

From the Field: The potential value of a decision support tool informing dynamic stocking rate decisions on rangelands in the inland Pacific Northwest

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Introduction

A group of researchers from the Center for Sustaining Agriculture and Natural Resources at Washington State University, Washington State University Extension, and the USDA Forest Service's Rocky Mountain Research Station (Box 1) are considering the development of a decision support tool to inform dynamic stocking rate decisions. The team's perspective is founded on their understanding that stocking rates established for various land ownerships often do not address the natural historical variability in forage production, and that the availability of remotely-sensed datasets going back 30 or more years pose an opportunity for using information on year-to-year and across-the-landscape variation in forage production to inform flexible stocking rate decisions, particularly those within agency planning and management processes.

In order to gain understanding of current approaches to evaluating stocking rate decisions, identify the limitations of current approaches, and to explore the need for and the value of developing a tool that could support flexible stocking rate decisions on rangelands in the inland Pacific Northwest (Box 2), the team hosted a series of three listening sessions

Box 1 – Research team hosting listening sessions

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across the Pacific Northwest. Sessions convened a total of 26 individuals, including interested state and federal agency staff, Tribal staff, and Cattlemen's Association representatives, and were held in Ephrata, Washington; Prineville, Oregon; and Boise, Idaho. All three listening sessions followed the same agenda and structure. First, the research team briefly presented their current thinking around dynamic grazing management decisions, and moderated a conversation using guiding questions (Appendix 1, sections A and B) to explore the range of perspectives that participants were willing to share on the topic. Second, the team described the opportunities they see for a decision support tool (Box 3), once again followed by open discussion in response to a second series of guiding questions (Appendix 1, section C). During these discussions, members of the research team

sometimes posed examples of tool functionality related to points the participants made, and the participants' responses to those examples were part of the dialog.

This report reflects the research team's understanding of the key points arising from the discussions at the three listening sessions. The report will be shared with all participants, and any comments they have on key points that were missing or misconceptions in this summary will be addressed.

The report is organized around the three main discussion topics:

- A. Current approaches to calculating stocking rates
- B. Dealing with interannual variability
- C. Tool development priorities

In addition, we discuss a range of other concerns and limitations the listening session participants shared relevant to the decision support tool, and provide a brief description of where the research team plans to go with this input. We would like to share our sincere appreciation to all listening session participants for sharing your perspectives and ideas, and taking the time to discuss with us the need for and the value of developing a tool that could support dynamic stocking rate decisions on rangelands in the inland Pacific Northwest.

Box 2 – Rangelands in the Inland Pacific Northwest

The research team's biogeographic focus, which provided the scope to the listening session discussions, is rangelands across the Pacific Northwest states: Washington, Oregon and Idaho (Figure 1). The vegetation in these mostly native ecosystems range from grasslands to shrub-dominated systems. In the Pacific Northwest, these arid and semi-arid areas occur in lower elevation lands between and around mountain ranges, such as the Cascades and the Rockies. Rangelands are characterized by low plant productivity, with productivity closely linked to precipitation. Substantial year-to-year variability in precipitation and this productivity is also drives fluctuations in plant productivity across these areas.

Participants in the listening sessions shared that most ranches have multiple public land leases. Leases governing grazing management on federal lands tend to be inflexible, while leases on state lands tend to allow for more flexibility and a more straightforward process to make changes in grazing management.



Figure 1. Extent of Pacific Northwest rangelands that define the scope of this project. Map courtesy of Sonia A. Hall and Kaelin Hamel-Rieken, Washington State University. Occurrence of rangelands is mapped using 250 m resolution data from Reeves and Mitchell (2011).

Reeves, M.C., and J.E. Mitchell. 2011. Extent of Coterminous US Rangelands: Quantifying Implications of Differing Agency Perspectives. *Rangeland Ecology and Management* 64: 1–12.

What We Heard – A Summary

This is a high-level summary of what we heard in the listening sessions. We elaborate on the key points summarized in this section in the rest of this report.

A. Current approaches to calculating stocking rates

Three approaches to estimating forage production (a key factor for calculating stocking rates) were discussed: past experience with the grazing unit or units, reference data such as provided by the NRCS web soil survey and ecological site descriptions, and forage sampling and use monitoring, including using clipping data. Participants also discussed the limitations they experienced with those approaches. New staff or managers may have limited experience with the grazing units, and even with deep personal experience with the unit, there may still be value to data that objectively documents variations in forage availability. The use of the soil survey is sometimes impossible where the resource is incomplete, such as in some forested grazing systems, and the forage production values may not capture the extremes in variation between years. Clipping data are rarely, if ever, based on a sufficiently extensive sample to effectively capture the variability in forage production. In addition to discussing current approaches and their limitations, participants shared a “wish list” of ideas of data or tools they would like to have to support stocking rate and other grazing management decisions.

B. Dealing with interannual variability

In general, participants acknowledged that interannual variability could and did impact cattle performance, such as weight gain and animal health. They pointed out there was a lack of good information and tools to better deal with interannual variability in forage production. They saw an opportunity for research to document best and worst “bookends” around forage production, as a way to quantify interannual variability, enabling them to estimate the probability of a low forage year, for example.

C. Tool development priorities

Participants articulated a need for detailed information on forage production to support two types of decisions: (a) long-term strategic decisions such as planning for long-term (e.g. 10 years) permits or agreements, or characteristics of a particular livestock operations (e.g. herd size, forage needs); and (b) tactical decisions, to inform within-season management decisions, such as when to start or end the grazing on particular grazing units, or stocking or destocking decisions based on forage availability expectations that year. In addition, participants shared ideas on tool functions that would be useful. These ideas included ways the information could support pursuit of grazing objectives beyond production, such as fuel load or invasive species management; an “alert system” that could highlight when (or where) forage surpasses or falls below certain thresholds; incorporating wildlife use; and the provision of regular updates on how the upcoming season is shaping up. A variety of characteristics that would enhance a tool’s usefulness were also shared.

A key aspect of the discussions was to explore potential uses for a decision support tool like the one the research team proposed. Participants articulated that such a tool’s ability to provide annual (or even more frequent) updates on forage production would provide an interesting option for tracking changes in vegetation. More generally, the transparency and consistency of the data sources supporting this tool could provide defensible data to support grazing management decisions on federal lands, ideally reducing the potential for litigation. Another value of the proposed decision support tool that participants raised in different ways throughout the sessions was as a basis for clear communications between different individuals and groups involved in grazing management. In addition, a key function the tool being discussed

could offer is the ability to explore “what if” scenarios, a variety of which were discussed. Participants articulated that such scenarios would be particularly useful if they provide information that ties directly into existing planning processes and programs.

Participants also provided valuable input on how to facilitate the use and interpretation of outputs of a decision support tool. They encouraged us to consider pairing tool development with an explicit technology transfer and extension effort, and discussed some factors they considered key to successful adoption of such a tool. They also highlighted the importance of providing guidance to users of a tool on how to interpret and appropriately use the information they would obtain from the tool, and provided input on how to facilitate such interpretation and use.

A. Current Approaches to Calculating Stocking Rates, and Their Limitations

Three approaches to estimating forage production (a key factor for calculating stocking rates) were described by listening session participants. These three approaches are not mutually exclusive and may be used in combination:

- *Experience.* Using agency range conservationists’ or private land owners’ past experience and personal knowledge on the same grazing unit or units. Past stocking rates are commonly used as reference to set future stocking rates, in some cases adjusting based on tracking annual use indicators.
- *Reference data.* The most common reference data used by participants was forage production information from the Natural Resource Conservation Service’s (NRCS) web soil survey and ecological site descriptions. Current NRCS practice when advising grazing operators is to do an initial assessment using the NRCS web soil survey and ecological site descriptions, calculate a conservative stocking rate based on that assessment of forage availability, then stock, monitor and adjust. The web soil survey provides range production values for “normal” or average conditions, as well as high and low estimates.
- *Forage sampling and use monitoring.* Forage sampling uses clipping data—samples of ungrazed vegetation taken around the grazing unit, clipped, air dried and weighed to estimate forage production in a season. These estimates are then the basis for calculating initial stocking rates, and operators or managers then stock, monitor and adjust.

Limitations to personal experience: Participants discussed the limitations of personal experience particularly in the case of public lands (though some of these limitations may also be relevant to private lands as well). These included situations when new staff are charged with managing grazing on particular grazing units. Participants also voiced the importance of being able to document the variations in forage availability that experienced range conservationists know about, in order to support or justify grazing management decisions, particularly when those decisions involve a change from past operations. There was also some discussion that changes in land condition (e.g. invasives) or climate may mean that relying on past experience may not always work in the future.

Limitations to soil survey information: Limitations mentioned during the listening sessions included the fact that soil surveys are not always complete, especially in forested systems, and they have limited ability to capture spatial variability at finer scales. Though soil survey information provides a range of values, this may not capture the extremes in variations in forage production. Participants acknowledged that having information on past variability in annual forage production could help evaluate the “normality” of production values used in the initial assessment. . This approach also makes implicit assumptions that the soil survey information is reasonably

up to date. This assumption may not be the valid, for example, when invasive species have altered forage conditions since the survey was carried out.

Limitations to clipping data: The overarching limitation to using clipping data is the lack of capacity to obtain data from a sufficiently extensive sample—in time and across space—to effectively capture landscape heterogeneity and year-to-year variability with any confidence. Participants generally agreed that the intensity of effort needed to obtain a robust and representative sample is not feasible for ranchers or even public lands managers.

The approaches described above target obtaining estimates of forage production. Estimating stocking rates, however, requires additional consideration of factors that determine if, where, and to what extent that forage is available to grazing livestock. These factors include what proportion of annual production is acceptable to harvest in a given season, as well as terrain characteristics and features that affect what locations are accessible to the livestock the forage is destined for. The impact of snowpack on forage accessibility of forage was also discussed in Washington state. Participants discussed that existing models used historically to predict livestock use based on slope, aspect, and vegetative cover did not work well, though the details were not discussed in depth.

Participants shared a “wish list” of ideas of data or tools that they would like to have to support stocking rate and other grazing management decisions. In some cases, the comments shared focused on particular functionalities of proposed tools. Participants discussed the value of tools that could:

- Complement current approaches, providing outputs that could, for example, inform the establishment of attainable objectives for each grazing unit (a step included in NRCS’s rangeland assessments), and help focus limited resources for on-the-ground data collection.
- Produce outputs that would complement permitting processes for public lands agencies, and associated permit documents. Such tools could also be useful for new staff and range conservationists, providing a starting point while they build expertise and experience with particular grazing units. In agencies like the Bureau of Land Management (BLM), that is moving toward outcome-based grazing, such tools could be used to inform future decisions as well as document the rationale for changes in stocking rate relative to past values.
- Provide a repository of all vegetation inventory information for a grazing unit, such as plant community composition and production, currently an unmet need.

These insights and perspectives on current approaches to stocking rate calculations and the need for potential improvements to address their limitations formed the foundation for later discussions with participants on tool development specifics that could be of value.

B. How You Deal with Interannual Variability

We posed to each group a set of questions around how they dealt with interannual variability. The insights obtained during this section of the listening sessions are generally linked to current approaches (previous section) and participants’ thoughts on tool development priorities (next section), so are captured in those sections of this summary.

In general, participants acknowledged that interannual variability could and did lead to impacts on cattle performance, including calf weights and cow body condition. They pointed out there was a lack of good information and tools to better incorporate interannual variability in forage production into decision making. In terms of what information they would find particularly useful in this context, participants pointed to a need to

research and document best and worst “bookends” around forage production, as a way to quantify interannual variability (e.g. how good the amount of forage can get, how bad it can get). Participants also articulated an interest in understanding the distribution of this variability, to answer questions such as what is the probability of a low forage year, for example. Similarly, they voiced interest in information about phenology of the vegetation, and how variable the timing of key phenological stages is from year to year.

C. Thoughts on Tool Development Priorities

The research team convened these listening sessions specifically to inform our thinking about a decision support tool for dynamic stocking rate decisions (Box 3). We presented, briefly, our thinking around the need for such a tool, and the opportunities that the digital age poses for developing such a tool. We also shared a few examples of remote-sensing-based datasets that are currently available that capture the variability at an appropriate scale and resolution, and a framework for how they could be used to calculate stocking rates. We emphasized that our interest during these listening sessions was to hear their reactions to what we had presented so that we could further develop our ideas based on their thoughts about datasets, needs, functionality and priorities.

One overarching message that we heard across the listening sessions is that there is need for detailed information on forage production to support two types of decisions: (a) strategic decisions, such as planning for long-term (e.g. 10 years) permits or agreements, or characteristics of a particular livestock operations (e.g. herd size, forage needs); and (b) tactical decisions, to inform within-season management decisions, such as when to start or end the grazing on particular grazing units, or stocking or destocking decisions based on forage availability expectations that year. Our emphasis, based on our thinking so far and what we considered feasible to develop in the short term, targeted the strategic type of decisions, and much of the input we received on these were in response to our framing of questions. Yet many of the needs to inform tactical decisions voiced during the listening sessions are also technically feasible, though likely require larger investments in tool development. We therefore also captured participants’ perspectives on both types of decisions.

Informing strategic decisions

Participants shared that potentially the greatest value of the proposed tool would be in providing information on historical variation in forage availability. For example, producers would like information on the percent of drought (low forage availability) years, and forage production for at the last 10 years. The need for having forage utilization information was also highlighted, as a metric to monitor how much forage is left in a grazing unit after the livestock are removed, and how that varies across the unit (though this is likely beyond current capabilities with remotely sensed data).

Participants were also interested in understanding spatial variation, as having information on where forage is available, especially at the beginning of the grazing season, would be valuable. Participants also considered the understanding of the dynamics of forage production, the timing of critical periods (points in plants’ growth and development when they are particularly sensitive to grazing) and how variable that timing might be from year to year important for the kinds of strategic decisions we were discussing. Another example of the interest in information on spatial and temporal variations was the need for an approach to tracking cheatgrass (*Bromus tectorum*), to guide targeted grazing to manage “cheatgrass blooms.” In summary, participants saw value in a tool that could quantify a series of metrics and reference conditions for different grazing units against which they could then compare current values.

Box 3 – Proposed decision support tool to inform dynamic stocking rate decisions

The team’s proposed decision support tool is founded on their understanding that stocking rates established for various land ownerships have often not addressed the natural historical variability in forage production and that the availability of remotely-sensed datasets going back 30 or more years pose an opportunity for using information on year-to-year and across the landscape variation in forage production to inform flexible stocking rate decisions, particularly those within agency planning and management processes.

Datasets exist for western U.S. rangelands that can provide annual (and even seasonal) estimates of forage production at fairly fine resolution. The research team envisions a tool that:

1. Obtains aboveground forage production estimates from available, remotely-sensed datasets, and allows the user to visualize spatial patterns and temporal trends in these data,
2. Allows the user to define, spatially, the parameters for their livestock’s terrain use (e.g., slope, distance to water), their harvest coefficient and other non-stocking rate management factors, and
3. Combines these elements via the stocking rate equation, producing maps of stocking rate values across the landscape for each year (e.g. 1984 to present).

Ultimately, we envision this tool providing annual maps of stocking rates that show how stocking rates vary from one grazing management unit to the next, and how they have varied through time (Figure 2). A great advantage of the availability of remote sensing data as the foundation of such a tool is that it is possible to reconstruct the past 30 or more years, allowing users to explore trends and patterns of variation from year to year. In addition, such a tool could also use climate change projections to estimate how variable forage production could become in the future, in what direction average production might shift as the climate continues to change, and what impact that might have on future stocking rates.

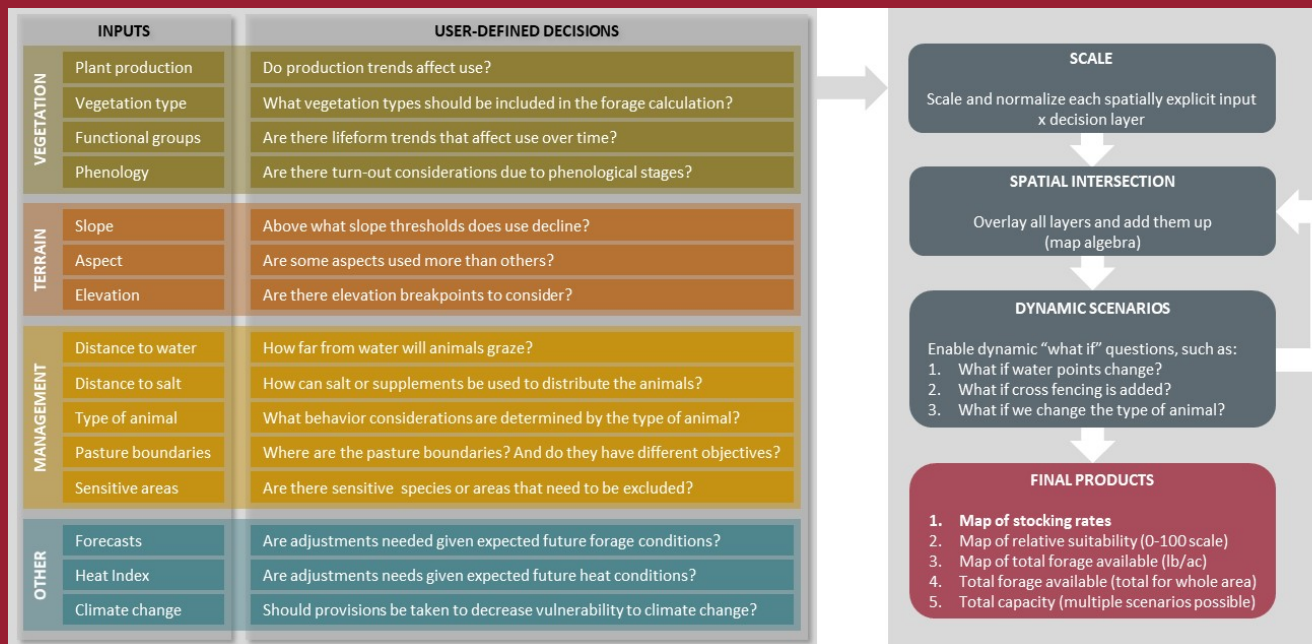


Figure 2. Flow chart characterizing the envisioned decision support tool to inform dynamic stocking rate decisions. The use of existing remotely sensed vegetation data from 1984 to the present would allow the tool to include vegetation trends and year-to-year variability. The integration of user-defined decisions would allow the user to run “what if” scenarios, exploring the consequences of management changes or infrastructure investments. This figure was used in Hudson et al. (in review).

Hudson, TD, Reeves, MR, Hall, SA, Yorgey, GG, Neibergs, JS. 2020. Big landscapes meet big data: informing grazing management in a variable and changing world. Rangelands, in review.

Informing tactical decisions

Participants said that credible information around the timing of forage availability and how it changes within a season could be very impactful, as it could inform turn-out dates and pull-off dates for each grazing unit used that year. In general, participants suggested that producers could more easily adjust the timing of grazing of particular grazing units than adjust livestock numbers. However, some exceptions to this were discussed, including producers who had the ability to change their herd size fairly nimbly, and the fact that permits on federal lands (in this case the discussion was around US Forest Service lands) have limited ability to modify timing of grazing, though changes of less than two weeks were possible.

There was interest in both short-term (e.g., two weeks) and mid-term (6-9 months) forecasting of forage availability, though participants acknowledged that such forecasts would likely require establishing the correlations between forage production and precipitation or other weather data, and therefore would accrue uncertainty. Examples of such forecasts included two-week projections of forage availability based on soil temperature and moisture, to inform decisions on pull-out dates and livestock movements; or forecast of next year's productivity, 6-9 months in advance, to inform stocking and destocking decisions early in the cycle. The earlier the forecast information is available, the better chance the operator can adjust (e.g. not much can change two thirds of the way into the grazing season).

Input on tool functionality

Historical livestock usage data is generally used to determine how many animal unit months (AUMs) are considered available in a grazing unit. Agencies, however, have recently moved towards more explicitly including other grazing objectives beyond livestock production, such as fuel load management and invasive species management. Participants showed interest, for example, in exploring how the information under discussion relates to fire risk. Questions of interest included: What are the trade-offs between fuel reduction and livestock production? Could a tool inform the use of cattle to reduce fuels? Could a tool provide data on the timing of annual grass and perennial green-up over time, and in the current year, to inform fuel control or targeted grazing treatments?

Location of water sources was among the factors affecting livestock distribution discussed during the listening sessions. In terms of usability of a tool, therefore, participants highlighted the importance of including information on water availability, which included location, characteristics, (linear feature, point, metadata on water type, quantity, timing) and period during which water is actually available, recognizing some water sources are seasonal.

Participants discussed the value of some kind of "alert system" that could highlight when (or where) forage surpasses or falls below a certain threshold (e.g. changes in the cover of bare soil). Such alerts were mainly discussed in terms of their within-season uses, though alerts around longer-term trends could also be useful.

Throughout the discussions at each listening session participants shared details on functionality they would find useful in a decision support tool. Some examples mentioned include:

- Flexibility, so that the tool could be applied to different sites and to address different management objectives.
- Possibility to incorporate wildlife use, which could potentially inform wildlife needs on grazed rangelands, or allow for wildlife management objectives.
- Need to consider connections between riparian and uplands, given certain grazing management decisions.
- Ability to customize the view, save scenarios or options explored for future reference, and to support adaptive management.

- Option for overlaying and using site-specific data the user has available.
- Ability to modify the characteristics of the herd, such as the type of grazing animal, average cow weight, etc.
- The provision of regular updates on how the upcoming season is shaping up. The approach used with evacuation notices was discussed as an example (e.g. starting one year in advance, describe conditions, and adjust periodically as the grazing season gets closer and forecasts are likely more accurate).

This information can help guide design decisions for a tool, highlighting characteristics that appear to be priorities to participants, who represent a sample of potential users of the tool.

Potential uses

Participants discussed a number of potential uses for a stocking rate tool. First, the proposed tool, with the ability to provide annual (or even more frequent) updates, provides an interesting option for tracking changes in vegetation over time. Such cost-effective monitoring, which could be used to complement field efforts, could help provide confidence that grazing management is appropriate and meeting objectives. In cases such as BLM's outcome-based management, this could support efforts to provide more flexibility to permittees. In certain circumstances, this confidence could potentially also support policy-related efforts within public land agencies to allow further flexibility as they strive towards achieving desired outcomes, such as management of invasive grasses.

More generally, the tool could provide defensible data to support grazing management decisions on federal lands, ideally reducing the potential for litigation. For example, the tool could provide a common basis of understanding about the vegetation that allows land management agencies to make changes (especially increases) to AUMs, while ensuring they do not create issues for other resources or programs (e.g. wildlife, fire, etc). Such reliable data could also be part of agencies' reviews to fulfill responsibilities under the National Environmental Policy Act (i.e., NEPA review), potentially improving the efficiency of these reviews.

Participants suggested a few additional ideas during this conversation, though these were not discussed in detail. Examples include using the tool to:

- Overlay administrative or regulatory constraints that vary spatially (e.g., certain grazing units cannot be grazed after a certain date because of bull trout in the stream that runs through the unit).
- Help design grassbanks (agreements under which property owners lease land to ranchers at a discount in exchange for ranchers carrying out conservation-related projects).
- Quantify the spatial and interannual variations in stocking rates of a grazing unit to inform bids on leases for that unit.

One value of the proposed decision support tool that participants raised in different ways throughout the sessions was as a basis for improved communications. The discussions touched on different contexts and groups between which communication could be facilitated by the common understanding of the resource that an easily accessible and usable tool could provide. Examples of situations mentioned were communication:

- Between federal lands managers and their lessees. The tool could provide a common understanding of forage resources when setting objectives for a grazing unit. This shared understanding could then help improve producer-agency interactions.
- Between agencies needing to co-manage lands (e.g. state land parcels surrounded by a federal allotment). Similar to the example above, the tool could provide a common understanding of the co-managed resources.

- Within agencies, during times of staff transitions. The tool could help newly hired range conservationists (especially if transferring from a different type of rangeland system) understand the dynamics and variability of forage availability in each grazing unit.
- Within agencies, across programs. The tool could help staff in the grazing program of an agency, for example, share and discuss alternative management scenarios with staff from the wildlife program, or the fire program. These kinds of discussions between interdisciplinary teams are common in public land agencies.

A key function the tool being discussed could offer is the ability to explore “what if” scenarios. The research team proposed this function to participants, to explore both their perspective on the value of such a function, and specifics of what kinds of scenarios would be of particular interest. In general, participants saw value in a tool that would allow them to run “what if” scenarios, and some of the scenarios that were discussed were:

- Informing contingency plans (e.g. for wildfire or drought).
- Exploring options for management (e.g. fuel reduction treatments).
- Evaluating options for investment (e.g. water development, fencing).
- Developing agency planning alternatives (e.g. fencing, watering locations).
- Discussing requests for increasing stocking rates in a grazing unit.
- Quantifying the impacts of large fires (e.g. the impact of shrub removal).
- Impact of grazing when used as a tool to achieve other objectives (e.g. fuel reduction).

As in earlier discussions focused on rangeland assessment and management plans, participants articulated that scenarios would be particularly useful if they provided information that ties into existing processes and programs. One such example voiced in the discussions was whether such a tool could estimate the economic return with and without specific conservation practices (as defined by NRCS), such as water development and fencing (seeding or brush management were also mentioned, though they are less common in this region).

[Suggestions to facilitate use and interpretation of outputs](#)

Participants shared their perspectives on various needs beyond the technical functionality of the tool, as they generally considered that improved communications and sharing of tools—and guidance on and how and when to use them—were needed to support their use. They encouraged us to pair tool development with an explicit technology transfer and extension effort, and discussed some factors they considered key to successful adoption of such a tool:

- *Accessibility and support:* Users need to be aware the tool exists, need to understand how to use it and feel encouraged to use it, and need to see benefits to their operations from using it.
- *Added value:* The tool should complement, not replace, field information. For example, a first evaluation of the grazing units using information provided by a decision support tool could be a powerful way to identify where to focus limited field assessment capacity.
- *Training:* Users would need to be trained efficiently (i.e. in limited time) to use the tool appropriately and to understand the limitations of both the tool and underlying data.
- *Diverse options:* Participants suggested a variety of options to consider when developing outreach and training around the tool, including short videos, blog articles, in-person trainings, a Rangeland Technology Summit, etc.
- *Familiarity:* Achieving the key factors described should be done by building from programs (such as Extension programs) that potential users are already familiar with.

Participants also highlighted the importance of providing guidance to users of a tool on how to interpret and appropriately use the information they would obtain from the tool. They provided input on how to facilitate such interpretation and use. Their examples included the following suggestions:

- Provide tool outputs in ways that allow an experienced on-the-ground practitioner to calibrate what they know with what the tool is saying. This would be particularly valuable in places where management has been consistent over a longer time period.
- Provide in-season information on the timing of forage production in relative terms, answering the question “Is this season’s growth ahead or behind average conditions?”
- Relate current conditions, as we move into the growing season, to past experiences (e.g., use temporal analogs, to frame information as “This year is shaping up to be like 20xx”). Such information could inform the timing of when livestock could graze particular grazing units, and therefore the need for flexibility in that timing, relative to average or permitted conditions.

These suggestions and ideas that cover a range of aspects that affect both the usability and adoption of tools are valuable for the research team to consider in determining how to best proceed.

D. Other Concerns and Limitations

Throughout the listening sessions participants presented insights on potential challenges and limitations that went beyond the specific questions the research team posed. In addition, we concluded each listening session’s discussion explicitly asking for further insights participants would like to share that had not yet been addressed. Some participants posed questions, others had suggestions, yet others identified limitations. Some highlights of these insights include:

- Limitations of the model and the data used need to be clearly communicated and understood.
- Could the tool inform stocking density decisions?
- Managers and producers do not necessarily know what tools are already available, and what functionality exists, so cannot fully address the issue of whether a new tool would add value.
- Other factors outside the control of the grazing manager, such as high (and unquantified) use of particular areas by wild horses, could overwhelm the usefulness of the tool. .
- In emphasizing the need to get information about a tool (during and after development) to potential users, participants suggested collaborating with Extension, Conservation Districts or Boards, Cattlemen’s Associations and others to communicate with private landowners. In terms of agency staff, participants suggested ensuring that national and regional agency staff are aware of the tool and its value, so they can encourage use within their agencies.
- Care is needed in determining how best to present information, to support the tool’s credibility and accuracy. For example, presenting data in relative terms (e.g. “where in the range” are you?) avoids giving a false sense of accuracy around a particular value of forage availability.
- If a user expects changes in their operation due to changes in stocking rate informed by the tool, and those changes do not occur, the tool would not be considered credible.
- How to increase stocking rate sufficiently (and sometimes out of season) to address other objectives, such as cheatgrass control, remains a challenge.
- It is preferable to stock up than to destock the cow herd, so stocking rates tend to be set conservatively to avoid risking the need to destock. However, on federal lands National Environmental Policy Act (NEPA) filings create “stickiness” in stocking rates, so the current permit system does not lend itself to dynamism and flexible stocking rates.

- For many ranchers, it is difficult to take advantage of a highly productive year. Their best option to exercise flexibility is generally to extend duration of the grazing period, though that is often not an option because of fixed dates prescribed by agencies.
- The lead time needed for ranchers to adjust management depends on the direction of change: more time is needed to increase herd numbers, less time is needed to reduce them (though the impact may be more direct: inability to increase herd numbers is a missed opportunity without cash loss, while inability to reduce herd numbers when needed represents an actual cost, such as from purchasing other forage).
- Herd size decisions are generally based on the long term availability of forage, so there is limited flexibility. Some producers can handle yearlings as well as cow-calf pairs, but some may not have the labor capacity or the experience to manage yearlings.
- In addition, when grazing resources include public lands leases, additional administrative obstacles limit flexible grazing management. Permit changes for federal agencies require significant work and effort, and are needed in order to change stocking rates. It is unclear whether having information on the range of vegetation conditions would help reduce this limitation.
- Public perception of a stocking rate tool might be limiting. Consider framing it in terms of informing multiple objectives.

Where We Are Going with This Input

In addition to hosting the three listening sessions, the research team is also evaluating the availability of data, technical capacity, and potential institutional support needed to develop such a tool. Given the general agreement we heard on the potential value for such a tool—while further considering the rich input on how to make it valuable and useable—the team is exploring funding options to develop a dynamic stocking rate decision support tool. All listening session participants will be kept informed on progress we make in that direction. We sincerely appreciate participants' time and willingness to share.

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This study has been certified as exempt from the need for review by the Washington State University Institutional Review Board.

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APPENDIX 1: GUIDING QUESTIONS

The questions below were posed to participants in each listening session, to help guide the conversation. The team moderated the discussion. The approach was to use these questions to prompt discussion and to ensure that this range of topics were discussed. However, the team did not organize or facilitate the discussion by going through each question individually; rather, each block of questions was posed, and left up on the screen where participants could see them while the discussion occurred freely.

A. Current Approaches to Calculating Stocking Rates, and Their Limitations

1. How do you currently make stocking rate decisions? What information do you use?
2. When, and as part of what processes, do you make stocking rate calculations?
3. What are the strengths and drawbacks of available information?
4. Do you wish you had “improved” information? If yes, what improvements would you seek? Why?
5. Would you also need improved mechanisms for planning and implementing grazing management decisions?

B. How You Deal with Inter-Annual Variability

1. What are your agency’s long-term goals for the rangelands you manage?
2. How important is understanding past annual productivity and its variability to achieving those long-term goals?
3. What information on interannual variability do you currently have to inform stocking rate decisions?
4. What information on interannual variability would you like to have to inform stocking rate decisions?

C. Your Thoughts on Tool Development Priorities

1. Do you have specific questions, reactions or thoughts on the ideas around a dynamic stocking rate calculation tool?
2. What factors or datasets do you think are missing and should be considered for further developing this dynamic tool?
3. Are there other design criteria that are very important in terms of how you would interact with a tool like this one?
4. How accurate would the information need to be to help you make stocking rate decisions during long-term planning?

D. Other Concerns and Limitations

1. Are there other concerns you deal with that we haven’t thought of or discussed?
2. Are there other needs or ideas you’d like to share?