Interior Columbia Basin
Ecosystem Management Project
Science Integration Team
Terrestrial Staff
Range Task Group

REVIEW DRAFT

Rangeland Ecology and Grazing Management: Preliminary Methods

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INTERIOR COLUMBIA BASIN SCIENTIFIC ASSESSMENT

RANGELAND ECOLOGY AND GRAZING MANAGEMENT

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INTRODUCTION

This report from the rangeland ecology and grazing management group of the terrestrial ecology staff of the Science Integration Team (SIT) is intended to summarize analyses that address specific rangeland issues as they relate to broader issues to be used in the development of EIS alternatives. Portions of these analyses are necessarily dependent on methods and results derived from other components of the SIT, particularly other terrestrial groups, landscape ecology, and aquatic/riparian components. Likewise, information presented here does not represent all rangeland ecology and grazing management inputs to related issues and analyses; it is merely a convenient way to address certain topics and provide some direct technology transfer undiluted by the integration process.

Where methods are described in detail elsewhere and referenced within the overall assessment, discussion is centered on the implications relative to specific rangeland analyses and interpretations.

This report emphasizes the biophysical components of past, present, and possible future conditions from which social implications may be inferred in other sections of the assessment. The synthesis of scientific knowledge and analyses relative to these biophysical components also emphasize the organism, community, and association levels of interrelationships and interdependencies from which broad scale interpretations are made based on ecosystem classification and/or regionalization of similar environmental characteristics.

I. ISSUES

Twelve preliminary issues for the development of alternatives are proposed by the Interior Columbia Basin Ecosystem Management Project (11/7/94). Of these issues, four are directly addressed by rangeland ecology and grazing management analyses:

1) Can ecosystems be restored and to what condition should they be restored?

2) Management activities (fire suppression, grazing, logging, pesticides use, etc.) have changed natural disturbance patterns and processes (wildlife, insect and disease outbreaks, floods) and have altered the composition, structure, recovery ability, amount, and distribution of vegetation and plant communities.

3) Management activities impact soil structure, biotic structure, productivity, and erosion rates.

4) Management activities have affected the productivity of some riparian and wetland systems.

Three additional issues are closely associated with biophysical components of rangeland ecology and grazing management through either habitat or disturbance regimes:

1) Native fish stock are declining.

2) The quality and quantity of surface and groundwater have been and are being impacted by management activities.

3) Management activities impact air quality.

In addition to the broad issues stated above, there are at least two related national administrative proposals that must be considered in analysis. Rangeland Reform and PACFISH proposals both include ecological health standards and grazing standards and guides that apply to the interior Columbia Basin.

In order to analyze the biophysical issues for development of alternatives, specific issues related to these analyses must also be addressed. Generally, these are issues of information availability and needs relative to past, current, and potential conditions as well as processes and functions that influenced or contributed to present ecological states and those that will most likely influence future change considering various use and management scenatios. We have separated information availability into categories of 1) inventories and 2) knowledge of process, function and related attributes.

1) Soil and vegetation resource information provide the foundation for range ecology and management assessments. Soil surveys and rangeland inventories are traditionally used to provide iformation for site specicfic and local management assessments. Specific inventory issues for the CRB assessment include:

a) Continuous coverage inventories of past, present, and potential vegetation are not available.

b) Inventories that are available are inconsistent in methodology used or attributes gathered (either between agencies or between times of completion).

c) Continuous coverage of soils information is available only in a generalized format.

Photointerpretaion of current vegetation provides a consistent format across all vegetation types.however ther aare known shortcomings to photointerpretation of vegetation (i.e. understory species). Processes and/or methods to incorporate existing inventory info have to be developed to supplement photointerpreted info.

Evaluation of inventory data is crucial for assessment of preliminary issues 1-3 above.

2) Concurrently with the development of preliminary issues, specific issues relating to rangeland processes and function in ICB were identified by the range staff. These include:

a) Noxious weeds;
b) Juniper;
c) Riparian grazing management;
d) Microbiotic crusts;
e) Introduced forage species;
f) Livestock-other large ungulate interactions and impacts; and
g) Fire.

These specific issues were generated previous to the preliminary issues above and directly relate to some and indirectly to others.

For example, the distribution and extent of noxious weeds can affect whether or not an ecosystem can be restored and the condition to which it may be restored. Past and present management activities have in some instances fostered noxious weed invasion. Current distribution and extent of these weeds is partially attributable to past and present management activities. Present status of these weeds will certainly influence management options for the future.

The apparent increase of juniper in the ICB, the causal agents related to its increase, and its perceived effects on ecosystem structure and function is controversial at present.

Riparian grazing management has been implicated with habitat degradation, decline in native fish species populations, decline in quantity and quality of surface water, and decline in overall productivity of some riparian-wetland systems.

Microbiotic crusts have been proposed as critical for maintenance of nutrient cycling and functioning of watersheds especially in the more arid zones of the ICB. Livestock grazing has been implicated as a factor that compromises the integrity of microbiotic crusts.

Introduced forage species have been widely used to augment forage for livestock, reclaim lands occupied by less desirable plant species, and protect the soil resource. There is concern that extensive use of introduced forage species may result in concurrent alteration of ecosystem structure and function and reduced biodiversity.

Relationships between livestock and other large ungulates are complex and controversial. The functional equivalency of livestock with other large ungulates is unresolved in the ICB, especially in regards to the maintenance of ecosystem structure and function and biotic diversity.

Fire, wild or prescribed, is a known disturbance factor with both beneficial and deleterious effects depending on timing, intensity, areal extent, etc. Fire is a natural process. Fire can alter: plant community succession, structure and function; vegetation pattern on the landscape; wildlife habitat; air quality; and human habitation.

II. RANGELAND ANALYSIS: PROCESS AND METHODS

Contract Literature Reviews for Specific Rangeland Issues

Several objectives were associated with each of these rangeland issues to aid in focussing assessment efforts. A goal of the Range Group was to satisfy the objectives by soliciting numerous scientific contract reports from credible experts. These experts were instructed to write comprehensive scientific reports that addressed some or all of the objectives within a rangeland issue. The citations for the 10 solicited scientific contract reports accompany the objectives for each rangeland issue and these are reported below.

Noxious Weeds

a. identify the species and species groups of particular concern;
b. develop databases and geographic information system (GIS) layer(s) that identify points of entry, current distributions, and rates of spread;

c. evaluate potential (future) species ranges (distributions);
d. evaluate potential effects on biodiversity including other plant species which may be native or non-native but yet desired, wildlife habitat, and soil organisms; and
e. evaluate methods of containment or control, considering potential chemical and biological control impacts.

Sheley, R.L. (ed.) 1994. The identification, distribution, impacts, biology and management of noxious rangeland weeds. 366 pp.

Juniper

a. current distribution and densities in the context of historical distributions and densities;
b. potential distributions and densities;
c. describe the ecology of juniper specifically as a genus/species and in the context of plant communities;
d. describe, in terms of basic principles, juniper's impacts on hydrology, wildlife habitat, competition with other vegetation, in relation to site characteristics;
e. provide a discussion of management options and implications.

Eddleman, L.E., R.F. Miller, P.M. Miller, and P.L. Dysart. 1994. Western juniper woodlands (of the Pacific Northwest): science assessment. 131 pp.

Riparian Grazing Management

a. identify and describe current riparian conditions;
b. elucidate the impacts of various grazing management strategies on riparian function, emphasizing other vegetation, wildlife habitat, silt deposition and trapping, and capture-storage-release of water; and
c. evaluate case studies, to assess potential for riparian improvement resulting from management changes that are based on site specific characteristics. Identify site characteristics that should be considered when evaluating management alternatives.

Kindschy, R.R. 1994. Riparian restoration and management. 54 pp. + illus.

Rasmussen, C. 1994. Riparian community and bank response to management: a comparison of old and new surveys in the Prineville District, Bureau of Land Management. 33 pp. + illus.

Microbiotic Crusts

a. the distributions, roles, and importance of microbiotic crusts.

Williams, J.D. 1994. Microbiotic crusts: a review. 56 pp.

Introduced Forage Species

a. provide descriptions of introduced species that have been widely used, with rationale for their use (e.g. forage, erosion control);
b. describe current distributions;
c. elucidate environmental factors (e.g. precipitation, soils) that are associated with suitability for seeding these species;
d. describe competitive abilities and potentials for spread; and
e. describe identified impacts on biodiversity (e.g. floral species and structure, wildlife species diversity).

Harrison, D., R. Page, M. Curto, and N.J. Chatterton. 1994. Introduced forage

grasses. 74 pp.

Kindschy, R.R. 1994. Crested wheatgrass in the ecosystem. 36 pp.

Livestock-Other Large Ungulate Interactions and Impacts

a. describe the potential for forage competition;
b. describe the potential for livestock to condition forage for other ungulates; and
c. describe wild horse and burro impacts on rangeland ecosystems.

Clark, P.E. 1994. Livestock-big game interactions: a selected review with emphasis on literature from the interior Pacific Northwest. 109 pp.

Burkhardt, J.W. 1994. Paleoecological relationships of prehistoric *Equus* in the Intermountain West--An overview with implications for management of wild horses and burros. 49 pp.

Fire

Contrast the effects of paleoecological, Native American, post-European settlement, and prescribed burning fire regimes on species composition (floral, faunal, microorganisms) and vegetative structure of juniper woodlands, sagebrush steppe, mountain meadows, and riparian zones.

Bunting, S.C., and E.F. Peters. 1994. Impact of fire management on rangelands of the Intermountain West. 26 pp. + illus.

Satisfying Objectives

Each scientific contract report addressed one to several objectives. Not all objectives within a rangeland issue were satisfied by the contract reports. Integration with other staffs on the Science Integration Team, e.g. the Landscape Staff and Spatial-Geographic Information System Staff, was necessary to satisfy some of the objectives, especially those objectives with a spatial component. The reports in some instances addressed additional facets that were not required to satisfy objectives; in other instances an objective may not have been addressed in adequate detail because of the paucity of scientific documentation and data relevant to that objective.

Peer Review of Scientific Contract Reports

Five external peer reviews were solicited for 3 of the scientific contract reports. Finances did not permit external peer review of all reports. Our criteria for selection of contract reports requiring external peer review were subjective. Reports were externally peer reviewed if, in our collective judgement: 1) the content and rangeland issue was highly contentious; or 2) the scope of the report's content was somewhat narrow. These solicited peer reviews were, in most instances, in addition to internal peer reviews that the author(s) had secured. Our objective in seeking these external peer reviews was to obtain additional credible scientific documentation that the author(s) may have overlooked and/or to seek viewpoints different than those presented that could be substantiated with scientific documentation. Scientific contract reports were peer reviewed using a blind process, where author(s) remained unknown to reviewers, when possible. Externally peer reviewed reports and the reviewers include:

1) Bunting and Peters. 1994

Reviewed by: David B. Sapsis, Ph.D. candidate in Wildland Resource Science, Department of Environmental Science, Policy and Management, University of California, Berkeley;

2) Burkhardt. 1994

Reviewed by: Dr. Elizabeth L. Painter, Research Associate, Jepson and University Herbaria, University of California, Berkeley.

Reviewed by: Dr. Charles Kay, Adjunct Assistant Professor, Department of Political Science, Utah State University, Logan;

3) Eddleman et al. 1994.

Reviewed by: Dr. James P. Dobrowolski, Associate Professor, Department of Rangeland Resources, Utah State University, Logan.

Reviewed by: Dr. A. Joy Belsky, Staff Ecologist, Oregon Natural Resources Council, Portland, Oregon.

Paragraph put in here about how we're going to integrate the issues with the scenarios:
1) Tell briefly what the scenarios are. Refer reader to section on scenarios (we're assuming there'll will be one) for additional info on how scenarios were developed, their role, etc.

Process:

Rangeland analyses follow the Interior Columbia Basin strategy of analyzing representative subsample watersheds at 4th and 6th code hydrologic units for midscale characterization and interpretation. Midscale characterization of upland rangeland consists primarily of identifying historic, present, and potential vegetation. Soil attributes affecting susceptibility to rangeland health stresses are characterized in selected watersheds where data is available. Interpretations consist of computer model (CRB-SUM) predictions of vegetation succession considering proposed management scenarios. Proposed midscale characterization and analyses are applied first to selected test basins to evaluate methods, identify data gaps, and validate results to the extent practicable. Refined methods and necessary qualifications for interpretation are then applied to all subsample watersheds. Broadscale characterization and analysis of issues for the development of management alternatives concerning the entire Interior Columbia Basin is accomplished by 1) extrapolation of midscale analyses to similar watershed classifications and 2) direct analysis of continuous coverage broadscale soil and climate information (ie STATSGO, Palmer Drought Severity Index, etc.). Analyses of current literature on specific rangeland issues and their relationship to proposed alternatives are also incorporated in broadscale characterizations and management interpretations and implications.

Potential riparian vegetation, successional sequences, and specific habitat analyses are addressed in the Riparian/Aquatic section; however, specific relationships to grazing management are also addressed in the broadscale analysis here.

Methods:

Photo interpreted present and historical vegetation cover types are provided in GIS format consistent across all landtypes. Photo interpreted present vegetation polygons and associated attributes for rangelands are then compared with and supplemented by Ecological Site Inventory and Soil Survey information, where available, to estimate potential, enhance successional modeling, determine susceptibility to rangeland health stresses, and provide other interpretations given various management scenarios.

Baseline information

- Photo Interpretation of Present Vegetation

-purpose to provide consistent map base for interpretation at midscale, comparison of short-term changes between early and recent aerial photo's (rate of change), etc.

-Brief description of subsample areas (reference appropriate section) and attribute data applicable to rangeland (N-F types and ovrsty codes/descriptions).

Interpretation of present vegetation from black and white aerial photograhs at 1:20,000-1:24,000 scales is marginal on arid and semiarid rangelands without extensive ground-truthing. Generally small stature and sparse cover of vegetation combined with high soil reflectance from interspaces limit interpretation to broad categories of cover types. Some shrub species are distinguishable while others, such as the many sagebrush subspecies, are not; particularly when communities occur as complexes on the landscape. Understory herbaceous species normally cannot be identified. Dominant shrub and understory species are critical in the interpretation of rangeland succession and determination of potential as well as other use and management interpretations.

Overstory shrub species are to some degree an indicator of a sites susceptibility to change from natural or man-caused stresses such as fire or improper grazing strategies and of possible rates of change. Wyoming and Basin big sagebrush communities, for instance, are more frequently susceptible to wildfire than low sagebrush communities simply because of fuel loading. The big sagebrush communities, however, also generally have a faster recovery rate (in the absence of flammable exotics) because of more favorable soil moisture characteristics. Identification of associated understory is extremely important for predicting successional sequences. A sagebrush community with a predominantly perennial understory such as bluebunch wheatgrass or Idaho fescue will become a perennial grassland following fire. The same sagebrush overstory with a depleted understory or an understory of cheatgrass has a high probability of becoming an annual grassland, often with little hope of recovery.

Although some successional sequences and site potentials are somewhat predictable from present vegetation characteristics alone, most are not. It is nearly impossible to determine if grassland communities are potential or merely successional stages of shrub steppe potential without additional information. It is likewise impossible to determine the extent of potential grasslands reduced by the encroachment of woody species from lack of fire.

We have attempted to mitigate some of the interpretive shortcomings of photographically interpreted rangeland vegetation types by comparing the interpreted information to present vegetation from Ecological Site Inventories on Bureau of Land Management administered lands and range site potentials from soil surveys conducted by the Natural Resources Conservation Service (formerly SCS), where available.

- Soil Survey

The Soil Survey Manual (USDA) describes the major principles and practices needed for making and using soil surveys and for assembling and using data related to them. The properties of soil vary from place to place, but the variation is not random. Natural soil bodies are the result of the interactions of climate, living organisms, parent material, topography, and time required for soil forming processes to act. Under similar environments in different places, soils are similar. This regularity permits prediction of the location of many different kinds of soil. Geographic order suggests natural relationships. Natural processes of erosion and deposition develop landforms within a landscape. An entire area has unity through the interrelationships of its landforms. Each distinguishable landform may have one or more kinds of soil depending on variations in parent material, relief, and other differences within the landform. The complex interactions among these factors occur in repetitive patterns which lead to the formation of repetitive combinations. These are the basis for defining, identifying, and mapping soils.

Map units are designed to carry important information about soils and for more common uses within survey areas. A map unit is a collection of areas defined and named the same in terms of their soil components or miscellaneous areas (e.g. areas having essentially no soil and support little or no vegetation such as rock outcrop) or both. Each map unit differs in some respect from all others in a survey area and is uniquely identified on a soil map. Each individual area on a map is a delineation.

Map unit design and scale of soil mapping is to a great extent dependent on intended uses of a soil survey identified during initial planning. Where intensive uses such as agriculture, construction, urban development, etc. are anticipated, the base map is usually at a scale of 1:12,000 to 1:31,680 depending on the complexity of the soil pattern within the area. Delineations are mostly consociations (mostly one soil or similar soils) or complexes (two or more contrasting soils that can't be individually delineated at this scale) with a minimum size of 0.6 to 4 hectares. For extensive uses such as range, forest, and recreation common to most undeveloped lands the map scale is generally 1:24,000 to 1:63,360. Delineations are mostly complexes and associations (two or more soils that could have been delineated at this scale but was not necessary for general interpretation) with a minimum size of 1.6 to 16 hectares.

The soil components and their approximate composition of map units are classified according to Soil Taxonomy (Soil Survey Staff 1975) and miscellaneous areas identified if they are present. Soil taxa are modified with phases, such as slope and stoniness to convey more specific information. Soil characteristics are described from field observations including horizon designation, depth and thickness, color, features of soil peds, texture, structure, consistence, and other special features. Site characteristics of the soil and its immediate surroundings are usually described. Chemical and chemical data are obtained from horizon samples analyzed in a laboratory. On rangelands, soil components of the map unit are usually correlated to range sites to provide information on potential vegetation. Information pertaining to map units and their soil components are available in soil survey reports and on automated databases through the Natural Resources Conservation Service.

Standard soil survey information is available for a majority of the subsample areas for midscale assessment. However, there is not continuous coverage soil survey level information throughout the Interior Columbia River Basin for use in broadscale assessment. Broadscale assessment of soil properties relating to susceptibility of areas to rangeland health stresses is accomplished using a more generalized continuous coverage STATSGO format available from the

Natural Resources Conservation Service. STATSGO incorporates generalized information from available soil surveys with schematic data using many sources of information to predict the geographic distribution of different kinds of soil. Map units generally are associations of many soil series with delineations covering thousands of acres at a scale of 1:1,000,000. These general soils information are considered useful in broad land use planning and aid in the identification of broad areas that have features suitable or unsuitable for a variety of uses.

Correlation of soil map units to photo interpreted (PI) present vegetation polygons at the mid-scale is accomplished by overlaying the photo interpretation polygons with soil map unit polygons and calculating the percentage of PI polygon occupied by a map unit. Because of differences in mapping protocol, a PI polygon may contain a portion of a map unit or more than one map unit. The percentage of each soil taxa or associated attribute (i.e. range site) is calculated from the map unit components and like properties or attributes are summed for the PI polygon to arrive at a dominant characteristic representing the polygon.

Broad scale STATSGO information may have a general correlation with broad scale themes such as vegetation or geology. However, because of very generalized information combined at this scale, the themes are probably best interpreted individually for discussions concerning regional characteristics.

- Ecological Site Inventory

The Natural Resources Conservation Service and Bureau of Land Management both use the Range Site Inventory procedures described in the National Range Handbook (USDA 1976) as the basis for rangeland inventory of present and potential vegetation. BLM uses the title Ecological Site Inventory (USDI 1990) to distinguish between some terminology, data storage, and policy on use differences with the National Range Handbook.

Range sites are the interpretive units for rangelands. An ecological site, as defined by the BLM, is synonymous with a range site and the concept also applies to grazeable woodlands, forest, and riparian/wetland sites. A range/ecological site is a distinctive kind of land that differs from other kinds of land in its ability to produce a characteristic natural plant community.

As previously noted, soil surveys on rangelands usually correlate soil components of map units with range sites. Therefore, the soil survey can also be interpreted as a map of potential vegetation. Soil survey map units are generally repeatable landscape units with more than one component. Composition of components described for a map unit are approximate for the entire distribution of the unit; compositions for an individual delineation may vary considerably.

ESI generally uses an individual soil map unit delineation as a basis for documenting both present and potential vegetation. An entire delineation may be used if vegetation characteristic are relatively constant across the delineation and the delineation does not contain an administrative boundary that could affect land use. A soil map unit delination may be subdivided by an administrative boundary or by a significant change in plant community (i.e. a fire pattern, etc.). Individual ecological sites can be mapped out if possible at the scale used and if desired for specific interpretations.

The smallest resulting delineation is called a Site Writeup Area or SWA. Each SWA is given a unique number in an inventory area for tracking. The specific composition of ecological sites is estimated for the delineation (if more than one) and the present vegetation species composition (based on production air-dry weight) is estimated or sampled for each site occuring in the delineation along with other descriptive and administrative information.

Correlation of SWA's to photo interpreted (PI) present vegetation polygons at the mid-scale is accomplished by overlaying the photo interpretation polygons with SWA polygons and calculating the percentage of PI polygon occupied by a SWA as done with soil map units. As with soil map units, a PI polygon may contain a portion of a SWA or more than one SWA. The percentage of each ecological site and associated present vegetation (from the estimate or sample) is calculated from the SWA components and like sites are summed for the PI polygon to arrive at a dominant present vegetation representing the polygon. Because of differences in computing percentages of components between soil map units and SWA's, there are differences in relative composition for determining dominance. There are also differences related to time of completion of soil surveys and completion of ESI because of site description updates, improved correlation procedures, etc. Most ESI data is also 10-12 years old. Therefore, the calculated compositions are only to be considered approximations to establish relative potential to present conditions for the scale of analyses appropriate for basin wide assessments and should not be considered absolute for a particular point. The ESI to PI polygon correlation, even with these limitations, is still particularly useful in establishing types of shrubs, understory species relationships, and presence of exotics, etc. for photo interpreted units and subsequently classifying the polygons to broad successional stages used in CRB-SUM modeling.

- Ancilary Climate Data

  -Pricipitation isohytes in two in. increments
  -Palmer Drought Severity Index (PDSI) 5 Yr mean/50 yr mean display in classes described by Palmer, 1965. (Talking to Sue Ferguson, FS, there are alo other alternatives. Seasonal PDSI displays already available, or possibly the McKee index - Standard Precipitation Index- that is easier and presumably better. I'll be coordinating with DR. Kelly Redmond, Desert Research Institute on the best format.)

Analyses

- CRB-SUM
  -Briefly summarize description of CRB-SUM model from Wendel's writeups, reference.
  -describe panel development of successional sequences and assumptions affecting outputs from the model.

- Susceptibility to rangeland health stresses

The National Research Counicil (1994) presented arguements that new methods are needed to classify, inventory, and monitor rangeland ecosystems. In particular, the NRC cites gross inconsistencies between agencies and range managers in the evaluation of rangeland conditions and ecological status. "Rangeland health" is proposed as the minimum standard for management and is defined as "the degree to which the integrity of the soil and ecological processes of rangeland ecosystems are maintained." It is important to note that rangeland health is not an estimate of the kinds or amounts of resources available for commodity production nor an evaluation of different uses. If rangeland health is sustained, then decisions about the appropriate plant community composition and production can be made depending on the desired use. The NRC further calls upon the secretaries of USDA and USDI to convene an interagency task force to develop, test, and standardize indicators and methods for inventorying and monitoring rangeland health on federal and nonfederal lands.

Rangeland health as proposed by the NRC incorpoates abiotic and biotic indicators of 1) soil stability and watershed function, 2) distribution of nutrients and energy, and 3) recovery mechanisms. Soil stability and watershed function are given greatest importance in the determination of rangeland health; soil movement off site should mean the rangeland is unhealthy because of the danger of irreversible effects. However, the determination is generally to be made based on a "preponderance of evidence."

Three broad catagories of rangeland health are described by the NRC. Rangelands should be considered 1) healthy if an evaluation of the soil and ecological processes indicates that the capacity to satisfy values and produce commodoties is being sustained, 2) at risk if the assessment indicates an increased vulnerability to degradation, and 3) unhealthy if the assessment indicates that degradation has resulted in an irreversible loss of capacity to provide values and commodities.

An interagency workgroup was convened in May, 1994, to :

1) Develop a national reporting system for rangeland health, and

2) Develop a rapid, qualitative assessment procedure to determine rangeland health on selected landscape sites.

A separate, technical workgroup was formed to address the second objective. A draft qualitative assessment procedure of rangeland health proposed by this workgroup (Pellant 1994) builds and elaborates upon the NRC report. The interagency workgroup proposes an independent assessment of abiotic factors and biotic factors leading to a two tier description of "health".

The first component or tier is hydrologic function which would be reported as:

1) functioning if capture and storage of water is satisfactory, resulting in soil stability and satisfactory operation of hydrological and ecological processes,

2) at risk if capture and storage of water is approaching nonfunctional status with soil stability declining and ecological processes showing signs of disruption,

3) nonfunctioning/reversible if capture and storage of water (one or more of each component) are dysfunctional with soil unstable and ecological processes disrupted. With proper management and/or land treatment (revegetation), these sites can return to a functioning status, or

4) nonfunctioning/not reversible if capture and storage of water are dysfunctional with soil unstable and ecological processes disrupted. Soil losses and lack of water storage have changed site potential.

Improved management and/or land treatment applied at an economically feasible level will not bring these sites back to a functioning status within 100 years.

The second component is biotic health which would be reported as:

1) healthy if structure and dynamics of flora is similar to an ecological reference area(s) indicating a healthy plant community. Native vegetation is both resistent and resilient to major diaturbance (disease, fire, weed invasions, etc.) Nutrient cycling, hydrologic cycle and energy flow are effective in providing for native plant needs.

2) at risk if structure and dynamics of flora are only marginally similar to ecological reference area(s) indicating the potential for movement into the unhealthy status. Native vegetation is losing either its resistence to disturbance and/or resiliency after a major disturbance. Nutrient cycling, hydrologic cycle and energy flow are not providing for native plant nor faunal needs.

3) unhealthy/reversible if structure and dynamics of flora differ significantly from the ecological reference area(s). The structure and composition of native lifeforms has changed significantly to the point that the remaining native vegetation no longer provides the basic structure and functions to maintain site productivity or ecosystem processes. Native vegetation has lost resistence to disturbance and resiliency to recover (or both) after major disturbances. Nutrient cycling, hydrologic cycle and energy flow are not providing for the maintenance of flora or fauna needs. However, with proper management and/or revegetation (with reasonable economic constraints) these sites can be restored to a healthy status.

4) unhealthy/not reversible if sites in this status exhibit the same conditions as described above with the exception that neither proper management nor reseeding (with reasonable economic inputs) can restore these sites to a healthy staus within 100 years.

The interagency team proposes a combined rating (i.e. hydrologically functioning/biologically at risk) to portray overall health rather than the single rating proposed by the NRC. Another important distinction is that the interagency evaluation is based on on-site indicators relative to reference areas of the same or similar ecological site predetermined to be hydrologically functioning and biologically healthy whereas the NRC evaluation does not include comparison to reference areas.

Although the methodology and, to some degree, the criteria used for determination of rangeland health are still developmental, there is considerable agreement on many of the indicators. Indicators of soil erosion status such as pedastaling, flow patterns, rills, gullies, and soil cover and soil physical/chemical crusting that retards plant establishment are common themes. There is no disagreement that present plant community characteristics such structure, composition, cover, age-class distribution and other factors are indicators of site stability, nutrient cycling, energy flow, and recovery mechanisms that should be considered in the determination of rangeland health. There is also agreement that determinations should be made based upon a "preponderance of evidence" provided by the indicators.

The present status of soil and vegetation indicators must be determined by on-site investigations. Determinations of at risk, unhealthy, or nonfunctional situations are interpreted to be a result of some past or continuing stress even though the direct cuase/effect relationship may not be readily apparent from the assessment.

For many of the proposed indicators, there is little existing inventory information. However, there are soil, vegetation, and climate attributes available for assessment that are indicators of relative susceptibility to stresses. Susceptibility does not indicate that particular areas are healthy, at-risk, or unhealthy; merely that the presence of susceptibility factors make sites more sensitive to disturbance stresses. Maps of susceptibility to health stresses should help managers prioritize areas for on ground assessments.

Table --

Proposed Criteria for Susceptibility Assessment

	MODERATE	HIGH
SOILS		
Erodibility		
K (surf.)	>.35	
K (surf.)x S	2-4	>4
WEG (class)	1,2,3	
Salts		
SAR	5-12	>12
Salinity	8-16 mmhos/cm	>16 mmhos/cm
Shrink/swell	high any vertisol	very high
CLIMATE		
Precip (MAP)	10-12"	<10"
PDSI (5/50 class)	moderate	severe/extreme
VEGETATION		
Present		
flam.exotic (BRTE/TAAS) or noxious	5-10%	>10%
Potential		
veg. type	ARTW/AGSP all ATCOtypes low prod. ARAR8 types (<500#/ac)	ARTRT/STTH ARTRW/STTH ARTR/STTH

The NRC cites repeated concerns of soil erosion in croplands and forests as well as rangelands (Bormann and Likens, 1979; Ellison, 1949;Klock, 1982; Larson et al., 1983; Pierce, 1991; Sheridan, 1981; Wight and Siddoway, 1982) and irreversible changes in productivity and site potential within practical timeframes as reasons that soil stability and watershed function should recieve greatest weight in the determination of rangeland health. Susceptibility to degradation greatly dependent on natural erosivity of the soil. The soil erodibility factor (K) is a measure of the susceptibility of a soil to particle detachment and transport by rainfall. It is a quantitative value, experimentally determined. A K factor greater than .35 has been used in existing soil interpretations by the Natural Resource Conservation Service (NRCS) as a limiting factor or erosion hazard (USDA 1983). Slope (S) increases water energies; therfore some interpretations of erosion hazard include K x S as a factor. Values of 2-4 and >4 to indicate moderate and high erosion hazard have been used in existing interpretatiions, such as suitability for motorcycle trails, etc., that relate to many surface disturbances on rangelands.

Wind erodibility groups (WEG) indicate a susceptibility to blowing. A wind erodibility group is a collection of soils that have sililar properties affecting their resistance to soil blowing. Groups 1,2, and 3 are often included in interpretations as a limiting factor because of wind erodibility.

Salinity and sodicity affect plant growth and can exacerbate soil surface disturbances limiting reestablishment of plants. Salinity is the concentration of all salts more soluble than gypsum whereas sodicity relates specifically to exchangeable sodium. Salinity is measured by electrical conductivity in decisiemens per meter (dS/m) or millimhos per centimenter (mmhos/cm). The units are equivalent. The sodium adsorption ratio (SAR) is the standard measure of sodicity. High concentrations of salts can interfere with the absorption of water by plants and with the exchange capacity of nutrient ions, thereby resulting in nutritional deficiencies. Reduced infiltration and high evaporation rates associated with surface disturbance can lead to even higher surface concentrations of salts exacerbating negative affects on plant establishment and growth. The dispersal effects of sodium on soil particles in combination with disturbance can increase "slick spot" areas and physical crusting further limiting establishment of many plants. However, halogeton glomeratus, a undesirable exotic forb, is particulary suited to high saline soils and disturbance. A moderate susceptibility of soils with SAR 5-12 and/or salinity of 8-16 mmhos/cm and high susceptibility of soils with SAR of >12 and/or salinity >16 mmhos/cm is consistent with other interpretations of limitations to plant growth or seeding establishment.

Shrink-swell potential is the susceptibility of soil to volume change due to loss or gain in moisture content. Shrink-swell is expressed as percent change in linear extensibility (LE) or as a coeficient of linear extensibility (COLE) in decimal fraction from a moist to dry state. High (6-9 LE or .06-.09 COLE) and very high (>9 LE or >.09 COLE) shrinkage can damage plant roots and limit establishment and persistence of many perennial plants. However, these soils are particularly susceptible to exotic annuals such as cheatgrass that have fibrous root systems and need only to persist for one year in place.

Climate is a driving variable affecting site susceptibility to stresses on both vegetation and soils and affecting resiliency to recover from stresses (Mouat et al. 1993). Arid climates in particular are subject to extremes and/or episodic events that in conjuction with other ecosystem stresses can lead to degradation and inhibit recovery. The 10 - 12 inch annual precipitation zone in the Interior Columbia Basin and other places in the arid west appears to be particularly suceptible to invasion by exotic annuals. However, the 10 - 12 inch zone is proposed as a moderate suseptibility to health stresses because it is also recognized in most seeding guides as the lower precipitation range for successful reseeding of perennial species. An annual precipitation of less than 10 inches may be somewhat less susceptible to initial invasion by annuals, but once established, the likelihood of recovery by reseeding or other means is exceedingly diminished.

The Palmer Drought Severity Index (PDSI) is computed using monthly temperature and precipitation, together with soil moisture, and represents an integrated measure of moisture availability (Wharton et al. 1990). PDSI exhibits a higher covariance with vegetation response than precipitation or temperature alone and may be calculated at a variety of temporal and spatial scales, depending on resolution desired. Mouat et al. used cumulative monthly values for calculating drought severity in four classes (mild, moderate, severe, and extreme) after Palmer, 1965, as a climate stress for a hypothetical drylands risk index for the Colorado Plateau. A five year mean PDSI relative to the fifty year mean was used in conjunction with other factors to establish susceptibility to desertification processes that are quite similar to those affecting rangeland health. We propose to use only the moderate or greater classes because most rangelands are at least mildly susceptible to climate stresses.

[After talking with Sue Ferguson 3/5, this'll probably be rewritten to reflect use of th "Mckee index" for drought- its simpler to derive and supposedly better]

The relationship of present plant community characteristics with rangeland health criteria relating to nutrient cycling, recovery mechanisms, and soil erosion is intrinsic. However, health classification criteria are still developmental and continuous information coverage at scales considered in this assessment are sketchy or absent. Current Ecological Site Inventories (ESI) provide information on species composition by weight and potential, but community structure (except as broadly classified from photo interpretation), age-class distribution, vigor and other characteristics being considered in health evaluations are generally unavailable. One aspect of present plant community that can be evaluated at the mid-scale is the amount of exotic annuals and/or noxious weeds as determined from ESI.

The emphasis for this assessment is on the flammable exotics, cheatgrass (Bromus tectorum) and/or medusahead rye (Taeniatherum asperum). In particular, cheatgrass greatly influences nutrient cycling and recovery mechanisms, and to a certain extent erosion, in a variety of ways and is widely adapted across the Interior Columbia Basin (Monsen and Kitchen, comp. 1994). Medusahead rye appears to be a successor to cheatgrass in many sites with even greater negative influences. Although there are not established guides on how much of these species is necessary to constitute a risk to rangeland health, Mike Pellant (personal communication) of the Interagency Rangeland Health Workgroup has suggested 5-10 % for being moderately susceptible to continued degradation and >10 % as being highly susceptible.

Cheatgrass and associated weedy species are abundant and can become dominant on a wide range of potential vegetation communities from the arid salt desert shrub communities to relatively mesic ponderosa pine communities (Monson 1994). Many ecologists agree that the more arid environments are most difficult to restore. Until recently, the xeric sagebrush potential vegetation types, especially those with Thurber needlegrass (Stipa Thurberiana) as the dominant grass followed by those dominated by bluebunch wheatgrass (Agropyron spicatum) as the dominant grass, were most considered most susceptible to invasion and most difficult to restore. Cheatgrass now continues to spread into drier environments and has dominated extensive areas of salt desert shrub of which shadscale (Atriplex confertifolia) potential vegetation types occupy the greatest area in the Interior Columbia Basin. This expansion into the shadscale types has led us to include these in at least moderately susceptible, but they may be more appropriate in the highly susceptible catagory.

A summary rating for susceptibility to rangeland health stresses will follow a simple "most limiting factor" rating common to many soil interpretations; that is even if there are two or more moderate susceptibility criteria evident in an area, the rating is still moderate, but if one high susceptibility criteria is evident then the rating is high. We are avoiding cumulative numerical ratings of individual criteria because some exhibit autocorrelation (i.e. many ARTRW/AGSP potential vegetation types will automatically be in the 10-12" precip. zone) while others are mutually exclusive (i.e. it would be rare, if not impossible, to have both a high wind erodibility rating and a high shrink/swell soil).

III. RESULTS

- Contract Literature Reviews

-Provide synopsis of each literature review with discussion of any dissenting views from reviewers, public, or knowledge of other literature.

- Integrating Analyses/Assessments for Characterizing the Present Situation and Scenario/Alternative Analysis ??????

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We appreciate the initial efforts by Dr. Michael Borman, currently the Oregon Extension Rangeland Specialist at Oregon State University in Corvallis, who was our predecessor in this assessment and generated the list of specific rangeland issues considered for inclusion.

- Present and Potential Vegetation (tabular summaries of veg. types and description)

    - Mid scale
    - Broad scale

- Susceptibility to Rangeland Health Stresses (tabular summaries)

- Scenarios

Documentation of assumtions relative CRB-SUM results and verbal analysis of relationships with rangeland issues, rangeland health, limitations, etc. This will be the real guts of the report.

IV. Recommendations

- Grazing standards and guides? or does this wait for evaluation of EIS alternatives.

- Research needs?

V. Appendices