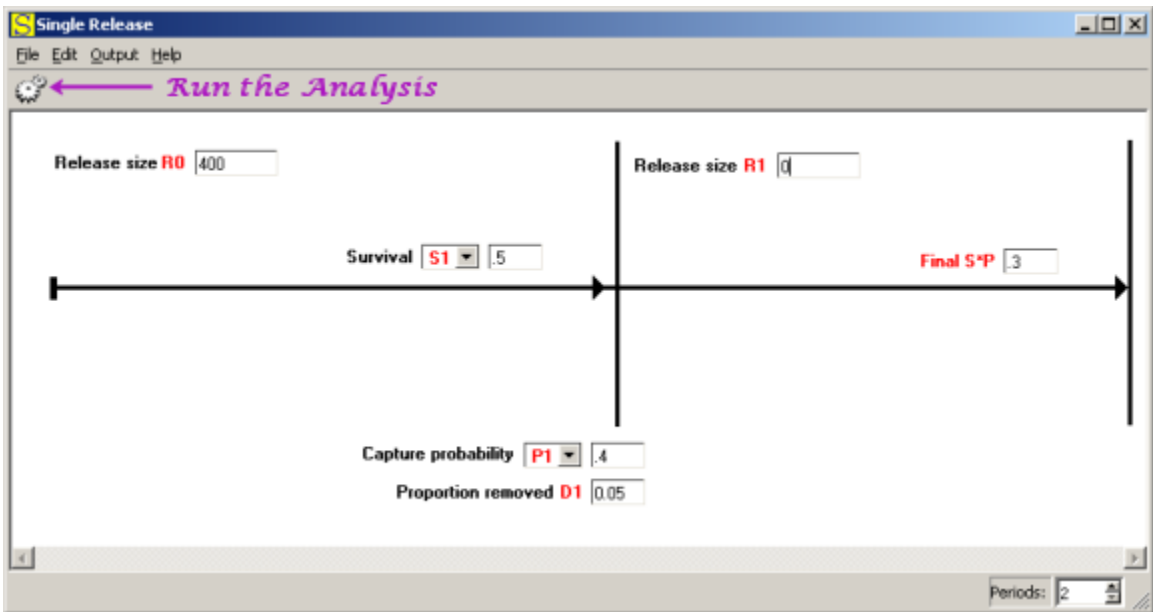


Figure 2.1: Dialog window for a single release-recapture model with two periods

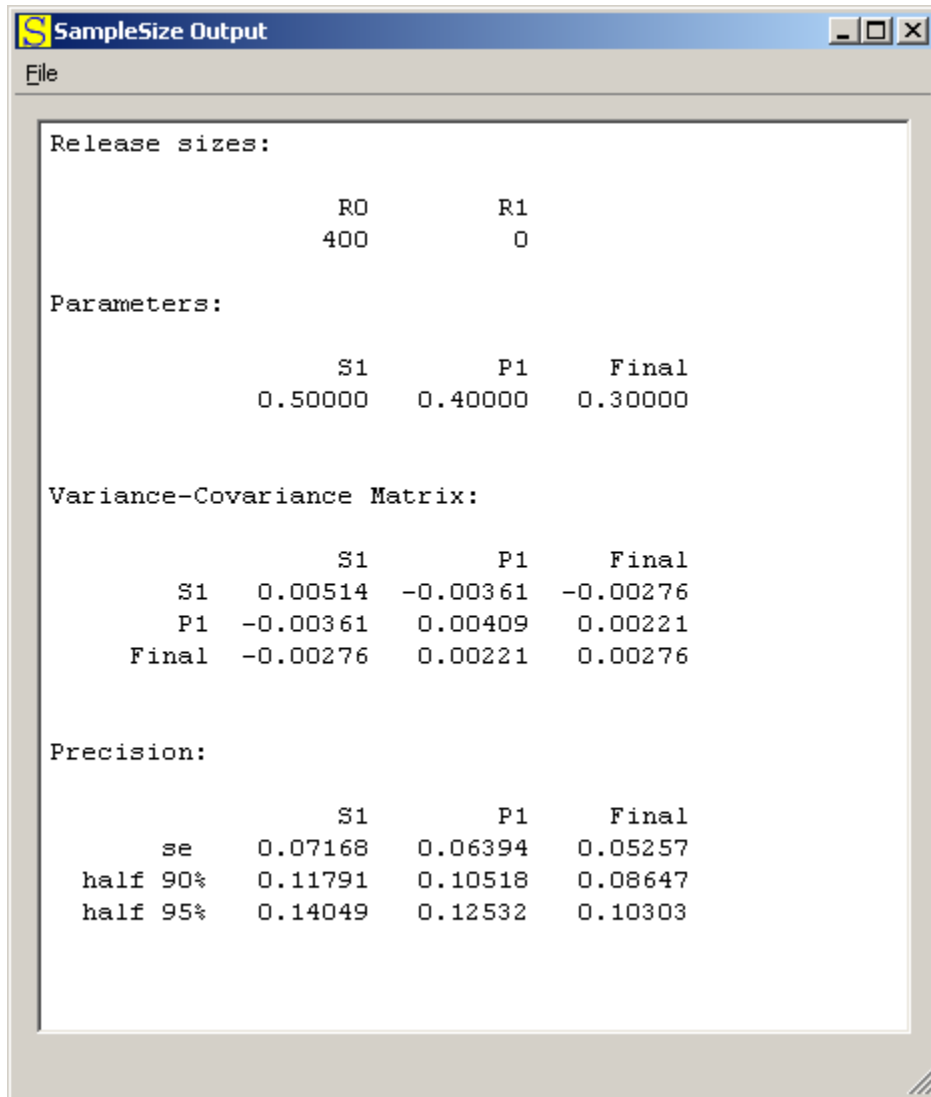


Figure 2.2: Analysis output for a single release-recapture model with two periods

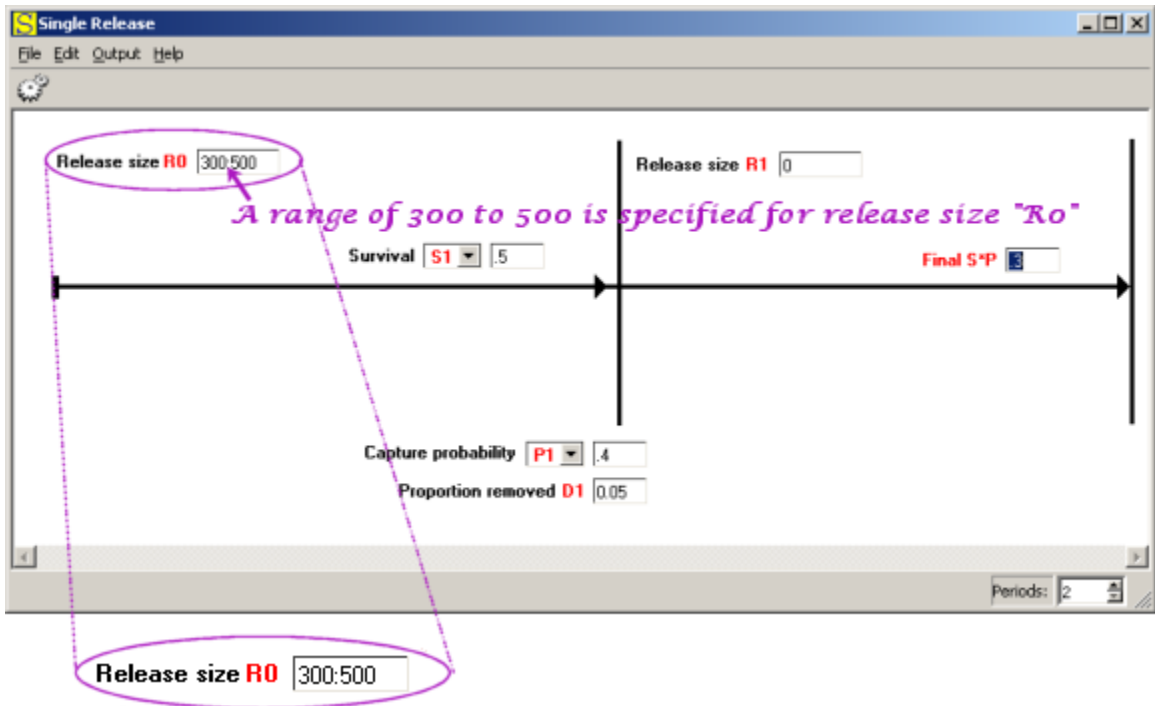


Figure 2.3: Dialog window with a range specified for Release Size “R0” in a single release-recapture study design with two periods.

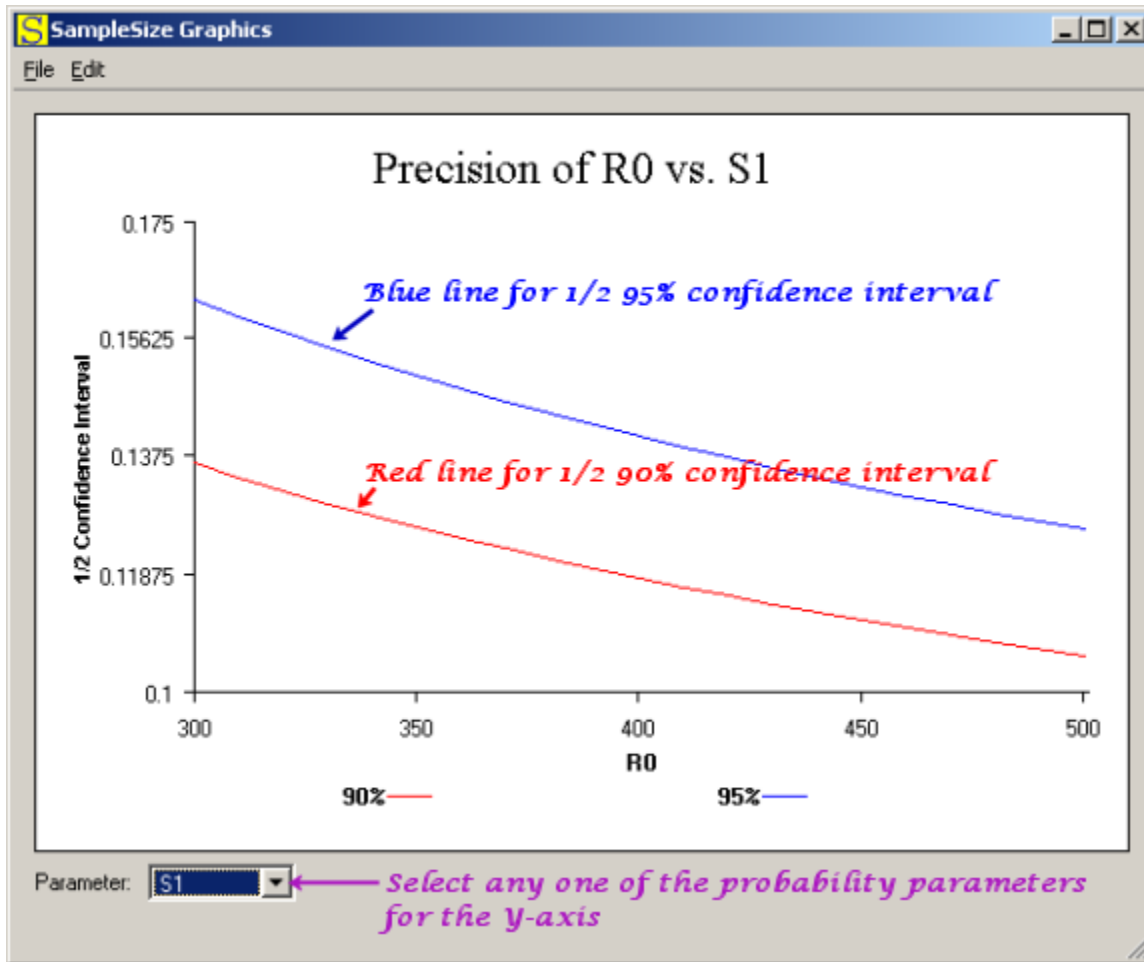


Figure 2.4: Analysis output for single release-recapture model with a range specified

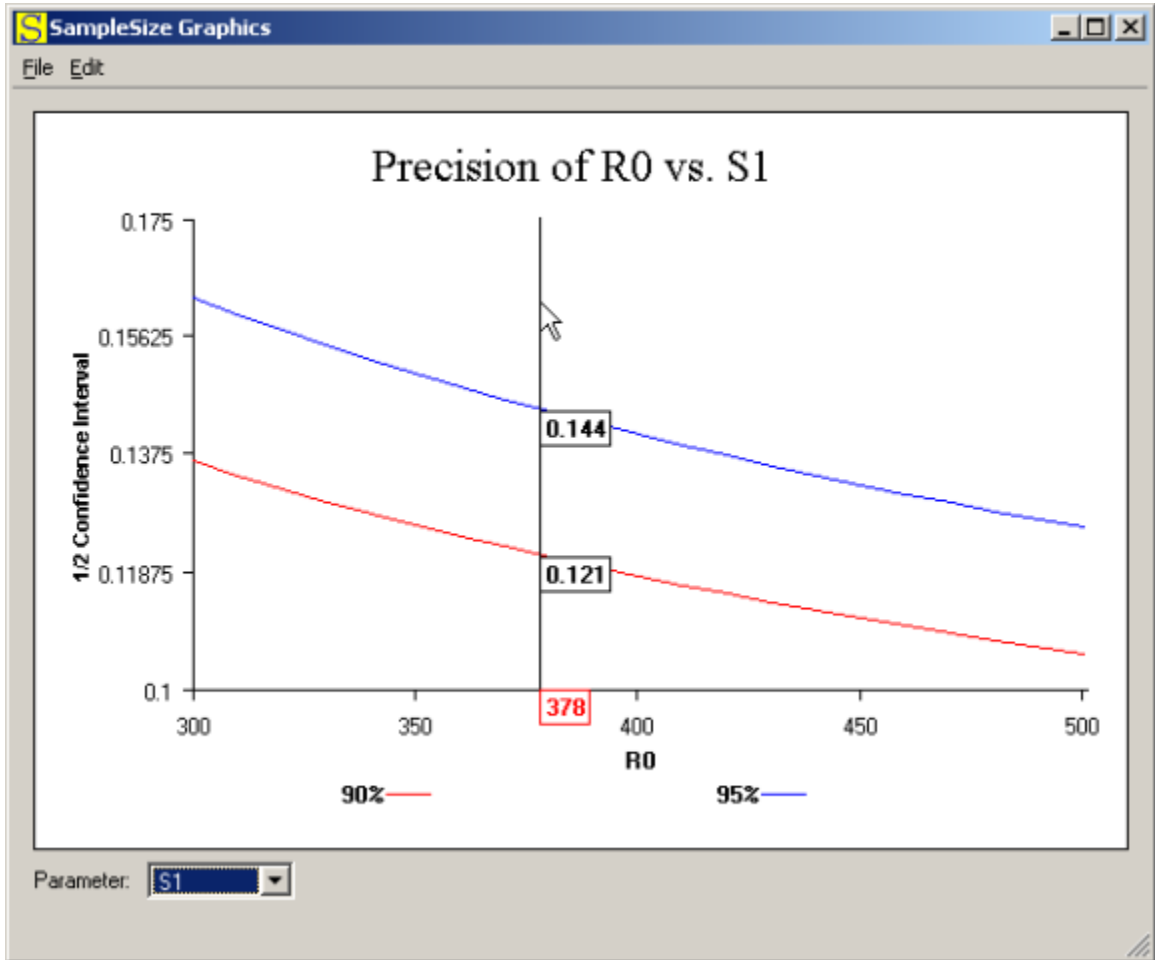


Figure 2.5: Analysis output for a single-release model with a range specified and an indicator line showing the precision for $R_0 = 378$

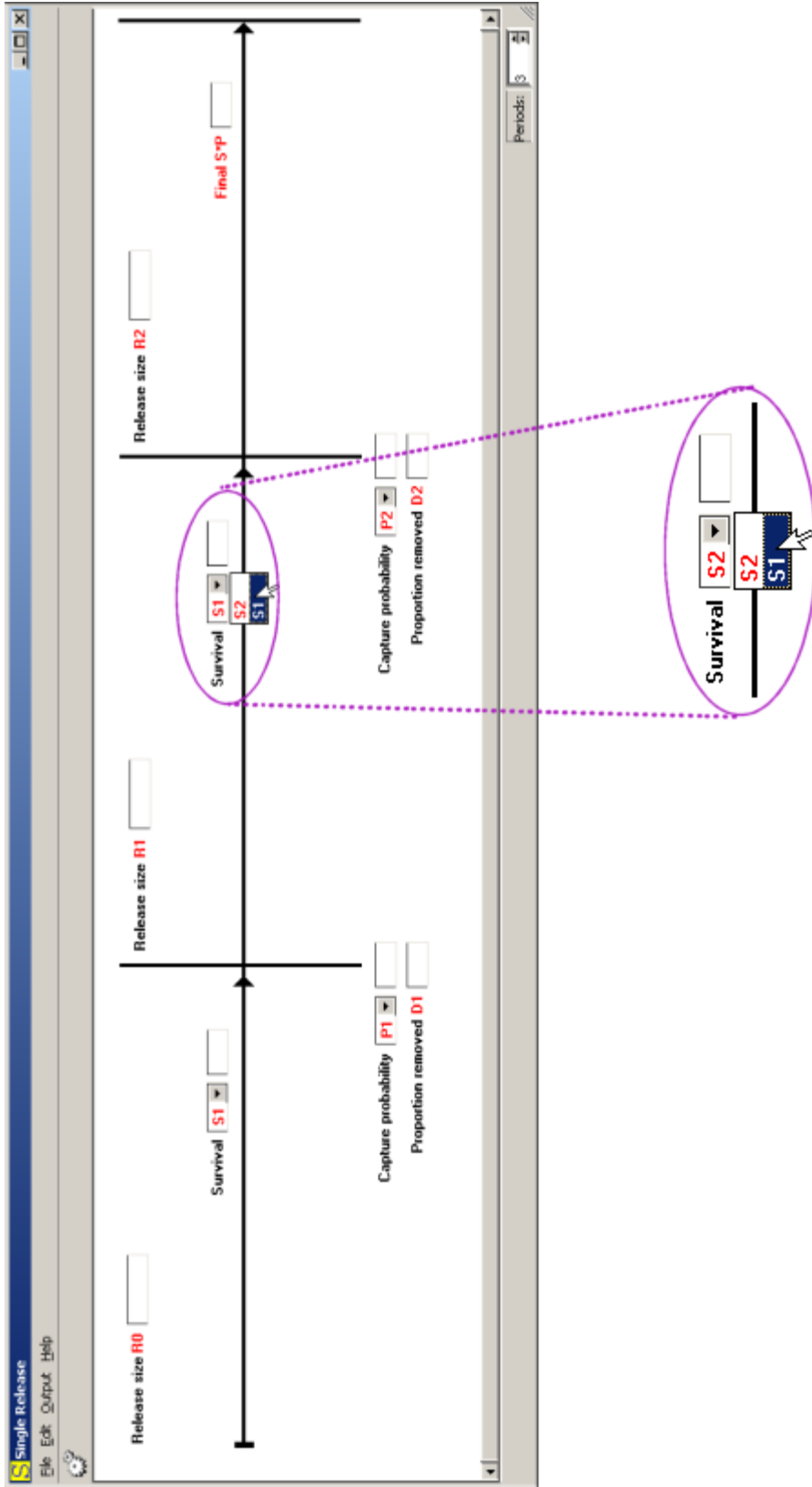


Figure 2.6: Modifying model assumptions for a single-release model with three periods

3.0 Single Release-Recapture Study

The single-release model is used to estimate period-specific survival probabilities. The design might consist of a single release of tagged individuals at the beginning of the study. Alternately, a staggered entry design might be used when tagged individuals enter the study at the beginning of each period. Figure 3.1 illustrates a single-release model with n sampling occasions after an initial release of R_0 tagged individuals. The parameters of the model are:

- $S_1 =$ the probability of survival from the initial release to occasion 1
- $S_i =$ the conditional probability of survival from occasion $i - 1$ to occasion i , given survival to occasion $i - 1$ for $i = 2$ to $n - 1$
- $P_i =$ the probability of detection at occasion i , $i = 1$ to $n - 1$, given survival to occasion i
- $\lambda =$ the product of survival and detection for the final occasion (labeled “Final S*P”, given survival to occasion $n - 1$ (the final detection probability and final survival probability can not be estimated separately)

The other editable fields are:

- $R_0 =$ the number of tagged individuals released in the initial release
- $R_i =$ the number of additional tagged individuals released at occasion i , $i = 1$ to $n - 1$
- $d_i =$ the proportion of the individuals detected at occasion i that are removed, $i = 1$ to $n - 1$

Figure 3.2 shows the dialog window for the single release-recapture model. The control in the lower right of the dialog window allows the user to set the number of periods for the study. For all periods from the second period to the next to last period, the survival probability parameter may be set to any one of the previous survival parameters; the same is true for the detection probability parameters (see Section 2.3). Again we do not recommend this option unless there is a good reason to expect equality of the parameters during the study.

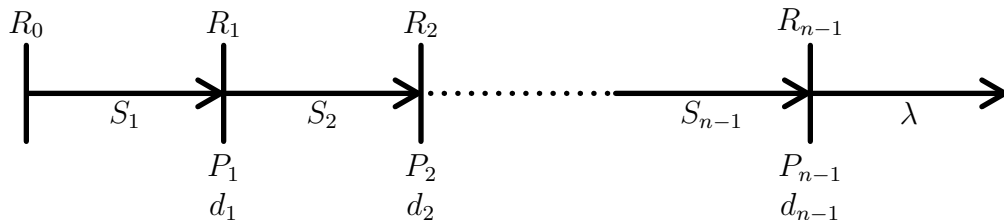


Figure 3.1: Schematic of a single release-recapture study design with n periods

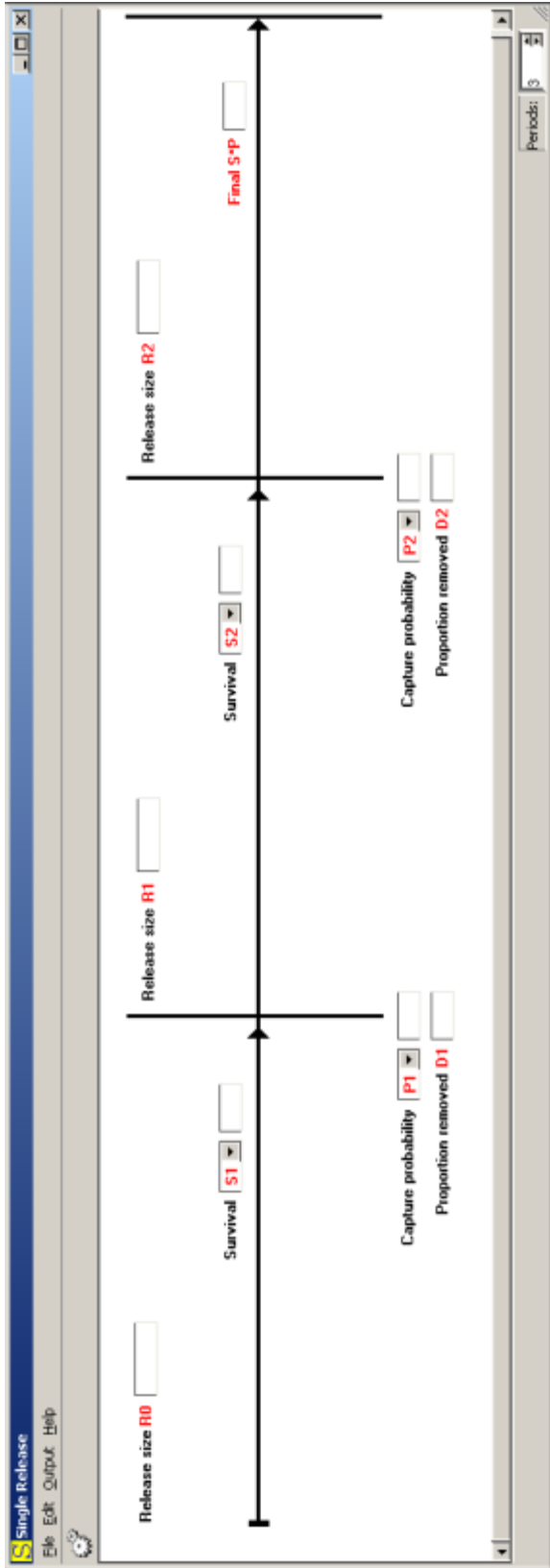


Figure 3.2: Dialog window for a single release-recapture study with three periods

4.0 Paired Release-Recapture Study

The paired release-recapture model is used to estimate survival between intervening initial release locations. Figure 4.1 illustrates the paired-release model. The model parameters are:

- $S_T =$ the probability of surviving the initial treatment interval.
- $S_C =$ the probability of surviving the first period with no treatment effect (control) shared by both release groups.
- $S_{Ti} =$ the probability of the treatment group surviving from occasion $i - 1$ to occasion i , given survival to occasion $i - 1$ for $i = 2$ to $n - 1$.
- $S_{Ci} =$ the probability of the control group surviving from occasion $i - 1$ to occasion i , given survival to occasion $i - 1$ for $i = 2$ to $n - 1$.
- $P_{Ti} =$ the probability of detection at occasion i for an individual from the treatment group, given survival to occasion i for $i = 1$ to $n - 1$.
- $P_{Ci} =$ the probability of detection at occasion i for an individual from the control group, given survival to occasion i for $i = 1$ to $n - 1$.
- $\lambda_T =$ the product of the survival and detection probabilities for in final period for an individual from the treatment group (the final detection probability and survival probability can not be estimated separately).
- $\lambda_C =$ The product of the final survival and detection probabilities for an individual from control group.

Figure 4.2 shows the dialog for the paired release-recapture model. As with the single release-recapture model, there is a control in the lower right for setting the number of periods. Also like the single release-recapture dialog, the survival probability parameters and the detection probability parameters for periods two through $n - 1$ may be set to the parameter for any previous period (Section 2.3).

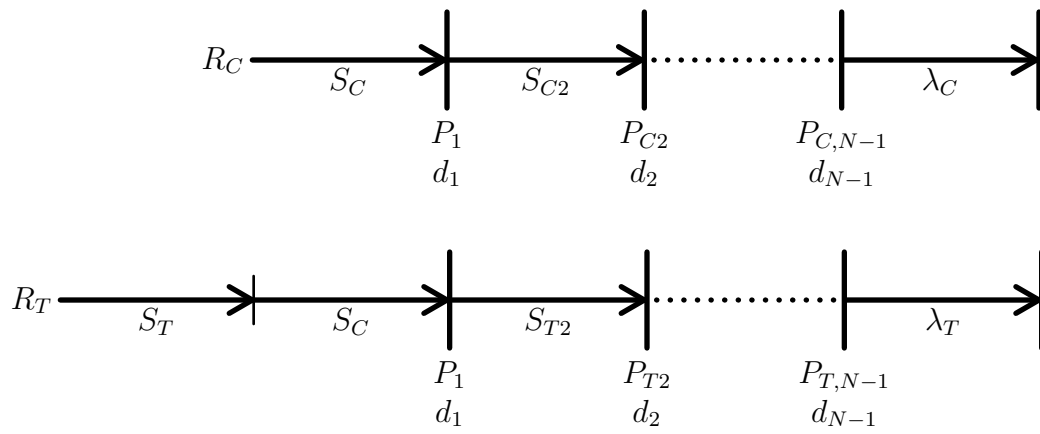


Figure 4.1: Schematic of a paired release-recapture study design with n periods

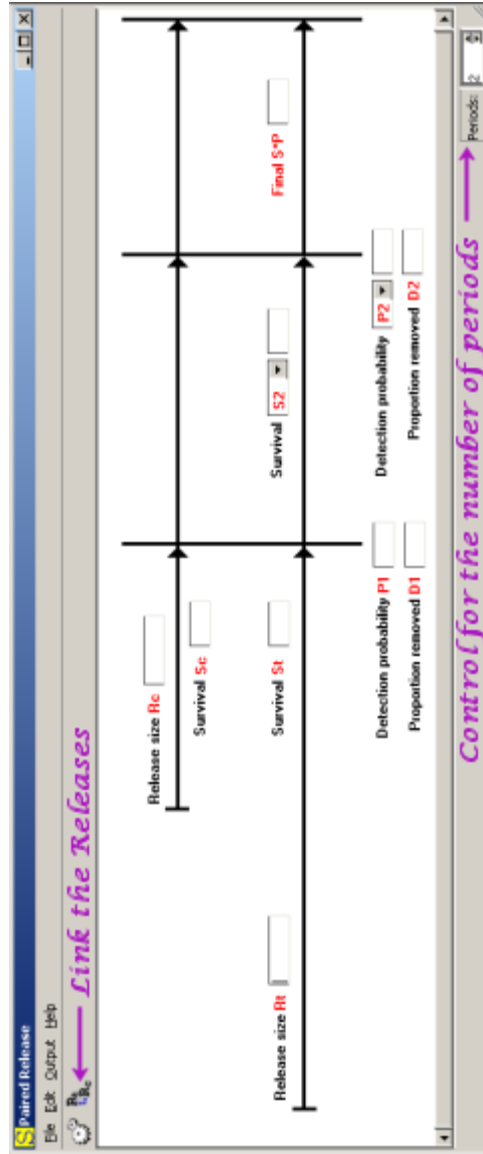


Figure 4.2: Dialog window for a paired release-recapture model with two periods

The paired-release model requires the assumption that the two release groups have the same survival probability for the “control period” (S_C). Although the input dialog for the paired-release model shows common downstream survival and detection probabilities for both releases, the calculated precision is based on the fully parameterized Cormack-Jolly-Seber models for each release. This is a worst-case scenario and ensures that the resulting sample size calculations are conservative (i.e., the most that is required).

Note the “Link releases” icon to the right of the “Run the analysis” icon. Depressing this button causes R_C to be set to whatever value is entered for R_T .

5.0 Transport-Inriver Ratio Study

The transport-inriver ratio model is designed to assess the effects on survival of transporting juvenile salmon on the Columbia River. The model is illustrated in Figure 5.1. The model parameters are:

- $S_C =$ the probability of survival from release to detection without transport
- $T =$ the proportional effect of transportation on survival
- $P =$ the probability of subsequent detection

Figure 5.2 shows the dialog window for the transport-inriver model. A range can be entered for any of the parameters, causing an output window similar to Figure 2.4 to appear.

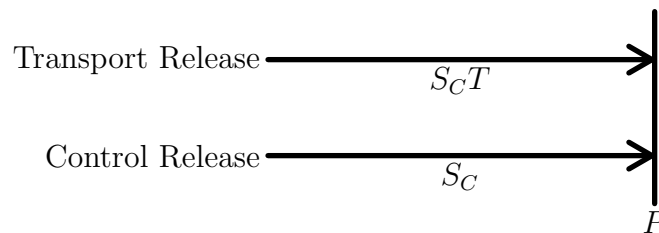


Figure 5.1: Schematic of a transport-inriver ratio study design

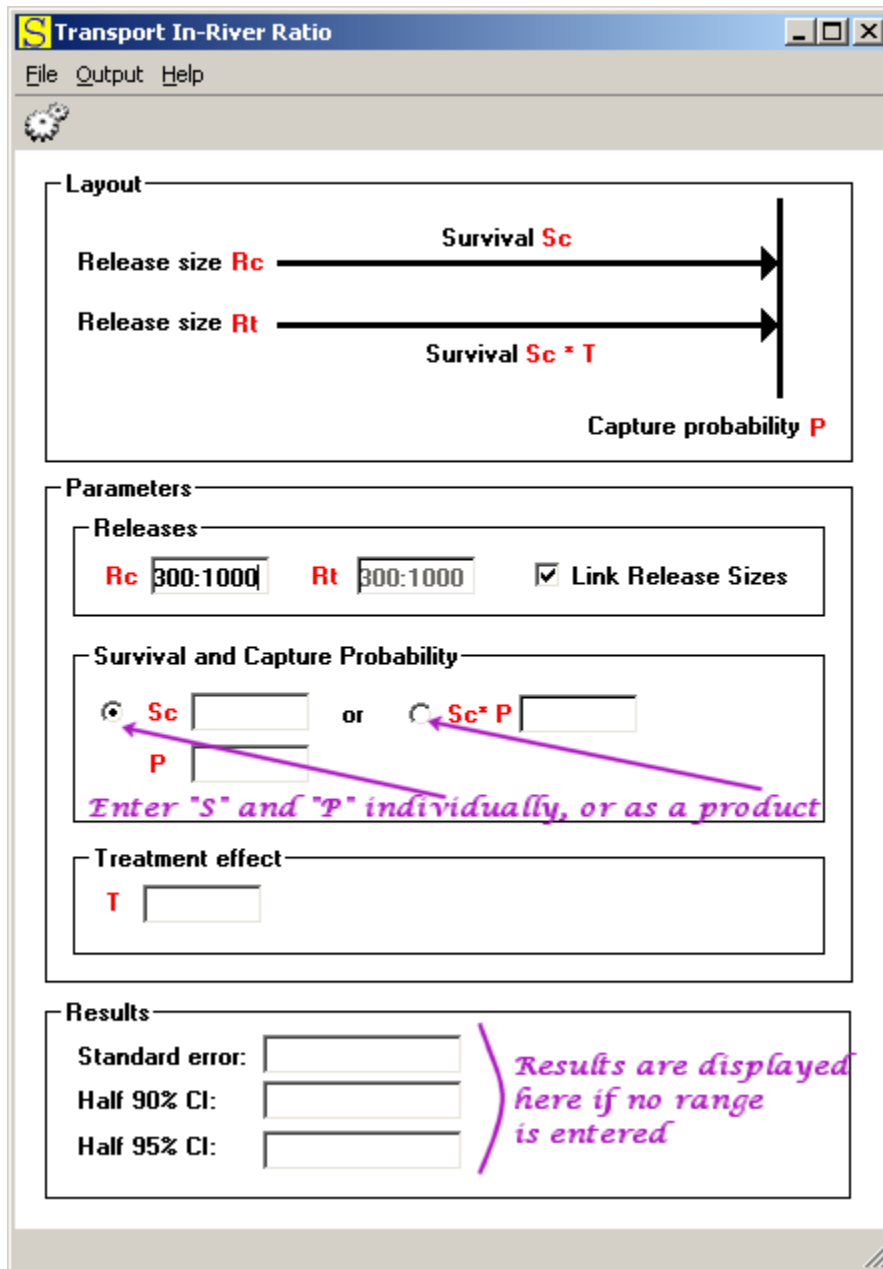


Figure 5.2: Transport-inriver ratio dialog window