Using GIS and Remote Sensing to Identify and Monitor Invasive Plant Species

As trade and travel increased over the years, so have invasive plants. Invasive plants are usually habitat generalists, produce a copious amount of seeds, often reproduce earlier than most of the native plants and generally do not have natural predators. These advantages allow the non native plant species to become more abundant and out-compete native plants causing loss in habitat diversity and economic damage. Invasive species often travel undetected and therefore lead to significant influx, especially in hard to access areas. To reduce spread of invasives, researchers are using GIS and remote sensing to help identify areas that are currently invaded and to predict areas of future invasions.

GIS and remote sensing technology have been improving over the years, and have also become more accessible, however making the decision on which platform to use can be a difficult one, mainly because of the large number of options. Several researchers have examined and compared the results of different techniques and combinations of remote sensing and GIS to identify the best method to identify and monitor invasives. What was often reinforced, in the papers I looked at, was that the technique one should choose should depend on the goal of the project and also the location of the project (taking into account land structure, tree canopy, type of invasive).

There are a few limitations with using GIS and remote sensing. One challenge is being able to identify the plants in the understory from the tree canopy, especially when the landscape is not flat and has abrupt changes. One study suggested using medium spatial resolution imagery along with high spatial resolution information, which together, should provide accurate detection of invasive plant species in the selected area. Another challenge is identifying emergent wetland plants. The current Landsat 30m resolution provides an image that is too course to accurately determine the plants, a solution is to use SPOT and/ or IKONOS images which have proven successful in identifying multiple classes of emergent wetlands. Another suggestion for wetland mapping is collecting multiseasonal images which “aid in discrimination of wetland types by detecting hydrological and phonological change in characteristics” (Ghioca-Robrecht et al.). This process also allows for distinguishing plants within a growing season.

It has also been concluded, by most papers I’ve read, that to get very reliable results on plant identities, one should use hyperspectral data. Hyperspectral imagery (especially with 5m resolution) improved identification of plants, mainly, because of the large amount of spectral bands. Therefore hyperspectral imagery can detect “subtle differences in reflectance” (He et Al.) resulting in better differential of plant species. It was also noted that using Object Based Image Analysis on very high spatial resolution panchromatic and color aerial orthophotos, one can obtain a good understanding of the plant species as long as the pixel size is smaller than the plant you are trying to detect.

There have been a couple ways to monitor the invaded area along with determine potential risk for invasion areas. One paper talked about constructing a bioclimatic envelope which takes into account a number of particular climatic parameters that will determine an invasive plants’ species preferred habitat. This information would be highly useful so one can focus more attention on monitoring a high risk area more often. Another study used a similar method to help detect potential high risk areas. Masocha et al. used remote sensing imagery that contained an advanced “expert system” that used advanced interpolators to determine most suitable areas for invasive plants at very high accuracy rate. This too allows for early detection and assessment of areas that are at high risk for invasives. Early detection is crucial to increase the success rate of eradicating the invasive

An important point to remember is that, though some images are available, there is a cost associated with them and not everyone is willing to spend a large some of money on data. Therefore some studies have suggested that one could use medium spatial resolution image analysis. This will provide one with a quick overview of the region of infestation or potential infestation. This would be helpful especially in the hard to access areas. These images very detailed; however they would be good in situations to view the limit of invasion or to use year to year for monitoring on the progress of invasive species control or on determining areas of infestation. Areas that are of
particular concern, such as high risk areas or edge of the invasives current location, one should then consider using hyperspectral data to view areas of interest in more detail.

From the papers I have read, both GIS and mainly remote sensing are very useful tools when it comes to identifying invasives and monitoring their spread. These tools are especially useful when it comes to hard to access areas, especially in wetlands, bogs, or deep forested areas. Also, developing risk assessment maps help land managers to closely monitor high risk areas, especially if those areas contain endangered plant or animals (who feed on particular native plants). These risk assessment models will also help with early detection and therefore help decrease the chance that an invasive will continue to spread by eradicating it early. I believe that GIS and remote sensing will continue to be used for invasive plant identification and even used more as the technology advances. I also think that even though the technology will become more sophisticated it may also become more user friendly and therefore more people will be opt to use it. Though none of the tools or models that were mentioned in the studies were 100 percent accurate at locating invasives and some platforms still have limitations, it is still wise to use them to help decrease the spread of a current invasive and/or prevent invasions all together.

Work Cited:


Annotated Bibliography

This paper discusses the use of orthophotos taken in the spring and summer and exploring its temporal, spectral, and spatial characteristics to identify locations of Japanese knotweed. Study done in Slovenia on a site that has been invaded for over 50 years. Study determined that the use of all three characteristics allowed for high accuracy of detection.

This paper looks at the use of QuickBird multispectral satellite images in the late Summer/ Fall during peak biomass and in the Spring during pre growing season along the coastal marsh, looking for invasive species, mainly phragmites and Typha. The authors discuss the inadequacy of course spatial resolution (Landsat 30m resolution) mapping of wetlands. Presently, both SPOT and IKONOS are excellent sources of images to use because with them one can identify with high accuracy multiple classes of emergent wetlands. Hyperspectral imagery (5m resolution) improved mapping with high accuracies. The paper also notes that QuickBird has not been used as a wetland mapping attempt of emergent vegetation.

He, Kate S., Bethany A. Bradley, Anna F. Cord, Duccio Rocchini, Mao-Ning Tuanmu, Sebastian Schmidtlein, Woody Turner, Martin Wegmann, and Nathalie Pettorelli. "Will Remote Sensing Shape the next Generation of
This paper discusses the future potential of using remote sensing to improve species distribution modeling. It looks at current ways to evaluate species distribution assessing and the advantages and limitations of different techniques for remote sensing. For plants, the best is hyperspectral data because it has a large amount of spectral bands and so the sensors can detect small differences in reflectance. This also helps reduce misidentification. For tree identification, LiDAR coupled with either multispectral or hyperspectral data works the best.

This paper looks at the ways GIS is used to estimate the probability of an invasive plant spreading to new locations. The paper discusses examining climatic parameters, based on invasives current location, to determine an invasives plant preferred habitat. The authors call this a bioclimatic envelope which tells one about the habitat suitability. These envelopes are useful to help map current distributions on an invasive, but also to be aware of areas that may be at a higher risk for invasives. This, in turn, will allow for better monitoring and early detection in the high risk areas which should potentially decrease the rate of invasive spread.

This paper discusses the benefits of using GIS and Remote Sensing to help map invasive plants species. The authors look at the traditional remote sensing coupled with advanced “Expert Systems”, together it allows for a more accurate map. The Expert Systems make estimations of areas that are thought to be most suitable for an invasive plant species. This allows for early detection and also helps to locate areas that are hard to get to and ground survey.

This paper compares Panchromatic, multispectral and color Very High Spatial Resolution (VHR) aerial photography and medium spatial resolution satellite data for assessing and analyzing their potential for monitoring hogweed. For small areas VHR is good, but over large areas, the data would be too large in size as opposed to multispectral satellite data of medium spatial resolution. The authors discuss the benefits and limitations of the VHR and satellite data and determining that remote sensing is very successful in invasive studies that involve trees and shrubs, but for herbatious species hyperspectral data is most accurate. Also that Object Based Image analysis, which is often used in ecological patterns and processes and which relies on both spectral and spatial information, has not been looked at as a way to identify and detect invasives, but showed promising results. The authors suggest for monitoring to use Medium spatial resolution image analysis which gives a quick overview of regional infestation and where needed to use VHR data provide details on invasion once it is located.

This paper looks at ways to accurately locate invasives in an urban forest which is a very heterogeneous environment. The paper states that very high spatial resolution is needed to identify/ differentiate low understory plants from high tree canopy and that it’s good to use on a landscape that has abrupt changes. The authors discuss
that choosing the correct remote sensing image depends highly on the project/studies goal. This paper also notes that medium spatial resolution imagery used along with high spatial resolution information allows for an accurate detection of invasives, however, as mentioned in other papers, the cost of using this platform is very high.


This paper discusses the use of hyperspectral image processing techniques, with imager from visible to near-infrared, to map out locations of purple loosestrife and to also assess the effectiveness of the biocontrol methods along the Niobrara River in Nebraska. The system that was used also has a Differential Global Positioning System and an Navigational system which allowed for a more accurate spatial data. This paper also discussed the importance of planning data collection with phonological cycle to allow for better separability of the invasive to other plants. FLAASH (Fast Line-of-sight Atmospheric Analysis of Spectral Hypercubes) was used to atmospherically correct the collected data. Discussed using ISODATA algorithm to classify collected data.