CHARACTERISTICS OF HUNTER-COLLECTED DATA
ON WHITE-TAILED DEER MOVEMENTS
AND ENVIRONMENTAL CONDITIONS

by

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ABSTRACT

The Stump Sitters Whitetail Study Group collected data on white-tailed deer (Odocoileus virginianus) movements and associated weather conditions in 30 states and 1 Canadian province from 1 July 1977 to 31 December 1980. Data reliability was tested by comparing hunter estimated and instrumentally monitored weather conditions. Observers in the field less than 4 hours reliably estimated temperature, precipitation, wind velocity and sky conditions. Observers in the field more than 4 hours inaccurately reported weather conditions throughout the day.

Stump Sitters recorded 33,026.9 hours of observation and 10,121 deer sightings, most occurring from September through December in Wisconsin. Sex and age classes of deer seen were reported as doe (41.4%), fawn (21.9%), uncertain (21.7%) and buck (14.9%). Bowhunters recorded the most (58.4%) observation hours. The most often used hunting method and covertype were treestands (44.5%) and hardwood forests (41.9%) respectively. To compare weapons, hunting methods and covertypes used by observers, I used: 1) the numbers of deer observed and expected to be seen (effectiveness), 2) the total number of deer seen and the number of bucks seen per 100 hours of observation (efficiency), and 3) the mean minimum sighting distances (MSD) between the deer and observers for each variable class. Hunters who used bows, treestands and field edges were the most effective and efficient.

Deer observations occurred in 3 peaks: 0530 to 0930, 1130 to 1230, and 1830 to 1930. Deer moved directly into the wind for all 8 primary compass directions, proportionately more than moving directly with, perpendicular to, quartering with or quartering into the wind. For all data, there were no practical relationships between deer seen and the independent variables: hours, temperature, wind velocity, precipitation, snow depth and sky condition. Moderate relationships existed in November (R^2= 0.165) and December (R^2= 0.457) between deer seen and temperature, wind velocity, snow depth and sky conditions for a selected subpopulation of deer sightings from Wisconsin, Michigan and Minnesota. These relationships were not present in non-winter months. Recommendations were made for the improvement of data collection procedures.

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The hunter reliability survey was conducted at the Fort McCoy Military Reservation by permission of acting commander Colonel William Moran. Kim Mello, area fisheries/wildlife biologist, provided assistance in conducting the survey.

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INTRODUCTION

The Stump Sitters Whitetail Study Group (Stump Sitters) is a national organization of sportsmen interested in hunting, photographing and observing white-tailed deer. In July 1977, the Stump Sitters began a systematic collection of data on deer movements and associated environmental conditions. A cooperative research project was established between the Stump Sitters and the University of Wisconsin-Stevens Point on 1 August 1980. The objectives of this project were to: 1) evaluate the Stump Sitter data sheets to ensure their utility in recording deer and environmental observations, 2) test the reliability of data collected by the Stump Sitters, 3) store and analyze the data, and 4) evaluate deer movement/environmental relationships based on data collected by the Stump Sitters and compare these results with those of more conventional studies.

Zagata and Haugen (1974) used deer observations, hunting conditions and weather reports from 18 selected bowhunters to correlate deer activity with environmental conditions. Gunhunters have collected data in a number of other studies (Leopold 1931, James et al. 1964, Roseberry and Klimstra 1974, Thomas et al. 1976). The use of nonprofessionals to collect scientific data has been a widely accepted practice.

The relationships between deer activity and environmental conditions have been studied by several authors. In general, a deer day consists of alternating periods of rest and rumination, periods of activity (mainly foraging) and travel from 1 site to another (Linsdale and Tomich 1953). The number of activity periods and intervals between them varies geographically, seasonally, and as a result of weather conditions, human activity and reproductive phenology of the deer (Halloran 1943, Montgomery 1963, Behrend 1966, Michael 1965, 1967, 1970, Thomas 1966, Heezen and Tester 1965, Tibbs 1967, Marshall and Whittington 1968, Rongstad and Tester 1969, Ozoga and Verme 1970, 1975, Jackson et al. 1972, Zagata and Haugen 1974). Since these studies were done under different environmental conditions and experimental techniques, it is difficult to compare their results and determine which factors are most important in influencing deer activity.

Numerous studies have indicated relationships between deer movements and weather conditions. Progulske and Duerre (1964) reported that 85.3% of the variability in deer movements resulted from an interaction of 5 weather factors: cloud cover, temperature, precipitation, dew and relative humidity. The number of deer seen on a roadside census correlated with rainfall on the day before the census, wind speed, temperature range and barometric pressure (James 1976). Decreased deer activity has been associated with increasing temperatures (Michael 1970) and relative humidity (Hahn 1949, Tibbs 1967, Hawkins and Klimstra 1970), precipitation (Tibbs 1967, Hawkins and Klimstra 1970, Michael 1970), decreasing temperatures below 40°F and extremes in barometric pressure (Thomas 1966). Deer activity increased on cool cloudy days (Montgomery 1963), during high temperatures in summer in Pennsylvania (Tibbs 1967), low temperatures in winter in Michigan (Ozoga and Gysel 1972), and under decreased relative humidity and cloudless days (Hahn 1949). Increased wind resulted in nervous and wary deer (Hardin 1974, Rue 1978). Again, since these studies were conducted under different conditions, it is difficult to compare their results and determine which factors are most important in influencing deer activity.

This study generated data from a large geographic area over an extended period of time. I will compare the results of this study with those of more conventional studies and discuss the use of this method for monitoring deer movements and their relation to environmental factors.

METHODS

Hunter Reliability Survey

On 20 September 1980 and 19 September 1981 (opening days of the 1980 and 1981 Wisconsin deer/archery season), I conducted a hunter reliabilty survey (HRS) at the Fort McCoy Military Reservation, Tomah, Wisconsin. Fort McCoy is a 23,920 ha active military base, located in the driftless area of southwestern Wisconsin. Roughly 20,000 ha are open to public hunting (U. S. Department of Defense 1982).

At the Fort McCoy Hunter Registration Center, bowhunters were shown Stump Sitter #101 IN-WOODS TIME and #201 DEER SIGHTINGS data sheets (Appendix 1) and asked to recall weather and hunting conditions experienced in the field. During the post-hunt registration, 148 bowhunters filled out data sheets.

I instrumentally monitored weather conditions on both survey days at half-hour intervals from 0500 to 2000 at the Hunter Registration Center. I collected data with a Tru-Chek rain gauge, Cory 132411 Fahrenheit thermometer, Taylor 3106 wind direction indicator and Deutra-Werke hand-held anemometer. To be consistent with Stump Sitter data sheets and since nonprofessionals collected data, the English system of measurement and variable guidelines (Appendix 2) were used to report the data. I categorized data by year, weather condition and time. Morning (0500-1000), midday (1001-1500) and evening (1501-2000) periods were used to compare events. Statistical tests could not be used to analyze the data. They were subjectively evaluated by comparing the fit of the weather estimates to the actual weather distributions.

Data Collection

From 1977 to 1981, 188 Stump Sitters collected data on deer movements and associated weather conditions. Participants recorded observations on Stump Sitter #101 IN-WOODS TIME and #201 DEER SIGHTINGS data sheets, while in or immediately upon returning from the field. Variables recorded included date, time, hunting method, weapon, covertype, temperature, precipitation, snow depth, sky condition, wind direction, wind velocity, deer's sex and/or age, deer's direction of travel and the shortest distance between the deer and observer. Completed data sheets were sent to the Stump Sitters' headquarters for analysis.

Data Processing

Data Sheet Verification

In June 1980, the data sheets were examined to determine their validity, accuracy and usability. Omitted from the study were 1,363 IN-WOODS TIME and 1,863 DEER SIGHTINGS lines due to illegible markings, incorrect symbol usage, inappropriate time schemes, missing data, inability to identify individuals, area or year of collection and general inconsistencies.

Statistical Analysis

I used the HYGNSTROM job (Appendix 3) to convert data on tape and disk into Statistical Package for the Social Sciences (SPSS) data files (Nie et al. 1975). SPSS Subprograms BREAKDOWN and CROSSTABS were used to analyze distributions of observer-hours and deer seen by year, month, area, weapon, method, covertype, sky condition, precipitation and wind velocity classes. Effectiveness, efficiency and mean minimum sighting distance values (MSD) per variable class were used to compare weapons, hunt methods and covertypes used by observers.

Effectiveness was defined as the comparison of the number of deer expected to be seen (percentage of the total hours of observation per variable class x total number of deer seen) and the number of deer observed per class. Efficiency was defined as the total number of deer seen per 100 hours of observation per class (DPH) and the total number of bucks seen per 100 hours of observation per class (BPH). MSD were the distances between the deer and the observer when the deer was the closest.

Frequency distributions were developed for sex and age classes, temperature, snow depth, MSD and time seen. Time seen reports were selected from observers who were in the field at least 10 hours, started observing before 0700 and ended after 1700, to hold the effects of hunter activity and sunrise and sunset times constant.

I crosstabulated deer directions with wind directions to find associations between the two variables.

Stepwise multiple regression was used to determine the combined effects of temperature, snow depth, sky condition, wind velocity, precipitation and observer-hours on deer seen for all Stump Sitter observations. Nonlinear relationships were tested by computing the natural logarithms, squares, square roots and reciprocals of the dependent variable, deer seen, and inserting them in the stepwise regression. Zero order partial correlation coefficients were calculated to compare relationships within the regression variables. A subpopulation of deer sightings (SUBPOP1) was selected to reduce the variability of the data by including only reports from Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less. Tests run on data from all Stump Sitter observations were also run on SUBPOP1 data.

RESULTS AND DISCUSSION

Hunter Reliability Survey

All hunter estimates and actual recordings of weather conditions were plotted to show reliability relationships (Appendix 6).

Temperature

In 1980 and 1981, temperature estimates from observers in the field 4 hours or less were more closely associated with the the actual temperatures than were estimates from observers in the field more than 4 hours. In the morning in 1980, both the actual temperatures and the estimated temperatures from observers in the field 4 hours or less ranged from 15.6 to 21.1°C (60 to 70°F).

One observer was in the field 15 hours in 1980 and recorded the temperature as 21.1°C (70°F). He was in effect stating that the temperature was 21.1°C for the entire 15 hour period. Even though the actual temperature was 21.1°C twice during the day (a total of 2.5 hours), it fluctuated from 17.2 to 23.9°C (63 to 75°F) during the 15 hour period. This report was characteristic of most data collected in the HRS. Due to the excessive time lag, observers were ineffective in reporting temperature changes throughout the day. Time lags were also present for observers in the field 4 hours or less, but since their estimates were for much shorter periods of time ($\bar{x}$= 2.6 hours as opposed to $\bar{x}$= 7.0 hours for observers in the field more than 4 hours), the time lags had far less of an effect on the fit of temperature estimates to the actual temperature distributions.

Precipitation

In 1980, precipitation estimates from observers in the field 4 hours or less were more closely associated with the actual precipitation distribution than were estimates from observers in the field more than 4 hours. In the morning, 6 of 12 observers in the field 4 hours or less accurately reported fog from 0600 to 0800, but continued to report fog up to 1030 when there was no precipitation. This post-time lag (observational carryover after the actual event occurred) averaged 1.1 hours for the fog reports and may have been due to the varying topography of the study area. Nine of 20 observers in the field more than 4 hours accurately reported fog from 0600 to 0800 but had an average post-time lag of 7.7 hours. Fog was still reported by 55.6% of the respondents at 1800.

In 1981, there was no precipitation from 0600 to 2000. Since there was no change in precipitation, there was little variation in hunter estimates. These data were of minimal use in determining hunter reliability.

Sky Condition

In 1980, estimates of morning and midday sky conditions from observers in the field 4 hours or less were more consistent with the actual cloud cover distribution than were estimates from observers in the field more than 4 hours. From 1400 to 1700, sky conditions fluctuated hourly between partly cloudy and overcast. Because of excessive time lags, none of the estimates were accurate. Twelve observers reported clear skies in 1980. These reports are likely due to confusion with the abbreviation system since at no time were the skies clear. Respondents probably used the abbreviation "Cl" to represent "Cloudy" rather than the correct term, "Clear". This confusion probably did not exist with actual Stump Sitter reports as Stump Sitters were likely more familiar with the data sheets than the hunter reliability respondents were.

In 1981, the skies were clear throughout the day. Since there were no changes in sky conditions, there was little variability in hunter estimates. Therefore these data were of little use in determining hunter reliability.

Wind Velocity

In 1980, midday and evening wind velocities varied from calm to light and light to moderate, respectively. In 1981, midday and evening velocities varied from light to moderate. Observers in the field more than 4 hours were ineffective at estimating wind velocities due to excessive time lags for both years. Observers in the field 4 hours or less were moderately effective. The 7 observers who reported "gusty" winds in 1980 made accurate assessments of the highly fluctuating evening wind conditions. The morning winds were calm in 1980 and 1981. Observers in the field 4 hours or less in 1980 were effective in estimating the morning wind velocity. Conversely, observers in 1981 were ineffective.

In general those in the field 4 hours or less were moderately reliable in reporting wind velocity. When actual conditions changed rapidly, all observers were unreliable due to inaccurate recording and excessive time lags.

Wind direction

In the morning of 1980, all observers but 1 were accurate in reporting no wind. The remaining periods in 1980 and 1981 were ineffectively reported by all observers.

Prevailing weather conditions were monitored from a flat prairie region. Some degree of local variability in weather conditions probably existed because of the varying topography and vegetation of the study area. Differing terrains may have been responsible for some inaccuracy in observer wind direction estimates.

Hunter Reliability Summary

Observers in the field 4 hours or less were reliable in estimating temperature, precipitation, sky conditions and wind velocity. Observers in the field more than 4 hours were unable to describe changes in weather conditions due to large pre- and post-time lags. Localized variablity in weather conditions due to topography and vegetation may explain some of the discrepancy between estimates and monitored conditions.

The sample for the reliability survey was obtained from bowhunters on the Fort McCoy Military Reservation. They were not Stump Sitters and therefore were not a sample of the true population. Stump Sitter data used in this study were probably more reliable than data from the HRS. Stump Sitters were more familiar with the data sheets and objectives of this study and probably more devoted to the generation of reliable data than survey respondents.

Observer-related Variables

Time

From 1 July 1977 to 31 December 1980, the Stump Sitters logged 33,026.9 hours of observation and 10,121 deer sightings. Most hours (30.2%) and deer sightings (31.3%) occurred in 1978.

Hours of observation and deer sightings were reported for all months of the year; however, they were unevenly distributed. Most hours (91.7%) and deer dightings (88.1%)

occurred from September through December. This was expected because of increased hunting activities during the fall.

Area

Records were submitted by cooperators from 30 states and Ontario. Of the total observation hours, 75.6% were from 5 states. Most hours (45.7%) and deer sightings (47.0%) occurred in Wisconsin.

Weapon

Most of the 10,117 deer observations were by bowhunters (50.9%), followed by gunhunters (31.0%). Gunhunter effectiveness was low; they were expected to see 3,136 deer but observed only 1,801. In all other weapon classes, observers saw more deer than were expected (Appendix 10).

Efficiency values were used to compare the deer sighting productivity of weapon classes based on time. The least efficient was gunhunting (17.6 DPH and 1.9 BPH). The most efficient was camera hunting (42.4 DPH and 7.3 BPH), followed by no weapon and bowhunting.

I used the MSD between observers and deer to compare the impacts that observers in different classes had on deer activity. In my study, bowhunters experienced the lowest mean (49.9 m (55.6 yd)) and mode (18 m (20 yd)) MSD. MSD for observers using guns, cameras or no weapons were similar while the mode MSD for gunhunters (45 m (50 yd)) was less than the mode for observers using cameras or no weapons (90 m (100 yd)). Mean flight distances were longer in hunted than in nonhunted areas for deer observed in 2 Adirondack forests (Behrend and Lubeck 1968). Altmann (1958) reported a drastic increase in flight distances for moose (Alces alces) at the onset of hunting season. Shorter flight and sighting distances reflect lower levels of human disturbance. Based on MSD and the above assumption, bowhunters in my study affected deer activity less than other weapon classes.

Hunting pressure affects natural movements and home ranges of deer (Schoonmaker 1938, Halls 1978, Rue 1978). Sparrowe and Springer (1970) reported that in South Dakota, hunting pressure influenced deer movements and distribution more than any other factor. The differences in hunting pressure for each weapon class must be considered when studying the relationships between deer movements and environmental conditions.

Bowhunters had little or no effect on deer activity in Texas, as deer were seen near centers of activity on hunt days and there were no changes in home ranges (Downing et al. 1969). Zagata and Haugen (1974) used 18 bowhunters to observe dawn and dusk movements of deer in Iowa, and assumed that there were no effects on deer activity. Conversely, Downing et al. (1969) and Sparrowe and Springer (1970) reported that bowhunters had considerable effects on deer movements and distribution. In my study, bowhunters had the highest effectiveness and efficiency values and the lowest MSD for all weapon classes. These results suggest that disturbance of deer by bowhunters was low.

Sparrowe and Springer (1970) reported that rifle hunting had strong effects on deer distribution and movement. Similarly, in southcentral Wisconsin, deer traditionally moved into a heavily posted swamp shortly after the opening day of the deer-gun season to avoid hunting pressure (Larson et al. 1978). Gunhunters saw 75.0 DPH and 5.6 BPH in a northern Michigan enclosure under moderate hunting pressure (Van Etten et al. 1965). These efficiency ratings are high compared to those of gunhunters in my study (17.6 DBH and 1.9 BPH) and do not conform to the idea that deer sightings decrease as human disturbance increases. Perhaps this was due to the high hunter density and the fenced enclosure which excluded emigration of deer from the hunted area. Large MSD by gunhunters suggest that gunhunting reduces deer observability.

In this study, bowhunting had less of an effect on deer activity than gunhunting. No literature was found concerning the effects of nonconsumptive uses on deer, but with their high effectiveness and efficiency ratings, they are probably similar to bowhunting in their impact on deer activity. This is important since the reliabiltiy of deer movement data is dependent upon the amount of human disturbance.

Method of Observation

Most of the 10,088 deer sightings were by observers who used treestands (50.5%). Fewest deer were seen when drives were used (2.7%). Observers who used treestands were expected to see 4,488 deer but observed 5,099. Similarly, those who scouted were expected to see 1,519 deer but observed 1,915. Those who stillhunted, drove deer or used groundstands observed fewer deer than expected. The most effective hunting methods were scouting (38.7 DPH and 6.2 BPH) and the use of treestands (34.9 DPH and 5.5 BPH). Driving deer was the least efficient method (20.5 DPH and 1.6 BPH) (Appendix 12).

Observers who used treestands had the lowest mean (50.2 m (55.8 yd)) and mode MSD (18 m (20 yd)). Those who drove deer experienced the highest mean MSD (77.0 m (85.6 yd)) while mean distances for stillhunt, groundstand and scouting methods ranged from 60.0 m (66.3 yd) to 69.5 m (74.2 yd). Based on MSD, observers who used tree stands affected deer activity less and those who drove deer affected deer activity more than observers using other methods.

The method by which a hunter observes deer strongly influences his efficiency (Roseberry et al. 1969, Holsworth 1973). Most of the literature on hunt methods dealt with deer driving. Deer in South Dakota responded to late season drives by moving long distances (Sparrowe and

Springer 1970). Hickie (1937) and Tester and Heezen (1965) reported erratic movements and behavior of deer being driven. Although driving was the most effective method per unit of effort for killing deer in northern Michigan, bucks were never seen (Van Etten et al. 1965). Holsworth (1973) noted that the number of deer seen was more a function of how the drive was conducted than a function of deer density. In my study, deer driving was the least effective and least efficient method for seeing deer.

Observers who used groundstands or stillhunted had moderate effectiveness, efficiency and MSD values. In an Ontario study, the few hunters who stillhunted expended large amounts of time and were relatively unsuccessful in killing deer (Holsworth 1973). Conversely, in Michigan, stillhunting was the most popular method, accounting for 46% of all hunting time, and therefore a fair proportion of the deer kill (Van Etten et al. 1965). It appears that observers using treestands and scouting had less of an impact on deer activity than those using groundstands, stillhunting or driving.

Covertype

Most of the 9,962 deer observations were by hunters in hardwood forests (41.9%) and field edges (28.1%). The fewest were seen in coniferous forests (7.7%). Hunters who used field edges were expected to see 2,250 deer, but observed 2,798. Expected and observed values for observers in hardwood forests were similar. Swamps and coniferous and softwood forests produced fewer observations than expected. The most efficient observers used field edges (38.3 DPH and 5.3 DBH) and hardwood forests (30.6 DPH, 5.0 BPH). Those who used swamps and coniferous and softwood forests varied in efficiency values for deer and buck sightings (Appendix 14).

Mean MSD were similar for observers in swamps and coniferous, hardwood and softwood forests. Mode MSD varied for these 4 classes with the shortest occurring in swamps (18 m (20 yd)). The longest mean (81.4 m (91.4 yd)) and mode (90 m (100 yd)) MSD occurred in field edges. Visibility was expected to improve on field edges compared to forests because of less obstruction by vegetation. These longer sighting distances probably were due to greater visibility rather than increased human disturbance.

In this study, observers were the most effective and efficient while on field edges. The high frequency of edge use by deer has been discussed by a number of authors (Hosely 1956, McCaffery and Creed 1969, Kohn and Mooty 1971, Kearney and Gilbert 1976). McCaffery et al. (1980) reported that in northern Wisconsin, deer used newly constructed forest openings 40 times more than the expected average use of adjacent range. Stump Sitter observations were consistent with these results.

Stump Sitter contributors were unsure of what forest types and species to group into hardwood, softwood and conifer covertype classes (Hofacker, pers. comm.). Due to the wide range of forest types and species throughout the United States and problems with forest type grouping, these data may be unreliable. The initial intent of this study was to classify forest types as: hardwood forest (areas dominated by hardwood deciduous species (*Quercus* spp., *Acer* spp., etc.)); softwood forests (areas dominated by softwood deciduous species (*Populus* spp., *Salix* spp., etc.)) and coniferous forest (areas dominated by coniferous species (*Pinus* spp., *Picea* spp., etc.)). The numerous inconsistencies in the literature regarding forest type groupings made it impossible to compare results.

Observers using swamps yielded low effectiveness and efficiency values. The low mode MSD may reflect poor visibility conditions which would reduce effectiveness and efficiency values. Winter deer use of conifer swamps due to shelter-seeking behavior has been well documented in the Great Lakes area (Ozoga 1968, Rongstad and Tester 1969, Ozoga and Gysel 1972, Moen 1976). Unfortunately, in this study, too few hours were spent in the field during the winter yarding period and in appropriate areas of the country to document this activity.

Results from covertype classes may not be justifiable indicators of habitat preference by deer. Covertypes were important determinants of where people hunted in West Virginia. The proximity of hunter access trails accounted for much more variation in hunter visits than did covertype, but game distribution related more to covertype than hunter access trails (Thomas et al. 1976). A similar situation was found in North Carolina (James et al. 1964).

Deer-related Variables

Sex and Age

Of the 10,121 deer observed, does were most often seen (41.4%), followed by fawns (21.9%), deer of uncertain sex and age (21.7%) and bucks (14.9%). Juveniles and antlerless deer comprised the greatest proportions of identifiable deer seen in Iowa at dawn and dusk, respectively (Zagata and Haugen 1974). Antlered deer were seen less than any other class of identifiable deer. Unidentifiable deer were the least seen of all classes. In a 258.8 ha (647.0 ac) enclosure in northern Michigan, from 1954 to 1960, of 905 deer observed, the most frequently seen were of unknown sex and age (34.3%), followed by does (29.6%), fawns (23.5%) and bucks (7.5%) (Van Etten et al. 1965). In general, results from these studies are similar to the results of my study. Does were the most and bucks the least often observed of the identifiable sex and age classes.

Deer observations per hunter-hour can provide a reliable index to population levels if observations are repeated annually in the same area (Downing et al. 1965). It would be impossible to use the Stump Sitter data in determining population sizes because they were collected over a large geographical area with no control over hunter site selection.

Time Seen

In this study, time seen reflects only activity of diurnal deer, as observers were in the field from 0430 to 2000. Daytime deer sightings occurred in 3 peak periods: 1) morning- 0530 to 0930, 2) noon- 1130 to 1230, and 3) evening- 1830 to 1930 (Figure 1). Daytime activity has been reported to involve 3 patterns: 1) movement and feeding from dawn to midmorning (Halloran 1943, Montgomery 1963, Michael 1970, Zagata and Haugen 1974 Carbaugh et al. 1975, Allen and McCullough 1976), 2) bedding from midmorning to midafternoon with a short increase in noon activity (Halloran 1943, Michael 1970, Zagata and Haugen 1974), and 3) movement and feeding from mid or late afternoon until dusk or later (Halloran 1943, Montgomery 1963, Progulske and Duerre 1964, McCaffery and Creed 1969, Zagata and Haugen 1974, Carbaugh et al. 1975, Allen and McCullough 1976). Results from my study are highly consistent with these and many other studies.

Few deer were observed before 0600 or after 1900. Zagata and Haugen (1974) experienced a similar situation and attributed it to poor light and the inability to see deer rather than a decrease in deer activity. Crepuscular activity of white-tailed deer has been well documented. In South Dakota and Wisconsin, deer began feeding 1 hour

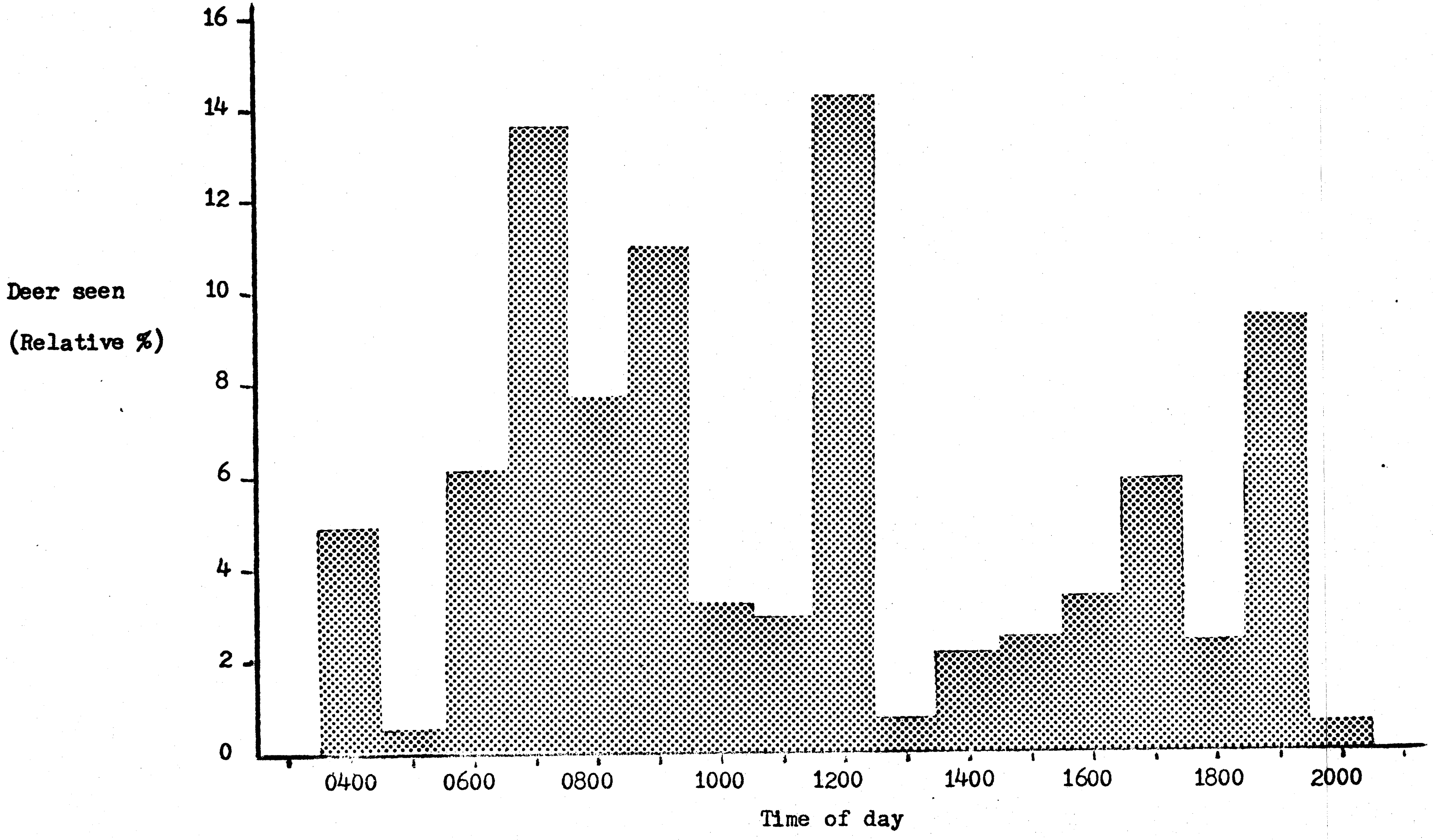

Figure 1. Deer sightings by time of day for a sample[a] of Stump Sitter observations during 1977-1980.

[a] Deer sightings by Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less (N= 290).

before sunset and remained active for about 6 hours with a peak of activity 4 hours after sunset (Progulske and Duerre 1964, McCaffery and Creed 1969).

Wind Direction and Deer Direction

Wind direction reports were unequally distributed among the 8 primary compass directions with most from the westerly directions. Most deer movements were from the 4 cardinal directions (Appendix 16).

Deer moved directly into the wind (example: wind direction= north and deer direction= north) for all 8 primary compass directions proportionately more than moving directly with, perpendicular to, quartering with or quartering into the wind. Provided that random deer movements would result in equal proportions, it appears that most deer are selectively moving directly into the wind.

These results conflict with reports from Zagata and Haugen (1974), in which wind direction affected deer movements in the morning. More deer were observed in the morning moving south past the investigators when the wind was from the north. The authors noted it was difficult to determine if deer were responding to a particular weather factor. Only 18% of the variability in the number of deer sighted was accounted for by 13 environmental factors.

Weather Variables and Deer Seen

Distributions of weather variables are shown in Appendices 17 through 20. Results from statistical tests are shown in Appendices 21 through 26.

Stump Sitters were more effective at seeing deer on days with clear skies, light or calm winds and no precipitation. Increased deer observations under clear skies were reported by Hahn (1949) and Progulske and Duerre (1964). Conversely, Montgomery (1963) reported increased deer sightings under cloudy skies. James (1976) noted increased deer observations under low wind speeds. Hardin (1974) and Rue (1978) noted that increased wind resulted in nervous, wary deer. Decreased deer activity was associated with increased precipitation (Tibbs 1967, Hawkins and Klimstra 1970, Michael 1970). In general, results from my study are consistent with the findings of these studies. However, increased effectiveness and sightings may be due to other factors. Temperature, relative humidity, barometric pressure and time of year are variables that are closely related to sky, wind and precipitation conditions. Overlapping effects of these and other environmental conditions may be responsible for the fluctuations in deer observations.

Multiple regression was used to test these overlapping effects. Of the variability in deer seen, 5.4% was caused by the interactions of the independent variables: temperature, snow depth, sky conditions, wind velocity, precipitation and observer-hours. Only 5.8% of the variability in transformed variables of deer seen could be explained by the independent variables. Zero order partial correlation coefficients showed relationships between temperature and snow depth (r= -0.45), sky condition and precipitation (r= 0.41), and sky condition and wind velocity (r= 0.24). The weather variable most correlated with deer seen was snow depth (r= 0.14), which accounted for only 1.8% of the variability in deer seen. There appear to be no practical relationships between deer seen and the independent variables.

The variability of data in this study is potentially enormous, because of the area, timespan, weather conditions and individual (deer and observer) variability in which they were collected. Observers in the field more than 4 hours were unreliable in reporting weather conditions. Differing levels in human disturbance due to weapon and hunt method may also bias results. Therefore, data were subjectively selected for further analysis to reduce variability in the data and improve result reliability. The distributions of sky condition, wind velocity, precipitation, temperature and snow depth for SUBPOP1 were similar to those of the entire population of deer sightings. Only 5.0% of the variability in deer seen could be explained by the independent variables. The weather variable most highly correlated with deer seen was sky condition (r= -0.14), which accounted for 1.8% of the variablilty in deer seen.

Differences between sex and age classes were examined by selecting SUBPOP1 sex and age classes and using multiple regression analysis, similar to that on the entire population. Observations that involved deer of uncertain sex and age showed a slight association between deer seen and weather variables (R^2= 0.105). The weather variable most highly correlated with deer seen was wind velocity (r= -0.19), which accounted for only 3.8% of the variability in does observed.

Differences in deer observations between months were examined by selecting SUBPOP1 months and using multiple regression analysis similar to that on the entire population. The greatest association between deer seen and the independent variables (R^2= 0.458) occurred in December. The variablilty in deer seen was accounted for by snow depth (20.4%), sky condition (12.5%), air temperature (6.6%) and wind velocity (5.7%). The slopes of the regression lines (B-values) indicate that more deer were seen as snow depth increased and as cloud cover, temperature, and wind velocity decreased.

Results from this study disagree with Banasiak (1961) and Heezen and Tester (1967), who reported that deer are normally less active in periods of low temperatures. My results agree with Ozoga and Gysel (1972), who reported maximum winter deer movements in low temperatures, which were the result of shelter seeking behavior. Deer move to areas of lower snow depths during winter (Banasiak 1961, Telfer 1967, 1970). In my study, deer sightings increased as snow depths increased. This may be due to increased shelter seeking activity or bias in hunter site selection. Ozoga and Gysel (1972) reported that during periods of high air-chill, deer movements increased. Conversely, in my study, as wind velocity increased, deer sightings decreased. Numerous authors have reported on deer yarding behavior in the Lake States (Hammerstrom and Blake 1939, Ozoga 1968, Ozoga and Gysel 1972, Verme 1973). All noted the importance of winter weather and its effects on deer movements. That winter weather affects deer movements is consistent with the findings of my study.

RECOMMENDATIONS

Results of this study dealing with deer movements and weather conditions were inconclusive; however, the information presented on hunter related activities and preferences are of possible future use. Much can be said for the socio-psychological value of projects such as this, where members are an active part of a research project or information gathering process. The following recommendations are made assuming that the Stump Sitters will continue their data collecting program.

Reporting Format

Data

I was concerned with the omission of roughly 20% of the data due to inappropriate recording. Data sheets were easy to understand so the problem was with the individuals who were recording the data. The quality of the data collected might be improved if instructions accompanied the data sheets, explaining the importance of legend symbols, complete data, accuracy and legibility .

Time

The time scheme used in reporting environmental conditions associated with deer observations was ineffective. Changes in weather conditions were not well represented, due to pre- and post-time lags. Fluctuations in weather conditions were accurately reported only by observers who were in the field 4 hours or less. A set of environmental conditions should be recorded every hour to monitor weather patterns. Deer movements are associated with environmental conditions experienced at a single point in time. Therefore, Stump Sitters should also record a set of environmental conditions each time a deer is observed. This will increase the accuracy of the data and reliability of the results.

Environmental Variables

Covertype

Initially, covertype classes were developed to depict forest types with representative species (example: hardwood forest- Quercus spp., Acer spp., etc.). This caused problems for deer observers because of regional differences in vegetation types and confusion with the terms hardwood, softwood and conifer forest. White-tailed deer range covers most of the United States' landscape, and is more a function of habitat structure and morphology than vegetative species (Hirth 1977). Regional habitat reporting would improve if habitat classes were associated with structure such as: open field, field edge, young forest (5-15 years), middle-aged forest (15-35 years), mature forest (35-60 years), old-aged forest (>60 years) and other. Covertype classes produced nominal order data. Habitat classes would generate data on at least an interval scale, which is necessary for regression analysis. Observers should report habitat class as that habitat in which the deer was first observed.

Hunting Pressure

An indication of hunting pressure as none, light, moderate or high would aid researchers in determining if deer movements were due to natural environmental conditions or human disturbance. In this study, human disturbance was assessed by comparing effectiveness, hunter efficiency and MSD for each method and weapon class. Assumptions in this technique are great and results may be unreliable.

Sky Condition and Wind Velocity

Sky condition and wind velocity classes were satisfactory but numeric intervals should be assigned to quantify ranges. Intervals such as those assigned in the hunter reliability survey (Appendix 2) would be suitable.

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Appendix 1. #101 IN-WOODS TIME and #201 DEER SIGHTINGS data sheets.

THE STUMP SITTERS WHITETAIL STUDY GROUP

DATA SHEET #101: IN-WOODS TIME

MEMBER I.D. NO. ____________

DATE	TIME IN	TIME OUT	HOURS	HUNT METH.	DEER SEEN	WEAPON	TERRAIN	AIR TEMP	SKY	WIND DIR.	WIND VEL.	PRECIP.	SNOW COVER	

MAKE SEPARATE ENTRY FOR EACH OUTING AND EACH CHANGE OF HUNTING METHOD.

RETURN DATA SHEET TO: **THE STUMP SITTERS**
P.O. BOX 1302
APPLETON, WI 54912

MAKE ADDITIONAL COMMENTS ON REVERSE SIDE

LEGEND

DATE: Month, Day, Year

TIME: Use 24 Hr. Clock -
Ex. 2:00 P.M. = 1400

HOURS: Time In-Woods

HUNT METHOD:
Still - ST
Tree Stand - TS
Ground Stand - GS
Deer Drive - DD
Scout - SC

DEER SEEN: No. Deer Observed

WEAPON:
Bow - B
Gun - G
Camera - C
None - N

TERRAIN:
Edge of Field - FL
Conifer Forest - CF
Hardwood Forest - HF
Softwood Forest - SF
Swamp - SW

AIR TEMP. - DEGREES F

SKY:
Clear - CL
Partly Cloudy - PC
Overcast - OC

WIND DIRECTION:
N NE E SE S SW W NW
Direction wind is coming from.

WIND VELOCITY:
Light - LT
Moderate - MD
Gusty - GT
Strong - ST
Calm - CM

PRECIPITATION:
Rain - RN
Snow - SN
Sleet - SL
Hail - HL
Fog - FG

SNOW COVER: Inches Snow on Ground

FORM 877?

INSTRUCTIONS

1. **WHEN TO USE:** The Data Sheets are to be used to record all hours spent in the woods in pursuit of whitetails. This includes time during the "closed season" as well as the bow and gun seasons.

2. **ENTRIES:** Make a separate entry for each outing and for each time the hunting method (Stand, Still, Scout) changes. For example, if the first two hours in the woods are spent Stand hunting and then you Still hunt upon leaving your stand, two entries would be made on Data Sheet #101.

3. **COMMENTS:** If you desire to make any comments pertaining to your observations while hunting, do so on the back side of the Data Sheets.

4. **ADDITIONAL SHEETS:** Data Sheets #101 and #201 may be reproduced or photocopied by Study Group members. To obtain single copies of the Data Sheets, send a stamped, self-addressed envelope. To order quantities of Data Sheets, send $1.00 per twenty (20) Data Sheets and specify which Data Sheet you want.

5. **RETURNING:** When completed or at the end of the year, you are encouraged to return the Data Sheets or a copy of them. The statistics from all members will be studied and the information acquired will be published in future issues of DEER AND DEER HUNTING. To return Data Sheets or order additional copies, send to:

The Stump Sitters
P. O. Box 1302
Appleton, WI 54912

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Appendix 1, Continued.

THE STUMP SITTERS WHITETAIL DEER STUDY GROUP

DATA SHEET #201: DEER SIGHTINGS MEMBER I.D. NO.____________________

SIGHT NO.	DATE	TIME	BUCK	DOE	FAWN	UNC.	WIND DIR.	DEER DIR.	DIST.	HUNT METHOD	WEAPON			
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														

LEGEND

DATE: Month, Day, Year

TIME: time of Deer Sighting.
Use 24 Hour Clock Ex. 2:00 P.M. = 1400

SEX OF DEER:
Place "X" in Box - Buck, Doe, Fawn, Unc. (uncertain of sex of deer)

WIND DIRECTION:
N NE E SE S SW W NW
Direction deer is coming from.

DEER DIRECTION: Indicate Direction Deer was Travelling When First Spotted.

DISTANCE: Distance between you and deer. Give distance in yards when deer was closest.

HUNT METHOD:
Still - ST
Tree Stand - TS
Ground Stand - GS
Deer Drive - DD
Scout - SC

WEAPON:
Bow - B
Gun - G
Camera - C

MAKE ADDITIONAL COMMENTS ON REVERSE SIDE

RETURN DATA SHEET TO:
THE STUMP SITTERS
P.O. BOX 1302
APPLETON, WI 54912

FORM 6879

INSTRUCTIONS

1. **WHEN TO USE:** The Data Sheets are to be used to record all hours spent in the woods in pursuit of whitetails. This includes time during the "closed season" as well as the bow and gun seasons.

2. **ENTRIES:** Make a separate entry for each outing and for each time the hunting method (Stand, Still, Scout) changes. For example, if the first two hours in the woods are spent Stand hunting and then you Still hunt upon leaving your stand, two entries would be made on Data Sheet #101.

3. **COMMENTS:** If you desire to make any comments pertaining to your observations while hunting, do so on the back side of the Data Sheets.

4. **ADDITIONAL SHEETS:** Data Sheets #101 and #201 may be reproduced or photocopied by Study Group members. To obtain single copies of the Data Sheets, send a stamped, self-addressed envelope. To order quantities of Data Sheets, send $1.00 per twenty (20) Data Sheets and specify which Data Sheet you want.

5. **RETURNING:** When completed or at the end of the year, you are encouraged to return the Data Sheets or a copy of them. The statistics from all members will be studied and the information acquired will be published in future issues of DEER AND DEER HUNTING. To return Data Sheets or order additional copies, send to:

The Stump Sitters
P. O. Box 1302
Appleton, WI 54912

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Appendix 2. Variables observed by Stump Sitters during 1977-1980 and phrases used to report those variables.

Stump Sitter variables	Report variables
HOURS	hunter-hours
Time in woods	time in the field
HUNT METHOD	hunting method
Still	stillhunting
Tree Stand	treestand
Ground Stand	groundstand
Deer Drive	deer drives
Scouting	scouting
WEAPON	weapon
Bow	bow
Gun	gun
Camera	camera
None	none
TERRAIN	covertype
Edge of field	field edge
Conifer Forest	conifer forest
Hardwood Forest	hardwood forest
Softwood Forest	softwood forest
Swamp	swamp

Appendix 2, Continued

AIR TEMP	temperature
°F	°C (°F)
SKY	sky conditions
Clear	clear: 0/10-1/10 cloud cover
Partly Cloudy	partly cloudy: 2/10-8/10 cloud cover
Overcast	overcast: 9/10-10/10 cloud cover
WIND DIRECTION	wind direction
direction wind is coming from NE, E, SE, S, SW, W, NW, N	direction wind is coming from NE, E, SE, S, SW, W, NW, N, none
WIND VELOCITY	wind velocity
Calm	calm: 0.0-1.6 km/hr (0-1 miles/hr)
Light	light: 3.2-8.0 km/hr (2-5 miles/hr)
Moderate	moderate: 9.6-24.0 km/hr (6-15 miles/hr)
Gusty	gusty: 25.6-40.0 km/hr (16-25 miles/hr)
Strong	strong: above 41.6 km/hr (above 26 miles/hr)

Appendix 2, Continued.

PRECIPITATION	precipitation
	none
Rain	rain
Snow	snow
Sleet	sleet
Hail	hail
Fog	fog
SNOW COVER	snow depth
Inches of snow on the ground	cm (inches) of snow on the ground
SEX OF DEER	sex and age of deer
Buck	buck: antlered adult
Doe	doe: antlerless adult
Fawn	fawn: less than 1 year old
Uncertain: uncertain of deer's sex and age	uncertain: uncertain of deer's sex and age
DISTANCE	
Yards	m (yards (yd))

Appendix 3. HYGNSTROM job.

```
?BEGIN JOB HYGNSTROM;
USERCODE=10366;
RUN *PAL/SPSS;
FILE FILE8(KIND=DISK,TITLE=DSALL,FILETYPE=7);
DATA IOCR
RUN NAME          THE STUMPSITTERS WHITETAIL STUDY GROUP
                       )SPSS DEER RECORD TYPE 1(
DATA LIST         FIXED / 1
                  IDNBR 1-4
                  IDALPHA 5-8 (A)
                  DATE 9-14
                  MONTH 9-10
                  DAY 11-12
                  YEAR 13-14
                  INTIME 15-18
                  OUTTIME 19-22
                  HOURS 23-25(1)
                  METHOD 26-27(A)
                  DEERSEEN 28-29
                  WEAPON 30 (A)
                  TERRAIN 31-32(A)
                  TEMP 33-34
                  SKY 35-36(A)
```

```
                  WINDDIR 37-38(A)
                  WINDVEL 39-40(A)
                  PRECIP 41-42(A)
                  SNOW 43-45(1)
                  AREA 46-47
                  TIME SEEN 48-51
                  SEX 52(A)
                  WINDDIR2 53-54(A)
                  DEER DIR 55-56(A)
                  DISTANCE 57-59
                  CRIPPLED 60
                  BAGGED 61
                  NOTES1 TO NOTES15 62-121(A)
                  NOTES16 122(A)
                  NEGTEMP 112-114
INPUT MEDIUM   DISK
MISSING VALUES  IDNBR (0)/
                  IDALPHA (999999999)/
                  DATE(999999)/
                  MONTH TO YEAR (99)/
                  INTIME,OUTTIME (9999)/
                  HOURS (99.9)/
                  METHOD (999999999)/
                  DEERSEEN (99)/
                  WEAPON (999999999)/
                  TERRAIN (999999999)/
                  TEMP (99)/
```

```
                SKY (999999999)/
                WINDDIR (999999999)/
                WINDVEL (999999999)/
                SNOW (99.9)/
                AREA (99)/
                TIMESEEN (9999)/
                SEX (999999999)/
                WINDDIR2 (999999999)/
                DEERDIR (999999999)/
                DISTANCE (999)/
                CRIPPLED (9)/
                BAGGED (9)/
VAR LABELS
                INTIME TIME STARTED HUNTING/
                OUTTIME TIME FINISHED HUNTING/
                HOURS TIME IN WOODS/
                METHOD HUNTING METHOD/
                DEERSEEN NUMBER OF DEER OBSERVED/
                TEMP AIR TEMPERATURE- DEGREES F/
                SKY SKY COVER/
                WINDDIR WIND DIRECTION/
                WINDVEL WIND VELOCITY/
                PRECIP PRECIPITATION/
                SNOW SNOW COVER- INCHES/
                TIMESEEN TIME OF DEER SIGHTING/
                SEX SEX OF DEER/
                WINDDIR2 DIRECTION OF WIND AT TIME OF
```

```
                       SIGHTING/
                  DEERDIR DIRECTION DEER WAS TRAVELING
                       WHEN SIGHTED
                  DISTANCE BETWEEN HUNTER AND
                       DEER/
                  CRIPPLED DEER WAS SHOT AND LOST/
                  BAGGED DEER WAS BAGGED/
VALUE LABELS
                  METHOD (1)STILL (2)TREE STAND (3)GROUND
                       STAND (4)DEER DRIVE (5)SCOUT
                       (999999999)#/
                  WEAPON (1)BOW (2)GUN (3)CAMERA (4)NONE
                       (999999999)#/
                  TERRAIN (1)EDGE OF FIELD (2)CONIFER
                       FOREST (3)HARDWOOD FOREST
                       (4)SOFTWOOD FOREST (5)SWAMP
                       (999999999)#/
                  SKY (1)CLEAR (2)PARTLY CLOUDY
                       (3)OVERCAST (999999999)#/
                  WINDDIR, DEERDIR, WINDDIR2 (1)N (2)NE
                       (3)E (4)SE (5)S (6)SW (7)W (8)NW
                       (999999999)#/
                  WINDVEL (1)CALM (2)LIGHT (3)MODERATE
                       (4)GUSTY (5)STRONG (999999999)#/
                  PRECIP (1)NONE (2)FOG (3)RAIN (4)HLSLSN
                       (5)  /
                  SEX (1)UNCERTAIN (2)FAWN (3)DOE (4)BUCK
```

```
                         (999999999)#/
                     CRIPPLED (1)YES (2)NO (3)  /
                     BAGGED (1)YES (2)NO (3)  /
PRINT FORMATS        HOURS(1)/SNOW(1)/IDALPHA(A)/NOTES1 TO
                         NOTES16(A)/
RECODE               METHOD ('ST'=1)('TS'=2)('GS'=3)('DD'=4)
                         ('SC'=5) (ELSE=999999999)/
                     WEAPON ('B'=1)('G'=2)('C'=3)('N'=4)
                         (ELSE=999999999)/
                     TERRAIN ('FL'=1)('CF'=2)('HF'=3)('SF'=4)
                         ('SW'=5)(ELSE=999999999)/
                     SKY ('CL'=1)('PC'=2)('OC'=3)
                         (ELSE=999999999)/
                     WINDDIR,DEERDIR,WINDDIR2
                         (' N'=1)('NE'=2)(' E'=3)('SE'=4)
                         (' S'=5)('SW'=6)(' W'=7)('NW'=8)
                         (' N'=1)(' E'=3)(' S'=5)(' W'=7)
                         (ELSE=999999999)/
                     WINDVEL('CM'=1)('LT'=2)('MD'=3)('GT'=4)
                         ('ST'=5)(ELSE=999999999)/
                     PRECIP ('FG'=2)('RN'=3)('HL','SN','SL'=4)
                         (ELSE=1)/
                     SEX ('U'=1) ('F'=2) ('D'=3) ('B'=4)
                         (ELSE=999)/
                     BAGGED, CRIPPLED (0=3)/
COMPUTE              SHOT = 0
IF                   (CRIPPLED EQ 1) SHOT=1
```

```
IF                (BAGGED EQ 1) SHOT=2

IF                (NEGTEMP LT 0) TEMP = NEGTEMP

VALUE LABELS      SHOT (1)CRIPPLED (2)BAGGED (3)

(TASK)

FINISH

?END JOB
```

Appendix 4. Eighty-column Punchcard Layout Form.

Burroughs

PUNCH CARD LAYOUT FORM

ENTITY	id no	date	time in	time out	hours	method	deer sn	weapon	terrain	temp	sky	wind dir	wind vel	ppt	snow	area		1
	1 2 3 4 5 6 7 8	9 10 11 12 13 14	15 16 17 18	19 20 21 22	23 24 25	26 27	28 29	30	31 32	33 34	35 36	37 38	39 40	41 42	43 44 45	46 47	48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79	80

ENTITY	id no	date	time	sex	wind dir	deer dir	dist	crip	bag		2
	1 2 3 4 5 6 7 8	9 10 11 12 13 14	15 16 17 18	19	20 21	22 23	24 25 26	27	28	29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79	80

Appendix 5. DEERLOAD and LIST jobs.

```
?BEGIN JOB DEERLOAD

USERCODE=10336;

MAXLINES=6000;MAXIOTIME=180;MAXPROCTIME=360;

RUN OBJECT/DEERLOAD;

DATA

?END JOB
```

```
?BEGIN JOB LIST;

USERCODE=10366/SCOTT;

MAXLINES=6000;MAXIOTIME=180;MAXPROCTIME=360;

RUN SYSTEM/DUMPALL("LIST CARDS");

DATA CARDS

?END JOB
```

Appendix 6. Actual weather conditions and weather estimates of observers tested at the Fort McCoy Military Reservation in September 1980 and 1981.

1980 temperature estimates

Hours in the field	Time in	Time out	Temperature estimates (°F)
0.5	1600	1630	74
0.5	1800	1830	65
1.0	1130	1230	78
1.0	1130	1230	78
1.5	1600	1730	68
1.5	1700	1830	68
2.0	0530	0730	65
2.0	0530	0730	60
2.0	0700	0900	65
2.0	1500	1700	67
2.5	0630	0900	61
2.5	0830	1100	70
2.5	0830	1100	65
3.0	0530	0830	70
3.0	0530	0830	70
3.0	0700	1000	60
3.0	1530	1830	70

Appendix 6, Continued.

1980 temperature estimates

Hours in the field	Time in	Time out	Temperature estimates (°F)
3.0	1530	1830	70
3.5	0630	1000	65
3.5	1200	1530	75
4.0	0600	1000	-
4.0	0600	1000	65
4.0	0630	1030	65
4.0	0700	1100	65
4.0	1500	1900	70
4.0	1500	1900	-
4.0	1500	1900	60
4.5	1500	1930	69
4.5	1500	1930	60
5.0	0600	1100	60
5.0	0600	1100	60
5.0	0600	1100	60
5.0	0630	1130	-
5.0	0700	1200	65
5.5	0630	1200	63
5.5	0630	1200	68
5.5	1430	2000	65

Appendix 6, Continued.

1980 temperature estimates

Hours in the field	Time in	Time out	Temperature estimates (°F)
5.5	1430	2000	65
6.0	0600	1200	75
6.0	1200	1800	74
6.5	1300	1930	70
7.0	0530	1230	80
8.0	0800	1600	70
9.0	0700	1600	70
9.0	0700	1600	70
9.0	1100	2000	79
9.0	1100	2000	79
11.5	0630	1800	65
12.0	0600	1800	76
12.0	0700	1900	70
12.5	0630	1900	70
13.0	0530	1830	70
13.0	0600	1900	60
13.0	0630	1930	65
15.0	0500	2000	70
15.0	0500	2000	-

Appendix 6, Continued.

1981 temperature estimates

Hours in the field	Time in	Time out	Temperature estimates (°F)
0.5	0815	0845	68
0.75	0930	1015	65
0.75	0930	1015	65
0.75	1815	1900	62
1.0	0600	0700	65
2.0	0600	0800	57
2.0	0700	0900	50
2.0	0800	1000	60
2.0	1630	1830	65
2.5	0530	0800	65
2.5	0600	0830	-
2.5	1300	1530	70
3.0	0530	0830	50
3.0	0600	0900	55
3.0	0730	1030	55
3.0	0730	1030	55
3.0	0730	1030	60
3.5	0530	0900	50
3.5	0530	0900	59
3.5	0730	1100	55

Appendix 6, Continued.

1981 temperature estimates

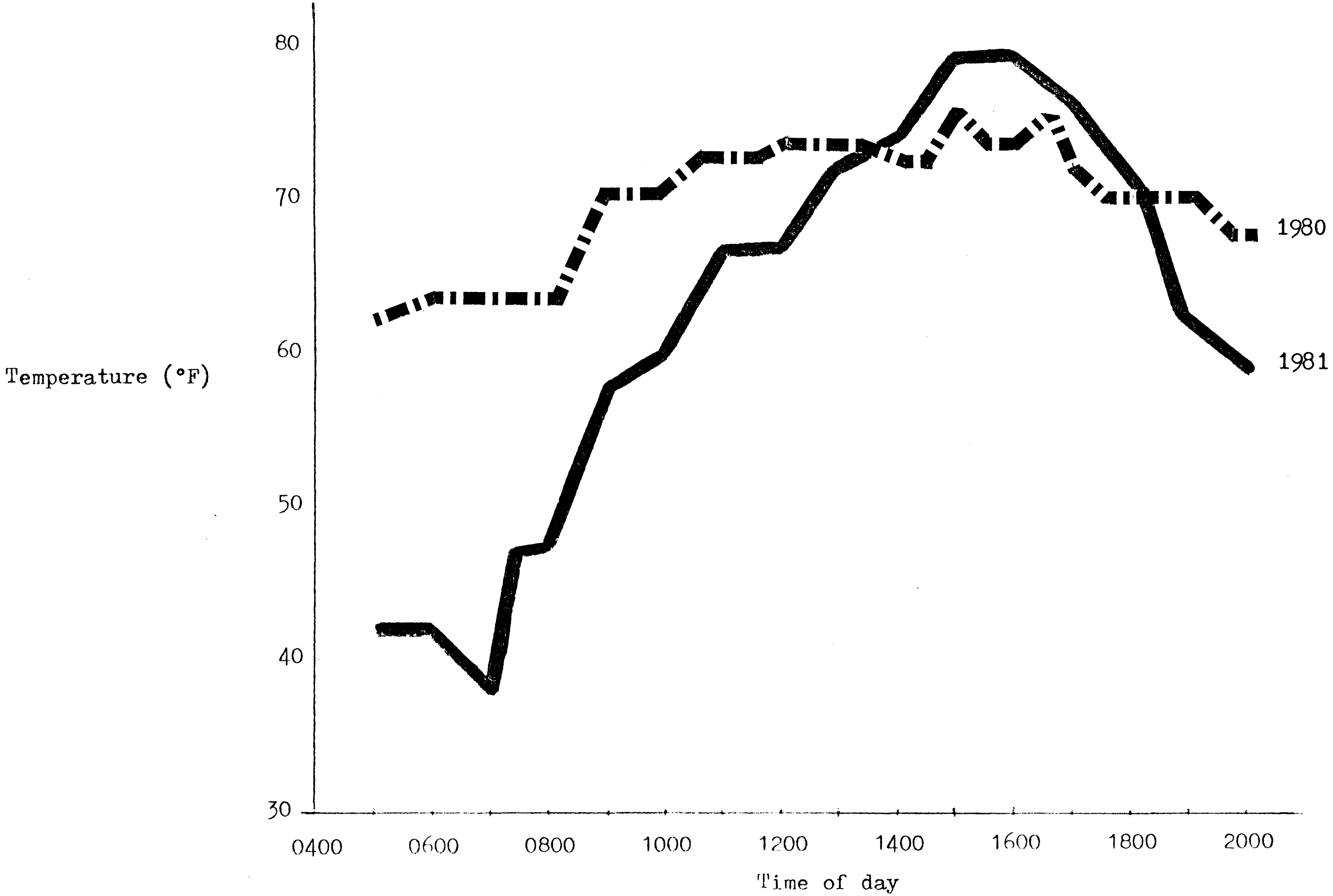
Hours in the field	Time in	Time out	Temperature estimate (°F)
3.5	1530	1900	60
4.0	0445	0845	50
4.0	0600	1000	40
4.0	0600	1000	40
4.0	0600	1000	50
4.0	0600	1000	65
4.0	0700	1100	50
4.0	1400	1800	72
4.0	1400	1800	72
4.25	0630	1045	55
4.25	0630	1045	60
4.5	0530	1000	60
4.5	0530	1000	55
4.5	0600	1030	55
4.5	0630	1100	50
4.5	0630	1100	68
4.5	0630	1100	65
5.0	0500	1000	55
5.0	0630	1130	40
5.0	0730	1230	45

Appendix 6, Continued.

1981 temperature estimates

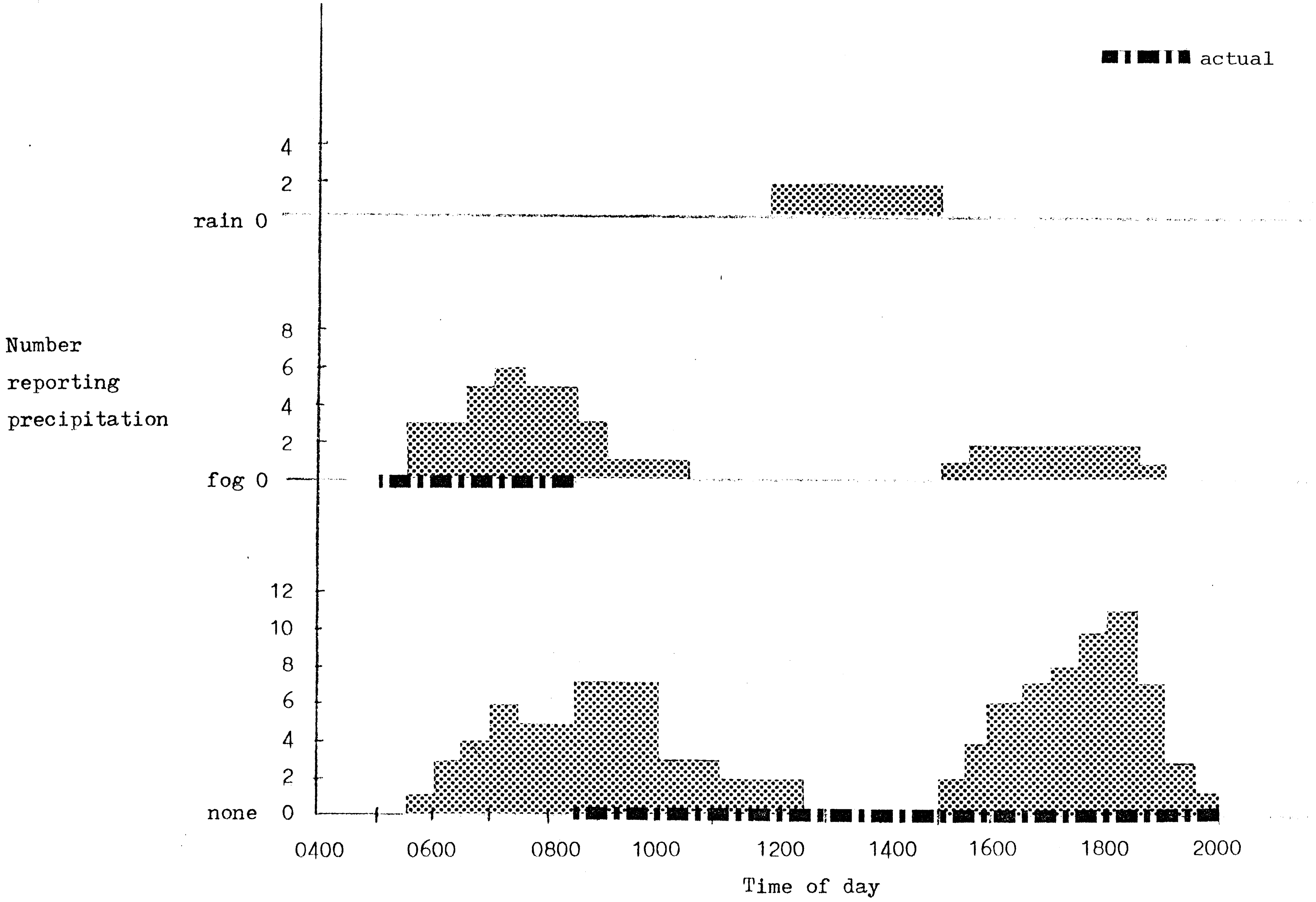
Hours in the field	Time in	Time out	Temperature estimate (°F)
5.5	0530	1100	40
5.5	0530	1100	60
6.0	0600	1200	68
6.0	0600	1200	68
6.0	0600	1200	65
6.0	0700	1300	60
6.0	0700	1300	60
6.0	0930	1530	60
6.0	1300	1900	75
6.0	1300	1900	75
6.0	1300	1900	75
6.75	0545	1230	65
7.0	1200	1900	70
7.0	1200	1900	60
7.0	1200	1900	70
7.5	0930	1700	70
8.0	0615	1415	75
9.0	0800	1700	75
9.0	0800	1700	75

Appendix 6, Continued.



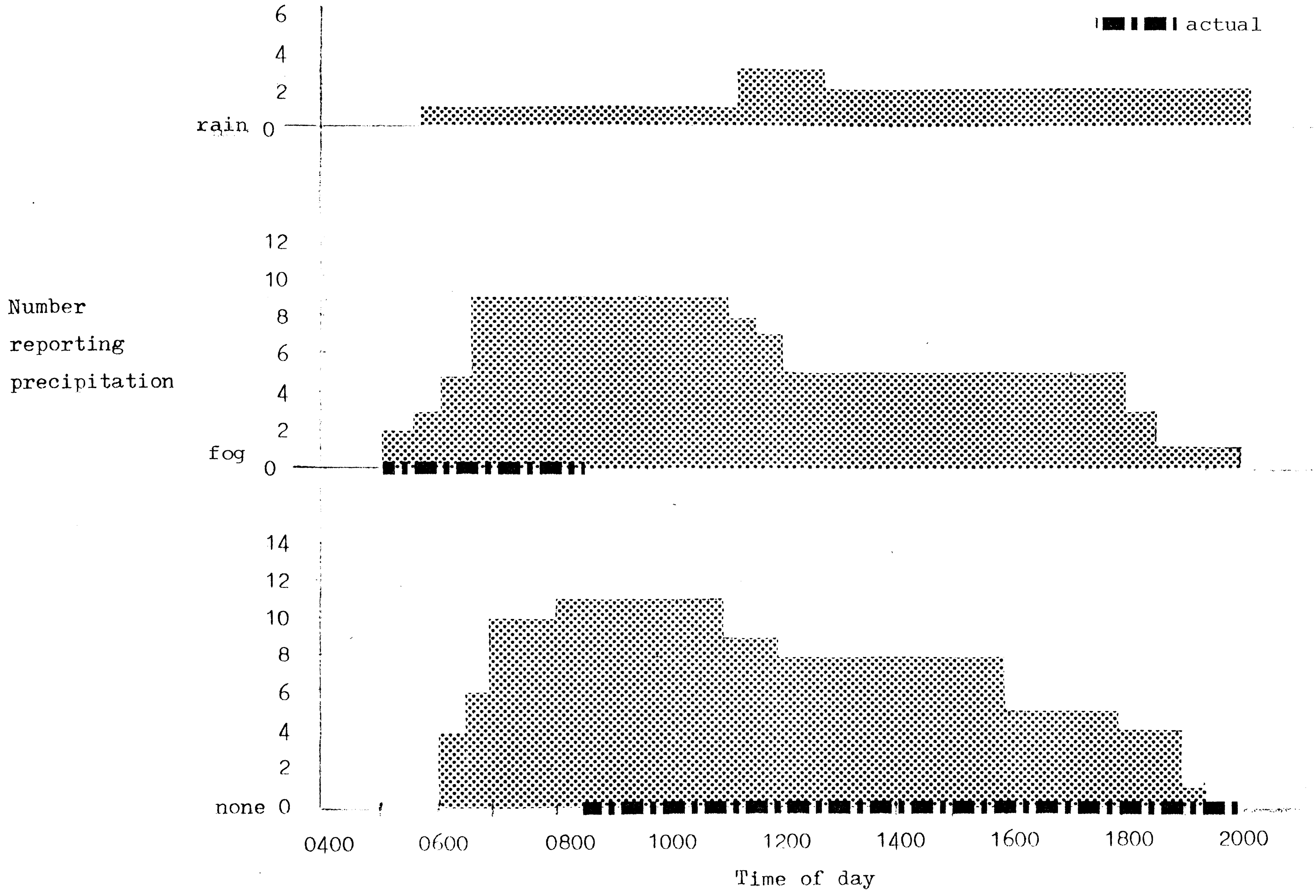
1980 and 1981 actual temperatures

Appendix 6, Continued [a].



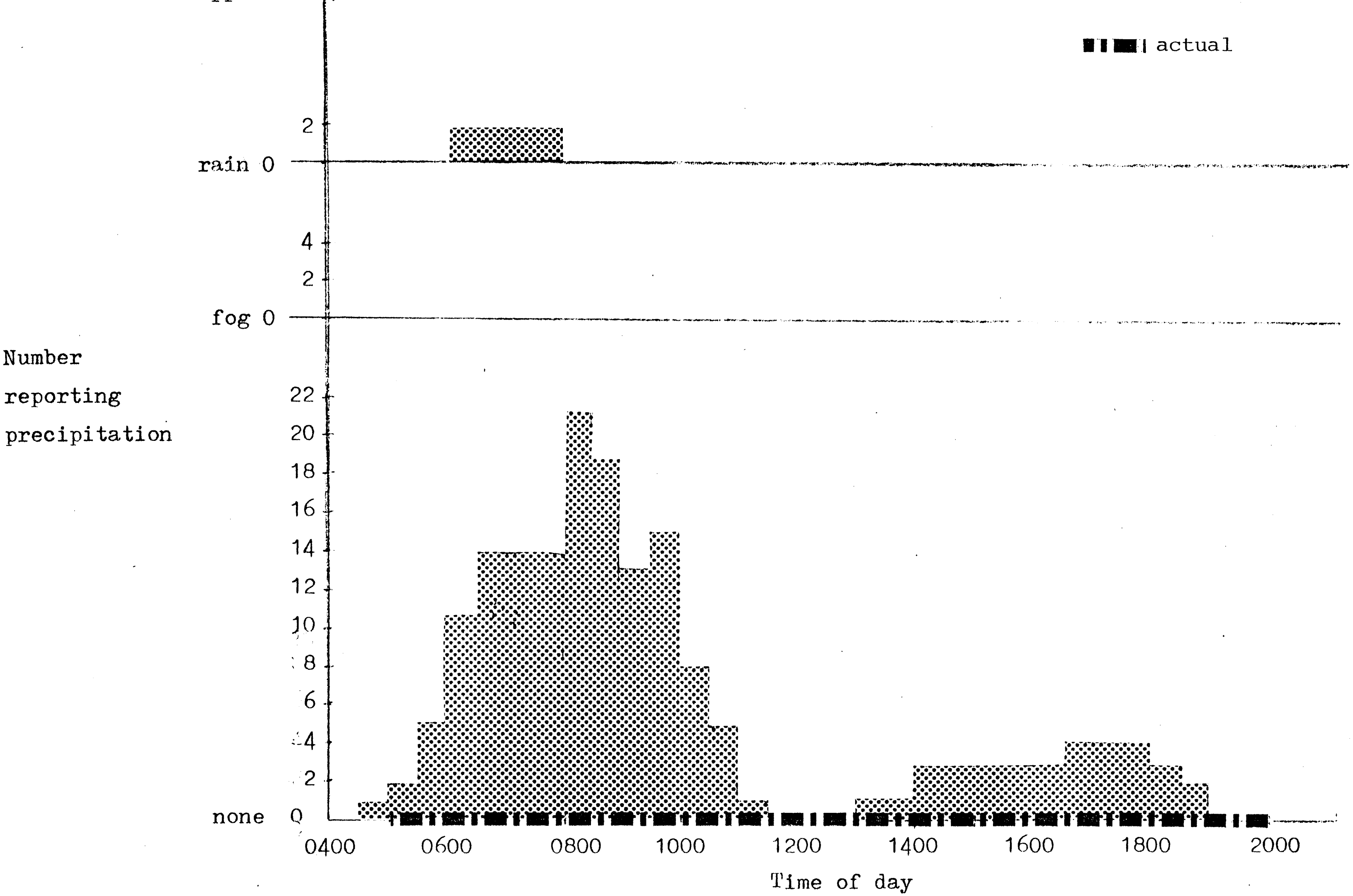
[a] 1980 precipitation distributions for observers in the field 4 hours or less.

Appendix 6, Continued [b].



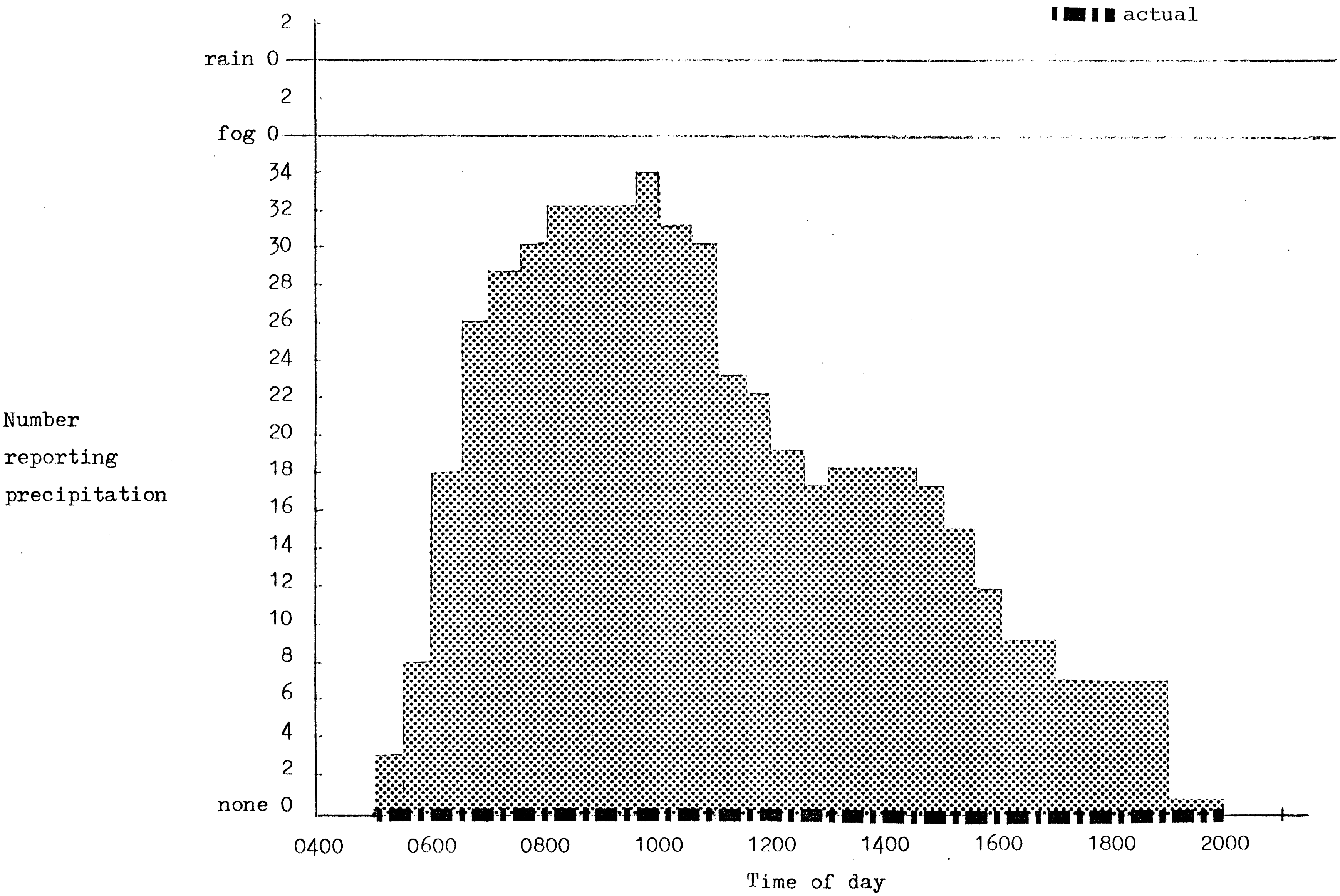
[b] 1980 precipitation distributions for observers in the field more than 4 hours.

Appendix 6, Continued [c].



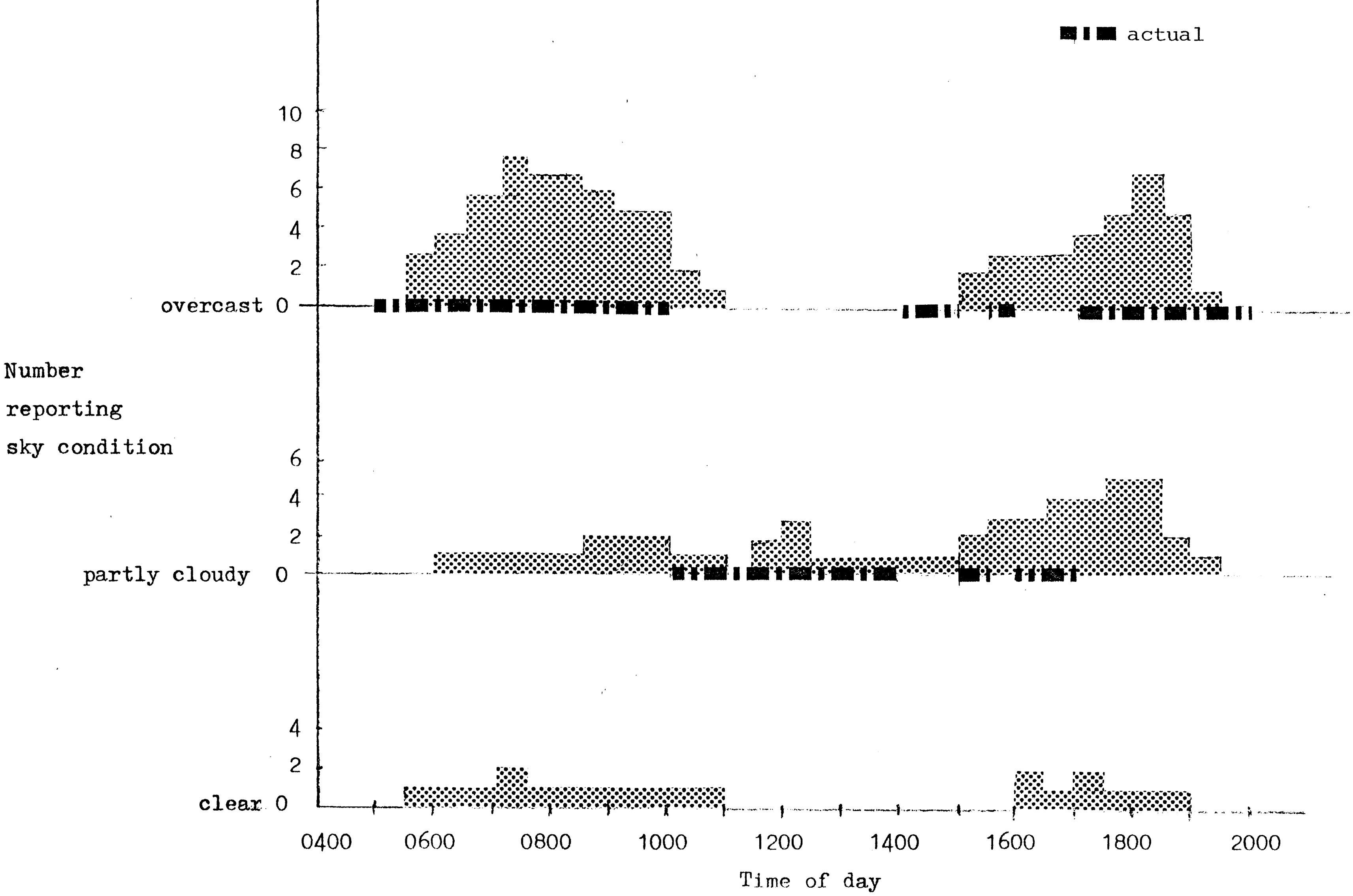
[c] 1981 precipitation distributions for observers in the field 4 hours or less.

Appendix 6, Continued ^{d}.



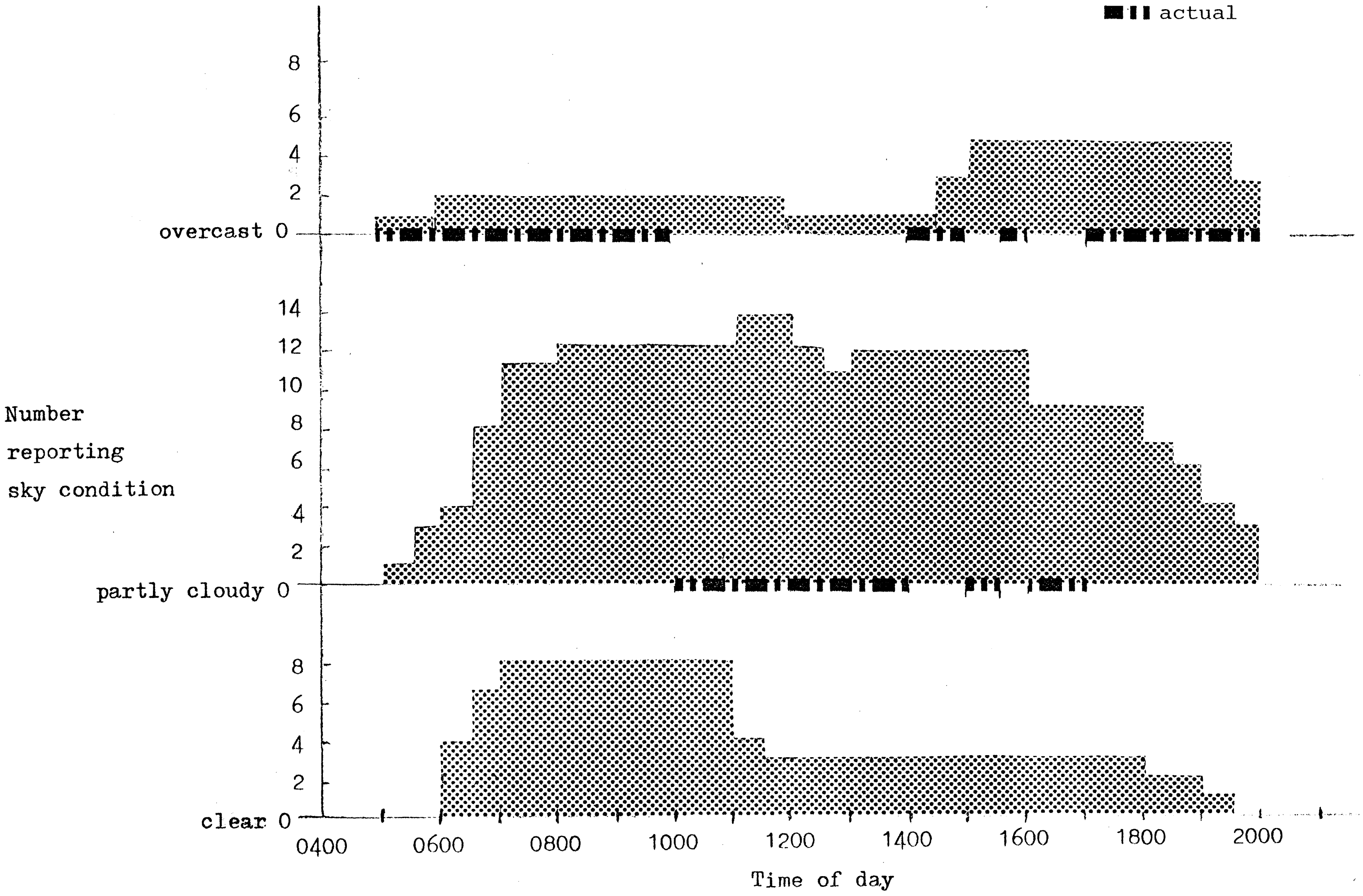
^{d}1981 precipitation distributions for observers in the field more than 4 hours.

Appendix 6, Continued [e].



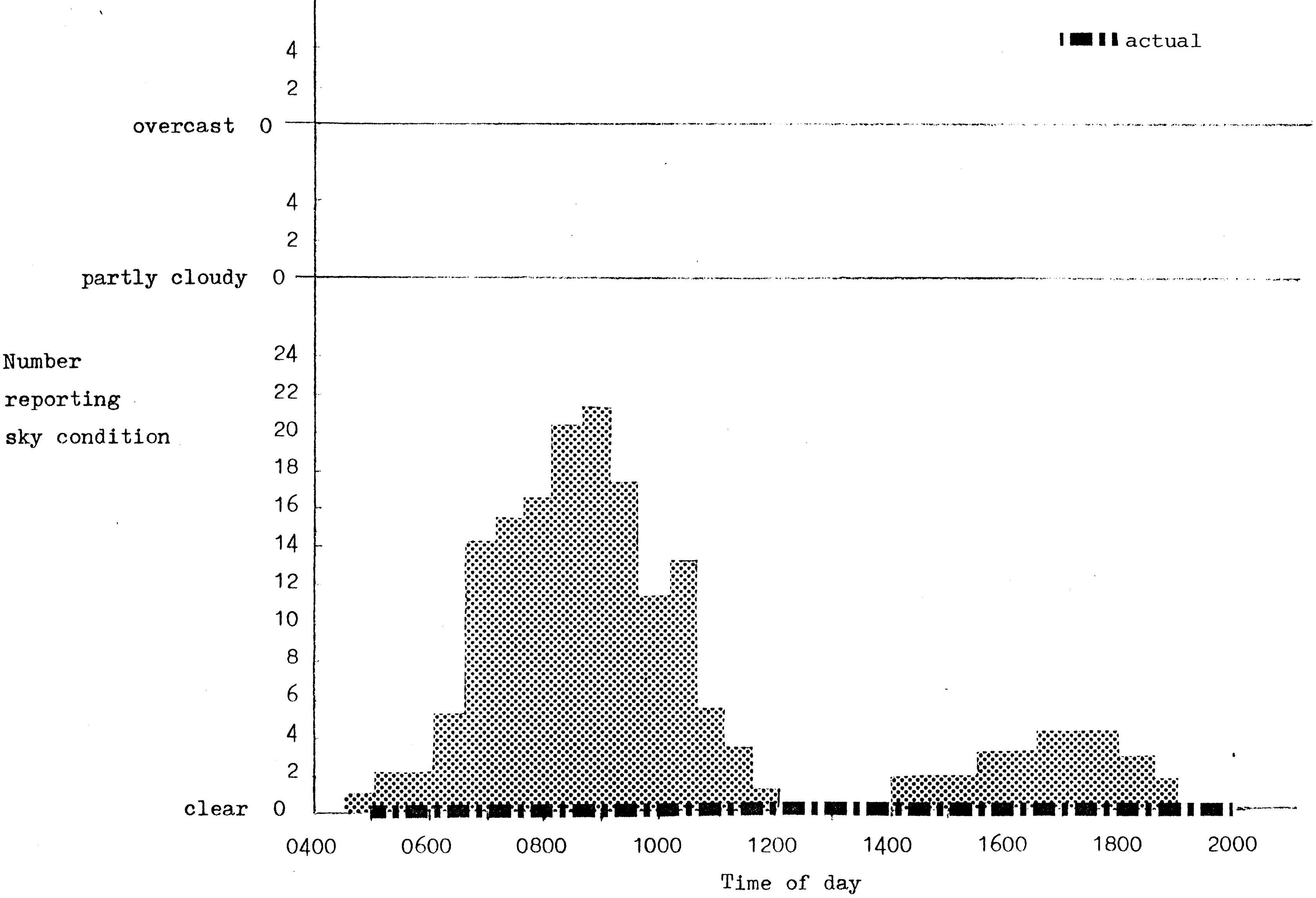
[e] 1980 sky condition distributions for observers in the field 4 hours or less.

Appendix 6, Continued [f].



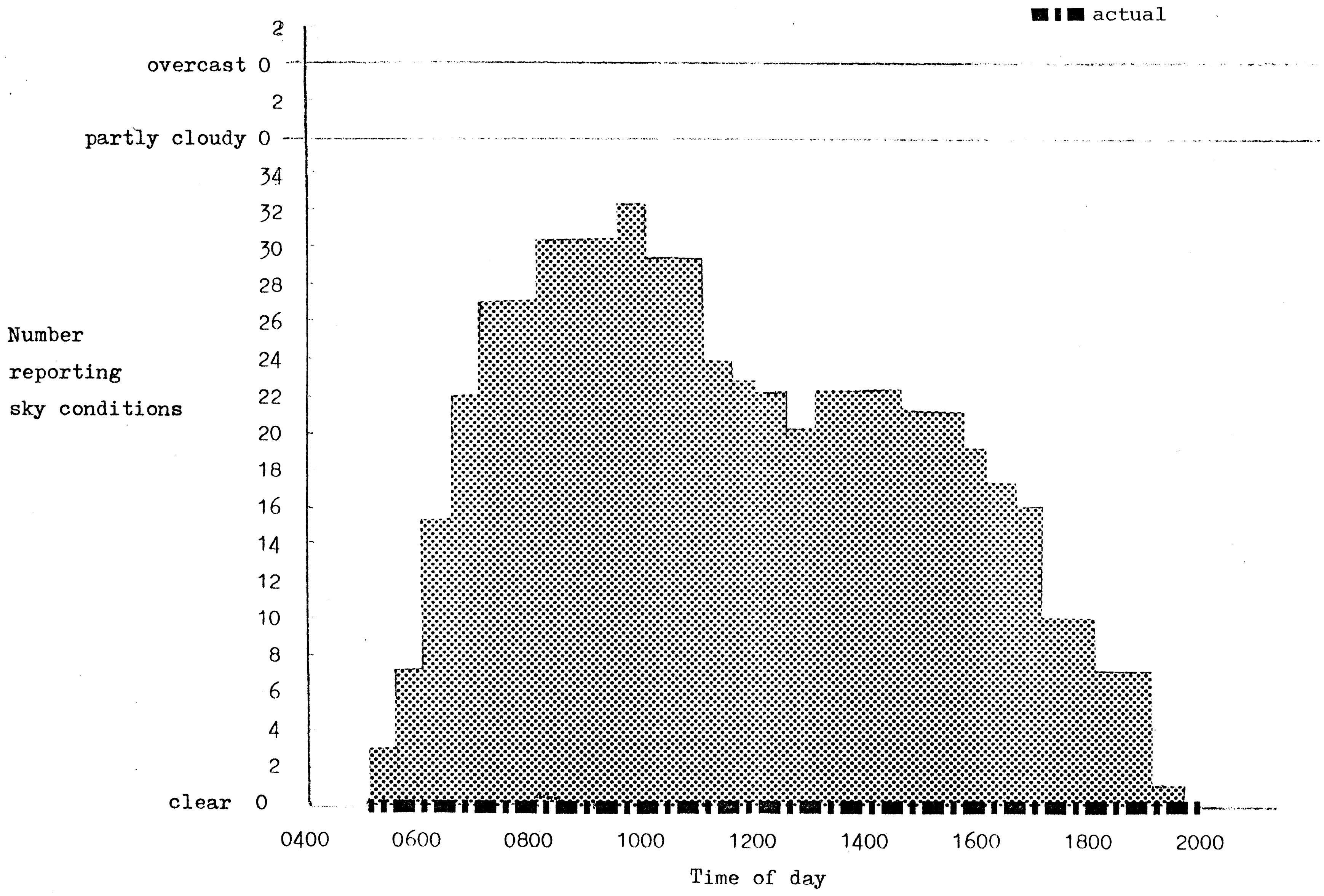
[f] 1980 sky condition distributions for observers in the field more than 4 hours.

Appendix 6, Continued [g].



[g] 1981 sky condition distributions for observers in the field 4 hours or less.

Appendix 6, Continued [h].



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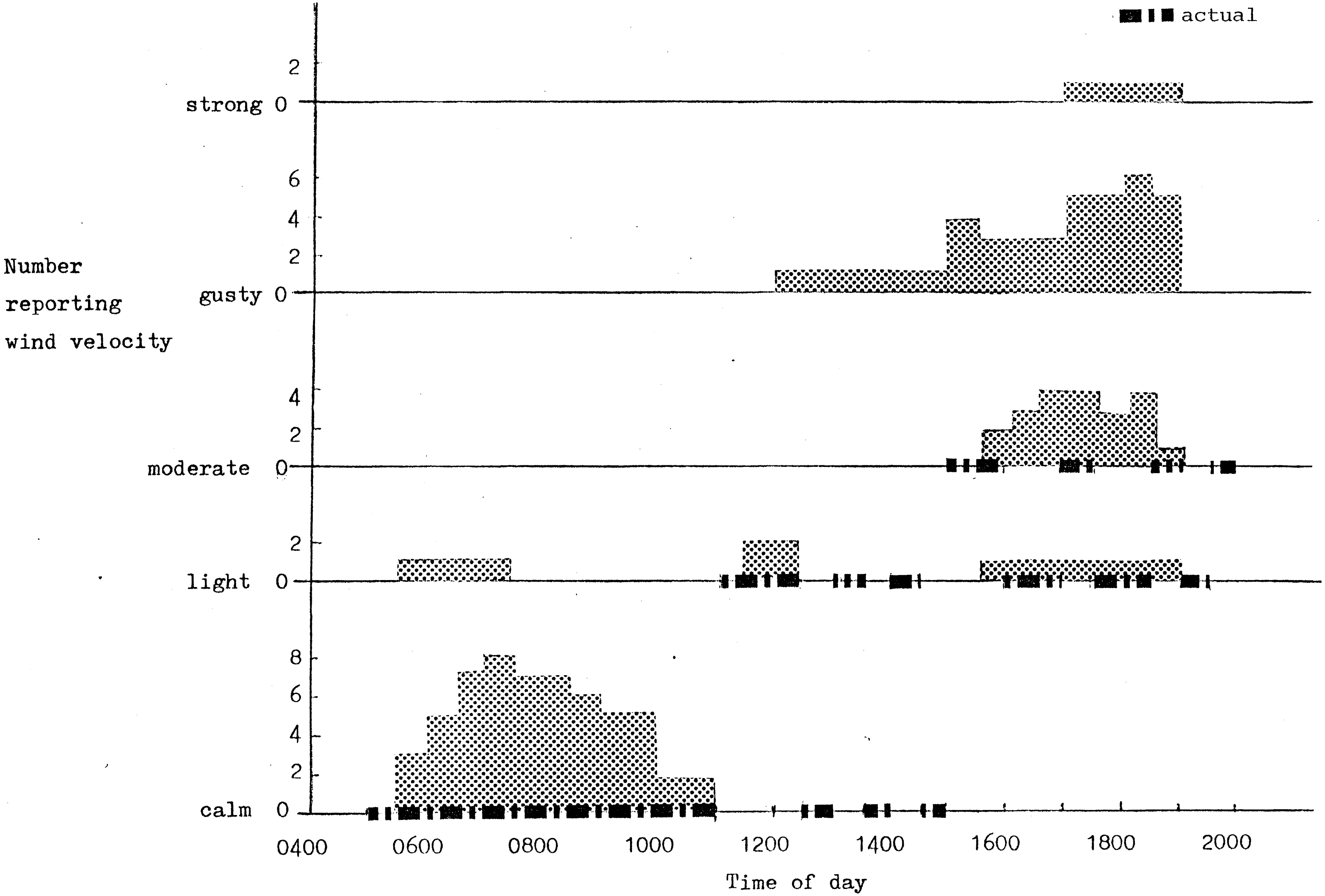
[h] 1981 sky condition distributions for observers in the field more than 4 hours,

Appendix 6, Continued [i].



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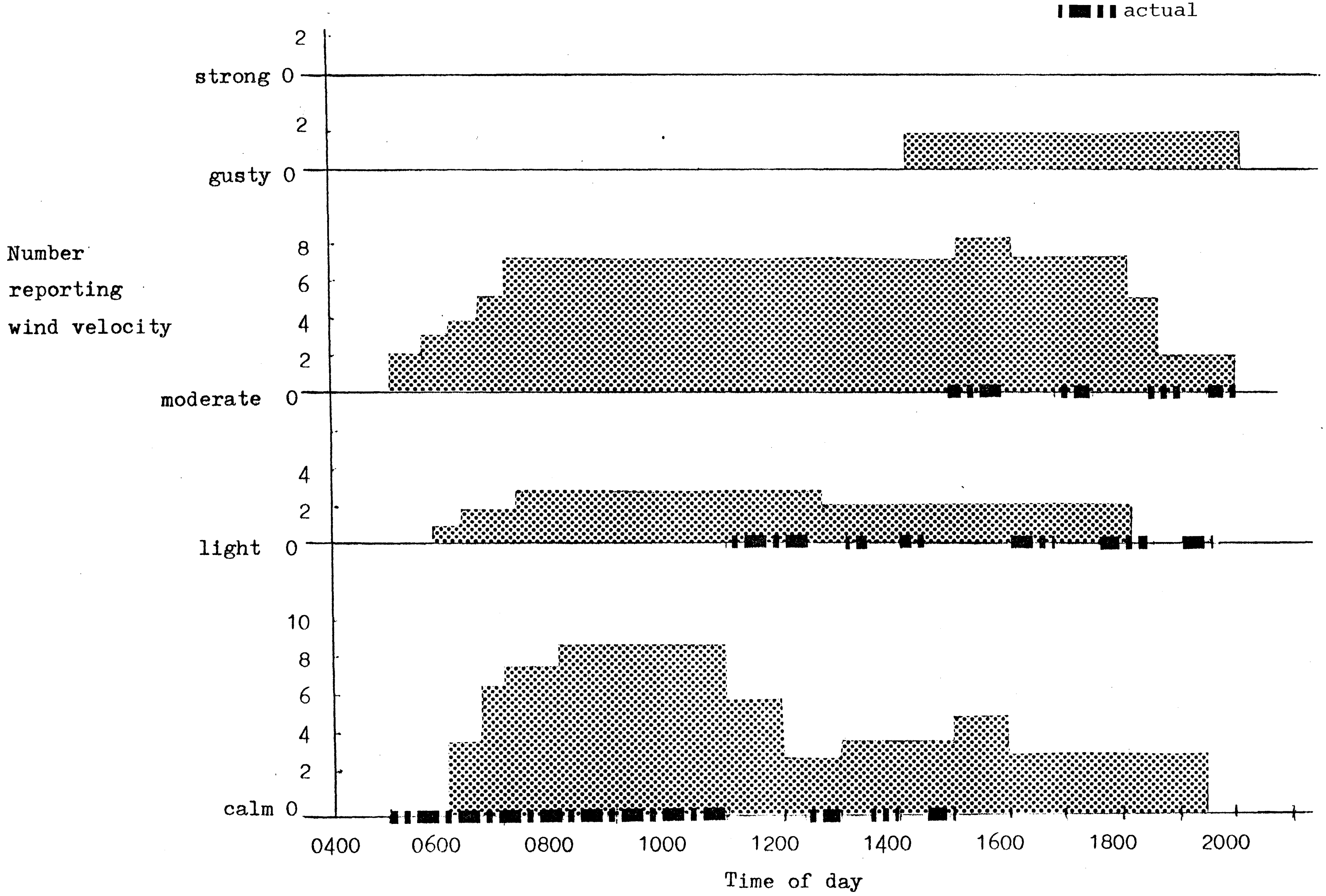
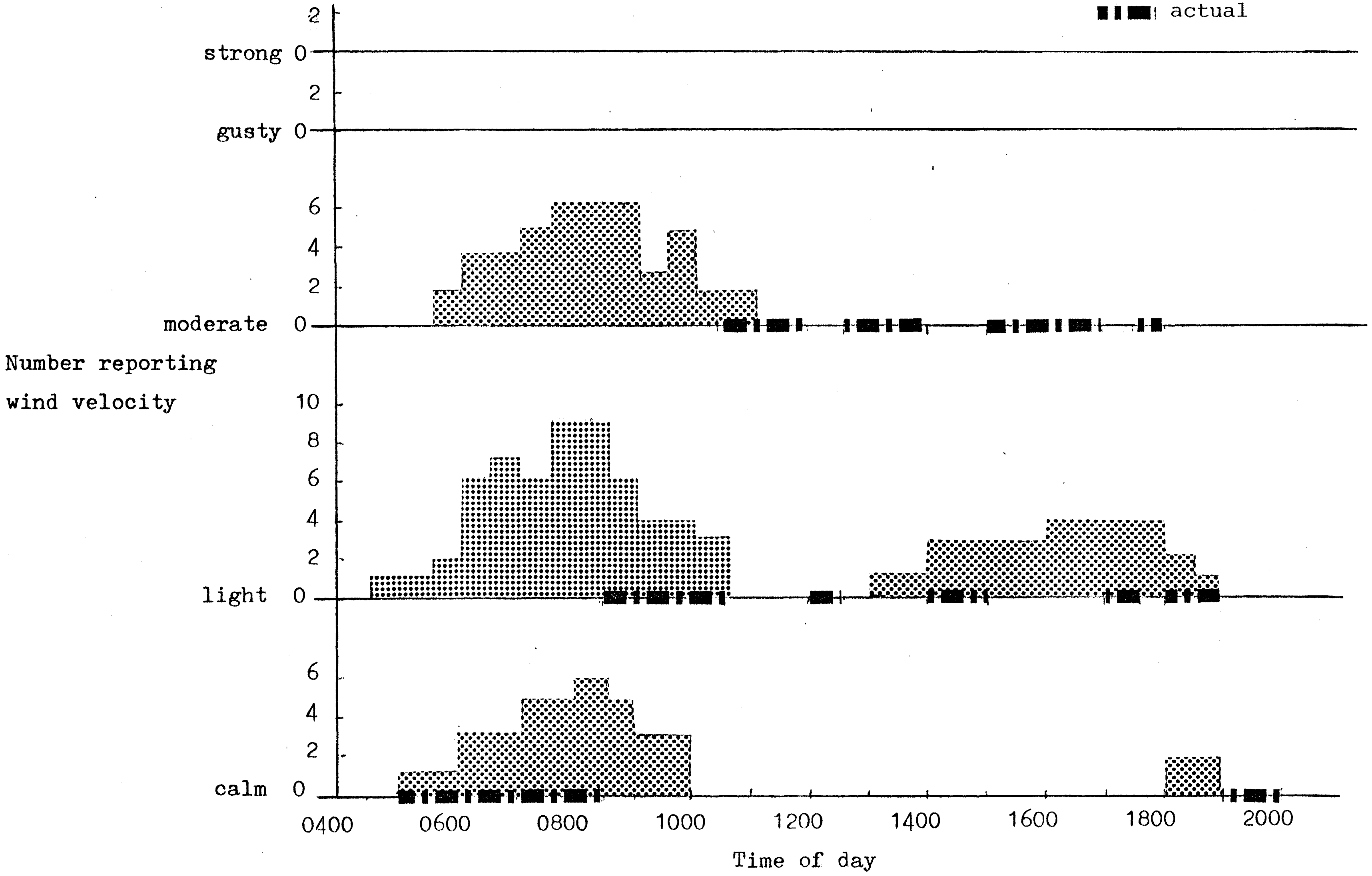
[i] 1980 wind velocity distributions for observers in the field 4 hours or less.

Appendix 6, Continued [j].



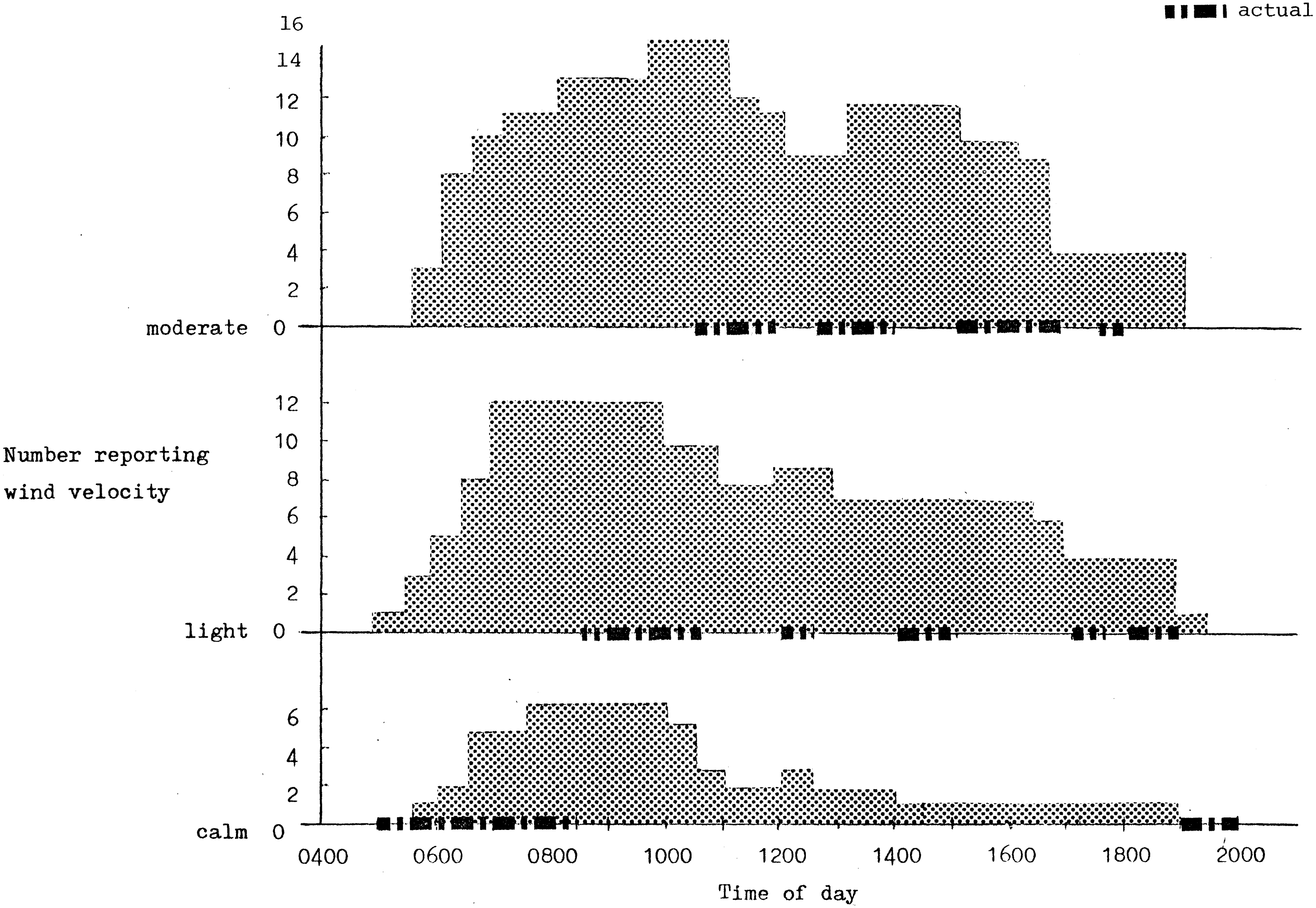
[j]1980 wind velocity distributions for observers in the field more than 4 hours.

Appendix 6, Continued [k].



[k] 1981 wind velocity distributions for observers on the field 4 hours or less.

Appendix 6, Continued [1].



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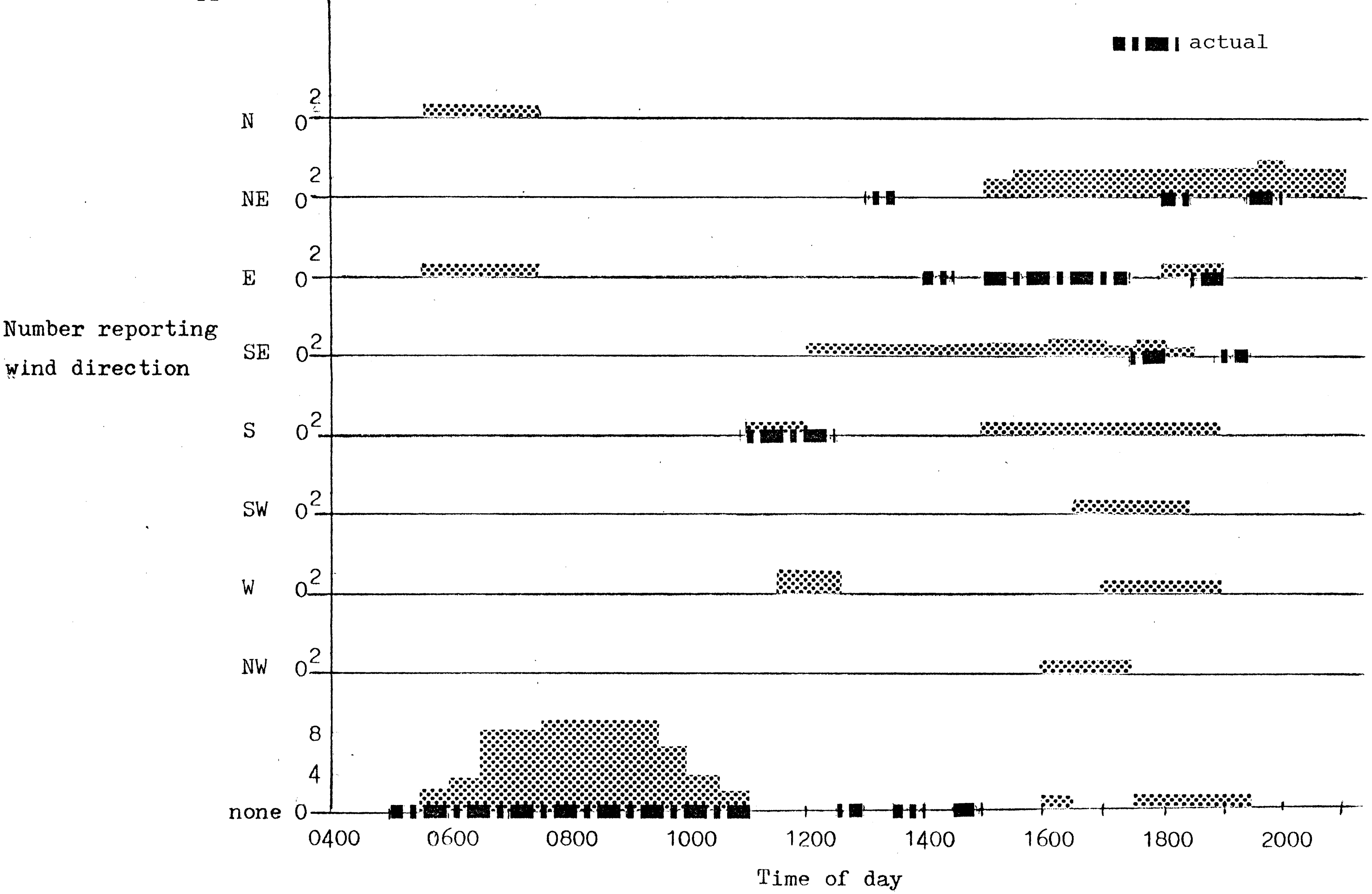
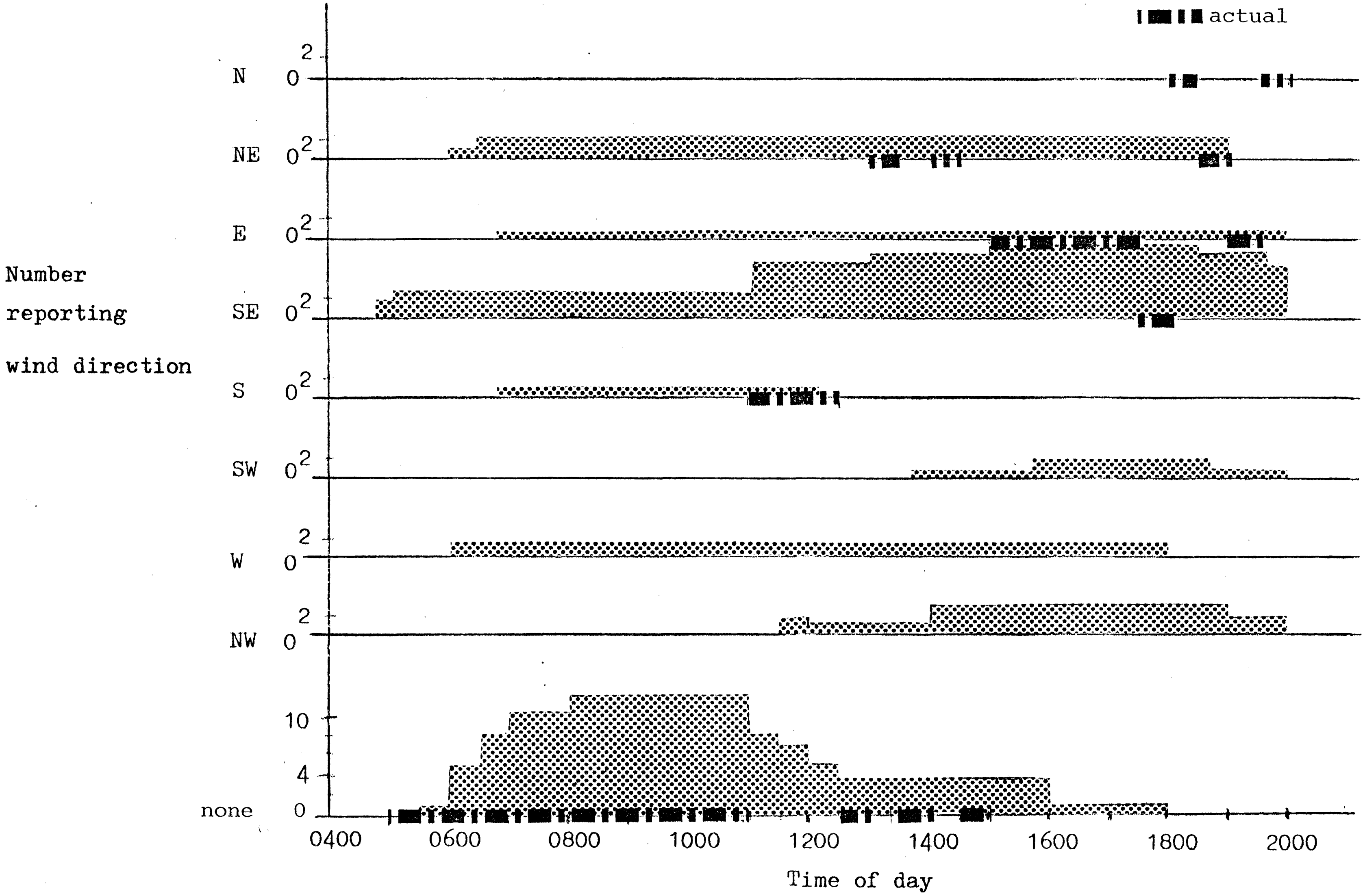
[1] 1981 wind velocity distributions for observers in the field more than 4 hours.

Appendix 6, Continued [m].



[m]1980 wind direction distributions for observers in the field 4 hours or less.

Appendix 6, Continued [n].



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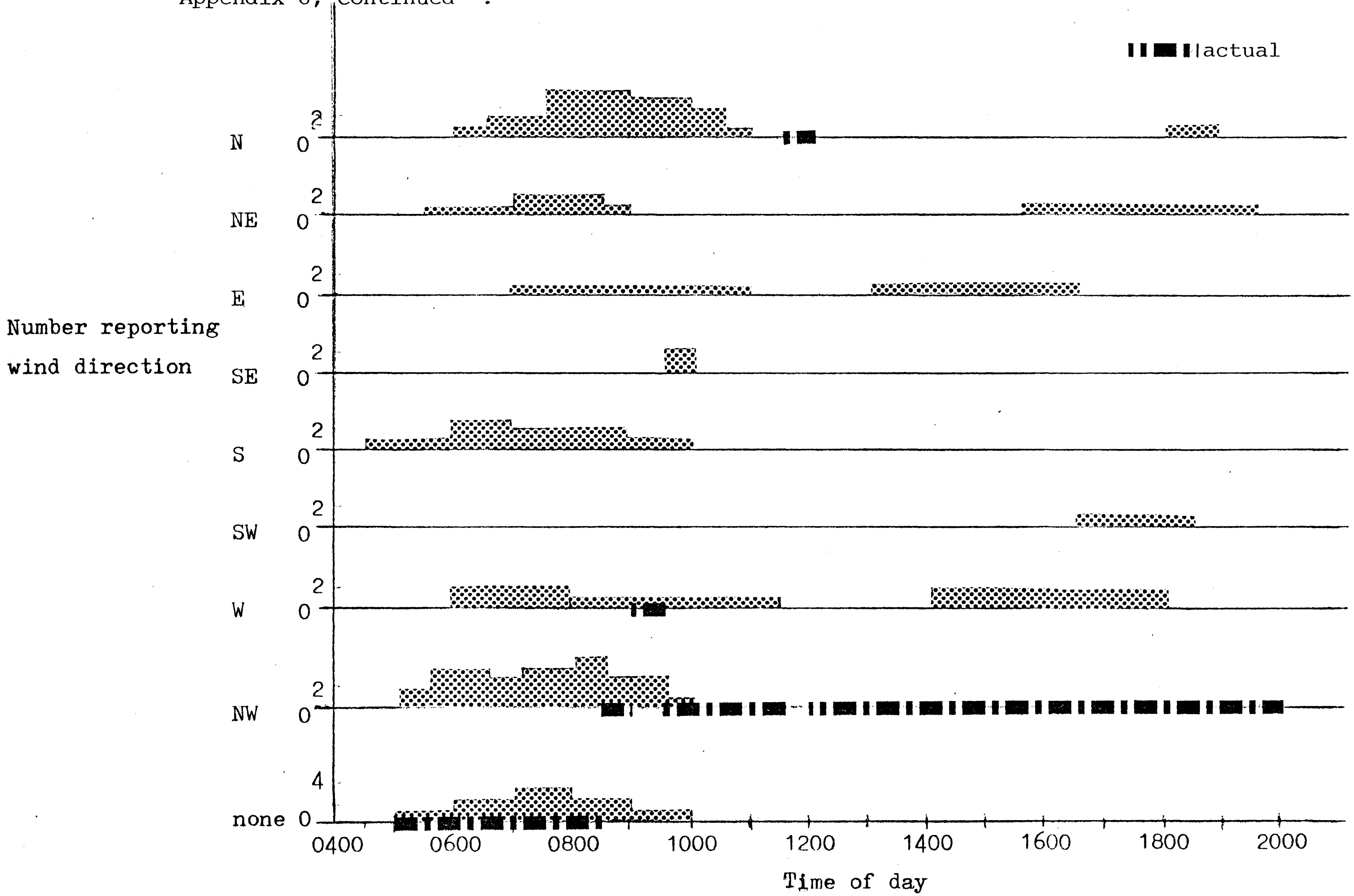
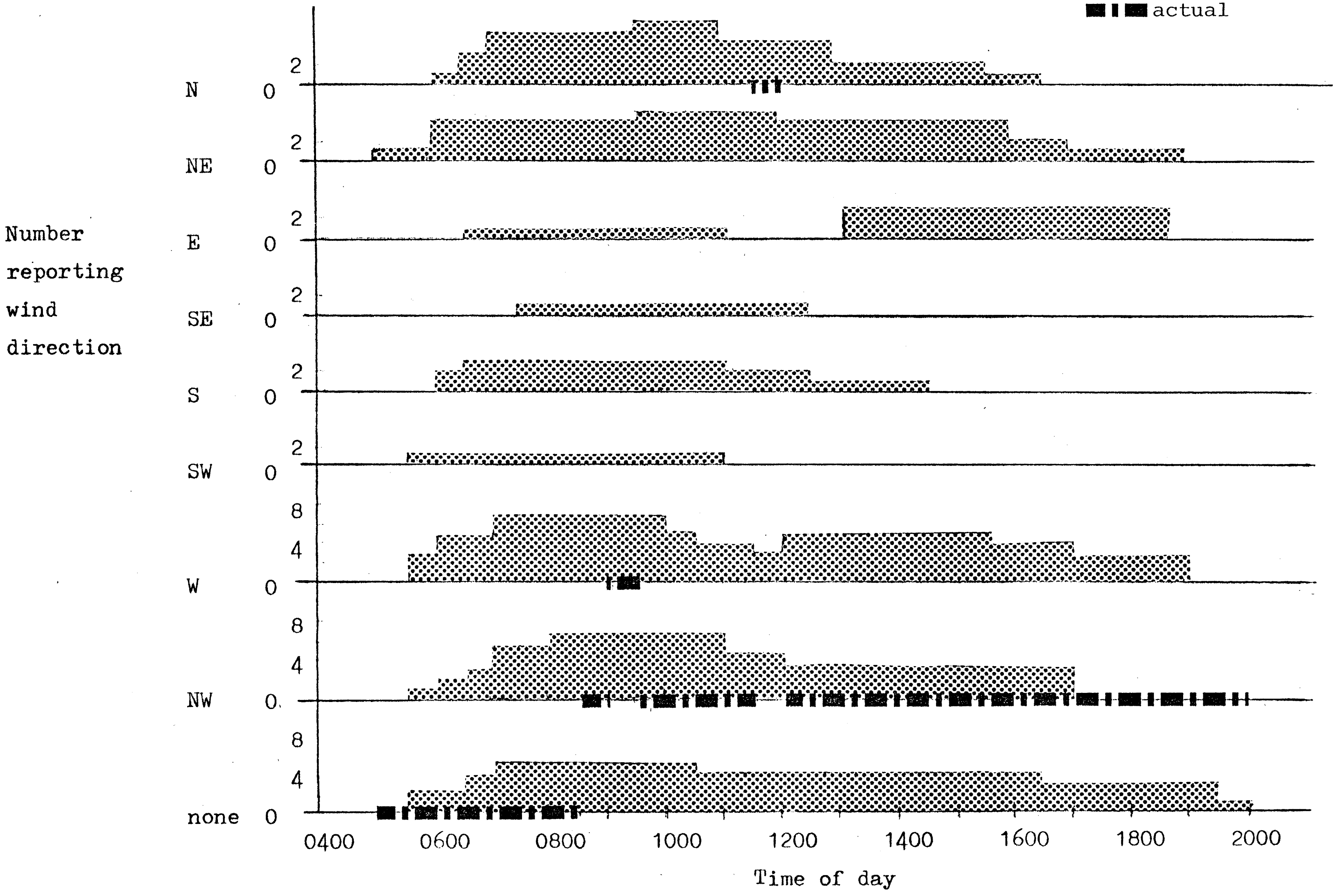
[n] 1980 wind direction distributions for observers in the field more than 4 hours.

Appendix 6, Continued °.



°1981 wind direction distributions for observers in the field 4 hours or less.

Appendix 6, Continued ^{p}.



^{p}1981 wind direction distributions for observers in the field more than 4 hours.

Appendix 7. Time afield and deer seen by Stump Sitter observers during 1977-1980.

Year	Hours in the field	% of total hours	Deer seen	% of total deer seen
1977	8,753.0	26.5	2,061	20.3
1978	9,975.5	30.2	3,167	31.3
1979	6,894.2	20.9	2,423	24.0
1980	7,404.2	22.4	2,470	24.4
Total	33,026.9		10,121	

Appendix 8. Time afield and deer seen by Stump Sitter observers during 1977-1980, classified by month.

Month	Hours in the field	% of total hours	Deer seen	% of total deer seen
January	98.0	0.3	23	0.2
February	103.5	0.3	51	0.5
March	165.0	0.5	67	0.7
April	200.0	0.6	81	0.8
May	253.5	0.8	103	1.0
June	110.5	0.3	63	0.6
July	543.5	1.6	285	2.8
August	1,281.0	0.9	524	5.2
September	5,231.5	15.8	1,776	17.5
October	7,956.7	24.1	2,914	28.8
November	14,024.7	42.5	3,313	32.7
December	3,059.0	9.3	921	9.1
Total	33,026.9		10,121	

Appendix 9. Time afield and deer seen by Stump Sitter observers during 1977-1980, classified by state and province.

Area	Hours in the field	% of total hours	Deer seen	% of total deer seen
WI	15,105.0	45.7	4,755	47.0
PA	3,705.0	11.2	1,265	12.5
MI	2,488.0	7.5	838	8.3
NY	1,979.0	6.0	452	4.5
IL	1,718.5	5.2	461	4.6
MT	1,569.0	4.8	253	2.5
MN	1,055.0	3.2	390	3.9
MO	792.2	2.4	249	2.5
KA	789.5	2.4	232	2.3
IA	764.7	2.3	304	3.0
ON	691.5	2.1	118	1.2
VA	674.5	2.0	169	1.7
ND	537.0	1.6	269	2.7
WY	314.5	1.0	81	0.8
NJ	136.5	0.4	40	0.4
WV	110.5	0.3	56	0.6
VT	91.5	0.3	34	0.3
OH	70.0	0.2	21	0.2

Appendix 9, Continued.

Area	Hours in the field	% of total hours	Deer seen	% of total deer seen
ME	68.5	0.2	10	0.1
IN	54.0	0.2	17	0.2
OK	54.0	0.2	19	0.2
CA	52.0	0.2	22	0.2
NC	51.5	0.2	16	0.2
OT	47.0	0.1	9	0.1
MD	39.0	0.1	11	0.1
AR	35.5	0.1	20	0.2
MA	32.0	0.1	9	0.1
AZ	1.5	0.0	1	0.0
Total	33,026.9		10,121	

Appendix 10. Time afield and deer seen by Stump Sitter observers during 1977 - 1980, classified by weapon used.

Weapon used	Hours in the field	% of total hours	Deer seen		Sightings per 100 hours	
			observed	expected	deer	bucks
Bow	16,800.2	50.9	5,904	5,147	35.1	4.6
Gun	10,237.2	31.0	1,801	3,136	17.6	1.9
Camera	2,019.0	6.1	855	619	42.4	7.3
None	3,966.5	12.0	1,557	1,215	39.3	6.2
Total	33,022.9		10,117	10,117		

Appendix 11. Minimum sighting distances of Stump Sitter observers during 1977-1980, classified by weapon used.

Weapon used	Distance (yd)				
	$\bar{X}$	SD	Mode	Max.	Min.
Bow	55.6	59.0	20	600	0
Gun	76.9	77.7	50	800	0
Camera	79.0	103.2	100	100	0
None	72.4	80.2	100	500	0

Appendix 12. Time afield and deer seen by Stump Sitter observers during 1977 - 1980, classified by hunting method used.

Method used	Hours in the field	% of total hours	Deer seen		Sightings per 100 hours	
			observed	expected	deer	bucks
Stillhunt	4,980.5	15.2	1,179	1,531	23.7	3.3
Treestand	14,604.2	44.5	5,099	4,488	34.9	5.5
Groundstand	6,979.2	21.3	1,625	2,145	23.3	3.0
Deer drive	1,316.0	4.0	270	405	20.5	1.6
Scout	4,944.0	15.0	1,915	1,519	38.7	6.2
Total	32,823.9		10,088	10,088		

Appendix 13. Minimum sighting distances of Stump Sitter observers during 1977-1980, classified by hunting method used.

Method used	Distance (yd) $\bar{x}$	SD	Mode	Max.	Min.
Stillhunt	66.3	64.4	50	500	0
Treestand	55.8	64.6	20	700	0
Groundstand	74.2	80.8	50	800	1
Deer drive	85.6	95.7	50	450	0
Scout	72.5	77.5	100	500	0

Appendix 14. Time afield and deer seen by Stump Sitter observers during 1977 - 1980, classified by covertype used.

Covertype used	Hours in the field	% of total hours	Deer seen		Sightings per 100 hours	
			observed	expected	deer	bucks
Field edges	7,299.7	22.6	2,798	2,250	38.3	5.3
Conifers	3,208.5	9.9	771	989	24.0	4.8
Hardwoods	13,550.7	41.9	4,154	4,176	30.6	5.0
Softwoods	4,489.0	13.9	1,241	1,383	27.7	3.8
Swamps	3,779.0	11.7	998	1,164	26.4	2.7
Total	32,325.9		9,962	9,962		

Appendix 15. Minimum sighting distances of Stump Sitter observers during 1977-1980, classified by covertype used.

Covertype used	Distance (yd)				
	$\bar{x}$	SD	Mode	Max.	Min.
Field edges	90.4	94.2	100	700	0
Conifers	53.2	42.7	50	400	1
Hardwoods	51.8	55.5	50	500	0
Softwoods	53.2	56.7	40	450	1
Swamps	61.4	72.1	20	800	0

Appendix 16. Crosstabulation of deer directions and wind directions observed by Stump Sitters during 1977 - 1980.

Deer Direction		Wind Direction								Row total
		N	NE	E	SE	S	SW	W	NW	
	<u>N</u>	160	95	151	209	212	352	425	231	1835
N	row %	8.7	5.2	8.2	11.4	11.6	19.2	23.2	12.6	20.2
	column %	20.9	15.5	25.5	25.5	19.5	21.7	20.5	15.2	
		39	47	37	21	40	99	83	96	462
NE		8.4	10.2	8.0	4.5	8.7	21.4	18.0	20.8	5.1
		5.1	7.7	6.2	2.6	3.7	6.1	4.0	6.3	
		108	145	148	137	223	294	383	240	1678
E		6.4	8.6	8.8	8.2	13.3	17.5	22.8	14.3	18.4
		14.1	23.7	24.8	16.7	20.5	18.1	18.5	15.8	
		21	28	27	59	34	62	109	139	479
SE		4.4	5.8	5.6	12.3	7.1	12.9	22.8	29.0	5.3
		2.7	4.6	4.5	7.2	3.1	3.8	5.3	9.1	

Appendix 16, Continued.

Deer Direction		Wind Direction								Row total
		N	NE	E	SE	S	SW	W	NW	
	N	183	85	75	111	224	310	429	270	1,687
S	row %	10.8	5.0	4.4	6.6	13.3	18.4	25.4	16.0	18.5
	column %	23.9	13.9	12.6	13.5	20.6	19.1	20.7	17.7	
		34	50	17	35	60	136	68	131	531
SW		6.4	9.4	3.2	6.6	11.3	25.6	12.8	24.7	5.8
		4.4	8.2	2.8	4.3	5.5	8.4	3.3	8.6	
		164	131	123	168	258	266	500	267	1,877
W		8.7	7.0	6.6	9.0	13.7	14.2	26.6	14.2	20.6
		21.4	21.4	20.6	20.5	23.7	16.4	24.2	17.5	
		57	31	19	80	38	102	72	148	547
NW		10.4	5.7	3.5	14.6	6.9	18.6	13.2	27.1	6.0
		7.4	5.1	3.2	9.8	3.5	6.3	3.5	9.7	
Column		766	612	597	820	1,089	1,621	2,069	1522	9,096
Total		8.4	6.7	6.6	9.0	12.0	17.8	22.7	16.7	100.0

Appendix 17. Time afield and deer seen by all[a] Stump Sitter observers during 1977-1980, classified by sky condition, wind velocity and precipitation.

Sky condition	Hours in the field	% of total hours	Deer seen observed	expected
Clear	8,496.8	41.9	4,541	4,217
Partly cloudy	4,441.7	21.9	2,112	2,204
Overcast	7,331.7	36.2	3,411	3,643
Total	20,270.2		10,064	10,064

---

[a] The entire population of deer and environmental observations

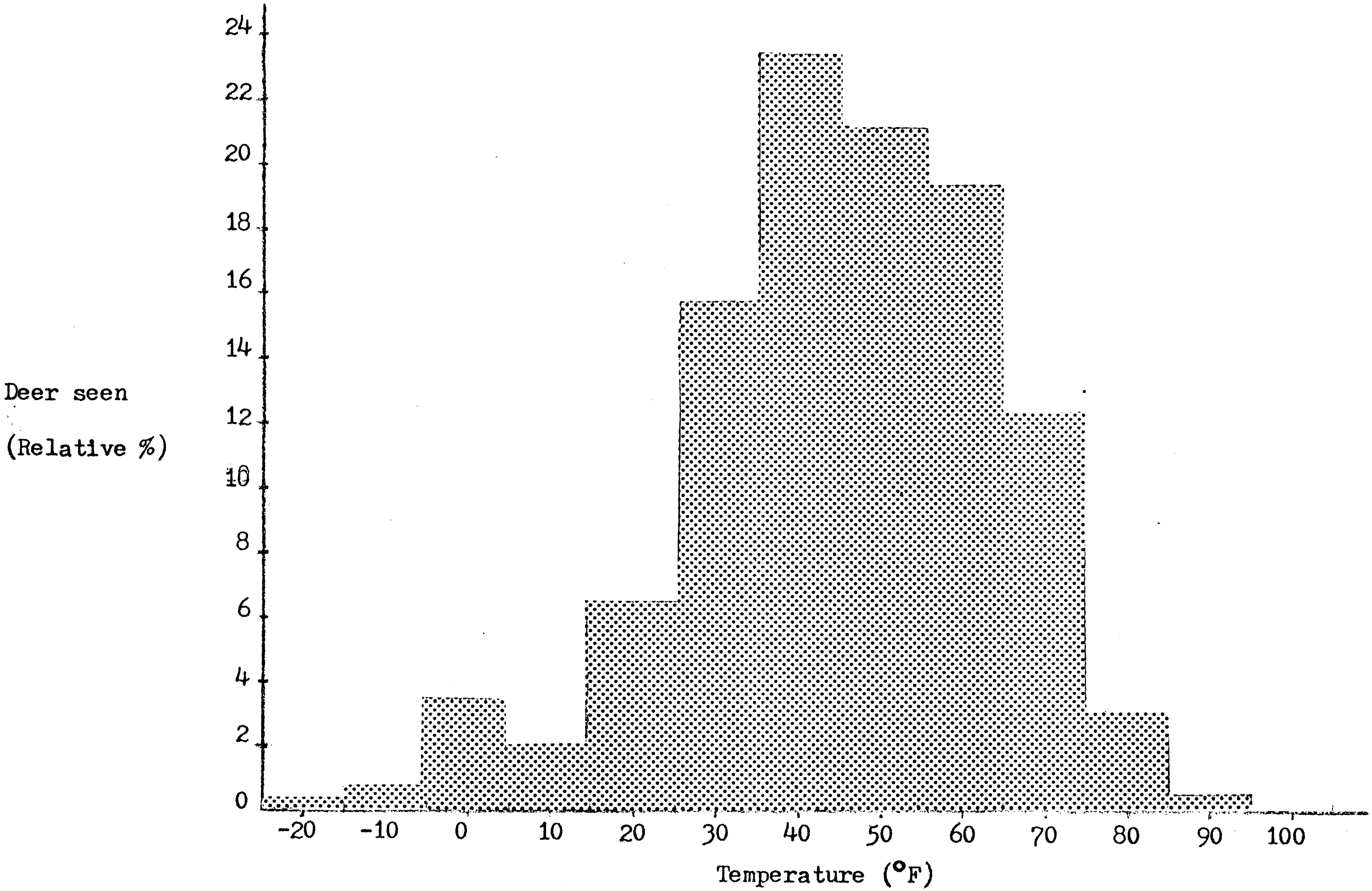
Appendix 17, Continued.

Wind velocity	Hours in the field	% of total hours	Deer seen observed	Deer seen expected
Calm	1,624.7	8.2	877	810
Light	8,909.5	44.9	4,943	4,437
Moderate	5,580.0	28.1	2,548	2,777
Gusty	2,424.5	12.2	977	1,205
Strong	1,318.5	6.6	537	652
Total	19,857.2		9,882	9,882

Appendix 17, Continued.

Precipitation	Hours in the field	% of total hours	Deer seen observed	Deer seen expected
None	16,917.0	82.6	8,588	8,359
Fog	365.5	1.8	99	182
Rain	2,147.5	10.5	919	1,062
Snow	957.7	5.7	448	576
Sleet	99.0	0.6	66	60
Hail	3.5	0.0	1	0
Total	20,490.2		10,121	10,121

Appendix 18. Deerseen by all[a] Stump Sitter observers during 1977-1980, classified by temperature[b] and snow depth[c].



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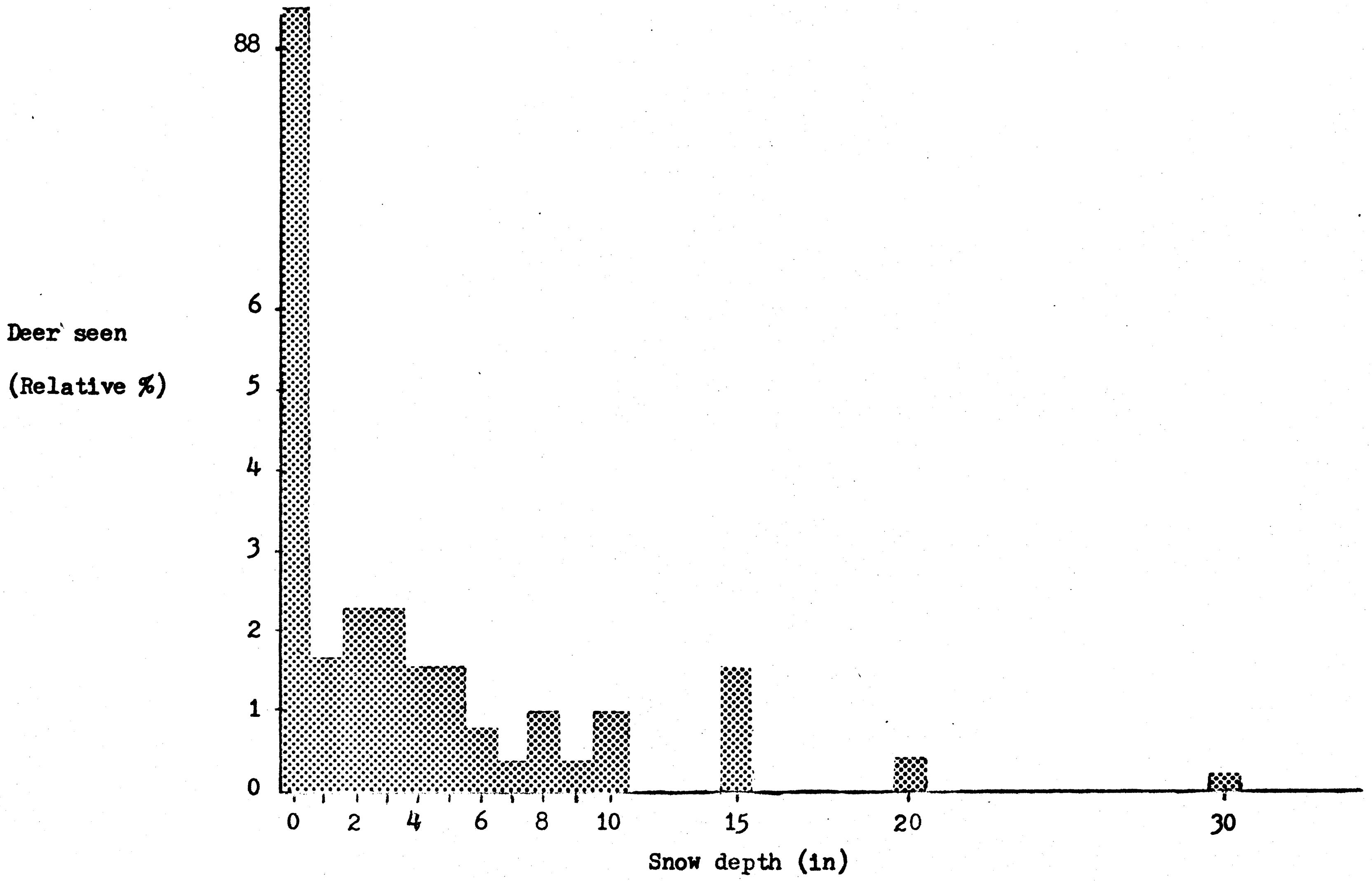
[a] The entire population of deer and environmental observations.

[b] N= 10,121, $\bar{x}$= 46.1, SD= 18.9, skewness= -0.374.

Appendix 18, Continued.



$^{c}\underline{N}$= 10,121, $\bar{x}$= 0.70, SD= 2.54, skewness= 5.33.

Appendix 19. Time afield and deer seen by a sample[a] of Stump Sitter observers during 1977-1980, classified by sky condition, wind velocity and precipitation.

Sky conditions	Hours in the field	% of total hours	Deer seen observed	Deer seen expected
Clear	1,514.5	40.9	743	737
Partly cloudy	930.5	25.1	448	453
Overcast	1,261.5	34.0	612	613
Total	3,706.5		1,803	1,803

[a] Deer and environmental observations by Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less.

Appendix 19, Continued.

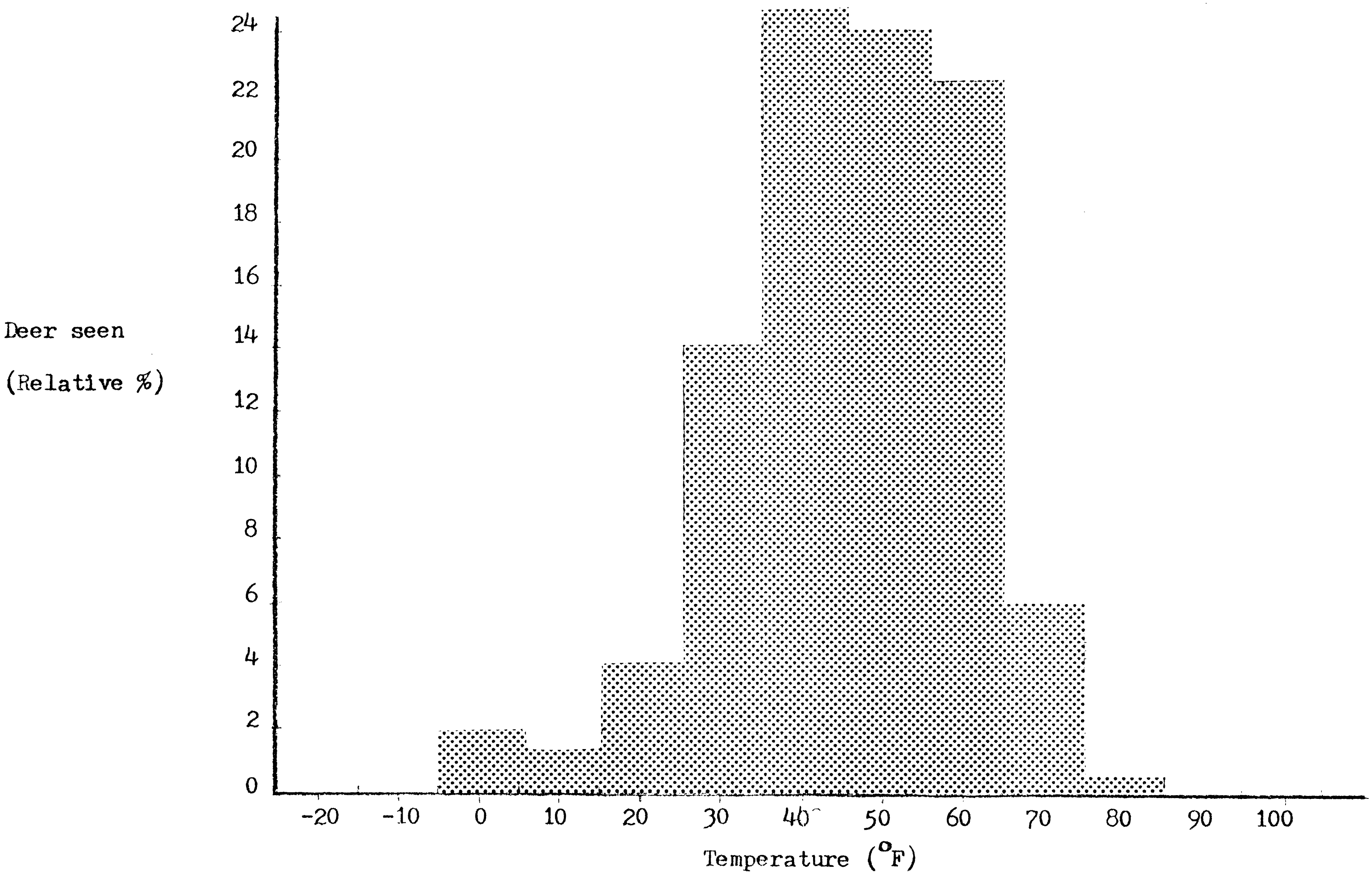
Wind velocity	Hours in the field	% of total hours	Deer seen	
			observed	expected
Calm	260.5	7.2	130	126
Light	1,742.5	48.5	854	850
Moderate	868.5	24.2	428	424
Gusty	438.0	12.2	204	214
Strong	285.0	7.9	136	138
Total	3,594.5		1,752	1,752

Appendix 19, Continued.

Precipitation	Hours in the field	% of total hours	Deer seen observed	Deer seen expected
None	3,304.5	88.9	1,615	1,607
Fog	44.0	1.2	21	22
Rain	275.5	7.4	127	134
Severe[b]	92.5	2.5	45	45
Total	3,716.5		1,808	1,808

[b] Severe is Snow, Sleet and Hail data taken collectively.

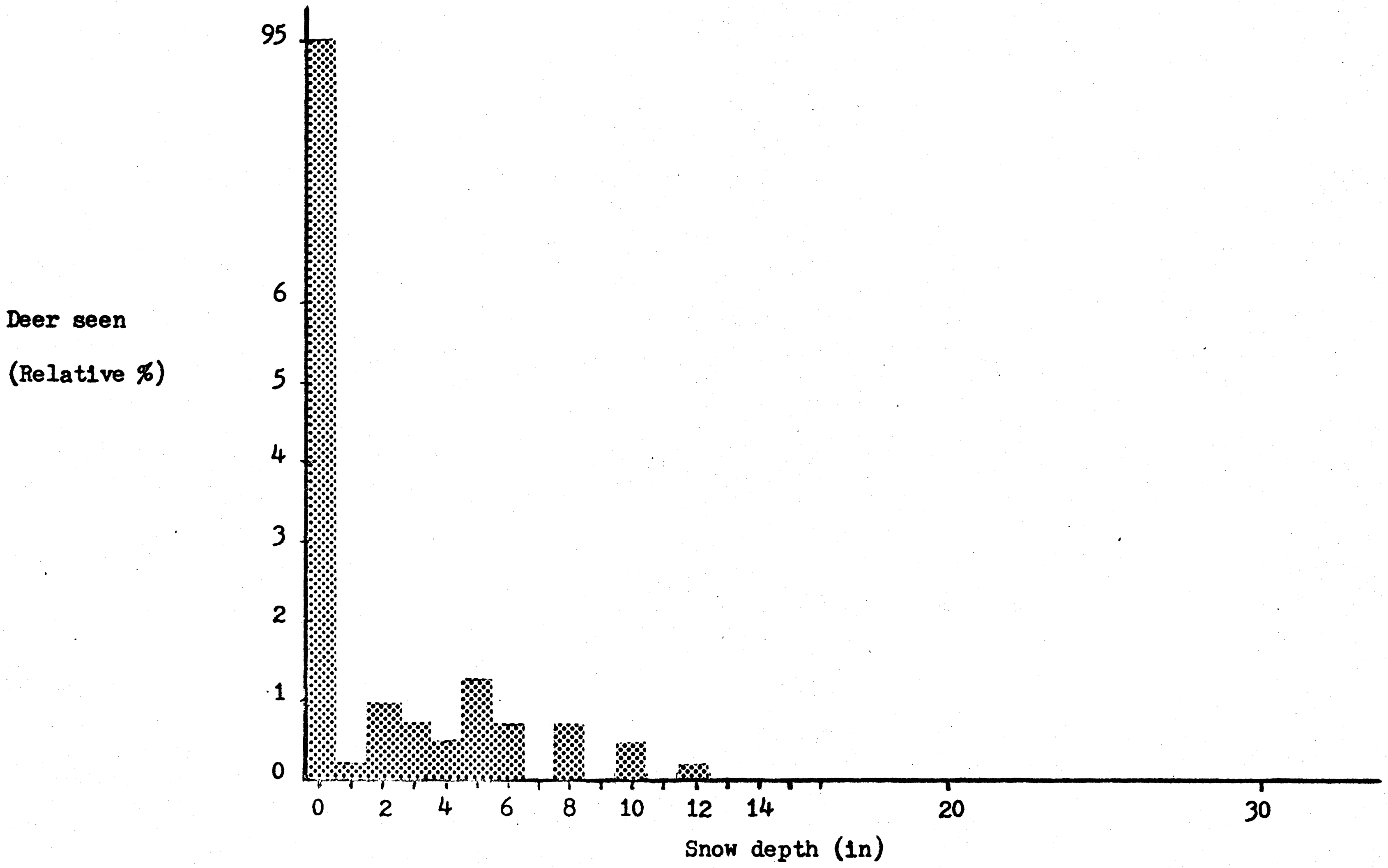
Appendix 20. Deer seen by a sample[a] of Stump Sitter observers during 1977-1980, classified by temperature[b] and snow depth[c].



[a] Deer seen and environmental observations by Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less.

[b] N= 1808, $\bar{x}$= 47.2, SD= 14.5, skewness= -0.689.

Appendix 20, Continued.



[c] N= 1808, $\bar{X}$= 0.26, SD= 1.26, skewness= 5.86.

Appendix 21. Stepwise multiple regressions of deer seen on hours and weather variables for all[a] and a sample[b] of Stump Sitter observations during 1977-1980.

Deer seen - population data.

Independent variable	R^2
Hours	0.021
Snow depth	0.036
Precipitation	0.046
Temperature	0.050
Sky conditions	0.054
Wind velocity	0.054

Deer seen - sample data

Independent variable	R^2
Sky conditions	0.018
Temperature	0.031
Snow depth	0.042
Hours	0.047
Precipitation	0.050
Wind velocity	0.050

[a] The entire population of deer and environmental observations.

[b] Deer and environmental observations by Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less.

Appendix 22. Stepwise multiple regressions of transformed deer seen on hours and weather variables for all[a] Stump Sitter observations during 1977-1980.

Deer seen - Natural logarithm		Deer seen - Square root	
Independent Variable	R^2	Independent Variable	R^2
Snow depth	0.015	Snow depth	0.019
Hours	0.024	Hours	0.031
Temperature	0.033	Sky conditions	0.040
Sky conditions	0.039	Temperature	0.047
Precipitation	0.040	Precipitation	0.049
Wind velocity	0.040	Wind velocity	0.049

Deer Seen - Square		Deer Seen - Reciprocal	
Independent Variable	R^2	Independent Variable	R^2
Hours	0.036	Snow depth	0.006
Precipitation	0.044	Temperature	0.012
Snow depth	0.053	Hours	0.018
Sky condition	0.056	Sky condition	0.021
Temperature	0.057	Wind velocity	0.021
Wind velocity	0.058	Precipitation	0.021

[a] The entire population of deer and environmental observations.

Appendix 23. Zero order partial correlation coefficients for sex and age classes of deer seen, hours and weather variables, for all[a] and a sample[b] of Stump Sitter observations during 1977 - 1980.

	Partial coefficients (all other variables constant) for all observations						
	Deer Seen	Temperature	Snow	Wind Velocity	Sky Conditions	Precipitation	Hours
Deer seen	1.00	-0.01	0.14	-0.01	-0.08	-0.05	0.15
Temperature		1.00	-0.45	-0.13	-0.09	-0.17	-0.17
Snow			1.00	0.08	0.03	0.19	0.08
Wind Velocity				1.00	0.24	0.16	0.05
Sky Conditions					1.00	0.41	0.08
Precipitation						1.00	0.16
Hours							1.00

[a] The entire population of deer and environmental observations.

[b] By bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less.

Appendix 23, Continued

Variable	Partial coefficients (all other variables constant) for a sample of Stump Sitter observations						
	Deer Seen	Temperature	Precipitation	Wind Velocity	Sky Conditions	Snow	Hours
Deer seen	1.00	0.12	-0.11	-0.06	-0.14	0.06	-0.07
Temperature		1.00	-0.12	0.07	-0.05	-0.40	0.05
Precipitation			1.00	0.12	0.33	-0.01	0.04
Wind Velocity				1.00	0.20	0.03	0.05
Sky Conditions					1.00	-0.03	0.02
Snow						1.00	-0.08
Hours							1.00

Appendix 23, Continued

Variables	Partial coefficients (all other variables constant) for does seen for sample of Stump Sitter observations						
	Does Seen	Temperature	Precipitation	Wind Velocity	Sky Condition	Snow	Hours
Does Seen	1.00	0.19	-0.17	-0.19	-0.12	0.07	-0.07
Temperature		1.00	-0.11	-0.11	0.07	-0.36	0.03
Precipitation			1.00	0.19	0.33	-0.06	0.09
Wind Velocity				1.00	0.23	0.03	-0.01
Sky Condition					1.00	0.06	-0.02
Snow						1.00	-0.05
Hours							1.00

Appendix 24. Stepwise multiple regressions of the sex and age classes of the deer seen on hours and weather variables for a sample[a] of Stump Sitter observations during 1977-1980.

Buck		Doe	
Independent Variable	R^2	Independent Variable	R^2
Hours	0.000	Sky condition	0.022
Temperature	0.021	Snow depth	0.028
Wind velocity	0.028	Temperature	0.034
Sky condition	0.033	Precipitation	0.036
Precipitation	0.035	Hours	0.038
Snow depth	0.036	Wind velocity	0.040

Fawn		Uncertain Sex or Age	
Independent Variable	R^2	Independent Variable	R^2
Sky condition	0.022	Wind velocity	0.038
Temperature	0.037	Temperature	0.067
Hours	0.047	Snow depth	0.087
Snow depth	0.051	Precipitation	0.100
Wind velocity	0.054	Hours	0.103
Precipitation	0.055	Sky condition	0.105

[a] Deer sightings by Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less.

Appendix 25. Stepwise multiple regressions of deer seen by months on hours and weather variables for a sample[a] of Stump Sitter observations during 1977-1980.

September		October	
Independent Variable	R^2	Independent Variable	R^2
Snow depth	0.000	Temperature	0.013
Sky condition	0.016	Precipitation	0.019
Temperature	0.022	Hours	0.023
Precipitation	0.026	Sky condition	0.025
Wind velocity	0.026	Wind velocity	0.026
Hours	0.026	Snow depth	0.026

November		December	
Independent Variable	R^2	Independent Variable	R^2
Wind velocity	0.060	Snow depth	0.204
Snow depth	0.105	Sky condition	0.330
Temperature	0.135	Temperature	0.396
Sky conditon	0.151	Wind velocity	0.453
Hours	0.165	Hours	0.457
Precipitation	0.165	Precipitation	0.458

[a] Deer sightings by Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less.

Appendix 26. Slopes (B) and F values (H:B=0)[a] for stepwise multiple regressions of deer seen on weather variables for a sample[b] of Stump Sitter observations during 1977-1980.

Variable	B-value (Slope)	F
Snow depth	0.182	17.14[c]
Sky condition	-0.835	23.43[c]
Temperature	-0.054	11.94[c]
Wind velocity	-0.507	10.71[c]

[a] Testing hypothesis that slope (B) equals 0.

[b] Deer sightings by Wisconsin bowhunters who used treestands, were in the field 3 hours or less from September through December and saw 10 deer or less.

[c] $P < 0.01$.