Effects of Future Forest Harvest on Wildlife Habitat in southeast British Columbia

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Executive Summary

This report summarizes the results of a wildlife habitat analysis completed for the Arrow, Cranbrook and Invermere timber supply areas (TSAs) in southeast British Columbia. Habitat models were completed for seven wildlife species: grizzly bear (*Ursus arctos*), elk (*Cervas elaphus*), mule deer (*Odocoileus hemionus*), marten (*Martes americana*), Williamson's sapsucker (*Sphyrapicus thyroideus*), flammulated owl (*Psiloscops flammeolus*) and northern goshawk (*Accipiter gentilis*). These species were selected in discussion with the Ktunaxa Nation and as indicators of representative habitat types in the TSAs, such as old and mature forests. Wildlife habitat models consisted of wildlife habitat ratings from high (1) to nil (6) applied to unique ecological units, as defined by predictive ecosystem mapping (PEM) and vegetation resources inventory (VRI) data, by expert wildlife biologists. Information from PEM and VRI used to rate habitat included: ecosection, biogeoclimatic ecosystem classification zone, subzone and variant, site series, vegetation structural stage and composition, slope and aspect. Wildlife habitat ratings models were completed following the British Columbia Provincial Wildlife Habitat Rating Standards Version 2.0 (RIC 1999).

Here we summarize the current amount of high to no value rated habitat for each wildlife species in each TSA and timber harvest land base (THLB) within each TSA. To assess the effects of future simulated forest harvest on wildlife habitat, the area of each habitat rating class for each species and season within the THLB was calculated at five year intervals, 100 years into the future. Habitat ratings were adjusted at each interval based on changes to vegetation structural stage within each PEM unit. Vegetation structural stage was re-calculated in each PEM unit at each interval based on changes to vegetation age due to simulated forest growth and forest harvest in each unit produced from timber supply models. In addition, future simulated forest harvest effects on wildlife habitat ratings were compared to simulated habitat ratings in a future scenario with no forest harvest. The results provided here are simulations of how current and future forest harvest may affect habitat amount and quality for focal wildlife species. Sixteen tables, 43 figures and 80 maps were produced to summarize current and predicted future habitat conditions for wildlife.

The wildlife habitat models suggest forest harvest may limit the amount of higher quality foraging or nesting habitat for marten, northern goshawk, and flammulated owl. These results are intuitive, as these species rely on older forests. Future simulated forest harvest did not appear to have a significant effect on elk and mule deer habitat. Downward pressure on timber supply for Wiliamson's sapsucker and flammulated owl management, beyond what is modeled as part of the current timber supply analysis, is not recommended because they are currently managed under British Columbia's Identified Wildlife Management Strategy. Downward pressure on timber supply is also not recommended for grizzly bear management based on habitat models results. However, additional information on how forestry road development influences grizzly bear populations is provided in a separate report. Downward pressure on timber supply is not recommended for northern goshawk or marten management. However, there is significant uncertainty on population status and trends of these species in the region. Additional information on these species is needed to adequately account for them in future timber supply analyses, particularly for marten given their high value to First Nations.

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Introduction

This report summarizes a wildlife habitat analysis completed for the Arrow, Cranbrook and Invermere timber supply areas (TSAs) in southeast British Columbia. Habitat models were completed for seven wildlife species: grizzly bear (*Ursus arctos*), elk (*Cervas elaphus*), mule deer (*Odocoileus hemionus*), marten (*Martes americana*), Williamson's sapsucker (*Sphyrapicus thyroideus*), flammulated owl (*Psiloscops flammeolus*) and northern goshawk (*Accipiter gentilis*). These species were selected in discussion with the Ktunaxa Nation and as indicators of representative habitat types in the TSA, such as old and mature forests. The details of how the habitat models were developed are described in Tripp (2016). In summary, wildlife habitat models consisted of wildlife habitat ratings applied to unique ecological units, as defined by predictive ecosystem mapping (PEM) and vegetation resource inventory (VRI) data, by expert wildlife biologists. Models were also reviewed by external biologists, including a biologist for the Ktunaxa Nation. The ratings reflect a habitat's value to a particular species relative to the best available habitat for that species in British Columbia, i.e., the highest rated habitat is optimum habitat for the species. Habitat ratings are therefore a proxy of the habitat carrying capacity of an ecological unit for a species, as higher-value habitat units have the potential to support a higher density of wildlife.

Habitat ratings for the seven focal wildlife species were assigned to spatial PEM units across the TSAs to determine the amount of high to no value habitat in each TSA (Tripp 2016). In addition, here we summarize the amount of high to no value habitat in the timber harvest land base (THLB) within each TSA, as defined in timber supply analyses recently completed for each TSA. We also estimate the area of high to no value habitat one hundred years into the future at five year intervals within each THLB using outputs from timber supply models.

The results provided here are simulations of how current and future timber harvest may affect the total amount of habitat for focal wildlife species. However, there are important considerations and limitations with this analysis. First, the habitat ratings are based on a coarse-scale description of habitat. PEM data is mapped at a 1:20,000 resolution, which provides a map of broad ecological features, such as general forest stand types (e.g., coniferous, deciduous or mixed) and biogeoclimatic zones, but PEM does not provide data on fine-scale habitat features, such as the amount or location of large, old trees. Therefore, the data may be limited for predicting habitat for species that rely on specific, fine-scale habitat features. In this case, PEM data is used to identify where these features are most likely to occur, for example, by identifying forests with an older structural stage as having high value for species that use large, old trees. Second, PEM provides data exclusively on vegetation and terrain features. PEM does not provide data on other landscape features, such as human disturbances like roads. Therefore, the habitat ratings may not account for all biophysical habitat features that influence a wildlife species. Third, the models do not consider the effects of other ecological processes that affect species distribution and abundance, for example, inter- or intra-specific competition, predation from other species, human hunting and poaching. Therefore, the models should not be used as a proxy for species distribution and abundance, but rather as a measure of the capability of habitat to influence species distribution and abundance in the absence of these other processes. Fourth, the models do not consider the spatial configuration of the habitat. Some wildlife species are sensitive to the spatial pattern of habitat on the landscape, for example, they may require habitat patches of a minimum size. These factors are not considered in the habitat ratings. Fifth, the predicted future habitat ratings are exclusively influenced by predicted changes in habitat structural stage within PEM units. Therefore, these models are most useful for predicting future habitat of species that are highly dependent on a specific forest structural stage.

We discuss the implications of the model outputs for timber supply. We focus the discussion on habitat models that clearly show a change in habitat ratings in the THLB in response to forest harvest over time. We also discuss the results within the context of the model limitations described above.

Methods

Wildlife habitat ratings models were completed for seven wildlife species by Tripp (2016) following the Provincial Wildlife Habitat Rating Standards Version 2.0 (RIC 1999). Models were completed for different seasons of the year and for specific life history requirements that were considered important for each species (Table 1). Habitat was rated on a scale of one to six, where one is highest and six is not considered habitat (Table 2). Habitat was rated based on its suitability and capability, where suitability is the habitat rating under current habitat conditions and capability is the habitat rating under its predicted optimum condition for the species being rated.

Information from PEM, VRI and a digital elevation model (DEM) was used to rate habitat value. This information included the following habitat characteristics:

- Ecosection, which are areas characterised by specific physiographic and macroclimatic conditions
- Biogeoclimatic Ecosystem Classification (BEC zone), subzone and variant, which are broad ecosystem classifications based on vegetation, climate and soil
- Ecosystem type (site series), including classification of the landcover
- Structural Stage, which is interpreted from vegetation age data provided by VRI
- Stand composition, which characterizes the forest as either broadleaf, mixed or coniferous
- Slope/aspect, which was used to classify whether a location was a steep warm/cool, or very steep warm/cool slope as per ecosystem mapping standards[1]

Structural stage was determined using vegetation age from VRI data. Age was converted into age classes (i.e., 20 year intervals) and the most common age class within a PEM habitat unit (i.e., unique mapped polygon) defined the age class for that polygon. The age class was then used to determine the structural stage (i.e., successional vegetation stage and structure)[2] for the PEM polygon using standardized provincial definitions (MoFR and MoE 2010).

[1] https://www.for.gov.bc.ca/hts/risc/pubs/teecolo/tem/tem_man.pdf
[2] https://www.for.gov.bc.ca/tasb/legsregs/fpc/fpcguide/other/species/species-61.htm

Some PEM polygons consisted of more than one type of habitat (e.g., more than one site series). In those cases, each unique habitat type was rated in the polygon and a weighted average of the ratings within the polygon was taken based on the area of each habitat type in the polygon.

We calculated the current area of each habitat rating class for each species, season and life history requirement for each TSA. In addition, we calculated the area of each habitat rating within the THLB of each TSA, as defined in the timber supply analysis. This provides for a comparison of the amount of habitat inside the THLB (which is more likely to be influenced by forestry practices) to the amount of habitat in the region.

To assess the effects of future simulated forest harvest on wildlife habitat, we calculated the area of each habitat class within the THLB five year intervals 100 years into the future. The start of the simulation was January 1, 2013 and forest harvest was measured at the middle point of five year (e.g., 2015, 2020, 2025, etc.) intervals. Habitat ratings were adjusted at each interval based on changes to vegetation structural stage within the unit. Vegetation age and structural stage were re-calculated in each PEM habitat unit at each time interval based on changes to vegetation age due to forest harvest and growth in each unit. For example, if a simulated cutblock occurred in a PEM unit, then vegetation age was set to 0 for that portion of the unit that was cut. Vegetation age would be advanced five years in the remainder of the PEM unit. A new age class and structural stage would then be calculated based on those changes. Habitat ratings under the forest harvest scenario were compared to a no forest harvest scenario 100 years into the future. The no harvest scenario is similar to a back-casting scenario with no disturbance, where forest age advances but young forest is not produced.

There were differences between the amount of area defined as THLB (in the case of the Arrow TSA) or as cut (in the case of the Cranbrook and Invermere TSAs) in the timber supply analysis completed using Woodstock software[3] and the spatially defined location of THLB and cutblocks used to calculate the wildlife habitat ratings. Some spatially defined THLB polygons and cutblock polygons were only partially included in the THLB or as cutblocks in the timber supply models. Therefore, the amount of area of the THLB (for Arrow) and the amount of area cut (for Cranbrook and Invermere) was overestimated in the habitat ratings analysis relative to the timber supply, model. Consequently, the effect of forestry on habitat ratings was likely overestimated in the Cranbrook and Invermere habitat ratings models. A comparison between the amount of area cut in the timber supply model and the amount of area cut in the wildlife ratings models (i.e., polygons) indicated that on average, the area of simulated cut was 3.3% higher in the habitat ratings model than in the Woodstock timber supply model in the Cranbrook TSA and 28.5% higher in the habitat ratings model than in the Woodstock timber supply model in the Invermere TSA. A comparison between the Arrow THLB indicated the spatial THLB was 17.0% larger than the THLB as defined in Woodstock. These differences should be considered when evaluating results.

[3] Remsoft © www.remsoft.com

Table 1. Wildlife species, seasons and life history requirements for which habitat was rated in the Cranbrook, Invermere and Arrow timber supply areas (adapted from Tripp 2016).

Species (Code)	Season	Life History Requirement
Grizzly Bear	Early Spring	Food
	Late Spring	Food
	Summer	Food
	Fall	Food
Marten	Winter	Living - Food and Security/Thermal Habitat
Mule Deer	Winter	Food
		Security/Thermal
Rocky Mountain Elk	Winter	Food
		Security/Thermal
	Growing	Forage values in the growing season (model can be adjusted to account for early spring versus summer forage; current result output reflects early spring forage)
Northern Goshawk	Growing	Reproducing – Eggs (Nesting Habitat)
	Growing	Forage
Flammulated Owl	Growing	Reproducing – Eggs (Nesting Habitat)
Williamson's Sapsucker	Growing	Living – Food and Nesting

Table 2. Six class rating scheme (RIC 1999) used to quantify wildlife habitat value in the Cranbrook, Invermere and Arrow timber supply areas (adapted from Tripp 2016).

Class Code	Percent of Provincial Best (upper and lower limit)	Description	Quality
1	100% - 76%	High	Optimum
2	75% - 51%	Moderately High	Slightly less
3	50% - 26%	Moderate	Moderately less
4	25% - 6%	Low	Substantially less
5	5% - 1%	Very Low	Much less
6	0%	Nil	Habitat or attribute is absent

Results

Tripp (2016) provided a subjective assessment of the predictive accuracy of each set of habitat models for each wildlife species. In summary, mule deer models were assessed as having a moderate to high reliability, marten, flammulated owl and northern goshawk models were assessed as having a moderate reliability, and elk models were assessed as having a low to moderate reliability. No explicit assessments were provided for grizzly bear or Williamson's sapsucker, but based on the detailed description of the model assessment provided in Tripp (2016) they could be assessed as having moderate and low reliability, respectively. Models with a lower reliability should be considered as having greater uncertainty in their ability to predict habitat for the species.

The amount of forest area that was clearcut in a five year period (10 year period for the Arrow TSA) was relatively stable over the 100 year timber supply simulation period in each TSA (Fig. 1). There was a slight downward trend in the area clearcut in the Cranbrook and Arrow TSAs. The average area cut per five-year period was 21,319 ha (4,264 ha/year) in the Cranbrook TSA and 14,491 ha (2,898 ha/year) in the Invermere TSA, and the average area cut per ten-year period was 19,313 ha (1,931 ha/year) in the Arrow TSA. The annual area cut represented less than 0.3% of each TSA and approximately 1% of each THLB. Note that the area cut did not include selective harvest or partially cut cutblocks in the Cranbrook and Invermere TSAs, and is therefore slightly less than the area cut in the timber supply model.

Grizzly Bear

Early spring forage habitat for grizzly bears was predominantly (3,497,860 ha, or 86%) rated as low to nil suitability in the three TSAs (Table 3). However, there was insufficient habitat data to produce ratings for large portions of the Cranbrook and Invermere TSAs (19% and 14%, respectively). In the Cranbrook TSA, 78% (1,162,732 ha) of habitat was rated low to nil value suitability, and in the Cranbrook THLB, 90% (395,766 ha) of habitat was rated low to nil value suitability. In the Invermere TSA, 84% (937,678 ha) of habitat was rated low to nil value suitability, and in the Invermere THLB, 90% (241,985 ha) of habitat was rated low to nil value suitability. Large proportions of the Arrow TSA (95%) and THLB (97%) were rated low to nil value suitability. Across the three TSAs, less than 3% of early spring foraging habitat was rated moderate to high suitability and less than 6% was rated as moderate to high capability. Within the THLBs less than 2% of early spring foraging habitat was rated moderate to high suitability and 3% was rated as moderate to high capability.

Late spring forage habitat for grizzly bears was predominantly (3,335,911 ha, or 82%) rated as low to nil suitability in the three TSAs (Table 4). In the Cranbrook TSA, 75% (1,119,372 ha) of habitat was rated low to nil value suitability, and in the Cranbrook THLB, 89% (393,219 ha) of habitat was rated low to nil value suitability. In the Invermere TSA, 80% (893,207 ha) of habitat was rated low to nil value suitability, and in the Invermere THLB, 89% (241,802 ha) of habitat was rated low to nil value suitability. In the Arrow TSA, 90% (1,323,333 ha) of habitat was rated low to nil value suitability and 95% (193,496 ha) of THLB was rated low to nil value suitability. Across the three TSAs, 7% of late spring foraging habitat was rated moderate to high suitability and less than 11% was rated as moderate to high capability. Within the THLBs less than 3% of late spring foraging habitat was rated moderate to high suitability and less than 4% was rated as moderate to high capability.

Summer forage habitat for grizzly bears was predominantly (2,376,865 ha, or 59% of the area) rated as low to nil suitability in the three TSAs (Table 5). There were large differences in the amount and proportion of moderate to high suitability and capability summer foraging habitat between the Cranbrook, Invermere and Arrow TSAs. The Cranbrook TSA and THLB consisted of 26% (382,120 ha) and 27% (117,984 ha) moderate to high suitability summer foraging habitat, respectively, and 41% (604,322 ha) and 42% (185,160 ha) moderate to high capability summer foraging habitat, respectively. The Invermere TSA and THLB consisted of 16% (172,429 ha) and 5% (14,226 ha) moderate to high suitability summer foraging habitat, respectively, and 19% (216,353 ha) and 9% (24,243 ha) moderate to high capability summer foraging habitat, respectively. The Arrow TSA and THLB consisted of 47% (694,200 ha) and 45% (91,427 ha) moderate to high suitability summer foraging habitat, respectively, and 63% (925,983 ha) and 71% (143,705 ha) moderate to high capability summer foraging habitat, respectively. Across the three TSAs, 31% (1,248,749 ha) of summer foraging habitat was rated moderate to high suitability and 43% (1,746,658 ha) was rated as moderate to high capability.

Fall forage habitat for grizzly bears was mostly rated as low to nil suitability (60%; 2,437,580 ha) and capability (60%; 2,422,623 ha) habitat in the three TSAs (Table 6). However, the Arrow TSA had a larger amount and proportion of moderate to high suitability and capability fall forage habitat than the Cranbrook and Invermere TSAs. In the Cranbrook TSA, 57% (845,264 ha) of fall forage habitat was rated low to nil value suitability, and in the Cranbrook THLB, 66% (289,785 ha) of fall forage habitat was rated low to nil value suitability. In the Invermere TSA, 73% (816,507 ha) of fall forage habitat was rated low to nil value suitability, and in the Invermere THLB, 88% (236,745 ha) of fall forage habitat was rated low to nil value suitability. In the Arrow TSA, 53% (775,809 ha) of fall forage habitat was rated low to nil value suitability, and in the Arrow THLB, 56% (114,208 ha) fall forage habitat was rated low to nil value suitability. Across the three TSAs, 30% (1,188,034 ha) of summer foraging habitat was rated moderate to high suitability and 40% (1,640,876 ha) was rated as moderate to high capability. Across the three THLBs, 23% (211,861 ha) of summer foraging habitat was rated moderate to high suitability and 37% (334,066 ha) was rated as moderate to high capability.

The amount of grizzly bear early spring forage habitat remained relatively stable over the 100 year simulation period in the Cranbrook TSA, with and without forest harvest (Fig. 2). In the no harvest scenario, the amount of low rated habitat was slightly higher (approximately 30,000 ha) in the long-term compared to the forest harvest scenario. There was no change in higher rated (i.e., moderate to high) habitat. In the Invermere TSA forest harvest scenario, the amount of grizzly bear early spring food habitat was relatively stable over the 100-year harvest scenario (Fig. 3). In the no harvest scenario, the amount of low rated habitat was slightly higher (approximately 15,000 ha) in the long-term compared to the forest harvest scenario. In the Arrow TSA, the amount of grizzly bear early spring food habitat was essentially stable over the 100-year no-harvest and harvest scenarios (Fig. 4).

The amount of grizzly bear late spring food habitat remained relatively stable over the 100 year simulation period in the Cranbrook TSA, with and without forest harvest (Fig. 5). In the no harvest scenario, the amount of low rated habitat was slightly higher (approximately 20,000 ha) in the long-term than in the forest harvest scenario. In the Invermere TSA forest harvest scenario, the amount of grizzly bear late spring food habitat changed little over the long-term (Fig. 6). In the no harvest scenario, the amount of low rated habitat was slightly higher (approximately 15,000 ha) in the long-term than in the forest harvest scenario. In the Arrow TSA forest harvest scenario, the amount of grizzly bear late spring food habitat ratings was relatively stable over the long-term (Fig. 7). In the no harvest scenario, the amount of low rated habitat was slightly higher (approximately 15,000 ha) than in the forest harvest scenario in the long-term.

In the Cranbrook TSA, the amount of high rated grizzly bear summer food habitat remained relatively stable in the harvest and no-harvest scenarios (Fig. 8). The amount of moderately-high and moderate rated habitat increased gradually over time in the no-harvest scenario (approximately 20,000 ha for each). However, the amount of moderately-high and moderate habitat decreased approximately 20,000 ha for each in the harvest scenario. Thus, in the long term, forest harvest reduced the amount of moderately-high and moderate habitat by approximately 40,000 ha each. In the Invermere TSA, the amount of high rated grizzly bear summer food habitat remained relatively stable in the harvest and no-harvest scenarios (Fig. 9). In the forest harvest scenario, the amount of low rated habitat was approximately 40,000 ha less in the long term compared to the no harvest scenario. In the Arrow TSA, the amount of high rated grizzly bear summer food remained relatively stable in the harvest and no-harvest scenarios (Fig. 10). The amount of moderately-high and moderate rated habitat increased over the medium to long term in the no-harvest scenario (approximately 15,000 ha and 20,000 ha, respectively). However, the amount of moderately-high and moderate habitat decreased approximately 10,000 ha each in the harvest scenario. Thus, in the long term, forest harvest reduced the amount of moderately-high and moderate habitat by approximately 30,000 ha and 20,000 ha, respectively.

In the Cranbrook TSA, the amount of high rated grizzly bear fall food habitat remained relatively stable in the harvest and no-harvest scenarios (Fig. 11). The amount of moderately-high and moderate rated habitat increased gradually over the long-term in the no-harvest scenario (approximately 40,000 ha and 20,000 ha, respectively). However, the amount of moderately-high rated habitat remained relatively stable in the forest harvest scenario and the amount of moderate rated habitat decreased approximately 20,000 ha over the long term. Thus, in the long term, forest harvest reduced the amount of moderately-high and moderate rated habitat approximately 40,000 ha each. In the Invermere TSA forest harvest and no harvest scenarios, the amount of grizzly bear fall food habitat remained relatively stable over the long-term (Fig. 12). In the Arrow TSA, the amount of high rated grizzly bear fall food habitat remained relatively stable in the harvest and no-harvest scenarios (Fig. 13). The amount of moderately-high and moderate rated habitat increased gradually over the long-term in the no-harvest scenario (approximately 10,000 ha and 20,000 ha, respectively). However, the amount of moderately-high and moderate rated habitat decreased in the forest harvest scenario by approximately 5,000 ha and 20,000 ha, respectively, over the long-term. Thus, in the long-term, forest harvest reduced the amount of moderately-high and moderate rated habitat by approximately 15,000 ha and 35,000 ha, respectively.

Marten

Marten winter habitat was mostly rated as moderate to high suitability (52%; 2,109,420 ha) and capability (64%; 2,607,985 ha) in the three TSAs (Table 7). In the Cranbrook TSA, approximately one half of the TSA (53%; 793,533 ha) and THLB (49%; 214,540 ha) was rated as moderate to high suitability habitat. Similarly, slightly less than one half of the Invermere TSA (43%; 793,533 ha) and THLB (48%; 214,540 ha) was rated as moderate to high suitability habitat. The Arrow TSA and THLB had the highest proportion of moderate to high suitability marten winter habitat at 57% (831,900 ha) and 70% (142,051 ha), respectively.

In the Cranbrook TSA no harvest scenario, the amount of high and moderately-high rated marten winter habitat steadily increased by approximately 70,000 ha each in the long-term (Fig. 14). However, in the forest harvest scenario, the amount of high and moderately-high rated marten winter habitat decreased by approximately 20,000 ha each in the mid-term to long-term. Thus, forest harvest reduced the amount of high and moderately-high rated marten winter habitat by approximately 90,000 ha each over the long-term.

In the Invermere TSA no harvest scenario, the amount of high and moderately-high rated marten winter habitat steadily increased by approximately 30,000 ha and 70,000 ha, respectively, over the long-term (Fig. 15). However, in the forest harvest scenario, the amount of high and moderately-high rated marten winter habitat decreased by approximately 20,000 ha and 10,000 ha, respectively, in the mid-term to long-term. Therefore, forest harvest reduced the amount of high and moderately-high rated marten winter habitat by approximately 50,000 ha and 120,000 ha, respectively, over the long-term.

In the Arrow TSA no harvest scenario, the amount of high and moderately-high rated marten winter habitat steadily increased by approximately 30,000 ha and 40,000 ha, respectively, over the long-term (Fig. 16). However, in the forest harvest scenario, the amount of high and moderately-high rated marten winter habitat decreased by approximately 20,000 ha and 50,000 ha, respectively, in the mid-term to long-term. Therefore, forest harvest reduced the amount of high and moderately-high rated marten winter habitat by approximately 50,000 ha and 90,000 ha, respectively, over the long-term.

Elk

Elk winter forage habitat was predominantly rated as low to nil suitability (82%; 3,334,002 ha) and capability (84%; 3,425,173 ha) in the three TSAs (Table 8). In the Cranbrook TSA, 11% (158,120 ha) of the TSA was rated moderate to high suitability winter forage habitat and 18% (79,452 ha) of the THLB was rated moderate to high suitability forage habitat. Similarly, in the Invermere TSA 10% (110,112 ha) of the TSA was rated moderate to high suitability winter forage habitat and 20% (53,351 ha) of the THLB was rated moderate to high suitability winter forage habitat. In the Arrow TSA, less than 2% (23,637 ha) of the TSA was rated moderate to high suitability and 1% (2,524 ha) of the THLB was rated moderate to high suitability winter forage habitat.

Elk growing season (summer) forage habitat was predominantly rated as low to nil suitability (62%; 2,535,993 ha) and capability (65%; 2,625,523 ha) in the three TSAs (Table 9). In the Cranbrook TSA, 18% (273,054 ha) of the TSA was rated moderate to high suitability summer forage habitat and 24% (105,769 ha) of the THLB was rated moderate to high suitability summer forage habitat. The Invermere TSA had 34% (377,931 ha) of the TSA rated moderate to high suitability summer forage habitat and 59% (158,814 ha) of the THLB was rated moderate to high suitability summer forage habitat. In the Arrow

TSA, 30% (438,635) of the TSA and 37% (74,151 ha) of the THLB was rated moderate to high suitability elk summer forage habitat.

Similar to winter foraging habitat, elk winter cover habitat was predominantly rated as low to nil suitability (82%; 3,334,784 ha) and capability (78%; 3,171,457 ha) in the three TSAs (Table 10). In the Cranbrook TSA, 10% (146,451 ha) of the TSA was rated moderate to high suitability winter cover habitat and 18% (80,412 ha) of the THLB was rated moderate to high suitability winter cover habitat. The Invermere TSA had 9% (94,951 ha) of the TSA rated moderate to high suitability winter cover habitat and 16% (43,999 ha) of the THLB was rated moderate to high suitability winter cover habitat. In the Arrow TSA, 3% (49,427 ha) of the TSA and 3% (5,141 ha) of the THLB was rated moderate to high suitability winter cover habitat.

In the Cranbrook TSA, the amount of high rated elk winter food habitat remained close to 0 ha in the harvest and no forest harvest scenarios (Fig. 17). In the no harvest scenario, the amount of moderately-high rated habitat fluctuated in the mid-term and increased slightly (approximately 10,000 ha) in the long-term. However, in the forest harvest scenario the amount of moderately-high rated habitat decreased in the mid- and long-term by approximately 10,000 ha. Thus, forest harvest reduced the amount of moderately-high rated habitat by approximately 20,000 ha over the long-term.

In the Invermere TSA, the amount of high rated elk winter food habitat remained close to 0 ha in the harvest and no forest harvest scenarios (Fig. 18). In the no harvest scenario, the amount of moderately-high rated habitat increased steadily by approximately 15,000 ha over the long-term. However, in the harvest scenario the amount of moderately-high rated habitat decreased in the long-term by approximately 5,000 ha. Thus, forest harvest reduced the amount of moderately-high rated habitat by approximately 20,000 ha over the long-term.

In the Arrow TSA, the amount of high to moderate rated elk winter food habitat remained close to 0 ha and did not change in the harvest and no forest harvest scenarios (Fig. 19). In the no harvest scenario, the amount of low rated habitat increased steadily by approximately 20,000 ha over the long-term. In the forest harvest scenario, the amount of low rated habitat decreased by approximately 20,000 ha over the long-term. Thus, forest harvest reduced the amount of low rated habitat by approximately 40,000 ha over the long-term.

In the Cranbrook TSA, the amount of high to moderate rated elk winter cover habitat remained relatively stable in the no forest harvest scenario (Fig. 20). Similarly, the amount of high to moderate rated habtiat was stable in the forest harvest scenario. The main difference between the no harvest and harvest scenarios were a large conversion of the amount nil rated habitat to low rated habitat in the no harvest scenario that did not occur in the harvest scenario.

In the Invermere TSA no harvest scenario, the amount of high rated elk winter cover habitat increased by approximately 10,000 ha over the long term (Fig. 21). However, in the forest harvest scenario, the amount of high rated elk winter cover habitat essentially remained stable over the long-term. Therefore, forest harvest limited the amount of high rated habitat by approximately 10,000 ha over the long term.

In the Arrow TSA, the amount of high to moderate rated elk winter food habitat remained close to 0 ha and did not change in the harvest and no forest harvest scenarios (Fig. 22). In the no harvest scenario, the amount of low rated habitat increased steadily by approximately 20,000 ha over the long-term. In the forest harvest scenario, the amount of low rated habitat decreased by approximately 10,000 ha over the long-term. Thus, forest harvest reduced the amount of low rated habitat by approximately 30,000 ha over the long-term.

In the Cranbrook TSA, the amount of elk summer forage habitat remained relatively stable over the long-term in the no harvest and harvest scenarios (Fig. 23). There were few differences in the amount of habitat between the two scenarios.

In the Invermere TSA, the amount of elk summer forage habitat remained relatively stable over the long-term in the no harvest and harvest scenarios (Fig. 24). There was slightly more (approximately 10,000 ha) moderately-high rated habitat in the harvest scenario compared to the no harvest scenario over the long term.

In the Arrow TSA, the amount of elk summer forage habitat remained relatively stable over the long-term in the no harvest and harvest scenarios (Fig. 25). There were few differences in the amount of habitat between the two scenarios.

Mule Deer

Mule deer winter forage habitat was mostly rated as low to nil suitability (83%; 3,357,399 ha) and capability (87%; 3,532,834 ha) in the three TSAs (Table 11). In the Cranbrook TSA, 11% (158,349 ha) of the TSA was rated moderate to high suitability summer forage habitat and 18% (78,075 ha) of the THLB was rated moderate to high suitability summer forage habitat. The Invermere TSA had 9% (102,049 ha) of the TSA rated moderate to high suitability winter forage habitat and 19% (51,089 ha) of the THLB was rated moderate to high suitability winter forage habitat. However, the vast majority of winter forage habitat was moderately rated at best. Almost none of the Arrow TSA (<1%; 7,817 ha) and THLB (<1%; 714 ha) had moderate to high suitability winter forage habitat for mule deer, and only 2% (33,065 ha) of the habitat was rated as moderate to high capability.

Mule deer winter cover habitat was mostly rated as low to nil suitability (82%; 3,341,807 ha) and capability (86%; 3,492,465 ha) in the three TSAs (Table 12). In the Cranbrook TSA, 10% (146,431 ha) of the TSA was rated moderate to high suitability winter security habitat and 18% (80,410 ha) of the THLB was rated moderate to high suitability winter security habitat (of which the majority, 75,975 ha, was rated high). In the Invermere TSA, 8% (93,657 ha) of the TSA was rated moderate to high suitability winter security habitat and 16% (43,344 ha) of the THLB was rated moderate to high suitability winter security habitat. In the Arrow TSA, 3% (36,510 ha) of the TSA was rated moderate to high suitability winter security habitat and 2% (4,777 ha) of the THLB was rated moderate to high suitability winter security habitat.

In the Cranbrook TSA, the amount of mule deer winter forage habitat remained relatively stable over the long-term in the no harvest and forest harvest scenarios (Fig. 26). There was a more cyclical pattern in the amount of moderately-high and moderate habitat in the harvest scenario compared to the no harvest scenario, but the differences between the amount of habitat in the two scenarios were relatively small (i.e., approximately 5,000 ha).

In the Invermere TSA no harvest scenario, the amount of high and moderately-high rated mule deer winter forage habitat remained stable over the long-term (Fig. 27). However, in the forest harvest scenario the amount of moderate rated habitat increased by approximately 5,000 ha. Conversely, in the forest harvest scenario, the amount of moderately-high rated habitat increased by approximately 5,000 ha in the long term.

In the Arrow TSA, the amount of high to moderate rated mule deer winter forage habitat remained stable over the long-term in the harvest and no harvest scenarios (Fig. 28). In the no harvest scenario, the amount of low rated habitat increased approximately 10,000 ha over the long term. However, in the forest harvest scenario, the amount of low rated habitat decreased approximately 10,000 ha over the long term.

In the Cranbrook TSA, the amount of high to moderate rated mule deer winter cover habitat remained relatively stable over the long-term in the forest harvest and no harvest scenarios (Fig. 29). There was little difference between the harvest and no harvest scenarios, except for approximately 40,000 ha less low rated habitat over the long-term in the harvest compared to no harvest scenario.

In the Invermere TSA no harvest scenario, the amount of high and moderately high rated mule deer winter cover habitat increased by approximately 10,000 ha and 5,000 ha, respectively, over the long-term (Fig. 30). However, in the forest harvest scenario the amount of high and moderately high rated habitat remained stable over the long-term. Thus, forest harvest reduced the amount of high and moderately high rated habitat by approximately 15,000 ha total over the long-term.

In the Arrow TSA, the amount of high to moderate rated mule deer winter cover habitat remained relatively stable over the long-term in the forest harvest and no harvest scenarios (Fig. 31). The amount of low rated habitat increased in the no harvest scenario, but decreased in the forest harvest scenario.

Northern Goshawk

Northern goshawk nesting habitat was mostly rated as low to nil suitability (69%; 2,672,471 ha) and capability (60%; 2,417,547 ha) in the three TSAs (Table 13). In the Cranbrook TSA, 27% (393,961 ha) of the TSA was rated moderate to high suitability nesting habitat and 50% (218,440 ha) of the THLB was rated moderate to high suitability nesting habitat. In the Invermere TSA, 22% (245,457 ha) of the TSA was rated moderate to high suitability nesting habitat and 45% (122,776 ha) of the THLB was rated moderate to high suitability nesting habitat. In the Arrow TSA, 37% (543,805 ha) of the TSA was rated moderate to high suitability nesting habitat and 53% (107,503 ha) of the THLB was rated moderate to high suitability nesting habitat.

Northern goshawk foraging habitat was mostly rated as moderate to high suitability (76%; 3,104,964 ha) and capability (86%; 3,489,842 ha) in the three TSAs (Table 14). In the Cranbrook TSA, 74% (1,093,912 ha) of the TSA was rated moderate to high suitability foraging habitat and almost the entire THLB (91%; 401,958 ha) was rated moderate to high suitability foraging habitat. In the Invermere TSA, 52% (573,912 ha) of the TSA was rated moderate to high suitability foraging habitat and 80% (215,622 ha) of the THLB was rated moderate to high suitability foraging habitat. In the Arrow TSA, 98% (1,437,140 ha) of the TSA was rated moderate to high suitability foraging habitat and 100% (203,395 ha) of the THLB was rated moderate to high suitability foraging habitat.

In the Cranbrook TSA no harvest scenario, the amount of high rated northern goshawk nesting habitat steadily increased from approximately 80,000 ha to approximately 170,000 ha over the long-term (Fig. 32). Similarly, the amount of moderately-high rated habitat increased from approximately 110,000 ha to approximately 140,000 ha. The amount of moderate rated habitat declined to 0 ha over the long-term and the amount of nil and very low rated habitat declined to 0 ha over the mid-term. Conversely, in the forest harvest scenario, the amount of high rated habitat steadily decreased from approximately 80,000 ha to approximately 45,000 ha over the long-term. The amount of moderately-high rated habitat decreased to approximately 50,000 ha in the mid-term but increased to approximately 110,000 ha over the long-term. Moderate rated habitat also increased to approximately 50,000 ha in the long-term. Thus, forest harvest reduced the amount of high rated northern goshawk nesting habitat by approximately 100,000 ha and reduced the amount of moderately-high rated habitat by approximately 40,000 ha over the long-term.

In the Invermere TSA forest harvest scenario, the amount of high rated northern goshawk nesting habitat steadily decreased from approximately 40,000 ha to approximately 10,000 ha over the long-term (Fig. 33). In addition, the amount of moderately high rated habitat decreased by approximately 25,000 ha over the mid-term and 5,000 ha over the long term. Conversely, in the no harvest scenario, the amount of high and moderately high rated habitat increased by approximately 40,000 ha and 55,000 ha, respectively. Therefore, forest harvest reduced the amount of high rated northern goshawk nesting habitat by approximately 100,000 ha and reduced the amount of high and moderately-high rated habitat by approximately 70,000 ha and 60,000 ha, respectively, over the long-term.

In the Arrow TSA forest harvest scenario, the amount of high rated northern goshawk nesting habitat decreased by approximately 50,000 ha, but the amount of moderately high rated habitat increased by approximately 40,000 ha over the long term (Fig. 34). Conversely, in the no harvest scenario, the amount of high rated habitat increased by approximately 50,000 ha and the amount of moderately high rated habitat decreased to 0 ha over the long term. Therefore, forest harvest reduced the amount of high rated habitat by approximately 110,000 ha over the long term.

In the Cranbrook TSA no harvest scenario, the amount of high rated northern goshawk foraging habitat increased from approximately 310,000 ha to 440,000 ha, while moderate rated habitat decreased to 0 ha over the mid-term (Fig. 35). In contrast, in the forest harvest scenario, high rated habitat decreased to approximately 190,000 ha over the mid-term and returned to approximately 310,000 ha over the long-term. Thus, forest harvest limited the amount of high rated northern goshawk foraging habitat by approximately 150,000 ha over the long-term.

In the Invermere TSA no forest harvest scenario, the amount of high rated northern goshawk foraging habitat increased by approximately 65,000 ha over the mid and long-term (Fig. 36). However, in the forest harvest scenario, the amount of high rated habitat fluctuated in the short to mid-term, but remained relatively stable over the long-term. Thus, forest harvest limited the amount of high rated northern goshawk foraging habitat by approximately 100,000 ha.

In the Arrow TSA no forest harvest scenario, the amount of high rated northern goshawk foraging habitat increased by approximately 50,000 ha over the mid- and long-term (Fig. 37). However, in the forest harvest scenario, the amount of high rated habitat decreased in the mid- to long-term by approximately 25,000 ha. Thus, forest harvest limited the amount of high rated northern goshawk foraging habitat by approximately 75,000 ha.

Williamson's Sapsucker

There was no moderate to high suitability and little moderate to high capability (9%; 271,935 ha) Williamson's sapsucker habitat in the three TSAs (Table 15). The highest habitat suitability or capability rating was moderate, and that was entirely in the Cranbrook TSA (271,935 ha), with over half of that habitat represented within the Cranbrook THLB (152,027 ha).

In the Cranbrook TSA, the amount of Williamson's sapsucker habitat remained stable over the long-term in the harvest and no harvest scenarios (Fig. 38). In the Invermere (Fig. 39) and Arrow (Fig. 40) TSAs, Williamson's sapsucker habitat ratings remained at nil throughout the 100-year harvest and no-harvest scenarios.

Flammulated Owl

Flammulated owl habitat was mostly rated as low to nil suitability (96%; 3,881,950 ha) and capability (75%; 3,741,116 ha) in the three TSAs (Table 16). In the Cranbrook TSA, 7% (101,085 ha) of the TSA was rated moderate to high suitability foraging habitat and 12% (52,657 ha) of the THLB was rated moderate to high suitability habitat. In the Invermere TSA, 7% (80,719 ha) of the TSA was rated moderate to high suitability foraging habitat whereas 14% (37,613 ha) of the THLB was rated moderate to high suitability foraging habitat. There was no flammulated owl habitat in the Arrow TSA.

In the Cranbrook TSA no forest harvest scenario, the amount of high and moderately-high rated flammulated owl habitat remained stable over the long-term (Fig. 41). However, the amount of moderate rated habitat increased steadily from approximately 50,000 ha to approximately 80,000 ha over the long-term. Conversely, in the harvest scenario, the amount of moderate rated habitat decreased approximately 25,000 ha over the long-term. Thus, forest harvest limited the amount of moderate rated habitat by approximately 55,000 ha over the long-term.

In the Invermere TSA forest harvest scenario, the amount of high rated flammulated owl habitat remained stable over the long-term, but the amount of moderately high rated habitat increased by approximately 15,000 ha over the long term (Fig. 42). In the no harvest scenario, the amount of moderately high rated habitat decreased approximately 10,000 ha over the long term. Thus, forest harvest limited the amount of high rated flammulated owl habitat by approximately 30,000 ha over the long term. Flammulated owl habitat ratings remained at nil throughout the 100-year harvest and no-harvest scenarios in the Arrow TSA (Fig. 43).

Table 3. Area (hectares) of grizzly bear early spring forage habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	4,564	1,617	6,059	1,340	1,945	123
2 (moderately high)	10,390	2,282	32	20	17,950	2,355
3 (moderate)	23,642	2,301	16,023	3,894	47,148	2,980
4 (low)	117,556	45,450	175,923	53,244	122,213	16,436
5 (very low)	761,853	346,788	468,693	185,934	765,290	167,406
6 (nil)	283,323	3,527	293,062	2,806	509,947	14,094
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	10,054	1,908	6,603	1,486	1,945	123
2 (moderately high)	14,897	3,748	7,993	885	21,041	2,525
3 (moderate)	27,806	5,165	53,727	5,286	76,568	6,968
4 (low)	187,344	69,275	219,209	89,958	127,870	20,944
5 (very low)	926,796	357,474	496,505	170,104	727,122	158,741
6 (nil)	318,101	3,581	329,972	2,833	509,947	14,094
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,552	1,464,493	203,395

Table 4. Area (hectares) of grizzly bear late spring forage habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	11,387	2,524	6,197	1,340	4,333	312
2 (moderately high)	8,462	2,085	37	20	27,787	3,840
3 (moderate)	62,108	4,137	60,352	4,076	109,041	5,746
4 (low)	152,397	57,142	175,102	53,641	227,903	27,079
5 (very low)	760,106	333,872	609,341	186,409	853,246	164,131
6 (nil)	206,868	2,204	108,764	1,751	242,183	2,286
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	17,319	2,883	13,675	1,680	4,333	312
2 (moderately high)	14,927	3,623	4,002	730	30,883	4,011
3 (moderate)	71,331	7,079	133,466	5,598	143,805	9,777
4 (low)	275,508	87,080	204,146	90,479	347,573	52,445
5 (very low)	899,045	338,283	649,955	170,314	695,717	134,564
6 (nil)	206,868	2,204	108,764	1,751	242,183	2,286
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 5. Area (hectares) of grizzly bear summer forage habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	8,565	2,837	2,779	45	29,499	4,338
2 (moderately high)	117,339	33,079	45,653	2,846	205,329	24,490
3 (moderate)	256,217	82,068	123,998	11,335	459,372	62,599
4 (low)	476,033	197,017	581,474	189,988	510,045	102,747
5 (very low)	142,974	84,761	97,125	41,273	78,348	8,504
6 (nil)	200,202	2,204	108,764	1,751	181,900	716
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	82,477	20,595	9,785	350	161,131	17,544
2 (moderately high)	159,953	52,047	55,681	4,476	168,351	25,619
3 (moderate)	361,892	112,518	150,888	19,416	596,500	100,542
4 (low)	523,419	177,021	759,480	242,198	336,592	58,909
5 (very low)	157,055	76,765	29,411	2,360	20,018	64
6 (nil)	200,202	2,204	108,764	1,751	181,900	716
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 6. Area (hectares) of grizzly bear fall forage habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	4,619	1,757	0	0	16,126	1,778
2 (moderately high)	74,551	14,173	42,795	269	182,172	21,165
3 (moderate)	276,895	96,250	100,490	10,225	490,386	66,244
4 (low)	496,728	200,522	639,230	212,062	515,002	104,973
5 (very low)	148,334	87,059	68,513	22,931	78,907	8,519
6 (nil)	200,202	2,204	108,764	1,751	181,900	716
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	32,190	8,988	11	2	40,920	3,781
2 (moderately high)	166,472	56,582	52,596	1,078	279,710	37,908
3 (moderate)	386,289	118,451	118,521	20,065	564,167	87,211
4 (low)	539,897	177,975	804,709	245,298	377,281	73,704
5 (very low)	159,948	76,951	29,407	2,358	20,515	75
6 (nil)	200,202	2,204	108,764	1,751	181,900	716
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 7. Area (hectares) of marten winter habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	285,031	57,284	185,206	32,430	218,763	31,834
2 (moderately high)	220,923	72,973	211,107	68,742	346,639	81,535
3 (moderate)	287,579	84,283	87,674	27,848	266,498	28,683
4 (low)	351,646	188,381	253,048	116,610	224,508	52,279
5 (very low)	44,342	29,719	16,278	9,997	27,722	4,299
6 (nil)	295,476	8,512	360,951	14,931	380,364	4,766
No Data	0	0	0	0	0	0
Capability						
1 (high)	413,872	122,385	238,904	59,215	341,602	59,471
2 (moderately high)	312,380	136,389	298,908	133,573	562,093	121,752
3 (moderate)	185,783	33,839	43,613	10,303	210,830	15,174
4 (low)	274,737	143,399	174,554	56,098	44,831	4,535
5 (very low)	7,683	932	2,642	424	4,161	686
6 (nil)	290,543	4,207	355,644	10,948	300,977	1,777
No Data	1,484,998	441,151	1,114,265	270,559	1,464,493	203,395
Total Area (hectares)	285,031	57,284	185,206	32,430	218,763	31,834

Table 8. Area (hectares) of elk winter forage habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	5,377	365	0	0	0	0
2 (moderately high)	49,520	25,951	18556.05	6,778	261	3
3 (moderate)	103,223	53,137	91556.3	46,573	23,376	2,521
4 (low)	164,605	90,105	197,681	115,392	448,840	97,301
5 (very low)	175,546	102,359	40,810	16,802	261,202	38,622
6 (nil)	703,058	130,049	611,445	61,701	730,815	64,947
No Data	283,668	23,314	154,216	23,314	0	0
Capability						
1 (high)	7,793	393	4,149	2,433	0	0
2 (moderately high)	149,282	76,113	128,354	57,832	468	3
3 (moderate)	111,463	39,435	188,994	108,412	48,078	4,809
4 (low)	362,635	185,420	67,607	35,274	503,709	113,912
5 (very low)	18,714	2,749	34,592	4,980	181,422	19,723
6 (nil)	835,109	137,042	690,570	61,628	730,815	64,947
No Data	1,484,996	441,151	1,114,265	270,559	1,464,493	203,395
Total Area (hectares)	5,377	365	0	0	0	0

Table 9. Area (hectares) of elk growing season forage habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	21,762	378	3,022	46	10,244	52
2 (moderately high)	98,063	36,708	33499.58	5,286	49,528	629
3 (moderate)	153,229	68,684	341409.3	153,481	378,863	73,470
4 (low)	735,067	294,239	403,247	83,316	827,199	128,527
5 (very low)	17,805	201	85,949	4,733	39,630	547
6 (nil)	175,402	1,756	92,665	375	159,029	170
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	21,762	378	3,022	46	10,244	52
2 (moderately high)	189,265	78,028	141,673	56,250	78,144	3,452
3 (moderate)	159,684	55,194	307,330	125,072	526,852	108,393
4 (low)	915,809	305,511	481,558	83,845	650,617	90,780
5 (very low)	23,075	283	87,760	4,964	39,607	547
6 (nil)	175,402	1,756	92,665	375	159,029	170
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 10. Area (hectares) of elk winter cover habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	36,374	15,017	4,192	2,710	0	0
2 (moderately high)	101,927	61,282	88,748	40,598	41	4
3 (moderate)	8,150	4,113	2,011	691	49,386	5,137
4 (low)	276,498	158,877	212,480	123,141	487,773	108,545
5 (very low)	187,845	73,703	2,391	452	107,839	16,385
6 (nil)	590,535	88,974	649,970	79,646	819,454	73,325
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	202,766	94,637	144,123	61,052	0	0
2 (moderately high)	9,318	4,312	0	0	39,770	5,221
3 (moderate)	313,870	160,335	166,704	104,152	15,491	390
4 (low)	75,208	41,991	71,331	37,448	555,993	128,601
5 (very low)	248,412	81,535	245,602	56,125	111,809	13,650
6 (nil)	635,425	58,341	486,248	11,775	741,430	55,534
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 11. Area (hectares) of mule deer winter forage habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	10,447	514	0	0	0	0
2 (moderately high)	55,413	31,620	6,786	2,518	188	-
3 (moderate)	92,489	45,941	95,263	48,571	7,629	714
4 (low)	110,484	68,719	175,536	102,497	342,710	72,256
5 (very low)	307,491	159,184	68,124	31,755	400,864	75,446
6 (nil)	625,005	95,988	614,083	61,898	713,102	54,978
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	10,447	514	4,149	2,433	0	0
2 (moderately high)	145,946	72,887	118,029	52,921	233	0
3 (moderate)	69,947	25,067	149,082	85,531	32,832	3,300
4 (low)	154,006	82,187	80,730	43,080	361,248	75,858
5 (very low)	367,813	159,309	121,080	33,200	357,078	69,259
6 (nil)	736,840	101,188	640,938	53,387	713,102	54,978
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 12. Area (hectares) of mule deer winter cover habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	136,476	75,975	203	86	0	0
2 (moderately high)	1,825	324	88,748	40,598	0	0
3 (moderate)	8,130	4,111	4,706	2,661	36,510	4,777
4 (low)	236,423	146,006	168,176	98,496	446,843	96,756
5 (very low)	225,430	86,474	47,895	25,751	154,478	28,173
6 (nil)	593,044	89,076	650,064	79,647	819,454	73,325
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	202,766	94,637	134,467	56,288	0	0
2 (moderately high)	1,672	266	0	0	7,822	381
3 (moderate)	8,268	4,308	176,266	108,915	39,773	5,221
4 (low)	384,608	201,854	73,347	37,612	511,946	114,487
5 (very low)	249,713	81,643	243,587	55,961	163,523	27,772
6 (nil)	637,970	58,443	486,342	11,776	741,430	55,534
No Data	-	-	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 13. Area (hectares) of northern goshawk nesting habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	167,589	81,731	104,926	46,494	416,405	91,649
2 (moderately high)	177,956	103,766	118,009	63,322	126,851	15,853
3 (moderate)	48,417	32,942	22,523	12,960	549	0
4 (low)	427,411	117,033	316,294	78,715	419,149	52,760
5 (very low)	28,153	20,321	24,741	16,705	35,460	14,048
6 (nil)	427,411	85,357	527,773	52,363	466,079	29,085
No Data	0	0	0	0	0	0
Capability						
1 (high)	356,937	170,542	191,229	88,746	667,844	136,599
2 (moderately high)	239,919	131,264	179,749	111,277	10,531	-
3 (moderate)	0	0	0	0	0	0
4 (low)	587,985	135,133	399,982	64,409	484,304	65,399
5 (very low)	0	0	0	0	0	0
6 (nil)	300,156	4,212	343,306	6,127	301,814	1,397
No Data	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395
Total Area (hectares)	167,589	81,731	104,926	46,494	416,405	91,649

Table 14. Area (hectares) of northern goshawk foraging habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	938,764	312,747	444,264	139,333	1,034,205	149,178
2 (moderately high)	0	0	0	0	0	0
3 (moderate)	155,148	89,211	129,647	76,289	402,935	54,217
4 (low)	0	0	0	0	0	0
5 (very low)	0	0	270,718	31,616	0	0
6 (nil)	107,417	8	115,162	0	27,354	-
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	1,331,726	439,478	649,924	236,348	1,292,426	202,985
2 (moderately high)	0	0	0	0	0	0
3 (moderate)	45,855	1,665	25,198	285	144,714	410
4 (low)	0	0	0	0	0	0
5 (very low)	0	0	323,724	33,919	0	0
6 (nil)	107,417	8	115,162	0	27,354	0
No Data	0	0	257	7	0	0
Total Area (hectares)	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395

Table 15. Area (hectares) of Williamson's sapsucker food and nesting habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	0	0	0	0	0	0
2 (moderately high)	0	0	0	0	0	0
3 (moderate)	0	0	0	0	0	0
4 (low)	0	0	0	0	0	0
5 (very low)	30,932	13,320	4,013	2,644	0	0
6 (nil)	1,170,396	388,645	955,779	244,595	1,464,493	203,395
No Data	283,668	39,186	154,473	23,321	0	0
Capability						
1 (high)	0	0	0	0	0	0
2 (moderately high)	0	0	0	0	0	0
3 (moderate)	271,935	152,027	0	0	0	0
4 (low)	57,174	29,480	0	0	0	0
5 (very low)	52,153	19,004	8,007	3,951	0	0
6 (nil)	1,103,735	240,641	257	7	1,464,493	203,395
No Data	1,484,997	441,151	1,114,265	270,559	1,464,493	203,395
Total Area (hectares)	0	0	0	0	0	0

Table 16. Area (hectares) of flammulated owl nesting habitat by suitability and capability class in the Cranbrook, Invermere and Arrow timber supply area (TSAs) and timber harvest land base (THLB).

	CRANBROOK		INVERMERE		ARROW	
Suitability	TSA	THLB	TSA	THLB	TSA	THLB
1 (high)	1,176	269	10,758	4,326	0	0
2 (moderately high)	4,994	2,223	39,822	20,557	0	0
3 (moderate)	94,915	50,165	30,139	12,731	0	0
4 (low)	126,283	74,802	82,954	42,259	0	0
5 (very low)	50,375	38,757	59,296	43,719	0	0
6 (nil)	1,207,254	274,935	891,295	42,259	1,464,493	203,395
No Data	0	0	0	0	0	0
Capability						
1 (high)	2,127	389	13,352	5,544	0	0
2 (moderately high)	20,535	6,596	74,434	40,370	0	0
3 (moderate)	169,949	84,548	42,244	11,908	0	0
4 (low)	207,196	116,915	148,692	90,332	0	0
5 (very low)	260	5	1,914	825	0	0
6 (nil)	1,084,930	232,699	833,631	121,582	1,464,493	203,395
No Data	1,484,997	441,151	1,114,267	270,559	1,464,493	203,395
Total Area (hectares)	1,176	269	10,758	4,326	0	0

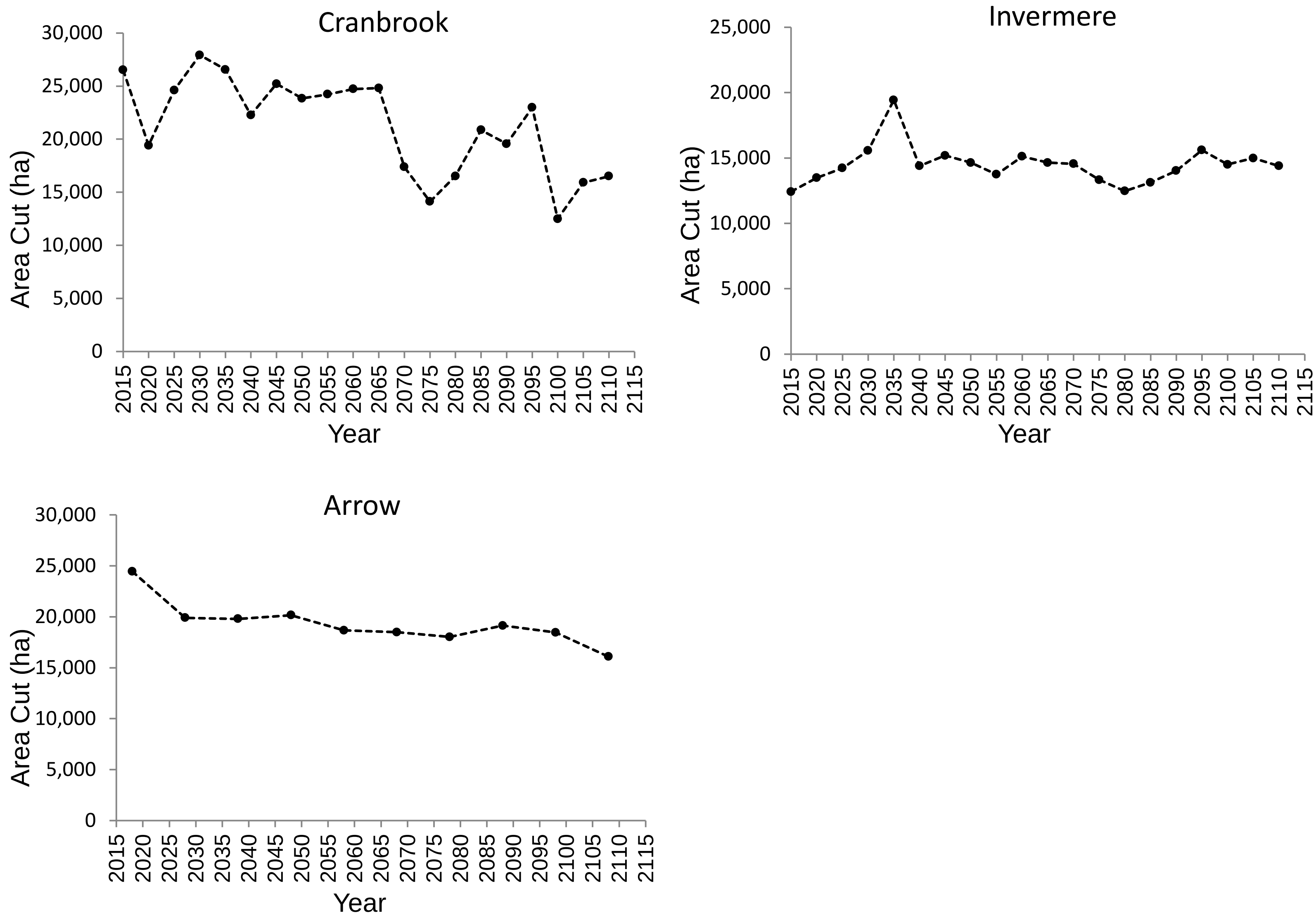
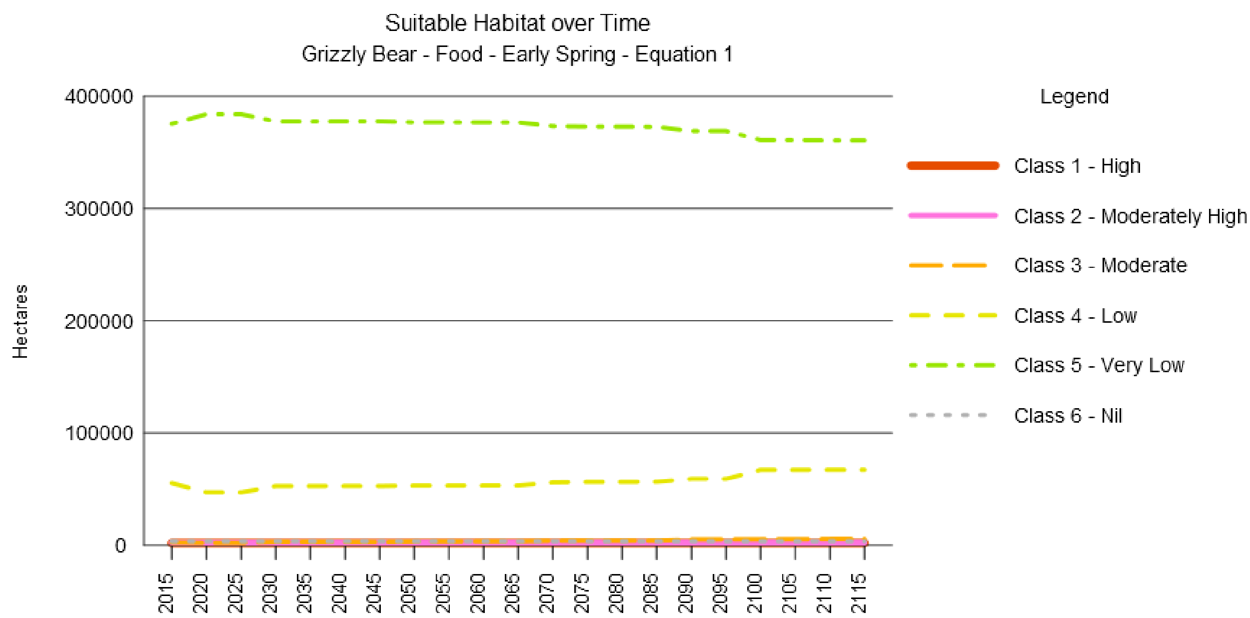


Figure 1. Area of forest that was clearcut over five year periods in the Cranbrook and Invermere timber supply areas (TSAs) and over 10 year periods in the Arrow TSA.



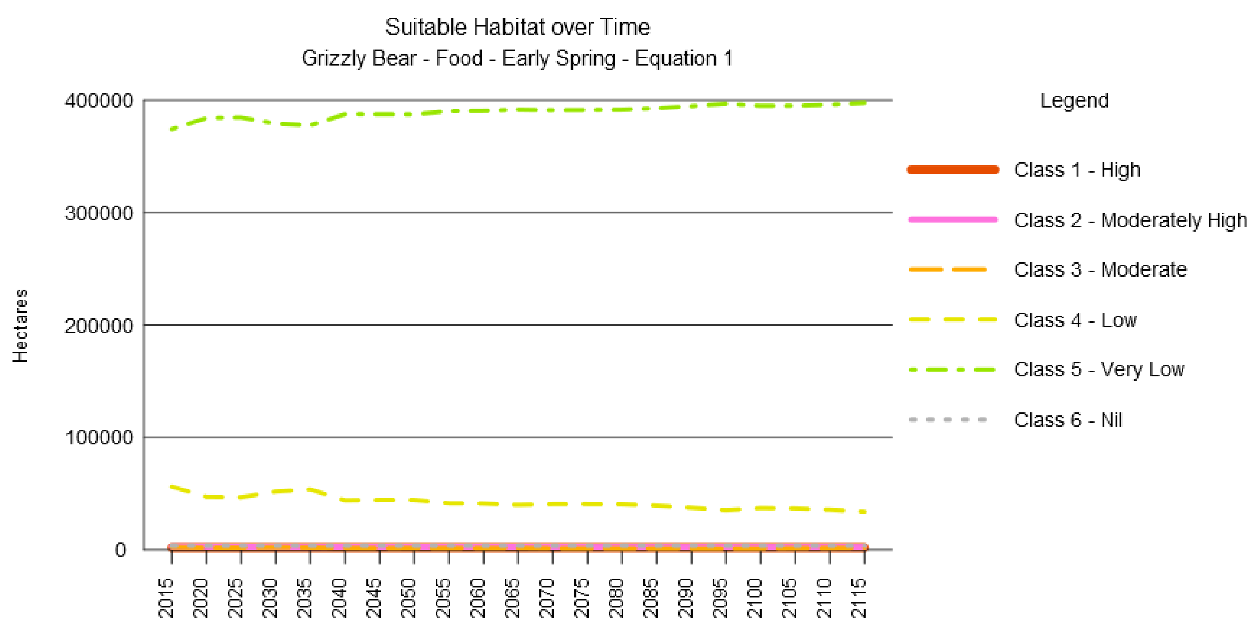
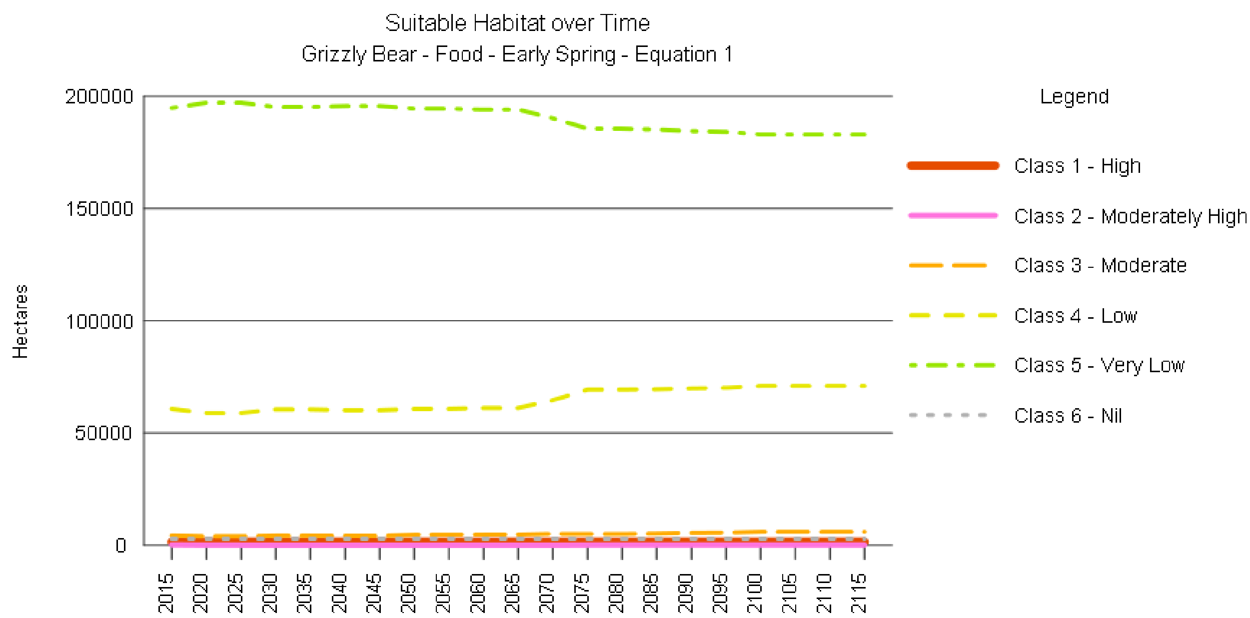


Figure 2. Grizzly bear early spring food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



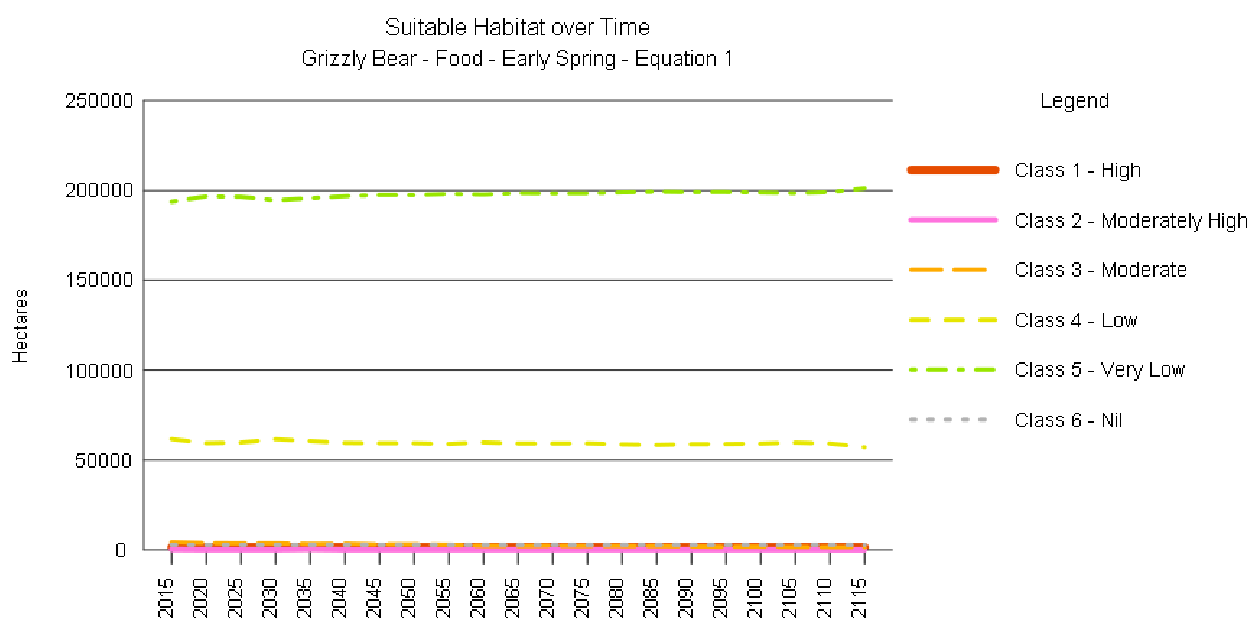
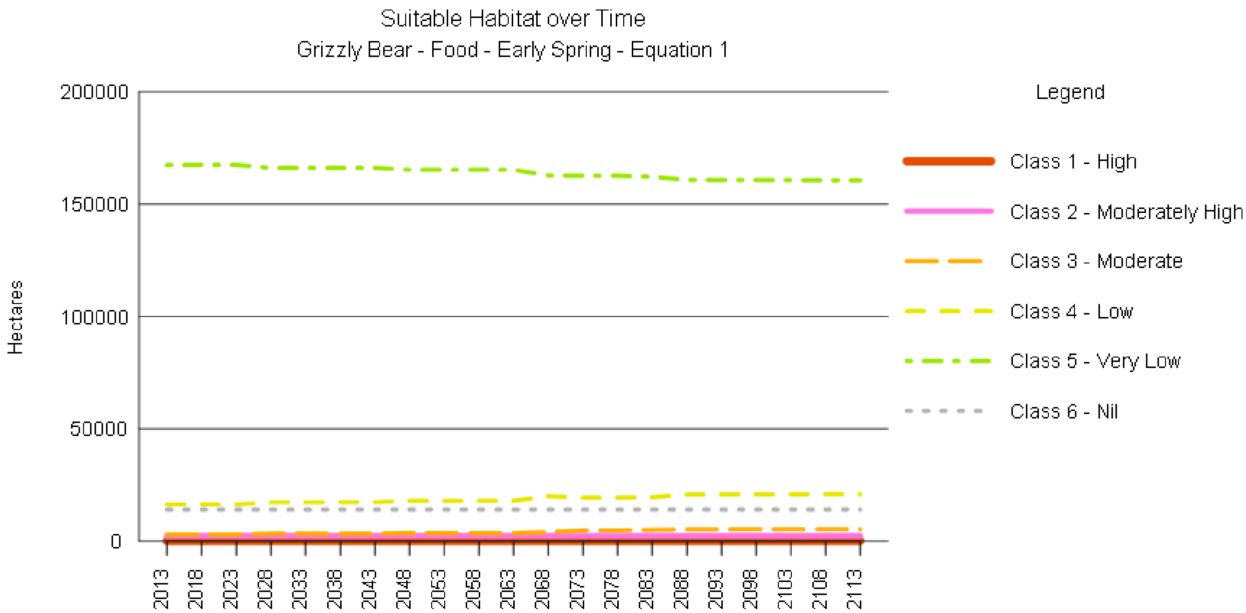


Figure 3. Grizzly bear early spring food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



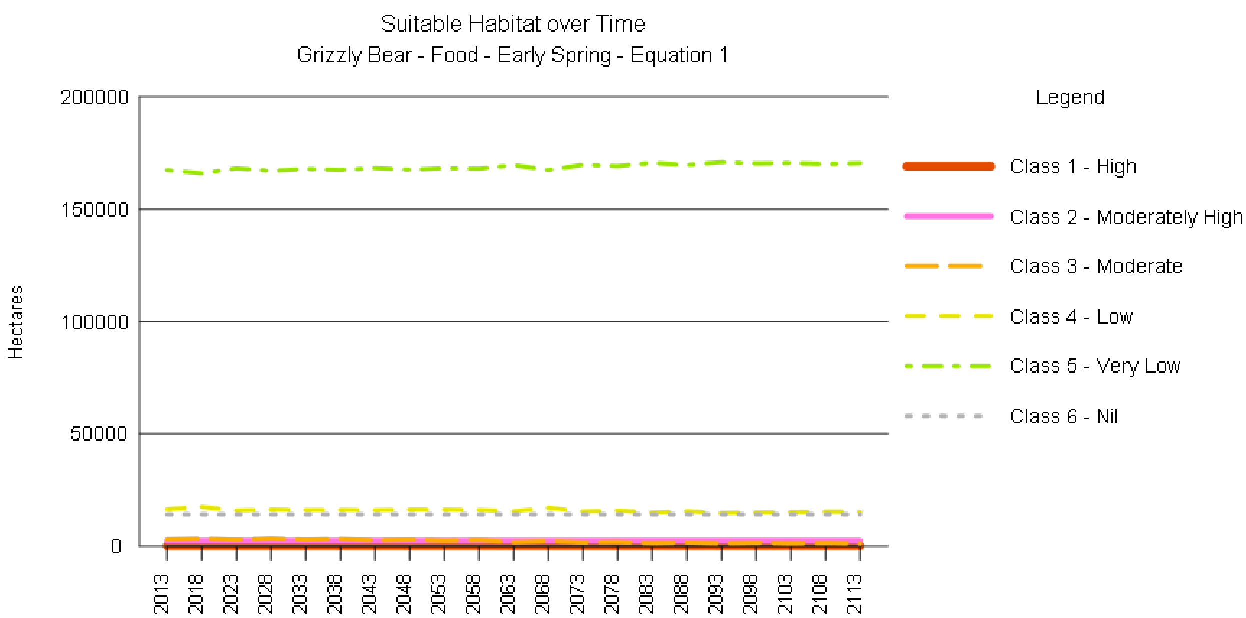
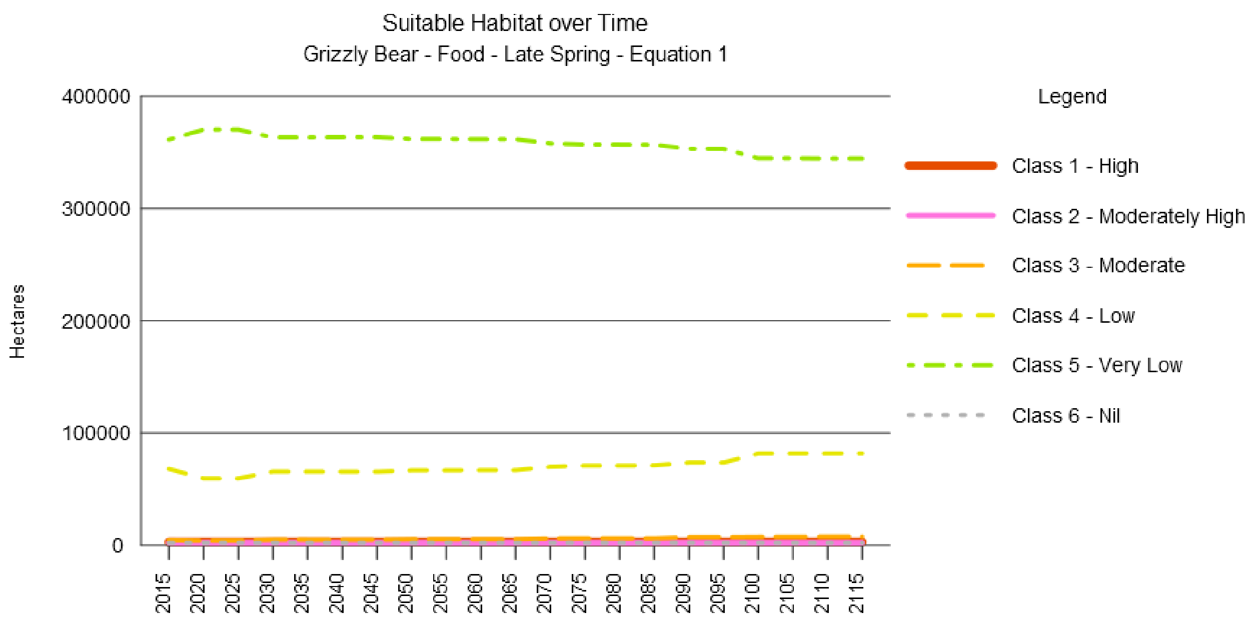


Figure 4. Grizzly bear early spring food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



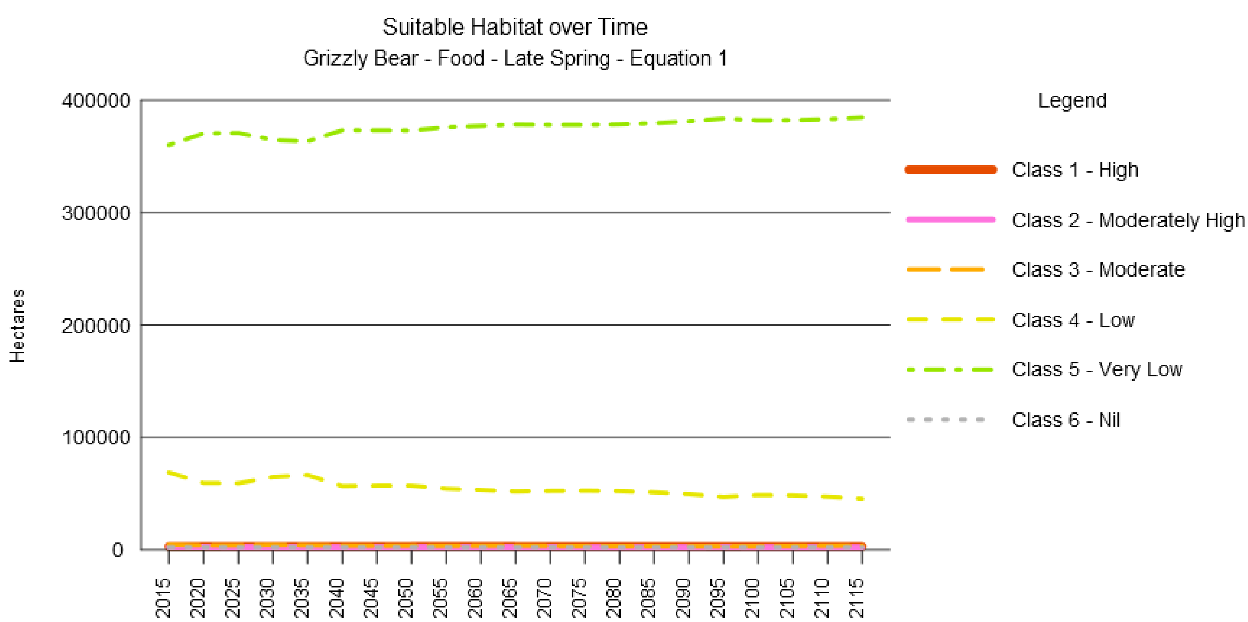
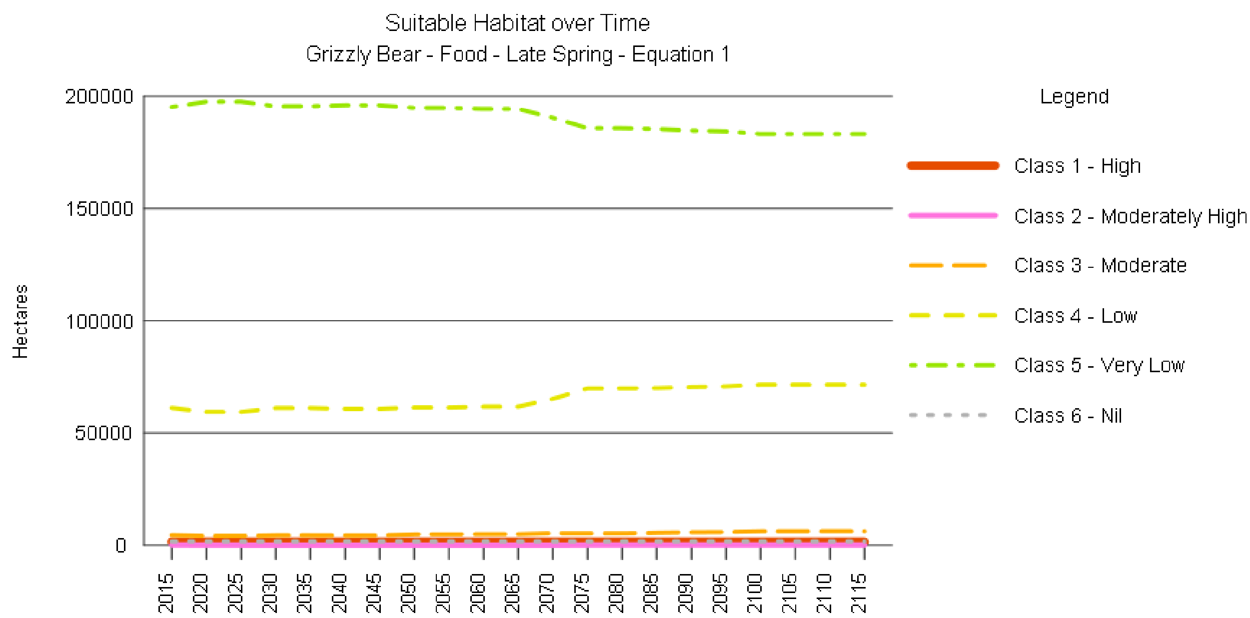


Figure 5. Grizzly bear late spring food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



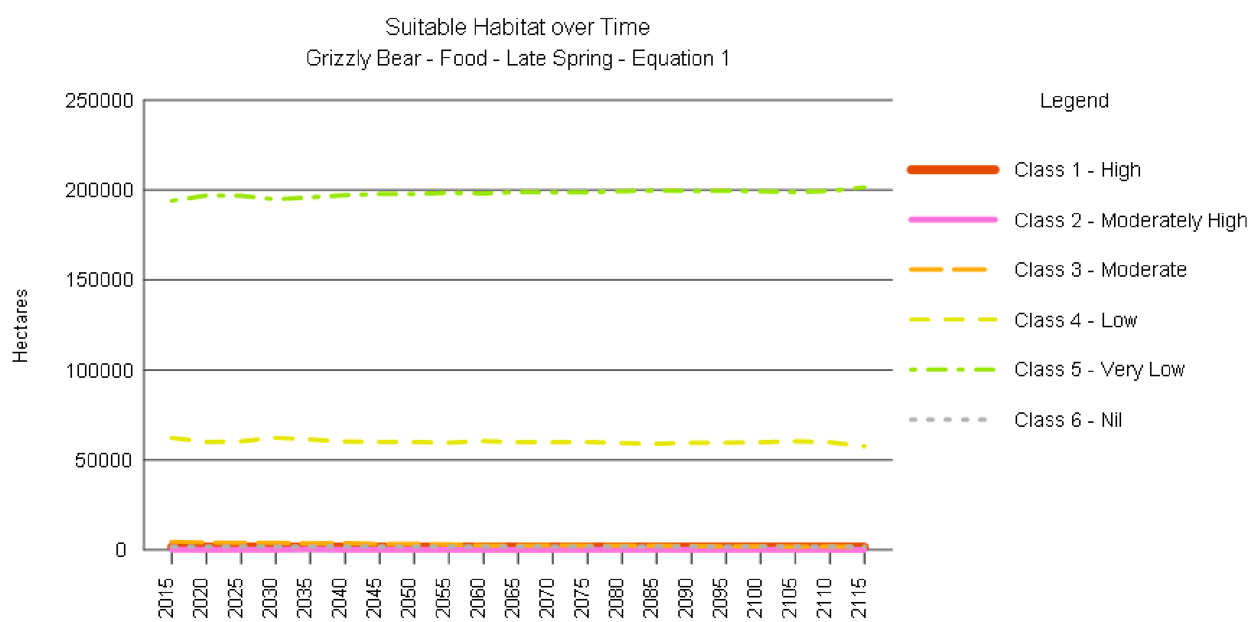
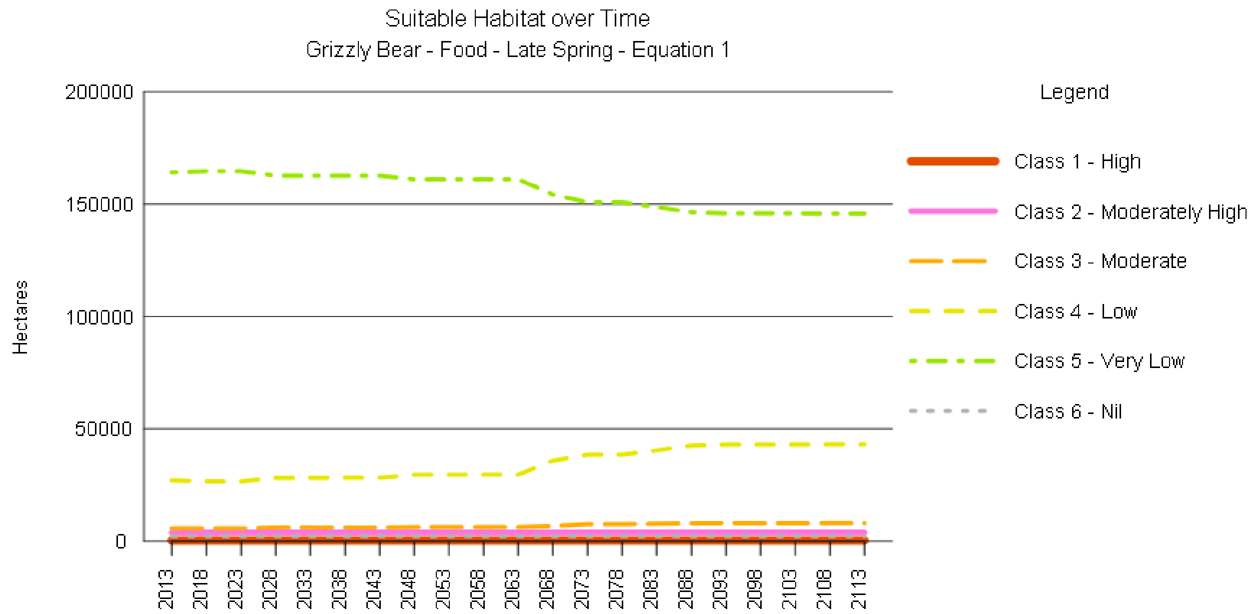


Figure 6. Grizzly bear late spring food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



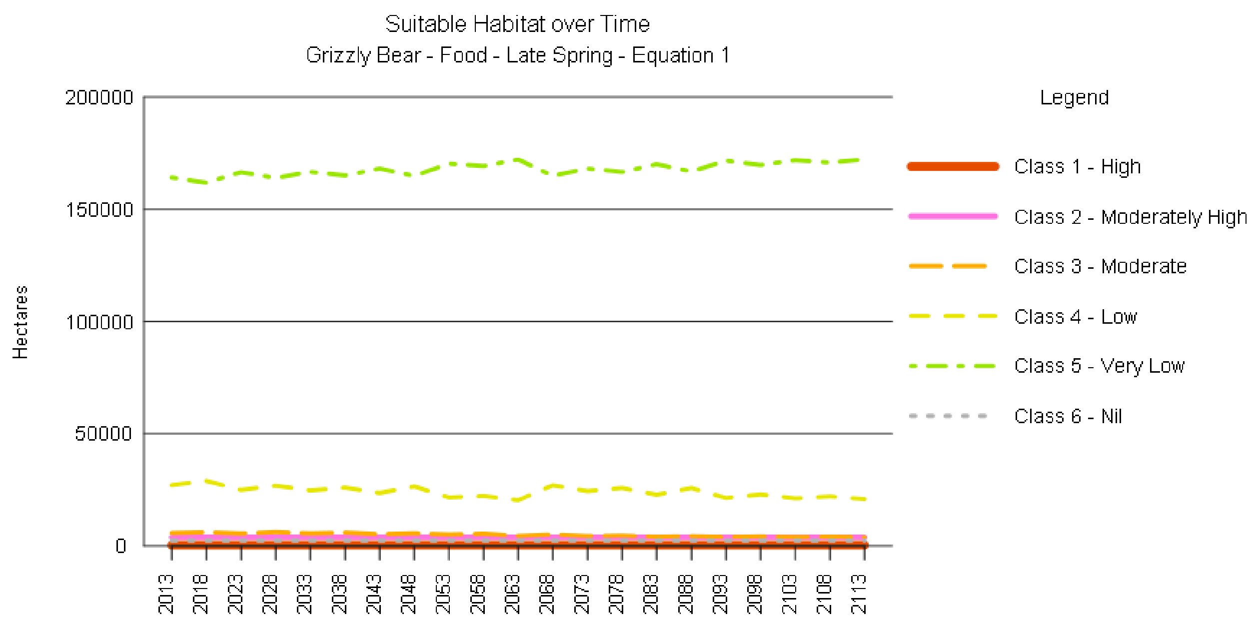
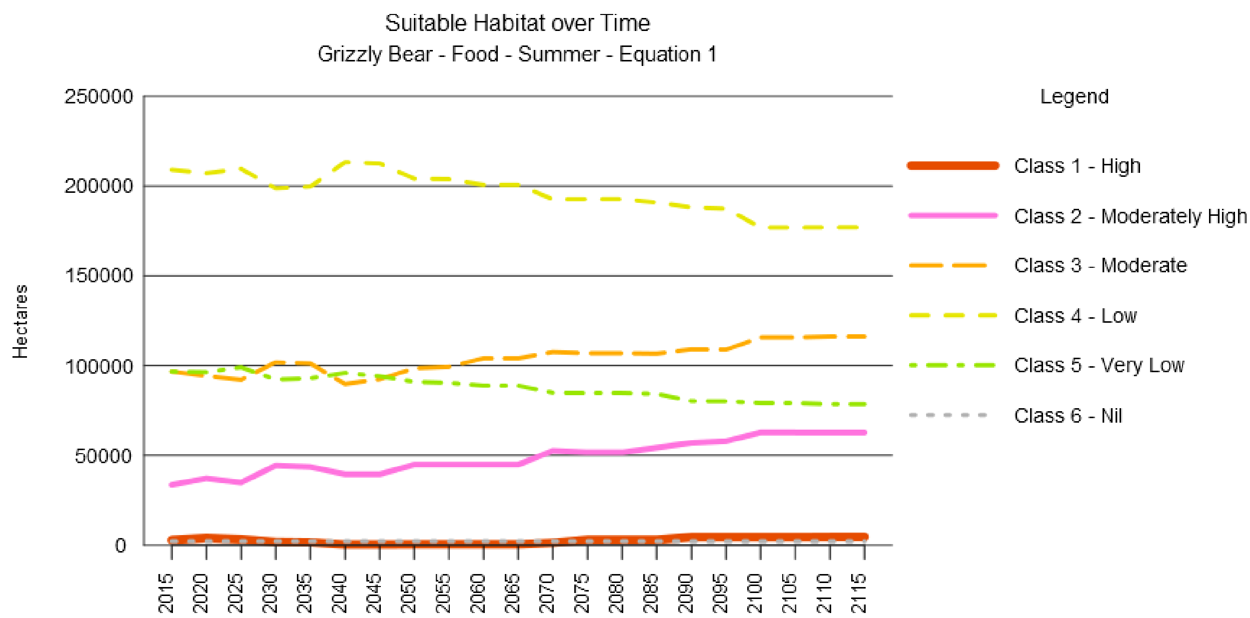


Figure 7. Grizzly bear late spring food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



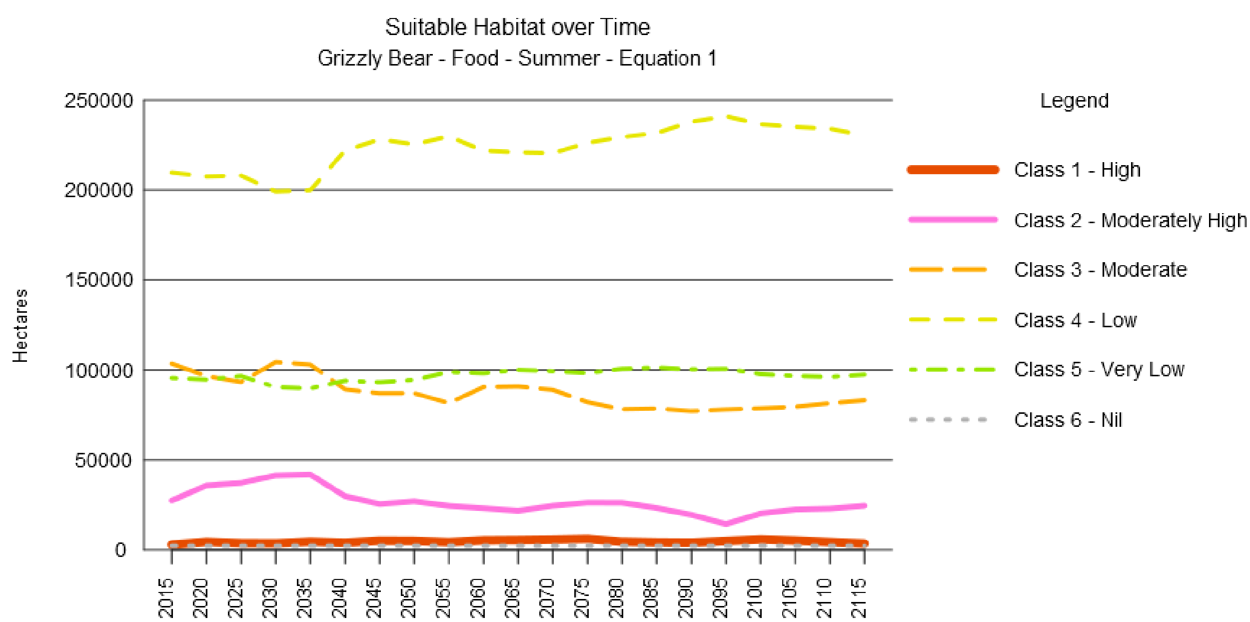
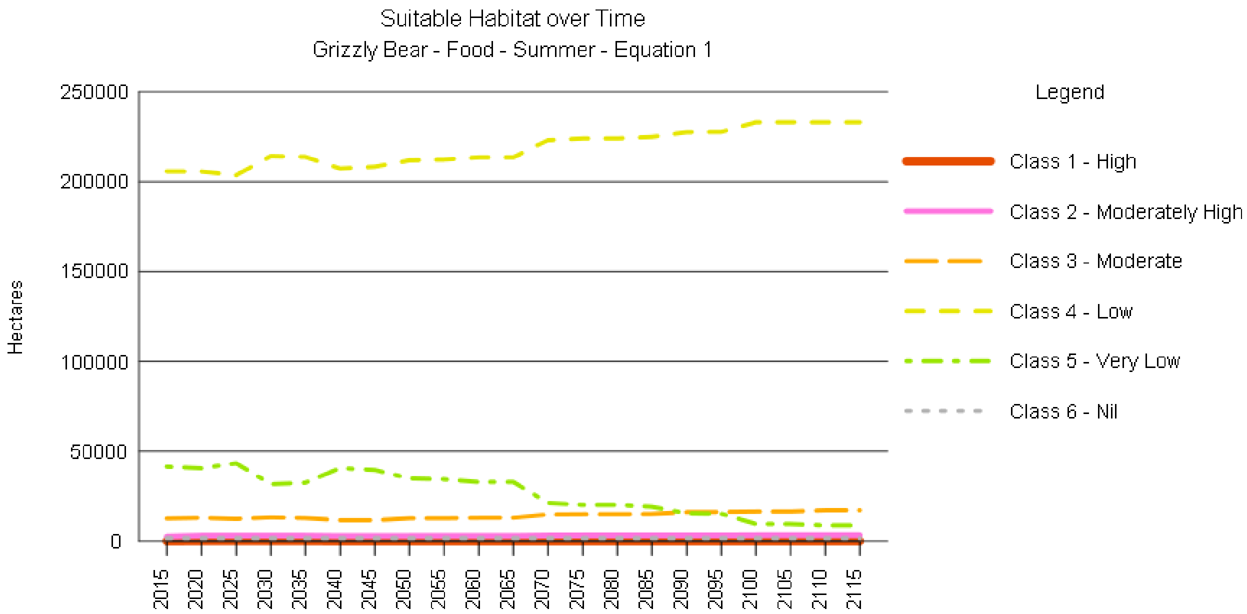


Figure 8. Grizzly bear summer food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



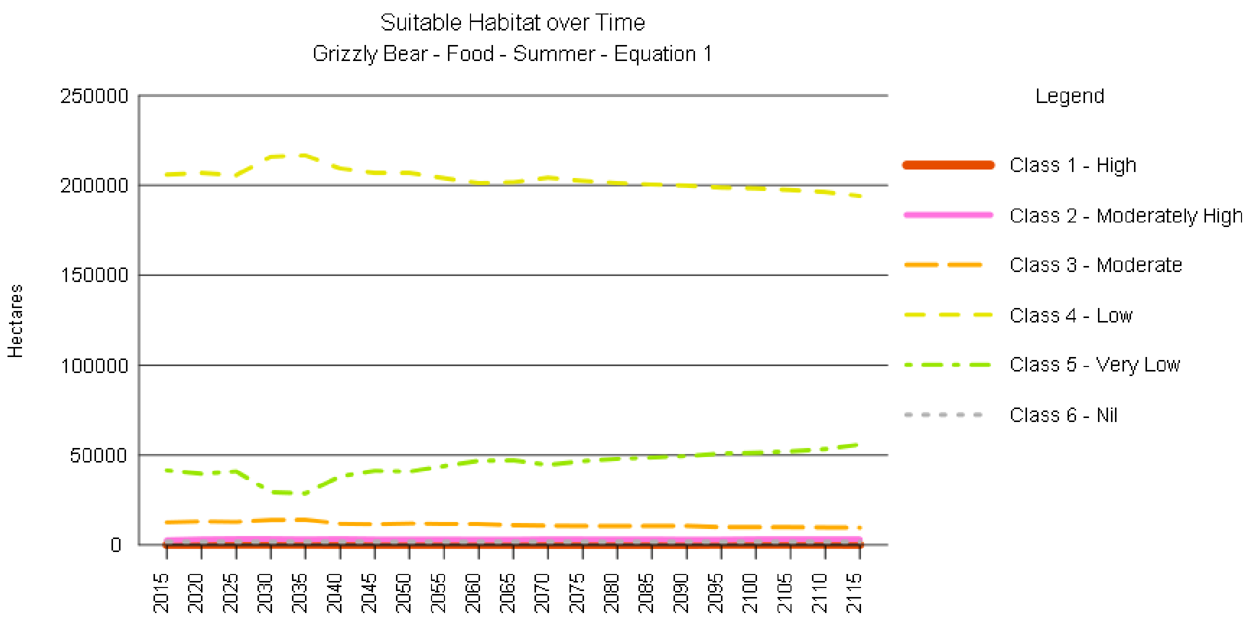
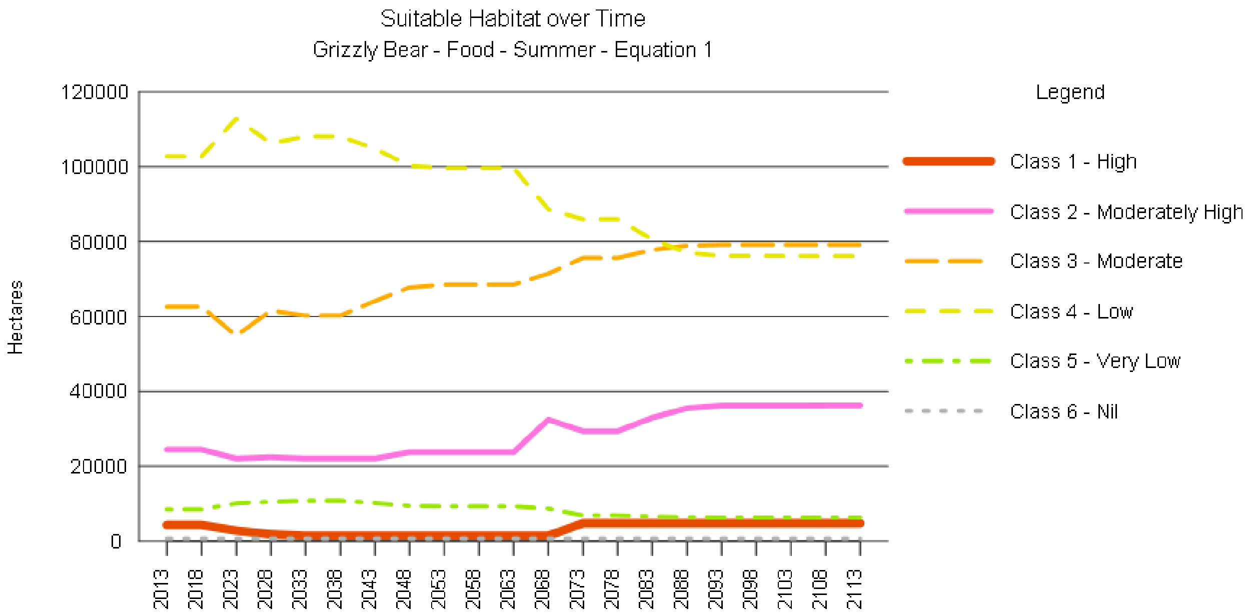


Figure 9. Grizzly bear summer food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



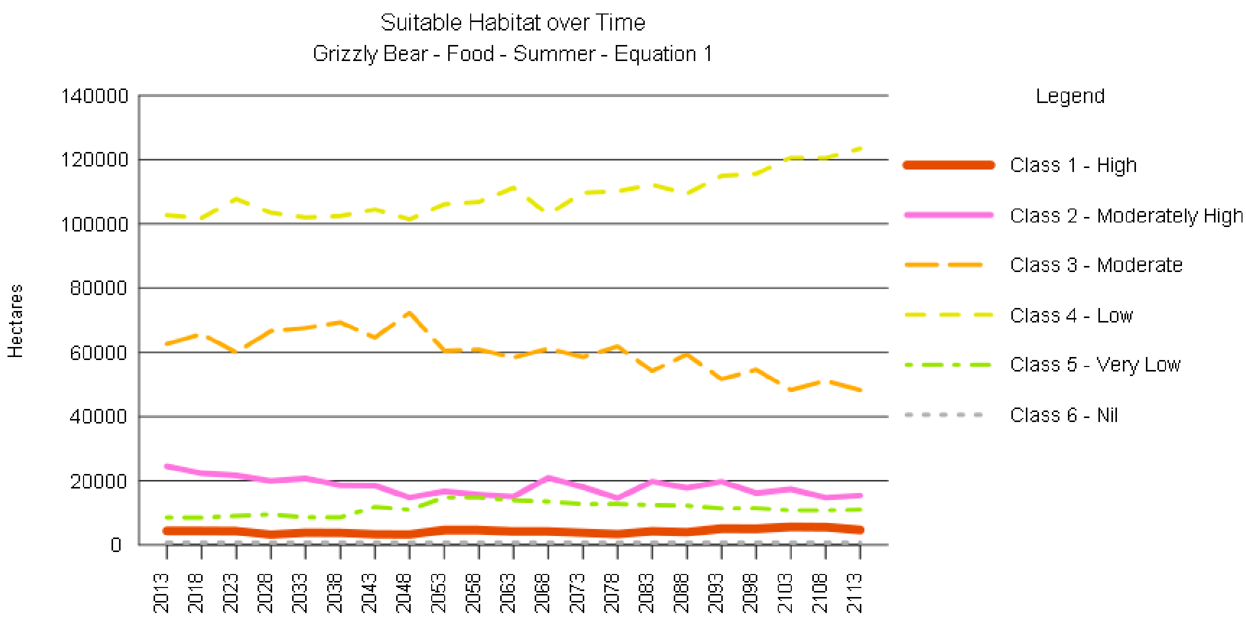
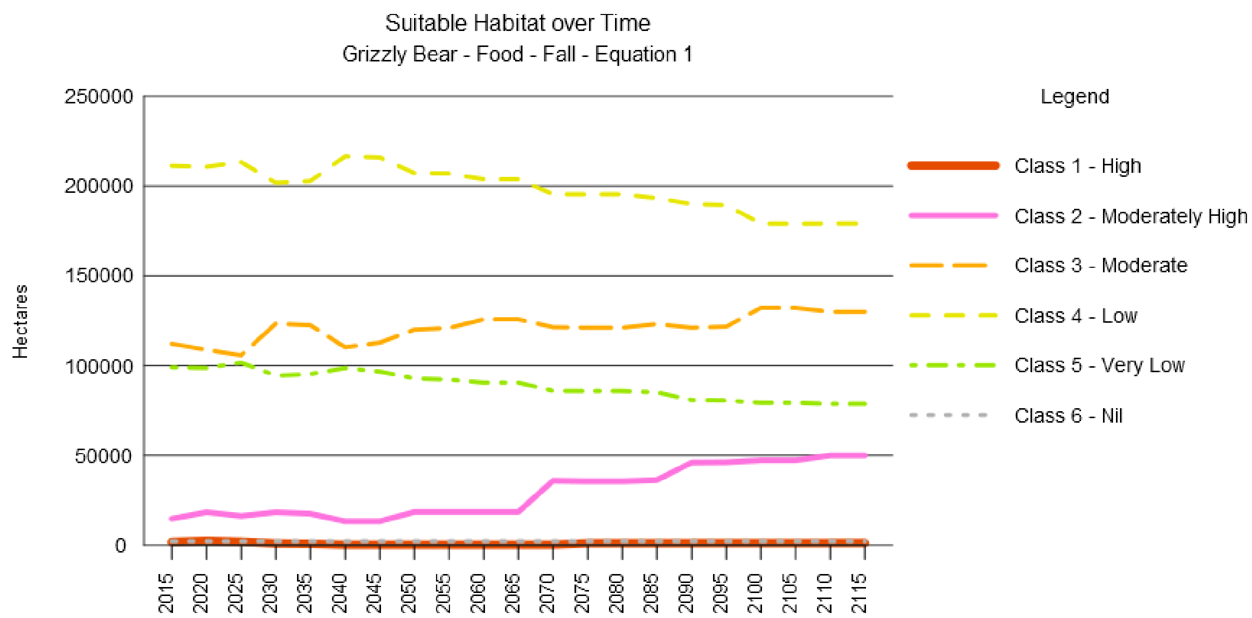


Figure 10. Grizzly bear summer food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



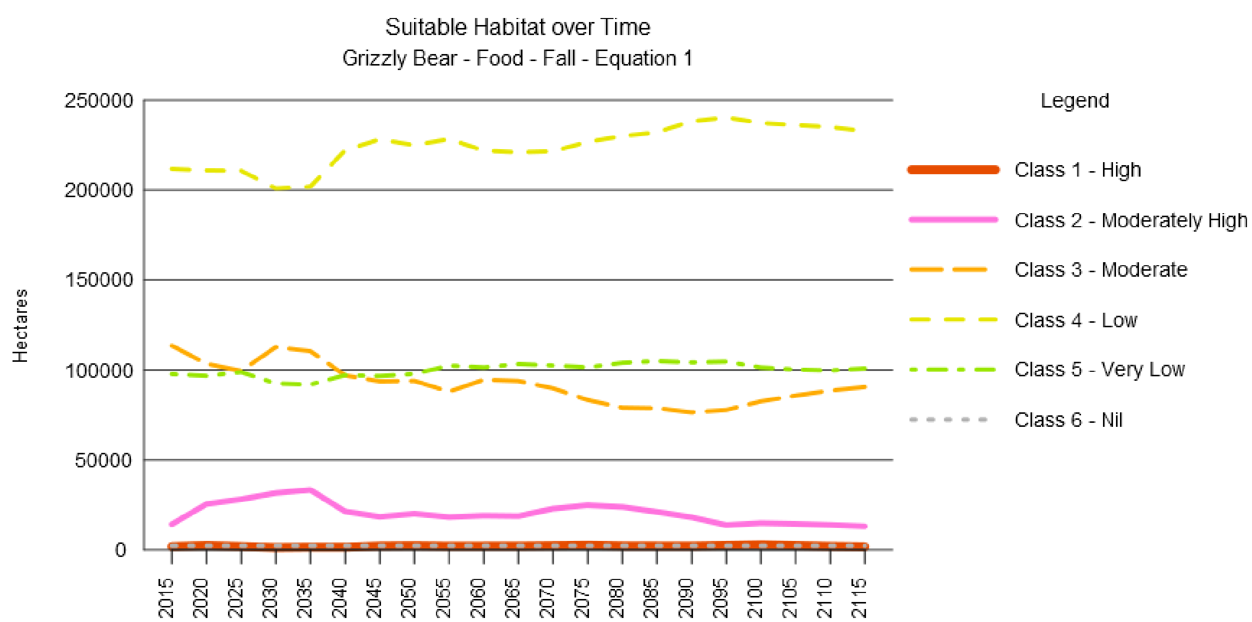
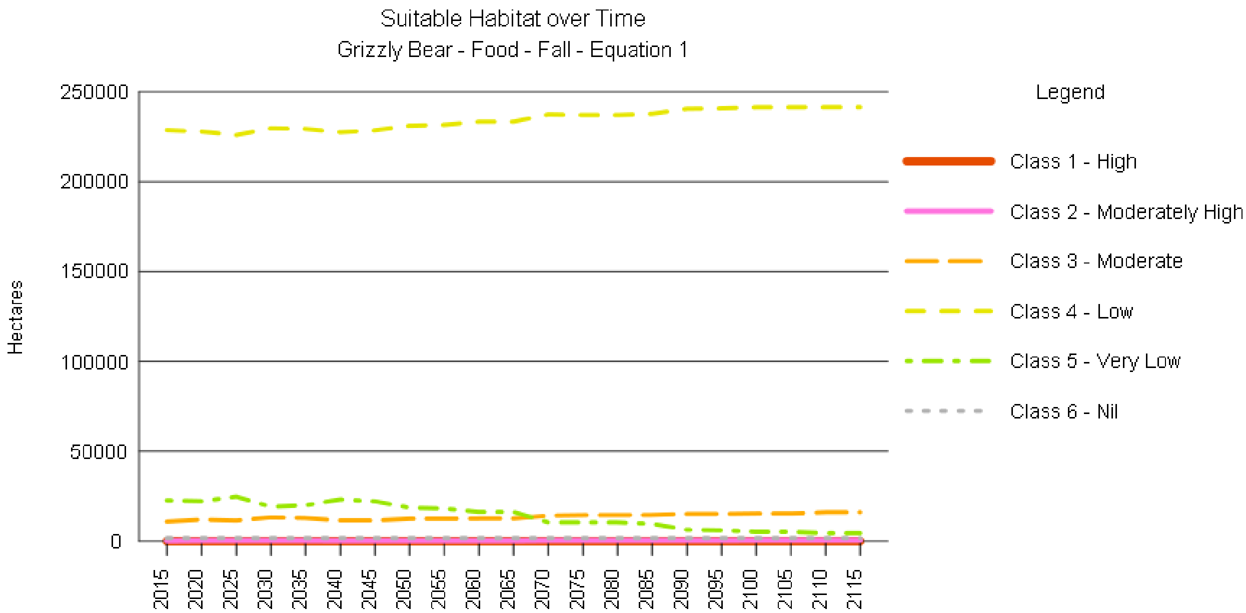


Figure 11. Grizzly bear fall food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



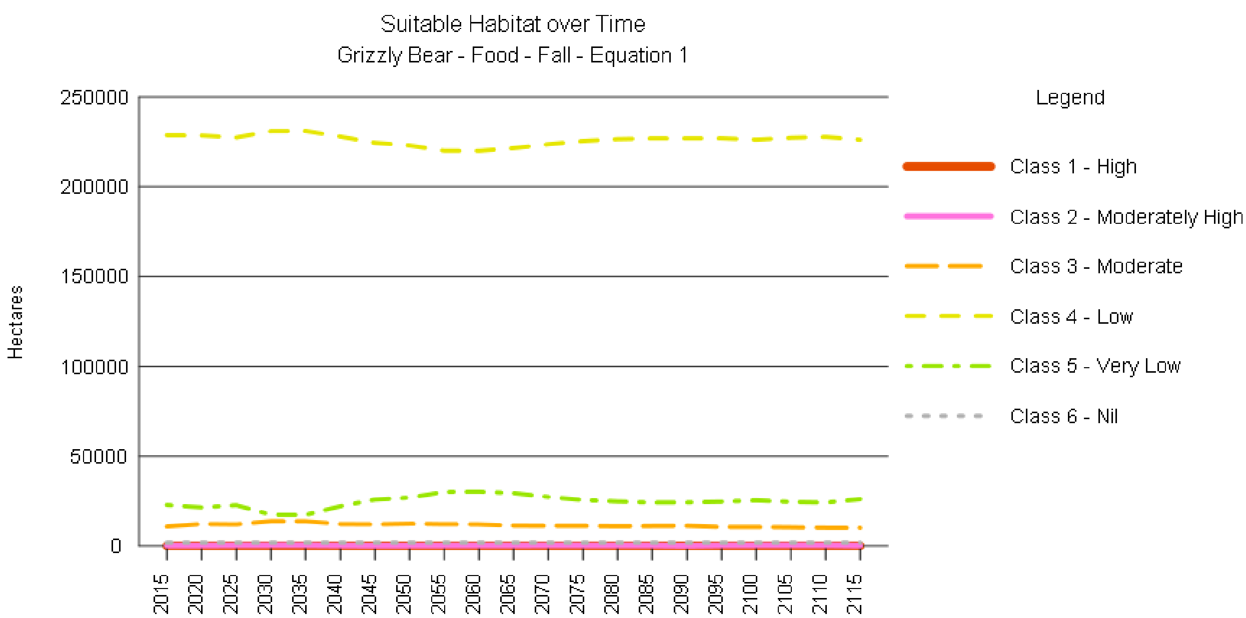
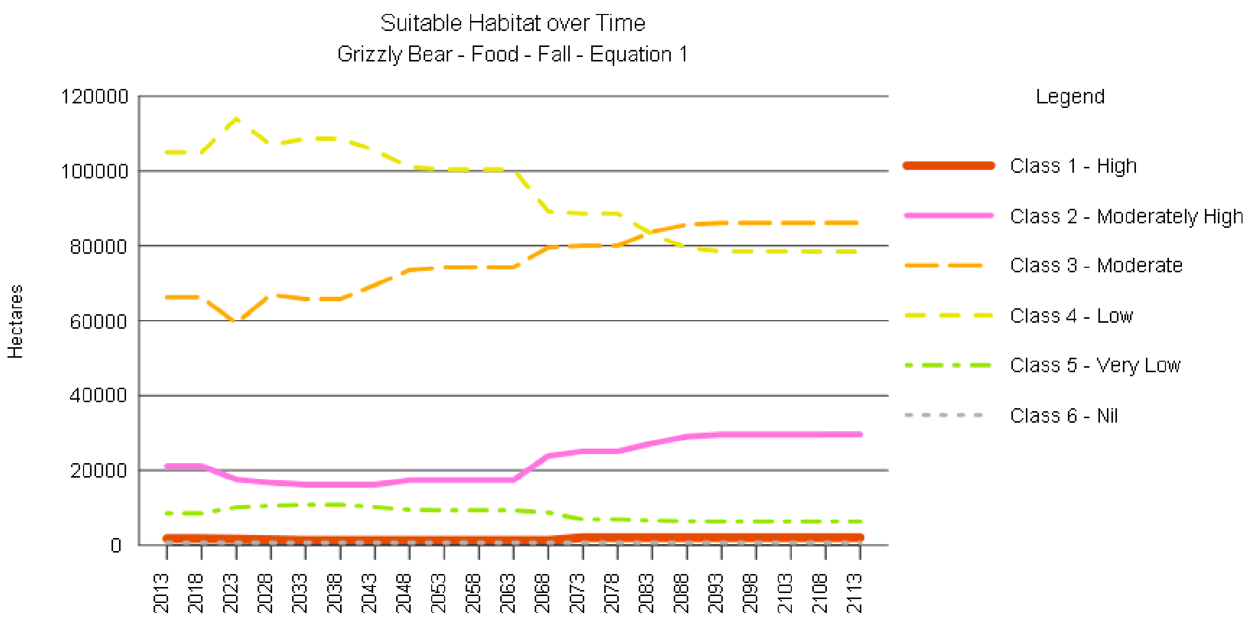


Figure 12. Grizzly bear fall food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



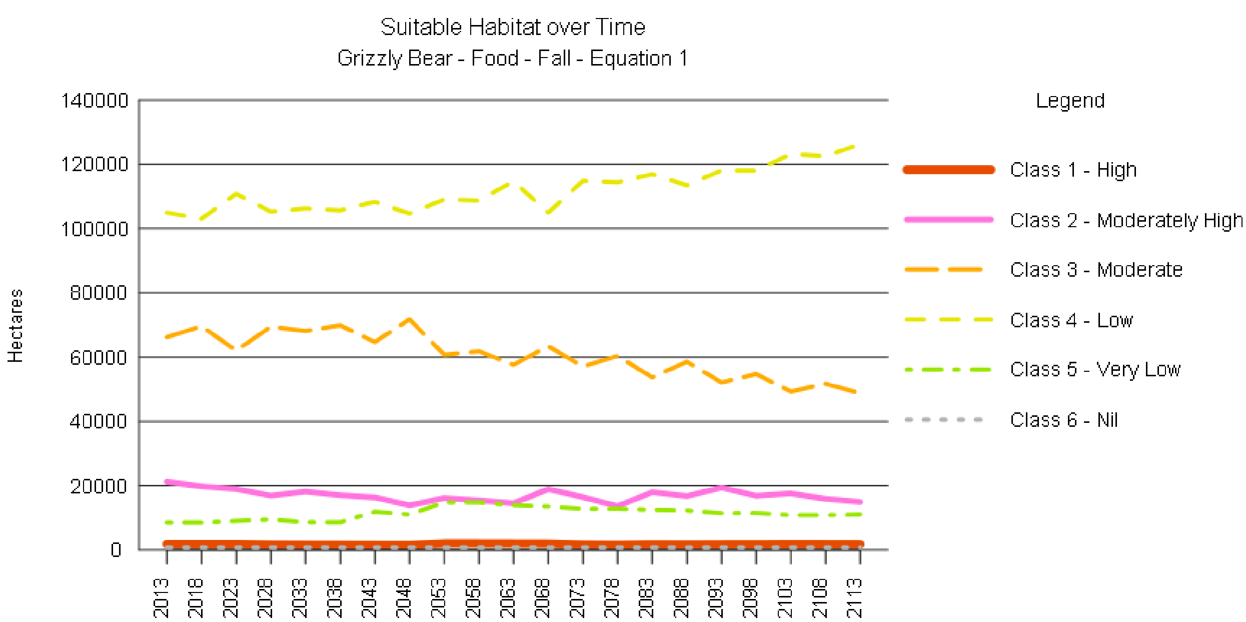
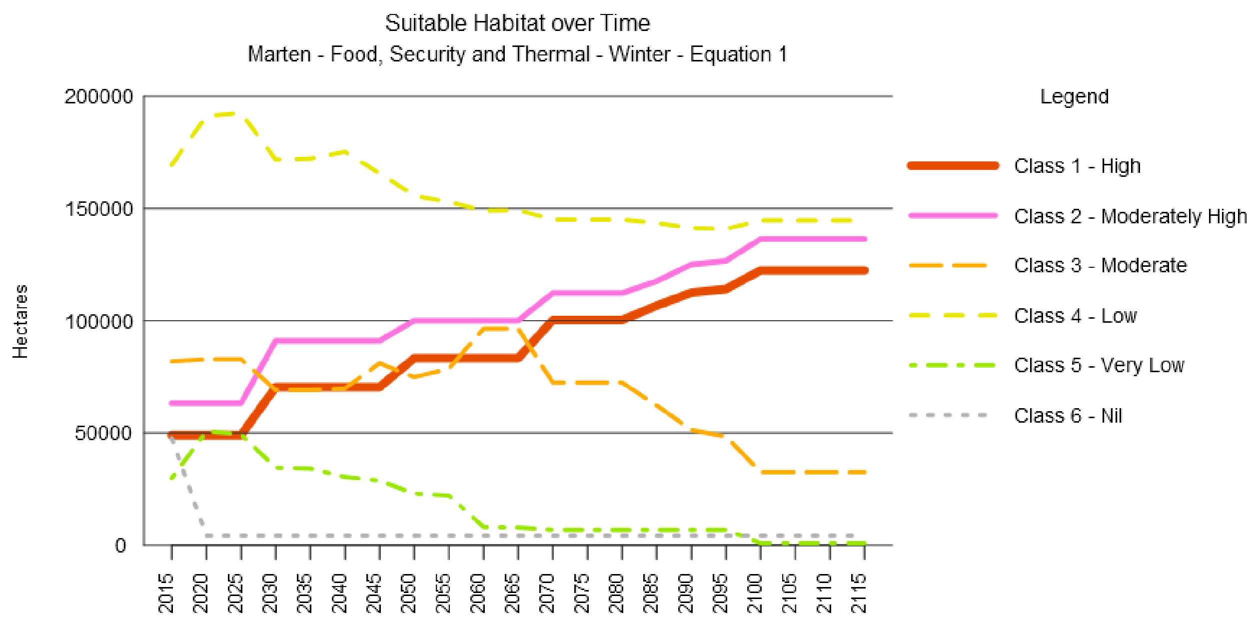


Figure 13. Grizzly bear fall food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



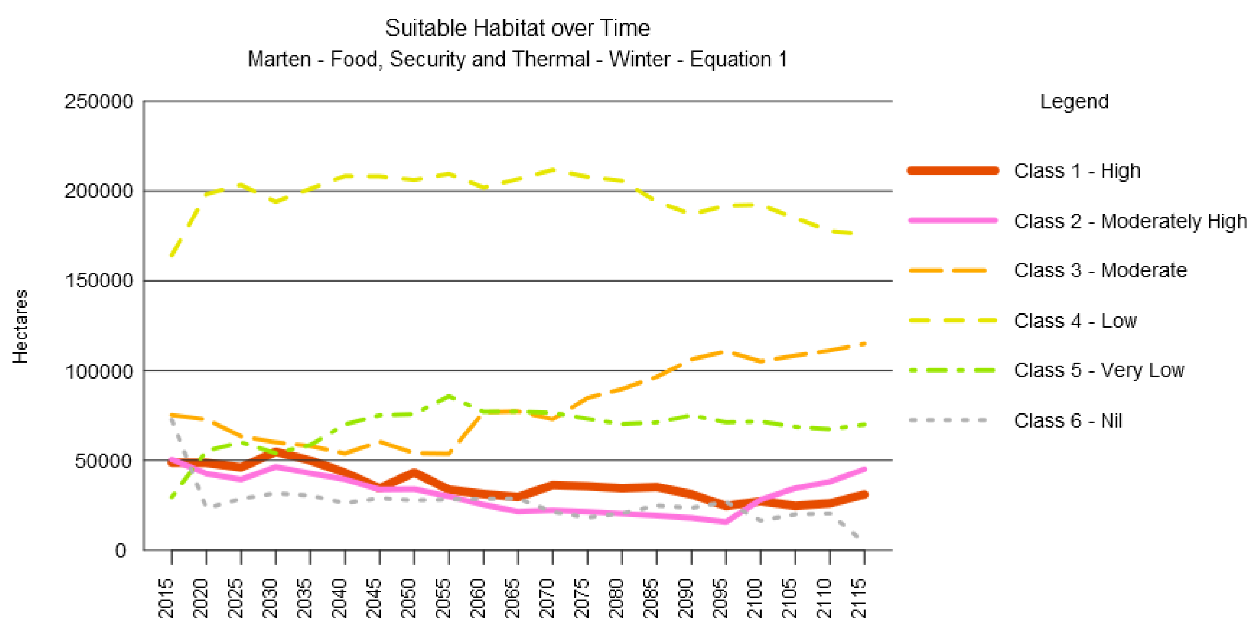
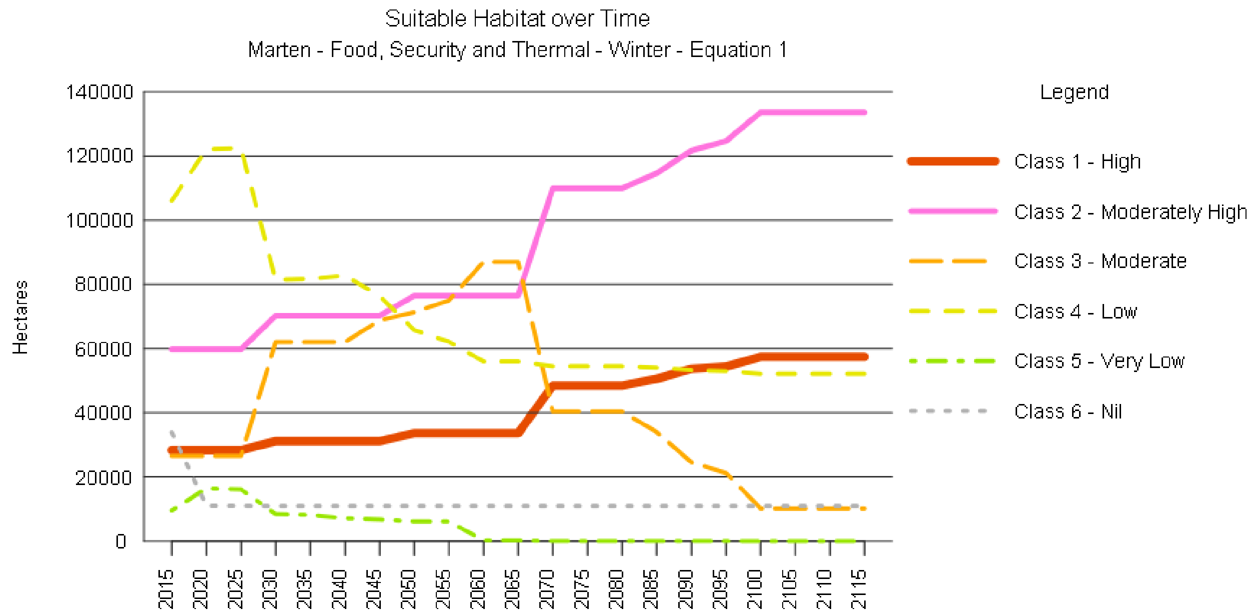


Figure 14. Marten winter habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



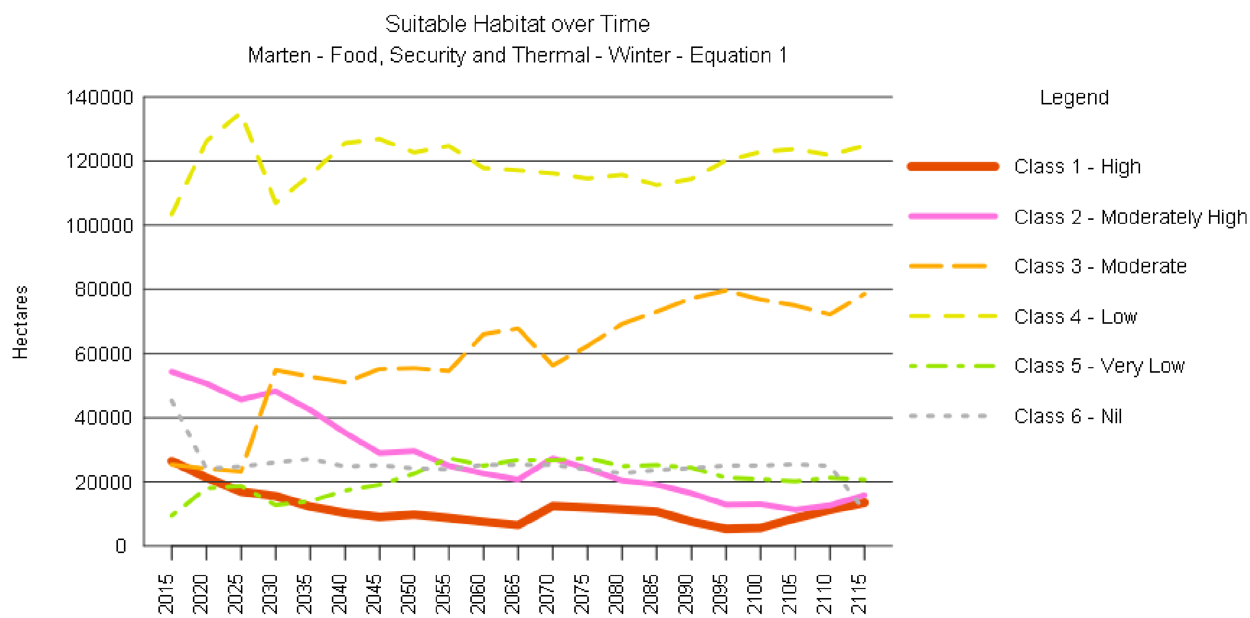
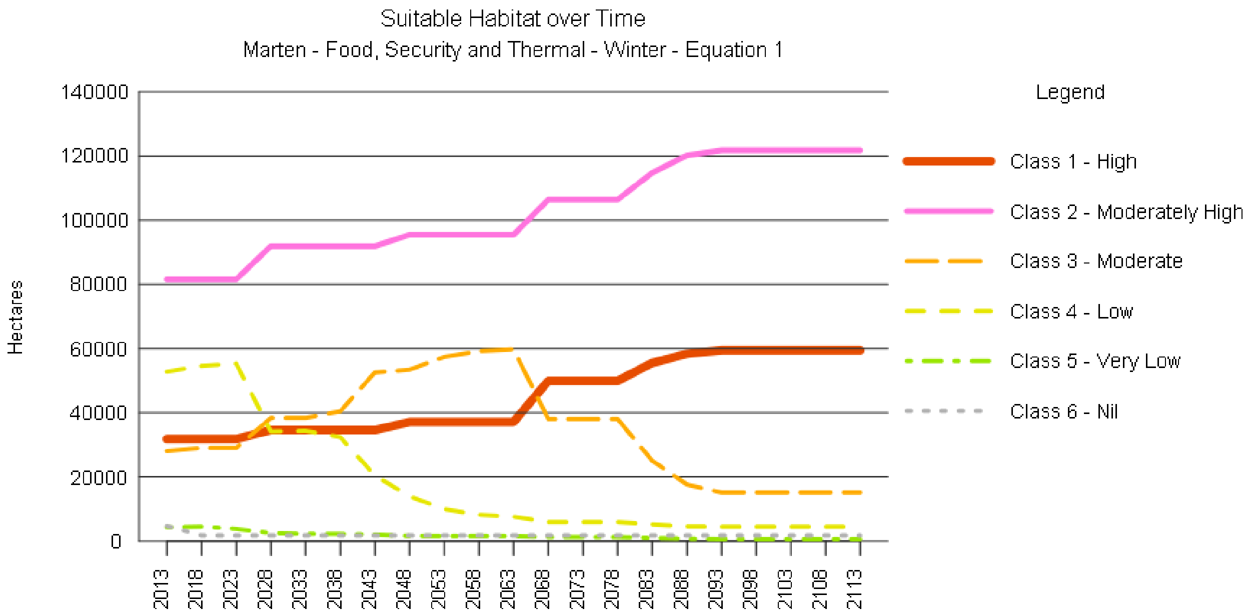


Figure 15. Marten winter habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



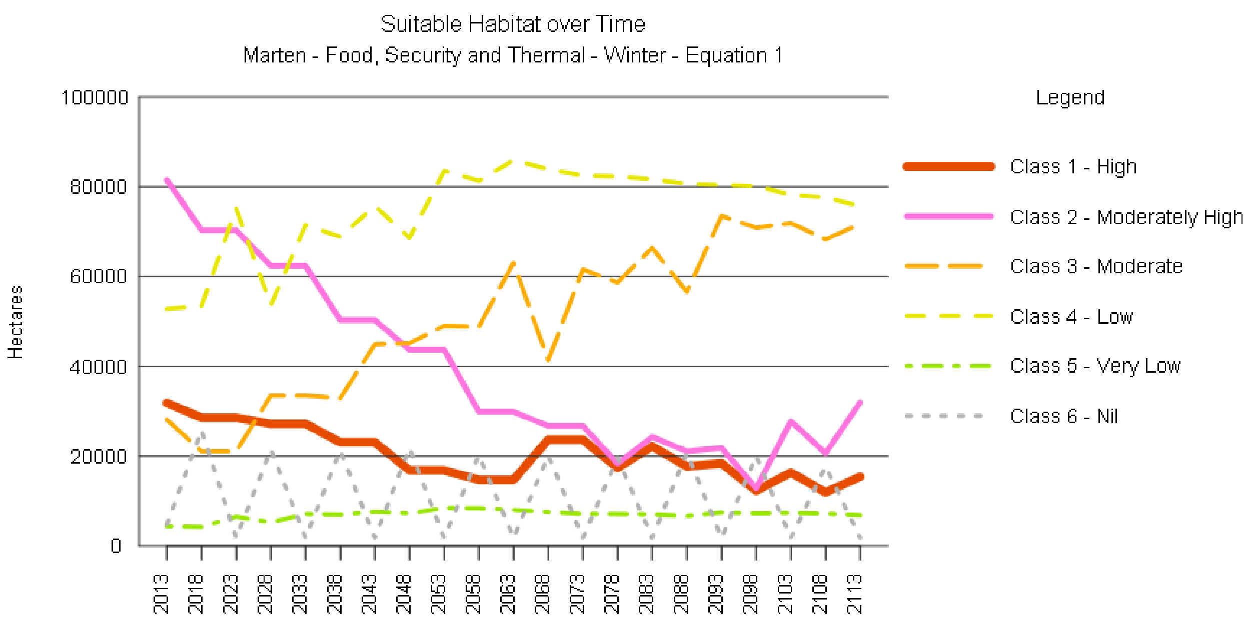
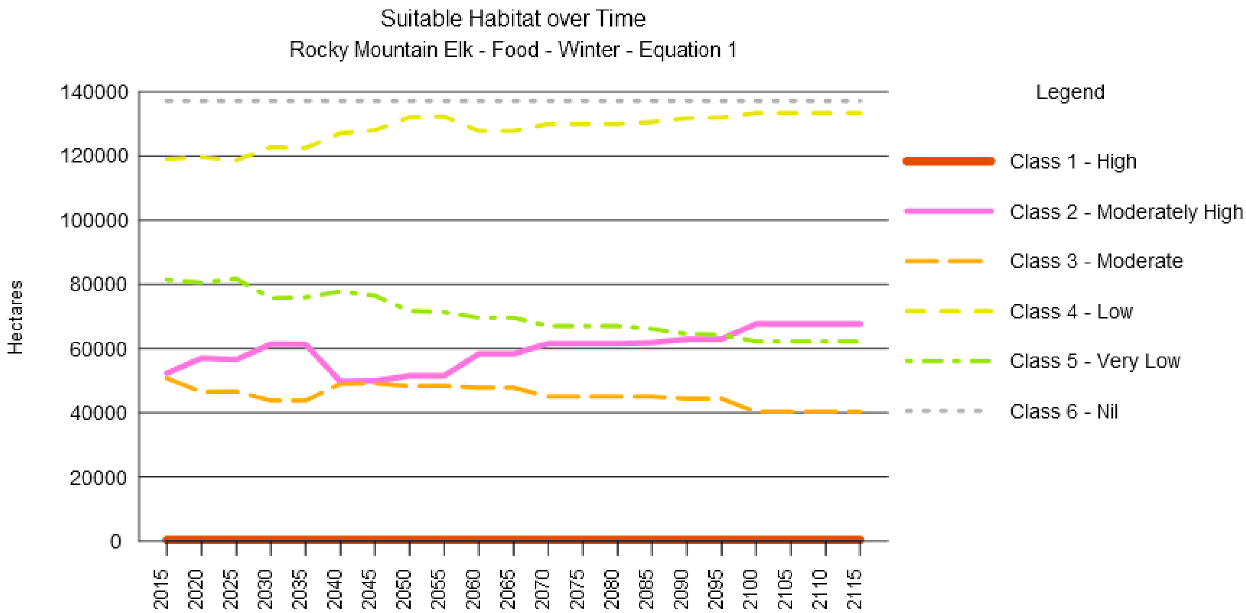


Figure 16. Marten winter habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



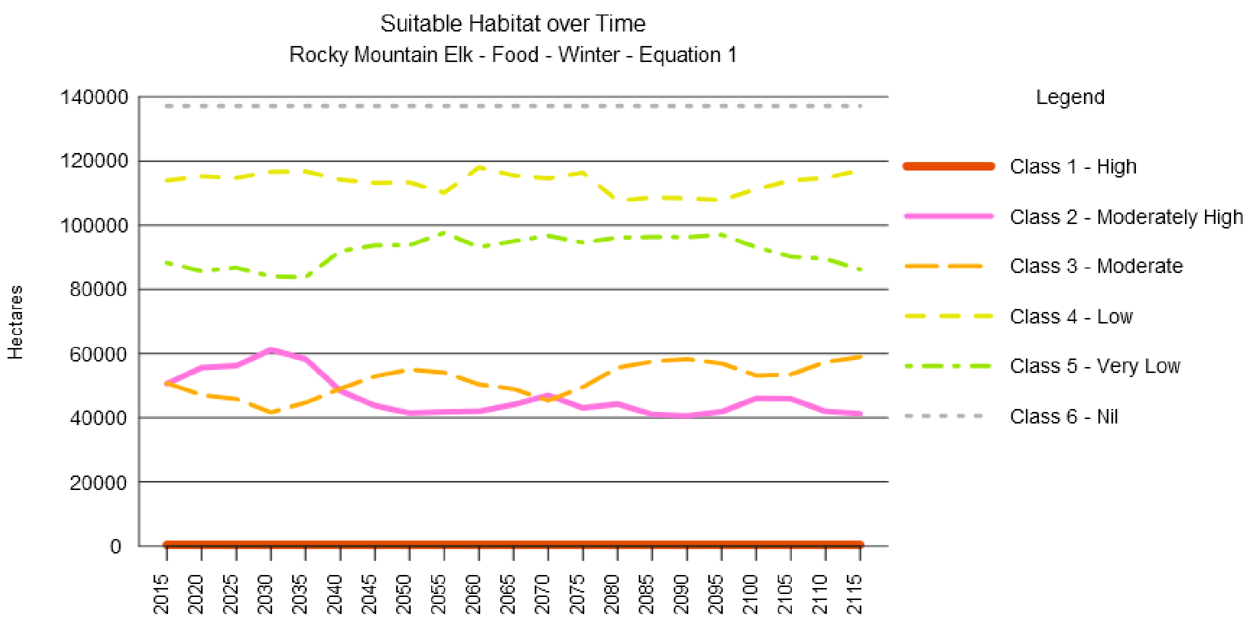
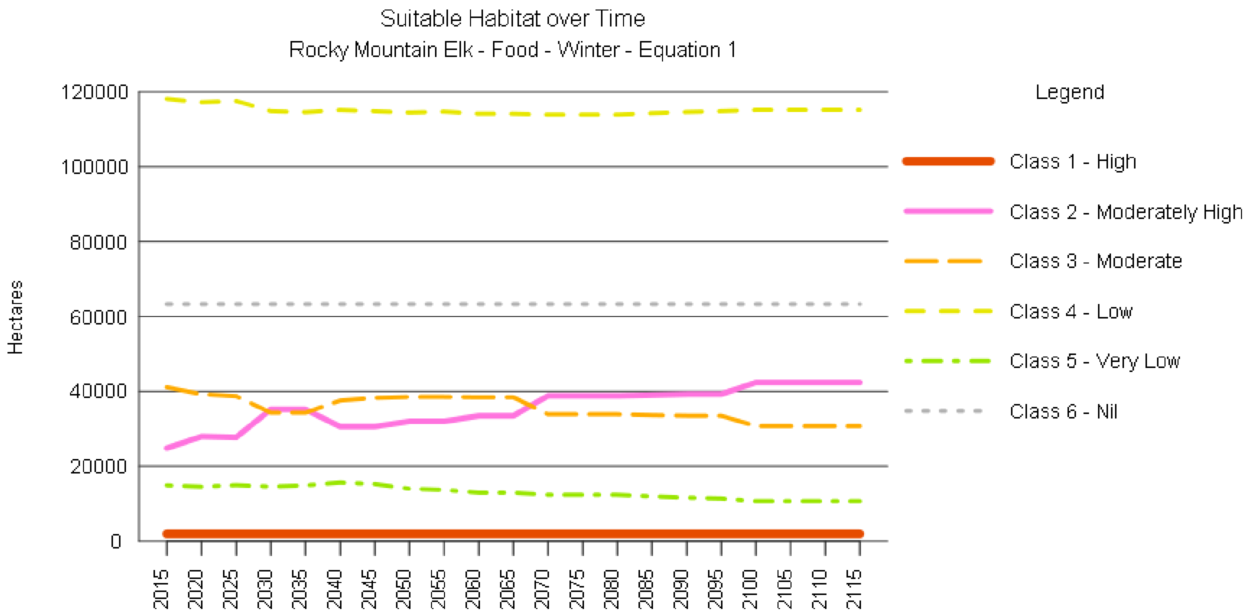


Figure 17. Elk winter food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



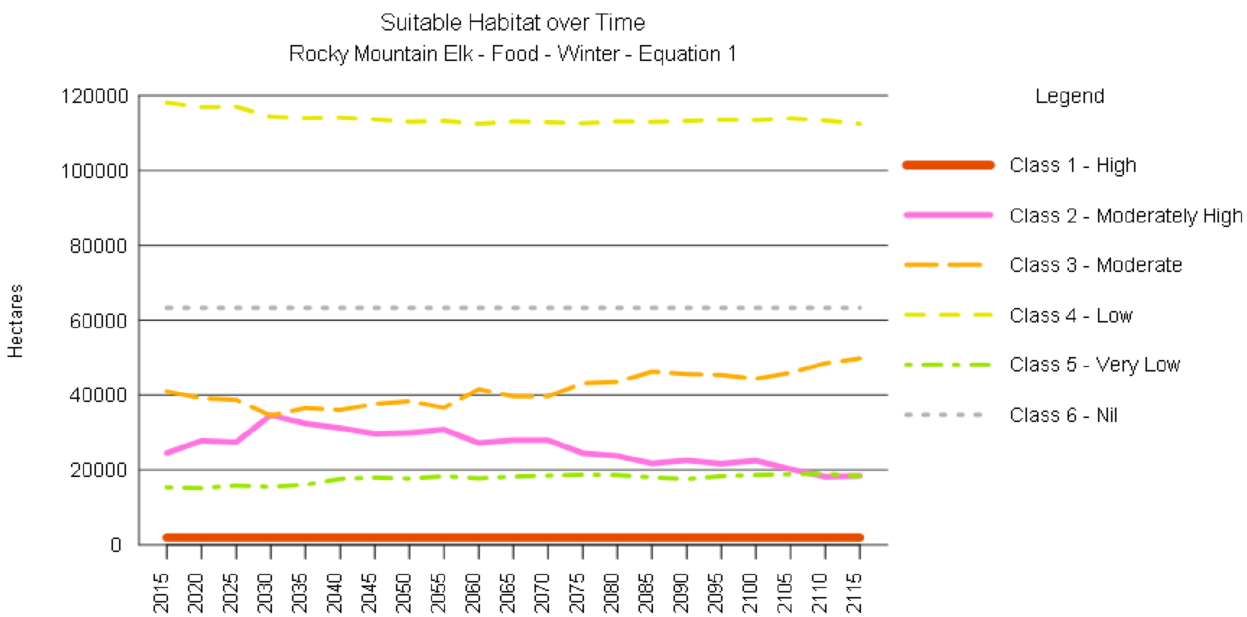
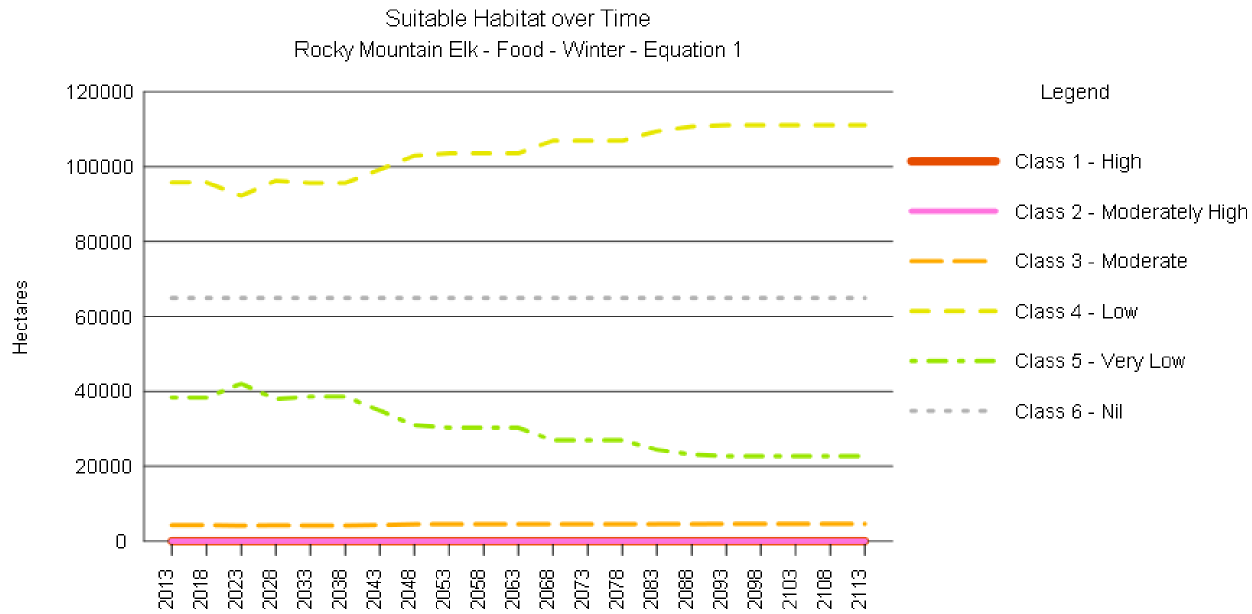


Figure 18. Elk winter food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



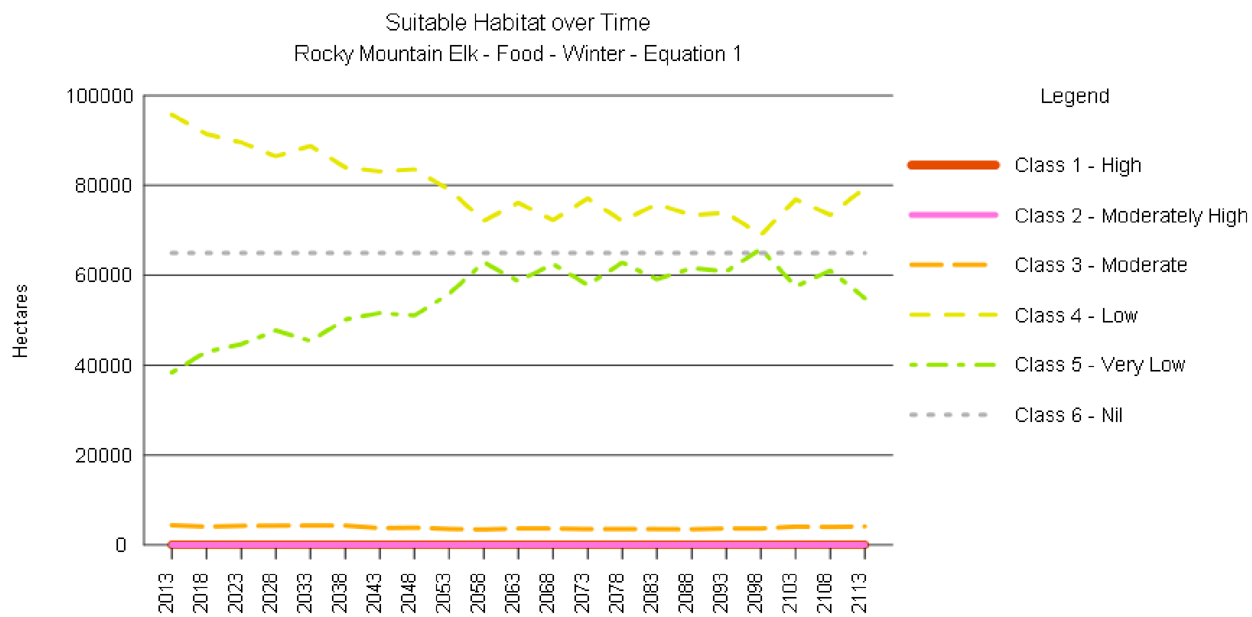
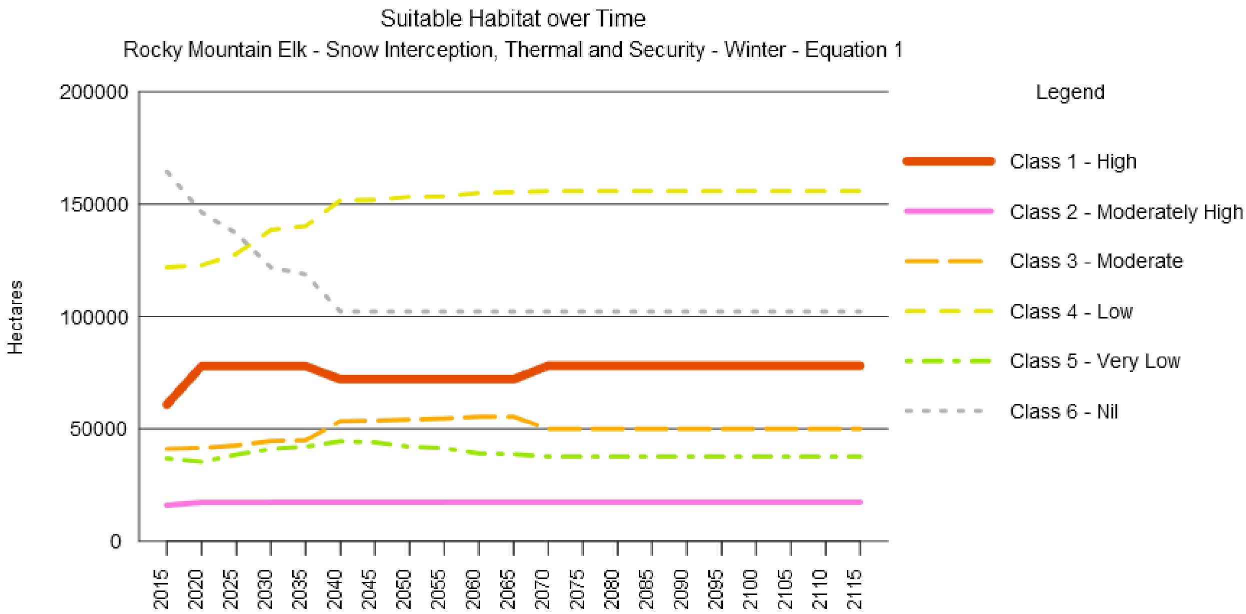


Figure 19. Elk winter food habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



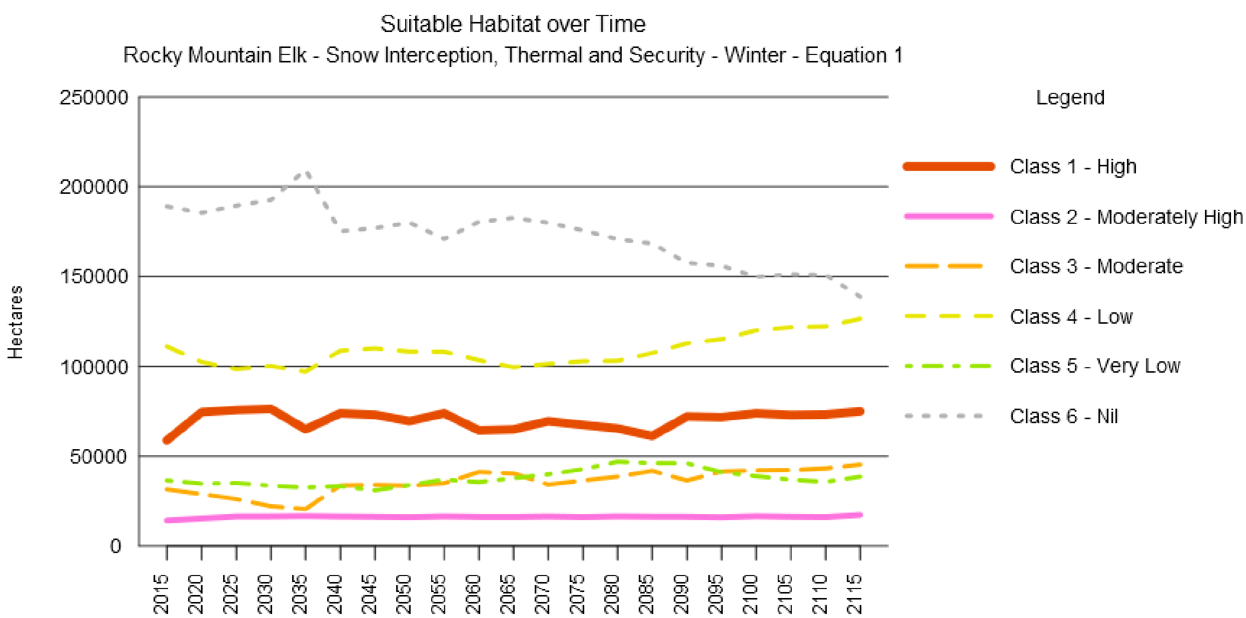
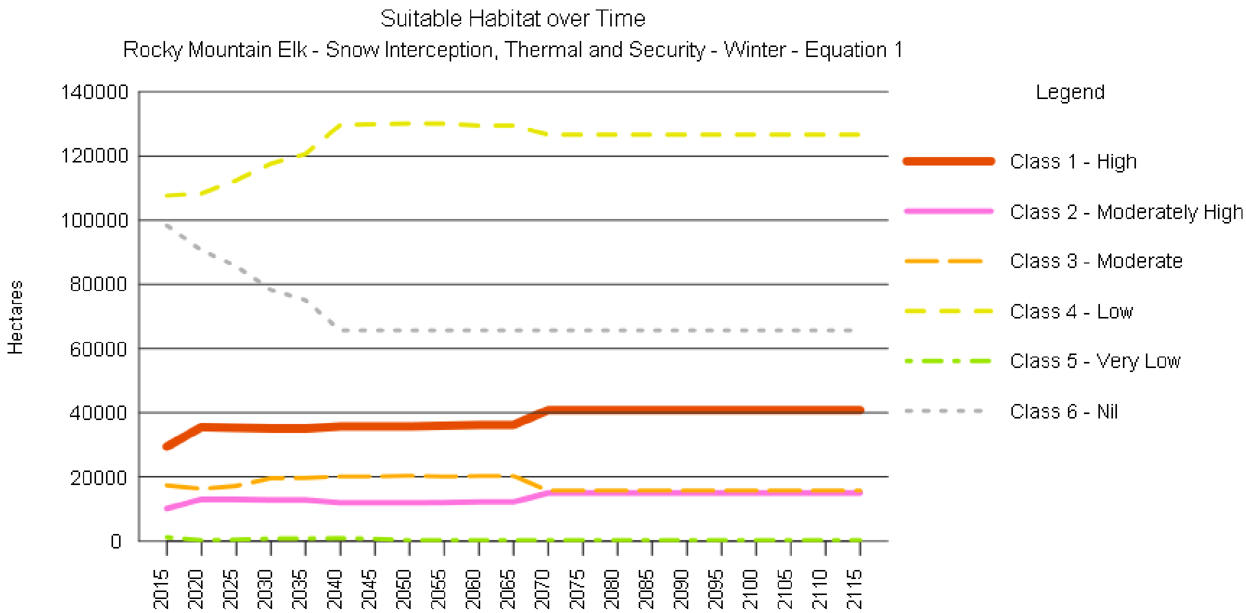


Figure 20. Elk winter cover habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



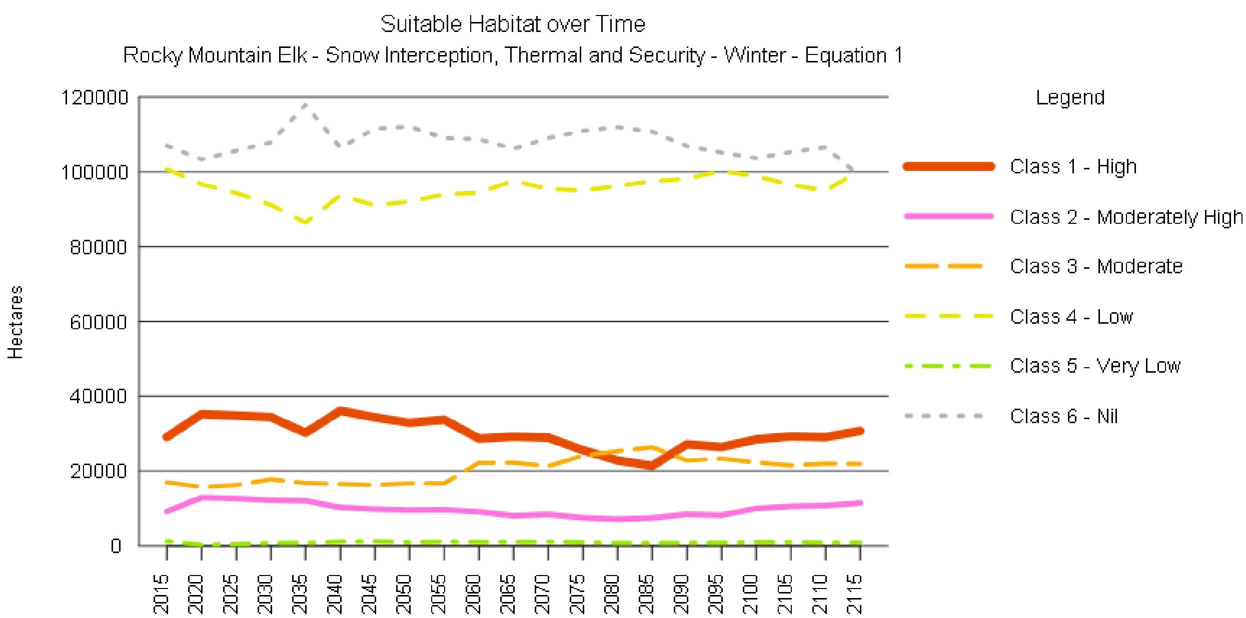
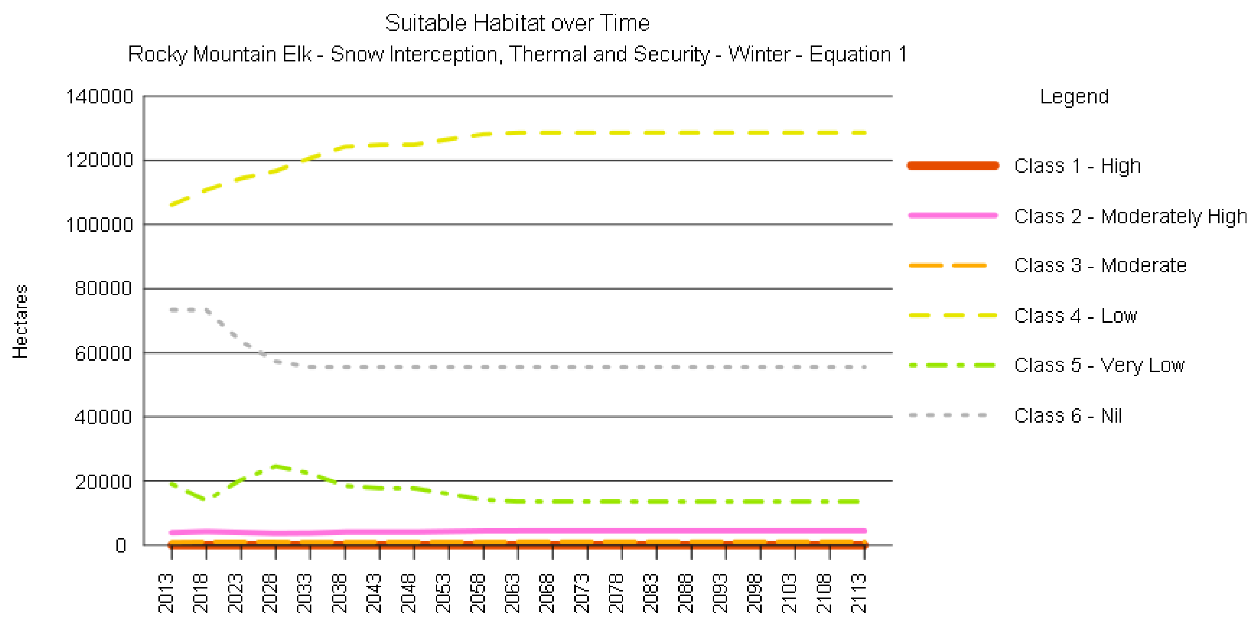


Figure 21. Elk winter cover habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



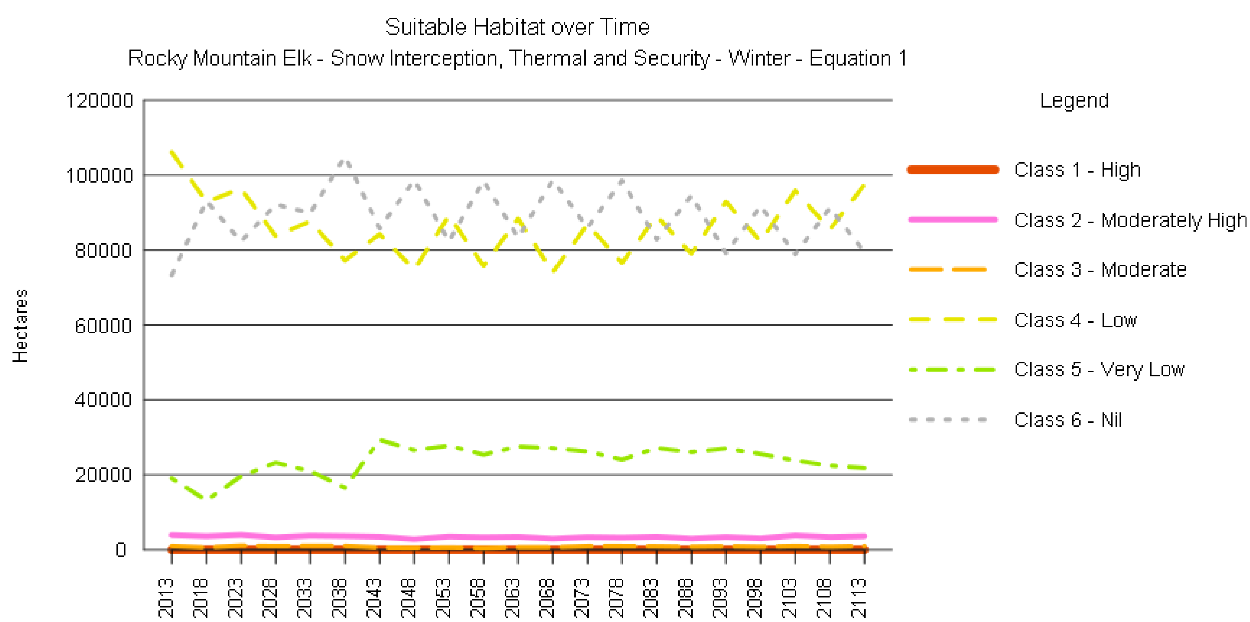
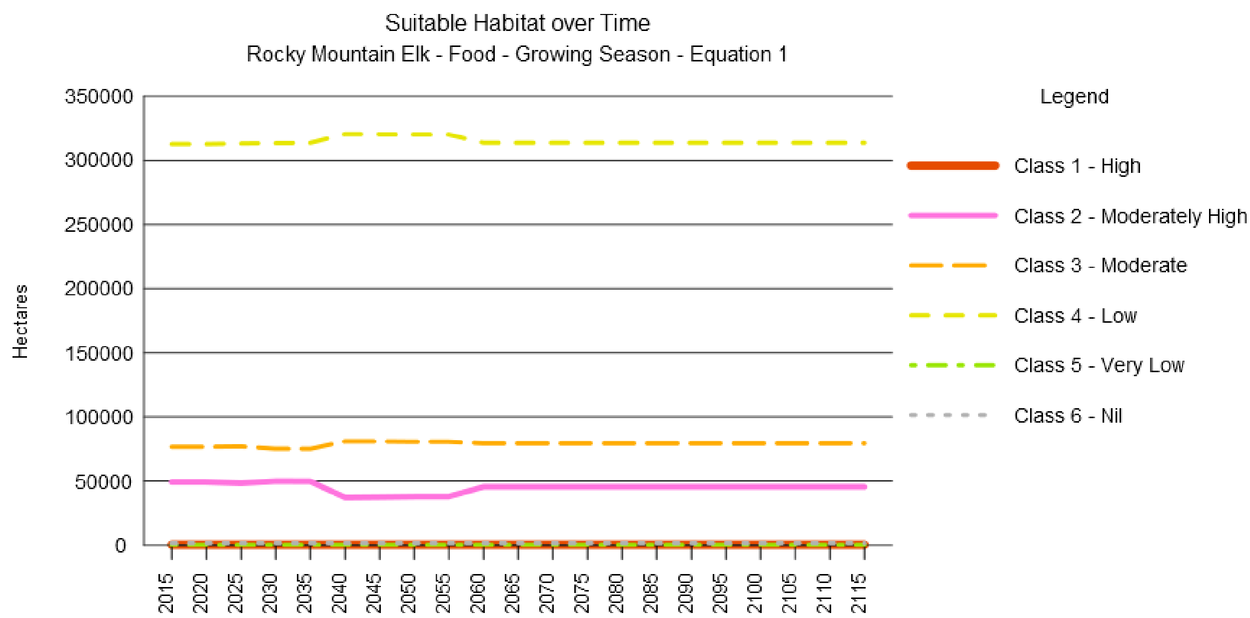


Figure 22. Elk winter cover habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



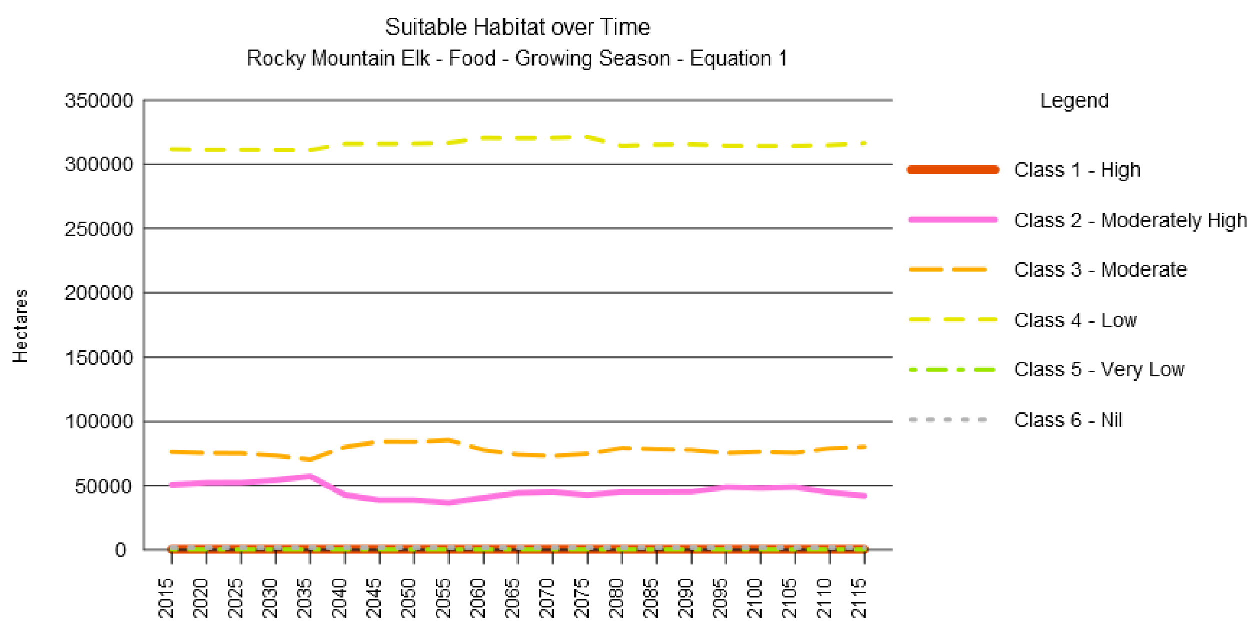
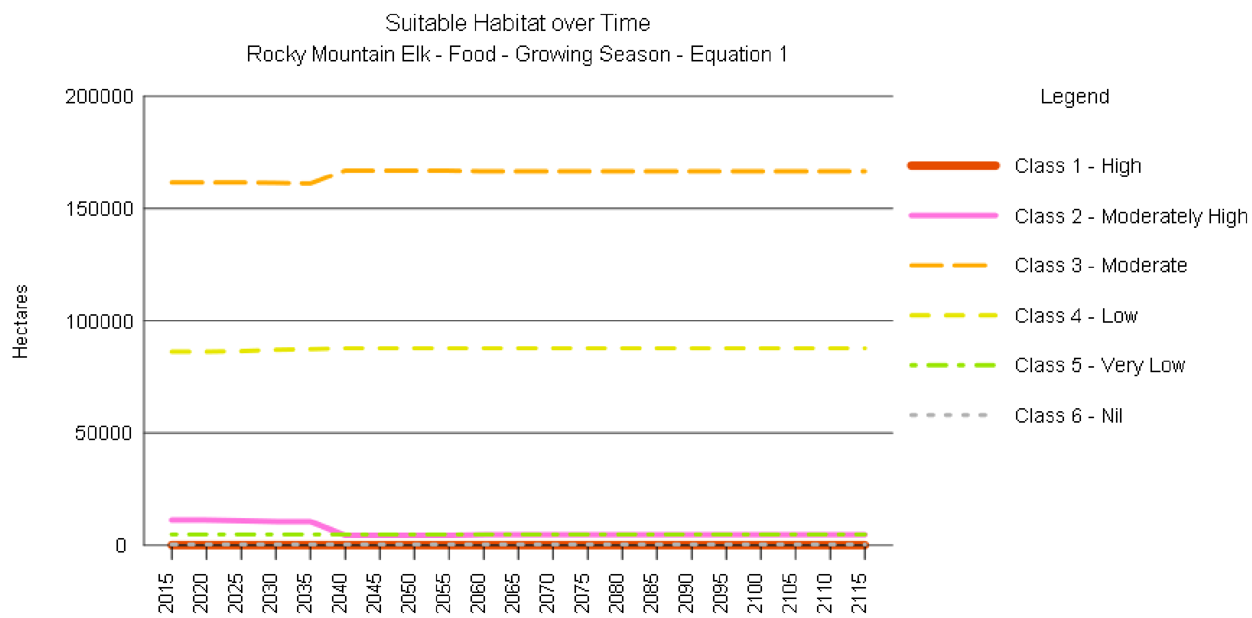


Figure 23. Elk summer forage habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



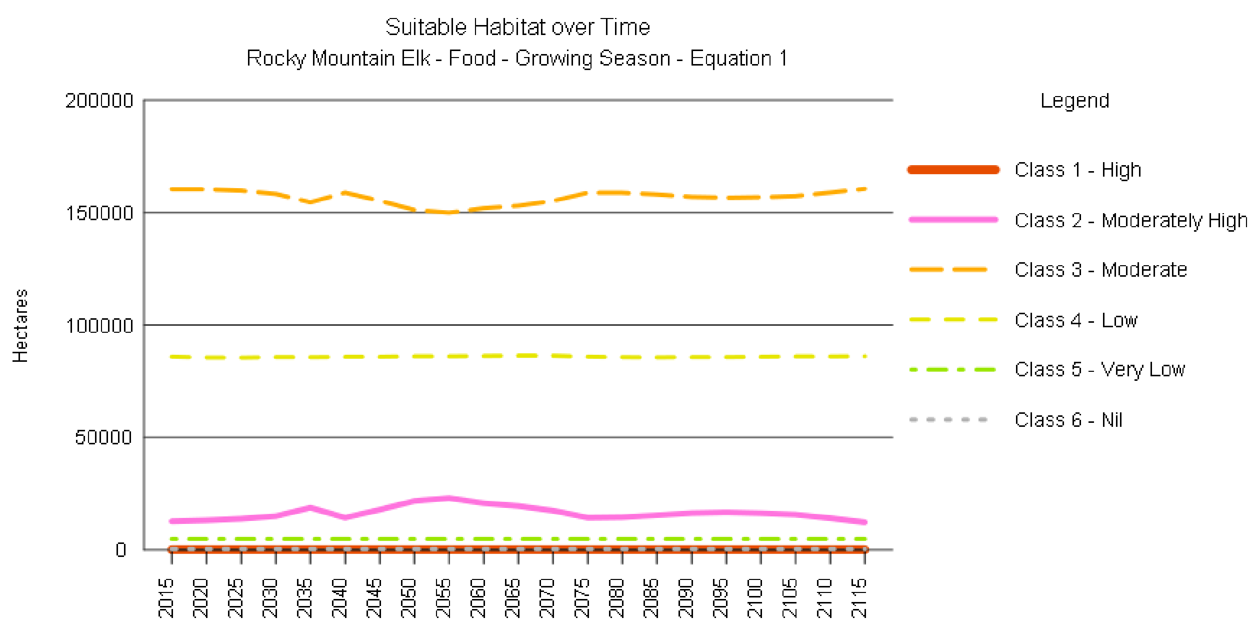
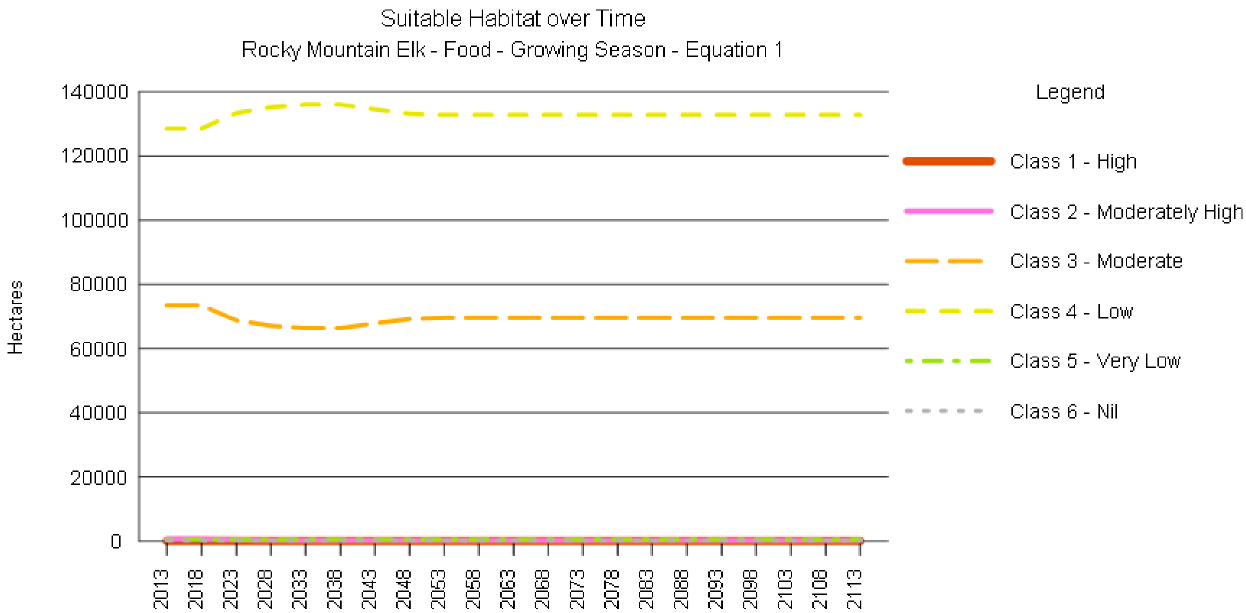


Figure 24. Elk summer forage habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



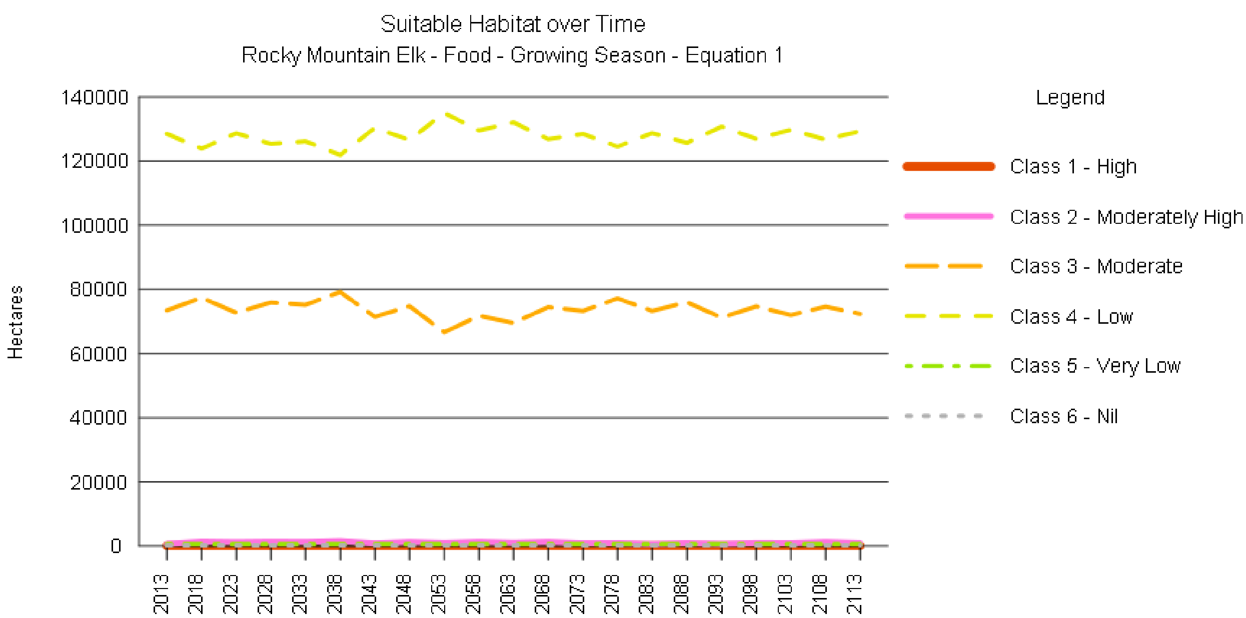
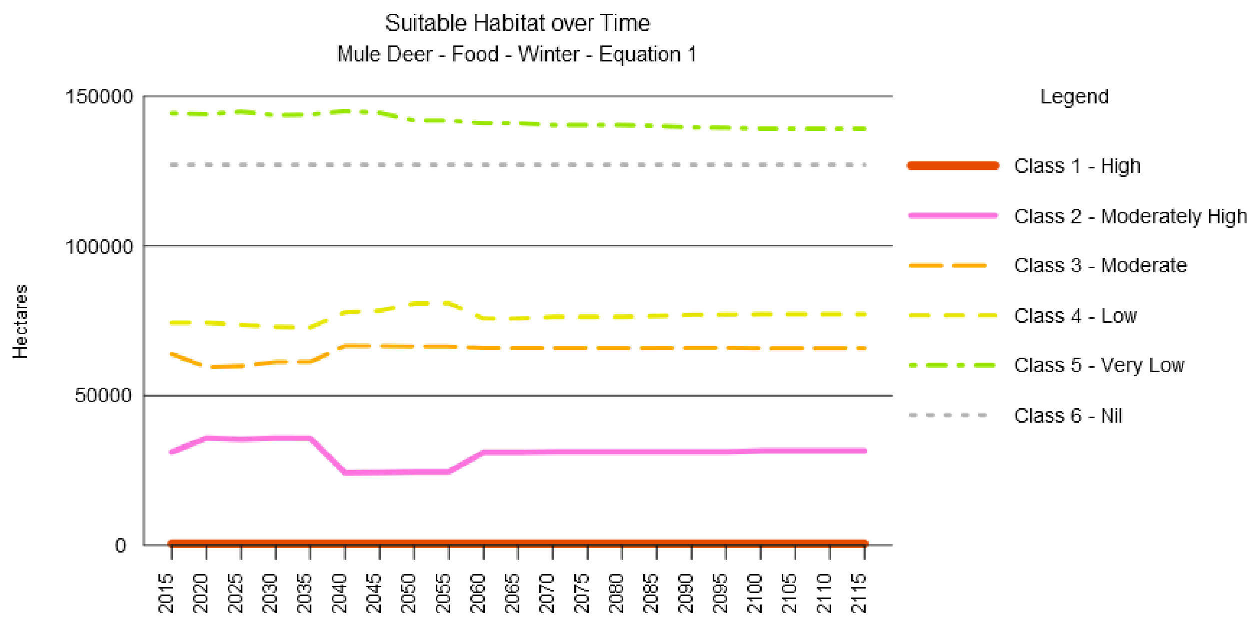


Figure 25. Elk summer forage habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



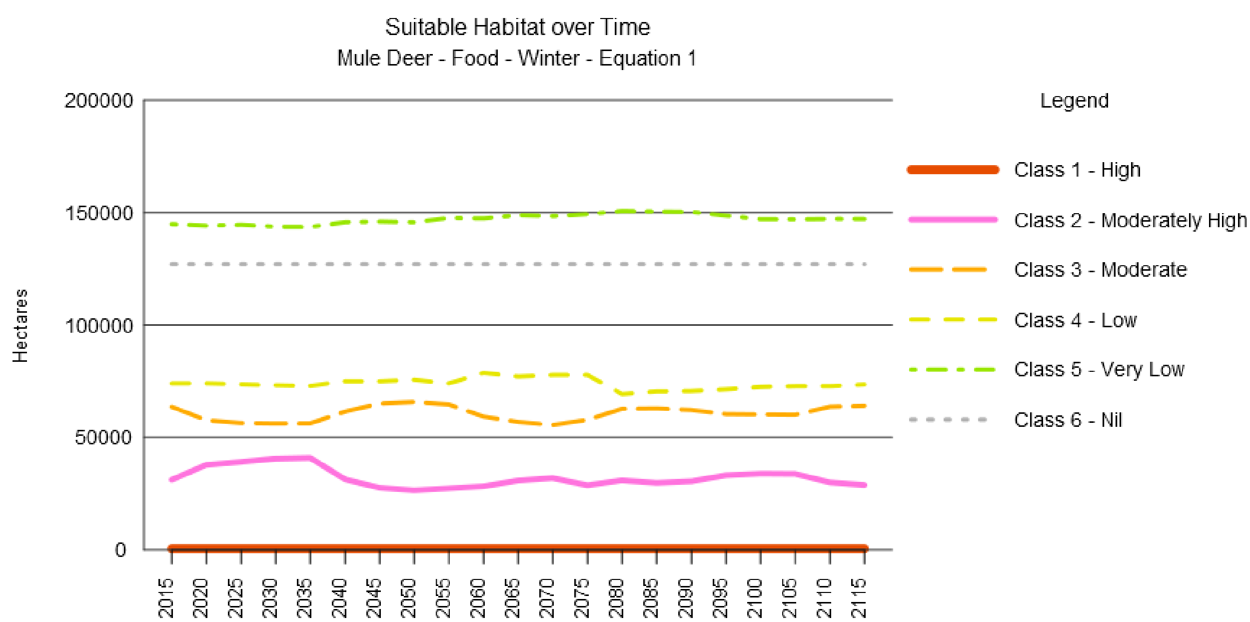
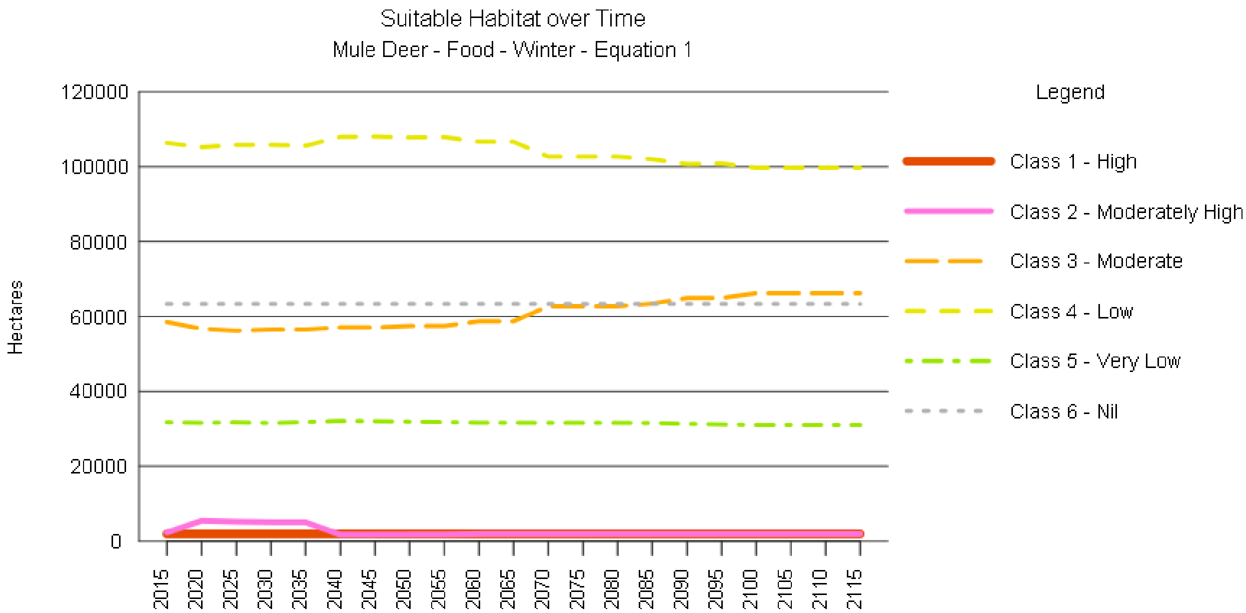


Figure 26. Mule deer winter forage habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



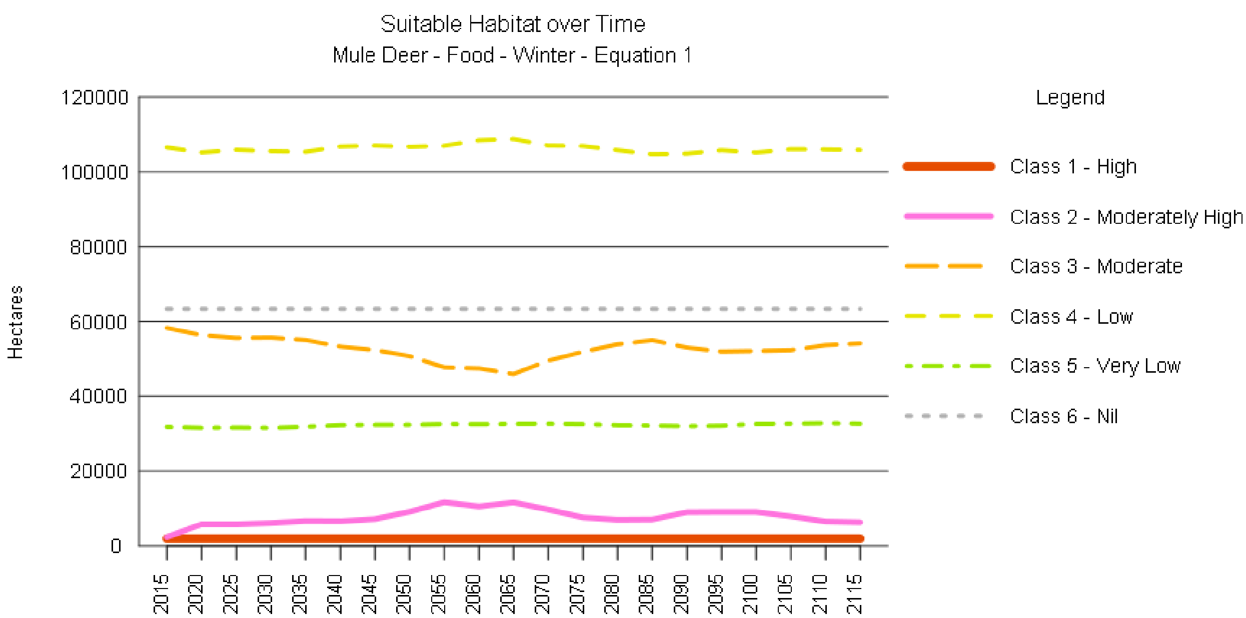
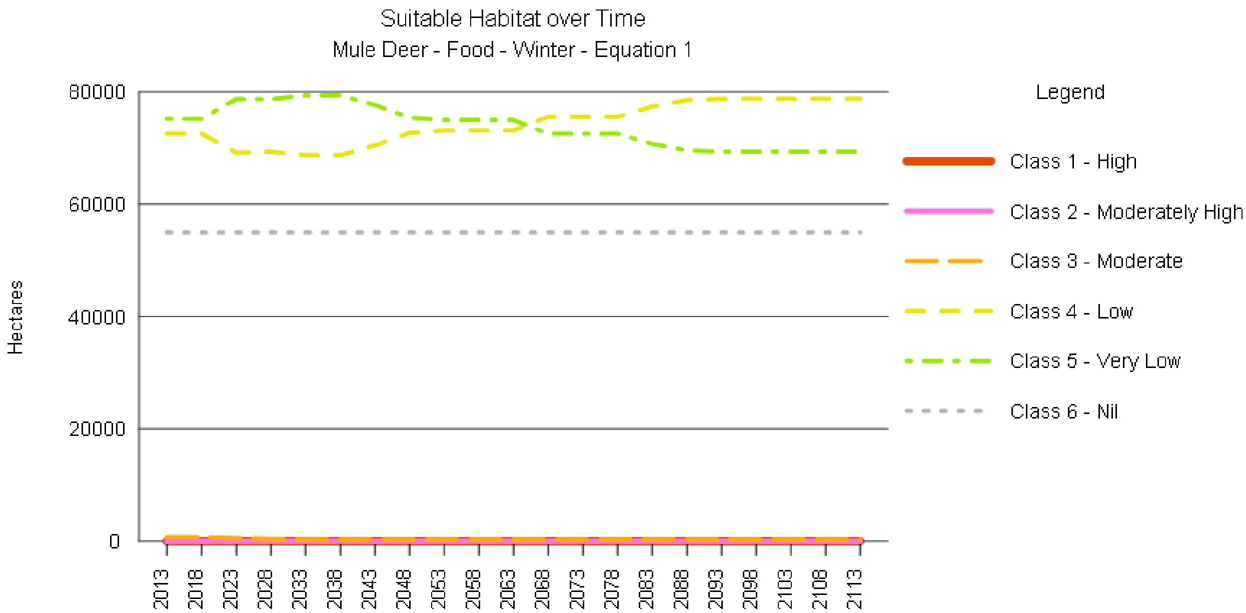


Figure 27. Mule deer winter forage habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



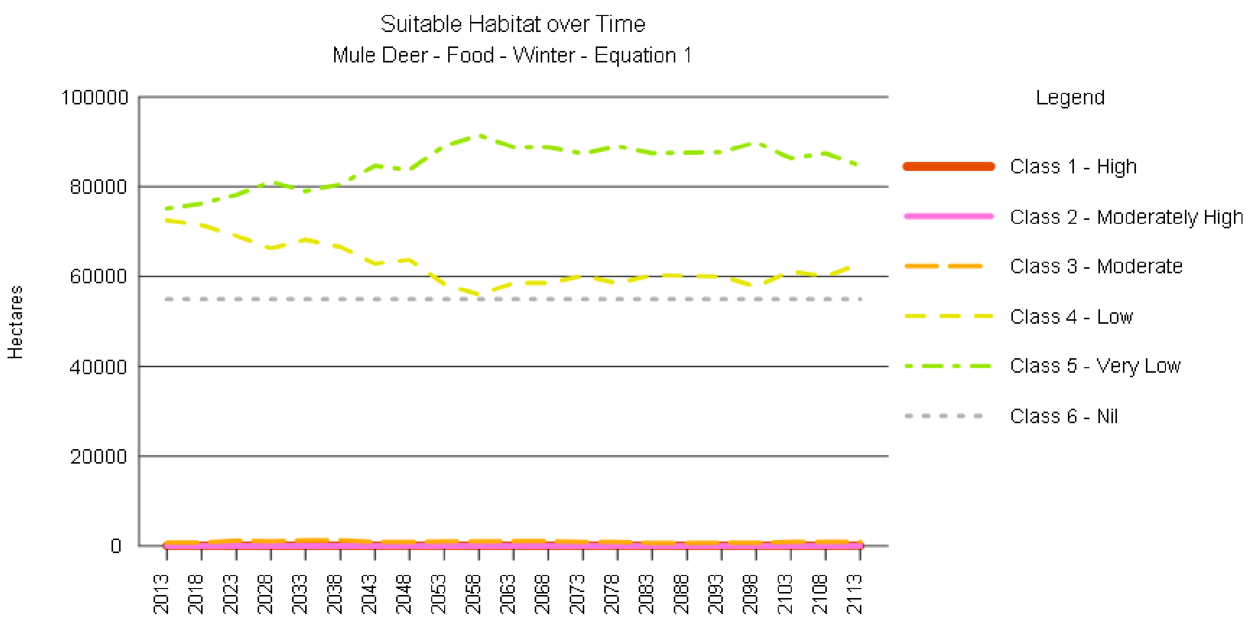
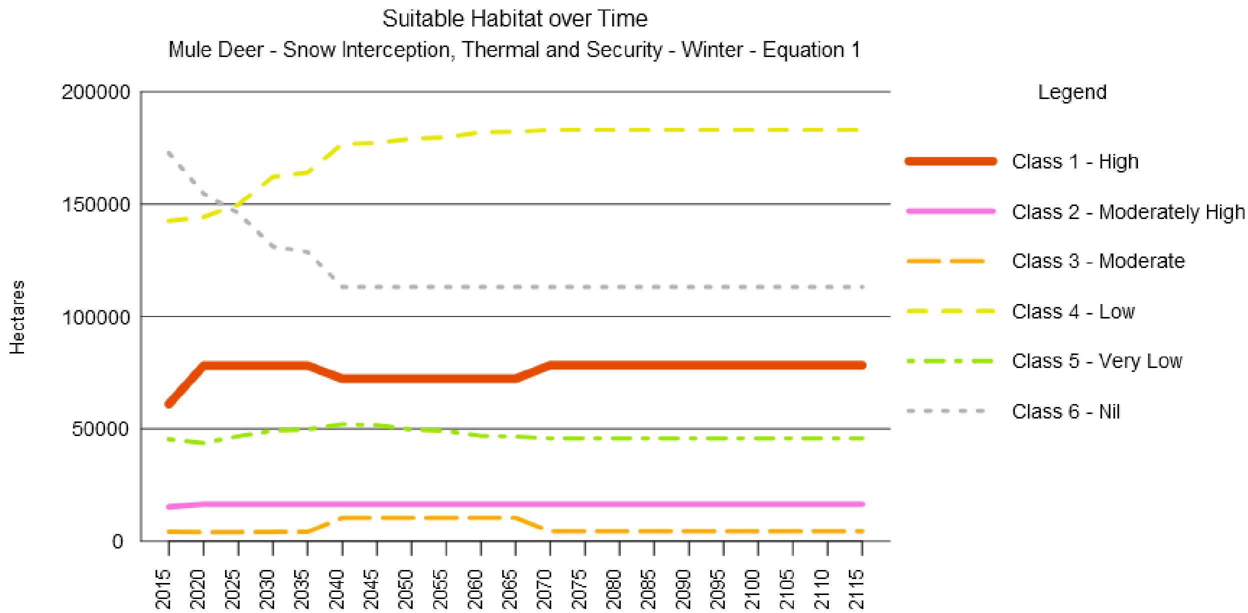


Figure 28. Mule deer winter forage habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



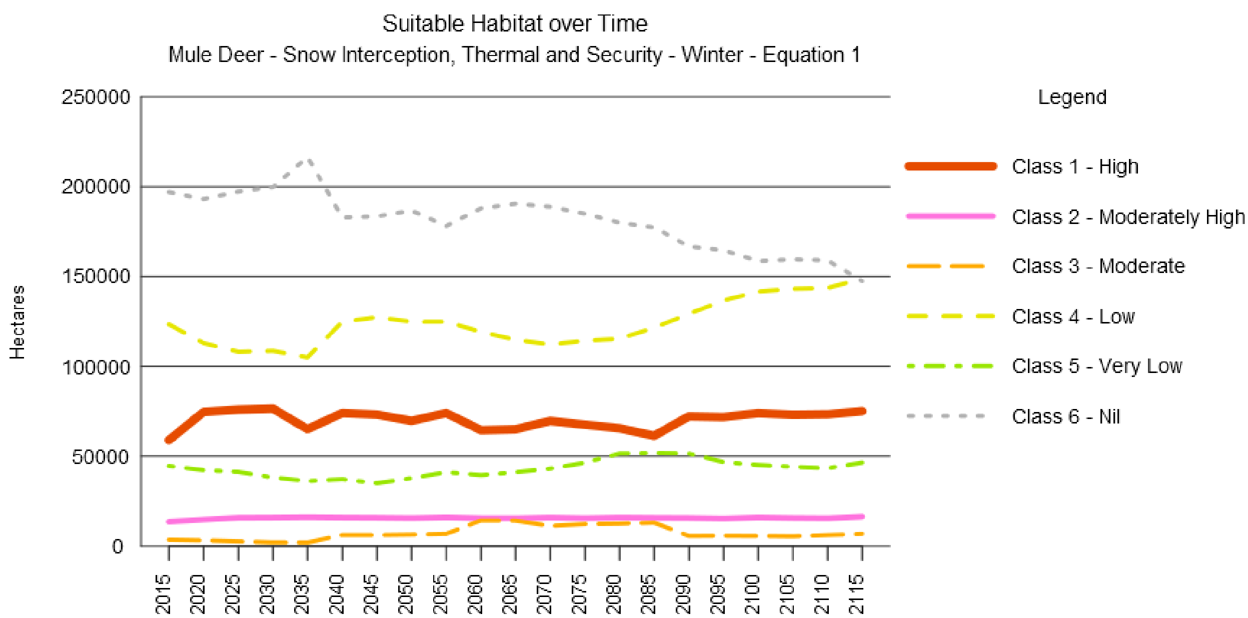
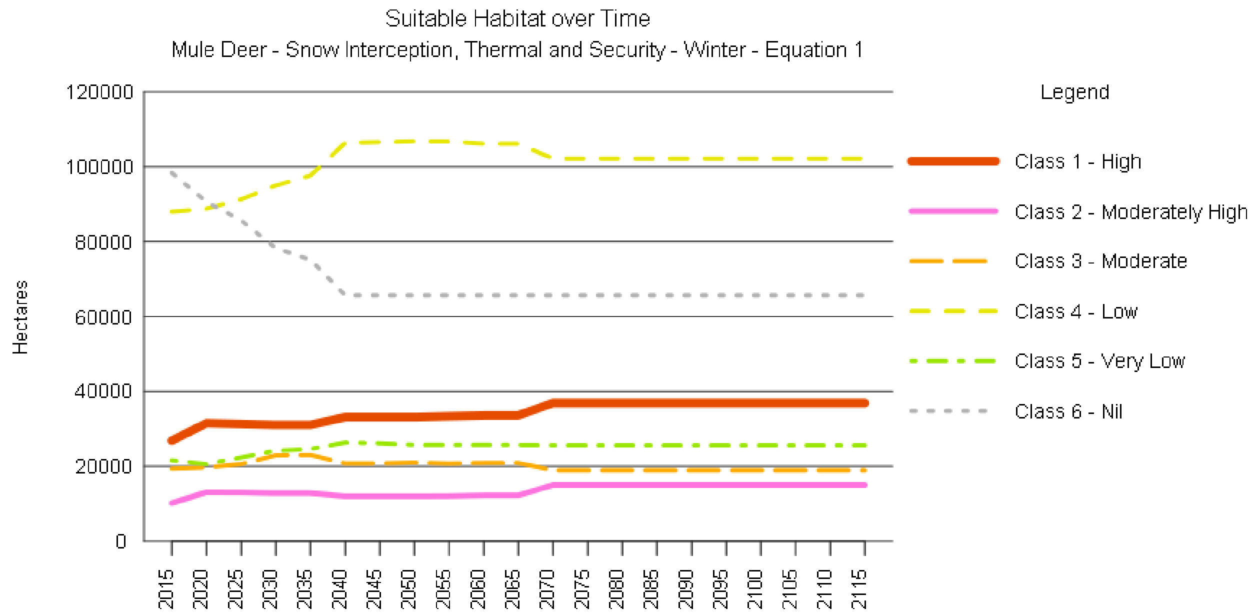


Figure 29. Mule deer winter cover habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



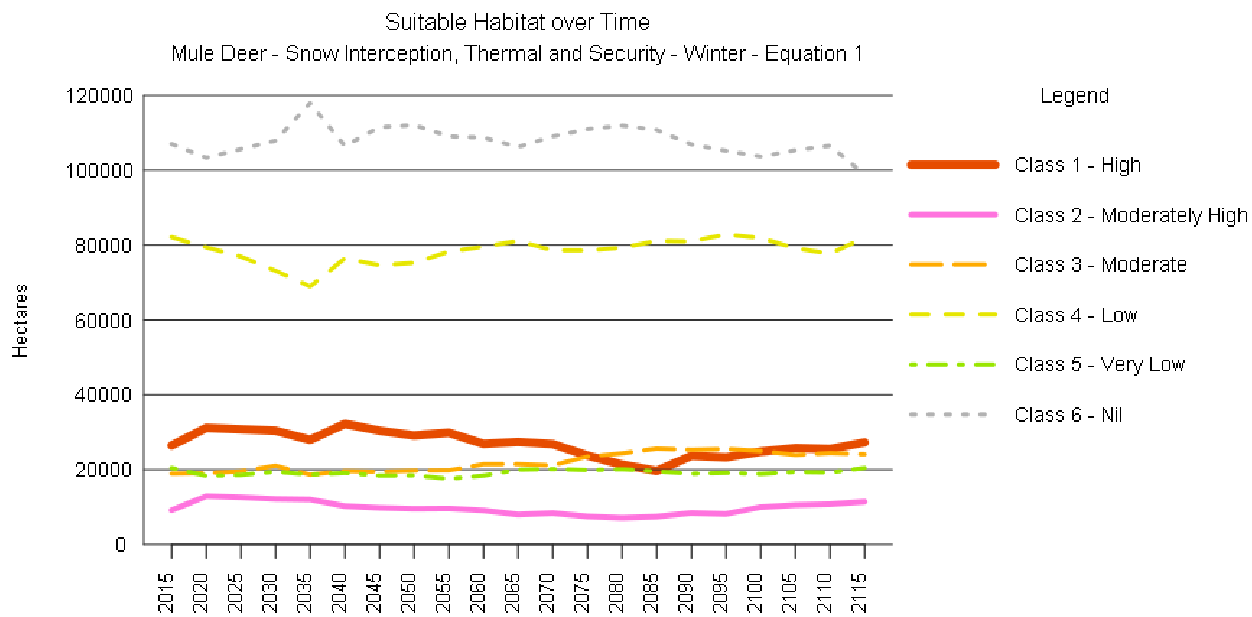
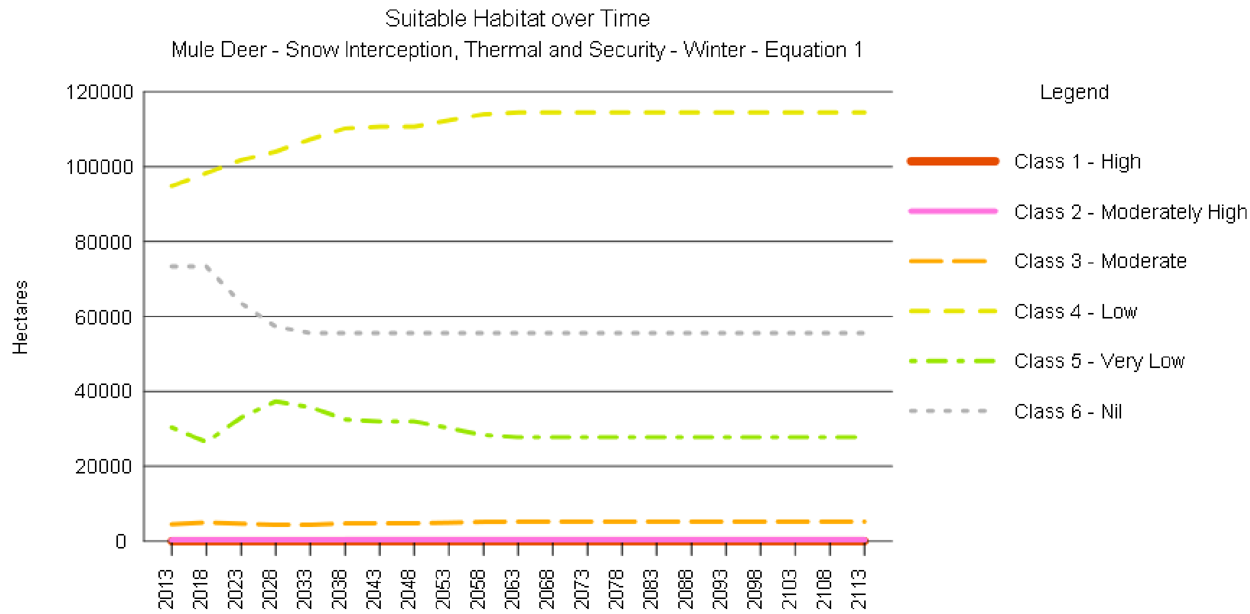


Figure 30. Mule deer winter cover habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



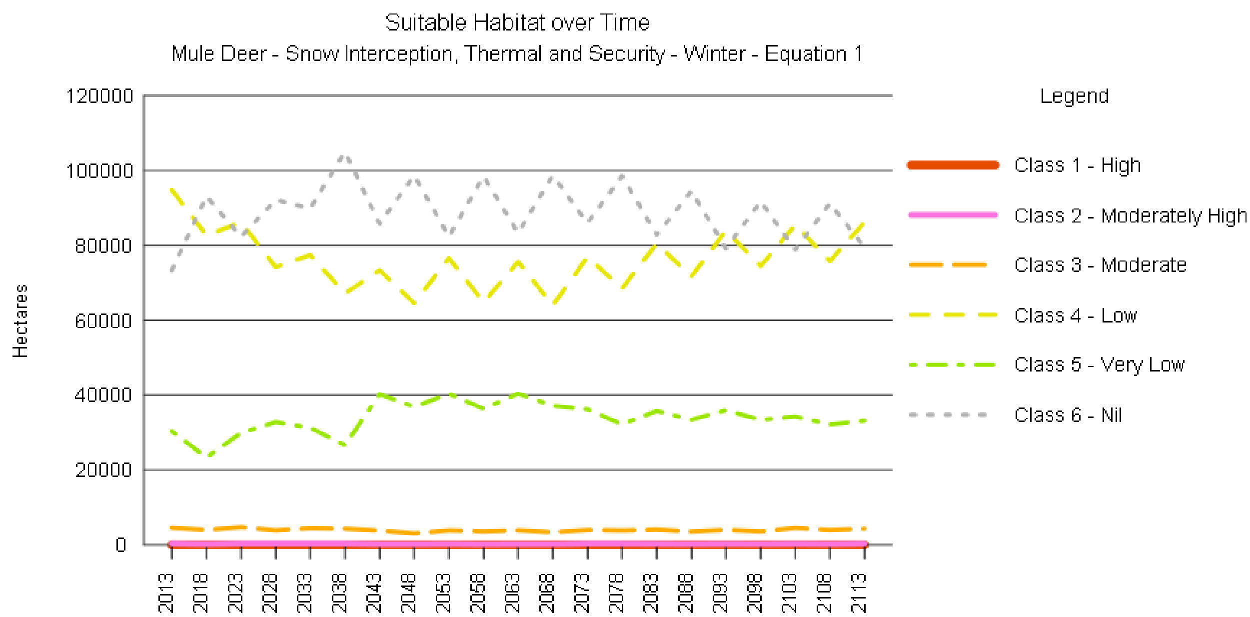
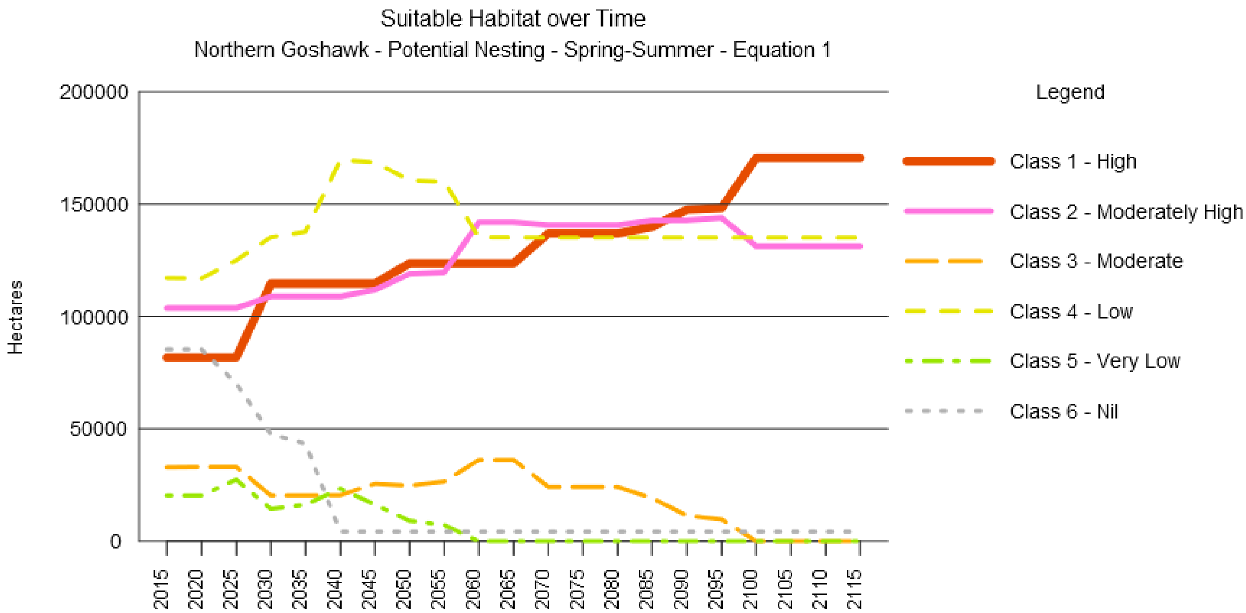


Figure 31. Mule deer winter cover habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



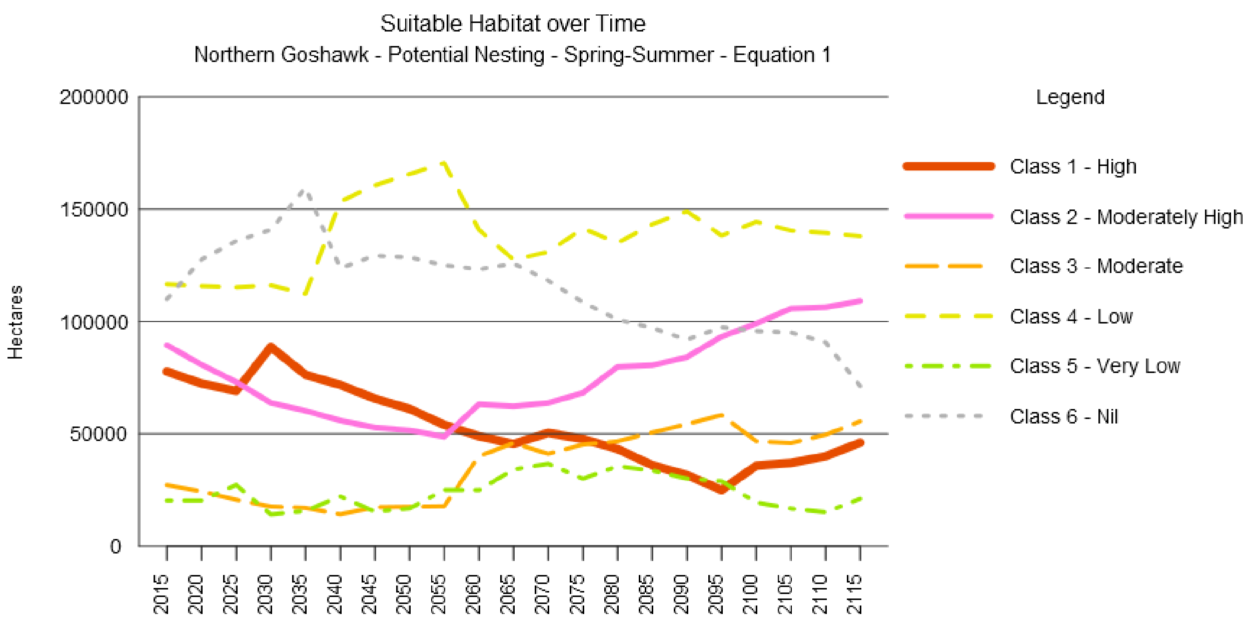
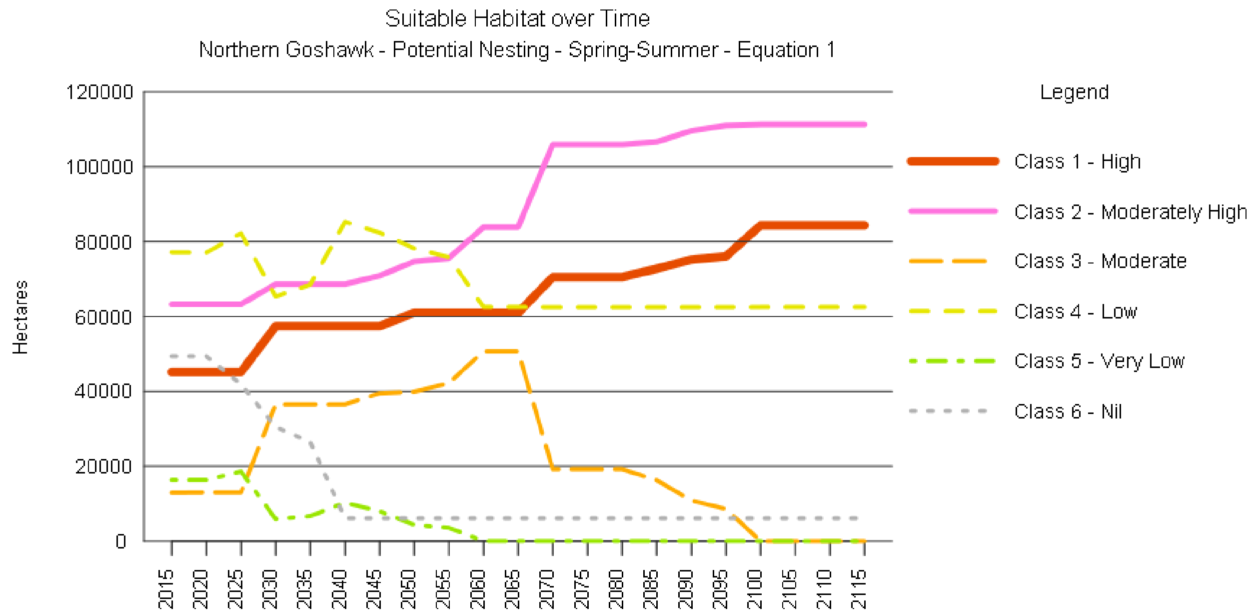


Figure 32. Northern goshawk nesting habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



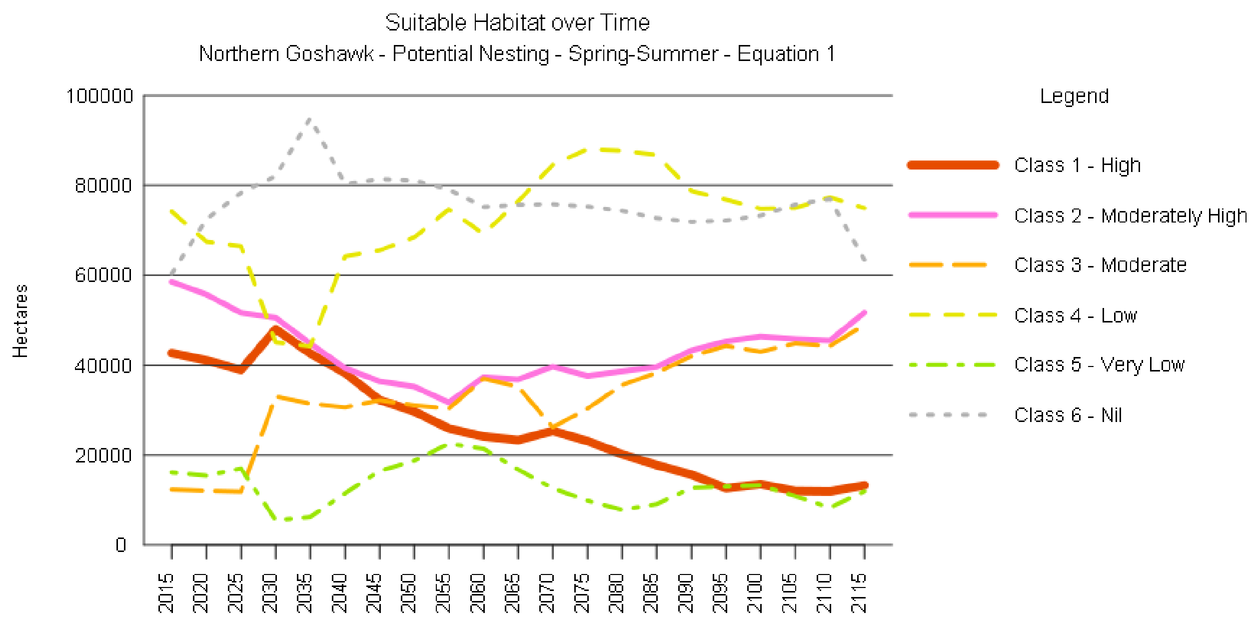
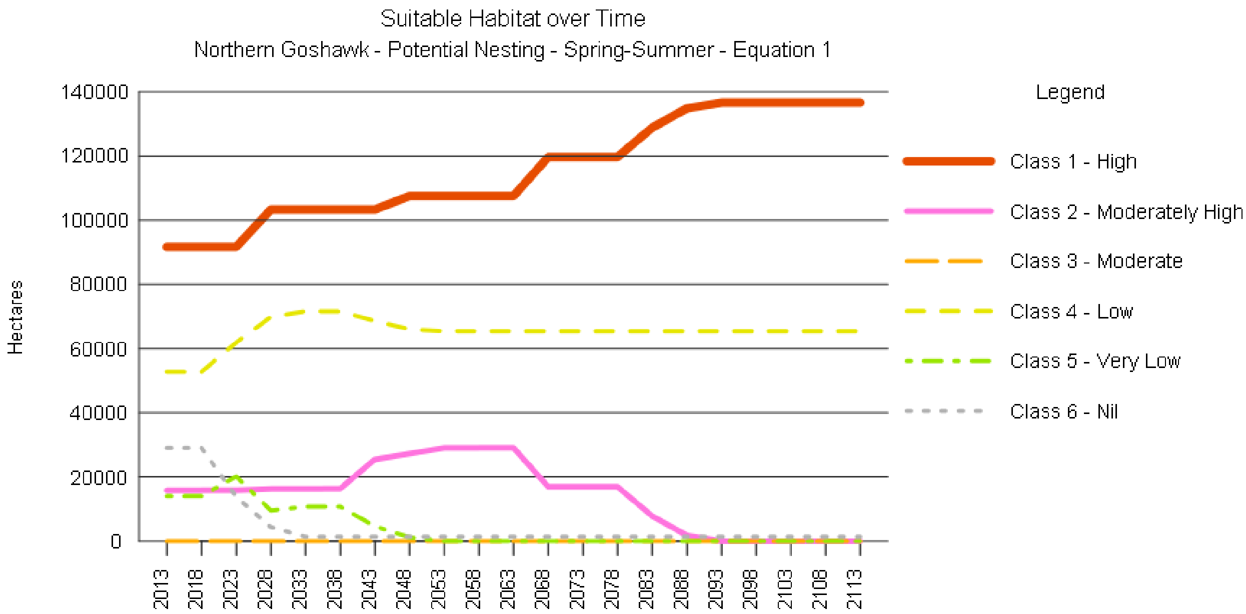


Figure 33. Northern goshawk nesting habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



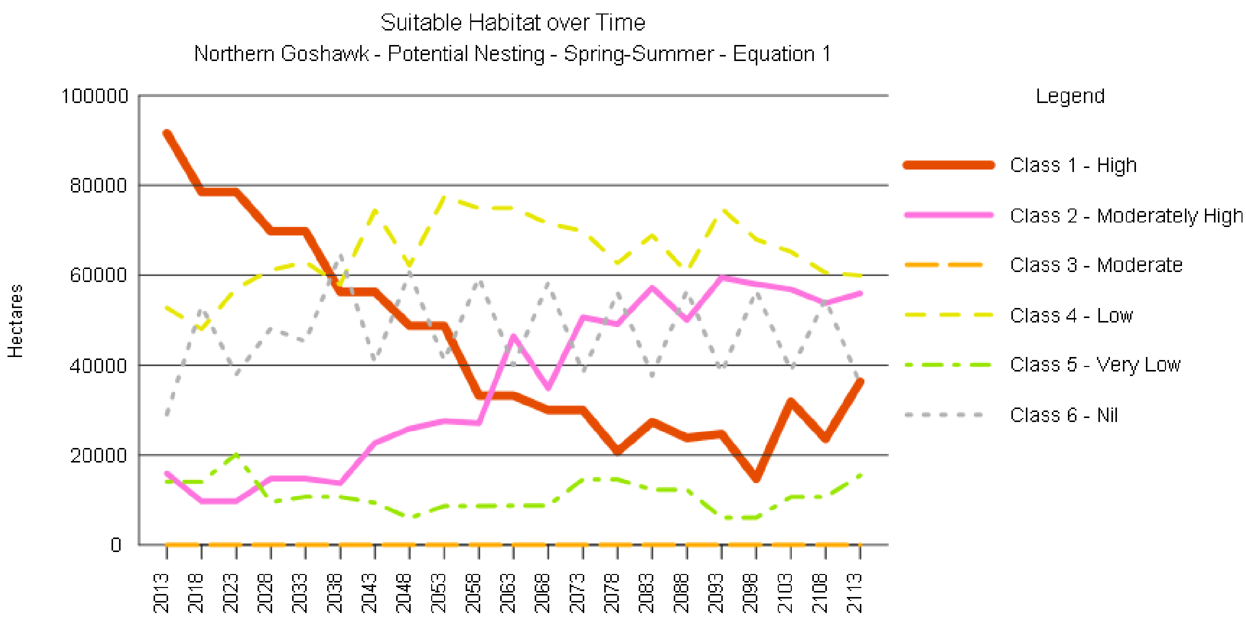
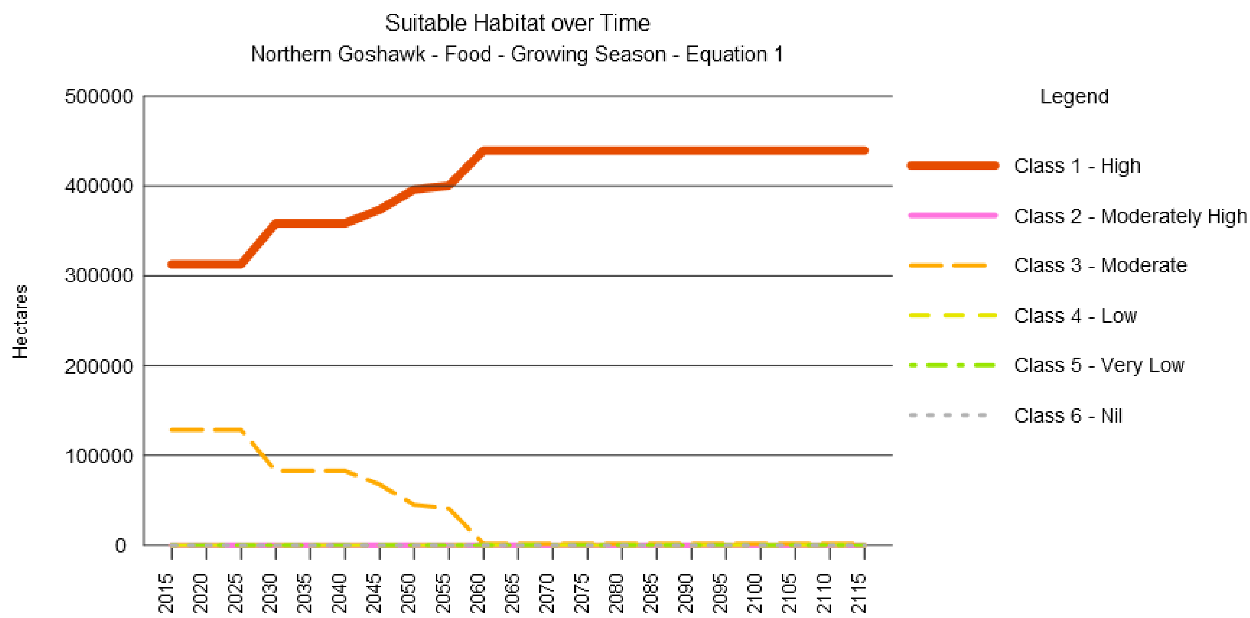


Figure 34. Northern goshawk nesting habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



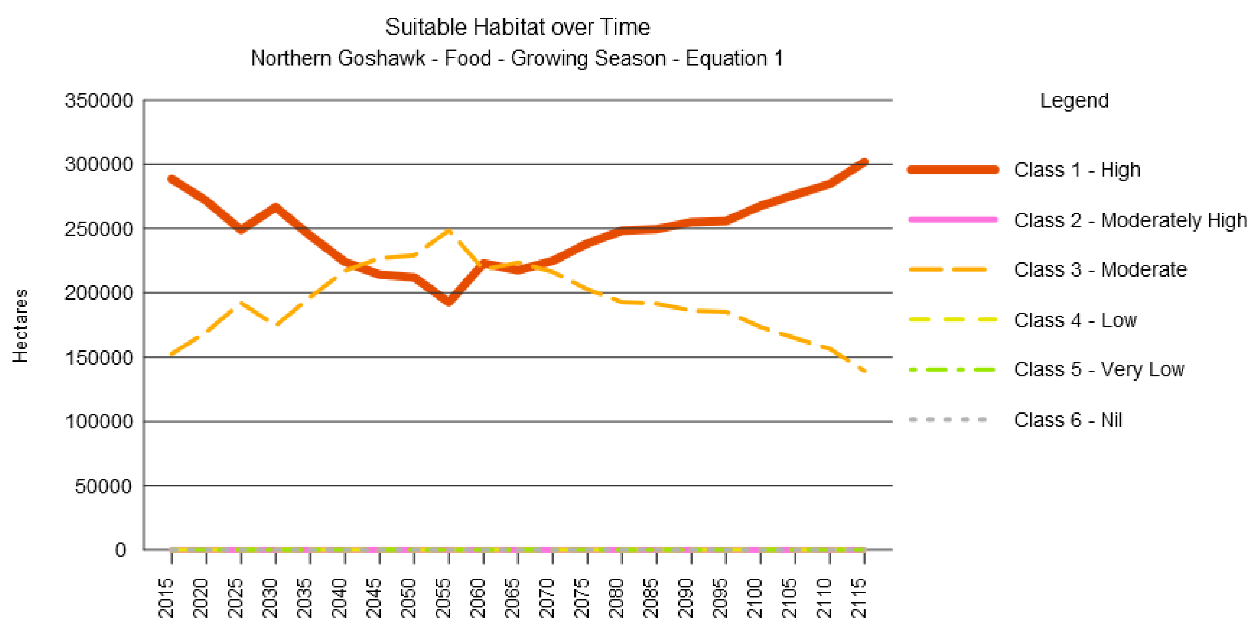
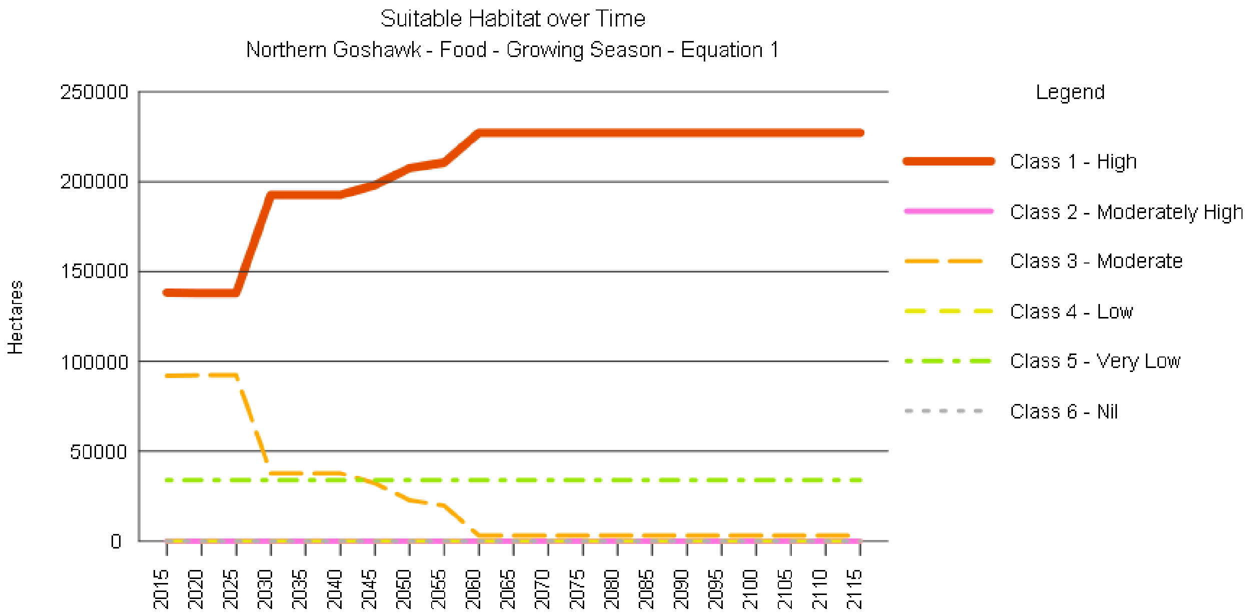


Figure 35. Northern goshawk foraging habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



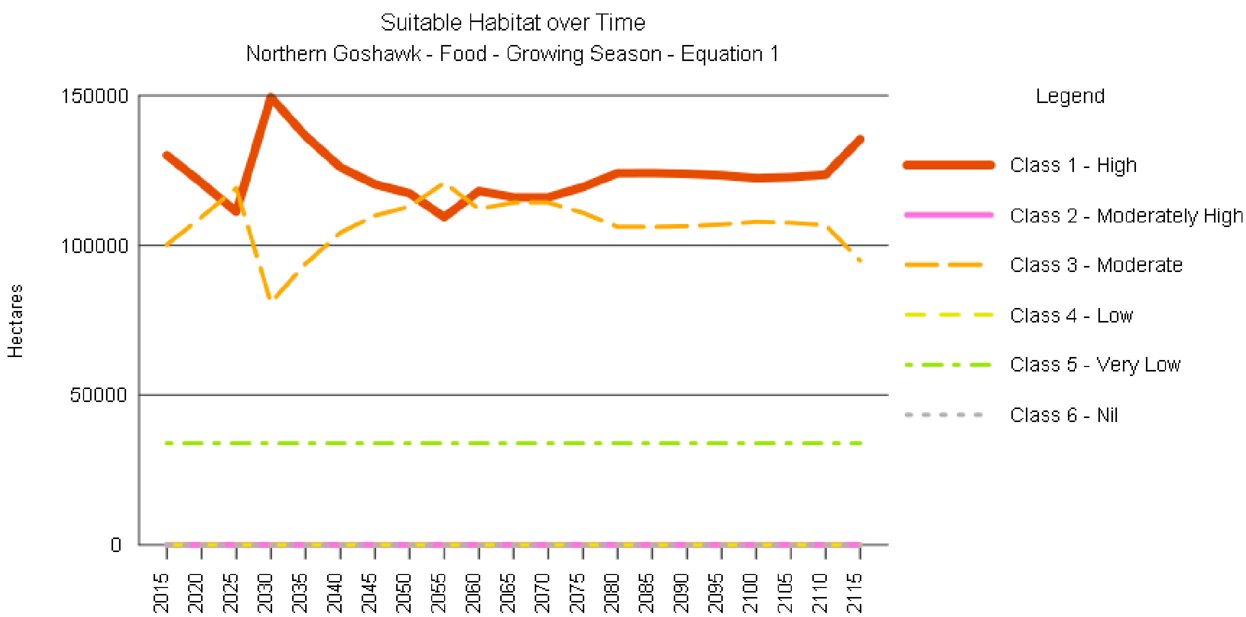
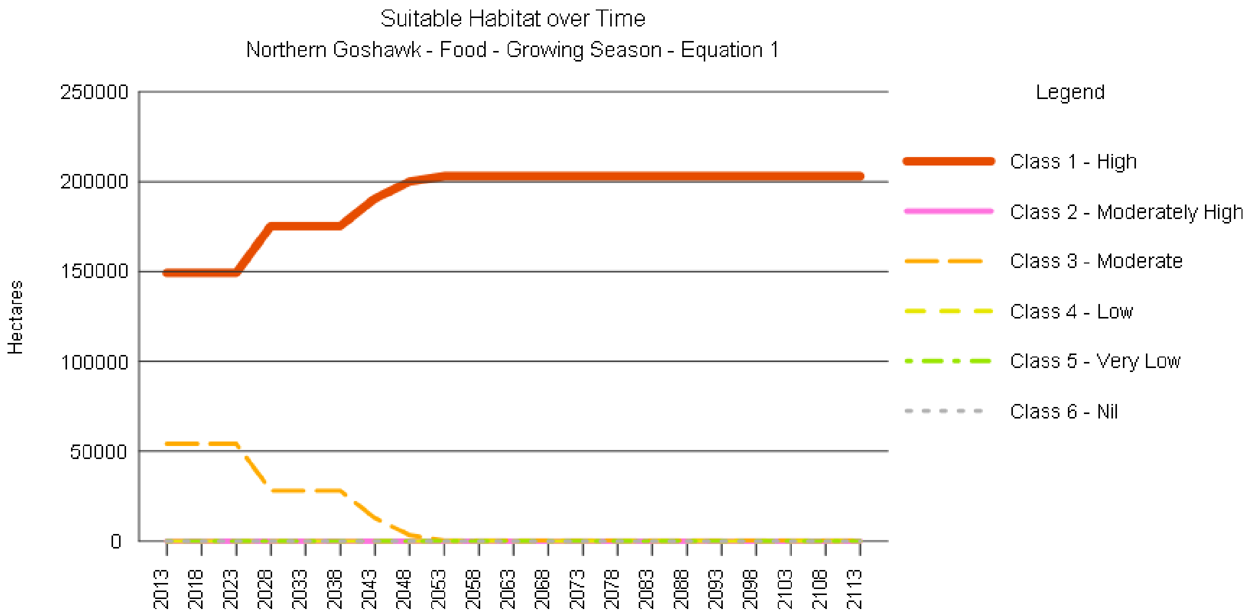


Figure 36. Northern goshawk foraging habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



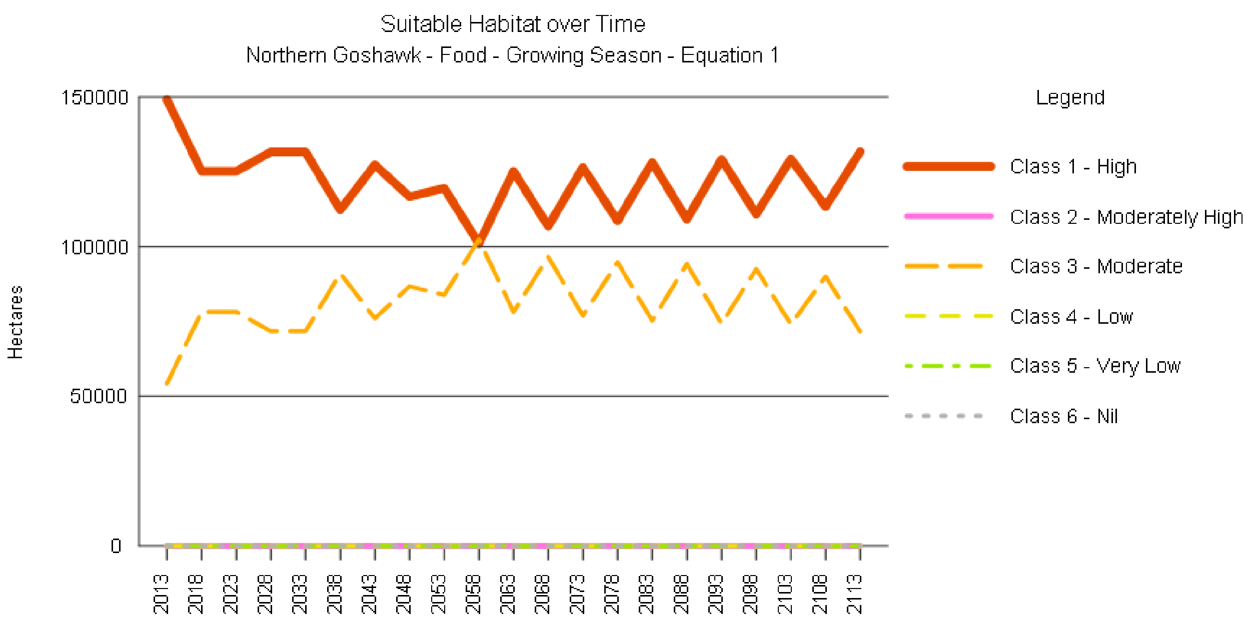
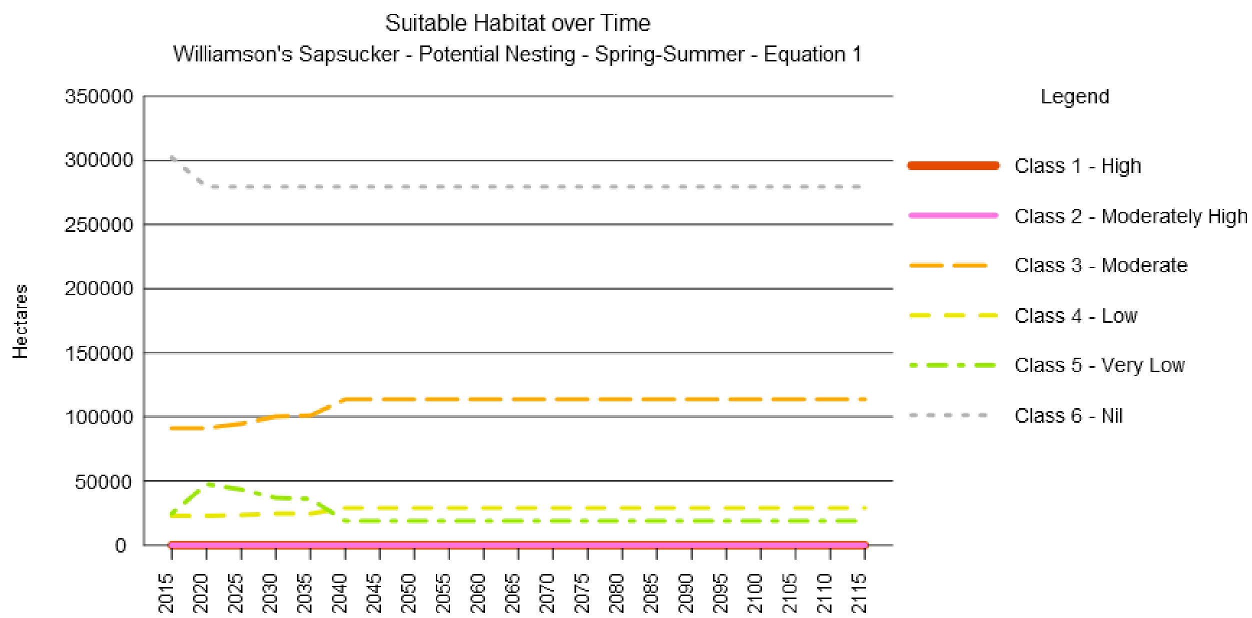


Figure 37. Northern goshawk foraging habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



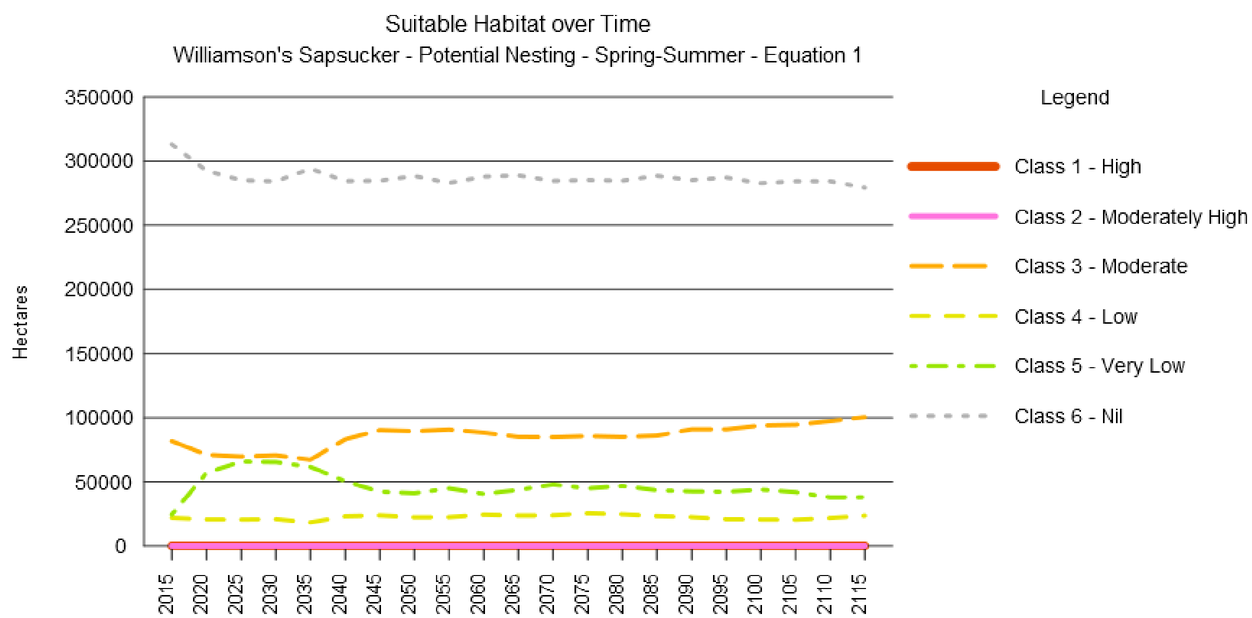
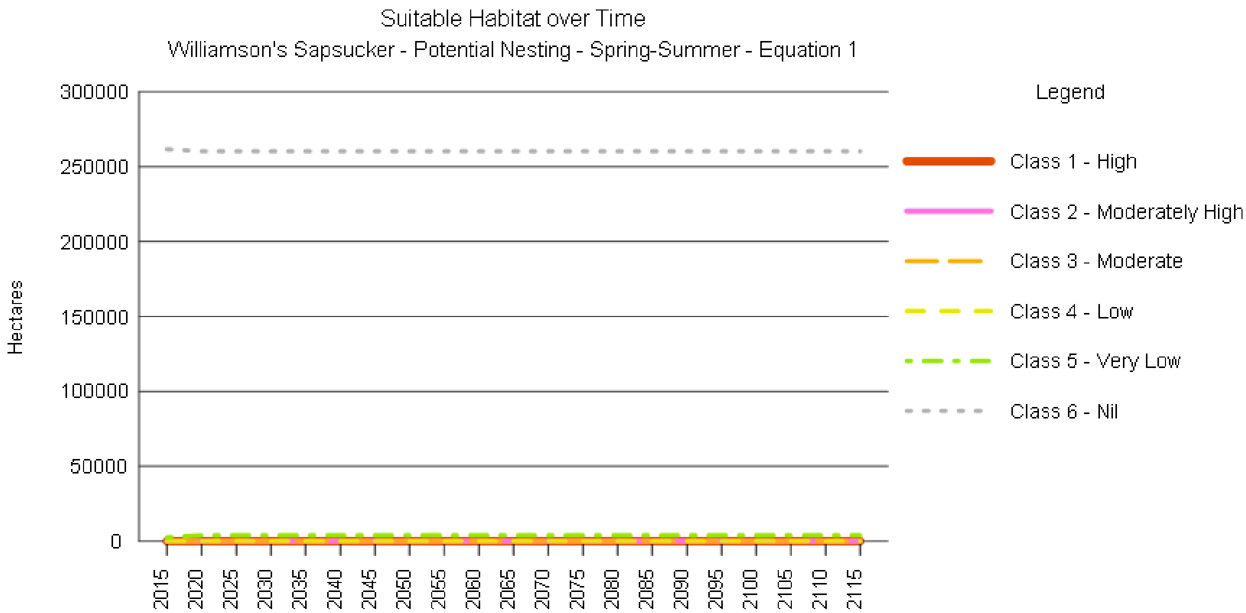


Figure 38. Williamson's sapsucker habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



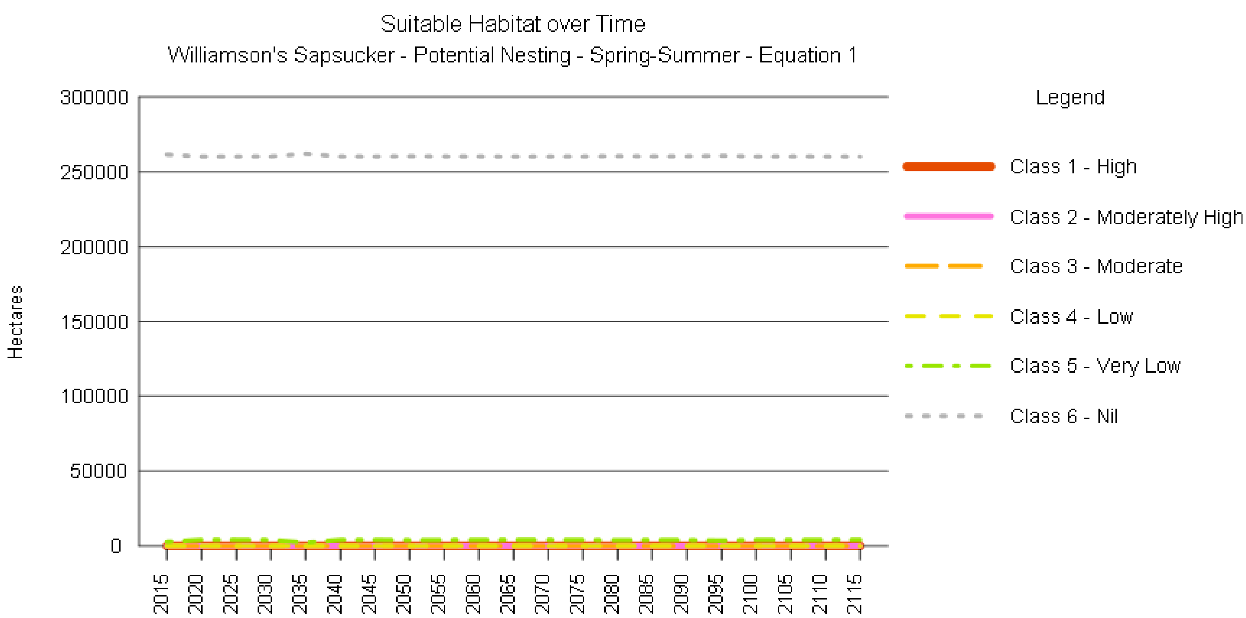
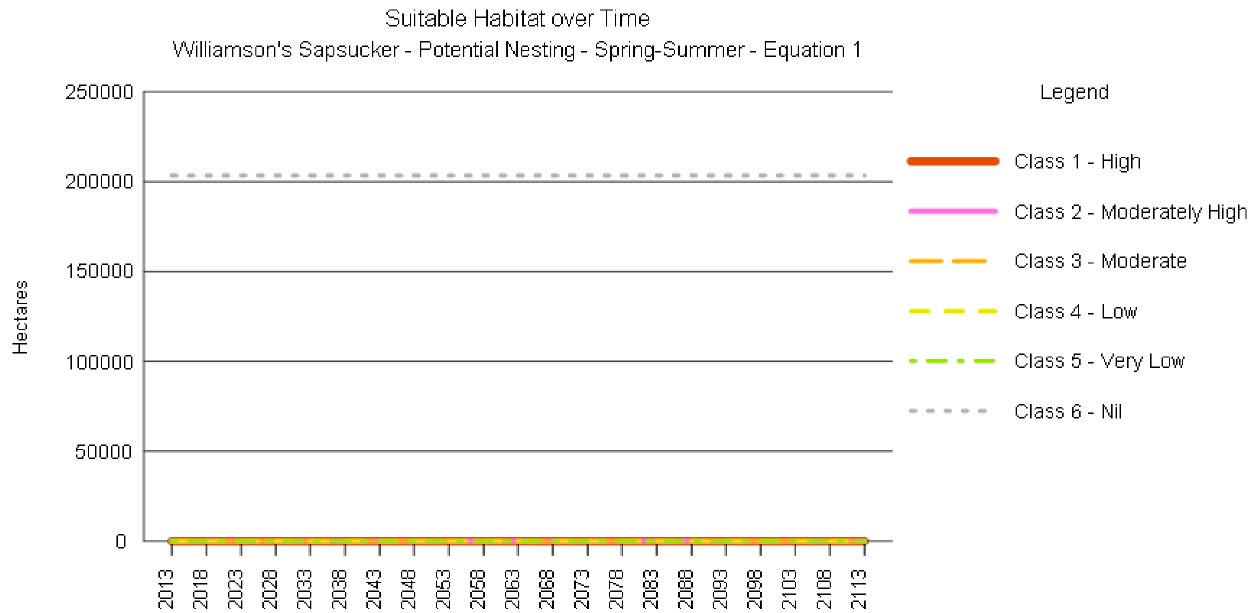


Figure 39. Williamson's sapsucker habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



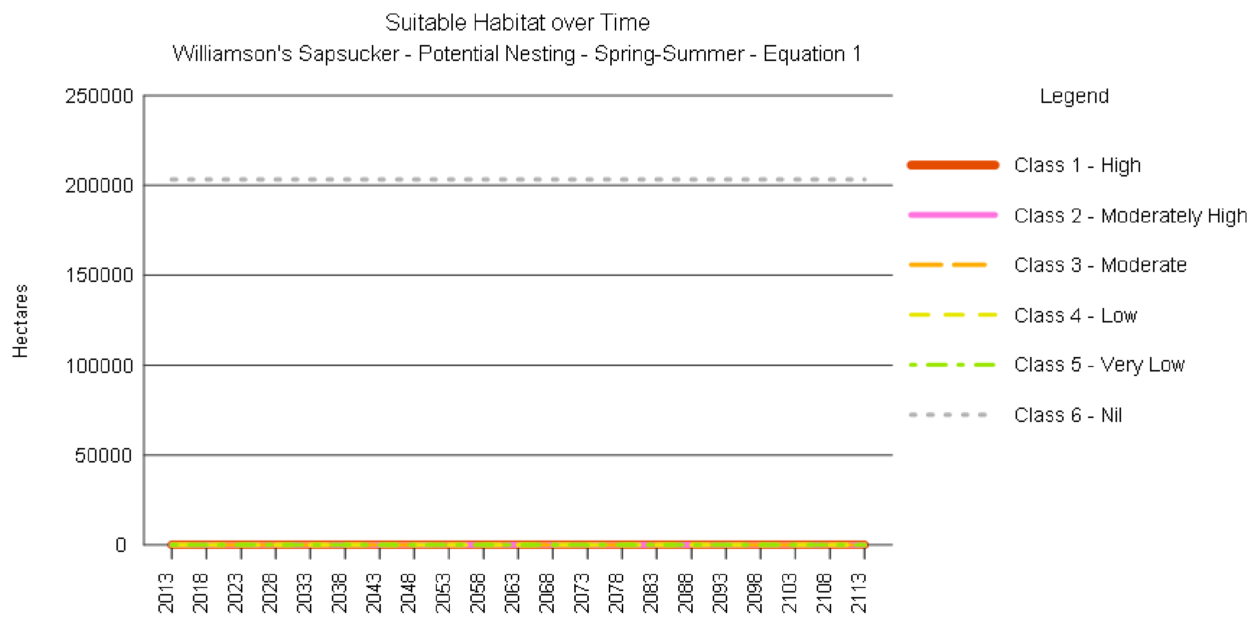
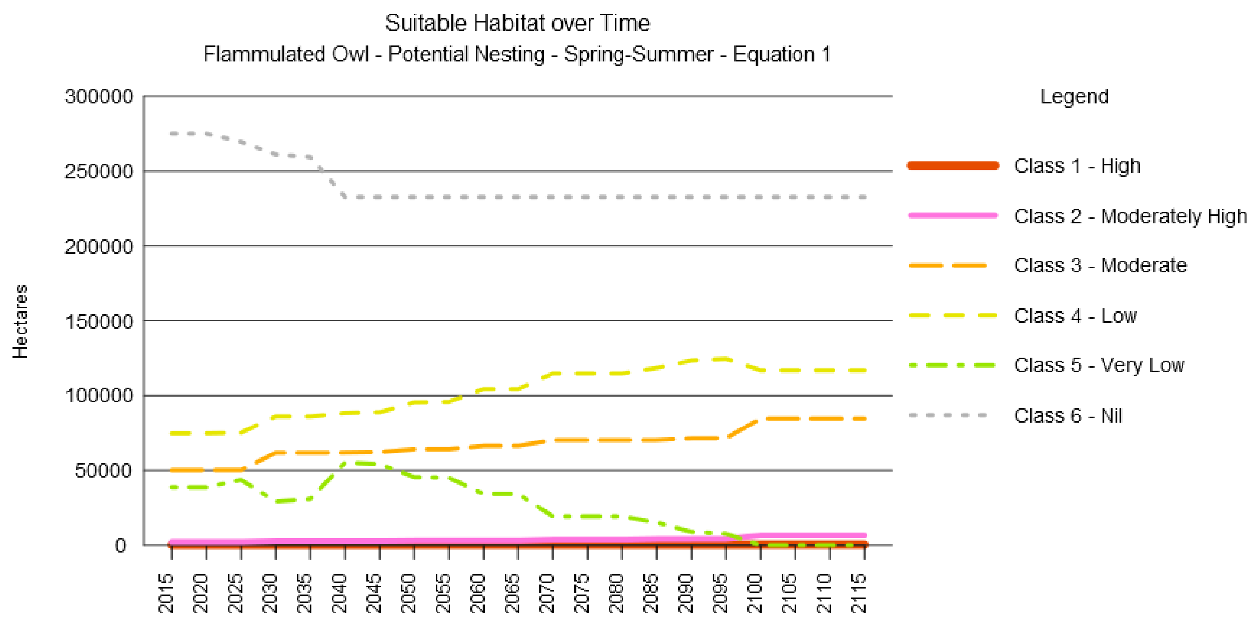


Figure 40. Williamson's sapsucker habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.



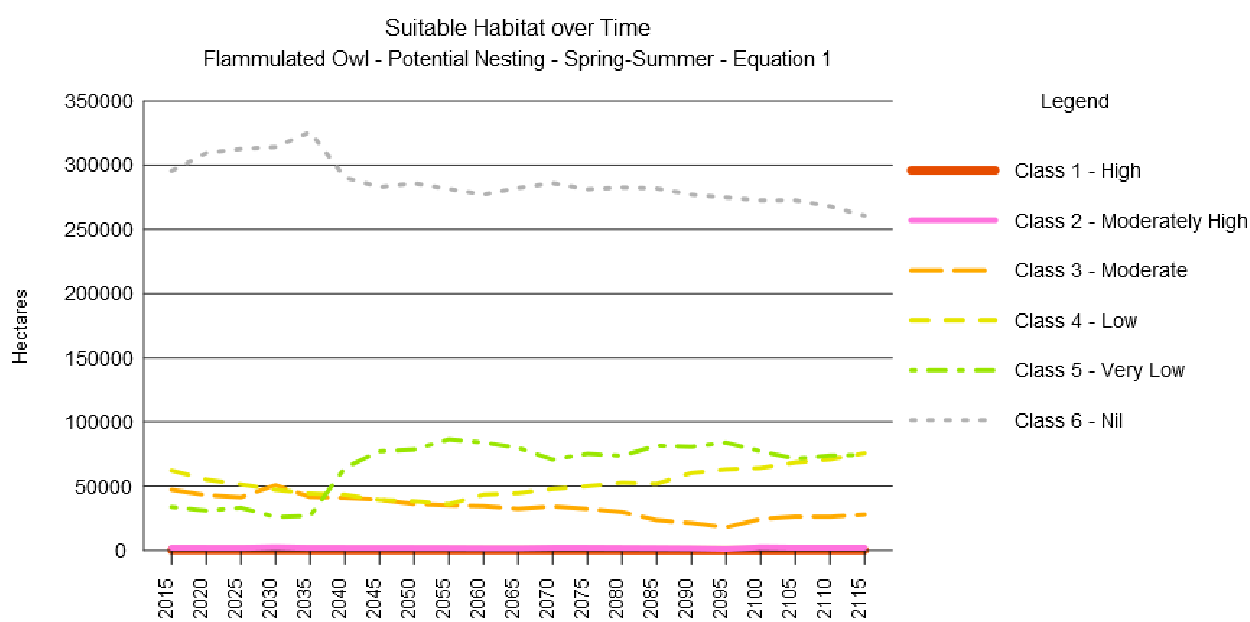
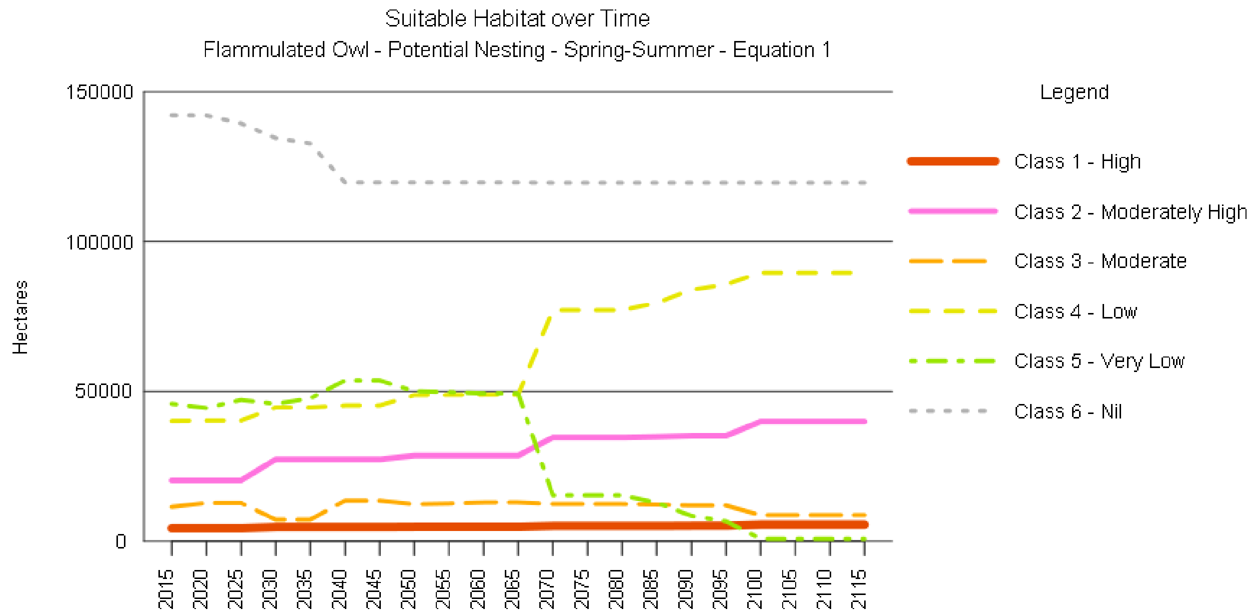


Figure 41. Flammulated owl habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Cranbrook timber harvest land base.



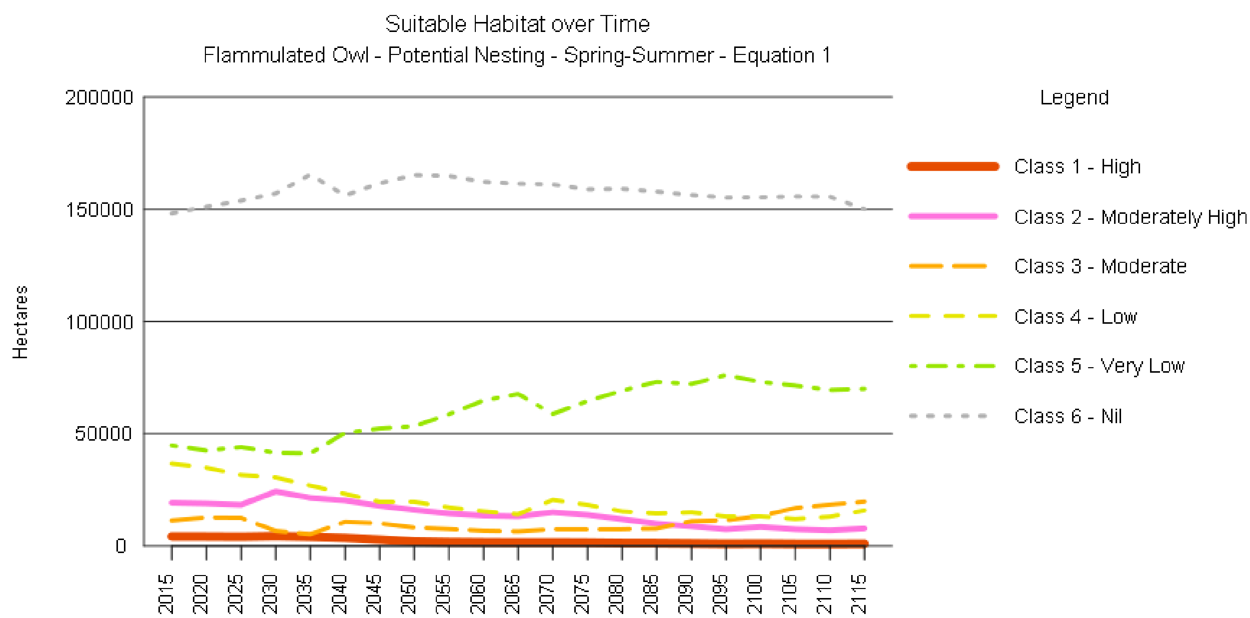
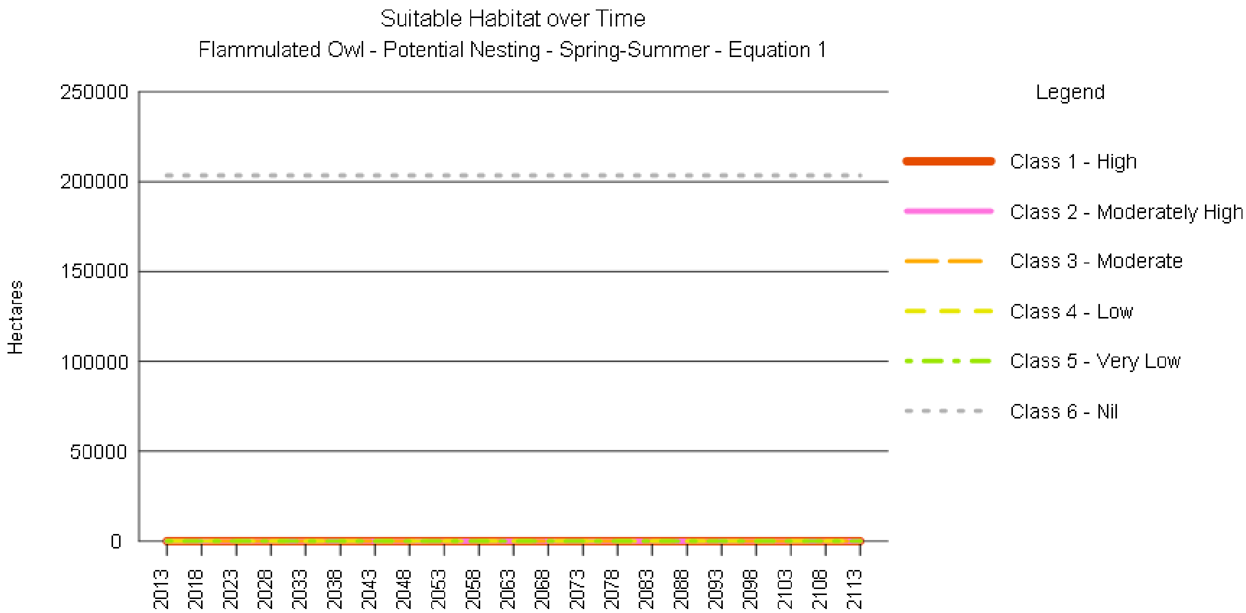


Figure 42. Flammulated owl habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Invermere timber harvest land base.



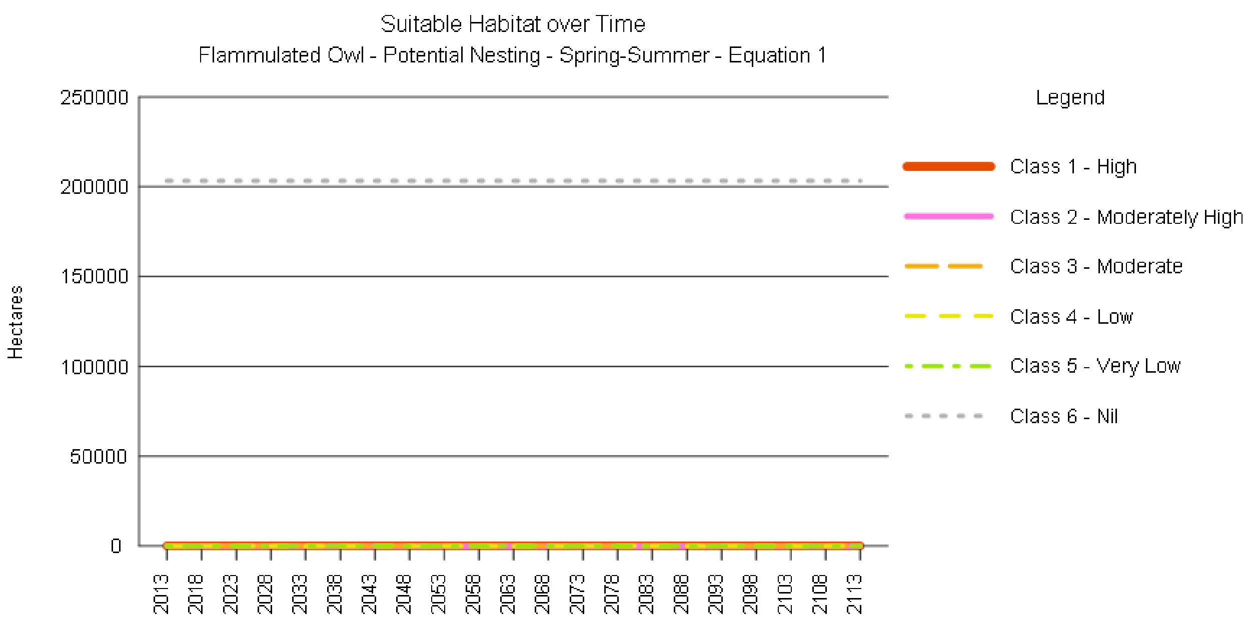


Figure 43. Flammulated owl habitat ratings over time in a no timber harvest (top) and simulated timber harvest (bottom) scenario in the Arrow timber harvest land base.

Discussion

The total area of forest predicted to be cut each year in each TSA was relatively small compared to the size of each TSA and THLB. However, it is important to consider the amount of area cut relative to the amount of high-value habitat for each wildlife species. In addition, it is important to consider the cumulative, multi-year effect of forest cutting on forest age within the THLB. For example, if forest greater than 10 years old is high-value habitat for a wildlife species, then it is important to consider the amount of area cut in a ten year period for evaluating the effects of forestry on habitat for that species, as all forests cut in the last 10 years will not be high-value habitat. Thus, the effects of forestry will be greater for species that require older (e.g., greater than 100 year old) forest habitats, as the area cut over time accumulates over a lengthy time period until it becomes high-quality habitat again. The habitat models described here consider these cumulative effects.

Grizzly Bear

In all TSAs and THLBs, early and late spring habitat appeared to be the limiting habitat for grizzly bear, as the amount of moderate to high rated habitat was relatively small. High-quality spring foraging habitats are characterized as locations with early emergent graminoids and herbs, over-wintered kinnikinnick berries and *Hedysarum* spp. at low elevations and in riparian areas or within avalanche chutes (MacHutcheon 2016). It appears that these habitat types are relatively rare in southeast British Columbia, and therefore should be the focus of grizzly bear habitat management. However, it appears that forestry may have little or no effect on early and late spring habitat quality. This may be because forestry has a limited effect on avalanche chutes, riparian areas (where forest harvest is typically excluded) or other low elevation wet areas.

Overall, forestry may limit the amount of high to moderate quality summer and fall grizzly bear habitat in the Cranbrook and Arrow TSAs in southeast British Columbia. However, the effect was not particularly strong in the short- to mid-term. In addition, the model did not consider the effects of roads created by forestry on grizzly bear mortality, which can be an important limiting factor for grizzly bear populations. The effects of forestry on grizzly habitat quantity and quality and roads, and the implications for grizzly bear populations in the region were analyzed and discussed in more detail in Muhly (2016).

Marten

The majority of the Cranbrook, Invermere and Arrow TSAs and THLBs had a relatively large amount of moderate to high suitability winter habitat for marten, suggesting southeast British Columbia provides excellent habitat for marten in general. However, the results did not consider habitat configuration (i.e., the proximity and composition of food and cover habitat in home ranges), which is an important consideration for marten (Tripp 2016). Therefore, these models likely overestimate the total amount of moderate to high suitability winter habitat for marten. Nevertheless, the habitat supply models suggested that forest harvest was a limiting factor in the amount of high-quality marten habitat in each TSA. If the forest was allowed to mature undisturbed, then marten habitat ratings would slowly increase over the mid to long-term as the forest ages, indicating that forestry historically had a negative effect on the amount of marten habitat in the region. In addition, future simulated forest harvest reduced the amount of moderately-high to high rated habitat in the long-term. Therefore, the model suggests that the amount and location of future forest harvest is an important consideration in marten management.

Elk

High-quality elk winter foraging and cover habitat was relatively limited in the region. Elk winter forage and cover habitat and summer forage habitat was rated highest in the Cranbrook TSA, suggesting it had the best habitat for elk in southeast British Columbia. Future simulated amounts of high to moderate quality elk habitat was relatively stable over time in forest harvest and no forest harvest scenarios, suggesting forestry had little or no effect on elk habitat.

Mule Deer

The majority of moderate to high quality mule deer winter cover and food habitat was located in the Cranbrook TSA. In general, the amount of moderate to high quality habitat was stable over time in forest harvest and no forest harvest scenarios, suggesting forestry had little or no effect on mule deer habitat.

Northern Goshawk

High-rated northern goshawk nesting and foraging habitat was relatively abundant in the Cranbrook, Invermere and Arrow THLBs. However, forest harvest appears to significantly limit the amount of moderate to high rated nesting and foraging habitat for northern goshawk, as indicated by future simulated forest harvest effects on habitat ratings. High-quality northern goshawk habitat is characterized as mature to old forest of diverse types. Therefore, forest harvest is an important consideration in northern goshawk management.

Williamson's Sapsucker

Williamson's sapsucker habitat only occurred in the Cranbrook TSA, and the best habitat was rated moderate. Future simulated forest harvest did not have a large effect on the amount of moderate rated habitat, suggesting it is not an important consideration in Williamson's sapsucker management.

Flammulated Owl

Flammulated owl habitat only occurred in the Cranbrook and Invermere TSAs and the amount of higher rated habitat there was relatively small. Optimum flammulated owl nesting habitat consists of mature to old Douglas-fir forest. Forest harvest may limit the amount of moderately-high rated flammulated owl habitat in these TSAs. Therefore, forest management appears to be an important consideration in flammulated owl management.

Conclusions

The wildlife habitat supply models suggest that historic and future forest harvest limits the amount of higher quality habitat for marten, northern goshawk and flammulated owl. This result is intuitive, as forest harvest reduces the amount of older forest habitat on the landscape, and it raises the important question of how much habitat is necessary to conserve these species or manage them at a level that meets socio-economic objectives. For example, it is unknown what a 100,000 ha reduction of high-quality habitat means for the marten population and for providing adequate trapping opportunities in the region. To achieve this level of understanding, more information is needed on how forest management influences the density of these wildlife species in the region, and there needs to be a policy mechanism for evaluating and making decisions on trade-offs between forest harvest and wildlife values. The habitat models described here do not provide solutions for how to manage wildlife species. However, they help focus discussion on wildlife species that appear most affected by forestry. Below is a summary of how each evaluated species should be considered in the Cranbrook, Invermere and Arrow TSRs.

Wildlife Species Unlikely to Have a Downward Pressure on Short Term Timber Supply

The amount of foraging habitat for ungulate species (i.e., elk and mule deer) was not negatively influenced by simulated future forestry, and was positively influenced in some cases. Historically, forestry may have influenced forage habitat quality and quantity for ungulates, but the influence may have been positive due to forestry creating early seral vegetation (i.e., herbaceous and shrub cover) that ungulates prefer to eat. In addition, future simulated ungulate cover habitat quality was not significantly negatively influenced by forestry. Currently, there is little evidence that cover habitat is or in the foreseeable future will be a primary limiting factor for elk or mule deer populations in southeast British Columbia (MOE 2010; MFLNRO 2014). Therefore, no additional consideration is recommended for elk and mule deer in this timber supply analysis.

Flammulated owl and Williamson's sapsucker are species of conservation concern in the Cranbrook and Invermere TSAs. They are both identified under the Identified Wildlife Management Strategy (IWMS) in British Columbia, and therefore receive special management attention. Flammulated owl are listed as *Special Concern* by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and under Schedule 1 of the *Species at Risk Act* (SARA). Consequently, federal and provincial management strategies to maintain stable or increasing populations have been developed for the species (Provincial Flammulated Owl Working Group 2011; Environment Canada 2013). In addition, in the Cranbrook TSA, 321 ha of habitat have been protected by WHAs, including 167 ha of conditional harvest area and 154 ha of no harvest area. In the Invermere TSA, 137 ha of habitat are protected by WHAs, including 29 ha of conditional harvest area and 108 ha of no harvest area. Williamson's sapsucker are listed as *Endangered* by COSEWIC and under Schedule 1 of SARA (MOE 2012; Environment Canada 2014c). Federal and provincial management plans have also been developed for Williamson's sapsucker. In the Cranbrook TSA 1,597 ha of habitat have been protected by WHAs as no harvest area.

Flammulated owl may be vulnerable to future forest activity. Historically, forestry activities likely reduced the amount and quality of habitat for this species. Therefore, management of this species (e.g., additional WHAs) should continue, which could have an effect on timber supply. However, the effect is likely to be small given the limited amount and extent of high quality habitat in the region. In addition, while flammulated owl are uncommon in Canada and British Columbia, their range extends throughout western North America, and therefore the species as a whole is unlikely to be extirpated in the foreseeable future. For these reasons, additional downward pressure on timber supply is not currently recommended for this species.

Wildlife Species That May Have a Downward Pressure on Short Term Timber Supply, but Further Information Needed to Understand Effects on Mid- to Long-term Timber Supply

Grizzly bear are listed as species of *Special Concern* by COSEWIC and are blue listed (i.e., species with characteristics that make them particularly sensitive to human activities or natural events) in British Columbia with a S3 conservation status (i.e., rare and local, found only in a restricted range or susceptible to extirpation or extinction). They are also valued as a harvested species in British Columbia, and hunting is regulated through a limited entry hunt system (Austin et al. 2004). Grizzly bear are an important wildlife species in British Columbia and receive a relatively large amount of management attention. Some grizzly bear population units in southeast British Columbia are in decline (Mowat and Lamb 2016) and are therefore of conservation concern.

Grizzly bear forage habitat quality and quantity did not appear to be significantly negatively influenced by future simulated forestry. Indeed, similar to ungulates, forestry may positively influence forage habitat quality and quantity by creating early seral vegetation (i.e., herbaceous and shrub cover) that grizzly bear prefer to eat. However, we caution that the habitat model did not consider the effect of forestry road development on grizzly bear mortality. Historical road development due to forestry likely increased grizzly bear mortality in the region, and additional forestry road development could continue to do so in the future, possibly contributing to population decline. The relationship between grizzly bear and timber supply requires consideration of the mortality effects of future forestry roads on grizzly bear. Those effects were considered separately (Muhly 2016). Given the high socio-economic and intrinsic value of grizzly bears and the decline of some populations in the region there is a reasonably high likelihood that additional management actions to conserve grizzly bear (e.g., additional access management or WHAs) within the next 10 years could affect timber supply. Data on grizzly bear will need to be continually collected in the future to ensure we have credible information to conserve them in the region and adequately account for them in future timber supply analyses.

Northern goshawk habitat quality and quantity has previously, and will likely continue to be limited by forestry. However, there currently is relatively abundant high-quality northern goshawk habitat in southeastern British Columbia. In addition, northern goshawk are a relatively common species throughout North America, including British Colombia and Canada. Thus, there is little evidence to suggest that northern goshawk management will require additional downward pressure on timber supply in the foreseeable future. However, there is also a great deal of uncertainty around northern goshawk in southeast British Columbia. Current population status and trends are unknown in the region. No additional downward pressure on timber supply is recommended at this time, but if northern goshawk remain a priority management species in southeast British Columbia, more information is needed to adequately account for them in timber supply analyses.

Wildlife Species That May Have a Downward Pressure on Short Term Timber Supply and May Require Development of a Management Regime to Understand Effects on Mid- to Long-term Timber Supply

High-quality and quantity marten habitat is relatively abundant in southeast British Colombia. However, previous forestry activity has likely limited current habitat quality and quantity because high-quality marten habitat is characterized by older coniferous forests with lots of coarse woody debris. In addition, future forestry will likely continue to limit the amount and quality of marten habitat.

Marten are relatively abundant and wide-ranging in Canada and British Columbia. They are not a species of conservation concern, but they are highly valued by trappers and First Nations. Relatively little is known about marten populations in British Columbia despite their importance as a commercial species. Furthermore, little is known about how forestry affects marten populations in British Columbia. Therefore, additional data and a more formal management regime may be needed for marten to adequately manage them. There is potential for marten management to have a significant downward pressure on timber supply if populations were to decline suddenly. Additional information on marten populations and forestry-marten interactions in southeast British Columbia is needed to adequately account for them in timber supply analyses.

Wildlife Species That Have a Downward Pressure on Short Term Timber Supply to Avoid Infringing on First Nations Rights to Hunt and Trap

As indicated above, existing ungulate winter ranges (UWRs) and WHAs are already accounted for the in the timber supply base case analysis and apply a downward pressure on timber supply. Additional downward pressure is not recommended here, as the results of the wildlife habitat models do not indicate a severe influence of forestry on wildlife that requires an immediate response in the form of a reduction to the AAC for the region. However, more credible information is needed on some species, particularly marten, to ensure timber supply does not further infringe on First Nations rights.

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Appendix A. Maps of Habitat Rating Suitability and Capability by Wildlife Species and Season