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Extension Program Prioritization Guides Web-mapping
Application Delivery to Ranchers

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Abstract.

Cooperative Extension has a long history of helping agricultural producers address their current needs and emerging public issues; often through training in the use of technologies that are not yet widely adopted. The quality of geospatial data and tools to visualize and analyze that data continues to improve. The sustainability of beef cattle production is a prominent issue of interest among scientists, consumers, retail corporations, and producers. Water quality and prairie forestation are two specific natural resource sustainability concerns associated with ranching in Kansas. A product of this work is a web based mapping tool selected to address one of those two natural resource sustainability concerns. The chosen subject of the web mapping application was determined largely from Extension program prioritization survey research. Grassland management, water, soil, and animal wellbeing were found to be Extension education priorities shared by Kansas beef cattle owners and by other Kansas citizens according to Mann-Whitney U test analysis. So, these topics were recognized as higher priority Extension education needs for ranchers. Cow/calf ranch management during the winter and spring months can have considerable impact on these priorities. Non-confined winter feeding sites located near streams can be particularly detrimental. Consequently, winter feeding site selection and management was identified as the chosen subject for the instructional web mapping application. The web mapping application provides necessary geographic information system (GIS) mapping data and video instruction for completing an adapted USDA NRCS feeding site assessment process. The intended audiences are ranchers in the Milford Reservoir watershed and their natural resource advisors. Advisors include local Extension Agents and watershed coordinators who provide cost assistance for relocating feeding sites. Demographic data from the program prioritization survey indicated that female beef cattle owners viewed water and animal wellbeing as somewhat higher priorities than did their male counterparts. This suggests that events such as the annual River Valley Extension District Women in Agriculture education series could be good venues for initial promotion of web mapping delivery of the winter feeding site assessment.

Keywords

Extension, survey, web-mapping application, livestock, water quality, decision support, gender

Introduction

Sustainability of the cow/calf sector of US and global beef production is questioned in findings of beef life cycle assessments and in evaluation of the environmental footprint of the beef industry. Notably, performance of the cow/calf sector is relatively poor in regards to greenhouse gas emissions (Rotz et al., 2019). Public focus on greenhouse gas issues has, to some extent, diverted needed resources away from other immediate concerns such as water quality and loss of biodiversity (Kansas Livestock Association, 2021; Verissimo et al., 2014). Two possible subjects for a cow-calf ranch sustainability web-mapping decision support tool were considered for helping achieve improved prairie rangeland sustainability in Kansas. One subject of concern was prairie forestation by eastern red cedar resulting in loss of livestock forage, habitat and biodiversity. The other was water quality degradation resulting from cow/calf winter feeding practices.

Literature review on prairie forestation, and on water quality associated with winter cattle feeding practices helped identify the relative need for a web mapping tool on these subjects. Additionally, analysis of survey research on Kansas Extension education priorities regarding livestock production and natural resources were used. Education priorities identified by 2,791 Kansas citizens, including 769 beef cattle owners directed the web mapping tool topic selection. Survey priorities most relevant to ranch stewardship were animal wellbeing, environmental regulation, grasslands, woodlands, water, invasive species, soil, and wildlife. Survey results indicate that animal wellbeing is a top priority of both owners and non-owners of beef cattle, and that grassland management is similarly important to beef cattle owners. The next highest priorities for both groups were water and soil. Invasive species was a higher priority for beef cattle owners while woodlands and tree planting was a higher priority for non-beef cattle owners.

Considering these survey results, literature review and available geospatial data, it was decided that the web mapping application should address the need for helping ranchers relocate or improve supplemental winter feeding sites. Management of these sites is important to production, animal wellbeing, and the impact cattle have on water quality. The web-mapping application is both relevant to producer priorities and responsive to public priorities about natural resources and livestock production. It builds upon a USDA Natural Resources Conservation Service (NRCS) spreadsheet tool for assessing resource concerns and documenting improvements associated with winter feeding site location and management. The spreadsheet is also used to determine eligibility for financial incentives for improving winter feeding practices. The web-mapping application adds a graphic interface, necessary spatial data, and video instruction for completing the assessment process.

Web mapping applications are becoming widely used tools to aid in natural resource management decision making. In some cases, videos have been made to explain how to use specific web map applications. A unique feature of the feeding site web mapping application is that video instructions for using the decision tool are imbedded within the application itself. Use of the web mapping feeding site tool to by local watershed coordinators, service providers and livestock producers will contribute directly support improved water quality in Kansas.

Survey Research Methodology

Overview

The purpose of analyzing K-State Research and Extension program prioritization survey research was to first identify natural resource and livestock education priorities of Kansas citizens. A better understanding of similarities and differences in their priorities aided in selection of a subject for a web mapping application to help with delivery of sustainability decision support. Next, within the group beef cattle owners, priority differences were compared based on gender to help determine if a male or a female audience might be more receptive to receiving education on water quality.

Survey Instrument and Sample

Eleven program focus teams developed six program survey topics each to make up the program prioritization survey. Survey respondents ranked the six topics for each program area in order from highest (1) to lowest (6) priority. Respondents also answered demographic questions. Eight topics from two program areas (livestock production and natural resources) and demographic questions that included gender were used in this research. The survey was administered online and in hard copy form to local residents for a period of approximately four months. Complete responses for the livestock and natural resource questions were provided by 2,791 respondents; of those, 769 (28%) were beef cattle owners. Priority scores were compared based on medians and by using Mann-Whitney non-parametric analysis.

Research Questions

One set of research questions is used to help determine a topic for development of a ranch stewardship decision tool. Answers help identify potential topics which are both relevant to the education priorities of beef cattle owner and responsive to differing priorities of other Kansas residents. Survey response differences in priorities across the category beef cattle ownership were evaluated on eight stewardship education topics: animal wellbeing, environmental regulation, grassland management, woodland/tree planting, water issues, invasive species, soil management, wildlife management. It was hypothesized that beef cattle owners consider grassland management and invasive species more important than do non-owners. It was also hypothesized that beef cattle owners consider woodlands/tree planting, and environmental regulation to be lower priority than do non-owners. Additional differences in the priorities of owners and non-owners were also considered. Rationale for the hypotheses is that grass production is foundational to cattle ranching, that trees and invasive species reduce grass production, and that ranchers may perceive environmental regulation to be a threat to the future of their operation (Roche et al., 2015).

A second research question was used to investigate priority differences of the subset of respondents who self-identified as beef cattle owners. Differences in priorities were evaluated on the same eight stewardship topics across the category gender. Answers to these questions were used to help identify a receptive audience for initial delivery of the ranch stewardship web mapping. It was hypothesized that female beef cattle owners consider animal wellbeing and environmental regulation to be higher priorities than do male beef cattle owners. Rationale for the hypotheses is that women tend to be more concerned than men about the environment and animal welfare (Price, 2011).

Research Design

Two lines of inquiry are the principle focus of this study. First is identification of a ranch stewardship education topic which is both relevant to the education priorities of beef cattle owner and responsive to other priorities of other Kansas residents. Top program prioritization education topics were most influential on selection of the subject for a web-based mapping application. Next is identifying a receptive audience for initial delivery of the ranch stewardship decision support tool. Planning for initial delivery of training in the use of the web mapping tool is influenced by education priority responses of the group gender within the category beef cattle owners.

Ranch Stewardship Education Topic Identification

Selection of the web mapping tool subject took into consideration priority rankings of the eight ranch stewardship oriented dependent variables identified in the program prioritization survey. Priority stewardship education topics were identified using a between subjects research design comparing ordinal priority scorings of the independent variable beef cattle ownership on the eight ranch stewardship dependent variables. Beef cattle ownership has two groups, beef cattle owners and non-beef cattle owners. Ordinal scores provided by the two groups are compared using the Mann-Whitney U test. Comparisons are used to determine if there are statistically significant differences in the priority score provided by beef cattle owners and non-beef cattle owners on the

eight dependent variables: animal wellbeing, environmental regulation, grassland, trees, water, invasive species, soil, wildlife. Mann-Whitney U is a non-parametric alternative to the independent samples t-test.

Planning Delivery of Stewardship Decision Support Tool

Planning delivery of the stewardship decision support tool began with identifying a demographic group from within the group beef cattle owners that might be more likely to be interested in the selected subject of the web mapping decision tool. Demographic comparisons were made on the independent variable gender. Ordinal scores for each of the eight dependent variables; animal wellbeing, environmental regulation, grassland, trees, water, invasive species, soil and wildlife were compared based on the independent variable gender.

The gender comparison is a between subjects design comparing ordinal priority scorings provided by male and female beef cattle owners on the eight dependent variables. Mann-Whitney U test is used to determine if there are statistically significant differences in the priority scorings. Mann-Whitney U is a non-parametric alternative to the independent samples t-test.

Survey Results and Discussion

Test Results for Stewardship Education Topic Identification

Hypotheses related to education priorities of two groups, owners and non-owners of beef cattle were tested to help identify ranch stewardship education topics which are of interest to beef cattle owners and also a priority of other Kansas citizens. Hypotheses were established on the topics of environmental regulation, grassland management, woodland management/tree planting, and invasive species.

A Mann-Whitney U test was run to determine if there were differences in environmental regulation score between beef cattle owners and non-beef cattle owners. Environmental regulation scores for beef cattle owners (mean rank = 1351.97) were significantly higher than for non-beef cattle owners (mean rank = 1193.75), $U = 731752.5$, $z = 5.168281$, $p < .001$.

A Mann-Whitney U test was run to determine if there were differences in grassland management score between beef cattle owners and non-beef cattle owners. Grassland management scores for beef cattle owners (mean rank = 1019.22) were significantly lower than for non-beef cattle owners (mean rank =), $U = 479773.5$, $z = -12.524992$, $p < .001$

A Mann-Whitney U test was run to determine if there were differences in woodland score between beef cattle owners and non-beef cattle owners. Woodland scores for beef cattle owners (mean rank = 1489.14) were significantly higher beef cattle owners than for non-beef cattle owners (mean rank = 1248.98), $U = 827792$, $z = 7.401814$, $p < .001$

A Mann-Whitney U test was run to determine if there were differences in invasive species scores between beef cattle owners and non-beef cattle owners. Invasive species scores for beef cattle owners (mean rank = 1242.69) were significantly lower beef cattle owners than for non-beef cattle owners (mean rank = 1351.71), $U = 647424$, $z = -3.358659$, $p = .001$

Hypotheses were not stated for four of the educational topics, however there were statistically significant differences in the mean ranks on all. This information could also be helpful in determining stewardship education topics. Mann-Whitney U tests indicated significantly lower mean ranks and thus a higher importance on a) the education topics of animal wellbeing, water and wildlife for non-beef cattle owners, and b) a higher importance on the education topic of soil erosion and fertility for beef cattle owners.

Test Results for Planning Education Delivery

Two specific hypotheses were stated which could be helpful for planning delivery of stewardship education the audience beef cattle producers. Both of these hypotheses involved gender.

A Mann-Whitney U test was run to determine if there were differences in animal wellbeing score between male beef cattle owners and female beef cattle owners. Animal wellbeing scores for male beef cattle owners (mean rank = 386.99) were significantly higher for beef cattle owners than for female beef cattle owners (mean rank = 341.58), $U = 53077.5$, $z = -2.945592$, $p = .003$.

A Mann-Whitney U test was run to determine if there were differences in environmental regulation scores between male beef cattle owners and female beef cattle owners. Environmental regulation scores for male beef cattle owners (mean rank = 378.20) and female beef cattle owners (mean rank = 355.94) were not statistically significant different, $U = 58883$, $z = -1.447931$, $p = .148$.

Web Mapping Application Development

A web map, in its simplest form, displays geographic information over the internet. More often the web map has interactive features giving users the opportunity to explore and analyze map data using simple tools for things such as measuring, navigating and customizing how data layers are displayed. The web map version of the ranch stewardship decision support tool described here was developed using ArcGIS Online, a product of Environmental Systems Research Institute, Inc. (ESRI). A personal or organizational account is required for developing a web map, but the decision tool can be embedded on a webpage so it can be used by anyone with or without an account.

A standard ArcGIS Online web map provides the base for the web-based decision support tool. GIS data needed to complete the US Department of Agriculture's (USDA) Kansas feeding site assessment was added to that standard web map template and organized in a manner appropriate for its completion. Data layer symbology, display order and display resolution were all designed to enhance the user experience. This web map, still in the standard ArcGIS online format, was further customized after it was imported into the selected ArcGIS online web mapping application (Figure 1). This additional customization simplified user access to needed tools by placing each tool directly on the screen in the order in which the tools are needed. At this stage, the web mapping decision support tool is functional and could be embedded into a web site for use by individuals who do not have an ArcGIS online account assuming they have a copy of the USDA spreadsheet calculator and are familiar with using online web mapping applications. However, it was clear that most users would need detailed instructions for using the web mapping application and for calculating the winter feeding site risk assessment. Consequently, the web mapping application was further embedded into a different type of web mapping application known as a story map (Figure 2). Story maps are designed to integrate other types of media into the web map display environment. In this case, instructional videos, photographs and text were added to facilitate completion of each step of the feeding site assessment. Finally, a customized web based calculator was embedded into the story map application so users can easily calculate

and print their feeding site water quality risk assessments (Figure 3).

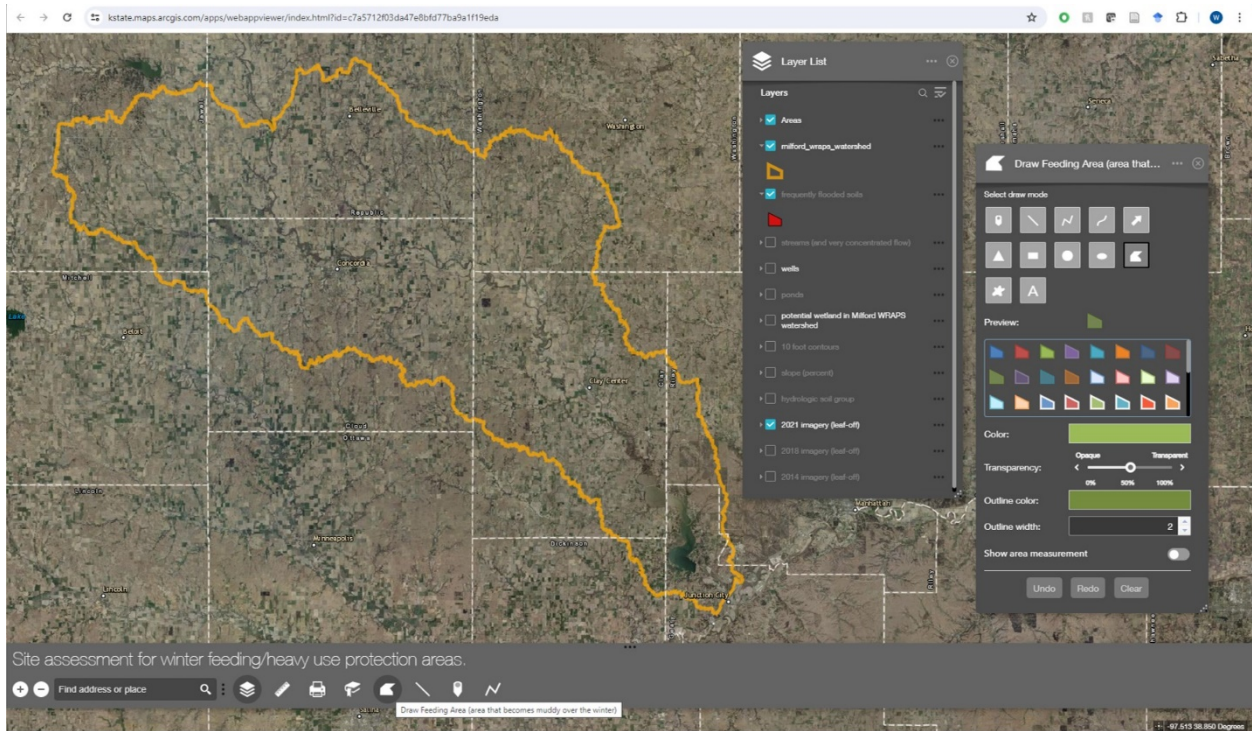


Figure 1. Web mapping application showing layer list and polygon drawing tool for drawing feeding sites being assessed.

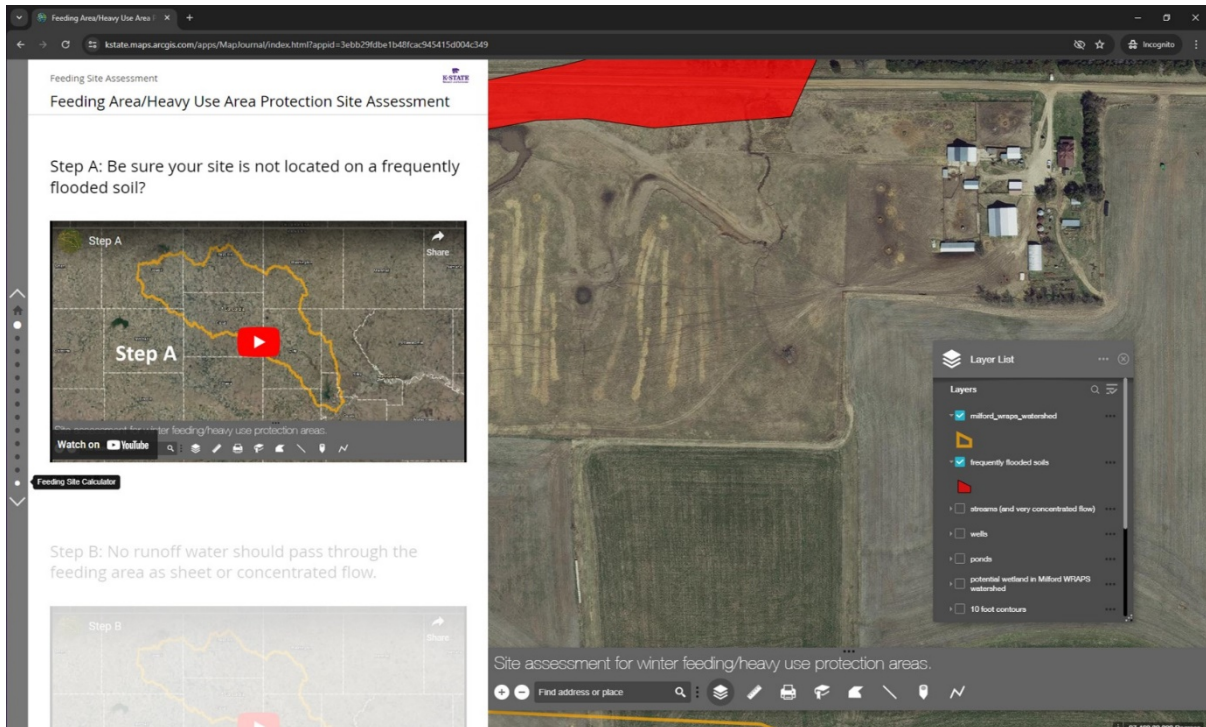
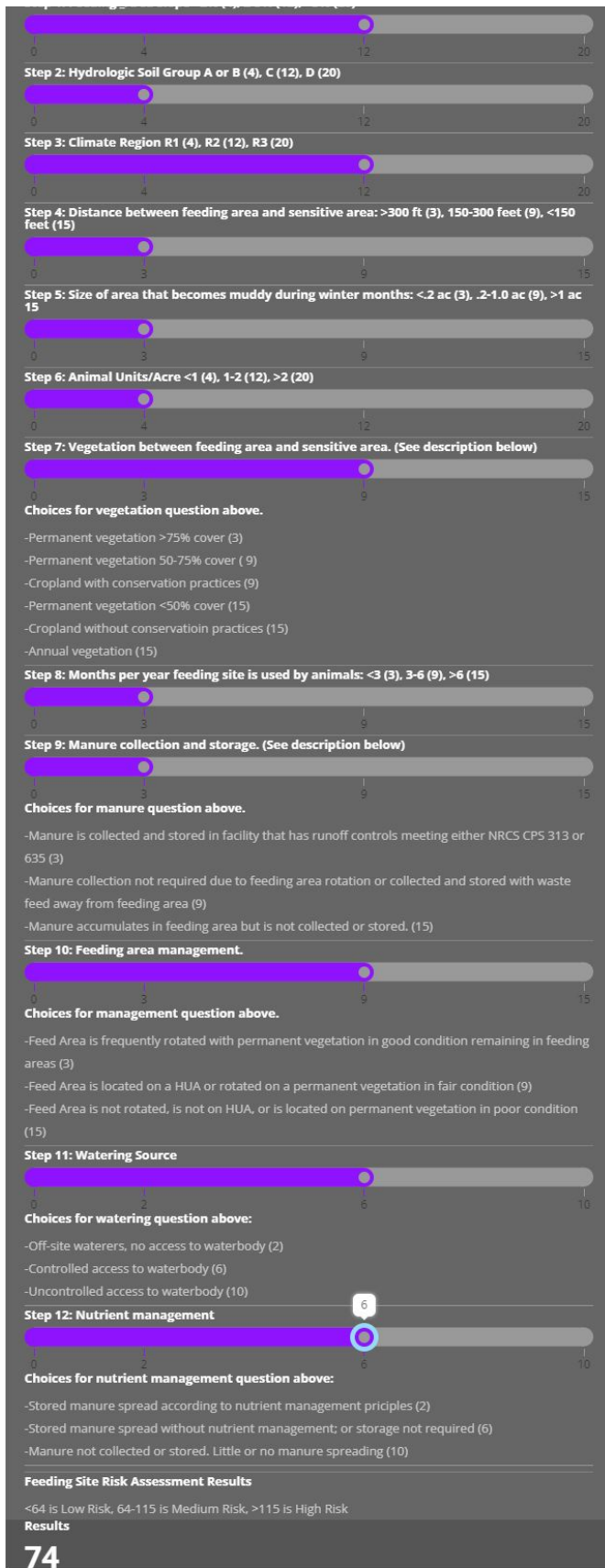


Figure 2. Story map web mapping application showing the instructions and calculator pane on the left, and the feeding site web mapping application on the right.



Print

Figure 3. Calculator page showing a medium risk assessment.

Conclusions and Discussion

Web mapping applications may be an underutilized tool for providing education to Cooperative Extension audiences such as ranchers and their advisors. An objective of this project is to deliver a web mapping version of an establish decision tool which addresses natural resource and livestock management education priorities in Kansas. Ranchers trying to achieve and maintain sustainable management face a wide variety of resource concerns. In Kansas, it was found that owners of beef cattle consider grassland management and invasive species to be higher priority than do other citizens who did not own beef cattle. Owner and non-owner priority rankings were reversed on the subject of tree and woodland management. It appears that there could be some between group differences in the level of concern about forestation of prairie grasslands of Kansas. On the other hand, both groups identified animal wellbeing and water as high priority education topics. In an attempt to identify a ranch sustainability education topic that is both responsive to public concerns about natural resources and highly relevant to the priorities of ranchers, it was decided to select management of winter feeding sites over the issue prairie forestation by eastern redcedar.

This first attempt at delivering a decision support tool in the form of an instructional web mapping application was somewhat challenging and tedious. All of the necessary data layers had to be processed and organized into a standard web map. Currently some of the data layers have statewide coverage while other large data sets have coverage limited to a particular watershed in the state. Completing statewide coverage is anticipated following evaluation of the product. The need for having multiple levels of embedded web maps initially caused the organization of this delivery system to seem overly complicated. However, the ability to have easily accessible video instructions and mapping tools, provided from features of the web mapping application and story map, are proving to it to be worthwhile. That convenience will hopefully increase the likelihood that people will use the product.

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