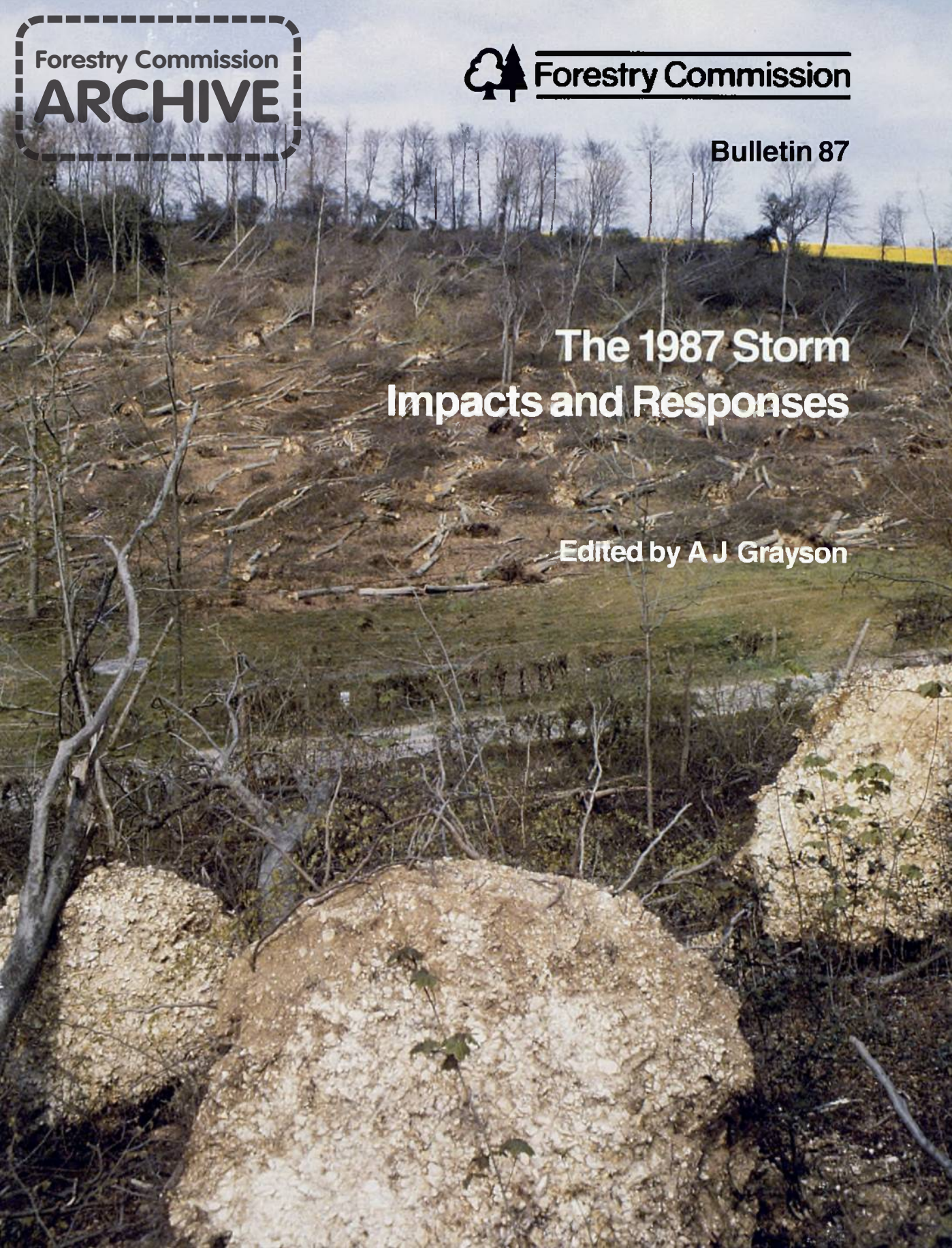
Forestry Commission

Bulletin 87

# The 1987 Storm
# Impacts and Responses

Edited by A J Grayson



*FORESTRY COMMISSION BULLETIN 87*

# The 1987 Storm: Impacts and Responses

*Edited by A. J. Grayson,* CBE
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**Front cover:**
Rootplates of blown beech on the chalk at West Dean Estate, West Sussex.
*(38087)*

# Contents

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# Preface

***G. J. Francis,*** *Director General of the Forestry Commission*

It is an occasional feature of our windy oceanic climate that Britain suffers storms that cause damage to woodlands and forests on a catastrophic scale. The gale that struck south-east England in the early hours of 16 October 1987 caused the worst damage to trees ever recorded in this country. An estimated 15 million trees were blown down, representing 3.9 million cubic metres of timber. This volume almost equals the total of the three previous major storms which occurred in January 1953 (in north-east Scotland), in January 1968 (in the west Highlands and the central belt of Scotland) and in January 1976 (in Wales, the Midlands and East Anglia) which together blew down an estimated 4.1 million cubic metres of timber. Not only was the storm of October 1987 unique for the sheer volume of timber blown down, but it occurred in a highly populated part of the country and in one not noted for its extremes of climate. The quality of the landscape of south-east England owes much to its mature trees, and the loss of so many of them on the 16 October had a devastating effect on the appearance and beauty of the countryside.

While the safety of human life and communications were the dominant concerns in the immediate aftermath of the storm, it soon became apparent that the damage to trees and woodlands was on an unprecedented scale, and that a major initiative would be needed to determine the full extent of the damage and the means of tackling it. This would require a concerted effort by forest owners and the timber trade. Guided by its experience of previous storms, the Forestry Commission established a Forest Windblow Action Committee and Mr John Goodwin, then Managing Director of the St Regis Paper Company, agreed to act as Chairman. The members of the Committee were Mrs Penny Greenwood, representing Timber Growers (UK), Mr Gordon Waugh, representing the British Timber Merchants' Association (England and Wales) and Mr Steve Quigley of the Forestry Commission. The Committee was set up within a week or so of the storm and, in a short space of time, did sterling work in bringing together the various industry interests, and producing a most valuable report on the scale of the damage and the resources needed to tackle it. The Committee was ably supported by a number of working groups which also drew their membership from growers' interests and the timber trade.

The very first objective of the Committee was to ascertain the scale of the damage, no easy task when the damage was spread across seven counties and many of the woodlands were totally inaccessible with fallen trees across roads and rides. The Committee's estimates of damage were published on 16 November 1987, just one month after the storm. The exercise was largely carried out by the Forest Survey

Branch of the Forestry Commission, using a ground survey based on sample strips recorded in the 1980 census of woodlands and trees, supplemented by some more detailed aerial surveys and ground surveys carried out in individual private estates and Forestry Commission forests. It was a feature of the storm that over 70% of the damage occurred in private woodlands and farms, involving thousands of individual ownerships.

It was also decided to set up a Task Force to serve as the Committee's agents and in particular to collate and distribute information on a wide range of subjects such as clearance priorities, the availability of harvesting contractors, safety, merchants and markets. This was based at Alice Holt Lodge and was led by Mr Jim Dewar. Over the first 4 months after the storm, over 1500 individual enquiries were dealt with. The role of the Commission's Research Division in providing information to the Task Force and advice to forest owners also deserves special mention. It was gratifying that the Agriculture Committee of the House of Commons, which investigated the storm and reported in February 1988, specifically commended the quality of the Commission's technical assistance made available to woodland owners and farmers.

At the time of writing (August 1989), some 65% of the windblown area had been cleared. It is expected that the bulk of the marketable timber will have been cleared by the end of 1989, and that over the succeeding 3 or 4 years, the greater part of the area damaged will be fully restocked in private and Commission forests. A sad legacy of this storm will be some significant areas of wind damaged broadleaved stands which, for a variety of reasons, cannot be cleared and restored profitably by their owners. Despite this, it is hoped that many of these will eventually return to woodland. A major lesson from the storm is the desirability of managing the tree stock to create a more balanced age structure, thus avoiding a preponderance of overmature trees – an objective which will enhance both their landscape value and productivity, as well as reducing the impact of any future storm.

All parts of the forest industry have shown their resourcefulness and adaptability in dealing with the effects of this most unusual event. However, much remains to be done, and the full story of the work of clearance and restoration will not be told until perhaps 1992. It is nevertheless timely that we should publish this account of the storm of 1987 now that the main initiatives and operations have been put in place.

In conclusion, I would like to pay tribute to the energy and dedication of all the members of the Action Committee and to the Task Force as well as all those who supported them. It was due to their experience, determination and initiative that so much has been accomplished. A special tribute is due to Mr John Goodwin for his invaluable work as Chairman of the Action Committee.

# The 1987 Storm

## *Summary*

The storm which struck south-east England on the night of 15/16 October 1987 was the worst in the region since 1703: it caused more damage to woodlands and trees than any other recorded gale in Britain. Some 4 million cubic metres of timber were blown, equivalent to about 5 years' cut in the seven worst affected counties. Broadleaved trees predominated and 72% of the damage occurred to privately owned woodlands and trees. The Forestry Commission set up a Forest Windblow Action Committee shortly after the storm for the purpose of assessing the damage, advising on the clearance and marketing of timber and recommending any action considered appropriate. A major concern was the potential degrade of logs left unharvested. Losses in value from this cause have not been as high as originally feared. Supplies of wood in other parts of the country were held back and many contractors moved teams into the affected region. Clearance of some 65% of the blown volume had been achieved by June 1989. However, some trees of lower value species or smaller sizes and in inaccessible sites are likely never to be cleared. Supplements to the Forestry Commission's normal planting grants were made available for replanting blown woodlands. In addition, £9 millions were provided for restoration of non-woodland trees over 3 years. Useful lessons were learnt on the way to deal with such emergencies, including the value of a focal point for information and advice. In the south-east, it is clear that a wider range of tree ages in the growing stock would have reduced the scale of the catastrophe.

# L'orage de 1987

## *Sommaire*

L'orage qui a éclaté dans le sud-est de l'Angleterre la nuit du 15/16 octobre était le pire dans la région depuis 1703. Il a causé plus de dégâts aux bois et aux arbres que tout autre orage enregistré en Grande-Bretagne. Quelque 4 millions mètres cubes de bois ont été renversés, ce qui équivaut à une coupe de 5 ans dans les sept comtés les plus gravement atteints. Les feuillus prédominaient et les bois et les arbres privés ont reçu 72% des dégâts. La Forestry Commission a assemblé un conseil (Forest Windblow Action Committee) court après l'orage pour évaluer les dégâts, pour renseigner sur la

récolte et la vente du bois et pour recommander toute action convenable. La diminution de valeur du bois non pas encore emporté était d'une importance capitale. La dépréciation à cause de cela n'a pas été aussi grande qu'on avait d'abord estimé. La provision de bois dans d'autres régions du pays a été supprimée et nombre d'entrepreneurs ont envoyé des équipes dans la région atteinte. On avait récolté environ 65% du volume endommagé dès juin 1989. D'ailleurs, il est peu probable qu'on puisse récolter les arbres plus petits ou d'espèce de moindre valeur ou dans les lieux inaccessibles. On a accordé des supplements aux subventions de plantation normales de la Forestry Commission pour la replantation des bois endommagés. En outre, £9 millions ont été pourvus pendant 3 ans pour le rétablissement des arbres isolés. On a dégagé en route des leçons utiles à propos de la réponse aux tels cas d'urgence, aussi l'importance d'un point central pour les informations et les conseils. Dans le sud-est il est évident qu'une variété plus grande dans l'âge des arbres représentés aurait réduit l'étendue du désastre.

# Der Sturm von 1987

## *Zusammenfassung*

Der Sturm, der in der Nacht des 15/16 Oktobers 1987 Südostengland durchstrich, war der schlimmste in der Region seit 1703: Er richtete Wäldern und Bäumen mehr Schaden an, als alle anderen eingetragenen Stürme in Grossbritannien. Etwa 4 Millionen Kubikmeter Holz wurden verherrt, was in den 7 meistbeschädigten Grafschaften dem Abtrieb von etwa 5 Jahren entspricht. Vorherrschend wurde Laubholz beschädigt, 72% der Beschädigung nahmen Privatwald und -bäume. Kurz nach dem Sturm beauftragte die Forestry Commission einen Forststurmnotausschuss, um die Beschädigung einzuschätzen, als Berater für Räumung und Verkauf des Holzes und um geeignete Massnahmen zu empfehlen. Ein dringendes Problem war der mögliche Wertverlust bei nicht abgeführtem Holz. Wertverlust aus diesem Grunde ist aber nicht so hoch gewesen, wie man es zuerst befürchtet hat. Holzlieferung in anderen Regionen wurde zurückgehalten und viele Unternehmer versetzten Belegschaften nach der Sturmregion. Bis Juni 1989 war etwa 65% des gefällten Holzes geräumt worden. Manche kleinere Bäume oder Arten mindereren Wertes jedoch, die auch unerreichbar sind, werden wahrscheinlich nie abgeführt werden. Zuschläge zu den Subventionen der Forestry Commission wurden für das Wiederherstellen gefällter Wälder zur Verfügung gestellt; während 3 Jahre wurden £9 Millionen gegeben, um Einzelbäume zu räumen und wiederherzustellen. Inzwischen offenbarten sich viele praktische Hinweise, wie solche Notfälle zu behandeln sind, einschliesslich der Wichtigkeit eines Brennpunkts für Informationen und Rat. Im Südosten ist es klar, dass eine breitere Vielfältigkeit im Alter der Holzvorräte den Umfang der Katastrophe verringert hätte.

# Chapter 1
# Introduction

For a country in middle latitudes, Britain's climate is a particularly windy one. Foresters are accustomed to the problems that attend this characteristic and make the necessary adjustments to their silviculture and arboriculture to meet the prevailing conditions. The occasion of a storm with winds gusting at over 80 knots (148 km per hour) is however a different matter. Few trees, though well grown and suitably sited, can withstand such forces; fortunately the expected frequency of these events in a particular part of the country is low. There have been four such storms in Britain in the past four decades: their zones of influence are shown in Figure 4. This history of storms is no guide to what may happen in a region such as the south-east of England. There have been none of equal severity in the Home Counties since Daniel Defoe capitalised on that of 1703 by recording the experiences of those who suffered in the great gale of that year (Hill, 1989).

As manager of the country's Forestry Enterprise and as Britain's Forestry Authority, the Forestry Commission has accumulated valuable experience of the planning and management needed to deal with the havoc created by catastrophic storms. Each event has its special features. This Bulletin provides a record of policy, operational, biological and technical points revealed by or learned as a result of the early morning of 16 October 1987 and its effects.

The storm had at least three unusual features by forestry standards. The first is that it occurred in a densely populated region of the country. It caught the attention of millions whose home life (3 million householders and businesses were without electricity at the peak of the power cuts), travel (no trains at all ran on Southern Region of British Rail on the morning of 16 October) and work it disrupted. More important, and well explored and exploited by the media, the public and hence political interest in the disaster was the higher because it happened in and around the capital. Perhaps no environmental disaster, domestic or foreign, since the 1953 floods along the Essex coast, the same event as caused a major windblow in east Scotland, has so hit the headlines. Secondly, in contrast to the three previous storms which caused major forest damage, the 1987 storm caused relatively and absolutely much more destruction of private woodlands and trees, urban and rural, than of Forestry Commission woods. The proportion of broadleaves blown or damaged was high. In the third place the potential technical and biological problems, notably of availability of harvesting teams and the chance of degrade, represented unknowns. In the event, these worries were not as troublesome as initially foreseen and market forces assisted by judicious arrangements for informing owners about markets and contractors proved effective.

This Bulletin chronicles the meteorological events (Chapter 2), records the nature and scale of damage done (Chapter 3), the administrative action taken by the Forestry Commission, other central government departments and local authorities (Chapter 4) and describes the clearance work (Chapter 5). In Chapter 6, a number of more purely biological matters concerning timber degrade and its avoidance are reported, while Chapter 7 discusses restocking. In publishing this record of 2 years of activity since the storm the Commission recognises that the restocking story cannot be told; that assessment will have to wait several years. Chapter 8

discusses lessons of this storm in terms of two particular aspects, one the clearance of blown trees, the other the implications for long-term management.

The damage wrought by the gale was severe; and the loss of particular features the most lasting effect. But the fears of those who thought of the Passchendaele appearance of their woods as if the damage was irreparable proved exaggerated.

**Chapter 2**

# Description of the Storm and Comparison with Other Storms

## *General meteorology*

The catastrophic damage to woodlands and trees on the night of 15/16 October 1987 was caused by exceptionally strong winds associated with the passage of a depression across southern Britain. The depression developed to the west of Spain and was one of a series of low centres to run north-eastwards across the Bay of Biscay. There was a pronounced polar front along which these lows formed with major temperature contrasts between the cold northerly airflow and the warm, moist southerly airflow (Burt and Mansfield, 1988). There are indications from satellite and other data that at least part of this warm airmass may have originated in the remnants of hurricane Floyd off the Florida coast a number of days before (Hoskins and Berrisford, 1988). A strong thermal gradient was also apparent in sea surface temperatures in the eastern Atlantic and this will have contributed to the storm intensification (Namias, 1989).

The depression that caused the dramatic damage to south-east England originated in the same sea area as other lows in the preceding days but deepened much more vigorously and tracked further north and east. The situation proved very difficult to forecast accurately, particularly given the lack of observations in the crucial sea areas, and led to criticism of the British Meteorological Office (Houghton *et al.*, 1988; Handmer and Parker, 1989). Official and independent inquiries subsequently refuted many of the wilder allegations (Meteorological Office, 1988; Swinnerton-Dyer and Pearce, 1988).

The depression moved rapidly from west of the Spanish coast (12.00 GMT) on the 15 October 1987, across the Bay of Biscay to reach a position to the north-west of the Brittany coast by 00.00 GMT on the 16 October 1987 (Figure 1). It deepened considerably during this time from 978 mb to 952 mb. The centre of the depression then continued north-eastwards crossing over mainland Britain between Exeter (02.00 GMT) and Hull (05-06.00 GMT), before moving out into the North Sea and deepening once more. Many meteorological stations on the track of the depression recorded a rapid fall in pressure but also an exceptional rise in pressure as the depression moved quickly away to the north-east. The barometric record for the Research Station at Alice Holt, which lay near to the centre track is shown in Figure 2. There was a modest pressure gradient to the north of the depression giving gentle winds but to the south of the depression there was a sector with an extremely strong pressure gradient. It was in this sector, which trailed behind both the cold and warm front, that the particularly strong winds were experienced. The passage of the fronts gave some very marked temperature variations during the night — with first a dramatic rise in temperature [e.g. 9.1 °C in 20 minutes from 21.40 to 22.00 GMT at South Farnborough Meteorological Office (Burt and Mansfield, 1988)] and then a sudden fall.

The sector to the south and south-east of the depression which was associated with the very strong winds lay over Brittany at 00.00 GMT, the Channel and northern Normandy at 03.00, and south-eastern England between 03.00 and 06.00 GMT on the 16 October.

## *Windspeeds experienced*

The windspeeds recorded during the passage of

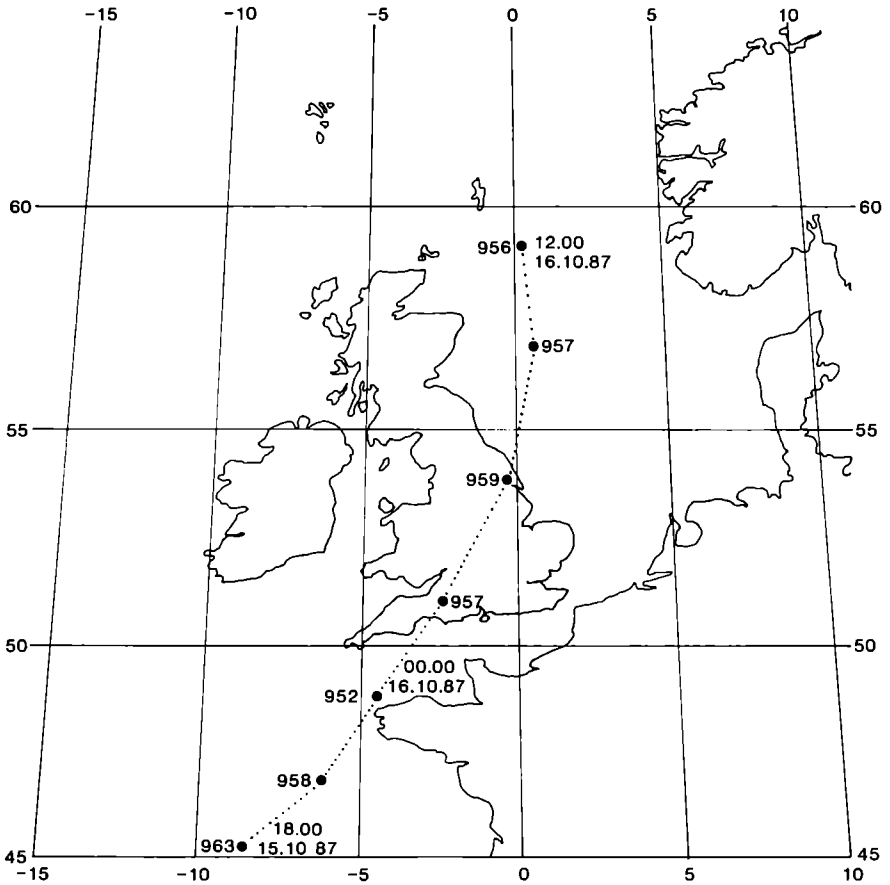



***Figure 1.*** *Passage of centre of depression at 3 hourly intervals. (Pressure in millibars.)*

the storm were noteworthy in national terms and were quite exceptional for south-east England. The storm was not a hurricane, which by definition is a tropical cyclone, but winds of hurricane force 12 on the Beaufort scale (i.e. mean windspeed of 64 knots or more) were experienced at several coastal locations.

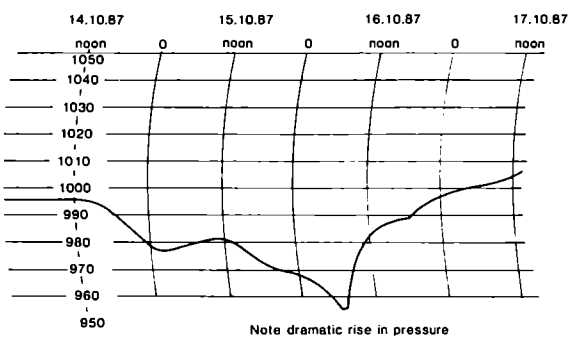



***Figure 2.*** *Barometric pressure variation (millibars) recorded at Alice Holt Research Station, Farnham, Surrey.*

A number of meteorological stations including Langdon Bay, Sheerness, Herstmonceux and Thorney Island recorded gusts in excess of 90 knots (*see footnote*) with the highest verified record being 100 knots (115 mph, 51 $ms^{-1}$) at Shoreham-by-Sea. Maximum mean hourly windspeeds for these stations ranged from 54 to 74 knots. A wide area to the south-east of a line from Southampton to King's Lynn was affected by gusts in excess of 80 knots. There was a very marked fall off in windspeeds to the north and west and gusts exceeding 60 knots were not generally experienced inland to the north of a line from the Wash to Exeter. This can be seen in Figure 3 which compares this storm with two

*Footnote:* To convert knots to mph (× 1.15), to $ms^{-1}$ (× 0.51), to km $h^{-1}$ (× 1.85).

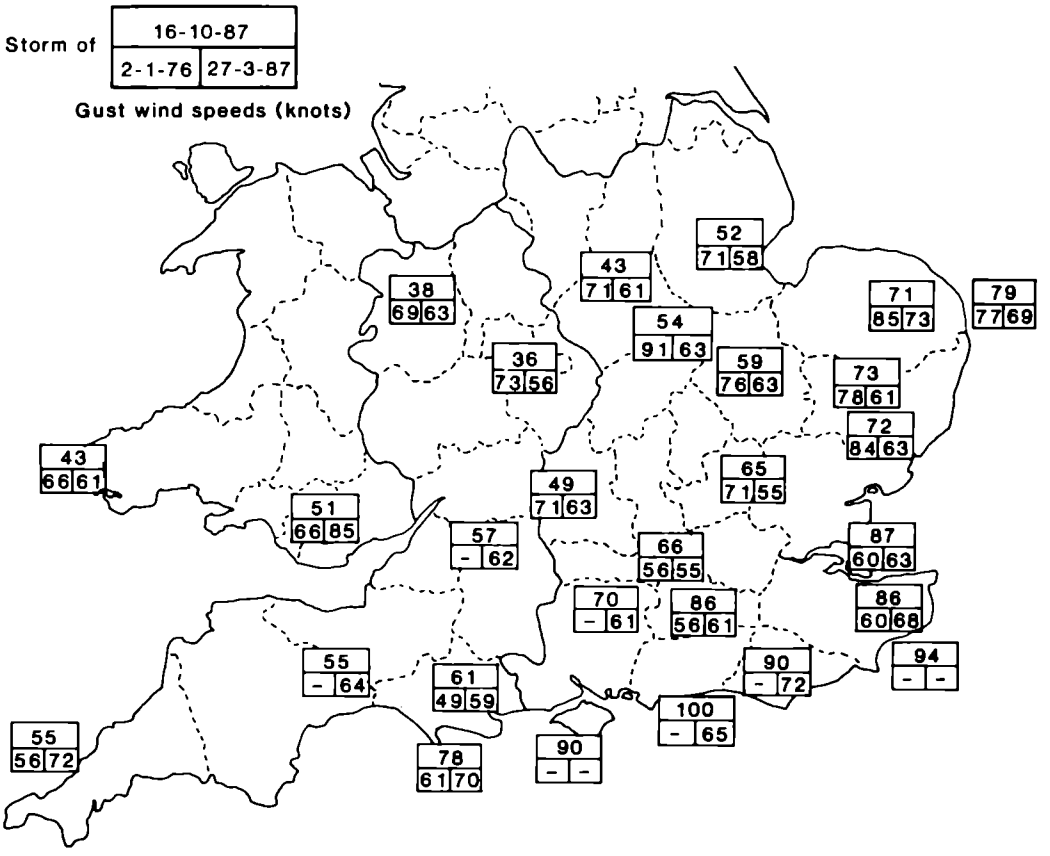



***Figure 3.*** *Comparison of the storm of 15/16 October 1987 with two previous storms in southern England and Wales. (Maximum gust recorded at selected Meteorological Office recording stations.)*

other notable events that affected southern Britain in 1976 and 1987.

Very strong winds with gusts in excess of 80 knots were also experienced in north-west Brittany and the Channel coast of Normandy during the passage of the storm. The maximum measured gust was 117 knots (135 mph, 60 $ms^{-1}$) at Pointe du Roc near Granville to the north-east of St Malo (Burt and Mansfield, 1988). These winds caused catastrophic damage to woodlands in Brittany and to a lesser extent in Normandy with approximately 7.2 million cubic metres being affected (Fillon, 1988).

The ratio of maximum gust to maximum mean hourly windspeed varied between individual recording sites depending on their exposure and the roughness of the surrounding area. The ratio was generally between 1.6 and 1.8, with lower figures on coastal sites and values in excess of 2.0 in urban areas (Burt and Mansfield, 1988). This range of values is similar to those normally obtained in strong winds and there is no evidence of a peculiarly gusty nature to the storm.

Both the maximum gusts and maximum mean hourly windspeeds experienced in south-east England were very rare. There is no instrumental record of any comparable storm in the affected area, and the calculated return periods which indicate the average interval between similar events emphasise the rarity. In south-east England gusts in excess of 80 knots have a return period in excess of 200 years; gusts of 70 knots have a return period of greater than 50 years (Burt and Mansfield, 1988). The return period for a similar storm to occur in October of any

year is much greater than 200 years (Advisory Services Branch, 1988).

## *Comparison with other storms*

The comparison with two other storms affecting southern England has been noted above. Foresters identify three storm events since 1945 that have caused catastrophic damage to British forests and woods. These are the storms of 2 January 1976 (as shown in Figure 3) and those of 15 January 1968 and 31 January 1953; each caused approximately one million cubic metres or more to be windthrown (Quine, 1988). Other storms that have caused serious localised damage with 50–300 000 cubic metres windthrown include those of 4 February 1957 (north and west Scotland), 15 February 1962 (Sheffield area), 12 January 1974 (south Scotland), 13 January 1984 (south-west Scotland) and 13 February 1989 (north-east Scotland).

Serious damage occurred to Irish forests on 16 September 1961 and also in January 1974 and 1984. There have also been notable damage events affecting continental Europe. For example forests in the Massif Central region of France were damaged by winds gusting in

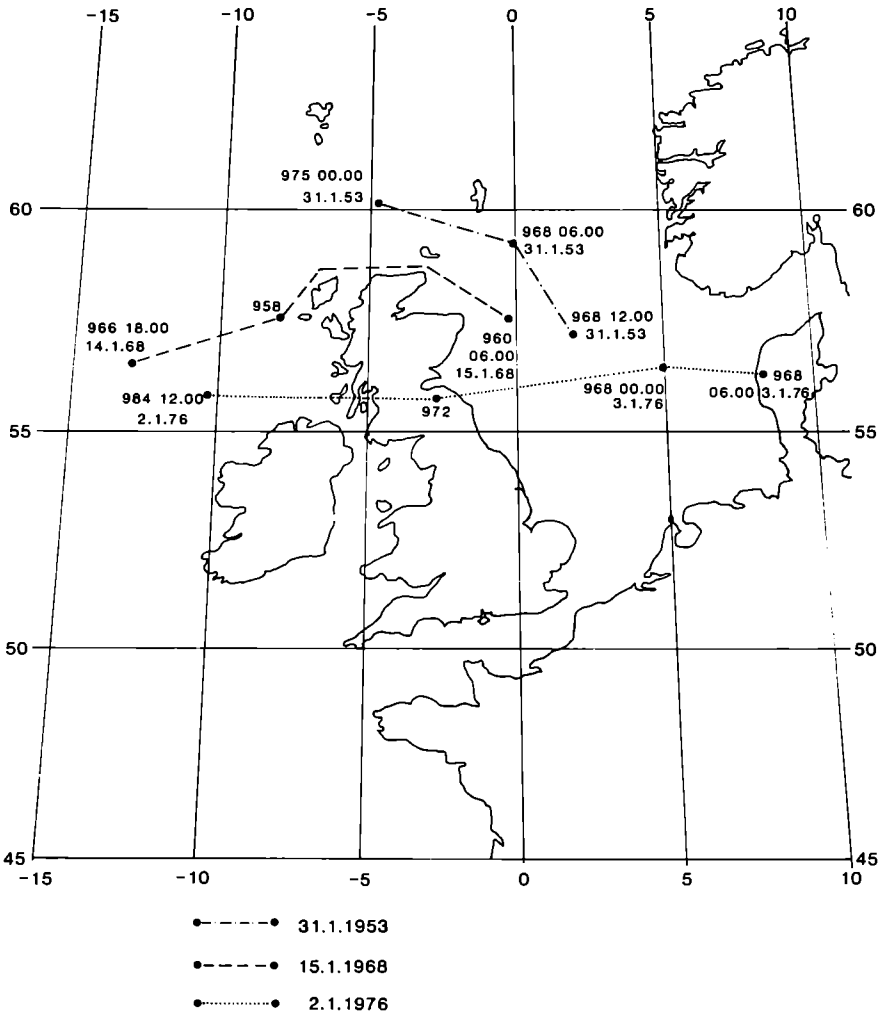



***Figure 4.*** *Passage of centres of depressions at 6 hourly intervals for notable storms in 1953, 1968 and 1976. (Compare with Figure 1.) (Pressure in millibars.)*

excess of 80 knots on 6–7 November 1982, and major forest damage occurred in Germany in March 1967, and in November 1972 and 1984. Forests in Denmark were badly damaged in October 1967 and November 1981.

Each of the British events was associated with the passage of a deep depression across the country. However the tracks of the depressions were different (Figure 4) thus giving rise to the variation in affected areas (Figure 5).

Windspeeds recorded during each of these events have been of a similar magnitude with gusts in excess of 90 knots being recorded at at least one low level station on each occasion, and substantial areas affected by gusts in excess of 80 knots. Precise definition of these areas is not possible for all these storm events as there was a lack of instrumentation in the areas affected in 1953 and 1968. It is important to compare duration of the events and Figure 6 shows the passage of four storms as reflected in maximum gusts for each hour for a number of stations close

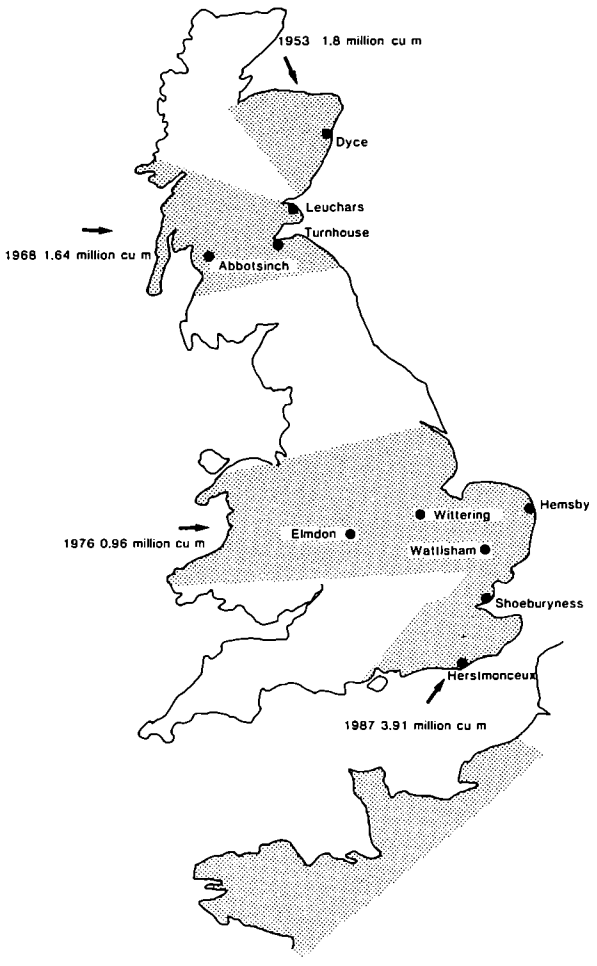



*Figure 5. Areas of catastrophic forest damage since 1945, showing volumes of timber windthrown in each event, and location of meteorological stations referred to in Figure 6.*

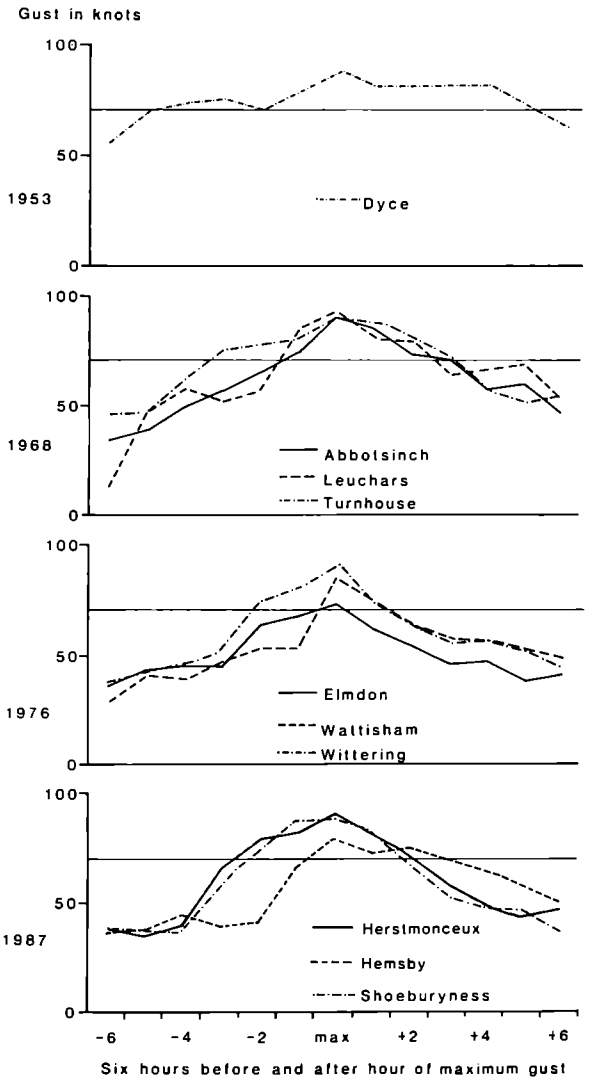



*Figure 6. Windspeeds during the storms that caused catastrophic forest damage. (Maximum hourly gust recorded in the 6 hours before and after the height of the storm at selected Meteorological Office stations; for locations of the stations see Figure 5.)*

to areas of woodland damage. Although the windspeeds recorded in each of the events appear comparable the storms do appear to have varied in their intensity. The storm of January 1953 was particularly prolonged as the associated depression moved south-eastwards across the North Sea. In contrast the strongest winds in the other three events were associated with the rapid progress of a deep depression across the country and the duration of the strong winds was therefore less. The highest winds in the 1968 and 1976 events appear to have been linked with the development of a trough behind the passage of the cold front (Shaw *et al.*, 1976).

In the media coverage of the storm much was made of the comparison with the tempest of 1703 described by Defoe (26–27 November on Julian calendar, 7–8 December on modern calendar). Certainly that storm also affected the south-east but the depression appears to have taken a different track passing from south of Ireland across mid Wales and out to the North Sea near the Humber estuary (Lamb, 1988). The affected area was greater and included the English Midlands, the Low Countries and Denmark.

## *Contributory factors*

It is apparent from the above review that the damage experienced in south-east England was associated with extreme winds similar to those known to have caused other major damage episodes. Why then was the volume blown, and in particular the broadleaved tree volume, so much greater than in other events?

Speculation (e.g. DOE *et al.*, 1988, Chapter II) has centred on the season of the gale which struck when broadleaved trees were still in leaf and also the exceptional rainfall experienced in the preceding weeks. However, it is by no means certain that the leafiness of the trees would in all cases exacerbate wind damage. It seems obvious that individual trees will have been more susceptible, at least to branch breakage due to the increased drag of the leaves. In woodlands the intact canopy may actually have reduced penetration of the wind into the woodland; this effect has certainly been recorded at lesser windspeeds (Dolman, 1986; Sigmon *et al.*, 1984). This could reduce the forces acting on the stem for a given windspeed experienced above the canopy.

Similarly the effect of the exceptional rainfall in the preceding weeks is difficult to assess. Waterlogging of soils reduces their strength and the effective anchorage of the tree may therefore be compromised. This can result in the upturning of the tree and rootplate. It is possible that the waterlogged conditions could have exacerbated the damage and may have increased the numbers of trees overthrown and reduced the number that suffered stem failure or snap. However, it is certainly not possible to allocate a proportion of the damage to this single factor.

It is known from experience in 1953 that winds of the strength experienced in October 1987 can blow over broadleaved trees even when they have shed their leaves. In 1953 waterlogging was not a factor as Andersen (1954) states "As the rainfall during January 1953 was less than normal over most of Scotland no additional effect of water saturation of the soil can be assumed."

It must be emphasised that the area affected by the 1987 storm was particularly well wooded. The area of broadleaved woodland greater than 60 years old was approximately five times larger in the 1987 affected area than in the 1953 affected area. In addition the windspeeds, though of a similar magnitude to those experienced in other events, were rarer. The return period of the other notable British storms which occurred further north were in the order of 40-50+ years for the 1976 event, and approximately 75 years for the 1953 and 1968 storms. The return period of greater than 200 years for the 1987 event indicates the reduced potential for 'weeding out' of the population by previous storms in south-east England. The trees may not have produced the structural adaptations to strong winds that those in more extreme climates can develop.

The contribution that the trees' leafiness and the high rainfall made to the final damage remains unclear. However, it seems certain that even without these factors there would have been catastrophic damage to trees in south-east England from a storm of the intensity of that experienced in October 1987.

# Chapter 3
# Scale and Nature of Damage

## *Introduction*

Although there have been a number of detailed assessments of damage to particular properties (see Lamb, 1989), information on the distribution and actual shape of blown areas is not easily understood. It is true as Lamb observed that the incidence of damage was very variable throughout the storm area "whilst apparently similar adjacent areas escaped largely unscathed". It might be thought that, given information on characteristics of the stand, such as species, height and condition, as well as of the site and the surrounding topography, it should be possible to explain why particular groups of trees were blown (Plate 1). The prospects for success are not good. As Neustein (1971) pointed out in relation to the distribution of blow after the 1968 gale in Scotland, where careful observations were made within forests with almost continuous tree cover over large areas, the waywardness of gusts may yet be the overwhelming reason for a particular patch of destruction.

In relation to species, there were certain distinctive features. Thus typically, oak, on the deeper soils, lost its branches, and a common sight was a bedraggled appearance with broken branches still hanging in the crown. Among more prominent species, the giant redwood *Sequoiadendron giganteum* stood out as the great survivor.

## *Overall scale of the damage to woodlands and trees*

An assessment of the total volume of timber brought down by the storm was necessary in order to estimate the resources and time required to clear the timber, the likely impact on markets and prices and the scale of the restocking problem.

The storm caused severe damage to both private and Forestry Commission woodlands. However, unlike previous major windblows in 1968 and 1976, the greater effect was in private estates, many of them in small ownerships. Many of the woodlands, if managed at all, are managed for purposes other than timber production and the amount of forestry expertise is often limited. These features and the very large number of ownerships made it impossible to compile statistics on total volume blown down in the private woodlands by relying exclusively on reports from owners or their agents. Neither satellite imagery nor aerial photography could be made available and interpreted quickly enough to provide answers within a month of the storm. Instead, a ground survey had to be carried out using Forestry Commission surveyors, but to save time and money only a sample of woodlands could be visited.

The accuracy and precision of estimates derived from samples depends on the variability of the population being sampled and the size of the sample. Since the variability of the woodland population was high and the sample size low the results reported here for components of the total should be treated with caution but the overall estimate is thought to be reliable. Rather than mount a survey based on a new sampling scheme, use was made of the scheme designed for the 1980 census of woodlands to give representative coverage of the woodland in each county. Pre-storm aerial photography and maps giving the location of the sample area already

existed and surveyors were asked to assess for each the proportion of the coniferous volume, broadleaved volume and volume in non-woodland trees which had been blown down in the storm or sufficiently damaged to require felling. Weighted average percentages were then applied to the estimated standing volume in each category to arrive at an estimate of total volume blown down in private woodlands and of non-woodland trees.

For Forestry Commission woodlands it was possible to use ground survey, or post-storm aerial photography where available, to map the boundaries of windblown areas on to existing stock maps and then measure the area of damage in each stand. Using information on the growing stock databases and the production forecasting system the volume of timber in each windblown stand could be calculated and summed to produce windblown volume estimates for each county.

The volume figures quoted in Table 1 are those published on 16 November 1987, one month after the storm. They refer, in accordance with normal forestry convention, to the volumes overbark of the main stem of the tree. For conifers this is to 7 cm diameter and for broadleaves to the point where the main stem is no longer obvious. Not all of this timber was utilisable either because of damage done by the storm or because the trees were already rotten or had other defects. It was estimated that around 10% of the conifer volume and 25% of the broadleaved volume might not be worth harvesting for this reason. In addition, further quantities would not be worth harvesting because of small size, scattered distribution and inaccessibility. Off-setting this to some extent is the volume of timber in the branchwood of broadleaved species a proportion of which has been harvested for firewood and pulpwood.

The percentage of the original standing volume blown down, classified by Forestry Commission, private woodlands, conifers, broadleaves and non-woodland trees by counties, is given in Table 2. Comparing the total volume brought down in the counties named in Table 2, that is 3.5 million cubic metres, with the original standing volume in these counties of about 30 million cubic metres implies that about 12% of the original standing volume was brought down by the storm. The total area of woodland in these

**Table 1.** Estimated volume of damage[a]

*Thousands of cubic metres overbark*

| | *Suffolk* | *Essex* | *Kent* | *E. Sussex* | *W. Sussex* | *Surrey* | *Hants* | *Other*[b] | *Total* |
|---|---|---|---|---|---|---|---|---|---|
| Forestry Commission conifers | 430 | 0 | 160 | 140 | 50 | 20 | 50 | 80 | 930 |
| Forestry Commission broadleaves | 0 | 0 | 10 | 20 | 50 | 0 | 30 | 0 | 110 |
| Total | 430 | 0 | 170 | 160 | 100 | 20 | 80 | 80 | 1040[c] |
| Private Woodland conifers | 80 | 10 | 70 | 240 | 300 | 90 | 40 | 150 | 980 |
| Private Woodland broadleaves | 200 | 90 | 300 | 340 | 400 | 160 | 80 | 150 | 1720 |
| Total | 280 | 100 | 370 | 580 | 700 | 250 | 120 | 300 | 2700 |
| Non-woodland conifers and broadleaves | 30 | 10 | 20 | 10 | 30 | 20 | 10 | 40 | 170 |
| Total conifers | 510 | 10 | 230 | 380 | 350 | 120 | 100 | 230 | 1930 |
| Total broadleaves | 230 | 100 | 330 | 370 | 480 | 170 | 110 | 190 | 1980 |
| Total volume blown | 740 | 110 | 560 | 750 | 830 | 290 | 210 | 420 | 3910 |

*a* As published on 16 November 1987.
*b* 'Other' includes London, Norfolk, Cambridgeshire, Hertfordshire, Buckinghamshire, Berkshire, Dorset and the Isle of Wight.
*c* Subsequently revised following later survey work to 1100 thousand cubic metres.

counties is 183 000 ha of which 46 000 ha is mainly conifer and 137 000 ha is mainly broadleaves. Assuming an average current increment of 10 cubic metres per ha per annum for the conifers and 3 cubic metre per ha per annum for the broadleaves, then annual increment would have been between 800 and 900 000 cubic metres or around 3% of standing volume. Thus the volumes blown down in the main storm damaged counties represented about 4 years normal increment in these areas. However, the volume cut in recent decades has fallen below increment and the blown volume probably represented a little over five times the average annual cut of recent years.

From Table 2 it can be seen that in general a much higher proportion of conifers blew down than broadleaves and non-woodland trees suffered a much smaller percentage loss than woodlands. The difference between Forestry Commission and private woodlands within a county reflects differences in the location and the ages of woods. For instance much of the Forestry Commission's conifer woodland in Suffolk is close to the coast where damage was much greater than further inland. Also, Forestry Commission plantations contained a higher proportion of older stands whereas many of the conifer woodlands in private ownership were post-war plantings and in general older woods were more vulnerable than younger ones. Table 3 shows the increase with age in the areas of Scots and Corsican pine removed by wind between 1986 and 1988 in the three Forestry Commission districts most affected by the storms. The representation of other species is too small to make meaningful assessments for them.

An estimate was also made of the volumes brought down by major species group (Table 4). Pines dominated in the conifers, especially in Forestry Commission woodlands, while amongst the broadleaves oak was the most abundant, with large quantities of beech also present. These are the two most significant broadleaved species in lowland England. As a percentage, significantly more beech was lost than oak.

The area of woodland requiring complete clearance has been estimated at 16 500 ha of which 4000 ha is in Forestry Commission ownership and the balance in private woodlands.

Later review of the areas and volumes blown on Forestry Commission land showed that where aerial photographs were available, the estimate of areas wholly or partially blown has been close to actual. Ground assessments shortly after the storm exaggerated the amounts of wind thinning and sporadic blow. The most important source of variation from the original estimates reported in

**Table 2.** Proportion of original standing volume blown down

| | *Suffolk* | *Essex* | *Kent* | *E. Sussex* | *W. Sussex* | *Surrey* | *Hants* |
|---|---|---|---|---|---|---|---|
| Forestry Commission conifers | 27% | 5% | 44% | 51% | 20% | 8% | 3% |
| Forestry Commission broadleaves | 3% | neg. | 10% | 23% | 22% | neg. | 3% |
| Private Woodland conifers | 20% | 7% | 25% | 35% | 30% | 10% | 4% |
| Private Woodland broadleaves | 8% | 4% | 18% | 18% | 18% | 5% | 2% |
| Non-woodland | 3% | 2% | 4% | 6% | 5% | 3% | 2% |
| Total | 13% | 4% | 18% | 24% | 19% | 6% | 2% |

**Table 3.** Proportions of areas[a] of pines blown in different age groups

| | | | | | | *Percentage of area in 1986*[b] |
|---|---|---|---|---|---|---|
| *Planting year class* | *1966-75* | *1956-65* | *1946-55* | *1936-45* | *1926-35* | *1916-25* |
| Scots pine | 9.9 | 22.6 | 28.8 | 34.6 | 71.0 | 94.3 |
| Corsican pine | 4.3 | 19.3 | 35.8 | 56.3 | 85.5 | 96.4 |

*a* Districts covered: South Downs, Weald, Suffolk.

*b* The analysis is crude since the representation of each species differs between 5-year planting year classes and among Districts.

**Table 4.** Estimated volume blown by species group, size class and ownership

| | | Volumes in thousands of cubic metres | | |
|---|---|---|---|---|
| | | *Forestry Commission* | *Private Woodlands* | *Total (rounded)* |
| Pine | Small roundwood | 200 | 200 | 400 |
| | Sawlogs | 500 | 350 | 850 |
| | Total | 700 | 550 | 1250 |
| Other conifers | Small roundwood | 100 | 200 | 300 |
| | Sawlogs | 100 | 250 | 350 |
| | Total | 200 | 450 | 650 |
| All conifers | Small roundwood | 300 | 400 | 700 |
| | Sawlogs | 600 | 600 | 1200 |
| | Total | 900 | 1000 | 1900 |
| Oak | Under 16″ diameter | 10 | 320 | 300 |
| | Over 16″ diameter | 10 | 480 | 500 |
| | Total | 20 | 800 | 800 |
| Beech | Under 16″ diameter | 60 | 240 | 300 |
| | Over 16″ diameter | 20 | 360 | 400 |
| | Total | 80 | 600 | 700 |
| Other broadleaves | Under 16″ diameter | 5 | 200 | 200 |
| | Over 16″ diameter | 5 | 300 | 300 |
| | Total | 10 | 500 | 500 |
| All broadleaves | Under 16″ diameter | 75 | 760 | 800 |
| | Over 16″ diameter | 35 | 1140 | 1200 |
| | Total | 110 | 1900 | 2000 |

Table 1 arose from underthinning and the use in the forecast of a lower yield class than actual in certain forests. Estimates of losses on private estates were necessarily less precise, but areas blown may have been slightly underestimated.

## *Trees outside woodlands*

Although trees in woodlands constituted by far the greater proportion of the total number and volume (95%) of trees blown or damaged, the damage done to trees in parks, streets, gardens and hedgerows provided perhaps the most dramatic evidence of the storm's effects. Trees blocking roads and railways, collapsing on to cars and tearing down electricity cables and telephone wires caused a major break in communications that influenced many people both within and outside the immediate area affected by the storm. The number of trees can only be assessed roughly: the estimates of the Department of the Environment's Joint Technical Coordination Committee (DOE, 1988) are set out in Table 5.

The region affected is densely populated and the loss of familiar trees made an immediate, dramatic effect on people travelling to work on the morning of 16 October. Despite the amount of damage to buildings directly, estimated to exceed £1 billion, it is likely that the sight and inconvenience caused by blown and broken trees triggered the greatest subsequent public concern.

Apart from the visual impact on a cherished view caused by a loss of mature trees, there were also economic losses where trees were destroyed in screens or shelterbelts. Such damage could, for example, create draughts capable of damaging future crops of top fruit in those orchards that survived the storm. Less tangible was the loss of shelter in gardens containing collections of half-hardy plants. In spite of the number of trees blown in built-up areas, there were few instances of buildings being made uninhabitable

**Table 5.** Estimated numbers of non-woodland trees blown down or damaged

| *Type of location* | *Trees blown* | *Trees damaged* |
|---|---|---|
| Non-woodland rural landscape | 200 000 | 500 000 |
| London Borough street trees | 55 000 | 35 000 |
| Roads and/or railways | 7000 | |
| Royal Parks | 3540 | 7925 |
| Other parks and gardens | 3000 to 4000 | |
| Royal Botanic Gardens, Kew | 500 | 500 |

*Note:* In addition it is estimated that some 500 000 orchard trees were blown down.

by falling trees. Many fell between buildings or more or less parallel to the street. This pattern is not surprising since a building creates an obstacle to wind which has to funnel round its sides, taking less substantial objects in its path.

Although some young trees were blown over, as with recently planted specimens in Hyde Park (Plate 2), the bulk of trees lost were older. Not surprisingly, the species blown reflected local abundance. Thus the many limes destroyed in Ealing reflects that Borough's large lime populations. Elsewhere in London, the London plane (*Platanus* × *acerifolia*) was the predominant species lost. Some species appear universally to have withstood toppling. Wellingtonia (*Sequoiadendron giganteum*) and ginkgo (*Ginkgo biloba*) are the prize examples. Losses in arboreta and gardens renowned for their specimen trees were serious, with some such as the National Trust garden at Nymans, West Sussex, losing more than half its trees. Among other famous collections, Kew, Wakehurst Place, Sheffield Park and Bedgebury suffered severely, half of the Forest Plots at the last location being blown (Plate 3).

Many trees experienced so much swaying that their roots were loosened and the stems were left more or less leaning. In many instances, especially near property and locations frequented by people, such trees were eventually felled. For example in the Royal Parks 925 trees were felled in addition to those that had been toppled. However, trees that suffered only minor root failure which did not disturb the soil surface remained; these may be permanently weakened and may fall in less severe winds in future. Minor root failure in trees already infected with a root pathogen may have provided the pathogen with an opportunity to progress rapidly through the root system. These trees may suddenly die in coming years especially if there is a drought.

Storms often cause failure of structural weaknesses in trees, or failure occurs close to a pocket of decay. In October 1987 the force and fluctuations in the wind were so great that exceptional damage occurred. Apparently sound branches and stems were twisted until the tissues failed. Branches and stems were completely fractured and thrown to the ground or in many instances left supported on other branches. In addition many branches were partially severed and left hanging in the crowns. Such damage is generally visible and remedial work can be undertaken. However, vigorous movement in the wind and sudden shock loading caused by falling trees and branches can cause structural weakening of branches, stems and roots without creating any visible symptoms. Many future fractures of branches and stems or root failures may, therefore, have their origin dating back to 16 October 1987, but in most cases this is unlikely to be recognised.

'Scorching' of leaves occurred from salt spray carried over 35 miles inland. The long-term effect of this damage was, however, minimal despite the initial appearance of some young evergreen plants.

Several surveys of non-woodland trees were conducted. One supervised by Dr Cutler of the Royal Botanic Gardens, Kew concerned roots. The results of this survey were not available at the time of writing but the nature of the information compiled was shown in Cutler *et al.* (1989). A second was a rapid survey of street

trees by members of the DOE funded arboriculture research team based at the Forestry Commission's Research Station at Alice Holt Lodge, near Farnham, Surrey. This showed that blown trees in streets had very few or no roots on one side as a result of the tree growing against a kerb (Plate 4). Some trees provided good illustrations of the much branched root system forming a sheet immediately below the paving where supplies of both oxygen and water are most favourable for root activity.

## *Survey of damage to parkland trees*

A special study of the effect of the storm on different tree species in parkland was undertaken between November 1987 and April 1988 by the Forestry Commission's Research Division with financial support from the DOE. Parkland was chosen in order to avoid as far as was possible the influence of roads, buildings and other trees. For this investigation 20 parkland plots were established, roughly on a line from Southampton to Central London, in the zone within which it is estimated that there is a 50–200 year return period both for the highest hourly windspeed and the highest gust speed. The plots encompassed a range of ownerships and soil types but all contained a minimum of 50 trees over 6 metres tall, 30% of which had blown over or suffered the loss of at least one major limb. Damage that was deemed to be due to the falling of adjacent trees was not recorded.

A total of 3900 trees was assessed, damaged plus undamaged; these comprising well over 100 taxa. Table 6 shows the incidence of damage in 18 of the most common species. Because of the great variation in species composition from plot to plot, these overall percentages can be misleading, and a more informative procedure is to rank the performance of the five most common species in those plots in which they all occurred. This analysis suggests that there was a progression from 'most' to 'least vulnerable' along the sequence: large-leaved lime (*Tilia platyphyllos*), horse chestnut (*Aesculus hippocastanum*), English oak (*Quercus robur*), beech (*Fagus sylvatica*), common lime (*Tilia vulgaris*). Although factors such as tree size and the degree of exposure to the storm are likely to have had some influence on performance, they do not appear to have been of overriding significance, and it seems probable that considerable importance can be attached to variation between the species in terms of intrinsic features such as the strength of the wood, the resilience of the

**Table 6.** Frequency of failure in the most common species encountered in the survey

| *Species* | *Number of plots in which present* | *Total number of trees assessed* | *Percentage of damaged trees in sample* |
|---|---|---|---|
| Poplars (*Populus* spp.) | 10 | 76 | 39 |
| Red horse chestnut (*Aesculus* × *carnea*) | 7 | 45 | 38 |
| English oak (*Quercus robur*) | 19 | 539 | 35 |
| Small-leaved lime (*Tilia cordata*) | 10 | 104 | 33 |
| Large-leaved lime (*Tilia platyphyllos*) | 11 | 155 | 33 |
| Horse chestnut (*Aesculus hippocastanum*) | 17 | 411 | 28 |
| Beech (*Fagus sylvatica*) | 17 | 442 | 28 |
| Turkey oak (*Quercus cerris*) | 14 | 78 | 25 |
| Ash (*Fraxinus excelsior*) | 11 | 68 | 21 |
| Sweet chestnut (*Castanea sativa*) | 14 | 104 | 19 |
| Black pine (*Pinus nigra*) | 5 | 61 | 18 |
| Red oak (*Quercus rubra*) | 7 | 41 | 17 |
| Common lime (*Tilia vulgaris*) | 17 | 532 | 16 |
| Sycamore (*Acer pseudoplatanus*) | 17 | 185 | 15 |
| Norway maple (*Acer platanoides*) | 13 | 132 | 15 |
| Scots pine (*Pinus sylvestris*) | 9 | 55 | 15 |
| London plane (*Platanus* × *acerifolia*) | 9 | 230 | 11 |
| Atlantic cedar (*Cedrus atlantica*) | 8 | 81 | 12 |

**Table 7.** Failure and associated decay in the five most common species

| *Species* | *Numbers[a] of failures occuring at:* | | | |
|---|---|---|---|---|
| | *root* | *trunk[b]* | *stem* | *branch[c]* |
| Large-leaved lime (*Tilia platyphyllos*) | 43 (1) | 7(4) | 4(1) | 5(0) |
| Horse chestnut (*Aesculus hippocastanum*) | 11(0) | 11(2) | 23(2) | 99(3) |
| English oak (*Quercus robur*) | 33(7) | 11(6) | 14(5) | 193(51) |
| Beech (*Fagus sylvatica*) | 64(16) | 9(7) | 23(7) | 28(2) |
| Common lime (*Tilia vulgaris*) | 65(2) | 10(9) | 9(4) | 6(1) |

*a* For each entry the first figure refers to the total numbers of trees observed and the second to the number with decay occupying more than one-third of the wood.

*b* Where the main stem was undivided it was recorded as a 'trunk'. Where two or more stems of equal importance were present the term 'stem' was used.

*c* Branch failures were only recorded if the branch exceeded 30 cm diameter at the point of failure or its diameter exceeded a quarter of the tree diameter at breast height.

branches or the propensity to decay.

The nature of the damage also varied markedly between species, as is shown by Table 7 which contains information on the point of failure in the five species selected for special analysis above. It will be noted that beech and the limes most commonly failed by blowing over at the roots while horse chestnut and English oak typically showed branch failure (Plate 5). The table also shows for each species the frequency with which appreciable decay was associated with the failure point. Again large differences are evident between species. Thus 26% of the branch failures in oak were associated with decay, while this was true for only 3% of the branch failures in horse chestnut. Similarly only 3% of the root failures in lime were associated with decay compared with 28% of the root failures in beech. Information was also collected on the fungi principally involved in causing the decay. *Laetiporus sulphureus* (Plate 6) was particularly common in the above ground parts of the trees, while *Armillaria* spp. were the most common causes of root decay. More details on this study can be found in Gibbs and Greig (1990).

## *Windsnap in pine plantations*

Windsnap was a feature of damage in several species. It was particularly prevalent in poplar where the break usually occurred at a rather higher level (*c.* 5 metres) than in pines and spruces (3–4 metres) (Powell, 1989). Though proportionately more common in spruce than in pines, the large blow of pine in Forestry Commission forests in Suffolk displayed a substantial incidence of snap.

As snapped timber would deteriorate more quickly owing to the ease with which fungi could enter the wood, it was considered that the affected areas would require early harvesting. The degree of snap could not be observed on vertical air photographs and oblique photography was therefore obtained by helicopter. Although snap was more visible in the obliques not all snapped trees could be identified even from photographs taken at low level. No general pattern of break was in fact found and this was later confirmed by ground survey. Overall, the snap in affected Forestry Commission areas in Suffolk was in the range of 6 to 10%, with Scots pine being more prone than Corsican to such damage, particularly close to ground level. No extensive areas of snap which would have merited preferential early harvesting were found.

It is possible that some reduction in sawlog quality resulted from cross-cutting logs too close to the break in a zone where splitting had occurred at the time of windsnap.

## *Effects on wood quality*

In view of the stresses to which a tree's stem is subjected before windblow occurs, surprisingly little evidence has been reported of the physical effects on wood quality arising in gale damaged trees. These effects, if present, might be expected to show themselves either in sawing or in machine stress grading the sawn wood. One such observation was made in the first 3 months after

the gale when it was claimed that pine logs from blown stands were shattering more frequently than before, while being sawn. Extensive investigations were made at sawmills from which it was concluded that the rate of shattering was something less than 1% of sawn pieces.

Concern also extended to the performance of sawnwood from blown Corsican pine in machine stress grading. Two small samples did not reveal any change from expected behaviour in stiffness or ultimate bending when examined by the Building Research Establishment.

One form of damage from excessive winds was foreseen. When a tree is bent by the wind, the windward side is in tension, the leeward in compression. Wood is weaker in compression than in tension so that failure may be expected to occur on the lee side first. This is realised in the form of fibre wall failures in the outermost rings at one or more locations on the stem, and such failures can extend, in the worst cases, almost to the pith. Evidence of this failure, which is termed a compression crease, is not apparent to the naked eye on the surface of logs or even on sawn timber. It is revealed by planing sawnwood, particularly when this is quarter sawn.

Preliminary examination of wood sawn from 208 Corsican pine logs grown at Rendlesham Forest, Suffolk showed that there were compression creases in 18% of the logs. Almost all the creases were associated with the bottom side of the trees as they lay. This observation suggests that the trees did not twist when blown down and that damage might have resulted from impact in falling. Some flitches with creases on the top side also showed creases on the bottom edges. This might indicate damage had occurred while the trees were still standing by lashing backward and forward. Examination of an unconnected sample of battens which had been machine stress graded also revealed the presence of compression creases. It was noted that a large proportion were in battens which had graded out at Strength Class 4. It was concluded that the risk of significant strength reduction from compression creases in Corsican pine is low.

## Chapter 4
# Administrative Action

## *Forestry Commission initiatives*

In the immediate aftermath of the storm, it was quickly apparent that the trees and woodlands of south-east England had suffered substantial damage and that woodland owners and indeed the entire forest industry faced considerable problems in dealing with the consequences. The problems arising from the storm differed from previous major windblows in the last 40 years in that the quantities blown down appeared to be greater and comprised a large proportion of broadleaves, the damage was spread over thousands of ownerships and many woodland owners had little experience or expertise in the harvesting and marketing of windblown timber. In addition the damage had occurred in the most populous part of the country and there was considerable public concern about its environmental impact.

### Forest Windblow Action Committee

It was against this background that the Forestry Commission established a committee with, as its principal objective, the determination of policy for restoration of damaged woodland. Previous experience of catastrophic windblow had shown it to be essential to constitute such a body in order to ensure the effective use of resources across all sectors of the forest industry. The committee's functions included the necessary fact finding and the provision of advice on priorities for clearance, prospects for harvesting and marketing, and on replanting.

The Forest Windblow Action Committee was set up within a few days of the storm under the chairmanship of Mr John Goodwin and comprised representatives of Timber Growers UK, the Forestry Commission, the British Timber Merchants' Association of England and Wales and the UK Wood Processors' Association. A number of groups were also established to advise on damage assessment, harvesting, marketing, restocking and financial implications. A Windblow Task Force was also set up at the Forestry Commission's Research Station at Alice Holt; its functions are described in detail below. Figure 7 shows the organisational structure of the Forest

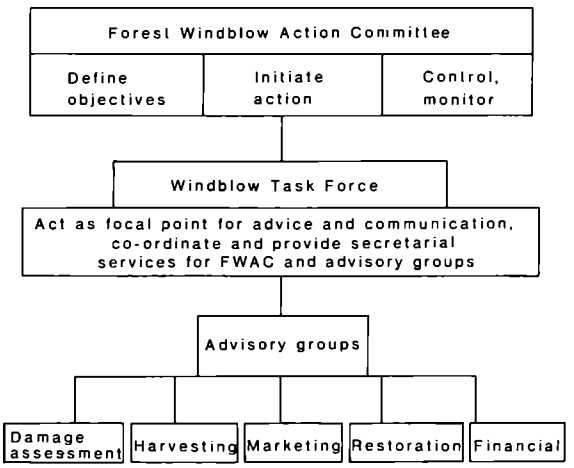



***Figure 7.*** *Structure and functions of the Forest Windblow Action Committee.*

Windblow Action Committee and the subordinate groups with their main functions. Details of the membership of the Committee and its Groups are shown in the Appendix. The staff of the Windblow Task Force were provided by the Forestry Commission.

The following is a list of the main actions taken by or on behalf of the Forest Windblow Action Committee.

- An assessment was made of the quantity of timber blown down in the storm; figures being published on 16 November 1987.
- A report to the Forestry Commission was published in January 1988 which gave an assessment of the problems caused by the storm, proposed action and made recommendations for Government assistance.
- Four public meetings were held in late January and early February 1988 to advise woodland owners on how to deal with the clearance of windblown timber.
- A booklet *Guidelines for dealing with windblow in woodlands* (FWAC, 1988) was published in late January 1988.
- County lists of contractors and timber merchants were prepared and these along with advisory leaflets prepared by FC research staff were made available to over 1500 enquirers.
- Two public meetings on restocking following clearance of windblown timber were held in October 1988.
- A second report to the Forestry Commissioners dated May 1989 gave a brief account of the work of the FWAC and its associated advisory groups and suggested the lessons which could be drawn from the experience of the storm.

On the setting up of the Action Committee, the sequence of actions to be taken was largely self-evident. The first priority had to be the assessment of the damage, including identification of the tree species affected. Advice on the harvesting and marketing imperatives was governed by the overall scale of damage and the relative susceptibility of different species to risk of degrade was an important factor in deciding priorities (Hibberd, 1987). Consultation within the industry also worked well with specific objectives being quickly agreed. Communication with those most affected was generally satisfactory, although there was some difficulty in getting through to the very large number of farmers and other landowners affected, many of whom have no regular contact with the forestry and timber trades press. Lessons on the best ways of co-ordinating and encouraging were of course learned and Chapter 8 details these.

The Action Committee met a total of eight times between October 1987 and October 1988, and its members have maintained a watching brief on the progress of clearance operations.

### The Windblow Task Force

Following the first meeting of the Forest Windblow Action Committee a Windblow Task Force was established at the Forestry Commission's Research Station at Alice Holt Lodge, near Farnham, Surrey. Staffed by three Forest Officers with clerical assistance, the main purpose of the Task Force was to provide advice and information to woodland owners on how to deal with problems of harvesting and marketing windblown timber and, in due course, replacing the trees which had been lost. Information was also provided to timber merchants, contractors and enquirers from the media. In addition the Task Force acted as the Secretariat to the Forest Windblow Action Committee and its advisory groups.

The setting up of the Task Force was publicised by Press Release and by coverage on radio. Other opportunities for advertising the existence of the Task Force occurred when the figures on total damage were released.

Although useful advice could be given and many specific enquiries dealt with by telephone, the most efficient method of working was to find out the concerns of the enquirer and send out leaflets dealing with these topics. The main demands from woodland owners were for the names and telephone numbers of timber merchants and contractors able to carry out clearance work and remove windblown timber. Initially most owners were anxious to clear accesses and in these circumstances the price of timber was not such a vital consideration. However, price information became more important as time passed. Lists of timber merchants and contractors were compiled for each county in the windblow area and these were made available to enquirers. These lists were updated as contractors and timber merchants from other parts of the country notified the Task Force that they were interested in carrying out clearance work or in buying windblown timber.

Leaflets were also prepared giving guidance

***Plate 1.*** *Aerial view of Knole Park, Kent showing beech blown in various directions. (37778).*

***Plate 2.*** *Young blown poplar. (37897).*

***Plate 3.*** *Snapped and blown Norway spruce, Forest Plots, Bedgebury. (E8359).*

***Plate 4.*** *Rootplate of London plane showing restriction of rooting by kerb. (37882).*

***Plate 5.*** *Oak showing loss of large limb.*

***Plate 6.*** *Yellowish mycelium visible in the decayed wood of the limb, characteristic of the brown rot fungus,* Laetiporus sulphureus.

***Plate 7.*** *Osa harvester at work. (38672).*

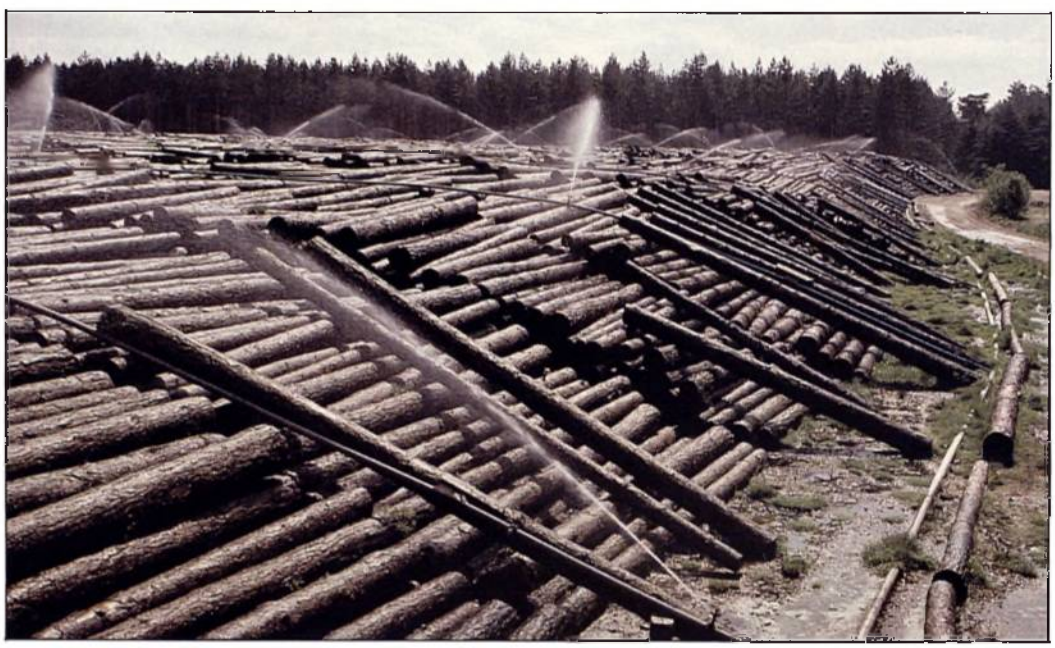
***Plate 8.*** *Tractor with grab and trailer extracting Scots pine. (37911).*

***Plate 9.*** *True blue stain in pine log. (38131).*

***Plate 10.*** *Stain in Corsican pine ascribed to inorganic origin. (38129).*

***Plate 11.*** *Aerial view of log store at Lynford, Thetford. (38793).*

***Plate 12.*** *Close-up of irrigation pipes and spray. (38804).*



on the priorities for action in dealing with windblown trees, the measurement of windblown timber and advice on restocking. A wide range of free Forestry Commission publications and relevant publications from other organisations such as the Arboricultural Association were also issued.

A number of visits were carried out to private woodland owners or their agents to give advice. Although useful for finding out how woodland owners were dealing with the problems caused by the storm, this proved to be extravagant in staff time and often involved people who already had considerable forestry knowledge and expertise. The woodland owners most in need of assistance were usually those with too small an area to justify continuing professional management and where the volumes of timber blown down were more than they could manage with their own resources. A publication *Guidelines for dealing with windblow in woodlands* was prepared which brought together in one document advice on harvesting and marketing windblown timber and subsequent replanting. Four public meetings attended in all by about 500 members of the public were held in order to give advice directly to woodland owners and publicise the booklet which was also made available through local Forestry Commission, Ministry of Agriculture, and County Council offices. Over 4000 copies of the booklet were distributed in a 6 month period.

By March 1988 the level of enquiries had declined to modest levels and staff were able to return to their normal duties although enquiries continued to be received and dealt with for a further year. In all some 1500 enquirers contacted the Task Force for information.

Following the announcement (detailed in 'Financial aspects' on p.21) in June 1988 of a supplement to existing Forestry Commission grants for replanting of storm damaged woodlands, two public meetings were held in Sussex and Kent both to publicise the availability of the supplement and to provide woodland owners with advice on restocking after windblow.

Information on the progress of clearance was compiled quarterly from returns submitted by over 50 private estates and from organisations such as the National Trust, forest management companies and estate agents. Information was collected on the total area of woodland managed by the respondent, the estimated volume of windblown timber and the amount cleared to the end of the quarter. Volume figures were split between conifers and broadleaves.

Because there was only a partial and non-representative coverage of private woodlands, estimates had to be made of quantities cleared on the non-reporting areas. Figures were also supplied by the Forestry Commission and the overall estimates of quantity cleared were compared with available information on quantities being consumed by major wood-using industries plus exports to ensure a measure of consistency.

It is clear that the Task Force's contribution to the flow of information was essential for an orderly development of the various operations required.

## *Initiatives by other bodies*

While highway authorities and the public utilities, supported by volunteers, contractors and services such as fire brigades and the Armed Forces, struggled to clear thoroughfares and to reconstruct and repair services, countryside bodies, landowners, foresters and local authorities compiled information and developed strategies for the clearance of trees and in many cases their restoration. The actions of some main public bodies are noted below.

### Department of the Environment and the Countryside Commission

Within days of the storm, the Secretary of State for the Environment announced a programme of special financial aid for the clearance and restoration of copses and non-woodland trees to be administered by the Countryside Commission, the remit of which was temporarily extended to include London and other urban areas. Task Force Trees was formed by the Countryside Commission to administer the additional aids through local authorities and to promote replanting within the affected areas during that winter. Details of this and subsequent Government assistance provided by the DOE are re-

corded under 'Financial aspects' on p.21.

Within a few weeks of the storm, Task Force Trees was able to announce preliminary applications of grant aid of almost £2.5 million to over 70 local authorities. Assistance was also offered to voluntary organisations such as the British Trust for Conservation Volunteers, County Wildlife Trusts, and Groundwork Trusts, to enable them to expand their activities encompassing a range of practical volunteer work. In addition, Task Force Trees produced an Action Pack (TFT, 1988) with the aim of encouraging as many people as possible to become involved in the recovery programme.

The Department commissioned aerial photography of the sample strips of the Forestry Commission's 1980 census of woodlands and trees so that an estimate could be made of the number of blown and damaged non-woodland trees (DOE, 1988). This confirmed the aggregate estimates made by the Forestry Commission shortly after the storm but provided more detailed figures.

The Department also convened an Interdepartmental Technical Coordination Committee including representatives from the Forestry Commission and the Ministry of Agriculture, Fisheries and Food to assess the effects of the storm on the landscape and make recommendations to Ministers for the support needed for restoration work. The report of the Committee (DOE *et al.*, 1988) provides much technical information but its publication (September) postdated the main management and financial decisions bearing on the issues of clearance and restocking.

### Ministry of Agriculture, Fisheries and Food

Operating through an Emergency Committee the Ministry of Agriculture, Fisheries and Food arranged special payments for fruit growers towards the cost of repairing storm damaged shelter features and replanting damaged orchards. Special provisions were made for repair and restoration of the Royal Botanic Gardens at Kew and Wakehurst Place and practical help for rural community needs was arranged under the MAFF Farm and Countryside Initiative (part-sponsored by National Westminster Bank) to assist in clearance.

### Local authorities

Local authorities have a statutory duty under the Highways Act to maintain access along thoroughfares and to keep them in a safe condition. Tree by tree examinations of authority trees and those lining roads were possible in some areas but in rural areas little more than an impression of the nature and extent of damage could be gained. Some local authorities therefore undertook either ground or aerial surveys. Bids were made to Task Force Trees for financial aid once plans for clearance and restoration could be formulated.

### Nature Conservancy Council

The Council instituted an ecological assessment of the immediate effects of the storm on habitats. Advice was sent to owners of Sites of Special Scientific Interest, and information sought about the extent of the damage to each site. In addition the Council (1988) issued guidelines for the future management of storm damaged woodlands.

## *Report of the House of Commons Select Committee on Agriculture*

In December 1987, the Agriculture Committee decided to carry out an investigation into the speed and effectiveness of actions by Government Departments in response to the storm. It considered the extent of damage suffered and assistance needed by farmers, glasshouse owners, soft fruit and hop growers and vineyard owners as well as woodland owners and local authorities. The Committee had available the report of the Forest Windblow Action Committee (FWAC, 1988) and members of the Agriculture Committee inspected the storm damaged areas. The summary of their recommendations (House of Commons, 1988) contained the following references to forestry matters and the work of the Forestry Commission:

"7. We endorse the Forestry Commission's

policy of self restraint in production of pine and hardwoods. [This policy was followed in order to avoid a glut on the market. Ed.]

8. We commend the advisory service that the Forestry Commission has given and the quality of technical assistance it has made available to woodland owners and farmers.
9. We urge the Minister of Agriculture, Fisheries and Food to come to a swift decision on what is now a matter of urgency. While we accept that there may be some difficulties in the detailed effect of a transport subsidy, it seems to us to be the most immediately effective measure the Minister can take to alleviate the present problem of pine and beech glut. Accordingly we support the Windblow Action Committee's recommendation.
10. We recommend that proposals for tax concessions to woodland growers badly affected by storm damage be looked at sympathetically.
11. We wish to emphasise the crucial importance that all those affected attach to clearance. The Government must give top priority to solving the clearance problem."

## *Financial aspects*

A common and strongly voiced reaction to the unfamiliar sight of large numbers of uprooted and broken trees in lowland England was a call for financial assistance to owners (including local authorities) in the work of clearance and restocking (see for example, Onslow, 1988).

The considerations surrounding the ensuing debate were so different for non-woodland trees and woodlands respectively that it is necessary to distinguish the two categories quite sharply. A measure of the strength of public concern over the loss of amenity is that within 5 days of the storm the Secretary of State for the Environment was able to announce in Parliament (Ridley, 1987) a package of measures. These included a Government undertaking to meet 75% of local authority expenditure on emergency work after the authority had spent the product of a 1 penny rate, £250 000 for tree planting in the Royal Parks and special assistance for Kew Gardens, and an extra £2.75 million for the Countryside Commission to allocate to replanting in 1987/88. Most of the restoration occurred on publicly owned land, although some private owners were able to respond quickly enough to benefit from the assistance available from this source.

Subsequently, in January 1988 the Government provided the Countryside Commission with a further £250 000 which allowed grants to be offered to certain local authorities which had for various reasons not benefited from the first round of allocation. Finally, in November 1988 the Government announced that it was making £6 million available for support of restoration operations in 1988/89 and 1989/90, with £2.5 million each year for work in the two succeeding planting seasons (MacIlwaine, 1989).

With regard to woodlands, the Forest Windblow Action Committee (1988) recommended provision of a transport subsidy as well as additions to the usual Forestry Commission grants available for restocking. Their call for assistance was supported by the House of Commons Agriculture Committee as already noted. In addition the Home Grown Timber Advisory Committee (1988), the statutory body responsible for advising the Forestry Commission, reported its "strong view that, without a transport subsidy to make the blown timber competitive outside the south-east, much valuable timber could rot on the ground".

On 7 June 1988 the Government announced that it would provide extra grant aid amounting to £3.5 million over the following 5 years as an incentive to woodland owners to replant storm-damaged areas (MacGregor, 1988). The Minister's statement was as follows:

"I am replying today to the Select Committee and a copy of my response will be placed in the House of Commons Library. Both the Select Committee and the Forest Windblow Action Committee recommended further financial assistance to deal with the rehabilitation of storm-damaged woodland. The Action Committee in particular recommended:

i. a short-term transport subsidy aimed at

encouraging the movement of pine and beech wood to more distant markets (supported by the Select Committee);

ii. a supplement to the normal Forestry Commission grants for replanting woodlands damaged in the storm of 16 October 1987.

After careful consideration of these recommendations, I have taken the view that the Action Committee's second proposal would provide a longer-lasting and more direct benefit than a transport subsidy, in respect of the woodlands concerned. I recognise that owners whose woodlands suffered storm damage on 16 October 1987 will incur additional costs both in preparing sites for planting and in the planting itself. As an incentive to replant in these circumstances, I therefore intend to make special supplements of £150 per hectare for conifers and of £400 per hectare for broadleaves available over the next five years on top of the Forestry Commission's normal planting grants in respect of restocking in these storm-damaged woodlands. These supplements will be provided for eligible restocking carried out by applicants under the new Woodland Grant Scheme and for those who still qualify under the Commission's old schemes. On mature consideration the Government has concluded that such a supplement is the best way of meeting the Select Committee's concern that we consider whether more support should be available to help repair the damage.

I have decided that there is an insufficient case for a transport subsidy. In reaching this conclusion, I have to take account of the fact that the loss of timber value, as opposed to the replanting cost, is insurable. The effect of a subsidy would be to reduce the insurable loss which it is not appropriate for the Government to undertake. Moreover, where there is a local glut after a storm prices will decline in any event and as a result it will be more economic for purchasers of timber to transport it, including over greater distances. Such a subsidy in these circumstances would be unlikely to provide cost-effective benefits.

Full details of the administrative arrangements for the new supplements will be announced by the Forestry Commission as soon as possible, but any owners who have already taken steps to secure the replanting of their storm-damaged woods under the Commission's grant schemes will not be placed at a disadvantage as we have agreed that the supplement may be applied to them retrospectively.

It is estimated that the total cost of the supplements, covering the replanting of some 5000 hectares of conifers and 7000 hectares of broadleaves, will come to £3.5 million over the five-year period. There will be no addition to the overall provision for public expenditure programmes set out in Cm 288-11.

I hope that full advantage will be taken of these special supplements, so that the much-loved landscapes so sadly affected by the storm can eventually be restored to their former state."

It was initially proposed that applications for these supplements would be required before 31 March 1989 but, as a result of representations by the Timber Growers UK, the Forestry Commission agreed that the closing date would be extended to 30 June 1989.

An important provision made by the Government concerned the tax treatment of clearance and restocking operations. It should be explained that in his Budget Statement of 15 March 1988, the Chancellor of the Exchequer announced the complete removal of forestry from income and corporation taxes (Forestry Commission, 1988a,b). Existing occupiers of commercial woodlands could qualify for continuing Schedule D tax relief on woodland expenditure under transitional arrangements (until 5 April 1993) providing that they were not in receipt of grants under the new Woodland Grant Scheme. However, special provision was made in the Finance Act 1988 whereby occupiers of storm-damaged woodlands could elect to treat specific areas of woodland as a separate estate for the purposes of the transitional rules. Thus, if they wished

to clear and replant their woodlands in stages, they could make successive elections in respect of each area as it was replanted under the Woodland Grant Scheme. This provision allowed the remaining woodland to continue to attract tax relief on clearance costs.

**Chapter 5**

# Harvesting and Marketing the Windblown Timber

## *The first 48 hours*

The immediate response to a catastrophic storm must be to rescue any injured or trapped people, to clear roads, other communications and power lines as well as trees which have damaged property. While local authorities and public utilities took the lead, forest managers on estates and in Forestry Commission forests were very heavily involved in giving assistance for at least the whole week following the storm. The Army was called in in several places as were outside contractors. Many people tried to help themselves and there were a number of serious injuries and fatalities during this initial clearance period caused by lack of training in chainsaw use and the extra hazards of working among windblown trees. Having assisted in the clearance of county roads and powerlines, forestry staff concentrated on clearing the major internal routes in their own woods to allow access to assess the damage and assist clearance. Removal of trees obstructing public footpaths and bridleways followed the clearance of forest roads but this work could not be completed in some places for up to a year after the storm.

## *Setting priorities and targets for clearance*

There are three principal factors which determine the rate of clearance of windblown timber, namely its likely rate of deterioration, harvesting resources and markets. These are considered in turn.

Unless treated or stored under special conditions, timber is subject to staining, decay and insect attack. Depending on the level of damage it will become unsuitable for higher value markets and ultimately will become unsaleable. The durability of timber varies with species. In addition, the greater the proportion of the root system still in contact with the ground, the longer the tree is likely to remain alive. Thus many windblown trees will survive for a year or more and will retain some resistance to attack by insects and fungal pathogens.

It rapidly became apparent that the major species at risk of serious degrade were Corsican pine, Scots pine and beech, and that the large volume of these species in the windblow would necessitate careful attention in setting timetables and priorities for clearance. The effect of staining on wood quality is mentioned elsewhere, and it was recognised at the outset that staining would have an impact on market acceptability. Disquiet was expressed by some merchants on the implications of such infection.

Advice on the desirable order of clearance of the different species was first given in Research Information Note 127 (Hibberd, 1987) and this was elaborated in guidance from the marketing advisory group of the Forest Windblow Action Committee in January 1988. It was pointed out that, where possible, broken or shattered trees should be cleared first. Trees on the root would remain green and, with the exception of pines and beech there was a time scale of 2 to 3 years in which clearance could safely take place, and for some species as long as 5 years. For pine and beech, fungal attack on exposed wood surfaces would occur during the spring and summer of 1988. However, for trees on the root with bark intact, the penetration of fungi causing first staining, then rotting of the wood, would not be a

serious problem until insect vectors were present in increased numbers; this was expected to be the early summer of 1989. This suggested that clearance of pine and beech should be completed by spring 1989, although it was recognised that this might be impossible for resource or market reasons.

At the time of the storm little was known about harvesting resources available in the region except that the normal annual production in the area was only 775 000 cubic metres or approximately one-fifth of the volume blown. However it was expected (FWAC, 1988) that the harvesting capability could be increased by more than 50% relatively quickly and that although harvesting resources might be a constraint in the short-term, the greater problem would be the availability of markets to absorb the windblown material.

So far as markets were concerned, the position was materially different for conifers and broadleaves. The conifer element represented 40% of the total country production in 1987, whereas the broadleaved element was equivalent to almost twice the total cut for Britain as a whole. The Forest Windblow Action Committee recognised that the twin jobs of provision of marketing information and the encouragement of timber merchants from outside the affected area were high priority tasks. The Committee's guidelines (FWAC, 1988a) provide a valuable summary of the considerations to be taken into account in clearance and marketing.

With a large number of owners involved, the ready availability of advice was a matter of high priority. The three most important lines of advice consistently given were: do not be panicked into clearing up anything which is not a danger to life and limb, do not reduce the value of fallen timber by cutting into small lengths, and do not undertake any clearance work which you do not have the skills to tackle.

The setting up of the Forestry Commission's Windblow Task Force, based at Alice Holt Research Station, and the Countryside Commission's Task Force Trees in the Department of the Environment's Office in London removed most of the pressure on other offices and organisations to handle queries.

## *Experience to date on degrade*

Problems with degrade have proved to be much less serious than was expected in some circles. During the first year there was a remarkably low incidence of blue stain in pine: indeed this was virtually no greater than is expected with normal sawlog production. Two factors were important here. First, most of the blown trees were still partly rooted in the ground and these were able to flush and remain green throughout what was a generally cool damp summer. Second, populations of bark beetles were very low prior to the gale in many of the pine areas that suffered most from storm damage. This is of crucial significance because most blue-staining fungi are introduced to fallen trees by bark beetles. Beech is another species that is well known for its susceptibility to stain. However, here again the majority of the blown trees were still partly rooted in the soil. These trees typically flushed and remained green throughout 1988 and some also survived the dry summer of 1989.

Although the problems of true blue stain were not serious, there was, in the second year of harvesting operations, some concern over the effects of other stains on timber quality in a number of uses. On occasion, brown stain caused by fungi such as *Stereum sanguinolentum* and *Peniophora gigantea* has been found in both small roundwood and sawlogs. This form of defect is not acceptable in many markets, for example pulpwood for paper making where the brightness of wood fibre is of paramount importance. Such staining is also unacceptable in many sawnwood uses. However, other markets are capable of absorbing this material. To date, there has been very little degrade attributable directly to insect attack.

## *Progress of clearance*

Taking account of the clearance priorities and likely harvesting and marketing constraints, it was decided to adopt certain clearance targets. For private woodlands, the potential rate of clearance was necessarily uncertain and forecasting had to take account of the expected

difficulties in marketing broadleaves which were often of indifferent quality and scattered in their distribution. The Action Committee estimated that clearance should be completed by the end of September 1990, although a proportion of the volume would never be salvaged; they thought that this would amount to some 20%.

Forestry Commission windblow was mainly of pine species. The large volume blown down, and the likely market constraints, suggested that a period of 2½ years would be necessary for clearance, so the target adopted was March 1990. The experience of the 1986 gale in east England suggested that pine windblow, while much of it remained on root, should remain marketable for this period.

By the summer of 1988, the Action Committee estimated that the harvesting resources working in the area had reached a peak with an annual capacity of over 1.5 million cubic metres in the area.

Table 8 sets out the progress of clearance of woodlands at the time of writing.

conservation of landscape, wildlife and heritage; and in the availability of funds, including insurance (many owners were not insured against this kind of event). The first reaction of many of the affected landowners was that they would be faced with exceedingly high clearance costs which would not be offset by the value of the timber that could be salvaged. Through the press and Parliament, there were vigorous demands for the Government to provide help for clearance (see for instance the Agriculture Committee's recommendations) and landowners' organisations expressed great concern about the delay in a Government announcement about assistance for the forestry industry. The uncertainty was eventually removed with the announcement, on 7 June 1988, that the Government had accepted the case for assistance and that this would be in the form of a replanting supplement (see pages 21-23).

While it is difficult to generalise, reactions to the storm and the progress of clearance depended to a large extent on the owner's familiarity with

**Table 8.** Progress of clearance of timber in woodlands [a,b]

| *Quarter ending* | *Private Woodlands cu.m.* | *%* | *Forestry Commission cu.m.* | *%* | *Total cu.m.* | *%* |
|---|---|---|---|---|---|---|
| December 1987 | 127 000 | 5 | 60 000 | 6 | 187 000 | 5 |
| March 1988 | 432 000 | 16 | 169 000 | 16 | 601 000 | 16 |
| June 1988 | 670 000 | 25 | 302 000 | 29 | 972 000 | 26 |
| September 1988 | 870 000 | 32 | 430 000 | 41 | 1 300 000 | 35 |
| December 1988 | 1 150 000 | 43 | 570 000 | 55 | 1 720 000 | 46 |
| March 1989 | 1 306 000 | 48 | 755 000 | 73 | 2 061 000 | 55 |
| June 1989 | 1 550 000 | 57 | 875 000 | 84 | 2 425 000 | 65 |

*a* Excluding non-woodland trees, clearance of which by June 1989 was assessed at 100 000 cubic metres out of an estimated total of 170 000 cubic metres.

*b* Percentage calculated relative to 3.7 million cubic metres. This volume represents the original estimated total: in the event some blown trees may not be harvested while others such as leaning and edge trees may be removed.

## Clearance in private woodlands

The practical response of private woodland owners to the damage was highly varied, reflecting the wide differences in the market value of the fallen timber; in the owners' perceptions of the value of the timber; in the costs of harvesting and site clearance preparatory to restocking; in the value ascribed to woodland (whether a burden or an asset); in the degree to which owners felt a sense of responsibility for the

forestry practice and his knowledge of marketing and management services. Private woodlands could be divided into the following categories:

- estate woodlands managed under Forestry Commission schemes with resident forestry staff;
- farm woodlands with some trained staff but little knowledge of the market place;
- small woodlands — mostly amenity — where

owners have no knowledge of markets or access to trained forestry staff.

Few private estates in the south of England have their own harvesting staff. Where they do, the size of the labour force was quite unable to match the scale of the task facing them; on certain large estates the volume blown exceeded 10 times the normal annual cut. The bulk of the clearance and marketing work accordingly fell to round timber merchants and the harvesting sections of sawmilling and other processing firms. For these entrepreneurs, the operation was a straightforward commercial activity. Certain merchants alert to the main chance came in quickly, once access was possible, to remove the best sticks or butts of high value. But the main focus of attention in the first months, and with impending winter in mind, was the first category of larger, managed estates where the presence of roads and substantial volumes made the clearance operation attractive. Properties linked to the management companies were also relatively well served since they could call on associated contractors (Plate 8).

Dealing with the storm was much more difficult for owners in the second and third categories, often with relatively small total volumes, and the circumstances made more difficult by the small, mixed and often less accessible character of the woods to be cleared. Some owners did not receive information due to the lack of familiarity with the forestry press; efforts were eventually made to reach them through the farming press and by widespread mailshots. It was inevitable, however, that such owners would find it difficult to attract resources for clearance and harvesting, given the greater interest of contractors and timber merchants in the larger estates. Even now, it is difficult to judge how many of these owners have tackled their windblow or plan to do so. The response to the replanting supplement noted in Chapter 7 gives cause for encouragement, although there may still be a fair number of small owners who have been too discouraged or disinterested to respond and where clearance has not and never will be attempted because the cost is too high and the value of the timber too low to offset the clearance costs.

It became apparent very quickly that the Forestry Commission and local authorities were not going to be able to cope with the volume of consultations resulting from the vastly increased numbers of felling licence and grant scheme applications which were being submitted in respect of trees which were damaged but required a licence. The Commission therefore decided to suspend the consultation arrangements for storm-damaged woodlands; local authorities accepted this with virtually no complaints.

The volume of 1 150 000 cubic metres cleared from private woodlands in 1988 (see Table 8) represented an increase in harvesting capacity in the private woodland sector of 300% compared with 1987, a remarkable achievement. A major contribution was made by operators from other regions who came from as far afield as Scotland. Even those normally engaged on harvesting work found the conditions called for special adaptations. This was especially true of machine harvesting by processor and harvester which accounted for much of the volume of conifers and smaller plantation-grown broadleaves. The performance of such machines was so satisfactory as to justify the purchase by timber buyers, contractors and, in some cases, estates of new machines. Apart from the gains in labour productivity achieved, machine harvesting was associated with much lower accident rates. With two favourable winters in 1987 and 1988, productivity has remained high, albeit with some fall-off in the very hot summer of 1989. Some decrease in the rates of clearing broadleaves in 1989 was due to the reduced visibility arising from the dense crowns on blown but still rooted trees.

### Clearance in Forestry Commission forests

The distinctive feature of the damage in Forestry Commission woods was that pine formed the bulk of the timber and fears of degrade were therefore dominant. Based on the degree of damage, the eight Forest Districts in East England Conservancy were divided into four categories as follows.

1. North Lincolnshire and Sherwood had no

damage. Normal harvesting of pine and beech could be deferred.

2. Thetford, New Forest, West Downs and South Downs. By modifying programmes the volume of timber blown could be harvested without exceeding the planned harvesting volumes for the clearance period of 2½ years.
3. Suffolk. The volume of timber blown could be harvested within the clearance period by using the combined resources of Suffolk and Thetford Forest Districts.
4. Weald. The volume of timber blown significantly exceeded that which could be harvested by local resources, either Forestry Commission or private.

It was clearly important to take off the market as much material as possible and therefore all late thinnings and clear fellings of pine were withdrawn from sales plans. A number of contracts were cancelled or suspended by mutual agreement, and the labour released redeployed on to other work. This caused some disruption to certain timber merchants who had to adjust to the shift in their sources of supply, but their response was one of willingness to co-operate in dealing with the problem.

The main resource problems arose in the Suffolk and Weald Forest Districts. In Suffolk, some 1400 hectares wholly of pine were blown, the volume of which amounted to 11 years' cut. It was apparent that this timber could only be cleared within the desired time if labour from the neighbouring District of Thetford could be used.

There were various options ranging from overnight accommodation in hostels and caravans to travelling daily. It was finally decided to undertake daily travel with the appropriate allowances for the extended hours. Three second-hand buses were bought and modified so that they could be used as mobile mess/wet weather shelters. It is expected that transport of men from Thetford will have ceased well before the target date of March 1990 owing to the high outputs achieved and, additionally, the employment of contractors.

In the Weald Forest District the estimated volume blown down represented almost exactly 9 years' normal work. Over the previous 5 years the timber from the Commission's plantations had been sold standing. There had been a high proportion of low quality small sized thinnings and sales in the region were notably difficult. With this background it was evident that there would not be enough local contractors to deal with the damage. However, a doubling of the contractor force was expected as a result of the countrywide interest in the clearance. This left an estimated 160 000 cubic metres to be harvested by Commission labour. Two harvesters and three forwarders were purchased and a processor was transferred from North England Conservancy together with its two operators and the associated forwarder and operator. Operators for the harvesters and the forwarders were selected from as far afield as North Scotland.

The training for supervisors, operators and mechanics was planned by Forestry Commission Education and Training staff and conducted at the Machine Operator Training Centre in Scotland and at the Manufacturers' Training Centres in Sweden. The importance of team work was stressed throughout the training and installation stages of the project and the successful achievement of this objective has been the single most important aspect contributing to the overall success of the harvesting operation.

The skills required to deal with windblow are highly specialised and were not within the repertoire of harvesting workers in the area. For the training of chainsaw operators, four training officers were sent in to provide the necessary courses and at the end of an 8 week period 25 such courses had been conducted for almost 100 men. In addition, special training was given in the use of skidders and forwarders.

## Clearance of non-woodland trees

Local authorities gave priority to clearing blown trees from thoroughfares. Although trunks and branches were removed rapidly in the towns the root systems posed difficulties. The normally adopted method of chipping stumps was frustrated by limited availability of machinery and the insecure positioning of many root plates. Heavy lifting equipment and disposal of

stumps to tips or burning sites proved most effective. Highway authorities and utilities such as British Gas were then faced with considerable work re-laying services and making thoroughfares safe. In rural areas the work of clearing roads and reconstructing telephone and power lines was hampered by weakened trees falling days after the storm had passed.

In the aftermath of the initial clearance many highway authorities made inspections of trees remaining along roadsides. In some localities many additional trees were felled because they were thought to be suspect. Of potentially greater significance for the long-term appearance of the landscape were calls from highway engineers and through the media for all trees that could affect a road to be felled. This would have created vast treeless open corridors throughout both urban and rural Britain. However, it seems likely that there will be considerable opposition to breaking-open paving surfaces to introduce replacement trees especially if such trees would be near to the line of an underground service.

While local authorities and the utilities cleared those trees immediately hampering restoration of more normal life, private owners were left to clear their own accesses and land. Where trees had fallen across boundaries there was uncertainty as to who was responsible for clearance and who owned the timber. More important, where householders saw clearance of their blown and broken garden trees as an urgent need, contractors were drawn away from jobs of general concern such as the reopening and reinstating of services. Responses by contractors to such urgent demands from householders frequently led to what many considered unreasonable bills for clearance and tree surgery repair work. While some of the work was undoubtedly over-priced other operations were inspired by well-intentioned but often ill-informed advisers. There were also cases of inaccurate advice on timber utilisation.

Though the clearance of blown trees was an obvious first step, attention had also to be given to the many severed and broken branches that could fall at any time. The most difficult task facing managers and advisers remains the need to detect those trees that have suffered internal weakening but do not show external symptoms. These trees can be expected to fail and shed branches, suffer stem snap or root failure in weather conditions less severe than those recorded in October 1987.

## *Marketing*

With the very large volume of timber blown down and the very limited capacity of local markets, it was evident from the outset that marketing was likely to represent the major constraint on the rate of clearance. As already noted, the overall volume destroyed was equivalent to five times the normal annual rate of production in the area; within this total the volume of broadleaves was some seven times the normal broadleaved cut and that of conifers about four times the normal rate.

The marketing of conifers proved easier because of the high degree of organisation of the softwood markets. Good collaboration between small roundwood users ensured maximum uptake as a result of strong demand from consumers, particularly in the first year after the gale. Although the international market for pulpwood was not buoyant in this period, the export of a volume of some 200 000 cubic metres made a significant contribution to the early clearance work in 1988. Again, benefiting from buoyant domestic demand, coniferous sawlogs have found a ready demand from traditional pine and spruce markets, with sawmillers from the west country and the Welsh borders, attracted by lower prices, moving large volumes. Small quantities have been moved as far afield as the Scottish borders, and there was at least one consignment to north-east Scotland. It seems that the bulk of the conifer volume likely to be cleared will have been sold by early 1990, apart from that stored in the Forestry Commission's log store at Thetford referred to in Chapter 6.

The situation with broadleaved wood was much more difficult. It has to be remembered that there was a marked fall in the consumption of British grown broadleaved wood during the 1980s, the annual volume country-wide falling from 1.4 million cubic metres in 1980 to 1.0

million in 1987. Of the latter volume, sawlogs accounted for some 700 000 cubic metres. While landowners in and around the affected area withdrew timber from the market for standing timber, this represented only a small contribution towards the marketing of the huge volumes of windblown material of diverse species and variable quality. The most problematic species was beech and to a smaller extent other white hardwoods (Venables, 1988), and much of this timber was sold into lower value markets such as mining timber, fuel wood, pulpwood and wood for particle board. The two pulpmills at Kemsley, Kent and Sudbrook, Gloucestershire doubled their intake during 1988. There was, nevertheless, a proportion of high value hardwoods, mainly oak, sweet chestnut and high quality beech which has gone into veneers, the construction and furniture industries at home and abroad. The destination of exported hardwood species included Germany, Italy, France, Portugal and Turkey.

Useful addition to haulage capacity was provided by an extension to British Rail's arrangements for rail transport (Anon., 1988). Railheads established in south-east England made it possible to move some 40 000 tonnes by early 1989.

Despite the various steps to widen the market through the many merchants and contractors working in the area, prices within the affected area fell substantially. Table 9 shows estimated price levels in south-east England, before and after the storm, for various timber descriptions, while Table 10 shows the prices obtained for sawlogs at roadside in the 6-monthly Forestry Commission Cambridge auction over the period from July 1987 to July 1989.

## *Log storage*

A further option for disposal of harvested material is log storage. The availability of a convenient source of water at a site at Lynford, Thetford Forest, led the Forestry Commission to the decision to establish a wet store, as described in Chapter 6. This enabled faster clearance of the damage than otherwise, and prevented prices deteriorating further following the 38% fall in prices of sawlogs at the Cambridge auction in February 1988.

**Table 9.** Estimated price levels in south-east England

| | | *Prices in £ per cubic metre under bark* |
|---|---|---|
| *Description* | *Before October 1987* | *September 1988* |
| standing and windblown | | |
| mature pine | 20-25 | 10-15 |
| mature oak | 25-40 | 10-40 |
| mature beech | 15-25 | 0-10 |
| logs at roadside | | |
| pine | 35-40 | 20-30 |
| oak | 40-60 | 30-60 |
| beech | 30-35 | 10-20 |

*Source:* Dewar, 1988.

**Table 10.** Prices obtained in the Forestry Commission's Cambridge auctions for sawlogs free on lorry

| | | | | *Prices in £ per cubic metre under bark* | |
|---|---|---|---|---|---|
| *Grade* | *July 1987*[a] | *February 1988* | *July 1988* | *February 1989* | *July 1989* |
| Standard Category I | 50.14 | 30.84 | 32.57 | 34.83 | 42.61 |
| Merchantable | 46.05 | 24.59 | 30.76 | 33.48 | 37.27 |

*a* From non-windblown material.

## *Other considerations*

The main points to be taken into account in planning and carrying the clearance, marketing and restocking of windblown woodlands were set out in Guidelines issued by the Forest Windblow Action Committee (1988a).

It may well be the case, either from necessity or preference, that an owner does not wish to clear all windblown material. This may be forced on him for commercial reasons where the removal of low quality wood in less accessible areas lowers the overall price excessively, or for reasons of wildlife conservation. At the time of writing, it seems likely that a volume of the order of 200 000 cubic metres, or an area amounting to between one and two thousand hectares, may remain uncleared or only partially cleared. The importance of such treatment for conservation was recognised and guidance issued by the Forestry Commission (Harding *et al.*, 1988; Winter, 1988a, b) and the Nature Conservancy Council (1988).

# Chapter 6
# Timber Degrade

## *Pathological and entomological aspects*

Storm-damaged trees are subject to loss in timber value through the development of stain and decay and through the wood-boring activities of certain insects. The term 'stain' is given to a discoloration of the wood that does not involve a reduction in strength. The stain is often blue or brown in colour and is typically due to the colonisation of the wood by species of fast-growing fungi in the Ascomycete or Fungi Imperfecti groups. For structural timber it is not considered to be a defect: however, as already noted, stain may affect price. By contrast 'decay' invariably involves loss of wood quality through the degration of cellulose and often also of lignin. It is principally caused by Basidiomycete fungi.

On the basis of existing knowledge of the degradation of wood of different species, it was considered that the greatest problems arising from the storm would be encountered with the estimated 1.2 million cubic metres of pine and the 0.8 million cubic metres of beech. Research attention was accordingly concentrated on these species.

In the event, no disquiet over the condition of beech was expressed by the trade. This was undoubtedly because most trees were blown at the roots and these typically flushed and remained in leaf throughout 1988. No development of stain had been recorded in such trees by July 1989.

With pine, more serious problems of degrade did occur although here again these were less than had been feared. Within a few weeks of the gale a greenish-black discoloration was conspicuous on exposed pine sapwood surfaces, whether on broken material or on trees cut to clear the roads. Examination of samples from a range of forests confirmed observations made after the gale of January 1976: namely that this discoloration was almost entirely due to superficial growth of air-borne moulds such as *Botrytis cinerea* and *Epicoccum nigrum*. Very little deeply penetrating stain was observed on any storm-damaged pines before early summer 1989. However *Ceratocystis coerulescens*, a classic blue stain fungus, was associated with some cases of stain developing up from the roots of blown trees, with both Scots and Corsican pines appearing to be affected equally (Plate 9). Very commonly the wood of the base of the stained trees was fractured, and it seemed probable that these fractures had provided entry points for the fungus. *C. coerulescens* produces several sticky spore stages that are well adapted to dispersal by insects and mites, but it was not possible to determine the particular species of vector involved.

The great majority of pines had been uprooted rather than snapped and most had fallen in such a way that very little of the trunk was in direct contact with the ground. Under these conditions it seemed reasonable to expect that the key factor in the development of blue stain during the summer months would be the abundance in the locality of the pine shoot beetle *Tomicus piniperda*, the commonest among the group of insects which have the ability to invade and colonise the trunks of trees resting in this position. Accordingly guidance was given that harvesting operations should, in the first instance, be concentrated in areas where *T. piniperda* populations were likely to be high as a result of recent felling activity. It was recom-

mended that Scots pine should be cleared first, because of the beetles' known preference for breeding in this species rather than in Corsican pine. In order to provide data to reinforce this advice, beetle populations were monitored in key forests by means of surveys in spring when the number of beetles entering to breed could be estimated from the beetle frass, and also in late summer when the number of emergence holes of the young adult beetles could be assessed. This work produced reassuring results in that beetle populations were found to be very low through most of the major pine-growing areas affected by the storm.

More detailed studies were carried out at Alice Holt Forest. The results confirmed earlier work in showing that *T. piniperda* attack was greater on Scots pine than on Corsican pine, and showed also that in blown trees successful breeding only occurred in those trees that failed to flush. *T. piniperda* populations were found to increase 8-fold during 1988, thus providing a fair indication of the beetle's ability to exploit damaged pine.

The precise mechanism whereby *T. piniperda*-attacked trees become infected with blue stain has been the subject of some speculation. Unlike many other bark beetles, *T. piniperda* does not have a symbiotic relationship with any staining fungus, and it has been suggested that it may act principally by creating an entry point through the construction of its breeding gallery, leaving mites and small insects such as flies to introduce the fungus into the tree (Mathiesen-Kaarik, 1953; Dowding, 1973).

This topic was investigated through the course of 1989 by macerating samples of adult beetles collected at various times of year and by culturing from the wood below the galleries. From this work, one blue stain fungus, a species of *Leptographium*, was found to be regularly associated with *T. piniperda* and although the proportion of adult beetles that were carrying the fungus at the time of breeding was quite low (*c.*17%), it seemed likely that this was sufficient to account for the blue-staining that eventually took place. In particular, the tendency of the beetles to 'mass attack' particular trees, combined with a rapid growth of the blue stain fungus once established, gave no grounds for invoking the role of mites or other insects as vectors.

In parts of southern England, most notably the forests of Bramshill and Alice Holt, another pine bark beetle *Ips sexdentatus* quite commonly attacked the fallen pines. In Europe this insect is known to have several regular 'blue stain' associates and *Ophiostoma brunneociliata* and (probably) *O. ips* were isolated from stained wood and from beetle galleries at two study sites.

As would be expected, blue stain developed very rapidly in the harvested pine. Isolation from logs in summer and autumn 1988 indicated that *C. coerulescens* was a common cause of such stain, with *O. piceae* and various *Leptographium* species also being present. With all these fungi, insect- or mite-vectoring was likely to be the means of infection, with the entry points most probably being the protected spaces between bark and wood created by harvesting and handling operations (Dowding, 1973). In Corsican pine logs, *Sphaeropsis sapinea* was quite common. In contrast to the fungi mentioned above, this seems likely to have reached the logs under the combined influence of wind and rain.

Finally, on two sites, one in Alice Holt Forest and one on a low-lying part of the Crown Estates, near Windsor, columns of conspicuous blue stain were found extending from the roots for up to 8 metres into the trunk. The stain was invariably on the lower side of the tree at the butt, but commonly spiralled round following the grain. In cross section the areas of stain were often crescent- rather than wedge-shaped (Plate 10). The stained wood had a moisture content of 100% or more (as compared with 30-40% typically found with fungal blue stain) and had a strong 'kippery' smell. There was a clear resemblance to a condition described for windthrown beech on an iron-rich waterlogged site in Denmark, where it was attributed to an interaction between iron salts and bacteria under anaerobic conditions (Moltesen and Dalgas, 1973; Felumb, Gallemtoft and Moltesen, 1973). When samples of the stained pine were treated with oxalic acid the stain faded and this was consistent with iron, in some form, being the cause. At one site (Alice Holt) several blown beech adjacent to the affected pine were examined for stain and small

columns of discoloration extending some 20 cm from the butt were found on one tree. An oak with small columns of purple stain that seemed likely to be of similar origin was found at the Windsor site.

Virtually no decay problems were encountered while the trees remained unharvested. This is particularly because the fungi concerned (*Peniophora gigantea, Stereum sanguinolentum* and *Heterobasidion annosum* (*Fomes annosus*)) infect freshly exposed sapwood surfaces via airborne spores and few such surfaces exist as long as trees remain attached to their roots and retain their crowns.

On occasion, however, brown staining caused by *S. sanguinolentum* and *P. gigantea* did cause some problems over the acceptability of the wood for certain purposes. It is probable that most of this wood came from snapped trees.

During 1989 wood-boring Cerambycid beetles have been found in a small proportion of logs reaching the sawmill. Although very little damage has been done, opportunity is being taken to collect more information on this normally uncommon group of insects.

## *The prevention of degrade in logs of windblown pine*

In Scandinavia there is a well established practice of preventing the development of fungal stain in conifer logs by water storage. Originally the logs were kept in lakes and rivers mainly because of the widespread use of floating as a means of transport to mills, but during the last 20 years there has been a change to the use of a system whereby the logs are stored on land under water-sprinklers. Emergency use of this technique has been made following severe storm damage in several European countries, most notably West Germany where 1.4 million cubic metres of pine were stored for 2 years after a gale in November 1972 (Liese and Peek, 1984). Hitherto, however, the technique has not been used in Britain.

In the light of information gleaned from a visit to relevant research institutes in Sweden and North Germany, it was decided that water storage of Forestry Commission pine sawlogs should be undertaken and a site at Lynford, Thetford Forest was established in late March 1988 according to the recommendations of Liese and Peek (1984). The site, which eventually extended to cover 4 hectares, was on a sandy soil and was cleared of a young conifer crop for the purpose. It was immediately adjacent to a 4 ha water-filled gravel pit and gravel from an adjacent active pit was available to construct a road and hard standings.

The pine logs were close piled to a height of 3.5 metres and sprinkled with in excess of 45 mm of water per day from an agricultural irrigation system, the supply pipes for which were laid out over the top of the stack (Plates 11 and 12). Additional rows of sprinklers were used to keep up the moisture content of the ends of logs at the sides of the stack. Initially, a tractor-powered pump was used to obtain water from the gravel pit but in the autumn this was replaced by a fixed engine driving a Sykes pump. The sprinkler system was extended once a week to cover new logs that had been added to the store. Fifty thousand cubic metres of wood (measured 'overbark') were in store by December 1988, and by April 1989 the store was full with a volume of 75 000 cubic metres overbark. Emphasis was placed on the importance of only storing clean logs freshly sawn from the roots, and while adherence to this requirement was not complete, it is estimated that not more than 5% of the logs contained significant blue stain on entry to the store. Because organic compounds leach from the bark and sapwood, particularly during the first 6 months of storage, water quality was monitored regularly. As of March 1989 it had been found to vary between the levels set in European standards for 'acceptable' and 'recommended' values.

In June-August 1988, an experiment was established whereby selected logs of nine species were placed in the store. The variables being examined include length of time in store and the length of time before logs were placed in store after felling. Logs were obtained from windblown sources and cut to 4.9 m length and minimum top diameter over bark of 18 cm. Sample lots of about 10 cubic metres were placed on a 2 m high deck filled with non-experimental pine logs. Spaces between the

sample lots were infilled with similar non-experimental logs to the standard height of 4 m.

In February 1989 the first sample of 20 Corsican pine logs was removed from the store. The logs were found to saw easily and accurately with a wide bandsaw. Following sawing, it was found that 9 of the logs had no blue stain at all while the remaining 11 had some stain. From each of these a board was removed for analysis. The stain was always at the end of the log and was as common at the butt end as at the crown end. It is not possible to calculate the volume of wood that was stained but, even on the worst board, the stained area did not cover more than 6.2% on the surface. On average, the amount of stain on the 11 boards amounted to less than 2% of the surface area. A batch of pine logs which provided the bed for the experimental logs gave even better results when sawn, with only 5 of 30 logs showing any stain at all.

Only in one instance did culturing from the stained areas regularly result in isolation of a rapidly growing staining fungus (a *Leptographium*). It thus seems that the fungi are generally quiescent within the stored logs.

Sapwood moisture content was determined in both batches of logs and found to be similar to that in freshly felled pine. It was typically over 130% and even at the end of the logs it averaged 120%. This is satisfactory in view of the statement by Liese and Peek (1984) that for Scots pine a minimum sapwood moisture content of 100-120% is necessary to ensure protection against staining.

Experimental batches of Sitka spruce and beech were also sawn and found to be free from blue stain.

The Commission's expenditure on the log store represents a substantial investment. The financial result will not be fully known until the bulk of the timber has been marketed in 1990/91.

**Chapter 7**

# Restoration of Woods and Trees

## *Preparations for replanting*

The area damaged by the storm has the greatest concentration of broadleaves in Britain, dominated by oak on the lower ground and beech on the chalk downlands. There are also extensive pine woodlands on the sandy heaths, often with birch as a minor component. Although restocking would provide an opportunity for the rejuvenation of the many older woods that were destroyed, it seemed unlikely that there would be many changes in the established land use pattern, and that in most cases, site and other considerations would dictate replacement with the same or similar species. Replacing the trees lost in the storm could be done by replanting with young transplants or by natural regeneration. Although no particularly unusual technical problems were expected to arise, apart from those commonly associated with small-scale working, the need for careful selection and specification of operations was recognised. In smaller estates, opportunities exist for a more intricate silviculture than is generally possible or desirable on large-scale holdings and natural regeneration, briefly discussed below, would be expected to have a place in restocking plans.

As was shown in Chapter 3, the initial estimate of the area of woodlands requiring complete clearance was 16 500 hectares of which 12 500 hectares was in private estates, the balance being in forests managed by the Forestry Commission. Some check of this area will eventually be possible through applications for planting grant. Restocking of the storm-damaged areas qualifies for the Commission's normal planting grants under the Woodland Grant Scheme (Forestry Commission, 1988c) and, for existing owners of Dedicated woodlands, under the Dedication Scheme. In addition, as mentioned in Chapter 4, woodlands damaged in the storm of 16 October 1987 qualify for a special planting supplement of £150 per hectare for conifers and £400 per hectare for broadleaves.

At the time of writing, many of the applications for the windblow supplement are still being processed, but it appears likely that approved grant applications will slightly exceed the original estimate of the area damaged in private woodlands. So far only a relatively small area has been replanted, since resources have been devoted to clearance. The bulk of the area is likely to be planted between 1989 and 1992; in order to qualify for the supplement, planting must be completed by 31 March 1993.

Mention has already been made of the difficulties faced by small landowners, particularly those unfamiliar with forestry practices and markets, and not always conversant with sources of professional advice. To help explore and advise on the problems of restocking, the Action Committee decided to mount two restocking seminars, these were held in the form of field demonstrations at Bedgebury, Kent and at Charlton, West Sussex in early October 1988. They were attended by a total of 200 people, most of whom were owners of small woodland properties. The subjects covered included ground preparation, choice of species, planting stock and methods of planting, weed control, protection from insects and wildlife, natural regeneration and landscape, sporting and grant aid considerations. Also in 1988, the Tree Council held a conference emphasising the restoration of non-woodland trees (Tree Council, 1988).

Most owners feel very deeply about their

woodlands as can be judged from the fact that some 2000 applications were received for the supplement. This has been a most encouraging response and an expression of the intention of a great majority of woodland owners affected to undertake the restoration of their damaged woodlands.

Forestry Commission managers have put in hand planning for the replanting of some 4000 hectares of windblow in Commission woodlands. Unfortunate as it was, the storm has provided Commission staff with an opportunity for species diversification and the introduction of modern ideas on forest design.

## *Natural regeneration*

Where sites are small, scattered or inaccessible, natural regeneration is an attractive means of restocking and, since 1987 was a good seed year for beech in southern England and good, in parts, for oak, it was important to determine what potential natural regeneration offered. A survey was carried out to assess this during the summer of 1988.

Forty-five windblown sites in 15 areas of forest were sampled in east Hampshire, Sussex and Kent and regeneration of the principal broadleaves, mainly beech and oak, assessed on plots of 50 square metres. The results are shown in Table 11. About one-quarter of beech and oak stands which had been windblown appeared to have an acceptable stocking (more than 2000 trees per hectare) of timber species. However, it was clear from the survey that to take advantage of the regeneration mammal protection would be needed. Occurrence of regeneration was associated with patches of bramble, piles of branches, holly, etc. Treeshelters offer the most convenient means of protection of small numbers of seedlings.

While a stocking of 2000 seedlings per ha offers potential for development into a worthwhile stand, there remains the problem of patchiness and its management. To ensure reasonable development it is necessary to enrich gaps by planting where they are larger than 50 square metres (7 × 7m) and to clear or respace very dense patches (more than 10 000 per hectare) when about 2 metres tall. With this additional silvicultural attention, restocking of up to as much as one quarter of blown broadleaved stands largely by natural means is a feasible option.

## *Restoration of non-woodland trees*

The blowing over of mature trees was seen by some as an opportunity to rationalise and regenerate landscapes. During clearance, therefore, steps were taken to redesign sites and to secure suitable planting stock for the 1988/89 planting season. This sound practice was in contrast to the demands of amenity societies and the media whose ideas on replanting without planning and before sites had been adequately cleared can only be described as foolishly precipitate. In arboreta also, one-for-one replacement is not appropriate and many managers admit that the thinning out of old trees, sad though the loss appeared at the time, produced benefits that

**Table 11.** Proportion of surveyed plots achieving indicated stocking of seedlings of timber species

| | *Percentage* | | |
|---|---|---|---|
| | *Dominant species of blown stand* | | |
| *Stocking (numbers per hectare)* | *beech* | *oak* | *ash* |
| Over 10 000 | 5 | 14 | 95 |
| Over 2000 | 24 | 26 | 100 |
| Over 1000 | 33 | 31 | 100 |
| Over 200 | 65 | 49 | 100 |
| 0-200 (no natural regeneration in plot) | 35 | 51 | 0 |

neither they nor their advisory committees would have dared advocate. Meanwhile, the collection of grafts and seed has ensured that valuable material has not been permanently lost.

As noted in Chapter 3, urban street trees commonly develop asymmetric root systems and careful consideration should therefore be given to the positioning of future trees. In rural areas, natural regeneration may be expected to replace at least some of the trees, provided grass cutting is not extensive and browsing animals can be controlled.

Task Force Trees estimates that around half a million amenity trees were planted in 1987/88 and that a further 300–350 000 were planted in the 1988/89 season (MacIlwaine, 1989). Under the guidance of Task Force Trees, landscape rehabilitation strategies are being prepared by local authorities and, in conjunction with English Heritage, a special grant scheme has been launched for historic parks and gardens.

## *Entomological considerations*

There are wider implications of windblow than the impact of insects on the blown timber.

'Shoot pruning', the characteristic damage resulting from adult *Tomicus piniperda* burrowing into the bases of pine shoots during the autumn and spring, was noted during surveys carried out in several Forest Districts. In all cases there was little damage to standing trees surrounding windblown areas; this damage was confined to areas in close proximity to the blown material most heavily attacked by *T. piniperda*. However this is a potentially serious form of damage and the considerably increased populations of *T. piniperda* will need to be monitored for their impact on the remaining standing trees. The 'six week' rule for removal of breeding material from site is the only practical method of controlling this damage.

General surveys have also revealed considerable breeding activity by a number of other beetles that may have implications for the quality of harvested material or of replanted trees. In particular, populations of *Hylobius abietis* and *Hylastes* spp. have already shown signs of increasing in the areas affected by the storm. They will undoubtedly threaten programmes of replanting and it is essential that adequate insecticide treatment regimes are instituted in the areas affected. Bark beetles such as *Ips sexdentatus* and *Orthotomicus laricis*, weevils in the genus *Pissodes* and some longhorn beetles have already been noted in numbers in some locations such as Alice Holt Forest and it is likely that, where resident populations of these insects exist, they will build up considerably over the next year or two.

# Chapter 8
# Lessons of the Storm

The storm has implications for both preventive and remedial measures. Since the latter are of more immediate interest and insistent in their demands on managers following storm damage, they are considered first. The 2nd Report of the Windblow Action Committee (FWAC, 1989) prepared in May 1989 listed a substantial number of points which have been drawn on here to highlight points of potential use to managers in the future.

## *Damage assessment and clearance*

### Industry co-operation and the role of the Forest Windblow Action Committee

Even if all reasonable precautions are taken to minimise the risk of windblow it is inevitable that from time to time windblow will occur on a scale which exceeds local harvesting capacity and markets. It can be argued that if each individual woodland owner looks after his own interests then the price mechanism and market forces will result in a reasonably efficient allocation of harvesting resources and of timber to different markets. To a large extent the experience in the aftermath of the October 1987 storm supports this view. Harvesting resources were attracted into the windblow area by the prospect of better returns and as prices for timber dropped it became economic to transport the timber to many other parts of Britain and overseas. However, there are areas, such as the overall assessment of damage, and the provision of advice and information, where co-operation among woodland owners and other parts of the forest industry are desirable. It is therefore useful to establish a Committee with representation from private woodland owners, timber consumers and the Forestry Commission to co-ordinate action where this is desirable. The recent experience confirms the view formed of the usefulness, even necessity, of such a group following the 1968 storm in mid-Scotland (Holtam, 1971).

It will always be unlikely, given a free flow of information between owners and merchants and their contractors, that a Committee can be so knowledgeable and wise as to be able to effect any improvement in allocation of harvesting resources or of harvested timber. It is considered therefore that such a Committee should not try and direct harvesting operations or the allocation of timber to markets.

### The Windblow Task Force

The storm created a great demand from woodland owners for advice and information on how to deal with the problems created by windblown trees including their harvesting, marketing and eventual replacement. There was also a demand from the media for information on the scale of the damage and subsequently on the progress of clearance. One of the most useful functions of the Committee and its associated groups was in meeting these demands for advice and information. The Windblow Task Force was set up as the focal point for enquirers in order to more closely reflect this function. Following any future catastrophic windblow a Windblow Information Desk should be established and full publicity should be given to its existence.

### Assessing the scale of the damage

An early requirement was to compile information on the quantity of timber blown in order to

assess the implications for harvesting and marketing. For Forestry Commission woodlands the task was made easier by the existence of stock maps and a growing stock database from which standing volumes could be calculated. The commissioning of aerial photography allowed the extent of the windblow to be assessed quickly and volumes of windblown timber to be calculated, demonstrating that the more information already known about the woodlands the easier it is to assess damage.

It was not possible to assess damage in private woodlands in the same way as for Forestry Commission woodlands owing to the lack of detailed stock maps, growing stock data or adequate aerial photography. Even if these had been available it would not have been possible to carry out a full assessment quickly and cheaply. The relevance of these considerations increases with the rising proportion and absolute area of private woodlands. In order to make objective assessments, sampling is necessary. The samples assessed in the course of the 1980 census of woodlands were an invaluable tool in making assessments of loss by main category of type of woodland. This use of census material should be considered in designing future censuses. In addition, if blow does occur on a significant scale, all those engaged in obtaining aerial photography should collaborate to make the best use of resources. Experience has shown that certain users require information on tree numbers and, since tree size is relevant in harvesting, future damage assessments should provide estimates of tree numbers, broad assortment mix and area of woodland.

## Advice on clearance and marketing

The initial advice given to woodland owners emphasised the need to avoid taking hasty decisions and being forced into accepting low prices or incurring high costs. In general this was sound advice but the pattern of price changes was for a steady decline in the first 6 to 9 months as increasing quantities of timber came on to the market, and a slow recovery thereafter. Accurate and timely price information for main wood markets is desirable at all times and never more so in the uncertain conditions following a catastrophe.

The sudden increase in harvesting work as well as attracting competent harvesting contractors from other parts of Britain also gives opportunities for the unscrupulous to take advantage of the unwary or ill-informed. Those employing contractors should always clearly specify in a legally enforceable contract the work to be done and the amount to be paid. Likewise sellers of timber should always specify the goods for sale, access routes, final site conditions and price to be paid; and confirm the purchaser's ability to pay.

With the increase in demand for forestry contractors and the large quantities of timber available many woodland owners found it difficult to obtain contactors or buyers. Regional lists of forestry contractors and timber buyers should be maintained and be made available to enquirers.

## Recommendations for financial assistance

The extent of the losses and their effects on the wood market, on forest management and on the landscape are features unique to each windblow. Where the circumstances are judged as meriting financial assistance from Government, it is in the interest of owners of trees and woodlands that decisions should be taken early in the aftermath of a catastrophe.

## Monitoring clearance

A number of parties were interested in monitoring the progress of clearance. In this work it proved difficult to obtain adequate coverage of the smaller woodland ownerships. Depending on the significance of windblow in these ownerships consideration should be given to physical checks on areas immediately following the storm as a means of monitoring the progress of clearance.

## Publicity

Useful contacts were established with the media and editors were helpful in publicising the activities of the Windblow Action Committee and reporting on progress. However, some of the

publicity was not successful in reaching the target audience, especially owners of small estates and farmers. With the growing efforts to involve farmers in woodland management it may be hoped that the situation will improve; on both general grounds and concern over future windblows better links with the farming press are desirable.

## *Management of woodlands in the long term*

A first group of questions concerns the appropriate treatment of surviving trees and forests in the light of the possibility of future gales of similar severity. A second group concerns the design and management of replacement stock, and indeed of future restocking both in the damaged area and elsewhere. The importance of this as a continuing requirement was noted by Lord Montague (1988) who pointed out that the storm "revealed the disturbing extent to which the great historic parks and gardens, which form such a characteristic part of the landscape, have been allowed to fall into decay".

British silviculture in the uplands, especially on wetter soils, has had to adjust to continuing 'endemic' windblow because the losses otherwise arising from frequent damage are judged too severe to be acceptable. Accordingly, thinning which often renders a crop at least temporarily unstable, is not carried out, felling is carried out early and special attention in restocking is paid to cultivation and drainage. Increasingly in future the actual design will be planned; not only the stand boundaries, but also the tree itself through selection to favour types with desirable crown and root architectures.

Such conditions do not occur in the lowlands. Here, damage from typical winter gales is negligible and clearly not so great as to justify special management aimed at reducing any derangements that occur. What is at issue is the question whether management should adjust in order to reduce the loss that large-scale catastrophic gales undoubtedly cause.

A high proportion of the timber blown in 1987 was mature or in some cases overmature. Had a higher rate of felling been taking place, then the local harvesting and processing capacity would have been greater, the timber quality would have been better and the quantity of timber at risk smaller. One reason for the large quantity of mature timber is that timber production is often a minor objective of woodland owners in south and east England, while sporting values and the environmental benefits of woodland figure much more highly than elsewhere, so leading owners to retain trees past maturity. This attitude may have been reinforced by a belief that a felling permission would be difficult to obtain and, if granted, it would be expensive to satisfy replanting conditions. It follows that woodland owners should not be unreasonably discouraged from felling mature marketable timber provided there is an intention to replant.

### Age of felling

As noted in Chapter 3, older coniferous stands were more heavily damaged than younger and, although no such clear evidence of an age relationship arises with parkland and street trees, it seems likely that older broadleaved stands also suffered more damage. However felling at an earlier age would lead to losses for the landscape, for recreation and for wildlife conservation. Where these factors are important, and this applies in most of south and east England, it would be reasonable to delay felling beyond economic maturity. But this should be done in the knowledge that trees are living things and as they age they become increasingly vulnerable to damage and decay.

Over and above these considerations, it is clear that events with long return periods, unless by chance repeated at a short interval, do not influence thinking significantly many years after the event that triggers such reflections. This probably also applies, unfortunately, to the commitment to insurance. This situation is in contrast to that with endemic gale damage.

### Restoration and subsequent management

The other group of topics influencing trees and woodlands in the long term concerns the replacement and subsequent management of blown

trees and woods. In the first place, the owner has to decide whether to replant speedily or to wait. Cash flow considerations have a more than usual significance. This is because despite the general rise in revenue occasioned by harvesting several times the average annual volume in the region (though at lower than normal prices), there will be many owners with poorer harvesting and marketing possibilities, including low-value material with little, if any, revenue increase and a good proportion with heavy net costs. In addition, for all owners and even with the aid of planting grants, the burden of expense of replacing trees is considerable. In particular, many restocking areas are small and unit costs high.

Secondly, more than two-thirds of the blown area in private woodlands was of broadleaves. Almost all such areas will be restocked with broadleaved species, for which the costs are greater and, despite grant differentials, net costs in a proportion of cases will be higher than for conifers.

Instead of undertaking the burden of restocking over a short period, an owner may choose to delay action, to await and accept any natural regeneration that appears and generally to be patient. Peterken (1989) has emphasised the value of slow replacement of woodlands; a more heterogeneous range of habitats will result from this course. Dependence on natural regeneration, often with shrubby species or non-timber trees may, however, leads to a visual effect that many accustomed to a tailored appearance in the landscape of south-east England find hard to accept as desirable. The opportunity given by enforced destruction of trees in park or woodland to design anew is a valuable one.

For owners of large-scale woodland enterprises and for the Forestry Commission, the gains from rapid replacement are, on the other hand, substantial. Individual large blocks provide scale economies; weeds, particularly woody weeds, have less time to develop; and the cost involved in keeping quite fertile land in an unproductive state is minimised. Landscape planning is also improved where large blocks are worked.

Whatever course of action is adopted in restocking and subsequent management, it makes sense for owners to grow trees of value for their timber even if timber production is not their main object of management. This and the remarks made above concerning felling age are equally true for non-woodland trees.

The hope is that the long-term legacy of the storm will be an enhanced awareness of the need for careful consideration of each step in the management of trees and woodlands. As North (1987) put it, our woodlands make landscape while they live and furniture (and, it may be said, houses) when they die.

## REFERENCES


ADVISORY SERVICES BRANCH (1988). A detailed description of wind and weather during the passage of the storm of 15/16 October 1987 across southern England. *Meteorological Magazine* **117,** 104-109.

ANDERSEN, K. F. (1954). Gales and gale damage to forests, with special reference to the effects of the storm of 31 January 1953, in the north-east of Scotland. *Forestry* **27** (2), 97-121.

ANON. (1988). Timber takes to the tracks. *Timber Grower* 108, 21.

BURT, S. D. and MANSFIELD, D. A. (1988). The great storm of 15-16 October 1987. *Weather* **43** (3), 90-114.

CUTLER, D. (1988). Kew after the storm: new research. *Biologist* **35** (5), 239-243.

DAVISON, M. and CURRIE, I. (1988). *Surrey in the hurricane.* Froglets. (120 pp.)

DEPARTMENT OF THE ENVIRONMENT (1988). *Monitoring landscape change: October 1987 storm damage assessment.* Department of the Environment, London. (44 pp.)

DEPARTMENT OF THE ENVIRONMENT/ MINISTRY OF AGRICULTURE, FISHERIES AND FOOD/FORESTRY COMMISSION (1988). *The effects of the great storm: report of a Technical Coordination Committee and the Government's response.* HMSO, London. (43 + 2 pp.)

DEWAR, J. (1988). *Clearance of windblown timber: progress to end September 1988.* Forest Windblow Action Committee Paper 8/2.

DOLMAN, A. J. (1986). Estimates of roughness length and zero plane displacement for a foliated and non-foliated canopy. *Agricultural and Forest Meteorology* **36,** 241-248.

DOWDING, P. (1973). Effects of time and insecticide treatment on the inter-relationships of fungi and arthropods in pine logs. *Oikos* **24,** 422-429.

FELUMB, G., GAMMELTOFT, L. and MOLTESEN, P. (1973). Bakteriers medvirken til blåfarvning i stormfaldet, vandlagret Bog. *Dansk Skovforenings Tidsskrift* **58,** 91-102.

FILLON, M. (1988). Les chablis de Bretagne. *Annales de Mecanisation Forestière 1987.* ARMEF.

FOREST WINDBLOW ACTION COMMITTEE (1988a). *Guidelines for dealing with windblow in woodlands.* Forest Windblow Action Committee, Farnham, Surrey. (35 pp.)

FOREST WINDBLOW ACTION COMMITTEE (1988b). *First report to the Forestry Commissioners.* Forest Windblow Action Committee, Farnham, Surrey. (12 pp. + appendices).

FOREST WINDBLOW ACTION COMMITTEE (1989). *Second report to the Forestry Commissioners.* Forest Windblow Action Committee, Farnham, Surrey. (6 pp.)

FORESTRY COMMISSION (1988a). *Storm damage: replanting supplement.* Forestry Commission, Edinburgh. (5 pp.)

FORESTRY COMMISSION (1988b). *68th annual report and accounts for the year ended 31 March 1988.* HMSO, London. (67 + xxxvi pp.)

FORESTRY COMMISSION (1988c). *Woodland grant scheme.* Unpriced private woodland booklet. Forestry Commission, Edinburgh.

GIBBS, J. N. and GREIG, B. J. W. (1990). Survey of parkland trees subject to the great storm of 16 October 1987. *Arboricultural Journal* (in preparation).

HANDMER, J. and PARKER, D. (1989). British storm-warning analysis: are customer needs being satisfied? *Weather* **44** (5), 210-214.

HARDING, P. T., ALEXANDER, K. N., ANDERSON, M. A. and LONSDALE, D. (1988). *Conserving insect habitats provided in dead broadleaved wood by the wind damage of 16th October 1987.* Research Information Note 136. Forestry Commission, Edinburgh.

HIBBERD, B. G. (1987). *The storm of 16th October 1987.* Research Information Note 127. Forestry Commission, Edinburgh.

HILL, G. (1988). *Hurricane force: the story of the storm of October 1987.* Collins, London.

HOME GROWN TIMBER ADVISORY COMMITTEE (1988). Annual report for year ended

31 March 1988. In, *Forestry Commission: 68th annual report and accounts for the year ended 31 March 1988.* HMSO, London.

HOLTAM, B. W. (ed.) (1971). *Windblow of Scottish forests in January 1968.* Forestry Commission Bulletin 45. HMSO, London. (53 pp.)

HOSKINS, B. and BERRISFORD, P. (1988). A potential vorticity perspective of the storm of 15-16 October 1987. *Weather* **43** (3), 122-129.

HOUGHTON, D. M., HAYES, F. R. and PARKER, B. N. (1988). Media reaction to the storm of 15/16 October 1987. *Meteorological Magazine* **117,** 136-140.

HOUSE OF COMMONS (1988). *Storm damage of 16 October 1987.* Report of the Agriculture Committee (Chairman: Mr. J. Wiggin). HMSO, London. (114 pp.)

LAMB, H. H. (1988). The storm of 15-16 October 1987: historical perspective. *Weather* **43** (3), 136-139.

LAMB, J. (1989). *The ecological effects of the great storm of October 1987.* NCC Report 937. Nature Conservancy Council, Peterborough. (120 pp.).

LIESE, W. and PEEK, R. (1984). Experiences with wet storage of conifer logs. *Dansk Skovforen. Tidsskrift* (Sonderheft), 73-91.

MACGREGOR, J. (1988). Storm damage: statement by the Minister of Agriculture. *Hansard, House of Commons,* 8 June, **134** (162), 493-494.

MACILWAINE, H. (1989). Private communication, Countryside Commission.

MATHIESEN-KAARIK, A. (1953). Eine Übersicht uber die Gewohnlichsten mit Borkenkäfern assozierten Bläuepilze Schweden und Einige für Schweden neue Bläuerpilze. *Medd. Statens Skogsforskningsinst.* **43,** 1-29.

MOLTESEN, P. and DALGAS, K. F. (1973). Rodlagring af stormfaeldet bog. *Dansk Skovforenings Tidsskrift* **58,** 1-37.

MONTAGUE, LORD (1988). In, Gale damage. *Hansard, House of Lords,* 21 January, **492** (63), 381-383.

NAMIAS, J. (1989). Anomalous climatological background of the storm of 15-16 October 1987. *Weather* **44** (3), 98-105.

NATIONAL TRUST (1989). *Annual report for 1988,* 11.

NATURE CONSERVANCY COUNCIL (1988). *Nature conservation guidelines for the management of storm damaged woods.* Nature Conservancy Council, Peterborough. (6 pp.)

NEUSTEIN, S. A. (1971). Damage to forests in relation to topography, soils and crops. In, *Windblow of Scottish forests in January 1968* (ed. B. W. Holtam). Forestry Commission Bulletin 45. HMSO, London.

NORTH, R. (1987). Time to plant tomorrow's mighty oaks. *The Independent,* 20 October.

ONSLOW, EARL OF, *et al.* (1988). In, Gale damage. *Hansard, House of Lords,* 21 January, **492** (63), 378-400.

PETERKEN, G. (1989). Defending the great storm. *Tree News,* May, 14. The Tree Council, London.

POTTER, M. J. (1987). *Restocking after windthrow.* Research Information Note 131. Forestry Commission, Edinburgh.

POWELL, A. (1989). Personal communication.

QUINE, C. P. (1988). Damage to trees and woodlands in the storm of 15-16 October 1987. *Weather* **43** (3), 114-118.

RIDLEY, N. (1987). Storm damage (England): statement by the Secretary of State for the Environment. *Hansard, House of Commons,* 21 October, **120,** 731-744.

ROLLINSON, T. J. D. (1987). *Timber measurement of windblown trees.* Research Information Note 130. Forestry Commission, Edinburgh.

SAYERS, A. (1988). British roundwood market report. *Forestry and British Timber* **17** (7), 12.

SHAW, M. S., HOPKINS, J. S. and CATON, P. G. F. (1976). The gales of 2 January 1976. *Weather* **31** (6), 172-183.

SIGMON, J. T., KNOERR, K. R. and SHAUGHNESSY, E. J. (1984). Leaf emergence and flow-through effects on mean windspeed pro-

files and microscale pressure fluctuations in a deciduous forest. *Agricultural and Forest Meteorology* **31,** 329-337.

SWINNERTON-DYER, P. and PEARCE, R. P. (1988). *The storm of 15/16 October 1987.* Report for the Secretary of State for Defence. HMSO, London.

TASK FORCE TREES (1988). *Action pack.* Countryside Commission, Cheltenham.

THOMPSON, D. A. (1988). *Effects of the gale of October 1987 on sawn pine timber.* Research Information Note 138. Forestry Commission, Edinburgh.

TREE COUNCIL (1988). *After the storm – one year on.* Proceedings of a conference. The Tree Council, London. (Typescript, 61 pp.)

VENABLES, R. (1988). Advice on clearance. *Timber Grower* 106, 18.

WINTER, T. G. (1988a). *Insects and storm-damaged broadleaved trees.* Research Information Note 133. Forestry Commission, Edinburgh.

WINTER, T. G. (1988b). *Insects and storm-damaged conifers.* Research Information Note 134. Forestry Commission, Edinburgh.

WOODROFFE, A. (1988). Summary of weather pattern developments of the storm of 15/16 October 1987. *Meteorological Magazine* **117,** 99-103.

**Appendix**

# Membership of the Forest Windblow Action Committee, the Windblow Task Force and Advisory Groups

## *Forest Windblow Action Committee*

Mr J. Goodwin (UKWPA) – Chairman
Mr J. Dewar (FC) – Joint Secretary
Miss A. Sayers (TGUK) to April 1988 – Joint Secretary
Mr P. Wilson (TGUK) from April 1988 – Joint Secretary
Mrs P. Greenwood (TGUK)
Mr S. E. Quigley (FC)
Mr G. Waugh (BTMAEW)

## *Windblow Task Force*

Mr J. Dewar (FC) – Leader
Mr R. Stern (FC)
Miss V. Shipp (FC)
Mr A. Taylor (FC)
Miss L. Caless (FC)

## *Damage Assessment Advisory Group*

Mr J. Dewar (FC) – Chairman
Mr J. Hardcastle (TGUK)
Mr H. Long (TGUK)

## *Marketing Advisory Group*

Mr A. Willis (BTMAEW) – Chairman
Mr R. Stern (FC) – Secretary
Mr A. Cobb (BTMAEW)
Mr S. Goody (BTMAEW)
Mr C. Irwin (TGUK)
Mr M. Oxnard (UKWPA)
Mr S. Quigley (FC)
Mr R. Venables (TGUK)

## *Financial Advisory Group*

Mr D. Gittins (TGUK)
Mr R. Herbert (FC)

## *Harvesting Advisory Group*

Mr M. Lofthouse (FC) – Chairman
Mr S. Maunder (UKWPA)
Mr C. Price (BTMAEW)

## *Restoration Advisory Group*

Mr B. Hibberd (FC)
Mr R. Lewis (TGUK)
Miss A. Sayers (TGUK)

*Note:*

| | |
|---|---|
| BTMAEW | British Timber Merchants' Association of England and Wales |
| FC | Forestry Commission |
| TGUK | Timber Growers UK Ltd. |
| UKWPA | UK Wood Processors' Association |

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