Windthrown in State Forests in the Republic of Ireland[1]

G. J. GALLAGHER[2]

Background

"A north west wind, along with the west wind to its south prevails here, and is more frequent and violent than any other. It bends (in the opposite direction) almost all trees in the west that are placed in an elevated position, or uproots them." This is not the acquisition report on a new planting site, but the comment of a visitor to Ireland, the Welsh monk Geraldis Cambrensis, who toured Wicklow in 1183 (O'Meara 1951).

That Ireland should have an endemic windthrow problem is hardly surprising, situated as the country is on the edge of Europe in the paths of the Atlantic depressions. Indeed in a review of storms throughout Irish history (Dixon 1959), wind and its effects can be traced back, in the annals of Clonmacnoise, to 1029 B.C. Storms and tempests have been mentioned regularly since A.D. 563, according to the Annals of Ulster. Here, the first mention of windthrow refers to A.D. 856 when "very great winds blew down woods and laid waste the islands in the lakes". Destructive storms have been recorded since then, numbering up to 15 in a century—and averaging about 7 per century. It is also interesting to note that exceptionally severe storms have occurred around the beginning of each century since 1608, when "a great tempest causing shipwreck occurred in Dublin". The greatest of the British "big winds" occurred in 1703, while "appalling disasters" occurred on the 19th of November 1807. This was followed by severe storms in 1815 and the "night of the big wind" in 1837, which caused damage to the extent of £64,000 in Dublin. The second greatest storm in recent historical times was in 1903 when 3,000 trees were uprooted in Phoenix Park. In fact damage to woods and plantations was widespread (Anon 1903). Windthrow was noted at Dromconrath, Ballybrack, Waterford, Kilkenny (thousands of trees), Killaloe, Nenagh (hundreds of thousands of trees) and Rockingham. The frequency of these storms seems to fit a pattern of exceptionally severe winds every century, being severe every 35 years or so—with bad storms also occurring at intervals of 11 to 15 years (Dixon 1959, 1974).

Storm damage in State forests

Though storm damage has occurred extensively in private wood-

1. Paper delivered at Wind Risk Symposium, Pomeroy, Co. Tyrone, 1st–3rd May 1974.
2. Research Branch, Forest and Wildlife Service, Dublin.

lands throughout the years, this paper will deal primarily with State forests because more detailed information is available. State forestry commenced in Ireland in 1903. The incidence of storm damage has been recorded in Departmental annual reports and files since 1915. Significant damage is reported for years ending March 1916, '36, '38, '40, '43 and '44. (Table 1.) While the magnitude of the damage must be related to the area under trees, it is probable that the storms of 1935–'36 caused relatively severe damage considering that the area of productive State woodlands was only 4,000 ha.

TABLE 1

Records of Early Windthrows

Year ending March	Extract from Report
1916	Some timber blown by severe storm.
1930	Windfalls in Douglas fir.
1931	Windfalls in Douglas fir
1936	Whole plantation of Larch and Douglas fir suffered. Thousands of trees were blown. Winds and snow occurred on 9th–10th January 1936.
1938	Serious storm damage in recently thinned conifers at Dundrum.
1939	Some losses in October.
1940	Many trees uprooted on centre and north midlands.
1943	Kenmare and Killarney suffered. Large trees in Kilrush were felled in December.
1944	Windfalls in Northern District whose plantation had been recently thinned.

Table 2 gives more detailed information on storms occurring since 1944. Here we see the pattern of damage to plantations beginning to emerge—with severe storms in 1945/6, 1954/5, 1951/2, 1957/8 and 1961/2—culminating with the windthrows of January this year.

Estimations of numbers of stems blown, irrespective of size, and the volume they comprised, are given in Table 2.

They show windthrow occurrences over 30 years—during which

TABLE 2

Storms causing damage in State forests between 1944–1974

Year ending March	Month	Forests reporting damage	Trees blown (1000's)
1945	January	33	8.0
1946	September	31	5.0
1948	April	6	3.0
1949	—	—	1.0
1950	—	22	5.9
1951	September	35	3.4
1952	December	81	113.0
1953	—	2	—
1954	—	—	—
1955*	May–December	2	126.5
1956	—	4	4.7
1957*	January–February	144	281.5
1958	January	21	3.5
1959	November	19	1.5
1960	—	26	40.5
1961	December–January	34	25.1
1962*	September	140	213.0
1963	November–January	32	65.5
1964	February–March	11	58.0
1965	December–January	11	32.7
1966	October–February	13	37.7
1967	December–February	6	19.6
1968	December–February	2	2.7
1969	October–January	—	4.3
1970	October–January	—	2.3
1971	August	68	2.6
1972	February	39	3.0
1973	December	65	21.0
1974*	January	150	not est.

*Storms causing greatest damage to forests.

time the size of productive State forest area has increased from 55,000 ha to almost 250,000 ha.

Weather

Table 3 gives a very condensed outline of weather conditions over the last 17 years. (Meteorological Service 1954–'72.) It can be seen that during the two most severe storms, 1st January 1957 and 16th September 1961, maximum speeds during highest gusts were over

90 knots in parts of the country, while gusting was over 70 knots over all stations, with mean speeds during gusts averaging 50 knots. The table also shows that individual gusts of over 60 knots occur throughout the country each year. Most gales come from west and south-west.

TABLE 3

Maximum Gust and Windspeed during Gust for all Meteorological Stations (knots)

	Highest			Mean for all stations	
Year ending December	Date	Speed of highest gust	Mean windspeed during highest gust	Speed of highest gust	Mean windspeed during highest gust
1950	16/9	72	47	61	39
1951	27/12	82	51	66	42
1952	28/10	68	40	58	37
1953	19/4	69	35	56	34
1954*	15/1	83	40	65	40
1955	28/12	69	44	61	37
1956	29/2	81	40	65	40
1957*	1/1	94	66	77	50
1958	8/1	86	52	63	39
1959	13/11	85	53	73	44
1960	26/12	76	29	66	40
1961*	16/9	98	66	85	52
1962	15/12	80	54	71	41
1963	20/1	75	53	63	38
1964	7/12	75	51	64	40
1965	13/1	88	60	73	44
1966	25/2	87	58	72	44
1967	27/1	78	58	66	36
1968	14/1	91	60	72	43
1969	21/10	71	46	60	34
1970	3/11	71	44	62	38
1971	9/1	76	45	59	32
1972	3/3	81	56	65	41

*Storms causing greatest damage to forests.

The picture then is one of frequent and often extremely severe gales of an intensity likely, according to recent studies, to cause some damage each year.

The 1974 Storms

The details of the storms of January 1974 should be familiar by now. Gale gusts occurred on at least 20 days during the month, while severe storms occurred on the 10th–12th, 15th–16th, 27th–28th. These had gusts over 70 knots. The highest gusts were recorded at Cork on the 12th (94 knots) and at Claremorris on the 27th (97 knots). Rainfall was above normal, 220% above normal in parts of the southern half of the country (Meteorological Service 1974).

TABLE 4
Windblow volume expressed—as ratio m^3 blown per ha of State forests 21 years and over

Forest Year	Volume blown m^3 (1000)	Area 21 years and over (1000)	Ratio
1947/48	1.24	9.4	.13
1948/49	0.30	10.8	.03
1949/50	1.80	12.2	.15
1950/51	1.06	13.4	.08
1951/52	4.23	14.9	.28
1952/53	0.31	16.4	.02
1953/54	—	17.8	—
1954/55	40.87	19.5	2.09
1955/56	0.17	21.7	.01
1956/57	108.00	24.5	4.40
1957/58	1.10	27.5	.04
1958/59	0.47	30.5	.02
1959/60	12.68	32.6	.39
1960/61	7.87	33.3	.24
1961/62	84.86	34.8	2.44
1962/63	6.10	35.3	.17
1963/64	5.34	45.6	.15
1964/65	6.97	36.4	.19
1965/66	4.26	37.0	.12
1966/67	4.33	37.9	.12
1967/68	0.53	39.0	.04
1968/69	0.56	40.8	.01
1969/70	2.23	49.4	.45
1970/71	0.69	58.6	.01
1971/72	1.42	68.1	.02
1972/73	3.04	77.3	.04
1973/74	277.00	85.3	3.25
Total 27	574.58	920.0	14.76
Mean	21.28	34.1	.62

The preliminary data can be compared with a very different type of storm, the Debbie windthrow of September 1961 in which gusts

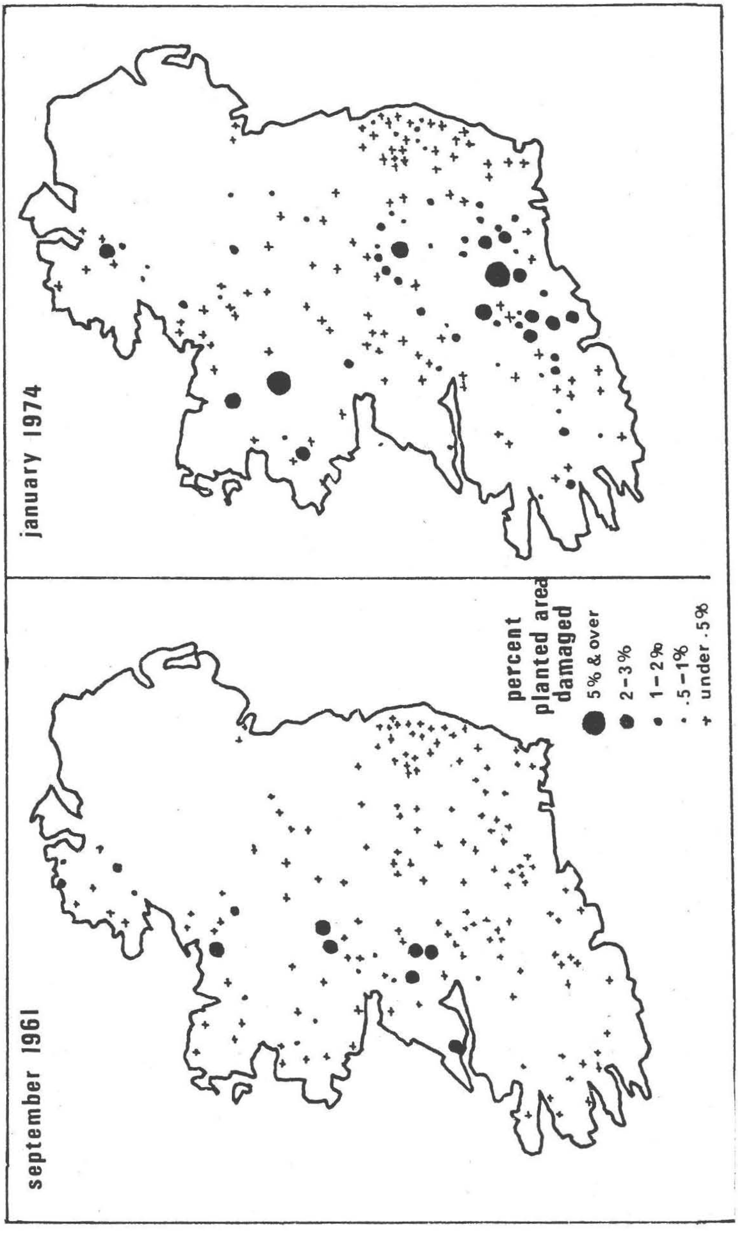

Figure 1: A comparison of area damaged in State forests in the Republic of Ireland in the storms of 1961 and 1974.

exceeded 90 knots over a wide area in western Ireland and over 70 knots over most of the island (Cruikshank, Stephens and Seymore 1962). Figure 1 shows the percentage, by area, of State plantations thrown. Forests damaged to the extent of 2–5% numbered 6 in 1961 and 10 in 1974. Those damaged to the extent of 1–2% were 3 in 1961 and 20 in 1974. Volume thrown in relation to total area—and to productive area was greater in 1974 (see Table 4). Damage was reported from some 140 forests in Forest year ending March 1962 and from over 150 in 1974. However as Table 5 shows, the ratio of volume thrown to area of forests over 21 years is not dramatically greater in the 1974 storms.

TABLE 5
Experimental and Permanent sample plots damaged
Thinning/Damage Category

	No Thin			Lt. to Mod.			Heavy			Mech.			Crown		
	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2
Contorta pine	2	3	3	5	6	9	–	4	14	1	5	12	–	–	–
Sitka spruce	25	–	–	25	–	1	6	3	8	40	9	6	6	–	1
TOTAL	27	3	3	30	6	10	6	7	22	41	14	18	6	–	1

0=Little or no damage
1=Moderately heavily damaged
2=Severely damaged

Expectedly, Sitka spruce (*Picea sitchensis*) and contorta pine (*Pinus contorta*) which now comprise 80% of the planting programme in the Republic, constituted the major species thrown in both storms.

As Figure 1 shows, damage was most severe in the south and south midlands as a result of the early January storms. Some individual forests suffered badly in the west and north-west from the storm on the 27th–28th January.

Breakage occurred in a number of centres, mainly in the older crops on dry soils. This was approximated at 15% of total numbers of trees.

Causal Factors

Research into causal factors has been carried out in Britain and Germany. Such aspects as mean wind speed during gusts and associated climatic factors (Gloyne 1968), topography factors such as oblique and middle windward slopes (Hütte 1968), susceptibility of species (Fraser and Gardiner 1967) and thinning (Neustein 1971) have been investigated.

Factors contributing to windthrow in the Republic

(1) *Climatic*

The historical detail given earlier demonstrates that our climatic conditions will result in extensive periodic windthrow—with severe gales at 10–15 year intervals, sometimes more frequently. The occurrence of annual gales at various locations suggests that some windthrow will occur each year.

(2) *Site*

The elevation, topography and soils, on which forests in the Republic are situated, mean that some of these must be pre-disposed to windthrow.

21% of the soils of the Republic are classified as mountain and hill, of which 5% are peaty gley and 3% peat. The 29% classified as wet lowland, include 8% Drumlin gleys and 10% of other gley soils, 7% climatic peats, and 3% basin peats (Gardiner and Ryan 1969). The forest area on peat is estimated at 101,000 ha (Carey 1973), 20,000 ha on high level peats, 20,000 ha on basin peats and the rest on climatic peat. An estimate of forest areas on peaty gleys and gleys shows approximately 10,700 ha on peaty gley, 7,000 ha on Drumlins, and 5,000 ha on other gleys. This amounts to a total of 123,700 ha on wet soils. As peat plantations are yet rather an unknown quantity as far as windthrow is concerned (Fraser 1965), forests, therefore, on soils definitely susceptible, amount to a little under 10% of the total productive area in State forests.

Other site factors to be considered are topography and elevation. 18% of the country lies between 244m and 360m, 21% of which is classified as mountain or hill. The many plantations at this elevation would lie on a variety of soils—podsols, peaty podsols, peaty gleys and peats. Again the most susceptible category here would be peaty gleys—about 10,700 ha or 5% of the national forest area. Valleys and rounded slopes are part of the environment of all our mountainous forests.

(3) *Silviculture*

Stress has been laid on thinning practices as factors contributing to windthrow. Thinning is, of course, general practice in State forests. Economic considerations, leading to the increased use of machinery, has meant the introduction of row thinning into many forests. "No thinning" regimes are the exception rather than the rule, and are usually related to very low productivity. The pressure for pulp and chipboard materials, and the need for fast growth has meant an increase in thinning intensity, and the "marginal" intensity proposed in forest management tables (Hamilton and Christie 1971) is now generally applied.

Virtually all plantations established since the early 1950s, over 200,000 ha, are on ploughed ground, another factor likely to contribute to instability.

Evidence of Contributing Factors

(1) *Climate*

Tables 2 and 3 indicate very generally that greatest damage in State forests was associated with individual gusts over 80 knots and mean of gusts in all stations over 65 knots showing average speed during gusts of over 50 knots. High gusting up to 60 knots for all stations occurs virtually every year.

(2) *Site*

By far the greatest damage is done during catastrophic storms and windthrow is greatest in the locality of the storm irrespective of site. For example, in the January 1974 storm windthrow occurred on old red sandston soils in the south, and on peaty podsols and shallow brown earths in the midlands. Damage occurred throughout a variety of topographical conditions.

(3) *Silviculture*

(a) *Species*

Sitka spruce and contorta pine constitute the major species to be thrown, followed by Douglas fir and other conifers. These proportions are probably related to proportion of the species in plantation.

(b) *Ploughing*

There are many instances of young plantations planted on ploughed ground being thrown—but the contribution of ploughing to windthrow cannot be specifically isolated.

(c) *Drainage*

Drainage in thicket plantations is not practised in the Republic so again no conclusions can be drawn as to its effects.

(d) *Spacing and Thinning*
Most plantations in the Republic were established at 1.6m–1.8m spacing.

Windthrows have been reported over the years from row thinned, selectively thinned and in a few cases unthinned plantations. Sample plots and thinning experiments have been damaged in the recent throw, and Table 5 gives a summary of damage done in various thinning treatments in two species. Here, it certainly seems as if unthinned plots get off lightly and heavily thinned contorta suffers. Also, however, a surprising number of row thinned plots in Sitka spruce have escaped serious damage.

Management Problems

The problems posed by extensive windthrow in management and marketing in State forests in the Republic can be outlined again, by reference to the January 1974 windthrow. In this context, the lessons learned from the 1961 and Scottish have been useful (Holtam 1971).

A committee was formed shortly after reports on the extent of damage caused on the 12th and 27th January. Its aims were to co-ordinate efforts in dealing with mensuration and extraction, and to review progress with clearing, without interfering in the normal chain of management command. Divisional officers were instructed to return estimates of thrown material as rapidly as possible. Initial returns indicated that the volume was between 200,000–300,000m^3. It became apparent that though extensive, the volume of thrown material would not greatly exceed the normal annual cut. Mature crops, however, constituted a large portion of the volume—this volume could be included within a two year normal clear fell.

The problem was mainly one of measurement and disposal. A questionnaire was issued to yield information on volume of sawlog and pulpwood material and extent of species, area and breakage. Information for sales purposes was also compiled—whether lots had been measured for sale, or sold. Extraction problems were also dealt with. An advisory group was set up to advise on measurement, and to provide help in the field if required.[1]

A study on factors contributing to the windthrow was initiated. The preliminary findings of the Committee put the damage into perspective. These were:

(1) In area, approximately 1,200 ha were thrown.

1. Forest and Wildlife Service. Unpublished information.

(2) Volume was estimated at at least 150,000m³ sawlog and 130,000m³ pulpwood.
(3) Breakage affected 15% of stems reducing useable wood content in these stems by 20%.
(4) The storms did not cause severe extraction problems.
(5) Though big by Irish standards the windthrow was not as fxtensive as those in Scotland or Germany in recent years. These have been estimated as 15,000,000m³ and 250,000,000m³ respectively (Holtam 1971, Hütte 1968).

Forecasting Windthrow

It has been shown that in the short-term windthrow has been, and will be a fairly unpredictable event. Management and silvicultural techniques will be unlikely to ensure against damage by catastrophic storms.

Over a long term it can be seen (in Table 4) that windthrow expressed as a ratio of volume per unit area of productive forest 22 years and over (O'Murgheasa 1964, O'Flanagan 1973) fluctuates as a result of severe storms. The ratio averages 0.62. Using this ratio an estimate could be made, as in Table 6, to cover 10 year periods or longer. While predictions within any given year would be unreliable they would serve as a guide for forecasting purposes and for early felling after a period free from storms.

TABLE 6

An Estimate of Windthrow for 1974–'84 in State Forests

Year ending March	Estimated area 21 and over (1000 ha.)	Volume blown ($1000m^3$)
1975	93.0	57.6
1976	101.0	62.6
1977	109.0	67.6
1978	117.0	72.5
1979	125.0	77.5
1980	133.0	82.5
1981	141.0	87.4
1982	149.0	92.4
1983	157.0	97.3
1984	165.0	103.2
TOTAL		800.6

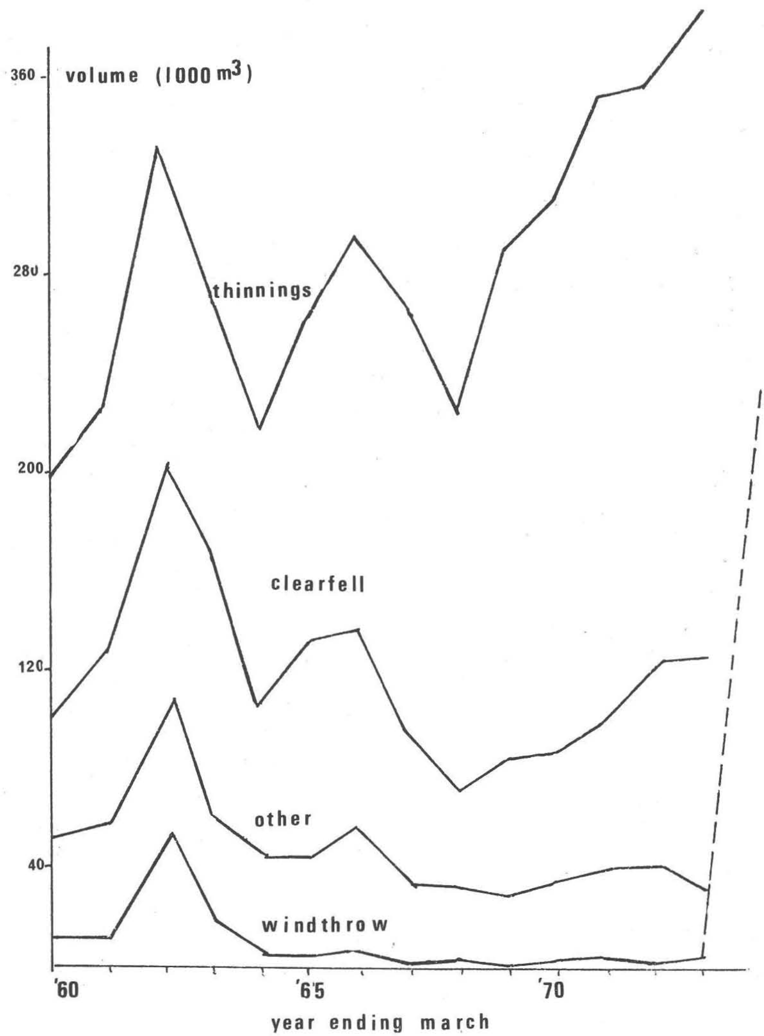

Figure 2: Volume (m^3) of blown material cleared each year in relation to total production (including cleanfell, thinnings and other fellings) iince 1960.

The release of thrown material over a number of years in relation to total production can also be seen on figure 2. In past years this has been a minor part of total production but the 1974 windthrow shows a rather different situation. Here thrown material will constitute the major proportion of total production forecasted at .34 million m^3 (O'Flanagan 1973) for 1974/'75.

Inferences and Conclusion

Our climate ensures that foresters must live with windthrow—and that it will be periodically extensive. In the short term this will be unpredictable. Investigations of storm periodicity may, however, help the forest manager to regulate felling, especially towards the end of periods of relative quiet. Soil and site conditions will predispose some 10% of our plantations to damage—perhaps much more if large areas of wet mineral soils are afforested. Though there is little room to extend species selection, consideration must be given as to how our conifer forests will be managed silviculturally —for example—the necessity of ploughing, spacing at establishment, thinning or no thinning and what rotation length to adopt. Records of new and continuing damage in these areas will be important. There also seems a need for soil/site mapping in individual forests. There is an obvious need to study the stability of peat plantations and to assess the relative stability of Sitka spruce and contorta pine.

It seems unlikely that damage from catastrophic storms can be greatly reduced by silvicultural techniques, though again some damage may be ameliorated by judicious management. However management must be considered with reference to demand and price for material as well as in the context of risks involved.

Up to now, the measurement and disposal of thrown material has not posed very serious problems, certainly not of the magnitude as in some other western European countries. In view of the extremely stormy conditions in January 1974 this is somewhat encouraging. Good communications between forest managers, marketers and merchants, and rapid feed-back of information from the forest greatly facilitate disposal.

The extent to which technology can deal with windthrow, by means of new and rapid methods of harvesting and processing, should not be underestimated.

Various institutions are involved in the study of wind and its influence. There is ample room for the exchange of ideas and facilities, to increase information on patterns of recurrence and biological and physical effects, without much replication. New techniques in computing will allow better analyses of the many interacting variables and provide management alternatives taking risk and economic factors into account. These studies require data which can be supplied through maintenance of adequate records and research.

References

Anon, 1906: British rainfall; Distribution of rain over British Isles.

Carey, M., 1973: Future utilisation of Peatland in Ireland. Paper, Agricultural Science Association, Dublin.

Cruikshank, J. G., Stephens, N., Symons, L. J., 1962: Report of the Hurricane i3 Ireland on Saturday, 16th September 1961. Irish Nat. Journal 14.1.4-12.

Dixon, F. E., 1953: Weather in Old Dublin. Dublin Historical Record 15. 65-107.

——, 1974: Personal Communication.

Forestry Division/Forest and Wildlife Service, 1935-'73: Reports of the Minister for Lands, Stationery Office, Dublin.

Frazer, A. I., 1965: The uncertainty of wind damage in forest management. Irish Forestry 22.1. 23-30.

——, and Gardiner, J. B. H., 1967: Rooting and stability in Sitka spruce Bull. 40. For. Comm. Lond.

Gardiner, M. J., and Ryan, P., 1969: A new generalised soil map of Ireland and its land use interpretation. J. Aric. Res. B. 95-109.

Gloyne, P. W., 1968: The structure of wind and its relevance to Forestry. Supplement to Forestry "Wind effects on the Forest" 7-20.

Hamilton, T., and Christie, J. M., 1971: Forest Management Tables (Metric). Booklet 17. For. Comm. Lond.

Holtam, B. W. (ed.), 1971: Windblow of Scottish Forests in January 1968. Bull. 45. Forestry Commission London.

Hütte, P., 1968: Experiments on windblow and wind damage in Germany. Supplement to Forestry "Wind effects on the Forest" 20-26.

Meteorological Service, Dept. of Transport & Power, 1957-'72: Weather Reports.

——, 1974: Agrometeorological Bulletin, Jan. 1974.

Neustein, S. A., 1971: Windthrow in For. Comm. Report on Research 1971.

O'Flanagan, L. P., 1973: The 1968 Inventory of woodlands of the Forest and Wildlife Service, Stationery Office, Dublin.

O'Meara, T. J., 1951: Topography of Ireland by Garaldis Cambrensis. Newly translated from the earliest MSS Dalgan Press.

O'Muirgheasa, N., 1964: Inventory Census of Woodlands. Forest Research Review. Forestry Division, Department of Lands, Stationery Office, Dublin.