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THE NATIONAL WEATHER SERVICE SKYWARN PROGRAM

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1. INTRODUCTION

Tornadoes, large hail, damaging straight-line winds, and flash floods take a large toll in both life and property each year in the United States. In fact, the National Severe Storms Forecast Center (NSSFC) data indicates that nearly 10,000 severe weather events take place in this country annually. Virtually every county of every state has experienced a severe weather event sometime in the past.

The National Weather Service (NWS) has a nationwide network of weather radars and a means for obtaining high resolutions satellite imagery in order to detect the presence of severe local storms, including flash floods. Yet, meteorologists realize that both radar and satellite data have inherent shortcomings which limit their accuracy in detecting severe events. In order to supplement these technological detection systems, the NWS must also make use of the most accurate visual detection device known to man, the human eye.

Various volunteer groups, individuals, and public service agencies have been solicited by the NWS to report visual sightings of severe weather to the agency in support of the warning function. These persons are commonly referred to as spotters and participate in the NWS program known as SKYWARN. The purpose of this paper is to describe the components, size, and structure of the NWS spotter program.

2. COMPONENTS OF SKYWARN

The components of the NWS spotter program are derived from many different sources. However, for the purposes of this study, they are categorized into four distinct groups. These are described in the next several sections.

2.1 The Amateur Radio Operator

The first group of volunteers to be discussed is amateur radio. The amateur radio operator transmits severe weather information to the NWS via a telecommunications device, usually a 2-meter band ham radio on a frequency between 144.0 to 148.0 megahertz. Since the power of the radio is such that it would not normally allow for transmission over a vast distance, devices known as "repeaters" are used. A repeater receives a message transmission from the radio operator and rebroadcast the information on a different frequency to the NWS office, or in some cases, to another repeater.

The amateur radio operator is a most valuable type of spotter for an NWS office to have because of the directness of the link of the meteorologist to the spotter in a remote location. This allows a meteorologist to quickly verify information received from other sources, such as radar and satellite systems. The NWS meteorologist can then issue timely and accurate warnings of severe weather with a high degree of confidence. As an example of their value to the agency, an amateur radio operator gave the initial report of a devastating tornado that struck Wichita Falls, Texas, in 1979. This amateur's report undoubtedly saved lives.

2.2 Government Employees

The next group of individuals discussed in this paper is denoted as government employees. This group consists of paid employees of local or state governmental agencies, such as policemen, county road crews, firemen, and other persons that may have frequent opportunities to observe the weather. Training these groups as spotters has proven useful because of their round-the-clock service. Because of the difficulty in obtaining late night severe weather reports, it is vital that groups such as the ones previously mentioned receive spotter training. Another benefit of using government employees is that the vast majority have access to radio communications. However, one of the problems in using government employees as spotters is the difficulty in scheduling spotter training.

2.3 Volunteer Groups

Group-affiliated spotters consist mainly of volunteer firemen, organized groups of civic minded individuals, and non-paid civil defense workers. These dedicated volunteers are called

upon to assist in many types of disasters, including ones that are weather related. They have proven vital in many instances, including the 1985 tornado outbreak in Ohio and Pennsylvania. During this severe weather episode, a fellow in a group known as the Safety Reserve was able to observe a tornado touching down near Newton Falls, Ohio, from a vantage point on the roof of the town's fire station. This man was also responsible for saving lives. Before the tornado struck, the man told 93 people playing bingo next door to the fire hall to take cover. Minutes later, the bingo hall was flattened by the twister but no one perished because they were warned.

One of the problems that may be encountered with using group-affiliated spotters that are not amateur radio operators or government employees is the lack of two-way radio communication. Without radio communication, most of this group of spotters are confined to areas within the localities. This severely limits the value of the spotter to the warning program.

2.4 Individuals

Individual spotters are not affiliated with any particular group. These persons are generally weather enthusiasts whose interest makes them quite reliable and useful, particularly in areas of the country that are sparsely populated. They are, however, like the government affiliated spotters, in that difficulty may arise in gathering a group of individuals not related by job or hobby for spotter training.

3. NATIONAL STATISTICS

3.1 Purpose of the study

The purpose of the spotter survey was to obtain a complete accounting of all severe weather spotters in the contiguous United States. Until this study was conducted, it was not known on a national level how many spotters existed, where they were located, and the type of training received. By establishing a data base of trained spotters on a state-by-state, county-by-county basis, the national statistics may be easily updated as changes in the spotter program occur.

It should be noted that Alaska and Hawaii were not included in this study, but we hope to gain some insight as to their use of spotters in the near future.

3.2 Methodology

To begin the NWS spotter study, a questionnaire was sent to all NWS field offices from Weather Service Headquarters. The field offices were asked to identify by county the type of spotter, the number trained, for which program, and the date of last training. These questionnaires were then returned to the National Weather Service Headquarters, entered into a computer database, and analyzed.

3.3 Results

The survey revealed that there were over 120,000 trained spotters in the contiguous United States. Of that total, about 25 percent were amateur radio operators, 16 percent were government employees, 38 percent were non-paid volunteers with individuals making up 21 percent of the total. The following national averages were calculated from the survey data:

Spotters per 100 square miles - 4.2
Spotters per 10,000 population - 5.6
County average - 40
Spotters per severe event for the year 1985 - 11.0

It became rather clear when analyzing the survey data that two factors were most important in determining the numbers of spotters trained in a particular area. The first and most important factor, of course, appeared to be population density with the other being the frequency of severe weather in that area. This is quite obvious when noting that the highest concentration of total spotters lies in the Ohio Valley and upper Midwest states of Ohio, Kentucky, Indiana, Illinois, Wisconsin, and Michigan (Figure 1.)

However, on a state-by-state basis, the highest numbers of spotters are found in state's with lower population but with a relatively high frequency of severe weather. An indication of this is depicted in Figure 2 which reveals that states in the northern and central Plains have a spotter to population ratio much higher than the national average.

Another interesting finding in the survey was that the NWS Eastern, Central, and Southern Regions each utilized about 10,000 persons in the amateur radio affiliated category. However, it was felt that the Western Region had very few amateur radio spotters because of the limited transmission range of the 2-meter band radio in mountainous terrain.

3.4 Regional Distribution

3.4.1 The Midwest

Overall, the NWS Central Region has over 70,000 trained spotters. This is more than twice the total of any other region of the country and reflects the fact that they utilize nearly 35,000 persons in the volunteer group category, specifically civil defense groups. No other region has trained as many in this category as Central Region offices.

- 70,950 SPOTTERS

- MAIN GROUPS		- DENSITY
+ AMATEUR RADIO	15%	7.5 PER 100 SQUARE MILES
+ GOVERNMENT WORKERS	15%	12.8 PER 10,000 PERSONS
+ VOLUNTEER GROUPS	49%	60 PER COUNTY
+ INDIVIDUALS	21%	10.5 PER SEVERE EVENT

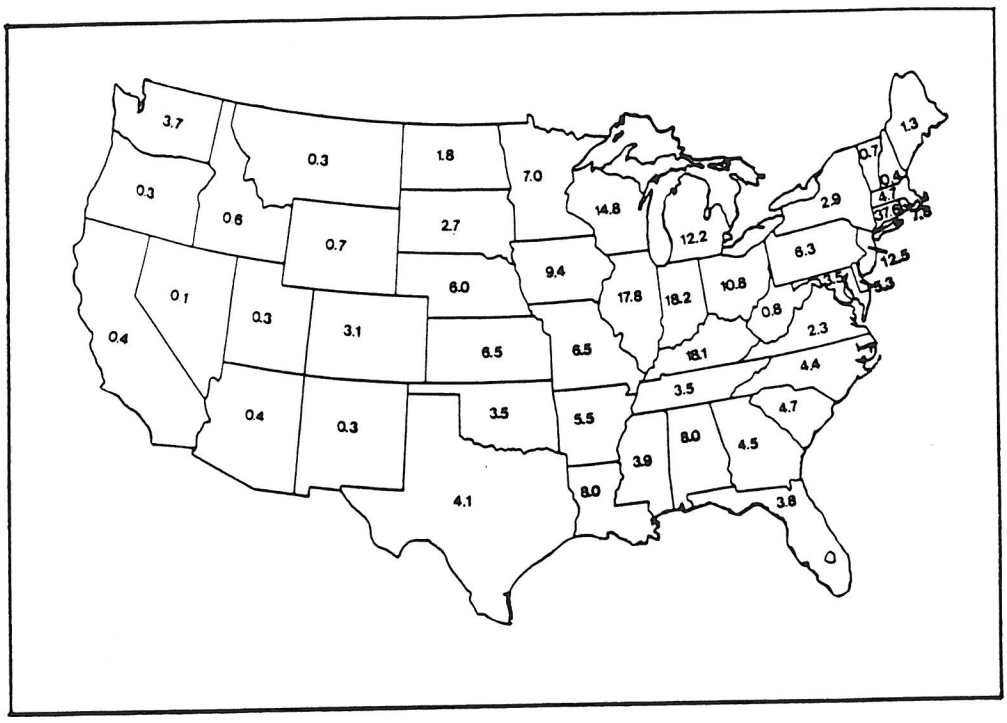

Figure 1. Average number of spotters per 100 square miles on a state basis.

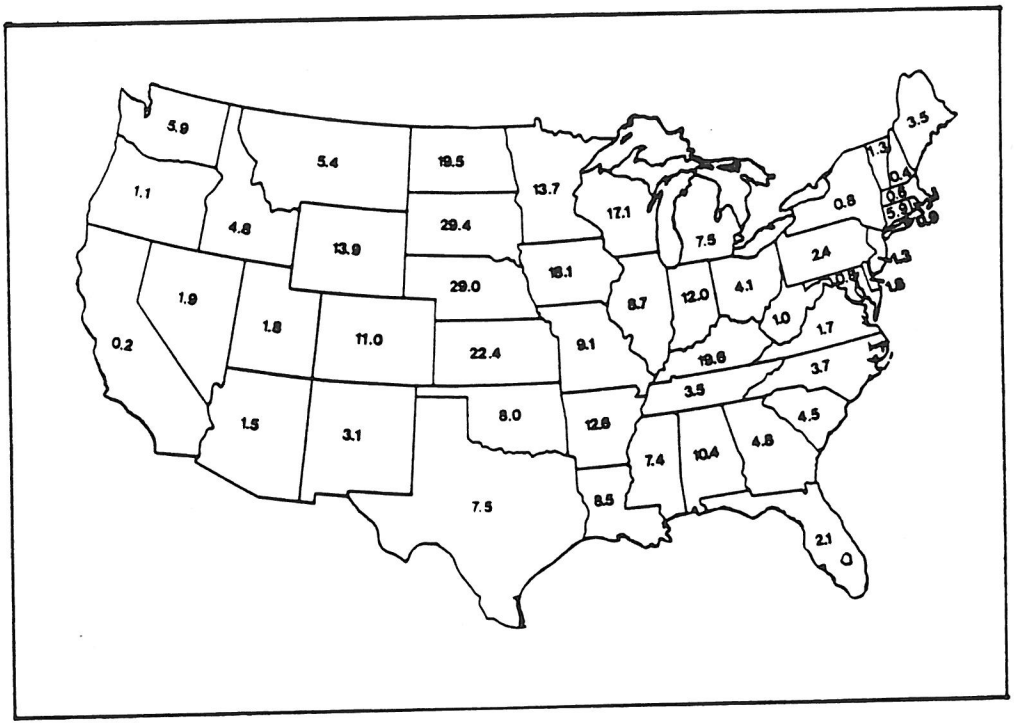

Figure 2. Average number of spotters per 10,000 population on a state basis.

3.4.2 The South

The NWS Southern Region covers a portion of the country that has a high incidence of severe weather and has nearly 32,000 trained spotters to report its occurrence. Some counties of the Deep South lack spotter networks, possibly the result of local socio-economic conditions and lack of population. It is true, however, that where no spotters were reported, local law enforcement officials can be called upon for severe weather reports if the need arises.

- 31,931 SPOTTERS

- MAIN GROUPS		- DENSITY
+ AMATEUR RADIO	32%	4.0 PER 100 SQUARE MILES
+ GOVERNMENT WORKERS	19%	6.2 PER 10,000 PERSONS
+ VOLUNTEER GROUPS	31%	33 PER COUNTY
+ INDIVIDUALS	18%	10.7 PER SEVERE EVENT

3.4.3 The East

The NWS Eastern Region offices rely most heavily on amateur radio operators to receive surface reports of severe weather. Of the 17,500 spotters here, almost 60 percent of them were affiliated with amateur radio operator. As previously mentioned, the ham operator provides the most valuable service in a severe weather event because of the directness of the communication link to the location of the event.

- 17,528 SPOTTERS

- MAIN GROUPS		- DENSITY
+ AMATEUR RADIO	59%	4.9 PER 100 SQUARE MILES
+ GOVERNMENT EMPLOYEES	7%	2.1 PER 10,000 PERSONS
+ VOLUNTEER GROUPS	16%	26 PER COUNTY/INDEPENDENT CITY
+ INDIVIDUALS	18%	11.5 PER SEVERE EVENT

3.4.4 The West

Because of vast areas of sparse population and lack of severe weather, the NWS Western Region does not use spotters extensively. A large percentage of the spotter networks existing in the western part of the United States are for hydrologic purposes as opposed to severe thunderstorm and tornado reporting. It is interesting to note, however, that of the roughly 5,000 spotters in the Western Region, nearly half of them are located in the state of Washington. WSFO Seattle has been creative in finding groups of individuals to train. Among them are the Seattle area transit workers, nearly 1,700 strong. It is apparent that the aggressive recruiting effort has proved to be beneficial.

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- 5,036 SPOTTERS

- MAIN GROUPS			- DENSITY
+ AMATEUR RADIO	14%		0.6 PER 100 SQUARE MILES
+ GOVERNMENT WORKERS	40%	(19%) *	1.4 PER 10,000 PERSONS
+ VOLUNTEER GROUPS	6%		17 PER COUNTY
+ INDIVIDUALS	40%	(61%) *	37.9 PER SEVERE EVENT

* WSFO SEATTLE HAS 1700 TRANSIT WORKERS TRAINED AS SPOTTERS. OTHERWISE, WESTERN REGION IS PRIMARILY INDIVIDUAL SPOTTERS.

4. SKYWARN'S FUTURE

SKYWARN is vital to the agency as a tool for acquiring data for the issuance of warnings and subsequently saving lives. Even with the technological improvements slated for implementation in the 1990's, spotters will always be a necessary component of the NWS warning program. The combination of Next Generation Radar (NEXRAD), Automated Weather Information Processing System (AWIPS), and spotters will allow the NWS meteorologist to obtain a 4-dimensional (x,y,z,t) perspective of the atmosphere and ground truth verification, which will lead to rapid and more accurate warnings. With the emergence of new technology such as Packett radio, communications will exist that will allow graphic information to be sent directly to the spotter. This would create a system that would increase the spotter's capability, and hence the forecaster would likely receive more accurate information. Also, using video for transmittion of pictures to the warning office would enhance the severe weather program.

With the advent of these new technologies and the continued and expanded use of spotters, loss of life from weather related hazards should continue to decline.