# Integrating Seasonal Dynamics into Risk-Informed Wildfire Planning


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Gabrielle Ayres, Tyler Hoecker, Nicole Hemming-Schroeder,
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North Central Climate Adaptation Science Center

USDA

FOREST SERVICE
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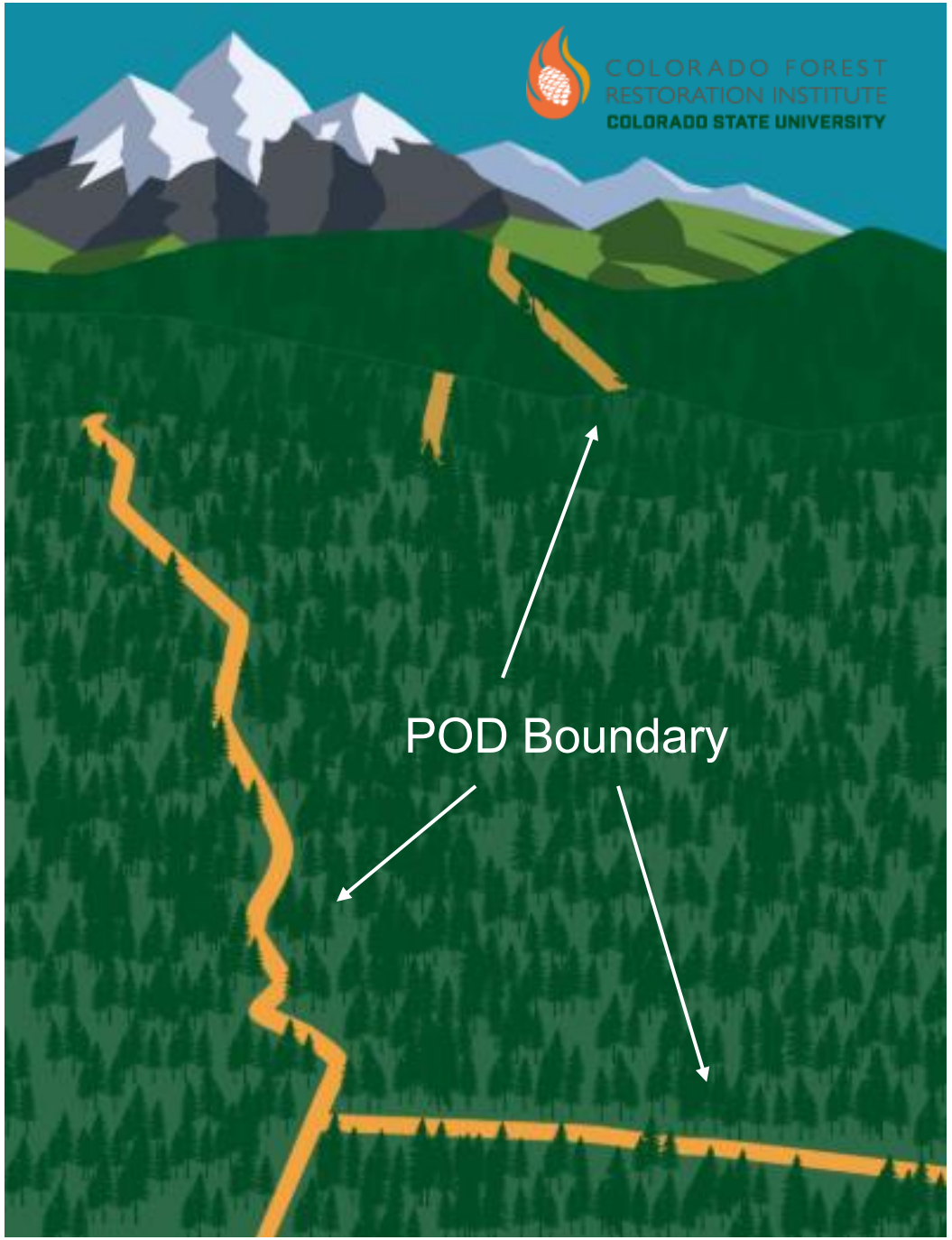
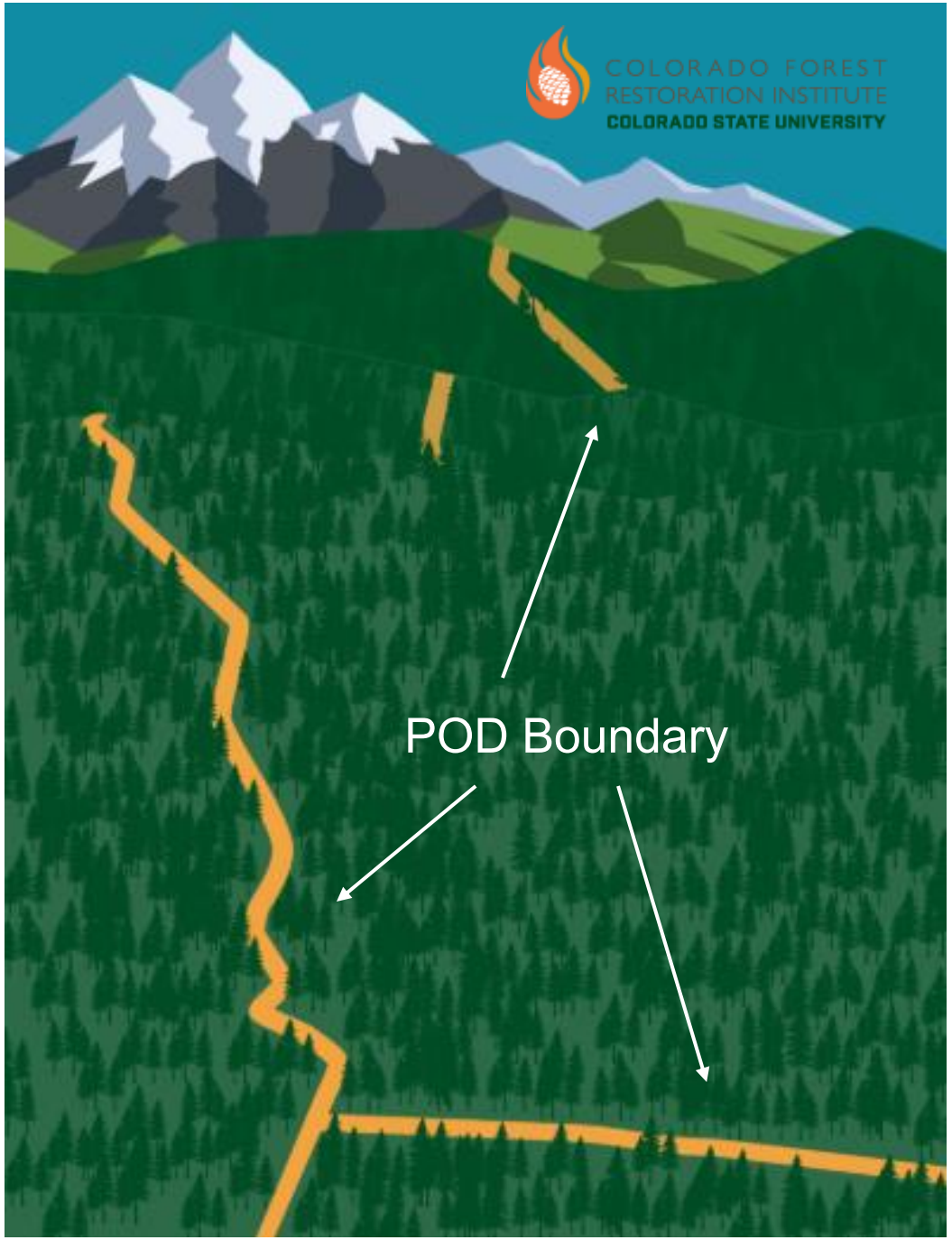



Potential Operational Delineations (PODs) carve up landscapes to make them more manageable for forest and fire management.

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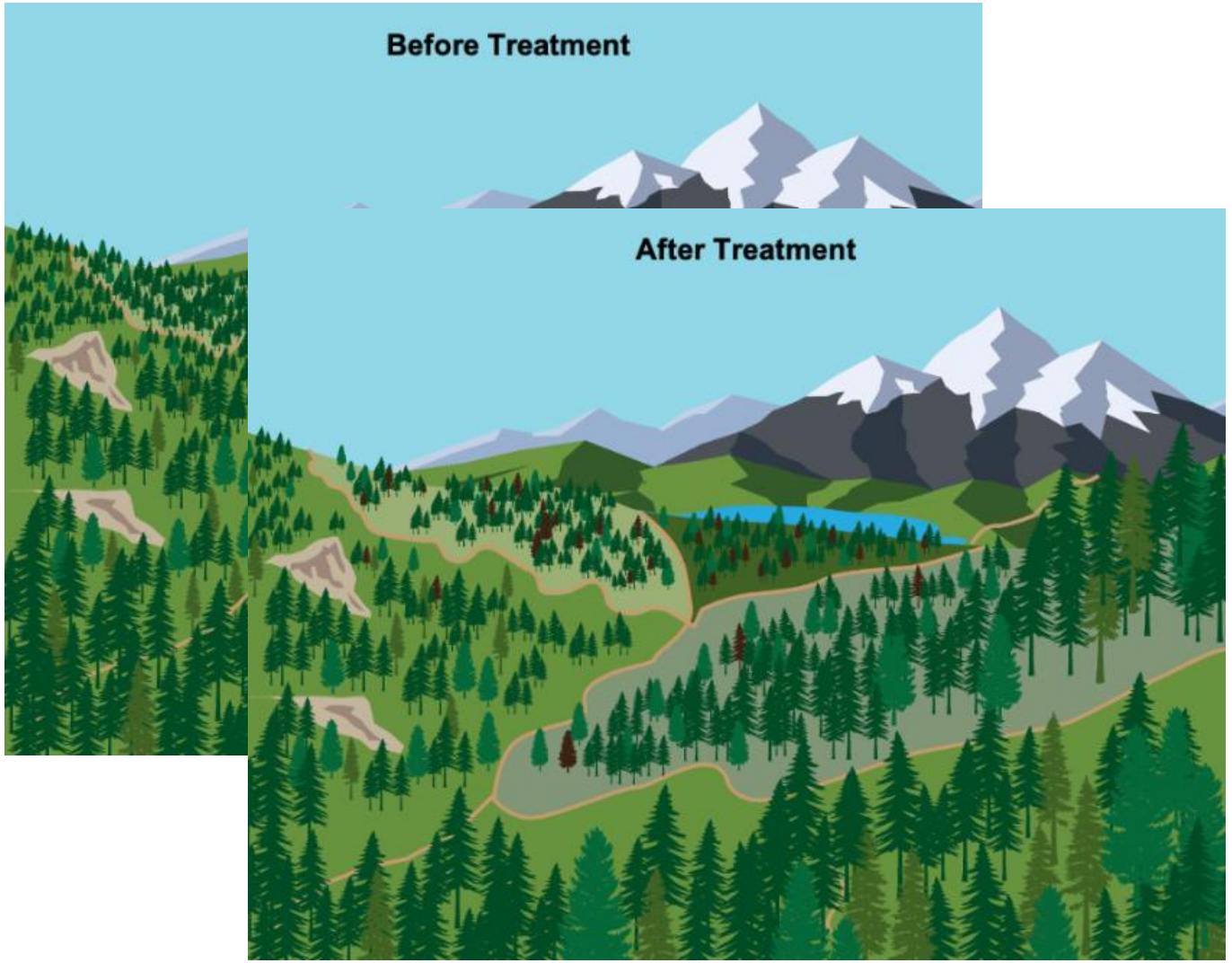

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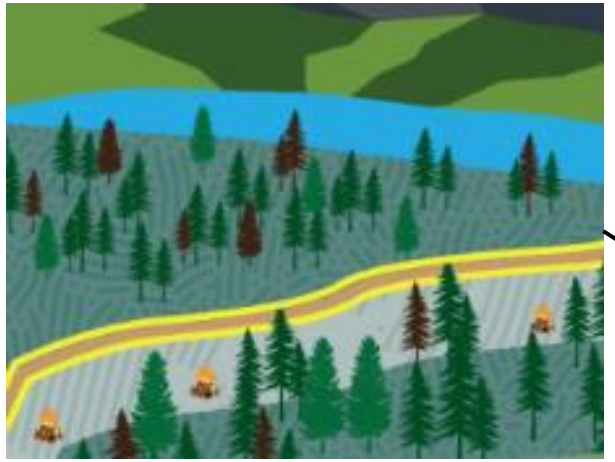
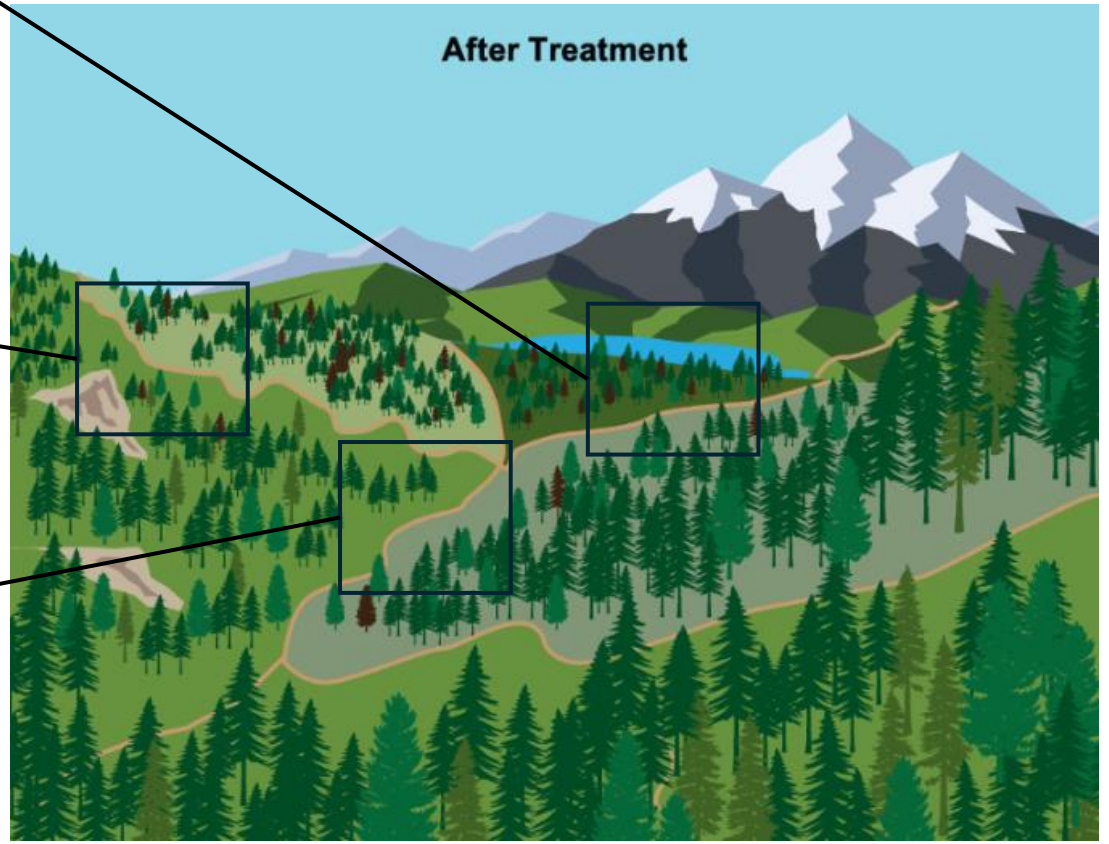
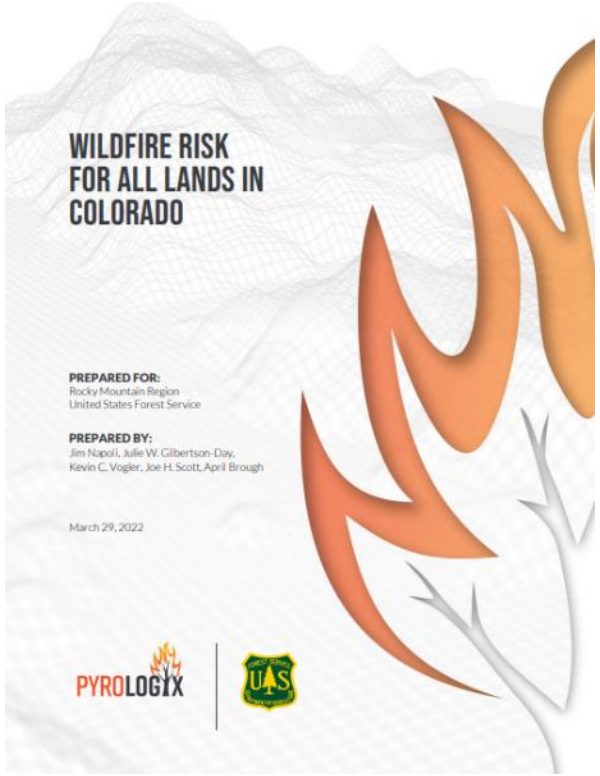
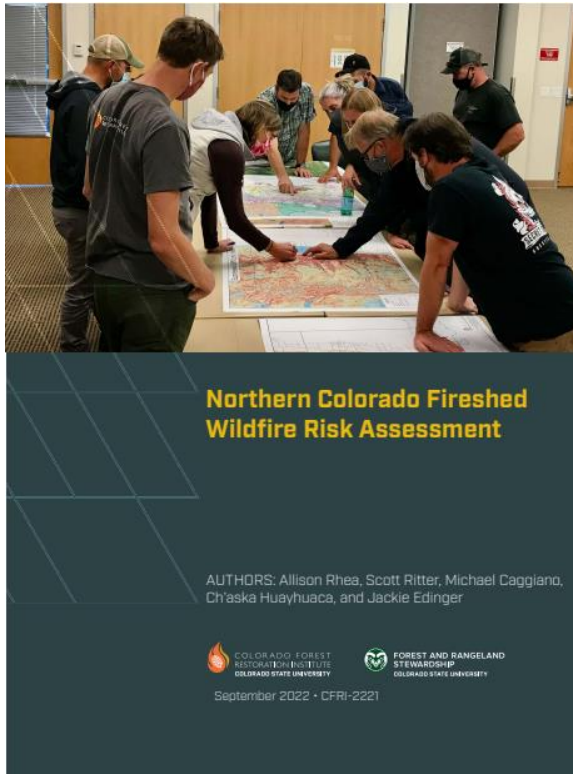


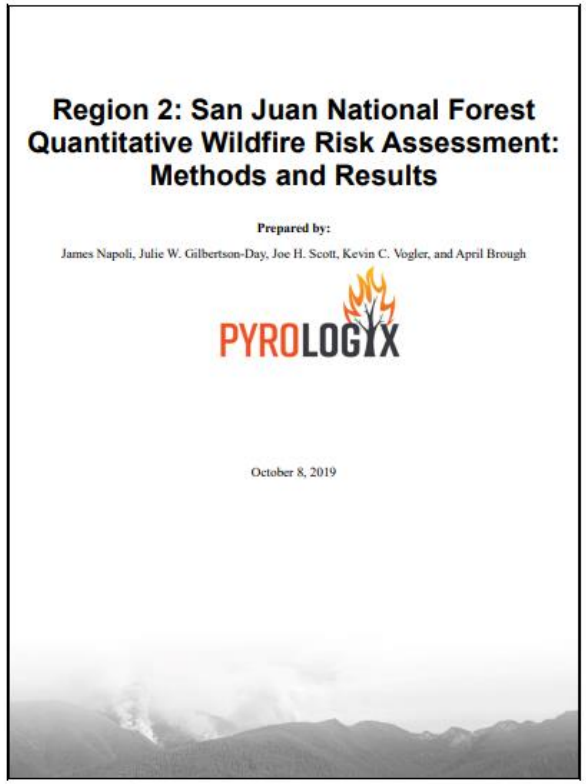
Road
POD Boundary
Fuelbreak
Prescribed Fire



Quantitative Wildfire Risk Assessments (QWRAs) map how wildfire might affect the resources and assets in a landscape that people care about.

Quantitative Wildfire Risk Assessments (QWRAs) map how wildfire might affect the resources and assets in a landscape that people care about.

# RISK

## HAZARD X IMPACT

### LIKELIHOOD

Probability of wildfire starting and spreading

### INTENSITY

Energy released by a wildfire

### EXPOSURE

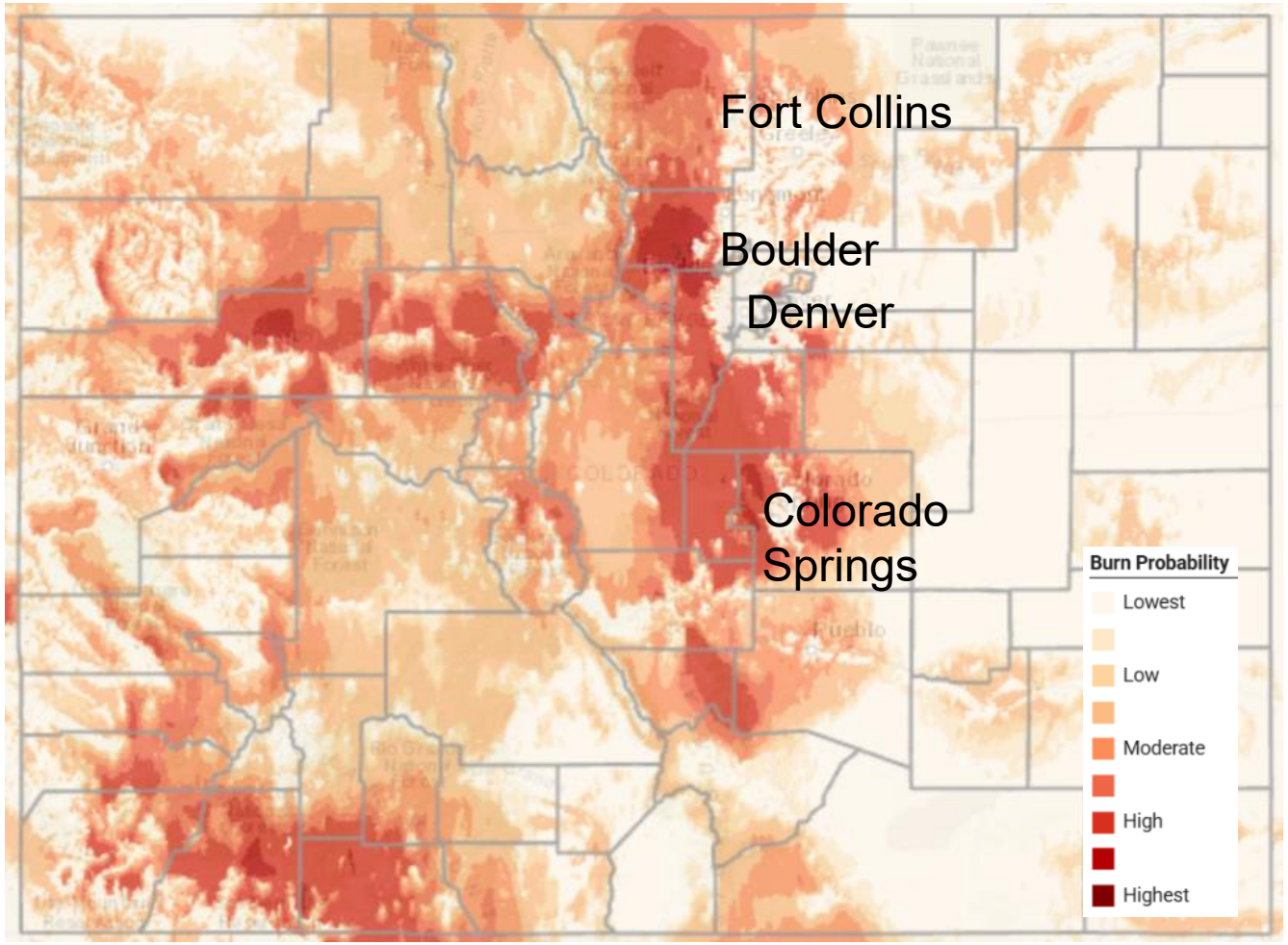
Spatial overlap of wildfire and values

### SUSCEPTABILITY

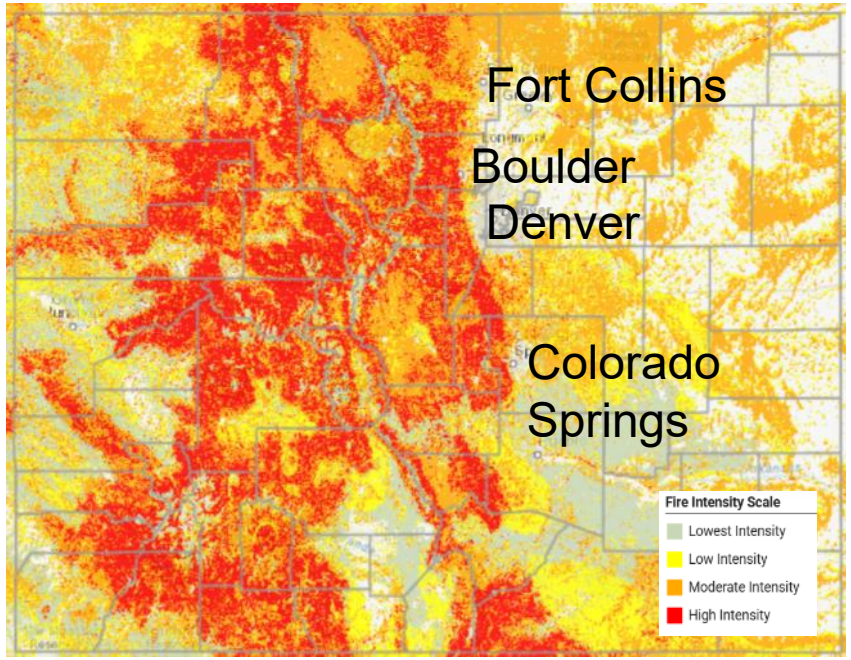
Whether a value may benefit or be harmed by wildfire

# Quantitative Wildfire Risk Assessments (QWRAs) map how wildfire might affect the resources and assets in a landscape that people care about.

## Likelihood = Annual Burn Probability




## Intensity = Conditional Flame Length Probability




**LIKELIHOOD**
Probability of wildfire starting and spreading

**INTENSITY**
Energy released by a wildfire

# Quantitative Wildfire Risk Assessments (QWRAs) map how wildfire might affect the resources and assets in a landscape that people care about.

**People and Property**

People and Property

**Infrastructure**

Electric transmission lines – high & low voltage

Communication Sites

Power

**Vegetation**

Ecosystem Function

**Drinking-Water**

Surface Drinking Water

| Category | HVRA |
|---|---|
| Infrastructure | Monitoring stations |
| | Roads |
| | Electrical Substations and Transmission Lines |
| | Mines |
| | Historic Structures |
| | Communications |
| Recreation | Trails |
| | Trailheads |
| | Camping |
| | Recreation Assets |
| | Ski Resorts |
| WUI | Buildings |
| Wildlife | Preble's Jumping Mouse Habitat |
| | Lynx Habitat |
| | Greenback Cutthroat Trout Habitat |
| Water | Critical Water Supply |
| | Designated Waters |
| Vegetation | Old Growth Forest |
| | Grassland |
| | Sagebrush |
| | Pinyon-Juniper |
| | Spruce Fir |
| | Mixed Shrubland |
| | Aspen-Mixed Conifer |
| | Aspen |
| | Riparian |
| | Ponderosa Pine |
| | Mixed Conifer |
| | Lodgepole Pine |

| Assets | Safety | Water | Biodiversity | Recreation |
|---|---|---|---|---|
| 1. **Transmission distribution lines**<br>2. **Water infrastructure**<br>3. **Critical infrastructure**<br>4. Structures<br>5. Energy facilities<br>6. Water facilities | 1. **Potential control lines (PCLs)**<br>2. **Critical access routes**<br>3. Emergency service facilities<br>4. Wildland urban interface (WUI) defense zone<br>5. Communication infrastructure<br>6. Community transmission zones | 1. **Post-fire erosion potential to high value aquatic habitat**<br>2. **Post-fire erosion potential to high value water suppliers**<br>3. **Post-fire debris flow potential to critical water infrastructure**<br>4. Perennial streams and rivers<br>5. Lakes | 1. **Bighorn sheep**<br>2. **Northern Goshawk**<br>3. **Mule deer**<br>4. **Trout gold medal rivers**<br>5. T&E species | 1. **Recreation trails**<br>2. **Recreation areas**<br>**Other**<br>1. Managed timberlands<br>2. Historic features<br>3. Monitoring stations<br>4. Aboveground live biomass |







**EXPOSURE**

Spatial overlap of wildfire and values

# Quantitative Wildfire Risk Assessments (QWRAs) map how wildfire might affect the resources and assets in a landscape that people care about.

| | Flame Lengths (m) 0.0–0.6 | 0.6–1.2 | 1.2–1.8 | 1.8–2.4 | 2.4–3.7 | >3.7 |
|---|---|---|---|---|---|---|
| *Open Dry or Moist Forest* | | | | | | |
| Live Large Tree | +10 | +15 | +20 | +25 | -25 | -25 |
| Dead Large Tree | -25 | -25 | -25 | -25 | -30 | -30 |
| *Closed Dry or Moist Forest* | | | | | | |
| Live Large Tree | +10 | +15 | +90 | +95 | -25 | -25 |
| Dead Large Tree | -25 | -25 | -25 | -25 | -30 | -30 |
| *Open Cold Forest* | | | | | | |
| Live Large Tree | +10 | -35 | -35 | -35 | -35 | -35 |
| Dead Large Tree | -35 | -35 | -35 | -35 | -40 | -40 |
| *Closed Cold Forest* | | | | | | |
| Live Large Tree | +10 | -35 | -35 | -35 | -35 | -35 |
| Dead Large Tree | -35 | -35 | -35 | -35 | -40 | -40 |

Peeler et al. *under review*

SUSCEPTABILITY
Whether a value may benefit or be harmed by wildfire

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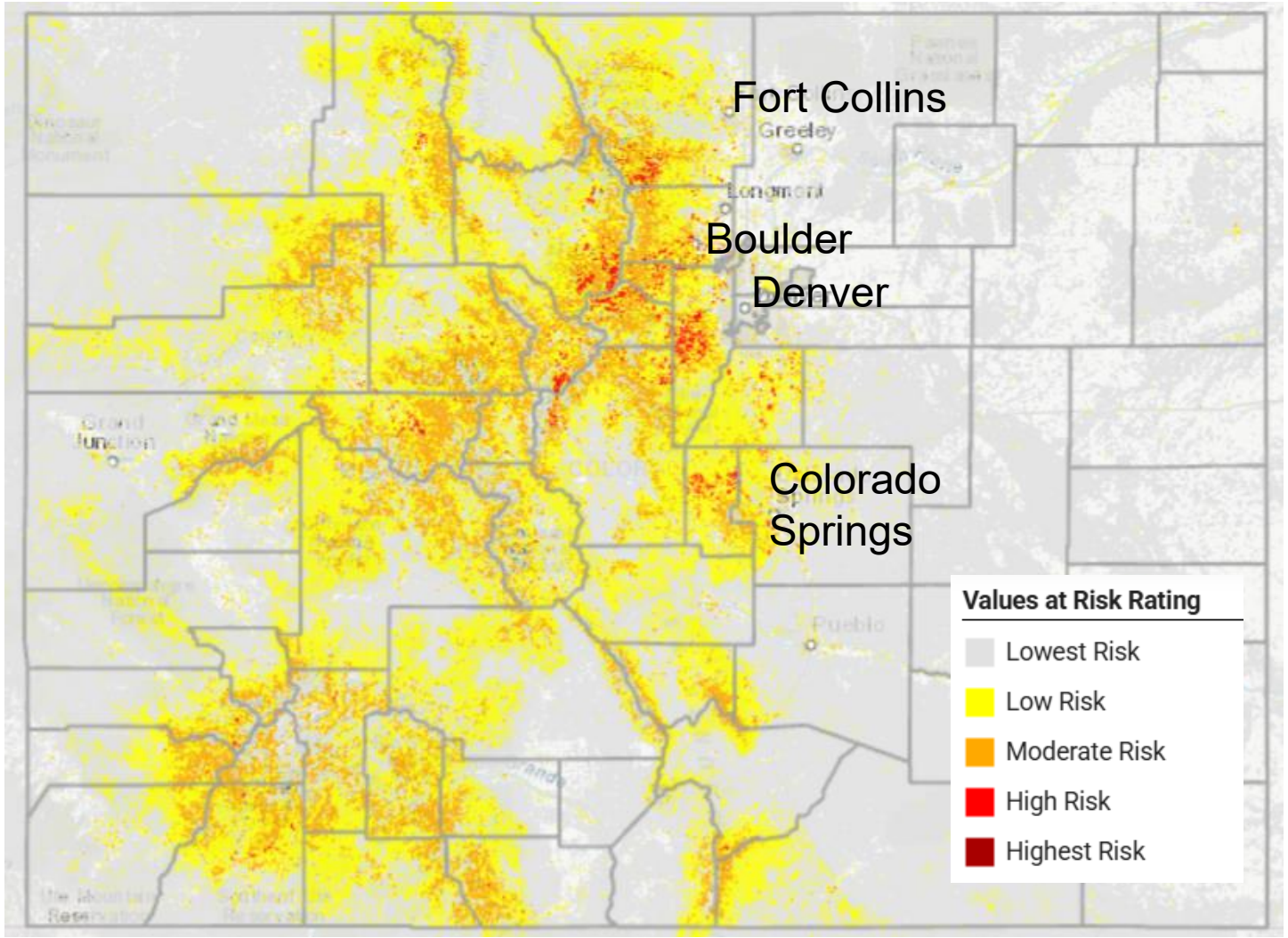
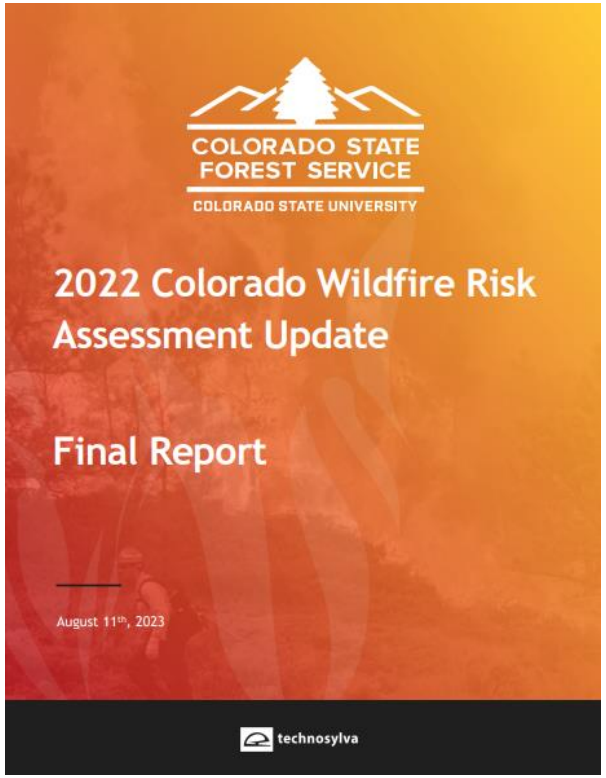


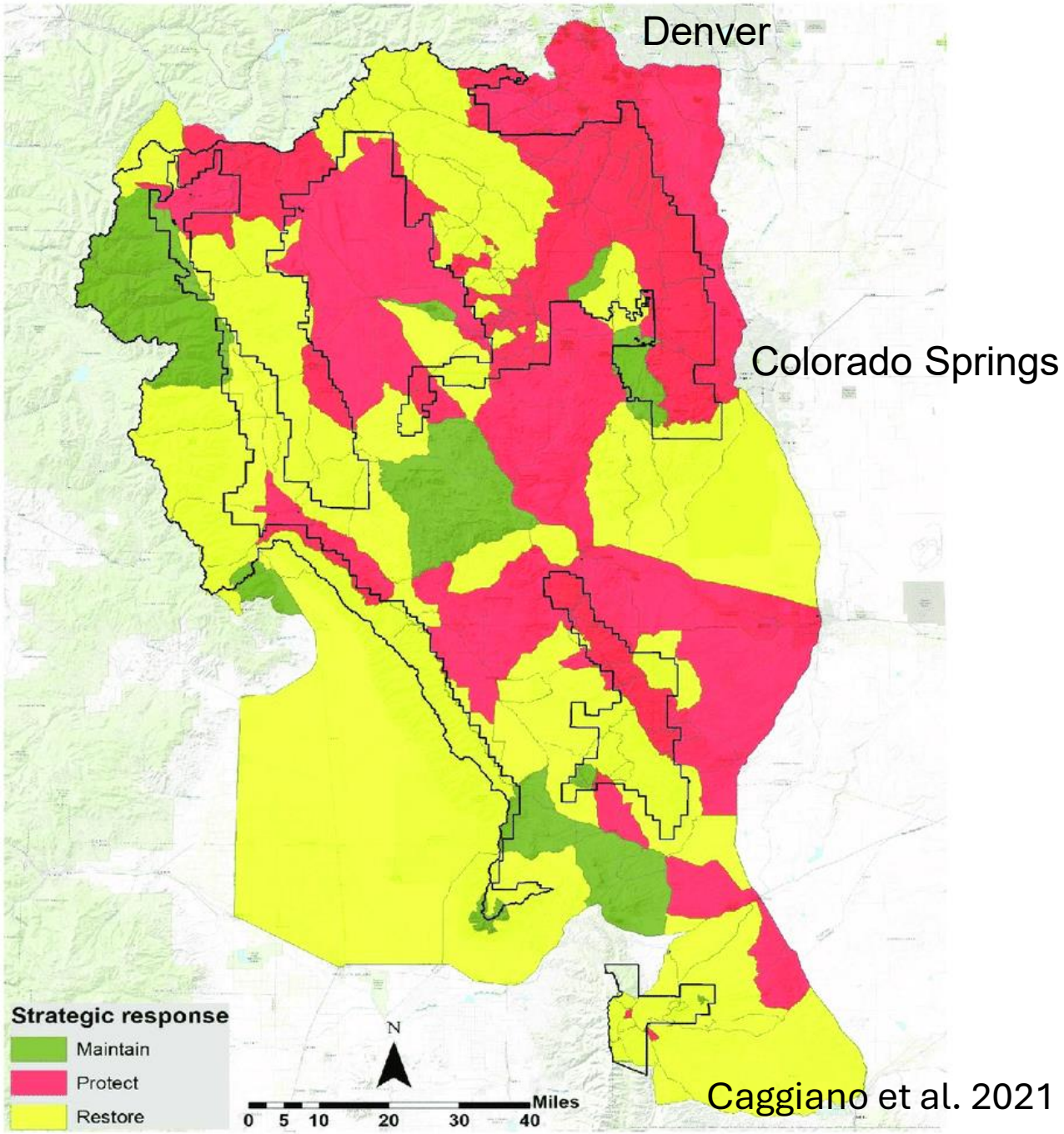



# PODs and QWRAs can be combined to create strategic response zones.

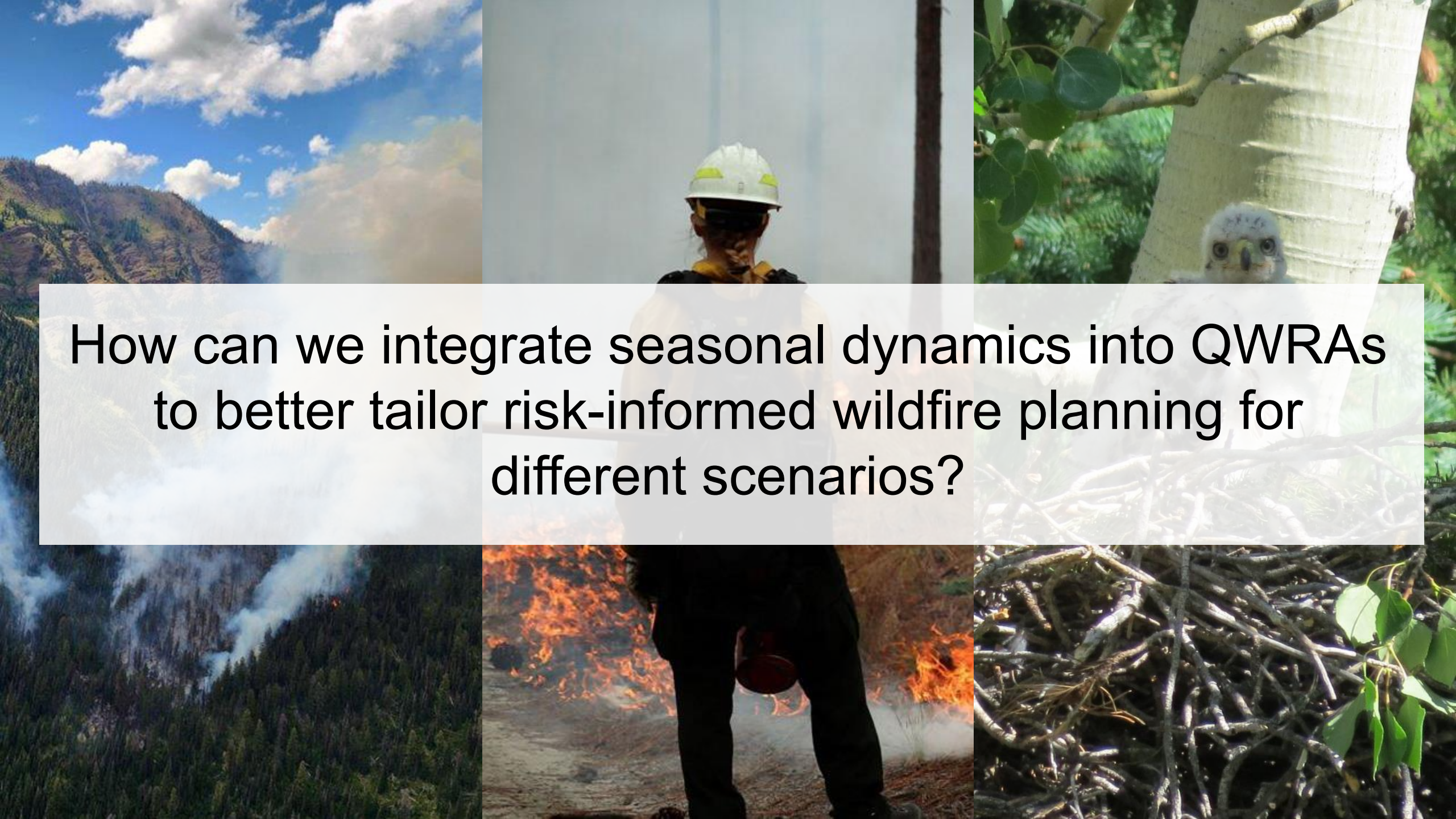
Maintain = wildfire would create acceptable or beneficial effects; strategy includes allowing fire to spread under right conditions.

Protect = wildfire would cause unacceptable impacts; strategy prioritizes keeping fire out or limiting spread.

Restore = wildfire would produce desired conditions that make the landscape healthier; strategy includes allowing fire to spread under right conditions.




Caggiano et al. 2021



How can we integrate seasonal dynamics into QWRAs to better tailor risk-informed wildfire planning for different scenarios?

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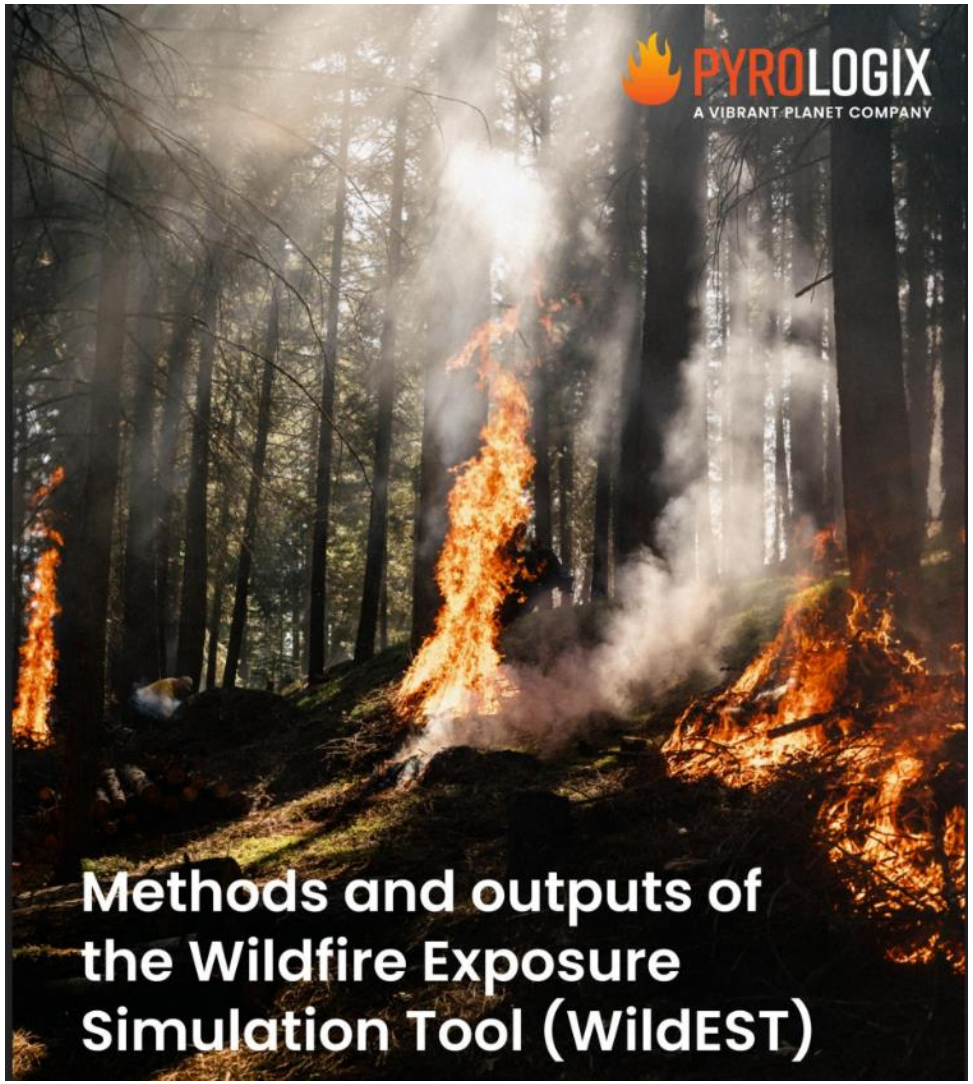
# Constraining WildEST weather types to creates scenarios that capture seasonal dynamics in intensity.




- WildEST is a deterministic fire-behavior modeling system that estimates conditional flame-length probabilities across a landscape.
- Each weather type is a distinct combination of historical wind, fuel moisture, temperature, and humidity conditions.
- Weather types are weighted by how often they occur and how much fire growth they historically produce.

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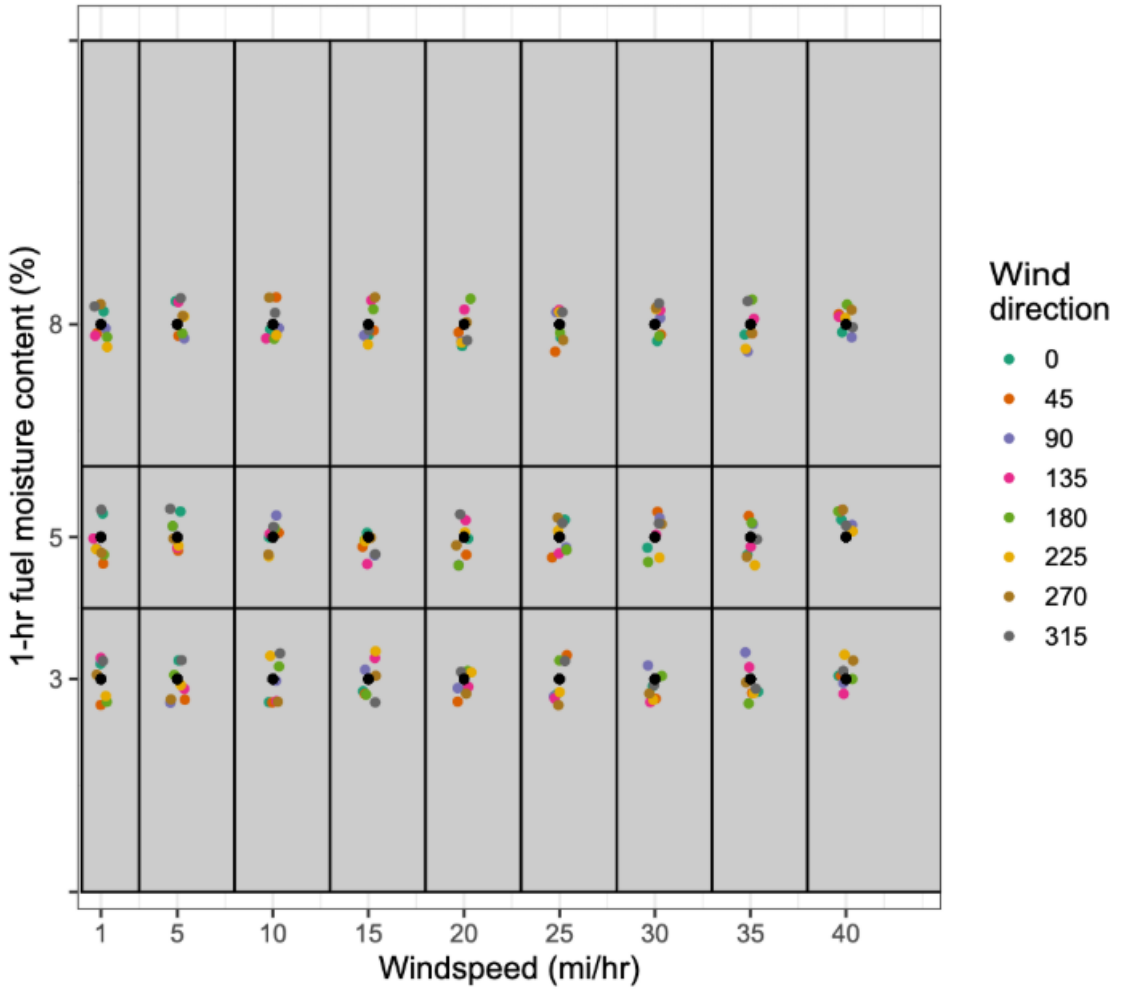


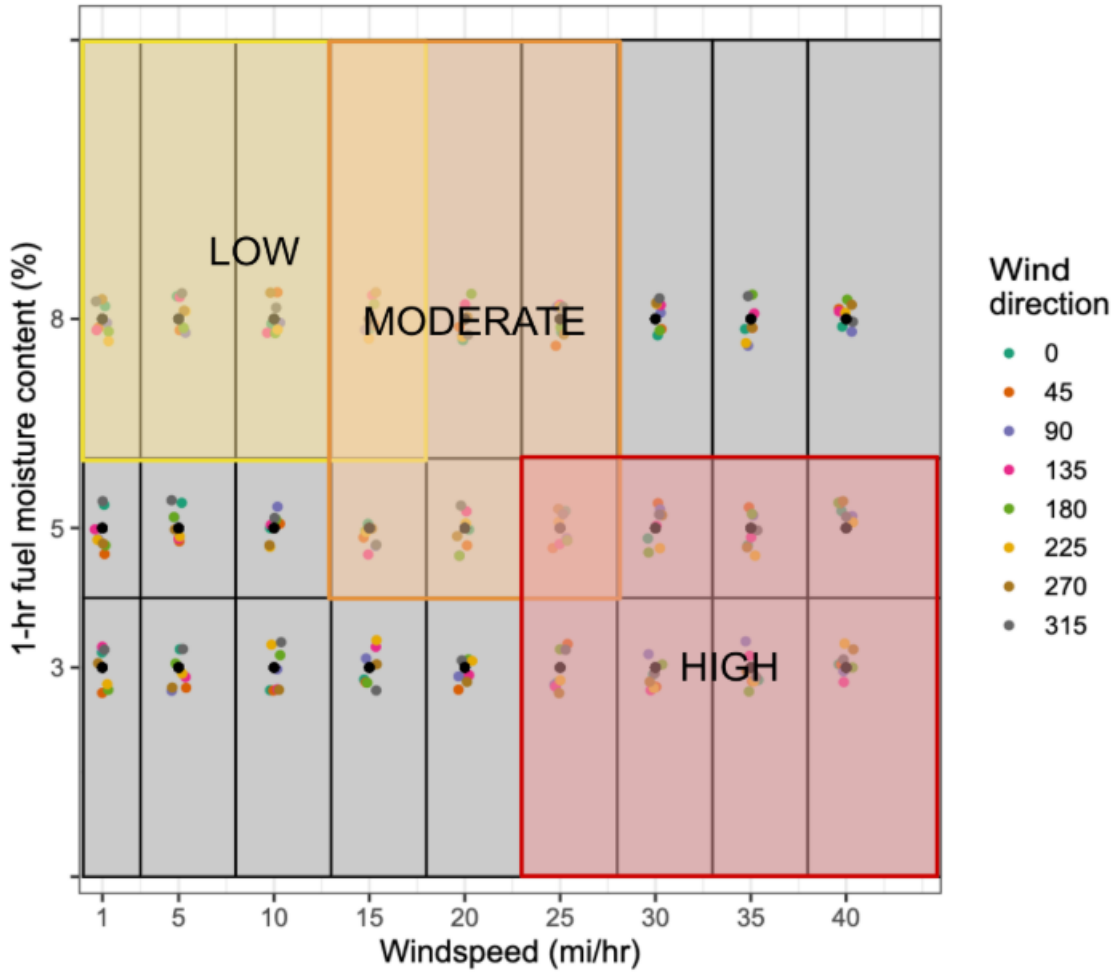


Data visualization by Tyler Hoecker

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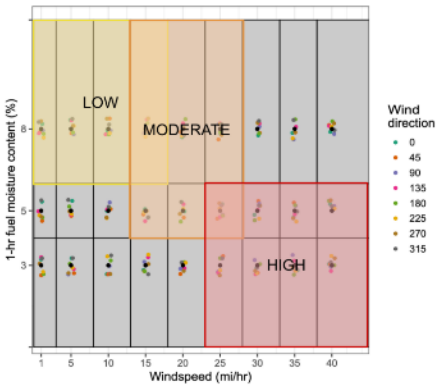
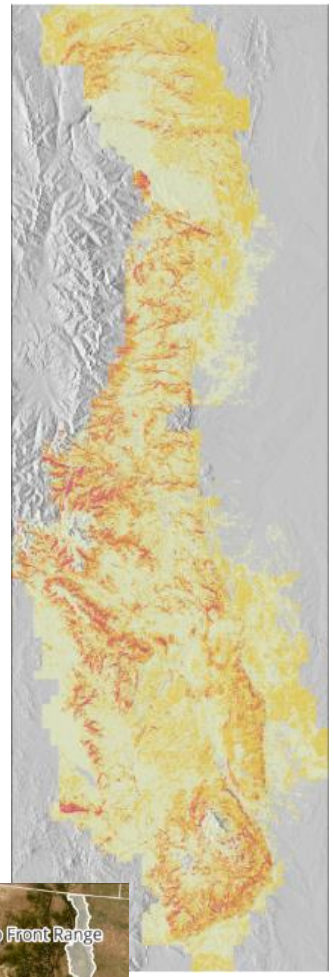
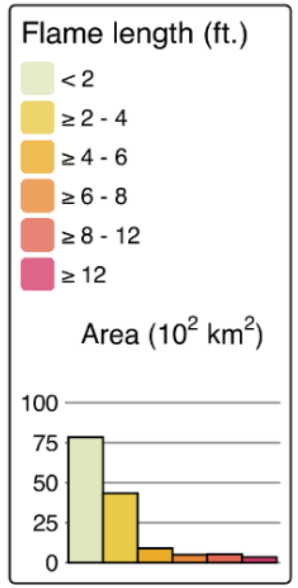


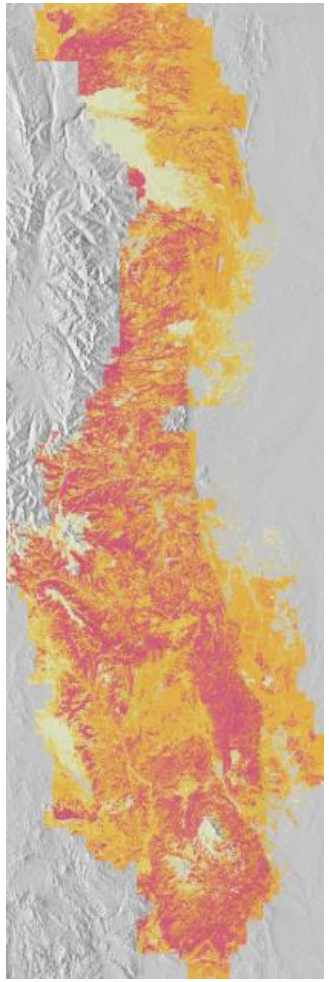


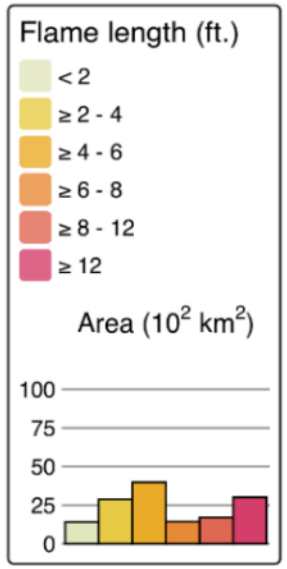
## Low



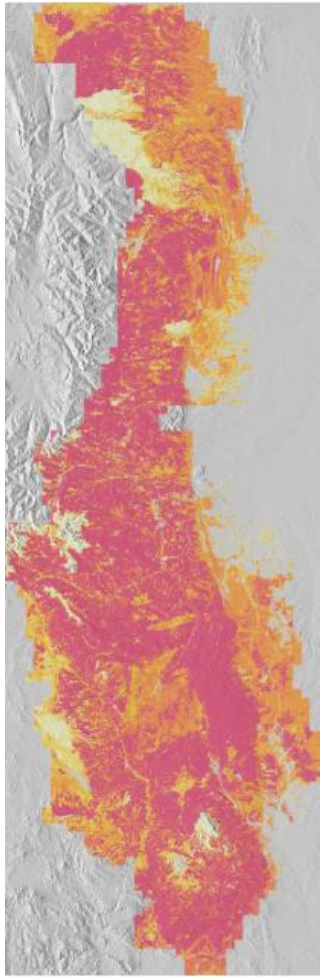


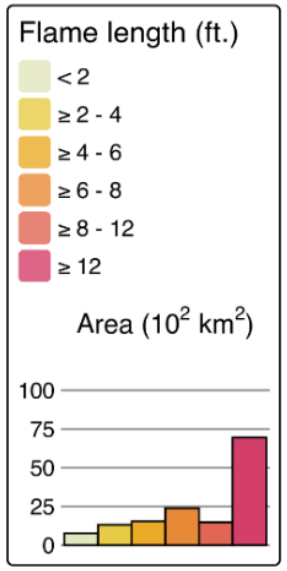

## Moderate






## High






Data visualization by Tyler Hoecker

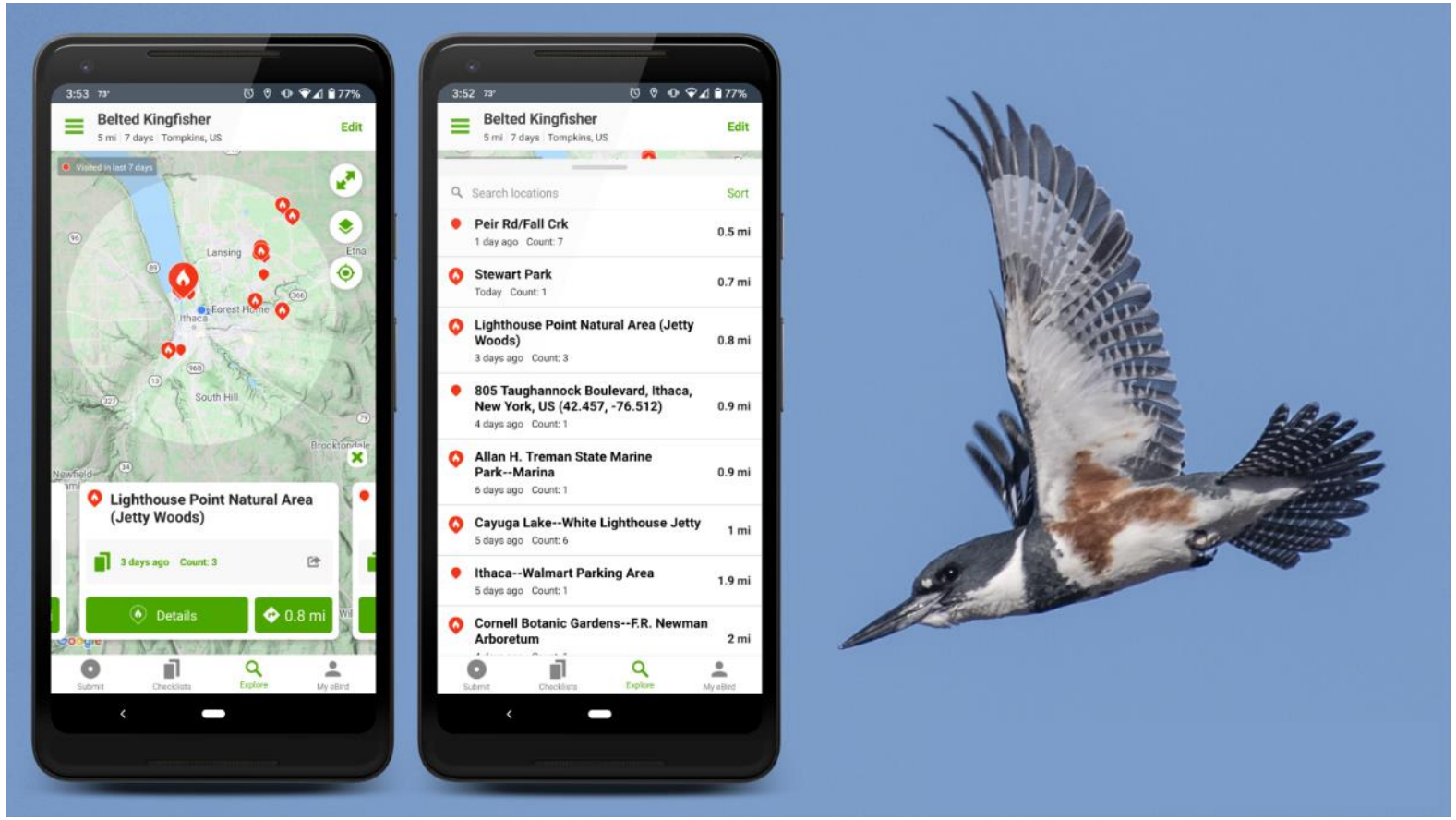
# Developing recreation scenarios that reflect seasonal patterns in how landscapes are seen and experienced.

Resource-bearing plants

Wildlife

Recreation

# Developing recreation scenarios that reflect seasonal patterns in how landscapes are seen and experienced.




eBird

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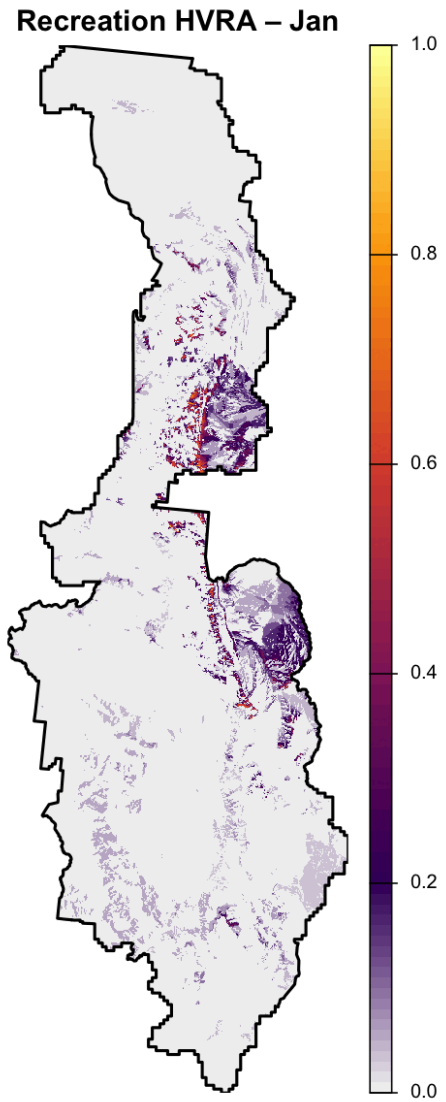
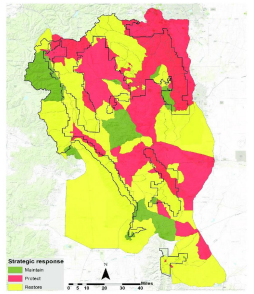


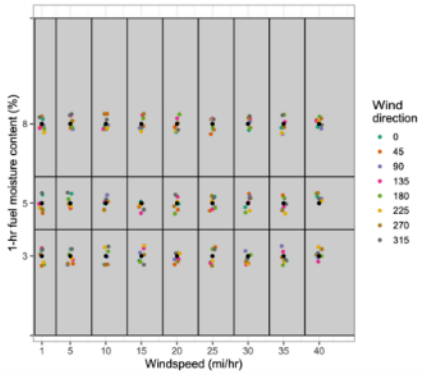

Data visualization by Gabrielle Ayres

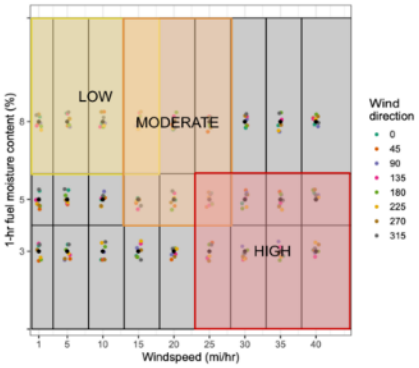
# Key Takeaways

**Risk-informed wildfire planning needs more than one playbook.** A single, high-consequence scenario misses important variability in how different values interact with fire and expanding beyond that can lead to more nuanced and actionable decisions.

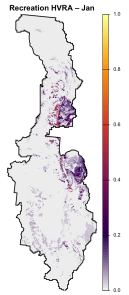


**WildEST offers a path to multiple hazard scenarios.** By drawing on weighted weather types, WildEST can generate seasonally specific intensity estimates that better reflect the full range of fires that managers actually encounter.




**Recreation has clear seasonal dynamics.** Using data like eBird user-days helps characterize how recreational settings are experienced across the year, allowing those seasonal patterns to be reflected in how recreation is represented in risk assessments.




Feel free to reach out if you want to talk more about risk-informed wildfire planning:

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