Coniferous And Desiduous Volume Estimates With Proposed Requirements For The Harvest Of White Spruce Sawtimber In The Forestry In The Liard

Type of Study: Resource Management

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Author: Diand

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J.G. Gilmour, Staff Forester
Forest Resources,
Department of Indian and Northern Affairs,
Fort Smith, N.W.T.
August 1982.

Summary

The Lower Liard Timber District occupies an area of 2 173742 ha, of which 1 770481 ha are classed as stocked productive forest land. The land area occupied by stands containing merchantable sized timber is 215 606 ha; the remaining 1 554 875 ha is immature stock (stands having a mean height of less than 15 m).

A survey area (706 563 ha) containing the bulk of white spruce sawtimber was established within the productive land base. The removal of stands that are unsuitable for harvest operations because of isolation or environmental concerns as weli as immature areas and pure hardwood stands, from the survey area, resuits in a harvest area of 73 099 ha of accessible stands containing white spruce sawtimber.

The reliable minimum estimate of white spruce sawtimber on the harvest area, calculated to a utilization level of 25.4 cm dbh, .3 m stump and 15.0 cm top dib. is 10 519 000 m^3. The corresponding white spruce pulpwood volume using utilization limits of 15.0 cm dbh., .3 m stump and 8.0 cm top dib is 16078000 m].

The accessible hardwood voiume within the harvest zone, to pulpwood utilization standards totals 24 739 000 m], of which 21 644000 m^3 is aspen. and poplar. Birch pulpwood voiume is 3 095 000 m^3, but this is accumulated on very smail diameters and may be overestimated.

Management of this area on a 120 year rotation resuits in an annual cut of white spruce sawtimber of 87 600 m^3 over an area of 609 ha. Because of the extremeiy large proportion of mature and overmature timber stands in this area, an initial annual cut could be set as high as 100000 m^3.

Hectares	Acres	Sq Miles
1,770,481	4.3 MM	6,800
73,099	180,000	282
609	1,500	2.4

Recommendations -

1. The harvest zone as proposed in this report should not be arbitrarily expanded to inciude areas from the mostly immature and physiographically different forest that exists on the large remaining portion of the Liard Timber District. The annual cut of white spruce sawtimber should not exceed 100 000 cubic meters until definitive information on the productivity and species content of the immature forest is available.
2. The calculated annual cutover area of approximately 609 hectares may be divided, for operational reasons, between two or more harvest blocks. In addition, a policy of balancing the annual cut between low and high volume timber stands should be a basic requirement of the harvest which may mean that yearly logging operations will not always be concentrated in any one harvest block.
3. Initial cutting should commence in the older stands on the southern harvest blocks (morainal uplands). The younger mixedwood stands on map sheets 25N, 32N, 32S, 33N, and 33S should not be cut until late in the first rotation. This will allow time for the conversion of these mixedwood stands to stands of greater softwood content and a resultant increase in the size and volume of spruce sawtimber.
4. Silvicultural trials, in a proposed local development area, are required much in advance of any large scale harvest operation in the Liard unit. To this end, funding and planning to initiate a silvicultural program in the N.W.T. is an immediate need.
5. Cost studies must precede any final decision to develop the timber resource of the Liard valley. The goal of logging and milling should be the complete utilization of spruce and as much of the hardwood component as possible. To assist the latter goal, a serious study to incorporate a wood gasification plant as an integral part of the development in the Liard is recommended.
6. Cooperation between the forest management and game "authorities in the N.W.T. is required to optimize the economics of harvest operations with the maintainance of wildlife populations. Silvicuitural and wildlife requirements must be an integral part of any pre-harvest survey for cut-block layouts.
7. The establishment of a variety of small independent enterprises by native northerners, doing contract work for the major developer in the Liard, should be pursued by the Economic Development Branch of the Territorial Government. Avenues for such contracts exist in site

preparation and reforestation, logging supplies, machine maintainance and independent logging contractors.

Coniferous and Deciduous Volume Estimates

with

Proposed Requirements for the Harvest of White Spruce Sawtimber

in

The Lower Liard Timber District, N.W.T.

Department of Indian and Northern Affairs

Forest Resources

Fort Smith, N.W.T.

August 1982

1. COMMUNITY PROFILE OF FORT LIARD

Archaeological evidence suggests that the Dene have inhabited the Liard valley for at least the past 13000 years. These nomadic hunters were the ancestors of the present day Slavey Indians who now reside in the valley.

One of the first settlements in the area, Fort Liard was established prior to 1807 by the Northwest Company. The plentiful beaver in the area became the basis of economic activity. Few opportunities for wage employment were available until very recently, thus, trapping remained the mainstay of the economy into the 1970's. However, with increased development during the seventies, wage employment has become more prevalent.

Resource development to date has focused on the exploitation of non-renewable resources. There are two producing gasfields in the area: Amoco Pointed Mountain is located approximately 12 air miles to the west of Fort Liard, Columbia Gas development is situated approximately 25 air miles to the southwest. A silver-lead-zinc mine operated by Cadillac Mines has recently been developed on the border of Nahanni National Park, approximately 150 air miles northwest of Fort Liard. The Liard Highway, due to open in early 1983, will connect the Alaska and Mackenzie Highways and encourage further development of both renewable and non-renewable resources.

Local government in the community of Fort Liard is directed by the' Liard Band Council, the only established political body. A locally owned and operated business, Beaver Enterprises Ltd., now provides much of the wage employment available. The Liard Band, whose members also include the Dene of Trout Lake and Nahanni Butte, is in the process of establishing a Liard Valley Development Corporation to ensure that Band members continue to receive economic benefit from expanding resource development.

Fort Liard today has a population of approximately 400 people, with a median age of 21 years. Although the economy is becoming one of wage employment, the majority of' the Dene still rely to a great extent *on* the land for food and housing.

II. THE FOREST ENVIRONMENT

Area

The Liard Timber District (Forest Management Unit: FMU) lies within the Fort Simpson Administrative District of the Department of Indian and Northern Affairs. It encompasses the Liard River watershed from latitude 60°N to approximately the mouth of the Poplar River at 610 17'N, and east from the Yukon-N .W.T. boundary to approximately longitude 12 1'30'W for an area of some 21 737 km:.

Forest Communities

Rowe (22) has subdivided this portion of the vast Canadian Boreal Forest Region into three subdivisions or Forest Sections based on distinctive patterns of vegetation and physiography (see following map "Lower Liard River Boreal Forest Sections").

The Upper Mackenzie Section (B.23a), which covers most of the area of interest in this report, is described as including "a large part of the riverine forest of the Mackenzie drainage, and because in the north, the valley flood-plain environment is much more favorable for tree growth than that of the uplands, it coincides with some of the best timber. producing land in the northwest.

"White spruce[1] and balsam poplar form the main cover types on alluvial flats bordering the rivers.

"Excellent merchantable stands of white spruce grow along the flood plains of the Liard River .('

The Liard valley exhibits the most productive white spruce sites found in this section of the Northwest Territories. The Slave River drainage, a part of the B.23a section, is with few exceptions generally less productive for white spruce than the Liard River.

The Upper Liard Section (6.24), east of the Liard River supports forest on more level landforms above the river courses and contains stands of black spruce, white spruce, lodgepole pine, jack pine and trembling aspen. Black spruce and tamarack occur in low lying areas.

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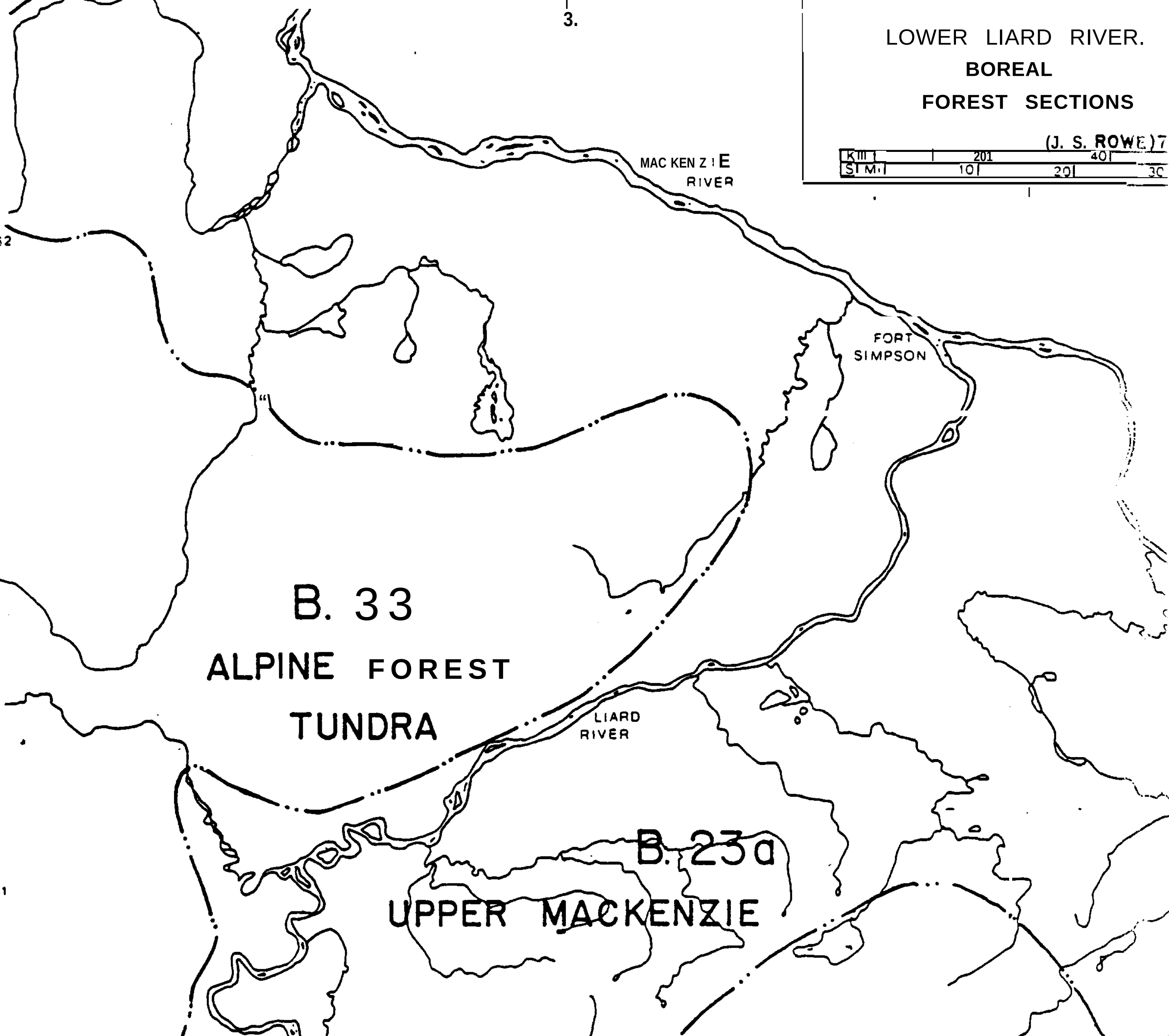
[1]A list of scientific names is appended.


LOWER LIARD RIVER.
BOREAL
FOREST SECTIONS
(J. S. ROWE)
MACKENZIE
RIVER
FORT
SIMPSON
B. 33
ALPINE FOREST
TUNDRA
LIARD
RIVER
B. 23a
UPPER MACKENZIE
FORT
LIARD
B. 24
UPPER LIARD

Productivity in-this area of the 8.24 drops off markedly because of impeded drainage and the distance from the more favorable river valley environment.

The third section is identified as Alpine Forest-Tundra (S.33). The characteristic vegetation in this section result from an aptitudinal transition from the lowland forests bordering and east of the Liard River, to the higher elevations of the Liard and Kotaneelee Ranges west of the Liard River. Vegetation consists of open stands of stunted white spruce alternating with patches of grassy or shrubby vegetation with frequent rocky exposures. Tree line is reached at about 3500 to 3800 feet above sea level (ASL). Subalpine fir is usual at the treeiine transition. Photo 1, page 14,illustrates the alpine vegetation on Flett Mountain (3 400' ASL).

The broad based vegetative description of the B.23a section as given by Rowe has been localized in the excellent report of Rostad, White and Acton [1] (21) whose task was to evaluate the soils and land types of the Liard-Mackenzie River area.

Their interpretation of previous work in this area by Jeffery (18) and the Forest Management Institute (3) in describing the forest types of the Liard Valley, provides a substantive and important means of communicating ideas between managers and users of this forest resource. The communication and study of techniques regarding harvesting, the regeneration of cutovers, wildlife and environmental concerns requires a common ecological base, however simple.

This simplified base essentially consists of four environments:

1. Forest and other vegetation on Recent Floodplains
   (Alluvial Deposition)
2. Forest and other vegetation on Abandoned Floodplains
   (Alluvial Deposition)
3. Upland Forest (on Lacustrine, Morainal, and Deltaic Sand Plains)
4. Bog Forest and Fen Vegetation on Organic Soils

Phvsiographic Districts as outlined by Rostad, and illustrated by the sketch map on the following page, tie directly to the above classification. These "districts" (landforms) are: (1) Alluvial Floodplains, (2) Lacustrine Benchland, (3) Deltaic Sands, (4) Morainal Uplands. They represent the depositional history of the area.

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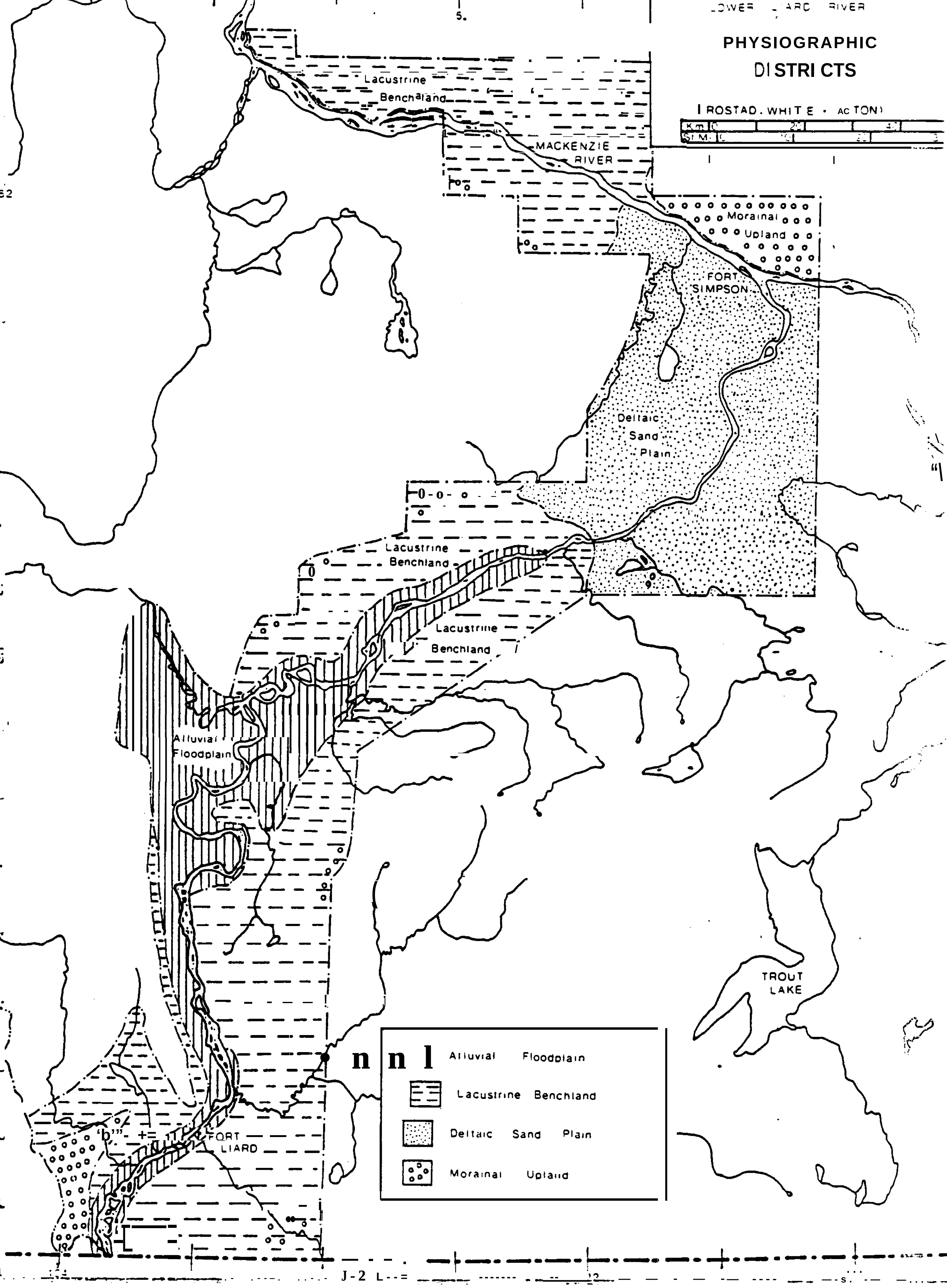
[1]Much of the material presented from this point to the end of the section, "Forest Soils of the Liard" is generalized from this publication. Further reference is made by use of the principal author only.



PHYSIOGRAPHIC DISTRICTS
ROSTAD, WHITE · ACTON
Lacustrine Benchland
MACKENZIE RIVER
Morainal Upland
FORT SIMPSON
Deltaic Sand Plain
Lacustrine Benchland
Lacustrine Benchland
Alluvial Floodplain
TROUT LAKE
FORT LIARD
Alluvial Floodplain
Lacustrine Benchland
Deltaic Sand Plain
Morainal Upland

The Alluvial Floodplains are of recent and current origin (photo 2, page 14), while the latter three result from the last period of glaciation. Comments on the vegetative groupings found on the four landforms follow:

Recent Floodplain Vegetation

Vegetation. on recent floodplains which occur within 12 meters of the present river level, can be observed as developing in successional stages from willow shrub species, the first to colonize new alluvium, to a later association with alder and balsam poplar (given a continued soil buildup). On the older (higher) surfaces within the flooding zone, mature stands of balsam poplar can be encountered, often with an understory of white spruce.

Since white spruce is a shade tolerant species it can establish under broadleaf vegetation. It often invades poplar riverine borders from a distant seed source, provided flooding with alluvial deposition is infrequent. Spruce, once established, can maintain itself by the production of adventitious (stem) roots, despite depostion from flooding.

The soil survey report indicates four distinctive types present on the Recent Floodplains.

1. Riparian Shrub - consisting of a dense layer of alder and willow with a balsam poplar-shrub mixture in later stages. These areas are subject to regular flooding.
2. Balsam Poplar Forest - consisting of tall balsam poplar, frequently overmature, often with a white spruce understory of varied density.
3. White Spruce Forest - consisting of tall mature and overmature spruce. The soil report separates this class into two units: the first , a late stage of natural succession on alluvial material where white spruce is becoming dominant because of the break-up of the overmature poplar component, ie. a stand conversion from a mixedwood (conifer-hardwood) to a pure spruce type. The second unit is a white spr'uce type with birch in the understory in which fire has determined the present stand composition. Photo 3, page 14, illustrates this forest.

   Examination of the colour-toned mapsheets (Map Folio) will indicate that the concentration of balsam poplar is adjacent to or near major drainage areas. Aspen predominates over balsam poplar away from the river channels and is probably of fire origin, regardless of location.

4. Channel Shrub - consisting of thick stands of shrubs (alder-willow) in channel scars.

Abandoned Floodplain Vegetation

Abandoned Floodplains have resulted from the progressive down-cutting of the river but have retained their typical floodplain features. These landforms are usually 12 to 30 meters above river level. Abandoned floodplains can occur adjacent to Recent Floodplains, but are always separated by a steep escarpment.

Forest vegetation presently existing on Abandoned Floodplains is of fire origin. Three units are present:

1. Tall mixedwood forests consisting of aspen-white spruce with the aspen being height dominant depending on the stand age. Given time and no disturbance such mixedwoods will convert to pure spruce types.
2. Pure stands of aspen or in mixture with a lesser amount of balsam poplar.
3. Sharply defined meadow vegetation dominated by sedges, willows and often bog birch can be found in abandoned channel scars.

Upland Forest Vegetation

Forest stands of the uplands ie. Lacustrine Benchland, Morainal areas and Deltaic Sand Plains consist of:

1. Mixedwood stands - various admixtures of aspen-spruce and birch.
2. Hardwood stands (broadleaf) - pure stands of aspen or admixtures of aspen, balsam poplar and birch.
3. Pine Forests - common on rapidly drained sites on sands (Deltaic Plains) or upland tills. Pine stands within the survey area are of little importance since their areal extent is minimal. It appears that lodgepole pine and jack pine introgress in areas east of the Liard River where difficulty was encountered by sampling crews in determining the pine species being tallied. On mapsheet 18N, pine was found associated with tamarack and black spruce, although the latter two species are not commonly associated with pine.
4. Black Spruce Forests - found on the lower slopes and less well drained sites. Here, tamarack is commonly associated with the black spruce.

5. Moist Seepage Forest - consisting of a dense cover of alder, willow and birch. The soil is wet, but in these telluric (seepage) areas there is little peat accumulation.

6, Brule - a term introduced by Jeffery but here used to describe the brushland vegetation on much of the large burn (1942) area east of the Liard River. This generalization of the vegetation to Brule is used as an inclusive term for the varied compositional areas of young aspen in mixture with willow, alder and birch. Frequently such vegetation has a vense layer of over-topped regeneration ot white or black spruce. It will require much future study to ascertain productive sites within the so called Bruie. Prediction problems as to the eventual yield of timber on this land base are formidable.

Bog Forest and Fen Vegetation on Organic Soils

Organic soils are found through the survey area as supporting two.vegetation types: sedge fens often with willow and bog birch in ridged patterns across the fen; or, bog forests consisting of open stands of stunted black spruce. Organic soils will usually be classed as unproductive land.

Forest Soils of the Liard

A unified- system of classification incorporating features of climate, topography, origin of parent soil material, soil development and drainage features of the soil body was used by Rostad to provide for the separation of distinctive soil areas of the Liard valley. Soils were grouped by textural similarities and soil profiles into soil associations and given local place names for identification.

Floodplain Associations

The Liard Association on Recent Floodplains is a grouping of soils which show little profile development (Regosols: Regosolic Order) on moderately to well drained alluvium. The texture of this alluvium ranges from sandy to silty, often with gravelly deposits in the subsoil; gravelly material being deposited first on sand bars. Buried organic layers, from repeated deposition, are a feature or these floodplain soils. Liard soils are highly productive for tree growth (photo 5, page 15).

in'contr&t, the Blackstone Association consists of similar recent alluvial deposits but these soils are found in poorly drained areas. They occupy abandoned channels of meander floodplains and are typified by shrub and meadow vegetation.

The Liard and Blackstone Associations represent the young soils (Regosols) of the recent (low): floodplains. The higher floodplains (abandoned) present soils of medium 'age with weak profile development (thin Brunisols) while soils developed on the highest floodplains show well developed Luvisols and are "older". Soils on the older floodplains vary in texture from coarse to fine silty alluvium over sandy material.

The Poplar, Netla and Swan Point Associations typify the age gradation of well drained floodplain soils; from the "younger" Liard Regosols, to the low terrace position of the Poplar Association (thin Brunisols). to the intermediate position of the more developed Brunisols of the Netla, to the Luvisolic Swan Point soils occupying the highest positions. Photo 4, page 14, illustrates the typical channel scarred Netla Association supporting a high quality mixedwood stand.

All of the above floodplain soils have less well to poorly drained "units" of soil in depressional channel scars or backswamp areas.

Lacustrine Benchland Associations

Soils in this physiographic district are overlaying veneers of coarse to fine silty material over till or sand.

A major association occupying the largest area of mapped associations is the Bovie Lake Association. The dominant profile is a degraded Eutric Brunisol developed on silt loam and fine sandy loam. This association is mapped on large burn areas east of the Liard River. Within this association are significant units of poor drainage with a consequent drop in tree growth and a change from Upland Forest white spruce and aspen vegetation to black spruce and tamarack. Bovie Lake soils in well drained positions near the Liard or Muskeg Rivers show good forest productivity but in general, the lacustrine area east of the Liard River is less productive than are the floodplain soils.

The Arrowhead Association is found on a similar but thicker deposition of material than the Bovie Associations. Arrowhead soils occupy positions along tributary valleys of the Liard. Profile characteristics are similar to the Bovie soils and are of high productivity.

Benchland Luvisols on silty loams predominate in the Celibeta Association of the Fisherman Lake area (map sheet 09S - Map Folio). The well drained areas here support good stands of aspen often with white spruce in a mixture or as the understory. A large area east from Fisherman Lake to the Liard River is occupied by this forested productive land.

Morainal Upland Associations

The Pointed Mountain Association groups a predominance of Luvisois developed on clay and heavy clay lacustro-till deposits. This association is mapped in many areas from west of the Liard River and south of Fisherman Lake to the British Columbia border (mapsheets 06N, 06 S).

White spruce sawtimber volumes on the latter noted mapsheets, are estimated to provide 1.3 and 1.1 million cubic meters respectively. In general, the merchantable stands contributing to this volume are growing on the morainal uplands.

In contrast to the Pointed Mountain soils, the Fisherman Lake Association on similar parent material, consists of poor to very poorly drained soils. This association occurs only in the Fisherman Lake area. An extensive 28 year old burn occurred on soils of this association south of Fisherman Lake; the present tree vegetation ranges from unproductive " 28 year old black spruce and treed muskeg" in low positions, to low site aspen and, -white spruce in upslope positions. "Willow swamp" areas were noted in higher positions as well, probably the result of perched water tables.

The authors of the soil survey rate the Liard Association as containing soils of the highest productivity for tree growth. The higher floodplain associations of the Poplar, Netla and Swan Point along with the Benchland Arrowhead and Ceiibeta Associations are indicated as intermediate sites. The morainal Pointed Mountain Association is also rated as intermediate for tree growth. A lower rating is given to the Bovie Lake Association of the Benchland.

A Yukon based study by Alemdag (5) and his published metric site index curves for white spruce, and correlating random height-age data taken from our sample plots, places most of the floodplain timber in his medium site index range (S.!. 24 m), while an individual sample in the Morainal area fell in his high range (S.1. 30 m).

Correlation of forest productivity with mapped soil units does present difficulty. It is unfortunate that all past productivity ratings for existing stands in the Liard unit have been done, to a large extent, without the benefit of physiographic and soil related knowledge. Hence, in the opinion of this report, past site ratings are inadequate.

it is not the intention of this report to repeat in detail the characteristics of some 30 soil associations which apply to our area of interest. However, this abbreviated discussion of some of the associations mapped cn land areas growing some of the most productive stands of commercial timber in the N. W. T., should be recognized as a base to improve future productivity (yield) determinations. A knowledge of differing soil-sites in terms of humus depths, moisture holding capacity and their propensity to shrub, herb and grass production following removal of the timber crop, must be recognized. Grass production, if prolific, can provide severe competition to attempts at spruce regeneration. Exposure of mineral soil may have to be avoided in site preparation for reforestation if particular soils exhibit low moisture retention.

In sum, it is imperative that the forest manager understand the environment in which he works. It is more than just a question of knowing where the greatest volume and largest tree stands are located.

Local Climate

The Liard unit is within a moisture deficient Dry-Subhumid Climate type as is all of the western Canadian boreal forest. Local rainfall is generally the same as most southern boreal areas of the prairie provinces. Equivalent precipitation is more effective in the north because of lower evaporation.

The summer season extends from mid-May to early October with the critical snow-melt taking place in the last half of April. The area in summer is one of essentially dry terrain, however there are frequent periods of wet weather with heavy rain which has a decided short-term influence on the level of the Liard River. Fog is common at low elevations, particularly in the autumn.

The usual statistics given for the Liard valley climate are extensions from the Fort Simpson weather records. Short term data taken at Fort Liard from 1973-1980 appears to indicate that the Liard valley received considerably more summer precipitation than Fort Simpson, Extremes of rainfall recorded at Fort Liard more closely correlate with the extremes of Fort Nelson, to the south, than with Fort Simpson. For example, Fort Liard recorded a monthly rainfall total of 97.8 mm for June 1973, while Fort Nelson recorded 127.8 mm and Fort Simpson only 26.7 mm. Values for August 1976 show 126.7 mm for Fort Liard, 125.7 mm for Fort Nelson and 91.9 mm for Fort Simpson. Conversely, a maximum recording (past 10 years) in Fort Simpson for August 1974 was 111.3 mm, while for the same period only 48.0 mm was recorded at Fort Nelson and 61.0 mm at Fort Liard. May to September short term rainfall totals for Fort Nelson, Fort Liard and Fort Simpson show 323.9 mm, 300.5 mm and 187.5 mm respectively. Selected climatological data follows:

Summer Temperature (°C) Data Summary [1]-Fort Liard, N.W.T.
(Recordings from August 1973 to December 1980)

	May	June	July	August	September
Monthly Max. Temp	28.0	31.5	32.8	30.0	27,2
Monthly Min. Temp	-8.9	0.6	2.0	-1.7	-11.7
Mean Daily Max. Temp.	16.1	21.3	22.7	20.0	15.6
Mean Daily Min. Temp.	2.8	7.9	10.6	8.3	3.9
Mean Daily Temp.	9.4	14.6	16.7	14.2	9.8
Rainfall (mm)					
Fort Liard (73-80)	41.5	59.3	92.6	67.2	39.9
Fort Simpson (71 -80)	27.3	40.4	46.5	52.9	20.4
Fort Nelson (71 -80)	44.9	81.7	97.6	60.3	39.4
Days with rain (Fort Liard)	7	8	11	11	9

Wind charts, from the 1962-63 records of the Fort Simpson Airport, as presented in the report by Crowe, et al. (10) indicate that northwest or southeast trending winds predominate during the summer. Crowe states that "there is a strong funneling effect (of wind) along the whole stretch of the Liard River. As a result, winds blow mostly up or down the river valley".

Insects and Diseases

Insects

The 1981 aerial survey of the Liard valley by the Forest Insect and Disease Survey, Still and Grandmaison (23), made no specific reference to any noteworthy infestations.

The large aspen tortrix (Choristoneura conflictana (Wilk)) was observed by our field crews (1979-80), to have defoliated small areas of aspen in the Liard valley.

Larch sawfly (Pristiphora erichsonii (Htg.)) was noted by the insect survey (1981) as causing moderate to severe defoliation west of Fort Simpson. This would likely apply to

[1] Information courtesy Atmospheric Environment Services Division, Western Region, Edmonton.

tamarack stands" in the Liard, since moderate defoliation of tamarack by this insect was observed throughout the Southern Mackenzie area.

The spruce budworm (Choristoneura fumiferana (Clem.)) was not recorded from the survey observations of 1981 in the Liard, but an endemic population is present. Evidence (1982) from southern prairie areas indicates that populations of this insect are on the increase. Prior to 1970 the survey observed major infestations of spruce budworm in the Liard from 1962 until 1965 when the population collapsed.

Diseases

Widely scattered infestations of yellow witches broom (Chysomyxa arctostaohvli (Diet)) was noted by our survey (1979-80). Witches broom is common in white spruce in the N.W.T. but is of little consequence.

The inland spruce cone rust (Chrvsomvxa pirolata(Wint.)) was evident in the summer of 1979. A very heavy white spruce cone crop was produced in 1979 but an estimated 50?" loss of the crop was caused by this disease.

The Insect and Disease Survey now intend to provide annual observations of the Liard valley. With improved access to the area more detailed observations are possible.

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[1]Personal Communication. Ben Moody, Head, Forest Insect and Disease Survey, Northern Forest Research Centre, Edmonton.

III. FOREST AREA AND TIMBER VOLUMES

Forest Area

Map Coding

Forest stands as identified in this report and on the supporting cover-type maps are given symbols for: Species composition-structure. Stand height, Density, Age and Site. The above variables in combination provide for the identification or classification features of individual stands. The complete legend of map symbols is given in Appendix 2.

For example : Type 415 on mapsheet 06N (see Map Folio) is classified as SWA 5 C 15 II.

SWA = Single story stand of white spruce and aspen

5 = Height [5 x 5 m)

C = Density (61-90%)

15 = Age(121 -180 years)

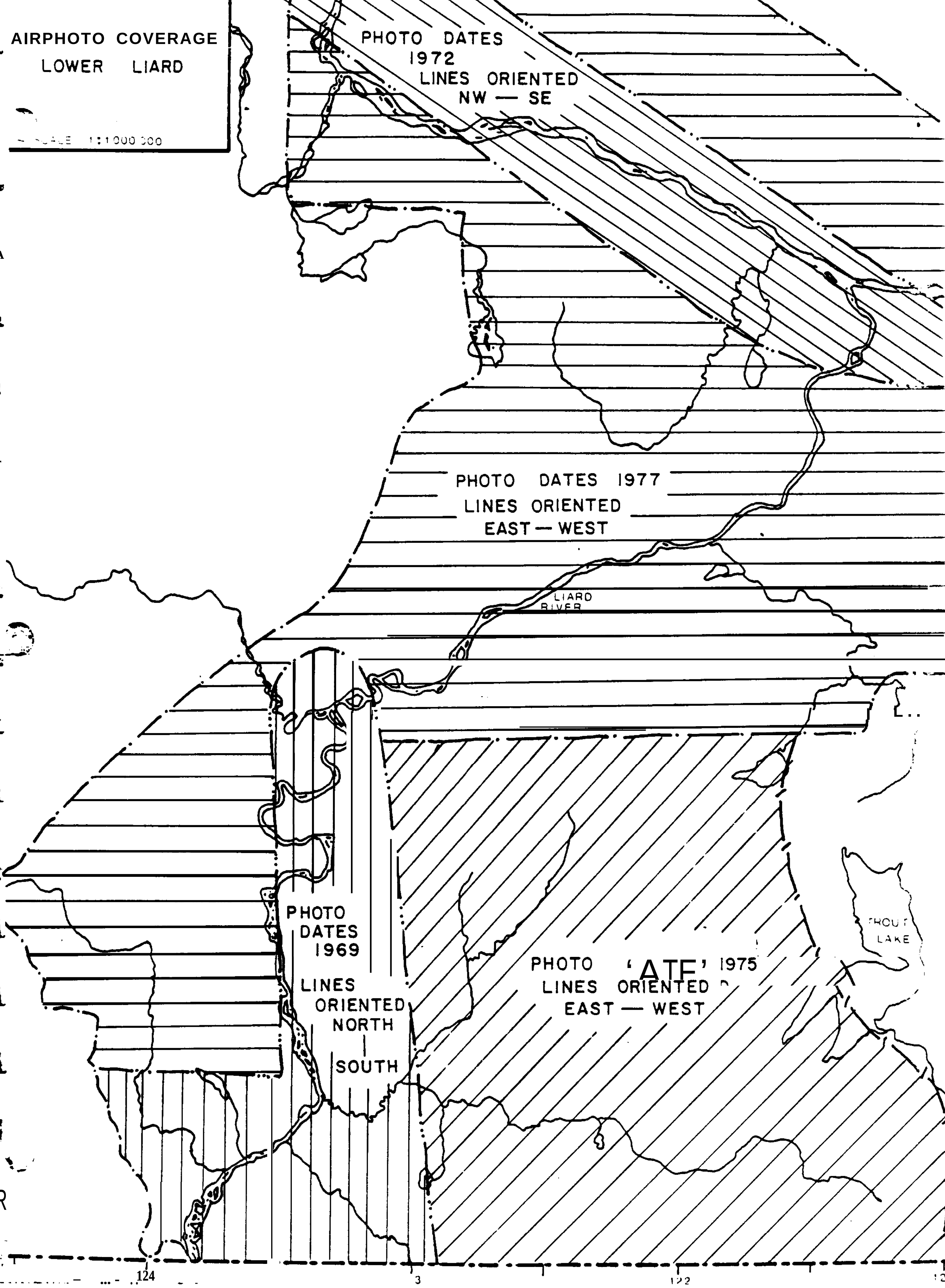
II = Site class II (Good)

This classification can be read as : A single storied white spruce aspen stand averaging 25 m in height, 61 -90% density, 121- 180 years of age on a good site.

Aerial Photography

Aerial coverage of the Lower Liard is composed of three sets of black and white prints at a scale of 1 :25 000.

1. The central area (see map on following page) from the Nahanni-Liard River Junction to the British Columbia-N.W.T. border covering most of the Liarci valley, was photographed in 1969. Flight lines run approximately north-south and contract interpretation was completed in 1978.
2. Photo coverage of the area east of this central portion as far as Trout Lake and north from the British Columbia border to approximately 61°N, was accomplished in 1975. Flight lines run approximately east-west and contract interpretation was completed in 1977.
3. Photo coverage to the north of the area described in point 2 and west of the area


AIRPHOTO COVERAGE
LOWER LIARD
SCALE 1:1 000 000
PHOTO DATES
1972
LINES ORIENTED
NW — SE
PHOTO DATES 1977
LINES ORIENTED
EAST — WEST
LIARD
RIVER
PHOTO
DATES
1969
LINES
ORIENTED
NORTH
SOUTH
PHOTO 'ATF' 1975
LINES ORIENTED
EAST — WEST
TROUT
LAKE
124
122

described in point 1, was completed in 1977. Flight lines run approximately east-west. Interpretation of these photos was completed in 1978.

Flight lines are indexed on the edge of all mapsheets, giving roll, line and photo numbers. Photo centers are indicated across each map. The map base is directly related to the aerial photographs to produce 1 :25 000 scale cover type maps.

Land Classification

Throughout this report reference will be made to 3 divisions of the land base; the Forest Management Unit (Timber District, FMU), the Survey Area and the Harvest Zone (see key map on the following page).

The Forest Management Unit includes the total area covered by the 77 mapsheets of the Lower Liard FMU.

The Survey Area is bounded by 26 contiguous mapsheets within the units of the FMU area. The Survey Area contains the bulk of the accessible merchantable spruce sawtimber in the Liard unit. Of these 26 mapsheets, only 20 actually received randomly selected samples assigned to stands representing the strata for which volume estimates were desired.

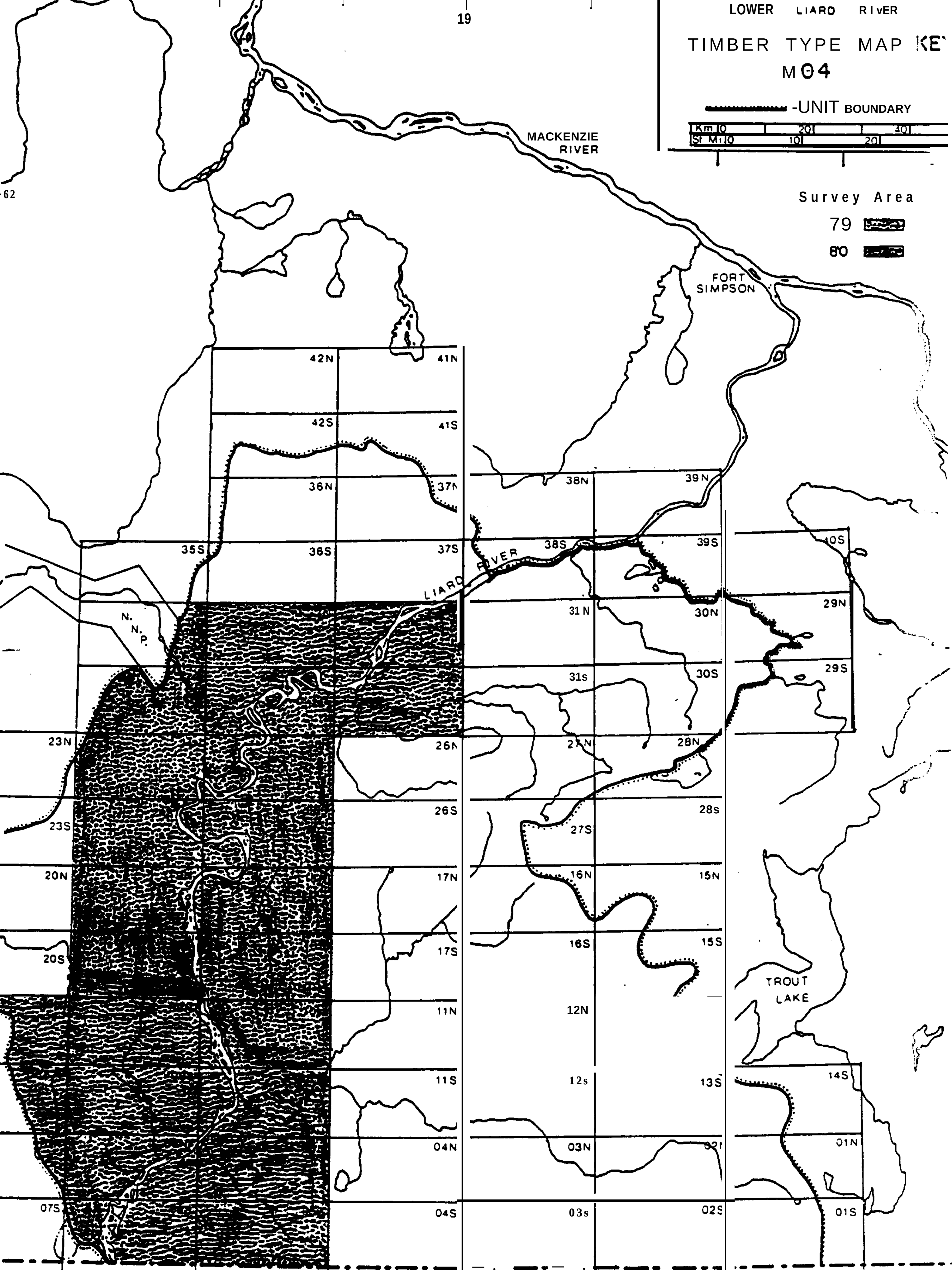
The Harvest Zone is the residual area available for timber harvesting after the removal of land from the Survey Area because of isolation or environmental concerns. The criteria for this removal are discussed in part V.

Productive and Unproductive Areas

Table 1 (page 20), is a summary of the area in hectares of the productive and unproductive groupings in each of the FMU, Survey and Harvest Areas. More detailed tables, showing these groupings by individual mapsheet are in Appendix 3.

Strata Groupings

Forest stand types were grouped into strata according to: species composition, height class (O-7) and two density classes A or B+, the latter combining density classes B, C and D. Strata were then combined by species composition into 4 major groups: Softwoods Only (SO), Mixedwoods - softwoods dominate (SH), Mixedwoods - hardwoods dominate (HS), and Hardwoods Only (HO).



19
LOWER LIARD RIVER
TIMBER TYPE MAP KEY
M04
-UNIT BOUNDARY
Km 0 20 40
St Mi 0 10 20
Survey Area
79
80
MACKENZIE RIVER
FORT SIMPSON
LIARD RIVER
N. N. P.
TROUT LAKE
42N
41N
42S
41S
36N
37N
38N
39N
35S
36S
37S
38S
39S
40S
31N
30N
29N
31S
30S
29S
23N
26N
27N
28N
23S
26S
27S
28S
20N
17N
16N
15N
20S
17S
16S
15S
11N
12N
11S
12S
13S
14S
04N
03N
02N
01N
07S
04S
03S
02S
01S
W

Table 1 : Sumnary of Productive and Unproductive Area

		FMU Area	Survey Area	Harvest Are
		(hect ares)		
Productive				
Stocked		1 770 481	706 563	545 085
Windfall/Logged		306	239	21C
Burn		22 779	3 898	3 110
Shrub		17 758	12 009	11 134
Treed grass		18	18	18
Improved		159	159	159
Total	(A)	1 811 501	722 886	559 716
Unproductive				
Burn		666	96	48
Windfall/Shrub		48 697	27 713	11 745
Grass		9 493	927	916
Swamp		6 430	2 880-	2 786
Treed Muskeg		185 438	18 375	17 758
Treed Rock		17 267	9 809	62
Rock		8 698	761	
Slide		31 038	12 649	20:
Mud, Sand, Gravel		3 058	2 342	2 006
Flood		398	286	283
Improved		975	565	368
Total	(B)	312 158	76 403	36 17S
Water	(c)	50 083	30 141	28 461
Total Area	(A)+(B)+(C)	2 173 742	829 430	624 356

Height classes O-3 were compiled separately from height classes 4-7 since height class 4 (20 m) was considered to be the minimum height for a merchantable stand. This division was made in an effort to gain more accurate volume estimates for sawtimber production.

Table 2, Appendix 3a, shows the individual stratum areas by site, for height classes 4-7, for each of the FMU, Survey and Harvest Areas. Similarly, Table 3, Appendix 3a, shows the individual stratum areas by site, for height classes 0-3. These two tables are summarized by a diagrammatic representation of the relative areas of the 4 strata groups in the FMU, Survey and Harvest Areas (see Figure 1, page 22).

Timber Volumes

Sampling

Field sampling was conducted during the summer months (June, July and August) of 1979 and 1980. A total of 3 091 plots had been established at the completion of field work. The number of plots to be established in each field season was an estimate of the maximum number of plots that could be measured, considering the riumber of w&king days, the size of the field staff, and the time” lost due to inclement, weather or helicopter maintainance.

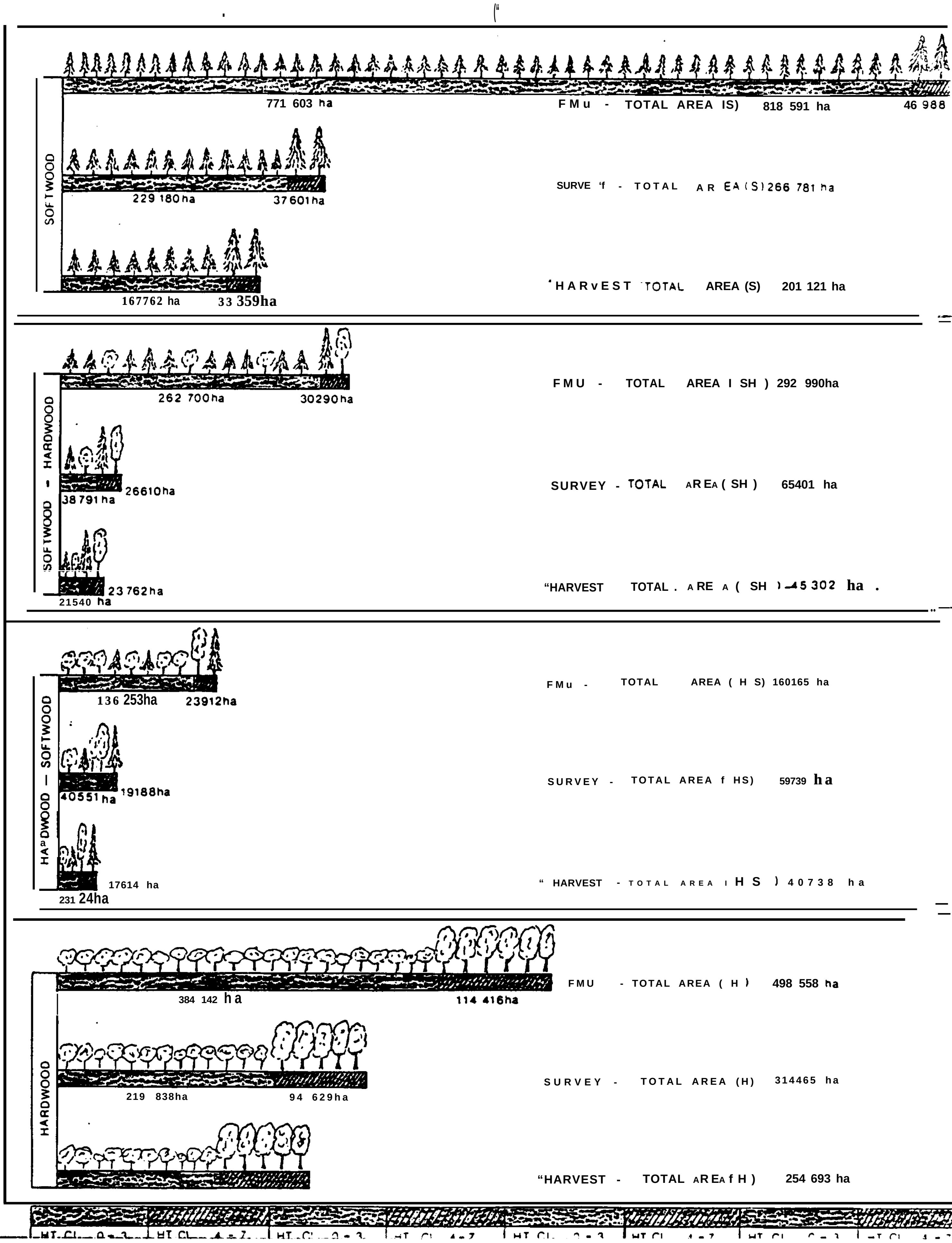
Difficulties were encountered in planning the first field season as no Information was available for the individual stratum areas on each mapsheet. With the scant area information that was available, an attempt was made to distribute the plots proportionally over the 4 major groups (SO, SH, HS, HO). Within each group, the allocated number of plots was then distributed to stands representing the strata that were to be sampled.

For the 1980 field season, a list of stratum areas was available. This allowed for the proportional allocation of plots to individual stratum, intended for sampling.

Plots were placed in individual stands in the form of a ‘sample’. In 1979, a sample consisted of 5 variable radius plots, equally spaced at 50 m, stretching from a random starting point along a randomly chosen bearing. The random start was chosen by using a sampling grid placed. over a map of the stand using co-ordinates generated by a T159 programmable calculator program. Random bearings were chosen using a similar T159

FIGURE I

AREA OF PRODUCTIVE FOREST LAND BY SPECIES GROUP



program. Normally one sample (5 plots) would be placed in each stand. Where stands were greater than 25 ha, 2 or more samples were placed within the same stand.

For 1980, in an effort to sample stands with respect to individual stand size, the number of plots placed in a single stand was determined to be the square root of the stand area (in hectares). The maximum number of plots in a sample was 7, so 2 or more samples of various sizes could be placed in large stands. The random starting point and bearing were chosen in the same manner as described above.

On each plot, the center was staked and flagged. A relascope using metric basal area factor (BAF) 2 or 4 was used to determine the trees to be measured. All live trees with a diameter at breast height greater than or equal to 9.6 cm were measured to the nearest 1 / 10 cm. Each tree was graded into 1 of 3 categories (sound, suspect, residual), based on external pathological characteristics. On one plot in each sample, complete pathological features were recorded for every tree, as well as such quality features as sweep, lean, spiral grain and extent of live limbs. On this plot, age, bark thickness, 10 and 20 year radial growth (all at breast height) plus total height and stump diameter were measured on 1 dominant and 2 codominant trees.

Stem Analysis

Thirty three stem analysis plots were established in a wide range of species, age, height and site classes. Of the 500 trees sectioned, 229 were white spruce and the balance allocated to the other 8 major species listed in Appendix 2. The data was divided by species and site class to compute height-diameter relationships, and by species alone to formulate volume tables.

The function chosen for estimates of individual tree volume was: $Vol = a + b(dbh^2 ht)$. Good correlation coefficients were obtained using this function and the resultant gross volume tables are shown in Appendix 8 [1].

To determine merchantable volume, limits were defined as:

1 Note: Appendices 8- 10 (Book 2) not included with this report but available uPon request.

	Sawtimber	Pulpwood
top dib (cm)	15.0	8.0
stump ht (m)	0.3	0.3
minimum dbh (cm)	25.4	15.0

Merchantable volume tables were compiled using total volume /merchantable volume conversion factors developed by Honer (16). While his coefficients are in imperial units, they were easily converted for metric use. The derivation of the metric conversion factors is shown in Appendix 4.

The functional form chosen to determine height from diameter was that derived by Staebler: Height = a + b(dbh) + c(dbh²), where the a,b and c coefficients *were* calculated using paired measurements from the stem analysis data in ail but two cases. Due to the lack of reliable data for aspen-site I and birch-site 1, these coefficients were determined from paired height-diameter measurements taken on pathological plots. In addition, for height estimates of larch-site III and birch-site III, the coefficients used were those for black spruce /fir-site III and aspen-site III, respectively. Tables of height estimates by diameter class, site class and species are presented in Appendix 9[1].

A summary of volume function and height diameter coefficients showing sample size and correlation coefficients, is presented in Table 4 (following page).

Stratum Volume Estimates

From the inventory data collected, standard sampling formulas (see Appendix 5), were used to compile a stand table (number of trees/ha by species and diameter class) and stock tables (volume in m^3 / ha by species and diameter class) for each stratum. Three stock tables are presented: gross volume, sawtimber volume and pulpwood volume, using the merchantability limits previously defined. The individual stratum stand and stock tables are provided in Appendix 10[2], however, Tables 5,6 and 7 (pages 27-29) provide a concise summary of the mean volume per hectare by species in each stratum.

In association with the volume estimates, the corresponding relative standard errors (RSE), at the probability level of 0.68 are shown in Appendix 6.

Individual stratum estimates were compiled into estimates for the 4 groups. Table 8 (page 30) shows the mean volumes (m^3/ha) for each of the 4 groups for both softwood and

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[1]Ibid., p.23.
[2]Ibid.

Table 4 : Gross Volume Equation and Height-Diameter Coefficients

Species		Volume Function V=a + b((dbh**2)*ht)			Height-diameter coefficients Ht=a + b(dbh) + c(dbh**2)				
	n	a	b	r**2	n	a	b	c	r
Sw	231	0.04316	0.000031526	.9929					
Site I					35	.10817	1.11765	-.00868	.9943
Site II					126	.12185	1.12681	-.01441	.9927
Site III					57	.10727	1.16586	-.01166	.9924
Sb/F	78	0.00432	0.000035718	.9904					
Site II					8	.07845	1.32343	-.01532	.9957
Site III					47	-.01941	1.22107	-.01915	.9901
L	[illegible]	[illegible]	0.000034212	.9628					
Site II					15	.00418	1.88058	-.04653	.9973
Site III						as for Sb/F - site III			
Pl/Pj	23	0.13387	0.000036106	.995					
Site II					10	.03272	1.94400	-.05008	.9986
Site III					13	.05735	1.18094	-.01638	.9966
A	58	0.04591	0.0000[illegible]133	.9861					
Site I					134*	.10765	1.46581	-.01806	.9921
Site II					42	.38003	1.48572	-.01777	.9912
Site III					15	.00545	1.27150	-.02042	.9909
Po	53	-0.[illegible]1008	[illegible]0000	.9842					
Site I					24	.53657	1.08311	-.00965	.9843
Site II					26	.24770	1.23773	-.01549	.9911
Site III					6	.02486	0.81071	-.00762	.9768
[illegible]	44	[illegible]110	[illegible]000[illegible]1563	.9770					
Site I					20*	.04909	1.61850	-.02974	.99[illegible]6
Site II					45	.10001	1.42317	-.02598	.99[illegible]8
Site III						as for A - site III			

* coefficients obtained from pathological plots - not stem analysis

hardwood species. In addition, the Reliable Minimum Estimate (RME) is provided. The RME, as defined by Husch, et al (17), is the expected minimum volume of wood that would be present and here is given at the probability level of 0.95.

Table 9 (page 31) expands the mean volume estimates to provide an estimate of the total volume of wood in each of the Harvest Area, Survey Area and FMU Area.

Decay

Decay was measured on sectioned tree data as either advanced (complete rotting) or advanced plus incipient (early stages of rot). As shown by the table below, incidence of decay in white spruce is very low and loss of volume is virtually insignificant. The incidence and percent loss of volume for aspen and poplar is high and generally reflects the state of overmature hardwoods in this area. No decay was recorded for larch or the pines, but this is most likely due to the small sample size.

Estimates of Decay of Total Volume

Species	Incidence	% Decay Advanced	Adv. & Incip.
White spruce	7.11	0.11	1.10
Black spruce/Fir	11.5	0.20	0.65
Larch	0.0	0.00	0.00
Pine	0.0	0.00	0.00
Aspen	55.2	15.40	29.60
Poplar	60.4	7.90	27.90
Birch	13.6	0.19	0.25

These decay estimates are very general and do not indicate the cause of decay, nor where the decay is most prevalent (stump, branches, top). Further work is necessary to determine the volume loss of merchantable stems, as well as to ensure adequate sampling across all age or diameter classes. An eventual aim of further sampling would be volume loss factors by species, diameter class and maturity class.

TABLE 5 : PRODUCTIVE STRATA VOLUMES - Sampled Strata : Height class 4-7

Gross volume (cu.m./ha)

Stratum	Plots	Sw	Sb	F	L	Pl	PJ	SO	A	Po	B	XO	TOTAL
Sw - 6 - B+	239	332.41	9.06	2.98	0.35	0.00	0.00	344.81	8.00	22.53	12.06	42.59	387.40
Sw - 5 - B+	179	268.77	19.19	1.70	2.34	0.00	0.00	292.00	10.58	14.12	9.26	33.97	325.98
Sw - 4 - B+	343	236.46	17.58	0.15	1.36	1.26	1.66	259.10	24.06	7.17	10.41	41.65	300.76
Sw - 4 - A	5	142.39	3.52	0.00	0.30	0.00	35.07	180.99	3.18	3.09	21.85	28.14	209.13
SwSb - 5 - B+	5	282.25	0.00	0.00	0.30	0.00	0.00	282.25	0.00	3.64	9.42	13.07	295.32
SwSb - 4 - B+	25	224.71	61.05	1.42	1.31	0.00	0.00	288.20	4.27	10.95	0.65	15.89	304.09
Sw L - 4 - B+	5	157.12	103.58	0.00	0.30	0.00	0.00	260.71	9.55	0.00	13.33	22.88	283.60
SwPJ - 4 - B+	13	269.17	1.58	0.00	0.30	1.40	30.71	302.87	24.33	4.36	3.21	31.91	334.79
Sb - 4 - B+	5	0.00	173.93	0.00	0.30	0.00	0.00	173.93	0.00	0.00	0.00	0.00	173.93
SbSw - 4 - B+	10	190.66	88.16	0.00	11.14	0.00	0.00	290.27	0.00	2.98	2.69	5.67	295.94
Sw A - 6 - B+	43	264.15	2.31	0.48	0.00	0.00	0.00	266.95	60.29	24.19	13.61	98.10	365.05
Sw A - 5 - B+	87	278.28	13.92	3.62	0.00	0.00	0.00	295.83	58.71	29.81	11.59	100.13	395.97
Sw A - 4 - B+	173	269.44	13.14	0.17	0.87	0.00	0.00	283.65	43.36	24.15	16.65	84.18	367.83
Sw A - 4 - A	5	108.58	0.00	5.04	0.00	0.00	0.00	113.62	64.35	15.77	19.17	99.30	212.92
SwPo - 6 - B+	146	292.67	0.42	0.00	0.69	0.00	0.00	293.79	14.77	57.65	16.80	89.23	383.02
SwPo - 5 - B+	129	278.76	1.00	0.00	0.13	0.00	0.69	280.58	21.08	35.53	10.95	67.58	348.17
SwPo - 4 - B+	93	215.22	11.98	0.00	3.28	0.00	0.00	230.49	26.53	14.38	15.55	56.47	286.96
Sw B - 4 - B+	5	273.40	0.00	0.00	0.00	0.00	3.55	276.95	225.80	3.16	0.00	228.97	505.93
ASw - 6 - B+	49	310.81	0.37	0.00	0.00	0.00	0.00	311.18	64.89	68.03	5.81	138.73	449.92
ASw - 5 - B+	86	201.51	4.21	1.09	0.39	0.00	0.00	207.21	78.45	38.55	28.03	145.04	352.25
ASw - 5 - A	5	22.96	0.00	0.00	0.00	0.00	0.00	22.96	45.23	22.01	3.18	70.44	93.40
ASw - 4 - B+	110	149.47	3.66	0.70	0.15	1.79	8.08	163.87	109.37	20.91	29.71	160.00	323.88
PoSw - 7 - B+	9	44.87	0.00	5.31	0.00	0.00	0.00	50.18	0.00	390.02	1.97	392.00	442.19
PoSw - 6 - B+	48	233.17	0.00	0.00	1.06	0.00	0.36	234.60	9.47	156.74	17.85	184.07	418.68
PoSw - 5 - B+	16	216.98	0.00	0.00	0.00	0.00	0.00	216.98	6.32	132.45	4.81	143.60	360.58
PoSw - 4 - B+	25	131.62	6.58	0.00	2.71	8.60	0.00	149.52	126.34	36.33	53.83	216.50	366.03
BSw - 5 - B+	12	142.92	0.00	0.00	0.00	0.00	0.00	142.92	0.00	0.00	124.93	124.93	267.85
A - 6 - B+	15	155.32	1.49	0.00	0.00	0.00	0.00	156.82	64.12	130.36	2.10	196.60	353.42
A - 5 - B+	83	97.89	0.79	0.00	0.20	2.15	0.43	101.47	171.77	72.04	11.40	255.22	356.70
A - 4 - B+	366	50.01	6.33	0.63	0.74	1.72	0.83	60.29	183.05	34.39	40.54	258.00	318.29
APo - 5 - B+	24	77.20	0.00	0.00	0.00	0.00	0.00	77.20	173.29	92.90	15.84	282.04	359.24
APo - 4 - B+	24	131.58	0.00	0.00	1.44	0.00	0.00	133.02	189.63	33.65	24.08	247.37	380.40
A B - 4 - B+	10	59.28	0.00	0.00	0.00	0.00	0.00	59.28	24.86	125.66	75.20	225.73	285.02
Po - 7 - B+	7	23.61	0.00	0.00	0.00	0.00	0.00	23.61	0.00	494.10	0.00	494.10	517.72
Po - 6 - B+	308	87.54	4.89	0.16	0.66	0.23	1.33	94.84	115.03	121.80	23.86	260.70	355.54
Po - 5 - B+	226	92.65	1.25	0.00	1.05	0.07	0.55	95.59	96.93	89.42	35.55	221.91	317.51
Po - 4 - B+	106	101.27	6.70	0.00	2.25	0.00	0.00	110.22	69.94	23.05	41.84	134.84	245.07
Po A - 6 - B+	11	66.50	0.00	0.00	0.00	0.00	0.00	66.50	276.08	36.99	12.39	325.4[illegible]	391.97
Po A - 5 - B+	13	74.25	0.00	0.00	0.00	0.00	0.00	74.29	36.23	66.43	78.35	241.61	315.30
Po A - 4 - B+	18	37.55	13.50	0.00	8.72	1.00	0.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 6 : PRODUCTIVE STRATA VOLUMES - Sampled Strata : Height class 4-7

Sawtimber volume (cu.m./ha) : 0.3 m. stump/15.0 cm top dib to minimum 25.4 cm dbhob.

Stratum	Plots	Sw	Sb	F	L	Pl	Pj	SO	A	Po	B	HO	TOTAL
Sw - 6 - B+	239	257.60	1.87	0.15	0.19	0.00	0.00	259.82	7.16	20.66	3.35	31.19	291.01
Sw - 5 - B+	179	189.45	7.04	0.67	0.64	0.00	0.00	197.82	8.85	11.64	2.88	23.39	221.21
Sw - 4 - B+	343	120.40	1.05	0.00	0.72	0.13	1.18	123.51	14.01	5.14	2.92	22.08	145.59
Sw - 4 - A	5	110.65	3.12	0.00	0.00	0.00	21.90	135.69	3.03	2.88	0.00	5.91	141.60
SwSb - 5 - B+	5	133.99	0.00	0.00	0.00	0.00	0.00	133.99	0.00	3.31	0.00	3.31	137.30
SwSb - 4 - B+	25	123.44	7.10	0.00	0.85	0.00	0.00	131.40	3.03	9.80	0.61	13.45	144.85
Sw L - 4 - B+	5	0.00	3.54	0.00	0.00	0.00	0.00	3.54	8.19	0.00	0.00	8.19	11.74
SwPj - 4 - B+	13	72.97	0.00	0.00	0.00	0.00	2.47	75.44	8.40	0.00	0.00	8.40	83.85
Sb - 4 - B+	5	0.00	56.44	0.00	0.00	0.00	0.00	56.44	0.00	0.00	0.00	0.00	56.44
SbSw - 4 - B+	10	69.00	5.64	0.00	5.64	0.00	0.00	80.30	0.00	2.75	0.00	2.75	83.05
Sw A - 6 - B+	43	200.60	0.87	0.00	0.00	0.00	0.00	201.48	45.50	20.74	7.56	73.80	275.28
Sw A - 5 - B+	87	192.55	6.12	1.59	0.00	0.00	0.00	200.27	41.75	26.29	1.63	69.68	269.95
Sw A - 4 - B+	173	166.92	4.45	0.00	0.43	0.00	0.00	171.81	28.38	18.17	3.73	50.30	222.12
Sw A - 4 - A	5	87.72	0.00	0.00	0.00	0.00	0.00	87.72	15.16	14.83	2.83	32.83	120.55
SwPo - 6 - B+	146	235.47	0.00	0.00	0.41	0.00	0.00	235.88	12.97	52.04	5.11	70.13	306.01
SwPo - 5 - B+	129	172.42	0.18	0.00	0.10	0.00	0.24	172.97	15.00	31.67	2.00	48.68	221.65
SwPo - 4 - B+	93	95.12	0.53	0.00	0.92	0.00	0.00	96.57	12.97	8.46	1.64	23.08	119.66
Sw B - 4 - B+	5	73.88	0.00	0.00	0.00	0.00	3.08	76.96	136.80	2.57	0.00	139.38	216.35
ASw - 6 - B+	49	243.96	0.00	0.00	0.00	0.00	0.00	243.96	58.52	61.09	1.65	121.27	365.24
ASw - 5 - B+	86	147.32	1.21	0.49	0.33	0.00	0.00	149.35	66.34	33.82	7.83	108.00	257.37
ASw - 5 - A	5	21.46	0.00	0.00	0.00	0.00	0.00	21.46	42.45	15.27	2.92	60.65	82.11
ASw - 4 - B+	110	90.57	1.67	0.32	0.13	0.83	0.00	93.55	79.54	11.20	10.37	101.12	194.67
PoSw - 7 - B+	9	22.60	0.00	0.00	0.00	0.00	0.00	22.60	0.00	367.69	0.00	367.69	390.29
PoSw - 6 - B+	48	137.54	0.00	0.00	0.58	0.00	0.33	138.45	8.82	139.41	6.43	153.66	292.12
PoSw - 5 - B+	16	181.82	0.00	0.00	0.00	0.00	0.00	181.82	5.97	125.34	2.68	133.99	315.82
PoSw - 4 - B+	25	88.49	0.00	0.00	1.75	3.09	0.00	93.35	100.48	25.26	14.49	140.25	233.60
BSw - 5 - B+	12	117.85	0.00	0.00	0.00	0.00	0.00	117.85	0.00	0.00	63.22	63.22	181.07
A - 6 - B+	15	125.84	1.25	0.00	0.00	0.00	0.00	127.09	59.96	120.26	1.05	181.28	308.37
A - 5 - B+	63	71.50	0.51	0.00	0.17	1.27	0.17	73.65	124.05	61.22	5.92	191.20	264.85
A - 4 - B+	366	22.38	0.52	0.00	0.15	0.38	0.08	23.53	120.95	22.85	11.78	155.60	179.13
APo - 5 - B+	24	29.49	0.00	0.00	0.00	0.00	0.00	29.49	113.23	81.68	1.10	195.02	225.52
APo - 4 - B+	24	58.74	0.00	0.00	0.00	0.00	0.00	58.74	104.79	13.12	6.47	124.40	183.14
A B - 4 - B+	10	36.10	0.00	0.00	0.00	0.00	0.00	36.10	20.47	98.55	15.23	134.26	170.37
Po - 7 - B+	7	11.57	0.00	0.00	0.00	0.00	0.00	11.57	0.00	459.89	0.00	459.89	471.46
Po - 6 - B+	308	33.64	0.58	0.06	0.14	0.04	0.64	35.12	74.88	108.28	1.10	184.26	219.39
Po - 5 - B+	226	33.10	0.00	0.00	0.00	0.00	0.13	33.23	58.03	71.35	2.72	132.10	165.34
Po - 4 - B+	106	36.93	3.50	0.00	0.54	0.00	0.00	40.98	41.39	14.89	8.79	65.07	106.05
Po A - 6 - B+	11	6.80	0.00	0.00	0.00	0.00	0.00	6.80	160.34	28.16	0.00	188.50	195.31
Po A - 5 - B+	13	58.06	0.00	0.00	0.00	0.00	0.00	58.06	88.21	53.12	26.86	168.20	226.26
Po A - 4 - B+	18	33.02	2.22	0.00	2.76	0.00	0.00	33.0[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 7 : PRODUCTIVE STRATA VOLUMES - Sampled Strata : Height class 4-7

Pulpwood volume (cu.m./ha) : 0.3 m. stump/8.0 cm top dib to a minimum 15.0 cm dbhob.

Table 8

Estimate of Population Means

SAMPLED STRATA - HEIGHT CLASS 4 - 7

DEFINITIONS: 1. S.E. - standard error of the mean (cu.m./ha)
2. R.M.E. - Reliable Minimum Estimate (cu.m./ha)

Species Composition	Gross Volume Estimates cu.m./ha		Gross Volume Estimates S.E.	Pulpwood Volume Estimates cu.m./ha		Pulpwood Volume Estimates S.E.	Sawtimber Estimate cu.m./ha		Sawtimber Estimate S.E.	Sawtimber Estimate R.M.E.
GROUP SD										
Softwood										
All species	285.91	+/-	4.55	249.93	+/-	4.35				
Sw only	262.45	+/-	5.06	232.63	+/-	4.72	167.06	+/-	4.29	151.80
Hardwood										
All species	37.65	+/-	1.98	33.42	+/-	1.83				
Aspen only	15.34	+/-	1.57	14.31	+/-	1.48				
Poplar only	12.21	+/-	1.06	11.52	+/-	1.01				
GROUP SH										
Softwood										
All species	279.57	+/-	5.54	250.93	+/-	5.09				
Sw only	269.54	+/-	5.69	242.91	+/-	5.23	179.14	+/-	4.53	161.42
Hardwood										
All species	85.90	+/-	3.50	77.04	+/-	3.26				
Aspen only	39.41	+/-	3.01	36.23	+/-	2.80				
Poplar only	31.89	+/-	2.24	30.10	+/-	2.13				
GROUP HS										
Softwood										
All species	190.82	+/-	7.07	171.22	+/-	6.59				
Sw only	181.34	+/-	7.18	163.70	+/-	6.65	123.84	+/-	[illegible]	104.36
Hardwood										
All species	155.53	+/-	7.12	143.56	+/-	6.73				
Aspen only	87.48	+/-	7.05	82.30	+/-	6.66				
Poplar only	41.36	+/-	3.35	38.93	+/-	3.12				
GROUP HD										
Softwood										
All species	80.96	+/-	3.02	66.10	+/-	2.64				
Sw only	73.63	+/-	2.88	60.50	+/-	2.52	35.00	+/-	1.83	26.82
Hardwood										
All species	245.93	+/-	4.91	223.26	+/-	4.64				
Aspen only	[illegible]	+/-	5.20	[illegible]	+/-	4.94				
Poplar only	62.49	+/-	2.99	[illegible]	+/-	[illegible]				

Table 9

Total Volume Estimates of Productive Strata

HEIGHT CLASS b 1

GROUP	No. Plots	Volume cu.m./ha	Standard Error cu.m./ha	F.M.U. Area ha	F.M.U. Volume cu.m. ('000)	SURVEY AREA Area ha	SURVEY AREA Volume cu.m. ('000)	HARVEST ZONE Area ha	HARVEST ZONE Volume cu.m. ('000)
SD	829			44s17		36677		32492	
Softwood									
Gross volume									
all species		285.91	+/- 4.ss		12727		104ss		9289
Sw nlv		262.45	+/- 5.06		11683		%2s		8527
Pulpwood									
All species		249.93	+/- 4.35		11126		9166		8120
Sw only		232.63	*l- 4.72		10356		8532		7558
Sawtimber									
Sw only		167.0S	+/- 4.ss		7431		6127		5428
R.M.E.		151.80			6758		2%7		42?2
Hardwood									
crow volume									
All species		37.s6	+/- 1.98		167s		MO		1223
Aspen only		15.34	●f- 1.57		682		%2		498
Poplar only		22.21	+/- 1.06		S43		448		394
Pulpwood									
All species		33.42	+/- 1.83		1487		1225		105
Aspen only		14.31	*/- 1.49		637		524		444
Poplar only		11.52	+1- 1.01		513		422		374
SH	ccl			tern		26501		23653	
Softwood									
crow volume									
All species		279.57	+/- 5.s4		8325		7408		6612
Sw only		269.54	+/- S.6S		8027		7143		6375
Pulpwood									
All species		250.93	+/- 5.09		74R		6649		5935
Sw only		242.91	w - 5.23		7334		6437		5745
Sawtimber									
Sw only		179.14	+f- 4.s2		5334		4747		4337
SAL		161.42			4s07		42n		3s18
Hardwood									
Gross volume									
All species		85.90	+/- 3.s0		2558		227s		2031
Aspen only		3s.41	+/- 3.01		1173		1044		V3t
Poplar only		31.ss	+/- 2.24		949		S4s		7s4
Pulpwood									
All species		77.04	+/- 3.2s		2294		2041		1222
Aspen only		36.23	+/- 2.80		107Y		960		857
Poplar only		30.10	+/- 2.13		Ss4		797		711
HS	330			21167		18433		954	
Softwood									
Gross volume									
All species		MOOR	w- 7.07		4039		3517		3235
Sw only		181.34	+/- 7.18		3838		3342		3074
Pulpwood									
All species		171.ss	+/- 6.59		3624		31ss		2902
Sw only		163.74	+/- 6.65		34ss		3017		2775
Sawtimber									
Sw only		123.84	+/- 5.81		eel		tte		2099
R.M.E.		104.36			2s0s		1ss3		1769
Hardwood									
crow volume									
All species		2ss.s3	*l- 7.12		3292		ts67		tu7
Aspen nlY		87.48	+/- 7.05		161		1612		1483
Poplar only		41.36	+/- 3.35		875		762		701
Pulpwood									
nll species		143.s	+/- 6.73		3034		SS46		2433
Aspen only		23.30	+/- 6.66		1742		Is17		1395
Poplar only		38.93	+/- 3.12		R4		717		660
HD	3217			109234		91539		86891	
Softwood									
Gross volume									
All species		80.96	+/- 3.00		8849		7443		7034
Sw only		73.63	*l- 2.88		8042		6769		S337
Pulpwood									
All species		66.10	+/- 2.64		7221		6077		5744
Sw only		60.s0	+/- 1.s3		6609		5563		2227
Sawtimber									
Sw only		3s.0s	+/- 1.83		38?3		3?18		3041
R.M.E.		26.82			2930		2466		?330
Hardwood									
Gross volume									
All species		?%s3	ef- 4.91		26863		22610		21369
Aspen only		S0.49	*f- 5.29		1s43s		13836		non
Poplar only		62.49	*1- 2.ss		6826		S74S		2434
Pulpwood									
All species		223.86	+/- 4.64		?43ss		20526		19399

IV. MANAGEMENT OF THE HARVEST

Proposed Initial Sawtimber Harvest

Past Surveys

Three previously published reports, Slaney (1), Wallace and Peaker (25) and Reid, Collins (2), all attempt to determine a suitable annual allowable cut for the Lower Liard Valley. Table 10 shows a summary of areas, volumes, yield and allowable cut calculations from each of the above mentioned reports. While each report used different units of imperial measure, all units have been converted to metric for presentation here. Comparing the results of these surveys is difficult due to varying survey areas, strata groupings and definitions of mature and merchantable timber.

The allowable cut figures presented by these authors should be viewed cautiously. In all the reports, heavy sampling of mature and overmature stands on the most productive sites bias the volume estimates. In addition, all included areas of the La Biche Timber District of the Yukon Territory. This area supports substantial volumes of mature and overmature white spruce that would not be included in any timber development of the Lower Liard unit. None of the reports attempted to deduct volumes that are inaccessible or located in areas that may be too sensitive for harvest.

The most questionable aspect of their allowable cut calculations lies in the determination of annual yield. The assumption that all immature areas will produce timber like that presently found in mature areas is unfounded. As described in part 11, the productivity of the land drops significantly with increasing distance from the alluvial floodplains: As mentioned earlier, the majority of sampling was conducted on the most productive sites and this gives rise to a biased estimate of mean annual increment from immature stands.

Bickerstaff et al (9) estimate the mean annual increment for this area to be 0.8 m^3 / ha, British Columbia Forest Service estimate the mean annual increment for the Boreal Biozone L (northeast B. C.) to be 1.4 m^3 / ha with estimates of 2.'4 m^3 / ha on medium sites.

The present inventory does not attempt to estimate growth and yield of immature areas as our map base is not reliable for the assessment of immature areas. Visual assessments of scattered immature areas were conducted as part of the field work and the

Table 10

Allowable Cut of White Spruce Sawtimber
Summary of Existing Reports

	Area ha	Volume M cubic meters	Yield cu m/ha/yr	Rotation years	AAC M cubic meters
F.F. Slaney[1]					
SO[2]	23 43[illegible]	6 957	1.4	140	76.8
Mixed[2]	12 5[illegible]	1 906	1.4	140	32.0
	36 03[illegible]	8 863			108.0
Reid, Collins[3]					
SO + SH					
Mature	70 179	19 725	[illegible].6	109	164.4
Immature	26 302	4 195	[illegible].4	109	34.0
Nonmerch Imm.	3 473	629	[illegible].5	109	4.8
	99 954	24 549			203.2
Northern Surveys Report No. [illegible][4]					
SO[5]	40 383	8 607	[illegible].9	150	80.0
SH[5]	73 432	2 555	[illegible].4	150	99.4
	113 815	11 162			179.4

[1] coniferous species over 10 cm dbhob.
[2] includes only height classes above 2[illegible] m.
[3] white spruce over 19.3 cm dbhob, .45 m stump to 15.0 cm top dib.
[4] white spruce over 10 cm dbhob.
[5] includes all heights and assumes yield at maturity correctly represents the productivity (present and future of the entire area).

results are discussed in the following section.

Immature Forest

Immature forest is defined as treed areas having stand heights in the classes 0, 1,2 and 3 (0,5, 10 and 15 m respectively). Field work was undertaken to gain insight into the productivity of these stands and their sawtimber potential.

Initial observations in 1979 determined that site IV stands would be generally unproductive and that site Ill areas were extremely variable and could not reliably be called productive or unproductive from the map base. Taking these initial observations into account. visual plot assessments (VPA) samples were allocated to stands in immature areas, with heavier sampling on site Ill areas.

Information gathered on VPA plots in 1980 and 1981 was divided into 5 sections:

1. Species composition - type and percent cover,
2. Growth rates - from increment cores of major species,
3. Soil - texture, drainage, and profile characteristics,
4. Regeneration - remarks" regarding white spruce regeneration and the amount of productive area in the stand,
5. General impressions - overall assessment of productivity, stand history, rooting depth, depth to permafrost, etc.

This information provided the criteria for deciding if the stand would grow to merchantable sawtimber size in a reasonable amount of time.

The assessment of productivity was essentially a yes/no response. The statistical results shown in Table 11 were calculated using formulas for the estimation of proportions, in this case, the proportion of productive area within the amount of sampled area.

The results obtained follow the general observations made in 1979. All, site 11's were considered productive areas for white spruce growth to sawtimber size. Conversly, all site IV areas were unproductive for such growth. Site Ill areas were considered productive when a hardwood component was present. As noted in the 1979 observations, the pure softwood stands were generally stocked only to black spruce or tamarack. Many of these stands were located in an area that had been completely burned over in 1942. Standing snags and fallen trees of sawtimber size were evidence to indicate that the area previously

Table 11 : Summary of VPA Field Results

		Site		
		II	III	IV
SO	Area sampled (ha)	57	638	320
	Productive area (ha)	43.5	243	0
	proportion (p)	,763	.381	0
	standard error	.056	.019	
	95% CI	(.653, .873	(.343, . 419)	
MX	Area sampled (ha)	944	1677	308
	Productive area (ha)	611	1172	120
	proportion (p)	.647	.699	.390
	standard error	.015	.011	s 02
	95% CI	(.617, . 677)	(.677, .721)	(.336, ,44
HO	Area sampled (ha)	631	496	20"/'
	Productive area (ha)	520	358	26
	proportion (p)	.824	.722	,126
	standard error	.015	.020	.11
	95% CI	(.794, . 854)	(.683, . 766)	(0, .34

proportion of total area that may be considered productive.
includes both SH and HS stands.

supported a white spruce stand suitable for sawtimber production. Hence, these areas were called productive despite the present vegetation of very dense white and black spruce only 1-2 m in height and at an age of 35-40 years. This same burned over area on the east side of the Liard River is the source of the majority of immature stands.

Pure softwoods in site III are the most difficult to interpret and assess for productivity. While low height stands of pure white spruce are common, their growth to sawtimber size is doubtful due to their extreme density.

In all categories other than SO, the hardwood component both enriches the site and reduces the density of the white spruce. In the SO category, many stands may be productive (ie supporting white spruce), but it would be unwise to rely on them to produce spruce sawtimber.

These visual assessments are only a preliminary look at the immature forest land base and cannot be taken as definitive of the present state. Most importantly, this assessment revealed the need for a detailed study into the growth of the immature areas in the Liard unit.

Allowed Cut

The total harvestable volume was determined by summing the product of the individual stratum volume by it's accessible area on each mapsheet in the survey area. Harvestable volume is defined as the white spruce Reliable Minimum Estimate in the SO, SH, and HS groups. Spruce sawtimber volume estimates in the HO group are not included as they are statistically extremely variable, however they can serve as a buffer or reserve crop.

The resulting harvest blocks (see map page 39) were so drawn in an attempt to divide the total volume into ten blocks of approximately equal volume. Due to the distribution of timber and the absence of natural or at least reasonable boundaries, some blocks are either smaller or larger than optimal. For equal distribution of volume, each block should contain 1 052755 m^3. As shown by Table 12, (page 38), blocks 3 and 10 deviate from this average by 14 and 18% respectively. The other eight blocks are within ± 10% of the desired average of 1 052755 m^3.

The recommended allowed cut is outlined below: "

Group	Area (ha)	Volume (k m])	Rotation (years)	A.A.C. k m^3 / year
SO	32492	4932	120	41.1
SH	23653	3818	120	31.8
HS	16954	1769	120	14.7
	73099	10519		87.6

On a rotation of 120 years, this allows an annual cut of mature timber of 87600 m^3 over an area of 609 ha.

Unlike previous surveys, the addition of increment from immature areas is not part of the allowed cut. In the previous discussion regarding the immature forest land base, it was shown that not all areas interpreted as being productive sites are really productive. This applies to pure softwood types in the site Ill areas. The area of these types in the Harvest zone alone is 53 526 ha, therefore, the inclusion of this area into the allowed cut calculations would be irresponsible. It is recommended, until such time that a detailed quantitative assessment of immature growth in the Liard is available. that the increment from immature stands be excluded from the allowed cut.

Due to the overmature nature of most of the white spruce in the Liard harvest zone. an initial increase could be made from the present 87 600 m^3 to 100 000 m^3. Initial cutting will presumably be in the southern portion of the unit where an annual cutting of 609 ha will yield a much greater volume than the average of 87600 m].

It is the opinion of this report that social concerns in the Liard valley overide any decision to maximize an allowed cut which aims only to prevent the loss of timber due to decadence.

Operational Cruising

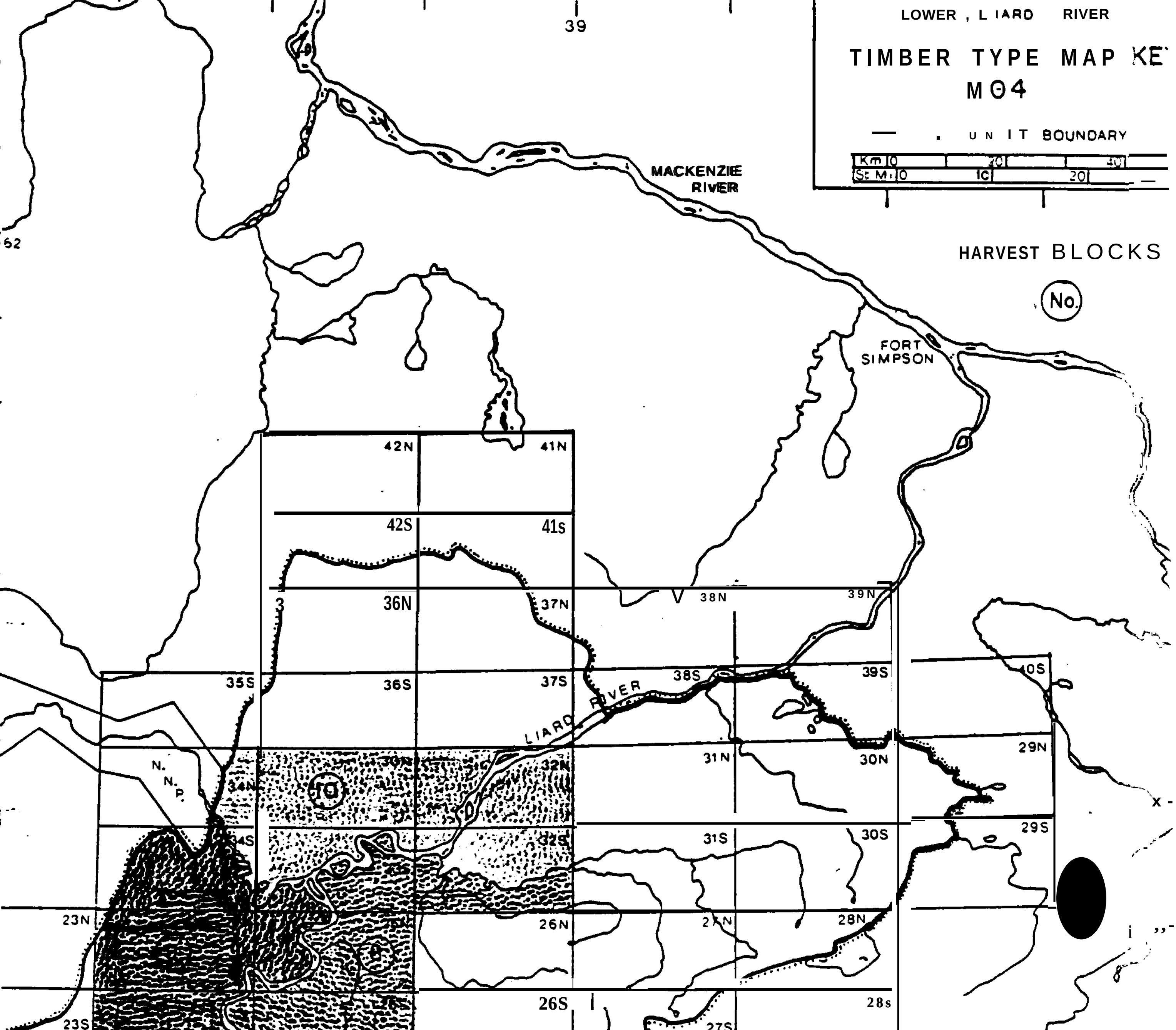
For effective forest management and harvest operations, it is necessary that operational cruises be completed annually in the stands planned for harvest. Operational level cruising will provide a more accurate estimate of the volume expected from each stand, and consequently, a better estimate of the annual harvest, since stratum estimates are not suitable for application to individual stands. In addition, operational cruises can yield useful information regarding access, topography, potential problems for harvesting or extent of spruce advanced growth.

Initial field work in devising a sampling method was completed and field testing undertaken in the Trout FMU in 1981.

Table 12: Lower Liard FMU - Harvest Blocks

Block	Area (hectares)	Volume (cubic meters)
1	9 002	1 046 587
2	6 815	1 101 783
3	8 278	1 201 179
4	8 642	1 145 839
5	8 432	1 023 802
6	6 441	1 026459
7	6 200	998 915
8	7 507	1 150 559
9	5 937	976 072
10	5 845	856 358
Total	73 099	10 527 553

total volume shown here is obtained by summing the individual stratum volumes on each mapsheet. The volume shown in the table on page 37 was calculated using group mean volume estimates, hence the slight difference in totals.



LOWER , L IARD RIVER
TIMBER TYPE MAP KE
M04
U N I T BOUNDARY
Km 0 20 40
St. Mi. 0 10 20
HARVEST BLOCKS
No.
MACKENZIE RIVER
FORT SIMPSON
LIARD RIVER
TROUT LAKE
N. N. P.
39
62
42N
41N
42S
41s
36N
37N
38N
39N
35S
36S
37S
38S
39S
30N
32N
31N
30N
29N
34N
31S
30S
29S
32S
23N
26N
28N
23S
26S
27S
28s
20N
17N
16N
15N
20S
17S
16S
15S
08N
11N
12N
13N
08S
11S
12S
13S
14S
04N
03N
01N
07S
04S
03S
01S

Briefly, the method allows the ease of systematic sampling, but introduces the element of randomness in plot location and location of survey lines. Details of the procedure involved will not be outlined here but are available upon request. Plot measurements are taken in the same manner as described in this report, and stand and stock tables by individual stands are produced using the statistical formulas appended.

Location of Timber Volumes

There are 5 major areas that contain merchantable stands of white spruce sawtimber.

1. West side of the Liard River, south of the Kotaneelee River (Maps 06N 06S).

This area has the greatest volume concentration of white spruce. The area is generally typed as mixedwood, but due to their mature, and overmature state, a stand conversion to white spruce is taking place. Survey results indicate that white spruce is the dominant species in both number of trees and per hectare volume. Height classes 5 and 6 predominate but scattered areas of depressional softwood and mixedwood types in height class 4 are present.

2. North along the Liard River from Fort Liard to Big Island (approx. 60°30'N) including the Petitot and Muskeg Rivers (Mare 05N, 10S, 10N).

South of the Petitot River (map 05 N), lie predominantly mixedwood stands of height class 4. The majority of these are interpreted as having an understory of aspen. Field observations have generally proven this understory to be heavy alder or willow. On the north side of the Petitot, softwood and mixedwood stands of generally 4th height class occur in a fluted pattern on the lacustrine benchland. The Muskeg River (map 10S) is bordered by mature softwoods, usually of height class 5, with an equal abundance of 4th and 5th height class mixedwood stands. On all 3 mapsheets, timber stands extending 3-5 km inland from each bank of the Liard River, and stretching north from Fort Liard to Big Island, contain mostly mature, and overmature mixedwood in the 5th and 6th height class.

3. North along the Liard River from Big Island to Blue Bill Creek including Flett Creek and Blue Bill Creek (Maps 18S 19S 19N 24S 25S).

The timber along the Liard River consists of a very narrow band (approx. 2 km inland from each bank) of mature mixedwoods. On the river banks and islands, stands of poplar-spruce are commonly 5th and 6th height class, with aspen-spruce stands of 4th height occuring inland.

This alluvial floodplain also supports overmature stands of poplar (height class 7). Inland, mature stands of aspen are present. Both hardwood areas often have white spruce understories.

Along the Flett and Blue Bill Creeks, softwood and mixedwood stands of 5th and 6th height class are found. Small tributaries of these creeks also support similar stands. In the alluvial floodplains (inside bank of the Liard River - maps 18S and 25S) there are generally poplar stands, many of which have a substantial white spruce understory. There are also large areas of pure spruce stands of 6th height class.

4. Alluvial Floodplains of the Liard north to Nahanni Butte and east to Blackstone River (Maps 25N, 32N, 32S, 33N, 33S).

Large areas of hardwoods (predominantly poplar) occur on the floodplains on map 25N. The majority of this area is two storied, having a substantial white spruce understory. In addition, many softwood areas are classed as stand structure 3, which means that a heavy hardwood component is present, with perhaps greater crown cover than the softwoods. In actual fact, much of this area should be classed as mixedwood. Stand ages in this area are generally mature, with spruce reaching ages of approximately 100-120 years. North of this hardwood area to the Nahanni-Liard River junction, on both banks of the Liard River, are softwood stands of 5th and 6th height class.

On the east bank of the Liard River, downstream from the Nahanni-Liard River junction, lies a large area of both softwood and mixedwood stands of height class 5 and 6. Much of the hardwood area here supports a white spruce understory while many of the softwood stands are structure 3 as described above. Again, much of this area could be classed as mixedwood.

It is suggested that the two storied and structure 3 stands on these mapsheets should not be harvested until the softwoods have had time to completely overtop the hardwoods. Essentially, these stands should be the last to be considered for harvest.

5. North along Nahanni River from Nahanni Butte to Nahanni National Park (Maps 34S, 34N).

Areas Immediately adjacent to the Nahanni River and the islands within the river, generally support softwood stands of height class 6 and mixedwood stands (mostly SH) of height class 5 and 6. These areas are mature to overmature. The hardwood stands (predominantly poplar on these alluvial plains) are interpreted to contain a white spruce understory. Mainly softwood types of height class 4 are present inland from the river 'to a maximum distance of 4 km.

V. PROTECTION AND RENEWAL OF THE FOREST LAND BASE

Environmental Requirements

Environmental Lines

The Harvest area, defined in part III, was determined by removing from the Survey area those areas which were felt to be impractical or environmentally unsuited for harvest operations. These excluded areas, bounded by their so called Environmental Lines, are marked on the applicable 1 :50 000 scale maps covering the survey area (see Map Folio). The placement of the lines on the maps was determined by the interpretation of 1 :25 000 scale aerial photos and the areas are identified on the maps in bold type as; EI, ES, or EH.

Definitions of the terms themselves give the rationale for the removal of area:

Environmentally Inoperative (EI) - for areas where topography is excessively rough, or where distances from ready access renders small volume stands uneconomic. The latter stands are not map identified.

Environmental Hydrology (EH) - for low lying areas, usually associated with streams, where harvesting could affect other uses such as fish spawn, trapping or wildlife.

Environmental Slope (ES) - for areas where slope is too great for ready harvesting and the danger of erosion from cutovers is too severe.

The labels EI and ES refer to areas that have been removed from harvesting. EH labels are discretionary, with some areas being removed from harvesting, while others are merely flag statements designed to bring attention to areas of possible conflicting use and environmental sensitivity.

The exact position of the environmental lines is somewhat subjective due to the scale of the photographs from which line interpretation was done. An on-site inspection may indicate that changes are warranted.

Environmental withdrawals more accurately reflect the judicious harvest area and remove stands that provide ‘ghost’ volumes, (volumes present, but not recoverable for a variety of reasons).

The summaries in Appendix 7 outline the rationale behind the environmental lines on each mapsheet.

Protection of the Land Base

It is Important to stress that first-rate planning for the harvest, the actual logging, wood extraction and subsequent reforestation activity must be done to minimize the loss of the productive land area. Logging activity seen elsewhere, such as dozing down to frozen ground at the start of breakup, before breakup makes movement impossible, will not be tolerated in the Liard. While this all too common practice enables truck access for the loading and removal of decked logs, the result of heavy dozing is to render that area unproductive. Similarly, the soil remaining on heavily dozed landing areas is lost from the productive land base.

Slope conditions and the construction of access roads may result in significant erosion. The removal of surface vegetation can create the potential for sheet or gully erosion. The lacustrine benchland east from the mountains to the river, and the morainal lacustro-till uplands in "the south of the unit, have areas of long sloping relief susceptible to erosion.

The Bovie Lake soil association is represented on sloping terrain and this coarse silty veneer is highly susceptible to erosion on the steeper slopes when vegetation is removed. Limiting the cut area may be required in this circumstance.

Erosion is a distinct hazard along the steeper side slopes of the Liard and along the tributary side slopes of the Muskeg and Petitot Rivers. Stream crossings should involve as little bank cutting as possible to minimize erosion.

The introduction of harvest machinery onto the lower terraces which are susceptible to flooding, must take soil and bank stability into consideration. In most cases, a buffer zone of vegetation must be left adjacent to all water bodies such as lakes, rivers and significant streams. Buffer vegetation also moderates the environmental conditions of both the water and shore areas.

Harvest activities such as summer logging or chain-drag scarification, may be possible in some areas, but hauling will undoubtedly be restricted to the winter months. Limited summer access may prevent many areas from being summer logged although it is conceivable that well drained sites will allow summer falling and skid-decking of logs for later haul on frozen ground.

Given the silty nature of a large part of the unit, roads used for summer access will not be usable for a number of days following a period of considerable rain. The access road and Pointed Mountain airstrip (lacustro-clay base) on mapsheet 09S are passable only when dry.

The Lower Liard is an area of discontinuous permafrost. Pure hardwood stands' do not support permafrost conditions, but softwood stands sometimes do. For example, the depressional channel scars in the Netla Association could become problem areas if summer operations are considered in adjacent timber stands.

Excessive surface drying can result if summer scarification or deepcut ripper winter scarification causes the removal of surface organics on such soils as Bovie Lake, Arrowhead and Poplar associations. These coarse silty lacustrine and alluvial soils have an inherent low moisture retention. Degradation of productivity can also be caused by the complete removal of the organic layer in Luvisolic soils like Celibeta and Pointed Mountain. The nutrient status of the top 15 cm of these soils is low. A retention of the organic layer can maintain a higher nutrient level.

A pre-harvest survey of the contemplated cut-block is necessary to plan the harvest with the aim of maintaining the land base. A post-harvest survey is necessary to prescribe the most appropriate method of site preparation to prepare for reforestation, and this should accommodate the aim of maintaining soil productivity.

Wildlife

Timber harvesting is an activity-that results in a large amount of site disruption. The vegetation cover on specific areas is partially or totally removed and human activity is increased. It is necessary to consider other area users when planning a harvesting operation to minimize possible controversy between users. Of prime concern to the local people in the Liard area is the impact that any harvesting operation will have on the wildlife population. Local people rely on wildlife for meat and furs and there appears to be a trend toward greater local use of the wildlife resource, Decker and Mackenzie (11).

Donaldson and Fleck (12) consider the moose population of this area to be in a stable condition, although specific population data on wildlife is sketchy. Moose favour low wet areas that have a high concentration of willow and other shrubs. Recent large scale fire disturbance has not taken place in this area and favorable moose browse sites are diminishing. Logging, while not equivalent to fire in returning vegetation to early successional stages, is a viable alternative. Site disturbance by logging or site preparation stimulates the growth of browse favoured by moose. Shrub and grass competition can however be detrimental to survival and growth of planted or naturally regenerated tree species. The actual harvesting operations themselves will have little direct effect on moose populations.

“ Other species such as Woodland caribou would not seem to be a problem because of their very low population in the harvest area.

Black bears would likely benefit from logging since cutover sites promote the growth of berry crops favorable to bear populations. Donaldson and Fleck (12) indicate that the usual denning sites for black bear are the islands of the Liard River. It is not likely that cut-blocks would be extensive enough at any one time to endanger this population.

The effect of logging on the wolf population is indirect, through the effect on their prey species. Logging can increase small animal populations which may in turn increase the predatory fur bearing population.

A definite problem is the greater access to previously isolated areas as the result of timber operations. This allows for a higher kill success rate for hunters. While populations of fur bearing animals are regulated by the Territorial Government, the moose population is not so protected. In the summer, the Liard River may offer some protection from vehicle access to the west side of the river. However, the extent of the moose population on that side of the river is not presently known.

Timber harvesting if properly conducted would appear to have little direct effect on the local wildlife populations. The effects would generally be favorable to browsing species, predatory hunters and bears. The monetary value of hunting and trapping may increase, especially if the ready access problem can be adequately dealt with. ,

Specific recommendations for the protection of wildlife populations follow:

1. Cutting would be limited in size to 50% of any one stand unless such stand in isolation is less than 10 ha. The residual standing timber would allow cover for game species as well as species such as martin, which require mature forests. Residual timber would not initially be removed for at least 20 years and likely much longer.
2. A minimum 100 m buffer zone of vegetation to be left next to all streams, creeks,

rivers, lakes. roads, and corridors between adjacent cut-blocks, as cover for wildlife and to protect bank areas from erosion.

3. Use of sensitive areas, such as willow runs, should be prohibited as access to a harvest area: browse areas should not be unnecessarily damaged.
4. Unrestricted access of hunters must be controlled to protect wildlife populations, ,in particular moose.

The Wildlife Service of the Government of the Northwest Territories has submitted planning guidelines to integrate wildlife and forest management programs. These guidelines appear in Appendix 1, but their appearance here does not necessarily indicate total endorsement by this report. It is important that the Wildlife Service be invited to make specific recommendations to any cutting operation in the Liard valley. Cooperation between the Wildlife Service and the forest management authority should result in optimal benefits to both wildlife and forest management programs.

Fisheries

The effects of timber harvesting on water bodies and their fish populations can be significant. When an unavoidable change in a habitat for fish species occurs frem logging,. - steps to restore the natural conditions should be taken as soon as possible.

Loading a stream with logging slash can increase the turbidity of the water, lower the oxygen content and present a physical barrier to fish migration. The presence of heavy slash can retard ice flow during spring breakup and any resultant ice jam can interfere with the early spring spawning habits of some fish species. McKinnon and Hnytka (20).

Some fish populations spawn in the spring and early summer from approximately May 1 to June 30, while others spawn in the fail from September 1 to November 15, Dryden and Stein (13). A typical spring spawning species is the Arctic grayling. Fall spawners found in this area are typified by the humpback or lake whitefish.

Migration of these species may occur over long distances and several months according to Dryden and such populations are particularly vulnerable to loss during migration and spawning. All logging debris, bank material and even ice bridges must be removed from streams as soon as it is practical but definitely before spring migration.

Semi-p~rmanent stream crossings should be designed to minimize interference with water flow. Bridge abutments shoud not change the normal passage of the stream. Dryden indicates a preference for bridging to the use of less expensive culverts. When economics dictate the use of culverts, they should be of the non-correlated type or buried sufficiently deep to leave the bed level and the stream unaltered. Culverts that are too small to carry the flow of a stream cause a local increase in water velocity, upstream pending, increased upstream siltation, a change in the temperature regime and a decrease in the oxygen content of the water. Any construction project should avoid the removal of gravel and sand material at sites adjacent to or in active streams.

Indirect problems caused by harvest operations relate to the removal of forest cover. A buffer zone of forest vegetation left adjacent to ail water bodies is necessary to prevent erosion and on smaller streams will help to maintain normal temperature regimes. Buffer vegetation can alleviate possible siltation of streams due to surface runoff from nearby cutover areas.

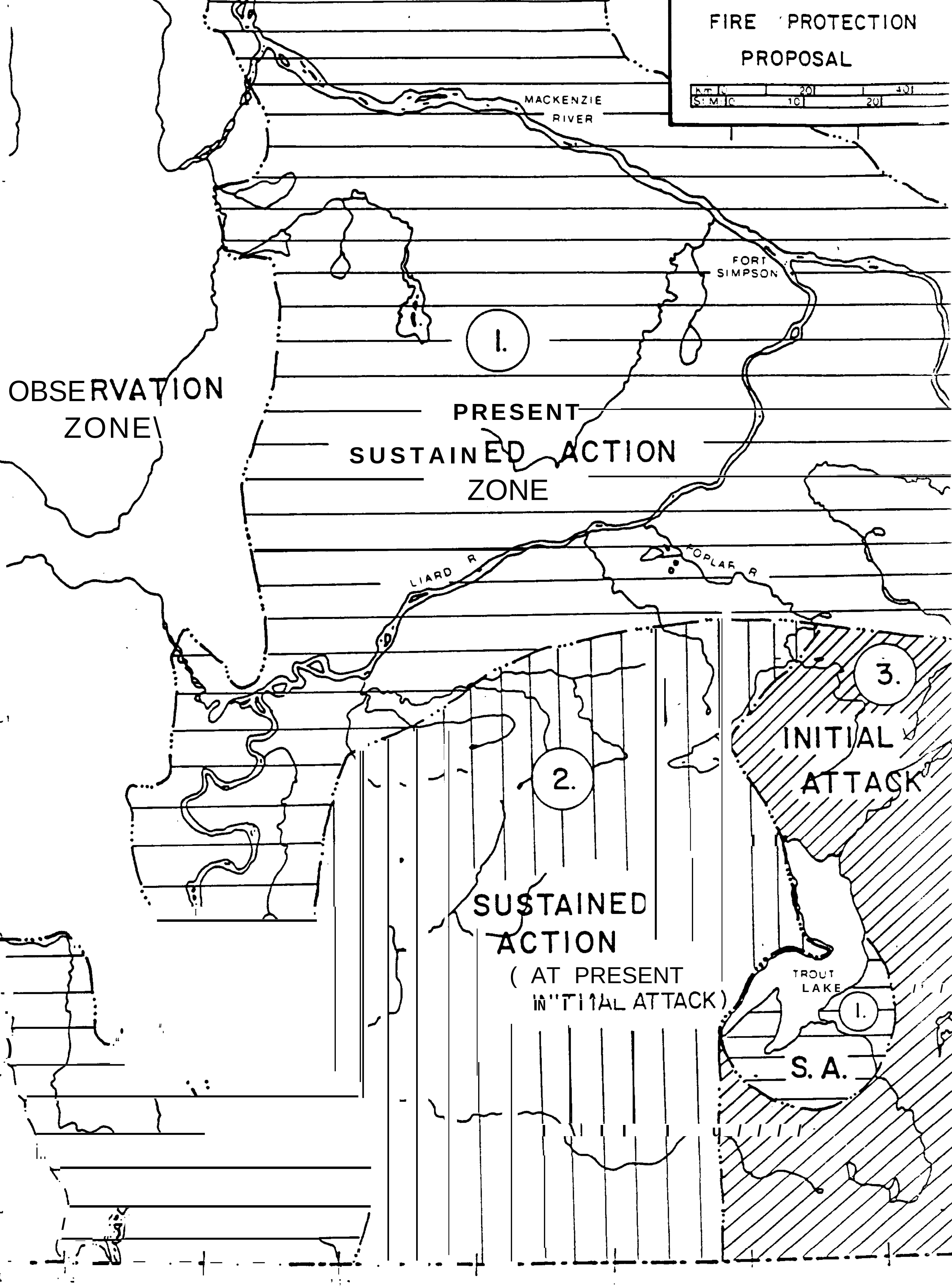
No information is available on the fish populations of the creeks and streams of the west side of the Liard River. Many of these tributaries have headwaters in the mountains and this may influence the kind of fish populations to be found in their waters. Many of the " smaller streams on this side of the Liard are dry during late summer months.

Fire

Action guidelines for wildfire protection throughout the Northwest Territories are based on a broad map division of operational zones. These zones are classed as sustained action, or initial attack with possible cessation of action, or observation zones involving no suppression activity.

Presently the mature timber resource of the Lower Liard is in a zone of sustained action as illustrated (area 1) on the sketch map on the following page. Area 2 on this map is presently zoned as initial attack but must be changed to one of sustained action. Area 3 is presently an initial attack zone and can remain as such for protection of the Liard timber.

It is the opinion of this report that the present zoning does not fully account for the value of the existing and potential timber resource for the eventual creation of a self-sufficient local economy. Early fires originating in the present zone of initial attack,


FIRE PROTECTION
PROPOSAL
KM 0 20 40
S.M. 0 10 20
MACKENZIE
RIVER
FORT
SIMPSON
1.
PRESENT
SUSTAINED ACTION
ZONE
OBSERVATION
ZONE
LIARD R
POPLAR R
2.
SUSTAINED
ACTION
(AT PRESENT
INITIAL ATTACK)
3.
INITIAL
ATTACK
TROUT
LAKE
1.
S.A.

given favourable weather conditions and a dry summer, could easily reach the present mature timber stands. In the same sense, fires originating in Nahanni National Park, should be prevented from endangering commercial stands that lie along the Nahanni River outside the park boundary.

A defensive strategy for the protection of the existing timber resource is called for and this can only be accomplished by enlarging the zone of sustained action. The danger of pulling committed resources from the present initial attack zone, to reinforce activity in a low value sustained action zone elsewhere, should be fully appreciated.

Silvicultural Requirements

Harvest Design

At the outset it should be emphasized that any proposed timber development plan must include provisions to maintain the forest resource of the Liard valley. Without a commitment to reforestation and appropriate environmental behaviour the development of this resource should not be allowed to proceed.

The basic premise of harvest is that no more than 50% of the area of merchantable timber is to be removed, in any one clearcut, “from the annual harvest-area. A total removal is acceptable for isolated stands of less than 10 hectares in area. Henderson (15) outlines the Alberta Forest Service guidelines for northern areas as:

1. No cut width in white spruce is to exceed 150 m to a maximum area of 35 ha on gently sloping or level terrain (AFS: Lowland).
2. On steeper slopes, widths can increase to 250 m, perpendicular to the contour, to a 35 ha maximum area.
3. Widths in lowland (level) areas can be wider than the above specifications but the maximum cut area is not to exceed 17 ha.
4. Where critical wildlife and watershed areas are identified, the above distances and areas can be altered.

White spruce seed dispersal from standing timber onto cutovers is about 100 m. Optimal (slope) conditions can increase this distance, but in general the cut unit width should not exceed 150 m.

The susceptibility of white spruce to wind damage (blowdown) on the coarse and fine silty lacustrine soiis or the clayey tills common to the Liard is not known. The Alberta experience has indicated surprisingly iittle blowdown on strip cut white spruce areas.[1]

Cut-blocks wili be scarified for naturai regeneration or pianting. Planting to overcome ieaf-fail smothering will be necessary on cut-blocks that retain heavy residuai stands of hardwood.

An exampie of residual hardwood voiume is given by stand 803 on mao 10S. Cutting 50% of the area of this stand (300 ha) and using stratum voiume averages, some 73000 m^3 of spruce sawtimber can be produced while 39 000 m^3 of hardwood puipwood wouid be left on the cutover. The metric volume of this hardwood, if stacked, wouid be equivalent to some 16000 cords of fueiwood. The presumed amount of hardwood left on this iand base wouid not oniy present a costly obstacle to site preparation, but also represents a tremendous waste of potential heat energy.

For the present, no concrete cut-biock specifications are suggested because of a reluctance to rely too heavily on prescriptions set down by other agencies. The Liard soil-sites may differ in certain respects from the Northern Alberta zone, hence the guidelines as outlined above may need modifications before being used in the Liard forest. Prescriptions for cut-biocks will have to be fully deveioped by the time any long term timber agreement is drawn for the Liard.

Site Preparation

Site conditions following a harvest operation must be conducive to recjeneration of the desired species if the forest is to be sustained. Debris left from logging and the surface. organic material usuaily requires disturbance to prepare the site for planting, or to create seedbeds receptive to seed germination. In nature, this is accomplished by wildfires which reduce the soiid materiais present, and thin the organic layer to provide a seedbed suitabie ,for natural regeneration. Where fire in not feasibie for seedbed preparation, some form of mechanical site preparation is required.

There are a variety of approaches to mechanical site preparation depending on the species" being regenerated and the accessibility and trafficability of the cutover. Many areas

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[1]Personal communication. C. Dermott, Refer. Div., Alta. For. Serv., Edmonton.

are not accessible, nor able to support heavy machinery until winter conditions provide frozen ground.

For those areas able to support tracked or wheeled vehicles (skidders) during summer conditions, there are a number of machine attachments available for site preparation. Disc trenchers, drum choppers, chain-drags, shark-fin drums and others are all designed to break up the slash from logging, along with unwanted shrub growth, and in most instances, to expose mineral soil.

If the site is properly prepared, natural regeneration to spruce from a standing seed source can take place. Factors such as: elapsed time since ground preparation; sufficiency of the seed crop; distance to seed source; and seasonal weather during and following germination will affect the success of regeneration on the cutover. Planting is often required to supplement inadequate levels of stocking from natural means.

Planting requires that a nursery be an integral part of the reforestation program. A local nursery is preferred so that 'hot lifts' of container reared seedlings (or bare root stock) are possible. Capital outlay for intermediate cold storage equipment between the planting site and nursery, is avoided by hot lifting.

Hand planting can be carried out on most terrain. Mechanical planting is restricted to topographically suited areas, and, because of the heavy machinery involved, the cutover must be accessible and able to support the necessary equipment. Winter scarification is the only means of providing ground disturbance for sites that are unstable or soft or lack access during the summer months. The ripper tooth plow allows for the trenching of frozen ground and is effective on deep duff areas. Care is required with this implement to avoid excessive gouging.

Winter scarification using the ripper plow on floodplain soils (similar to Liard Association) in the Yukon has had initial success.[1] These soils have a high-propensity to brush and grass production.

Duff (organic layer) disturbance is essential in cutovers of overmature white spruce stands on alluvial soils, which have not been subject to recent flooding, since a developed dense mat of feathermoss can often mean low soil temperatures with seasonal frost persisting well into the summer months.[1] Alluvial soils with better drainage and occasional

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[1] Personal communication. A.C. Gardner, Can. For. Serv., Victoria.
[2] Personal commumcation. J. Senyk, Res. Scientist, Can. For. Serv., Victoria.

flooding are usually warmer and do not require the intensity of duff removal.

Experience in the Fort Nelson area indicates that some heavily scarified terrace sites, with deep organic layers (20 cm), and underlain by compacted clay or silty clays (similar to Liard-Morainal uplands), have been receptive to an abundance of spruce seedlings on the exposed mineral soil. However, many of the resultant seedlings frost-heave (common 'on clay substrates), and the remainder show poor growth because of a nutrient deficient soil.[1] Retention of an organic cap to provide a nutrient source, and planting directly into the organic layer gave good results; seedling growth was satisfactory after planting with adequate size stock. Spot herbiciding is now a common practice for brush and grass control where these are create competition problems in planted or naturally regenerated areas.

In sum, techniques for obtaining natural or artificial regeneration are available. Treatments vary depending on the site conditions as previously discussed (see also Influences on Forest Regeneration). Decisions on the eventual method or treatment for a specific site are made by a pre-harvest survey.

Costs of treatment vary but the maintainance of the forests will not come cheaply. For example, present costs for chain-drag scarification are a low of S50.00 per ha, to a high of S 160.00 per ha for ripper plow winter scarification. Planting can cost anywhere from a low of S 125.00 per ha to well over $200.00.

Influences On Forest Regeneration

Since white spruce represents the chief commercial species in this area, the following discussion applies to this species alone. Reforestation of cutovers in the Liard area will present numerous difficulties such as periodic flooding of the river flats, early fall or late spring frosts, thickness of the duff layer, low soil temperatures, animal browse, grass and brush invasion, and aspen-poplar leaf fall from residual trees and surrounding stands.

Periodic spring flooding of river flats, if heavy and prolonged, may contribute to seedling mortality, Gardner (14). The extent of deposition of 'silty material during flooding will determine if the flooding is harmful to seedling growth. Sutton (24) reports that the growth of white spruce on floodplains of northern rivers may be related to the "periodic

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[1]Personal communication. J.R. Gilmour. Silviculturist. B.C. For. Serv. Victoria.

accretion of alluvium deposited by floodwaters. Any flood damage to the trees is more than offset by enhanced fertility". This will depend on seedling height and water levels. Both Sutton (24) and Lees (19) indicate that short periods (1 -3) days of flooding are not harmful to seedlings. although mortality will increase with duration and repeated immersion. Lees (19) also indicates that a positive relationship exists between increased seedling age and survival after periods of immersion.

Typical frost prone areas are depressions with an insufficient outlet for drainage of cold air. Gardner (14) reports that on planting trials in the Yukon, the most prevalent injury to seedlings was frost damage in the late spring when the current year's bud was killed during the early stages of flush. July planting with container stock may alleviate this problem.

The thickness of the duff layer will have several effects on seedling establishment and performance. The complete removal of the duff layer may lead to extreme drying of the surface susceptible to wind erosion, particularly with the silty nature of most of the Liard area. If the organic layers are thick, soil temperatures in the underlying mineral horizons may be very cool or cold which retards germination, rate of nutrient cycling and decomposition of organic material, Gardner (14). In addition, organic matter becomes a poor moisture retaining medium if exposed to prolonged direct sunlight as it dries out quickly .-However, it does reduce moisture loss from underlying mineral soil by acting as an insulating layer.

Animal browse, particularly the snowshoe hare, has been reported to be a severe problem in many parts of Canada, Bailey and McNalley (6). Late fall and early spring appear to be the times when browse on young seedlings is most severe. The extent of the hare population in the Liard area is unknown and only time will tell how much of a problem browsing will be to white spruce regeneration.

Grass and brush invasion after clearcutting will be the most common problems. The recent alluvial floodplains and abandoned floodplains are areas conducive to heavy moss (feathermoss), herb (horsetail, dewberry, bunchberry) and shrub (dogwood, alder, raspberry, wildrose, cranberry) growth. Invasion by these species is both quick and dense after land clearing as illustrated by photo 8, page 15, a seismic *line,* approximately 12 years old on mapsheet 07N.

Aspen and poplar leaf fall from standing residual trees on a cutover, or from surrounding stands, can have a smothering effect on young seedlings. Naturally regenerated spruce is a delicate plant for 3-5 years after germination and initial mortality can be severe from a heavy leaf fall.

Assessment of Regeneration

Bella (7,8) undertook the problem of estimating stocking standards for cutovers in Alberta by deriving the minimum number of trees per unit area that would ensure complete crown closure at a reference age of one half the rotation. In his analysis he accounted for the spatial distribution of the seedlings. The recommendations of this assessment were that the minimum number of well-dispersed seedlings on sawtimber stands be 610 per hectare for mixedwood types and 720 per hectare in pure conifer types. The respective stocking percentages by 1 millihectare ($10 m^2$) quadrats were 70 and 80%. The adoption of these standards in the Liard unit appears reasonable until such time as local conditions may dictate modifications, or until a new standard can be devised locally.

The Alberta forest regeneration survey field procedures (4), would also be recommended for use on cutovers in the Liard unit.

The timing of regeneration surveys is dependant upon the type of regeneration being relied on. If natural seeding on scarified sites is the primary regeneration technique, then surveys could be delayed until as late as the "7th year (as in Alberta). -If seeding or planting is used, surveys could be conducted much sooner. However, a cutover must be satisfactorily restocked to the recommended level with acceptable species within 10 years after harvest.

Proposed Development Area

A silvicultural beginning has to be made in the Northwest Territories. Silvicultural planning, with attendant cost analysis, should precede development of the Liard by a minimum of 3-5 years. Included in this advance stage would be a site location for a container nursery and, most importantly, a plan to implement reforestation.

It is proposed, subject to ground sampling verification, that stands contained in the northwest corner of mapsheet 26N (not included in the Harvest area) be open to harvest by permit. Small areas of map-identified merchantable stands lie within 1-3 km of the present highway and should they prove viable, could be offered for utilization to a small sawtimber operator. It would be understood by any permittee that such timber would be operated in a cut-leave block system. The logging operation should be conducted with the aim of providing cut-blocks suitable for later scarification, preferably using both summer and winter methods. Planting trials would be undertaken on unscarified and prepared sites. Other scarified cut-blocks would be left for natural or artificial seeding.

These stands represent tree growth on gently sloping to undulating lacustrine benchland, fine sandy loam and silty loam Arrowhead soils. The trials previously mentioned would give useful answers for much of the soil textures found in the Liard valley.

Problems exist in the utilization of small diameter wood with the usual portable style mill, so it may be necessary to support this proposal with some form of subsidy.

At present no scarification machinery nor plans to obtain such machinery exist in the N.W. T. Initially, expensive scarification equipment will have to be obtained by rental or loan if possible.

Any development trial would, by necessity, include the assistance, advice and expertise of the Canadian Forestry Service, Edmonton. The infrastructure, costs and co-ordination with the C.F.S. and or logging operator is not for discussion here, but this proposal must create the impetus for the necessary planning.

Management Considerations

The eventual management of any Liard valley conversion plant and harvest operation could assume one of a variety of ownership and contractual agreements. Regardless of the final management form taken, it is imperative that, at a minimum, a resident staff should include an experienced forester supported by a forest technician(s) responsible for the renewal aspects of the harvest. Their responsibilities would include the layout of cut-blocks, with due consideration for all environmental requirements, through to the re-establishment of a future tree crop.

The 'renewal' staff, along with qualified logging and plant supervisors, should be assembled at least one year in advance of any operation in the woods or conversion plant.

Time is needed for a decision(s) to establish the corporate structure of any Liard timber development. However, some independent apolitical steps can be taken reasonably soon to study and deal with: an update of the economics of operation as outlined by Slaney (1); provision of money to develop the infrastructure for silvicultural beginnings (development area); solicitation of designs for the most cost efficient miil suited to the timber and allowed cut; a study of the potential chip market-in northern British Columbia; a quantitative assessment of immature areas; and finally, initiation of a *serious* assessment of the viability of using a wood gasifier to supply the power and heat requirements for a log conversion plant.

Reference to the previous discussion on the residual volume of hardwood left on mixedwood areas after logging with the consequent waste of potential heat energy, points to the need to find a use for this wood material. One possible means to alleviate the problem would be wood gasification on a large scale.

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COMMON AND SCIENTIFIC NAMES

Plant*	
Alder	*Alnus* spp.
Aspen, trembling	*Populus tremuloides* Michx.
Birch, bog	*Betula gladulosa* Michx.
Birch, white	*Betula papyrifera* Marsh.
Bunchberry	*Cornus canadensis* L.
Cranberry, low-bush	*Viburnum edule* (Michx.) Raf.
Cranberry, small	*Vaccinum oxycoccos* L.
Dewberry	*Rubus* spp.
Dogwood, red osier	*Cornus stolonifera* Michx.
Fir, alpine	*Abies lasiocarpa* (Hook) Nutt
Grasses	*Gramineae* spp.
Horsetail, woodland	*Equisetum sylvaticum* L.
Moss, feathermoss	*Hylocomium splendens* (Hedw) BSG
Moss, sphagnum	*Sphagnum* spp.
Pine, jack	*Pinus banksiana* Lamb.
Pine, lodgepole	*Pinus contorta* Dougl.
Poplar, balsam	*Populus balsamifera* L.
Raspberry	*Rubus* spp.
Rose	*Rosa* spp.
Sedge	*Cyperaceae* spp.
Spruce, black	*Picea mariana* (Mill) BSP
Spruce, white	*Picea glauca* (Moench) Voss
Tamarack	*Larix laricina* (DuRoi) K. Koch.
Willow	*Salix* spp.

Mammals

Bear, black	*Ursus americanus*
Caribou, woodland	*Rangifer tarandus*
Hare, snowshoe	*Lepus americanus*
Marten	*Martes americanus*
Moose	*Alces alces*
Wolf, grey	*Canus lupus*

Fish

Arctic grayling	*Thymallus arcticus* (Pallas)
Humpback (lake) whitefish	*Coregonus clupeaformis* (Michill).

APPENDICES 1-7

LOWER LIARD F.M.U. - Summary of Survey Area

Productive and Non-productive Grouping by Mapsheet

MAP	PRODUCTIVE						NON-PRODUCTIVE											WATER	TOTAL
	Stocked	W.Fall/ Logged	Burn	Shrub	Treed Grass	Impro	Burn	W.Fall/ Shrub	Grass	Swamp	Treed Muskeg	Treed Rock	Rock	Slide	Sand	Flood	Impro		
05N	[illegible]612	96	0	613	0	0	0	86	2[illegible]	365	135	0	0	73	43	[illegible]	50	878	3[illegible]543
05S	37010	2	410	82	0	0	8	10	136	137	143	0	0	176	13	23	0	771	38921
06N	33433	0	0	2307	0	10	0	94	24	47	623	22	0	138	132	0	0	1888	38718
06S	2[illegible]694	64	[illegible]	[illegible]	0	0	0	1[illegible]3	123	106	189	0	0	0	2[illegible]2	13	0	1613	33699
07N	4334	0	0	0		0	0	1028	8	32	27	121	168	102	2	0	0	12	5834
07S	34	0	0	0	0	0	0	[illegible]	0	0	0	0	0	0	[illegible]	0	0	0	34
08N	12951	0	0	112	0	0	0	4123	0	7	203	2469	18	972	4	0	28	99	20986
08S	8574	0	0	324	0	0	0	3293	1	3	9	1258	255	229	19	0	0	108	14073
09N	33543	6	0	832	18	0	36	1797	13	81	484	848	11	366	3	1	125	225	38389
09S	31364	0	29	7	0	0	0	3379	101	184	1076	304	298	139	12	0	121	1495	38509
10N	32112	11	410	919	0	0	25	242	166	635	1199	0	0	0	59	16	0	2381	38175
10S	33821	29	247	1103	0	0	15	217	4	438	258	0	0	54	176	9	1	1976	38348
18N	34025	0	174	663	0	0	0	444	30	30	1744	0	0	0	23	22	0	953	38108
18S	34518	0	35	762	0	12	0	201	0	21	1674	0	0	0	6	58	0	807	38094
19N	30316	0	43	89	0	0	0	1109	49	56	70	1379	11	3344	425	0	98	948	37937
19S	32529	0	0	325	0	2	0	2637	0	47	34	939	0	590	193	3	0	810	38109
24N	29338	0	0	171	0	0	0	1905	177	78	1879	1673	0	1883	0	29	0	496	37629
24S	32872	0	0	202	0	0	0	812	0	217	978	79	0	1655	203	0	3	941	38[illegible]03

34N	6929	0	0	5	0	0	0	159	0	0	r)	126	0	0	81	0	0	110	7410
34s	22372	"27	0	92	0	0	0	530	0	25	83	276	0	136	223	0	56	945	24765
35	62 9	0	745	0	0	0	Q	0	0	0	49	0	0	0	Q	0	0	0	1473
36N	23740	5S	2918	O	0	0	0	219	114	132	2144	452	0	2613	0	0	8	700	33095
36S	23977	0	7293	63	0	0	219	265	0	17	1205	296	"""O	1918	0	o	0	348	35601
37N	3392Q	Q	n.--	48	0	0	1	251	177	·	2591	Q	Q	Q	Q	14	0	i14	'37169
37S	28450	9	3285	249	0	0	6	155	2	4	4421	0	0	0	3	27	0	704	37315
38N	5968	0	0	62	0	0	0	5	123	0	732	0	0	0	o	3	0	123	7016
38s	26573	0	0	106	0	0	0	403	0	141	1694	Q..	Q..	5	-..35	14.	116	27s3	31840
39s	13430	0	o	30	0	0	0	163	281	306	3149	0	0	0	0	i	46	1507	10912
40s	365	0	0	0	0	0	0	0	0	0	34	0	'o	o	0	o	0	0	399
41S	24777	0	0	203	0	0	24	909	0	561	1438	0	Q..	Q	0	5.	16	152	28085
42S	8678	0	483	31	0	0	89	91	22	6	525	41	0	362	0	0	o	41	10369
43S	328	0	0	0	0	0	0	0-	o	0	0	0	0	0"""-"	o	0	0	0	"" 328
TOTAL	1770481	306	22779	17758	18	159-----	_&...4	8697	9493	6430	185438	17267	8698	31038	3058	338..	975	50083	..2172742

21s	88	o	0	0	0	0	0	66	0	0	"O	259	0	141	0	0	0	0"	554
22S	162	0	0	4	4	C	0	66	0	0	0	10	0	713	0	0	0	Q	!355
23N	299	0	0	0	0	0	0	171	0	0	0	253	0	642	0	0	0	0	1365
23S	13441	0	0	169	0	0	0	1580	0	0	0	1212	585	5046	53	0	0	27	22117
24 N	29338	0	0	171	0	0	0	1905	177	78	1879	1673	0	1883	Q	29	0	496	37629
24S	32872	0	0	202	0	0	0	812	0	217	970	79	0	1696	203	0	3	941	38003
25N	32047	0	27	108	0	0	0	1698	1	177	755	0	0	24	11	95	2	2683	37622
26S	33461	0	52	460	0	0	0	843	30	186	1W	Q	O	0	33	9	10	1747	37864
26N	36629	0	0	149	0	0	0	19i	6	49	666	0	0	0	C	3	0	65	37758
26S	36362	0	38	20	0	0	0	54	0	10	1259	0	0	0	0	0	0	168	37911
27N	33263	0	598	103	0	0	55	111	? 5	13	31?5	Q	Q	Q	[illegible]	0 0	1	144	37758
27S	24843	0		87	28	0 0	41	51	211	56	1987	0	0	0	0	0	42	389	27735
28N	15503		0		0 0	0 0	0	41	25	0	6462	0	0	0	0	0	13	224	22268
29N	12207	0	0	64	0	0	0	138	56	0	1284	Q	Q	Q..	Q.	Q	1	53	13803
29S	4947	0	0	127	0	0	0	107	0	0	465	0	0	0	0	0	11	4	566i
30N	32086	0	5	22i	o	0	0	473	0	0	4469	0	0	'o	o	23	3	1B2	37462
30S	33068	0	0	209	o	(	0	588	31	37	3335	0	.0	.0	-----	0 0	0	343	37611
31N	29996	0	48	24	0	0	0	369	0	0	6844	0	0	0	0	0	6	i75	37462
31S	25285	0	80	45-	0	0	0	520	,0	8	1069	0	0	3	5	0	i1	585	37611
32N	30918	0	374	134	0-	.122	0	.33	3	6	2872	0.	.0	0-.	220.	0	8	2339	37339
32S	33252	0	0	115	0	0	0	518	i9	0	1555	0	0	15	117	0	45	1418	37454
33N	22078	0	2042	22	i)	13	12	340	14	0	521	147	"O	1610	0	0	0	335	37342
33-S	29918	4	[illegible]	37	0	0.	.0	1795	0.	-2.	3h7	168	0	8	142	0	18	416[illegible]	375[illegible]

21S	[illegible]	0	0	0	0	0	0	66	0	0	0	259	0	141	0	0	0	0	554
22S	162	0	0	4	0	0	0	66	0	0	0	10	0	713	0	0	0	0	955
23N	299	0	0	0	0	0	0	171	0	0	0	253	0	642	0	0	0	0	1365
23S	13441	0	0	169	0	0	0	1580	0	0	0	1212	589	5046	53	0	0	27	22117
24N	29338	0	0	171	0	0	0	1905	177	78	1879	1673	0	1883	0	29	0	496	37629
24S	32872	0	0	202	0	0	0	812	0	217	978	79	0	1696	203	0	3	941	38003
25N	32047	0	27	108	0	0	0	1698	1	177	759	0	0	24	11	95	2	2683	37632
25S	33461	0	52	460	0	0	0	843	30	186	1033	0	0	0	33	9	10	1747	37864
26N	36629	0	0	149	0	0	0	191	6	49	666	0	0	0	0	3	0	65	37758
26S	36362	0	38	20	0	0	0	54	0	10	1259	0	0	0	0	0	0	168	37911
27N	33263	0	598	103	0	0	55	111	345	13	3125	0	0	0	0	0	1	144	37758
27S	24843	0	87	28	0	0	41	51	211	56	1987	0	0	0	0	0	42	389	27735
28N	15503	0	0	0	0	0	0	41	25	0	6462	0	0	0	0	0	13	224	22268
29N	12207	0	[illegible]	64	0	0	0	138	56	0	1284	0	0	0	0	0	1	53	13803
29S	4947	0	0	127	0	0	0	107	0	0	465	0	0	0	0	0	11	4	5661
30N	32086	0	5	221	0	0	0	473	0	0	4469	0	0	0	0	23	3	182	37462
30S	33068	0	0	209	0	0	0	588	31	37	3335	0	0	0	0	0	0	343	37611
31N	29996	0	48	24	0	0	0	369	0	0	6844	0	0	0	0	0	6	175	37462
31S	35285	0	80	45	0	0	0	520	0	8	1069	0	0	3	5	0	11	585	37611
32N	30918	0	374	134	0	122	0	343	3	6	2872	0	0	0	220	0	8	2339	37339
32S	33252	0	0	115	0	0	0	518	19	0	1955	0	0	15	117	0	45	14.8	37454
33N	32078	0	2042	22	0	13	12	340	14	0	521	147	0	1818	0	0	0	335	37342
33S	29918	4	0	37	0	0	0	1796	0	2	367	168	0	894	142	0	18	415[illegible]	37509

10N	32112	11	410	919	0	0	25	242	166	635	1199	0	0	0	59	16	0	2381	38175
10S	33821	29	247	1103	0	0	15	217	4	438	258	0	0	54	176	9	1	1976	38348
11N	31502	0	206	193	0	0	0	15	86	21	5648	0	0	0	0	0	14	665	38350
11S	33487	0	647	93	0	0	0	0	179	76	3468	0	0	0	24	0	0	521	38495
12N	29252	0	379	128	0	0	0	0	214	9	7900	0	0	0	0	0	18	450	38350
12S	32485	0	382	309	0			0	72	15	4901	0	0	0	2	0	0	329	38495
13N	18355	0	0	11	0	0	0	122	76	0	3586	0	0	0	0	0	0	47	22197
13S	24793	0	166	755	0	0	0	0	404	71	8800	0	0	0	0	13	0	273	35275
14S	8043	0	0	104	0		0	0	20	0	377	0	0	0	0	0	0	88	8632
15N	3207	0	0	[illegible]	0	0	0	[illegible]	130	11		0	0	0	0	0	0	128	5062
15S	12132	0	97	485	0	0	0	0	239	8	6267	0	0	0	0	0	0	229	19457
16N	18245	0	17	0	0	0	0	31	391	14	10430	0	0	0	0	0	0	84	29212
16S	28267	0	6	85	0	0	0	360	35	36	9238	0	0	0	0	0	0	178	38205
17N	35312	0	234	98	0	0	0	496	122	29	1701	0	0	0	0	0	0	[illegible]	[illegible]
17S	34432	0	140	5	0	0	0	217	106	13	2976	0	0	0	0	0	0	316	38205
18N	34025	0	174	663	0	0	0	444	30	30	1744	0	0	0	23	22	0	953	38108
18S	34518	0	35	762	0	12	0	201	0	21	1674	0	0	0	6	58	0	807	38094
19N	30316	0	43	89	0	0	0	1109	49	56	70	1379	11	3344	425	0	98	948	37937
19S	32529	0	0	125	0	2	0	2637	0	47	34	939	0	590	193	3	0	810	38109
20N	28069	3	0	311	0	0	18	3411	0	0	22	2089	197	3643	208	0	24	65	38060
20S	21378	0	0	84	0	0	0	3855	0	0	0	2069	6773	843	385	0	0	123	35510
21N	22[illegible]1	0	104	30	0	0	47	1036	0	0	0	777	378	2460	0	0	4	6	7123

LOWER LIARD F.M.U. - Summary of F.M.U. Area

Productive and Non-productive Grouping by Mapsheet

MAP	PRODUCTIVE						NON-PRODUCTIVE											WATER	TOTAL
	Stocked	W. Fall/ Logged	Burn	Shrub	Treed Grass	Impro	Burn	W. Fall/ Shrub	Grass	Swamp	Muskeg	Treed Rock	Rock	Slide	Sand	F hid	Impro		
01N	12350	0	56	58	0	0	0	85	196	0	3927	0	0	0	0	0	0	34	16706
01s	23068	0	'74	96	0	0	61	136	348	22	2860	0	0	0	0	0	11	327	17003
02N	25897	0	126	287	0	0	0	272	1152	7	10635	0	0	0	0	0	0	265	36641.
02s	25858	0	45	130	0	0	0	1387	671	337	10016	0	0	0	0	0	16	326	38786
03N	22368	0	241	89	0	0	9	376	1237	1223	100EIO	0	0	0	0	0	'o	3018	38641
03s	27820	0	103	57	0	0	0	1254	718	123	8003	0	0	0	0	o.	24	684	38766
04N	32688	0	136	32	0	0	0	295	638	41	3082	0	0	0	0	9	25	1655	38641
04s	33565	0	142	254	0	0	0	547	79	101	2875	0	0	'-0	1	0	0	1222	38786
05N	36120	96	0	613	0	0	0	86	22	365	195	()	. . .	0	73 ... 43	8	50	878	36549
05s	37010	2	410	82	0	0	8	10	136	137	143	0	0	176	13	23	0	771	33921
06N	33433	0	o	2307	0	10	0	94	24	47	623	22	'0	138	132	0	0	1888	38718
06S	28694	64	55	2525	0	0	0	109	129	106	189	0	0	0	202	13	0	1613	.33699
07N	4334	0	0	0	0	0	0	1028	8	32	27	121	168	102	2	0	0	12	5834
07s	34	0	0-o		0	0	0	0,	0	0	0	0	0	0	0	0	0	0	34
08N	4.2951	0	0	112	0	0	0	4123	0	.1	203	2465	18	922	4	0	28	99	20986
08s	8574	0	0	324	0	0	0	3293	1	3	9	1258	255	229	19	0	0	108	14073
09N	33543	6	0	832	18	0	36	1797'	13	81	484	840	11	366	3	1	125	225	38389
09S	31354	0	29	7	o	0	0	32"?9	M	184	1076	304	.....	296	135	12	0	121	1495	38509

GENERAL PLANNING GUIDELINES TO INTEGRATE WILDLIFE AND FOREST MANAGEMENT PROGRAMS

A. Cut Block Design

1. Clear cuts should not exceed 100 meters in width and all cut blocks should simulate natural openings. Forest wildlife are reluctant to forage in open areas and prefer to remain at the edge of clearings where there is ready access to protective shelter. The 100 meter rule is a compromise between the optimum foraging radius for moose and the widest clearing that marten will cross. A management strategy that satisfies the requirements of these two species will probably be suitable for a wide range of forest dwelling species. Wildlife habitat can be created by maintaining an interspersion of residual patches. These patches should provide travel corridors and be interconnected using physiographic land form features where possible.

2. Where it is not possible to establish discrete cutblocks that have maximum widths of not more than 100 meters, larger cutovers may be considered if shelter patches (islands of vegetation} are distributed thoughout every cut block so that the distance between the patches, and the patches and the edge, does not exceed 100 meters. Shelter patches should consist of undisturbed areas of timber that are not less than 200 meters wide when measured in any direction across the patch. No cutover should be larger than 20 hectares.

3. Cut blocks should have irregular boundaries to create maximum edge effect; long, linear cutovers should be avoided.

4. Cut blocks should have their long axis at right angles to the prevailing wind direction. This orientation reduces the amount of fetch and the degree to which snow characteristics (eg., hardness and depth) are affected by wind. The degree of openness to the wind is also important consideration in setting the maximum cut-block size at 20 hectares. Orientation and size of cut blocks are also important planning variables for ensuring wind firmness of uncut residual areas.

5. All nonmerchantable timber should be left standing to facilitate greater habitat diversity. Stands of dead timber form important microhabitats and foraging areas for wildlife.

6. Leave 200 m residual areas (buffers) between all cut blocks regardless of shape or size, to provide cover for resting wildlife and for travailing (eg. seasonal travel corridors/game trails). Buffers between cut blocks should be contiguous with buffers along roads, lakes and rivers. As cutting operations proceed, a lattice-like configuration of cutovers and buffers will develop as a result of the juxtaposition of cutovers and buffers.

7. Plan cutting of residual areas when regrowth on cutovers is 4 m or more in height. The time interval between successive cutting operations will vary between sites. If a return interval of 30 to 50 years between successive logging operations is adopted, a three tiered scheme, in which there is even distribution between early, middle and late successional stages, is recommended.

B. Critical Wildlife Habitats

A constraint mapping system to show areas exempted from cutting should be developed to identify critical wildlife habitat areas. This may be accomplished by the overlay method whereby critical areas are overlayed on a base map showing the proposed cutting areas.

1. Areas of concentrated population density, mineral licks, calving areas, nesting sites, and denning sites are examples of areas where special cutting restrictions should be applied on a site-specific basis. Cutting near such places should ensure that there are travel corridors to connect habitat areas. The place and time of cutting in relation to each site will have to be considered independently; however, timber within a radius of 300 meters should remain undisturbed.

2. Raptor nesting sites near cutting areas will require special planning in cutblock design. The presence of a nesting tree will require an undisturbed buffer of not less than 200 meters between it and the edge of the nearest cutover. Where

summer operations are contemplated, timing restrictions will be required to defer cutting in the area during critical reproduction periods.

C. Buffer Strips

1. Shelter buffers not less than 200 meters wide should be left on either side' of rights-of-way. The width of buffers should reflect the resistance to wind-throw in individual stands. Shallow-rooted trees may require buffer strips much wider than the recommended minimum in order to prevent blow-down.

2. Selective cutting to remove over-story trees along the edge of buffer strips can strengthen resistance to blow-downs and improve the edge effect. Cutting within buffers should not be undertaken unles the degree of disturbance can be minimized.

3. Cutting should not be permitted within 200 meters of the strand line of any lake of river. Riparian habitat must be left undisturbed because vegetational deveiopment there, is critical for moose, some fur bearers, small mammals, and numerous species of avifauna. Access roads may of necessity transect riparian areas but right-of-way alignments should be kept out of pr-otective buffers along lakes and water courses.

D. Road Design

Right-of-way selection and road design should be subjected to careful review. Poor or faulty road design could have detrimental effects on aquatic and terrestrial biota. Road construction and operation and maintenance, together with retirement and restoration of abandoned right-of-way, should be considered with each cutting plan.

1. Right-of-way width should be kept to the minimum width that is technically practicable under design specifications for roads classified as primary, secondary or tertiary.

2. Secondary and tertiary roads should be closed immediately upon termination of their usefulness for timber hauling. A network of post-logging roads could lead

to local over hunting and other disturbance of wildlife.

3. Local wildlife managers and HTAs should be consulted in right-of-way planning to avoid conflicts With hunting and trapping operations. Planning to reopen existing roads should include consultation with the above groups.

E. Post-Cutting Treatment of Cutovers

1. Where scarification techniques are used for seedbed preparation, side casting of slash into rows should be avoided.

2. Extremely close grooming of cutovers should be avoided. Tree tops and slash that extend above the snow surface provide access to beneath snow foraging and nesting areas for small mammals and some furbearers.