CHAPTER 2

Data formatting: the input file . . .

Clearly, the first step in any analysis is gathering and collating your data. We'll assume that at the minimum, you have records for the individually marked individuals in your study, and from these records, can determine whether or not an individual was 'encountered' (in one fashion or another) on a particular sampling occasion. Typically, your data will be stored in what we refer to as a 'vertical file' – where each line in the file is a record of when a particular individual was seen. For example, consider the following table, consisting of some individually identifying mark (ring or tag number), and the year. Each line in the file (or, row in the matrix) corresponds to the animal being seen in a particular year.

tag number	*year*
1147-38951	73
1147-38951	75
1147-38951	76
1147-38951	82
1147-45453	74
1147-45453	78

However, while it is easy and efficient to record the observation histories of individually marked animals this way, the 'vertical format' is not at all useful for capture-mark-recapture analysis. The preferred format is the *encounter history*. The encounter history is a contiguous series of specific dummy variables, each of which indicates something concerning the encounter of that individual – for example, whether or not it was encountered on a particular sampling occasion, how it was encountered, where it was encountered, and so forth. The particular encounter history will reflect the underlying model type you are working with (e.g., recaptures of live individuals, recoveries of dead individuals).

Consider for example, the encounter history for a typical mark-recapture analysis (the encounter history for a mark-recapture analysis is often referred to as a *capture history*, since it implies physical capture of the individual). In most cases, the encounter history consists of a contiguous series of '`1`'s and '`0`'s, where '`1`' indicates that an animal was recaptured (or otherwise known to be alive and in the sampling area), and '`0`' indicates the animal was not recaptured (or otherwise seen). Consider the individual in the preceding table with tag number '`1147-38951`'. Suppose that 1973 is the first year of the study, and that 1985 is the last year of the study. Examining the table, we see that this individual was captured and marked during the first year of the study, was seen periodically until 1982, when it was seen for the last time. The corresponding encounter-history for this individual would be: '`1011000001000`'. In other words, the individual was seen in 1973 (the starting '`1`'), not seen in 1974 ('`0`'), seen in 1975 and 1976 ('`11`'), not seen for the next 5 years ('`00000`'), seen again in 1982 ('`1`'), and then not seen again ('`000`').

While this is easy enough in principal, you surely don't want to have to construct capture-histories manually. Of course, this is precisely the sort of thing that computers are good for – large-scale data manipulation and formatting. **MARK** does not do the data formatting itself – no doubt you have your own preferred 'data manipulation' environment (**dBASE**, **Excel**, **Paradox**, **SAS**). Thus, in general, you'll have to write your own program to convert the typical 'vertical' file (where each line represents the encounter information for a given individual on a given sampling occasion; see the example on the preceding page) into encounter histories (where the encounter history is a horizontal string).

In fact, if you think about it a bit, you realize that in effect what you need to do is to take a vertical file, and 'transpose' (or, 'pivot') it into a horizontal file – where fields to the right of the individual tag number represent when an individual was recaptured or resighted. However, while the idea of a 'transpose' or 'pivot' seems simple enough, there is one rather important thing that needs to be done – your program must insert the '`0`' value whenever an individual was not seen.

We'll assume for the purposes of this book that you will have some facility to put your data into the proper encounter-history format. For those of you who have no idea whatsoever on how to approach this problem, we provide some practical guidance in the Addendum at the end of this chapter. Of course, you could always do it by hand, if absolutely necessary!

begin sidebar

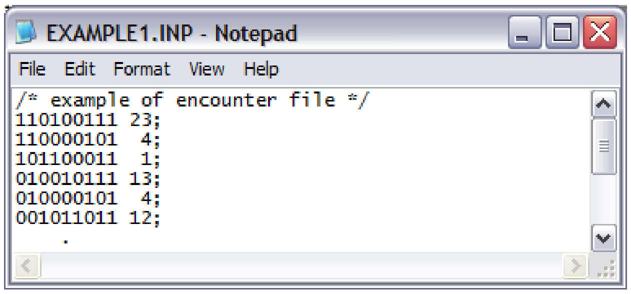
editing the INP file

Many of the problems people have getting started with **MARK** can ultimately be traced back to problems with the `INP` file. One common issue relates to choice of editor used to make changes/additions to the `INP` file. You are strongly urged to avoid – as in 'like the plague' – using Windows Notepad (or, even worse, Word) to do much of anything related to building/editing `INP` files. Do yourself a favor and get yourself a real ASCII editor. There are a number of very good 'free' applications you can (and should) use instead of Notepad (e.g., Notepad++, EditPad Lite, jEdit, and so on...)

end sidebar

2.1. Encounter histories formats

Now we'll look at the formatting of the encounter histories file in detail. It is probably easiest to show you a 'typical' encounter history file, and then explain it 'piece by piece'. The encounter-history reflects a mark-recapture experiment.



```
/* example of encounter file */
110100111 23;
110000101  4;
101100011  1;
010010111 13;
010000101  4;
001011011 12;
    .
```

Superficially, the encounter histories file is structurally quite simple. It consists of an ASCII (text) file, consisting of the encounter history itself (the contiguous string of dummy variables), followed by one or more additional columns of information pertaining to that history. Each record (i.e., each line) in the encounter histories file ends with a semi-colon. Each history (i.e., each line, or record) must be the same length (i.e., have the same number of elements – the encounter history itself must be the same length over all records, and the number of elements 'to the right' of the encounter history must also be the same) – this is true regardless of the data type. The encounter histories file should have a `INP` suffix (for example, `EXAMPLE1.INP`). Generally, there are no other 'control statements' or 'PROC statements' required in a **MARK** input file. However, you can optionally add comments to the `INP` file using the 'slash-asterisk asterisk/slash' convention common to many programming environments – we have included a comment at the top of the example input file (shown at the bottom of the preceding page). The only thing to remember about comments is that they do **not** end with a semi-colon.

Let's look at each record (i.e., each line) a bit more closely. In this example, each encounter history is followed by a number. This number is the frequency of all individuals having a particular encounter history. This is not required (and in fact isn't what you want to do if you're going to consider individual covariates – more on that later), but is often more convenient for large data sets. For example, the summary encounter history

```
110000101 4;
```

could also be entered in the `INP` files as

```
110000101 1;
110000101 1;
110000101 1;
110000101 1;
```

Note again that each line – each 'encounter history record' – ends in a semi-colon. How would you handle multiple groups? For example, suppose you had encounter data from males and females? In fact, it is relatively straightforward to format the `INP` file for multiple groups – very easy for summary encounter histories, a bit less so for individual encounter histories. In the case of summary encounter histories, you simply add a second column of frequencies to the encounter histories to correspond to the other sex. For example,

```
110100111 23 17;
110000101  4  2;
101100011  1  3;
```

In other words, 23 of one sex and 17 of the other have history '`110100111`' (the ordering of the sexes – which column of frequencies corresponds to which sex – is entirely up to you). If you are using individual records, rather than summary frequencies, you need to indicate group association in a slightly less-obvious way – you will have to use a '`0`' or '`1`' within a group column to indicate the frequency – but obviously for one group only.

We'll demonstrate the idea here. Suppose we had the following summary history, with frequencies for males and females (respectively):

```
110000101   4   2;
```

In other words, 4 males, and 2 females with this encounter history (note: the fact that males come before females in this example is completely arbitrary. You can put whichever sex – or 'group' – you want in any column you want – all you'll need to do is remember which columns in the `INP` file correspond to which groups).

To 'code' individual encounter histories, the INP file would be modified to look like:

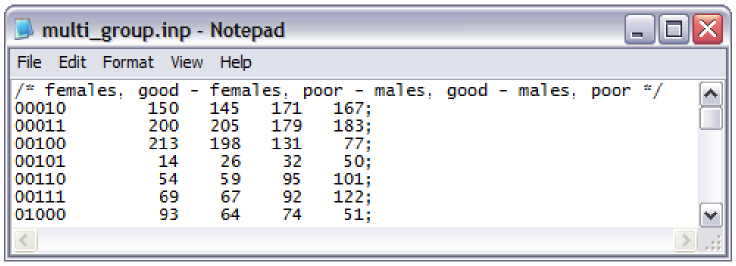
```
110000101   1 0;
110000101   1 0;
110000101   1 0;
110000101   1 0;
110000101   0 1;
110000101   0 1;
```

In this example, the coding '1 0' indicates that the individual is a male (frequency of 1 in the male column, frequency of 0 in the female column), and '0 1' indicates the individual is a female (frequency of 0 in the male column, and frequency of 1 in the male column). The use of one-record per individual is only necessary if you're planning on using individual covariates in your analysis.

2.1.1. Groups within groups...

In the preceding example, we had 2 groups: males and females. The frequency of encounters for each sex is coded by adding the frequency for each sex to the right of the encounter history.

But, what if you had something like males, and females (i.e., data from both sexes) and good colony and poor colony (i.e., data were sampled for both sexes from each of 2 different colonies – one classified as good, and the other as poor). How do you handle this in the INP file? Well, all you need to do is have a frequency column for each (sex.colony) combination: one frequency column for females from the good colony, one frequency column for females from the poor colony, one frequency column for males from the good colony, and finally, one frequency column for males from the poor colony. An example of such an INP file is shown below:



```
/* females, good - females, poor - males, good - males, poor */
00010         150    145    171    167;
00011         200    205    179    183;
00100         213    198    131     77;
00101          14     26     32     50;
00110          54     59     95    101;
00111          69     67     92    122;
01000          93     64     74     51;
```

As we will see in subsequent chapters, building models to test for differences between and among groups, and for interactions among groups (e.g., an interaction of sex and colony in this example) is relatively straightforward in **MARK** – all you'll really need to do is remember which frequency column codes for which grouping (hence the utility of adding comments to your INP file, as we've done in this example).

2.2. Removing individuals from the sample

Occasionally, you may choose to remove individuals from the data set at a particular sampling occasion. For example, because your experiment requires you to remove the individual after its first recapture, or because it is injured, or for some other reason. The standard encounter history we have looked at so far records presence or absence only. How do we accommodate 'removals' in the INP file? Actually, it's very easy – all you do is change the 'sign' on the frequencies from positive to negative. Negative frequencies indicates that that many individuals with a given encounter history were removed from the study. For example,

```
100100 1500 1678;
100100  -23  -25;
```

In this example, we have 2 groups, and 6 sampling occasions. In the first record, we see that there were 1,500 individuals and 1,678 individuals in each group marked on the first occasion, not encountered on the next 2 occasions, seen on the fourth occasion, and not seen again. In the second line, we see the same encounter history, but with the frequencies '`-23`' and '`-25`'. The negative values indicate to **MARK** that 23 and 25 individuals in both groups were marked on the first occasion, not seen on the next 2 occasions, were encountered on the fourth occasion, at which time they were removed from the study. Clearly, if they were removed, they cannot have been seen again. So, in other words, 1,500 and 1,678 individuals recaptured and released alive, on the fourth occasion, in addition to 23 and 25 individuals that were recaptured, but removed, on the fourth occasion. So, (1,500 + 23) = 1,523 individuals in group 1, and (1,678 + 25) = 1,703 individuals in group 2, with encounter history '`100100`'.

Note: the '`-1`' code is for *removing* individuals from the live marked population. This is usually reserved for losses on capture (i.e., where the investigator captures and animal, and then, for some reason, decides to remove it from the study). The idea is that you don't want to include these 'biologist-caused' mortalities in the survival estimate.

On the other hand, if the known mortalities are *natural* (i.e., the investigator encounters a 'dead recovery'), and are not associated with the capture event itself, you have two options to get unbiased survival estimates

1. pretend you never observed the mortalities (i.e., just treat those individuals as regular releases that you never observe again). This approach is probably reasonable if the number of such mortalities is relatively small.
2. conduct a joint live recapture-dead recovery analysis with these 6 individuals treated as dead recoveries (see Chapter 9). Including the known mortalities (i.e., dead recoveries) will improve precision of your survival estimates.

`begin sidebar`

uneven time-intervals between sampling occasions?

In the preceding, we have implicitly assumed that the sampling interval between sampling occasions is identical throughout the course of the study (e.g., sampling every 12 months, or every month, or every week). But, in practice, it is not uncommon for the time interval between occasions to vary – either by design, or because of 'logistical constraints'. This has clear implications for how you analyze your data.

For example, suppose you sample a population each October, and again each May (i.e., two samples within a year, with different time intervals between samples; October $\rightarrow$ May (7 months), and May $\rightarrow$ October (5 months)). Suppose the true monthly survival rate is constant over all months, and is equal to 0.9. As such, the estimated survival for October $\rightarrow$ May will be $0.9^7 = 0.4783$, while the estimated survival rate for May $\rightarrow$ October will be $0.9^5 = 0.5905$. Thus, if you fit a model without accounting for these differences in time intervals, it is clear that there would 'appear' to be differences in survival between successive samples, when in fact the monthly survival does not change over time.

So, how do you 'tell **MARK**' that the interval between samples may vary over time? You might think that you need to 'code' this interval information in the `INP` file in some fashion. In fact, you don't

– you specify the time intervals when you are specifying the data type in **MARK**, and not in the INP file. In the INP file, you simply enter the encounter histories as contiguous strings, regardless of the true interval between sampling occasions. We will discuss handling uneven time-intervals in more detail in a later chapter.

end sidebar

2.3. Different encounter history formats

Up until now, we've more or less used typical mark-recapture encounter histories (i.e., capture histories) to illustrate the basic principles of constructing an INP file. However, **MARK** can be applied to far more than mark-recapture analysis, and as such, there are a number of slight permutations on the encounter history that you need to be aware of in order to use **MARK** to analyze your particular data type. First, we summarize in table form (below) the different data types **MARK** can handle, and the corresponding encounter history format.

recaptures only	LLLL
recoveries only	LDLDLDLD
both	LDLDLDLD
known fate	LDLDLDLD
closed captures	LLLL
BTO ring recoveries	LDLDLDLD
robust design	LLLL
both (Barker model)	LDLDLDLD
multi-strata	LLLL
Brownie recoveries	LDLDLDLD
Jolly-Seber	LLLL
Huggins' closed captures	LLLL
Robust design (Huggins)	LLLL
Pradel recruitment	LLLL
Pradel survival & seniority	LLLL
Pradel survival & λ	LLLL
Pradel survival & recruitment	LLLL
POPAN	LLLL
multi-strata - live and dead encounters	LDLDLDLD
closed captures with heterogeneity	LLLL
full closed captures with heterogeneity	LLLL
nest survival	LDLDLDLD
occupancy estimation	LLLL
robust design occupancy estimation	LLLL
open robust design multi-strata	LLLL
closed robust design multi-strata	LLLL

Each data type in **MARK** requires a primary from of data entry provided by the encounter history. Encounter histories can consist of information on only live encounters (LLLL) or information on both live and dead (LDLDLDLD). In addition, some types allow a summary format (e.g., recovery matrix) which reduces the amount of input. The second column of the table shows the basic structure for a 4 occasion encounter history. There are, in fact, broad types: live encounters only, and mixed live and dead (or known fate) encounters.

For example, for a recaptures only study (i.e., live encounters), the structure of the encounter history would be '`LLLL`' – where '`L`' indicates information on encountered/not encountered status. As such, each '**L**' in the history would be replaced by the corresponding 'coding variable' to indicate encountered or not encountered status (usually '`1`' or '`0`' for the recaptures only history). So, for example, the encounter '`1011`' indicates seen and marked alive at occasion 1, not seen on occasion 2, and seen again at both occasion 3 and occasion 4.

For data types including both live and dead individuals, the encounter history for the 4 occasion study is effectively 'doubled' – taking the format '`LDLDLDLD`', where the '`L`' refers to the live encountered or not encountered status, and the '`D`' refers to the dead encountered or not encountered status. At each sampling occasion, either 'event' is possible – an individual could be both seen alive at occasion (i) and then found dead at occasion (i), or during the interval between (i) and (i+1). Since both 'potential events' need to be coded at each occasion, this effectively doubles the length of the encounter history from a 4 character string to an 8 character string.

For example, suppose you record the following encounter history for an individual over 4 occasions – where the encounters consist of both live encounters and dead recoveries. Thus, the history '`10001100`' reflects an individual seen and marked alive on the first occasion, not recovered during the first interval, not seen alive at the second occasion and not recovered during the second interval, seen alive on the third occasion and then recovered dead during the third interval, and not seen or recovered thereafter (obviously, since the individual was found dead during the preceding interval).

2.4. Some more examples

The **MARK** help files contain a number of different examples of encounter formats. We list only a few of them here. For example, suppose you are working with dead recoveries only. If you look at the table on the preceding page, you see that it has a format of '`LDLDLDLD`'. Why not just '`LLLL`', and using '`1`' for live', and '`0`' for recovered dead? The answer is because you need to differentiate between known dead (which is a known fate) , and simply not seen. '`0`' alone could ambiguously mean either dead, or not seen (or both!).

2.4.1. Dead recoveries only

The following is an example of dead recoveries only, because a live animal is never captured alive after its initial capture. That is, none of the encounter histories have more than one '`1`' in an **L** column. This example has 15 encounter occasions and 1 group. If you study this example, you will see that 500 animals were banded each banding occasion.

```
000000000000000000000000000010  465;
000000000000000000000000000011   35;
000000000000000000000000001000  418;
000000000000000000000000001001   15;
000000000000000000000000001100   67;
000000000000000000000000100000  395;
000000000000000000000000100001    3;
000000000000000000000000100100   25;
000000000000000000000000110000   77;
```

Traditionally, recoveries only data sets were summarized into what are known as recovery tables.

MARK accommodates *recovery tables*, which have a 'triangular matrix form', where time goes from left to right (shown below). This format is similar to that used by Brownie *et al*. (1985).

```
 7    4   1    0   1;
      8   5    1   0;
         10    4   2;
              16   3;
                  12;
99   88 153  114 123;
```

Following each matrix is the number of individuals marked each year. So, 99 individuals marked on the first occasion, of which 7 were recovered dead during the first interval, 4 during the second, 1 during the third, and so on.

2.4.2. Individual covariates

Finally, an example (below) of known fate data, where individual covariates are included. Comments are given at the start of each line to identify the individual (this is optional, but often very helpful in keeping track of things). Then comes the capture history for this individual, in a 'LDLDLD. . .' sequence. Thus the first capture history is for an animal that was released on occasion 1, and died during the interval. The second animal was released on occasion 1, survived the interval, released again on occasion 2, and died during this second interval. Following the capture history is the count of animals with this history (always 1 in this example). Then, 4 covariates are provided. The first is a dummy variable representing age (0=subadult, 1=adult), then a condition index, wing length, and body weight.

```
/* 01 */     1100000000000000     1    1   1.16   27.7  4.19;
/* 04 */     1011000000000000     1    0   1.16   26.4  4.39;
/* 05 */     1011000000000000     1    1   1.08   26.7  4.04;
/* 06 */     1010000000000000     1    0   1.12   26.2  4.27;
/* 07 */     1010000000000000     1    1   1.14   27.7  4.11;
/* 08 */     1010110000000000     1    1   1.20   28.3  4.24;
/* 09 */     1010000000000000     1    1   1.10   26.4  4.17;
```

What if you have multiple groups, such that individuals are assigned (or part of) a given group, and where you also have individual covariates? There are a couple of ways you could handle this sort of situation. You can either code for the groups explicitly in the .inp file, or use an individual covariate for the groups. There are pros and cons to either approach (this issue is discussed in Chapter 11).

Here is an snippet from a data set with 2 groups coded explicitly, and an individual covariate. In this data fragment, the first 8 contiguous values represent the encounter history, followed by 2 columns representing the frequencies depending on group: '1 0' indicating group 1, and '0 1' indicating group 2, followed by the value of the covariate:

```
11111111 1 0 123.211;
11111111 0 1  92.856;
11111110 1 0 122.115;
11111110 1 0 136.460;
```

So, the first record with an encounter history of '11111111' is in group 1, and has a covariate value of 123.211. The second individual, also with an encounter history of '11111111', is in group 2, and has a covariate value of 92.856. The third individual has an encounter history of '11111110', and is in group 1, with a covariate value of 122.115. And so on.

If you wanted to code the group as an individual covariate, this same input file snippet would look like:

```
11111111 1 1 123.211;
11111111 1 0  92.856;
11111110 1 1 122.115;
11111110 1 1 136.460;
```

In this case, following the encounter history, is a column of 1's, indicating the frequency for each individual, followed by a column containing a 0/1 dummy code to indicate group (in this example, we've used a 1 to indicate group 1, 0 to indicate group 2), followed by the value of the covariate.

A final example – for three groups where we code for each group explicitly (such that each group has it's own 'dummy column' in the input file), an encounter history with individual covariates might look like:

```
11111  1 0 0  123.5;
11110  0 1 0   99.8;
11111  0 0 1  115.2;
```

where the first individual with encounter history '11111' is in group 1 (dummy value of 1 in the first column after the encounter history, and 0's in the next two columns) and has a covariate value of 123.5, second individual with encounter history '11110' is in group 2 (dummy code of 0 in the first column, 1 in the second, and 0 in the third) and a covariate value of 99.8, and a third individual with encounter history '11111' in group 3 (0 in the first two columns, and a 1 in the third column), with a covariate value of 115.2.

As is noted in the help file (and discussed at length in Chapter 11), it is helpful to scale the values of covariates to have a mean on the interval $[0, 1]$ to ensure that the numerical optimization algorithm finds the correct parameter estimates. For example, suppose the individual covariate 'weight' is used, with a range from 1,000 g to 5,000 g. In this case, you should scale the values of weight to be from 0.1 to 0.5 by multiplying each 'weight' value by 0.0001. In fact, **MARK** defaults to doing this sort of scaling for you automatically (without you even being aware of it). This 'automatic scaling' is done by determining the maximum absolute value of the covariates, and then dividing each covariate by this value. This results in each column scaled to between -1 and 1. This internal scaling is purely for purposes of ensuring the success of the numerical optimization – the parameter values reported by **MARK** (i.e., in the output that you see) are 'back-trasformed' to the original scale. Alternatively, if you prefer that the 'scaled' covariates have a mean of 0, and unit variance (this has some advantages in some cases), you can use the '**Standardize Individual Covariates**' option of the '**Run Window**' to perform the default standardization method (more on these in subsequent chapters).

More details on how to handle individual covariates in the input file are given in Chapter 11.

Summary

That's it! You're now ready to learn how to use **MARK**. Before you leap into the first major chapter (Chapter 3), take some time to consider that **MARK** will always do its 'best' to analyze the data you feed into it. However, it assumes that you will have taken the time to make sure your data are correct. If not, you'll be the unwitting victim to perhaps the most telling comment in data analysis: 'garbage in...garbage out'. Take some time at this stage to make sure you are confident in how to properly create and format your files.

Addendum: generating .inp files

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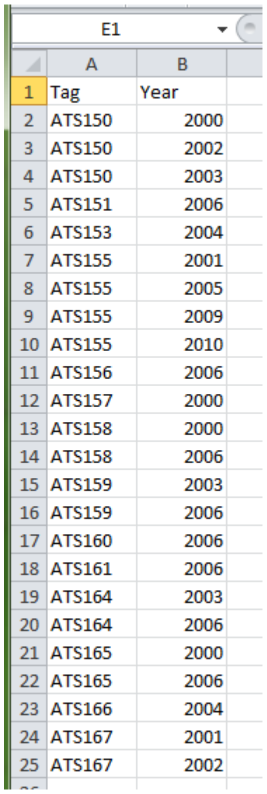
As noted at the outset in this chapter, **MARK** has no capability of generating input (`INP`) files. This is something you will need to do for yourself. In this short addendum, we introduce one approach to generating `INP` files, based on 'Excel pivot tables'. Since there are any number of different software applications for managing and manipulating data, we state for the record that we are going to demonstrate creating `INP` files using Excel, not as a point of advocacy for using Excel, but owing more to its near ubiquity (*note*: most of what follows applies generally to Access databases as well).

We will demonstrate the basic idea using an example where we will reformat an Excel spreadsheet containing some live encounter data. We wish to format these data into an `INP` file. The data are contained in the Excel spreadsheet `csj-pivot.xlsx` (note, we're clearly using Excel 2007 or later). Here are what the data look like before we transform them into an input file.


E1

	A	B
1	Tag	Year
2	ATS150	2000
3	ATS150	2002
4	ATS150	2003
5	ATS151	2006
6	ATS153	2004
7	ATS155	2001
8	ATS155	2005
9	ATS155	2009
10	ATS155	2010
11	ATS156	2006
12	ATS157	2000
13	ATS158	2000
14	ATS158	2006
15	ATS159	2003
16	ATS159	2006
17	ATS160	2006
18	ATS161	2006
19	ATS164	2003
20	ATS164	2006
21	ATS165	2000
22	ATS165	2006
23	ATS166	2004
24	ATS167	2001
25	ATS167	2002

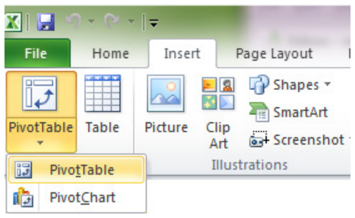
The file consists of two data columns: `TAG` (indicating the individual), and `YEAR` (the year that the individual was encountered). This data file contains encounter data for 14 marked individuals, with encounter data collected from 2000 to 2010 (thus, the encounter history will be 11 characters in length).

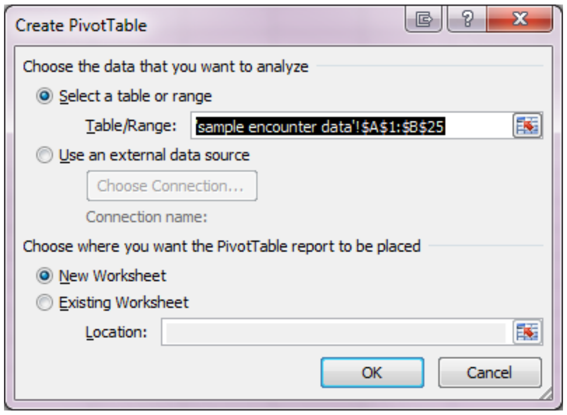
Our challenge, then is to take this 'vertical' file (one record per individual each year encountered), and 'pivot' it horizontally. For example, take the first individual in the file, `ATS150`. It was first encountered in 2000, again in 2002, and again (for the final time) in 2003. The second individual, `ATS151`, was seen for the first time in 2006, and then not seen again. The third individual, `ATS153`, was seen in 2004, and not seen again after that. And so on. If we had to generate the `INP` file by hand for these individuals, their encounter histories would look like:

```
/* ATS150 */ 101100000   1;
/* ATS151 */ 000000100   1;
/* ATS153 */ 000010000   1;
```

As it turns out, we can make use of the 'pivot table' in Excel (and some simple steps involving 'search and replace' and the `CONCATENATE` function), to generate exactly what we need. The process can be more involved for more complicated data types (e.g., robust design), but the basic principle of 'pivoting' applies.

Here are the basic steps. First, we select the rows and columns containing the data. Then, select '**`Insert | PivotTable | PivotTable`**', as shown to the right (make sure you select **`PivotTable`** and not **`PivotChart`**). This will bring up a dialog window (shown at the top of the next page) asking you to choose the data you want to 'pivot', and where you want the pivot table to be placed.




Create PivotTable

Choose the data that you want to analyze

[● Select a table or range]

Table/Range: sample encounter data'!$A$1:$B$25

○ Use an external data source

Choose Connection...

Connection name:

Choose where you want the PivotTable report to be placed

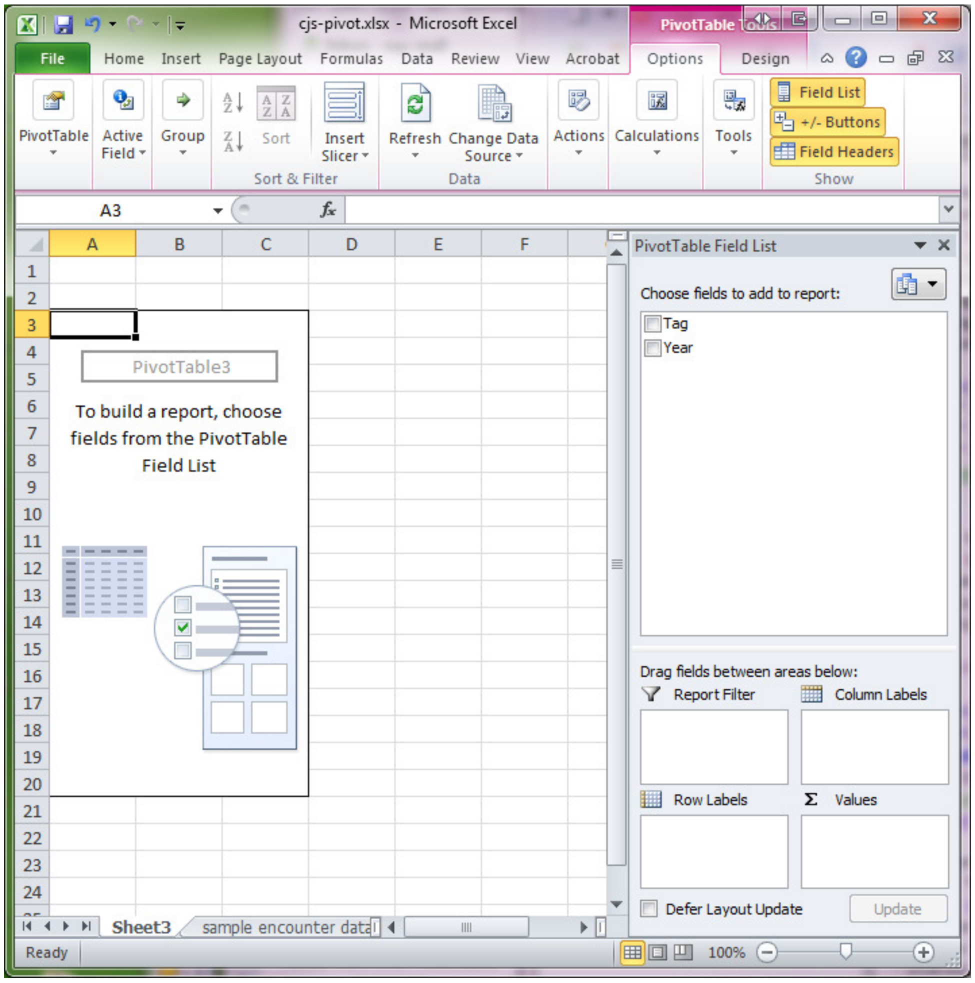
[● New Worksheet]

○ Existing Worksheet

Location:

OK Cancel

The ‘**`Table/Range`**’ field will already be filled with the rows and columns of the data you selected. We strongly recommend you put the pivot table into a ‘**`New Worksheet`**’ (this is selected by default). Once you click ‘**`OK`**’, you will be presented with the template from which you will generate the pivot table:



To build a report, choose fields from the PivotTable Field List

PivotTable Field List

Choose fields to add to report:

☐ Tag

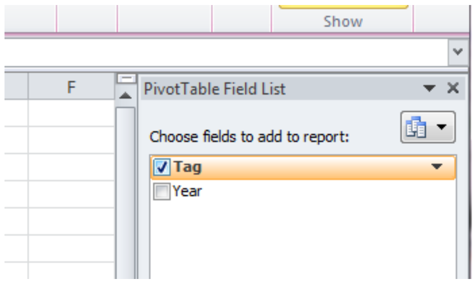
☐ Year

Drag fields between areas below:

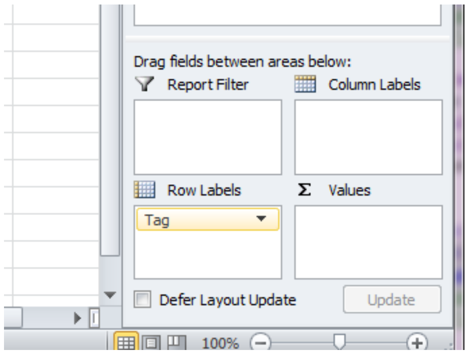
Report Filter | Column Labels | Row Labels | Values

☐ Defer Layout Update Update

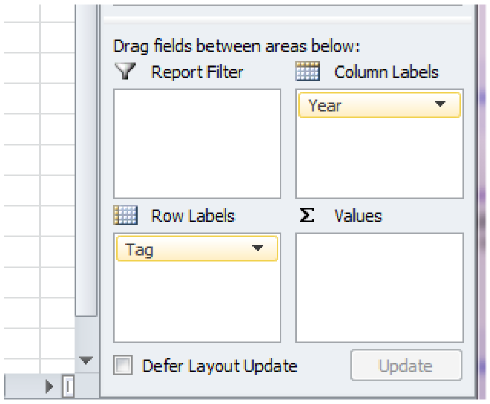
All you really need to do at this point is specify the '**`row labels`**', the '**`column labels`**', and the '**`values`**' (on the right hand side of the template). So, to specify the row labels, we simply select '**`tag`**'



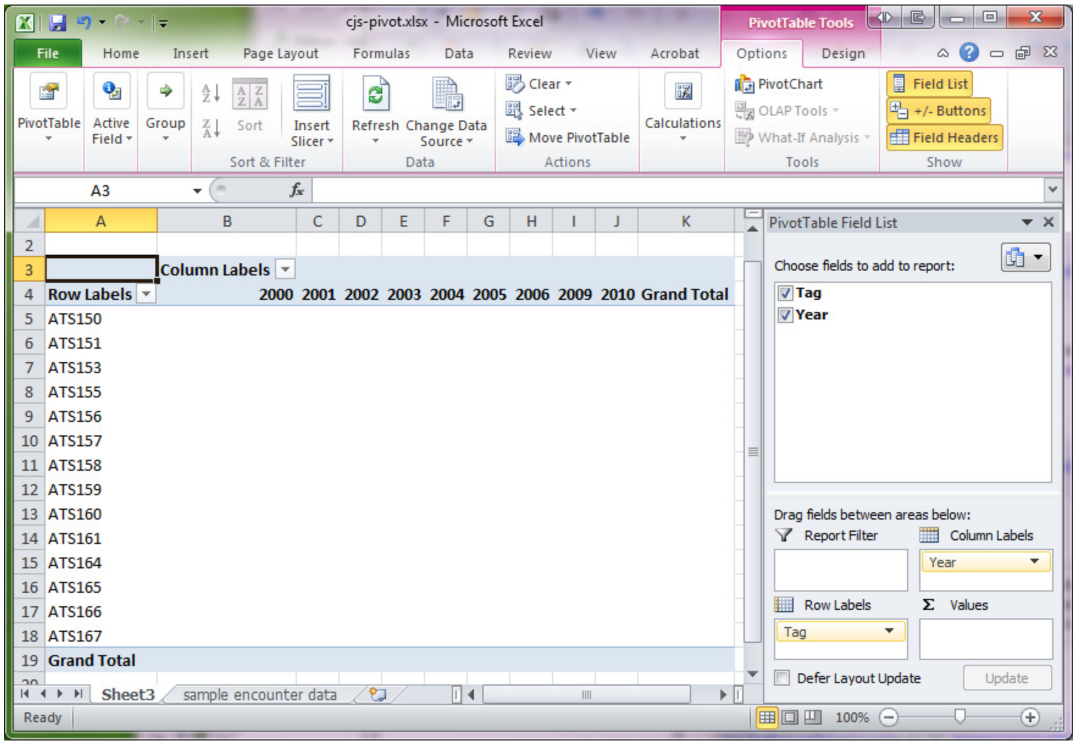
and then drag the '**`tag`**' field down to the '**`row labels`**' box at the bottom-right:



Then, do the same thing for the '**`Year`**' field: select '**`Year`**', and drag it down to the '**`column labels`**' box.



Once you have done this, you will quickly observe that a table (the 'pivot table') has been inserted into the main body of the template (see top of the next page). The table has row labels (individual tag numbers) and column labels (the years in your data file), plus some additional rows and columns for '**`Grand total`**' (reflecting the fact that pivot tables were designed primarily for business applications).



	Column Labels									
Row Labels	2000	2001	2002	2003	2004	2005	2006	2009	2010	Grand Total
ATS150										
ATS151										
ATS153										
ATS155										
ATS156										
ATS157										
ATS158										
ATS159										
ATS160										
ATS161										
ATS164										
ATS165										
ATS166										
ATS167										
Grand Total										

PivotTable Field List

Choose fields to add to report:

- [x] Tag
- [x] Year

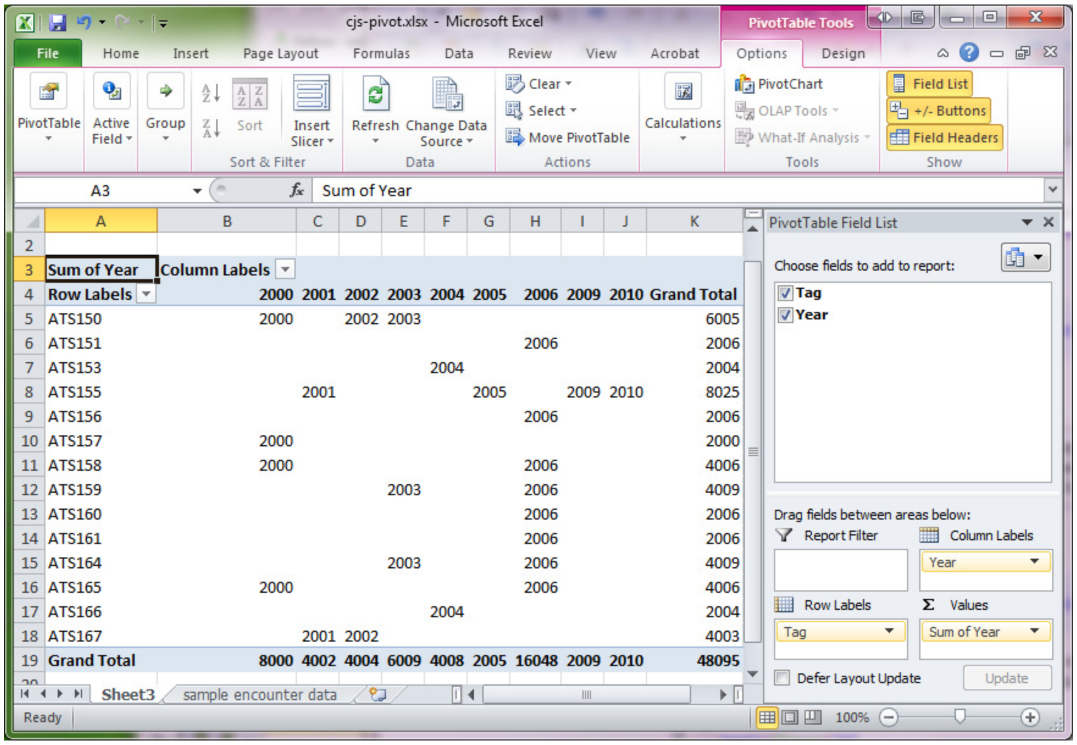
Drag fields between areas below:

Report Filter | Column Labels: Year

Row Labels: Tag | Values

Defer Layout Update | Update

However, at present, there is nothing in the table (all of the cells are blank). Now, drag the '**year**' field label down to the '**values**' box in the lower right-hand corner.



A3 Sum of Year

Sum of Year	Column Labels									
Row Labels	2000	2001	2002	2003	2004	2005	2006	2009	2010	Grand Total
ATS150	2000		2002	2003						6005
ATS151							2006			2006
ATS153					2004					2004
ATS155		2001				2005		2009	2010	8025
ATS156							2006			2006
ATS157	2000									2000
ATS158	2000						2006			4006
ATS159				2003			2006			4009
ATS160							2006			2006
ATS161							2006			2006
ATS164				2003			2006			4009
ATS165	2000						2006			4006
ATS166					2004					2004
ATS167		2001	2002							4003
Grand Total	8000	4002	4004	6009	4008	2005	16048	2009	2010	48095

PivotTable Field List

Choose fields to add to report:

- [x] Tag
- [x] Year

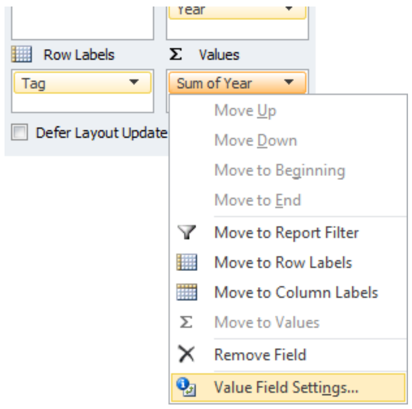
Drag fields between areas below:

Report Filter | Column Labels: Year

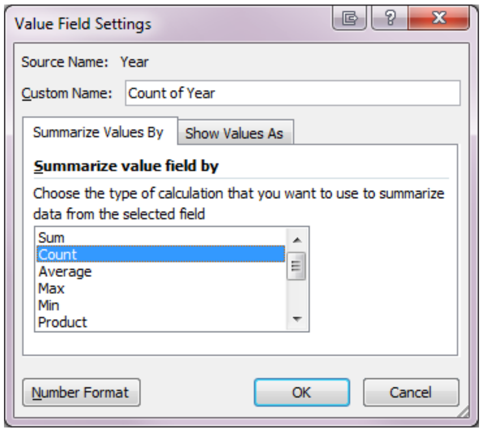
Row Labels: Tag | Values: Sum of Year

Defer Layout Update | Update

What we see is that the year during which an encounter has occurred for a given individual has been entered explicitly into the table, in the column corresponding to that year. But, for an encounter history, we want a '1' to indicate the encounter year, not the year itself, and a '0' to indicate a year when an encounter did not occur. Achieving the first objective is easy. Simply pull down the '**Sum of Year**' menu, and select '**Value Field Settings...**':



Then, switch the '**Summarize value field by**' selection from '**Sum**' to '**Count**':



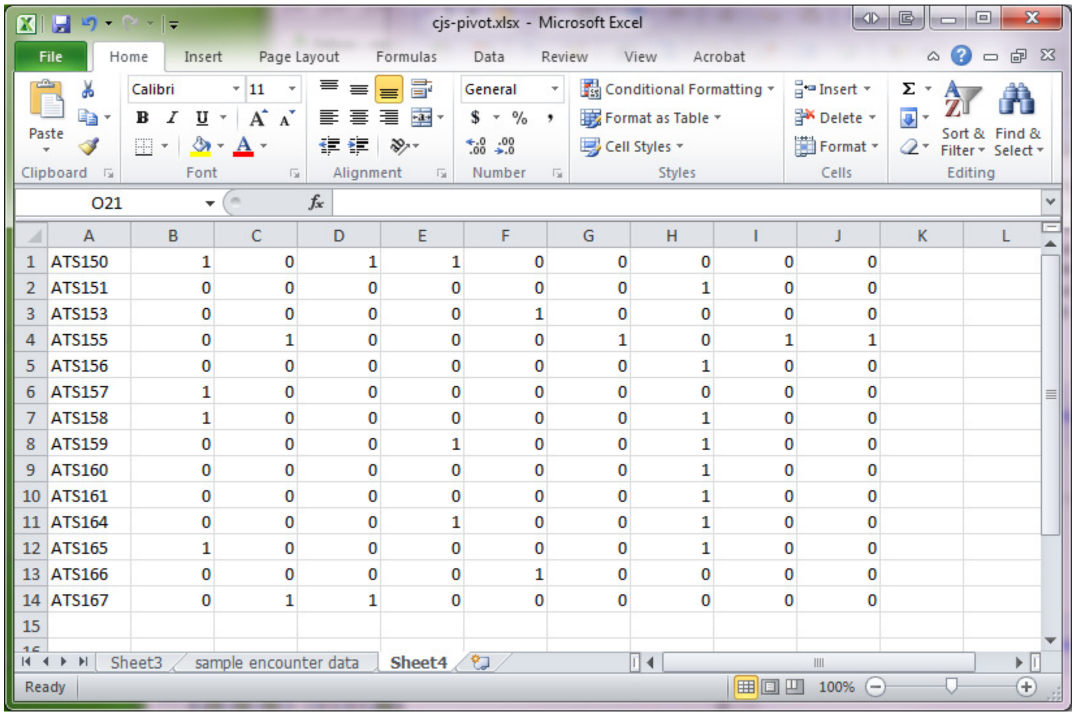
Source Name: Year
Custom Name: Count of Year

Summarize value field by
Choose the type of calculation that you want to use to summarize data from the selected field

As soon as you do this, then all of the years in the pivot table will be changed to 1. Why? Simple – all you've told the pivot table to do is count the number of times a year occurs in a given cell. Since the data file contains only a single record for each individual for each year it was encountered, then it makes sense that the tabulated '**Count**' should be a 1. Moreover, now the '**Grand Total**' rows and columns have some relevance – they indicate the number of individuals encountered in a given year (column totals), or the number of times a given individual was caught over the interval from 2000 to 2010 (row totals).

OK, on to the next step – putting a '0' in the blank cells for those years when an individual wasn't caught. This sounds easy enough in principle – a reasonable approach would be to select the rows and columns, and execute a 'search and replace', replacing blank cells with '0'. In fact, this is exactly what we want to do. However, for various reasons, you can't actually edit a pivot table. What you need to do first is select and copy the rows and columns (including the row labels, but excluding row and column totals), and paste them into a new worksheet. Then, simply do a '**Find & Select**'), replacing blanks (simply leave the '**Find what'** field empty) with a '0'.

The result is shown below:



	A	B	C	D	E	F	G	H	I	J	K	L
1	ATS150	1	0	1	1	0	0	0	0	0		
2	ATS151	0	0	0	0	0	0	1	0	0		
3	ATS153	0	0	0	0	1	0	0	0	0		
4	ATS155	0	1	0	0	0	1	0	1	1		
5	ATS156	0	0	0	0	0	0	1	0	0		
6	ATS157	1	0	0	0	0	0	0	0	0		
7	ATS158	1	0	0	0	0	0	1	0	0		
8	ATS159	0	0	0	1	0	0	1	0	0		
9	ATS160	0	0	0	0	0	0	1	0	0		
10	ATS161	0	0	0	0	0	0	1	0	0		
11	ATS164	0	0	0	1	0	0	1	0	0		
12	ATS165	1	0	0	0	0	0	1	0	0		
13	ATS166	0	0	0	0	1	0	0	0	0		
14	ATS167	0	1	1	0	0	0	0	0	0		
15												

(Alternatively, if you navigate to '**PivotTable | PivotTable Name | Options**', you will see an option to specify what an empty cell should show. Simply change it to a '0').

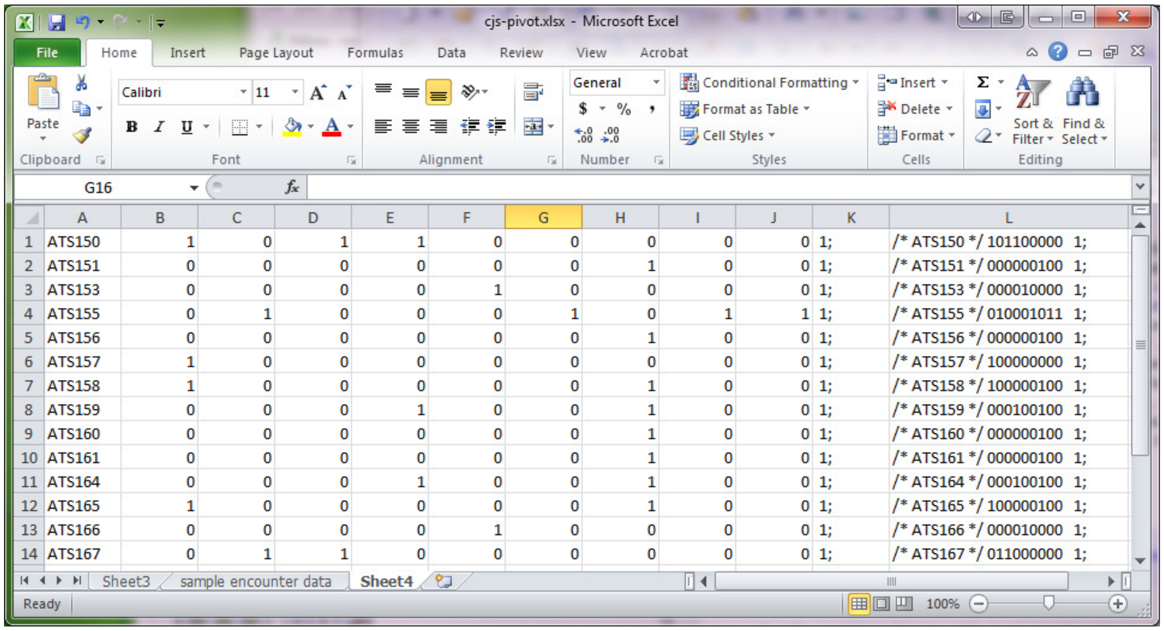
We're clearly getting closer. All that remains is to do the following. First, we remember that each line of the encounter history file must end with a frequency – where each line in the file corresponds to a single individual, then this frequency is simply '1;'. So, we simply enter '1;' into column **K**, and copy it down for as many rows as there are in the data (there are a number of ways to copy a value down a set of rows – we'll assume here you know of at least one way to do this).

Now, for a final step – we ultimately want an encounter history (INP file) where the encounters form a contiguous string (i.e., no spaces). We can achieve this relatively easily by using the **CONCATENATE** function in Excel. Simply click the top-most cell in the next empty column (column **L** in our example), and then go up into the function box, and enter

```
=CONCATENATE("/* ",A1," */ ",B1,C1,D1,E1,F1,G1,H1,I1,J1,"  ",K1)
```

In other words, we want to 'concatenate' (merge together without spaces), various elements – some from within the spreadsheet, others explicitly entered (e.g., the delimiters for comments, so we can include the tag information, and some spacer elements).

Once you execute this cell macro, you can copy it down in column **L** over all rows in the file. If you manage to do this correctly, you will end up with a spreadsheet looking like the one shown at the top of the next page. All that remains is to select column **L** (which contains the formatted, concatenated encounter histories), and paste them into an ASCII text file. (A reminder here that you should avoid – as in 'like the plague' – using Word or Notepad as your ASCII editor. Do yourself a favor and get yourself a real ASCII editor. As mentioned earlier, there are a number of very good 'free' applications you can – and should – use instead of Notepad (e.g., Notepad++, EditPad Lite, jEdit, and so on...).



	A	B	C	D	E	F	G	H	I	J	K	L
1	ATS150	1	0	1	1	0	0	0	0	0	1;	/* ATS150 */ 101100000 1;
2	ATS151	0	0	0	0	0	0	1	0	0	1;	/* ATS151 */ 000000100 1;
3	ATS153	0	0	0	0	1	0	0	0	0	1;	/* ATS153 */ 000010000 1;
4	ATS155	0	1	0	0	0	1	0	1	1	1;	/* ATS155 */ 010001011 1;
5	ATS156	0	0	0	0	0	0	1	0	0	1;	/* ATS156 */ 000000100 1;
6	ATS157	1	0	0	0	0	0	0	0	0	1;	/* ATS157 */ 100000000 1;
7	ATS158	1	0	0	0	0	0	1	0	0	1;	/* ATS158 */ 100000100 1;
8	ATS159	0	0	0	1	0	0	1	0	0	1;	/* ATS159 */ 000100100 1;
9	ATS160	0	0	0	0	0	0	1	0	0	1;	/* ATS160 */ 000000100 1;
10	ATS161	0	0	0	0	0	0	1	0	0	1;	/* ATS161 */ 000000100 1;
11	ATS164	0	0	0	1	0	0	1	0	0	1;	/* ATS164 */ 000100100 1;
12	ATS165	1	0	0	0	0	0	1	0	0	1;	/* ATS165 */ 100000100 1;
13	ATS166	0	0	0	0	1	0	0	0	0	1;	/* ATS166 */ 000010000 1;
14	ATS167	0	1	1	0	0	0	0	0	0	1;	/* ATS167 */ 011000000 1;

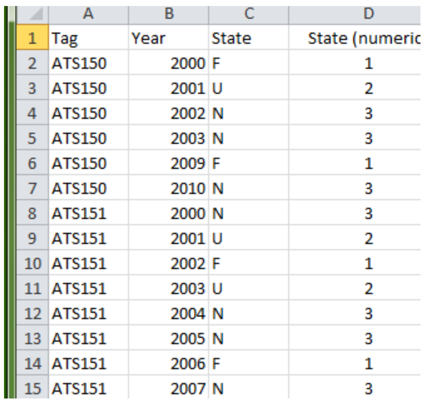
Other data types

Here we will consider 2 other data types, the robust design, and multi-state. Clearly, there are more data types in **MARK**, but these two represent very common data types, and if you understand steps in formatting `INP` files for these two data types, you'll more than likely be able to figure out other data types on your own.

multi-state

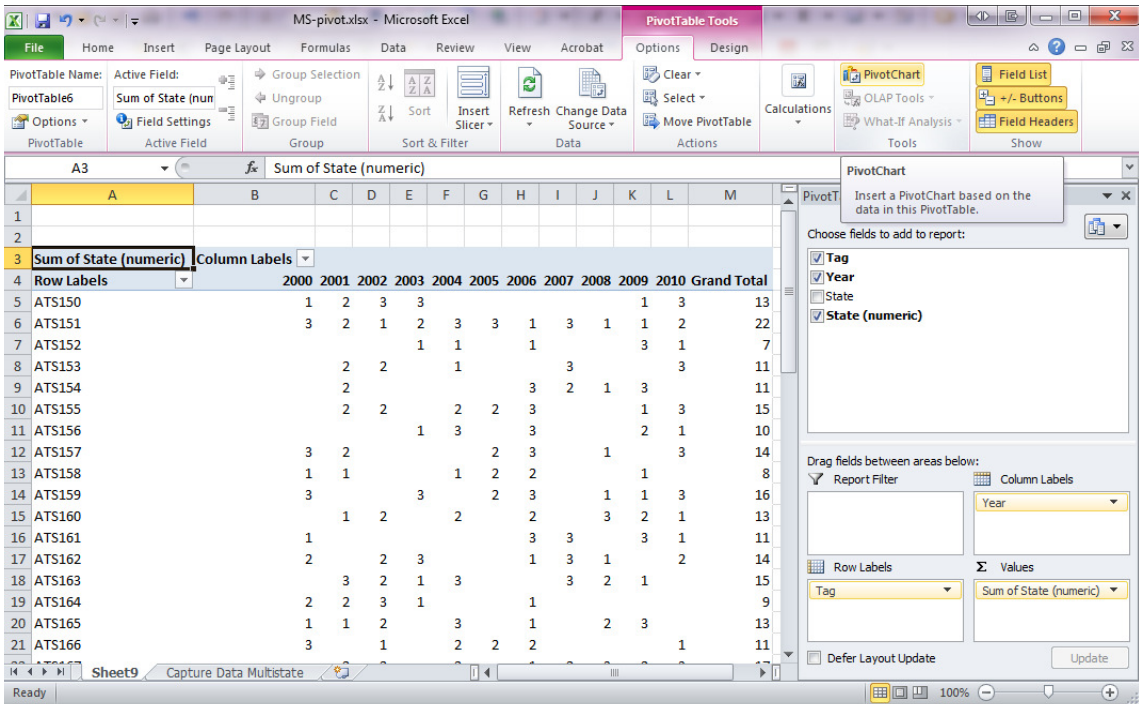
Here we will demonstrate formatting an `INP` file for a multi-state data set (see Chapter 10). The encounter data we will use are contained in the Excel spreadsheet `MS-pivot.xlsx`. The file consists of 3 columns: `TAG` (indicating the individual), `YEAR` (the year the individual was encountered), and the `STATE` (for this example, there are 3 possible states: `F`, `U`, `N`).

We start by noting that `STATE` is a character (i.e., a letter). This might seem perfectly reasonable, since the most appropriate state name (indicator) might be a character. Unfortunately, Excel can't handle characters in the table cells when you pivot the table. As such, you first need to (i) select the column containing the state variable, (ii) copy this into the first empty column, and (iii) execute a '**`Find and Replace`**' in this column, such that you change `F` $\longrightarrow$ `1`, `U` $\longrightarrow$ `2`, and `N` $\longrightarrow$ `3`. Once finished, your Excel spreadsheet shoot look something like what is shown to the right.



	A	B	C	D
1	Tag	Year	State	State (numeric
2	ATS150	2000	F	1
3	ATS150	2001	U	2
4	ATS150	2002	N	3
5	ATS150	2003	N	3
6	ATS150	2009	F	1
7	ATS150	2010	N	3
8	ATS151	2000	N	3
9	ATS151	2001	U	2
10	ATS151	2002	F	1
11	ATS151	2003	U	2
12	ATS151	2004	N	3
13	ATS151	2005	N	3
14	ATS151	2006	F	1
15	ATS151	2007	N	3

Next, select the data, and inset a Pivot Table into a new sheet in the spreadsheet. Drag `TAG` to the '**`Row Labels`**' box, `YEAR` to the '**`Column Labels`**' box, and `State (numeric)` to the '**`Values`**' box, as shown below.



A3 | Sum of State (numeric)

Sum of State (numeric) | Column Labels

Row Labels	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Grand Total
ATS150	1	2	3	3						1	3	13
ATS151	3	2	1	2	3	3	1	3	1	1	2	22
ATS152				1	1		1			3	1	7
ATS153		2	2		1			3			3	11
ATS154		2					3	2	1	3		11
ATS155		2	2		2	2	3			1	3	15
ATS156				1	3		3			2	1	10
ATS157	3	2				2	3		1		3	14
ATS158	1	1			1	2	2			1		8
ATS159	3			3		2	3		1	1	3	16
ATS160		1	2		2		2		3	2	1	13
ATS161	1						3	3		3	1	11
ATS162	2		2	3			1	3	1		2	14
ATS163		3	2	1	3			3	2	1		15
ATS164	2	2	3	1			1					9
ATS165	1	1	2		3		1		2	3		13
ATS166	3		1		2	2	2				1	11

Choose fields to add to report:
- [✓] Tag
- [✓] Year
- [ ] State
- [✓] State (numeric)

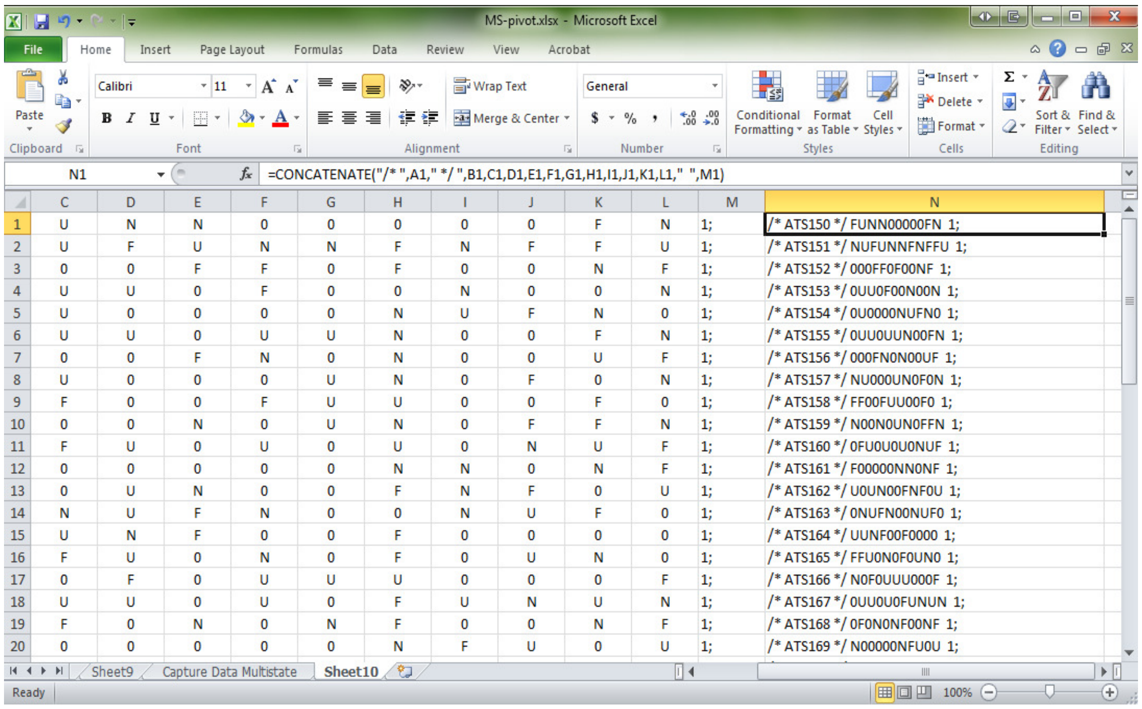
Column Labels: Year
Row Labels: Tag
Values: Sum of State (numeric)

Next, copy the `TAGS`, `YEARS` and table values to a new worksheet. Then '**`Find and Replace`**' all the blank cells with zeros. At this point, you have a decision to make: you can either (i) '**`Find and Replace`**' the states from numeric back to their original character values (i.e., 1 → `F`, 2 → `U` and 3 → `N`), or (ii) leave the states numeric, and simply inform **MARK** what the states mean. For this example, we'll '**`Find and Replace`**' the states from numeric back to their original character values. Finally, add a column of '`1;`' to the new worksheet.

Then click the top-most cell in the next empty column (column **L** in our example), and then go up into the function box, and enter

```
=CONCATENATE("/* ",A1," */ ",B1,C1,D1,E1,F1,G1,H1,I1,J1,K1,L1,"  ",M1)
```

In other words, we want to 'concatenate' (merge together without spaces), various elements – some from within the spreadsheet, others explicitly entered (e.g., the delimiters for comments, so we can include the tag information, and some spacer elements). Once you execute this cell macro, you can copy it down in column **L** over all rows in the file. The final worksheet should look something like the one shown at the top of the next page. At this point, you simply copy your concatenated encounter histories from column **N** into an editor, and save into an `INP` file.

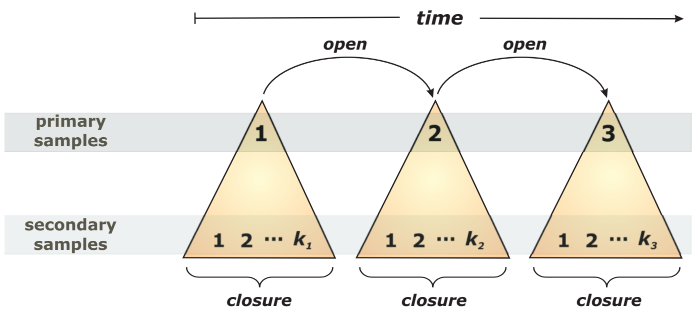


N1 =CONCATENATE("/* ",A1," */ ",B1,C1,D1,E1,F1,G1,H1,I1,J1,K1,L1," ",M1)

	C	D	E	F	G	H	I	J	K	L	M	N
1	U	N	N	0	0	0	0	0	F	N	1;	/* ATS150 */ FUNN00000FN 1;
2	U	F	U	N	N	F	N	F	F	U	1;	/* ATS151 */ NUFUNNFNFFU 1;
3	0	0	F	F	0	F	0	0	N	F	1;	/* ATS152 */ 000FF0F00NF 1;
4	U	U	0	F	0	0	N	0	0	N	1;	/* ATS153 */ 0UU0F00N00N 1;
5	U	0	0	0	0	N	U	F	N	0	1;	/* ATS154 */ 0U0000NUFN0 1;
6	U	U	0	U	U	N	0	0	F	N	1;	/* ATS155 */ 0UU0UUN00FN 1;
7	0	0	F	N	0	N	0	0	U	F	1;	/* ATS156 */ 000FN0N00UF 1;
8	U	0	0	0	U	N	0	F	0	N	1;	/* ATS157 */ NU000UN0F0N 1;
9	F	0	0	F	U	U	0	0	F	0	1;	/* ATS158 */ FF00FUU00F0 1;
10	0	0	N	0	U	N	0	F	F	N	1;	/* ATS159 */ N00N0UN0FFN 1;
11	F	U	0	U	0	U	0	N	U	F	1;	/* ATS160 */ 0FU0U0U0NUF 1;
12	0	0	0	0	0	N	N	0	N	F	1;	/* ATS161 */ F00000NN0NF 1;
13	0	U	N	0	0	F	N	F	0	U	1;	/* ATS162 */ U0UN00FNF0U 1;
14	N	U	F	N	0	0	N	U	F	0	1;	/* ATS163 */ 0NUFN00NUF0 1;
15	U	N	F	0	0	F	0	0	0	0	1;	/* ATS164 */ UUNF00F0000 1;
16	F	U	0	N	0	F	0	U	N	0	1;	/* ATS165 */ FFU0N0F0UN0 1;
17	0	F	0	U	U	U	0	0	0	F	1;	/* ATS166 */ N0F0UUU000F 1;
18	U	U	0	U	0	F	U	N	U	N	1;	/* ATS167 */ 0UU0U0FUNUN 1;
19	F	0	N	0	N	F	0	0	N	F	1;	/* ATS168 */ 0F0N0NF00NF 1;
20	0	0	0	0	0	N	F	U	0	U	1;	/* ATS169 */ N00000NFU0U 1;

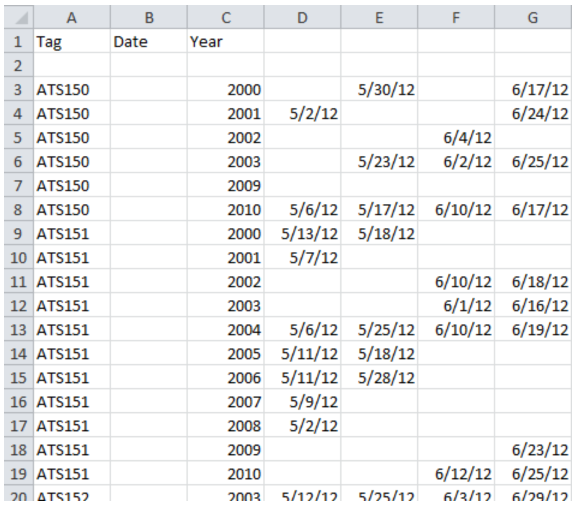
robust design

For our final example, we consider formatting an INP file for a robust design analysis (the robust design is covered in Chapter 15). In brief, the robust design combines closed population samples embedded (nested) within open population samples. Consider the following figure:



As shown, there are 3 'open population' samples (known as primary period samples). Between open samples, population abundance can change due to emigration, death, immigration or birth. Within each open sample period are embedded k 'closed population' (or secondary) samples. The trick here is to encode the encounter history taking into account the presence of both primary and secondary samples (where the number of secondary samples may vary among primary samples). As you might expect, the greater complexity of the RD encounter file might require a somewhat higher level of Excel proficiency than the first two examples we discussed earlier.

In this example (data contained in RD-pivot.xlsx), we assume primary samples from 2000-2010. Within each primary period, we have 4 secondary samples, which occur from May 1 to May 15 (secondary sample 1), May 16 to May 30 (secondary sample 2), June 1 to June 15 (secondary sample 3), and June 16 to June 30 (secondary sample 4). For each secondary sample, and encountered individual is recorded only once. We imagine that your data are stored in the following way. For each individual (TAG), for each primary sample (YEAR), you have a series of columns, one for each secondary sampling period.



	A	B	C	D	E	F	G
1	Tag	Date	Year				
2							
3	ATS150		2000		5/30/12		6/17/12
4	ATS150		2001	5/2/12			6/24/12
5	ATS150		2002			6/4/12	
6	ATS150		2003		5/23/12	6/2/12	6/25/12
7	ATS150		2009				
8	ATS150		2010	5/6/12	5/17/12	6/10/12	6/17/12
9	ATS151		2000	5/13/12	5/18/12		
10	ATS151		2001	5/7/12			
11	ATS151		2002			6/10/12	6/18/12
12	ATS151		2003			6/1/12	6/16/12
13	ATS151		2004	5/6/12	5/25/12	6/10/12	6/19/12
14	ATS151		2005	5/11/12	5/18/12		
15	ATS151		2006	5/11/12	5/28/12		
16	ATS151		2007	5/9/12			
17	ATS151		2008	5/2/12			
18	ATS151		2009				6/23/12
19	ATS151		2010			6/12/12	6/25/12
20	ATS152		2003	5/12/12	5/25/12	6/3/12	6/29/12

For example, in the preceding figure, we see that individual with tag 'ATS150' was observed during primary sample, 2000, 2001, 2002, 2003, 2009, and 2010. In 2000, the individual was not observed during the first secondary sample (May 1 to May 15), was observed during the second secondary sample (May 16 to May 30), was not observed during the third secondary sample (June 1 to June 15), and was observed during the fourth and final secondary sample (June 16 to June 30). In contrast, in 2010, the individual with tag 'ATS1150' was observed in all 4 secondary samples.

Now, you may be wondering why we've entered dates in terms of 2012, even for primary encounter years <2012. For example, for 'ATS150', we enter '5/30/12' as the date for the encounter during the second secondary sample period. We need to do this in order to make use of some very handy Excel functions. For example, consider the 'year' function. This function extracts the year associated with a given date (such that if you type in '=year(B2)' and B2 is a date, it will return the year associated with that date. So, for robust design data, you may have intervals (for a secondary sample period) spanning from 5/1/12 to 5/15/12, and you want to know if the encounter date falls between them.

All you need to do is

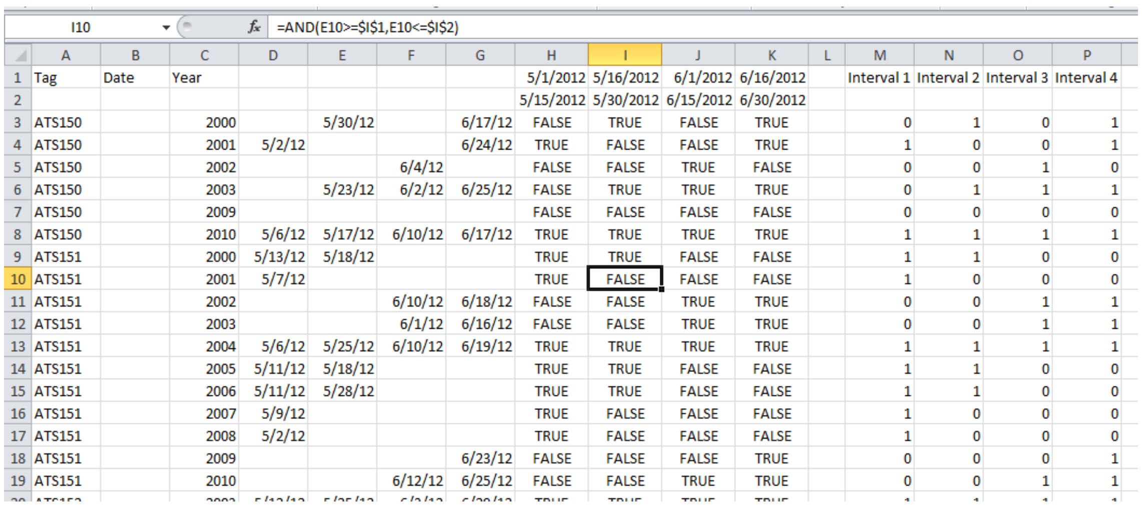
- use the AND function to determine if a date falls within a given range. For example, in cell H3 in the spreadsheet, we enter

```
=AND(D3>=H1,D#<=H2)
```

- What you are asking Excel is: "Is D3 (my date of capture) greater than or equal to my first date, 5/1/12, and less than or equal to 5/15/12". We do the same thing for each of the other 3 secondary sample periods.
- This may seem a bit odd at first but keep in mind that Excel treats all dates as a number of days since January 1, 1900 or 1904 (depending on which version of Excel you are using)
- The AND function will return a TRUE value is the criteria in the parenthesis are met or a FALSE value if they are not

- Once you have got all of your `TRUE` and `FALSE` values copy them into a separate set of columns. Note that instead of just '**`paste`**'or '**`ctrl+v`**', you want to right click and '**`paste special`**' and select the '**`Values`**' box. This tells Excel to just give you the displayed number text or whatever appears in the box without any of the underlying formulas.
- Now you can '**`Find and Replace`**' `TRUE` with `1` and `FALSE` with `0`

These steps (and cell macros) are shown in worksheet '`RD within season period trick`'. At this point, you will se something that look like


I10 =AND(E10>=$I$1,E10<=$I$2)

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Tag	Date	Year					5/1/2012	5/16/2012	6/1/2012	6/16/2012		Interval 1	Interval 2	Interval 3	Interval 4
2								5/15/2012	5/30/2012	6/15/2012	6/30/2012					
3	ATS150		2000		5/30/12		6/17/12	FALSE	TRUE	FALSE	TRUE		0	1	0	1
4	ATS150		2001	5/2/12			6/24/12	TRUE	FALSE	FALSE	TRUE		1	0	0	1
5	ATS150		2002			6/4/12		FALSE	FALSE	TRUE	FALSE		0	0	1	0
6	ATS150		2003		5/23/12	6/2/12	6/25/12	FALSE	TRUE	TRUE	TRUE		0	1	1	1
7	ATS150		2009					FALSE	FALSE	FALSE	FALSE		0	0	0	0
8	ATS150		2010	5/6/12	5/17/12	6/10/12	6/17/12	TRUE	TRUE	TRUE	TRUE		1	1	1	1
9	ATS151		2000	5/13/12	5/18/12			TRUE	TRUE	FALSE	FALSE		1	1	0	0
10	ATS151		2001	5/7/12				TRUE	FALSE	FALSE	FALSE		1	0	0	0
11	ATS151		2002			6/10/12	6/18/12	FALSE	FALSE	TRUE	TRUE		0	0	1	1
12	ATS151		2003			6/1/12	6/16/12	FALSE	FALSE	TRUE	TRUE		0	0	1	1
13	ATS151		2004	5/6/12	5/25/12	6/10/12	6/19/12	TRUE	TRUE	TRUE	TRUE		1	1	1	1
14	ATS151		2005	5/11/12	5/18/12			TRUE	TRUE	FALSE	FALSE		1	1	0	0
15	ATS151		2006	5/11/12	5/28/12			TRUE	TRUE	FALSE	FALSE		1	1	0	0
16	ATS151		2007	5/9/12				TRUE	FALSE	FALSE	FALSE		1	0	0	0
17	ATS151		2008	5/2/12				TRUE	FALSE	FALSE	FALSE		1	0	0	0
18	ATS151		2009				6/23/12	FALSE	FALSE	FALSE	TRUE		0	0	0	1
19	ATS151		2010			6/12/12	6/25/12	FALSE	FALSE	TRUE	TRUE		0	0	1	1

At this point, the remaining steps are similar to the same steps we used for CJS and MS data types (as described earlier). You simply

1. copy the the data to a new worksheet (shown in '`capture data-robust design`')
2. Select the data, then '**`Insert | Pivot Table | Pivot Table`**'
3. Drag `Tag` to '**`Row Label`**', `Year` to '**`Column Label`**'
4. Now here is another difference for the RD: there are multiple occasions per year. So just drag each one to the values box in the order that they occur!
5. concatenate into a contiguous encounter history, and you're done. Have a look at the worksheet '`RD Input Construction`' for what it should look like.