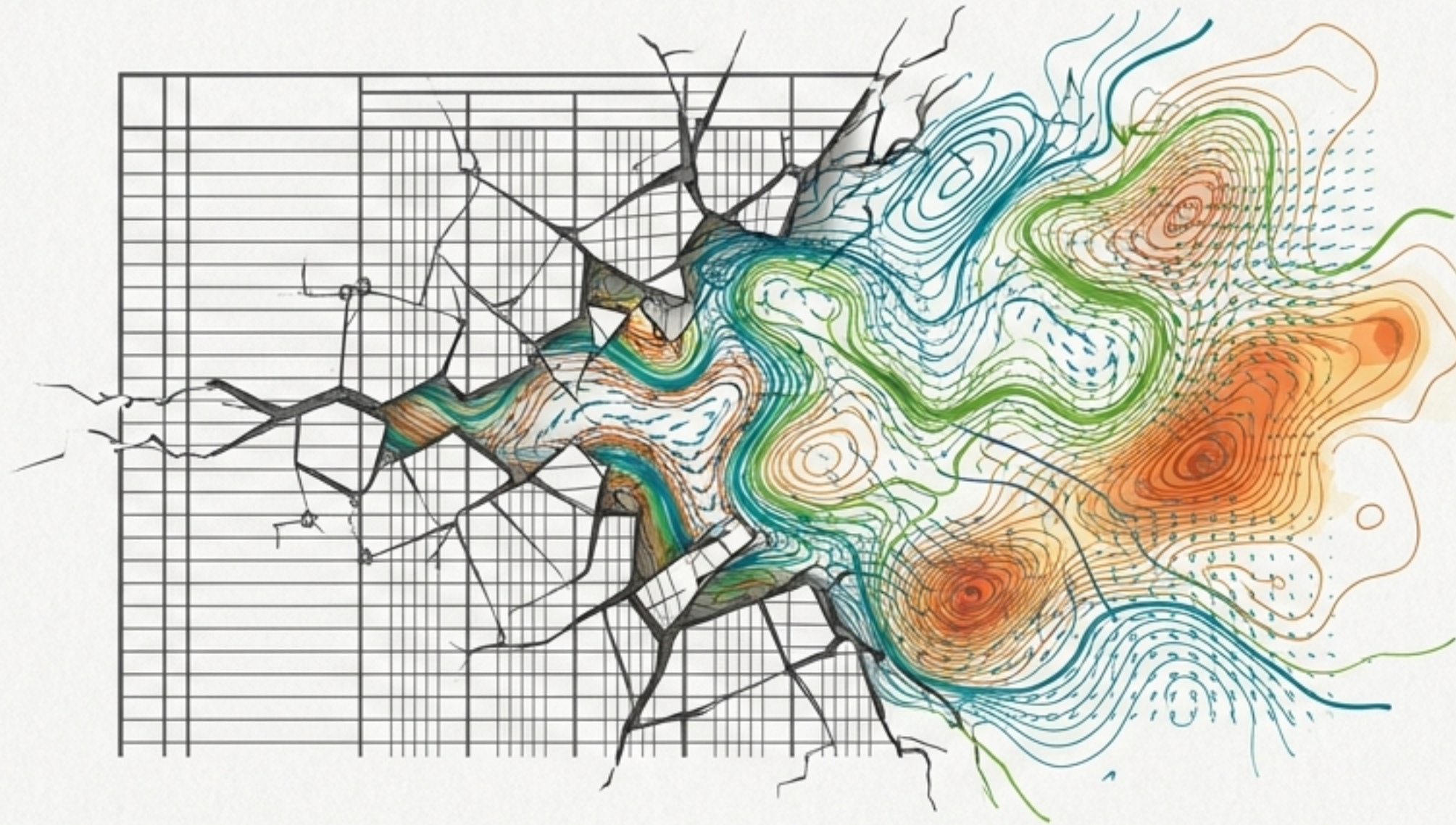


Proxy Permanence Failure

Carbon Governance, Biodiversity, and the Collapse of Admissibility

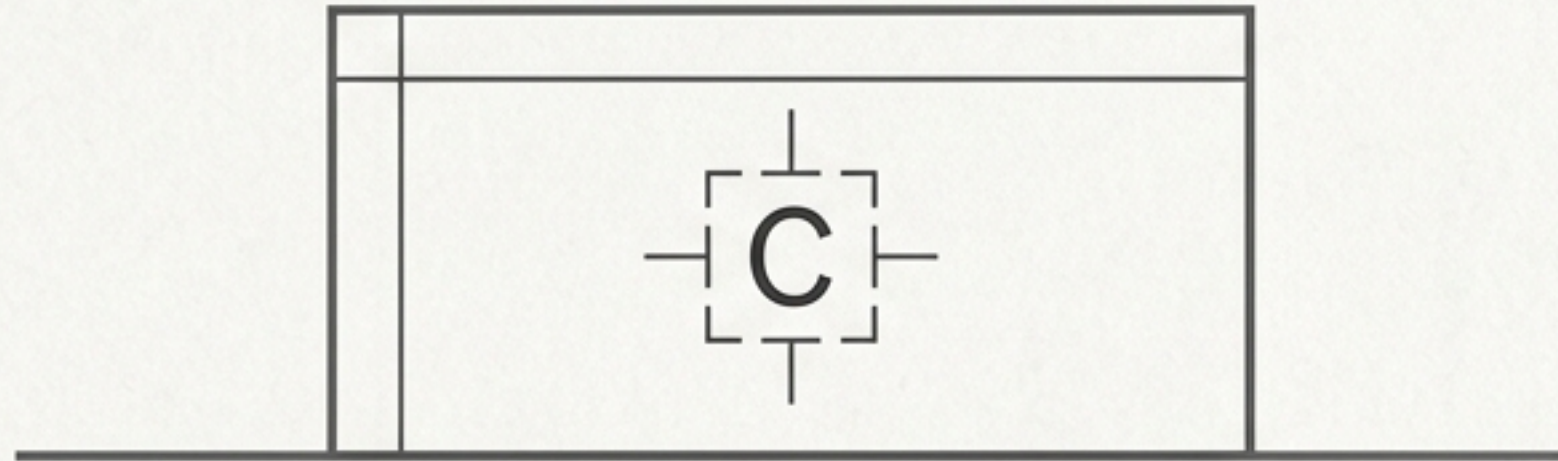


A Theoretical Analysis via the RSVP-TARTAN-CLIO Framework

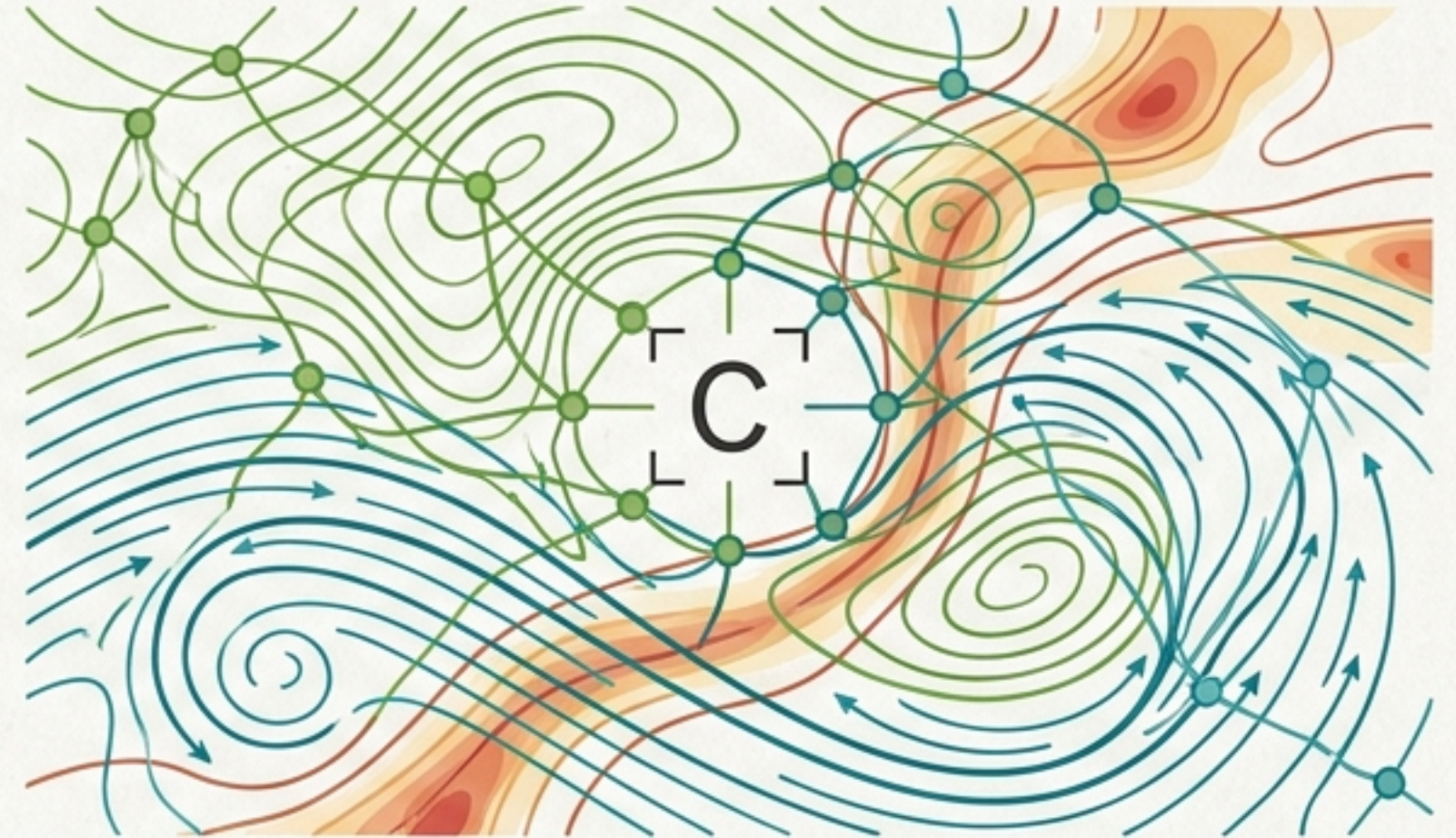
The Illusion of a Fungible Stock

The claim that forests and coastal vegetation constitute stable, tradeable carbon sinks rests on a deceptively simple ontological premise: that carbon is a durable, fungible stock.

The Ledger (Object Ontology)

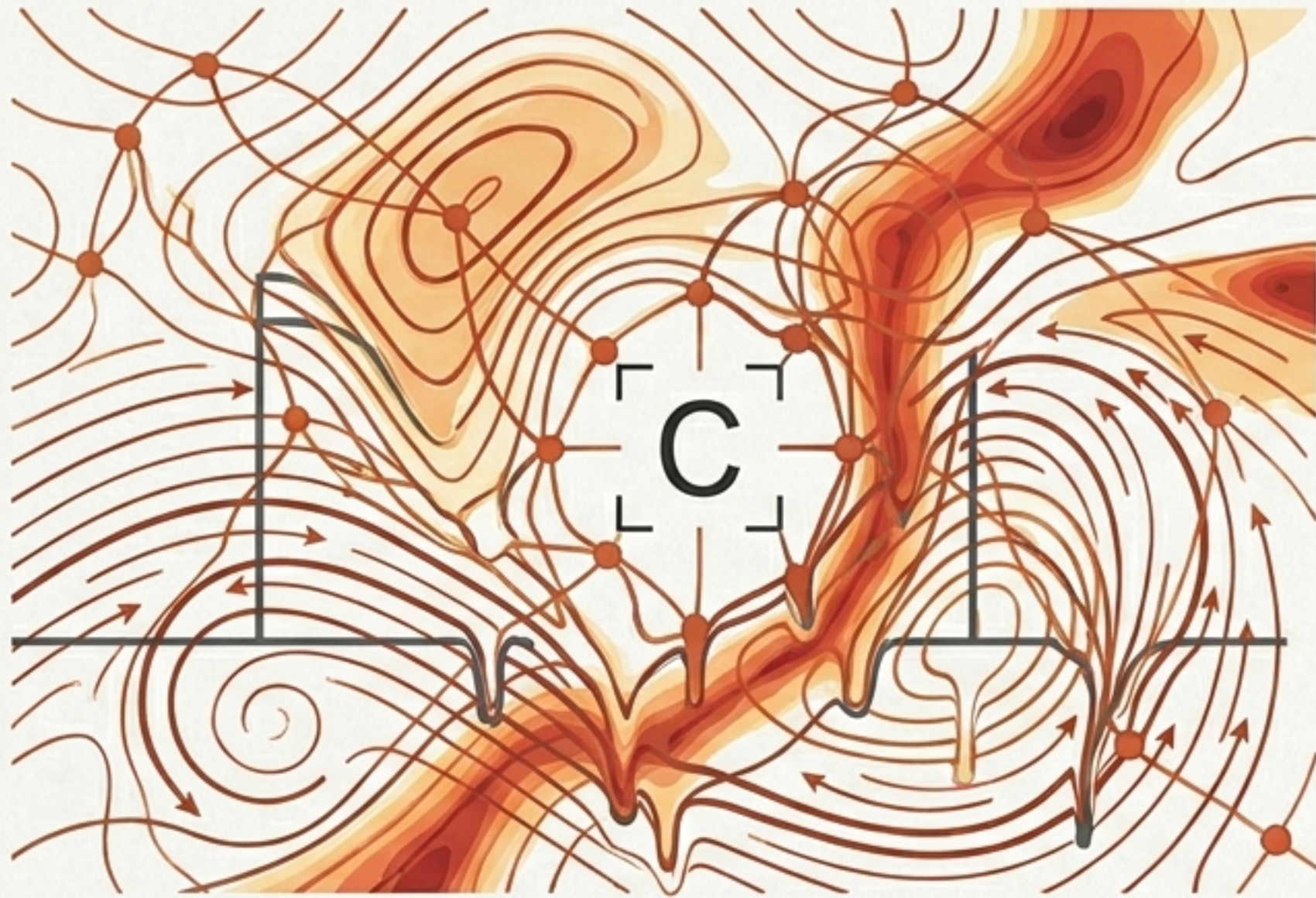


The Reality (Field Ontology)



Current ledger systems rely on binary actuarial logic. But three recent empirical studies expose that when the underlying ecological field departs from its calibrated geometry, this low-dimensional accounting projection violently fails.

Fracture 1: Actuarial Collapse in Forests



6.3x

The factor by which the CARB forest carbon offset buffer pool is currently undersized due to stationary ecological assumptions (Wu et al., 2026).

41%

The percentage of active offset projects facing reversal probabilities exceeding 50% under a moderate emissions scenario.

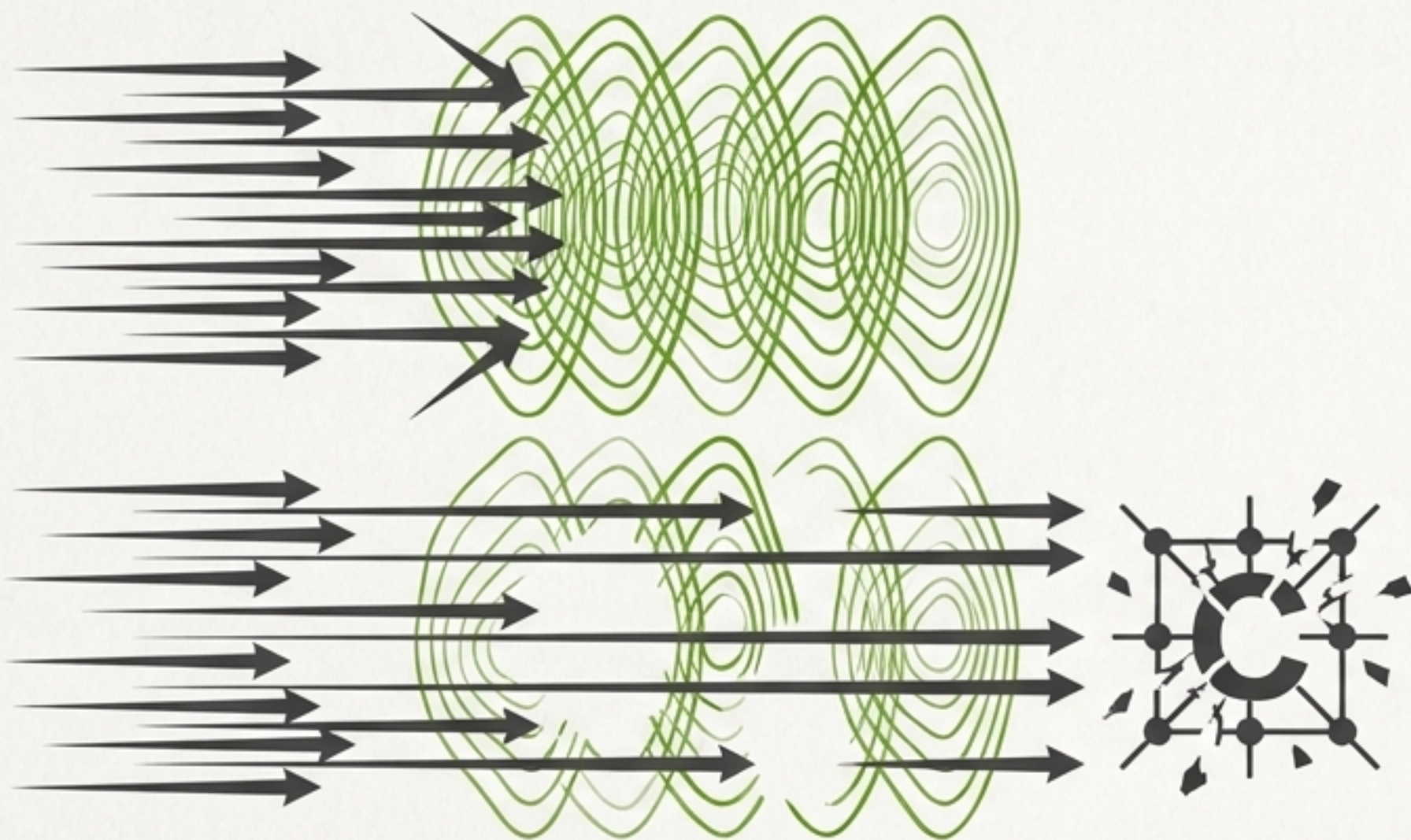
Equation Fragment: Disturbance Reversal Loss

$$+ C_0 p_b R [1 - \prod (1 - p_D(t))] \sigma$$

Concept: Climate change roughly triples wildfire-driven reversal probabilities. The accounting buffer assumes stationary ecological conditions, but disturbance-risk probabilities are rapidly accelerating.

Fracture 2: The Hidden Carbon Penalty of Biodiversity Loss

The Constraint Network



7.4 – 146.0 PgC

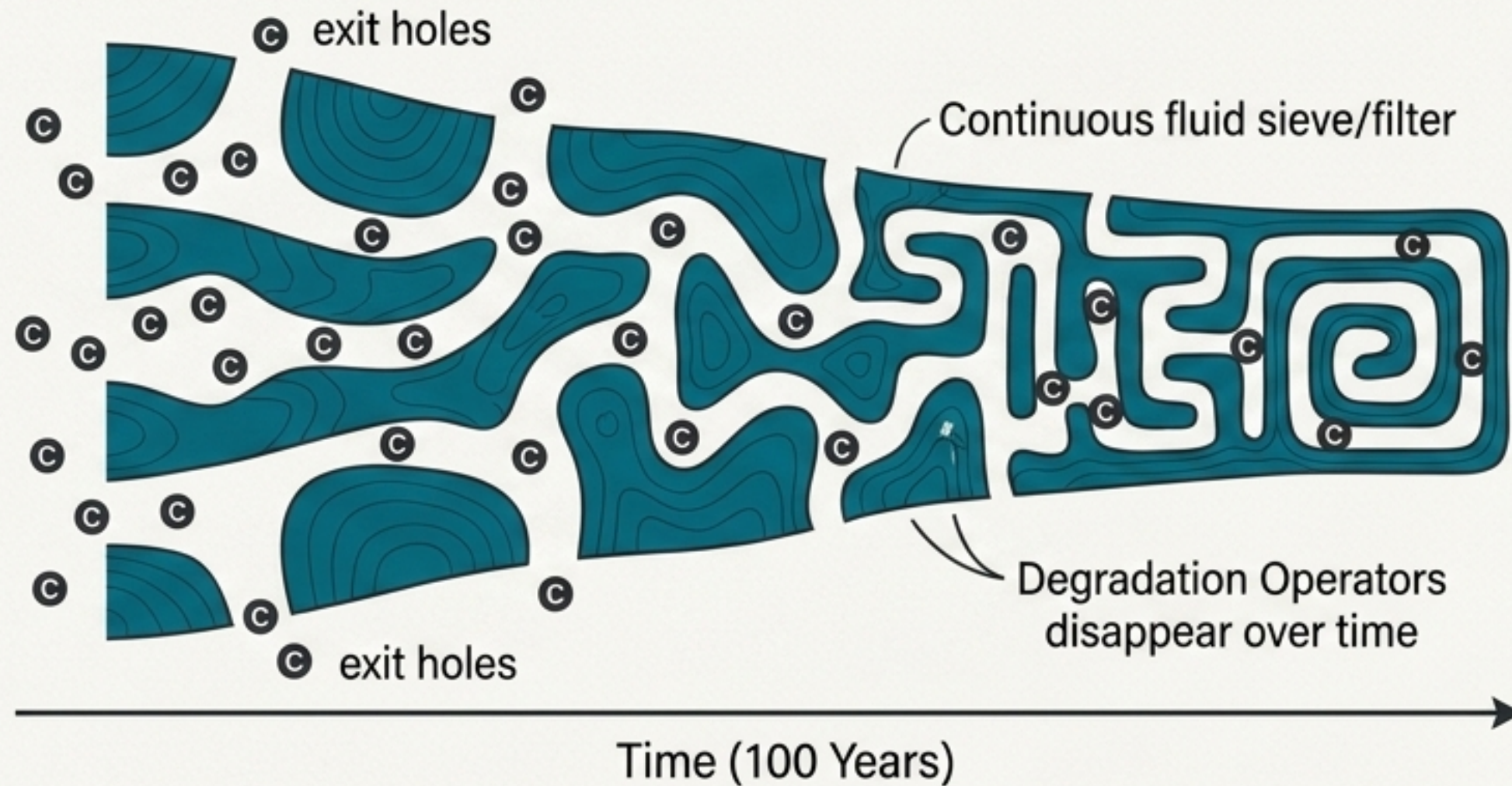
Potential global terrestrial carbon loss driven solely by biodiversity decline (Weiskopf et al., 2024).

Equation Fragment: Biodiversity Loss

$$E[\Delta C] = C_0(1 - p_b R) + C_0 p_b R \left[1 - \prod (1 - p_D(t)) \right] \sigma$$

Concept: Earth System Models project vegetation using a few plant functional types, ignoring biodiversity. But biodiversity operates as a constraint-density field. It provides overlapping channels that absorb disturbances. Erasing species erases the ecosystem's structural shields.

Fracture 3: The Ocean's Recalcitrance Illusion



14–25%

Amount of dissolved organic carbon (DOC) from marine macrophytes that persists over 100-year timescales (Watanabe et al., 2026).

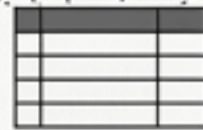
Equation Fragment: Accessibility Contraction

$$+ \text{DOC}_{M0}(1 - \Pi_{RDOC})$$

Concept: Current blue carbon frameworks miss Recalcitrant DOC because it isn't chemically inert. Instead, it is operationally inaccessible. It survives through transformation accessibility contraction—progressively excluding itself from available microbial degradation pathways.

The Unified Carbon-Balance Equation

$$E[\Delta C] = C_0(1 - p_b R) + C_0 p_b R [1 - \prod (1 - p_D(t))] \sigma + \text{DOC}_{M0} (1 - \Pi_{\text{RDOC}})$$

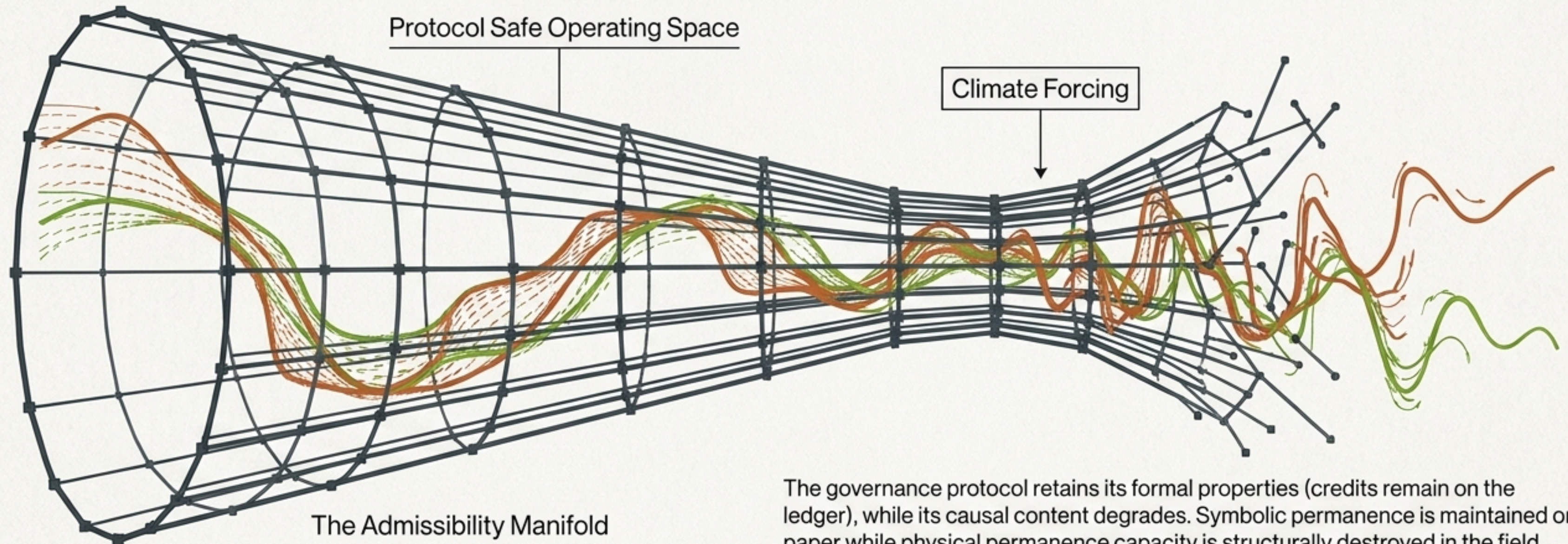


Current Governance Ledgers

Synthesis Insight: These three independent empirical papers expose the exact same structural failure. Current governance frameworks discard the dynamical variables—biodiversity $\kappa(B)$, nonstationary disturbance $D(t)$, and transformation accessibility $T(x,t)$ —that dictate whether the projected carbon value actually survives in physical reality.

The Root Diagnosis: Proxy Permanence Failure

Proxy Permanence Failure occurs when a symbolic accounting projection becomes progressively decoupled from its causal ecological substrate.

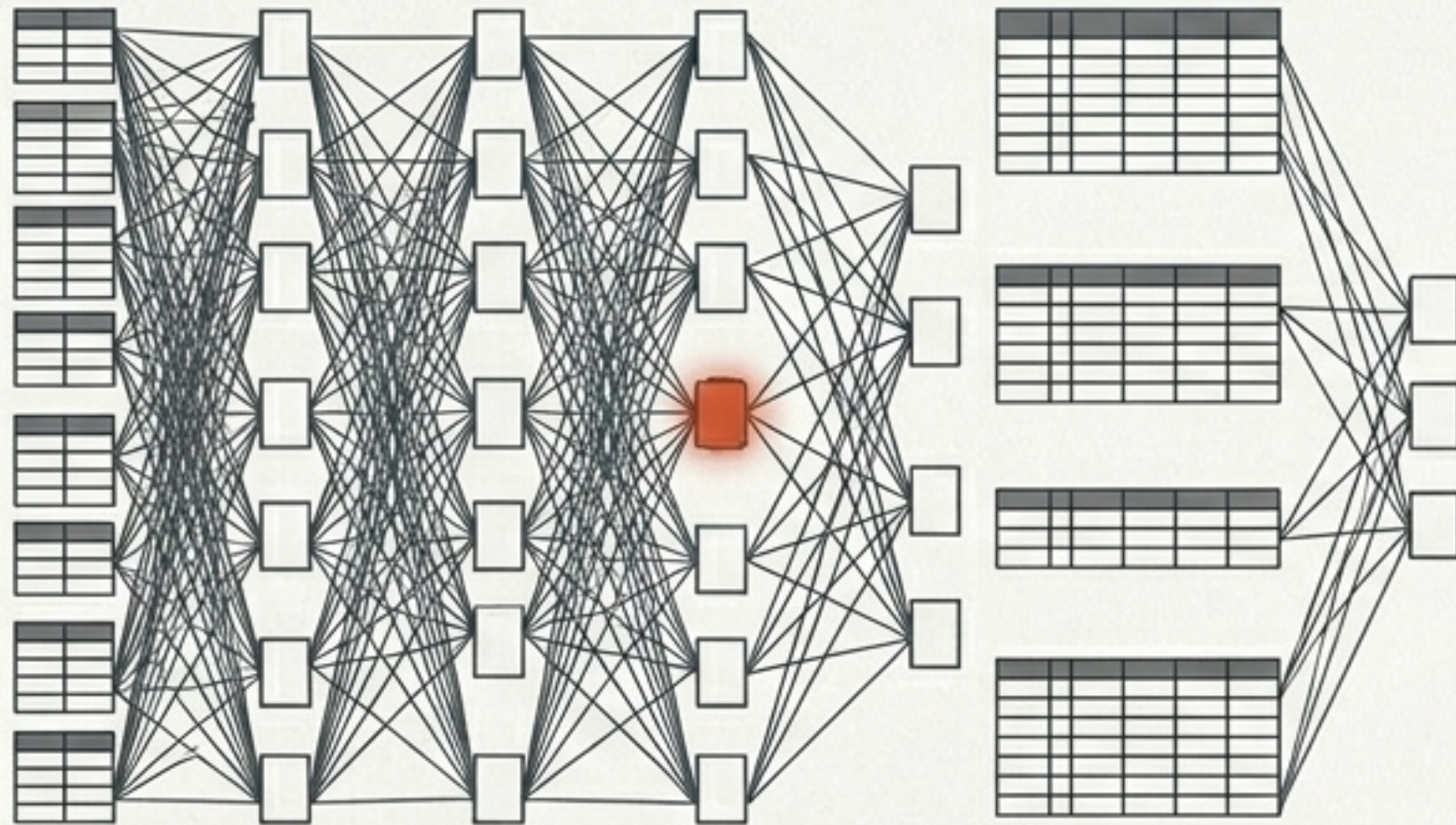


The governance protocol retains its formal properties (credits remain on the ledger), while its causal content degrades. Symbolic permanence is maintained on paper while physical permanence capacity is structurally destroyed in the field.

The Negligible-but-Constitutive Bridge

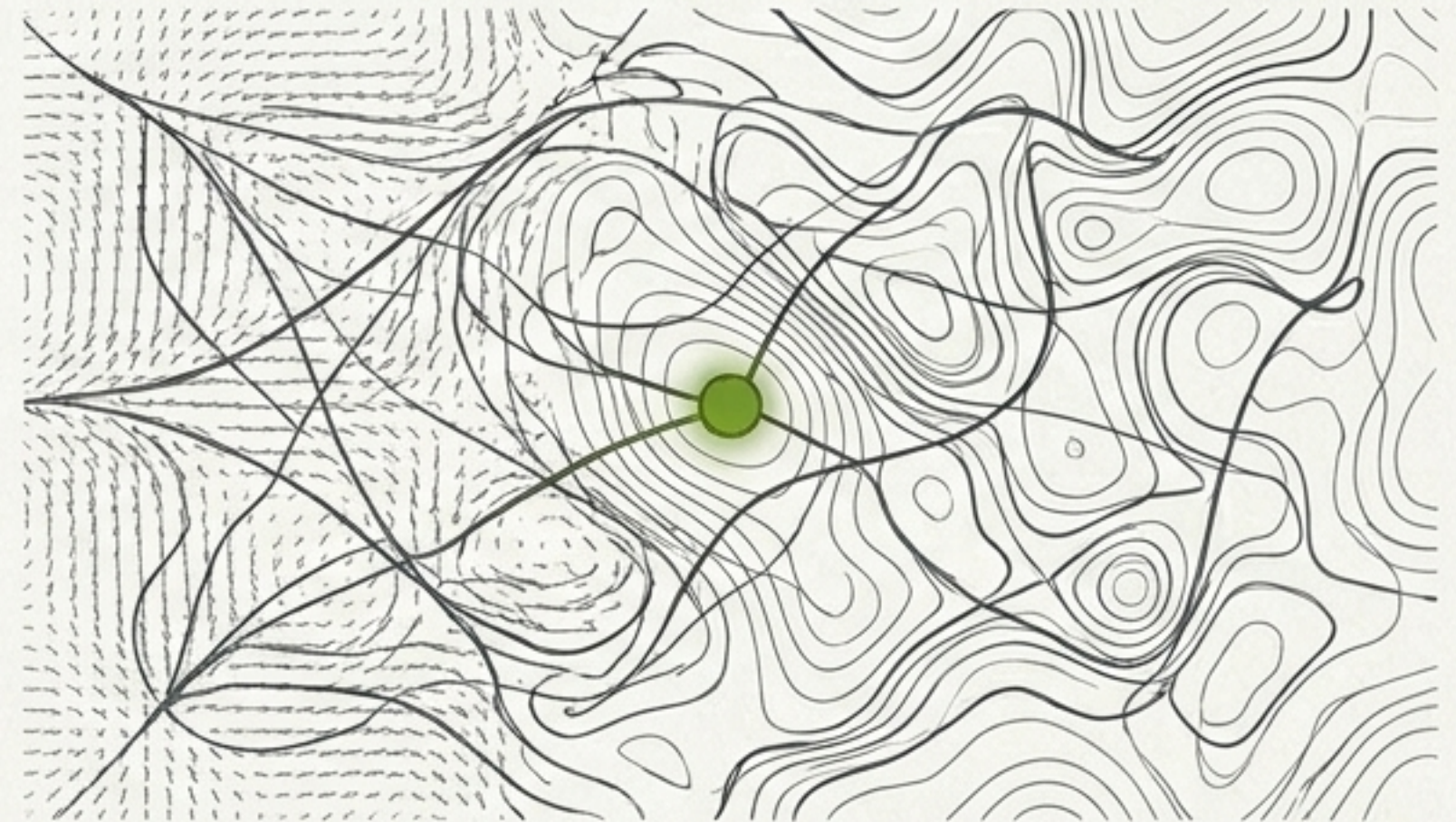
How can omitting a tiny fraction of species crash a global carbon stock? Look at artificial intelligence architecture.

Silicon (Large Language Models)



- LLM Scale Vectors constitute just 7.84×10^{-5} of a 1B-parameter model.
- They are mathematically redundant under idealized assumptions.
- Yet, removing them degrades pre-training and destroys convergence.

Carbon (Ecological Systems)

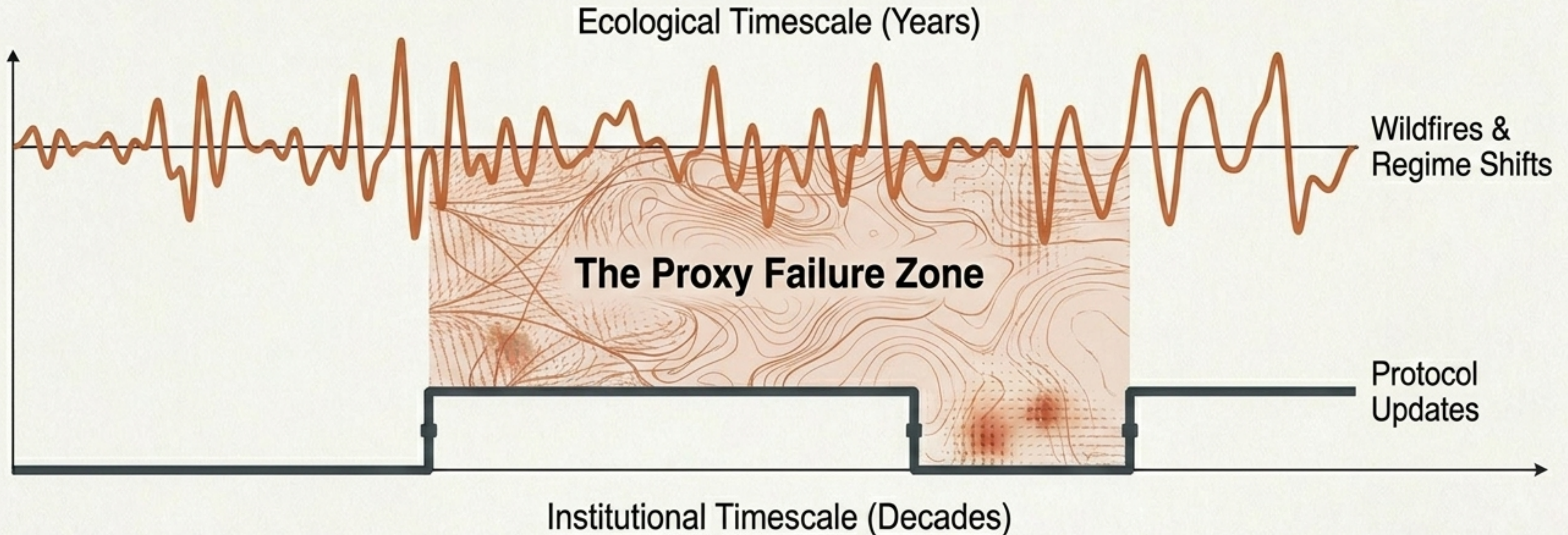


- Biodiversity represents a tiny fraction of total ecosystem biomass.
- It is entirely excluded from standard Earth System Models.
- Yet, removing it destroys the constraint network that absorbs environmental shock.

Insight: In complex fields, variables that are negligible in scale are structurally constitutive of stability.

The Synchronization Lag

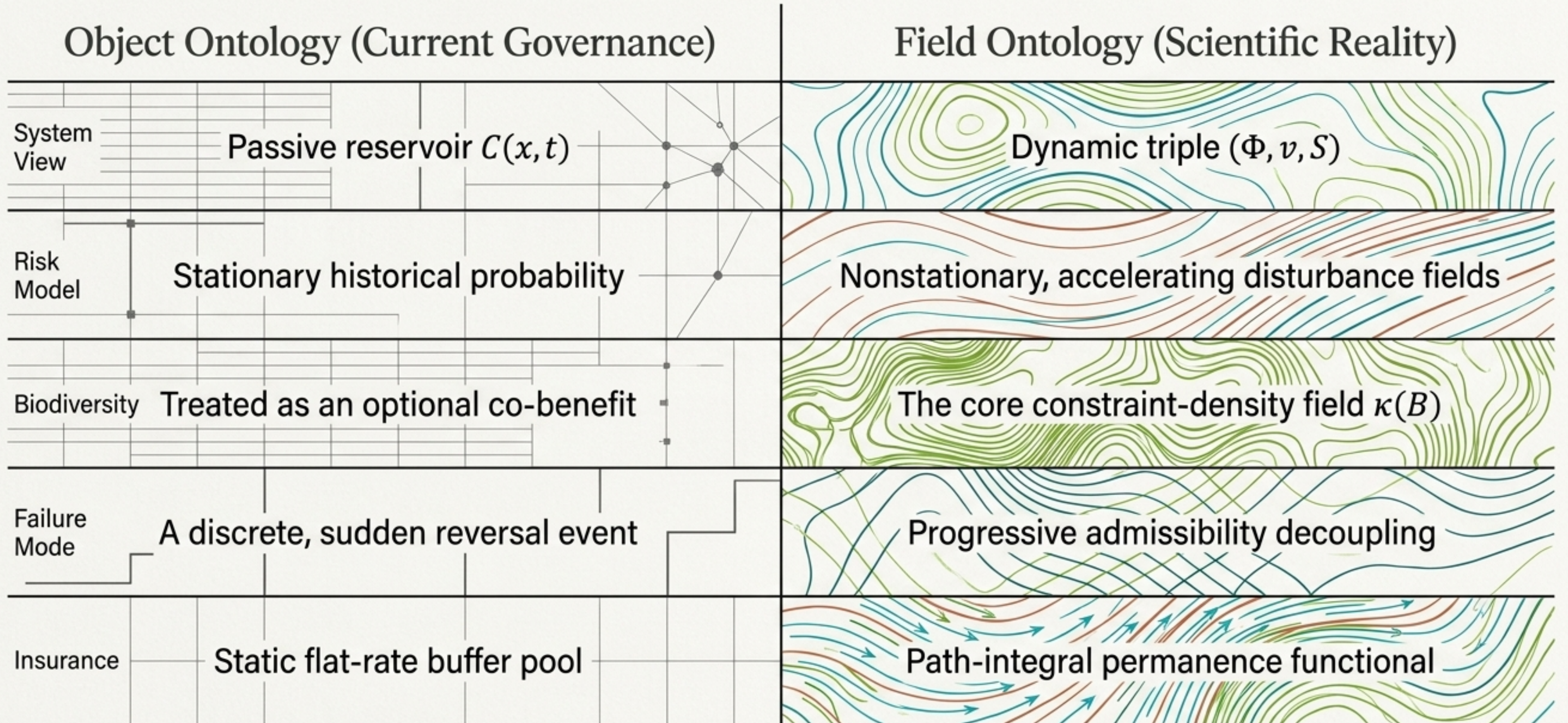
$$\tau_{\text{institution}} \gg \tau_{\text{ecology}}$$



Institutional memory integrates outdated data. Protocol updates occur on timescales of decades, while ecological attractor restructuring occurs in years.

A control system with delayed state estimation operating on a rapidly changing nonstationary field guarantees actuarial instability. Collapse is institutional, not just ecological.

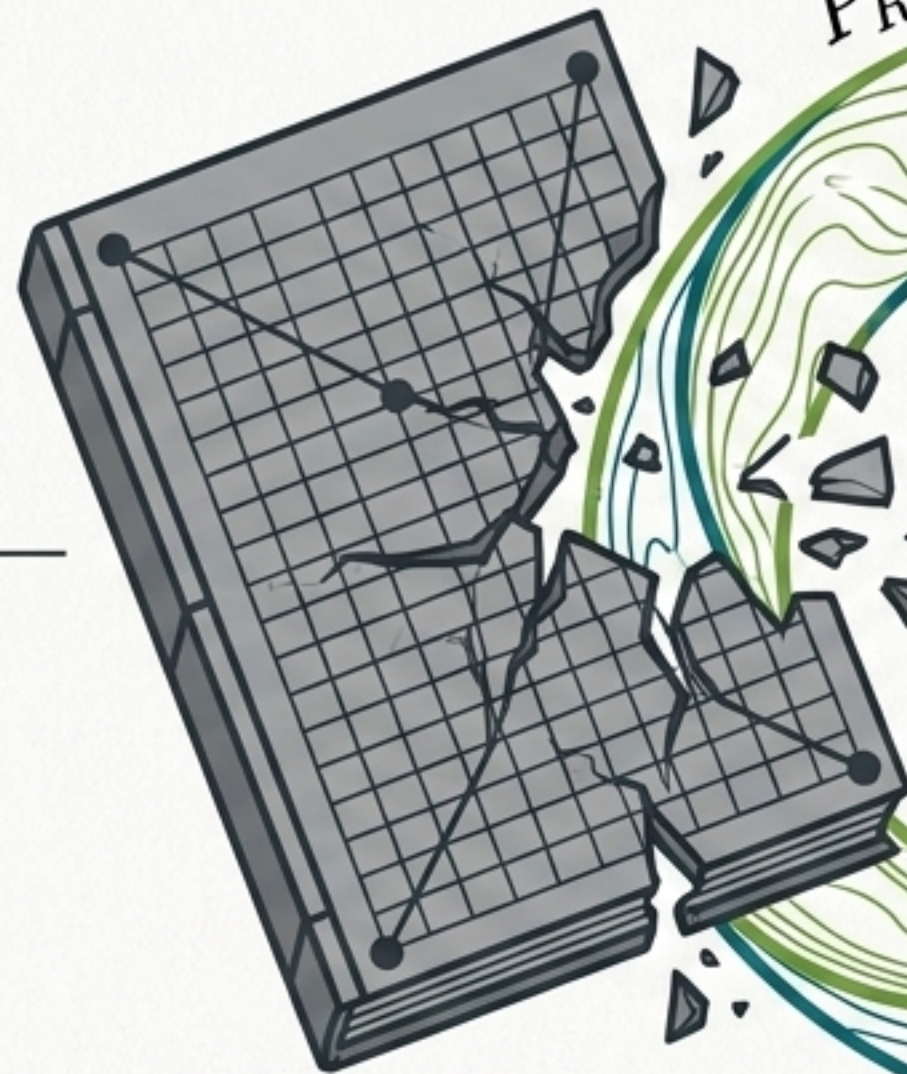
The Paradigm Shift in Carbon Governance



The Solution: A Self-Correcting Resilience Premium

Current Concept:

Buffer pools are static reserve functions updated once a decade.



$$P_R(t) = P_0 \exp(\lambda_1 E_D + \lambda_2 E_B + \lambda_3 E_\Sigma + \lambda_4 E_C)$$

New Reality: An adequate governance instrument must be a field operator—a dynamically self-correcting premium.

Takeaway: The premium rises automatically whenever any destabilization channel intensifies, creating a living **adaptive regulator** that prices future admissibility maintenance rather than current biomass stock.

The Four Geometric Observables



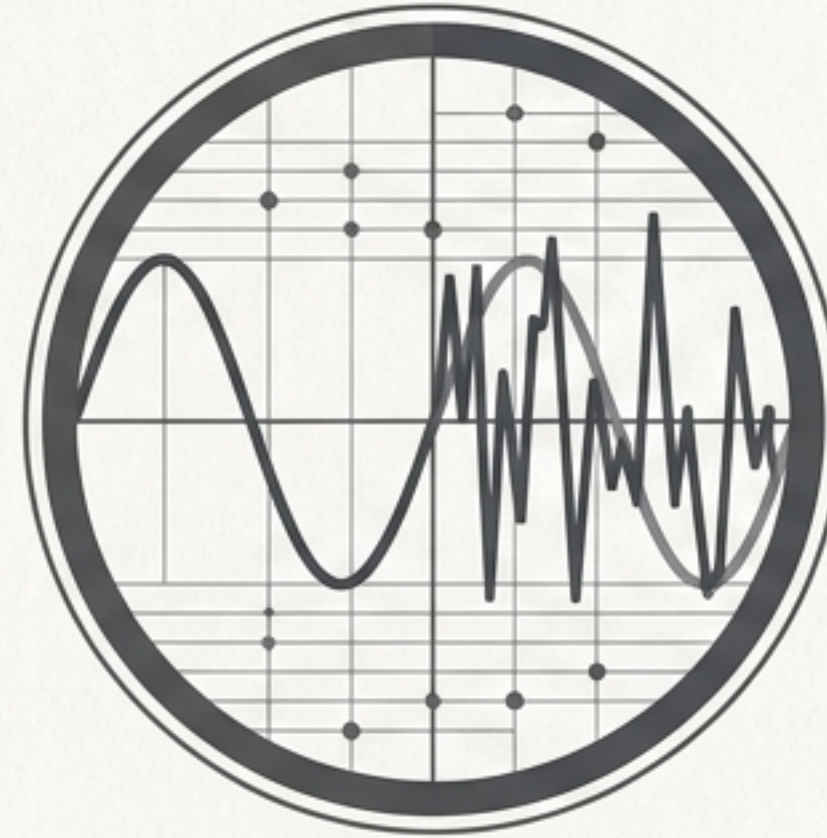
**Disturbance Entropy
Pressure ($\bar{\mathcal{E}}_D$)**

The logarithmic contraction rate of resilience trajectories due to climate forcing.



**Constraint-Channel
Erosion ($\bar{\mathcal{E}}_B$)**

The real-time rate at which biodiversity loss removes independent survival channels.



**Governance
Entropy ($\bar{\mathcal{E}}_Z$)**

The mathematically quantified desynchronization lag between outdated institutional memory and actual ecological state.



**Contagion
Coupling ($\bar{\mathcal{E}}_C$)**

Systemic fragility propagation across interconnected carbon markets.

Redefining Permanence

Permanence is not a default, passive property of stored carbon. It is an achieved and contingent outcome of constraint maintenance under ongoing perturbation.

Continuing to maintain accounting coherence at the cost of physical incoherence guarantees market collapse. We must align the geometry of human governance with the geometry of the living field.