**Benchmark Paper Approach:**

This investigation into benchmark development will attempt to address the following questions:

1. How do benchmarks developed using data-driven approaches vary across spatial scales?
2. Are the differences observed between methods or spatial scales meaningful in an ecological or management decision making context?
3. When comparing benchmarks for indicators related to different ecosystem services, are there opportunities for synergistic applications or is a deeper tradeoff analysis potentially required?

The objective of this investigation will be to analyze the potential implication of applying different benchmark development approaches at different scales to determine if the approaches properly address the resources concerns related to each benchmark. First, a subset of indicators for specific ecosystem services will be identified for use in this investigation. This subset should reflect the primary resource concerns for management of rangelands in the New Mexico and align with the Bureau of Land Management (BLM) Land Health Standards (LHS). Potential desired ecosystem services and the related indicators for benchmarking in this investigation are listed below.

1. Site Stability
   1. Soil aggregate stability
   2. Bare soil
   3. Canopy/Basal gaps
   4. Erosion model estimates (AERO=wind, RHEM=water)
2. Hydrologic Function (Resistance to Erosion)
   1. Soil aggregate stability
   2. Bare soil
   3. Canopy/Basal gaps
   4. Erosion model estimates (AERO=wind, RHEM=water)
3. Biotic integrity
   1. Wildlife habitat indicators (species specific)
   2. Invasive species cover
   3. Functional/Structural cover composition
   4. Annual production

To address the questions above, the current BLM data-driven approach using the distributions of indicator data to identify benchmarks will be applied to available data across multiple spatial scales from ecological state to the state of New Mexico. The primary data source will be the BLM Assessment, Inventory, and Monitoring (AIM) strategy and the Landscape Monitoring Framework (LMF), part of the AIM strategy. (Note: Could include additional data as necessary where data limitations exist.) The benchmarks that emerge from this component will then be compared to benchmarks developed using methods that seek to identify natural breaks or inflection points within the data distributions. These methods should seek to reflect an underlying functional threshold in ecological processes related to each specific indicator. By looking deeper into the data distributions at multiple scales, benchmarks that are potentially generalizable across approach and scale should emerge.

Next, the comparisons across approach and scale will be evaluated against known or possible functional and structural thresholds specific to the scale under investigation. This evaluation will provide insight into how the approach and scale influences benchmarks in relation to the ecological processes occurring on the landscape. By evaluating the benchmarks in the context of these potential thresholds, an understanding of which benchmarks and approaches require which scale of information is needed to facilitate effective management decision making may come to light. (Note: Unsure if this part is needed if the initial step is slightly altered but could allow for incorporation of publish thresholds from literature into the analysis.)

Comparing benchmarks related to different ecosystem services and ecological processes within and across scales will allow for the identification of potential synergies amongst the benchmarks and the opportunities for management decisions to address multiple resource concerns simultaneously. On the other side, potential conflicts and tradeoffs can also be identified and evaluated within the context of management goals and objectives to facilitate the most desirable outcomes. This component of the investigation will provide a way to incorporate the differences between approaches and scales into a framework for use by management to potentially simplify decision making at the scale of interest.

This investigation will begin by evaluating selected ecological sites in MLRA 42 that include quantitative information regarding ecological state. The focus of comparisons within MLRA 42 would be the effects of using ecological state vs. ecological site level data for development of benchmarks. AIM and LMF plots will be classified to ecological site based on information published in Ecological Site Descriptions (ESDs) available from the Ecological Dynamics Interpretive Tool (EDIT). From there, the investigation would proceed to evaluations at an MLRA scale. (Note: Potentially could add or use the field office or district office scale here instead to reflect decision-making units. E.g., Las Cruces, Rio Puerco, Farmington, Taos, Carlsbad) Potential MLRAs include 35, 36, and 42A. (Note: Could also include method comparisons, such as the fuzzy clustering in 42A that Allie did.) The focus of comparisons at this scale will evaluate using data distributions from the entire area vs. categorization to a general ecological state using a simplified keying approach developed from the more detailed approach used at the ecological site level in MLRA 42. By using this approach in multiple MLRAs, the effects of shifting ecological system could potentially be evaluated by comparing across MLRA lines. The results of this step would then be utilized in looking at data at the state of New Mexico scale. Although this final spatial scale is not ecologically defined, there are opportunities to begin evaluating benchmark development at decision-making scales, specifically related to BLM Land Health Standards used at the state level. An additional opportunity to compare approaches in diverse ecological systems could provide insight into the transferability and applicability of benchmark development methods. (Note: These spatial scales and areas of interest may be adjusted or adapted due to data availability with the area.)

Note: This work will focus primarily on comparing known/used methods for benchmark development across various spatial scales and may act as a functional extension of the planned paper we are discussing on Monday. Between our internal conversations and discussions with the BLM moving forward, I think many of the questions and uncertainties noted above will become much clearer moving forward and allow a more focused evaluation of the questions I hope to address with this work.