

# drone<sub>seed</sub>



Precision Forestry

drone<sub>seed</sub>

LINKS TO MEDIA, ARTICLES AND VIDEOS



<https://www.bloomberg.com/news/videos/2019-02-01/how-drones-can-plant-and-protect-trees-after-wildfires-video>

<https://vimeo.com/301939193>

<https://cleantechnica.com/2019/02/08/drones-seeds-fires-how-droneseed-plants-trees-from-the-sky/>

<https://techcrunch.com/2018/11/26/that-night-a-forest-flew-droneseed-is-planting-trees-from-the-air/>

<https://twitter.com/FAANews/status/1067911218021703686>

UAV **swarms** are an entirely new class of aircraft

PREMISE  
Evolution

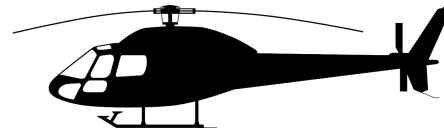
1907

**Fixed wing**



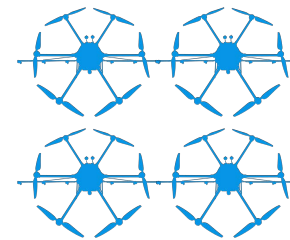
1936

**Heli**



present

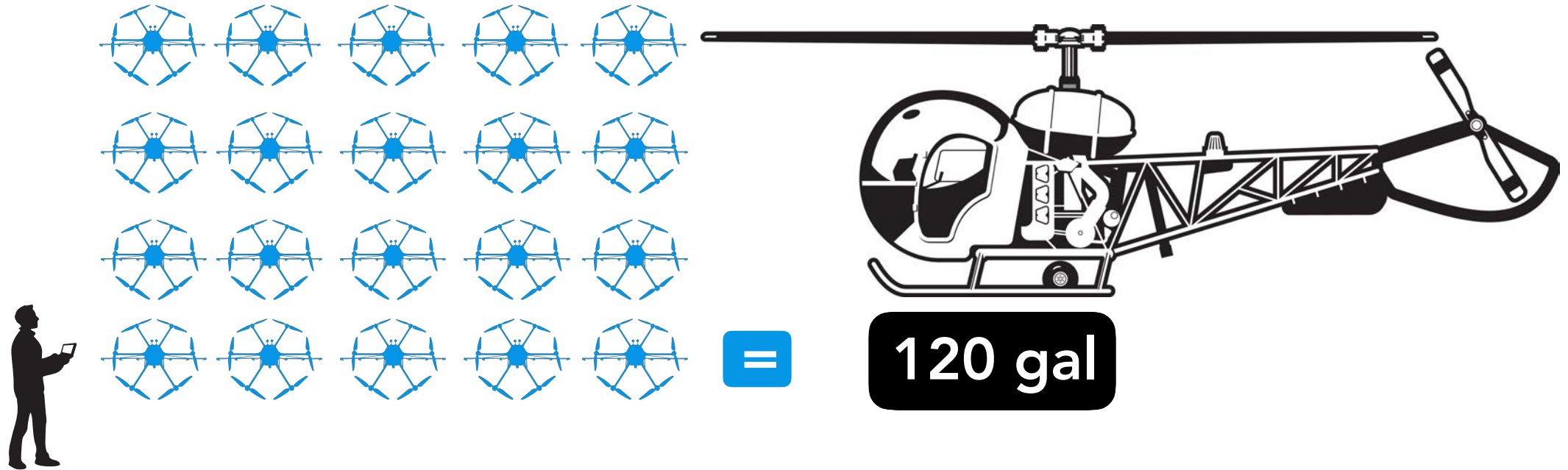
**Swarms**





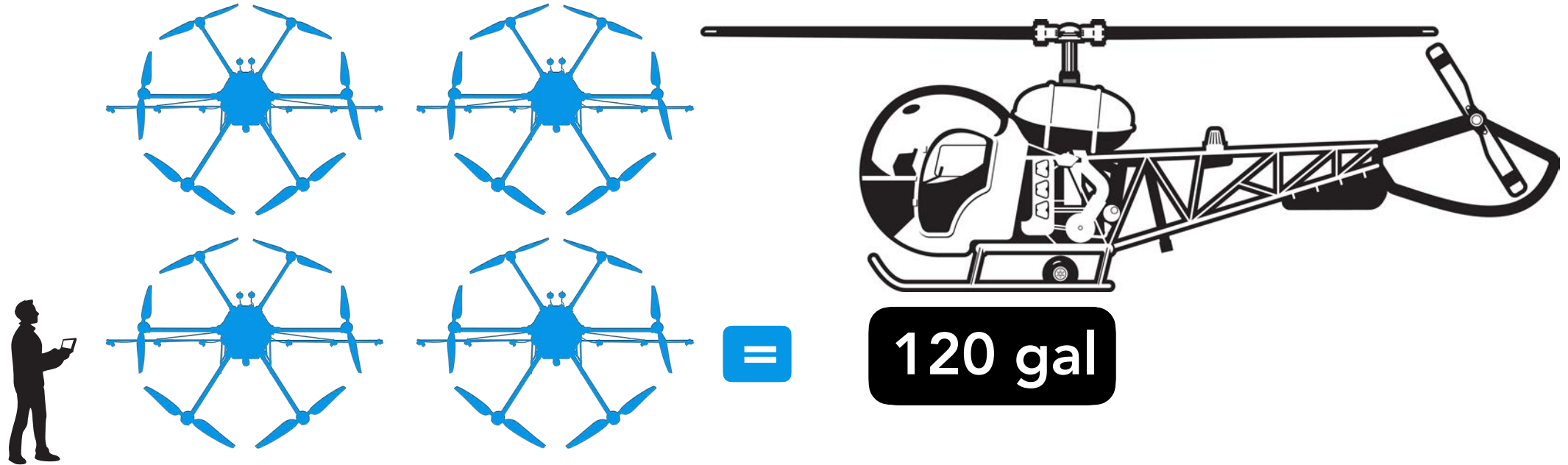
## PREMISE

The larger the swarm, the larger the payload



## PREMISE

Drones will evolve: longer flight time, more payload



CHALLENGE

Dated processes moving material

1

Spray (broadcast)



2

Plant



3

Spray (spot)



CHALLENGE

Conventional processes move significant material



1

Spray (broadcast)



CHALLENGE

Conventional processes move significant material



2

Plant

PROBLEM

Antiquated processes move significant material, exposure to chemicals



3

Spray (spot)



**This work sucks.**



Photo credit Vice Magazine

PROBLEM

Swarms are safer

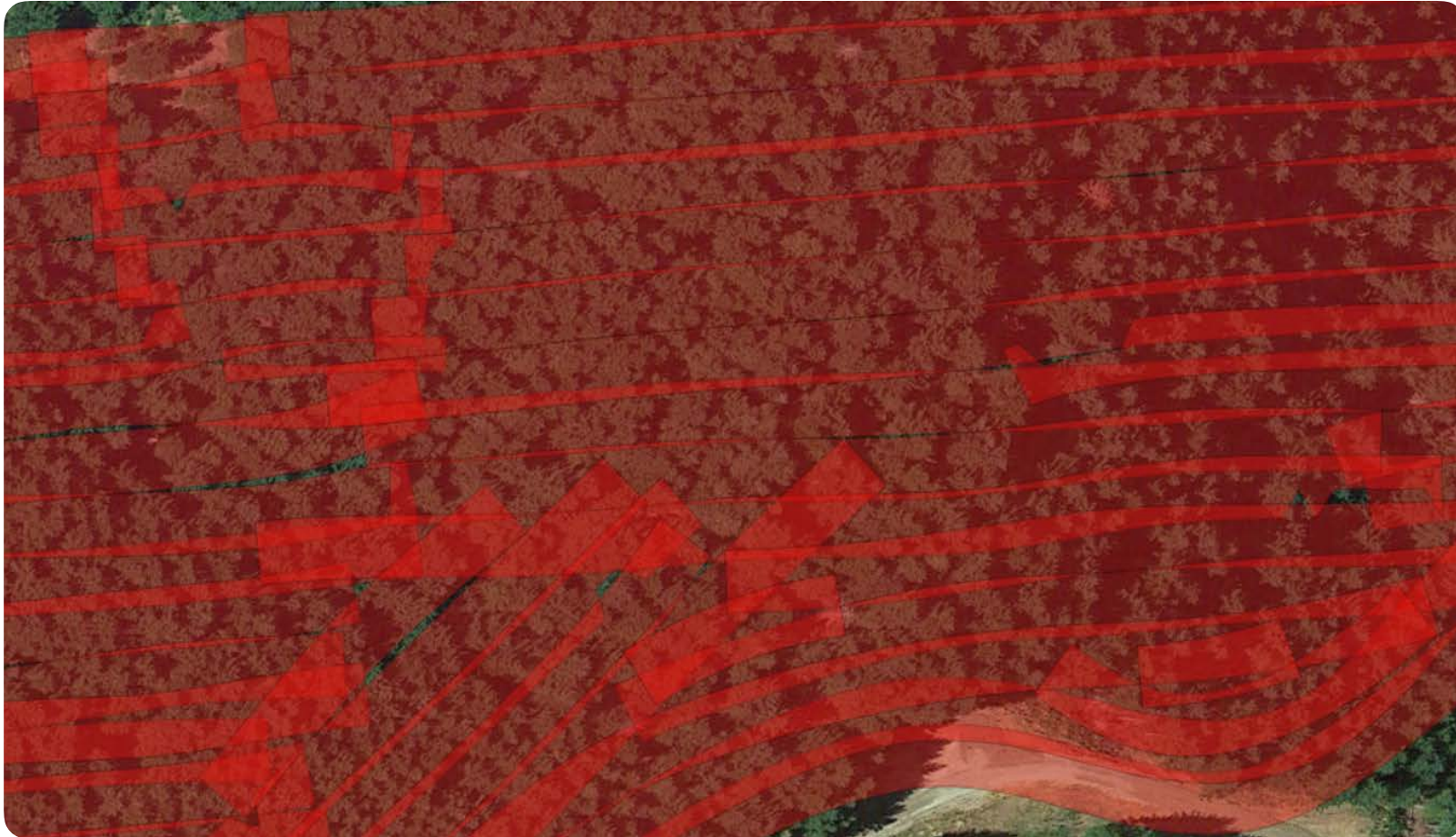


Over 10 years, 29% of cropdusting pilots crash



PROBLEM

Swarms have greater precision

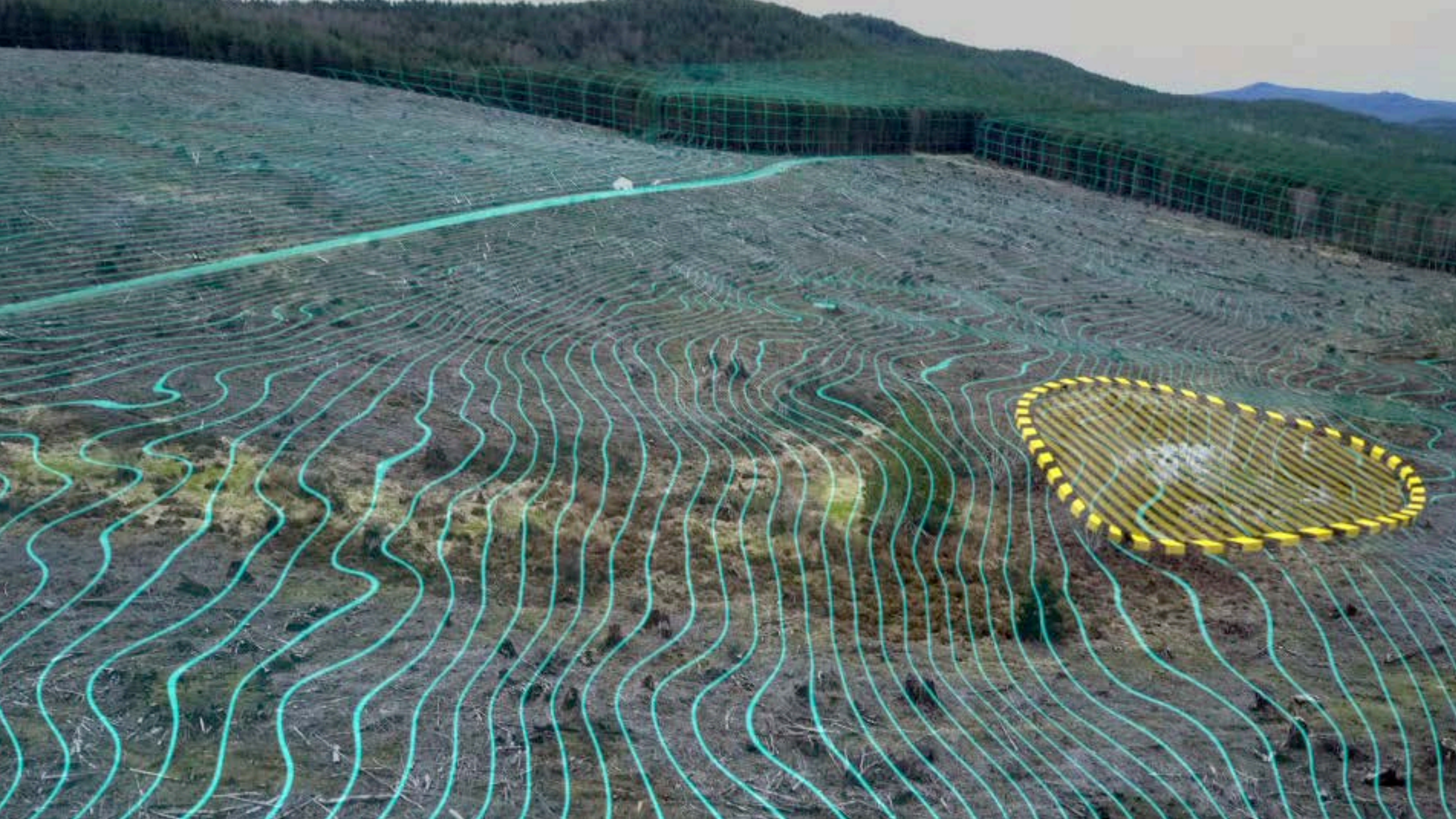


Overlaps show wasted chemical application by manual flight

PROBLEM

Missing: **software** to automate







SOLUTION

Our algorithm automates swarm mission-planning



flight segmentation

obstacle routing



pump on/off

2017: 1st and only FAA-approved company to use swarms for spraying



## EXECUTION

2017: Executed 2 customer contracts for #1 and #5





drone seed





EXECUTION

2017: Executed 2 customer contracts for #1 and #5



Before: Aug 2017



After: April 2018

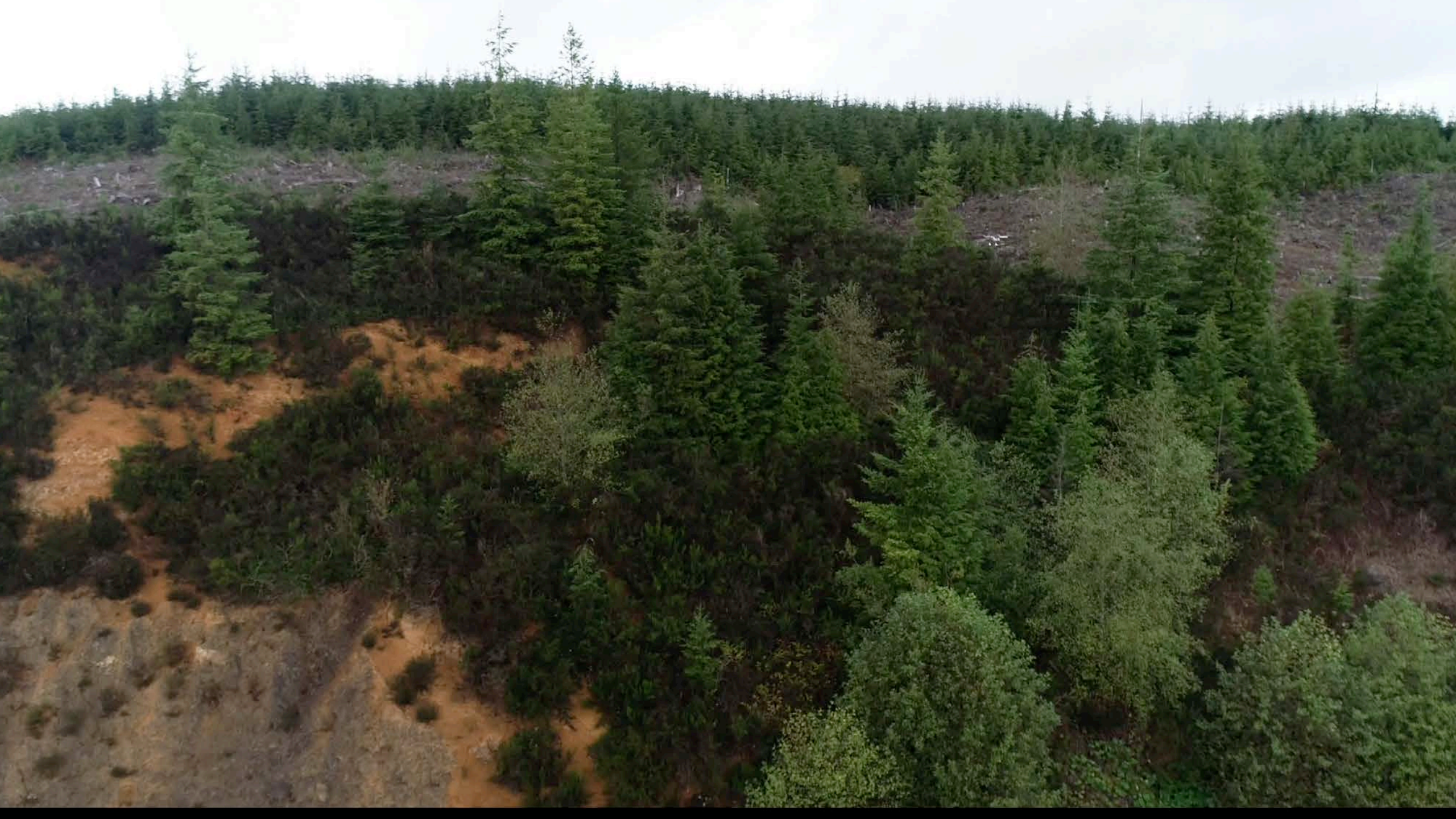














# EVOLUTION

## 2017 Concept Art: Swarm operating system



EXECUTION

2018: This is it in the field today operating with up to five drones



Truck

Charging Truck

Generator Water trailer

Drones on launch pads



PLANTING TECHNOLOGY

We are developing planting platforms for private, public, and non-profit sectors



## PROBLEM

### Post-fire revegetation rates are dismal on public lands



Critical	<b>&gt; 60% of fires are moderate to high severity*,**</b>
USFS	<b>11% revegetation from 2000-2015*</b>
BLM	<b>16% revegetation from 2000-2015**</b>

\*Ringo, Chris; Ager, Alan A.; Day, Michelle A.; Crim, Sarah. 2016. A spatial database for restoration management capability on national forests in the Pacific Northwest USA. Gen. Tech. Rep. PNW-GTR-919. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 71 p.

\*\* Haugo, R.D., Kellogg, B.S., Cansler, C.A., Kolden, C.A., Kemp, K.B., Robertson, J.C., Metlen, K.L., Vaillant, N.M., Restaino, C.M. In Prep. The Missing Fire: Quantifying human exclusion of wildfire in Pacific Northwest forests, USA.



## PROBLEM

### Dated technology still in service



Scale

**Western Fires are typically large!**

**July 2018 fire in Nevada was 500k acres**

**That's on the order of what Weyerhaeuser annually harvests across the US**



Mitigation

**Current practice uses antiquated tech with many limitations, including low success rate, physical limitations, and no precision**

Propagule needs

**For the fire in Nevada, half a billion propagules would be needed for direct seeding at 1000/acre**

CHALLENGE

Planting for timber co's



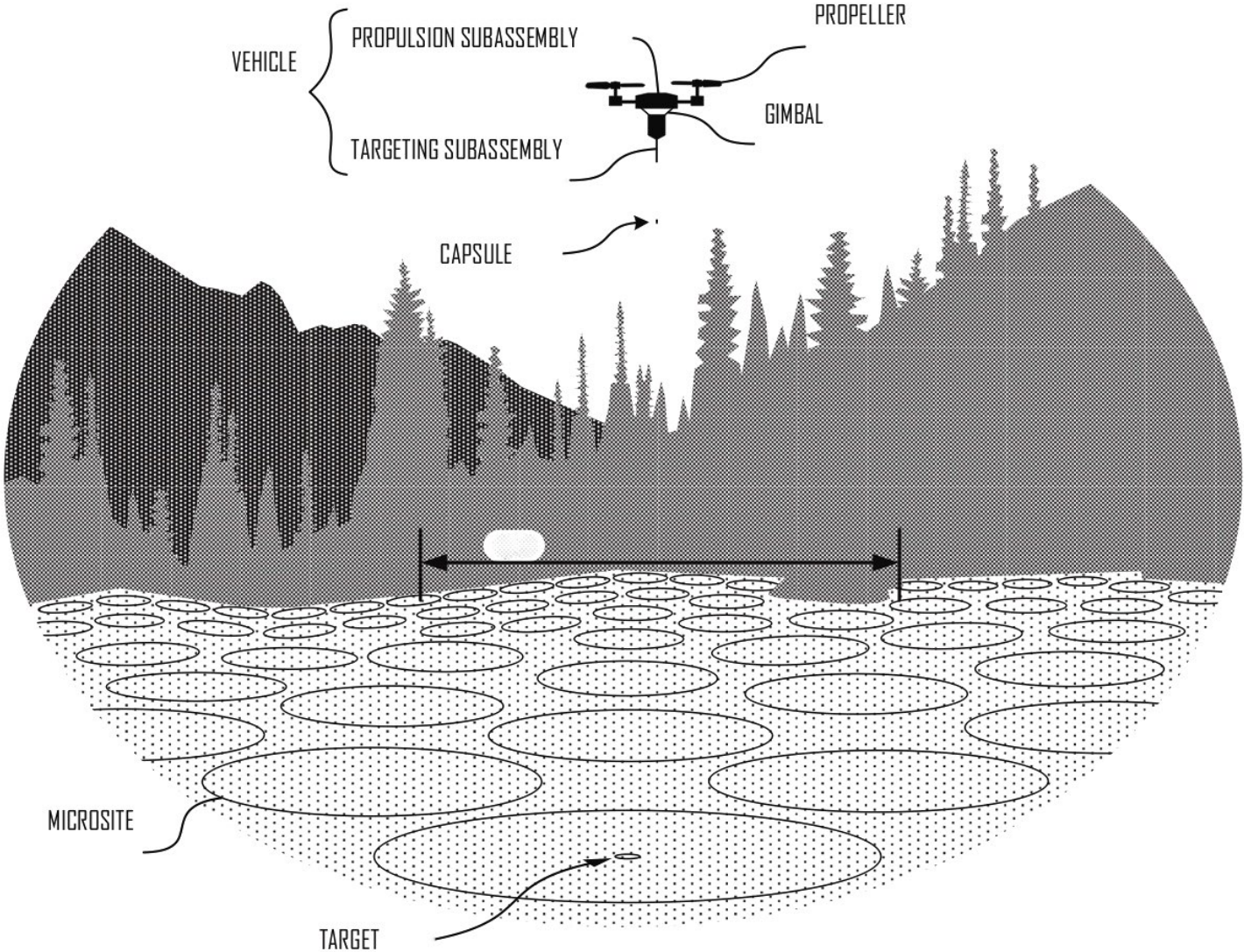
## BOOSTING SEED SURVIVAL

1. Software for **spraying**
2. Software for **micro-site planting**
3. **Seed vessels**



FUTURE

2019: Scalable micrositeing with automation



# PLANTING

Four vessels for varied eco-systems



Coating

Rangelands



Capsule (Paintball)

All ecosystems  
(rare species)



Microsite Precision

Forestlands



Nucleated Plantings

Stabilization post-fire





**RGB IMAGERY**





ELEVATION





NORTH SOUTH





NORTH SOUTH PIXELATED

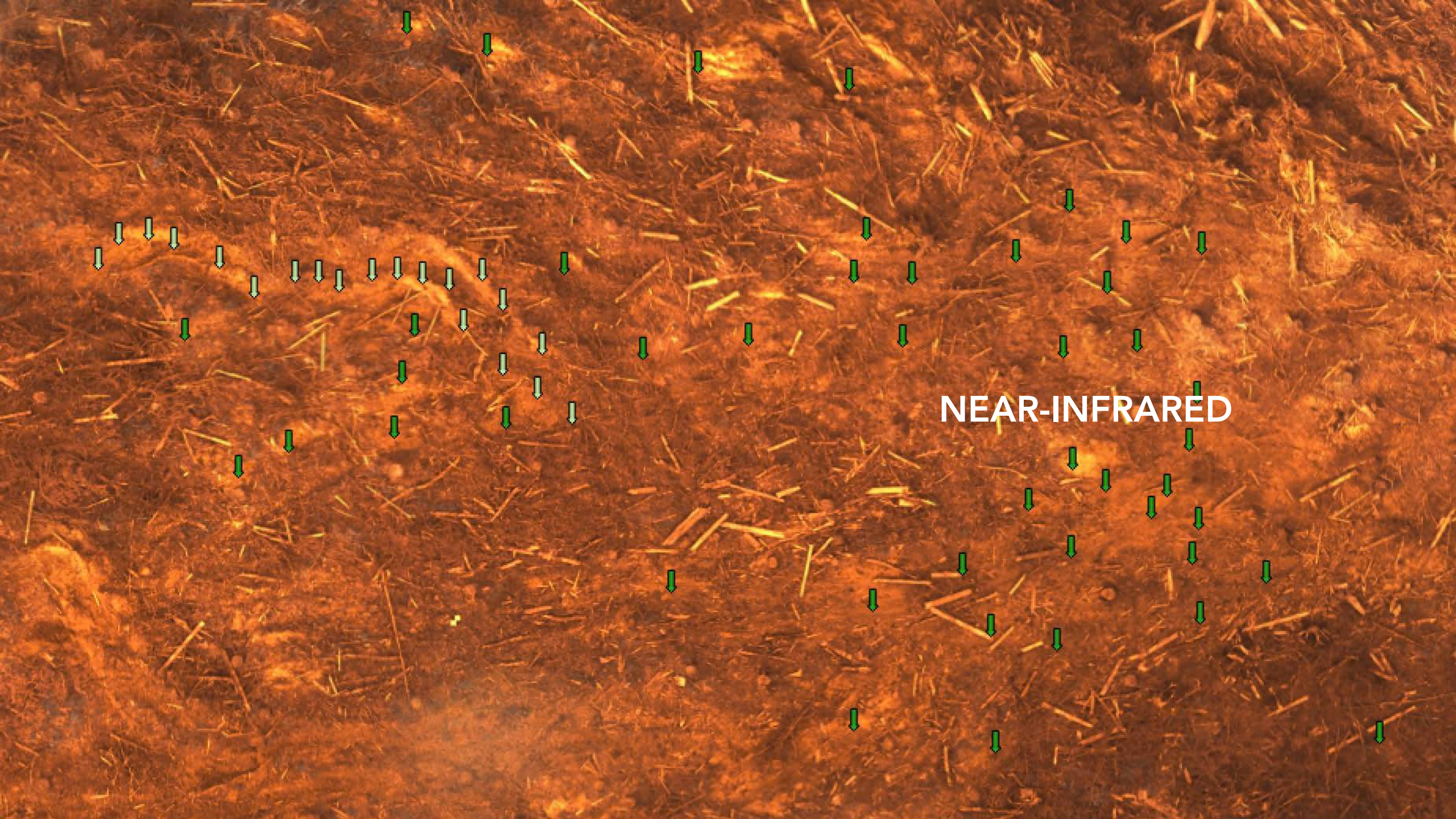


**MICROSITE ANNOTATED**





NEAR-INFRARED





## MAPPING

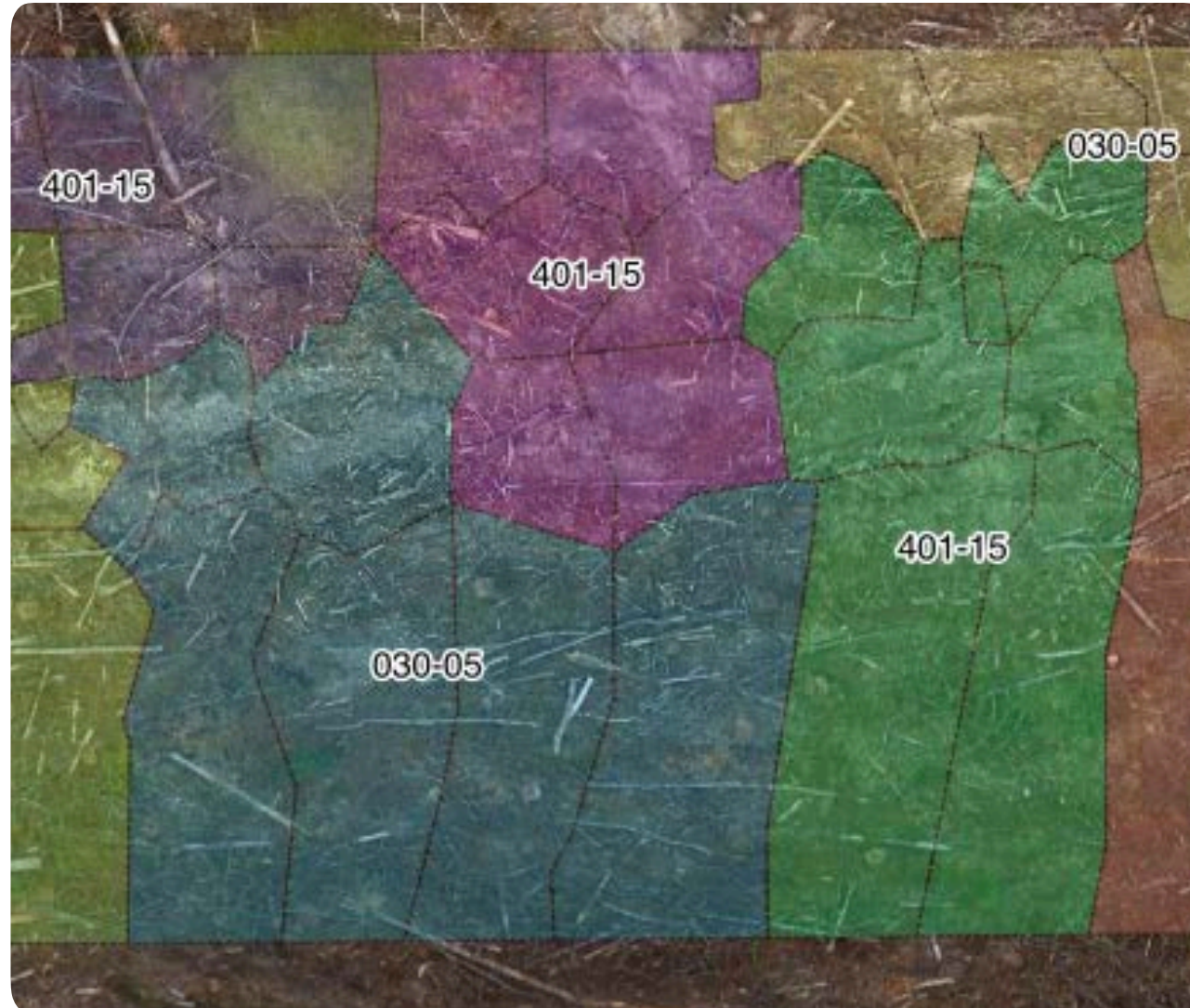
Machine learning summarized





## MAPPING

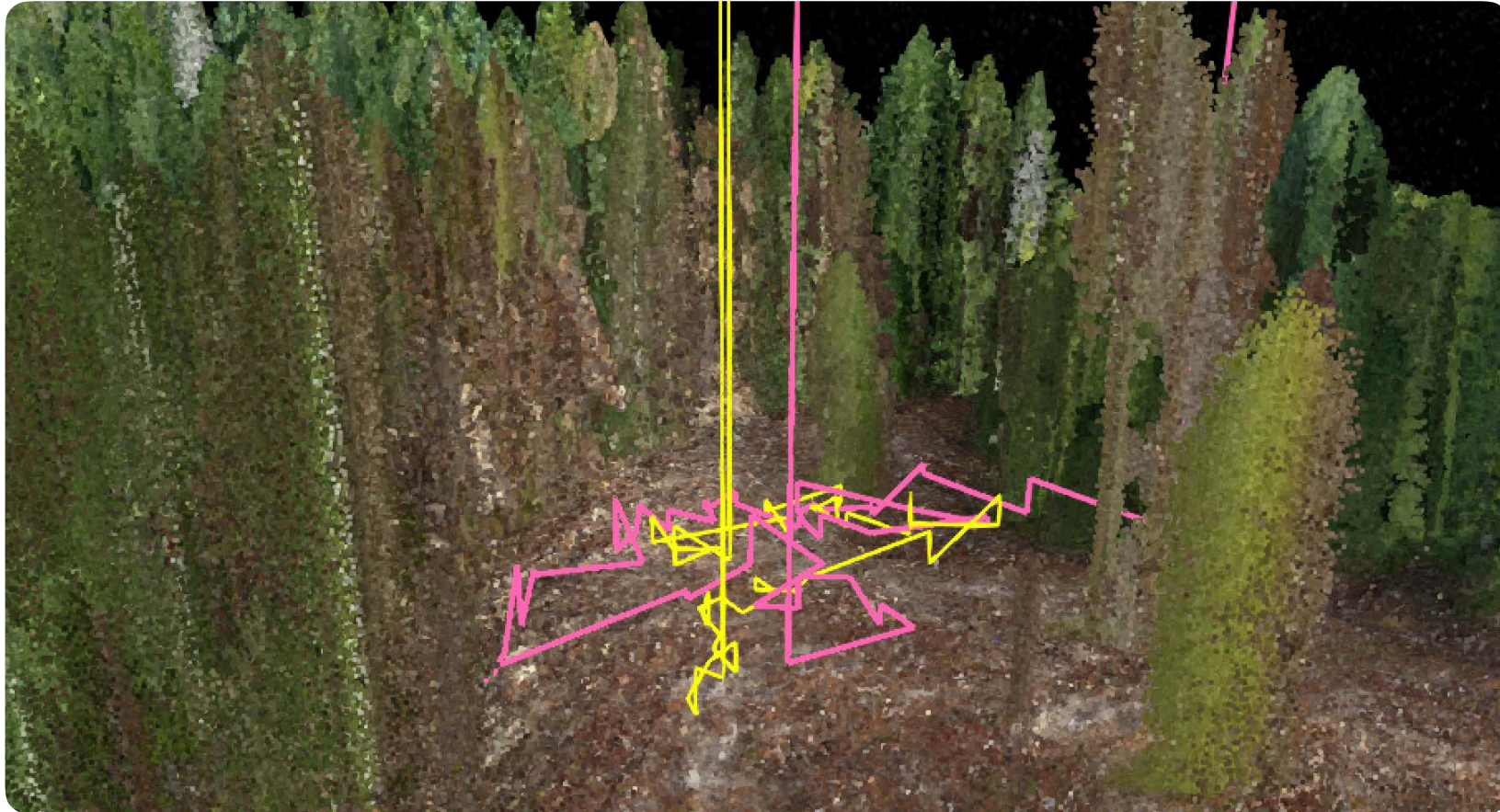
2018: Sophisticated microsite identification





PLANTING

Colorized LiDAR targeting microsities





2018: 1st and only FAA-approved heavy lift swarms (55-115lbs)







PLANTING

2016: Early prototype





## EXECUTION



Multi-vehicle - autonomously flown





Delivering spray payloads to prepare ground for planting



PLANTING TECHNOLOGY

2018: Signed our 1st private sector planting **contract**



PLANTING

## 2018: SW Oregon Post-Fire Project Site





1ST PLANTING PROJECT

## 2018: SW Oregon Post-Fire Project Site





1ST PLANTING PROJECT

## 2018: SW Oregon Post-Fire Project Site





PLANTING

## 2018: Production Forestry Model









PLANTING

## Microsited pucks at Washington pilot project



1

Forests



TEAM

Exceptional Talent in Software/Hardware/Ops

Team (16+)

CTO GIS, Software Engineer (1 acquisition, 1 merger)

Drone Eng Built custom flight controller (7 yrs)

VP Ops USAF Weapons School Instructor and Grad

SW Eng Multi-vehicle aquatic drone co. (acquired)

CEO Sustainability focus...including Vestas Wind Energy and industrial feed co that was acquired



Our mission is to make reforestation **scaleable with automation**



## LICENSED

### DroneSeed Waivers and Exemptions

1

**FAA:** 1st and only UAV company approved for swarms for spraying

- 107 Multi-Vehicle Waiver
- 137 Spraying Exemption
- FSDO Knowledge and Skills test
- 107 Remote Pilot's certificate

2

**State:** State licenses for applicators

- WSDA
- IDA
- ODA



## LEARNING AND DEVELOPING

- (1) Accepting 2-3 more projects for 2019
- (2) Full platform, survey>spray>seed
- (3) Conversations (~20 minutes) to refine our product and consumer expectations



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