

Type II Forest Estate Analysis For Tree Farm License 48

Version 2

Prepared for:
Canadian Forest Products Ltd.
Chetwynd Operations

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Prepared by:
Robert J. Schuetz, RPF
Industrial Forestry Service Ltd.

Executive Summary

A Type II silviculture/forest management analysis was completed for TFL 48 and is described in this report. The analysis was unconventional in that significant effort was focused towards wildlife habitat monitoring, rather than concentrating primarily on silviculture management alternatives.

The analysis was completed by Industrial Forestry Service Ltd. using the MOF's Forest Service Simulator (FSSIM) model. The output from this model was linked to an ARC-INFO spatial representation of the TFL to provide spatial resolution on the impact of harvesting on seral structure and wildlife habitat.

Silviculture management alternatives included basic silviculture, shelterwood management alternatives, brushing versus not brushing post-harvest blocks and adjusting site index using biogeoclimatic ecosystem classification estimates (SIBEC). The UBC growth model FORECAST was used to predict the growth of shelterwood stands and the yield impact of not brushing managed stands.

Wildlife species monitored included Grizzly Bear, moose, marten, Northern Goshawk, and Black-Throated Green Warbler. For each species, habitat quantity and quality over time were tracked as a result of the completion of wildlife habitat ratings linked to BEC labels. Spatial maps and graphs show that the quantities of habitat values remain relatively constant over time. The location of these habitat values shift yearly with the aging of forest stands and the harvesting of cut blocks.

The analysis showed that forest management can have a significant impact on the short and long-term harvest levels. Better site index information and utilization of Class A seed (when it comes available) are two initiatives that will provide the greatest positive gain in the short and long term harvest flow.

Timber quality is shown to remain relatively stable over the next 100 years. The shift thereafter to managed stands will result in a significant reduction in larger piece sizes (i.e., piece sizes greater than 0.8m³/tree will drop from 30% of the harvest to 10%).

Wildlife habitat quantity is shown to remain reasonable constant over the long-term. However, there is some small reduction in high quality habitat in the short-term. The impact of significantly more harvesting or less harvesting on wildlife habitat quality and quantity was not tested, but should be explored.

A preferred management program was suggested in this report. The program utilizes the quantitative results from this analysis to budget a silviculture program that considered timber supply, timber quality, wildlife habitat, economic return, corporate philosophy and employment opportunity. With regard to all regimes tested, SIBEC inventory information and sowing class A seed were shown to provide the greatest overall benefit to the TFL.

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Assisting with the technical components of this project, the following individuals provided valuable contributions:

Bailey, Chris (Industrial Forestry Service Ltd.)
Cross, Gord (Industrial Forestry Service Ltd.)
Mannhardt, Hans (Industrial Forestry Service Ltd.)
McKinley, Robin (Spatial Mapping Ltd.)
Seeley, Brad (UBC)
Wang, Zhili (Spatial Mapping Ltd.)

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Type II Analysis for Tree Farm License 48

1. Introduction

This report presents the results of a spatial investigation into the quality and quantity of timber and wildlife habitat within the confines of Tree Farm License #48 (TFL48). A Type II Analysis is typically focused towards quantifying the impact of alternative silviculture regimes to maintain or improve the forecasted harvest flow for a specified land base. Silviculture management regimes are also used to improve timber quality and/or wildlife habitat.

This analysis provides a first look at the spatial consequence of timber harvesting on the quantity and quality of wildlife habitat over time. In so doing it follows a slightly different approach to the “standard” Type II analysis. The reason for this approach can be better understood through a brief summary of recent inventory and planning initiatives completed by Canfor for TFL 48.

A timber supply analysis was completed for TFL 48's Management Plan #3 (MP#3) in March 2001. This analysis showed that the current harvest level for the TFL is sustainable for the next 250 years. A harvest forecast above the current allowable annual cut was also shown to be very probable, through improvement in site index estimates for older stands. The MP#3 analysis report also examined the impact of several alternative silviculture management strategies (some of which are summarized in this report as well). Following the MP#3 timber supply analysis submission, Canfor completed Terrain Ecosystem Mapping and site series mapping across the TFL. Canfor biologists have also developed habitat ratings for several critical wildlife species found within the TFL. With consideration for this new information, and Canfor's commitment to protect and conserve timber and non-timber values¹, an analysis that focused towards measuring the impact of wildlife habitat quantity and quality was deemed to be more valuable from a strategic planning perspective.

With respect to the goals of this report, perhaps the one most important point to stress is that this exercise is a work in progress. In analyzing the various inventories and developing management assumptions, we discover that there is much that we do not know and much for which operational precision in estimating mid and long-term impacts of management alternatives is lacking. Although the best information available is used in the analysis, it is the process of explicitly defining these uncertainties that has the potential to provide the greatest value in guiding resource managers towards future research endeavours.

¹ Pursuant to the TFL's certification with the Canadian Standards Associations (CSA) Sustainable Forest Management System Standard (CAN/CSA-Z809-96)

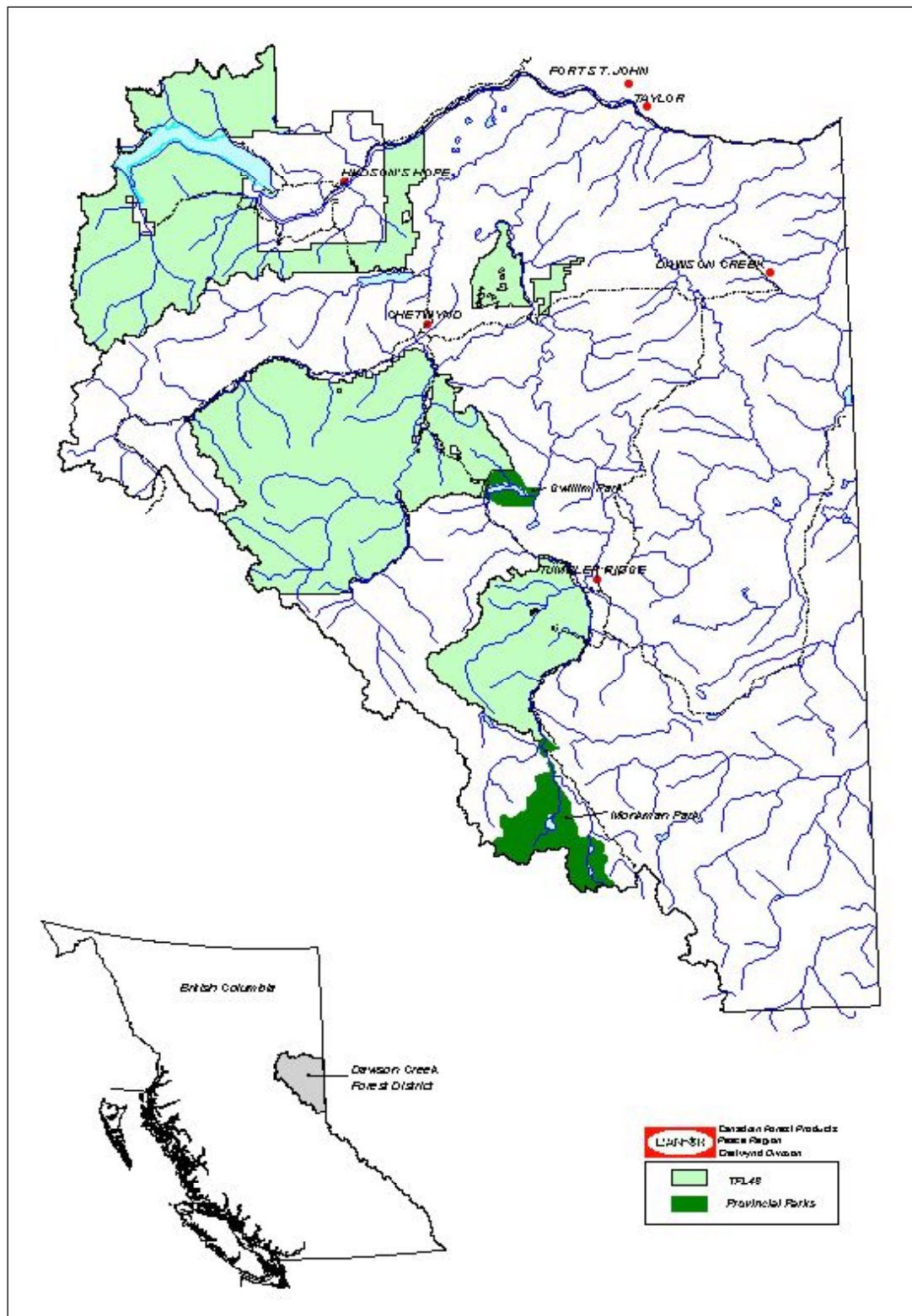
1.1. Tree Farm License 48

Tree Farm License 48 is located in the Prince George Forest Region, with the Rocky Mountains and foothills of the Hart Range in the west and the Alberta Plateau in the east (Map 1). The TFL comprises five supply blocks that are clustered around the communities of Chetwynd, Hudson Hope and Tumbler Ridge. TFL48 is held by Canadian Forest Products Ltd. (Canfor). It is administered by Canfor's Chetwynd Operations office and by the Ministry of Forest's Dawson Creek Forest District Office. TFL48 covers approximately 644 thousand hectares, of which approximately 321 thousand is suitable for timber harvesting.

Commercial forests within the TFL are predominately White Spruce, Lodgepole Pine, Sub-Alpine Fir (balsam), Trembling Aspen and cottonwood. Terrain varies considerably, from gently rolling slopes to steep mountain valleys. The climate is continental. Classification of the TFL based upon climate and biophysical criteria places 40 percent of the productive land in the Engelmann Spruce Sub-Alpine Fir (ESSF), 36 percent in the Boreal White and Black Spruce (BWBS) and 24 percent the Sub-Boreal Spruce (SBS) biogeoclimatic ecosystem classification zones.

The current allowable annual cut was set in September 2001 at 580,000 cubic metres. This is apportioned 55,000 cubic metres to deciduous leading stands and 525,000 cubic metres to coniferous leading stands.

The primary timber processing facility that utilizes the annual coniferous harvest is Canfor's Chetwynd sawmill. The sawmill processes approximately 1.9 million cubic metres of coniferous wood per year. Deciduous fibre is sold on the open market. Locally, Louisiana-Pacific has a pulp mill in Chetwynd, an OSB mill in Dawson Creek and is building a veneer plant in Dawson Creek. All three of these mills utilize deciduous fibre.



Map 1 Location of TFL 48

2. Information Preparation

In a forest estate analysis, three categories of information are required to complete a harvest simulation that attempts to predict the future. An inventory is required of the attributes that you wish to manage and monitor. Growth assumptions are needed to predict changes to inventory attributes over time. Management assumptions are necessary to explicitly describe the human interaction with the forest estate.

2.1. Land Base and Forest Inventory

The land base and forests for the TFL are described by a vegetation resource inventory (VRI). This inventory remains unchanged from the MP#3 analysis. The VRI was completed in 1998 and provides a detailed description of species and stand attributes (age, height, stocking) throughout the TFL. This information was merged with stream classifications, visual inventories, landscape unit mapping, the 20-year strategic plan and several other inventories to provide a comprehensive description of area in the TFL and the spatially defined management regions or zones tied to it. Details on these zones are provided in the data package appended to this report and in the MP#3 timber supply analysis report.

The land base inventory for TFL 48 has been enhanced since the completion of the MP#3 analysis. Site series mapping was made possible through the completion of terrestrial ecosystem mapping (TEM) and predictive ecosystem mapping (PEM) across the TFL. Site index adjustments according to "site index and biogeoclimatic ecosystem classification" (SIBEC) have not been completed for the TFL. However, one of the scenarios examined in this analysis looks at the possible impact of SIBEC on the timber harvesting land base and the harvest forecast.

As much as possible, the net down logic used to define the THLB remained unchanged from the logic used and described in MP#3. However, some changes did occur to the net-down process due to the spatial nature of the analysis. In order to track each forest stand over time and to spatially identify each stand when and where it is harvested, the database was modified to reflect changes necessary to model these dynamics over time. A summary of these changes are described in Section 5.1 in the appended Data Package.

The current timber harvesting land base in the TFL is 320,636 hectares. This area is slightly smaller (943 ha) than the THLB defined in the MP#3 analysis. The principle reason for the change is a modification in the status of small polygons (forest stands less than 1 hectare in size) which were merged to the largest adjacent polygon in order to simplify a spatial coverage which would otherwise comprise almost 1 million polygons.

Figure 1 illustrates the present area distribution of the THLB by 10-year age class. The figure reveals that a significant portion of the TFL is in older, mature forest stands.

Figure 2 shows the distribution of leading forest stands across the TFL. Coniferous leading stands cover the majority of the TFL and comprise about 280 thousand hectares in the THLB. Deciduous stands, to which an apportioned AAC was allocated, cover approximately 40 thousand hectares.

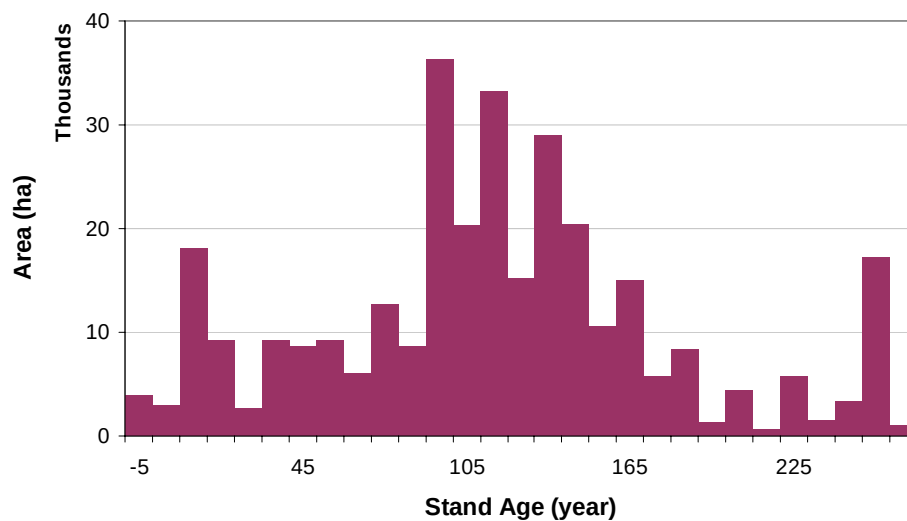


Figure 1 age-class distribution of the THLB in TFL 48

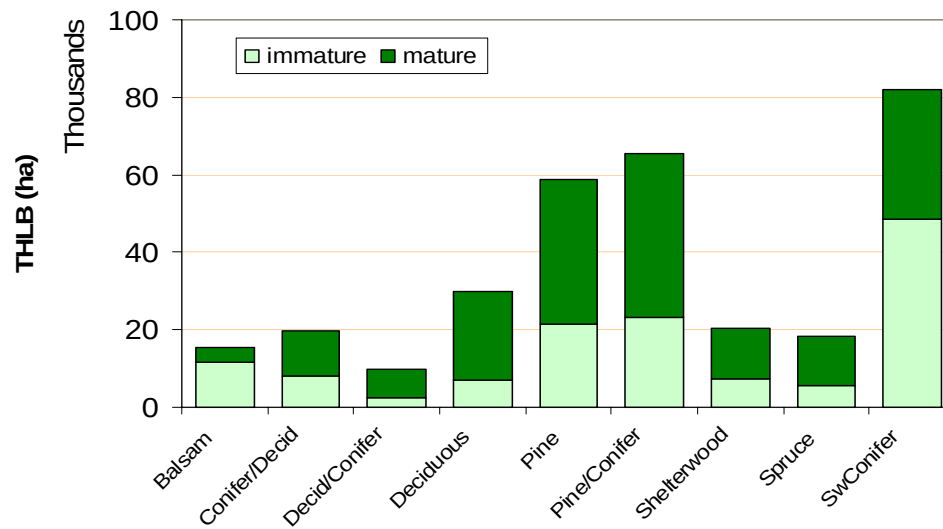


Figure 2 Distribution of area by species

2.2. Land Base and Wildlife Inventory

This analysis is unique from previous long-term harvest simulations completed for TFL 48, as the land base inventory is now enhanced with wildlife habitat ratings. More work is in progress with respect to the completion of these ratings. However, sufficient information is available for 5 of the 12 critical wildlife species currently being mapped, to incorporate the information into this analysis. Mapping of wildlife habitat values is made possible through Canfor's efforts towards the completion of terrestrial ecosystem mapping (TEM), predictive ecosystem mapping (PEM) and site series mapping across the TFL. TEM and PEM allow Canfor biologists to use the information in the development of wildlife habitat ratings tables. These tables link biogeoclimatic attributes to specific habitat values and assign a habitat quality rating. The information was developed according to the B.C. RIC Wildlife Habitat Ratings Standard. The amount of area within the TFL that matches a given BEC wildlife code, provides a measure of the quantity of area that meets a given habitat quality value. Ratings have been completed for moose, marten, Grizzly Bear, Northern Goshawk and Black-Throated Green Warbler.

The assumptions used in this analysis to track wildlife habitat over time are reasonably simple. For each forest polygon BEC is tracked throughout the simulation period. Within a stands BEC label, only structural stage is forecast to change. At time zero, structural stage is based upon forest attributes such as age, stand density, subzone, percent vegetation and crown closure. As time progresses, forests will age and if given sufficient time, the structural stage will change. Timber harvesting operations will also change the structural stage of the forest. Following are the basic assumptions used to define structural stage over time. They are an attempt to utilize relatively simple, available information and apply this to what can be a very complex classification.

1. At the present time, structural stage was defined by Canfor using a complex query of stand attributes such as age, vertical complexity, percent vegetation, stand density subzone, etc.
2. After time 0 structural stage is defined by stand age and for mature and old stands by subzone.
3. Stands cannot revert to a younger structural class other than through harvesting.
4. Following harvesting structural stage reverts to a class 3 or "shrub/herb".
5. Shelterwood harvesting occurs to a small extent on the TFL. Structural stage designations were designed primarily for clearcut harvest management actions in mind. Following a shelterwood harvest, the stand reverts to an advanced class 3 (age of about 35 years) before converting to class 4, "poles."

Figure 3 and Map 2 illustrate graphically and spatially the structural stage classification of the TFL. Quite obvious in both illustrations is the predominance of mature forest existing throughout the TFL.

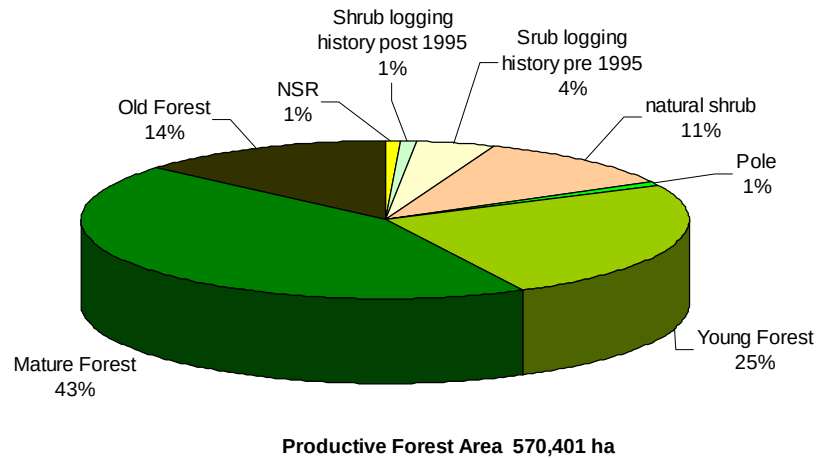


Figure 3 Structural Stage distribution and management history



Map 2 Current Structural Stage Map

2.3. Growth and Yield

In this analysis, growth and yield refers to the change in stand volume over time and the change in the average diameter and piece size per stem over time.

Stand growth and yield tables were allocated based upon silviculture history and silviculture management system. The MOF's Variable Density Yield Prediction (VDYP) model was used to predict the current volume and diameter and future growth of existing unmanaged stands. The Ministry's Table Interpolation Program for Stand Yields (TIPSY) model was used to determine the volume, diameter and pieces sizes of future managed stands. Pieces sizes for unmanaged stands were also predicted using the TIPSY model, with adjustments for stem diameter. Yields for shelterwood stands were predicted using a combination of TIPSY and VDYP in the Base Case scenario. Additional scenarios incorporated the output from UBC's FORECAST model to better predict the growth of shelterwood stands. Pieces size information was also obtained for shelterwood stands using the FORECAST model.

Site index assignments for unmanaged stands and most managed stands utilized the VDYP program. VDYP predicts the height of a stand at 50 years, using current age and height information. Existing managed stands that had a site index assignment allocated based upon their biogeoclimatic attributes, used this site index in preference over the VDYP estimate. As shown in Figure 3 previously, the majority of the TFL does not have management history.

Timber quality is a second growth and yield item that was predicted and tracked throughout the simulation period. Diameter at breast height (DBH) is a yield measure that can be reported for each analysis unit using both the VDYP and the TIPSY models. Although this measure is not used to drive the selection of stands during the harvest simulation, the results of the simulation can be used to link a data set of diameters by age class. In addition to diameter, piece size is the log attribute of greatest interest to Canfor's sawmill managers in Chetwynd. Although it is not an exact science in B.C., estimating piece size can be approximated for managed stands using TIPSY 'stand and stock' tables. These tables, specifically m³/ha by diameter class and the corresponding m³/tree by diameter class, were used to determine the proportion of 5 piece size classes harvested from each stand. Piece sizes were grouped into 5 classes ranging from "less than 0.2 m³/stem" to "greater than 0.8 m³/stem". Table 1 provides an example of the correlation between diameter and piece size for a 24 metre tall, 80 year old pine stand.

Table 1 Example of DBH / Piece size correlation (24m tall Pine @ 80 years)

DBH class (cm)	15	20	25	30	35	40	45
Piece Size (m ³ /tree)	0.11	0.22	0.40	0.60	0.83	1.06	1.38

Figure 4 and Figure 5 shows the current diameter class distribution of stands within the TFL and the current piece size profile that is being harvested from stands within the TFL. Diameters across the TFL range from 0 cm to over 45 cm. Stands with a diameter ranging from 20-25cm DBH comprise approximately one third of the THLB. This

diameter class distribution results in about 50 percent of the stems delivered to the mill averaging about 0.4 cubic metres per tree.

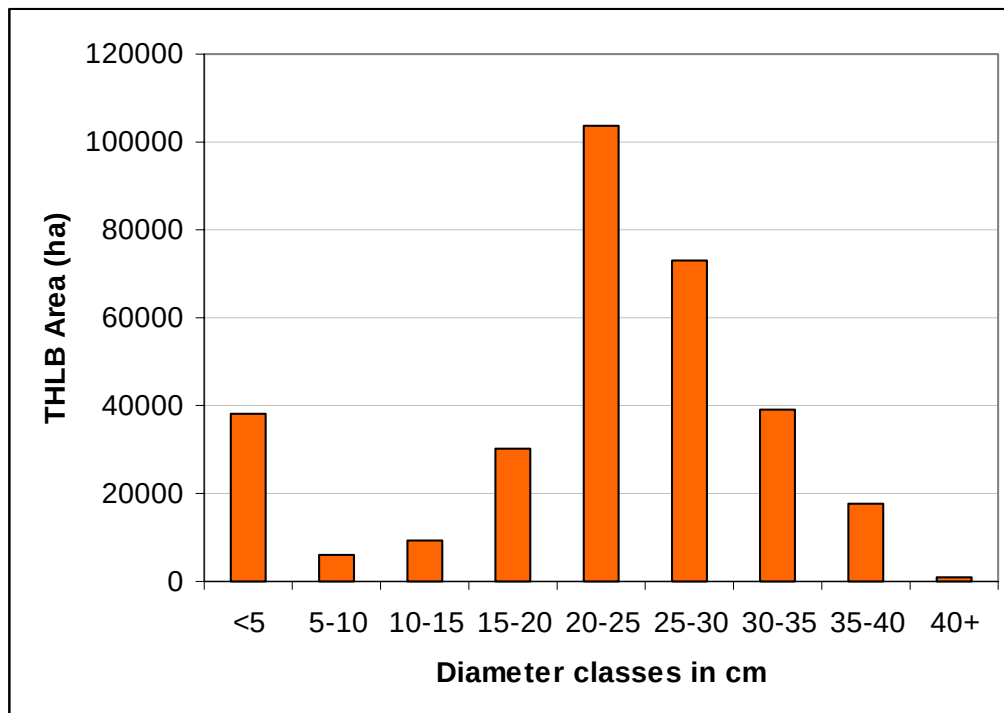


Figure 4 Initial diameter class distribution of the THLB

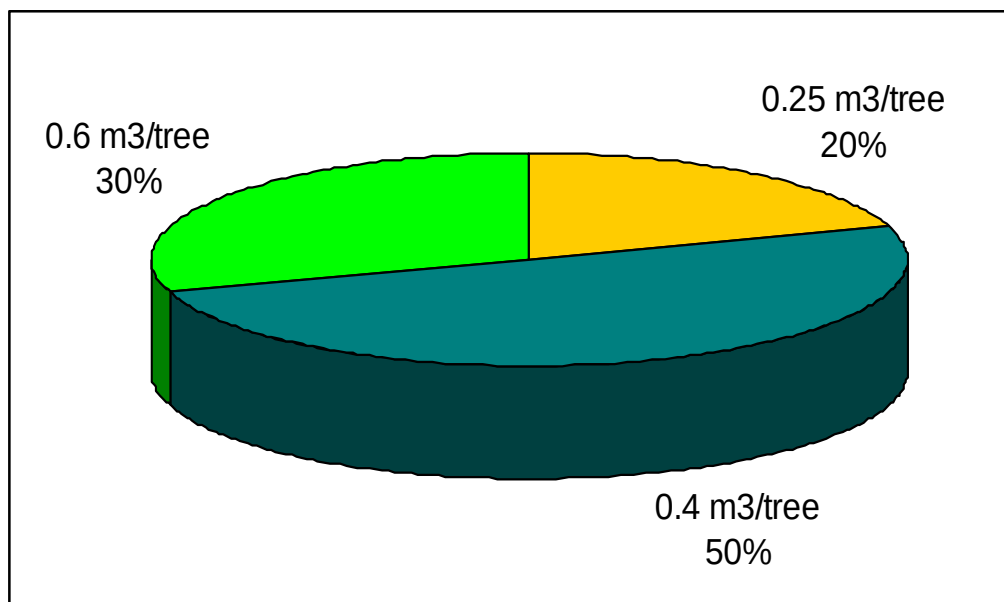


Figure 5 Current average piece sizes delivered to the mill

2.4. Management Practices

Management assumptions modelled in the Base Case represent as much as possible current management practices carried out in the TFL. Details on minimum harvest age, harvest priorities, regeneration assumptions and operational strategies in support of non-forest values are detailed in the appended Data Package. Table 2 provides a summary of the forest cover requirements applied to the productive forest land base. This analysis differs slightly from the MP#3 analysis in that early seral forest cover constraints were not applied to a Grizzly Bear zone. The intent of this omission was to see if in-fact, Grizzly Bear habitat is being adversely affected by harvesting operations.

Table 2 Forest Cover Requirements

Zone/ Group	Forest Cover Requirements
Retention Visual Quality Objective	Maximum 1.6 % < 6.0 metres (28.0 yrs)
Partial Retention Visual Quality Objective	Maximum 9.9 % < 5.0 metres (24.5 yrs)
Modification Visual Quality Objective	Maximum 21.9 % < 5.0 metres (24.5 yrs)
Integrated Resource Management	Maximum 33% < 3 metres (17.3 yrs)
ESSF mv2, mv4 and SBS wk2	Minimum 9.4% > 250 years
ESSF wc3, wk2	Minimum 19.9 % > 250 yrs
BWBS (conifer)	Minimum 11.5% > 140 yrs
BWBS (deciduous)	Minimum 13.6% > 100 yrs

Note: Old growth constraints were factored in over 140 years

A second deviation from the Base Case analysis for MP#3 occurred in the assignment of minimum harvest age for existing unmanaged stands. As a result of the spatial nature of this analysis, assumptions regarding wildlife tree patches were considerably more constraining than the assumptions previously used. To offset the drop in the harvest flow as a result of the removal of WTPs from the timber harvesting land base, minimum harvest ages for existing unmanaged stands was changed from regional priority cutting age to 95% of economic culmination age.

This analysis followed the previous general statements made by Canfor that there will be no net loss in the distribution of species in coniferous-deciduous or deciduous-coniferous mixed-wood stands. Regeneration assumptions included management for mixed-wood stands in future plantations. Furthermore, to preserve the uniqueness of deciduous stems occurring in the ESSF, these stands were spatially recognized and had their yield tables reduced to account for the deciduous component.

2.5. Wildlife Habitat Quality and Quantity

The habitat values for five species of wildlife are tracked in this timber supply analysis. For each of these species, 4 or 5 specific habitat attributes have been mapped by Canfor. Table 3 describes these species and habitat attributes. Although this analysis is able to track and report on any of these habitat values, previous short-term analysis completed

by Canfor revealed that for each of the five species, only one or two values were believed to be significantly impacted by harvesting operations. Table 3 identifies the habitat values that were specifically mapped and reported in this document.

Table 3 Wildlife Species and Habitat Values

Species	Habitat Values ¹
Moose (ALAL)	FDW – Winter feeding
	STW - Security / Thermal – Winter
	FDG - Feeding – Growing
	STG - Security/Thermal - Growing
Marten (MAAM)	AW – All Winter
	RB – Reproducing (birthing)
	FDG – Feeding / Growing
	STG – Security / Thermal - Growing
Black-Throated Green Warbler (BTNW)	RE – Reproducing (eggs)
	AG – all growing
	AMI – All migrating
Northern Goshawk (NOGO)	RE – Reproducing (eggs)
	FDG – Food – Growing
	STG – Security – Thermal - Growing
Grizzly Bear (URAR)	DE – Denning
	FDP – Spring Feeding
	FDF – Fall Feeding

¹ **BOLD faced** value indicates that they were specifically identified in this report.

Wildlife habitat ratings were assigned for each species using the combination of the following:

- subzone
- variant
- site series
- site series map code
- site modifier
- seral association
- structural stage

The combined results provide a classification rating that may have read something like this: BWBSmk101\$(ap)c1a.

For each of these ratings, some 3800 of which currently exist across the TFL, a habitat quality value was assigned. For birds, the values ranged from 1 to 4, with 1 indicating highest potential value. Mammals had ratings slightly more defined, ranging from 1 to 6.

3. Analysis Methods

The MOF's forest estate model FSSIM was used to simulate harvesting operations across the TFL. A spatial component to this model was incorporated into the analysis by maintaining a unique numerical indicator for each stand/polygon that occurred within the TFL. Version 3.0 of FSSIM was used to complete the harvest simulation for all scenarios. UNIX version 4.0 of FSSIM was used to produce a report that tracked which polygon was harvested in each period. The result from the FSSIM model was linked back to the spatial ARC-Info graphic files, to produce spatial maps of seral and wildlife changes over time. These maps were converted to jpeg files for ease of reporting in this document. FSSIM has the ability to apply constraints on polygons to ensure that adjacent stands are not harvest until green-up has been achieved. This function was not used in this analysis for four reasons:

1. Forest cover constraints applied at the landscape unit, subzone and variant level have splintered the land-base sufficiently that it is unlikely harvesting will become overly concentrated in any one place.
2. The strategic 20-year plan developed by Canfor as part of MP#3 was incorporated into the analysis and a priority was placed on harvesting these stands in the first 2 decades. This action will ensure that an initial, logical distribution of harvesting will occur across the TFL in the first 2 decades.
3. Forest stands tracked in the analysis ranged in size from 1 hectare to 300 hectares. However, the mean polygon size is approximately 8 hectares. This is well below the average cut-block size across the TFL. This indicates correctly, that cut-block harvesting typically involves the removal of more than one adjacent polygon.
4. Patch size distribution targets, as described in the landscape unit planning guidebooks, prescribe that a reasonable distribution of large blocks should be planned across the landscape. Concerns over harvesting too much area in one location were therefore, reduced.

This analysis did not track patch size distributions or cut-block adjacency. At a strategic level, it is impossible for any model to reasonably predict the spatial shape or harvest schedule that will be operationally followed 10 years in the future, let alone 80 or 200 years. These models are tools, to provide spatial and non-spatial insight into the possible impact of management alternatives, based upon a defined set of modelling assumptions.

This analysis did not place any harvesting constraints in preference to the wildlife species tracked. It seemed more prudent to assess the impact of unconstrained harvesting at the current AAC, to first assess whether or not some form of constraint is warranted.

All harvest scenarios were run for a 400-year simulation period. Harvesting of deciduous stands in all scenarios remained at the current deciduous apportionment. Only the coniferous harvest level was adjusted in support of a non-declining harvest flow.

4. Results

In this analysis, seven management alternatives were tested and grouped into the following 4 sections.

Section 4.1. This section revisits the Management Plan #3 Base Case harvest level. The results from this scenario were also described at length in the MP#3 timber supply analysis report. Tracking timber quality and wildlife values as a result of the current AAC is a primary focus to this section.

Section 4.2. Two scenarios incorporate shelterwood yield tables predicted by the UBC FORECAST model. One scenario mimics the Base Case assumptions. The second scenario reduces planting densities in shelterwood stands, in support of greater quantities of brush and improved grizzly bear habitat.

Section 4.3. Three scenarios analyze alternative silviculture management strategies with respect to brush competition following harvesting:

- a. The first scenario examined the impact of a “basic” silviculture management regime.
- b. The second scenario assumed brush control and current silviculture management treatments. In essence this is the same as the Base Case, but utilizes a different set of yield tables and different analysis input files.
- c. Scenario 3 analyzes the impact of no brush treatment in wetter sites.

Section 4.4. The final scenario adjusts the site index estimate for coniferous stands using site series and biogeoclimatic zone and variant of each stand. Site index values were estimated using the publication: *Site Index Estimates by Site Series for Coniferous Tree Species in BC*, MOF 1997. As a result of this change in site index both the THLB and the estimated yield tables were recalculated.

4.1. Base Case

4.1.1. Timber Supply

The harvest flow indicated for the Base Case remains relatively unchanged from the MP#3 analysis. An annual deciduous harvest of 55,000 m³ was projected for 250 years. Following this, drops in the deciduous harvest flow were forecast. The annual coniferous harvest level remained at 525,000 m³. Although the average volume harvested from all stands was reduced by 4.4 percent to account for volume lost to wildlife tree patches (WTPs), the harvest was supported by a change in the minimum harvest age for existing stands. In the Base Case for MP#3, regional priority cutting age was used as the minimum harvest age criteria for unmanaged stands. For poor stands, this often resulted in a harvest occurring prior to the point in time when their economic rotation age was achieved. Changing the minimum harvest criteria resulted in an improvement in mean annual increment sufficient to offset the volume lost to WTPs. Figure 6 illustrates the Base Case harvest flow for this analysis. The small dip in period 19 indicates that this is the period in the future when timber availability is most constrained under this harvest flow and these management

assumptions. In period 20, a 3.8 percent increase to the long-term sustainable harvest level is possible.

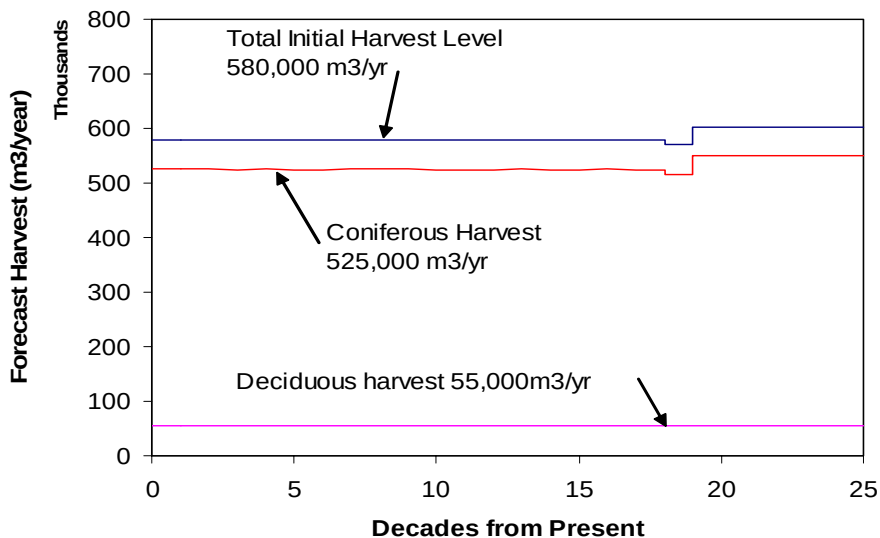


Figure 6 Base Case Harvest Forecast

Figure 7 shows the change in growing stock over time. The graph shows that the TFL currently has an abundance of mature and over-mature merchantable timber - approximately 40 million m³. Over the next 100 years, this level declines to about 20 million m³. The low points in the graph at periods 19 and 35 are also indicative of the times when timber availability is most constrained. Although in periods 19 and 35 there is still about 15 million m³ of mature timber, most of this volume is held in reserve as timber that is part of the THLB, and is constrained for green-up or old growth requirements.

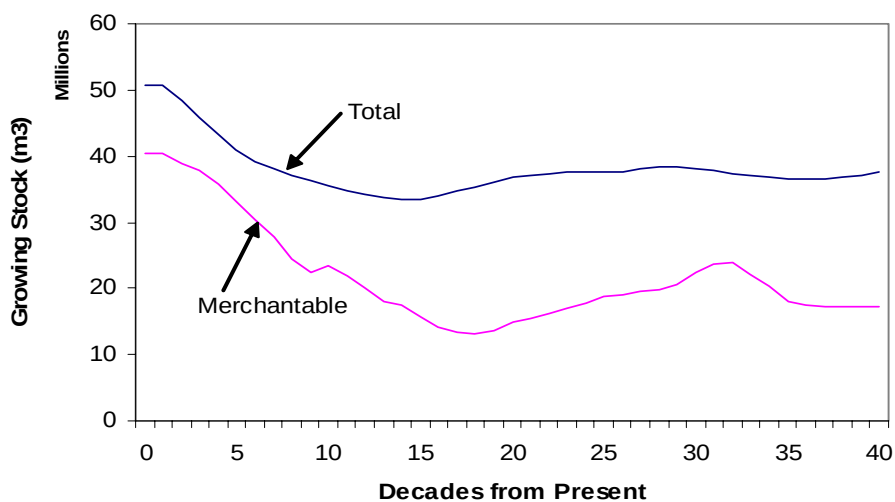


Figure 7 Growing Stock Forecast

Figure 8 shows the change in the structural state of the total forest land base. This graph was also mapped spatially for decades 0, 20, 50, 100 and 200 for the TFL. Map 2 showed the current structural stage. Map 3 shows the structural stage predicted in 100 years. All of these maps are also provided in Appendix II. Two points are evident from these images: 1) harvesting appears to have a relatively minor impact on the structural stage of the forest over time; and 2) the amount of old forest increases over time from 10 percent to 40 percent. The underlying assumption here is that stands do not die. Although many may find this assumption illogical, it demonstrates how the non-THLB land base ages over time and eventually reduces the seral constraints on the THLB in the long-term. A more logical approach might be to factor in catastrophic events into the harvest simulation. This is done to some extent through the reduction of the gross possible harvest level by 55,400m³/year for non-recoverable losses. However, this is a volume not an area loss.

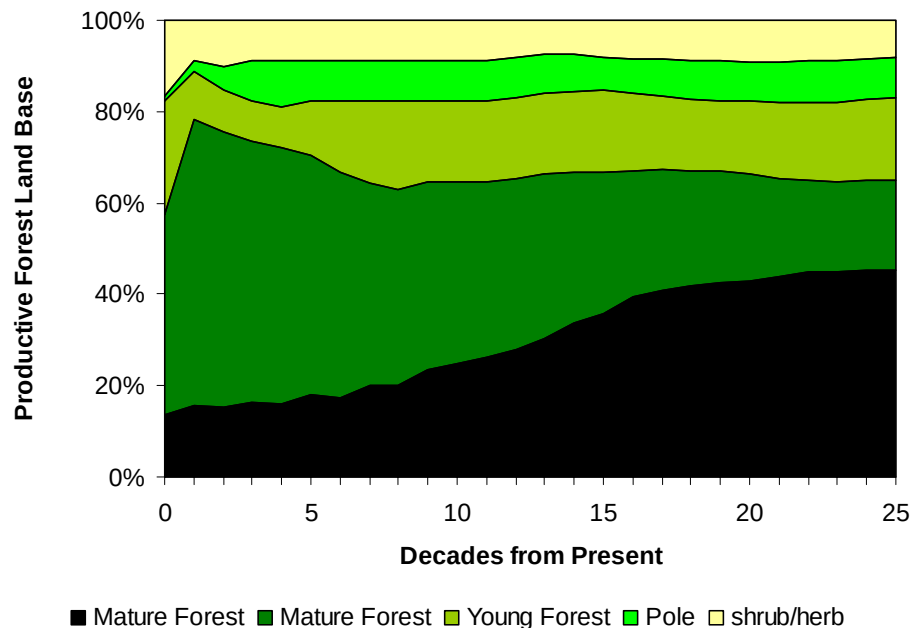


Figure 8 Forecasted change in the Structural State of the Land Base



Map 3 Forecast Structural Stage in Decade 10, TFL 48

4.1.2. Base Case Timber Quality

Timber quality is something that has not been tracked in previous harvest simulations for TFL48. The approach used in this analysis involved tracking average harvested stand diameters over time and the relative change in piece size over time. Both of these stand attributes are very subjective with respect to forest inventory information (i.e., the degree of confidence in the estimates for any one stand are likely quite variable, since few or no auditing has been done to verify the estimates used.). However, prior to analyzing these results, it is important to place in perspective the change in the average harvested stand age over time, and the time when stands convert from unmanaged to managed through harvesting. These results are shown in Figures 9 and 10.

Over time, stands are gradually harvested at a younger age. This would suggest that the amount of knots found in stems should increase, due to lower managed stand densities and greater live crowns. Overall, the average age of stems harvested across the TFL remains fairly high over the long term. At the ages indicated and densities managed, natural pruning should remain evident in many stands. Figure 12 illustrates the time when harvesting moves away from natural stands towards managed plantations. This transition begins to occur 90 years from present. By the 13th decade, approximately 98% of the harvest is supported by plantations. The remaining 2% harvest from natural stands comes primarily from old growth existing in visually sensitive areas with retention VQO.

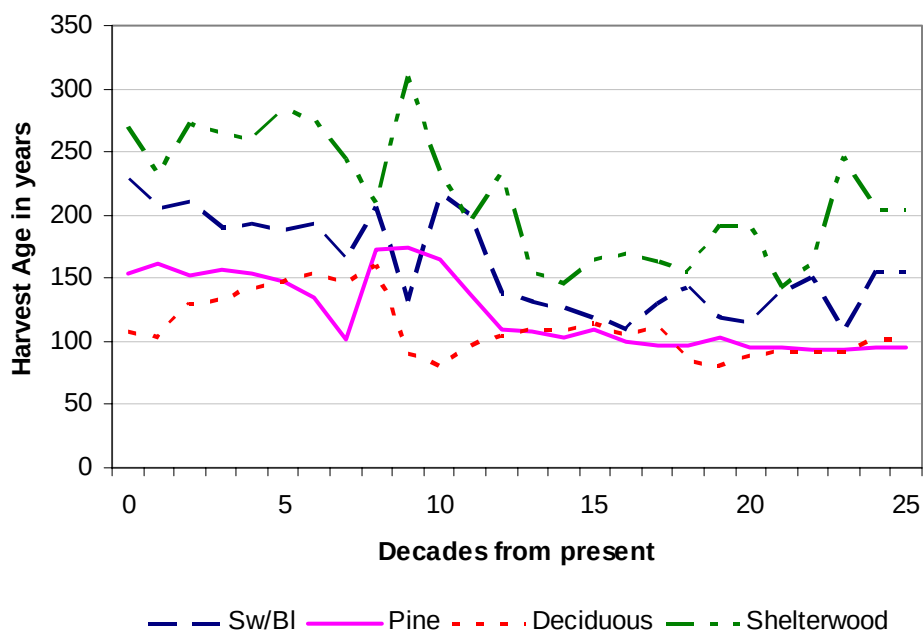


Figure 9 Average harvest age by leading timber type

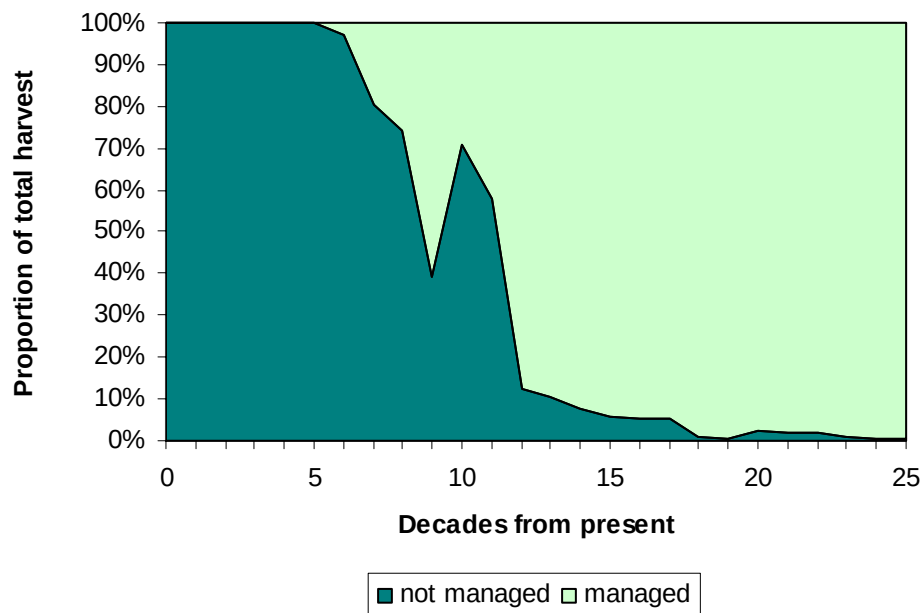


Figure 10 Change in harvest profile from natural to managed stands

Piece size is an output that is available for managed stands using the TIPSy model. Piece size for existing unmanaged stands is not available. The change in diameter for each analysis unit, at each age class, was used to adjust managed stand piece size proportions and make them applicable to the corresponding unmanaged stand. Although some fault may be found with this logic, alternatives provided no better solution.

In light of the trends shown in Figures 9 and 10, the developments shown in Figure 11 for diameter over time and Figure 12, piece size over time, offers some interesting topics for discussion. As expected, average diameter will decrease. However, actual dramatic changes will not occur for about 130 years. This observation is supported by Figure 12 illustrating the proportion of harvest volume that falls into 5 piece size categories. Initially, about 45 percent of the TFL's harvest provides piece sizes greater than $0.6\text{m}^3/\text{tree}$. This is slightly more liberal than the measures indicated in Figure 5. Here we showed that 30% of the current stems harvested from the TFL were greater than $0.6\text{m}^3/\text{tree}$. The difference can either be attributed to the harvest scheduling of relative oldest first stands, or to an overestimation of relative piece size proportions for unmanaged stands.

Between periods 7 and 10, some fluctuations occur with respect to diameters and piece sizes. As shown in Figure 9, this is the point when harvesting comes increasingly from managed stands of timber and a reduced percentage of old growth. In the long-term, pieces sizes greater than $0.6\text{m}^3/\text{tree}$ will comprise about 12% of the annual cut. This is a reduction of more than 50 percent.

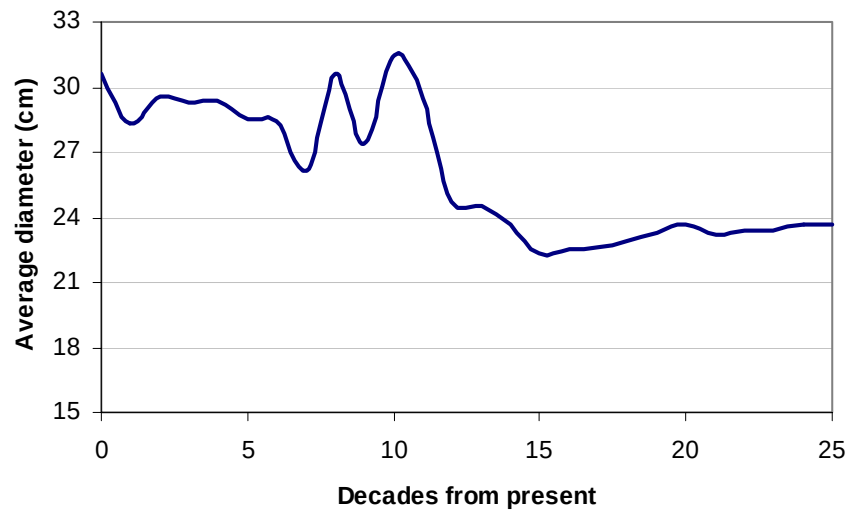


Figure 11 Change in average harvested coniferous diameter

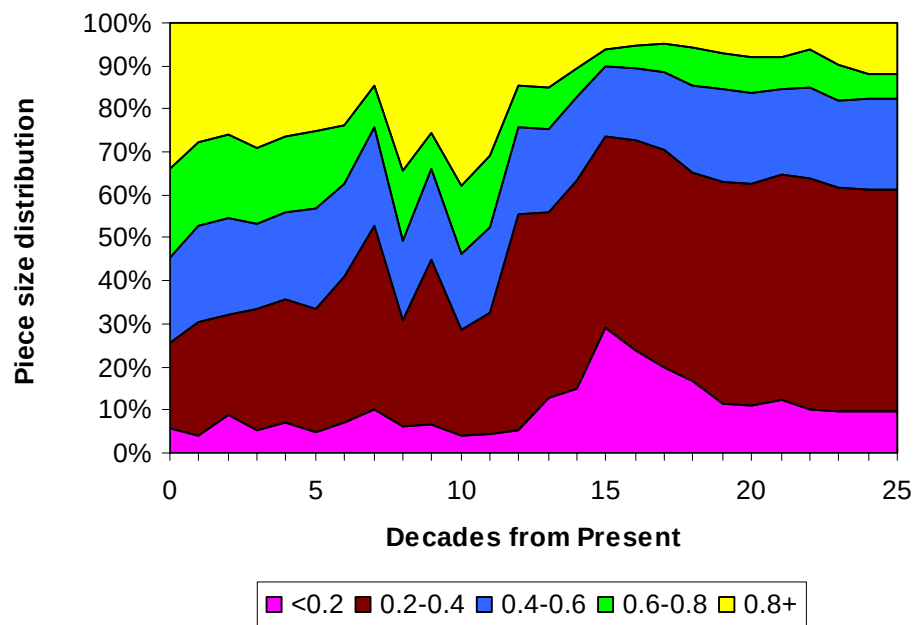


Figure 12 Change in harvested piece size (m3/tree)

4.1.3. Base Case Habitat Supply and Quality

Results from the Base Case harvest simulation enabled the construction of a data matrix that described the structural stage of each stand by period. This matrix then used wildlife habitat ratings as a look-up table to determine the habitat quality value for each stand at each period in time. Five habitat quality and quantity graphs illustrate the change in habitat values over time. Grizzly bear was the only species for which more than one habitat value was tracked. Corresponding to each of these graphs, Appendix II provides a spatial depiction of the habitat values at time 0, 20, 50, 100 and 200. Maps 4, 5 and 6 provide a sample of these results for Northern Goshawk in periods 0, 50 and 200.

The graphs illustrate that the total amount of specific habitat values slight change slightly occur over time. Some increase slightly, others decrease during the period. The over-riding impression is that the level of habitat values remains reasonably constant. A view of the distribution of these values in Appendix II shows that slight to moderate shifts in higher quality habitat locations occurs over time. What is not possible to see at the resolution shown in these maps, is that at various points in time a small stand of high quality habitat may be completely surrounded by low quality habitat. Whether or not this is reasonable is for wildlife biologists to rationalize.

To summarize the results from these graphs, Table 4 provides a brief numerical account at times 0, 20, 100 and 200. Very generally, high quality habitat declines over the long term for all reported values except Grizzly Bear fall feeding (moderate-high habitat) which increases by 20 percent. Whether or not this decrease can be attributed to too much harvesting or not enough harvesting was not analyzed.

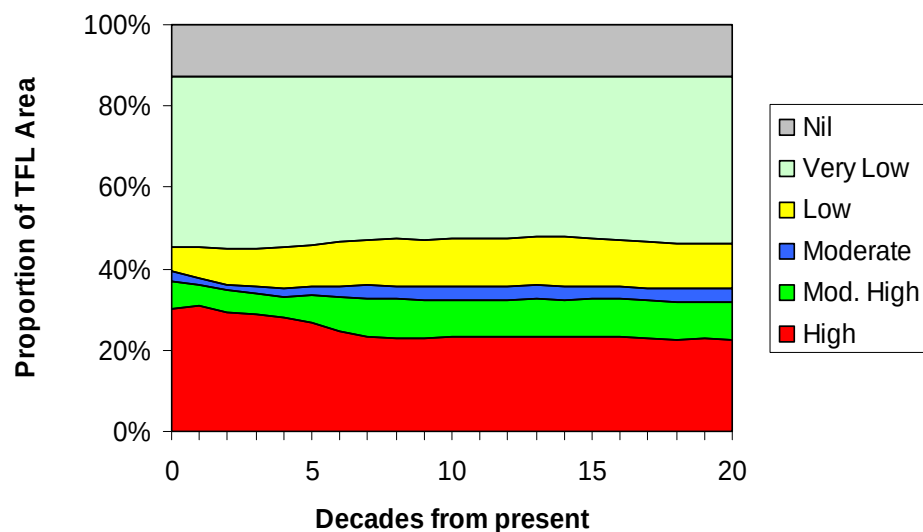
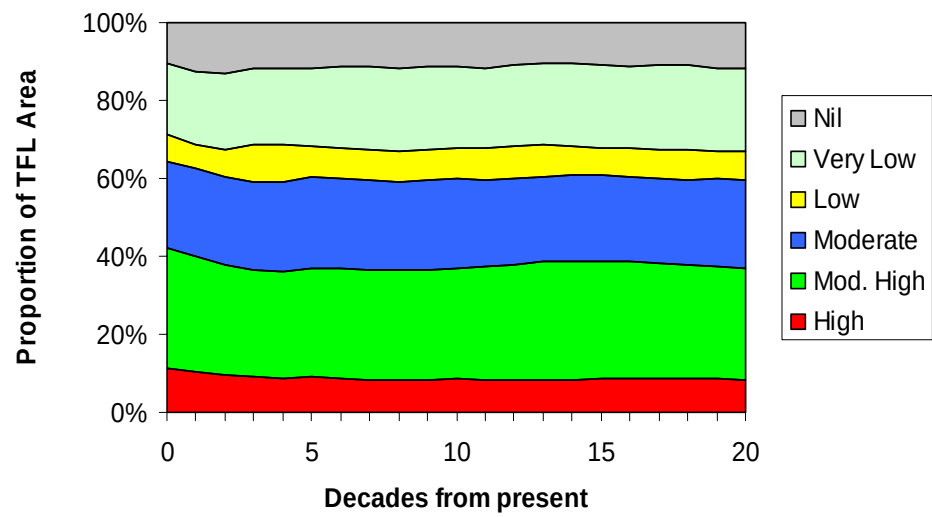
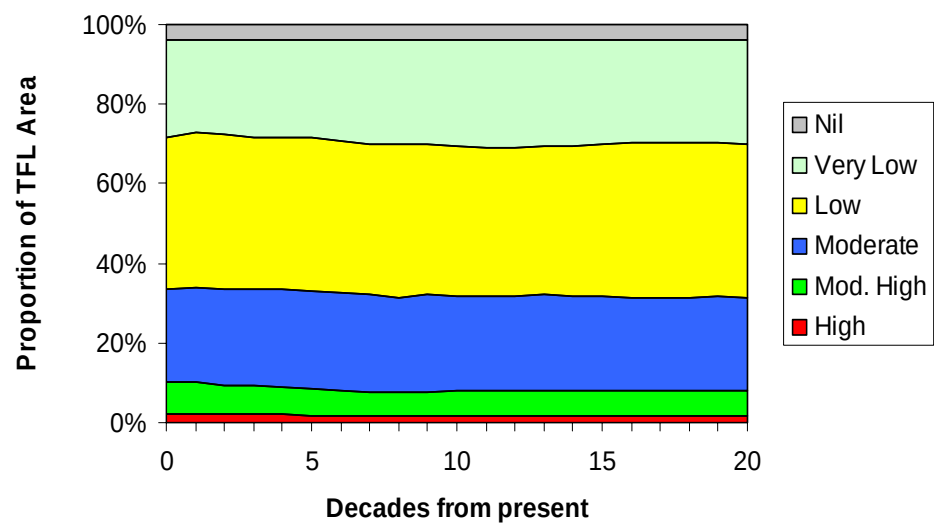


Figure 13 Moose Winter Security and Thermal Cover

**Figure 14 Marten Winter Habitat****Figure 15 Grizzly Bear - Spring habitat**

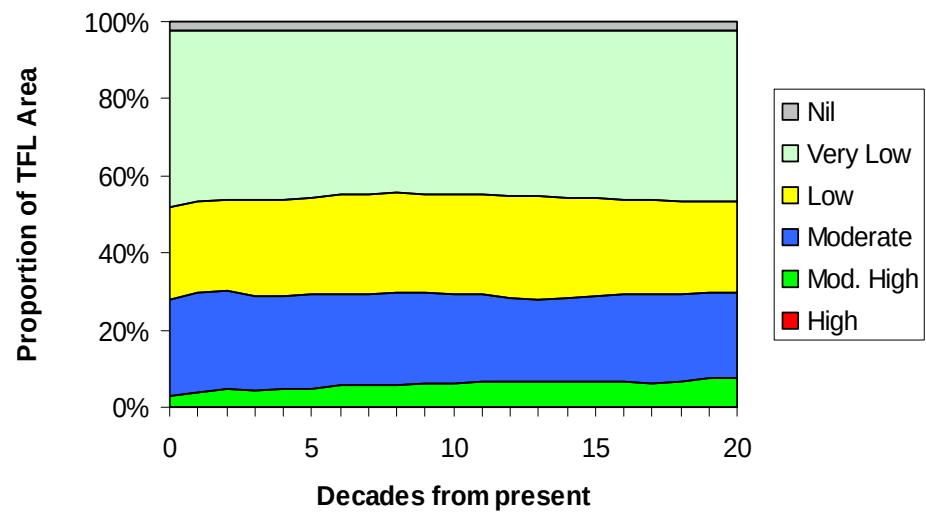


Figure 16 Grizzly bear - Fall habitat

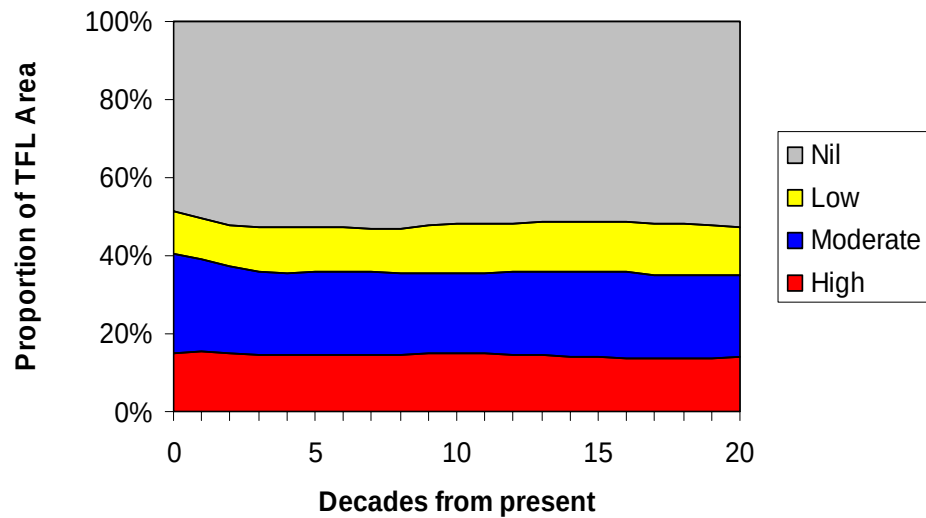


Figure 17 Black-Throated Green Warbler - Reproductive Habitat

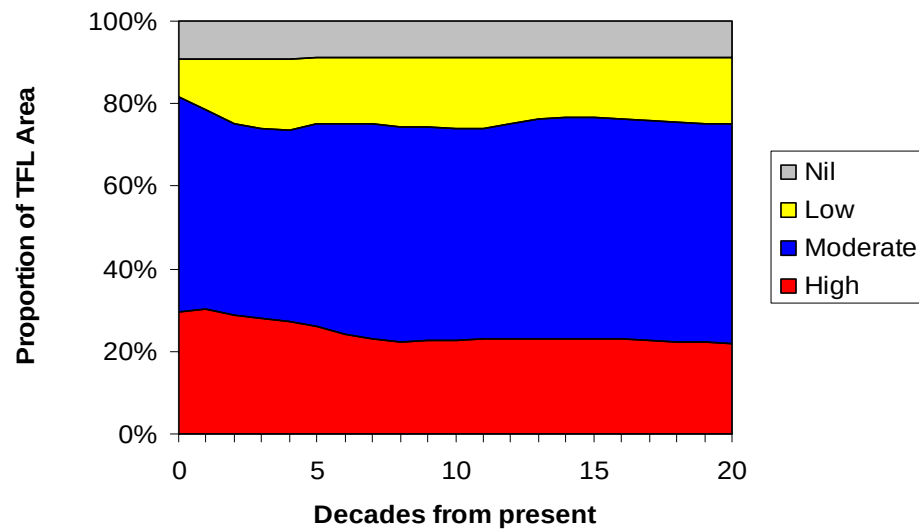


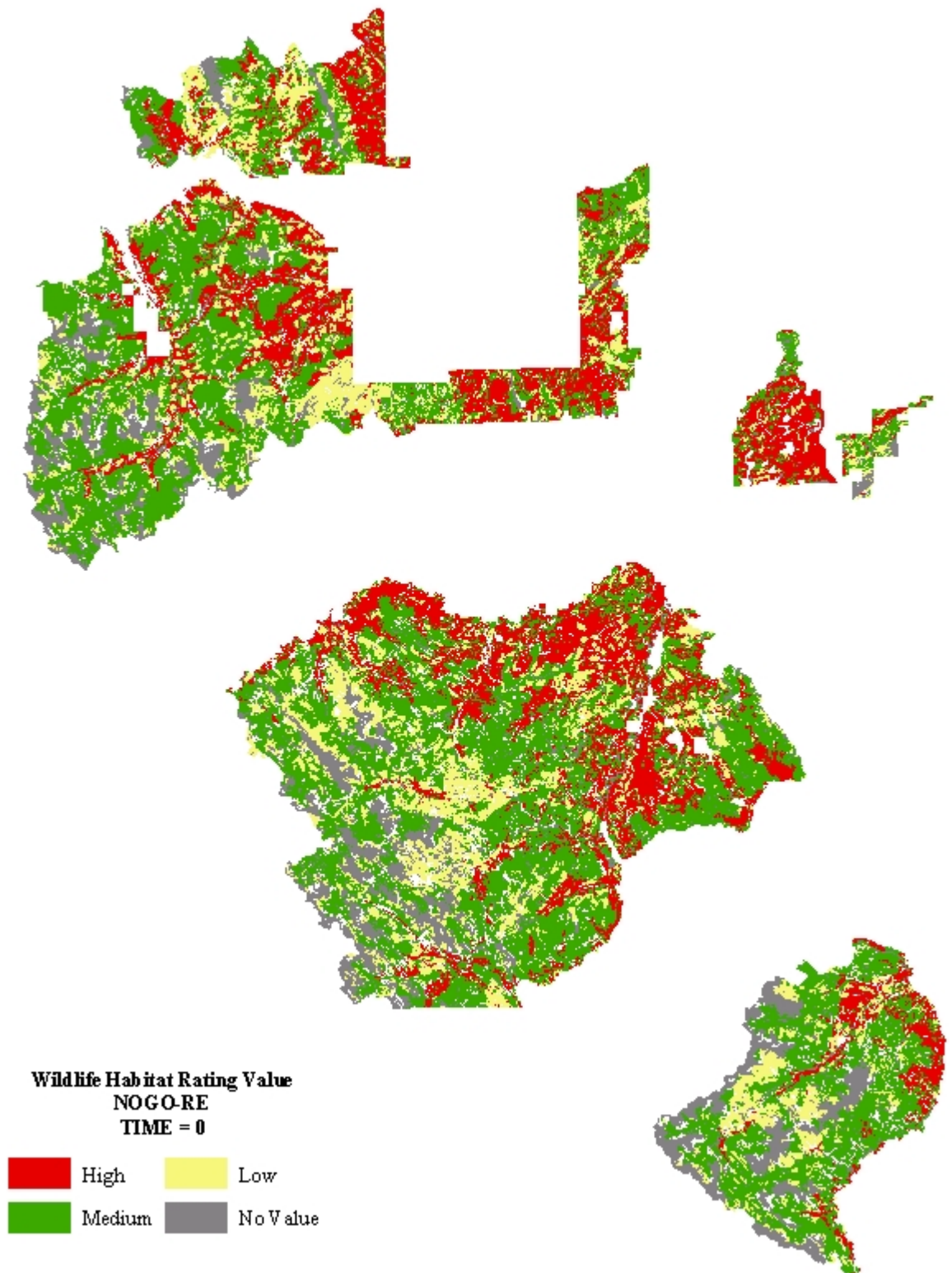
Figure 18 Northern Goshawk - Reproductive habitat

Table 4 Summary of Habitat Area (ha)

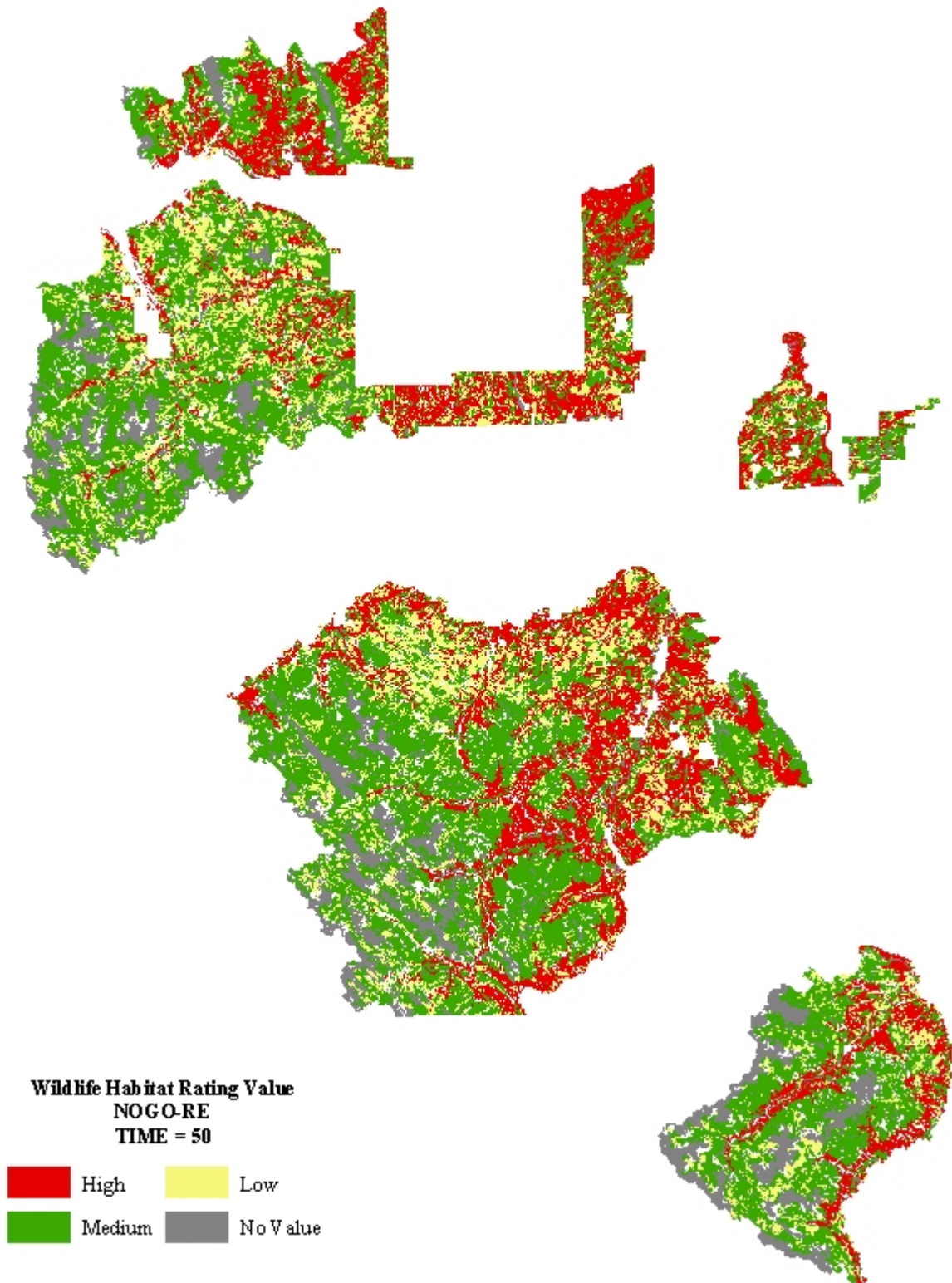
Species	Time	Habitat Value					
		High		Moderate		Low	
		Area (ha)	% change ²	Area (ha)	% change	Area (ha)	% change
Moose	0	144,403	0.0	14,089	0.0	80,718	0.0
	20	173,595	20.2	9,170	-34.9	61,546	-23.8
	100	132,491	-8.2	21,166	50.2	83,282	3.2
	200	128,226	-11.2	22,445	59.3	79,027	-2.1
Marten	0	53,758	0.0	109,829	0.0	29,222	0.0
	20	54,849	2.0	130,066	18.4	37,113	27.0
	100	48,510	-9.8	127,459	16.1	42,833	46.6
	200	47,234	-12.1	125,764	14.5	41,645	42.5
Grizzly Bear Spring	0	10,089	0.0	130,151	0.0	212,639	0.0
	20	10,401	3.1	142,189	9.2	230,606	8.4
	100	9,171	-9.1	136,555	4.9	165,825	-22.0
	200	9,191	-8.9	134,692	3.5	161,072	-24.3
Grizzly Bear Fall ¹	0	37,552	0.0	140,477	0.0	158,524	0.0
	20	28,920	-23.0	146,497	4.3	132,801	-16.2
	100	36,408	-3.0	133,341	-5.1	147,369	-7.0
	200	44,744	19.2	127,019	-9.6	134,566	-15.1
Black Throated Green Warbler	0	81,495	0.0	138,110	0.0	319,822	0.0
	20	84,932	4.2	125,083	-9.4	64,920	-79.7
	100	82,916	1.7	114,427	-17.1	77,943	-75.6
	200	77,875	-4.4	116,262	-15.8	76,295	-76.1
Northern Goshawk	0	137,771	0.0	277,676	0.0	109,660	0.0
	20	163,320	18.5	261,078	-6.0	103,176	-5.9
	100	124,170	-9.9	288,354	3.8	115,895	5.7
	200	120,092	-12.8	298,266	7.4	110,715	1.0

Note: 1) Grizzly - Fall Habitat, moderate-high values were used in replace of high since no high quality habitat is found in the TFL.

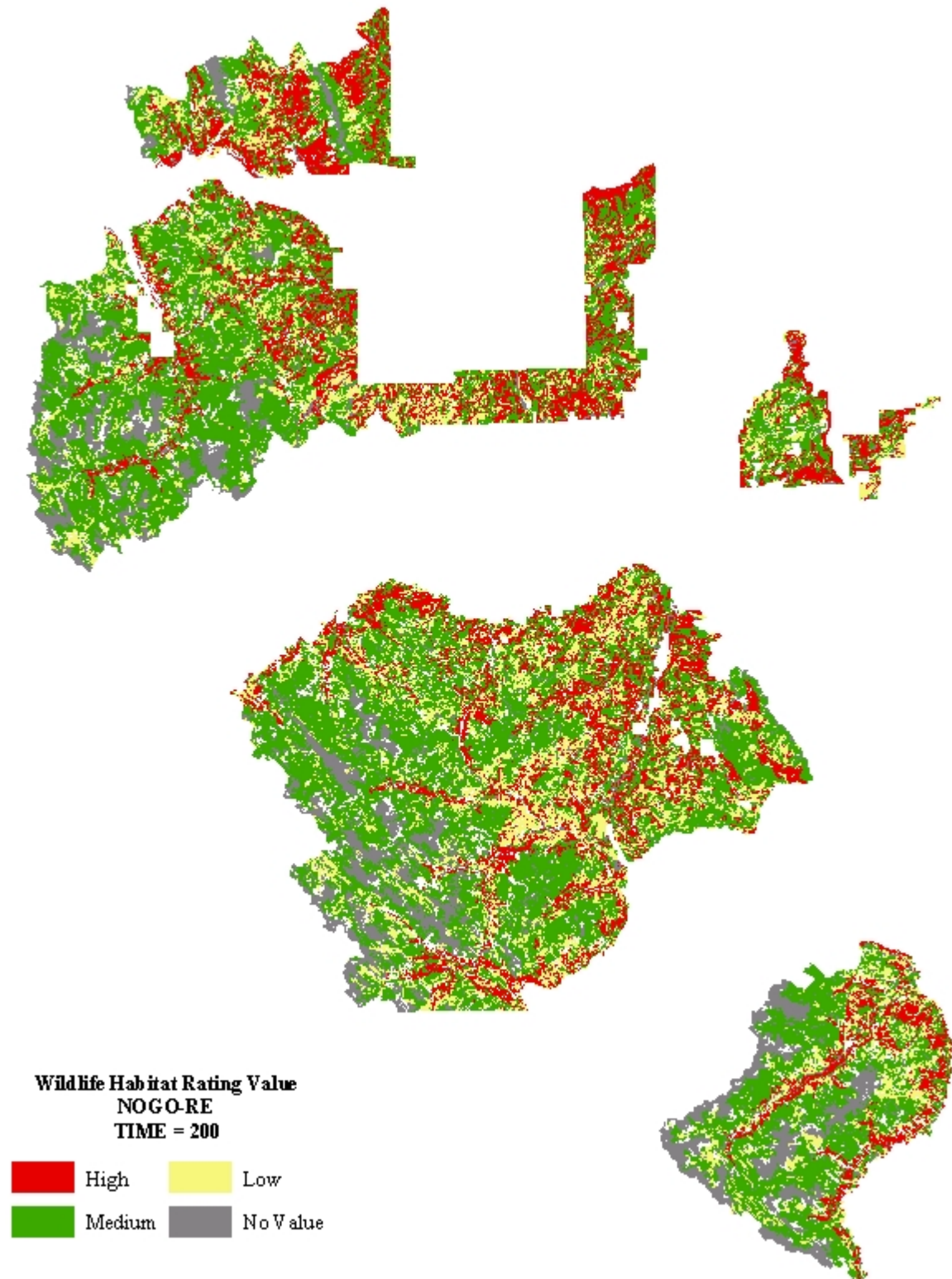
2) Percent change in habitat area is relative to time 0.



Map 4 Northern Goshawk Reproductive Habitat Time 0



Map 5 Northern Goshawk Reproductive Habitat - Period 5



Map 6 Northern Goshawk Reproductive Habitat - Period 20

4.2. Shelterwood Harvesting

The Base Case harvest forecast incorporated a shelterwood harvest system on stands identified in the land base as candidates for this type of harvesting. Approximately 20,000 hectares within the THLB met the criteria to be eligible for a shelterwood harvesting system. Typically, when Canfor harvests these stands, 90 percent of the stand volume is removed. Roads, trails and landings affect 45% of the block area. This area is replanted immediately. The remaining 55% of the area (equal to 10% of the volume) is the undisturbed under-story. The under-story seedlings in this area typically exist across a wide spectrum of ages. The Base Case analysis estimated the future growth and yield from these stands using a combination of the VDYP and TIPS models. Neither of these models has been designed to estimate the response of advanced regeneration and planted seedlings under a shelterwood management system. Assumptions were made which the author acknowledges were a best guess using the tools at hand. The University of British Columbia's Forest Ecosystem Management Simulation Group have developed an ecologically based forest growth model, (FORECAST) that was designed "to accommodate a wide variety of harvesting and silvicultural systems in order to compare and contrast their effect on forest productivity, stand dynamics and various biophysical indicators of non-timber values²". Shelterwood harvesting is one of the systems for which this scientific approach to stand growth responses following a shelterwood harvest can be applied.

4.2.1. Timber Supply

Figure 19 show the total coniferous harvest level as a result of incorporating FORECAST's shelterwood growth tables, in replace of the tables used in the Base Case. A 1.2 percent (6,400m³/year) increase in the initial harvest level was possible by integration of these yield tables into the simulation model.

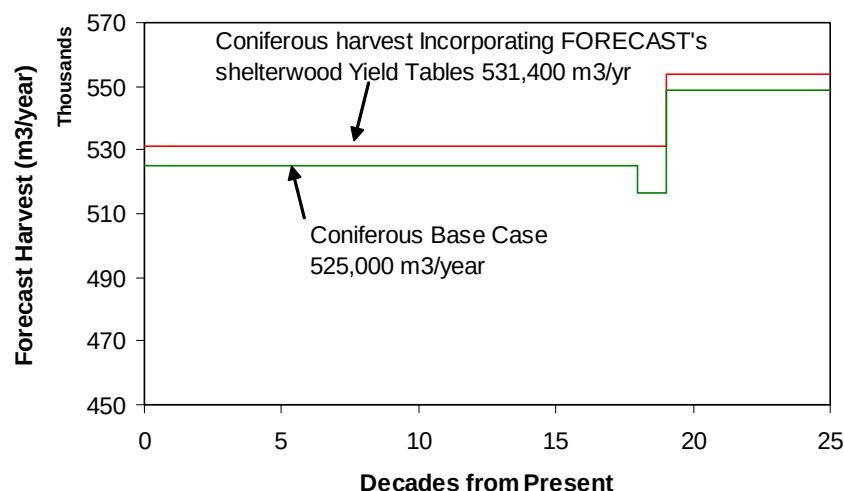


Figure 19 Harvest Forecast incorporating revised shelterwood tables

² Welham, Seely, Kimmins, Bringing biology into growth and yield: An overview of the ecologically based forest growth model, FORECAST

4.2.2. Timber Quality and Habitat

About 4.8 percent of the annual harvest is predicted to come from shelterwood stands. Therefore, changes to timber quality and wildlife habitat over time as a result of the utilization of these FORECAST yield tables and a slightly elevated harvest level are negligible.

It is worth noting that the assumptions used to determine the structural stage of shelterwood areas may be worthy of additional consideration. An alternative may be to divide the stand based upon the proportion that is planted versus the proportion that is advanced regeneration, and track the values in this manner. Graphically the results are quite simple to produce. Spatially, this would be more difficult.

4.3. Grizzly Bear habitat

Opportunity to improve Grizzly Bear habitat throughout shelterwood stands possibly exists through the reduction in planting densities within these harvested stands. This action would theoretically promote brush regeneration that may be of a type suitable for Grizzly Bear browse. FORECAST yield tables were modified, whereby the planting densities in shelterwood stands were reduced to approximately 3/4 of the levels in the previous scenario.

4.3.1. Timber Supply, Timber Quality, Habitat

The harvest flow as a result from this activity is minor. An initial annual harvest level of 529,400m³ is only 2,000 m³/year less than the previous shelterwood scenario. Again, the impact on timber quality is negligible. The impact on habitat supply is also negligible under the management assumptions used. For although reduced planting densities may improve Grizzly Bear forage within shelterwood stands, our interpretation of the structural stage designations for these sites remains unchanged. The wildlife habitat quality designation is not sensitive to changes in silviculture management prescriptions, using the methods employed at this time. On the other hand, if the values were sensitive to changes in silviculture treatments, at this level the result would again be negligible. Temporary stand modifications would only occur on an average of 125 hectares annually, across a forested land base of 570,000 ha.

4.4. Silviculture management alternatives

Three scenarios investigated the timber supply implications of Canfor's current expenditures on brush management and basic silviculture. For all three scenarios, sites that are more prone to brush competition were identified. Using stand site index and subzone/variant indicators to distinguish between problem sites, two sets of yield tables were developed for each of the three scenarios. In the "Basic" silviculture scenario, TIPSy yield tables predicted the impact of longer regeneration delays, reduced planting densities and a change in the proportion of naturals to planted stock. In the brushing versus no brushing scenarios, FORECAST yield tables predicted the potential results of

brush management. Using the criteria defined in the Data Package to identify potential brush management sites, a total of 99 thousand hectares of the 321 thousand hectares in the THLB were identified as likely problem areas.

The results from these three scenarios are shown in Figure 20. Brush management is implicitly assumed in the Base Case harvest forecast. Thus there is no change to the Base Case harvest forecast when this management practice is carried out. When no brush management was applied we see a 7,000 m³/year (1.3%) drop in the initial harvest level and a 5,000 m³/year drop in the long-term harvest level. When Basic silviculture becomes the management alternative, the coniferous harvest level drops 8.8 percent to 479,000m³/year.

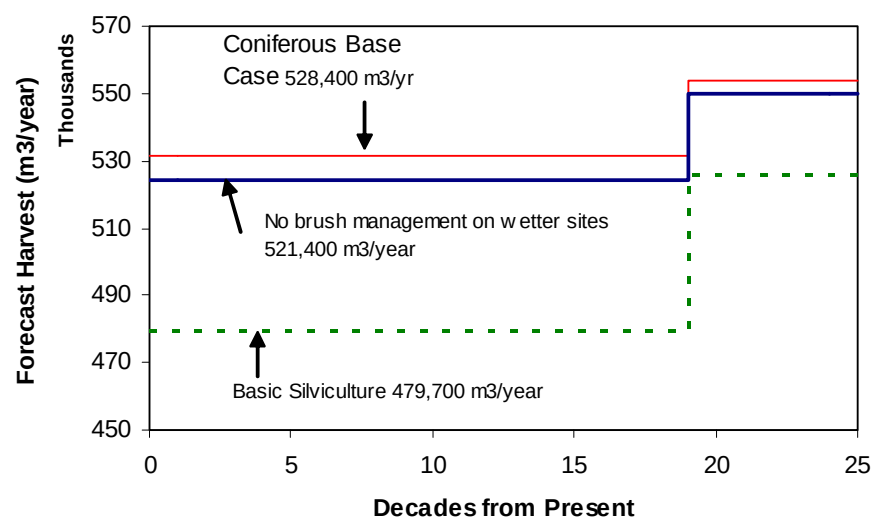


Figure 20 Alternative Silviculture

4.5. Site Index Adjustments (SIBEC)

A SIBEC scenario involved a re-evaluation of the inventory and growth and yield tables for the entire coniferous land base. Using the site series mapping information completed for the TFL and site index estimates developed by the MOF, a new site index was applied to most coniferous polygons throughout the productive forest land base. Generally, the site index improved for most stands. As a result, the coniferous THLB increased by 34,000 hectares, primarily due to fewer stands being excluded from the THLB as a result of having a low site index. As a result of this change in the THLB, the area-weighted site index for many of the analysis units in the THLB also changed. Average site index for the THLB in the Base Case was calculated to be 13.6m at 50 years. The average site index resulting from this scenario was calculated to be 15.9. A summary of these changes are included in the appended Data Package.

The harvest flow resulting from this increase in THLB and general improvement in site index is shown in Figure 21. The deciduous harvest level remained unchanged. The

initial coniferous harvest level increased 9 percent to 570,900m³/year and is sustainable at this level for 180 years. In period 19, the long-term harvest level of 632,100m³/year is reached (15 percent above the Base Case).

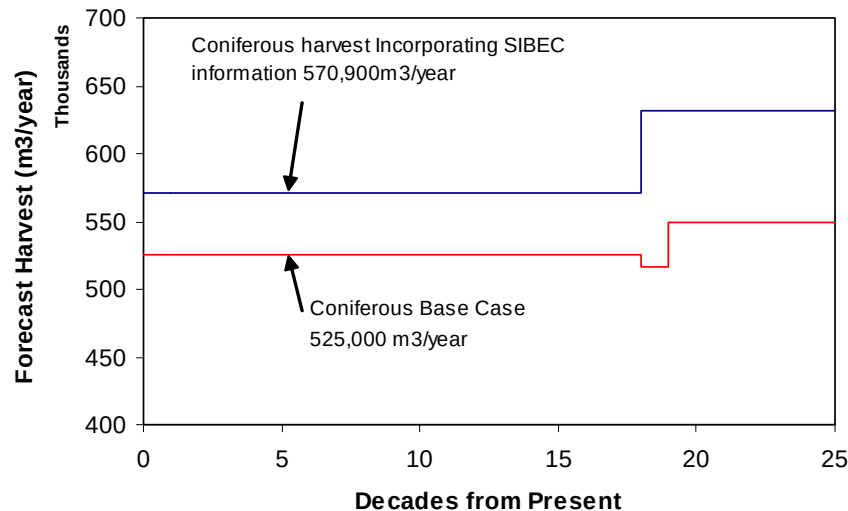


Figure 21 Harvest flow impact of SIBEC

SIBEC estimates have an impact on the estimated quality of timber harvested as well. Figure 24 illustrates the change in diameter as a result of improved site index estimates. The graph shows that the diameter harvested over time follows the same trend as in the Base Case; however the average estimated sizes are approximately 4 percent larger.

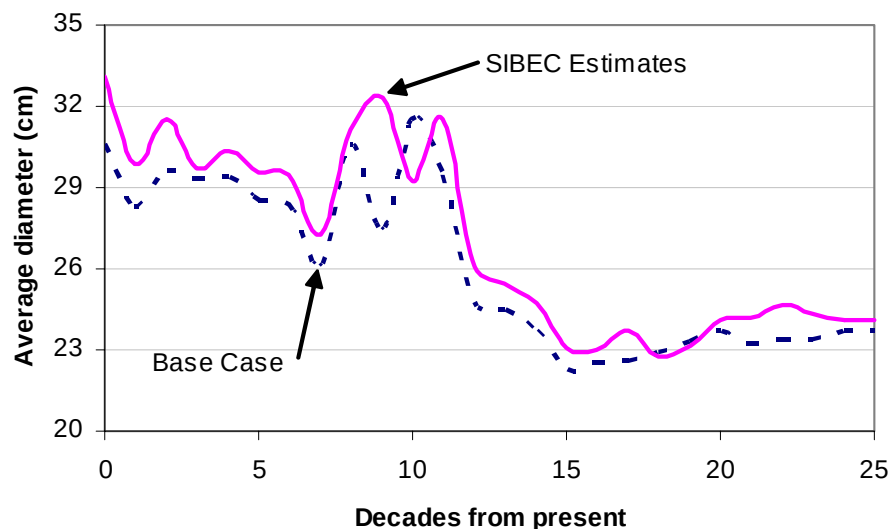


Figure 22 Diameter Harvested Using SIBEC Information

5. Working towards a Preferred Management Program

Timber supply harvesting simulations are useful tools for measuring the aggregate affect of different silviculture management alternatives. Stand level tools are also helpful when used in conjunction with forest level simulations, to focus management decisions towards the most appropriate operational management regime.

What has been described in the previous Sections is a quantitative analysis of several different management alternatives. However, the results here are limited by the assumption that current conditions (i.e., utilization, economic demand, climate etc.) remain unchanging in the long-term. Professional judgement, forest industry preference, market trends, technology, climate and politics all bear weight in a decision on where best to invest time and labour when dealing with very long planning horizons.

In order to determine a Preferred Management Program there is a need to rank management regime options and then select the most appropriate regime for a designated land base. This ranking should consider the above noted influences. Table 5 describes the management regimes identified in this analysis, as well as several of the management options identified in the MP#3 analysis. The table shows that a rank measure of high (H), moderate (M), low (L), or negative (N), was assigned to each management regime, based upon its relative merit with respect to several decision categories. Each measure was then awarded a numerical value as follows: H=2, M=1, L=0, N=-1. The decision categories were assigned an equal weighting in the Table. This ranking method assumes equal priority on all selected influences.

Different users may wish to assign different weights to each category or assign different values to each cell in Table 5.

Table 5 Weighting Management Regimes

Management Regime Description	Timber Supply		Timber Quality		Wildlife		Judgement, Trends and Politics			Aggregate Ranking
	Short & Mid term	Long-term	Current Timber Quality	Future Timber Quality	Habitat Supply	Habitat Quality	Return on investment	Employment	Current Activity Focus	
Base Case	L	L	L	L	L	L	L	L	L	0
Reduce planting in Shelterwood	N	N	L	L	M	M	N	L	L	-1
Basic Silviculture	N	N	L	L	L	L	M	N	N	-3
No Brushing	N	N	L	L	M	M	M	N	N	-1
SIBEC	H	H	L	L	L	L	H	M	M	8
Class A Seed	H	H	L	M	L	L	H	L	M	8
Reduced Voids (OAFs)	M	H	L	N	N	N	M	M	L	2
Partial cutting in VQOs	M	M	L	L	M	M	N	L	L	3

Note: H=2, M=1, L=0, N= -1

In the table described above, return on investment and employment were educated guesses. Results from this analysis of management alternatives show that two management regimes produce an aggregate ranking considerably higher than the rest. Class A Seed and SIBEC both scored a value of 8 relative to the Base Case. This suggests that these two management regimes provide the greatest net benefit to TFL48.

Operational costs can be associated with each of the management regimes identified in Table 5. Generally, treatment costs can be applied to a target area to estimate the gross impact of the management regimes. These investment costs are summarized in Table 6.

Table 6 Management Regime Costs

Management Regime	Candidate Area (ha/year)	Relative Cost of the Management Regime (\$/ha) ¹	Opportunity Cost ² (\$/year)
Base Case	2600	0	0
Reduce planting in Shelterwood ⁴	56	-200	-11,200
Basic Silviculture	2600	-800	-2,080,000
No Brushing	380	-420	-159,600
SIBEC ³	114,000	2	228,000
Class A Seed	1200	70	84,000
Reduced Voids ⁵ (OAFs)	2000	300	600,000
Partial cutting in R, PR VQOs ⁶	30	3200	96,000
Total			-1,194,100

1. Regime costs indicate a positive or negative gain. These costs are relative to the current Base Case management regime.
2. A negative value in this column indicates a cost savings; a positive value, an expense above the current Base Case.
3. The cost of the SIBEC was estimated at \$2/ha across a forested land base of 570,000 ha and amortized over a 5 year return.
4. Assumes 125 ha harvested per year, 45% of which is replanted.
5. Assumes an additional cost of \$0.15/tree
6. Assumes a \$12/m³ increase in cut block development costs

Table 6 suggests that if the regimes described in this analysis were carried out, a potential cost savings of \$1.2 million dollars would accrue to Canfor. This however, does not incorporate the lost revenue as a result of a change in harvest flow. The results from Table 5 must be weighted against the information from Table 6 and the overall objectives of this analysis, to derive a preferred management program.

6. Preferred Management Program

In keeping with the spirit of a Type II Silviculture Analysis, this section outlines a preferred management program. The proposed program brings together information from this report and the MP#3 Timber Supply Analysis Report. Specifically, the information provided in Tables 5 and 6 provide the basis for a Proposed Program that is described in Table 7. This table reorganizes the results in order of ranking preference. The result is a working table from which to allocate area and funding. The distribution of the budget is influenced by both the treatment rankings and our objective of improving timber supply, timber quality, habitat supply and habitat quality. The proposed budget is also influenced by the desire to diversity investments between several management options.

Table 7 Preferred Management Program

Management Regime	Ranking	Treatment Area (ha/year)	Budget Allocation (,000 \$/year)	Proportion of Budget (%)	Employment (FTE jobs)
Class A Seed	8	1200	84,000	12	1.5
SIBEC	8	114,000	228,000	31	4.2
Partial cutting in R, PR VQOs	3	10	320,000	44	5.9
Reduced Voids (OAFs)	2	300	90,000	12	1.7
Reduce planting in Shelterwood	-1	50	-10,000	n/a	-0.2
No Brushing	-1	100	-42,000	n/a	-0.8
			670,000		12.3

The program described in Table 6 makes use of risk management to diversify investments across several management regimes. Risk is also reduced by ensuring that there is a reliable, ongoing flow of harvestable volume from managed second growth stands. This is accomplished through prompt reforestation, rapid early growth, high levels of stocking and increased stand volumes above those that natural unmanaged stands would produce. For this reason, the basic silviculture regime has been discounted entirely.

Emphasis on log quality has been relatively minor in this program for two reasons. The TFL continues to support an abundance of old growth timber and this old growth should continue to provide large piece sizes for the next 120 years. Considerable emphasis has been placed on the acquisition and sowing of Class A seed. Class A seed is currently not available for most of the TFL. As it comes available Class A Seed is forecast to greatly improve managed stand yields, if these stands are harvested at or near their economic rotation age. Class A seed can also be genetically selected for other qualities such as pest resistance and increased diameters. If

management emphasis shifts in the future towards these qualities, future planted stocks can be selected to alleviate some of the future timber quality short-comings.

Wildlife habitat is a large component of this analysis. The relative change in habitat quality and quantity forecasted as a result of the harvest simulations performed in this analysis provide considerable data for additional review. Much of this review may be focussed towards the goal of determining if it is harvesting or general aging of the forest that will result in improved levels of high quality habitat. In light of the operational influences that post harvesting activities may have on habitat quality, some consideration has been given to selecting appropriate sites prone to provide better forage for some species. The selections of these sites require a degree of operational precision that has not been explicitly incorporated into this analysis.

7. Conclusions

Not surprisingly, this analysis verified the results from the MP#3 analysis that the current harvest level of 580,000m³/year is sustainable for a very long time. A scenario which investigated an improvement in site index estimates indicated that this harvest level is likely to increase as more detailed information is acquired in the form of site index based upon biogeoclimatic ecosystem classification. Alternative silviculture management regimes examined in this analysis show that there can be a variety of harvest flow impacts as a result of changing silviculture management practices. The changes investigated in this analysis showed several initiatives that placed downward pressure on the harvest flow. However, we refer you to the analysis completed for MP#3 to see that there are also many silvicultural and policy initiatives that can provide significant upwards pressure on the harvest flow.

Timber quality (as it relates to diameter and pieces size) is forecast to remain fairly constant over the next 9 decades. After this time, a gradual decrease in quality is forecast to occur.

Habitat supply and habitat quality are forecast to change, but only by relatively small amounts over a very long planning horizon. When the quality levels of one species drops slightly, another's improves. Timber harvesting each year affects only 0.5 percent of the total area of the TFL.

8. Discussion

Forest estate analysis can provide considerable insight into the impacts of alternative management initiatives. However, this insight must be carefully weighted against the assumptions used in the analysis. It was mentioned in the introduction that a potentially valuable result of this analysis is a list of the modelling assumptions for which the degree of confidence is not significant.

Following are some of these items:

1. Site index adjustments for stands based upon BEC have been predicted in many of the ecosystems found within the TFL. However, the confidence level of these estimates is low. Field sampling is required to provide an improved level of confidence, before these site indices can be applied to Base Case management assumptions.
2. The use of the FORECAST model to predict the yield from shelterwood stands provides higher level of comfort around the growth and yield of these stands than was predicted using VDYP and TIPSYS. The evolution of the structural stage in these stands still remains questionable. Analysis is also required to describe habitat values in post harvesting shelterwood stands.
3. The current BEC/structural stage combinations (wildlife tags) describing wildlife values throughout the TFL include most of the possible combinations of that could occur in the future, but not all. Approximately 1000 hectares of THLB will revert to a structural stage 3 that has no corresponding wildlife tag. Similarly, many stands currently in structural stage 6, do not have a tag for stage 7. (We assumed the habitat value would not change).
4. The question arose where or not an island (1-8 hectares) of high quality habitat can be surrounded by low quality habitat?
5. In a spatial simulation model the analysis can incorporate additional management features into the harvest schedule. With respect to TFL 48, what are these features, if any, and what management assumptions are applicable.
6. The impact of catastrophic events is not modelled spatially. Although wildfires are forecast to occur on the TFL and are addressed through a volume reduction on the gross harvest level, the area impacted was not spatially identified. Thus the amount of old forest is overestimated in the long-term. Incorporating this information into a spatial analysis is possible, but requires a defined set of assumptions regarding which stands are most likely to be lost to wildfire.
7. Although the process of dissolving sliver polygons to create larger stand aggregations lost some of the spatial integrity of the original data set, referencing the resultant habitat

information back to the original data set indicated shifts in "true" values of only 1-2 percent.

8. This analysis predicts the location and amount of wildlife habitat quantity and quality. Of particular interest is in time zero, i.e., year 2000. Other habitat analyses viewed by the author have shown that similar exercises, when combined with actual tracking of targeted species, revealed that the species may be just as inclined to visit low value sites as high (Reference: Quesnel Eastern Caribou Project). With this in mind, caution is stressed to the reader that this information is a first look at potential modelling and management strategies. Emphasis is also made that the author is NOT a wildlife biologist.

9. References

Timber Supply Analysis Report in Support of Management Plan #3, March 2001, Canfor

Timber Supply Analysis Information Package in Support of Management Plan #3, Version 3
March 2001, Canfor

Management Plan #3 for TFL 48, June 14, 2001 Canfor

Standard for Terrestrial Ecosystem Mapping in BC, May 1998, Terrestrial Ecosystems Task
Force Resources Inventory Committee

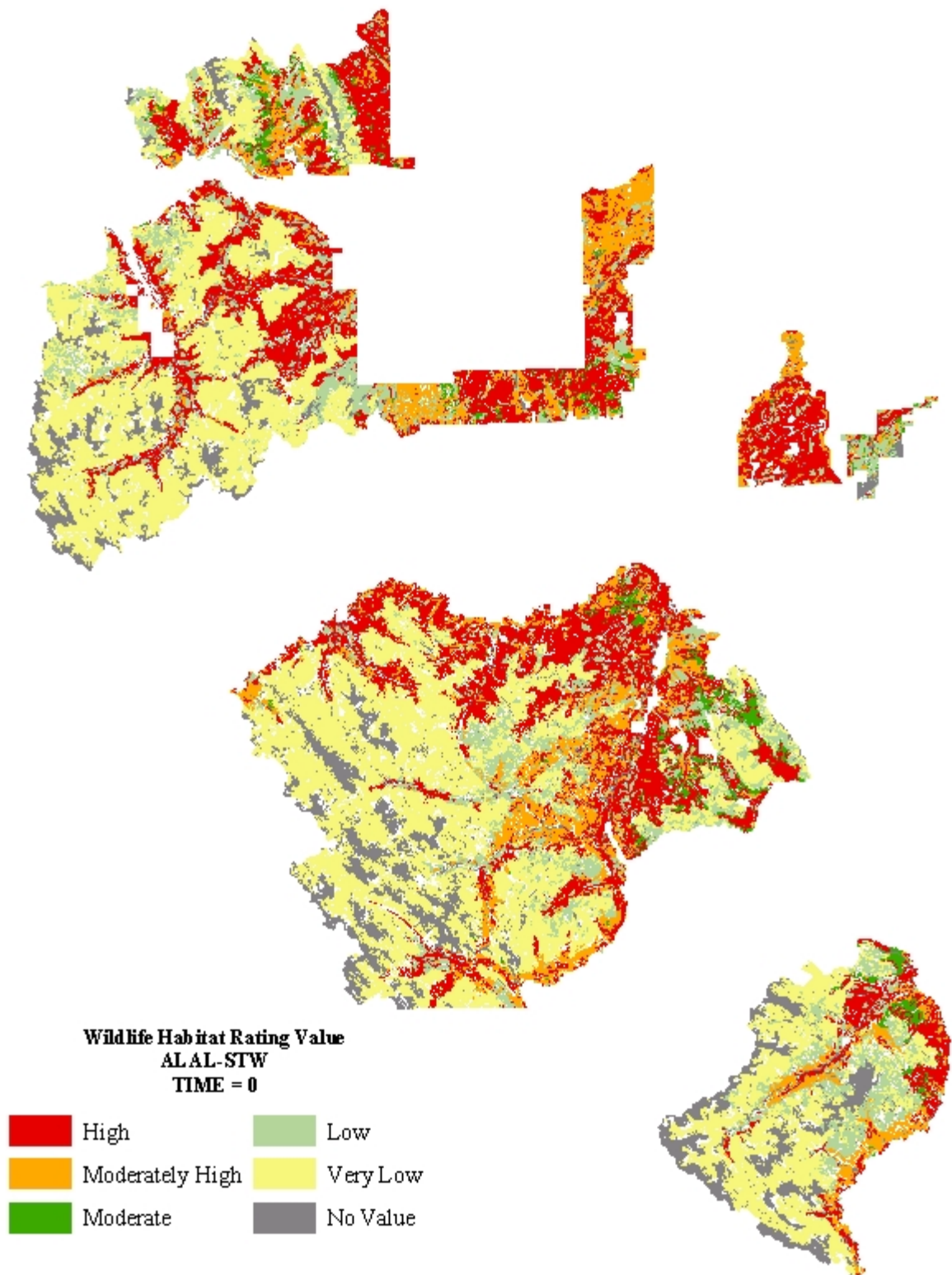
BC Wildlife Habitat Rating Standards, Version 2.0, May 1999 MOELP

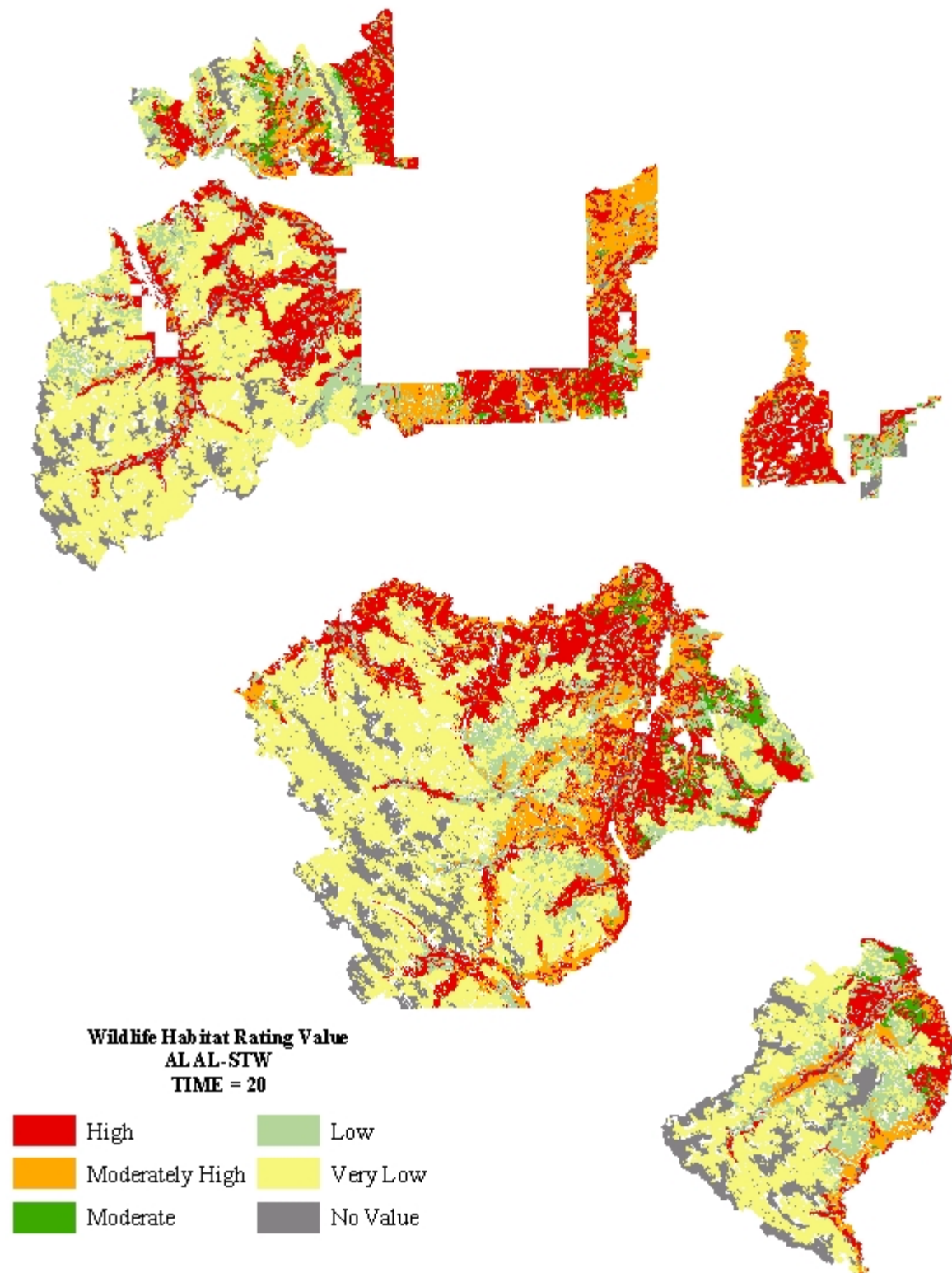
Data Package in Support of a Type II Forest Estate Analysis for TFL 48, April 2002, Industrial
Forestry Service Ltd.

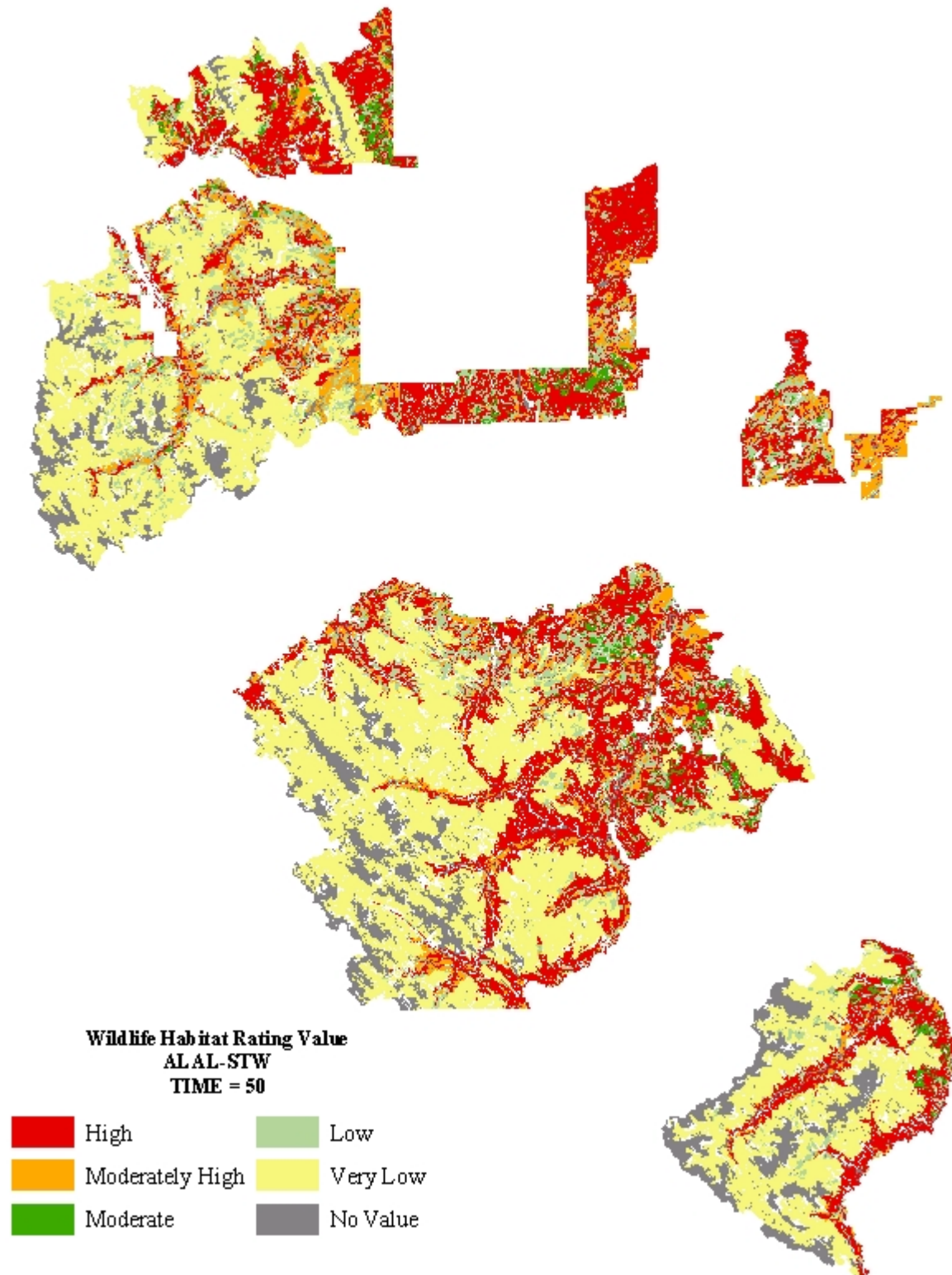
Bringing biology into growth and yield: An overview of the ecologically based forest growth
model, FORECAST, Welham, Seely, Kimmins, 1998?

Appendix I

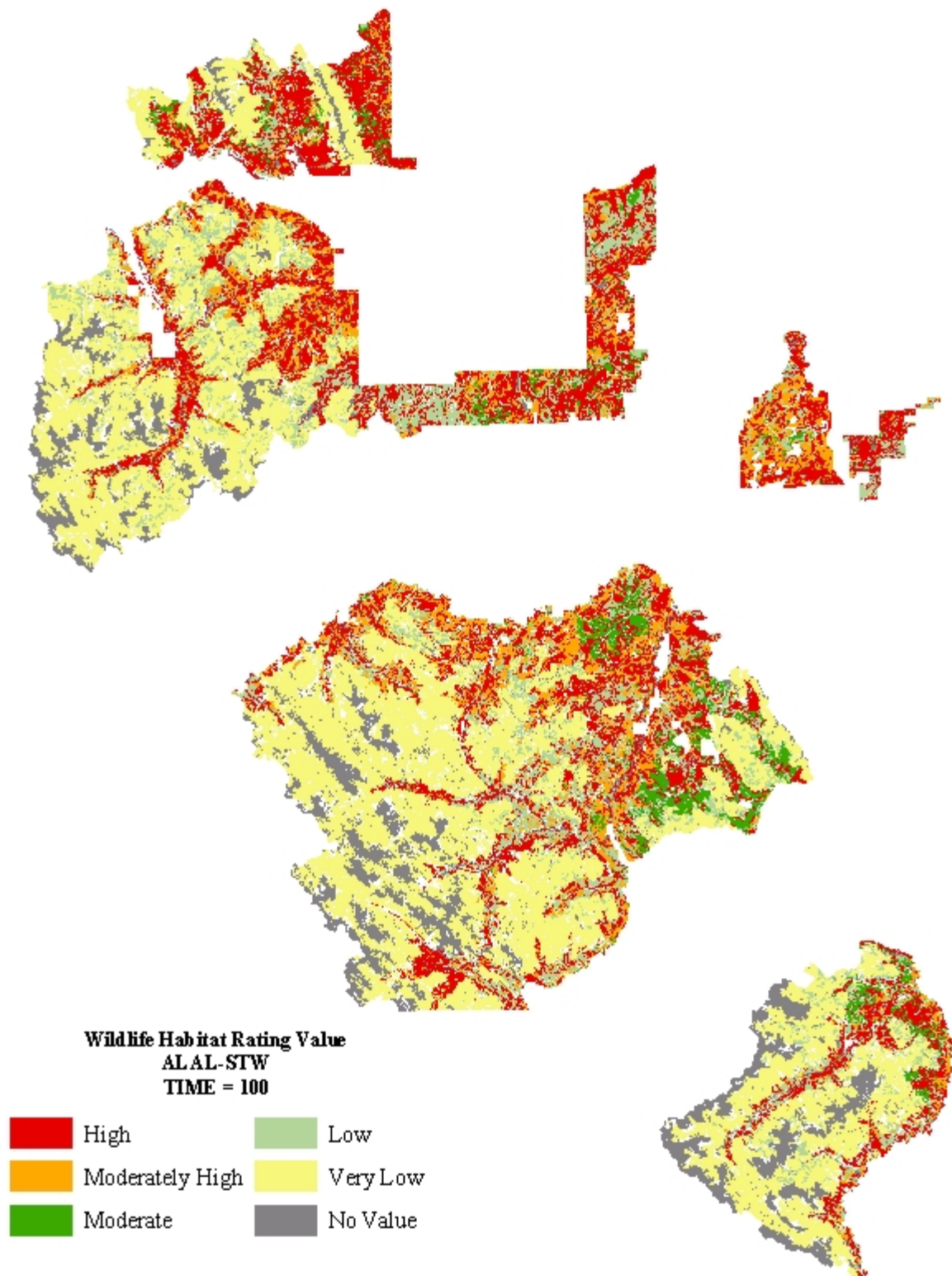
Wildlife Maps

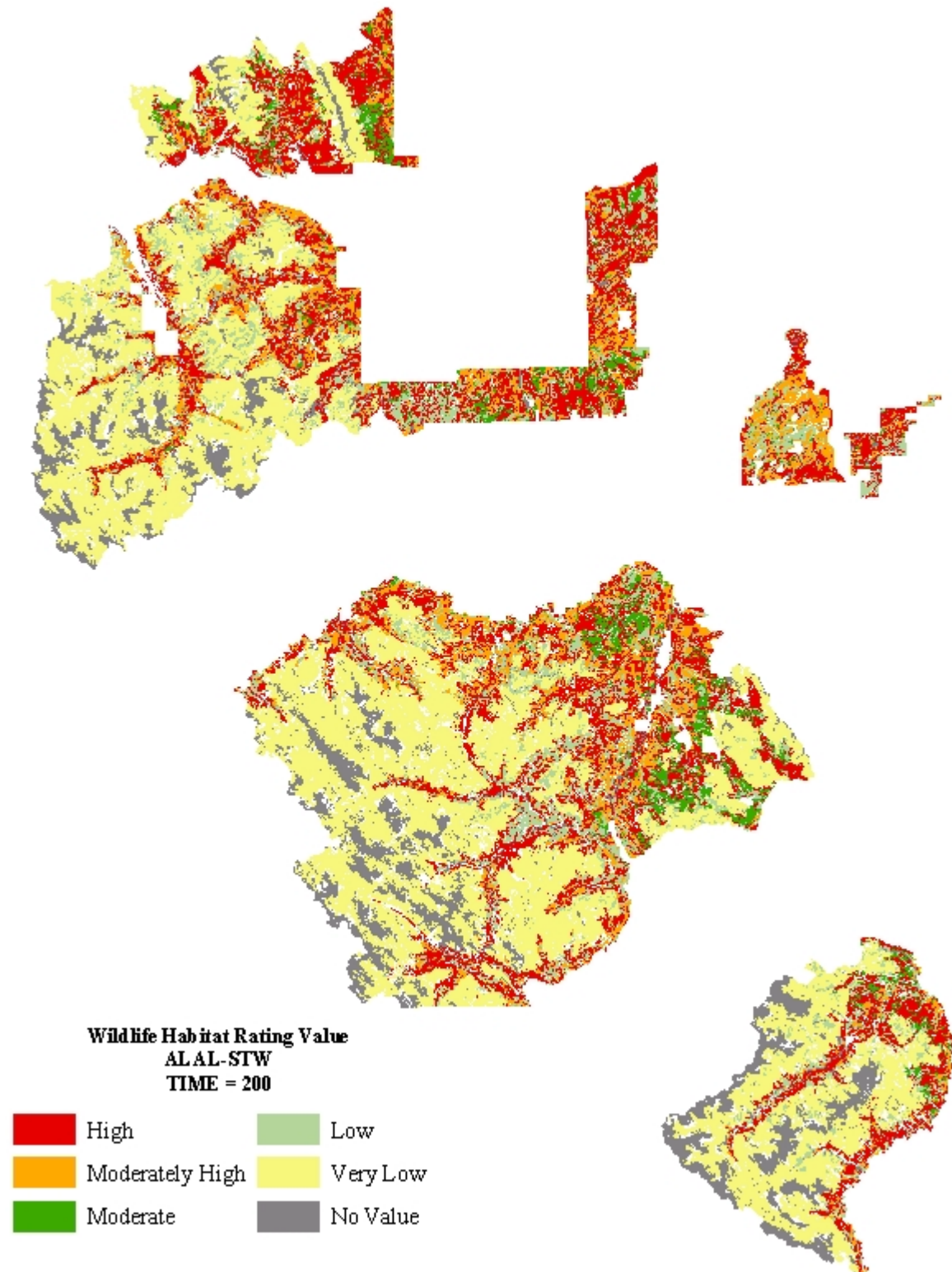
**Appendix Map 1 Moose Winter Security Thermal - Decade 0**

**Appendix Map 2 Moose Winter Security Thermal - Decade 2**

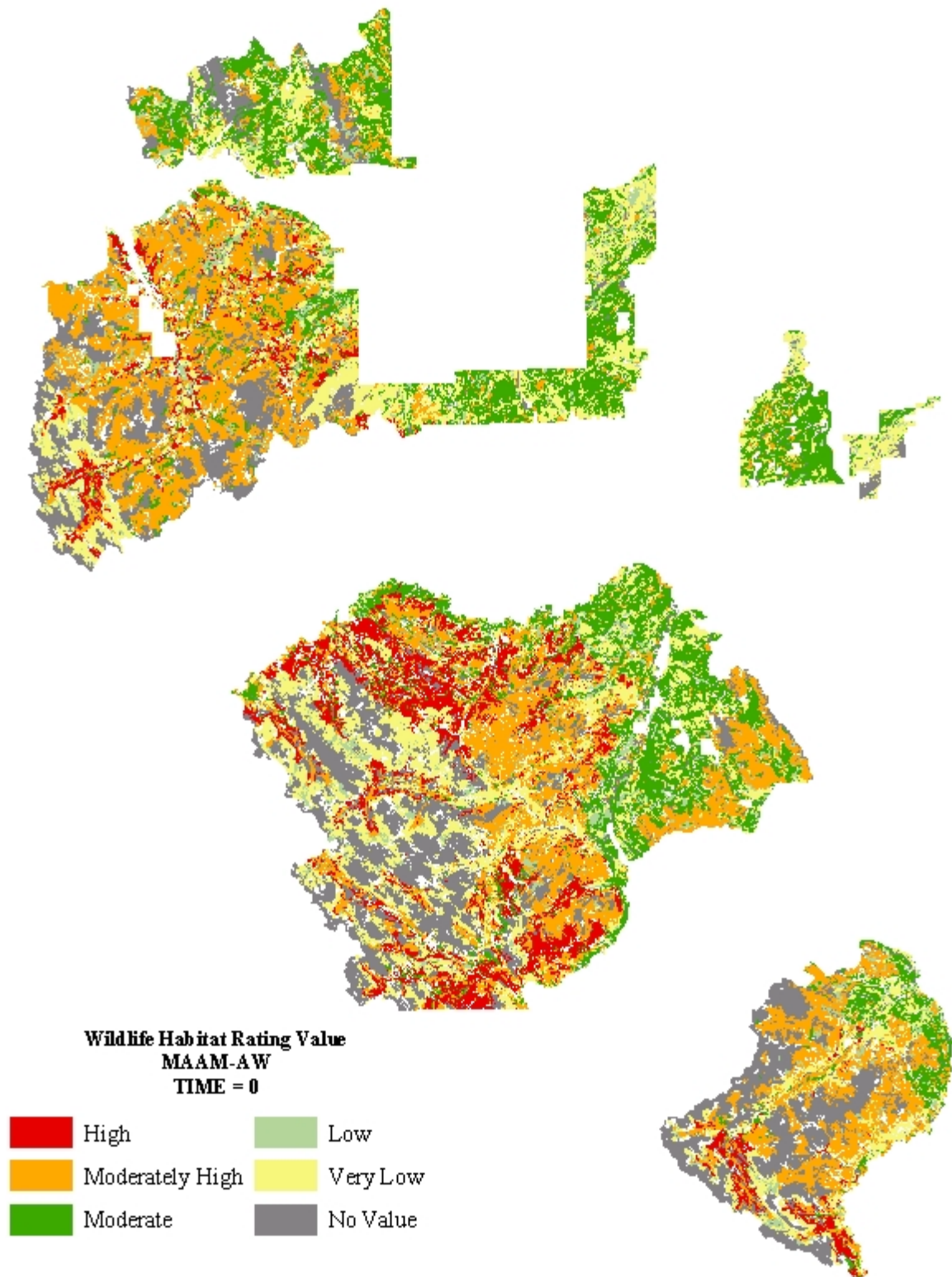


Appendix Map 3 Moose Winter Security Thermal - Decade 5

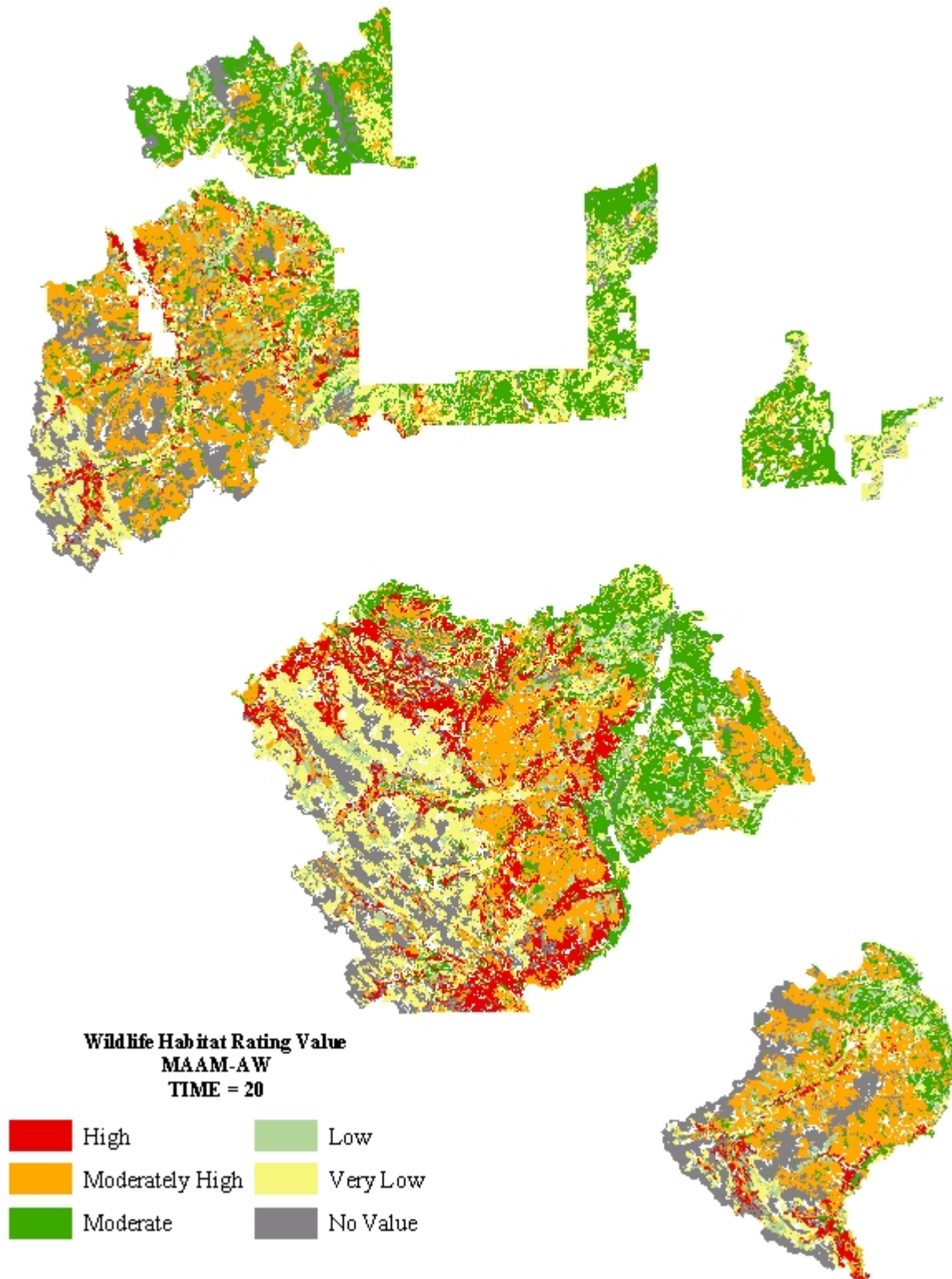
**Appendix Map 4 Moose Winter Security Thermal - Decade 10**



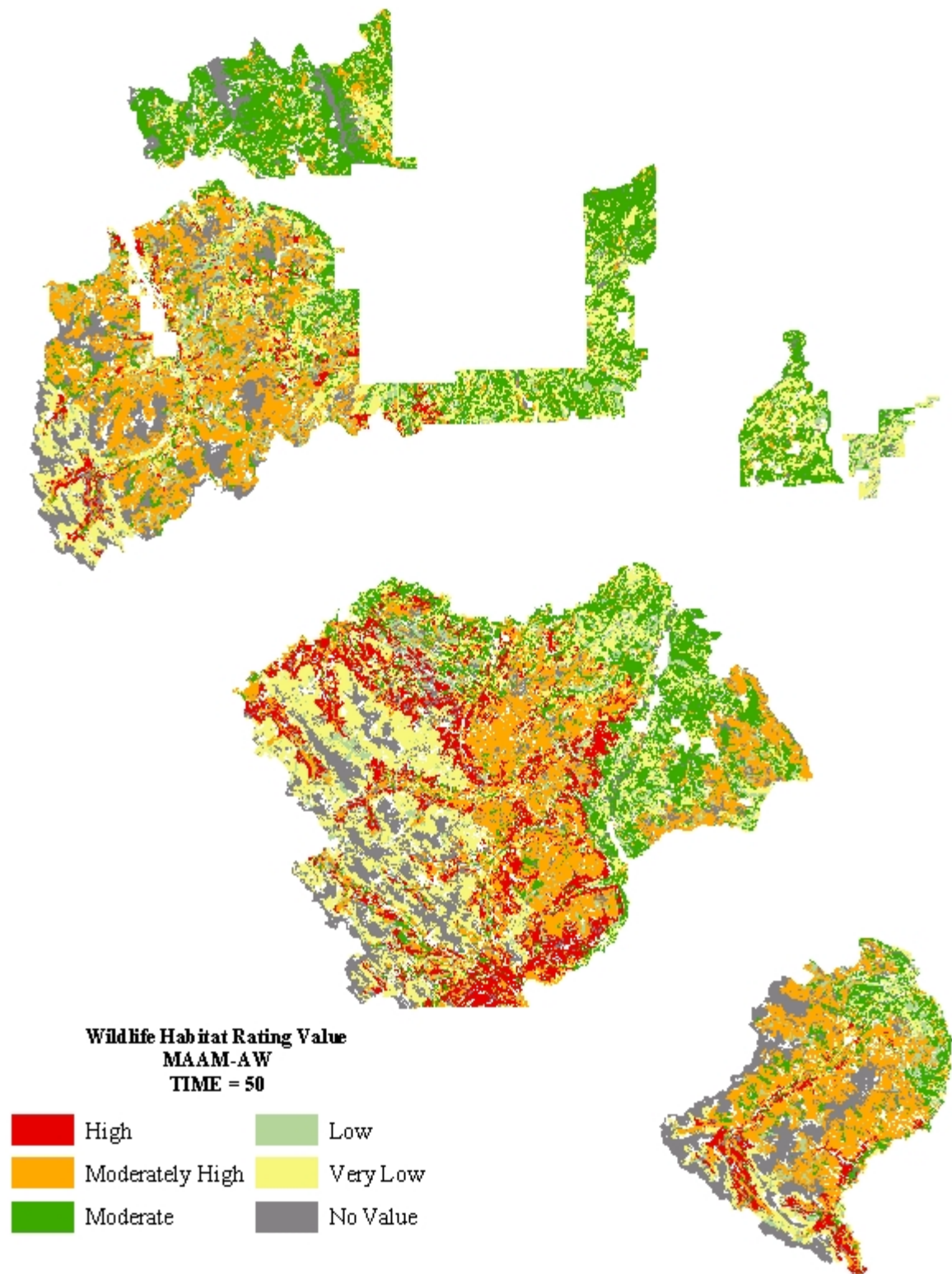
Appendix Map 5 Moose Winter Security Thermal - Decade 20



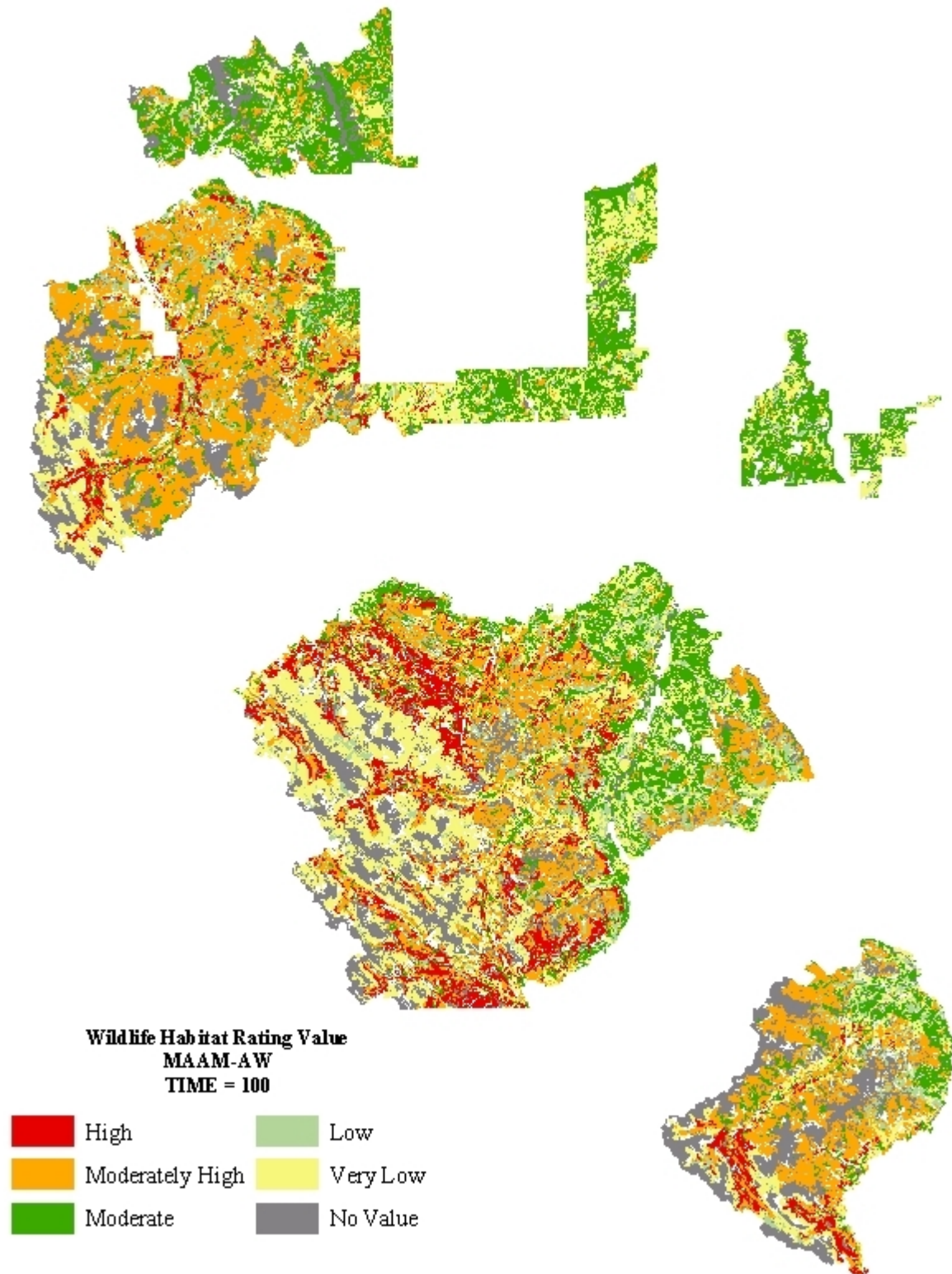
Appendix Map 6 Marten All Winter Habitat – Decade 0

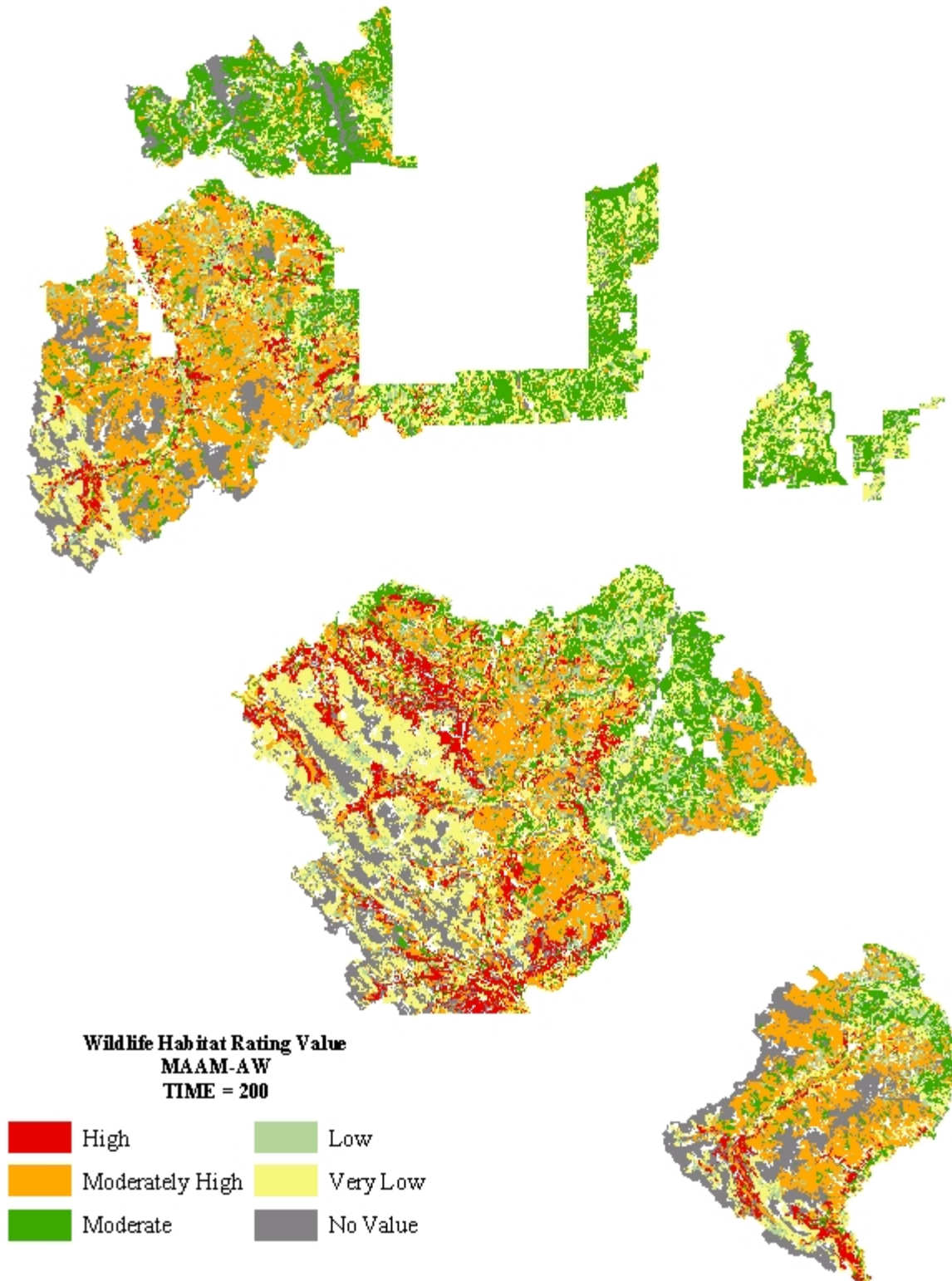


Appendix Map 7 Marten All Winter Habitat – Decade 2

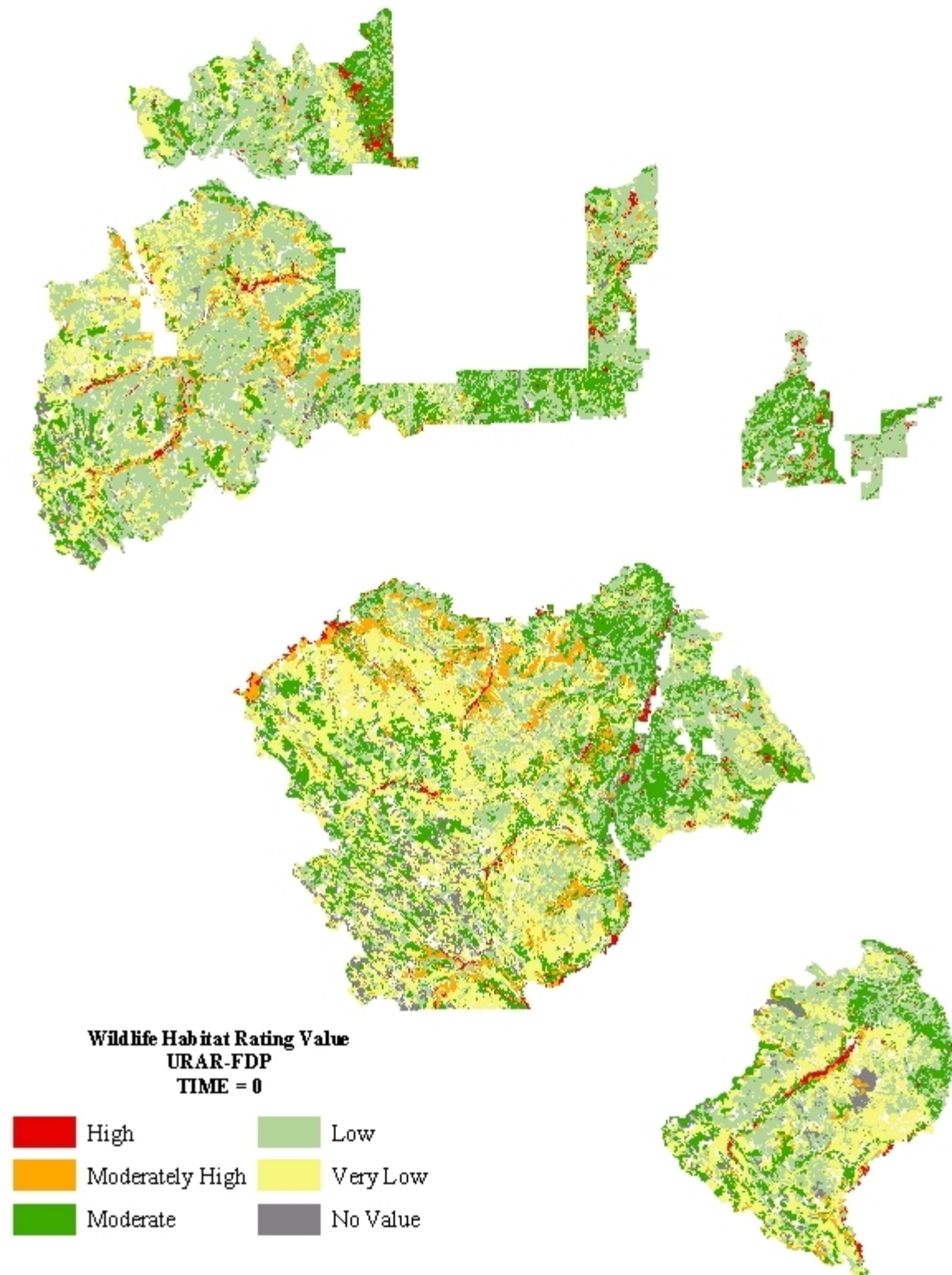


Appendix Map 8 Marten All Winter Habitat – Decade 5

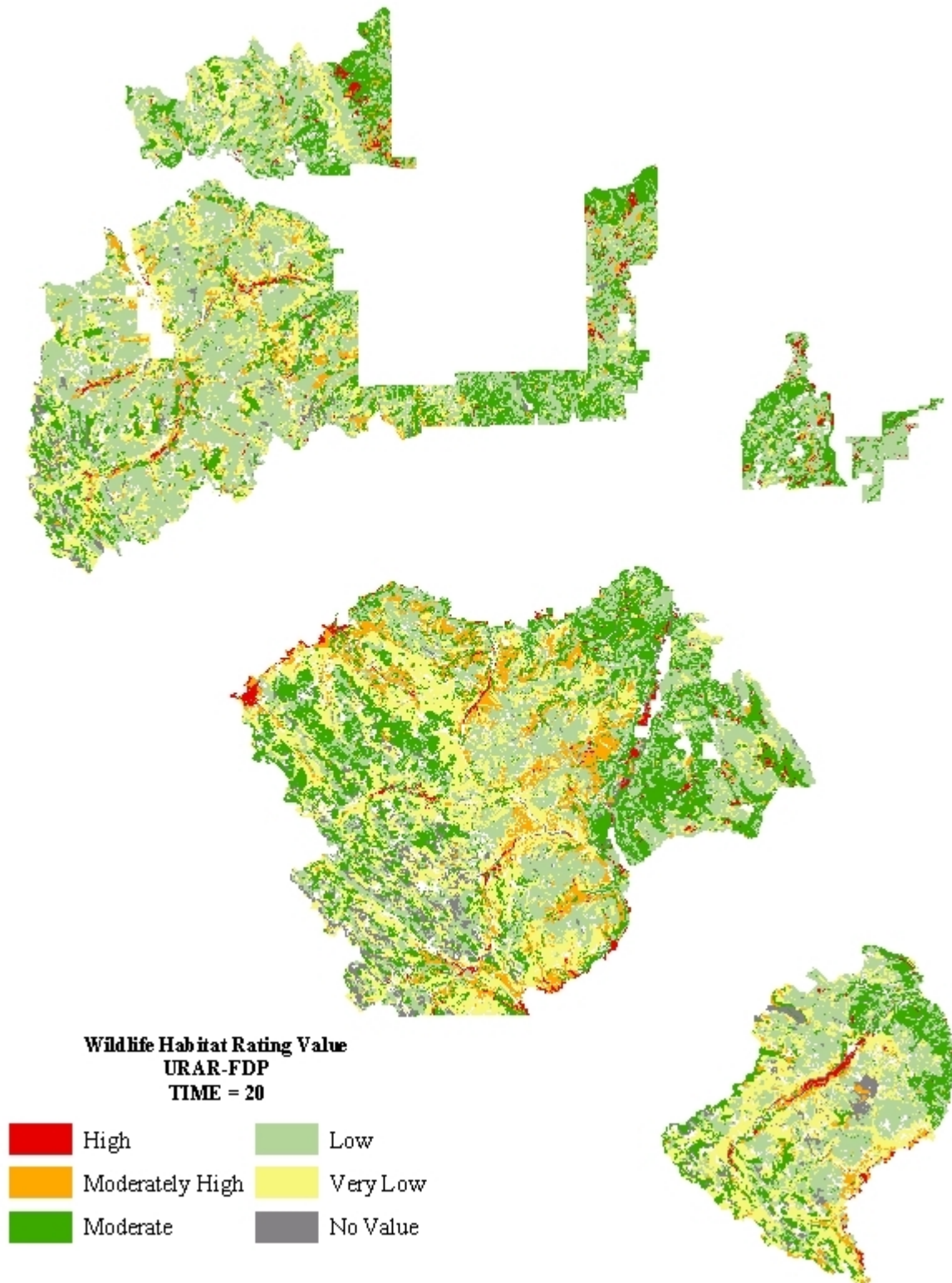
**Appendix Map 9 Marten All Winter Habitat – Decade10**



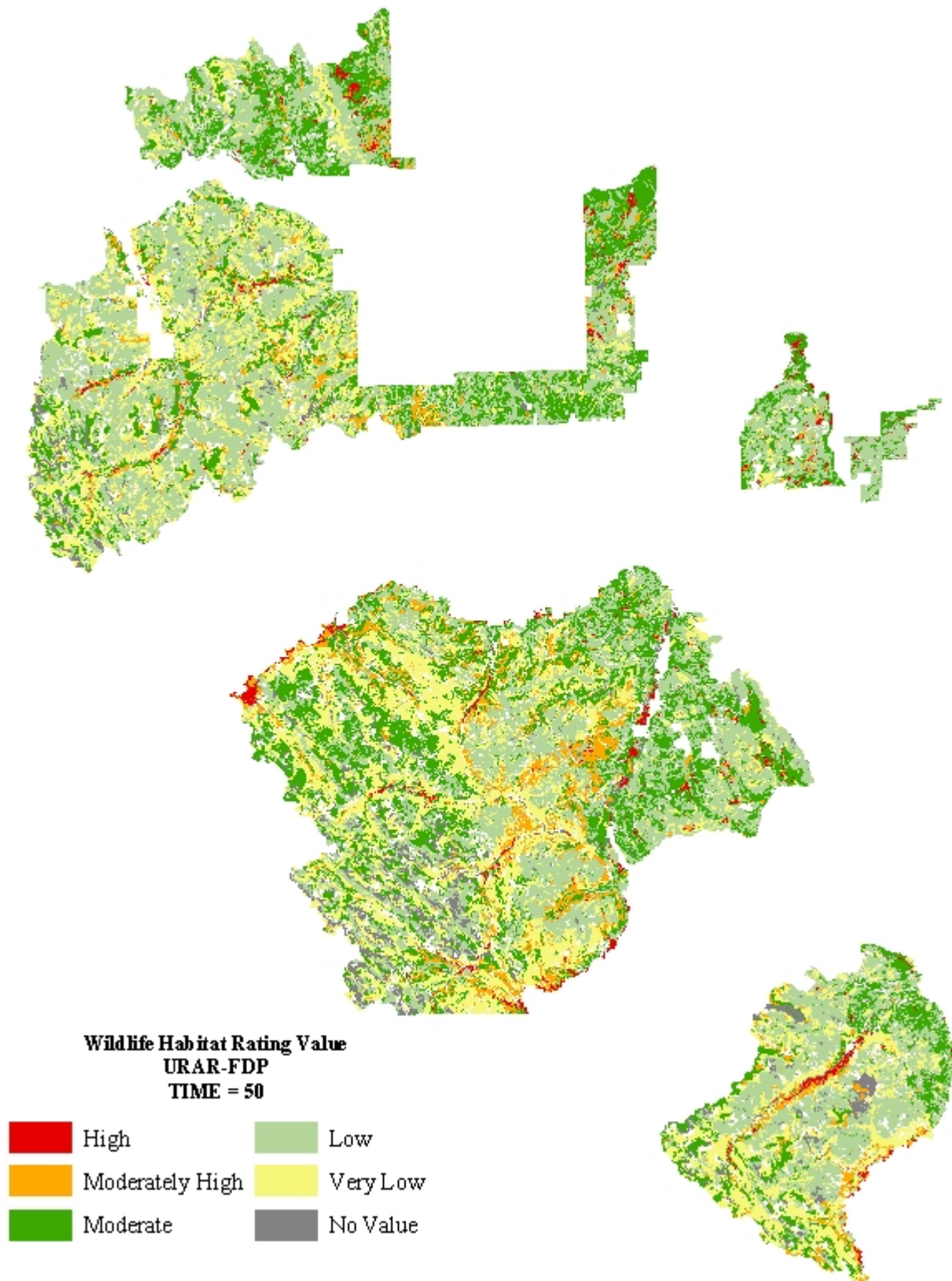
Appendix Map 10 Marten All Winter Habitat – Decade 20



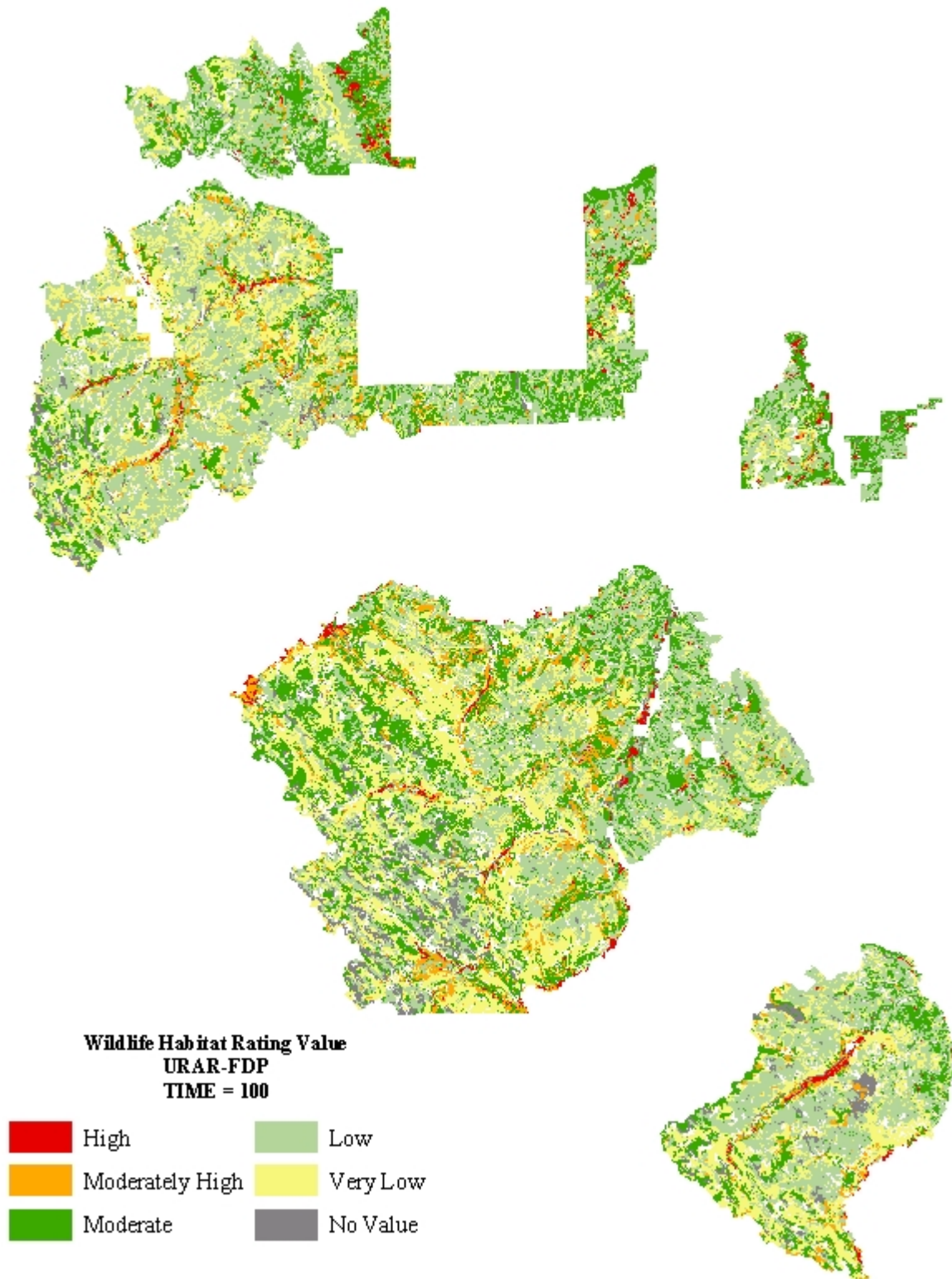
Appendix Map 11 Grizzly Bear Spring Feeding Areas – Decade 0



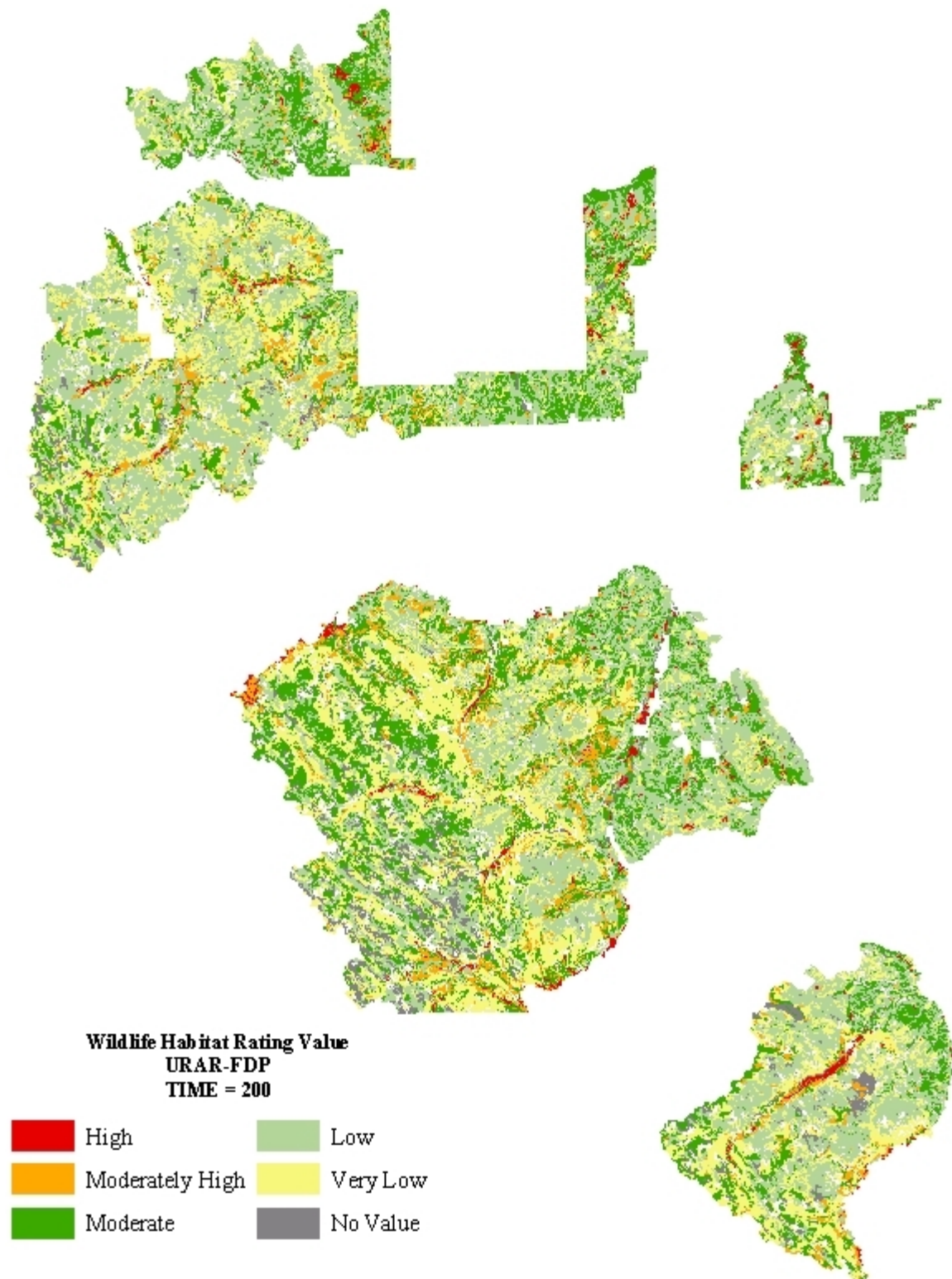
Appendix Map 12 Grizzly Bear Spring Feeding Areas – Decade 2



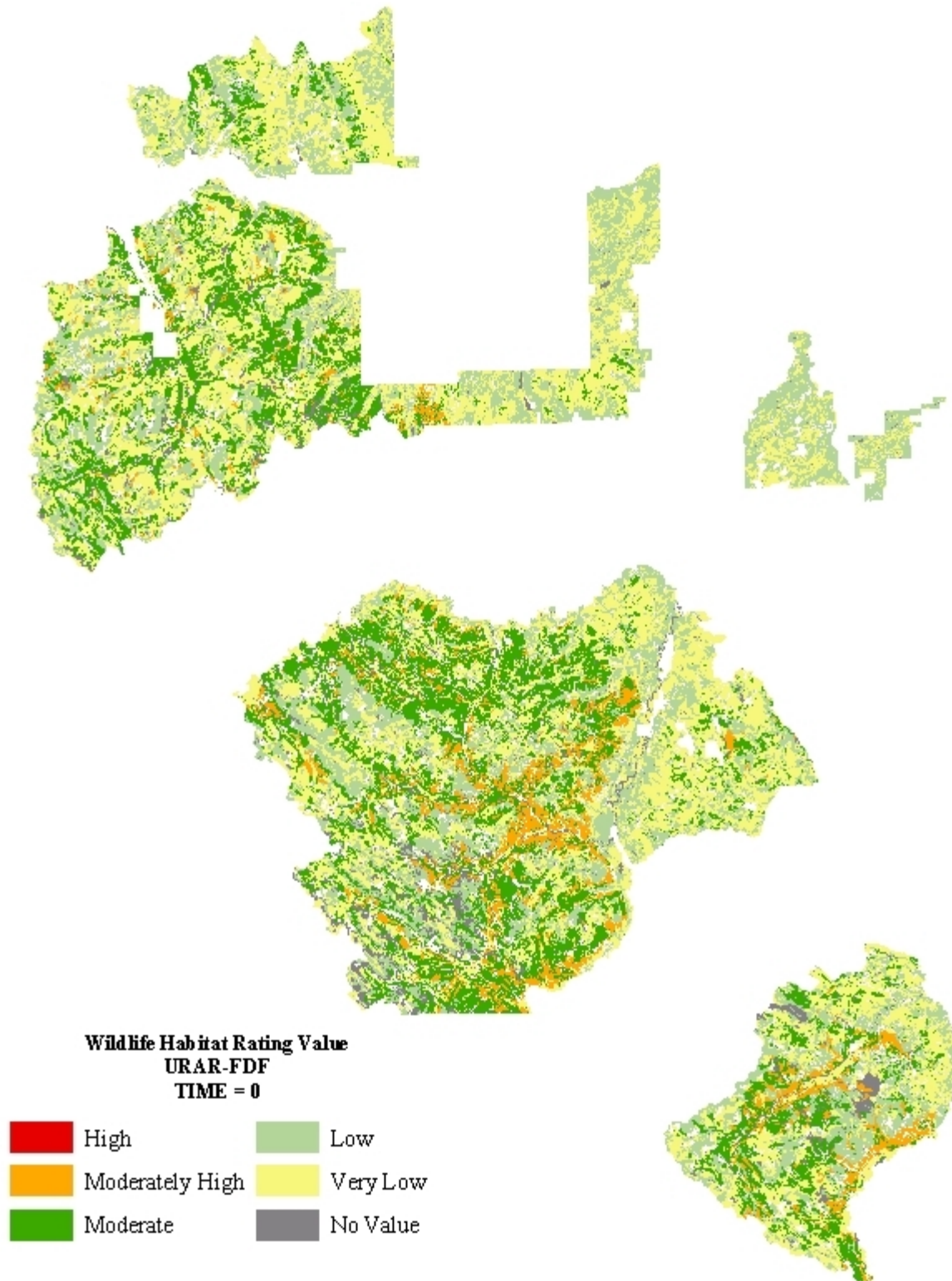
Appendix Map 13 Grizzly Bear Spring Feeding Areas – Decade 5



Appendix Map 14 Grizzly Bear Spring Feeding Areas – Decade 10



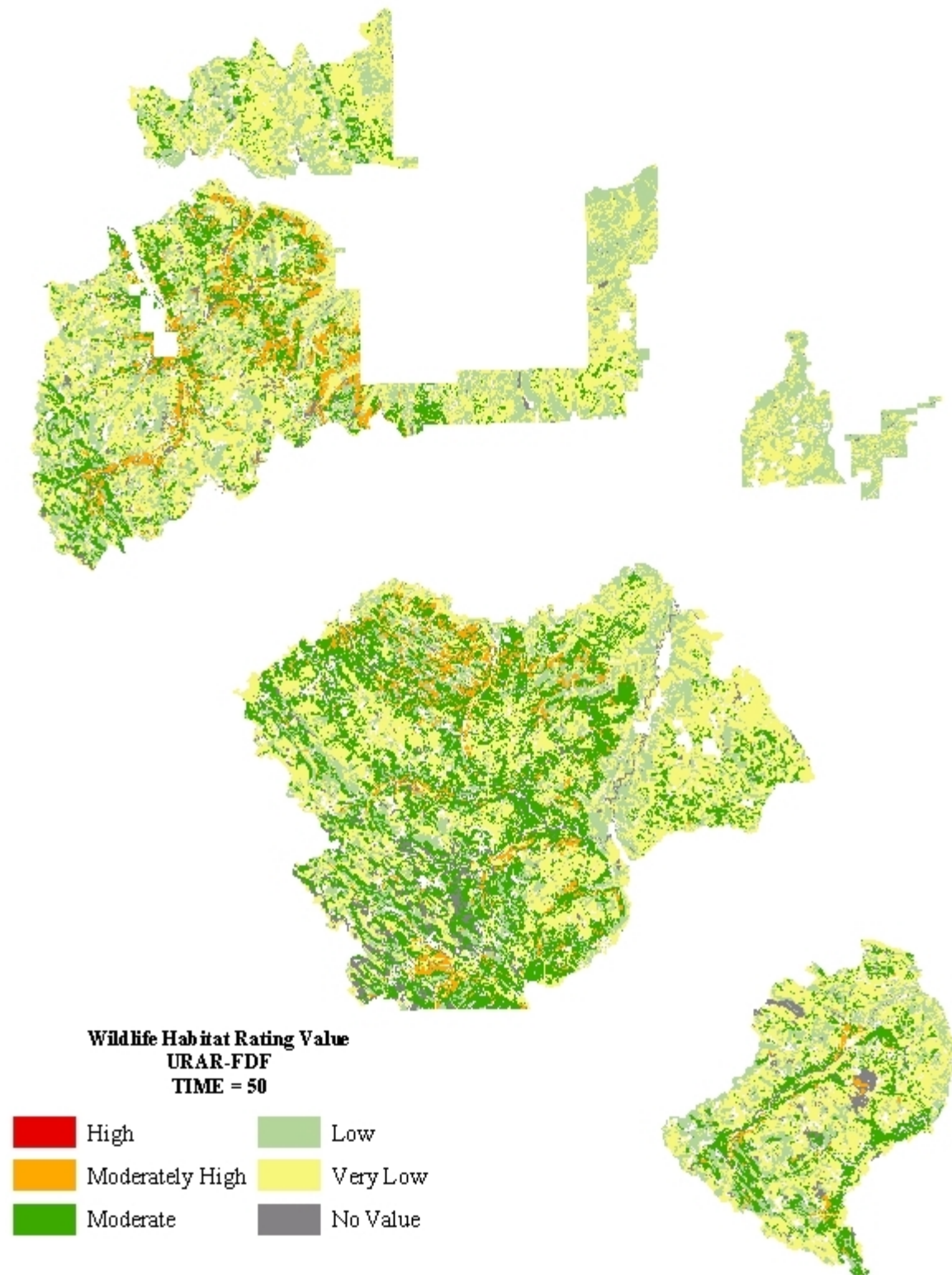
Appendix Map 15 Grizzly Bear Spring Feeding Areas – Decade 20



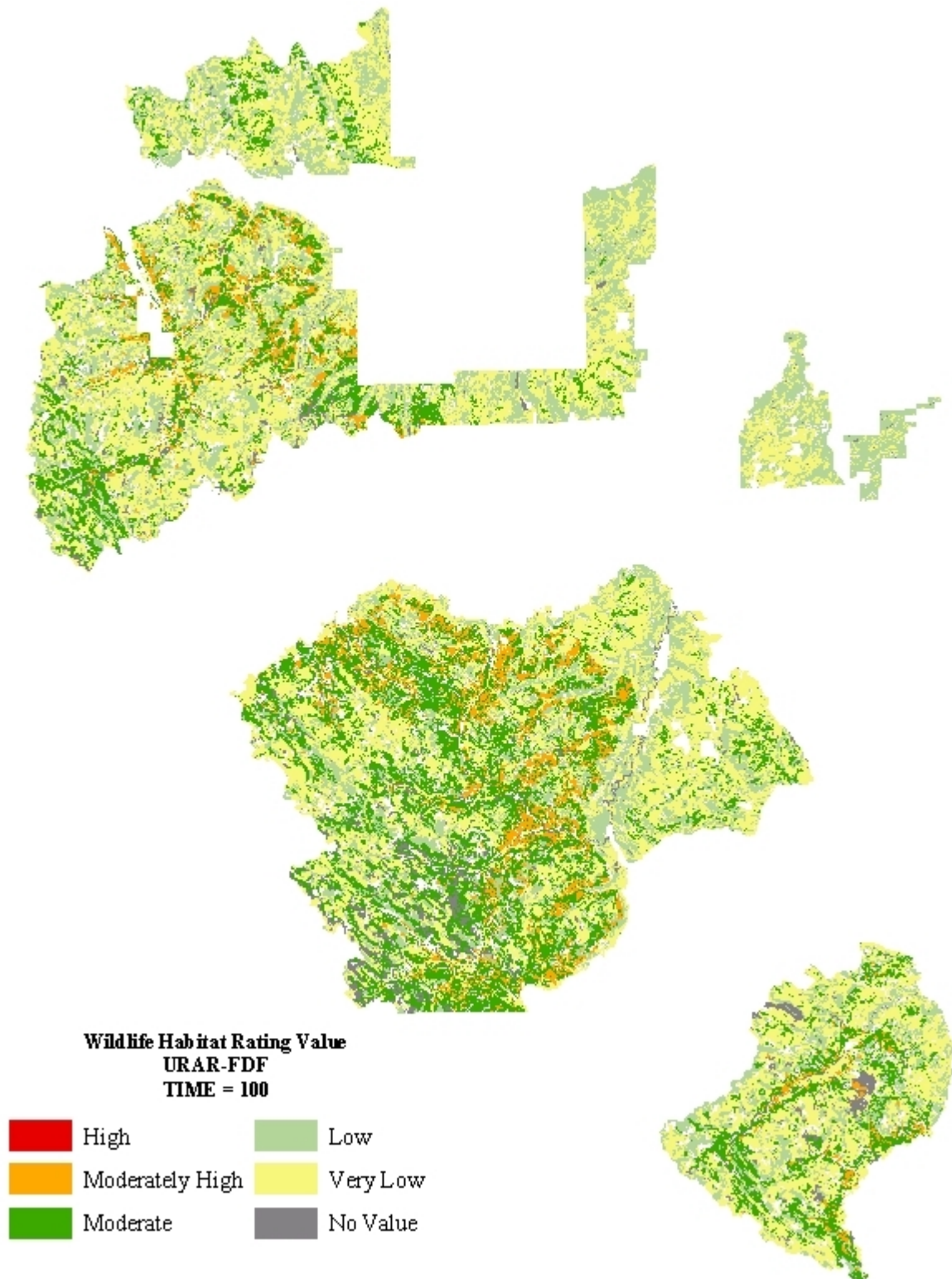
Appendix Map 16 Grizzly Bear Fall Feeding Areas – Decade 0



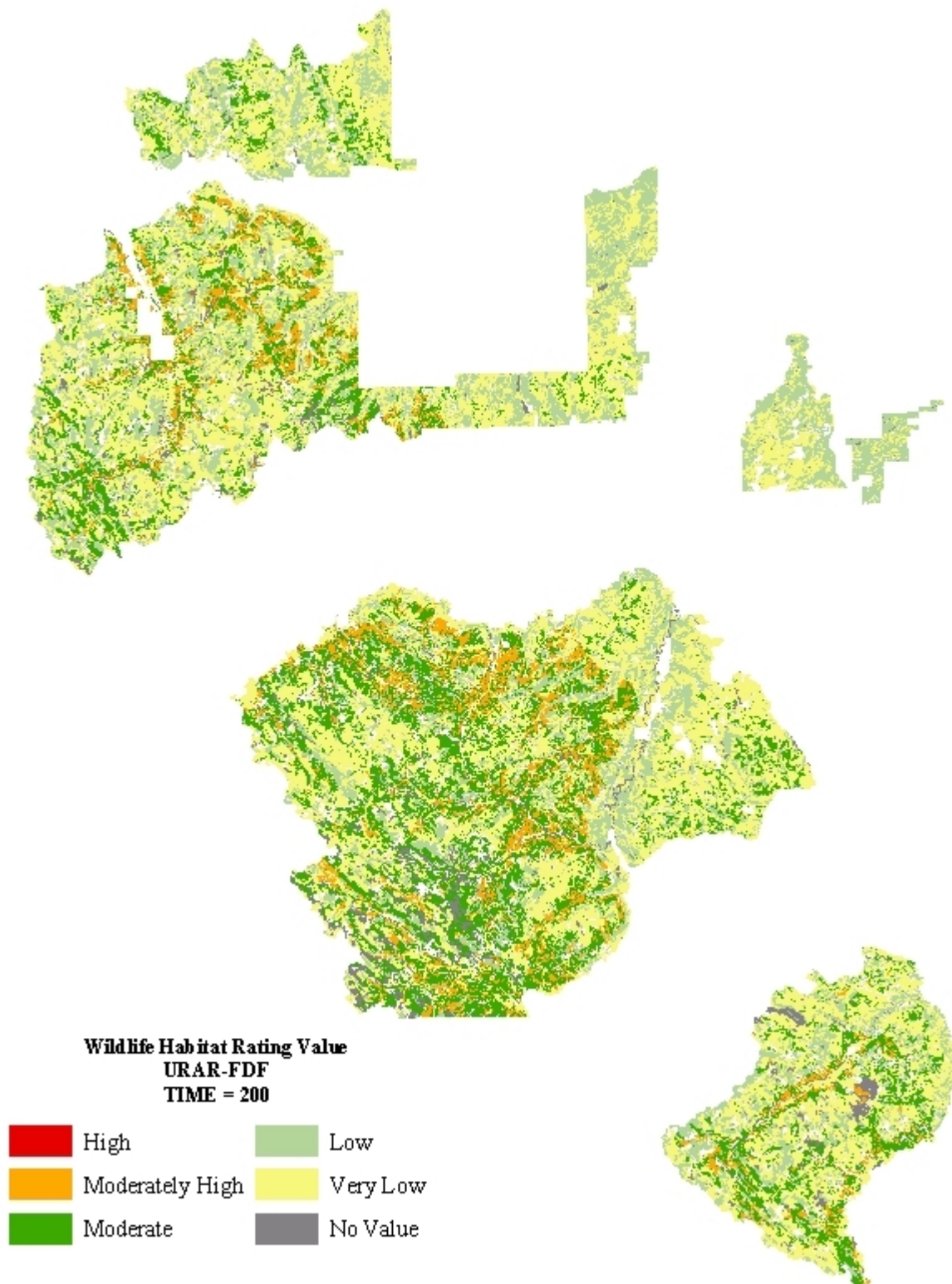
Appendix Map 17 Grizzly Bear Fall Feeding Areas – Decade 2

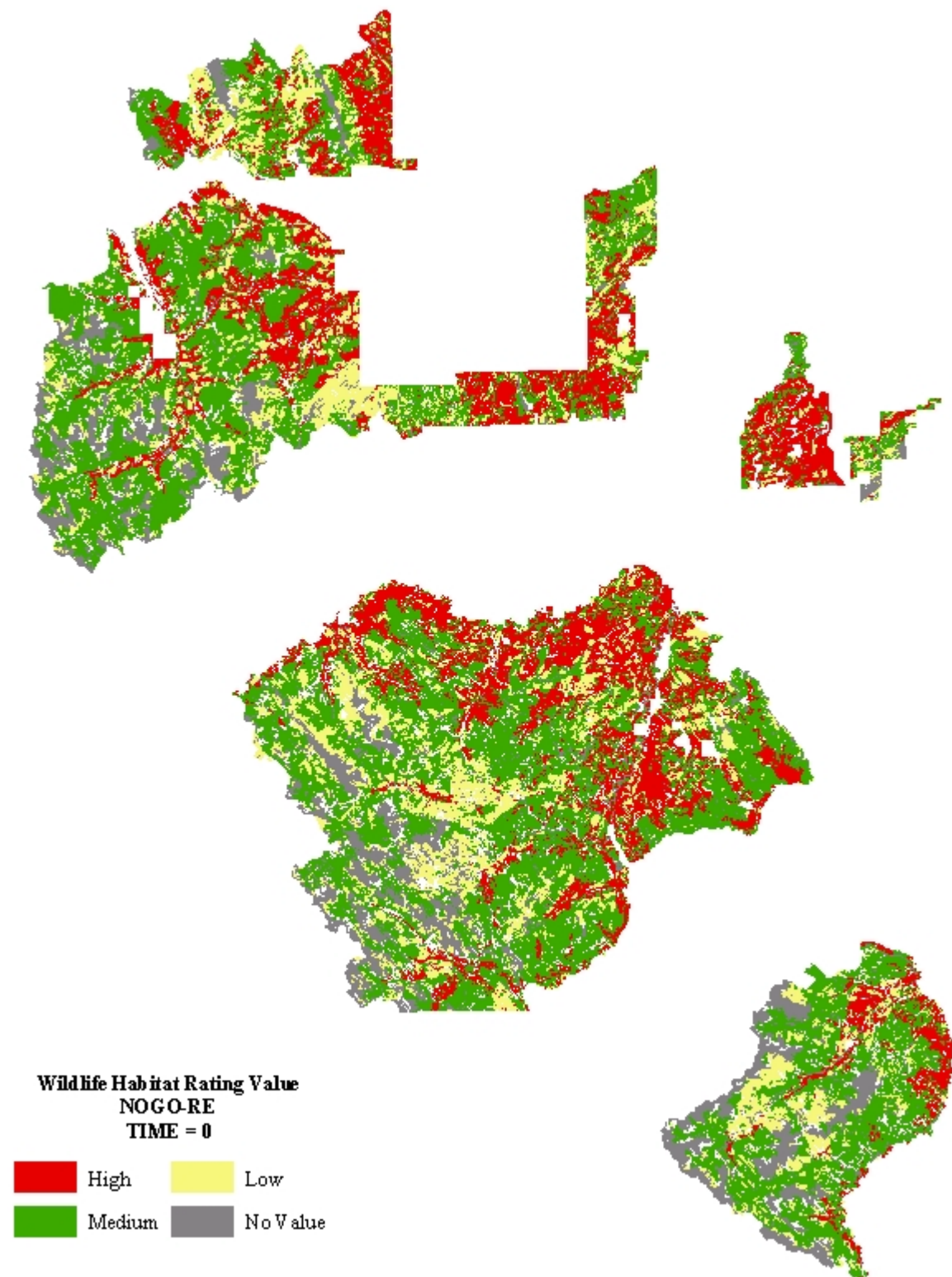


Appendix Map 18 Grizzly Bear Fall Feeding Areas – Decade 5

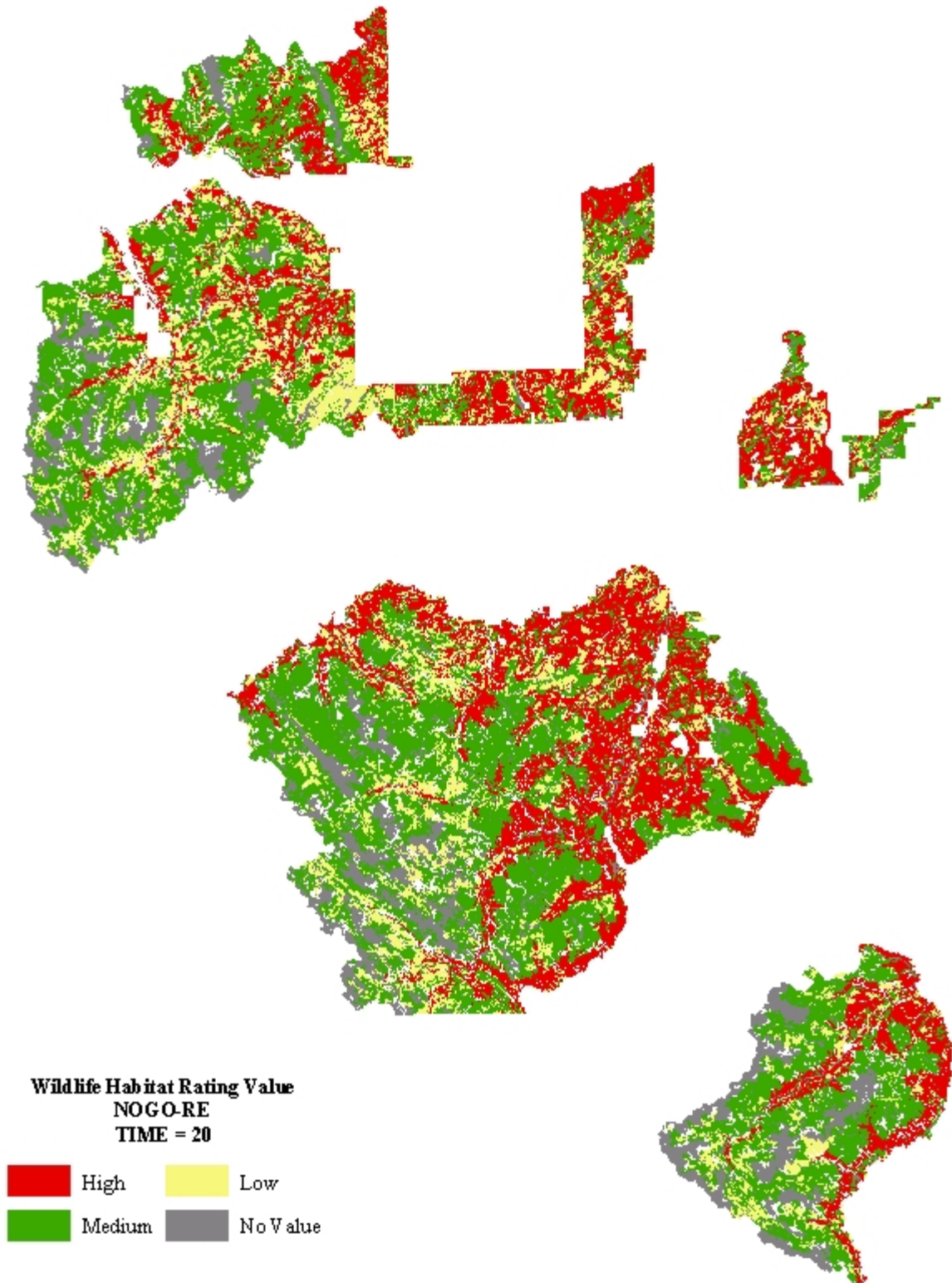


Appendix Map 19 Grizzly Bear Fall Feeding Areas – Decade 10

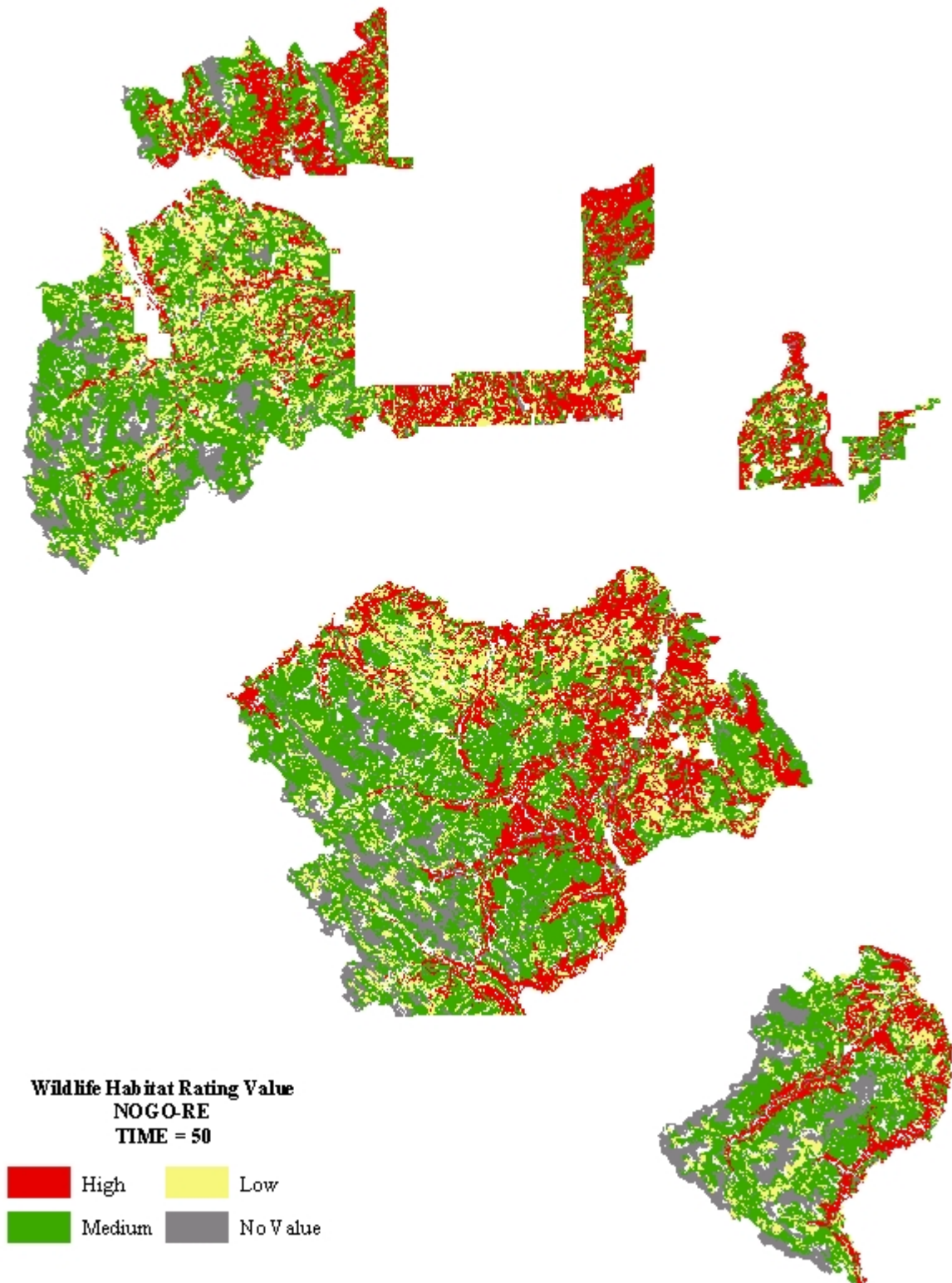
**Appendix Map 20 Grizzly Bear Fall Feeding Areas – Decade 20**



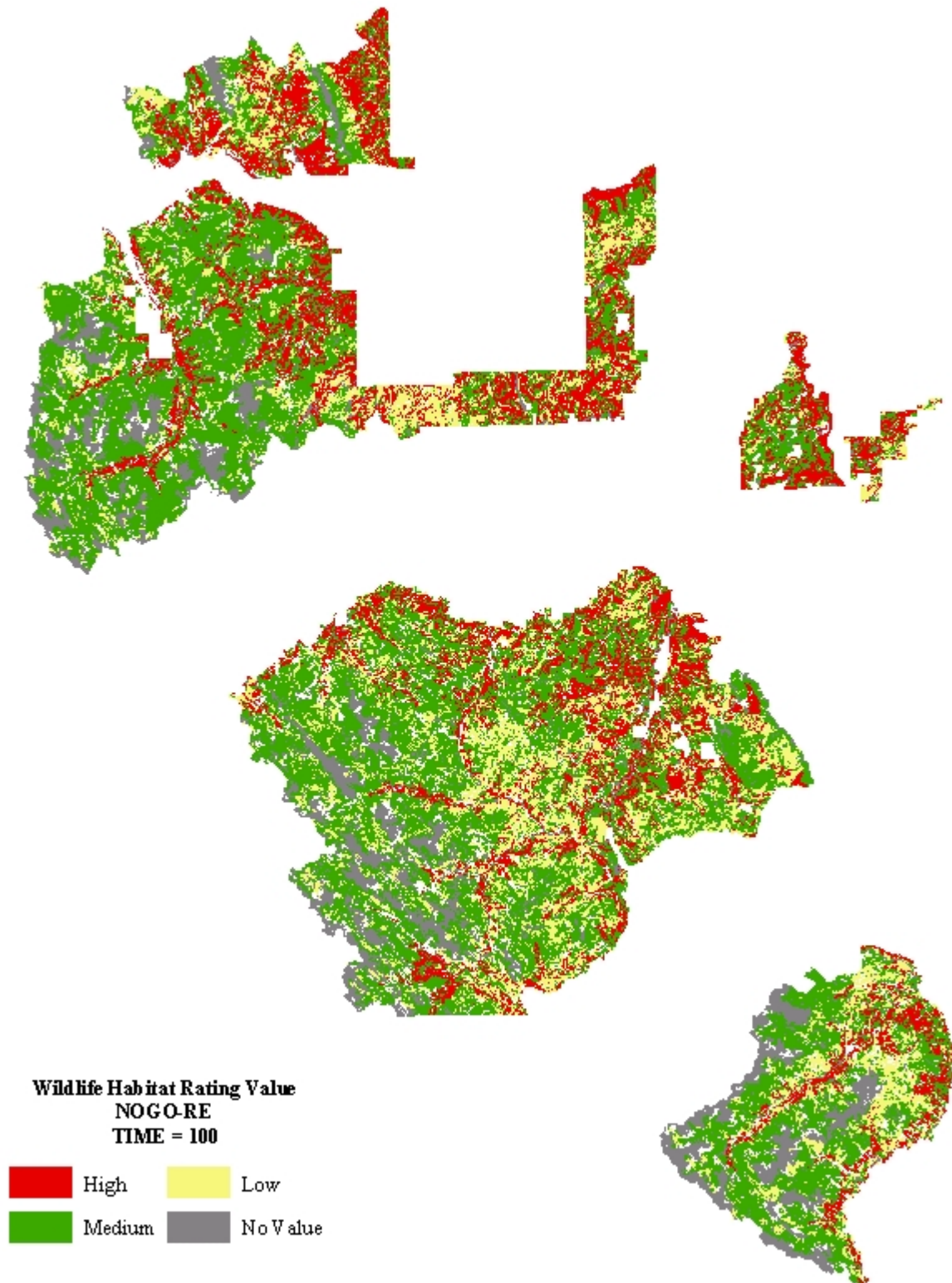
Appendix Map 21 Northern Goshawk Reproductive Habitat – Decade 0



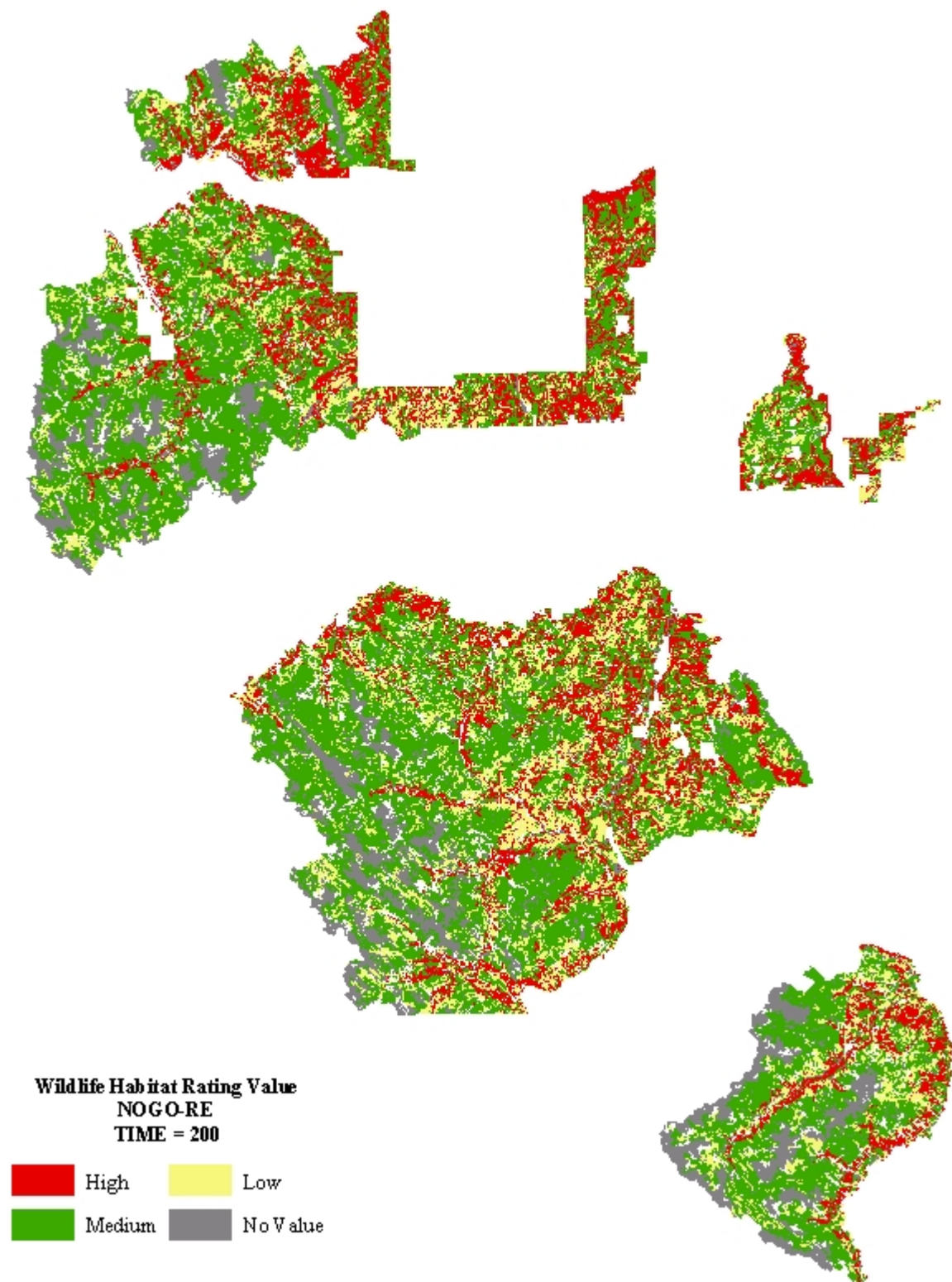
Appendix Map 22 Northern Goshawk Reproductive Habitat – Decade 2



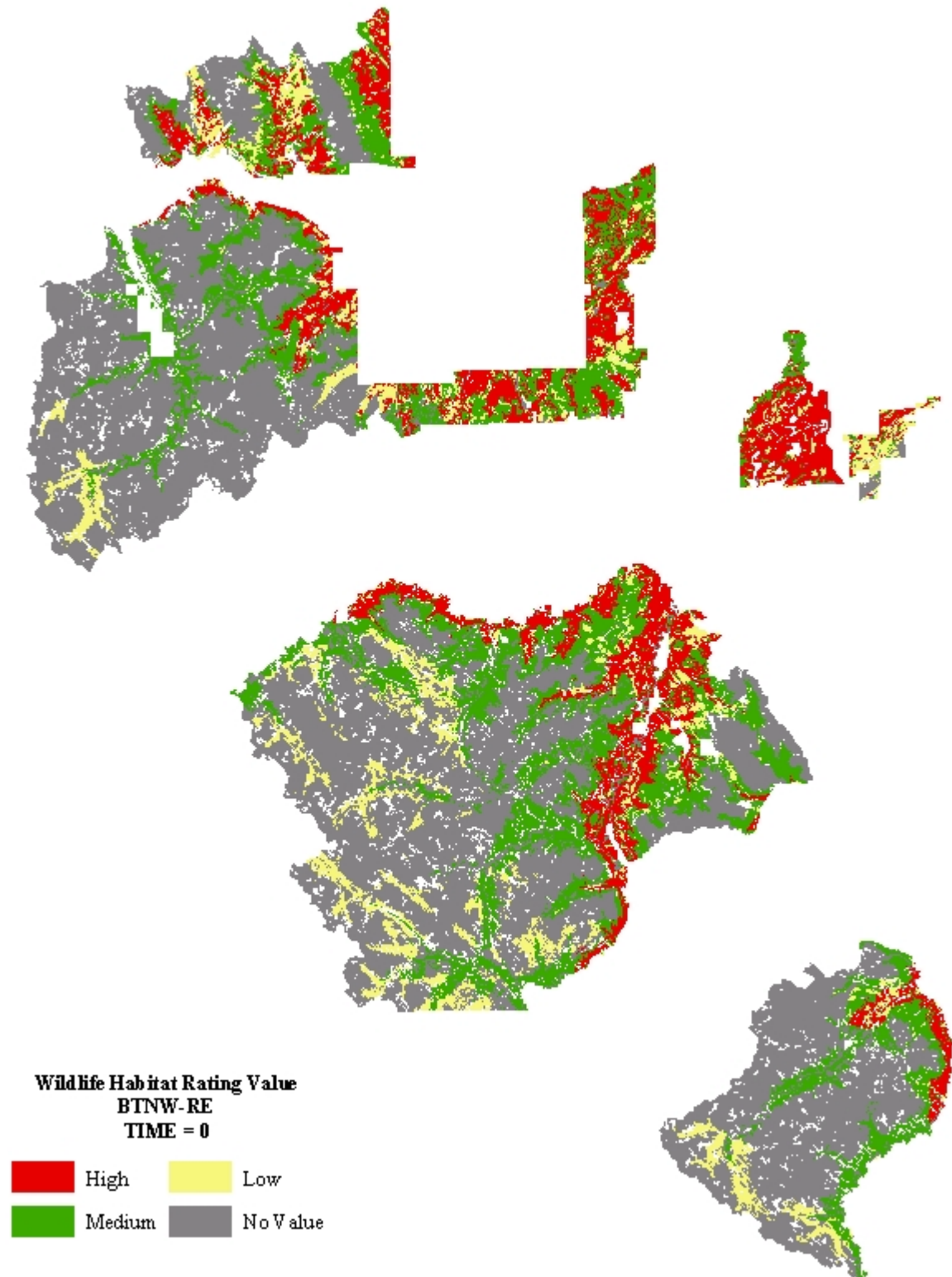
Appendix Map 23 Northern Goshawk Reproductive Habitat – Decade 5



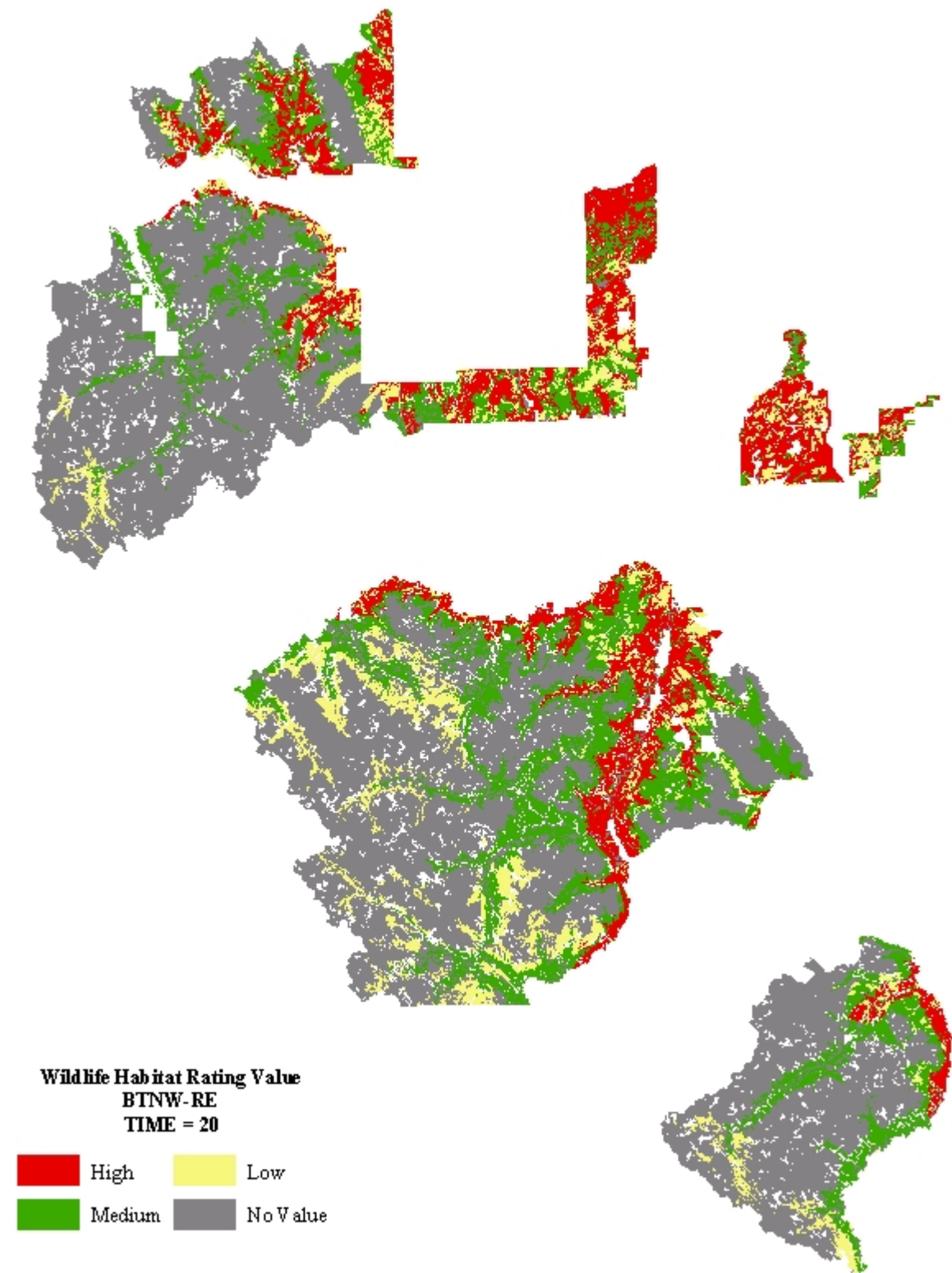
Appendix Map 24 Northern Goshawk Reproductive Habitat – Decade 10



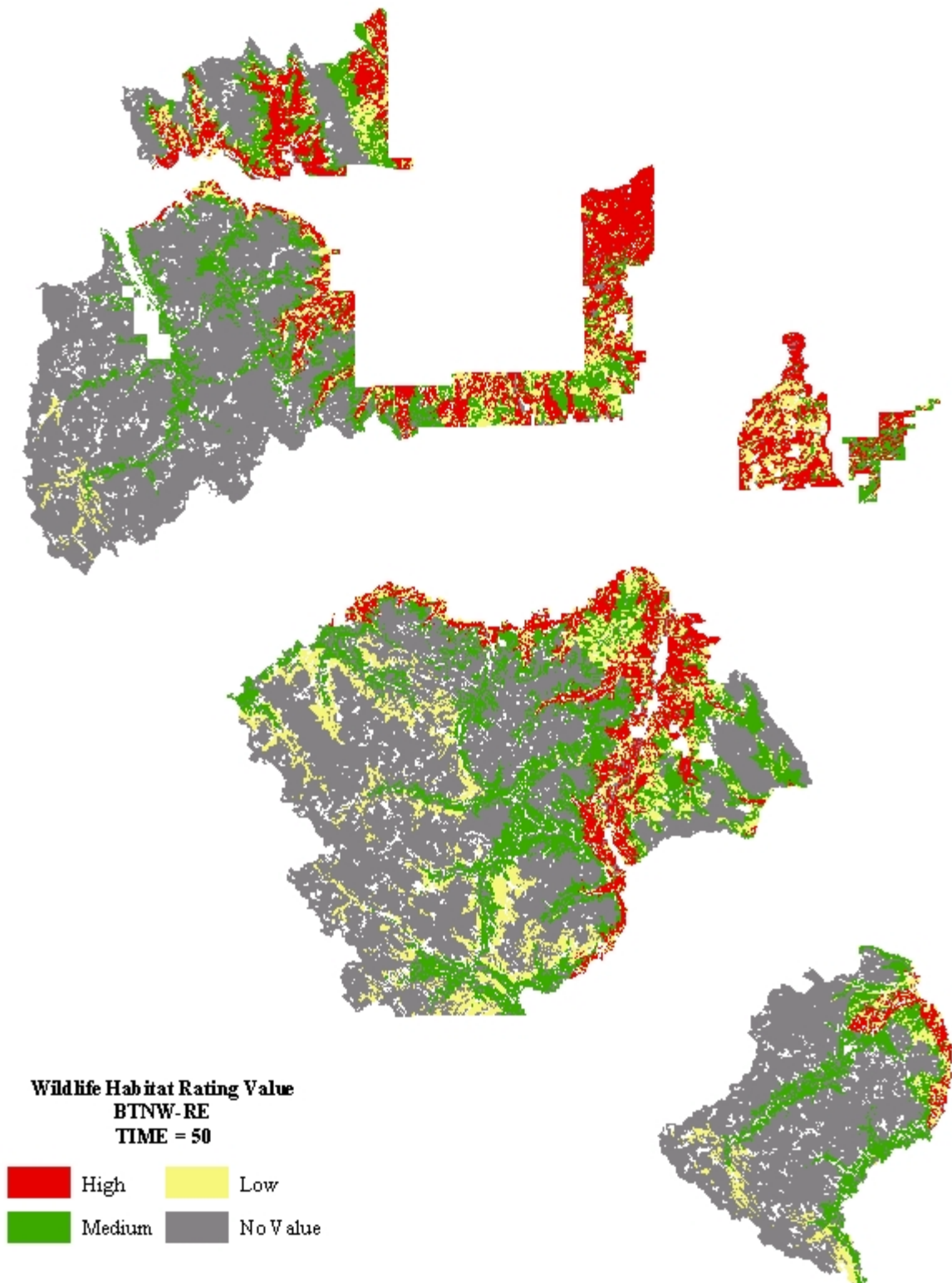
Appendix Map 25 Northern Goshawk Reproductive Habitat – Decade 20



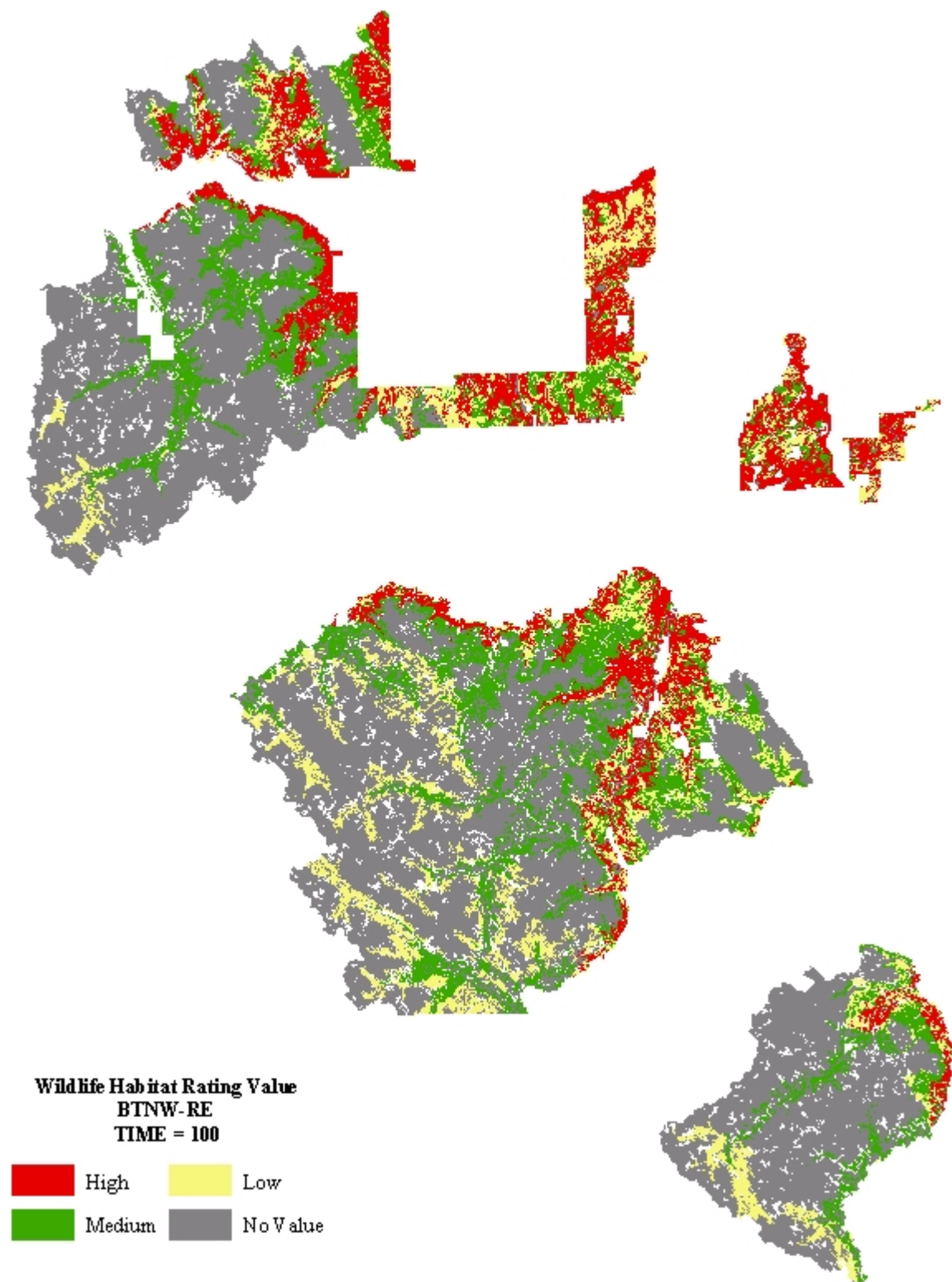
Appendix Map 26 Black-Throated Green Warbler Reproductive Habitat – Decade 0



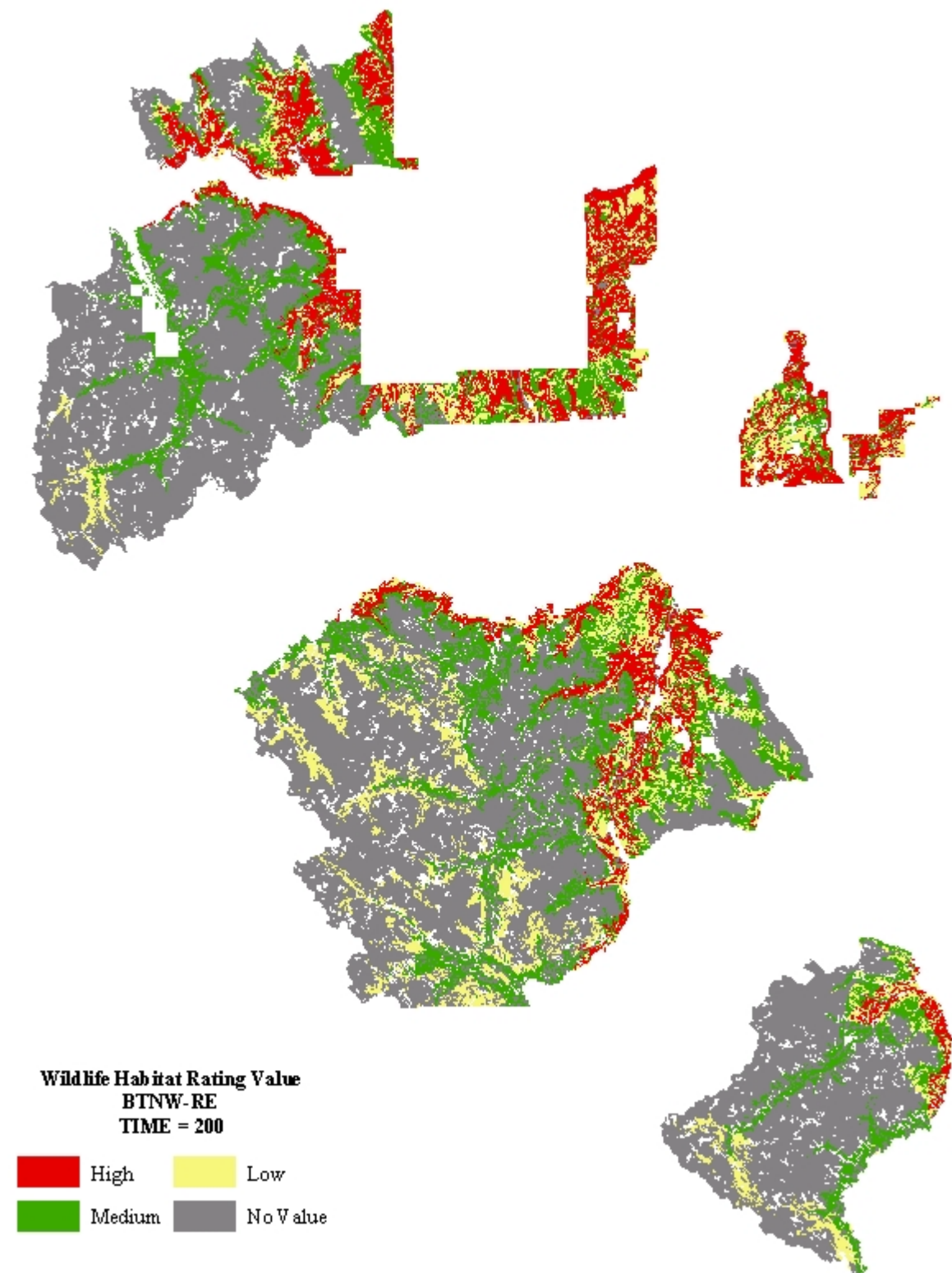
Appendix Map 27 Black-Throated Green Warbler Reproductive Habitat – Decade 2



Appendix Map 28 Black-Throated Green Warbler Reproductive Habitat – Decade 5



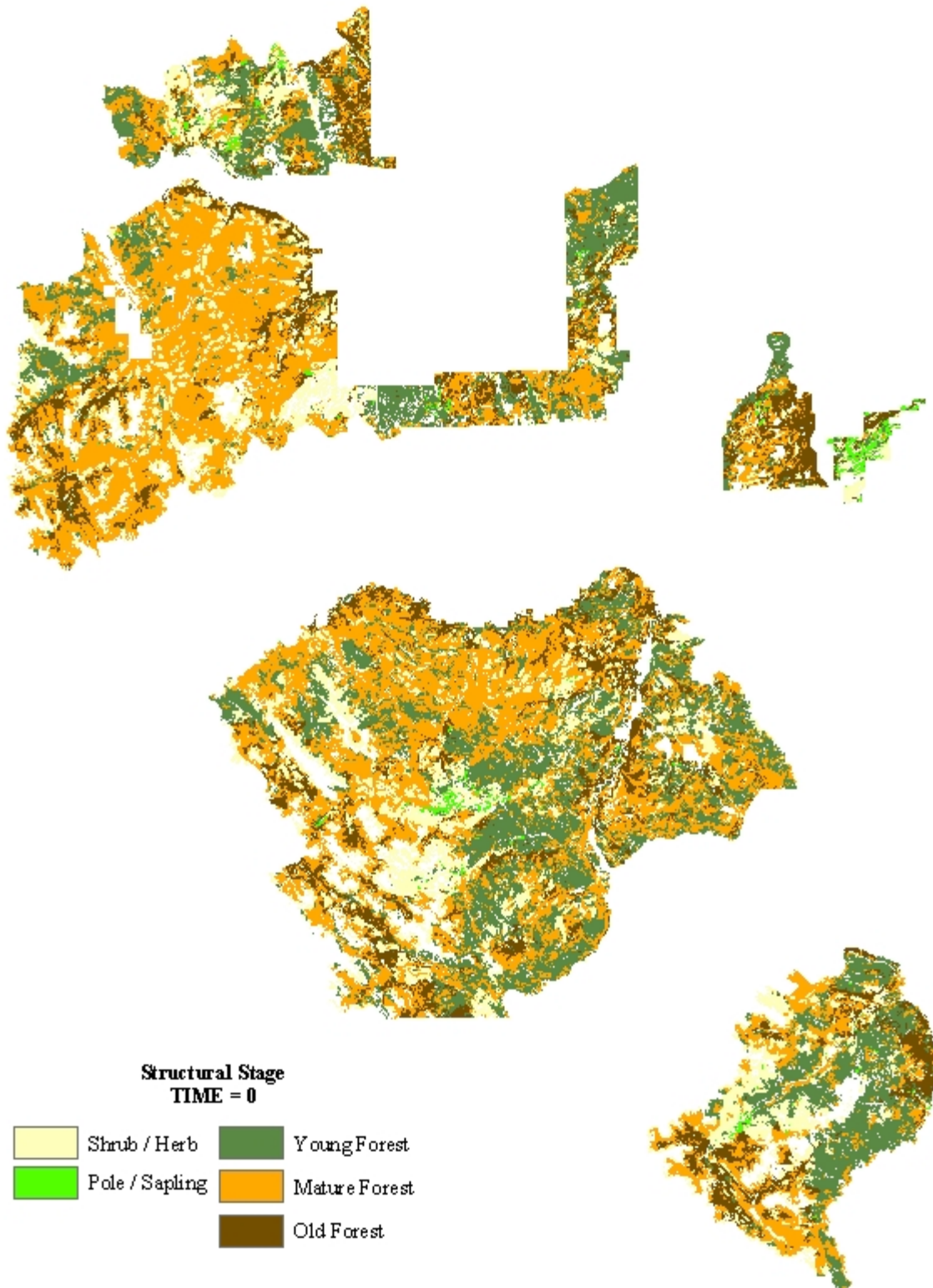
Appendix Map 29 Black-Throated Green Warbler Reproductive Habitat – Decade 10



Appendix Map 30 Black-Throated Green Warbler Reproductive Habitat – Decade 20

Appendix II

Structural Stage



Appendix Map 31 Structural Stage – Decade 0



Appendix Map 32 Structural Stage – Decade 5



Appendix Map 33 Structural Stage – Decade 10



Appendix Map 34 Structural Stage – Decade 20

Appendix III

Data Package