Assessing the Risk of Invasive Species Using Community Science Data

**Instructor’s Manual**

# Module Description

Community science projects (also referred to as citizen science) provide novel data on species occurrence and can help scientists and land managers to understand where species are found. Community science data are also often both spatial and ecological and can be used to help students address a variety of different questions and give students exposure to novel skills including spatial data analysis and GIS. In this activity, students will examine geospatial data from a widely-used community science platform - iNaturalist – which can accurately predict the risks posed by invasive plant species. This is important because it exposes students to GIS tools and analyses through the program QGIS, helps students gain experience in data management and organization, and because it addresses an important applied ecological question.

# Pedagogical Connections

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| **Phase** | **Functions** | **Examples from this module** |
| Engagement | Introduce topic, gauge students’ preconceptions, call up students’ schemata | Pre-Class Reading  Short Introductory Lecture |
| Exploration | Engage students in inquiry, scientific discourse, evidence-based reasoning | Exploration of iNaturalist Platform  Development of Hypotheses & Species Selection |
| Explanation | Engage students in scientific discourse, evidence-based reasoning | In-Class Discussion on Invasive Species  Collection & Visualization of Data |
| Expansion | Broaden students’ schemata to account for more observations | Analysis of Data  Comparison of Different Areas  Assessing Spread of Invasive Species |
| Evaluation | Evaluate students’ understanding, using formative and summative assessments | Scientific Write-Up  Discussion About Development of New Ranking System |

# Learning Objectives

Spatial Analysis Learning Objectives

* To understand how we can use spatial biodiversity and community science data to answer ecological questions
* To utilize and download large-scale biodiversity data from online repositories, including a community science database called iNaturalist
* To learn to make maps that examine species distribution patterns and how they change depending on the species you are observing

Invasive Species Learning Objectives

* To understand the threat invasive species pose to native species and ecosystems
* To use spatial biodiversity data to assess the threat posed by invasive species in a given region
* To determine if community science data is documenting the occurrence of invasive species

# How to Use this Module

This entire module can be completed in one 3-hour lab period or two hour-long lecture periods for undergraduate science students with GIS experience. I found that teaching this module was easy to do in two class periods. The first period was used to introduce the concept of invasive species and to explore iNaturalist. The second class period focused on identifying the species and focal area we would use and then collecting and analyzing the data.

This module is recommended for undergraduate-level courses such as Introduction to Geographic Information Systems, Conservation Biology, and Introduction to Environmental Science. Module materials can be tailored to increase or decrease the background information depending on students' geospatial skills. Depending on the number of students and their experience level with GIS software, having additional instructions available to answer questions is useful, particularly if students have limited prior experience using QGIS.

It is helpful for the instructor to have a working knowledge of QGIS and iNaturalist to help troubleshoot and respond to student questions. However, if they do not there is also an introduction to QGIS in the teacher materials that could be used.

Quick overview of the activities in this module

1. **Pre-Class Activity**: Students will read pre-assigned paper on invasive species and create an account with iNaturalist; Optional Intro to QGIS included as well
2. **Activity A**: Students will have a brief discussion on invasive species and community science (including a focus on iNaturalist as a tool for biodiversity data collection)
3. **Activity B**: Students will use data from iNaturalist and the open access mapping program QGIS to explore the spread and distribution of a common invasive plant
4. **Activity C**: Students will determine if community science data can accurately assess the threat posed by invasive species

# Module Workflow

1. Have students install QGIS on their laptops before class. As of 2021, we recommend using QGIS 3.16 since it is the long term supported platform. However, please request that students download whatever version is the “long term release” as this will be the most stable.
2. Have students set up an iNaturalist account. Instructions are listed below.
3. Give students their assigned pre-class reading. Reference listed below.
4. Instructor gives brief PowerPoint presentation on invasive species and why they are important to study. This presentation also includes information on geospatial data analysis and introduces QGIS, which is a free and commonly used geographic information software program.
5. After the presentation, the students divide into small groups and have a discussion (Activity A). This activity could also include selection of invasive species and geographic region to explore.
6. Students will examine the spread of a common invader using iNaturalist and QGIS (Activity B).
7. Students will then work to download data on five invasive species of their choice and determine if the rankings for these species matches the category level from expert management groups (Activity C).
8. Students complete a take home assignment or class discussion that compares their findings with expert findings and discusses the implications.

**Important Note to Instructors:**

The QGIS and iNaturalist programs used in this module are continually being updated, so these module instructions will periodically change to account for changes in the appropriate stable version or to the iNaturalist website. If you find any errors or have other feedback about this module, please contact the module developers (see “We’d love your feedback” below).

**We encourage instructors to read through and run the QGIS and iNaturalist instructions before teaching the module so that you are familiar with all of the steps of this activity.**

# Things to do prior to starting the instructor’s presentation

* Make sure that all students have downloaded QGIS and created an iNaturalist account.

# Introductory PowerPoint Presentation

We have provided some text in the “Notes” of the PowerPoint slides that can be viewed when projecting in Presenter View.

**Pre-Class Activity: How do we examine the spread and distribution of invasive species?**

*Invasive Species Pre-Assigned Readings:* Students will read the pre-assigned paper by Early et al. (2016) that examines the impacts of invasive species on native ecosystems. This article is open access and is intended to provide context for the activity and general information on the threats posed by invasive species.

Early et al. (2016) Global threats from invasive alien species in the twenty-first century and national response capacities. *Nature Communications* **7**, Article Number: 12485.<https://www.nature.com/articles/ncomms12485>

*Setting up an account with iNaturalist:* Students will create their own free iNaturalist account. To do this, visit [www.inaturalist.org](http://www.inaturalist.org) and click on the button that says sign up in the top right corner. This will allow you to set up an account and username so that you can download species occurrence data.

*Downloading and Installing QGIS:* Students will download and install QGIS. To do this, visit <https://qgis.org/en/site/forusers/download.html> and either on the download for Windows or MacOS. Make sure to have students only download the long-term release. For Windows users, make sure they download the 64-bit version.

# Activity A: How do we examine the spread and distribution of invasive species?

Activity A begins with a brief presentation about the importance of invasive species. After the presentation, I recommend breaking students into small groups to discuss the following themes and questions:

1. What is an invasive species?
2. What are some common examples of invasive species and what are their impacts?
3. Why is it important to know where invasive species are found?
4. What areas are at the greatest risk from invasive species (both today and in the future)?

Students will then have a brief discussion about iNaturalist and the role of community science data collection. This will include discussion on the following themes:

1. The purpose of iNaturalist
2. Who collects data
3. How we can use these data to answer ecological questions

This activity is primarily targeted at students who have some exposure to GIS programs. They should be able to load a basemap. If they have not had experience doing this, you will likely need to include a brief discuss of what basemaps are and how they work.

# Activity B: What is the spatial distribution of invasive species

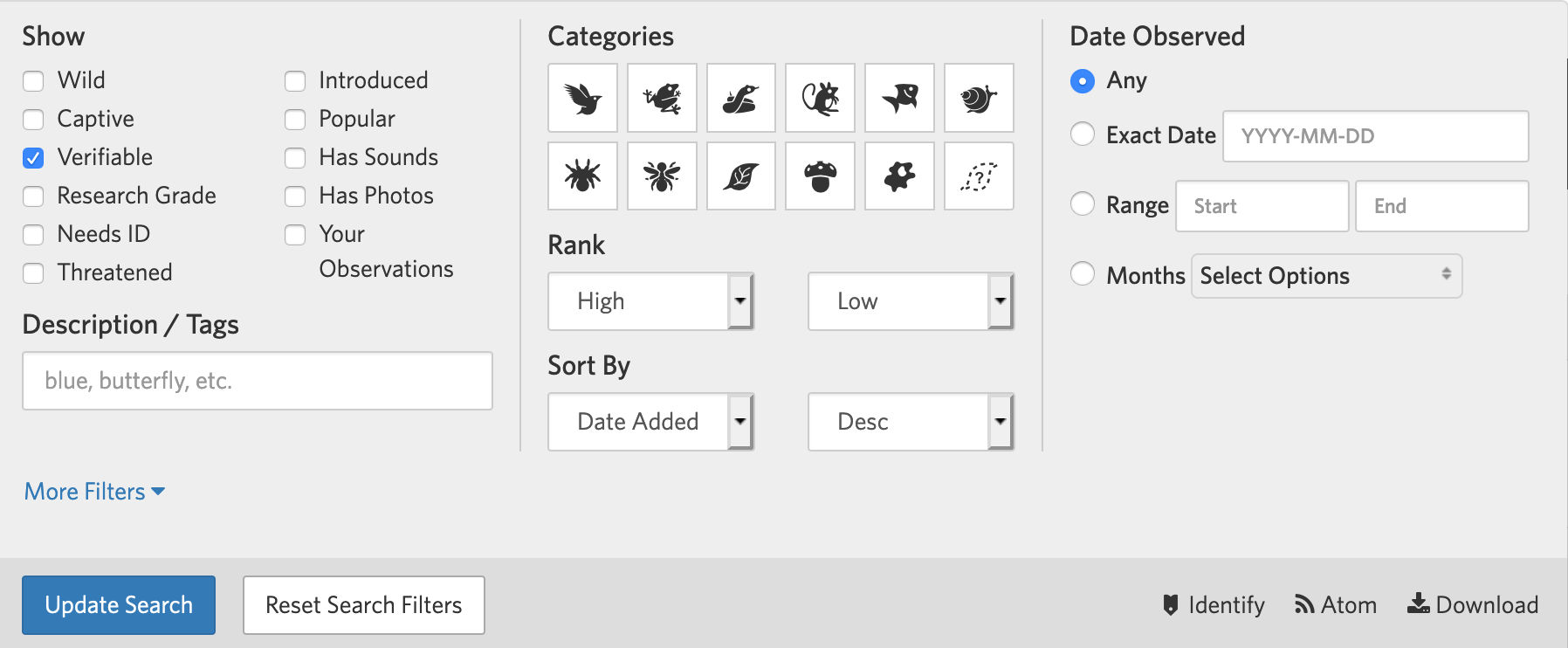
This part of the activity is the most straight forward because you are walking through an example of how a common invasive species is distributed. Everyone in the class will get the same result, so it means that everyone can compare their data/outputs to each other.

The instructions below provide details on how to look for a common invasive plant - *Lonicera japonica* (Japanese honeysuckle) in a single state (TN). You can and should adjust this to wherever you are located.

*Downloading Data for A Common Invasive Species From iNaturalist*:

These instructions can be used to download data for any species.

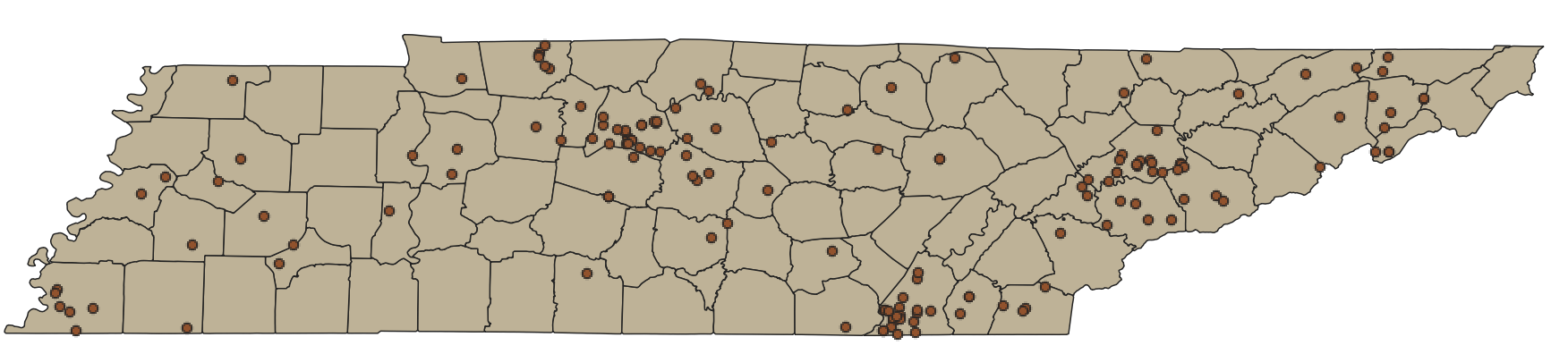
1. Go to [www.inaturalist.org](http://www.inaturalist.org) and log in to your account
2. Once you are logged in, click on the button at the top of page that says *Explore*
3. From there, enter into the species box on the top right “Lonicera japonica” and in location enter “Tennessee”
4. Once you have done this, click the filters button on the top right. This should bring up a box that looks like this:



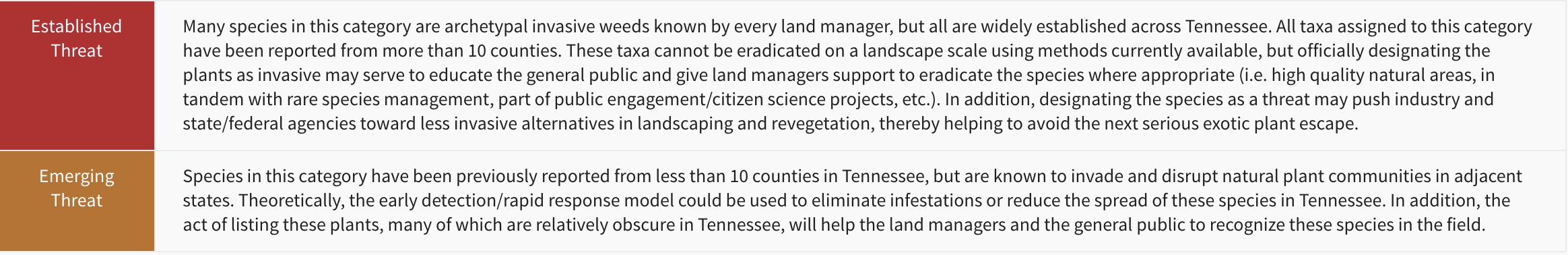
1. Once you have done this, make sure the verifiable box is checked and then click on the download button in the bottom right corner of the box.
2. This will take you to the export observations page where you can create a query.
3. De-select everything by hitting the ‘none’ box at the top and then re-select id, latitude, and longitude. This will decrease the size of the CSV file and make it easier to work with.
4. Scroll down to the bottom of the page and then select create export.
5. This will take a few minutes to download, but once it is done (time depends on file size) you will need to click on the download button. This will begin the download of a csv file that it is in a zip form.
6. Once the download is complete, open the file in Excel or Google Sheets to make sure that it is properly formatted as a CSV and that it includes latitude and longitude data.

*Mapping Invasive Species Occurrence Data in QGIS:*

1. Begin by opening up QGIS
2. Choose a state and load a basemap that has the county boundaries. If you do not already have a basemap, you can download the shapefile from the following website: http://www.tngis.org/administrative-boundaries.htm.
3. For the purposes of this lab, we will focus on Tennessee, but again if you are using another state, the map will be similar and have points and county boundaries.
4. Once you have loaded in this basemap, add in the csv layer (as a delimited layer file). When you are finished, this should like similar to this map:



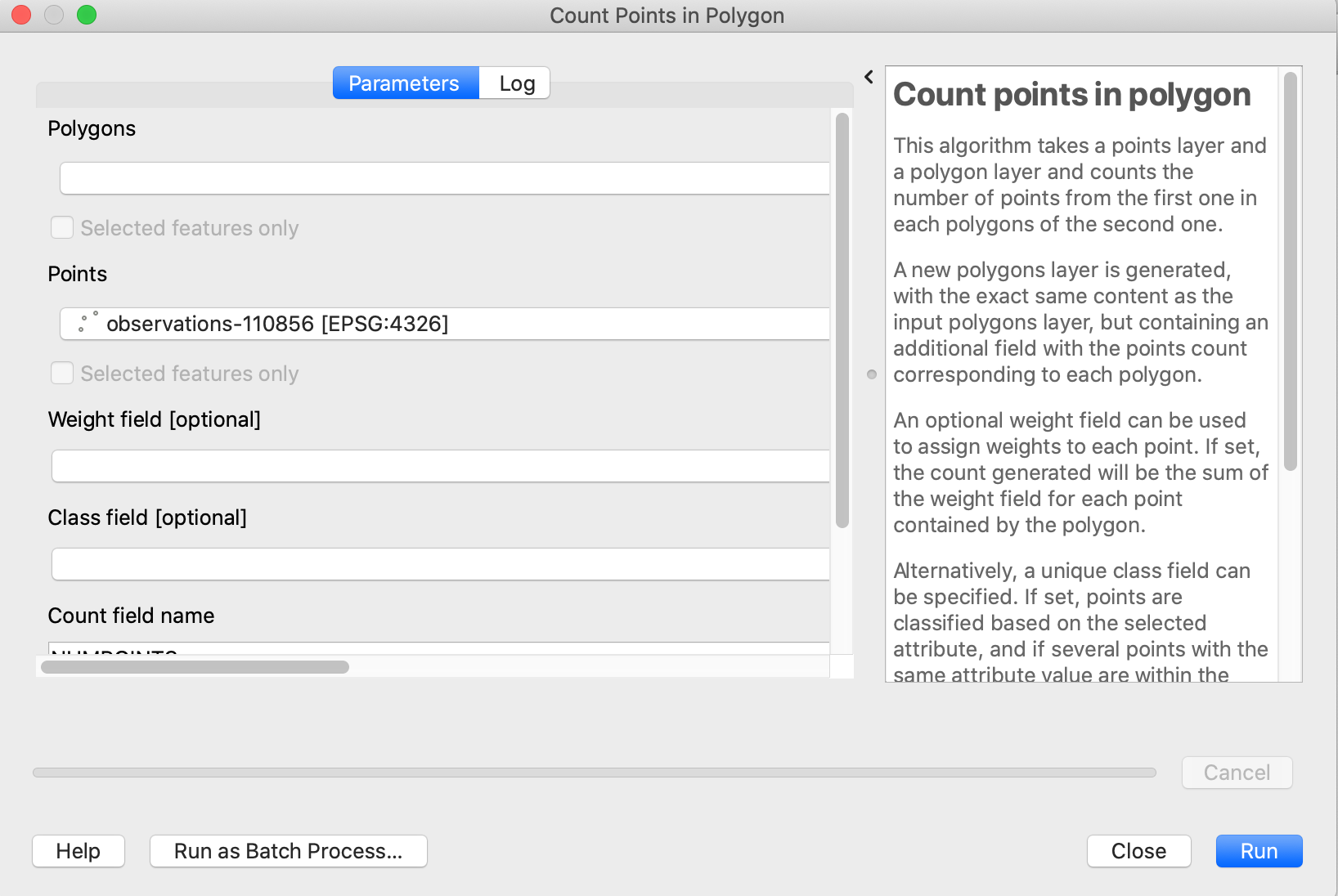
*Tennessee Ranking of Invasive Species:* The Tennessee Invasive Plant Council classifies invasive plants into two different threat categories: Established and Emerging Threats. These threat categories are based on the number of counties in which these invasive species are found:



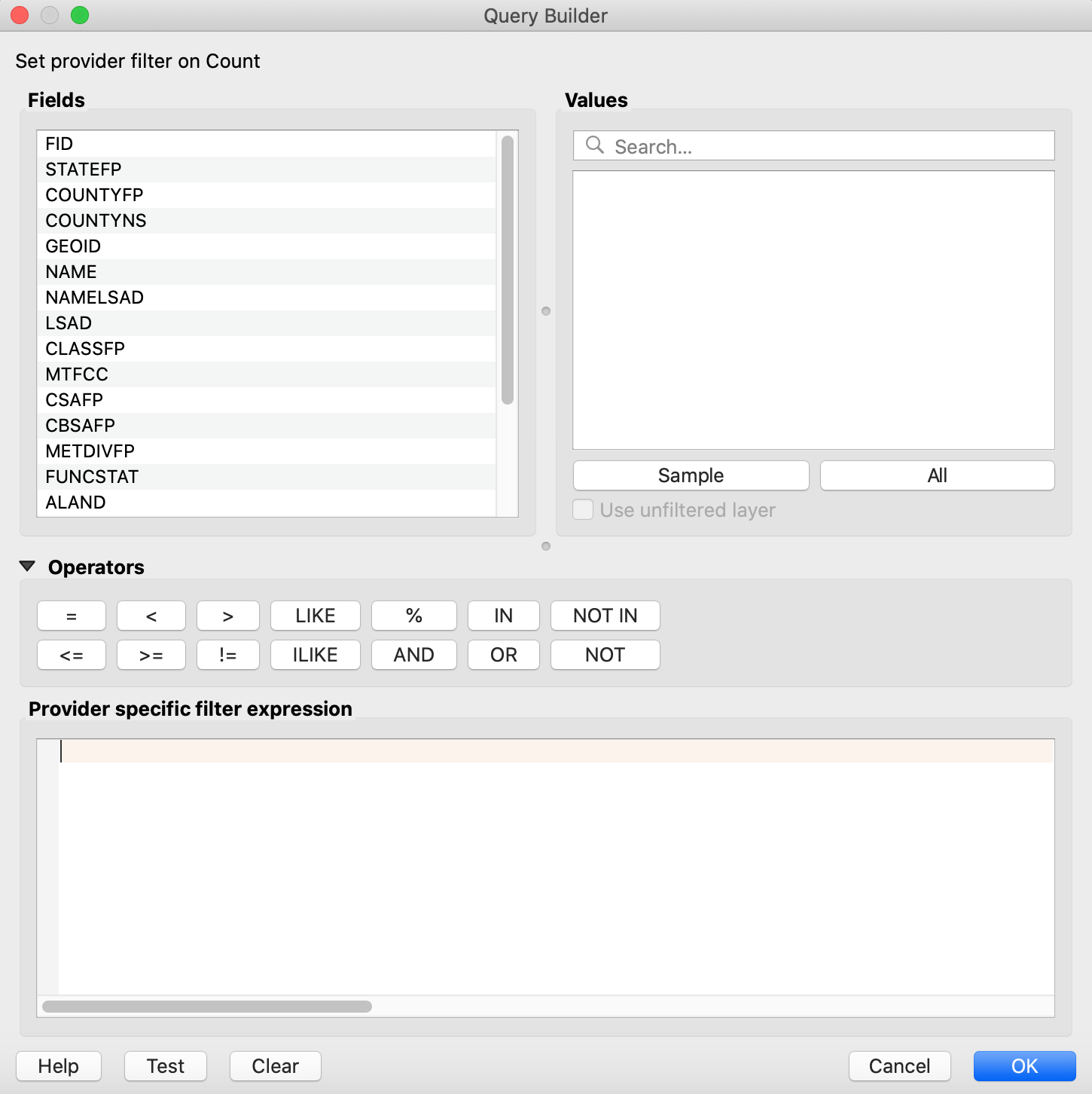
Source: <https://www.tnipc.org/invasive-plants/>

*Determining If Citizen Science Data Accurately Assesses Threat of Invasive Species*: In this next step, we will evaluate if data from iNaturalist accurately predicts the threat posed by an invasive species according to the Tennessee Invasive Plant Council Ranking system. To do this, we will need to learn how to filter and sort data in QGIS and then to compare this to the TN rankings.

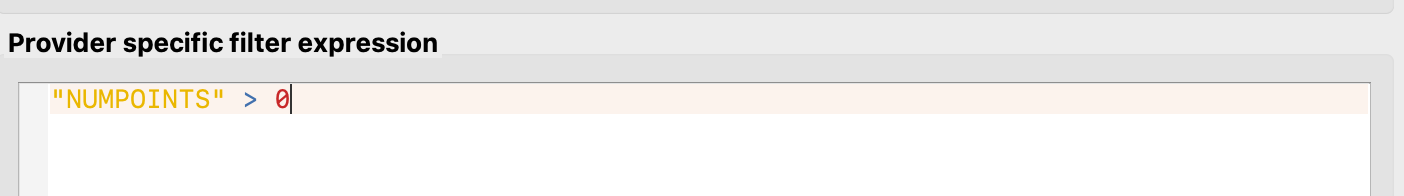
1. Click on the vector button on the top menu of QGIS and this will lead you to a dropdown menu.
2. Go to analysis tools and then select ‘count points in polygon.’
3. When you do this a new box will pop up that looks like this:



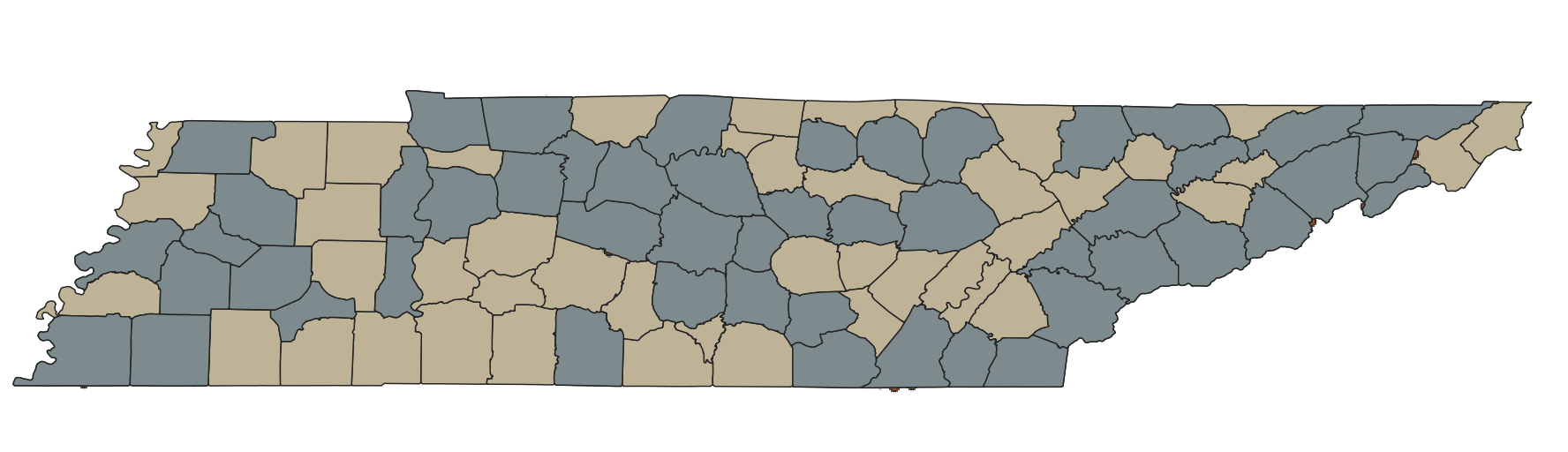
1. Once you have done this, enter your TN counties map as the polygon layer by using the dropdown menu, and enter your points layer as the points layer using the dropdown menu.
2. When you have done this, select run. This takes some time, so be patient.
3. When this finishes running, a new layer will appear. This new layer will look just like the county layer because it has merged the point/shapelayer files together.
4. To determine the number of counties that have points in them, you will have to filter your file.
5. To do this, left click (right click on PC) on the new layer that you just created and then select filter.
6. This will take you to a box that looks like this:



1. In this box, you need to scroll down and click the mouse on the field entitled “NUMPOINTS”
2. Once you have clicked on this, then click on the ‘All’ button on the right side. This will give you a list of all the numbers that are in the polygons (so the total # of points).
3. Go back to the field box and double click on “NUMPOINTS,” then select the greater than sign and then double click on the 0 button. If you have done this correctly, it should look like this:

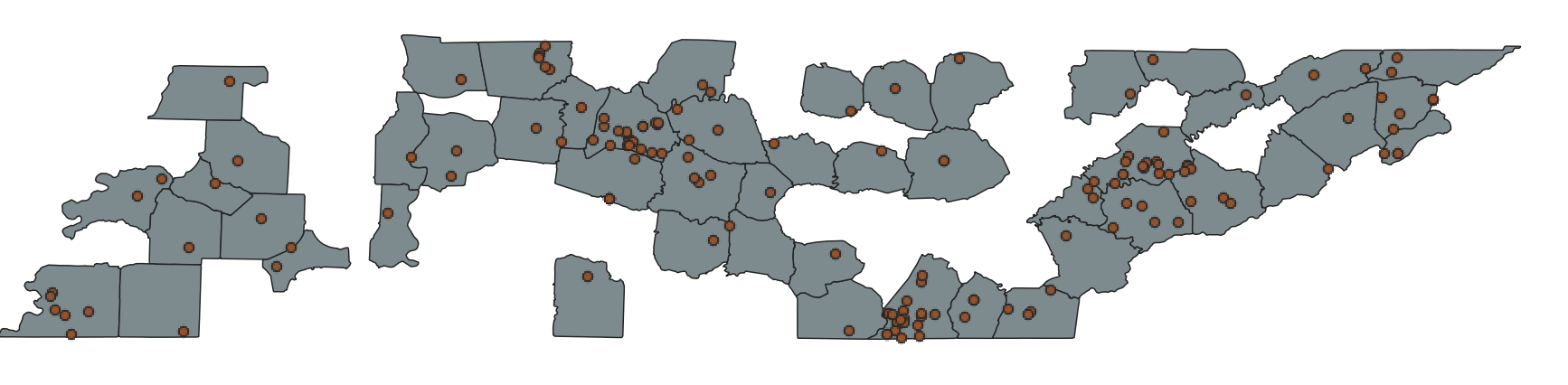


1. Once you have this, it will create a map of all the counties that have more than one occurrence data.
2. Then, to determine the total number, left click (right click on PC) on the layer and select ‘attribute table.’ At the top, it will tell you the total count.
3. In addition, you should have a map that now looks like this:



*Editing the Map to Show Only Counties With Invasive Species Present:* The next step is to adjust the colors of the map and the layer visibility. To do this, use the following steps:

1. Click your mouse on the TN county layer map.
2. Then click on the view button on the menu at the top and select “Hide Selected Layers.” This will eliminate all the counties underneath.
3. From there, you can then move the point layer up by selecting it and dragging it over the “Count Layer” that you created.
4. This should result in a map that looks like this:



1. After you have created this map, discuss what you know about these counties across Tennessee with a partner (or in small groups) and then talk about what type of geographic environments this invasive species may prefer or be found in.

## Common stumbling blocks for Activity B include:

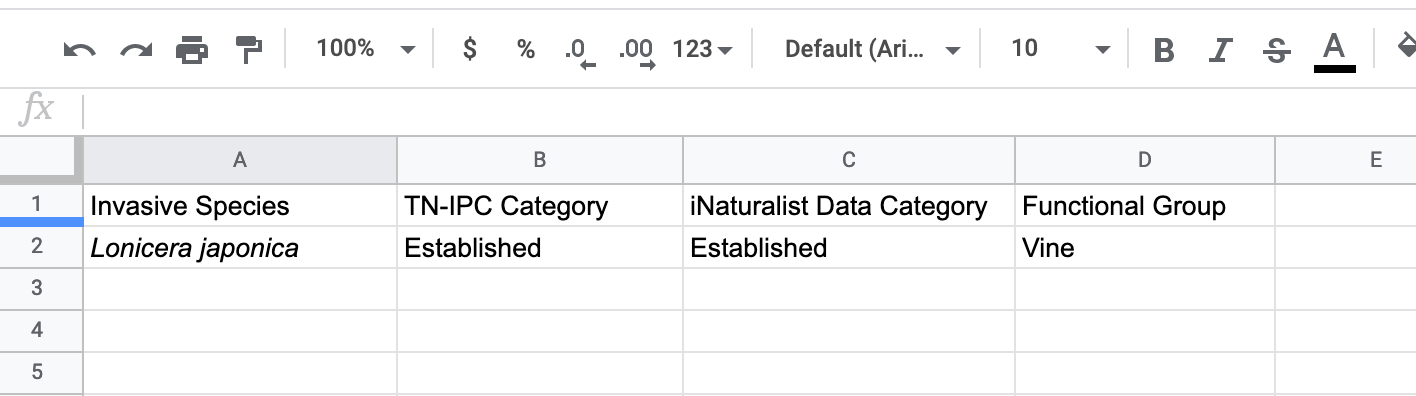
* Make sure students can load shapefiles into QGIS.
* Navigate through how to selectively filter data in iNaturalist
* Make sure the correct boxes are checked in iNaturalist. The easy way to deal with this is to make sure everyone’s sample size is the same.
* Make sure that you can access the processing toolbox through vector. If this isn’t showing up in a student’s menu, they will have to go to plugins on the menu and then check the box to show processing.

# Activity C: Can community science data accurately predict the threat of invasive species?

Activity C allows students to do comparisons between expert rankings and community science distribution data. Following the activity, instructors can lead a class discussion on how student data answers the questions they chose.

Students will work to download data on five invasive species of their choice from the Tennessee Invasive Plant Council website and determine if the rankings for these species matches the category level from TN-IPC. Students can select the invasive species by going to the following website and downloading the list of TN Invasive Plants. <https://www.tnipc.org/invasive-plants/>. Then for each of the five species, students will go through the same steps above in iNaturalist and QGIS to make the maps and determine the number of counties these invaders are found in.

Following completion of these activities, students will aggregate their data together in a class Google Sheet that includes the categories pictured below. Additional columns could be added including functional class or numbers of counties from different ranking systems to increase the analysis. Instructors can then lead a class discussion on how student data answers the questions they chose.



Potential Assignments:

1. Pre-Activity: Have students submit write-ups or grade discussions on Early paper.
2. Activity A: Have students search for invasive species and determine creative ways to have them explore iNaturalist
3. Activity B: Have students submit assignments that include the individual components of making these maps. These could include showing they correctly downloaded the data, uploaded county maps, and then made point maps
4. Activity B: Have students examine and evaluate information on the TN-IPC page.
5. Activity C: Using these findings, you can write a mini-scientific paper explaining their question, approach, results, and implications of the findings.
6. Activity C: Students could break their state into different geographic regions and create their own ranking system based on the number of counties they occur in.