



IN VIRIDIAN

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Viridian's Three Verticals

An Integrated Natural Infrastructure Platform

1. Forest Infrastructure Services [FIS]

- Partnering with local stewards offering forestry services
- Supporting administrative practices, strategic growth & pursuit of catalytic opportunities.

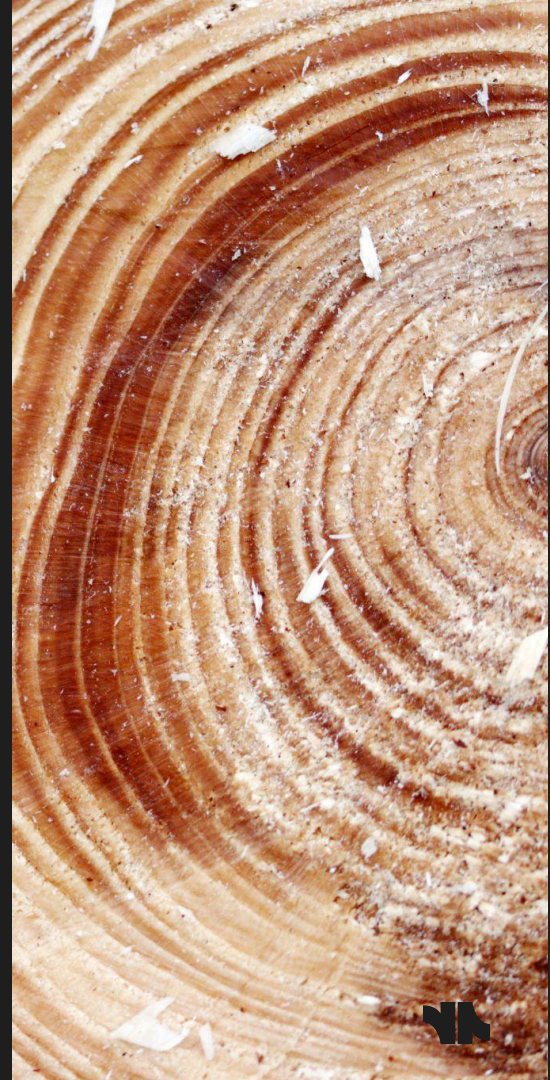
2. Forest Infrastructure Capital [FIC]

- Financial instruments notation to support a modern forestry work force and an evolving marketplace
- Debt capital market solution for addressing wildfire in the WUI and beyond.

3. Global Advisory

- Advising & development of NbS and sustainability strategies with NGOs and Family Offices.

<https://www.viridian.eco/>



01

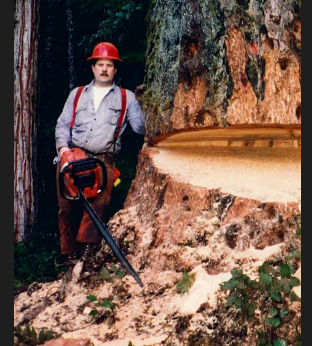
Historical Framing

Innovation and investment in forestry practices are economically intertwined across the pipeline of services and practices.

Post-Settlement Origins



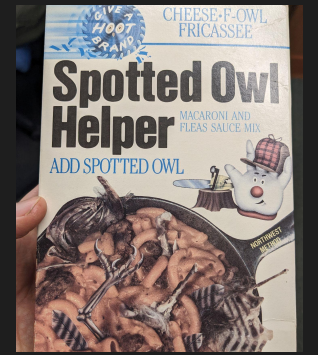
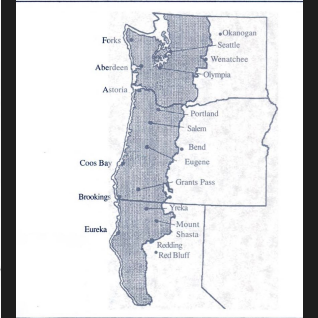
Peak Extraction and Subsidies



1990s Environmental Inflection & Rupture

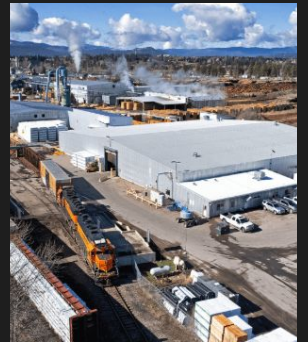


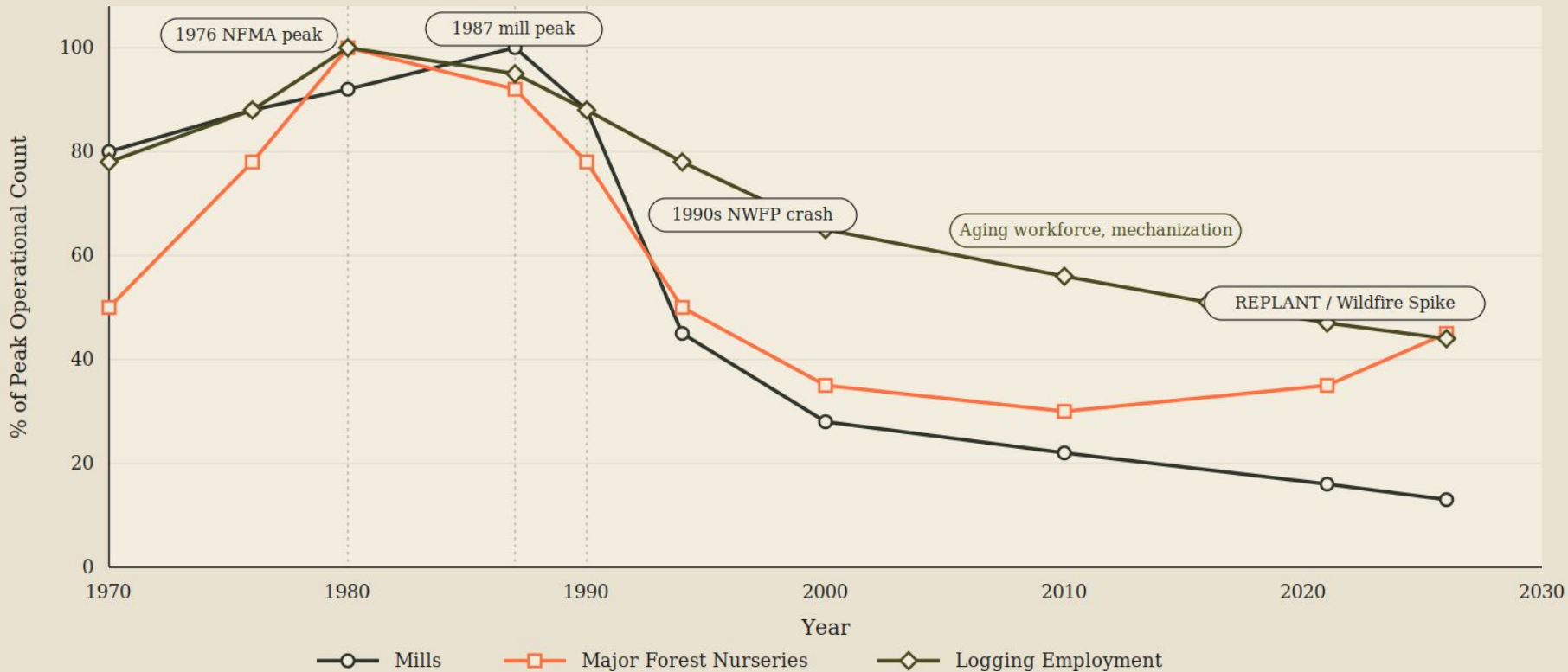
Area Included in the Northwest Forest Pla



HISTORY — WESTERN ECOLOGY & ECONOMIES INTERTWINED

40 Years of Accelerating Change





Western Forest Infrastructure & Labor Trends, 1970 to 2026

Source: Adapted from Dumroese et al. (2012) and Crandall et al. (2025).

Each series indexed to its own peak year (=100). Mills peak 1987, nurseries peak 1980, logging employment peak ~1980. Western US scope for mills; national scope for nurseries and employment. 2026 endpoint is reported through 2024 with a one-year forward extrapolation. Series are stylized to peak-relative form for cross-sector comparison; absolute counts available on request.

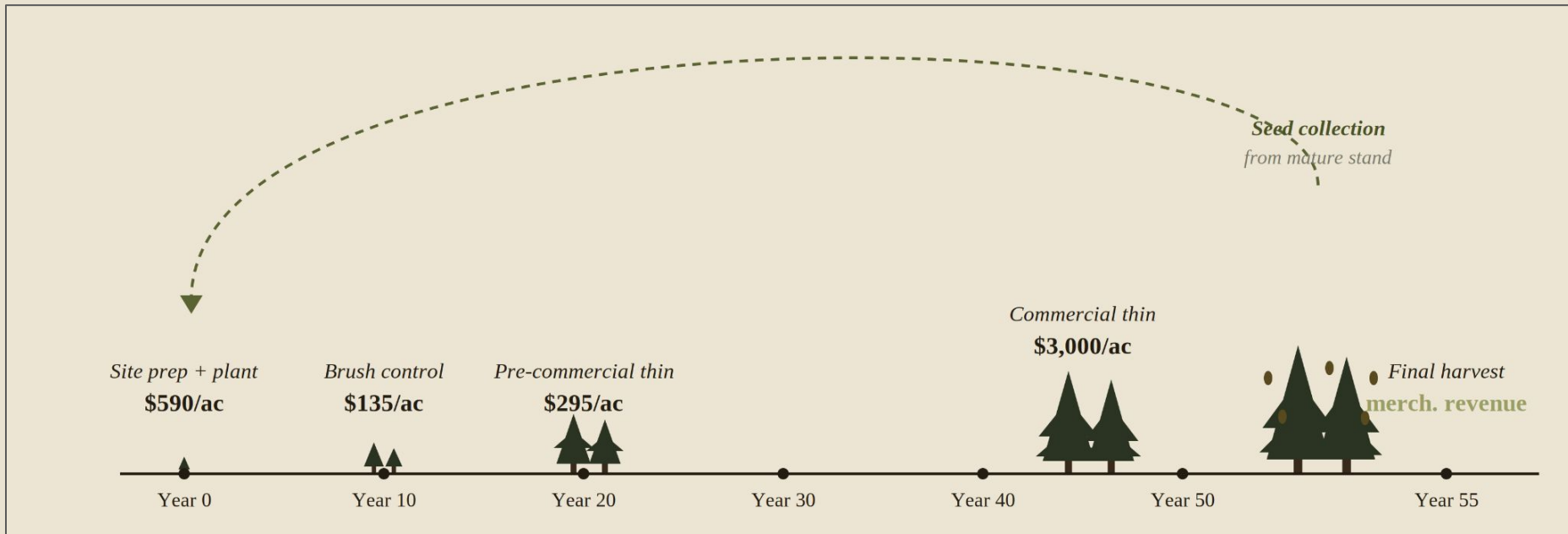


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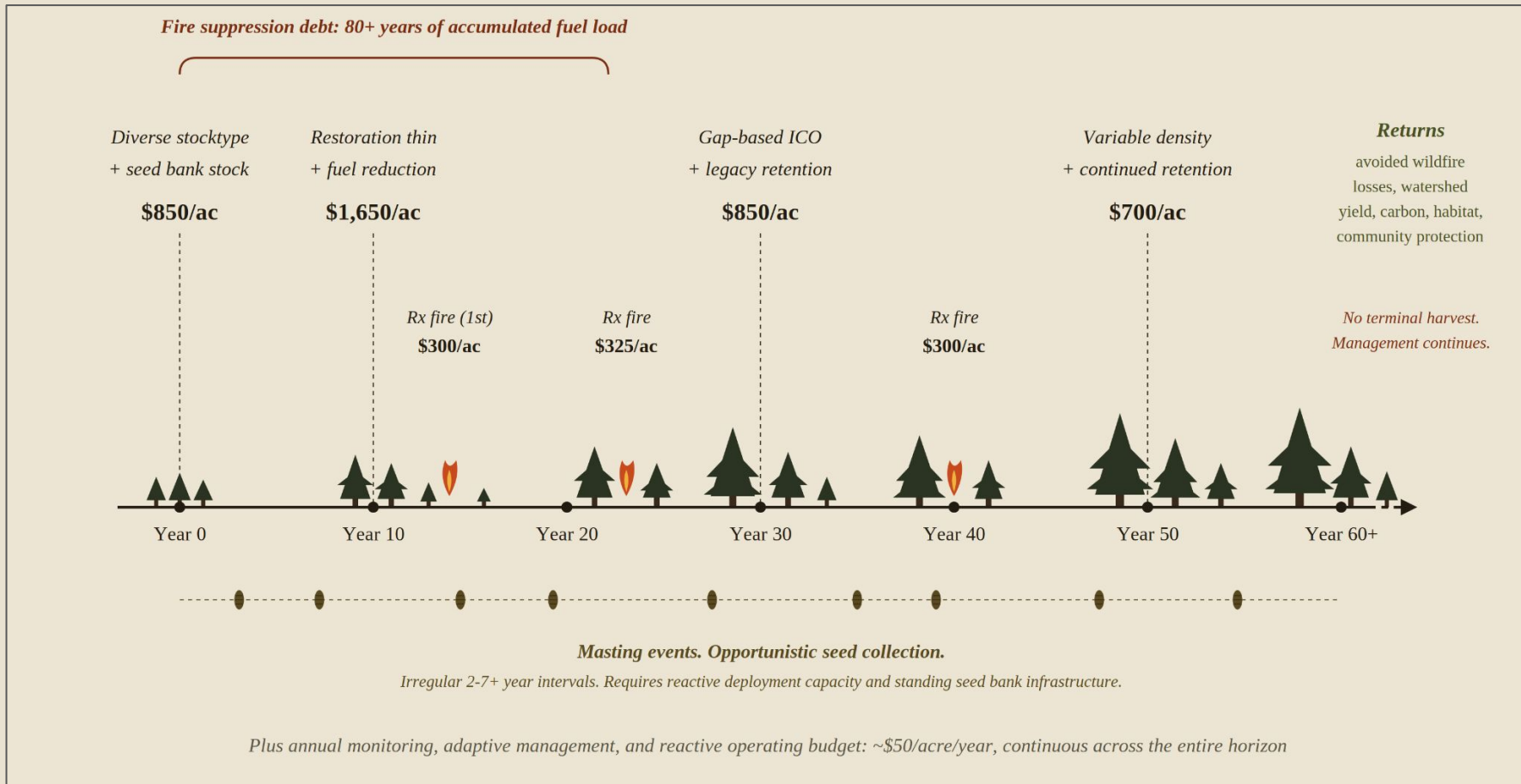
Costs Vary

No forest is the same, nor ownership objective. Costs often correlate to labor pool/quality and project size. No one-size-fits-all model just favorable or unfavorable unit economics.

Model of tending costs (e.g. industrial/agronomic)



Model of tending costs (e.g. ecological/restoration)



Source: Forest Biometrics Research Institute 2016 & 2019 Silvics Cost Assessment Survey data, with inflation adjusted baseline costs for 2025.



03

Fundamentals

A brief review of the process.

...because the technology only makes sense against the operational sequence it serves.

Reforestation Planning

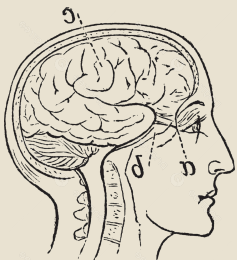
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The Pipeline

The reforestation pipeline is a cycle, not a checklist.

Each project closes a loop that started 3–7 years earlier with seed planning and ends with monitoring data that feeds the next budget cycle.

Multi-year obligation embedded at every stage.



Outlook & Budgeting

Seed Planning & Collection

Seed Extractory & Bank

Nursery Operations

Reforestation Rx

Site Preparation

Seedling Packing, Cold Storage & Transport

Outplanting

Survey & Reporting

Profit & Loss



Reforestation Planning

03

Decision Variables

Project objectives drive every downstream decision.

Species, stocktype, tooling, density, crew, window, budget — all flow from the foresters' answer to **"what are the objectives and risks for this area/unit/stand, and on what timeline?"**



Project Objectives

Species

Stocktype

Tool(s)

Planting Spacing and/or

Trees per Acre

Crew Size/Availability

Planting Season & Window

Budget & Expenses

Survey & Reporting

Outlook & Budgeting



The Target Seedling (or Plant) Concept



Key considerations

1. Objectives of outplanting project/program
2. Type of plant material
3. Source of genetic material (no longer just seed or scion)
4. Limiting factors at outplanting site
5. Outplanting window (& timing)
6. Outplanting tools (or systems)



04

Innovation

What's actually deployed, what's under deployed, what's over promised — and what should change how you spend your attention.

The Reforestation Technology Stack

01

Nursery Technology

Seedling production, sensors, hardening, physiology.

02

Robotics

UAVs and terrestrial systems for site prep, planting, monitoring.

03

Biotechnology

Somatic embryogenesis, genetic engineering, propagation.

04

Microbial Enhancement

Mycorrhizal and endophyte inoculation, site-matched.

05

Site Prep & Pest Deterrence

Herbicides, repellents, shelters, regulatory.

06

Software & AI

Planning, MRV, remote sensing, decision support.



Nursery Technology



01

Seedling production

- **Stocktype**
 - Bare-root vs. container; sortable vs. fixed systems
- **Container**
 - Styrofoam vs. plastic vs. paper. Recyclability and root architecture trade-offs
- **Automation**
 - Sensor-driven irrigation, nutrition, and climate control. Targeted growth and hardening.
- **Physiology measurement**
 - Chlorophyll fluorescence (F_v/F_m) in addition to root growth potential, water potential.
 - Non-destructive readouts that predict field survival



Robotics

02

For dull, dirty, & dangerous jobs

- UAVs for seed/seedling/herbicide delivery, survey/monitoring, & mapping
- Terrestrial systems for chemical site prep and planting containerized seedlings
- Safety vs. precision vs. cost tradeoffs
- Paired with AI & improved regulatory environment there will be leaps forward

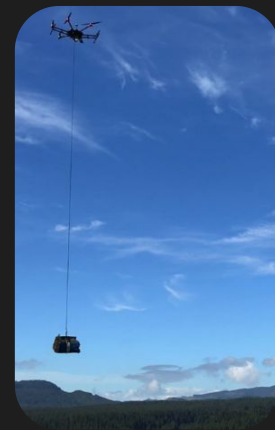


Robotics

02

The validation gap

- Hand-planted benchmark: ~80% first-season survival across 297 Interior West fires, 69,245 seedlings (Davis et al. 2024)
- No published Western conifer dataset shows aerial seeding matching that benchmark at cost
- Operational cost of power/fuel still a factor
- Cost of manufacturing and deploying myriad robotics will decrease over time, keep watching this space!



Biotechnology

03

Lab to forest

- **Somatic embryogenesis & synthetic seed (commercial, narrowing risks)**
 - Embryos generated from somatic cells in a bioreactor
 - Propagules without cones, pollination, or seed orchards
 - Cryo-bankable embryogenic cell lines store recalcitrant species indefinitely (oaks, dipterocarps, conifers that)
 - AI driven protocol-prediction software to improve output
- **Transgenic engineering (preprint stage, no FSC pathway)**
 - Photorespiration bypass: rerouted metabolic pathway claims faster CO₂ fixation per unit light and water
 - Engineered metal accumulation for in-situ rot resistance and extended carbon storage

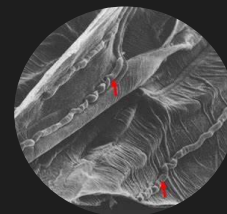


Microbial Enhancements

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Harnessing the phytobiome — “bugs in jugs”

- Stress tolerance, survival and growth enhancement
- **DNA-sequencing** native fungal communities from healthy reference forests
 - Identifying **mycorrhizal community compositions** associated with faster tree growth (and carbon capture)
 - Reintroducing those native fungal communities at nursery
- The commercial bet is that site-specific community matching
 - Converts mycorrhizal inoculation from "unreliable" to "site-targetable."
- **Endophytes** — the parallel underdeveloped track.



Site Prep & Pest Deterrence

Site Prep & Pest Deterrence

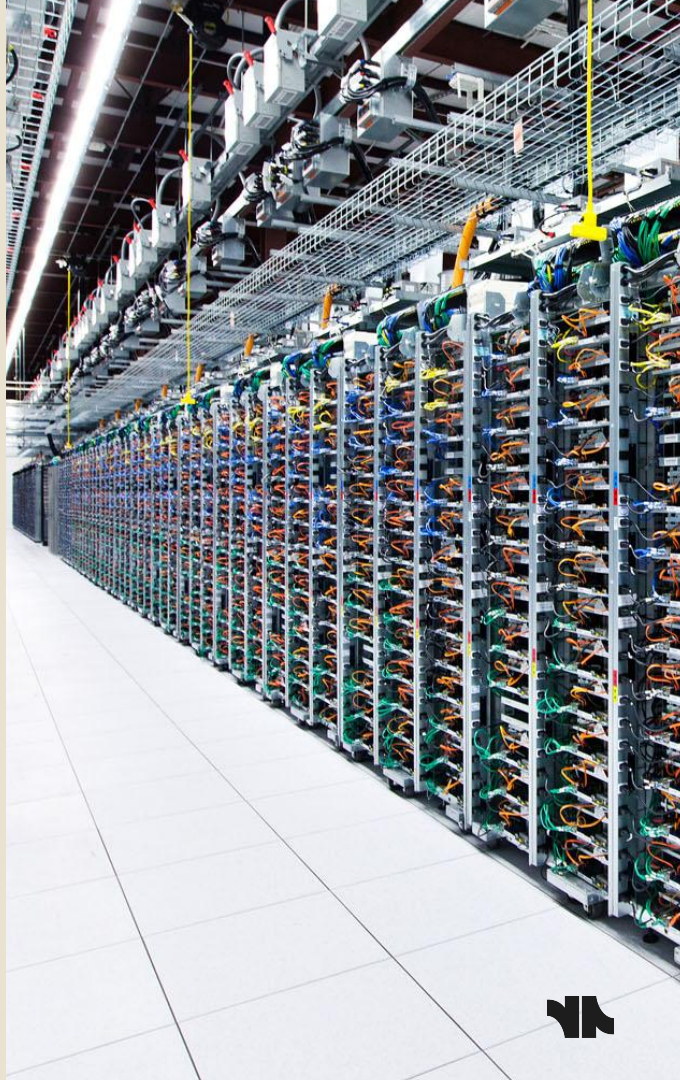
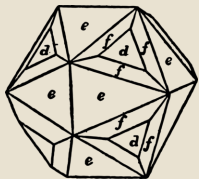
- **Novel herbicide mixtures** like for pre-emergent invasive annual grasses
 - Group 29 cellulose biosynthesis inhibitor — pre-emergent action, no foliar effect on established perennials
 - Depletes invasive annual grass seed bank for 5–6 years from a single application
- **Bioherbicides**
 - Bacteria/Fungi formulated to selectively kill target weeds
- **Olfactory & gustatory**
 - Blood-meal-based or fat-based, & other odor/taste repellents
 - Application at nursery or field
- **Tree shelters**
 - Biodegradability needs improvement
- No operationally deployable commercial repellent for pocket gophers



Software & AI

06 Models, GIS, and AI – where the majority of investment capital has actually gone.

- **Landscape planning and prioritization**
 - Integrated fire risk, fuels, habitat, watershed, and treatment-cost models at parcel-to-region scale
 - Peer-reviewed methodologies entering state-agency operational use
- **Remote sensing and detection**
 - Satellite-based wildfire detection at sub-hour latency
 - LiDAR-derived forest structure for inventory, treatment design, growth modeling
 - Stand-level survival and mortality surveys post-treatment

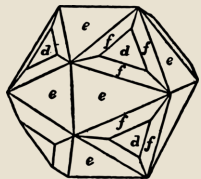


Software & AI

06

Models, GIS, & AI...oh my!

- **MRV — measurement, reporting, verification**
 - Carbon project quantification using satellite, LiDAR, and field calibration
 - Demand scaffolded by corporate carbon buying (then leveraged for forest industry)
- **Decision support**
 - Silviculture optimization, harvest scheduling, climate-adapted species matching
 - Real-time field tools integrated with planning systems



05

Closing Points

Considerations to take to the woods with you...

What the tech?

05

The fundamentals haven't changed.

1. Technologies are changing our options for management faster than ever....but trust grows as slow as the trees.
2. Reforestation is still "fitness for purpose" & success is determined at the outplanting site. Every technology either serves it or fails against these tenants.
3. Reforestation is still an investment, so the unit economics of process/technology adoption need to work.

The technology pitch is almost always: "*we bridge that gap.*"

...Most don't. Some do. We should adapt or ...



“

Acts of creation are ordinarily reserved for gods and poets, but humbler folk may circumvent this restriction if they know how. To plant a pine, for example, one need be neither god nor poet; one need only own a shovel.

Aldo Leopold





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