Using GIS & Remote Sensing Data to Identify Persistent Crop Productivity Trends

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Introduction & Background

Research Question:

- Can remote sensing be used to identify and quantify statistically significant temporal trends in crop productivity?

Goals Supported:

- Landscape restoration
- Water quality improvement
- Salmon recovery

Image Source: Sierra Club, 2024

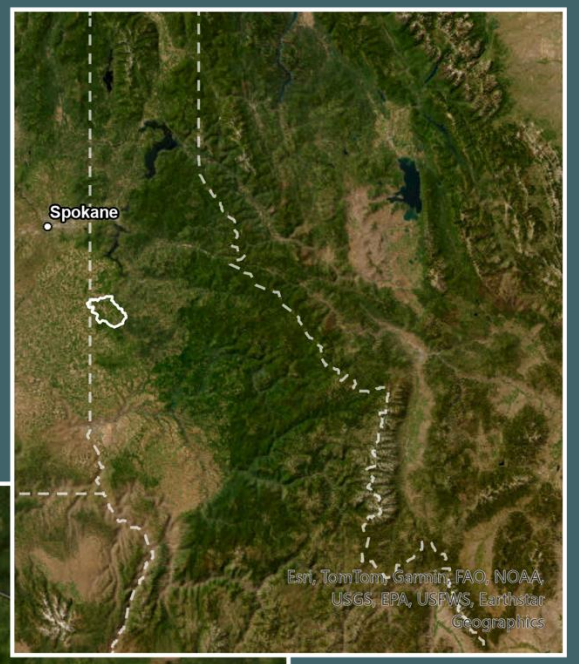
Hangman Creek Watershed (HCW)

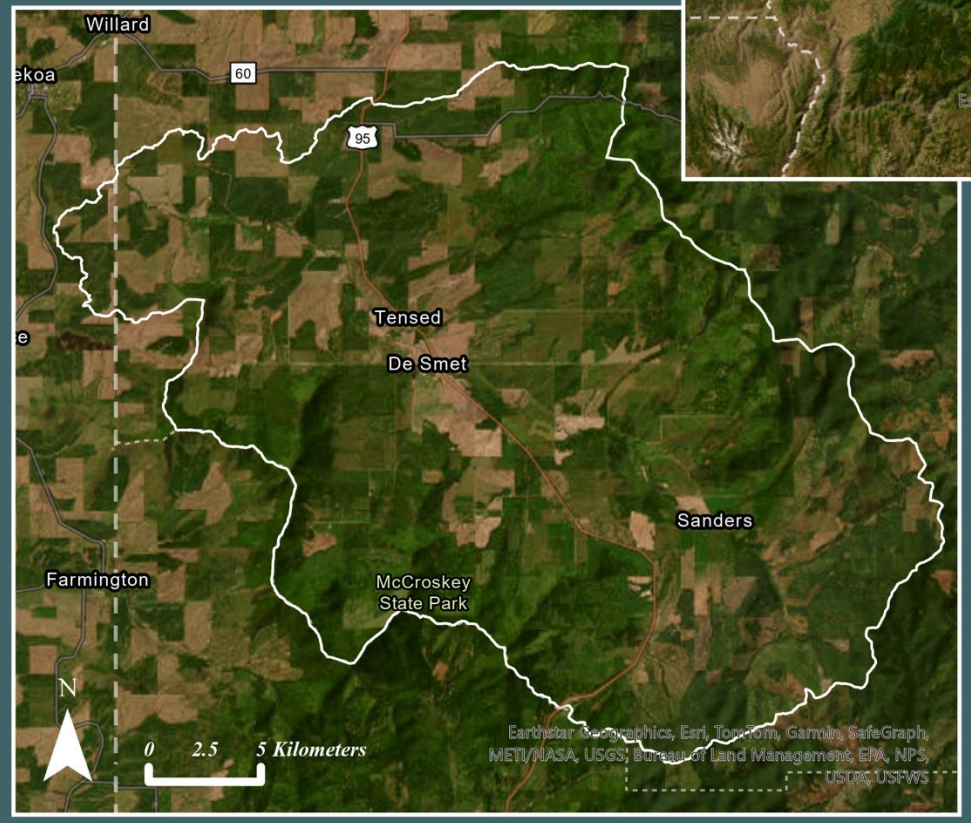
Location:

- Northern Idaho
- Forested headwaters
- Drains into Spokane River

Water Quality Issues:

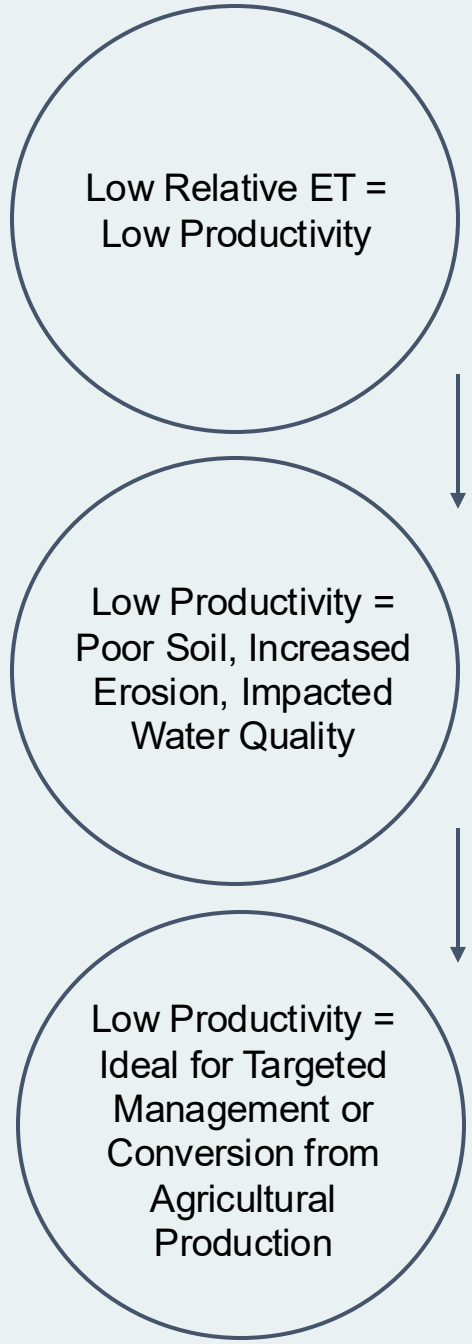
- Turbidity & suspended sediments
- Nutrients, especially P
- Fecal coliform





Hypotheses and Assumptions

- Crop productivity varies across watershed.
- Relative evapotranspiration (ET) is a strong predictor of crop productivity.
- Fields with relatively low productivity will exhibit poor soil
    - Poor water retention, shallow bedrock depth, hydric, etc.
- Unproductive fields with poor soils should be targeted for conservation agriculture practices or removed from production:
    - Unproductive fields are more likely to erode, causing water quality problems for the HCW.
    - Unproductive fields are less economically viable.



Methods

Data Sources:

- Field boundaries: Cropland Data Layer (USDA NASS, 2008-2024)
- ET: Accessed through Google Earth Engine, eeMETRIC model
- Soils data: SSURGO (NRCS)
- Erosion modeling: WEPP

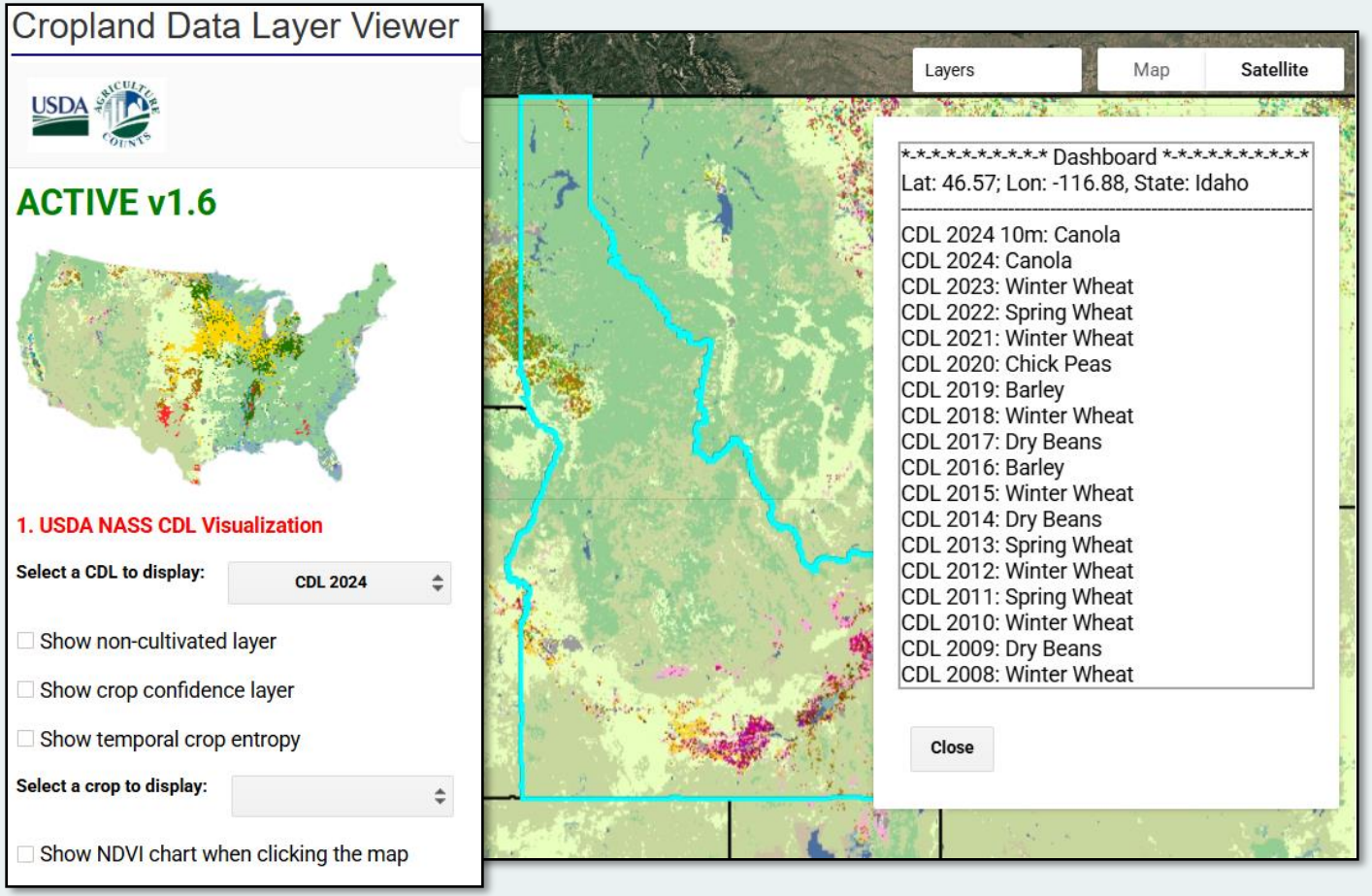
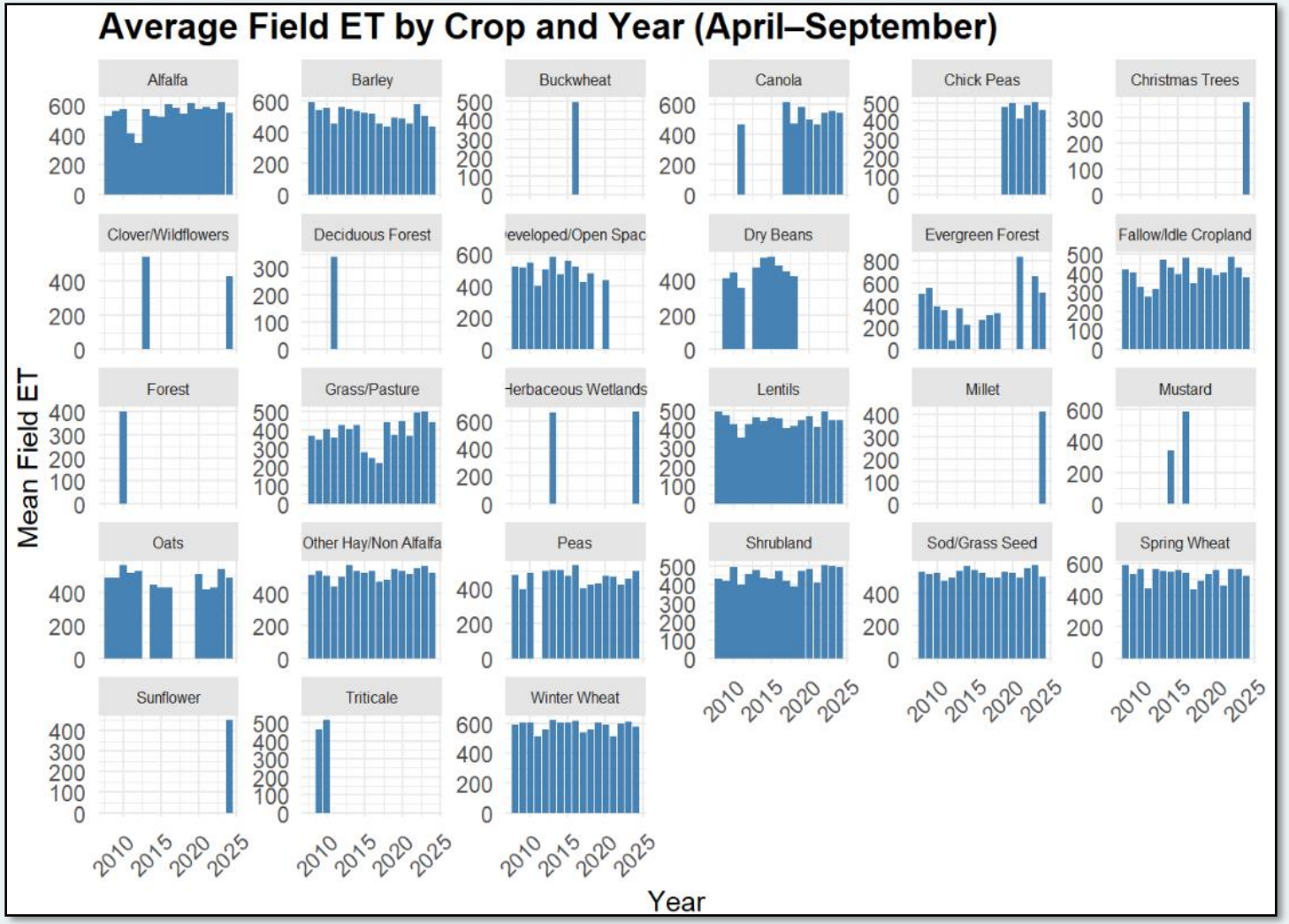


Image Source: Cropland Data Layer Viewer Tool, 2024

Methods (Cont.)

Statistical analyses:

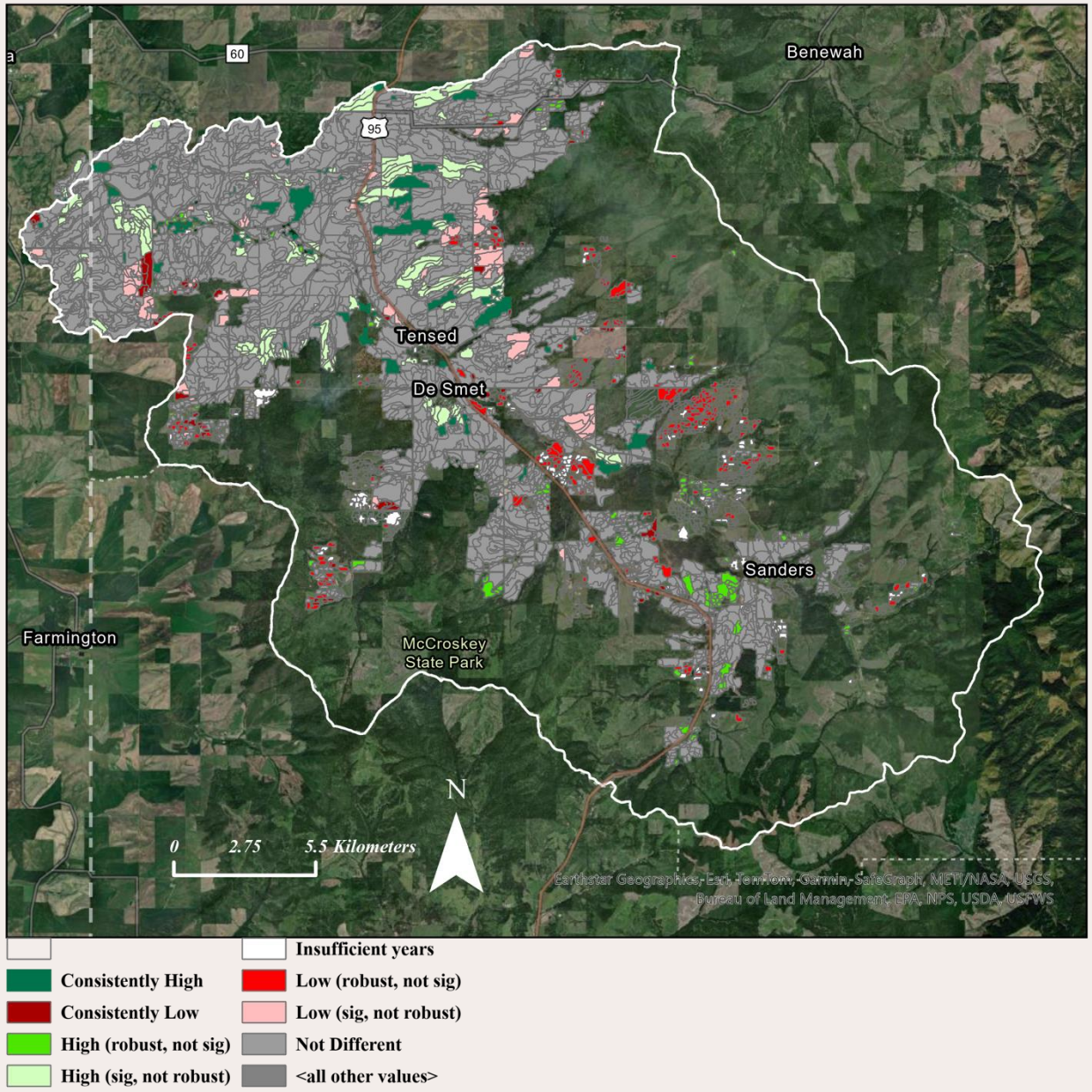
- Using monthly median ET from April-September (2008-2024), calculate relative ET for each crop type and year
    - Calculate t-test and robust z-score for each field based on relative ET
- Classify fields based on significance and frequency of deviation from long-term averages



- The *t*-test and **robust z-score** results are merged, and each field is assigned a performance class:

Category	Criteria	Interpretation
Consistently High	Robust $z \geq +1.5$ and $p_{adj} < 0.05$	Field ET consistently above crop–year mean
Consistently Low	Robust $z \leq -1.5$ and $p_{adj} < 0.05$	Field ET consistently below crop–year mean
High (sig, not robust)	$p_{adj} < 0.05$ only	Statistically high but not strongly outlying
Low (sig, not robust)	$p_{adj} < 0.05$ only	Statistically low but not strongly outlying
High (robust, not sig)	$z \geq +1.5$ only	Outlying but not statistically significant
Low (robust, not sig)	$z \leq -1.5$ only	Outlying but not statistically significant
Insufficient years	$n < 2$	Not enough temporal data
Not Different	—	Within expected variation

Preliminary Results



Generated spatial maps that classify fields by:

- Productivity
- Soil properties (e.g. hydric soils, water table depth, etc.)
- WEPP erosion by crop and field

Significance

- Open source
- Does not require empirical yield data
- Novel temporal approach:
  - Considers relatively long period of historical data
  - Processes large amount of data quickly
    - Calculates median ET for individual fields from individual pixels
    - Relative ET can consider large number of fields
    - Well suited for persistent productivity trends within a field, or to contextualize a field within region

Next Steps

- Soil sample analysis
- Validating remote sensing productivity analysis
- Further erosion analysis
- Prepare comprehensive report for Tribe

QUESTIONS AND COMMENTS

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