AN AERIAL RECONNAISSANCE OF SOFTWOOD REGENERATION ON MIXEDWOOD SITES IN SASKATCHEWAN

W.J. BALL AND V.S. KOLABINSKI

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NORTHERN FOREST RESEARCH CENTRE
CANADIAN FORESTRY SERVICE
ENVIRONMENT CANADA
5320 - 122 STREET
EDMONTON, ALBERTA, CANADA
T6H 3S5

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ABSTRACT

Forty-nine townships (4566 km^2) near Hudson Bay, Saskatchewan, were examined for softwood regeneration using large-scale color imagery at an approximate average scale of 1:830. Softwood regeneration $\geqslant$1 m in height was readily detected beneath a leafless mixedwood canopy and in the open using a conventional pocket stereoscope. Clusters of approximately 75 quadrats per stereogram were interpreted in terms of 11 forest cover types.

Data from 1665 plots (averaging 0.138 ha) distributed 230 m apart over nine physiographic regions indicated that areas not stocked to softwood reproduction occurred as frequently as those satisfactorily stocked—on two-thirds of all plots.

Data from 123 899 quadrats (averaging 17.3 m^2) indicated that slightly more than one-third of the area was occupied by hardwoods $\geqslant$10 m in height, one-fifth of the area was stocked to softwoods $<$10 m in height, one-sixth of the area was unstocked to softwood regeneration, and less than one-tenth of the area contained softwood timber.

RESUME

Les auteurs ont examiné la régénération des résineux dans 49 townships (4566 km^2) près de la baie d'Hudson, en Saskatchewan, à l'aide d'images en couleur à une échelle moyenne d'environ 1/830. La pousse de régénération des résineux d'au moins 1 m était facilement décelable sous un couvert d'arbres mélangés sans feuilles et à découvert, à l'aide d'un stéréoscope de poche ordinaire. Environ 75 quadrats par stéréogramme ont été interprétés en fonction de 11 types de couvert forestier.

Les données pour 1665 parcelles (de 0,138 ha en moyenne) réparties à 230 m d'intervalle dans neuf régions physiographiques indiquent que les régions non pourvues pour la reproduction des résineux sont aussi nombreuses que celles qui le sont de façon satisfaisante—sur deux tiers de toutes les parcelles.

Les données pour 123 899 quadrats (de 17,3 m^2 en moyenne) indiquent qu'un peu plus du tiers de la superficie est occupé par des feuillus mesurant au moins 10 m, que le cinquième est pourvu en résineux d'au moins 10 m, que le sixième n'est pas pourvu pour la régénération de résineux et que moins du dixième de la superficie est occupé par des résineux susceptibles de produire du bois d'oeuvre et d'industrie.

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INTRODUCTION

White spruce (*Picea glauca* (Moench) Voss) sawtimber has been harvested heavily in Saskatchewan during this century. White spruce lumber production peaked at 368 160 m^3 (157 million foot board measure) in 1912 and at 324 500 m^3 (137.5 million fbm) in 1920; it reached the 1920 level again in 1946 (Kabzems 1959, 1971; Anderson 1976). Current 1978-79 production is approximately 351 750 m^3 (150 million fbm).

The Hudson Bay area of eastern Saskatchewan (Figure 1) has a complex logging history. Most of the mixedwood stands have been selectively cut for spruce sawlogs on one or more occasions. Until 1955 the smallest trees logged were 35.6 cm in diameter at breast height. Since that time, diameter limits have been lowered progressively to 30, 25, and 20 cm and smaller (Kabzems 1971). In this area many thousands of hectares of once highly productive sites are considered to have been degraded to brush and low-value hardwoods following a long, steady period of diameter-limit cutting and infrequent but extensive burns.

Surveys cited by Jarvis *et al.* (1966), Candy (1951), and Rowe (1972) have shown that white spruce regeneration is scarce in both disturbed and undisturbed stands in the Mixedwood Forest Section. Recent regeneration surveys (Price 1973, 1974) show cutover lands in the Hudson Bay region to be understocked to coniferous species following recent logging.

The potential productivity of forest lands on the Hudson Bay map sheet (National Topographic System) is the highest in the province, with 75% of the area in classes 3 to 5 in terms of the Canada Land Inventory. Mean annual increments range from 2.2 to 6.3 m^3/ha (31 to 90 ft^3/acre) (Kabzems *et al.* 1972). It would seem advisable that currently unproductive high-quality sites that are not satisfactorily regenerated (NSR) be restored to full productivity. Before this can be done, the amount and location of NSR land must be determined.

Conventional regeneration surveys are costly and limited, however. Since the use of large-scale (1:100 to 1:1000) color aerial photos had been tested in Alberta (Kirby and van Eck 1973) and in Manitoba (Kirby and van Eck 1975) to assess forest regeneration in softwood clear-cuts, it was decided to test its practicality on these disturbed mixedwood sites in Saskatchewan.

In 1975 five trial strips that had been selected for access and logged-over condition were flown in the Hudson Bay area. Stereo pairs were spaced about 160 m apart; scale of color contact prints averaged 1:500 over 48 km of flight lines. Percentage stocking from photo estimates on 88 selected plots was highly correlated ($r = 0.94$) with ground tallies based on softwood seedlings $\geqslant 30$ cm in height and 4-m^2 quadrats (Ball 1976 in Kirby 1978).

STUDY AREA

The study area is located in the eastern portion of the Mixedwood (B.18a) Section of the Boreal Forest Region (Rowe 1972). Plots were distributed over nine physiographic regions as described by Ellis and Clayton (1970). Ecosystems encountered are well described in Kabzems *et al.* (1976).

Many of the mixedwood stands have been partially cut over on one or more occasions; often the remaining hardwood mixture of aspen (*Populus tremuloides* Michx.) and balsam poplar (*Populus balsamifera* L.) resembles a hardwood forest with openings rather than a cut block with residuals.

Access is a problem throughout most of the area. Many of the bush roads are impassable after a day's rain. Flooding is a problem on wetter sites that were harvested in the winter. The water table frequently rises following logging, particularly on landings.

Other types of disturbances encountered in the area include aspen and white spruce clear-cuts and several areas burned over in 1961, such as the Bertwell burn, which has been planted mainly to white spruce, and the Jim Lake burn, which appears to be stocked densely with black spruce (*Picea mariana* (Mill) B.S.P.).

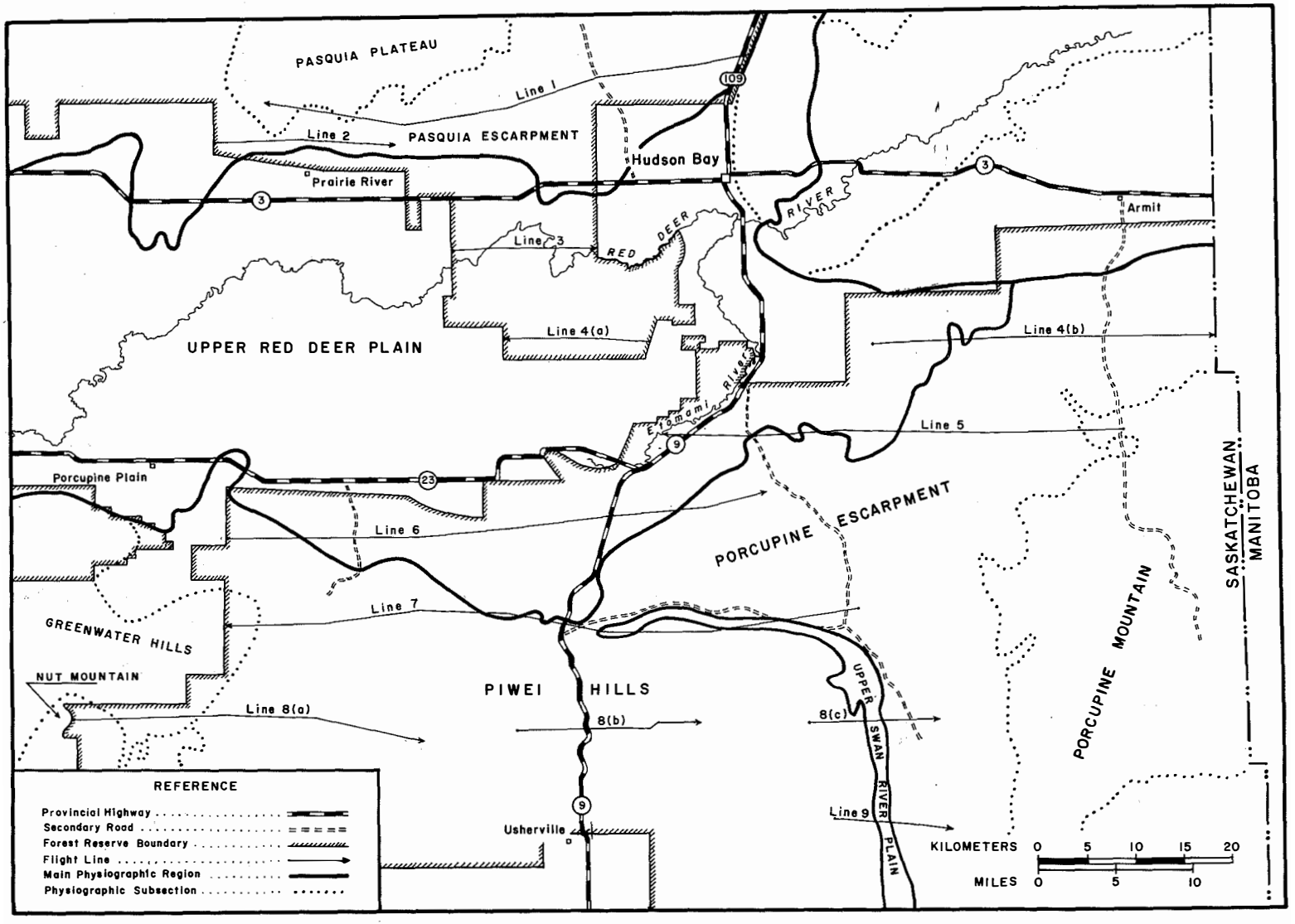

Figure 1. The study area, showing physiographic regions (after Ellis 1970) and locations of flight lines.

METHODS

Nine flight lines (Figure 1) were flown through 49 townships in early May 1976, when deciduous trees were leafless and snow cover absent. Two 70-mm Vinten cameras connected to an intervalometer provided simultaneous two-stage imagery: color at approximately 1:830 with a 281.9-mm lens at 230-m intervals, and black and white at approximately 1:5000 with a 44.5-mm lens. A radar altimeter provided by the Forest Management Institute was unable to provide scale as intended due to a damaged antenna.

Large-scale stereograms were located on the 1:5000 imagery, which was then used to locate flight lines on conventional (1:15 840) township maps. Forty accessible plots were ground sampled to determine scale, stocking, and site conditions. Color contact prints from the 70-mm Vinten camera were overlaid with a transparent grid (50 x 50 mm) subdivided into 100 equal quadrats. At an average scale of 1:831, each 25-mm^2 quadrat represented 17.3 m^2 on the ground. At this scale approximately 75 quadrats per plot were obtained in stereo, which were interpreted in terms of 11 cover types, defined in Appendix II.

The quadrat size of 17.3 m^2 was considered reasonable for a reconnaissance-level study. As well, use of the traditional 4-m^2 (1 milacre) quadrat in regeneration surveys is giving way to larger quadrat sizes. Alberta has recently increased quadrat size from 4 to 10 m^2, and Sweden also uses a 10-m^2 quadrat (Häggström 1977). Bella (1976) and Bella and De Franceschi (1978) recommend the use of 10-, 12- and 12.5-m^2 quadrats to ensure the minimum number of well-dispersed seedlings when seedling patterns are clumpy.

RESULTS

Large-scale photo plots fell approximately 230 m apart over 375 km of flight line. Scale on 40 ground-sampled plots averaged 1:831; average plot size at this scale was 0.138 ha. Plots fell in nine physiographic regions (Appendix I); however, four regions—the Red Deer Plain, Porcupine Escarpment, Piwei Hills, and Pasquia Escarpment—contained 92% of the plots. Data from 1665 plots (123 899 quadrats) were recorded and sorted by computer.

Of all quadrats, 22.8% were typed as unproductive[1] for forestry (Figure 2), and these were distributed over 31.5% of all plots (Appendix III, Table 2).

Softwood regeneration, which was distributed over 65.5% of all plots, occurred on 21.6% of all quadrats. Of the potentially productive forest land, 27.9% was stocked to softwoods less than 10 m in height (Figure 3). Slightly more than half of the softwood reproduction occurred as an understory beneath a poplar canopy (Appendix III, Table 1).

Softwood sawtimber (greater than 10 m in height) was relatively uncommon; 17 of the 49 townships sampled had fewer than 5% of their quadrats in S, SH, and HS types combined (Appendix II). Such sawtimber was found on 9.6% of all quadrats (Appendix III, Table 1) and was distributed over 40.4% of all plots (Appendix III, Table 2).

Of the productive forest land, 21.6% was interpreted as not sufficiently regenerated to softwoods (Figure 3). Such NSR quadrats occurred on 66.4% of all plots (Appendix III, Table 2).

Hardwoods greater than 10 m in height occurred on 36.1% of all quadrats (Table 1). Almost half of the productive forest land was occupied by hardwoods, one-third of which had a softwood understory (Figure 3). Hardwoods with no softwood understory occurred on 64.2% of all plots, while H/s quadrats (containing both hardwoods >10 m and softwoods <10 m) occurred on 53.4% of all plots (Appendix III, Table 2).

The Upper Red Deer Plain region contained the greatest backlog of NSR land. Of

[1] Thirteen subtypes in this category are listed in Appendix II.

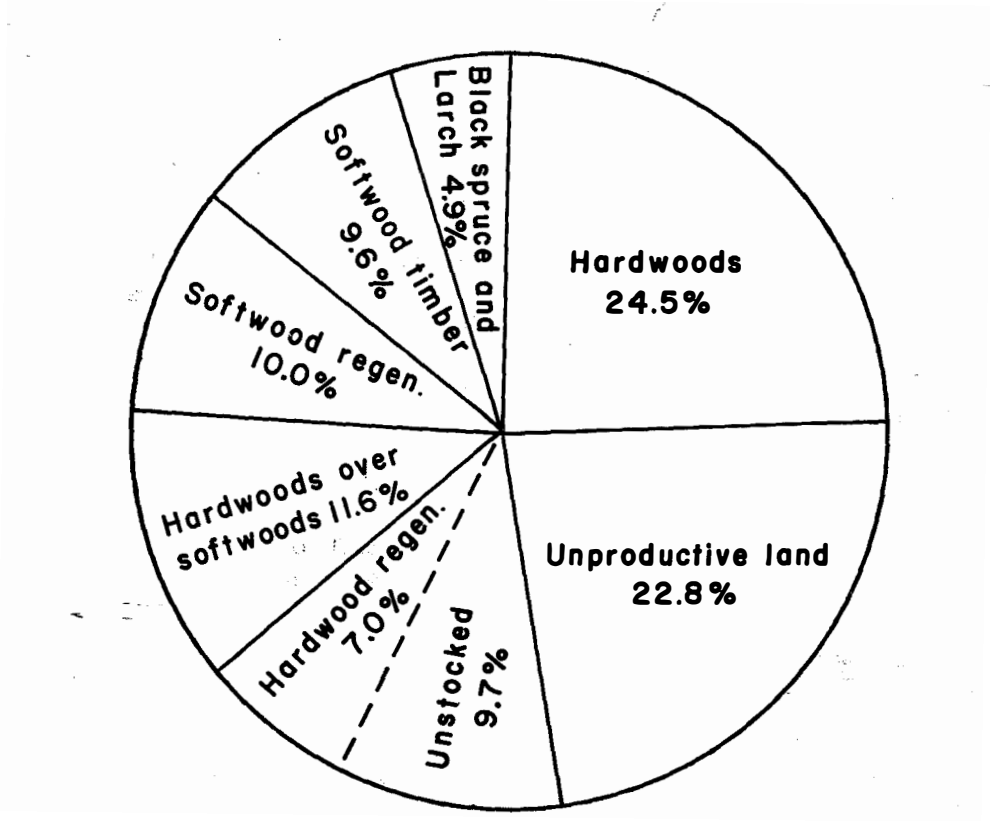

Figure 2. Total forest land.

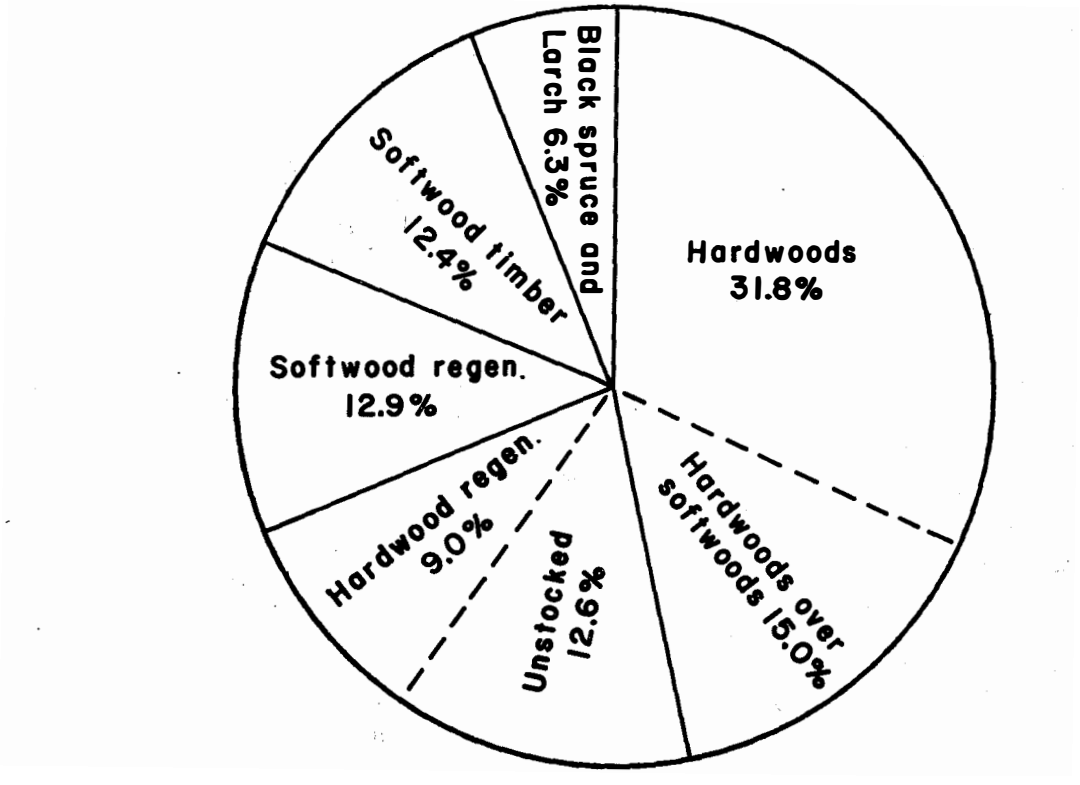

Figure 3. Productive forest land.

Table 1. Distribution of cover types over the study area

Type	Quadrats	Percentage of total land	Percentage of productive land
Unstocked[1]	12 014	9.7	12.6
Hardwood regeneration	8 639	7.0	9.0
NSR (softwoods)	20 653	16.7	21.6
Softwood regeneration	12 358	10.0	12.9
Softwood understory	14 344	11.6	15.0
Softwood reproduction	26 702	21.6	27.9
Mixedwood HS	1 431	1.1	1.5
Mixedwood SH	1 590	1.3	1.7
Softwood S	8 817	7.1	9.2
Softwood timber	11 838	9.5	12.4
Hardwood H	30 377	24.5	31.8
(Hardwoods over softwoods)[2]	(14 344)	(11.6)	(15.0)
Hardwood timber	44 721	36.1	46.8
Black spruce	5 619	4.5	5.9
Larch	430	0.4	0.4
Unproductive land	28 280	22.8	-
TOTAL	123 899	100.0	100.0

[1] Types are defined in Appendix II.
[2] Included also in softwood understory.

all quadrats in this region, 24.6% were interpreted as potentially highly productive but inadequately regenerated to softwoods. NSR quadrats were present on 78.4% of all plots in this area (Appendix III, Table 2). Only 7% of this area contained softwood sawtimber (Appendix III, Table 1).

Most of the H/s quadrats occurred in the Porcupine Escarpment region (Figure 4). This region contained more softwood reproduction either as an understory or in the open (Appendix III, Tables 1 and 2) than any other surveyed. A good deal of this was balsam fir (*Abies balsamea* (L.) Mill.) in spruce budworm (*Choristoneura fumiferana* (Clem.)) balsam blowdown.

Black spruce was most abundant (7%) in the Piwei Hills (Appendix III, Table 1). A large amount of the softwood reproduction in the Jim Lake burn in this area was black spruce. Black spruce close to 10 m in height was commonly typed as treed muskeg.

Some larch (*Larix laricina* (DuRoi) K. Koch) greater than 10 m in height was found in association with large balsam fir and white spruce on upland sites in the Porcupine Escarpment region. Tamarack swamps were usually interpreted as treed muskeg and defined as unproductive.

Jack pine was less common than larch ($\leq$0.5%) throughout the region; where it was

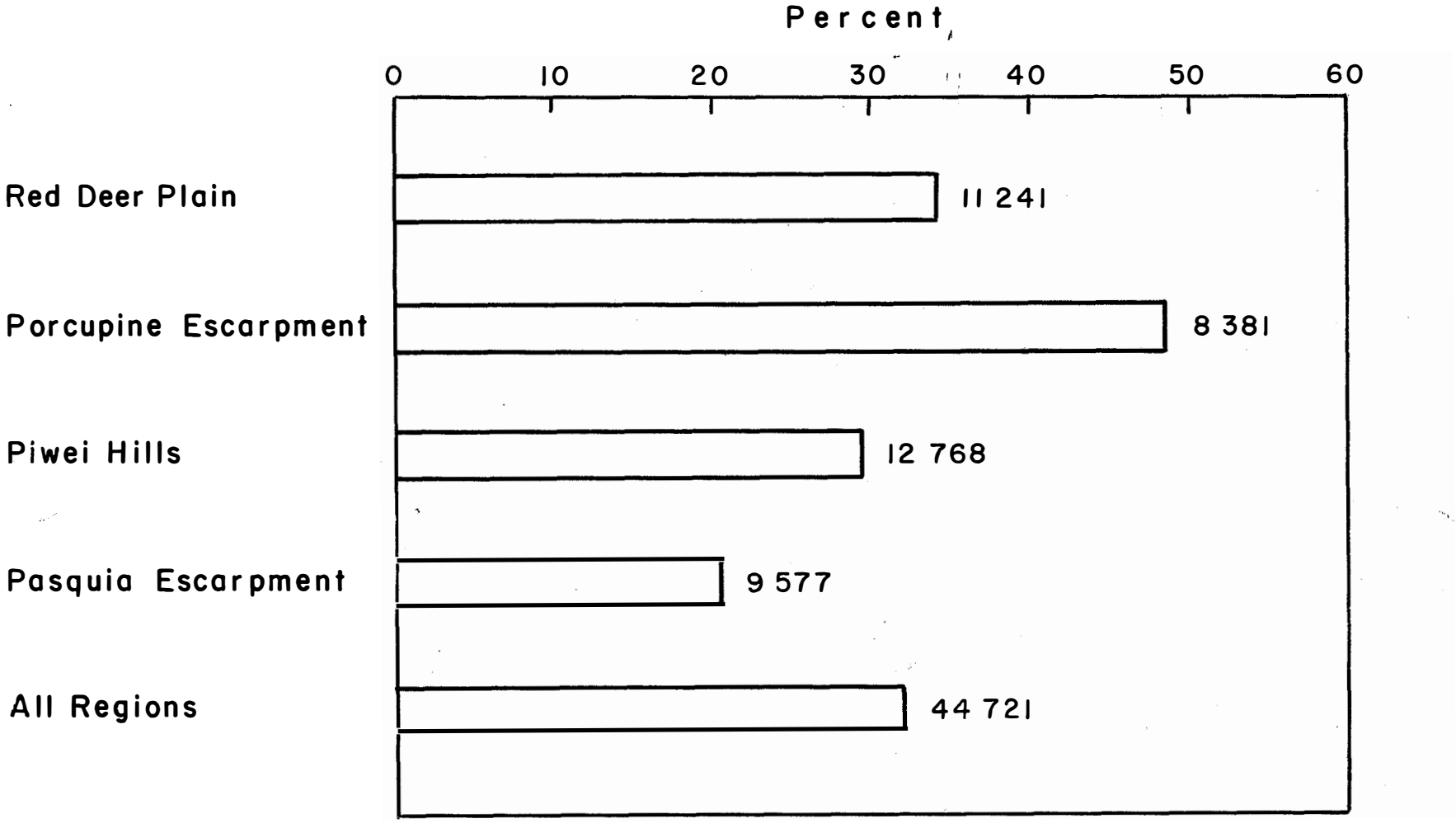

Figure 4. Percentage of hardwood quadrats with a softwood understory (H/s) by major region. Percentages are based on total number of hardwood quadrats, indicated beside each bar.

found—in the Porcupine Mountain and Pasquia Escarpment regions—it was in association with black spruce. With the possible exception of the Jim Lake burn, which was not ground sampled, no jack pine reproduction was encountered.

DISCUSSION

White spruce, initially a very slow-growing species, is difficult to establish; most plantations have been unsuccessful in this region (Froning 1972; 1978 personal communication). If the establishment difficulties (flooding, frost, browsing, drought, vegetative competition, and other liabilities) can be overcome, however, the rewards are great. The wood from a well-stocked pure white spruce stand from an average site was worth $3,000/ha in 1970 (Kabzems 1971). Immense reforestation opportunities thus lie ahead.

The total backlog of unstocked productive land encountered exceeds eight townships (790 km^2), and this is distributed over two-thirds of the area. Where NSR areas occur they occupy less than 30% of an average plot, or 0.04 ha (Figure 5). If 610 trees/ha is acceptable halfway through a rotation of 80 years for white spruce sawlog stands in the Mixedwood Section (Bella and De Franceschi 1978), then approximately 25 trees should be planted on an average plot containing NSR area. Mechanical site preparation and planting opportunities are impeded by the presence of other cover types on an average plot (Figure 5).

If the decision is made to restock NSR lands in this mixedwood area with white spruce, regeneration surveys using large-scale color imagery coupled with ground sampling could prove extremely effective in identifying and ranking candidate areas for plantations. An aerial regeneration survey has several obvious advantages over a conventional ground survey. Inaccessible areas, where a great deal of the NSR backlog exists, are easily covered. Another major advantage is that the bulk of the work can be performed in winter. Costs are several times cheaper; a ground survey of similar size would take a two-man crew over 12 years to complete, assuming that 100 of these large quadrats could be reached and measured per day for 5 months of the year.

Although actual number of stems per quadrat cannot be identified (even at 1:500) due to clumping confusion, percentage stocking of softwoods $\geq$30 cm in height can be determined accurately at this scale. At scales between 1:500 and 1:1000, conifers $\geq$1 m in height are visible. At 1:633 a 25-mm^2 quadrat on the photo would represent 1 mha (10 m^2) on the ground, and percentage stocking of seedlings $\geq$1 m could be very easily determined.

Because we are now examining only the most productive forest sites in the province, we should be conservative in our definition of an established seedling. It is suggested that the omission of smaller seedlings (many of which are growing on rotting wood and are not truly established) from stocking estimates is of no great significance. Discussing white spruce growth and established seedlings, Price (1973) noted that 90% of the regeneration in this area was growing on rotting wood and that an 8-year-old seedling might be no more than 2.5 cm in height; seedlings that appear 2 or 3 years old actually may be more than 20. Some forest renewal decisions are now predicated on breast height age, a new concept (Ter Bush 1978) embodying total costs to attain full stocking at heights of 1.3 m. The best criterion for defining an established seedling may well be whether it is large enough to be visible on large-scale (1:633) color photography.

Color infrared or, in some cases, color imagery at scales of approximately 1:5000 should be a tremendous asset in delineating potential plantation perimeters. In this study, secondary imagery at 1:5000 from the 44.5-mm lens on the low-level flight was used for locating flight lines. However, it was not suited to mapping due to fish-eye distortion and too great an interval between frames, which usually resulted in poor stereo coverage. It is suggested, therefore, that once the low-level (large-scale) color aerial photographs for the regeneration survey are taken, the area(s) should be reflown with a 78- or 150-mm lens and color infrared film to obtain the clearest possible map at 1:5000.

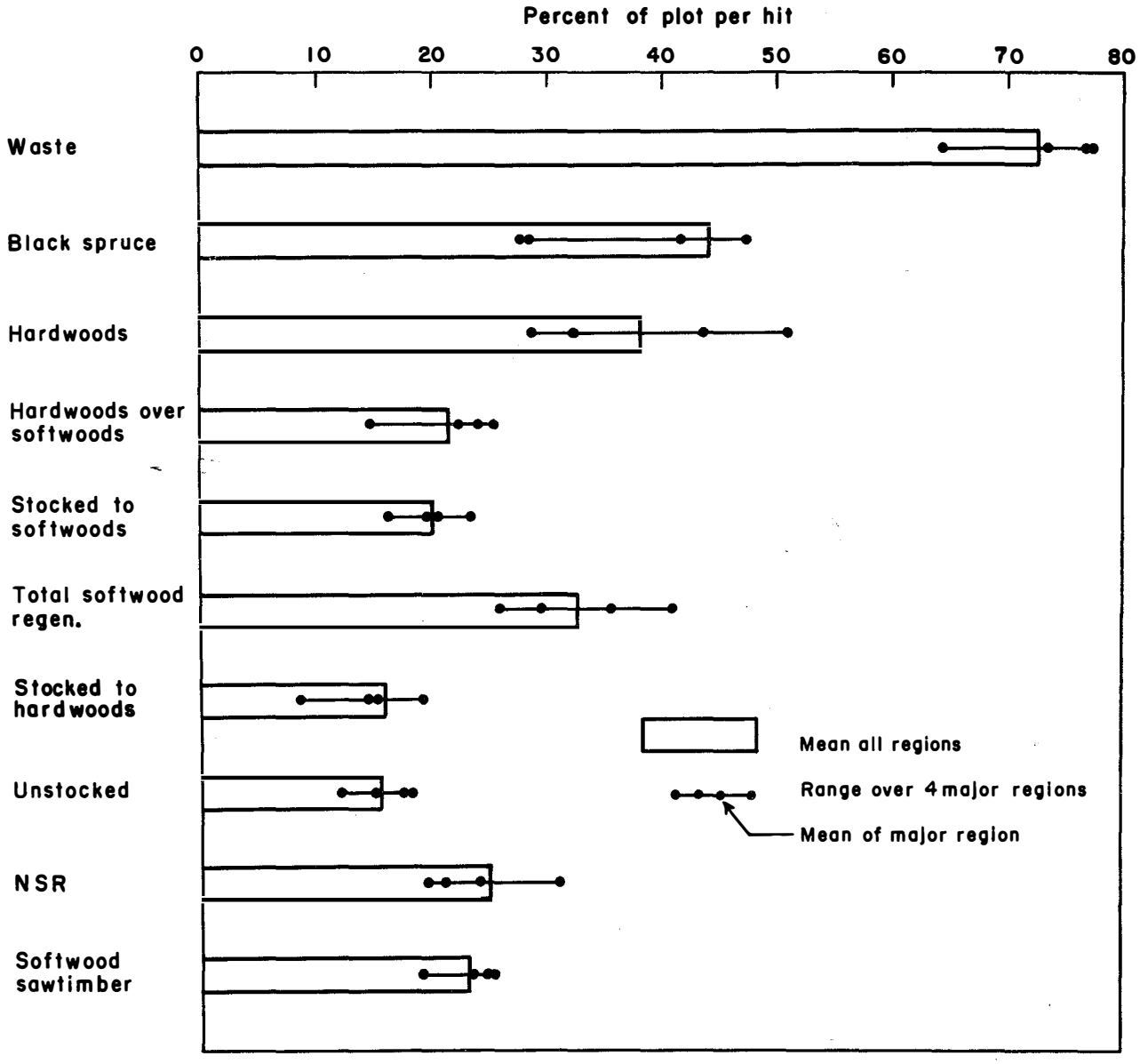

Figure 5. Plot homogeneity by region.

CONCLUSION

Despite assertions by some that our forests will last forever with wise management and long-range planning, these results clearly indicate that softwood timber is now extremely scattered and scarce in this region. Equally evident is the substantial backlog of NSR land.

Remote sensing costs for regeneration surveys are very attractive; operational surveys using these methods should run well under 5% of stand establishment costs. Forest managers also require an economical method of monitoring forest regeneration investments. Remote sensing should prove invaluable not only for determining the magnitude of the NSR backlog and for operational surveys but for follow-up surveys of plantations, scarifications, and burns.

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REFERENCES

Anderson, H.G. 1976. The future forests of Saskatchewan. Ph.D. Thesis. Dep. Plant Ecol., Univ. Saskatchewan, Saskatoon.

Ball, W.J. 1976. A closer look at the forest with large-scale color photography. Unpublished file report cited in Kirby 1978.

Bella, I.E. 1976. Assessment of regeneration stocking standards used in Alberta. Environ. Can., Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-167.

Bella, I.E. and J.P. De Franceschi. 1978. Assessment of regeneration stocking standards used in Alberta: A follow-up. Environ. Can., Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-211.

Candy, R.H. 1951. Reproduction on cut-over and burned-over land in Canada. Can. Dep. Resour. Dev., For. Br., For. Res. Div., Silv. Res. Note No. 92.

Ellis, J.G. and J.S. Clayton. 1970. The physiographic divisions of the northern provincial forest in Saskatchewan. Sask. Inst. Pedol. Publ. SP3.

Froning, K. 1972. An appraisal of recent plantations in forests of the Prairie Provinces. Environ. Can., Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. Inf. Rep. NOR-X-31.

Häggström, B. 1977. Problems and methods in forest regeneration. Results from the 1975 regeneration survey and pine weevil research. J. R. Acad. Agric. For., Sweden. 116:27-34.

Jarvis, J.M., G.A. Steneker, R.M. Waldron, and J.C. Lees. 1966. Review of silvicultural research. White spruce and trembling aspen cover types, Mixedwood Forest Section, Boreal Forest Region, Alberta-Saskatchewan-Manitoba. Can. Dep. For. Rural Dev., For. Br. Publ. No. 1156.

Kabzems, A. 1959. Saskatchewan forest inventory 1947-1956. Sask. Dep. Nat. Resour., For. Br.

————. 1971. The growth and yield of well-stocked white spruce in the Mixedwood Section in Saskatchewan. Sask. Dep. Nat. Resour., For. Br. Tech. Bull. No. 8.

Kabzems, A., D.M. Newman, D.L. Bernier, and S.C. Zoltai. 1972. Land capability classification for forestry in Saskatchewan. Dep. Nat. Resour., For. Br. Tech. Bull. No. 6.

Kabzems, A., A.L. Kosowan, and W.C. Harris. 1976. Mixedwood Section in an ecological perspective, Saskatchewan. Sask. Dep. Tour. Renew. Resour., For. Br. Tech. Bull. No. 5.

Kirby, C.L. and P.I. van Eck. 1973. Forest regeneration sampling from the air. Environ. Can., Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. For. Rep. Vol. 3, No. 3.

————. 1975. A place for aerial photography in regeneration surveys. Environ. Can., Can. For. Serv., North. For. Res. Cent., Edmonton, Alberta. For. Rep. Vol. 4, No. 4.

Kirby, C.L. 1978. A camera and interpretation system for assessment of forest regeneration. Paper presented at 5th Canadian Symposium on Remote Sensing, Victoria, B.C., August 1978.

Price, H.S. 1973. A report on the 1972 regeneration survey. Sask. Dep. Nat. Resour., For. Br.

————. 1974. Regeneration survey, 1973. Sask. Dep. Nat. Resour., For. Br.

Rowe, J.S. 1972. Forest regions of Canada. Environ. Can., Can. For. Serv., Ottawa. Publ. 1300.

Ter Bush, F.A. 1978. Seedlings and planting. U.S. Dep. Agric., For. Serv., Pac. Northwest Reg. Forest. Notes, Dec.

APPENDIX I

PLOT DISTRIBUTION BY PHYSIOGRAPHIC REGION

Region	Code	Plots
1. Upper Swan River Plain	D	54
2. Upper Red Deer Plain	D	449
3. Porcupine Mountain	E	25
4. Porcupine Escarpment	E	324
5. Piwei Hills	E	453
6. Nut Mountain	E	18
7. Greenwater Hills	E	34
8. Pasquia Plateau	E	10
9. Pasquia Escarpment	E	298
		1665

D = Manitoba-Saskatchewan Lowlands.
E = Saskatchewan Plains.

APPENDIX II

COVER TYPES

W Unproductive

All areas unsuited for forest growth. Includes 13 subtypes: water, open muskeg, treed muskeg, floodplain, wet brushland, grassy slough, road right-of-way, railway, road ditch, embankment, debris mound, borrow pit, and power line.

H Hardwood

Hardwoods greater in height than 10 m (approximate). If less than 10% of the quadrat is covered with hardwood branches it is labelled U (unstocked).

H/s Hardwoods over softwoods

Hardwoods with a softwood understory. If any softwood regeneration or advanced growth less than 10 m in height is present on a quadrat that otherwise would be labelled H, that quadrat is called H/s.

HS Mixedwood forest

Hardwoods and softwoods are both greater than 10 m (approximate). Softwoods are at least codominant; 50-90% of the forested portion of the quadrat is hardwood.

SH Mixedwood forest

Hardwoods and softwoods are both greater than 10 m (approximate). Softwoods are at least codominant; 10-49% of the forested portion of the quadrat is hardwood.

S Softwood forest

Softwoods are greater than 10 m (approximate). Less than 10% of the forested portion of the quadrat may be hardwood.

bS Black Spruce forest

Black spruce greater than 10 m (approximate). Determined mainly on the basis of density and crown width. Only pure stands are labelled; where mixtures of black spruce and white spruce occur the quadrat is labelled S. Shadows of crowns are useful in differentiating white and black spruce.

tL Tamarack

Larch greater than 10 m (approximate), primarily on upland sites.

STh Stocked to hardwoods

If any aspen or balsam poplar suckers are present on a quadrat that is otherwise unstocked, it is labelled STh. Recent (1-2 year) aspen clear-cuts are labelled STh.

STs Stocked to softwoods

Any quadrat with no overstory that contains one softwood stem under 10 m.

U Unstocked productive

If the quadrat appears productive (e.g., it contains stumps or is similar to stocked quadrats near it) and no overstory or reproduction is present, it is labelled U. If an unstocked quadrat appears nonproductive, it is labelled W, and the type of unproductive land is indicated.

APPENDIX III

Table 1. Percentage distribution of quadrats by region

Region	Quadrats	H[1]	W	H/s	STs	U	S	STh	bS	SH	HS	tL	Softwood Regen. H/s + STs	Softwood Timber HS + SH + S	Softwood Unstocked STh + U
2	33,744	21.9	21.7	11.4	11.6	12.4	5.4	12.2	1.5	0.8	0.8	0.3	23.0	7.0	24.6
4	25,102	17.1	22.0	16.3	13.8	8.5	8.3	6.7	4.0	1.8	1.1	0.5	30.1	11.2	15.2
5	31,732	28.4	22.4	11.8	6.6	7.4	7.8	5.5	7.0	1.3	1.4	0.3	18.5	10.5	13.0
9	23,218	32.8	24.6	8.5	9.3	10.0	6.7	2.3	2.4	1.5	1.5	0.4	17.7	9.8	12.3
Total (4)	113,796	25.0	22.7	12.0	10.3	9.6	7.1	6.7	3.7	1.3	1.2	0.4	22.2	9.5	16.8
1	4,188	14.4	24.0	8.8	13.7	13.0	10.2	12.0	2.2	0.7	0.4	0.5	22.5	11.3	25.0
3	1,843	7.6	2.3	4.8	1.7	7.8	10.6	0.1	62.2	1.5	1.3	0.1	6.6	13.3	7.8
6	1,246	37.5	27.8	6.6	0.8	12.4	9.9	1.2	0.0	3.1	0.8	0.0	7.4	13.8	13.6
7	2,026	38.1	36.4	4.5	4.2	6.9	2.7	1.0	5.5	0.4	0.3	0.0	8.7	3.4	7.9
8	800	12.7	62.5	4.5	2.9	4.0	6.2	1.1	0.0	3.1	2.9	0.0	7.4	12.2	5.1
Total (9)	123,899	24.5	22.8	11.6	10.0	9.7	7.1	7.0	4.5	1.3	1.2	0.4	21.6	9.6	16.7

[1] Types are defined in Appendix II.

APPENDIX III

Table 2. Cover type presence by region. Percentage of plots where strata occurred. (Total hits/total plots) X 100

Region	Plots	H[1]	W	H/s	STs	U	S	STh	bS	SH	HS	tL	Softwood Regen. H/s + STs	Softwood Timber HS + SH + S	Softwood Unstocked STh + U
2	449	67.9	33.8	47.4	57.9	70.2	33.8	62.4	5.1	16.9	16.3	2.9	64.8	36.5	78.4
4	324	60.2	29.9	64.2	58.3	55.9	40.1	43.8	9.6	26.2	21.6	7.7	73.8	44.4	63.0
5	453	65.1	28.9	52.8	41.1	61.6	38.2	37.8	14.8	25.2	27.6	4.6	62.9	42.2	65.3
9	298	65.8	32.2	57.7	45.3	55.0	37.6	28.2	9.1	30.5	25.8	7.0	68.1	40.9	58.1
Total (4)	1,524	65.0	31.2	54.6	50.5	61.6	37.2	44.4	9.7	24.0	22.6	5.2	66.8	40.7	67.3
1	54	55.6	31.5	57.4	55.6	63.0	37.0	53.7	11.1	20.4	11.1	1.8	63.0	38.9	66.7
3	25	36.0	8.0	32.0	44.0	64.0	40.0	4.0	64.0	32.0	40.0	4.0	52.0	52.0	64.0
6	18	72.2	38.9	38.9	11.1	38.9	33.3	11.1	0.0	33.3	27.8	0.0	44.4	33.3	38.9
7	34	64.7	44.1	23.5	20.6	50.0	20.6	20.6	5.9	14.7	8.8	0.0	38.2	23.6	50.0
8	10	40.0	70.0	40.0	40.0	40.0	40.0	20.0	0.0	40.0	40.0	0.0	40.0	40.0	40.0
Total (9)	1,665	64.2	31.5	53.4	49.5	61.1	36.9	43.1	10.3	24.0	22.4	4.9	65.5	40.4	66.4

[1] Types are defined in Appendix II.