7.6.1 Mule Deer (*Odocoileus hemionus hemionus*) Winter Range Even-aged Systems

1. Key Habitat Objectives

Maintain and or recruit habitat elements for mule deer winter range – for winter forage, thermal protection (snow interception) and security cover**.**

Landscape Level: Landscape level management objectives such as connectivity, patch size distribution and seral stage targets should be described in higher level plans and sustainable forest management plans. It is important to link higher level plan objectives such as mature/old forest targets for a landscape unit or other planning area, with specific practices implemented at the stand level (see Management Guidelines below).

A further discussion of landscape level considerations is found in the Landscape Considerations section of this report.

2. Forest Types or BEC Zones

BG all, BWBS dk, mw, ICH dk, dw, mk, IDF all, MS dk, PP xh, SBS dh, dw, mh

Note: There will be some variation in the harvesting and silviculture Management Guidelines recommended below, based on site-specific ecosystem variation. Site variables such as soil moisture regime will influence the growth characteristics of stands on those sites, thereby affecting stand structural features such as canopy height and crown closure.

3. Management Guidelines and Specific Habitat Objectives for Access Development and Harvesting

1. Retain and or recruit critical winter habitat (i.e., mature and old forests (predominantly Douglas-fir (*Pseudotsuga menziesii*) leading in the southern and central interior) with closed, multi-layered canopies (generally > 60% canopy closure), on moderate to steep slopes (approximately > 40%), on warm, southerly aspects in low and moderate snowpack areas). This stand structure provides a balance of snow interception and browse/litterfall availability. Other slopes and aspects in association with the warmer aspect stands are often important components of winter ranges.

2. Retain and or recruit winter forage in mature and old forest stands on valley bottoms and slopes that receive winter sun that are <1000 m in elevation.

3. Minimize the width (< 120 m) of clearcuts to provide accessible security cover for foraging.

4. Security cover patches should be a minimum of 100-300 m wide for deer.

5. Maintain and or recruit forage areas through alternative silvicultural practices (e.g., sequential harvesting).

6. Minimize the amount and size of roads, skid trails and landings in important forage habitat.

7. In general, harvest according to topographic profile - deer tend to use ridges and topographic breaks frequently, these areas should be avoided where possible.

8. Retain and or recruit vegetation or incorporate topographical relief into cutblock layout that visually screens ungulates from roads and access points.

9. Maintain and or recruit forage areas by creating openings with small group selection or clumpy single-tree selection (i.e., maximum opening width of 1 tree length for clumpy single tree selection, or 2 tree lengths with sizes ranging from 0.2-0.6 ha for group selection).

10. Maintain and or recruit openings adjacent to rock outcroppings, particularly downslope and or southerly to maximize solar exposure.

11. Retain and or recruit ungulate forage species such as Saskatoon (*Amelanchier alnifolia*), tall Oregon-grape (*Mahonia aquifolium*), big sagebrush (*Artemisia tridentata*), Douglas maple (*Acer glabrum*), red-oiser dogwood (*Cornus stolonifera*), *Vaccinium* spp., wild rose (*Rosa* spp.), willow (*Salix* spp.), arboreal lichens, grasses (*Poaceae* spp.) and forbs.

12. Retain and or recruit large, old Douglas-fir trees to provide snow interception and thermal cover, litterfall, and substrate for arboreal lichen. Douglas-fir foliage litterfall becomes increasingly important as winter food, especially as snow deepens.

13. Reduce slash to a depth of < 20 cm on 75% of treatment areas in important foraging habitat.

14. Maintain and or recruit components of western redcedar (*Thuja plicata*) on warm aspects in the deep and very deep snowpack zones.

15. Minimize harvest or damage to residual Douglas-fir stems to ≤ 5% (including skid road development) of the pre-harvest basal area of stems > 12.5 cm diameter at breast height (dbh).

16. Regenerate Douglas-fir as much as ecologically possible and protect and promote established Douglas-fir regeneration.

17. In shallow and moderate snowpack zones, where possible:

    - On warm aspects (135-270^{o} aspect), use small group harvest (0.1- 0.3 ha in size) on flat slopes (0-10% slope) and single tree harvest on steeper slopes (> 10% slope).

- On moderate aspects (270-315^{o} and 90-135^{o} aspect), use small group harvest (0.2-0.4 ha in size) on flat to moderate slopes (0-30% slope), small group harvest (0.1-0.3 ha in size) on steep slopes (31-60% slope), and single tree harvest on very steep slopes (> 60% slope).
- On cool aspects (315-90^{o} aspect), use small group harvest (0.2-0.4 ha in size) on flat to moderate slopes (0-30% slope), and small group harvest (0.3-0.5 ha in size) on steeper slopes (> 30% slope).

18. In deep and very deep snowpack zones, where possible:

    - On warm aspects (135-270^{o} aspect), use small group harvest (0.2-0.4 ha in size) on flat and moderate slopes (0-30% slope) and single tree harvest on steeper slopes (> 30% slope).
    - On moderate aspects (270-315^{o} and 90-135^{o} aspect), use small group harvest (0.3-0.5 ha in size) on all slopes.
    - On cool aspects (315-90^{o} aspect), use small group harvest (0.3-0.5 ha in size) on flat to moderate slopes (0-30% slope), and small group harvest (0.4-0.6 ha in size) on steeper slopes (> 30% slope).

4. Management Guidelines and Specific Habitat Objectives Post Harvest

Restoration:

1. In shallow snowpack zones (< 100 cm/year) maintain 40% of the habitat as low crown closure (< 35% canopy closure) habitat, 40% as moderate crown closure (36-65% canopy closure) habitat, and 20% as high canopy closure (> 65% canopy closure) habitat. Increasing crown closure results in increased snow interception.

2. In moderate snowpack zones (100-150 cm/year) maintain 1/3 each of low, moderate and high crown closure habitats.

3. In deep snowpack zones (150-200 cm/year) maintain 1/3 of the habitat as low crown closure habitat and 2/3 as high crown closure habitat.

Regeneration:

1. On subhygric to hygric sites utilizing even aged management to target desirable forage conditions, consider establishing new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern as per the Additional Planting Information section.

2. On subxeric to submesic sites utilizing even aged management to target desirable thermal and security conditions, establish plantations in a uniform pattern to encourage earlier crown closure. The intent is to have the mesic and drier ecosystems across a landscape provide the canopy cover required for effective thermal protection (snow interception) and security cover. Management of these ecosystems (subxeric to submesic) should focus on developing closed canopies as rapidly as possible.

3. Regenerate to Douglas-fir on all sites where Douglas-fir is ecologically appropriate and or viable.

Brushing:

1. On subhygric to hygric sites utilizing even aged management to target desirable forage conditions, do not employ broadcast brushing techniques such as herbicides. In addition, during brushing and or spacing treatments, ensure that forage production between clusters can be sustained or enhanced for a longer period.

2. On subxeric to submesic sites utilizing even aged management to target desirable security conditions, maintain low levels of competing vegetation through the establishment phase by manual, or possibly chemical, treatments to promote the rapid development of closed canopy conditions.

Spacing/Thinning/Pruning:

1. Maintain and or recruit forage areas through alternative silvicultural practices (e.g., single heavy thinning, or repeated lighter thinnings).

2. Maintain and or recruit long-term forest structure by thinning pole layer (trees 12.5-37.5 cm dbh) in ungulate management areas.

Protection (fire, insects, disease, damage):

1. Where possible, use single tree harvesting of stems currently infested with Douglas-fir bark beetles (*Dendroclonus pseudotsugae*). Avoid damage or removal of non-affected stems.

2. In mixed Douglas-fir/lodgepole pine (*Pinus contorta*) stands currently infested with mountain pine beetle (*D. ponderosae*), minimize harvest and damage of Douglas-fir by:

   a) harvesting pine only in areas where there is a reasonable expectation of beetle control; and
   b) careful harvest block and skid trail design and layout.

5. Recommended Silvicultural Regimes (Even Aged Systems)

BEC – Zones ***BG all*** ***BWBSdk, mw*** ***ICHdk, dw, mk*** ***IDF all*** ***MSdk*** ***PPxh*** ***SBSdh, dw, mh***	**Subhygric to Hygric sites**: Management of these sites should focus on the enhancement and or recruitment of areas for woody ungulate forage species. The following regimes reflect only those possible regimes associated with even aged silvicultural systems. **However, uneven aged management targeting variable residual post harvest densities should be practiced wherever possible.** • Silvicultural Systems that may be applicable for this objective include: Clearcut, Patch Cut or Small Group Selection, Shelterwood, Retention, Seed Tree, and Selection systems. The season of harvest should be limited to conditions that will limit soil and root disturbance. • Consider establishing new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern as per the Additional Planting Information section. • Do not employ broadcast-brushing techniques such as herbicides. In addition, during brushing and or spacing treatments, ensure that forage production between clusters can be sustained or enhanced for a longer period. • Implement juvenile spacing programs as required (max density 5000 stems per ha) to ensure canopy gaps linked to forage production will be present later into stand development (20-60 years). **Subxeric to Submesic sites**: Management of these sites should focus on the enhancement and or recruitment of areas for thermal protection (snow interception). The following regimes reflect only those possible regimes associated with even age silvicultural systems. Uneven aged management targeting variable residual post harvest densities should be practiced where possible. • Silvicultural Systems that may be applicable for this objective include: Clearcut, Patch Cut or Small Group Selection, Shelterwood, Retention, Seed Tree, and Selection systems. • Establish plantations in a uniform pattern to encourage earlier crown closure. The intent is to have the mesic and drier ecosystems across a landscape provide the canopy cover required for effective thermal protection (snow interception). Management of these ecosystems (subxeric to submesic) is intended to develop closed canopies as rapidly as possible. • Maintain low levels of competing vegetation through the establishment phase by manual, or possibly chemical, treatments to promote the rapid development of closed canopy conditions. • Implement juvenile spacing programs as required (max density 5000 stems per ha) to ensure an even distribution of crop trees and rapid crown closure is occurring. Post spacing standards should equal the target stocking standard for single entry spacing; however, a more desirable option would be to plan for a two entry spacing regime. For example, the first entry could target 3000 stems per ha with a second spacing entry (approximately at age 25 years) reducing the density to target levels.

6. Monitoring Standards – Establishment to Free Growing Seral Stage (Even Aged Systems)

Table 1.1 – Stocking Standard Guidelines

Applicable Ecosystem (BEC)			Stocking Standard Modifiers									
Zones	**Subzones**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier[1]**	**Regen Delay**	**Assessment Time Frame**	**Minist. Tree Ht.**	**% Tree Over Brush**	**Min Inter Tree Distance**	**Max Density**	**Survey Method**	**Comments**
BG	All	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0	5000[3]	Same	
BG	All	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5	5000[3]	Footnote 4	
BWBS	dk, mw	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0	5000[3]	Same	
BWBS	dk, mw	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5	5000[3]	Footnote 4	
ICH	dw	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0	5000[3]	Same	
ICH	dw	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5	5000[3]	Footnote 4	
IDF	dm, xh, xm	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0	5000[3]	Same	
IDF	dm, xh, xm	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5	5000[3]	Footnote 4	
MS	dk	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0	5000[3]	Same	
MS	dk	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5	5000[3]	Footnote 4	
PP	xh	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0	5000[3]	Same	
PP	xh	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5	5000[3]	Footnote 4	
SBS	dh, dw	2-3/A-E	Broadleaf[2]	1.2	Same	Same	Same	Same	2.0	5000[3]	Same	
SBS	dh, dw	5-6/C-E	Broadleaf[2]	0.8	Same	Same	Same	Same	1.5	5000[3]	Footnote 4	

1. The term Stocking Standard Modifier refers to the factor applied to existing stocking standards contained within Establishment to Free Growing Guidebooks. For example: the stocking standards (well-spaced/ha) for IDFxm 08 site as found in the Establishment to Free Growing Guidebook, Cariboo Forest Region equals = TSSpa **1200**, MSSpa **700**, MSSp **600**. The equivalent stocking standards (well-spaced/ha) for areas with maintenance and or recruitment of forage supply, stand structure and habitat elements for mule deer winter range objectives would be TSSpa **960**, MSSpa **560**, MSSp **480**. TSS - target stocking standard, MSS – minimum stocking standard, pa – preferred and acceptable, and p - preferred.
2. Broadleaf species management should be seriously considered where applicable for this management objective. Utilize the appropriate broadleaf species as a primary or secondary species as indicated in the Establishment to Free Growing Guidebooks.
3. Maximum density is 5000 stems per ha for these ecosystems. Densities exceeding this threshold at the free growing stage will severely limit the suitability of forage (moisture regime 5-6 sites) and or security (moisture regime 2-3 sites) habitat requirements through subsequent stand development.
4. The survey methodologies used to assess the success of meeting these standards should be consistent with existing methodologies. However, do not stratify areas into contiguous units smaller than one ha, or use dispersed stratum methodologies. In general, more plots may be required to prove obligations are met due directly to the desired variable post-free growing density distribution targeted. The maximum number of plots required will be 1.5 per ha.

6. Monitoring Standards – Establishment to Free Growing Seral Stage (Even Aged Systems)

Table 1.2 – Cluster Distribution

Stocking (tress/ha)	Clusters per ha								Triangular Inter-cluster spacing (m)							
	Trees per cluster								Trees per cluster							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
200	25	29	33	40	50	67	100	200	21.5	20.1	18.6	17.0	15.2	13.2	10.7	7.6
250	31	36	42	50	63	83	125	250	19.2	18.0	16.6	15.2	13.6	11.8	9.6	6.8
300	38	43	50	60	75	100	150	300	17.5	16.4	15.2	13.9	12.4	10.7	8.8	6.2
350	44	50	58	70	88	117	175	350	16.2	15.2	14.1	12.8	11.5	9.9	8.1	5.7
400	50	57	67	80	100	133	200	400	15.2	14.2	13.2	12.0	10.7	9.3	7.6	5.4
450	56	64	75	90	113	150	225	450	14.3	13.4	12.4	11.3	10.1	8.8	7.2	5.1
500	63	71	83	100	125	167	250	500	13.6	12.7	11.8	10.7	9.6	8.3	6.8	4.8
550	69	79	92	110	138	183	275	550	13.0	12.1	11.2	10.2	9.2	7.9	6.5	4.6
600	75	86	100	120	150	200	300	600	12.4	11.6	10.7	9.8	8.8	7.6	6.2	4.4
650	81	93	108	130	163	217	325	650	11.9	11.2	10.3	9.4	8.4	7.3	6.0	4.2
700	88	100	117	140	175	233	350	700	11.5	10.7	9.9	9.1	8.1	7.0	5.7	4.1
750	94	107	125	150	188	250	375	750	11.1	10.4	9.6	8.8	7.8	6.8	5.5	3.9
800	100	114	133	160	200	267	400	800	10.7	10.1	9.3	8.5	7.6	6.6	5.4	3.8
850	106	121	142	170	212	283	425	850	10.4	9.8	9.0	8.2	7.4	6.4	5.2	3.7
900	112	129	150	180	225	300	450	900	10.2	9.5	8.8	8.0	7.2	6.2	5.1	3.6
950	119	136	158	190	238	317	475	950	9.9	9.2	8.5	7.8	7.0	6.0	4.9	3.5
1000	125	143	167	200	250	333	500	1000	9.6	9.0	8.3	7.6	6.8	5.9	4.8	3.4

Notes: When cluster planting is prescribed, silviculture prescriptions should specify target trees per cluster and target clusters per ha, in addition to the target stocking standard.

Two methods have been developed to determine the prescribed number of clusters per ha.

1. Final Crop Tree Method

   The final crop tree formula is the preferred method of determining the number of clusters. Managers must first determine the number of crop trees desired at rotation. Working backward from the density at final rotation, free growing targets and planting targets should be established based on appropriate mortality factors for the site. The following should be considered when deriving a mortality factor: species selection (e.g., shade-tolerant species show less mortality), availability of suitable microsites (e.g., moisture and nutrient requirements, likelihood of flood events), vegetative competition, and anticipated mortality due to stock handling. Dividing the planting target stocking by trees per cluster will result in the required number of clusters per ha.

   Number of clusters per ha = planting target/ trees per cluster

2. Target Stocking Method

   Managers wishing to use the target stocking method should first consult the stocking standards table to determine the free growing target stocking recommended for the site series. Next, they should establish a mortality factor based on the site series and conditions, as in the final crop tree method, to derive the planting target. Dividing the planting target stocking by trees per cluster will result in the required number of clusters per ha. The cluster distribution table above can be consulted to help verify the calculated figure.

   Number of clusters per ha = planting target/ trees per cluster *(Triangular inter-cluster spacing = The square root of 11547/# of clusters per/ha)*

- Spacing between clusters should be adjusted to reflect site conditions and microsite location. Uniform distribution of clusters over the block is appropriate where site conditions are relatively uniform. However, clusters should be located on appropriate planting sites, taking advantage of natural site features such as elevated hummocks or stumps.
- Inter-cluster spacing is measured from the centre of one cluster to the centre of the adjacent ones on a square grid. However, where sites are undulating, clusters should be located on appropriate planting sites to take advantage of natural features such as elevated hummocks or stumps. Inter-cluster distances should be varied in order to optimize microsite selection.
- Inter-cluster spacing is recommended to be a minimum of 80% and a maximum of 120% of that required to achieve the desired planting target. This range should result in achieving the overall desired stocking density, within acceptable statistical limits, when a stocking survey is applied across the area.
- "Dispersed or non-uniform cluster" uses a mix of cluster densities across the block, and is appropriate for some blocks where microsites suitable for clusters (e.g., elevated hummocks) are not evenly distributed.
- For dispersed cluster planting, the minimum inter-tree distance within a cluster is 1.5 m on suitable microsites. The number of suitable clusters per ha should be estimated from a reliable survey that covers the entire area. The minimum/maximum inter-cluster distances may vary substantially, as long as the overall target density is met.

6. Monitoring Standards – Additional

Establishment (Age 0-4 Years) Phase:

Refer to Management Guidelines section for strategies through this portion of stand development.

Juvenile (Age 20-60 Years) Phase:

No specific standards are developed for this point in stand development. Management of younger age classes (e.g., establishment to free growing 0-20 years) is intended to develop suitable stand conditions through this age class. Existing stands within this age class may be managed to encourage forage production by creating gaps through late juvenile spacing or commercial harvesting.

Mature (Age 60+ Years) Phase:

No specific standards are applicable for this age class. In general, subsequent harvesting strategies should be implemented that are consistent with the Management Guidelines outlined. In addition, review of Cariboo Forest Region Extension Note 25A (MoF 2000) is recommended prior to harvest planning.

Figure 19: Security cover provides important bedding habitat for mule deer. Photo: Alex Inselberg.

Selected References:

Resources Inventory Committee. 1998. British Columbia wildlife habitat rating standards. B.C. Minist. Environ., Lands and Parks, Resour. Inventory Comm., Wildl. Interpretations Subcomm., Victoria, BC. 108pp.

Stevens, V. 1995. Database for wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds and mammals in biogeoclimatic zones. Working Pap., B.C. Minist. Environ., Lands and Parks, Victoria, BC.

Wood, C. 1998. Habitat/ecosystem objectives and monitoring procedures for incremental and backlog silviculture treatments, ver. 2.0. B.C. Minist. Environ., Lands and Parks, Resour. Stewardship Branch, Victoria, BC. 70pp.

7.6.2 Mule Deer (*Odocoileus hemionus hemionus*) Winter Range Uneven Aged Systems

NOTE: The following habitat objectives and accompanying guidelines are intended to **apply to UNEVEN AGED silvicultural systems management**, and can be implemented **where uneven-aged systems are appropriate**. Consequently, stocking standard tables (establishment to free growing stage) are not included. Recommendations are provided for access development and harvesting, and post harvesting phases. Also refer to the **Selected References** section (below) for additional information on uneven aged systems management in mule deer winter range.

1. Key Habitat Objectives

Maintain and or recruit habitat elements for mule deer winter range – for winter forage, snow interception (thermal cover) and security cover**.**

Landscape Level: Landscape level management objectives such as connectivity, patch size distribution and seral stage targets should be described in higher level plans and sustainable forest management plans. It is important to link higher level plan objectives such as mature/old forest targets for a landscape unit or other planning area, with specific practices implemented at the stand level (see Management Guidelines below).

Cariboo-Chilcotin whole winter range (landscape) level objectives for deer winter ranges are as follows:

1. In shallow snowpack zones (approximately < 100 cm mean snowfall/year) maintain 40% of the habitat as low crown closure (< 35% canopy closure) habitat, 40% as moderate crown closure (36-55% canopy closure) habitat, and 20% as high canopy closure (> 55% canopy closure) habitat. Increasing crown closure results in increased snow interception.

2. In moderate snowpack zones (approximately100-150 cm mean snowfall /year) maintain 1/3 each of low, moderate and high crown closure habitats.

3. In transition snowpack zones (approximately 150-200 cm mean snowfall/year) maintain 20% of low, 40% of moderate, and 40% of high crown closure habitats.

4. In deep snowpack zones (approximately >-200 cmmean snowfall/year) maintain 1/3 of the habitat as low crown closure habitat and 2/3 as high crown closure habitat.

A further discussion of landscape level considerations is found in the Landscape Considerations section of this report. Also refer to the Cariboo Chilcotin Land Use Plan Mule Deer Strategy (Dawson et al., 2002) for additional information on landscape level planning and related stand level management practices.

2. Forest Types/BEC Zones

BG all, BWBS dk, mw, ICH dk, dw, mk, IDF all, MS dk, PP xh, SBS all , SBPS all

Note: There will be variation in the harvesting and silviculture Management Guidelines recommended below, based on biogeoclimatic and site-specific ecosystem variation. Stand and landscape level recommendations for mule deer winter range management in the Cariboo Chilcotin are divided into four different ecological types: shallow, moderate, transition and deep snow-pack zones, which are defined on the ground as groups of biogeoclimatic subzones. Site variables such as soil moisture regime will influence the growth characteristics of stands on those sites, thereby affecting stand structural features such as canopy height and crown closure.

3. Management Guidelines and Specific Habitat Objectives for Access Development and Harvesting

1. Retain and or recruit critical winter habitat (i.e., mature and old forests (predominantly Douglas-fir (*Pseudotsuga menziesii*) leading in the interior) with closed, multi-layered canopies (with a variety of crown closure reflecting the three winter range habitat classes), on moderate to steep slopes (approximately > 20%), on warm, southerly aspects in low and moderate snowpack areas). This stand structure provides a balance of snow interception and browse/litterfall availability. Other slopes and aspects in association with the warmer aspect stands, are often important components of winter ranges.

2. Retain and or recruit winter forage and shelter in mature and old forest stands on lower elevation slopes that receive winter sun.. *(many winter ranges contain areas >1000 m, and the elevation of useful winter range is often highly dependent on the local topography and weather systems/snow shadows so it is probably best to just refer to generally lower elevation.*

3. Manage winter range stands using uneven-aged management to maintain suitable winter range conditions through time. Cariboo_Chilcotin management guidelines recommend patch width ranges from 0.3-1 tree lengths in shallow and moderate snowpack zones to a maximum of 2 tree lengths in the deep snowpack zone. These patches are harvested within the context of a clumpy single-tree selection system for shallow and moderate snowpack zones, and, primarily, small group selection systems in the transition and deep snow-pack zone.

4. Maintain and recruit Douglas-fir litterfall forage areas by maintaining stands composed of mature and old trees arranged in a clumpy distribution.

5. Minimize the amount and size of roads, skid trails and landings in winter range habitat.

6. Harvest according to topographic profile - deer tend to use ridges and topographic breaks frequently, these areas should be avoided or only lightly cut where possible.

7. Retain and or recruit vegetation or incorporate topographical relief into cutblock layout that visually screens ungulates from roads and access points.
8. Maintain and or recruit shrub forage areas by creating openings with small group selection or clumpy single-tree selection (i.e., maximum opening width of 1 tree length for clumpy single tree selection, or 2 tree lengths with sizes ranging from 0.2-0.6 ha for group selection).
9. Maintain and or create small openings adjacent to rock outcroppings, particularly downslope and or southerly aspect to maximize solar exposure.
10. Retain and or recruit ungulate forage species such as Saskatoon (*Amelanchier alnifolia*), tall Oregon-grape (*Mahonia aquifolium*), big sagebrush (*Artemisia tridentata*), Douglas maple (*Acer glabrum*), red-oiser dogwood (*Cornus stolonifera*), *Vaccinium* spp., wild rose (*Rosa* spp.), willow (*Salix* spp.), arboreal lichens, grasses (*Poaceae* spp.) and forbs. The appropriate shrub species will vary widely depending on the biogeoclimatic zone that the winter range is located within.
11. Retain and or recruit large, old Douglas-fir trees to provide snow interception and thermal cover, litterfall, and substrate for arboreal lichen. Douglas-fir foliage litterfall becomes increasingly important as winter food, especially as snow deepens.
12. Reduce slash to a depth of < 20 cm on 75% of treatment areas in important winter habitat.
13. Maintain and or recruit components of western redcedar (*Thuja plicata*) on warm aspects and toe slopes in the deep and very deep snowpack zones.
14. Minimize harvest or damage to residual Douglas-fir stems when selectively removing other species such as lodgepole pine from mixed species stands. Recommendations in the Cariboo-Chilcotin are: " Harvest or damage to Douglas-fir must not exceed 15% for stems 22.5-37.5 cm and 5% for stems >37.5 cm (including skid trail development) of the preharvest basal area of each of these two diameter class groupings.
15. Regenerate Douglas-fir as much as ecologically possible and protect and promote established Douglas-fir regeneration.
16. In shallow and moderate snowpack zones, a specialized, clumpy single tree selection is recommended. Prescriptions would first target non-Douglas-fir species for harvest. Additional harvest of Douglas-fir would include various amounts of three types of cutting depending on the initial stand structure and the stand structure objectives. The 3 types of cutting include: 1) thinning from below of suppressed and intermediate stems of poor to fair vigour or quality; 2) harvest of small clumps of trees (2-8 trees) of all diameter and crown classes producing small (0.3-1.0 tree length) regeneration openings; 3) harvet of single isolated stems that do not occur as part of a group. Long-term post-harvest basal area targets have been developed for IDF stems in the Cariboo Chilcotin (Dawson and Armleder, 2000).:
17. In transition and deep snowpack zones apply a small group selection silviculture system.

    Recommendations from the Cariboo-Chilcoltin for group selection objectives include:

    - Small harvest patch sizes (0.- 0.7 ha in transition zone and 0.1 -1.0 ha in deep zone) depending on the slope and aspect
    - In the Transition snowpack zone, create harvest patch sizes 0.1 - 0.3 ha on warm aspects and frost prone micro sites

- In the Deep snowpack zone, create openings 0.1- 0.4 ha on warm aspects and frost prone microsites and create harvest openings 0.1-1.0 ha (average 0.6 ha) on other aspects.
- A minimum cutting cycle of 40 years
- Area harvested per pass of 20, 25 and 33% for high, moderate and low stand structure habitat classes, respectively

4. Management Guidelines and Specific Habitat Objectives Post Harvest

Restoration:

1. In shallow snowpack zones (approx. < 100 cm mean snowfall/year) maintain 40% of the habitat as low crown closure (< 35% canopy closure) habitat, 40% as moderate crown closure (36-55% canopy closure) habitat, and 20% as high canopy closure (> 55% canopy closure) habitat. Increasing crown closure results in increased snow interception. Decreasing crown closure results in increased shrub forage production. However, forests managed with small group selection or clumpy simple tree selection will incorporate small shrub producing openings throughout the stand.
2. In moderate snowpack zones (approx 100-150 cm mean snowfall/year) maintain 1/3 each of low, moderate and high crown closure habitats.
3. In transition snowpack zones (approximately 150-200 cm mean snowfall/year) maintain 20% of low, 40% of moderate, and 40% of high crown closure habitats.
4. In deep snowpack zones (approx >200 cm mean snowfall/year) maintain 1/3 of the habitat as moderate crown closure habitat and 2/3 as high crown closure habitat.

Regeneration:

1. Regenerate to Douglas-fir on all sites where Douglas-fir is ecologically viable. Regeneration objectives should be addressed during the harvesting phase by:

   a) protecting regeneration from harvesting damage where possible;
   b) using opening sizes and/or silvicultural systems that do not cause frost problems for Douglas-fir regeneration.

2. Residual stems and natural regeneration may be sufficient for many areas. Other areas, especially where group selection is used, may require some planting to meet regeneration objectives. The intent is to maintain or create uneven-aged Douglas-fir dominated stands in a fine scale mosaic of tree patches of various sizes and ages. This mosaic of patches will provide snow interception, thermal and security cover as well as litterfall, lichen and shrub forage. High, moderate and low crown closure variation in this basic structure will provide different mixes of forage and cover benefits.

Brushing:

1. Brushing will seldom be required on mule deer winter ranges except possibly in some sites in wetter subzones. The minimum level of brushing required to establish the regeneration should be used.

Spacing/Thinning/Pruning:

1. Maintain and or recruit long-term forest structure by thinning pole layer (trees 12.5-37.5 cm dbh) in ungulate management areas. Thinning should be a light (maximum of 25%) thinning from below that concentrates harvesting on trees in suppressed and intermediate canopy layers.

Protection (fire, insects, disease, damage):

1. Where possible, use single tree harvesting of stems currently infested with Douglas-fir bark beetles (*Dendroclonus pseudotsugae*). Avoid damage or removal of non-affected stems.

2. In mixed Douglas-fir/lodgepole pine (*Pinus contorta*) stands currently infested with mountain pine beetle (*D. ponderosae*), minimize harvest and damage of Douglas-fir by:

   a) harvesting pine only in areas where there is a reasonable expectation of beetle control; and
   b) careful harvest block and skid trail design and layout.

5. Additional Long-Term Habitat Management Objectives

Long-term Objectives for High, Moderate and Low Stand Structure Habitat Types:

For each of the three stand structure habitat classes , objectives for long-term stand structure are provided in the Mule Deer Handbook (Armleder *et al.* 1986) and Extension Note 25A (Dawson and Armleder, 2000). The key objectives for shallow and moderate snowpack winter ranges in the Cariboo-Chilcotin are:

- **Basal Area** – Meet basal area requirements described in table 2 in Extension Note 25A (Dawson and Armleder, 2000). These describe the post-harvest total basal area (m^2 of Douglas-fir stems > 12.5 cm dbh) and the post-harvest basal area of large trees (m^2 of Douglas-fir stems > 37.5 cm dbh).

- **Cutting Cycle** – The basal area values given apply to cutting cycles of 30 years or greater. Shorter cutting cycles would require substantially greater residual basal area values.

- **Canopy Openings** – Recommended silvicultural systems combine thinning from below with creation of small canopy gaps. Create canopy openings ranging in diameter from 0.3-1 of the local mature tree height, with an average opening diameter of 1/2 of a mature tree height. For example, in a stand with mature trees 30 m in height, the average diameter of canopy openings created by harvesting would be 15 m.

- **Access Development** – Carefully minimize area in roads, landings and skid trails. Skid trails must cover no more than 10% of the net harvested area in moderate and high stand structure habitat types. **Clumpiness** – Maintain and promote a clumpy distribution of residual Douglas-fir trees.

- **Species Composition** – Maximize the proportion of Douglas-fir by all possible means. Always harvest in a way that optimizes the maintenance and regeneration of Douglas-fir. Do not plant pine or spruce unless these are the only silviculturally viable option.

- **Tree Size Distribution** – Maintain and promote multi-layered, uneven-aged stands dominated by mature Douglas-fir, with deep, wide crowns and a high component of large, old trees. Recommended B, D and q values in Table 3 of Extension Note 25A (Dawson and Armleder, 20002000) will provide guidance on recommended diameter distributions. The values in Table 3 quantitatively describe a type of desired stand structure. The relatively low values for 'q' describe a stand that has much of its volume in larger trees. The relatively high values for 'D' mean that some trees with large diameters are desirable.

- **Snags and Declining Trees** – Maintain a high level of snags and declining trees especially in stands managed for moderate and high habitat classes. Extra care is required in these stands because Workers' Compensation Board (WCB) regulations combined with the short cutting cycle could easily result in stands with few snags.

- **Trees on Special Topographic Features** – Maintain higher than average tree cover on ridges, topographic breaks, and knolls. Manage these microsites to maintain a higher basal area than that prescribed for the surrounding polygon as a whole.

Long-term Objectives for Topographic Buffers:

Topographic buffers are identified on winter range maps around major topographic breaks, knolls and ridges because these features receive very high use by mule deer.

- Any new roads should be designed to avoid these buffer areas. Exceptions to this can be made where a road needs to cross the buffer area and no other suitable location for the road can be found. In these cases, the road should cross perpendicular to the buffer to minimize road within the buffer.
- Skid trails must be minimized in this zone, but are acceptable if they run perpendicular to the buffered ridge or break to minimize skid trail within the buffer.
- Note that smaller scale ridges and breaks, not identified on the long-term spatial objectives maps are also important stand level features that need to be appropriately managed when conducting road building and harvesting operations. As with the larger scale topographic features, skid trials must not be located along these smaller scale ridges and breaks.

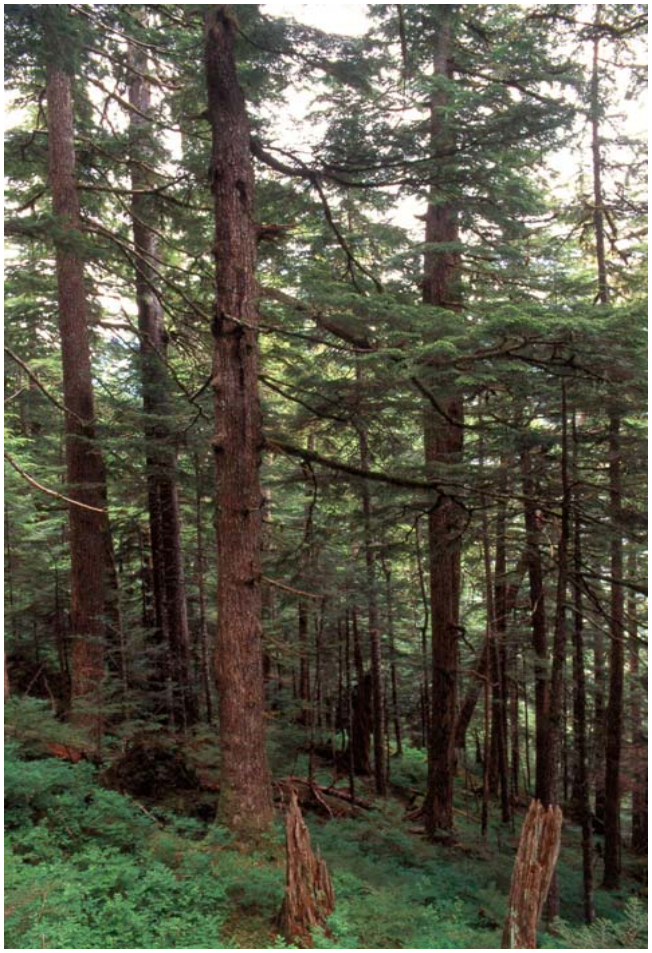

Figure 20: Old forest with large limb structure provide snow interception in deer winter ranges. Photo: Alex Inselberg.

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7.7 Mountain Caribou (*Rangifer tarandus caribou*) Winter Range

1. Key Habitat Objectives

Maintain and or recruit habitat elements for mountain caribou – for forage and security in winter range (**not applicable to northern caribou**).

Landscape Level: Landscape level management objectives such as connectivity and habitat fragmentation, patch size distribution and seral stage targets, as well as **access management**, should be described in higher level plans and forest stewardship plans. It is important to link these higher level plan objectives with specific practices implemented at the stand level (see Management Guidelines below).

A further discussion of landscape level considerations is found in the Landscape Considerations section of this report.

2. Forest Types/ BEC Zones

ESSF dk, mm, vc, vv, wc, wk, wm, ICH mk2, mm, mw, vk, wk

3. Management Guidelines and Specific Habitat Objectives for Access Development and Harvesting

NOTE: the following guidelines are intended to apply only to areas where harvesting is permitted through a Higher Level Plan.

1. Maintain and or restore forested connectivity corridors to facilitate predator avoidance and movement of caribou between seasonal ranges.

2. Protect caribou from access-related impacts by developing a road/access management plan. Try to reduce access and habitat fragmentation adjacent to caribou summer habitats where possible.

3. Where forest harvesting is planned in mountain caribou winter range, maintain most of the stand in a late seral condition by using partial cutting techniques with low (< 30%) volume removal and long cutting cycles. For example: 30% volume removal at intervals of 80 years, or 25% removal at intervals of 60 years. Coordinate harvest entries with an access management plan in order to minimize any increase in human access or natural predation.

   Note: Harvest cycles of this duration are intended to ensure that the regeneration from the first entry will be of sufficient size to provide travel habitat and have an inner defoliated zone, which is important for lichen forage development.

4. Maintain pre-harvest tree species composition.

5. In the ICH and on the ICH/ESSF ecotone, minimize disturbance of soil and vegetation during harvesting and silvicultural activities in order to:
   - Maintain low evergreen shrubs and herbs with persistent green leaves (e.g., falsebox (*Pachystima myrsinites*), bunchberry (*Cornus canadensis*), foamflower (*Tiarella* spp.), and wintergreen (*Pyrola* spp.))
   - Avoid enhancing shrub species such as willow (*Salix* spp.), red-osier dogwood (*Cornus stolonifera*) and Douglas maple (*Acer glabrum*), which are preferred by moose, deer and elk.
6. Avoid excessive physical obstructions (such as wind-rowed slash or many downed trees).

4. Management Guidelines and Specific Habitat Objectives Post Harvest

Restoration:

1. Young or mid-seral stands that are dense or homogeneous may be spaced or thinned to encourage development of a multi-layered structure with heterogeneous spacing.

Regeneration:

1. Minimize visual obstructions and maintain freedom of movement for caribou by keeping regeneration density low.

2. Maintain a clumped stand structure where it occurs naturally, and by cluster planting where possible (see Additional Planting Information, section 6).

Brushing:

1. In the ICH and on the ICH/ESSF ecotone, vegetation management should be planned to discourage woody browse species.

Spacing/Thinning/Pruning (or associated practices):

1. **In the ICH** and on the **ICH/ESSF ecotone**, manage for a multi-layered stand structure and heterogeneous spacing – some areas should have more open spacing to encourage production of forage lichens, and other areas should have higher canopy closure and dense, wide, long crowns to provide snow interception. Overall, manage for approximately 300 live and 25-30 dead stems/ha (> 19 cm dbh) at age 140 years. To achieve this stand structure:
   - Conserve some advance regeneration during harvesting.

- Plant widely spaced trees, and allow natural regeneration of western hemlock (*Tsuga heterophylla*) and western redcedar (*Thuja plicata*).
- Space trees to encourage variable stem densities and support advance regeneration. Dense thickets of regeneration that interfere with sight distances may be reduced.

  Note: Pruning does not significantly affect caribou forage in the ICH, where there is little forage lichen within reach. Pruning can actually be used to improve sight distances in these stands.

2. **In the ESSF**, manage for a multi-layered stand with clumped trees separated by gaps. Overall, manage for approximately 300 live and 25-30 dead stems per ha (> 19 cm dbh) at age 140 years. To achieve this stand structure:

   - In the prescription, reduce acceptable inter-tree spacing to 1 m.
   - Conserve some advance regeneration during harvesting.
   - Cluster-plant on naturally raised microsites or on clumped mounds. For example, plant an average of 4 seedlings per clump and space clumps approximately 5-7 m apart.
   - Avoid pruning in areas where arboreal lichens on low branches are important forage for ungulates.

     Note: It is important to avoid pruning in the ESSF, where caribou eat lichens directly off the lower branches of trees.

Protection (fire, insects, disease, damage):

1. Mountain caribou are adapted to forests that regenerate through gap-dynamics processes. Caribou winter ranges should be protected from extensive stand-destroying fires.

5. Recommended Silvicultural Regimes

BEC – Zones ***ESSFdk mm, vc, vv, wc, wk, wm*** ***ICHmk2, mm, mw, vk, wk***	Uneven-aged management with high retention of residuals should be practiced where possible. However, the following silvicultural regimes apply to even-aged stands where recruitment of future caribou habitat is a management objective. Examples would be pre-existing even-aged stands, or harvest blocks within movement corridors that are being managed to provide snow-interception habitat in the future. The use of moderate, rather than low densities early in stand history discourages browse species and encourages dieback of lower branches, which improves sight distances. Later management should focus on the enhancement and or recruitment of heterogeneous stem density and inter-tree spacing throughout the stand rotation. The associated standards reflect this goal. **Modified standards are provided only for submesic to subhygric sites** in an effort to create conditions across a landscape that will contain various free growing densities (e.g., a bell curve density distribution). • Silvicultural Systems that may be applicable for this objective include: Patch Cut, Shelterwood, Retention and Selection systems. Harvesting practices should ensure that post harvest debris loading does not create excessive physical obstruction to animal movements. • Site preparation treatments should not create excessive physical obstructions (such as windrows) and must preserve retained advance regeneration. • On subhygric sites establish new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern. On submesic sites establish plantations in a uniform pattern to encourage earlier crown closure. • Do not employ broadcast-brushing techniques such as herbicides. In addition, during brushing and or spacing treatments ensure that variable density distribution of target crop trees is achieved. • Implement juvenile spacing programs as required (max density 5000 stems per ha) to ensure the desired variation in stand densities and inter tree spacing is achieved. Post spacing standards can range significantly and it is preferable to obtain a non uniform spacing throughout an area post treatment, this will help to ensure heterogeneous canopy conditions will be present later into stand development (20-60 years).

6. Monitoring Standards – Establishment to Free Growing Seral Stage

Table 1.1 – Stocking Standard Guidelines

Applicable Ecosystem (BEC)			Stocking Standard Modifiers									
Zones	**Subzones**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier[1]**	**Regen Delay**	**Assessment Time Frame**	**Min. Tree Ht.**	**% Tree Over Brush**	**Min Inter Tree Distance**	**Max Density**	**Survey Method**	**Comments**
ESSF	dk, mm, un, vc, vv, wc, wk, wm	5/A-E	Footnote 2	0.8	Same	Same	Same	Same	1.0	Footnote 3	Footnote 4	
ESSF	dk, mm, un, vc, vv, wc, wk, wm	3/A-E	Footnote 2	1.2	Same	Same	Same	Same	2.0	Footnote 3	Footnote 4	
ICH	mk2, mm, mw, vk, wk	5/A-E	Footnote 2	0.8	Same	Same	Same	Same	2.0	Footnote 3	Footnote 4	
ICH	mk2, mm, mw, vk, wk	3/A-E	Footnote 2	1.2	Same	Same	Same	Same	2.0	Footnote 3	Footnote 4	

1. The term Stocking Standard Modifier refers to the factor applied to existing stocking standards contained within Establishment to Free Growing Guidebooks. For example: the stocking standards (well-spaced/ha) for ESSFwk 05 site as found in the Establishment to Free Growing Guidebook, Cariboo Forest Region equals = TSSpa **1200**, MSSpa **700**, MSSp **600**. The equivalent stocking standards (well-spaced/ha) for areas with maintenance and or recruitment of forage supply, stand structure and habitat elements for the mountain caribou winter range objective would be TSSpa **960**, MSSpa **560**, MSSp **480**. TSS - target stocking standard, MSS – minimum stocking standard, pa – preferred and acceptable, and p - preferred.

2. Lodgepole pine (*Pinus contorta*) should be managed as a minor (< 20%) stand component for areas with caribou management objectives.

3. Maximum Density is 5000 stems per ha for these ecosystems. Post spacing densities should range significantly (1000-3000 stems per ha) on a given area in an effort to provide varied post free growing inter tree spacing and total density per ha.

4. The survey methodologies used to assess the success of meeting these standards should be consistent with existing methodologies. However, do not stratify areas into contiguous units smaller than one ha, or use dispersed stratum methodologies. In general, more plots may be required to prove obligations are met due directly to the desired variable post free growing density distribution targeted. The maximum number of plots required will be 1.5 per ha. The statistical requirements for these areas will be consistent with existing methodologies.

6. Monitoring Standards – Establishment to Free Growing Seral Stage

Table 1.2– Cluster Distribution

Stocking (tress/ha)	Clusters per ha								Triangular Inter-cluster spacing (m)							
	Trees per cluster								Trees per cluster							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
200	25	29	33	40	50	67	100	200	21.5	20.1	18.6	17.0	15.2	13.2	10.7	7.6
250	31	36	42	50	63	83	125	250	19.2	18.0	16.6	15.2	13.6	11.8	9.6	6.8
300	38	43	50	60	75	100	150	300	17.5	16.4	15.2	13.9	12.4	10.7	8.8	6.2
350	44	50	58	70	88	117	175	350	16.2	15.2	14.1	12.8	11.5	9.9	8.1	5.7
400	50	57	67	80	100	133	200	400	15.2	14.2	13.2	12.0	10.7	9.3	7.6	5.4
450	56	64	75	90	113	150	225	450	14.3	13.4	12.4	11.3	10.1	8.8	7.2	5.1
500	63	71	83	100	125	167	250	500	13.6	12.7	11.8	10.7	9.6	8.3	6.8	4.8
550	69	79	92	110	138	183	275	550	13.0	12.1	11.2	10.2	9.2	7.9	6.5	4.6
600	75	86	100	120	150	200	300	600	12.4	11.6	10.7	9.8	8.8	7.6	6.2	4.4
650	81	93	108	130	163	217	325	650	11.9	11.2	10.3	9.4	8.4	7.3	6.0	4.2
700	88	100	117	140	175	233	350	700	11.5	10.7	9.9	9.1	8.1	7.0	5.7	4.1
750	94	107	125	150	188	250	375	750	11.1	10.4	9.6	8.8	7.8	6.8	5.5	3.9
800	100	114	133	160	200	267	400	800	10.7	10.1	9.3	8.5	7.6	6.6	5.4	3.8
850	106	121	142	170	212	283	425	850	10.4	9.8	9.0	8.2	7.4	6.4	5.2	3.7
900	112	129	150	180	225	300	450	900	10.2	9.5	8.8	8.0	7.2	6.2	5.1	3.6
950	119	136	158	190	238	317	475	950	9.9	9.2	8.5	7.8	7.0	6.0	4.9	3.5
1000	125	143	167	200	250	333	500	1000	9.6	9.0	8.3	7.6	6.8	5.9	4.8	3.4

Notes: When cluster planting is prescribed, silviculture prescriptions should specify target trees per cluster and target clusters per ha, in addition to the target stocking standard.

Two methods have been developed to determine the prescribed number of clusters per ha.

1. Final Crop Tree Method

   The final crop tree formula is the preferred method of determining the number of clusters. Managers must first determine the number of crop trees desired at rotation. Working backward from the density at final rotation, free growing targets and planting targets should be established based on appropriate mortality factors for the site. The following should be considered when deriving a mortality factor: species selection (e.g., shade-tolerant species show less mortality), availability of suitable microsites (e.g., moisture and nutrient requirements, likelihood of flood events), vegetative competition, and anticipated mortality due to stock handling. Dividing the planting target stocking by trees per cluster will result in the required number of clusters per ha.

   Number of clusters per ha = planting target/ trees per cluster

2. Target Stocking Method

   Managers wishing to use the target stocking method should first consult the stocking standards table to determine the free growing target stocking recommended for the site series. Next, they should establish a mortality factor based on the site series and conditions, as in the final crop tree method, to derive the planting target. Dividing the planting target stocking by trees per cluster will result in the required number of clusters per ha. The cluster distribution table above can be consulted to help verify the calculated figure.

   Number of clusters per ha = planting target/ trees per cluster *(Triangular inter-cluster spacing = The square root of 11547/# of clusters per/ha)*

- When cluster planting is implemented, spacing between clusters should be adjusted to reflect site conditions and microsite location. Uniform distribution of clusters over the block is appropriate where site conditions are relatively uniform. However, clusters should be located on appropriate planting sites, taking advantage of natural site features such as elevated hummocks or stumps.
- Inter-cluster spacing is measured from the centre of one cluster to the centre of the adjacent ones on a square grid. However, where sites are undulating, clusters should be located on appropriate planting sites to take advantage of natural features such as elevated hummocks or stumps. Inter-cluster distances should be varied in order to optimize microsite selection.
- Inter-cluster spacing is recommended to be a minimum of 80% and a maximum of 120% of that required to achieve the desired planting target. This range should result in achieving the overall desired stocking density, within acceptable statistical limits, when a stocking survey is applied across the area.
- "Dispersed or non-uniform cluster" uses a mix of cluster densities across the block, and is appropriate for some blocks where microsites suitable for clusters (e.g., elevated hummocks) are not evenly distributed.
- For dispersed cluster planting, the minimum inter-tree distance within a cluster is 1 m on suitable microsites. The number of suitable clusters per ha should be estimated from a reliable survey that covers the entire area. The minimum/maximum inter-cluster distances may vary substantially, as long as the overall target density is met.

6. Monitoring Standards – Additional

Establishment (Age 0-4 Year) Phase:

N/A. Refer to the Management Guidelines section for management strategies through this portion of stand development.

Juvenile (Age 20-60 Year) Phase:

No specific standards are developed for this point in stand development. Management of younger age classes (e.g., establishment to free growing 0-20 years) is intended to develop suitable stand conditions through this age class. Existing stands within this age class may be managed to create the desired variable inter tree spacing and total density per ha through late juvenile spacing or commercial harvesting.

Mature (Age 60+ Year) Phase:

No specific standards are applicable for this age class. In general, subsequent partial cutting harvesting strategies should be implemented that are consistent with the Management Guidelines outlined.

Figure 22: Single tree selection with a zero-tail-swing feller buncher minimizes damage to caribou habitat. Photo: Darwyn Coxson.

Figure 21: Old forests with arboreal lichens provide winter forage for ungulates. Photo: Alex Inselberg.

Figure 24: Partial cutting, both single-tree and group selection, maintain habitat attributes for caribou. Photo: Darwyn Coxson.

Figure 23: Group selection harvesting provides openings for caribou foraging habitat. Photo: Susan Stevenson.

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7.8 Grizzly Bear (*Ursus arctos horribilis*)

1. Key Habitat Objectives

Maintain and or recruit habitat elements for grizzly bears – for forage and security cover.

Landscape Level: Landscape level management objectives such as patch size distribution and seral stage targets should be described in higher level plans and sustainable forest management plans. It is important to link higher level plan objectives such as seral stage targets for a landscape unit or other planning area, with specific operational plans and practices implemented at the stand level.

A further discussion of landscape level considerations is found in the Landscape Considerations section of this report. Also refer to Extension Note 54 (MoF 2001) for additional information on landscape planning and stand-level forest management practices (silviculture treatments) in grizzly bear habitat.

2. Forest Types or BEC Zones

BWBS dk, CWH all, ESSF all, ICH dw, mc, vc, wk, MH mm, MS dk, SBS mc, mk, mm, wk, SWB dk, mk

3. Management Guidelines and Specific Habitat Objectives for Access Development and Harvesting

1. Retain and or establish forested travel corridors between riparian habitats, using subhygric and wetter site series where possible. These areas should provide security and escape cover for bears as they travel.

2. Leave buffer strips of forested habitat to provide security cover and bedding areas adjacent to important foraging areas (e.g., avalanche chutes, wet meadows, estuaries, riparian habitats, skunk cabbage (*Lysichiton americanum*) swamps, seeps and alder swales) and existing den sites. Avoid planting of these forage sites. These areas will often provide additional habitat elements such as mark and rub trees, as well as connectivity and escape habitat.

3. Minimize new road placement near important bear foraging areas. Use access management plans to minimize potential human grizzly interactions.

4. If roads have been previously located near areas important for bear foraging, permanently deactivate these roads when they are no longer required for access. Restrict grass seeding to > 500 m away from active roads.

5. Blowdown patches, large root wads, large diameter black cottonwood (*Populus balsamifera*) and western redcedar (*Thuja plicata*), caves, or overhanging banks that can be dug out, all make potential den sites. Where possible, include these habitat elements in wildlife tree patches or riparian reserves to provide a buffer around them.

6. In areas where fish are an important part of the diet, retention of security cover and escape terrain along streams, rivers and estuaries are critical. This applies to any watersheds that drain to the Pacific Ocean (i.e., coastal watersheds including the Skeena and Fraser river systems).

7. Schedule stand entry activities outside of expected times of grizzly bear use of that area.

8. Maintain and or recruit canopy gaps, in a variety of shapes and sizes, to create a range of light and growing conditions for forage species production. Newly created gaps should range in size between 0.1-2.0 ha and be grouped (i.e., within 500 m of one another). Gaps of this nature should be considered regardless of the silvicultural system and harvest opening size. Total area retained in gaps should be similar to pre-harvest natural gap levels, which can be identified at the cutting permit scale.

4. Management Guidelines and Specific Habitat Objectives Post Harvest

Restoration:

1. Maintain and or recruit berry production through controlled, light impact broadcast burns in dense berry forage areas.

2. Maintain and or recruit areas of important grazing species (i.e., grass (*Poaceae* spp.), sedge (*Carex* spp.) or clover (*Trifolium* spp.), through scarification in areas > 500 m from access roads. This should be practiced on < 20% of prescription sites in a planning area.

3. Remove clover from the grass seed mixtures when close to active roads (< 500 m), so that these areas are less preferred by grizzlies for foraging.

4. Maintain and or recruit habitat for ants (e.g., carpenter ants (*Camponotus pennsylvanicus*), particularly on drier site series, by not disturbing large naturally occurring pieces of coarse woody debris (CWD), by enhancing levels of CWD across a prescription area, and by leaving high cut stumps (minimum of 0.5 m tall).

5. Forage quality depends, to a large extent, on herb and shrub cover, which in turn is influenced by seral stage, stand density and canopy closure. Higher forage value is usually associated with wetter site series and higher shrub cover (> 50% cover between clusters). This relationship is most valid in the CWH (except Douglas-fir (*Pseudotsuga menziesii*) dominated stands), and wet subzones of the ICH and SBS, but is also applicable to other subzones where berry forage is found. In areas where there are important forage species for bears, at the landscape level, manage the seral stage distribution and at the stand level manage for stand structure that has gaps of sufficient size to promote forage production. Three strategies to provide gaps at the stand level are:

   i) protecting existing natural gaps;
   ii) cluster planting; and
   iii) patchy spacing treatments (see below).

Regeneration:

1. Planting a mix of tree species should be considered when the number of trees per cluster is high. For cluster planting, a range of 10-30 conifer seedlings per cluster is recommended.

2. Plant a mixture of tree species and retain a deciduous component in the stand. Do not plant through existing alder swales, non-commercial cover, shrub fields, etc., that have been identified in operational plans as forage habitat.

3. Target tree stocking in clumps or patches so that berry forage production between clumps can be sustained for a longer period. A range of 10-30 conifer seedlings per cluster is recommended.

4. For clumpy planting (i.e., cluster planting), a reduced minimum inter-tree spacing and a lower maximum density are prescribed.

5. Shade-tolerant species (e.g., western hemlock (*Tsuga heterophylla*)) or species subject to epicormic branching (e.g., Sitka spruce (*Picea sitchensis*)) should be planted in the centre of a cluster, with less shade-tolerant species planted around the cluster perimeter.

6. The recommended inter-crop tree distance within clusters is 1-2 m (closer to 1 m for small clusters; and closer to 2 m for large clusters where more tree growing space is required).

7. Use the existing distribution of forage, crop trees and available microsites to roughly determine the target number of clusters per ha. Fewer clusters may be more suitable on uneven, wet, brushy or hummocky sites.

8. Manage seral stage distribution and stand structure to create gaps of sufficient size to promote forage production through cluster planting.

9. Avoid planting in important foraging areas (e.g., avalanche chutes, wet meadows, estuaries, riparian habitats, skunk cabbage swamps, seeps and alder swales).

10. Minimize soil and root disturbance between clusters to reduce damage to forage species root systems.

11. Spacing between clusters should be adjusted to reflect site conditions and microsite location. Uniform distribution of clusters over the block is appropriate where site conditions are relatively uniform. However, clusters should be located on appropriate planting sites, taking advantage of natural site features such as elevated hummocks or stumps.

12. Inter-cluster spacing is measured from the centre of one cluster to the centre of the adjacent ones on a square grid. However, where sites are undulating, clusters should be located on appropriate planting sites to take advantage of natural features such as elevated hummocks or stumps. Intercluster distances should be varied in order to optimize microsite selection.

13. Inter-cluster spacing is recommended to be a minimum of 80% and a maximum of 120% of that required to achieve the desired planting target. This range should result in achieving the overall desired stocking density, within acceptable statistics limits, when a stocking survey is applied across the area.

14. “Dispersed or non-uniform cluster” uses a mix of cluster densities across the block, and is appropriate for some blocks where microsites suitable for clusters (e.g., elevated hummocks) are not evenly distributed. For dispersed cluster planting, the minimum inter-tree distance within a cluster is 1 m on suitable microsites. The number of suitable clusters per ha should be estimated from a reliable survey that covers the entire area. The minimum/maximum inter-cluster distances may vary substantially, as long as the overall target density is met.

Brushing:

1. Use crop-tree centered brush treatments. Avoid herbicide application or spot treat in areas containing important forage species (i.e., *Vaccinium* spp., cow parsnip (*Heracleum lanatum*), fireweed (*Epilobium angustifolium*), devil's club (*Oplopanax horridus*), salmonberry (*Rubus spectabilis*), red elderberry (*Sambucus racemosa*), gooseberries and currants (*Ribes* spp.), red-osier dogwood (*Cornus stolonifera*), soopolallie (*Shepherdia canadensis*), black twinberry (*Lonicera involucrata*), horsetail (*Equisetum* spp.) and sedges (*Carex* spp.).

2. Brush treatments should be limited to within and immediately adjacent to clusters, using backpack chemical applications or manual brushing methods.

Spacing/Thinning/Pruning:

1. As stands mature, use thinning to create partially open canopies (40-60% crown closure) to promote shrub forage production.

2. A combination of cluster planting and patchy spacing treatments can be used to achieve this stand structure.

3. Manage seral stage distribution and stand structure to create gaps of sufficient size to promote forage production through patchy spacing treatments.

4. Spacing can be used to open the canopy, or enlarge or create gaps; determine which method is most appropriate for the specific stand. Maintain a deciduous tree component after spacing or brushing treatments. Prescribe a range of spacing densities across a site, higher densities should be maintained along roads and adjacent to special habitats for security cover.

Protection (fire, insects, disease, damage):

1. Management of catastrophic and endemic stand damaging events must be done in the context of a well thought out access management strategy.

5(a) Recommended Silvicultural Regimes (Interior Sites)

Interior BEC – Zones

BWBS

ESSF

ICH

SBS

SWB

MS

Subhygric to Hygric sites:

Management of these sites should focus on the enhancement and or recruitment of areas for berry and forb forage at the stand level. As well, where these areas are a part of a riparian system, they can be important travel corridors and feeding areas for fish. The strategies and regimes that may achieve these objectives include:

- All silvicultural systems may be applicable for this objective. The season of harvest should be limited to conditions that will limit soil and root disturbance.
- Site preparation treatments should consider light controlled broadcast burns to promote maintenance and recruitment of berry forage.
- Establish new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern as per the Additional Planting Information section. Establish a target percent area of gap retention that will be maintained so this objective can be measured at the free-growing survey.
- Use brush treatments that center around crop trees.
- Do not use broadcast brushing techniques such as herbicide treatment.
- During brushing and or spacing treatments ensure that berry forage production between clusters can be sustained or enhanced for a longer period by pruning shrub species to increase forage quality, or pruning crop trees on the edge of clusters to allow light to enter gaps.
- Use spacing to reduce crown cover or actually create canopy gaps that will persist later into stand development (20-60 years).

Submesic to Mesic sites:

Management of these sites should focus on the enhancement and or recruitment of areas for berry and herbaceous forage at the stand level. This is especially important in areas with south aspects that can produce spring forage. The strategies and regimes that may achieve this objective include:

- All silvicultural systems may be applicable for this objective. The season of harvest should be limited to conditions that will limit soil and root disturbance.
- Site preparation treatments could include light controlled broadcast burns to promote maintenance and recruitment of berry forage and or mechanical scarification methods followed by grass seeding to promote forage opportunities. This treatment should not be conducted near roads and on < 20% of a cutblock area.
- Establish new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern as per the Additional Planting Information section.

Interior BEC – Zones ***BWBS*** ***ESSF*** ***ICH*** ***SBS*** ***SWB*** ***MS***	• Do not employ broadcast-brushing techniques such as herbicides. In addition, during brushing and or spacing treatments ensure that berry forage production between clusters can be sustained or enhanced for a longer period. • Implement juvenile spacing programs as required to ensure canopy gaps will be present later into stand development (20-60 years). **Very Xeric to Submesic sites:** Management of these sites should focus on the enhancement and or recruitment of areas for insects (ants) and shrubby forage species (e.g., Soopolallie/dry *Vaccinium* spp.) production at the stand level. This is especially important in non-Pacific drainages and when berry crops are low. All silviculture systems may be applicable for this objective. Harvesting should be conducted to a lower utilization standard to provide high stumps (> 0.5 m) and larger pieces of CWD to provide a substrate for ants and small mammal forage. The interim CWD strategy (MOF 2002) is $4m^3$/ha dry belt, $10m^3$/ha transitional, and $20m^3$/ha in the interior wet belt and coastal areas. Where possible, minimum CWD piece sizes dispersed throughout the harvest area (recommended > 10 cm dbh and > 6 m long (NSC 2002). • Site preparation treatments should be avoided, as the disturbance of existing CWD will reduce piece size and increasing decay rates. • Establish new plantations through planting or retention of natural advance regeneration in a uniform fashion so that subsequent crown closure will provide screening and security habitat, in particular, along roads, travel corridors and identified bear habitat features.

5(b). Recommended Silvicultural Regimes (Coastal Sites)

Coastal BEC – Zones ***CWH*** ***MH***	**Subhygric to Hygric sites**: Management of these sites should focus on the enhancement and or recruitment of areas for berry and forb forage at the stand level. The strategies and regimes that may achieve this objective include: • All silvicultural systems are applicable for this objective. The season of harvest should be limited to conditions that will limit soil and root disturbance. • Site preparation treatments should consider light controlled broadcast burns (where possible) to promote maintenance and recruitment of berry forage. • Establish new plantations through cluster planting or retention of natural advance regeneration in a cluster pattern as per the Additional Planting Information section. • Use brush treatments that center around crop trees. • Do not use broadcast brushing techniques such as herbicide treatment. • During brushing and or spacing treatments ensure that berry forage production between clusters can be sustained or enhanced for a longer period by pruning shrub species to increase forage quality, or pruning crop trees on the edge of clusters to allow light to enter gaps. • Use spacing to reduce crown cover or actually create canopy gaps that will persist later into stand development (20-60 years).

6. Monitoring Standards – Establishment to Free Growing Seral Stage

Table 1.1 – Stocking Standard Guidelines

Applicable Ecosystem (BEC)			Stocking Standard Modifiers									
Zones	**Subzones**	**Moisture Nutrient Regime**	**Species Selection**	**Stocking Standard Modifier[1]**	**Regen Delay**	**Assessment Time Frame**	**Minist. Tree Ht.**	**% Tree Over Brush**	**Min Inter Tree Distance**	**Max Density**	**Survey Method**	**Comments**
BWBS	dk	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	
CWH	All	3-5/D-E	Same	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	
ESSF	All	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	
ICH	dw, mc wk, vc	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	
MH	mm	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	
MS	dk	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	
SBS	mm, mk mc, wk	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	
SWB	dk, mk	4-6/A-E	Broadleaf[2]	0.67	Same	Same	Same	Same	1.0	4000[3]	Footnote 4	

1. The term Stocking Standard Modifier refers to the factor applied to existing stocking standards contained within Establishment to Free Growing Guidebooks. For example: the stocking standards (well-spaced/ha) for CWHvm1 01 site as found in the Establishment to Free Growing Guidebook, Prince Rupert Forest Region equals = TSSpa **900**, MSSpa **500**, MSSp **400**. The equivalent stocking standards (well-spaced/ha) for areas with maintenance and or recruitment of grizzly bear foraging and security habitat objectives would be TSSpa **600**, MSSpa **335**, MSSp **270**. TSS - target stocking standard, MSS – minimum stocking standard, pa – preferred and acceptable, and p - preferred.

2. Broadleaf species management for mixed coniferous/deciduous stands should be seriously considered where applicable for this management objective. Utilize the appropriate broadleaf species as a primary or secondary species as indicated in the Establishment to Free Growing Guidebooks.

3. Maximum density is 4000 stems per ha for these ecosystems, this max density standard is inclusive of deciduous species. Deciduous stems will contribute to maximum density calculations in the same fashion as coniferous stems. In addition, stands will not be considered free growing unless they are demonstrated to contain a minimum of 20% canopy gaps. This is to be assessed through the establishment of random systematic free growing survey plots as discussed in point 4 below. If inadequate gap creation exists, then a juvenile spacing entry must be completed to provide the required gaps. Spacing is to target leaving gaps in areas with abundant forage present.

4. The survey methodologies used to assess the success of meeting the forage objectives should be consistent with existing methodologies. However, do not stratify areas to units smaller than one ha, or use dispersed stratum methodologies. In general, more plots will be required to prove obligations are met due directly to the desired patchy nature of the target stocking desired. The maximum number of plots required will be 1.5 per ha. The statistical requirements for these areas will be consistent with existing methodologies. In addition to meeting the stocking requirement for these stands it is imperative that gap creation has occurred by the free growing determination stage. To test if adequate gap creation exists, a minimum of 20% (per standards unit) of the randomly systematic established plots ($50m^2$) must contain less than or equal to one conifer (> 50 cm height), or the equivalent of 200 stems per ha.

6. Monitoring Standards – Establishment to Free Growing Seral Stage

Table 1.2– Cluster Distribution

Stocking (tress/ha)	Clusters per ha								Triangular Inter-cluster spacing (m)							
	Trees per cluster								Trees per cluster							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
200	25	29	33	40	50	67	100	200	21.5	20.1	18.6	17.0	15.2	13.2	10.7	7.6
250	31	36	42	50	63	83	125	250	19.2	18.0	16.6	15.2	13.6	11.8	9.6	6.8
300	38	43	50	60	75	100	150	300	17.5	16.4	15.2	13.9	12.4	10.7	8.8	6.2
350	44	50	58	70	88	117	175	350	16.2	15.2	14.1	12.8	11.5	9.9	8.1	5.7
400	50	57	67	80	100	133	200	400	15.2	14.2	13.2	12.0	10.7	9.3	7.6	5.4
450	56	64	75	90	113	150	225	450	14.3	13.4	12.4	11.3	10.1	8.8	7.2	5.1
500	63	71	83	100	125	167	250	500	13.6	12.7	11.8	10.7	9.6	8.3	6.8	4.8
550	69	79	92	110	138	183	275	550	13.0	12.1	11.2	10.2	9.2	7.9	6.5	4.6
600	75	86	100	120	150	200	300	600	12.4	11.6	10.7	9.8	8.8	7.6	6.2	4.4
650	81	93	108	130	163	217	325	650	11.9	11.2	10.3	9.4	8.4	7.3	6.0	4.2
700	88	100	117	140	175	233	350	700	11.5	10.7	9.9	9.1	8.1	7.0	5.7	4.1
750	94	107	125	150	188	250	375	750	11.1	10.4	9.6	8.8	7.8	6.8	5.5	3.9
800	100	114	133	160	200	267	400	800	10.7	10.1	9.3	8.5	7.6	6.6	5.4	3.8
850	106	121	142	170	212	283	425	850	10.4	9.8	9.0	8.2	7.4	6.4	5.2	3.7
900	112	129	150	180	225	300	450	900	10.2	9.5	8.8	8.0	7.2	6.2	5.1	3.6
950	119	136	158	190	238	317	475	950	9.9	9.2	8.5	7.8	7.0	6.0	4.9	3.5
1000	125	143	167	200	250	333	500	1000	9.6	9.0	8.3	7.6	6.8	5.9	4.8	3.4

Notes: When cluster planting is prescribed, silviculture prescriptions should specify target trees per cluster and target clusters per ha, in addition to the target stocking standard.

Two methods have been developed to determine the prescribed number of clusters per ha.

1. Final Crop Tree Method

   The final crop tree formula is the preferred method of determining the number of clusters. Managers must first determine the number of crop trees desired at rotation. Working backward from the density at final rotation, free growing targets and planting targets should be established based on appropriate mortality factors for the site. The following should be considered when deriving a mortality factor: species selection (e.g., shade-tolerant species show less mortality), availability of suitable microsites (e.g., moisture and nutrient requirements, likelihood of flood events), vegetative competition, and anticipated mortality due to stock handling. Dividing the planting target stocking by trees per cluster will result in the required number of clusters per ha.

   Number of clusters per ha = planting target/ trees per cluster

2. Target Stocking Method

   Managers wishing to use the target stocking method should first consult stocking standards table to determine the free growing target stocking recommended for the site series. Next, they should establish a mortality factor based on the site series and conditions, as in the final crop tree method, to derive the planting target. Dividing the planting target stocking by trees per cluster will result in the required number of clusters per ha. The cluster distribution table above can be consulted to help verify the calculated figure.

   Number of clusters/ha = planting target/# trees per cluster *(Triangular inter-cluster spacing = The square root of 11547/# of clusters per/ha)*

- Spacing between clusters should be adjusted to reflect site conditions and microsite location. Uniform distribution of clusters over the block is appropriate where site conditions are relatively uniform. However, clusters should be located on appropriate planting sites, taking advantage of natural site features such as elevated hummocks or stumps.
- Inter-cluster spacing is measured from the centre of one cluster to the centre of the adjacent ones on a square grid. However, where sites are undulating, clusters should be located on appropriate planting sites to take advantage of natural features such as elevated hummocks or stumps. Intercluster distances should be varied in order to optimize microsite selection.
- Inter-cluster spacing is recommended to be a minimum of 80% and a maximum of 120% of that required to achieve the desired planting target. This range should result in achieving the overall desired stocking density, within acceptable statistics limits, when a stocking survey is applied across the area.
- "Dispersed or non-uniform cluster" uses a mix of cluster densities across the block, and is appropriate for some blocks where microsites suitable for clusters (e.g., elevated hummocks) are not evenly distributed.

6. Monitoring Standards – Additional

Establishment (Age 0-4 Years) Phase:

No more than 10% of individual opening sizes created for areas with this objective are to be > 2 ha in size. In addition, no individual opening may exceed 5 ha in size (e.g., a 10 ha block created with a patch cut system may contain the following gap sizes 5, 2, 1, 0.5, 0.25, 0.4, 0.6 ha). These openings reflect the natural gap sizes found in ESSF and wet SBS ecosystems.

Juvenile (Age 20-60 Years) Phase:

No specific standards are developed for this point in stand development. Management of younger age classes (e.g., establishment to free growing 0-20 years) is intended to develop suitable stand conditions through this age class. Opening up existing stands by creating gaps through late juvenile spacing or commercial thinning may be strategies that could be implemented to encourage forage species.

Mature (Age 60+ Years) Phase:

No specific standards are applicable for this age class. At stand maturity, partial cutting harvest systems can be used to create a patchy network of new seral openings (i.e., which simulate canopy gaps and open areas for forage production) and nearby forested security cover. In general, subsequent harvesting strategies (regardless of the silvicultural system) will have to be implemented that are consistent with the gap creation strategies discussed.

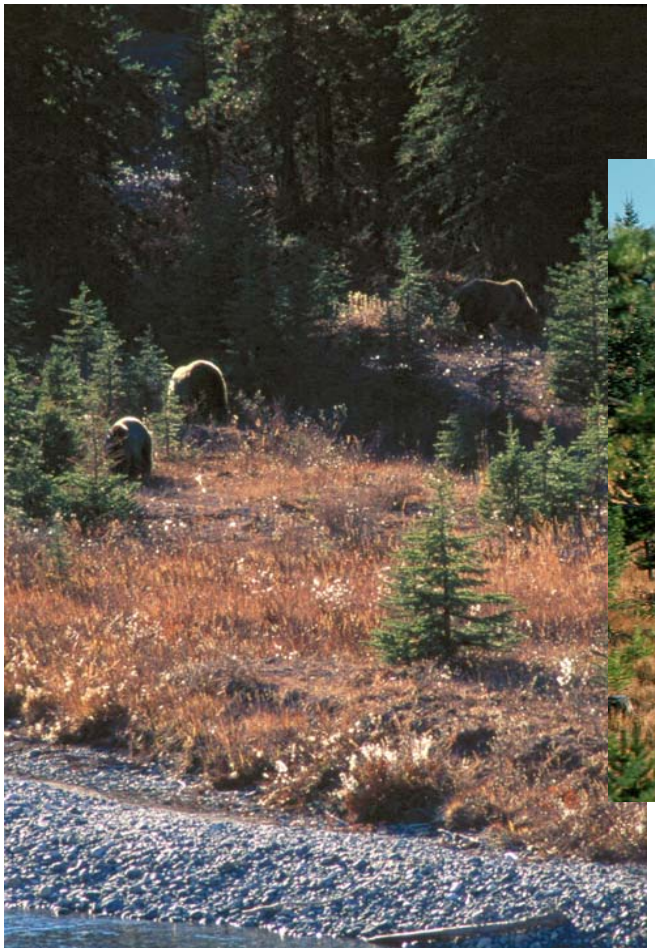

Figure 26: Planting and spacing regimes can mimic naturally occurring patchy, foraging habitat. Photo: Alex Inselberg.

Figure 25: Patchy and clumpy forest mosaic with shrubby openings provide forage and security habitat. Photo: Alex Inselberg.

Figure 27: Patchy and clumpy forest mosaic with heavy understory provide good security habitat. Photo: Alex Inselberg.

Figure 28: Patchy and clumpy forest mosaic with varied shrub and regeneration understory provides foraging and security habitat. Photo: Alex Inselberg.

Figure 29: Old forest with varied, berry-producing shrub understory provides important forage. Photo: Alex Inselberg.

Figure 30: Selective harvesting provides light penetration for shrub growth. Photo: Alex Inselberg.

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Glossary of Terms

Arboreal Lichen – A lichen species that tends to grow above ground, typically from the branches of standing trees.

Biodiversity (biological diversity) – The diversity of plants, animals, and other living organisms in all their forms and levels of organization, including genes, species, ecosystems, and the evolutionary and functional processes that link them.

Blowdown – A tree or trees uprooting by the wind. Often referred to as windthrow.

Bole – The trunk of a tree.

Broadcast Burning – A controlled burn, where the fire is intentionally ignited and allowed to proceed over a designated area within well-defined boundaries, to reduce fuel hazard after logging or to prepare the site before planting.

Brushing – A silviculture activity done by chemical, manual, grazing, or mechanical means to control competing forest vegetation and reduce competition for space, light, moisture, and nutrients with crop trees or seedlings.

Buffer – A strip of land (often including undisturbed vegetation) where disturbance is not allowed or is closely monitored to preserve or enhance aesthetic and other qualities along or adjacent to roads, trails, watercourses and recreation sites.

Canopy – The forest cover of branches and foliage formed by tree crowns.

Canopy Closure – The percentage of the ground surface covered when the canopy crown is projected vertically.

Canopy Gap – A distinct air-space or hole between the foliage of the canopy crown.

Closed Canopy – The condition when the crowns of trees touch and effectively block sunlight from reaching the forest floor.

Clumpy – Refers to the pattern of distribution of vegetation in an area such as a harvest opening, and can include the distribution of trees, regeneration, or shrub cover. A clumpy distribution is characterized by groups or clusters of vegetation, as opposed to uniformly or randomly distributed vegetation. “Clumpy” is often used in the context of planting and juvenile spacing treatments, and is also referred to as “patchy”.

Commercial Thinning – A silviculture treatment that removes or cuts stems that can be used commercially (e.g., fence posts) from an immature stand to help accelerate the growth and diameter size of the remaining stems.

Conk – A hard, fruiting body that typically grows on the trunk of a tree, which contains spores of a wood-decaying fungus

Connectivity – To have forest stands or habitat areas attached or linked to one another across the landscape.

Critical Winter Range – Forested habitat, usually stands of mature or old-growth conifers, which provides ungulates with resources critical to survival during severe winters.

CWD (Coarse Woody Debris) – Above ground, dead woody material in various stages of decomposition that is not self-supporting and provides habitat for plants, animals, and insects and is a source of nutrients for soil development.

CWD Decay Classes – A five-category system that describes the amount of decay that is present on a downed piece of wood >7.5 cm in diameter (i.e., class 1 is intact, hard and elevated above ground; class 5 is decayed into many small pieces with soft portions that is partly sunken into the ground).

Danger Tree (Hazard Tree) – A live or dead tree whose trunk, root system or branches have deteriorated or have been damaged to such an extent as to be a potential danger to human safety.

DBH (Diameter at Breast Height) – The stem diameter of a tree measured at breast height, 1.3 metres above the ground.

Deactivation – Measures taken to stabilize roads and logging trails during periods of inactivity, including the control of drainage, the removal of sidecast where necessary, and the re-establishment of vegetation for permanent deactivation.

Disturbance – A discrete event, either natural or human-induced, that causes a change in the existing condition of an ecological system.

Edge Habitat – Habitat conditions that exist along the outer band of a forested patch that are significantly different (e.g., differences in humidity, vegetation heights, plant associations, and exposure to light or wind) from the interior of the patch.

Exotic Species – A species introduced accidentally or intentionally to a region beyond its natural range. "Exotic" is a preferred synonym for "alien", "foreign", and "non-native".

Forest Floor – The layers of fresh leaf and needle litter, moderately decomposed organic matter, humus or well-decomposed organic residue found on the ground within a forest stand.

Fragmentation – The process of transforming large continuous forested areas into one or more smaller patches surrounded by human-made or naturally occurring disturbed areas.

Fungal Inoculation – An artificial means of introducing wood-decaying fungal spores into a live tree to increase decay and wildlife value.

Girdling – To kill a tree by severing or damaging the cambium layer and interrupting the flow of food between the leaves and the rest of the tree.

Habitat – The place where an organism lives and/or the conditions of that environment, including the soil, vegetation, water, and food.

Habitat Feature (elements) – An element of a forest stand that is used by a wildlife species for sustaining its ecological role, i.e., a snag, hollow log, mossy covered branch, forked limb crotch, rocky outcropping, etc.

Habitat Matrix – A series of linked habitat areas that maintain large-scale ecological processes at the landscape level.

Hard Forest Edge – An immediate, well-defined boundary between two or more distinctly different seral stages (i.e., the edge between an early seral stage and a late seral stage).

Herb Layer – All herbaceous plants (regardless of height) and low woody plants <15 cm tall.

Interior Forest Habitat – Microclimate conditions (i.e., light intensity, temperature, wind, relative humidity and moisture levels) found deep within forests, away from the effects of open areas.

Juvenile Spacing – A silvicultural treatment to reduce the number of trees in young stands, often carried out before the stems removed are large enough to be used or sold as a forest product. Also called precommercial thinning.

Landscape Level – The level of forest management at which ecosystem processes, habitat types and seral stage distribution are managed for large, geographically separate areas.

Landscape Unit – A planning area, up to 100 000 ha in size, based on topographic or geographic features such as a watershed or series of watersheds.

Landing – An area modified by equipment that is designed for accumulating logs before they are transported.

Leave Trees – All trees, regardless of species, age, or size, remaining on a harvested area as a result of a predetermined silviculture prescription to address a possible range of silviculture or resource needs.

Maintain – To stay at, or approximate, current natural levels of forage or other habitat attributes.

Management Guideline - Generally accepted non-mandatory guidance and management recommendations based on the best available data and expert opinion.

Mature Forest – The stage at which trees in a narrowly even-aged stand attain full development, particularly in height and seed production.

Natural Disturbance Regime – The historic patterns (frequency and extent) of fire, insects, wind, landslides and other natural processes and disturbances in an area.

Old Forest – Over-mature, structurally complex stands consisting of live and dead trees of various sizes, species, composition, and age class structure.

Overstory – Foliage within the shrub and canopy layers of a forest stand that obstruct sunlight from reaching the forest floor.

Partial Harvesting – A general term referring to silvicultural systems other than clearcutting, in which only selected trees are harvested.

Patch Cutting – A silvicultural system that creates openings less than 1 hectare in size and is designed to manage each opening as a distinct even-aged opening.

Patchy – Refer to definition of Clumpy

Prescribed Burning – The knowledgeable application of fire to a specific unit of land to meet predetermined resource management objectives.

Pruning – The manual removal, close to or flush with the stem, of side branches, live or dead, and of multiple leaders from standing, generally plantation-grown trees.

Recruit – To restore forage or other habitat attributes to previous natural equilibrium levels. Recruit can also be used in the context of enhancement, which means to increase forage or other habitat attributes above previous natural equilibrium levels.

Red List – Includes any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered, or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do occur elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed.

Retention – To retain or save a portion of the original stand in a cluster or clump.

Riparian – an area adjacent to a stream, lake, pond or wetland where water influences the vegetation.

Riparian Management Area (RMA) – Means an area of width (as determined in accordance with standards described in the Forest Practices Code Operational Planning Regulations) that

is adjacent to a stream, wetland or lake. The RMA consists of a riparian management zone **(RMZ)** and, depending on the riparian class of the stream, wetland or lake, a riparian reserve zone **(RRZ)**. The riparian class is determined by the attributes of the stream, wetland or lake, as well as the adjacent terrestrial ecosystems. Attributes include channel width, size (area) of the wetland, presence of fish, domestic water use, and gully status (stream gradient and sidewall slope).

Riparian Reserve Zone (RRZ) – The portion of a riparian management area that borders the stream channel. RRZs are determined by the stream class and associated attributes (see RMA). Forest management activities are restricted in RRZs.

Rotation Period – The planned number of years between the formation or regeneration of a tree crop or stand and its final cutting at a specified stage of maturity.

Scarification – A method of seedbed preparation that consists of exposing patches of mineral soil through mechanical action.

Second Growth – A forest or stand that has grown up naturally after removal of a previous stand by fire, harvesting, insect attack or other cause.

Security Cover – Vegetation structure or topographical features, or both, that provide an animal with security or a means of escape from the threat of predators or harassment.

Selective Harvesting – The removal of certain trees in a stand as defined by specific criteria (species, diameter at breast height, height or form).

Seral Stage – Any stage of development of an ecosystem, from a disturbed, unvegetated state to a climax plant community.

Shrub Layer – All woody plants <10 m and >15 cm tall.

Silviculture – The theory and science of controlling the establishment, growth, composition, health and quality of forests and woodlands.

Silviculture Prescription – A site-specific, integrated operational plan to carry out one or a series of silviculture treatments.

Single Tree Selection – A silvicultural system that removes mature timber either as single scattered individuals or in small groups at relatively short intervals.

Slash – The residue left on the ground as a result of forest and other vegetation being altered by forest practices or other land use activities.

Small Group Selection – A silvicultural system that removes mature timber in a small area or grouping, typically $\leq$0.5 ha in size.

Snag – A standing dead tree.

Snag Classes – A nine-category system that describes the amount of decay that is present on a standing tree (i.e., class 1 is a live tree with no rot or decay present; class 9 is a fully decayed stump partially incorporated into the forest floor).

Soft Forest Edge – A gradual, transitional boundary between two or more seral stages (i.e., the edge between an middle seral stage and a late seral stage).

Soil Moisture Regime – The available moisture supply for a soil relative to other sites and soil types.

Soil Nutrient Regime – The available nutrient supply for a soil relative to other sites and soil types.

Spacing – The removal of undesirable trees within a young stand to control stocking, to maintain or improve growth, to increase wood quality and value, or to achieve other resource management objectives.

Stand Attribute – A measurable component of a forest stand (i.e., canopy closure, basal area, stem distribution, or seedlings/ha, etc.)

Stand Level – The level of forest management at which a relatively homogeneous land unit can be managed under a single prescription, or set of treatments, to meet well-defined objectives.

Stand Structure – The distribution of trees in a stand, which can be described by species, vertical or horizontal spatial patterns, size of trees or tree parts, age, or a combination of these.

Stocking – A measure of the area occupied by trees, usually measured in terms of well-spaced trees per hectare, or basal area per hectare, relative to an optimum or desired level.

Stub Tree – An artificially created wildlife tree, mechanically cut from a class 1, 2 or 3 tree.

Succession – The gradual supplanting of one community of plants by another.

Thermal Cover – Vegetation structure and or topographical features that provide an animal a means to thermoregulate.

Thinning – A silviculture treatment that removes or cuts stems in an immature crop or stand primarily to accelerate diameter increment but also, by suitable selection, to improve the average form of the trees that remain.

Treatment Area – A productive forest land area designated in a prescription for a specific silviculture activity or series of treatments.

Tree Layer – All woody plants >10 m tall.

Understory – Any plants growing under the main tree canopy, particularly those found in the herbaceous and shrub layers.

Veteran Tree (Vet) – A tree that is significantly older (usually $\geq$150 years of age) than the trees of the main forest canopy. Veteran trees may have survived one or more fires as evidenced by fire scars, and are usually isolated in distribution and often extend well above the main tree canopy. Because of their large size, they usually provide valuable wildlife tree habitat for many decades.

Wildlife Corridor – A strip or band of habitat that wildlife use to travel from one habitat area to another.

Wildlife Tree – A standing dead or live tree with special characteristics that provide valuable habitat for the conservation or enhancement of wildlife.

Wildlife Tree Patch (WTP) – An area specifically identified for the retention and recruitment of suitable wildlife trees that is reserved from harvest for at least 1 rotation length.

Winter Range – A range, usually at lower elevation, used by ungulates during the winter months that is typically better defined and smaller than summer range.

Yellow List – Any indigenous species or subspecies (taxa) that is not at risk in British Columbia.

Young Forest – A loose term applied to all stages of forest after it is established and before it becomes mature.

Appendix 1. List of Persons Contacted for Technical Information or Review Comments

- Harold Armleder – Wildlife Research Ecologist, Ministry of Forests, Southern Interior Forest Region, Williams Lake, B.C.
- Bryce Bancroft – Forestry Consultant. Symmetree Consulting Group, Victoria, B.C.
- Liesbet Beaudry – Wildlife/Forestry Consultant. P. Beaudry and Associates, Prince George, BC.
- Kim Brunt – Wildlife Biologist. Ministry of Water, Land and Air Protection, Nanaimo, BC.
- Michael Burwash – Senior Ecosystem Biologist. B.C. Ministry of Water, Land and Air Protection, Kamloops, BC.
- Rick Dawson – Wildlife Research Ecologist. B.C. Ministry of Forests, Cariboo Forest Region, Williams Lake, BC.
- Nancy Densmore – Biodiversity Specialist, B.C. Ministry of Forests, Forest Practices Branch, Victoria, BC
- Frank Doyle – Wildlife Consultant. Wildlife Dynamics Consulting, Telkwa, BC.
- Doug Folkins – Silviculture Forester. Canadian Forest Products Ltd., Woss, BC.
- Les Gyug – Wildlife Consultant. Merritt, BC.
- Tony Hamilton – Provincial Bear Biologist. B.C. Ministry of Water, Land and Air Protection, Biodiversity Branch, Victoria, BC.
- Trevor Kinley – Wildlife Biologist. Sylvan Consulting Ltd., Invermere, BC.
- Marlene Machmer – Wildlife Consultant. Pandion Ecological Research, Nelson, BC.
- Erica McClaren – Inventory Specialist. B.C. Ministry of Water, Land and Air Protection, Wildlife Branch, Nanaimo, BC.
- Ian McDougall – Senior Forest Planner. B.C. Ministry of Sustainable Resource Management, Campbell River, BC
- Brian Raymer. Silvicultural Operations Forester. B.C. Ministry of Forests, Forest Practices Branch, Victoria, BC
- Chris Ritchie – Ecosystems Section. B.C. Ministry of Water Land and Air Protection, Prince George, BC.

- Dale Seip - Wildlife Research Ecologist, Ministry of Forests, Northern Interior Forest Region, Prince George, BC.

- Chistoph Steeger – Wildlife/Forestry Consultant. Pandion Ecological Research, Nelson, BC.

- Richard Thompson – Effectiveness Monitoring Specialist. Ministry of Water, Land and Air Protection, Biodiversity Branch, Victoria, BC.

- Guy Woods – Wildlife Biologist. B.C. Ministry of Water, Land and Air Protection, Nelson, BC.

- Jim Young – Wildlife Biologist. B.C. Ministry of Water, Land and Air Protection, Williams Lake, BC.

Appendix 2. Biogeoclimatic Subzones of British Columbia

Zonal Group	Biogeoclimatic Zone	Subzone	Subzone Code
Coastal	Coastal Douglas-fir	Moist Maritime	CDFmm
	Coastal Western Hemlock	Wet Hypermaritime	CWHwh
		Very Wet Hypermaritime	CWHvh
		Very Dry Maritime	CWHxm
		Dry Maritime	CWHdm
		Moist Maritime	CWHmm
		Wet Maritime	CWHwm
		Very Wet Maritime	CWHvm
		Dry Submaritime	CWHds
		Moist Submaritime	CWHms
		Wet Submaritime	CWHws
Mountain Hemlock	Mountain Hemlock	Wet Hypermaritime Parkland	MHwhp
		Wet Hypermaritime	MHwh
		Moist Maritime Parkland	MHmmp
		Moist Maritime	MHmm
Dry Interior	Bunchgrass	Very Dry Hot	BGxh
		Very Dry Warm	BGxw
	Ponderosa Pine	Very Dry Hot	PPxh
		Dry Hot	PPdh
	Interior Douglas-fir	Very Dry Hot	IDFxh
		Very Dry Warm	IDFxw
		Very Dry Mild	IDFxm
		Dry Mild	IDFdm
		Dry Cool	IDFdk
		Moist Warm	IDFmw
		Wet Warm	IDFww
	Montane Spruce	Very Dry Very Cold	MSxv
		Very Dry Cool	MSxk
		Dry Cold	MSdc
		Dry Cool	MSdk
		Dry Mild	MSdm
Interior Cedar-Hemlock	Interior Cedar-Hemlock	Very Dry Warm	ICHxw
		Dry Warm	ICHdw
		Moist Warm	ICHmw
		Moist Mild	ICHmm
		Wet Cool	ICHwk
		Very Wet Cool	ICHxk
		Dry Cool	ICHdk
		Moist Cool	ICHmk
		Moist Cold	ICHmc
		Very Wet Cold	ICHvc

Zonal Group	Biogeoclimatic Zone	Subzone	Subzone Code
Central Plateau	Sub-boreal Pine-Spruce	Very Dry Cold	SBPSxc
		Dry Cold	SBPSdc
		Moist Cool	SBPSmk
		Moist Cold	SBPSmc
	Sub-boreal Spruce	Dry Hot	SBSdh
		Dry Warm	SBSdw
		Dry Cool	SBSdk
		Moist Hot	SBSmh
		Moist Warm	SBSmw
		Moist Mild	SBSmm
		Moist Cool	SBSmk
		Moist Cold	SBSmc
		Wet Cool	SBSwk
		Very Wet Cool	SBSvk
Engelmann Spruce-Subalpine Fir	Engelmann Spruce-Subalpine Fir	Very Dry Cold	ESSFxc
		Dry Cool	ESSFdk
		Dry Cold	ESSFdc
		Dry Very Cold	ESSFdv
		Moist Warm	ESSFmw
		Moist Mild	ESSFmm
		Moist Cool	ESSFmk
		Moist Cold	ESSFwc
		Moist Very Cold	ESSFmv
		Wet Mild	ESSFwm
		Wet Cool	ESSFwk
		Wet Cold	ESSFwc
		Wet Very Cold	ESSFwv
		Very Wet Cold	ESSFvc
		Very Wet Very Cold	ESSFvv
Boreal	Boreal White and Black Spruce	Dry Cool	BWBSdk
		Moist Warm	BWBSmw
		Wet Cool	BWBSwk
	Spruce-Willow-Birch	Dry Cool	SWBdk
		Moist Cool	SWBmk
		Dry Cool Scrub	SWBdks
		Moist Cool Scrub	SWBmks
Alpine Tundra	Alpine Tundra		AT

Source: Meidinger, D. and J. Pojar. 1991. Ecosystems of British Columbia. B.C. Minist. For., Spec. Rep. Ser. 6, Victoria, BC.