IDENTIFICATION AND SPATIAL CHARACTERIZATION OF A NOVEL AUTUMN OLIVE PATHOGEN IN SOUTHWESTERN VIRGINIA

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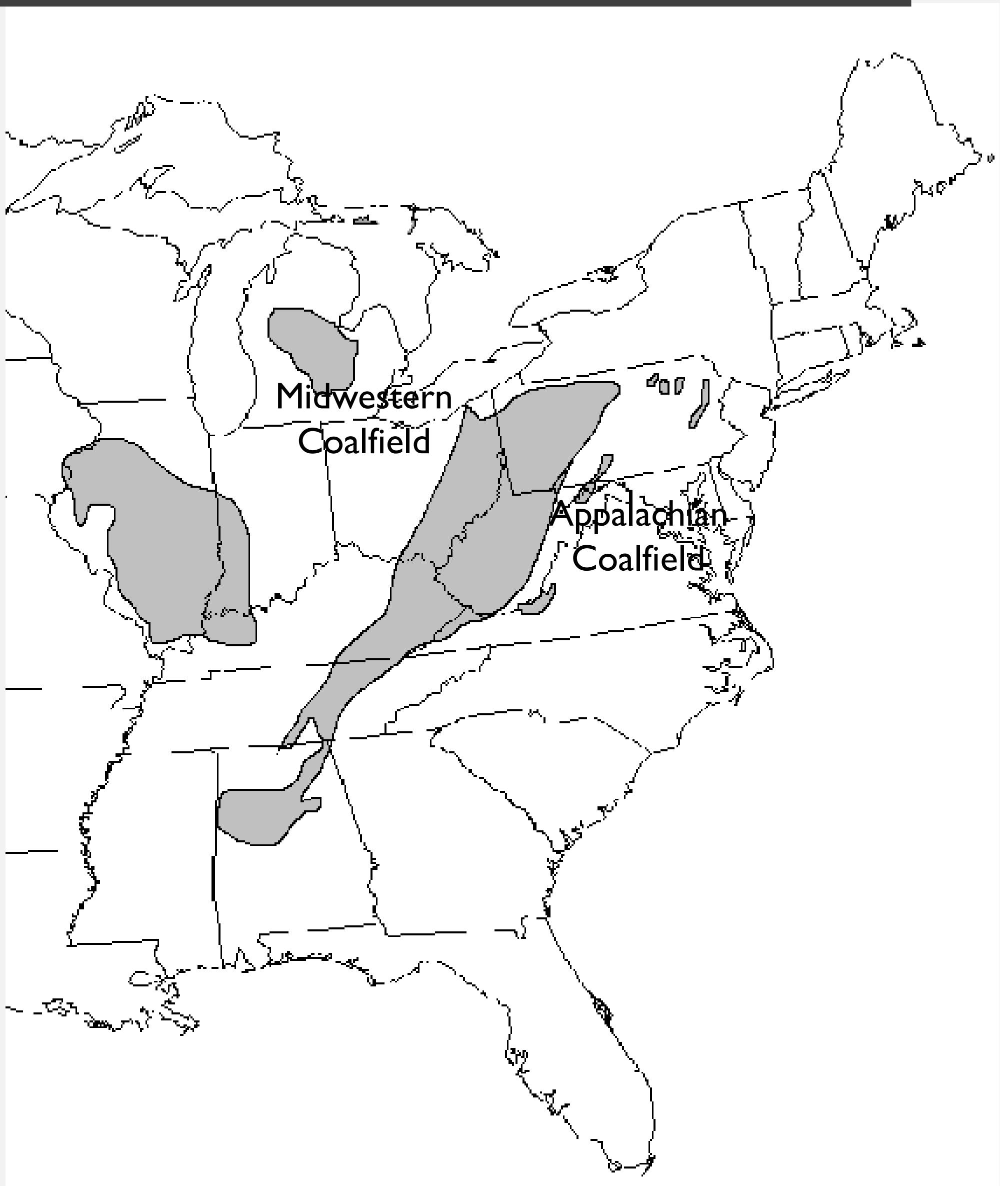
EASTERN UNITED STATES COALFIELD REGIONS



SURFACE MINE CONTROL AND RECLAMATION ACT (1977)

Photo: WL Daniels - Highwall-bench-outslope landform in SW Virginia.
Unstable outslopes such as these caused water quality degradation.

- Federal law requiring environmentally responsible coal mining and reclamation, as well as began program for reclamation of abandoned mine lands
- Focus on soil stabilization and water quality

1977-2007: GRASSLAND REPLACEMENT APPROACH

Goal: Hayland-pasture, unmanaged forest

UNMANAGED GRASSLANDS SUCCUMB TO SCRUB

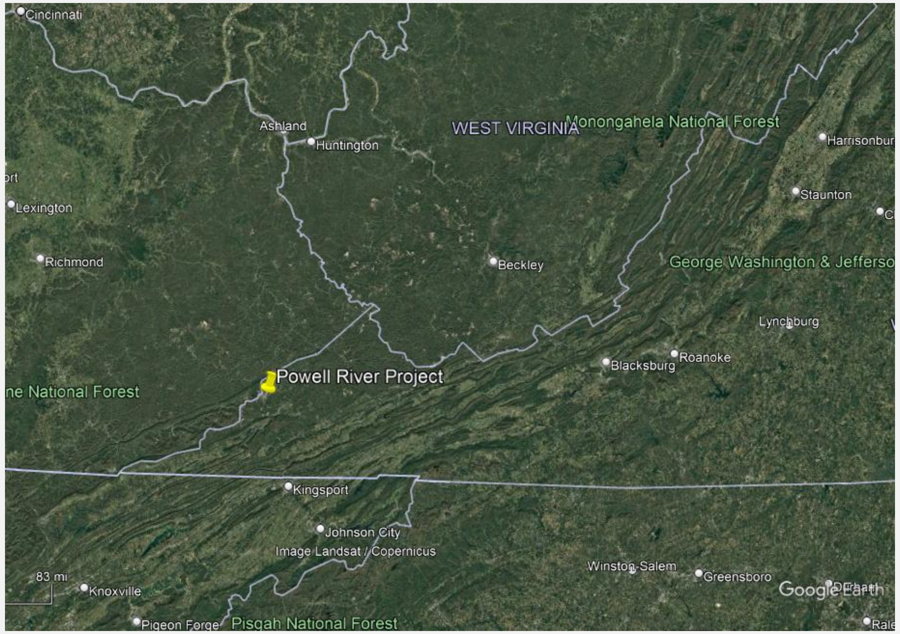
- Unmanaged grasslands succumb to scrub
- Dominated by exotic, invasive species
  - Often planted purposefully – dense cover to reduce erosion (Zipper et al. 2011)
- Many former coal mines in arrested succession (Fields-Johnson 2011, Pericak et al. 2018, Zipper et al. 2021, Putnam 2025)

AUTUMN OLIVE (*ELAEAGNUS UMBELLATA*)

Photo credit: The Nature Conservancy

- Prolific fruits (Stark 2000) and vegetative spread
  - 10-18% of land cover on former surface mines (Oliphant et al. 2017, Putnam 2025)
  - ~39,000 ha in VA, +500 ha/yr (Miller et al. 2013)
  - 6-fold increase in AO over 2 years (Dornbos et al. 2016)
- Outcompetes native woody plants
  - N-fixing
  - Not foraged by herbivores
- Mechanical/chemical removal expensive (Szafoni 1991, MDNR 2012, Hipkins 2013)
  - $10,000/acre (Eddie Clapp, personal comm.)
  - Recolonized 3 yrs after herbicide (Edgin & Ebinger 2001)

AUTUMN OLIVE (AO) PATHOGEN



- First observed by C. Fields-Johnson and S. Klopf in May 2024
- Stem death, cankers, vascular streaking, chlorosis, mortality
  - No pathogen documented to cause these symptoms in AO
  - Preliminary identification by the Davey Institute: Phomopsis canker and stem blight

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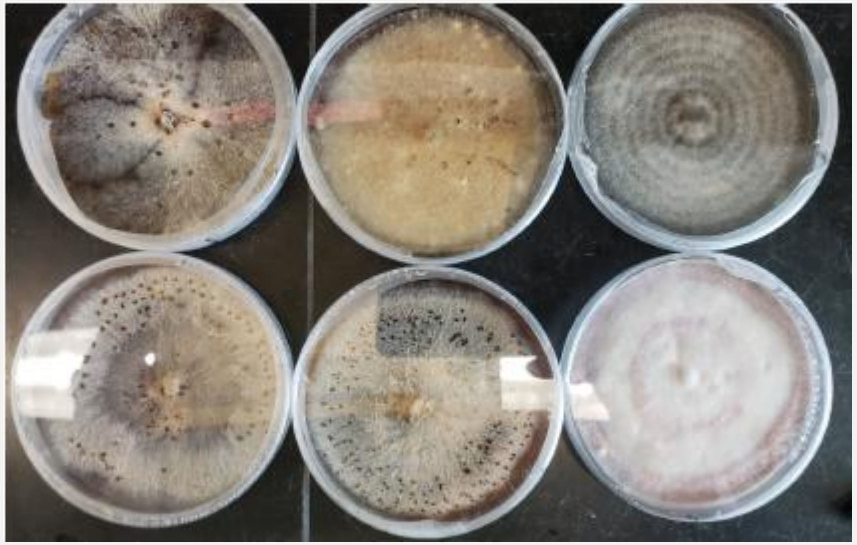
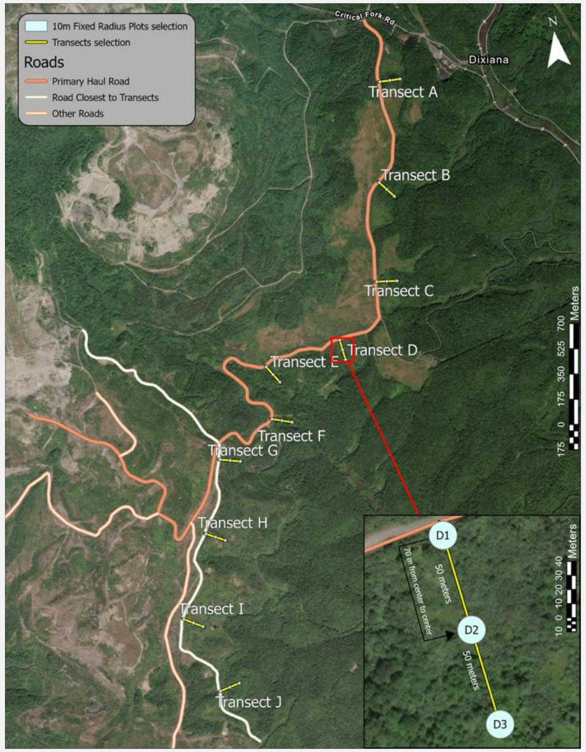
Pathogen identification



Confirmation of Koch's postulates of pathogenicity

Spatial characterization



- Fall 2024 began preliminary study with Carrie Fearer (plant pathology), Jacob Barney (invasive species ecology), Daniel Putnam, and Pat Donovan (remote-sensing, aerial imagery specialists)

PATHOGEN IDENTIFICATION – SAMPLE COLLECTION

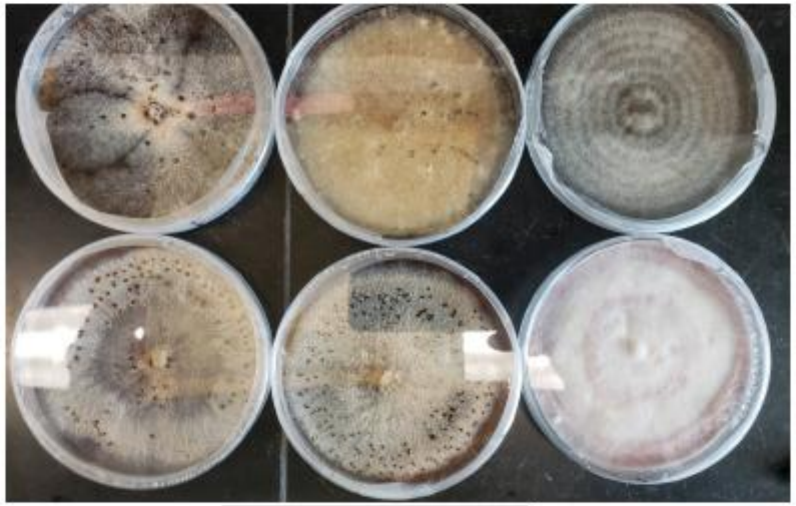
- October 2024 – sampled cuttings from multiple locations, age classes
- Focused on live branches – active infection
- More widespread disease presence than initially thought

PATHOGEN IDENTIFICATION

Helena Azar

Shane Allan, M.S. student

Jacob Kanouff

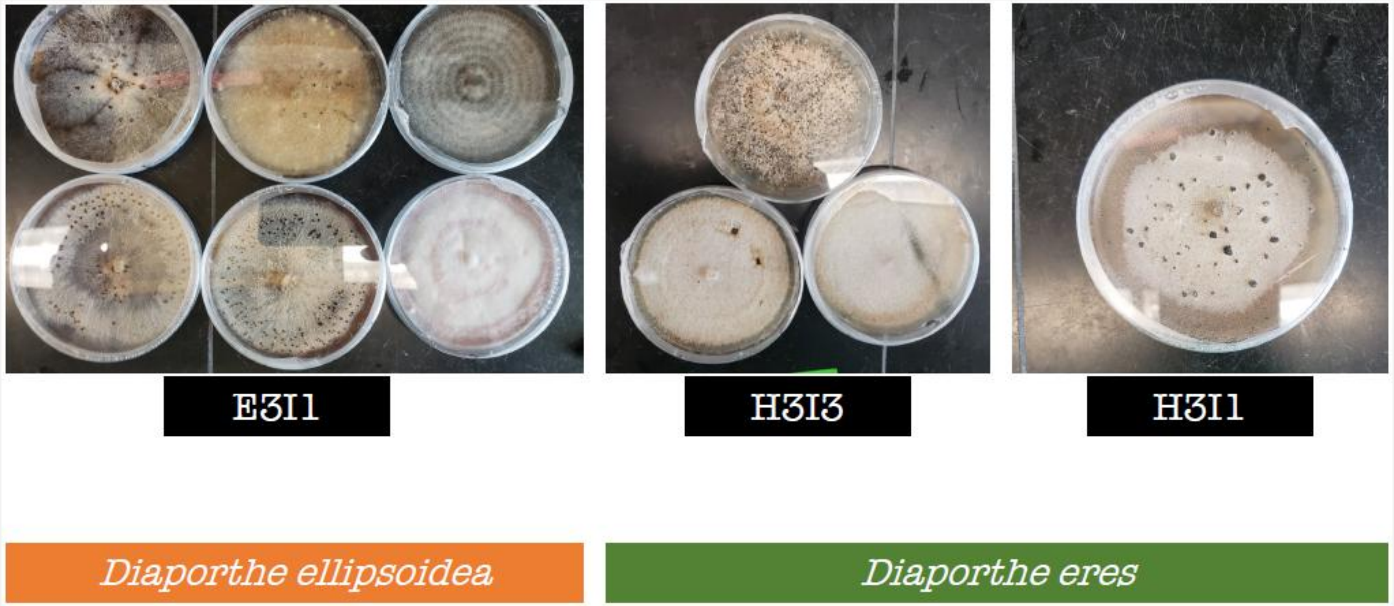


E3I1

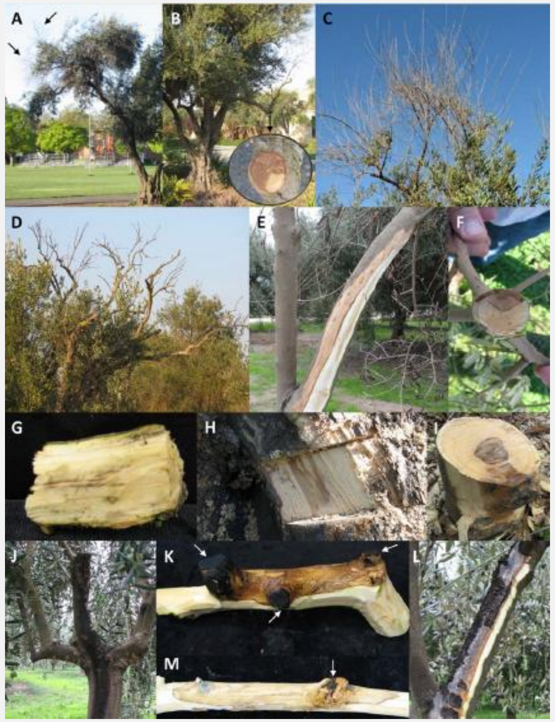
H3I3

H3I1

RESULTS: PATHOGEN IDENTIFICATION



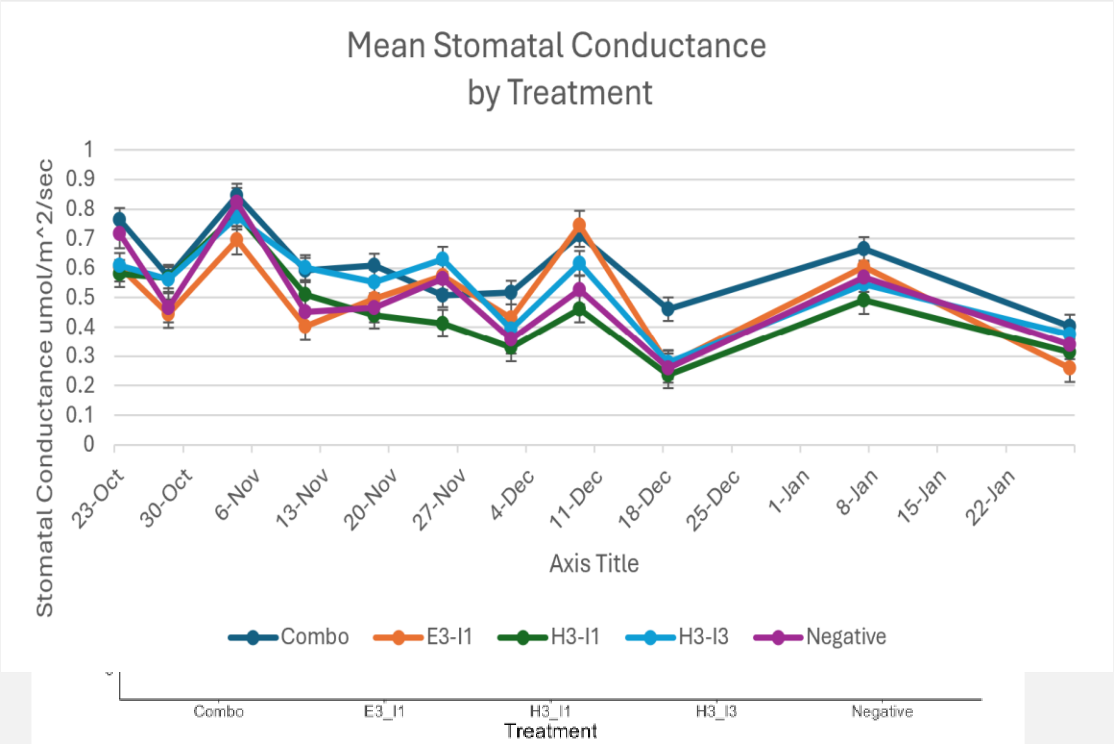
- *Diaporthe* spp. – causes Phomopsis stem canker/blight
  - Opportunistic fungi, cosmopolitan, infects trees predisposed to stress
  - Unk. to infect AO, does infect European olive (Urbez-Torres, et al. 2013)



CONFIRMING KOCH'S POSTULATES OF PATHOGENICITY

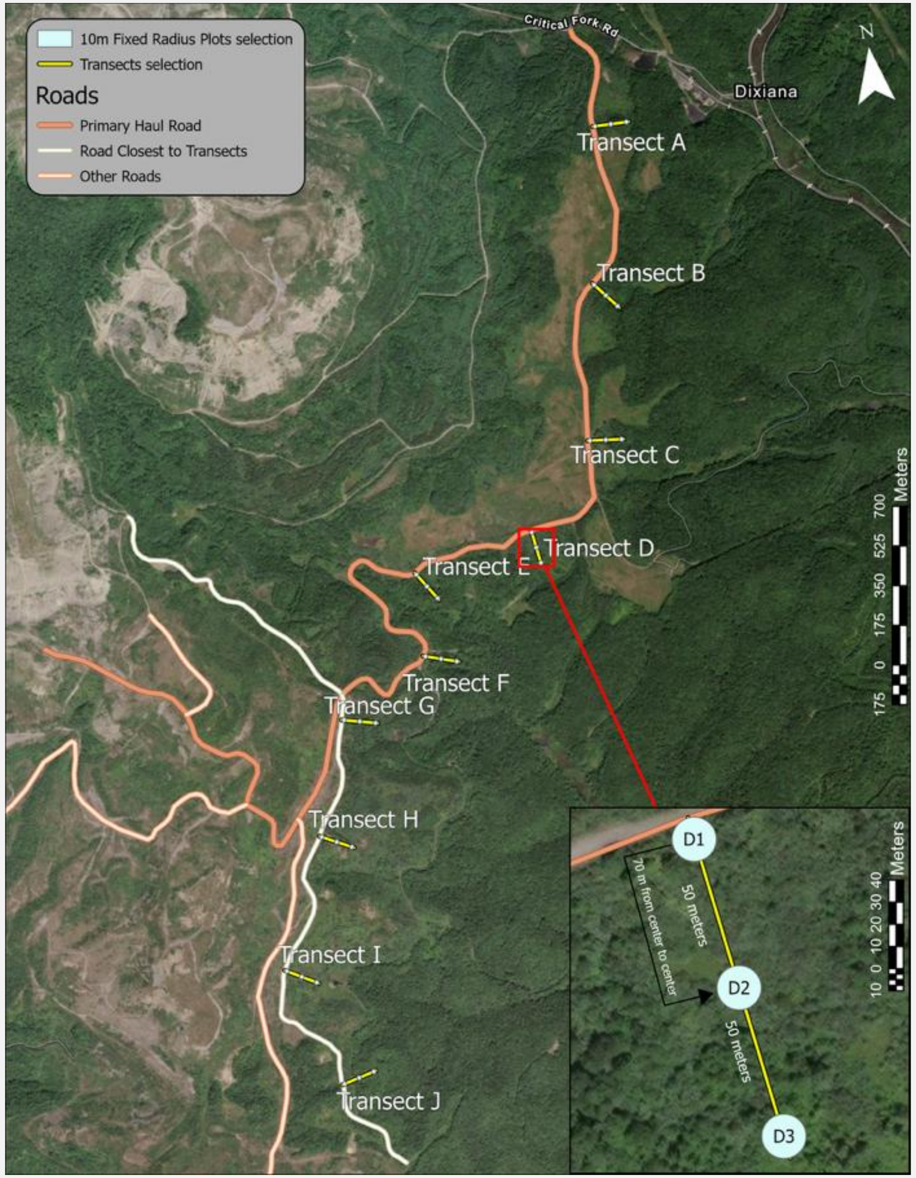
- 4 treatments and control, 3 reps, 12 week duration
  - 1. Isolate H311 (*D. eres* 1); 2. Isolate H313 (*D. eres* 2); 3. Isolate E311 (*D. ellipsoidea*); 4. Combination (all three); Control (agar only)

RESULTS: CONFIRMING KOCH'S POSTULATES OF PATHOGENICITY



- Canker formation, vascular streaking
  - *Diaporthe eres* significantly more streaking than control
  - Potentially one virulent and one less virulent strain?
  - Disease progression relatively slow
- Lowest stomatal conductance in the H3-I1 treatment (p=0.0547), though mean (0.46) only slightly lower than control (0.50)

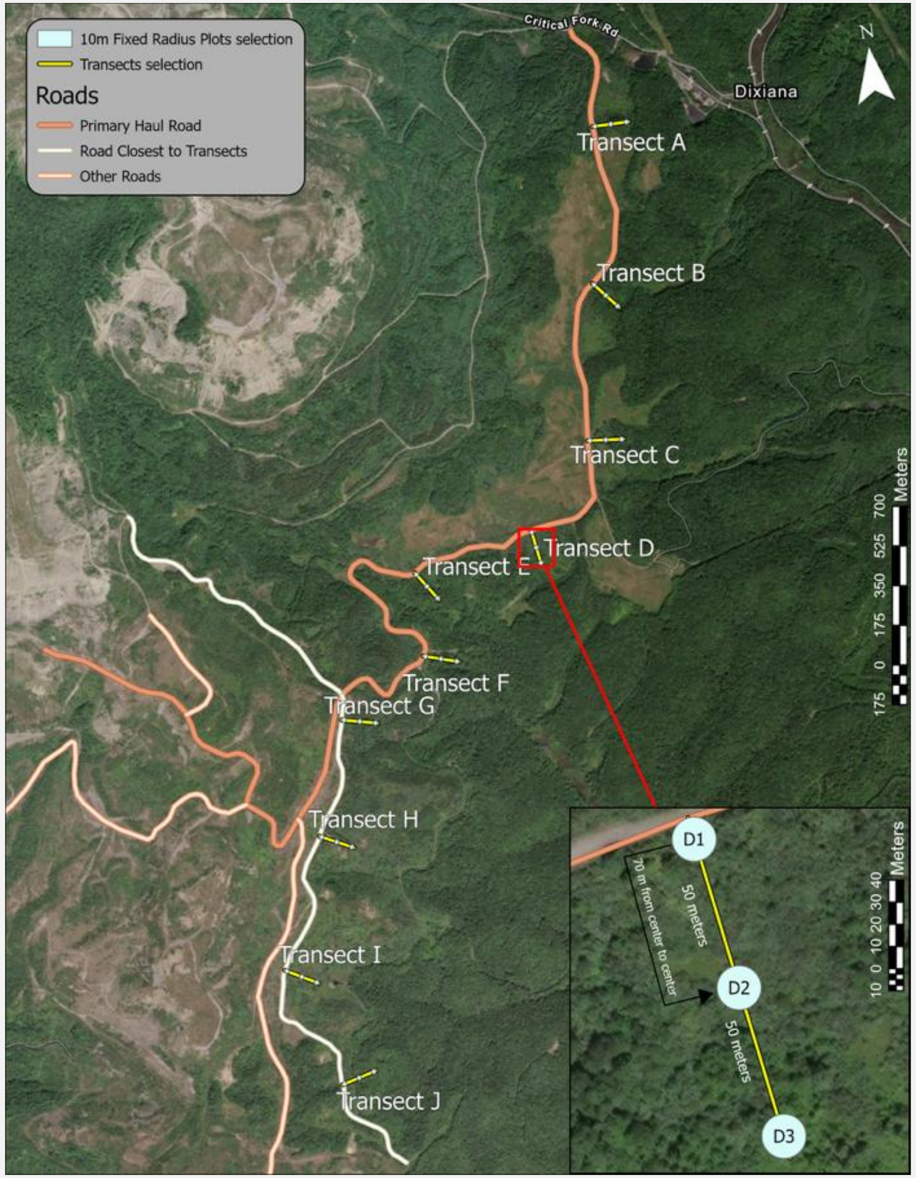
SPATIAL CHARACTERIZATION METHODS- VEGETATION PLOTS



Cover Class Rankings			
1	0	6	25-50%
2	1-<2%	7	50-75%
3	2-5%	8	75-95%
4	5-10%	9	95-100%
5	10-25%		

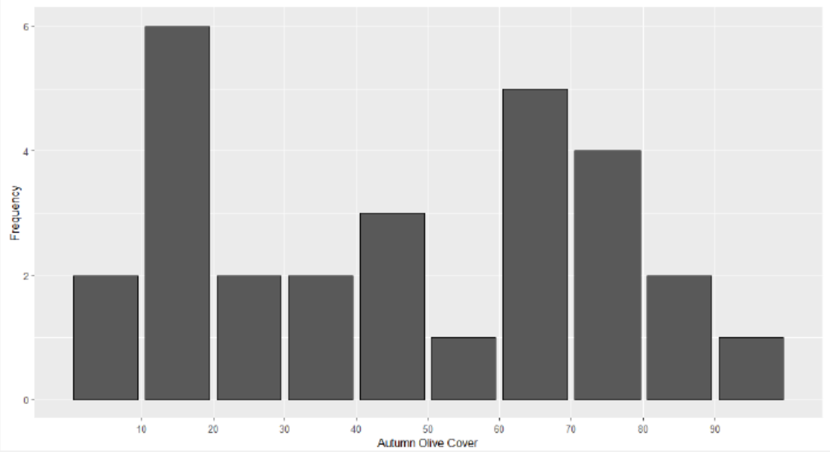
- Ten, 140 m transects ⊥ to haul road at 650 m intervals
- Three 10 m veg plots per transect – assessed May 2025
  - Cover (%) of AO and other woody species
  - Noted presence of other species with similar cankers in/near plots
  - Quantified disease incidence/severity
    - Cover class ranks: dead main branches, dead fine branches, main stem cankers, epicormic shoots, epicormic shoot cankers
      - Averaged to calculate mean plot disease severity

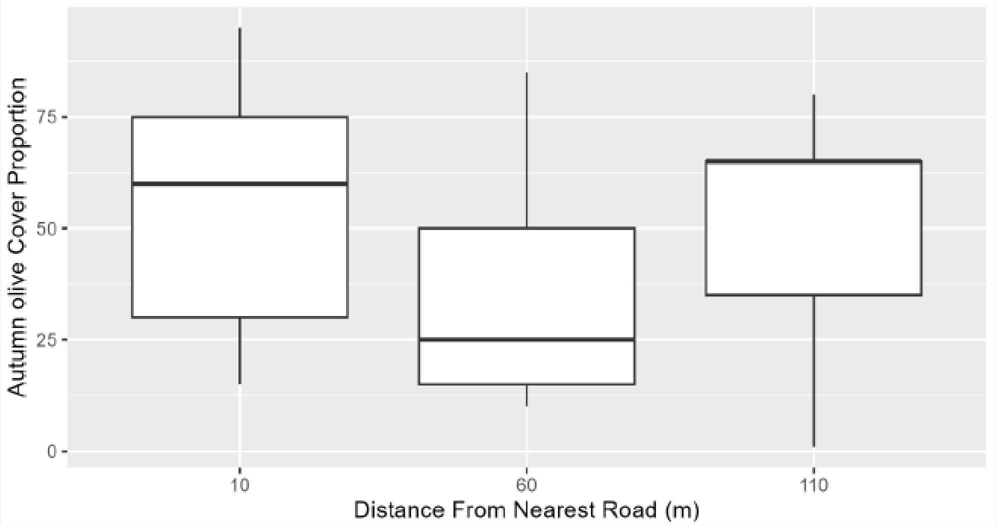
SPATIAL CHARACTERIZATION METHODS- UAS IMAGERY

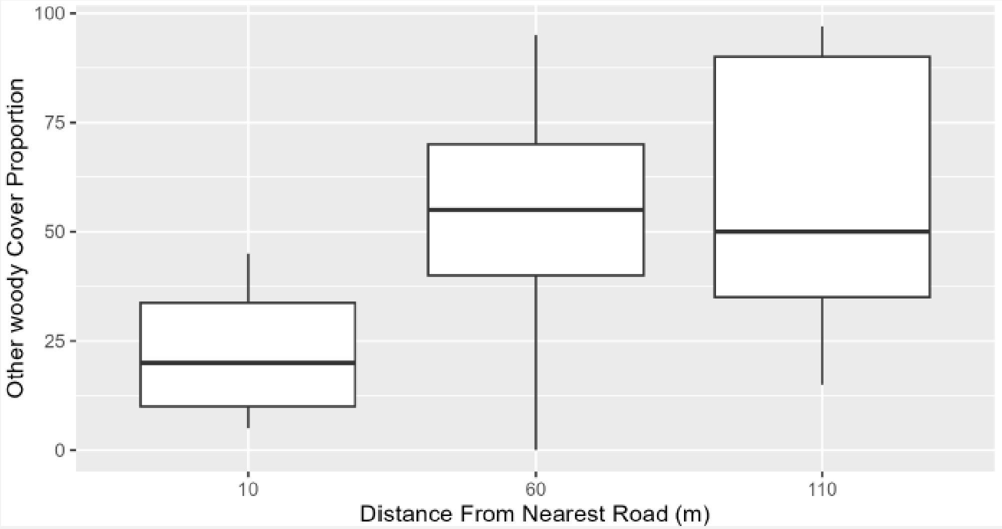


- UAS flight at each transect with DJI Mavic 3 enterprise multispectral: green, red, red-edge, and near infrared imagery
  - Goal: determine band/indices that were best predictors of diseased AO
  - 6 mph, 200 ft (60 m) ht, 80% side overlap, 2.81 cm ground sampling distance collected; ground control points as feasible
- Processing: Pix4Dmapper version 4.8.4 to create radiometrically corrected orthomosaic, digital surface model, digital terrain model, and photogrammetric point cloud. 50+ manually verified tie points corresponding to each ground control point

RESULTS: SPATIAL CHARACTERIZATION

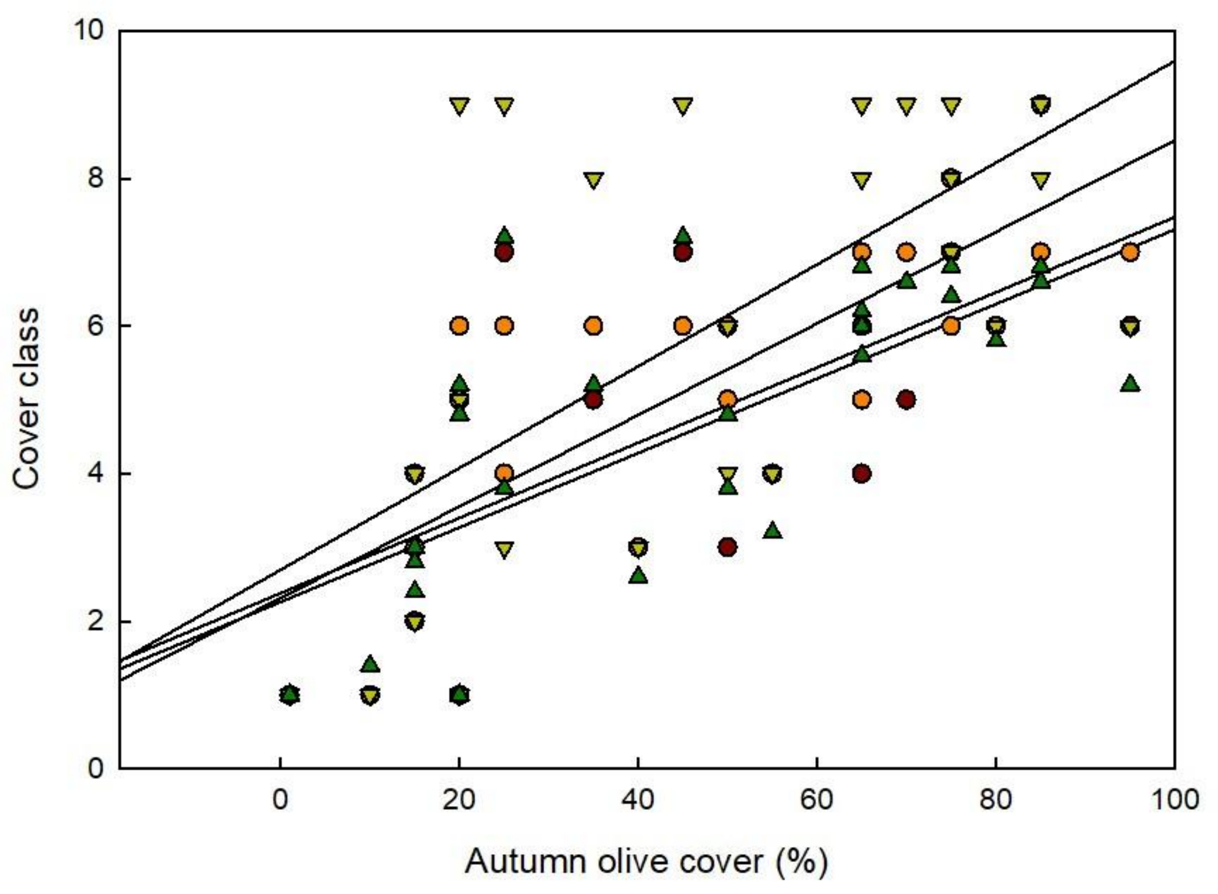


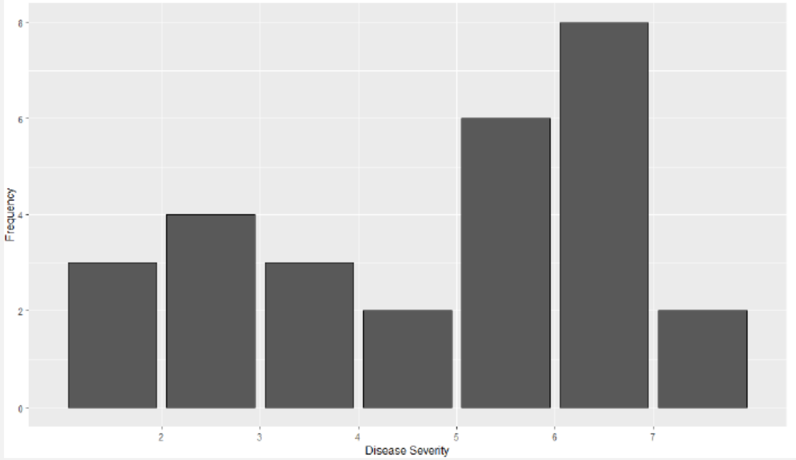




- AO cover 1 to 95% per plot (mean 48%)
  - Varied by distance to nearest road, no consistent trends ($p=0.054$)
  - Small sample size, overall fairly consistently high AO cover
- Other woody cover 0-97% (mean 41%)
  - Higher cover further from road ($p=0.036$)

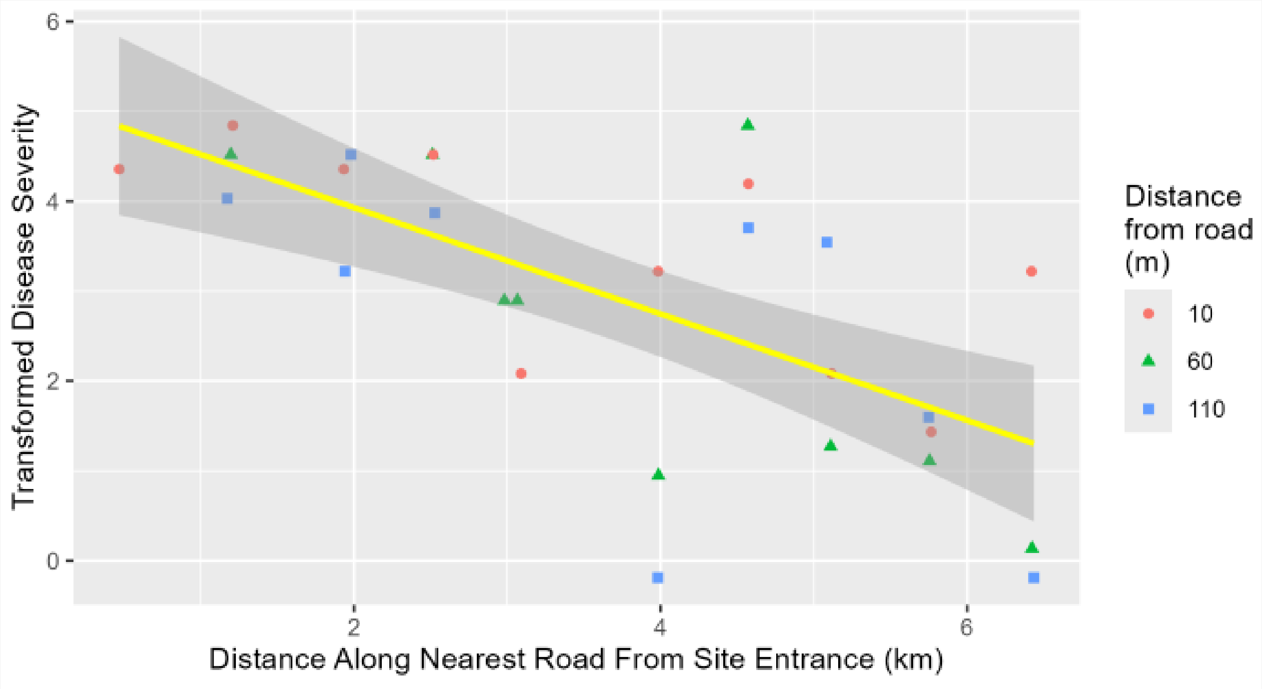
RESULTS: SPATIAL CHARACTERIZATION

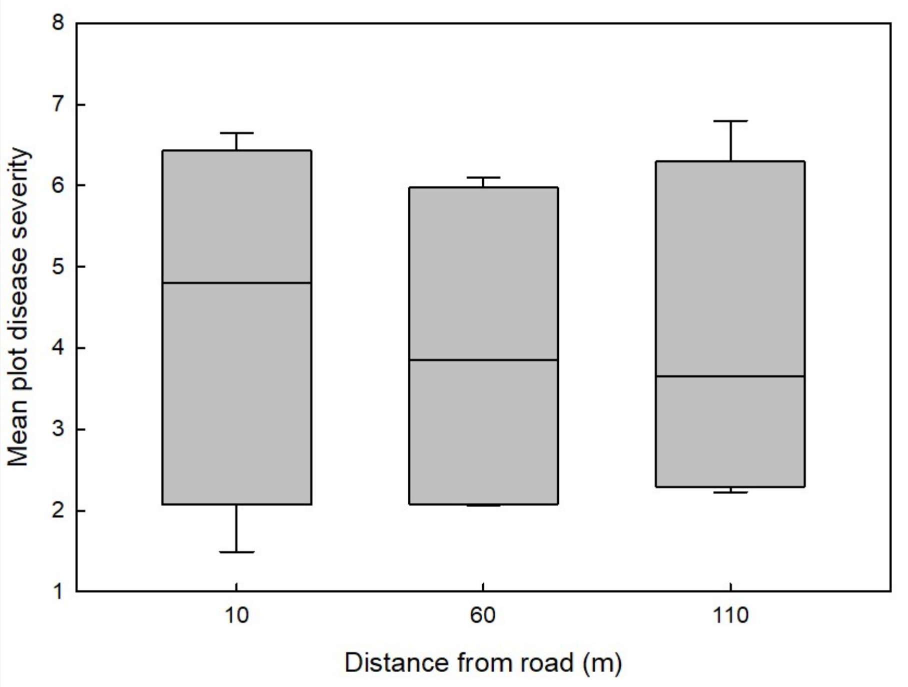




- Disease severity 1-7.2 (mean 4.8 ± 2.0)
  - Disease severity positively correlated to AO cover

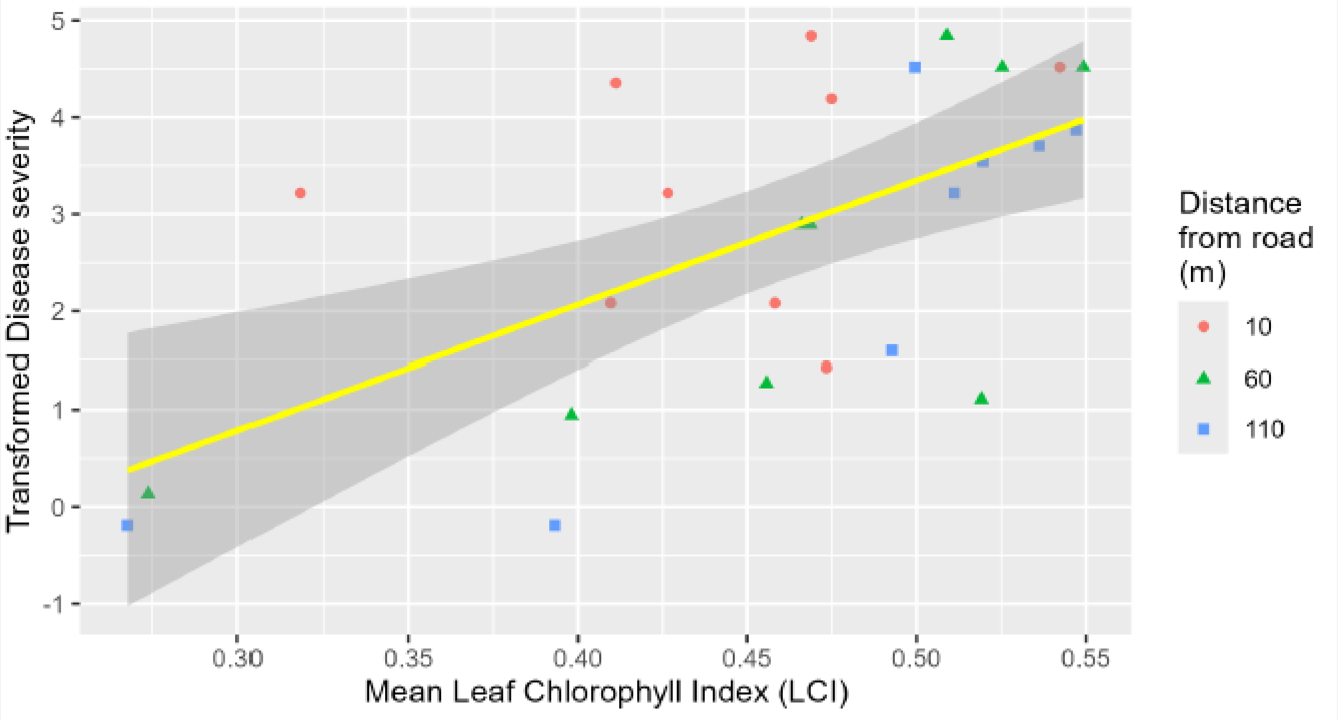
RESULTS: SPATIAL CHARACTERIZATION

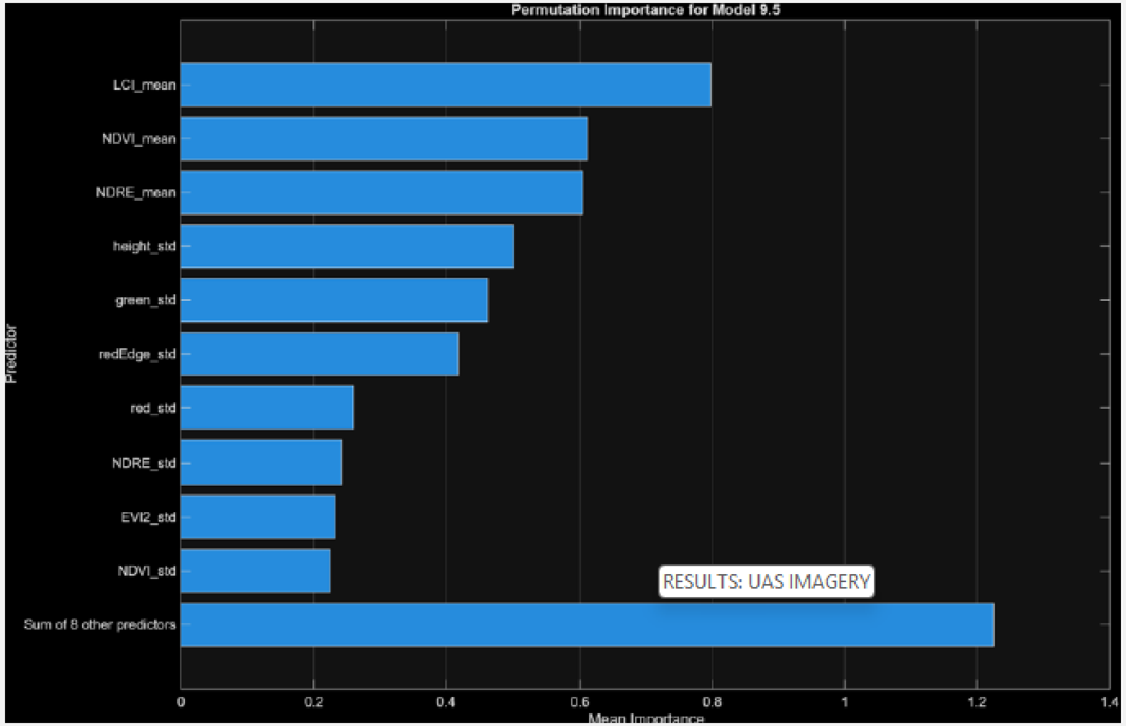




- Overall lower severity further from site entrance (R^2 = 0.42; p<0.001)
  - Higher disease severity on more frequently traveled sections of road
  - Slightly higher disease severity closest to road, not significant (p=0.512)

RESULTS: UAS IMAGERY





- Band or index most strongly correlated with transformed disease severity is the mean plot value of leaf chlorophyll index (LCI) ($p<0.001$; $R^2 = 0.38$)
  - Useful index for discriminating AO from other vegetation, weaker correlation for AO ($p=0.020$; $R^2 = 0.21$) and other woody cover ($p=0.15$; $R^2 = 0.084$)
- Other potential bands/indices

SUMMARY AND CONCLUSIONS

- Pathogen species identified as *Diaporthe eres* and *Diaporthe ellipsoidea*
  - Newly reported pathogens affecting AO
  - Multiple strains of differing virulence?
  - Symptoms beyond initial cankers and vascular streaking not observed in greenhouse yet
    - Slow disease progression? Additional stress required?
  - Inoculations in two field locations to assess longer term effects on larger shrubs and in different conditions, same treatments as GH
    - Will same isolate show most severe symptoms in field setting?

SUMMARY AND CONCLUSIONS

- AO cover variable, somewhat higher closer to roads
  - Powerlines, other ‘perchable’ infrastructure?
  - Higher light availability (Moore et al. 2013)
- Higher AO cover associated with higher disease severity
  - Higher pathogen transmission rates? (Mitchell et al. 2002, Rottstock et al. 2014, Keesing & Ostfeld 2015, Liu et al. 2020, Wang et al. 2023)
- Higher disease severity closer to mine entrance
  - Increased airborne concentration and short-range transmission on more frequently traveled road sections (Numminen & Laine 2020, Carlin et al. 2025, Radujkovic et al 2025)
- LCI associated with disease severity
  - Possible to conduct wider surveys to track disease progression?

FUTURE DIRECTIONS

- Inoculation studies in field ongoing
  - Phenological data, disease progression
- Additional field work/investigations
  - Correlate specific disease severity cover classes with imagery data
  - Environmental stressors (why now???)
    - Soil pH? – AO prefers slightly acidic soils, but soils did not change
    - Shade? – non-issue in most locations on mine
    - Frost? – earlier springs but ~normal hard frosts late in spring*
- Applying for funding to study potential for *D. eres* as a biocontrol (alone vs. combined with herbicide)

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- **Drone access**: Virginia Tech Drone Park

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VIRGINIA TECH

ANY QUESTIONS???

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