Simple Methods for Measuring Indicators of Ecologically Sustainable Grazing

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December 28, 2012

Introduction

This compilation of simple and formal methods of assessing key ecological indicators of sustainable/unsustainable grazing management was compiled by a subgroup of the Collaborative Group on Sustainable Grazing for Southern Utah Forest Service Lands ("Collaboration"). This multi-stakeholder, multi-agency collaboration was co-convened in 2012 by the Utah Department of Agriculture and Food and Utah Department of Natural Resources. The collaboration's goal was to "develop consensus agreement on grazing management principles and practices for Forest Service lands in Southern Utah that provide for ecological sustainability, are socially acceptable, and economically viable."

The Collaboration developed a set of ecological indicators (see pp. 1-4). A subgroup of the Collaborative, including a range specialist with the Dixie and Fishlake National Forests, subsequently compiled some suggested "simple" methods of formally assessing these indicators on Forest Service lands. This handbook presents those methods.

Our intent is to encourage the gathering of valuable, objective, repeatable data on sustainable and unsustainable grazing management on the Dixie, Fishlake, and Manti-La Sal NFs by not only the Forest Service but also permittees and other interested parties. We hope that data indicating grazing management could be improved will be used positively and collaboratively to generate management improvements These same methods can indicate that current grazing management is ecologically sound, or that recent grazing management changes are increasing the ecological sustainability of livestock grazing in a particular allotment, district, or forest.

Some notes on using this handbook:

Where a method is described in detail in another monitoring handbook, a website link is provided to the document. This handbook qualitatively/subjectively indicates considerations regarding use of each method. For each method, certain questions are answered regarding:

- Overall difficulty (High, medium, low, as a subjective judgment by the Ecological Indicators Subgroup, based on the sum of the elements immediately below)
- Whether more than minimal training (defined as more than two hours) is required to allow a person to be proficient in the use of the method
- Whether plant species will need to be identified while using the method, and if so, whether the needed plant species identification will be minimal.
- Whether a permanent transect needs to be established when using the method
- Whether analysis of the data that has been gathered will require offsite expertise
- Whether statistical analysis beyond the calculation of percentages or averages is needed

Some methods are identified by an abbreviation, as noted below:

IIRCv4	**Interpreting indicators of Rangeland Health version 4 (qualitative),** http://www.blm.gov/nstc/library/pdf/1734-6rev05.pdf
MIM	**Multiple Indicator Monitoring (quantitative),** http://www.blm.gov/nstc/library/pdf/MIM.pdf
MM	**Monitoring Manual for Grassland, Shrubland and Savanna (quantitative),** http://jornada.nmsu.edu/monit-assess/manuals/monitoring

MVRRA	**Monitoring Vegetation Resources in Riparian Areas (Winward greenline) (quantitative), http://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf**
NRI	**National Resources Inventory (quantitative), http://www.nrisurvey.org/nrcs/Grazingland/2011/instructions/instruction.htm**
PFC	**Proper Functioning Condition (qualitative) ftp://ftp.blm.gov/pub/nstc/techrefs/Final%20TR%201737-9.pdf**
SVA	**Sampling Vegetation Attributes (quantitative), http://www.blm.gov/nstc/library/pdf/samplveg.pdf**
SVAP2	**Stream Visual Assessment Protocol v2 (qualitative), ftp://ftp-fc.sc.egov.usda.gov/NDCSMC/Stream/pubs/NBH_Part_614_Subpart_B_10_Dec_09.pdf**
US&RM	**Utilization Studies and Residual Measurements (mostly quantitative), http://www.blm.gov/nstc/library/pdf/utilstudies.pdf**

Two assumptions underlie all the methods in this handbook:

(1) Georeferenced photos will assist with all methods; and

(2) All indicators benefit from a reference area both for knowledge of potential conditions and potential rate of change/restoration.

As noted in Appendix A, estimating the potential role of current grazing management in causing, sustaining, or exacerbating any indicators associated with unsustainable grazing, additional information may be useful or essential. Such additional information may include site-specific information, assessment of small and large reference areas (e.g., exclosures, inaccessible areas, closed or vacant allotments), historic photos, collateral signs of unsustainable grazing management, signs of use by wild ungulates (deer, elk), actual use information, and/or relevant scientific literature.

We hope this handbook is useful for gathering information that can be shared for collaborative problem solving as well as appreciation of good grazing practices.

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Table of Contents

List of Ecological Indicators

I. UPLAND

1	**Gross, visual indicators of sustainable upland grazing** (qualitative assessment at landscape scale)
1a	**Positive indicators –** examples: • Aspen stands of mixed heights • Diverse grass and forb understory between sagebrush • Biological soil crust • Tall flowering native forbs • Absence of plant pedestaling • Ponderosa pine spacing
1b	**Negative indicators (indicators of grazing management needing change) –** examples: • Lack of aspen recruitment • Bare trampled soil between sagebrush • Pedestaled plants
2	**Soil stability**
2a	**Percent soil cover by ecosystem** (compared to rested areas) Breakdown of: • % plant litter • % plant basal cover • % plant canopy cover • % bare ground
2b	**Evidence of erosion –** examples: • Bare trampled soil between sagebrush • Pedestaled plants • Gullying • Evidence of patterns of water movement
2c	**Soil surface susceptibility to erosion**

3	**Plant species composition** (compared to rested areas)
3a	**Desired plants (see Appendix A)** • Key decreaser species • High value species for soil protection • Native species of high value / structure for wildlife and livestock use
3b	**Desirable plant reproduction / vigor** • **Plant diversity** • **Lack of significant presence of species associated with poor grazing management** • **Full range of size classes of woody species present** ○ Woody plants continue leader growth upward after grazing • **Evidence of seedhead maturation**
3c	**Presence of invasive plants (yes/no)**
4	**Landscape composition and structure** • **Existing vegetation compared to reference area or historic conditions**

II. RIPARIAN

1	**Gross, visual indicators of sustainable riparian grazing** (qualitative assessment at landscape scale)
1a	**Positive indicators – examples:** • Mixed height and dense willow • Mixed height cottonwood • Palatable woody riparian plants • Deep-rooted native riparian plants • Graminoids overhanging banks • Overhanging and vegetated banks • Lack of hummocking in wet meadows
1b	**Negative indicators (indicators of grazing management needing change) – examples:**

	• Riparian areas dominated by shallow-rooted species • Riparian areas lacking in graminoid diversity • Sheared / trampled banks • Significant hummocking of wet meadows
2	**Plant species composition (comparison to reference area)**
2a	**Desired plants (see Appendix A)** • Short list of palatable or decreaser woody riparian plants • Short list of native graminoids that would decrease or disappear with excessive grazing

2b	**Desirable plant reproduction / vigor**
	• **Simplified measure of plant diversity**
	• **Evidence of seedhead maturation**
	  ○ Significant number of seed heads or willow catkins left after grazing
	• **Full range of size classes of woody species present**
	  ○ Woody plants continue leader growth upward after grazing
	• **Percentage of streambank with overhanging vegetation**

2c	**Presence of invasive plants** • Detect first invasive plants
3	**Riparian area structure and function**
3a	**Presence and abundance of deep-rooted vegetation overhanging stream banks** • Identify short list of key palatable woody species, high value species for soil protection, and decreaser key species • Identify short list of unpalatable species
3b	**Presence and abundance of stable stream banks – examples of instability:** • Active cutting (headcutting, ongoing incision) • **Bank trampling and shearing**

4	**In-stream conditions**
	• **Pool depths** • **Sedimentation**
5	**In-stream water quality**
	• **Water quality** • **Macroinvertebrates (at landscape scale)**
6	**Biodiversity**
	• **Potential reproduction/pollination** • **Restoration/reproduction/pollination**

I. Simple Methods For Measuring Upland Indicators

Assumptions:

(1) Georeferenced photos will assist with all methods listed below

(2) All indicators benefit from a reference area both for knowledge of potential conditions and potential rate of change/restoration

Indicator:	**Gross, visual indicators**
Method:	**Georeferenced photos**
	The greater and more systematic the coverage the better
Equipment needed:	**GPS & Camera (georeferencing software is helpful)**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Gross, visual indicators**
Method:	**Field tours for obvious cases everyone agrees on**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**No**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

SOIL STABILITY

Indicator:	**Percent soil cover**
Method:	Error! Reference source not found. **bare ground and litter indicators**
Equipment needed:	**Tape, pointer, pin flag**
Overall difficulty:	**Medium**
More than minimal training?	**Yes/No**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Percent soil cover**
Method:	Error! Bookmark not defined.Error! Reference source not found.**, Volume I p.9 step point or line point cover, or SVA, p. 70 step point method**
Equipment needed:	**Tape, stakes, pin flag**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**No, if the purpose is just measuring effective ground cover. Yes, if want species composition information.**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Percent soil cover**

Method:	**Remote sensing**
Equipment needed:	**Computer, software, satellite data, field verification**
Overall difficulty:	**High expertise, but likely low cost per acre**
More than minimal training?	**Yes**
Plant i.d. needed?	**Only as far as being sufficiently familiar with the area to have an idea of the vegetation type one is looking at.**
Require permanent transect?	**No**
Offsite technical analysis?	**Yes**
Statistical analysis?	**Yes**

Indicator:	**Percent soil cover**
Method:	**SVA p. 64 and p. 31; or paced or line intercept transect and photo points**
Equipment needed:	**Camera, GPS, stakes**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Depends on what is being measured: No if ground cover, Yes if ground cover plus species composition**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Percent soil cover**
Method:	**SVA p. 55 - Daubenmire quadrat**
Equipment needed:	**Camera, tape, GPS, frame**
Overall difficulty:	**High**
More than minimal training?	**Yes**
Plant i.d. needed?	**Depends on what is being measured, ground cover no, ground cover plus species composition yes.**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**

Statistical analysis?	**No**

Indicator: Evidence of erosion

Method: Georeferenced photos

Equipment needed:	**Camera, GPS, stakes**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Evidence of erosion

Method: IIRCv4, indicators 1,3,5,6 and 9

Equipment needed:	**Depends on what is being measured and whether quantified.**
Overall difficulty:	**Varies with indicator and whether quantifying.**
More than minimal training?	**Less than a day**
Plant i.d. needed?	**No**
Require permanent transect?	**Depends on indicator and whether quantified**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Evidence of erosion

Method: Visual review during paced transect

Equipment needed:	**Paper, clipboard**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**

Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Soil surface susceptibility to erosion

Method:	**IIRCv4 Indicator 8**
Equipment needed:	**Bottle caps (qualitative) or soil stability kit (quantitative)**
Overall difficulty:	**Low/Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**No**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Soil surface susceptibility to erosion

Method:	**MM Volume I soil stability test**
Equipment needed:	**Soil stability kit**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**No**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

PLANT SPECIES COMPOSITION *(compared to rested areas)*

Indicator: **Plant diversity**

Method: **Transect plant surveys**

(1) For those unfamiliar with individual species, first walk the transect area and compile list of species or collect one distinctive example or leaf or reproductive structure of each type of plant species seen and tape onto board and/or photograph. (2a) Record plant species intercepted along point-intercept transect, coupled with presence within 3' of the transect; or (2b) Count/list species present within hoops/frames at set distances along the transect.

Equipment needed:	**Camera, GPS, stakes**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes, but can be minimal with species taped on board.**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: **Plant diversity**

Method: **MM, Chapter 10 - Plant species richness**

Equipment needed:	**Plots, tapes**
Overall difficulty:	**High**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Plant diversity**
Method:	**NRI, Chapter 16 – Plant census**
Equipment needed:	**GPS**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Plant diversity**
Method:	**SVA p. 64 - Paced transect or line intercept transect**
Equipment needed:	**Paper, clipboard**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Significant presence of species associated with poor grazing management *(See Appendix A)***
Method:	**IIRCv4, Indicators 10, 12, and 16**
Equipment needed:	**Evaluation sheet**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes, for major species**
Require permanent transect?	**NA**

Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Significant presence of species associated with poor grazing management *(See Appendix A)***
Method:	**Abridged techniques from MM, SVA, NRI**

For any frequency, density, cover, or production method that is species specific, but only consider the indicator species rather than the entire plant community.

Equipment needed:	**Depends on technique**
Overall difficulty:	**Medium**
More than minimal training?	**Perhaps a half day.**
Plant i.d. needed?	**Minimal, just indicator species to identify**
Require permanent transect?	**Yes if recording change at a specific spot.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Significant presence of species associated with poor grazing management *(See Appendix A)***
Method:	**SVA p. 64 and p. 31 Paced or line intercept transect and photo points**
Equipment needed:	**Camera, paper, clipboard**
Overall difficulty:	**LowMedium**
More than minimal training?	**No**
Plant i.d. needed?	**Minimal, with few increasers/weeds to identify**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Significant presence of species associated with poor grazing management *(See Appendix A)***
Method:	**SVA p. 37 - Nested frequency transect**
Equipment needed:	**Nested frequency frame, tape, clipboard**
Overall difficulty:	**Medium-High**
More than minimal training?	**Half day**
Plant i.d. needed?	**Minimal - identifying specific species**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No for site description, but yes if want to compare statistical changes between sample years.**

Indicator: Full range of size classes of woody species present

Method:	**SVA; or any photo, density or frequency technique but with species and size class distinction**
Equipment needed:	**Plots and tapes**
Overall difficulty:	**Low/Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes; minimal if few woody species to identify**
Require permanent transect?	**Yes; if tracking over time**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Full range of size classes of woody species present**
Method:	**MM, Vol. 1 belt transect p. 30**
Equipment needed:	**Stick and tape**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**

Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Full range of size classes of woody species present

Method: Photos

Georeferenced photos may suffice; the greater and more systematic coverage (e.g., a photo with range pole every 10' along a 500' transect) the better.

Equipment needed:	**Camera, GPS, paper and clipboard**
Overall difficulty:	**Low/Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes –for a few woody species.**
Require permanent transect?	**Depends**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Full range of size classes of woody species present

Method: SVA p. 64 and p. 31 photographs - Paced or line intercept transect and photo points

Equipment needed:	**Camera, paper, clipboard**
Overall difficulty:	**Low/Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes, but few woody species to identify**
Require permanent transect?	**Yes if recording change at specific spot; No if getting general condition.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Evidence of seedhead maturation

Method: Transect plant surveys

Representative transect(s) with hoops/ frames at set distances, counting plants with and without flowers/seedheads within the hoop/frame. A subset of the most dominant species could be selected for counting. Photos of plants within the hoops/frames may add to assessment.

Equipment needed:	**Camera, GPS, frames, stakes**
Overall difficulty:	**Low/Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes, but minimal if selecting dominant species.**
Require permanent transect?	**Yes if recording change at specific spot. No if getting general condition**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Evidence of seedhead maturation

Method: IIRCv4, indicator 17 – Reproductive capability of perennial plants

Equipment needed:	**None**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**NA**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Evidence of seedhead maturation

Method: SVA p. 64 and p. 31 Paced or line intercept transect and photo points

Equipment needed:	**Camera, paper, clipboard**

Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Evidence of seedhead maturation**
Method:	**Georeferenced photos**
Equipment needed:	**Camera, GPS, paper and clipboard**
Overall difficulty:	**Medium/Low**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

LANDSCAPE COMPOSITION AND STRUCTURE

Indicator:	**Change in relative coverage of vegetation types**
Method:	**Remote sensing/Google Earth/ satellite imagery over time**
Equipment needed:	**Google Earth (free) for various dates; any other existing aerial images**
Overall difficulty:	**Low if using existing imagery**
More than minimal training?	**No, if trained by an expert**
Plant i.d. needed?	**Yes, but minimal to identify veg types**
Require permanent transect?	**No – just same location**
Offsite technical analysis?	**No, unless attempting to quantify w/ GIS**

Statistical analysis?	**No**

Indicator:	**Change in relative coverage of vegetation types**
Method:	**SVA p. 31 Repeat photos**
Equipment needed:	**Camera, GPS**
Overall difficulty:	**Low**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes: minimal – to identify veg types**
Require permanent transect?	**No; just same location**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Change in relative coverage of vegetation types**
Method:	**SVA p. 64 and p. 31 Photographs - Paced or line intercept transects and photo points in the same location over time**
Equipment needed:	**Camera, GPS, paper and clipboard, tape**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes: minimal – to identify veg types**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

II. Simple Methods for Measuring Riparian Indicators

Assumptions:

(1) Georeferenced photos will assist with all methods listed below

(2) All indicators benefit from a reference area both for knowledge of potential conditions and potential rate of change/restoration

Indicator:	**Gross visual indicators of sustainable riparian grazing**
Method:	**Georeferenced photos; the greater and more systematic the coverage the better**
Equipment needed:	**Camera, GPS, stakes**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Merely need reach location and length formerly photographed.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Gross visual indicators of sustainable riparian grazing**
Method:	**Photos and field tours for obvious cases everyone agrees on**
Equipment needed:	**Camera**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**No**
Offsite technical analysis?	**No**

Statistical analysis?	**No**

Indicator: Gross visual indicators of sustainable riparian grazing

Method:	**Proper Functioning Condition (PFC) protocol**
Equipment needed:	**Camera, GPS**
Overall difficulty:	**Medium**
More than minimal training?	**Yes, usually a 2-3 day class**
Plant i.d. needed?	**Yes, primarily dominant species**
Require permanent transect?	**N/A, this is an assessment tool and not a trend tool**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Percent bare soil (exclusive of rock)

Method:	**SVA p. 64 and p. 31 - Paced or line intercept transect and photo points**
Equipment needed:	**Camera, GPS, stakes**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**Yes**
Statistical analysis?	**No**

Indicator: Percent bare soil (exclusive of rock)

Method:	**MIM, streambank stability and cover p. 47**
Equipment needed:	**Plot frame, tape**
Overall difficulty:	**Medium/High**

More than minimal training?	**Yes**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

PLANT SPECIES COMPOSITION (comparison to reference area)

Indicator:	**Simplified measure of plant diversity (count) (species richness) -- accounting for patch diversity**
Method:	**Transect plant surveys**

(1) For those unfamiliar with individual species, first walk the transect area and compile list of species or collect one example or leaf or reproductive structure of each type of plant species seen and tape onto board and/or photograph. (2a) Record plant species intercepted along point-intercept transect, coupled with presence within 3' of the transect; or (2b) count/list species present within hoops/frames at set distances along the transect

Equipment needed:	**Camera, GPS, stakes**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes: minimal – e.g., with species taped on a board**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Simplified measure of plant diversity (count) (species richness) -- accounting for patch diversity**
Method:	**MM, Chapter 10 - Plant species richness**
Equipment needed:	**Plots, tapes**
Overall difficulty:	**High**

More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Simplified measure of plant diversity (count) (species richness) -- accounting for patch diversity**
Method:	**NRI, Chapter 16 – Plant census**
Equipment needed:	**GPS**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Simplified measure of plant diversity (count) (species richness) -- accounting for patch diversity**
Method:	**MVRRA, cross sections, p. 9**
Equipment needed:	**None**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes, dominants only**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Simplified measure of plant diversity (count; species richness) -- accounting for patch diversity**
Method:	**SVA p. 64 and p. 31 - Paced or line intercept transect and photo points**
Equipment needed:	**Paper, clipboard**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Simplified measure of plant diversity (count; species richness) -- accounting for patch diversity**
Method:	**MVRRA - Greenline**
Equipment needed:	**Stake, camera, GPS, tape**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Simplified measure of plant diversity (count; species richness) -- accounting for patch diversity**

Method:	**MIM – Greenline composition p.39**
Equipment needed:	**Stake, camera, GPS, tape**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: **Significant presence of plant species associated with poor grazing management *(See Appendix A)***

Method: **Transect plant surveys**

Transect with hoops/frames at set intervals,, recording presence and approximate dominance (e.g., 0-25%; 26-50%; >50% of the "increasers" or noxious weeds within the hoop/frame. Use list or photo-annotated list of plant species that become common/dominate with poor grazing management. Depending on extremes or visibility, systematic georeferenced photos may assist.

Equipment needed:	**Camera, GPS, frame, stakes**
Overall difficulty:	**Medium/High**
More than minimal training?	**Half day**
Plant i.d. needed?	**Yes, minimal for the few increasers/weeds to identify**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: **Significant presence of plant species associated with poor grazing management *(See Appendix A)***

Method: **Abridged techniques from MVRRA, MIM, MM, SVA, NRI**

Abridged techniques from MM, SVA, NRI for any frequency, density, cover, or production method that is species specific, but only consider the indicator species rather than the entire plant community.

Equipment needed:	**Plots**
Overall difficulty:	**Medium**
More than minimal training?	**Low**
Plant i.d. needed?	**Yes, some**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: **Evidence of seedhead maturation (including willow catkins)**

Method: **Representative transect(s)**

Representative transect(s) with hoops/ frames at set distances, counting plants with and without reproductive structures/seedheads within the hoop/frame. A subset of the most dominant species could be selected for counting. Photos of plants within the hoops/frames may add to assessment.

Equipment needed:	**Camera, GPS, frame, stakes**
Overall difficulty:	**Low Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes, but minimal if selecting dominant species., e.g., willow**
Require permanent transect?	**Yes if recording change at a specific spot.** **No if getting general conditions**
Offsite technical analysis?	**No**
Statistical analysis?	**Yes**

Indicator: **Evidence of seedhead (including willow catkins) maturation**

Method:	**SVA p. 64 and p. 31 - Paced transect or line intercept transect and photo points**
Equipment needed:	**Camera, GPS, frames, stakes**
Overall difficulty:	**Low/Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes, but minimal if selecting dominant species, e.g. willow**
Require permanent transect?	**Yes only if recording change at a specific spot. No if getting general conditions**
Offsite technical analysis?	**No**
Statistical analysis?	**Yes**

Indicator:	**Full range of size classes of woody species present (site dependent)**
Method:	**Photos**

Georeferenced photos may suffice; the greater and more systematic coverage (e.g., a photo with range pole every 10' along a 500' transect) the better.

Equipment needed:	**Camera, GPS, paper, clipboard**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**Minimal – few woody species to identify**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Full range of size classes of woody species present (site dependent)**
Method:	**A 6' wide belt transect**

A 6' wide belt transect recording height of woody species within a foot increment (e.g., using a range pole) or height classes that will be reported, by woody plant species (if identification not certain, include photos of plant, leaf, reproductive structure)

Equipment needed:	**Camera, GPS, paper, clipboard, tape**
Overall difficulty:	**Low Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Minimal, with few woody species to identify**
Require permanent transect?	**Yes if recording change at a specific spot. No if getting general conditions**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Full range of size classes of woody species present (site dependent)**
Method:	**MIM, woody species age class p. 51**
Equipment needed:	**Plot frame, tape**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Full range of size classes of woody species present (site dependent)**
Method:	**SVA p. 64 and p. 31 - Paced or line intercept transect and photo points**
Equipment needed:	**Camera, paper, clipboard**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Minimal – few woody species to identify**
Require permanent transect?	**Perhaps; or may merely need reach location and length formerly measured.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Percentage of streambank with overhanging vegetation (with channel type as context)**
Method:	**Continuous or set interval measurements**

Measure continuously or within frames at set intervals along the length of streambank with vegetation hanging a set distance (e.g., at least 2") horizontally beyond edge of bank. Record length of rocks or cliff faces separately as N/A.

Equipment needed:	**Camera, GPS, tape or frame, stakes**
Overall difficulty:	**Medium**
More than minimal training?	**Half day**
Plant i.d. needed?	**Minimal**
Require permanent transect?	**May merely need reach location and length formerly measured.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Percentage of streambank with overhanging vegetation (with channel type as context)**
Method:	**Paced distances parallel to the stream bank or ocular estimates**
Equipment needed:	**Camera or clipboard**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No or very minimal**
Require permanent transect?	**No – merely need reach location and length formerly measured**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

RIPARIAN AREA STRUCTURE AND FUNCTION

Indicator:	**Extent of riparian vegetation**
Method:	**Remote sensing**
Equipment needed:	**Computer, software, satellite data**
Overall difficulty:	**High expertise, but may be low cost/acre**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes – Only some species can be detected w/ remote sensing**
Require permanent transect?	**No**
Offsite technical analysis?	**Yes**
Statistical analysis?	**Yes**

Indicator:	**Abundance of deep-rooted vegetation (sedges, rushes, and woody species)**
Method:	**Transect plant surveys**

Objectively-set transects perpendicular to the stream/water body, with hoops/frames at set distances, recording presence and approximate dominance (e.g., 0-25%; 26-50%; >50% of common, deep-rooted woody species and riparian sedges/rushes and grasses within the hoop/frame. Use list or photo-annotated list of common woody species., sedges, rushes

Equipment needed:	**Camera, GPS, frames, stakes**
Overall difficulty:	**Medium/High,but captures riparian, not just greenline.**
More than minimal training?	**Yes**
Plant i.d. needed?	**Minimal**
Require permanent transect?	**Yes if recording change at a specific spot. No if getting general conditions**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Abundance of deep-rooted vegetation (sedges, rushes, and woody species)**
Method:	**PFC, item 11**
Equipment needed:	**None**
Overall difficulty:	**Medium (high expertise)**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**NA**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Abundance of deep-rooted vegetation (sedges, rushes, and woody species.)**
Method:	**MIM, greenline composition**
Equipment needed:	**Plot frame, tape**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Abundance of deep-rooted vegetation (sedges, rushes, and woody species.)**
Method:	**MVRRA, greenline**
Equipment needed:	**Plot frame, tape**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**

Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Abundance of deep-rooted vegetation (sedges, rushes, and woody species.)

Method: SVA p. 31 - Ocular estimates and photo points

Equipment needed: Camera, GPS, paper and clipboard

Overall difficulty:	**Low Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Minimal**
Require permanent transect?	**Depends**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Trampling/shearing associated with hoofprints (depending on channel type and grazing method for restoration)

Method: Georeferenced photos; and/or instream transect

Estimate percent of banks both sides of the transect where banks are trampled and/or sheared, with evidence of ungulate hoofprints.

Equipment needed: Camera, GPS, paper and clipboard

Overall difficulty:	**High-Medium. Can be difficult to estimate percent alteration.**
More than minimal training?	**No, but time must be spent doing actual measurements to get a person's eye calibrated.**
Plant i.d. needed?	**No**
Require permanent transect?	**No, because this is an annual indicator, not measuring trend.**

Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Trampling/shearing associated with hoofprints (depending on channel type and grazing method for restoration)**
Method:	**MIM, streambank alteration**
Equipment needed:	**Plot frame, tape**
Overall difficulty:	**Medium**
More than minimal training?	**Half day**
Plant i.d. needed?	**No**
Require permanent transect?	**No, because this is an annual indicator, not measuring trend.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

IN-STREAM CONDITION

Indicator:	**Pool depths**
Method:	**Number of riffle/pool units and pool depths within a given length of low-gradient stream**
Equipment needed:	**BPS, clipboard**
Overall difficulty:	**Low/Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**No – merely need reach location and length formerly measured**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

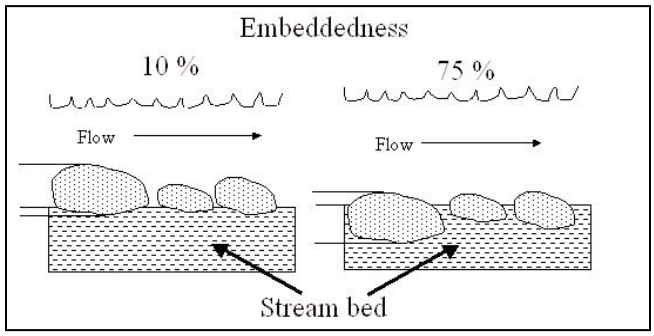
Indicator:	**Pool depths**
Method:	**MIM, pool depth and frequency**
Equipment needed:	**Plot frame, tape**
Overall difficulty:	**Medium**
More than minimal training?	**Yes**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Pool depths**
Method:	**SVAP2, element 10**
Equipment needed:	**None**
Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**NA**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Sedimentation**
Method:	**Embeddedness, per** *User's Guide for the Rapid Assessment of the Functional Condition of Stream-Riparian Ecosystems in the American Southwest*

Randomly select three riffle areas along the reach. Within each area, stand in the middle of the channel and randomly pick up from the bottom six rocks that are 3-8 inches in diameter and note the degree to which each rock was embedded within the substrate. A "sediment\ line" should be readily visible on the rock, separating that portion of the rock which was resting below the streambed and that above the bed in the flowing water zone (Figure below). If the sediment line separates the rock

halfway between top and bottom, the rating is 50% embedded;25% of the rock below the line would be 25% embedded.)



Equipment needed:	**GPS, clipboard**
Overall difficulty:	**Low-Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**No – merely need reach location and length formerly measured**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Sedimentation

Method: PFC, item 17

Equipment needed:	**None**
Overall difficulty:	**Medium (high expertise)**
More than minimal training?	**Yes**
Plant i.d. needed?	**No**
Require permanent transect?	**NA**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Sedimentation**
Method:	**Ocular estimates and photo points**
Equipment needed:	**Camera, GPS, paper and clipboard**
Overall difficulty:	**Low, Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Merely need reach location and length formerly measured.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Sedimentation**
Method:	**Substrate Composition in MIM**
Equipment needed:	**Ruler or rock gauge frame**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

IN-STREAM WATER QUALITY

Indicator:	**Water quality**
Method:	**SVAP2, elements 7, 8, 9**
Equipment needed:	**Data form**
Overall difficulty:	**Low**
More than minimal training?	**No**

Plant i.d. needed?	**No**
Require permanent transect?	**Merely need reach location and length formerly measured.**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: Water quality

Method: Sampling along stream for laboratory analysis

Equipment needed: Sampling equipment, GPS, camera, clipboard

Overall difficulty:	**Medium - Low**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Merely need reach location and langrth formerly measured.**
Offsite technical analysis?	**Yes**
Statistical analysis?	**Yes**

Indicator: Water quality

Method: On-site sampling for turbidity and sediment load

Equipment needed: Sampling equipment, GPS, camera, clipboard

Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator: **Macroinvertebrates (at landscape scale)**

Method: **Sampling per *User's Guide for the Rapid Assessment of the Functional Condition of Stream-Riparian Ecosystems in the American Southwest***

Sampling for aquatic invertebrates should be done at the same locations in riffle areas where embeddedness is recorded. Pick up and, using a hand lens, observe the organisms on six rocks greater than 6 inches in diameter in each of the three riffle areas. Identify (to the Order only: e.g., stonefly larvae, mayfly larvae, caddisfly larvae, beetles) using the illustrations in Appendix 1[See pp. 39-40 in Stacey, et al.; link in references below] or a suitable field guide. List the Orders found on the worksheet. Note the presence of crawfish, but for this protocol, do not include them in the final tally of the total number of orders found in the samples to determine the final score. This is because crayfish are often introduced (non-native) in many streams, and their presence in such situations can be an indicator of other conditions in the stream that are problematic.

Equipment needed: **Data form**

Overall difficulty: **Medium**

More than minimal training? **Half day**
Plant i.d. needed? **No**
Require permanent transect? **Yes**
Offsite technical analysis? **No**
Statistical analysis? **No**

Equipment needed: **Screen/net**
Overall difficulty: **Medium**

Indicator: **Macroinvertebrates** (at landscape scale)

Method: **SVAP2, element 14**

More than minimal training? **No**
Plant i.d. needed? **No**
Require permanent transect? **NA**
Offsite technical analysis? **No**
Statistical analysis? **No**

Indicator: **Macroinvertebrates** (at landscape scale)

Method: **Stream collection at various locations for analysis in the Joint Agency Laboratory at USU**

Equipment needed: **Sampling equipment, GPS, camera, clipboard and paper**

Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**Yes**
Statistical analysis?	**Yes**

BIODIVERSITY

Indicator: **Potential reproduction/pollination**

Method: **Transect plant surveys**

Representative transect(s) with hoops/ frames at set distances, counting plants with and without reproductive structures/seedheads within the hoop/frame. A subset of the most dominant species could be selected for counting. Photos of plants within the hoops/frames may add to assessment.

Equipment needed: **Camera, GPS, frames, stakes**

Overall difficulty:	**High**
More than minimal training?	**Yes**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**Yes**
Statistical analysis?	**Yes**

Indicator:	**Potential reproduction/pollination**
Method:	**US&RM- indirectly through the key species method**
Equipment needed:	**None**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**No**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Potential Reproduction/pollination**
Method:	**Paced transect or line intercept transect and photo points**
Equipment needed:	**Camera, GPS, paper and clipboard**
Overall difficulty:	**Medium**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

Indicator:	**Potential Reproduction/pollination**
Method:	**Georeferenced photos**
Equipment needed:	**Camera, GPS, frames, stakes**
Overall difficulty:	**Medium/Low**
More than minimal training?	**No**

Plant i.d. needed?	**Yes**
Require permanent transect?	**Yes**
Offsite technical analysis?	**Yes**
Statistical analysis?	**No**

Indicator: Restoration/reproduction/ pollination

Method: On-site review during the grazing season

Equipment needed: Camera, GPS, maps, clipboard

Overall difficulty:	**Low**
More than minimal training?	**No**
Plant i.d. needed?	**Yes**
Require permanent transect?	**No**
Offsite technical analysis?	**No**
Statistical analysis?	**No**

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Appendix A

PLANT SPECIES INDICATORS ASSOCIATED

WITH POOR AND SUSTAINABLE LIVESTOCK GRAZING

Purpose of this vegetation chart: Provide vegetation indicators or flags that further assessment might be in order regarding livestock management.

Caveat: The "plant species indicators associated with poor grazing management" identified in this chart may have been wholly or partially caused by other disturbances, e.g., historic rather than (or in addition to) current grazing management, dispersed recreation, fire, flooding, wild ungulate grazing/browsing.

In estimating the potential role of current grazing management in causing, sustaining, or exacerbating these conditions, the following may all be useful or essential: site-specific information (e.g., both long and short term monitoring of compliance, condition and trend transects); small and large reference areas (e.g., exclosures, inaccessible areas, closed or vacant allotments); historic photos; collateral signs of unsustainable grazing management (e.g., trampled banks, bare soil, lack of willow recruitment, erosion); and relevant scientific literature.

Similarly, both short- and long-term reference areas can be useful or essential in estimating the potential of a site to attain conditions associated with sustainable grazing management (column 3 below)

Habitat	**Plant species indicators associated with poor grazing management**	**Plant species indicators of sustainable grazing management**
Riparian	**Dominance of Kentucky bluegrass *Poa pratensis***	**A diversity of sedges/rushes**
	Dominance of dandelion *Taraxacum officinale*	
	***A lack of diversity of sedges/rushes where diversity is expected**	
	Dense stand of Baltic rush *Juncus balticus* and lack of graminoid diversity	
	Dominance of Redtop *Agrostis gigantea*	
	Near-dominance of water birch *Betula* and/or alder *Alnus* or rose where greater contribution of willows would be expected	**A diversity of native riparian woody species, including palatable woody species**
	Mullein *Verbascum* species.	

Uplands	**Lack of diversity of forbs**	**A diversity of native palatable forbs that are taller than a few inches**
	Near-monoculture of exotic pasture grasses, e.g., intermediate wheatgrass, crested wheatgrass in environments where native grasses could be re-established	**A diversity of native grasses**
	Blue grama *Bouteloua gracilis* when a diversity of native grasses is lacking	
	Cheatgrass *Bromus tectorum* – Note: there is a particular need to determine whether or the degree to which it's related to grazing	
	More than insignificant presence of certain species, e.g., • **Stickseed *Hackelia floribunda*, *Lappula occidentalis*** • **Tarweed *Madia glomerata*** • **Pepperweed, *Lepidium* species.** • **Bur buttercup *Ranunculus testiculatus***	
	Dense broom snakeweed *Gutierrizia sarothrae*	
	Presence of exotic invasive species, e.g., yellow sweet clover, houndstongue, non-native thistles *Cirsium* species.	
	Near monoculture of • **Mule's ear *Wyethia ampexicaulus*** • **Arrowleaf balsamroot *Balsamorhiza sagittata*** • **Western coneflower *Rudbeckia occidentalis* specially when associated with other signs of poor grazing management**	
Meadows/ grasslands	**Essentially only "belly flowers"; the only flowers are those within an inch or two of the soil, e.g,:** • **Pussytoes *Antennaria* species.** • **Dandelion *Taraxacum officinale***	**A diversity of native forbs that are taller than a few inches**

	When tall forbs are present, the only ones dominating, and/or common are unpalatable or toxic, e.g., • **Rydberg's penstemon *Penstemon rydbergii*** • **Groundsel *Senecio integerrimus*** • **Death camas *Zigadenus* species.** • **Lupine *Lupinus* species.** • **Yarrow *Achillea millefolium*** • **Larkspur *Delphinium* species.**	
	Near monoculture of Letterman's needlegrass *Stipa lettermanii*	
	Prostrate knotweed, *Polygonum aviculare;* Douglas' knotweed, *P.douglasii*	
Moist/wet **meadows**	**Dominance of certain species, e.g.,** • **Iris *Iris missouriensis*** • **Goldenpea *Thermopsis montana*** • **Cinquefoil *Potentilla gracilis*** • **Clover *Trifolium repens*** • **Kentucky bluegrass *Poa pratensis*** • **Baltic rush *Juncus balticus***	**Diverse native graminoids, forbs**