LAND MANAGEMENT HANDBOOK

34

Sheep Grazing Guidelines for Managing Vegetation on Forest Plantations in British Columbia

1995

BRITISH COLUMBIA
Ministry of Forests
Research Program

Sheep Grazing Guidelines for Managing Vegetation on Forest Plantations in British Columbia

T. Newsome, B. Wikeem, and C. Sutherland

BRITISH COLUMBIA
Ministry of Forests
Research Program

Canadian Cataloguing in Publication Data
Newsome, Teresa Hardie, 1957-
Sheep grazing guidelines for managing vegetation on forest plantations in British Columbia

(Land management handbook ; 34)

Includes bibliographical references: p.
ISBN 0–7726–2461–5

1. Forest plants – Biological control – British Columbia. 2. Sheep – British Columbia – Feeding and feeds. 3. Grazing – British Columbia. 4. Forest management – British Columbia. I. Wikeem, Brian M. II. Sutherland, D. C. (D. Craig) III. British Columbia. Ministry of Forests. Research Branch. IV. Title. V. Series.

SD387.G73N48 1995 634.9'696'09711 C95–960159–7

Prepared by
Teresa Newsome and Craig Sutherland
B.C. Ministry of Forests
Cariboo Forest Region
540 Borland Street
Williams Lake, BC V2G 1R8
and
Brian Wikeem
B.C. Ministry of Forests
Agriculture Canada Research Station
3015 Ord Road
Kamloops, BC V2B 8A9

Published by the
Research Branch
B.C. Ministry of Forests
31 Bastion Square
Victoria, BC V8W 3E7

Copies of this and other Ministry of Forests
titles are available from
Crown Publications Inc.
521 Fort Street
Victoria, BC V8W 1E7

Hardwood and Vegetation Management Research Program

This study was initiated by the British Columbia Hardwood and Vegetation Management Technical Advisory Committee (HVM TAC) as project CO2. Funding for the project and publication was provided by the Sustainable Environment Fund and the Canada–British Columbia Partnership Agreement on Forest Resource Development: FRDA II.

HVM TAC was established in 1990 under funding from the Sustainable Environment Fund–Forest Renewal Initiatives Program, to establish a co-ordinated research and extension program supplying relevant information to forest resource managers. Representatives on HVM TAC include the Ministry of Forests (Research Branch, Silviculture Branch, and forest regions); Ministry of Environment, Lands and Parks (Wildlife Branch); and the Canadian Forest Service. Since its inception, a total of 31 vegetation management projects have been supported province-wide.

The current vegetation management goal of HVM TAC is to support the acquisition, communication, and application of information needed for implementing effective vegetation management prescriptions consistent with sustainable and integrated management of forest resources.

The 5-year strategic plan for vegetation management research outlines six priority areas for investigation. They are:

1. **Prediction and Diagnosis of Vegetative Competition Problems**, to provide information on vegetation development, the effects of neighbouring vegetation on crop seedling survival and growth, and competition indexes to support operational decisions;
2. **Effectiveness of Treatment Options**, to provide information on the efficacy of all vegetation management options, including biological, chemical, physical, mechanical, and prescribed fire, to assist in making sound treatment prescriptions;
3. **Ecology of Crop and Non-Crop Species**, to provide information on the ecological requirements, tolerances, and roles of crop and non-crop species to aid in the development of vegetation management prescriptions;
4. **Silvicultrual Benefits and Impacts of Treatments**, including both short-term and long-term impacts of treatments on crop species survival, growth, and yield to support operational vegetation management decisions;
5. **Impacts of Treatments on Non-Timber Resources**, with emphasis on identifying and quantifying the impacts of vegetation management treatments on fish and wildlife habitat, range, recreation, and water quality at both the stand and landscape levels; and
6. **Development of Tools to Assist Resource Managers in the Selection and Evaluation of Treatments**, including handbooks, decision charts, simulation models, expert systems, and geographic information systems.

Further information about the program may be obtained from the B.C. Ministry of Forests, Research Branch, 31 Bastion Square, Victoria, B.C. V8V 3E7.

Many hours of work went into this document. Thank you to all the people who contributed their time and shared their experiences. A few key people who assisted us in producing this document are: Dr. Henry Lange, Carol Thompson, and Laila Salm. Also, a special thanks to the Horsefly and 100 Mile House Forest Districts, who provided the opportunity to learn about using sheep in forest plantations.

Acknowledgements iii

1 Introduction 1

2 Sheep Grazing as a Vegetation Management Option 2
2.1 Definition of Vegetation Management 2
2.2 Sheep Grazing versus Other Vegetation Management Options 2

3 Site Selection 4
3.1 Conifer Species and Age 4
3.2 Vegetation Complexes 5
3.2.1 Sheep forage preferences 5
3.2.2 Forage quality 7
3.2.3 Forage quantity 8
3.2.4 Poisonous plants 8
3.3 Site Characteristics 8
3.3.1 Climate 8
3.3.2 Topography 9
3.3.3 Water availability 9
3.3.4 Amount of slash 9
3.3.5 Sheep visibility 9
3.3.6 Accessibility 9
3.3.7 Proximity to alternative blocks 9
3.3.8 Proximity to other plantations 9
3.4 Interactions with Wildlife and Other Resource Values 9

4 Sheep Health Inspections 10

5 Transportation 10
5.1 Sanitation and Bedding 10
5.2 Stress and Disease 10

6 Preparing Sheep for Grazing Plantations 10
6.1 Food and Water on Arrival 10
6.2 Pre-conditioning Sheep to Available Forage 10

7 Sheep Management 11
7.1 Breed and Class of Sheep 11
7.2 Corral Placement 11
7.3 Fencing 11
7.4 Water and Salt 12
7.5 Shepherds and Herding 12
7.6 Bedding 12
7.7 Sheep Growth and Performance 12
7.8 Poisonous Plants 13
7.9 Interactions with Wildlife and Other Resource Values 13

8 Sheep Grazing as a Treatment for Conifer Release 13
8.1 Grazing Intensity 13
8.2 Grazing Frequency 14
8.3 Grazing Timing 15

9 Monitoring 15
9.1 Short-term Monitoring 15
9.2 Long-term Monitoring 16

10 Legal and Administrative Requirements 17
10.1 Permits 17
10.2 Silviculture Contract 17
10.3 Health Certificate 17
10.4 Transportation Regulations 17

11 Grazing Schedule 17
11.1 Activities the Year Before Grazing 17
11.2 Activities the Year of Grazing 18

Appendices 19

References 46

TABLES

1 A comparison of various vegetation management options 3
2 Comparison of vegetation management treatment costs 3
3 Relative susceptibility of conifer seedlings to sheep browsing 4
4 Grazing project studies that provide information on sheep forage preferences 5
5 Vegetation species that compete with conifers and are preferred forage for sheep 6
6 Vegetation species that may compete with conifers that sheep have grazed either minimally or erratically 6
7 Vegetation species that may compete with conifers but are not generally preferred by sheep 7
8 Vegetation species readily grazed by sheep but not usually considered conifer competitors 7
9 Poisonous plant species for domestic sheep that may occur on forest plantations 8

APPENDICES

1 Glossary of technical terms 19
2 People surveyed and interviewed 21
3 Common and scientific names of plant species 23
4 Summary of data to be collected during monitoring 25
5 Sample silviculture contract 29

Sheep grazing has recently been introduced to British Columbia as a vegetation management option. In 1984, sheep producers requested grazing permits from the British Columbia Ministry of Forests in 100 Mile House to graze clearcuts with high fireweed cover. The possibility of using sheep to reduce vegetation competition in conifer plantations became apparent and the first sheep grazing trial was initiated in 1985. The Clearwater Forest District also started a trial in that year. Both projects showed that sheep grazing could become an effective method of brushing plantations. By 1986, enough interest had been generated to establish a formal trial at Doreen Creek in the Horsefly Forest District. These three projects, which used approximately 4000 sheep to graze just under 1000 ha, continued in 1987 and 1988. In 1989, sheep grazing was accepted as an operational tool by the British Columbia Ministry of Forests. By 1992, approximately 26 700 sheep were grazing over a wide range of environmental conditions on 6000 ha throughout the province. Project monitoring has shown that sheep can effectively control some species of vegetation that compete with conifer seedlings (Ellen 1988; Lousier 1990; Bancroft 1992a, 1992b; Erickson 1992; Sutherland et al. 1992). The purpose of most grazing projects has been to brush established plantations, but grazing was also used as a site preparation tool.

Since sheep grazing is a relatively new management option in British Columbia, there are no data available yet that can demonstrate statistically significant increases in seedling growth response. In the United States, however, increases in seedling growth rates have been observed on plantations where sheep grazed competing vegetation for a number of years. Sharrow et al. (1989) found a 7% increase in Douglas-fir seedling height and a 5% increase in seedling diameter three years after grazing. Jaindl and Sharrow (1988) found that Douglas-fir seedling growth increases were still apparent 20 years after grazing was completed.

All sheep grazing projects should consist of three components: planning, implementation, and evaluation. Adequate planning of a sheep grazing project is essential to ensure that grazing treatments are properly applied and that silvicultural objectives are accomplished. Prepare a flexible written plan several months before the projects will begin. Try to anticipate problems and develop contingency actions to address them. Ensure that the plan follows the British Columbia Ministry of Forests protocols for Pre-Harvest Silvicultural Prescriptions. Also make sure that the plan is referred to all appropriate agencies and interest groups. They should either be involved in the planning process or have an opportunity to review the plan. The British Columbia Ministry of Environment, Lands and Parks must have an opportunity to view the site at least 1 year before the project begins. See Section 11 for a detailed summary of scheduling activities.

This handbook will assist forest managers to evaluate sheep grazing as a vegetation management option and to implement sheep grazing projects. Information was obtained by reviewing scientific literature and internal reports. Two questionnaires were also developed to collect information from government and industry personnel, sheep grazing contractors, and sheep producers. The first focused on the effects of sheep grazing on target vegetation, and crop tree response. The second questionnaire was directed toward sheep producers and dealt primarily with sheep management. Appendix 2 lists the individuals surveyed and interviewed. Survey information, literature, and the interviews were evaluated to develop a consensus on managing sheep to successfully achieve vegetation management goals. Also, the "Interim Guidelines for the Use of Domestic Sheep for Vegetation Management in British Columbia" (Schwantje 1992) is frequently referenced in this handbook. A final version of this document should be available in 1995.

2.1 Definition of Vegetation Management

Vegetation management for conifer production is the act of manipulating vegetation and the micro-environment to redirect resources such as light, water, and nutrients to crop trees (Conard 1984). Vegetation management options are considered effective if the treatment reduces current competing vegetation, minimizes future competition, and results in negligible damage to crop trees (Newton and Comeau 1990). The goals of vegetation management are to:

- reduce the competing vegetation with minimal damage to crop tree seedlings,
- increase seedling survival and growth, and
- reduce the time to achieve free-growing status.

2.2 Sheep Grazing versus Other Vegetation Management Options

Sheep grazing is only one of many vegetation management options. It can be used for site preparation or to control competing vegetation in established plantations. All vegetation management options should be considered to ensure that the most suitable treatment is chosen for the conifer species, target vegetation, site conditions, and other resource management interests in the area.

Many factors need to be considered before sheep are used on a forest plantation. Good sheep management is essential to a successful project. If problems do arise, sheep cannot be turned off like machines or easily sent home. Conflicts between sheep and wildlife, or any other resource use, must be resolved. For example, a study by Lousier (1990) indicated that sheep may increase coliform bacteria counts in streams within the grazing block. Also domestic and native sheep herds will need to be segregated to avoid disease transmission. Conversely, sheep can control vegetation in areas where other methods are not feasible. For example, sheep may be able to graze buffers left after herbicide applications or sites that have too many surface streams for a herbicide application. Sheep are generally well accepted by the public and are usually cheaper than manual methods, although cost is very site-specific. Table 1 lists some of the factors that should be considered when choosing a vegetation management option and indicates when each treatment is most effective. Table 2 shows the cost comparisons between vegetation management methods for the province.

TABLE 1 *A comparison of various vegetation management options*

	Treatment type				
	Chemical		Manual		Biological
	Aerial	Ground	Power/ brush saw	Other manual	Sheep grazing
General treatment efficacy					
Controls a variety of vegetation species	M[a]	M	G	G	P
Spot treatments	P	M	G	G	P
Treats belowground competition	G	G	P	P	P
Site conditions					
Steep slopes	G	P	P	P	M
Heavy slash accumulation	G	P	M	M	P
Standing water	P	M	G	G	G
Woody brush >2 m	G	P	G	P	P
Woody brush <2 m	G	G	M	M	M[b]
Herbaceous >2 m	G	M	M	M	P
Herbaceous <2 m	G	G	M	G	G[b]
Near flowing streams	P	M	G	G	M
Risk of injury					
Operator	L	H	H	H	L
Seedlings	M	M	H	H	M
Species other than spruce	M	M	H	H	H

[a] The treatments are rated as G=Good, M=Medium, P=Poor except for 'Risk of injury' where H=High, M=Moderate, L=Low.
[b] Recommend vegetation less than 1 m.

TABLE 2 *Comparison of vegetation management treatment costs*

Treatment method	Range[a] ($)	Average ($)	Number of treatments
Chemical: aerial	105–500	248	1 or 2
Chemical: backpack	300–1200	524	1 or 2
Manual: herbaceous	150–1700	740	2 or 3
Manual: young shrubs / trees	260–1700	804	1 to 3
Biological: sheep	180–1000	465	2 or 3

[a] Costs are for one treatment only.
Source: Farnden (1992)

Sheep have been used for vegetation management in the Coastal Western Hemlock (CWH), Interior Cedar–Hemlock (ICH), Sub–Boreal Spruce (SBS), Boreal White and Black Spruce (BWBS), and the Engelmann Spruce–Subalpine Fir (ESSF) biogeoclimatic zones. Use in other zones has not been tested. Sites within particular zones may have different potential depending on the plant community and the suitability of the target vegetation for sheep grazing.

Before selecting any vegetative management treatment, clearly identify that a real vegetation management problem exists and that potential target vegetation species compete with crop trees. Assess the biological and physical conditions of all potential treatment areas to ensure that the site is suitable for sheep grazing. The following are factors to consider when choosing plantations for sheep grazing treatments.

3.1 Conifer Species and Age

Selecting a site with a conifer species considered "safe" for a sheep grazing treatment is not simple. Selection will depend on the species of crop tree, its stage of growth (i.e., flushing or dormant), its health and size, and the vegetation complex. Sheep will browse some conifer species more readily than others. For example, spruce plantations can be grazed safely at any time during the growing season or at any seedling age if adequate amounts of acceptable forage are present. Douglas-fir foliage is much more palatable than spruce and sheep may browse on it, especially when the seedlings are flushing (Sharrow and Leininger 1983). Leader damage is minimal if the seedlings are taller than 1 m (Sharrow et al. 1992). However, especially in the interior of the province, seedlings are often less than 1 m tall when

TABLE 3 *Relative susceptibility of conifer seedlings to sheep browsing*[a]

Tree species	Sheep preference for conifer seedlings	Growth Stage of seedling				
		Seedlings < 1 yr.	Small seedlings < 1 m		Large seedlings > 1 m	
			Flushing	Hardened	Flushing	Hardened
Spruce	low[b]	3[c]	3	1	2	1
Douglas-fir						
Coastal	moderate	5	5	3	4	2
Interior	moderate	?	3	3	2 or 4	2
Lodgepole pine	high	3	5	3	?	?
Western white pine[d]	high	?	4	?	?	?
Grand fir[d]	low	1	1	1	1	1
Western redcedar[d]	low	?	2	N/A	?	N/A

[a] A number of provincial studies and one American study have been used to develop this table: Sharrow and Leininger (1983), Ellen (1988), Lousier (1990), Lousier and Lousier (1991), Bancroft (1992a, 1992b), Sutherland et al. (1992), Ken Gilbert (pers. comm. 1993).
[b] Indicates the relative preference for sheep to browse on different conifer species.
[c] Susceptibility ratings: 1 - Low (minimal damage); 2 - Moderately low (may get minor lateral damage); 3 - Moderate (may get minor lateral and leader damage); 4 - Moderately high (may get major lateral damage); 5 - High (may get major lateral and leader damage); and ? - No information available.
[d] Very limited data.

brushing is required. Browsing less than 50% of the lateral branches is not considered serious damage. Growth reductions of 1% for every 10% of browsed laterals were observed on Douglas-fir (Sharrow et al. 1992). The species composition on site will affect the amount of seedling damage. Damage to conifer seedlings can be minimized by ensuring that adequate amounts of preferred species of vegetation are available.

The relative susceptibility of specific tree species to sheep browsing is shown in Table 3. Each species is rated for susceptibility to grazing damage. Trampling damage resulting in crushed seedlings or scarred stems is not considered. If managed properly, sheep should not cause trampling damage to any seedlings, regardless of the species. A distinction is made between coastal and interior Douglas-fir, as coastal trees grow more quickly and consequently have more succulent new sprouts available to sheep.

The susceptibility rating system used in Table 3 is based on well-managed sheep grazing projects. These ratings are comparable across species. The susceptibility ratings of 1-3 are considered within acceptable levels, where less than 5% of the crop seedlings are seriously damaged. If sheep management is inadequate, or if the vegetation complex is composed of unpalatable forage, then damage to seedlings could be much higher than indicated. Conversely, if sheep are well managed, and forage quality is high with a moderate to low grazing intensity, then damage to seedlings could be less than indicated. Seedlings are most vulnerable to mechanical damage and sheep browsing during the period from bud flush to stem elongation. Their palatability declines rapidly after they have hardened-off (Halloin 1989). Sheep walking by or brushing up against young seedlings can knock off the young, soft terminal shoots. However, when these have hardened-off, seedlings are less susceptible to damage.

3.2 Vegetation Complexes

Vegetation species, quality, and quantity all need to be carefully considered when sheep grazing is used as a management option. If any of these factors is unsatisfactory, the grazing results may be unacceptable. The vegetation species that the sheep are expected to control should be a preferred forage species. It must fulfill all nutritional requirements, have adequate nutritional value, and be present in sufficient quantities to produce acceptable weight gains on the sheep.

3.2.1 Sheep forage preferences

Sheep will usually browse selectively, starting with the most favoured vegetation and progressing to the next most desirable species. The favoured vegetation may not be a single species but may include many different plants. These preferences may change as the season progresses and plants mature. Some of the preferred forage should be left on site after grazing is complete to minimize seedling damage.

Many completed grazing projects in British Columbia, Alberta, and Oregon provide information on sheep forage preferences (Table 4). In most trials, only the use of target species was recorded in detail. Lists of sheep forage preferences (Tables 5, 6, 7, and 8) have been compiled from these studies.

TABLE 4 *Grazing project studies that provide information on sheep forage preferences*

No.	Study	Location of study
1	Sutherland (1987)	Cariboo Forest Region, B.C.
2	Tweedhope (1985)	Cariboo Forest Region, B.C.
3	Ellen (1988)	Kamloops Forest Region, B.C.
4	Bancroft (1992a)	Nelson Forest Region, B.C.
5	Dewar and Green (1992)	Prince George Forest Region, B.C.
6	Negrave (1992)	Prince George Forest Region, B.C.
7	Erickson (1992)	Prince Rupert Forest Region, B.C.
8	Lousier (1990)	Vancouver Forest Region, B.C.
9	Lousier and Lousier (1991)	Vancouver Forest Region, B.C.
10	Bancroft (1992b)	Vancouver Forest Region, B.C.
11	O'Brien and Bailey (1987)	Calling Lake area, Alta.
12	Sharrow and Leininger (1983)	Oregon, U.S.A.

TABLE 5 *Vegetation species that compete with conifers and are preferred forage for sheep*

Species	Studies[a]	Species	Studies
Grasses (general)	3, 5, 7, 8, 9, 12	*Epilobium angustifolium*	1, 2, 3, 4, 5, 6, 7, 8, 10, 11
Calamagrostis canadensis	6, 7, 11	*Valeriana sitchensis*	3
Festuca occidentalis	7	*Populus tremuloides*	5, 11
Phleum pratense	3	*Salix* spp.	2, 3, 11

[a] Refer to Table 4 for author-date citation corresponding to study number.

Vegetation cover before grazing had to be approximately 3% or greater to be included in Tables 5–8. Some vegetation is only identified by genus, as the species is not known or was not named in the study. Some of the studies provide conflicting information. This is noted in the text following the tables. As well, these data indicate only the potential for species reduction immediately after grazing, and do not reflect long-term effects.

Table 5 lists plant species that both compete with conifers and are preferred sheep forage. Grazing substantially reduced vegetation cover of most species listed in Table 5. However, *Populus* spp. have not been grazed extensively and caution should be used when these are the primary target, and other species, such as fireweed, do not occur in the vegetation complex. Negrave (pers. comm., October 1993) found that aspen (up to 1 m tall) was significantly reduced after one grazing season. However, he also observed that sheep may require conditioning to aspen if it has not been previously browsed. As well, some observations from private land in Alberta indicate that if aspen is defoliated by sheep for 3 years the tree will die (O'Brien and Bailey 1987).

Table 6 lists some species that have been grazed only lightly or erratically and are therefore not recommended as primary target species for a sheep grazing treatment. The *Rubus* spp. have been erratically grazed. Bancroft (1991) found that sheep browsed *Rubus idaeus* one year and not *Rubus parviflorus*, while the opposite was true the next year. Lousier (1990), and Lousier and Lousier (1991) observed discrepancies in browsing on the blackberry species. Very light browsing occurred both years on the *Rubus ursinus* in May and June but when the site was grazed in July, plant cover was not reduced. *Rubus leucodermis* was browsed lightly in one early graze in May, but no significant browsing occurred later in the year. Sharrow and Leininger (1983) found that the *Rubus* spp. were not the first choice of sheep, although light browsing occurred on most sites. But while sheep may reduce the cover of *Rubus* spp. substantially, on other sites they may not browse it at all. In the case of alder, sheep will graze on the leaves up to a height of ap-

TABLE 6 *Vegetation species that may compete with conifers that sheep have grazed either minimally or erratically*

Species	Studies[a]	Species	Studies
Rubus parviflorus	4, 5, 10, 12	*Alnus viridis*	2, 3, 5
Rubus idaeus	1, 4, 5	*Alnus rubra*	9, 12
Rubus spectabilis	10, 12	*Pteridium aquilinum*	2, 3, 4, 8, 9 (mainly trampled and not browsed)
Rubus leucodermis	9, 12	*Veratrum viride*	2, 3
Rubus ursinus	8, 9, 12	*Betula papyrifera*	11
Vaccinium spp.	5, 12	*Acer marcophyllum*	5, 10
Lonicera involucrata	2	*Acer circinatum*	5, 10
Prunus emarginata	12	*Corylus cornuta*	12

[a] Refer to Table 4 for author-date citation corresponding to study number.

TABLE 7 *Vegetation species that may compete with conifers but are not generally preferred by sheep*

Species	Studies[a]	Species	Studies
Mahonia nervosa	9	*Gaultheria shallon*	8, 12
Sambucus racemosa	10	*Cirsium arvense*	12
Paxistima myrsinites	3	*Aralia nudicaulis*	3
Spiraea spp.	3	*Hieracium* spp.	3
Rhododendron albiflorum	3	*Digitalis purpurea*	12

[a] Refer to Table 4 for author-date citation corresponding to study number.

TABLE 8 *Vegetation species readily grazed by sheep but not usually considered conifer competitors*

Species	Studies[a]	Species	Studies
Lathyrus nevadensis	2, 7	*Dicentra formosa*	10
Vicia americana	11	*Claytonia sibirica*	10
Lathyrus ochroleucus	11	*Gymnocarpium dryopteris*	4
Clover spp.	3, 11	*Anaphalis margaritacea*	12
Lupinus spp.	2, 3	*Taraxacum officinale*	2
Aster conspicuus	11	*Galium* spp.	8
Hypochaeris radicata	8, 12		

[a] Refer to Table 4 for author-date citation corresponding to study number.

proximately 1 m without seriously damaging the shrub or tree. No data are available on the browsing of new shoots under 1 m. Sheep will not graze on bracken (*Pteridium aquilinum*) unless it is in the early frond stage, but the mature plant can be controlled by trampling (Bancroft 1992a). If the species in Table 6 are the only species of vegetation left on site, then the susceptibility of browse damage to conifers, especially Douglas-fir or pine, increases.

Table 7 lists species not generally preferred by sheep but that may be considered a potential competitor to crop seedlings. Sheep browse *Gaultheria shallon* inconsistently. It was grazed lightly in one study (Lousier 1990) but not in another study (Lousier and Lousier 1991). Also, Sharrow and Leininger (1983) found that *Sambucus* spp. were readily consumed, but studies have not produced similar results in British Columbia.

Sheep prefer a diverse vegetation community rather than a monoculture. Therefore if any of the vegetation species listed in Table 8 are mixed with the target vegetation, sheep will have more variety in their diet and this may reduce damage to conifer seedlings. Also, if sheep prefer the non-target vegetation over the target species, they may consume it first. Legumes tend to be favoured over most vegetation (O'Brien and Bailey 1987; B. Smith, pers. comm., 1990). *Galium* spp. were grazed in one coastal study (Lousier 1990) but not in an interior study (Ellen 1988).

3.2.2 Forage quality

Forage must be of satisfactory quality to ensure a successful grazing project. Quality in this context is the forage's combined nutrient status and palatability. Palatability refers to the acceptability of the forage to the sheep. The protein value of forage is one of the more important nutritional constituents. Heath et al. (1973) suggested that the minimum protein requirement for a ewe is 8.9%. Negrave (1992) found that the protein content decreased from May 29 to August 12 in all forage tested, including fireweed, black twinberry, bluejoint, and prickly rose. However, these values never dropped below the required levels. Bancroft (1991) analyzed vegetation samples including fireweed and thimbleberry, collected on August 26, and found that the protein value of the ungrazed vegetation did fall below the required levels. Samples of re-sprouting vegetation, taken at the same time from the grazed areas still contained adequate

amounts of protein. Sheep do prefer the succulent new vegetation early in the growth cycle, and the regrowth on vegetation previously grazed. Vegetation at this stage appears to be both palatable and nutritious. These results also suggest that if grazing is to be continued into late August, previously grazed blocks with re-sprouting vegetation are preferable.

Both frost and drought can alter forage palatability and make it unacceptable for sheep. However, conifers are not as susceptible to damage from frost or drought, and if no other forage remains, sheep will even browse spruce seedlings. This was demonstrated at the Doreen Creek trial when fireweed was damaged by an early frost. In less than 48 hours, approximately 70% of the spruce seedlings were browsed (Sutherland 1987). Also, when left on plantations after a light frost, sheep caused increased trampling damage to seedlings because they had to walk further to find acceptable forage. Studies in the Cariboo Forest Region show that as soon as the forage palatability decreases, the sheep should be removed from the site to avoid increased seedling damage.

Sheep will not consume the woody parts of vegetation, including fireweed stems later in the season. Nor can they eat vegetation that is much over 1 m tall. Sheep will walk over willow to bring the foliage down to a grazable level, but this is an exception and the behaviour is not consistent.

3.2.3 Forage quantity

Ensure that adequate target vegetation is on the site before grazing begins. If the quantity of preferred forage is inadequate, sheep will browse other plant species including conifer seedlings. Serious illnesses and even death can result if sheep are undernourished. Dry ewes require 2 kg of dry forage per day (Ellen 1988). To determine if the quantity of vegetation is sufficient, sample the year before grazing occurs (see Section 8.1). In most cases, the quantity of vegetation at maturity will probably be adequate if vegetation control is required and the target vegetation is the predominant species. However, the quantity may be questionable in the spring when grazing projects are initiated and on sites that are re-grazed in the same season. Lousier and Lousier (1991) found high amounts of seedling damage when sheep started grazing too early. In the case of re-grazing, sufficient vegetation should be available in the form of new sprouts. Sheep have a strong preference for vegetation that has re-sprouted and may not consume the older vegetation when new vegetation is available on the site. Therefore, assessments of quantity should be based only on the amount of the new sprouts. Refer to Section 8 for more information on the timing and intensity of grazing.

3.2.4 Poisonous plants

Plantations containing poisonous plants should be grazed cautiously or not grazed at all. Table 9 lists some of the plants known to be poisonous to sheep. Sheep have consumed vegetation listed in Table 9, such as *Veratrum viride*, with no obvious ill effects. Local experience and knowledge is important when determining the risk of grazing plantations with these vegetation species. Also see Section 7.8.

3.3 Site Characteristics

3.3.1 Climate

Sheep can adapt to a variety of environments. However, sites that experience high rainfall and cool temperatures can create problems for sheep grazing on forest plantations. Sheep stressed from long periods of exposure, chilling, and dampness are susceptible to illnesses such as pneumonia. Also, sheep grazing

TABLE 9 *Poisonous plant species for domestic sheep that may occur on forest plantations*

Grasslike	Forbs and ferns	Shrubs and trees
Triglochin maritima	*Pteridium aquilinum*	*Ledum groenlandicum*
Equisetum arvense	*Zygadenus elegans*	*Kalmia microphylla*
	Aconitum columbianum	*Prunus virginiana*
	Delphinium glaucum	*Rhododendron macrophyllum*
	Cicuta douglasii	*Rhododendron albiflorum*
	Veratrum viride	

Adapted from McLean and Nicholson (1958)

performance can be reduced and night corrals may have to be moved more frequently during long periods of cool wet weather. If very cool wet conditions occur, sheep care and management must be intensified.

3.3.2 Topography

Even though sheep are well adapted to grazing on steep slopes (over 60%) sites with a slope of less than 50% are recommended (Schwantje 1992). Sheep on sites with steep slopes will require more herding. As the slope gradient increases, the uniformity of the grazing treatment is reduced and the risk of sheep injury is increased.

Avoid very wet sites. Wet areas will restrict sheep movement and increase the risk of sheep contracting foot rot.

3.3.3 Water availability

In most cases, sheep should be kept away from continually flowing streams to avoid contamination. Sheep can use small pools of standing water on site and will often obtain a considerable amount of their required moisture from dew on the forage. However, if these sources do not provide enough water then it will have to be trucked in to the site or diverted from a local stream. A water use permit must be obtained from the Ministry of Environment, Lands and Parks when a diversion is necessary to provide drinking water.

3.3.4 Amount of slash

Manually brushed sites and those with excessive amounts of slash are not recommended for sheep grazing. Slash piles higher than 50–80 cm can restrict sheep movement, increase the risk of sheep injuries, and divide the flock. Sheep will graze around slash piles, but they usually will not climb over or into them. Manually brushed sites may have large amounts of woody stubble that can physically impede sheep access, restrict animal distribution on the site, and potentially injure the sheep.

3.3.5 Sheep visibility

To ensure that sheep are managed appropriately and that predation is minimized, the shepherd should be able to see the flock clearly at all times. Uneven terrain, frequent clumps of large brush species such as alder, and large slash piles can impede the visibility of the flock.

3.3.6 Accessibility

Most sheep are initially transported to the site by livestock liners. A drop-off point is required that is both easily accessible by livestock liners and close to the plantations to be treated. This location should be set back from the roads and have a corral to contain the sheep. All sites should be accessible by trucks and other camp equipment. Avoid, where possible, blocks located on roads with heavy amounts of traffic.

3.3.7 Proximity to alternative blocks

Select sites where one or more alternative blocks are located near the target plantation so that sheep can be moved to another forage source if unacceptable levels of seedling damage occur or if forage decreases in quality. These alternative areas could be older plantations with seedlings over 1 m tall, clearcuts that are not satisfactorily restocked, meadows, or transmission line rights-of-way. They should not be located more than 8 km from the target plantation so that sheep can be easily herded to these sites by road within a day.

3.3.8 Proximity to other plantations

The flock can be herded between the plantations to be treated when these are close together. This will improve the cost-effectiveness of the operation. If the area has potential predator problems (especially grizzly bears), Green (1992) suggests moving sheep long distances in mid-season so that predators will not become familiar with the project. A series of plantations that continually rise in elevation can be an asset, as the vegetation will develop more slowly on the higher blocks. Sheep can begin grazing at the lower elevations and work their way up as the vegetation develops. Then the flock can re-graze the blocks on its way down.

3.4 Interactions with Wildlife and Other Resource Values

Considerable concern has been expressed by the Ministry of Environment, Lands and Parks regarding potential interactions of the sheep with predators, disease transmission to wildlife, and the effects of sheep grazing on wildlife habitat. Refer to the "Interim Guidelines for the Use of Domestic Sheep for Vegetation Management in British Columbia" (Schwantje 1992). All sheep grazing projects should be discussed with the Ministry of Environment, Lands and Parks during the year before grazing is to commence. This will allow enough time to view sites.

4 SHEEP HEALTH INSPECTIONS

The British Columbia Ministry of Agriculture, Fisheries and Food has developed health protocols for sheep used on vegetation management projects in the province. All contractors and producers must comply with these protocols as defined by the Ministry's Chief Veterinarian. Ensure that the protocols are the most current available. The protocol requires that all flocks be examined on the farm of origin by an accredited veterinarian. This inspection should be completed 6 weeks before sheep are released onto the plantation. Sheep are susceptible to infectious diseases that can reduce production, cause mortality, or be transmitted to wildlife. Sheep with foot rot, caseous lymphadenitis, contagious ecthyma, conjunctivitis, internal or external parasites, and other causes of poor health or condition, will be excluded from grazing on plantations. For further details refer to the protocols, which are available from the Ministry's Animal Health Office.

5 TRANSPORTATION

Any transportation of sheep must adhere to Agriculture Canada guidelines. A copy of these guidelines can be obtained from the Animal Health Directorate, Agriculture Canada. Avoid shipping sheep when the weather is extremely hot or very cold. If sheep are to be moved during hot weather, consider shipping at night or early in the morning. Withhold grain, or alfalfa and clover hays, for 12 hours before shipping and do not allow the sheep access to water within 2–3 hours of shipment (Ensminger 1970).

5.1 Sanitation and Bedding

Most sheep are transported to plantations in British Columbia by livestock liner or occasionally by private vehicle. All vehicles used to transport sheep must be cleaned, and disinfected, and have bed facilities properly installed before sheep are loaded. Vehicles must be cleaned and disinfected with 5% bleach solution or commercial disinfectant to kill *Salmonella*. Bedding must be provided in the trucks.

5.2 Stress and Disease

Sheep that are shipped long distances will be stressed. Under extreme circumstances, they can develop diseases such as shipping fever. Similarly, shipping fever can develop when sheep are exposed to other forms of severe stress such as bad weather, fatigue, or inadequate nutrition (Ensminger 1970). Stressed or diseased animals will not graze in the same manner as healthy sheep. Animals with infectious diseases such as shipping fever should be removed immediately from the herd and then assessed and treated by a veterinarian. To avoid stress and opportunities for disease, minimize any factors that lower the animal's resistance such as overcrowding, lack of rest, herding the flock very quickly and/or for long distances, improper shelter during inclement weather, and inadequate nutrition (Ensminger 1970). Keep the sheep as calm as possible during loading and unloading.

6 PREPARING SHEEP FOR GRAZING PLANTATIONS

6.1 Food and Water on Arrival

When sheep arrive at the grazing area they should be unloaded into a fenced area where the flock can congregate, mother-up if lambs are in the flock, drink, and eat without damaging tree seedlings. Have fresh water and hay or barley available for the sheep. *Never* release hungry sheep directly onto a plantation, as indiscriminate eating may cause conifer damage.

6.2 Pre-conditioning Sheep to Available Forage

Avoid sudden changes in diet, especially from dry hay or grain rations to succulent green forage. Dietary

changes can cause digestive disturbances and may result in sheep going off their feed. Consequently, animal health may be impaired and the effectiveness of sheep in grazing target plants may diminish. Sheep will need to become familiar with the plant species available on sites where they have no previous experience. After the sheep have eaten some hay and have become stabilized within an enclosed area for at least 24 hours (Schwantje 1992), they can be released to an area that contains the forage they will consume on the plantation. Adjacent non-timber producing areas such as transmission line rights-of-way or meadows are preferred locations. Small fenced areas or older plantations can also be used but very hungry sheep may graze on conifer seedlings and acquire a taste for them. Once they have acquired a taste for conifer seedlings, they will have to be removed from the project. Therefore, if conifers are on the initial grazing areas, make sure the sheep have been well fed before turn out.

7 SHEEP MANAGEMENT

Good sheep management is essential to promote
- uniform removal of vegetation,
- minimal seedling damage,
- adequate nutrition,
- healthy sheep,
- minimal problems with predators, and
- no adverse effects on other resource uses.

7.1 Breed and Class of Sheep

Both the breed and class of sheep may be important factors in minimizing damage to conifers. Different sex and age classes can exhibit distinct forage preferences and have different abilities to travel over rough terrain. Ewes with lambs younger than 8 weeks old or less than 23 kg should not be included in the flock. Different breeds of sheep also have variable tendencies to flock and this can affect herd management and the uniformity of the grazing treatment. Flocking breeds of sheep such as Rambouillet, Columbia, and Corriedale will tend to form close herds that can be more easily managed and enable more uniform grazing on sites with rough terrain. Conversely, breeds such as Dorset, Suffolk, Cheviots, and Hampshire generally do not flock as well. These breeds may be more inclined to form open herds that can be more difficult to manage.

When several producers combine sheep from different herds into one flock, it may take up to 1 month for the sheep to flock together. More intense management is required until the sheep will flock together naturally.

Sheep herds that have successfully completed a few grazing projects will generally be easier to manage than those with no previous grazing experience on forest plantations.

7.2 Corral Placement

Sheep should be enclosed in the corral every night. To minimize or eliminate seedling damage, locate night corrals in non-productive areas such as old logging landings, gravel pits, or spur roads. Corral sites should have the following attributes:
- be dry and well drained,
- have minimal debris present,
- be large enough to accommodate the whole flock,
- be away from heavy brush or anything else that could provide cover for predators,
- have no poisonous plant species present,
- be at least 30 m from all watercourses (drainage from night corral sites must not flow into any streams, lakes, or other bodies of water),
- be accessible to vehicles and camp equipment, and
- be portable and yet secure enough to hold the sheep.

The night corral should be placed where the sheep can be herded over roads, skid trails, or other non-productive areas to reach the day's grazing area. Avoid locations where the sheep must travel repeatedly over the same areas of the plantation because seedling damage from trampling will result. Ideally, corrals should be relocated to the next block when sheep are moved. In some larger blocks, the corrals may need to be relocated as the grazing progresses.

7.3 Fencing

Although it is not necessary, fencing can be used to enclose the area to be grazed. Fencing can add an extra safety factor. It can help to contain the flock on the plantation when there are no natural barriers present, such as forested edges or watercourses. Electric fencing may

deter some, but not all, predators. Also, if fences are used on a full-time basis, additional people may be required for maintenance. Extra fencing will increase the costs and should only be used where necessary. With or without fences, sheep should be herded as a flock and should not be allowed to stray at any time.

7.4 Water and Salt

Mature sheep require about 4.5 L of water daily, although this may vary depending on the age and size of sheep, weather conditions, and water content of forage (Ensminger 1970). If on-site water is being used (see Section 3.3.3), sheep should be herded to water sources on the block, watered, and moved away from the riparian areas. Watercourses may dry out in late summer so be prepared to truck water to the site if necessary.

Sheep require 5-14 g of salt daily depending on the age and size of the animal and the succulence of the forage (Ensminger 1970). Generally, salt is located at or near their bedding grounds and away from water. Additions of trace minerals suitable to sheep are also advised.

7.5 Shepherds and Herding

Hire only experienced shepherds who understand the silvicultural, sheep production, and environmental objectives for the clearcut. Use herd dogs that are well trained in moving and controlling sheep. For a flock of 1500 sheep, three shepherds should be on site with at least one herd dog per shepherd and one spare healthy herd dog available. For flocks under 1000 sheep, two shepherds and two dogs are adequate. Guardian dogs should be used for additional protection against predators, with two dogs in a flock of 1500 sheep (Schwantje 1992). When several shepherds are used, ensure that at least one shepherd with previous, successful experience in managing sheep is on site at all times.

The shepherd is responsible for:

- checking the block for predators and wildlife each morning before turning the flock out onto the plantation;
- herding the sheep so that they use forage uniformly and to the prescribed level to meet the silvicultural objectives;
- maintaining sheep health and weight; and
- returning the flock to the night corral before dark and checking for any sheep remaining on the clearcut.

The flock should be accompanied by a shepherd at all times. Camps should be located next to night corrals to discourage predators. A very detailed description of shepherd responsibilities is given Appendix 5.

To minimize damage to tree seedlings the shepherd should:

- move the flock out of the night corral slowly so as not to excite the animals;
- use different routes each day from the night corrals to the grazing areas;
- use skid trails and old roads to move sheep through the plantation;
- move sheep as a flock but allow them to form a loose flock and graze independently; and
- move sheep slowly and constantly throughout the plantation in a systematic manner.

Portable two-way radios can help shepherds to communicate when herding the flock.

7.6 Bedding

Sheep need to rest and ruminate one or two times each day. Sheep can be herded back to the night corral during the day if a route exists where they will not be herded over the plantation. More commonly, the flock can bed down where they are grazing; however, these bedding grounds should be located in different places each time to prevent seedling damage.

7.7 Sheep Growth and Performance

Animal growth and performance are determined by both the quantity and quality of forage available (Moore 1987). Forage quality should be adequate throughout the grazing season. However, supplemental feed should always be available on site if forage does become limiting. If forage quality is poor, the flock should be removed from the site, because seedling damage will increase and sheep performance will decrease. To promote the growth and health of sheep, Moore (1987) recommends the following practices for maintaining high forage quality:

- turn sheep out onto the plantation early if adequate forage is available;
- move sheep up in elevation gradient where possible, to maintain a high level of nutrition throughout the grazing season;
- where feasible, re-graze clearcuts that have sufficient regrowth; and
- graze plantations that have been seeded to legumes.

Also, lambs should be weaned and removed from the plantation as early as possible.

7.8 Poisonous Plants

Poisonous plants contain a wide range of chemicals that can affect sheep health, alter the grazing behaviour of the animal, and even cause mortality. A list of some of the more common poisonous plants is given in Table 9. Because of the wide range of chemicals contained in poisonous plants, there are no general symptoms, but animal poisoning may be suspected if the following conditions occur (Ensminger 1970):

- sheep suddenly become ill without visible cause;
- sheep demonstrate disorders of the central nervous or digestive system, without fever, but with prostration or rapid weight loss;
- sheep have an elevated heart rate, and vomit or repeatedly defecate; or
- sheep show signs of extreme weakness, collapse, and have difficulty breathing.

Although some antidotes to poisonous plants are available, the most effective way to prevent poisoning is with sound animal and grazing management (Holecheck et al. 1989). The following practices will minimize animal losses to poisonous plants:

- know what poisonous plants may be present on a site; learn how to identify them and what symptoms they cause;
- avoid areas where poisonous plants are abundant;
- if possible, alter the grazing period on the plantation to coincide with periods when poisonous plants are less toxic, or not available;
- ensure that sheep have adequate forage available, since most poisonous plants are relatively unpalatable;
- provide supplemental feed when forage becomes limited because of drought or frosts;
- ensure that sheep have adequate salt and minerals — sheep may eat poisonous plants with high salt contents or that contain minerals missing from their diets;
- do not turn hungry sheep out onto plantations where poisonous plants occur, especially after the sheep have first arrived at the plantation;
- avoid herding animals too quickly when moving them between plantations; allow them to graze along the way or have access to supplemental feed before they are turned out onto a new plantation;
- remove all animals from the area if poisoning occurs; and
- treat sheep immediately and preferably by a veterinarian (Ensminger 1970; Holecheck et al. 1989).

7.9 Interactions with Wildlife and Other Resource Values

To reduce conflicts and interactions with predators and other wildlife species, follow the guidelines produced by Schwantje (1992). The silviculture contract in Appendix 5 also covers most aspects of sheep-wildlife interactions.

8 SHEEP GRAZING AS A TREATMENT FOR CONIFER RELEASE

If grazing is to be used to control competing vegetation, the methods to achieve the highest efficacy must be determined. From a silvicultural point of view, intensity, timing, and frequency of grazing are the three major factors that will influence the success of a project.

8.1 Grazing Intensity

The optimal grazing intensity will allow release of the crop seedlings from competing vegetation with minimal damage. The amount of vegetation remaining on the site after grazing is completed, the number of treatments, and the long-term effectiveness of grazing are all silvicultural considerations. Often the amount of vegetation removed from the site, or the percent utilization, is assessed on grazing treatments. However, the amount of vegetation removed can be difficult to measure and does not provide any information about the effect of the remaining vegetation on the crop seedlings. Instead, assess the grazing quality by measuring the amount of competing vegetation left on the site. To determine the amount of vegetation remaining, estimate the vegetation cover. These measurements will determine if grazing has been adequate or if the treatment should continue. To minimize seedling damage, the remaining target vegetation cover should be 5–15%.

Seedlings should not be seriously affected by leaving a 15% cover of competing vegetation. Comeau (1993) presented data for spruce seedlings grown in a fireweed complex. With 15% and 5% vegetation cover of 1 m tall fireweed, a 30-cm spruce seedling achieved approximately 75% and almost 100%, respectively, of its optimal

growth performance. Survival of spruce seedlings under similar conditions does not start to decrease seriously until vegetation cover reaches 30%. Pine and Douglas-fir are less shade tolerant than spruce. However, as sheep will graze more readily on these species, a 15% cover of remaining target vegetation cover is still recommended to minimize seedling damage. Total vegetation cover may exceed 15% if the vegetation complex includes non-target vegetation; however, sheep cannot be expected to consume vegetation that is unpalatable to them.

Trampling of the vegetation also reduces the total vegetation cover. If vegetation is trampled to a point where it is not affecting the seedling growth, it should not be included when estimating the final vegetation cover. However, trampling by itself is not recommended as a vegetation management treatment.

The number of days required to achieve the desired grazing intensity can be estimated with the following method. Vegetation should be sampled the year before, at the same times that grazing is expected to occur. The timing of the sampling is important because in spring a site may have only 500 kg/ha dry weight of forage whereas later in the season this may increase to 1000 kg/ha. Only the vegetation species that the sheep are expected to consume should be sampled. This will include the target vegetation and other vegetation that sheep will consume readily but that are not considered serious competitors, such as clover. The number of days required to graze a site with a given amount of sheep can be estimated by the following calculation:

$$\text{Number of grazing days} = \frac{\text{Area(ha)} \bullet \text{Dry wt. of forage(kg/ha)} \bullet \text{\% Removal}}{\text{2 kg/day} \bullet \text{Number of sheep}}$$

where:

Area = area to be grazed in hectares,

Dry wt. of forage = oven-dried weight of target vegetation sampled on the site,

% Removal = amount of target vegetation removed by sheep to achieve the desired silviculture goals.

If the target vegetation cover on the site was 30% and the acceptable cover after the treatment is 15%, then 50% of the vegetation needs to be removed. Percent cover should be assessed at the same time that the target vegetation samples are collected. The following example shows the calculation for a 50-ha block containing 1000 kg/ha of available forage for a flock of 1000 sheep.

$$\text{Number of grazing days} = \frac{\text{50 ha} \bullet \text{1000 kg/ha} \bullet \text{0.50}}{\text{2 kg/day} \bullet \text{1000 sheep}} = \text{12.5 days}$$

Note that this is only an estimate and a buffer of at least 2 days should be allowed. An exact calculation will not be possible, so alternative grazing arrangements should be made in case grazing is finished earlier than estimated. Two possible options would be to leave the area early or have extra blocks available for treatment. Obviously, the number of days required to graze a plantation could be reduced by an increase in flock size. However, larger flocks are more difficult to manage. A maximum of 1500 sheep per flock is recommended. To estimate grazing intensity, plantations should be divided into manageable units with a maximum size of 50–60 ha.

8.2 Grazing Frequency

There is limited information about the number of grazing seasons required to achieve silvicultural objectives on any biogeoclimatic unit. We believe that sheep grazing may be required for 2–3 years, but up to 5 years of consecutive grazing could be necessary for seedlings to achieve free-growing status. However, repeated defoliation, especially at high levels of forage use, can impair the physiological processes of target plant species.

In one trial in the ICH zone in the Cariboo Forest Region, grazing over 3 consecutive years reduced fireweed cover by approximately 60% in the first year, 75% in the second year, and 85% in the last year . Three years after grazing was completed, the fireweed cover was still 50% less than that on the control plot. However, other vegetation had invaded the site and the total cover in the control exceeded that in the grazed areas. The vegetation that had re-invaded the site has not been described in detail, but grasses and *Cornus canadensis* are the two predominant species replacing the fireweed (Newsome 1993). In this study, the vegetation replacing the fireweed did not impede seedling development. However, vegetation species that may replace the target vegetation should be considered before grazing begins to ensure that competition is reduced and not enhanced by the treatment. O'Brien and Bailey (1987) reported that three seasons of grazing were required to kill aspen. More information is needed about the number of graz-

ing periods that are required and the long-term effect of grazing on vegetation species shifts.

Some sheep grazing treatments in the province have used rotational grazing systems where sheep graze the plantation once and then return to graze regrowth. The time between the first and second passes on a plantation is site specific and can range from 40 to 70 days before an adequate supply of forage is again available for sheep grazing.

8.3 Grazing Timing

New vegetation sprouts are the preferred forage of sheep. These are generally found in spring on new plantations and on plantations that have been previously grazed. The target species is most significantly affected when new sprouts are available and the whole plant is completely consumed. However, the volume of forage is low when new sprouts dominate the site. Therefore, sites must be closely monitored to achieve balance between an early start to grazing and sufficient quantities of vegetation.

Where a series of plantations is distributed over an elevational gradient, sheep can be herded from low- to high-elevation sites to maintain high forage quality of palatable plants (Ellen 1988). The same plantations are re-grazed on the way down but the high-elevation sites are treated only once because of the short growing season. On sites where forage is important for wildlife, a two-pass rotation may not be acceptable and regrowth should be left for wildlife use.

Ellen (1988) reported that sheep prefer different species of vegetation at different times of the year. However, these changes in preference are not well defined and will be different for each vegetation complex. Local experience will best define timing for vegetation preferences.

Less forage may be available on the second pass over the clearcut, so the number of animals, or the length of time the plantation is grazed, should be adjusted to ensure that seedlings are not damaged. Alternative blocks or forage sources must be available nearby so that sheep can be moved if forage becomes depleted.

Conifer seedlings are most susceptible to damage when they are flushing in spring. This generally coincides with the sprouting of the competing vegetation. Careful flock management is required during this period. If the conifer species is highly susceptible to grazing damage, then grazing should be delayed until the seedlings have hardened off.

If the sheep become restless and difficult to manage, it may be because forage quality has dropped and they should be removed from the site. Generally, grazing occurs from the time sufficient vegetation is present on the site until the first frost. These dates should be determined on a site-specific basis. Never over-extend grazing on plantations into fall. It can result in more sheep management and predator problems, more seedling damage, less effective vegetation control, and sheep weight loss. Even grazing in early September is usually not acceptable on most sites in the interior of British Columbia.

9 MONITORING

Sheep projects should be monitored throughout the grazing season (particularly with new contractors) to ensure that the vegetation control treatment is being appropriately applied without damage to seedlings. Immediately after completion, all projects should be surveyed to determine if the contract's terms of reference have been met and the the short-term silvicultural goals have been achieved. Long-term monitoring should be considered on selected sites to determine the effectiveness of sheep grazing for enhancing conifer growth, and to compile information that will improve our understanding of how this treatment can be used successfully for silvicultural purposes. Data on seedling and vegetation response should be collected during the treatment and up to 10 or more years after the treatment is completed.

The following procedures were developed from sheep grazing research in the Cariboo Forest Region and are intended to be a basic format for operational monitoring. For research monitoring procedures specifically for sheep grazing, refer to Hays (1992). Other general vegetation monitoring procedures such as PROBE (Simard 1993) could also be used.

9.1 Short-term Monitoring

Short-term monitoring plots should ideally be completed at two different times: halfway through a project

(midterm plots) and on completion of the project (payment plots).

- Midterm Plots These determine the progress of the grazing treatment and the length of time sheep should remain on site. Both seedling damage and vegetation removal are assessed on the grazed portion of the block. Preferably the plots are assessed with the sheep contractor or head shepherd. Otherwise, the results from these surveys should be given to the sheep contractor or head shepherd immediately to help them modify their management strategies if necessary. Only about 20 plots are required (even on larger blocks), but these should cover most of the grazed area.
- Payment Plots These are completed after the sheep have been removed. Plots should be established as soon as possible after the sheep have left to ensure that the cover values for target species accurately reflect the sheep grazing treatment. Some species such as fireweed can re-sprout quickly, which could bias their cover estimates.

Use the following procedures for short-term monitoring.

1. Establish a grid at a density of one plot per hectare, with a minimum of 20 plots.
2. The recommended plot radius is 3.99 m for recording seedling damage and 1.78 m for recording percent cover of vegetation. The plot centres can be established using methods similar to those in stocking surveys. The same plot centre can be used for seedling and vegetation assessment. Always record vegetation information first, as vegetation may become trampled during the seedling assessment.
3. Record percent vegetation cover within the 1.78 m radius plot. Only the target species should be assessed. A list of these target species should be prepared before the project starts. Percent cover of each target species should be recorded separately. Total percent vegetation cover, including all species present, can also be assessed to provide further information.
4. Vegetation 10 cm or less in height should not be included in the cover estimates. This includes mosses, small plants, or vegetation that has been trampled.
5. Unacceptable plots contain more than 15% cover of all target vegetation. Seventy-five percent of the plots must be classified as acceptable before payment is made.
6. Record the total number of seedlings and seedling damage attributed to current sheep grazing (by species) in the 3.99 m plot. Types of damage include:
   - seedling terminals browsed (BT),
   - seedling trampled, crushed, or bent (TC),
   - seedling bark peeled or abraded over more than one-third of the stem (TA),
   - seedling uprooted (UR), or
   - seedling laterals browsed (BL).

   Record only one form of damage per seedling. Start at BT and work down the list. Use BL only if no other form of damage is obvious. Browsing of seedling laterals should only be considered serious if more than 50% are damaged. Penalties imposed for seedling damage will vary for each contract. If appropriate grazing techniques are used, the damage should remain under 5%.

9.2 Long-term Monitoring

Use the following procedures for long-term monitoring.

1. Establish a 50 by 50 m exclosure on each plantation to monitor the long-term effects of sheep grazing. The exclosure should be representative of the grazing area. Either permanent or electric fencing can be used. If electric fencing is used, mark the corners with permanent wooden stakes. Sheep should always be kept out of the exclosures.
2. Establish a minimum of five lines of 10 trees each with approximately 10 m between trees in the grazed area. These lines should be established where site characteristics and vegetation species are similar to those in the exclosure. Place a stake 1 m north of the seedling and tag the stake. Do not use any flagging tape in the grazing area because sheep may be attracted to it.
3. Stake 50 seedlings approximately 5 m apart in the exclosure. Place the stake 50 cm north of the seedling to avoid shading.
4. Approximately 10 days before grazing starts and within 10 days of finishing, assess the vegetation in both the exclosures and grazed areas for:
   - percent cover of total vegetation,
   - percent cover of target species and other vegetation over 5% in cover,
   - height of vegetation species recorded,
   - seedling condition,
   - vegetation cover, and
   - seedling damage.

   The seedling assessed will act as a plot centre for the 1.26 m radius vegetation plot. Note that the vegetation plot size is smaller than that for the operational plots due to the higher sampling intensity and to correspond to other operational monitoring procedures used in the province.

5. Make a photographic record by taking pictures of the control and grazed areas at permanently marked photo points.
6. Assess seedling growth in both the exclosure and grazed area in fall after the current year's terminal bud is set. Seedlings are easier to locate after frost has knocked back the surrounding vegetation.
   The long-term monitoring should be continued for a minimum of 5 years or until the seedlings have reached a free-growing status. Long-term monitoring plots should be established on as many blocks as possible — three is a recommended minimum.

See Appendix 4 for a summary of data required for short- and long-term monitoring and examples of data sheets.

10 LEGAL AND ADMINISTRATIVE REQUIREMENTS

10.1 Permits

A Grazing Permit under the *Range Act* or a Special Use Permit under the *Forest Act* is usually required to use sheep grazing to meet silvicultural objectives. Both permits are issued by the Ministry of Forests. Check with the Ministry's regional office to determine which permits are required. Additionally, the Pre-Harvest Silviculture Prescription must state that sheep grazing is a planned silvicultural treatment option for the plantation.

10.2 Silviculture Contract

The Ministry of Forests or the Licensee will issue a silviculture contract for brushing projects on specific sites. This contract is usually divided into a number of schedules. Examples of schedules A and C are given in Appendix 5. Schedule A covers the general aspects of sheep grazing. Schedule B deals with the areas to be grazed, the number of sheep and dogs required, the target vegetation, the species of crop trees to be released, and the cost of the project. Schedule C includes more specific requirements for the individual contract. In Appendix 5, schedule C was developed to graze sites in the Cariboo Forest Region where grizzly bears are a major concern.

10.3 Health Certificate

A licensed veterinarian must inspect each flock on the farm 1 month before release onto the plantation and 2–3 weeks after arrival at the plantation to ensure that health standards as specified by the Ministry of Agriculture, Fisheries and Food health protocol are met. The veterinarian should be authorized by the Ministry to inspect and certify sheep, and should not be responsible for the routine care of the animals. After the inspections, health certificates must be signed by the inspectors, the producer at the farm, and the contractor on the grazing site, and sent immediately to the contract officer, the Ministry's Animal Health Division veterinarian, and the Ministry of Environment, Lands and Park's regional office.

10.4 Transportation Regulations

All commercial or private vehicles that transport sheep must conform to the Transportation of Animals guidelines set by Agriculture Canada's Animal Health Directorate. This applies to all sheep entering, leaving, or moving within Canada.

11 GRAZING SCHEDULE

The following schedule outlines the procedures that should be completed before, during, and after a grazing project. It is a general outline and is not intended to be exhaustive.

11.1 Activities the Year Before Grazing

1. Identify potential blocks and ensure that a vegetation management problem exists and that the sites are ap-

propriate for sheep grazing. A variety of site criteria is given in the guidelines.
2. Notify the Environment section of the Ministry of Environment, Lands and Parks and any other people or agencies that the grazing may affect. Early notification allows the Ministry staff to assess the sites and identify potential concerns before grazing begins.
3. Collect forage samples to estimate the preferred forage available when grazing will occur and to ensure that the amount of forage will be adequate.
4. Inspect the block, ensure that access is adequate, and locate potential corral placements (including the corral needed when the animal transport liner unloads the sheep) and exclosures.
5. Identify "safe" alternative areas for sheep in case seedling damage becomes unacceptable or forage becomes limited.
6. Identify the blocks to be grazed, the order of grazing, and how long the grazing will last. Preferably, a whole season should be available for a flock. Note if livestock liners will be needed to move sheep mid-season.
7. Consult with the Ministry of Environment, Lands and Parks before the project is tendered to ensure that no problems exist.
8. Ensure that applications for all appropriate licences are completed.

11.2 Activities the Year of Grazing

1. Monitor the site in early spring to determine when grazing should begin. Keep in close contact with the contractor.
2. Notify the Ministry of Forests, Ministry of Environment, Lands and Parks, and Ministry of Agriculture, Fisheries and Food at least 1 month before the arrival of the sheep.
3. Fence exclosures (if these are required) before grazing commences.
4. Complete a pre-grazing survey, if long-term monitoring is to be used, as outlined in the long-term monitoring section.
5. Review expectations with the contractor and *all* shepherds at the pre-work conference. The acceptable amount of remaining vegetation should be shown to the shepherds and contractor so that they know what 15% cover looks like in the field. Also supply all appropriate phone numbers of contact people for emergencies and wildlife issues.
6. Make sure all aspects of the Ministry of Agriculture, Fisheries and Food health protocol are followed and review all necessary certificates outlined in Section 10.
7. Complete a set of mid-term plots on the grazed section, preferably with the head shepherd. Provide feedback to the shepherds and contractor.
8. Complete the payment and long-term plots, within 10 days of finishing the treatment, and provide feedback to the contractor.
9. Monitor the vegetation quantities on sites that are scheduled for a second graze to determine if the forage available is adequate.
10. Monitor vegetation conditions closely to ensure that the quality has not become unacceptable (especially in late August when frost may damage the vegetation).
11. Complete seedling measurements for long-term monitoring once the seedlings have set bud.
12. Complete grazing report and data summaries.

Administration Policies and management regimes as they affect range, livestock, wildlife, forestry, mining, reclamation, land management, tenure, and multiple use.

Animal distribution The demographics, and spatial and temporal distribution of animals. Also includes control of grazing livestock by means of fencing, salting, riding, and water, and the improvement of range use by trail development, seeding, and fertilization.

Bedding The act of sleeping or resting or the material used to provide a bed for livestock.

Bed ground An area where animals sleep and rest (Kothmann 1974).

Brushing To eliminate or reduce competing brush to enhance survival and provide better nutrient, moisture, and light conditions for the early stages of growth of recently planted seedlings (Watts 1983).

Browse That part of leaf and twig growth of shrubs, woody vines, and trees available for animal consumption (Kothmann 1974).

Browsing To consume browse (Kothmann 1974).

Clearcut. An area of forest land from which all merchantable trees have recently been harvested (Bonnor 1978).

Competition The general struggle for existence within a trophic level in which the living organisms compete for a limited supply of the necessities of life (Kothmann 1974).

Crop tree Commercially harvested tree species.

Diet Forage species used by domestic animals under free-ranging conditions.

Exclosure An area fenced to keep livestock out.

Fencing A range improvement method to control grazing and livestock distribution (Vallentine 1974).

Foot rot An inflammation and swelling of the foot that may extend above the hoof and around to the heel, resulting from contaminated pastures or occasionally thorns, stones, or other material lodged between the animal's toes (Ensminger 1970).

Forage All browse and herbaceous foods that are available to grazing animals. It may be grazed or harvested for feeding (Kothmann 1974).

Forage preference Selection of certain plant parts, or plant species, by grazing animals.

Forage production The weight of forage that is produced within in a designated period of time on a given area (Kothmann 1974).

Forage quality Characteristics that make forage valuable to animals as a source of nutrients (Heath et al. 1973). Also includes "antiquality" factors that may make forage unacceptable for livestock.

Graze The consumption of standing forage by livestock (Kothmann 1974).

Grazing period The length of time that livestock are grazed on a specific area (Kothmann 1974).

Health Disease, defects, toxicities, and deficiencies contributing to reductions in animal production, and treatment methods.

Herding The handling or tending of an assemblage of animals, usually of the same species.

Landing An area used for storage and loading of harvested logs.

Livestock Domestic animals kept for production of meat, milk, wool, or work (Campbell and Lasley 1969).

Livestock damage All damage (trampling, lateral and bud damage, girdling, defoliation, and mortality) directly occurring on crop trees resulting from livestock.

Night corrals Small enclosures constructed to hold sheep at night.

Nutritional requirements The necessary protein, fats, carbohydrates, minerals, and vitamins that contribute to the maintenance of body processes, growth, and development.

Palatability The relish with which a particular species or plant part is consumed by an animal (Kothmann 1974).

Parasite An organism living on or in another organism during all or part of its existence (Hutchinson 1976).

Plant cover The combined aerial parts of plants and mulch (Kothmann 1974).

Preferred species Species that are grazed by animals by first choice (Kothmann 1974).

Predation The act of any animal, including insects, preying upon and eating other animals (Campbell and Lasley 1969).

Riparian Land situated along the bank of a stream or other body of water (Hutchinson 1976).

Shipping fever A respiratory infection that appears in livestock within 10 days after shipment, believed to

be caused by a mixture of viruses and bacteria (Ensminger 1970).

Site preparation Prescribed treatments used to produce a suitable seedbed for seeding forage plant species or conifer regeneration on forest land including: scarification, windrowing, slash removal, burning, and weed control.

Skid trail A disturbed area caused by logging equipment during the process of moving logs to the landing.

Species composition The proportions of plant species in relation to the total on a given area (Kothmann 1974).

Target vegetation Vegetation that is targeted for reduction because it is competing with crop seedings.

Turn out The act of turning livestock out onto the range or forest plantation at the beginning of the grazing period (Kothmann 1974).

Use The proportion of current year's forage or browse production that is consumed by grazing animals (Kothmann 1974).

Interviewees

Name	Occupation	Affiliation	Location
Kevin Bonnett	Forester	Weyerhaeuser	Clearwater
Shirley Bowden	Sheep Breeder	Thompson Nicola Sheep Association	Kamloops
Nola Daintith	Assistant Research Silviculturist	Ministry of Forests	Williams Lake
Rob Deither	Sheep Breeder	Cariboo Sheep Breeders	Miocene
Geoff Ellen	Range Resource Officer	Ministry of Forests	Clearwater
Ken Gilbert	Silviculture Technician	Ministry of Forests	Horsefly
Rod Henneker	Sheep Breeder	Cariboo Sheep Breeders	150 Mile House
Bert Smith	Sheep Breeder	B.C. Sheep Grazing Committee	100 Mile House
Dirk Trigg	Timber Forester	Ministry of Forests	Williams Lake

Government and industry personnel, and consultants, surveyed

Name	Occupation	Affiliation	Location
Greg Ashcroft	Habitat Protection Biologist	Ministry of Environment, Lands and Parks	Williams Lake
Bryce Bancroft	Forestry Consultant	Madrone Consultants	Victoria
Kevin Bonnett	Forester	Weyerhaeuser	Clearwater
Dave Campbell	Range Officer	Ministry of Forests	Victoria
Gordon Clarkson	Area Supervisor	Westar Timber	Vanderhoof
Peter Corbett	Consultant	Mirkwood Ecological Consultants	Nelson
Doug Eastman	Operations Manager	Ministry of Forests	Duncan
Wayne Erickson	Range Planning and Research Specialist	Ministry of Forests	Victoria
Peter Fofonoff	Senior Agrologist	Ministry of Agriculture, Fisheries and Food	Williams Lake
Bruce Johnson	Regional Range Specialist	Ministry of Forests	Prince George
Tom Johnston	Silviculture Resource Officer	Ministry of Forests	Castlegar
Dave King	Regional Habitat Biologist	Ministry of Environment, Lands and Parks	Prince George
Henry Lange	Health Management Veterinarian	Ministry of Agriculture, Fisheries and Food	Abbotsford
Peter Love	Silviculture Forester	Rustad Brothers	Prince George
Sandy MacDonald	Regional Habitat Protection Biologist	Ministry of Environment, Lands and Parks	Kamloops
Andy MacKinnon	Manager-Forest Ecology Research	Ministry of Forests	Victoria
Ted Moore	District Agrologist	Ministry of Agriculture, Fisheries and Food	Kamloops
Roderick Negrave	Assistant Research Silviculturist	Ministry of Forests	Fort St. John
Les Priest	Forestry Consultant	Aldermere Forestry Services	Telkwa

Name	Occupation	Affiliation	Location
Gerald Reichenback	Stand Tending Forester	Ministry of Forests	Nelson
Mel Scott	Stand Tending Forester	Ministry of Forests	Burnaby
Mark Seilis	Silviculture Research Officer	Ministry of Forests	100 Mile House
Kathy Smith	Silviculturist	Westar Timber	Nakusp
Bill Somes	Veterinarian	Nakusp Veterinary Clinic	Nakusp
Al Soobotin	Regional Habitat Biologist	Ministry of Environment, Lands and Parks	Nelson
Malcom Tait	Professor	Animal Science, Univ. B.C.	Vancouver
Yo Yano	Regional Silviculture Officer	Ministry of Forests	Kamloops

Sheep producers and shepherds surveyed

Name	Location
Jeff Cusworth	Kamloops
Mary Marriott	Falkland
Moilliet/Finley Ranch	Clearwater
Brian Yanciw	Burns Lake
West Coast Browsing	Merville

Scientific Name	Common Name
Acer circinatum	Vine maple
Acer macrophyllum	Bigleaf maple
Aconitum columbianum	Columbian monkshood
Alnus rubra	Red alder
Alnus viridis	Sitka alder
Anaphalis margaritacea	Pearly everlasting
Aralia nudicaulis	Wild sarsaparilla
Aster conspicuus	Showy aster
Athyrium filix-femina	Lady fern
Betula papyrifera	Paper birch
Calamagrostis canadensis	Bluejoint
Cicuta douglasii	Douglas water-hemlock
Cirsium arvense	Canada thistle
Claytonia sibirica	Siberian miner's-lettuce
Corylus cornuta	Beaked hazelnut
Delphinium glaucum	Tall larkspur
Dicentra formosa	Bleeding heart
Digitalis pupurea	Foxglove
Epilobium angustifolium	Fireweed
Equisetum arvense	Common horsetail
Festuca occidentalis	Western fescue
Galium spp.	Bedstraw
Gaultheria shallon	Salal
Gymnocarpium dryopteris	Oak fern
Hieracium spp.	Hawkweed
Hypochaeris radicata	Hairy cat's-ear
Kalmia occidentalis	Bog-laurel
Lathyrus nevadensis	Purple peavine
Lathyrus ochroleucus	Creamy peavine
Ledum groenlandicum	Labrador tea
Lonicera involucrata	Black twinberry
Lupinus spp.	Lupine
Mahonia nervosa	Dull Oregon-grape
Paxistima myrsinites	Falsebox
Phleum pratense	Timothy
Populus tremuloides	Trembling aspen
Prunus virginiana	Choke cherry
Pteridium aquilinum	Bracken
Rhododendron albiflorum	White-flowered rhododendron
Rhododendron macrophyllum	Pacific rhododendron
Rubus idaeus	Red raspberry
Rubus leucodermis	Black raspberry
Rubus parviflorus	Thimbleberry
Rubus spectabilis	Salmonberry
Rubus ursinus	Trailing blackberry
Salix spp.	Willow

Scientific Name	Common Name
Sambucus racemosa	Red elderberry
Spiraea spp.	Spirea spp.
Taraxacum officinale	Common dandelion
Triglochin maritimum	Seaside arrow-grass
Vaccinium spp.	Blueberry spp.
Valeriana sitchensis	Sitka valerian
Veratrum viride	Indian hellebore
Vicia americana	American vetch
Zygadenus elegans	Mountain death-camas

1. Short-term Monitoring

- Grazing dates: start and finish
- Block size
- Number of sheep (one lamb counts as one sheep)
- Point of Commencement, bearing, plot number, and the distance between plots
- Percent cover of total vegetation[1]
- Percent cover of target vegetation[1]
- Seedling damage as a result of sheep grazing. Browsed lateral branches should be recorded but not included in the percent damage estimate unless 50% or more are damaged.

2. Long-term Monitoring

- All grazing dates (i.e., for all years)
- Block size
- Number of sheep
- Line and plot locations
- Vegetation and some seedling assessments to be completed before and after grazing at the same time as short-term monitoring.
  - percent cover of total vegetation[1]
  - percent cover of target species and other vegetation over 5% cover excluding mosses and lichens[1]
  - height of target vegetation
  - overall seedling condition[2]
  - seedling vegetation cover[2]
  - seedling damage[2]

Note: percent cover of target vegetation should be recorded even if less than 5% cover.

- Seedling Assessment to be completed in fall (late August – October). The following example form does not include these measurements. A separate form will be required.
  - seedling heights (to nearest cm)
  - seedling diameter (to nearest 0.1 mm)

1 Percent vegetation should be estimated to the nearest 10% for 20% – 100% cover. Estimate under 20% cover to the nearest 5%.
2 See following pages for seedling assessment codes adapted from Herring and Pollack 1985.

SHORT-TERM MONITORING FORM

SHEEP GRAZING PROJECT 19__
PROJECT #

Date: _____ Block number: _____ Size: _____ha

Grazing dates: Start:_____Finish: _____ Number of sheep: _____

Completed by: _____ Midterm plots: _____
Payment plots: _____

Damage codes: **BT - Browsed terminals** **TC - Trampled crushed**
BL - Browsed laterals **TA - Trampled abraded**
UR - Uprooted

Bearing	Dis. (m)	Plot no.	Vegetation Cover (%)		Avg. Ht. of Target (cm)	Seedling damage						
			Target	Total		Spp	Total	BT	TC	TA	UR	BL

Vegetation and seedling damage data for permanent plots

DATE

D	M	Y	Site	Blk.	Size (ha)	Treat.	No. of Sheep

Grazing dates: 1) Start _____ Finish _____
2) Start _____ Finish _____

Measured by: _____

Bearing	Dist.	Plot no.	Tree no.	Tree spp.	Seed. cond.	V.C.	Damage codes						Total veg. cover	Target vegetation and species (>5%)	Veg. cover	Veg. height
							F	C	L	C	S	C				

SEEDLING CONDITION CODES

Overall Seedling Condition

Code		
1	Good	Seedling shows no signs of stress; has a vigorous growth rate and a generally healthy appearance.
2	Fair	Seedling is under some form of stress, may have minor defects, and has a moderate growth rate.
3	Poor	Seedling is under severe stress, may have major defects, and the growth rate is poor.
4	Moribund	Seedling is almost dead.
5	Dead	
6	Missing	

Seedling Vegetation Cover Codes

O	Overtopped	Leader of crop tree is currently overtopped by surrounding vegetation; available sunlight for crop tree is greatly reduced.
T	Threatened	Leader of crop tree is roughly equivalent to height of the surrounding vegetation. It is likely to be overtopped within two growing seasons.
F	Free-growing	Leader of crop tree is well above the surrounding vegetation and is unlikely to become threatened.

Seedling Damage Codes

	Stem Condition Code
H	- No visible effect (healthy)
B	- Stem bent
C	- Stem cut, clipped, broken
D	- Tree dead, dying
F	- Stem forked
G	- Gall rust
M	- Tree missing
P	- Bark peeled or abraded
S	- Stem smashed, crushed, trampled
Ø	- Other symptoms (specify)
	Damage Cause Code
A	- None
B	- Big game
D	- Disease
E	- Climate: frost
F	- Fire
G	- Winter damage
H	- Herbicide
I	- Insects
L	- Livestock
M	- Mechanical equipment
N	- Snowpress
R	- Rodents, small animals
S	- Falling slash (human-caused)
T	- Hand tools
U	- Unknown
V	- Vegetation press
W	- Climate: drought
X	- Falling or sliding debris
Z	- Destructively sampled
Ø	- Other (specify)
	Foliage Condition Code
H	- No visible effect (healthy)
A	- Needles absent, defoliated
B	- Browsed
D	- Dead buds on lateral branches
G	- Gall aphid
M	- Mottled
N	- Necrotic
Y	- Chlorotic (yellow)
Ø	- Other symptoms (specify)
	Leader Shoot Condition Code
H	- No visible effect (healthy)
A	- Absent, missing
B	- Browsed
C	- Curled
F	- Forked
P	- Pissodes
S	- Snapped, broken
T	- Dead terminal bud
Ø	- Other symptoms (specify)

There are two schedules included in this appendix. Schedule A is the standard silviculture contract developed by the Ministry of Forests for using livestock for vegetation management. The other is a schedule C developed specifically for the Cariboo Forest Region by the Ministry of Forests in conjunction with Ministry of Environment, Lands and Parks. It incorporated all the concerns of the Ministry's Northern Sub-Regional office regarding wildlife, specifically grizzly bears, and other issues concerning sheep grazing on forest plantations that were not addressed in the more general Schedule A. The clauses included in schedule C should be specific to each contract and may be different from the example given.

Other relevant silviculture contract forms pertaining to brushing contacts will also be required in addition to the schedules A and C.

MINISTRY OF FORESTS LIVESTOCK VEGETATION MANAGEMENT CONTRACT

Schedule A

PART 1: GENERAL TERMS AND CONDITIONS

Definitions:

1.01 In this Schedule:

"Treatment Type" means the particular methods of treatment that the Contractor is obligated to carry out under this Contract.

"Treatment Unit" means the delineated area on any attached map wherein one or more Treatment Types may be prescribed to be carried out.

"Work" means the services which the Contractor is obligated to perform under this Contract.

"Work Day" means every day except Saturday, Sunday and statutory holidays.

"Livestock" means domestic animals (eg. sheep or cattle), used for grazing/brushing forest sites.

"Shepherd/guardian animals" means domestic animals (eg. shepherd dogs/guardian dogs), used for shepherding or protecting livestock used for grazing/brushing.

"Attend" means to be close to and within sight of the livestock.

Amendments and Supplements:

1.02 The specifications in this Schedule may be amended or further supplemented in other Schedules to this Contract or in the Work Progress plan.

Provision of Grazing Permits:

1.03 The type of permit (Temporary Grazing Permit under the Forest Range Act or Special Use Permit under the Forest Act), shall be as stated in Schedule C of this contract. Any permit fees shall be paid by the Contractor.

Compliance with the 'Inter-Ministry Guidelines for Use of Domestic Sheep for Vegetation Management in British Columbia'

1.04 The Contractor shall conform to the standards set out in the 'Inter-Ministry Guidelines for Use of Domestic Sheep for Vegetation Management in British Columbia', prepared by the British Columbia Inter-Ministry Committee for the Use of Domestic Sheep in Vegetation Management.

Provision and Inspection of Livestock, Shepherd/Guardian Animals and Equipment:

1.05 The Contractor must provide all of the equipment, livestock (eg. sheep), shepherd/guardian animals and other supplies that are required for the Treatment Type(s) specified in Schedule B attached hereto.

1.06 The equipment, livestock and shepherd/guardian animals supplied must be capable of meeting the requirements contained herein without causing unacceptable levels and/or kinds of site disturbances (environmental impacts) to the work area or Treatment Units.

1.07 Should the Ministry Officer, upon inspecting the equipment, livestock and shepherd/guardian animals prior to the commencement of work, determine that they are unsuitable for the required Work, this Contract may be terminated forthwith.

1.08 All equipment, livestock and shepherd/guardian animals intended for use during this Contract shall be inspected by the Ministry Officer. Should equipment, livestock and/or shepherd/guardian animals not approved by the Ministry Officer be used, the Province may terminate this Contract forthwith.

1.09 The livestock and shepherd/guardian animals used for the project must meet all on-farm and on-project area health requirements as set out by the B.C. Ministry of Agriculture, Fisheries and Food (BCMAFF), Animal Health Branch (Schedule E). The Contractor shall be responsible for all health inspection costs. Should the health of the livestock and shepherd/guardian animals not meet the standards of the BCMAFF, the Province may terminate this Contract forthwith. On-site veterinarian inspection reports must be submitted to the Ministry Officer and the appropriate local representative of the Ministry of Environment, Lands and Parks within five (5) days of the inspection.

Provision of Treatment Units:

1.10 Subject to this Contract, the Province shall permit the Contractor to conduct specified Treatment Types in the Treatment Units.

Substitution of Treatment Units or Treatment Types:

1.11 Where, in the opinion of the Province, it is not feasible to proceed with the Work or Treatment Type(s) in any or all of the Treatment Unit(s), the Province may substitute alternate Treatment Types orTreatment Units.

1.12 Where either party hereto considers that the substitution of Treatment Unit(s) or Treatment Type(s) will cause an increase or decrease in the Contractor's cost of performing the Work, that party may request that an equitable adjustment be made to the price per Treatment Unit set out in Schedule B attached hereto, and that the Contract be modified accordingly, in writing.

1.13 Where the Province and the Contractor are unable to agree on an equitable adjustment to the price per Treatment Unit then, subject to paragraph 1.14, the Contract shall be deemed to be terminated by mutual consent, and the Province shall not be obligated to make any further compensation to the Contractor other than payment for any Work the Contractor has already completed to the satisfaction of the Province.

Compensation for Reductions in Contract Size:

1.14 If, after notifying the Contractor to commence Work, the Province determines that it is not feasible to proceed with the Work on any or all of the Treatment Units and it is unable to substitute alternate areas or agree with the Contractor on an equitable adjustment to the bid price then, in addition to making payment for any Work the Contractor has completed to the satisfaction of the Province, the Province shall pay to the Contractor fifteen percent (15%) of the amount by which the reduction of the total bid price in Schedule B (herein called the "shortfall") exceeds ten percent (10%) of the total bid price before the reduction was made.

1.15 The Province shall make no payment under paragraph 1.14 and no claim by the Contractor for any losses occasioned by such a shortfall shall be allowed in circumstances where the shortfall was occasioned

by an Act of God, unsuitable weather, natural disaster, withdrawal of labour in labour disputes or any other unforeseeable causes over which the Province has no direct control or where the amount of the shortfall is less than or equal to ten percent (10%) of the total bid price before the reduction was made.

1.16 Where the Province makes a compensation payment to the Contractor under paragraph 1.14, the Contractor shall have no further claim in respect to the shortfall.

Insurance:

1.17 The Contractor shall, upon execution of this Contract, unless otherwise directed by the Province, provide proof that the insurance specified in paragraph 1.18 and 1.19 is in full effect with insurers acceptable to the Province and that each policy cannot be cancelled, lapsed or materially altered without a minimum of fifteen (15) days written notice to the Province.

1.18 The Contractor shall have comprehensive general liability insurance that provides a minimum of one million dollars ($1,000,000.00) coverage and is inclusive of bodily injuries and property damage. This coverage shall include:

(a) one hundred thousand dollars ($100,000.00) fire fighting expenses;
(b) the Contractor's premises, property (including unlicenced motor vehicles) and operations;
(c) contingent liability with respect to contractors and subcontractors approved by the Province;
(d) contractual liability covering Contractor's liability under any and all terms of this Contract; and
(e) non-owned automotive liability.

1.19 The Contractor shall have statutory motor vehicle liability insurance that provides a minimum of one million dollars ($1,000,000.00) coverage and is inclusive of bodily injury and property damage coverage for all of the Contractor's licenced motor vehicles (owned or leased).

1.20 In the event the Contractor does not obtain or maintain insurance as specified in paragraphs 1.18 and 1.19, the Province may, at its option, at any time obtain such insurance at the Contractor's expense and any premium payable shall be paid by the Contractor to the Province, or the Province may terminate the whole or any part of this Contract.

Liability:

1.21 There shall be no personal liability upon the Minister or the Ministry Officer in charge, their agents or employees, for any act performed in the discharge of any duty imposed or in the exercise of any power or authority conferred upon them by, or within the scope of, the Contract if it can be demonstrated that all reasonable care was exercised in the conduct of the operations; it is understood that in all such matters they act solely as agents and representatives of the Crown.

1.22 Neither the Province of British Columbia nor any of its employees or agents shall be liable to the Contractor, or the Contractor's employees or agents, for any injury, loss or damage, however occasioned, to any of them or their equipment or livestock while being transported or conveyed in any vessel, boat or aircraft owned or operated by the Province, and the Contractor shall undertake no claims against the Province, its employees or agents, to recover any such injury, loss or damage either on his own behalf or on behalf of his employees or agents. The Contractor undertakes to indemnify and save harmless the Province and its employees or agents from any such claims initiated by the Contractor's employees or agents.

Records To Be Kept:

1.23 The Contractor is responsible for keeping daily records of the brushing operation(s), and at the conclusion of the project, shall send the original records to the Ministry Officer. The records shall include information on:

(a) actual dates of operation,
(b) human workers and duties on site,

(c) number of livestock and shepherd/guardian animals used,
(d) days spent on each grazing unit,
(e) successes: areas (hectares) treated,
(f) problems encountered: (including predator sightings and problems; lambing (if any), livestock and shepherd/guardian animal health problems and number of dead, physically injured or lost livestock and shepherd/guardian animals).

The Ministry Officer in charge may view the daily records at any time.

Assessments:

1.24 Any assessments made against the Contractor by the Province under this Contract shall be collected by deducting the amount of the assessment from either the basic payment or from the performance security held by the Province prior to the returning of the performance security to the Contractor.

Site Cleanup:

1.25 Upon the Contractor vacating any work area, camp or rest area, the Ministry Officer shall inspect the area to determine, at his sole discretion, whether or not the area was left in acceptable condition.
1.26 Should the Ministry Officer determine that the Contractor left the work area, camp or rest area in an unacceptable condition, the Province will repair the area and charge the entire cost of the repairs to the Contractor.
1.27 Any determination of the Ministry Officer under paragraphs 1.25 and 1.26 is final and binding on the parties hereto.

Interpretation:

1.28 Any reference in this Contract to a manual or a form means a manual or form published by or for the Ministry of Forests, and includes every amendment to them and any manual or form published in substitution for them or replacement of them.
1.29 The powers in this Schedule for the Province to enforce the Contractor's compliance with the terms and conditions of this Contract may be exercised separately, concurrently or cumulatively with those powers of the Province set out elsewhere in this Contract.

PART 2: PERSONNEL

2.01 The Contractor shall be solely responsible for the supervision, conduct and discipline of their employees and agents and they shall ensure that all Work performed by their employees and agents pursuant to this Contract conforms with the terms and conditions of the Range Act and the applicable federal and provincial acts, regulations and policies.
2.02 Where sheep are used for grazing, the Contractor shall provide the required number of qualified shepherds as specified in the British Columbia Interministry Agreement for the Use of Domestic Sheep in Vegetation Management. The Ministry Officer shall specify the required number of qualified workers where livestock other than sheep are used.
2.03 The Contractor's people involved in the grazing project must be familiar with the basic identification of large carnivores and avoidance methods.
2.04 The Contractor's project supervisor must have at least one seasons experience in the use of the specified livestock for managing forest vegetation, and must be familiar with the constraints and requirements of the applicable permit(s), BCMAFF (Animal Health Branch), and the British Columbia Inter-Ministry Guidelines for the Use of Domestic Sheep in Vegetation Management (where sheep are used).
2.05 The Ministry Officer may require the Contractor to demonstrate that their employees and agents are adequately equipped and trained to take remedial action in the event of predator/livestock interaction or matters relating to the health of the livestock and shepherd/guardian animals.

PART 3: MATERIALS AND EQUIPMENT

Corral Placement:

3.01 The Province and Contractor shall mutually agree on the location for the placement of corrals (holding pens).
3.02 The construction (and upkeep) of the holding pens is the responsibility of the Contractor.
3.03 Corrals must be constructed/set up prior to the arrival of the livestock at the work area.
3.04 The corrals must have satellite pens for holding sick and injured livestock, or shepherd/guardian animals.

Feed for Livestock:

3.05 Sufficient feed must be available at the corrals (holding pens) prior to arrival of the livestock at the work area.
3.06 The livestock and shepherd/guardian animals must be fully fed while in holding pens before being let out on the treatment site.
3.07 Supplementary feed must be available at all times during the project in case of need.

Safety Equipment:

3.08 The Contractor shall, at his/her own expense, provide the necessary safety clothes and equipment, including first aid kit(s), for all employees and agents employed for this Contract.

Communication Equipment:

3.09 The Contractor shall supply all of the equipment necessary to establish suitable on-site and off-site communications. The Contractor shall be responsible for maintaining on-site and off-site radio communication throughout the duration of the Contract. Off-site communication with people shall include the Ministry Officer, local Conservation Officer (MOELP), and others as discussed at the Pre-Work Conference.

Public Information Signs:

3.10 The Contractor shall, where directed by the Province, post the Public Information Signs (provided by the Province), at the Treatment Unit(s) and along public access routes.

PART4: LIVESTOCK AND SHEPHERD/GUARDIAN ANIMALS

Transport, Handling and Storage:

4.01 The Contractor is responsible for the safe and secure transport of their livestock and shepherd/guardian animals and shall act in accordance with all of the applicable federal and provincial statutes and regulations. The Contractor must comply with the regulations/guidelines set by Agriculture Canada, Animal Health Directorate.
4.02 Movement of livestock and shepherd/guardian animals to the work area shall be only on "non-productive" ground such as a road, or a powerline right-of-way.
4.03 The Contractor shall confine the livestock in secured holding pens immediately on arrival at the work area and care for them in accordance with the MOAFF Health Protocol.

Control of Livestock and Shepherd/Guardian Animals:

4.04 The Contractor shall be responsible for the control and management of their livestock and shepherd/guardian animals during transportation and while on the work site. Where sheep are used, they should not be left unattended.

Number and Types of Animals:

4.05 The quantities and types of livestock and shepherd/guardian animals to be used in the Treatment Unit(s) shall be as stated in Schedule B attached hereto. Any changes in the number and types of livestock and shepherd/guardian animals must be authorized in writing to the Ministry Officer prior to use on the treatment block.

Ewes Lambing:

4.06 Where sheep are used, lambing is not acceptable on the work area.

PART 5: STANDARDS OF PERFORMANCE AND WORK PROGRESS

Livestock Grazing on Treatment Units

5.01 Where sheep are used for the brushing project, the Contractor shall conform to the standards set out in the Interministry Agreement for the Use of Domestic Sheep in Vegetation Management.

Work Plan Map:

5.02 The Province shall provide the Contractor with the applicable operational photographs and maps of the Treatment Unit(s) and Treatment Type(s). The treatment boundaries shall be clearly marked.

Work Performed:

5.03 All Work shall be performed in accordance with the appropriate standards, procedures and limitations that are stipulated in the Schedules attached hereto, and in the Work Progress Plan.

5.04 The species of vegetation to be brushed and the species of crop trees to be released shall be specified in Schedule B attached hereto. The crop species specified shall not be damaged.

5.05 Damaged crop trees shall be defined as: crop trees

(a) with the terminal leaders browsed;
(b) with 50% of the lateral leaders browsed;
(c) which are bent or broken;
(d) which are scarred (greater than one-third [1/3] of the stem circumference damaged);
(e) which are uprooted.

5.06 Crop tree damage over 5% may be subject to a reduction in payment. See Schedule C for amount of payment reduction. The project may be cancelled if crop tree damage exceeds 10%. The Contractor must constantly monitor the condition of conifer seedlings in each grazing unit and move the flock if necessary to prevent unacceptable animal trampling or browse damage. If the Contractor uses a horse, seedling damage caused by the horse will be assessed the same as sheep damage.

Continuity of Work:

5.07 The actual date that the Work may start is dependent upon the weather and/or plan development. Once commenced, Work shall be continuous except as provided for in paragraph 5.08.

5.08 Notwithstanding the suspension of Work provisions contained in the FS 700 form attached hereto, the Province may, at its discretion, direct the Contractor to suspend Work for either a specified or an indefinite period, in accordance with the provisions of paragraphs 5.09 and 5.10, where the Ministry Officer determines that the weather or other conditions are unsuitable.

5.09 If the Province, having suspended Work pursuant to the paragraph 5.08, does not permit Work to resume within five (5) Work Days, the Contractor may, by giving written notice to the Province, terminate this Contract without penalty. There shall be no claim by either party for compensation of any kind arising out of the suspension of operations. Payment shall be made for areas satisfactorily treated prior to the suspension of Work.

5.10 Notwithstanding paragraph 5.09, where Work is suspended by the Province pursuant to paragraph 5.08

and the Contract is not terminated by the Contractor after five (5) Work Days pursuant to paragraph 5.09, the Contractor is eligible to be compensated by the Province from the beginning of the sixth Work Day of the suspension to the date of either the recommencement of Work or the termination of the Contract, at a rate mutually agreed-upon by the parties hereto or as specified in Schedule C attached hereto.

Work Progress Plan Development:

5.11 Further to the Pre-Work Conference requirements of the Contract (FS 700), the Contractor and the Ministry Officer shall inspect the Treatment Unit(s) and shall review all requirements and conditions pertaining to this Contract. The Work Progress Plan will be developed by the Contractor and approved by the Province. The Work Progress Plan shall include:

a) radio frequencies to be used for communication;
b) the number and types of livestock and shepherd/guardian animals;
c) a contingency plan in the event of an accident;
d) a schedule of grazing on the Treatment Units as listed in Schedule B;
e) the human resources to be utilized to complete this Contract; and
f) other scheduling requirements and conditions as deemed necessary by the Ministry Officer.

5.12 The Work Progress Plan shall be subject to modification by mutual consent when required by development of unforeseen conditions beyond the Contractor's control, such as weather, fire conditions, etc.

Progressive Treatment:

5.13 Unless otherwise authorized in writing by the Ministry Officer, the Contractor shall complete the Treatment Units in the Order set out in the Work Progress Plan.

5.14 Unless otherwise authorized in writing by the Ministry Officer, each Treatment Unit must be completed to the satisfaction of the Ministry Officer before the Contractor may commence Work on the next Treatment Unit.

Site Degradation Not Tolerated:

5.15 The Contractor shall not cause by any means, whether directly or indirectly, the potential productivity of the Treatment Unit(s) to be degraded to an unacceptable level.

5.16 The Ministry Officer shall determine the levels and/or kinds of site disturbances which will be acceptable for each Treatment Unit and Treatment Type, and may stipulate these limits in Schedule B or C attached hereto, or in the Work Progress Plan.

First Incidence of Site Degradation:

5.17 Where the Ministry Officer determines that the Contractor has caused, by any means whether directly or indirectly, any unacceptable levels and/or kinds of site disturbances, as stipulated in Schedule B or C attached hereto, or in the Work Progress Plan, the Ministry Officer may make an assessment of five hundred dollars ($500.00) for each Treatment Unit in which an infraction occurred, and the Province may notify the Contractor that he/she must rehabilitate the specified site(s) to an acceptable level at his/her own expense.

5.18 Should a notice be given by the Ministry Officer under paragraph 5.15, the notice shall specify a deadline by which time the Contractor must have rehabilitated the site(s) to an acceptable level as determined by the Ministry Officer.

5.19 Should the Contractor, upon being given a notice by the Province, fail to rehabilitate the site(s) to an acceptable level, no payment will be made for those Treatment Unit(s) containing site(s) which remain below the acceptable level(s).

Further Incidences of Site Degradation:

5.20 Should the Ministry Officer determine that the Contractor has caused, by any means whether directly

or indirectly, a further incidence of unacceptable levels and /or kinds of site disturbances, the Province may, at its sole discretion and without further warning to the Contractor:

- notwithstanding paragraph 5.15, make an additional assessment of five hundred dollars ($500.00);
- issue a notice pursuant to paragraph 5.15; and
- terminate the contract forthwith.

Detailed Standards:

5.21 In addition to the conditions specified in this Schedule, the Contractor shall comply with the standards of performance (if any) by Treatment Type and Treatment Unit stipulated in Schedules B and C attached hereto, and in the Work Progress Plan.

5.22 The Contractor must have on site at all times:

a) a copy of this Contract package;
b) safety equipment including Workmens' Compensation Board approved First Aid Kits;
c) a copy of the required permit(s); and
d) a copy of the Guidelines for the Use of Domestic Sheep for Vegetation Management in British Columbia (where sheep are used).

Conditions Regarding Lakes, Streams and Buffer Strips:

5.23 The Ministry Officer may make an assessment of five hundred dollars ($500.00) for any infraction by the Contractor of the provisions of this paragraph or, after written warning, for any other infraction which the Ministry Officer determines to be detrimental to the Contract or to the quality of the environment:

(a) No Work may take place in streams, streambeds, buffer strips or other areas indicated on the Work Plan Map. A five-metre buffer strip shall bemaintained along water courses by controlling livestock movements onthe block through grazing/shepherding practices.
(b) No obstruction or fill may be placed or caused to be placed within the high-water level of any lake or stream channel.
(c) At no time may any substance which may cause pollution be deposited in any lake, stream, streambed or buffer strip.

Conditions Regarding Animal Health and Escapes, and Predator Problems

5.24 The Contractor shall immediately give verbal notice to the Ministry Officer of any escapes, disease or death of sheep or predator problems. In case of predator problems, the local Ministry of Environment Conservation Officer shall also be given verbal notice immediately by the Contractor.

5.25 Livestock shall be moved or removed from the site at the order of the Ministry Officer in charge whenever the Province deems it necessary or when:

(a) there is improper management or care of livestock;
(b) the mortality of the herd is in excess of 4%;
(c) livestock weight loss is excessive;
(d) vegetation becomes unpalatable or unsuitable for grazing;
(e) predators become a problem; and
(f) excessive crop-tree damage is occurring as a result of the grazing.

5.26 Predator management shall conform to the British Columbia Wildlife Act (Section 27).

5.27 Predatory animals shall not be shot or destroyed except in self-defense. If a predatory animal is shot or destroyed, the Contract may be cancelled and livestock removed from the work area within 48 hours. The Ministry of Forests and the Ministry of Environment, Lands and Parks shall not be held liable for any losses of livestock and shepherd/guardian animals used on the project.

Conditions Regarding Movement/Bedding of Livestock on the Treatment Site:

5.28 Livestock shall be managed within the grazing site in such a manner that no seedling damage results (from fast turning of the flock etc.) and all areas of the site receive adequate grazing.

5.29 Movement of livestock and shepherd/guardian animals between a corral and the treatment units shall be only on "non-productive ground" such as a road or a powerline right-of-way.

5.30 Livestock shall not be permitted to utilize the same area for bedtime bedding more than once in order to avoid seedling damage.

5.31 Livestock shall be kept in corrals/holding pens each night. The Contractor shall check the work area each morning by walking the site and sending out the shepherd/guardian animals to be sure the site is free of predatory animals prior to the release of the livestock.

Conditions Regarding Removal of Dead or Unacceptable Animals From Site:

5.32 The Contractor is responsible for:

(a) the transporting and disposal of carcasses and placentas from the project area;

(b) removal of unhealthy or injured animals from the treatment site and,

(c) removal of ewes which happen to lamb on-site, with their lamb(s). The removal, transportation and disposal, shall be done in a manner that complies with federal and provincial regulations and the British Columbia Inter-Ministry Agreement for the Use of Domestic Sheep in Vegetation Management (where sheep are used).

5.33 Where the Contractor has left live or dead sheep unattended or has by any other means put the health or safety of sheep in jeopardy or increased the risk of predator interaction, the basic payment may be reduced by fifty dollars ($50.00) for each occurrence involving one (1) sheep or two hundred fifty dollars ($250.00) for each occurrence involving more than one sheep.

5.34 At the discretion of the Ministry Officer in charge, an autopsy by a veterinarian may be required to determine the cause of death of any sheep. The Contractor shall be responsible for all costs and the Ministry Officer shall receive a copy of the autopsy report.

PART 6: INSPECTION AND ACCEPTANCE

Inspections:

6.01 The Ministry Officer may, at any time during the Term of the Contract, inspect the Contractor's equipment, livestock, shepherd/guardian animals and employees, to determine if they comply with the standards specified herein.

6.02 The Ministry Officer will inspect each Treatment Unit, or the number of plots within the Treatment Unit as agreed to at the pre-work conference or as deemed necessary by the Ministry Officer, for the purpose of determining the quality of Work and the amount of payment due.

Determining Satisfactory Treatment:

6.03 To determine the quality of Work, the Ministry Officer shall establish inspection plots which shall be well distributed throughout the Treatment Unit (or part of the Treatment Unit) being inspected. Plot size and amount are given in Schedule C.

6.04 The Ministry Officer shall consider a plot to be satisfactory if within the plot, all target species as specified in Schedule B meet the conditions as stated in Schedule C and discussed in the pre-work conference.

6.05 To qualify for payment, at least seventy-five percent (75%) of the number of plots established in a Treatment Unit (or designated portions of a Treatment Unit)must be satisfactory. Only those satisfactory plots which contain one or more of the target species can be used in the calculation of payment.

6.06 The Ministry Officer will advise the Contractor of the results of the inspection within seven (7) working days.

Re-inspection:

6.07 Where the results of an inspection are unacceptable to the Contractor, he may, provided that he does so within three (3) Work Days of receiving the inspection results, request that the Province re-inspect the Treatment Unit(s).

6.08 Where the Contractor requests a re-inspection of the Treatment Unit(s), the Province will perform the re-inspection at a time mutually agreed to by the parties hereto, but in any event no later than ten (10) Work Days after receiving the request.

6.09 The results of the re-inspection shall be used to determine payment.

6.10 The Contractor shall pay the Province's costs of the re-inspection if the difference in Work quality between the original inspection and the re-inspection is less than ten percent (10%) of the original inspection results.

6.11 The Province shall bear its costs of the re-inspection if the difference in Work quality between the original inspection and the re-inspection is equal to or exceeds ten percent (10%) of the original inspection results.

6.12 In those instances where the Province must bear its costs of the re-inspection it shall also pay the Contractor or his/her representative, provided they are present for the entire re-inspection, the sum of one hundred and fifty dollars ($150.00) as reimbursement for time spent re-inspecting the Treatment Unit(s).

PART 7: PAYMENT

Basic Payment:

7.01 If the Work is to be performed on a rate per unit of time basis, the basic payment shall be determined by multiplying the number of hours completed on an area satisfactorily treated by an hourly rate stipulated in Schedule B attached hereto.

7.02 If the Work is to be performed on a bid price per unit area basis, the basic payment shall be determined by multiplying the area satisfactorily treated by the bid price per unit area stipulated in Schedule B attached hereto.

7.03 The basic payment shall be subject to the charges, if any, as set out in the Contract.

Restriction on Payment:

7.04 If the Ministry Officer detects, during the final inspection, that the Contractor has allowed brushing to occur on any areas that are outside of the designated Treatment Unit(s), the Contractor will be assessed by subtracting the amount of area that was treated without authorization from the area satisfactorily treated within the Treatment Unit(s). No payment reduction pursuant to this paragraph will be made if the wrongfully-treated area is less than one-tenth (1/10) of a hectare.

7.05 If the Contractor is unable or unwilling to treat any Treatment Unit(s) (or parts thereof) listed in Schedule B attached hereto which the Province considers treatable, the basic payment may be reduced by an amount equal to the product of the amount of untreated area (in hectares) multiplied by a rate of one thousand dollars ($1,000.00) per hectare. No payment reduction will be made if the untreated area is less than one-tenth (1/10) of a hectare.

7.06 The assessments provided for in paragraphs 7.04 and 7.05 shall be without prejudice to any other remedies that the Province may have, in law or in equity, as a result of the acts or omissions giving rise to the assessment.

Part Performance:

7.07 Where Work is commenced on a Treatment Unit but weather or other conditions do not allow for its completion, the Contractor shall only be paid for the Work which was satisfactorily performed.

PART 8: NON-COMPLIANCE, TERMINATION

Unacceptable Quality:

8.01 Nothwithstanding the foregoing provisions regarding the calculation of payments, whenever an inspection indicates that the Work quality is less than the applicable minimum standard for the Treatment Type(s) in the Treatment Unit, the Province shall consider the Contractor's performance to be unsatisfactory, and shall notify the Contractor accordingly.

8.02 Any notice given to the Contractor for unsatisfactory performance shall specify whether or not the Province wishes to exercise its option to require the Contractor to rework the substandard area(s) within the Treatment Unit. If the areas are to be reworked, the notice shall specify a deadline by which time the Contractor must have, at his/her own expense, improved the quality of Work within the Treatment Unit to at least the minimum acceptable standard.

8.03 Should the Contractor fail to comply with a notice from the Province that demands that the quality of the Work in the Treatment Unit be raised to an acceptable standard by a specified deadline, the Province shall make no payment for that Treatment Unit and may terminate this Contract forthwith.

8.04 If, after giving a notice under paragraph 8.01, an inspection of further Work indicates that the quality is again below the minimum acceptable standard, the Province shall make no payment for the Treatment Unit and may terminate this Contract forthwith.

Repeated Environmental Damage:

8.05 Notwithstanding any paragraph in this Contract, where the Ministry Officer determines that the conduct of the Contractor has been such that the Contractor has degraded the quality of the environment in or around the Treatment Unit(s), camp or rest area which he has occupied or worked, even after having received a written notice requiring that he refrain from such conduct, the Province may, at its sole discretion and without further warning to the Contractor, terminate this Contract forthwith.

Assessment Imposed For Non-Production or Under-Production:

8.06 The Province may, at its sole discretion, impose an assessment on the Contractor as an alternative to terminating the Contract, in those circumstances where the Ministry Officer determines that the Contractor has either failed to commence Work on the date specified or has not met the production rates, if any, as specified in the Schedules attached hereto or in the Work Progress Plan.

8.07 An assessment imposed by the Province pursuant to paragraph 8.06 may be in the form of either a fixed dollar amount or may vary as a function of the amount by which the Contractor has failed to meet specified production rates. The methods by which the assessments are to be determined shall be specified in the Schedules attached hereto or in the Work Progress Plan.

8.08 For the purposes of paragraph 8.06, no notice is required to be given by the Province to the Contractor prior to the imposing of the applicable assessments.

Schedule C

Of Vegetation Management Contract Non-Chemical Treatments Biological – Sheep

This Schedule C shall be used in conjunction with Schedules A and B. When completed by the Ministry of Forests these Schedules (A, B, and C) form integral parts of the contract when attached to the Form of Agreement.

1. General Conditions

1.1 The unit(s) shall be treated in the order specified in Schedule B. Each unit must be satisfactorily completed before work on the next unit is commenced, unless otherwise authorized in writing by the Ministry of Forests Officer.

1.2 These areas are being proposed for a one pass method which has to utilize the June 1 - August 31, 199_ time frame. The need for a second pass will be determined by the Forest Officer in charge. The second pass will consist of the areas that need regrazing in the original contract.

1.3 A grazing permit covering operation under this contract shall be obtained by the contractor. The contractor will also be responsible for paying the associated grazing fees.

1.4 A penalty of $500 a day will be imposed if the sheep have not been removed from the contract site by August 31, 199_.

1.5 Unless otherwise stated in this contract, the guidelines referred to in Schedule A, Section 1.04 must be adhered to. The Forest Officer may impose a fine not exceeding $500 for non-compliance to these guidelines.

2. Inspection and Payment

2.1 The Ministry of Forests Officer will inspect each treatment unit or parts thereof, as agreed to at the pre-work conference, for the purpose of payment due.

2.2 In determining the quality of work or satisfactory treatment, the Ministry of Forests Officer shall examine the treated unit(s) on the basis of conditions specified in this Schedule.

2.3 To qualify for payment at the proposed price, at least seventy-five (75) percent of the unit must be satisfactorily treated.

2.4 For those areas which do not meet the minimum seventy-five (75) percent acceptable standard, on the written instruction of the Ministry of Forests Officer, the contractor shall upgrade his work to the required seventy-five (75) percent minimum at his own expense if those areas are reworkable. Failure to do so will result in no payment for those areas falling below the seventy-five (75) percent standard.

2.5 The inspection procedure will consist of a survey of one plot per hectare with a minimum of twenty (20) plots. These plots will be established in a grid pattern that thoroughly covers the payment unit. The plot size will be 1.78 metre radius to assess vegetation cover and 3.99 metre radius to assess seedling damage.

The percent vegetation cover within the 1.78 metre radius plot will be recorded. The vegetation assessed will only include vegetation that the sheep are expected to graze as identified in Schedule B. Plots with greater than fifteen (15) percent cover of the target vegetation after grazing are unacceptable. A minimum of seventy-five (75) percent acceptable plots is required for the payment unit to be considered satisfactorily treated.

During the survey each seedling within the 3.99 metre radius plot will also be assessed damage resulting from sheep grazing. If seedling damage exceeds five (5) percent but is less than ten (10) percent the contractor's pay rate will be reduced by twenty-five (25) percent. When seedling damage is between ten (10) and fifteen (15) percent the contractor's pay rate will be reduced by fifty (50) percent. If seedling damage is greater than fifteen (15) percent there will be no payment.

3. The following other conditions shall apply:

3.1 Each payment unit will be grazed once with the possibility of regrazing twenty-five (25) percent of the area if needed during each summer season. Payment will be calculated after each treatment.

3.2 The grazing intensity will be kept under three hundred (300) sheep days per hectare.

3.3 Before being shipped to the site, all sheep must meet the most current "Sheep Health Protocol." (Attached - Appendix _)

3.4 The contract flock should be sheep of a flocking variety with good herding instinct. Dry ewes, yearlings or ewes with lambs older than eight weeks are best suited for plantation grazing. Lambs cannot be younger than 8 weeks or less than 23 kg.

3.5 Prior to the start of the contract, areas (i.e. suitable farms etc.) must be available for use in the event of contract cancellation.

3.6 In addition to Schedule A, Section 4.06, a penalty of $100 per lamb will be imposed if lambing occurs on the site and the lamb and ewe are not removed within 24 hours. Placenta and afterbirth are to be cleaned up and removed.

4. Additions to Camp Standards

4.1 Upon the contractor vacating any project area, camp or rest area, the Ministry of Forests Officer shall inspect the area to determine, at his sole discretion, whether or not the area was left in an acceptable condition.

4.2 Should the Ministry of Forests Officer determine that the contractor left the project area, camp or rest area in an unacceptable condition, the Ministry of Forests will repair the area and charge the entire cost of the repairs to the contractor.

4.3 Any determination of the Ministry of Forests Officer under Paragraphs 4.1 and 4.2 is final and binding on the parties hereto.

4.4 Camps should be near the sheep corrals for adequate monitoring of disturbances.

4.5 Foodstuffs are to be stored properly to avoid attracting wildlife.

5. Site Disturbance

Site disturbances pursuant to Schedule A, Section 5.16, which are NOT acceptable are as follows:

5.1 Excessive sheep travel along the same route (trails) causing excessive soil compaction and damage to seedlings.

5.2 Contamination of any watercourse in the area including road ditches.

5.3 Destruction of watercourse banks including road ditches.

5.4 Excessive muddy run-off from corral bedding areas into watercourses including road ditches.

5.5 Animal/vehicle travel through watercourses.

5.6 Excessive soil displacement caused by sheep climbing small hills composed of loose material, including slumping.

5.7 Alteration of watercourse routes resulting in erosion and/or siltation.

The above unacceptable site disturbances are subject to a $500 assessment as stated in Schedule A, Section 5.17, under site degradation.

6. Disposal of Sheep Carcass

In addition to schedule A, section 5.32 the following sections apply.

6.1 If a permitted refuse disposal site is not available, carcasses will be moved at least 10 km from the browsing site and completely burned. These remains should be buried.

6.2 Portable propane incinerators may be used to dispose of individual carcasses if they burn carcasses effectively. The burner's ability to burn carcasses effectively must be proven to any inspection

individuals or teams. The burner must be located in a suitable site (i.e. no fire hazards) for burning the remains. The remains must be buried following incineration.

7. Procedures for Predator Interactions and Dead or Missing Sheep

In addition to Schedule A, Sections 5.24 to 5.27 the following Sections apply.

7.1 All contractor staff must be familiar with the basic identification of large carnivores and avoidance methods. All predator sightings and interactions must be recorded in the daily log book. Every reasonable effort must be made to avoid conflicts with predators, however, if a wild predator kills a sheep the following procedures should be followed:

(a) The contractor's staff must report the sheep kill immediately to the MOELP representative and MOF representative. Failure to notify will result in contract cancellation.

(b) Destruction of the predator will not occur unless human life is in immediate danger. For predators other than grizzly bears, a first infraction will result in the assessment of a minimum $100 fine against the contractor, a subsequent infraction will result in contract cancellation. The killing of a grizzly bear for any reason will result in contract cancellation.

(c) Any predator killed must be reported to the Conservation Officer within 24 hours. Failure to notify is an infraction. A first infraction will result in the assessment of a minimum $100 fine against the contractor, a subsequent infraction will result in contract cancellation.

(d) Predators carcasses are the property of the Crown, disposal must be at the direction of the Ministry of Environment, Lands and Parks staff and in any case must be removed at least 10 km from the site within 24 hours.

(e) In the event of a confirmed sheep kill by a grizzly bear, the flock must immediately vacate to an alternative site which is acceptable to the Ministry of Environment, Lands and Parks representative. Failure to remove the flock will result in contract cancellation.

(f) Attack by a grizzly on a human resulting in injury or death of the human will result in the cancellation of the contract.

(g) If firearms are on site, all necessary licences for carrying and using firearms must be available on site for inspection at any time. The first infraction will result in the assessment of a minimum $100 fine against the contractor and any subsequent infraction will result in contract cancellation.

7.2 Any serious predator interactions are to be reported to the MOELP representative and the Forest Officer and a detailed report completed in the logbook. Examples of serious interactions could include disruption of camp, necessity of firing a warning shot to scare away a predator, or any aggressive action by a predator.

7.3 In order to minimize the potential for predator interactions, food garbage must be removed from the site daily to the nearest permitted Regional District refuse disposal site. If daily removal is not practical then the garbage must be stored in a bear-proof container and removed to a permitted refuse site every 3 days.

8. Corrals and Bedding Areas

In addition to Schedule A, Section 3.01 to 3.04, the following Sections apply.

8.1 Corrals will be designed and qualified to provide effective service with low maintenance. They should have the following:

(a) be highly portable and easy to set up or take down quickly.

(b) require few posts to be driven and be manageable by two persons.

(c) stand up to hard use and require minimal repairs.

(d) include counting and drafting areas with isolation pens for sick or injured animals.

8.2 To reduce soil compaction, corral areas should be confined to vehicle-accessible roadways, land-

ing areas or non-productive ground as much as possible. They should be moved regularly and more often in wet conditions.

8.3 Areas with good drainage and shade are preferred corral areas.

8.4 Livestock shall not be permitted to utilize the same area for daytime bedding more than once in order to avoid seedling damage.

9. Guardian and Herding Dogs

In addition to Schedule A Section 4.05 the following Sections apply:

9.1 Each shepherd requires a minimum of one qualified herding dog with proven working ability. There must be at least one healthy qualified herding dog on site to act as a substitute.

9.2 Guardian dogs are at the option of the contractor.

10. Shepherd Requirements

In addition to Schedule A, Section 2.02 the following Sections apply.

10.1 For a flock of a 1000 sheep or less a minimum of two shepherds are required and for flocks between 1000 and 1500 sheep, 3 shepherds will be required.

10.2 When the sheep are corralled, a minimum of one shepherd can be off site for up to 4 hours. During this absence, the remaining person and dogs must remain with the flock.

10.3 In addition to Schedule A, Section 2.04, at least one shepherd with at least one season's experience grazing sheep in a forest setting must be present on the site at all times.

11. Dead, Missing or Injured Sheep

11.1 A sheep count will be conducted every 3 days at minimum or more frequently as required by the Forest Officer. If a sheep is missing then the following procedures must be followed:

(a) A search for the sheep will immediately be conducted and will be continued until darkness limits the effectiveness of the search or the sheep are found.

(b) If the sheep are not found, the sheep in the corral will be recounted in the morning. If the sheep are still missing then the Ministry of Forests Forest Officer and the Ministry of Environment, Lands & Parks, Williams Lake Office will be immediately notified. A message left with the answering service is adequate.

(c) The missing sheep will be recorded in the notebook along with the time of notification of MOELP and the Forest Officer and the person contacted. Failure to notify the MOELP or MOF will result in contract cancellation on the third offence.

(d) An intensive search for the sheep will be conducted, the areas searched and time spent searching will be recorded in the notebook and the Ministry of Forests and MOELP will be notified again within 24 hours regarding the search results.

(e) If a dead sheep is found then the MOELP representative and the Forest Officer will be notified immediately. If MOELP is not immediately available, then the sheep carcass must be destroyed within 24 hours as per Section 6. Failure to notify the MOELP or MOF and or remove the sheep carcass within 24 hours will result in contract cancellation.

(f) If possible the contractor will identify the cause of death, this cause of death along with the time and location will be recorded in the logbook as per Section 13.1.

11.2 Sick, injured or dead animals should be isolated and examined by the contract veterinarian on the site or after removal from the site as per the MOAFF HEALTH PROTOCOL. MOELP staff, the Forest Officer and the veterinarian shall be notified of any disease outbreaks within 48 hours.

11.3 Necropsies should be performed on dead sheep to distinguish death from disease or death from predation.

12. Water Sources

In addition to Schedule A, Section 5.23 the following Sections apply.

12.1 Since sheep drink lots of water, every effort must be taken by the contractor to protect existing water sources from contamination, therefore, direct access to streams and the use of stream sides for grazing is to be avoided unless authorized by the MOELP. The first incidence will result in a fine to be determined by the forest officer, a second will result in contract cancellation.

12.2 Contractors should develop ponds, haul or pipe water to tanks and troughs from natural sources to create their own water sources.

12.3 Contractors must obtain temporary water permits/rights if they need to interfere with natural water sources.

13. Communications and Logbooks

13.1 In addition to Schedule A, Section 1.23 the following information will be recorded:

a) daily sheep movements;
b) frequent (daily/weekly) tally of sheep totals; and
c) problems encountered must include all those listed in Schedule A, Section 1.23 (f) as well as:
   i) all predator scats/tracks
   ii) all interactions between predators and sheep/staff
   iii) record of sheep losses including sheep identification and reasons for loss.

13.2 The logbook report/summary must be submitted monthly as well as yearly at the end of the grazing season as stated in Section 1.23 of Schedule A to the Ministry Officer in charge. This will subsequently be forwarded to the MOELP and MOAFF staff. If at anytime the logbook is not up to date or not available the contractor will be issued a notice to comply and/or a fine of $ 200, the third case of non-compliance will result in cancellation of the contract.

13.3 In addition to Schedule A Section 3.09, the off site communication contacts will also include:

a) Wildlife Biologist / Technician, Habitat Biologist / Technician,
b) Contract Veterinarian, and
c) an off site contact for messages.

14. Assessments

14.1 The following Sections describe infractions that will result in fines to the contractor: (descriptions are a guide only and do not limit the clauses listed)

Sections in Schedule A

5.17 Unacceptable levels of kinds of site disturbances, first infraction
5.20 Unacceptable levels of kinds of site disturbances, second and subsequent infractions
5.23 Unacceptable activities regarding waterbodies

Sections in Schedule C

1.4 Removal of sheep
1.5 Non-compliance to Interministerial Guidelines
3.6 Lambing
7.1(b) Destruction of predator - first infraction
7.1(c) Reporting of killing of predator - first infraction
7.1(g) Licences for firearms available on site - first infraction
13.2 Logbook not up to date or not available on site - first and second infraction

14.2 The following Sections describe infractions that will result in contract cancellation: (descriptions are a guide only and do not limit the clauses listed)

Sections in Schedule A

1.07 Livestock or dogs not suitable

1.08 Equipment, or livestock not approved for use
1.09 Health of livestock does not meet standards
8.05 Repeated environmental damage

Sections in Schedule C

7.1(a) Failure to notify of sheep kill
7.1(b) Destruction of predator - second infraction, grizzly bear - first infraction
7.1(c) Reporting of predator kills - second infraction
7.1(e) Failure to move flock if sheep killed
7.1(f) Any attack by grizzly bear on human with injury or death
7.1(g) Licences for firearms available on site - second infraction
11.1(c) Recording of missing sheep in log - third offence
11.1(e) Failure to notify dead sheep / failure to remove carcass
12.1 Direct use of watercourse - second infraction
13.2 Logbook not up to date and available - third infraction

14.3 If not otherwise specified, three infractions of any of the above Sections of the contract will result in contract cancellation.

Bancroft, B. 1991. Sheep browsing for vegetation control: an operational trial, Sable Creek, B.C. First year report. Madrone Consultants Ltd., Victoria, B.C. Unpubl. rep. 19 p.

———. 1992a. Sheep browsing as a silvicultural vegetation control method: an operational trial, Sable Creek, B.C. Second year report. Madrone Consultants Ltd., Victoria, B.C. Unpubl. rep. 22 p.

———. 1992b. Sheep browsing for vegetation control: an operational trial, Sumas Mountain. Establishment information and Second year results. Madrone Consultants Ltd., Victoria, B.C. Unpubl. rep. 39 p.

Bonnor, G.M. 1978. A guide to Canadian forest inventory terminology and usage. 2nd ed. Environ. Can., Can For. Serv., Ottawa, Ont. 57 p.

Campbell, J.R. and J.F. Lasley. 1969. The science of animals that serve mankind. McGraw Hill Book Co., New York, N.Y. 771 p.

Comeau, P.G. 1993. Competition indices and decision making. *In* The socio-economic realities of brushing and weeding. Proceedings: Northern Interior Vegetation Management Association annual general meeting, January 20–21, 1993, Smithers, B.C. C. Farnden (editor). pp. 5–10.

Conard, S. 1984. Forest vegetation management in British Columbia: Problem Analysis. B.C. Min. For. Victoria, B.C. Res. Rep. RR84001-HQ 119 p.

Dewar, P. and R. Greene. 1992. Suggested silviculture guidelines for the silvicultural use of sheep. B.C. Min. For., Prince George Region. Unpubl. rep.

Ellen, G. 1988. Clearwater agroforestry trials 1985–1988. B.C. Min. For., Clearwater, B.C. Unpubl. rep. 94 p.

Ensminger, M.E. 1970. Sheep and wool science. Interstate Printers and Publishers Inc., Dansville, Ill. 948 p.

Erickson, W. 1992. Companion sheep grazing trial, Lawson Site (SX89708R), Prince Rupert Forest Region, B.C. Min. For., Victoria, B.C. Unpubl. rep. 43 p.

Farnden, C. 1992. Cost and efficiency variation of forest vegetation management treatments in B.C. B.C. Environ. Pesticide Manage. Program. Victoria, B.C. Unpubl. rep. 31 p.

Green, M.B. 1992. Progress report for 1992 sheep grazing site investigations. B.C. Min. Environ., Lands and Parks, Integrated Manage. Br. and Wild. Br., Victoria, B.C. 14 p.

Halloin, L. 1989. Guidelines, sheep grazing for vegetation control in plantations. Wash. Dep. of Nat. Resour., For. Land Manage. Div., Ellensburg, Wash. 16 p.

Hays, W.J. 1992. Experimental design protocol for monitoring operational sheep browsing trials. Draft. B.C. Min. For., For. Sci., Prince George Forest Region. Unpubl. rep. 12 p.

Heath, M.E., D.S. Metcalfe, and R.F. Barnes. 1973. Forages. 3rd ed. Iowa State Univ. Press, Ames, Iowa. 755 p.

Herring, L. and J. Pollack. 1985. Experimental design protocal for forest vegetation management research: level B trials. First approx. B.C. Min. For. Victoria, B.C. Res. Rep. RR84013-HQ.

Holecheck, J.L., R.D. Peiper, and C.H. Herbel. 1989. Range management principles and practices. Prentice-Hall, Englewood Cliffs, N.J. 501 p.

Hutchinson, D.E. 1976. Resource conservation glossary. Soil Cons. Soc. Amer. Ankeny, Iowa. 63 p.

Jaindl, R.G. and S.H. Sharrow. 1988. Oak/Douglas fir/sheep: a three crop silvopastoral system. J. Agrofor. Systems 6(2): pp. 147–152.

Kothmann, M.M. 1974. A glossary of terms used in range management. 2nd ed. Soc. Range Manage., Denver, Colo. 36 p.

Lousier, J.D. 1990. Using sheep to control competing vegetation on Vancouver Island, impacts on seedlings, competing vegetation and water quality: Glenora Creek, Duncan Forest District, first year report. W.F.S. Enterprises Ltd., Nanaimo, B.C. Unpubl. rep. 19 p.

Lousier, J.D. and M. Lousier. 1991. Using sheep to control competing vegetation on Vancouver Island, impacts on seedlings, competing vegetation and water quality: Glenora Creek, Stocking Creek, and Banon East, Duncan Forest District. W.F.S. Enterprises Ltd., Nanaimo, B.C., Unpubl. rep. 22 p.

McLean A. and H.H. Nicholson. 1958. Stock poisoning plants of the British Columbia ranges. Can. Dep. Agric. Ottawa, Ont. Pub. No. 1837. 31 p.

Moore, T. 1987. Boss Mountain sheep grazing project, 1987 report on sheep performance. Min. Agric., Kamloops, B.C., Unpubl. rep. 5 p.

Negrave R. 1992. Sheep grazing as a silvicultural tool for Calamagrostis control in the BWBS. Establishment report. B.C. Min. For., Fort St. John, B.C. Unpubl. rep. 15p.

Newsome, T. 1993. The use of sheep in forest vegetation management. Paper presented at the Integrated Forest Vegetation Management: Options and Applications Conf., Nov. 29-30, 1993, Richmond, B.C.

Newton, M. and P.G. Comeau. 1990. Control of competing vegetation. *In* Regenerating British Columbia's forests. D.P Lavender, R. Parish, C.M. Johnson, G. Montgomery, A. Vyse, R.A. Willis, and D. Winston (editors). Univ. B.C. Press, Vancouver, B.C. pp. 256–265.

O'Brien, J. and A. Bailey. 1987. Sheep grazing for vegetation control in coniferous plantations: Calling Lake area. Alta. For., Lands and Wildlife, Alta. For. Ser., Edmonton, Alta. 81 p.

Schwantje, H.M. 1992. Interim guidelines for the use of domestic sheep for vegetation management in B.C. Prepared for the B.C. sheep/vegetation management guidelines committee. B.C Min. For., Min. Environ., Lands and Parks, and Min. Agric., Fish. and Food, Victoria, B.C. Unpubl. rep. 12 p.

Sharrow, S.H., D.H. Carlson, W.H. Emmingham, and D.P. Lavender. 1992. Direct impacts of sheep upon Douglas-fir trees in two agrosilvopastoral systems. Agrofor. Systems 19:223–232.

Sharrow, S.H. and W.C. Leininger. 1983. Forage preferences of herded sheep as related to brush control and seasonal browsing damage to Douglas-fir regeneration. Final Report 1980–1983. U.S. Dep. Agric. For. Serv., Alsea Ranger Dis. Siuslaw Nat. Forest, Oreg. 187 p.

Sharrow, S.H., W.C. Leininger, and B. Rhodes. 1989. Sheep grazing as a silvicultural tool to suppress brush. J. Range Manage. 42(1): 2–4.

Simard S.W. 1993. PROBE: Protocol for operational brushing evaluations. B.C. Min. For., Res. Br., Victoria B.C. Land Manage. Rep. 86.

Sutherland, C. 1987. Experimental sheep grazing in the Cariboo Forest Region of British Columbia. B.C. Min. For., Williams Lake, B.C. Unpubl. rep. 25 p.

Sutherland, C., T. Newsome, N. Daintith, and J. Perry. 1992. Sheep grazing: a biological tool for controlling competing vegetation in spruce plantations. *In* Biocontrol of forest weeds: proceedings of a workshop held at the western international forest disease conference, Vernon, B.C., C.E. Dorworth and S.G. Glover (editors). For. Can., Pac. For. Cent., Victoria, B.C. p. 21–29.

Tweedhope, D.J. 1985. Report on the sheep grazing projects at Hendrix Lake, 100 Mile House Forest District, Cariboo Forest Region. B.C. Min. For., 100 Mile House, B.C. Unpubl. rep. 9 p.

Vallentine, J.F. 1974. Range development and improvements. Brigham Young Univ. Press, Provo, Utah. 516 p.

Watts, S.B. 1983. Forestry handbook for British Columbia. 4th ed. For. Undergrad. Soc., Univ. B.C., Vancouver, B.C. 611 p.