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Survival Is Conditional: Resilience as a Retrospective Verdict from EF–CT–FL

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Abstract

Resilience is frequently treated as a forward-visible property inferred from equilibrium, allowing stability in calm-states to masquerade as security. This article reframes resilience as a retrospective verdict applied only after disturbance discloses whether persistence occurred. The latent architecture carried forward is formalised as Evolutionary Flexibility (EF) = (D + R) + C + K, where D is diversity, R redundancy, C contingency, and K categorical coherence where $K \in \{-1, 0, +1\}$. Two diagnostic constructs—Constraint Topology (CT) and Fragility Landscape (FL)—map admissible corridors, thresholds, and bottlenecks, and project where failures initiate under preregistered opposition profiles. Operational proxies for EF are outlined, together with a procedure to derive CT and FL from existing monitoring, and a preregistered evaluation programme comparing EF–CT–FL predictors against equilibrium-trait surrogates across disturbance-rich datasets. The framework relocates "resilience" from a purported trait to a conditional verdict and replaces equilibrium reassurance with structural diagnosis suitable for measurement, stress-testing, and actionable forecasting under real disturbance regimes. In contrast with metric-centric approaches that describe trait geometry or role overlap, EF–CT–FL models the architecture and routing of function under opposition (Ω): metrics become informative only after conditional pathways (CT), coherence (K), and fragility gates (FL) are specified.

1. Introduction

Ecological resilience has been a central concept for fifty years, yet its meaning remains contested. Classical interpretations, shaped by equilibrium metaphors such as basins of attraction, often treat resilience as a measurable property visible in calm-states (Holling, 1973). Under this framing, ecosystems that appear stable are inferred to "have resilience," and abundance or equilibrium metrics are used as predictors of persistence. However, stability under familiar conditions does not guarantee viability under novel disturbance regimes, invasive pressures, or altered climatic sequences.

A more mechanistic lineage emerges from Darwin's selector logic and Elton's constraint-based ecology. Darwin articulated a conditional logic in which persistence is disclosed only under opposition, shaped by variation, reproduction, contingency, and coherence of fit (Darwin, 1859/1872). Elton extended this logic by mapping structural constraints, dependencies, and conditional pathways that determine whether ecological systems can route disturbance. Together, they imply an architecture of persistence under changing conditions. The EF–CT–FL framework restores this architecture by formalising the conditional structures that natural selection produces, enabling persistence to be diagnosed mechanistically rather than inferred from equilibrium appearance.

Disturbance leads to competition by activating Darwin's eliminative logic of survival under opposition. Darwin described persistence as being scrutinised "daily and hourly" by the conditions of life, not determined by visible rivalry or equilibrium matching. In ecological systems, access to essential pathways—energy, nutrients, space, timing, and regeneration—may appear unconstrained under calm conditions, masking latent fragility. When disturbance changes conditions, access constraints are

imposed and non-viable routes are removed. Competition therefore emerges as the outcome of disturbance-driven elimination rather than as a continuous process operating in advance. Within EF–CT–FL, competition is diagnosed retrospectively through the loss of access revealed by disturbance: the framework specifies which pathways remain viable when opposition acts and which are pruned, making persistence a verdict revealed only after disturbance.

It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, whenever and wherever opportunity offers, at the improvement of each organic being in relation to its organic and inorganic conditions of life.

— Charles Darwin, *On the Origin of Species*, Chapter IV (1859)

Darwin's description makes clear that natural selection operates through exposure to opposition imposed by conditions of life, not through competition understood as a standing interaction among organisms. This distinction also clarifies a common explanatory error in ecology: attributing outcomes shaped by constraint to competition. For example, the tallest tree in a forest is often described as having achieved its position through superior competition for light. In reality, maximum tree height is bounded by hydraulic, mechanical, and developmental constraints that define which growth trajectories are viable at all. Most individuals are excluded from extreme height not because they lose a contest with neighbours, but because the routes required to sustain further growth become physiologically or structurally inaccessible. Apparent competitive outcomes therefore frequently reflect prior eliminative filtering by constraints rather than active rivalry among organisms. Within the EF–CT–FL framework, such outcomes are understood as expressions of which pathways remained open under opposition, not as victories achieved through competition per se.

A contrasting but equally common misattribution occurs in drought-driven mortality, which is frequently described as intensified competition for water. In practice, large-scale drought die-offs are determined less by competitive displacement than by physiological and temporal constraints, including xylem vulnerability to cavitation, rooting depth, carbon storage capacity, and the sequencing of water stress relative to phenology. Many individuals fail without any direct interaction with neighbours, simply because the routes required to maintain hydraulic function close under prolonged or mistimed stress. Survival in such events reflects whether access to critical pathways remains viable as conditions deteriorate, not whether an organism out-competes others for a shared resource. As with maximum tree height, apparent competitive outcomes in drought are therefore better understood as the result of eliminative filtering by constraints activated through disturbance, rather than as outcomes of standing competition among organisms. These examples do not deny resilience as a post-disturbance description of persistence; they challenge the inference of resilience from calm-state dominance or competitive appearance.

Elton's structural-constraint lens.

While cycle-oriented accounts later emphasised basin geometry and state trajectories, Elton framed communities as architectures of constraints and dependencies in which admissible interactions are limited by conditional pathways, prerequisites, and sequence. A structural view first developed in *Animal Ecology* (Elton, 1927) and later extended in his invasion work (Elton, 1958). Under this lens, disturbance functions as a mechanical failure test: it does not create outcomes so much as expose whether sufficient, coherent routes existed to carry function when primary pathways fail. The EF–CT–FL framework adopts this Eltonian stance explicitly: Constraint Topology (CT) is treated as the structural expression of conditional pathways and dependencies, and the Fragility Landscape (FL) as the projection of where failures initiate when an opposition profile (Ω*) is routed through that structure.

Elton's contribution can be read as an early routing ontology: communities are not persistent because of equilibrium geometry but because conditional pathways and compensating pressures exist to absorb novelty; when those pathways are absent, disturbance produces "ecological explosions" that expose hidden fragility. In EF terms, Elton anticipated CT (admissible corridors) and R/K (whether overlap is functional), and treated disturbance as the revealer rather than the cause of outcome—resilience is thus post hoc, a verdict after opposition.

1.1. Re-examining Holling (1973): From Conditional Survival to Property-Based Resilience

Holling's (1973) *Resilience and Stability of Ecological Systems* remains the canonical origin point for modern ecological resilience. The paper begins by rejecting a narrow equilibrium-centred tradition inherited from classical physics, arguing that constancy and return time under small perturbations are insufficient when systems face large, irregular change and risk of extinction. This move aligns with an older Darwin–Elton logic in which viability is disclosed only under pressure and in which persistence is ultimately an outcome rather than a guaranteed system attribute.

Holling's key contribution was to distinguish engineering stability—rapid return to a reference state—from ecological resilience, defined as the persistence of functional relationships under disturbance, including the possibility of reorganisation among alternative states. By introducing multiple stable states and thresholds between them, Holling shifted ecological attention away from equilibrium geometry alone and toward regime shifts and the conditions under which populations and interactions persist. This conceptual turn became foundational for later syntheses of resilience and social–ecological systems. It also underpins subsequent developments such as the adaptive cycle and the cross-scale dynamics formalised in the Panarchy framework (Gunderson & Holling, 2002).

However, Holling's paper also introduces an ontological shift that is essential to make explicit when resilience is used as a diagnostic or predictive concept. Darwin frames survival as a retrospective verdict delivered under selective pressure: variation is scrutinised, eliminated, or preserved, and the outcome is disclosed only when conditions act on organisms and their relations. Elton extends this logic to communities, emphasising that ecological "explosions" and invasions reveal whether compensatory

pressures and interaction structure are sufficient to restrain runaway change. In both cases, persistence is disclosed by opposition; it is not inferable from calm-states.

Holling relocates this conditional logic into a stability-landscape grammar. Ecological resilience becomes representable as a property of the system's attractor structure—its domain of attraction, distance to a boundary, and the qualitative geometry that separates alternative regimes. Even when introduced as metaphor, this representational choice makes resilience appear as something a system *has* prior to disturbance. It therefore becomes tempting to treat resilience as forward-visible and to infer it from pre-disturbance indicators that track basin geometry or apparent stability, rather than from the internal route architecture that must exist for persistence to remain possible.

This shift matters because basin geometry describes a system's macroscopic state dynamics but does not specify the mechanistic architecture that enables disturbance to be routed without exhausting options. In particular, the landscape grammar leaves underspecified the roles of redundancy as overlapping functional pathways, coherence as the integrity of coupling among those pathways, and contingency as sequence- and history-dependent accessibility of routes. Subsequent resilience literature has recognised the plural meanings of resilience and the risks of analogy transfer. The stability landscape remains useful as a descriptive heuristic, but it is incomplete as a diagnostic mechanism when applied to real disturbance regimes where pathway loss can accumulate silently beneath apparent stability.

Evolutionary Flexibility (EF) is introduced here to restore and formalise the pre-disturbance architecture implied by Darwin's selector logic and Elton's disturbance-first ecology, while retaining Holling's insight that persistence is not reducible to return time. EF does not redefine resilience; it specifies what must already exist for resilience (as a post-disturbance label) to be possible. Formally, EF is defined as $EF = (D + R) + C + K$, where diversity supplies the option space, redundancy supplies overlapping functional routes, contingency specifies which routes are accessible given sequence and history, and coherence is categorical integration ($K \in \{-1, 0, +1\}$) determining whether routes operate as a system or become stranded. Under EF, resilience is the retrospective verdict applied only if at least one coherent route remains open when disturbance occurs; EF is the carried-forward architecture that makes that verdict possible.

1.2. Why metric-centric ecology misses conditional survival

Most ecological accounts remain metric-centric: they quantify trait volumes, niche distances, or role overlaps. These indices describe how a system looks in calm states, not how it behaves when disturbed. Metrics are static portraits; persistence is a conditional process that depends on routing under thresholds, dependencies, and timing. This ambiguity reflects the long-observed status of resilience as a boundary object with multiple, sometimes conflicting definitions (Brand & Jax, 2007).

In practice, coverage ≠ survivability, overlap ≠ functional continuity, richness ≠ redundancy that works. Under EF–CT–FL, metrics are reinterpreted as proxies for option space (D) and potential thickness (R),

while contingency (C) and coherence (K) determine whether those options are reachable and operable when Ω acts; FL then identifies where failure initiates and propagates. In short, metrics only become meaningful after the routing architecture is known—a lesson long established in engineered networks and consistent with Elton's disturbance-first diagnosis of ecological "explosions," where apparent stability masked a lack of compensating routes.

Box 1 (clarification).

Resilience as used in ecology is not stabilising selection. Stabilising selection is an evolutionary process acting on trait distributions across generations under a given selective regime. EF instead addresses pre-disturbance system architecture: the existence and integration of multiple functional routes that determine whether persistence is possible when disturbance acts. "Selection" in this manuscript is used strictly in the Darwin–Elton sense of conditional disclosure under opposition—an eliminative test—rather than as a claim about equilibrium-maintaining selection on trait means.

The practical consequence of making Holling's ontological shift explicit is that resilience can be retained as a descriptive term without being treated as a measurable property in calm-states. EF, together with Constraint Topology (CT) and Fragility Landscape (FL), provides an architecture-first diagnostic layer. This restores the Darwin–Elton ontology—persistence as a verdict under opposition—while preserving Holling's core insight that persistence requires concepts beyond local equilibrium stability.

Guiding question

What must already exist for survival to remain possible when disturbance occurs? Disturbance does not create outcomes; it reveals whether the latent architecture was sufficient to route opposition without exhausting options. Resilience, where it appears, is therefore not a trait carried forward but a verdict applied after the system's routing architecture is tested by Ω. Pre-shock metrics can estimate EF proxies (D, R, C, K), but only CT/FL reveal conditional pathways and gates—i.e., whether redundancy is usable bandwidth or stranded multiplicity when opposition acts.

To describe what ecosystems, carry forward prior to disturbance, Evolutionary Flexibility (EF) is formalised as the latent persistence architecture comprising diversity (D), redundancy (R), contingency (C), and categorical coherence (K). Two complementary diagnostic constructs—Constraint Topology (CT) and Fragility Landscape (FL)—map conditional corridors, thresholds, and failure pathways.

Definition (admissibility).

Admissibility denotes the set of reorganisations and response routes that are structurally possible given CT and K.

Definition (opposition profile, Ω).

An opposition profile is a preregistered disturbance vector comprising type, intensity, duration, frequency, and sequence. Routing Ω through CT projects stress and identifies initiation points of failure within the FL.

2. Materials and Methods

2.1. Conceptual Derivation of Evolutionary Flexibility (EF)

The framework begins with the axiom of conditional survival: systems persist only while coherent, redundant routes remain open under opposition. EF explains outcomes by examining available routes, not apparent states—calm operation hides architecture.

Component roles.

- Diversity (D): variation—the upper bound on what a system could do.
- Redundancy (R): overlapping function—backup pathways.
- Contingency (C): historically conditioned accessibility of options.
- Coherence (K): whether accessible options operate as a system.

EF is not resilience. EF is the carried-forward architecture; resilience is the name applied afterward only if at least one coherent route remained open.

Contingency (C) as architectural selector.

Contingency converts latent options into reachable routes by conditioning availability on sequence, timing, and prior state. It operates over the Constraint Topology (CT) by *positioning* thresholds and dependencies so that some corridors become admissible only after prerequisites are met, while others close when loads or timing misalign. In this framing, Record → Contingency turns historically retained successes into currently reachable ports, and Coherence (K) governs whether those ports pass or block when opposition (Ω*) acts. Thus, EF separates existence (D, R), accessibility (C), and operability (K): diversity and redundancy provide potential routes; contingency arranges which are reachable given recent history; coherence determines whether reachable routes function under Ω*.

Eltonian grounding for CT and C.

In EF, CT is not an abstract graph; it is the Eltonian map of admissible routes produced by historically retained constraints and dependencies. Contingency (C) then positions access on that map by sequence and timing, converting Record into the currently reachable subset of corridors; Coherence (K) determines whether those reachable routes operate as a system when opposition acts. This separation—existence (D, R), accessibility (C), operability (K)—makes structural viability diagnosable without inferring “resilience” from equilibrium appearance.

2.2. Operationalisation of EF Proxies

Diversity: functional diversity indices; trait richness.

Redundancy: role overlap; parallel pathways.

Contingency: legacy effects; sequence dependence.

Coherence: coupling strength; synchrony; feedback compatibility.

Operational principle: treat indices as inputs to CT/FL, not as forward-visible "resilience metrics"; they parameterise option space and potential thickness, but **routing, gating, and verdict are architectural**, not metric, objects.

2.3. Short Methods Note on Empirical Implementation

EF, CT, and FL integrate with existing monitoring programmes. CT is constructed from thresholds, dependencies, and historical interaction pathways. FL is derived by routing Ω* through CT to identify where stress concentrates.

2.4. Mapping Constraint Topology (CT)

CT is the architecture of historically accessible traits and pathways, including thresholds, dependencies, bottlenecks, and timing rules. It contains both strengths and latent weaknesses shaped by past filtering.

Constraint Topology (CT) is the structural expression of historically accessible traits. It is not a map of all possible responses; it is the architecture produced when contingency filters variation through historical sequences, preserving some pathways while closing others. CT captures the conditional layout of ecological possibility through features such as: thresholds (e.g., fire-intensity limits, hydrological minima), dependencies (e.g., mutualisms, trophic couplings), bottlenecks and prerequisites, timing rules, and corridor thickness. Because CT is constructed from historically accessible variation rather than raw diversity, it embeds both strengths and latent weaknesses shaped by past filtering.

2.5. Deriving Fragility Landscapes (FL)

FL projects stress onto CT under an opposition profile. It distinguishes where collapse initiates from where it propagates. Operational definition

Contingency is the time-indexed map of which CT corridors are reachable now, given the order and timing in which thresholds and dependencies have been met.

FL projects stress onto CT under an opposition profile (Ω). It distinguishes between:

Latent fragility: $FL = f\left(CT, \left(D + R\right), K\right)$

Dynamic fragility: $FL\left(t\right) = risk_map\left(CT\left(t\right), \left(D + R\right), K, \Omega^{*}\right)$

FL differentiates where collapse begins from where it ultimately propagates, revealing bottlenecks, load-bearing points, and synchronisation risks.

2.6. Evaluation Programme Design

Disturbance-rich datasets; preregistered opposition profiles; EF proxies; CT/FL mapping; comparison against equilibrium surrogates.

2.7. Statistical Analyses

The article develops a conceptual framework. When applied, analyses include preregistered comparisons, out-of-sample performance metrics, and robustness checks.

2.8. Ethics Statement

Not applicable. This work presents a conceptual and methodological framework only; it involves no experiments, field interventions, animal or human participation, and does not require approval from an ethics committee.

3. Results

3.1. Evolutionary Flexibility (EF) Architecture

Figure 1 summarises the operational architecture used in the analyses: packet-level ports (functional interfaces), gates (conditional thresholds on CT corridors), the Constraint Topology (CT) as the positioned network of corridors, and the Fragility Landscape (FL) as the projection of stress under a preregistered opposition profile (Ω*). Coherence (K) governs whether gates tend to PASS or BLOCK, determining whether redundancy is usable, stranded, or collapses through synchronised failure. Every small circle in the CT mesh represents a port; the enlarged port panel is a zoom-in of any CT node.

Ports regulate internal flows and cross-system interactions; gates impose conditional thresholds on those corridors. Under K = + 1 (integrative coherence) corridors knit into a functional mesh and redundancy is usable; under K = 0 redundancy is partly stranded and outcomes are path-contingent; under K = − 1 gates synchronise into BLOCK cascades and CT collapses into an FL where failure initiates and spreads along load-bearing points. Routing Ω* through CT distinguishes initiation points of collapse (black nodes/edges) from stranded potential (grey) that no longer contributes to persistence.

Result framing. EF explains outcomes by examining the routes a system has available, not its calm-state appearance. Disturbance reveals which routes remain usable; some routes that appear intact can fail under timing dependence, single-condition reliance, or gate synchronisation. EF separates the map of routes (CT) from the map of likely failures (FL).

3.2. Coherence Categories (K)

- K = + 1 (integrative coherence): redundancy is usable; failures tend to localise.

- K = 0 (unmanaged coherence): redundancy is stranded; outcomes become patchy.
- K = − 1 (misaligned coherence): gates synchronise into failure; cascades propagate.
- Coherence determines whether diversity and redundancy act as a system (see Fig. 1) or collapse together.

3.3. Constraint Topology (CT)

CT formalises Elton's view of communities as architectures of admissible interactions—positioned thresholds, prerequisites, and dependencies that delimit which corridors can carry function when primary routes fail.

This routing-based, constraint-driven view of ecological organisation originates in Elton's *Animal Ecology* (1927), where niches, roles, and functional dependencies were first formalised as structural relations, and is later echoed in his analysis of compensating pressures and ecological 'explosions' in *The Ecology of Invasions* (1958).

It codifies Elton's contention that community function is governed by *the availability and connectivity of routes*, not by equilibrium geometry. Under this lens, persistence hinges on which corridors are accessible (C) and operable (K) at the moment of testing. Because CT is constructed from historically accessible variation, it embeds both strengths and latent weaknesses that disturbance can expose.

Contemporary link. This structural view aligns with modern functional-connectivity work showing that corridor admissibility depends on real-time and seasonal conditions, not merely static structure, so movement routes and process routing vary with state and sequence (Viau et al., 2024; Martínez-Richart et al., 2025).

3.4. Fragility Landscape (FL)

FL identifies where stress concentrates when an opposition profile (Ω*) is routed through CT, marking initiation points, load-bearing elements, and synchronisation risks (see Fig. 1) (Holling, 1973). Collapse begins at fragility points, not necessarily where it ends.

Empirical analogue. In eco-hydrology, drought mortality is increasingly modelled as a threshold-gate failure: once hydraulic tension drives xylem beyond cavitation thresholds, routing collapses and systemic dysfunction propagates—an explicit, measurable instance of FL in living systems (Adams et al., 2017; Choat et al., 2018).

3.5. Failure Modes: Monoculture and Hyper-diversity

- Monoculture: compressed corridors, thin redundancy, rapid collapse (Holling, 1973).
- Hyper-diversity misconfiguration: excessive overlap fragments coherence; redundancy degrades into noise; stability depends on how options integrate and are selected and operated, not on richness alone (Dehling & Stouffer, 2018; Loreau et al., 2021).

Resulting expectation. Persistence is most likely where D, R, C, and K align to preserve coherent, redundant routing under Ω*.

3.6. Prediction Set

Under the conditional-verdict hypothesis (H_1):

1. EF proxies (D, R, C, K) explain more variance in outcomes under disturbance than equilibrium-trait proxies (Holling, 1973).
2. Systems with similar calm-state appearance diverge due to CT/FL differences (Holling, 1973).
3. High abundance without redundancy/coherence amplifies collapse magnitude (Loreau et al., 2021).
4. Restoration that increases D and R without stabilising K can generate noisy fragility (Dehling & Stouffer, 2018; Loreau et al., 2021).

Contemporary corollary. Where functional connectivity is seasonal or state-dependent, predictions must be time-indexed because C(t) repositions access and therefore the location of FL(t) (Viau et al., 2024).

3.7. Evaluation Programme

A structured evaluation includes: (i) selecting disturbance-rich datasets; (ii) preregistering opposition profiles and outcome classes; (iii) measuring EF proxies; (iv) mapping CT and deriving FL; and (v) comparing EF/CT/FL predictors against equilibrium-trait surrogates using out-of-sample metrics (Holling, 1973).

Anchors for measurement. Hydraulic failure thresholds in drought mortality provide a tractable FL analogue for validation; functional-connectivity case studies provide CT/C grounds for seasonal admissibility tests (Choat et al., 2018; Viau et al., 2024).

4. Discussion

Holling's motivating problem remains unresolved in much contemporary usage of resilience: why do whole ecological systems sometimes persist and sometimes collapse, even when they appear stable? Holling's (1973) central contribution was to show that equilibrium-centred stability—such as return time under small perturbations—is not a sufficient explanation of persistence under large, irregular disturbance, and to introduce a stability-landscape grammar in which persistence is framed through domains of attraction, thresholds, and regime shifts. This move correctly displaced equilibrium reassurance and made nonlinear transitions conceptually central. Yet the stability-landscape grammar is primarily descriptive: it represents how systems can move among regimes, but it does not specify what internal structures must already exist for persistence to remain possible when disturbance acts. As a consequence, resilience can drift from a retrospective description of observed persistence to a forward-visible property inferred from pre-disturbance appearance or equilibrium surrogates, particularly when landscape geometry is treated as a proxy for mechanism.

Disturbance leads to competition by activating Darwin's eliminative logic of survival under opposition. Darwin described persistence as being scrutinised "daily and hourly" by the conditions of life, not determined by visible rivalry or equilibrium matching. In ecological systems, access to essential pathways—energy, nutrients, space, timing, and regeneration—may appear unconstrained under calm conditions, masking latent fragility. When disturbance changes conditions, access constraints are imposed and non-viable routes are removed. Competition therefore emerges as the outcome of disturbance-driven elimination rather than as a continuous process operating in advance. Competition is therefore not assumed as a standing interaction but diagnosed retrospectively through the loss of access revealed by disturbance. The EF–CT–FL framework formalises this sequence by specifying which pathways remain viable when opposition acts and which are pruned, making persistence a verdict revealed only after disturbance.

The EF–CT–FL framework addresses Holling's question at an earlier causal level by shifting attention from state-space geometry to persistence architecture. The decisive explanatory requirement is not the apparent size of a basin but the availability of coherent, redundant routes through constraint space that allow essential functions to continue when primary pathways fail. Under this route-based ontology, disturbance does not create outcomes; it discloses whether usable routes exist. Collapse occurs when coherent routes are driven to zero; persistence occurs when at least one coherent route remains open. The architecture carried forward prior to disturbance is formalised as Evolutionary Flexibility (EF) = (D + R) + C + K, where diversity (D) supplies option space, redundancy (R) supplies overlapping functional routes, contingency (C) specifies sequence- and history-dependent accessibility of routes, and coherence (K) is categorical integration ($K \in \{-1, 0, +1\}$) determining whether redundancy is usable or stranded. Resilience is therefore not treated as a trait carried forward but as a retrospective verdict applied only after disturbance reveals whether persistence occurred. This reframing retains Holling's rejection of equilibrium stability while restoring the Darwin–Elton logic that viability is disclosed under opposition rather than inferred from calm-states.

Within this architecture-first account, Constraint Topology (CT) specifies the positioned thresholds, dependencies, bottlenecks, and timing rules that define admissible corridors, and Fragility Landscape (FL) projects where stress concentrates and failure initiates under preregistered opposition profiles. In this sense, EF–CT–FL does not discard resilience; it relocates resilience from a purported equilibrium-visible capacity to a post-disturbance classification, replacing equilibrium reassurance with structural diagnosis suitable for measurement, stress-testing, and actionable forecasting under real disturbance regimes.

In this sense, resilience is not a forward property but the verdict on whether Elton's conditional pathways remained open during Darwinian scrutiny under Ω^*. Where those pathways were absent, stranded by C, or inoperable under K, the outcome is collapse regardless of calm-state appearance.

This article replaces equilibrium-centred, trait-based resilience with a conditional, architectural account in which persistence is diagnosed via EF–CT–FL rather than inferred from calm-state appearance;

resilience is retained as a retrospective verdict applied only after disturbance reveals whether any coherent route remained open (Holling, 1973).

Elton's ecology is explicitly architectural and diagnostic: communities persist while compensating routes remain and fail when disturbance exposes that those routes are missing or thinned—his "ecological explosions" are selector tests that reveal conditional structure. EF–CT–FL formalises this Eltonian stance by mapping corridors (CT) and locating initiation points of failure (FL) under Ω.

Position relative to Elton and contemporary work.

Framing CT as the structural expression of conditional pathways formalises Elton's constraint logic and clarifies why admissibility is sequence- and state-dependent—an insight convergent with modern functional connectivity studies that document temporally varying corridor use and the need to integrate structural and functional measures across timescales (Elton, 1958; Viau et al., 2024; Martínez-Richart et al., 2025).

Mechanistic grounding of FL.

The routing-failure interpretation of FL maps directly onto empirical threshold failures in eco-hydrology: widespread evidence links drought-induced hydraulic failure to mortality, with identifiable cavitation thresholds functioning as selector gates—i.e., where collapse initiates in the landscape of possible routes (Adams et al., 2017; Choat et al., 2018).

D, R, and K vis-à-vis functional diversity. Classical functional-diversity indices quantify option space (D) but often under-represent the categorical integration (K) that determines whether those options operate as a system. Re-introducing the Eltonian niche into diversity assessment emphasises roles and integration across interaction processes—precisely the layer EF assigns to K and to redundancy R as usable, not merely present, capacity (Dehling & Stouffer, 2018; Loreau et al., 2021).

Implications. Naming resilience a verdict and making EF the carried-forward architecture redirects practice from "building resilience" to safeguarding and rebuilding persistence architecture: (i) track redundancy and coherence rather than abundance alone; (ii) map CT to identify corridors, thresholds, and dependencies governing admissibility; and (iii) project FL to locate bottlenecks where failures concentrate—now with contemporary anchors in functional connectivity (time-varying access) and eco-hydrology (threshold-gate failure) (Viau et al., 2024; Choat et al., 2018).

Limitations and next steps. Mapping CT at ecological resolution remains challenging where thresholds and timing rules are partially observed; measuring K also warrants refinement. Future work should standardise EF proxies, develop reproducible CT/FL pipelines, and benchmark predictive performance against equilibrium-trait proxies across disturbance-rich datasets, prioritising systems where functional connectivity is seasonally variable and where hydraulic thresholds provide tractable FL validators (Viau et al., 2024; Adams et al., 2017).

Box 2 — Metrics after Mechanism (one rule):

Do not treat metrics as resilience. Use trait and role indices to populate EF (D, R, C, K). Then compute CT (which corridors actually exist and are reachable) and FL (where failure initiates under Ω). Only the system's behaviour under Ω licenses the retrospective name resilience.

5. Conclusions

Resilience is best understood as a retrospective verdict applied after disturbance. EF, CT, and FL provide a structural architecture for diagnosing conditional persistence. Realism belongs not to equilibrium states, traits, or prospective claims of resilience, but to the architectures that condition survival. Constraint topology, redundancy, coherence, and selector logic determine which outcomes remain possible when opposition acts. Practically, monitoring and policy should prioritise mapping corridors (CT), safeguarding redundancy (R), and stabilising coherence (K), with stress-tested profiles that make conditional persistence empirically diagnosable before the next disturbance.

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Figures

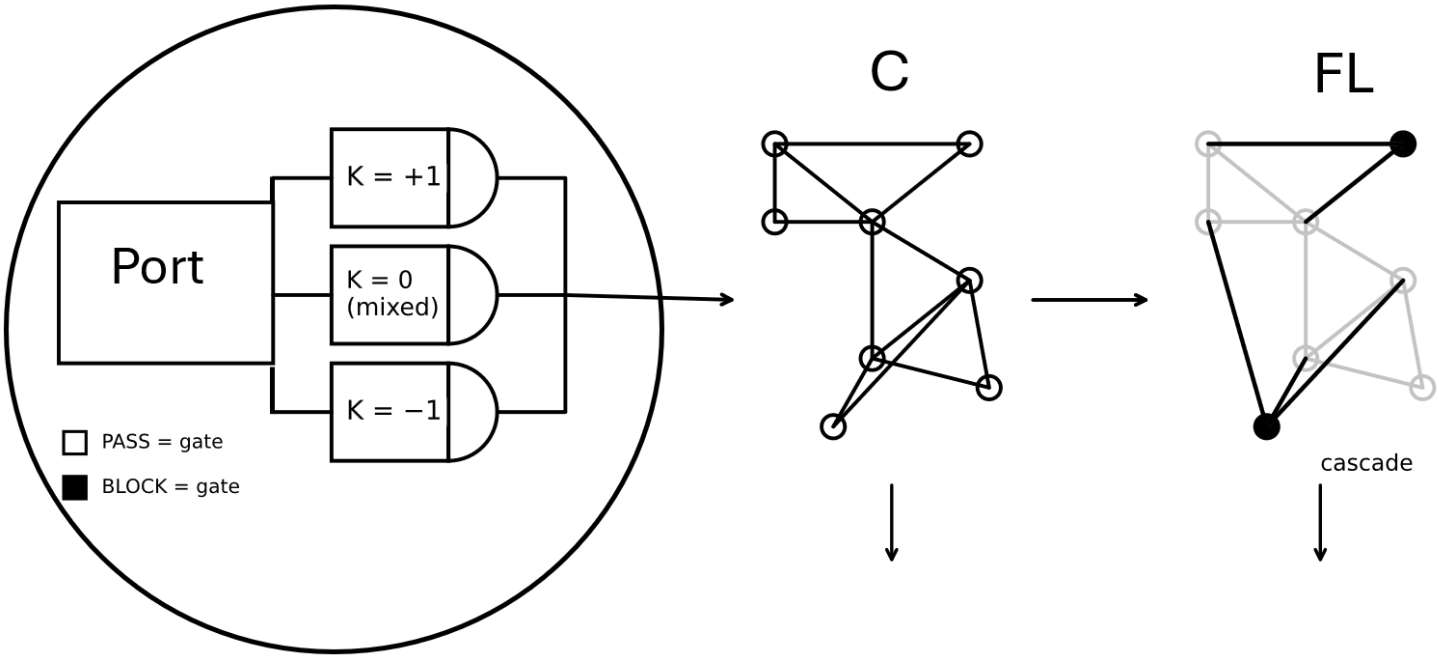


Figure 1.

Figure 1

Figure 1 summarises the operational architecture used in the analyses: packet-level ports (functional interfaces), gates (conditional thresholds on CT corridors), the Constraint Topology (CT) as the positioned network of corridors, and the Fragility Landscape (FL) as the projection of stress under a preregistered opposition profile (Ω*). Coherence (K) governs whether gates tend to PASS or BLOCK, determining whether redundancy is usable, stranded, or collapses through synchronised failure. Every small circle in the CT mesh represents a port; the enlarged port panel is a zoom-in of any CT node.