Focal species assessment of current condition and the proposed action (alternative B) for the Blue Mountains forest plan revisions (draft Oct.2011)

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This document provides information on how terrestrial species viability assessment were developed and used in the Blue Mountain Forests of R6. Regional guidance on how to conduct terrestrial species viability assessments were developed (2010) for National Forests that were revising their Forest Plans (USDA 2010).

The National Forest Management Act (NFMA) requires land management plans to provide for diversity of plant and animal communities based on the suitability and capability of the land area while meeting overall multiple-use objectives.

The Regional guidance was developed by a team of biologists from the Washington, Regional, and National Forest offices in cooperation with a science team from the Pacific Northwest Research Station. The purpose of the Regional guidance was to improve efficiencies in the assessment process, reduce costs by reducing redundancy in analyses, provide a forum for a rigorous science review of the process, and provides consistency across the Region as National Forests or groups of National Forests revise their plans. An application of this process on the Forests of northeast Washington has also been published, see Suring et al. 2011.

The Regional Guidance included steps to identify focal species and steps to evaluate viability. This document describes primarily the steps and interpretations of the viability assessments that were developed and applied to the Forests of northeastern Oregon (Umatilla NF, Wallowa-Whitman NF, Malheur NF) for the forest plan revisions.

Based primarily on Holthausen (2002), and tiering to the Interior Columbia Basin Ecosystem Management Project (ICBEMP) science (Wisdom et al. 2000, Raphael et al. 2001), a detailed process was developed to guide terrestrial species assessments.
The Regional guidance follows these basic steps:

- Identification of Species of Conservation Concern
- Defining Source Habitats for Species of Conservation Concern
- Grouping Species of Conservation Concern
- Description of Ecological Relationships of Species of Conservation Concern
- Selection of Focal Species
- Development of Focal species assessment models

Identifying Species of Conservation Concern

Species of conservation concern are species for which the Responsible Official determines that analysis at the plan scale is warranted to determine if management actions may be necessary to provide for viable populations in the planning area.

Species were selected for assessment using various sources of information which indicate species that have conservation concerns, including Heritage protocols. Andelman et al. (2004) recommended the Heritage global ranks as a system that would be appropriate for use by the Forest Service to meet the NFMA requirement for diversity. They recommend the Heritage protocols because many of the species occurring on National Forest lands have been ranked, the database is readily available, and the state and global ranks may be the most suitable of existing protocols for identifying species of concern. However, they suggest that the initial protocol used to rank species (Master 1991, Master et al. 2000) did not explicitly incorporate weightings for threats. Because of this, the Regional guidance process includes risk factors for each species that can be used to evaluate how management activities can influence species viability.

Also incorporated were the Partners in Flight rankings (Carter et al. 2000) and two additional broad-scale viability analyses that were completed as part of the ICBEMP assessments (Lehmkuhl et al. 1997, Raphael et al. 2001, Wisdom et al. 2000). Once the species were selected, it was necessary to create a subset of species upon which to focus assessment and conservation efforts. One approach to this is the focal species concept (Lambeck 1997).

Defining Source Habitats for Species of Conservation Concern

The definition of source habitat was used from Wisdom et al. (2000) which are those characteristics of macro-vegetation that contribute to stationary or positive population growth. Source habitats are distinguished from habitats simply associated with species occurrence; associated habitats may or may not contribute to long-term population persistence (Wisdom et al. 2000). We used extensive literature searches as well as professional opinion to determine source habitats for each of the species of conservation concern.

Grouping Species of Conservation Concern

While managing species habitats and populations using a species-by-species approach has intuitive ecological merit, the sheer number of species of conservation concern often makes such an approach untenable. In many cases, the ecological understanding and resources needed to manage all species on an individual basis are not available. More importantly, attempting to manage for species of conservation concern on an individual basis may not result in holistic management of all species' needs because management focus is often fine-scale, piecemeal, and without explicit understanding of the commonalities and differences in species needs among large sets of species.

Tremendous efficiencies can be gained from managing groups of species. The idea that efficiency can be gained, while maintaining effectiveness in accounting for all species needs, is a central premise to grouping approaches (Van Horne and Wiens 1991). Grouping species based on one or more ecological factors provides a strong foundation for developing conservation strategies for species of conservation concern, because the conservation strategies can then be ordered around ecological principles.

Species were grouped primarily based on habitat associations using cover type and structural stage, as in Wisdom et al. (2000) and suggested by Forest Service planning directives. A cluster analysis was performed to describe groups of species based on their habitat associations. In the cluster analysis, 51 habitat variables were used consisting of seven land cover types, five tree size classes, and two canopy closure categories for forested vegetation; three non-forest land cover types; five riparian/water land cover types; and a cave category.

We sequentially examined sets of clusters with increasing numbers of clusters in each set to find an aggregation that was consistent with our understanding of species ecological relationships at the macro-habitat scale as done by Wisdom et al. (2000). We also evaluated similarities among species and clusters using the Ochiai index of similarity (Ludwig and Reynolds 1988).

Based upon our knowledge of ecological relationships of the species evaluated, the smallest number of groups possible was chosen that still allowed a meaningful aggregation of species and habitats. Groups were then combined into families to help describe how similar groups of species are related to each other[1]. Families include one or more groups that were associated with similar broad-scale macro-habitat conditions. These generalized habitat conditions were often used by managers to interpret broad scale patterns and trends (reference). By using a hierarchical evaluation of species, groups, and families, the analysis process addressed single and multi-species needs as well as identifying patterns of habitat change similar to the process followed by Wisdom et al. (2000).

Description of Ecological Relationships of Species of Conservation Concern

To more thoroughly understand the ecological requirements of the species of conservation concern, it was necessary to review other information beyond source habitats for each species. Besides focusing on habitats that are key to population growth of species, it is acknowledged that factors beyond macro-vegetation can affect population persistence. Additional information on risk factors, fine scale habitat features, home-range size, and species ranges for each species of conservation concern should be considered (Andelman et al. 2001).

We reviewed other scientific information, in addition to defining source habitats, to more thoroughly understand the ecological requirements of the species of conservation concern. Additional information was compiled on risk factors, fine scale habitat features, home-range size, and species ranges for each species of conservation concern. We followed the recommendations of Andelman et al. (2001) when determining what ecological information we compiled for each species. Compiling this information was important for determining which species were best suited to be focal species, and to model relationships between species, habitats, and risk factors.

Focal Species Approach

Species were grouped to facilitate viability assessments, similar to the way they were grouped for ICBEMP assessments (Wisdom et al. 2000, Raphael et al. 2001). Species groups are defined by having similar habitat requirements. A species selected from the group becomes

[1] Note that the term "Families" does not have a taxonomic meaning, but instead identifies robust similarities in habitat requirements among large groups of species, regardless of taxonomic relation (Wisdom et al. 2002).

the species upon which the assessment is focused. The focal species approach is an attempt to streamline the assessment of ecological systems by monitoring a subset of species and can be seen as a pragmatic response to dealing with ecosystem complexity (Noon 2003, Roberge and Angelstam 2004). The key characteristic of a focal species is that its status and trend provide insights to the integrity of the larger ecological system to which it belongs (Lambeck 1997, Noss et al. 1997, Andelman et al. 2001, Noon 2003). Focal species serve an umbrella function in terms of encompassing habitats needed for other species, are sensitive to the changes likely to occur in the area, or otherwise serve as an indicator of ecological sustainability (Lambeck 1997, Noss et al. 1997, COS 1999, Andelman et al. 2001). The viability of the focal species is assumed representative of a group of species with similar ecological requirements and this group is assumed to respond in a similar manner to environmental change. In addition, the focal species is assumed to have more demanding requirements for factors putting other group members at risk of extinction (Andelman et al. 2001). In this analysis, focal species are intended to represent ecological conditions that provide for viability of other species in the group. Focal species represent the species group in that, providing for adequate amounts and distribution of habitat and managing risks for focal species provide the ecological conditions needed to maintain viability of other associated species.

Lindenmayer et al. (2002) pointed out some of the limitations of the focal species concept, including that the approach is data-intensive, that scientific understanding is lacking for many species, and there is a lack of testing to validate the approach. Lindenmayer et al. (2002) were concerned that the focal species approach not be the only approach used to guide landscape restoration. However, the focal species approach has recently been tested for some wide-ranging carnivores (Carroll et al. 2001) and birds (Watson et al. 2001) with promising results. In addition, Roberge and Angelstam (2004) recently reviewed the umbrella species concept and concluded that the focal species approach seems the most promising because it provides a systematic procedure for selection of umbrella species. The focal species approach described here is designed to complement an ecosystem diversity assessment that would be completed before or in conjunction with the species viability assessment. The focal species approach is a relatively rigorous way, compared to other approaches, to deal with assessments that involve large numbers of species (Andelman et al. 2001, Roberge and Angelstam 2004).

The goal for our assessment, based on the Pacific Northwest Region’s guidance, was to have a manageable number of focal species to assess while still maintaining a reliable inference for providing appropriate ecological conditions for non-focal species. After species were clustered into groups based on habitat relationships and other environmental factors, a single or small set of focal species was identified within each group or family. The intent was to select a set of species that represented the full array of potential responses of species to management activities (Raphael et al. 2001).

In the Blue Mountains of Oregon and Washington, we identified 33 focal species representing 25 groups (or families) of terrestrial habitats for our assessment area (table 1). These species represent the full range of habitats and risk-factors. . Focal species were selected to represent other species in their group of family. Focal species usually best represent species in their group, but in some cases these species are also acting as a focal species for other species in the family/group.

TABLE 1 _ FOCAL SPECIES – BLUES

Development of Focal Species Assessment Models

Assessing the viability of each focal species requires the development of credible and repeatable analysis processes. One way this was accomplished in the ICBEMP was using Bayesian Belief Networks (BBNs) (Marcot et al. 2001, Raphael et al. 2001, Rieman et al. 2001). The use of Bayesian statistics, specifically BBNs, is one way to combine scientific data and information with expert knowledge and experience (Lehmkuhl et al. 2001, Marcot et al. 2001, Wade et al. 2002). This is especially important when trying to assess a multitude of species, many of which have little or no available empirical data. A BBN is an influence diagram, which depicts the relationships among ecological factors (such as habitat and risks) that influence the likelihood of the outcome of some parameter(s) of interest, such as forest condition or wildlife species viability (Marcot et al. 2001). This approach provides a conceptual model outlining the interconnections among ecosystem components and how a species is anticipated to respond to the risk factors.

Focal species' assessment models (or BBN's) were used to assess response of focal species to changes in habitat conditions and risk factors resulting from proposed management actions. BBN models provide a structured tool for integrating several sources of information to make comparisons among management alternatives on how well the conservation of focal species was addressed (Marcot et al. 2001). The BBN modeling approach was selected for the following reasons (Marcot et al. 2001, Marcot 2006, Raphael et al. 2001):

1. Major influences on population persistence and/or quality of habitat can be displayed.
2. Linkages between features of a proposed management action and the predicted response of a species can be represented.
3. Empirical data and expert judgment can be combined.
4. Models may be easily re-run with different management actions or new model assumptions.
5. Predicted outcomes are based on probabilities and are presented as probabilities.
6. Model results included measures of uncertainty and sources of variation.
7. Model results are spatially explicit.

The guidelines suggested by Marcot et al. (2006) were used to develop focal species' assessment models. Briefly, this included the following steps: creation of an influence diagram of key factors affecting the sustainability of a species; development of an alpha-level BBN model from the influence diagram; revising the model with input from expert reviewers; testing and calibrating the model with case files to create a beta-level model; and evaluation of the model.

Focal species' assessment models were developed for application at two spatial scales: 1) the watershed (HUC 5) and 2) the planning area (National Forest). At the watershed scale we developed the Watershed Index (WI), and a Weighted Watershed Index (WWI). The WI provided a measure of change in the amount of source habitat (range of variation compared to current conditions), and the influences of habitat quality and risk factors for each watershed. The WWI was calculated from the WI by weighting it by the amount of source habitat that was currently available in each watershed. The WWI provided a measure of the potential capability of each watershed to contribute to the viability of the focal species.

The second model calculated an overall index of the potential capability of the planning area to provide for viability of the focal species. This, the Viability Outcome (VO) model uses the aggregated data from the Watershed Index model, the WWI, and an assessment of how well habitats are connected and distributed across the planning area.

The use of ecological thresholds is highly controversial and difficult to validate (Muradian 2001, Bestelmayer 2006, Lindenmayer and Luck 2005, Tear et al. 2005, Lindenmayer et al. 2006) yet they are continually being applied to address conservation issues (e.g., Noss et al. 1997, Groves 2003, Svancara et al. 2005, Tear et al. 2005). We conducted a review of the literature to identify a habitat threshold that we could apply to evaluate the number, distribution, and connectivity of watersheds across the planning area that are in "relatively" good condition and may make important contributions toward the sustainability of focal species. It is important to note that we did not use a threshold as a conservation goal; rather the threshold was used to evaluate a watershed's contribution to species sustainability. We chose 40% as a minimum amount of source habitat after reviewing approaches used in other conservation assessments and empirical studies (Noss et al. 1997, Groves 2003, Olson et al. 2004, Radford et al. 2005, Svancara et al. 2005, Tear et al. 2005, Denoel and Ficetola 2007). Svancara et al. (2005) showed that conserving a minimum of 40% of total habitat available maintained representation, resiliency, and redundancy in the remaining habitat and associated wildlife populations. Representation, resiliency, and redundancy were elements we considered important to maintaining or restoring species sustainability (Schaffer and Stein 2000, Groves 2003).

Watershed Index Models

Focal Species Assessment models were developed for most focal species using findings reported in the professional literature reviews and expert opinion. The primary variables in the WI and WWI models included: 1) habitat departure (e.g. estimates of the range of variation) of source habitats, 2) estimates of the current amount and distribution of source habitats, 3) factors that influenced the quality of the source habitat (e.g., patch size, fine-scale habitat features, habitat connectivity), and 4) risk-factors (e.g., road density, recreation routes, domestic grazing, invasive species).

Databases of life history traits were developed for each focal species based on literature reviews and expert opinion in order to develop models for assessing focal species viability. Each model was peer reviewed by species experts. The WI models incorporate information that influences the quality of the source habitat such as patch size, connectivity, and fine scale features such as snags and downed logs. **Figure 1** displays the primary variables used in the Watershed Index models.

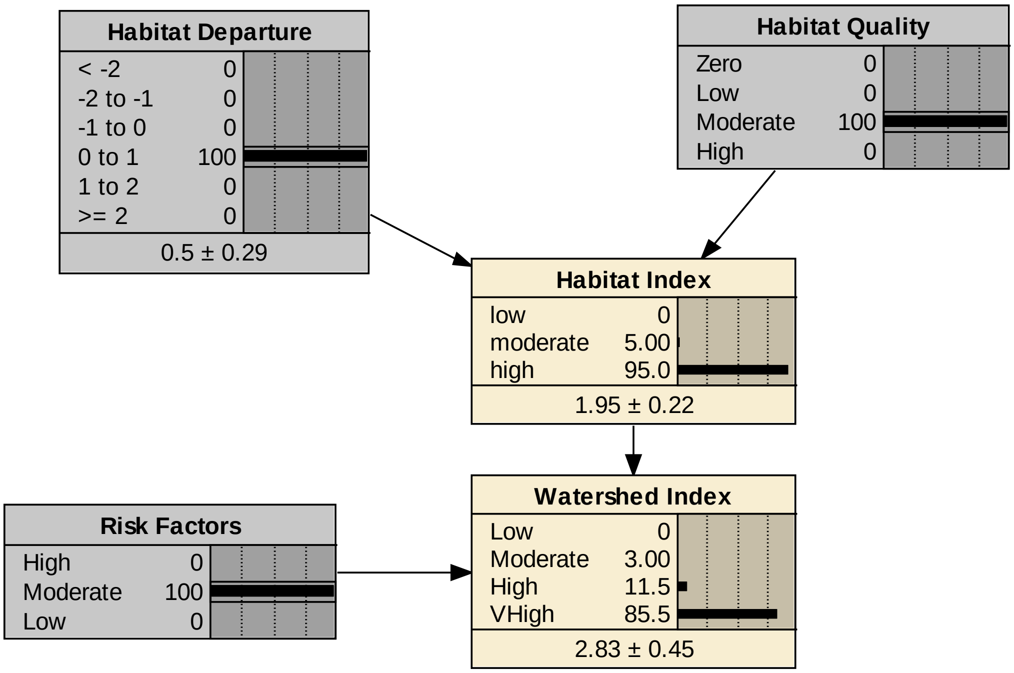


Figure 1: Basic Structure Watershed Index Model

The primary variables used in the Watershed Index model include:

Habitat Departure of Source Habitat*:* The range of natural variability (RNV) refers to the composition, structure, and dynamics of ecosystems before settlement (Morgan et al. 1994, Swanson et al. 1994, Fule' et al. 1997, Landres et al. 1999). It is assumed that by managing habitat within the RNV species will remain viable because they survived those levels of habitat in the past to be presten today (Landres et al. 1999). By comparing the current condition of source habitats with the range of variability together with an analysis of risk factors, insights were gained into the capability of each watershed to provide habitat that would contribute to the viability of focal species (Wisdom et al. 2000). The mort that the current and likely future conditions depart from the RNV, the greater the risk that species may be lost from the system.

The Habitat Departure of all forested habitats was estimated by **Countryman _HRV_2008 (citation).**

Habitat departure for each species was calculated on a watershed scale using the appropriate potential natural vegetation groups for each focal species. We calculated this range based on the estimates of source habitat from suitable PNVGs across all watersheds for each planning area (National Forest). We calculated a low, median and high expected range of variability and broke this into 6 classes. The assumption was that the closer the amount of source habitat per each watershed to the median range of variation (or above), the abundance of habitat was contributing to a sustainable or viable population.

Reference Conditions of Forested Source Habitats

We used the RNV as the reference condition. We estimated reference conditions for source habitats using the following steps:

Step 1. Using information in Table x we identified the low and high percentages of forest group(s), structural stage(s), and canopy closure(s) that corresponded best to our description of source habitats for the focal species.

Table 2_HRV -- Estimated range of variation for forested habitats in the Blue Mountains assessment area

Step 2. We then determined the area of each watershed that is potential source habitat based on the potential natural vegetation group (PVG). Potential source habitat was a combination of PVGs that had the capability of providing source habitat given the appropriate structure stage and canopy closure were present.

Step 3. We used the percentages derived from Step 1 and the area estimates from Step 2 to calculate a range of high and low area estimates of the predicted amount of source habitat for each watershed.

Step 4. We then divided the range of area estimates from Step 3 by the area (size) of each watershed that corresponded to the appropriate potential natural vegetation group (PNVG) in order to get to estimates of the percent of each watershed that historically had the potential to provide source habitat for the focal species. Each watershed had a high and low percentage generated at this step. We used the absolute low and absolute high across all watersheds (for each planning area) to bound our estimated reference condition for each species. We also calculated the median percent of the potential of all the watersheds for each planning area.

Step 5. We then classified the range into 3 equal categories between the absolute low and the median, and 3 equal categories between the median and the absolute high (Fig.X).

	Low			Median			High
Categories	-3	-2	-1	0	1	2	3

projected

Figure X. A depiction of how the departure classes were created using the low, median and projected estimates of the amount of source habitat for each watershed was implemented.

Reference Conditions of Post-fire Source Habitats

Reference conditions for post-fire source habitats were also developed by Countryman_HRV 2008. These reference values were used in the black-backed woodpecker and Lewis's woodpecker analysis.

We used the same calculation as in Forested habitats to describe the range of variation expected for these 2 species.

	Post-Fire - HRV (%)		
PVG	Low	Median	High
cd	5.1	15.6	26.1
cm	5.8	17.5	29.2
dd	1.5	4.6	7.7
dg	2.4	7.4	12.4
dp	1.0	2.9	4.8
xp	1.2	3.7	6.2

Table Post-fire HRV -- Estimated reference conditions for post-fire habitats by forest group in the Blue Mountains assessment area

Reference Conditions for species associated with non-forested source habitats.

As described above, in forested communities we have projected proportions of different potential vegetation groups and structural stages that were predicted to occur at any given time considering succession and disturbance across the landscape. In the non-forested, shrublands and riparian environments we did not have these predictions. Therefore, we have assumed in this analysis that if the amount of source habitat in a watershed was reduced to <40% of the median of the estimated reference condition, the ecological function of the remaining source habitat to provide for the viability of the focal species was greatly diminished (Noss et al. 1997, Groves 2003, Olson et al. 2004, Radford et al. 2005, Svancara et al. 2005, Tear et al. 2005, Denoel and Ficetola 2007). Variation in amount of habitat lost or gained was characterized by assigning the proportion of habitat lost or gained to 1 of 6 classes. We created 9 classes of departure: loss (-1, -2, -3) and gain (+1, +2, +3) totaling to a 0-60% loss or gain (e.g., 30% per class).

	Class -3	Class -2	Class-1	Class 1	Class2	Class 3
Percent Source Habitat	<40% (of historical)	>=40-70% (of historical)	>=70-100% (of historical)	Historical (0-30%)	30-60% greater than historical	>60% of Historical

Reference Conditions of Upland Non-forest Source Habitats

To evaluate the relative amount of upland non-forest source habitat within watersheds we compared the current amount of source habitat in the watershed with changes in physiognomic types in the Blue Mountains as described by Hann et al. 1997. Because we are evaluating USFS lands only, we assumed no loss in these habitats due to development. We used vegetation data on potential vegetation from the ILAP project for these habitat types. Because Hann et al (1997) described a portion of these vegetation types on BLM/FS lands as now being Exotci Herbland, we assumed the following reductions for the 3 species: Sage Thrasher (primarily Shrub associated) -5%, Lark Sparrow (Shrub/Grass associated) -10%, Harrier (Grass associated) -10%. However, although we assumed a loss of habitat, we did not change the departure class for these species. Although there may have been a decline in source habitat due to exotic encroachment, this loss of <=10% we did not feel warrant a change in departure class.

Blue Mtns ERU			
Dry Grass	BLM/FS	15% Exotic Herbland	p. 548 Han
Dry Shrub	BLM/FS	8% Exotic herbland	P. 549 Har
Cool Shrul	BLM/FS	4% Exotic herbland	p. 550 Han

Reference Conditions for Wetland and Riparian Deciduous Source Habitats

Numerous reports describe how human activities (e.g., those from dams, diversions, agriculture conversion, stream channelization, road construction, etc.) have permanently altered large areas of wetland habitat. Brinson et al. (1981) estimated that 9.3 million ha of the original floodplain forest has been converted to urban and cultivated agricultural land uses in the United States. Klopatek et al. (1979) estimated that northern floodplain forests have decreased 69 percent in area from their potential, and Hirsh and Segelquist (1978) estimate that 70 to 90 percent of all natural riparian areas have been subjected to extensive alteration. Little is known about the extent and status of mountain riparian ecosystems, which are affected primarily by impacts associated with other natural resource uses (e.g.,. timber harvest, recreation, livestock grazing) although Federal and State surveys have found that 50 percent of all fish habitats on public and private lands in western Oregon have been altered since 1960 (Kadera 1987). Dahl (1990) describes that approximately 47.3 million ha or 53% of all U.S. wetlands have been lost since the 1780s. In Oregon, wetland area has declined 38 percent since 1800 (Swift 1984). The intentional near extirpation of beaver may also have been a factor in the decline of riparian and aquatic habitats in the Blue Mountains, especially in basins where beaver were formerly abundant (Knopf and Scott 1990).

Based on this information, we assumed that the current amount of source habitat for wetland and riparian deciduous focal species in the planning area was approximately 80% of the historical amount in each watershed. In the WI source habitat departure node we used the Class -1 category for every watershed to reflect our assumption that the availability of these habitats were near 80% historical median.

Reference Conditions for Stream-side Riparian, and Cliff Source Habitats

For these habitats, we assumed that their availability has not changed from their historical amounts. Therefore, our assessment focused on factors that could influence the quality of these habitats. In the WI source habitat departure node we used the 0-1 quartile for every watershed to reflect our assumption that the availability of these habitats were near the historical median.

Source Habitat Abundance: *S*patial data files of source habitat for each focal species were developed for the planning area based on source habitat definitions, cover types, and structural classes primarily using the Forest EVG data.

Source habitats were defined as those providing characteristics of macro-vegetation that contribute to stationary or positive population growth (Wisdom et al. 2000). Source habitats are distinguished from habitats simply associated with species occurrence; such habitats may or may not contribute to long-term population persistence (Wisdom et al. 2000). The macro-habitats used by each of the species considered in our assessment were described using cover type and structural stage. We included habitats used for reproduction, movement, and cover (e.g., protection, thermoregulation) as described by Johnson and O'Neil (2001), other primary literature, and professional judgment.

Habitat quality factors: For many focal species, the quality of source habitat was assessed based on information such as the density of snags and logs, patch size of source habitat, or amount of shrubs. Based on the literature and species experts we measured or indexed the spatial effects of these quality factors for each watershed based on the availability of spatial data.

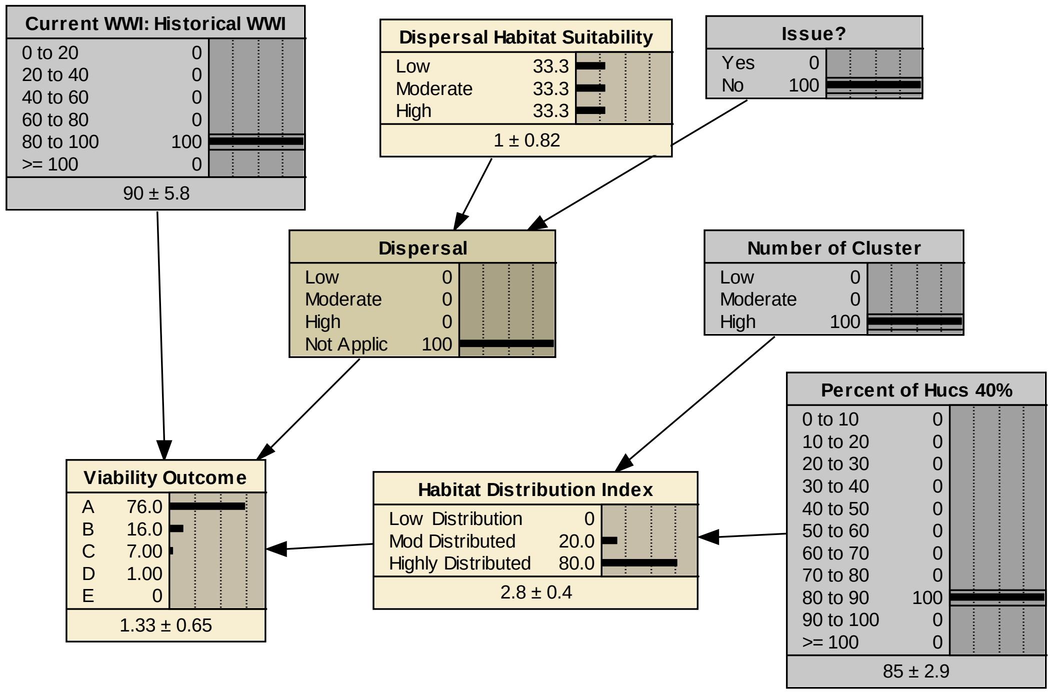
Other risk factors: Risk factors attributed to human activities were identified from literature review or species experts. The influence of these factors on focal species viability was assessed for each watershed by measuring or indexing the spatial extent of their effects to source habitats. Application of these indices relied on the availability of spatial data describing factors such as roads, trails, and human population centers.

Viability Outcome Models

The Viability Outcome (VO) models that were developed for each focal species incorporate information from the watershed index scores, distribution of source habitats across the planning area, and for some species, how well habitats were connected across watersheds. The VO should be thought of as a large-scale index of the capability of the environment to support population abundance and distribution. It is assumed that species with high VO scores would have a high probability of having populations that are self-sustaining, and well distributed throughout their historical ranges in the planning area.

The VO model incorporated the WWI score (described earlier), a habitat distribution index, and for some species, a habitat connectivity index that assessed how well habitats were connected across watersheds. Each variable of the VO model is described in detail below.

Figure 2 – Viability Outcome model



Weighted Watershed Index Calculation (Current WWI:Historic WWI) - The WWI was incorporated into the VO model by calculating the ratio of current WWI to historical WWI as a way of assessing the current capability of the assessment area to provide for the viability of focal species compared to what the capability was historically. We define the WWI as a relative measure of the potential capability of the watershed to contribute to the viability of the focal species.

Habitat Distribution Index- This node is used to help describe the distribution of the species across the range of the species within each planning area (on USFS lands). This index assessed how watersheds with relatively high amounts of source habitat were distributed across the assessment area. The habitat distribution index was calculated by the interaction of two variables: 1) number of clusters[2] with at least one watershed that met the threshold for the amount of source habitat amount, and 2) percentage of the total number of watersheds that met the threshold for amount of source habitat. The threshold amount of source habitat within a watershed was at least 40% of the historical median of source habitat (see page 6 for further explanation).

Number of Clusters at the Forest Level

Low = 1
Moderate = 2 (UMA, MAL), 2-3 (WAW)
High = 3 ((UMA, MAL), and 4 (WAW) (or 3 on WAW if cluster 1 meets the criteria)

Dispersal Habitat Suitability - We evaluated dispersal habitat suitability for American marten and wolverine whose dispersal patterns were appropriate to assess. Our analysis was based on the idea that resistance to movement across a landscape can be mapped by assigning

[2] Clusters were identified by Barb Wales as her best guess at how to evaluate habitat as being widely distributed across the Forest. Subbasin's and forest ownership patterns were used. The Wallow-Whitman has 4 clusters, while the Umatilla NF and Malheur NF have 3 each.

resistance values to habitat attributes. These values depict the relative “cost” for an animal to move across areas (Singleton et al. 2002). Areas with “good” habitat characteristics (i.e. forested land cover, low road densities, and low human population densities) have low costs of movement, whereas areas with “poor” habitat characteristics (i.e. agriculture land cover, high road densities, and high human population densities) have high movement costs.

Methods similar to those used by Singleton et al. (2002) were used to model dispersal habitat suitability within each planning area.

Viability Outcome

Environmental outcomes defined in Raphael et al. (2001) were used as a basis to describe five viability outcomes. These outcomes were calculated for current and historical conditions for each focal species to assess changes in habitat conditions. The term ‘suitable environment’ refers to the combination of source habitat and risk factors that influence the probability of occupancy and demographic performance of a focal species. The five viability outcomes we used were:

> **Outcome A** – Suitable environments are broadly distributed and of high abundance across the historical range of the species. The combination of distribution and abundance of environmental conditions provides opportunity for continuous or nearly continuous intra-specific interactions for the focal species. Focal species with this outcome are likely well-distributed throughout the plan area.
>
> **Outcome B** - Suitable environments are broadly distributed and of moderate to high abundance across the historical range of the species, but there may be gaps where suitable environments are absent or present in low abundance. However, any disjunct areas of suitable environments are typically large enough and close enough to permit dispersal among subpopulations and to allow the species to potentially interact as a metapopulation. Species with this outcome are likely well-distributed throughout most of the plan area.
>
> **Outcome C** – Suitable environments are moderately distributed and/or exist at moderate abundance across the historical range of the species. Gaps where suitable environments are either absent or present in low abundance are large enough such that some subpopulations may be isolated, limiting opportunity for intra-specific interactions especially for species with limited dispersal ability. For species for which this is not the historical condition, reduction in the species’ range within the plan area may have resulted. Focal species with this outcome are likely well-distributed within only a portion of the plan area.
>
> **Outcome D** – Suitable environments exist at low abundance and/or are low to moderately distributed across the historical range of the species. While some of the subpopulations associated with these environments may be self-sustaining, there may be limited opportunity for population interactions among many of the suitable environmental patches for species with limited dispersal ability. For species for which

this is not the historical condition, reduction in species' range within the plan area may have resulted. These species may not be well-distributed within the plan area.

Outcome E – Suitable environments are highly isolated and exist at very low abundance relative to historical conditions. For species with limited dispersal ability there may be little or no possibility of population interactions among suitable environmental patches, resulting in strong potential for extirpations within many of the patches, and little likelihood of recolonization of such patches. There has likely been a reduction in the species' range from historical conditions, except for some rare, local endemics that may have persisted in this condition since the historical time period. Focal species with this outcome are not well-distributed throughout much of the plan area.

Based on Raphael et al. (2001), it is assumed that species with VO scores of A or B would have a high probability of having populations that are self-sustaining, and well distributed throughout their historical ranges in the planning area. C outcome indicates that likely habitat distribution or abundance issues lead to uncertainty of viability, while a D or E outcome indicates a low likelihood of viability of the species across the planning area.

RESULTS

We evaluated the Watershed Index Model and the Viability outcome model for most of the Focal species for the Historical and Current time period.

For the species associated with forested environments we also used these models to evaluate projected viability for the preferred action alternative (Alt. B) using the outputs of vegetation modeling provided by the planning team. For those species that there was no vegetation modeling data available such as riparian and grassland and shrubland associated species, we evaluated potential future viability based on Alt. B qualitatively. Table 3 shows the viability outcomes for the focal species we evaluated using the models described above by time period. Parts 2, 3, and 4 of this document provide individual species analysis for all focal species evaluated. Focal species model inputs and outputs are discussed for each National Forest. There are a few focal species for which viability was not evaluated. These species, except for the bats, all had extremely limited distribution on lands managed by the USFS. These species are addressed in Table 4 and Part 5. Although each of the bat species fits within a group or family that at least one focal species was analyzed except the Townsend's big-eared bat, there is an additional discussion on bats in part 5.

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