DEVELOPING WILDLIFE MANAGEMENT OBJECTIVES HAVING A SOUND ECOLOGICAL BASIS: A CASE STUDY

DON C. DeLONG, Jr.,[1] Hart Mountain National Antelope Refuge, P.O. Box 111, Lakeview, Oregon 97630

Key Words: Hart Mountain National Antelope Refuge, livestock grazing, native wildlife communities, planning, problem analysis, sagebrush community

1995 TRANSACTIONS WESTERN SECTION OF THE WILDLIFE SOCIETY 31:12-18

Essential to preparing a quality land management plan is the prudent development of management objectives, which should be solidly founded in principles of ecology and land management. One way to increase the likelihood that management objectives will have a strong foundation in ecological principles is to carry out a problem analysis using the best available scientific information as part of the objective-development processes. Problem analyses are used to isolate underlying reasons why desired conditions, broadly expressed in management goals, are not being achieved (Coughlan and Armour 1992).

In this paper, I use the development of a comprehensive management plan (CMP) for Hart Mountain National Antelope Refuge (Hart Mountain NAR) as a case study to describe several aspects of conducting a problem analysis. My discussion primarily is limited to restoring native wildlife communities in upland shrub communities of the refuge. I begin with an overview of the CMP planning processes. This is followed by a more detailed examination of one aspect of this: the analysis of problems limiting the restoration of native wildlife communities in shrubland areas of Hart Mountain NAR. I close with an example of why objectives with a strong ecological basis are crucial to sound wildlife management.

Hart Mountain NAR is 254,015 acres (102,798 ha) of semi-desert habitat in the northwestern corner of the Great Basin. The dominant vegetation types of the refuge landscape are Wyoming big sagebrush (*Artemesia tridentata wyomingensis*), low sagebrush (*A. arbuscula*), and mountain big sagebrush (*A. t. vaseyana*) (Reiswig et al. 1994a). The Wyoming big sagebrush and low sagebrush vegetation types comprise about 80% of the refuge. Other prevalent vegetation types include aspen (*Populus tremuloides*), willow (*Salix* spp.), and several meadow and playa vegetation types. Hart Mountain NAR is administered by the U.S. Fish and Wildlife Service.

OVERVIEW OF THE HART MOUNTAIN NAR COMPREHENSIVE MANAGEMENT PLAN

A CMP recently was developed for Hart Mountain NAR by the U.S. Fish and Wildlife Service (Reiswig et al. 1994a). This section presents an overview of the main components of the CMP with emphasis on the goals and objectives that address native wildlife communities and their restoration.

Hart Mountain NAR goals were based on the purpose for which the refuge was established and goals of the National Wildlife Refuge System. Two of the five goals of Hart Mountain NAR pertinent to this paper are:

> "Manage for healthy and balanced populations of pronghorn and other species of native wildlife in their natural habitat, to the extent that populations can be influenced on Refuge lands."

> "Restore and maintain, on Refuge lands, the structure, species composition, and processes of native ecological communities and ecosystems of the northern Great Basin Region" (Reiswig et al. 1994a:6).

In order to maximize the probability that these goals would be achieved, and to make efficient use of limited resources, the Hart Mountain NAR planning staff identified underlying reasons why these goals were not being achieved. The following core problems were identified.

> "Shrub and juniper cover are excessively high throughout Refuge uplands, and periodic fires are lacking in these habitats."

> "Stream channels are eroded, and riparian vegetation on streambanks is deficient along the majority of Refuge streams" (Reiswig et al. 1994a:6).

There are two aspects of the problem of excessive shrub cover. One is that about 93% of shrublands are in late succession (Reiswig et al. 1994a). Early and mid succession stages comprise about 2% and 5% of shrubland areas, respectively. This disproportional mix is undesirable because one goal of Hart Mountain NAR calls for the restoration and maintenance of native communities. Fire, having played a major role in sagebrush communities of the Intermountain West prior to Euro-American settlement (Kauffman 1990, Miller et al. 1994), historically maintained a higher proportion of areas in early and mid succession (Winward 1991). Another aspect of the prob-

[1] Present address: Stillwater National Wildlife Refuge, P.O. Box 1236, Fallon, NV 89407

lem of excessive shrub cover is that shrub cover in late succession shrublands of Hart Mountain NAR is up to twice the level considered healthy (DeLong 1993, Reiswig et al. 1994a), based on Winward (1991). Winward (1991) contended that shrub cover above 12-15% in Wyoming big sagebrush stands appears to restrict herbaceous production; below 12%, healthy stands of herbaceous vegetation appear able to persist. Miller et al. (1994) surmised that shrub cover in Wyoming big sagebrush communities probably ranged between 5-10% prior to Euro-American settlement. In a recent assessment of Hart Mountain NAR, shrub cover in the Wyoming big sagebrush type, which comprises one-third of the refuge, averaged 27% (DeLong 1993, Reiswig et al. 1994a).

Of the 98 miles (158 km) of riparian habitat, approximately 73 miles (117 km, or 74%) are in low-moderate condition, or dysfunctional (Pyle 1995). They were considered dysfunctional because of excessive streambank erosion, deformed stream channels, lowered water tables, and diminished composition of native riparian vegetation.

Core problems provided the focal points for the development of long-range objectives, and thus functioned as a link between Hart Mountain NAR goals and long-range objectives. The central theme of long-range objectives was the replication, to the extent possible, of the range of habitat conditions under which native wildlife communities evolved. In the uplands, this meant establishing objectives to increase the acreage of early succession grassland-like communities, to create and maintain a mosaic of different succession stages, and, over the long-term, to increase the cover of native grasses and forbs in the understory of late succession shrub communities. In riparian areas, it meant establishing objectives to stabilize streambanks, to increase the composition of native riparian vegetation, and to raise water tables. An important aspect of long-range objectives of Hart Mountain NAR is that they were developed with the recognition that habitat is a product of ecological processes (e.g. fire, herbivory, secondary succession, soil erosion). Another principle upon which long-range objectives were developed is that plant communities are under constant change as a consequence of disturbances and succession.

Management strategies were designed to resolve core problems, with long-range objectives functioning as targets at which to direct management actions. The CMP emphasized the use of prescribed burning and exclusion of livestock grazing as the primary means to resolve core problems in the uplands and riparian areas (Reiswig et al. 1994a). Recognizing that limited fine fuels may restrict the effectiveness of prescribed fire, that exotic plants may invade treated areas, and that diminished seed sources may prevent re-establishment of desired vegetation, the strategy for achieving long-range objectives also allowed for the following management practices: mechanical treatment, possible use of herbicides, reseeding after shrub reduction, and noxious weed control. Monitoring is a crucial component of the plan, both from the standpoint of determining if long-range objectives are being met and for determining whether assumptions of the CMP were correct, in particular those that address wildlife-habitat relationships.

PROBLEM ANALYSIS

A problem analysis provides an important link between goals and objectives by identifying the underlying reasons why goals are not being reached. A problem analysis is much more than problem identification (Coughlan and Armour 1992). By conducting a problem analysis, long-range objectives and subsequent strategies can be formulated in such a way that they focus limited resources on the root of the problem, thereby avoiding a band-aid approach to management.

Coughlan and Armour (1992) discussed the problem analyses process in detail, presenting several different methods of analyzing problems. In this paper, I describe 2 of these methods: Watson's circles and cause-and-effect trees, both of which are used to examine cause-and-effect relationships. The Watson's circles technique appears to be fairly "user friendly" and can be used in conjunction with one or more other methods such as cause-and-effect trees. However, Coughlan and Armour (1992) specified that Watson's circles were useful for evaluating the causes of problems when 10 or less problems are involved. In exploring cause-and-effect relationships on Hart Mountain NAR, the method was primarily used with subsets of problems, not with the entire set of problems identified for uplands or riparian areas. While somewhat messy, Watson's technique can be used on more than 10 problems. Cause-and-effect trees are useful for exploring problems further. Examples in this section are limited to problems associated with Hart Mountain NAR shrublands.

Watson's Circles

Originally published in a business magazine (Watson 1976), this four-step technique can be used to analyze causes and symptoms of natural resource problems in order to isolate one or more root causes of these problems (Coughlan and Armour 1992). The first step is to list all pertinent problems and symptoms. The second step is to draw circles scattered throughout a piece of paper, a problem or symptom being contained within each circle (Fig. 1a). The third step is to identify the cause-and-effect relationship between problems. For each circled item, an arrow is drawn from the circle to all other circles that identify the symptoms of that particular problem or the problems that it causes or helps to cause (Fig. 1b). Asking the following questions for each circled problem may be helpful: "to what other problems does this problem lead or contribute?" (draw arrow toward other circles) and "what are the causes of this problem?" (arrow is drawn from other circles toward this one). The redundancy in asking both questions at each circle should increase the likelihood of catching all pertinent relationships. Using the problems identified in Figure 1a as an example, the question can be asked "what are the causes of reduced herbaceous cover in upland areas of Hart Mountain NAR?" (Fig. 1b). As illustrated in Figure 1b, historic heavy livestock grazing, the current overabundance of shrub cover throughout much of the refuge, and reduced soil productivity and water availability in some areas were identified as causes of reduced grass and forb cover (Reiswig et al. 1994a).

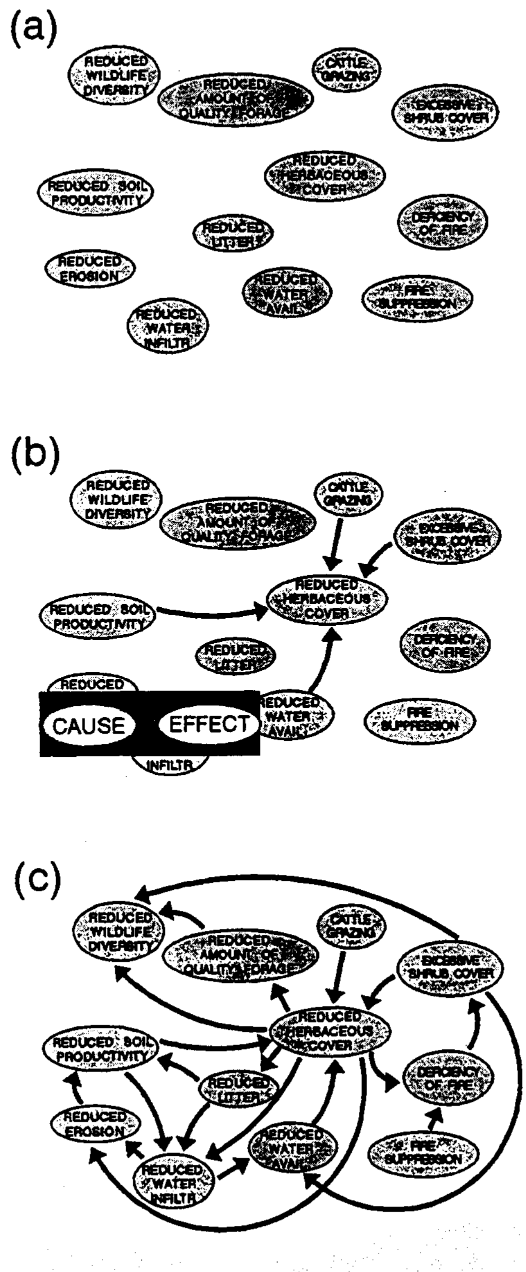

Fig. 1. Steps used in the Watson's circles method of problem analysis, using a simplified example from Hart Mountain National Antelope Refuge, Oregon: (a) list problems, (b) identify cause-and-effects relationships, and (c) identify root causes of problems (those with arrows leading away from them and no arrows pointing in).

The fourth step is to sort through the network of arrows to isolate the root cause(s) of the problems (Fig. 1c). Root causes of problems are those that have arrows pointing away from them, but none pointing toward them. However, while management objectives should be developed with an understanding of root causes of problems, root causes of problems may not always provide meaningful targets for management objectives. The factor(s) that originally caused a particular set of habitat problems may not necessarily be the same as the factor(s) maintaining the habitat in degraded condition. For example, the outcome of the analysis for Hart Mountain NAR suggests that historic livestock grazing and fire suppression are the root causes of problems in uplands (Fig. 1c). However, abandoning fire suppression activities and excluding cattle grazing, alone, likely will not resolve the problems that they have caused on Hart Mountain NAR (Reiswig et al. 1994a). Core problems, the underlying factors maintaining habitats in degraded condition and preventing goals from being achieved, provide more meaningful targets for management objectives. In the following three paragraphs, the differences between the underlying causes of problems and the factors that currently sustain those problems in shrubland areas of Hart Mountain NAR are examined.

Winward (1991:4) argued that "There are more acres of sagebrush-grass lands in the western United States being held in a low ecological status the past decade due to abnormally high sagebrush cover and density than currently is occurring due to livestock grazing." Although Young et al. (1979) and Miller et al. (1994) contended that early livestock grazing in sagebrush communities depleted understories of perennial grasses, allowing sagebrush to increase in density, Laycock (1991) and Winward (1991) argued that removing livestock from these areas would not result in reduced cover of shrubs and increased cover of herbaceous understories. Once sagebrush establishes dominance, this condition has a high likelihood of persisting (Westoby et al. 1989, Laycock 1991). Several exclosure studies, including those of Sneva et al. (1984), West et al. (1984), and Rose et al. (1994), support this theory. Westoby et al. (1989) cited several other studies conducted in desert shrublands and grasslands that found no significant changes in vegetation after livestock were removed. Notwithstanding, some degree of improvement in watershed conditions may occur as a consequence of excluding livestock from upland areas of Hart Mountain NAR, but uplands of the refuge would not be expected to fully recover simply by removing livestock.

A near lack of fire in sagebrush communities appears to have permitted excessive shrub cover to persist once shrub dominance was established. However, even if shrublands in late succession returned to healthy condition as a consequence of removing livestock, the problem of an overabundance of shrublands in late succession would remain. Addressing the other root cause of problems of upland habitats by abandoning all fire suppression activities on Hart Mountain NAR likely would not result in the return of a native fire regime and mosaic of succession stages, at least in the foreseeable future. Winward (1991) contended that reductions in fine fuels that occurred during the period of extremely heavy livestock grazing contributed to the loss of natural fire in sagebrush-grass lands in the western United States. Depleted understories remain a problem on Hart Mountain NAR (Reiswig et al. 1994a). Westoby et al. (1989) and Miller et al. (1994) similarly asserted that an area may be less prone to fire when dominated by woody plants than when it has a relatively high composition of grasses. Depleted understories would make it difficult for naturally ignited fires to spread (Young et al. 1979, Archer and Smeins 1991), and as explained previously, excessive shrub cover appears to be the primary factor controlling reestablishment of herbaceous vegetation in late succession stands of sagebrush. Another consideration is that fire suppression may continue outside Hart Mountain NAR boundaries, reducing the likelihood that fires naturally ignited adjacent to Hart Mountain NAR would spread onto the refuge. Furthermore, a naturally ignited fire on the refuge may create more damage than improvement given the high woody composition of fuels, diminished seed sources, and presence of cheatgrass (*Bromus tectorum*).

Consequently, excessive shrub and juniper cover and lack of periodic fire (as distinguished from fire suppression), in combination, were identified as core problems to be addressed through management. A one-time reduction of shrub cover will not correct the problems, however. In most cases, sagebrush will reestablish after a fire (Tisdale and Hironaka 1981). Therefore, to maintain a mosaic of different successional stages and to maintain a higher level of herbaceous cover in late successional stages (over the long-term), periodic reduction of shrub cover, on a rotational basis, is necessary.

Cause-and-Effect Trees

Another way to analyze problems is through the use of cause-and-effect trees (Coughlan and Armour 1992). Once a problem is recognized, this procedure can be used to

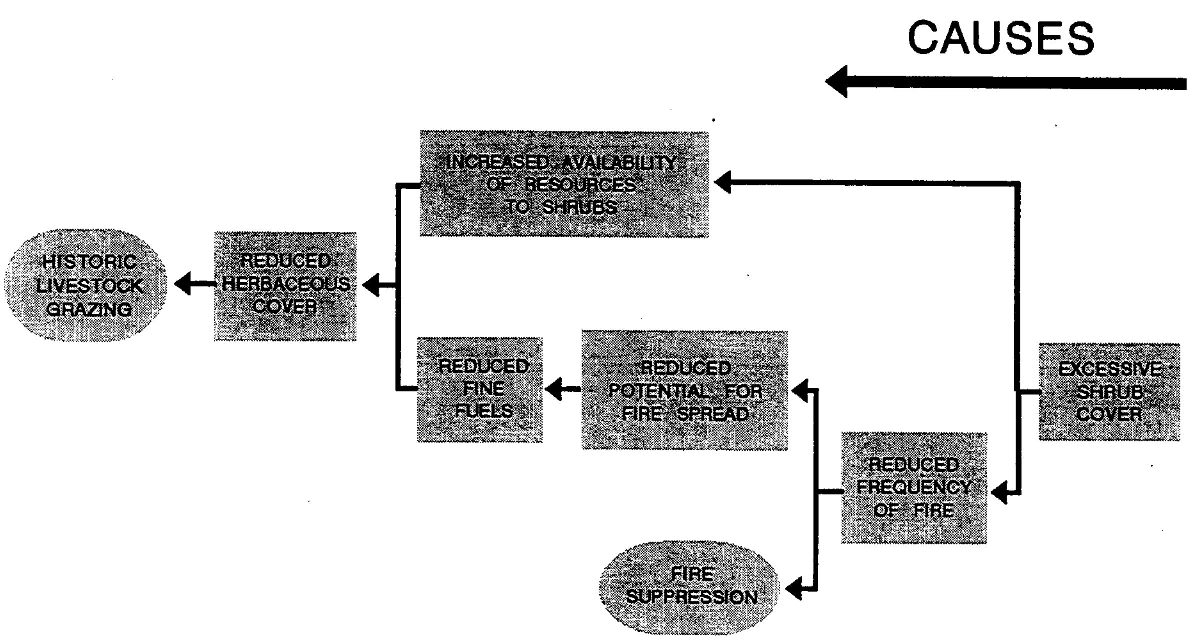

Fig. 2. A model of the causes of excessive shrub cover on Hart Mountain National Antelope Refuge, OR.

identify and further explore underlying causes. For instance, by moving progressively backward (backward analysis)(Coughlan and Armour 1992) from the problem of excessive shrub cover on Hart Mountain NAR, causes of the problem can be traced back to its root causes (Fig. 2).

The root causes of excessive shrub cover identified by cause-and-effect tree (Fig. 2) are the same as those identified by Watson's circles (Fig. 1c): historic heavy livestock grazing and fire suppression.

Effects of excessive shrub cover can be identified and assessed by proceeding in the other direction from the problem (Fig. 3). One possible pathway of effects is as follows. Excessive sagebrush cover can maintain a low amount of herbaceous cover (a), which results in a low amount of standing dead grass and forb material (b), which in turn limits the amount of litter that covers the soil and subsequently is incorporated into the soil (c). Reduced above-ground herbaceous vegetation, litter, and organic material in the soil can hinder water infiltration into the soil (d). One consequence of this is excessive overland flow of water which, along with depleted residual herbaceous vegetation and litter cover, can accelerate soil erosion (e). Soil erosion can contribute to reduced soil productivity (f), which in turn can hamper reestablishment of herbaceous vegetation (a).

Another consequence of reduced amounts of standing dead grass in sagebrush communities is that it appears to be a major cause of lowered nest success of sage grouse (Centrocercus urophasianus) on Hart Mountain NAR (Gregg et al. 1994, DeLong et al. 1995). Additionally, excessive shrub cover may influence sage grouse productivity by maintaining a depleted understory of forbs, some of which may be important to sage grouse during the breeding season. Drut et al. (1994) and Barnett and Crawford (1994) identified several forb species that are important in the diets of sage grouse chicks and pre-laying hens.

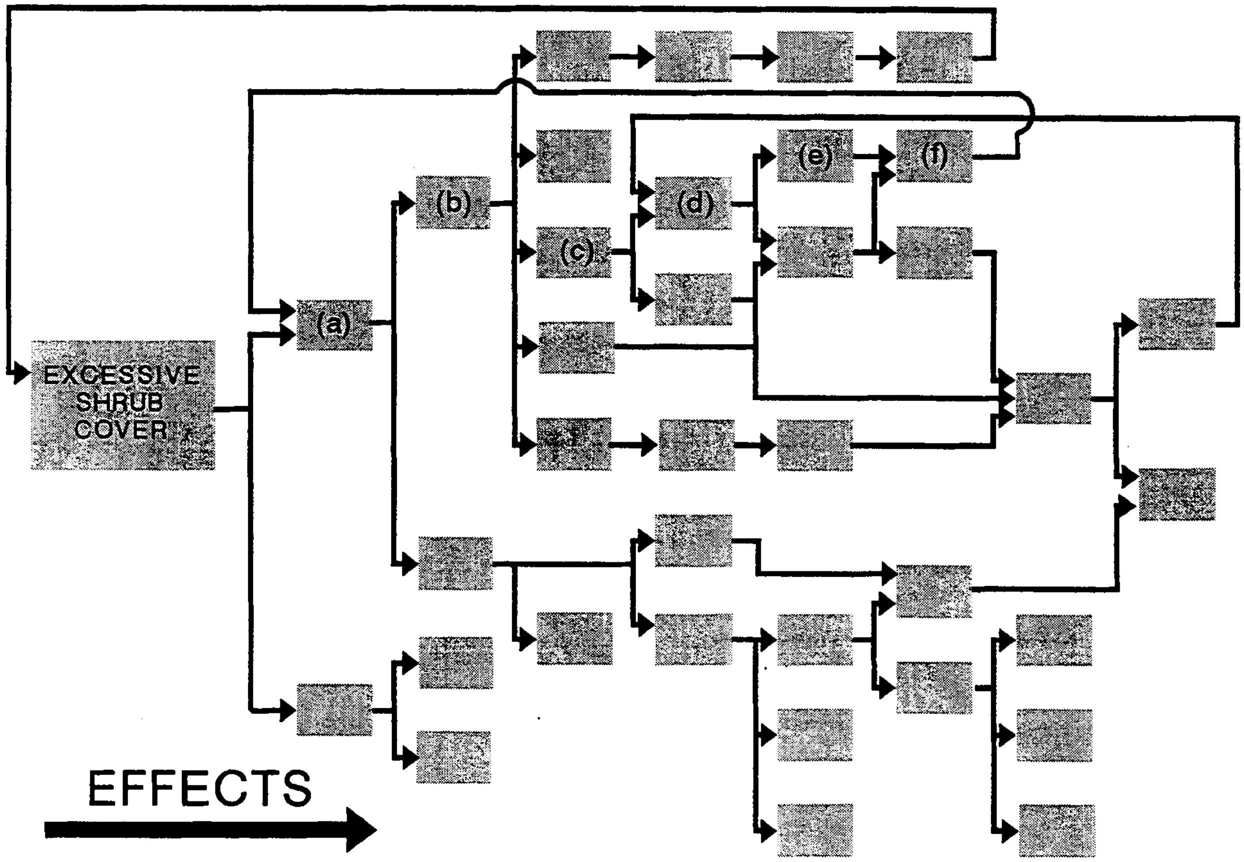

Figure 3. A simplified model of the effects of excessive shrub cover, Hart Mountain National Antelope Refuge, Oregon. In the model, (a) = reduced amount of herbaceous cover, (b) = reduced standing dead herbaceous cover, (c) = reduced litter cover, (d) = reduced water infiltration, (e) = accelerated soil erosion, and (f) = reduced soil productivity.

On a landscape level, about 93% of Hart Mountain NAR shrublands are in a late stage of succession (i.e., shrub dominated). Based on a wildlife-habitat relationships model that he developed, W.H. Pyle (Complex Biologist, Sheldon-Hart Mountain Refuges, Lakeview, OR) estimated that many areas within the major shrubland types on Hart Mountain NAR are inhabited by approximately half the number of the species that would occupy these areas if a mosaic of succession stages were available (Reiswig et al. 1994a). While late successional habitats are abundant on the refuge, early succession grassland-like habitats in the uplands are scarce (Reiswig et al. 1994a). Other examples of impacts of excessive shrub cover on wildlife are provided in Reiswig et al. (1994a,b).

IMPORTANCE OF HAVING AN ECOLOGICAL BASIS FOR LONG-RANGE OBJECTIVES

In the next few paragraphs, I describe a situation that arose during the Hart Mountain NAR planning process in order to illustrate the need to have a solid, ecological basis for long-range objectives and to have a direct and definable link between goals and long-term objectives. The situation involves different viewpoints by several entities relative to the discontinuation of livestock grazing on Hart Mountain NAR. Although it involved other entities (e.g. local ranchers, County Commissioners), I limit my discussion to input received from several range professionals. After the draft CMP/environmental impact statement (EIS) (Reiswig et al. 1993) was released for public distribution and review, several range professionals submitted letters expressing concern that livestock grazing was not included in the preferred alternative as a means to manipulate vegetation for the benefit of wildlife (Reiswig et al. 1994b:Appendix O). Before and after release of the draft CMP/EIS, they identified, with supportive references, several ways in which livestock could be used to enhance habitat for wildlife.

Although the U.S. Fish and Wildlife Service recognized that livestock grazing can benefit certain species of wildlife under some circumstances, no information was located during the planning period indicating that cattle grazing could address wildlife management needs on Hart Mountain NAR, as identified in long-range objectives. Specifically, no information was located suggesting that cattle could be used (1) to periodically reduce sagebrush and western juniper cover; or (2) to stabilize streambanks, return water tables to their historic levels, and restore native riparian vegetation. Nor was information obtained to indicate that cattle could be used to control cheatgrass and other exotic plant species on Hart Mountain NAR. Furthermore, a considerable amount of information suggests that livestock grazing would hamper restoration efforts on Hart Mountain NAR (Reiswig et al. 1994b). Based on long-range objectives, which were based on thoroughly analyzed core problems and contemporary ecological principles, cattle grazing was not included in the management program developed for Hart Mountain NAR (Spear 1994).

Using core problems as the foundation of long-range objectives facilitated efforts to focus attention on important management issues. As an example, several range professionals criticized the draft CMP/EIS because it did not propose the use of livestock to enhance the nutritional quality of forage plants for wildlife on Hart Mountain NAR (Reiswig et al. 1994b:Appendix I,O). This was one of the main arguments in favor of maintaining a livestock grazing program on the refuge. However, none of the long-range objectives identified for Hart Mountain NAR called for enhanced forage plant quality (Reiswig et al. 1993), as existing forage plant quality was not a core problem. Furthermore, attempting to use livestock to enhance forage quality could detract from efforts to achieve goals established for the refuge. In short, working from different sets of objectives impedes agreement on management strategies.

ACKNOWLEDGEMENTS

U.S. Fish and Wildlife Service personnel with primary responsibility for preparing the Hart Mountain NAR CMP/EIS, in addition to the author of this paper, were B. Reiswig, W.H. Pyle, and R.A. Miller. J.D. Yoakum also contributed significantly to its preparation. I thank J.D. Yoakum, J.G. Kie, E. Loft and B. Valentine for reviewing the manuscript, and A.K. DeLong and K.M. Kilbride for reviewing preliminary drafts of the manuscript.

LITERATURE CITED

Archer, S. and F.E. Smeins. 1991. Ecosystem-level processes. Pp. 109-139 *In* R.K. Heitschmidt and J.W. Stuth (eds.). Grazing management: an ecological perspective. Timber Press, Portland, OR. 259pp.

Barnett, J.K., and J.A. Crawford. 1994. Pre-laying nutrition of sage grouse hens in Oregon. J. Range Manage. 47:114-118.

Coughlan, B.A.K. and C.L. Armour. 1992. Group decision-making techniques for natural resource management applications. U.S. Dept. of Interior, Fish and Wildl. Serv., Resource Publ. 185, Washington, D.C. 55pp.

DeLong, A.K., J.A. Crawford, and D.C. DeLong, Jr. 1995. Relationships between vegetational structure and predation of artificial sage grouse nests. J. Wildl. Manage. 59:88-92.

DeLong, D.C. Jr. 1993. Vegetation cover on Hart Mountain NAR, 1989-1992. Unpubl. rep., U.S. Fish and Wildl. Serv., Sheldon-Hart Mountain Refuges, Lakeview, OR. 14pp.

Drut, M.S., W.H. Pyle, and J.A. Crawford. 1994. Technical note: diets and food selection of sage grouse chicks in Oregon. J. Range Manage. 47:90-93.

Gregg, M.A., J.A. Crawford, M.S. Drut, and A.K. DeLong. 1994. Vegetational cover and predation of sage grouse nests in Oregon. J. Wildl. Manage. 58:162-166.

Laycock, W.A. 1991. Stable states and thresholds of range condition on North American rangelands: A viewpoint. J. Range Manage. 44:427-433.

Kauffman, J.B. 1990. The ecology of fire in rangelands: historical and current contexts. Pp. 2-5 *In* T.E. Bedell, (tech. ed.) Proc. 1990 Pacific Northwest range management short course: fire in Pacific Northwest ecosystems. Oregon St. Univ., Dept. Rangeland Resources, Corvallis, OR. 123pp.

Miller, R.F., T.J. Svejcar, and N.E. West. 1994. Implications of livestock grazing in the Intermountain sagebrush region: plant composition. Pp. 101-146 *In* M. Vavra, W.A. Laycock, and R.D. Pieper (eds.). Ecological implications of livestock herbivory in the West. Society for Range Management, Denver, CO. 297pp.

Pyle, W.H. 1995. Riparian habitat restoration at Hart Mountain National Antelope Refuge. Rest. and Manage. Notes 13:40-43.

Reiswig, B., D.C. DeLong, Jr., W.H. Pyle, and R.A. Miller. 1993. Hart Mountain National Antelope Refuge comprehensive management plan draft environmental impact statement (volume I). U.S. Fish and Wildl. Serv., Region 1, Portland, OR. 273pp.

_______., D.C. DeLong, Jr., W.H. Pyle, and R.A. Miller. 1994a. Hart Mountain National Antelope Refuge comprehensive management plan final environmental impact statement (volume I). U.S. Fish and Wildl. Serv., Region 1, Portland, OR. 326pp.

_______., D.C. DeLong, Jr., W.H. Pyle, and R.A. Miller. 1994b. Hart Mountain National Antelope Refuge comprehensive management plan final environmental impact statement (volume II: appendices). U.S. Fish and Wildl. Serv., Region 1, Portland, OR. 503pp.

Rose, J.A., R.F. Miller, and T. Svejcar. 1994. Vegetation and livestock exclusion in the sagebrush steppe. Pp. 53-59 *In* Oregon State Univ. Agric. Exp. Stat. Spec. Rep. 935.

Sneva, F.A., L.R. Rittenhouse, P.T. Tueller, and P. Reece. 1984. Changes in protected and grazed sagebrush-grass in eastern Oregon, 1937-1974. Oregon St. Univ. Agric. Exp. Stn. Bull. 663. Corvallis, OR. 11pp.

Spear, M.J. 1994. Record of Decision: Hart Mountain National Antelope Refuge comprehensive management plan final environmental impact statement. U.S. Fish and Wildl. Serv., Region 1, Portland, OR. 34pp.

Tisdale, E.W. and M. Hironaka. 1981. The sagebrush-grass region: a review of the ecological literature. Univ. of Idaho Range, For., and Wildl. Exp. Stn. Bull. 33, Moscow, ID. 31pp.

Watson, C.E. 1976. The problems of problem solving. Business Horizons 19:88-94.

West, N.E., F.D. Provenza, P.S. Johnson, and K.M. Owens. 1984. Vegetation change after 13 years of livestock grazing exclusion on sagebrush semi-arid-desert in West Central Utah. J. Range Manage. 37:262-264.

Westoby, M., B. Walker, and I. Noy-Meir. 1989. Opportunistic management for rangelands not at equilibrium. J. Range Manage. 42:266-274.

Winward, A.H. 1991. A renewed commitment to management of sagebrush grasslands. Pp. 2-7 *In* R.F. Miller, (ed.) Management in the sagebrush steppe. Oregon St. Univ., Agric. Exp. Stn. Special Rep. 880, Corvallis, OR. 48pp.

Young, J.A., R.A. Evans, and P.T. Tueller. 1976. Great Basin plant communities - pristine and grazed. Pp. 186-215 *In* R. Elson, (ed.). Holecene environmental change in the Great Basin. Nev. Arch. Surv. Res. Pap. No. 6. Reno, NV.

Young, J.A., R.E. Eckert, Jr., and R.A. Evans. 1979. Historical perspectives regarding the sagebrush ecosystem. Pp. 1-13 *In* The sagebrush ecosystem: a symposium. Utah State Univ., Logan, UT.