



Assessing the Threat of Winter Events



**NOAA/National Weather Service
WFO Duluth, Minnesota**

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Danger Degree Project

Weather Forecasting Office Duluth, MN

Motivation

There are situations where the physical science can be perfect, but its utility is greatly reduced where there is not adequate attention to the societal aspects

Goal

An effort to create a historical reference for use in assessing the threat of snowfall cases that may or may not fall into the National Weather Service (NWS) defined criteria for winter weather advisories or warnings





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Project Overview

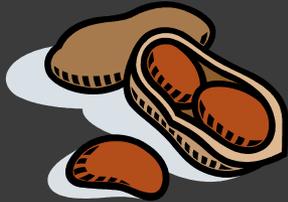
- Developed a “Checklist”
- Weighted Values for Weather & Societal Factors
- Quantitative “Score” or *Danger Degree*
- Theory:

↑ Danger Degree = ↑ Threat



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Process in a Nut Shell



- ◎ “Event” Criteria
 - Snowfall > 2 inches/day
- ◎ Locations
 - Duluth, MN & International Falls, MN
- ◎ 250 Events/Checklists
 - Archived Hourly METAR Data (1997-2009)
 - Snow Amounts from Climate Summaries (LCDs)
- ◎ Data Entry/Analysis
 - Compared Warning/Advisory/None



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Disclaimers

- Caution! Assigning Values to Event
Not Intended to Categorize Storms (like Hurricanes)
- A Tool for Additional Perspective
- Point Specific - May miss “Big Picture”
- Adaptable to other Areas or Hazards
- Multi-Stage Project. *Stay Tuned!*

Other Similar Checklists

WINTER STORM IMPACT ASSESSMENT

Parameter	Low	Moderate	High	Extreme
¹ Storm Total Snowfall (in).....	< 1-3	3-6	6-12	12+
² Snowfall Rate (in/hr).....	< 1	1	> 1-2	2+
³ Ice accumulation (in).....	≤ T	< ¼	¼ - ½	> ½
⁴ Wind (mph, sustained or frequent gusts)	< 15	15-25	25-35	> 35
⁵ Visibility (mi).....	3+	½ - 3	¼ - ½	< ¼
⁶ Air Temperature (°F).....	33+	28-32	20-27	< 20
⁷ Dew Point (°F).....	33+	30-32	25-29	< 25
⁸ Ground/Pavement Temperature (°F).....	33+	28-32	19-27	< 19
⁹ Time of Day.....	Overnight	Evening	Day	
⁹ Day of the Week.....	Weekend	Weekday	Rush Hour	Holiday
⁹ Time of the Year.....	Mid-winter	Early/late season		
Total #				

¹More snow = greater effort for removal

- 1 More snow = greater effort for removal
- 2 Higher snowfall rates = rapid accumulation = increased challenge for keeping roads open
- 3 Ice accumulation = impact on travel, power
- 4 Wind = impact on blowing and drifting; synergy with ice accum
- 5 Visibilities = impact on travel including aviation
- 6 Temperature= impact on melting and wind chill
- 7 Dew Point = influence on melting
- 8 Ground/Pavement Temperature = influence on melting
- 9 Societal impact factors



Other Similar Checklists

- Applicable for entire region?
- Impact factors vary based on locality (CWA TO CWA)?
- Impact of an event vary across an area (within same CWA)?

HIGH-IMPACT GUIDELINES FOR WINTER WEATHER*

Rick Watling
March 3, 2008

Instructions:

Pick one numerical impact value from each of the 4 categories shown below and enter the numbers into the list below that. Add the numbers together to estimate public impact.

CATEGORY

IMPACT VALUES

Timing

Rush hour/school buses running = **3**
Non-rush hour, day and evening = **2**
Overnight (10 PM to 6 AM) = **1**

Seasonality

First/last storm of season or holiday/election day storm = **3**
Mid-season, infrequent storms (< 1 / month) = **2**
Mid-season, frequent storms (1 or more / month) = **1**

Weather Phenomena

Freezing precipitation, black ice = **3**
Widespread visibilities below ¼ mile = **3**
Extreme Cold (2 SD below normal minimum) = **4**
Moderate/heavy intensity sleet, wet snow or mix = **2**
Windy (sustained winds > 30 mph or gusts > 45 mph) = **2**
Light intensity sleet, snow or mix = **1**
None of the above = **1**

Post-storm Conditions (12 or more hours)

Windy *and* temperatures \leq 32F = **3**
Windy *or* temperatures \leq 32F = **2**
Temperatures much > 32F with rapid snowmelt = **2**
Temperatures slowly moderating above freezing = **1**
None of the above = **1**

- 1) TIMING _____
- 2) SEASONALITY _____
- 3) PHENOMENA _____
- 4) POST-STORM CONDITIONS _____

TOTAL SCORE _____

IMPACT BASED ON TOTAL SCORE:

8-12 HIGH
6-7 MODERATE
4-5 LOW





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Specific Location



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A Quantitative Method to Classify Winter Events



Dates of Event _____

Location _____ Initials _____

Category

Condition

Onset Time:	Weekday Peak Traffic: 4-9 am, 2-7pm	3
	Other Onset Time	2
	Sunday: 7 am - 9 pm	1 _____

Seasonality: (Select all that apply)	Holiday Period, High Travel (Refer to Reference Guide)	3
	First Event of the Season	2
	None of the Above	0 _____

Weather Threat; (Select all that apply)	Multiple Phases, or any FZRA/IP, or FZFG/ FZDZ for >=3hrs	4
	Visibilities <= 1/4 mile for >= 3 hrs	4
	Storm Total, >= 10 in snow, or FZRA for >=3hrs	3
	Peak Wind >= 25 kt/29 mph	2
	Temperature < 0 F (-18 C)	2
None of the Above	1 _____	

Pre-storm Conditions; (Select all that apply)	Rain as initial phase	3
	Lull in weather for 2-6 hrs (if >6hrs, treat as separate event)	2
	None of the Above	0 _____

Warning or Advisory _____

Event Notes:



Danger Degree _____ In Database _____





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Onset Time

Category

Condition

Onset Time:

Weekday Peak Traffic: 4-9 am, 2 -7pm

3

Other Onset Time

2

Sunday: 7 am - 9 pm

1

- Maximum Traffic - Rush Hours

Dependent on Location

- Minimum Traffic – Sunday

Reference: Weather Impact on Traffic, 2008 Winter Storm Conference, Todd Shea WFO ARX





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Seasonality

Seasonality: (Select all that apply)	Holiday Period, High Travel (Refer to Reference Guide)	3
	First Event of the Season	2
	None of the Above	0

- High Travel Periods
Further detail on following Slide
- First Event of Season
Caught off guard, Unfamiliar with Winter Driving
- Everything Else

High Travel Periods

Locally Defined

Northeast Minnesota:

➤ MEA Weekend

Start Tribune,. Bob Von Sternberg
 “At Minneapolis-St. Paul
 International Airport, this long
 weekend [MEA] is as busy, or
 busier, than Thanksgiving”

➤ Hunting and Fishing Openers

➤ HS State Tournaments

MN State High School League
 130,000 Attendees
 Less for other Sports

The Holiday or High Travel days recognized for this project as are follows:

(Holiday/High Travel Period includes one day either side of a Holiday/High Travel Day)

- Minnesota Educators Association (MEA) Weekend.....3rd Weekend in October (Wed -Mon)
- Deer Hunting Opener
 - Minnesota.....2nd Sat (Fri-Sun) in November
 - Wisconsin.....3rd Sat (Fri-Sun) in November
- Thanksgiving.....4th Thurs (Wed-Fri) in November
- Christmas.....24-26th December
- New Years Day.....31st December - 2nd January
- Fishing Opener (Friday – Sunday)
 - Minnesota.....2nd weekend (Fri-Sun) in May: *Mother's Day*
 - Wisconsin.....1st Sat (Fri-Sun) in May
- National Election Day.....1st Tuesday in November/every 4 yrs
 - 2008 November 4th, 2004 November 2nd, 2000 November 7th, 1996 November 5th
- MN State High School Sports Tournaments

Boys Hockey		Boys Basketball	
2009	March 10-15	2009	March 24-29
2008	March 4-9	2008	March 26-30
2007	March 6-11	2007	March 20-25
2006	March 7-12	2006	March 21-26
2005	March 1-6	2005	March 15-20
2004	March 9-14	2004	March 23-28
2003	March 4-9	2003	March 18-23
2002	March 5-10	2002	March 20-24
2001	March 6-11	2001	March 21-25
2000	March 7-12	2000	March 22-26
1999	March 2-7	1999	March 17-21
1998	March 3-8	1998	March 18-22
1997	March 4-9	1997	March 19-23
1996	March 5-10	1996	March 19-24





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Weather Factors

Weather Threat; (Select all that apply)	Multiple Phases, or <i>any</i> FZRA/IP, or FZFG/ FZDZ for ≥ 3 hrs	4
	Visibilities $\leq 1/4$ mile for ≥ 3 hrs	4
	Storm Total, ≥ 10 in snow, or FZRA for ≥ 3 hrs	3
	Peak Wind ≥ 25 kt/29 mph	2
	Temperature < 0 F (-18 C)	2
	None of the Above	1

- Mixed Precipitation
- Visibility – Hazardous Travel/Aviation/Could imply +SN
- Storm Total - greater effort for removal/ challenge for keeping roads open
 - $>10''$ Implies heavy snow, high snowfall rates
 - Tree Branches & Phone Lines
- Freezing Rain sustained for 3 consecutive hours – ice accumulation
- Peak Wind – implies blowing and drifting
- Temperature – black ice/wind chill
- None - had to have 2'' of snow to qualify



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Pre-storm Conditions: (Select all that apply)	Rain as initial phase	3
	Lull in weather for 2-6 hrs (if >6hrs, treat as separate event)	2
	None of the Above	0

- Rain Implies
 - *Warm Initially*
 - *Ice Beneath Snow*
 - *Wet “heavy” Snow*
- Lull Between Snowfall Periods Creates Confusion

Example

(Data from archived hourly METAR observations)

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A Quantitative Method to Classify Winter Events

Dates of Event 2006 October 11-13th
 Location DLH Initials _____

Category **Condition**

Onset Time:	Weekday Peak Traffic: 4-9 am, 2-7pm	3	<u>2</u>
	Other Onset Time	2	
	Sunday: 7 am - 9 pm	1	
Seasonality: (Select all that apply)	Holiday Period, High Travel (Refer to Reference Guide)	2	<u>2</u>
	First Event of the Season	2	
	None of the Above	0	
Weather Threat: (Select all that apply)	Multiple Phases, or any FZRA/IP, or FZFG/ FZDZ for >=3hrs	4	<u>6</u>
	Visibilities <= 1/4 mile for >= 3 hrs	4	
	Storm Total, >= 10 in snow, or FZRA for >=3hrs	2	
	Peak Wind >= 25 kt/29 mph	2	
	Temperature < 0 F (-18 C)	2	
None of the Above	1		
Pre-storm Conditions: (Select all that apply)	Rain as initial phase	3	<u>3</u>
	Lull in weather for 2-6 hrs (if >6hrs, treat as separate event)	2	
	None of the Above	0	

RA Began 8 pm 10th (Tues)
 Changed to SN at 400 am

First Event (>2) of Season

Yes: Mixed Phases

No: Snow Total 3.5"
 (2.3" in 24 hr period)

Yes: Gusts 30-35 kt for 24 hrs

Yes; Began 36 F & Rain

Warning or Advisory _____

Event Notes:

! Danger Degree 13 In Database _____





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Duluth, MN

146 Events

- 2009: 4
- 2008: 10
- 2007: 8
- 2006: 18
- 2005: 18
- 2004: 8
- 2003: 6
- 2002: 10
- 2001: 11
- 2000: 9
- 1999: 10
- 1998: 16
- 1997: 11

International Falls, MN

105 Events

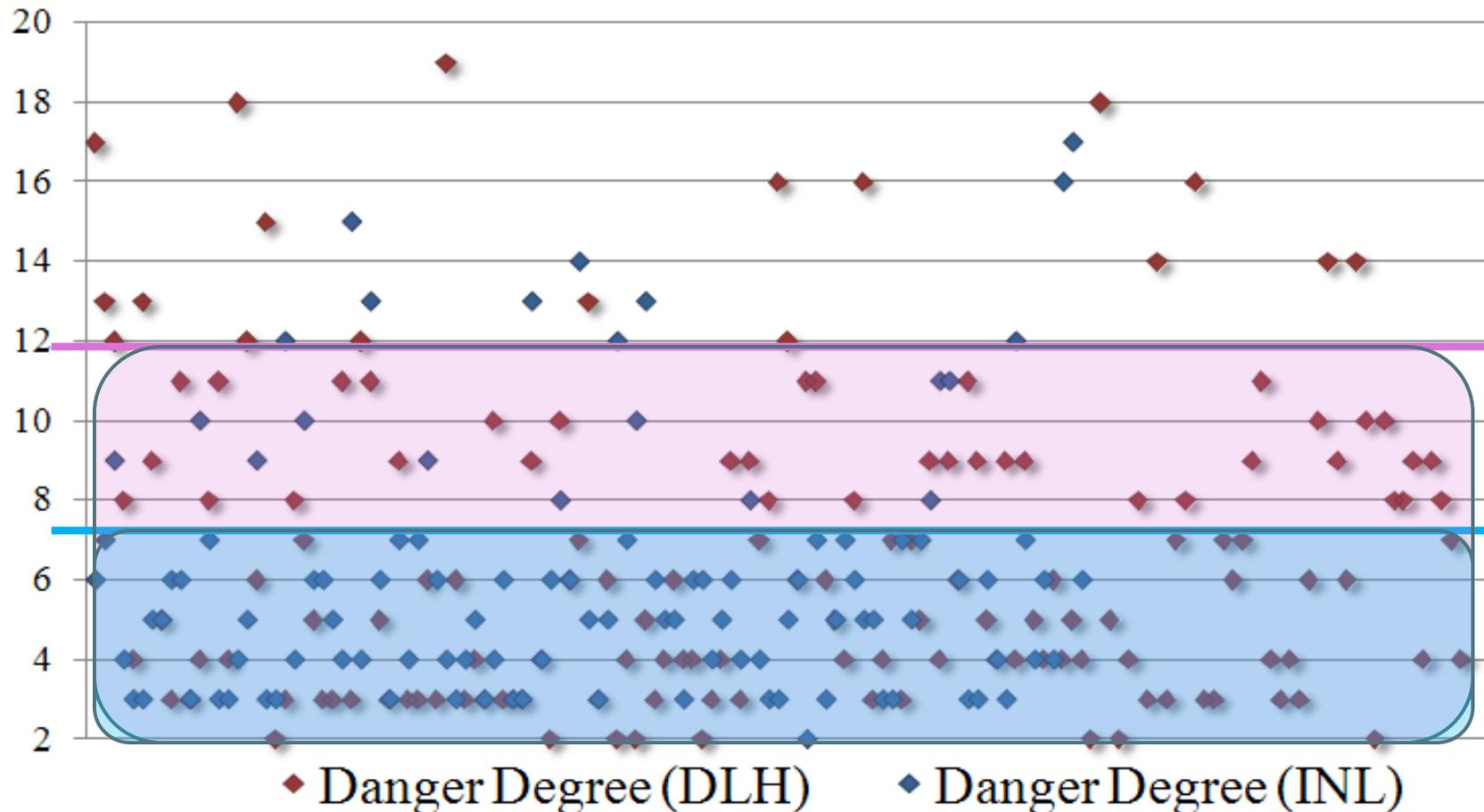
- 2009: 12
- 2008: 10
- 2007: 8
- 2006: 18
- 2005: 18
- 2004: 8
- 2003: 16
- 2002: 3
- 2001: 11
- 2000: 9
- 1999: 10
- 1998: 9
- 1997: 12



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10% of Events Showed Danger Degree Above 12

60% of Events Showed Danger Degree Less than 8



91%

60%

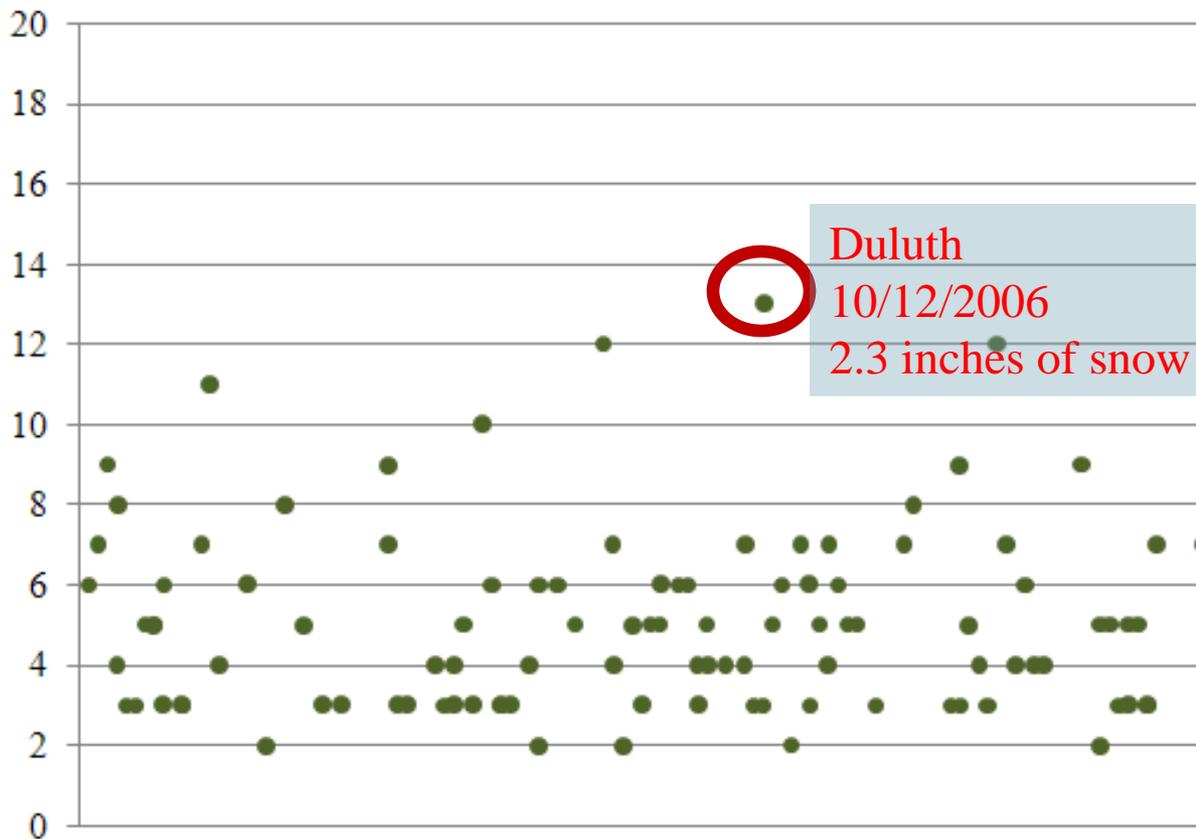




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No Advisory or Warning

47% of All Events

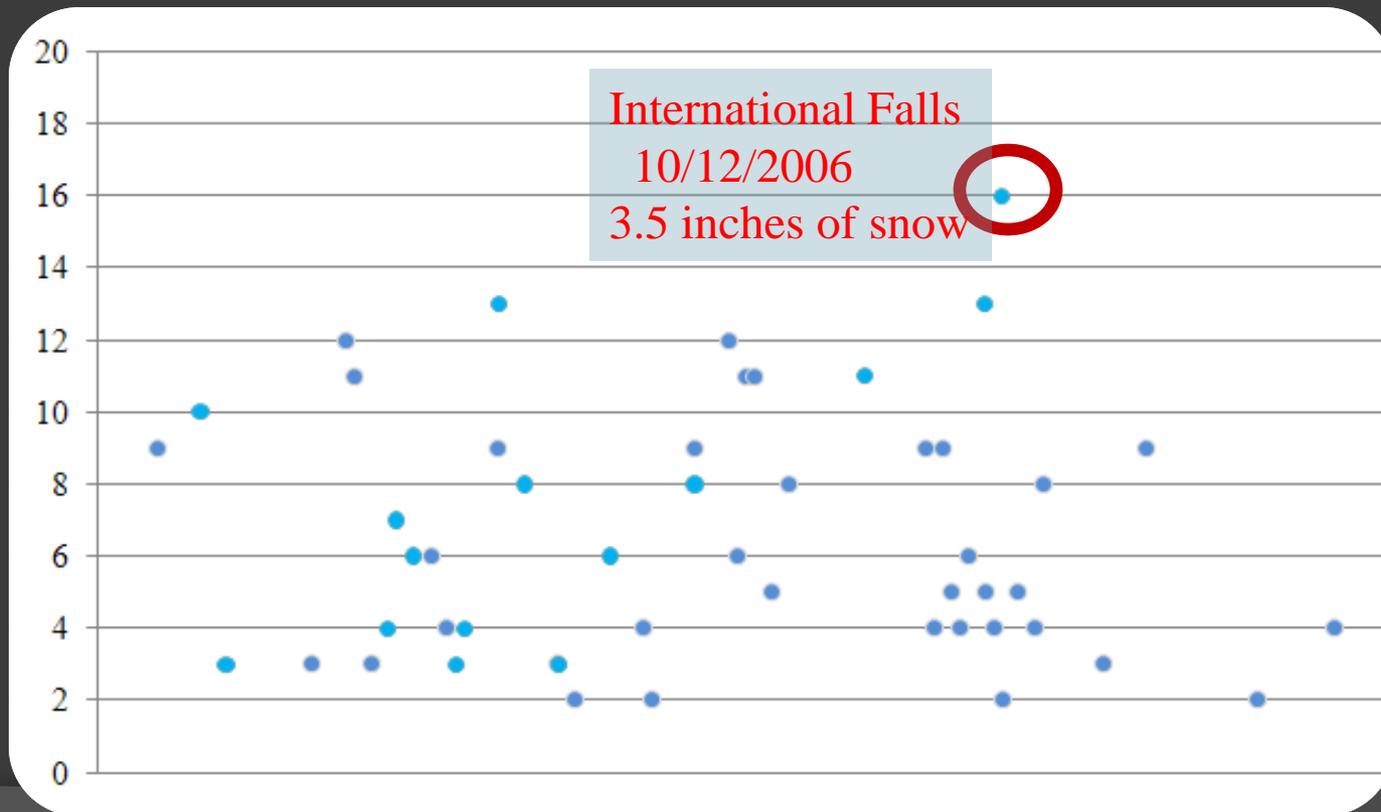




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Winter Advisory Events

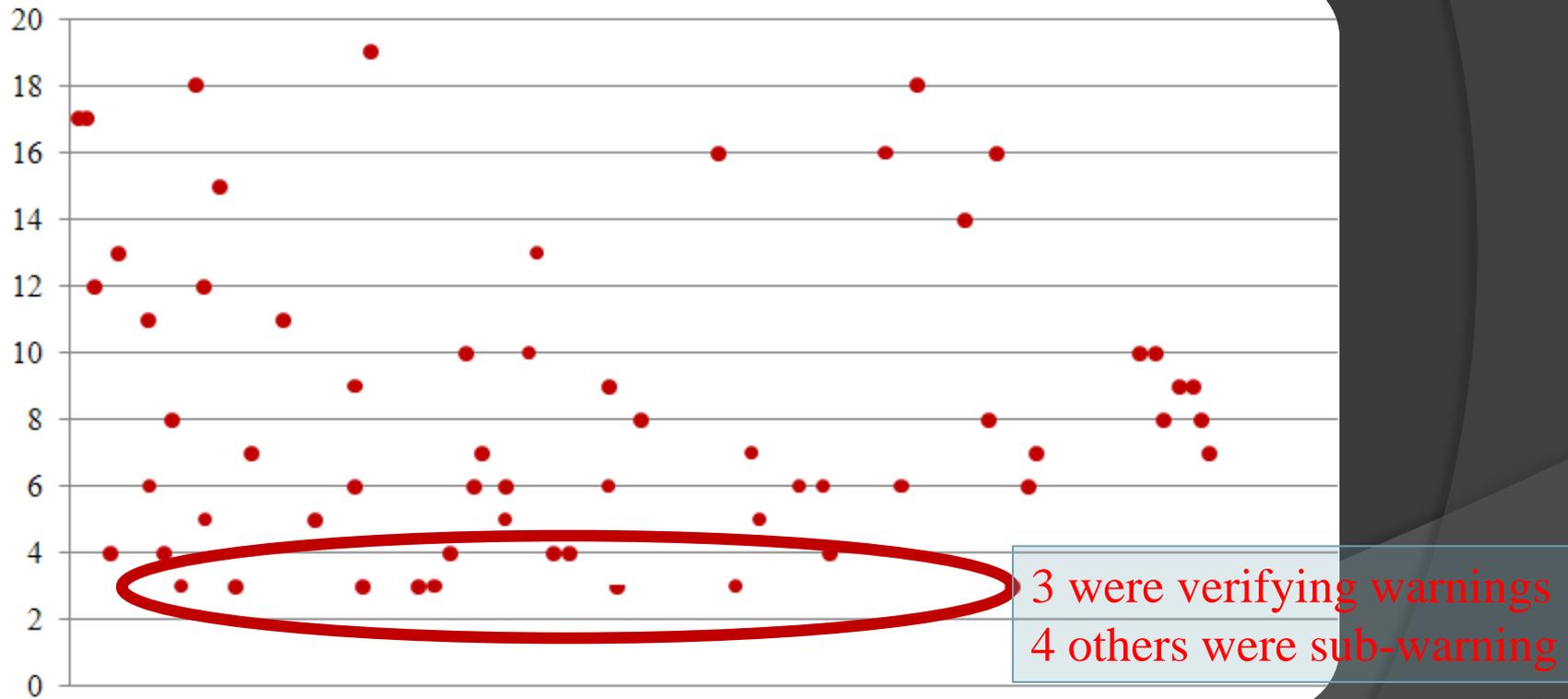
23% of All Events





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Winter Warning Events *32% of All Events*



Not all Warnings are Created Equal





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Preliminary Findings

Several Warnings with DD Values $DD < 4$

- Low Threat or *Potential* Impact

Few Non-Advisory/Warning Events with DD Values > 12

- High Threat or *Potential* Impact

Correct Assumption?



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=

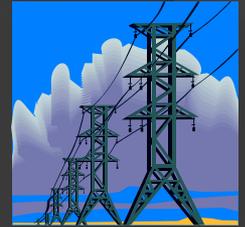


Impact



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What was the Impact?



WAS*IS	WORKSHOPS				
weather & society * integrated studies		Changing from what <i>WAS</i> to what <i>IS</i> the future of integrated weather studies			





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Current Impact Information

- Local News
- Paper Clipping Service
- Personal Experiences

**Need Better System to Gather
Impact Information**

WAS*IS

WORKSHOPS

weather & society * integrated studies



Changing from what **WAS** to what **IS** the future of integrated weather studies





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What's Next?

Part Two: Stakeholder Impact Reporting

- AAA.....Traffic/Accident Statistics
- Red Cross.....Shelters/Disasters
- State Dept. of Transportations...Road Conditions/Clearing/Closures
- MN Power/Lakes Power.....Power Outages
- Duluth Transit Authority.....Public Transit
- Duluth International Airport.....Flight Cancellations
- School Superintendents.....School Closures/Attendance
- Hospital Administrators.....Winter Weather Related Injuries
- City Officials.....Public Works/Social Services/Business Closures
- County Emergency Manager.....Vulnerable Populations, Disasters
- Dept. of Natural Resources.....Wildlife





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Thank You



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