Lower Michigan Storm Surveys/INVEST Training

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F to EF Comparison

FUJITA SCALE			DERIVED EF SCALE		**OPERATIONAL EF SCALE**	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	**EF Number**	**3 Second Gust (mph)**
0	40-72	45-78	0	65-85	**0**	**65-85**
1	73-112	79-117	1	86-109	**1**	**86-110**
2	113-157	118-161	2	110-137	**2**	**111-135**
3	158-207	162-209	3	138-167	**3**	**136-165**
4	208-260	210-261	4	168-199	**4**	**166-200**
5	261-318	262-317	5	200-234	**5**	**Over 200**

Wind speeds in the operational scale were rounded to avoid implying more accuracy than is justified. These winds are at the standard height of 10 meters.

Ranking Damage From Surveys

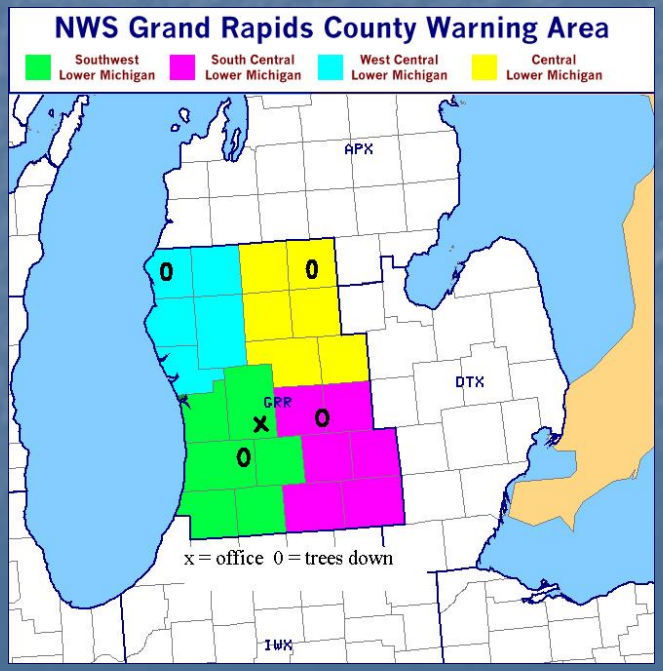
- DI = Damage Indicator
- DOD = Degree of Damage

Damage Indicators: 28 of them in the EF scale consisting of buildings, structures, trees

Degree of Damage: Sequenced so that each one has a higher expected wind speed than the previous one, ranging from the initiation of visible damage to that DI, to its complete destruction.

GRR Storm Surveys

- Vast Majority of Surveys are for EF0/EF1 damage
- Only two F2 tornadoes since 2000
- Majority of Marginal Severe Events (55-60 mph winds) are not surveyed



Collapse of walls of barn: DOD 6 = 97 mph expected

DOD 1 for Family Residence: Expected 65 mph

Maple Valley High School: 8/25/04. From the EF Scale this is a DOD 5 with expected wind of 101 mph, lower bound would be 85 mph.

But notice that no other visible damage was done besides the roof failure

Even this scoreboard remained standing despite being directly in the path of the high winds

Narrow vortex or effect of flow around the building?

8/21/03, F2 rating based on structural damage

DOD 5 expected 143 mph wind = EF3

DOD	description	EXP	LB	UB
1	Small limbs broken (up to 1” diameter)	60	48	72
2	Large branches broken (1”-3” diameter)	74	61	88
3	Trees uprooted	94	76	118
4	Trunks snapped	107	93	134
5	Trees debarked, only stubs of largest branches	143	123	167

DOD=degree of damage, EXP=expected, LB=lower bound, UB=upper bound

Widespread Blowdowns = DOD 3?

At what wind speed does this begin to happen?

What about when tree damage seems greater than structural damage?

What about when structural damage seems much greater than tree damage?

At what wind speed does this begin to happen?

Crop Damage: corn flattened. What role does rain/hail play?

Debris carried long distances by tornado

Vehicle rolled or hit by debris? What wind speeds will flip or carry cars?

Weak structures: should look for other indications (DOD references) to apply wind speeds to this type of damage. If none found use lower bound values for similar DOD indicators.

INVEST Training

- INcreased VErification of Severe Thunderstorms
- Spotters are trained to differentiate severe/non severe wind damage and EF0/EF1 wind damage
- Also includes training on differentiating downburst from tornado damage
- INVEST spotter database currently being built, about two dozen spotters covering about 2/3 of our area

Some of the Problems Estimating Wind Speeds from Tree Damage

The Reference Dilemma

1. No standardized, detailed reference relating tree damage to wind speed.

2. Difficult to estimate the effect of so many variables.

3. It takes time to do a thorough survey (you may not be able to cover a large area in one day).

Important Variables for Trees:

"Structural Integrity" : Insects, disease, lightning, fire, and type of tree. Root system: shallow or deep?

Exposure: Exposed or protected from the direction of the wind?

Ground: For uprooting: Soil Type. Wet or dry?

Tree Species: Deciduous/Non-deciduous. If deciduous, leafed out? Height/age, crown size. Root system. How brittle?

Rules of Thumb

- To estimate wind speeds from tree damage, only consider healthy trees with the diameter of the downed trunk or limb being 6 inches or greater
- Non-severe winds (less than 58 mph) will generally not take down many healthy trees or tree limbs of this size
- Wind speeds of EF1 (86 to 110 mph) or greater will often take down groups of healthy, large trees

The “Swath Concept”

To differentiate between EF0 and EF1 wind speeds

- A stand of at least 10 healthy trees, greater than 6 inches in diameter
- More than half of them downed
- Implies EF1 damage
- Lesser damage assigned EF0

What about stronger damage?

100% blowdown = EF2?

Standardize: We should try to match up measured wind speeds and estimates from structural damage and apply those values to observed tree damage.

Part II: What was it?

Differentiating downburst from gustnado

- Match up damage in space and time with radar data (gather eyewitness data on storm time)
- Make detailed plot of tree and debris fall
- Ask eyewitnesses: did rain/hail precede or accompany the storm? Most downbursts will occur at the time of heavy rain/hail.

Tornado Damage:

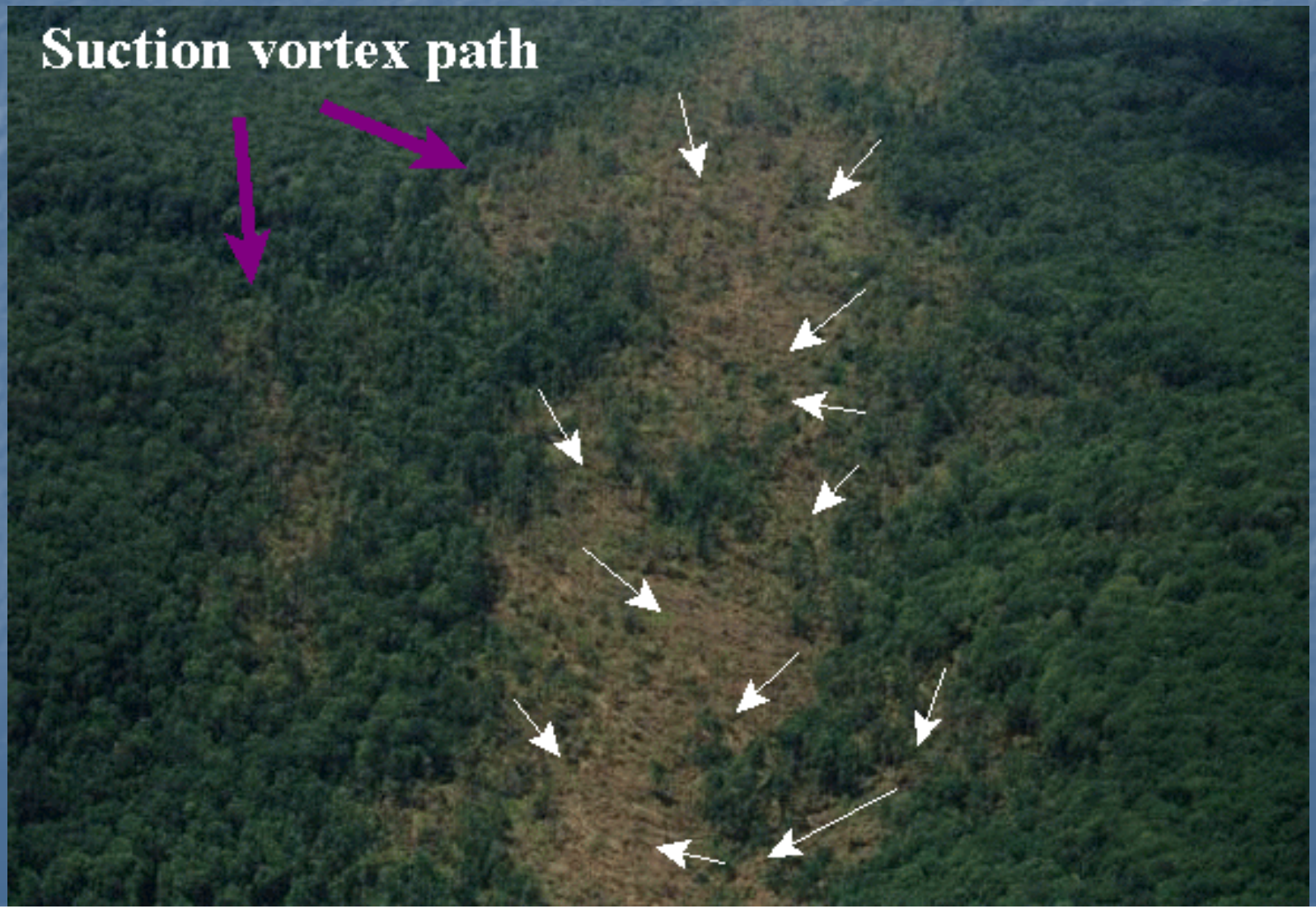
Damage is convergent: trees fall generally pointing inward towards the center of the damage path.

Microburst/Downburst (aka “straight-line winds”):

Damage is divergent: trees fall generally pointing away from the center of the damage path.

This is an example of a convergent tree fall pattern as seen from the ground. A tornado moved from left to right across the field of view. The two trees in the foreground fell first as the leading edge of the tornado's winds hit them and the trees in the background were then downed by the back side of the tornado. Look for signs of this crossing or "herringbone" pattern in the downed trees to indicate tornado wind damage.

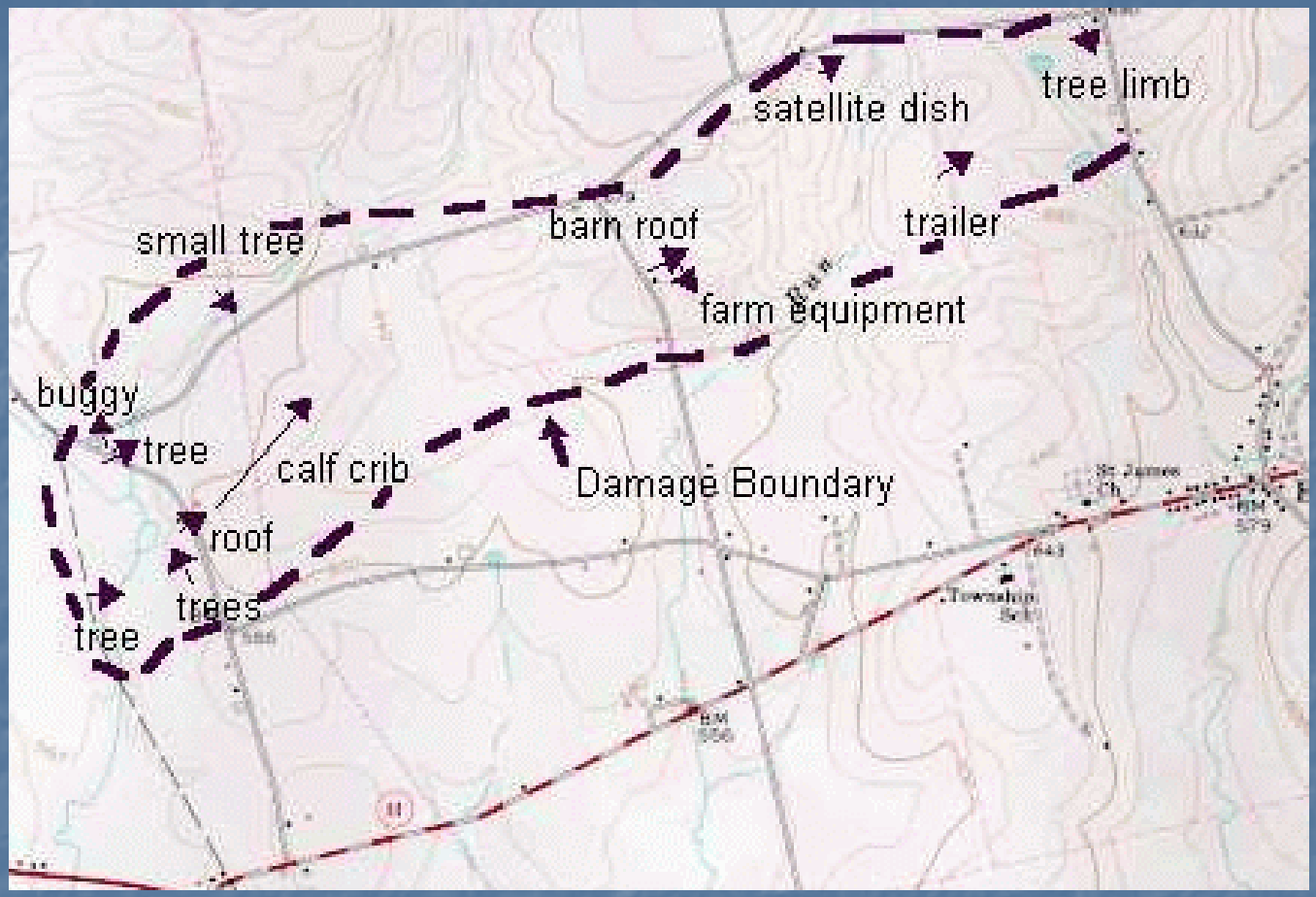
Some tornadoes have more than one funnel, rotating about a common center. These funnels are called suction vortexes and create a more chaotic, but still convergent, pattern of fallen trees. This tornado moved from top to bottom of the field of view.



The fan-shaped, divergent tree fall pattern that is typical of a microburst, as seen from the air:

Complicating factor: tornado damage may be close to or within downburst damage.

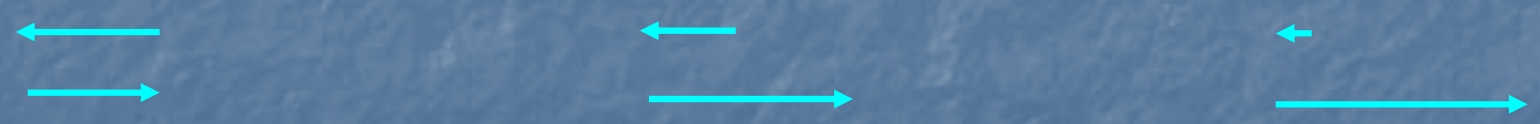
Draw a detailed map of “damage vectors”. Include every downed tree, blown debris.



Be careful of “outliers”: trees may have been moved after the storm or forced to fall in a different direction.

Tornadoes can knock trees down in one prevailing direction. The faster a vortex is moving, the more the debris pattern will appear to be unidirectional. This is because the force of the wind in the direction of the storm movement becomes greater than the force of the wind in other directions.

For example, a tornado with 100 mph winds moving to the east at 50 mph will produce 150 mph winds on its south side and only 50 mph winds on its north side. A simple schematic illustrates what happens to the magnitude of the wind as a vortex begins moving towards the right:



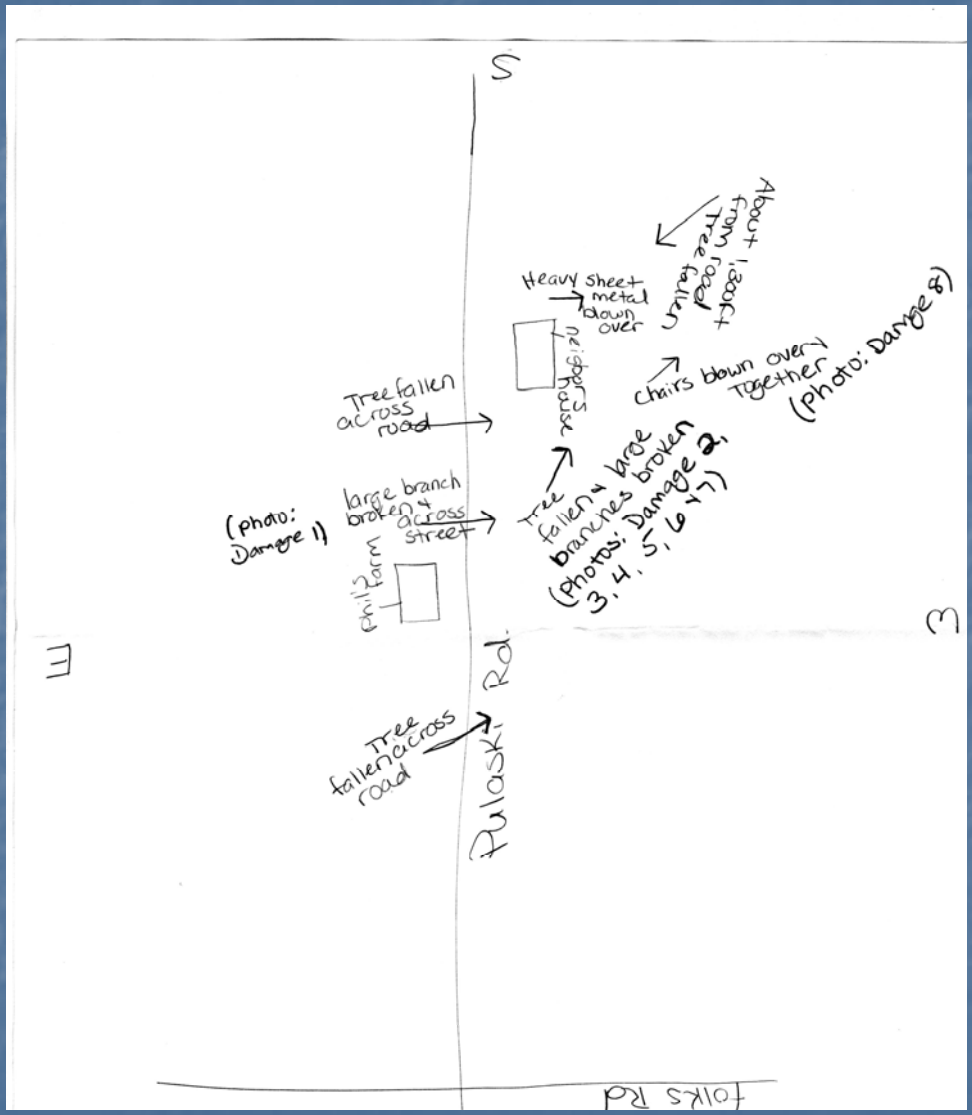
Stationary Slow Fast

Finally, a subjective observation: Tornadoes seem more likely to do odd things such as impaling debris into walls or the ground, carrying debris for long distances and suspending debris aloft on power lines and trees.

Reporting Procedures

- Digital photos of damage or survey maps can be emailed to the office. Contact the office at 1-800-647-3836 or use e-spotter to ask for email address to send photos to
- The most useful photo of tree damage is a close-up of the break point, but also include a wide-field photo to show perspective

Spotters send in photos and maps of wind damage, helping our verification effort



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