Instructions for IPM analysis

Izzy McDonald (israel.mcdonald@wsu.edu)

Introduction

This repository contains the required code and file structure to analyze pear IPM study data and the landscape management factors effects on pear pest populations as collected in the study data. The landscape analysis design is a standard multi-ring buffer approach, where non-overlapping zones of specified width are generated around a feature of interest, and landscape statistics within each of those buffers are calculated, allowing for analysis to be done on the relationship between landscape statistics, data collected on the features of interest, and buffer distances. For an example of this sort of analysis in practice, please see the following study: https://www.mdpi.com/2072-4292/13/13/2551.

This README contains instructions and specifications as to the formatting of data for use with the included Analysis.Rmd file, which provides automatic data cleaning and a function to calculate the buffer and zonal statistics.

You will require and up-to-date version of R, along with the packages terra, sf, the tidyverse, tidyterra, basemaps, plotly, and furrr. You will also require the free and open source program QGIS, or some other software to create and annotate polygon data in a shapefile.

Site location and management data

The first piece of data to properly format is a .csv file containing study site codes, locations, and per-year management annotations.

There should be a numeric column named Code that has numbers corresponding to the pest collection data. These act as primary keys connecting the location and management data in this file to insect data in other files.

There should be an arbitrary number of boolean (true/false) columns named by a year (2022, 2023,...). For each site in this column, it should be 'true' if the site was conventionally managed in that year, and 'false' if it was organically managed or managed according to IPM practices.

The last two columns should be named x and y respectively (and in that order), and contain easting and northing coordinates in the EPSG:26911 (NAD83 UTM11) coordinate reference system. It is likely the site coordinates you have are in degrees of latitude and longitude (in the WGS 84 CRS and datum). If this is the case, enter your R console and source the provided transform_crs.R file. It provides as function named transform_to_utm11() that takes a file path to a csy file formatted as specified above and transforms the x and y columns from

lat/long into UTM11. Write this properly formatted and transformed data frame to the data/folder inside this project as pear_siteinfo.csv.

Landscape annotation

The second piece of data you will need is a shapefile (.shp) containing polygons and an associated attribute table that annotates those polygons for the type of management by year. The three management codes are CONV, ORG, IPM, and UNKN, corresponding to conventional, organic, IPM, and unknown management types respectively. All agricultural land within the maximum buffer radius must be annotated for effective analysis.

To begin this process, open up the QGIS project file located within the qgis/ folder in this project called ipm_analysis.qgz. If you followed the last steps correctly, the pear_siteinfo.csv should already be loaded in the project, along with a layer called orchards_utm11 which is loaded from a shapefile of the same name within data/orchards/. If you already have a shapefile you want to work with, rename it and it's associated files to orchards_utm11 and replace the existing one. In order to find out how much area you have to annotate, select the pear_siteinfo layer in the Layers panel on the left side of the screen, and then use the key combination Ctrl-K to use the locate bar. Search for Buffer and press enter to select the first result. It should look like this:

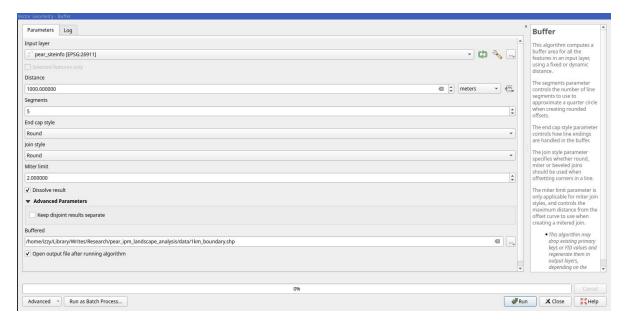


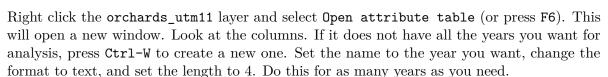
Figure 1: buffer

Set the distance to your desired maximum buffer distance and ensure Dissolve result is checked (this combines overlapping boundaries into one). Save the layer as a shape file to the

data/boundary/ folder.

Now, select the $orchards_utm11$ layer and in the toolbar at the top select the Toggle Editing

button. It should look like a yellow pencil



To edit the annotations for exiting polygons, press Ctrl-Shift-i to switch to the Identify tool, and click any polygon; this will open the Identify panel. In the toolbar at the top of this panel there is a wrench icon that will pull up extra options. Within these, make sure Auto open form for single feature results. Now with the Identify tool selected, a form to edit annotations will appear when you click on polygons.

To create new polygons, first select the Add polygon feature, or press Ctrl-, Slao, go to the top left and select File > Snapping options. This will open a new panel. From it, click on the magnet button, change the distance from 2 to 10 meters. Also in this panel, click the button that says Vertex; it will pull up a list and from it select Segment as well. You can now close the panel. This will make clicking on exiting vertices more convenient. You can now click on the screen to add new vertices and draw polygons. When you are done, right click to finish the polygon and it will automatically open a form for you to annotate the attributes. If you are digitizing many unknown fields, double click the orchards_utm11 layer, then go to the Attributes form page. Go through each of the years listed under Fields and change the default value to UNKN.

To edit existing polygons, click on the Vertex Tool button next to the Add polygon feature

With some practice you will be able to lay down dozens of polygons and annotate them very quickly.

Nymph and predator data

Nymph data is collected by leafbrush. Take your existing leafbrush data (most likely in an excel spreadsheet) and save the data to csv files by year. Filter each year of data to only

include data before August. Then select only the columns containing the counts and the site codes. The tidyverse (particularly the readxl and dplyr packages) are immensely helpful in formatting your data from excel. The column names should be Plot and Nymphs, respecting capitalization.

Predator data is collected differently. Take the data (also most likely in excel) and perform the same steps as for the nymphs, except filter for data before July instead of August. There should be three predator columns, named Trechnites, Derae_total, and Campy_total. The site code column should also be named Plot.

Example data in multiple years is included within the data/ directory.

Analysis

The analysis.Rmd file within this project contains templates for processing the data from the standard formats specified above into the format the zonal_analysis() function requires to have a coherent output. The zonal_analysis() function is actually very versatile. If you have any data frame with site coordinates in UTM11 and a corresponding shapefile with a numeric field conv, you will be able to get multiple ring buffer zonal statistics on it.