

Finding Seed Traps In USGS Plots

Samantha Davis

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1 Introduction

I made a series of functions that will rotate “crooked” plots and draw subplot lines for those plots, to generate corners. These subpolygon corners are needed by the function `trap_UTM`. This PDF will introduce the use of those functions and hopefully, barring any weird or bad data, we can generate seed trap locations for any plots of interest.

2 Loading the Package and Data

I used “BBBPIPO” as my sample plot, simply because it was at the top of the list. Now, you’ll need to have a few data files loaded into R. I’ve saved the individual trees file as `treeinfo`, the seedling counts as `seedlings`, and the plot descriptions as `plotinfo`. I’ll load these locally and do a `head()` command so that you can see:

```
> load("../data/plotinfo.RData")
> load("../data/seedlings.RData")
> load("../data/treeinfo.RData")
> head(plotinfo)
```

	Plot	Park	Elev	UTME	UTMN	size_ha	sdl_pl	BA_m2_ha	Est	Burn	Sdl.
1	YOHOPIPO	YOSE	1500	247367.0	4187650	1.0	2	76.4	1991	2007	1
2	BBBPIPO	SEKI	1609	339876.0	4048133	1.0	2	66.5	1992	<NA>	1
3	CCRPIPO	SEKI	1637	338884.0	4048723	1.1	2	68.3	1991	<NA>	1
4	CRCRPIPO	YOSE	1637	255941.6	4179572	1.0	2	77.8	1993	<NA>	1
5	FFS7CONTROL	<NA>	1941	342286.0	4049870	1.0	.	.	2001	<NA>	1
6	FFS6BURN	<NA>	2018	342588.0	4050299	1.0	.	.	2001	2003	1

	Clim99_08.	Adults.	ABCO	ABMA	CADE	PICO	PIJE	PILA	PIMO	PIPO	PSME	QUCH	QUKE	SEGI
1	1	1	35	0	32	0	0	26	0	5	1	0	1	0
2	1	1	12	0	55	0	0	5	0	4	0	1	24	0
3	1	1	46	0	30	0	0	5	0	4	0	0	15	0
4	1	1	44	0	29	0	0	19	0	6	0	0	2	0
5	0	1	.	.	.	.	.	.	.	.	.	.	.	.

```

6          0          1      .      .      .      .      .      .      .      .      .
      Forest X
1      Mixed conifer
2      Mixed conifer
3      Mixed conifer
4      Mixed conifer
5 White fir - mixed
6 White fir - mixed

> head(seedlings)

  PLOT_NAME SUBPLOT QUADRAT SPPCODE SIZE_CLASS COUNT1999 COUNT2000 COUNT2001 COUNT2002
1  BBBPIPO      6      1   ABCO      1          0          0          0          0
2  BBBPIPO      6      1   ABCO      2         62         26          0          2
3  BBBPIPO      6      1   ABCO     10          0          4         28         19
4  BBBPIPO      6      1   CADE      1          0          4          0          0
5  BBBPIPO      6      1   CADE      2          6          1          0          6
6  BBBPIPO      6      1   CADE     10          4          9          6          0
  COUNT2003 COUNT2004 COUNT2005 COUNT2006 COUNT2007 COUNT2008 COUNT2009 DATA_YEAR
1          0          0          0          0          0          0          5      2009
2          1          2          1          0          0          2          0      1999
3         19         10          6          4          5          3          2      2000
4         21          0         36          3         16          0          0      2000
5          0          0          0          0          1          1          0      1999
6          5          3          1          2          2          1          1      1999

> head(treeinfo)

  PLOT SUBPLOT TAGNUMBER SppCode IngrowthYear YearFirstRecorded MortalityYear DBH1
1 BBBPIPO      1      1991   ABCO          NA          1992          NA    4.4
2 BBBPIPO      1      2012   ABCO          NA          1992          NA    8.7
3 BBBPIPO      1      2015   ABCO          NA          1992          NA    5.1
4 BBBPIPO      1      2022   ABCO          NA          1992          NA    3.2
5 BBBPIPO      1      1954   CADE          NA          1992          NA 106.6
6 BBBPIPO      1      1955   CADE          NA          1992          NA  31.1
  DBH2 DBH3 DBH4 DBH5 DBH6 DBH7 XCoord YCoord
1  5.0  5.6  6.0  6.2  NA  NA 339902.5 4048132
2  9.1  9.8 10.4 11.1  NA  NA 339908.8 4048134
3  5.5  5.5  3.5  6.0  NA  NA 339908.2 4048137
4  2.9  3.3  4.0  4.9  NA  NA 339905.2 4048131
5 106.1 107.5 106.0 106.4 NA  NA 339882.4 4048139
6  32.7  34.9  38.0  40.3 NA  NA 339887.7 4048137

```

As you can see, these are more or less unchanged from the original data files. We'll also need one more piece. I've been trying to put functions that I create into R packages for reusability. These R packages, so far, are *not* on CRAN, but I do upload the packages to my GitHub. The package "devtools" in R has

a neat little tool that allows you to install a package directly from GitHub. Uncomment the lines that you need, below, to install packages and download my package, nicknamed "disperseR" – this will give you the functions to rotate plots.

```
> #install.packages("devtools")
> library(devtools)
> #install_github("ecology-rocks/disperseR")
> library(disperseR)
```

You can access the code by typing the name of the function directly into the R console. So, if something isn't working, you can try to modify it, or at least see how it works and how you might change your inputs. This package is a work in progress, and I'll be trying to update it daily, so if you access it later, you can always redownload and install from GitHub.

Because it's on GitHub, you can also download the source and try to add your own updates and documentation. You can click [here](#) to get a bare-bones introduction to writing packages, and RStudio is an IDE that helps tremendously by streamlining both the package building and GitHub sharing process.

Finally, if you have a question about how to use a function in disperseR, you can access the function's help file by using the standard help feature, `?function` in R. You can also do this with any data included.

Okay, onto the real code.

3 Rotating The Plot

Given the `TrapUTM()` function, we have a working, repeatable algorithm to find seed trap locations, as long as the plots are situated so that their sides are parallel with the four cardinal directions. Unfortunately, not all of the plots are situated in that fashion. BBBPIPO, for example, is in more of a "diamond" shape when you plot it. So, the first thing I did was to write a series of functions that take the plot, and its southwestern corner (found in `plotinfo`), and rotates it so that its southernmost point in the original plot will have the same y (North/South) value as the southwestern corner.

To do this, I found the angle of rotation, converted the points from a Cartesian system (x,y) to a Polar system (distance, angle), added the angle of rotation to each of the angles, then converted the points back to a Cartesian system. Since this rotation makes the UTMN/UTME points essentially useless, I have the new origin (southwest corner) set to (0,0), but it could be easily set to something else with the function's flexibility. Here's how it works:

```
> ## separate out bbbpipo
> bbbpipo <- treeinfo[treeinfo$PLOT=="BBBPIPO",]
> colnames(bbbpipo) <- c("plot", "subplot", "tag", "spp",
+                        "ingrowth", "firstrec", "deathyear", "dbh1",
+                        "dbh2", "dbh3", "dbh4", "dbh5",
```

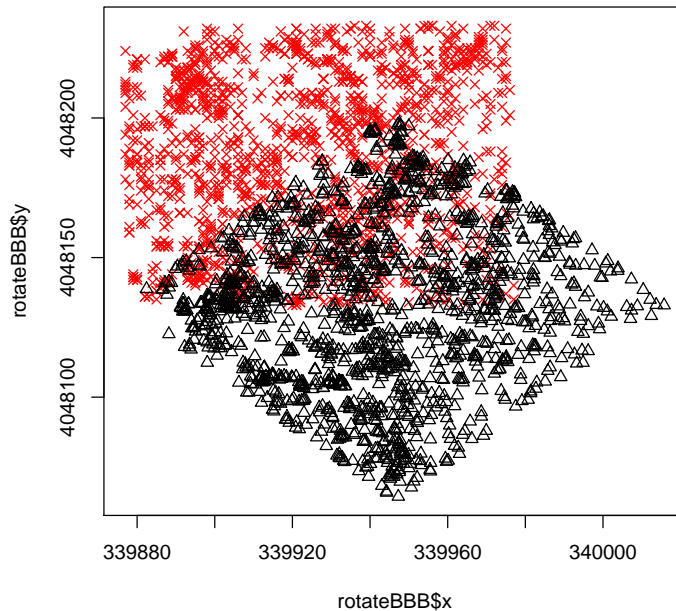
```

+           "dbh6", "dbh7", "x", "y")
> ## pull out the plot origin from plotinfo
> bbbpipoOrigin <- data.frame(x=plotinfo[plotinfo$Plot=="BBBPIPO", "UTME"],
+                             y=plotinfo[plotinfo$Plot=="BBBPIPO", "UTMN"],
+                             stringsAsFactors=FALSE)
> bbbpipoOrigin

      x      y
1 339876 4048133

> ## In this example, you can rotate the plot and set the origin to the trueSW
> ## values. I'm doing it this way to show how the plot is rotated. This function
> ## takes your large tree dataframe (bbbpipo), and your "true southwestern corner"
> ## coordinates as a vector.
> rotateBBB <- rotatePlot(bbbpipo,
+                          truesw=c(bbbpipoOrigin[1,1],
+                                    bbbpipoOrigin[1,2]),
+                          origin=c(bbbpipoOrigin[1,1],
+                                    bbbpipoOrigin[1,2]))
> ## check our work
> plot(rotateBBB$x,
+      rotateBBB$y,
+      xlim=c(min(rotateBBB$x),
+              max(bbbpipo$x)),
+      ylim=c(min(bbbpipo$y),
+              max(rotateBBB$y)),
+      col="red",
+      pch=4)
> points(bbbpipo$x,
+        bbbpipo$y,
+        col="black",
+        pch=2)
> ## Let's overwrite rotateBBB and let the origin be the default, c(0,0), for ease
> ## of reading and seeing later on. This is just changing the values of (x,y) by
> ## a uniform amount.
> rotateBBB <- rotatePlot(bbbpipo,
+                          truesw=c(bbbpipoOrigin[1,1],
+                                    bbbpipoOrigin[1,2]))

```



Let's check and make sure that our rotated plot is the correct size. According to the `plotinfo` file, it should be about a hectare or 100mx100m.

```
> ## set our min and max values
> corners <- c(min(rotateBBB$x),
+             max(rotateBBB$x),
+             min(rotateBBB$y),
+             max(rotateBBB$y))
> ## make sure the plot is actually 100x100
> corners[2]-corners[1]

[1] 100

> corners[4]-corners[3]

[1] 100
```

4 Generating Subplot Corners

Okay. We know the plot is 100x100, and we know the subplot file originally used had the important columns: "Subplot", "POINT_X", and "POINT_Y". So, we need to replicate that. Let's build all of the corners, then look in the middle for a subplot identity. First, we're going to use the function "getSubplotCoords",

which basically returns a vector of values, by 25m increments, until all possible points are surrounded. So, if you have 100 m of possible points, this function will return a vector of `c(0, 25, 50, 75, 100)`, taking into account your `min(x)` and `max(x)`. This particular rotation has the x-values starting at 1 and the y values starting at 0, so we'll get back vectors of `c(1, 26...101)` and `c(0, 25...100)`. I wrote it as a function so that if we have rectangular plots, it'll work just the same.

```
> ## get coords
> xcoords <- getSubplotCoords(corners[1:2], increment=25)
> ycoords <- getSubplotCoords(corners[3:4], increment=25)
> ##make sure the values are right...
> xcoords

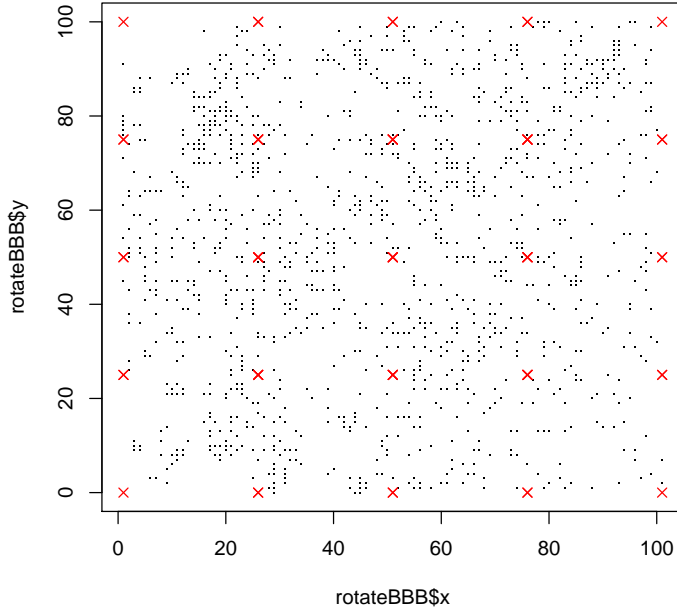
[1] 1 26 51 76 101

> ycoords

[1] 0 25 50 75 100
```

So we have the coordinates, and now we need to build the subplot boxes. We know that all subplots are 25 m x 25 m, so it makes sense that we can build boxes using those corner values to fill the entire plot space. We can then assign a subplot identity to them. We'll do that using "buildBoxes", then plot our results overtop of our rotated bbbpipo plot.

```
> bbbpipoSubs <- buildBoxes(xcoords, ycoords)
> ## check our work
> plot(rotateBBB$x, rotateBBB$y, pch=".")
> points(bbbpipoSubs$POINT_X, bbbpipoSubs$POINT_Y, col="red", pch=4)
>
```



5 Subplot Identities

Okay, the last thing we need to do is to assign the correct subplot identities. `buildBoxes` assigns arbitrary Subplot values that definitely do not match the true subplot values for our rotated plot. So, we can use the function `assignSubplots` to search the larger `data.frame` and figure out which subplots match our corners.

One note about `assignSubplots`: it does have tie breakers inside, since any rounding present inside the computer may have caused a slight shift in tree location according to subplot identity. E.g., a tree on the boundary between subplot 6 and 7 might be assigned to 7 instead of 6 in our subplot drawings. So, when we search the rotated plot for trees, we may find 100 trees in the area with an identity of 6, and 2 with an identity of 7.

Since the trees were kept equidistant from each other during the rotation, the subplots are (supposedly) a definite size, *and* the trees are only needed to assign subplot identity to find seed trap locations, this is not a big deal. It's just a necessary tie breaker. So the function `assignSubplots` does the following: For each box (set of four points in the `bbbpipoSubs` `data.frame`), it will subset `rotateBBB` to find all trees within those bounds. It will then count the number of trees for each subplot identified in that subset. In the run with `BBBPIPO`, during development of this function, 4 of the subplots had multiple records show, but they showed the same pattern as my example above: many in one identity,

one or a few in the other.

Finally, at the end of this, you'll need to write a CSV file for the TrapUTM function to read in. We might modify that later? This data.frame gets rid of the stuff associated with the ArcGIS exported CSV file, like the repeat points and unused columns.

```
> ## look at results
> finalsubplots <- assignSubplots(rotateBBB, bbbpipoSubs)
> ##take a look
> head(finalsubplots)
```

	POINT_X	POINT_Y	Subplot
1	1	0	4
2	1	25	4
3	26	0	4
4	26	25	4
5	26	0	8
6	26	25	8

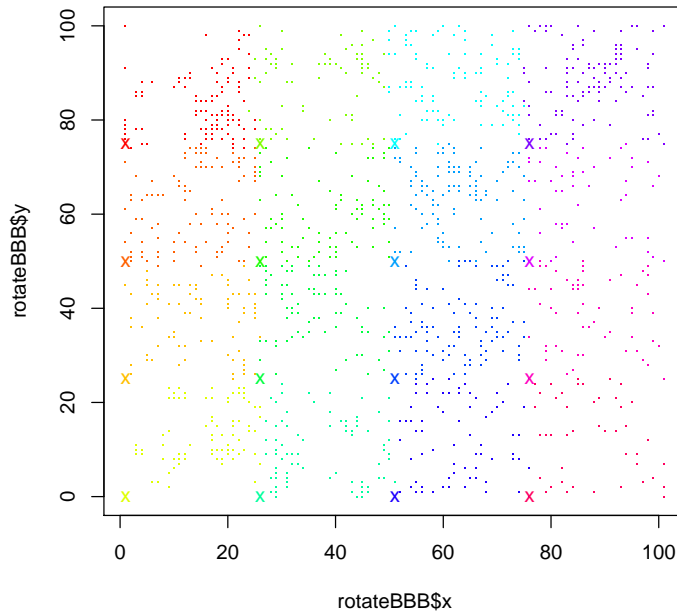
```
> tail(finalsubplots)
```

	POINT_X	POINT_Y	Subplot
59	76	75	9
60	76	100	9
61	76	75	13
62	76	100	13
63	101	75	13
64	101	100	13

```
> ##write.csv(finalsubplots, file="bbbpipo-subplots.csv")
```

And, as a proof of concept, we can take a look at the rotated plot with correct subplot locations. This figure is generated by getting a rainbow palette with N colors, plotting the individual trees with "." symbols, then overlaying the Subplot boundaries onto the graph by putting an "X" at the southwest start of each plot.

```
> rainbowColors <- rainbow(max(rotateBBB$subplot))
> palette(rainbowColors)
> plot(rotateBBB$x,
+      rotateBBB$y,
+      col=rotateBBB$subplot,
+      pch=".")
> points(finalsubplots$POINT_X,
+        finalsubplots$POINT_Y,
+        col=finalsubplots$Subplot,
+        pch=c("x", ".", ".", "."))
```

6 Finding Seed Trap Locations

Finally, let's do what we actually came here to do, which is stick these files into `TrapUTM` and get some seed trap locations. First, we need to figure out which subplots of `BBBPIPO` actually have seed traps. We can do this by taking a look at "seedlings", which has the subplots for seedlings.

```
> subplotsForTraps <- unique(seedlings$PLOT_NAME=="BBBPIPO", "SUBPLOT")
> subplotsForTraps
```

```
[1] 6 11
```

For ease, I've included `TrapUTM` in `disperseR` as is, and have not yet modified it, though I may do so later to clean up some of its function and make it a bit easier to read. The only thing I've changed is its name, to `trapUTM`, to match the style of other functions in the package. Ok, let's find our seed trap locations.

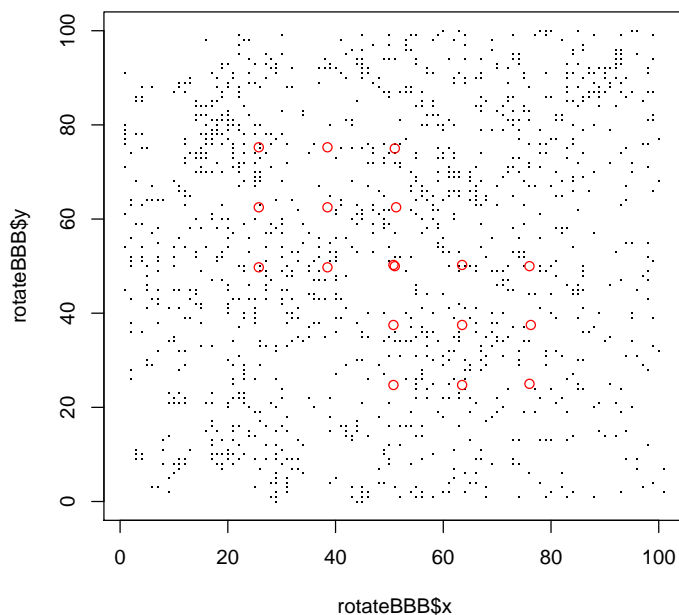
```
> trapcoords <- trapUTM(
+   filename="../data/BBBPIPO_subpolygon_corners.csv",
+   subplots=subplotsForTraps,
+   site="BBBPIPO",
```

```

+   bearing=0,
+   plotcorns=list(T,paste("../data/", "BBBPIP0", "_traps.png", sep=""))))

> plot(rotateBBB$x, rotateBBB$y, pch=".")
> points(trapcoords$XCoord, trapcoords$YCoord, col="red")

```



I'll be working to update this vignette and package until we can successfully do this with the other plots. I have not tested it with other plots, but I imagine it will work for the other plots as long as they're entered correctly and don't have anything different about subplot or seed trap locations. As an end note, you can access the most updated version of this vignette after installing through GitHub and loading this package by using the `vignette("FindingSeedTraps")` command; you can also list the vignettes for any attached package using `vignette(all=FALSE)`.