# Saguaro Detection User Manuel

Updated 5/24/2018. A newer version may be available -<https://github.com/forestcarter/saguaro_detection>

# Introduction

This project was developed to detect saguaro shadow signatures in high-resolution imagery. I used the tool to detect ~450,000 in Saguaro National Park (SNP) using 6-inch resolution aerial images taken in April 2011 and provided by Pima Association of Governments (PAG). If you are running the tool on other imagery of SNP, you will need to provide a folder containing the imagery and an image acquisition file similar to Pima\_Photos\_2011.shp. For location other than SNP, you will need a boundary file similar to SNPBoundaries.shp and possibly a PLSS file similar to trs.shp if your region is not in Arizona.

# File List

Folders are shown in bold.:

**thesis\_data** – Analysis performed in 2017-2018 on the 2011 imagery

* Flowchart.docx – brief overview of the process
* FCARTER\_MA\_THESIS\_FINAL.docx – my report
* rmd\_hect\_density.mxd – uses shapefiles in data folder to display hectare density in RMD
* tmd\_hect\_density.mxd – uses shapefiles in data folder to display hectare density in TMD
* **data –** files generated from my thesis work
  + **data**\\sag\_hect\_rmd.shp – hectare densities in RMD
  + **data**\\sag\_hect\_tmd.shp – hectare densities in TMD
  + **data**\\sag\_hect\_snp.shp – hectare densities in both districts
  + **data**\\point.shp – detected saguaro point locations in both districts. The “grid\_code” attribute indicates the strength of the shadow signature.
  + **data**\\site\_locators.shp – location of the eleven plots I used for accuracy assessment. The saguaro data in these plots was collected in 2010 and is available from IRMA

**saguaro\_detection** – Tools for running the saguaro detection process yourself

* Toolbox.tbx – Stores the two Script Tools MainScript and MergeClip
  + MainScript – Script Tool that detects saguaros in images. See instructions below.
  + MergeClip – Script Tool that combines points shapefiles that MainScript creates and clips them to desired boundaries. See instructions below.
* **dem**//largedem – DEM of a large part of Southern Arizona
* **Ortho2011\_FlightPoints**\\Pima\_Photos\_2011.shp – Images acquisition data provided by PAG. Contains data about the date and time the photos were taken. This is used to calculate the expected direction of the saguaro shadow.
* **scripts** – Contains python scripts that the script tools in the toolbox looks for.
* **trs**\\trs.shp – Public Land Survey System (township, range, and section polygons) of Arizona. Since the PAG imagery is based on PLSS sections, the shadow method processes on section at a time.
* **PAG\_2011\_6inchOrtho** – PAG imagery from April 2011. Organized as one square mile PLSS sections with overlap. All sections that intersect SNP are included.
* **snp\_boundary\\**SNPBoundaries.shp –Used to deleted points outside of SNP boundaries.
* **outputs** - a place to store the output files of the script tools
  + **outputs\\intermediate –**  a place for MergeClip to write temporary files. These may be useful for troubleshooting
  + **outputs\\finished** – a place for MainScript to write the finished point shapefiles of each square mile section
  + **outputs\\final\_products** – a place for MergeClip to write the combined point shapefiles that have been clipped to the desired boundaries

# Using MainScript

The Script Tool called MainScript is inside the **sagauro\_detection**\\Toolbox.tbx can be access in the Catalog Pane of ArcMap. It will ask for 9 inputs.

1. Imagery Folder – This is the folder that contains your imagery. If you don’t want to run all of your imagery right now, make another folder and put the imagery you want to run into your new folder. You can use the imagery **PAG\_2011\_6inchOrtho** or use your own imagery folder.
2. Flight Points – This is the shapefile of image equation points that contains information about the date and time when the images were acquired. You can use the imagery **Ortho2011\_FlightPoints**\\Pima\_Photos\_2011.shp if you are running the imagery in **PAG\_2011\_6inchOrtho**. If you have your own data, make sure the fields names and formats match those of **Ortho2011\_FlightPoints**\\Pima\_Photos\_2011.shp.
3. Township and Range File – This is used to process the imagery in one square mile chunks. You can use **trs**\\trs.shp
4. DEM – This is used to delete points above the elevation (meters) you will specify in the next step. You can use **dem**\\largedem
5. Maximum Elevation – This is used to delete points that are above the saguaro’s elevational limit. This helps avoid false positives in areas you know don’t have saguaros. I used 1550
6. Shadow Width – This is the width of shadow the algorithm will look for. The 2011 PAG imagery had 6-inch resolution, so I used 2 pixels as the average width. You will need to adjust this if your resolution is not 6 inches.
7. Shadow length – This is the length of shadow the algorithm will look for. I found that ten pixels was the minimum length that reliably differentiate saguaros. You will need to adjust this if your resolution is not 6 inches.
8. Intermediate Folder – This is a place for temporary files to be written. You can use **outputs\\intermediate**
9. Finished Folder – This is a place for the finished point shapefiles to be written. One shapefile will be produced for each PLSS section of imagery. You can use **outputs\\finished**

The output point shapefiles will have filenames of “TRSDA”. T is two digits indicating Township. R is two digits indicating Range. S is two digits indicating Section. D is either the letter e or the letter w, indicating if the shadow fell in the east or the west. A is the shadow angle, with 0 being directly east and 180 being directly west.

For example, 121125e32\_0741996765Y.shp indicates Township 12, Range 11, Section 25, which had a sun angle of 32.0741996765.

If no saguaros are found, no shapefile will be produced. Instead, a file called nosaguaros.txt will be produced that contains the name of the input image. If this file already exists, the name of the image will be appended at the end.

\*Bonus Feature: The program will not run a section if a point shapefile already exists for that section in the Finished Folder.

# Using MergeClip

The Script Tool called MergeClip is inside the **sagauro\_detection**\\Toolbox.tbx can be access in the Catalog Pane of ArcMap. It will ask for 4 inputs.

1. Finished Folder – This is the folder where MainScript wrote the point shapefiles. You can use **outputs\\finished**
2. Boundary File – This is the boundary you want to clip the points to. I used **snp\_boundary\\**SNPBoundaries.shp
3. Merged File – This will be your output shapefile that combines all of the point shapefiles in your Finished Folder. You can call this output shapefile anything you want.
4. Merged File – This will be your output shapefile that deletes all of the points in your Merged File that are outside the Boundary File. You can call this output shapefile anything you want.

# Troubleshooting

1. If you get “Unexpected Error 999999” try saving your outputs to a local drive instead of the external hard drive.
2. Running more than 30 image files at once can be a bit unstable, so you can try breaking the job up into smaller chunks.
3. If one image file is causing problems, take it out of the image folder and run everything else.
4. ArcMap will sometimes crash if the tool is run twice in a row. I recommend restarting Arcmap between runs.
5. Stumped? Take a screenshot of you error and email [forest.carter@gmail.com](mailto:forest.carter@gmail.com)
6. If nothing else works, put on some sunscreen and go outside and count them. :)