



STATENS BRANDINSPEKTION

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Forest Fire Prevention and Forest Fire Fighting in Sweden.

Representatives of other countries often show a great and very pleasant interest in the Swedish organization of Forest Fire Prevention and Forest Fire Fighting.

To facilitate studies of these matters the National Swedish Inspectorate of Fire Services has summarized the essential facts in this publication.

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Skannat av Utkiken



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1. Sweden - a Country of Forests.

1.1 Geographical situation.

Sweden occupies the eastern and southern parts of the Scandinavian Peninsula, and extends from Lat. N 55° to Lat. N 69° , i.e. some 1,000 miles. It is about 300 miles at its greatest width.

Sweden has a land-frontier in the west to Norway and in the north-east to Finland, and is otherwise surrounded by water, mainly the Baltic.

1.2 Area, Population.

The area of Sweden totals $450,000 \text{ km}^2$ (175,000 square miles) of which $40,000 \text{ km}^2$ (15,600 square miles) is water. 10 % of the land area consists of cultivated and meadow land, 55 % of productive forest land and 35 % of mountains, marshes and moors.

The population is 7.6 million.

Of old, the country from the south upwards, is divided into Götaland with 10 provinces, Svealand with 6 provinces and Norrland with 9 provinces (Fig. 1). As regards the state administration, however, Sweden is nowadays divided into the Prefecture of Stockholm and 24 counties, the boundaries of which coincide to a certain extent with the old boundaries of the provinces. At the head of each county there is a County Administration. Each county consists of a varying number of primary municipalities (cities, boroughs, urban districts and rural districts), some 1,000 in all. The municipalities which to a large extent are politically independent, answer for several of the public undertakings, among other things for the fire services, including the forest fire services.

1.3 Climate.

Sweden holds a middle position between the maritime and continental climate types, the former mainly on the west and south coasts, the latter in the inland of northern Svealand and Norrland. On account of the Gulf Stream the climate is milder and damper than the latitude would

warrant.

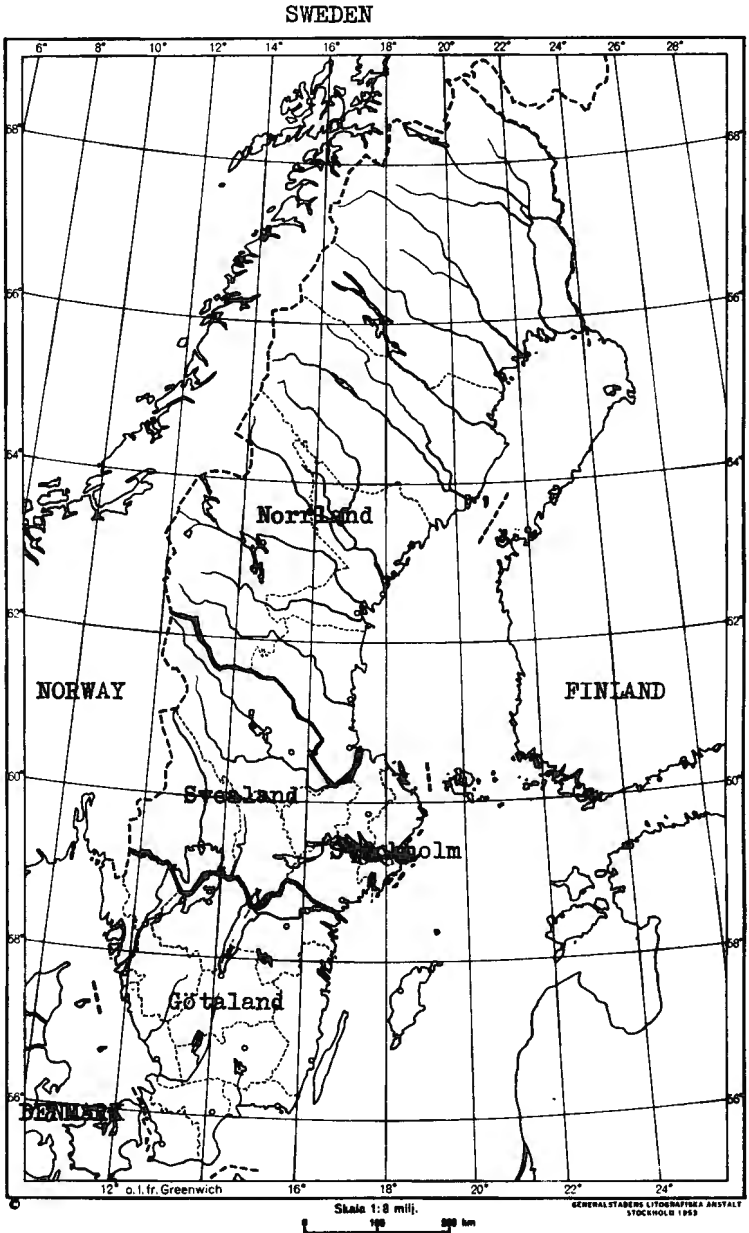


Fig. 1. Sweden.

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The rainfall in the largest part of the country is 500 - 600 millimetres per annum. In the inland of Norrland and in the coastal zone of the Baltic, however, it is less, some 400 millimetres, but in western Götaland and in the mountainous districts at the Norwegian frontier larger, some 700 respectively 1.000 millimetres per annum.

The average temperature in the extreme north in January is about -13°C (9°F), in July $+13^{\circ}\text{C}$ (55°F), and in the southern parts of the country about -1°C respectively $+16^{\circ}\text{C}$ (30°F , respectively 61°F).

Since about a century, in each decade there have been eight comparatively moist and cool summers, and two warm and dry, with of course a heavily increased number of forest fires. As a general rule, the majority of forest fires occur in April - May and in the dry summers there is generally a secondary agglomeration, with heavier damage, in July - August.

1.4 Phytogeographical Regions.

The Mountain Region comprises the north-west part of the country along the Norwegian frontier. The vegetation consists of lichens and mosses, at lower levels of grassy and scrubby moors with dwarf birches.

The Birch Region extends between the Mountain Region and the upper limit of pine forests, the latter according to latitude some 400 - 800 metres above sea level.

The North Coniferous Region comprises the whole of Norrland below the Mountain and Birch Regions and also northern Svealand. This region is the largest forested area of the country, with Scots pine and Norway spruce as the principal species. The rotation of coniferous stands varies between 90 and 150 years.

The South Coniferous Region comprises the middle and southern parts of Svealand, and the greater part of Götaland except the extreme South. Scots pine and Norwegian





Fig. 2. Swedish birch forest.





Fig. 3. Swedish pine forest.



spruce are predominant, but also a fair percentage of broadleaved trees. The forest is often interspersed with arable and meadow lands. The rotation of the coniferous trees is on an average 80 to 100 years, that of the broadleaved trees 60 to 100 years.

The Beech Woods region.

Beeches and oaks are here rather common, but the coniferous stands are predominant even in this region - especially the spruce which is replacing the old beech forests. The rotation of the region is 40 to 80 years.

1.5 Forestry.

The annual cutting averages 55 million forest cubic metres (about 1.500 million cu.ft) whereof 47 million cu.m. coniferous. The cutting per hectare of forest averages 2.4 cubic metres (about 65 cu.ft) whereas the average production potential is stated to be 3.6 forest cubic metres per hectare - about 98 cu.ft - (in northern-most Sweden 2.1, in the south 6.0 cu.m. - i.e. about 57 respectively 165 cu.ft).

The transportation to the saw-mills and pulp mills, which earlier mostly was done by log driving on the rivers (Fig. 4) is nowadays more and more done by lorry, owing to a large extension of the forest road network, which of course comes in highly useful also to the forest fire services (Fig. 5).

Manufactured timber and pulp constitute the most important exports. The export value of the forest products in 1963 was about 5 milliard kronor (about £ 355 million).





Fig. 4. Timber-floating.





Fig. 5. Timber load.



2. Forest Fire Frequency and Damage.

Both frequency and damage will vary within wide limits, depending on the seasons weather.

A few examples:

Year	Number of forest fires		Damage: Burned productive forest area, ha
	Total	Quenched as incipient Number Per cent	
1954	578	216 37	573
1959	7093	5462 77	4501
1964	3099	2074 67	2245

Both 1954 and 1964 come within the limits of a "normal" season. In 1964, the spring was rather early and dry. There is also this consideration that in the last decade the yearly average of forest fires has increased by some 50 %.

In spite of the general increase in the number of fires, it has been possible to increase the number quenched before appreciable damage (limit less than 0,1 ha damage) from an average of some 45 % in the previous decade to some 70 % in the present one.

There have also of late been some noteworthy changes in the frequency of certain causes of fires. In the period 1954-1963 as compared with 1944-1948, for instance, "Railways" has come down from 24,4 % to 8,8 %. The percentage of "Lightning" has come down from 14,6 to 7,5. "Children" on the other hand, show a big and factual increase, from 8,6 % to 17,9 %, the damage caused by this type of fires being as a rule comparatively slight, however. Contrariwise, when "Controlled Burning-over", 3,8 % resp. 3,5 %, gets out of control, the damage may be serious. For instance, in 1964, the percentage of such fires was as low as 2,4 %, but the damage caused by them 16 % of the entire damage. This method of preparing the soil of a tract after cutting for sowing or planting is considered very advantageous, in the north rather a necessity, and as of course it has to be performed in fire weather, it is necessarily done very circumspectly, but nonetheless an unforeseen rise and change of wind may bring havoc.





Fig. 6 A. Forest fire extinction.



Fig. 6 B. Forest fire extinction.



3. Forest Fire Prevention.

3.1 General Policy.

The Swedish policy in regard to the forest fires may be condensed as follows:

1:0 Have the general public, responsible for the majority of forest fires, alerted and rendered ~~fire-conscious~~ by broadcasts, television, posters and cinematic strips (Fig. 7).

2:0 Trace and locate the fires at the earliest possible moment as surely and economically as possible.

3:0 Enable the fire fighters with adequate equipment to follow up and reach the fire site with the least possibly delay.

4:0 Have the fire fighters trained for this special purpose by yearly courses.

3.2 Legislation:

According to the Fire Laws:

- 1) Each municipality shall have fire services for settled country as well as forests satisfying a reasonable claim to security from fire damage;
- 2) When required, anyone between 16-65 years of age, of sound constitution and health, and who is staying or living in the place, is bound to assist in the forest fire fighting;
- 3) At a fire which is or threatens to be of great extent, military may be requisitioned;
- 4) The Crown reimburses the actual costs of forest fire detecting and fighter services.



Fig. 7.

An example of a poster.



3.3 Meteorological Prognostics and Warning Services.

3.31 General Prognostic Service.

The Swedish Meteorological and Hydrological Institute (SMHI) performs in summer the following prognostic and warning services with a view to forestry:

- 3.31.1 Weather Forecasts for Burning-Over. The SMHI gives on week-days, on the radio about 6.35 a.m., the prognosticated wind and weather conditions in a specified number of Burning-over districts.
- 3.31.2 Estimating the Degree of Fire Hazard. The latent forest fire hazard depends on a number of meteorological factors: the moisture of the atmosphere, soil and rainfall, solar-radiation, air temperature and wind. The SMHI estimates the fire hazard values (see below) and broadcasts at about 8.10 a.m. daily estimates, for convenience relating to the same comparatively large districts as for the Burning-over.

As a basis for the estimating of the fire hazard a measurement of the temperature and relative air moisture is performed at 1 o'clock p.m. at a certain number of meteorological stations.

The degree of fire hazard is indicated by the figures below:

- 1 = very little fire hazard
- 2 = little fire hazard
- 3 = normal fire hazard
- 4 = great fire hazard
- 5 = very great fire hazard

The forecast of the fire hazard as broadcast in the morning is based on the figures of the preceding day. There is, however, taken into consideration also the weather prevalent since that day and the weather to be expected on the actual day. The fire hazard forecast by 8.10 a.m. thus gives the fire hazard values expected in the afternoon.



3.31.3 Forest Fire Warnings. The SMHI issues forest fire warnings on the radio and television as occasion requires, in order to call the attention of the public to the fire-danger.

3.32 Local Fire Hazard Observations.

For the efficiency and not least the economy of the airborne patrolling (see 3.4) it is evidently a prerequisite that the daily flights can be co-ordinated as closely as possible with the actual hazard. Now the latent forest fire hazard is mainly the result of previous weather during a period of practically indeterminable length, and the weather factors may have collaborated or counteracted each other. Present and immediately prognosticated weather may sometimes, as for instance thunderheads, rain, high winds, be the determining factors, but mostly is more of a secondary factor. Moreover, the broadcasts are necessarily applicable to comparatively large districts, and especially during periods of higher hazard there are often considerable local weather variations.

For the daily planning of the flights it was therefore necessary to have, in addition to the broadcast, also a series of local observations along the flight routes. For the purpose a special, easily readable device had to be elaborated (Fig 8). The dimension of this fire hazard gauge is about 20 x 15 x 15 cm (8 x 6 x 6 in.). The gauge shows automatically the fire hazard on a scale from 1 (minimum) to 5 (maximum). For comparable readings it is to be used in an open place exposed to sun, wind and rain, the apparatus itself simulating the average protection afforded by the forest canopy, and is placed on an even plot of soil or sand directly on the ground. The gauge reacts to the accumulating weather factors, i.e. rainfall, solar radiation, temperature and wind, modified by the daily rhythm of the relative air moisture and the actual wind.

The gauge is also being turned to account at a number of Fire Brigades independently of the airborne patrolling. It has come in useful, as the Fire Chiefs have to sanc-



tion any Controlled Burning-over, burnings of slash, grass, straw etc.

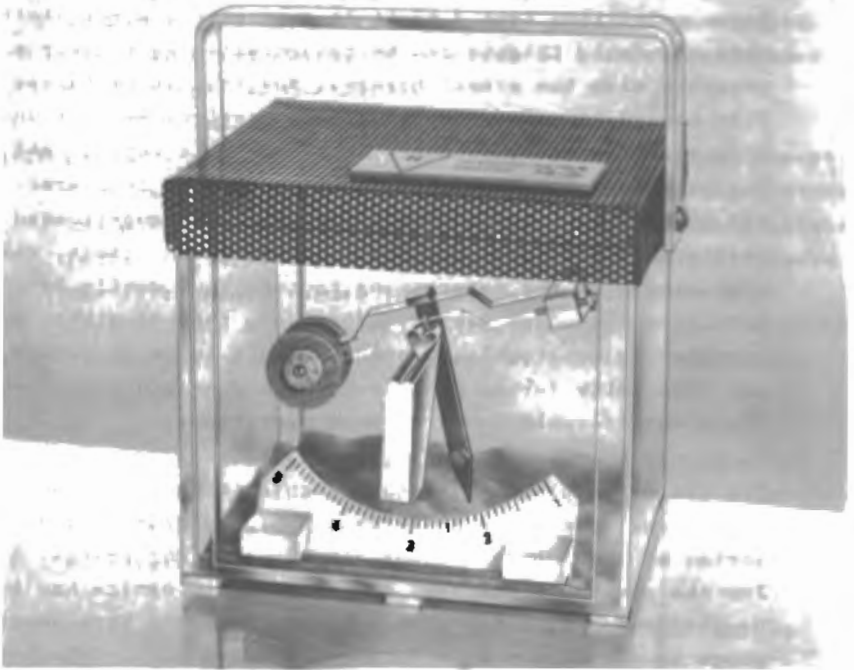


Fig. 8. Fire hazard gauge.



3.4 Airborne Patrolling.

Even if the majority of forest fires are discovered and reported by the general public, evidently it would not do to rely on this, especially in the comparatively sparsely populated main forest areas. Therefore, for the purpose of early discovery a chain of 300 Watch Towers has been used. The manning of these has however proved comparatively costly, as compared with the effect.

Therefore, in 1955 the National Inspectorate of Fire Services decided to try airborne patrolling on a small scale by establishing a collaboration with the Royal Swedish Aero Club (KSAK). This collaboration with the associated local clubs has proved mutually advantageous and extended to a regular service, May-September, within the North Coniferous Region and temporarily in periods of high hazard in the South Coniferous Region (Fig. 9 and 10). The Watch Tower services have been discontinued.

The regular sport planes, of varying makes and types, of the clubs are used. The activities are regulated and paid for by flight hour by the respective County Administrations. The pilots are not paid, but get their requisite flight hours for the maintenance of their certificate free.

In addition to the patrolling, it has proved possible to turn these airplanes to good account also for the organizing and directing of the firefighting at larger forest fires.

4. Forest Fire Suppression.

4.1 The Municipalities and the Forest Fires.

As mentioned above, each municipality has, by law, to establish adequate fire services against forest and other fires. The municipal organ in charge of the fire services is the Local Fire Service Board. The officer responsible is the Fire Chief. In forested areas, the Fire Chief should be familiar with forest matters, study local conditions, and do the requisite preplanning.





Fig. 9. Airborne patrolling.



Fig. 10. Marking out on the map a forest fire, which has just been reported from their comrades (via the radio).

In each municipality is established a Fire-Brigade distributed on so many Fire Stations that every part of the municipality can be reached by a fire squad within reasonable time. The Fire Personnel is to an overwhelming extent parttime employed. In the municipal Fire-Regulations is stated, among other things, the minimum force that within a certain time stated can be turned out from each station.

As a complement to the Fire-Brigade a Fire Guard is established in many municipalities. If mainly concerned with forest fire fighting, it is named Forest Fire Guard. The equipment of the groups of the Fire Guards is maintained in special Equipment Depots. The personnel of the Fire Guards has not got to do watch duty and is not so strictly attached to the service as the Fire-Brigade personnel. The training is not very extensive. While a part-time fireman gets an average training of 35 to 40 hours per year, the corresponding time for the personnel of the Fire Guards is 2 to 8 hours per year.



Fig. 11. Forest fire extinction jeep (Volvo).

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The Vehicle Equipment for Forest Fire Fighting consists as a rule of tank lorries and jeeps with trailers (Fig. 11). Other equipment are light, portable fire pumps, spray cans, small-bore hose, steel brooms etc (Fig. 12).



Fig. 12. A portable fire pump.

Whereas formerly practically all forest fire fighting was done by levies, what with the perfection of the forest road network and the motorization of the Fire Brigades the use of their equipment has come into the foreground. In order to be used to best advantage, it must evidently arrive at an incipient stage of the fire - later you have got to rely on man-power - and so an early detection becomes the more important. At the present time some 70 percent of the forest fires are extinguished mainly by Fire Brigade equipment, and co-incidentally the same percentage of fires are extinguished before appreciable damage.



4.2 Training courses in Forest Fire Fighting.

Under guidance of the National Fire College in Stockholm - where Fire Brigade Personnel of all degrees get their basic training - there are in every year, on a regional basis, arranged training courses in Forest Fire Extinction. These training courses are going on for two days during april - june on about 20 different places all over the country.

4.3 The State and the Forest Fires. As mentioned above, the expenses connected with airborne patrolling and forest fire fighting are ultimately borne by the Crown.

Forest fire fighting is done by the municipal Fire Forces - Fire-Brigades and Fire Guards - and, at larger fires, also by levies of civil and military personnel. In charge of the extinguishment is normally the municipal Fire Chief or another fire officer. At larger forest fires, when a great number of fire-brigades and other extinguishing personnel must attend, the County Administration may appoint a special organizer, mostly the County Fire Inspector, of the extinguishment operations. The costs are to be charged to the Crown according to a standard list of rates determined by the National Inspectorate of Fire Services, and bills for the extinguishment are to be handed in to the County Administration concerned.

As regards the Airborne Patrolling, the Costs are to be charged to the Crown according to provisions determined by the National Inspectorate of Fire Services in consultation with the KSAK.

The Crown also answers for the supervision of the Fire Services, the Forest Fire Services included. On the county level this is done by the County Administration concerned, which has an expert associated with it, the County Fire Inspector, and for the whole country by the National Inspectorate of Fire Services the Chief of which is the Inspector General of Fire Services. The Inspectorate has also, for the guidance of the Fire Chiefs, to issue directions. This is done principally by means of Circulars and Informative Recommendations. The National Inspectorate

of Fire Services has also to edit the yearly Forest Fire Statistics.

5. Forest Fire Statistics.

On every forest fire occurred - inclusive of fires on grass and moors, the municipal Fire Chief has got to hand in a Forest Fire Report to the County Fire Inspector. Fires with a burned area of 0.1 ha (0,25 acres) or more, so-called A-fires, are reported on a more detailed form than B-fires, burned area less than 0.1 ha.

The productive forest soil burned is to be given in percentage terms (alternatively 100, 75, 50, 25 and 0 %) of the total area burned.

No report is needed as to a forest fire within townplanned areas.

The entries of the report cards as well as the details of the costs from the County Administrations concerning fire extinguishing and forest fire-watching are made up to the National Statistics of Forest Fires every year. The National Inspectorate of Fire Services answers, as was mentioned above, for this duty.

The estimate of Forest Fire Damages is done with the help of a standard method worked out by the Royal College of Forestry, which on the whole implies the following:

The Country has been divided into areas within which the variations as to the production potential and the costs of the preservation of the timber are comparatively small (Fig. 13). For each such area has been estimated the average damage cost per hectare of productive forest soil, "C", which could be caused by forest fire. The estimates are based on a basic value of 10 kronor per forest cubic metre (m^3sk) of the so-called 30 cm tree, i.e. a tree with a diameter of 30 cm at breast-height (1.3 m or 4.5'). If for instance the current value of the season of the 30 cm tree is 40 kronor per m^3sk thus "C" should be multiplied by 4. The total damage cost in each area is obtained by multiplying the number of hectares of productive forest soil burned by the thus corrected value of "C", (National Inspectorate of Fire

Services Informative Recommendations (1963:5).

6. Costs.

During a normal year the costs caused by forest fires are approximately the following:

Forest fire damages - some 2.0 million kronor.
 Forest fire-watching - some 0.5 million kronor.
 Forest fire extinguishment (charged to the Crown) - some 1.5 million kronor.

During a dry year the costs may increase to the double or more.

7. Circulars and Informative Recommendations.

In the following the Circulars and the Informative Recommendations of the Inspectorate - each with a short summary in English - concerning Forest Fire Questions up to date are listed.

1. Circular 19 (Forest Fire Statistics 1944-1953).
2. Informative Recommendations.

1956:13 Forest Fire Statistics 1954 and 1955

1957:13 Forest Fire Statistics 1956

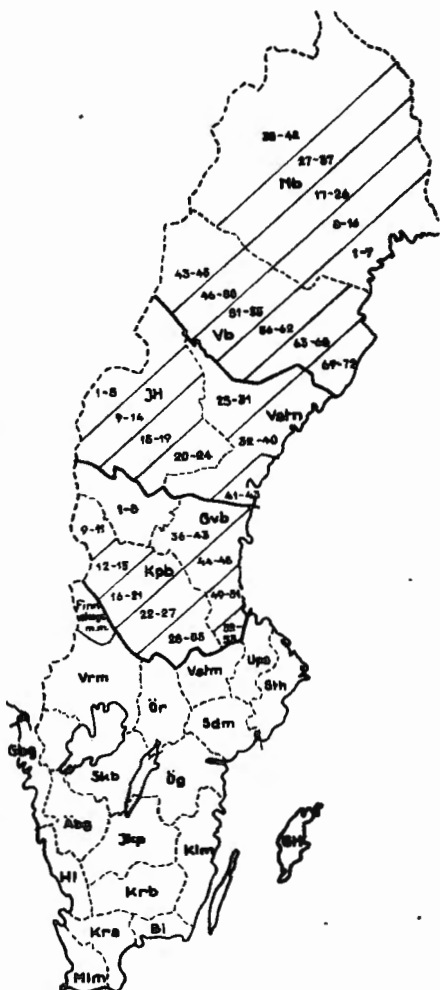


Fig. 13.
 Map showing Sweden subdivided into districts with regard to the valuation of the forest fire damage costs.

1958:7	Forest Fire Statistics	1957
1959:11	" " "	1958
1960:8	" " "	1959
1961:12	" " "	1960
1963:11	" " "	1961 and 1962
1964:17	" " "	1963
1965:5	" " "	1964
1959:5	Preparedness against Conflagrations	
1959:6	Model Remuneration Tariff for Communal Co-operation at Fires	
1963:5	Forest Fire Statistics	
1963:7	Remuneration and Indemnity for Fire Fighting Work	
1964:4	Controlled Burning for Silvicultural Purposes	
1964:5	Forest Fire Protection	
1965:3	Aeroplanes against Forest Fires.	

