The Forestry Corp.

NEPTUNE

User Guide

Prepared for:

Foothills Model Forest

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1. Introduction

1.1 Overview

One of the broad research areas conducted by the Foothills Model Forest (FtMF) is called the 'Natural Disturbance Program'. The focus of research within this program area is to assess the impact of natural and cultural disturbances on the landscape with an eye towards helping to guide land management practices. To that end, the New Emulation Planning Tool for Understanding Natural Events (NEPTUNE) was developed as a way of assessing cultural disturbances (both existing and planned) compared to the historical disturbances for a given landscape.

Development of NEPTUNE began in the spring of 2005. Representatives for the initial project partners (West Fraser Timber - Hinton Wood Products and Alberta Newsprint Company) met with the lead researcher and The Forestry Corp. to discuss the requirements for the new tool. An analysis of the historical disturbance patterns had already been completed for the landscape under management by the forest company partners, however this had largely been a manual process. The new tool would provide an automated way to conduct a similar analysis for various disturbance 'scenarios' and compare the results against the historical results.

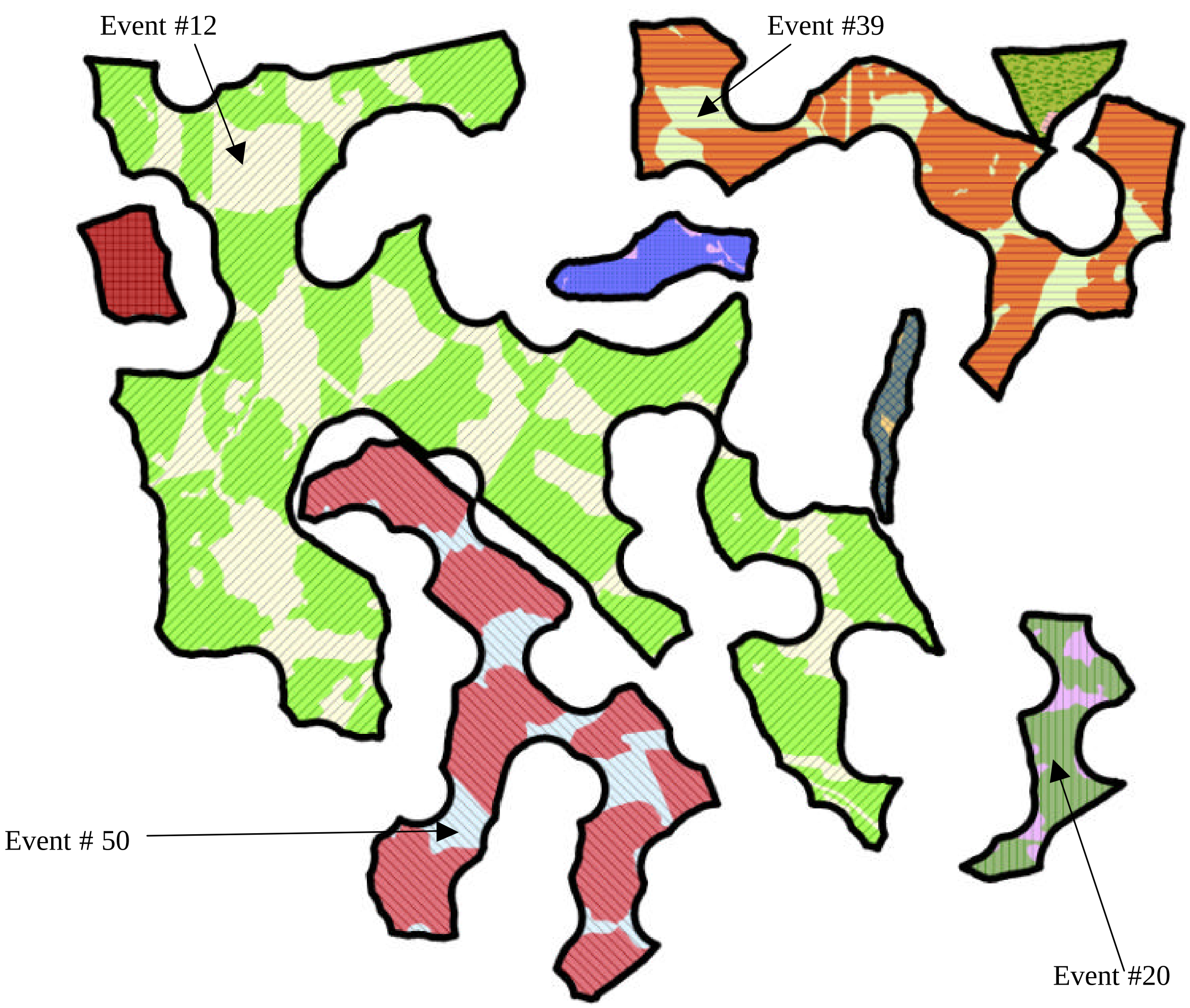
The first prototype of NEPTUNE was completed in the fall of 2005. Since then, numerous revisions have occurred to fix problems and to make the tool more efficient. A new project partner, Mistik Management, joined the project in the spring of 2006. Because Mistik operates in Saskatchewan while the previous partners operate in Alberta, some changes were required in the tools to track the jurisdiction and apply the appropriate historical data for the final analysis. Alberta Sustainable Resource Development became the fourth project partner in the summer of 2006.

NEPTUNE is still in the development stage. Testing and enhancement is ongoing based on feedback from the project partners and researchers.

1.2 Disturbances on Landscapes

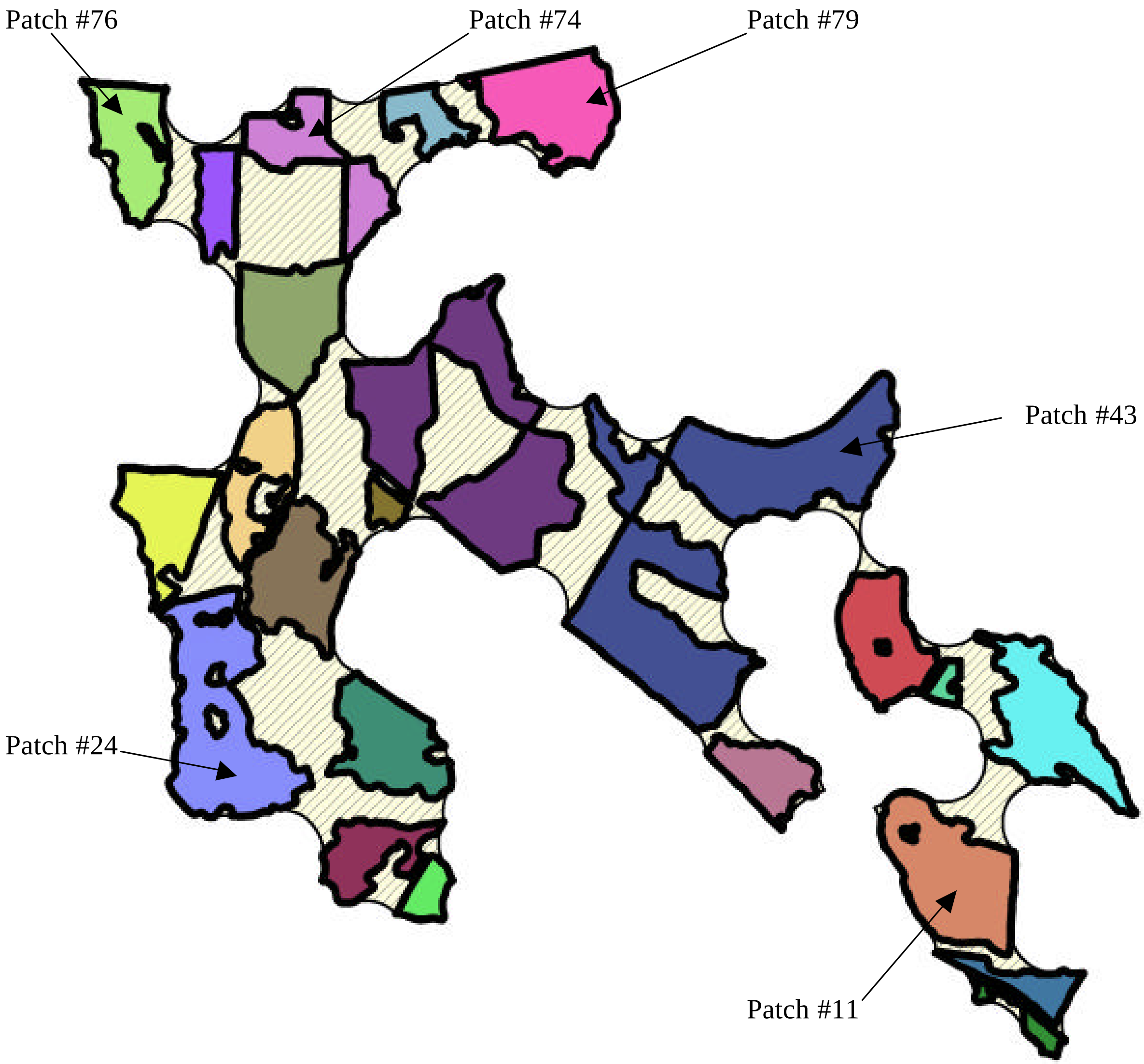
The FtMF natural disturbance research introduced the concept of 'disturbance events' as the most recognizable aspect of natural disturbance to humans. The research analysis is based on such events and their component patches. Therefore, NEPTUNE requires the ability to generate these same types of spatial features for anthropogenic disturbances.

A **disturbance event** is basically a grouping of disturbances that happened close enough together in both time and space to be considered a single occurrence. For example, several cutblocks whose boundaries are within a few hundred metres of each other and which happen over a period of two or three years could be treated as a single 'disturbance' on the landscape. However, in order to compare such anthropogenic disturbances to historical disturbances caused by fire, these 'disturbance events' need to not only encompass the disturbances themselves but also the undisturbed areas between them. The boundary for a given forest fire will encompass both burned and unburned areas. Similarly, a boundary must be drawn around the disturbed areas to encompass both the disturbance and the undisturbed areas between them. Each 'event' shape generated by these tools is given a unique event number by NEPTUNE. As with natural disturbances, these events can overlap each other in space.



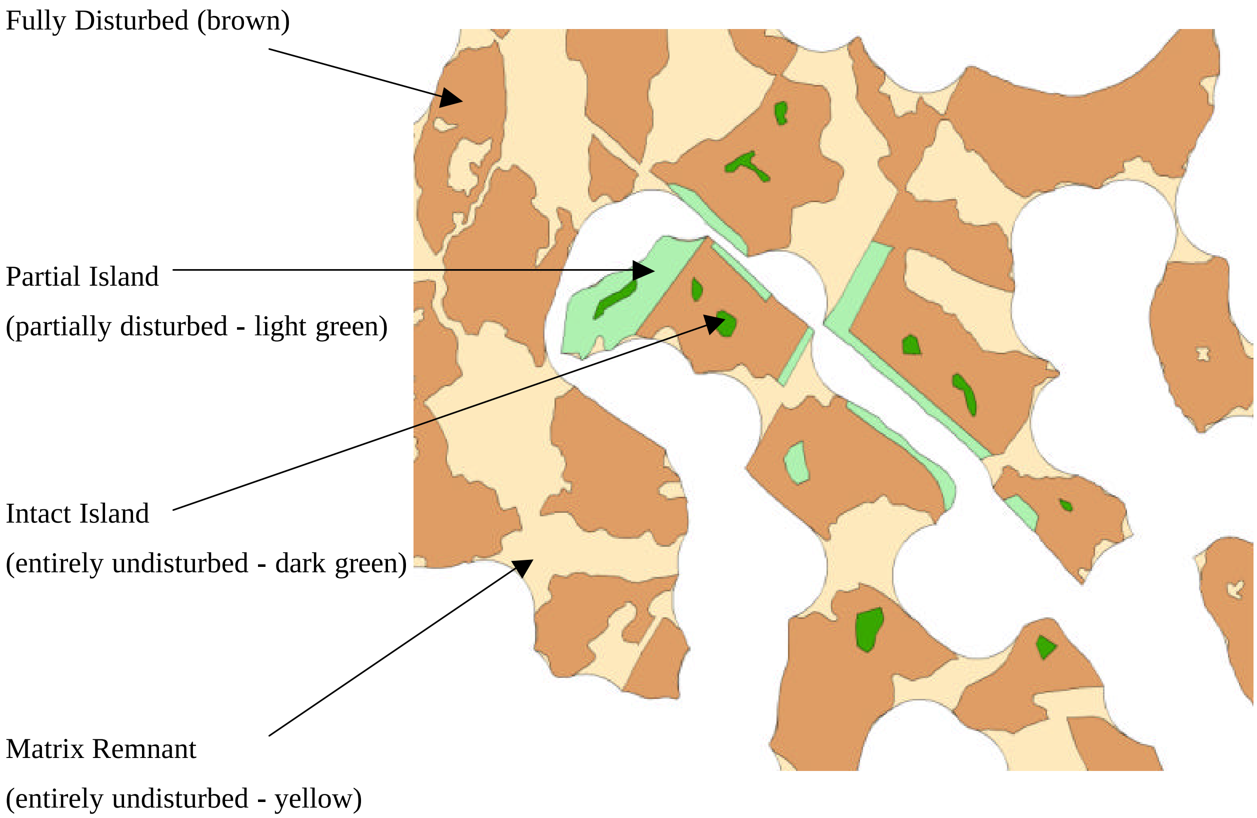
(coloured shapes within events are the harvest blocks used to generate the events)

Within a forest fire event boundary, the individual, contiguous disturbance polygons are called '**disturbed patches**'. A single disturbed patch may include areas which are completely disturbed, partially disturbed or entirely undisturbed. Similarly, once an event boundary has been drawn around a group of anthropogenic disturbances, the boundary may encompass multiple disturbed patches of which pieces may have various levels of disturbance. Disturbed patches are the building bocks of disturbance events. Each disturbed patch is uniquely numbered within a scenario run in NEPTUNE (i.e. the same patch number is not repeated within different disturbance events).



The example above is one event (event #12) - each color indicates a unique, spatially separate but contiguous 'disturbed patch' that may contain area of complete, partial or no disturbance.

Within a given 'disturbed patch' there could be various levels of disturbance from total to none. Within NEPTUNE, disturbance levels are currently categorized as either 'fully disturbed', 'partial island' or 'intact island' (see definitions in section 1.5). Undisturbed areas between patches are considered to be 'matrix remnants'. Matrix remnants are NOT found within a disturbed patch and are always connected spatially at some point to the area surrounding the event boundary.



A more detailed description of events and patches can be found in the FtMF natural disturbance research reports. See section 5 for references.

1.3 Tools

NEPTUNE includes two distinct types of processing. First, the spatial disturbance boundaries must be analyzed to generate the appropriate 'disturbance events' and 'disturbed patches'. This is a fairly complex analysis and requires the use of advanced GIS functionality. Therefore, a tool was created using ESRI's ArcGIS software to perform the spatial analysis.

Second, once the spatial analysis is complete the output attribute data (i.e. the attributes of the 'disturbance events' and 'disturbed patches' such as area and perimeter) must be analyzed to produce the required output graphs. This analysis includes the results of the NEPTUNE disturbance model data itself and a comparison to the historical data. Microsoft Excel was chosen as the best tool to perform this second stage of analysis given the current requirements.

The two tools, the ArcGIS spatial model and the Excel spreadsheet, were originally developed as separate tools that were run individually by the user. However, they have now been combined under a single 'tool' that is run from within the ArcMap module of ArcGIS.

In order to use NEPTUNE, an analysis of the historical disturbances for the landscape of interest must first be performed. Currently this is completed by Bandaloop Landscape-Ecosystem Services and has been completed for two landscape areas: the Alberta Foothills (Hinton area) and western Saskatchewan. Once complete, any number of disturbance 'scenarios' can be run against that same historical landscape analysis. Users select the appropriate 'jurisdiction' when running the tools to indicate which historical landscape to use.

For a user to run a disturbance 'scenario' they must first prepare the necessary spatial disturbance data, as documented in section 2.2. Once the data is ready, NEPTUNE is run within the ArcMap interface of ArcGIS. The user is provided with an interface to select the appropriate parameters for the scenario run. Running the model requires an ArcInfo level license of ArcGIS version 9.1, see section 2.5 for other known limitations related to the spatial processing. The output from the spatial model run is a single shape file containing the 'disturbance events' and 'disturbed patches', which is automatically added to the ArcMap Table of Contents.

Once the spatial analysis is complete, the user then selects the analysis button to perform the attribute analysis. This part of the tool includes a series of simple buttons that allow the user to select the input shape file data and generate the prescribed analysis graphs. A number of different graphs are created which assess the size of various types of features and the relationships between them. Graphs can be generated both for the disturbance scenario itself and as a comparison between the disturbance scenario and the historical values for that landscape. The output can be saved for future reference.

The output from both the spatial ArcGIS model and the Excel analysis together constitute the results of a given disturbance scenario from NEPTUNE. Refer to sections 2 and 3 for more details regarding these tools.

1.4 Acknowledgements

A number of people have provided input and feedback for the development of NEPTUNE. The initial research and tool concept was developed by Dave Andison of Bandaloop Landscape-Ecosystem Services. Please refer to section 5 for a list of the background research documents used in the tool development.

Input on use of the tool from a land management perspective was initially provided on behalf of the forest company partners by Rick Bonar of West Fraser Timber and Greg Branton of Alberta Newsprint Company. Roger Nesdoly later provided input from a Saskatchewan perspective on behalf of Mistik Management.

Christian Weik (then with FtMF) provided technical input regarding the software platform choice and integration of the project within the FtMF.

1.5 Glossary of Terms

Current range of variability/variation (CRV) – similar to the NRV but assessing the results of an existing or planned anthropogenic disturbance scenario.

Disturbance – any abrupt event that results in the destruction of damage of any part of the biota. Disturbances can occur at any scale.

Disturbance level – the relative amount of disturbance within a given polygon. For the purposes of these tools the disturbance level has been categorized as follows: matrix remnant, intact island, partial island or fully disturbed (see further descriptions within this glossary).

Disturbed patch – contiguous area affected by a single disturbance event. Disturbed patches combine to form disturbance events and may contain areas of complete, partial or no disturbance within a single patch.

Event (or disturbance event) – an area of land that is affected by the same disturbance. Events can be composed of multiple disturbance patches, as well as non-disturbed patches of forest and non-forest land. Disturbed patches are considered to be the same 'event' if they are close enough in both time and space. In rare cases where the disturbance patches are arranged in a particular fashion on the landscape, the resulting event will have multiple, spatially separate pieces do to the processing methodology. However, generally an event will be made up of a single shape.

Fully disturbed – an area of land that has been disturbed such that no patches or clumps of trees remain which are large enough to be considered 'islands'.

Intact island – a wholly undisturbed island remnant. Found entirely within a disturbed patch.

Island remnant – a patch or clump of tress that survived the last stand-replacing disturbance event in whole or part, located within a disturbed patch.

Matrix remnant – the undisturbed areas which separate disturbed patches within an event. Always connected at some point to the land outside of the disturbance event (i.e. not completely surrounded by disturbed patches).

Natural disturbance – disturbances that originate from natural, non-anthropogenic sources.

Natural range of variability / variation (NRV) – structural, compositional and functional variation of an ecosystem, at any spatial or temporal scale, predominantly (but not wholly) caused by natural disturbance regimes.

Partial island – a partially undisturbed island remnant. Found entirely within or along the edge of a disturbed patch.

Patch – a contiguous area of the same type (defined by age, composition, structure or other feature).

Sliver – a relatively small gap or polygon, either between polygons or along an edge, which was generated as a result of processing and which is not relevant to the analysis in question.

Timeslice – the time period used to combine individual disturbed patches into events. Patches which have disturbance dates within the same ‘timeslice’ and are spatially close together will be considered part of the same disturbance event. If the disturbance dates are not within the same timeslice then the disturbed patches will not be part of the same event, regardless of how close they are together in space.

2. Spatial Tool - ArcGIS

2.1 Overview

Spatial processes sometimes seem relatively intuitive to a user but are often quite complex from a programming perspective. Such was the case with the spatial model within NEPTUNE. The goal of the model was to duplicate the process that had been used to assess the historical disturbance patterns, but in an easily repeatable, automated fashion. Based on the complexity of the required analysis and the GIS software already in use by the project partners, it was decided very early on to use the ESRI suite of GIS tools as the spatial software platform. In particular, the new ‘ModelBuilder’ functionality in ArcMap version 9 would be used to program the analysis process into a sequential model that would be easy for the user to run and could be graphically displayed as an aid in understanding the process.

Some of the steps required in the model could not be performed using the tools provided in the standard ArcMap toolboxes. For example, splitting the input features into separate datasets based on their disturbance date required the use of a ‘data cursor’ which cannot be done with the standard ArcMap tools. Therefore, small programs, called ‘scripts’, were written to accomplish these tasks and such scripts are run from within the model at the appropriate time. These scripts were written using a language called ‘Python’.

Details of the model inputs, steps and outputs can be found in the following sections. A copy of the model diagram can be found in Appendix I; the model documentation is in Appendix II.

2.2 Required Inputs

Before running the spatial model, the user will be required to provide a number of inputs. These inputs are the actual and/or planned disturbances and the parameters to be used for the analysis. Some of the inputs have default values, some do not. Following is a detailed description of each required input.

2.2.1 Disturbance Features

The input disturbance features will be used to determine the disturbance events. There can be four different types of features: blocks, fires, roads or 'other', and there can be any number of input datasets of each type. Currently these different disturbance types are all processed the same within the model so features of different types (e.g. blocks and roads) will be combined to generate event boundaries. The input features can be provided in either shape file format or as geodatabase feature classes. Each shape file or feature class must contain the following fields:

- DIST_DATE - the year the disturbance did/will occur (4 digit integer field)
- DIST_LEVEL - the level of disturbance. Values must be one of the following (note these values are CASE sensitive and it must be a text/character type field):
  - fully disturbed
  - partial island
  - intact island

Fully disturbed shapes are those that will be clear cut, partial islands are patches that will be only partially harvested and intact islands are patches that will have no harvest activity. **Note that 'holes' within harvest shapes will NOT be interpreted as islands**, an island must have an explicit shape in order to be assessed within the model.

There is NO default value for the DIST_LEVEL, all shapes must have one of the values listed above or an error message will be presented to the user and the model will not run. If there are invalid or missing DIST_DATE values, the user will be given the option of either using the default date for those features (i.e. 9999) or stopping the model to edit the dates manually.

Extra fields on the input shape files will be ignored. Selected dataset names cannot contain spaces.

The input dataset(s) can be selected from the current ArcMap Table of Contents or from other data on the local/network drive(s). However, please note that in the current version of NEPTUNE, **even if a dataset from the Table of Contents currently has a selection applied to it, the full set of features from that dataset will still be processed in the model run**.

Due to a current limitation in ArcMap, each of the input disturbance types must have at least one input dataset. Since the user may not always want to run data of all tyupes, a 'dummy' shape file is included for each disturbance type. This shape file, called 'default.shp', is empty and will not affect the model output. It should not be removed and can be ignored by the user.

2.2.2 Start Year

The start year is combined with the event interval to determine which disturbance shapes will be considered part of the same 'event' based on their proximity in time. The event interval is applied both forward and backward in time, based on the start year.

For example, if 1999 is selected as the start year and 5 is selected as the event interval then the 'timeslices' used to help group shapes into events would be:

- 1989 - 1993
- 1994 - 1998
- 1999 - 2003
- 2004 - 2008
- etc.

The model will create as many 'timeslices' as necessary to accommodate all years (past and future) included in the input shape data.

The default value for the start year is 2000.

2.2.3 Event Interval

The start year is combined with the event interval to determine which disturbance shapes will be considered part of the same 'event' based on their proximity in time. The event interval is applied both forward and backward in time, based on the start year.

For example, if 2000 is selected as the start year and 10 is selected as the event interval then the 'timeslices' used to help group shapes into events would be:

- 1980 - 1989
- 1990 - 1999
- 2000 - 2009
- 2010 - 2019
- etc.

The model will create as many 'timeslices' as necessary to accommodate all years (past and future) included in the input shape data.

The default value for the event interval is 10.

2.2.4 Buffer Distance

The buffer distance determines how close shapes must be in space in order to be considered part of the same 'event'. Based on the value provided, a buffer is created around each shape. Where the buffers from different shapes overlap those shapes will be considered part of the same 'disturbance event' (provided they are also in the same 'timeslice').

For example, given a 250m buffer distance, if two input disturbance shapes are 450m apart and occur in the same timeslice then they will be part of the same disturbance event (each shape is buffered out by 250m so their buffers would overlap). If the two disturbance shapes are more than 500m apart then they will be part of two different disturbance events, regardless of the timeslice in which the disturbance occurs.

The default value for the buffer distance is 250m. This is the distance that was used for the *historical* fire analysis. PLEASE NOTE THAT CHANGING THE BUFFER DISTANCE MAY AFFECT THE VALIDITY OF COMPARING THESE MODEL RESULTS WITH THE NATURAL HISTORICAL PATTERNS!

2.2.5 Output Workspace

This is the location where the output shape file and documentation will be saved (see section 2.2.6). These output files will be time/date stamped as part of the file names so that the output from multiple model runs can be placed in the same output workspace.

All intermediate processing for the model takes place in a fixed workspace called L:\gis_proj\NEPTUNE\disturb_event_temp. The requirement for this is fully explained in Section 2.5.2

2.2.6 Output Shape File Name

This is the name that will be used for the model output in conjunction with the date/time stamp (based on a 24 hour clock). The default value is 'neptune.shp' but it can be changed by the user. If the '.shp' extension is left off the name it will be added when the final output is created. Spaces are not allowed in the output file name. Once a model run finished successfully there will be two types of output created as follows:

- a shape file of the disturbance events, named as per the selected output shape file name plus '_YYYYMmmdd_hhHmmM'
- a documentation file, named as per the selected output shape file name plus '_YYYYMmmdd_hhHmmM' with the file extension '.readme'. It is a plain text file that can be easily read in Notepad or Wordpad. This file contains a list of the input datasets, the date/time the run started and finished, and parameters that were used in the model run.

(where YYYY is the year, Mmm is the month, dd is the day, hh is the hour and mm is the minutes):

2.2.7 Jurisdiction

The jurisdiction identifies which historical data for natural disturbance should be used to compare with the output of this model run. The user must select the appropriate input, there is no default value provided. It is used in the graphing functionality but does not affect the spatial model in any way. Currently, the allowable options are:

- AB Foothills
- Western Saskatchewan

2.3 Model Steps

Following is a breakdown of the steps followed by the model in creating the disturbance events and disturbed patches based on the input spatial data. Note that not all processes are listed, in most cases the step described actually encompasses several distinct processes that together accomplish a specific task. See the preceding and following sections for details regarding the input and output datasets.

1. **Setup model run**
    - Check the input datasets to ensure they have the required attributes fields, if yes then continue, if not then warn the user and end the model run.
    - Make a copy of the input dataset(s), rename them to indicate the type of features they represent (blocks, fires, etc.) then delete any extra fields that are not required by the model (this simplifies the final output dataset for the user).
    - Save the selected input parameters to a documentation file for later import into the Excel tool.
2. **Combine disturbance types**
    - Populate the DIST_TYPE for the features in all input datasets.
    - Append the input datasets together into a single disturbance dataset.
    - Check the appended input for valid DIST_LEVEL values. If any invalid values are found, warn the user and end the model run.
    - Check the appended input for valid DIST_DATE values. If any invalid values are found, ask the user whether to continue the run using the default value (i.e. 9999) or end the model run.
3. **Determine the ‘timeslice’ for each input disturbance shape.**
    - Add a field for ‘TIMESLICE’ and populate the values based on the provided DIST_DATE value.
    - Determine the unique timeslice values.

4. **Create 'events'**

   - Split the shapes into individual coverages by timeslice.
   - Buffer out each timeslice coverage by the selected distance.
   - Fill in any 'holes' and calculate the event number.
   - Buffer each timeslice coverage back 'in' by the selected distance.
   - Convert the timeslice coverages back into shape files then append them all together into a single shape file.
   - Dissolve the shape file based on timeslice and event number, allowing multipart shapes.
   - Calculate the area (in hectares) and perimeter (in metres) for each event.

5. **Create general 'patches'**

   - Split the output from Step #3 (multi-piece timeslices) into spatially separate 'patches'.
   - Calculate a 'patch number' for each feature.

6. **Combine 'events' and 'patches'**

   - Combine the output from Step #4 and Step #5 together, by timeslice.
   - Delete/merge any 'slivers' that were not part of an original event or patch or that are under the minimum size criteria.
   - Combine adjacent features that have the same event and patch numbers.
   - Calculate the area (in hectares) and perimeter (in metres) for each patch within an event.

7. **Create general 'islands'**

   - Select all island features and dissolve them based on timeslice value (regardless of DIST_LEVEL – intact island or partial island).
   - Add and populate a field for the unique island number.
   - Calculate the area (in hectares) and perimeter (in metres) for each island.
   - Overlay these general islands back on the original disturbances to transfer the island number, area and perimeter to the base disturbance features.

8. **Combine 'event/patch' with disturbance levels**

   - Combine adjacent disturbance features that have the same timeslice, disturbance level and disturbance type.
   - Combine with 'event/patch', by timeslice.
   - Combine adjacent features that have the same event, patch, island, disturbance type and disturbance level values.
   - Calculate the area (in hectares) and perimeter (in metres) for these disturbance level polygons within each event/patch.
   - Identify the features that have no value for disturbance level and populate the disturbance level as 'matrix remnant'.
   - Delete all matrix remnant slivers (i.e. under 0.02 ha).
   - Merge all non-matrix remnant slivers (i.e. under 0.02 ha) with their neighbouring features.
   - Recalculate the area and perimeter values for each disturbance level polygon within an event/patch due to elimination of slivers.

9. **Model completion**

   - Copy the final output shape file and the model run documentation file to the selected output workspace.

Note that all intermediate datasets created during the model run are stored in a single, predefined workspace separate from the model output. See Section 2.5 for details.

2.4 Output

There are two types of output produced by the NEPTUNE spatial model. First, a single shape file containing the disturbance events, disturbed patches, disturbance types and disturbance levels within each patch as generated by the model. Second, a documentation file which lists the inputs selected for the model run. These outputs are named using the selected output file name and a date/time stamp when the run was completed and both are copied to the selected output workspace.

2.4.1 Disturbance Final Shape File

The model produces a single output shape file. By default the file is called neptune.shp but that can be changed by the user when the model is run. This shape file contains the polygons generated by the model for events, patches, disturbance types and disturbance levels. The .dbf portion of this shape file is used as input to the Excel graphing tool. The columns in this shape file are:

- TIMESLICE – the timeslice into which this polygon was categorized, based on the input start date, interval and disturbance date.

- EVENT – the disturbance event number. Events can have multiple, spatially separate pieces, although this is relatively uncommon as it only happens with disturbances that are arranged in a very specific way. Events can overlap each other if they occurred within different timeslices.

- EVENT_HA – the area of the disturbance event, in hectares.

- EVENT_PER – the perimeter of the disturbance event, in metres.

- PATCH – the disturbed patch number. Note that ‘matrix remnants’ did not exist in the input data and therefore do not have a disturbed patch number.

- PATCH_HA – the area of the disturbed patch, in hectares.

- PATCH_PER – the perimeter of the disturbed patch, in metres.

- DIST_LEVEL – the disturbance level for the polygon within a disturbance event or a disturbed patch (i.e. fully disturbed, partial island, intact island or matrix remnant).

- DIST_TYPE – the type of disturbance, either block, fire, road or other.

- ISLAND – the island number. This is determined after dissolving adjacent islands (regardless of disturbance level) that are in the same timeslice. There can be multiple pieces which make up a single dissolved island.

- ISLD_HA – the area of the island polygon, in hectares.

- ISLD_PER – the perimeter of the island polygon, in metres.

- SUBPAT_HA – the area of the disturbance level polygon, in hectares.

- SUBPAT_PER – the perimeter of the disturbance level polygon, in metres.

2.4.2 Documentation Text File

The documentation text file is a simple ASCII text file containing a list of the inputs that were selected by the user for the model run. The file name is the same as the shape file (see 2.4.1) but with an extension of ‘.readme’. The date/timestamp on the file name can be used to link this text file with the associated output shape file. Following is an example of a documentation file:

```
The following specifications were used for this
run of the disturbance event analysis tool:

Run start date/time = Wed, 30 Aug 2006 17:01:06
Output workspace = L:\Neptune_training_sept_2006\output
Selected output shape file name = blocks_200m_buffer.shp
Input datasets - blocks = L:\Neptune_training_sept_2006\training_datasets\blocks1.shp
Input datasets - fires  =
Input datasets - roads  =
Input datasets - other  =
Buffer distance = 200
Event interval = 10
Start year = 2000
Intermediate workspace = L:\gis_proj\NEPTUNE_Model\disturb_event_temp
Jurisdiction = AB Foothills
Run finish date/time = Wed, 30 Aug 2006 17:03:18
Final output shape file =
L:\Neptune_training_sept_2006\output\blocks_200m_buffer_2006Aug30_17H03M.shp
```

2.5 Known Limitations

2.5.1 Input Dataset Size

The model runs well with input datasets up to approximately 4500 shapes in size. However, testing has been sporadic on larger datasets of approximately 6000 shapes. These larger datasets will sometimes run perhaps 2/3 of the way through the model then will crash on one of the spatial processes. The resulting error (related to "topoengine") is likely a hardware limitation of either RAM, processor performance, swap space or disk I/O as the model will often run on a more powerful PC. If the user experiences these issues the options are to either run smaller input datasets or use a more powerful PC.

As well, problems have been encountered when running the model on smaller datasets but with very complex disturbance shapes, such as a convoluted boundary from a large forest fire. The errors in this case are slightly different (the model typically crashes during a buffering process) but the causes are likely similar to the large dataset issue. More testing could be conducted to try to isolate and rectify the problem however such testing is often very time consuming and expensive.

2.5.2 Hard Coded Working Directory

The ModelBuilder functionality in ArcMap has the ability to use a user input parameter for the working directory for all intermediate datasets. However, during development it was discovered that this functionality does not work properly when combined with the use of Python scripts inside a model. Therefore, the only way to have the intermediate datasets written to a single common directory and read from the appropriate location for subsequent processes was to hard code that directory location within the model. Since the model was first written to be tested on site at West Fraser, that working directory was hard coded to match the directory structure at that site.

The model requires a directory called: L:\gis_proj\NEPTUNE\disturb_event_temp in order to run. The 'L' drive can be mapped to a portion of the local drive if necessary using the drive map batch file included with the model files at installation. If the PC already has a drive mapped to the letter 'L' that drive will need to be disconnected. The alternative is to change the directory location in the model itself however this would require changes to most of the processes in the model (approximately 35 – 40 changes). These changes would have to be made again whenever the model code was upgraded. Hopefully this limitation will be removed in a future version of ArcMap.

2.5.3 Output Workspace Selection

One of the inputs that must be selected by the user for a model run is the location for the model run output. The tools will allow the user to create a new workspace if necessary. However, due to limitations in ArcMap, the model will not run if that output workspace did not exist prior to opening the NEPTUNE model tool. A red X will appear beside the output workspace selection, indicating that ArcMap thinks the workspace does not exist. Therefore, if a new output workspace is desired, it should be created prior to opening ArcMap and running the model.

2.5.4 Buffer Process Issues

Several significant problems were encountered with the ArcGIS buffering tools during the development of the Neptune spatial model. These are known bugs at ESRI but a timeline for a fix is not yet known. TFC developed 'work arounds' that deal with the problem in almost all instances however, on rare occasions the output buffers are still incorrect. Unfortunately, when such a problem occurs there is no error generated and the model appears to complete successfully. The only indication of a problem is an obviously incorrect event shape in the output shape file. Therefore, **it is critical that the user thoroughly review the output shape file to ensure that the results are correct**.

If there does appear to be a problem it is generally due to minute errors in the input shape itself. The easiest solution is to remove the offending input shape and rerun the model. In order to fix that shape for future runs it may be necessary to use advanced GIS tools to convert the shape to a coverage, clean the coverage, then convert back to the original data format.

3. Viewing Analytical Results

3.1 Overview

The charts produced as part of the analytical component of NEPTUNE are described in the natural disturbance program reports published by FtMF. These are detailed in Section 5. The specific metrics to be presented were selected by the participating Companies and the FtMF Project Manager. The chosen metrics are listed below:

Chart Title	Chart Reference	
	Publication	**Figure**
Estimated Disturbance Event Size Distribution	Report No. 4, March 2003	Figure 6
Event Shape Index by Event Area	Report No. 5, November 2003	Figure 6
Percent Area of Event as Matrix Remnants	Report No. 5, November 2003	Figure 11
Number of Disturbed Patches Relative to Event Area	Report No. 5, November 2003	Figure 12
Size of the Largest Disturbance Patch as a Percent of Net Disturbed Area	Report No. 5, November 2003	Figure 13
Patch Shape Index by Patch Area	Report No. 5, November 2003	Figure 16
Percent Area of Disturbed Patches in Island Remnants by Patch	Report No. 6, November 2004	Figure 6
Percent of Event Areas in Island Remnants	Report No. 6, November 2004	Figure 7
Sizes of Island Remnants by Numbers	Report No. 6, November 2003	Figure 15
Percent Area of Event as Residual Remnants (Matrix + Island)	Unpublished Reference	

For each of these 10 metrics, charts are produced representing:

- Current Range of Variation as calculated from the geoprocessing tools described in Section 2.
- A comparison of the CRV against the NRV for the chosen jurisdiction.

3.2 Required Inputs

There are three sources of inputs to run these analyses:

1. Parameters for the NRV comparisons. i.e.: the values to be charted which represent the natural range of variation by jurisdiction.
2. Data and program items required to ensure the analysis can be run.
3. User data to analyze.

3.2.1 Parameters for NRV Comparisons

The parameters for NRV values are contained within the Excel workbook on sheets that are hidden from the user. There are administrative capabilities to allow the Application Administrator to access these sheets to update values should they change over time. Each jurisdiction has it's own set of values, because the NRV for each jurisdiction will differ.

3.2.2 Data and Program Requirements

These data elements are necessary to ensure proper program control. For example, the required column names for the analysis to proceed are documented, along with what column they must appear in for the analysis to work properly. Also, the codes used to identify the type of disturbance (see section 2.2.1); and finally, the minimum threshold on the number of events where the system will produce charts comparing individual events to each other (see below "Minimum Threshold for Individual Event Analysis") for more detail on this.

These program control variables are also contained on a single common worksheet, hidden from the user. These variables and settings are common to the entire application; they are NOT specific to a jurisdiction.

3.2.2.1 Minimum Threshold for Individual Event Analysis

The Application Administrator can set a value at which a separate chart is produced which shows the individual event values. Typically, this might be set to a relatively small number (3, 5 or 7 events). If the total number of events in the CRV dataset is less than or equal to this threshold value, then a separate chart is produced for each of the 10 outputs described in Section 3.1 in addition to the summary graph produced by default. A maximum of 10 events is allowed.

3.2.3 User Data (CRV Data)

The inputs required to produce the analytical results are:

- the DBF file of the disturbance_final shape file produced by the geoprocessing steps,
- the corresponding documentation ASCII file associated with the disturbance_final shape file.

It is not required that all the files associated with the disturbance_final shape file be present. Only the DBF file is necessary.

The documentation ASCII file is required for the analysis because that file contains the name of the jurisdiction to which the results will be compared.

3.3 Output

All the processing and outputs are saved in Microsoft Excel workbooks. A variety of worksheets hold intermediate data, but the primary sheets of interest will contain the charts analyzing the NEPTUNE results. Table 1 provides information about how to interpret the contents of Table 2. Table 2 below documents the contents of the workbook after the results are analyzed.

Samples of all the outputs (both CRV and CRV/NRV) are provided in Appendix III.

Table 1: Metadata for NEPTUNE Workbook Description below

Worksheet name	The name of the worksheet tab in the work book.
Sheet type	**Chart** (contains a graph) **Data** (contains tabular data)
CRV/NRV	Contents of the chart • **CRV**: contains on the CRV data based on the input shape file • **CRV/NRV**: contains the CRV values and the historical NRV data for the proper jurisdiction
Description	For charts, this is the chart title, for data, this is a description of the data the sheet contains

Table 2 : Contents of NEPTUNE Workbook

Worksheet Name	Sheet Type	CRV/NRV	Chart Title
E-size	Chart	CRV	Estimated Disturbance Event Size Distribution
E-shape	Chart	CRV	Event Shape Index by Event Area
E-M-area	Chart	CRV	Percent Area of Event as Matrix Remnants
E-I-area	Chart	CRV	Percent of Event Areas in Island Remnants
E-M&I-area	Chart	CRV	Percent Area of Event as Residual Remnants (Matrix + Island)

Worksheet Name	**Sheet Type**	**CRV/NRV**	**Chart Title**
P-shape	Chart	CRV	Patch Shape Index by Patch Area
P-density	Chart	CRV	Number of Disturbed Patches Relative to Event Area
P-largest	Chart	CRV	Size of the Largest Disturbance Patch as a Percent of Net Disturbed Area
P-I-area	Chart	CRV	Percent Area of Disturbed Patches in Island Remnants by Patch
I-size	Chart	CRV	Sizes of Island Remnants by Numbers
E-size_Compare	Chart	CRV/NRV	Estimated Disturbance Event Size Distribution Comparison with Historical Disturbance Patterns
E-shape_Compare	Chart	CRV/NRV	Event Shape Index by Event Area Comparison with Historical Disturbance Patterns
E-M-area_Compare	Chart	CRV/NRV	Percent Area of Event as Matrix Remnants Comparison with Historical Disturbance Patterns
E-I-area_Compare	Chart	CRV/NRV	Percent of Event Areas in Island Remnants Comparison with Historical Disturbance Patterns
E-M&I-area_Compare	Chart	CRV/NRV	Percent Area of Event as Residual Remnants (Matrix + Island) Comparison with Historical Disturbance Patterns
P-shape_Compare	Chart	CRV/NRV	Patch Shape Index by Patch Area Comparison with Historical Disturbance Patterns
P-density_Compare	Chart	CRV/NRV	Number of Disturbed Patches Relative to Event Area Comparison with Historical Disturbance Patterns
P-largest_Compare	Chart	CRV/NRV	Size of the Largest Disturbance Patch as a Percent of Net Disturbed Area Comparison with Historical Disturbance Patterns
P-I-area_Compare	Chart	CRV/NRV	Percent Area of Disturbed Patches in Island Remnants by Patch Comparison with Historical Disturbance Patterns
I-size_Compare	Chart	CRV/NRV	Sizes of Island Remnants by Numbers Comparison with Historical Disturbance Patterns
PATCH_STAT	Data	N/A	Summary calculations by Patch
EVENT_STAT	Data	N/A	Summary calculations by Event
ISLAND_STAT	Data	N/A	Summary calculations by Island
RawData	Data	N/A	Shape file data reformatted; required attributes calculated
Parameters	Data	N/A	“Documentation” ASCII file as described in section 2.4.2

Worksheet Name	Sheet Type	CRV/NRV	Chart Title
ShpData	Data	N/A	Data as loaded from the source DBF file.

3.4 Known Limitations

The known limitations are generally a result of using Microsoft Excel as the tool for analysis and output. However, Excel provides the greatest flexibility in terms of viewing and summarizing tabular data and integrating tabular data with graphical summaries.

3.4.1 Number of patches that can be analyzed

Problem: Versions of Excel prior to Excel2003 have a limitation of 8000 rows in a Pivot table analysis. Therefore there cannot be greater than 8000 event/patch combinations.

Resolution: If possible, upgrade to Excel2003. The limitation on number of rows in a Pivot table is limited to available memory in your computer. If upgrading is not possible, you will need to split your data into small chunks for analysis. The NEPTUNE code checks for the version of Excel the user is running and if it has this limitation, then the user is warned. However, the user can proceed to analyze their data. Should the number of patches exceed 8000, the NEPTUNE code will notify the user that it cannot analyze the dataset.

3.4.2 Number of disturbance level records readable

Problem: The limitation of 65,000 rows of data in a single Excel worksheet still exists. Therefore your shape file cannot contain more than 65,000 rows or the dataset cannot be loaded into an Excel worksheet.

Resolution: There is no resolution until the analytical components are re-developed without reliance on Microsoft Excel.

3.4.3 Code Bug on “Administration”

Problem: When the Application Administrator attempts to access the “Administrator” worksheet in the application, they must choose the Jurisdiction of interest to allow the sheet to be viewable. The first time this dialog box is opened (each session), the application may not open the requested sheet and the dialog box remains open.

Resolution: click on the desired Jurisdiction again, then OK. The dialog box should close and the proper administration sheet should open. Repeat if necessary. This only happens the first time the Administration function is invoked in a session.

4. Usage and Current Status

4.1 Installation

Installation instructions are included on the CD with the NEPTUNE delivery. Please follow those instructions for installing NEPTUNE.

4.2 Using the Tools

Following are the steps to run NEPTUNE tools:

1. Open an ArcMap session (optionally use a saved ArcMap project .mxd file).

2. Look for the NEPTUNE toolbar. If it is visible but is greyed out then the current .mxd project will need to be saved in order to make the toolbar active (NEPTUNE can only be run from a saved .mxd file). To make the toolbar active simply select the button to save the project then select the desired project name and path location. If the NEPTUNE toolbar is not visible, pull down the Tools menu and select the 'Customize' option to open the ArcMap customization window. In the toolbars list find the one beginning with 'TheForestryCorp' and turn the check box on, then select 'Close'. The NEPTUNE toolbar should now be visible. If it is still not visible, or the required toolbox is not in the list of available toolbars, refer to section 4.1 on installing NEPTUNE.

3. Pull down the NEPTUNE toolbar and select 'Run'. This will open the NEPTUNE spatial model menu. Fill in the input fields as appropriate then select the 'OK' button to run the model. A detailed description of the required inputs can be found in section 2.2. Note that the model will not run until ALL of the fields have been populated.

4. When the model is running two new windows will be open: a black window in which the current commands and program messages will be echoed and the standard ArcMap window showing that

an ArcMap process is running. Once the model run is complete, the black window will disappear and the ‘Cancel’ button in the ArcMap process window will change to be a ‘Close’ button. Simply select the ‘Close’ button to close that window. The output shape file from the model run will have been added to the current table of contents in the main ArcMap window. If the model did not appear to finish successfully contact The Forestry Corp. for technical support.

5. The next step is to thoroughly review the spatial output of the model run. Even though the model appeared to run successfully, the results may not be what was desired. Use the standard ArcMap zoom and pan tools to review the output shapes for any obvious errors.

6. If the spatial output appears to be correct then pull down the NEPTUNE toolbar and select the ‘Analyze’ button. This will open the Microsoft Excel tool (note that macros will need to be enabled for this tool to function properly).

7. The Excel macros will present the user with a selection of possible actions as described below. The typical order to perform these tasks would be: Load Shapefile, Analyze then Compare.

Task	Description of Action
Load Shapefile	Load the shape file and documentation data from the DBF file into the workbook
Analyze	Produce the EVENT_STAT and PATCH_STAT summaries and all the CRV charts as documented in Table 2
Compare	Produce the EVENT_STAT and PATCH_STAT summaries and all the CRV/NRV charts as documented in Table 2
Save Results	Save all the results run so far to a new Work book. The user will be prompted if they wish to delete the working data from the CURRENT workbook.
Administration	Allows the Application Administrator to modify the NRV parameters (by Jurisdiction). The user must select the jurisdiction they wish access to. This function is password protected.
Delete Working	Deletes all the working sheets in the workbook (all the sheets named in Table 2. The hidden sheets will all NRV values and the program variables are not deleted.
Exit	Exits the application.

8. Users can open/exit/run and rerun data any number of times in the Excel tool. You many run part of the analysis, then come back and rerun the rest at another time. When the user elects to “Save Results”; all the application code is saved with the output so that the new work book can be used to rerun the existing data without reloading from the shape file.

   Charts can be printed directly to any user printer from the Excel workbook, or cut & paste from the Excel environment to any other digital document.

4.3 Current Status

NEPTUNE is still in development and testing and is not yet expected to be used in a production environment. The Forestry Corp. is working with the project partners to assess the accuracy and usefulness of the current tool as well as to identify opportunities for enhancement. Current partners and their contacts in the project include:

- Dave Andison – Bandaloop Landscape-Ecosystem Services
- Rick Bonar – West Fraser Timber, Hinton Wood Products
- Greg Branton – Alberta Newsprint Company
- Roger Nesdoly – Mistik Management
- Herman Stegehuis – Alberta Sustainable Resource Development
- Brian Maier / Carol Doering – The Forestry Corp.

4.4 Future Development

The area of natural disturbance modelling and assessment of current landscape metrics is still under development. To that end, there have been many ideas put forward for enhancing the current models and processes within NEPTUNE. We have split the discussion of future development into two components:

Biological and Model Related Components: These are areas of research or investigation that require biological domain expertise. These issues might involve re-assessment or re-interpretation of research results, or re-calculation of model parameters.

Technical Components: These are technical issues related to the underlying software(s) being utilized, the types of spatial data or the formatting or content of the data to be analyzed. Generally, no domain-centered research is applicable here; these are simply issues that should be resolved in order to physically improve the model performance, stability or availability.

4.4.1 Biological and Model Related Developments

4.4.1.1 Disturbance Assessment

Current, disturbed areas are all treated in the same manner regardless of their content. However in a real landscape, many disturbed areas are made up of various components: merchantable areas, non-merchantable and non-forest (all these assessments are from the viewpoint of forest management). Future versions of NETUNE might allow differentiation of the status of the vegetation inside the disturbed areas.

4.4.1.2 Calibration or Addition of New Fire Regimes

NEPTUNE currently allows comparison to one of two fire regimes: the Alberta Foothills or Western Saskatchewan. However, any stratification could be used that recognizes that a different 'disturbance regime' may apply, be it further calibration of existing regimes or the addition of new regimes. In Alberta, the Natural Subregion stratifications typically act as a proxy for this differentiation. However, the bulk of the Alberta data is from the Upper Foothills Subregion; enough observations from other regions have not been analyzed to provide this level of resolution. As noted, this calibration does not have to be done within the current schema of Natural Subregions – any schema would suffice, it just requires an adequate amount of data to provide the NRV results for comparison.

4.4.1.3 Assessment of Residual Lands

The assessment of residual lands (matrix and island) do not allow for any level of survival assessment. Any area of residual is assumed to contribute in its entirety to non-disturbed area. However, in the real landscape, some residual areas may have various levels of success (high, medium, low) with respect to survival and growth.

4.4.1.4 Expand List of Metrics

It is possible that the list of outputs will expand beyond the current 10 metrics. Metrics that relate to research output from other agencies (for example: FSC) may be of interest in order to use the tools to meet reporting requirements of other agencies.

4.4.2 Technical Developments

4.4.2.1 Compare Multiple Scenarios

Currently, the analytical tools assess one scenario and compare that scenario result to NRV. NEPTUNE could be further developed to allow a user to compare multiple scenarios such that the graphical output would show all chosen scenarios against each other as well as against the NRV. This would allow forest planners and managers to evaluate various options.

4.4.2.2 Create User-Designed Events

In the way that natural disturbances frequently include un-disturbed lands, forest planners may also want to consciously create events which contain undisturbed lands. One example may be to include (for example) some lowland area between two planned cutblocks and call the entire feature an 'event'. In the current model, the user would need to add the lowland area to the disturbance layer and tag it as "island matrix" for the model to assess this land correctly with respect to the NRV comparison.

4.4.2.3 Eliminate ROW

Frequently, the input datasets created by forest companies contain rights-of-way (ROW) representing narrow openings in the forest. Some of these ROW are so narrow that they have negligible impact in terms of 'disturbance'. It may be useful to have a methodology to allow the user to opt for elimination of these narrow openings such that they do not influence the creation of 'events'. These openings tend to be very long and narrow and cannot be easily dissolved due to the topological structure of the spatial data. However, this essentially is a spatial data format issue.

4.4.2.4 GeoDataBase Processing

The current *analytical* spatial data format within NEPTUNE is ESRI shape files. Under investigation is the ability to do all the processing inside a geodatabase (GDB). Using a GDB would result in faster processing, however there are a number of other technical issues that do not favour this option in the short term. Implementing an enterprise GDB would require additional coding to all for whatever 'flavour' of database was being used by the client (Oracle, SQL Server, DB2, etc). Any of these databases require a corporate instance which would provide the data necessary for the analysis. The most 'portable' (and free) option is the use of a Personal GDB (PGDB) which can be built in MS Access. The limiting factor here is that a MS Access database cannot exceed 2GB in size. The spatial data necessary for NEPTUNE analysis can easily exceed this 2GB limit if large landscapes are being analyzed.

4.4.2.5 Graphing and Analysis Tools

Microsoft Excel can only load datasets containing up to 65000 rows of information. Currently this is not a limitation since we are only analyzing lands within disturbance or residual area boundaries. However, if additional spatial overlays are incorporated (for example, with forest inventory, or natural subregion boundaries, etc), then the number of rows of data to import may start to exceed the capacity of Excel. Then, the analysis would likely need to move to a database environment, and would have to incorporate additional custom coding along with additional third-party charting tools.

4.4.2.6 Web Based Tools

As more partners express interest in the development and use of Neptune it becomes more difficult to manage the distribution and support of the tools. One potential solution is to convert the current tools to some kind of web based delivery solution. Depending on the methodology chosen this could mean simply running the existing application on a remote server (e.g. a Citrix server located at FtMF) or an almost complete re-write of the existing code to become a totally web based tool.

5. References

Andison, D.W. 2003. Disturbance Events on Foothills and Mountain Landscapes of Alberta – Part I. Alberta Foothills Disturbance Ecology Research Series, Report No. 4, March 2003. Foothills Model Forest, Hinton, Alberta.

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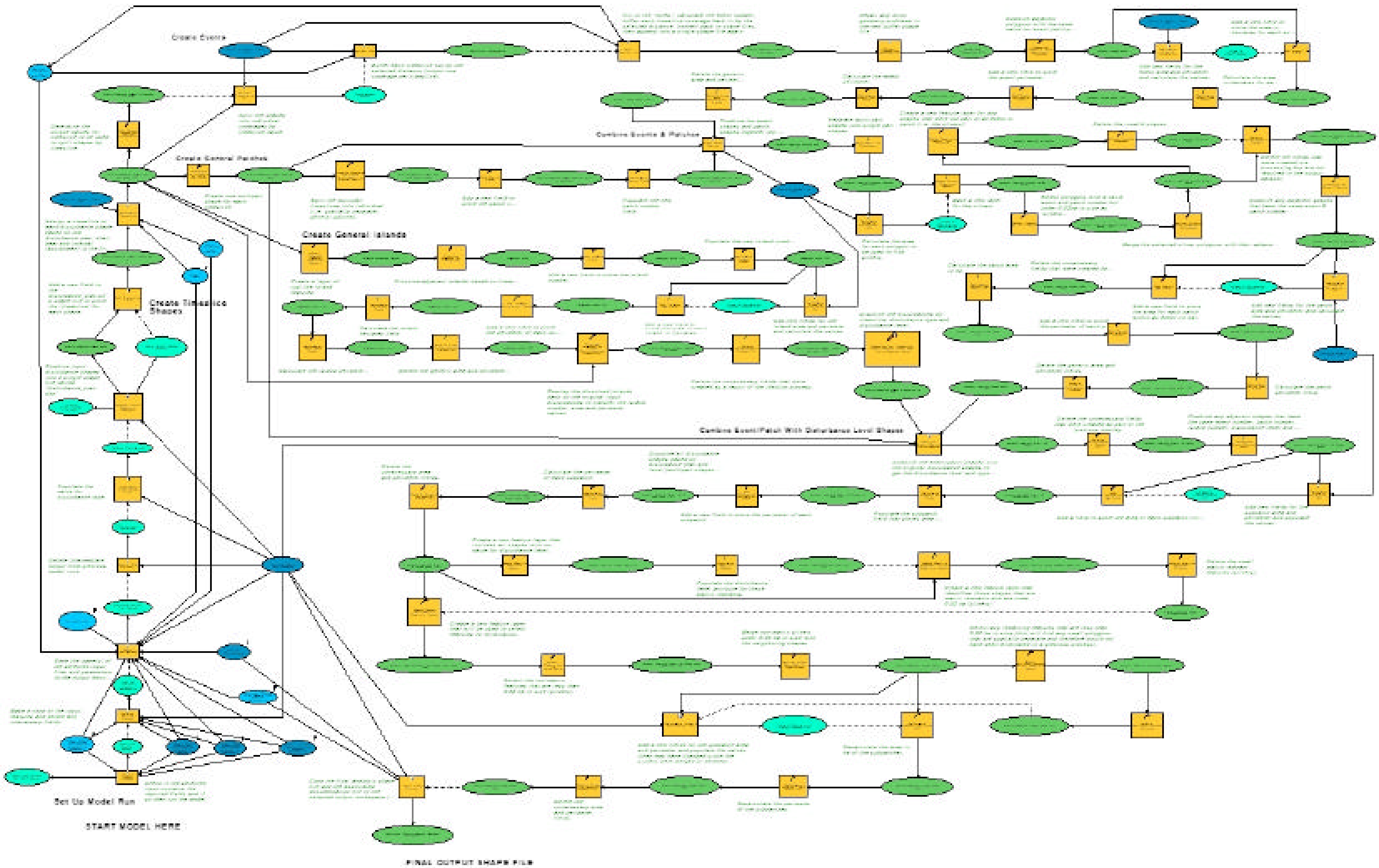
Andison, D.W. 2005. Determining Island Remnant Patterns and Meso-Scale Fire Patterns in Saskatchewan – Part I: Disturbance Event Patterns. September 2005. Bandaloop Landscape-Ecosystem Services, Vancouver, B.C.

Andison, D.W. 2006. Determining Island Remnant Patterns and Meso-Scale Fire Patterns in Saskatchewan – Part II: Island Remnant Event Patterns. January 2006. Bandaloop Landscape-Ecosystem Services, Vancouver, B.C.

Andison, D.W. 2006. Finding Common Ground: Some Definitions. Foothills Model Forest Integration Note, Natural Disturbance Program Integration Assistant 1, June 2006. Foothills Model Forest, Hinton, Alberta.

Appendix I NEPTUNE Disturbance Model – Diagram



Appendix II NEPTUNE Disturbance Model - Documentation

ArcToolbox

NEPTUNE Disturbance Model

This model, called NEPTUNE, was developed as part of a process to compare the natural range of variability (NRV) to the current range of variability (CRV) in a forest landscape. The model basically takes input disturbance shapes (harvest blocks, fires, roads, etc.) and produces an output shape file of disturbance 'events' based on several parameters. These disturbance 'events' can then be compared to the historical pattern of natural 'events' (i.e. fire) over the same landscape.

Disturbance 'events' are created from the input shapes based on their proximity to each other both in time and space. All shapes that are spatially close enough together and that happened within a short enough period of time will be considered a single 'event'. The user can select the parameters that determine the time and space limitations or can simply accept the default values.

The model was developed for West Fraser (Hinton Wood Products), ANC (Alberta Newsprint Company), Mistik Management and Alberta Sustainable Resource Development by The Forestry Corp. It is based upon research conducted by Dr. David Andison through the Foothills Model Forest (Natural Disturbance Program).

A separate Excel tool has been created to take the output from this model and compare it to the output from a similar analysis of the natural history data. The historical data used for the comparison depends upon the jurisdiction selected when the model is run.

☐Command Line Example:

NEPTUNE_Model <Input_Block_Features__no_spaces_allowed_in_names_;Input_Block_Features__no_spaces_allowed_in_names_...>
<Input_Fire_Features__no_spaces_allowed_in_names_;Input_Fire_Features__no_spaces_allowed_in_names_...>
<Input_Road_Features__no_spaces_allowed_in_names_;Input_Road_Features__no_spaces_allowed_in_names_...>
<Input_Other_Features__no_spaces_allowed_in_names_;Input_Other_Features__no_spaces_allowed_in_names_...> <Start_Year>
<Event_Interval__in_years_> <Buffer_Distance__in_metres_> <Output_Workspace>
<Output_Shape_File_Name__no_spaces_allowed_in_names_> <AB Foothills | Western Saskatchewan>

Parameters:

Expression	Explanation
<Input_Block_Features__no_spaces_allowed_in_names_;Input_Fire_Features__no_spaces_allowed_in_names_...>	The input feature datasets will be used to determine disturbance events. There are four types of input features allowed: blocks, fires, roads or other. Features within any type may be combined into single events if they are close enough together in both space

and time.

There can be any number of input datasets selected for each disturbance type, however each must contain the following fields:

- DIST_DATE - the year the disturbance did/will occur (a 4 digit year)
- DIST_LEVEL - the level of disturbance. Values must be one of the following (note these values are CASE sensitive):
    - fully disturbed
    - partial island
    - intact island

Fully disturbed features are those that will be completely cleared (e.g. clear cuts, roads, etc.), partial islands are patches that will be only partially cleared (e.g. selective harvest areas) and intact islands are patches that will have no harvest activity (e.g. watershed buffers wtihin a harvest block). Note that 'holes' within features will NOT be interpreted as islands, an island must be an explicit feature (i.e. a feature which can be selected spatially) in order to be assessed within the model.

There is NO default value for the DIST_LEVEL, all shapes must have one of the values listed above or an error message will be presented to the user and the model will not run. If there are invalid or missing DIST_DATE values, the user will be given the option of either using the default date for those features (i.e. 9999) or stopping the model to edit the dates manually.

Extra fields on the input shape files will be ignored.

The input dataset(s) can be selected from the current ArcMap Table of Contents or from other data on the local/network drive(s). However, please note that in the current version of NEPTUNE, even if a dataset from the Table of Contents currently has a selection applied to it, the full set of features from that dataset will still be processed in the model run.

Input datasets can be shape files or geodatabase feature classes. All inputs are converted to shape files for processing.

Due to a current limitation in ArcMap, each of the disturbance types must have at least one input dataset. Since the user may not always want to run data of all types, a 'dummy' shape file is included for each disturbance type. This shape file, called 'default.shp', is empty and will not affect the model output. It should not be removed and can be ignored by the user.

Selected input dataset names cannot include spaces.

<Start_Year>	The start year is combined with the event interval to determine which disturbance features will be considered part of the same 'event' based on their proximity in time. The event interval is applied both forward and backward in time, based on the start year. For example, if 1999 is selected as the start year and 5 is selected as the event interval then the 'timeslices' used to help group features into events would be: • 1989 - 1993 • 1994 - 1998 • 1999 - 2003 • 2004 - 2008 • etc. The model will create as many 'timeslices' as necessary to accommodate all years from the input features, both past and future dates. The default value for the start year is 2000.
<Event_Interval__in_years_>	The start year is combined with the event interval to determine which disturbance features will be considered part of the same 'event' based on their proximity in time. The event interval is applied both forward and backward in time, based on the start year. For example, if 2000 is selected as the start year and 10 is selected as the event interval then the 'timeslices' used to help group features into events would be: • 1980 - 1989 • 1990 - 1999 • 2000 - 2009 • 2010 - 2019 • etc. The model will create as many 'timeslices' as necessary to accomodate all years from the input features, both past and future dates. The default value for the event interval is 10.
<Buffer_Distance__in_metres_>	The buffer distance in metres. The buffer distance determines how close features must be in space in order to be considerd part of the

	same 'event'. Based on the value provided, a buffer is created around each feature and where the buffers from different features overlap those features wil be considered part of the same 'event' (as long as they are close enough together in time as well). For example, given a 250m buffer distance, if two input disturbance features are 450m apart and occur in the same year then they will be part of the same event (each shape is buffered out by 250m so their buffers would overlap). If those same two features occurred in different years then whether or not they were part of the same event would depend on the selected start year and interval. If the two distubance features are more than 500m apart then they will be part of two different event, regardless of the year in which the disturbance occurs. The default value for the buffer distance is 250m. This is the distance that was used for the historical fire analysis. PLEASE NOTE THAT CHANGING THE BUFFER DISTANCE MAY AFFECT THE VALIDITY OF COMPARING THESE MODEL RESULTS WITH THE NATURAL HISTORICAL PATTERNS!
<Output_Workspace>	This is the location where the output shape file and documentation will be saved. These output files will be time/date stamped as part of the file names so that the output from multiple model runs with the same output name can be placed in the same output workspace. Once a model run finished successfully there will be two types of output created as follows (where YYYY is the year, Mmm is the month, dd is the day, hh is the hour and mm is the minutes): • a shape file of the disturbance events, named as per the selected output shape file name plus '_YYYYMmmdd_hhHmmM' • a documentation file, named as per the selected output shape file name plus '_YYYYMmmdd_hhHmmM' with the file extension '.readme'. It is a plain text file that can be easily read in Notepad or Wordpad. This file contains a list of the input datasets and parameters that were used in the model run. All intermediate processing for the model takes place in a fixed workspace called L:\gis_proj\NEPTUNE_Model\disturb_event_temp. That directory MUST exist in order for the model to run properly.
<Output_Shape_File_Name__no_spaces_allowed_in_names_>	This is the name that will be given to the final shape file which is output from the NEPTUNE model. The shape file will be created in the selected output workspace. A date and time stamp will be added to the name automatically so that the same name can be given to subsequent model runs in the same output workspace. For example, if the user selects an output shape file name of 'fma_5yr_1990' then the output shape file may be named something like 'fma_5yr_1990_2006Jun14_14H35M'.The format for the date/time stamp on the file name will always be YYYYMmmdd_hhHmmM, where YYYY is the year, Mmm is the

	month name, dd is the day, hh is the hour (24 hour clock) and mm is the minutes. The default name for the output shape file is 'disturbance_final.shp' and can either be kept as is or replaced with a name of the user's choosing. If the '.shp' extension is left off the name it will be added when the final output is created. The selected output file name cannot include spaces.
<AB Foothills | Western Saskatchewan>	The jurisdiction identifies which historical data for natural disturbance should be used to compare with the output of this model run. The user must select the appropriate input, there is no default value provided. Currently, the allowable options are: • AB Foothills • Western Saskatchewan

☐Model

Name	Explanation
Check Input Fields	This python script checks the selected input shape files to see if they have the required fields (i.e. DIST_DATE and DIST_LEVEL). It cursors through each selected input shape file one at a time. If the required fields do exist then the output parameter is set to 'true' and the model will continue. If not, then the output is set to 'false' and the model will stop. The script does NOT check if the values in the required fields are populated or valid. check_input_fields.py
Delete Extra Fields	This python script copies the selected input shape file(s) to the intermediate workspace then deletes any unnecessary fields from those copies (i.e. everything except the FID, SHAPE, DIST_DATE and DIST_LEVEL) fields. delete_extra_fields.py
Save Variables	This python script creates a documentation file in the intermediate directory, called 'ReadMe.txt'. The file contains a list of the selected inputs/parameters and the time the model run started. The documentation file is copied to the final output workspace, with the name time/date stamped, during a later process. save_variables.py

Delete Old Output	This python script deletes existing intermediate files (i.e. shape files, text files) from previous model runs. delete_old_output.py
Populate DIST_TYPE Field	This python script populates the value for the DIST_TYPE field before the input datasets are appended together. The disturbance type value (block, fire, road or other) depends on which input parameter the dataset was included in. populate_dist_type.py
Append Input Feature Classes	This python script appends the copies of the input datasets into a single shape file for further processing. append_inputs.py
Add TIMESLICE Field	This tool adds a new field, called 'TIMESLICE', to the disturbance_plan.shp shape file. This field will be used to store the time period assigned to each shape based on the disturbance year of the shape, the start year parameter and the event interval parameter. Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate Timeslice	This python script calculates and populates the TIMESLICE field for each shape. The value of the field is based on the disturbance year for the shape, the start year input parameter and the event interval input parameter. calc_timeslice.py
Find Unique Timeslice Values (Frequency)	This tool determines the unique values for the timeslice field, to be used in a subsequent process for splitting the shapes into different datasets by timeslice. Uses the standard Frequency tool from the Analysis Tools toolbox, Statistics toolset.
Buffer Preparation	This script splits the input dataset into a separate shape file for each timeslice value. It then converts the shape files to coverages for the subsequent buffer processing. buffer_prep.py
Buffer Out	This script takes the individual timeslice coverages and buffers out each one by the selected buffer distance. The output is one coverage per timeslice. buffer_out.py
Split Buffer In	This script takes the buffered out timeslice coverages, fills the 'holes', calculates the event number, buffers back in by the negative of the selected buffer distance, converts the coverages back to shape files then appends all of the shape files together. split_buffer_in.py

Repair Timeslice Geometry	This script runs a command to repair any minor geometry errors that were created as a result of the buffer processing. repair_timeslice_geometry.py
Dissolve Events into Multipart Shapes	This tool dissolves the events based on timeslice and event number. Multipart shapes are allowed so one event could have multiple, disconnected pieces. Uses the standard Dissolve tool from the Data Management Tools toolbox, Generalization toolset.
Calculate Area & Permieter	This script adds fields for the area and perimeter and calculates the values. calc_ha_perim.py
Add Event Ha Field	This tool adds a new field, called EVENT_HA, to the the disturbance_event.shp shape file. This new field will store the area of the event (in hectares). Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate Event_ha Field	This tool populates the EVENT_HA field using the formula: [AREA]/10000. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Add Event Perimeter Field	This tool adds a new field, called EVENT_PER, to the disturbance_event.shp shape file. This new field will store the perimeter of the event (in metres). Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate Event_Per Field	This tool populates the EVENT_PER field as a direct copy from the standard PERIM field.The original PERIM field cannot be kept because it would not be uniquely named once the perimeter field for patches is added. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Delete Area and Perimeter Fields	This tool removes the original AREA and PERIM fields because they have been replaced by the event specific field names. Output shape file is the same as the input: 'disturbance_event.shp'. Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Dissolve Disturbances Into Patches	This tool dissolves the original disturbance shapes into one multipart shape per timeslice. The output shape file is called 'disturbance_plan_patch.shp'. Uses the standard Dissolve tool from the Data Management Tools toolbox, Generalization toolset.

Create General Patches (multipart to single part)	This tool splits the multipart shapes for each timeslice into spatially separate shapes (general patches). Uses the standard Multipart to Singlepart tool from the Data Management Tools toolbox, Features toolset.
Add Patch Field	This tool adds a new field, called PATCH, to the disturbance_plan_patch_multi.shp shape file which will be used to store the unique patch number. Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate Patch Field	This tool populates the patch number field with a unique value. The value is calculated by adding 1 to the system feature ID value (FID), since the FID values start at 0. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Union Event Patch	This python script first separates the events shape file into a new shape file for each timeslice. It then does the same for the patch shape file. The event and patch shape file for each timeslice are then combined using the 'union' command. Once all of the timeslices have been completed the output shape files are again combined into a single shape file. union_event_patch.py
Make Feature Layer for Slivers	This tool creates a new logical feature layer that includes any shapes where the event number is 0. These will be sliver shapes that were created as part of the earlier processing and can be deleted. The output feature class is called 'event_patch_slivers'. Uses the standard Make Feature Layer tool from the Data Management Tools toolbox, Layers and Table Views toolset.
Delete Unnecessary Fields	This tool deletes the unnecessary fields that were created by the previous process of combining the event and patch shapes together. The fields that are deleted are: FID_distur, TIMESLIC_1 and FID_dist_1. The output shape file is the same as the input: event_patch_union.shp Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Delete Slivers	This tool uses the feature layer for slivers to delete those shapes that are not part of any particular event. Uses the standard Delete Features tool from the Data Management Tools toolbox, Features toolset.
Dissolve on Event/Patch	This tool merges any adjacent shapes that have the same value for timeslice, event number, patch number, event area and event perimeter. The output shape file is called 'event_patch_diss.shp'. Uses the standard Dissolve tool from the Data Management Tools toolbox, Generalization toolset.

Calculate Area & Permieter (2)	This script adds fields for the area and perimeter and calculates the values. calc_ha_perim.py
Add Patch Ha Field	This tool adds a new field, called PATCH_HA, that will be used to store the area for each patch within an event (in hectares). The output shape file is the same as the input: 'event_patch_diss.shp'. Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate Patch_ha Field (2)	This tool populates the PATCH_HA field using the formula [AREA]/10000. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Add Patch Perimeter Field	This tool adds a new field, PATCH_PER, to the event_patch_diss.shp shape file. This new field will store the perimeter of the patch (in metres). Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate Patch_per Field	This tool populates the PATCH_PER field as a direct copy from the standard PERIM field. The original PERIM field will not be kept because the name is not distinct. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Delete Area & Perimeter Fields	This tool removes the original AREA and PERIM fields because they have been replaced by the patch specific field names. Output shape file is the same as the input, 'event_patch_diss.shp'. Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Select Islands (Make Feature Layer)	This tool creates a virtual feature layer of all features having a DIST_LEVEL value of 'intact island' or 'partial island'. Uses the standard Make Feature Layer tool from the Data Management Tools toolbox, Layers and Table Views toolset.
Dissolve Islands by Timeslice	This tool dissolves adjacent islands based on their timeslice value and regardless of their DIST_LEVEL (i.e. partial islands and intact islands will be dissolved together if they are adjacent and in the same timeslice). Uses the standard Dissolve tool from the Data Management Tools toolbox, Generalization toolset.
Add Island Field	This tool adds a new field, called ISLAND, to the islands.shp shape file which will be used to store the unique island number. Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.

Calculate Island Field	This tool populates the island number field with a unique value. The value is calculated by adding 1 to the system feature ID value (FID), since the FID values start at 0. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate Area & Permieter (5)	This script adds fields for the area and perimeter and calculates the values. calc_ha_perim.py
Add Island Ha Field	This tool adds a new field, called ISLD_HA, that will be used to store the area for each dissolved island (in hectares). The output shape file is the same as the input: 'islands.shp'. Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Add Island Perimeter Field	This tool adds a new field, ISLD_PER, to the islands.shp shape file. This new field will store the perimeter of the island (in metres). Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate ISLD_HA Field	This tool populates the ISLD_HA field using the formula [AREA]/10000. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate ISLD_PER Field	This tool populates the ISLD_PER field as a direct copy from the standard PERIM field. The original PERIM field will not be kept because the name is not distinct. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Delete Area & Perimeter Fields (4)	This tool removes the original AREA and PERIM fields because they have been replaced by the island specific field names. Output shape file is the same as the input, 'islands.shp'. Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Overlay Islands on Input Disturbances (Identity)	This tool overlays the dissolved islands on the original disturbance dataset to get the island number, area and perimeter for future processing. Uses the standard Identity tool from the Analysis Tools toolbox, Overlay toolset.
Delete Unnecessary Fields (1)	This tool deletes the unnecessary fields that were created by the previous process of combining the island and original disturbance shapes together. The fields that are deleted are: FID_distur and FID_island. The output shape file is the same as the input: disturbance_plan_islands.shp

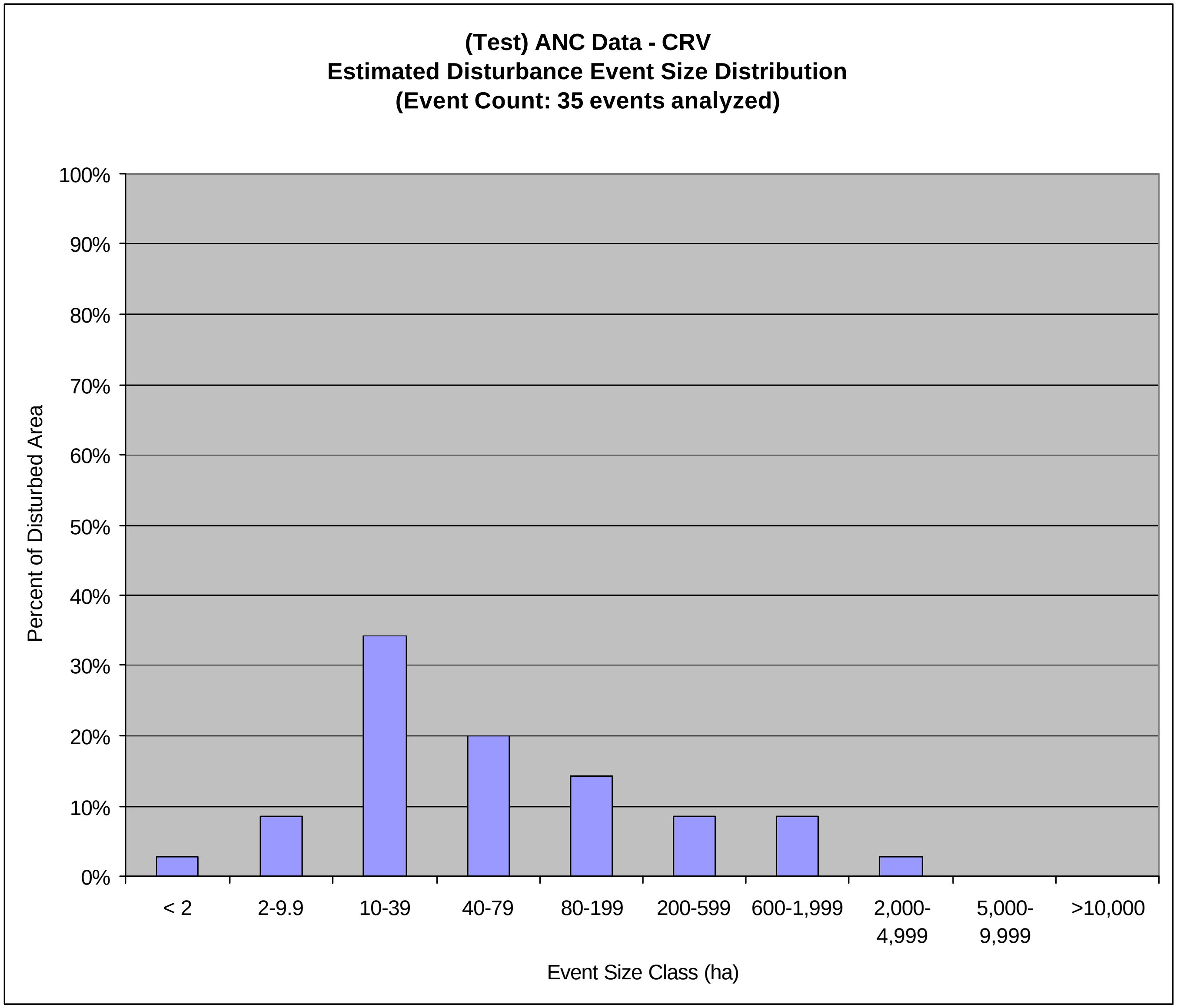
	Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Dissolve on Timeslice, Disturbance Type and Disturbance Level	This tool takes the disturbance shape file (disturbance_plan.shp) and merges adjacent shapes that have the same values for DIST_DATE and DIST_LEVEL. Multipart shapes are not allowed so each output shape will be spatially explicit. The output shape file is called 'disturbance_plan_dissolve.shp'. Uses the standard Dissolve tool from the Data Management Tools toolbox, Generalization toolset.
Identify Event/Patch Disturbance	This python script first separates the dissolved event/patch shape file into a single new shape file for each timeslice. It then does the same for the original input disturbances. Then for each timeslice, the event/patch and disturbance shape files are overlaid using the 'identify' command'. Once all timeslices are complete, the new shape files are again combined into a single shape file for further processing. identify_eventpatch_distlevel.py
Delete Unnecessary Fields (2)	This tool deletes the unnecessary fields that were generated as part of the previous process of overlaying the event/patch shapes with the disturbance level shapes. The fields deleted are: DIST_DATE, FID_distur and FID_event_. The output shape file is the same as the input shape file: 'event_patch_dist_id.shp'. Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Dissolve Event/Patch/Dist	This tool merges adjacent features that have the same values for all fields (i.e. TIMESLICE, EVENT, EVENT_HA, EVENT_PER, PATCH, PATCH_HA, PATCH_PER and DIST_LEVEL). Uses the standard Dissolve tool from the Data Management Toolbox, Generalization toolset.
Calculate Area & Permieter (3)	This script adds fields for the area and perimeter and calculates the values. calc_ha_perim.py
Add Subpatch Ha Field	This tool adds a new field, SUBPAT_HA, to the event_patch_dist_id_diss.shp shape file. This new field will store the area of the subpatch (in hectares). Uses the standard Add Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate SUBPAT_HA Field	This tool populates the SUBPAT_HA field using the formula [AREA]/10000. Uses the standard Calculate Field tool from the Data Manaegment Tools toolbox, Fields toolset.
Add Subpatch Perimeter Field	This tool adds a new field, called SUBPAT_PER, to the event_patch_dist_id_diss.shp shape file. The new field will store the

	perimeter of the subpatch (in metres). Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate SUBPAT_PER Field	This tool populates the SUBPAT_PER field as a direct copy from the standard PERIM field. The original PERIM field will not be used because the name is not distinct. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Delete Area & Perimeter Fields (2)	This tool removes the original AREA and PERIM fields because they have been replaced by the subpatch specific field names. Output shape file is the same as the input, 'event_patch_dist_id_diss.shp'. Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Make Matrix Feature Layer	This tool creates a new logical feature layer that includes all shapes that currently have no value for disturbance level (DIST_LEVEL). Such shapes are considered 'matrix remnants' within an event. The output feature layer is called 'event_patch_dist_id_diss_matrix'. Uses the standard Make Feature Layer tool from the Data Management Tools toolbox, Layers and Table Views toolset.
Populate Matrix Value	This tool populates the disturbance level field (DIST_LEVEL) to be 'matrix remnant' for those shapes that did not have a value in that field. These shapes are outside the actual disturbances but within an event. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Make Matrix Remnant Sliver Feature Layer	This tool creates a new logical feature layer that is comprised of all shapes that are matrix remnants (i.e. DIST_LEVEL = 'matrix remnant') and are under 0.02ha in size. These are considered slivers that will be removed in a later process. The new feature layer is called 'event_patch_diss_small_matrix'. Uses the standard Make Feature Layer tool from the Data Management Tools toolbox, Layers and Table Views toolset.
Delete Matrix Remnant Slivers	This tool deletes the previously identified matrix remnant 'slivers' (i.e. those that are under 0.02 ha in size). The output shape file is called 'event_patch_dist_id_diss.shp'. Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Make Small Non-Matrix Feature Layer	This tool creates a new logical feature layer which includes all features from the event_patch_dist_id_diss.shp shape file after deleting the small matrix remnant slivers. The output feature layer is called 'event_patch_dist_id_diss_non_matrix'. Uses the standard Make Feature Layer tool from the Data Management Tools toolbox, Layers and Table Views toolset.

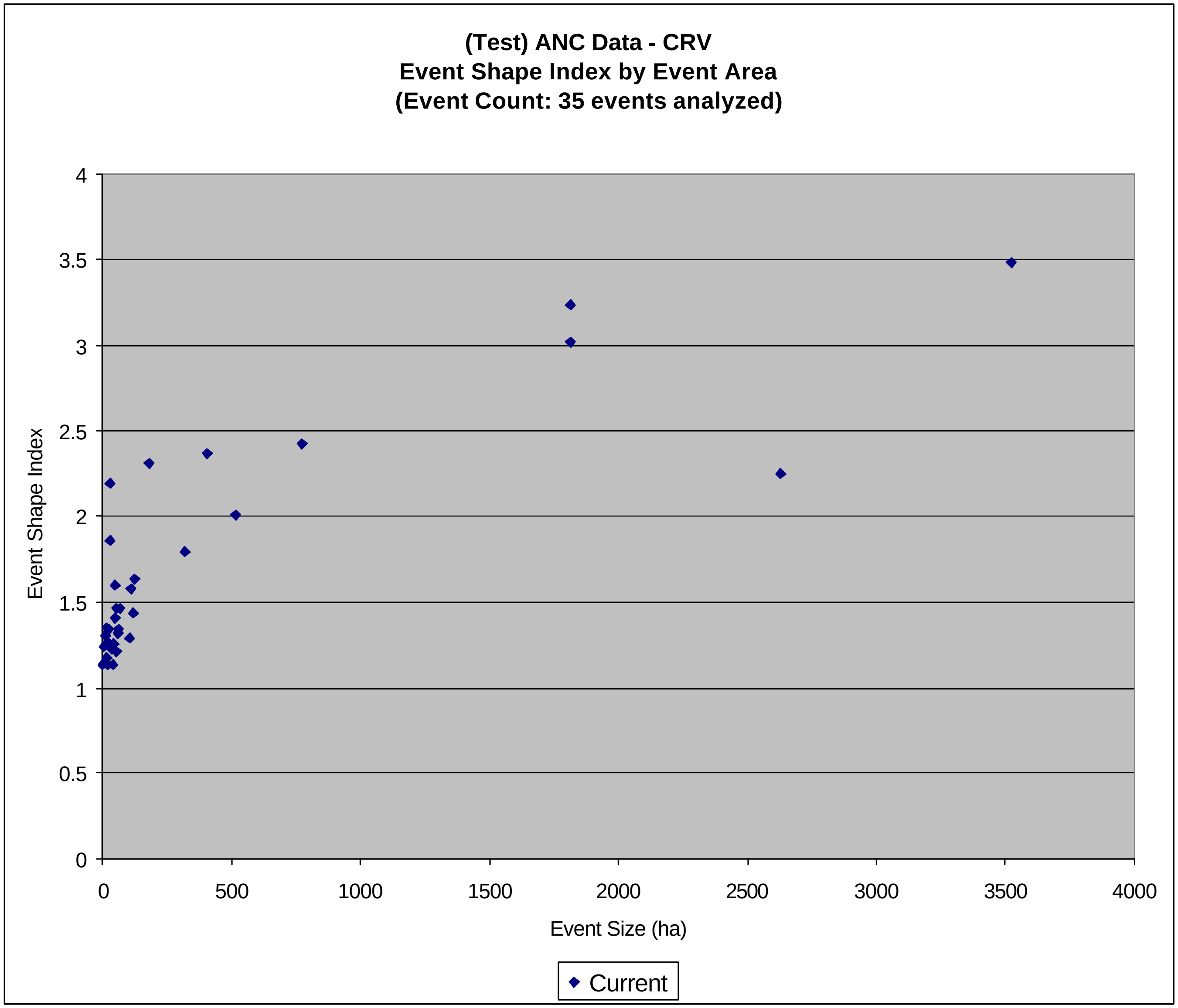
Select Features to Eliminate	This tool selects from the feature layer 'event_patch_dist_id_diss_non_matrix', those features that are NOT matrix remnants and are under 0.02 ha in size. The output is the same feature layer. Uses the standard Select Layer By Attribute tool from the Data Management Tools toolbox, Layers and Table Views toolset.
Merge Small Non-Matrix Features	This tool takes the selected non-matrix featues (i.e. those that are less than 0.02 ha in size, from the event_patch_dist_id_diss_non_matrix feature layer), and merges them with the adjacent polygon that has the longest shared border. The output shape file is called 'disturbance_final.shp'. Uses the standard Eliminate tool from the Data Management Tools toolbox, Generalization toolset.
Calculate Area & Permieter (4)	This script add fields for the area and perimeter and calculates the values. The area and perimeter must be recalculated because the previous sliver elimination may have changed some of the values. calc_ha_perim.py
Calculate SUBPAT_HA Field (2)	This tool recalculates the SUBPAT_HA field using the formula: [AREA]/10000. The area must be recalculated because the previous sliver elimination may have changed some of the areas. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Calculate SUBPAT_PER Field (2)	This tool recalculates the SUBPAT_PER field as a direct copy from the standard PERIM field. The perimeter must be recalculated because the previous sliver elimination may have changed some of the values. Uses the standard Calculate Field tool from the Data Management Tools toolbox, Fields toolset.
Delete Area & Perimeter Fields (3)	This tool removes the original AREA and PERIM fields because they have been replaced by the subpatch specific field names. Output is the same as the input, disturbance_final.shp Uses the standard Delete Field tool from the Data Management Tools toolbox, Fields toolset.
Copy Final Output	This python script makes a copy of the final output shape file (disturbance_final.shp) and the associated documentation file (readme.txt) and puts them into the selected output workspace. The files are renamed to include a time/date stamp. copy_final_output.py

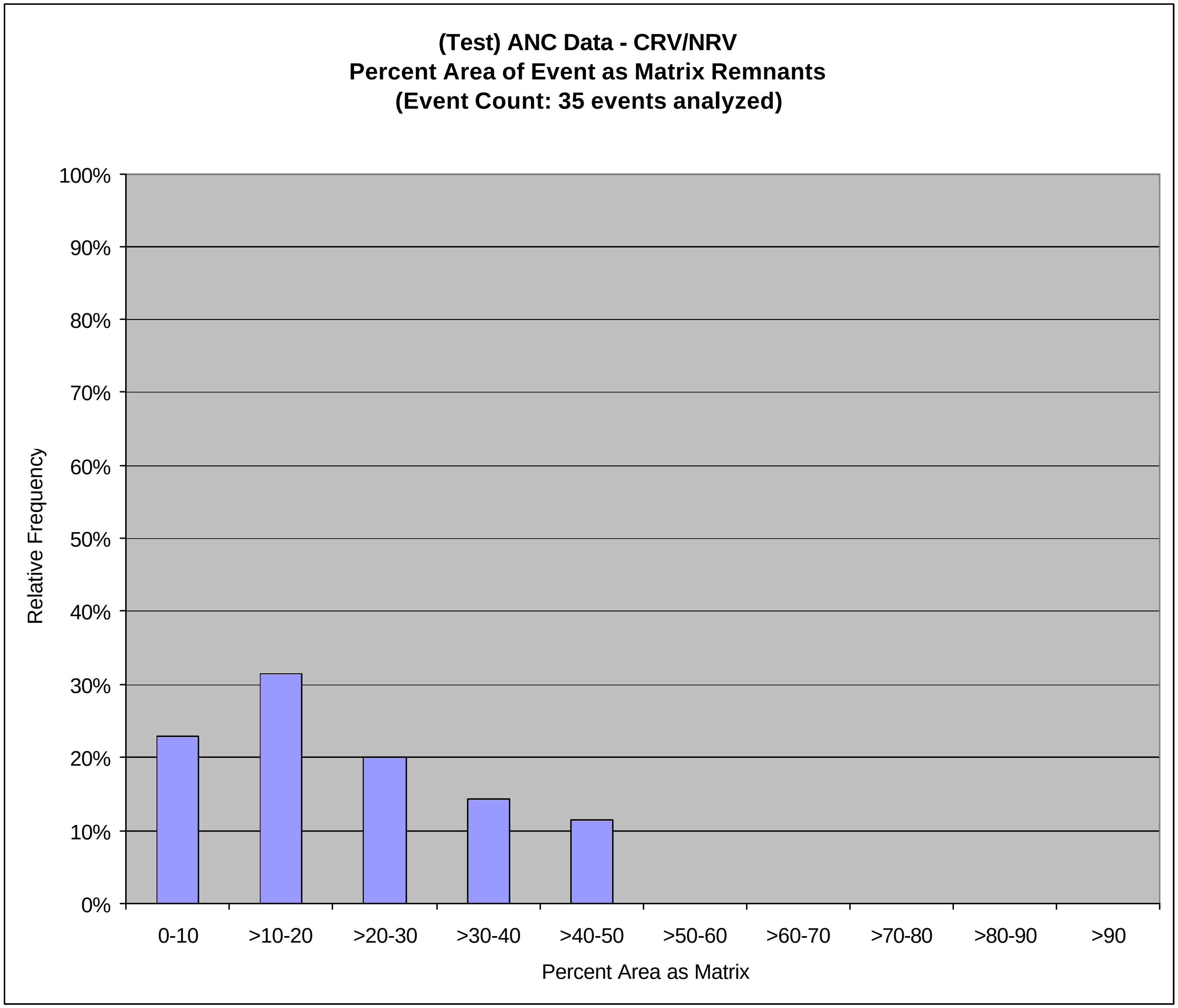
Appendix III NEPTUNE Sample Analysis Outputs

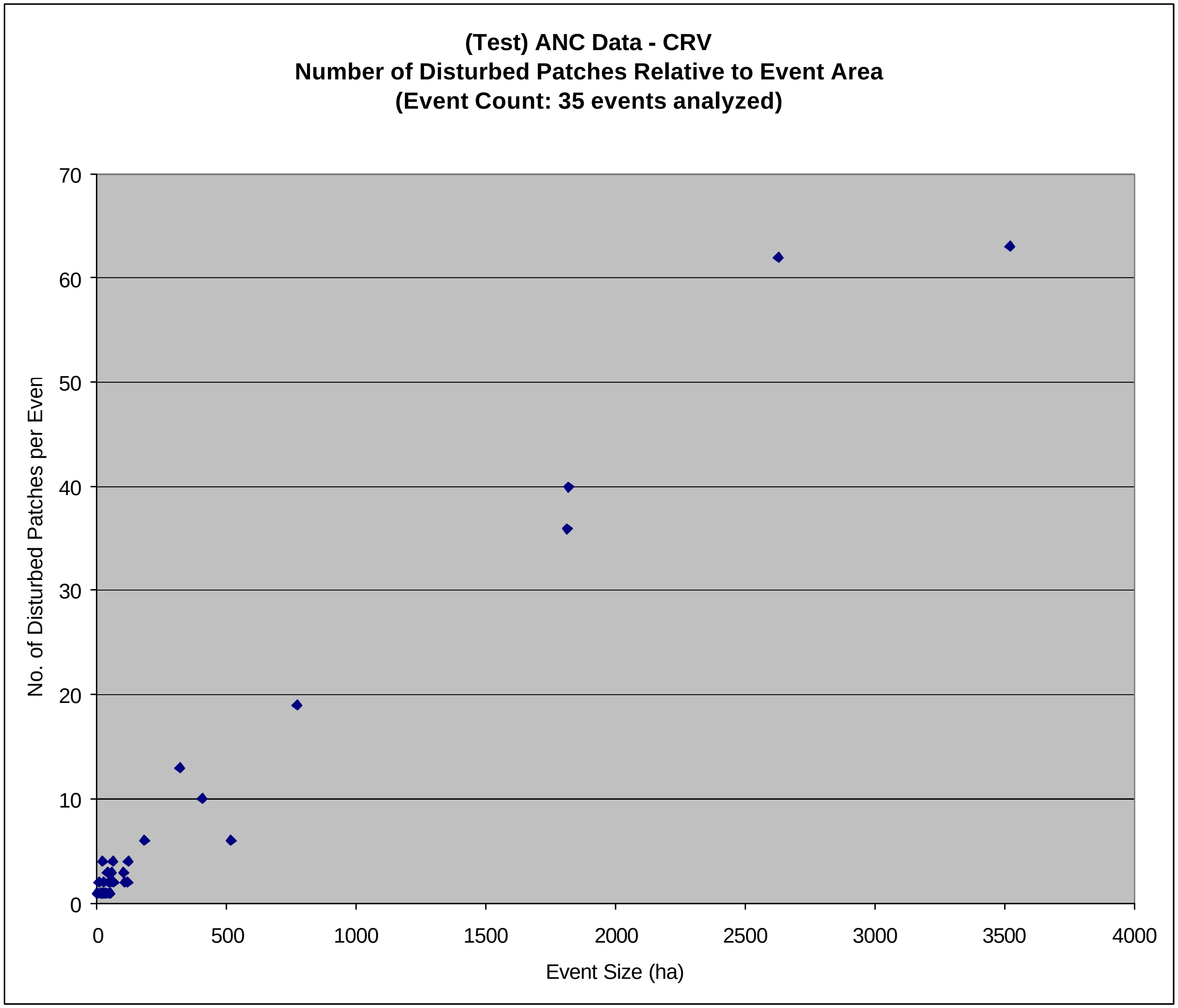
Sample Output
Sheet Name: E-size_Current



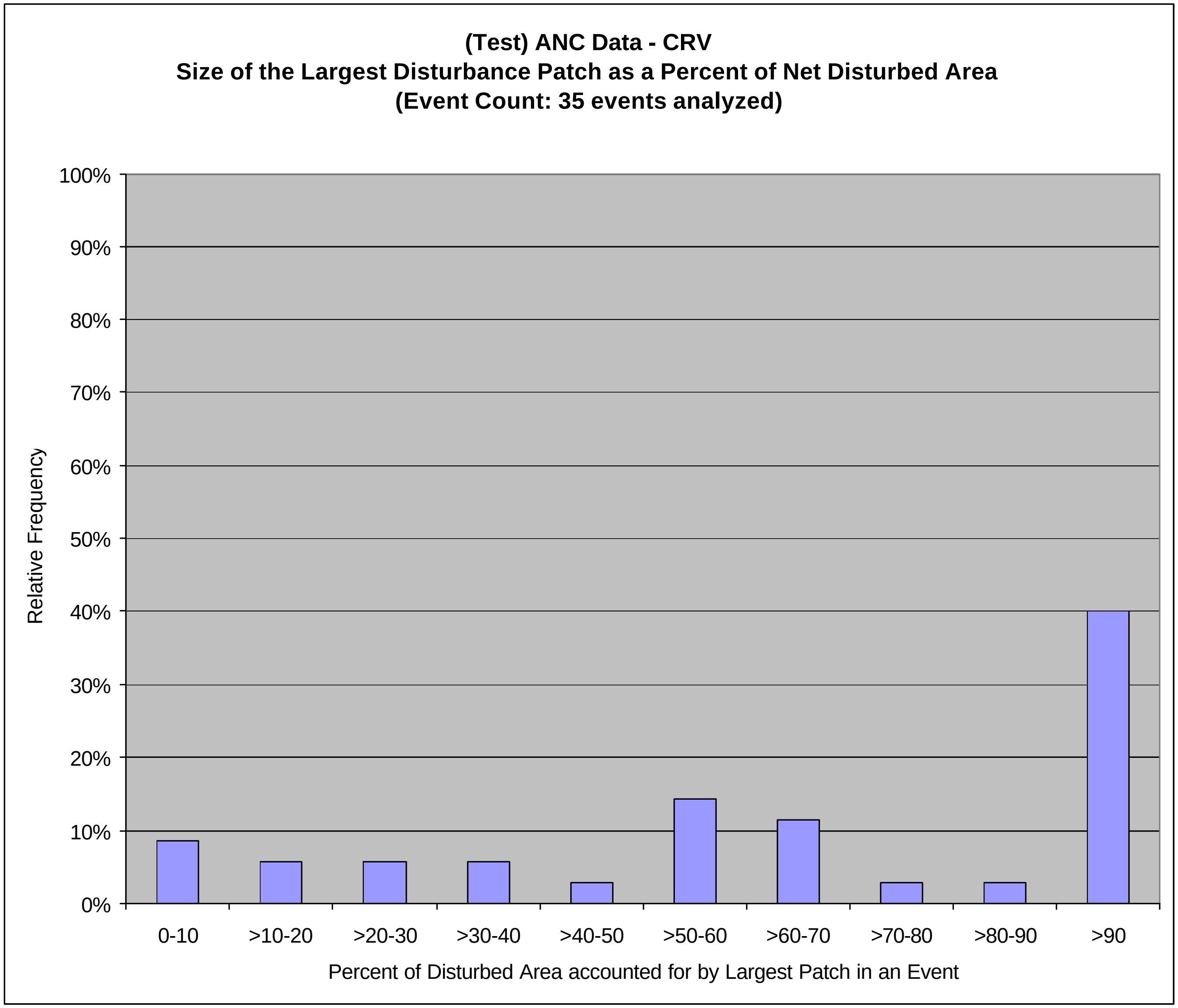
Sample Output
Sheet Name: E-shape_Index



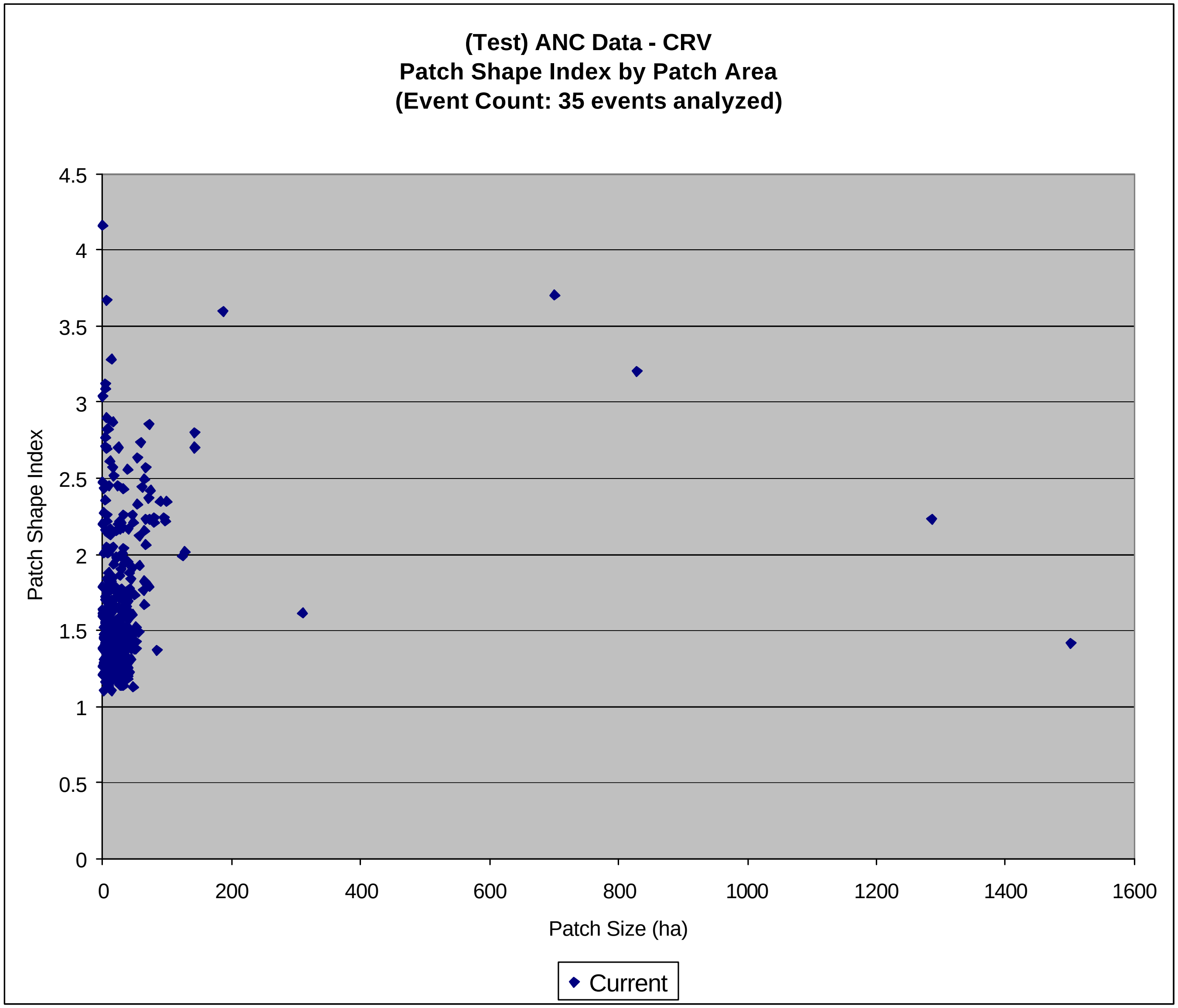

(Test) ANC Data - CRV/NRV
Percent Area of Event as Matrix Remnants
(Event Count: 35 events analyzed)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Relative Frequency
0-10
>10-20
>20-30
>30-40
>40-50
>50-60
>60-70
>70-80
>80-90
>90
Percent Area as Matrix


(Test) ANC Data - CRV
Number of Disturbed Patches Relative to Event Area
(Event Count: 35 events analyzed)
70
60
50
40
30
20
10
0
No. of Disturbed Patches per Even
0
500
1000
1500
2000
2500
3000
3500
4000
Event Size (ha)

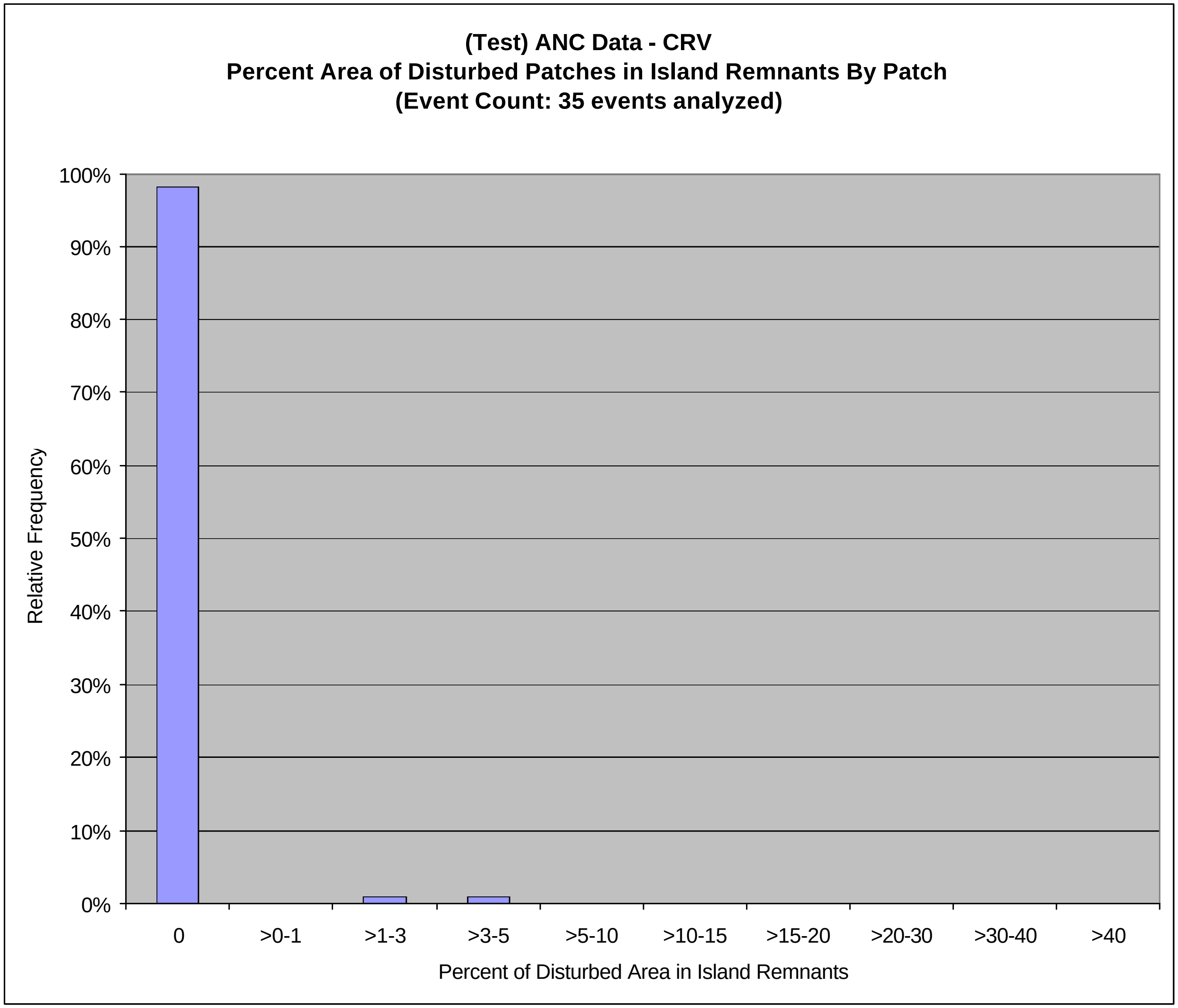
Sample Output
Sheet Name: P-largest_Current



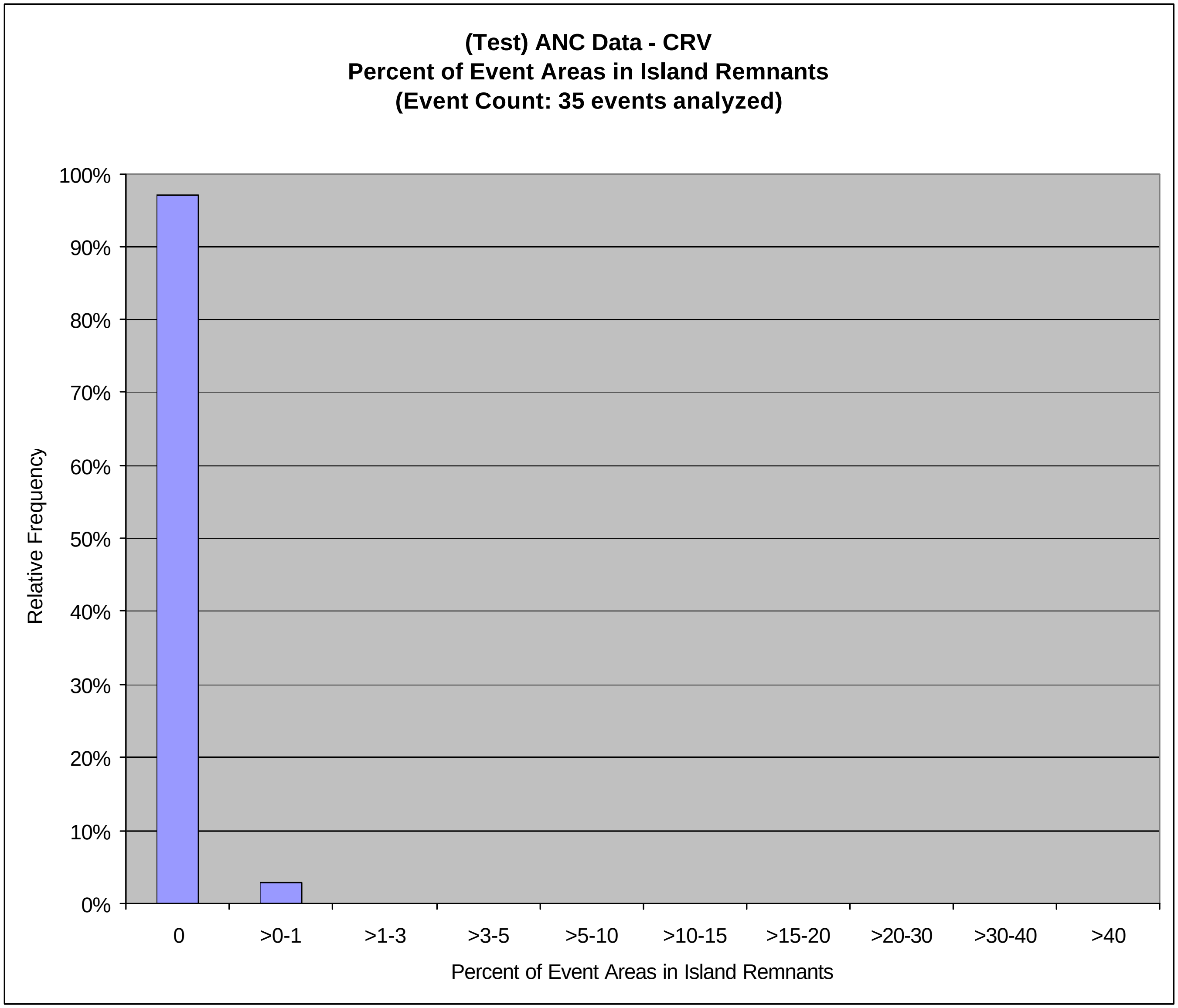
Sample Output
Sheet Name: P-shape_Current



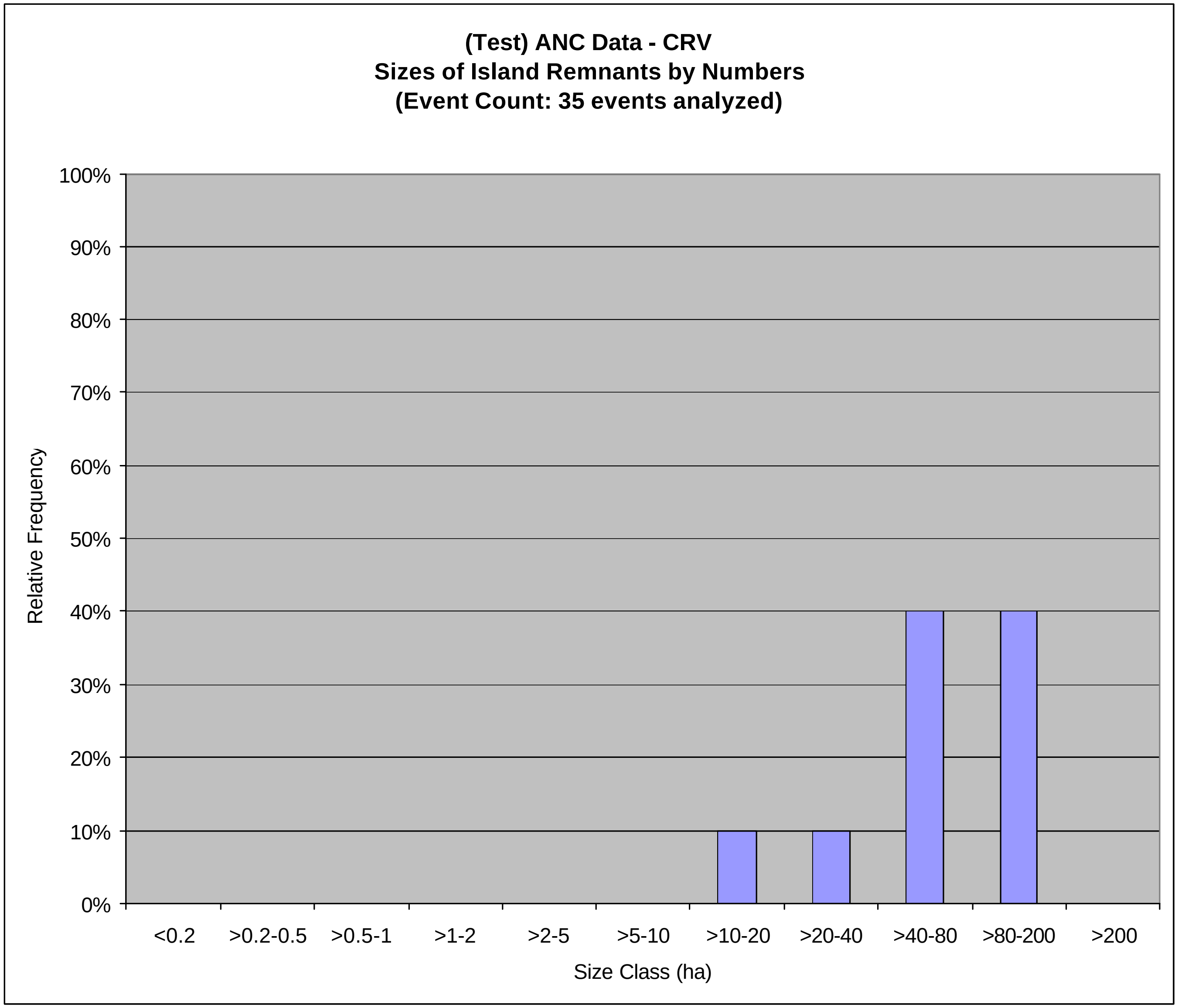
Sample Output
Sheet Name: P-I-area_Current



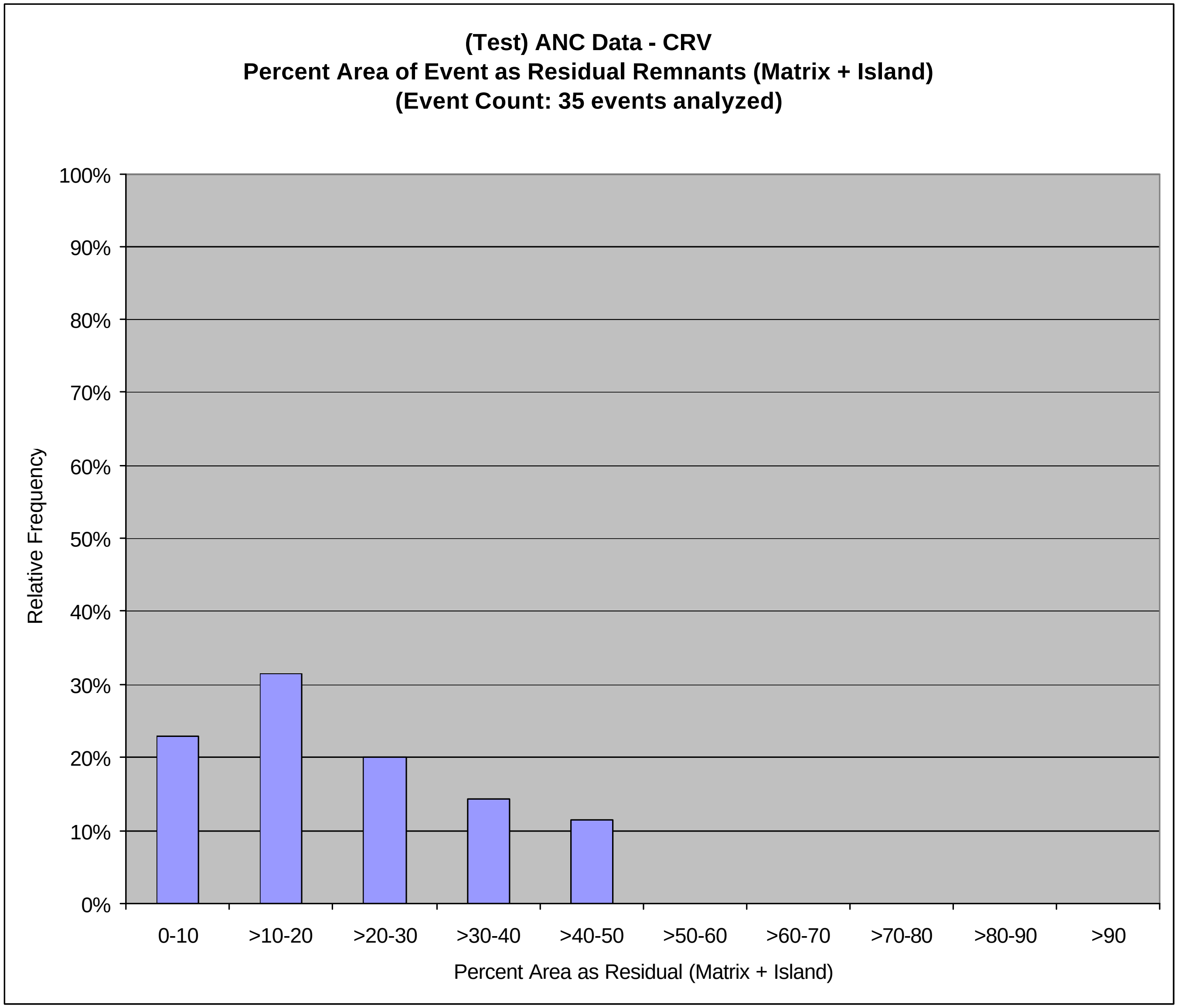
Sample Output
Sheet Name: I-area_Current

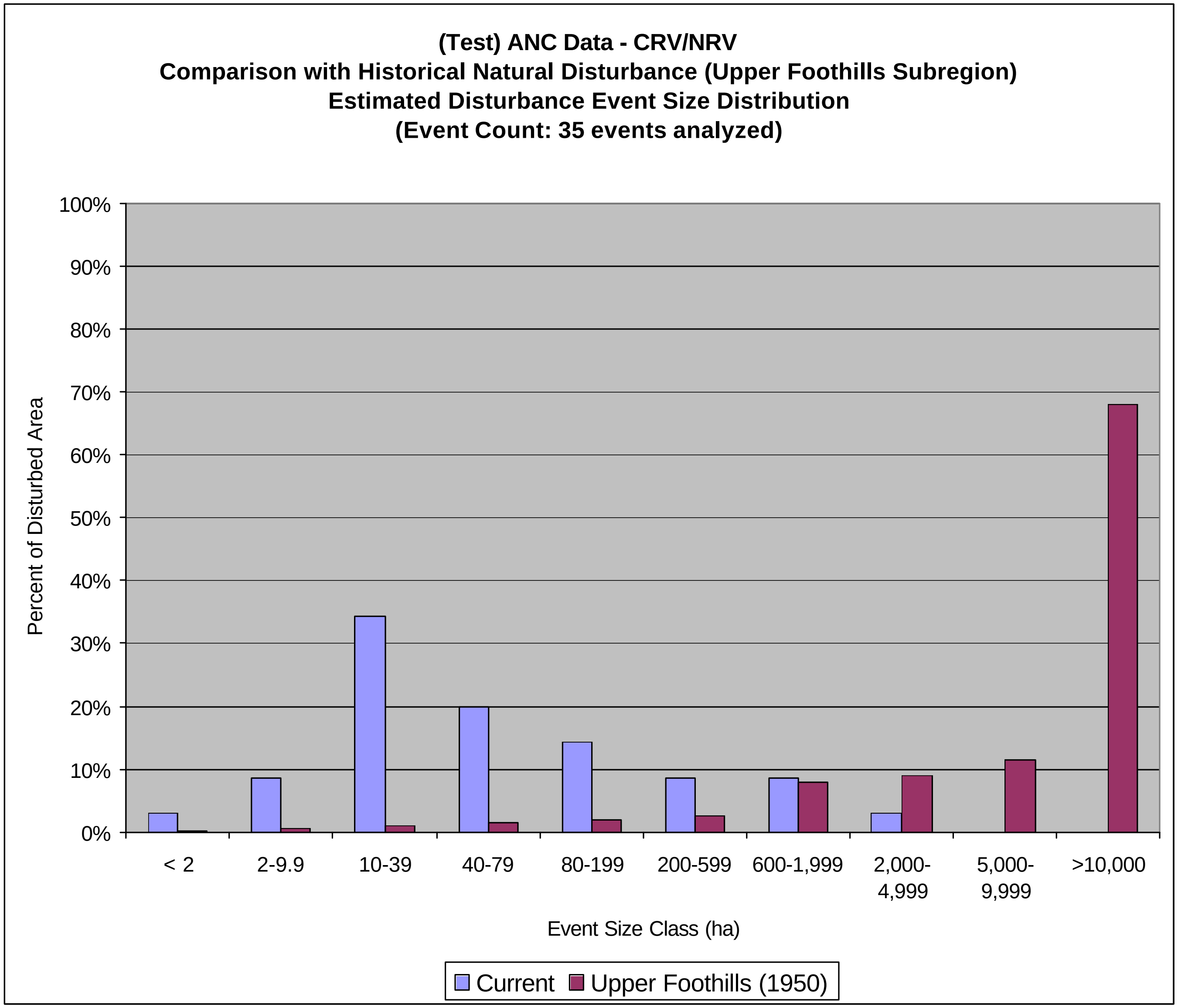


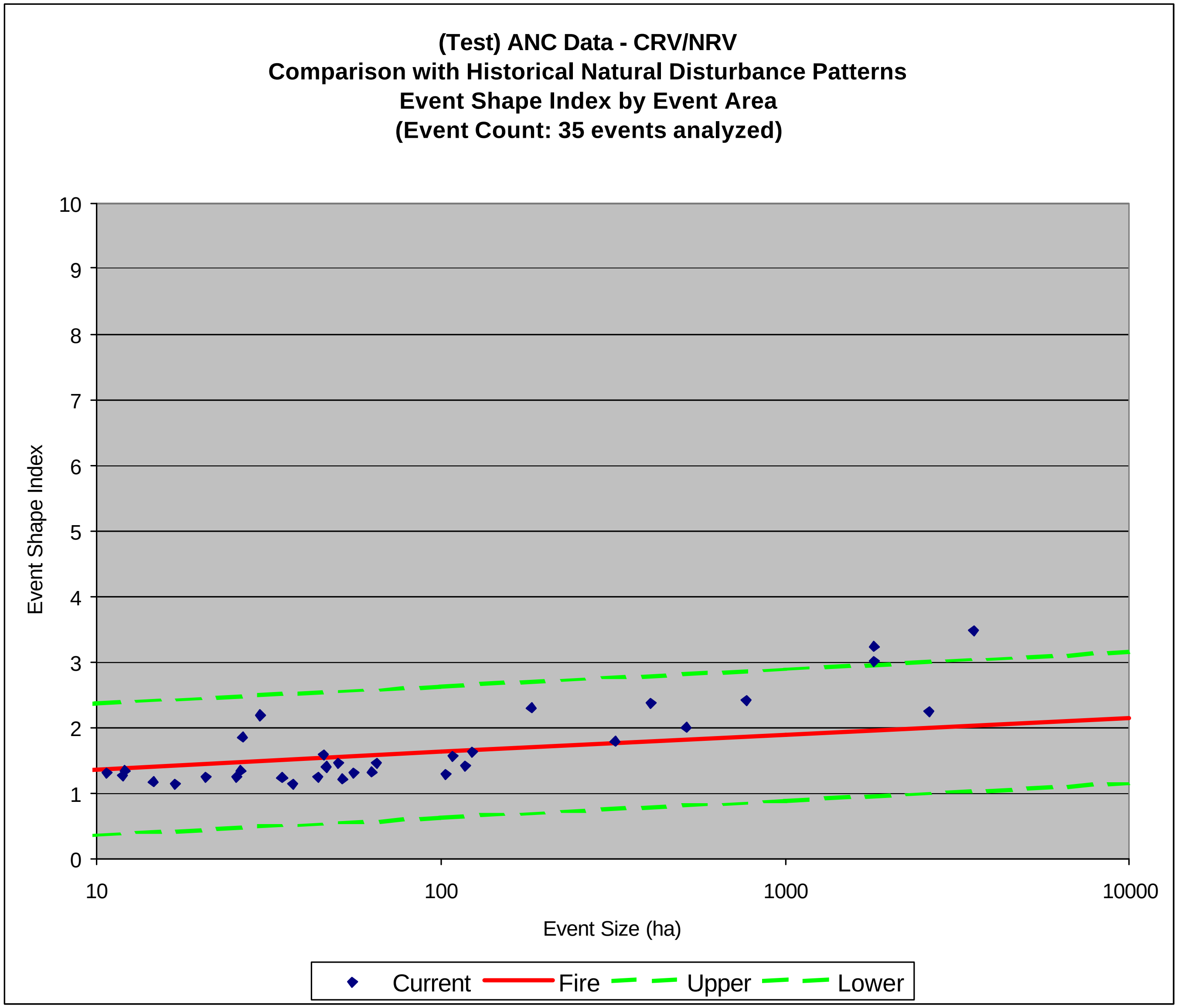
Sample Output
Sheet Name: I-size_Current



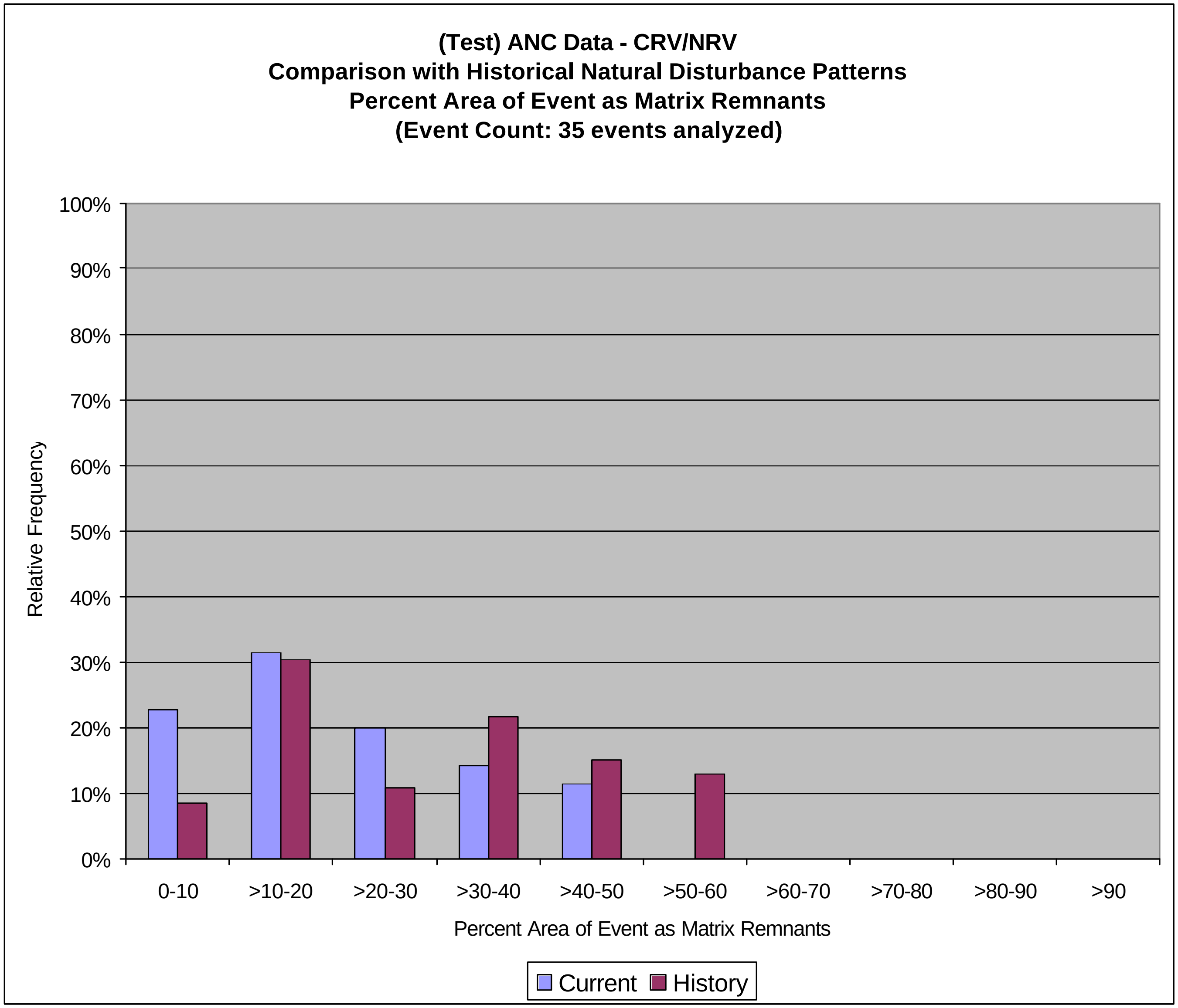
Sample Output
Sheet Name: E-M&I-area_Current



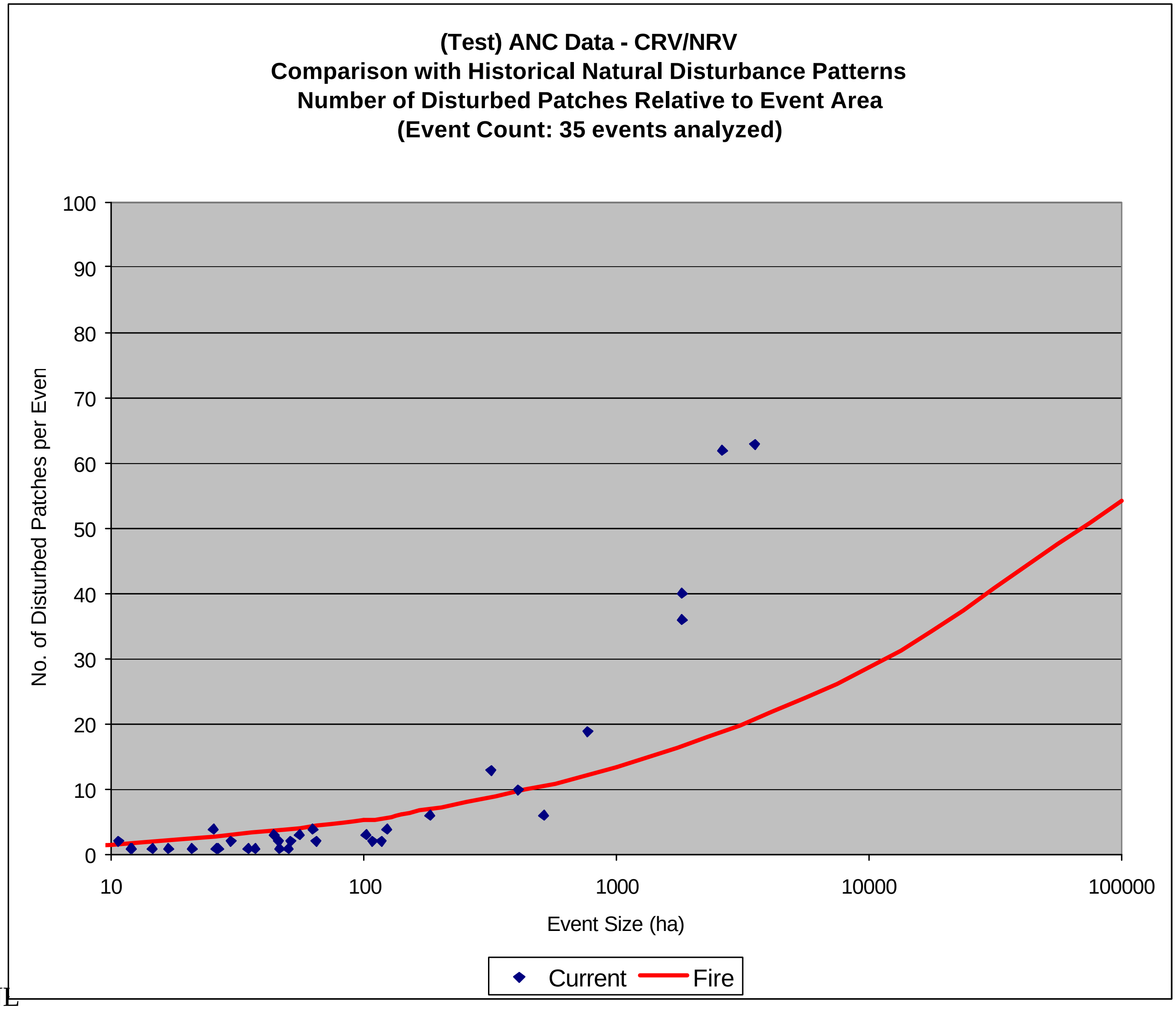

(Test) ANC Data - CRV/NRV
Comparison with Historical Natural Disturbance (Upper Foothills Subregion)
Estimated Disturbance Event Size Distribution
(Event Count: 35 events analyzed)
Percent of Disturbed Area
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
< 2
2-9.9
10-39
40-79
80-199
200-599
600-1,999
2,000-4,999
5,000-9,999
>10,000
Event Size Class (ha)
Current
Upper Foothills (1950)

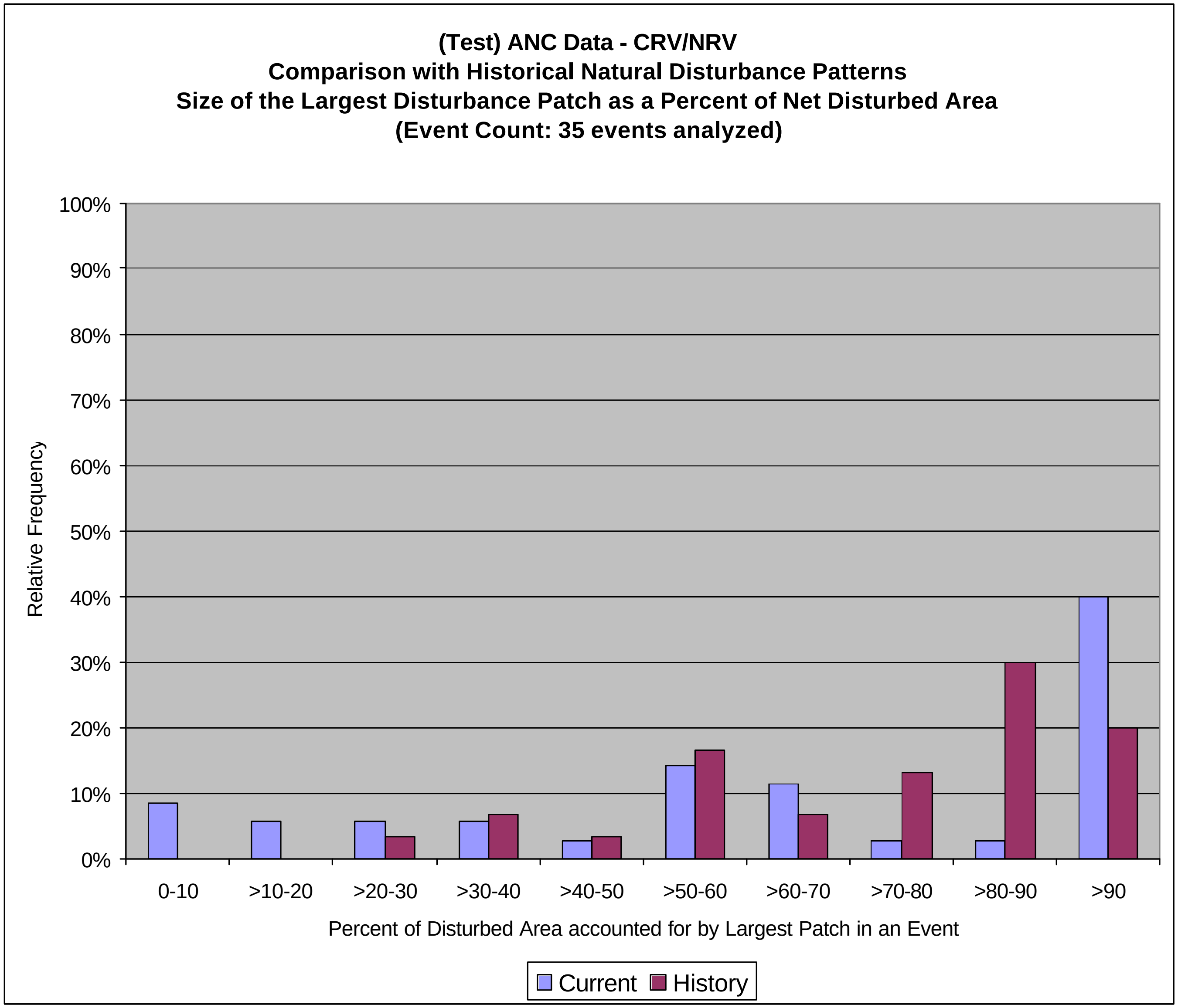

(Test) ANC Data - CRV/NRV
Comparison with Historical Natural Disturbance Patterns
Event Shape Index by Event Area
(Event Count: 35 events analyzed)
Event Shape Index
0
1
2
3
4
5
6
7
8
9
10
10
100
1000
10000
Event Size (ha)
Current
Fire
Upper
Lower

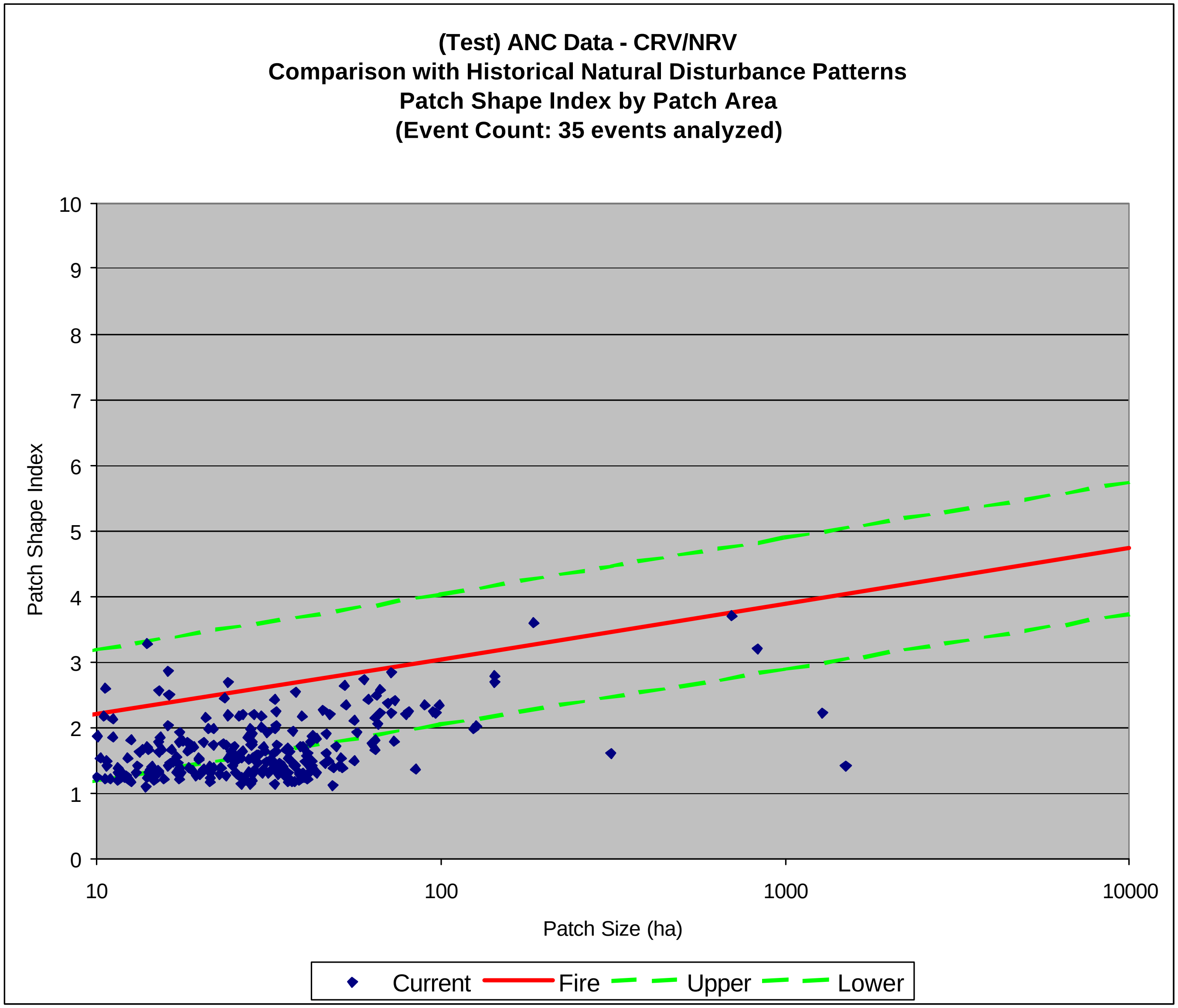
Sample Output
Sheet Name: E-M-area_Compare



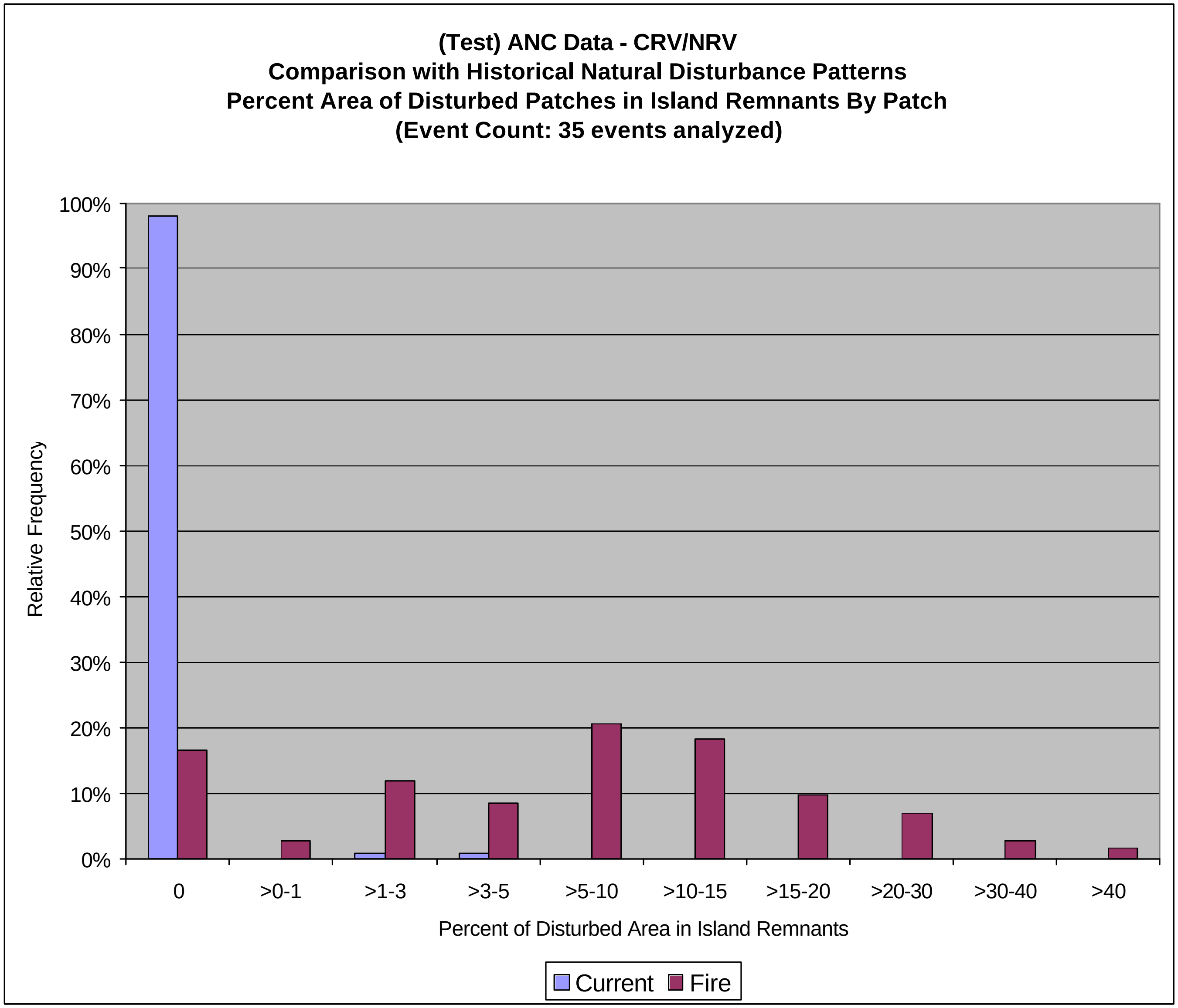
Sample Output
Sheet Name: P-density_Compare



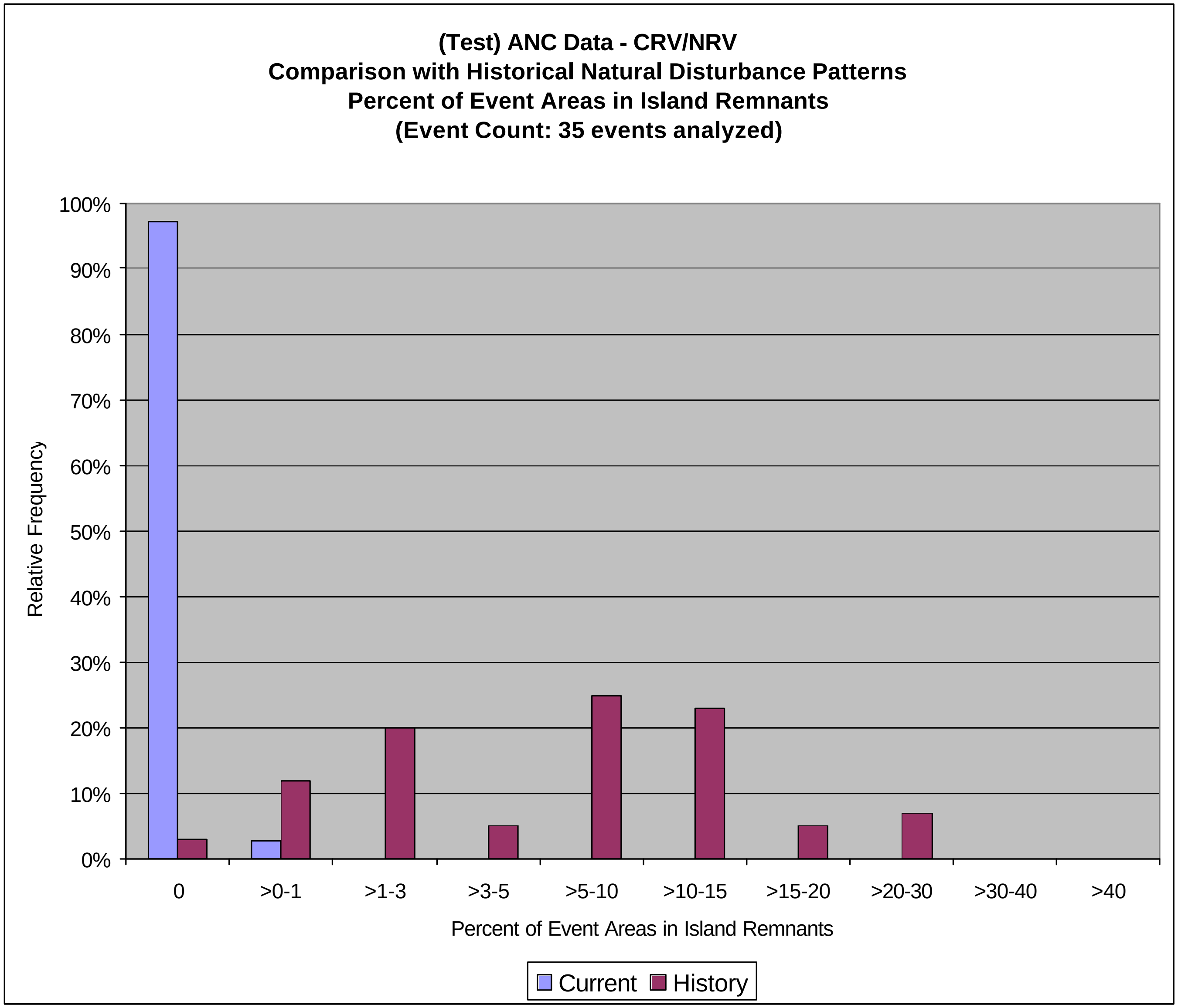

(Test) ANC Data - CRV/NRV
Comparison with Historical Natural Disturbance Patterns
Size of the Largest Disturbance Patch as a Percent of Net Disturbed Area
(Event Count: 35 events analyzed)
Relative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0-10
>10-20
>20-30
>30-40
>40-50
>50-60
>60-70
>70-80
>80-90
>90
Percent of Disturbed Area accounted for by Largest Patch in an Event
Current
History

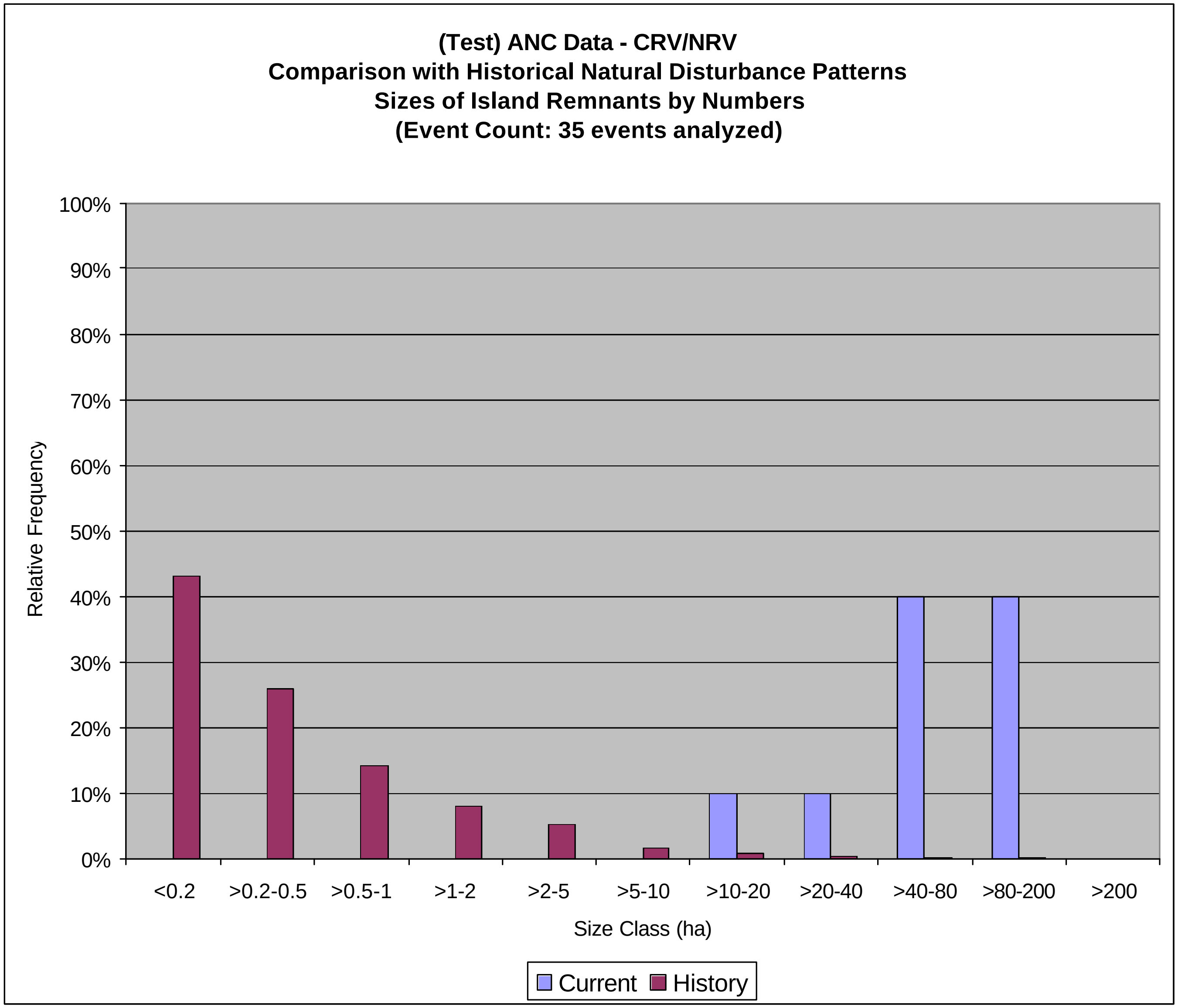

(Test) ANC Data - CRV/NRV
Comparison with Historical Natural Disturbance Patterns
Patch Shape Index by Patch Area
(Event Count: 35 events analyzed)
Patch Shape Index
10
9
8
7
6
5
4
3
2
1
0
10
100
1000
10000
Patch Size (ha)
Current
Fire
Upper
Lower

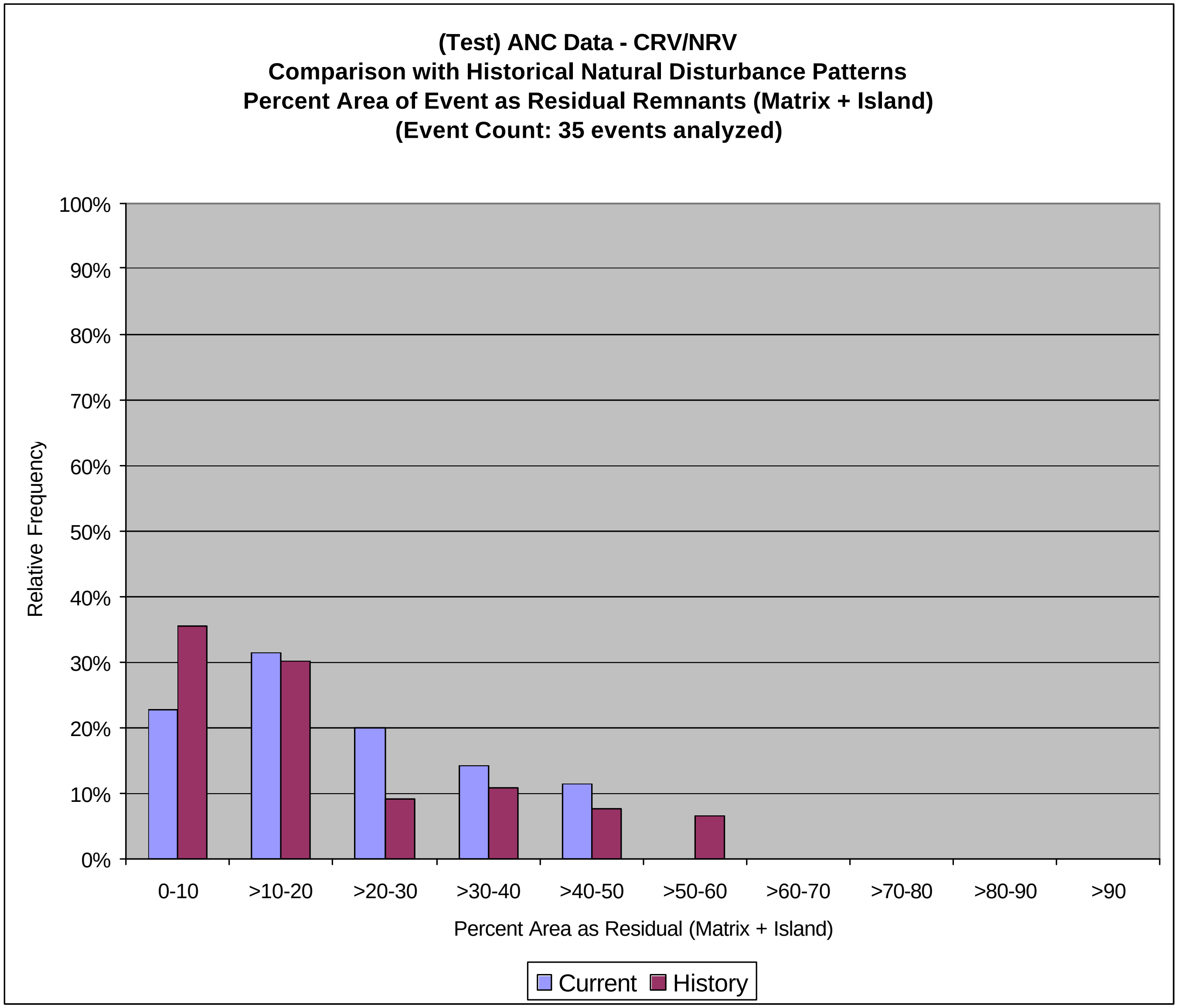
Sample Output
Sheet Name: P-I-area_Compare



Sample Output
Sheet Name: E-I-area_Compare



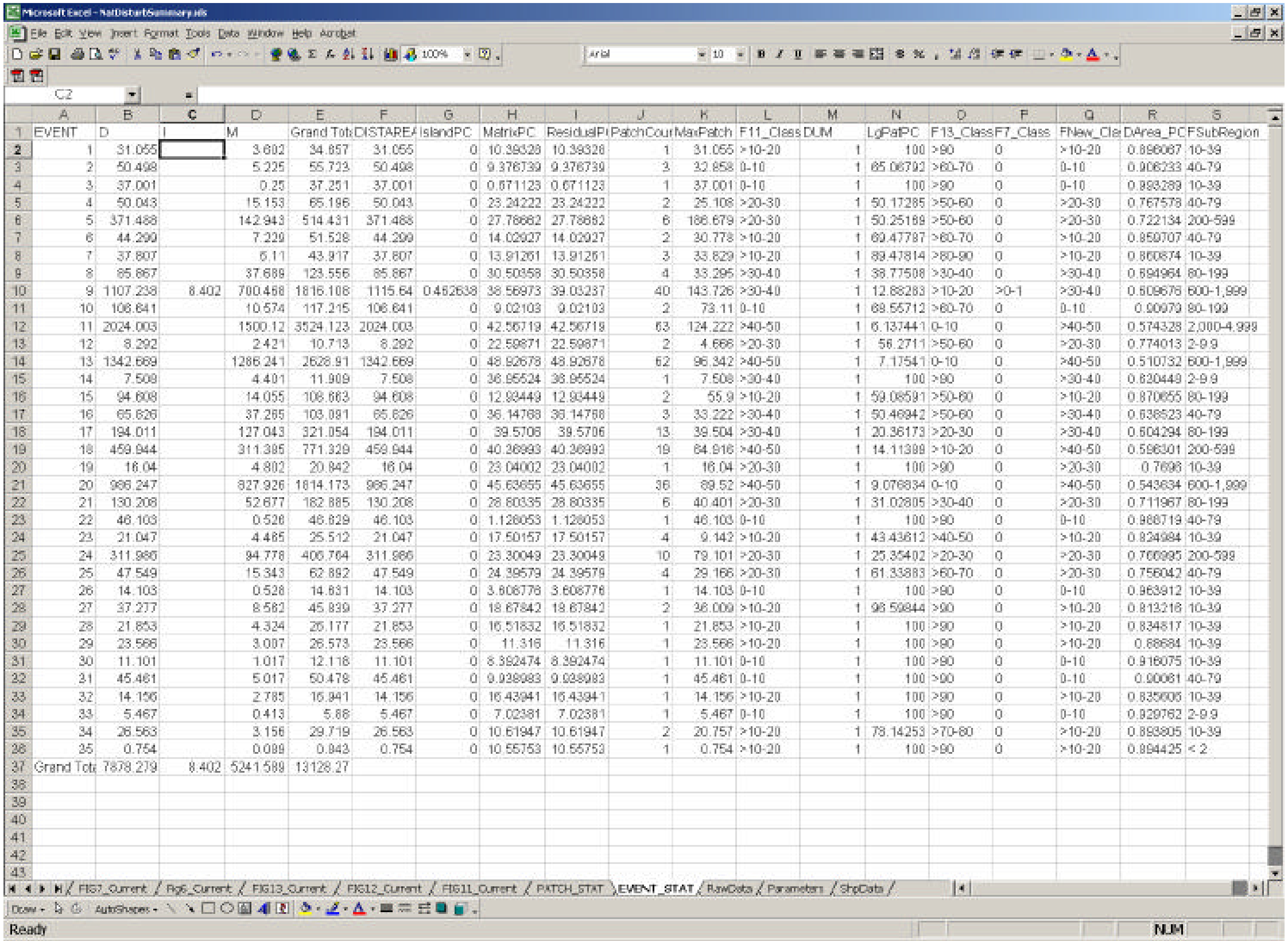

(Test) ANC Data - CRV/NRV
Comparison with Historical Natural Disturbance Patterns
Sizes of Island Remnants by Numbers
(Event Count: 35 events analyzed)
Relative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
<0.2
>0.2-0.5
>0.5-1
>1-2
>2-5
>5-10
>10-20
>20-40
>40-80
>80-200
>200
Size Class (ha)
Current
History


(Test) ANC Data - CRV/NRV
Comparison with Historical Natural Disturbance Patterns
Percent Area of Event as Residual Remnants (Matrix + Island)
(Event Count: 35 events analyzed)
Relative Frequency
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0-10
>10-20
>20-30
>30-40
>40-50
>50-60
>60-70
>70-80
>80-90
>90
Percent Area as Residual (Matrix + Island)
Current
History

Sample Output - Data
Sheet Name: PATCH_STAT

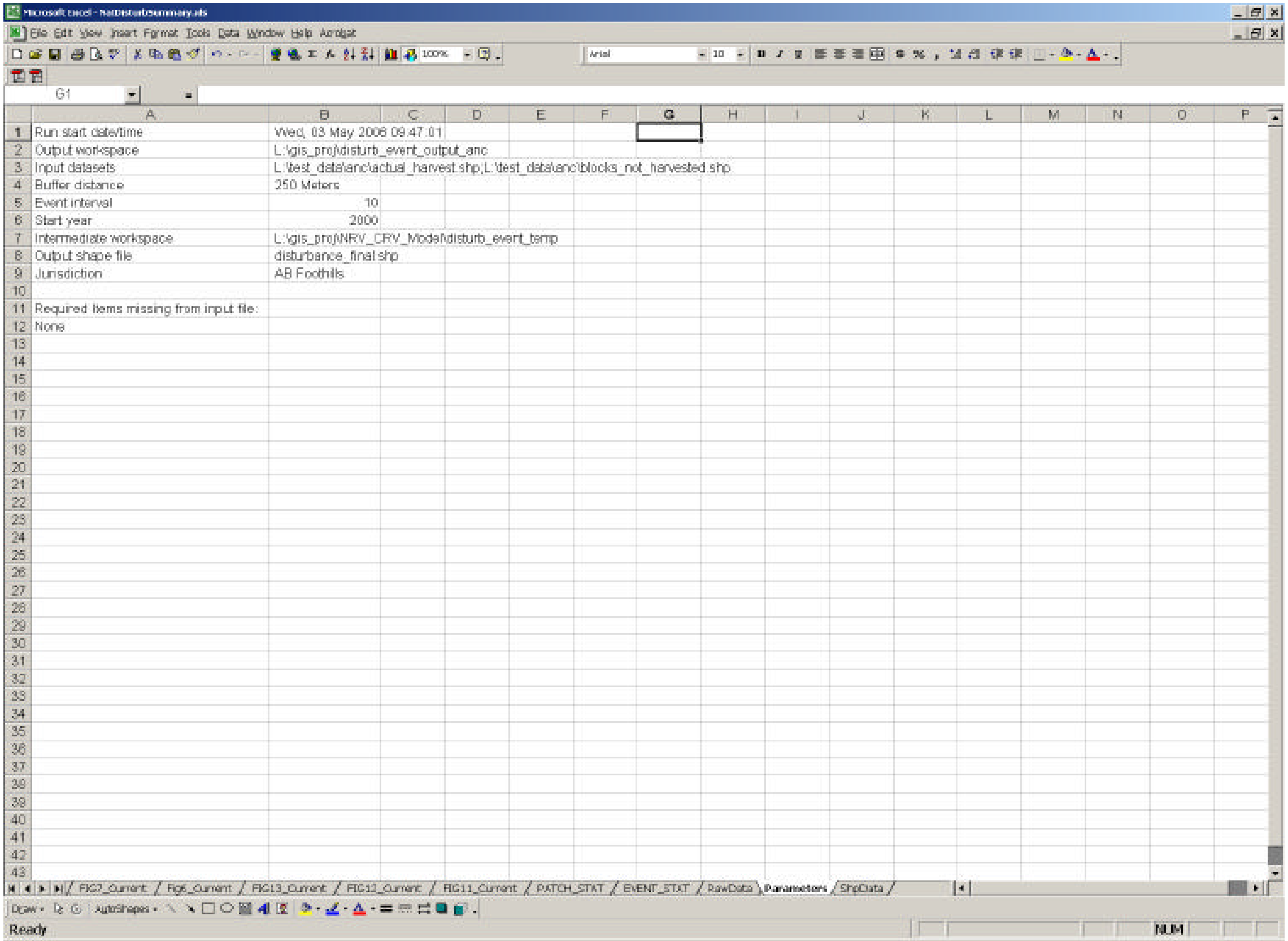
	EV_PAT	D	I	M	Grand Tot	DISTAREA	IslandPC	F6_Class	DUM	ShapeIndex
2	1_0			3.602	3.602	0	0	0		2.354403
3	1_2	31.055			31.055	31.055	0	0		1.481591
4	10_0			10.574	10.574	0	0	0		2.611615
5	10_173	33.531			33.531	33.531	0	0		1.748614
6	10_175	73.11			73.11	73.11	0	0		1.794325
7	11_0			1500.12	1500.12	0	0	0		1.421575
8	11_10	25.388			25.388	25.388	0	0		1.305833
9	11_105	28.63			28.63	28.63	0	0		1.350341
10	11_107	61.472			61.472	61.472	0	0		2.441264
11	11_11	10.209			10.209	10.209	0	0		1.527707
12	11_111	80.771			80.771	80.771	0	0		2.241334
13	11_113	36.071			36.071	36.071	0	0		1.17475
14	11_115	26.292			26.292	26.292	0	0		1.238559
15	11_12	4.353			4.353	4.353	0	0		1.551087
16	11_121	40.723			40.723	40.723	0	0		1.572236
17	11_122	36.413			36.413	36.413	0	0		1.212332
18	11_127	35.095			35.095	35.095	0	0		1.281443
19	11_129	18.563			18.563	18.563	0	0		1.381391
20	11_130	17.775			17.775	17.775	0	0		1.796076
21	11_135	30.366			30.366	30.366	0	0		1.319303
22	11_14	31.699			31.699	31.699	0	0		1.306497
23	11_142	27.935			27.935	27.935	0	0		1.136907
24	11_147	31.869			31.869	31.869	0	0		1.493354
25	11_150	24.959			24.959	24.959	0	0		1.414473
26	11_154	37.473			37.473	37.473	0	0		1.414733
27	11_156	2.568			2.568	2.568	0	0		1.522234
28	11_160	24.749			24.749	24.749	0	0		1.65668
29	11_163	7.506			7.506	7.506	0	0		1.535532
30	11_168	73.354			73.354	73.354	0	0		2.41716
31	11_17	32.747			32.747	32.747	0	0		1.610418
32	11_171	34.847			34.847	34.847	0	0		1.410648
33	11_172	15.126			15.126	15.126	0	0		1.34685
34	11_176	42.568			42.568	42.568	0	0		1.881986
35	11_19	39.233			39.233	39.233	0	0		1.723539
36	11_20	35.283			35.283	35.283	0	0		1.863733
37	11_22	0.605			0.605	0.605	0	0		1.207573
38	11_23	9.792			9.792	9.792	0	0		1.187132
39	11_24	23.326			23.326	23.326	0	0		1.760125
40	11_25	15.241			15.241	15.241	0	0		1.63234
41	11_26	12.153			12.153	12.153	0	0		1.241047
42	11_27	33.194			33.194	33.194	0	0		1.65514
43	11_30	36.624			36.624	36.624	0	0		1.491825

Sample Output - Data
Sheet Name: EVENT_STAT



EVENT	D	I	M	Grand Tot	DISTAREA	IslandPC	MatrixPC	ResidualP	PatchCou	MaxPatch	F11_Class	DUM	LgPatPC	F13_Class	F7_Class	FNew_Cla	DArea_PC	FSubRegion
1	31.055		3.602	34.657	31.055	0	10.39326	10.39326	1	31.055	>10-20	1	100	>90	0	>10-20	0.896067	10-39
2	50.498		5.225	55.723	50.498	0	9.376739	9.376739	3	32.858	0-10	1	65.06792	>60-70	0	0-10	0.906233	40-79
3	37.001		0.25	37.251	37.001	0	0.671123	0.671123	1	37.001	0-10	1	100	>90	0	0-10	0.993289	10-39
4	50.043		15.153	65.196	50.043	0	23.24222	23.24222	2	25.108	>20-30	1	50.17285	>50-60	0	>20-30	0.767578	40-79
5	371.488		142.943	514.431	371.488	0	27.78662	27.78662	6	186.679	>20-30	1	50.25189	>50-60	0	>20-30	0.722134	200-599
6	44.299		7.229	51.528	44.299	0	14.02927	14.02927	2	30.778	>10-20	1	69.47787	>60-70	0	>10-20	0.859707	40-79
7	37.807		6.11	43.917	37.807	0	13.91261	13.91261	3	33.829	>10-20	1	89.47814	>80-90	0	>10-20	0.860874	10-39
8	85.867		37.689	123.556	85.867	0	30.50358	30.50358	4	33.295	>30-40	1	38.77508	>30-40	0	>30-40	0.694964	80-199
9	1107.238	8.402	700.468	1816.108	1115.64	0.462638	38.56973	39.03237	40	143.726	>30-40	1	12.88263	>10-20	>0-1	>30-40	0.609676	600-1,999
10	106.641		10.574	117.215	106.641	0	9.02103	9.02103	2	73.11	0-10	1	68.55712	>60-70	0	0-10	0.90979	80-199
11	2024.003		1500.12	3524.123	2024.003	0	42.56719	42.56719	63	124.222	>40-50	1	6.137441	0-10	0	>40-50	0.574328	2,000-4,999
12	8.292		2.421	10.713	8.292	0	22.59871	22.59871	2	4.666	>20-30	1	56.2711	>50-60	0	>20-30	0.774013	2-9.9
13	1342.669		1286.241	2628.91	1342.669	0	48.92678	48.92678	62	96.342	>40-50	1	7.17541	0-10	0	>40-50	0.510732	600-1,999
14	7.508		4.401	11.909	7.508	0	36.95524	36.95524	1	7.508	>30-40	1	100	>90	0	>30-40	0.630449	2-9.9
15	94.608		14.055	108.663	94.608	0	12.93449	12.93449	2	55.9	>10-20	1	59.08591	>50-60	0	>10-20	0.870655	80-199
16	65.826		37.265	103.091	65.826	0	36.14768	36.14768	3	33.222	>30-40	1	50.46942	>50-60	0	>30-40	0.638523	40-79
17	194.011		127.043	321.054	194.011	0	39.5706	39.5706	13	39.504	>30-40	1	20.36173	>20-30	0	>30-40	0.604294	80-199
18	459.944		311.385	771.329	459.944	0	40.36993	40.36993	19	64.916	>40-50	1	14.11389	>10-20	0	>40-50	0.596301	200-599
19	16.04		4.802	20.842	16.04	0	23.04002	23.04002	1	16.04	>20-30	1	100	>90	0	>20-30	0.7696	10-39
20	986.247		827.926	1814.173	986.247	0	45.63655	45.63655	36	89.52	>40-50	1	9.076834	0-10	0	>40-50	0.543634	600-1,999
21	130.208		52.677	182.885	130.208	0	28.80335	28.80335	6	40.401	>20-30	1	31.02805	>30-40	0	>20-30	0.711967	80-199
22	46.103		0.526	46.629	46.103	0	1.128053	1.128053	1	46.103	0-10	1	100	>90	0	0-10	0.988719	40-79
23	21.047		4.465	25.512	21.047	0	17.50157	17.50157	4	9.142	>10-20	1	43.43612	>40-50	0	>10-20	0.824984	10-39
24	311.986		94.778	406.764	311.986	0	23.30049	23.30049	10	79.101	>20-30	1	25.35402	>20-30	0	>20-30	0.766995	200-599
25	47.549		15.343	62.892	47.549	0	24.39579	24.39579	4	29.166	>20-30	1	61.33883	>60-70	0	>20-30	0.756042	40-79
26	14.103		0.528	14.631	14.103	0	3.608776	3.608776	1	14.103	0-10	1	100	>90	0	0-10	0.963912	10-39
27	37.277		8.562	45.839	37.277	0	18.67842	18.67842	2	36.009	>10-20	1	96.59844	>90	0	>10-20	0.813216	10-39
28	21.853		4.324	26.177	21.853	0	16.51832	16.51832	1	21.853	>10-20	1	100	>90	0	>10-20	0.834817	10-39
29	23.566		3.007	26.573	23.566	0	11.316	11.316	1	23.566	>10-20	1	100	>90	0	>10-20	0.88684	10-39
30	11.101		1.017	12.118	11.101	0	8.392474	8.392474	1	11.101	0-10	1	100	>90	0	0-10	0.916075	10-39
31	45.461		5.017	50.478	45.461	0	9.938983	9.938983	1	45.461	0-10	1	100	>90	0	0-10	0.90061	40-79
32	14.156		2.785	16.941	14.156	0	16.43941	16.43941	1	14.156	>10-20	1	100	>90	0	>10-20	0.835606	10-39
33	5.467		0.413	5.88	5.467	0	7.02381	7.02381	1	5.467	0-10	1	100	>90	0	0-10	0.929762	2-9.9
34	26.563		3.156	29.719	26.563	0	10.61947	10.61947	2	20.757	>10-20	1	78.14253	>70-80	0	>10-20	0.893805	10-39
35	0.754		0.089	0.843	0.754	0	10.55753	10.55753	1	0.754	>10-20	1	100	>90	0	>10-20	0.894425	< 2
Grand Tot	7878.279	8.402	5241.589	13128.27														

Sample Output - Parameters
Sheet Name : Parameters



The Forestry Corp. Project Number: P528
For additional information, please contact:
The Forestry Corp.
101-11710 Kingsway Avenue
Edmonton, AB
T5G 0X5
(780) 452-5878
www.forcorp.com

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