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DRAMATICALLY IMPROVING WARNING SERVICES - ONE OFFICE'S EXPERIENCE

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1. INTRODUCTION

The Morristown, TN National Weather Service (NWS) office, which serves East Tennessee, far Southwest Virginia, and extreme Southwest North Carolina, has shown dramatic improvement and sustained excellence in the issuance of severe thunderstorm, tornado and flash flood warnings over the past three years.

These remarkable improvements resulted largely from the following: aggressive use of science and training; an internal/external evaluation program for all warning-related activities; increased verification efforts; and increased teamwork among all office personnel.

These four factors will be discussed in detail and suggestions will be presented for how other offices can make use of this information. Many of the concepts we applied are well-known. However, the importance of applying those concepts, and the benefits to be reaped, need to be emphasized.

2. VERIFICATION SCORES

The National Weather Service measures verification of severe weather warnings using the Critical Success Index (CSI), the Percentage of Detection (POD), and the False Alarm Rate (FAR) (National Weather Service, 2002). Table 1 displays these parameters for the Morristown NWS Office from 1998 through 2001 for all severe thunderstorm and tornado warnings combined.

Table 1	1998	1999	2000	2001
CSI	35.8	69.3	75.1	79.7
POD	85.7	89.4	93.2	92.9
FAR	62.0	24.6	20.6	15.2

CSI and POD have increased substantially, and FAR has decreased even more impressively. FAR is only one-quarter what it was in 1998. CSI has more than doubled over a four-year period. In that time, we have moved from "off the charts" in 1998, to 6th in the country in 1999, to 4th in 2000, and then 3rd in 2001 (using CSI as the ranking factor). This office had the highest CSI in the Southern Region of the National Weather Service each of the past three years. From another perspective, office CSI was 11.4% below the national average in 1998, but finished 25.3% above the national average in 2001. Our scores far exceed regional and national goals.

Flash flood warnings showed even larger numerical gains during this period (see Table 2).

Table 2	1998	1999	2000	2001
CSI	7.2	17.0	52.6	66.4
POD	87.5	31.0	93.8	94.6
FAR	92.7	72.5	45.5	31.0

The CSI has increased by a factor of nine over a four-year period. At the same time, the FAR has decreased by over 60%. Again, the 2001 numbers far exceed regional and national goals.

3. DISCUSSION

We feel these remarkable improvements resulted largely from the following:
- aggressive use of science and training;
- an internal/external evaluation program of all warning-related activities;
- increased verification efforts; and
- increased teamwork among all office personnel.

Concerning the aggressive use of science and training - The office aggressively conducted training and research to increase the staff's use of the latest in the science and psychology of warning operations. We both hosted and attended nearby-office seminars by severe weather experts from SPC (Storm Prediction Center), sent several staff to the Warning Decision-Making workshops hosted by the WDTB (Warning Decision Training Branch) and followed these up with local seminars to transfer the information to the entire staff. We held local seminars covering the latest from the 1998 and 2000 Severe Storms Conferences, sent an individual to attend a COMAP Symposium on Heavy Precipitation and Flash Flooding, and conducted post-event hydro-meteorological reviews so the entire staff could learn from each significant severe weather event. We conducted research on local pre-storm environments, radar parameterization, wind events, and heavy rain climatology.

Our situational awareness has increased notably. For example, most of our CWA is heavily forested, and downed trees have resulted in three deaths in recent years. We realized that in certain situations (e.g., wet soil, full foliage) winds as low as 40 to 45 mph would bring

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down trees, and we began to issue warnings for wind speeds below the official wind speed criterion (50 kts). POD improved as a result. We also realized that tornadoes are rare here, and have avoided overwarning. We currently average fewer than five unverified tornado warnings per year, while experiencing *only one* totally unwarned tornado over the past three years. Flash-flood warnings improved largely due to increased emphasis on pre-existing hydrologic conditions, mesoscale analysis and forecasting, and proper use of the Urban and Small Stream Advisory for non-life-threatening conditions.

Concerning our internal/external evaluation of all warning-related activities - Each significant severe weather event was reviewed for successes and failures in operations, including hardware, software, communication with customers, verification, and meteorology (storm-scale and mesoscale). Internal interviews of staff determined if any operational problems arose. External interviews of a cross-section of customers determined if excellent service was provided. Problems were logged and remedied in short order, if in our control. Otherwise, suggestions for improvement and/or deficiency reports were sent to the appropriate national offices. Many changes to internal operational programs resulted from this process, including NOAA Weather Radio, Warngen, staffing levels, product formats, Valid Time Event Code (VTEC) testing, use of the System for Convective Analysis and Nowcasting (SCAN), and use of the Local Analysis and Prediction System (LAPS). All final severe weather reports remain in the operations area for the staff to review.

Concerning increased verification efforts - The office doubled its commitment to reach out to county officials and spotters. More coordination trips and spotter training sessions were held than in previous years. New and innovative sources of damage reports were sought, such as county Highway Departments. In a region where felled trees are the major threat from severe weather, those who clear the roads provide excellent information concerning where the trees were downed. In addition to our normal spotter lists, calls were made to grocery stores, insurance agents, convenience stores, and local diners - places where customers gather and discuss damage they recently experienced. A key is perseverance - the staff keeps trying until all reasonable options are exhausted. Also, the HAM radio operation has improved. Coverage increased from about 65% of the population in 1998, to about 95% in 2001. An increased emphasis on coordination between the in-office HAM volunteer and the warning team resulted in more timely and accurate information in the hands of the warning forecasters, and this resulted in better warnings.

Concerning increased teamwork among all office personnel - There was a noticeable improvement in operations when the concept of team environment was stressed. Better communications now exist between the HMT staff and the forecasters than in the past, and this created an environment where all felt empowered and valued. An increase in the efficiency of both staffs emerged as they learned to rely on and trust each other more than before. Working together to save lives has helped unlock the potential of a gifted, experienced staff.

4. SUGGESTIONS FOR OTHER OFFICES

We urge other offices to adopt and maintain a rigorous training program in severe weather, focusing especially on any local or regional problems. Each part of the country has its own balance of severe weather threats. While national training centers have done a tremendous job of supplying field offices with training material in severe weather, local or regional issues still exists which demand a higher level of local attention.

We urge other offices to begin a program of internal and external evaluation after each significant severe weather event. It is well worth the extra effort involved. Perhaps nothing has improved internal operations faster than these detailed looks at what did or didn't work well immediately after each significant severe weather episode. The external contacts help keep the customer's perspective foremost in mind.

We urge other offices to increase their verification efforts. One of the suspected major causes of the low CSI scores in 1998 and before was the failure to receive reports of severe weather that actually occurred. It is likely that this office was putting out warnings near the quality of present operations, but was never made aware of damage that occurred in warned areas. A quick review of Table 1 indicates that the POD in 1998 was quite high (85.7), and the most significant problem was a high FAR (62.0). We feel many of the warnings that went unverified, and therefore contributed to the high FAR, were actually good warnings in which damage occurred, but word of that damage never reached the office.

Finally, we urge other offices to stress teamwork in severe weather operations. If certain sections of the staff typically make most of the verification phone calls, make sure they understand how critical those calls are to the overall success of the program. Certain individuals may take the lead in writing up the post-event reports - make sure they are well-rewarded for the extra work. It takes more than just the warning forecasters to make an office warning program function at its highest possible level.

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REFERENCES

National Weather Service, 2002: *National Weather Service Operations Manual*. National Watch/Warning Verification Program. WSOM Issuance 00-06, Part C, **75**, Appendix G.