Site selection for: Limited conifer regeneration, but widespread regeneration of aspen seedlings following the Cameron Peak Fire, northwestern Colorado

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# Objective

The purpose of this code is to identify accessible sites that burned at high severity within the Cameron Peak Fire that were nearby existing patches of aspen.

# Identification of potential study sites

## Select areas of public land that burned in the Cameron Peak fire

# Read in fire severity data  
severity <- rast(here('Data', 'Spatial', 'MTBS', 'mtbs\_CO\_2020.tif'))  
  
# Read in perimeter data  
CameronPeak <- st\_read(here("Data", "Spatial", "MTBS", "mtbs\_perims\_DD.shp")) %>%   
 filter(Incid\_Name == "CAMERON PEAK") %>% # pull out just Cameron Peak  
 st\_transform(st\_crs(severity)) %>%   
st\_write(here("Data", "Spatial" ,"MTBS", "mtbs\_perims\_DD-CameronPeak.shp"), append=F)

## Reading layer `mtbs\_perims\_DD' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/MTBS/mtbs\_perims\_DD.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 30730 features and 22 fields  
## Geometry type: MULTIPOLYGON  
## Dimension: XY  
## Bounding box: xmin: -166.1885 ymin: 17.94736 xmax: -65.33821 ymax: 70.15893  
## Geodetic CRS: NAD83  
## Deleting layer `mtbs\_perims\_DD-CameronPeak' using driver `ESRI Shapefile'  
## Writing layer `mtbs\_perims\_DD-CameronPeak' to data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/MTBS/mtbs\_perims\_DD-CameronPeak.shp' using driver `ESRI Shapefile'  
## Writing 1 features with 22 fields and geometry type Multi Polygon.

CameronPeak.severity <- crop(severity, CameronPeak)   
CameronPeak.severity <- mask(CameronPeak.severity, CameronPeak)  
CameronPeak.severity[!CameronPeak.severity ==4] <- NA  
  
CameronPeak.severity <- as.polygons(CameronPeak.severity, aggregate=T, values=T)   
CameronPeak.severity <- CameronPeak.severity %>%   
 st\_as\_sf() %>%   
 st\_union()  
  
  
comap <- st\_read(here("Data", "Spatial", "CoMaP", "COMaP\_v20190306.gdb")) %>%  
 filter(PUBLIC\_ACCESS=="Yes") %>%   
 st\_transform(st\_crs(severity))

## Reading layer `COMaP\_v20190306' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/CoMaP/COMaP\_v20190306.gdb'   
## using driver `OpenFileGDB'

## Simple feature collection with 35994 features and 26 fields  
## Geometry type: GEOMETRY  
## Dimension: XY  
## Bounding box: xmin: 139987.5 ymin: 4094065 xmax: 763240.4 ymax: 4546740  
## Projected CRS: NAD83 / UTM zone 13N

burned.public <- st\_intersection(comap, CameronPeak.severity) %>%   
 st\_union()

## Select roads that are easy enough to drive

select.usfs.roads <- st\_read(here("Data", "Spatial", "Roads", "S\_USA.Road\_MVUM.shp")) %>%   
 filter(OPERATIONA %in% c("5 - HIGH DEGREE OF USER COMFORT", "4 - MODERATE DEGREE OF USER COMFORT", "3 - SUITABLE FOR PASSENGER CARS")) %>%  
 st\_transform(st\_crs(CameronPeak)) %>% # change projection  
 st\_crop(st\_bbox(CameronPeak)) %>% # crop to study area  
 st\_union()

## Reading layer `S\_USA.Road\_MVUM' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Roads/S\_USA.Road\_MVUM.shp'   
## using driver `ESRI Shapefile'  
## replacing null geometries with empty geometries  
## Simple feature collection with 340885 features and 58 fields (with 189864 geometries empty)  
## Geometry type: GEOMETRY  
## Dimension: XY  
## Bounding box: xmin: -149.9813 ymin: 28.96099 xmax: -70.79476 ymax: 61.02898  
## Geodetic CRS: NAD83

hwys <- st\_read(here("Data", "Spatial", "Roads", "SHP", "STATEWIDE", "Highways.shp")) %>%   
 st\_as\_sf() %>%   
 st\_zm() %>%  
 st\_transform(st\_crs(CameronPeak)) %>%   
 st\_crop(st\_bbox(CameronPeak)) %>% # crop to study area  
 st\_union()

## Reading layer `Highways' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Roads/SHP/STATEWIDE/Highways.shp'   
## using driver `ESRI Shapefile'  
## replacing null geometries with empty geometries  
## Simple feature collection with 81599 features and 45 fields (with 28 geometries empty)  
## Geometry type: LINESTRING  
## Dimension: XYM  
## Bounding box: xmin: 140686.6 ymin: 4094319 xmax: 761614.1 ymax: 4542778  
## m\_range: mmin: -2.220622e-08 mmax: 497.223  
## Projected CRS: NAD83 / UTM zone 13N

local <- st\_read(here("Data", "Spatial", "Roads", "SHP", "STATEWIDE","local\_roads.shp")) %>%  
 st\_zm() %>%  
 st\_transform(crs=st\_crs(CameronPeak)) %>%   
 st\_crop(st\_bbox(CameronPeak)) %>% # crop to study area  
 st\_union()

## Reading layer `Local\_Roads' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Roads/SHP/STATEWIDE/Local\_Roads.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 179915 features and 38 fields  
## Geometry type: LINESTRING  
## Dimension: XYZM  
## Bounding box: xmin: 140224.1 ymin: 4094518 xmax: 763180.4 ymax: 4546534  
## z\_range: zmin: 0 zmax: 1832.849  
## m\_range: mmin: -2.716843e-08 mmax: 45.54  
## Projected CRS: NAD83 / UTM zone 13N

major <- st\_read(here("Data", "Spatial", "Roads", "SHP", "STATEWIDE", "Major\_Roads.shp")) %>%  
 st\_zm() %>%   
 st\_transform(crs=st\_crs(CameronPeak)) %>%   
 st\_crop(st\_bbox(CameronPeak)) %>% # crop to study area  
 st\_union()

## Reading layer `MAJOR\_ROADS' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Roads/SHP/STATEWIDE/MAJOR\_ROADS.shp'   
## using driver `ESRI Shapefile'  
## Simple feature collection with 43055 features and 38 fields  
## Geometry type: LINESTRING  
## Dimension: XYZM  
## Bounding box: xmin: 140523.4 ymin: 4094344 xmax: 762741.6 ymax: 4545672  
## z\_range: zmin: 0 zmax: 0  
## m\_range: mmin: -2.716843e-08 mmax: 71.69  
## Projected CRS: NAD83 / UTM zone 13N

## Select trails that intersect the fire

trails <- st\_read(here("Data", "Spatial", "Trails", "S\_USA.TrailNFS\_Publish.gdb")) %>%  
 st\_transform(st\_crs(CameronPeak)) %>%   
 st\_crop(st\_bbox(CameronPeak))

## Reading layer `TrailNFS\_Publish' from data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/Trails/S\_USA.TrailNFS\_Publish.gdb'   
## using driver `OpenFileGDB'  
## replacing null geometries with empty geometries  
## Simple feature collection with 82687 features and 103 fields (with 5453 geometries empty)  
## Geometry type: GEOMETRY  
## Dimension: XY  
## Bounding box: xmin: -149.9974 ymin: 18.27177 xmax: -65.74393 ymax: 61.13142  
## Geodetic CRS: NAD83

## Select areas are within 1000 m from a road

sf\_use\_s2(FALSE) # turn off spherical geometry  
  
hwys1000 <- hwys %>% st\_buffer(dist=1000)  
major1000 <- major %>% st\_buffer(dist=1000)  
local1000 <- local %>% st\_buffer(dist=1000)  
select.usfs.roads1000 <- select.usfs.roads %>% st\_buffer(dist=1000)  
roadz1000 <- st\_union(hwys1000, major1000) %>% st\_union(local1000) %>% st\_union(select.usfs.roads1000)

## Select areas of severely burned public land that are 500 m away from a trail and no more than 1 km up the trail or are within 250 m of a road

hwys500 <- hwys %>% st\_buffer(dist=500)  
major500 <- major %>% st\_buffer(dist=500)  
local500 <- local %>% st\_buffer(dist=500)  
select.usfs.roads500 <- select.usfs.roads %>% st\_buffer(dist=500)  
roadz500 <- st\_union(hwys500, major500) %>% st\_union(local500) %>% st\_union(select.usfs.roads500)  
  
# identify trails that are within 30 m of a road  
hwys30 <- hwys %>% st\_buffer(dist=30)  
major30 <- major %>% st\_buffer(dist=30)  
local30 <- local %>% st\_buffer(dist=30)  
select.usfs.roads30 <- select.usfs.roads %>% st\_buffer(dist=30)  
roadz30 <- st\_union(hwys30, major30) %>% st\_union(local30) %>% st\_union(select.usfs.roads30)  
trail.id <- st\_intersects(roadz30, trails)  
trailz <- trails[trail.id[[1]],]  
   
trailz <- trailz %>% st\_buffer(dist=500) # buffer by 500 m  
trailz2 <- st\_intersection(trailz, roadz1000) # select part of trail within 1 km of a road  
  
## identify area within 250 m of a road  
hwys250 <- hwys %>% st\_buffer(dist=250)  
major250 <- major %>% st\_buffer(dist=250)  
local250 <- local %>% st\_buffer(dist=250)  
select.usfs.roads250 <- select.usfs.roads %>% st\_buffer(dist=250)  
roadz250 <- st\_union(hwys250, major250) %>% st\_union(local250) %>% st\_union(select.usfs.roads250)  
  
accessible <- st\_union(trailz2, roadz250)  
burned.public.accessible <- st\_intersection(accessible, burned.public) %>% st\_union()

## Exclude areas that are within 50 m of a road

hwys50 <- hwys %>% st\_buffer(dist=50)  
major50 <- major %>% st\_buffer(dist=50)  
local50 <- local %>% st\_buffer(dist=50)  
select.usfs.roads50 <- select.usfs.roads %>% st\_buffer(dist=50)  
roadz50 <- st\_union(hwys50, major50) %>% st\_union(local50) %>% st\_union(select.usfs.roads50)  
  
burned.public.accessible <- burned.public.accessible %>% st\_difference(roadz50)

## Identify areas >100 m and <1000 m away from pre-fire aspen patch

aspen <- rast(here("Data", "Spatial", "Aspen", "srme\_skcv\_distribution\_binopt.tif"))  
aspen[aspen==0] <- NA

##   
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CameronPeak.1000 <- CameronPeak %>% st\_buffer(1000) %>%   
 st\_transform(st\_crs(aspen))  
  
aspen <- aspen %>%   
 crop(CameronPeak.1000) %>%   
 mask(CameronPeak.1000)  
  
aspen.p <- aspen %>% as.polygons(aggregate=T, values=T) %>%   
 st\_as\_sf() %>%   
 st\_union()  
  
aspen.p.100 <- aspen.p %>%   
 st\_buffer(dist=100) %>%  
 st\_union()  
  
aspen.p.1000 <- aspen.p.100 %>%   
 st\_buffer(dist=900) %>%  
 st\_union()  
  
aspen.p.100.1000 <- st\_difference(aspen.p.1000, aspen.p.100) %>% st\_union()  
  
  
burned.public.accessible.re <- st\_transform(burned.public.accessible, st\_crs(aspen.p.100.1000))   
  
burned.public.accessible.aspen <-st\_intersection(burned.public.accessible.re, aspen.p.100.1000) %>%   
 st\_write(here("Data", "Spatial", "studyarea.shp"), append=F)

## Deleting layer `studyarea' using driver `ESRI Shapefile'  
## Writing layer `studyarea' to data source   
## `/Users/sarahhart/Library/CloudStorage/GoogleDrive-sarahjanehart13@gmail.com/My Drive/JOB/RESEARCH/Analyses/PostfireAspen/Data/Spatial/studyarea.shp' using driver `ESRI Shapefile'  
## Writing 1 features with 0 fields and geometry type Multi Polygon.