Miscellaneous Report NOR-Y-4

THE 1971 THOMPSON SMOKE EASEMENT SURVEY

by

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Northern Forest Research Centre
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Canadian Forestry Service
Department of the Environment
April, 1972

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SUMMARY AND CONCLUSIONS

Aerial reconnaissance of the easement revealed two areas of forest damage attributable to smoke emissions from the Inco plant, the severest damage is in an area approximately three miles wide by six miles long, due south of the Inco plant. The smoke was impinging on the forest in this area during the survey. A preliminary ground check conducted at one location revealed that from 60 to 80 percent of the trees and other vegetation were dead, and that the remainder of the forest was in extremely poor condition. The symptoms displayed by the forest in this area were diagnostic of fume damage. No other diseases or insects capable of causing the observed symptoms or damage distribution patterns were present.

Less severe damage occurred in another area about one mile wide by seven miles long south-west of the Inco plant. Some of the forest in the immediate plant area suffered from water effluent damage.

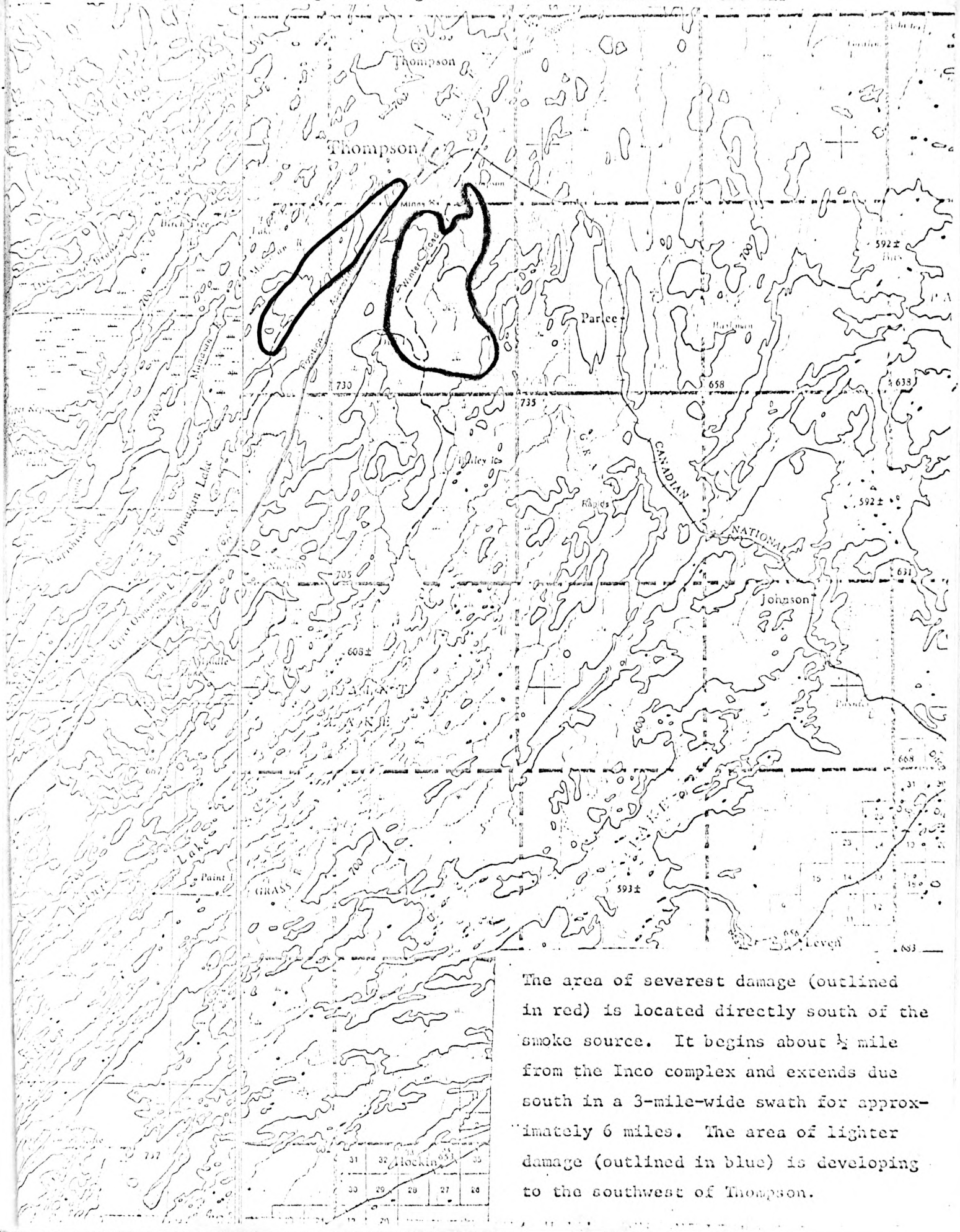
No smoke damage was found near the sulfur dioxide detection box locations examined several miles from apparent plume impingement areas.

It is recommended that the 1972 survey include a ground evaluation survey to: 1) clearly define the intensity of the forest damage throughout the two damaged areas, 2) accurately delineate the current parameters of the forest fume damaged areas, 3) devise a forest fume injury index for the area and use it to zone the damage area according to various stages of injury. This will facilitate determination of future damage progression rates.

Consideration should be given to locating sulfur dioxide detection boxes in the damaged forest areas and to monitoring the smoke for pollutants other than sulfur dioxide.

Map of the Thompson Area

roughly delineating the damaged forest areas visible from the air



The area of severest damage (outlined in red) is located directly south of the smoke source. It begins about ½ mile from the Inco complex and extends due south in a 3-mile-wide swath for approximately 6 miles. The area of lighter damage (outlined in blue) is developing to the southwest of Thompson.

The 1971 Thompson Smoke easement survey was conducted on July 7, 8 and 9 by the Forest Insect and Disease Survey staff, Northern Forest Research Centre, Edmonton, in cooperation with the Department of Mines, Resources and Environmental Management, of the Government of Manitoba.

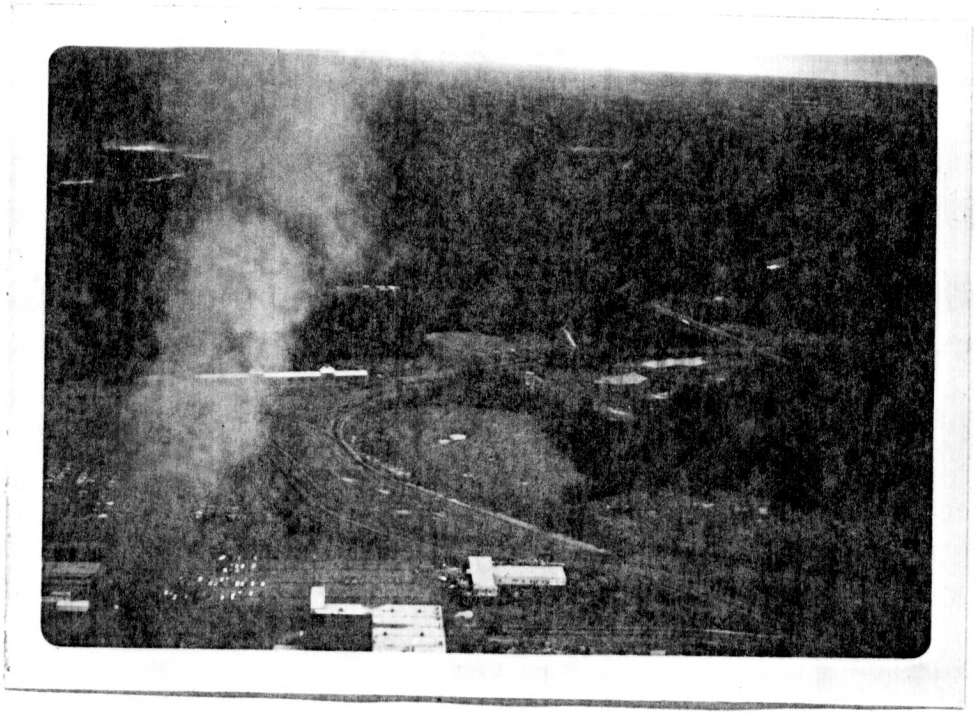
The following is an annotated photographic record from that survey.

A. SMOKE EMISSIONS

The major smoke emission source in the Thompson easement area is the Inco milling, smelting and refining complex (photo #1).

The level of sulfur dioxide in the ambient air has been monitored by Inco via lead peroxide candles regularly set out and collected from permanent stations in the surrounding forest.

The physical properties of the smoke from Inco's main stack indicate that gases other than SO_2 and particulate matter are also being emitted.



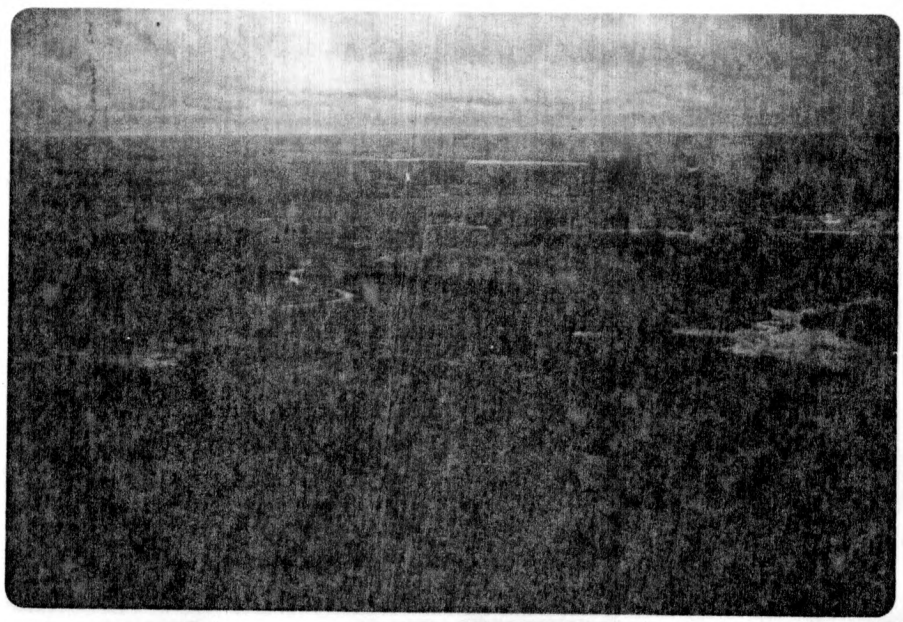
#1. Smoke issuing from Inco's main stack. Note the color and density.

B. SMOKE IMPINGEMENT AREAS

The color and density of the emission facilitated aerial observation of smoke pluming characteristics (photo #2) and detection of impingement areas (photo #3). During the aerial survey the smoke was impinging on a forested area due south of the Inco plant. This area displayed notable forest fume damage symptoms.

Another area of forest fume damage, much less severe in nature, was located to the south-west of the emission source (refer to map pp. 2).

As the aerial reconnaissance progressed it became apparent that the sulfur dioxide detection boxes were located out of the major smoke impingement areas.

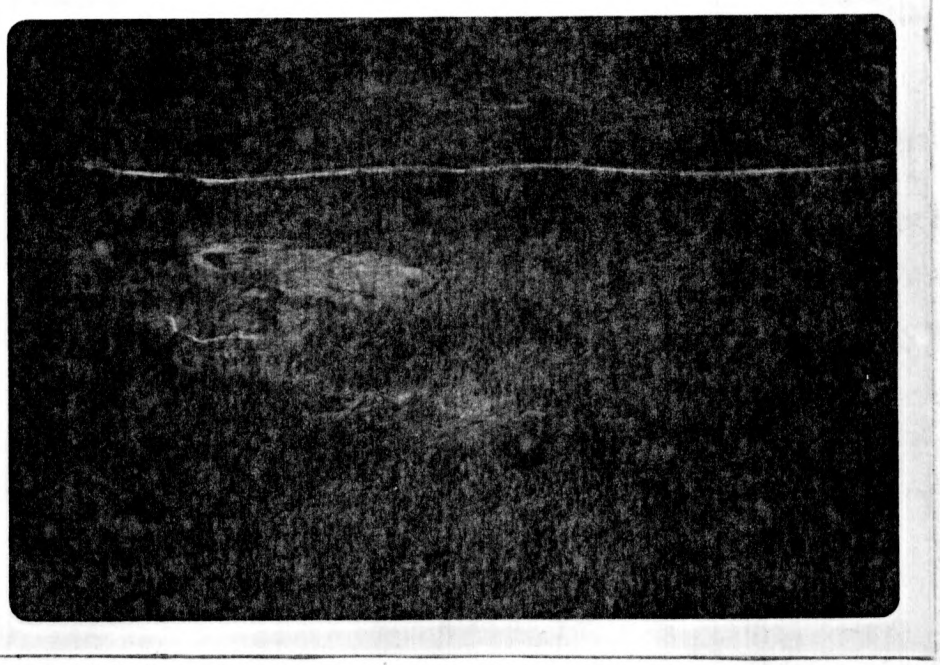


#2. A fanning smoke plume moving due south of the Inco plant into a forested area displaying fume damage. Note the browned, discolored patches of forest along the smoke's path.

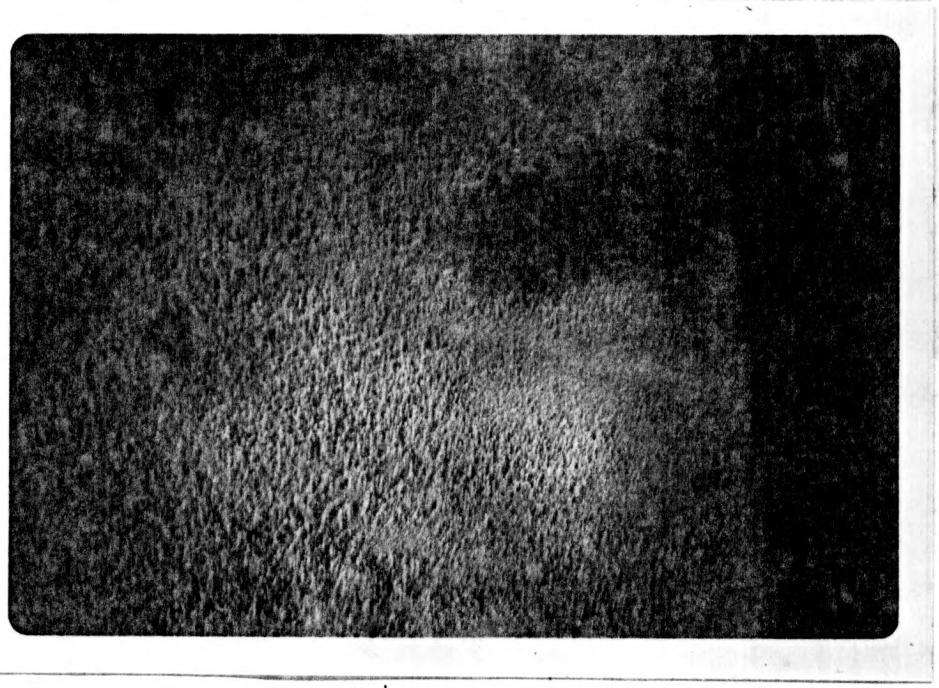
#3. A looping smoke plume moving south of plant and impinging at various points in the damaged area.

C. FOREST FUME DAMAGE AS SEEN FROM THE AIR

The severest forest damage was observed in the smoke impingement area due south of the Inco plant (refer to map pp. 2). From the air this stand damage appeared as grey, discolored patches (photo #4). Stands of dead and partially defoliated, declining trees account for these discolored patches (photo #5).



#4. Grey, discolored patches of the forest in the southern smoke impingement area.



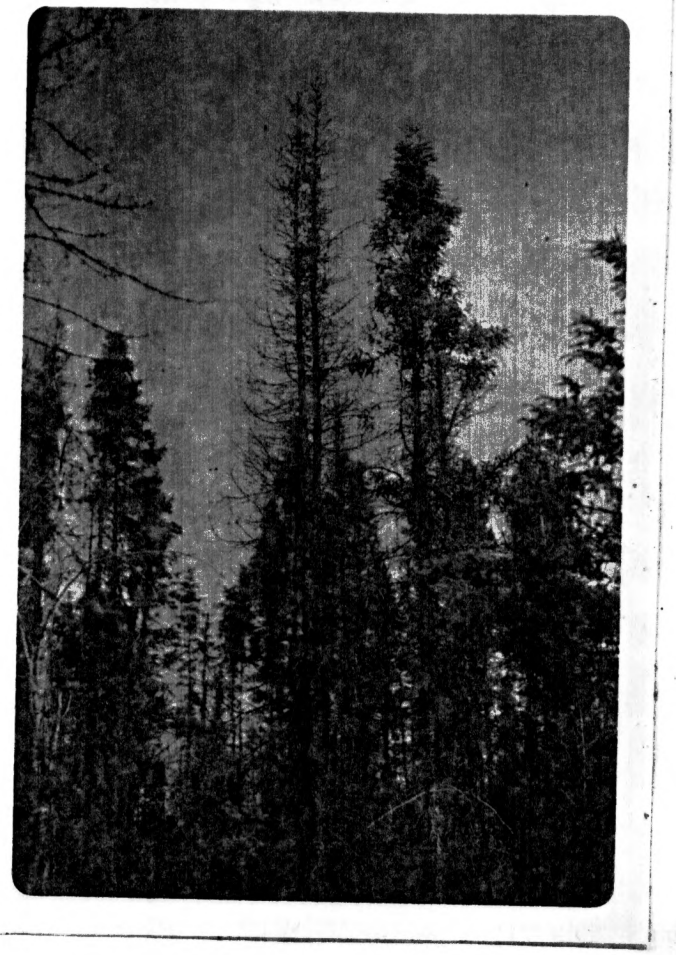
#5. Defoliated dead trees and partially defoliated, chlorotic declining trees account for the greyed, discolored appearance of the forest.

D. STAND DAMAGE

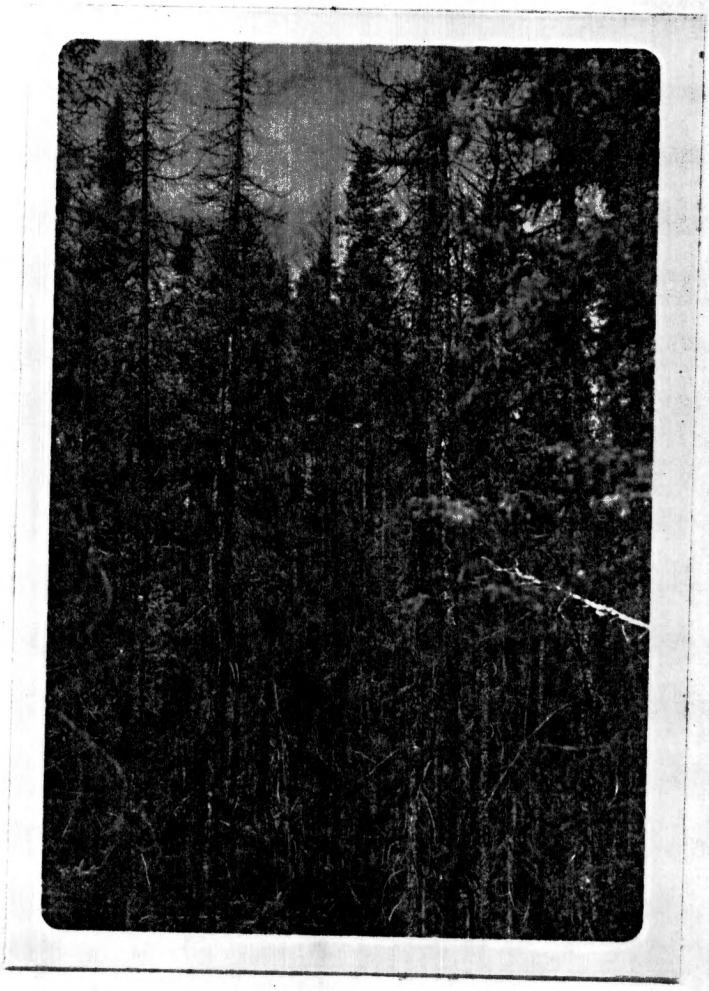
A ground check was carried out at a location inside of the smoke damaged area south of the plant. The smoke plume was periodically impinging on this location during the course of the examination.

D 1. DAMAGE TO THE STAND OVERSTORY

Jack pine and black spruce were the main components of the overstory in the area examined. Both of these species were found to be severely damaged. The damage ranged from partially defoliated trees in extremely poor condition to completely defoliated dead trees (photo #6, 7, 10).

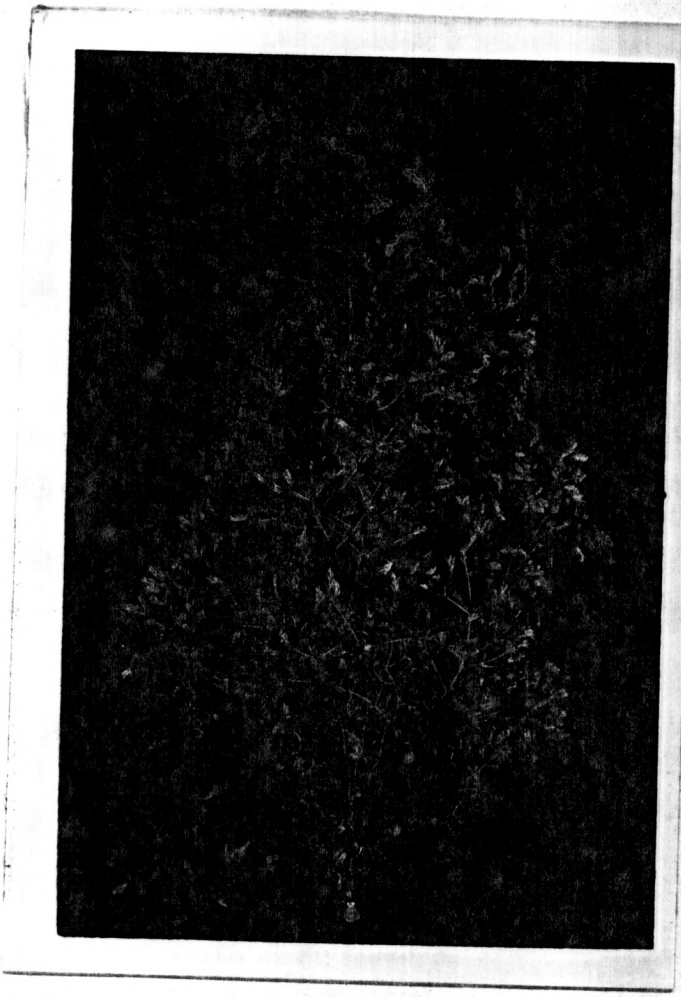


#6. Damaged conifers in the impingement area. Note the completely defoliated dead trees and the sparcely foliated trees in extremely poor condition.

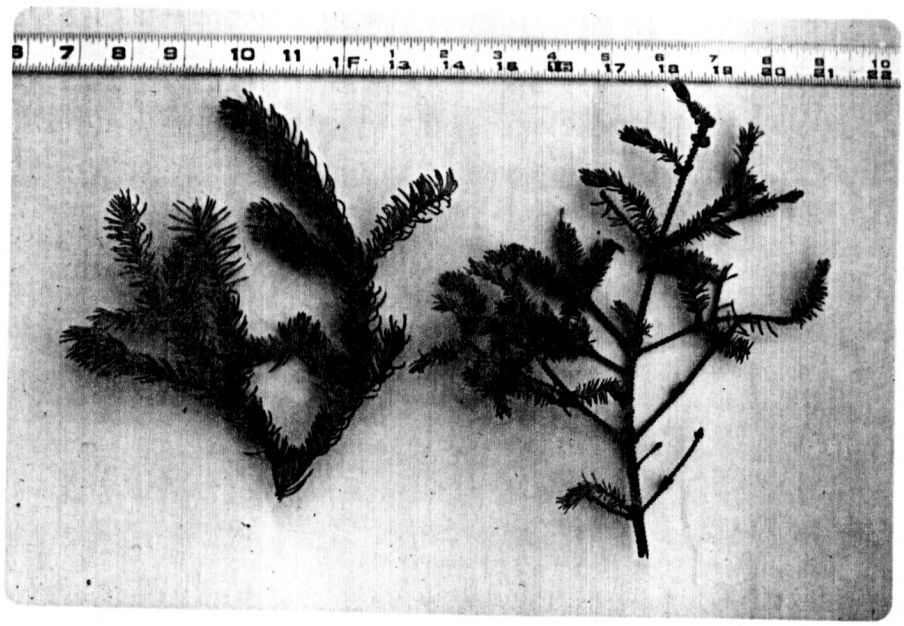


#7. The remaining live mature conifers were of poor thrift and displayed emission damage symptoms.

The larger spruce remaining alive in the area were rapidly declining. Short, stubby, discolored crowns resulting from foliar chlorosis and defoliation were common (photo #8). Dwarfed internodal growth also resulted from the necrosis and premature drop of the foliage. (photo #9).



#8. The severely shortened live crown of a 30-foot high black spruce. Note the discoloration (chlorosis) of the foliage facing the smoke source.



#9. Normal smoke damaged foliage from older spruce.

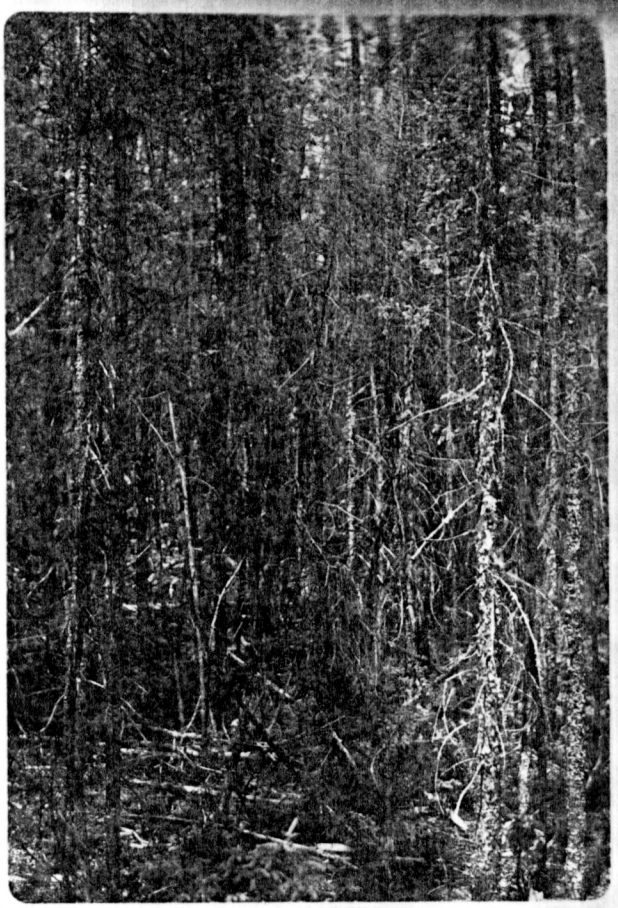
The overstory pine in the affected area suffered the highest mortality rates. The trees remaining alive had declined to a point near death (photo #10). Sparse, discolored foliage on extremely brief crowns were typical of the fume damage symptoms (photo #11).

#10. Dead and dying overstory pine and spruce.

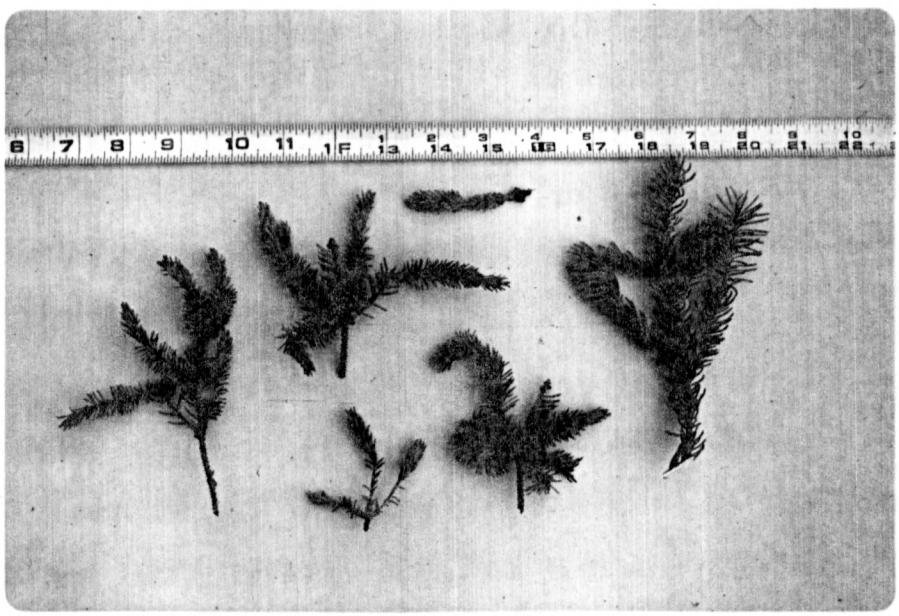
#11. The remaining live crown taken from a 40-foot tall jack pine. Note the sparse, discolored foliage.

D 2. DAMAGE TO THE ESTABLISHED IMMATURE TREES

The younger established trees in the area were also severely damaged by the smoke (photo #12). The smoke damage symptoms of needle necrosis, erratic needle lengths and early defoliation were common on the young spruce still alive (photo #13).

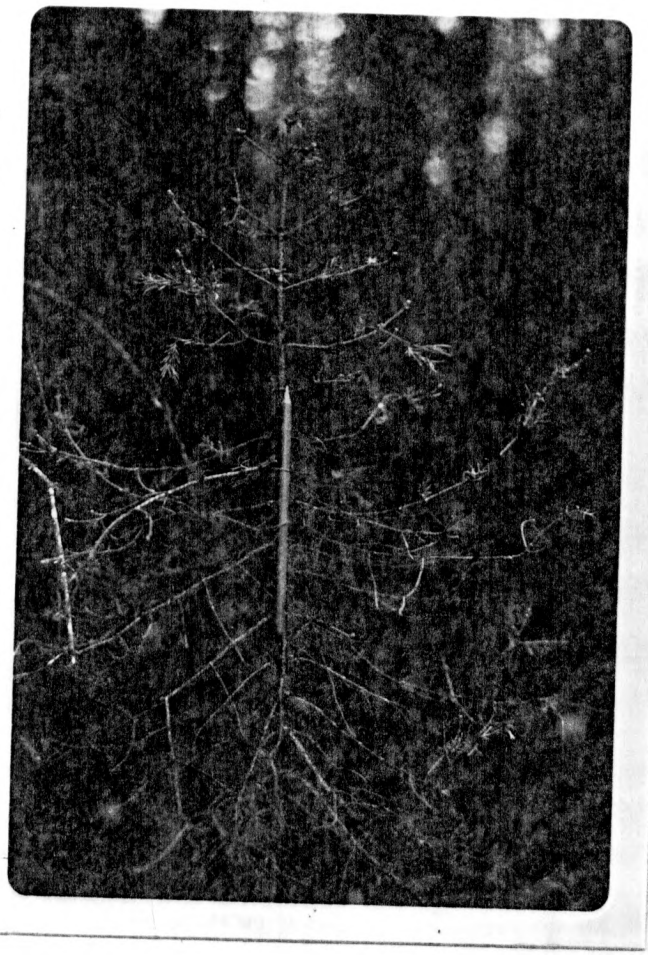


#12. Severely damaged immature conifers.

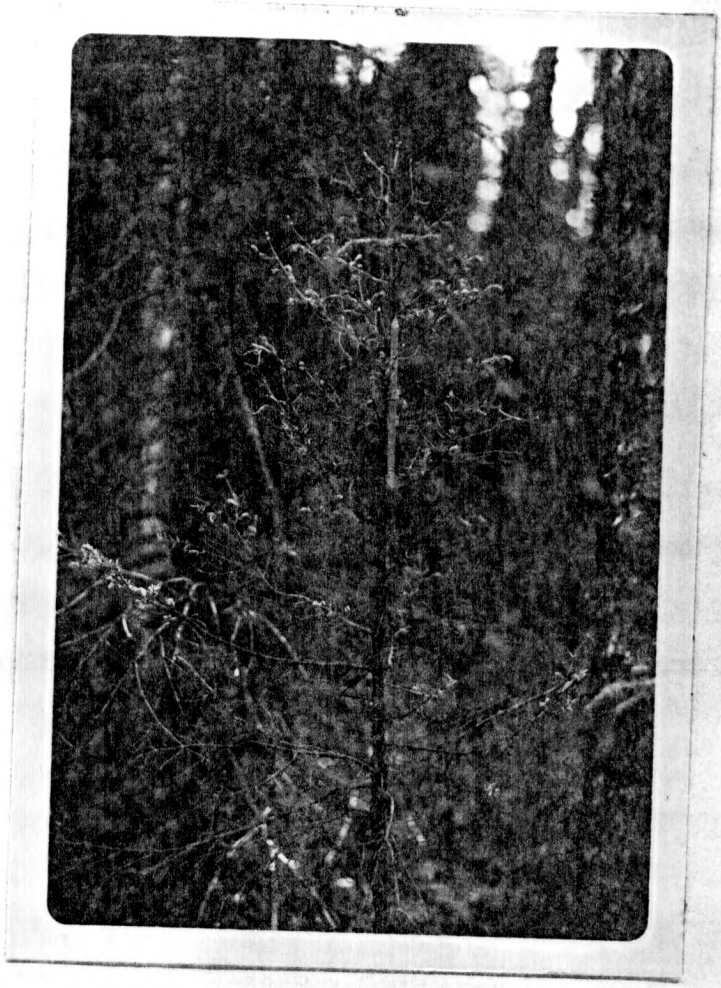


#13. Smoke damaged foliage (left) compared to a branch of normal foliage (extreme right), all from immature spruce trees.

Many of the young trees had been recently killed (photo #14) and the remainder were declining rapidly (photo #15).



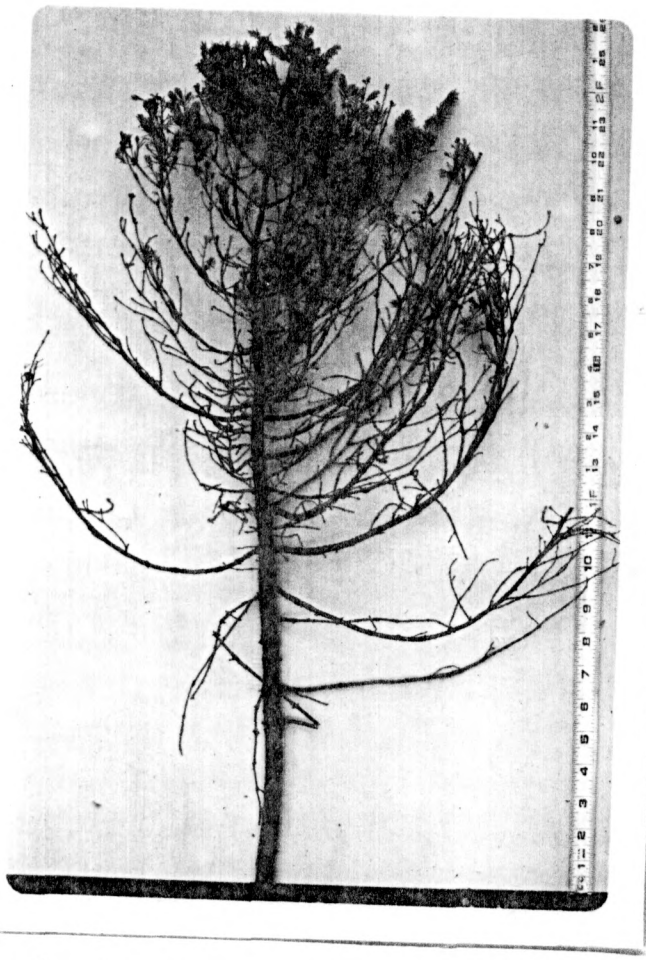
#14. A recently killed young spruce tree (identified by the retention of necrotic needles).



#15. A badly defoliated, rapidly declining young spruce tree.

D 3. DAMAGE TO THE REGENERATION

The regeneration in the location examined commonly suffered severe damage. The young conifers usually displayed the typical smoke damage symptoms of foliage discoloration, needle growth stunting and early defoliation (photo #16). Mortality among the regeneration was also commonplace (photo #17).



#16. A very young tree displaying foliage discoloration, needle stunting and partial defoliation.

#17. A dead seedling. These were common.

D 4. SMOKE DAMAGE TO THE GROUND COVER

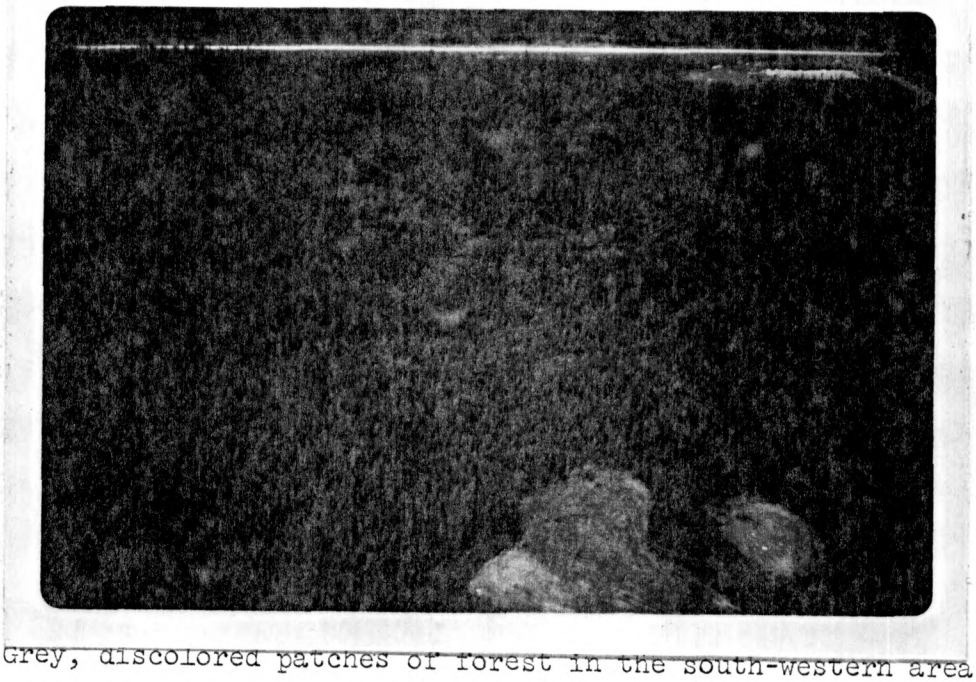
The ground vegetation left alive in the location examined was extremely sparce and reduced to a very few species (photo #18). Many of the lichens and mosses normally present were dead, even though rainfall had been abundant in the area (photo #19).

#18. Typically sparce, live ground vegetation.

#19. Dead lichens and dead mosses.

E. THE SECOND DAMAGED AREA

Another damaged area appeared to be developing to the south-west of the emission source (refer to map pp. #2). The damage was much less obvious from the air than that in the southern area, however some notable patches of damage were present (photo #20 and 21). No ground examination was carried out in this area.



#20. Grey, discolored patches of forest in the south-western area.

#21. A small patch of dead trees in the area.

F. FOREST DAMAGE FROM WATER EFFLUENT

The effects of water effluents were noted on the forest community in the immediate vicinity of the plant (photo #22). Tree mortalities were apparently caused by effluent water inundation.

#22. The forest damaged by water.

#23. Drowned trees.

G. REMARKS AND SUGGESTIONS

1. The sulfur dioxide detection boxes are located outside of the two fume damaged forest areas noted in this survey (refer to map pp. 2). Considerations should be given to placement of SO_2 detection boxes within these two areas and on other plume impingement areas.

2. The color, density and odor of the smoke plume indicated the presence of sulfur dioxide and other emissions. It is recommended that the smoke be monitored to determine the amount of SO_2 and other pollutants emitted (e.g. oxides of lead, arsenic, nitrogen, antimony etc.).

3. Further ground truthing is needed to more clearly define the amount and intensity of forest fume damage in the easement area. It is suggested that the damaged forest areas detected in this survey be subjected to an evaluation survey conducted from the ground. Concomitantly a forest fume injury index should be established for the entire smoke easement area.

4. It is further suggested that the area be zoned into various damage categories, on the basis of the forest injury index, in order that damage progression rates may be determined.

APPENDIX I

A HISTORICAL SUMMARY OF THE THOMPSON SMOKE EASEMENT SURVEY

In 1960 the International Nickle Company began operation of a fully integrated mining complex consisting of mines, milling, smelting and refining operations at Thompson, Manitoba. The Manitoba provincial government decreed a smoke easement area surrounding the mining complex, required the company to monitor SO_2 levels on a regular basis via lead peroxide candles set out at various locations within the easement, and requested the Federal Forestry Service to carry out an emission damage survey.

From 1960 to 1965 an aerial survey was carried out over the entire sample easement area. Ground inspections were carried out at some of the SO_2 detection box locations. Results from these surveys show little evidence of damage with the exception of a zone of lightly damaged jack pine extending for $2\frac{1}{2}$ miles immediately south of the smelter.

From 1966 to 1970, the aerial coverage was shortened to direct flight lines between the SO_2 detection box locations. No damage of any consequence was reported during this interval. International Nickle also reported that they had not detected any damage to vegetation in the easement area by 1970.

A summary of results from earlier surveys (1961 - 1970) follows.

SUMMARY OF VEGETATION SYMPTOMS FROM 1963 THROUGH 1970 IN THE THOMPSON SMOKE EASEMENT AREA

Smelter operation began in 1961
First symptoms observed in 1963

Year	Species & Damage	Location & SO_2 Station No.
1963	Balsam poplar (light damage to the foliage)	Isbister Lake #9 Witchai Lake #12 Natawahunan Lake #8
1964	White birch, balsam poplar, dogwood, trembling aspen, high-bush cranberry, white spruce (light damage to the foliage)	Natawahunan Lake #8 Witchai Lake #12 Aspwagan Lake #17 Paint Lake #18 Wintering Lake #5 and #19 In a 35 mile area extending to the northeast and south-east of Thompson
1965	Black spruce (light damage to 10% of the trees)	Natawahunan Lake #8
	Alder (10% of the foliage damaged on 50% of the trees)	Burntwood River #10 Natawahunan Lake #8
	White birch (light damage to a few trees)	Isbister Lake #9 Burntwood River #10
	Saskatoon (10% of the foliage damaged on 30% of the trees)	Wintering Lake (S) #19
	Balsam poplar (10% of the foliage damaged on 30% of the trees)	Harding Lake #15
	White spruce (10% of the foliage damaged on 30% of the trees)	Harding Lake #15
	Jack pine, trembling aspen (light damage to the foliage)	In an area extending for 2½ to 3 miles immediately south of the smelter in a band about one mile in width

Year	Species & Damage	Location & SO_2 Station No.
1966	No definite occurrence of fume damage was recorded	
1967	White birch, Saskatoon (light to moderate damage to a few trees)	Wintering Lake (S) #19 Paint Lake #18 Aspwagan Lake #17 Harding Lake #15
	Wild rose (light damage to a few plants)	Aspwagan Lake #17
1968	Willow (moderate damage)	Aspwagan Lake #17
	White birch (light damage)	Paint Lake #18
	Saskatoon (light damage)	Wintering Lake #5 (N)
	High-bush cranberry (very light damage)	Isbister Lake #9
1969	Black spruce (very light damage)	Wintering Lake #19 & #5 Paint Lake #18
1970	White birch (light damage to the foliage of a few trees)	Paint Lake #18
	White spruce (light damage to the foliage of one tree)	Wintering Lake (S) #19
	Alder (light damage to the foliage of several trees)	Isbister Lake #9 Aspwagan Lake #17
	Balsam poplar (moderate damage to the foliage of one tree)	Aspwagan Lake #17

Edmonton, Alberta
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