Calculate Burn Severity Patch Sizes with SDMtools in R

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Overview

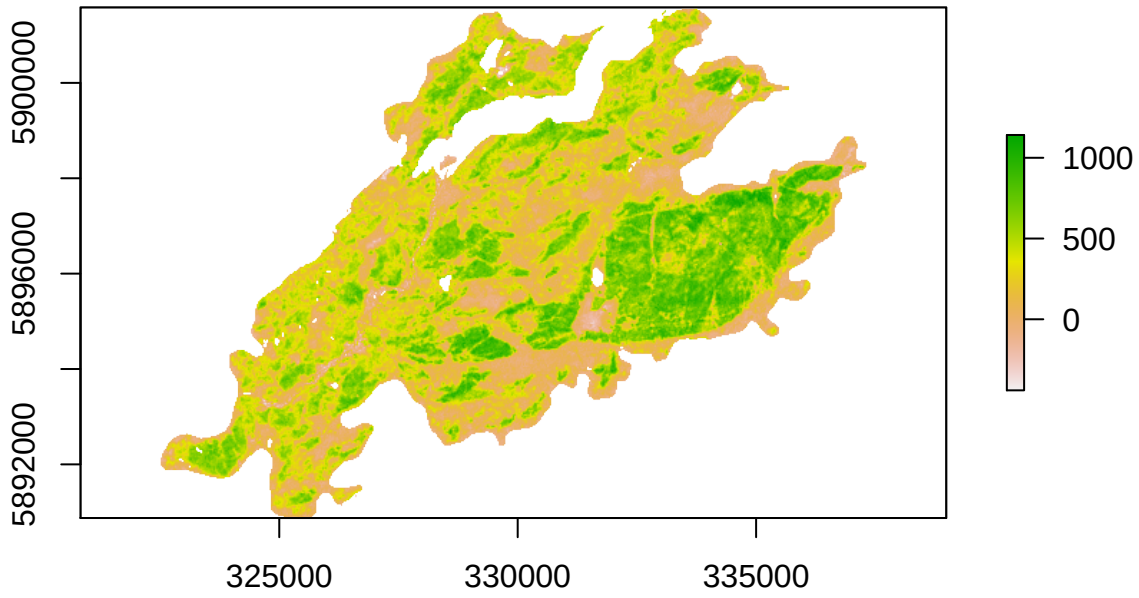
This analysis is focused on generating some descriptive statisitcs about patch size for burn severity classes across the burn mosaic. The SDMtools package is used for calculating patch metrics similar to FRAGSTATS. Other packages needs for this type of analysis are: raster, rgdal, sp, dplyr, and igraph.

Load Packages

Data

Read in data and veiw data.

```
entiako.no = raster("../raster/entiako_dNBR1_Clip31.TIF")
plot(entiako.no)
```




```
cellStats(entiako.no, 'min')#returns the minimum cell value -439.9731
```

```
## [1] -439.9731
```

```
cellStats(entiako.no, 'max')#returns the maximum cell value 1141.094
```

```
## [1] 1141.094
```

```
summary(entiako.no)
```

```
## Warning in sampleInt(length(x), size): size changed to n because it cannot
## be larger than n when replace is FALSE
```

```
## Warning in .local(object, ...): summary is an estimate based on a sample of 1e+05 cells (56.59% of al
```

```
##         entiako_dNBR1_Clip31
## Min.                -439.9731
## 1st Qu.              124.9195
## Median               321.8701
## 3rd Qu.              550.1217
## Max.                1141.0944
## NA's                   0.0000
```

```
structure(entiako.no)
```

```
## class       : RasterLayer
## dimensions  : 357, 495, 176715  (nrow, ncol, ncell)
## resolution  : 30, 30  (x, y)
## extent      : 322485, 337335, 5890875, 5901585  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=utm +zone=10 +datum=WGS84 +units=m +no_defs +ellps=WGS84 +towgs84=0,0,0
## data source : D:\OSU\Research\Chapter3_Patches\spatial_data\raster\entiako_dNBR1_Clip31.TIF
## names       : entiako_dNBR1_Clip31
## values      : -439.9731, 1141.094  (min, max)
```

Classify Raster

Raster is currently a continuous data set. Here it will be binned into classes based on break points outlined by Reilly et al 2017 for this exercise.

First, define matrix with 3 columns - from, to, becomes. 1 will be low/unburned, 2 will be moderate, and 3 with be high burn severity classes. Break points are from a dNBR Raster.

```
m = c(-439.9731,235,1, 235,649,2, 649,1142,3)
rclmatrix = matrix(m, ncol=3, byrow=TRUE)
```

Then, apply the function to reclassify and write raster to save the classified raster.

```
classburn = reclassify(entiako.no, rclmatrix, right = FALSE,
                       filename="../raster/entiako_class_Reilly_v1", format="GTiff",
                       overwrite=TRUE)
```

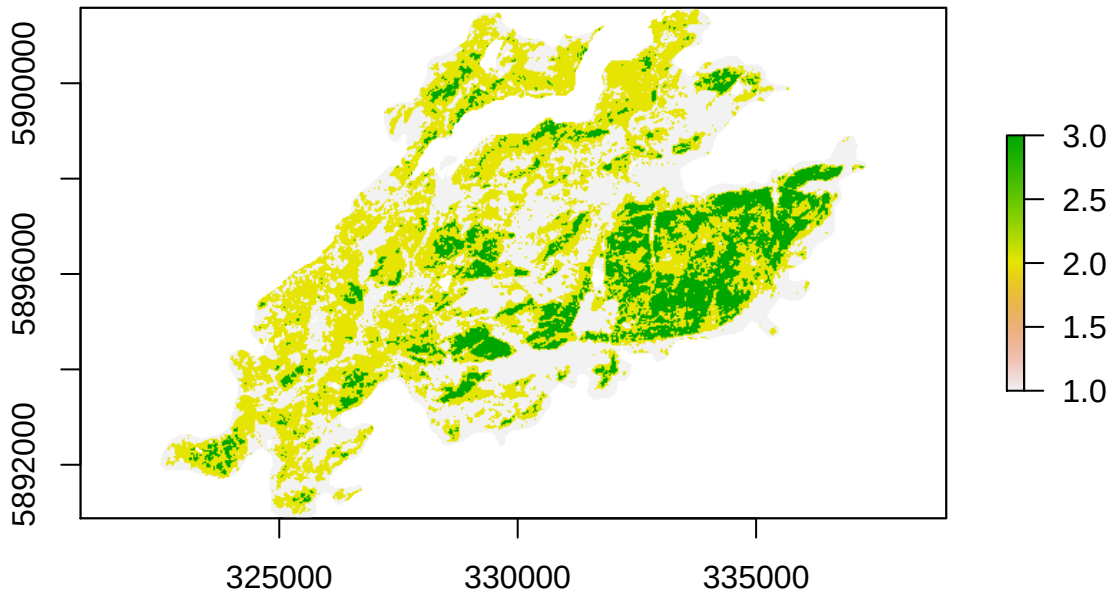
Now read in the classified raster and explore the data

```
enclr = raster("../raster/entiako_class_Reilly_v1.TIF")
structure(enclr)
```

```
## class       : RasterLayer
## dimensions  : 357, 495, 176715  (nrow, ncol, ncell)
## resolution  : 30, 30  (x, y)
## extent      : 322485, 337335, 5890875, 5901585  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=utm +zone=10 +datum=WGS84 +units=m +no_defs +ellps=WGS84 +towgs84=0,0,0
## data source : D:\OSU\Research\Chapter3_Patches\spatial_data\raster\entiako_class_Reilly_v1.TIF
## names       : entiako_class_Reilly_v1
```

```
## values      : 1, 3  (min, max)
```

```
plot(enclr)
```




```
cellStats(enclr, min)
```

```
## [1] 1
```

```
cellStats(enclr, max)
```

```
## [1] 3
```

```
cellStats(enclr, median)
```

```
## [1] 2
```

Fragstats in R

Here I will use the SDMtools package in R to calculate similar metrics to those in FRAGSTATS and the Patch Analyst/Grid extension in Arc GIS.

Class Statistics

First, calculate class statistics based on the binned fire severity classes created in the classified raster for the entire area in the fire perimeter.

```
entiako_classr_metrics = ClassStat(enclr, cellsize = 30)

dplyr::tbl_df(entiako_classr_metrics)
```

```
## # A tibble: 3 × 38
##   class n.patches total.area prop.landscape patch.density total.edge
## * <dbl>     <int>      <dbl>          <dbl>         <dbl>      <dbl>
## 1     1       382   27671400      0.3936395  5.434141e-06     625500
## 2     2       448   31797900      0.4523410  6.373024e-06     912420
## 3     3       422   10827000      0.1540195  6.003161e-06     348480
## # ... with 32 more variables: edge.density <dbl>,
## #   landscape.shape.index <dbl>, largest.patch.index <dbl>,
## #   mean.patch.area <dbl>, sd.patch.area <dbl>, min.patch.area <dbl>,
## #   max.patch.area <dbl>, perimeter.area.frac.dim <dbl>,
## #   mean.perim.area.ratio <dbl>, sd.perim.area.ratio <dbl>,
## #   min.perim.area.ratio <dbl>, max.perim.area.ratio <dbl>,
## #   mean.shape.index <dbl>, sd.shape.index <dbl>, min.shape.index <dbl>,
## #   max.shape.index <dbl>, mean.frac.dim.index <dbl>,
## #   sd.frac.dim.index <dbl>, min.frac.dim.index <dbl>,
## #   max.frac.dim.index <dbl>, total.core.area <dbl>,
## #   prop.landscape.core <dbl>, mean.patch.core.area <dbl>,
## #   sd.patch.core.area <dbl>, min.patch.core.area <dbl>,
## #   max.patch.core.area <dbl>, prop.like.adjacencies <dbl>,
## #   aggregation.index <dbl>, lanscape.division.index <dbl>,
## #   splitting.index <dbl>, effective.mesh.size <dbl>,
## #   patch.cohesion.index <dbl>
```

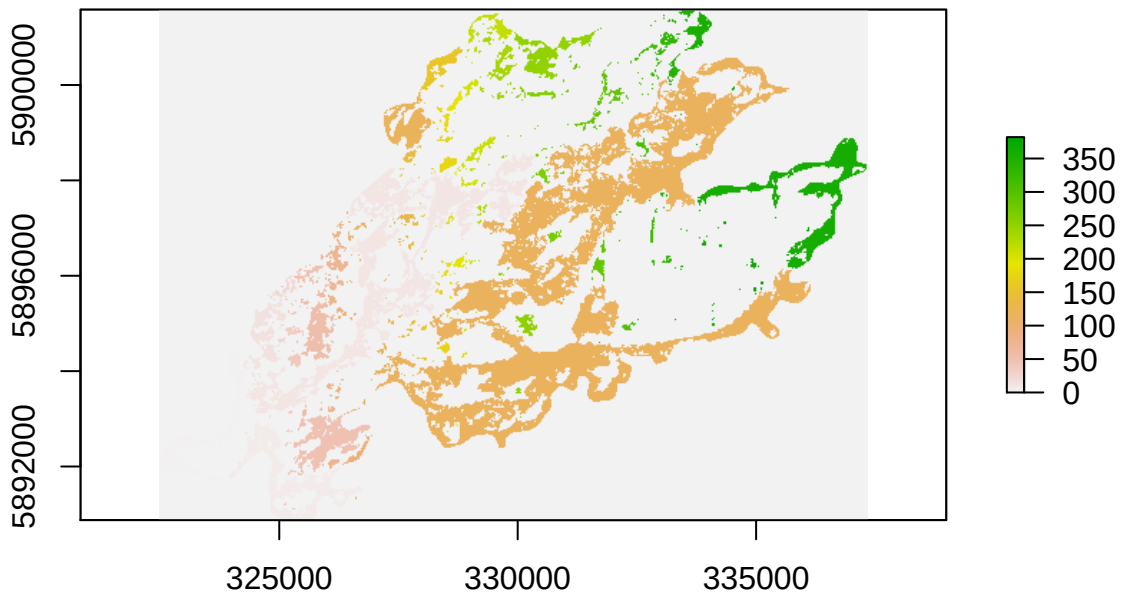
```
write.csv(entiako_classr_metrics, "../output/class_Reilly_1")
```

Patch ID and Patch Stats

Then, use the ConnCompLabel function to ID patches followed by the patchstat function to calculate patch statistics. I had to trouble shoot here a bit, and found that performing the function on each individual class allowed the function to perform appropriately.

Combined class of low and unburned

```
lowr = ConnCompLabel(enclr %in% c(1))
plot(lowr)
```



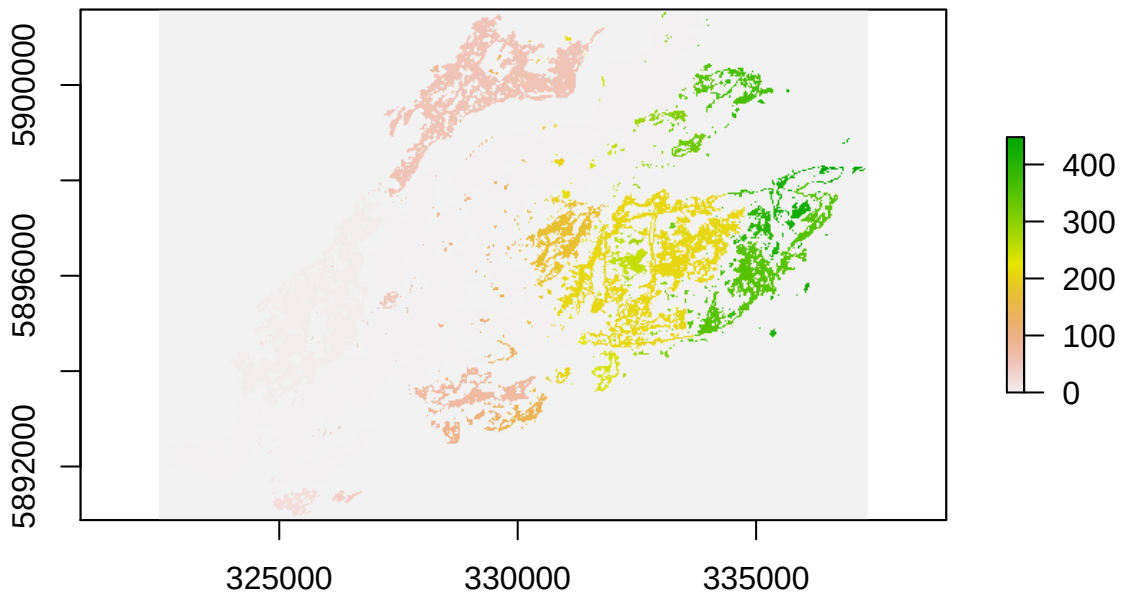

```
lowr_patchstat = PatchStat(lowr, cellsize = 30)
dplyr::tbl_df(lowr_patchstat)
```

```
## # A tibble: 383 × 12
##    patchID n.cell n.core.cell n.edges.perimeter n.edges.internal      area
##      <int>  <int>       <int>             <int>            <int>     <dbl>
## 1        0 145969      125446             22536           561340 131372100
## 2        1    612         167               522             1926    550800
## 3        2      2           0                 6                2      1800
## 4        3     11           0                22               22      9900
## 5        4      1           0                 4                0       900
## 6        5      1           0                 4                0       900
## 7        6   1292         520               868             4300   1162800
## 8        7      1           0                 4                0       900
## 9        8      1           0                 4                0       900
## 10       9     15           0                26               34     13500
## # ... with 373 more rows, and 6 more variables: core.area <dbl>,
## #   perimeter <dbl>, perim.area.ratio <dbl>, shape.index <dbl>,
## #   frac.dim.index <dbl>, core.area.index <dbl>
```

```
write.csv(lowr_patchstat, "../output/low_patch_Reilly_1")
```

Class Moderate Burn Severity

```
modr = ConnCompLabel(enclr %in% c(2))
plot(modr)
```



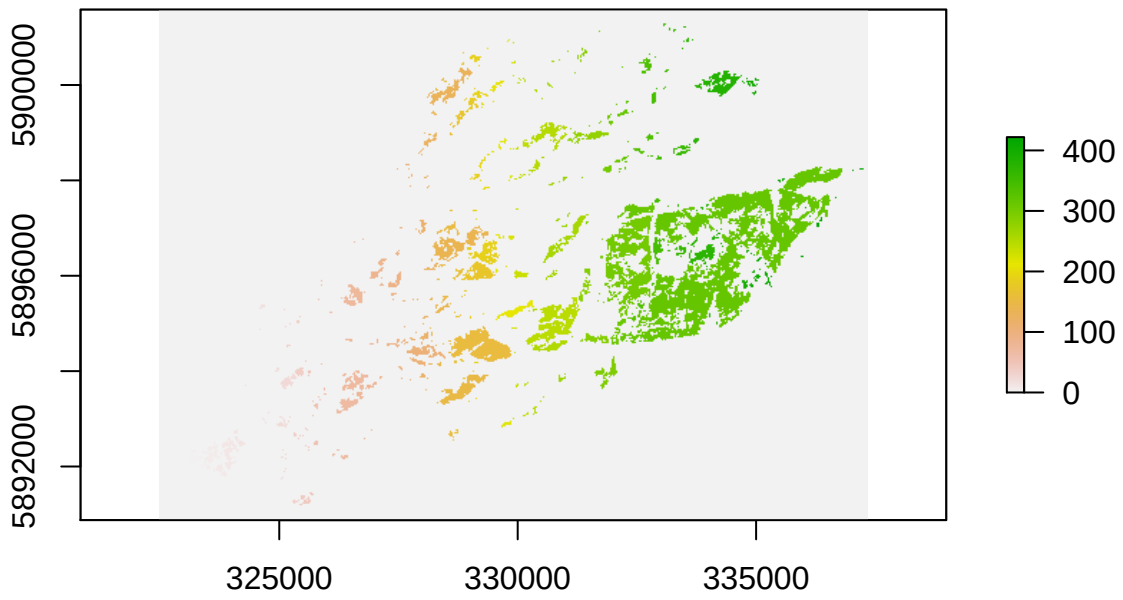

```
modr_patchstat = PatchStat(modr, cellsize = 30)
dplyr::tbl_df(modr_patchstat)
```

```
## # A tibble: 449 × 12
##    patchID n.cell n.core.cell n.edges.perimeter n.edges.internal      area
##      <int>  <int>       <int>             <int>            <int>     <dbl>
## 1        0 141384      115237             32118           533418 127245600
## 2        1  16241        5622             12072            52892  14616900
## 3        2      1           0                 4                0       900
## 4        3      2           0                 6                2      1800
## 5        4      3           0                 8                4      2700
## 6        5   4432        1840              2720            15008   3988800
## 7        6      1           0                 4                0       900
## 8        7      2           0                 6                2      1800
## 9        8      1           0                 4                0       900
## 10       9      3           0                 8                4      2700
## # ... with 439 more rows, and 6 more variables: core.area <dbl>,
## #   perimeter <dbl>, perim.area.ratio <dbl>, shape.index <dbl>,
## #   frac.dim.index <dbl>, core.area.index <dbl>
```

```
write.csv(modr_patchstat, "../output/mod_patch_Reilly_1")
```

Class High Burn Severity

```
highr = ConnCompLabel(enclr %in% c(3))
plot(highr)
```




```
highr_patchstat = PatchStat(highr, cellsize = 30)
dplyr::tbl_df(highr_patchstat)
```

```
## # A tibble: 423 × 12
##    patchID n.cell n.core.cell n.edges.perimeter n.edges.internal      area
##      <int>  <int>       <int>             <int>            <int>     <dbl>
## 1        0 164685      151820             13320           645420 148216500
## 2        1      4           0                 8                8      3600
## 3        2     15           0                30               30     13500
## 4        3      4           0                10                6      3600
## 5        4      2           0                 6                2      1800
## 6        5     11           0                22               22      9900
## 7        6     69           1               100              176     62100
## 8        7      3           0                 8                4      2700
## 9        8     29           3                38               78     26100
## 10       9      2           0                 6                2      1800
## # ... with 413 more rows, and 6 more variables: core.area <dbl>,
## #   perimeter <dbl>, perim.area.ratio <dbl>, shape.index <dbl>,
## #   frac.dim.index <dbl>, core.area.index <dbl>
```

```
write.csv(highr_patchstat, "../output/high_patch_Reilly_1")
```

Descriptive Analysis of Patch Area

Here, I read back in the data from the above functions, reorganize, and calculate some additional columns of data.

```
low = read.csv("../output/low_patch_Reilly_1")
low = low[-c(1), -c(1)]
low = mutate(low, burnclass = "low")
head(low)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal    area
## 1       1    612         167               522             1926  550800
## 2       2      2           0                 6                2    1800
## 3       3     11           0                22               22    9900
## 4       4      1           0                 4                0     900
## 5       5      1           0                 4                0     900
## 6       6   1292         520               868             4300 1162800
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1    150300     15660       0.02843137    5.220000       1.251606
## 2         0       180       0.10000000    1.000000       1.015714
## 3         0       660       0.06666667    1.571429       1.109953
## 4         0       120       0.13333333    1.000000       1.000000
## 5         0       120       0.13333333    1.000000       1.000000
## 6    468000     26040       0.02239422    6.027778       1.257465
##   core.area.index burnclass
## 1       0.2728758       low
## 2       0.0000000       low
## 3       0.0000000       low
## 4       0.0000000       low
## 5       0.0000000       low
## 6       0.4024768       low
```

```
mod = read.csv("../output/mod_patch_Reilly_1")
mod = mod[-c(1), -c(1) ]
mod = mutate(mod, burnclass = "mod")
head(mod)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal     area
## 1       1  16241        5622             12072            52892 14616900
## 2       2      1           0                 4                0      900
## 3       3      2           0                 6                2     1800
## 4       4      3           0                 8                4     2700
## 5       5   4432        1840              2720            15008  3988800
## 6       6      1           0                 4                0      900
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1   5059800    362160       0.02477680    23.67059       1.383654
## 2         0       120       0.13333333     1.00000       1.000000
## 3         0       180       0.10000000     1.00000       1.015714
## 4         0       240       0.08888889     1.00000       1.036411
## 5   1656000     81600       0.02045728    10.14925       1.305782
## 6         0       120       0.13333333     1.00000       1.000000
##   core.area.index burnclass
## 1       0.3461610       mod
## 2       0.0000000       mod
## 3       0.0000000       mod
## 4       0.0000000       mod
## 5       0.4151625       mod
## 6       0.0000000       mod
```

```
high = read.csv("../output/high_patch_Reilly_1")
high = high[-c(1), -c(1)]
high = mutate(high, burnclass = "high")
head(high)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal  area
## 1       1      4           0                 8                8  3600
## 2       2     15           0                30               30 13500
## 3       3      4           0                10                6  3600
## 4       4      2           0                 6                2  1800
## 5       5     11           0                22               22  9900
## 6       6     69           1               100              176 62100
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1         0       240       0.06666667    1.000000       1.000000
## 2         0       900       0.06666667    1.875000       1.138979
## 3         0       300       0.08333333    1.250000       1.054500
## 4         0       180       0.10000000    1.000000       1.015714
## 5         0       660       0.06666667    1.571429       1.109953
## 6       900      3000       0.04830918    2.941176       1.199669
##   core.area.index burnclass
## 1      0.00000000      high
## 2      0.00000000      high
## 3      0.00000000      high
## 4      0.00000000      high
## 5      0.00000000      high
## 6      0.01449275      high
```

Here, I will combine my low, moderate, and high burn severity class tables into one table.

```
patch_burnclass = bind_rows(low, mod, high)
summary(patch_burnclass)
```

```
##     patchID          n.cell          n.core.cell      n.edges.perimeter
##  Min.   :  1.0   Min.   :    1.00   Min.   :   0.00   Min.   :    4.00
##  1st Qu.:105.0   1st Qu.:    1.00   1st Qu.:   0.00   1st Qu.:    4.00
##  Median :209.0   Median :    2.00   Median :   0.00   Median :    6.00
##  Mean   :210.0   Mean   :   62.39   Mean   :  22.61   Mean   :   50.22
##  3rd Qu.:313.2   3rd Qu.:    6.00   3rd Qu.:   0.00   3rd Qu.:   12.00
##  Max.   :448.0   Max.   :16241.00   Max.   :8755.00   Max.   :12072.00
##  n.edges.internal       area            core.area         perimeter
##  Min.   :    0.0   Min.   :     900   Min.   :      0   Min.   :   120
##  1st Qu.:    0.0   1st Qu.:     900   1st Qu.:      0   1st Qu.:   120
##  Median :    2.0   Median :    1800   Median :      0   Median :   180
##  Mean   :  199.3   Mean   :   56147   Mean   :  20344   Mean   :  1507
##  3rd Qu.:   10.0   3rd Qu.:    5400   3rd Qu.:      0   3rd Qu.:   360
##  Max.   :56590.0   Max.   :14616900   Max.   :7879500   Max.   :362160
##  perim.area.ratio   shape.index     frac.dim.index  core.area.index
##  Min.   :0.01427   Min.   : 1.000   Min.   :1.000   Min.   :0.00000
##  1st Qu.:0.06667   1st Qu.: 1.000   1st Qu.:1.000   1st Qu.:0.00000
##  Median :0.10000   Median : 1.000   Median :1.016   Median :0.00000
##  Mean   :0.09971   Mean   : 1.343   Mean   :1.046   Mean   :0.02058
##  3rd Qu.:0.13333   3rd Qu.: 1.333   3rd Qu.:1.078   3rd Qu.:0.00000
##  Max.   :0.13333   Max.   :23.671   Max.   :1.384   Max.   :0.60072
##   burnclass
##  Length:1252
```

```
##  Class :character
##  Mode  :character
##
##
##
```

```
patch_burnclass = mutate(patch_burnclass, area.ha = area * 0.0001)
head(patch_burnclass)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal    area
## 1       1    612         167               522             1926  550800
## 2       2      2           0                 6                2    1800
## 3       3     11           0                22               22    9900
## 4       4      1           0                 4                0     900
## 5       5      1           0                 4                0     900
## 6       6   1292         520               868             4300 1162800
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1    150300     15660       0.02843137    5.220000       1.251606
## 2         0       180       0.10000000    1.000000       1.015714
## 3         0       660       0.06666667    1.571429       1.109953
## 4         0       120       0.13333333    1.000000       1.000000
## 5         0       120       0.13333333    1.000000       1.000000
## 6    468000     26040       0.02239422    6.027778       1.257465
##   core.area.index burnclass area.ha
## 1       0.2728758       low   55.08
## 2       0.0000000       low    0.18
## 3       0.0000000       low    0.99
## 4       0.0000000       low    0.09
## 5       0.0000000       low    0.09
## 6       0.4024768       low  116.28
```

From the combined table generated above I calculate some Summary Stats for patch area by burn severity class

```
patch_burnclass %>% group_by(burnclass) %>%
  summarise(n = length(patchID),
            min = min(area.ha),
            max = max(area.ha),
            mean = mean(area.ha),
            median = median(area.ha),
            sd = sd(area.ha))
```

```
## # A tibble: 3 × 7
##   burnclass     n   min     max     mean median       sd
##       <chr> <int> <dbl>   <dbl>    <dbl>  <dbl>    <dbl>
## 1      high   422  0.09  445.95 2.565640   0.18 22.51552
## 2       low   382  0.09 1449.45 7.243822   0.18 77.69004
## 3       mod   448  0.09 1461.69 7.097746   0.18 75.32307
```

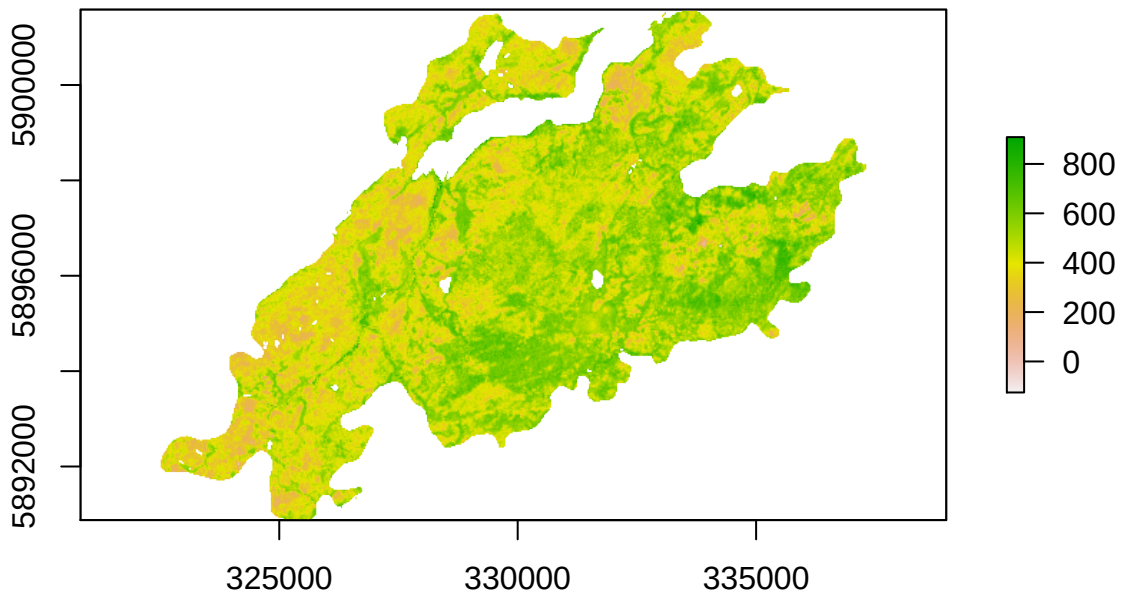
Here, I read in the class metrics for the entire fire perimeter and add two columns with area by hectares instead of meters squared.

```
landclass = read.csv("../output/class_Reilly_1")
landclass = mutate(landclass, area.ha = total.area * 0.0001)
landclass = mutate(landclass, meanpatch.area.ha = mean.patch.area * 0.0001)
head(landclass)
```

```
##   X class n.patches total.area prop.landscape patch.density total.edge
## 1 1     1       382   27671400      0.3936395  5.434141e-06     625500
## 2 2     2       448   31797900      0.4523410  6.373024e-06     912420
## 3 3     3       422   10827000      0.1540195  6.003161e-06     348480
##   edge.density landscape.shape.index largest.patch.index mean.patch.area
## 1  0.008898050              29.70085          0.20619151        72438.22
## 2  0.012979631              40.44415          0.20793271        70977.46
## 3  0.004957302              26.40000          0.06343862        25656.40
##   sd.patch.area min.patch.area max.patch.area perimeter.area.frac.dim
## 1      776900.4            900       14494500              0.04520895
## 2      753230.7            900       14616900              0.05738855
## 3      225155.2            900        4459500              0.06437138
##   mean.perim.area.ratio sd.perim.area.ratio min.perim.area.ratio
## 1            0.09902628          0.03601475           0.01620615
## 2            0.10185290          0.03326557           0.02045728
## 3            0.09805182          0.03501571           0.01426859
##   max.perim.area.ratio mean.shape.index sd.shape.index min.shape.index
## 1            0.1333333         1.359461      1.1190882               1
## 2            0.1333333         1.366270      1.5554212               1
## 3            0.1333333         1.303656      0.7304071               1
##   max.shape.index mean.frac.dim.index sd.frac.dim.index min.frac.dim.index
## 1        15.41339            1.047376        0.06229210                  1
## 2        23.67059            1.042386        0.06399849                  1
## 3        10.98582            1.047241        0.05962384                  1
##   max.frac.dim.index total.core.area prop.landscape.core
## 1           1.331850        12294900          0.17490110
## 2           1.383654         9756900          0.13879678
## 3           1.313267         3419100          0.04863841
##   mean.patch.core.area sd.patch.core.area min.patch.core.area
## 1            32185.602          413117.55                   0
## 2            21778.795          261247.20                   0
## 3             8102.133           98779.48                   0
##   max.patch.core.area prop.like.adjacencies aggregation.index
## 1             7879500             0.7100825          83.52333
## 2             5059800             0.6458093          78.89907
## 3             1970100             0.6110888          76.56040
##   lanscape.division.index splitting.index effective.mesh.size
## 1               0.9530582        21.30297           3299835.5
## 2               0.9482219        19.31317           3639811.2
## 3               0.9956248       228.56132            307559.9
##   patch.cohesion.index area.ha meanpatch.area.ha
## 1             9.850008 2767.14          7.243822
## 2             9.849301 3179.79          7.097746
## 3             9.720694 1082.70          2.565640
```

Beetle OUtbreak Severity Summary

```
beetle <- raster("../raster/entiako_preNDMI1_nowater_noisland.TIF")
plot(beetle)
```



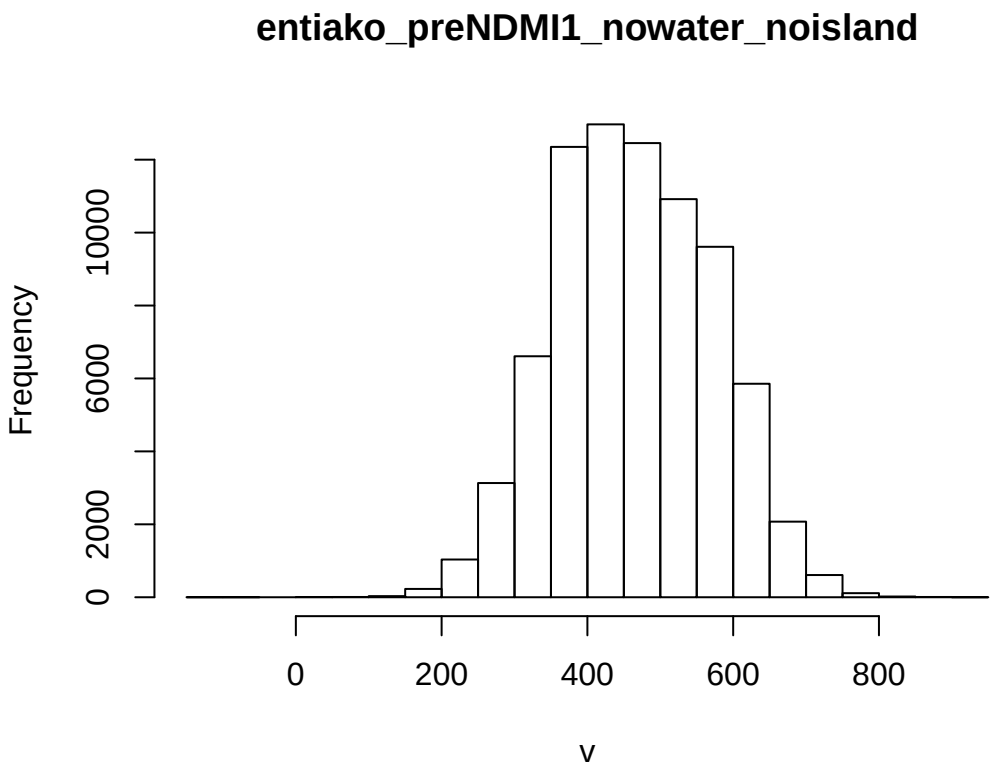

```
structure(beetle)
```

```
## class       : RasterLayer
## dimensions  : 357, 495, 176715  (nrow, ncol, ncell)
## resolution  : 30, 30  (x, y)
## extent      : 322485, 337335, 5890875, 5901585  (xmin, xmax, ymin, ymax)
## coord. ref. : +proj=utm +zone=10 +datum=WGS84 +units=m +no_defs +ellps=WGS84 +towgs84=0,0,0
## data source : D:\OSU\Research\Chapter3_Patches\spatial_data\raster\entiako_preNDMI1_nowater_noisland
## names       : entiako_preNDMI1_nowater_noisland
## values      : -125.6186, 908.6343  (min, max)
```

```
hist(beetle)
```

```
## Warning in sampleInt(length(x), size): size changed to n because it cannot
## be larger than n when replace is FALSE
```

```
## Warning in .hist1(x, maxpixels = maxpixels, main = main, plot = plot, ...):
## 57% of the raster cells were used (of which 22% were NA). 78031 values
## used.
```




```
cellStats(beetle, 'min')#returns the minimum cell value -125.6186
```

```
## [1] -125.6186
```

```
cellStats(beetle, 'max')#returns the maximum cell value 908.6343
```

```
## [1] 908.6343
```

Class breaks based on cross referencing orthophotos for no gray phase (600-909), low-mod gray-phase (450-600), mod-high gray phase -125.6186-450). Based on Normalized differenced Water Index (NDWI), aka Normalized differenced Moisture Index (NDMI).

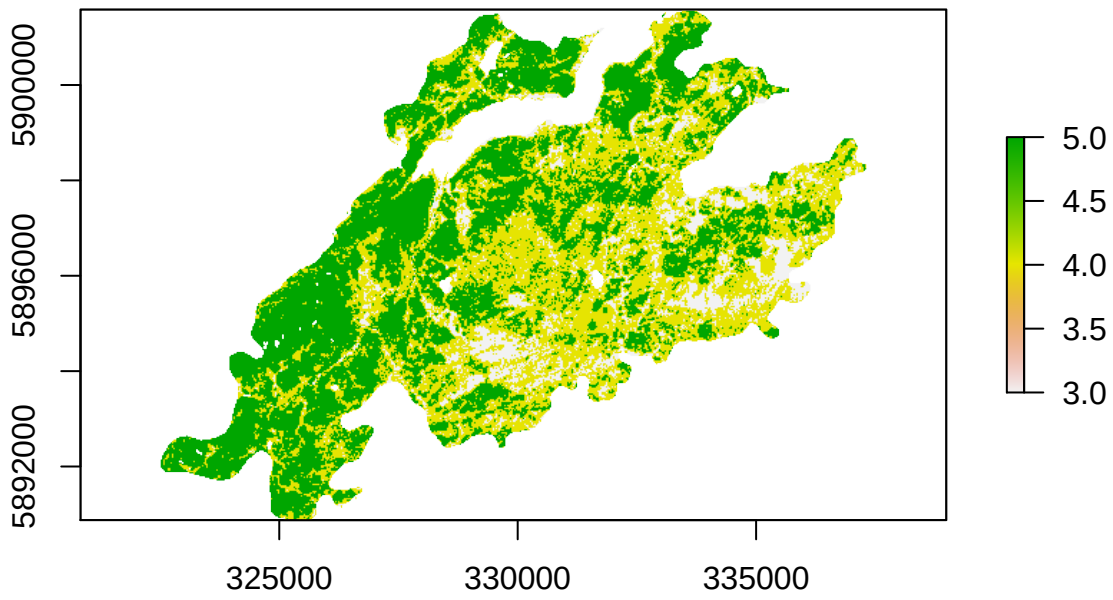
Define classification matrix - from, to, becomes Beetle Class offset from Fire Class for overlay analysis Use class 3, 4, 5 3=no beetle, 4=low-mod gray phase, 5=mod-high gray phase

```
mb = c(-125.6186,450,5, 450,600,4, 600,909,3)

bmatrix = matrix(mb, ncol=3, byrow=TRUE)

classbeetle = reclassify(beetle, bmatrix, right = FALSE,
                         filename="../raster/entiako_class_beetle_v7",
                         format="GTiff", overwrite=TRUE, datatype = "INT2U")

classbeetle = raster("../raster/entiako_class_beetle_v6.TIF")
plot(classbeetle)
```



Class Statistics

First, calculate class statistics based on the binned fire severity classes created in the classified raster for the entire area in the fire perimeter.

```
entiako_beetle_class = ClassStat(classbeetle, cellsize = 30)

dplyr::tbl_df(entiako_beetle_class)
```

```
## # A tibble: 3 × 38
##   class n.patches total.area prop.landscape patch.density total.edge
## * <dbl>     <int>      <dbl>          <dbl>         <dbl>      <dbl>
## 1     3       985    7809300      0.1111994  1.402576e-05     431400
## 2     4       656   29685600      0.4227038  9.341017e-06    1174740
## 3     5       709   32733000      0.4660968  1.009570e-05     780720
## # ... with 32 more variables: edge.density <dbl>,
## #   landscape.shape.index <dbl>, largest.patch.index <dbl>,
## #   mean.patch.area <dbl>, sd.patch.area <dbl>, min.patch.area <dbl>,
## #   max.patch.area <dbl>, perimeter.area.frac.dim <dbl>,
## #   mean.perim.area.ratio <dbl>, sd.perim.area.ratio <dbl>,
## #   min.perim.area.ratio <dbl>, max.perim.area.ratio <dbl>,
## #   mean.shape.index <dbl>, sd.shape.index <dbl>, min.shape.index <dbl>,
## #   max.shape.index <dbl>, mean.frac.dim.index <dbl>,
## #   sd.frac.dim.index <dbl>, min.frac.dim.index <dbl>,
## #   max.frac.dim.index <dbl>, total.core.area <dbl>,
## #   prop.landscape.core <dbl>, mean.patch.core.area <dbl>,
```

```
## #   sd.patch.core.area <dbl>, min.patch.core.area <dbl>,
## #   max.patch.core.area <dbl>, prop.like.adjacencies <dbl>,
## #   aggregation.index <dbl>, lanscape.division.index <dbl>,
## #   splitting.index <dbl>, effective.mesh.size <dbl>,
## #   patch.cohesion.index <dbl>
```

```
write.csv(entiako_beetle_class, "../output/entiako_beetle_class_1")
```

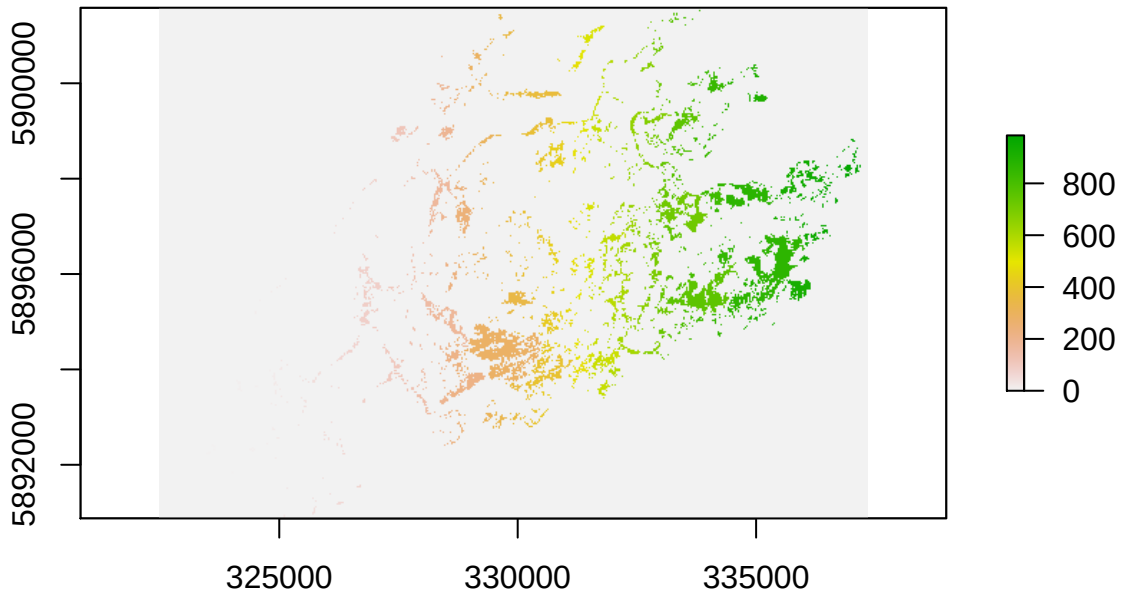
Patch ID and Patch Stats

Then, use the ConnCompLabel function to ID patches followed by the patchstat function to calculate patch statistics. I had to trouble shoot here a bit, and found that performing the function on each individual class allowed the function to perform appropriately.

Use class 3, 4, 5 3=no beetle, 4=low-mod gray phase, 5=mod-high gray phase

Class None for beetle severity

```
none = ConnCompLabel(classbeetle %in% c(3))
plot(none)
```




```
none_patchstat = PatchStat(none, cellsize = 30)
dplyr::tbl_df(none_patchstat)
```

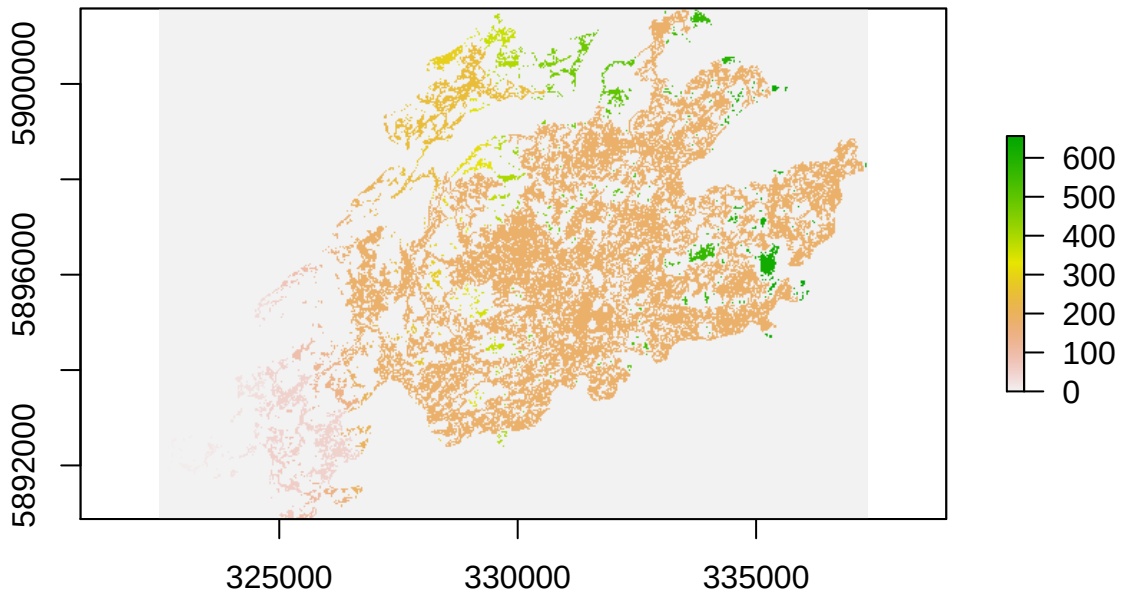
```
## # A tibble: 986 × 12
##    patchID n.cell n.core.cell n.edges.perimeter n.edges.internal      area
##      <int>  <int>       <int>             <int>            <int>     <dbl>
```

```
## 1        0 168038      150671             16084           656068 151234200
## 2        1      1           0                 4                0       900
## 3        2      3           0                10                2      2700
## 4        3      2           0                 8                0      1800
## 5        4      1           0                 4                0       900
## 6        5      1           0                 4                0       900
## 7        6      5           0                12                8      4500
## 8        7      5           0                14                6      4500
## 9        8      5           0                18                2      4500
## 10       9      2           0                 6                2      1800
## # ... with 976 more rows, and 6 more variables: core.area <dbl>,
## #   perimeter <dbl>, perim.area.ratio <dbl>, shape.index <dbl>,
## #   frac.dim.index <dbl>, core.area.index <dbl>
```

```
write.csv(none_patchstat, "../output/entiako_beetle_none_patch1")
```

Class low-moderate beetle severity

```
lowmod = ConnCompLabel(classbeetle %in% c(4))
plot(lowmod)
```




```
lowmod_patchstat = PatchStat(lowmod, cellsize = 30)
dplyr::tbl_df(lowmod_patchstat)
```

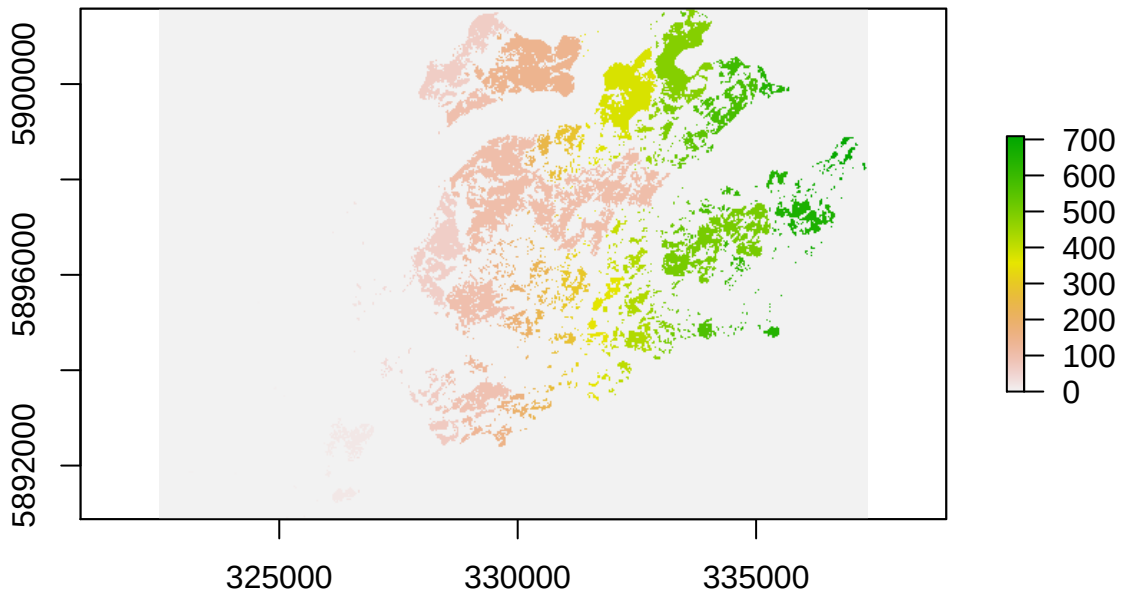
```
## # A tibble: 657 × 12
##    patchID n.cell n.core.cell n.edges.perimeter n.edges.internal      area
##      <int>  <int>       <int>             <int>            <int>     <dbl>
```

```
## 1        0 143731      113358             40850            534074 129357900
## 2        1     11           0                24                20      9900
## 3        2      4           0                 8                 8      3600
## 4        3      1           0                 4                 0       900
## 5        4      1           0                 4                 0       900
## 6        5      3           0                 8                 4      2700
## 7        6      3           0                10                 2      2700
## 8        7      6           0                12                12      5400
## 9        8     36           1                56                88     32400
## 10       9      2           0                 8                 0      1800
## # ... with 647 more rows, and 6 more variables: core.area <dbl>,
## #   perimeter <dbl>, perim.area.ratio <dbl>, shape.index <dbl>,
## #   frac.dim.index <dbl>, core.area.index <dbl>
```

```
write.csv(lowmod_patchstat, "../output/entiako_beetle_lowmod_patch1")
```

Class moderate-high beetle Severity

```
modhigh = ConnCompLabel(classbeetle %in% c(5))
plot(modhigh)
```




```
modhigh_patchstat = PatchStat(modhigh, cellsize = 30)
dplyr::tbl_df(modhigh_patchstat)
```

```
## # A tibble: 710 × 12
##    patchID n.cell n.core.cell n.edges.perimeter n.edges.internal      area
##      <int>  <int>       <int>             <int>            <int>     <dbl>
```

```
## 1        0 140345      116391             27722           533658 126310500
## 2        1  16240        9824              6736            58224  14616000
## 3        2      3           0                 8                4      2700
## 4        3      1           0                 4                0       900
## 5        4      1           0                 4                0       900
## 6        5      3           0                 8                4      2700
## 7        6      1           0                 4                0       900
## 8        7      1           0                 4                0       900
## 9        8      2           0                 8                0      1800
## 10       9      1           0                 4                0       900
## # ... with 700 more rows, and 6 more variables: core.area <dbl>,
## #   perimeter <dbl>, perim.area.ratio <dbl>, shape.index <dbl>,
## #   frac.dim.index <dbl>, core.area.index <dbl>
```

```
write.csv(modhigh_patchstat, "../output/entiako_beetle_modhigh_patch1")
```

Descriptive Analysis of Patch Area

Here, I read back in the data from the above functions, reorganize, and calculate some additional columns of data.

I remove the first row as it is a talley not an actual patch (see SDMtools documentation)

```
nobeetle = read.csv("../output/entiako_beetle_none_patch1")
nobeetle = nobeetle[-c(1), -c(1)]
nobeetle = mutate(nobeetle, beetleclass = "none")
head(nobeetle)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal area
## 1       1      1           0                 4                0  900
## 2       2      3           0                10                2 2700
## 3       3      2           0                 8                0 1800
## 4       4      1           0                 4                0  900
## 5       5      1           0                 4                0  900
## 6       6      5           0                12                8 4500
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1         0       120        0.1333333    1.000000       1.000000
## 2         0       300        0.1111111    1.250000       1.092896
## 3         0       240        0.1333333    1.333333       1.092475
## 4         0       120        0.1333333    1.000000       1.000000
## 5         0       120        0.1333333    1.000000       1.000000
## 6         0       360        0.0800000    1.200000       1.069876
##   core.area.index beetleclass
## 1               0        none
## 2               0        none
## 3               0        none
## 4               0        none
## 5               0        none
## 6               0        none
```

```
lowmod = read.csv("../output/entiako_beetle_lowmod_patch1")
lowmod = lowmod[-c(1), -c(1) ]
lowmod = mutate(lowmod, beetleclass = "low-mod")
head(lowmod)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal area
```

```
## 1       1     11           0                24               20 9900
## 2       2      4           0                 8                8 3600
## 3       3      1           0                 4                0  900
## 4       4      1           0                 4                0  900
## 5       5      3           0                 8                4 2700
## 6       6      3           0                10                2 2700
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1         0       720       0.07272727    1.714286       1.128868
## 2         0       240       0.06666667    1.000000       1.000000
## 3         0       120       0.13333333    1.000000       1.000000
## 4         0       120       0.13333333    1.000000       1.000000
## 5         0       240       0.08888889    1.000000       1.036411
## 6         0       300       0.11111111    1.250000       1.092896
##   core.area.index beetleclass
## 1               0     low-mod
## 2               0     low-mod
## 3               0     low-mod
## 4               0     low-mod
## 5               0     low-mod
## 6               0     low-mod
```

```
modhigh = read.csv("../output/entiako_beetle_modhigh_patch1")
modhigh = modhigh[-c(1), -c(1)]
modhigh = mutate(modhigh, beetleclass = "mod-high")
head(modhigh)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal     area
## 1       1  16240        9824              6736            58224 14616000
## 2       2      3           0                 8                4     2700
## 3       3      1           0                 4                0      900
## 4       4      1           0                 4                0      900
## 5       5      3           0                 8                4     2700
## 6       6      1           0                 4                0      900
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1   8841600    202080       0.01382594    13.20784       1.312931
## 2         0       240       0.08888889     1.00000       1.036411
## 3         0       120       0.13333333     1.00000       1.000000
## 4         0       120       0.13333333     1.00000       1.000000
## 5         0       240       0.08888889     1.00000       1.036411
## 6         0       120       0.13333333     1.00000       1.000000
##   core.area.index beetleclass
## 1       0.6049261    mod-high
## 2       0.0000000    mod-high
## 3       0.0000000    mod-high
## 4       0.0000000    mod-high
## 5       0.0000000    mod-high
## 6       0.0000000    mod-high
```

Here, I will combine my beetle severity class tables into one table.

```
patch_beetleclass = bind_rows(nobeetle, lowmod, modhigh)

patch_beetleclass = mutate(patch_beetleclass, area.ha = area * 0.0001)
head(patch_beetleclass)
```

```
##   patchID n.cell n.core.cell n.edges.perimeter n.edges.internal area
```

```
## 1       1      1           0                4                0  900
## 2       2      3           0               10                2 2700
## 3       3      2           0                8                0 1800
## 4       4      1           0                4                0  900
## 5       5      1           0                4                0  900
## 6       6      5           0               12                8 4500
##   core.area perimeter perim.area.ratio shape.index frac.dim.index
## 1         0       120        0.1333333    1.000000       1.000000
## 2         0       300        0.1111111    1.250000       1.092896
## 3         0       240        0.1333333    1.333333       1.092475
## 4         0       120        0.1333333    1.000000       1.000000
## 5         0       120        0.1333333    1.000000       1.000000
## 6         0       360        0.0800000    1.200000       1.069876
##   core.area.index beetleclass area.ha
## 1               0        none    0.09
## 2               0        none    0.27
## 3               0        none    0.18
## 4               0        none    0.09
## 5               0        none    0.09
## 6               0        none    0.45
```

From the combined table generated above I calculate some Summary Stats for patch area by beetle severity class

```
patch_beetleclass %>% group_by(beetleclass) %>%
  summarise(n = length(patchID),
            min = min(area.ha),
            max = max(area.ha),
            mean = mean(area.ha),
            median = median(area.ha),
            sd = sd(area.ha))
```

```
## # A tibble: 3 × 7
##   beetleclass     n   min     max      mean median        sd
##         <chr> <int> <dbl>   <dbl>     <dbl>  <dbl>     <dbl>
## 1     low-mod   656  0.09 2380.86 4.5252439   0.18 93.069193
## 2    mod-high   709  0.09 1461.60 4.6167842   0.18 57.683859
## 3        none   985  0.09   77.58 0.7928223   0.18  4.035084
```

Here, I read in the class metrics for the entire fire perimeter and add two columns with area by hectares instead of meters squared.

```
blandclass = read.csv("../output/entiako_beetle_class_1")
blandclass = mutate(blandclass, area.ha = total.area * 0.0001)
blandclass = mutate(blandclass, meanpatch.area.ha = mean.patch.area * 0.0001)
blandclass = mutate(blandclass, minpatch.area.ha = min.patch.area * 0.0001)
blandclass = mutate(blandclass, maxpatch.area.ha = max.patch.area * 0.0001)
blandclass = mutate(blandclass, sdpatch.area.ha = sd.patch.area * 0.0001)

head(blandclass)
```

```
##   X class n.patches total.area prop.landscape patch.density total.edge
## 1 1     3       985    7809300      0.1111994  1.402576e-05     431400
## 2 2     4       656   29685600      0.4227038  9.341017e-06    1174740
## 3 3     5       709   32733000      0.4660968  1.009570e-05     780720
##   edge.density landscape.shape.index largest.patch.index mean.patch.area
## 1  0.006142858              38.44920          0.01104689        7928.223
```

```
## 2  0.016727540              53.78846          0.33901911       45252.439
## 3  0.011116949              34.06283          0.20812241       46167.842
##   sd.patch.area min.patch.area max.patch.area perimeter.area.frac.dim
## 1      40350.84            900         775800              0.11047782
## 2     930691.93            900       23808600              0.07914519
## 3     576838.59            900       14616000              0.04770189
##   mean.perim.area.ratio sd.perim.area.ratio min.perim.area.ratio
## 1             0.1082361          0.02920105           0.02337662
## 2             0.1081535          0.02914874           0.02599581
## 3             0.1022531          0.03350800           0.01382594
##   max.perim.area.ratio mean.shape.index sd.shape.index min.shape.index
## 1            0.1333333         1.237699      0.5279909               1
## 2            0.1333333         1.328366      1.7657913               1
## 3            0.1333333         1.304447      0.8813686               1
##   max.shape.index mean.frac.dim.index sd.frac.dim.index min.frac.dim.index
## 1        6.949153            1.042401        0.05834524                   1
## 2       42.276074            1.042837        0.06399696                   1
## 3       13.207843            1.044744        0.06082811                   1
##   max.frac.dim.index total.core.area prop.landscape.core
## 1           1.286600          983700          0.01400725
## 2           1.441127         4505400          0.06415399
## 3           1.331084        14763600          0.21022414
##   mean.patch.core.area sd.patch.core.area min.patch.core.area
## 1             998.6802           11264.41                   0
## 2            6867.9878          162564.52                   0
## 3           20823.1312          340240.36                   0
##   max.patch.core.area prop.like.adjacencies aggregation.index
## 1              229500             0.4141134          59.20662
## 2             4162500             0.5422633          70.71063
## 3             8841600             0.6965202          82.54512
##   lanscape.division.index splitting.index effective.mesh.size
## 1               0.9996626     2963.821793            23695.05
## 2               0.8846916        8.672396          8097866.12
## 3               0.9519272       20.801779          3376052.58
##   patch.cohesion.index area.ha meanpatch.area.ha minpatch.area.ha
## 1             9.274297  780.93         0.7928223             0.09
## 2             9.892898 2968.56         4.5252439             0.09
## 3             9.839222 3273.30         4.6167842             0.09
##   maxpatch.area.ha sdpatch.area.ha
## 1            77.58        4.035084
## 2          2380.86       93.069193
## 3          1461.60       57.683859
```

THE END