

The Unauditable Market

On what the carbon market is actually trading, why it is never going to work, and what the measurement of living systems requires to be real

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There is a building in London, just north of the Thames, where for more than seven centuries a specific kind of work has been done that almost no one thinks about. In the Goldsmiths' Hall, craftspeople sit at benches with instruments that weigh and assay metal. When a refiner or a jeweler brings an object in to be marked, the assayer scrapes a trace of material from it, tests the purity, records the result, and stamps the object with a small symbol. The symbol certifies that an independent party, paid only for the accuracy of the test, has verified what the object contains.

The London assay office was established in 1300. It has been continuously operating for seven hundred and twenty-six years. During that time, monarchies have risen and fallen, empires have been built and dismantled, currencies have collapsed, financial systems have been reinvented, and an entire industrial civilization has replaced the agrarian one that preceded it. The assay office is still there. It still stamps small symbols onto small objects. The reason it is still there – the reason every functioning gold market in the world has something like it – is that seven hundred and twenty-six years of experience have taught humanity that markets in valuable things do not work unless an independent party, with no stake in the outcome, performs the measurement.

The entire edifice of functioning markets rests on the ability of buyers and sellers to trust that what is being traded is actually what it is represented to be, and that trust is not produced by good intentions or professional ethics or regulatory oversight. It is produced by a physical, reproducible, independent measurement that anyone with equivalent equipment could replicate. Remove that foundation and the market does not gradually degrade. It collapses, usually in ways that take decades to fully understand, and always in the same direction: the party that controls the measurement extracts value from the parties that must take the measurement on faith.

I want to tell you something I believe to be true and that almost nobody in the field of ecological finance has been willing to say clearly. Every market that humanity has ever built to price living systems – to pay for the protection of forests, the preservation of biodiversity, the maintenance of watersheds, the provision of pollination services, the absorption of floodwater, the storage of atmospheric carbon – has been built without an assay office. Every one. For thirty years, we have been issuing certificates against representations we could not independently verify, certified by parties with direct interests in the outcome, traded through registries whose revenues scale with the volume of issuance, and retired in accounting exercises that no instrument ever watched happen. And for thirty years, we have been surprised, over and over, that the certificates turn out to be worth less than we thought.

They were not worth less than we thought. They were worth what the structure was capable of producing, which is nothing we could verify. The surprise was not in the result. The surprise was in how long it took to notice what the structure guaranteed.

This essay is about that structure, why it was adopted, why it failed, and what must replace it before the next generation of ecological markets – the ones being built right now, by well-intentioned people, on the same architecture that just collapsed – makes the same mistakes at a scale that will make the carbon market's failures look small. It is also about what I have been building for the last several years with a team that includes some of the most careful people I have ever worked with, and why I believe the next twenty-four months will determine whether the architecture of ecological finance shifts before mandatory disclosure regimes harden standards around the old one.

I am not writing as a disinterested analyst. I am writing as someone who is building the alternative, who believes the alternative is possible, and who thinks the field will spend another three decades failing if the architecture does not change. I am trying to persuade you. I am trying to persuade you with arguments and evidence, and I have tried to be honest about what remains unfinished and what could still go wrong. This is the most important thing I have ever written.

The claim

The voluntary carbon market did not fail because its methodologies were weak, because its verifiers were captured, or because its participants were dishonest. It failed because of a structural property that no methodology, verifier, or participant could have fixed. The market was never a market for carbon. It was a market for representations of carbon, operating alongside an atmosphere that was completely indifferent to the representations.

The atmosphere does not read certificates. It responds to physical reality. A tonne of carbon dioxide that a project developer's consultant estimated to have been sequestered, that a seller-retained verifier reviewed and approved, that a registry issued as a credit, that a buyer retired as an offset against their emissions – none of that is a tonne of carbon. It is a paper claim about a tonne of carbon. The paper and the atmosphere operate in separate systems. The paper can be issued, traded, retired, accounted for, written into sustainability reports, and counted against net-zero commitments. The atmosphere continues to absorb whatever it is physically given, regardless of what the paper says.

This is what I mean by an unauditible market. Not that the audits were insufficient. Not that the auditors were compromised. But that the thing the market claimed to be trading had no independent measurement separating the claim from the underlying physical reality. The entire edifice rested on a chain of representations – project developer to verifier to registry to buyer – with no instrument, owned by any party outside that chain, ever measuring the physical thing.

Every study conducted on the voluntary carbon market over the last decade has reached the same

conclusion. In October 2025, Oxford and Penn researchers published in the *Annual Review of Environment and Resources* the most comprehensive review ever attempted: twenty-five years of evidence, more than sixty empirical studies, every major project type. Their finding was that carbon offset programs routinely overestimated their climate impact by a factor of five to ten or more. Systematic. Deep-seated. Intractable. Incremental reform would not fix it. Most of the market should be phased out. A 2023 *Guardian* investigation of rainforest offsets from the largest certifier in the voluntary market found approximately ninety percent of examined credits were effectively phantom. A 2024 meta-analysis in

Nature Communications found eighty-seven percent of offsets purchased by the world's twenty largest corporate buyers carried high risk of non-additionality. The voluntary carbon market contracted sixty percent between 2023 and 2025.

These results were not outliers. They were the expected output of an unauditible market. The surprise was not that the numbers were wrong. The surprise was how long it took to notice.

An obvious question is why the field did not notice for a quarter-century. The answer is that in the late 1990s, when the voluntary carbon market was designed, continuous ecological measurement at scale was not possible. The cost of measuring an entire forest at the resolution needed for accurate carbon accounting was approximately the GDP of a small country. Satellite data was coarse. On-device inference did not exist. The measurement architecture I describe in this essay was technologically out of reach. Given those constraints, there were two choices: abandon the project, or build the market with estimation substituting for measurement and accept the consequences. The field chose the second path. I do not think they were wrong to try. But the institutional arrangements that grew up around estimation – the methodology bodies, verification firms, registries, consultancies – developed interests in those arrangements continuing. When the technological constraint began to lift, around 2015 to 2018, the constituencies did not dissolve and reconstitute on the new technological basis. They persisted. Institutional arrangements built under a technological constraint typically outlive the constraint by twenty to forty years, because the humans inside the arrangements reasonably believe that incremental reform is the path of least resistance. They built additional layers of procedural reform on top of the estimation architecture. What they did not do was rebuild the measurement layer, because the measurement layer had never existed and the constituencies had not been formed around producing it. The same pattern is now playing out again, in real time, at a larger scale. The people designing the next generation of ecological markets are working from the same estimation-based templates. If nothing changes, the next generation will fail for the same reasons as the first.

The distinction between verification and measurement

I want to name what I think the core psychological error has been, because I have made this error myself and I have seen the field make it for a quarter-century. The error is that we confuse verification with measurement.

Verification of an estimate is a judgment about whether the estimate was reasonable. Measurement is a physical fact. They are not the same kind of thing. The atmosphere responds to physical facts. It does not respond to judgments about reasonable estimates. The carbon market has been, for its entire operational

history, a verification market pretending to be a measurement market, and the gap between verification and measurement is the gap in which every phantom credit was issued. No amount of reform at the verification layer transforms an estimation market into a measurement market, because the verification layer and the measurement layer are different layers.

An auditable market is one in which the thing being traded can be independently measured by a party that does not benefit from the measurement outcome. The measurement is produced by instruments that are owned by the independent party. The measurement is continuous or reproducible at will. The raw data from which the measurement is derived is available for inspection, not just the summary statistics. The party that profits from higher numbers has no mechanism by which to produce higher numbers.

Gold markets are auditable. An assay office, paid for the assay and not for the result, receives a physical

sample and runs a reproducible chemical analysis. The refinery cannot change the answer. The buyer can have the sample reassayed at any other assay office and get the same answer. The measurement is physical, independent, and reproducible. This is why gold markets have functioned, with variation only in ornament, for approximately two thousand years.

Equity markets are auditable at the measurement level that matters. The price at which a trade executed is recorded by an exchange that does not benefit from the price being higher or lower. Quarterly earnings are audited by independent accounting firms whose professional licenses depend on the audit being accurate, subject to SEC enforcement and litigation risk. The arrangements are imperfect. When they fail – Enron, Worldcom, the 2008 structured credit rating failures – they fail visibly, attribution is possible, and the system reforms. That is what an auditable market looks like when it is working. The failures are detected, attributed, and corrected.

The carbon market's failure mode is not reparative. It is cumulative. Phantom credits issued in 2012 are not retrospectively unretired when a study in 2023 proves they did not represent real sequestration. The corporate buyer's net-zero claim remains on the record. The compensation paid to the project developer remains in their bank account. The atmospheric CO₂ that was supposed to be offset was never offset. The market continues. The constituencies continue. The failure accumulates.

What measurement requires

The path forward is to build the measurement layer that the first generation of ecological markets was never able to build. This is a technical claim, and I want to be specific about what it involves, because most discussions of "better measurement" in this field remain at a level of abstraction that does not commit to anything.

Measurement means three things, operationally.

First, the instruments are owned by an independent party. Not by the project developer. Not by a consultant the project developer retains. Not by a verification firm the project developer pays. By an entity whose compensation does not depend on the numbers coming out a particular way. This is the

single most important architectural decision, and almost every existing ecological market has gotten it wrong. The instrument ownership is the measurement. When I say "independent measurement," I mean instruments owned by an independent party – not a review of measurements owned by an interested party.

Second, the measurement is continuous, and the raw data is public. Not periodic. Not a snapshot. Not a retrospective sample. Continuous data streams from physical sensors, flowing to a public registry without human intervention at the collection stage. The raw data is auditable at any time by any party. This is how the gold market works. This is how equity markets work. This is how every other functioning commodity market in human history has worked. The continuous, public, physical data stream is what makes the market auditable.

Third, the measurement captures the full dimensionality of the thing being priced. For carbon, one variable was almost enough – if you only want to know how much carbon is stored, carbon stocks is the variable. But ecosystems are not stocks of a single gas. They are multidimensional living systems. The international standard for this measurement already exists. The UN Statistical Commission adopted the System of Environmental-Economic Accounting Ecosystem Accounting in March 2021. More than thirty-four countries have implemented it. It defines ecological condition across six dimensions: physical,

chemical, compositional, structural, functional, and landscape. This is not my methodology. This is the international statistical standard, adopted by the body that also defines the System of National Accounts every country uses to measure GDP. A market that prices one dimension of ecological condition will systematically degrade the other five, because participants will optimize for the priced dimension at the expense of the unpriced dimensions. This is what happened when the carbon market drove monoculture plantations that stored carbon while destroying biodiversity, depleting water tables, and degrading soil. The one-dimension failure is structural, not accidental.

An auditable ecological market, built on continuous independent measurement across all six SEEA EA dimensions, produces an instrument that is categorically different from a carbon credit. I call this instrument an Earth Credit. It is not a better carbon credit. It is a different kind of thing. A carbon credit is a paper claim about a single variable, retrospectively estimated, verified by an interested party. An Earth Credit is a continuous record of six-dimensional ecological condition, physically measured by independent instruments, aggregated using a penalized geometric mean that cannot be gamed by optimizing one dimension at the expense of another. It is minted conservatively at the lower bound of the measurement confidence interval, anchored to a legal instrument on a specific piece of land, retired into a permanent public record that remains verifiable against ongoing sensor data after the retirement.

Each piece of that architecture is a design response to a specific failure mode of the carbon market. The independent instrument ownership addresses the measurement-by-interested-party failure. The continuous measurement addresses the retrospective-estimation failure. The six-dimension aggregation addresses the single-variable-optimization failure. The penalized geometric mean addresses the gameable-aggregation failure. The conservative minting at the confidence interval lower bound addresses the optimistic-point-estimate failure. The legal anchoring addresses the double-counting and boundary failures. The public retirement record addresses the opacity failure.

None of these elements are speculative. Each has operational precedent in adjacent markets. The assay office model is seven hundred years old. Continuous public data feeds are how all financial market infrastructure works. Six-dimensional ecological measurement is implemented in peer-reviewed literature. The penalized geometric mean is the aggregation method of the UN Human Development Index. The legal anchoring is adapted from conservation easement law, which has been tested for decades. The public retirement record is how carbon retirements already work, with the additional requirement of ongoing verifiability.

What does not yet exist is the combination of these elements into a functioning market. That is the work.

The separation problem

There is a second structural flaw in existing ecological markets, and it compounds the measurement problem. In the carbon market, and in most emerging biodiversity credit schemes, the functions that should be structurally separated are not separated.

The project developer verifies the project. The methodology body certifies the methodology, often with substantial input from the project developers whose credits will be issued under that methodology. The registry issues the credits and collects fees that scale with issuance volume. Sometimes the same institutional actor spans the entire chain – setting methodology, certifying projects, operating the registry, administering the marketplace. Each of these combinations creates a conflict of interest whose consequences are predictable and whose mitigation through ethical commitments is predictably

inadequate.

Other commodity markets handle this differently, because they have learned – usually through catastrophic experience – that mission-driven sincerity is not a substitute for structural separation. The organization that assays gold is not the organization that trades gold. The auditor that certifies a company's financials is not the investment bank that underwrites its offerings. The weather service that issues the forecast is not the insurance company that prices policies against the forecast. These separations are not cultural norms or best-practice recommendations. They are structural features – legal, governance, operational – that make the conflicts impossible to act upon rather than merely discouraged.

The ecological finance field grew up inside environmental nonprofits and conservation-linked consultancies, where institutional culture was mission-driven, where everyone involved genuinely cared about protecting nature, and where the concentration of functions inside single organizations was obscured by shared good intentions. This is how many of the largest failures in financial history have begun. The mortgage-backed securities crisis was not driven by malicious actors. It was driven by people who genuinely believed the models they had built were reliable and who had no institutional check on that belief. The carbon market's failures have been driven by exactly this pattern – an interconnected field of professionals, all deeply committed to environmental protection, none of whom had structural incentives to say that the system they had built was not working.

The design principle for a functioning ecological market is structural separation imposed through legal and governance mechanisms, not assumed through cultural commitment. The entity that measures the

ecosystem must not trade credits, hold credit inventory, or influence credit prices. The exchange on which credits trade must not control the methodology by which credits are defined. The investment fund that aggregates capital into ecological assets must not influence the underlying measurement. The market makers providing liquidity must be independent of the issuer. Each entity performs one function. The separations are structural, so that no actor can benefit from distortions in any function other than their own. This is how markets work, when they work, across every other commodity category humanity prices.

This design is not an accusation against the existing ecological finance community. Many of the people operating in that community are people I admire, who have done important work under difficult constraints, and whose judgment I trust in many ways. The argument is not that they are dishonest. The argument is that the structural arrangement they inherited was never compatible with reliable measurement, and that reforming the arrangement – rather than replacing it – cannot solve the problem. You do not fix a market by making the people who run it better. You fix it by changing the structure so that whether the people are better or worse is no longer the determining variable.

What I have been measuring

I have spent years going to places to see whether the animals were still there.

Sumatra, watching for tigers down to fewer than 500 individuals across an island losing primary forest at a rate the official maps do not capture. Rwanda, in cooperatives at the edges of ecosystems that had collapsed within living memory and were now being slowly, uncertainly rebuilt. Madagascar, documenting a forest where a grassroots model was keeping a critically-endangered lemur from extinction. The Chocó in Ecuador, surveying terrain that had never been formally mapped because no one had gone there with the right equipment. Patagonia, tracking pumas through Torres del Paine. Dominica,

photographing whales on their breeding grounds and working with a marine NGO on the specific conservation problem I have spent the most technical effort on.

I went to these places because I wanted to know whether the specific animals were still there. Not in the population-statistic sense. In the sense of: is this individual tiger, this individual whale, this specific family of orangutans, still occupying this specific place. The question sounds small. It is actually the foundational question of conservation, and almost no one can answer it at scale, because the infrastructure to answer it did not exist until very recently and still does not exist for most species in most places.

Identifying an individual humpback whale is a specific kind of problem. A humpback is a specific being with a specific life. It is born in a specific tropical breeding ground, migrates annually to a specific polar feeding ground, has a skin pigmentation unique to that individual, lives for decades. Without a system to identify it as an individual, it is anonymous to science. It is one whale among many, indistinguishable from its neighbors, invisible in any record that treats whales as a population statistic rather than as a collection of individuals. The Whale ID system I built uses multiple deep learning models to extract per-body part embeddings from an underwater photograph and search a database of known individuals for a match. The first time the system resolved a match above 90% similarity, a humpback whale that had

never before been identifiable as an individual became permanent in a record that can be checked, extended, and verified by anyone with access to the system, forever.

That is the moment I keep returning to. Not because the technology was impressive. The technology was borrowed – deep learning models, computer vision pipelines, running on commodity cloud infrastructure. The moment was not about the code. The moment was that a specific being, who had been invisible as an individual for her entire life, became visible. The record of her existence could not be revised after the fact. It could only be extended. Every subsequent sighting of her would be matched back to that first photograph. The file in the database was permanent in a way that the whale herself, in her specific lifetime in the specific ocean, was not.

The technology outlasted the animal that it made permanent. That is what conservation technology does when it works.

I am a wildlife photographer. It is on my LinkedIn, listed after finance and baseball, and it is not decoration. I have carried a camera into every one of the places I just named, because a photograph is the same kind of artifact as a transaction receipt. It is a verifiable record of a moment that would otherwise be invisible and ephemeral. The image of a specific puma in Torres del Paine, on a specific morning, with specific light, cannot be revised after the fact. The animal in the image was there. The image is evidence. The evidence compounds.

That experience – years of trying to make specific animals permanent in specific records – is what taught me what a market for living systems would actually need to be built on. Not testimony. Evidence. Not estimates reviewed by interested parties. Physical measurements produced by independent instruments. The same principle that makes a photograph trustworthy makes an ecological market trustworthy: the record is produced by an instrument that does not benefit from the record coming out a particular way.

This is what the carbon market has never had. The photograph. The measurement. The evidence that the specific thing was there, in that specific place, at that specific moment. What the carbon market has had instead is testimony – project developers testifying about counterfactual forests that would have been cut down but were not, consultants testifying about sample plots extrapolated to landscapes, auditors testifying about whether the testimony was plausible. Testimony is not evidence. Testimony is what you

get when evidence is not available. For twenty-five years, evidence was not available for ecological systems at scale. Now it is.

When I look at the carbon market's failures, what I see is a market that priced testimony at the rate of evidence. The projects that claimed to protect forests, and did not. The additionality claims that turned out to be wrong when actually investigated. The permanence claims reversed by fires and logging that the registries did not track. The baseline scenarios that assumed futures which never arrived. In each case, the underlying physical reality was not what the testimony said it was, and the testimony could be revised – quietly, incrementally, defensively – when the gap became embarrassing. The market accepted the testimony and continued trading.

The carbon market was never trading carbon. It was trading testimony about carbon. The atmosphere does not accept testimony.

What I am building is the ability to construct a record that is evidence, not testimony. Continuous measurement from physical sensors. Public registries with on-chain retirement. Six-dimensional aggregation that cannot be gamed. Conservative minting at the lower confidence bound. Legal instruments anchored to specific acres of specific land in specific counties. Separation of the entity that measures from the entity that trades, from the entity that aggregates capital, from the entity that prices prediction markets, so that no actor has a position of structural conflict across the value chain. Each piece is designed to make the record unmanipulable by the people who profit from it, and auditable by everyone else. This is not a better carbon market. It is a different kind of thing. It is the photograph rather than the testimony.

A system that can be checked is categorically different from one that cannot. I came to this principle not from finance, but from the jungle and the ocean – from years of trying to answer whether the specific animals were still there. The answer to that question, when you can actually answer it, is a permanent artifact. The answer to whether a specific acre of land is producing a specific six-dimensional ecological condition, when you can actually answer it, is the same kind of artifact. Continuous. Physical. Auditable. Permanent. The Earth Credit is the photograph of the acre.

What the Earth produces

The Earth produces. Every day, continuously, in ways that are astonishing when you actually look at them. It produces oxygen through photosynthetic organisms that have been performing this function for billions of years. It produces water through cycles humans had to reverse-engineer to understand. It produces soil through microbial processes that are still only partially characterized. It produces species through evolutionary mechanisms whose rate and direction are themselves ecological variables that scale with the health of the underlying systems. It produces, somewhere in the calculation, the possibility of civilizations like ours.

Every calorie of food, every liter of fresh water, every cubic meter of breathable air, every molecule of the pharmaceuticals that keep us alive past what our ancestors could imagine – all of it is drawn from these systems. For most of human history, the impact of our activity on biological systems was local, slow, and recoverable on timescales shorter than the duration of civilizations. This condition no longer holds. Our scale has crossed a threshold. The systems that produce the conditions for our existence are now showing signs of strain measurable within single generations. Markets are the most efficient coordination mechanism human beings have developed for allocating resources under conditions of uncertainty and

distributed information. When a resource has a price, decisions about that resource get made by everyone who interacts with it, in ways that aggregate into outcomes no central planner could produce. When a resource does not have a price, it gets overused. This is as true of the biosphere as it is of any other resource category. The free provision of ecosystem services has produced the overuse we now observe, not because the users are bad people but because the users face no signal.

But the pricing, to matter, has to measure what is actually there. A pricing system that does not measure the physical reality cannot produce decisions that bring human activity into alignment with the physical reality. It can only produce decisions that bring human activity into alignment with the representations. This is what the carbon market has done for twenty-five years. The atmospheric concentration of CO₂ has continued to rise. The rate of biodiversity loss has continued to accelerate. The market has absorbed the capital and produced representations. The question is whether the next pricing system measures what the Earth produces, or measures representations of what it produces.

What is unfinished

I want to be direct about what is built and what is not, because the carbon market's credibility problem was partly a credibility problem – promises that outran the evidence – and I have no interest in reproducing that pattern.

The sensor architecture is specified and each component is commercially available. The integrated system has not been field-tested. The first draft of the measurement methodology is complete – 1,500 lines of specification, 32 indicators, 40+ citations, aligned with SEEA EA – and has not yet been validated against field data. We call the aggregate metric the Ecological Condition Index, or ECI: a penalized geometric mean across all six SEEA EA dimensions, designed so that collapse in any single dimension drops the overall score dramatically, preventing the single-variable optimization that drove carbon-market monocultures. First ECI computation from real sensor output occurs in Phase 1. Full annual validation extends into Phase 2, because a year of data takes a year. The legal instrument – what we call a Nature Rights Deed, or NRD – is a county-recorded conveyance of the right to measure and issue credits from a specific property, designed to stack on top of existing conservation easements and carbon program commitments rather than replacing them. It has been designed in conversation with numerous advisors and has not been executed on a real property. Phase 1 includes the first execution. The registry architecture is clear but not yet production-grade. Phase 2 builds it. The exchange does not yet exist. Phase 3 builds it.

The demand side is early. The voluntary biodiversity credit market is currently around five to ten million dollars globally. The UK Biodiversity Net Gain regime, effective February 2024, is the first mandatory biodiversity credit market in the world and prices statutory credits at £84,000 per unit. The EU Corporate Sustainability Reporting Directive requires nature-related disclosure from approximately fifty thousand entities. The Taskforce on Nature-related Financial Disclosures has adoption commitments from 526 companies with \$6.5 trillion in combined market capitalization. These regimes will require verified ecological data at scale. The measurement infrastructure to supply that data is what I am describing.

I have been building this with Greg Curtis, who as Patagonia's Deputy General Counsel helped structure the transfer of the company to nonprofit ownership, and who as founding Executive Director of the Holdfast Collective – Patagonia's nonprofit shareholder holding 98% of the company's shares – oversaw one of the most consequential corporate governance decisions of the last decade. Greg designed the

Nature Rights Deed that anchors the Earth Credit to specific land. Our domain is landseed.earth. The company is a Public Benefit Corporation. It is called Landseed.

This essay is me telling you it exists, what it is for, and why I believe the next decade of environmental finance will be defined by the decisions made in the next twenty-four months about whether ecological markets continue on the estimation architecture that the carbon market just proved does not work, or begin on the measurement architecture that is now possible for the first time in human history.

A note to the people who have been building the other market

If you have been working inside the estimation-based carbon market – as a methodology expert, a verification firm principal, a registry operator, a corporate buyer, a consultancy partner – I want to address you directly, because I think the honest conversation is worth having and because the energy the field has historically put into defending the existing architecture would be more productive if it were redirected.

The architecture you have been operating inside was designed under technological constraints that no longer exist. The evidence that the architecture has not worked has been accumulating for at least a decade and is now overwhelming. I am not the person saying this. The Oxford-Penn meta-review is saying it. The Guardian investigation said it. The Nature Communications meta-analysis said it. The voluntary carbon market itself, by contracting sixty percent in two years, has said it. The architecture does not work. The evidence that it does not work is a matter of scientific and market consensus. Continuing to layer procedural reforms on top of it will not make it work, because the architecture's failure modes are not procedural.

You are not responsible for the fact that the architecture did not work. The people who designed it in the late 1990s made the best choice available under the constraints they faced. I said earlier in this essay that I do not think they were wrong to try. What is true, and what the field has been reluctant to confront, is that the constraints that made estimation necessary have lifted, and the architecture estimation required has not lifted with them. The work of the next decade is not the further refinement of the estimation architecture. It is the construction of the measurement architecture that the estimation architecture was substituting for.

I would rather do this work with you than against you. The field contains enormous accumulated expertise – in ecology, in methodology design, in registry operations, in the legal and regulatory structure of ecological markets, in corporate buyer relationships, in integrity governance – and most of that expertise is directly relevant to building the measurement architecture. What has to change is not the people. It is the architecture they are working inside.

If any of this is landing for you, I would like to hear from you. I am not going to ask you to abandon anything. I am going to ask you to consider whether the architecture you have been operating inside is the one the next decade needs, and whether the skills you have developed would be better applied to the construction of the replacement. My view is that they would be. My door is open for that conversation.

The stakes

The pricing of ecological condition is the mechanism by which the scale of human activity could, in principle, be brought into alignment with the capacity of the living systems that support it. A market that accurately prices ecological condition would cause millions of individual decisions – about land use,

about agricultural practice, about corporate procurement, about capital allocation – to begin accounting for a variable that has been effectively free for civilizational-scale time periods. The effect, if the pricing were accurate, would be transformative at a scale that is difficult to exaggerate.

If the pricing is inaccurate, the market does not produce that effect. The market produces something worse than nothing. It produces the illusion of transition, the moral cover of participation in nature-related disclosure, the comfort of having a sustainability report, without the underlying change in physical reality. This is what the carbon market has been doing for twenty-five years. The market has absorbed the capital and produced representations.

The question in front of us now is whether the next generation of ecological markets – which will be much larger, much more embedded in mandatory regulatory regimes, and covering much more of the environmental economy – is going to repeat this pattern at a larger scale, or whether it is going to be built on a different architecture. I am describing the different architecture. I am not the only person who can build it. I am telling you about it because the window for changing the architecture is the window between now and the point at which the mandatory disclosure regimes – UK BNG, EU CSRD, TNFD, SBTN, the post-Kunming-Montreal national commitments – harden their standards around the estimation architecture. That window is closing. Once the standards harden, the cost of rebuilding them is an order of magnitude higher than the cost of building them correctly the first time.

I am building Landseed because I believe the window is still open. I am publishing this essay because I believe the window is closing, and the number of people who understand what needs to be built is too small for the work to be done quietly. If we get this right – if the measurement architecture becomes the foundation of the next generation of ecological markets – the effect on the relationship between human civilization and the living systems that sustain it will be one of the more consequential shifts of this century. If we get it wrong, we will have spent the second twenty-five years of ecological finance building the same kind of market the first twenty-five years proved could not work, in the period during which the biosphere's margin for error became narrower than at any point in the history of our species.

I am not neutral about which of these paths I want to live in.

What I am asking

This essay is the first public statement of a body of work that I have been building for years, largely in private, with a small group of collaborators, without trying to be visible. I am making it public now because the work is at a stage where private building is no longer sufficient. The measurement infrastructure that needs to exist is larger than any single entity can construct. The regulatory landscape is moving. The window for first-mover architectural decisions is open and closing. The operational constraint, from this point forward, is not technical execution. It is the construction of a network of people who understand what is being built, why it matters, and what their own work contributes to it.

If you are an investor: understand the structural difference between the estimation architecture and the measurement architecture, and apply that distinction when you evaluate opportunities in this space. The vocabulary is going to converge. Every new entrant in nature-related finance will use similar language about biodiversity, ecosystem services, and verified impact. The distinction that will matter is whether the underlying architecture involves continuous independent measurement or whether it is reconstructed estimation with a new vocabulary. That distinction determines whether the market can work. Most of what you see will be the latter.

If you are a scientist: the methodologies for six-dimensional ecological condition measurement need external review, calibration, publication, and eventually governance by an open standards body. I am looking for peer reviewers, calibration collaborators, and eventually methodology board members who can carry this work out of any single company and into an open standard that multiple operators can build against. If that work interests you, it is available.

If you are a conservation landowner or a land trust executive: there is an alternative to the twenty-year carbon contract that locks your property into single-dimensional carbon optimization. The instruments we are building stack on top of existing conservation easements and existing carbon program commitments, where the legal stacking is possible, rather than replacing them. The additional revenue comes from the additional dimensions of ecological condition the carbon market cannot price. If that is interesting to you, I want to talk.

If you are a regulator or a standards-body participant: the standards you are drafting for TNFD technical guidance, SBTN methodology, CSRD implementation, and Article 6 under the Paris Agreement will determine whether the next generation of ecological markets inherits the estimation architecture or begins on the measurement architecture. That decision is being made now, in your committees, with your input. I would like to provide technical and operational detail on what the measurement architecture involves, so that the standards you draft reflect what is possible rather than what was possible in 1998.

If you are someone considering what to build with your working life: the construction of ecological measurement infrastructure is one of the very small number of projects available right now where technical capability, ecological literacy, and market design intuition combine into a domain that is strategically open, materially consequential, and structurally resistant to the pathologies of adjacent markets. The people who can do this work are in short supply. I am hiring for some of it. Other entities are hiring for other parts of it. If this is the work you want to do with your next ten years, it is available.

The technology now exists to build a pricing system that measures what the Earth actually produces. Sensor networks, continuous data, public registries, six-dimensional aggregation, structural separation, conservative minting. The architecture exists in specification form. The components are commercially available. The legal instruments are drafted. The regulatory trajectory is moving toward requiring exactly this kind of measurement. What is missing is the deployment, the temporal datasets that no retrospective analysis can reconstruct, and the structural decisions about whether the market will be built on

measurement or on another generation of estimation.

The Goldsmiths' Hall has been operating for seven hundred and twenty-six years because someone, in 1300, decided that the measurement of gold was important enough to require an independent party paid only for the accuracy of the measurement. That decision did not produce the gold market by itself. The gold market existed before. What the decision produced was a gold market that could be trusted, that could scale, that could support a civilization's worth of financial infrastructure on top of it. The decision, made once, compounded for seven centuries.

We are at the equivalent moment for ecological markets. The question is not whether there will be a pricing system for nature. There will be. The mandatory disclosure regimes are already being written. The question is whether the pricing system measures the thing, or measures representations of the thing. The answer will compound for a long time.

I am building Landseed because I want to live in the world where the pricing system measures the thing. I am publishing this essay because I want to find the people who want to live in that world with me. The

next twenty-four months are when the decision gets made. There is a lot to do.

The quest is hard. The version that would have been easier has already been tried. The easier version is what we have been watching not work for twenty-five years.

Everything that comes after this essay begins with sensors in the ground.

Alex Roessner

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If this landed for you – in recognition, in challenge, or in the particular discomfort of seeing a system you have been working inside described from the outside – I would like to hear from you. The work ahead is larger than any single entity can carry. If you are one of the people who can help build it, my door is open.