

Disturbance Before Agency: Establishing Ecological Baselines for Interpreting Forest Structural Anomalies

Daniel H. Kegley

holstonia-investigations.org

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Abstract

Reports of unusual tree formations are sometimes interpreted as evidence of unknown biological agency. Yet forests are dynamic systems shaped by recurring disturbance processes, including wind, ice loading, and storm-driven mechanical failure. This paper argues that claims of anomalous tree manipulation cannot be evaluated responsibly until natural disturbance regimes are understood and modeled. Drawing on forestry research and mechanistic studies of wind damage, the analysis demonstrates that tree breakage, uprooting, and clustered structural damage often emerge predictably from physical forces

acting on heterogeneous forest stands. A baseline-first framework is proposed in which ecological processes are treated as default generators of structural irregularity. Only after such baselines are established can deviations be meaningfully assessed. The paper advances anomaly detection as a comparative exercise grounded in disturbance ecology rather than interpretive speculation.

1. Introduction

Forests are not static landscapes but mechanically active systems continually reshaped by environmental forces. Among these forces, wind disturbance is recognized as a fundamental natural process contributing to tree mortality across many ecosystems (USDA Climate Hubs, n.d.). Ice storms similarly alter forest structure through crown loss, stem breakage, and damage that increases susceptibility to insects and disease (USDA Climate Hubs, n.d.).

When disturbance is expected, irregular structure is not inherently anomalous.

Yet interpretations of unusual tree configurations sometimes proceed without reference to disturbance ecology, implicitly treating structural deviation as evidence requiring explanation. This paper proposes an alternative posture: **disturbance must be treated as the default hypothesis.**

Only against a modeled ecological baseline can claims of unknown agency be evaluated.

2. Windthrow and Mechanical Failure as Normal Forest Processes

Windthrow — the uprooting or breakage of trees when wind forces exceed structural resistance — plays a critical role in forest dynamics and biodiversity (Xi, Peet, & Decoster, 2019). Extreme wind events can reshape forest composition and succession trajectories.

Mechanistic modeling demonstrates that tree failure occurs when bending moments and compressive stresses exceed structural thresholds within the stem or root system (Gardiner et al., 2004). Wind speed remains the most significant variable explaining damage patterns, although tree characteristics and stand structure strongly influence outcomes.

Irregular stands, for example, often experience scattered damage across a range of wind speeds rather than uniform collapse (Gardiner et al., 2004). Such heterogeneity can easily produce configurations that appear deliberate despite arising from stochastic physical processes.

Storm-driven mortality is not geographically limited. Convective storms represent a major disturbance driver even in tropical forests, with projected increases in windthrow density under future climate scenarios (Aleixo et al., 2022).

Disturbance, therefore, is neither rare nor exceptional.

It is structural to forest ecology.

3. Ice Storms and Differential Damage

Ice accumulation imposes substantial mechanical loads on branches and stems, frequently resulting in snapped boles and widespread crown loss. In one severe event, over 90% of overstory trees were damaged, with snapped stems responsible for the greatest mortality (Klos et al., 2020).

Importantly, vulnerability varies across species. Evergreen broadleaf trees, for example, may be more susceptible than other lifeforms during heavy icing events (Klos et al., 2020).

Species-selective damage can create patterns that appear intentional unless ecological susceptibility is considered.

Baseline knowledge prevents misattribution.

4. Structural Predictors of Tree Failure

Tree damage is shaped by interacting biological and physical factors. Heavy winds combined with site conditions and stand characteristics can produce top breakage, bole snaps, or uprooting across areas ranging from single trees to extensive forest patches (U.S. Forest Service, n.d.).

Recent research further shows that natural root grafting — physical connections between neighboring trees — can reduce uprooting while increasing the likelihood of stem breakage (Tarrow & DesRochers, 2025). Tree proximity itself becomes predictive of failure mode.

At the stand level, prior stem or root damage and high slenderness ratios significantly influence snapping height and fracture probability (Kitenberga et al., 2021).

Such findings reinforce a critical point:

Forest damage is governed by identifiable mechanics rather than arbitrary occurrence.

5. Environmental Encoding of Disturbance

Windthrow events can leave lasting geomorphic signatures. Uprooted trees often create pit-and-mound topography, altering forest floor roughness and influencing long-term ecological processes (Doane et al., 2023).

These landscape-scale patterns demonstrate that disturbance is not merely episodic but structurally encoded into forest environments.

What appears unusual at small spatial scales may reflect broader disturbance regimes.

6. The Baseline-First Framework

Given the predictability of disturbance processes, anomaly detection must proceed comparatively rather than impressionistically.

A baseline-first approach asks:

- Does the structure align with known disturbance mechanics?
- Are species vulnerabilities consistent with observed damage?
- Do surrounding trees show correlated effects?
- Are site conditions compatible with wind exposure or ice loading?

If the answer to these questions is affirmative, the parsimonious explanation remains ecological.

Science advances by exhausting ordinary mechanisms before invoking extraordinary ones.

7. Indicators of Mechanical Coherence

Forestry research suggests several signatures typical of natural disturbance:

Distributed damage: Storm events commonly affect individual trees through large patches rather than isolated specimens (U.S. Forest Service, n.d.).

Force-consistent failure: Breakage reflects structural thresholds governed by bending stress and anchorage limits (Gardiner et al., 2004).

Species-linked vulnerability: Differential responses to ice and wind shape damage patterns (Klos et al., 2020).

Stand-structure effects: Tree height, crown characteristics, and spatial arrangement influence susceptibility (Gardiner et al., 2004).

Together, these characteristics establish expectations against which structural claims can be evaluated.

8. When Scientific Curiosity May Be Warranted

A baseline framework does not deny the possibility of unusual phenomena. Instead, it clarifies the conditions under which further investigation becomes scientifically justified.

Potential signals include:

- mechanically inconsistent break angles
- repeated geometric configurations exceeding chance expectation
- selective damage lacking environmental correlates
- structural modifications implying force beyond plausible loading thresholds

Even here, restraint remains essential. Apparent improbability often dissolves under expanded ecological context.

Anomalies must be statistically demonstrated, not visually inferred.

9. Disturbance as a Generator of False Signals

High-energy systems routinely produce configurations that invite anthropomorphic interpretation. Forests, governed by gravity, wind, decay, and competition, are prolific creators of structural irregularity.

Failure to model this background noise risks conflating natural processes with intentional construction.

Other observational sciences confront analogous challenges:

- astronomy models atmospheric distortion
- seismology models background tremor
- wildlife biology models imperfect detection

Forestry models disturbance.

The lesson is consistent across disciplines:

Anomaly is unintelligible without baseline.

10. Implications for Anomalous Biological Research

Importing disturbance ecology into anomalous-report analysis accomplishes several methodological goals:

- establishes parsimonious default explanations
- reduces interpretive inflation
- protects inference from confirmation bias
- aligns analysis with mature ecological science

Most importantly, it relocates the burden of proof.

Structures are not anomalous because they appear unusual.

They are anomalous only when they resist ecological explanation.

11. Conclusion

Forests are mechanically expressive systems shaped by recurring disturbance regimes. Wind, ice, and structural vulnerability generate patterns that can appear purposeful despite arising from known physical processes.

Recognizing this reality marks an epistemic transition:

from interpreting structure
to modeling its origins.

Before agency can be inferred, disturbance must be understood.

Scientific progress does not begin with the search for mystery, but with disciplined attention to the forces that routinely produce the unexpected.

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