

**FOREST DEPLETION BY WILDLAND FIRE IN CANADA,
1977-1981**

Information Report PI-X-21

W.R. Clark

**Petawawa National Forestry Institute
Canadian Forestry Service
Department of the Environment
1983**

Issued under the authority of
the Minister, Environment Canada

•Minister of Supply and Services Canada 1983
Catalogue No. Fo46-11/21-1983E
ISSN 0706-1854
ISBN 0-662-12527-4

Additional copies of this publication can
be obtained from:

Technical Information and Distribution Centre
Petawawa National Forestry Institute
Environment Canada
Chalk River, Ont.
K0J 1J0

Telephone 613 589-2880

Cette publication est aussi disponible en français
sous le titre L'Appauvrissement des forêts canadiennes
causé par les feux de végétation de 1977 à 1981.

Contents

<i>i</i>	Abstract/Résumé
1	Introduction
1	Wildland fire protection in Canada
3	Forest depletion by wildland fire
6	Summary and conclusions
6	Acknowledgments
6	References
9	Appendix
9	About the data
10	Key to symbols used in tables

Tables

11	1. Area protected by forest fire control agencies, Canada, 1981
12	2. Area burned, by fire control agency, and total number of fires, Canada, 1977-1981
13	3. Area burned, by merchantability class, Canada, 1976-1980

Figures

Cover: The average area of "merchantable" timber burned equalled half of that harvested for the five-year period ending in 1980.

2	1. Area protected compared to total forest land and total land, Canada, 1981.
2	2. Area protected, by fire control agency, 1981.
4	3. Area burned and number of fires, Canada, 1977-1981.
4	4. Area protected compared to mean annual area burned, by jurisdiction.

- 5 | 5. Mean annual area burned, by fire control agency,
1977-1981.
- 5 | 6. Mean annual area burned, by merchantability
class, Canada, 1976-1980.

ABSTRACT

The area burned by wildland fire during the period 1977-1981 is reviewed, classified according to forest fire control agency. A breakdown of area burned by timber merchantability class for the period 1976-1980, but without agency detail, is also given. Original data on the area protected by each of the 14 agencies, broken down by priority zone, plus comparative data on the areas of total land and total forest land, are presented in an introductory section. Emphasis is placed throughout on graphics drawn to scale, and on the identification of data inadequacies.

The annual total area burned averaged about three times the mean annual area harvested for the 1976-1980 period, although only one-sixth of that was "merchantable timber." Over 75% of the five-year mean annual area burned was classified as "cutover and other area," 17% was "merchantable timber" and 8%, "regeneration and immature."

A tendency toward higher total burned area was evident between 1977 and 1981, although the number of fires remained relatively constant. All-time records were set in 1980 and again in 1981 (54 100 km²). The average recorded was 29 398 km², concentrated mainly in west-central Canada. This five-year mean was 0.83% of the total area protected in Canada.

RÉSUMÉ

La superficie touchée par les feux de végétation de 1977 à 1981 fait l'objet d'une analyse. Cette superficie est découpée par régions selon les organismes chargés de les protéger contre les feux de forêts. On en fait aussi un découpage, pour la période s'étendant de 1976 à 1980, selon l'âge d'exploitabilité, sans égard aux territoires des organismes concernés. En introduction, on présente des données sur les régions protégées par chacun des 14 organismes et classées en zones prioritaire ainsi que des données comparatives sur la superficie de l'ensemble des terres et de l'ensemble des terres forestières. Partout dans le texte, les graphiques dessinés à l'échelle sont à l'honneur et les données insuffisantes sont relevées.

En moyenne, la superficie touchée annuellement au cours de la période a été environ trois fois plus grande que la superficie moyenne annuelle sur laquelle on a fait la récolte de bois, même si seulement un sixième de la superficie était occupée par du bois marchand. Plus de 75 % de la superficie moyenne brûlée par année a été classée forêts exploitées, 17 % forêts exploitables et 8 % forêts régénérées et immatures.

En ce qui a trait à la superficie totale brûlée, la tendance à la hausse a été manifeste de 1977 à 1981, bien que le nombre de feux soit demeuré relativement constant. Des records ont été établis en 1980 et de nouveau en 1981 (54 100 km²). La moyenne enregistrée a été de 29 398 km², et c'est surtout le centre-ouest du Canada qui a été touché. Cette moyenne pour les 5 années représente 0,83 % de toute la superficie protégée au pays.

FOREST DEPLETION BY WILDLAND FIRE IN CANADA, 1977-1981

INTRODUCTION

The main purpose of the report is to provide a concise graphic review of forest depletion by wildland fire¹ in Canada. The data used are the best available for the most recent 5-year period. Data limitations preclude the direct study of fire effects on forest inventories and commercial timber supplies. In the absence of context-specific volumetric data, broad resolution area-based statistics are therefore relied upon.

All tabular data are presented together in the Appendix. The main text consists of two parts: first, a short section dealing with forest fire protection in Canada, and second, the main presentation on forest depletion. A short summary concludes this paper.

To aid the reader's retention of important statistics, the presentation stresses general relationships and orders of magnitude through the use of graphical devices.²

¹ The term "wildland fire" is chosen in preference to "forest fire" because a significant proportion of the total area protected consists of nonforest land. The terms "forest land" and "nonforest land" are as defined by Bonnor (1978).

² To this end, a series of six figures have been prepared to convey the essential details. All data used in these diagrams are derived from the tables in the Appendix. To facilitate comparisons, all figures have been drawn to scale, except for the histogram (Fig. 3). Also to aid comparisons, Quebec and P.E.I. are excluded from most of the diagrams because data on the area protected were unavailable for both provinces, and Quebec area-burned data for 1979 and 1980 were incomplete.

William R. Clark is a research officer at the Petawawa National Forestry Institute.

Manuscript approved for publication:
November 1982.

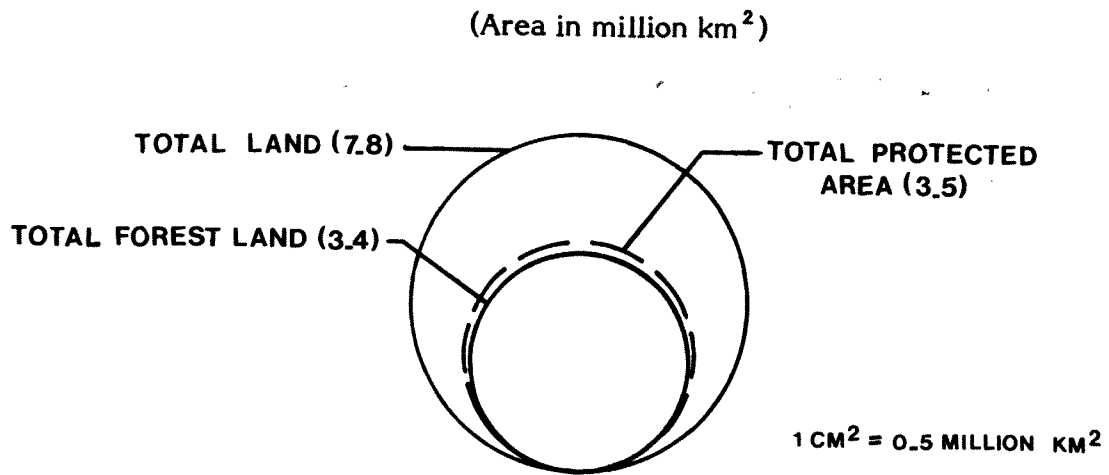
WILDLAND FIRE PROTECTION IN CANADA

Forest protection is a basic element of any complete forest management program. The recent and parallel concepts of "integrated pest management" and "integrated fire management" give much-needed recognition to this interrelationship. Although in practice they are carried out as separate programs, forest protection and forest management share a mutual goal: to maximize net economic and social benefits from the use of the forest resource for the production of various outputs, including timber, animal life, water, and opportunities for recreation and human habitation. The costs of achieving this goal are large. In 1980, for example, approximately 225 million dollars were spent in Canada on fire protection programs alone (Ramsey and Higgins, 1982). This represents a significant share of the total budgetary commitment to forestry by provincial and federal governments.

Table 1 contains original data showing the total area protected from wildland fire in Canada, together with statistics on total forest land and total land for comparison. Data have been segregated to facilitate regional and jurisdictional comparisons. A breakdown of area protected by priority zones is also contained in Table 1. These zones recognize the different values and levels of risk in different geographic areas, and permit fire agencies to cope with the vast areas that require protection.

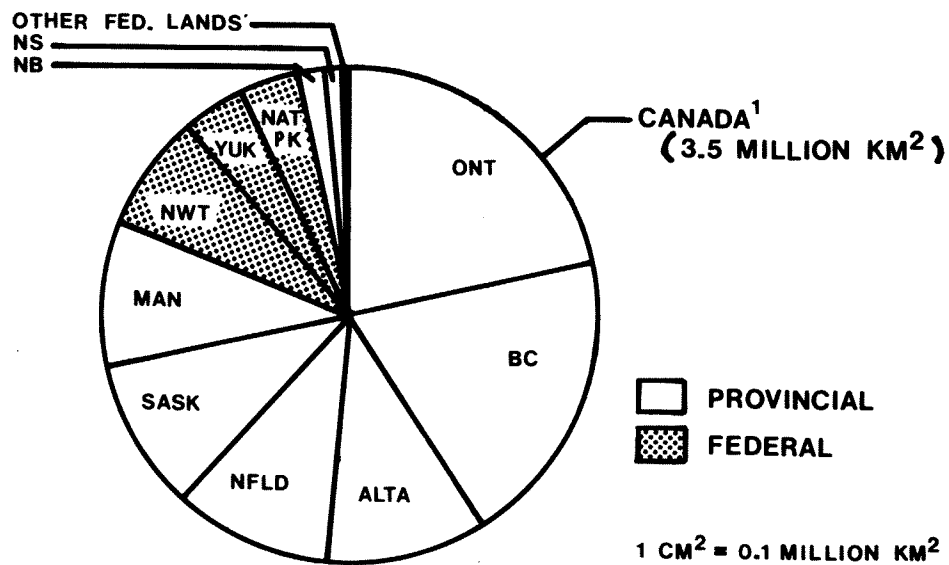
To provide a visual impression of key relationships in Table 1, the total areas of land, forest land, and protected area are all nested together in Figure 1. In this diagram forest land area is about 44% of total land, whereas the total area

Figure 1. Area protected compared to total forest land and total land, Canada¹, 1981.



¹ Except Quebec and Prince Edward Island

Figure 2. Area protected, by fire control agency, 1981.



¹ Except Quebec and Prince Edward Island

protected from forest fire is approximately 45%.

The breakdown of area protected by agency is shown in Figure 2. Three agencies—Ontario, B.C., and Alberta—of the twelve shown, account for over half of the total area protected. Approximately 15% of the total area is protected by federal agencies, whereas the remainder is a provincial responsibility.

FOREST DEPLETION BY WILDLAND FIRE

Forest fire losses captured national attention in the period from 1977 to 1981, with total area burned setting records in 1980 and again in 1981, as shown in Table 2. The upward-sloping, staircase-like progression of the shaded bars in Figure 3 clearly justifies that national attention. A longer-term increasing trend is also apparent from a 28-year analysis of area-burned statistics carried out by Harrington (1982, p. 5), but he warns that: "Our current knowledge provides no basis for extrapolating the trend ..." (A preliminary report lists 1982 area burned as 17 000 km², a 69% decline from 1981, based on 8 350 fires.)

The wide variation of the burned-area data for the most recent 5-year period should also be highlighted, especially for its practical importance to fire management planners (Table 2). Total burned area ranges from a low of 2 890 km² in 1978 to a high of 54 100 km² in 1981—a difference of about 19 times. Mean fire size was 0.36 km² (36 ha) and 5.34 km² (534 ha) for the same years respectively—a difference of about 15 times. Variation among regions was also pronounced, especially as it existed between west-central Canada and the rest of the country in 1980 and 1981.

The high variability of area burned is in stark contrast to the number of fires, which remained relatively constant throughout the 5-year period (Fig. 3).

Mean annual area burned for Canada during 1977-1981 was 29 398 km². This area is equivalent to a swath 5.7 km wide stretching for 5 187 km from Cape Spear,

Nfld., to Mt. St. Elias in the Yukon at Canada's widest dimension. Figure 4 compares average area burned annually to total area protected. Burned area amounted to 0.83% of area protected, which implies a cyclical fire "harvest" (or "rotation") of about 120 years.

Also highlighted in Figure 4 is federal and provincial jurisdiction. Areas of federal responsibility suffered losses (42%) far out of proportion to the size of area protected (26%). Figure 5 provides detail by agency. The Northwest Territories experienced the heaviest losses of any area (31%), followed by Saskatchewan (24%). Combined, these two areas alone accounted for more than half of total area burned during the period, but neither is among Canada's larger timber producers.

It is difficult to explain the wide differences observed in area burned compared to area protected for different agencies, because there are many variables to consider and few data available. The principal factors involved, however, are the following: weather and climate, fuel types, sources of ignition (especially the susceptibility to lightning), total area and value protected compared to resources available for fire control, and quality and productivity of fire control resources. If area-burned data were available for zones of first priority, for example, this would partially control the fire protection variable and increase our insight into the causes of fire losses.

For purposes of illustration, consider the findings of Stocks et al. (1981, p. 11) for three provinces (Saskatchewan, Manitoba, and Ontario) pertaining to average area burned in areas "inside intensive protection" (i.e. first priority) as opposed to areas "outside intensive protection" for the years 1970-1979. The areas of lower priority accounted for 60.9% of area burned, but experienced only 8.1% of the fires. This relationship is hidden by the conventional statistics.

To evaluate forest depletion by wildland fire, we must rely for now on indirect indicators, particularly area burned, because national statistics on volume losses are not available. Table 3

Figure 3. Area burned and number of fires, Canada, 1977-1981.

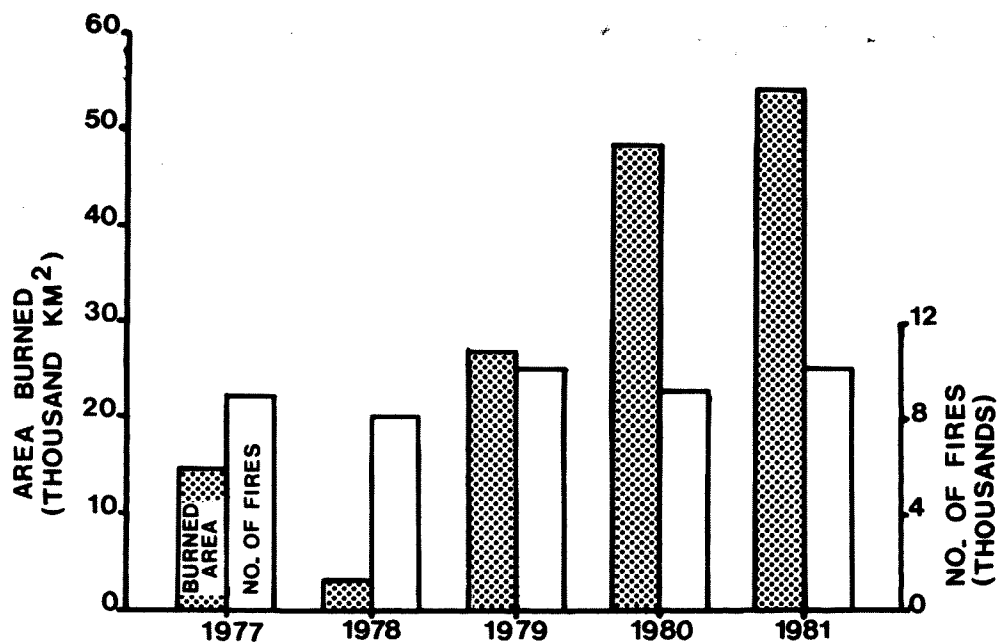
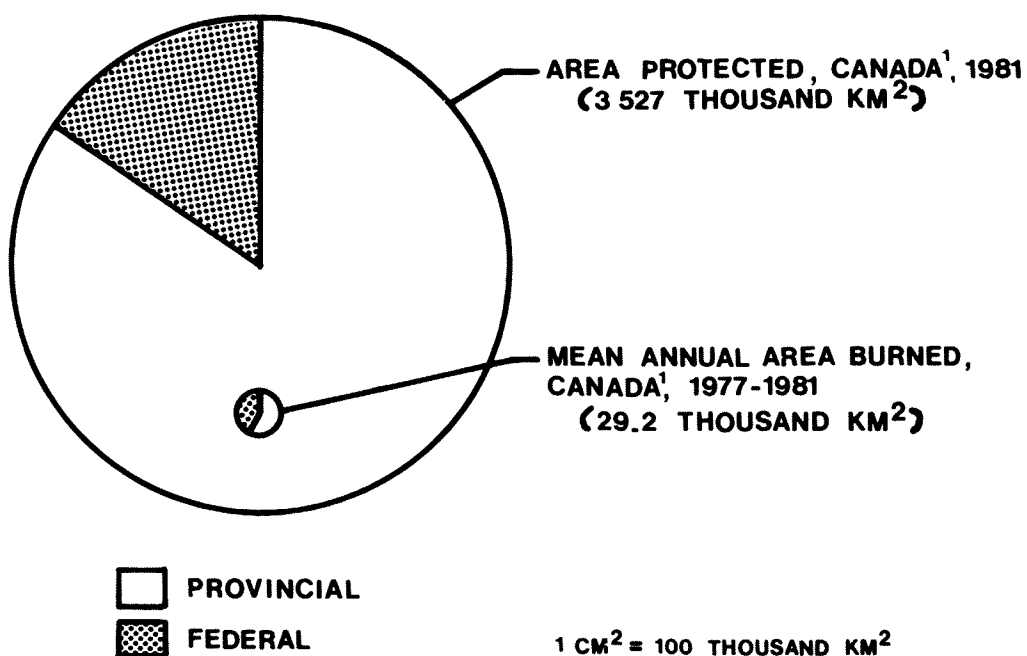
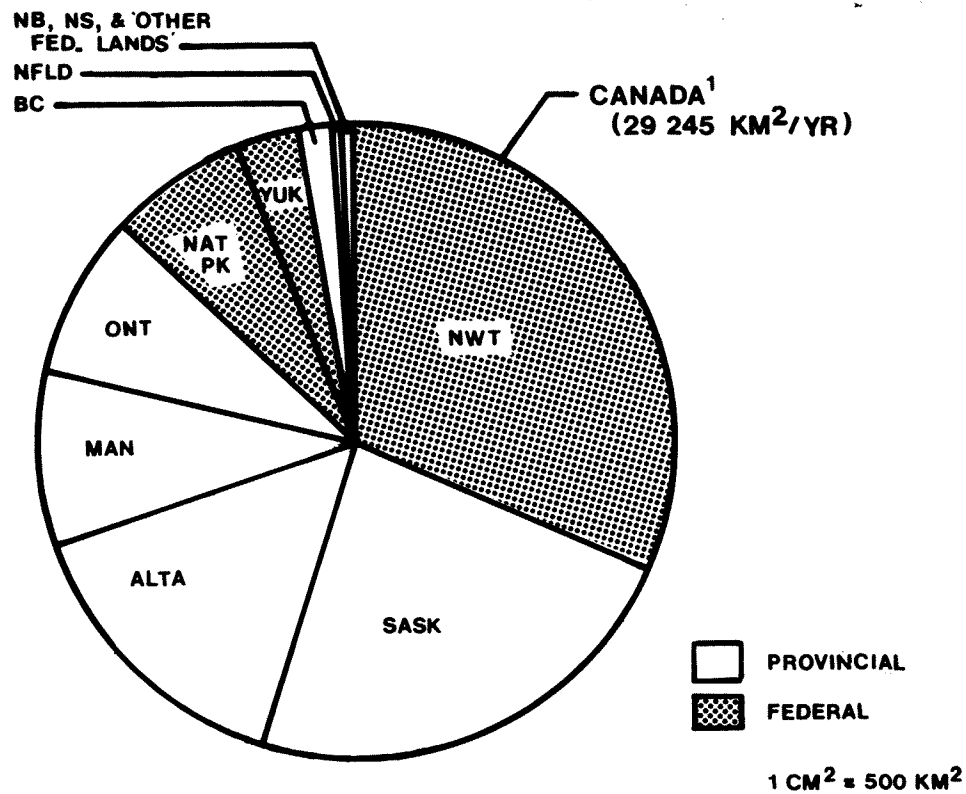


Figure 4. Area protected compared to mean annual area burned, by jurisdiction.



¹Except Quebec and Prince Edward Island

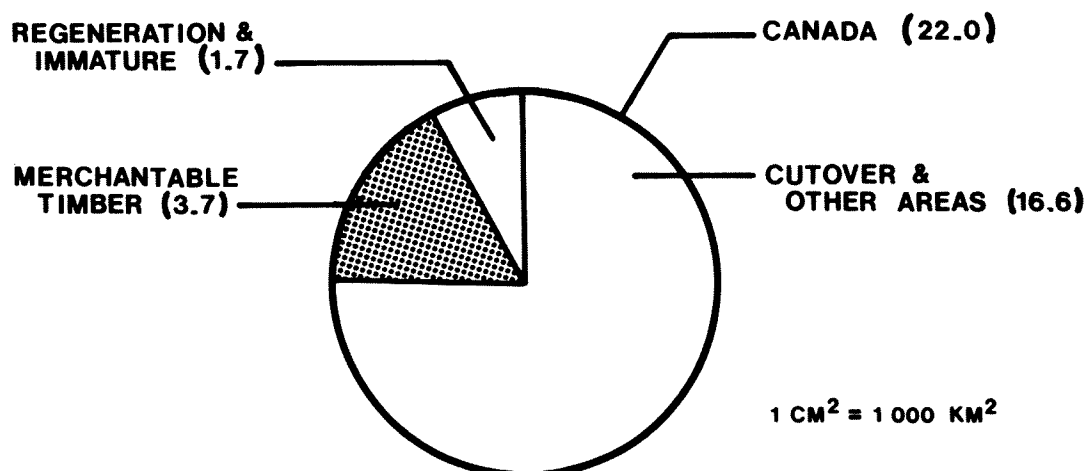
Figure 5. Mean annual area burned, by fire control agency, 1977-1981.



¹Except Quebec and Prince Edward Island

Figure 6. Mean annual area burned, by merchantability class, Canada, 1976-1980.

(Area in thousand km²/yr)



presents a separate national breakdown of area burned by merchantability class for the 5-year period 1976-1980³. Figure 6 presents the salient relationships from Table 3 in graphical form. The mean annual area of "merchantable timber"⁴ burned accounted for just 17% (3 714 km² per year) of the total. "Cutover and other areas" comprised more than 75% of the total area burned.

Brace and Golec (1982, p. 4) report that area harvested in Canada for the same time-period averaged 7 594 km² per year. Total area burned, therefore, exceeded the area harvested by three times, whereas the area of merchantable timber burned was about half of that harvested.

Without more detailed knowledge, especially of the location and nature of the area burned, we cannot confidently draw conclusions about the economic consequences of wildland fire during this period. It is illuminating, however, to note the results of two case studies carried out in connection with the 1980 fire season, as reported by Stocks *et al.* (1981, p. 19). Based on the reduction in the annual allowable cut on management units in Alberta and northwestern Ontario relative to present harvesting levels in those same units, almost no impact could be discerned beyond some expected displacements of small operators. These results do not reflect upon the severity and extent of forest fires so much as they

do upon present harvesting levels, which in these case studies were generally low.

SUMMARY AND CONCLUSIONS

Forest fire losses expressed as area burned increased sharply between 1977 and 1981, but tended to be concentrated in west-central Canada. The effect on commercial timber stocks, however, is not well known. Less certain still is the impact of fire on annual wood flows. It should not be long, however, before the necessary data are acquired and appropriate evaluation methods are developed. Governments have recently become acutely aware of the great economic importance, but finite limit, of Canada's forest resources.

ACKNOWLEDGMENTS

The author expresses his gratitude to the following individuals and groups for their assistance: Mr. Gordon Ramsey, PNFI, especially for his help in procuring data on area protected; Dr. J.B. Harrington and Mr. D.E. Williams, also of PNFI, for their helpful comments; the CFS Regional Committee on FORSTATS, especially Brian Haddon, for reviewing an earlier draft and for verifying some of the data; and finally, the Canadian Committee on Forest Fire Control, without whose cooperation there would be no data to report.

REFERENCES

- Bonnor, G.M. 1978. A guide to Canadian forest inventory terminology and usage (2nd ed.) Published for the Canadian Forest Inventory Committee by Environ. Can., Can. For. Serv. 57 pp.
- Bonnor, G.M. 1982. Canada's forest inventory - 1981. Environ. Can., Can. For. Serv., For. Stat. and Sys. Br. 79 pp.
- Brace, L.G.; Golec, P.J. 1982. Silviculture statistics for Canada, 1975-80. Environ. Can., Can. For. Serv., Nor.

³ The one-year discrepancy in the period of coverage between Table 3 and Table 2 is explained as follows: a) Complete area-burned data are available by agency for as recently as 1981 (Table 2) but the breakdown by merchantability class (Table 3) is available only up to 1980; b) the time span used in Table 3 (i.e. 1976-80) correlates well with that used in a recent report (Brace and Golec, 1982) that contains national harvest statistics with which comparisons are being made, and c) the data in Table 3 are incomplete for certain years and are thus underestimates. The principal use of Table 3, therefore, is to provide the proportional breakdown of area burned by merchantability class, and to enable comparisons (albeit underestimates) with harvest statistics.

⁴ The term "merchantable timber" essentially means "timber of merchantable dimensions." There may or may not be current demand (and thus value) for this timber depending upon its accessibility, spatial concentration, species composition, or quality.

- Forest Res. Cen. Inf. Rep. NOR-X-245. 48 pp.
- Brady, P. 1979. Canadian forest fire statistics 1977. Environ. Can., Can. For. Serv. 35 pp.
- Harrington, J.B. 1982. A statistical study of area burned by wildfire in Canada 1953-1980. Environ. Can., Can. For. Serv., Petawawa Natl. For. Inst. Inf. Rep. PI-X-16. 32 pp.
- Ramsey, G.S.; Higgins, D.G. 1981. Canadian forest fire statistics/Part I -1978; Part II - 1979. Environ. Can., Can. For. Serv., Petawawa Natl. For. Inst. Inf. Rep. PI-X-9. 71 pp.
- Ramsey, G.S.; Higgins, D.G. 1982. Canadian forest fire statistics 1980. Environ. Can., Can. For. Serv., Petawawa Natl. For. Inst. Inf. Rep. PI-X-17. 38 pp.
- Stocks, B.J.; Van Wagner, C.E.; Clark, W.R.; Dubé, D.E. 1981. The 1980 forest fire season in west-central Canada -social, economic and environmental impacts. Task Force report prepared for Environ. Can., Can. For. Serv. 27 pp.

APPENDIX: TABLES

About the data

Table 1 contains some original data specially collected for this report. Data in Tables 2 and 3 were taken from records of the Petawawa National Forestry Institute, which publishes selected fire statistics annually. The Canadian Forestry Service has been collecting such information since 1918.

As there is no scientific evidence to verify the accuracy of the data on area burned and number of fires, a set of rules for rounding was adopted based on personal judgment. Burned area data pose a particular problem because of the wide range in reported values (from 0.01 km^2 to $10\,000 \text{ km}^2$ and more), which necessitated the use of variable rule:

0.01 to 9.99 km^2 - nearest 0.1 km^2 ;
 10.00 to 99.99 km^2 - nearest 1.0 km^2 ;
 100.00 to $9\,999.99 \text{ km}^2$ - nearest 10.0 km^2 ;
 $10\,000.00 \text{ km}^2$ + - nearest 100.00 km^2 .

Numbers of fires are rounded to the nearest 10.

The unit of area measure used throughout, the square kilometre, was

chosen so as to maintain consistency with the FORSTATS program and minimize burdensome and unjustified detail. The original published data on area burned are expressed in hectares.

The median has been added as a measure of central tendency of the 5-year data series. This statistic is most meaningful in cases where the frequency distribution of data values is skewed; that is, where a relatively small number of extreme values are present. The median, unlike the mean, is related to the number of observations, not the total, and so has limited analytical use. However, when used with skewed data the median lies closest to the condition that occurs most frequently. As such, it is more representative of "typical" or "average" conditions in the popular sense than is the arithmetic mean. Burned area frequency distributions are well known to exhibit the skewness required for meaningful use of the median, yet the median has rarely been used in this context. For example, Harrington (1982, p. 3) discovered that 60% of area burned in Canada occurred in only 5% of the total number of "fire months" in the most recent 28-year period.

Key to symbols used in tables

- nil or zero
- too small to be expressed
- .. not available
- ... not applicable

Table 1. Area protected by forest fire control agencies, Canada, 1981*

Fire control agency	Total area protected	Priority for protection**			Total forest land†	Total land†
		First	Second	Third		
(thousand km ²)						
NFLD.	369	192	74	103	140	369
N.S.	51	...	...	...	40	52
P.E.I.	..	..	..	..	3	6
N.B.	64	...	...	...	63	70
QUE.	..	..	..	..	939	1 356
ONT.	761	504	257	-	805	889
MAN.	329	18	151	159	346	545
SASK.	353	156	197	-	174	566
ALTA.	383	383	--	-	295	590
B.C.	674	...	...	...	628	926
Total provincial	2 984	1 253	679	262	3 433	5 369
Yukon	145	...	...	...	220	456
N.W.T.	267	...	...	...	579	3 210
National parks	130	100	21	8	130	130
Other federal lands††	1	...	...	...	1	1
Total federal	543	100	21	8	930	3 797
Canada	3 527	1 353	700	270	4 363	9 166

*Source: Petawawa National Forestry Institute, except as noted.

**These data cannot be used for interagency comparisons because the definition of each priority is unique to each agency.

†Provincial and Territorial data are taken from Bonnor (1982:4), but have been reduced by the total areas of National Parks and "Other federal lands." For present purposes these latter areas are assumed to be 100% forested land.

†† Canadian Forces Base Gagetown, N.B., and Petawawa National Forestry Institute, Ont.

Table 2. Area burned, by fire control agency, and total number of fires, Canada, 1977-1981*

Fire control agency	1977	1978	1979	1980	1981	MEAN**	MEDIAN**
	(km ²)						
NFLD.	13.0	47.0	320.0	9.5	260.0	127.9	47.0
N.S.	12.0	7.4	7.6	9.5	3.7	8.0	7.6
P.E.I.	5.3	2.0	-	0.7	1.5	1.9	1.5
N.B.	12.0	26.0	14.0	28.0	3.5	16.7	14.0
QUE.	320.0	65.0	32.0	130.0 [†]	210.0	153.4	130.0
ONT.	4 160.0	75.0	640.0	5 600.0	1 790.0	2 453.0	1 790.0
MAN.	2 320.0	250.0	820.0	5 140.0	4 210.0	2 548.0	2 320.0
SASK.	1 300.0	930.0	2 300.0	13 500.0	16 500.0	6 906.0	2 300.0
ALTA.	160.0	78.0	1 950.0	6 720.0	13 100.0	4 401.6	1 950.0
B.C.	38.0	500.0	290.0	660.0	1 070.0	511.6	500.0
Total provincial	8 340.3	1 980.4	6 373.6	31 797.7	37 148.7	17 128.1	8 340.3
Yukon	2 770.0	74.0	73.0	1 310.0	350.0	915.4	350.0
N.W.T.	3 220.0	790.0	19 900.0	12 100.0	9 850.0	9 172.0	9 850.0
National parks	53.0	53.0	670.0	2 790.0	6 800.0	2 073.2	670.0
Other federal lands	2.8	2.6	0.2	0.2	0.1	1.2	0.2
Total federal	6 045.8	919.6	20 643.2	16 200.2	17 000.1	12 161.8	16 200.2
Canada - Total burned area ^{††}	14 800.0	2 890.0	27 000.0	48 200.0	54 100.0	29 398	27 000.0
Canada - Total no. of fires	8 960	8 050	10 060	9 150	10 140	9 272	9 150

*Sources: 1977: Brady (1979); 1978-1980: Ramsey and Higgins (1981, 1982); 1981: Canadian Committee on Forest Fire Control (1982), unpublished data, with permission.

**Basis: rounded data.

[†] Excludes all areas outside of "intensive protection" zone.

^{††} Derived independently.

Table 3. Area burned, by merchantability class, Canada, 1976-1980*

Class	1976	1977	1978	1979	1980	MEAN**	MEDIAN**
	(km ²)						
Merchantable timber	2 730	3 360	410	2 240	9 830	3 714	2 730
Regeneration and immature	1 840	1 880	210	720	3 720	1 674	1 840
Cutover & other areas [†]	13 600	9 040	2 260	23 400	34 700	16 600	13 600
Canada - Burned area ^{††}	18 100	14 300	2 890	26 300	48 200	21 958	18 100

*Sources: 1976: Petawawa National Forestry Institute (unpublished data); 1977: Brady (1979); 1978-1980: Ramsey and Higgins (1981, 1982).

**Basis: rounded data.

[†]Includes all other areas under protection, including unproductive forest land, nonforest land and areas of dead timber.

^{††}Derived independently. Discrepancies with Table 2 are due to incomplete classified data. Table 2 is complete.