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Development of Management Prescriptions for Modeling Disturbance Regimes and Succession in the Interior Columbia River Basin

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INTRODUCTION

The Columbia River Basin SUccession Model (CRBSUM) (Keane and others 1996), a landscape succession model, was developed as part of a broad scale scientific assessment of the Interior Columbia Basin and portions of the Klamath and Great Basins (ICB). CRBSUM uses a multiple pathway approach to model successional dynamics where succession classes are linked along succession pathways and disturbances occur based on stochastic probabilities. A given type of environment with similar succession and disturbance response is represented by a Potential Vegetation Type (PVT) (Keane and others 1996). Other factors, such as succession age or disturbance, affect the rate at which the changes in succession class occur. Disturbance usually causes immediate change in succession class. Disturbance generally alters the pathway that the given succession class would follow in the absence of the disturbance and instead, sends it to a different succession class. Disturbances are modeled stochastically in CRBSUM using probabilities, stratified both spatially and temporally, that are determined by the developer of the model given a certain management scenario (or future). Within a management scenario, each disturbance probability is conditional on the management region. PVT and succession class may also affect the disturbance probability where, for instance, structural stages in moist, productive PVTs, with high timber volume would more likely be harvested, given a certain management scenario. Management regions are stratified to identify the geographic area for simulation of a given type of management. As a result, for each management scenario and management region combination, there are a unique "set" of probabilities that determine a disturbance regime for a particular PVT.

Phase I - Modeling and Testing Scenarios of Management

Initial model development and fine tuning of model parameters utilized a PC based succession model, the Vegetation Dynamics Development Tool (VDDT) (Beukema and Kurtz 1996). VDDT used the same algorithms as CRBSUM and allowed the user to evaluate one PVT at a time. Through a series of workshops, which assembled a wide group of both forest and range ecologists and resource specialists (Byler and others 1996; Long and others 1997), over eighty succession models were developed to predict the succession dynamics of ICB vegetation at the coarse scale.

Four management scenarios were designed for each of these models (Keane and others 1996). These included historical (HI), consumptive demand (CD), passive management (PM), and active management (AM). The Historical management scenario was used to predict disturbance and successional dynamics prior to the extensive influence of Euro-American settlement. Disturbance types, probabilities, and effects were consistent with our data on vegetation structure and dynamics prior to the year 1900. The Passive management scenario emphasized management of Bureau of Land Management- and Forest Service-administered lands (BLM/FS) for recreation, education, and research with minimal emphasis on commodity production. Fire suppression efforts were assumed to continue at current levels but with an emphasis on protection of lives and property rather than the standing crop of commodity resources. In the Consumptive Demand management scenario, the

emphasis was assumed to maximize commodity production through grazing, timber harvest, and other management practices. The effects of disease, insects, and fire were prevented or suppressed where economical. The Active management scenario focused on the maintenance of functioning ecosystems within their inherent succession/disturbance regime as constrained by their biophysical capability. The objective was to simulate management for a properly functioning system as described in Landscape Dynamics of the Basin (Hann and others 1997). Timber harvest, grazing, prescribed fire, fire suppression, and other forest and rangeland management activities were designed to achieve vegetation structure consistent with ecosystem function and process. Fire, disease, insect, and other disturbance functions were maintained where feasible, generally through vegetation manipulation. The effects of introduced agents were assumed to be mitigated.

Different management scenarios were also developed for different management regions. Management regions identified a geographic area with a certain type of management. We addressed three management regions: 1) Wilderness and National Parks, 2) BLM- and FS-administered Lands, and 3) Private and Tribal Lands (Byler and others 1996; Long and others 1997). Historical models had only one management region, Wilderness and National Parks, since historically disturbance probabilities did not vary geographically; there were no ownership or administrative boundaries such as currently exist. At the close of the workshops, participants had built all pathway information in a succession file for each PVT as well as a number of scenario files for each PVT to reflect a wide range of management approaches.

Phase II - Use of VDDT Modeling for CRBSUM Simulations

Phase II involved the many different simulations of spatial and temporal response through the use of CRBSUM. These involved a test simulation on the Yakima subbasins, a test run of scenarios, multiple simulations using the same input files to assess potential differences caused by stochastic parameters (Keane and others 1996), several iterations of Draft Environmental Impact Statement (DEIS) alternatives, and a simulation of management scenarios for the science assessment (Quigley and others 1997).

The first step in a CRBSUM simulation involved the transfer of succession and disturbance relationships and coefficient information for each PVT from the VDDT model files or the PARADOX data files into the CRBSUM data format. Prior to transfer of data for each CRBSUM simulation, the VDDT models or the PARADOX data files were reviewed by a small group of project ecologists[1] to evaluate for consistency between PVTs, scenarios, and management regions. Test CRBSUM simulations were conducted using the input files for VDDT which resulted in iterative rectification of succession and disturbance model files with other input files in CRBSUM. These test simulations were required in order to rectify relationships between the input CRBSUM files, which included the PVT, cover type,

[1]This group usually consisted of Wendel Hann, Don Long, Jim Menakis, and Bob Keane, with help from other ecologists (as available), at the U.S. Forest Service Fire Lab in Missoula, Montana.

structural stage, and management regions, and the input successional pathway and disturbance files coming from VDDT. The tested and rectified results became the CRBSUM scenario data file that was the base for development of 17 different management prescriptions.

In order for the reader to understand this complex relationship, we emphasize that VDDT modeling did not display or account for spatial relationships - only changes in vegetation and dynamics of disturbance through time, for a given type of environment. However, the input files of successional change and probability of disturbance can be used in association with various GIS models that have the appropriate environment and successional classes. For the Interior Columbia Basin Ecosystem Management Project (ICBEMP), the environmental classes used in VDDT modeling were PVTs and the successional classes were structure/cover type combinations. The VDDT succession and disturbance probability files were used in conjunction with the CRBSUM model (Keane and others 1996). However, the relationships between the nonspatial VDDT files and the CRBSUM spatial/temporal files were not direct. The nonspatial VDDT modeling emphasized understanding of changes through time for a given type of environment. In contrast, the spatial/temporal CRBSUM modeling emphasized projection of the changes through time and across space of many different types of environments. Consequently, spatial combinations of environment, successional states, and disturbance regimes may often occur in CRBSUM that were not well represented in the non-spatial VDDT modeling. For the ICBEMP spatial modeling, these differences were rectified in the CRBSUM succession and disturbance models, but were not rectified in the VDDT models. This choice was deliberate, because making the changes in the CRBSUM data files was much more efficient and consistent. Rectification of relationships or development of different response variations could be done with the CRBSUM data files quickly and consistently across many different types, as compared to making the changes in each of the many VDDT models. In addition, trends in probabilities and lists of classes and rates of change could be summarized from the CRBSUM files and compared across many types.

Consequently, in some cases the successional classes, rates of change, or disturbance probabilities could be different between VDDT and CRBSUM files. For the ICBEMP, we found the VDDT model most useful for developing our understanding of succession and disturbance, and for subsequent sensitivity testing to examine relationships between multiple disturbances and succession through time in one type of environment. In contrast, we found CRBSUM most useful for understanding the various spatial combinations of environment, successional classes, disturbances, and differences in management scenarios as they changed and interacted through time.

Management prescriptions for the various iterations of alternatives and the final science assessment scenarios were constructed from the original VDDT succession and scenario files in a two-step process. First, we developed a group of ICB DEIS management prescriptions for the No Action Alternative[2], designed to depict current management direction, based on the BLM/FS Forest and

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[2]We emphasize that “no action” does not mean no management. This term is a term that implies no change in current management.

Resource Management Plans as currently written and implemented at current funding levels. Next, we developed an additional suite of management prescriptions to depict the Action Alternatives, which provided a diverse range of potential future management outcomes of vegetation compositions, structures, and associated disturbances. In addition, the original historical models developed during the workgroup effort (Byler and others 1996) were reviewed and fine tuned to serve as baseline data for vegetation change from historical to current. This process enabled modification of individual probability sets or creation of new ones from existing probabilities using a series of database queries in conjunction with a number of other reference tables, which helped to modify groups of PVTs, cover types, structural stages, or disturbances.

Figure 1 shows the flow of data files from VDDT, through the database and back to VDDT. In Step 1, individual succession files, developed during the workshops in VDDT, were saved as comma-delimited ASCII text files. These succession files contained both successional development and disturbance pathway information for every PVT. In Step 2, individual scenario files, developed during the VDDT workshops, were also stored as comma-delimited ASCII text files. There was one scenario file (.scn) for each PVT and management scenario. In Steps 3 and 4, these text files were imported into relational databases. One database contained all pathway information while the other stored all disturbance probabilities for each probability set. In Step 5, pathway information was modified based on any new disturbances, and by using the report function in the database, these databases were converted to the new VDDT succession file format for each PVT. In Step 6, individual probability sets from the original workshop scenario file information for all PVTs were expanded into multiple management prescription options through database queries. The primary expansion of the original VDDT workshop files took place during Step 6. We extracted individual probability sets for all successional pathway models and evaluated them for potential use in modeling the ICB DEIS Alternatives. We applied rule sets to the disturbance probabilities contained in these probability sets through database queries in order to construct 17 different management prescriptions and a historical simulation for each successional pathway model. These prescriptions were designed for use in various combinations to model effects of the ICB DEIS Alternatives across the entire ICB. Each prescription was stored as an individual database. Text files were created in the new VDDT scenario file format from database reports in Step 7 for each new probability set for each PVT. In Steps 8 and 9, some final text editing was done to prepare the final VDDT management prescription succession file and scenario files.

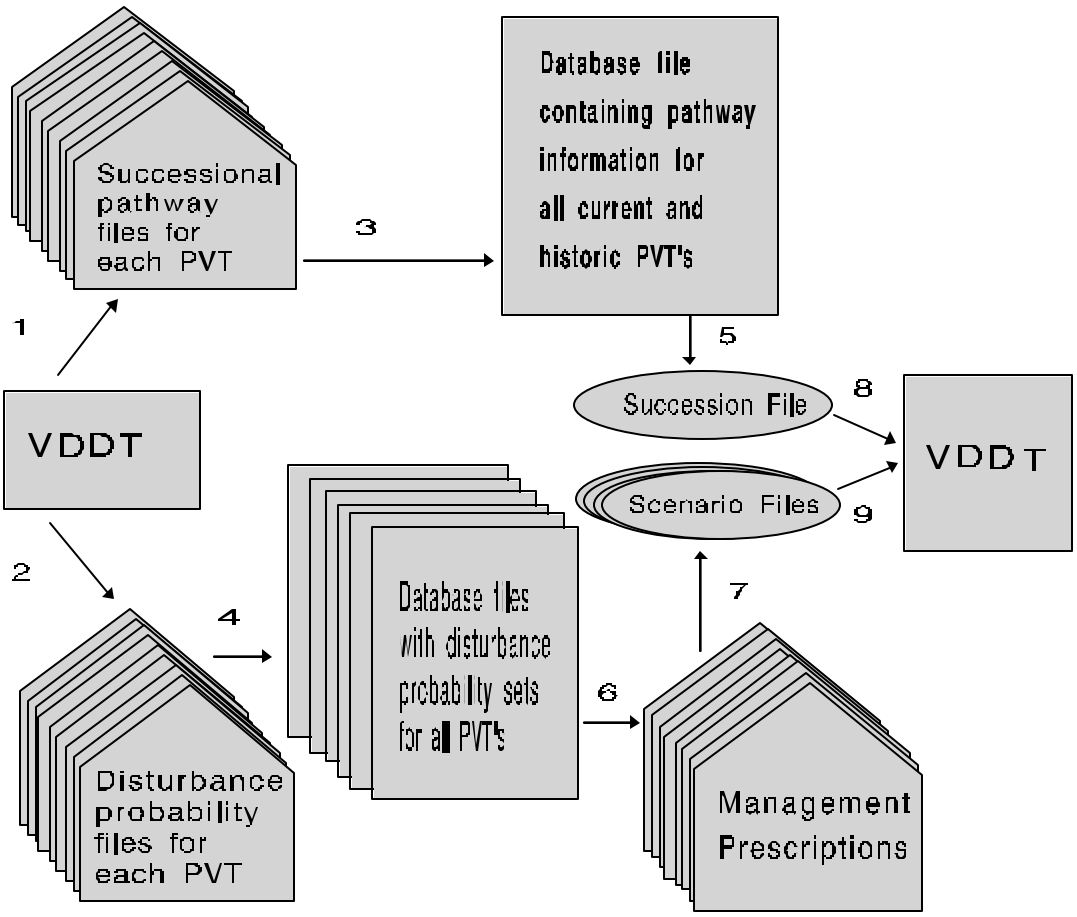

Figure 1.--The flow of vegetation data between VDDT, Paradox, and CRBSUM for simulation of the ICB Draft EI
Alternatives.

MANAGEMENT REGIONS

Since CRBSUM was used to simulate change across the entire ICB assessment area, the process used for developing the ICB DEIS Alternatives required probability sets that were consistent across the Basin. In any given scenario or alternative there were a variety of management regions within each EIS area as well as differences between the two EIS areas. Initial efforts at developing probability sets focused on management regions such as "Wilderness and National Parks," "USFS and BLM Lands," and “Private, State, and Tribal Lands." Simulation modeling for the ICBEMP DEIS alternatives required more refined management regions to show differences in management regimes across the federally administered lands. This more refined classification was created by using Management Area Categories (MACs) which combined both FS and BLM lands into one of eight management area categories (Gravenmier and others 1997).

These eight categories were then aggregated into three management regions. MACs 1 and 2 consisted mostly of wilderness-like landscapes with primarily natural disturbance processes and included areas designated as Wilderness, Wild Rivers, and Research Natural Areas (RNAs). MACs 3 and 4 encompassed landscapes with a mixture of natural and human disturbance processes and included areas designated as Scenic Rivers, National Recreation Areas, and Visual Emphasis Zones. MACs 5, 6, 7, and 8 consisted of landscapes with predominantly human-caused disturbance processes including areas designated as Forest-Timber Emphasis, Range/Non-forest- Grazing Emphasis, and Public/Private intermixed lands. Areas designated as MACs 3 and 4 and MACs 5, 6, 7, and 8 were also stratified by whether they were roaded or unroaded (Menakis and others 1996). In addition, the Greater Yellowstone Ecosystem area was separated from the two EIS areas (Upper Columbia River Basin EIS area and Eastside EIS area), which further stratified the management regions. As a result there were a total of twenty one different management regions.

Management prescriptions were designed for simulation modeling purposes to offer a variety of outcomes representing different approaches to management of succession and disturbance. These different prescriptions could then be “fit” as appropriate for a given scenario or alternative to the different management regions found on federal lands. In general, the prescriptions were based on various mixtures of management policies that emphasized either "natural" disturbance processes that maintained "native" composition and structure of vegetation and soils, or "human" disturbance processes that maintained or departed from native composition and structure of vegetation and soils. In this context, "natural" inferred the frequency and type of disturbances that were prevalent prior to the Euro-American settlement and the effects from development of the cattle and timber industries, in association with wildfire suppression. "Native" inferred the dominant species and/or structures of vegetation that were indigenous to the ICB prior to introduction of exotic species in the late 1800s, and also included "naturalized" species that do not dominate in the absence of human-related disturbance. This did not infer any one point or "snapshot" in time, but the pattern of changes that would occur through time under those succession and disturbance regimes. We referred to this concept as the historical range of variability (HRV) (Morgan and others 1994).

Action management prescription set G1 was designed to simulate management for non-commodity management regions that maintained or restored natural disturbance processes that contributed to maintaining native composition and structure with little influence from human-related disturbance processes. Action management prescription set G2 was designed to simulate management that produced a moderate level of commodities using a mixture of human-related disturbances and natural disturbances. Action management prescription set G3 was designed to simulate management that produced a high level of commodities using a mixture of human-related disturbances and natural disturbances.

The mixture of management prescriptions associated with natural disturbance processes that maintained native composition and structure included prescribed natural fire planned ignitions; prescribed natural fire unplanned ignitions; wildfire control/contain/confine management (the amount of wildfire allowed to burn once past the initial attack stage); wildfire prevention, detection, and initial attack management; wild ungulate grazing; insect/disease control to recover native species; livestock grazing managed to simulate wild ungulate grazing; exotic plant control to restore native species; exotic plant invasion where the technology for control does not exist or low levels of exotic plant invasion where allowed because the effect is considered naturalized; seeding of native or non-native vegetation for restoration of native composition and/or structure; non-motorized recreation use; big game habitat management to mimic native conditions; big game hunting to mimic native population levels; and reintroduction of native species to their native habitats.

The mixture of management prescriptions and policies related to human disturbance processes that maintained or departed from native composition and structure included: timber thinning, harvest, and planting; livestock management to maximize production of livestock commodities; big game habitat management to maximize big game production; prescribed fire for forage production, fuel management, and silvicultural site preparation; insect and/or disease control to reduce effects on commodity production; exotic plant control for forage production; and introduction of vegetation species for forest or range commodity production.

The management prescriptions for the No Action simulations in CRBSUM were designed to depict current management direction, based on BLM/FS Forest and Resource Management Plans as currently written, implemented at current funding. No Action management prescription set G4 was designed to approximate such a management alternative.

"ACTION" MANAGEMENT PRESCRIPTIONS

Management prescriptions used in the Action Alternatives were designed to depict potential future management of succession and associated disturbance. They included a mixture of management policies that relied upon a more "active" use of natural or human-related disturbance processes, a more

"passive" use of natural or human-related disturbance processes, a more traditional "consumptive" use of resources, or some combination of all three.

Active Management (AM) and Passive Management (PM) as well as Consumptive Demand (CD) scenario files developed by the work groups (Byler and others 1996), became the baseline for developing probabilities for the different Action Alternative management prescriptions. These scenario files provided the maximum number of disturbance probabilities for use as a starting point for these three types of management. Using the AM, PM, and CD scenario files, we created twelve management prescriptions to model the Action Alternatives for the DEIS (Figure 2). We developed rule sets that determined what percentage of timber harvest, precommercial thinning, grazing, wildfire, prescribed fire, exotics, and seeding and exotic control would be reduced or increased from the probabilities entered in the AM, PM, or CD scenario files for the "Wilderness and National Parks" and the "USFS and BLM Lands" management regions. The objective was twofold. First, we wanted to design rule sets through global replacement of disturbance probabilities that would portray realistic increases or decreases of disturbance hectares from current management. Second, we wanted these disturbance probabilities to produce contrasting effects on future trajectories of vegetation composition and structure.

N1, A1, C1, and P1 were management prescriptions designed primarily for wilderness and unroaded lands to model potential future management. The original probability set designed for "Wilderness and National Park" lands under the Consumptive Demand management scenario, CD1, was the starting point for management prescriptions N1 and C1. Scenario files constructed for "Wilderness and National Park" lands under the Active and Passive management scenarios, AM1 and PM1, were the starting points for the A1 and P1 management prescriptions, respectively.

For management prescriptions N1 and C1, wildfire probabilities were reduced from CD1 by 40 to 80 percent in Dry Forest, Moist Forest, Woodland, and Dry Grass PVT groups. In the Cool Shrub PVT group, probabilities of wildfire were mostly decreased 20 to 40 percent. However, in the exotics cover type of the Cool Shrub PVT group they were increased by about 20 to 30 percent. Wildfire probabilities were increased in the Cold Forest PVT group by about five percent and in the Dry Shrub PVT group by five to 10 percent, except for in the woodland cover type where they were decreased by about 15 percent.

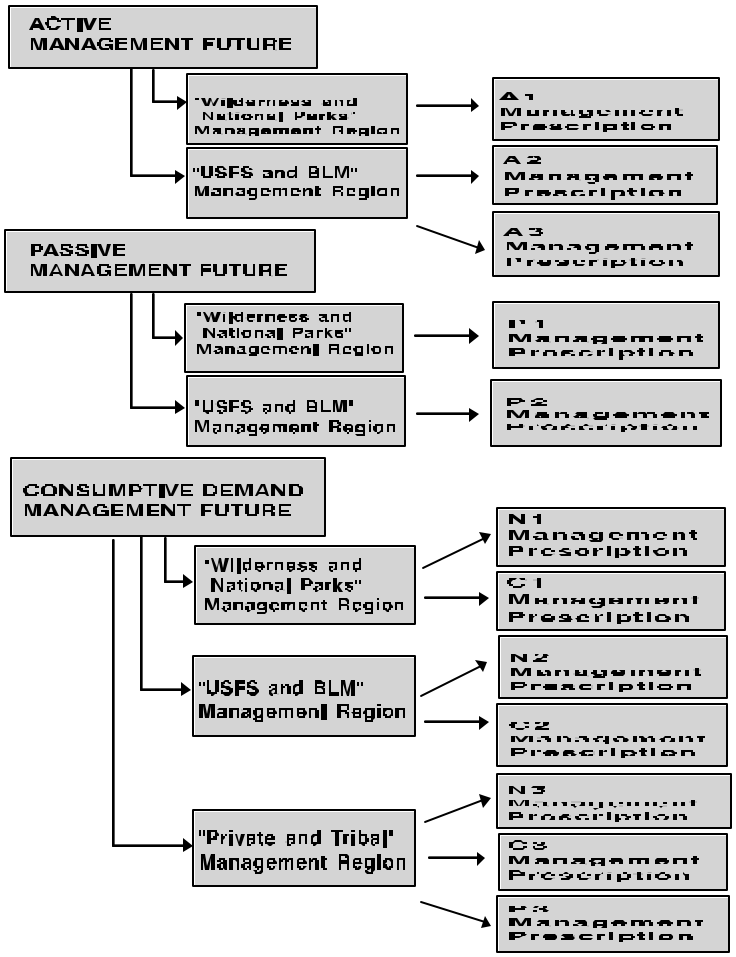

Figure 2.--Process used to build "Action" alternative management prescriptions from probability sets contained in the initial management scenarios.

For management prescription A1, wildfire probabilities were reduced from AM1 by 50 to 85 percent in Dry Forest, Moist Forest, Woodland, and Dry Grass PVT groups in order to reflect a more aggressive fire management program. In the Cool Shrub PVT group, probabilities of wildfire were decreased 40 to 50 percent, except for in the exotics and woodland cover types where they were increased by about 25 percent. Wildfire probabilities decreased in the Cold Forest PVT group by about five to 15 percent in some cases, and increased five to 10 percent in other cases, reflecting less success at managing wildfire in these generally remote settings. The Dry Shrub PVT group had decreased wildfire probabilities of 10 to 40 percent, except for in the exotics cover type where they were increased by about 16 percent. Wildfire probabilities for the P1 management prescription remained the same as the original PM1.

Because prescribed fire was not emphasized in the Consumptive Demand management scenario, these probability sets were generally lacking in prescribed fire disturbance probabilities. This resulted in an underestimation of prescribed fire hectares and required the addition of prescribed fire disturbance probabilities for selected PVTs. For management prescription C1, only a few relatively small probabilities were added, generally emphasizing just Cold Forest cover types. For N1, a broader array of probabilities were assigned, primarily emphasizing Cold and Moist Forest PVT groups as well as Dry Shrub, and to a lesser degree, Dry Forest. Relatively low disturbance probabilities were individually assigned to cover types within these PVT groups normally targeted for prescribed fire under current management approaches.

Prescribed fire probabilities in the P1 management prescription were set to zero following the assumption of a lack of an active fire program. Prescribed fire was generally lacking in the "Wilderness and National Parks" scenario of the Active management scenario, requiring the addition of prescribed fire disturbance probabilities for selected PVTs. Moderately high prescribed fire probabilities were assigned to cover types generally targeted for prescribed burning, but not originally assigned in the AM1 scenario file, and increased substantially where they had already been assigned in order to reflect a more aggressive approach to fire management.

Grazing probabilities, which mainly addressed big game grazing in CD1, were increased 20 to 30 percent to account for the low levels of livestock grazing that occur on USFS and BLM lands within these land management designations, and assigned to management prescription N1. A 50 to 80 percent increase in management prescription C1 from CD1 reflected even higher levels of livestock grazing, or possibly increased big game grazing pressure, such as is found on some wildlife refuges or winter ranges. Substantially lower levels of grazing were assumed under management prescription P1, even lower than assumed under the original PM1 scenario file. Management prescription A1 resulted from lowering grazing probabilities in the AM1 scenario files for successional change grazing, while increasing probabilities of non-impactive grazing, suggesting a move to a more intensive grazing management program.

Probabilities of exotics followed these same trends, generally increasing for management prescriptions

N1 and C1, remaining the same for P1, and decreasing for A1.

N2, C2, A2, and P2 were management prescriptions designed primarily for moderately managed lands with a mixture of natural and human-related disturbance processes to model potential future management. The original probability set designed for "USFS and BLM Lands" under the Consumptive Demand management scenario, CD2, was the starting point for management prescriptions N2 and C2. Scenario files constructed for "USFS and BLM Lands" under the Active and Passive management scenarios, AM2 and PM2, were the starting points for the A2 and P2 management prescriptions, respectively.

For management prescriptions N2 and C2, wildfire probabilities were reduced from CD2 by 40 to 80 percent in Dry Forest, Moist Forest, Woodland, and Dry Grass PVT groups. In the Cool Shrub PVT group, probabilities of wildfire were decreased 20 to 40 percent, except for in the exotics type where they were increased by over 200 percent. Wildfire probabilities were increased in the Cold Forest PVT group by about five percent in C2 and 10 to 15 percent in N2. In the Dry Shrub PVT group, we created a five to 30 percent decrease in wildfire probabilities, except for in the woodland and shrub types where they were increased slightly.

For management prescription A2, wildfire probabilities were reduced from AM2 by 50 to 85 percent in Dry Forest, Moist Forest, Woodland, and Dry Grass PVT groups in order to reflect a more aggressive fire management program. In the Cool Shrub PVT group, probabilities of wildfire were decreased 40 to 50 percent, except for in the exotics cover type where they were increased by about 150 percent. Wildfire probabilities increased in the Cold Forest PVT group by about five to 15 percent, which reflected lower success at managing wildfire in these generally remote settings. The Dry Shrub PVT group had decreased wildfire probabilities of 10 to 40 percent, except for in the exotics cover type where they were increased by about 16 percent. Wildfire probabilities for the P2 management prescription increased by 50 percent overall from the original PM2.

For management prescription C2, only a few prescribed fire probabilities were changed from CD2, with generally decreased probabilities in the woodland, shrub, and exotics cover types in the Cool Shrub, Dry Shrub, and Dry Grass PVT groups. For N2, a broader array of probabilities were changed; we primarily decreased prescribed fire probabilities in the Cold and Moist Forest PVT groups as well as Dry Shrub, Cool Shrub, and Dry Grass PVT groups by 80 to 100 percent. Prescribed fire probabilities in the P2 management prescription were set to zero following the assumption of no active fire program. Moderately high prescribed fire probabilities were already assigned to cover types generally targeted for prescribed burning in the AM2 scenario file, and were increased substantially in order to reflect an even more aggressive approach to fire management in A2.

Successional change grazing probabilities, which assumed fairly intensive livestock and additional big game grazing in CD2, were decreased 20 to 50 percent and assigned to management prescription N2. Fifty to 80 percent decreases in successional change grazing for a smaller set of cover types

characterized management prescription C2. Substantially lower levels of grazing were assumed under management prescription P2 as well, even lower than assumed under the original PM2 scenario file. Management prescription A2 also had lower probabilities than in the AM2 scenario files for successional change grazing, while probabilities for non-impactive grazing were increased.

Probabilities of exotics followed the same trends as grazing probabilities; they were generally decreased for all management prescriptions compared to the original scenario files from which they were built.

Forest management disturbance probabilities, including precommercial thinning and commercial timber harvest, remained approximately the same for management prescriptions C2 and P2 when compared to CD2 and PM2, respectively. CD2 probabilities were decreased around 50 percent overall to create N2 probabilities. AM2 probabilities increased 10 to 30 percent in mid-seral cover types in the Dry and Cold Forest, and 55 to 65 percent in late-seral cover types in Moist Forest PVTs.

N3, C3, A3, and P3 were management prescriptions designed to simulate management that produced a high level of commodities and that generally occurred in highly managed lands with predominantly human-caused disturbance processes. Forested lands were generally designated as timber emphasis and roaded at levels to allow access for timber management activities. Rangelands were generally designated as grazing emphasis and similarly roaded at levels to allow access for management of livestock distribution. The original probability set designed for "Private and Tribal Lands" under the Consumptive Demand management scenario, CD3, was the starting point for management prescriptions N3, C3, and P3. Scenario files constructed for "USFS and BLM Lands" under the Active management scenario, AM2, was the starting point for the A3 management prescription.

For management prescriptions P3 and C3, wildfire probabilities were reduced from CD3 by 40 to 80 percent in Dry Forest, Moist Forest, Woodland, and Dry Grass PVT groups. In the Cool Shrub PVT group, probabilities of wildfire were decreased 20 to 40 percent, except for in the exotics cover type where they were increased by about 20 to 30 percent. Wildfire probabilities were increased in the Cold Forest PVT group by about five percent and in the Dry Shrub PVT group by five to 10 percent, except for in the woodland type where the probabilities were decreased by about 15 percent.

For management prescription A3, wildfire probabilities were reduced from AM2 by 50 to 85 percent in Dry Forest, Moist Forest, Woodland, and Dry Grass PVT groups in order to reflect a more aggressive fire management program. In the Cool Shrub PVT group, probabilities of wildfire were decreased 40 to 50 percent, except for in the exotics and woodland cover types where they were increased by about 25 percent. Wildfire probabilities were decreased in the Cold Forest PVT group by about five to 15 percent in some cases, and increased five to 10 percent in other cases, reflecting lower success at managing wildfire in these generally remote settings. The Dry Shrub PVT group had decreased wildfire probabilities of 10 to 40 percent, except for the exotics cover type where they were increased by about 16 percent. Wildfire probabilities for the N3 management prescription resulted from substantial increases in the Cold Forest and Moist Forest PVTs, and 20 to 30 percent decreases

in the Dry Forest, Dry Shrub, Cool Shrub, and Dry Grass PVTs.

For management prescription C3, only a few prescribed fire probabilities were changed from CD3. Generally, the probabilities were decreased in the woodland, shrub, and exotics cover types in the Cool Shrub, Dry Shrub, and Dry Grass PVT groups. For N3, a broader array of probabilities were changed. We primarily decreased prescribed fire probabilities in the Cold Forest, Dry Shrub, Cool Shrub, and Dry Grass PVT groups by 80 to 100 percent, and substantially increased the probabilities in late-seral multi-layer cover types in the Dry Forest PVT group. Prescribed fire probabilities in the P3 management prescription were set to zero based on the assumption of no active fire program. Moderately high prescribed fire probabilities were already assigned to cover types generally targeted for prescribed burning in the AM2 scenario file, and were increased substantially in order to reflect an even more aggressive approach to fire management in A3.

Successional change grazing probabilities, which mainly addressed livestock grazing on private lands in CD3, were decreased 30 to 90 percent to account for the lower levels of livestock grazing that occur on USFS and BLM lands within these land management designations. Management prescription A3 reflected increased probabilities of non-impactive grazing, with minor changes in other management prescriptions.

Probabilities of exotics followed these same trends and were generally increased for management prescription P3, remained the same for C3, and decreased for A3 and N3.

Forest management disturbance probabilities, including precommercial thinning and commercial timber harvest, remained roughly the same for management prescriptions C3 and N3, when compared to CD3. P3 probabilities were increased around 20 percent across the board from CD3 probabilities. A3 harvest probabilities showed an increase of 25 percent in the Dry and Cold Forest, and almost 90 percent in the Moist Forest PVTs from AM2. Thinning probabilities were increased 50 percent, but strictly in the mid-seral types in Dry Forest PVTs.

HISTORICAL MANAGEMENT PRESCRIPTION

The original set of historical scenario files were evaluated for further refinement and it was determined that the 100-year model runs were not sufficient for establishing any reliable trends. Accordingly, a longer, 400-year run formed the basis for using historical trends as baseline comparison data for the management prescriptions. Only a few adjustments were made, primarily in wildfire probabilities, which had been set too low in some forest and range types where they rarely occur. In many cases, the distribution of successional classes associated with these types was dominated by just one class over the long run, somewhat oversimplifying conditions that we felt actually occurred on the landscape at any point in time historically. These adjustments were deemed necessary in order to rectify the situation. Aside from this, all other historical disturbance probabilities were accepted.

"NO ACTION" MANAGEMENT PRESCRIPTIONS

The management prescriptions for the No Action simulations in CRBSUM were designed to depict current management direction with no change in direction for management actions. This was based on BLM/FS Forest and Resource Management Plans as currently written, but designed to simulate how they have been implemented over the past decade. Timber management was generally assumed to be funded at a level needed to meet commodity targets, while range management, fire management, and amenity values were assumed to have less emphasis. Resource allocations, such as control of exotic plant species, riparian restoration and management, rangeland restoration, monitoring to support management actions, precommercial and non-commercial thinning of overstocked stands, and prescribed fire in natural fuels, would occur at levels lower than those specified in existing plans due to lack of emphasis. In addition, it was assumed that Allotment Management Plans (AMPs) would not be revised at a rate sufficient to correct current range health problems. Other types of No Action prescriptions were designed to simulate the current effects on reduced timber management activities in response to PACFISH, the Eastside Screens, and trends in administrative appeals and litigation.

Consumptive Demand (CD) scenario files developed by the work groups (Byler and others 1996), formed the basis for disturbance probabilities in the No Action probability sets. The CD management scenario provided the maximum number of disturbances probabilities for use as a starting point, and provided a more intuitive management approach with which to work on federal lands. Using the CD management scenario as a base, we created five management prescriptions designed for modeling the No Action Alternative of the DEIS (Figure 3). We developed general rule sets to determine what percent of commercial timber harvest, precommercial thinning, grazing, wildfire, prescribed fire, exotic invasion, exotic control, and seeding would be reduced or increased from the probabilities entered in the CD scenario files for each of the three management regions. The objective was to come up with rule sets that would allow for global replacement of disturbance probabilities that would produce disturbance hectares in the model run that closely approximated recent records.

N6 was the management prescription designed for primarily wilderness and unroaded lands to approximate current management. The original probability set designed for "Wilderness and National Park" lands under the Consumptive Demand management scenario, CD1, was the starting point for these probabilities.

In the Dry Forest, Moist Forest, Woodland, and Dry Grass PVT groups, wildfire probabilities were reduced from CD1 by 40 to 80 percent, due to overestimation of wildfire hectares evident in preliminary CRBSUM runs. In the Cool Shrub PVT group, probabilities of wildfire were decreased 20 to 40 percent, except for in the exotics cover type where they were increased by about 30 percent. Wildfire probabilities were increased in the Dry Shrub PVT group by 10 to 20 percent, except for in woodland cover types where they were decreased by about 15 percent.

Prescribed fire was not emphasized in the Consumptive Demand management scenario; hence, these probability sets were generally lacking in prescribed fire disturbance probabilities. This resulted in an underestimation of prescribed fire hectares for the No Action situation and required the addition of prescribed fire disturbance probabilities for selected PVTs, generally emphasizing Cold and Moist Forest PVT groups as well as Dry Shrub and, to a lesser degree, Dry Forest. Relatively low disturbance probabilities were individually assigned to cover types within these PVT groups normally targeted for prescribed fire under current management approaches.

Grazing probabilities, which mainly addressed big game grazing in management prescription C1, were increased 20 to 30 percent to account for low levels of livestock grazing that occur on USFS and BLM lands within these land management designations. Probabilities of exotics were also increased due to this increased level of livestock grazing.

N4 and N7 management prescriptions were designed for moderately managed lands with a mixture of natural and human-caused disturbance processes, such as sites designated as Scenic Rivers, National Recreation Areas, and Visual Emphasis Zones. More specifically, N7 represented such areas located in the Eastside EIS area while N4 represented such areas located in the Upper Columbia River EIS area. The original probability set designed for "USFS and BLM Lands" under the Consumptive Demand management scenario, CD2, was the starting point for these probabilities.

Wildfire disturbance probabilities were adjusted in a similar manner as management prescription set #1. Preliminary CRBSUM runs indicated an overestimation of wildfire hectares and probabilities. The wildfire probabilities were subsequently reduced 20 to 80 percent from CD2 probabilities for most PVT groups. However, wildfire probabilities in exotic cover types were increased substantially due to the invasion of annual grasses, primarily cheatgrass (*Bromus tectorum*). For similar reasons, we also increased wildfire probabilities by five to 30 percent in woodland and shrub cover types in the Woodland, Dry Shrub, and Cool Shrub PVT groups with probable cheatgrass understories.

Prescribed fire was not emphasized in the Consumptive Demand management scenario, and these probability sets that used CD2 probabilities as a starting point were generally lacking in prescribed fire disturbance probabilities. This resulted in an underestimation of prescribed fire hectares occurring under current management and required addition of disturbance probabilities for prescribed fire for selected PVTs, generally emphasizing Dry Forest and Dry Shrub PVT groups. Relatively low disturbance probabilities were individually assigned to cover types within these PVT groups normally targeted for prescribed fire under current management approaches.

Management prescription CD2 was originally created with disturbance probabilities typical of management across all designations of USFS and BLM lands (Byler and others 1996), and generally emphasized higher commodity production. Management prescriptions N4 and N7 represented current management with moderate commodity emphasis and thus, most disturbance probabilities related to commodity production had to be reduced.

Disturbance probabilities associated with rangeland management were reduced roughly 80 to 90 percent for both N4 and N7, except for non-impactive grazing which was only reduced about 15 to 20 percent. Forest management disturbance probabilities, including thinning and harvest, were also reduced, but in different proportions for the Eastside and Upper Columbia EIS areas. N4 harvest probabilities were reduced 50 to 70 percent from CD2, while thinning probabilities were reduced 65 to 75 percent. N7 harvest probabilities were reduced 50 to 70 percent from CD2, while thinning probabilities were reduced 30 percent in Moist Forests, 5 percent in Dry Forests, and remained the same in Cold Forests.

N5 and N8 were management prescriptions designed to simulate management that produced a high level of commodities, generally occurring in highly managed lands with predominantly human-caused disturbance processes. Forested lands were generally designated as timber emphasis and were roaded at levels to allow access for timber management activities. Rangelands were generally designated as grazing emphasis and were also roaded to allow access for management of livestock distribution. More specifically, N8 represented these areas located in the Eastside EIS area while N5 represented these areas located in the Upper Columbia River EIS area. The original probability set designed for "Private and Tribal Lands" under the Consumptive Demand management scenario, CD3, was the starting point for these probabilities.

Wildfire disturbance probabilities were adjusted in a similar manner as management prescription set #1. Preliminary CRBSUM runs indicated an overestimation of wildfire hectares and probabilities; probabilities were subsequently reduced 20 to 80 percent from CD3 for most PVT groups. However, wildfire probabilities in exotic cover types were increased substantially due to the invasion of annual grasses, primarily cheatgrass. For similar reasons, we also increased wildfire probabilities by 20 to 30 percent for woodland and shrub cover types in the Woodland, Dry Shrub, and Cool Shrub PVT groups that may have cheatgrass understories.

Prescribed fire was not emphasized in the Consumptive Demand management scenario. Subsequently, these probability sets that used CD3 probabilities as a beginning point were generally lacking in prescribed fire disturbance probabilities. This resulted in an underestimation of prescribed fire hectares under current management and required the addition of disturbance probabilities for prescribed fire for selected PVTs, generally emphasizing the Dry Forest PVTs. Relatively low disturbance probabilities were individually assigned to cover types within these PVT groups normally targeted for prescribed fire under current management approaches.

Disturbance probabilities associated with rangeland management were reduced approximately 80 to 90 percent for both N5 and N8, except for non-impactive grazing, which was only reduced about 15 to 20 percent. Forest management disturbance probabilities, including thinning and harvest, were also reduced, but in different proportions for the Eastside and Upper Columbia EIS areas. N8 harvest and thinning probabilities remained primarily the same as CD3 with slight increases (five to 25 percent) in Cold Forests. N5 harvest and thinning probabilities were reduced 35 to 45 percent from CD3.

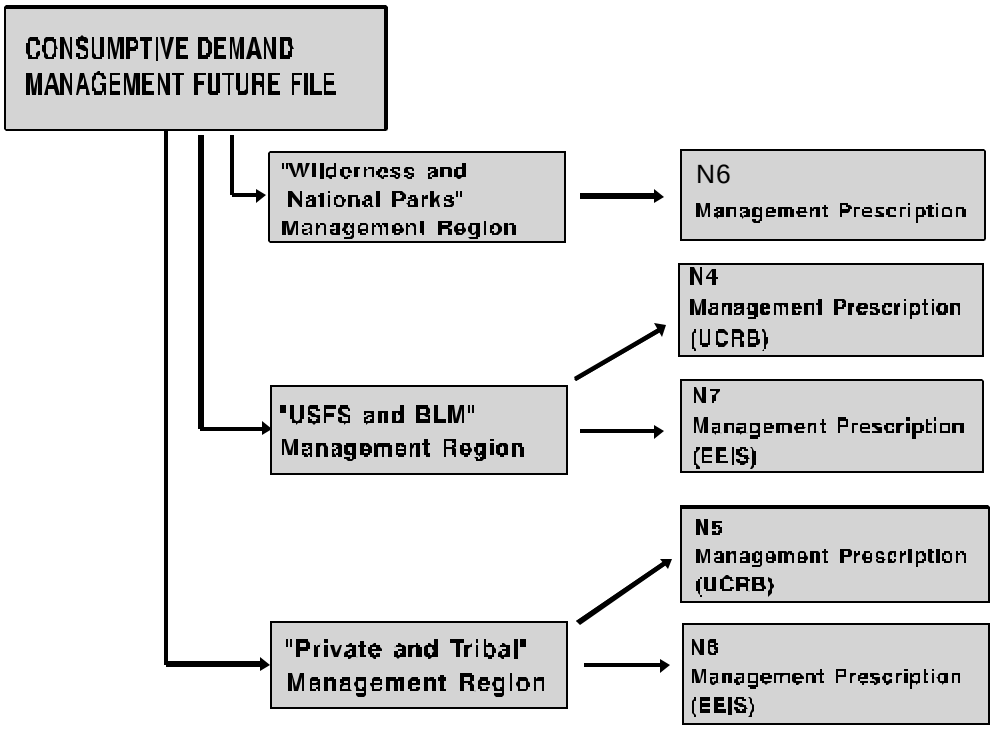

Figure 3.--Process used to build the "No Action" alternative management prescriptions from the Consumptive Demand management scenario.

MANAGEMENT PRESCRIPTION DESCRIPTION

Management Prescription Set G1

P1 was generally designed for large BLM/FS wilderness-like or roadless areas, larger National Parks, and larger State or Federal Wildlife Refuges. It had no emphasis on active management of natural disturbance processes to maintain or restore native composition and structure, and had low success with wildfire detection and initial attack, primarily because of size of the areas and high risk fuel conditions. These areas were generally large and contiguous without substantial human facilities and with low probability of successful fire detection and suppression. These areas were assumed to have lower probabilities of exotic plant introduction because of large size and minimal human disturbance.

C1 was generally appropriate for smaller BLM/FS wilderness-like or roadless areas, smaller National Parks, and smaller State or Federal Wildlife Refuges. It had low emphasis on active management of natural disturbance processes to maintain or restore native composition, and had moderate success with wildfire initial detection and attack, primarily because of adjacent road access. These areas were assumed to have higher susceptibility to exotic plants than P1 areas because of small size areas.

N1 was generally suitable for large BLM/FS wilderness-like or roadless areas, larger National Parks, and larger State or Federal Wildlife Refuges. It had moderate emphasis on active disturbance processes to maintain or restore native composition and structure, and had moderate success with wildfire initial attack and control, primarily because of the lack of adjacent road access and the moderate to large size of wilderness-like areas. These areas were generally large and contiguous without substantial human facilities. Current prescribed natural fire (PNF) programs would have low overall success in reducing high risk fuels because of the requirement of natural unplanned lightning ignitions. During the summer period when wildfire risk is high there would be a low probability for lightning ignited fires that meet PNF prescriptions. As a consequence, most lightning ignited fires would be suppressed and there is no active planned ignition to replace those extinguished fire. These areas were assumed to have lower susceptibility to introduction of exotic plant seed sources because of the large size and minimal human disturbance.

A1 was generally appropriate for any size BLM/FS wilderness-like or roadless areas, National Parks, and State or Federal Wildlife Refuges. It had high emphasis on active disturbance processes to maintain and restore native composition and structure, and moderate success with wildfire initial attack and control. The active emphasis of fire management resources for suppression and management of prescribed natural fire (planned and unplanned ignitions) to burn areas under confined time frames enabled this management prescription applicability to both small to large size areas.

Management Prescription Set G2

P2 was generally designed for USFS and BLM visually sensitive areas and State or Federal wildlife

refuges. It had low production of forest products and used methods to minimize any appearance of harvest disturbance, such as selection and patch cutting of large trees in areas where roads already exist. It had low levels of livestock grazing, with low investment in both grazing systems and improved livestock distribution through riding, fencing, salt, and maintenance of water developments.

C2 was generally suitable for traditional management of State, other Federal, and Tribal lands. It had moderate production of forest products, using traditional forest road systems and silvicultural cutting methods to maximize net profits while achieving regeneration objectives. There was a moderate level of livestock grazing, using traditional season-long or rest-rotation methods. There were also low level investments in improved livestock distribution. C2 had an aggressive fire suppression program with traditional use of fire for post-harvest fuel management, site preparation, and range forage improvement.

N2 was generally appropriate for BLM/FS visually sensitive areas or reduced production areas. It had moderate production of forest products through the use of methods that maintained forest visual cover, such as select and patch cutting of the large trees, and the use of existing road systems. Additionally, N2 had moderate levels of livestock grazing that used traditional season-long or rest-rotation methods. There was moderate investment in methods to remove livestock from riparian areas, such as fencing and riding. Also, there was traditional use of prescribed fire for post-timber harvest fuel management/site preparation and livestock and/or big game forage production, and an aggressive fire suppression program.

A2 was generally appropriate for active vegetation restoration efforts. Management practices included high production of small diameter and low production of large diameter forest products. Treatments emphasized thinning from below and removal of the shade-tolerant trees that are also insect, disease, and fire susceptible. Treatment priority was placed in areas of high forest health risk and high fire risk. In rangelands, there were moderate production levels of livestock; the emphasis was on landscape allotment management using dormant/growing season rotation-deferred systems. Grazing in riparian areas was managed in context with the upland rangelands, with moderate investment in improved livestock distribution through use of riding, fencing, salt, water development, control of noxious weeds, and seeding desirable vegetation species for forage. There was aggressive use of prescribed natural fire with timber thinning/harvest and grazing programs to represent natural processes and provide for native composition and structure along with use of prescribed fire for post-harvest fuel management and livestock and/or big game forage production. Also, there was an aggressive and proactive fire suppression program using control, confine, and containment options, as well as prescribed fire unplanned ignitions.

Management prescription Set G3

P3 was primarily designed to simulate effects of high demand for commodities from private lands due to

high prices or difficult economic conditions for private land owners. It had very high production of commodities to maximize short-term production of commercial timber volume and livestock numbers with harvest and road systems that minimized costs of logging commercial volume. There was traditional livestock grazing, using season-long or rest-rotation methods, and moderate level investments in improved distribution. Also, there was low level use of fire for post-harvest fuel management/site preparation and range forage improvement and an aggressive fire suppression program.

C3 was generally designed to simulate traditional sustained yield forestry, while maximizing economic return on private or public lands. It had high commodity production that maintained a sustained flow of commercial timber volume and livestock numbers through use of traditional forest management, road system access, and traditional season-long or rest-rotation livestock grazing systems with moderate level investments in improved distribution. There was traditional use of prescribed fire for post-harvest fuel management/site preparation and range forage improvement and an aggressive fire suppression program.

N3 was generally suitable for BLM/FS commodity managed lands with high production of forest products through the use of methods to sustain forests and provide some wildlife habitat and recreational values. N3 had a high level of livestock grazing, using traditional season-long or rest-rotation methods. There was traditional use of prescribed fire for post-timber harvest fuel management/site preparation and livestock and/or big game forage production. N3 also included an aggressive wildfire suppression program.

A3 was primarily appropriate for representing active vegetation restoration efforts. It encompassed a high level of forest and rangeland restoration emphasis, with moderate production of commodities to finance restoration activities. There was high production of small diameter and low to moderate production of large diameter forest products through the use of thinning from below and through selection of shade tolerant trees that are insect, disease, or fire susceptible. These activities were focused in areas of high forest health risk and high fire risk. There were moderate livestock production levels that emphasized landscape allotment management of dormant/growing season rotation systems, grazing in riparian areas in context with the upland rangelands, high investment in distribution improvement through riding, fencing, salt, and water development, control of noxious weeds, and seeding of desirable vegetation species and forage. There was aggressive use of prescribed natural fire with timber thinning/harvest and grazing programs to represent natural processes and provide for native vegetation composition and structure. Additionally, there was active use of prescribed fire for post-harvest fuel management and livestock and/or big game forage production. A3 had an aggressive and proactive fire suppression program using control, confine, and containment options, as well as prescribed fire with unplanned ignitions.

Management Prescription Set G4

N6 was generally appropriate for any size BLM/FS wilderness-like or roadless areas, National Parks,

and State or Federal Wildlife Refuges and depicted current management direction, based on BLM/FS Forest and Resource Management Plans as currently written, and implemented at current emphasis levels. This implied moderate success with wildfire initial attack and control, due to active suppression program management, even given the lack of adjacent road access and the moderate to large size wilderness-like areas. These areas ranged from small to large size because of active emphasis of fire management resources for suppression and management of prescribed natural fire planned and unplanned ignitions to burn areas under confined time frames.

N4 was designed to depict current management direction, based on BLM/FS Forest and Resource Management Plans as currently written, implemented at current emphasis levels, restoration, mitigation, inventory, and monitoring in order to meet commodity and amenity targets at moderate levels.

N7 was designed to depict current management direction, based on BLM/FS Forest and Resource Management Plans as currently written, implemented at current emphasis levels, restoration, mitigation, inventory, and monitoring in order to meet commodity and amenity targets at moderate levels, but with different types of treatments than N4.

N5 was designed to depict current management direction, based on BLM/FS Forest and Resource Management Plans as currently written, implemented at current emphasis levels, restoration, mitigation, inventory, and monitoring in order to meet commodity and amenity targets at moderate levels, but with different types of treatments than N4 and N7.

N8 was designed to depict current management direction, based on BLM/FS Forest and Resource Management Plans as currently written, implemented at current emphasis levels, restoration, mitigation, inventory, and monitoring in order to meet commodity targets and amenity targets at comparatively high levels.

USING THE MANAGEMENT PRESCRIPTION FILES IN VDDT

Appendix 1 shows a list of Potential Vegetation Types for the Historical (HI) model and the four different prescription group models, G1, G2, G3, and G4. To use these files in the VDDT model they must be opened under the “New Format” files. For rangeland PVTs, cover types that did not exist historically were added to management prescription models. Therefore, the historical (HI) models are separated from the four prescription group models for the range PVTs; there are two “.pvt” files for each PVT. The naming convention for the prescription “.pvt” files is similar to that for the management scenario ”.pvt” files. For the historical model, “_HI” follows the PVT abbreviation and for the prescription group models, “_G1,” “_G2,” “_G3,” and “_G4" follow the PVT abbreviation. After a “.pvt” file has been chosen, VDDT defaults to five “.scn” files. One “.scn” file is for the historical model and should only be chosen to run with the historical “.pvt” file. The other four “.scn” files represent

prescription groups. Group "_G1" contains models for prescriptions A1, C1, N1, and P1. Group "_G2" contains models for prescriptions A2, C2, N2, and P2. Group "_G3" contains models for prescriptions A3, C3, N3, and P3. Group "_G4" contains models for prescriptions N4, N5, N6, N7, and N8. After selecting a ".scn" file for a prescription group, the desired prescription is chosen by clicking "Run Model" followed by clicking "Select Management Region." These actions produce a pop-up window for selecting a prescription.

Forest PVTs are also under the "New Format" files. The forest models are more simple to run because the historical models (HI) are not separated from the four prescription group models (G1, G2, G3, G4) as the current cover types also existed historically. The desired prescription model is chosen in the same way as explained for the rangeland PVTs.

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Appendix 1.--Potential Vegetation Type (PVT) Listing

PVT	Name	Description
1	AGST_HI	Historic Agropyron Steppe
2	PUTR_HI	Historic PurshiaTridentata
3	BSBW_HI	Historic Basin Big Sage/Wildrye
4	LSME_HI	Historic Low Sage-Mesic
5	LSMJ_HI	Historic Low Sage-Mesic With Juniper
6	LSXE_HI	Historic Low Sage-Xeric
7	LSXJ_HI	Historic Low Sage-Xeric With Juniper
8	WBSW_HI	Historic Wyoming Big Sage-Warm
9	WBSC_HI	Historic Wyoming Big Sage-Cool
10	CTRV_HI	Historic Cottonwood Riverine
11	FESC_HI	Historic Fescue Grassland
12	BSML_HI	Historic Mountain Big Sage-Mesic-East
13	BSMC_HI	Historic Mountain Big Sage-Mesic-East w/Conifer
14	BSMW_HI	Historic Mountain Big Sage-Mesic-West
15	BSMJ_HI	Historic Mountain Big Sage Mesic West w/Juniper
17	SDSH_HI	Historic Salt Desert Shrub
18	TTSA_HI	Historic ThreeTipp Sage
19	SALX_HI	Historic Salix/Carex
20	ASPEN_HI	Historic Aspen
21	CEW1_HI	Historic CELE Woodland Without ArtRva
22	CEW2_HI	Historic CELE Woodland With ArtRva
23	MTSH_HI	Historic Mountain Shrub
24	RIGR_HI	Historic Riparian Graminoid
25	SARP_HI	Historic Saltbrush Riparian
26	RPSED_HI	Historic Riparian Sedge
27	MRLS_HI	Historic Mountain Riparian Low Shrub
29	CFESC_HI	Historic Conifer-Fescue Grassland
30	JUOC_HI	Historic Juniper
31	ALSHR_HI	Historic Alpine Shrub-Herbaceous
50	CDHME	Cedar/Hemlock East Cascades
51	CDHMI	Cedar/Hemlock Inland
52	DRDFA	Dry Douglas-fir without PPine

PVT	Name	Description
53	DRDFB	Dry Douglas-fir with PPine
54	DGFWF	Dry GrandFir/WhiteFir
55	LIMP	Limber Pine
56	LPPA	Lodgepole Pine-Yellowstone
57	LPPB	Lodgepole Pine-Oregon
58	MSDF	Moist Douglas-fir
59	GFWFE	Grand Fir/White Fir East Cascades
60	GFWFI	Grand Fir/White Fir Inland
61	MTHME	Mountain Hemlock East Cascades
62	MTHMI	Mountain Hemlock Inland
63	INTPP	Interior Ponderosa Pine
64	PPSMC	Pacific P-Pine/Sierra Mixed Con
65	MTHRF	Mountain Hemlock/Shasta Red Fir
66	PSF	Pacific Silver Fir
67	SFDWA	Spruce-Fir Dry with Aspen
68	SFDNA	Spruce-Fir Dry without Aspen
69	SFWET	Spruce-Fir Wet
70	SFWBP	Spruce-Fir(WBP>LPP)
71	SFLPP	Spruce-Fir(LPP>WBP)
72	WBALN	White Bark Pine/Subalpine Larch North
73	WBALS	White Bark Pine/Subalpine Larch South
74	WOAK	White Oak
101	AGST	Agropyron Steppe
102	PUTR	PurshiaTridentata
103	BSBW	Basin Big Sage/Wildrye
104	LSME	Low Sage-Mesic
105	LSMJ	Low Sage-Mesic With Juniper
106	LSXE	Low Sage-Xeric
107	LSXJ	Low Sage-Xeric With Juniper
108	WBSW	Wyoming Big Sage-Warm
109	WBSC	Wyoming Big Sage-Cool
110	CTRV	Cottonwood Riverine
111	FESC	Fescue Grassland

PVT	Name	Description
112	BSML	Mountain Big Sage-Mesic-East
113	BSMC	Mountain Big Sage-Mesic-East w/Conifer
114	BSMW	Mountain Big Sage-Mesic-West
115	BSMJ	Mountain Big Sage Mesic West w/Juniper
117	SDSH	Salt Desert Shrub
118	TTSA	ThreeTipp Sage
119	SALX	Salix/Carex
120	ASPEN	Aspen
121	CEW1	CELE Woodland Without ArtRva
122	CEW2	CELE Woodland With ArtRva
123	MTSH	Mountain Shrub
124	RIGR	Riparian Graminoid
125	SARP	Saltbrush Riparian
126	RPSED	Riparian Sedge
127	MRLS	Mountain Riparian Low Shrub
129	CFESC	Conifer-Fescue Grassland
130	JUOC	Juniper
131	ALSHR	Alpine Shrub-Herbaceous
151		Irrigated Crop Land
152		Dry Crop Land
153		Urban
154		Water
155		Rock