



San Juan – Rio Grande National Forests
Wilderness Monitoring Manual
Weminuche and South San Juan Wilderness Areas

Revised 1999

TABLE OF CONTENTS

I.	INTRODUCTION.....	2
II.	NATURAL RESOURCE MONITORING.....	2
A)	Natural Resource Monitoring Definition.....	2
B)	Monitoring Capabilities.....	2
C)	Monitoring in a Management Framework.....	3
III.	FIELD PROCEDURES.....	3
A)	Campsite Condition.....	3
B)	Rangeland Health.....	8
C)	Noxious Weeds.....	9
D)	Streambank Trampling.....	10
E)	Encounter Monitoring.....	11
F)	Black Swift Monitoring.....	11
IV.	References.....,	12

I. INTRODUCTION

The Wilderness Act was passed in 1964 creating the National Wilderness Preservation System administered by federal land management agencies (e.g., Forest Service, National Park Service, etc.). In the Act, Wilderness is defined as “federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions...” Congress directed that wilderness areas “be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness.”

Wilderness managers are challenged to manage for natural wilderness conditions while providing recreational opportunities to visitors. National Forests try to accomplish these goals by developing wilderness management plans. The SJ-RG wilderness management team developed our plan, the SJ-RG Wilderness Direction. The wilderness team is composed of representatives from each district and staff from the Supervisor’s Office. The Wilderness Direction describes standards for wilderness conditions in the Weminuche and South San Juan wilderness areas and also in the Piedra Area. In order to know whether wilderness standards are being met, the management team needs on-the-ground information about wilderness conditions. This is the responsibility of the wilderness monitoring crew. The SJ-RG wilderness monitoring crew is based in the San Juan Supervisor’s Office and serves the districts and the wilderness team. The crew collects data on wilderness conditions related to standards in the Wilderness Direction. Results of wilderness monitoring provide information about conditions and allow managers to make decisions based on good evidence.

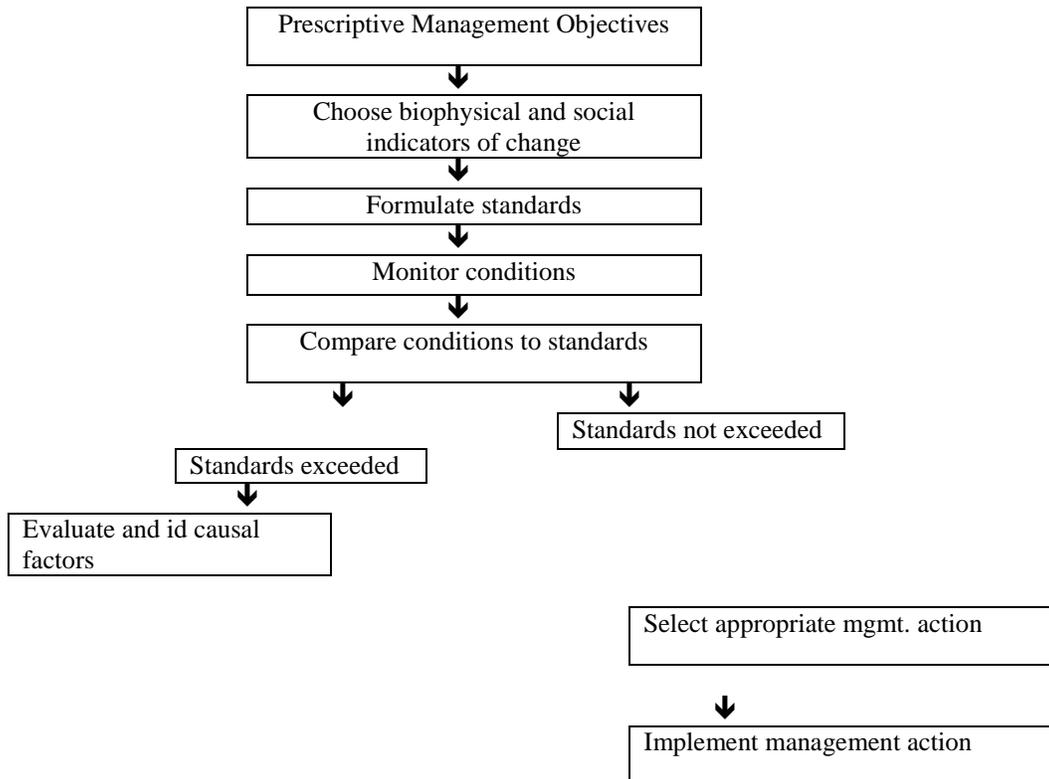
II. NATURAL RESOURCE MONITORING

A) Natural resource monitoring definition - The systematic collection and analysis of resource data at regular intervals, in perpetuity, to predict or detect natural and human-induced changes, and to provide the basis for appropriate management response (Marion, 1991).

B) Monitoring Capabilities (Marion, 1991)

- Identify and quantify site-specific resource impacts.
- Summarize impacts by environmental or use-related factors to detect and evaluate relationships.
- Aid in setting and monitoring management standards for resource conditions.
- Evaluate deterioration in resource conditions to suggest potential causes and effective management actions.
- Evaluate the effectiveness of resource protection measures.
- Identify and assign priority maintenance needs.

C) Monitoring in a Management Framework (Marion, 1991)



III. FIELD PROCEDURES

Follow these procedures closely in order to provide valid and reliable information that is a good basis for management decisions and a good indicator of problems or trends. The monitoring crew collects data on the following:

- Campsite condition
- Rangeland health of meadows grazed by recreational livestock
- Noxious weeds
- Streambank trample

A) CAMPSITE CONDITION

1) **Sampling Plan** – The Weminuche and South San Juan wilderness areas are divided into watershed-based management units called compartments. Wilderness Direction standards are often expressed in terms of compartments (e.g. % campsites in X condition class per compartment). In compartments inventoried in the past, the crew will locate every site with a GPS unit and on a topo map. The monitoring crew will inventory every *new* site but will only inventory every 10th *relocated* site (10% of relocated sites). This should provide a representative sample of campsite condition in a compartment if at least 10 campsites per compartment are inventoried (Cole, 1997). If compartments were not inventoried in the past, *every* site should be located and inventoried.

2) **Data Collection** - We use the adapted Cole (1983a, 1984) method of assessing campsite condition (Appendix A) on most of our campsite inventories unless a more intensive fixed sampling site needs to be monitored (e.g. designated sites at West Fork Hot Springs, Pagosa District; South Shore Emerald Lakes, Columbine District). This system takes two people approximately 10 – 15 minutes.

A) Location Information

- 1) District – Write the district name where you are surveying : Columbine, Pagosa, Divide, Conejos Peak.
- 2) Site Number – Two letter compartment code, three digit site code, two-digit year. It is important that you have a current compartment map and name the site using the appropriate code.
- 3) Previous Site Code – If inventorying a relocated site, write old site number listed on the old topo map.
- 4) Date coded – MM/DD/YY
- 5) Coded by – first initial, last name of recorders
- 6) Section, Township, Range, Elevation – from topo map
- 7) GPS file number – if GPS reading taken, write file number on inventory

B) Ecological Information – use keys and hand outs (Appendix B)

- 1) Vegetation (circle one category)

Alpine/krummholz – at high elevations, above treeline (alpine), transition zone between the continuous sub-alpine coniferous forest and the treeless alpine tundra.

Aspen – dominated by aspen trees. A variety of coniferous trees (e.g., Engelmann spruce and sub-alpine fir or white fir, Douglas fir and blue spruce) may be present as understory or minor overstory components. Aspen stands are intermixed with ponderosa pine forests at lower elevations.

Mixed conifer – dominated by white fir, Douglas fir, and ponderosa pine. Minor components include Engelmann spruce and sub-alpine fir on cooler sites; ponderosa pine on warmer sites; limber pine, southwestern white pine and blue spruce at higher elevations.

Piñon-juniper/Gambel oak – characterized by piñon pine, Utah juniper, and one-seed juniper. Gambel oak is often a component in the understory. Ponderosa pine, Douglas fir, and Rocky Mountain juniper may be minor components in cooler sites (piñon-juniper). Oak-dominated shrublands. Ponderosa pine, Douglas fir, and juniper often present (Gambel oak).

Ponderosa pine – ponderosa pine is the dominant, single species overstory. Douglas fir, white fir, blue spruce, and aspen may be minor components at higher elevations and cool moist sites. Rocky Mountain juniper, Utah juniper, and piñon pine may be codominant in areas. Gambel oak is a common component.

Riparian/wetland – typically adjacent to streams, springs, lakes, and bogs and characterized by species that are different from those of the immediately surrounding non-riparian climax community. Willows may be present.

Spruce/fir – dominated by Engelmann spruce, sub-alpine fir, and corkbark fir. At higher elevations, spruce is usually dominant; at slightly lower elevations, spruce and fir codominate. Douglas fir and white fir are also common at lower elevations. Lodgepole, limber, and bristlecone pine and blue spruce occur as minor components.

Upland Grassland – non-riparian areas where grasses dominate. Thurber fescue, other bunch grasses may be present.

- 2) Ground vegetation (circle one category)

Shrubs – woody plants of relatively low height, usually have several stems rather than one trunk.

Forbs – broad-leaved, non-woody plants.

Graminoids – grasses, sedges, rushes

Tree seedlings & saplings

Moss

Barren – area is naturally bare of vegetation, not due to human activity

- 3) Dominant species – identify both dominant overstory and dominant understory species.

- 4) Land form

Valley bottom – valley floor; broad flat part of a valley

Cirque basin – a deep, steep-walled, flat or gently floored half-bowl-like recess or hollow; horseshoe or crescent shaped; semi-circular. Situated high on the side of a mountain, commonly at the head of a glacial valley. Often contains a small round lake with no prominent inlet or outlet.

Sideslope – sloping surface that forms a hillside or mountainside.

Mesa/plateau – an isolated, nearly level land mass standing distinctly above the surrounding country, bounded by abrupt or steep slopes or cliffs on one to all sides.

Ridgetop – Top or upper part of a hill, narrow or elongated crest of a hill or mountain.

- 5) Distance to System trail (feet) – measure from the middle of the site to the middle of the system trail. System trails are those which are shown on the Forest Service map, currently maintained.
- 6) Screening – estimate if campsite obtrusiveness as it relates to visibility from the trail.
Complete – campsite unobtrusive and screened by terrain, natural features, vegetation.
Partial – campsite visible but partially screened.
None – campsite highly visible.
- 7) Distance to Water – self explanatory
- 8) Type – self explanatory
- 9) Distance to closest campsite – “>500” if more than 500 feet away
- 10) Screening from Campsite – estimate of campsite visibility as it relates to *visibility from other campsites*.
- 11) Maximum party size that can be accommodated – based on available tent space and size of firering.
- 12) Type of use – circle all that apply.
- 13) Firewood – down and dead wood or woody debris.
- 14) Forage – closest source of grass greater than 1 acre

C) Campsite mapping

- 1) Locating sites on topo maps - The location of every campsite should be marked on a topo map and its position recorded with a GPS unit (if possible). If a previously inventoried site is not re-inventoried, the site should be assigned a current site number (the old site number with the year changed) on the topo map. If a GPS reading is recorded, note the Rover file number on the topo map next to the site number. Be sure that it is clear on the topo map that a site was relocated or that you were unable to locate a previously inventoried site.
- 2) Campsite maps – When surveying a new site or re-surveying an old site, draw a detailed campsite map to aid in relocation and to document conditions (Appendix C). Map the campsite by delineating the campsite boundary and marking any relatively permanent features (e.g., large rocks, trees, gravel beaches, firerings, etc.). Draw the trail, any body of water and which way it is flowing or the location of inlets, outlets, or bays in relation to the campsite. If it would be helpful in relocating the site, draw a larger scale map showing nearby campsites in relation to each other and the trail or water. It is also helpful to note what types of trees are in or around the site.

D) Impact Evaluation – Directions from Cole, 1989 and Marion, 1991

- 1) Percent Vegetative Cover

On campsite – Estimate the percent coverage of live understory vegetation. Include forbs, grasses, and mosses. Exclude dead vegetation, duff, tree seedlings, saplings, and shrubs taller than a person. With a large campsite, it may help to divide the campsite into quarters, estimate coverage for each quarter and take the average. You may also visualize all the vegetation in one corner of the campsite and estimate what percentage would be covered. It may be helpful to narrow your decision to two categories and concentrate on the boundary that separates them. For example, if vegetative cover is either 2 (6-25%) or 3 (26-50%), focus on whether vegetative cover is greater than 25%. Include disturbed satellite use areas and include them on campsite map.

Off campsite – Estimate percentage of vegetative ground cover in a nearby largely undisturbed control area. Choose a site that is similar to the campsite in terms of rockiness, tree canopy cover, aspect, and understory species composition.

2) Percent Mineral Soil Exposure

On campsite – Mineral soil exposure is defined as ground with very little or no organic litter. Estimate the percentage of the campsite area that is not covered by live vegetation or duff. If a thin layer of disturbed needles, duff, or wood chips is scattered around with mineral soil showing through, count these areas as exposed mineral soil. Include satellite use areas in your estimate.

Off campsite – Estimate mineral soil exposure on the nearby comparative area used to estimate off campsite vegetative cover.

E) **Rating – Directions from Cole, 1989 and Marion, 1991**

- 1) Vegetation Loss - Using the information on vegetative cover, record the difference in vegetation cover class between campsite and comparative area. If there is no difference (for example, both on campsite and off campsite vegetative cover are in category 2, 6-25%), circle rating 1. If coverage on campsite is one class less than on the comparative area, circle 2. If the difference is greater, circle 3.
- 2) Mineral Soil Increase - Record the difference in mineral soil exposure classes by comparing on campsite and off campsite ratings as with vegetation loss.
- 3) Tree Damage – Count the total number of damaged trees on the campsite, the area visible from the campsite, and any stock holding areas. Never count the same tree on more than one site. Damaged trees include stumps, cut marks, scarred trees, and trees with nails in them. If no trees were damaged, rate the site 1. If one to eight trees were damaged or if one to three trees were felled or had bad scars (scars larger than 1ft², rate the site a 2. If more trees are damaged, badly scarred or felled, rate the site 3.
- 4) Root Exposure – Count the number of trees with exposed roots on the same area as for tree damage. Exposure should be pronounced, extending at least 1 ft from the tree trunk. Exposure should be a result of trampling – not the result of the root running over a rock for example. Assign a rating of 1 (no trees with exposed roots), 2 (on to six trees), or 3 (more than six trees).
- 5) Development – Assign a rating of 1 if there are no facilities – not even a firering. I firering is considered a ring only if the ring of stones is there; if they have been scattered, it is a fire scar. Assign 2 for a site with only one firering, a primitive log seat, or both. Assign a 3 is there is more than one firering, or more elaborate structures like seats, shelves, hitchrails, toilets, etc. If you remove and destroy the structures, assign the rating as it was found and note your actions.
- 6) Cleanliness – Count the number of fire scars on the site including any firerings as fire scars. Assign a 1 if there is only one fire scar and no litter, manure, or human waste. Assign a 2 if there is more than one fire scar or if litter or stock manure is evident. Assign a 3 if litter or stock manure is all over the place or if there is any evident human waste.
- 7) Social Trails – Social trails are the informal trails that lead from the campsite to water, the main trail, other campsites, or satellite sites. Discernible trails are the trails that you can see but that are mostly still vegetated. Well-worn trails are mostly devegetated. Count the number of well-worn and discernible trails. Assign a 1 if there us only one discernible trail and no well-worn trails. Assign a 2 if there are two or three discernible trails or one well-worn trail. Assign a 3 if there are more than three discernible trails or more than one well-worn trail.
- 8) Campsite Area – Estimate the square footage of the disturbed campsite area and any satellite or disturbed stock holding areas. The disturbed area can usually be identified by either shorter or no vegetation in comparison to the periphery of the site. Where there is no vegetation naturally and no other evidence of disturbance to identify the edge of the site, write N/A in the estimated area space and assign a rating of 1. This may also be necessary on lightly used sites where vegetation loss is not evident. Use the geometric figure method to estimate campsite area (Figure 1). Visualize the site as a geometric figure and pace off the dimensions. Calculate area and assign the appropriate rating.

Figure 1: Geometric method for estimating area.

- 9) Barren core area – Bare area may or may not be covered with duff. Areas with scattered vegetation are not counted as bare areas. Include all bare areas on the campsite including the area around the fire, bare tent areas, etc. Calculate the bare area using the geometric method described above and assign the appropriate rating. If the area is naturally devoid of vegetation, write N/A in the estimated area space and assign a rating of 1.
- 10) Woody Debris – Compare woody debris such as fallen sticks and twigs on campsite to a comparative area off campsite. Assign the appropriate rating.

F) Impact Index

The impact index is the sum of the weighted ratings (excluding woody debris). The weights for each parameter follow: vegetation loss (2), mineral soil increase (3), tree damage (2), root exposure (3), development (1), cleanliness (1), social trails (2), camp area (4), and barren core camp area (2). Individual ratings are multiplied by these weights and then the products are summed to determine the impact index. The index can range from 20 (least impact) to 60 (most impact). Ratings are grouped into Frissel-like condition classes. Class 1 (impact ratings 20-25), Class 2 (impact ratings 26-35), Class 3 (impact ratings 36-45), Class 4 (impact ratings 46-55), Class 5 (impact ratings >55). The impact index and condition class for each campsite should be calculated in the office after every trip.

B) MEADOW HEALTH

- 1) **Sampling Plan** – Alpine and riparian area meadows will be inventoried, especially meadows that seem to be impacted or are associated with a campsite.
- 2) **Data Collection** – The following discussion comes from the Committee on Rangeland Classification, Board of Agriculture, National Research Council 1994 Rangeland Health, New Methods to Classify, Inventory, and Monitor Rangelands, National Academy Press, Washington DC.

The process of rangeland degradation is complex and involves interaction of changes in the physical, chemical, and biological properties of soils, as well as changes in plant vigor, species composition, litter accumulation and distribution, seed germination and seedling recruitment, total biomass production, and other ecological functions.

The evaluation of rangeland health is a judgement, not a measurement. Rangeland health is not a physical characteristic that can be measured directly. However, the indicators of rangeland health can be measured. The process outlined here has a three phased approach including an evaluation of abiotic factors (soil stability and watershed function), an evaluation of vegetative conditions and an evaluation of the probability that recovery mechanisms will occur on the area being assessed.

A) Location and Identification Information (Appendix D)

- 1) Date – MM/DD/YY
- 2) Recorded by – First initial and last name of all recorders
- 3) District – name of district (Columbine, Pagosa, Divide, Conejos Peak)
- 4) Compartment – name of compartment from map
- 5) Legal description – Township and range from topo ,map
- 6) Sight code – Compartment, Site number, Year
- 7) GPS file number – take GPS reading and record Rover file number
- 8) Photo – Record number of roll of film and frames. Stand in same spot where you took the GPS reading (Pick out a good spot in relation to stationary objects and take GPS reading and photo from same position). Note time of day, overcast/direct sunlight. Note position on map of meadow and compass bearings to stationary objects (e.g. trees, boulders, etc.). Include landmarks or features in the picture. Keep in mind that in the future, someone will be trying to take the picture from the same spot so be exact.
- 9) Approximate size of meadow – use geometric method used to estimate camp area to estimate meadow area.
- 10) Slope
- 11) Aspect

B) Phase 1 – Abiotic Factors: evaluates soil and watershed function

- 1) A-horizon – Soil layer where the organic matter from plant litter, animal manure, and other sources begin to decompose and becomes incorporated into the soil. Biological activity in the A-horizon is important to the productivity of the site.
- 2) Pedestaling – The occurrence of plants or rocks on pedestals means that the soil has eroded away from the base of the plant or rock and it has become elevated above the eroded surface of the soil.
- 3) Rills and Gullies – Channels made by the rapid flow of water. Indicates soil erosion and water infiltration.
- 4) Scouring or Sheet erosion – Removes or reduces the depth of the a-horizon and deeper soil layers. Indicated by patches of bare soil.
- 5) Sedimentation or Dunes – Accumulation of eroded materials around plants or in small basins. Range from small accumulations to large fan-shaped deposits

C) Phase 2 – Vegetation Conditions: indicator of nutrient cycling and energy flow (Appendix E)

- 1) Dominant native perennial grasses and forbs – common native grasses (Thurber fescue, Arizona fescue, oatgrass), reduction of native grasses may indicate adverse changes are occurring.

- 2) Native plants that normally occur in minor amounts – Many native plants occur in minor amounts with the dominant perennial grasses (on the San Juan these include vetch, Junegrass or Muhly). If the native perennials are reduced due to overgrazing, these species may increase and eventually come to dominate a site (e.g., sites dominated by mule’s war or golden banner).
- 3) Age class distribution – the lack of plants of certain age classes or a predominance of old or deteriorating plants may indicate a change in the plant community’s structure and function.

D) Phase 3 – Recovery Mechanisms: involve extension of biotic control over the abiotic environment through the processes of soil and plant community development

- 1) Litter distribution and incorporation – a fragmented distribution where there are large bare areas between patches of litter and rooted plants indicates unfilled niches and opportunities for erosion.
- 3) Plant vigor – color, seed and rhizome production, size of plants, amount of annual biomass production.
 - a) Class 1: Grasses robust with numerous leaves, seedstalks tall and numerous, leaves dark green. No hedged high-lined browse (tender shoots, twigs, leaves eaten), forage plants reproducing.
 - b) Class 2: Palatable plants lack vigor, forage grasses shorter with fewer seedstalks, few younger forages plants represented. Less-palatable grasses and weeds vigorous.
 - c) Class 3: Grasses weak, forage plants don’t reproduce.
 - d) Class 4: Grasses pale or yellowish, no seedlings, sod is thinning.
- 4) Germination Microsite – depends on moisture, nutrients, and protection from herbivory.

E) Narrative Summary – most descriptive part of the inventory, note type of use (e.g. horse, elk, etc.), and add anything that will help relocate the sit in the future.

F) Map

- 1) Locating sites on topo maps - The location of every rangeland site should be marked on a topo map and its position recorded with a GPS unit (if possible). If a GPS reading is recorded, note the Rover file number on the topo map next to the site number. Be sure that it is clear on the topo map that the site is a rangeland site as opposed to a campsite.
- 2) Rangeland site maps – Draw a detailed site map to aid in relocation and to document conditions. Map the rangeland site by delineating the meadow boundary and marking any relatively permanent features (e.g., large rocks, trees, gravel beaches, campsites, etc.). Draw the trail, any body of water and which way it is flowing or the location of inlets, outlets, or bays in relation to the rangeland site. If it would be helpful in relocating the site, draw a larger scale map showing nearby rangeland sites or campsites in relation to each other and the trail or water. It is also helpful to note what types of trees are in or around the site.

C) NOXIOUS WEEDS

- 1) **Sampling Plan** – Record presence of all noxious weed infestations $\geq 20\text{ft}^2$. Record presence of single plants for knapweed, leafy spurge, and houndstooth.
- 2) **Data Collection**

- A) **Mapping** - Note locations of infestations of noxious weeds on topo map.
- B) **Location and Weed Type Information (Appendix F)** –
 - 1) Date – MM/DD/YY
 - 2) Recorder – First initial, Last name
 - 3) District – Columbine, Pagosa, Divide, Conejos Peak
 - 4) Compartment
 - 5) Site Code – NOX/Compartment/Number/Year
 - 6) Type of Weed
 - 7) Size of Infestation - depending on type of weed and location in wilderness, note either number of plants or size of infestation (if thistles within 1 mile of wilderness border, mark on map if infestation $\geq 20\text{ft}^2$)
 - 8) Narrative – note distance from trail or water, indicate if it is a threat (e.g. a patch of thistles in a grassy meadow poses a bigger threat for expansion than a patch in a tree-dominated area), short narrative summary

C) STREAMBANK TRAMPLING

- 1) **Sampling Plan** – Sampling sites will be selected and prioritized by wilderness managers on each district and by Supervisor’s Office hydrologist (Joanie Vanderbilt).
- 2) **Data Collection** (Appendix G)
 - A) Site number – TRAM/Compartment/Number/Year
 - B) Date – DD/MM/YY
 - C) Recorders – First initials, Last names
 - D) Photos – roll number and frame number, note time of day and weather (overcast/sunny)
 - E) Map – note location of survey site on map and record site number on topo map
 - F) Directions – Select 1 to 3 reaches of stream that are sensitive to trample, where vegetation is the key to holding stream banks together. Pace along the edge of the greenline. At each pace, look for hoof prints within the greenline between you and the water’s edge. Note whether there is trample. Just one hoof print counts as trample. Comment if an area is severely trampled or has only one or two hoof prints. Take at least one hundred notations (hits), with one hit at every pace. Repeat with one hundred hits on the other side of the stream. There are one hundred blanks per side of this page.
 - G) Percentage of trample - Calculate the percentage of trample. If greater than 20%, there is a reason for concern.

D) ENCOUNTER MONITORING

- 1) **Sampling Plan** – Record all encounters on the trail. Stop recording when out of sight of the trail for more than 10 minutes. Begin recording when back on trail or in sight of trail.
- 2) **Data Collection** –
 - A) Date – Record the date in MM/DD/YY format.
 - B) Trail, Compartment, Management Area – Begin a new column every time you enter a new *Trail, Compartment, or Management Area*. Refer to map and note the names of those areas.
 - C) Beginning Time – Record the time you enter each new trail, compartment, or management area.
 - D) People Groups – Record the number of people per group. Separate numbers with commas to indicate different groups (e.g., a group of four people and then a group of two would be recorded as “4,2”).
 - E) Stock Groups – Record the number of people over the number of stock and separate groups with commas (e.g., record two people on two horses with a mule and later one person leading a llama as “2/3, 1/1”).
 - F) Dogs – Record *all* that dogs you see. Record number of dogs “not under control” – defined as dogs that are unleashed, *and* over ten feet from owner, *and* not immediately responsive to commands, or chasing wildlife or livestock, or disturbing people.

- G) Ending Time – Record the time that you leave a trail, compartment, or management area or when out of sight of the trail for more than ten minutes.
- H) Camp Contact – Record the number of camps within sight or sound of each occupied site that you contact.

E) Black Swift Monitoring

- 1) **Sampling Plan** – Conduct monitoring at waterfalls identified by Forest Wildlife Biologist while on regularly scheduled monitoring trips.
- 2) **Data Collection** – Follow Proposed Black Swift Survey Protocol found in Appendix G.

REFERENCES

Cole, David N. 1983a. Monitoring the condition of wilderness campsites. Res. Pap. INT 302. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.

1984. An inventory of campsites in the Flathead National Forest part of the Bob Marshall Wilderness. Unpublished report on file at: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Forestry Sciences Laboratory, Missoula, MT.

1989. Wilderness campsite monitoring methods. Gen. Tech. Rep. INT 259. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station.

1997. Personal Communication, June 13, 1997.

Committee on rangeland Classification. 1994. Rangeland health, new methods to classify, inventory, and monitor rangelands. Board of Agriculture, National Research Council, National Academy Press, Washington DC.

Marion, Jeffrey L. 1991. Developing a natural resource inventory and monitoring program for visitor impacts on recreation sites: a procedural manual. Natural Resources Report/NRVT/NRR-91/06. U.S. Department of the Interior, National Park Service, Denver, CO.