

CHAPTER 4

ECOSYSTEM INTEGRITY: ECOLOGICAL INTEGRITY AND SOCIOECONOMIC RESILIENCY



The land ethic recently described by the Chief of the Forest Service articulates the priorities and commitments toward an ecosystem-based management approach (Thomas 1994). This land ethic links together the concepts of sustainable interactions between humans and ecosystems to maintain health, diversity, and productivity. The management context and priorities are: 1) protect ecosystems, 2) restore deteriorated ecosystems, 3) provide multiple benefits for people within the capabilities of ecosystems, and 4) ensure organizational effectiveness. The SIT assumed the broad goal for ecosystem management of trying to maintain ecosystem integrity. We interpreted this as a focus on the component goals of ecological integrity and socioeconomic resiliency. From the scientific perspective, the ICBEMP has attempted to bring together an understanding of the capabilities of ecosystems within the Basin, to determine the current status of the ecosystems, and to describe the ecological risks and opportunities associated with attempts to achieve assumed goals.

We recognize that there are no direct measures of ecological integrity or socioeconomic resiliency and that this process is not strictly a scientific endeavor (Wickium and Davies 1995). Our assessment of ecosystem integrity draws from the assumed intent of the FS and BLM to achieve particular ecological and socioeconomic goals in the Basin. These two agencies have stated their intentions to file two EISs in order to achieve

broad purposes and needs [see U.S. Government 1994c, (Feb. 28, 1994, 59 FR 4680; revised: May 23, 1994, 59 FR 26624; Dec. 7, 1994, 59 FR 63071)]. These broad purposes are to enhance or maintain ecological integrity while simultaneously providing a sustainable flow of desired goods and services consistent with the capability of the ecosystems.

To provide information useful to FS and BLM managers which was to be considered in the development of new management direction, the SIT addressed three broad questions:

1. Where within the Basin is ecological integrity and socioeconomic resiliency high, medium, or low?
2. Where are there opportunities to improve (restore) ecological integrity?
3. Where are there opportunities to produce desired goods, functions, and conditions with a low risk to ecological integrity?

Both Chapter 4 and Chapter 5 address these questions. Discussions related to questions 2 and 3 are mostly contained in Chapter 5.

The integrity of ecosystems encompasses both social and biophysical components. In this context, ecological integrity refers to the presence and functioning of ecological components and processes. The social and economic counterpart to ecological integrity is resiliency, which in the context of ecosystem management reflects the

abilities of people to maintain well-being through personal and community transitions. To address the three previously listed questions, we developed two composite ratings (ecological integrity and socioeconomic resiliency) which were derived from more specific ratings for individual processes or functions. Application of these ratings to detailed planning at subregional or landscape levels may be inappropriate.

We began by carefully examining all the information brought together through the ICBEMP process to determine which elements might prove most useful in explaining differences in ecological processes and functions across Basin ecosystems. Use of these elements to classify subbasins resulted in six forest and six rangeland clusters of subbasins with common characteristics and descriptions of current ecological conditions. The variables found most useful to explain and characterize the clusters were used to develop relative integrity estimates across the 164 subbasins. We assume that high levels of ecological integrity indicate that evolutionary and ecological processes are being maintained; functions and processes dependent on multiple ecological domains and evolutionary timeframes are being maintained; and viable populations of native and desired non-native species are being maintained. These processes and functions are evaluated in a relative sense within the Basin, so that those areas exhibiting the most elements of a system were rated as high, and those with the fewest elements were rated low. The basic components of ecological integrity include the forest, range, and aquatic systems with a hydrologic system that overlays the landscape as a whole. These actual ratings are shown in appendix B (table B-1).

We rated social and economic resiliency for the 100 counties based on a county typology (specifically, a cluster of counties based on selected attributes). Social and economic resiliency deals with the adaptability of human systems. High ratings imply that these systems are highly adaptable. That is, changes in one aspect are quickly offset by self-correcting changes in other sectors or

aspects. We assume that high levels of socioeconomic resiliency include communities and economies that are adaptable to change, that “sense of place” is recognized in management actions, and that the mix of goods, functions, and services that society wants from ecosystems is maintained. The actual ratings are shown in appendix B (table B-2).

We present these integrity and resiliency ratings as initial estimates based on available information. We acknowledge that these estimates are based on broad proxies for various processes. Some of the proxies for ecological measures, for example, reflect structure rather than the underlying process. These proxies represent the best approximations at this broad extent for the underlying processes that we have at this time. We do not presume to have measured nor revealed the absolute levels of integrity or resiliency within the Basin. Rather, these ratings represent the first attempt at estimating integrity and resiliency at this spatial level. Given more time and information, integrity indices might include direct consideration for elements such as recovery cycles, synergistic interactions between environmental components and biophysical linkages, and feedback mechanisms operating on different spatial and temporal scales within the area.

Ecological Integrity Ratings

Based on the data sets and analysis conducted through the project, each subbasin (4th Hydrologic Unit Code level, see appendix B, fig. B-1) was rated as having high, medium, or low ecological integrity for forestlands, rangelands, forestland hydrology, rangeland hydrology, and aquatic systems. These ratings were based on relative differences between subbasins. The ratings were described for the 164 subbasins [each approximately 800,000 to 1,000,000 acres/325,000 to 400,000 ha and included all ownerships within the Basin (for more detail see Sedell and others 1996)]. The actual ratings combined analysis based on descriptive data layers, empirical process models, trend analysis, and expert judgment. The basic data sets on which the ratings were based are aggregations of data from broad scale map themes,

subwatershed (approximately 8,500 to 25,000 acres/3,500 to 10,000 ha) information, or model projections. We examined all the data sets, model outputs, and map themes brought forward through the ICBEMP or otherwise available for use as possible measures for estimating ecological integrity. We did not have consistent measures of elements that might be considered direct measures of integrity across all ownerships within the Basin. Proxies were selected from the data available to represent a broad array of functions, processes, conditions, and outcomes.

Forestland and Rangeland Integrity

A forest and range (terrestrial environment) system that exhibits high integrity is defined here as a mosaic of plant and animal communities consisting of well connected, high-quality habitats that support a diverse assemblage of native and desired non-native species, the full expression of potential life histories and taxonomic lineages, and the taxonomic and genetic diversity necessary for long-term persistence and adaptation in a variable environment. This interpretation is consistent with, and driven by, the goal of sustainable biotic diversity and the maintenance of ecological processes. Areas exhibiting the most elements of a system with high integrity were rated as high and those with the fewest elements were rated low; the medium rating fell in between.

Forestland integrity ratings were estimated for each subbasin if the forested vegetation component was at least 20 percent of the area. Likewise, relative rangeland integrity ratings were estimated if the rangeland potential vegetation types within a subbasin comprised at least 20 percent of the area of the subbasin. This resulted in 112 subbasins with a forest integrity rating and 86 subbasins with rangeland integrity ratings. Thirty-nine subbasins were classified as both forest and rangeland. There were five subbasins that were predominantly agricultural and were not rated as forest or rangeland.

Forestland integrity

Measures of forestland integrity include such elements as: (1) consistency of tree stocking levels with long-term disturbances typical for the forest vegetation present; (2) the amount and distribution of exotic species; (3) the amount of snags and down woody material present; (4) disruptions to the hydrologic regimes; (5) the absence or presence of wildfire and its effect on the composition and patterns of forest types; and, (6) changes in fire severity and frequency from historical (early 1800s) to the present. Specific proxies for forestland integrity include: (1) proportion of area in dry and moist forest potential vegetation groups; (2) proportion of area having estimated road densities of moderate or greater (> 0.7 miles/sq. mile); (3) proportion of the area in wilderness or essentially unroaded (< 0.1 miles/sq. mile); (4) proportion of the area where fire severity increased between historical (early 1800s) and current periods by at least one class (that is, nonlethal to mixed severity, mixed to lethal, or nonlethal to lethal); and, (5) proportion of area where fire frequency declined between historical and current periods by at least one class (fire frequency classes were 0-25 year return interval, 26-75 year interval, 76-150 year interval, and greater than 150 year interval). Seventeen percent of the forested subbasins have high integrity (fig. 33).

Rangeland integrity

Measures of rangeland integrity include such elements as: (1) grazing influences on vegetation patterns and composition; (2) disruptions to the hydrologic regimes; (3) expansion of exotic species; (4) changes in fire severity and frequency; (5) increases in bare soils; and (6) expansion of woodlands into herblands and shrublands. Specific proxies for rangeland integrity include: a) proportion of area in dry grassland and shrubland potential vegetation groups; b) proportion of area having estimated road densities of moderate or greater (> 0.7 miles/sq. mile); c) proportion of the area in potential agricultural vegetation groups; and, d) the proportion of the area comprised of western juniper and big sage vegetation types. Six percent of the rangeland subbasins have high integrity (fig. 34).

Figure 33—Forest integrity was rated for those 112 subbasins that had 20 percent of their area in forest PVGs.

Figure 34—Range integrity was rated for those 86 subbasins that had 20 percent of their area in range PVGs.

Hydrologic Integrity

Landscapes jointly encompass the terrestrial and aquatic environments so that hydrologic networks operate within basins on the landscape. A hydrologic system that exhibits high integrity is defined here as a network of streams, along with their unique ground water ecosystems, within the broader landscape where the upland, floodplain, and riparian areas have resilient vegetation; where the capture, storage, and release of water limits the effects of sedimentation and erosion; and where infiltration, percolation, and nutrient cycling provide for diverse and productive aquatic and terrestrial environments. This definition is consistent with, and driven by, the goal to maintain ecological processes. Subbasins exhibiting the greatest level of these characteristics were rated high, those exhibiting the least were rated low; subbasins that were between high and low were rated as medium.

A lack of fine resolution stream characteristic data for the Basin necessitated a generalized probabilistic approach for use in determining subbasin hydrologic integrity in this analysis. Information concerning the resiliency of watersheds to disturbance and estimates of past management disturbance to watersheds were both used in determining the current hydrologic integrity of subbasins. Rangeland and forestland subwatersheds were assessed independently in this analysis to facilitate characterization of these environments separately at the subbasin level.

Measures of hydrologic integrity include such elements as: (1) disturbance to water flow; (2) bare soil and disturbances to soil structure; (3) riparian vegetation; (4) sensitivity of stream banks and hill slopes to disturbance; (5) cycling of nutrients, energy, and chemicals; (6) surface and sub-surface flows; (7) stream-specific measurements such as gradient, stream bed substrate, full bank width, and depth; and, (8) recovery potential following disturbance. Specific proxies for forest and rangeland hydrologic integrity include: (1) hydrologic effect variables (for example, surface mining, dams, cropland conversion, and roads); and

(2) sensitivity of stream banks and stream channel function to disturbance. Ratings include potential for sediment to reach streams following road construction; potential for sediment to reach streams following fire or vegetation removal; potential to adversely affect stream hydrologic function through increased sediment or stream flow; inherent stream bank sensitivity; rating of riparian vegetation importance to stream function; and potential for a watershed to recover hydrologic functions following disturbance. Forestland and rangeland hydrologic integrity are shown in figures 35 and 36. Twenty-four percent of the forestland subbasins have high forestland hydrologic integrity (fig. 35). Twenty-one percent of the rangeland subbasins have high rangeland hydrologic integrity (fig. 36).

Riparian disturbance was estimated based on information concerning the sensitivity of stream banks to grazing and the sensitivity of stream channel function to the maintenance of riparian vegetation (*Component Assessment—Biophysical*). In this approach the resiliency of grazed riparian areas was used to infer probable riparian area disturbance since most riparian areas of the Basin have experienced historically high grazing pressure. Areas with low relative grazing resiliency were considered to have high riparian disturbance while areas with relatively high grazing resiliency were considered to have lower riparian disturbance.

The hydrologic and riparian disturbance ratings reflect relative differences in management effect across subbasins within the Basin. These ratings do not, however, indicate the total resiliency of such watersheds to disturbance (that is, their ability to recover following disturbances). To better understand the potential hydrologic integrity of these subbasins, a variety of resiliency ratings were developed for each subwatershed and subbasin (*Component Assessment—Biophysical*). These ratings are used in conjunction with the hydrologic disturbance ratings in the assessment of overall hydrologic integrity. For example, areas with high hydrologic disturbance, and high stream