Forestry Commission Bulletin

45

Windblow of Scottish Forests in January 1968

HMSO 45p net

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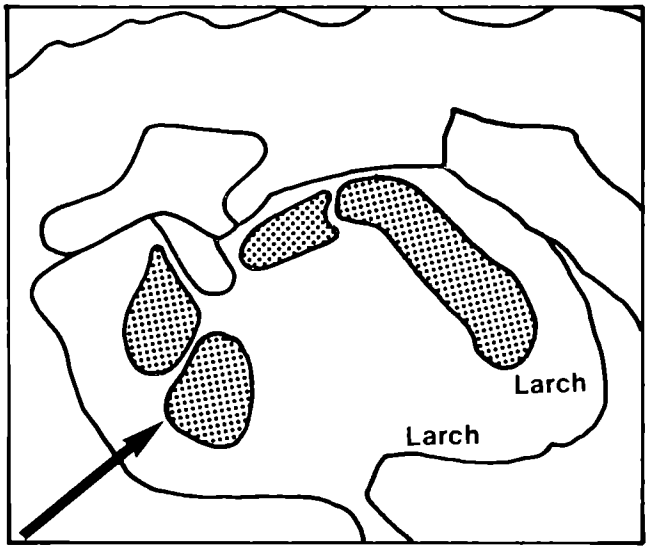

Plate 1. Knapdale Forest, Argyll. The gale damage on the rather isolated knoll is concentrated on the upper windward and oblique slopes and the top. Little damage occurred on the lee sides. CS 17506

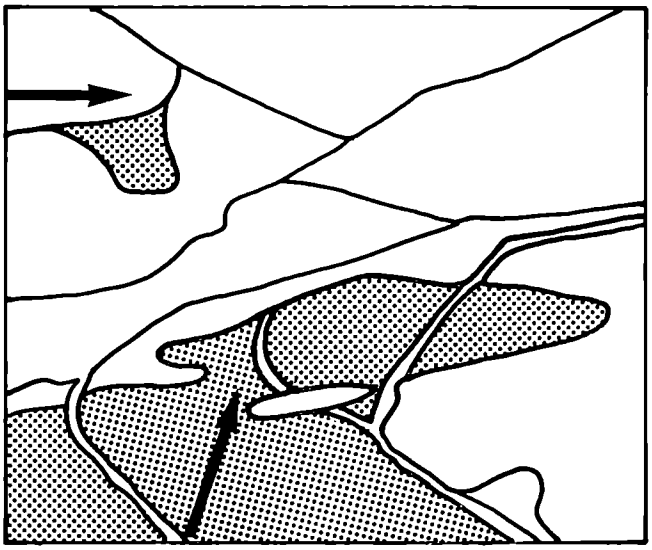

Plate 2. Extensive damage at Glenbranter Forest, Argyll, on a smooth slope oblique and parallel to the gale direction. The grassy area in the foreground reflects damage caused by a previous gale. On the distant hill another air-stream parallel to the slope has damaged the upper crops, stopping at the shoulder without extension on the lee side. CS 17519

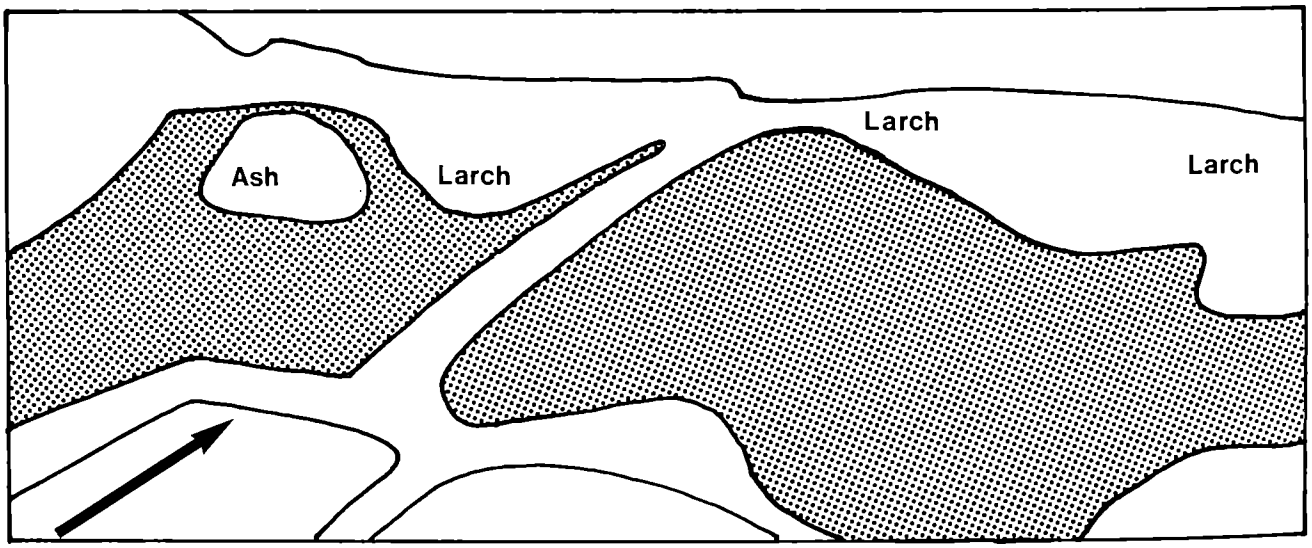

Plate 3. Knapdale Forest. A windward slope (lying south of the Crinan Canal). Damage stopped at a hardwood edge and, in part, at a larch stand. More deeply rootable soil, as well as the leaflessness of these crops, probably contributed to their stability. The greater windfirmness of trees on compartment edges is also typical. CS 17494

FORESTRY COMMISSION BULLETIN
No. 45

Windblow of Scottish Forests in January 1968

REPORT OF THE WINDBLOW ACTION GROUP

Edited by
B. W. HOLTAM B.Sc.
Forestry Commission

This Report is prepared by the Windblow Action Group for its parent committee, the Home Grown Timber Advisory Committee, as a final report on, and history of, the Group's work in dealing with the problems arising from the windthrow of Scottish forests in the gale of 15th January 1968.

EDINBURGH: HER MAJESTY'S STATIONERY OFFICE
1971

SBN 11 880153 8

CONTENTS

		Page
FOREWORD By T. Y. GIBSON, O.B.E., *Chairman, Windblow Action Group*		ix
Membership of the Windblow Action Group		x
SECTION 1		
INTRODUCTION		
By B. W. HOLTAM, *Forestry Commission*, Editor		1
SECTION 2		
METEOROLOGY		
By A. I. FRASER, *Forestry Commission*		3
Table 1	Surface wind velocities on 15 January, 1968 for five forest areas	5
Figure 1	Map showing distribution of maximum mean hourly wind speed	6
Figure 2	Map showing the main areas affected by the gale	7
SECTION 3		
DAMAGE TO FORESTS: QUANTITATIVE STATEMENTS OF AREAS AND VOLUMES OF TIMBER WINDTHROWN		
By A. M. MACKENZIE, *Forestry Commission*, and R. K. MARTIN, *Scottish Woodland Owners' Association*		8
Figure 3	Map showing Forestry Commission Conservancies and general direction and main path of gale	9
Table 2(*a*)	Volume of timber windthrown in gale of January 1968: Volumes in hoppus feet	10
Table 2(*b*)	Volume of timber windthrown in gale of January 1968: Volumes in cubic metres	11
Table 3(*a*)	Area windthrown in gale of January 1968—acres	12
Table 3(*b*)	Area windthrown in gale of January 1968—hectares	12
Table 4	Distribution of volume windthrown in January 1968 as percentages, by major species	12
Table 5	Area windthrown in conifer high forest aged 31 years and over expressed as a percentage of forest of the same age before the gale.	13

SECTION 4

FORMATION, ACTIVITIES AND RECOMMENDATIONS OF THE WINDBLOW ACTION GROUP

Page

By D. B. CRAWFORD, *Scottish Woodland Owners' Association*, and G. G. STEWART, *Forestry Commission* 14

Formation of the Action Group 14
Terms of reference and composition of the Windblow Action Group 14
Reports 15
Summary of official assistance and action . . . 16
Use of windthrown timber 16
Transport allowances (see also *SECTION* 5 below) 16
Industrial and general activities 16
Liaison with parent bodies 16
Marketing activities 16
Information 16
Training 16
Figure 4 Graph showing rates of harvesting and despatch of timber . 17
General liaison 18

Summary and Assessment of the Windblow Action Group's
- Activities 18
- Number of Meetings 18
- Continuity of representation 18
- The unanimous approach 18
- Lessons 18

Appendix: Details of Working Parties formed by the Windblow Action Group . 20

SECTION 5

FORESTRY COMMISSION AID

By J. WHARAM, *Forestry Commission* . . 21

Recommendations of the Windblow Action Group 21
Windthrow transport allowances 21
Scale of transport allowances 21
Expenditure on allowances 21
Table 6 Transport allowances; sawlogs; small roundwood 22–23
Table 7 How expenditure on transport was incurred 23–24
Table 8 Comparison between forecasts of quantities of wood to be transported and actual results 24
Windthrow Machinery Hire Scheme 25
Figure 5 Map showing places to which windthrown timber was despatched 26

SECTION 6

MARKETING

Page

By T. SMITH, *Home Timber Merchants' Association of Scotland*,
D. BRIERTON, *Scottish Woodland Owners' Association*, and
J. L. DAVIDSON, *Forestry Commission* . 27

Introduction 27
Marketing of millwood (sawlogs) 27
Marketing of small roundwood 29
Felling deferment 31
Other measures 32
Marketing: conclusions . 32

SECTION 7

HARVESTING

By T. SMITH, *Home Timber Merchants' Association of Scotland*,
D. BRIERTON, *Scottish Woodland Owners' Association*, and
J. L. DAVIDSON, *Forestry Commission* . 33

Harvesting Working Party 33
Attempts to obtain help in supplying harvesting machines and equipment . . . 33
Possible opportunities provided by the windthrow 33
The harvesting equipment used and its improvement 33
Labour, deployment, recruitment, transfer of volunteers and training . 34
Labour productivity . 34
Supply of technical papers . . 35
Possible need for safe storage of logs . . . 35
Rate of progress in harvesting 35
Table 9 Progress of harvesting and despatch of windthrown timber . 35
Lessons learned 35
Harvesting consultant's observations . 36

SECTION 8

TRANSPORT

By T. SMITH, *Home Timber Merchants' Association of Scotland*,
D. BRIERTON, *Scottish Woodland Owners' Association*, and
J. L. DAVIDSON, *Forestry Commission* 37

SECTION 9

Page

PROTECTION OF WINDTHROWN, STANDING AND REPLANTED TREES: PATHOLOGY AND ENTOMOLOGY 38

A. PATHOLOGY

By D. A. BURDEKIN, *Forestry Commission* 38

Advisory leaflet 38
Blue stain on pine 38
Stump treatment against *Fomes annosus* 38

B. ENTOMOLOGY

By D. BEVAN, *Forestry Commission* 38

Advice on protection of trees 38
The result 39
Summary notes on beetles and recommendations for dealing with them: 39
Trypodendron lineatum 39
Tomicus piniperda 39

SECTION 10

REPLANTING

By E. J. M. DAVIES, *Forestry Commission*, and
R. H. ADAM, *Scottish Woodland Owners' Association* 40

The main problems 40
Orderly clearance of ground . . 40
Arguments for and against replanting 40

Management considerations 40
Size of coupe: clearance of remnants of stands . 40
Burning lop and top 40
Drainage and cultivation 40
Insect attack 40
Grazing and fencing 41
Natural or artificial regeneration . 41
Weeding 41

Programme . . 41

Methods of restocking 41
Preparation of ground 41
Drainage 41
Plant size, planting method and spacing . 41
Plant protection 41
Weeding 41
Use of fertilizers 41
Costs 41

SECTION 11

DAMAGE TO FORESTS IN RELATION TO TOPOGRAPHY, SOILS AND CROPS

By S. A. NEUSTEIN, *Forestry Commission* . 42

Introduction 42
Methods of investigation 42
Analysis of windthrow notification cards 42
Photographic survey of selected forests 43
Integrated surveys 43
Results of investigations 43
Table 10 Percentage of crops windthrown in relation to tree height and soil type at Carron Valley Forest 46
Table 11 Classification of crops and percentage windthrown in relation to tree height and elevation 47
Summary and conclusions 47
Methodology 47
Pattern of damage 47

SECTION 12

SUMMARY OF MAIN CONCLUSIONS

By B. W. HOLTAM, *Forestry Commission*, Editor 49

The windthrow was costly 49
The spirit of co-operation . . . 49
Effect on confidence in the future of forestry 49
Value of surveys 49
Need for continuing research . 50
The importance of scientific help . . 50
Fire risk 50
Use known machines and methods but encourage improvisation. 50
Transport allowances 50

SELECT BIBLIOGRAPHY . 51
GLOSSARY . . 52
CONVERSION FACTORS . 53

FOREWORD

By T. Y. GIBSON, O.B.E.

Chairman, Windblow Action Group

When I arose on the morning of 15 January, 1968 (I advisedly do not use the word "awakened" as sleep, for many, was scarce that night), I knew that a lot of damage had been done by the gale force winds. It was no surprise that we should be inundated by requests to clear roads, buildings, etc., of blown trees.

At 10.30 I telephoned Mr Tom Robbie, Assistant Conservator in the West Scotland Conservancy of the Forestry Commission, and he confirmed that the position regarding windthrow of forests appeared to be serious. He agreed that an informal meeting should be held to view the situation. I then telephoned Mr Dennis Crawford, General Manager of Scottish Woodland Owners' Association (Commercial) Limited, and his reports confirmed that a severe windthrow had occurred and agreed that a meeting was necessary. By 11.30 of that morning a date had been fixed. As you will read later this was superseded by a general and formal conference from which the Windblow Action Group, the membership of which is detailed overleaf, was born.

I should like right away to thank the members of the Windblow Action Group for the excellent work which they did putting the cause of windthrow clearance before any sectional interests. I should like to thank Mr George Stewart, then Conservator for West Scotland and now a Forestry Commissioner, for his excellent work as our first Chairman and Mr James Davidson, now Chief Harvesting and Marketing Officer of the Forestry Commission, for his application of many and varied talents. No praise is too high for the sterling work done by Mr Dennis Crawford and Mr David Brierton who represented the private growers through the Scottish Woodland Owners' Association. Their ability and determination to find the best solution to problems was remarkable. Mr Tom Smith who, along with me, represented the Home Timber Merchants' Association of Scotland on the Group had a deep furrow to plough. Not only had he his own business to run but he was Vice President and then President of that Association during the time of the clearance of the windthrow timber. Despite this his sound business sense and personal experience made him a most useful asset to the group. Mr John Wharam, our Secretary, proved an outstanding success in that capacity. He has talent for words and his ability to write reports was fully utilised. He was fully involved in discussions and was a tower of strength to the Windblow Action Group and I am glad to be able to thank him here.

The Windblow Action Group are greatly appreciative of the assistance they received from the Forestry Commission, in particular from Mr L. A. W. Jenkins, the then Chairman, and Mr J. A. Dickson, Director General, whose sound advice was always appreciated.

I should like to thank Dr F. C. Hummel and Mr E. G. Richards for their advice and assistance, and Mr John Davies, Mr Tom Robbie and the staff of the Glasgow Office for all their kindnesses and various forms of assistance.

We are indebted to the Forestry Commission for allowing us to use the Glasgow Office for all meetings, and for all organisation undertaken.

We are grateful to Mr Brian Holtam, the Commission's Chief Research Officer, North, for undertaking to edit this report, and to his staff for all their assistance, both during the period of the clearance and with this report. I would like to thank the members of the various Working Parties for their excellent and speedy contributions to the work of the parent Group.

Since the Windblow Action Group became a sub-Committee of the Home Grown Timber Advisory Committee and came under the wing of Mr F. A. Bishop and the Joint Secretaries, Mr R. C. Stern and Mrs M. Alison and later, Mr R. B. M. Williams. I would like to record our appreciation of their help and encouragement.

I cannot close this foreword without placing on record my personal appreciation of the happy spirit which was evident throughout our thirty-two meetings. The ready co-operation of all sections represented on the Group must indeed be a classical object lesson and one which I can commend for the future.

MEMBERSHIP OF THE WINDBLOW ACTION GROUP

NAME	REPRESENTING
Mr. T. Y. Gibson, O.B.E. (*Chairman*)	Home Timber Merchants' Association of Scotland
Mr. T. Smith	Home Timber Merchants' Association of Scotland
Mr. D. B. Crawford	Scottish Woodland Owners' Association Limited
Mr. D Brierton	Scottish Woodland Owners' Association Limited
Mr. J. Wharam (*Secretary*)	Forestry Commission
ASSESSORS	
Mr. G. G. Stewart, M.C.	Forestry Commission
Mr. J. L. Davidson	Forestry Commission

SECTION 1

INTRODUCTION

By B. W. HOLTAM,

Forestry Commission

Editor

A very severe westerly gale blew across central Scotland in the early hours of 15 January 1968. This report describes damage it did to forests and tells how representatives of the private woodland owners, the home timber trade and the Forestry Commission, appointed to an advisory committee called the Windblow Action Group, appraised and advised effectively on the measures necessary for surveying the damage, harvesting and marketing the wind-thrown timber, safeguarding forest hygiene, and re-stocking the forests with trees. This report is submitted by the Windblow Action Group to its parent committee, the Home Grown Timber Advisory Committee, as its final report on its work.

The Windblow Action Group has now been disbanded. Its membership, constitution, and mode of action are dealt with in this report. (See Section 4, page 14.)

The experience gained by the Windblow Action Group is likely to be of particular interest to forest managers and to administrators who might have to deal with a similar occurrence in future; it has therefore been decided to publish. To make the published account as useful as possible, the Group has invited authors who were not among its members, but who had helped in various ways in its work, to contribute sections to this report.

There is inevitably some overlap in presentations of closely related subjects by separate authors; it is hoped that there is no more repetition than is necessary for clarity.

The last previous serious gale which caused extensive forest damage in Scotland occurred on the 31 January 1953 when an estimated 51 million hoppus feet (1.8 million cubic metres) of timber were windthrown in an area east of a line from Inverness to Dundee. 92 per cent of that total volume was on private estates. At that time the Forestry Commission did not have quite such extensive areas of forest at risk. In the windthrow of 15 January 1968 the total volume estimated to have been windthrown was 45.5 million hoppus feet (1.6 million cubic metres), and this total volume was distributed almost equally between the private sector and the Forestry Commission.

Terminology

The title of this report and the name of the Action Group include the word "windblow", because the Group was so named at the beginning, and this is its report. In forestry jargon the word "windthrow" describes more precisely the uprooting of trees in a gale and this word has been used to describe this condition throughout the text.

The winds that blew in the early hours of 15 January 1968 are referred to throughout as a "gale" or a "severe gale" rather than as a "storm" or a "tempest"; the Meteorological Office described those winds as a "very severe gale".

Acknowledgements

The members of the Group wish to record their thanks for the ready help they have received from the authors, from their Secretary, Mr. John Wharam, and also from many others who have contributed enthusiastically to their work. Dr R. W. Gloyne, and his colleagues in the Meteorological Office in Edinburgh helped in many unseen but very practical ways. Mr R. G. Sangster, Secretary of the Scottish Woodland Owners' Association Limited, and Mr D. M. Macarthur, Secretary of the Home Timber Merchants' Association of Scotland, have both borne heavy additional burdens in dealing with the windthrow and the work of the Windblow Action Group. They have given the Group staunch support in assembling and disseminating essential information from, and to, their respective associations and their help is gratefully acknowledged. The eighteen members of the five working parties, named in the Appendix to Section 4 of this report (page 20), all gave enthusiastically of their energy and expertise. Without their willing acceptance of their responsibilities the Windblow Action Group could not have performed its task.

The help given by the staff of the Forestry Commission's Research Division, Work Study Branch, and Industrial Training Branch was equally essential. Mr A. I. Anderson, Principal Photographer, accompanied by Mr S. A. Neustein, a Silviculturist, surveyed the windthrown forests by helicopter in April 1968. The three aerial colour photographs on the front cover were taken then; they belong to the Commission's official collection.

The black and white photographs within the report were taken by Mr Tom Weir of Gartocharn, Dunbartonshire (Plates 5 and 6) and by Mr B. S. Thompson, a Commission Forester at Achray Forest, Perthshire (Plates 4 and 7).

SECTION 2

METEOROLOGY

By A. I. FRASER

Forestry Commission

During 14 January 1968 a fairly fast-moving depression travelled up the west coast of Britain and by midnight it was centred near the island of Lewis off the north-west coast of Scotland. In the following seven hours the centre of this depression turned eastwards and travelled across the North of Scotland to the North Sea, causing very strong winds in the central belt of Scotland. (See Figure 2, page 7.)

The mean pressure gradient over Scotland during the height of the gale was about 7 nautical miles per millibar, corresponding to a mean geostrophic wind of about 105 knots (193 km per hour). The synoptic chart for 04.00 hours on 15 January, showed that over the Clyde-Forth valley the pressure gradient was substantially above the mean, giving geostrophic wind velocities of about 180 knots (332 km per hour).

Using the general relationship between surface wind speed V_z at height Z, and the geostrophic wind speed V_G, with values recommended by Davenport (1965) for the power factor d and the height of the geostrophic wind Z_g, it is possible to estimate the surface wind speeds from the formula:

$$V_z = V_G \frac{(Z)^d}{(Z_g)}$$

The estimated wind speed at 40 feet (12 metres) above the ground with a geostrophic wind speed of 180 knots (332 km per hour) is about 68 knots (125 km per hour); this corresponds closely with the actual measurements made which showed a mean hourly wind speed of 60 knots (111 km per hour), gusting up to about 90 knots (166 km per hour) in the Glasgow area.

These calculations are appropriate to flat or gently rolling countryside and may considerably over or under-estimate local wind speeds where topographic features have modified the airflow. However, the calculations can be used to provide a good guide as to the distribution of high winds.

A detailed examination of the synoptic charts for the period from midnight to 07.00 hours on 15 January shows that only the extreme north-east corner of Scotland escaped some high winds. One feature which distinguished the central belt of Scotland from the rest of the country was the duration of the high winds. Figure 2, page 7, shows that almost all the damage occurred in the region which experienced more than 6 hours of continuous high winds (above 55 knots (101 km per hour)).

Table 1 on page 5 gives calculated surface wind velocities on 15 January 1968, with actual observations in brackets for five forest areas. The velocities have been estimated from the pressure gradient and represent conditions of open exposure. Wind speed is given in knots and in km per hour; wind direction is given in degrees on the 360° scale (270° = due west).

Table 1, page 5, has been prepared from the synoptic charts and uses the measured values of pressure gradient at five forests to calculate surface wind speed from the geostrophic wind. Two of the forests for which the calculations have been made are near stations which made anemometer readings during the gale. These two stations have been included in the table, and their measurements show good agreement with the calculations.

At Loch Eck Forest in Argyll, where anemometer data was available from the U.S.S. *Simon Lake*, then based nearby in the Holy Loch, the calculated wind speeds agree very closely with the actual measurements, though they tend to underestimate the recorded speeds slightly. At Tentsmuir Forest on the east coast of Fife, whose data can be compared with data from the Royal Air Force Station at Leuchars, the agreement is reasonable, though the calculations appear to underestimate the wind speeds early in the gale and overestimate them later. However the pressure gradient calculations are confirmed by the nearby Bell Rock lighthouse measurements which showed very high winds at 05.00 hours and 06.00 hours when the wind at Leuchars was subsiding. There may thereafter have been some local variations which are not detectable from the pressure gradient, or the Leuchars wind speeds have been affected by local shelter which could have had an effect when wind direction shifted slightly.

These comparisons suggest that useful indications of surface wind speed can be obtained from the pressure gradient.

In Figure 1, page 6, the available information on mean wind speed from anemometer records has been plotted on a map of Scotland to show the distribution of maximum mean hourly wind speed. This information is of limited value because of the small number of stations which have records, and because some of the stations could only provide data for a few selected occasions. The maximum values shown for some stations may represent the only data for that station, and may refer to a time early or late in the gale. However, despite these limitations the data do show a good agreement with the duration data shown in Figure 2, page 7, in that the zone of

highest wind speeds is very similar to that with the longest duration.

It can be concluded from this analysis of the available information that the unusually severe conditions were confined to a belt of country approximately 20 miles (32 km) wide, running north-south down the west coast from just north of Oban in Argyll to about West Loch Tarbert, also in Argyll on the Kintyre peninsula; and also to a belt of country approximately 40 miles (64 km) wide running west to east across Scotland, with its centre line more or less from Glasgow to Edinburgh. The severe conditions do not appear to have extended much north of Stirling, nor much south of Peebles. The area affected by the storm is therefore about 4,000 square miles (10,300 square km) or approximately 13 per cent of Scotland's total land area.

Using tables produced by Shellard (1958) a return period of about 75 years is estimated for this storm, making it comparable with the storm of 31 January 1953, which caused similar amounts of damage in the North-East of Scotland.

The only other characteristic of this storm worth a brief mention is the apparently lower-than-expected ratio of maximum gust speed to mean wind speed. Most of the anemometer stations had ratios of 1.4 to 1.5, whereas 1.8 or even about 2.0 is more common (Aanensen 1964).

The available evidence on the wind speeds attained during the storm, shows that mean wind velocities in excess of 60 knots (111 km per hour) were probably common throughout the area affected. Using curves produced by Fraser and Gardiner (1967) showing the height at which trees will be damaged on various soil types in relation to wind speed, it must be concluded that even on the best soils trees taller than 40 feet (12 metres) would be unlikely to survive when exposed to the full force of the wind in a gale such as that of January 1968. Local topography, through its influence on wind speed, is therefore likely to be the dominating factor in determining the location of wind damage, rather than soil type or species distribution.

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TABLE 1

SURFACE WIND VELOCITIES

Table 1 gives calculated surface wind velocities on 15 January 1968, for five forest areas, with actual observations given in brackets for two of them (Loch Eck and Tentsmuir). The velocities have been estimated from the pressure gradient and represent conditions of open exposure. Wind speed is given in knots, and in km per hour; wind direction is given in degrees.

Forests:	Knapdale, Argyll			Loch Eck, Argyll (U.S.S. *Simon Lake*)			Carron Valley, Stirlingshire			Glendevon, Perthshire			Tentsmuir, Fife (R.A.F. Leuchars)		
	Speed			Speed			Speed			Speed			Speed		
Time of Day (1)	Knots (2)	Km per hour (3)	Direction, degrees (4)	Knots (5)	Km per hour (6)	Direction, degrees (7)	Knots (8)	Km per hour (9)	Direction, degrees (10)	Knots (11)	Km per hour (12)	Direction, degrees (13)	Knots (14)	Km per hour (15)	Direction, degrees (16)
00.00 hrs.	57	105	230	35 (45)	65 (83)	230 (255)	22	41	230	14	26	230	16 (29)	29	230 (230)
01.00 hrs.	68	125	250	47 (54)	86 (100)	250 (245)	35	65	250	36	66	250	29 (27)	53	250 (230)
02.00 hrs.	64	120	250	64 (61)	120 (110)	250 (265)	51	94	250	45	83	250	38 (37)	70	250 (230)
03.00 hrs.	45	83	250	57 (63)	100 (116)	250 (255)	49	90	250	36	66	250	38 (55)	70	250 (230)
04.00 hrs.	38	70	250	38 (58)	70 (107)	250 (285)	37	68	260	43	79	260	43 (54)	79	250 (230)
05.00 hrs.	35	65	270	54 (52)	100 (96)	260 (300)	79	145	270	85	157	270	79 (56)	145	250 (230)
06.00 hrs.	47	86	270	47 (47)	86 (86)	270 (290)	68	125	270	68	125	270	68 (48)	125	250 (230)

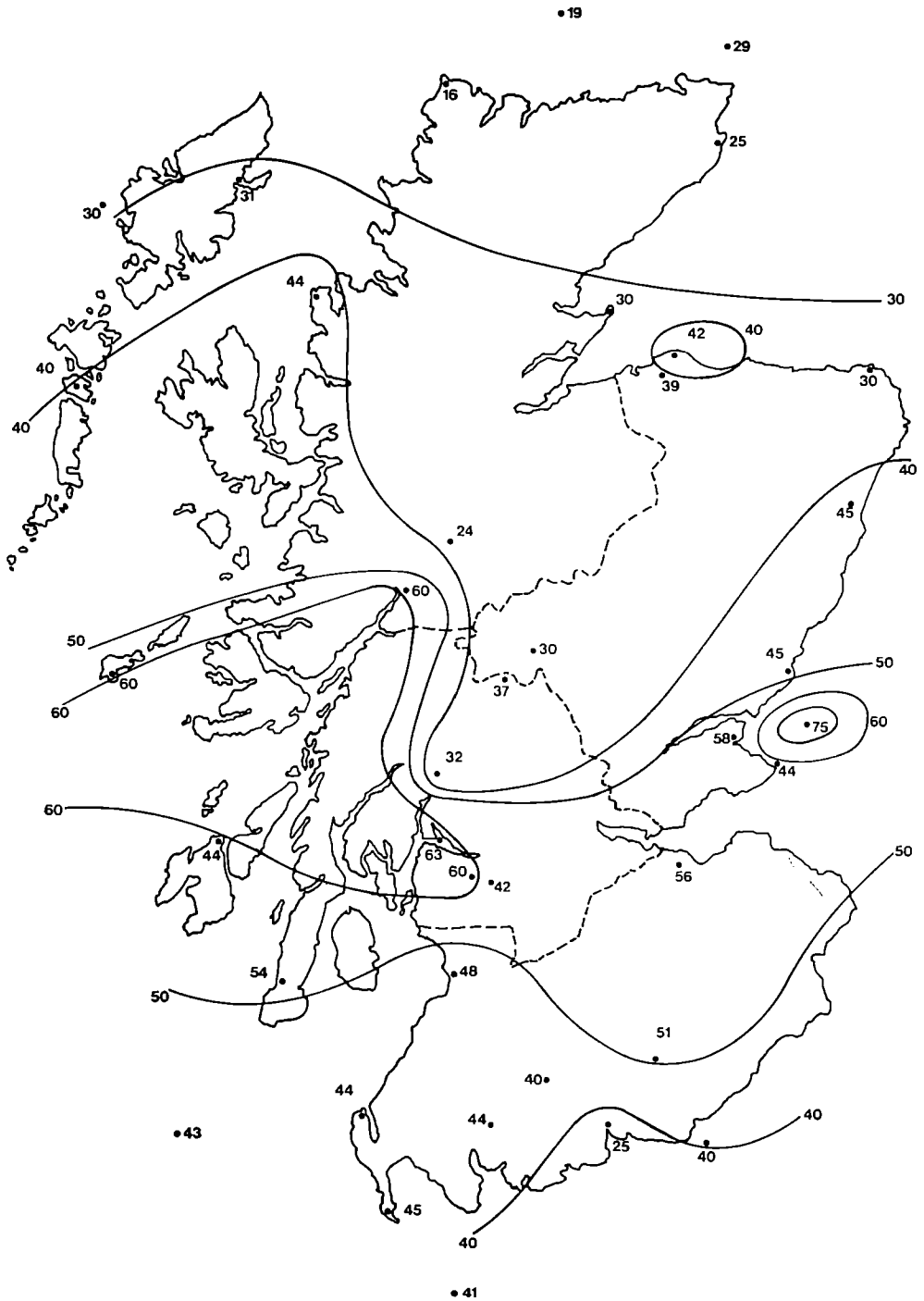

Fig. 1. Map of Scotland showing distribution of maximum values of mean wind speeds in knots during the gale. The black dots indicate locations of wind-speed measurements, including ships and lighthouses. The data shown on this map should be compared with the duration data shown on Figure 2.

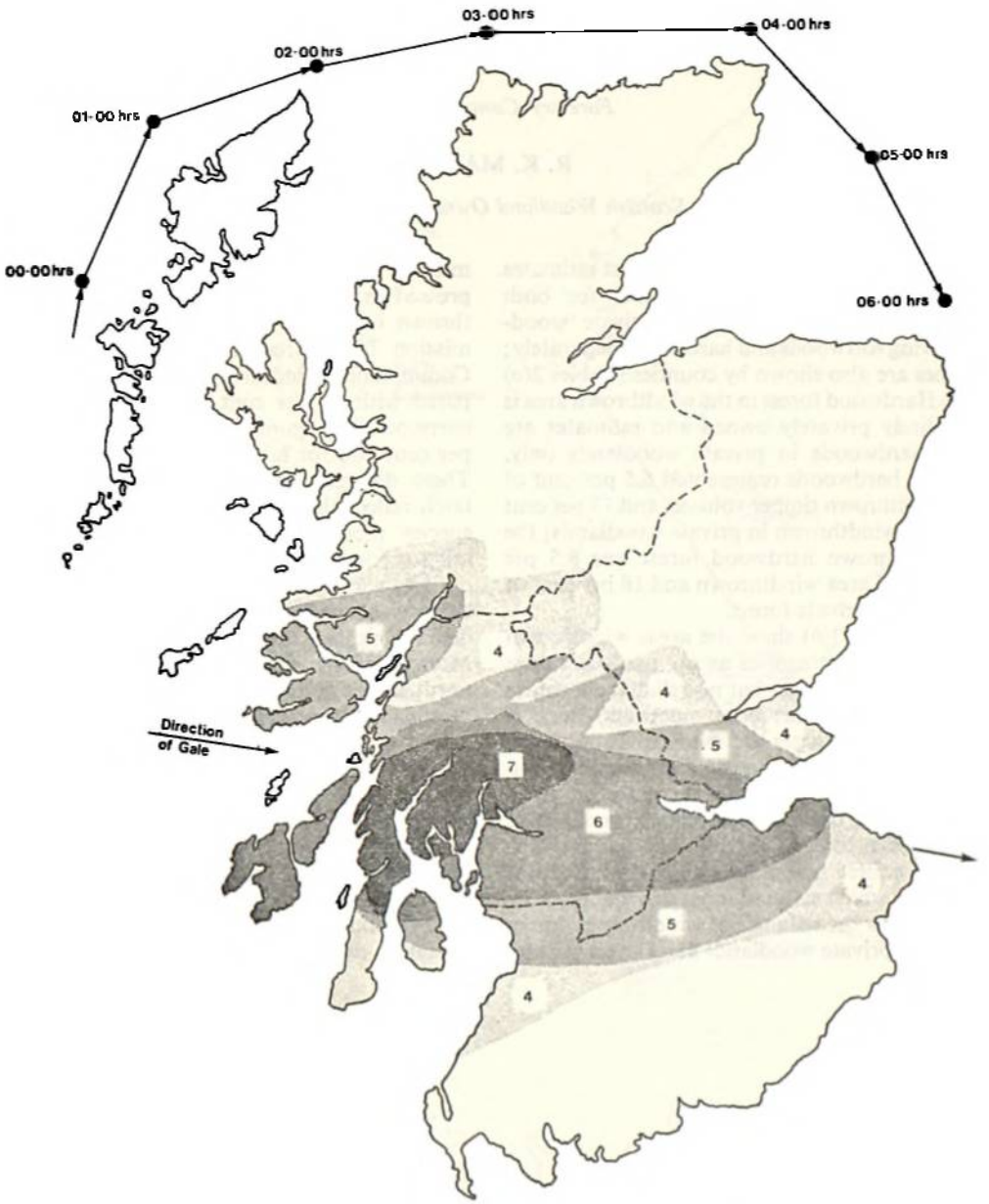

Fig. 2. Map of Scotland showing the main areas affected by the gale, the number of hours during which surface wind speeds are estimated to exceed 55 knots (101 km per hour) and the path of the main centre of the depression to the north of Scotland, plotted at hourly intervals. The figures in the shaded areas of the map (the main areas affected by the gale) show the number of hours during which surface wind speeds are estimated to have exceeded 55 knots (101 km per hour).

SECTION 3

DAMAGE TO THE FORESTS: QUANTITATIVE STATEMENTS OF AREAS AND VOLUMES OF TIMBER WINDTHROWN

By A. M. MACKENZIE

Forestry Commission and

R. K. MARTIN

Scottish Woodland Owners' Association

The tables in this Section set out the latest estimates of the volumes of windthrown timber for both Forestry Commission Forests and private woodlands, showing softwoods and hardwoods separately; the volumes are also shown by counties (Tables 2(*a*) and 2(*b*)). Hardwood forest in the windthrown area is almost entirely privately owned and estimates are made for hardwoods in private woodlands only. Windthrown hardwoods represented 6.5 per cent of the total windthrown timber volume, and 13 per cent of the timber windthrown in private woodlands; the area of windthrown hardwood forest was 8.5 per cent of the total area windthrown and 18 per cent of the windthrown private forest.

Tables 3(*a*) and 3(*b*) show the areas windthrown by the same main categories as are used in Tables 2(*a*) and 2(*b*) for volumes, but no reliable allocation of areas to counties has been made and none is shown. Instead, estimates are made in Table 5, for private woodlands and Forestry Commission combined, of the areas of windthrown coniferous forest aged 31 years and over, expressed as percentages of the comparable total areas of coniferous high forest which existed before the gale and of the same age class, and which suffered most damage.

Table 4 shows the volumes of windthrown timber separately for private woodlands and Forestry Commission forests; the main species volumes are expressed as percentages of the total volumes windthrown in private woodlands and Forestry Commission forests respectively. 87 per cent of the Commission's windthrown volume was spruce, compared with 37 per cent in the private sector; the corresponding figures for pine are 6 per cent and 27 per cent and for larch 2 per cent and 16 per cent. These different proportions for spruce, pine and larch reflect the difference in past interest in these species groups in private woodlands and Commission forests respectively.

Certain counties from which little or no windthrow was reported are excluded from these tables. In detail: Caithness and Sutherland in the north; Nairn, Moray, Banff, Aberdeen and Kincardine in the north-east, and Bute and Wigtown in the south-west. "Lothians" comprises West, Mid, and East Lothian.

The statistics shown in these tables have been assembled and periodically revised as more reliable information has become available throughout the clearance of the windthrown timber; they have provided the bases for most of the Windblow Action Group's work and for much of what is presented in other sections of this report. The references in those other sections to these statistics make further explanation of them unnecessary.

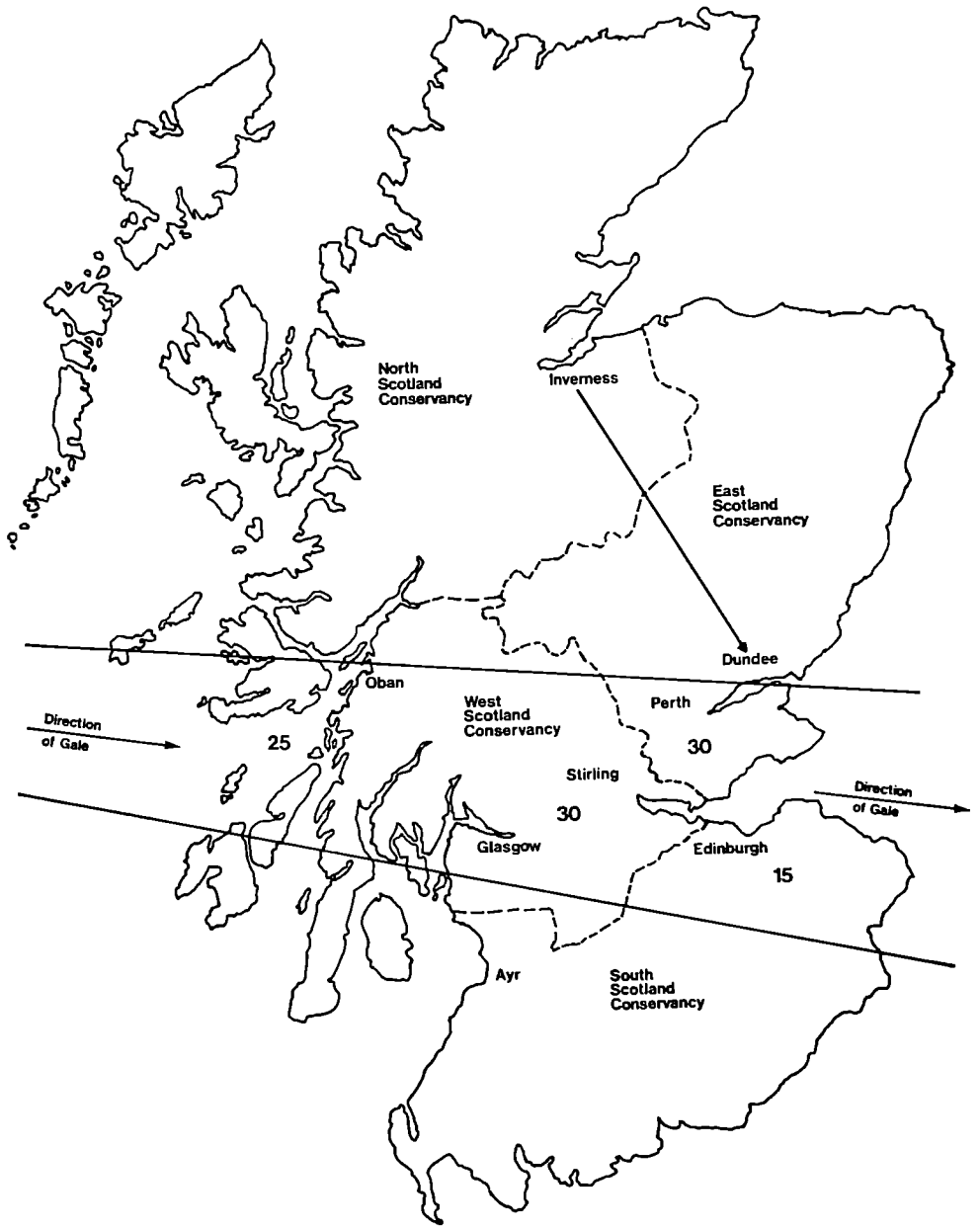

Fig. 3. Map of Scotland showing Forestry Commission Conservancy boundaries, the general direction of the gale and its main path. The figures 15, 30, 30 and 25 indicate the percentage distribution of the windthrown timber volumes. The lines are merely notional. There was no clear boundary to the windthrown forest areas. The arrow from Inverness south-east towards Dundee shows the general direction of the 1953 windblow.

TABLE 2(A)

VOLUME OF TIMBER WINDTHROWN IN GALE OF JANUARY 1968

VOLUMES IN MILLIONS OF HOPPUS FEET

(See Table 2(B) for metric equivalents)

County	Private woodlands			Forestry Commission	Private Woodlands and Forestry Commission combined (Cols. 4 & 5)
	Softwood	Hardwood	Total	Softwood only	
(1)	(2)	(3)	(4)	(5)	(6)
Angus	0.1	—	0.1	—	0.1
Argyll	2.8	0.1	2.9	13.1	16.0
Ayr	0.2	—	0.2	—	0.2
Berwick	0.7	0.3	1.0	0.4	1.4
Clackmannan	0.3	—	0.3	—	0.3
Dumfries	0.7	—	0.7	0.9	1.6
Dunbarton	0.8	0.1	0.9	—	0.9
Fife	2.1	0.4	2.5	2.4	4.9
Inverness	—	—	—	0.2	0.2
Kinross	0.3	—	0.3	0.2	0.5
Kirkcudbright	—	—	—	0.2	0.2
Lanark	1.2	0.1	1.3	—	1.3
Lothians	1.4	0.7	2.1	—	2.1
Peebles	1.0	0.1	1.1	0.3	1.4
Perth	5.3	0.4	5.7	2.3	8.0
Renfrew	0.8	0.1	0.9	—	0.9
Ross	—	—	—	0.2	0.2
Roxburgh	0.9	0.1	1.0	0.1	1.1
Selkirk	0.2	—	0.2	—	0.2
Stirling	1.2	0.6	1.8	2.2	4.0
	20.0	3.0	23.0	22.5	45.5

TABLE 2(B)

VOLUME OF TIMBER WINDTHROWN IN GALE OF JANUARY 1968

THOUSANDS OF CUBIC METRES

(See Table 2(A) for volumes in hoppus feet)

County	Private Woodlands			Forestry Commission	Private Woodlands and Forestry Commission combined (Cols. 4 & 5)
(1)	Softwood (2)	Hardwood (3)	Total (4)	Softwood only (5)	
Angus	4	—	4	—	4
Argyll	101	4	105	508	577
Ayr	7	—	7	—	7
Berwick	25	11	36	14	50
Clackmannan	11	—	11	—	11
Dumfries	25	—	25	32	57
Dunbarton	29	4	33	—	33
Fife	76	14	90	87	177
Inverness	—	—	—	7	7
Kinross	11	—	11	7	18
Kirkcudbright	—	—	—	7	7
Lanark	43	4	47	—	47
Lothians	50	25	75	—	75
Peebles	36	4	40	11	51
Perth	191	14	205	83	288
Renfrew	29	4	33	—	33
Ross	—	—	—	7	7
Roxburgh	32	4	36	4	40
Selkirk	7	—	7	—	7
Stirling	43	22	65	80	145
TOTAL	720	110	830	811	1,641

TABLE 3(a)

AREA WINDTHROWN IN GALE, JANUARY 1968

ACRES

(See Table 3(b) below for equivalent areas in hectares)

	Private Woodlands	Forestry Commission	Total
Coniferous High Forest	8,200	10,600	18,800
Broadleaved High Forest	1,800	—	1,800
TOTAL	10,000	10,600	20,600

TABLE 3(b)

HECTARES

(See Table 3a above for acres)

Coniferous High Forest	3 319	4 290	7 609
Broadleaved High Forest	728	—	728
TOTAL	4 048	4 290	8 337

TABLE 4

DISTRIBUTION OF VOLUME WINDTHROWN IN JANUARY 1968
AS PERCENTAGES, BY MAJOR SPECIES

Species	Private Woodlands	Forestry Commission
Pine	27	6
Larch	16	2
Spruce	37	87
Other Conifers	7	5
Beech	8	—
Other Broadleaves	5	—
TOTAL	100	100

TABLE 5

AREA WINDTHROWN IN CONIFER HIGH FOREST, AGED 31 YEARS AND OVER, EXPRESSED AS A PERCENTAGE OF THE AREA OF FOREST OF THE SAME AGE BEFORE THE GALE

"Thirty-one years and over" was the age-class in which most of the damage occurred

County/Region	Private Woodlands and Forestry Commission Combined
Argyll	25 per cent
Dunbarton/Stirling/Perth/Renfrew	30 per cent
Fife/Kinross/Clackmannan	30 per cent
Peebles/Lothians/Selkirk/Roxburgh/Berwick	15 per cent
Percentage of forest in the same age category windthrown throughout Central Scotland	22 per cent

SECTION 4

FORMATION, ACTIVITIES AND RECOMMENDATIONS OF THE WINDBLOW ACTION GROUP

By D. B. CRAWFORD

Scottish Woodland Owners' Association and

G. G. STEWART

Forestry Commission

Formation of the Action Group

Within three days of the gale, the reports obtained by the Scottish Woodland Owners' Association and the Forestry Commission clearly established that the damage was of a catastrophic nature and by the end of the week proposals for convening a meeting of the forest industry's representatives were under discussion. The need for this meeting reflected the magnitude of the damage, the realisation that all sections of the industry in Scotland were affected, and that the problems called for co-operative action. This awareness of the need for co-operation was demonstrated almost immediately by the action of The Home Timber Merchants' Association of Scotland, which organised a meeting of the Scottish forest industry in Glasgow on 29 January.

About forty people from the Forestry Commission (F.C.), Scottish Woodland Owners' Association (S.W.O.A.) and The Home Timber Merchants' Association of Scotland (H.T.M.A.S.) attended the meeting. In addition, the presence of representatives from the Home Timber Merchants' Association of England and Wales (H.T.M.A.E. & W.) and the Timber Growers' Organisation (representing private woodland owners in England and Wales) enabled the meeting to take into account the effects of the gale on the English and Welsh as well as the Scottish forest industry. In the afternoon two representatives from the pulp industry also joined the meeting.

After electing as Chairman Mr L. A. W. Jenkins, the Chairman of the Forestry Commission, the meeting heard regional reports from the four Scottish Forestry Commission Conservators and from the four Regional Managers of the Scottish Woodland Owners' Association (Commercial) Ltd., the latter acting on behalf of the Scottish Woodland Owners' Association which represents the interests of the private growers. The summary of these reports gave a total preliminary estimate of 38 million hoppus feet (1.37 million cubic metres) of windthrown timber, of which between 5 and 15 per cent was of trees with broken stems and so classified as windsnap. This estimate also suggested that the volume was more or less equally divided between the Forestry Commission and private estates, but it indicated that there were important differences in the sizes and species of the blown trees in each sector.

Having considered the problems of windthrow, including harvesting, sawmilling capacity, markets, transport, and insect and fungus damage, it became clear that there was not enough information available at the time to allow the meeting to make decisions. It was therefore decided to set up an Action Group.

Terms of Reference and Composition of the Windblow Action Group

This Windblow Action Group, as it was named, was given the following task:

> "To examine the facts; to identify problems and, as far as possible, to resolve these problems. Problems which the Group consider to be outwith their competence to resolve should be referred to parent organisations represented on the Group, but in submitting these problems the Group should, in so far as it is able, suggest possible solutions."

It was decided that the Group should consist of six members made up of two representatives from each of the parent bodies, the Forestry Commission, Scottish Woodland Owners' Association and the Home Timber Merchants' Association of Scotland. It was also decided that the Group should appoint working parties to assist in establishing the facts and problems.

Within three days of the Glasgow meeting, the parent bodies had nominated their representatives and the Group had held its first meeting. This and subsequent meetings took place at the Forestry Commission's West Scotland Conservancy Office in Glasgow. In addition to providing the Group with office facilities, the Forestry Commission provided the Group's Secretary, Mr J. Wharam. The members of the Group and the organisations they represented were as follows;

F.C. —Mr J. L. Davidson and Mr G. G. Stewart

S.W.O.A. —Mr D. Brierton and Mr D. B. Crawford

H.T.M.A.S.—Mr T. Y. Gibson and Mr T. Smith

The first meeting was held on 1 February 1968 and Mr G. G. Stewart was elected Chairman. At this meeting it was concluded that no national action could be planned or Government aid requested until the Group had produced a comprehensive report on the situation. This decision established the urgency of the task and this sense of urgency remained a feature of the Group's activities. The need for quick action was transmitted to the six working parties set up at this meeting, who were asked to submit their preliminary reports within a fortnight. (Details of the Working Parties are given in the Appendix to this Section, page 20). This objective was achieved and on 23 February, within three weeks of the first meeting, the Group produced its all-important first report.

Reports

That First Report established the preliminary estimates on which the Group's future actions rested. First of all, it established the extent of the damage as being 40 million hoppus feet (1.44 million cubic metres) covering an area about 17,000 acres (6 900 hectares); of this area about 9,000 acres (3 650 hectares) were owned by the Forestry Commission and about 8,000 acres (3 240 hectares) by private owners. Of this volume, 20.8 million hoppus feet (0.753 million cubic metres) were in Forestry Commission forests and the balance of 19.2 million hoppus feet (0.69 million cubic metres) in private forests. The county of Argyll accounted for approximately one-third of the total while the counties of Perth, Dunbarton and Stirling accounted for another one-third. The volume windthrown represented twice the annual cut for the whole of Scotland. (Section 3, Tables 2-4, pages 10-12) gives details of the final assessments of areas and of volumes of timber windthrown).

To ensure that this large volume of timber was cleared without serious wastage due to insect and fungal damage, the Action Group determined that the aim should be to clear the timber within eighteen months. The Report also made a number of recommendations. Two of these were (*a*) that for the next eighteen months the level of felling in areas of Scotland unaffected by the windthrow should be restricted by voluntary agreement; and (*b*) that a transport allowance should be given by the Forestry Commissioners to enable timber to be moved to markets beyond the normal economic limit.

The Secretary of State for Scotland announced in the House of Commons on 4 April his acceptance of these recommendations. The Commission gave details of the transport allowances a few days later (but for sawmill logs only, and not for small roundwood).

A Second Report made on 17 May recommended allowances for transporting small roundwood to specific markets, for example Scottish Pulp and Paper Mills at Fort William. These recommendations were accepted in general and transport allowances for small roundwood were announced on 3 July. Thus within six months of the gale the main pattern of the Commissioners assistance in the form of allowances for the transport of windthrown timber to markets beyond the normal economic limit had been established and the allowances were in operation. This was a notable result and the Windblow Action Group played a major role in its achievement.

Between the submission of the First and Second Reports questions arose over the official standing of the Group and especially over the question of to whom should it report. It was decided that the Group should become a sub-committee of the Home Grown Timber Advisory Committee (H.G.T.A.C.) the statutory body whose duty it is to advise the Forestry Commissioners. Accordingly at the 11th meeting on the 11 June 1968 the Group assumed its new status; Mr T. Y. Gibson, as a member of the H.G.T.A.C., became Chairman and the two Forestry Commission representatives became assessors to the Group although still playing a full part in the Group's discussions. This proved to be a most valuable arrangement. It gave the Group not only a clear line of responsibility but, in addition, the knowledge that its reports and recommendations would be considered by and could expect to have the backing of the H.G.T.A.C.

The Fourth Report recorded progress as at 31 December, 1968, that is after virtually one year of activity. About 40 per cent of the total volume of windthrown timber had been cleared; this rate of clearance was not regarded as satisfactory. Although the demand for timber, especially sawlogs, was good, progress was slow. One reason was a shortage of skilled men and a lack of harvesting and wood handling machinery. The Commission's resources were adequate; the problem concerned the working of timber merchants in Commission forests and all work being done on private estates. Another reason for the slow progress was thought to be that a much lower volume of timber than had been anticipated was being transported to sawmills in the north of Scotland. An increase in the rate of transport allowance to the north was accordingly recommended as was the adoption of a more flexible approach to transport allowances within Scotland.

In the Fifth Report (April 1969) it was estimated that the half-way point in clearance had been reached. Suggestions for extending the transport allowances were made but at the same time the Group looked ahead to the time when the allowances should cease, and they made their first tentative recommendations for their orderly termination.

The Sixth Report covered the period up to 30 June 1969 and, although the clearance rate was still slower than desirable, it was felt that the question of deferring felling outwith the windthrow area should now receive attention. This voluntary deferment of felling by both private growers and the Forestry Commission had created an extra demand for timber from sawmills in these areas. Clearly there had to be some indication given as to when this voluntary deferment could be reduced or finally terminated and the Group suggested how this transition from deferred to normal felling should be carried out.

The Seventh Report assessed the position as at 30 September 1969. The clearance rate, although reasonably satisfactory, was retarded in some localities by lack of transport and labour; the Group therefore recommended that the transport allowances should be extended.

In March 1970 the Eighth Report described the millwood situation as satisfactory but considered that the small roundwood position warranted an extension of the transport allowances for small roundwood for another three months.

Table 9, page 35, and the graph comprising Figure 4, page 17, show the rate of progress in felling and despatch.

SUMMARY OF ASSISTANCE AND ACTION

Although it failed to obtain agreement for all its recommendations, the Group believes that the aid received greatly helped the rate of clearance and substantially increased stumpage values. This aid can be summarised as follows:

Use of Windthrown Timber

The Government urged local authorities and wood-using industries to give preferences to home-grown timber whenever possible; this probably stimulated the market for windthrown timber. It is impossible to quantify its extent, but without this stimulus the clearance rate might well have been at a lower level.

Transport Allowances

The various transport allowances are described in Section 5, on Commission Aid, page 21. It should be noted that not only were transport allowances given for both sawlogs and small roundwood, but requests for increases in specific categories were also granted. The extra sawlog transport allowance brought the Midlands, Wales and Ireland within an economic transport range. The amended allowance for spruce for Kemsley Pulp Mill in Kent resulted in a better return for the private grower. The flexibility introduced into the transport allowance scheme meant that the grower was given complete freedom in securing the best markets for his timber, while retaining an incentive to minimise the distance which the timber had to travel.

Industrial and General Activities

Although the main activities of the Group were by necessity directed towards the Forestry Commission it has nevertheless operated over a very wide field and involved itself with virtually every aspect of the windthrow. Some of the more important work may be summarised under the following headings:

Liaison with Parent Bodies

From the moment the Group was formed it has worked as a link between the Forestry Commission, H.T.M.A.S., and S.W.O.A. The ability to establish rapid communication with the main representational and commercial bodies involved was undoubtedly an important factor in the work of clearance.

Marketing Activities

Under this heading is included liaison with the principal wood users, including pulp mills, chipboard factories and major sawmills. The Group by various means encouraged these users to take the maximum amount of windthrown timber. The Group also acted as an information service and directed enquiries for windthrown timber from Ireland and England to the parent bodies and other interested parties.

Information

With the help of the Research Division and of the Work Study Branch of the Forestry Commission and of the Scottish Woodland Owners' Association, papers and reports were prepared on a wide range of subjects including pests and diseases, windthrow cutting and harvesting techniques, costs of spraying against insects, stump treatment, log storage and restocking of windthrown forest.

Training

Immediate liaison was established with the Industrial Training Branch of the Forestry Commission, which was able to offer, almost immediately, training facilities for the windthrow harvesters. Although the Group encouraged the holding of courses and demonstrations throughout the windthrow area,

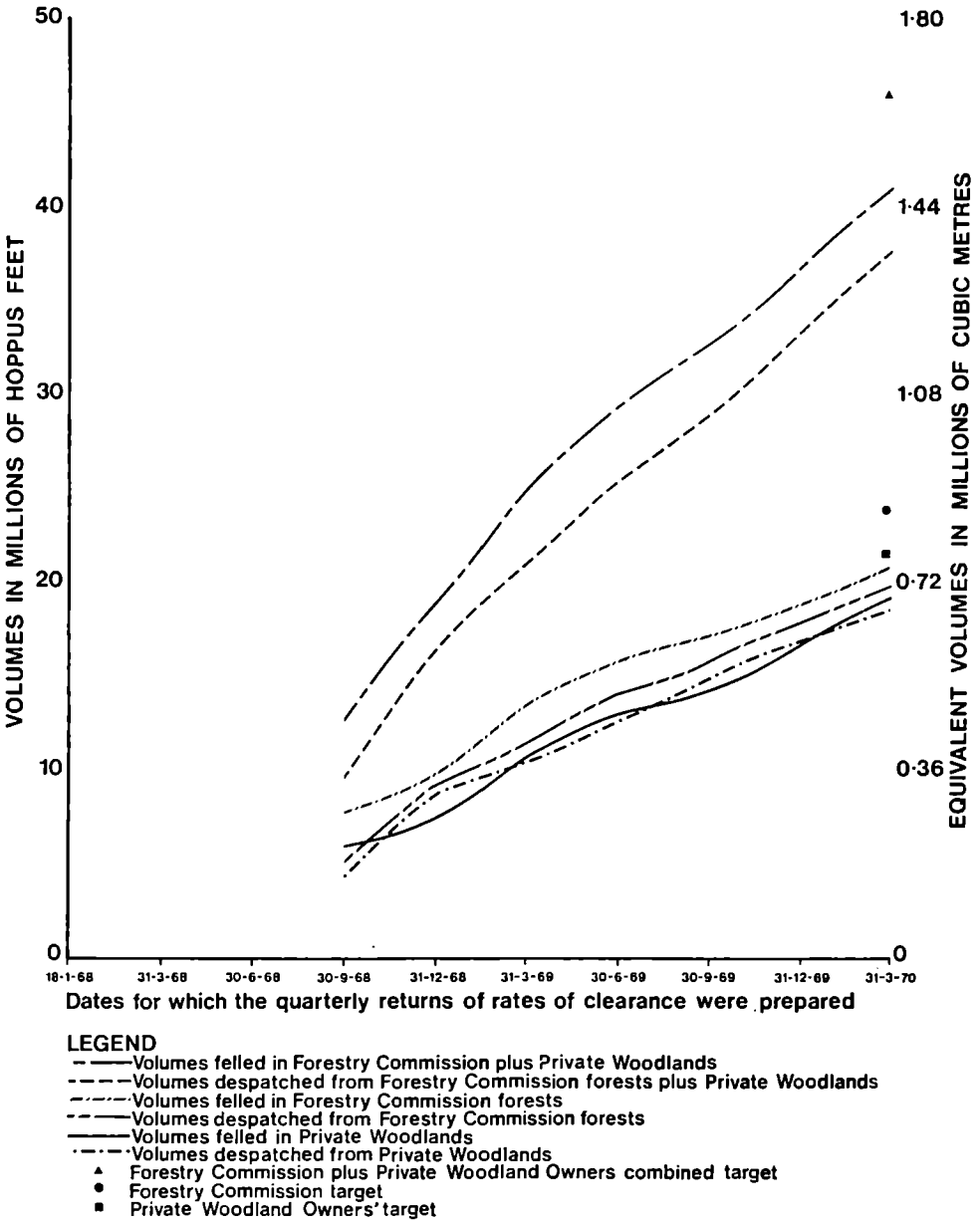

Fig. 4. Windthrow clearance. This graph shows the rates of harvesting as well as the rates of despatch of wood from the forests, by volumes, for private woodlands, and Forestry Commission forests; it shows the progress of both, separately and jointly. It also shows the target volumes set by the Windblow Action Group to be harvested and despatched in each sector by 31 March, 1970.

generally the training facilities were not adequate. In retrospect the Group feels that it did not press the need for training sufficiently strongly, with the result that in the home timber trade and in the private forestry sectors, more opportunity could have been taken of those training facilities which the Forestry Commission provided.

General Liaison

This has included contact with a wide range of official and industrial bodies, including British Rail and the National Coal Board. European experts skilled in windthrow clearance were contacted and the Group invited Professor Steinlin of Freiburg University, West Germany, to Scotland.

This leading European harvesting expert toured the windthrow area in July 1968 and gave practical advice to help with the clearance.

SUMMARY AND ASSESSMENT OF THE WINDBLOW ACTION GROUP'S ACTIVITIES

Number of Meetings

In all, the Group held thirty-two formal meetings. These meetings were organised to conform with the overall position of the windthrow and were naturally more frequent during the first twelve months. The Chairman and Secretary were given complete flexibility in calling meetings, so that urgent problems, as they arose, were given immediate attention. Some meetings, therefore, had to be called at very short notice, but despite this each member of the Group, although heavily committed with his own responsibilities, maintained an average attendance of thirty-one out of the thirty-two meetings. This record demonstrates very clearly the dedicated service given by the members of the Group.

Continuity of Representation

The Group maintained its original representation throughout. This continuity built up a very satisfactory internal relationship, while ensuring a uniform development of experience and knowledge. It was a factor which undoubtedly contributed greatly to the success achieved by the Group.

The Unanimous Approach

Despite the fact that the representatives came from organisations which had differing interests and different ideas on how the windthrow clearance was to be organised, the Group invariably made unanimous decisions on all major issues. This was a remarkable achievement and much of the credit must go to the Chairman, Mr Tom Gibson. However, the contribution of the representatives must not be overlooked.

Lessons

Many lessons have been learned from the working of the Windblow Action Group. First and perhaps most important, the establishment of the Action Group proved to be a very useful method of dealing with a temporary but severe problem affecting a particular part of the country. The success of this small group of people representing the organisations most concerned, and acting as a Sub-Committee of the Home Grown Timber Advisory Committee, is a valuable precedent for the future.

Secondly there are points to be noted from the Group's decision to aim at clearing the blown timber in 18 months. This decision was based on (*a*) the need to establish that the windthrow was a catastrophe; if the target had been say, 24 or 30 months, it would have tended to remove the sense of urgency and the need for co-operative action; (*b*) the danger of timber deterioration and the possibility of creating conditions which might increase the fungal and insect population in the affected and fringe forests. The effects of the decision to try to complete clearance in eighteen months were considerable. Harvesting resources in the windthrown area were clearly inadequate and many extra men came from other parts of the country in the attempt to clear the timber within the time limit which had been set. Bringing men in was expensive as these men had, of course, to be paid extra to cover their increased expenses in living away from home. Extra machines also had to be bought. Further, in trying to meet the clearance date everyone in the forest worked under very great pressure. Extra long hours and weekend working became normal. These pressures were too great and many men did not stand the unnatural conditions for very long. Many left the area and there were individual cases of men who had worked for many years on harvesting who asked to be allowed to change to other work. In the event no pathological or entomological problems developed in the forest trees and thus, if a longer period than 18 months had been chosen, these particular clearance problems might not have arisen. While we can now say a longer clearance period would have been desirable it would be clearly dangerous to recommend longer periods for future windthrows. Perhaps the best advice we can give is to suggest that the scientific working party concerned with any future similar problem should keep under continual review the pathological dangers and to recommend the appropriate clearance dates based on their investigations.

Thirdly, the difficulties of harvesting were over-

estimated in some cases with the result that contract prices and piece work rates initially were too high. Clearing windthrown timber is obviously more difficult than clear felling, but insufficient allowance was made where a much larger tree size was being worked for the first time. The effect was that, to begin with, harvesting costs were sometimes unnecessarily high.

Two more points are worth recording. The summer of 1968 was exceptionally dry in the West of Scotland and 1969 was also a good year. The work of clearance was helped very considerably by these fine summers which were so much better than anyone could have expected. And then there was a further piece of good fortune which played a major part in the clearance. That there was no dramatic drop in sawlog prices as has so often happened in past windthrow was probably due more than anything else to the effects of the 14.3 per cent devaluation of sterling which occurred on 18 November 1967. This devaluation increased the prices of imported timber and the resulting boost to the selling prices of home grown timber gave vital help in keeping up the value of the produce from the windthrown area.

APPENDIX

Details of Working Parties

formed by the

Windblow Action Group

The working parties which assisted the Group to produce the first report were as follows:

Field of Study (*Name of Working Party*)	Name	Representing
1. Collection of Data	Mr A. M. Mackenzie (*Convener*)	F.C.
	Mr R. K. Martin	S.W.O.A.
2. Harvesting	Mr A. A. Rowan (*Convener*)	F.C.
	Mr R. H. Adam	S.W.O.A.
	Mr D. Brown	H.T.M.A.S.
3. Marketing		
(3*a*) Small Round-wood	Mr D. B. Crawford (*Convener*)	S.W.O.A.
	Mr J. L. Davidson	F.C.
	Mr C. MacRae	H.T.M.A.S.
(3*b*) Mill-wood	Mr T. Bruce Jones (*Convener*)	H.T.M.A.S.
	Mr A. Brownlee	H.T.M.A.S.
	Mr R. S. Pelly	S.W.O.A.
	Mr E. G. Richards (*Assessor*)	F.C.
4. Transport	Mr D. Brierton (*Convener*)	S.W.O.A.
	Mr P. McAinsh	H.T.M.A.S.
	Mr J. A. Dunford (*Assessor*)	F.C.
5. Felling Deferment	Mr T. H. Woolridge (*Convener*)	H.T.M.A.S.
	Mr J. G. Chrystall	F.C.
	Mr D. Harrison	S.W.O.A.

Abbreviations F.C. = Forestry Commission
S.W.O.A. = Scottish Woodland Owners' Association
H.T.M.A.S. = Home Timber Merchants Association of Scotland.

SECTION 5

FORESTRY COMMISSION AID

By J. WHARAM

Forestry Commission

Recommendations of the Windblow Action Group

The first report of the Windblow Action Group dated 23 February 1968 made the following four recommendations to the Forestry Commissioners:

(1) An Appeal should be made to all Government Departments, Local Authorities and wood-using industries generally, to use as much home grown timber as possible in the next 2 years.

(2) A transport subsidy should be given to enable timber to be moved beyond the normal economic limit.

(3) For the next 18 months, the level of felling in areas of Scotland unaffected by the windthrow should be restricted by voluntary agreement.

(4) Investment Grants or similar financial assistance, should be given to the Timber Trade for harvesting, wood handling and forest processing machinery within the windthrow area.

This section of this report deals with the above recommendation regarding a transport subsidy which, in those cases agreed by the Commission, was implemented by payment of transport allowances. It also deals briefly with the windthrow machinery hiring scheme.

Windthrow transport allowances

In the Group's first report it was considered that 5 million hoppus feet (0.18 million cubic metres) of sawlogs would have to be transported to mills in the northern part of Scotland, and 6.5 million hoppus feet (0.23 million cubic metres) to the south of Scotland. In the second report it was considered that 4.3 million hoppus feet (0.15 million cubic metres) of small roundwood would be transported to specific markets beyond the normal economic transport limit. That figure excluded an estimated 750,000 hoppus feet 27 000 cubic metres) of small roundwood which it was anticipated would be transported to the National Coal Board for which government assistance was requested but not agreed.

In total, therefore, nearly 16 million hoppus feet (0.58 million cubic metres) of windthrown timber had to be moved to markets outside the normal economic transport distances and it was envisaged that this quantity would qualify for transport allowance. In the event, transport allowances were paid on 544,700 tons (553 400 tonnes) of sawlogs and small roundwood which, at 33 hoppus feet to the ton (1.17 cubic metres to the tonne), is equivalent to a little less than 18 million hoppus feet (0.65 million cubic metres).

Although the distribution differed from original estimates as can be seen from Table 8, page 24, the overall forecast was accurate.

Scale of Transport Allowances

The scale of allowances and subsequent variations are shown in Table 6 below, which presents the separate arrangements which were made at different times to help towards paying the costs of transport of sawlogs and small roundwood respectively.

Expenditure on Allowances

Table 7 below shows how expenditure on transport allowances was incurred.

A factor of 33 hoppus feet to the ton (1.17 cubic metres to the tonne) has been used throughout all the foregoing calculations. This is an arbitrary conversion factor and is not based on conclusive evidence. It is known that in the early part of clearance, timber was transported in almost fresh-felled condition at 30 hoppus feet to the ton (1.06 cubic metres to the tonne); in the latter part some timber was despatched in much drier condition at about 40 hoppus feet to the ton (1.42 cubic metres to the tonne).

The original forecasts by the Group were based on an estimate that about 40 million hoppus feet (1.44 million cubic metres) of timber had been windthrown. During the period of clearance this figure was revised to 45.5 million hoppus feet (1.64 million cubic metres).

Perhaps the disappointing feature revealed by the tables below is the comparatively small amount of timber which was moved to sawmills in the north part of Scotland despite the fact that the relevant transport allowance had been increased in March 1969.

At the time the Group made its original forecast of the movement of sawlogs (February 1968) the interests of Irish Timber merchants who later bought timber in the windthrow area were not taken into account. In the event these merchants shipped nearly 1.5 million hoppus feet (0.04 million cubic metres)—a sizeable contribution.

TABLE 6(A)

TRANSPORT ALLOWANCES:

SAWLOGS

EFFECTIVE DATE	CONDITIONS	ALLOWANCES
15 January 1968	Sawlogs moved *south* from the counties of Argyll; Clackmannan; Dunbarton; Fife; Kinross; Perth; Stirling; Berwick; Lanark; East Lothian; Mid Lothian; West Lothian; Peebles; Renfrew and Selkirk.	50 per cent of transport costs in excess of 20/- per ton subject to a maximum of 20/- per ton.
	Sawlogs moved *north* from Argyll (mainland only); Clackmannan; Dunbarton; Fife; Kinross; Perth and Stirling.	75 per cent of transport costs in excess of 20/- per ton subject to a maximum of 20/- per ton.
1 August 1968	Sawlogs moved *south* from scheduled counties.	50 per cent of transport costs for the excess between 30/- and 60/- per ton and 75 per cent for the excess over 60/- per ton subject to an overall maximum of 37/6d per ton.
	Sawlogs moved *north* from scheduled counties.	No change.
1 March 1969	Sawlogs moved *south* from scheduled counties.	No change.
	Sawlogs moved *north* from scheduled counties.	80 per cent of transport costs in excess of 17/6d per ton subject to maximum allowance of 26/- per ton.
1 May 1969	Change in conditions giving effect to the Group's recommendation that sawlogs moving *within* the windthrow area would receive transport allowances at the same rate as movement south.	
1 October 1969	Transport allowances extended to 31 December 1969 but allowance reduced for sawlogs moving south.	50 per cent of transport costs in excess of 20/- per ton subject to a maximum of 20/- per ton.
	Sawlogs moving north.	No change in allowances.
1 January 1970	Transport allowances extended to 31 March 1970.	At current level.

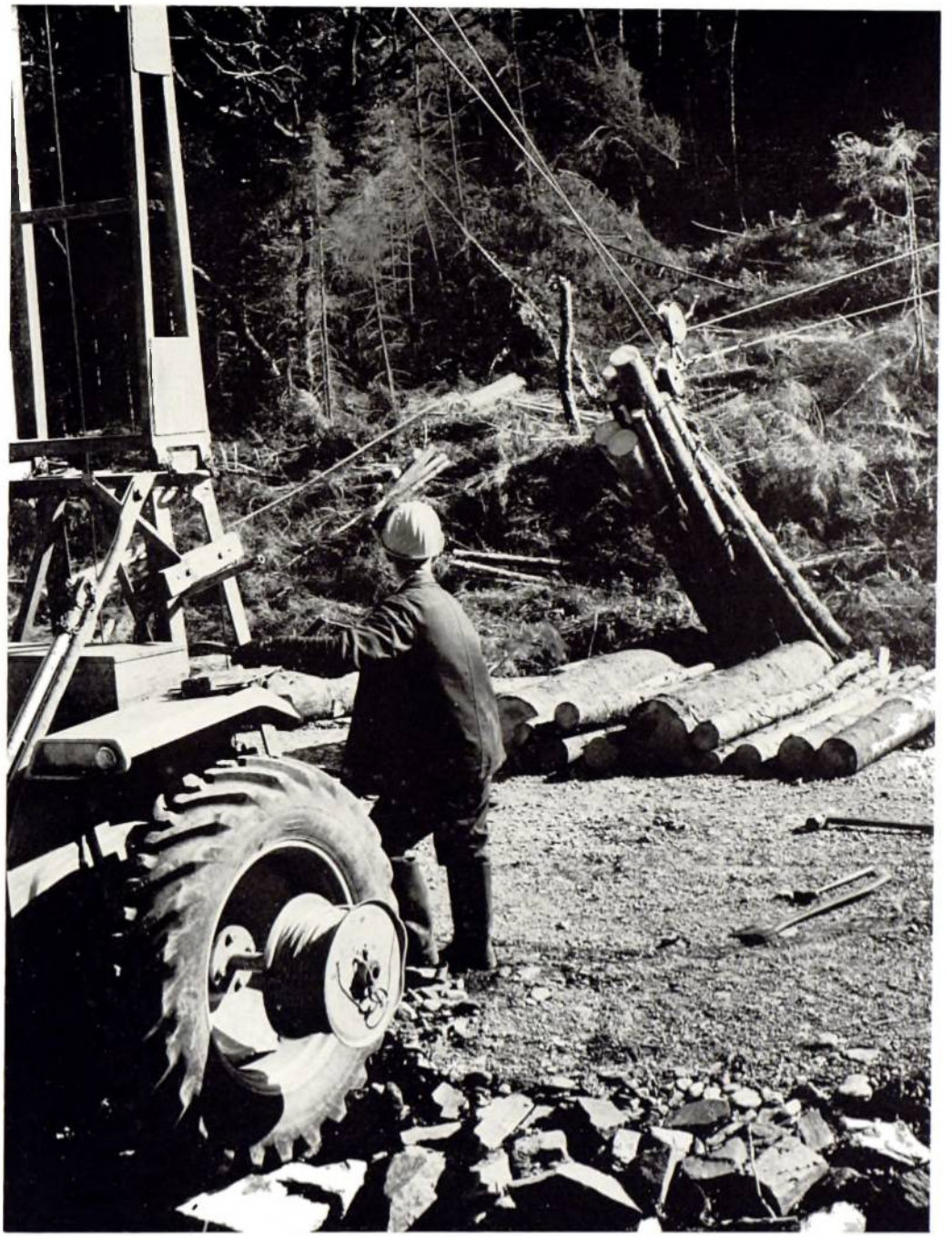

Plate 4. Well-tried machines of the type shown here proved effective in harvesting windthrown timber. B6130

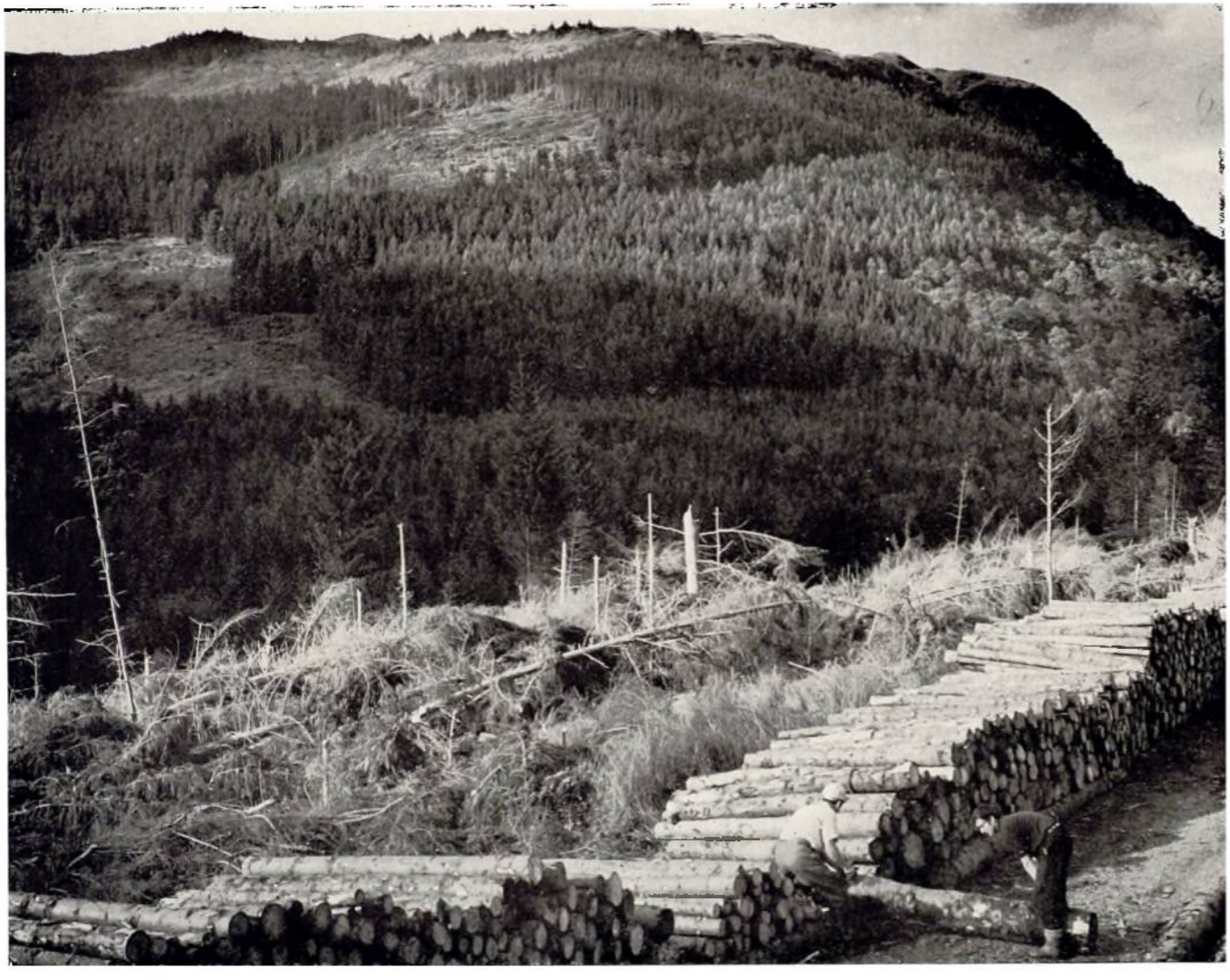

Plate 6. Despite the devastated appearance of the woods, a useful harvest of timber was reaped.

Plate 7. While the removal of lop and top might have made planting easier, it proved neither necessary nor economic to do so. B6129

TABLE 6(B)

TRANSPORT ALLOWANCES

SMALL ROUNDWOOD

EFFECTIVE DATE	CONDITIONS	ALLOWANCES
1 July 1968	For consignments to Scottish Pulp & Paper Mills Ltd., Fort William (from outside the normal supply area only).	10/- per ton.
	For consignments to Formica, Scotboard and Weyrock.	75 per cent of the cost over 25/- per ton subject to a maximum of 15/- per ton.
First Deliveries	For consignments to Bowaters processing depot at Grangemouth.	15/- per ton for distances up to 20 miles from Grangemouth. 22/6 per ton for distances between 20 and 30 miles. 25/- per ton for distances over 30 miles.
Notified 14 November 1968 but retrospective	For consignments to Bowaters processing depot at Grangemouth.	32/6 per ton for distances up to 25 miles from Grangemouth. 35/- per ton for distances over 25 miles.
1 October 1969	Transport allowances extended to 31 December 1969 except those for Bowaters (Grangemouth) which terminated 30 November 1969.	
1 January 1970	Transport allowances extended to 31 March 1970.	

TABLE 7(A)

EXPENDITURE ON TRANSPORT ALLOWANCES:

SAWLOGS

	Weight		Estimated Volume in millions		Expenditure £
	Tons	Tonnes	hoppus feet	cubic metres	
SAWLOGS					
Movement North	89,500	90 900	2.954	0.106	62,700
Movement South (including Ireland and within windthrow area)	265,200	269 400	8.752	0.315	240,100
Total	354,700	360 300	11.706	0.421	302,800

Notes. Weights: To nearest 100 tons and to nearest 100 tonnes.
Volume: Calculated at 33 hoppus feet to a ton (1.17 cubic metres to a tonne).
Expenditure: To nearest £100.

Breakdown of Movement South

To England and Wales	196,200 tons (199 300 tonnes) = 6.475 million hoppus feet (0.233 million cubic metres)
Ireland	45,300 tons (46 000 tonnes) = 1.495 million hoppus feet (0.054 million cubic metres)
Southern part of Scotland, and within windthrow area	23,700 tons (24 100 tonnes) = 0.782 million hoppus feet (0.028 million cubic metres)

TABLE 7(B)

EXPENDITURE ON TRANSPORT ALLOWANCES: SMALL ROUNDWOOD

	Weight		Estimated Volume in millions		Expenditure £
	Tons	Tonnes	hoppus feet	cubic metres	
Scottish Pulp & Paper Mills	120,200	122 100	3.967	0.143	60,100
Chipboard	45,800	46 500	1.511	0.054	23,000
Bowaters (Grangemouth)	24,000	24 400	0.792	0.028	23,000
Total	190,000	193 000	6.270	0.225	106,100

Notes. Scottish Pulp & Paper Mills accepted deliveries at their pulpmill near Fort William in Inverness-shire, and at a railhead depot at Crianlarich in Perthshire.

Wood for chipboard was despatched to mills at Annan in Dumfries-shire, at Irvine in Ayrshire and at Wallsend-on-Tyne and Hexham in Northumberland.

Bowaters' pulpmill at Kemsley, near Sittingbourne in Kent was supplied through a collecting depot which the firm set up at Grangemouth in Stirlingshire during the clearing of the windthrow.

Comparison Between Forecasts and Actual Deliveries

Table 8 below shows comparisons with comments.

TABLE 8

COMPARISON BETWEEN FORECASTS OF QUANTITIES OF WOOD TO BE TRANSPORTED AND ACTUAL RESULTS

	Forecast				Actual			
	Weight		Volume in millions		Weight		Volume in millions	
	Tons	Tonnes	hoppus feet	cubic metres	Tons	Tonnes	hoppus feet	cubic metres
(A) SAWLOGS								
Movement North	—	—	5.0	0.180	89,500	90 900	2.954	0.106
Movement South (including Ireland)	—	—	6.5	0.234	265,200	269 400	8.752	0.315
Total	—	—	11.5	0.414	354.700	360 300	11.706	0.421
(B) SMALL ROUNDWOOD								
Scottish Pulp & Paper Mills	—	—	1.0*	0.036	120,200	122 100	3.967	0.143
Chipboard	—	—	1.3	0.047	45,800	46 500	1.511	0.054
Bowaters (Grangemouth)	—	—	2.0	0.072	24,000	24 400	0.792	0.028
Total	—	—	4.3	0.155	190,000	193 000	6.270	0.225
GRAND TOTAL	—	—	15.8	0.569	544,700	553 300	17.976	0.646

(*Note.* *The forecast of 1.0 million hoppus feet (0.036 million cubic metres) was for private estates only. In fact, deliveries from Forestry Commission forests both direct and via timber merchants, also attracted this particular transport allowance.

A map comprising Figure 5 shows some of the many areas to which sawlogs and small roundwood were despatched.

Windthrow Machinery Hire Scheme

In an effort to assist both timber merchants and growers, the Forestry Commission announced a scheme whereby it would make suitable machines available on hire, at commercial hiring rates, for extraction and loading of the windthrown timber.

Although that scheme evoked a number of enquiries the maximum number of machines hired during the windthrow was only ten. The machines varied from a Hough Paylogger to a small ground skidding unit. All of the machines used in the hire scheme had first to be specially purchased by the Forestry Commission and cost in all about £21,000.

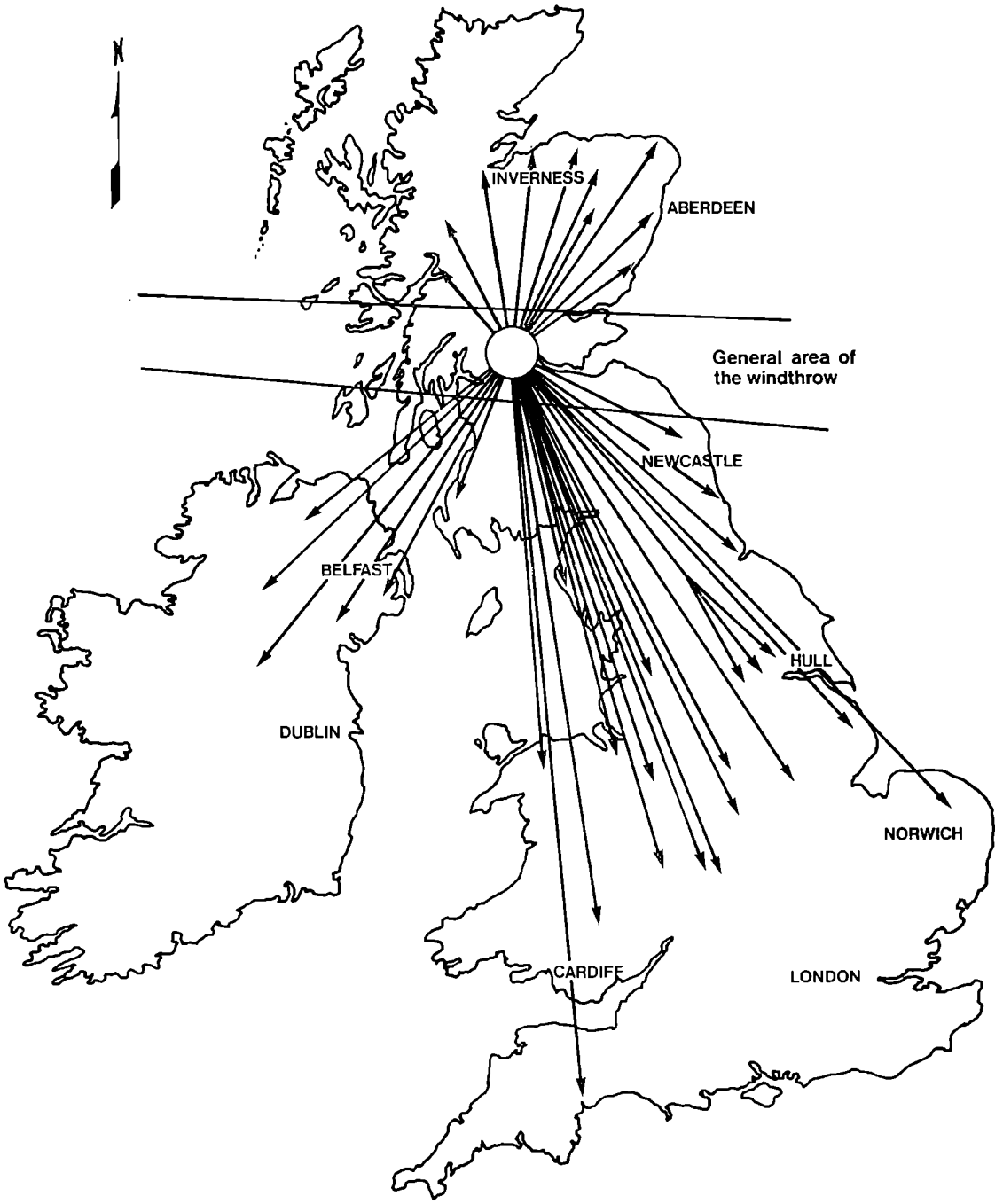

Fig. 5. Map of the British Isles showing some of the places to which windthrown timber was despatched. It is not practicable to show all the places from which timber was despatched and the one arbitrary centre shown on this map is chosen for diagrammatic representation only.

SECTION 6

MARKETING

By T. SMITH

Home Timber Merchants' Association of Scotland,

D. BRIERTON

Scottish Woodland Owners' Association, and

J. L. DAVIDSON

Forestry Commission

Introduction

The volume of timber initially estimated to have been blown down in State forests and private woodlands was 40 million hoppus feet (1.4 million cubic metres). Subsequent re-assessment revealed that this figure was an under-estimate and the full amount was probably 45.5 million hoppus feet (1.6 million cubic metres) including further minor windthrow which occurred during the course of clearance operations. Taking into account advice that insect and fungal attack might lead to serious deterioration if clearance were longer delayed, the Windblow Action Group set as the objective the clearance of all the windthrown timber within 18 months.

In 1967, the last year before the gale, total felling in the whole of Scotland was estimated to have been 23.3 million hoppus feet (0.84 million cubic metres) of which 7 million hoppus feet (0.025 million cubic metres) had been in the zone affected by the gale and 16.3 million hoppus feet (0.54 million cubic metres) in other parts of the country either unaffected by the storm or which had suffered only minor localised damage. When considering the marketing of windthrown timber the Windblow Action Group had to take account of the probability that felling would continue, although at a reduced rate, outside the area damaged by the gale; it followed that a substantial increase in the scale of harvesting and marketing would be necessary. The problems thus associated with marketing were remitted at an early stage for detailed but prompt study to three Working Parties, respectively referred to as the Millwood Working Party, the Small Roundwood Working Party and the Deferment of Felling Working Party and their findings are referred to below.

The Millwood and Small Roundwood Working Parties were given the task of examining the potential capacities of existing wood-using industries to absorb increased volumes of wood, noting the preference that so far as possible processing of the wood should be done in Scotland, and in the light of their assessments to make recommendations designed to maintain forest prices at levels not less than those current at the time of the gale. The Felling Deferment Working Party was given the task of examining the extent to which felling and thinning in those parts of the country outside the windthrow area might be temporarily reduced to relieve market congestion, and to make recommendations on what measures appeared practicable to achieve this. The first reports of the Working Parties were completed by 15 February 1968.

Marketing of Millwood (Sawlogs)

The original estimate of windthrown timber of sawlog size (specified as logs of 7 inches (18 cm) minimum top diameter and 10 feet (3 metres) minimum length) was:

Softwood: 19 million hoppus feet (0.68 million cubic metres) (of which 12 million hoppus feet (0.43 million cubic metres) on private estates, 7 million hoppus feet (0.25 million cubic metres) Forestry Commission)

Hardwood: 2 million hoppus feet (0.072 million cubic metres) (all on private estates)

Total 21 million hoppus feet (0.76 million cubic metres)

This estimate was probably too low and the final total is believed to have been 23 million hoppus feet (0.83 million cubic metres).

In planning to market millwood (sawlogs) the assumption was made that, after allowing for voluntary restraint of normal felling, there would be 6 million hoppus feet of millwood felled during the 18 months period in addition to the windthrown timber; there would thus be a total quantity of Scottish grown sawlogs of 27 million hoppus feet (0.97 million cubic metres) to be marketed in the 18 months period.

Firm conclusions on the capacity of Scottish sawmills were difficult to draw from the information available. Replies to a questionnaire circulated by

H.T.M.A.S., indicated to the Millwood Working Party a total capacity of 15.5 million hoppus feet (0.56 million cubic metres) per annum, but Board of Trade returns suggested that it might be as low as 8 million hoppus feet (0.29 million cubic metres) per annum excluding mining timber. For planning purposes the Windblow Action Group adopted a figure of 12 million hoppus feet (0.43 million cubic metres) per annum; this figure included an allowance for in-increased throughput in existing mills to meet the new situation. On this basis it appeared that there would be a surplus of 9 million hoppus feet (0.32 million cubic metres) which would have to be sawn outside Scotland if the objective were to be achieved of clearing the windthrow within 18 months.

In practice a somewhat different position emerged as the result of under-estimating total volumes, capacity of Scottish sawmills and duration of clearance operations. The assessment of long-distance sawlog movement, which formed the basis for a transport allowance, was not unrealistic, but more movement of wood occurred within Scotland and less to places outside Scotland than was forecast. Precise figures are not available but the general situation appears to have been as follows:

	Millions of:	
	hoppus feet	*cubic metres*
1967 annual felling rate *outside* the windthrow area:	6.5	0.23
Equivalent volume for 2 years, 1968 and 1969, would therefore have been:	13	0.47
Less reduction due to voluntary restraint:	2	0.07
∴ Sawlogs felled *outside* the windthrow area in two years:	11	0.40
Add: Total windthrown sawlogs:	23	0.83
∴ Total Scottish production of sawlogs in the two years:	34	1.23
Less volume transported outside Scotland:	8	0.29
∴ Balance consumed by Scottish sawmills:	26	0.94

This represents a consumption of about 13 million hoppus feet (0.47 million cubic metres) of sawlogs per annum in Scotland, or some 8 per cent greater than the figure adopted by the Windblow Action Group for planning purposes.

On the assumption that regional sawmilling capacity follows a pattern similar to that of regional sawlog production, it was estimated that half of the sawmilling capacity in Scotland was located north of the windthrow area, and, from this, that the northern sawmills would be able to absorb 5 million hoppus feet (0.18 million cubic metres) of windthrown millwood in addition to local supplies resulting from continued felling at a reduced rate. Subsequent events showed this to have been over-optimistic, in part because of a failure to realise the extent to which mills were already working to capacity, in part because commitments prevented a reduction of local felling to the extent forecast, and in part because northern merchants did not as a rule seek to purchase windthrown timber on root, certainly not to the extent of their English, Irish and South Scottish counterparts.

From the considerations outlined above it was clear at an early stage that substantial movements of millwood would be necessary over abnormally long distances which could result only in the depression of forest prices, unless artificially supported. To assist in disposal of the timber while maintaining reasonable stability of prices, recommendations were made, and approved, for payment of transport allowances (See Section 5, page 21). The rates were revised from time to time on recommendations from the Windblow Action Group in the light of reviews of progress. It is difficult to assess with any precision the relative effectiveness of the special measures taken to ensure satisfactory marketing of millwood because of the interplay of other factors, but there can be no doubt that, without the assistance of transport allowances and the consequent flow of timber to mills beyond normal economic transport range, clearance would have been much more prolonged with resultant heavy losses from deterioration. In addition the degree of confidence engendered resulted in a commendably controlled attitude on the part of buyers and sellers, and the combined effect of the measures taken and improved trading conditions resulting from the effects of devaluation of sterling (see below) led to forest prices being maintained at generally acceptable levels.

The Millwood Working Party foresaw no problems in the disposal of sawn timber and indeed none has been reported. The Secretary of State urged Government Departments, local authorities and other users of wood to use as much home-produced timber as possible. The response to this request is impossible to quantify, but it was a move which was greatly appreciated.

In retrospect the following points may be noted for the bearing they had on the marketing of millwood, many of which were not fully appreciated in the early stages and some were fortuitous:

The consequences of the 14.3 per cent devaluation of sterling which had been decided on 18 November 1967 had a stimulating effect on the marketing of home grown timber.

Lack of reliable information on sawmilling capacities both in Scotland as a whole and by regions.

Failure to appreciate that windthrown timber, if unbroken, and if left unsevered from the root, can remain sound in this region for periods longer than 18 months. Planning could safely have been based on two years for clearance (although it is arguable that if the plans had been based on a 2-years clearance period, the actual clearance might have taken longer still because the same sense of urgency might not have been conveyed to all concerned.)

Failure to give full enough allowance for the period required to switch harvesting resources and buying to windthrown timber, from normal operations in *unaffected* areas. (By contrast the switch within the affected areas was almost universally immediate).

Failure to allow for the declining rate of clearance towards the end of the period as the more accessible areas with more readily available labour resources and larger-sized timber became cleared.

Lack of balance between harvesting and transport of wood from the forest in the early stages, especially in Forestry Commission forests, resulting in cut logs lying too long in the forest before removal, with consequent danger of deterioration.

Marketing of Small Roundwood

The original estimate of the volume of windthrown small roundwood (taken to mean timber under 7 inches (18 cm) top diameter) was 19 million hoppus feet (0.69 million cubic metres) of softwood, of which 74 per cent was in Forestry Commission forests. Subsequent windthrow occurred, damaging between 2 and 3 million hoppus feet (between 0.072 and 0.108 million cubic metres) and raising the total to about 22 million hoppus feet (0.8 million cubic metres).

The Small Roundwood Working Party based its planning on the assumption that the normal (1967) rate of felling outside the windthrow area would be reduced by about one-third by voluntary restraint to 8 million hoppus feet (0.29 million cubic metres) over 18 months set for windthrow clearance. The total volume to be marketed in the 18 months would therefore be 19+8=27 million hoppus feet (0.69+0.29=0.98 million cubic metres) as compared with the 1967 position when total production of small roundwood in Scotland was 15 million hoppus feet (0.54 million cubic metres) equivalent to 22.5 million hoppus feet (0.81 million cubic metres) over an 18 months period. Additional markets would therefore have to be found to take 4.5 million hoppus feet (0.16 million cubic metres) and, as a result of preliminary enquiries, this did not appear too formidable a task, provided transport allowances were granted to assist with haulage to mills normally considered beyond economic distance. Allowances were subsequently negotiated to cover certain supplies of wood to chipboard mills, Scottish Pulp and Paper Mills, and a special scheme for shipment of pulpwood to Messrs. Bowaters' mill at Kemsley near Sittingbourne in Kent.

Although the broad strategy for the marketing of windthrown small roundwood proved to be right in that it led to disposal of the whole at prices reasonably in line with those current at the time of the gale, events not foreseen at that time forced a number of changes to detailed plans as the operation proceeded. The volume of windthrown timber was higher than at first assessed, the restraint in felling was not as fully effective for the whole of the period as expected, and the expected increases in consumption by some of the main buyers did not materialise. Against these factors it became clear that no serious losses would occur if the operation were spread over two years, and this increased time fitted better the availability of harvesting and transport resources. Although no exact account is possible of the course of events it appears fair to assess the position as follows over the two-year period as shown on page 30.

The position of the main small roundwood markets and their value in taking up windthrown small roundwood may be summarised as below. The most important feature is the dominance of the new pulp and board industries which have developed since the last major windthrow in 1953. Their importance lies not only in the large quantities of wood they were able to absorb, but also in the relative simplicity of their specifications (as compared for example with the specifications for pitprops) which simplified switching of supply sources and eased demands on already strained harvesting resources.

Scottish Pulp and Paper Mills Ltd., at their Corpach Mill near Fort William, Inverness-shire, had not, in early 1968, worked up to full capacity and were faced with a problem of high wood stocks at their mill. The assumption was made that their rate of intake of wood would increase from about 90,000 hoppus feet (3 240 cubic metres) per week to over 120,000 hoppus feet (4 330 cubic metres) fairly quickly, but this was over-optimistic and the increase became possible only towards the end of the operation. On the other hand no great difficulty was experienced in switching a substantial part of their supply from fellings in the northern Forestry Commission forests to the windthrow areas in the west and centre of the country. To enable private estates to benefit, arrangements were made for re-allocation of part of the supply contract from the Forestry Commission until expansion of intake by the mill

MARKETING OF SMALL ROUNDWOOD

	Volumes of small roundwood in millions of: hoppus feet	cubic metres
Revised total of windthrown small roundwood	22	0.8
Normal felling (1967) of small roundwood in Scotland outside the windthrow area 9.75 million hoppus feet (0.35 million cubic metres) × 2 years	19.5	0.7
	41.5	1.5
Less effect of restraint of normal felling, a reduction of	5	0.18
	36.5	1.32
Less uncleared windthrown timber at end of two years, including economically unexploitable timber	2.5	0.09
Total small roundwood marketed in two years, therefore:	34	1.23

DELIVERIES OF SMALL ROUNDWOOD

Deliveries to:	*Small roundwood volumes in millions of:* hoppus feet	cubic metres
Scottish Pulp and Paper Mills, Fort William	12.0	0.43
National Coal Board	8.0	0.29
Bowaters: Mersey, Cheshire, 5.0 million Kemsley, Kent, 0.75 million	5.75	0.21
Chipboard mills (especially Tyne Board Co., Wallsend)	3.25	0.12
Woodwool manufacturers	2.25	0.08
Thames Board Mill, Workington	0.25	0.01
Miscellaneous, including small millwood, fencing, etc.	2.5	0.08
Total	34	1.22

made this unnecessary. Limiting factors on the change of source of supply were the necessity to provide continuity of employment for men working in the northern forests who could not be moved to windthrow clearance, and re-deployment of transport. Since most of the windthrow on private estates was beyond the usual economic range of the mill, a transport allowance was negotiated and 46,500 tons (47 250 tonnes) had the benefit of this assistance. A similar situation arose for part of the supply from Commission forests and compensation became payable to the Scottish Pulp and Paper Mills Ltd., to recompense them for costs of re-deployment of transport.

Thames Board Mills Limited at Workington, Cumberland, were in the situation of starting up a new pulp and board mill and were encountering technical difficulties and teething troubles which forced them to curtail deliveries of smallwood for 1968, since most of the limited supplies required by the pulpmill were provided from Workington Sawmills, located on the same site, which was a major consumer of sawlogs from the windthrown forests.

Bowaters' Mersey Mill at Ellesmere Port, in Cheshire, was already a well-established market for large quantities of spruce pulpwood which included supplies from Scotland, but at the time of the gale and for some considerable time afterwards high stocks of wood at the mill prevented Bowaters from enlarging their intake to help the windthrow situation. It was however possible to switch a sizeable part of their normal Scottish supply to windthrown sources and this was helped by the voluntary restraint of felling in areas unaffected by the gale including, in the case of the Forestry Commission, part of the felling plans for North Wales and Northern England.

Messrs. Bowaters foresaw the limited assistance which could be rendered by their Mersey Mill, and they approached the Windblow Action Group with an offer to consider the establishment of one or more depots from which timber could be shipped to their Kemsley Mill near Sittingbourne in Kent. This offer, coming within a few days of the gale, was much appreciated by the Windblow Action Group. Unfortunately the preparation and equipment of a

depot at Grangemouth docks, on the east coast of Central Scotland, together with negotiation of supply and financial arrangements, including provision of a transport allowance, took longer than had been expected and the Grangemouth depot started to receive wood only at the end of September 1968. By this time the marketing situation for small roundwood had shifted somewhat, and many of the areas of spruce near to Grangemouth had been cleared. Further, unusual difficulties were being experienced within the harvesting of the main designated source of supply at Carron Valley Forest, in Stirlingshire close to Grangemouth, because of the large areas of small trees blown flat there. The combined result of these factors was to reduce deliveries to this depot from the intended volume of 2 million hoppus feet (0.07 million cubic metres) to less than half of that volume.

The chipboard mills at Wallsend-on-Tyne and Hexham in Northumberland, and at Irvine in Ayrshire, were recovering from a period of marketing difficulties. They were able to provide an important market for such windthrown smallwood, especially in specifications for which alternative markets would have been difficult to find, and then only at the expense of much heavier haulage costs. Although the major part of their requirements was met from within the normal areas of supply, transport allowance was negotiated. With its aid 45,000 tons (45 700 tonnes) were delivered from parts of the windblow area which would, in normal circumstances, have been beyond economic transport range, owing to high haulage costs.

Expansion of the demand for small roundwood for woodwool manufacture was foreseen by the Small Roundwood Working Party and this expansion did in fact take place. Although good prices were offered, delivery costs to the factories in the Midlands and North of England were high. A transport allowance to assist in delivering wood to this important and expanding market was strongly recommended by the Windblow Action Group, but no allowance was granted on the grounds that these markets were being supplied before the gale from the localities affected by the gale and were considered therefore to be within economic supply radius.

Lengthy discussions took place with the National Coal Board, and within trade circles in Scotland,with the object of increasing the uptake of wood for pitwood. Much of the discussion revolved around a proposal to establish one or more depots for conversion and stock-piling of pitwood, but price considerations prevented this scheme from materialising. Some increase of normal pitwood trading with Scottish merchants was reported and a special sale of 200,000 hoppus feet (7 000 cubic metres) of stock sizes was arranged by the Forestry Commission.

Felling Deferment

The Working Party on Deferment of Felling, after examining existing relations between buyers and growers, drew attention to the very real difficulties in suspending or severely modifying current contracts of sale because of hardship which would result for merchants who had already bought timber, often several months in advance of requirements, and also for private growers who were managing their estates against a budget. The Forestry Commission's position was more flexible; the main limitation was maintenance of a level of felling which would continue to provide employment for those of its own employees and of contractors employed by merchants in its forests who were unable or unwilling to transfer to windthrow clearance work elsewhere. For these reasons thoughts of using any form of compulsory regulation of felling were rejected until the effect of persuasion had been tried, and on the recommendation of the Windblow Action Group the Secretary of State appealed for restraint to be exercised by those operating outside the windthrown areas.

Until the result of the call for voluntary restraint of felling was known the assumption was made that, for market planning purposes during the emergency, felling would be reduced to two-thirds of the 1967 level in forests which had not suffered windthrow, including those outside the gale damaged area. This proved over-optimistic because of the time required to work through commitments already entered into, and because of the gradual resumption of felling towards the end of 1969 as local windthrow was cleared and the demand for timber became stronger. A survey conducted by S.W.O.A., indicated that among private estates outside the windthrow area only a few were able to make significant reductions in their rate of felling before September 1968, but 75 per cent of estates were planning to reduce the rate by a third for the following year. The Forestry Commission revised its felling plans to provide for a 37 per cent reduction in the rate of felling during the summer of 1968 and a 40 per cent reduction during 1969 in their Scottish forests outside the windthrown areas, and lesser reductions of felling plans in North Wales and North-east England.

Where owners of Dedicated or Approved woodlands voluntarily undertook to delay felling, the Forestry Commission agreed to accept appropriate modifications to their Plans of Operations.

Although restraint in felling was not exercised to the extent envisaged, it played a significant part in easing the problem of marketing windthrown timber and the Windblow Action Group was duly grateful to those who made the sacrifice to help others who suffered from the gale.

Other Measures

The Commissioners of Inland Revenue authorised the proceeds of sales of timber blown down in the storm to be treated as "casual windfall" for estate duty purposes.

Marketing: Conclusions

In general the problem of finding satisfactory markets for windthrown timber was, for most of the time, less limiting to the rate of clearance than inability to concentrate harvesting resources towards the end of the operation on those remaining areas where very heavy damage had occurred, and less limiting also than bottlenecks in availability of transport for removal of extracted timber. Throughout there was a marked absence of panic selling. The credit for this must be given to the participating bodies who agreed to the prompt formation of the Windblow Action Group; the publicity given to its activities and the confidence, good-will and co-operation shown by private growers, timber merchants and the Forestry Commission contributed greatly.

SECTION 7

HARVESTING

By T. SMITH

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Scottish Woodland Owners' Association, and

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Forestry Commission

Harvesting Working Party

A Harvesting Working Party was appointed at the first meeting of the Group (see Section 4, page 14, and the Appendix to Section 4, page 20), to examine the availability of labour and mechanical equipment and to assess these in relation to the requirements for cutting, extracting and loading of windthrown timber. After a rapid survey of the situation they were able to report that:

(1) Given a reasonable degree of mobility of labour, which they defined, sufficient labour would be available to clear the timber within two years.

(2) After allowing for re-deployment of machinery there would be a need for additional equipment to achieve the degree of labour productivity which had been assumed.

(3) Although study would be needed on techniques to deal with windthrow timber, a more important need would be for training courses, particularly for those Forestry Commission employees who were not accustomed to harvesting operations.

Attempts to Obtain Help in Supplying Harvesting Machines and Equipment

The Windblow Action Group, after examining those findings, reached the conclusion that the survey had taken too broad a view and pointed to the heavy concentration of windthrown timber in certain areas where the probability of concentrating sufficient men to achieve clearance within eighteen months, which was set as the objective, was remote. In such areas there was a need to raise greatly the productive capacity of the men employed, calling for a high degree of mechanisation and training. It was therefore recommended that Investment Grants, or similar financial assistance, should be made available as a matter of urgency for the purchase of harvesting and forest processing machinery and equipment.

Though it was pressed with vigour through the Home Grown Timber Advisory Committee, the recommendation to pay Investment Grants was not accepted on the grounds that the particular case for machinery for windthrow clearance could not be treated separately from the wider issue of grants relating to timber harvesting machinery in the country generally. In retrospect the Group felt that the lack of Investment Grants for harvesting machinery had a detrimental effect on windthrow clearance.

To help in providing equipment the Forestry Commission was authorised to make purchases of machinery for hire at commercial rates to timber merchants and to private estates involved in the windthrow clearance. The response to this scheme was slow, but for varying periods ten items of equipment were on hire, including one tractor/debarker, four tractors with high-lead winches, four medium sized skidding tractors, and one heavy skidding tractor.

Possible Opportunities Provided by the Windthrow

It was urged by the Scottish timber trade that whenever there were large concentrations of timber to be harvested the opportunity should be taken to introduce a number of the more advanced types of high capacity harvesting and debranching machines which were being developed on the Continent and elsewhere. Such innovations, it was argued, would not only assist in clearance of the windthrow, but would also provide valuable experience for the development of future harvesting systems for application in forests where normal felling of large volumes would shortly be taking place. The Forestry Commission's Machinery Development and Work Study staff, after reviewing the most up-to-date information on such mechanical development, were however unable to recommend machines which would be likely to give reliable and beneficial results. One advanced type of debranching and cross-cutting machine was brought from Canada by a timber merchant, but it proved unreliable in operation and unsuitable for the conditions in which it was employed.

The Harvesting Equipment Used and its Improvement

Basically the equipment used was that which was already in use—according to terrain conditions—

prior to the windthrow, but the new pressure of work led to a hastening of development and to improvement in performance both in mechanical details and operation. High-lead and sky-line winching equipment was stretched to accommodate ranges of distance and loads well beyond those for which there was previous experience. This has resulted in reappraisal of its value in normal operating conditions and in improvements to mechanical specifications, with particular reference to acceptable safety limits. In the field of tractor and ground skidding equipment also, a wide range of modifications and adaptations of basic machines was introduced and a demonstration of many of these was arranged by the Forestry Commission at a three-day exhibition at Edensmuir Forest, in Fife.

Labour, Deployment, Recruitment, Transfer of Volunteers and Training

Re-deployment of labour was effected with speed by the timber trade within the windthrown areas where they were operating at the time of the gale; this was followed by a slower increase in the labour force as recruitment became necessary from further afield. Although two merchants moved their operations from the northern part of Scotland to windthrow areas, the assessment made by the Working Party of the part which northern operators would play was over-optimistic. This may be accounted for by failure to appreciate the extent to which northern merchants were already committed in their home region, despite a measure of voluntary felling restraint. A number of English and Irish merchants moved squads into the windthrow area. As operations progressed, it became apparent that labour was a more limiting factor than markets, and buyers were urged to accept a larger proportion of their purchases on root, and to bring in their own men to harvest; there was little response to this after the initial build-up during the summer of 1968.

There was a good response to the call from the Forestry Commission for volunteers from within its own organisation to move to windthrow areas and for varying periods considerable numbers of workers from all parts of Britain were employed. Felling in northern Scotland was reduced as much as possible within the constraint that men who were unable or unwilling to transfer to windthrow areas should continue in active employment in their home forests. The speed with which volunteers could be transferred was slower than had been hoped by a month or two because of the problem of finding and furnishing suitable bothy or other accommodation. The first to move were those engaged on felling, followed later by others with their extraction equipment, after they had extracted timber already cut at their home forests. This time-lag between felling and extraction gave rise to problems through large amounts of timber being cut too far in advance of extraction and despatch; this created barking difficulties at the mills. The effect of this increase in labour can be demonstrated by Forestry Commission figures in Table 9 below.

In addition to the recruiting of volunteer labour from other parts of the country by the three organisations involved, the Forestry Commission carried out extensive training of employees who had previously been engaged on work other than harvesting.

At the peak of clearance operations in West Scotland, the area most affected, it was estimated that 470 men were employed in harvesting windthrown timber in Forestry Commission forests, as compared with a pre-windthrow figure of 215. Of the additional men, 86 were brought in by timber merchants, 53 were Forestry Commission employees not previously engaged in harvesting, and 116 were Forestry Commission employees on voluntary transfer from other parts of Scotland and from England and Wales.

Enquiries were made by the Windblow Action Group to find whether the Department of Employment and Productivity, or other Government agency, was able to make payments to assist with travel and subsistence costs for labour moving voluntarily to windthrow areas, but without success.

The Forestry Commission concentrated a large part of its training resources in the windthrow areas mainly for training its own employees who had no earlier experience of harvesting and for re-training others in new harvesting techniques, but provision was also made for training private estate employees. The subjects which were given most attention were general courses on use of chain saws for felling and cross cutting, the use of chain saws for snedding, and winch operation.

Labour Productivity

The rate of output per man had originally been estimated by the Working Party at 20,000 hoppus feet (720 cubic metres) felled and extracted per man-year, but in practice better results were achieved. In part this is accounted for by the good weather experienced, especially in 1968, which allowed full scale working and often long hours of working; but training and accrued experience in the techniques of handling windthrown trees also played a big part. The original estimate also erred on the side of caution in giving too much weight to the expected problems of working in the tangle of trees, branches and upturned roots, and too little to the effects of working with larger average tree sizes and the advantage of high concentrations of volume per acre as compared with relatively low volumes from thinning operations which had been the limit of experience of many operators before the gale.

Supply of Technical Papers

With the assistance of the Forestry Commission's Research and Work Study staff papers were prepared and circulated on technical information. Subjects dealt with were:

(1) Protective measures against pests and diseases —a general assessment in relation to windthrown timber.

(2) Cutting techniques—a translation of a German paper with emphasis on safety aspects.

(3) Organisation and Technique of Logging Windthrown Timber—translated from a paper in German by H. Weiss.

(4) Pinhole Borer—an account of techniques, costs, and procedures for protecting timber against insect attack.

(5) Storage of windthrown timber—a translation of a Danish paper with additional cost details kindly supplied by a S.W.O.A., member.

(6) Stump protection in windthrow areas—recommendations on treatment of stumps for control of *Fomes annosus*.

(7) Restocking of windthrown forest. A summary of all available published information on the storage of roundwood was also prepared.

Possible Need for Safe Storage of Sawlogs

Consideration was given to the advisability of cutting and storing sawlogs, and plans were drawn up for alternative schemes to store 0.5 million hoppus feet (0.018 million cubic metres) in Argyll, including the creation of an artificial log pond. The schemes were estimated to involve direct costs of 6d or more per hoppus foot (£0.69) or more per cubic metre) and it was decided to hold them in reserve in view of the reasonably satisfactory marketing situation. As it became clearer that when timber was left on root it could remain sound for two years, the necessity for storage diminished and none was attempted.

Rate of Progress in Harvesting

The rate of progress with harvesting from Forestry Commission and Private Woodlands can be seen from Table 9 below. This represented the conclusion of the critical phase of the windthrow clearance; there remained a balance still to be cleared at March 1970.

Lessons Learned

The main lessons to be learned for dealing with any future large windthrow are:

(*a*) The necessity of allowing more time for the build-up of harvesting resources switched from areas beyond normal daily travelling distance, having re-

TABLE 9

PROGRESS OF HARVESTING AND DESPATCH OF WINDTHROWN TIMBER,

By Volume—Millions hoppus feet

(equivalent millions of cubic metres given in brackets)

Date	Harvested			Despatched		
	Forestry Commission	Private Woodlands	Total	Forestry Commission	Private Woodlands	Total
30th June '68	—	—	—	2.7(0.097)	2.4(0.086)	5.1(0.183)
30th Sept. '68	7.7(0.270)	5.0(0.180)	12.7(0.457)	5.9(0.212)	3.9(0.140)	9.8(0.352)
31st Dec. '68	9.9(0.357)	9.0(0.324)	18.9(0.681)	9.9(0.285)	8.6(0.310)	16.5(0.595)
31st Mar. '69	13.5(0.487)	11.5(0.415)	25.0(0.902)	10.7(0.386)	10.3(0.371)	21.0(0.757)
30th June '69	15.8(0.570)	13.5(0.487)	29.3(1.057)	12.7(0.450)	12.5(0.451)	25.2(0.909)
30th Sept. '69	17.3(0.624)	16.0(0.577)	33.3(1.201)	14.6(0.526)	15.0(0.541)	29.0(1.067)
31st Dec. '69	19.0(0.685)	18.0(0.649)	37.0(1.334)	16.7(0.602)	17.0(0.613)	33.7(1.215)
31st Mar. '70	21.0(0.757)	19.5(0.703)	40.5(1.460)	19.0(0.685)	18.5(0.667)	37.5(1.352)
30th June '70	—	—	42.8(1.543)	—	—	41.4(1.493)

gard to the need to allow time to round off commitments and operations already in progress.

(*b*) The need to allow for a slowing down of the overall rate of clearance if, as happened in this case, the work becomes more concentrated on a few particularly heavily affected localities.

(*c*) The need to avoid cutting too far ahead of extraction and so to avoid danger of deterioration and loss of value. Deterioration and loss of value might occur through logs lying too long on the ground when they might be kept more safely if left attached to the roots; pulpwood which is allowed to dry through lying too long might become difficult to bark; it might also suffer loss in value when sold by weight.

(*d*) The need for full recording of experiences, techniques and productivity data for possible future application. There was little information available from previous windthrows on these points to guide the Windblow Action Group in the early stages.

(*e*) The realisation that windthrown trees could remain sound for as long as two years or even more provided they remain attached to their roots; this was so at least so far as trees of the species and sizes which were windthrown were concerned, and in the climatic and other environmental conditions of the region described in this report.

Harvesting Consultant's Observations

At the invitation of the Windblow Action Group, Professor Steinlin of Freiburg University toured the windthrow areas in the summer of 1968. In the light of his extensive experience with similar situations in Germany and elsewhere he gave valuable and practical advice to operators in the field. In summing up at the end of his tour his main observations were:

(*a*) He commended the timber trade the private growers and the Forestry Commission on their close co-operation and on the speed with which they had planned and started clearance operations.

(*b*) He praised the Forestry Commission for the high degree of operational planning, training and supervision seen in their operations. Although those operations were highly effective, he felt that greater scope should be given to local initiative and to improvisation.

(*c*) He noted the reverse position as seen in many timber merchant's and private estate operations where hard work, skill and initiative were partly wasted by inadequate planning and supervision.

(*d*) He saw weaknesses in the planning of details such as provision of loading points and assessing the priorities of areas to be cleared.

(*e*) Too much work was being attempted in the tangle of fallen trees; instead, he advised, trees should be drawn out by using cheap tractors, for snedding, after having been cut off root.

(*f*) He approved of the use of well-tried machines instead of experimenting with new types while the emergency existed.

(*g*) Over-cautious attitudes towards investment in machinery he criticised; the emphasis should be on the reduction of overall operational costs.

(*h*) More particularly, in Forestry Commission operations, he saw weaknesses in sorting produce to obtain best value.

SECTION 8

TRANSPORT

By T. SMITH

Home Timber Merchants' Association of Scotland,

D. BRIERTON

Scottish Woodland Owners' Association, and

J. L. DAVIDSON

Forestry Commission

The Transport Working Party (see Section 4, page 14, and the Appendix to Section 4, page 20) was asked to consider and report on the case for a transport subsidy for windthrown timber and to examine transport facilities in general. In their report they pointed out that, since the capacity of markets to which timber was normally sold from the windthrow area was too small to absorb the volumes to be cleared within the time allowable, there must be provision for a degree of dispersal of timber to markets outwith the normal supply radius. From this was argued the case for payment of transport allowances to:

(*a*) Spread the consumption load and prevent loss to the country of utilisable timber which would otherwise begin to suffer from insect and fungal degrade.

(*b*) Assist in maintaining reasonably normal trading conditions and prices and prevent a glut of timber available only to the markets within economic transport distance.

(*c*) Prevent, by the above means, too great losses being suffered by growers as a result of the natural catastrophe, which would otherwise seriously undermine confidence in forestry.

The transport allowances recommended by the Windblow Action Group and approved by Government were related to separate classes of timber, namely sawlogs, chipwood, pulpwood for supply to Scottish Pulp & Paper Mills, and actual rates and conditions, and the modifications which applied from time to time in the light of developments are dealt with separately in Section 5 on page 21.

Following on information gleaned from questionnaires circulated to road haulage firms, the timber trade, forest management organisations and the Forestry Commission, the Working Party concluded that substantial reliance would have to be placed on regular long-distance hauliers. It was foreseen that one problem associated with this would be loading, for it was unlikely that such vehicles would be fitted with loading devices for the sake of timber handling alone.

Consultations took place with British Railways, but little use was made of their facilities. The inadequacy of suitably located sidings and loading equipment, combined with costs, including costs of double-handling, and lack of suitable wagons, were reasons for concentrating on road haulage, with the exception of the normal arrangements for carriage of pulpwood by rail from Crianlarich in Argyll to Corpach, near Fort William in Inverness-shire.

A feature which did not enter into the original assessment, but which had a substantial influence on timber movements, was sea transport. This came about through the purchase by merchants from Ireland of considerable quantities of timber in the western part of the windthrown area. In all about 1.5 million hoppus feet (0.054 million cubic metres) were shipped from small Argyll piers such as Strone, Ardrishaig and Kilmelford. In addition, pulpwood shipped from Grangemouth on the Forth to Sittingbourne, on the Thames estuary in Kent, by Messrs. Bowaters amounted to some 0.8 million hoppus feet (0.028 million cubic metres) and about 0.25 million hoppus feet (0.009 million cubic metres) was shipped to Corpach from the island of Mull in Argyll under the scheme already in operation for pulpwood.

As operations progressed, shortage of road transport became one of the most critical factors in regulating the rate of clearance. There was reluctance on the part of the long-distance hauliers to take up timber transport, despite attractive rates and the prospect of regular traffic of a substantial nature. Some hauliers are thought to have been influenced by the possibility of damage to lorries from large unfamiliar loads at a time when there was no shortage of normal work including opportunities of renumerative return loads.In the event, great reliance had to be placed on smaller firms and on those who regularly carried wood to the pulp mills and to other remotely located users of small roundwood.

Equally critical was the provision of loading equipment. Although regular timber hauliers were often adequately equipped to undertake their own loading, others had to rely on independent loading equipment provided by the consignors. For most of the time this was inadequate, and there was reluctance to remedy the situation because of the heavy outlay that would have been involved for relatively short-term use.

SECTION 9

PROTECTION OF WINDTHROWN, STANDING AND REPLANTED TREES: PATHOLOGY AND ENTOMOLOGY

A. PATHOLOGY

By D. A. BURDEKIN

Forestry Commission

Advisory Leaflet

A leaflet entitled *Protective Measures against Pests and Diseases* was prepared jointly by the Entomology and Pathology Sections of the Forestry Commission's Research Division and was widely distributed to foresters within three weeks of the gale. It included practical advice on how to deal with the two main pathological risks of damage from fungal blue stain in pine and from root and butt rot in conifers caused by the fungus *Fomes annosus*.

Blue Stain on Pine

Blue staining fungi are likely to cause serious discolourisation of pine timber when trees or logs are left lying in the forest for long periods. As a relatively small area of pine was windthrown and this was cleared rapidly, no reports were received of degrade caused by blue stain.

Stump Treatment Against the Fungus: Fomes annosus

It was recommended that stump treatment should be carried out in all windthrown areas, using sodium nitrite which contained a marker dye when sold in packs for forestry use, together with Ministry of Agriculture, Fisheries and Food advice on precautions to be observed in its use. Those who were unfamiliar with this protective measure and who proposed to use it were urged to obtain expert advice from Forestry Commission staff in Scotland. This was done though it was considered impracticable in some cases particularly where densely stocked areas were windthrown (e.g. in Carron Valley Forest).

It was considered that the surfaces of the tree stumps exposed after cutting windthrown or windsnapped trees were potentially major entry points for the basidio-spores of *Fomes annosus*. There was some risk of infection entering through broken roots but it was felt that this risk was less than that of entry through the stump surfaces.

Checks were made by means of foliage samples to determine whether viable spores of *Fomes annosus* were present in the windthrown areas. Their presence was confirmed in all forests where major windthrow had occurred.

It is too early to say how effectively the advice has been applied but it is certain that the future effects of *Fomes* in conifers in adjoining stands and in reafforested windthrown sites will be reduced as a result of applying the recommended treatment.

B. ENTOMOLOGY

By D. BEVAN

Forestry Commission

Advice on Protection of Trees Against Insects

The special advisory leaflet which has been described in Part A of this Section alerted foresters to the likely nature of damage to conifers from certain beetles. It stressed that all practicable steps should be taken to keep infestations as low as possible, with three objectives:

First, to minimise damage to the wood of windthrown and windsnapped trees which would be harvested.

Second, to prevent later spread of beetles to trees which remained standing after the gale.

Third, to minimise damage to young conifers replanted on windthrown sites.

Prevention of damage to healthy trees which were to be left to grow was expected to be no more than a local problem; it was in the second breeding season that beetle numbers might have reached outbreak levels, some 15 to 18 months after the gale, by which time it was hoped to have harvested most of the windthrown trees.

The Result

No serious damage has been caused by beetles to trees or logs in the windthrow areas. This has been due mainly to the effective dissemination and application of the advice which was given within three weeks of the gale.

Summary Notes on the Beetles and on the Recommendations Given for Dealing With Them

We are fortunate, in Britain, in having no species of bark beetle which is of economic importance on the spruces, and no advice on such beetles was necessary.

Advice was given mainly on the most common beetle pests and is summarised below.

Trypodendron lineatum. This is a pinhole borer (ambrosia beetle) which was known to attack felled trees or logs of most coniferous trees. It was expected to attack broken stumps and felled trees or logs in 1968 and the resulting increased numbers were expected to attack all susceptible wood in 1969; wood attacked in 1968 would not be suitable for the beetles in 1969 but trees harvested during the winter of 1968/69 would be attacked during the following early summer; such windthrown trees could be left unharvested so long as their tops were green, and their harvesting was advised only when the wood could be cleared from the site before a *Trypodendron* attack period (April-June).

Attack by these beetles had only been of serious economic importance in sawlogs. Advice was therefore given that if sawlogs could not be removed from the forest in good time to avoid damage, they should be arranged in the biggest practicable stacks; the surfaces of the stacks were then to be sprayed with 0.5 per cent solution of a Lindane (Gamma BHC) emulsion which treatment would give at least three months protection against beetle attack.

Tomicus piniperda, the pine shoot beetle, was expected to attack wind-broken pines and produce. Pines on dunes, which usually lack vigour and frequently appear to be under some physiological stress, are susceptible to attack irrespective of whether they are windthrown or not. Windthrown broken pines on dunes and other sites are liable to be attacked in the first year; although there was less pine than spruce in the windthrown area, its clearance was urged as first priority because it was less likely to remain undamaged when windthrown, whereas spruce would survive the first year's attentions from *Trypodendron*. This beetle was of particular concern because its attacks provided points of entry for blue staining fungi (see Part A of this Section). The adult beetles breed in windthrown stems and recently felled logs; attack was therefore expected to be fairly light in 1968, but warning was given that large populations would result in 1969 from any neglect to clear suitable breeding material. Such increased populations of adult beetles would cause much loss of shoots from growing trees. It was also explained that windthrown pines would be attacked in 1969 even if their tops remained green, and even in the summer of 1968 if dry weather prevailed. Neither shoot damage nor entry of stems for breeding was expected among healthy fast growing pines on the better soils.

SECTION 10

REPLANTING

By E. J. M. DAVIES

Forestry Commission, and

R. H. ADAM

Scottish Woodland Owners' Association

The gale of January 1968 is estimated to have destroyed 10,600 acres (4 300 hectares) of woodland in Forestry Commission forests and about 10,000 acres (4 050 hectares) in the private sector. It was more difficult to estimate the area on private estates because of the many small and isolated clumps of trees under 10 acres (4 hectares) in extent which were windthrown, including amenity woods or clumps in parks.

THE MAIN PROBLEMS

Orderly Clearance of Ground

One difficult problem in the early months after the gale was to control the clearance of the timber in an orderly way so that replanting could be planned properly. New and often untrained labour had to be employed in harvesting the worst hit areas; consequent delays and uncertainties meant that only after the first six to twelve months could proper planning begin.

Arguments For and Against Replanting

Several problem areas were encountered when replanting was considered. Fairly old established woodland sites with reasonable access and drainage were in general considered suitable for replanting without presenting major problems. The main categories which gave cause for concern were sites with impervious clay soils where tree rooting had been superficial; sites which, particularly in private woodlands, were virtually inaccessible due to lack of roads; those areas which were subjected to considerable vandalism; and lastly, the small strips or isolated blocks of bad shape.

In general a larger proportion of the windthrown timber on private estates had grown on more fertile ground than that in Commission forests, so that the private owner's decision to replant generally hinged more on the accessibility than on the fertility of the site. In many cases substituted areas were planted in place of the less attractive areas. This was an economic forestry consideration but on many estates the sporting and shelter aspects had to be considered.

MANAGEMENT CONSIDERATIONS

Windthrow resulted in premature realisation of crops; this disrupted budgets for timber revenues and for replanting costs. Programmes had to be reviewed and in some areas afforestation schemes were postponed in favour of replanting windthrown areas; while this was a logical decision it often strained financial resources which, in some cases, had been set aside for other purposes. Other matters which managers had to consider before replanting are dealt with briefly below.

Size of Coupe: Clearance of Remnants of Stands

In many of the partially windthrown stands continuing damage was inevitable and the definition of the final coupe was important. The first priority was to clear the windthrown areas and then to reappraise the condition and stability of the remnants of the crop so that a decision could be made on the size and shape of the area to be cleared and replanted. It was important to assess the stability of the remaining crop in relation to soil conditions, to improve the shape of the area where new fencing was essential and to eliminate isolated pockets and fringes of trees which would otherwise produce management problems in the future.

Burning Lop and Top

The question of whether or not to burn lop and top before replanting had to be decided in individual cases on the bases of practical needs and costs.

Drainage and Cultivation

Many of the windthrown woodlands had been inadequately drained; it was clear that it would be difficult to re-drain among upturned roots.

Insect Attack

On old coniferous woodland sites and more particularly where windthrow had occurred previously, severe insect attack was feared.

Grazing and Fencing

In general the devastation of woodlands and the accompanying destruction of their surrounding fences, had the effect of increasing grass growth and of increasing the opportunities for browsing planted trees in areas where deer and sheep were common.

Natural or Artificial Regeneration

A choice had to be made in some instances between early replanting or waiting hopefully for natural regeneration.

Weeding

It was appreciated that in the interests of economy the sooner the windthrown areas could be re-stocked the less would be the weeding costs.

PROGRAMME

Approximately 20,000 acres (8 000 hectares) of woodland required to be replanted as a result of the gale; this total area was more or less equally divided between private and Forestry Commission woodlands. By September 1970 the Commission had replanted or scheduled for natural regeneration some 4,000 acres (1 600 hectares), and private owners had re-stocked rather less than half this amount.

In view of troubles expected from invading weed growth, the work has been given high priority by both sectors, and it is hoped that nearly all of the areas which are deemed to be economic, will be replanted by June 1972. However, shortages of large transplants of Sitka spruce (the species most widely favoured) and lack of cold storage facilities for plants have caused some difficulties for private growers. The Forestry Commission has four cold stores in West Conservancy; these have enabled restocking to take place outside the normal planting season.

METHODS OF RE-STOCKING

The methods adopted vary greatly and may be summarised as follows:

Preparation of Ground

Some private owners favour burning lop and top because they hold that it makes subsequent weeding easier and reduces the cover for rabbits.

The Forestry Commission, dealing chiefly with spruce woods, believe that it is unwise to burn lop and top because:

(*a*) It is costly,
(*b*) It encourages weed growth,
(*c*) Lop and top deters roe deer,
(*d*) There may be a risk of fungal infection from fires.

There has been a shortage (particularly in the private sector) of large transplants which are almost essential for successful planting through deep lop and top. On wet sites where turfing might be needed, no suitable mechanical aid has yet been developed and hand cut turves have been used.

Drainage

Attempts to plough drains through felled areas have not been successful; either expensive back-acter diggers have been used or laborious hand methods employed.

Plant Size, Planting Method and Spacing

It is accepted that large plants are best and specially designed spades have been used for planting through brash. Numbers of trees used vary from 800–1,000 per acre (2 000–2 500 per hectare).

Plant Protection

Insect damage was foreseen and trees have been dipped in insecticide before planting in both Commission and private woodlands.

It has been noted that naturally regenerated seedlings have been damaged by beetles whereas adjacent insecticide treated transplants have remained immune.

Grazing damage from deer and sheep was foreseen; it has been serious in some areas and new internal fences have been necessary in places.

Weeding

Weeding has been done mostly with hand tools but chemical methods have been used increasingly.

Use of Fertilizers

Generally speaking the brown earths have not been fertilized, but on poorer sites where heather (*Calluna vulgaris*) and purple moor grass (*Molinia caerulea*) were abundant on rides, 3 cwt of Gafsa phosphate per acre (380 kg per hectare) is being applied by hand within two years of planting.

Costs

Costs vary greatly depending upon the amount of ground preparation undertaken. Where it has been possible to plant through the lop and top, costs have been up to 40 per cent less than where full burning has been done.

The cost of burning may not be apparent in the private sector when merchants have been required to burn lop and top as one of the customary conditions of purchase of standing trees.

SECTION 11

DAMAGE TO FORESTS IN RELATION TO TOPOGRAPHY, SOIL AND CROPS

By S. A. NEUSTEIN

Forestry Commission

Introduction

The earliest reports indicated that this gale had many features which might enable one to study the effects of topography on the extent and distribution of damage. The gale was thought to have been sufficiently strong to mask variations in tree resistance which might have been due to soil differences and, because of its steadiness in speed and direction; it was hoped that the pattern of damage might therefore reflect the effects of topography sufficiently to suggest qualitative guidelines for future planning. Unlike the gale of 1953 in North-east Scotland much of its path traversed a mountainous region in which topographic variation might have been expected to influence the pattern of damage.

Methods of Investigation

At a preliminary meeting of the Forestry Commission's Research Division staff it was decided that the main topic of study would be the effect of topography on the distribution of damage.

On the assumption that clearance of timber would proceed rapidly, a ground survey at selected forests would concentrate on recording those features of crop damage which would be obliterated by the removal of damaged timber.

At each of the forests listed on page 44 all windthrown areas were roughly mapped, inspected and described in terms of terrain and crop factors. Maps showing approximate location of damage were obtained from the responsible Conservators.

These ground surveys suffered from several severe limitations. Firstly because of the virtually inaccessible tangle of uprooted trees most of the assessment had to be carried out from the margins of the damaged areas. The conditions at the margins in terms of tree height, direction of fall and soil may not have been typical of the area as a whole, and indeed these very conditions may have been the cause of restricting the damage on many sites. Secondly, there was a strong subjective element in the assessment and as several assessors were involved the standard of interpretation of the assessment may be assumed to have varied somewhat. Thirdly, these surveys did not include an appraisal of standing crops; they did not therefore permit analysis of proportions of susceptible crops damaged and, hence, a testing of hypotheses. In spite of these failings, which have been common to many previous surveys, significant factors associated with the windthrow damage could be recognised in the results of this survey; the importance of those factors is better reflected in other forms of survey.

Analysis of Windthrow Notification Cards

Since 1961 the approximate extent and distribution of windthrow in Forestry Commission forests have been recorded by means of notification cards on which each forester has described the location, type and silvicultural background of damage as soon as possible after its occurrence. In West Scotland and East Scotland Conservancies, however, the pressure of events precluded full completion of the cards by local staff and specialist staff assisted in this work. Elsewhere, subsequent ground survey indicated that the cards gave a marked underestimate of the damage.

A full analysis of the national windthrow returns is still in preparation, but an extraction covering the gale of 15 January 1968 is given below.

In total 1,201 cards reporting 10,500 acres (4 250 hectares) of damage were processed. 73 per cent of the damaged area was in West Scotland Conservancy and 16 per cent was in East Scotland Conservancy. South Scotland Conservancy reported 550 acres (220 hectares) and North Scotland and North East England Conservancies each reported approximately 150 acres (60 hectares).

Spruce plantations accounted for 51 per cent of reported damage, but there was no suggestion that a higher proportion of spruce was damaged than of other species.

Only in West Conservancy were extensive areas of unthinned plantations recorded as damaged, and in particular at Carron Valley Forest, several hundred acres of crops which were not yet in the thinning stage were windthrown. It is noteworthy that in West Scotland the percentages of areas of the existing height classes that were damaged rose sharply with increasing height of crop, as the following figures show:

0.04 per cent of the area 0–20 ft (0–6 metres) height class was damaged

2.55 per cent of the area of 21–30 ft (6.5–9.0 metres) height class was damaged

9.79 per cent of the area of 31–40 ft (9.5–12.0 metres) height class was damaged

12.40 per cent of the area of 41–50 ft (12.5–15.0 metres) height class was damaged

20.16 per cent of the area of 50 ft+ (15 metres+) height class was damaged

When compared with analogous figures for Carron Valley Forest (Tables numbers 1 and 2 below) some appreciation of the vulnerability of the latter forest can be gained.

The card survey showed broadly that the gale was not of exceptional severity outside its main path.

Photographic Survey of Selected Forests (see cover pictures, Plates 1–3)

In April 1968 a helicopter was hired for 3¼ hours of flying time and approximately 1,800 acres (730 hectares) of windthrown forest were photographed, mainly to produce colour slides. This was done in mid-Argyll, bringing in the Forests and woods named. Glenbranter, Loch Eck, Benmore, Ballochyle, Glenfinart (part), Loch Goil, Ardgartan, Minard (part) and Asknish, and also the policy or parkland plantations on the Duke of Argyll's estate at Inveraray. The object was to obtain a complete record of damage with emphasis on the direction of fall in relation to topography, and to identify site and crop features associated with starting and stopping points of damage.

Following a satisfactory short-term weather forecast (cloud base 3,000 feet (900 metres) ⅜th cover and winds up to 15 knots (8 m per second)) and the confirmation of emergency landing sites, the Forestry Commission's principal photographer met the writer and the pilot. The fertiliser spinners that had been fitted to the helicopter for its usual work were removed and certain other weight adjustments were made to allow a navigator with maps to sit centrally and a photographer to sit adjacent to the starboard doorway; the door had been removed to allow him to use his camera.

After study of RAF vertical photographs of damage at Tentsmuir Forest in Fife taken at 100–300 feet (30–90 metres) and preliminary tests of visibility from a range of altitudes, an altitude of 900–1,100 feet (270–340 metres) above sea level was chosen. Photographs were taken with a hand-held 35 millimetre camera using Kodachrome X film at angles of sight approximately 60° from vertical. Flight lines had been selected to take photographs in the most effective direction in relation to the sun and to the direction of windthrow, the latter being less clear if windthrown trees were photographed from tip to stump. Pre-determined flight lines were not adhered to consistently as intermittent cloud made deviation preferable to obtain well lit areas rather than those on the pre-arranged path which were often in shadow.

The colour slides were subsequently projected and in association with 1 inch to 1 mile (1: 63,360) Ordnance Survey and forest stock maps the damage was classified into the following topographic categories: flats, funnels; windward slopes; slopes oblique to the wind; lee slopes, peninsulas; bays; ridge tops; and shoulders. In addition, species, apparent causes of start of damage and stopping features, degree of uniformity of tree fall direction, amount of stem break and the effect of roads and rides were recorded.

In September 1969 when most areas had been cleared of windthrown timber, a sample ground survey to incorporate soil variation was undertaken to assess the need for more detailed ground survey and to confirm the conclusions reached up to that date.

Integrated Surveys (i.e. including both damaged and standing crops).

The effect of the gale was surveyed in detail at two forests. At Glendevon (Perthshire and Kinross-shire) two members of the staff of the Forestry Department of Aberdeen University (Messrs. W. H. Parry and J. A. Petty) interpreted the damage from a ground survey. Maximum wind speed for this area is estimated to have been approximately 110 knots (55 m per second) at 40 feet (12 metres) above ground level at 1,000 feet (305 metres) elevation. Fifty sample plots were sited at random on a grid basis. At each sampling point the five nearest trees were assessed in terms of species, age, number of trees thrown or snapped (and height of breakage) and mean height, quarter girth, direction of fall, rooting depth and ground slope. Maps and overlays were subsequently prepared to show the overall pattern of damage in relation to topography, tree height and soil.

At Carron Valley Forest the direction of fall of practically all single trees and small clumps of woodland in an area to the west of the forest were mapped to determine local gale direction before it was affected by the topography of the forest itself. Thereafter a map showing topographically susceptible locations was prepared (c.f. Hütte, 1967) and finally damage was mapped and correlated with land form, species and soil type.

Results of Investigations

The photographic survey using a helicopter was the most illuminating of those which were concerned only with damaged crops. The oblique nature of the photographs made them unsuitable for mapping, but on the other hand it was particularly helpful in showing land relief. Investigations using a range of

Forests (*Forestry Commission except in Dunbartonshire and Stirlingshire*).	*County*	*Remarks*
Ae	Dumfriesshire	The gale had mainly extended previously windthrown areas in easterly and south-easterly directions.
Ardgartan	Argyll	Subsequently aerially photographed.
Auchenroddan, near Moffat	Dumfriesshire	Mainly extension of previously windthrown areas in east and south-east directions.
Cardrona	Peebles-shire	New patchy damage
Carron Valley	Stirlingshire	Damage was subsequently correlated with soil and elevation. A "Scottish Border type" forest in the main path of the gale, occupying a depression amid the Campsie Fells, at heights of 500–1,200 feet (160–400 metres).
Edgarhope	Berwickshire and Midlothian	Damage associated in part with fungal attack by *Fomes annosus*.
Eredine	Argyll	———
Glentress	Peeblesshire	———
Inverliever	Argyll	———
Inverinan	Argyll	———
See remarks in right-hand column	Dunbartonshire and Stirlingshire	Five privately owned forests and one Forestry Commission area (Lennox, Garadhban Forest) subsequently studied by Mr A. Caddel, Geography Department, Strathclyde University for an M.Sc. thesis.

other aerial photographic techniques with more elaborate equipment are now in hand.

Most of the damage could be attributed variously to topographic and to assumed soil factors but it would be untrue to say that the logic of the damage pattern was wholly clear from a bird's eye view. It was often impossible to determine why crops in apparently equally susceptible sites had escaped damage other than by attributing this to the vagaries of the wind.

At Knapdale Forest damage was predominantly influenced by topography. Windward slopes, oblique slopes and ridge tops were most susceptible. There was very little lee-side damage. Windthrow affected mainly stands of more than 50 feet (15.2 metres) top height and the average tree volume was 7 hoppus feet (0.25 cubic metres). Very steep windward slopes (35°–40°) escaped damage even when the tree height was above 50 feet (15.2 metres). Subsequent assessment of slope gradients which was carried out by Conservancy staff for the purpose of setting piece work rates for harvesting showed that no damaged crops occurred on gradients exceeding 30°. A possible explanation is the development of so called "back pressure" on such windward slopes. The soils of damaged areas included surface-water gleys, peaty gleys and flushed basin peats (often associated with funnel features) and also brown earths. The latter were shallow on ridges but elsewhere quite deep (18 ins+ (4.6 centimetres+)). The largest windthrown areas were associated with surface-water gleys in open relief. Soil changes at the leeward edge of clearings where neither topography nor tree height nor change of species could account for cessation of damage were not always predictable. For example, damage stopped on occasion at surface-water gleys and deep peats as well as at better rooted soils. Only vagaries of the wind could account for this. Humus iron podzols on quartzite with crops up to 65 feet (19.8 metres) acted as stops but this only occurred on a minor scale. Hardwoods and larch, which were leafless at the time of the gale, often restricted the extension of damage but there were no other obvious differences in stability which could be attributed to species. The distribution of soil types at Knapdale Forest is complex and a detailed survey would be required to determine the influence of soil on damage, but this is in any case subsidiary to the influence of topography. The virtual absence of sporadic damage or extension since January 1968 suggests that Knapdale is not greatly at risk to anything other than very exceptional gales.

At Inverliever windthrow was also primarily correlated with topography and a small amount of lee-side damage did occur though without evidence of turbulence; i.e. tree fall was generally in one direction. Windthrown areas contained all local soil types; these were brown earths, ironpan soils, surface-water gleys, peaty gleys and flushed deep peats. "Stopping" features were almost invariably associated with reduced tree heights but not with "better" soils. Damage was concentrated on stands exceeding 70 feet (21.3 metres) on surface water gleys and moist brown earths with indurated subsoils. Few crops of 40–50 feet (12.1–15.2 metres) were damaged even when on susceptible soils on windward slopes. Windsnap which locally affected up to 15 per cent of damaged crops was seen on weak ironpan soils particularly, but it also occurred even in large trees on surface-water gleys and intensively drained flushed basin peat. The high degree of accuracy of the first volume estimate of damage at Inverliever as at Knapdale reflected the virtual absence of sporadic damage.

The damaged parts of Glenbranter Forest consisted in large measure of uniform slopes on gley soils in contrast to the more serrated topography of Inverliever and Knapdale. Windthrow occurred in crops of 40–60 feet height (12–18 metres) with associated scattered damage in the standing plantations surrounding the wholly flattened areas. Where weak ironpan soils on convex slopes did not themselves lead to topographically induced damage they either tended to restrict windthrow or were associated with higher amounts of windsnap. It was concluded that future management should accept the possibility that in upper elevations on susceptible soils physical rotations of below 60 feet (18 metres) may have to be accepted, although improved drainage should increase the critical tree height. Further soil survey appears justified to identify areas requiring drainage.

Damage at Loch Eck was more complex due to the fact that its main slopes are steeper and more irregular than at Glenbranter, with consequent alternations of gleys with drier soils on intervening knolls and spurs. Also tree fall direction showed that the forest was subject to the clash of winds from two directions. A main north-westerly stream came down the Loch which struck or alternated with westerly streams which were funnelled through the valleys on the opposite side of the Loch. The result was a patchy distribution of damage with local multi-directional tree fall.

In total 159 separate windthrown areas of various sizes were photographed. 45 per cent of these were on windward slopes or on slopes oblique to the wind and 32 per cent were associated with funnels and ridge tops. Only 6 per cent were on lee slopes and the remaining 7 per cent were on flats, peninsulas and bays.

Although this study was confined to damaged areas only, it appeared that on this occasion at least

lee slopes had been much less susceptible to windthrow than the literature on the subject suggests. Only at Ardgartan was there significant lee-side damage and even here it was a small proportion of the total. A total of 115 starting points of damage were identified on aerial photographs and in 51 per cent of these the cause of damage could be attributed with some certainty. Plantation edges and extensions of previous damage accounted for 25 per cent of occurrences, roads and rides for 14 per cent and 9 per cent originated in crops which were taller than the windward crop e.g. where the latter was hardwood scrub or younger plantations.

In 57 per cent of 133 recorded stopping points the cause of the stop could be identified. 22 per cent were associated with shorter crops, larch and hardwoods, 13 per cent with plantation edges, 11 per cent with roads and rides, and 11 per cent with lee slopes where damage on the windward slope petered out at or near the ridge top.

At Glendevon the ground survey by Aberdeen University staff confirmed the above findings. Here it was thought that three air streams were channelled on to the forest and the areas of most severe damage coincided with areas in which previous gales had weakened the crops. Windthrow was confined almost wholly to the oldest age classes, planted 1938–43 on the previously mentioned topographically susceptible situations. Uni-directional damage on a slight lee slope (6°–7°) illustrated the principle that neither shelter nor turbulence occur on lee slopes of less than about 10°. Norway and Sitka spruce were the main species and no significant difference in their respective stabilities was indicated. Stem snap was rare and it occurred at points between 20 and 45 per cent of total tree height. Soil variation had little influence as rooting was generally shallow due to heavy textured gleys or indurated material at depths ranging from 9–18 inches (22–45 centimetres). An unusual feature in one area was the uprooting of the edge row of trees without further encroachment into the wood. This runs counter to the more commonly observed greater stability of edge trees. As a plough furrow along the forest edge prevented root extension and development in the open, the instability of these trees was probably caused by the absence of roots to windward. It is unfortunate that the extensive programme of drainage at Glendevon which had been applied to soils supporting thicket stage crops in the 1950's was confined almost wholly to eastern aspects.

The survey of wind direction as reflected by thrown trees to the west of Carron Valley indicated that the main west south-west air stream was split by the escarpment of the Fintry Hills and part was deflected about 48° to west north-west and thereafter hit Carron Valley along the Upper Endrick Valley. A valley which branched off the main airstream at 90° was too oblique to cause much diversion of the wind. At the forest itself a total of 818 acres (364 hectares) of windthrow was recorded of which 85 per cent was on mapped gley and peat soils and 15 per cent on brown earths and peaty ironpan soil. Table 10 shows percentage of height classes of damaged crops on these soil types.

It can be seen that there was some soil-induced difference in shorter crops, but it is relevant that the dark coloured basaltic parent material of most of the soils makes the differentiation of intergrades between gleys and brown earths particularly difficult. Also indurated material (not mapped) which occurred at varying depths reduced the normally better rooting in the brown earths and ironpan soils. Hence one can conclude no more than that the distribution of the windthrow masked the differences in soils.

TABLE 10

PERCENTAGE OF CROPS WINDTHROWN IN RELATION TO TREE HEIGHT AND SOIL TYPE AT CARRON VALLEY FOREST

Tree Height Class	0–15 feet (0–4.5 Metres)	16–20 feet (4.5–6.0 Metres)	21–25 feet (6.5–7.0 Metres)	26–30 feet (7.5–9.0 Metres)	31–35 feet (9.5–10.0 Metres)	36–40 feet (10.5–12.0 Metres)	41–45 feet (12.5–13.5 Metres)
Percentage of Crop Windthrown on—gley/peat soils	0.7%	0.3%	11%	52%	49%	62%	14%
Ironpan Soils & Brown Earths	0.8%	Nil	7%	37%	51%	70%	Nil

TABLE 11

CLASSIFICATION OF CROPS AND PERCENTAGE WINDTHROWN IN RELATION TO TREE HEIGHT AND ELEVATION

Tree Height Classes	0–15 feet (0–4.5 Metres)	16–20 feet (5.0–6.0 Metres)	21–25 feet (6.5–7.0 Metres)	26–30 feet (7.5–9.0 Metres)	31–35 feet (9.5–10.0 Metres)	36–40 feet (10.5–12.0 Metres)	41–45 feet (12.5–13.5 Metres)
Area of Crops above 1,000 feet (305 metres)	*In acres*						
	1,477	155	123	243	259	74	Nil
	In hectares						
	596	63	50	98	105	30	Nil
Percentage windthrown	0.6%	Nil	32%	63%	56%	72%	Nil
Area of Crops below 1,000 feet (305 metres)	*In acres*						
	1,456	622	573	285	465	101	12
	In hectares						
	590	251	232	115	187	41	5
Percentage windthrown	0.7%	0.3%	5%	39%	45%	57%	8%

Table 11 classifies the distribution of windthrow in respect of elevation. If the tallest tree height class, which is hardly represented, is excluded there is a clear indication that risk in such a catastrophic gale increases with tree height and with elevation. Those are the main bases used for mapping susceptibility of crops to windthrow in the Border forests which grow under endemic windthrow conditions. The only areas of Carron Valley forest which had been thinned were too small to have had any effect on the pattern of damage.

The attempt to apply Hütte's (*ibid.*) identification of high-risk locations was not successful in that the large majority of so called potential starting points of damage were included within widespread windthrow. It was concluded that this classification, though of value in more serrated topography, has less merit in smoother relief.

Summary and Conclusions

After the gale the influence of topography and site on the extent and distribution of damage was investigated on a sample of affected forests by means of various survey methods, namely ground surveys of damage with and without associated appraisal of undamaged crops, a questionnaire, and oblique colour photographs.

The following conclusions were drawn:

(a) Methodology

All the surveys which did not include undamaged crops are basically weak. It is equally important to explain survival of crops which did not suffer windthrow when attempting to understand the causes and the pattern of damage. Where the surveys were unsupported by careful local investigations (e.g. the notification cards) they give only an incomplete picture of the causes of damage.

Aerial survey was rapid, effective and illuminating. Although for the purpose of this investigation oblique photography was suitable, vertical photography would have permitted accurate mapping and quantification; recent enquiries have shown that this could be easily arranged on future occasions. Hence, if staff are not available for ground survey and if common standards of accuracy are required, aerial photography should be seriously considered.

The value of an aerial view of the forest for general management purposes was also noted. The extent and distribution of poorly growing crops was evident from photography in a way that neither tabulated yield class figures nor a ground traverse could convey. The scope for using aerial photography of various kinds is now being investigated further.

(b) Pattern of Damage

In the more mountainous western forests windthrow was mainly influenced by topography. The most

common positions of damage were windward and oblique slopes, funnels, and ridges. Lee-side damage, though frequently mentioned in foreign literature, was very rare. Hence as most gales in Britain are westerly most silvicultural attention should be given to westerly aspects in such matters as drainage intensity and thinning policy in relation to crop stability. It may be of value, at least in some areas, to classify windthrow hazard in the following terms:

High Hazard. Funnel features open to south-west, west or north-west with surface-water gley and peat soils. Upper windward slopes open from south-west to north-west with similar wet soils.

Moderate Hazard. Windward or oblique slopes open to south-west, west or north-west with surface-water gleys and peaty gleys. Ridge tops having shallow brown earths.

Low Hazard. Very steep western aspects, all eastern aspects, windward slopes with deep brown earths even if they are open from south-west to north-west.

However, such a broad classification should not be expected to be accurate when applied to areas as small as individual compartments as slight changes in general wind direction may be markedly affected by topography.

In the smoother topography of the central and eastern spruce forests (Carron Valley, Blairadam, and the Lennox Castle block of Garadhban Forest) damage was more extensive with a larger proportion of damage distributed through those crops which remained standing. These forests also suffered more damage from subsequent less strong gales. An important lesson is that shallow-rooted crops in rolling opography are particularly vulnerable.

Within the main path of the gale variations in soil did not play a dominant role. Windthrow, and, to a lesser extent, windsnap occurred on all soil types. Rooting depth of thrown trees was generally inadequate and this was due either to water-logging or, on the drier soils, to induration. Adequate soil maps were not available to derive a quantitative correlation between soil and damage. However, the largest areas of damage were associated with wet soils.

Windsnap, even when apparently widespread at first sight, rarely affected more than 15 per cent of the damaged crop. Its occurrence was only partially associated with soil type, and other factors presumably associated with tree form and wind structure are involved.

Hardwood scrub and larch were leafless at the date of the gale; they often limited the extension of damage especially when they were associated with deeper soils. Adjacent shorter conifer crops which were below the critical tree height for the site in question also did so. The use of wind-firm belts justifies consideration under certain conditions but as they are not appropriate in areas of uniformly high susceptibility (e.g. in Carron Valley where they would serve simply to fractionate damage) and in serrated topography where aspect, soil and uneven tree growth already provide adequate irregularity, the scope for their use appears more limited in this country than continental experience might suggest.

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SECTION 12

SUMMARY OF MAIN CONCLUSIONS

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Forestry Commission

Editor

The Windthrow was Costly

In designing this report the Windblow Action Group had hoped to include an estimate of the ultimate cost of the damage caused by the gale. The Group has since recognised that this is not practicable because there are too many unanswered related questions about such matters as, for example, insurance cover, estate duty relief, and the cost of restraining felling in forests unaffected by the windthrow; the same might be said about the possible value of the few benefits that the windthrow brought, such as the early opportunities of improving the investment when replanting.

The Spirit of Co-operation

It is certain that the damage was costly both to private woodland owners and to the Forestry Commission.

It is equally certain that the costs of clearance and of marketing would have been much higher without the individual and collective efforts of members of the Windblow Action Group and of the organisations that its members represented. The goodwill and enthusiastic co-operation which characterised the spontaneous and sustained response to a serious emergency were of the greatest value in promoting good organisation, communication and understanding and in developing the will and the determination to work together to clear the windthrow effectively, to minimise the loss, and to repair the damage. Surely this spirit will continue long after the windthrow is forgotten. A model now exists to guide those who may have to deal with any future comparable emergency.

The Scottish Woodland Owners' Association as well as the Home Timber Merchants' Association of Scotland provided an effective communication network because they represented the private owners and the merchants respectively; without their readily available knowledge and the co-operative resources of their members it is certain that the Windblow Action Group could not have deliberated or advised with such confidence and such speed; its advice could not have been translated so effectively into action and the emergency would not have been dealt with so effectively. These organisations also provided an effective means of winning the co-operation of those woodland owners and timber merchants who, though not directly affected by the gale, exercised helpful restraint in deferring their own planned felling.

One important conclusion is therefore that, in times of disaster, well established co-operative organisations can be of immense value. Owners might regard membership of a forestry co-operative, and timber merchants might regard membership of their trade association, as important insurance investments to help them and others to deal with such emergencies.

Effect on Confidence in the Future of Forestry

Windthrown forests are a depressing sight. Gale damage can bring a despondent lack of confidence in the future of forestry. The Windblow Action Group and the represented organisations successfully countered such effects. Foresters, growers and merchants who co-operated in dealing with the problems arising from this gale, have developed a more confident appraisal of their ability to deal with any comparable future emergency.

Value of Surveys

Surveys of the extent and nature of damage are an essential prelude to advice on, or action to deal with, severe gale damage. Appreciation of this need and the knowledge that thorough survey is intended will themselves be of value in restraining owners from taking panic measures such as trying to be first to sell.

Experience gained on this occasion demonstrated that in intensively managed plantations reasonably accurate estimates of area and of volume of damaged timber can be rapidly obtained to allow broad planning to proceed.

Local staff may make these estimates from ground surveys; or aerial photography, even of a quite simple kind, could be used in conjunction with existing forest stock maps.

Where the surveys are intended to be used to understand the distribution of damage, or to attempt to explain why certain crops are more vulnerable than others, aerial photographs of both standing and damaged crops are particularly valuable.

The distribution of damage resulting from this very severe gale was dominated by local topography.

Although soil differences appear to have played a subsidiary role this does not detract from the value of thorough soil surveys which will help, not only in predicting the proneness of existing tree crops to windthrow from lesser gales, but also in identifying those sites where there is a prospect of improving the physical properties of the soil to provide better rooting for trees.

Need for Continuing Research

Site surveys (see above) will also provide a basis for future research. It is reasonable to conclude that research must continue into ways of predicting, with greater certainty, the proneness of forest crops to windthrow and, even more important, into improved ways of growing more windfirm crops. It might be suggested that windfirmness will lead to more windbreak in a severe gale; windbreak usually appears more serious in extent than it is in fact, and only a small proportion of trees were windsnapped compared with those that were windthrown.

Questions have been raised as to whether or not severe frosts which occurred three or four weeks before the gale, together with the considerable rainfall, contributed to the severity of the damage. Too little is known about these factors to apportion their effects in relation to other environmental factors. High winds affected the greater part of Scotland; one feature which distinguished the central belt of Scotland, where most of the damage occurred, was the duration of winds at speeds above 55 knots (101 km per hour) for more than 6 hours.

The Importance of the Windblow Action Group Being Constituted as a Sub-committee of the Home Grown Timber Advisory Committee

The arrangements whereby the Windblow Action Group became a short-term sub-committee of the Home Grown Timber Advisory Committee worked extremely smoothly and effectively. This provides a sound precedent for any future disaster.

The Importance of Scientific Help

The importance of having the help of a small scientific team has been stressed. For any future occasion it will be important to have a forest entomologist and a forest pathologist to assess the threats from insects and disease and then to advise on the urgency and priorities for harvesting and on the protective measures to be observed in harvesting and in restocking, as well as to monitor the changing nature of such matters throughout.

Fire Risk

One further point deserves mention because it is not referred to in the report. It is often thought that the danger from forest fires will present particular problems when large areas are windthrown. While usual care was always exercised during the clearance of the windthrown trees no particular problems were encountered and no losses from fire were reported that were attributed to conditions resulting from windthrow, despite the fact that the summers of 1968 and 1969 were particularly dry.

Use Known Machines and Methods—but Encourage Improvisation

Emergency operations to harvest windthrow do not provide practical opportunities for using untried expensive machines. Reliable and known machines should be used. At the same time such conditions provide good opportunities for effective improvisation which should be encouraged.

Transport Allowances

The various transport allowances were effective. With their help the windthrown timber was marketed without too serious a depression of prices which might otherwise have resulted from over-supply to nearer markets, and without consequent loss from deterioration of wood.

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GLOSSARY

BROWN EARTHS. Brown earths are freely drained soils with brownish colours throughout the soil profile and with merging boundaries between the different soil horizons.

CRITICAL TREE HEIGHT. The top height of a tree crop at which significant windthrow occurs or is expected to occur. Critical height is dependent on hazard and is determined from experience which might include "tree pulling" when the forces necessary to pull sample trees over mechanically are assessed experimentally.

GALE. The well known Beaufort Scale of windspeeds was prepared to describe winds and associated conditions at sea. This scale is not suitable for describing winds on land. The Meteorological Office described the winds that blew in the early hours of the morning of the 15 January 1968 as a very severe gale. Throughout this report the word "gale" or the expression "severe gale" should be regarded as being synonymous with that description.

GEOSTROPHIC. In non-technical terms a geostrophic wind might be regarded as a wind that flows at such altitude that its theoretic speed is unaffected by physical features of the earth's surface. Over level ground the calculated geostrophic wind speed is normally a close approximation to the wind at some 450 to 600 metres above the ground.

GLEYS AND SURFACE WATER GLEYS. These are soils which are developed under conditions of poor drainage, often on sites which are generally concave; the poor drainage results in reduction of iron and other elements and it gives the soil profile grey colours and mottled effects.

HAZARD. See "Windthrow hazard" below.

HOPPUS FOOT. The hoppus foot is the traditional British unit of volume for measuring roundwood (logs and billets) and is equivalent to 1.273 cubic feet; there are 27.73 hoppus feet to 1 cubic metre. In February 1971 the cubic metre became the standard unit of volume for both round and sawn wood in Britain.

IRONPAN. An indurated soil horizon in which iron oxide is the principal cementing agent; an ironpan soil is a soil containing such an indurated horizon.

INTERGRADE SOILS. In references to British forest soils, intergrade soils denote soils that are intermediate in structure and properties between brown earths and ironpan soils.

ISOBAR. An isobar is a line drawn on a map to connect points on the earth's surface where the barometric pressure is the same at a given point in time.

LEE SLOPE. A slope exceeding 10 degrees from horizontal on the lee side of a topographic obstruction to the wind.

MILLWOOD. Roundwood suitable for sawmilling, or for conversion by cross-cutting into sawlogs that would then be suitable for sawmilling. Such logs were described as being of 7 inches (18 cm) minimum top diameter over bark and of 10 feet (3 m) minimum length.

PRESSURE GRADIENT. The rate of change of atmospheric pressure with distance, measured normal to the isobars.

RISK. A tree crop is at risk from windthrow when its trees have reached critical height (q.v.).

SMALL ROUNDWOOD. Roundwood of less than 7 inches (18 cm) minimum top diameter over bark.

SYNOPTIC. In meteorology, refers to concurrent weather elements, usually charted, used to obtain a bird's eye view of the weather for forecasting developments.

WINDBLOW. This expression is used only for the title of the Windblow Action Group and for the title of this report; elsewhere in the report the word "windthrow" (see below) has been used.

WINDTHROW. Windthrow is used to describe the wind's action in uprooting trees, or in blowing trees over so that they lift their roots, or a large part of their roots, out of the ground. Unless otherwise made clear in the context of use, the expression "windthrown trees" includes trees whose stems have been snapped (see Windsnap below).

WINDTHROW HAZARD. Hazard is a property of the site. It is determined by relative exposure and rooting conditions (i.e. by soil type and depth). The soil conditions may, of course, be affected by treatment and may vary seasonally, e.g. in moisture content.

WINDSNAP. The action of the wind in breaking the stem of the tree, whose roots may or may not remain firmly in the ground.

CONVERSION FACTORS

The following conversion factors have been used. They have been taken from Forestry Commission Booklet No. 30, *Metric Conversion Tables and Factors for Forestry* (HMSO, 1971, 50p). After converting measures from imperial to metric figures a good deal of rounding has been done in the text, tables and graphs of the report merely to avoid giving false impressions of precision; in some cases the conversion factors were rounded before use to one decimal place.

Length

Inches to centimetres: 1 inch = 2.54 centimetres
Feet to metres: 1 foot = 0.30481 metres.
Yards to metres: 1 yard = 0.914399 metres
Miles to kilometres: 1 mile = 1.60934 kilometres.

Area

Acres to hectares: 1 acre = 0.404685 hectares
Square miles to square kilometres: 1 square mile = 2.58998 square kilometres
Square miles to hectares: 1 square mile = 258.998 hectares.

Volume

hoppus feet to cubic metres: 1 hoppus foot = 0.036540 cubic metres
(See glossary for hoppus foot
Volume per acre to volume per hectare
1 hoppus foot of wood per acre = 0.0890520 cubic metres per hectare.

Weight

long tons of 2,240 lb to tonnes of 1 000 kilogrammes:
1 ton = 1.01605 tonnes.

Volume/Weight

Wood transported in the early stages of the windthrow clearance was nearly fresh felled and was reckoned to measure about 30 hoppus feet to a ton (about 1.08 cubic metres to a tonne). Later some wood was transported in drier condition at about 40 hoppus feet to a ton (about 1.45 cubic metres to a tonne). A notional weighted mean figure of 33 hoppus feet to a ton (1.17 cubic metres to a tonne) has been used in this report.

Speed

Miles per hour to kilometres per hour:
1 mile per hour = 1.60934 kilometres per hour
Knots (of 6,080 feet per hour) to miles per hour:
1 knot = 1.1515 miles per hour.

Printed in Scotland for Her Majesty's Stationery Office
by Bell & Bain Ltd., Glasgow. Dd. 131941/2960 K32.

Published by
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