NOAA Technical Memorandum NWS FCST-30

1982 and 1983 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind

Silver Spring, MD
January 1985

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Weather Service

NOAA TECHNICAL MEMORANDUMS

National Weather Service, Program Requirements and Planning Division Series

The Program Requirements and Planning Division of the Office of Meteorology is specifically responsible for preparation of program requirements and plans relating to forecasting services for the public, aviation, marine, agriculture, and fire weather interests. NOAA Technical Memorandums in the Program Requirements and Planning Division series communicate scientific and technical information relating to field forecasting operations. The series includes information on present techniques, procedures, and performance data. Background information and detail on selected service operations are also given. The series provides a means for the personnel in the National Weather Service Headquarters and Regional Offices to report on forecasting methods of general interest and wide application.

NOAA Technical Memorandums in the Program Requirements and Planning Division series facilitate rapid distribution of material which may be preliminary in nature and which may be published formally elsewhere at a later date. Publications 1 through 4 by this Division are in the former series, Weather Bureau Technical Notes (TN), Notes to Forecasters (FCST); publications 5 through 15 are in the former series, ESSA Technical Memorandums Weather Bureau Technical Memorandums (WBTM). Beginning with FCST 16, publications are now part of the series, NOAA Technical Memorandums, National Weather Service (NWS).

Publications listed below are available from the National Technical Information Service (NTIS), U.S. Department of Commerce, Sills Bldg., 5285 Port Royal Road, Springfield, VA 22161. Prices vary for paper copy. Microfiche copies available. Order by accession number, when given, in parentheses.

Weather Bureau Technical Notes

TN 8 FCST 1 On the Use of Probability Statements in Weather Forecasts. Charles F. Roberts, September 1965. (PB-174-647)

TN 13 FCST 2 Local Cloud and Precipitation Forecast Method (SLYH). Matthew H. Kulawiec, September 1965. (PB-168-610)

TN 16 FCST 3 Present and Future Operational Numerical Prediction Models. Charles F. Roberts, October 1965. (PB-169-126)

TN 23 FCST 4 Forecasting the Freezing Level Objectively as an Aid in Forecasting the Level of Icing. Jack B. Cox, December 1965. (PB-169-247)

ESSA Technical Memorandums

WBTM FCST 5 Performance of the 6-Layer Baroclinic (Primitive Equation) Model. Julius Badner, September 1966. (PB-173-426)

WBTM FCST 6 Forecasting Mountain Waves. Phillip A. Calabrese, September 1966. (PB-174-648)

WBTM FCST 7 A Method for Deriving Prediction of Soil Temperature from Medium-Range Weather Forecasts. Charles F. Roberts, June 1967. (PB-175-773)

WBTM FCST 8 Recent Trends in the Accuracy and Quality of Weather Bureau Forecasting Service. Charles F. Roberts and John M. Porter, November 1967. (PB-176-953)

WBTM FCST 9 Report on the Forecast Performance of Selected Weather Bureau Offices for 1966-1967. C. F. Roberts, J. M. Porter, and G. F. Cobb, December 1967. (PB-177-043)

WBTM FCST 10 Size of Tornado Warning Area When Issued on Basis of Radar Hook Echo. Alexander F. Sadowski May 1969. (PB-184-613)

WBTM FCST 11 Report on Weather Bureau Forecast Performance 1967-68 and Comparison with Previous Years. Charles F. Roberts, John M. Porter, and Geraldine F. Cobb, March 1969. (PB-184-366)

WBTM FCST 12 Severe Local Storm Occurrences 1955-1967. Staff, SELS Unit, NSSFC, Maurice E. Pautz, Editor, September 1969. (PB-187-761)

WBTM FCST 13 On the Problem of Developing Weather Forecasting Equations by Statistical Methods. Charles F. Roberts, October 1969. (PB-187-796)

WBTM FCST 14 Preliminary Results of an Empirical Study of Some Spectral Characteristics of Skill in Present Weather and Circulation Forecasts. Charles F. Roberts, November 1969. (PB-188-529)

WBTM FCST 15 Weather Bureau Forecast Verification Scores 1968-69 and Some Performance Trends from 1966. Robert G. Derouin and Geraldine F. Cobb, May 1970. (PB-192-949)

(Continued on inside back cover)

NOAA Technical Memorandum NWS FCST-30

1982 and 1983 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind

A. Kristine Campbell

Office of Meteorology
Silver Spring, MD
January 1985

UNITED STATES
DEPARTMENT OF COMMERCE
Malcolm Baldrige, Secretary

National Oceanic and
Atmospheric Administration
Anthony J. Calio,
Deputy Administrator

National Weather Service
Richard E. Hallgren,
Assistant Administrator

CONTENTS

NATIONAL WEATHER SERVICE 1982 AND 1983 WATCH/WARNING VERIFICATION: FLASH FLOOD, WINTER STORM AND HIGH WIND

A. Kristine Campbell

ABSTRACT. A limited program was begun in 1979 to develop a measure of watch/warning forecast performance for flash flood, winter storm and high wind. Weather Service forecast offices provide verification logs to national headquarters for this purpose. These logs consist of issue time, valid time, lead time, area, verification for watches and warnings, and events that occur in the absence of a watch or warning.

A total of 436 flash flood, 186 winter weather and 111 high wind events were reported on the logs in 1982. Collectively, 10 percent of those events occurred without a watch or warning being issued. Of the total warnings disseminated 78 percent showed positive verification, but 41 percent of those were issued with an event in progress.

In 1983 a total of 414 flash floods, 147 winter weather and 80 high wind events were reported on the logs. Collectively, 11 percent of those events occurred without a watch or warning being issued. Of the total warnings disseminated 79 percent showed positive verification, but 36 percent of those were issued with an event in progress.

1. PURPOSE

Any organization charged with providing a service must be able to detect the strengths and deficiencies in that service in order to improve its performance. Providing the public with watches and warnings to alert them to life-threatening hazardous weather events is the most important function of the National Weather Service (NWS). Verification of these forecasts is essential to build a constant measure of our skill so that a baseline may be established against which we can evaluate the effect of new techniques or equipment on those forecasts.

We recognize many faults in the present watch/warning verification system: it is subjective, inconsistent and incomplete. Even though there are flaws in this scheme that may inhibit the establishment of a true base measure, it represents the best measure currently achievable.

2. BACKGROUND

Since January 1979, all 52 forecast offices listed in Appendix I have been required to enter verification data on standardized logs each month for flash flood watches and warnings; winter storm watches and warnings, specifying if the warning is for blizzard, heavy snow or freezing rain; and high wind and duststorm/sandstorm warnings.

One of the most difficult aspects of watch/warning verification is obtaining observations, which is the reason watches and warnings may be listed as verification unknown. Reports of events come from a variety of sources: Civil Defense, law enforcement officials, cooperative observers, spotter networks and newspaper clippings.

A manual tabulation and statistical calculation of the data has been accomplished by the Services Evaluation Branch of the NWS. Preliminary in-house reports were issued for calendar year 1979, and Technical Memorandums were issued for 1980 and 1981 (Campbell, 1982).

Most of the statistics in this report are straightforward percentages and definitions for terms, such as lead time, are given in the text. One statistic that does, however, need more of an explanation is the measure of how often warnings are issued but no event occurs. This statistic has several definitions; the following are used in this report:

1. false alarm ratio (FAR) from the definition of Donaldson, et.al. (1975)

$$FAR = \frac{\text{Warnings with negative verification}}{\text{Warnings issued}} \times 100\%$$

2. $$\text{overwarning} = \left(\frac{\text{Warnings issued}}{\text{Warnings with positive verification}} - 1 \right) \times 100\%$$

To achieve zero percent FAR or overwarning, one would have to be certain an event was going to occur before a warning could be issued. At the present level of technology, near zero percent would certainly mean an unacceptable increase in the number of events that would occur without a warning and a further increase in cases with zero lead time.

Occasionally the logs are incomplete or are filled out incorrectly with contradictory information included in remarks. In these cases the tabulation calls for judgment and is, therefore, subjective and to some degree inconsistent from year to year. Instructions for filling out the logs require all flash flood warnings to be verified and all flash flood events without a watch or warning to be entered on the log. For the remainder of watch/warning

issuances and events each forecast office has preselected one zone to verify for flash flood watches and one zone to verify for winter weather and high wind.

A proposal to expand the amount of data collected and to partially automate the verification program is being evaluated. Implementation will begin once the details have been agreed to.

3. PROBLEMS

The following is a partial list of problems encountered when entering the data on the forms, when tabulating the data from the forms, and when using the statistics found in this report. Most of these problems will be solved or at least ameliorated when the proposed verification plan is implemented.

1. Prior to 1981, each forecast office was given the option of entering all watches, warnings and events or a subset that could consist of one or several zones, the only exception being all flash flood warnings and events had to be entered. Beginning in January 1981, forecast offices were instructed to choose one zone to verify for flash flood watches, winter storm watches and warnings and high wind warnings. The purpose was to provide a more consistent verification program. The alternative was to require at least all flash flood watches, but increased workload caused this option to be ruled out. As expected, the bias in a couple of statistics changed substantially: the number of flash flood events with both a watch and warning is too low and the number of events with a warning but no watch is too high.

2. Verifying individual warnings versus verifying for a zone or counties can make a difference in lead time distribution. If a warning is issued for three counties and the event begins at a different time in each county, only the earliest known time would be used as the lead time for the warning, while each of the three times would be used when verifying counties. For example, using county lead times of 1, 3 and 5 hours, if the warning is verified the lead time is 1 hour, if the counties are verified separately the average for the warning is 3 hours. This is mainly a problem for flash flood warnings since all winter weather and high wind warnings are verified strictly on a zone basis. Besides increasing the workload, verifying all flash flood warnings county by county would almost surely increase the percentage of unknown lead times.

3. A problem arises when, for example, there is a tropical depression that dumps 10 to 20 inches of rain in a day or two or a series of mesoscale storms track over one area. The result of such situations is flash flooding for the lack of a more suitable name. Some aspects of this problem are:

a) As stated in WSOM Chapter E-13 section 5.3b, the valid period of a flash flood warning "will not normally exceed 4 hours from the time of issuance". In situations like those stated above, warnings are extended often

and the majority of these extensions have a built-in zero lead time. One partial solution would be to verify for counties instead of warnings as is done for tornadoes and severe thunderstorms. That way any new counties added would have their positive lead times counted. This would certainly increase the workload at offices and is not recommended under the present verification system. Another possibility is counting the extensions separately so their "automatic" zero lead times would not affect the first-time warning statistics.

b) There may be some exaggeration in the number of events because of the subjective analysis of the watch/warning logs. It is often difficult to tell whether an event used to verify a warning is new or the continuation of an event.

c) A few offices put out flash flood warnings that are in effect for an unusually long period of time (over 18 hours is considered unusual). While this practice eliminates the extension problem, it conflicts with the definition of a flash flood as a short fused event.

4. Generally, a set of more than 10 cases will give a useful small sample. The national samples are large enough to make some preliminary assessments in all areas except freezing rain warnings and events. The following are categories where regional samples are too small to draw any reliable conclusions: 1) all heavy snow warnings and events 1983 and all except Central Region 1982; 2) all blizzard warnings and events 1983 and all except Central Region 1982; 3) high wind warnings and events Southern and Pacific Regions 1982 and 1983; 4) Pacific Region, all except flash flood watches, warnings and events 1982; and 5) Alaska Region, all except high wind warnings and events 1982 and 1983 and heavy snow warnings 1982.

4. 1982 FLASH FLOOD

The first three problems addressed in Section 3 deal directly with flash flood verification and should be considered when using the statistics presented in this section.

A flash flood is defined by WSOM Chapter E-13 as follows: "A flood which follows within a few hours of heavy or excessive rainfall, dam or levee failure, or a sudden release of water impounded by an ice jam." A wall of water rushing through a narrow channel is not the only type of flash flood; water may rise rapidly due to poor drainage. Ponding of water is especially common in low lying coastal regions.

Table 4-1 presents a quick overview of the number of watches, warnings and events plus information on lead time and valid time.

4.1 EVENTS

The national distribution of flash floods was uneven: 58 percent occurred in the Southern Region followed by 21 percent in the Central Region, 9 percent in the Western Region, 6 percent in the Pacific Region, 5 percent in the Eastern Region and less than 1 percent in the Alaska Region. Figure 4-1 shows the actual number of events by management area.

Ideally, both a watch and a warning should be issued before a hazardous weather event occurs. The statistics in this report do not give an accurate measure of this, but it was accomplished at least 11 percent of the time for flash floods during 1982, as illustrated by the solid portion of the bars in Figure 4-2. The numbers in brackets above the bars are the actual number of events with a watch and warning. Nationally, at least 49 times out of 436, both a watch and warning were in effect for an event. The dotted portion of the bars in Figures 4-2a and 4-2b show the percentage of events with watches but no warnings and events with warnings but no watches, respectively. Together the solid and dotted portions of a bar show the total percentage of events with watches (Figure 4-2a) and the total percentage of events with warnings (Figure 4-2b). Above each bar the number in parentheses is the actual number of flash floods with watches (Figure 4-2a) and with warnings (Figure 4-2b). The number in brackets is included in the number in parentheses. For example, in the Eastern Region 3 floods had both a watch and a warning; an additional 3 had a watch but no warning, and 11 flash floods had a warning but no watch. Warnings with zero lead time were counted.

Nationally, 14 percent of the flash floods occurred without the Weather Service issuing a watch or warning, as shown in Figure 4-2c. The number above each bar is the actual number of events. For example, in the Southern Region 45 events out of 255 were not covered by a watch or warning.

4.2 WATCHES

Twenty-eight percent of the flash flood watches issued in 1982 were followed by an event. Figure 4-3a shows the regional breakdown of these statistics. The solid portion of the bars gives the percentage of watches with positive verification, while the dotted portion accounts for those watches where information was unavailable as to whether an event occurred.

Figure 4-3b shows that, on a national basis, one-tenth of the flash floods issued were extensions of previous watches. Watches may be extended in three ways: 1) keep the same area but extend the valid time, 2) alter the area but keep the same time period, or 3) change both area and time. The extensions are counted in the total number of watches and are included in all watch statistics.

Lead time is counted from the time of issuance to the time an event occurs. Nationally, three-fifths of the flash flood watches had lead times of

6 hours or less. Regional lead time distributions may be found in Figure 4-4 and Table 4-1. Table 4-1 also gives the average lead time and the average valid period for flash flood watches.

Projection time is the interval between the issuance of a watch or warning and when it goes into effect (the beginning of the valid period). The national average projection time for flash flood watches in 1982 was 1 hour and 36 minutes. Projection times ranged from zero for 187 of the 283 watches to 20 hours for 1 of the watches.

4.3 WARNINGS

Nationally, four out of five flash flood warnings were associated with an event. Figure 4-3c gives the regional statistics. The solid bars show the percentage of warnings that verified with a known event, while the dotted sections account for those where information was unavailable to verify whether an event occurred. Nationally, 15 percent of the flash flood warnings were extensions of previous warnings; regional percentages are given in Figure 4-3d. Warnings, like watches, may be extended in three ways.

The difference between 100 percent and the solid bars in Figure 4-3c gives the FAR, assuming all the unknowns are counted as no event. Nationally, 522 warnings were issued and 422 had events, which results in 24 percent overwarning.

So far the statistics have included warnings regardless of lead time. The average lead time was half an hour; over half of the warnings nationwide had no lead time. Table 4-1 and Figure 4-5 provide regional lead time distribution. One criterion for issuing a warning is the report of an event in progress. These warnings with zero lead time are legitimate and may in fact provide a nearby community with enough time to take effective action. Since advance notice of a hazardous weather event is very important, the following is a recalculation for Figure 4-3c if only warnings with lead times greater than zero are counted as having positive verification: 1) East, 25 percent vs 70 percent; 2) South, 37 percent vs 81 percent; 3) Central, 52 percent vs 92 percent; 4) West, 31 percent vs 84 percent; 5) Pacific, 30 percent vs 61 percent; and 6) National, 38 percent vs 81 percent.

All flash flood warnings except one went into effect at the time they were issued. Projection time for that one warning was half an hour. The average valid time for a flash flood warning was 3.9 hours, but they ranged from 1 hour to 28 hours in duration.

Warnings are generally issued for counties. Figure 4-6 shows the number of counties covered by flash flood warnings during 1982. The shaded sections represent the percentage of counties in which an event occurred, the dotted sections represent the percentage of counties where it was not determined whether or not an event occurred, and the clear sections represent the percentage of counties where it is known an event did not occur.

Table 4-1

1982 summary of regional and national statistics for flash floods.

FLASH FLOOD WATCHES

Region	Number of Watches	Watches No Event	Watches with Event	Watches Event Unknown	Percentage Distribution Lead Time in Hours 0≤6	>6≤12	>12≤18	>18≤24	>24	Unknown	Average Lead Time (Hours)	Average Watch Duration (Hours)
East	26	18	6	2	33%	67%	0%	0%	0%	0%	7.2	13.5
South	122	74	40	8	57%	12%	5%	3%	0%	22%	5.0	15.4
Central	74	50	21	3	67%	33%	0%	0%	0%	0%	5.0	13.1
West	43	25	12	6	75%	17%	8%	0%	0%	0%	4.8	8.1
Alaska	1	1	0	0								6.0
Pacific	17	17	0	0								6.9
National	283	185	79	19	61%	23%	4%	1%	0%	11%	5.2	13.0

FLASH FLOOD WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	20	2	14	4	64%	0%	7%	14%	0%	14%	0.8	4.2
South	317	46	256	15	53%	17%	4%	0%	1%	24%	0.3	3.5
Central	90	3	83	4	43%	36%	17%	2%	1%	0%	0.9	3.8
West	49	5	41	3	63%	24%	5%	5%	0%	2%	0.6	2.6
Alaska	0											
Pacific	46	18	28	0	50%	29%	14%	0%	0%	7%	0.5	8.5
National	522	74	422	26	53%	22%	7%	1%	1%	16%	0.5	3.9

FLASH FLOOD EVENTS

Region	Number of Events	Events* Warning Only	Events Watch Only	Events Neither	Events* Both
East	21	11	3	4	3
South	255	166	14	45	30
Central	90	61	9	8	12
West	41	28	8	1	4
Alaska	1	0	0	1	0
Pacific	28	28	0	0	0
National	436	294	34	59	49

*These numbers are biased because not all flash flood watches are counted. This problem is addressed in section 3.

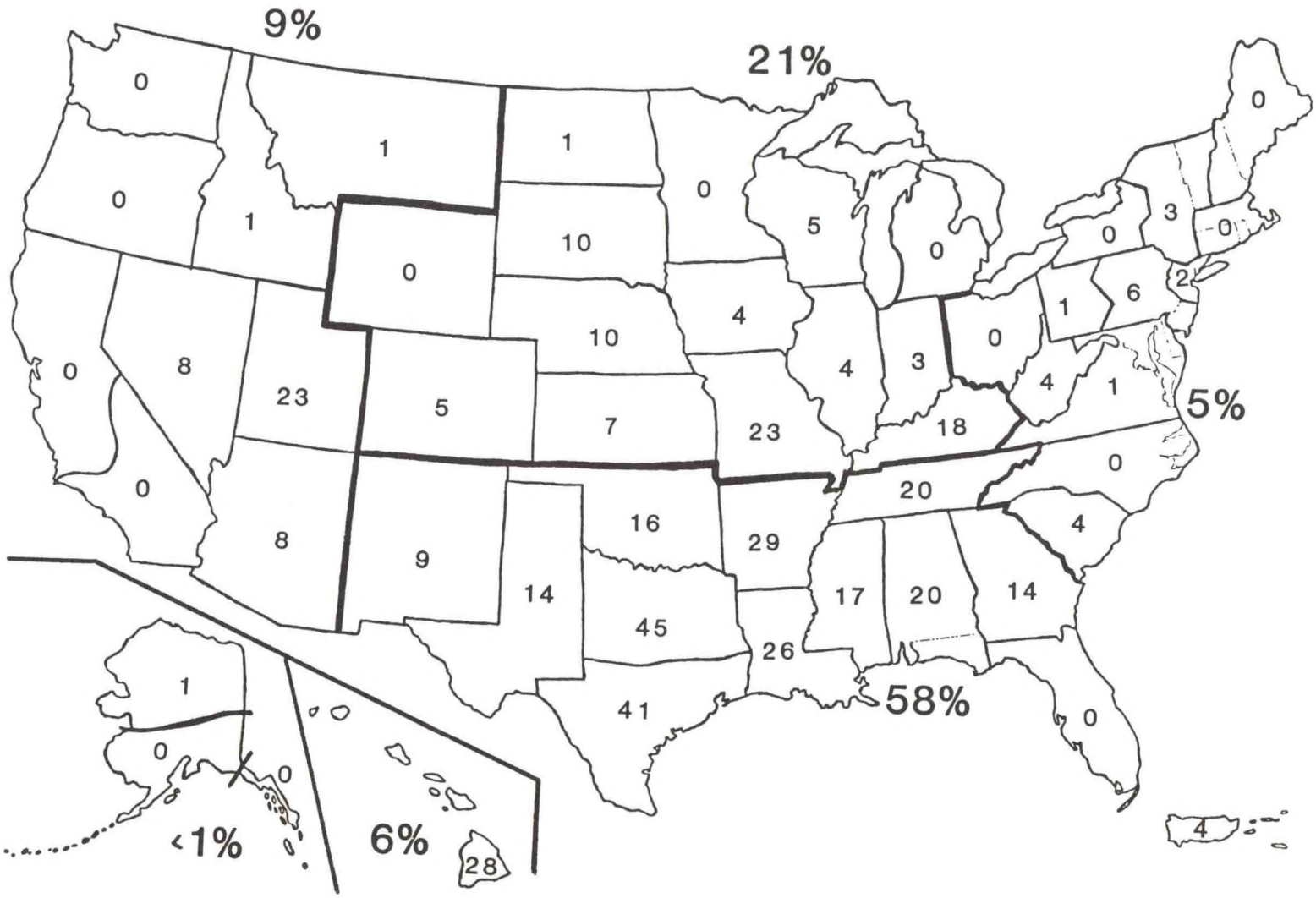

Figure 4-1: Number of flash flood events by forecast office with percentage of events in each region for 1982.

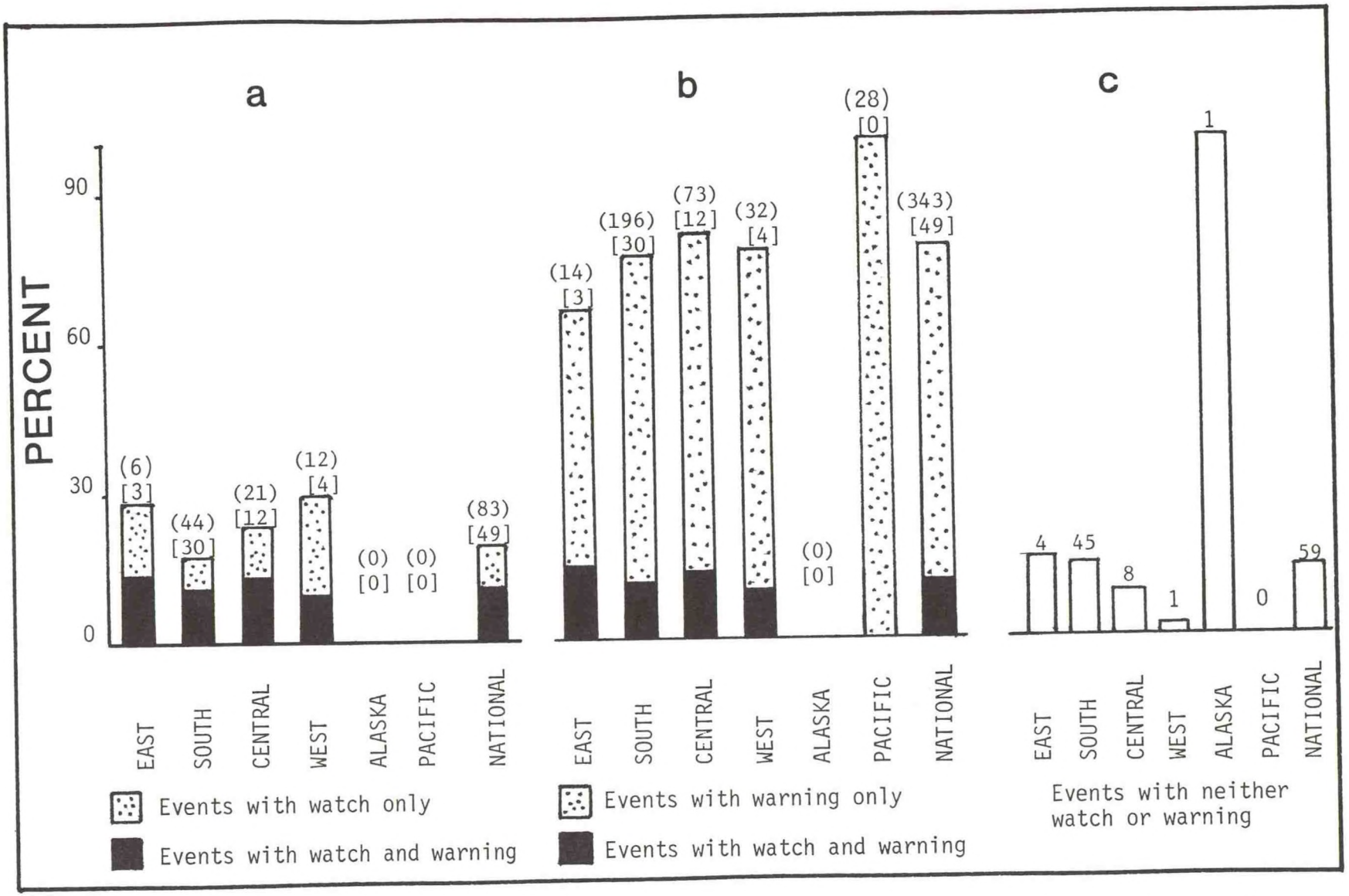

Figure 4-2: (a) Percentage of flash floods with watches; actual number in parentheses. Number of flash floods with both a watch and warning is in brackets. (b) Percentage of flash floods with warnings; actual number in parentheses. Number of flash floods with both a warning and watch is in brackets. (c) Percentage of flash floods with neither a watch or warning; actual number above each bar.

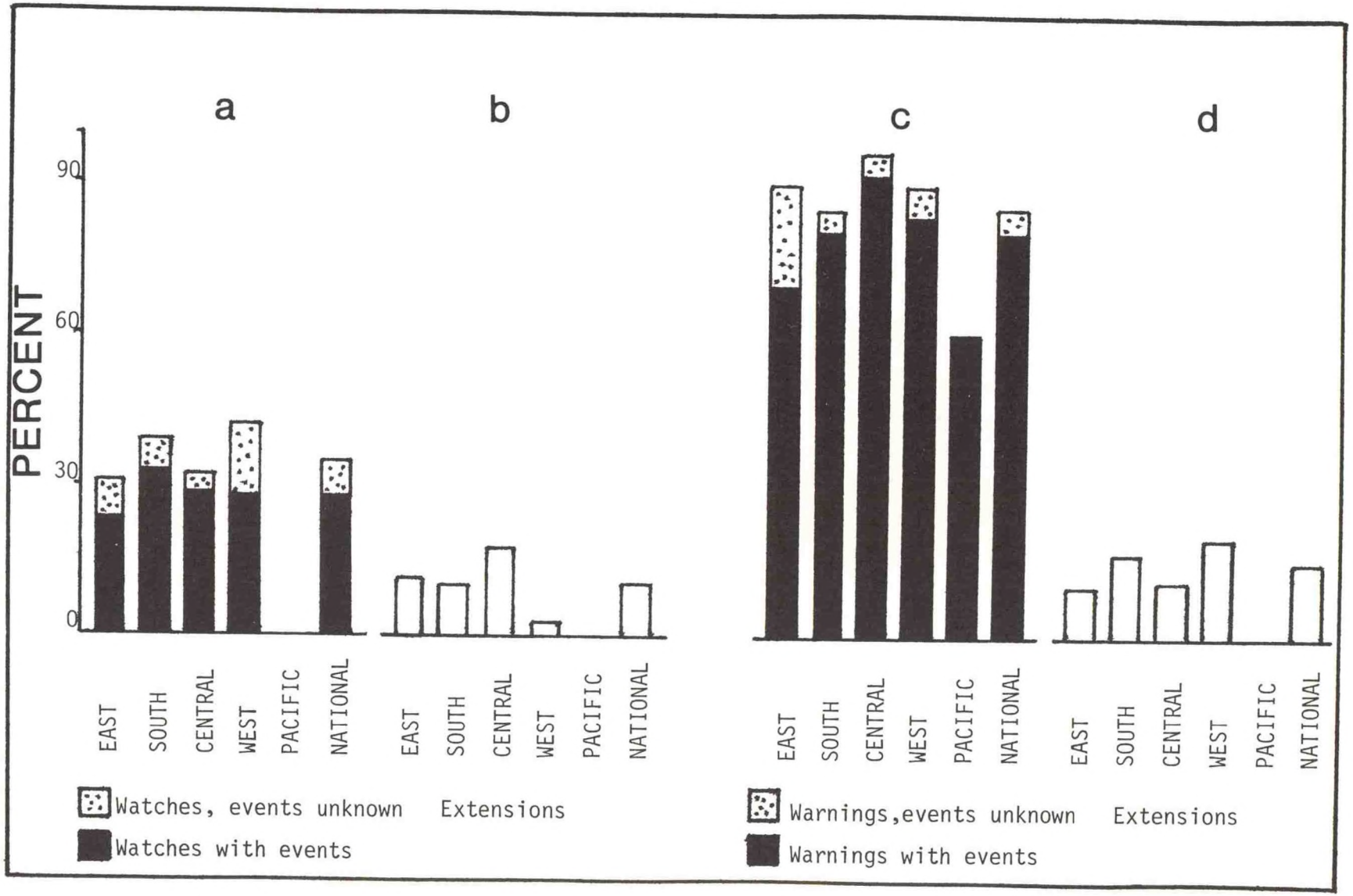

Figure 4-3: (a) Percentage of flash flood watches with known events and possible events. (b) Percentage of the total number of flash flood watches that are extensions. (c) Percentage of flash flood warnings with known events and possible events. (d) Percentage of total number of flash flood warnings that are extensions.

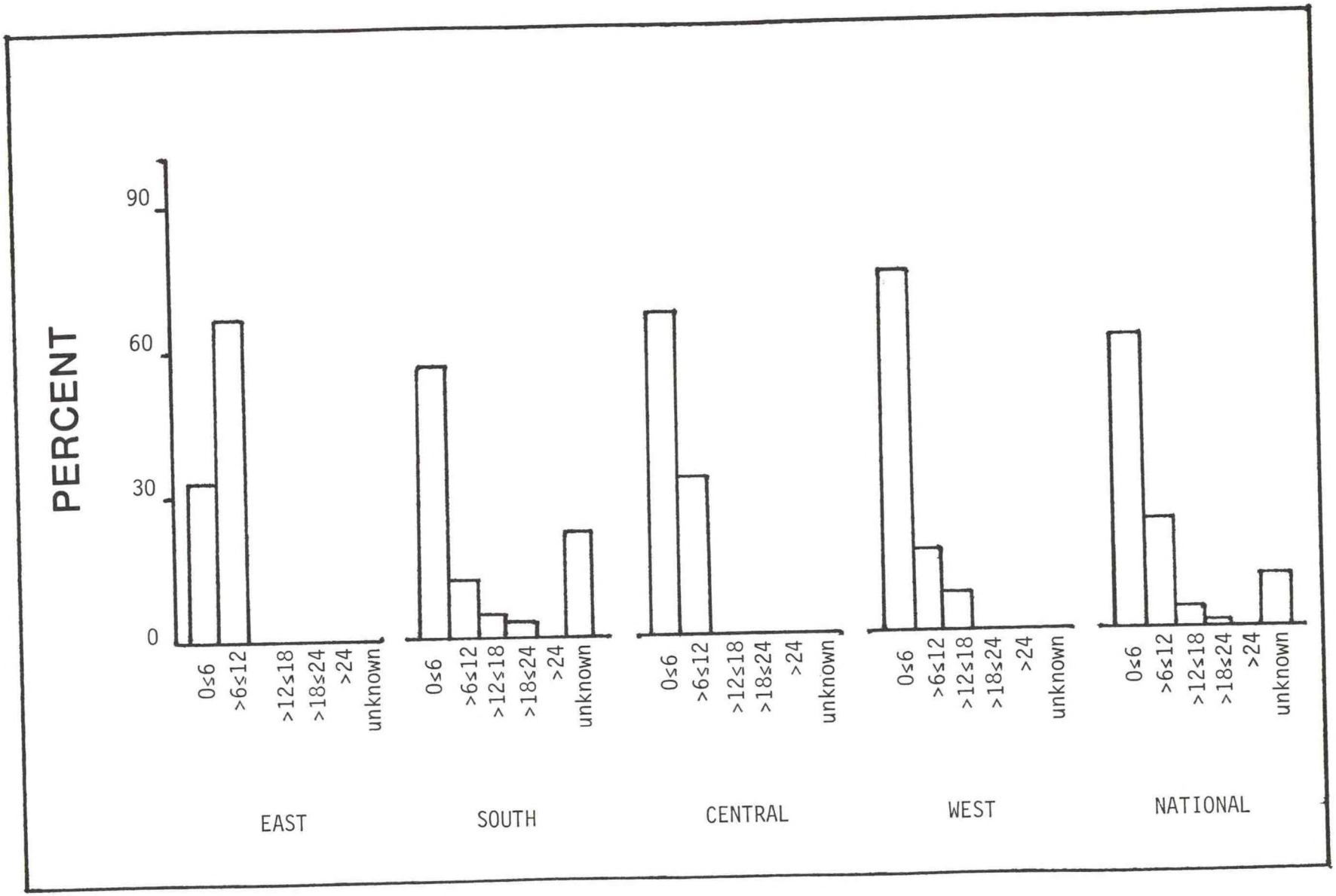

Figure 4-4: Regional and national distribution of lead times for flash flood watches. Lead time categories are in hours.

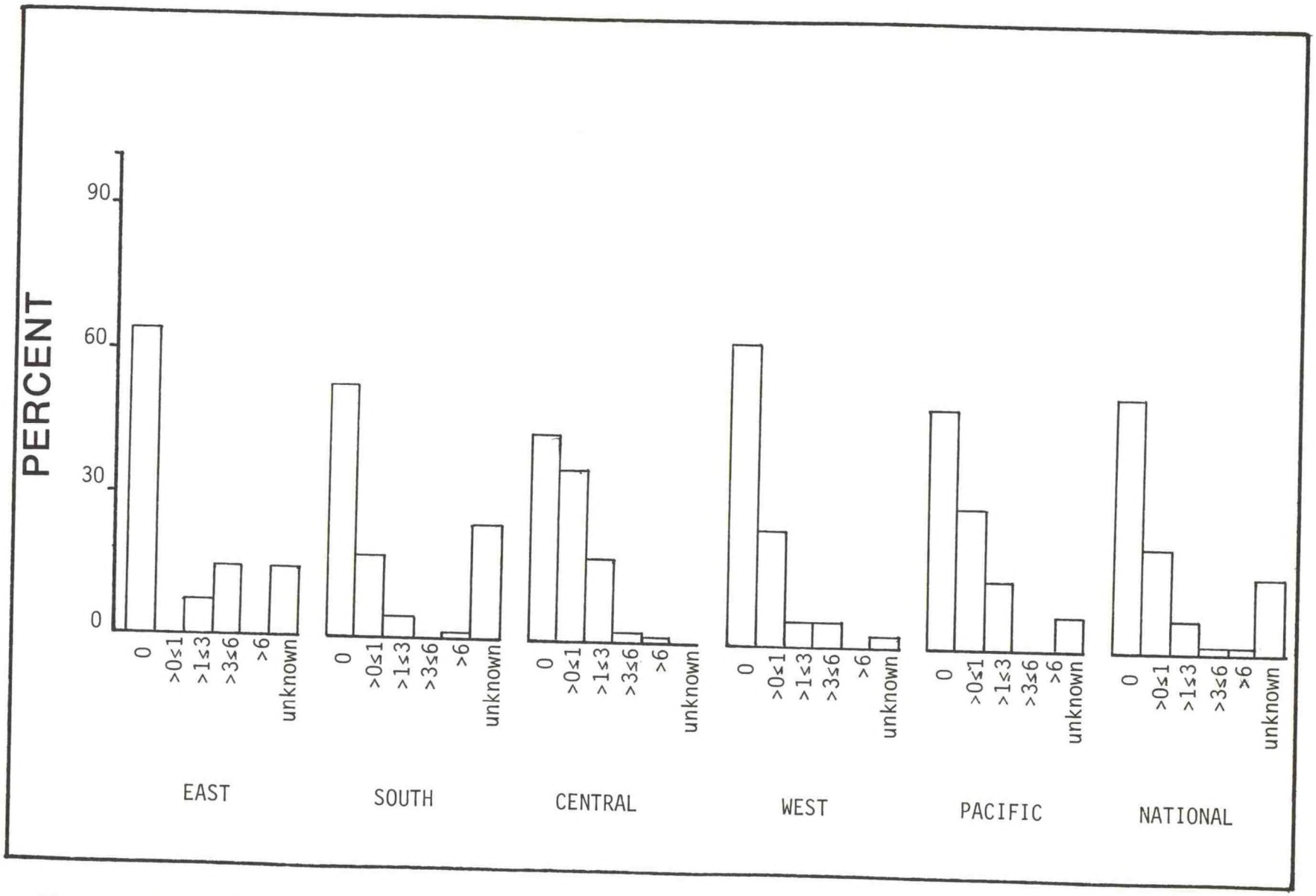

Figure 4-5: Regional and national distribution of lead times for flash flood warnings. Lead time categories are in hours.

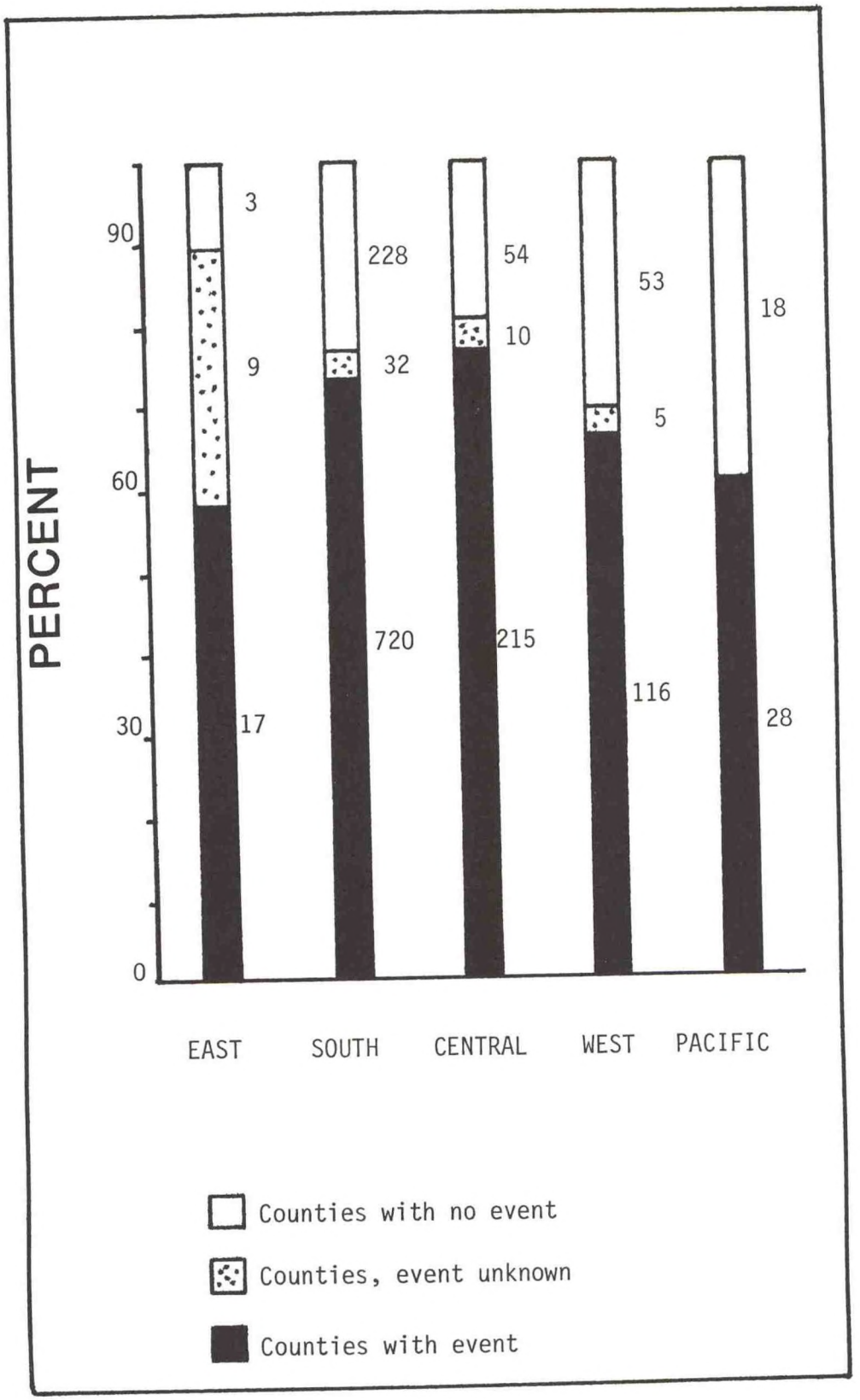

Figure 4-6: Percentage and actual number of counties with and without an event while a flash flood warning was in effect.

5. 1982 WINTER WEATHER

Winter storm, blizzard, heavy snow, and freezing rain warnings and events were combined to form what we call group warnings and group events. This was done for two reasons: mainly to simplify the discussion of winter weather, but also because the number of specific warnings and events, when divided into regions, is too small in many cases to provide useful statistics. Definitions, as stated in WSOM Chapter C-42, for winter storm watch and warning and the various winter events can be found in Appendix II.

5.1 WATCHES

As stated in WSOM Chapter C-42 Section 4.1, a winter storm watch should be issued 12 to 36 hours before a hazardous winter storm is expected to reach an area. The specific type of weather that may occur 24 to 48 hours in the future is uncertain enough to preclude the use of more definitive titles such as "blizzard watch" or "heavy snow watch". The projection time is the interval between the issue time and when the watch goes into effect. During 1982, the average projection time for winter storm watches was 17.3 hours, with a range in values of zero to 38 hours.

Lead time is defined as the difference between issue time and occurrence time. Nationally, 85 percent of the watches had lead times of longer than 12 hours, as shown in Table 5-1 and Figure 5-1. The average lead time for a winter storm watch was 21.6 hours. Valid times, the duration of watches, varied from 6 to 36 hours, but the most common time periods were 12 and 24 hours.

Watches are supposed to be issued if there is a possibility severe winter weather may occur. Since it is uncertain whether an event will occur, all watches are not expected to have positive verification. As the solid bars in Figure 5-2a show, nationally 56 percent of the watches verified. The dotted portion of the bars accounts for those watches where information was unavailable as to whether an event occurred.

Watches and warnings may be extended in three ways: 1) keep the same area but extend the valid period, 2) alter the area but keep the same time period, or 3) change both area and time. Eleven percent of the winter storm watches were extensions of a previous watch; regional statistics can be found in Figure 5-2b. Extensions are counted in the total number of watches.

5.2 WARNINGS

As illustrated in Figure 5-2c, 71 percent of the group warnings were followed by an event. National statistics for positive verification of specific warnings are: 1) winter storm, 74 percent; 2) blizzard, 100 percent; 3) heavy snow, 56 percent; and 4) freezing rain, 86 percent. Figure 5-2d shows that 8 percent of the group warnings were extensions of previous

warnings. The following are statistics for the extension of specific warnings: 1) winter storm, 8 percent; 2) blizzard, 12 percent; 3) heavy snow, 6 percent; and 4) freezing rain, 0 percent.

The difference between 100 percent and the percent of warnings with positive verification gives the false alarm ratio. The national FAR for group events, if all unknowns are counted as not verified, is 29 percent. National values for overwarning are: 1) group, 41 percent; 2) winter storm, 35 percent; 3) blizzard, 0 percent; 4) heavy snow, 79 percent; and 5) freezing rain, 17 percent.

Statistics thus far have included warnings regardless of lead time. Nationwide, the average lead time for winter weather warnings as a group was a little over 6.5 hours. Lead time distributions and averages for group and specific types of warnings are given in Figure 5-3 and Tables 5-1, 5-2, 5-3, 5-4, and 5-5. Although zero lead time is not desirable, in some cases the warning could benefit part of the area. For example, freezing rain may begin in one part of the warning area before affecting the entire area, but it is the first report that is entered as the occurrence time. In the case of heavy snow, a lead time of zero could be adequate because WSOM Chapter C-72 Section 5.3f states that a heavy snow event has begun when "snowfall begins in a general continuous manner", not when 4 inches (or any regionally predetermined amount) has accumulated. A heavy snow warning with zero lead time in such a case is much better than no warning because it informs the public that a significant amount of snow is expected to fall. If the occurrence time for heavy snow was defined as the time when the depth criterion is met, then lead time in many cases would be greater than zero. Notwithstanding, lead time is of utmost importance in all warning programs and to take that into account, the following results represent a conservative recalculation for Figure 5-2c if only warnings with lead times greater than zero are counted as having positive verification: 1) East, 56 percent; 2) South, 48 percent; 3) Central, 54 percent; 4) West, 72 percent; 5) Alaska, 31 percent; and 6) National, 56 percent.

Half of the winter weather warnings went into effect at the time they were issued. The difference between the issue time and the beginning of the valid period is projection time. The average projection times for winter weather warnings were: 1) group, 3.1 hours; 2) winter storm, 3.3 hours; 3) blizzard, 1.9 hours; 4) heavy snow, 3.0 hours; and 5) freezing rain, 1.5 hours. The average valid time for group warnings was 18.1 hours but they ranged from 3.5 hours to 36 hours in duration. Averages for specific types of warnings can be found in Tables 5-2 through 5-5.

5.3 EVENTS

Figure 5-4 shows the total number of group events by forecast area. When the warnings are separated by type, the regional distributions are: 1) winter storms: East - 22 percent, South - 14 percent, Central - 35 percent, and West - 30 percent; 2) blizzards: East - 12 percent and Central - 88 percent; 3) heavy snows: East - 20 percent, South - 6 percent, Central - 53 percent, West - 10 percent, and Alaska - 12 percent; 4) freezing rains: East - 14 percent, Central - 71 percent, and Alaska - 14 percent.

Ideally, both a watch and a warning should be issued before a hazardous weather event occurs. In the case of group warnings this happened 46 percent of the time as illustrated by the solid bars in Figure 5-5. The number in brackets above each bar is the actual number of events that occurred while both a watch and warning were in effect. The dotted portion of the bars in Figures 5-5a and 5-5b show the percentage of events covered by watches but no warnings and the percentage of events covered by warnings but no watches, respectively. Together the solid and dotted portions of a bar show the total percentage of events with watches (Figure 5-5a) and the total percentage of events with warnings (Figure 5-5b). Above each bar the number in parentheses is the total number of events with watches (Figure 5-5a) or with warnings (Figure 5-5b). The number in brackets is included in the number in parentheses. For example, in the Central Region 46 events had both a watch and warning, and additional 11 events had a watch but no warning and 22 events had a warning but no watch. Warnings with zero lead time were counted.

In 1982, 8 percent of the severe winter weather occurred without the Weather Service issuing a watch or warning. Regional percentages can be found in Figure 5-5c; the number above the bar is the actual number of events. Statistics for each specific type of event can be calculated by using the appropriate numbers from Tables 5-2 through 5-5.

Table 5-1

1982 summary of regional and national statistics for winter weather.

WINTER STORM WATCHES

Region	Number of Watches	Watches No Event	Watches with Event	Watches Events Unknown	Percentage Distribution Lead Time in Hours 0≤6	>6≤12	>12≤18	>18≤24	>24	Unknown	Average Lead Time (Hours)	Average Watch Duration (Hours)
East	40	18	22	0	0%	0%	45%	23%	27%	5%	20.9	16.0
South	21	9	11	1	18%	9%	27%	27%	18%	0%	16.0	18.9
Central	94	42	52	0	4%	12%	17%	21%	46%	0%	22.7	17.4
West	21	7	14	0	0%	14%	29%	14%	43%	0%	22.6	18.2
Alaska	2	1	0	1								18.0
Pacific	0											
National	178	77	99	2	4%	9%	26%	21%	38%	1%	21.6	17.4

GROUP WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	52	18	34	0	15%	9%	9%	20%	44%	3%	5.9	15.4
South	21	4	17	0	41%	0%	29%	6%	24%	0%	3.8	21.6
Central	97	25	71	1	27%	4%	15%	14%	38%	1%	6.6	18.3
West	43	6	32	5	3%	6%	13%	13%	56%	9%	9.4	19.4
Alaska	13	5	6	2	33%	0%	0%	33%	17%	17%	3.8	17.1
Pacific	0											
National	226	58	160	8	21%	5%	14%	15%	41%	4%	6.6	18.1

GROUP EVENTS

Region	Number of Events	Events Warning Only	Events Watch Only	Events Neither	Events Both
East	37	14	4	1	18
South	18	5	3	2	8
Central	86	22	11	7	46
West	38	19	2	4	13
Alaska	7	6	0	1	0
Pacific	0				
National	186	66	20	15	85

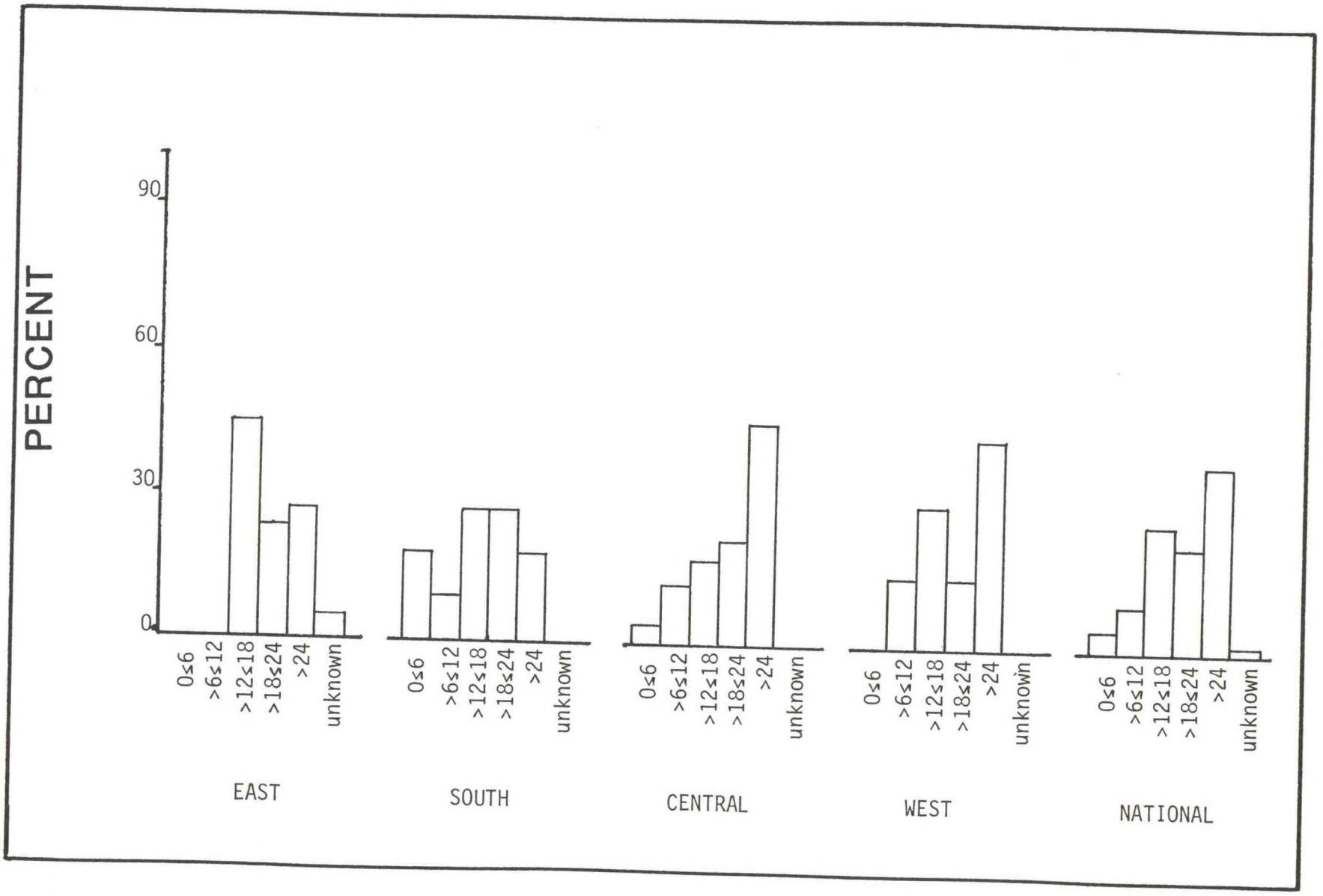

Figure 5-1: Regional and national distribution of lead times for winter storm watches. Lead time categories are in hours.

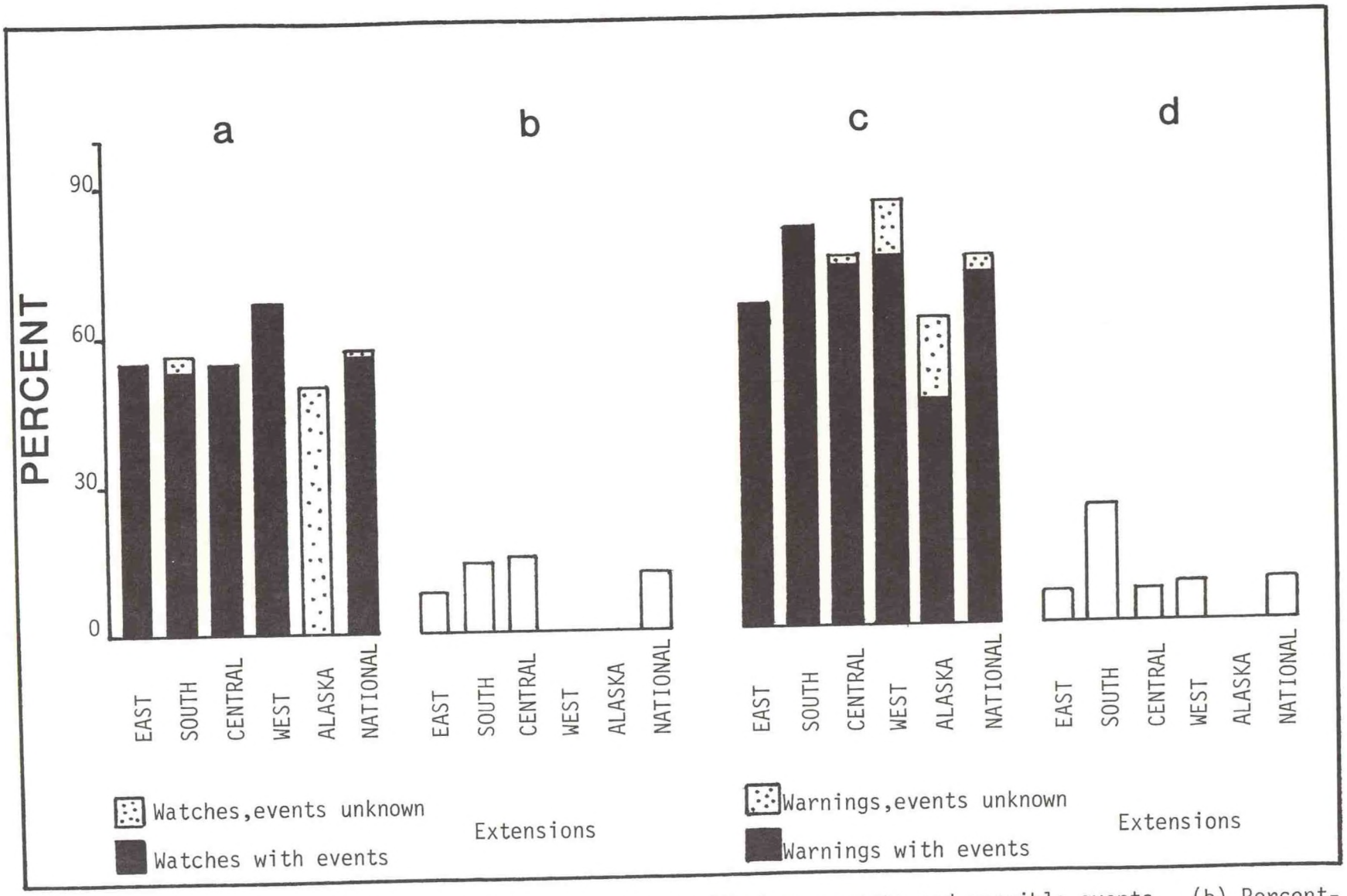

Figure 5-2: (a) Percentage of winter storm watches with known events and possible events. (b) Percentage of the total number of winter storm watches that are extensions. (c) Percentage of group warnings with known events and possible events. (d) Percentage of the total number of group warnings that are extensions.

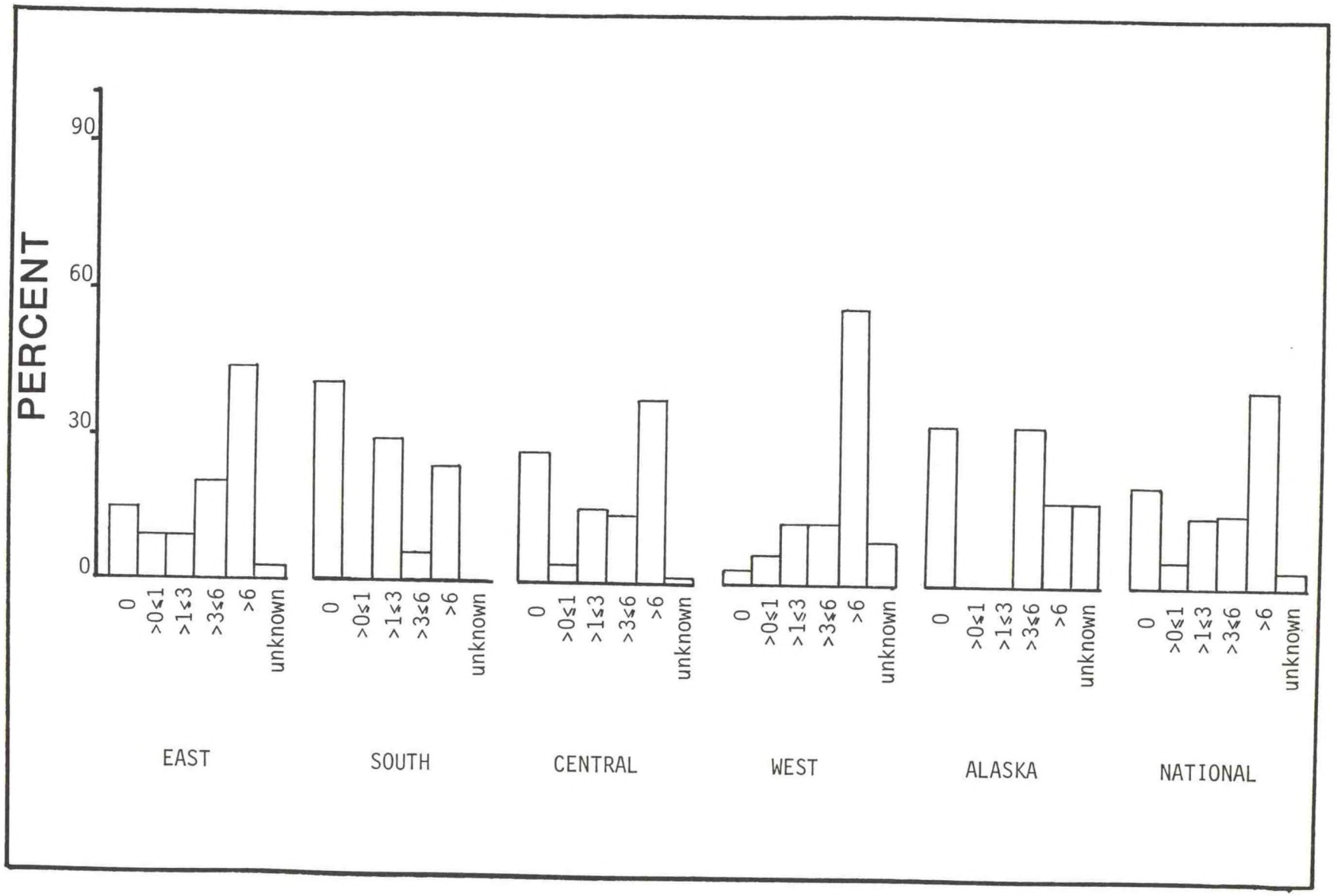

Figure 5-3: Regional and national distribution of lead times for group warnings. Lead time categories are in hours.

Table 5-2

1982 summary of regional and national statistics for winter storms.

WINTER STORM WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours: 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	35	13	22	0	9%	14%	4%	27%	41%	4%	6.4	14.9
South	20	4	16	0	44%	0%	31%	6%	19%	0%	3.2	21.5
Central	43	11	31	1	16%	0%	10%	19%	52%	3%	9.0	18.9
West	36	4	30	2	3%	7%	13%	13%	53%	10%	9.4	19.7
Alaska	0											
Pacific	0											
National	134	32	99	3	15%	5%	13%	17%	44%	5%	7.5	18.4

WINTER STORM EVENTS

Region	Number of Events	Events WarningOnly	Events Watch Only	Events Neither	Events Both
East	24	7	4	0	13
South	15	5	3	0	7
Central	39	11	9	0	19
West	33	18	2	1	12
Alaska	0				
Pacific	0				
National	111	41	18	1	51

Table 5-3

1982 summary of regional and national statistics for blizzards.

BLIZZARD WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours: 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	2	0	2	0	0%	0%	0%	0%	100%	0%	12.5	13.0
South	0											
Central	15	0	15	0	53%	13%	13%	7%	13%	0%	2.5	15.6
West	0											
Alaska	0											
Pacific	0											
National	17	0	17	0	47%	12%	12%	6%	23%	0%	3.6	15.4

BLIZZARD EVENTS

Region	Number of Events	Events Warning Only	Events Watch Only	Events Neither	Events Both
East	2	1	0	0	1
South	0				
Central	15	4	0	2	9
West	0				
Alaska	0				
Pacific	0				
National	17	5	0	2	10

Table 5-4

1982 summary of regional and national statistics for heavy snow.

HEAVY SNOW WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	13	4	9	0	33%	0%	11%	11%	44%	0%	3.8	17.5
South	1	0	1	0	0%	0%	0%	0%	100%	0%	13.0	24.0
Central	35	14	21	0	24%	5%	24%	9%	38%	0%	6.7	17.3
West	7	2	2	3	0%	0%	0%	0%	100%	0%	10.0	17.0
Alaska	12	5	5	2	20%	0%	0%	40%	20%	20%	4.8	17.5
Pacific	0											
National	68	25	38	5	24%	3%	16%	13%	42%	3%	6.1	17.5

HEAVY SNOW EVENTS

Region	Number of Events	Events WarningOnly	Events Watch Only	Events Neither	Events Both
East	10	6	0	1	3
South	3	0	0	2	1
Central	27	6	1	5	15
West	5	1	0	3	1
Alaska	6	5	0	1	0
Pacific	0				
National	51	18	1	12	20

Table 5-5

1982 summary of regional and national statistics for freezing rain.

FREEZING RAIN WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours: 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	2	1	1	0	0%	0%	100%	0%	0%	0%	2.0	12.0
South	0											
Central	4	0	4	0	25%	0%	25%	25%	25%	0%	4.3	16.3
West	0											
Alaska	1	0	1	0	100%	0%	0%	0%	0%	0%	0.0	12.0
Pacific	0											
National	7	1	6	0	33%	0%	33%	17%	17%	0%	3.2	14.4

FREEZING RAIN EVENT

Region	Number of Events	Events WarningOnly	Events Watch Only	Events Neither	Events Both
East	1	0	0	0	1
South	0				
Central	5	1	1	0	3
West	0				
Alaska	1	1	0	0	0
Pacific	0				
National	7	2	1	0	4

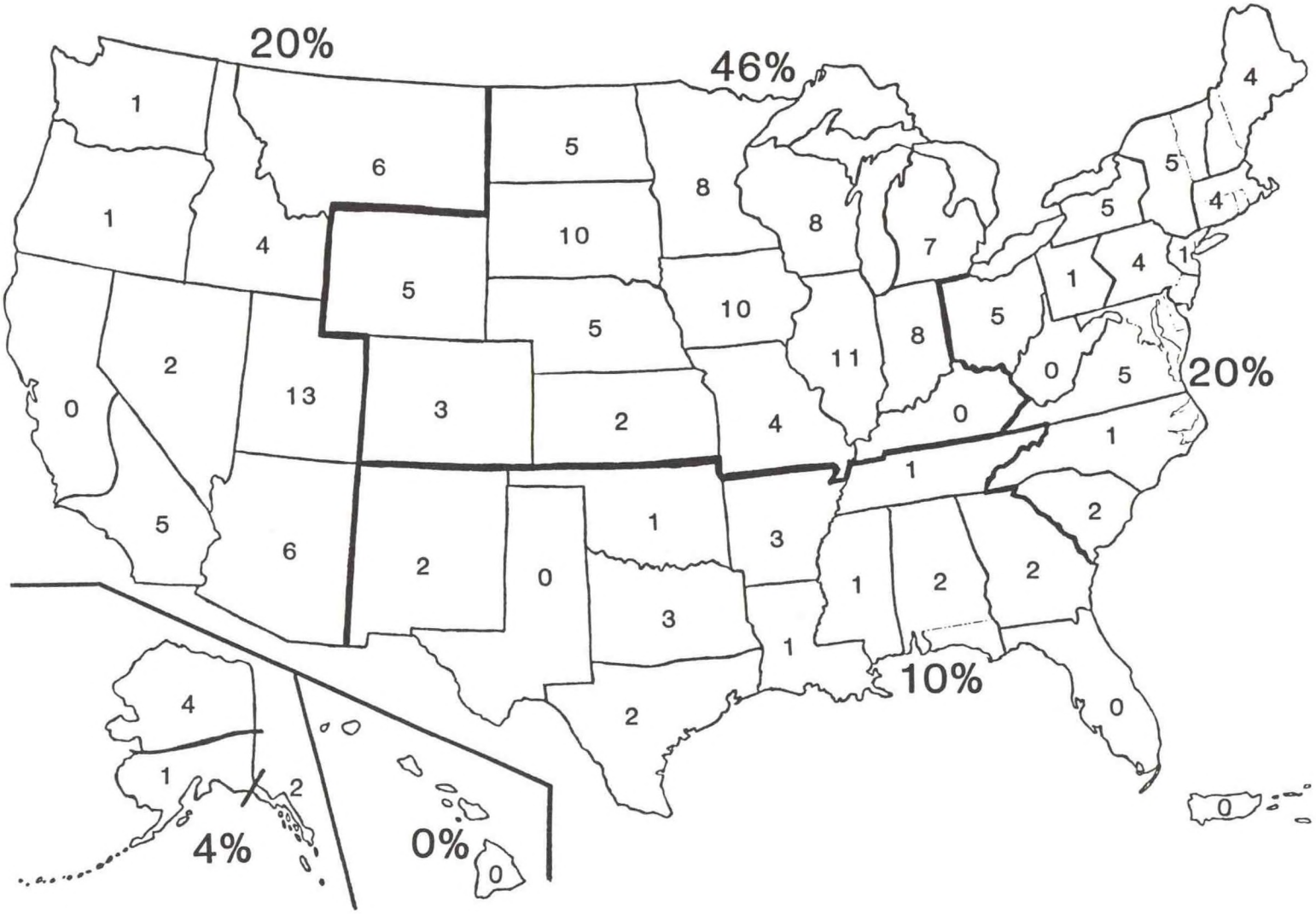

Figure 5-4: Number of group winter events by forecast office with percentage of events in each region for 1982.

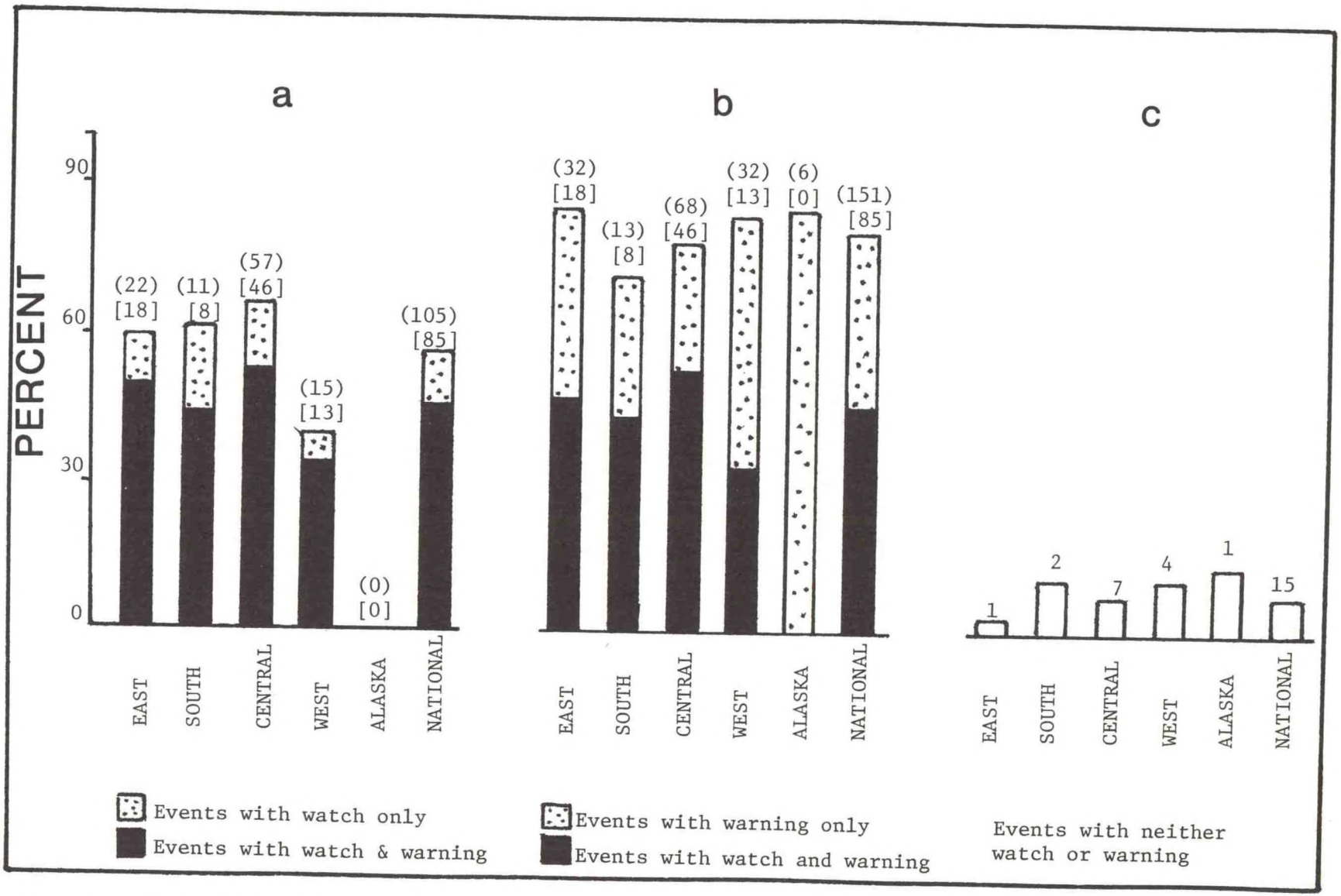

Figure 5-5: (a) Percentage of group events with watches; actual number in parentheses. Number of group events with both a watch and warning is in brackets. (b) Percentage of group events with warnings; actual number in parentheses. Number of group events with both a warning and watch is in brackets. (c) Percentage of group events with neither a watch or warning; actual number above each bar.

6. 1982 HIGH WIND

During 1982, no duststorms or sandstorms were reported on the verification logs and no warnings were issued.

Most offices do not issue high wind watches and there is no national policy concerning such watches, therefore they are not included in the verification program. Definitions for duststorm/sandstorm and high wind events are given in Appendix II.

6.1 EVENTS

Figure 6-1 shows the national distribution of the 111 high wind events reported during 1982. The total number of events for each region is given in Table 6-1. Several years of data may be needed to provide a meaningful sample for the Southern and Pacific Regions.

The percentage of events covered by a warning is given by Figure 6-2a. The actual number of high wind events with warnings is given in Table 6-1. Warnings with zero lead time were counted.

6.2 WARNINGS

Nationally, 81 percent of the high wind warnings had positive verification in 1982. The solid portions of the bars in Figure 6-2b represent the percentage of warnings followed by events, while dotted sections account for the warnings where information was unavailable to verify whether an event occurred.

The difference between 100 percent and the percentage of warnings with positive verification gives the false alarm ratio. The FAR for high wind warnings is 19 percent, nationally, if the unknowns are counted as no event. Using the overwarning equation, we overwarn 24 percent nationally.

Warnings may be extended in three ways: 1) keep the same area but extend the valid period, 2) alter the area but keep the same time period, or 3) change both area and time. Nine percent of the high wind warnings were extensions of previous warnings; regional statistics are found in Figure 6-2c. Extensions are counted in the total number of warnings.

So far all statistics have included warnings regardless of lead time. If only warnings with lead times greater than zero are to be counted, then nationally 60 percent of the high wind warnings were followed by an event. A lead time distribution for high wind warnings can be found in Figure 6-3 or Table 6-1.

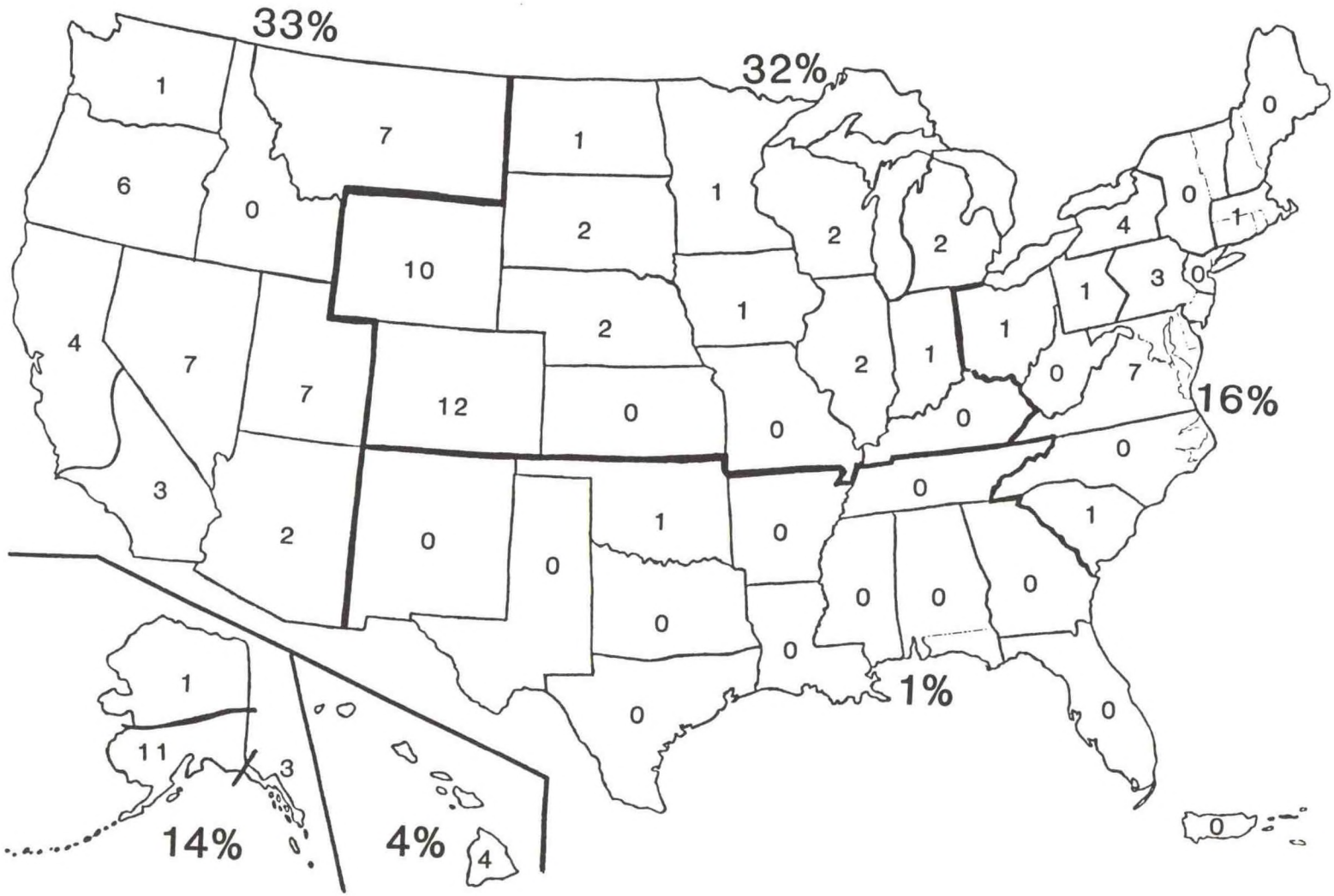

Figure 6-1: Number of high wind events by forecast office with percentage of events in each region for 1982.

Table 6-1

1982 summary of regional and national statistics for high wind.

HIGH WIND WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	15	0	15	0	20%	27%	13%	7%	33%	0%	4.6	9.3
South	1	0	1	0	0%	100%	0%	0%	0%	0%	1.0	6.0
Central	53	7	40	6	30%	2%	25%	20%	23%	0%	3.9	12.4
West	41	3	37	1	24%	5%	11%	5%	35%	19%	6.3	15.9
Alaska	23	6	15	2	20%	0%	7%	27%	33%	13%	7.2	17.9
Pacific	6	2	4	0	50%	25%	0%	0%	25%	0%	2.0	12.4
National	139	18	112	9	26%	8%	15%	13%	29%	8%	5.0	13.9

HIGH WIND EVENTS

Region	Number of Events	Events No Warning	Events with Warning
East	18	3	15
South	1	0	1
Central	36	0	36
West	37	0	37
Alaska	15	0	15
Pacific	4	0	4
National	111	3	108

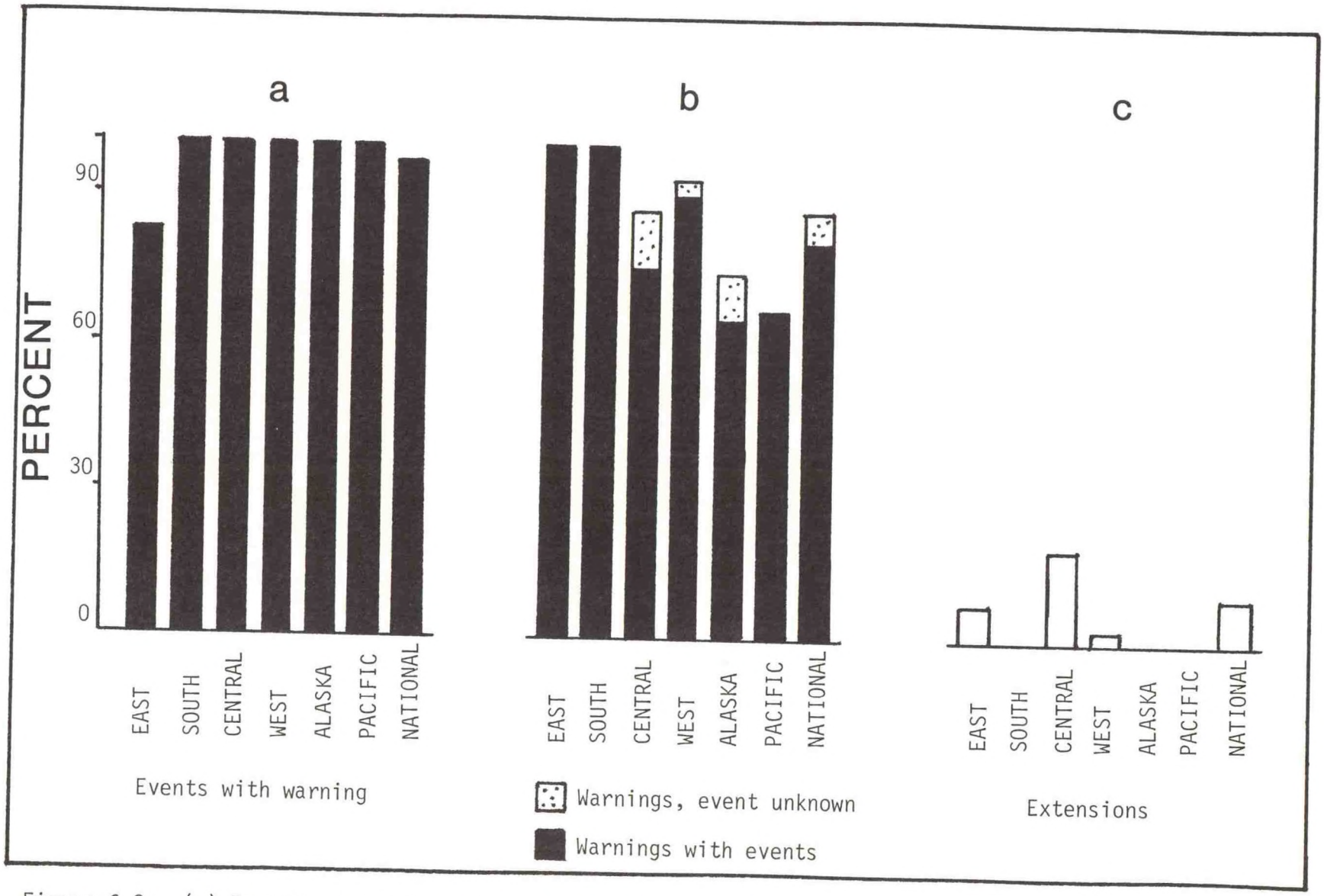

Figure 6-2: (a) Percentage of high wind events with warnings. (b) Percentage of high wind warnings with known events and possible events. (c) Percentage of total number of high wind warnings that are extensions.

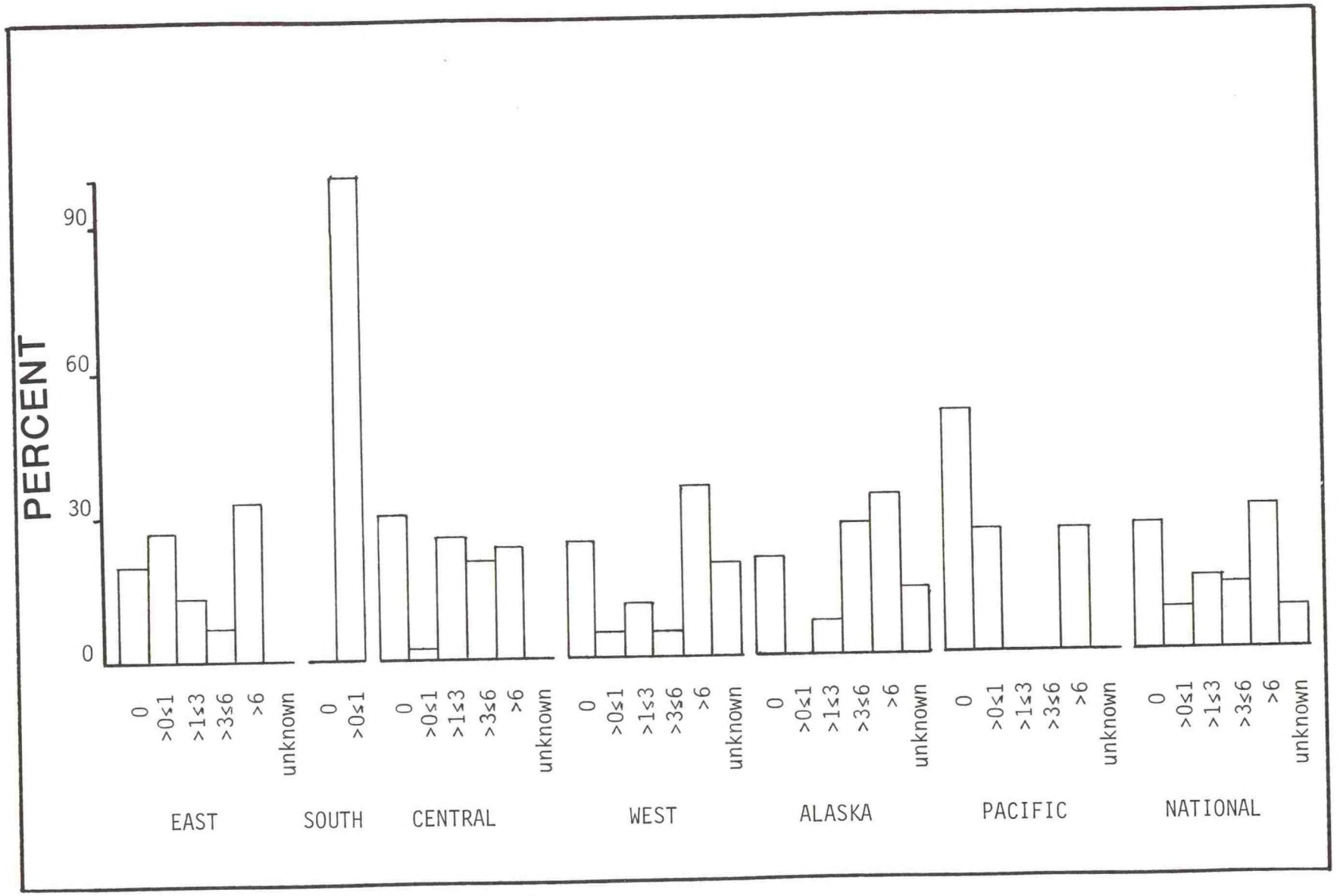

Figure 6-3: Regional and national distribution of lead times for high wind warnings. Lead time categories are in hours.

7. 1983 FLASH FLOOD

The first three problems addressed in Section 3 deal directly with flash flood verification and should be considered when using the statistics in this section.

A flash flood is defined by WSOM Chapter E-13: "A flood which follows within a few hours of heavy or excessive rainfall, dam or levee failure, or a sudden release of water impounded by an ice jam." A wall of water rushing through a narrow channel is not the only type of flash flood; water may rise rapidly due to poor drainage. Ponding of water is especially common in low lying coastal regions.

Table 7-1 presents a quick overview of the number of watches, warnings and events plus information on lead time and valid time.

7.1 EVENTS

The national distribution of flash floods was uneven: 55 percent occurred in the Southern Region, followed by 15 percent each in the Central and Western Regions, 14 percent in the Eastern Region and less than 1 percent in the Alaska and Pacific Regions.

Ideally, both a watch and a warning should be issued before a hazardous weather event occurs. The statistics in this report do not give an accurate measure of this, but it was accomplished at least 17 percent of the time for flash floods during 1983, as illustrated by the solid portion of the bars in Figure 7-2. The numbers in brackets above the bars are the actual number of events with a watch and warning. Nationally, at least 71 times out of 414, both a watch and warning were in effect for an event. The dotted portion of the bars in Figure 7-2a and 7-2b show the percentage of events with watches but no warnings and events with warnings but no watches, respectively. Together the solid and dotted portions of a bar show the total percentage of events with watches (Figure 7-2a) and the total percentage of events with warnings (Figure 7-2b). Above each bar the number in parenthesis is the actual number of flash floods with watches (Figure 7-2a) and with warnings (Figure 7-2b). The number in brackets is included in the number in parentheses. For example, in the Eastern Region 20 flash floods had both a watch and a warning; an additional 9 had a watch but no warning, and 20 flash floods had a warning but no watch. Warnings with zero lead time were counted.

Nationally, 14 percent of the flash floods occurred without the Weather Service issuing a watch or warning, as shown in Figure 7-2c. The number above each bar is the actual number of events. For example, in the Southern Region 42 of the 226 events were not covered by a watch or warning in 1983.

7.2 WATCHES

Forty-three percent of the flash flood watches issued were followed by an event. Figure 7-3a shows the regional breakdown of these statistics. The solid portion of the bars gives the percentages of watches with positive verification, while the dotted portion accounts for those watches where information was unavailable as to whether an event occurred.

Figure 7-3b shows that, on a national basis, 13 percent of the flash flood watches issued were extensions of previous watches. Watches may be extended in three ways: 1) keep the same area but extend the valid time, 2) alter the area but keep the same time period, or 3) change both area and time. The extensions are counted in the total number of watches and are included in all watch statistics.

Lead time is counted from the time of issuance to the time an event occurs. Nationally, 58 percent of the flash flood watches had lead times of 6 hours or less. Regional lead time distributions may be found in Figure 7-4 and Table 7-1. Table 7-1 also gives the average lead time and the average valid period for flash flood watches.

Projection time is the interval between the issuance of a watch or warning and when it goes into effect (the beginning of the valid period). The national average projection time for flash flood watches was 1 hour 36 minutes. Projection times ranged from zero for 172 of the 264 watches to 20 hours for 2 of the watches.

7.3 WARNINGS

Nationally, 4 out of 5 flash flood warnings were associated with an event. Figure 7-3c gives the regional statistics. The solid bars show the percentage of warnings that verified with a known event, while the dotted sections account for those where information was unavailable to verify whether an event occurred. Nationally, 10 percent of the flash flood warnings were extensions of previous warnings; regional percentages are given in Figure 7-3d. Warnings like watches may be extended in three ways.

The difference between 100 percent and the solid bars in Figure 7-3c gives the FAR, assuming all unknowns are counted as no event. Nationally, 433 warnings were issued and 340 had events, which results in 27 percent overwarning.

So far the statistics have included warnings regardless of lead time. The average lead time as nearly an hour but almost half of the warnings nationwide had no lead time. Table 7-1 and Figure 7-5 provide regional lead time distribution. One criterion for issuing a warning is the report of an event in progress. These warnings with zero lead time are legitimate and may in fact provide a nearby community with enough time to take effective action. Since advance notice of a hazardous weather event is very important, the following is a recalculation for Figure 7-3c if only warnings with lead times greater than zero are counted as having positive verification: 1) East,

48 percent vs 81 percent; 2) South, 41 percent vs 74 percent; 3) Central, 57 percent vs 93 percent; 4) West, 33 percent vs 84 percent; 5) Pacific, 50 percent vs 100 percent; and 6) National, 43 percent vs 79 percent.

Most flash flood warnings went into effect at the time they were issued. Only 5 warnings had projection times which ranged from half an hour to six hours. The average valid time for a flash flood warning was 4.3 hours, but they ranged from half an hour to 40 hours in duration.

Warnings are generally issued for counties. Figure 7-6 shows the number of counties covered by flash flood warnings during 1983. The shaded sections represent the percentage of counties in which an event occurred. The dotted sections represent the percentage of counties where it was not determined whether or not an event occurred, and the clear sections represent the percentage of counties where it is known an event did not occur.

Table 7-1

1983 summary of regional and national statistics for flash floods.

FLASH FLOOD WATCHES

Region	Number of Watches	Watches No Event	Watches with Event	Watches Event Unknown	Percentage Distribution Lead Time in Hours 0≤6	>6≤12	>12≤18	>18≤24	>24	Unknown	Average Lead Time (Hours)	Average Watch Duration (Hours)
East	52	27	22	3	45%	14%	9%	23%	9%	0%	11.1	15.7
South	109	62	47	0	62%	6%	6%	2%	0%	23%	4.6	14.3
Central	35	20	15	0	40%	40%	13%	7%	0%	0%	7.8	13.7
West	67	18	28	21	68%	11%	4%	4%	0%	14%	4.2	7.8
Alaska	1	0	1	0	100%	0%	0%	0%	0%	0%	3.0	7.0
Pacific	0											
National	264	127	113	24	58%	13%	7%	7%	2%	13%	6.4	12.7

FLASH FLOOD WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	52	8	42	2	40%	33%	10%	12%	5%	0%	1.4	7.9
South	265	50	196	19	45%	31%	7%	2%	0%	15%	0.6	3.8
Central	58	1	54	3	39%	41%	15%	4%	2%	0%	2.0	4.0
West	55	6	46	3	61%	33%	4%	2%	0%	0%	0.4	3.5
Alaska	1	1	0	0								6.0
Pacific	2	0	2	0	50%	50%	0%	0%	0%	0%	0.5	12.0
National	433	66	340	27	46%	33%	8%	4%	1%	8%	0.9	4.3

FLASH FLOOD EVENTS

Region	Number of Events	Events* Warning Only	Events Watch Only	Events Neither	Events* Both
East	57	20	9	8	20
South	226	137	14	42	33
Central	64	47	10	2	5
West	63	30	15	5	13
Alaska	2	0	1	1	0
Pacific	2	2	0	0	0
National	414	236	49	58	71

*These numbers are biased because not all flash flood watches are counted. This problem is addressed in section 3.

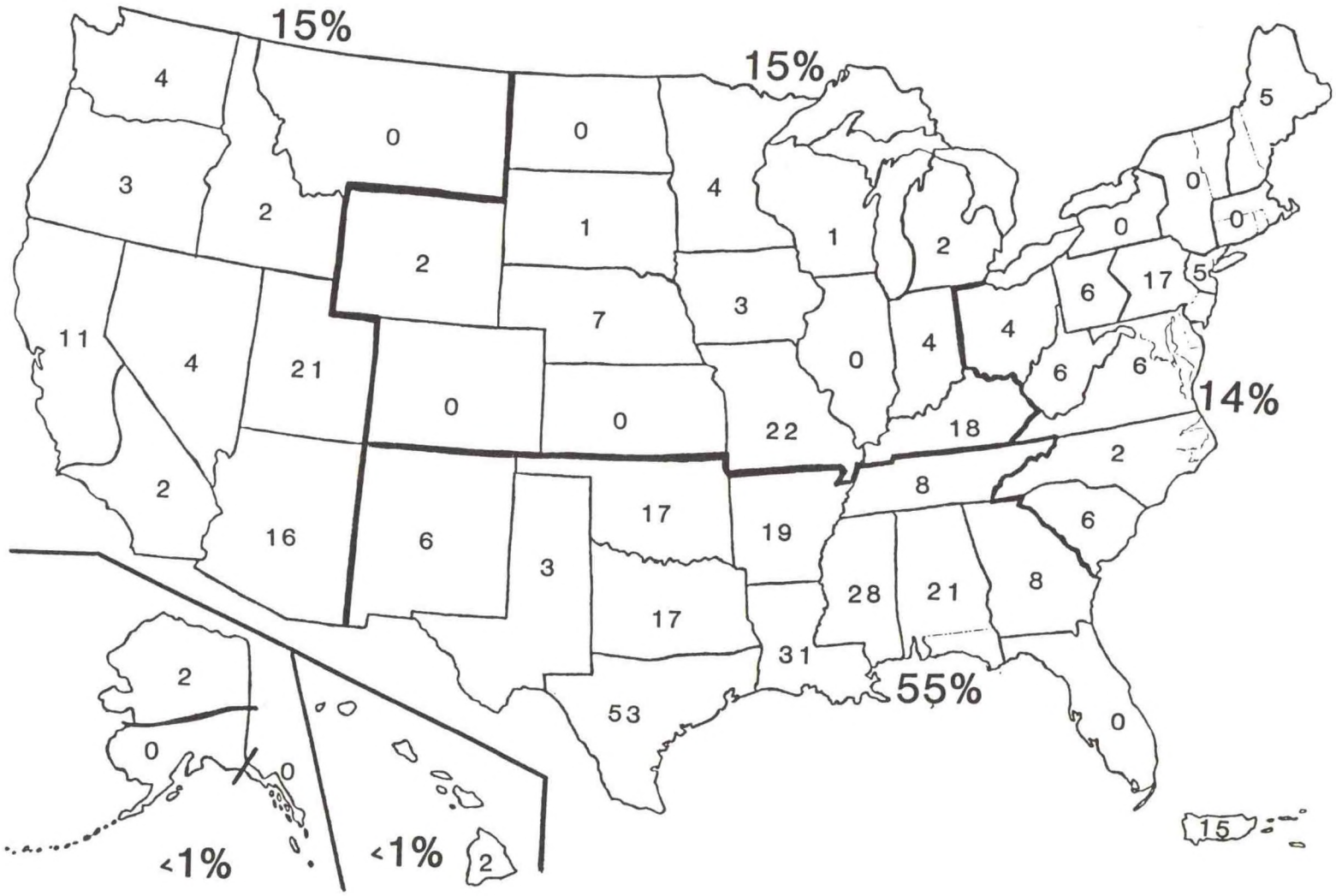

Figure 7-1: Number of flash flood events by forecast office with percentage of events in each region for 1983.

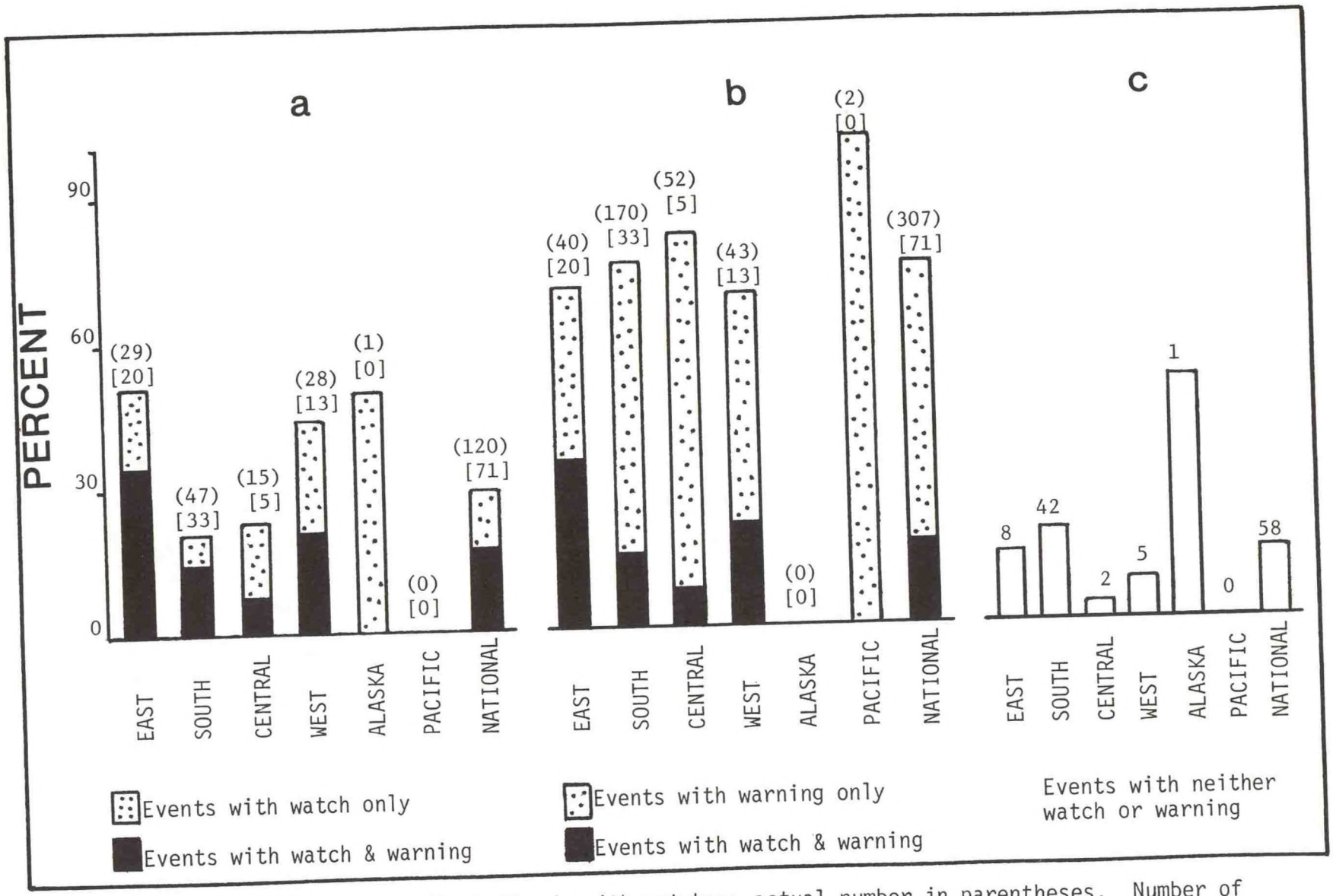

Figure 7-2: (a) Percentage of flash floods with watches; actual number in parentheses. Number of flash floods with both a watch and warning is in brackets. (b) Percentage of flash floods with warnings; actual number in parentheses. Number of flash floods with both a warning and watch is in brackets. (c) Percentage of flash floods with neither a watch or warning; actual number above each bar.

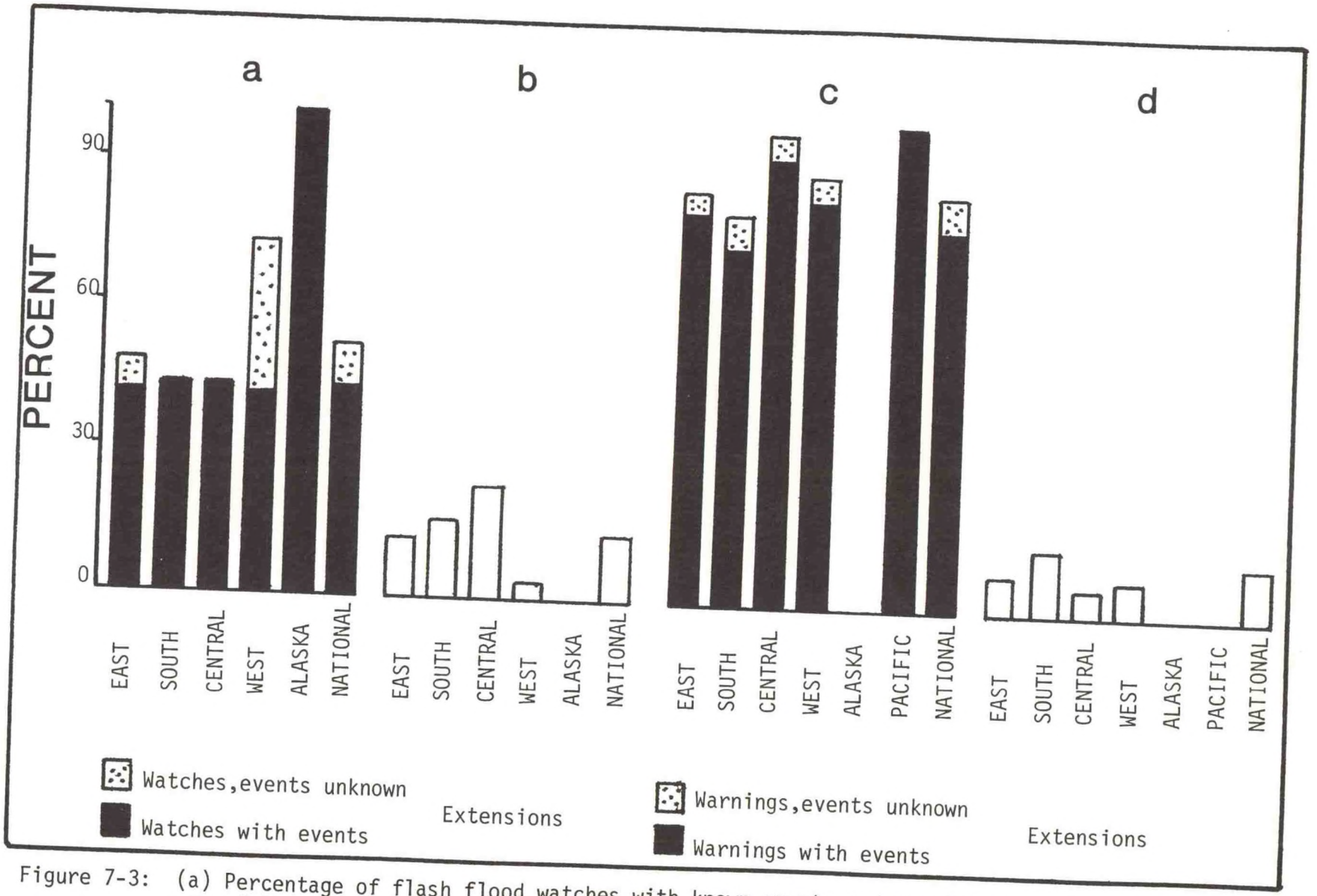

Figure 7-3: (a) Percentage of flash flood watches with known events and possible events. (b) Percentage of the total number of flash flood watches that are extensions. (c) Percentage of flash flood warnings with known events and possible events. (d) Percentage of total number of flash flood warnings that are extensions.

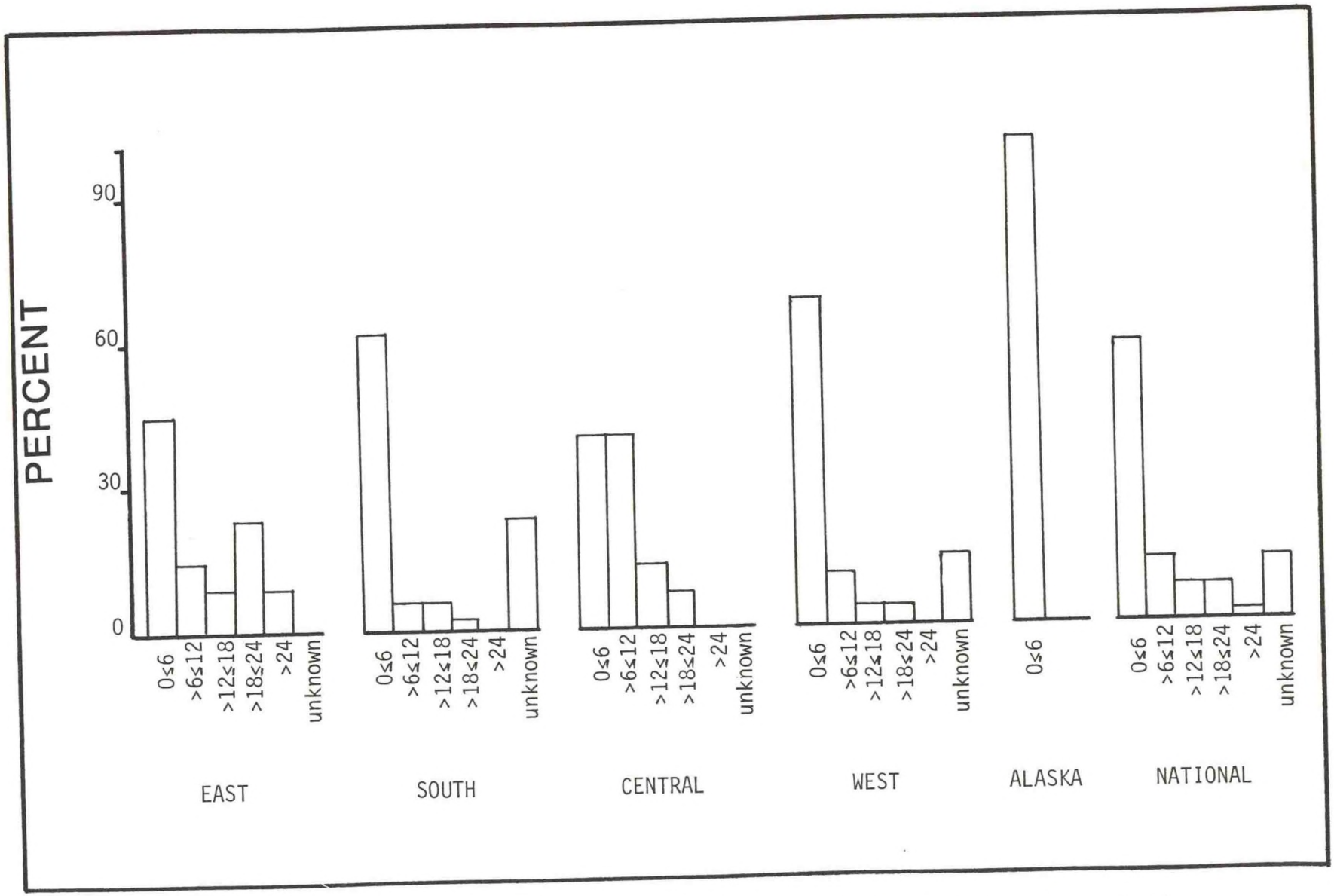

Figure 7-4: Regional and national distribution of lead times for flash flood watches. Lead time categories are in hours.

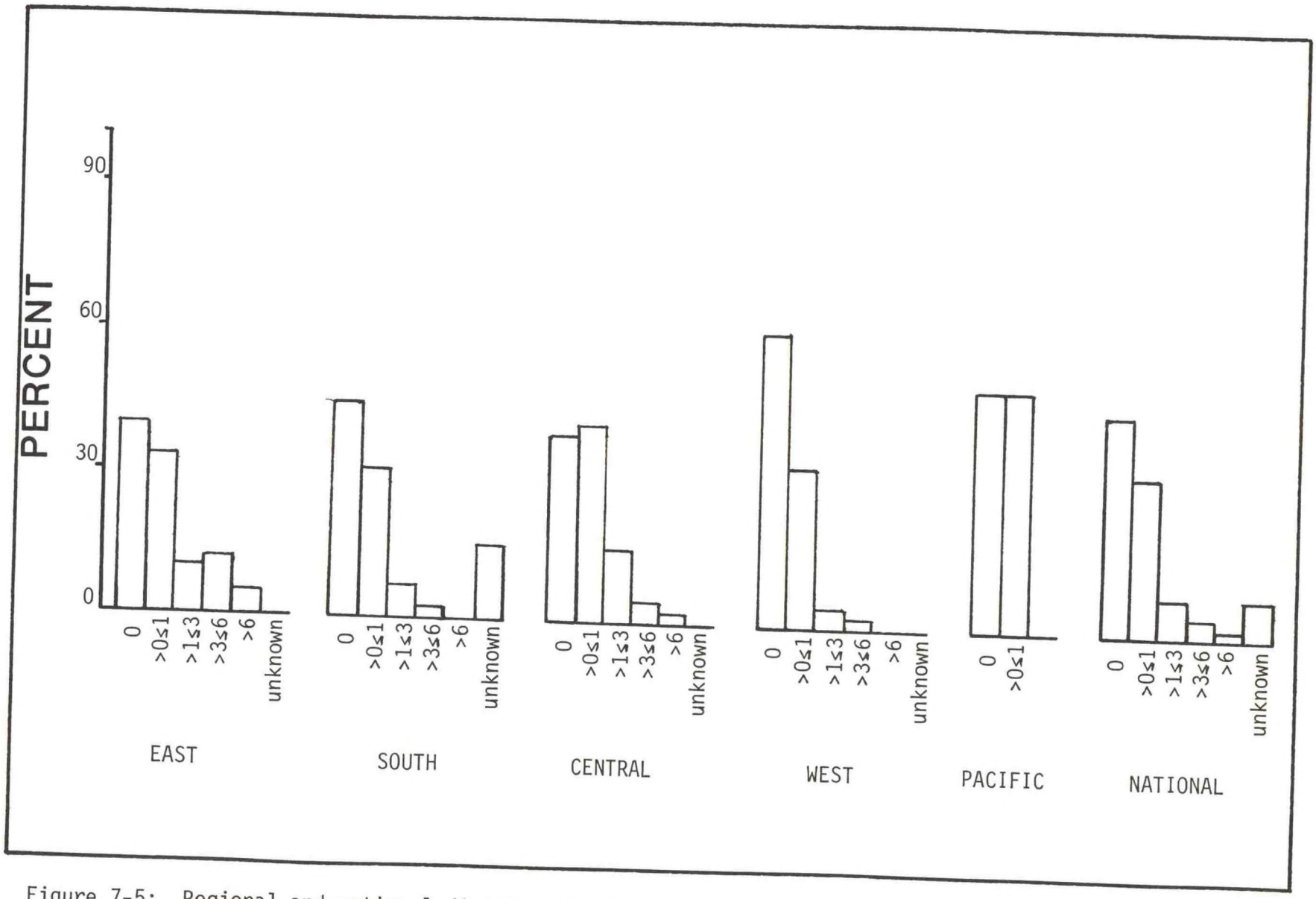

Figure 7-5: Regional and national distribution of lead times for flash flood warnings. Lead time categories are in hours.

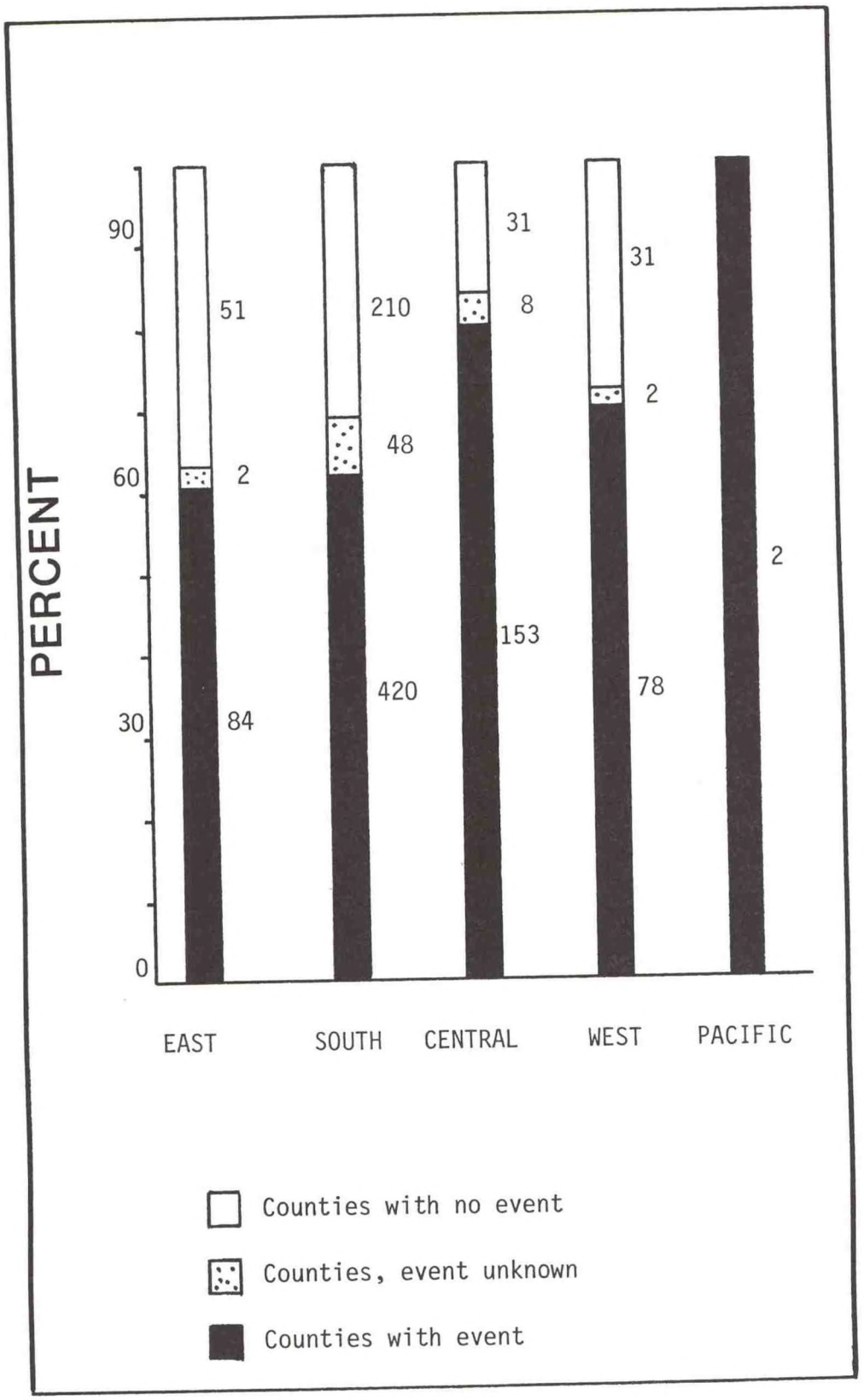

Figure 7-6: Percentage and actual number of counties with and without an event while a flash flood warning was in effect.

8. 1983 WINTER WEATHER

Winter storm, blizzard, heavy snow, and freezing rain warnings and events were combined to form what we call group warnings and group events. This was done for two reasons: mainly to simplify the discussion of winter weather, but also because the number of specific warnings and events, when divided into regions, is too small in many cases to provide useful statistics. Definitions, as stated in WSOM Chapter C-42, for winter storm watch and warning and the various winter events can be found in Appendix II.

8.1 WATCHES

As stated in WSOM Chapter C-42 section 4.1, a winter storm watch should be issued 12 to 36 hours before a hazardous winter storm is expected to reach an area. The specific type of weather that may occur 24 to 48 hours in the future is uncertain enough to preclude the use of more definitive titles such as "blizzard watch" or "heavy snow watch". The projection time is the interval between the issue time and when the watch goes into effect. During 1983, the average projection time for winter storm watches was 16.5 hours, with a range in values of zero to 39 hours.

Lead time is defined as the difference between issue time and occurrence time. Nationally, 79 percent of the watches had lead times of longer than 12 hours as shown in Table 8-1 and Figure 8-1. The average lead time for a winter storm watch was 22.7 hours. Valid times, the duration of watches, varied from 3 to 29 hours, but the most common time periods were 12 and 24 hours.

Watches are supposed to be issued if there is a possibility severe winter weather may occur. Since it is uncertain whether an event will occur, not all watches are expected to have positive verification. As the solid bars in Figure 8-2a show, nationally 51 percent of the watches verified in 1983. The dotted portion of the bars accounts for those watches where information was unavailable as to whether an event occurred.

Watches and warnings may be extended in three ways: 1) keep the same area but extend the valid period, 2) alter the area but keep the same time period, or 3) change both area and time. Eight percent of all watches were extensions of a previous watch; regional statistics are found in Figure 8-2b. Extensions are counted in the total number of watches.

8.2 WARNINGS

As illustrated in Figure 8-2c, 79 percent of the group warnings were followed by an event. National statistics for positive verification of specific warnings are: 1) winter storm, 79 percent; 2) blizzard, 89 percent; 3) heavy snow, 67 percent; and 4) freezing rain, 100 percent. Figure 8-2d shows that 9 percent of the group warnings were extensions of previous

warnings. The following are statistics for the extension of specific warnings: 1) winter storm, 9 percent; 2) blizzard, 11 percent; 3) heavy snow, 3 percent; and 4) freezing rain, 18 percent.

The difference between 100 percent and the percent of warnings with positive verification gives the false alarm ratio. The FAR for group events, if all unknowns are counted as not verified, is 21 percent. The national values for overwarning are: 1) group, 27 percent; 2) winter storm, 27 percent; 3) blizzard, 13 percent; 4) heavy snow, 50 percent; and 5) freezing rain, 0 percent.

Statistics thus far have included warnings regardless of lead time. Nationwide, the average lead time for winter weather warnings as a group was almost 6 hours. Lead time distributions and averages for group and specific types of warnings are given in Figure 8-3 and Tables 8-1 through 8-5. Although zero lead time is not desirable, in some cases the warning could benefit part of the area. Notwithstanding, lead time is of utmost importance in all warning programs and to take that into account, the following results represent a conservative recalculation for Figure 8-2c if only warnings with lead times greater than zero are counted as having positive verification: 1) East, 78 percent; 2) South, 57 percent; 3) Central, 46 percent; 4) West, 78 percent; 5) Alaska, 67 percent; and 6) National, 63 percent.

Half of the winter weather warnings went into effect at the time they were issued. The difference between the issue time and the beginning of the valid period is projection time. The average projection times for winter weather warnings were: 1) group, 2.4 hours; 2) winter storm, 2.8 hours; 3) blizzard, 0.6 hours; 4) heavy storm, 1.9 hours; and 5) freezing rain, 1.1 hours. The average valid time for group warnings was 18.9 hours but they ranged from 6 to 37 hours in duration. Averages for specific types of warnings can be found in Tables 8-2 through 8-5.

8.3 EVENTS

Figure 8-4 shows the total number of group events by forecast area. When the warnings are separated by type, the regional distributions are: 1) winter storms: East - 21 percent, South - 12 percent, Central - 28 percent, and West - 39 percent; 2) blizzard: East - 14 percent, Central - 43 percent, West - 29 percent, and Alaska - 14 percent; 3) heavy snow: East - 28 percent, South - 40 percent, Central - 16 percent, West - 12 percent, and Alaska - 4 percent; 4) freezing rain: East - 50 percent, South - 20 percent, and Central - 30 percent.

Ideally, both a watch and a warning should be issued before a hazardous weather event occurs. In the case of group warnings this happened 41 percent of the time as illustrated by the solid bars in Figure 8-5. The number in brackets above each bar is the actual number of events that occurred while both a watch and a warning were in effect. The dotted portion of the bars in Figures 8-5a and 8-5b, show the percentage of events covered by watches but no warnings and the percentage of events covered by warnings but no watches respectively. Together the solid and dotted portions of a bar show the total percentage of events with watches (Figures 8-5a) and the total percentage of

events with warnings (Figure 8-5b). Above each bar the number in parentheses is the total number of events with watches (Figure 8-5a) or with warnings (Figure 8-5b). The number in brackets is included in the number in parenthesis. For example, in the Central Region 14 events had both a watch and warning, an additional four events had a watch but no warning, and 20 events had a warning but no watch. Warnings with zero lead time were counted.

In 1983, 5 percent of the severe winter weather occurred without the Weather Service issuing a watch or warning. Regional percentages can be found in Figure 8-5c; the number above each bar is the actual number of events. Statistics for each specific type of event can be calculated by using the appropriate numbers from Tables 8-2 through 8-5.

Table 8-1

1983 summary of regional and national statistics for winter weather.

WINTER STORM WATCHES

Region	Number of Watches	Watches No Event	Watches with Event	Watches Event Unknown	Percentage Distribution Lead Time in Hours 0≤6	>6≤12	>12≤18	>18≤24	>24	Unknown	Average Lead Time (Hours)	Average Watch Duration (Hours)
East	40	15	25	0	0%	20%	36%	16%	28%	0%	21.0	16.8
South	21	15	6	0	17%	0%	83%	0%	0%	0%	13.2	18.5
Central	55	33	22	0	9%	23%	14%	14%	41%	0%	22.9	19.1
West	37	11	25	1	0%	12%	12%	24%	48%	4%	26.5	17.8
Alaska	1	1	0	0								12.0
Pacific	0											
National	154	75	78	1	4%	17%	26%	17%	36%	1%	22.7	18.1

GROUP WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration(Hours)
East	36	5	31	0	10%	6%	23%	26%	35%	0%	5.9	16.4
South	28	6	22	0	27%	5%	27%	18%	14%	9%	3.5	18.3
Central	61	18	43	0	35%	9%	19%	14%	23%	0%	3.9	18.8
West	50	7	42	1	7%	2%	10%	14%	60%	7%	9.5	21.6
Alaska	3	1	2	0	0%	0%	0%	50%	0%	50%	4.0	18.2
Pacific	0											
National	178	37	140	1	19%	6%	18%	18%	35%	4%	5.9	18.9

GROUP EVENTS

Region	Number of Events	Events Warning Only	Events Watch Only	Events Neither	Events Both
East	35	7	2	2	24
South	25	15	2	3	5
Central	39	20	4	1	14
West	46	22	4	2	18
Alaska	2	2	0	0	0
Pacific	0				
National	147	66	12	8	61

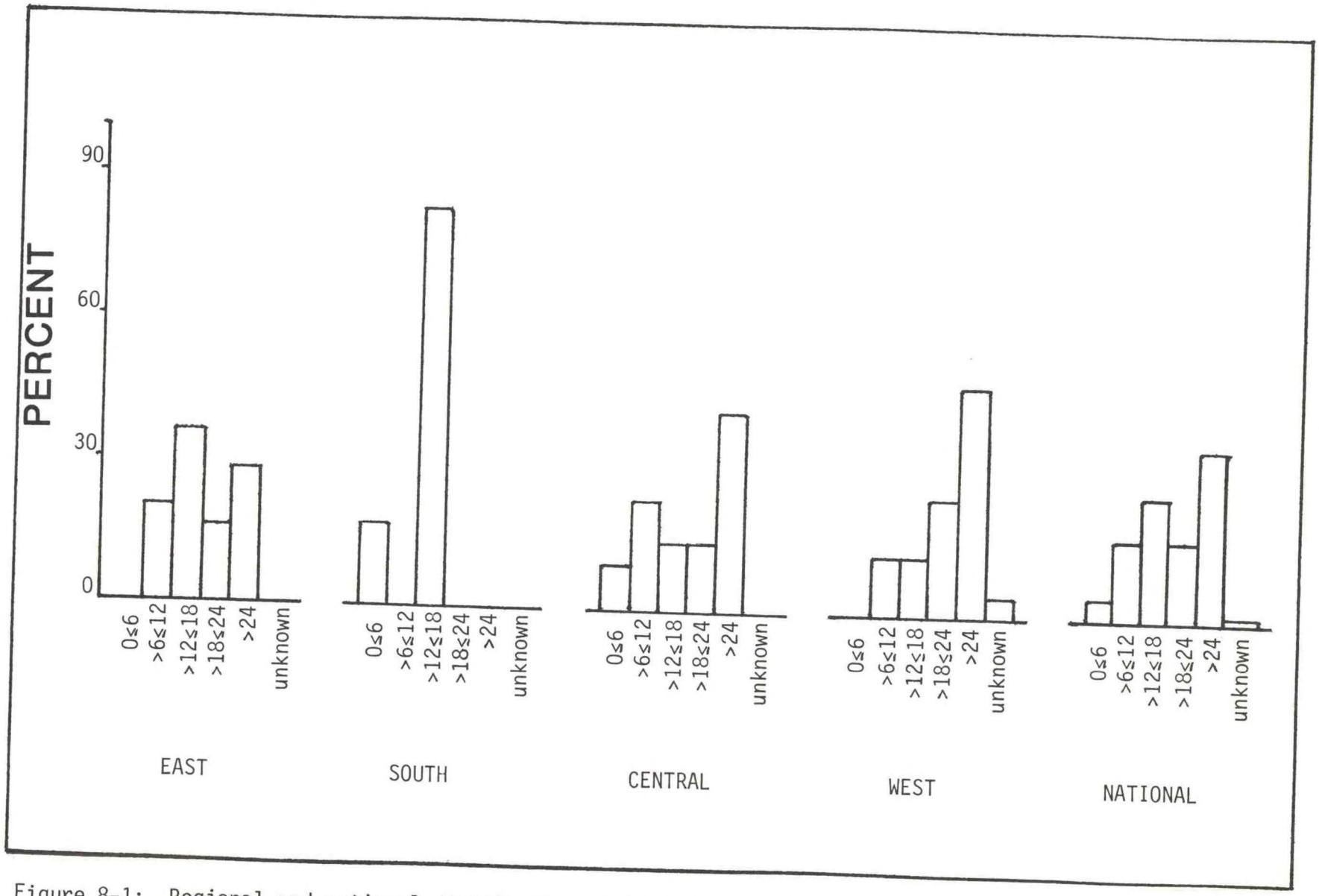

Figure 8-1: Regional and national distribution of lead times for winter storm watches. Lead time categories are in hours.

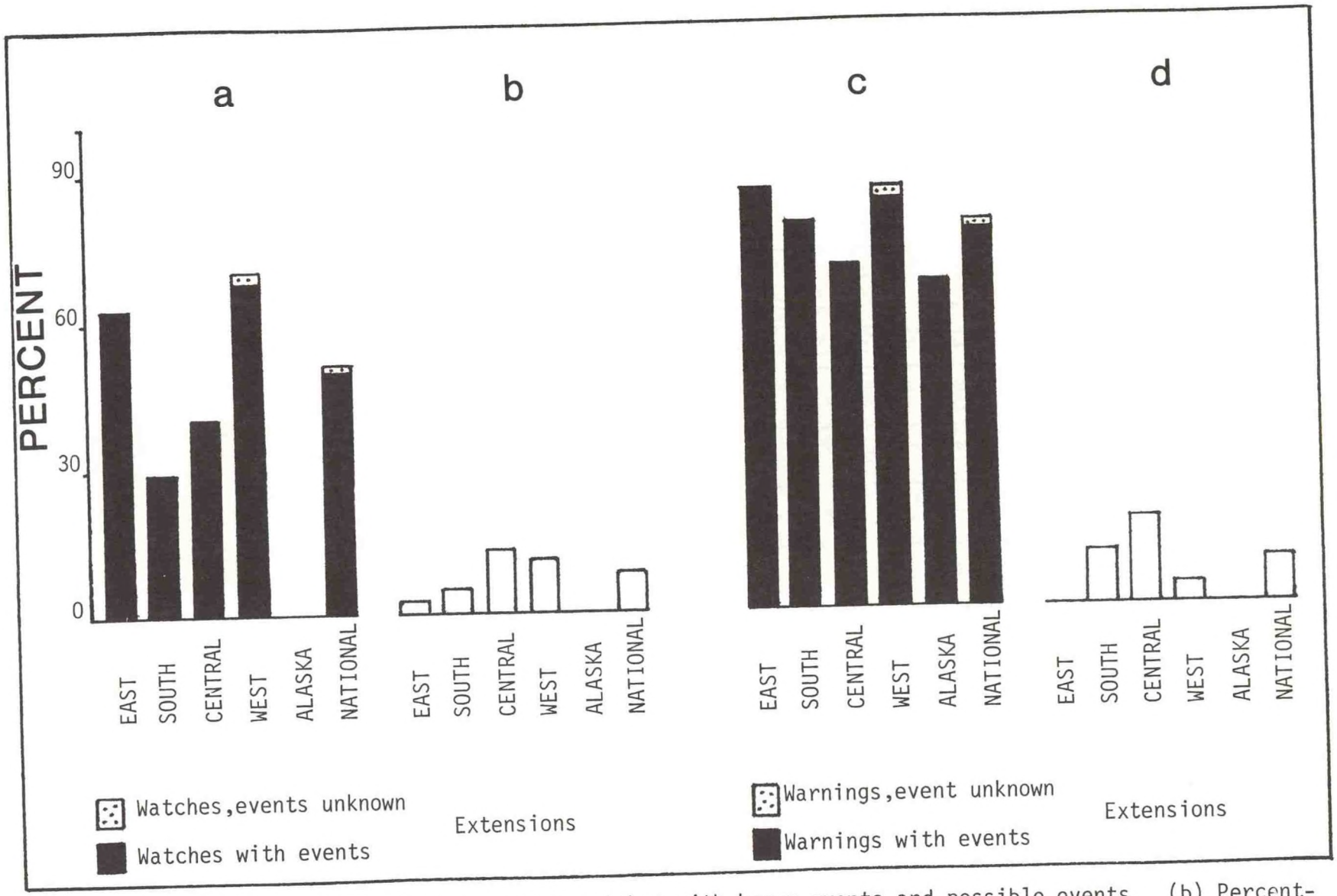

Figure 8-2: (a) Percentage of winter storm watches with known events and possible events. (b) Percentage of the total number of winter storm watches that are extensions. (c) Percentage of group warnings with known events and possible events. (d) Percentage of the total number of group warnings that are extensions.

Table 8-2

1983 summary of regional and national statistics for winter storm.

WINTER STORM WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	24	4	20	0	10%	5%	15%	30%	40%	0%	6.8	16.5
South	17	5	12	0	33%	8%	8%	25%	8%	17%	2.6	17.9
Central	43	12	31	0	32%	10%	19%	16%	23%	0%	4.0	18.9
West	44	6	38	0	5%	3%	8%	13%	63%	8%	10.2	20.0
Alaska	0											
Pacific	0											
National	128	27	101	0	18%	6%	13%	19%	40%	5%	6.7	18.6

WINTER STORM EVENTS

Region	Number of Events	Events Warning Only	Events Watch Only	Events Neither	Events Both
East	22	6	2	0	14
South	13	9	2	0	2
Central	29	17	3	0	9
West	41	19	4	1	17
Alaska	0				
Pacific	0				
National	105	51	11	1	42

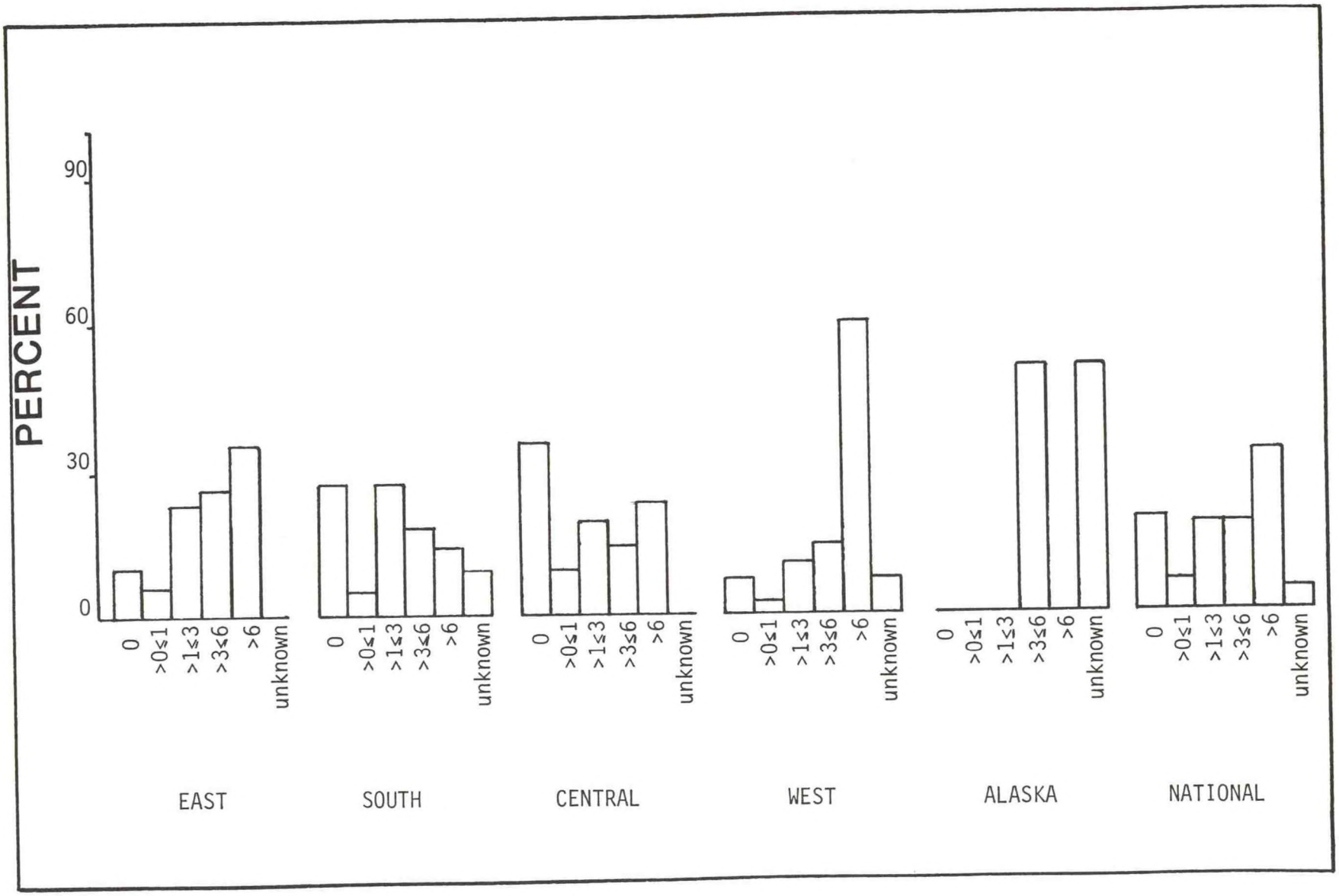

Figure 8-3: Regional and national distribution of lead times for group warnings. Lead time categories are in hours.

Table 8-3

1983 summary of regional and national statistics for blizzards.

BLIZZARD WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	1	0	1	0	100%	0%	0%	0%	0%	0%	0.0	17.0
South	0											
Central	4	0	4	0	75%	0%	25%	0%	0%	0%	0.7	15.3
West	3	1	2	0	50%	0%	50%	0%	0%	0%	1.0	10.3
Alaska	1	0	1	0	0%	0%	0%	100%	0%	0%	4.0	12.0
Pacific	0											
National	9	1	8	0	63%	0%	25%	12%	0%	0%	1.1	13.8

BLIZZARD EVENTS

Region	Number of Events	Events WarningOnly	Events Watch Only	Events Neither	Events Both
East	1	0	0	0	1
South	0				
Central	3	2	0	0	1
West	2	1	0	0	1
Alaska	1	1	0	0	0
Pacific	0				
National	7	4	0	0	3

Table 8-4

1983 summary of regional and national statistics for heavy snow.

HEAVY SNOW WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	7	1	6	0	0%	0%	50%	17%	33%	0%	5.0	18.1
South	8	1	7	0	0%	0%	57%	14%	29%	0%	5.9	21.3
Central	10	6	4	0	25%	0%	25%	25%	25%	0%	5.5	20.8
West	3	0	2	1	0%	0%	0%	50%	50%	0%	5.5	9.5
Alaska	2	1	1	0	0%	0%	0%	0%	0%	100%	--	16.3
Pacific	0											
National	30	9	20	1	5%	0%	40%	20%	30%	5%	5.5	19.2

HEAVY SNOW EVENTS

Region	Number of Events	Events Warning Only	Events Watch Only	Events Neither	Events Both
East	7	0	0	1	6
South	10	5	0	3	2
Central	4	0	1	1	2
West	3	2	0	1	0
Alaska	1	1	0	0	0
Pacific	0				
National	25	8	1	6	10

Table 8-5

1983 summary of regional and national statistics for freezing rain.

FREEZING RAIN WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours: 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	4	0	4	0	0%	25%	25%	25%	25%	0%	4.3	12.4
South	3	0	3	0	67%	0%	33%	0%	0%	0%	0.7	12.5
Central	4	0	4	0	25%	25%	0%	0%	50%	0%	5.1	16.6
West	0											
Alaska	0											
Pacific	0											
National	11	0	11	0	27%	18%	18%	9%	27%	0%	3.6	14.0

FREEZING RAIN EVENTS

Region	Number of Events	Events WarningOnly	Events Watch Only	Events Neither	Events Both
East	5	1	0	1	3
South	2	1	0	0	1
Central	3	1	0	0	2
West	0				
Alaska	0				
Pacific	0				
National	10	3	0	1	6

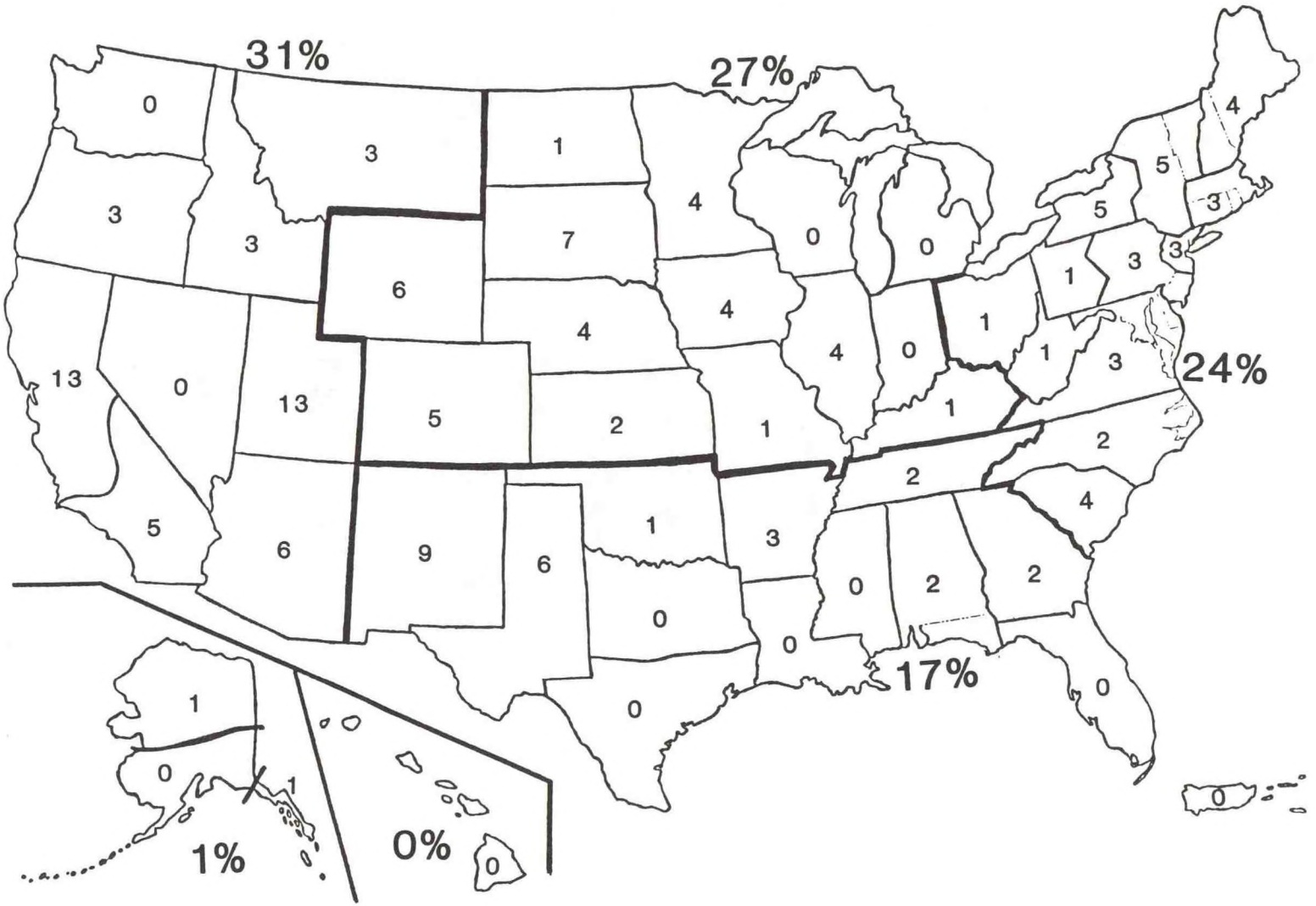

Figure 8-4: Number of group winter events by forecast office with percentage of events in each region for 1983.

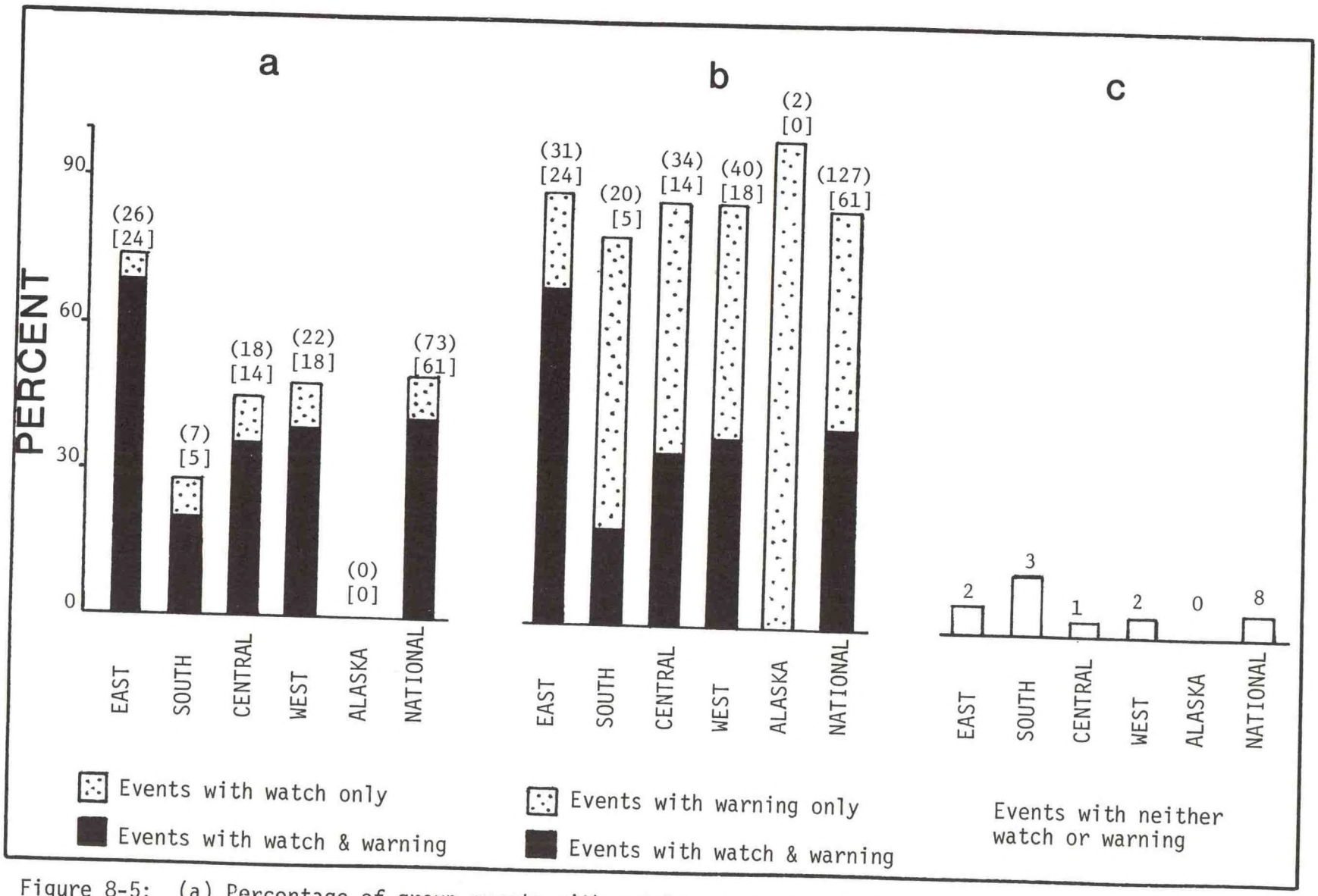

Figure 8-5: (a) Percentage of group events with watches; actual number in parentheses. Number of group events with both a watch and warning is in brackets. (b) Percentage of group events with warnings; actual number in parentheses. Number of group events with both a warning and watch is in brackets. (c) Percentage of group events with neither a watch or warning; actual number above each bar.

9. 1983 HIGH WIND

During 1983, no duststorms or sandstorms were reported on the verification logs and no warnings were issued.

Most offices do not issue high wind watches and there is no national policy concerning such watches, therefore they are not included in the verification program. Definitions for duststorm/sandstorm and high wind events are given in Appendix II.

9.1 EVENTS

Figure 9-1 shows the national distribution of the 80 high wind events reported during 1983. The total number of events for each region is given in Table 9-1. Several years of data may be needed to provide a meaningful sample for the Southern and Pacific Regions.

The percentage of events covered by a warning is given by Figure 9-2a. The actual number of high wind events with warnings is given in Table 9-1. Warnings with no lead time were counted.

9.2 WARNINGS

Nationally, 81 percent of the high wind warnings had positive verification in 1983. The solid portions of the bars in Figure 9-2b represent the percentage of warnings followed by events, while the dotted sections account for the warnings where information was unavailable to verify whether an event occurred.

The difference between 100 percent and the percentage of warnings with positive verification gives the false alarm ratio. The FAR for high wind warnings is 19 percent, nationally, if unknowns are counted as no event. Using the overwarning equation, we overwarn 24 percent, nationally.

Warnings may be extended in three ways: 1) keep the same area but extend the valid period, 2) alter the area but keep the same time period, or 3) change both area and time. Seven percent of the high wind warnings were extensions of previous warnings; regional statistics are found in Figure 9-2c. Extensions are counted in the total number of warnings.

So far all statistics have included warnings regardless of lead time. If only warnings with lead time greater than zero are to be counted then nationally 63 percent were followed by an event. A lead time distribution for high wind warnings can be found in Figure 9-3 or Table 9-1.

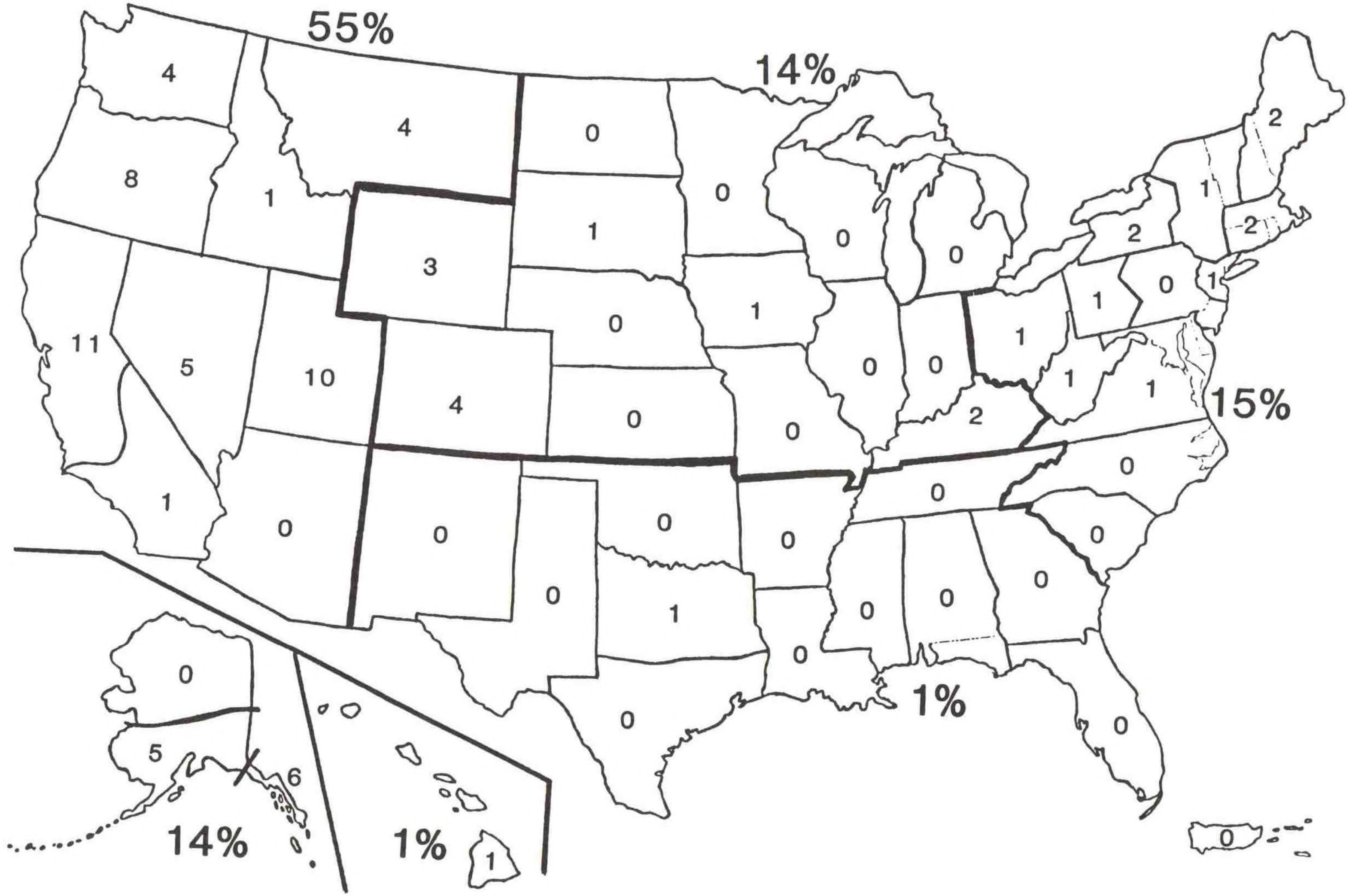

Figure 9-1: Number of high wind events by forecast office with percentage of events in each region for 1983.

Table 9-1

1983 summary of regional and national statistics for high wind.

HIGH WIND WARNINGS

Region	Number of Warnings	Warnings No Event	Warnings with Event	Warnings Event Unknown	Percentage Distribution Lead Time in Hours 0	>0≤1	>1≤3	>3≤6	>6	Unknown	Average Lead Time (Hours)	Average Warning Duration (Hours)
East	11	0	11	0	45%	18%	36%	0%	0%	0%	1.3	8.2
South	1	0	1	0	100%	0%	0%	0%	0%	0%	0.0	14.0
Central	15	2	13	0	15%	31%	15%	15%	23%	0%	4.5	13.0
West	54	9	42	3	19%	9%	19%	17%	12%	24%	3.6	11.1
Alaska	17	4	12	1	8%	17%	17%	25%	25%	8%	5.0	15.1
Pacific	1	0	1	0	100%	0%	0%	0%	0%	0%	0.0	21.0
National	99	15	80	4	22%	15%	20%	15%	14%	14%	3.5	12.0

HIGH WIND EVENTS

Region	Number of Events	Events No Warning	Events with Warning
East	12	1	11
South	1	0	1
Central	11	0	11
West	44	6	38
Alaska	11	0	11
Pacific	1	0	1
National	80	7	73

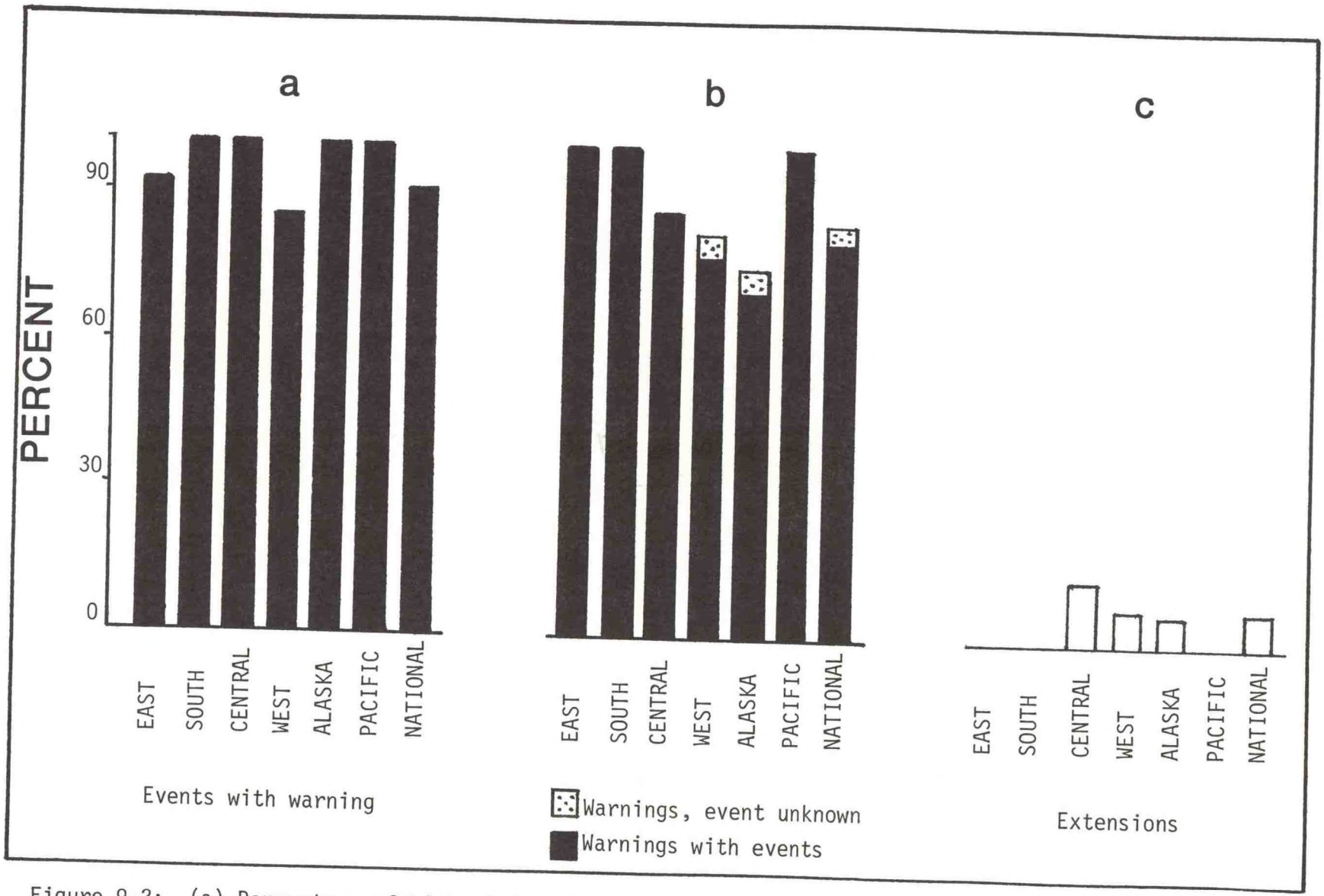

Figure 9-2: (a) Percentage of high wind events with warnings. (b) Percentage of high wind warnings with known events and possible events. (c) Percentage of total number of high wind warnings that are extensions.

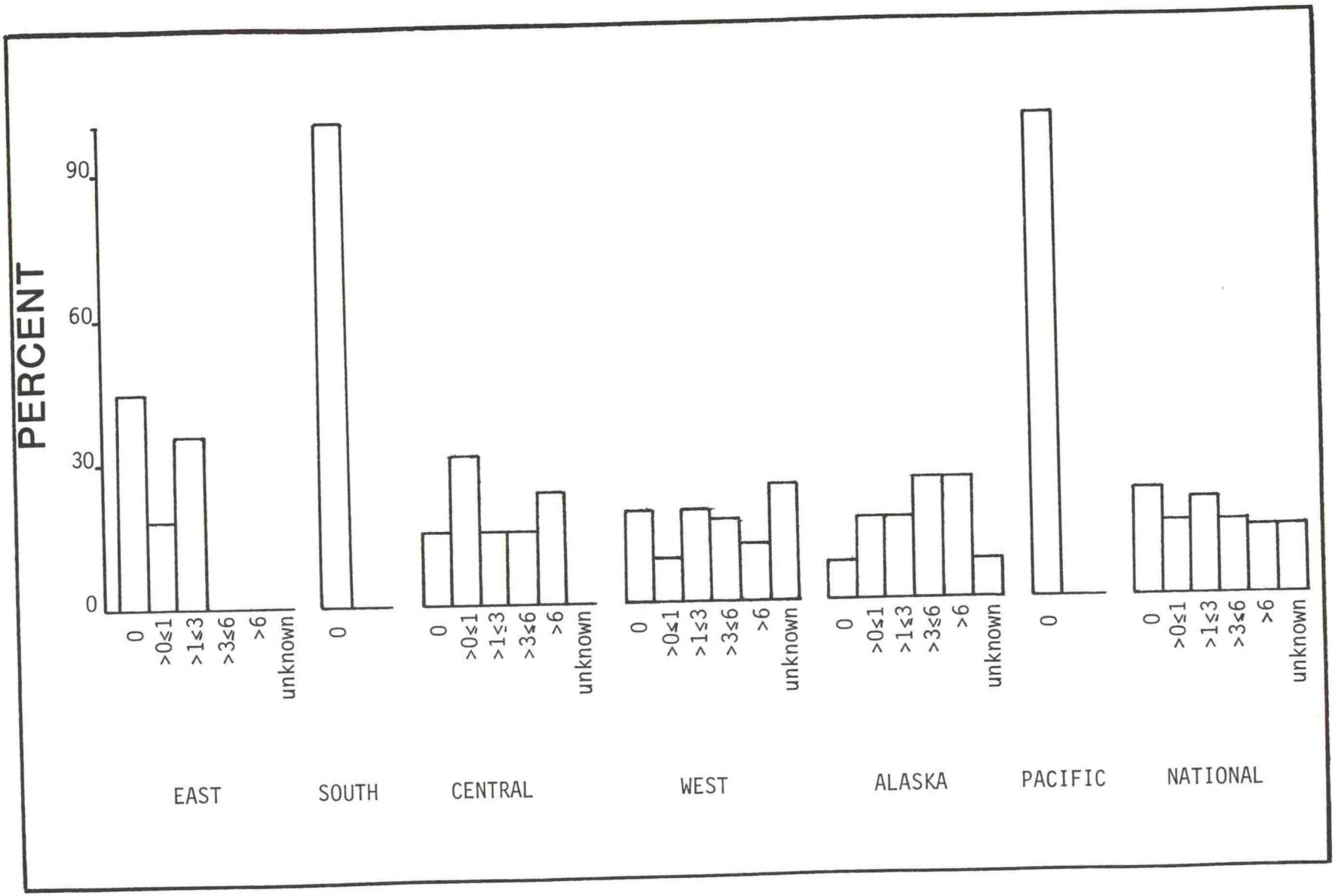

Figure 9-3: Regional and national distribution of lead times for high wind warnings. Lead time categories are in hours.

10. SUMMARY

Fifty-eight percent of the 436 flash flood events recorded during 1982, occurred in the Southern Region. Nationally, 14 percent of the events occurred without a watch or warning. Looking at performance another way, 81 percent of the flash flood warnings showed positive verification, but a little over half of those had zero lead time.

One hundred eighty-six winter weather events were reported on the logs during 1982, 8 percent of which occurred without a watch or warning. Looking at the issuances, 71 percent of the warnings were followed by an event, but 21 percent of those warnings had zero lead time.

Sixty-five percent of the 111 high wind events occurred in the Central and Western Regions during 1982. Only 3 percent of all high wind events occurred without a warning. Of the total warnings issued, 81 percent were followed by an event, but 26 percent of those were issued with an event in progress.

Fifty-five percent of the 414 flash flood events recorded during 1983, occurred in the Southern Region. Nationally, 14 percent of the events occurred without a watch or warning. Looking at performance another way, 79 percent of the flash flood warnings showed positive verification, but 46 percent of those had zero lead time.

One hundred forty-seven winter weather events were reported during 1983, 5 percent of which occurred without a watch or warning. Looking at issuances, 79 percent of the warnings were followed by an event, but 19 percent of those warnings had zero lead time.

Fifty-five percent of the 80 high wind events occurred in the Western Region during 1983. Only 9 percent of all high wind events occurred without a warning. Of the total warnings issued, 81 percent were followed by an event, but 22 percent of those were issued with an event in progress.

11. ACKNOWLEDGMENTS

The author wishes to thank Burt Kirschner and Bob Thompson of the Services Evaluation Branch for taking time to review this report. Thanks also to Fran Wescott and Diane Savoy for typing the text.

REFERENCES

Campbell, A. K., 1982: National Weather Service 1981 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind. NOAA Tech. Memo., NWS FCST-27, 36pp.

Donaldson, R.J., Jr., R.M. Dyer, and M.J. Kraus, 1985: An objective evaluator of techniques for predicting severe weather events. Preprints, 9th Conf. on Severe Local Storms, Boston, Amer. Meteor. Soc., 321-326.

APPENDIX I

National Weather Service Forecast Offices

EASTERN REGION

Portland, Maine
Boston, Massachusetts
New York City, New York
Albany, New York
Buffalo, New York
Cleveland, Ohio
Charleston, West Virginia
Pittsburgh, Pennsylvania
Philadelphia, Pennsylvania
Washington, D.C.
Raleigh, North Carolina
Columbia, South Carolina

CENTRAL REGION

Louisville, Kentucky
Ann Arbor, Michigan
Indianapolis, Indiana
Chicago, Illinois
Milwaukee, Wisconsin
Des Moines, Iowa
Minneapolis, Minnesota
Sioux Falls, South Dakota
Bismarck, North Dakota
Cheyenne, Wyoming
Denver, Colorado
Omaha, Nebraska
Topeka, Kansas
St. Louis, Missouri

SOUTHERN REGION

San Juan, Puerto Rico
Miami, Florida
Atlanta, Georgia
Birmingham, Alabama
New Orleans, Louisiana
Jackson, Mississippi
Memphis, Tennessee
Little Rock, Arkansas
Oklahoma City, Oklahoma
Fort Worth, Texas
San Antonio, Texas
Lubbock, Texas
Albuquerque, New Mexico

WESTERN REGION

Phoenix, Arizona
Salt Lake City, Utah
Great Falls, Montana
Boise, Idaho
Reno, Nevada
Los Angeles, California
San Francisco, California
Portland, Oregon
Seattle, Washington

PACIFIC REGION

Honolulu, Hawaii

ALASKA REGION

Juneau, Alaska
Anchorage, Alaska
Fairbanks, Alaska

APPENDIX II

Definitions: WSOM Chapter C-42, Winter Weather Warnings

Blizzard indicates that the following conditions are expected to prevail for an extended period (for 3 hours or longer):

1.) Wind speeds of 35 miles an hour or more and
2.) considerable falling and/or blowing snow (i.e., visibility frequently less than 1/4 mile).

Severe Blizzard generally indicates:

1.) wind speeds of 45 miles an hour or more,
2.) great density of falling and/or blowing snow (i.e., visibility frequently near zero), and
3.) temperature of 10 degrees Fahrenheit or lower.

Duststorm (or Sandstorm) indicates the following conditions will prevail over a widespread area:

1.) Visibility of 1/2 mile or less due to dust or sand, and
2.) Wind speeds of 30 miles an hour or more.

Heavy Snow generally means:

1.) a fall accumulating to 4 inches or more in depth in 12 hours, or
2.) a fall accumulating to 6 inches or more in depth in 24 hours.

(Some variation in the criteria for heavy snowfall in certain sections of the country may be established at the option of the Regional Director.)

High Wind normally indicates sustained winds of 40 miles an hour or greater are expected to persist for 1 hour or longer. In this context, it is intended to be used for strong gradient wind conditions lasting for an extended period of time. However, at regional option, some variation in these criteria may be established to describe strong gusty winds occurring over a shorter time period.

Freezing Rain (or Drizzle) describes the freezing of rain or drizzle on objects as it strikes them. Winter storm warnings should be reserved for occasions where significant, and possible damaging accumulations of ice are expected.

Winter Storm Warning. A winter storm warning is a headline carried in

forecasts and highlighted in special weather statements that serves notice to the public of a high probability for the occurrence of severe winter weather. The warning is issued for the same events (except for blizzard conditions) that serve as a basis for the issuance of a winter storm watch.

Winter Storm Watch. A winter storm watch is a headline carried in forecasts and in special weather statements to cover the possible occurrence of the following weather elements, either separately or in combination: blizzard conditions, heavy snow (or light in areas where snow is relatively rare), accumulations of freezing rain or freezing drizzle, and/or heavy sleet.

(Continued from inside front cover)

NOAA Technical Memorandums

NWS FCST 16 Weather Bureau April 1969 to March 1970 Verification Report With Special Emphasis on Performance Scores within Echelons. Robert G. Derouin and Geraldine F. Cobb, April 1971. (COM-71-00555)

NWS FCST 17 National Weather Service May 1970 to April 1971 Public Forecast Verification Summary. Robert G. Derouin and Geraldine F. Cobb, March 1972. (COM-72-10484)

NWS FCST 18 Long-Term Verification Trends of Forecasts by the National Weather Service. Duane S. Cooley and Robert G. Derouin, May 1972. (COM-72-11114)

NWS FCST 19 National Weather Service May 1971 to April 1972 Public Forecast Verification Summary. Alexander F. Sadowski and Geraldine F. Cobb, July 1973. (COM-73-11-55 7/AS)

NWS FCST 20 National Weather Service Heavy Snow Forecast Verification 1962 to 1972. Alexander F. Sadowski and Geraldine F. Cobb, January 1974. (COM-74-10518)

NWS FCST 21 National Weather Service April 1972 to March 1973 Public Forecast Verification Summary. Alexander F. Sadowski and Geraldine F. Cobb, June 1974. (COM-74-1 1467/AS)

NWS FCST 22 Photochemical (Oxidant) Air Pollution Summary Information. Stephen W. Harned and Thomas Laufer, December 1977. (PB-283868/AS)

NWS FCST 23 Low-Level Wind Shear: A Critical Review. Julius Badner, April 1979, 72 pp. (PB-300715)

NWS FCST 24 Probability Forecasting--Reasons, Procedures, Problems. Lawrence A. Hughes, January 1980, 89 pp. (PB80-164353)

NWS FCST 25 National Weather Service Public Forecast Verification Summary--April 1973 to March 1978. Duane S. Cooley, Frederick S. Zbar, Dean F. Dubofsky, and A. Kristine Campbell, March 1981,
136 pp. (PB81-231714)

NWS FCST 26 National Weather Service 1980 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind. A. Kristine Campbell, August 1981, 36 pp. (PB82-148719)

NWS FCST 27 National Weather Service 1981 Watch/Warning Verification: Flash Flood, Winter Storm and High Wind. A. Kristine Campbell, July 1982. (PB83-118018)

NWS FCST 28 National Weather Service Public Forecast Verification Summary, April 1978 to March 1982. Paul D. Polger, April 1983. (PB83-232173)

NWS FCST 29 Public Response to Hurricane Probability Forecasts. Jay Baker, January 1984. (PB84-158658)

NOAA SCIENTIFIC AND TECHNICAL PUBLICATIONS

The National Oceanic and Atmospheric Administration was established as part of the Department of Commerce on October 3, 1970. The mission responsibilities of NOAA are to assess the socioeconomic impact of natural and technological changes in the environment and to monitor and predict the state of the solid Earth, the oceans and their living resources, the atmosphere, and the space environment of the Earth.

The major components of NOAA regularly produce various types of scientific and technical information in the following kinds of publications:

PROFESSIONAL PAPERS-Important definitive research results, major techniques, and special investigations.

CONTRACT AND GRANT REPORTS-Reports prepared by contractors or grantees under NOAA sponsorship.

ATLAS-Presentation of analyzed data generally in the form of maps showing distribution of rainfall, chemical and physical conditions of oceans and atmosphere, distribution of fishes and marine mammals, ionospheric conditions, etc.

TECHNICAL SERVICE PUBLICATIONS-Reports containing data, observations, instructions, etc. A partial listing includes data serials; prediction and outlook periodicals; technical manuals, training papers, planning reports, and information serials; and miscellaneous technical publications.

TECHNICAL REPORTS-Journal quality with extensive details, mathematical developments, or data listings.

TECHNICAL MEMORANDUMS-Reports of preliminary, partial, or negative research or technology results, interim instructions, and the like.