Program TribPit

Cohort Analysis of Juvenile Salmonid Movement and Survival in Tributaries

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Chapter 1: Overview

1.1 Motivation

Traditional release-recapture models have been used on the Columbia River system to estimate survival with the assumption that from release to a detection point, or from one detection point to the next, an individual fish either (1) migrates downstream or (2) dies. Studies of Chinook salmon and steelhead, however, show that many juvenile salmon and steelhead stay upstream ("residualize") in the tributaries for one or more years before migrating downstream. A traditional release-recapture analysis, which assumes all released fish migrate downstream in the release year, would treat the fish that residualize as mortalities. Program TribPit provides cohort-based survival estimates that account for the possibility of an individual fish overwintering for multiple years during the downstream migration process.

1.2 The TribPit Model

Figure 1 illustrates the TribPit model for a hypothetical study with a release in year 1 and detections at three downstream locations. The parameters of the model are:

ϕ_{ijk} = the probability of survival and movement from site $i-1$ in year j to site i in year k, given that the individual was alive at site $i-1$ in year j.

P_{ik} = the probability of detection at site i in year k, given that an individual was alive at site i in year k.

λ_{jk} = the probability of survival and movement and detection from the penultimate site in year j to the final site in year k, given that the individual was alive at the penultimate site in year j.

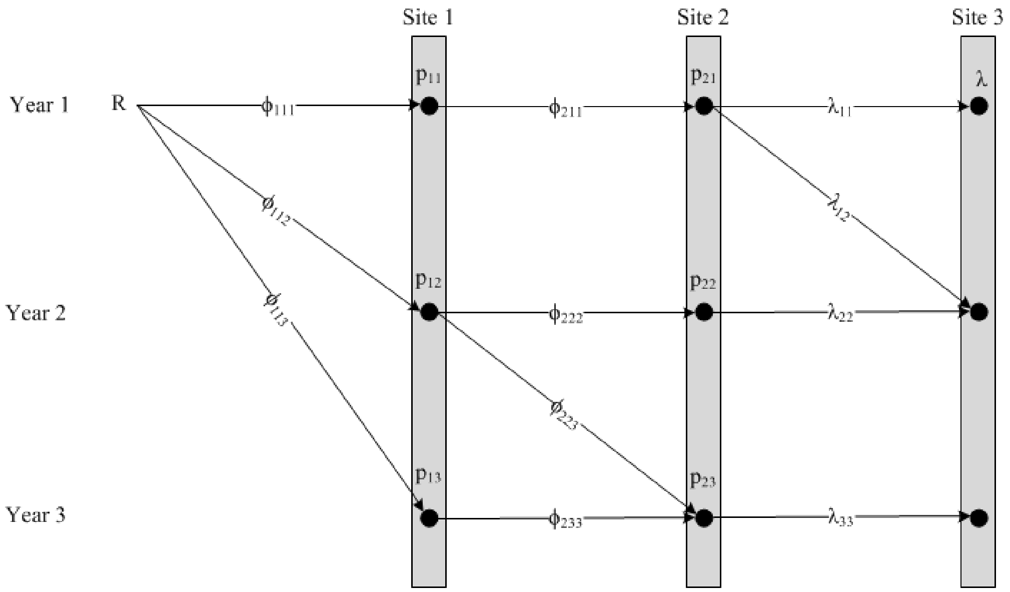

Site 1
Site 2
Site 3
Year 1
Year 2
Year 3
R
ϕ_{111}
ϕ_{112}
ϕ_{113}
ϕ_{211}
ϕ_{222}
ϕ_{223}
ϕ_{233}
p_{11}
p_{12}
p_{13}
p_{21}
p_{22}
p_{23}
λ
λ_{11}
λ_{12}
λ_{22}
λ_{33}

Figure 1. Illustration of the TribPit model for a hypothetical study

For the sake of clarity, Figure 1 does not show all possible overwintering possibilities of a release (the diagonals on the diagram). For example, if fish detected at site 2 in year 1 were next detected at site 3 in year 3, Program TribPit would include the parameter λ_{13} in the model; TribPit only includes the overwintering-related parameters in the model for which there are observations.

Note that for the final reach, from the penultimate site to the final site, the probability of survival and movement cannot be separately estimated from the probability of detection. For this reason, TribPit models the final λ parameter as the product of the two. A consequence of this is that a study must have an additional downstream detection site beyond the site at which an estimate of survival and movement is desired.

1.3 Auxiliary Releases

Program TribPit allows for multiple releases of a given cohort in other years and/or sites for the purpose of increasing the precision of the resulting parameter estimates. For example, continuing with the hypothetical study of Figure 1, another release from the same cohort and from the same site might be performed one year later, as shown in Figure 2.

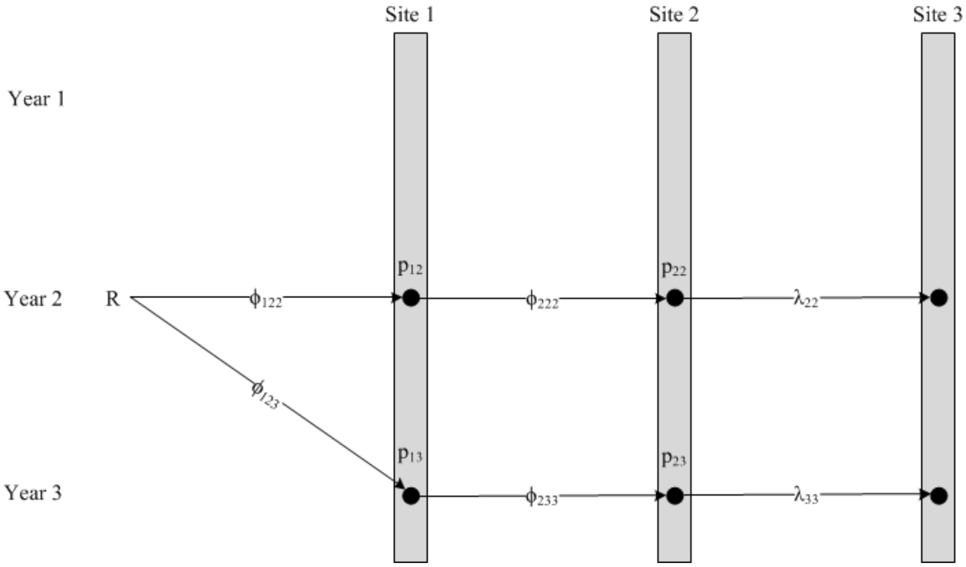


Figure 2. An auxiliary release for a hypothetical study of the same cohort as in Figure 1 in the following year

There are several parameters that might be in common across the two releases: ϕ_{222}, ϕ_{233}, λ_{22}, λ_{33}, P_{12}, P_{13}, P_{22}, and P_{23}. Program TribPit provides hypotheses testing via the AIC to see if it is possible to equate the equivalent parameters across the releases. The release process depicted in Figures 1 and 2 may be repeated for a number of years.

Program TribPit assumes that the earliest release in time and the most upstream release is the primary release; all other releases are assumed to be auxiliary releases.

1.4 Model Parameterization

As explained in the previous example, auxiliary releases may be used to increase the precision of parameter estimates by equating equivalent parameters across releases. The possibilities include:

1. Keeping all parameters unique across releases, in which case the auxiliary releases do not provide additional precision for the estimates of the primary release.
2. Equating only the detection parameters (P_{ik}) across releases.
3. Equating both the detection parameters and the survival and movement parameters (ϕ_{ijk} and λ_{jk}) across releases.

In addition, parameters may be combined:

1. Across all releases released from the same release site.
2. Across all releases released in the same year.
3. Across all releases regardless of release site and release year.

Although the previous discussion referred to the TribPit model, from here on out the term "model" will be used to refer to the parameterization used in estimating the parameters. The available models are dependent on the number of and the nature of the releases. The four possible scenarios are:

1. One release only.
2. Multiple releases all released from the same site but in different years.
3. Multiple releases all released in the same year but from different sites.
4. Multiple releases from different sites and in different years.

The tables in Sections 1.4.1 to 1.4.4 show what models are available in Program TribPit for each of these four scenarios. Note that in some cases some available models may not be estimable due to the sparseness of the data. The "Model ID" is a unique identifier assigned to each model for ease of reference.

1.4.1 Scenario One: One Release Only

Model ID	Equivalent Capture Parameters	Equivalent Survival and Movement Parameters
M.n.1A	Unique	Unique

1.4.2 Scenario Two: Multiple Releases from the Same Site But in Different Years

Model ID	Equivalent Capture Parameters	Equivalent Survival and Movement Parameters
M.y.1A	Unique	Unique
M.y.2A	Equated across release years	Unique
M.y.2B	Equated across release years	Equated across release years

1.4.3 Scenario Three: Multiple Releases in the Same Year But from Different Sites

Model ID	Equivalent Capture Parameters	Equivalent Survival and Movement Parameters
M.s.1A	Unique	Unique
M.s.2A	Equated across release sites	Unique
M.s.2B	Equated across release sites	Equated across release sites

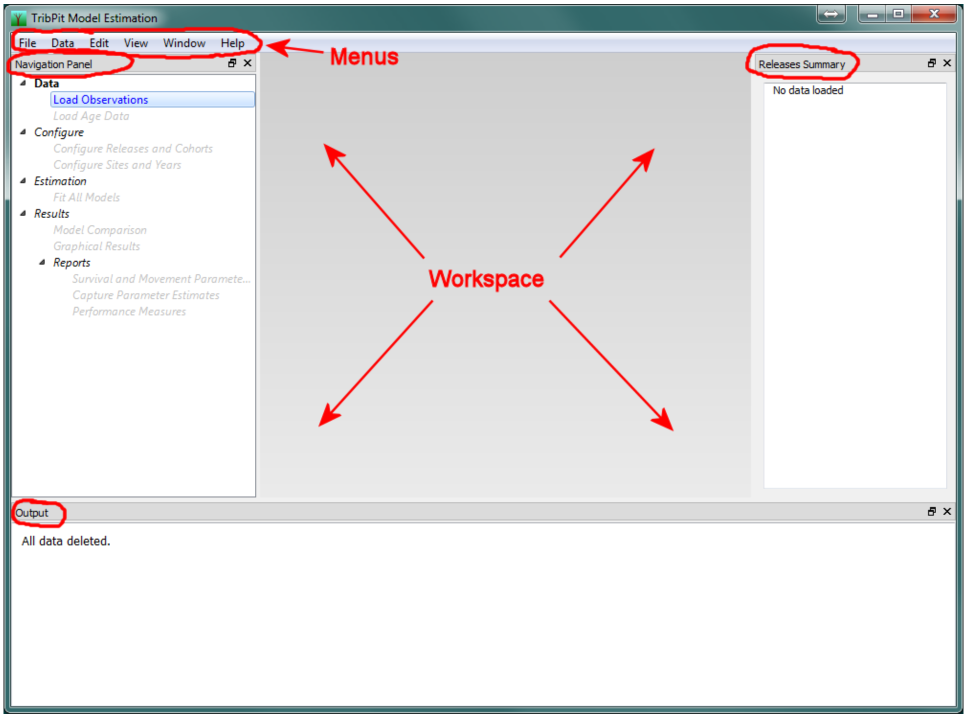
1.4.4 Scenario Four: Multiple Releases from Different Sites and in Different Years

Model ID	Capture Parameters	Equivalent Survival and Movement Parameters
M.ys.1A	Unique	Unique
M.ys.2A	Equated across release years, release sites unique	Unique
M.ys.2B	Equated across release years, release sites unique	Equated across release years, release sites unique
M.ys.3A	Equated across release sites, release years unique	Unique
M.ys.3B	Equated across release sites, release years unique	Equated across sites, release years unique
M.ys.4A	Equated across all releases	Unique
M.ys.4B	Equated across all releases	Equated across release years, release sites unique
M.ys.4C	Equated across all releases	Equated across release sites, release years unique
M.ys.4D	Equated across all releases	Equated all releases

Chapter 2: Using TribPit

Figure 3 below shows the main dialog of Program TribPit at startup. The main components are:

- The **Navigation Panel** is on the left-hand side. It lists all commands available to the user organized in a hierarchical way, from top to bottom in the order that the user would generally access them.
- The **Releases Summary** is on the right-hand side. It summarizes the releases for all data currently loaded into Program TribPit.
- The **Output** is at the bottom. All status messages and error messages that occur during program execution are displayed here.
- The **Workspace** occupies the center portion of the main dialog. This is where all user dialogs and reports are displayed.
- **Menus** across the top of the main dialog, described below.


TribPit Model Estimation
File Data Edit View Window Help
Menus
Navigation Panel
Data
Load Observations
Load Age Data
Configure
Configure Releases and Cohorts
Configure Sites and Years
Estimation
Fit All Models
Results
Model Comparison
Graphical Results
Reports
Survival and Movement Paramete...
Capture Parameter Estimates
Performance Measures
Workspace
Releases Summary
Output

No data loaded

All data deleted.

Figure 3. Main dialog of Program TribPit at startup with main components highlighted

2.1 Menus

The **File** menu commands are shown in Figure 4. The Exit command causes Program TribPit to exit. The other commands – “Save As,” “Print” and “Print Preview” - are available when reports and graphs are active, allowing reports to be saved to a file or sent to a printer.

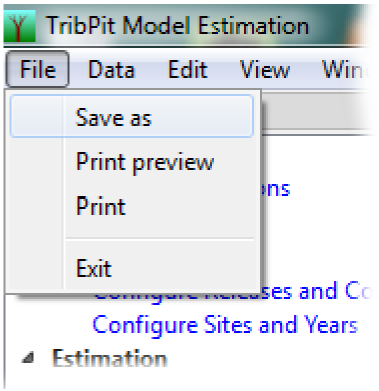

TribPit Model Estimation
File Data Edit View Win
Save as
Print preview
Print
Exit
Configure Sites and Years
Estimation

Figure 4. File Menu

The **Data** menu has one command – "Clear All Data." It clears all data currently loaded and returns Program TribPit to its initial state. The user will be asked to confirm this request before performing this destructive command.

The **View** menu, shown in Figure 5, allows the user to control whether or not the Navigation Panel, Output, or the Releases Summary is visible or not. Figure 5 shows the default state with all three components having a checkmark, indicating they are visible. Clicking on a component will "un-check" it and hide it from view; clicking on an "un-checked" item will cause the hidden component to be visible again.

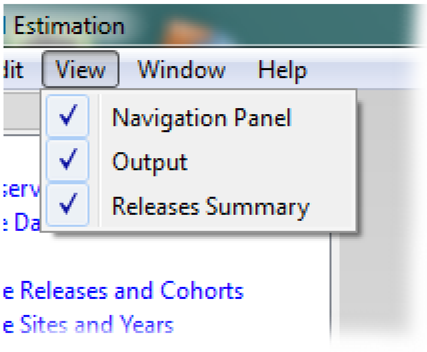

Estimation
lit
View
Window
Help
✓ Navigation Panel
✓ Output
✓ Releases Summary
serv
Da
e Releases and Cohorts
e Sites and Years

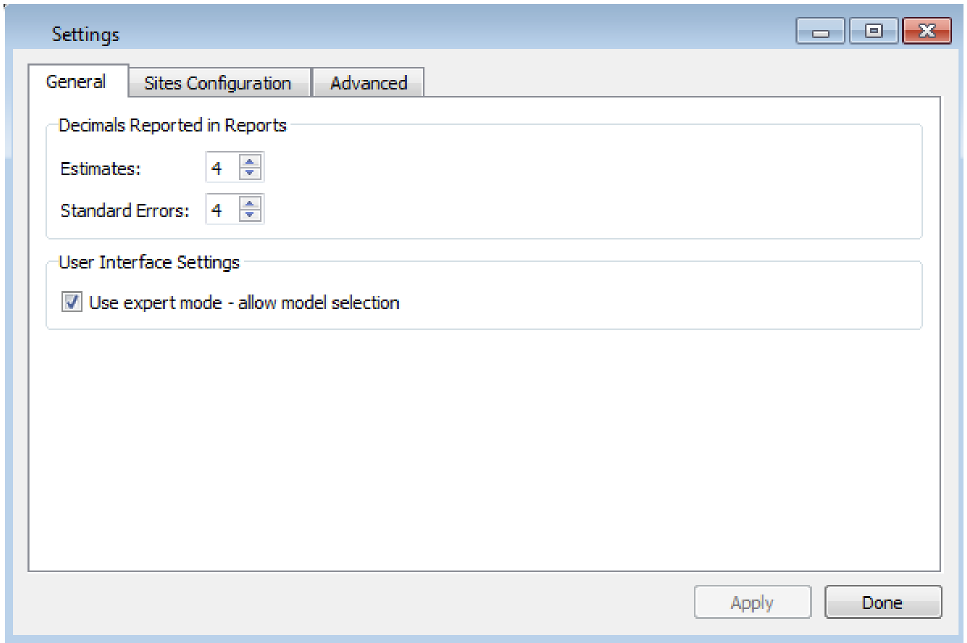
Figure 5. View Menu

The **Window** menu has three actions: "Tile Windows," "Cascade Windows," and "Close All," allowing the user to organize the currently open windows in the workspace.

The **Edit** menu has one item, "Settings" as described below.

2.2 Settings

The settings dialog, shown in Figure 6, has three tabs across the top: “General,” “Sites Configuration,” and “Advanced.” These three tags define the computing environment and are described in detail below.



Decimals Reported in Reports

Estimates: 4

Standard Errors: 4

User Interface Settings

☑ Use expert mode - allow model selection

Figure 6. General Settings Dialog

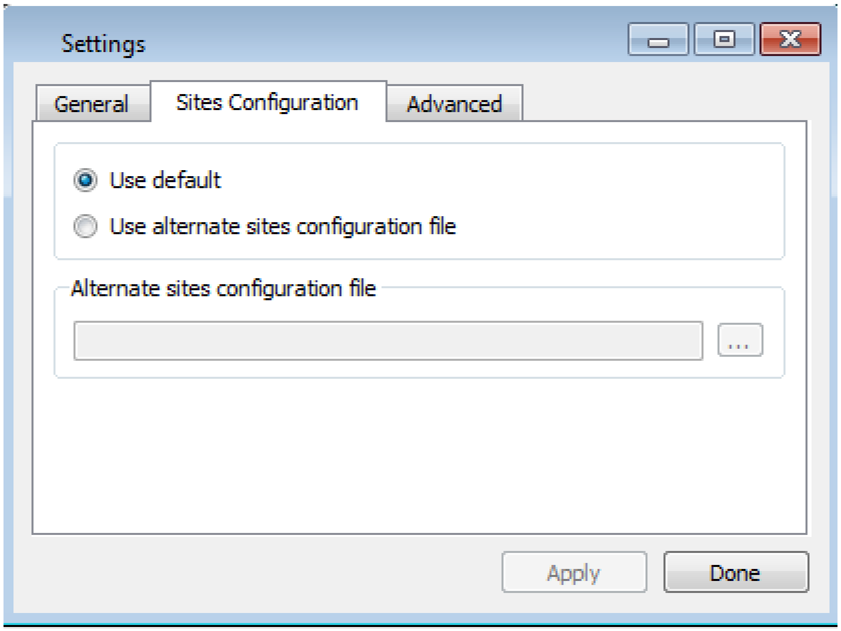
2.2.1 General Settings

The general settings dialog is shown in Figure 6. The top part allows the user to control the number of decimal places displayed in reports, both for estimates and the standard errors of estimates.

In the User Interface Settings, the user may turn on “Use expert mode – allow model selection.” This is described in detail in Section 5.4.

2.2.2 Sites Configuration Settings

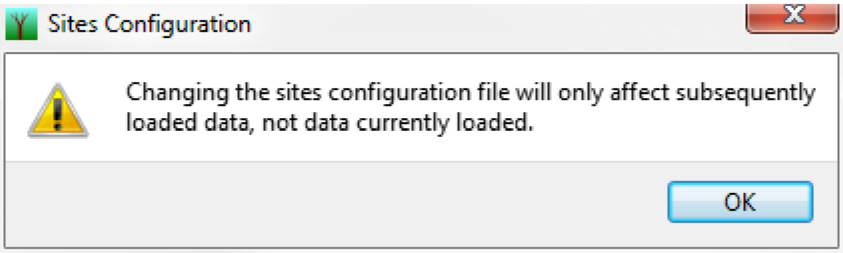
As will be explained in Chapter 3, a sites configuration file is necessary before loading observations data. The Sites Configuration tab, shown in Figure 7, allows the user to select an alternate sites configuration file. If the user changes the sites configuration file, a warning will appear as shown in Figure 8, which the user must acknowledge by pressing the “OK” button. The sites configuration file is used only when data are loaded; if the user wants to apply an alternate sites configuration file to data already loaded, then the File->Clear All Data command must be invoked, and the observations must be reloaded after specifying the desired sites configuration file.


Settings
General
Sites Configuration
Advanced
Alternate sites configuration file
...
Apply
Done

● Use default

○ Use alternate sites configuration file

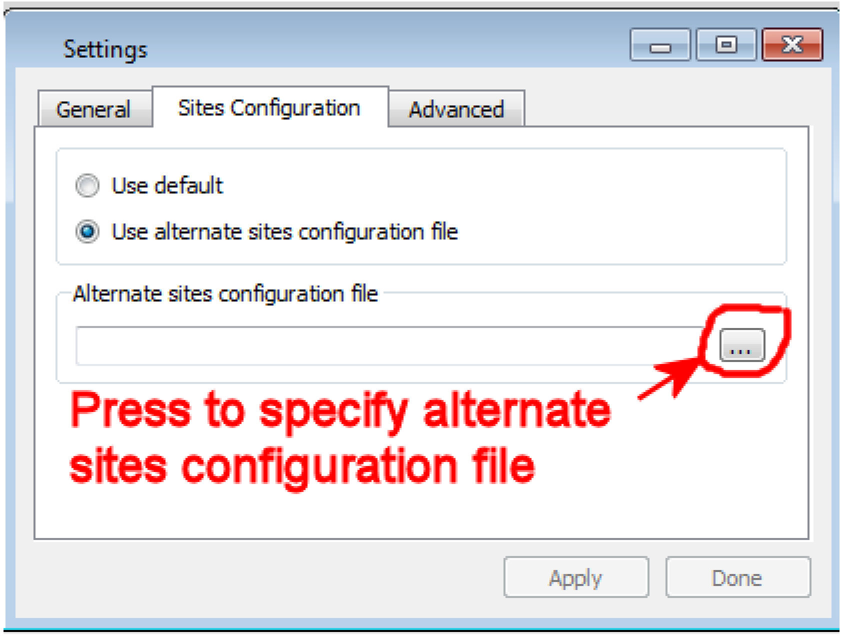
Figure 7. Sites Configuration Settings tab


Sites Configuration
OK

Changing the sites configuration file will only affect subsequently loaded data, not data currently loaded.

Figure 8. Warning Message when the user changes the sites configuration file

When the user selects "Use alternate sites configuration file," the dialog appears as shown in Figure 9, with both the "Apply" and "Done" buttons disabled. The user must specify the alternate configuration file before proceeding by pressing the tool button shown in Figure 9.



○ Use default

● Use alternate sites configuration file

Alternate sites configuration file

Press to specify alternate sites configuration file

Figure 9. Sites Configuration Setting after selecting "Use alternate sites configuration file"

Note that when the user exits Program TribPit and then restarts it, it defaults to using the default configuration file; if the user desires an alternate sites configuration file, the user must explicitly select it each time at startup.

2.2.3 Advanced Settings

The Advanced Tab has one item – a checkbox for "Show Diagnostic Tools." Enabling this will cause a "Diagnostic Tools" section to be added to the Navigation Panel, as explained in detail in the Appendix B.

Chapter 3: Data – TribPit Input Files

3.1 Sites Configuration File

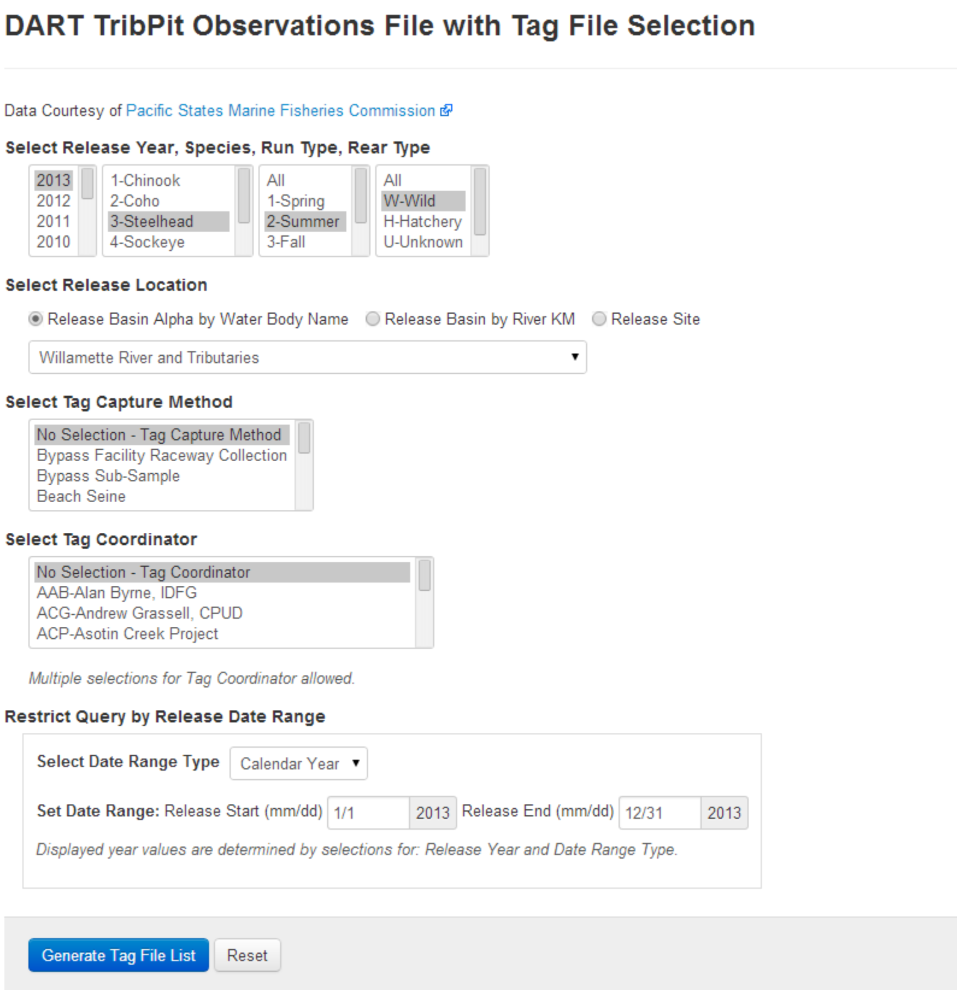
The sites configuration file is maintained on the Columbia Basin Research (CBR) website, and is updated as the configuration of PIT-tag arrays on the Columbia River and Snake River systems changes. Program TribPit requires the sites configuration file to be loaded before loading observations in order to be able to convert PIT-tag detections to capture histories.

A version of the sites configuration file is loaded when Program TribPit is installed. The first time an observations file is loaded, Program TribPit accesses the CBR website to see if a newer version of the sites configuration file exists. If so, it is downloaded and loaded into Program TribPit before loading the observations file. Subsequently, whenever the user loads an observations file, if the sites configuration has not already been loaded, and it has been more than a day since the CBR site was queried, Program TribPit queries the CBR website for a newer version, and downloads the newer version and loads it. The sites configuration file is always loaded before loading an observations file.

The loading of the sites configuration file described above is all done in the background without the user needing to intervene. The user may, however, load an alternate sites configuration file if desired, as explained is Chapter 2. A new sites configuration file will only apply to subsequently loaded observations; it will not affect observations already loaded into Program TribPit.

3.2 Observations File

The observations file contains all of the actual PIT-Tag detections of the tags in the study. It is created via the Columbia Basin Research (CBR) website at the DART TribPit Observations File (http://www.cbr.washington.edu/dart/query/pit_basin_branching). Figure 10 shows a portion of the start page at this web address.



DART TribPit Observations File with Tag File Selection

Data Courtesy of Pacific States Marine Fisheries Commission

Select Release Year, Species, Run Type, Rear Type

2013 2012 2011 2010 | 1-Chinook 2-Coho 3-Steelhead 4-Sockeye | All 1-Spring 2-Summer 3-Fall | All W-Wild H-Hatchery U-Unknown

Select Release Location

● Release Basin Alpha by Water Body Name ○ Release Basin by River KM ○ Release Site

Willamette River and Tributaries ▾

Select Tag Capture Method

No Selection - Tag Capture Method
Bypass Facility Raceway Collection
Bypass Sub-Sample
Beach Seine

Select Tag Coordinator

No Selection - Tag Coordinator
AAB-Alan Byrne, IDFG
ACG-Andrew Grassell, CPUD
ACP-Asotin Creek Project

Multiple selections for Tag Coordinator allowed.

Restrict Query by Release Date Range

Select Date Range Type Calendar Year ▾

Set Date Range: Release Start (mm/dd) 1/1 2013 Release End (mm/dd) 12/31 2013

Displayed year values are determined by selections for: Release Year and Date Range Type.

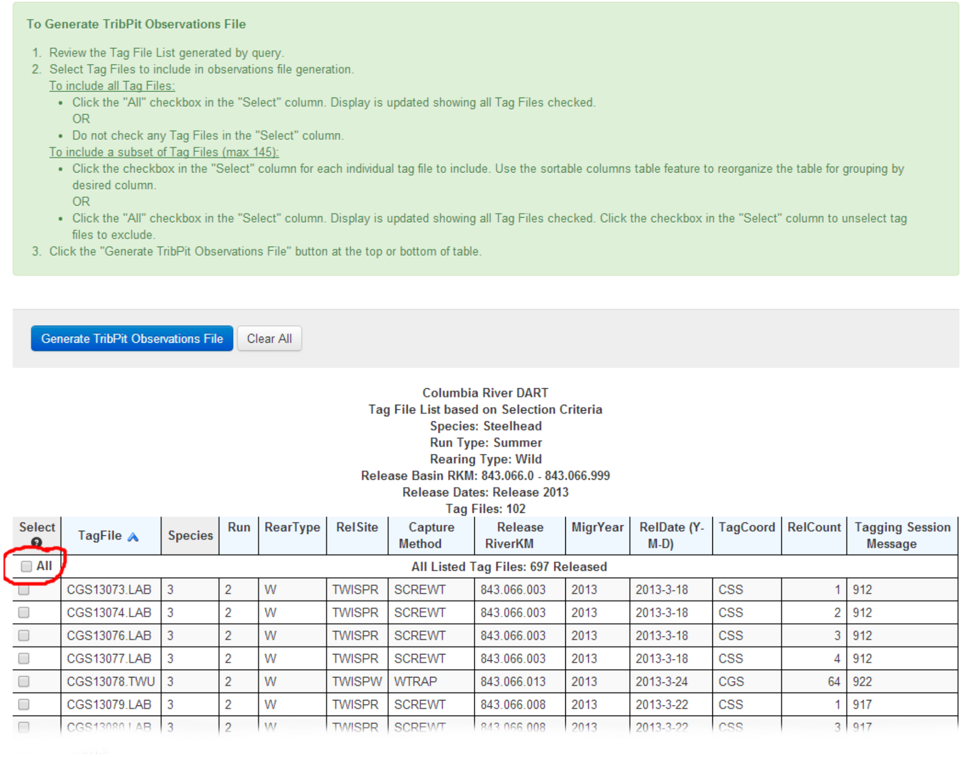
Figure 10. Portion of the start page for the query to create the observations file

The user specifies the desired

1. Release year
2. Species
3. Run Type
4. Rear Type
5. Release Location
6. Tag Capture Method
7. Tag Coordinator
8. Date Range for the Release Date and Release End

After making the selections, press the “Generate Tag File List” button at the bottom of page.

Once the “Generate Tag File List” button has been pressed, it may take several minutes to process the query. Once complete, the results will be displayed as show in Figure 11.



To Generate TribPit Observations File

1. Review the Tag File List generated by query.
2. Select Tag Files to include in observations file generation.
   To include all Tag Files:
   - Click the "All" checkbox in the "Select" column. Display is updated showing all Tag Files checked.
     OR
   - Do not check any Tag Files in the "Select" column.

   To include a subset of Tag Files (max 145):
   - Click the checkbox in the "Select" column for each individual tag file to include. Use the sortable columns table feature to reorganize the table for grouping by desired column.
     OR
   - Click the "All" checkbox in the "Select" column. Display is updated showing all Tag Files checked. Click the checkbox in the "Select" column to unselect tag files to exclude.
3. Click the "Generate TribPit Observations File" button at the top or bottom of table.

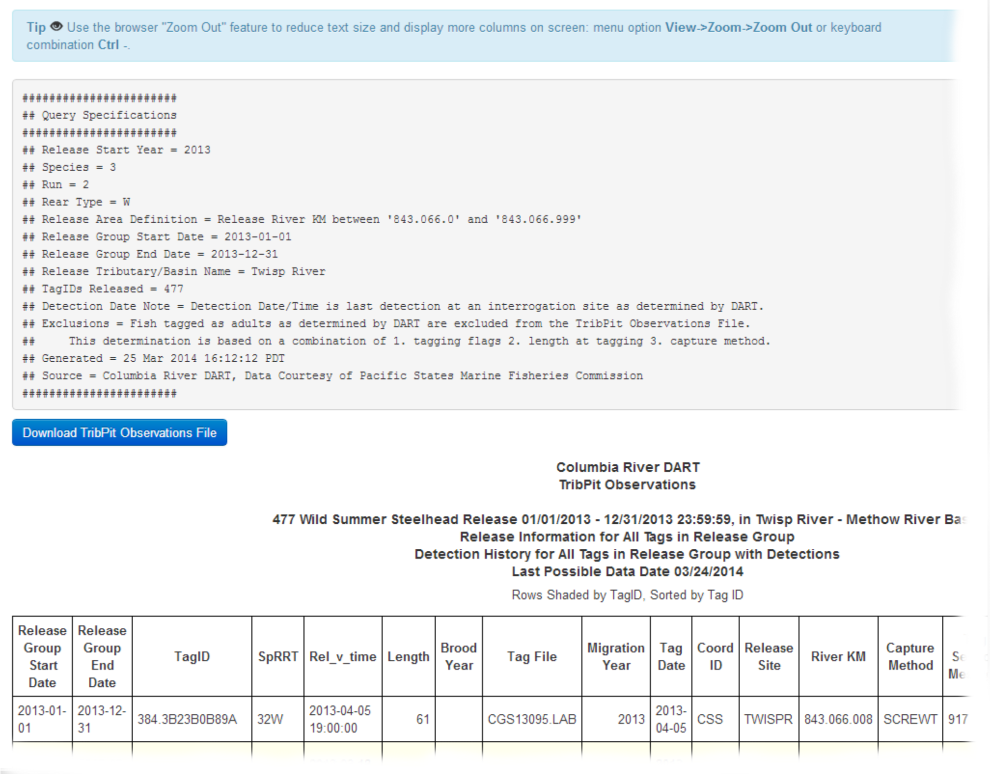
Columns River DART
Tag File List based on Selection Criteria
Species: Steelhead
Run Type: Summer
Rearing Type: Wild
Release Basin RKM: 843.066.0 - 843.066.999
Release Dates: Release 2013
Tag Files: 102

Select	TagFile	Species	Run	RearType	RelSite	Capture Method	Release RiverKM	MigrYear	RelDate (Y-M-D)	TagCoord	RelCount	Tagging Session Message
☐ All	All Listed Tag Files: 697 Released											
☐	CGS13073.LAB	3	2	W	TWISPR	SCREWT	843.066.003	2013	2013-3-18	CSS	1	912
☐	CGS13074.LAB	3	2	W	TWISPR	SCREWT	843.066.003	2013	2013-3-18	CSS	2	912
☐	CGS13076.LAB	3	2	W	TWISPR	SCREWT	843.066.003	2013	2013-3-18	CSS	3	912
☐	CGS13077.LAB	3	2	W	TWISPR	SCREWT	843.066.003	2013	2013-3-18	CSS	4	912
☐	CGS13078.TWU	3	2	W	TWISPW	WTRAP	843.066.013	2013	2013-3-24	CGS	64	922
☐	CGS13079.LAB	3	2	W	TWISPR	SCREWT	843.066.008	2013	2013-3-22	CSS	1	917
☐	CGS13080.LAB	3	2	W	TWISPR	SCREWT	843.066.008	2013	2013-3-22	CSS	3	917

Figure 11. Portion of an example of the results of a query to create the observations file

The user then reviews the tag files in the results and selects the ones to be used to create the observations file. The user may select all of them by select the “All” checkbox in the first row of the first column (circled in Figure 11), or by simply not selecting anything. Alternatively, a subset of the tag files may be included by selecting the checkbox next to each desired tag file. When ready, the user then presses the “Generate TribPit Observations File” button to continue.

Figure 12 shows the results of the query. The user then presses “Download TribPit Observations File” to download the observations file which can be loaded directly into Program TribPit.



Tip 👁 Use the browser "Zoom Out" feature to reduce text size and display more columns on screen: menu option **View->Zoom->Zoom Out** or keyboard combination **Ctrl** -.

```
#######################
## Query Specifications
#######################
## Release Start Year = 2013
## Species = 3
## Run = 2
## Rear Type = W
## Release Area Definition = Release River KM between '843.066.0' and '843.066.999'
## Release Group Start Date = 2013-01-01
## Release Group End Date = 2013-12-31
## Release Tributary/Basin Name = Twisp River
## TagIDs Released = 477
## Detection Date Note = Detection Date/Time is last detection at an interrogation site as determined by DART.
## Exclusions = Fish tagged as adults as determined by DART are excluded from the TribPit Observations File.
##     This determination is based on a combination of 1. tagging flags 2. length at tagging 3. capture method.
## Generated = 25 Mar 2014 16:12:12 PDT
## Source = Columbia River DART, Data Courtesy of Pacific States Marine Fisheries Commission
#######################
```

Columbia River DART
TribPit Observations

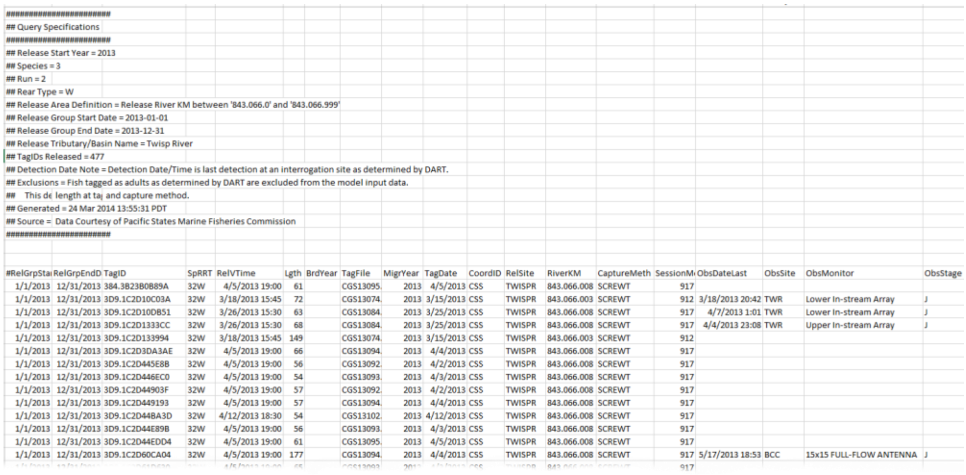
477 Wild Summer Steelhead Release 01/01/2013 - 12/31/2013 23:59:59, in Twisp River - Methow River Ba
Release Information for All Tags in Release Group
Detection History for All Tags in Release Group with Detections
Last Possible Data Date 03/24/2014

Rows Shaded by TagID, Sorted by Tag ID

Release Group Start Date	Release Group End Date	TagID	SpRRT	Rel_v_time	Length	Brood Year	Tag File	Migration Year	Tag Date	Coord ID	Release Site	River KM	Capture Method	Se Me
2013-01-01	2013-12-31	384.3B23B0B89A	32W	2013-04-05 19:00:00	61		CGS13095.LAB	2013	2013-04-05	CSS	TWISPR	843.066.008	SCREWT	917

Figure 12. Final page of the dart query for downloading the observations file

Figure 13 shows the top portion of an observations file, as displayed in Microsoft Excel (2013).



```
########################
## Query Specifications
########################
## Release Start Year = 2013
## Species = 3
## Run = 2
## Rear Type = W
## Release Area Definition = Release River KM between '843.066.0' and '843.066.999'
## Release Group Start Date = 2013-01-01
## Release Group End Date = 2013-12-31
## Release Tributary/Basin Name = Twisp River
## TagIDs Released = 477
## Detection Date Note = Detection Date/Time is last detection at an interrogation site as determined by DART.
## Exclusions = Fish tagged as adults as determined by DART are excluded from the model input data.
##    This de length at ta; and capture method.
## Generated = 24 Mar 2014 13:55:31 PDT
## Source =  Data Courtesy of Pacific States Marine Fisheries Commission
########################
```

#RelGrpStai	RelGrpEndD	TagID	SpRRT	RelVTime	Lgth	BrdYear	TagFile	MigrYear	TagDate	CoordID	RelSite	RiverKM	CaptureMeth	SessionM	ObsDateLast	ObsSite	ObsMonitor	ObsStage
1/1/2013	12/31/2013	384.3B23B0B89A	32W	4/5/2013 19:00	61		CGS13095.	2013	4/5/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D10C03A	32W	3/18/2013 15:45	72		CGS13074.	2013	3/15/2013	CSS	TWISPR	843.066.003	SCREWT	912	3/18/2013 20:42	TWR	Lower In-stream Array	J
1/1/2013	12/31/2013	3D9.1C2D10DB51	32W	3/26/2013 15:30	63		CGS13084.	2013	3/25/2013	CSS	TWISPR	843.066.008	SCREWT	917	4/7/2013 1:01	TWR	Lower In-stream Array	J
1/1/2013	12/31/2013	3D9.1C2D1333CC	32W	3/26/2013 15:30	68		CGS13084.	2013	3/25/2013	CSS	TWISPR	843.066.008	SCREWT	917	4/4/2013 23:08	TWR	Upper In-stream Array	J
1/1/2013	12/31/2013	3D9.1C2D133994	32W	3/18/2013 15:45	149		CGS13074.	2013	3/15/2013	CSS	TWISPR	843.066.003	SCREWT	912				
1/1/2013	12/31/2013	3D9.1C2D3DA3AE	32W	4/5/2013 19:00	66		CGS13094.	2013	4/4/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D445E8B	32W	4/5/2013 19:00	56		CGS13092.	2013	4/2/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D446EC0	32W	4/5/2013 19:00	54		CGS13093.	2013	4/3/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D44903F	32W	4/5/2013 19:00	57		CGS13092.	2013	4/2/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D449193	32W	4/5/2013 19:00	57		CGS13094.	2013	4/4/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D44BA3D	32W	4/12/2013 18:30	54		CGS13102.	2013	4/12/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D44E89B	32W	4/5/2013 19:00	56		CGS13093.	2013	4/3/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D44EDD4	32W	4/5/2013 19:00	61		CGS13095.	2013	4/5/2013	CSS	TWISPR	843.066.008	SCREWT	917				
1/1/2013	12/31/2013	3D9.1C2D60CA04	32W	4/5/2013 19:00	177		CGS13094.	2013	4/4/2013	CSS	TWISPR	843.066.008	SCREWT	917	5/17/2013 18:53	BCC	15x15 FULL-FLOW ANTENNA	J

Figure 13. Top portion of an example of a TribPit observations file

3.3 Age Data

Program TribPit depends on the tagged fish in a study being of a known age. The age data file provides the age for all aged fished in the study. The age data file is a commas separated value (CSV) text file. All lines beginning with a hash mark ("#") are ignored. Otherwise, each line is a record for one fish. Each record may be in one of two formats:

1. A record consisting of two fields: (1) tag ID, followed by (2) brood year. A brood year of "NA" indicates that the age of the fish is unknown.

2. A record consisting of three fields: (1) tag ID, (2) release year, (3) age at release. The brood year is then calculated by subtracting the age from the release year. A value of "NA" for the age at release indicates that the age of the fish is unknown.

Analysis can be performed in Program TribPit without loading any age data by assuming that all individuals are of the same brood year. However, pooling the age-class data can seriously bias the survival analysis and is **not** recommended.

3.4 Loading the Data

At initial startup with no observations loaded, the Navigation Panel of Program TribPit appears as shown in Figure 14 with only the "Load Observations" command enabled; no analysis can be done until the observations are loaded.

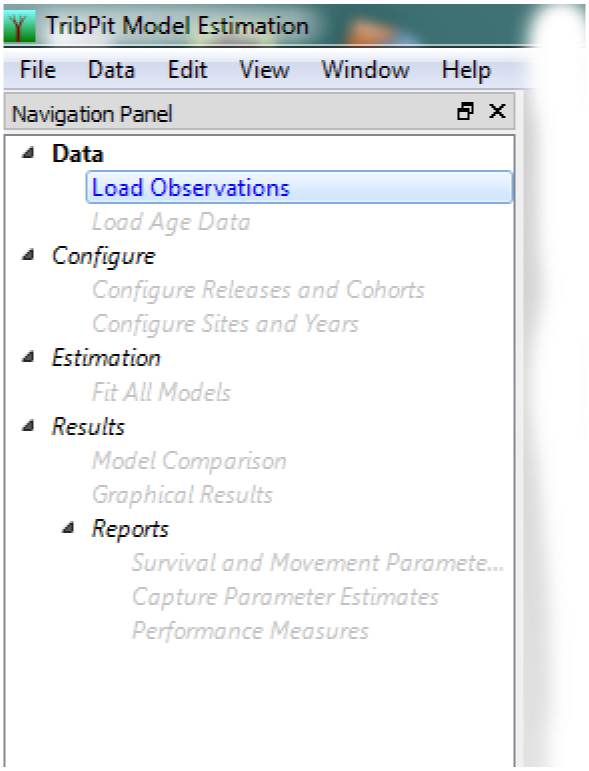
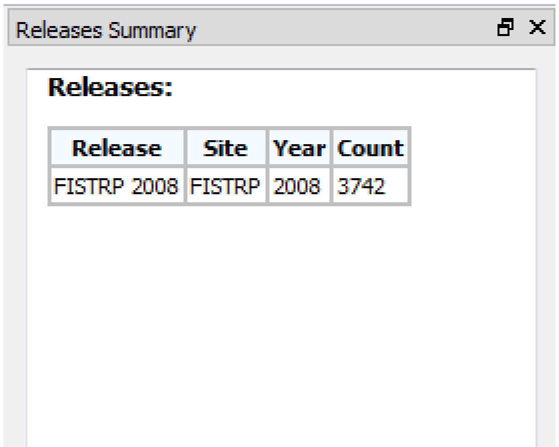

TribPit Model Estimation
File
Data
Edit
View
Window
Help
Navigation Panel
Data
Load Observations
Load Age Data
Configure
Configure Releases and Cohorts
Configure Sites and Years
Estimation
Fit All Models
Results
Model Comparison
Graphical Results
Reports
Survival and Movement Paramete...
Capture Parameter Estimates
Performance Measures

Figure 14. The Navigation Panel at initial startup with no observations loaded

When the user double-clicks on "Load Observations," TribPit will prompt the user to select the observations data file to be loaded. While loading the data, all status messages will appear in the Output at the bottom of the screen. For this example, we load a file with one release: "FISTRP 2008."

Once the data are loaded, the Releases Summary will be updated as shown in Figure 15. A “release” is defined as all fish released from a given site in a given year. One observation file may contain more than one release.

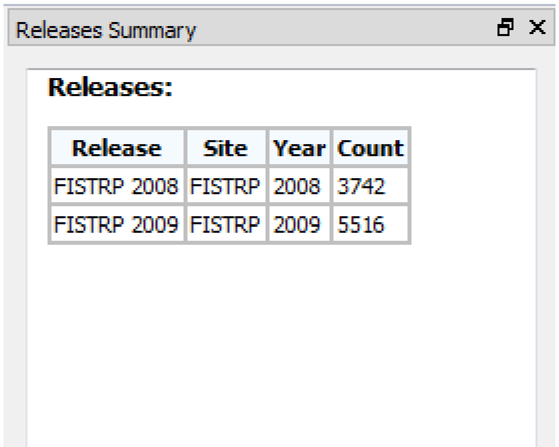


Releases:

Release	Site	Year	Count
FISTRP 2008	FISTRP	2008	3742

Figure 15. Releases Summary after loading observations file fistrp2008.csv

Multiple observation files may be loaded into TribPit. In this case, we will load another file with a release named “FISTRP 2009”—fish released from the same site in the year 2009. After loading this observations file, the Releases Summary appears as shown in Figure 16.

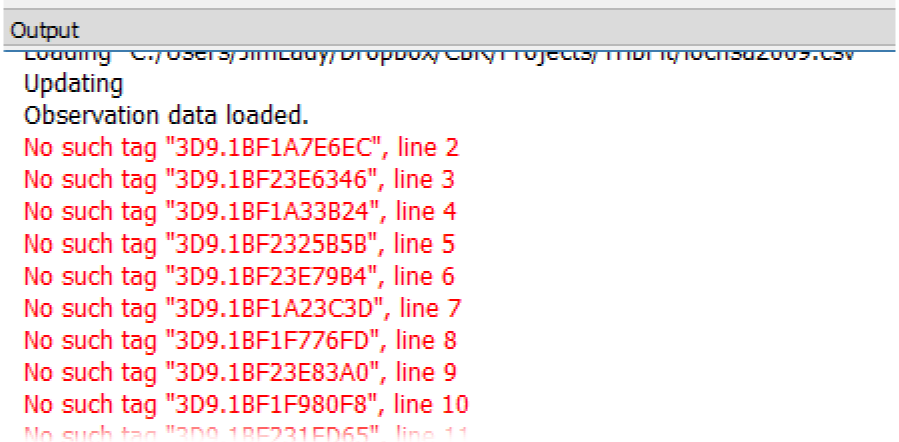


Releases:

Release	Site	Year	Count
FISTRP 2008	FISTRP	2008	3742
FISTRP 2009	FISTRP	2009	5516

Figure 16. Releases Summary after loading observations files for 2008 and 2009

After loading the observation files, the user may continue with Configuration if all the releases are from the same brood year. If not, an age data file must be loaded, assigning brood years to the tag IDs. This is done by double clicking on “Load Age Data” on the Navigation Panel and selecting the age data file to be loaded. As with the loading of observations data, all status messages appear in the Output. The user may see error messages such as shown in Figure 17, indicating tag IDs are in the age data file but not in the observations data; in this case, tags that are found in the observations data will still have the brood year assigned to them.



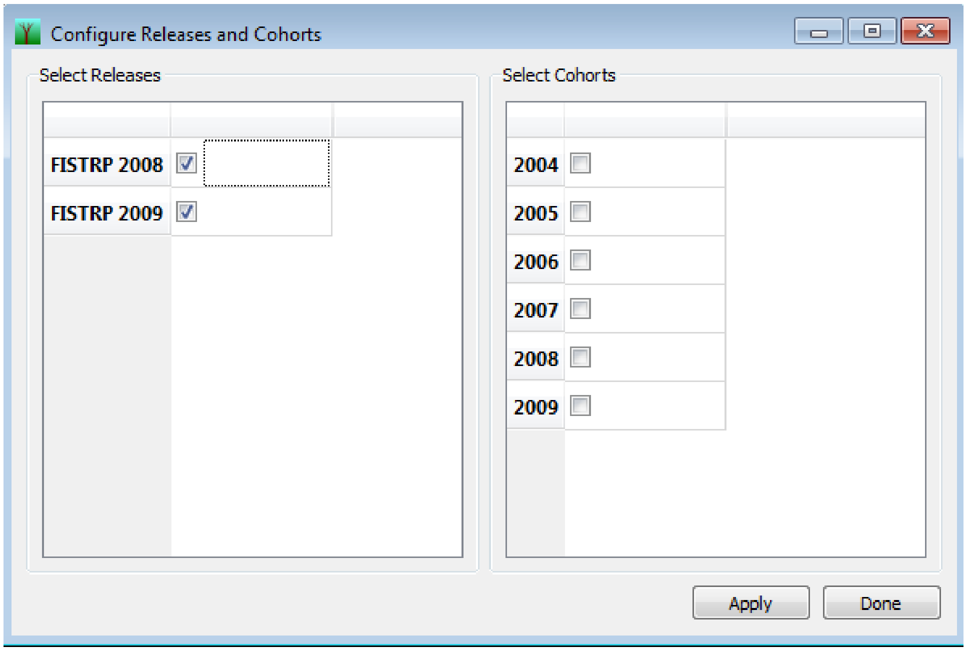
```
Updating
Observation data loaded.
No such tag "3D9.1BF1A7E6EC", line 2
No such tag "3D9.1BF23E6346", line 3
No such tag "3D9.1BF1A33B24", line 4
No such tag "3D9.1BF2325B5B", line 5
No such tag "3D9.1BF23E79B4", line 6
No such tag "3D9.1BF1A23C3D", line 7
No such tag "3D9.1BF1F776FD", line 8
No such tag "3D9.1BF23E83A0", line 9
No such tag "3D9.1BF1F980F8", line 10
```

Figure 17. Output when loading age data

Chapter 4: Study Configuration

4.1 Configuring Releases and Cohorts

Figure 18 shows the dialog for configuring releases and cohorts.



Select Releases

FISTRP 2008 ☑
FISTRP 2009 ☑

Select Cohorts

2004 ☐
2005 ☐
2006 ☐
2007 ☐
2008 ☐
2009 ☐

Figure 18. Dialog for configuring releases and cohorts

On the left are the releases. By default, they are all selected to be included in the analysis. On the right are the cohorts, as determined by the age data. By default none of the cohorts are selected. The user can select one (and only one) cohort at a time to be included in the analysis. The analysis will assume all fish to be of the same cohort.

When any changes are made to the releases and cohorts to be used, the "Apply" button must be pressed to save those changes. The Releases Summary will then be updated to reflect the subset of fish to be used in subsequent analysis. For this example, the 2007 cohort is selected.

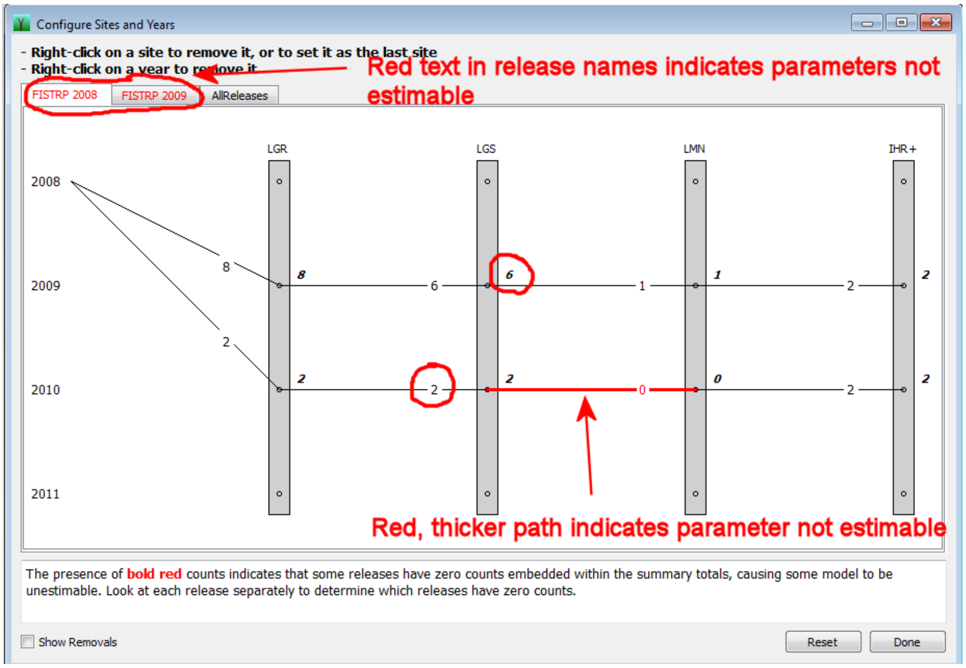
4.2 Configure Sites and Years

Section 1.4 describes the models created by Program TribPit for given scenarios of the data loaded in TribPit. Sometimes, even though TribPit creates a model, the data are too sparse to actually estimate the parameters for the model. The Sites and Years Configuration section of Program TribPit allows the user to change the configuration to allow for parameter estimation. This is done by:

1. Removing detection sites, causing all detections at the sites to be ignored.
2. Removing detection years, causing all detections in those years to be ignored.
3. Setting an upstream site to be the last detection site. This causes all downstream detections to be pooled and treated as detections at the last site set by the user. The parameter estimate for this final reach will lack biological significance, but the reduction in the number of parameters to be estimated may improve the ability of TribPit to estimate upstream parameters of interest to the user.

4.2.1 Interpreting the Diagrams

Figure 19 gives an example of the Sites and Years Configuration dialog. Note that the Sites and Years Configuration dialog always references a single cohort. Figure 19 references a 2007 cohort with two releases: (1) a release of yearlings in 2008 from location FISTRP labeled “FISTRP 2008” and (2) a release of two-year-olds in 2009 from the same location labeled “FISTRP 2009.”



- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

Red text in release names indicates parameters not estimable

Red, thicker path indicates parameter not estimable

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some model to be unestimable. Look at each release separately to determine which releases have zero counts.

Figure 19. Example of a Sites and Years Configuration Dialog for a 2007 cohort

The tabs along the top allow the user to look at each individual release, or the user can look at both releases together by selecting the “AllReleases” tab. In Figure 19, the “FISTRP 2008” tab is selected, illustrating the yearling release in 2008. Since this is the initial release, it considered the primary release and the “FISTRP 2009” is considered an auxiliary release.

Some things to notice in this example:

- If the release name is in red, it indicates that any model that estimates unique parameters for this release will not be estimable. In Figure 19, both the individual release names are in red, but the "AllReleases" is not. This means that the only model that may be estimable is the one that combines parameters across both releases (both the capture parameters and the survival and movement parameters).

- The "FISTRP 2008" tab is selected, showing the configuration for that release. Each row represents a year, and each shaded vertical bar represents a detection site. In this example, the years 2008 through 2011 are present in the data as either release years and/or detection years. The first detection site is labeled "LGR" (Lower Granite Dam), the second "LGS" (Little Goose Dam), and so on. Notice that the final fourth and final detection site is labeled "IHR+." The "+" indicates that there are downstream detection sites after Ice Harbor Dam that the user has already configured to be pooled with detections at Ice Harbor.

- The narrow diagonal and horizontal lines represent paths that fish were observed to follow. The number in the center of the paths indicates the number of individuals known to have traveled that path and were detected at the end site of the path. For example, two fish were known to survive and migrate from LGR to LGS and were detected at LGS in 2010 (circled in Figure 19).

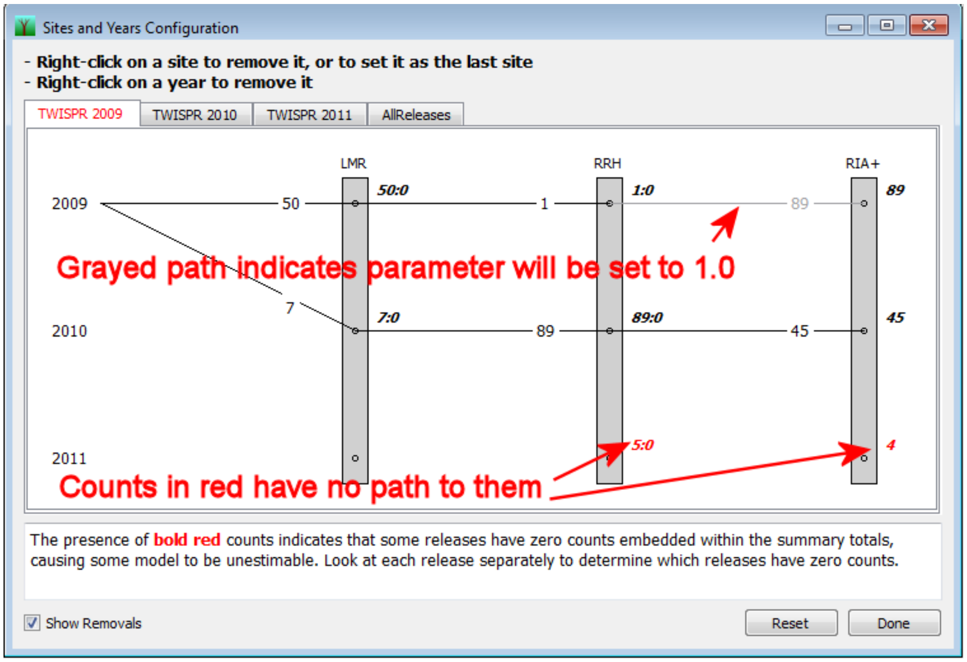
- The bold, italicized numbers at each detection site show the number detected at that site and year. For example, six fish were detected at the site LGS in the year 2009 (circled in Figure 19).

- The path from LGS to LMN in 2010 has zero counts, making the survival and movement parameter for that path unestimable. Program TribPit thus highlights this path by making it thicker and in red. This is why any model that that has unique parameters for this release is unestimable.

- There are no paths for the year 2008. This is because there were no detections for this release in 2008, and Program TribPit thus removes that branch from the model. The same is true for the year 2011. 2011 is included because even though there are no detections in 2011 for this particular release, there were detections in 2011 for other data currently loaded in TribPit.

- The numbers in the paths indicate the number of fish "known" to have traveled that path and were detected at the end site of the path—"known" according to the assumptions of the models. In the example in Figure 19, the diagram indicates that six fish traveled from LGR to LGS in 2009. This does **not** mean that all six fish were necessarily detected at LGR and then at LGS in 2009. It is possible that some of those six fish were released in 2008 and then next detected at LGS. It's also theoretically possible that they traveled through LGR in 2008 undetected, and then migrated and survived to LGS in 2009. But since we did not observe any fish along that path, we cannot estimate the parameters for that path. Thus, Program TribPit must assume that they traveled along the only observed paths to arrive at LGS in 2009.

Figure 20 shows another example of a study with three releases of a cohort in three consecutive years: 2009, 2010, and 2011.


Sites and Years Configuration
TWISPR 2009
TWISPR 2010
TWISPR 2011
AllReleases
LMR
RRH
RIA+
2009
2010
2011
50
50:0
1
1:0
89
89
7
7:0
89
89:0
45
45
5:0
4
Grayed path indicates parameter will be set to 1.0
Counts in red have no path to them
Reset
Done

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some model to be unestimable. Look at each release separately to determine which releases have zero counts.

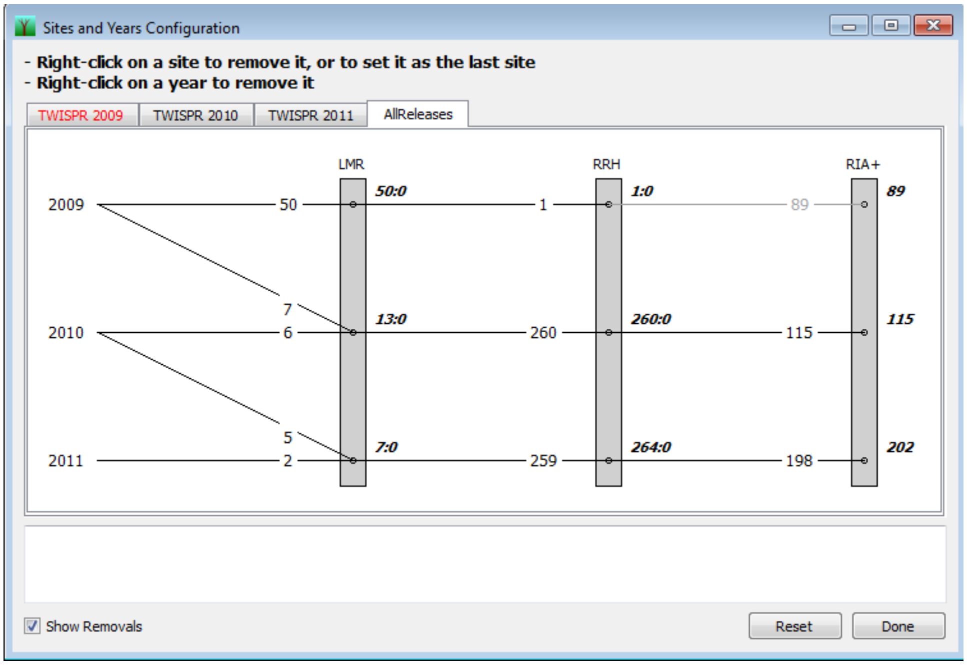
☑ Show Removals

Figure 20. Sites and Years Configuration illustrating removals at detection sites

In the case of Figure 20, the “Show Removals” checkbox is checked, thus showing the number of removals after the colon (“:”) at each detection site and year. For example, at LMR in 2009, 50 fish were detected, none of which were removed.

- The counts at RRH and RIA+ in 2011 are in red, because there is no observed path to these sites and years. No counts were observed from release to LMR in 2011, or from LMR in 2010 to RRH in 2011. Program TribPit cannot estimate parameters for unobserved paths and, thus, cannot create a model that includes the 2011 counts. The counts are in red, because they cause any model that estimates unique parameters for the TWISPR 2009 release to be unestimable.
- The path from RRH to RIA+ in 2009 is grayed out. This is because the 87 fish detected at RRH were also detected at RIA+ and trying to estimate the survival and movement parameters along that route would cause numerical problems. Program TribPit thus removes the final survival and movement and detection parameter and uses a fixed value of 1.0 (with standard error of 0.0) to avoid estimation problems.

Figure 21 shows the same cohort and releases with the “AllReleases” tab selected. This shows the counts for all of the releases of the given cohort.



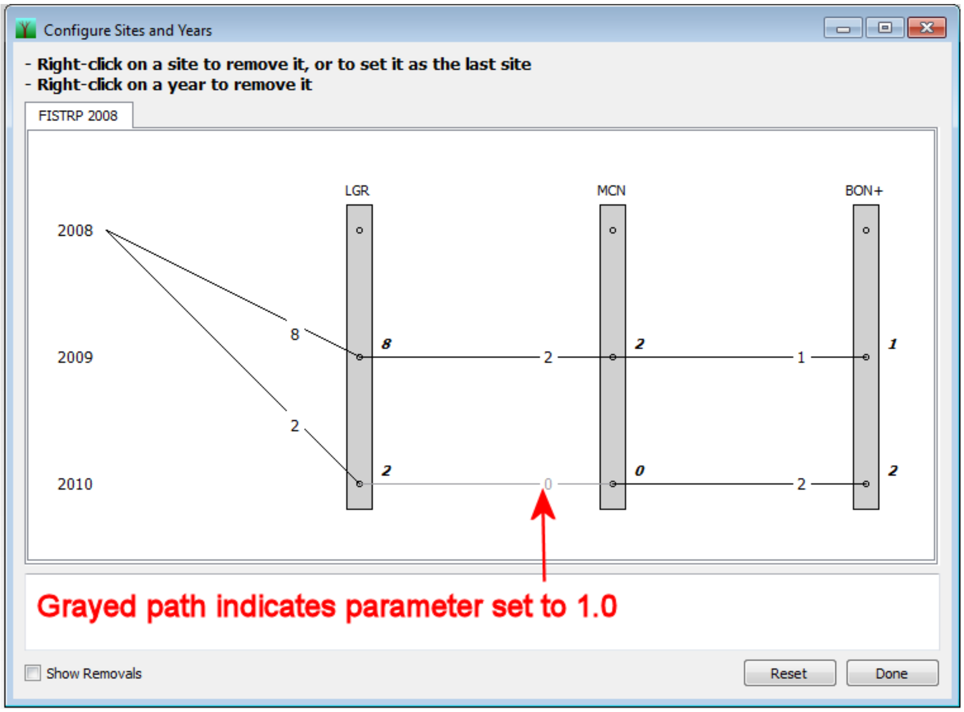
Sites and Years Configuration

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

☑ Show Removals

Figure 21. Sites and Configuration showing the “AllReleases” tab for combined releases

Figure 22 shows another example where a path indicates a parameter is fixed to 1.0.


Configure Sites and Years
FISTRP 2008
LGR
MCN
BON+
2008
2009
2010
8
8
2
2
2
1
1
2
0
0
2
2
Show Removals
Reset
Done

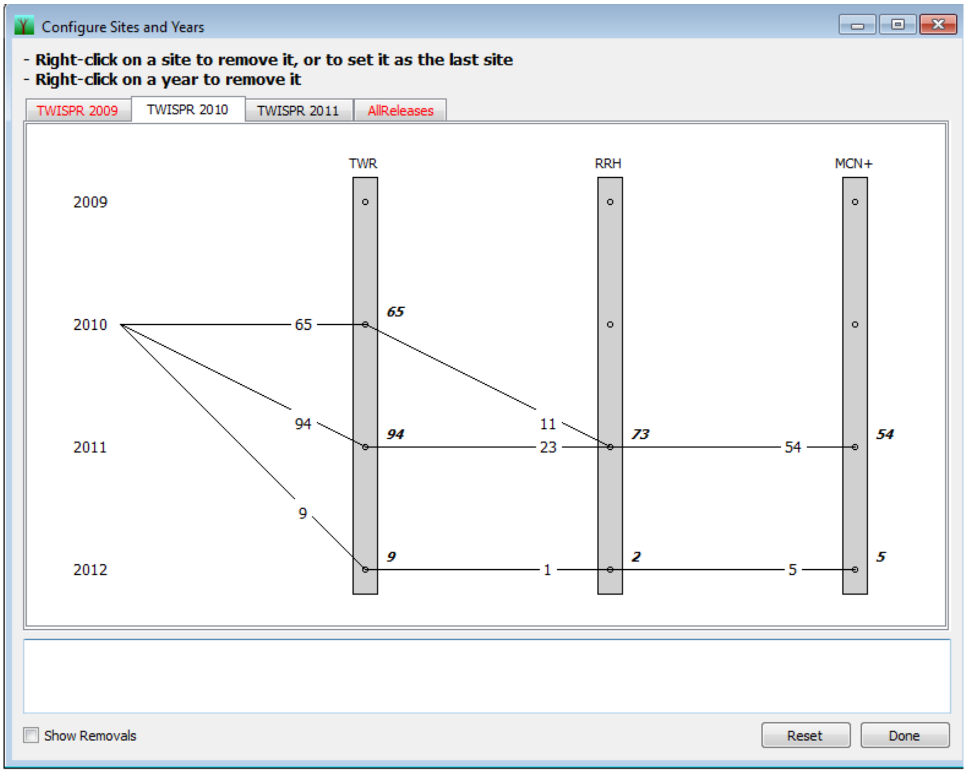
- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

Grayed path indicates parameter set to 1.0

Figure 22. Sites and Years Configuration illustrating pathways with parameters fixed at 1.0

In Figure 22, there are no detections at MCN in 2010, but there are detections downstream at BON+. Due to the configuration of this model, we know that the two fish detected at BON+ had to travel from LGR to MCN in 2010. Thus, Program TribPit fixed the survival and movement parameter at 1.0, and the detection parameter at MCN in 2010 at 0.0, and the model is still theoretically estimable (disregarding the sparse data in this case).

In the example in Figure 23, there are 65 detections at TWR in 2010, but no observations downstream of that in 2010. However, this does not make the parameters in the releases unestimable because there is another path downstream from TWR in 2010—the path to RRH in 2011. Thus, Program TribPit simply removes the downstream paths for year 2010.

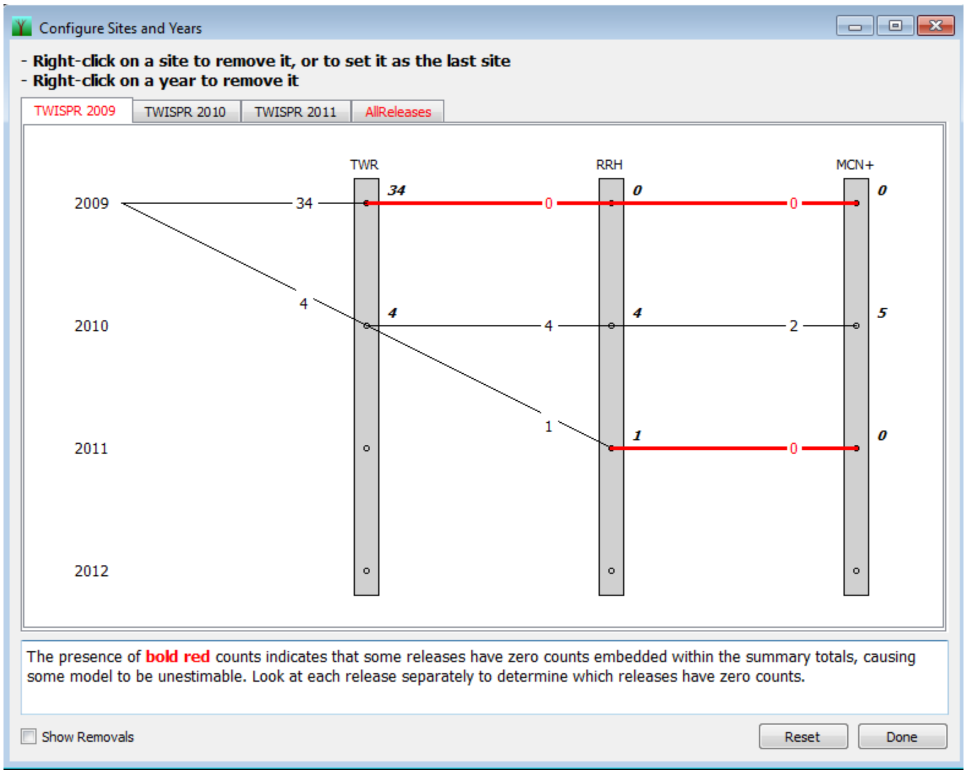

Configure Sites and Years
TWISPR 2009
TWISPR 2010
TWISPR 2011
AllReleases
TWR
RRH
MCN+
2009
2010
2011
2012
65
65
94
94
9
9
11
23
73
2
1
54
54
5
5
Reset
Done

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

☐ Show Removals

Figure 23. Sites and Years Configuration illustrating unnecessary downstream paths removed

Contrast the last example with Figure 24. In this case, there are 34 fish detected at TWR in 2009, and there are no downstream detections in 2009. But since there are no other paths downstream from TWR in 2009, Program TribPit leaves the downstream paths in 2009, and makes them thicker and in red to indicate that they render any model that estimates unique parameters for this release unestimable.


Configure Sites and Years
TWISPR 2009
TWISPR 2010
TWISPR 2011
AllReleases
TWR
RRH
MCN+
2009
2010
2011
2012
34
34
0
0
0
0
4
4
4
4
2
5
1
1
0
0
☐ Show Removals
Reset
Done

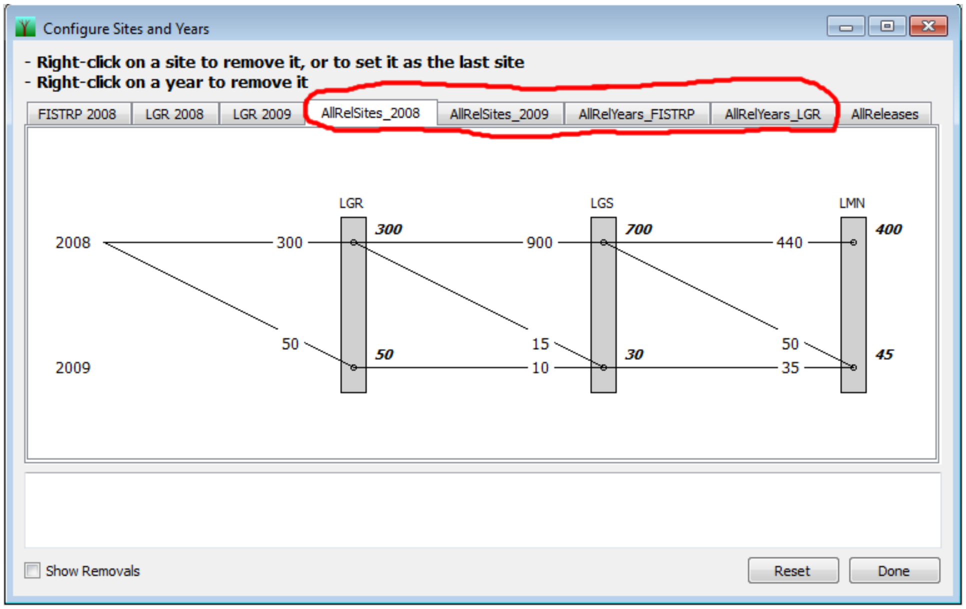
- **Right-click on a site to remove it, or to set it as the last site**
- **Right-click on a year to remove it**

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some model to be unestimable. Look at each release separately to determine which releases have zero counts.

Figure 24. Sites and Years Configuration illustrating missing downstream counts

Finally, we look at a hypothetical example where there are multiple releases of a single cohort, both from different sites and different years. This is a 2007 cohort with two releases of yearlings in 2008—one from FISTRP ("FISTRP 2008") and another from LGR ("LGR 2008")—and one release of two-year-olds in 2009 from LGR ("LGR 2009"). Since the "FISTRP 2008" is the earliest and most upstream release, it is considered the primary release, and the others are auxiliary releases. Figure 25 shows the Sites and Years Configuration for the data.

As with the other examples, there is a tab for each release and an "AllReleases" tab for the combined releases. With multiple release sites and multiple release years, however, there are additional tabs with label beginning with "AllRelSites_" and "AllRelYears_." For example, the tab, "AllRelSites_2008" shows the configuration and combined counts for all releases in the year 2008. Similarly, the tab "AllRelYears_LGR" shows the configuration and combined counts for all releases from the LGR site. This allows the user to see if models that combine parameters across sites and across years are estimable.


Configure Sites and Years

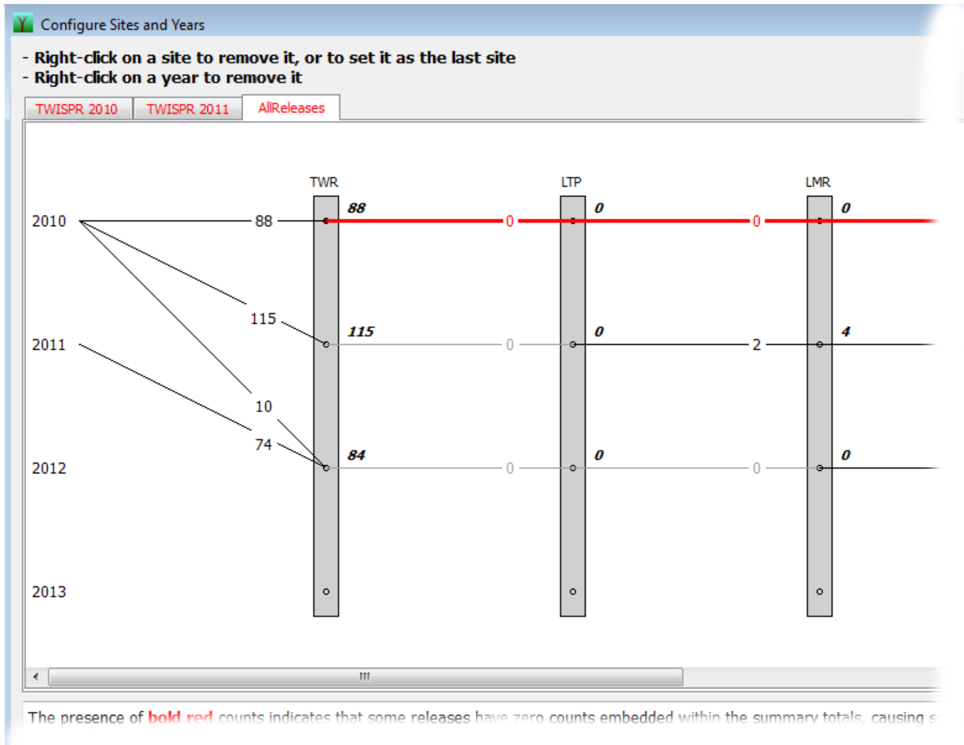
- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

FISTRP 2008
LGR 2008
LGR 2009
AllRelSites_2008
AllRelSites_2009
AllRelYears_FISTRP
AllRelYears_LGR
AllReleases
LGR
LGS
LMN
2008
2009
300
300
900
700
440
400
50
50
15
10
30
50
35
45
☐ Show Removals
Reset
Done

Figure 25. Sites and Years Configuration with simulated releases from multiple sites and multiple years

4.2.2 Changing the Sites and Years Configuration

Figure 26 shows the left portion of the Sites and Years Configuration dialog after some data are loaded with the “AllReleases” tab selected. Notice that there are no detections at the LTP site, and only four detections at LMR. The ability to estimate parameters will be improved by removing these two sites.



Configure Sites and Years

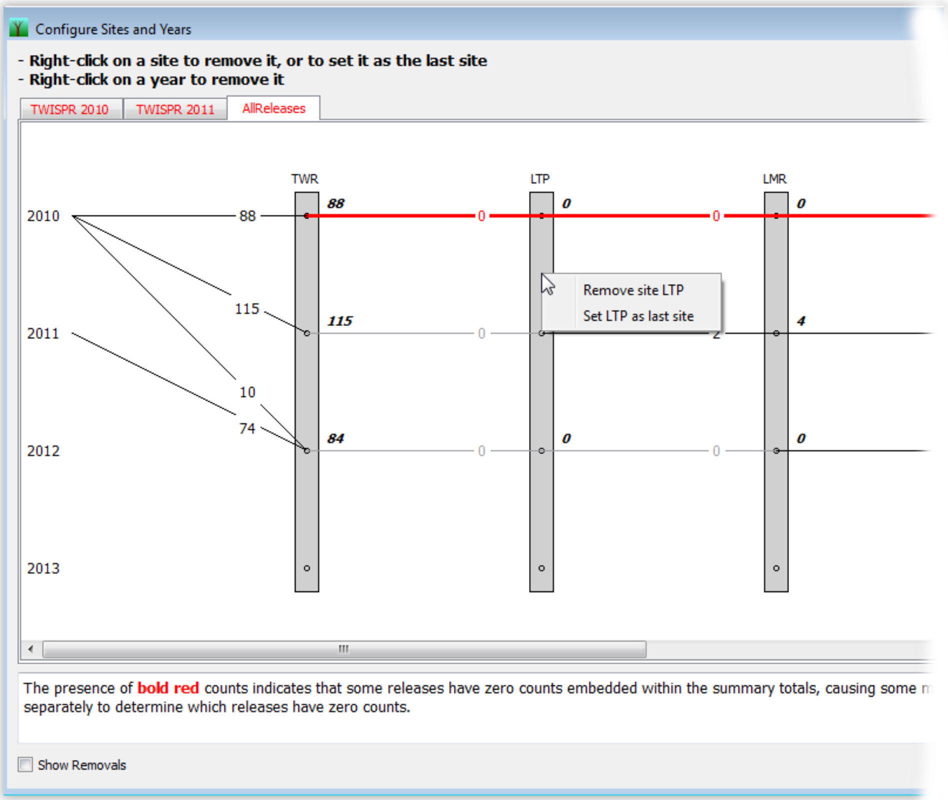
- **Right-click on a site to remove it, or to set it as the last site**
- **Right-click on a year to remove it**

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing s

TWISPR 2010
TWISPR 2011
AllReleases
TWR
LTP
LMR
2010
2011
2012
2013
88
115
10
74
88
115
84
0
0
0
0
2
0
0
0
0
0
4
0

Figure 26. Sites and Years Configuration in initial state

Right click anywhere on the gray column representing LTP and select "Remove site LTP" from the popup menu, as shown in Figure 27. The diagram will then be updated with LTP removed. In the same way, right-click on the LMR site and select "Remove site LMR."

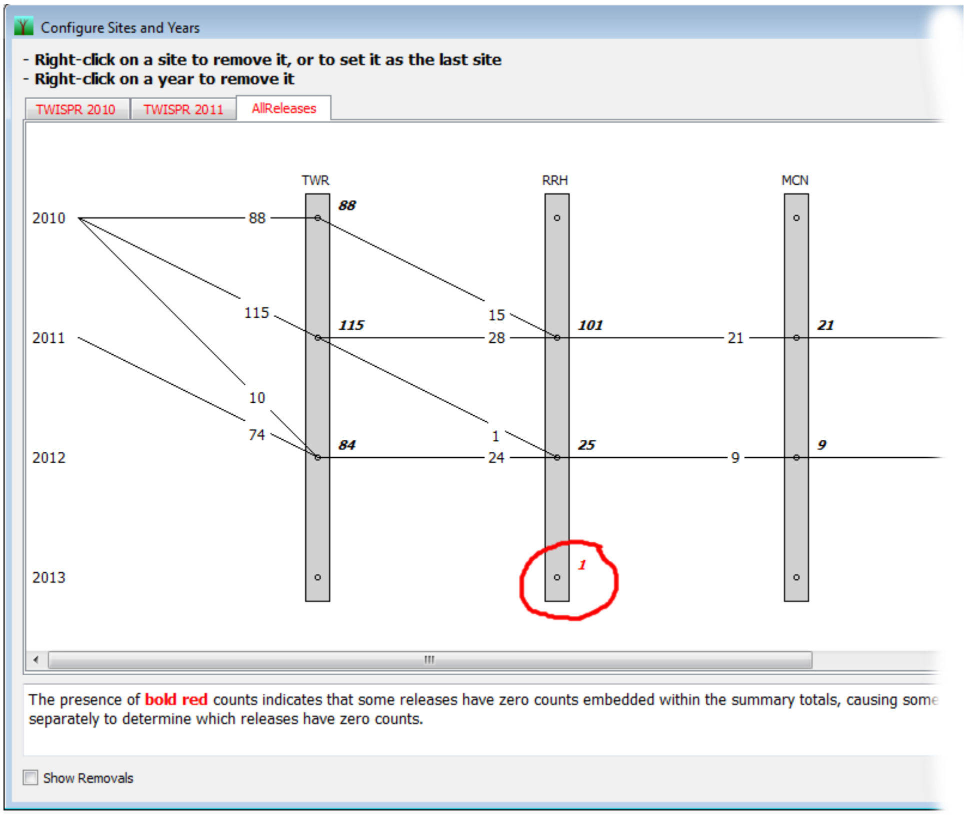

Configure Sites and Years
TWISPR 2010
TWISPR 2011
AllReleases
TWR
LTP
LMR
2010
2011
2012
2013
88
115
10
74
88
115
84
0
0
0
4
0
0
0
0
0
2
Remove site LTP
Set LTP as last site
☐ Show Removals

- **Right-click on a site to remove it, or to set it as the last site**
- **Right-click on a year to remove it**

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some
separately to determine which releases have zero counts.

Figure 27. Removing a site in the Sites and Years Configuration dialog

The diagram should now appear as shown in Figure 28.


Configure Sites and Years

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

TWISPR 2010
TWISPR 2011
AllReleases
TWR
RRH
MCN
2010
2011
2012
2013
88
88
115
115
10
74
84
15
28
101
1
24
25
21
21
9
9
1

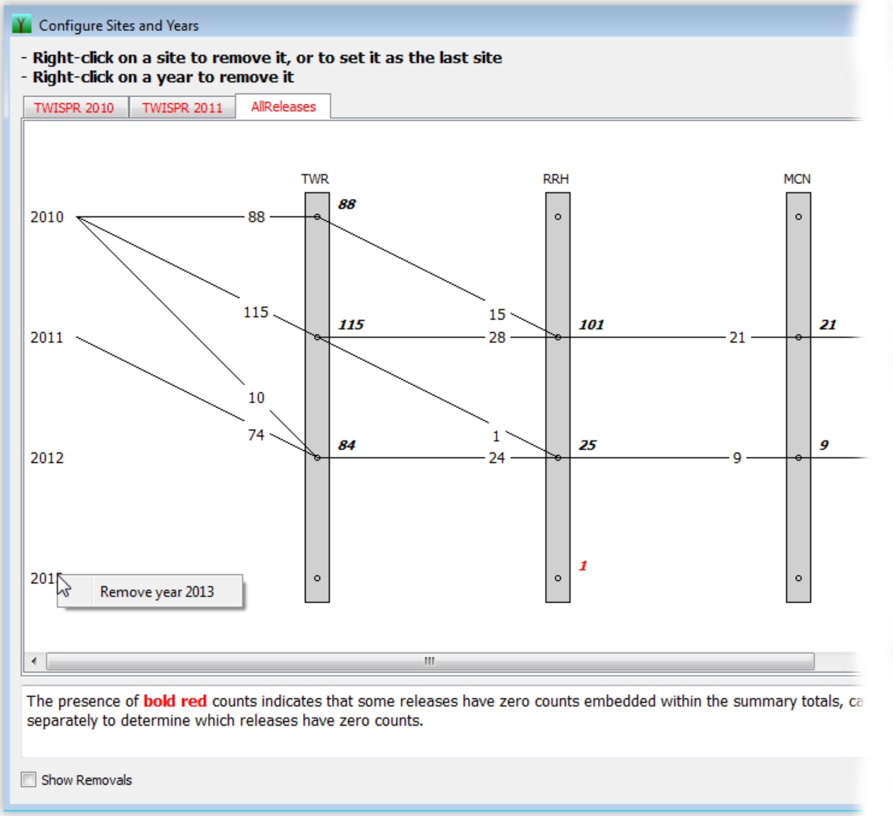
The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some
separately to determine which releases have zero counts.

☐ Show Removals

Figure 28. Sites and Years Configuration after removing two sites

All the tabs are still red, showing that there are no estimable models. The problem is the one detection in 2013, circled in Figure 28. There is a detection there, but no observed paths leading to that detection. This can be rectified by removing the year 2013 from the analysis.

Right-click on the “2013” label on the left and select “Remove year 2013” from the popup menu, as shown in Figure 29.


Configure Sites and Years
TWISPR 2010
TWISPR 2011
AllReleases
TWR
RRH
MCN
2010
2011
2012
201
Remove year 2013
88
115
10
74
15
28
1
24
21
9
101
25
84
1

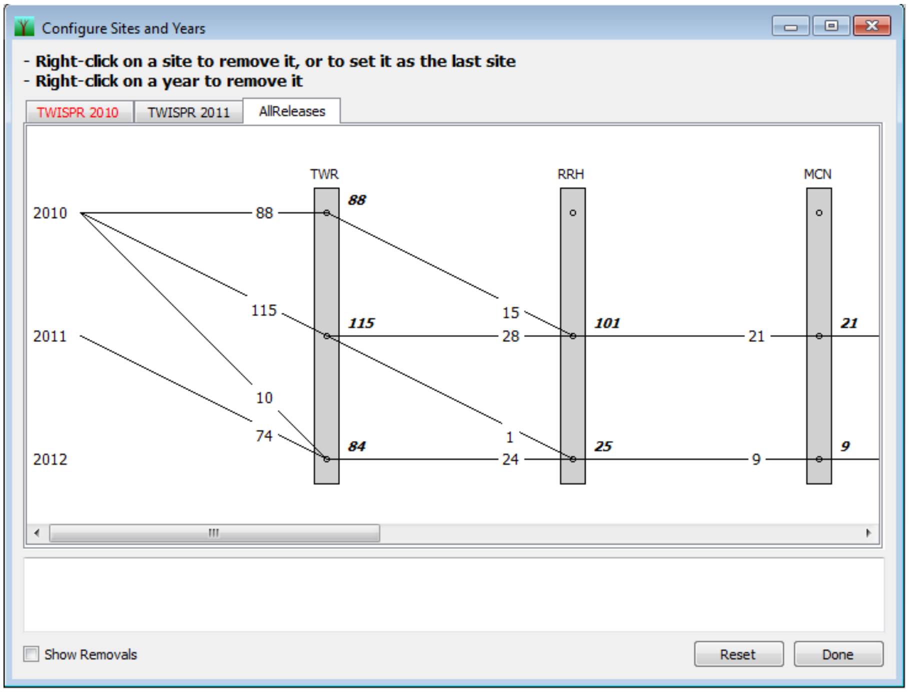
- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, ca
separately to determine which releases have zero counts.

☐ Show Removals

Figure 29. Removing a year in the Sites and Years Configuration dialog

At this point, the “AllReleases” tab should appear as shown in Figure 30. The “AllReleases” tab and the “TWISPR 2011” are no longer in red, but the “TWISPR 2010” is in red. This indicates that the model combining parameters across releases will be estimable, but the models that use unique parameters for individual releases will not be estimable.

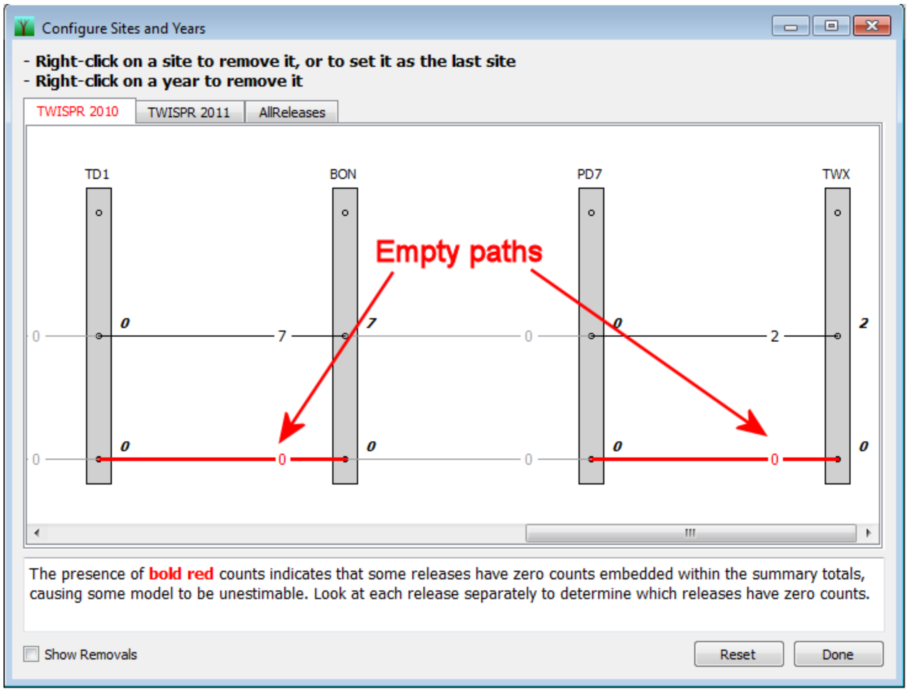

Configure Sites and Years

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

TWISPR 2010
TWISPR 2011
AllReleases
TWR
RRH
MCN
2010
2011
2012
88
88
115
115
10
74
84
15
28
101
1
24
25
21
21
9
9
☐ Show Removals
Reset
Done

Figure 30. Sites and Years Configuration after removing sites and years

If we select the “TWISPR 2010” tab and scroll all the way to the right, it appears as shown in Figure 31.



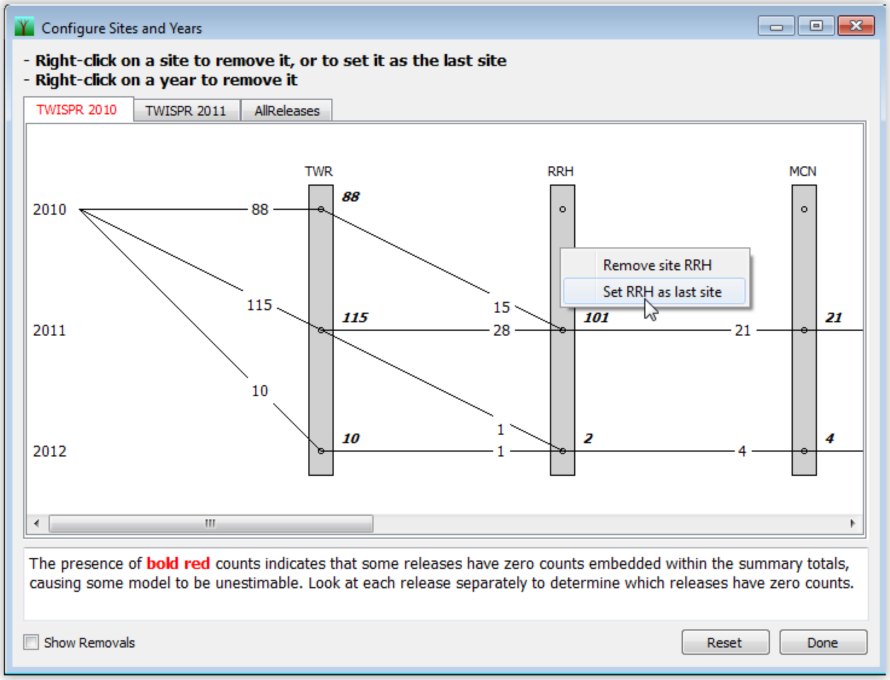
Configure Sites and Years
TWISPR 2010
TWISPR 2011
AllReleases
TD1
BON
PD7
TWX
Empty paths
0
7
2
☐ Show Removals
Reset
Done

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some model to be unestimable. Look at each release separately to determine which releases have zero counts.

Figure 31. Sites and Years Configuration Dialog with empty paths downstream

Notice that the paths for year 2012 between TD1 and BON, and between PD7 and TWX have zero counts and are in red. In this case, the user is not interested in estimates this far downstream—only in survival to the first site, TWR. To get survival and movement estimates to TWR, we need one detection site beyond TWR—namely, RRH. So now scroll back to the left portion of the diagram, click on the RRH site and select “Set RRH as the last site” from the popup menu as shown in Figure 32.



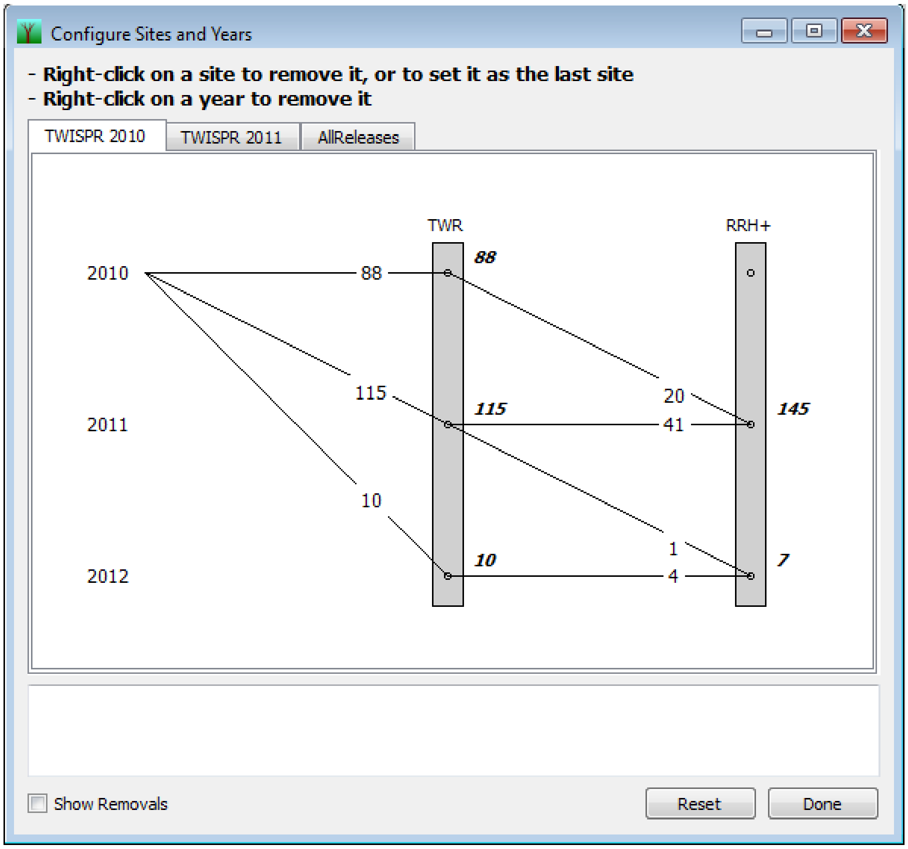
Configure Sites and Years
TWISPR 2010
TWISPR 2011
AllReleases
TWR
RRH
MCN
2010
2011
2012
88
115
10
15
28
1
1
21
4
101
2
21
4
Remove site RRH
Set RRH as last site
Show Removals
Reset
Done

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some model to be unestimable. Look at each release separately to determine which releases have zero counts.

Figure 32. Setting the last detection site in the Sites and Years Configuration

The diagram should now appear as shown in Figure 33 with no red tabs, indicating all available models should now be estimable.



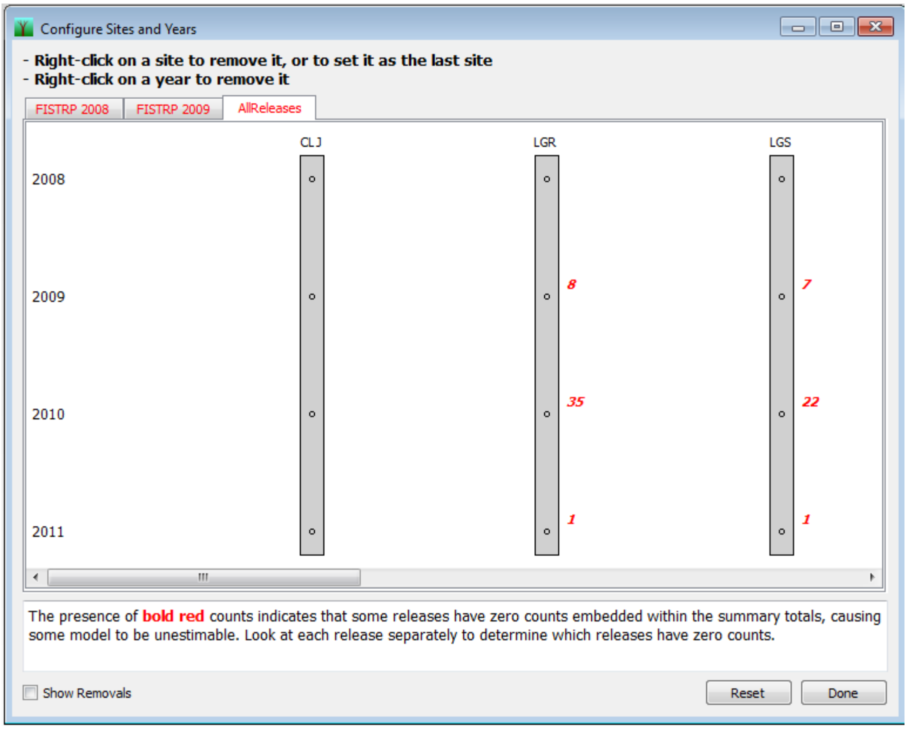
- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

Configure Sites and Years
TWISPR 2010
TWISPR 2011
AllReleases
TWR
RRH+
2010
2011
2012
88
115
10
88
115
10
20
41
1
4
145
7
☐ Show Removals
Reset
Done

Figure 33. Sites and Years Configuration dialog after setting the last site

The "+" after "RRH" indicates that this site includes detections from multiple sites downstream of RRH.

Figure 34 shows an example of another situation that may occur. There are no detections at the first site CLJ; thus, no observable paths to any of the downstream detection sites. The CLJ site appears because it is in the data that has been loaded, but not in the cohort data selected for analysis. This situation can be remedied by simply removing the CLJ site, and the diagram will appear as in Figure 35.


Configure Sites and Years
FISTRP 2008
FISTRP 2009
AllReleases
CLJ
LGR
LGS
2008
2009
2010
2011
8
35
1
7
22
1
Show Removals
Reset
Done

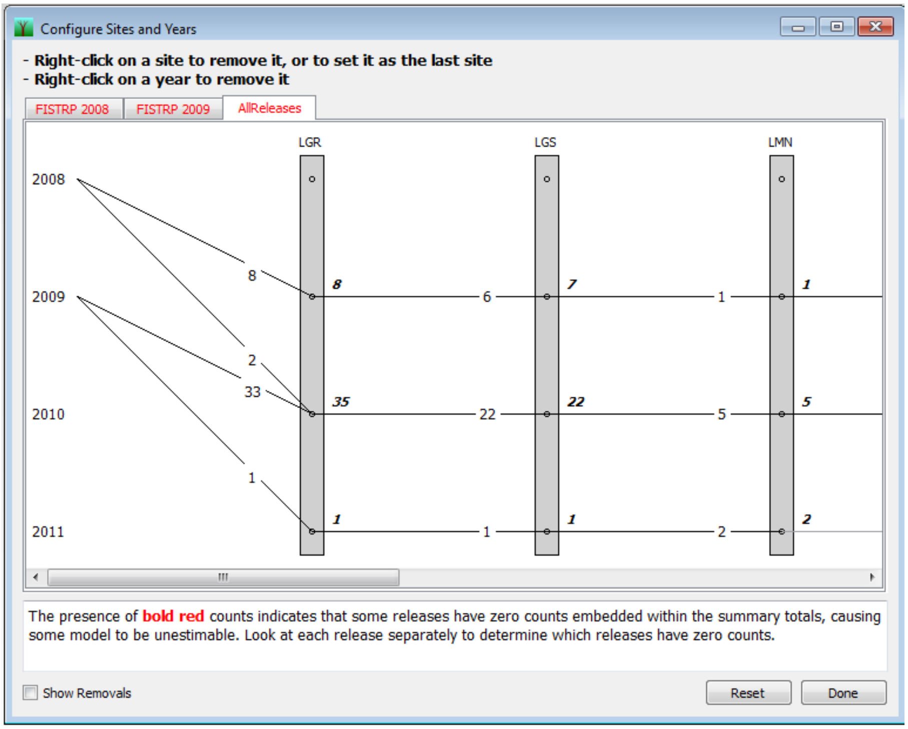
- **Right-click on a site to remove it, or to set it as the last site**
- **Right-click on a year to remove it**

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some model to be unestimable. Look at each release separately to determine which releases have zero counts.

☐ Show Removals

Figure 34. Sites and Years Configuration with no detections at the first site

Note that release sites cannot be removed, nor can release years be removed. Also, the initial detection site cannot be set as the last detection site because Program TribPit requires at least two downstream detection sites.


Configure Sites and Years
FISTRP 2008
FISTRP 2009
AllReleases
LGR
LGS
LMN
2008
2009
2010
2011
8
2
33
1
8
6
7
1
1
35
22
22
5
5
1
1
1
2
2
☐ Show Removals
Reset
Done

- Right-click on a site to remove it, or to set it as the last site
- Right-click on a year to remove it

The presence of **bold red** counts indicates that some releases have zero counts embedded within the summary totals, causing some model to be unestimable. Look at each release separately to determine which releases have zero counts.

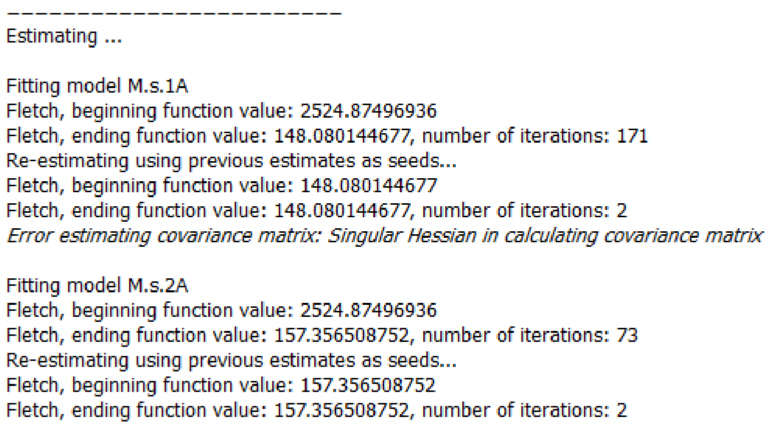
Figure 35. Sites and Years Configuration after removing the first site with no detections

4.2.3 Resetting the Sites and Years Configuration

If the user wants to undo any changes made to the configuration, the user simply presses the “Reset” button in the lower right of the Sites and Years Configuration dialog to restore the configuration to the initial state.

Chapter 5: Estimation and Results

Once the user has finished configuring the sites and years, the user can double-click on “Fit All Models” on the Navigation Panel to estimate the parameters. The output from the estimation process is displayed in the Output portion of the TribPit dialog (Figure 36). “Fletch” refers to the optimization routine used to maximize the log-likelihood and obtain the parameter estimates.



```
________________________
Estimating ...

Fitting model M.s.1A
Fletch, beginning function value: 2524.87496936
Fletch, ending function value: 148.080144677, number of iterations: 171
Re-estimating using previous estimates as seeds...
Fletch, beginning function value: 148.080144677
Fletch, ending function value: 148.080144677, number of iterations: 2
Error estimating covariance matrix: Singular Hessian in calculating covariance matrix

Fitting model M.s.2A
Fletch, beginning function value: 2524.87496936
Fletch, ending function value: 157.356508752, number of iterations: 73
Re-estimating using previous estimates as seeds...
Fletch, beginning function value: 157.356508752
Fletch, ending function value: 157.356508752, number of iterations: 2
```

Figure 36. Example of output during the “Fit All Models” process

Information displayed in the output includes:

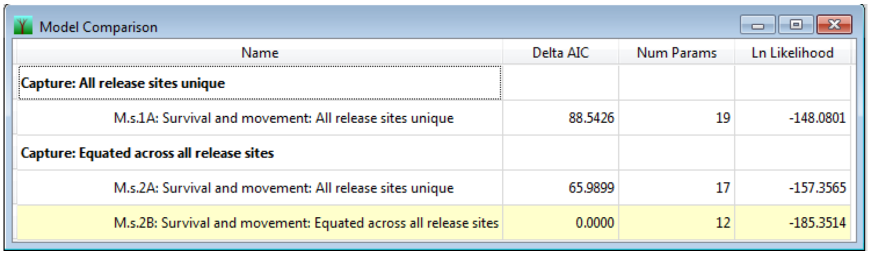
- The model ID currently being fitted.
- The beginning and ending negative log-likelihood function values.
- The number of iterations used to converge to a maximum likelihood value.

- Whether or not the covariance matrix is available. In Figure 36, the text "Error estimating covariance matrix" indicates that the standard errors will not be available for the estimates for model M.s.1A. For model M.s.2A, there is no such message, and the standard errors will be available.

Once the estimation process is complete, the Model Comparison window will be displayed. It can also be displayed at any time subsequent to fitting the models by double-clicking on "Model Comparison."

5.1 Model Comparison Window

Figure 37 shows the Model Comparison window for multiple releases from different sites. The headings in bold describe the parameterizations of the capture parameters for all models beneath the heading.



Name	Delta AIC	Num Params	Ln Likelihood
Capture: All release sites unique			
M.s.1A: Survival and movement: All release sites unique	88.5426	19	-148.0801
Capture: Equated across all release sites			
M.s.2A: Survival and movement: All release sites unique	65.9899	17	-157.3565
M.s.2B: Survival and movement: Equated across all release sites	0.0000	12	-185.3514

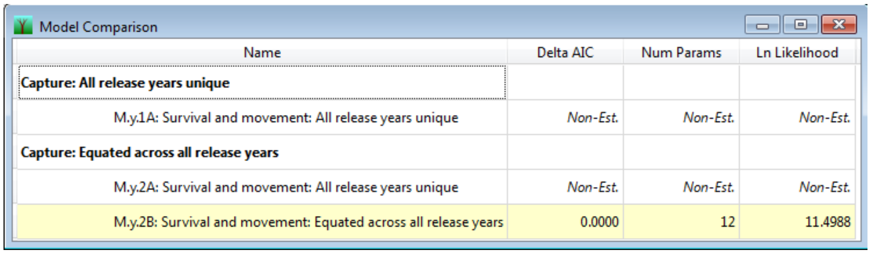
Figure 37. Model Comparison Window for releases from different sites

The columns in the Model Comparison window are:

1. The name of the model (the Model ID), followed by a brief description of the model.
2. The delta AIC, which is the deviation of the AIC from the best model. The best model—the one with the lowest AIC — is given the value 0.0, and all other AICs are presented as deviations from that model. In Figure 37, model M.s.2B has the best AIC. Note the actual AIC can be found in the headers of the reports as shown in Section 5.3.1.
3. The number of parameters
4. The log likelihood

The model with the best AIC is highlighted with a yellow background. All subsequent reports and graphical results will be for the best model.

Figure 38 shows another example of the Model Comparison window. In this case, there were multiple releases in different years. However, two of the models were not estimable. The text "Non-Est." is used when models are not estimable, typically due to sparseness of data.



Name	Delta AIC	Num Params	Ln Likelihood
Capture: All release years unique			
M.y.1A: Survival and movement: All release years unique	*Non-Est.*	*Non-Est.*	*Non-Est.*
Capture: Equated across all release years			
M.y.2A: Survival and movement: All release years unique	*Non-Est.*	*Non-Est.*	*Non-Est.*
M.y.2B: Survival and movement: Equated across all release years	0.0000	12	11.4988

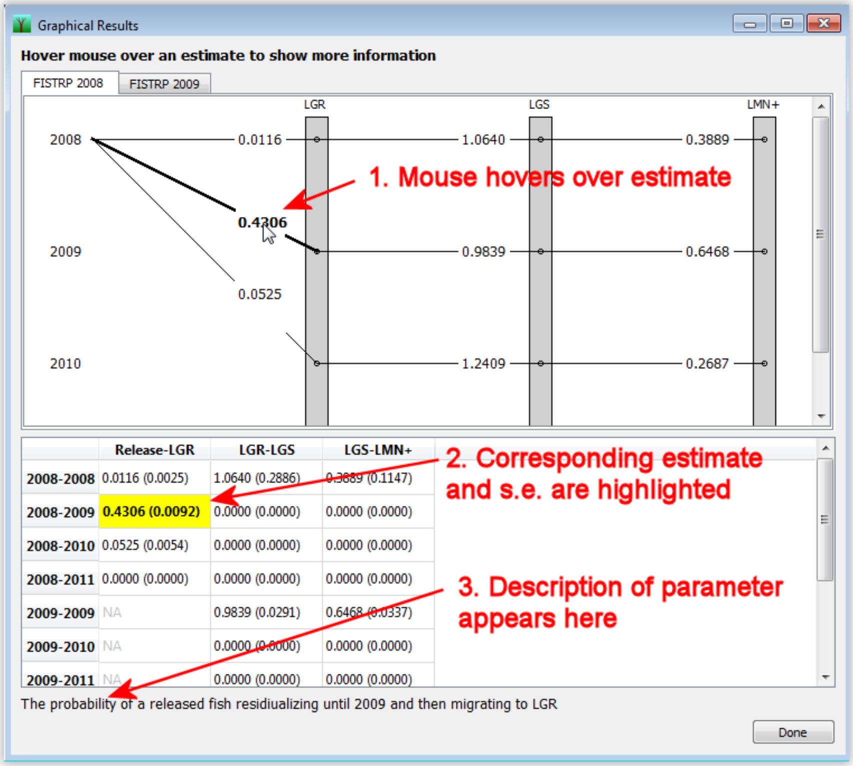
Figure 38. Model Comparison Window with some available models not estimable

5.2 Graphical Results

Once estimation is complete, the user can double-click on "Graphical Results" on the Navigation Panel to bring up a graphical display of the survival and movement parameters estimates for the best model (the one with delta AIC of 0.0).

The user may look at the results of the suboptimal models by turning on "Expert Mode," as explained in Section 5.4.

An example of the Graphical Results dialog from simulated data is shown in Figure 39. The tabs at the top allow the user to select the release of interest. The point estimates are given on the path lines on the diagram. On the bottom half are the point estimates with their standard errors in parentheses.



Hover mouse over an estimate to show more information

1. Mouse hovers over estimate

	Release-LGR	LGR-LGS	LGS-LMN+
2008-2008	0.0116 (0.0025)	1.0640 (0.2886)	0.3889 (0.1147)
2008-2009	**0.4306 (0.0092)**	0.0000 (0.0000)	0.0000 (0.0000)
2008-2010	0.0525 (0.0054)	0.0000 (0.0000)	0.0000 (0.0000)
2008-2011	0.0000 (0.0000)	0.0000 (0.0000)	0.0000 (0.0000)
2009-2009	NA	0.9839 (0.0291)	0.6468 (0.0337)
2009-2010	NA	0.0000 (0.0000)	0.0000 (0.0000)
2009-2011	NA	0.0000 (0.0000)	0.0000 (0.0000)

2. Corresponding estimate and s.e. are highlighted

3. Description of parameter appears here

The probability of a released fish residiualizing until 2009 and then migrating to LGR

Figure 39. Graphical Results window

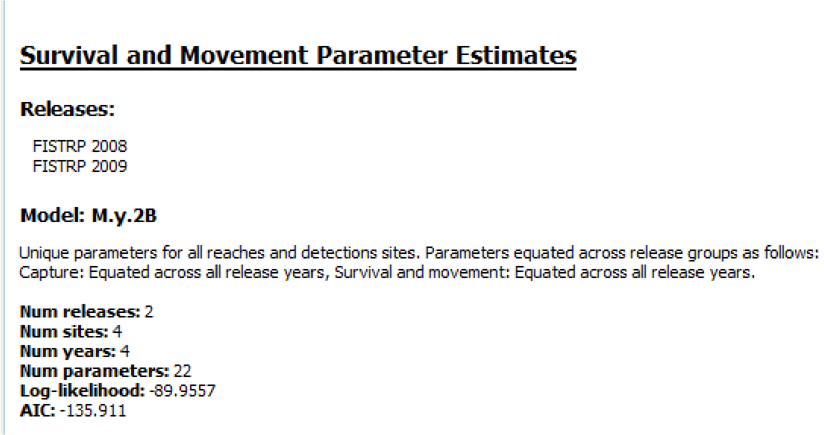
The user may hover the mouse pointer over any result on the diagram, and the corresponding value in the table will be highlighted with bold text and yellow background. In addition, a description of the parameter will appear below the table.

5.3 Reports

Three reports are available after the estimates have been obtained and the model with the best AIC selected (or possibly a suboptimal model if "Expert Mode" is turned on): (1) Survival and Movement Parameter Estimates, (2) Capture Parameter Estimates, and (3) Performance Measures.

5.3.1 Report Header

At the top of each of the reports is information about the currently selected model. An example is shown in Figure 40.



Survival and Movement Parameter Estimates

Releases:

FISTRP 2008
FISTRP 2009

Model: M.y.2B

Unique parameters for all reaches and detections sites. Parameters equated across release groups as follows: Capture: Equated across all release years, Survival and movement: Equated across all release years.

Num releases: 2
Num sites: 4
Num years: 4
Num parameters: 22
Log-likelihood: -89.9557
AIC: -135.911

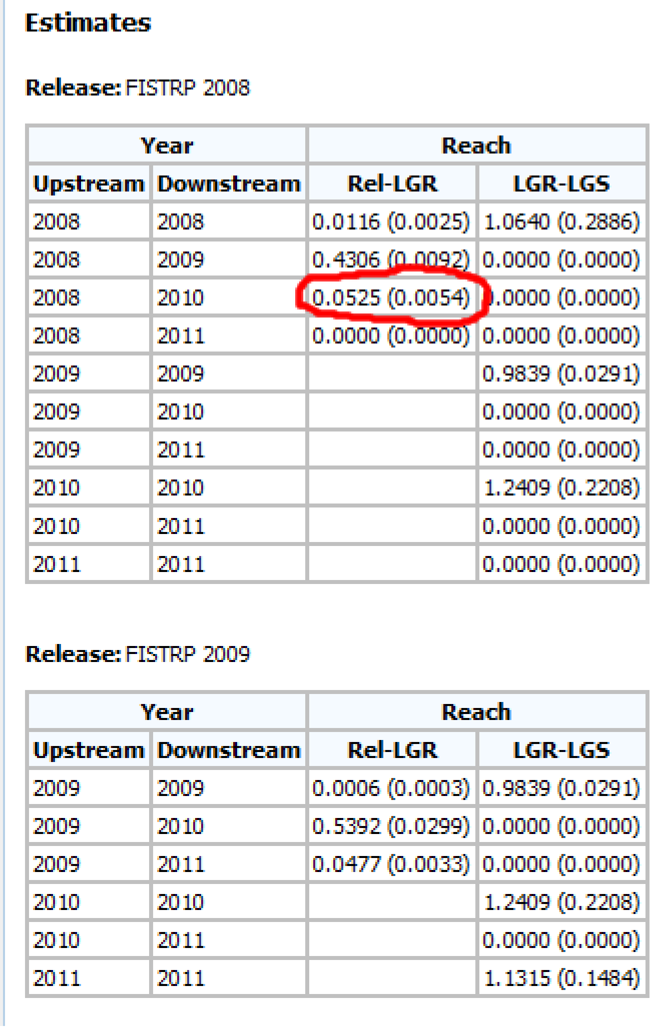
Figure 40. Header Information at the top of each report

The information in the report header includes in order:

1. The names of the releases used for the estimates.
2. The Model ID.
3. A description of the model.
4. The number of releases.
5. The number of sites.
6. The number of years.
7. The number of parameters.
8. The log-likelihood.
9. The actual AIC value, not the ΔAIC value.

5.3.2 Survival and Movement Parameter Estimates

Figure 41 shows the body of the Survival and Movement Parameter Estimates report (excluding the header information at the top).



Estimates

Release: FISTRP 2008

Year		Reach	
Upstream	**Downstream**	**Rel-LGR**	**LGR-LGS**
2008	2008	0.0116 (0.0025)	1.0640 (0.2886)
2008	2009	0.4306 (0.0092)	0.0000 (0.0000)
2008	2010	0.0525 (0.0054)	.0000 (0.0000)
2008	2011	0.0000 (0.0000)	0.0000 (0.0000)
2009	2009		0.9839 (0.0291)
2009	2010		0.0000 (0.0000)
2009	2011		0.0000 (0.0000)
2010	2010		1.2409 (0.2208)
2010	2011		0.0000 (0.0000)
2011	2011		0.0000 (0.0000)

Release: FISTRP 2009

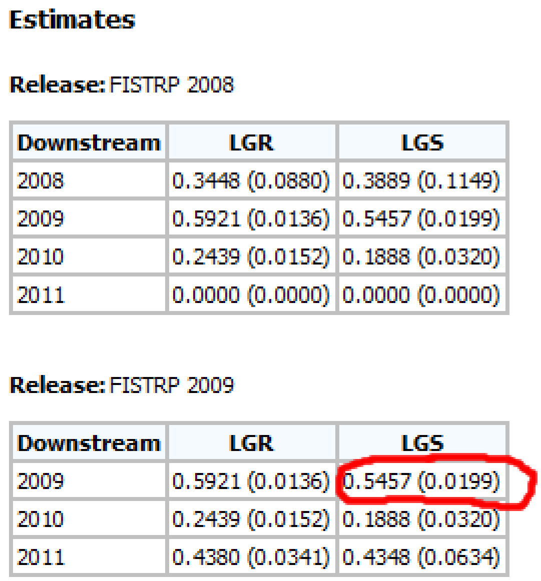
Year		Reach	
Upstream	**Downstream**	**Rel-LGR**	**LGR-LGS**
2009	2009	0.0006 (0.0003)	0.9839 (0.0291)
2009	2010	0.5392 (0.0299)	0.0000 (0.0000)
2009	2011	0.0477 (0.0033)	0.0000 (0.0000)
2010	2010		1.2409 (0.2208)
2010	2011		0.0000 (0.0000)
2011	2011		1.1315 (0.1484)

Figure 41. Body of Survival and Movement Parameter Estimates Report

There is a table for each of the releases, showing all survival and movement parameter estimates for the selected model with the standard errors in parentheses. For example in Figure 41, the probability of a fish in the FISTRP 2008 release surviving and migrating to LGR in 2010 is 0.0525 with a standard error of 0.0054.

5.3.3 Capture Parameter Estimates

Figure 42 shows the body of a Capture Parameter Estimates Report.



Estimates

Release: FISTRP 2008

Downstream	LGR	LGS
2008	0.3448 (0.0880)	0.3889 (0.1149)
2009	0.5921 (0.0136)	0.5457 (0.0199)
2010	0.2439 (0.0152)	0.1888 (0.0320)
2011	0.0000 (0.0000)	0.0000 (0.0000)

Release: FISTRP 2009

Downstream	LGR	LGS
2009	0.5921 (0.0136)	0.5457 (0.0199)
2010	0.2439 (0.0152)	0.1888 (0.0320)
2011	0.4380 (0.0341)	0.4348 (0.0634)

Figure 42. Body of Capture Parameter Estimates Report

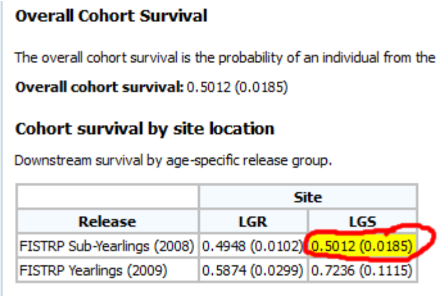
As with the Survival and Movement Parameter Estimates report, there is a table for the detection probabilities for each release with the associated standard errors in parentheses. For example, for a fish of the FISHTRP 2009 release, alive at LGS in 2009, the probability of being detected at LGS in 2009 is 0.5457 with a standard error of 0.0199.

5.3.4 Performance Measures Report

The Performance Measures report gives several different meaningful metrics that are functions of the estimated survival and movement parameters, and capture parameters.

5.3.4.1 Overall Cohort Survival and Cohort Survival by Site Location

Figure 43 shows the section of the Performance Measures Report that reports the overall cohort survival and the cohort survival by site location.



Overall Cohort Survival

The overall cohort survival is the probability of an individual from the 2008 release group reaching the detection site furthest down-river.

Overall cohort survival: 0.5012 (0.0185)

Cohort survival by site location

Downstream survival by age-specific release group.

	Site	
Release	**LGR**	**LGS**
FISTRP Sub-Yearlings (2008)	0.4948 (0.0102)	0.5012 (0.0185)
FISTRP Yearlings (2009)	0.5874 (0.0299)	0.7236 (0.1115)

Figure 43. Overall Cohort Survival and Cohort Survival by Site location section of the Performance Measures Report

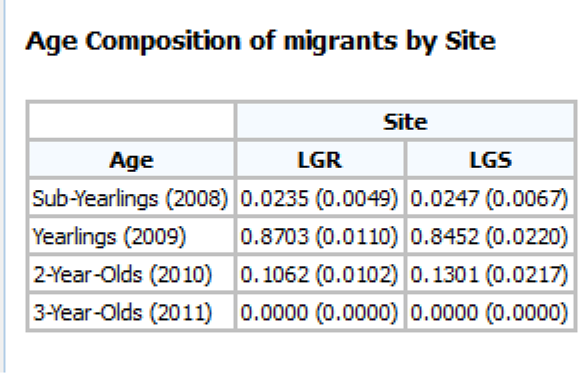
The overall cohort survival is the probability that an individual from the primary release survives and migrates over time to the "furthest downriver" site. The primary release is the earliest and furthest upstream release. We can only estimate survival to the penultimate site—the site upstream from the furthest downstream site. In the example in Figure 43, there is one site downstream from LGS; thus, we can estimate survival only to LGS. Therefore, the "furthest downriver" site is LGS, and survival from release to LGS is reported as the overall cohort survival.

The table under the "Cohort survival by site location gives the survival probability for each release to each downstream site. The overall cohort survival is emphasized in bold with yellow background (circled in Figure 43).

The calculations for survival to a site are shown in Appendix A.

5.3.4.2 Age Composition of Migrants by Site

Figure 44 shows the age composition of a cohort as they migrate past a detection site. For those migrants that pass by each detection site, this table shows the estimated proportion by age class.



Age Composition of migrants by Site

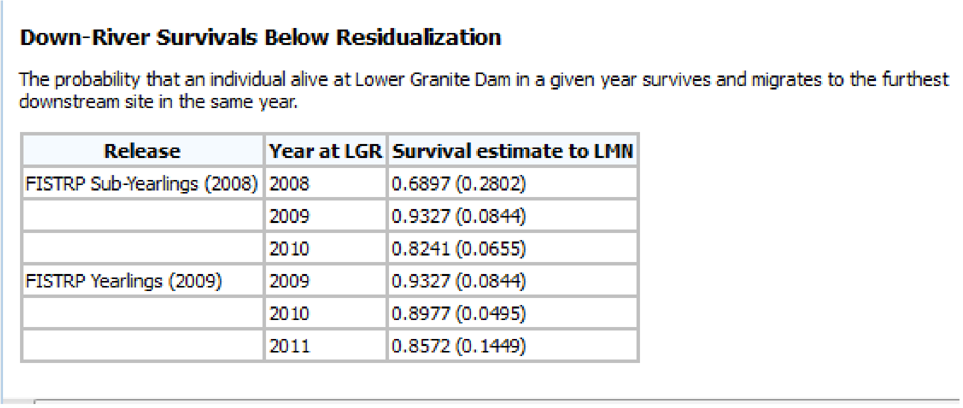
	Site	
Age	**LGR**	**LGS**
Sub-Yearlings (2008)	0.0235 (0.0049)	0.0247 (0.0067)
Yearlings (2009)	0.8703 (0.0110)	0.8452 (0.0220)
2-Year-Olds (2010)	0.1062 (0.0102)	0.1301 (0.0217)
3-Year-Olds (2011)	0.0000 (0.0000)	0.0000 (0.0000)

Figure 44. Age Composition of migrants by Site section of the Performance Measures Report

The calculations for age composition are shown in Appendix A.

5.3.4.3 Downriver Survivals Below Residualization

Figure 45 shows the downriver survival estimates for each age class that passed the site of the last "residualizing," or overwintering. In the example in Figure 45, there was no residualization beyond LGR. This table will only be displayed if there are at least two detection sites beyond the site of the most downstream residualization.



Down-River Survivals Below Residualization

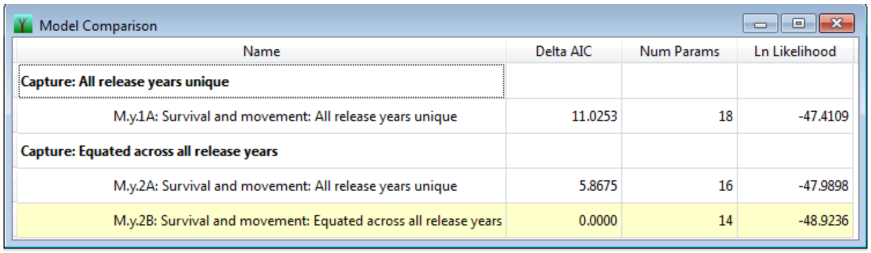
The probability that an individual alive at Lower Granite Dam in a given year survives and migrates to the furthest downstream site in the same year.

Release	Year at LGR	Survival estimate to LMN
FISTRP Sub-Yearlings (2008)	2008	0.6897 (0.2802)
	2009	0.9327 (0.0844)
	2010	0.8241 (0.0655)
FISTRP Yearlings (2009)	2009	0.9327 (0.0844)
	2010	0.8977 (0.0495)
	2011	0.8572 (0.1449)

Figure 45. Downriver Survival Below Residualization section of the Performance Measures Report

5.4 Expert Mode

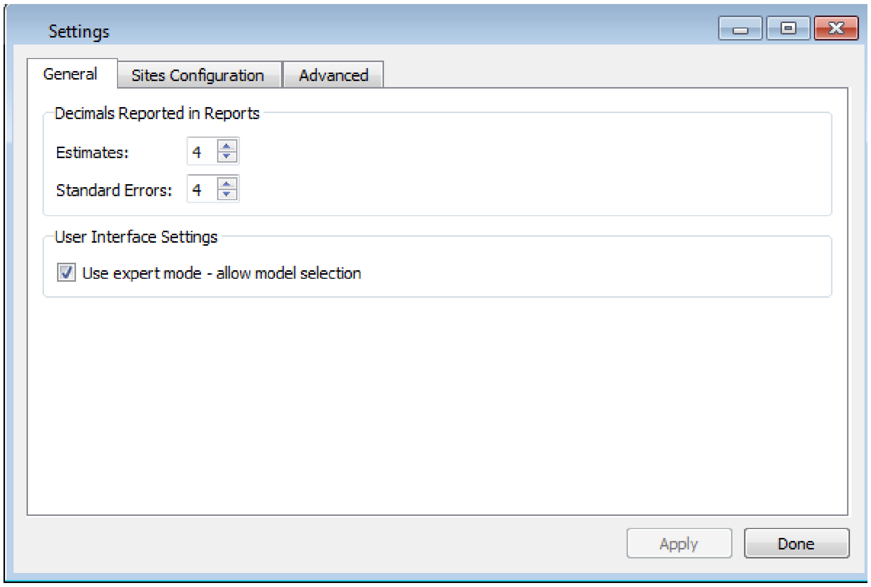
By default, after fitting the models, the model with the best AIC is selected, indicated by the yellow background in the Model Comparison report, as shown in the example in Figure 46, where there are multiple releases in different years. All graphical results and reports are for the model highlighted in yellow.



Name	Delta AIC	Num Params	Ln Likelihood
Capture: All release years unique			
M.y.1A: Survival and movement: All release years unique	11.0253	18	-47.4109
Capture: Equated across all release years			
M.y.2A: Survival and movement: All release years unique	5.8675	16	-47.9898
M.y.2B: Survival and movement: Equated across all release years	0.0000	14	-48.9236

Figure 46. Model Comparison dialog for multiple releases in different years

If the user would like to look at the results for other models besides the one with the best AIC, the user can do so by turning on expert mode. Go to the Edit menu, select Settings, and select the General tab. Then check the box labeled "Use expert mode – allow model selection" as shown in Figure 47.



Decimals Reported in Reports

Estimates: 4

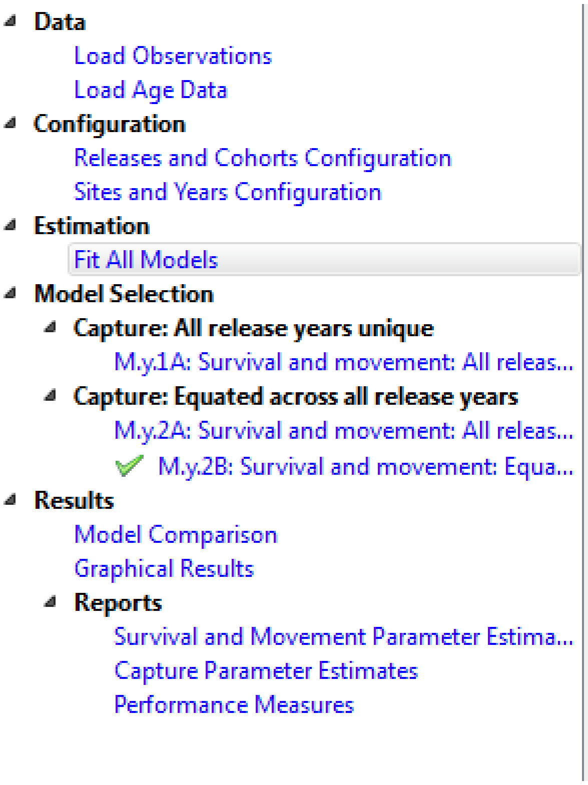
Standard Errors: 4

User Interface Settings

☑ Use expert mode - allow model selection

Figure 47. Turning on expert mode in the Settings dialog

Then click the Apply button, and then the Done button. A new heading will appear in the Navigation Panel labeled “Model Selection,” as shown in Figure 48.



- **Data**
  - Load Observations
  - Load Age Data
- **Configuration**
  - Releases and Cohorts Configuration
  - Sites and Years Configuration
- **Estimation**
  - Fit All Models
- **Model Selection**
  - **Capture: All release years unique**
    - M.y.1A: Survival and movement: All releas...
  - **Capture: Equated across all release years**
    - M.y.2A: Survival and movement: All releas...
    - ✓ M.y.2B: Survival and movement: Equa...
- **Results**
  - Model Comparison
  - Graphical Results
  - **Reports**
    - Survival and Movement Parameter Estima...
    - Capture Parameter Estimates
    - Performance Measures

Figure 48. Navigation Panel with expert mode enabled

A green check mark is next to the M.y.2B model—the one with the best AIC. To look at the estimates for one of the other models, say M.y.1A, simply double-click on it in the Navigation Panel, and green check mark will now be by M.y.1A, indicating that it is the currently selected model, as shown in Figure Figure 49.

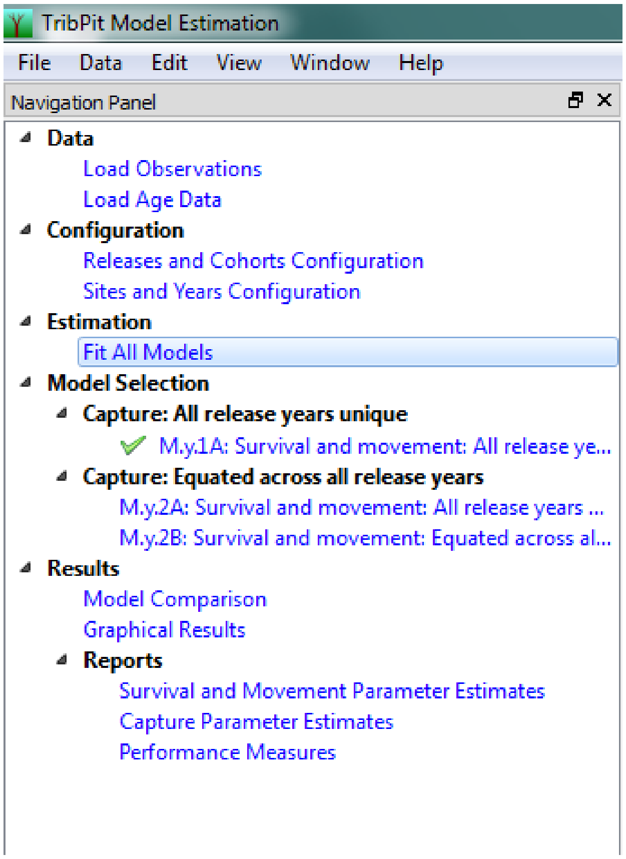
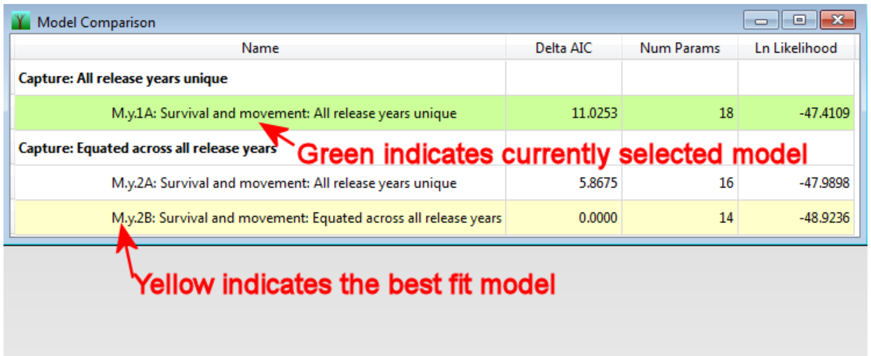

TribPit Model Estimation
File Data Edit View Window Help
Navigation Panel
Data
Load Observations
Load Age Data
Configuration
Releases and Cohorts Configuration
Sites and Years Configuration
Estimation
Fit All Models
Model Selection
Capture: All release years unique
M.y.1A: Survival and movement: All release ye...
Capture: Equated across all release years
M.y.2A: Survival and movement: All release years ...
M.y.2B: Survival and movement: Equated across al...
Results
Model Comparison
Graphical Results
Reports
Survival and Movement Parameter Estimates
Capture Parameter Estimates
Performance Measures

Figure 49. Navigation Panel with expert mode enabled and an alternative model selected

The Model Comparison Dialog will now appear as shown in Figure 50. The best model will still be highlighted in yellow, and the currently selected model will be highlighted in green. The graphical results and all the reports will now pertain to model M.y.1A.


Model Comparison

Name	Delta AIC	Num Params	Ln Likelihood
Capture: All release years unique			
M.y.1A: Survival and movement: All release years unique	11.0253	18	-47.4109
Capture: Equated across all release years			
M.y.2A: Survival and movement: All release years unique	5.8675	16	-47.9898
M.y.2B: Survival and movement: Equated across all release years	0.0000	14	-48.9236

Green indicates currently selected model

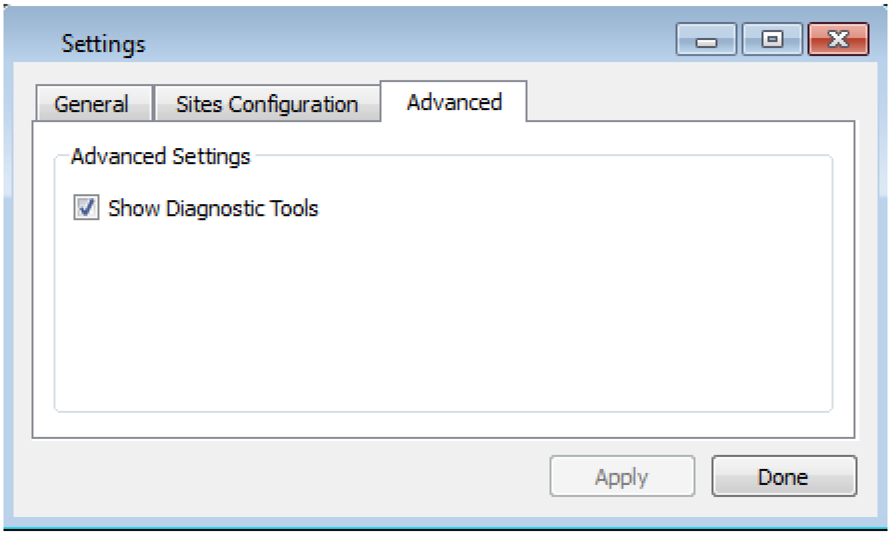
Yellow indicates the best fit model

Figure 50. Model Comparison dialog with an alternative model selected

Chapter 6: Diagnostic Tools

Next Detections

Program TribPit provides some diagnostic tools used mainly for debugging the program. Go to the Edit menu, select “Settings,” and select the “Advanced” tab and check the checkbox labeled “Show Diagnostic Tools” as shown in Figure 51.


Settings
General
Sites Configuration
Advanced
Advanced Settings
Apply
Done

☑ Show Diagnostic Tools

Figure 51. Turning on the Diagnostic Tools

After clicking “Apply,” a new heading will appear in the Navigation Panel labeled “Diagnostic Tools.” as shown in Figure 52.

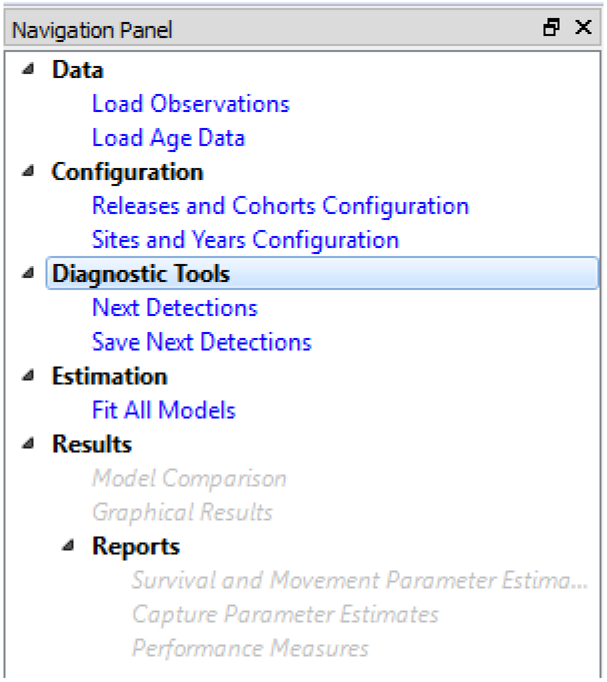
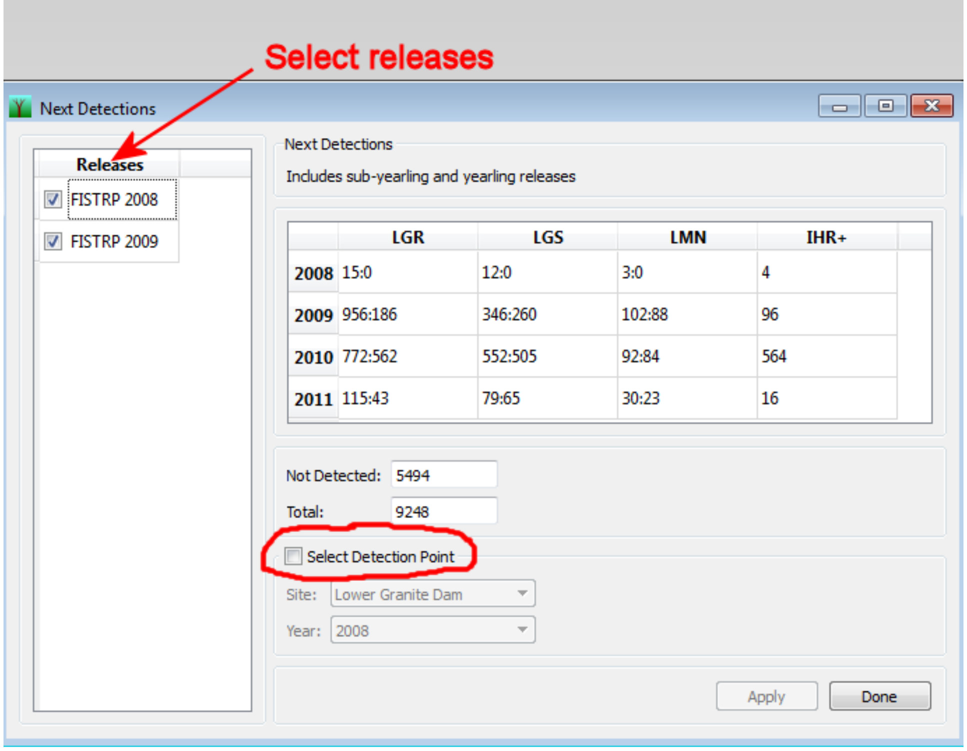

Navigation Panel
Data
Load Observations
Load Age Data
Configuration
Releases and Cohorts Configuration
Sites and Years Configuration
Diagnostic Tools
Next Detections
Save Next Detections
Estimation
Fit All Models
Results
Model Comparison
Graphical Results
Reports
Survival and Movement Parameter Estima...
Capture Parameter Estimates
Performance Measures

Figure 52. Navigation Panel with Diagnostic Tools enabled

Double-click on Next Detections to bring up the Next Detections dialog as shown in Figure 53.



Releases

☑ FISTRP 2008

☑ FISTRP 2009

Next Detections

Includes sub-yearling and yearling releases

	LGR	LGS	LMN	IHR+
2008	15:0	12:0	3:0	4
2009	956:186	346:260	102:88	96
2010	772:562	552:505	92:84	564
2011	115:43	79:65	30:23	16

Not Detected: 5494

Total: 9248

☐ Select Detection Point

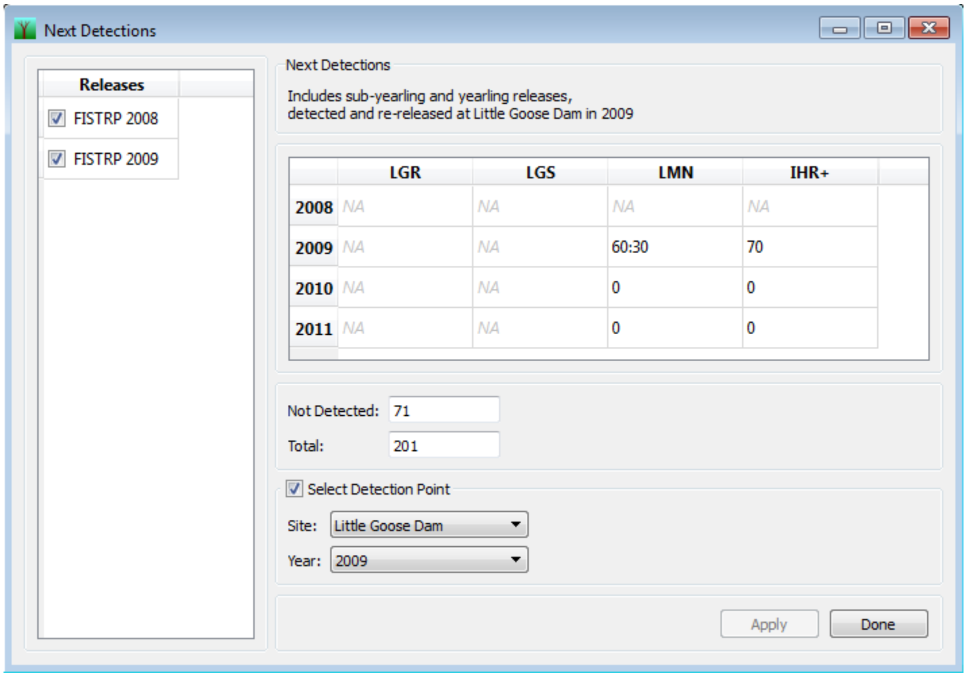
Site: Lower Granite Dam

Year: 2008

Figure 53. Next Detections Dialog

In the default mode, all releases are selected; the user can look at only one release by deselecting on of them. The “Select Detection Point” is cleared (circled), so we are looking at fish at the initial release. This dialog tells us, for example, that of the 9,248 fish released, 552 of these were next detected at LGS. Of these 552, 505 were removed (probably due to transportation). Of the 9,248 fish, 5,494 were never detected again.

If the “Select Detection Point” check box is checked, the user can select a Site and Year of interest. To look at detections at Little Goose Dam in 2009, for example, check the “Select Detection Point” check box, choose “Little Goose Dam” for the Site and “2009” for the Year and press the “Apply” button. The result is shown in Figure 54.



Releases
☑ FISTRP 2008
☑ FISTRP 2009

Next Detections

Includes sub-yearling and yearling releases,
detected and re-released at Little Goose Dam in 2009

	LGR	LGS	LMN	IHR+
2008	NA	NA	NA	NA
2009	NA	NA	60:30	70
2010	NA	NA	0	0
2011	NA	NA	0	0

Not Detected: 71

Total: 201

☑ Select Detection Point

Site: Little Goose Dam

Year: 2009

Figure 54. Next Detections Dialog with a detection point selected

This tells us that of the 201 fish detected and “re-released” (not removed) from Little Goose Dam in 2009, 71 were never detected again, 60 were next detected at LMN, 30 of which were removed; and 70 were next detected at IHR+.

The “Save Next Detections” action on the Navigation Panel allows the user to save the next detections data to a text file.

Appendix A: Performance Measures Calculations

This appendix shares the calculations of the performance measures in the Performance Measures Report (Section 5.3.4). The variances of these performance measures are calculated using the delta method.

A.1 Overall Cohort Survival and Cohort Survival by Location

Let S_{jk} be the probability of survival to site k in year j for a given cohort. Let j_0 be the release year, k_0, the release site, and using the parameter definitions from Section 1.2,

$$S_{jk} = \phi_{k,j_0,j} \quad \text{for} \quad k = k_{0+1}$$

$$S_{jk} = \textstyle\sum_{j=j_0}^{j} \phi_{kmj} \cdot S_{k-1,m} \quad \text{for} \quad k > k_0 + 1$$

Now let S_k be the probability of survival to site k for a given cohort

$$S_k = \sum_{j=j_0}^{J} S_{jk}$$

where J is the last observed detection year.

A2. Age Composition of Migrants by Site

Let A_{jk} = the age composition of a cohort at site k in year i.

$$A_{jk} = \frac{S_{jk}}{S_k}.$$

A3. Downriver Survival Below Residualization

Let K_R = the first downriver site beyond all observed residualization, and K be the furthest downriver site for which we can estimate survival (the penultimate detection site), and S_{jk} be the survival from site K in year j,

$$S_{jK_R} = \prod_{k=K_R+1}^{K} \phi_{jjk}.$$