ADDA
Lab

Conservation Planning

Forest Planning for Wildlife Protection

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Overview, Objective, and Skills

Overview: In many instances, natural resource managers, conservation scientists, and wildlife rangers must consider the presence of, and vegetation use by threatened, endangered, or sensitive species in an area. In order to protect something, we need to understand it well. With respect to protecting wildlife, it is important to have a clear knowledge of what the habitat requirements are and how far the species in question travels for securing food and for nesting. With that knowledge, we can set out to collect necessary data to help answer the questions in hand. Depending on the location and ownership of the land under study, it will often be necessary to engage various stakeholders including but not limited to the representative government agencies, local NGO's with interest in conservation, and most importantly the local community in the area under study. Conservation plans without community involvement and support would be to implement. As a first step, you will have to have series of meetings with the stakeholders to given them the knowledge they need to understand the value of the species under question and how it is important for the community to be a part of the plan. In this project, presence of a sensitive (fictitious, just made up!) species, the brown-winged owl, at a hunting club in northern Michigan imposes additional criteria necessary to develop and implement forest management plans for timber and game species.

Scenario: As a forest manager working at a private hunting club, with extensive GIS knowledge from ADDA training you have received previously, you are set out to assess habitat use by the owls and develop forest management considerations for conserving habitat and manage timber harvest responsibly. Your final map should show areas

Learning Objective: In this project, you will be using geoprocessing tools including buffer, clip, attribute and spatial joins, nearest neighborhood analysis, and other spatial analysis methods to address conservation related problem. The goal is to understand the conceptual framework that is used in addressing issues related to conservation or protection of anything in the world using GIS approaches.

Skills Introduced and Practiced: You will learn to use many of the spatial analysis techniques and geoprocessing. You will also practice skills involving adding and importing various dataset, process and import GPS data collected in the field, and visualizing the outcomes using appropriate symbology.

Submit: 1) answer the questions provided, 2) make a good cartographic map of your results that answer the primary question.

Background and Your Task:

In natural resources management, the presence of sensitive, threatened, or endangered species must be considered when developing land-use or management plans. Many private landowners who harvest timber want their property to be sustainable or certified under programs like the Sustainable Forestry Initiative. As such, landowners must ensure they are conserving habitat for wildlife species. In this scenario, you are the forest manager at a privately-owned hunting club called Windfall Trails. The hunting club's land consists primarily of forest that is managed for timber and wildlife habitat (mainly deer and turkey). During your routine timber inspections, you observe a sensitive species, the brown - winged owl (a fictitious species) nesting in some forested stands adjacent to openings. You are aware that this owl lives in only a few counties within the state. You and your field technicians conduct a property-wide survey to assess the number and locations of brown-winged owls on the property. Governmental policies state that to protect habitat of this particular sensitive species, timber harvesting must not occur within a 10-hectare (ha) buffer of known nesting locations unless population densities exceed and remain above threshold levels.

As the forest manager at Windfall Trails, you would like to assess the owls' habitat use on your own land, which will be helpful for developing proper management plans. Specifically, you need to be able to answer these questions:

1. What vegetation types are the owls using for nesting?
2. What percentage of nest locations occurs in each cover type?
3. Where are possible foraging sites?
4. What are the average, minimum, and maximum distances of nest sites from foraging sites?
5. How much forested area is unavailable for timber harvesting due to presence of owl nests?

In addition, your supervisor and the club members would like to have a map illustrating all the above information. Important information needed to solve the spatial problem includes

- All known nesting locations were recorded with a GPS receiver in units of decimal degrees using the WGS84 datum.
- Literature and prior research on brown-winged owls suggest that they forage for mice and other small rodents in herbaceous openings that are at least 0.405 ha (1 acre) in size.
- Their home ranges are approximately 10 ha.

Before you start the lab, explore this website:

Exploring Wolf Habitat Suitability in Washington State (pay attention to the **Flowchart section** - you will be expected to make a flowchart like this as part of the submission for this lab). Many students choose to use programs like Microsoft Powerpoint/Word/Visio or Google Slides/Google Docs to create these flow charts.

http://randallboone.org/nr505/projects/project7/Introduction.html

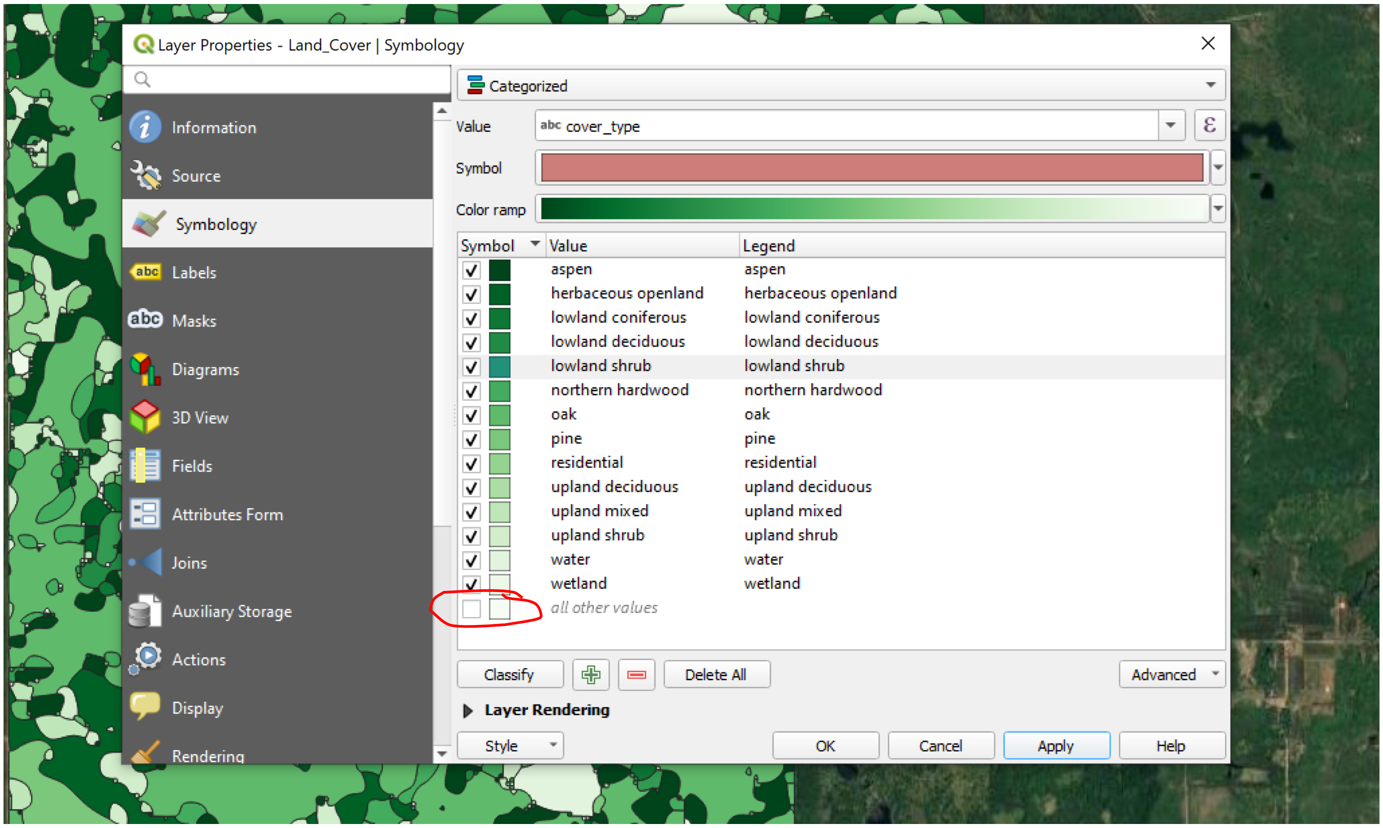
Data Used: You are provided all the data you need for this project on Moodle. Download the data and uncompress it to a separate lab folder. The data folder contains, 1) Land Cover data (Projected Coordinate System **EPSG:32616 - WGS 84 / UTM zone 16N**) from Michigan State's Open GIS Data portal: http://gis-michigan.opendata.arcgis.com/ , 2) Owl locations GPS data (not real, just made up for this lab) is in **WGS 84 (ESPG:4326)**. This means it is unprojected data, and the coordinates, in this case latitude and longitude, are in Geographic Coordinate System (GCS) with World Geodetic System 1984 as the reference datum.

Important Note: Having gone through a lot of training with detailed instruction, you have been exposed to what is possible using GIS. Though it is good to have detailed steps to carry out the project, in real life, you will not be given steps involved in conceptualizing and completing a project. It is your job to know how to get started and all the steps involved and ways to take the project to finishing stage. So, keeping this in mind, this exercise is designed with reduced details in instructions for some of the basic steps that you are expected to know well by now (like adding data to your project or saving the output to your lab folder etc.). You are encouraged to refer to your previous training materials if necessary, to learn the steps involved.

Project Setup: From Start Menu, open **QGIS Desktop**

Step 1: Assess Vegetation and Spatial Characteristics Associated with Brown-Winged Owl Nesting Locations

1. Add **Land_Cover.shp** data from project folder. Open properties for the layer and change symbology to **categorized** by **cover_type.** Hit Classifty button. You can select an appropriate color ramp to go with the data. Remember to uncheck **All other values**, so it would not show in the legend. Q: What projection/coordinate system is used for this layer? (hint: look under the **Source** tab under symbology)



Coordinate Systems Review: What is the difference is between a geographic coordinate system and a projected coordinate system? This distinction is very important to understand. Geographic coordinate systems use angular measurements on a sphere to define location. Usually, these angular measurements are recorded in units of latitude and longitude. Because the earth resembles a sphere, lines of longitude converge at the poles. Thus, if the earth were flattened out or projected onto a flat surface, there would be some distortion in size, shape, area, or distance of the earth's features. Because of this, projected coordinate systems are used to mathematically convert locations on a spherical surface (geographic coordinate system) to locations on a flat surface (projection).

To learn more about this area, let's add a satellite imagery as background (basemap) and zoom in and explore the area covering the

2. Add a base map for reference. Click on **Web → Quick Map Services → Google → Google Satellite** (if you don't see Google as option, then click **Web → Quick Map Services → Settings → More Services** tab **→ Get Contributed Pack**. Then go back and look for Google Satellite)

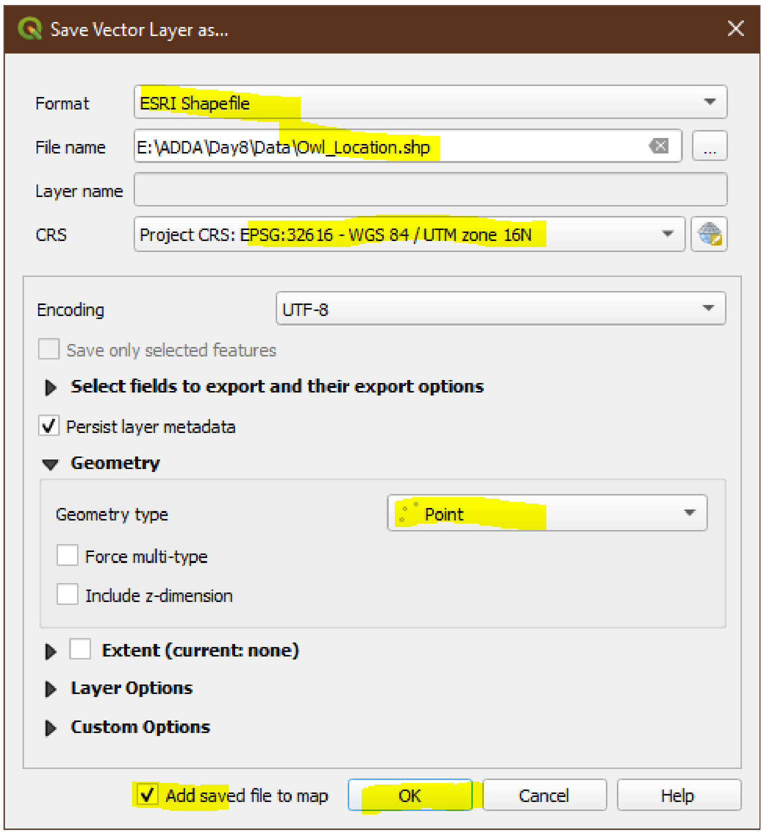
Zoom close and see what the forest cover looks like.

3. Now, let's import the GPS location data for the owl nesting sites that is stored in your data folder (given in **.CSV format**, contains nest ID, latitude, and longitude information). You should use **Layer → Add Layer → Add Delimited Text Layer** option to import the **CSV file**. Under **Geometry Definition**, it should be selected as point coordinates with **Longitude as X field** and **Latitude as Y field**. Under Geometry CRS, select WGS 84 - refer to **Data Used** section

on page 2 to know relevant projection information for importing this as a geographic data). Then Click **Add**. If your points are showing up in the middle of the ocean or in the wrong location, that means you didn't pick the right values – check your steps again!

Q: Are the point files displayed in QGIS in shape file format? Where are they saved? How can you tell? What do you think happened when you imported them into the project? You can right-click on the layer and select **Properties.** Then Go to **Information** Tab. You will find the answers to these questions there.

4. You know that your <u>Owl locations data needs to be projected to the same projection system as your land cover data</u> in order to do any geoprocessing or spatial analysis. To do this, right click on the layer, and select **Export Save Feature As,** and save it as a new Shape file. In the window, you can indicate the projection system to be same as your land cover.



5. Change the symbology for the nesting sites to make sure the points clearly visible.
6. Now that we have a permanent shape file created of the nesting locations, you can delete the CSV file that is on your table of contents in QGIS. **Save your project!**

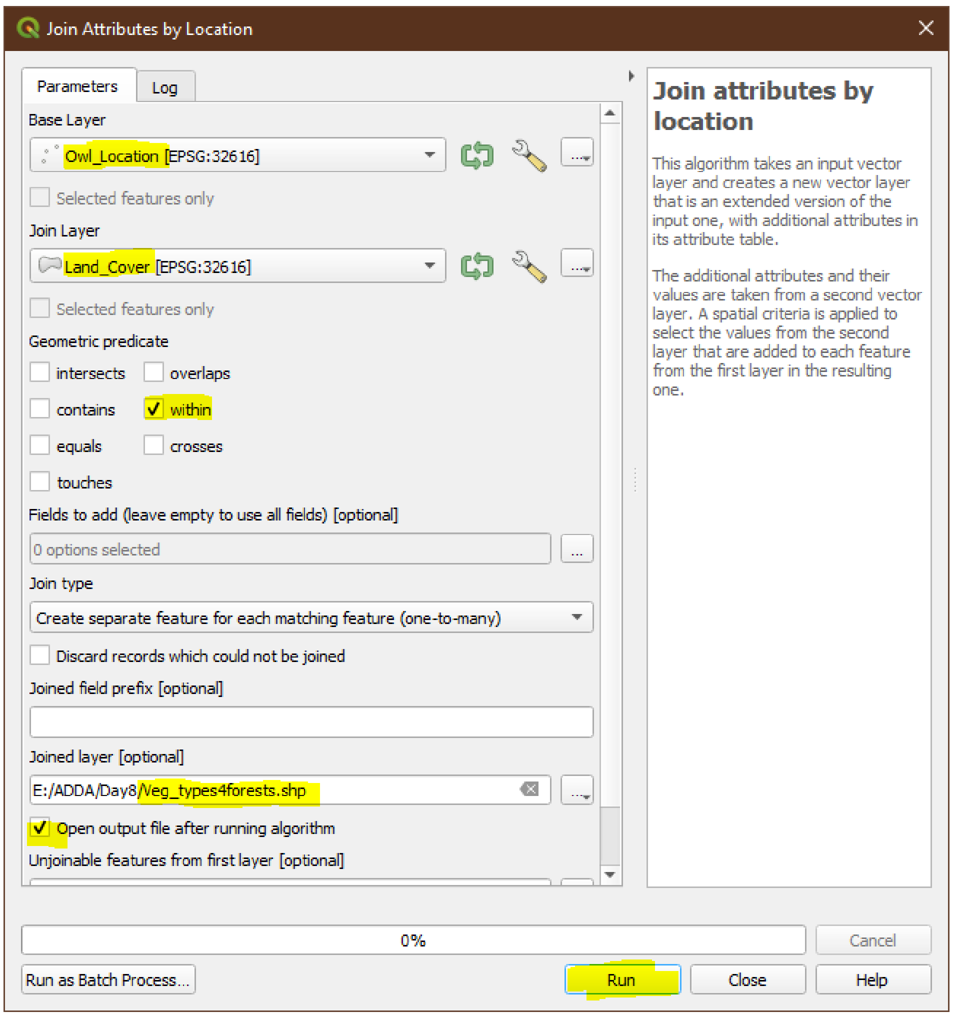
Step 2: Owl Nesting Habitat characterization

While doing project, one should have a good idea as to what kind of outcomes are expected. To understand what vegetation types the owls are using for nesting and what percentage of nests are found in different vegetation types, visualize what type of information you would need as the end-product. Visualizing the end-product might make a solution easier to identify. For instance, you probably are visualizing a table that is constructed similarly to the one below:

Vegetation Type	Number of Nests	Percentage of Nests

A good way to get a result like this is to use a spatial join. Instead of joining based on columns with matching attributes, we're essentially joining based on location (like you have done in one of your earlier labs). In other words, we're telling QGIS to join shapes based on a spatial relationship that we define. This is where having the same projection becomes critical – if your two-dataset had different projection definitions, this process will fail to execute. There are multiple ways to conduct a spatial join. The steps below describe one way.

1. Under the processing tool bar, search for **Join Attributes by Location**.
2. You will perform a spatial join based on the location that two different shapefiles have in common. So, on the dialog box, choose Owl_Location as the Base Layer and Land Cover as the Join Layer based on spatial location. Make sure to specify **within** as the **Geometric predicate** so that each point will be given the attributes of the polygon it is inside of.
3. Name the new file something descriptive, such as veg_types4nests.shp. Remember to select "**Save as type is shapefile**". Click **Run**.



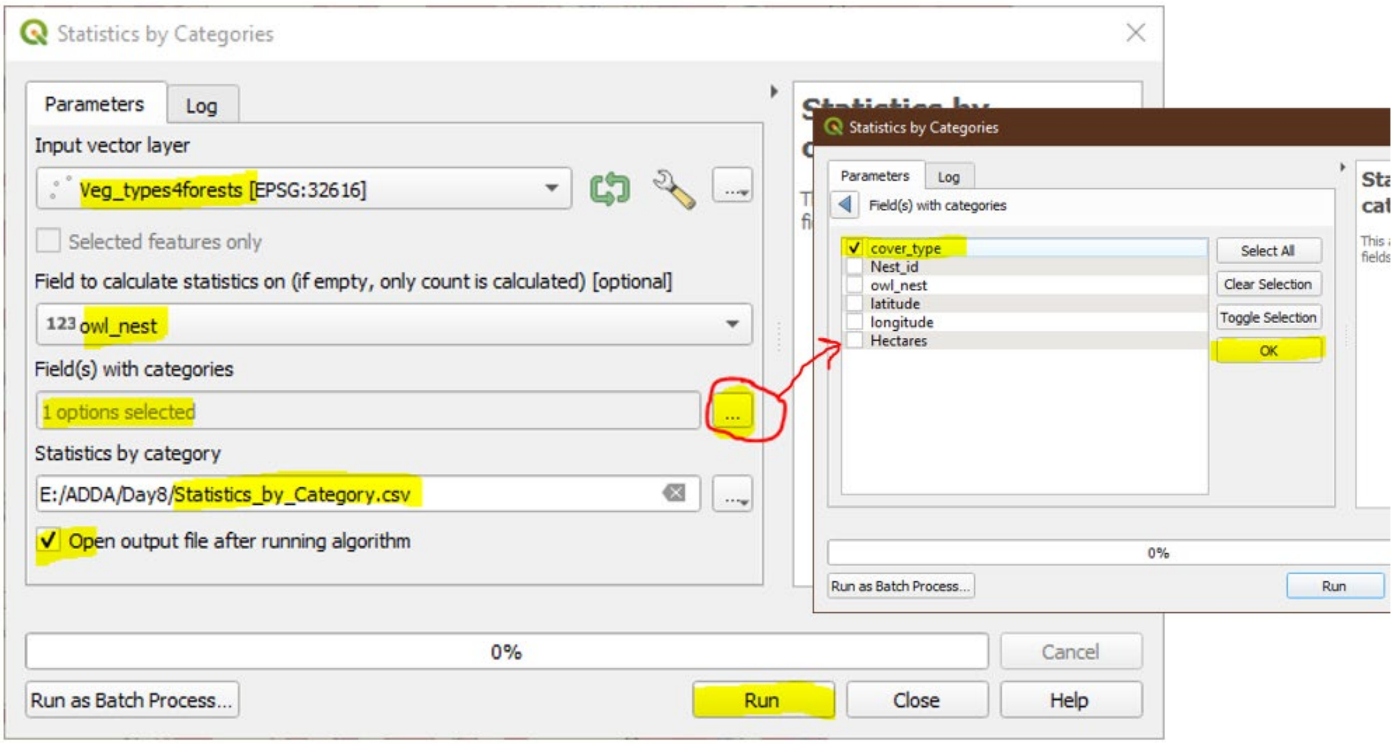
4. This is a quick process, so you should look at your table of contents for the new layer. Open the attribute table of the new layer. Data from the land cover and owl nesting locations shapefiles should be combined into one table. You can scroll through it and see what vegetation types the owls are using for nesting (should include only: oak, northern hardwood, upland mixed, and aspen).

So, now you have answered the first question. Here are some additional things to think about with regard to the biology of the owls. You know what vegetation types the owls are using for nesting. How many vegetation types are they using in relation to the total number of available vegetation types? Do the owls use upland (dry) or lowland/wetland areas? How do you suppose the owls select vegetation types?

Step 3: Summarize by Attributes

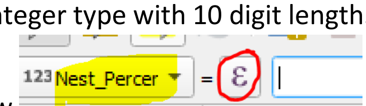
From the spatially joined table for veg_types4nests.shp layer, you can easily determine the percentage of owl nesting locations within each cover type. The capability to summarize a table within GIS lets you do that easily.

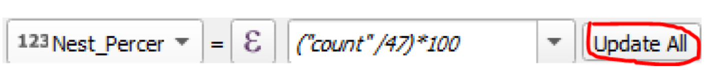
1. Under processing toolbox, search for and select **Statistics by Categories** option. Provide the input as indicated in the figure below. For output in **Statistics by** Category field, select **Save to File** – in the dialogue box enter a name for the output file (for example, **Statistics by Category**, and under **Save as Type** option, select **CSV.** Once satisfied, click **Run** to complete the process. Though we are selecting .**CSV** as the output file, it can be any other format that you are familiar with and can handle.



2. Open the resulting table (Statistics by Category.csv) by right clicking and clicking **Open Attribute Table** and explore. You will notice that several new columns of statistics data have been added. The **Count** column contains the number of Owl Nests under each forest cover type. We need this count in **Percentage** rather than just raw number.

Q: How would you calculate the percentage of Owl Nests under each forest cover type? What do you have to do to show percentage values as a column in the table?

3. With the attribute table open, click **Toggle Editing Mode ON** (the pencil  button on top left of the attribute table).
4. You can go ahead and delete all other statistics fields except **Cover Type** and **Count.** You can do this by clicking **Delete Field** button  on top, followed by selecting multiple fields (by holding shift key and clicking through unwanted fields)
5. Now, click on **New Field** button . Give **Nest_Percent** as integer type with 10 digit length.
6. Using **Field Calculator** option within the attribute table window 

, click and calculate the **Percentage value.**
7. When satisfied with your expression, Click "**Update All**" 

8. Summarize the results in the following table (you can do this table in a word document).

Vegetation Cover Type	Number of Nests	Percentage of Nests

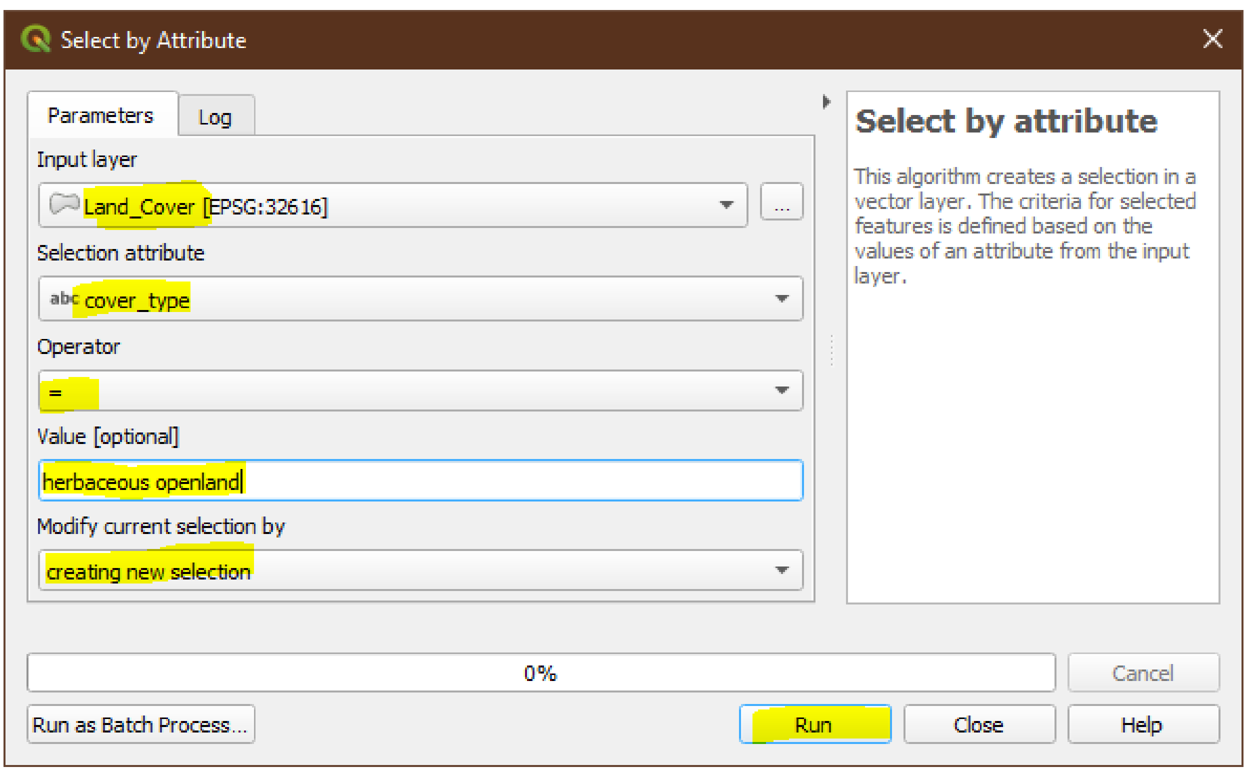
Now you have successfully determined the percentage of nest locations in each vegetation type. What might be an effective way to represent this information? You might include this information in the map layout as a table, or you might append a table to a report document.

Think about these questions: What do you suppose the percentages mean? What land-cover type has the highest percentage of nesting use? What characteristics of the vegetation might affect whether an owl selects it for nesting?

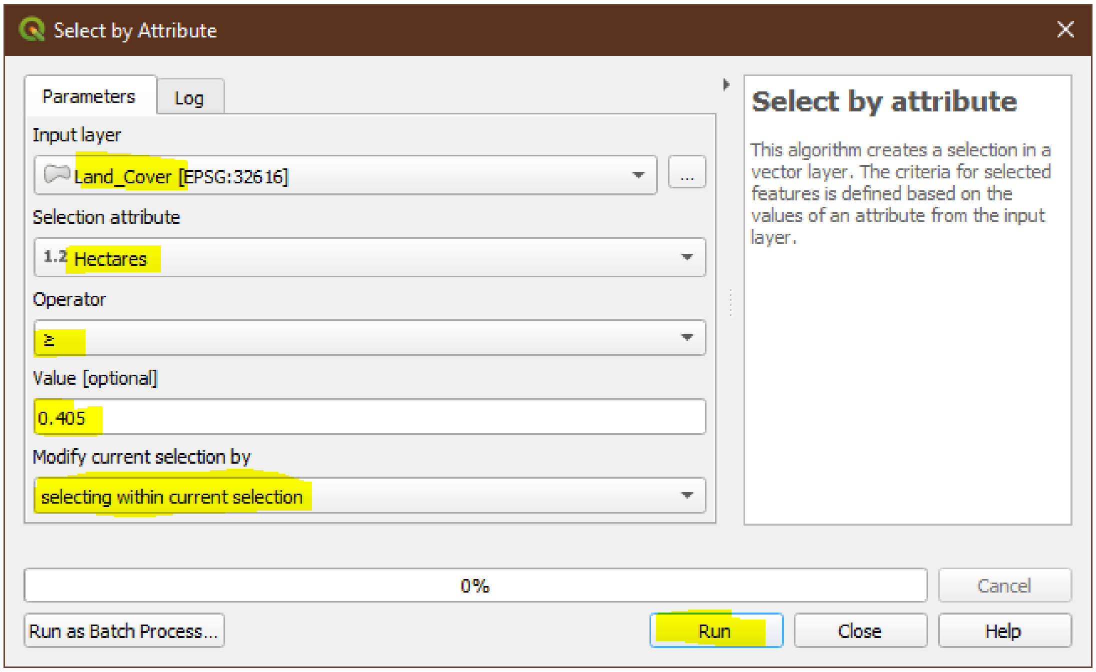
Step 4: Attribute Query and Proximity Analysis to Understand Spatial Relationship between Nesting & Foraging Sites

You want to determine possible foraging locations and the maximum distance from a nesting site to a foraging site. You know that the owls forage in herbaceous openings at least 0.405 ha in size. Therefore, you can identify foraging locations using a simple attribute query to select all herbaceous openland ≥ 0.405 ha. In order to do this, we need to do a two-step query by attribute.

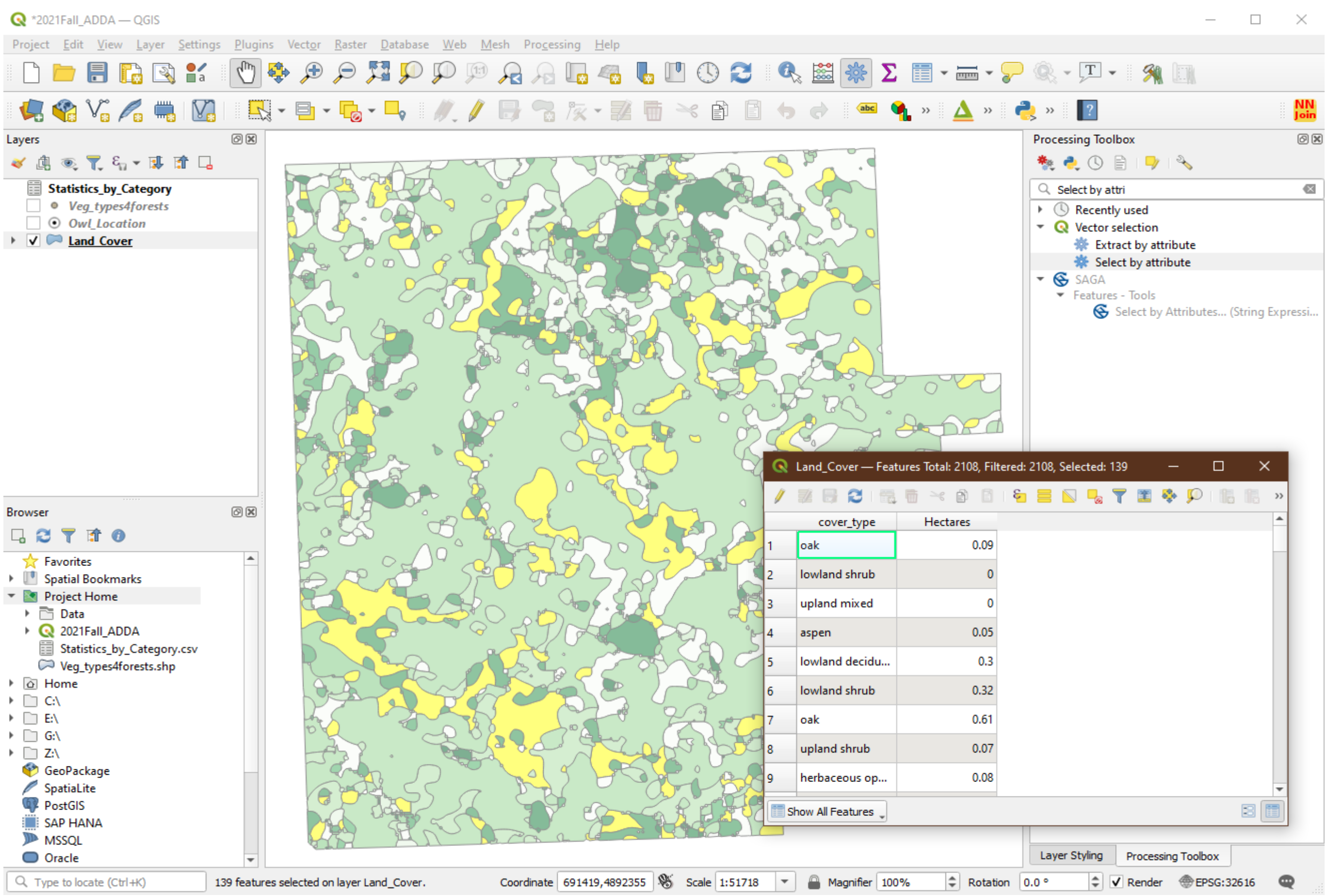
1. First make a new selection with Land Cover = herbaceous openland (make sure the spelling is correct from the attribute table and type exactly as it is in the attribute table).



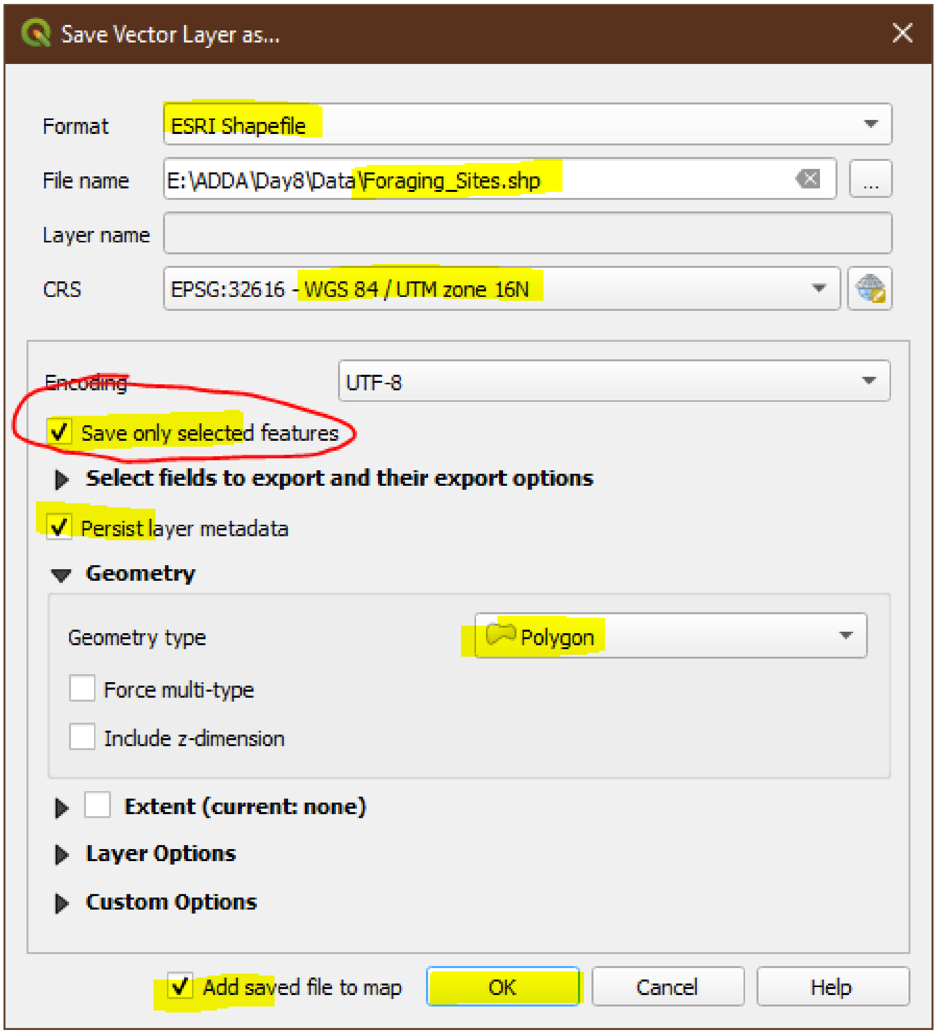
Open the attribute table for the land cover layer. You should have 310 features selected and those selected features should be highlighted in your map view. Now, we will make selection from within already selected features that meet the second criteria, area, which should be Hectares greater than or equal to 0.405 ha.



This query should result in 139 records being selected from the land_Cover shapefile. You can look at the map and see which polygons have been selected that meet the foraging habitat criteria.



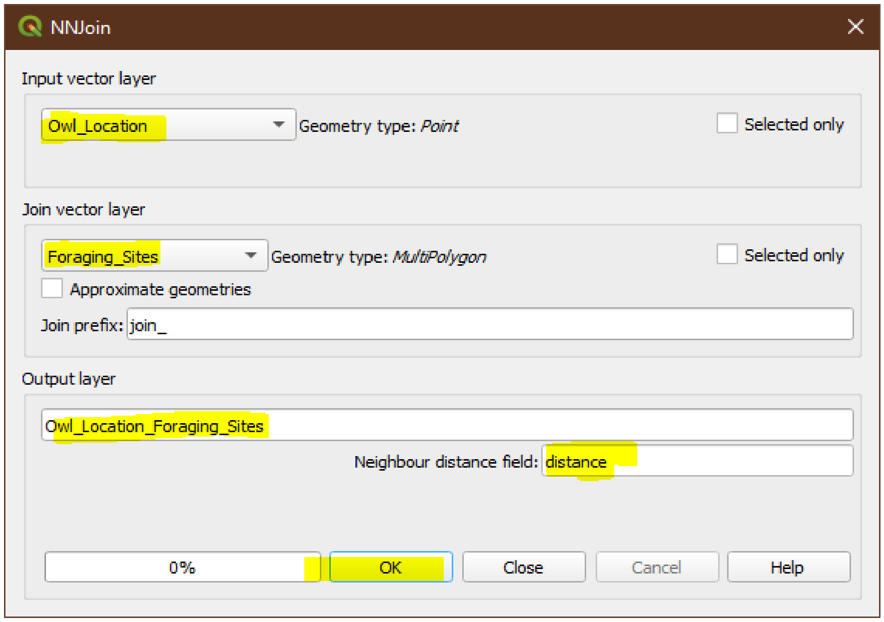
2 Make a new layer from the selected polygons by right-clicking the ***land_cover*** shapefile and selecting **Export ▯ Save Selected Features As**. This essentially hides everything else that is not selected so that you can use the selected features for further analysis. Name this file "**foraging sites**". Be sure to clear all selections in Land_Cover layer and turn it off.



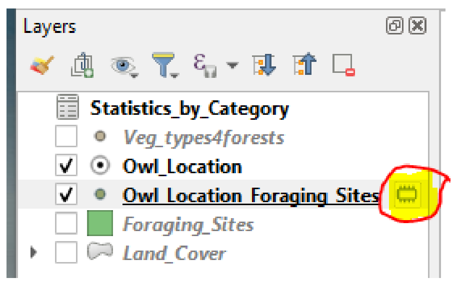
Thought question: What do you notice about the distribution of foraging areas in relation to nesting areas? In the next several steps, you will determine the distances between nesting locations and foraging sites. Often, wildlife biologists or conservation scientists are interested in knowing this type of information to create habitat management plans.

Proximity Analysis:

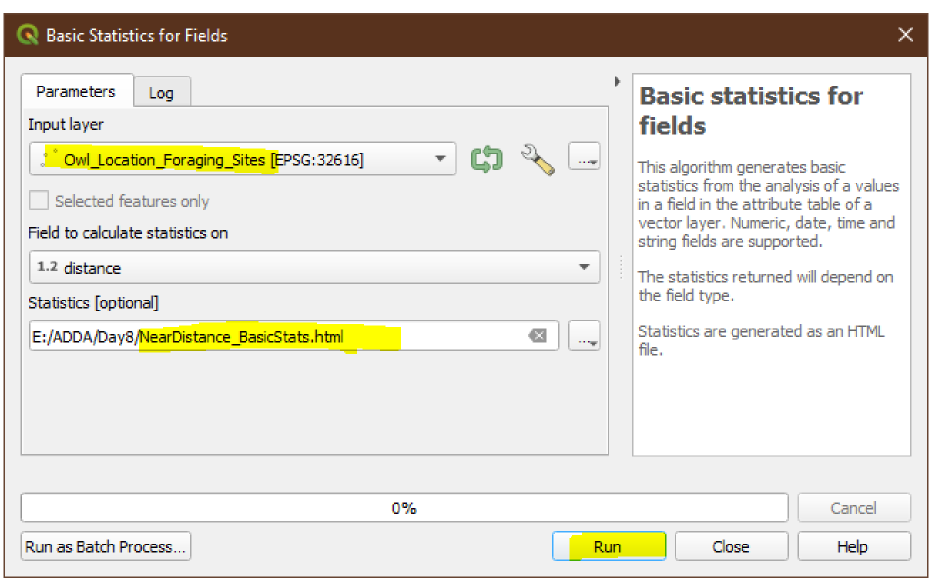
1. To determine the maximum distance from a nest site to a foraging site, you can conduct another spatial join or use the *proximity* tool - ***NNJoin*** (a new plugin that you need to download - as always, you need to be connected to the Internet to be able to download plugins). This tool performs nearest neighbor identification and then joins the spatial attributes together as well as computes the distance to the nearest neighbor.
2. After you have successfully installed the plugin, open **NNJoin** tool from the menu **Vector ▯ NNJoin ▯ NNJoin**
3. On the NNJoin dialog box, make sure your input **vector layer is the owl locations** and **the join vector layer is the foraging sites**. Click **OK**. This will create a new point file that includes all fields from *owl location* file as well as the information on nearest foraging site to each *owl location*.

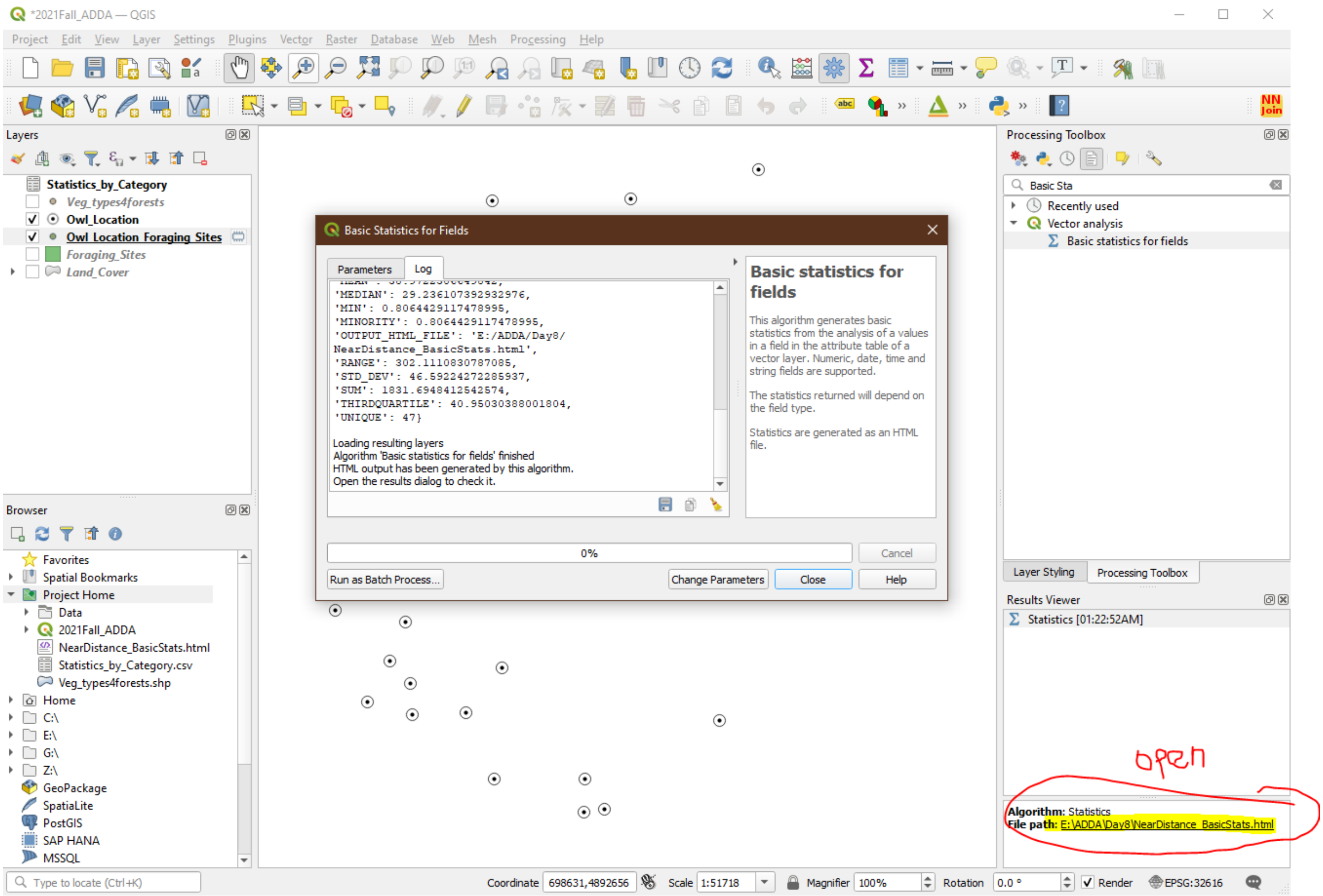


The output layer might be stored as a temporary file (see the icon that indicates so below). If you want to make it permanent, you can click on that icon or right click on the layer and export it as a new shape file.



4. If you open the attribute table of the newly created shapefile, containing owl locations, you will notice that the NNJoin tool has combined the attributes from Owl_Location and Foraging_Sites and additionally, a new field named **distance** has been added. The NEAR_DIST field contains the distance from each nesting site to the nearest foraging site. Unit for distance is based on the projection data associated with your data. Given that your data is in UTM, the unit of measure is in meters. Now instead of using all the distance values, we can generate simple statistics from the field like average, minimum, and maximum distances from nesting sites to foraging sites by using **Basic Statistics for Fields** tool.





5. Open the output html file that contains the basic statistics for **distance** field and fill in the information below.

The minimum distance is _______ m

The maximum distance is _________ m

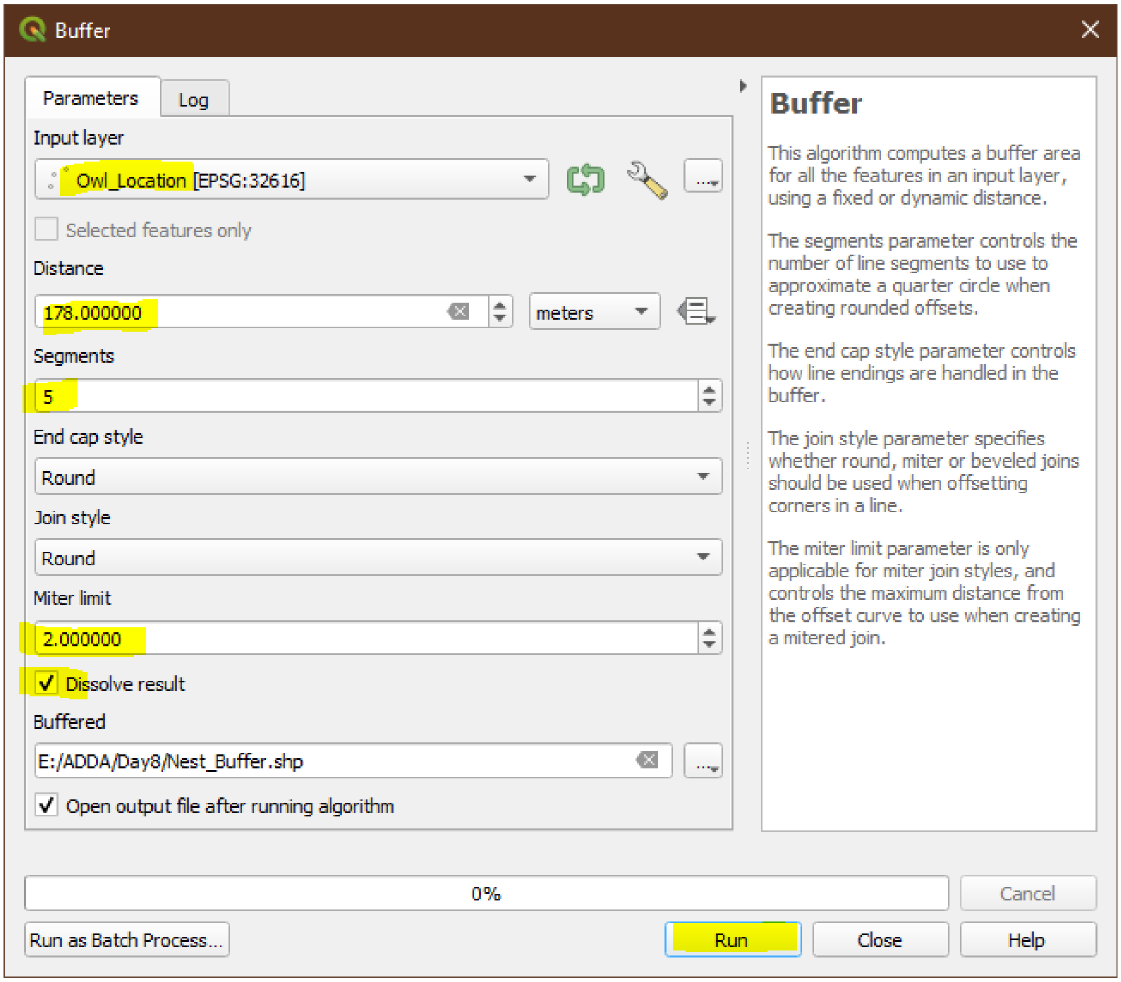
The average distance is _______ m.

So, now you have determined the distances between nesting and foraging sites. If you were creating a habitat management plan to increase habitat availability for brown-winged owls, what should be the spatial arrangement of vegetation types to provide the best habitat?

Step 5: Determine how much Forested area is unavailable for timber harvesting

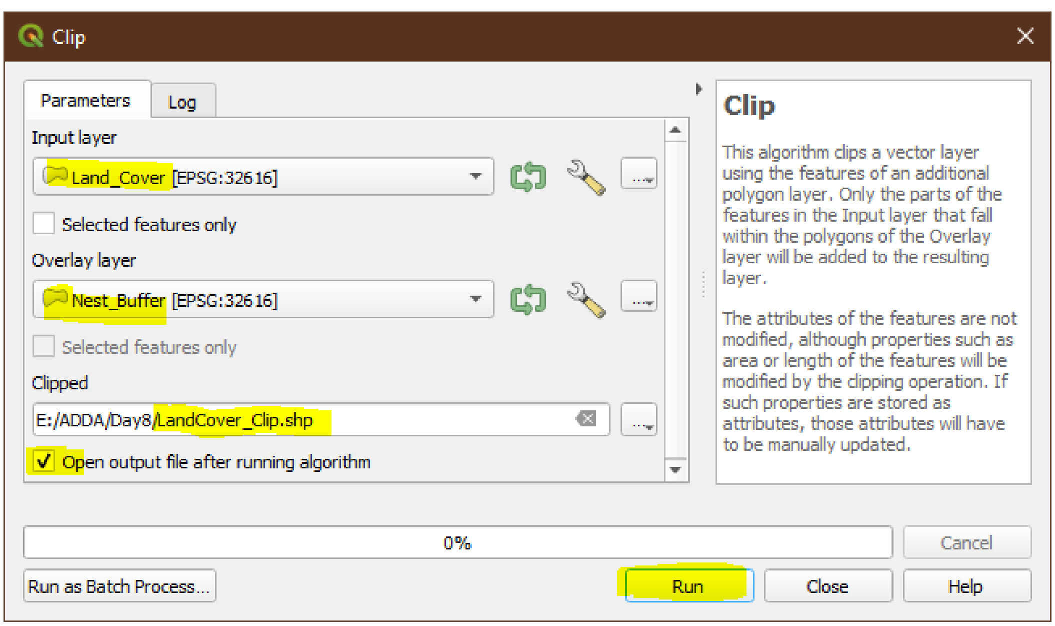
To determine how much forested area is unavailable for timber harvesting, you must create a 10-ha buffer around nesting sites (i.e., the governmental stipulation for protecting nesting sites). Fortunately, there is a buffer tool you can use. Once we create a buffer shape file, we can then use buffer polygon to clip / extract land cover data within the buffer region.

1. Search for buffer in Processing Toolbox and select the Buffer tool within the Vector Geometry toolset.
2. The input features are the Owl Nest Locations. A 10 ha area equals a circle with a radius of 178 m. So, enter 178 meters as the distance. Also, check to enable **Dissolve result** as well. You want to make sure that if buffers overlap, you are not counting that area twice. Name the **Buffered** output file as **Nest_Buffer**.shp and specify where you would like to save it. Click **OK** to run the program.

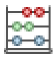


Now that we know the actual area around the nest sites (as dictated by the buffer area) that need to be protected, we can now start looking at the Land Cover data set and see what type of vegetation cover would be within those protected buffer zone. To do this, we can use the **clip tool** from the **Processing Toolbox** to extract the land cover polygons that falls within the buffer polygon. Clip extracts information from land cover layer that falls within the buffer zone.

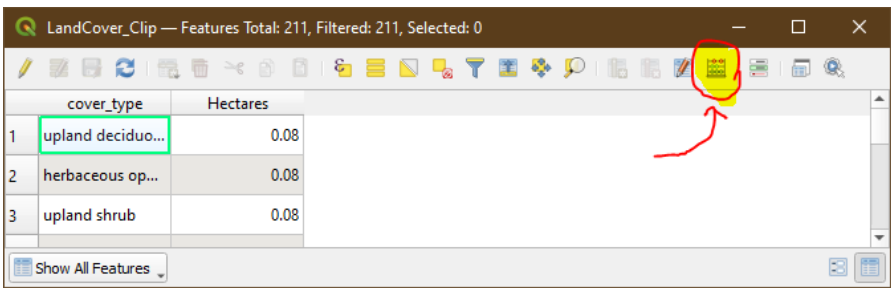
3. From **Processing Toolbox**, search for and open **Clip** tool. Enter land cover as the input and buffer layer as the clip boundary. Save your output file as **LandCover_Clip.shp** and click **Run**.



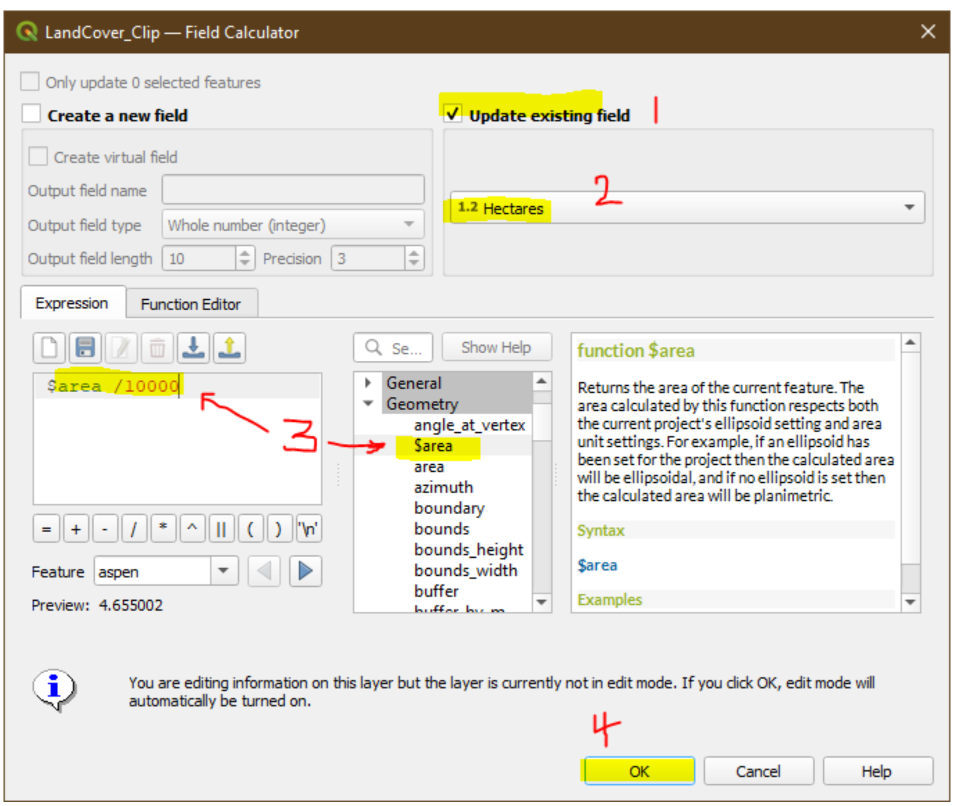
4. When the process is complete, open the **attribute table** for the newly created Land Cover Clip layer. You will notice that area field has not changed even though we expect it to be different and only represent clipped area. It's always IMPORTANT to verify area after doing clip (or any other geoprocessing operations) to see if it is updated or not. A good way to verify is to select a small and simple polygon from the attribute table and measure the area using the **Measure Tool** using appropriate unit. If the area doesn't match what is on the table for that polygon, it means the area field should be updated/recalculated to make them reflect clipped area. Most of the geoprocessing will just extract the data and keep all original attributes as is. So, we have to update the geometry fields as necessary.
5. To update the area field, we will use **Field Calculator** tool. This tool can be accessed in two ways – one from the **Processing Toolbox**, and the other from within the attribute table**.** Since we are interested in updating an existing field (Area in Hectares), we must use the field calculator tool available within the attribute table.

The Field Calculator button  in the attribute table allows you to perform calculations on the basis of existing attribute values or defined functions, for instance, to calculate length or area of geometry features. The results can be used to update an existing field, or written to a new field.

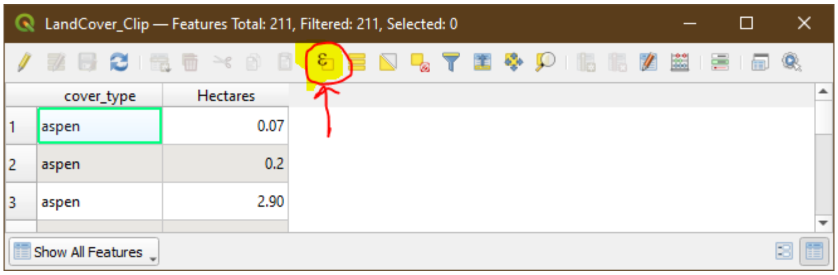
6. With the attribute table open, click on the **Open Field Calculator** button.



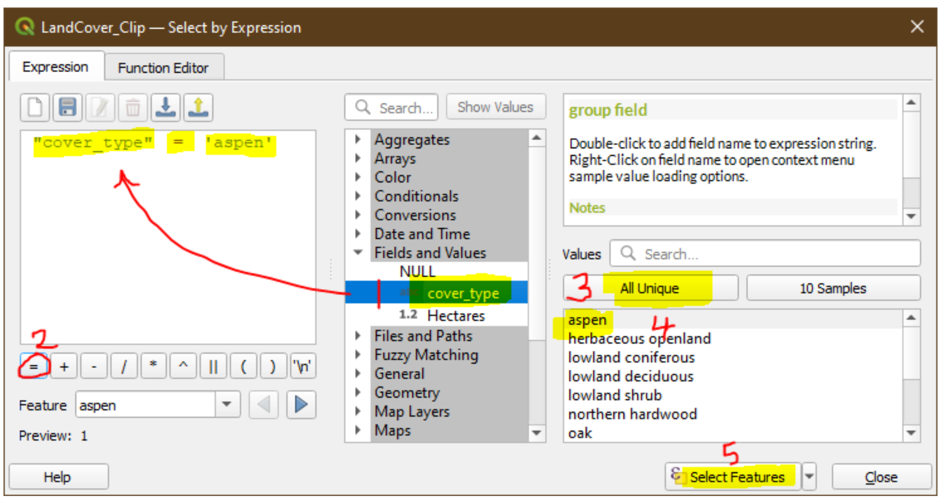
7. By default, area calculated using **Geometry $area** code will produce output in the same unit as the overall map projection unit (in our case, area will be output in meter square since our projection is in UTM with meters as unit). We have to make sure we do appropriate conversion depending on the desired output unit. So, in our case, we will divide $area by 10,000 to create units in Hectare.

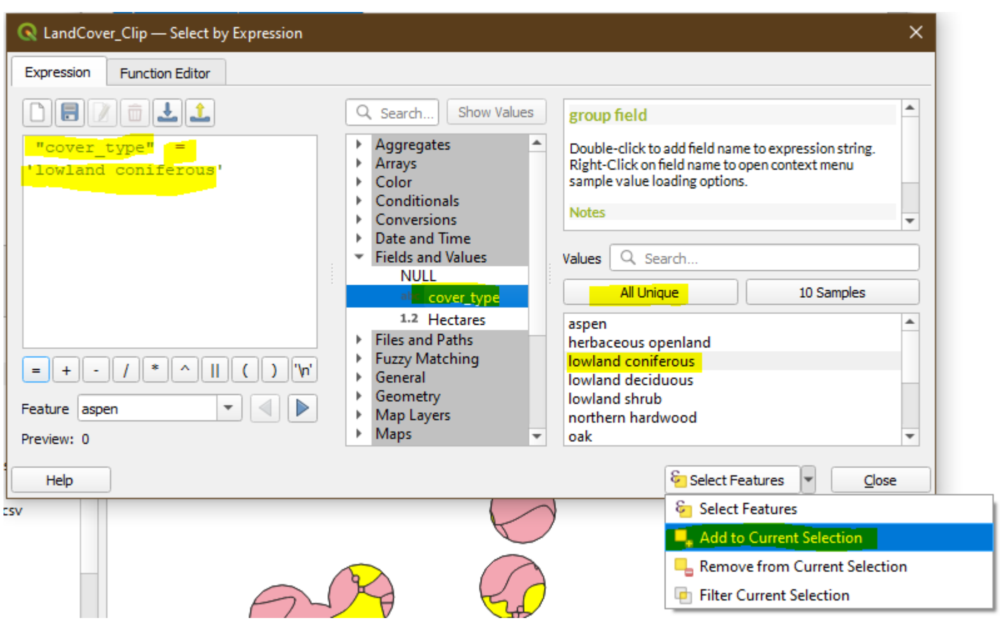


8. Now that we have updated the area, we can now query all forested polygons. Forested cover types include **aspen, lowland coniferous, lowland deciduous, northern hardwood, oak, pine, upland deciduous, and upland mixed** (not all of these forest types might be present in your clipped land cover data). You can use **Select by Attribute** or **Select by Expression** tool to accomplish - it is possible to select all forested land cover in one expression using OR function (see this short video - https://www.youtube.com/watch?v=jPXSMBgA8Rg&t=5s). But I am showing you a longer way to do this using **Select by Expression** tool. Remember, **Select by Expression** tool can be opened from **Processing Toolbox** OR from within the attribute table. In this case, we will call this function from within the attribute table. Try both and see how these tools differ.
9. Open attribute table for **Landcover_Clip** layer. Then open the Select features using expression tool

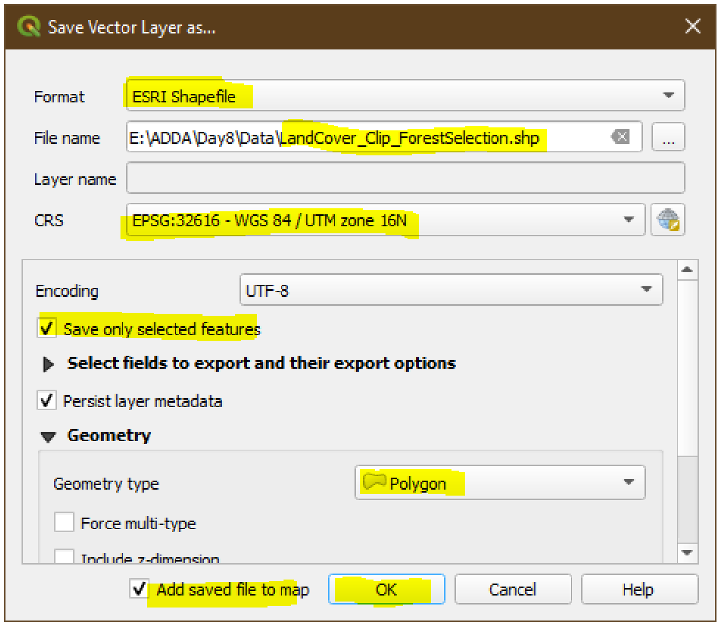


10. Select one land cover at a time, after the first selection, remember to use **Add to Current Selection** to continue add new forest cover to already selected classes. Go through this until you are done selecting all the forest land cover.

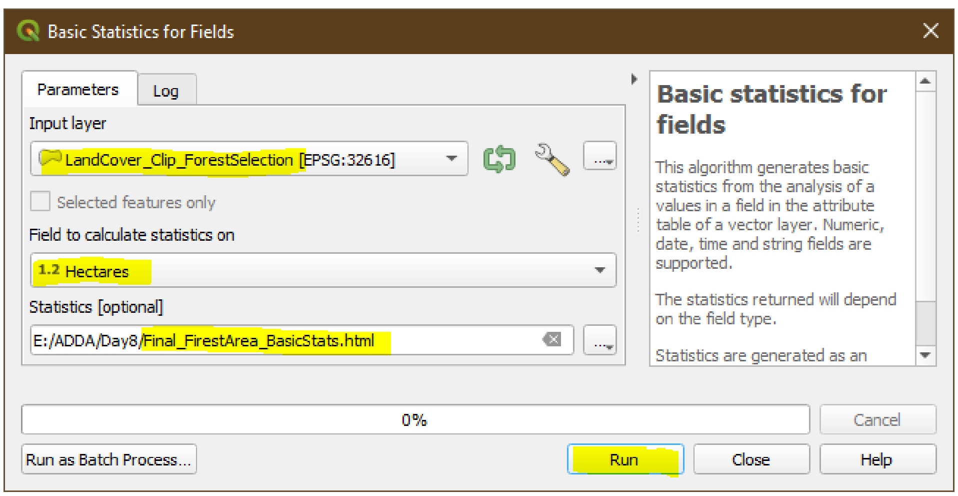




11. If all worked well, you should have 130 features out of 211 selected in your attribute table. Now, save selected features as a new layer (right click Export Save Selected Features As) name it **LandCover_Clip_ForestSelection.shp.**



12. Now, it time to summarize the information provided in the output file to calculate the area of forest that will have to be protected. Search for and open **Basic Statistics for Fields**



13. Open the output html file.

14. What is the total (Sum) area of the protected forest within the buffer zones? ____________ha

Using the same tool, find out the total area for **all land cover types**, and **total area of only forest types** (exclude all shrubs, residential, water, and wetland from the calculation) within the entire hunting club (tip: use land cover original shape file instead of the clipped land cover shape file).

15. What is the total area of the hunting club, including all land cover types? ____________ha

16. What is the total area of the forested areas within the hunting club? ____________ha

17. What percentage of the forested area needs to be protected, and therefore, the hunting club will not gain revenue for the timber? _________% of their forest land.

Critical Questions and Thoughts in Conservation Practice:

Now that you have completed the analysis, think about what your results mean in terms of habitat conservation for the brown-winged owls and forest management. How do you think this information might be valuable for members of the hunting club? Often, the presence of sensitive, threatened, or endangered species requires special consideration in management activities. For instance, in the case of brown-winged owls, timber cannot be harvested within a defined area surrounding known nesting locations. If a landowner depends on timber revenue (like in many resources strapped counties where people rely on harvesting wood from protected forests for their livelihood), alternatives must be considered. Therefore, it is not uncommon for sensitive, threatened, or endangered species to acquire a bad image in the eyes of some people who do not want to deal with adjusting management plans or land-use activities. Presence of sensitive, threatened, or endangered species can also be a very valuable asset to landowners concerned about maintaining biodiversity or even looking to do eco-tourism. Some timberlands may be certified as sustainable through programs such as the Sustainable Forestry Initiative or the Forest Stewardship Council. Local communities in many parts of Africa are actually developing partnerships to protect the natural resources and wildlife that is part of it and bring revenue through eco-tourism and use those revenues to provide means of supporting livelihoods – so the actual natural resource that used to be exploited ends up being protected by the same group of people.

Another approach to conservation involves finding ways to celebrate what we have. Natural resources management agencies and organizations have to devise creative solutions to overcome challenges of managing threatened or endangered species. For example, you may have heard of some festivals or special days devoted to celebrating the existence of threatened or endangered species. The Kirtland's warbler in northern Michigan is celebrated each year with the Kirtland's Warbler Wildlife Festival (http://www.fws.gov/midwest/EastLansing/te/kiwa/tour.html). At this festival, people can learn about the warbler, purchase artwork or other paraphernalia, and participate in guided tours to view the bird. An entrance fee is charged to generate revenues that is used to help fund costs of conserving habitats. Thus, if hunting club members decide that they need to replace revenue lost from not harvesting timber in owl habitats, they may organize a Brown-Winged Owl Festival (a type of Eco-Tourism) to earn money that will help maintain the land and conserve habitat.

Because of your GIS skills, you have provided Windfall Trails Hunt Club with some valuable information. You mapped out the nesting locations of the owls and conducted some spatial analyses that will help managers understand owl habitat characteristics and develop forest management activities that will allow not only timber harvesting but also habitat conservation and community development. You have provided information such as selected vegetation types for nesting and distance between nesting and foraging sites. A manager could easily make recommendations on how to conserve owl habitat by making sure that preferred nesting cover types (e.g., aspen, oak) are maintained as well as ensuring that these preferred nesting cover types are within approximately 40 meters of foraging areas.

This exercise was one example of how GIS may be used in wildlife and forest management. But hopefully, you can understand how spatial skills might help you be marketable for careers in natural resources and how those skills will be valuable in developing management plans for land use activities such as timber harvest and wildlife conservation.

Submit:

1) Answer all the questions in red throughout the instructions.

2) Create a map layout illustrating the results of this analysis. Use your previous GIS knowledge to create an aesthetically pleasing map for the members of the hunting club, include relevant data tables as you see fit

3) Create a detailed methodology flowchart illustrating the procedures. Having completed the whole project, you have to create a good flow-chart that shows all the steps involved in completing the project from the beginning. The idea of providing a flowchart form of methodology is to help yourself and the client visually understand what kinds of data transformation and analysis methods have been used. In addition, it also helps anyone else interested in implementing a similar project to use your work as reference. See examples provided below (taken from the Wolf Habitat Suitability modeling project that is specified on page 2)

4) Write a paragraph reflection on your experience from this lab and how the skills you learned helped you better understand complex problems and solving them.

Congratulations! You just completed your very first complex spatial analysis as applied for conservation.

Some Sample Flowcharts

Sample Flowcharts from http://randallboone.org/