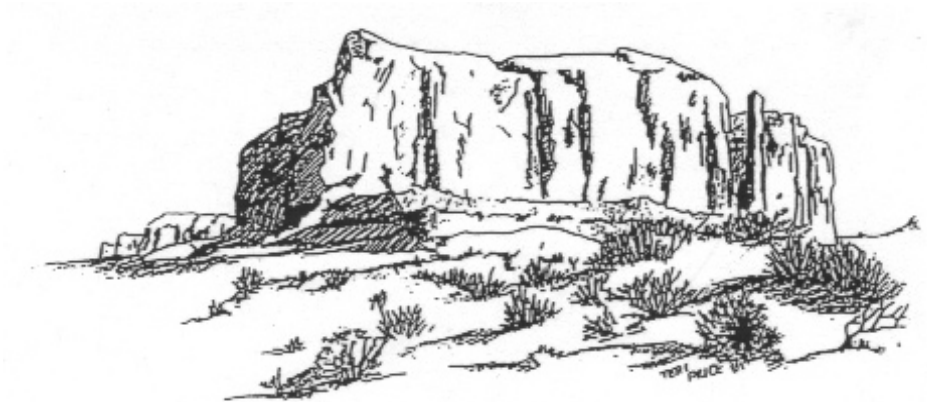


Monitoring Rangelands: Interpreting What You See

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**Funded by US EPA in cooperation with the Utah Department of Environmental Quality
and the Utah Department of Agriculture.**

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Revised September 2001

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SECTION 1



INTRODUCTION

Monitoring Rangeland Resources

Introduction

Experts keep telling us to monitor our resources. There are many very good reasons to do this—improve production, maintain the best mix of plant species, reduce erosion, maintain the health and function of rangelands, improve water quality, maintain resource sustainability, demonstrate good stewardship, or because a government agency requires it. All of these are good reasons. **But we need to monitor to help us make better decisions in managing our natural resources for the future.** With this in mind, how well do we understand monitoring? Why should we be monitoring? How should we use the information? This manual was designed to teach people what to monitor on rangelands and how to interpret the information so it can be used to make better decisions.

At the most basic level, monitoring is just watching what is happening, then adjusting your management to make sure you will meet your goals. The only problem is, you have to watch those things that will help you decide what your management has done—or will do—to your resources in meeting those goals. Too often we have collected useless information because we were told this is the best way, instead of monitoring for the information we really need. Often monitoring programs do not look at the economic reality of implementing the monitoring program or how easily the information can be used by a land owner. Additionally, often only a few people can use the information that has been generated. As a result, few people ever implement and maintain a monitoring program.

This monitoring program was developed to help provide landowners with information to see if they are meeting their management goals. The techniques discussed will provide an indication of potential forage production, erosion, water

quality and diversity of plant species in major vegetation communities. We will focus on the uplands, riparian areas, and streams. We propose that you watch the vegetation cover on upland and riparian areas. If this is done over time, it will identify change so a land owner can assess the impact of decisions, predict future conditions, then plan for the future.

This notebook is organized into five major sections. The first introduces monitoring, the second describes how you can determine your stream type, the third describes the techniques we recommend, the fourth discusses how to interpret the monitoring information, and the last section is the appendix, which has a copy of the forms you can use in the field as well as those that can be used to record your information for long-term use. This program is intended as a starting point. You may want to increase the type of monitoring you are doing and we would encourage this activity. Please contact your local natural resource specialist for more details. A list of potential resource specialists is in Appendix 1.

Monitoring allows managers to identify the resources they have available, and the potential sustainability of these resources in the future. For example, if you monitor the cover of Wyoming big sagebrush, you can predict how many years it will take before 50 to 70% of the forage is gone. Or, if you monitor total cover, you can predict changes in erosion and subsequent water quality. Monitoring also teaches. A person who looks carefully at the land will see new relationships among plants, soil, water, and animals. The more people observe, the better they will be able to predict effects of their actions on rangeland resources.

Before you implement a monitoring program, you should set your goals and objectives. Many planning methods offer ways to develop your goals so we will not address that here. If you need help, contact your local natural resource professional or consultant. Examples of programs include: Western Integrated Range/Farm Management (Cooperative Extension Service), Holistic Resource Management, Integrated Resource Management and Coordinated Resource Management.

Numerous monitoring methods have been developed and are very useful for specific objectives. However, the level of detail needed in many of these other methods is not always warranted. Many management objectives center around changes in forage production, erosion, plant diversity, stream bank stability and water quality and the time associated with those changes. This monitoring program has been designed to provide the methods and interpretation of the information collected to assess these goals or objectives. This workbook has been developed to teach land managers to monitor cover classes on selected vegetation types and areas, then use the information to predict trends in forage production, biodiversity, and erosion. It will also teach land managers to identify basic stream types and riparian areas, then monitor the vegetation cover to predict stream bank stability and water quality.

Types of Monitoring Methods

Vegetation has been monitored using structure, species composition, frequency, density, production, cover and various combinations. Each method provides unique types of information that can be used to describe a plant community and each has different limitations.

Monitoring methods are evaluated based on expense, precision, repeatability over time and among people, usefulness of the type of

information, and the amount of technical expertise required. Expense includes the cost of the materials and the time needed to collect the information. Repeatability is the ability to describe changes in vegetation instead of changes caused by the method. A repeatable method is one that will provide the same results over time even when different people collect the information. For example, two people can take a picture of the same area five years apart and record real changes. But two people can measure the height of plants in a community and might record different rates of change because the height differences among specific plants measured. A method is more useful if it is simple because more people can collect and evaluate the information.

Why Monitor?

Monitoring:

- ***Helps you make decisions.***
- ***Identifies trends so a manager can plan for the future***
- ***Confirms good management practices***
- ***Reveals potential problems early***
- ***Teaches about relationships in nature***

Upland Areas

Structure provides information about the three-dimensional space of vegetation and is often used to describe wildlife habitat. Monitoring structure to measure long-term effects is often difficult if you are interested in other aspects, such as erosion.

Species composition describes the plants in an area, but not the age, density or physical properties. It is one of the most common methods used to measure long term changes in a plant community. However, advanced training is required to obtain and interpret this information. Species composition is the principle behind the idea of range condition classes.

Frequency measures the percentage of species or life forms in an area. It is dependent on the size and shape of the plot used and is one of the easiest plant measurements to collect. However, it is the hardest to interpret, which makes it difficult for most people to use.

Plant density is the number of plants in a unit of area. It has been used to assess when it would be economical to treat specific areas for forage production. It is hard to use when dealing with rhizomatous or sprouting plants because individual plants are hard to identify.

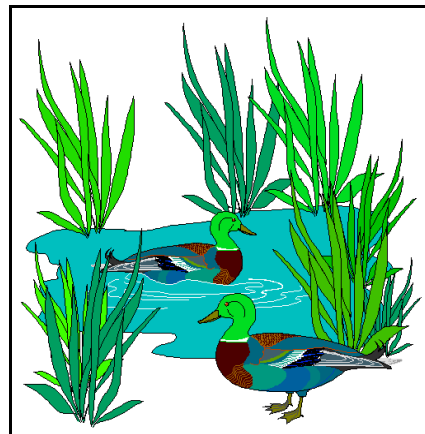
Production (biomass) measures the weight of the plants. Production is a simple concept, but expensive to implement because it is time-consuming. Also, it varies depending on the effective rainfall. Often, people derive utilization of forage species from production estimates, but the effect of different management programs is hard to interpret because of other factors affecting utilization, i.e., annual growth and season of use.

Cover describes the percent of an area that is covered by vegetation, rocks, and litter. The vegetation can be divided by species example or life forms (shrub, forb, grass, etc.) depending on the information desired. Many people are concerned about using cover because it varies depending on rainfall and time of year. However, cover by life form (or functional group) can be used to predict forage production as a percentage of potential, erosion, and plant diversity of a particular site. Cover provides information about the broadest spectrum of management goals. Three techniques to measure cover will be described in this workbook. Other monitoring methods provide more detailed information for specific goals. If you are

interested in these methods, consult your local natural resource specialist (see Appendix 1).

Riparian Areas

Monitoring techniques used on uplands can be modified for use in riparian areas. The most common techniques use a combination of density and species composition on the cross-section and at the green line. They tend to rely heavily on species composition, which is very difficult because of the sedges and willows that dominate these areas. A detailed approach is described in Burton et al. (1992). One of the primary functions of these techniques is to determine the bank stability of the associated stream. The cover of the plants by lifeform—grass, forb, grasslike (sedges and rushes), shrub and tree—can provide an indication of the plant community's ability to maintain the bank and riparian areas. The grasslikes and shrubs are deep-rooted plants which are very resistant to erosional forces of water compared to the shallow-rooted grasses. Photographs, visual estimations, step-points and point-intercepts measure cover with increasing precision. All four methods are relatively inexpensive, simple, and reliable. You can decide which method to use based on the precision of the information you feel comfortable with to make your management decisions. However, photographs provide the most limited amount of information.



TIPS TO EFFECTIVELY USE THIS WORKBOOK

After you have completed the workshop and understand the differences associated with the different techniques used to estimate cover, we suggest you decide how much time you will be able to dedicate to gathering this information. Each of the techniques has its own advantages and disadvantages. You must be comfortable with the information supplied by each since you will be the one deciding how much confidence, environmental impact, and ultimately how much money you will generate from each management decision.

To Monitor Uplands:

- 1) Establish a photo point in a relevant area.
- 2) Select one technique to estimate cover.
- 3) Plot cover on the desired graph to determine your management impacts on:
 - a. potential forage production
 - b. potential erosion
 - c. potential plant diversity.
- 4) Plot information using the appropriate vegetation community type to:
 - a. predict where you could be in the future for each category depending on your management decisions
 - b. to understand what your past management has done for your current situation
 - c. record where you are currently for each category.
- 5) Adjust your management practices to achieve your resource goals.
- 6) Keep these records to help you understand and explain what your management has done for your resources.

To Monitor Riparian Areas:

- 1) Determine the type of streams you have. Most often this can be done with the help of your local Natural Resources

specialist (Cooperative Extension, NRCS, or other). Once this is done, the stream assessment type does not have to be done again unless a catastrophic event changes the stream.

- 2) Establish a photo-point in the key area.
- 3) Determine the cover by lifeform with the technique you selected for the uplands.
- 4) Plot the cover of the deep-rooted plants on Figure 15 for the appropriate stream type.
- 5) Adjust your management practices depending on the information to achieve your resource goals.
- 6) Keep these records to help you understand and explain what your management has done for your resources.

Depending on your specific situation, two techniques have been included which you may want to use. They are forage utilization and macroinvertebrate (water insect) sampling. Forage utilization is often used to estimate short-term objectives, but is an ineffective prediction of future resources. Additionally, it is difficult to use in making decisions concerning soil erosion or diversity. Forage utilization is most often used to help with current year management decisions and understanding animal distribution. We have included the utilization wheel technique to simplify the use of this method.

In stream water, quality is often a concern and can be estimated using macroinvertebrate (water insect) sampling. This technique is simple to execute, collect but the samples must be sent to a lab for professional analysis for interpretation. It is very good at evaluating the past and current management but is of limited use in predicting future conditions.

SECTION 2



STREAM CLASS

A BASIC GUIDE TO DETERMINE STREAM CATEGORIES

If you do not know the category of your stream it can be determined using the steps in this section. On public land, the stream categories have already been determined in many streams. Over long periods of time (decades to centuries), streams and river channels show a pattern of continuing change. The most obvious changes along a stream channel are the erosion of sediment from the stream banks and bed and deposition of that sediment in or near the stream channel.

When we evaluate the stability of a river system, we are, in effect, evaluating the rate of change in the river. Rivers erode and deposit sediment to maintain a long-term balance in the volume of sediment moved through the stream system. Too much change (through erosion or deposition) can be an indication that stream processes are not in balance. Likewise, too little change (little or no erosion and deposition) also can be an indication that processes are not properly adjusted to existing conditions.

This section of the workbook is aimed at providing a simple framework to evaluate the long-term stability of a stream or river channel. To accomplish this evaluation, we will consider the balance between erosive forces provided by the flowing water and resistive forces offered by the stream banks and bed.

Principles of Stream Channels

Stream channels can be described by a number of simple measurements that determine the size of the channel, slope of the channel, and volume of water passing a particular point along the channel. A graphic depiction of these simple measures is shown in Figure 1. As shown in the figure, the width, depth, and velocity of flowing water in the channel can be combined to provide an estimate of the total volume of water moving past any point. This volume, known as the stream discharge, generally is reported in cubic feet per second (cfs) or cubic meters per second (m^3/sec).

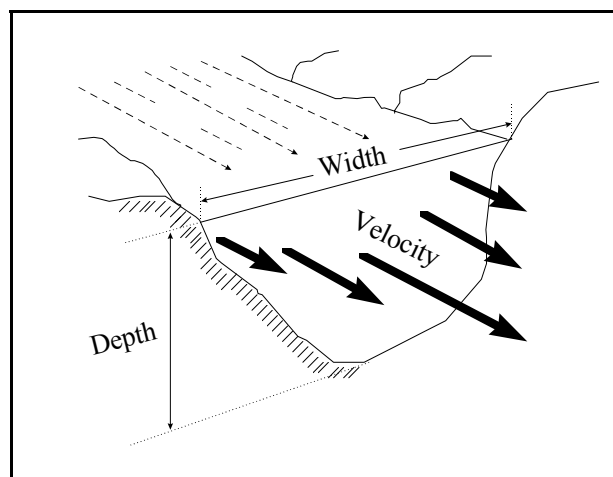


FIG. 1 Diagram of stream depth, width and velocity.

Our monitoring program is designed to evaluate the complex relationships between the forces of flowing water and the resistance offered by the channel banks and stream bottom. We will attempt independently to characterize these two components of the stream system.

The basic measurements required to characterize the forces of flowing water include the channel width, channel depth, average velocity of the flowing water and stream slope. Our evaluation of channel resistance consists of an assessment of the sediment in the stream banks and channel bottom (bed), as well as a characterization of the vegetation along the channel banks.

Channel Measurements

In this workbook, reference to a line across the stream is a cross-section and a line viewed down the stream channel is a profile (Figure 2).

The Stream Environment

Stream channels are most likely to experience erosion at high flows. As a result, **it is important to characterize the forces of flowing water under these conditions.** However, for safety reasons, it is recommended that markers be placed around the channel at high flow and measurements be taken during low flow conditions. Using this strategy, estimates of high flow conditions can be made during the safety of low flow conditions (Photo A, page 11).

Channel Gradient: Our initial measurement of the stream system involves determining the channel gradient (or slope). An accurate assessment of channel slope requires use of professional surveying equipment or an inclinometer.

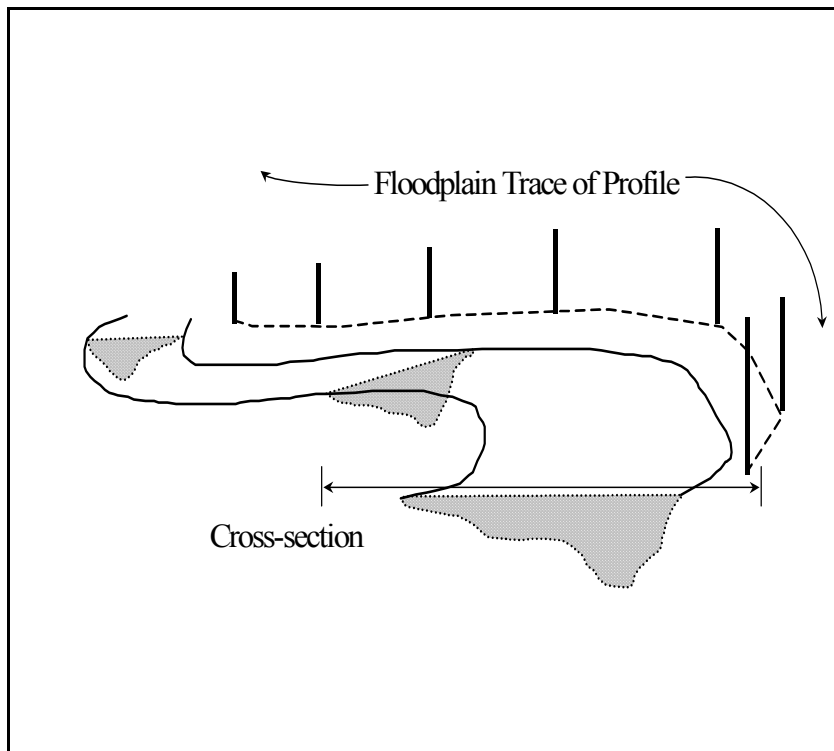


FIG. 2 Diagram of stream cross-section and profiles.

Techniques for determining stream gradient using an inclinometer described here are best conducted with two people.

- 1) The channel gradient should be measured over a distance of roughly 100-200 feet (approximately 30-60 meters). Extend the tape along the channel bank to some distance within this range.
- 2) Stand at the downstream end of the tape and place a sturdy rod approximately 10 ft (3 m) away at the same end of the tape.
- 3) Look through the inclinometer and sight the rod with the slope reading 0 (degrees or percent).
- 4) Record the elevation on the rod for this reading.
- 5) Move the rod to the upstream end of the tape.
- 6) Look through the inclinometer and sight the rod at the same elevation as determined in Step 4.
- 7) Read the slope in percent or degrees and record this value as the channel gradient.

Channel Width: The second measurement of the stream channel is the stream width. Channel width should be measured at a relatively straight section of channel. The measurement should be made orthogonal (at a right angle) to the principal direction of flowing water. Three to five measurements should be made using a standard tape measure (fiberglass tapes are recommended).

- 1) Stretch a tape measure across the stream cross-section at an elevation near the annual high water mark. Be sure to keep the tape taut during this procedure.
- 2) Measure the width of the channel at the top of the banks determined during high flow conditions. *Do not attempt to guess channel width for flows not observed.*
- 3) Record the average of the three to five measurements (in feet or meters) as the stream channel width (Photo B, page 11).

Channel Depth: Channel depth should be measured at the same locations (cross-sections) where channel width was determined. Typically, the depth of water varies across the stream and therefore several measurements are necessary to determine the average depth.

- 1) Stretch a tape measure across the stream cross-section at an elevation near the annual high water mark. Be sure to keep the tape taut during this procedure.
- 2) Using a sturdy rod, record the depth of water at five places across the channel (Photo C, page 11). If water depth is recorded during low flow conditions, be sure to measure the depth of the high water mark (indicated by the tape).
- 3) Repeat this procedure for each of three cross-sections and determine the average depth as the average of the measurements.

Stream Velocity: The final measurement necessary to characterize the channel system is an estimate of stream velocity. This measure should be made at the highest possible flow condition so that estimates of discharge approximate the highest possible stream flows. When and where possible, a mechanical or electrical current meter should be used to estimate stream velocity. However, in the absence of this equipment, a reasonable estimate can be made using simple techniques involving floatable material, a stopwatch or watch, and a tape measure.

- 1) Determine a length of channel 50-100 ft long (15-30 m) that has relatively uniform flow characteristics. The section of channel should be as straight as possible.
- 2) Measure the length of the section.
- 3) Drop a floatable object (small piece of wood, cork, or orange) into the stream approximately 10-15 feet (3-5 m) above the measurement section as near the center of the stream as possible.

- 4) When the object passes the upper end of the section, begin timing. Stop timing when the object reaches the lower end of the section.
- 5) Record the velocity as: $v = (\text{length of section})/(\text{time to travel distance})$. Velocity is given in ft/sec or m/sec.
- 6) Repeat three times and determine the average velocity of the flowing water.

The Stream Bank Environment

Sediment in the channel banks and on the stream bed and vegetation along the stream banks make up the basis of resistance to flowing water. **This workbook focuses on linking properties of vegetation and materials in the channel perimeter to overall stream resistance.**

Stream Channel Material: The first stream bank measurement needed to characterize the

stream system involves an estimate of the dominant size of sediment that makes up the channel perimeter (banks and bottom). We will consider two forms of information; the first is a measure of the bed material and the second is a representation of channel bank material.

- **Bed material** is characterized by the dominant particle size of material on the stream bottom. Traditional methods for reporting and monitoring channel bed material involve measurement and analysis of the intermediate axis of particles found on the stream bottom (Figure 3). Although not as reliable as statistical measures of particle size, use a simple visual assessment of stream bed material to evaluate the dominant class of particle sizes.

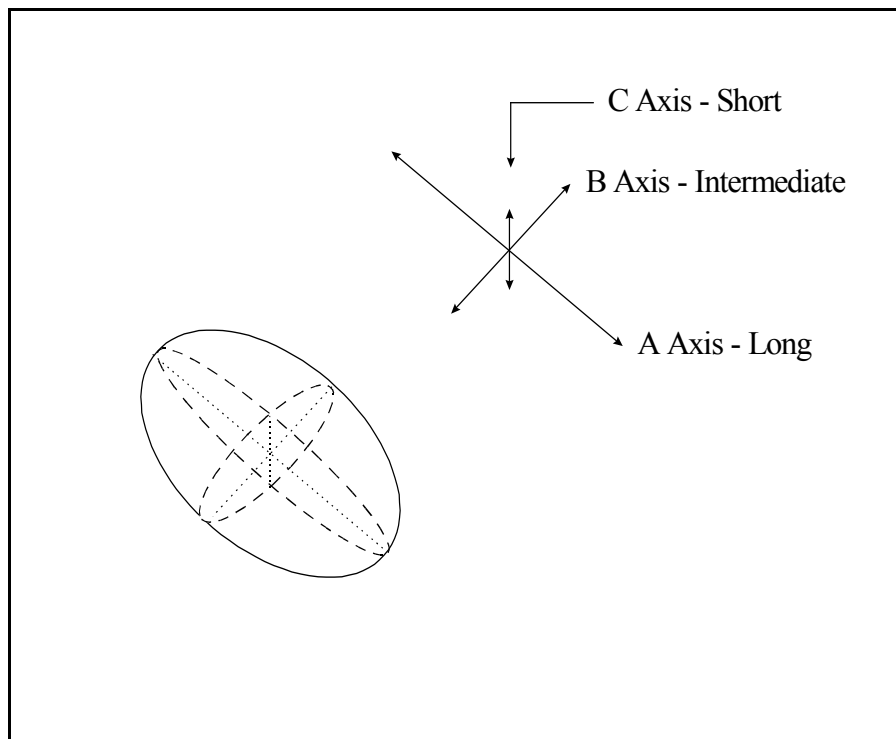


FIG. 3 Diagram of particle showing the intermediate axis.

- 1) Identify an area of the stream bed that is representative of sediment on the stream bottom.
- 2) Select a square section approximately 3 feet (1 meter) on each side. Within this area, determine the particle size class that covers the largest portion of the total area (silt/clay, sand, gravel, cobbles, boulders).

Bank material: Often this is overlooked in the evaluation of stream stability. Our monitoring program requires a simple classification of stream bank material based on the descriptions provided below.

- 1) Assess the nature of bank stratigraphy. Banks that consist entirely of one class of particle sizes (silt/clay, sand, gravel, etc.) are designated uniform bank materials (see Photo D, page 12). Banks that are formed by two or more layers of different classes of particle sizes (e.g., silt/clay over sand/gravel) are referred to as composite banks.
- 2) Record the particle size class of material(s) in the banks (Table 1). Be sure to record more

than one size class for composite banks (see Photo E, page 12).

Stream Bank Hydrology: Our second characterization of the stream bank environment involves an assessment of the hydrologic properties of the stream banks. Again, we will use a simple description of this system to evaluate the role of bank hydrology.

- 1) During low flow conditions, determine the height of exposed banks above the low flow water surface.
- 2) Indicate the existence and type of (where they exist) irrigation practices above (adjacent to) stream banks.

Stream Bank Vegetation: Our final measurement of the stream bank environment involves an assessment of the vegetation. To do this, conduct a survey of vegetation similar to that completed on rangelands. The focus is to determine the extent (cover) of deep-rooted plants along stream banks.

TABLE 1 Particle size classes for stream classification.

| Particle Size | | | | Size Class Name |
|------------------|------------------|------------------|------------------|-----------------|
| Lower Limit (in) | Upper Limit (in) | Lower Limit (mm) | Upper Limit (mm) | |
| ----- | ----- | ----- | <1/256 | Clay |
| ----- | 0.0025 | 1/256 | 1/16 | Silt |
| 0.0025 | 0.08 | 1/16 | 2 | Sand |
| 0.08 | 2.5 | 2 | 64 | Gravel |
| 2.5 | 10 | 64 | 256 | Cobble |
| 10 | 80 | 256 | 4096 | Boulders |

Rapid Assessment of Stream Stability

Upon completion of the evaluation process described in the previous section, it is now possible to use a rapid assessment technique to evaluate the overall condition of the stream system. This rapid evaluation process is not intended to replace monitoring methods described above. Rather, it is to be used as a tool to guide management planning for the stream and near stream environment. As described above, streams are extremely variable over time and through space. The rapid assessment tool described here provides guidelines for determining the overall health of a stream system. The unpredictable nature of floods and flooding lends some difficulty to the overall assessment. However, if management techniques are implemented to improve overall stream health, long-term stability of the stream system will be improved.

Stream Evaluation

Methods described here are based upon stream evaluation techniques previously described

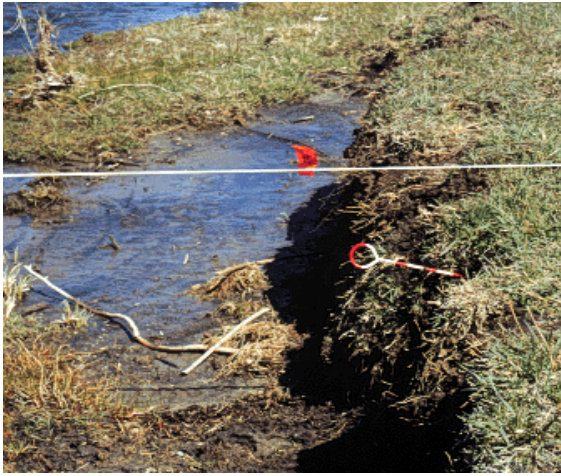
by Burton et al. (1992). (See publication for additional details.) Burton used channel gradient classes and bed material (or substrate) size classes to produce a matrix of possible stream groups (I-VIII)(Figure 4). These stream groups are consistent with aggregated stream types detailed in the classification system described by Rosgen (1992). Data collected in the monitoring procedures described above can be used to complete the rapid stream evaluation process described here.

Evaluation Process:

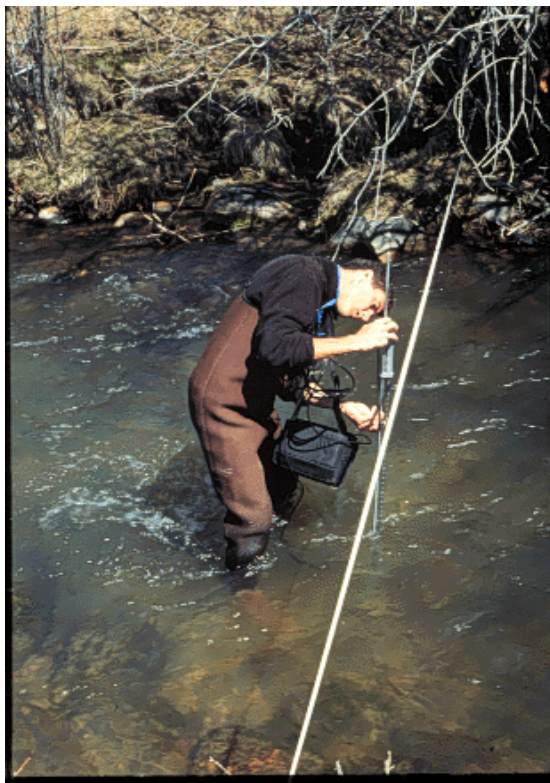
1. Determine the gradient class on Figure 4 using the stream gradient as determined in the previous section.
2. Determine substrate class on Figure 4 using stream bed material sizes estimated using techniques described above.
3. Determine the appropriate stream channel group (I - VIII) from the matrix of possible stream groups.

| | | Gradient Class | | | | |
|-----------------|-------------|----------------|------------|------------|--------------|-------|
| | | 0 - 0.5% | 0.5 - 1.5% | 1.5 - 4.0% | 4.0 - 10.0% | > 10% |
| Substrate Class | Silt & Clay | I | | III | V (VII?) | |
| | Sand | I | | | VII | |
| | Gravel | I | II | IV | VII (VI?) | |
| | Cobbles | | II | IV | VI | |
| | Boulders | | | | VI | VIII |

FIG. 4 Stream classification using substrate class and gradient.



Photograph A Photograph showing surveying pin marking high water mark. Tape measure stretched across the stream is being used to determine channel width. Several width measurements should be made at each reach.



Photograph B Determination of channel width estimated during high flow. Note, water surface indicates low flow conditions.

Photograph C Survey rod being used to determine the elevation of the water surface at high flow. Tape measure indicates high flow elevation. Mean depth for a cross-



section is recorded as the average of several depth measurements.



Photograph D Stream bank consisting of uniform silt and clay. Note that little or no layering is visible in stream bank material.



Photograph E Composite stream banks showing interspersed layers of coarse gravel with fine-grained sediment. Note the presence of more than one coarse layer in the stream bank.

SECTION 3



TECHNIQUES

TECHNIQUES

Getting Started

1. Establish goals.
2. Gather resource inventory and other historical information.
3. Take pictures.
4. Choose a monitoring method.

To get started, think of land management as a highway map. The resource inventory and historical information provide the various roads for you to choose. Your goals tell you where you want to go. Monitoring describes the consequences of management; it tells you where you are and the direction you are going on the map. It can also tell you if your goals can be achieved.

Established goals allow the manager to evaluate the monitoring information. Goals should be described as general management directions (i.e. “to provide sustainable livestock production and good water quality”), then described in concrete objectives (i.e. “the shrub component of big sage communities will not rise above 20% cover, measured by the step-point method”). For more information about setting goals, contact your WIRE (Western Integrated Ranch/Farm Education) program coordinator, your county extension agent, or other program on planning.

Resource inventory will help you establish what you have. This has already been done in many areas by NRCS, BLM, or USFS. An inventory includes such things as the range sites, size of pastures, location of water sources, carrying capacity, number and location of riparian areas and wetlands, watershed boundaries, and stream segments with problems. Historical information will help managers establish trends. Old photographs, records and

memories (write them down now) offer clues to cover, species composition and production. When did droughts occur? Did you run out of hay one spring and have to turn on to pastures early? Did high livestock prices allow you to improve forage in an area? Did a wildfire burn through a juniper community, killing the trees and releasing more water? This information can help you interpret the probable cause for some patterns. Appendix 2 is a table designed to help you record unusual events.

We have divided this monitoring program into two intensities. The first is to establish key areas and photograph them at regular intervals. The second is to photograph and collect additional information on cover by vegetation lifeform in riparian and upland areas. If you want additional information about water quality, you can collect macroinvertebrate samples from your stream. However, to interpret this information you must send these samples to a laboratory.

Key Areas

Key areas are used because they can reduce the cost of monitoring the management unit. Key areas are indicators that represent a larger portion of the management area. Usually, a management unit is divided into vegetation communities, then the key areas are selected in each important vegetation community. If only one community is critical to management goals, one or more key areas should be located in that community. Monitoring two or more key areas in each management area will provide more accurate information.

Key areas should be located away from fences, trails, barriers, and salt or mineral supplement sites so the higher rate of trampling will not skew the monitoring information. Also, avoid isolated corners or other areas that do not represent the average use in a pasture. If you need help, your local natural resource specialist (county extension agents, NRCS, BLM, or USFS) can help locate key areas. If you plan to monitor vegetation on public land, cooperate with agency managers and other interested groups to establish key areas.

Frequency and Timing

How often you need to monitor depends on your management goals. If you estimate cover so you know when to move livestock out of a pasture, you should monitor as the forage is used. If your goal is to protect the watershed, monitor after the growing season. If the long-term trend is important, establish some baseline information, then monitor every 3-5 years.

Consistent timing provides more accurate results. For the best information, measure the vegetation during the same season and growth stage every year. This is most important when using photographs. If it is important to access the differences between wildlife and livestock a very detailed plan must be developed. We suggest you talk to your local natural resource specialist.

Sample Size

The diversity of vegetation in an area influences the number of samples required to represent an accurate estimation. The recommendations in this workbook assume areas will be relatively homogeneous. If you want to monitor an area with diverse vegetation or are concerned about gathering statistically

valid information, see a resource specialist to help you determine the appropriate sample size.

Life Forms

Plant species can be grouped in life forms or functional groups. Grasses, grasslikes, forbs, shrubs, and trees all play different roles in nature. Grasses and forbs protect the soil from rain erosion and provide forage for livestock and wildlife. Deeper-rooted grasslikes, shrubs, and trees are better for protecting soil from stream erosion.

Key areas should be located away from fences, trails, barriers, and salt or mineral supplement sites . . .

- Life forms
 - Trees
 - Shrubs
 - Forbs
 - Grasses—perennial
 - annual
 - Grasslikes (sedges, rushes)
- Rock
- Litter
- Bare ground

Grasses generally have hollow stems that are jointed, leaves with parallel veins and the leaves come off the stem opposite each other (often referred to as 2-ranked) (see Figure 5). Most have inconspicuous flowers. Examples include Western wheatgrass and Indian ricegrass.

Grasslike plants resemble grasses but they have solid, triangular stems with no joints. The leaves have parallel veins but they come off the stem in three directions (referred to as 3-ranked) (see Figure 5). Most have inconspicuous flowers. Examples include elk sedge, and Nebraska sedge. This group would also include the rushes which have round hollow stems with very small or no leaves. Forbs are plants that generally have broad leaves with net venation. In addition the stems are solid or spongy and they die back to the ground every year. The flowers tend to be showy (Figure 5).

Shrubs have woody stems that remain alive year around. The leaves tend to have net venation. Rarely do shrubs grow larger than 13 feet

(Figure 5). Trees are similar to shrubs in that they generally have a single woody perennial stem but they grow larger than 13 feet.

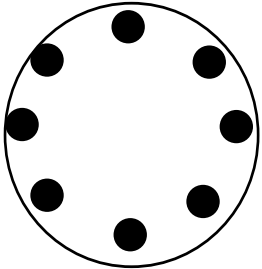
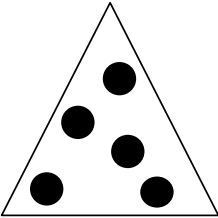
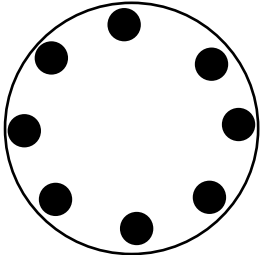
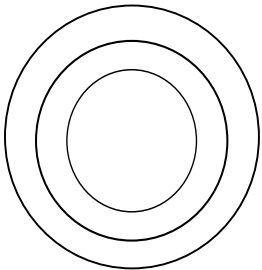







| | Grasses | Grasslike sedges | Forbes | Shrubs |
|---------|--|--|--|---|
| Stems |  <p>Hollow or Pithy</p> |  <p>Solid, not Jointed</p> |  <p>Solid</p> |  <p>Growth rings Solid</p> |
| Leaves |  <p>PARALLEL VEINS</p> | |  <p>VEINS are NETLIKE</p> | |
| |  <p>LEAVES on 2 sides</p> |  <p>LEAVES on 3 sides</p> | | |
| Example |  | |  |  |

FIG. 5 Vegetation characteristics of plants to help determine their lifeforms.

Taking Photographs

- 1) Establish a permanent photo point and a reference point in each key area.
- 2) Photograph each area during the same season.

Photographs describe vegetation cover long after memory has forgotten. They also provide a record so more people can discuss the monitoring results. Permanent photo points in each key area provide consistency over time. They should include a distinguishing, identifiable point in the photo (such as a skyline or rock outcrop), and a reference point in the photo to provide perspective. We suggest a 3-foot pole placed 50 feet away from the reference point, and an identifying label (chalkboard with the date and photopoint at the bottom of the photo). Photographs should represent a major ecological site, not a transition zone. Photos of both a general view and a close-up view should be taken. Dated color photos are recommended.

It is important to photograph key areas during the same season each year. Vegetation structure and color change seasonally, making comparisons among different seasons difficult in many community types. Photographs will better describe real changes in vegetation if you don't have to compensate for seasonal variations of similar vegetation.

Techniques to Monitor Cover

The following monitoring techniques provide cover information. Each manager has to decide which method to use based on how accurate and precise he or she wants the information. **No matter which method is selected, it is important to consistently use the same one.** Information from different monitoring methods cannot be accurately compared.

The following methods will be described:

1. Visual Estimations
2. Step-point
3. Point-intercept

These methods follow the Interagency Technical Reference 96/002+1730. All methods will use the following data form. Cover will be estimated by looking at what is on top (the first foliar intercept). The cover information will be collected in the following categories.

Lifeforms

- Trees
- Shrubs
- Forbs
- Grasses—perennial
— annual
- Grasslikes (sedges, rushes)

Visual Estimations

To visually estimate cover, walk around the area and estimate the cover of each category. It is best to look down on the vegetation (vertical view) instead of at a distance (horizontal view). The estimates can also be improved by looking at several small areas and estimating the cover in each category. Despite all of the techniques used to improve them, visual “eyeballing” estimations for vegetation are the least precise or accurate. People tend to over-estimate tall plants and under-estimate short plants. Also, few people can repeat the estimates of others—or even themselves. However, it is the quickest and simplest method.

Step-point Method

The step-point method is quick and easy, but care must be taken so the results will not be biased. People naturally tend to see what they are looking for. Accurate, unbiased data collection will result in more useful monitoring information.

First, mark a line on the toe of your boot with a notch or paint (fingernail polish works well). Then establish a transect in each key area by choosing a distinctive landmark in the distance. Walk toward this landmark as you collect your hits. At each pace (every two steps), slide a long (3-4 foot), sharpened pin or rod (a piece of brazing rod works well) straight down from your outstretched hand to the line on the toe of your boot so the rod is vertical. Record the first vegetation lifeform, litter, or rock that the pin hits. If you are under a tree, record a “tree” hit. If it hits dirt, record a “bare” hit. Record 100 hits in each vegetation community. Appendix 5 contains a data sheet to record your hits. Make a note of unusual conditions or circumstances and of possible reasons for what you see.

To calculate percent cover using the step-point method:

$$\% \text{ cover of lifeform} = \frac{\# \text{ of lifeform hits}}{\text{Total hits}} \times 100$$

$$\% \text{ total cover} = \frac{\text{Total \# of hits} - \text{bare grnd}}{\text{Total hits}} \times 100$$

In riparian areas the individual lifeform is not as important as the rooting structure of the lifeforms.

This requires several of the lifeforms to be grouped together as follows:

$$\% \text{ cover of shallow-rooted vegetation} = \frac{\# \text{ of grass \& forb hits}}{\text{Total hits}} \times 100$$

$$\% \text{ cover of deep-rooted vegetation} = \frac{\# \text{ of sedge, shrub \& tree hits}}{\text{Total hits}} \times 100$$

Step-point monitoring works in grass, forb, shrub, and tree communities. In tall or dense vegetation, be careful to stay on your transect instead of avoiding difficult areas or shrubs.

Point Intercept on a Transect Method

The point intercept method is the most reliable and time consuming of the three techniques discussed. However, it also samples the smallest area. It is similar to the step-point method, but uses a 100-foot tape placed at a permanent location. Cover is estimated by observing the first foliar intercept at specific set distances (generally 1 foot) along the tape.

To use the point intercept method:

- 1) Establish a permanent transect in each key area.
- 2) Stretch a 100-foot tape above the vegetation along the transect.
- 3) Use a sharpened pin or rod to record hits every foot along the tape.
- 4) Make notes about unusual or remarkable circumstances or conditions.

Permanent transects should be located by placing a stake or post in the ground, then moving a minimum of 10 feet from it to avoid the area of increased trampling (from curious livestock and people). Record the direction you moved so you can set the transect in the same spot in the future. If possible, it is best to stake the beginning and end of the transect with PVC pipe to make the transect easier to find in the future. Stake a 100-foot tape along the transect. Record the first foliar intercept, by cover class, at every foot along the tape by holding the rod vertically to the tape, then extending it down until it hits the vegetation, rock, litter or bare ground. A hit is the first vegetation lifeform, litter or rock that the rod touches. To increase accuracy, the rod can be held by a string as it is lowered. Record any notable conditions or possible reasons for conditions. The information is summarized using the same formulas as the Step-point method.

$$\% \text{ cover of lifeform} = \frac{\# \text{ of lifeform hits}}{\text{Total hits}} \times 100$$

$$\% \text{ total cover} = \frac{\text{Total hits} - \text{bare ground}}{\text{Total hits}} \times 100$$

In riparian areas several of the lifeforms have the same function. Individual lifeform type is not as important as the rooting structure of the lifeforms because the root systems hold the stream banks together. This requires several of the lifeforms to be grouped together as follows:

$$\% \text{ cover of deep-rooted vegetation} = \frac{\# \text{ of grasslike, shrub \& tree hits}}{\text{Total hits}} \times 100$$

Measuring Utilization on Herbaceous Grass Plants

There are numerous methods that can be used to measure forage utilization (ITR 196). These methods generally try to estimate the amount of forage removed. We will only discuss one technique here, which tends to be easier to learn and collect this information. This is the Utilization Gage (Height-Weight Method page 89 ITR 1996). This method consists of measuring the height of grazed and ungrazed plants of the key species to determine the average utilization. The average plant height measurements are converted to the average weight of the plant removed using a utilization gauge and expressed as a percentage. This gauge has been developed from plant height-weight relationships. This technique must be used with key species since each plant species has its own height-weight relationship. You must be able to identify the key species you are managing. This method cannot be used on shrubs or forbs. We would suggest that this type of monitoring **be started and interpreted** with the help of your local natural resource specialist.

Procedure: Measure ungrazed and grazed plants found along a transect to deter utilization between plants, the more plants required to determine the average utilization.

Measuring Plant Height: Best results are obtained by placing the measuring tape or ruler in the center of the bunch or turf circle, rather than along one side. The tape or ruler should not be forced down into the crown but should rest firmly on the cushioned portion of the plant. Where rhizomatous/sod-forming grasses or grasslike plants are the key species, use a circle of turf 2 inches in diameter as one plant.

Sampling Plants: At each interval along the transect, select the plant of the key species (seedlings excepted) nearest the toe and measure the height of the plant to the nearest 1/4 inch. If the plants are not evenly grazed, determine the average stubble height. If the selected plant has not been grazed, record the height for that plant in the ungrazed height column (Appendix 6). If the plant has been grazed, record the height in the grazed height column (Appendix 6).

Measure at least 20 ungrazed plants to obtain a reliable cross section of ungrazed plant heights. If a sufficient number of ungrazed plants is not encountered along the transect, it may be necessary to extend the transect or add more transects to the baseline (measuring both grazed and ungrazed plants). In some cases it may be necessary to select, in a subjective manner, ungrazed plants on an adjacent area to determine average ungrazed plant height. Remember, if you have more than one key species, its use must be determined separately. If more than 80% of the plants measured produce culms or when more than 80% produce no culms the remaining 20% may be disregarded without great error. However, when a combination occurs with 80% or more culm-producing plants, and a plant lacking culms is encountered nearest the sampling point, measure the nearest culm-producing plant of the species. A similar approach should be used when the dominant plants are with culms and a culm-producing plant is encountered.

To Calculate the Level of Utilization of the Key Species

First, divide the total of the ungrazed plant heights by the number of ungrazed plants sampled to determine the average ungrazed plants (see formula below).

$$\text{Average height of all ungrazed plants} = \frac{\text{sum of the heights of all ungrazed plants}}{\text{total number of ungrazed plants}}$$

Next, determine the average of all ungrazed and grazed plants found on the transect (see formula below).

$$\text{Average height of all plants sampled} = \frac{\text{sum of the heights of all plants measured on the transect}}{\text{total number of all plants measured}}$$

Pull the sliding card in the gauge out of the envelope until the utilization scale for the key species appears in the window. Then adjust the dial to the number representing the previously calculated average ungrazed height at the arrow designated "Average Ungrazed Height" (Appendix 7). The percent utilization may then be read on the scale in the window opposite the number on the dial representing the average height of the grazed plants. Use the culmless curve for the key species when seasonal utilization studies are conducted on early growth of the plants. If you do not have the scales for the particular key species you are using, they can be developed using the method in ITR 1996 pages 92-95. To order the utilization guide, contact your local Forest Service or natural resource specialist.

Monitoring Macroinvertebrate "Macros"

Macroinvertebrates are the "bugs" you can see in the water. They include everything from caddis flies to crayfish. In some cases you may want to monitor the macroinvertebrate to

improve the understanding of your management and its impact on water quality and aquatic habitat or because of requirements of state or federal agencies that are concerned about effects of your management on downstream water quality.

In many areas the water quality can be assessed by monitoring macroinvertebrates. While we know of thousands of species of macroinvertebrates, scientists can divide them into four major feeding groups which have relatively narrow habitat ranges.

Shredders feed on large plant tissue. They usually live in shady areas near the headwaters of a stream. **Scrapers** feed on algae and microscopic animals attached to rocks and logs. They prefer stream sites with some sediment loads so the algae will grow, but they cannot withstand high sediment loads. **Collectors** eat mostly algae and microscopic animals. They can withstand high sediment loads in streams. **Predators** eat other macroinvertebrates. They live wherever other macroinvertebrates live. In general, shredders and scrapers indicate higher water quality.

To monitor macroinvertebrates, choose a stream site to manage. Habitat conditions vary considerably over the whole stream, so monitoring is site specific. The timing of sampling depends on your management objective. Whatever your objective, it is important to monitor at the same time each year. Macroinvertebrates go through several stages in their life cycles that will affect sampling in a stream. For example, caddis flies hatch in late spring, so they would not be found in a stream sample after early spring.

If your management objective is to determine how your livestock affects water quality and aquatic habitat within one season, monitor before and after your grazing period. If your objective is to determine how your management affects water quality over the long term, monitor in the spring for 3-5 years to set a baseline, then monitor every 2-3 years. This method is not complicated, but we recommend

that you attend a training demonstration before attempting this by yourself. A good reference video is available from the BLM training center, “A Management Tool: Aquatic Macroinvertebrate Sampling” from the Phoenix Training Center. If you need additional help to initiate this type of monitoring, please consult your local natural resource specialist (Appendix 1).

To collect a sample:

- 1) Choose a spot in the stream, then walk up to it from downstream.
- 2) Quickly place a surber net and frame on the bottom of the stream. Place your foot on the frame if the net feels like it will float away.
- 3) Wash each rock within the frame to remove attached macroinvertebrate. Allow them to float into the net. Throw each rock outside the frame after washing it.
- 4) Stir the top 2-3 inches of sediment at the bottom of the stream to dislodge any macroinvertebrates in the sediment.
- 5) Wash the net in the stream until all the articles attached to it fall into the filter at the bottom of the net.
- 6) Pour the contents of the filter into a plastic jar, then fill the jar with ethyl alcohol or water.
- 7) Send the jar to:

BLM/USFS
Aquatic Ecosystem Laboratory
Utah State University
Logan UT 84322

This lab charges \$50 per sample. Other labs are available throughout the state.

- 8) When you collect a sample include:
 - water velocity
 - water depth
 - substrate composition
 - name of the stream, county, state
 - elevation where sample is taken.

It is important to include this extra information because standards have been developed based on these criteria. Steep, high-elevation streams with rocky substrates have more potential for different types of macros than flat, meandering streams. The lab will analyze your sample and send you the results and interpretations including an indication of the water quality of the stream. Charting these results over time will help you determine how your management is impacting water quality. If you are interested in understanding which macroinvertebrate are associated with different levels of water quality, see Appendix 8.

SECTION 4



INTERPRETATION

INTERPRETATION

Monitoring information is not useful unless it can be interpreted. This section provides the information to interpret cover data that was collected on upland and riparian areas. We have included interpretations that will allow the relative amount of forage in the most common vegetation communities to be estimated, relative variety of plant species found in a community and estimated amount of soil erosion as these parameters relate to cover by lifeform. These estimates were developed from various publications, NRCS site guides, expert opinions and various other sources. All of these interpretations are approximations and as more information is developed they will be refined and changed. If there is a different plant community that you deal with and would like the interpretations developed for that community, please contact us at the addressed listed on the back cover.

The utilization and macroinvertebrate monitoring should be established and interpreted with the help of your local natural resource specialist.

Evaluating Cover Information

Collecting information is only the beginning of the management process. Cover information alone will not manage land. To make wise decisions, a manager has to combine information from monitoring with other knowledge to determine why the land looks the way it looks, then predict how it will look and what management will be required in the future. Weather, precipitation, insects, wild herbivores, fire, flood, disease, natural cycles and actions by people influence natural resources.

Cover should be evaluated by vegetation community. How does your range compare to historical cover information? Is the composition of lifeforms changing? How fast? How does this change relate to your management goals? How much time do you have before negative impacts will be severe? What are your options for influencing this change?

The following graphs provide information about how cover by lifeform relates to other aspects of land management. With this information, cover can be used to help you make decisions based on your goals and objectives.

Uplands

Three vegetation communities dominate Utah. Shadscale (34%), pinyon/juniper (29%), Wyoming big sagebrush (21%) are most common. In the pinyon/juniper sagebrush communities, herbaceous forage production is directly related to the shrub or tree cover. As percent cover of shrubs and trees increases, forage production decreases. Rates of increase in percent cover of shrubs and juniper can be predicted for each of the dominant upland community types in Utah. By knowing the canopy cover of the shrubs, a time horizon can also be developed to help determine how long you can count on a certain level of forage production. Then you can determine when it will be profitable to make improvements. In several communities, this information can be used as an index to the diversity of plant species.

Wyoming Big Sagebrush

Figure 6 represents the potential forage production you would have at any given level of shrub cover in a Wyoming big sagebrush community type. As you look at the graph notice that herbaceous forage production does not decline until shrub cover is about 5-7%. Once the cover goes above 7% the competition between the sagebrush and other shrubs with the herbaceous plants increases. The shrubs out-compete the herbaceous plants for the available moisture and nutrients. If management does not change after the shrub canopy goes above 7% the shrubs will continue to increase. It will take 5 to 10 years, depending on weather conditions, before the sagebrush canopy doubles to 13-15%. At this time the herbaceous forage production has decreased to about 40% of the potential. If nothing else is done, the shrub canopy will

about double (25%) in another 5 to 10 years. Now the potential forage production is only about 10% of the potential. With the graph you can use a one-time assessment to determine your potential herbaceous forage production. If you record this information over time you will be able to assess the direction and potential production over time. To determine the absolute (lbs/ac) forage production, consult your local range site guides with your local Natural Resource Specialist. Figure 9 is an example of mountain big sagebrush. It is similar to Wyoming big sage, but notice the change in both the rate of reduction and the amount of reduction of herbaceous forage production. This is related to the amount of rainfall associated with these different sites.

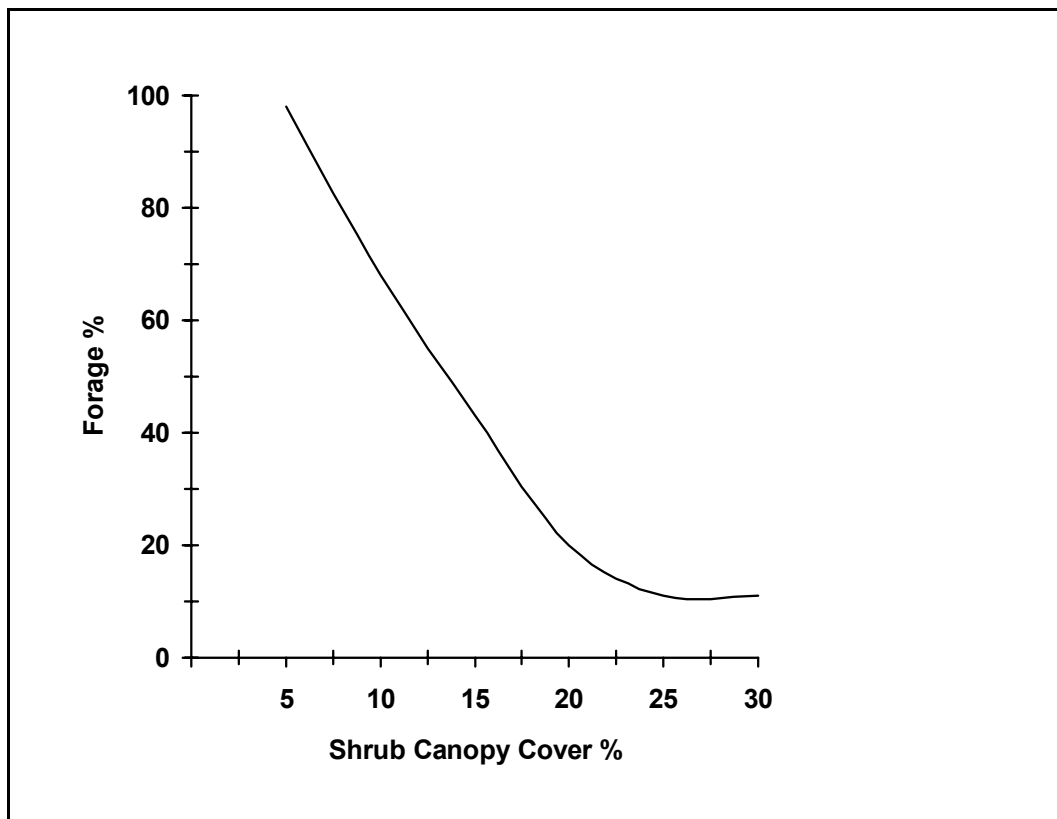


FIG. 6 Potential herbaceous forage production in relation to shrub canopy cover in Wyoming big sagebrush communities.

Wyoming Big Sagebrush/Plant Diversity

Figure 7 represents the potential plant diversity found in Wyoming big sagebrush communities. The maximum diversity is generally found when the canopy cover of the sagebrush is about 13 to 15 percent. In most cases the diversity and density of the herbaceous plant community is so low after the shrub canopy is greater than 20% that any disturbance which removes the sagebrush must be

followed by reseeding. In addition, if the annual grass cover is greater than 10% or is greater than the perennial grass cover, any disturbance that removes the sagebrush, such as fire, leaves the community susceptible to annuals. You can end up with a stand of cheatgrass. Management should be changed to reduce the influence of the annuals.

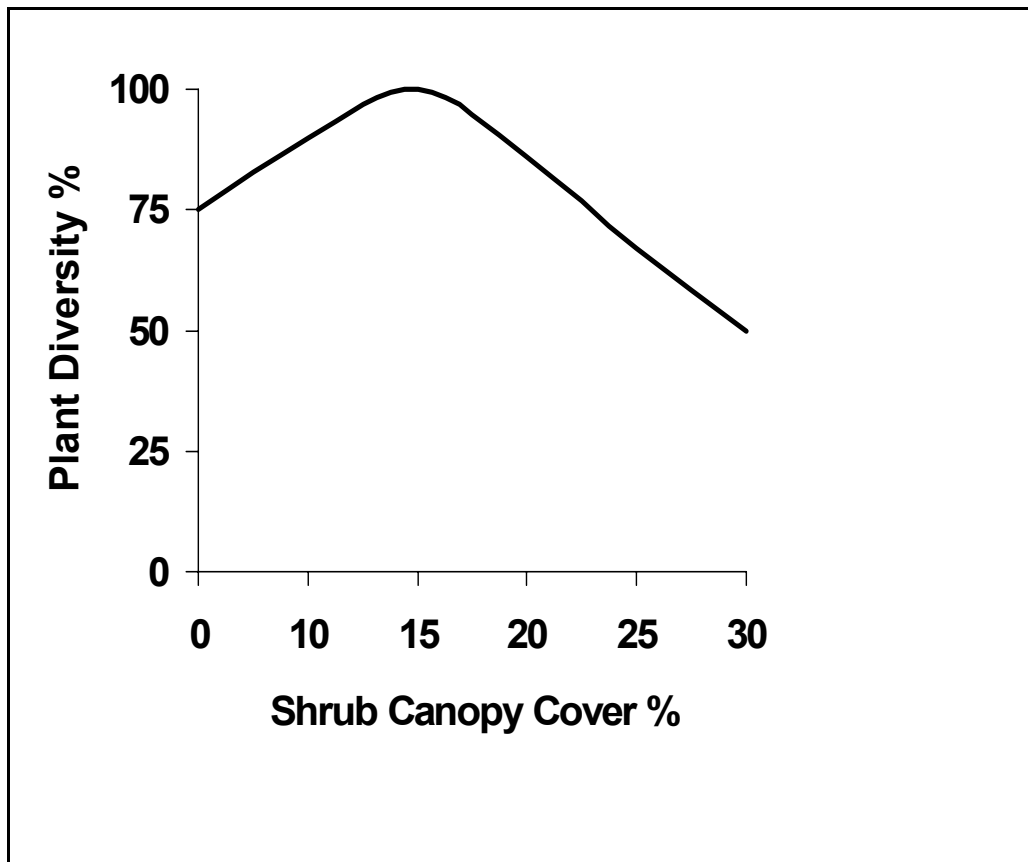


FIG. 7 Potential plant diversity (%) of a Wyoming big sagebrush community type.

Wyoming Big Sagebrush Erosion

The actual amount of erosion will depend on the slope, soil type, and amount and distribution of total cover. You must include all types of cover for this evaluation. In most cases, you will not be able to increase the cover beyond a site's potential even though these covers will go to 100 percent. What is recommended is that you try to stay within 80% of your potential cover. For example, many of the Wyoming big sagebrush sites in Utah have a potential cover of about 60-70%, so you should

manage the site to keep cover above 48% to minimize erosion potential (Figure 8). This ensures your soil is protected as much as possible and the site impacts of sediment loading into riparian areas and streams are minimized. To assess potential total cover on your range site, consult your local range site guides with the NRCS. Many of the Wyoming big sagebrush sites in Utah have a potential total cover of about 60-70%. Monitoring total cover you would want to stay above 48%.

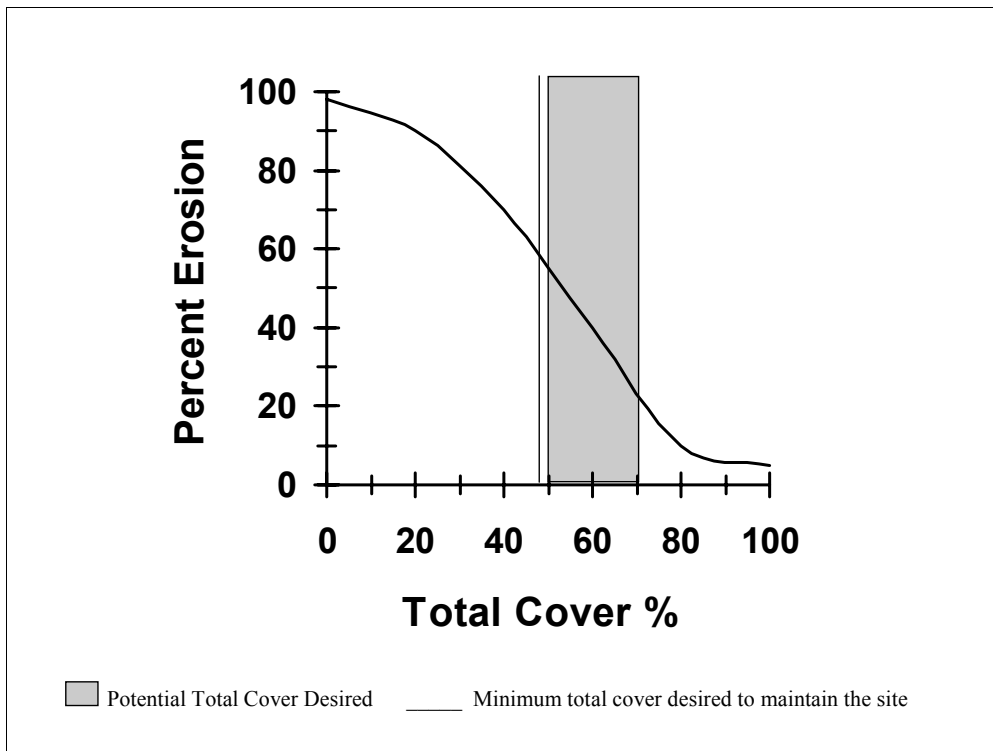


FIG. 8 Potential erosion (%) in relation to shrub cover on Wyoming big sagebrush sites.

Mountain Big Sagebrush Potential Forage Production, Erosion and Biodiversity

The reduction in herbaceous forage production is not as great as in other communities and the actual number of plant species is greater (Figures 9, 10). The amount of

moisture available to the plants is greater, which allows for the greater production in these areas. Total cover is also greater in these sites with the potential ranging from 80-95% (Figure 11).

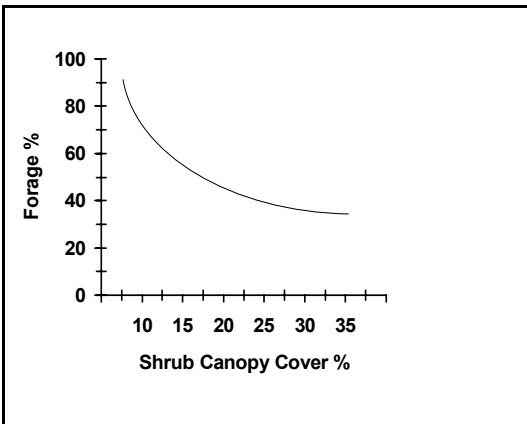


FIG. 9 Mountain big sagebrush generalized potential forage production.

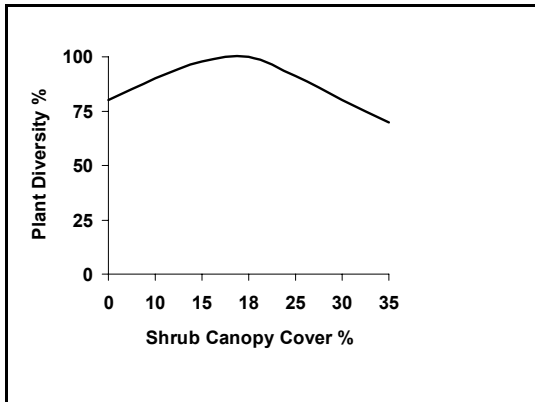


FIG. 10 Mountain big sagebrush generalized potential plant diversity.

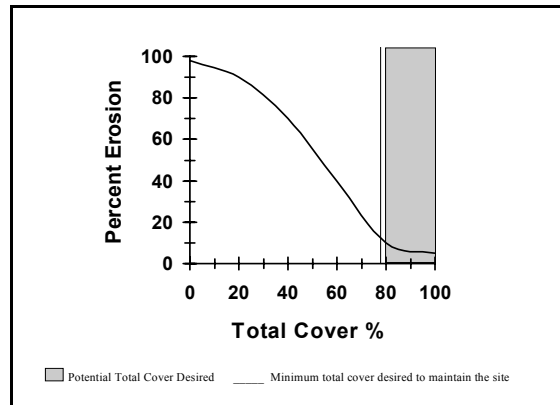


FIG. 11 Potential erosion (%) in relation to shrub cover on Mountain big sagebrush sites.

Pinyon/Juniper Potential Forage Production, Erosion and Biodiversity

Herbaceous forage production drops very quickly on pinyon/juniper PJ sites (Figure 12). Total plant diversity is found to decrease dramatically as P/J cover dominates the site (Figure 13). Erosion on mature P/J sites generally found to be low because they are armored with rock pavement. This may be caused by the topsoil being removed as the P/J dominates the site. Generally, if the total cover drops below 80% on these sites there is a cause

for concern (Figure 14). While P/J has greater drastic effects on forage production, diversity, and potential erosion, it generally does not increase as rapidly. To go from 5 to 15 percent generally takes 10 to 30 years. However, the potential for irreversible changes to the land are much greater. To minimize erosion on these areas, total cover should be maintained above 75%.

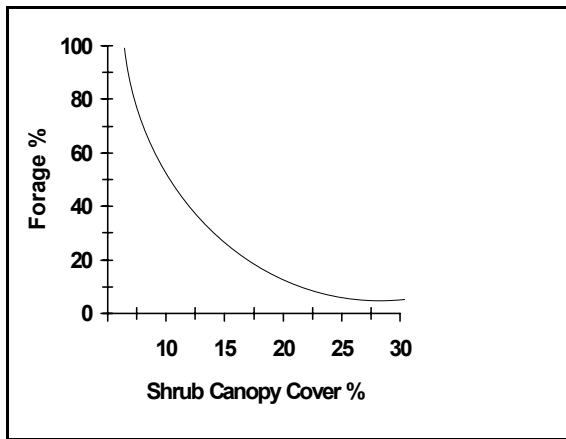


FIG. 12 Potential herbaceous forage production in relationship to pinyon/juniper canopy cover.

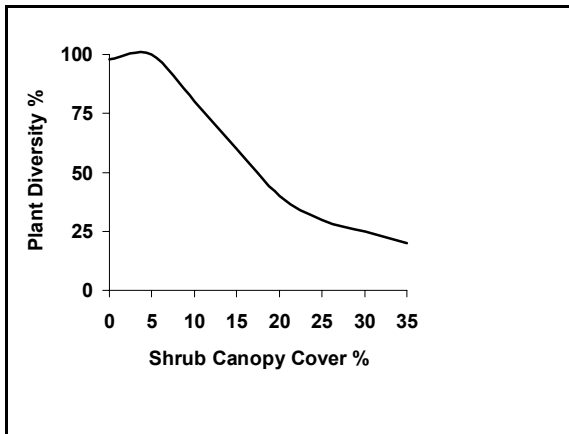


FIG. 13 Potential plant diversity (%) of Mountain big sagebrush community type.

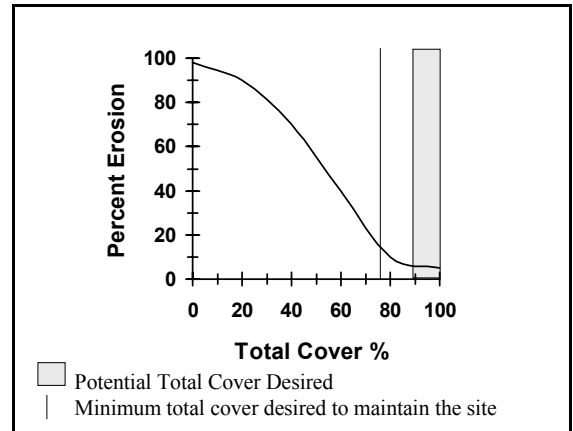
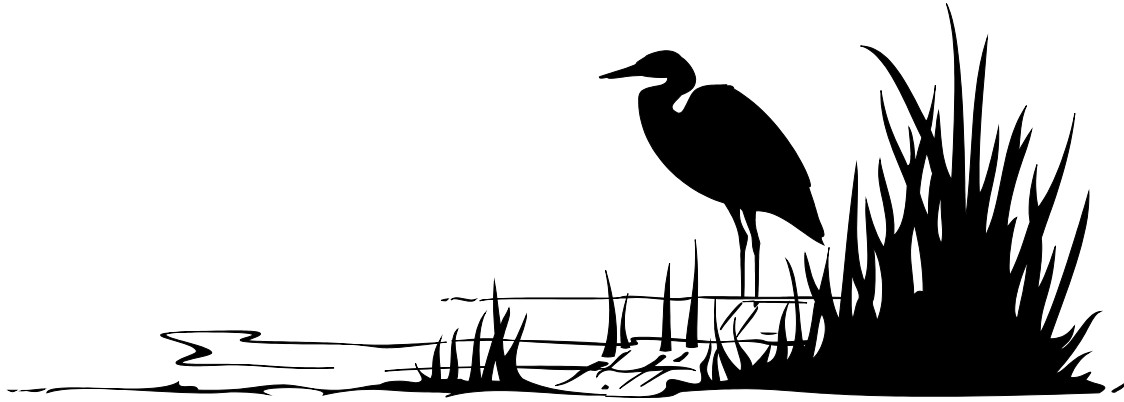


FIG. 14 Potential total cover desired in relation to shrub cover on pinyon/juniper forage production sites.



Riparian Areas and Streams

Along streams, shallow-rooted grasses are inversely related to the stability of the streambank and nearby damp areas. Deep-rooted plants, such as sedges, shrubs and trees hold the soil together and resist the erosional forces of the water (see stream type section). To determine which mix of shallow- and deep-rooted species are appropriate, the type of stream must be identified.

If you do not know your stream type you can determine this by going to the stream type section. On public land, most streams have already been classified. On private land, you may have to get help from your local natural resource specialist. In general, as the percentage of grass increases, the susceptibility of the stream bank to erosion increases. By monitoring cover by lifeform in riparian areas, you can predict when critical grass cover percentages will be reached in the same way you can predict critical percentages of shrub cover in upland communities.

Vegetation Evaluation

Under natural conditions, the amount of deep-rooted bank vegetation along stream types varies over time and space. However, it is

common under completely natural circumstances (no human disturbances) to have gaps in the cover provided along stream banks by deep-rooted vegetation. The assessment of stream bank vegetation focuses on the relative importance of stream bank vegetation to various stream groups (defined above). Figure 15 presents a matrix of stream groups, degrees of impacts on stream bank vegetation, amounts of deep-rooted vegetation needed in each stream type to maintain bank stability, and recommended levels of management for differing degrees of impacts. If you drop below the lower amount, then your management must be intensified to try and bring back up the percentages of deep-rooted plants back up because the stream banks are at risk of breaking apart, thus, increasing the amount of sediment going into the stream.

- 1) Identify the stream group as defined in Figure 5.
- 2) Determine the current (existing) amount of bank vegetation using monitoring techniques described above.
- 3) Identify the recommended degree of management required to restore function to the riparian vegetation community and improve stream health.

Stream Evaluation Guide

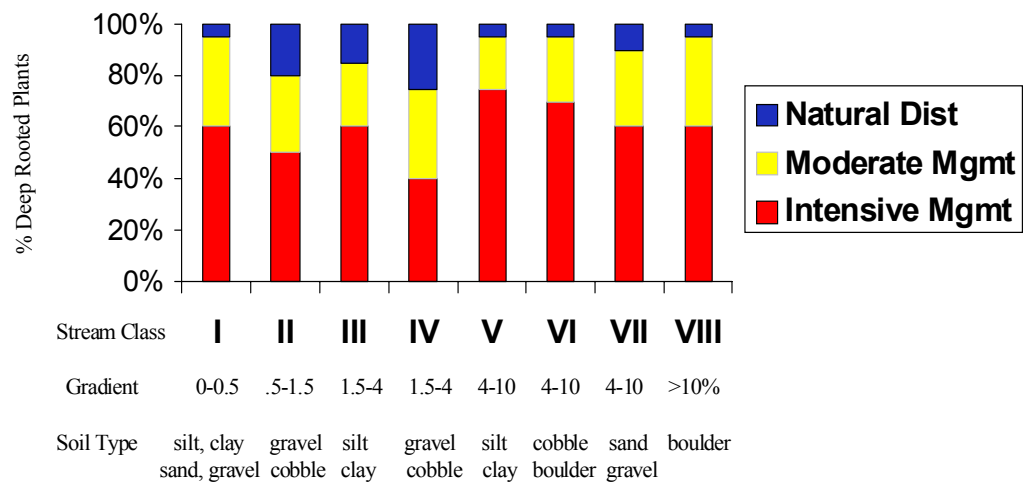


FIG. 15 Stream evaluation guide utilizing the percent of deep rooted plants along the green line to maintain stream bank integrity associated with the stream class.

SECTION 5



APPENDIX

APPENDIX

APPENDIX 1 LOCAL NATURAL RESOURCE EXPERTS

County Extension Agents, State Cooperative Extension Service
Natural Resource Conservation Service (NRCS)
USDI Bureau of Land Management (BLM)
USDA United States Forest Service (USFS)
Local State Wildlife Management Department (in Utah UDWR)

APPENDIX 3 FORM TO RECORD COVER DATA IN THE FIELD

Pasture:

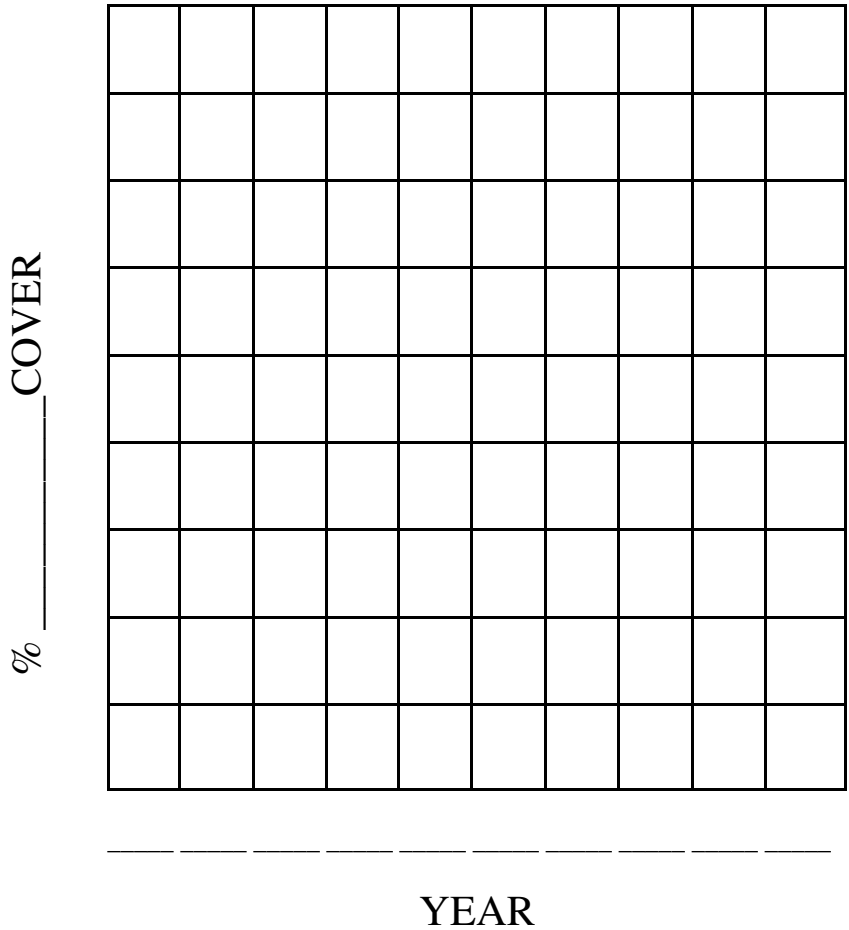
Community:

| Lifeform: | Hits | Total |
|------------------------------|-------|-------|
| Perennial Grass | | |
| Annual Grass | | |
| Forbs | | |
| Grasslikes (sedges & rushes) | | |
| Shrubs | | |
| Trees | | |
| Rocks | | |
| Litter | | |
| Bare Ground | | |
| | Total | |

Notes:

APPENDIX 4 RECORD COVER INFORMATION OVER TIME. PUT THE YEAR THE INFORMATION WAS RECORDED ON THE BOTTOM (X AXIS) AND THE PERCENT COVER ON SIDE (Y AXIS).

Pasture or Unit Name _____ Type of Cover _____



NOTES: _____

APPENDIX 5 FORM TO RECORD STREAM PARAMETERS

TO ALLOW A STREAM TO BE CLASSIFIED

STREAM STABILITY MONITORING GUIDE

Stream Name: _____

Approximate Location: _____

CHANNEL MEASUREMENTS

STREAM SLOPE

Elevation on rod at downstream position _____

Stream slope (using survey equipment or inclinometer): _____ (% or degrees)

CHANNEL WIDTH

X1: _____ X2: _____ X3: _____ X4: _____ X5: _____

Average channel width: _____ (ft or m)

CHANNEL DEPTH

| | | | | | |
|----|-----------|-----------|-----------|-----------|-----------|
| X1 | d1: _____ | d2: _____ | d3: _____ | d4: _____ | d5: _____ |
| X2 | d1: _____ | d2: _____ | d3: _____ | d4: _____ | d5: _____ |
| X3 | d1: _____ | d2: _____ | d3: _____ | d4: _____ | d5: _____ |

Average channel depth: _____ (ft or m)

STREAM VELOCITY

Distance (L) _____ (ft or m)

Time of Travel t1: _____ t2: _____ t3: _____ (sec)

Estimated velocity:

$v1 = t1/L:$ _____ $v2 = t2/L:$ _____ $v3 = t3/L:$ _____

Average stream velocity: _____ (ft/sec or m/sec)

TOTAL STREAM DISCHARGE = _____ x _____ x _____ = _____ (cfs or m³/sec)

(Avg. width x Avg. depth x Avg. velocity)

STREAM STABILITY MONITORING GUIDE

Stream Name: _____

Approximate Location: _____

STREAM BANK MEASUREMENTS

Indicate the dominant channel bed material:

Silt/Clay _____ Sand/Gravel _____ Gravel/Cobble _____ Boulder _____ Bedrock _____

Indicate the dominant channel bank type:

Silt/Clay _____ Sand/Gravel _____ Gravel/Cobble _____

Boulder _____ Composite _____ (if composite, note upper [U] and lower [L] layers)

Indicate the height of exposed channel banks at low flow:

0 - 1 ft _____ 1 - 3 ft _____ 3 - 6 ft _____ > 6 ft _____

OR

0 - 0.3 m _____ 0.3 - 1 m _____ 1 - 2 m _____ > 2 m _____

Indicate the existence and type of irrigation practices above or adjacent to stream banks:

No Irrigation _____ Flood Irrigation _____ Sprinkler Irrigation _____ Other _____

Indicate the percentage of deep-rooted plant species adjacent to the stream channel:

0 - 25% _____ 25 - 50% _____ 50 - 75% _____ 75 - 100% _____

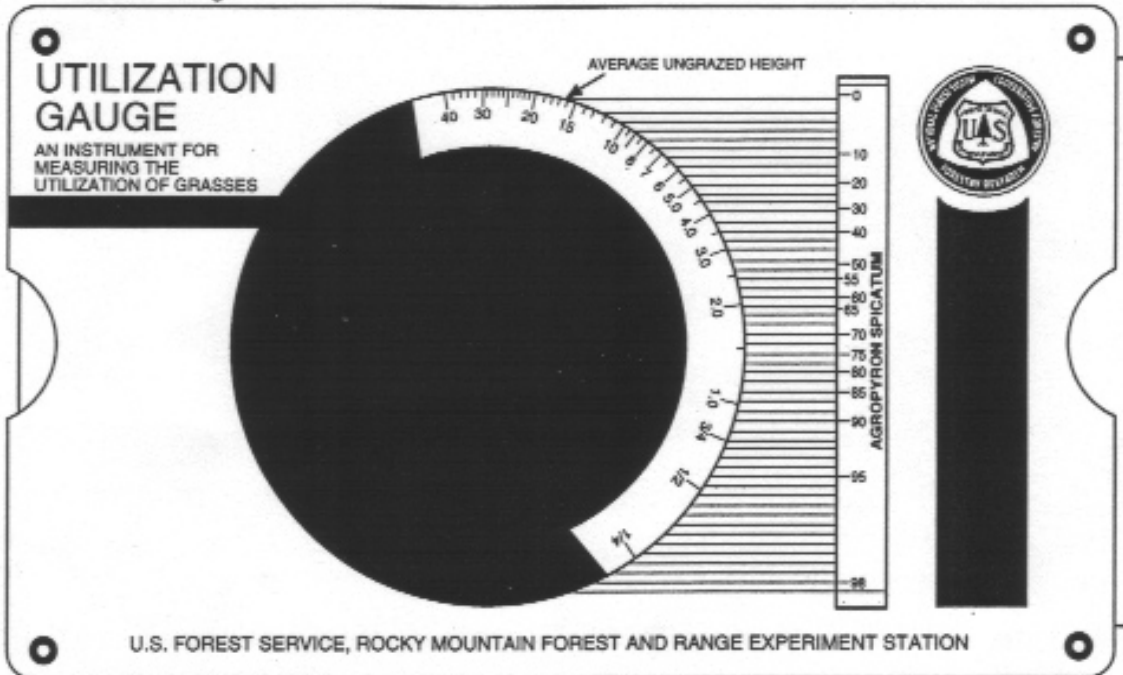
APPENDIX 6 DATA SHEET TO ESTABLISH UTILIZATION OF HERBACEOUS PLANTS

| Height-Weight | | | | | | | | | | | | | | | |
|---------------------------------|--------|-------|---------------|--------------------------------|--------|-------|---------------|---------------------------|--------|----------|---------------|--------------------------------------|--------|-------|---------------|
| Study Number | | | | | | Date | | | | Examiner | | | | | |
| Allotment Name & Number | | | | | | | | Pasture | | | | | | | |
| Kind and/or Class of Animal | | | | | | | | Period of Use | | | | | | | |
| Key Species | | | | | | | | | | Culm | | Culmless | | | |
| No | Height | | % Utilization | No | Height | | % Utilization | No | Height | | % Utilization | No | Height | | % Utilization |
| | Ungra | Graze | | | Ungra | Graze | | | Ungra | Graze | | | Ungra | Graze | |
| 1 | | | | 16 | | | | 31 | | | | 46 | | | |
| 2 | | | | 17 | | | | 32 | | | | 47 | | | |
| 3 | | | | 18 | | | | 33 | | | | 48 | | | |
| 4 | | | | 19 | | | | 34 | | | | 49 | | | |
| 5 | | | | 20 | | | | 35 | | | | 50 | | | |
| 6 | | | | 21 | | | | 36 | | | | 51 | | | |
| 7 | | | | 22 | | | | 37 | | | | 52 | | | |
| 8 | | | | 23 | | | | 38 | | | | 53 | | | |
| 9 | | | | 24 | | | | 39 | | | | 54 | | | |
| 10 | | | | 25 | | | | 40 | | | | 55 | | | |
| 11 | | | | 26 | | | | 41 | | | | 56 | | | |
| 12 | | | | 27 | | | | 42 | | | | 57 | | | |
| 13 | | | | 28 | | | | 43 | | | | 58 | | | |
| 14 | | | | 29 | | | | 44 | | | | 59 | | | |
| 15 | | | | 30 | | | | 45 | | | | 60 | | | |
| Number of Ungraz. Plants | | | | Total Height of Ungraz. Plants | | | | Number of Sampled Plants | | | | Total % Util. for All Sampled Plants | | | |
| Total Height of Ungrazed Plants | | | = | Average Ungrazed Plant Height | | | | Total Percent Utilization | | | = | Average Utilization | | | |

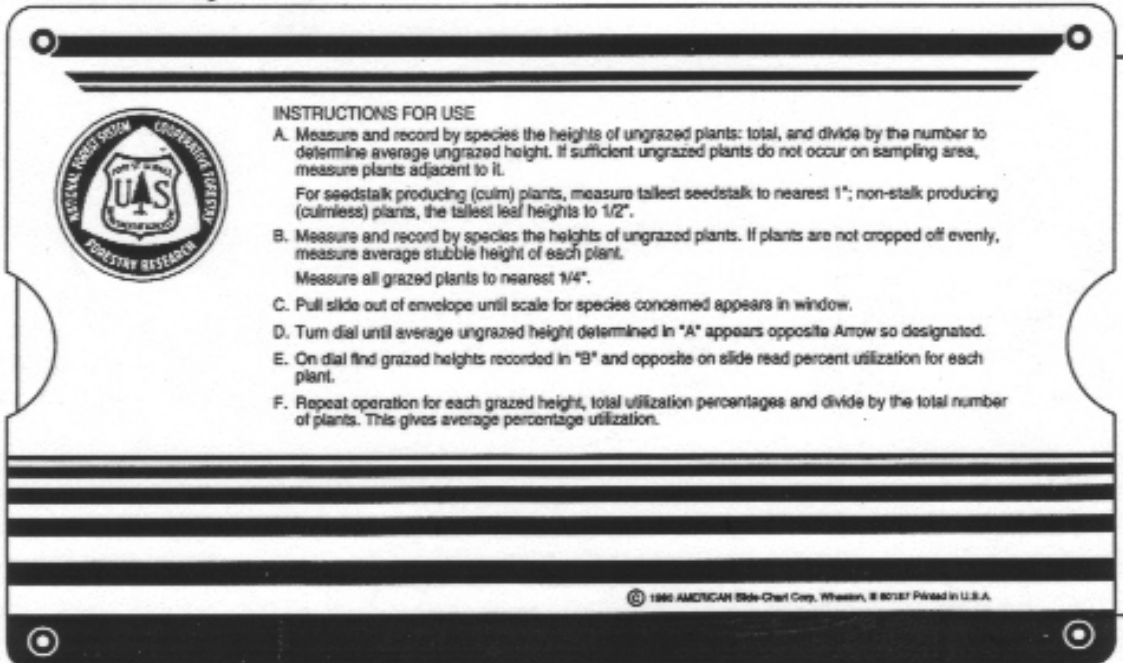
APPENDIX 7 ILLUSTRATION OF THE UTILIZATION GAUGE USED IN THIS NOTEBOOK

Utilization Gauge

Front Side of Gauge



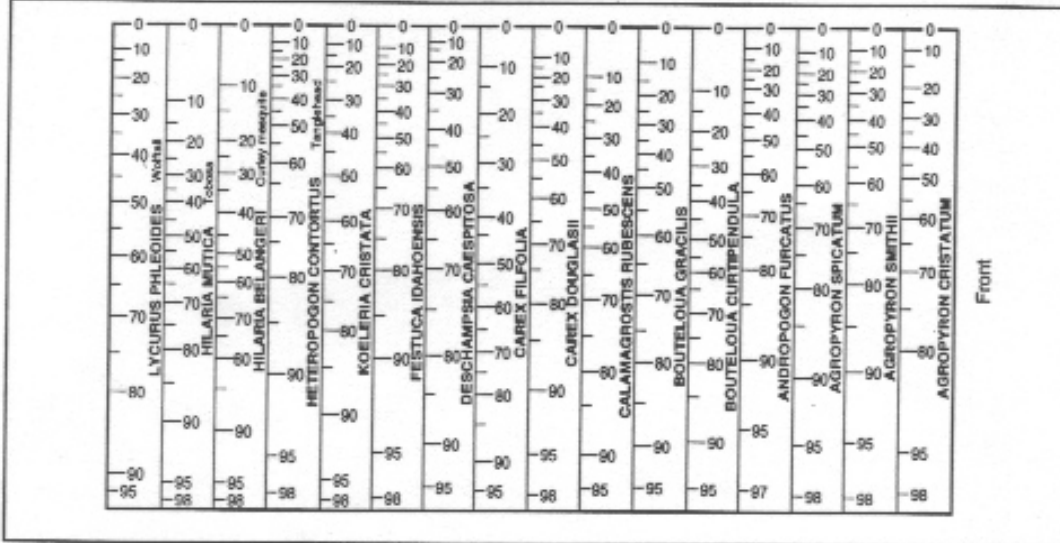
Back Side of Gauge



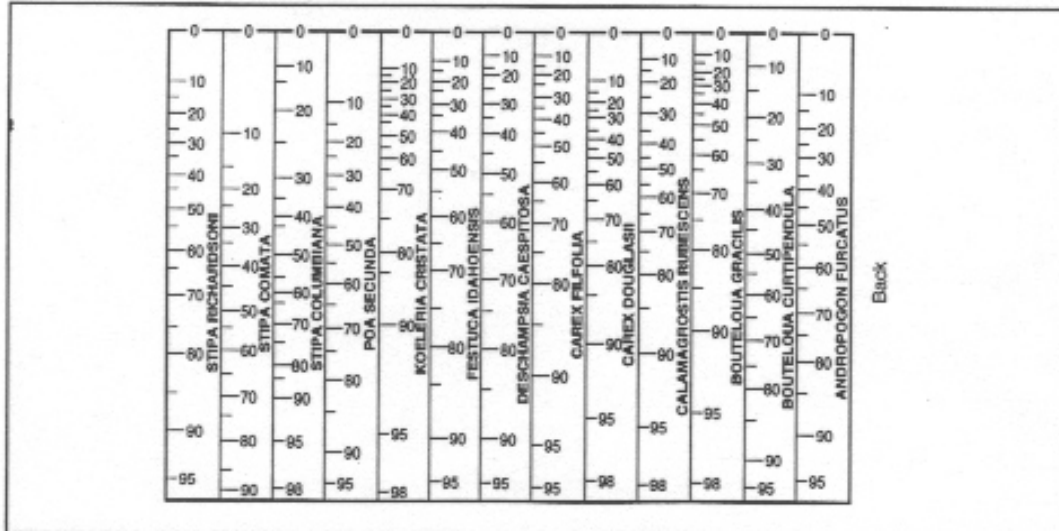
Utilization Gauge (continued)

These utilization scales must be checked to see whether or not they fit the species on the rangeland where they will be used.

Front side of card



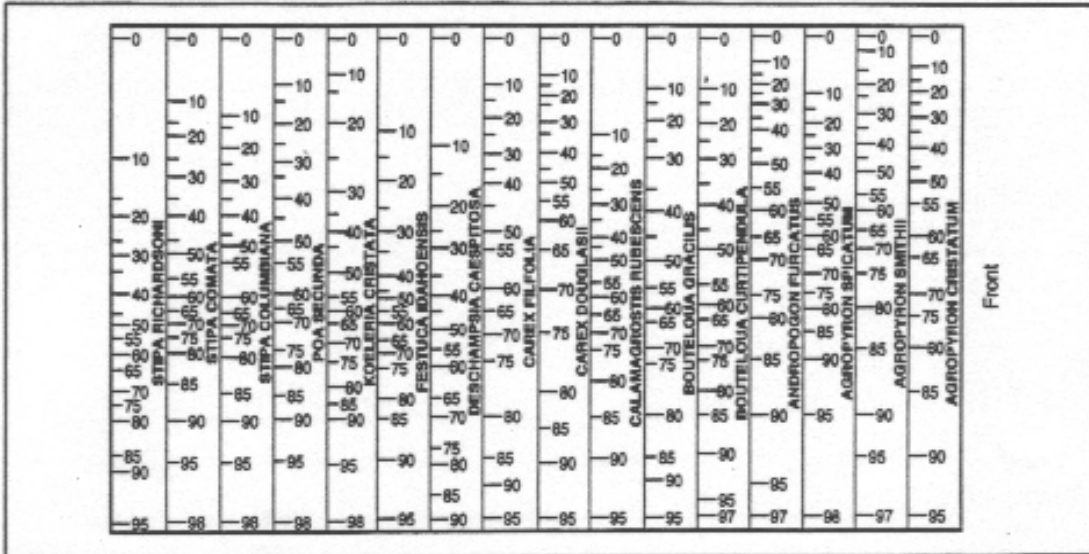
Back side of card



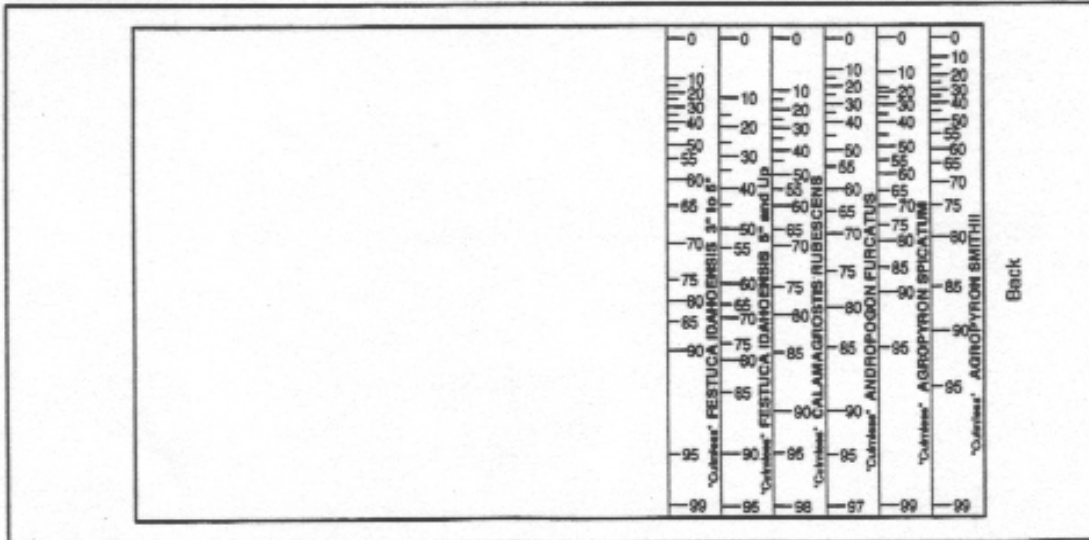
Utilization Gauge (concluded)

These utilization scales must be checked to see whether or not they fit the species on the rangeland where they will be used.

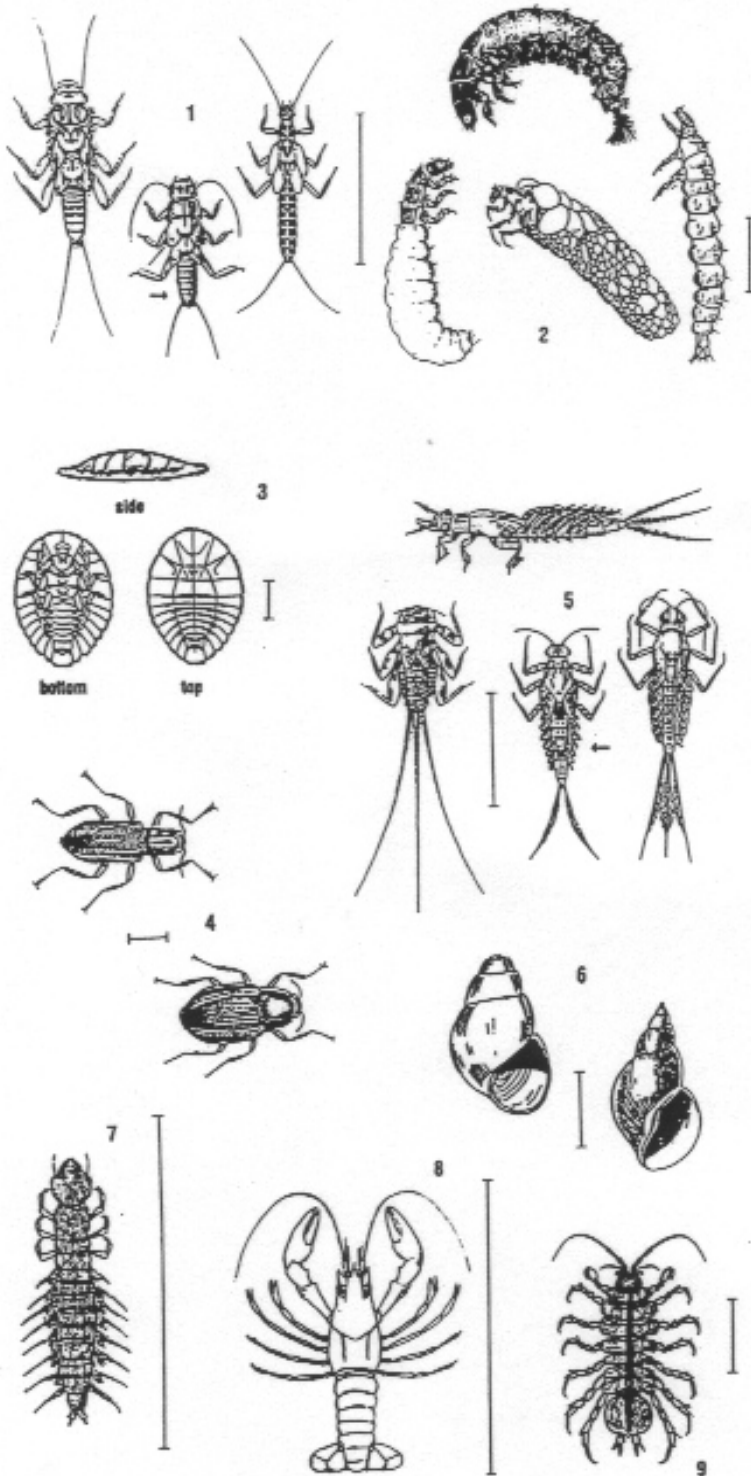
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APPENDIX 8 MACROINVERTEBRATE AND THEIR ASSOCIATED WATER QUALITY
(FROM IZAAK WALTON LEAGUE OF AMERICA)



Bar lines indicate relative size

Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

- 1 **Stonefly: Order Plecoptera.** 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)
- 2 **Caddisfly: Order Trichoptera.** Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on underside.
- 3 **Water Penny: Order Coleoptera.** 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs and fluffy gills on the other side. Immature beetle.
- 4 **Riffle Beetle: Order Coleoptera.** 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.
- 5 **Mayfly: Order Ephemeroptera.** 1/4" - 1". brown, moving, plate-like or leathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.
- 6 **Gilled Snail: Class Gastropoda.** Shell opening covered by thin plate called operculum. When opening is facing you, shell usually opens on right.
- 7 **Dobsonfly (Hellgrammite): Family Corydalidae.** 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

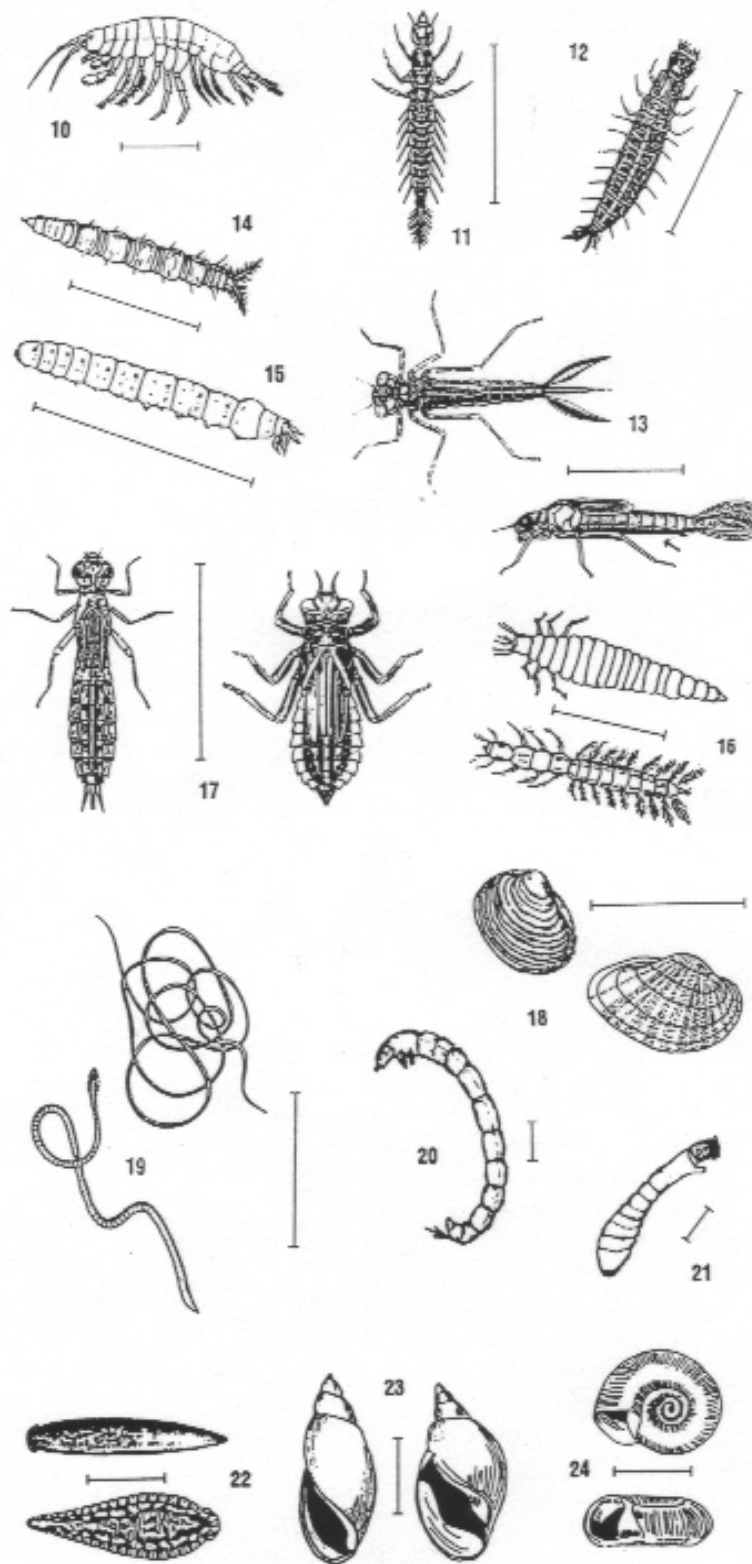
GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in good or fair quality water.

- 8 **Crayfish: Order Decapoda.** Up to 6", 2 large claws, 8 legs, resembles small lobster.
- 9 **Sowbug: Order Isopoda.** 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Save Our Streams

Izaak Walton League of America
707 Conservation Lane
Gaithersburg, MD 20878-2983
1(800)BUG-IWLA



Bar lines indicate relative size

GROUP TWO TAXA CONTINUED

- 10 Scud: Order Amphipoda.** 1/4", white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.
- 11 Alderfly Larva: Family Sialidae.** 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.
- 12 Fishly Larva: Family Corydalidae.** Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.
- 13 Damselfly: Suborder Zygoptera.** 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad ear-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow)
- 14 Watersnipe Fly Larva: Family Athericidae (Atherix).** 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.
- 15 Crane Fly: Suborder Nematocera.** 1/3" - 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.
- 16 Beetle Larva: Order Coleoptera.** 1/4" - 1", light-colored, 6 legs on upper half of body, feelers, antennae.
- 17 Dragon Fly: Suborder Anisoptera.** 1/2" - 2", large eyes, 6 hooked legs. Wide oval to round abdomen.

18 Clam: Class Bivalvia.

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

- 19 Aquatic Worm: Class Oligochaeta.** 1/4" - 2", can be very tiny, thin worm-like body.
- 20 Midge Fly Larva: Suborder Nematocera.** Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.
- 21 Blackfly Larva: Family Simuliidae.** Up to 1/4", one end of body wider. Black head, suction pad on other end.
- 22 Leech: Order Hirudinea.** 1/4" - 2", brown, slimy body, ends with suction pads.
- 23 Pouch Snail and Pond Snails: Class Gastropoda.** No operculum. Breathe air. When opening is facing you, shell usually opens on left.
- 24 Other Snails: Class Gastropoda.** No operculum. Breathe air. Snail shell coils in one plane.



APPENDIX 9 REFERENCES CITED

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