Ecosystem Canaries: Rangeland Health

Grade: 7 to 12

Length: variable

Subjects: life science, research

Topics: weed facts

Objectives

Exercises in this lesson help students achieve the following objectives:

- Understand the purpose of and need for rangeland assessment
- Learn the parameters used to qualitatively assess rangeland health
- Perform a qualitative rangeland assessment comparing a functioning system (healthy) with a marginally functioning system (unhealthy)

Introduction

Students will determine the characteristics of desirable rangeland by identifying an Ecological Reference Area (ERA), visiting the ERA, and filling out a series of forms to characterize physical attributes and assess the ecological health of the ERA. This information will serve as a benchmark against which to compare similar sites of interest. Next, students will visit an area with an extensive, invasive plant infestation. Using the same forms, students will perform a qualitative assessment of the second area. Before teaching this lesson, read the entire lesson and make sure all materials are available.

Background

Qualitative assessment is an important method that land managers use to quickly determine the health of an ecosystem. Generally, this method considers a variety of parameters, including soil stability, hydrologic function, and **integrity** of the biotic community. Qualitative assessment compares a site of interest to a similar "healthy" site known as an **Ecological Reference Area** (ERA). Reasons to conduct a qualitative assessment include concern about a current condition, lack of information regarding a specific site, or public perceptions surrounding a specific area. Qualitative assessment can provide early warnings of problems and alert land managers to potentially dangerous trends. While qualitative assessment does not identify the causes of problems, it might, in combination with quantitative monitoring and inventory information, serve as a starting point for corrective management action.

Overview of ecosystems

Ecosystems include all the **biotic** (living) and **abiotic** (non-living) elements that interact with each other in a particular area. Within an ecosystem, many inter-related cycles, such as the water, energy, and nutrient cycles and the cycles of the seasons, closely entwine biotic and abiotic elements. Complex **food chains** and **food webs** tie organisms within an ecosystem to one another. Changes that affect any one species may ultimately affect the entire ecosystem.

A balanced ecosystem is not static; the ecosystem changes constantly. An ecosystem at equilibrium is in a state of **dynamic equilibrium**. Populations that are in balance always fluctuate. Changes in the population may appear to be chaotic. However, changes usually occur within specific parameters that are unique to the population or ecosystem.

Many wildlife populations experience a predictable cycle of peaks and valleys; environmental factors determine the limits of the peaks and valleys. Cicada populations reach a peak every 17 years.

Wildfires, which are often driven by cycles of drought, usually appear to be catastrophic. However, wildfires are usually within natural parameters for a particular ecosystem. In Yellowstone National Park, large-scale wildfires occur every 200 to 400 years. When these fires occur, they seem unusually large to people who are unfamiliar with the fire cycle. When natural cycles exceed the life span of a human, it is often difficult for us to comprehend that the cycles are naturally occurring.

Invasive species and their influence

Invasive **species** are plants and animals that have not evolved in a particular ecosystem, and these invasive species can upset an ecosystem's balance. When humans intentionally or unintentionally introduce a species into areas, the introduced species often thrive. The introduced species might have few or no predators in the area, or the introduced species might have special **adaptation**s that enable it to out-compete or overcome the original inhabitants or species. This situation often occurs in disturbed environments.

When an environment has been disturbed and altered, especially by humans, the changes often disrupt and damage the delicate web of environmental connections and inter-related cycles that exist within that environment. Plants and animals living in the environment have adapted to conditions in that particular environment. They might be unable to adapt to the changes.

Invasive plant species have developed a wide range of adaptations that enable them to establish themselves in a disturbed environment before the native species can recover. Some invasive species produce seed heads with thousands of seeds in each pod, produce seeds that germinate within a wider range of temperature and moisture conditions, grow rapidly and use nutrients before native plants can use them, and have extensive root systems that rob other plants of precious water reserves. When invasive plant species enter an environment, there is often a profound loss of species diversity. In an environment that has been impacted by habitat loss, population growth, pollution, and over-harvesting, the entire ecosystem can collapse. Invasive species are one of the most significant threats to **biodiversity** and ecosystem stability.

Definition of rangeland

The Society for Range Management (1999) defined **rangelands** as "land on which the indigenous vegetation (climax or natural potential) is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem. If plants are introduced, they are managed similarly. Rangelands include natural grasslands, savannas, shrublands, many deserts, tundra, alpine communities, marshes, and wet meadows." This definition also includes oak and pinyon-juniper woodlands.

The National Research Council (1994) defined **rangeland health** as "the degree to which the integrity of the soil and ecological processes of rangeland ecosystems are maintained." The Society for Range Management (1995) defined rangeland health as "the degree to which the integrity of the soil, vegetation, water, and air, as well as the ecological processes of the rangeland ecosystem are balanced and sustained." Both organizations defined integrity as "maintenance of the functional attributes characteristic of a locale, including normal variability."

Ecological processes

Ecological processes include the following **cycles**:

Water – the capture, storage, and redistribution of precipitation

Energy flow – conversion of sunlight to plant and animal matter

Nutrient – the cycle of nutrients, such as nitrogen and phosphorus, through the physical and biotic components of the environment

Qualitative assessment

Qualitative assessment, which is sometimes referred to as rapid assessment or visualization of rangeland health, relies on quick observations rather than detailed measurements and data collection relevant to water, energy, and nutrients. Direct measurements of ecological processes are difficult to take or expensive due to the complexity of the processes and their interrelationships.

To evaluate site integrity and ecological processes, land managers rely on the presence or absence of biological and physical attributes and their quantity and distribution. We use the Dow Jones Index to gauge the strength of the stock market. In a similar manner, land managers use soil, water, and biotic indicators to gauge ecosystem health. There is no one indicator of ecosystem health. It is essential to use a combination of key indicators when conducting a qualitative assessment.

Key indicators

The following three key indicators comprise the assessment tool for the *Activity* in this lesson:

1. Soil/Site Stability is the capacity of the site to limit redistribution and loss of soil, including nutrients and organic matter, by wind and water.
2. Hydrologic Function is the capacity of the site to capture, store, and safely release water from rainfall, run-on, and snowmelt (where relevant); to resist a reduction in this capacity; and to recover this capacity following degradation.
3. Integrity of the Biotic Community is the capacity of the site to support functional and structural communities, with normal variability, characteristic of the site; to resist loss of these functional and structural communities due to disturbance; and to recover following disturbance.

   Disturbances are natural and necessary parts of all ecosystems. Healthy ecosystems are resistant to external disturbances, and the ecosystem has the resiliency or ability to recover if external disturbances occur, which allows various combinations of plant species to fluctuate over time.

Threshold

A threshold is a transition boundary that an ecosystem crosses, resulting in a new, stable state that is not easily reversed without a significant input of resources. Once an ecosystem crosses a threshold, it may be very difficult to restore the original plant community and ecological processes by changes in management alone. Expensive restoration measures, such as weed control, reseeding, and soil modifications may be necessary to restore the degraded ecosystem.

Preparation

Materials

- photo of a canary or a caged bird

1 Show students a photo of a canary, or bring a caged bird to class. Discuss how sensitive canaries are to environmental changes, such as temperature.

2 Ask students if they know why canaries were once important to miners.

Before gas analysis was routinely available, miners who worked in deep tunnels brought a caged canary with them. If harmful gases were present, the canary would die or show signs of sickness before humans detected gases in the air.

3 Explain that when it is not feasible to collect detailed data and analyze it, we can observe key factors or perform qualitative analysis.

Students will use qualitative analysis to determine ecosystem health.

4 Ask students to name indicators of ecosystem health that they can readily observe. Encourage students to consider physical, such as soil and water, and biological indicators.

If you are unfamiliar with assessing rangeland, contact a local rangeland specialist with the BLM or other agency for help with the *Activity*.

Activity

Materials

- Ecological Reference Area (ERA)
- copies of the *Rangeland Assessment* worksheet – Have available one copy for each student.
- clipboards and pencils

1 Identify a weed-infested area and an ERA. The ERA should be similar to the weed-infested area. Use ecological site descriptions, soil surveys,

topographic maps, and vegetation inventories to determine if the areas are similar. ERAs might be protected areas or well-managed rangelands.

Examine the ERA during the same year and season as the weed-infested area, since weather can affect the rating indicators.

Upon arrival at an area, evaluators should walk one to two acres of the area to determine variability and select the assessment area accordingly. The assessment areas should be large enough to include the natural variability of the site. Evaluators should identify the boundaries of the assessment area.

2 Have students visit the ERA. Use the Rangeland Assessment worksheet to characterize the site. Complete all sections of the worksheet. This information will establish benchmark parameters for comparison.

3 Visit a weed-infested area and complete the worksheet for this area.

Conclusion and Evaluation

- Discuss the similarities and differences students observed at the two sites. Determine the assessment ratings for the two sites. Based on field observations, discuss the potential causes for the differences in the sites. Conclude the lesson by asking students to suggest potential actions that would improve the ecosystem at the less healthy site.
- Evaluate students on their fieldwork and completeness and accuracy of their worksheets.

Independent Practice and Related Activities

- Assess additional weed-infested areas for purposes of comparison and to improve observational skills.

Vocabulary

abiotic, adaptation, biodiversity, biotic, dynamic equilibrium, energy flow cycle, ecological resource area (ERA), food chain, food web, integrity, nutrient flow cycle, qualitative assessment, rangeland, rangeland health, species, water cycle

Resources

Interpreting Indicators of Rangeland Health, Version 3 (2000); U.S. Department of the Interior, U.S. Department of Agriculture Technical Reference 1734-6.

The U.S. Department of Agriculture Natural Resources Conservation Service Web site contains information about assessing an ecological site.
http://esis.sc.egov.usda.gov/About.aspx

County weed boards, extension offices, and state and federal agencies can provide information on invasive weed species and may be able to provide data collection forms that are specific to your area.

National Science Education Standards

As a result of activities in grades 7 to 12, students should develop abilities in and an understanding of the following areas:

Science as Inquiry – Content Standard A: scientific inquiry, understandings about scientific inquiry

Life Science - Content Standard C: structure and function in living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, diversity and adaptations of organisms

Science and Technology - Content Standard E: technological design, science and technology

Science in Personal and Social Perspectives - Content Standard F: personal and community health; environmental quality; science and technology in local, national, and global challenges

History and Nature of Science - Content Standard G: understanding of science as a human endeavor

Weed Warrior Worksheet

Rangeland Assessment

Observers: _____ Date:_____

Site Documentation

Management Unit (Allotment) _____

_____

Watershed _____

_____

Pasture _____

_____

Ecological Reference Area: Yes or No

Major Land Resource Area _____

_____

Identification Number (if applicable) _____

_____

Photos taken: Yes or No

Legal Description of Location:

Township _____

Range _____

Section _____, _____ ¼, _____¼

Latitude_____ Longitude _____

or UTM Coordinates _____

Site characteristics

Ecological Site _____

Soil Map Unit Name _____

Geology or Parent Material _____

Aspect _____

Slope _____

Elevation (feet) _____

Topographic position _____

Annual Precipitation (inches) _____

Recent Climate: Drought Normal Wet

Site uses

Describe wildlife and livestock use

_____

_____

_____

_____

_____

Describe recent evidence of disturbance (wildfire, recreation, grasshoppers, etc.)

_____

_____

_____

_____

Rangeland Assessment

Species Abundance

Rank the dominant species according to abundance on the site (Section I) and by life form (Section II). Estimate abundance based on percent of cover. Identify weeds by species in Section III.

Section I – Dominant species on site

1. ________________________________
2. ________________________________
3. ________________________________

Section II – Dominant species by life form

Annual Grasses

1. ________________________________
2. ________________________________
3. ________________________________

Annual Forbs

1. ________________________________
2. ________________________________
3. ________________________________

Perennial Grasses

1. ________________________________
2. ________________________________
3. ________________________________

Perennial Forbs

1. ________________________________
2. ________________________________
3. ________________________________

Shrubs and Trees

1. ________________________________
2. ________________________________
3. ________________________________

Section III – Noxious weeds

1. ________________________________
2. ________________________________
3. ________________________________

Comments

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____

Rangeland Assessment

Estimated Life Forms and Ground Cover (%)

Estimate all ground cover in categories I-IV from interspace areas only. Category V is an estimate of total vascular plant cover; count overlapping canopies as only one canopy.

Cover Classes	0	0-1	1-5	6-15	16-30	31-50	51-75	75-100
Life Forms								
I. Grass								
Annual								
Native Perennial								
Exotic Perennial								
II. Forbs								
Annual								
Perennial								
III. Shrubs								
IV. Trees								
V. Succulents								
VI. Microbiotic crust								
Ground Cover								
I. Litter								
II. Bare ground								
III. Rock/gravel								
IV. Microbiotic crust								
V. Vascular plants								

Rangeland Assessment

Assessment of Observed Apparent Trend

Vigor		
10 points		Desirable grasses, forbs, and shrubs are vigorous, showing good health. Plants have good size and color and produce abundant herbage.
6 points		Desirable grasses, forbs, and shrubs have moderate vigor. Plants are medium size with fair color and produce moderate amounts of herbage; some seed stalks are present.
2 points		Desirable grasses, forbs, and shrubs have low vigor. Plants appear unhealthy with small size and poor color. Portions of clumps or entire plants are dead or dying. Seed stalks and seedheads are almost non-existent, except in protected areas.
Seedlings		
10 points		There is seedling establishment of desirable grasses, forbs, and shrubs. Seedlings are present in open spaces between plants and along edges of soil pedestals. Few seedlings of invader or undesirable plants are present.
6 points		Some seedlings of desirable grasses, forbs, and shrubs may or may not be present in open spaces between plants. Some seedlings of invader or undesirable plant species may or may not be present.
2 points		Few if any seedlings of desirable grasses, forbs, and shrubs are being established. Seedlings of invader or undesirable plants should be present in open spaces between plants.
Surface Litter		
5 points		Surface litter is accumulating in place.
3 points		Moderate movement of surface litter is apparent and deposited against obstacles.
2 points		Very little surface litter is remaining.
Pedestals		
5 points		There is little visual evidence of pedestalling. Those pedestals present are sloping or rounding and accumulating litter. Desirable forage grasses may be found along edges of pedestals.
3 points		Moderate plant pedestalling. No visual evidence of healing or deterioration. Small rock and plant pedestals may be occurring in flow patterns.
1 point		Most rocks and plants are pedestalled. Pedestals are sharp sided and eroding, often exposing grass roots.
Gullies		
5 points		Gullies may be present in stable condition with moderate sloping or rounded sides. Perennials should be establishing themselves on bottom and sides of channel.
3 points		Gullies are well developed with small amounts of active erosion. Some vegetation may be present.
1 point		Sharply incised V-shaped gullies cover most of the area with most of the gullies actively eroding. Gullies are mostly devoid of perennial plants with fresh cutting of the bottom.

TOTAL POINTS _______

Rating: 26 to 35 = Upward   17 to 25 = Stable   7 to 16 = Downward

Weed Warrior Worksheet

Weedy Definitions

abiotic – the non-living parts of an ecosystem

adaptation – changes an organism makes so it will fit into a different or changing environment

biodiversity – all of the species that are present in a particular area or an ecosystem

biotic – the living parts of an ecosystem

dynamic equilibrium – a balance that always exists even though things change

ecological reference area (ERA) – a defined area where the soil stability, hydrology, and health of the biotic community are at their peak levels

energy flow cycle – ecological process by which sunlight is converted to plant and animal matter

food chain – a series of plants and animals, each of which feeds on the one below it in the chain

food web – food chains that are connected in an ecosystem

integrity – maintenance of the near-perfect condition of an ecosystem *Invasive plants can disrupt the integrity of a streamside community.*

nutrient flow cycle – ecological process by which nutrients, such as nitrogen and phosphorus, cycle through the physical and biotic components of the environment

qualitative assessment – evaluation based on the quality or character of something rather than its size or quantity

rangeland – land on which native vegetation is predominantly grasses, grass-like plants, forbs, or shrubs and is managed as a natural ecosystem; includes natural grasslands, savannahs, shrublands, many deserts, tundra, alpine communities, marshes, and wet meadows

rangeland health – the degree to which the integrity of the soil and ecological processes of rangeland ecosystems are maintained

species – a category of individual plants or animals that resemble one another, are related, and produce offspring; identified by a two-part scientific name

water cycle – ecological process by which precipitation is captured, stored, and redistributed

Weed Warrior Worksheet

Weedy Word Syllables

Mark the syllables that make up each word.

invasion	in / va / sion
abiotic	____________________
water cycle	____________________
biodiversity	____________________
species	____________________
equilibrium	____________________
cycle	____________________
food chain	____________________
adaptation	____________________
integrity	____________________
nutrient	____________________
qualitative	____________________
rangeland	____________________
ecological	____________________
biotic	____________________