Communicating Ecological Data With Land Managers: Lessons Learned

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BACKGROUND

Communicating ecological data to land managers and management entities represents a different challenge than communicating with the scientific community and the general public. Land managers need to not only understand results but also the inherent limits and assumptions in order to make effective and legally defensible decisions. However, many face barriers to producing or interpreting results of data analysis including time, resources, and technical skills.

Our group, a collaboration between the USDA Agricultural Research Service (ARS), the National Aquatic Monitoring Center (NAMC), and the Bureau of Land Management (BLM) since 2010, partners to implement the BLM Assessment, Inventory, and Monitoring Strategy (AIM). The purpose of AIM is to provide land managers with robust, high quality monitoring data gathered with consistent methods and statistically-sound sampling techniques. Through this effort, we have experienced both successes and failures in communicating data to land managers.

As a result, our data communication has necessarily evolved. We refined the amount of data, their format, and the kinds of results and delivery mechanisms.

PRIORITIES

Many of our lessons learned relate to our primary role: to empower land managers by providing data in a format that can be applied to making management decisions and avoids restricting the decision space.

Our group and land managers share common goals:

- **Clarity**
  Figures should be parsable at a glance or with minimal explanatory text.
- **Scientific integrity**
  Figures and tables must report values in ways that do not misrepresent data (*e.g.,* include confidence intervals for statistics).
- **Flexibility**
  Figures and tables should not be single-purpose unless necessary and should be portable to multiple documents and decisions.
- **Empowerment**
  All data should be useful but should not imply a decision or judgement (*e.g.* indicate that values are "good" or "bad") and land manages should feel confident that they can explain them.

PROCESS

We produce reports and summaries from AIM data by request for use by land managers in various BLM offices. Many of these reports are intended to support or inform National Environmental Policy Act (NEPA) decisions. These documents are the result of constant dialogue with the points of contact within BLM field offices and multiple iterations prior to a final product.

After each of these efforts, we informally request for feedback about both the process and how the results were ultimately used in real-world documents and decisions. We also hold workshops for land managers to discuss applications of data and use those to gather opinions about legibility, content, and usability of results and figures.

KEYS to SUCCESS

Involve the stakeholders early

Our highest impact figures and tables are the result of conversations with the offices about what they needed and expected for their purposes *before* we started work.

Land managers and entities already have existing workflows for making and supporting decisions. Simply asking for examples of what they have produced for themselves in the past can guide the direction of our work. If the results and data we provide are in a format that can't be slotted easily into those workflows, they are likely to go unused.

For the end users, sharing our previous work and understanding what else is possible sometimes prompts requests for other data or rethinking and extending their approaches.

Use "neutral" symbology

Symbology must always be clear and accessible but beyond those concerns, cultural associations need to be considered.

One of our most common early design decisions was to use "stoplight colors"—red, yellow/orange, and green, usually when we reporting condition classifications like "Unsuitable", "Marginal", and "Suitable". We very quickly found that classes these implied "good" and "bad" results, which land managers felt limited their decision space. (Fig. 1)

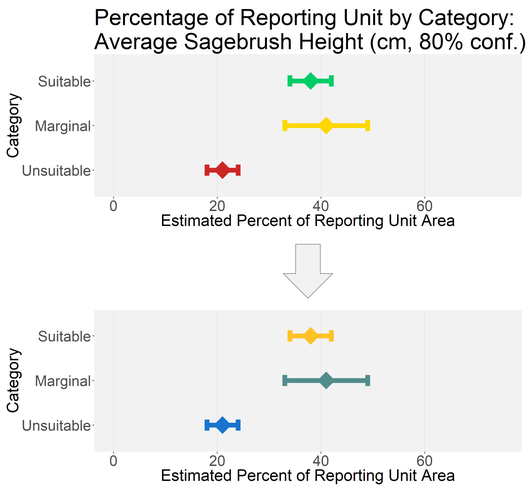

Figure 1: A simple color palette change makes a dramatic difference in terms of emotional feel of figures and can avoid implied judgement.

Provide both tables *and* figures

Land managers are themselves communicators to other stakeholders and need to have flexibility and options when it comes to their data. They will inevitably be applied across contexts and there reasons to want both tabular and figural versions available to suit.

Additionally, concepts like uncertainties are often perceived differently in tables versus figures—feedback we received suggested that uncertainties depicted graphically are often seen as more limiting or concrete than the same values in a table. By providing both, we avoid disempowering land managers by implying a decision or judgement.

Ask for interpretations

We aim to present statistics in ways that users can interrogate and discuss on their own. Some concepts such as confidence intervals are integral to science, but have a comparatively shorter history in land management. Likewise, certain types of figures are more immediately accessible due to familiarity.

When we asked land managers if they were comfortable interpreting or describing the our initial figures, we discovered that several of our figures failed to meet our goals of clarity and empowerment, particularly for indicator distributions and estimated classification proportions.

Our first attempts at representing distributions of vegetation and soil values were histograms, but land managers reported that they chose not to use them because they were difficult to intuitively apply to their management objectives. Discussions led us instead to provide box plots. Although the land manager consensus is that box plots are still relatively complicated they felt confident reading and explaining them to other stakeholders.

We also started with bar charts to represent percentages of landscapes falling into condition categories. Through in-person workshops, we learned that the bars implied a "fullness" that skewed the interpretations of confidence intervals. By asking workshop participants to interpret different styles of figures depicting the same data and asking for their open ended opinions, we arrived at a point-based approach. (Fig. 2)

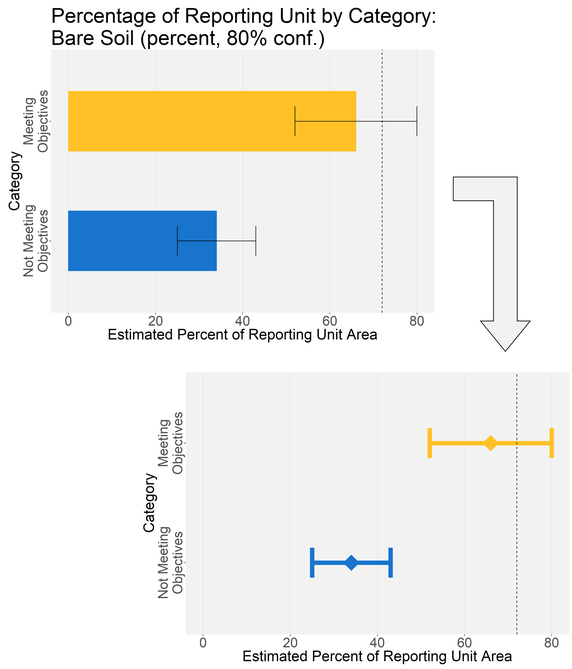

Figure 2: Land managers felt that the confidence intervals around the ends of bars were lopsided and that they would be more likely to interpret the range as truly including their decision threshold (dotted line) with points instead.

Keep data density low

We have found that figures are much more likely to be used when they are as simple and direct as possible. Although that may run counter to expectations, it means that land managers can readily use the same figures across a variety of documents and decisions without worrying about unnecessary data.

This includes steps as simple as creating a figure for each area reported on instead of a more efficient single figure that contains information from multiple sources. (Fig. 3)

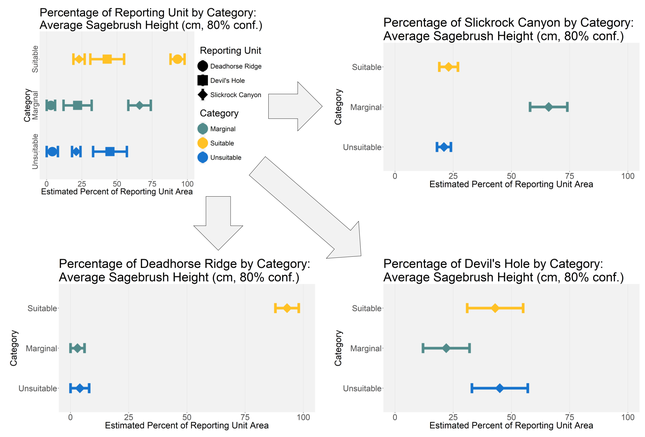

Figure 3: Although the percentage of all three areas meeting criteria for sagebrush height could be reported on a single figure, splitting it into three separate figures means that land managers can easily use only a subset for their own documentation

CONCLUSIONS

Based on feedback from users and observing how data have been applied, we have general principles for communicating data to land managers. We find that starting with conversation about users' analysis objectives and existing decision-making workflows often shapes data requests and presentation of results. High density, high complexity figures are less likely to be impactful; we try to consistently produce simple, direct figures which display only one kind of result. Land managers often find graphical figures easier to draw general conclusions from, but may also need tabular results for documentation; we provide equivalent data in multiple formats which can be integrated into different analyses. We aim to present statistics in ways that users can interrogate and discuss as part of interpretation; this is especially important for statistics like uncertainty of which users may have intuitive rather than formal understandings

Our conclusions are shaped by direct feedback from land managers regarding what helps and hinders their use of AIM data. We will continue to refine our approaches through workshops with the community of practice of land managers who are using the data.

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