Script: Ecological Concepts

Slide 1

Hello, and welcome to the Ecological Concepts lesson of the Interpreting and Measuring Indicators of Rangeland Health class. I am Mike Pellant and I am a rangeland ecologist with the Bureau of Land Management in Boise, Idaho. The landscape in this scene appears to be a relatively homogeneous unit with little variability other than the riparian area in the middle. Appearances can be deceiving! Soils, plant communities, landforms, precipitation patterns and disturbances such as wildfires and droughts are factors that affect the spatial and temporal dynamics of the plant communities and soils on this landscape. Let's explore some of the ecological concepts that help us better understand these functions and serve as the building blocks for the assessment, inventory and monitoring of these landscapes.

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This lesson will cover some of the key ecological concepts required to understand and properly assess, inventory and monitor rangelands. By the end of this lesson, you will be able to define and apply these principles in conducting monitoring studies and rangeland health assessments.

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Here are the ecological concepts, in the order they will be presented, to assist you in meeting this objective. The concepts are: 1) the landscape context, 2) natural range of variability, 3) disturbances, resistance and resilience, and 4) a section on setting the stage to utilize Ecological Sites and State and Transition models in the assessment, inventory and monitoring of rangelands.

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Our challenge in meeting this objective is the a high degree of variability across landscapes in both space and time. The functions that sustain rangeland ecosystems are complex and variable...

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…and require an understanding of key ecological concepts that help inform how we assess, inventory, and monitor rangelands. Let's now move to the first ecological concept in this lesson, the landscape context.

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Landscapes have many definitions. Landscapes are spatially heterogeneous, geographic areas characterized by diverse interacting patches or ecosystems. The definition is not as important as the understanding that landscapes are large areas that require subdividing in order to organize and apply a monitoring program or an assessment of condition. The soil map in this slide illustrates one approach to subdividing a landscape into ecologically relevant units. Each soil unit delineated in this map has the potential to produce a distinct kind and amount of vegetation. These delineations serve as the basis for

the development of Ecological Sites and associated Ecological Site descriptions that will be discussed later in this lesson and in the Stratification lesson.

In addition to soils, land relief, for example the slope and aspect, is part of the landscape context and it may directly and indirectly influence the soil and vegetation on that site. For example, direct effects of surrounding areas include water run-off or run-on, erosion, or seed dispersal. An example of an indirect effect is the proximity of the evaluation area to a water source used by herbivores. The water source indirectly affects the impacts of herbivores on vegetation at the evaluation area.

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Let's look at the following scene and evaluate the effects of this landform on water processes. First, how would you subdivide this area into landforms. What criteria would you use to make these divisions? Water movement provides one option to classify this area into run-off on slopes and run-on in valley bottom areas. The effect on downslope areas can be positive for water but negative if it results in accelerated erosion. Aspect is another factor that affects water movement and erosion. South slopes generally have higher evaporation, shallower soils, and more bare soil than north slopes. Plant productivity is generally lower and erosion potential higher on south slopes compared to north slopes. Let's move on the concept of natural range of variability.

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The natural (or normal) range of variability is defined as the deviation of characteristics of biotic communities and their environment that can be expected given natural variability in climate and disturbance regimes. This variability includes spatial and temporal aspects. It is associated with natural, not anthropogenic, disturbances. The reference or benchmark for assessments of current condition includes this natural range of variability. It must be described and considered when conducting an evaluation of rangeland health and can be helpful for interpreting quantitative monitoring data. This reference is described later in this lesson in the State and Transition model section.

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Spatial variability reflects the differences in slope, aspect, soils and landforms that occur across a landscape. This can also include spatial differences in weather events such as convective storms that impact one location, but not another in the same vicinity. Temporal variability includes differences in weather cycles that occur over time and its effects on vegetation and soils. Periodic droughts are one example of temporal variability as is the time since natural fire. The natural disturbance regime is a component of the natural range of variability. Periodic wildfires are a part of the natural disturbance regime, but catastrophic wildfires resulting from long-term fire suppression are not. Frequent wildfires due to the introduction of flammable, exotic grasses are another example of fire outside of the natural disturbance regime.

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Here are two examples to illustrate the natural range of variability. Bare ground can increase as plant cover diminishes across a site due to weather conditions such as drought as shown in the top slide. Bare ground will decrease as precipitation increases resulting in greater plant production and increased foliar cover as shown in the lower slide. Let's now consider the effects of fire on woody plant cover. Woody plant cover is initially reduced as a result of fire, but can increase with time since fire if resprouting shrubs are present or conditions are favorable and a woody plant seedbank is present after the fire. In the scene below, a fire in big sagebrush results in shrub mortality and a gradual return of sagebrush from the seedbank. Let's move on to a description of the concepts of disturbances and resistance to and resilience after disturbances.

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As previously stated, disturbances are a natural component of functioning ecosystems. Healthy ecosystems are generally resistant to natural disturbances and resilient or able to recover from these disturbances. Degraded systems are also often very resistant to change, thus resistance and resilience are often not good criteria to characterize healthy ecosystems. Let's take a little closer look at both of these concepts in the next two slides.

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Resistance is the capacity of ecological processes to continue to function without a major change following a disturbance. In this example, a severe wildfire in a riparian area has resulted in accelerated erosion and plant mortality which will negatively affect ecological processes of this area. The resistance of this stream to a severe wildfire was not sufficient to allow this riparian area to maintain its ability to capture and safely release water.

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Resilience is the capacity of ecological processes to recover following disturbance. In simple terms, resilience is a function of recovery time and is defined by the rate and extent of recovery. In the photo we see a post-fire sagebrush steppe community that appears to be recovering function as time since the fire and successional processes proceed. The rate of recovery for big sagebrush is relatively slow in this system so one would expect the herbaceous component to recover more quickly than the shrub component. The extent of recovery would be expected to encompass the burned area although some sites in the burn may recover more slowly than others.

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This figure helps us understand resistance and resilience concepts based on a hypothetical plant community and the changes that could occur after a disturbance. Resistance is illustrated by the dotted line that indicates that the ecological processes continue to function after a disturbance and where a threshold is not crossed. In other words the plant community remains in State 1. Resilience is illustrated by the blue solid line showing a recovery after the disturbance that brings the plant community to a

threshold and eventually a recovery to State 1. A lack of resilience is illustrated by the red line that shows the inability of the plant community to recover to State 1; thus, the plant community remains in an alternative state or State 2.

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Now that we have discussed the five ecological concepts, how can these concepts be used to better inform our assessments, inventories and monitoring? State and Transition models provide a framework to incorporate these concepts to assist in the stratification of studies and to help identify important attributes and indicators to monitor. So what are State and Transition Models?

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State and transition models help us organize and communicate complex information about the relationships between vegetation, soil, animals, hydrology, disturbances and management actions on rangelands. You will learn more about these models and ecological sites in the following lessons. Let's now examine a simple Sagebrush Steppe State & Transition conceptual model to see how our ecological concepts contribute to this model.

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First, let's look at the reference state which describes the ecological potential and reflects the natural range of variability of the ecological processes, soils and vegetation. Natural, non-anthropogenic disturbances contribute to the natural range of variability in the reference state. In this sagebrush steppe model, occasional wildfires reduce shrubs and increase the herbaceous understory with a gradual return to a co-dominance of shrubs and herbaceous species. The community phases within the reference state are resistant to outside disturbances and are able to recover after disturbance. The introduction of invasive annual grasses and an increased fire return interval exceed the capability of the reference state to resist these stressors and to recover from them. A threshold is crossed resulting in an alternative state that is dominated by nonnative annual grasses which is difficult to restore back to the reference state. At the landscape scale, multiple ecological sites create a complex mosaic of plant communities in different states which complicates our ability to assess, inventory and monitor rangelands.

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To conclude the Putting Concepts Together section of this lesson, we stress the importance of ecological sites as a means of dividing the landscape into units, describing the natural range of variation and helping us to understand and utilize resistance and resilience concepts in our assessment, inventory and monitoring programs.

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To improve your understanding of these concepts and their utility in the assessment, inventory and monitoring programs, you are requested to read Section 2.0 Ecological Site Classification Concepts in the "Interagency Ecological Site Handbook for Rangelands (2013).

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We have presented some basic ecological concepts important for assessment, inventory and monitoring. Utilizing these concepts, we have the tools required to divide the landscape into similar ecological units, develop models that help us understand natural variability and biotic community reactions to disturbances and ultimately to assist us in interpreting the information and data we gather from our assessment, inventory and monitoring programs.

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If you will remember, the objective for this lesson was for you to be able to Identify key ecological concepts and explain how they relate to and support the assessment, inventory and monitoring of the health of rangeland ecosystems .

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In order to help you accomplish this objective we covered several key topics. First, we described the importance of dividing the landscape into units to assist in conducting studies. We generally use Ecological Sites for this division since they are a conceptual division of the landscape based on soil, landform, geological, and climate characteristics. We then discussed how the natural range of variability helps explain non anthropogenic effects of disturbances, weather, and other variables in both time and space across a landscape. This understanding is important as we develop references for monitoring and assessments of rangeland health. We then explored how resilience or the ability to recover after disturbance and resistance to disturbance help explain changes in plant communities and soils over time. Finally, we put all of these concepts together in our discussion of State and Transition Models and Ecological Sites and described how these tools could assist us in our assessment, inventory and monitoring of rangelands.

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I will close with the landscape that I showed you at the start of this lesson and ask if you now have a better understanding of how ecological concepts can help us understand and sort through the complexity and variability of these ecosystems? You have completed the Ecological Concepts lesson and will now proceed to the Core Indicators and Attributes lesson to continue your pre-class assignments.