NATIONAL CENTER FOR CASE STUDY TEACHING IN SCIENCE

Could Grazing Be Dangerous? Ask the Cows!

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Part I – The New Farm

Elmer Johnson recently purchased a 180-acre parcel of land and a farm in eastern Washington (Figure 1). He moved his herd to his new property and they have been grazing on it for a couple of months. In the last two weeks, three cattle have gotten sick, and two have died. The cattle have been lethargic; they have not been eating well and have gradually been losing weight. Elmer also notices that some of his cattle have a unique series of small seed pods fastened to their fur. Elmer decides to call a local veterinarian, Dr. Roberts, who specializes in bovine diseases.

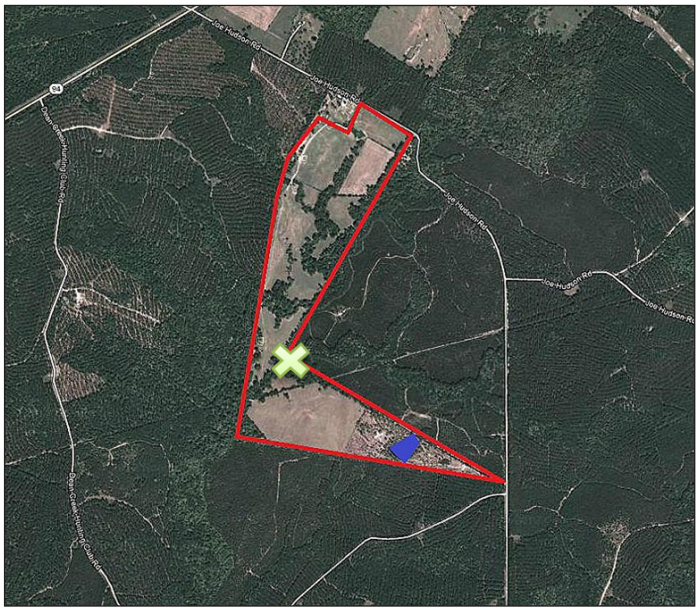

Figure 1. Overhead map of 180-acre parcel outlined in red. The green X shows the location where the sick cattle were found.

Dr. Roberts arrives the following day to evaluate the ailing cattle. Dr. Roberts observes the cattle hanging their heads and they seem to be bothered by some ailment in the abdomen, evident by their kicking towards the stomach area (Graham & Johnson, 2007). As the doctor examines two of the cattle's eyes with a small light, he notices them pulling their heads away. This is an indication of photosensitivity. After an examination of the feces he also discovers the cattle have been suffering from severe diarrhea (Graham & Johnson, 2007).

As he examines the feces further, he notices curious triangular seed pods. The seed pods found in the feces are similar to seed pods (Figure 2) that were found attached to the fur of the sick cattle. He consults an invasive weed guide to identify the seed pods. (See ***Invasive Weed Management Handbook***.)

Figure 2. Seed pods like those found in cattle feces.

Question

1. Given Dr. Roberts' examination, what could be ailing the cattle?

Part II – Finding the Culprit

Dr. Roberts studies an invasive weed guide, which describes invasive weeds commonly found in this region. He finds four weed species of interest: diffuse knapweed, common bugloss, leafy spurge and houndstongue (Figures 3–6).

Figure 3. Diffuse knapweed (Asteraceae family, *Centaurea diffusa).*

Figure 4. Common bugloss (Boraginaceae family, *Anchusa officinalis).*

Figure 5. Leafy spurge (Euphorbiaceae family, *Euphorbia esula).*

Figure 6. Houndstongue (Boraginaceae family, *Cynoglossum officinale).*

Question

1. Review the above pictures; which noxious weed do you think might be causing the illness in the cattle?

Part III – The Diagnosis

Dr. Roberts completed his examination and concluded the cattle have been poisoned by the noxious weed houndstongue, *Cynoglossum officinale*. Houndstongue contains toxic pyrolizidine alkaloid, which stops the production of liver cells (Graham & Johnson, 2007). Elmer now knows he is dealing with a noxious weed and he wants to locate the areas of infestation on his property.

Questions

1. Are there other invasive weeds that also threaten livestock?
2. Why do livestock eat plants that are dangerous to them?
3. How would you go about locating the areas of infestation on Elmer's property?
4. While threats to livestock by way of invasive weeds are concerning, there are other even more significant threats from invasive weeds. What else is known about invasive weeds and their impact on agriculture and wildlife?

Part IV – The Weed Mapping App

Elmer does some research and talks with some farmers in the area who are part of the Lincoln County Conservation District. Conservation districts are geographically-defined areas which have significant agricultural and wildlife significance. As such, they are federally, locally, or grant-funded agencies that are designed to help support land owners with conservation-related issues—in the case of Elmer's land, invasive weeds. The Lincoln County Conservation District informs Elmer of a newly developed Weed Mapping Application that can be used to help identify and geo-locate weed species so they can be treated, controlled or eradicated (Figure 7). This application allows the user to take a picture of the weed and pinpoint the exact location/coordinates for further study and sharing. The data can then be uploaded to the citizen scientist database "CitSci.org" for further research and inquiry. This allows land owners to not only determine the extent of invasive weeds on their property, but also helps conservation districts better understand the distribution of invasive species.

Elmer installs the app on his mobile phone and goes out to his property to further determine the extent of the houndstongue infestation. He starts at the initial site where his ill cattle were found and walks the fence line of his property. He begins to find more and more houndstongue. He takes pictures of the species he observes and uploads this data to the invasive weed database. He determines an initial species distribution.

As shown in Figure 8, Elmer identifies over twenty instances of houndstongue in proximity to his property. Elmer runs out of daylight and realizes he is going to need to get some more help to further identify and treat what he now believes is a major infestation of houndstongue.

Questions

1. What can be said about the distribution of houndstongue as was initially determined by Elmer in Figure 8?
2. Given that Elmer wants to continue sampling his land for houndstongue, what might be some appropriate sampling/surveying techniques which would help him further determine the extent of the houndstongue infestation? (Refer to the Field Work section of the *Invasive Weed Management Handbook*).

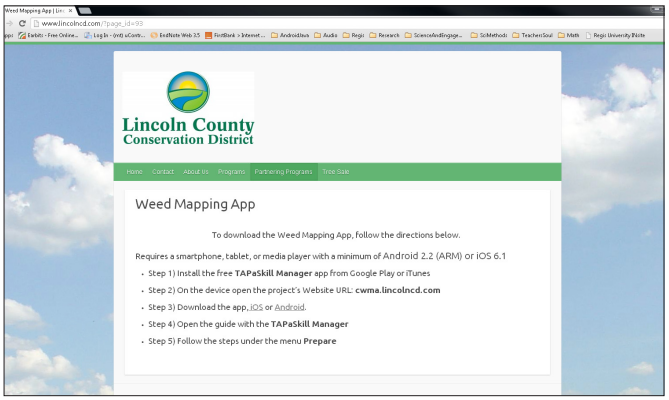

Figure 7. Weed Mapping App at https://www.lincolncd.com/weed-mapping-area?page_id=93.

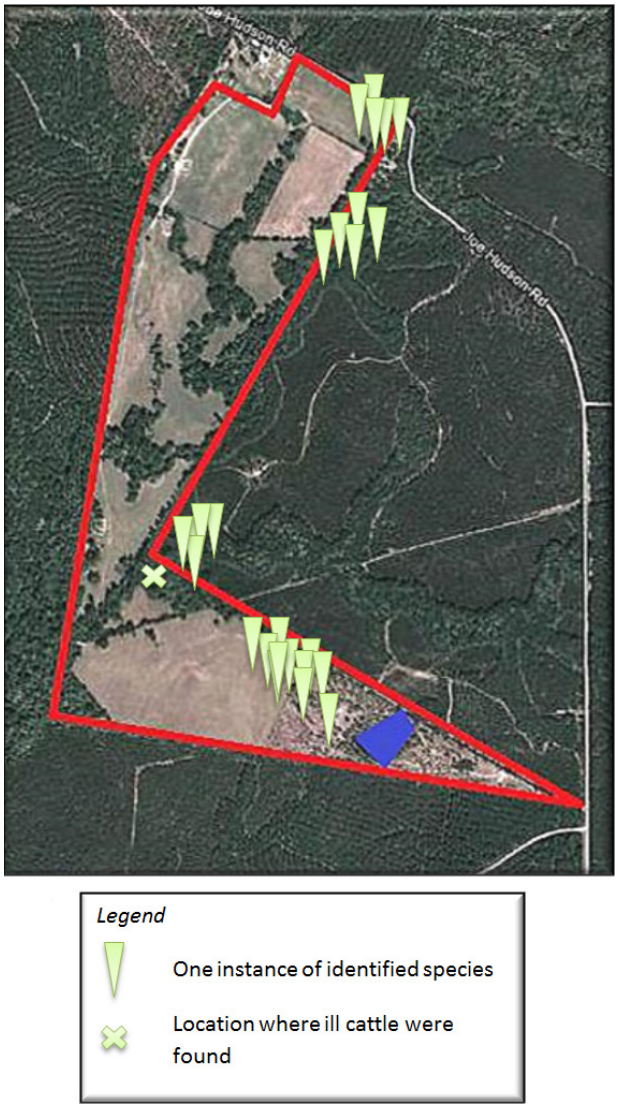

Figure 8. Species distribution of houndstongue.

Part V – The Hunt for Houndstongue

At day break the next morning, Elmer is out once again ready to hunt for more houndstongue. This time he brought with him citizen scientists from the local-area middle school and high school. He also solicits the help of ecologists and invasive-weed experts from Turnbull Wildlife Refuge, Eastern Washington University, as well as nearby property owners—all of whom are part of a Cooperative Weed Management Area (CWMA). "CWMAs are 'grassroots' organizations where local partners and communities voluntarily combine their resources to manage noxious weeds across ownership boundaries" (Lincoln County Conservation District, 2013).

Before the hunt for houndstongue begins, the volunteers—twenty in all—are taken through a short training session where they are introduced to the sampling and observation protocols, as well as how to use the Weed Mapping Application. This is an important aspect of invasive weed mapping because there needs to be assurance that the data being captured, tagged and uploaded are reliable. For example, it is important to make sure, in the case of opportunistic sampling of houndstongue as described in this case, that what is being identified as houndstongue, is, in fact, houndstongue.

Specifically, the citizen scientists are introduced to the field elements that are described in the "Field Work" section of the *Invasive Weed Management Handbook* that was referenced earlier. The topics include: (1) Prevention; (2) Detection and Elimination; (3) Established or Emerging Infestations; (4) Sampling/Surveying; (5) Cooperative Weed Management Areas; and (6) Public and Private Land Determination and Access. They also explore how to set up the Weed Mapping App, and they practice making observations, taking pictures and uploading their data. They then convene and decide on a plan for how they are going to survey Elmer's property to further determine the extent of the houndstongue infestation.

Questions

1. Given that the size of Elmer's property is 180-acres (Figure 8), and given that there are 20 volunteers, what would be a reasonable approach to surveying the land for houndstongue?
2. Given that it is not possible to sample all of Elmer's land, what sampling approaches do you suppose would be most reliable, and which would be most resource intensive?

Part VI –The Sampling Plan

After reconvening, Elmer, the CWMA volunteers and citizen scientists decide that the best way to survey the affected property is to do so in small teams (e.g., 2–3 observers). These teams will begin where the initial ill cattle were found and will radiate out across the property, making observations opportunistically until they reach the perimeter. They will then walk five miles of fence line, making observations along this property segment. They will then walk back to the point where they started. The plan is diagramed in the Figure 9 below. Notice that the chevron shapes show the direction out and the dashed-arrow shows the return path. The circles show the out-bound destinations for each of the 12, 2-member teams.

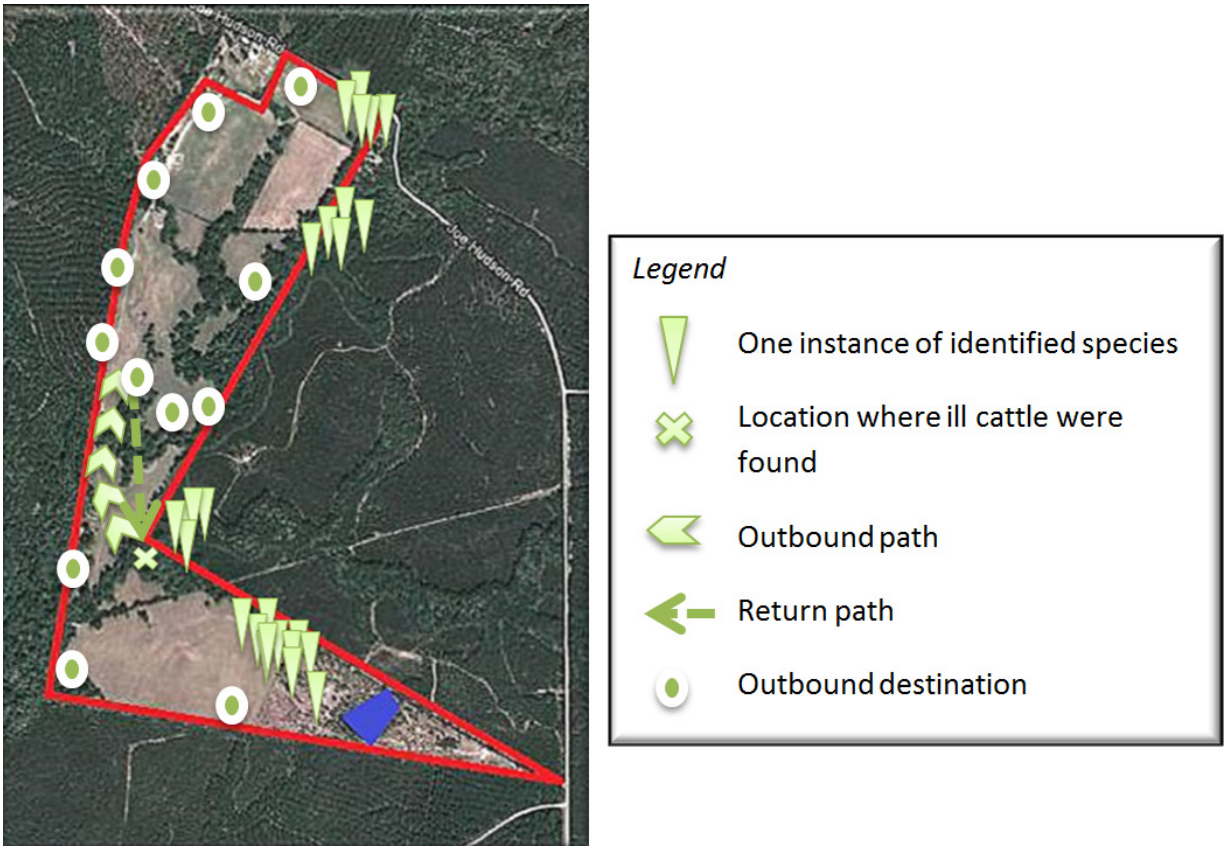

Figure 9. Opportunistic sampling diagram for one of the observation teams.

Questions

1. As the volunteers prepare to go out and sample Elmer's land, what are some considerations that need to be taken into account in terms of property access?
2. Is the proposed sampling plan described in the figure above reasonable in terms of proportion of land sampled and available resources (i.e., number of volunteers)?

Part VII – Analyzing and Interpreting the Data

Armed with their Weed Mapping App, their knowledge of field-specific observation practices, and their houndstongue knowledge, the teams set out to begin surveying. Before long, each team is identifying plant species and reporting their results to the citsci database. The teams return back just in time for a hard-earned lunch and lemonade. After a brief rest, the teams convene and study a species distribution map, which is shown below (Figure 10).

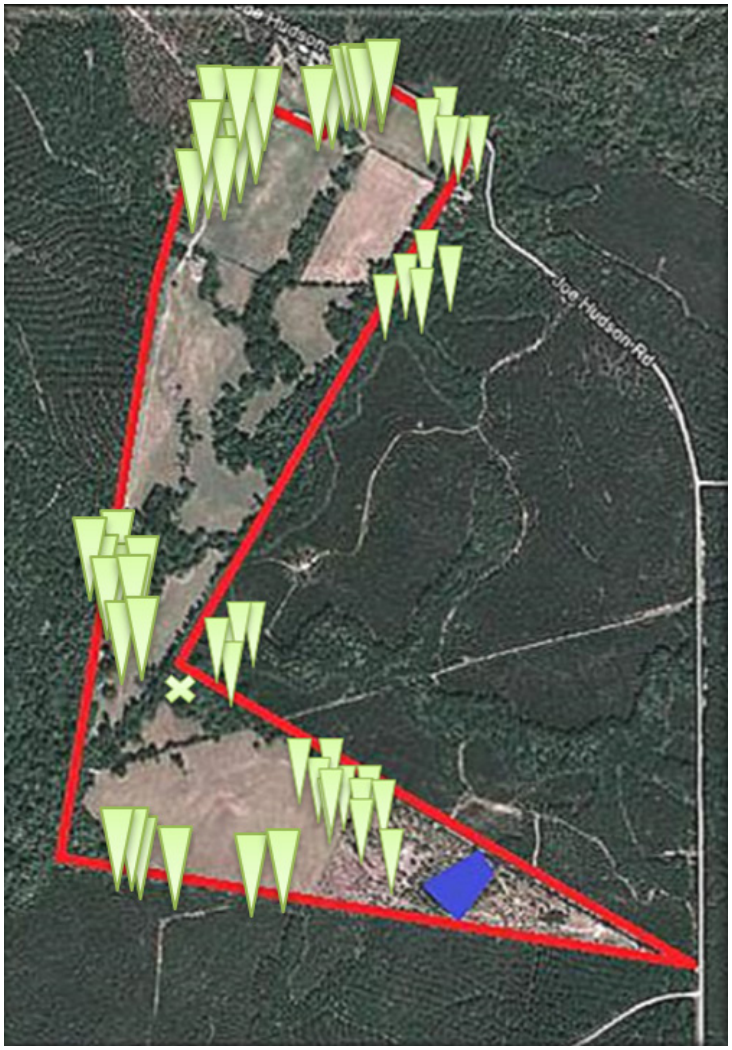

Figure 10. Species distribution of houndstongue.

Questions

1. Based on the data that are shown here, what can be said about the infestation of houndstongue on Elmer's property?
2. Is the degree of infestation severe, moderate or minimal? How so? Are there areas of the property that have heavier infestations than others? What is it about these areas that is unique and might be resulting in higher infestation?
3. Would you consider the infestations that were found on Elmer's property established or emerging?
4. Based on this analysis, what might be some appropriate measures Elmer could take to deal with the houndstongue infestation?

Part VIII – Management, Control and Eradication

Following the exciting and productive surveying session, the volunteers gather their belongings and make their way back to their vehicles to return home for the day. One of the volunteers, Tom Strolson, a local area high school biology teacher, approaches Elmer to discuss the reality that has only recently been revealed. Elmer clearly has a serious problem that must be faced soon if he is going to have any luck with cattle on his land. As Tom approaches Elmer, he notices Elmer appears deflated and overwhelmed. Elmer is glad to know the extent of the problem, but now what? Tom mentions that the students in his biology class are involved in service-learning projects that promote land conservation, including management of invasive species. Specifically, biology students get trained and work with land owners in conservation districts and cooperative weed management groups to assist in mapping, planning and implementing weed management plans. The weed management plans get prepared by students, reviewed by weed experts, and implemented by land owners and cooperative weed management groups. Over time, the collaboration can result in significant information about emerging and existing weed species, as well as the effectiveness of treatment and management practices. Elmer is excited to hear more about this possibility.

Questions

1. Assume you are a student in Mr. Strolson's biology class, and you and members of your class have been tasked with preparing a weed management plan for Elmer. Review the following documents and propose a weed management plan for Elmer.
   a. **"Weed Management Plan Outline for Public Land Managers"**
   b. **"Integrated Pest Management: Guidance for Preparing and Implementing Integrated Pest Management Plans"**
2. What are some available resources students and land owners can consult for advice regarding weed management plans (e.g., integrated pest management)?
3. Given that some of the recommendations made in the weed management plan may involve purchasing control agents for houndstongue, as well as planting of native species, what options might be available to help land owners fund such control efforts?
4. Based on the survey which was conducted on Elmer's land, it was determined that houndstongue is established in several locations along the perimeter of Elmer's property. It was also revealed that houndstongue was also established on land which was adjacent to Elmer's property. What might be done from a weed management perspective to assist other land owners in their management of houndstongue?

Part IX – Locate and Survey a Land Area for Invasive Weeds

This project was initially funded to aid Channel Scablands landowners in surveying their land for invasive weed species. Contact the Channel Scablands Weed Management Association (CWMA) and identify a landowner or public land area that has invasive weed infested land. Obtain permission from the owner to access the land. The students are now ready to survey the parcel of land, using the aforementioned techniques, and later upload their findings.

References

Graham, J., and W.S. Johnson. 2007. Managing Houndstongue. Fact Sheet-03-49. University of Nevada Cooperative Extension, Reno, NV. Available at https://www.unce.unr.edu/publications/files/nr/2003/FS0349.pdf.

Integrated Pest Management: Guidance for Preparing and Implementing Integrated Pest Management Plans.

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Weed Management Plan Outline for Public Land Managers.