Wildfire Risk Products

A Technical Comparative Review for Pacific Northwest Professionals

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About the Northwest Fire Science Consortium:

The Northwest Fire Science Consortium works to accelerate the awareness, understanding, and adoption of wildland fire science in Washington and Oregon. It connects managers, practitioners, scientists, local communities, and collaboratives working on fire issues on forest and range lands. The Northwest Fire Science Consortium is one of the 15 regional exchanges established by the Joint Fire Science Program's Fire Science Exchange Network to bring fire science users together to address regional fire management needs and challenges. Each regional exchange provides current and regionally relevant wildland fire science information to users in the region. For more information: http://www.nwfirescience.org/.

About the Washington Department of Natural Resources:

The Washington State Department of Natural Resources manages 5.6 million acres of aquatic lands, forests, natural areas, and more from the Puget Sound to the Palouse. Washington's public landscapes are a legacy that provide all Washingtonians with enormous environmental, recreational, and economic benefit. The Department manages seven state trusts to generate revenue and preserve habitat for public schools, state institutions, and county services to meet the needs of present and future generations. The Department provides recreational opportunities on these lands and protects them as the state's wildfire fighting workforce. For more information: https://dnr.wa.gov/.

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Established by the Oregon Legislature to support science-based natural resource decisions, the Institute for Natural Resources works to deliver management-relevant information that informs discussions and decisions about the long-term stewardship of Oregon's natural resources, and works to advance centralized, science-based natural resource information for Oregon and the Pacific Northwest. The Institute for Natural Resources is located at Oregon State University and Portland State University. For more information: https://inr.oregonstate.edu/.

Acronyms

AGOL – ArcGIS Online

AOI – Area of Interest

API – Asset Priority Index

BLM – Bureau of Land Management

cRPS – Conditional Risk to Potential Structures

CRV – Current Replacement Value

eNVC – Expected Net Value Change

cNVC – Conditional Net Value Change

ERC – Energy Release Component

FBFM – Fire Behavior Fuel Model

FEI – Fire Effects Index

FEMA – Federal Emergency Management Agency

FIL – Fire Intensity Level

FOA – Fire Occurrence Areas

FOD – Fire Occurrence Database

FRI – Fire Risk Index

FSA – Fire Service Areas

FTI – Fire Threat Index

GIS – Geographic Information System

HIP – Hazard Importance and Probability

HVRA – Highly Valued Resources and Assets

IARF – Integrated Additional Risk Factor

IDG – Ignition Density Grid

IFTDSS – Interagency Fuel Treatment Decision Support System

LANDFIRE – Landscape Fire and Resource Management Planning Tools

LBP – Landscape Burn Probability

LRB – Loss Ratio Per Basis

MTBS – Monitoring Trends in Burn Severity

NARR – North American Regional Reanalysis

NFDRS – National Fire Danger Rating System

NPS – National Park Service

NWCC – Northwest Interagency Coordination Center

NWCG – National Wildfire Coordinating Group

ODF – Oregon Department of Forestry

PNW – Pacific Northwest

POD – Potential Operational Delineations

QWRA – Quantitative Wildfire Risk Assessment

RAVG – Rapid Assessment of Vegetation Condition After Wildfire

RAWS – Remote Automatic Weather Stations

SVI – Social Vulnerability Index

USDA – United States Department of Agriculture

USDI – United States Department of Interior

USGS – United States Geological Survey

VIR – Values Impacted Rating

WADNR – Washington Department of Natural Resources

WIZ – Weather Influence Zones

WTP – Weather Type Probabilities

WUI – Wildland Urban Interface

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Executive summary

Wildfire risk products are analytical tools that help land managers, planners, and decision-makers understand where wildfires are likely to occur, how intense they might be, and how values such as homes, forests, or water sources would respond to fire. These products use available data, models and expert guidance to simulate fire behavior and assess potential fire impacts on values at risk. Risk products take many forms, including maps, dashboards, rankings, and statistics that can inform planning, mitigation, and response efforts aimed at reducing losses from wildfire. Managers and decision-makers have increasingly turned to these tools as wildfires have grown more intense and damaging, seeking ways to better anticipate where fires may occur and their impacts.

As the use of risk products has grown, so has confusion and controversy about how they work, their strengths and limitations, and the distinction between wildfire risk and wildfire hazard. Wildfire risk products vary widely in their design, purpose, and technical details. They may use different definitions of risk, values, data sources, fire metrics and models. This diversity means that risk assessments for the same location can vary by design. This variability does not necessarily indicate that the products are flawed or inaccurate. Rather, it reflects that wildfire risk analysis is a diverse field with evolving techniques that serve different users and applications. As this comparative review shows, there is no universal formula for assessing wildfire risk. For potential users of wildfire risk products, the strength in understanding diverse approaches lies not in direct comparison but in recognizing the unique contributions each makes. It also means that users need to invest time into selecting the right risk product(s) for their specific application.

We conducted a technical comparative review to summarize and compare twelve products used in Oregon (OR) and Washington (WA), collectively referred to as the Pacific Northwest (PNW). We rely on each product's technical documentation to consolidate and explain key technical differences among commonly used risk products and offer considerations for their practical use. The goal of this document is to improve understanding of the science behind wildfire risk products to support informed use. We do not attempt to create a roadmap for selecting and using risk products, as these processes are typically tailored to a specific group or community and its goals.

There are many risk products available for PNW. We identified and selected products self-described as wildfire risk products, relevant to the PNW, and supported by metadata, technical reports, and peer-reviewed papers. Commercial products with fees to access data were not included. We included in this review one hazard product, the OR State Wildfire Hazard Map. Although it does not meet the technical criteria of being a self-described risk product, the widespread attention it received and the questions it raised about wildfire risk analysis warranted its inclusion.

Wildfire risk products are powerful tools for understanding and addressing wildfire risk, but they must be used thoughtfully. Their effectiveness depends on how well users understand their design, strengths, limitations, and appropriate applications. We included a set of considerations for using risk products most effectively:

- Risk assessments begin by identifying values at risk, which are natural resources or human assets. The choices of which values to include, how to combine them, and their relative importance shape how risk is calculated and the results. When multiple values are combined into an overall risk map, users need to be able to answer the question "Risk to what?" and understand how individual risks (e.g., to structures, forest, habitat) combine to produce the overall map.

- Risk products evolve with new and better data and methods. Changes between versions can reflect real-world shifts in conditions but may also result from technical improvements in data and fire modeling techniques. Teasing out the origin of changes in risk between two versions of maps can be challenging.

- Because risk only can be estimated based on the best available knowledge and data and cannot be directly measured, building trust and support for risk maps requires confidence in the science and agency behind the assessment. Validation of risk products often focuses on components of the risk assessment and remains limited.

- Risk products can be complex and raise difficult political, economic, and social questions about how to best undertake wildfire adaptation actions. The decision-support literature offers approaches that can aid collaboration and communication.

- Some products allow for customization, which can increase the relevance to a specific user's context. Taking advantage of these opportunities for refinement and socialization of the risk product can increase acceptance but requires technical expertise and resources.

- Most products rely on publicly available data and fire behavior models, which have limitations. In addition, wildfire is an inherently uncertain natural process. Understanding the data sources, assumptions, modeling techniques, and calibration behind the fire modeling used in risk products can help users determine which may be best suited to their area of interest and most well-validated for their purposes.

How to use this document

This document is organized into nine sections:

Section 1, **Introduction** outlines the goals of this work, distinguishes between wildfire risk and hazard, and briefly reviews complementary work.

Section 2, **Opportunities for using risk products** reviews some of the use cases of risk products in the PNW.

Section 3, **Approach to comparative review of risk products** describes the methodology and provides a brief introduction to each product, including its geographic extent, data availability, supporting documentation, and key features that distinguish each product from the others. This is a good starting point for users looking for a general understanding of the products covered in this review.

Section 4, **Attributes of risk products** provides an overview of the attributes used in the comparative review of wildfire risk products. It serves as an introduction to the Tables in Section 7, which are placed later in the document for ease of use.

Section 5, **Considerations for using risk products** offers seven considerations for users, tying into the risk attributes where relevant. It includes callout boxes that summarize the key takeaways for users and guiding questions when assessing risk products.

Section 6, **Conclusions** lays out final remarks and includes a summary table comparing selected attributes of risk products.

Section 7, **Comparative review of attributes: The tables** contain 15 comparison tables that describe the technical attributes of wildfire risk products included in this review. Section 7 is most useful for users who want to compare products based on a set of specific technical attributes or find technical information for a given product's attributes.

Section 8, **Citations** lists the full citation of the work referenced throughout this document.

Section 9, **Appendices** consists of a glossary of terms used in this document (Appendix 1) and a summary of methods associated with each of the products included in this review (Appendix 2). Method descriptions are based on the methods provided in each product's technical documentation, which are listed in the product's overview introduction (Section 3).

1. Introduction

In the PNW, wildfire risk is a common concern for fire and forest managers, scientists, policymakers, and communities. In response to large and destructive fire events, there has been increasing use of wildfire risk analysis to inform planning, prioritizing, and funding of forest restoration, fuels reduction, and community preparedness across the region. These analyses often utilize simulation models, data and fire and fuels management expertise to predict the likelihood, behavior, and potential impact of wildfires on values at risk.

There can be confusion about how to best use these products. Risk is an inherently uncertain concept with no single definition, and it is used alongside or interchangeably with other terms, such as wildfire hazard (**Box 1**). Different products provide varying results for predicting areas of high risk based on the technical inputs and methods underlying each product. It can also be difficult to understand each product's development, intended applications, approach to risk valuation, and limitations because these products use different data, and levels of documentation. This can pose challenges for users who require a high degree of confidence and certainty to allocate funding, propose risk reduction projects, or implement regulations. Still, the limitations of risk analytics can be outweighed by the risks of not using them at all. Above all, risk maps, statistics, and other analytics are helpful tools, but not the only information decision-makers rely on. Risk products are most effective when used within a broader decision-making framework that is transparent about tool limitations and appropriate uses, and that draws on multiple sources of information, including local knowledge.

There is a significant body of literature about wildfire risk. Seminal work on the topic is pertinent to the products reviewed here and warrants mention. Key work includes the introduction of quantitative wildfire risk assessment (Finney, 2005) and the application of these concepts to estimate the effects of fuel treatments on wildfire risk to owl habitat, carbon and old growth (Ager et al., 2006; 2007; 2010). Calkin et al. (2010) describe procedures for the first approximation of wildfire risk and hazard using Oregon as the prototype. Scott et al. (2013) presents a framework to assess wildfire risk and explore mitigation actions for land and resource management. A glossary of wildfire risk terminology and a review of uncertainty in the context of wildfire risk management are presented in Thompson and Calkin (2011) and Thompson (2016), respectively.

Some peer-reviewed research and syntheses also address the challenges associated with identifying and applying risk products appropriately. For instance, Oliveira et al. (2021) identified multiple international examples of risk assessment and how methods can influence assessment results. Brown et al. (2024) provided a wildfire risk primer that describes risk concepts and addresses likely questions about assessing and managing risk. More recently, Thompson et al. (2025) produced a review of wildfire risk indices within the context of the built environment – defined as human-made areas where people live and work, including structures, infrastructures and utilities. This included an inventory of current models, gaps, and opportunities.

The Electric Power Research Institute's Wildfire Risk Tool Inventory[1] supports the planning needs of electric power companies and is national in scope. The Southwest Ecological Restoration Institute produced a series of briefing papers about the application of risk products, before and during wildfires, which featured examples in OR. The United States Geological Survey (USGS) Wildfire Hazard and Risk Assessment Clearinghouse[2] is an online tool that identifies wildfire hazard and risk assessments available across the United States. It provides links to the assessments when available.

Although these resources offer valuable background on the development and application of risk products, they do not focus on comparing risk products specific to the PNW. To help fill this gap, we reviewed wildfire risk products commonly used in the PNW. The need for this technical review and its approach was developed and refined through dialogue between the WA Department of Natural Resources (WADNR), Oregon State University (OSU), and Washington State University (WSU) under the auspices of the Northwest Fire Science Consortium (NWFSC). This review is intended for professional audiences, including land and fire managers, practitioners, local officials and planners, and policymakers. In this synthesis, we:

- Describe the basic components of wildfire risk products.
- Compare and explain key differences in the technical information behind commonly used risk products, including values at risk, intended applications, fire modeling methods, and data sources, among other attributes.
- Provide considerations for the selection and use of risk products by potential users.

The purpose of this document is to compare wildfire risk products available in the PNW, compile key attributes into a single document, and provide key considerations for practitioners interested in using wildfire risk products. We do not offer recommendations on which products to use or connect products to applications for two reasons: 1) the diversity of offerings and the diversity of potential users and applications render specific recommendations unhelpful, and 2) we believe it's important for users to have informed use of wildfire risk products, which includes making difficult decisions about tradeoffs and which products better meet their unique needs. We developed this review to support users by striking a balance between providing enough information to help them make decisions without expecting them to be wildfire risk experts.

Box 1. Wildfire Risk versus Wildfire Hazard

A risk assessment involves considering how wildfires might impact values at risk in a geographic area (e.g., the continental US, a state, or lands managed by a specific ownership). Values refers to resources (natural) and assets (human-made), which are deemed to be important and could be impacted by fire.

Without identified values, there is no wildfire risk – just wildfire hazard describing where fire is likely to occur and how intense it may be, regardless of the values present on the landscape. This is a small but fundamental distinction when communicating risk and hazard. Wildfire by itself is a hazard. It's only when it impacts values that we deem it a risk.

If values are present, risk can be calculated for one or multiple values that coexist in the same geographic area. For example, in a forested area on the east slopes of the Cascades, where fires are frequent and expected to be of high intensity, the risk to homes will be zero if the area has no homes. However, the same area may also have a wildfire risk to timber.

Examples of situations where fire and values co-exist in the same area, but no change to the value is expected due to fire, are extremely rare. This is because natural and human-made things can be either beneficially or adversely affected when exposed to fire.

[1] https://apps.epri.com/wildfire-tool-inventory/en/inventory-risk-tools.html. *Electric Power Research Institute, Inc (EPRI) 3420 Hillview Avenue, Palo Alto, California 94304.*

[2] https://apps.usgs.gov/wildfire_hazard_and_risk_assessment_clearinghouse/

2. Opportunities for using risk products

Risk assessments can provide helpful information and inform strategic decision-making by:

- Bringing partners together to build shared understanding and goals related to wildfire hazards and risks.
- Defining important values and assets.
- Determining boundaries for priority areas.
- Selecting strategic locations and sequences of project areas.
- Making financial and resource capacity decisions.
- Assessing social and economic conditions as factors in activity prioritization.
- Informing discussions where communities are reviewing land use and development policies related to wildfire risk.
- Prioritizing mitigation actions.

Some common uses of risk products in the PNW include:

Large landscape management: Research emphasizes the need to treat larger spatial areas to accomplish ecosystem restoration and fuels reduction goals at scale (Prichard et al., 2021). Working across large landscapes can allow managers to address interconnected dynamics between vegetation conditions, fuels, and insects and disease. Landscape management efforts that have used the Quantitative Wildfire Risk Assessment (QWRA) and other products include the United States Forest Service (USFS) Collaborative Forest Landscape Restoration Program, which has funded seven priority national forest landscapes in the PNW (five in OR and two in WA), and the cross-boundary USFS-Natural Resources Conservation Service Joint Chiefs' Landscape Restoration Program. On private lands, there have been some rapid vegetation assessments and plans for treatment across multiple parcels, most notably in dry forest landscapes within OR (Leavell et al., 2018). At the state level, WADNR used risk analysis to create a 20-Year Forest Health Strategic Plan for Eastern WA in 2018, and in 2023, the Oregon Department of Forestry (ODF) collaborated with federal, state, and Tribal partners to launch a 20-Year Landscape Resiliency Strategy.

Community planning: Locally developed plans such as natural hazard mitigation plans and community wildfire protection plans (CWPP) help guide fire preparedness, mitigation, response, and recovery. Risk analysis

is often used in CWPPs to identify values at risk and highest priority areas for treatment. CWPPs came into use in the PNW after the National Fire Plan (2000) provided funds and incentives to communities (Jakes et al., 2011; Sturtevant and Jakes, 2007). Creating or updating CWPPs helps communities access funding such as Community Assistance Grants or Community Wildfire Defense Grants. These plans can be at the community, county, or nested scales. For example, Deschutes County, OR, has seven CWPPs covering its full extent and some neighboring areas, but no overarching county-level plan. Chelan County, WA, has a single plan with nine zones designed to reflect distinct terrain, wildland fuels, and development features. Tillamook County, OR, has a county-wide, multiple-hazard mitigation plan that includes wildfire.

Fire response: Government fire management agencies use a variety of tools for identifying where fires might happen, their possible impacts, and suppression strategies. The Interagency Fuel Treatment Decision Support System (IFTDSS) provides a unified and web-based platform for these purposes. IFTDSS has numerous applications before, during, and after fire events (Drury et al., 2016). Wildfire risk assessments combined with Potential Operational Delineations (PODs) can be used to provide strategic response zones during wildfire incident management. PODs are pre-identified, strategic planning units on the landscape, bound by natural or human features (like roads, rivers, or ridgelines) that can be used to manage fire (Thompson et al., 2021). Breaking a landscape into PODs and using them as summary units for risk can help fire managers anticipate where and how they would respond to a wildfire, assess its suppression difficulty, and guide pre-fire planning (Wollstein et al., 2022).

3. Approach to comparative review of risk products

We developed an initial list of products commonly known and used in the PNW. We further refined it through an internet search using the keywords "wildfire + risk + products" and cross-referencing the results with products in the USGS Wildfire Hazard and Risk Assessment Clearinghouse. The necessary conditions for an individual product to be included were that it had: 1) the term "risk" in its title or description; 2) data for WA, OR, or both; and 3) available technical documentation.

Three products met these conditions but were not included in this review:

- The USGS Wildfire Hazard and Risk Assessment Clearinghouse was omitted because it is a compilation of products that did not fit the specific structure of this comparative review.
- The RiskMonitor, a USFS framework to help managers identify the most effective treatment strategies to reduce wildfire risk and monitor progress toward this goal, was also omitted due to its recent launch (2024) and limited available technical information.
- The Communities at Risk Report released in 2021 by the National Association of State Foresters lacked sufficient information on the methodology used.

Conversely, we included the OR State Wildfire Hazard Map in this review. Although this product focuses on hazard and does not assess risk to values, the widespread attention it received and the questions it raised about wildfire risk analysis warranted its inclusion.

Our review did not cover commercial products, including those used by insurance and real estate companies, nor any products that require fees to access data. The vast number of commercial offerings and the limited availability of detailed technical documentation made a comprehensive review infeasible. Examples of commercial products not included are First Street Foundation Fire Factor[3], Vibrant Planet, Zesty.ai, CoreLogic Wildfire Risk Score (CoreLogic), Precisely Fire Pro Model, AIR Wildfire Model, Verisk Wildfire Catastrophe Model, Fireline Score (Verisk), CoreLogic Brushfire Risk Layer Model, Gallagher's Spatial Key, RedZone wildfire model, Cape Analytics, AON Wildfire Hazard, and MunichRe Wildfire HD Risk Scores, among others.

In total, we reviewed and compared eleven risk products and one wildfire hazard product (Figure 1). Below, we provide a brief introduction to each product, focusing on the product type, availability of public data, documentation used, initial release and updates and key features from our perspective as authors. Section 7 of this review focuses on additional attributes related to the values included in the assessment, risk definition and details on the fire modeling (Figure 1).

To ensure that we accurately characterized the attributes of risk products, we requested early input from thirteen scientists who develop and manage these products. We then obtained reviews from nine selected professionals who work with, or may work with, risk products in practice, focusing on the clarity and accessibility of the document. Finally, anonymous reviews by four experts in wildfire risk science was conducted before publication.

[3] Fire Factor scorings are available for free at https://firststreet.org/ for residential addresses. Access to additional information, including full access to physical risk data and interactive tools, is available for a fee. The methodology behind the calculations and fire modeling has been published in a peer-reviewed publication (Kearns et al., 2022).

Figure 1. Wildfire risk (yellow sticky notes) and hazard products (blue sticky note) included in this review and list of tables of attributes for which products were reviewed.

OSU - Extension Fire Program Relative Risk Assessment

A wildfire risk assessment for the state of OR, including a geospatial dataset of relative and overall risk by fire service area (FSA). The risk map is a companion to a tool that allows for customized wildfire risk assessment by enabling users to modify individual values at risk and fire behavior characteristics to produce overall-risk maps that can replace the broader-scale risk maps initially produced. Geospatial data are not publicly available. OSU developed this product and our review of it was based on a peer-reviewed journal article providing details on methods (Schmidt et al., 2022).

Key features include:

- Embedded in a tool that enables users (using preferably county-sized or smaller landscapes) to modify individual values at risk and fire behavior characteristics to produce overall-risk maps that can replace the broader-scale risk maps, tailoring risk maps to regionally specific user goals and knowledge of values and fire behavior.
- Integrates weather data from multiple Remote Automatic Weather Stations (RAWS) into the analysis.
- Incorporates additional hazards: drought, invasive species and insects and disease.
- Allows different valuations by FSA.
- The "Relative risk" and "Overall relative risk" are similar to the calculation of conditional and expected net value change in other risk assessments. Potentially positive effects of low-intensity fire are represented through response function values, but the final classification does not include a positive effect classification or rating.
- Risk ratings are based on quantiles calculated using data for each FSA, rather than quantiles calculated based on statewide risk data. This means that risk ratings are relative within the FSA and independent of other FSAs.

OSU - Community-Level Wildfire Risk Rankings for PNW

A tabular ranking of communities in the PNW based on social vulnerability-informed risk. Includes the 50 top communities in each state, ranked based on their wildfire risk, with and without social vulnerability considerations, and using hazard products from the 2023 PNW QWRA. Tabular and spatial data are available by request to the product authors. This review is based on the available white paper on methods and results (McEvoy and Dunn, 2025). Released in 2025, key features include the summary of risk by community and integration of the social vulnerability index with a quantitative risk assessment, addressing a known gap in risk assessments that focus solely on biophysical variables.

OSU - Oregon Statewide Wildfire Hazard Map

A map of wildfire hazard for the state of OR, developed under Senate Bill 80. Geospatial data are available through the OR Wildfire Risk Explorer. This review is based on a white paper describing the methods and results (Dunn and McEvoy, 2025). This product had an initial release in 2022, which received strong public opposition, followed by legislative changes to the bill that directed the production of the map, including modifications, as well as requiring robust community engagement and coordination with state agencies and counties. This led to the release of a draft hazard map in 2024 and the final version in 2025. The OR Legislature repealed this map for defensible space and home hardening enforcement in June 2025.

Key features include:

- The initial release (2022) led to the review of over 4,000 comments, including appeals, written comments, and public hearing testimony. Additional public comments and refinements to the map followed the second draft (2024). This level of engagement with the public and partners during and after development is substantial and unique across all products included in this review.
- Product development included a process of iterative corrections made to adjust wildfire hazard in irrigated agriculture, woody crops, and wetlands following feedback from county planners on identifiable data gaps in these datasets. Once the datasets were corrected, the burn probability in these areas was adjusted post-modeling by reducing it from the original model result.

United States Department of the Interior: Bureau of Land Management (BLM) - Wildfire Risk Assessment

A wildfire risk assessment across BLM-managed public lands in the United States. Geospatial data are available for visualization on an online explorer and available to download through ArcGIS. Resources used in this review include a story map describing methods and an AGOL web application, where users can explore data. The first release of this product was in 2020 and it is updated every five years.

Key features include:
- The only risk assessment that includes a sensitivity analysis.
- Novel use of Bayesian Theory to calculate wildfire risk in the United States.
- The combination of threat (likely to inflict damage) and consequence to provide a degree of confidence in the need for treatment. This does not include the treatability of the location. While "certainty" is not explicitly defined, the high values are locations where there is certainty of fire likelihood and BLM values are concentrated.

WADNR - 20-Year Forest Health Strategic Plan for Eastern WA - QWRA

Geospatial datasets of wildfire risk for priority planning areas in WADNR's 20-Year Forest Health Strategic Plan for eastern and central WA. Geospatial data are available for download. As of December 2024, risk products have been generated for 47 priority planning areas covering approximately 5 million acres in eastern WA. Methods associated with this product can be found in DNR legislative reports. The analysis of planning areas with associated risk map was released in 2018, and new analyses covering different areas are released every even year thereafter (2022, 2024). Every biennium, a new set of analyses covering additional planning areas in eastern WA is produced and made publicly available. The next data release is scheduled for 2026. No risk updates are planned for planning areas where assessments have been completed. Key features include customized risk assessment using the same framework and hazard layers as in the 2018 and 2023 PNW QWRA. Modifications include the selection and mapping of values, as well as the application of response functions and relative importance schemes.

ODF - West Wide Wildfire Risk Assessment

A geospatial dataset quantifying the level of risk to communities and resources in 17 western states and selected United States-affiliated Pacific Islands, and the oldest risk product in this review, released in 2013. Geospatial data is available from ODF by request. Authorship of this product belongs to ODF, on behalf of the Council of Western State Foresters, with funding from the USFS. Analytics and the project report was completed by The Sanborn Map Company. All credits and citations from this report should be attributable to ODF.

Key features include:
- The first wildfire risk assessment produced for the Western United States.
- Response functions were developed for and by each state.
- The use of only negative response functions.

United States Department of Interior: National Park Service (NPS) - Wildfire Risk Assessment

An assessment of the risk of structure ignition during a wildfire for NPS facilities in the United States. The assessment includes a second metric, the HIP value (Hazard Importance Probability), which was developed to help prioritize NPS facilities for hazardous fuels treatments. The results of risk assessments for each facility and the HIP value are available for viewing in an online tool and as web services for use in map production. This review was based on the methodology described online. We found no information on the year of release, and updates are made as needed, i.e., when new risk assessments are conducted. The online tool is updated annually at the end of each fiscal year.

Key features include:
- The only risk assessment in this review that includes field data on structure-specific attributes, such as access and building materials, through the NPS Wildfire Risk Assessment Form.
- The HIP value, developed to help prioritize NPS facilities for hazardous fuels treatments, which uses the risk assessment score, burn probability, and importance of the facility.
- The assessment of structural conditions as a way to bring about changes in hazard scores (through treatments and modifications to the built environment), and to influence the final risk score, which is transparently conveyed.
- Ground-truthing and field verification of the facilities that have been assessed, and the risk ratings that have been assigned. On rare occasions, facilities have been verified during remote assessments and have been marked as such.

United States Department of Homeland Security: Federal Emergency Management Agency (FEMA) - National Risk Index + Future Risk Index – Wildfire

A dataset and online tool that illustrates the United States communities most at risk for 18 natural hazards, including wildfire. Using an online tool, users can explore data and summary reports at different scales. Geospatial data are publicly available. The Future Risk Index is a prototype risk analysis tool to estimate future natural wildfire risk in the United States. It provides future wildfire risk under four potential temperature scenarios by the middle and end of the 21st century. This review is based on available technical documentation in Zuzak et al. (2023) and peer-reviewed work in Zuzak et al. (2022). Version 1.19.0 was released in 2023. In February 2025, the Future Risk Index was removed from the FEMA website, and as of April 2025, litigation regarding access to this index has made it currently unavailable to the public.

Key features include:

- It is the first to incorporate social and community vulnerability into the risk calculation - natural hazards are typically the only factors considered in risk assessment tools.
- It is also unique in the representation of expected annual loss in terms of dollars.
- It expects loss only under higher fire intensity.
- Assumes only negative impacts.
- The development of a companion product, Future Fire Risk.

USFS - 2018 PNW QWRA

The 2018 wildfire risk assessment depicts wildfire risk for the PNW. Currently, there is no visualization or distribution tool publicly available (it was previously available through the OR Wildfire Risk Explorer). This product was developed by Quantum Spatial, Pyrologix, BLM and USFS. Technical documentation used in this review is in Gilbertson-Day et al. (2018). This product was released in 2018 and updated in 2023 (the update is also included in this review).

Key features include:

- The first installment of a regional QWRA and one of the first regional quantitative wildfire risk assessments.
- One of the most well-known and commonly used risk products covering the PNW, this dataset has been adapted for use in many planning documents across the two states.
- Absolute values of conditional net value change and expected net value change are mapped instead of categorical risk ratings.

USFS - 2023 PNW QWRA

A 2023 wildfire risk assessment for the PNW. OSU and Pyrologix developed the product with participation from federal and state agencies. Geospatial data are distributed by OSU and federal and state agencies that participated in the product's development (ODF, WADNR, USFS and BLM). Data for OR can be visualized using the Oregon Explorer. This review followed the methods description in McEvoy et al. (2023). This product is an update to the 2018 PNW QWRA.

Key features include:

- This is the first update to the 2018 version of the PNW QWRA.
- Assesses wildfire risk in the current landscape, accounting for changes in fuel from wildfires and land management activities since the previous assessment.
- Utilizes updated risk assessment tools, technology, and data.
- Considers and incorporates feedback offered since the release of the previous assessment.

USFS - Wildfire Risk to Homes from Wildfire Risk to Communities 2.0

A website with interactive maps, charts, and resources to help communities understand, explore, and reduce wildfire risk across the United States. Users can search by community name, and view data associated with the community. Geospatial data are available for download and visualization. The description in this review is based on a white paper summarizing methods (Scott et al., 2024). The first edition of this product was released in 2020, and we reviewed the second edition, released in 2024.

Key features include:

- The assumption that homes exist everywhere where there is habitable land cover, regardless of whether a home exists at that location. As such, the resulting risk products allow users to consider risk to homes in areas with existing homes, as well as in areas where new construction might be proposed.
- Use of the concept of "oozing" of certain hazard layers to populate simulated fire into areas mapped as unburnable to mimic the way fire can penetrate developed areas.

- Significant online documentation, access to geospatial data and complementary products on the website.
- The inclusion, in addition to risk, of Community Wildfire Risk Reduction Zones, delineating areas where mitigation activities can be most effective at reducing the risk of structure losses from wildfire.

United States Department of Interior (USDI) and U.S. Department of Agriculture USFS Interagency Fuel Treatment Decision Support System – QWRA

A web-based tool that provides access to data and models for creating a risk assessment of any study area of interest in the United States. Access to the tool requires credentials with login.gov, which can be obtained by members of the public for free. Outputs can be downloaded and shared with anyone, including summary reports and geospatial data. This review used the product's online documentation, which is part of the tool. The initial release of this product was in 2020, followed by regular updates to include new datasets and functionalities. We reviewed version 3.11, released in 2025.

Key features include:

- Allows users to compare risk on the same landscape with and without treatments to quantify the effect of forest health work on modeled fire hazard.
- Employment of the same framework (risk as a product between hazard and susceptibility) as other products reviewed (e.g., PNW QWRA).
- The only risk product to use a single weather scenario, fire modeling is based on "problem fire" conditions where a single wind speed and direction, representative of the worst-case conditions, are used to model fire spread and behavior.
- A web application that conducts all calculations in the cloud.
- A significant amount of supporting material, tutorials and descriptions of the limitations associated with different data and calculations.
- Allows users to create intermediate products short of a full risk assessment, including creating and mapping value data for display purposes in conducting an exposure analysis (likelihood and hazard evaluations, but not incorporating susceptibility).

4. Attributes of risk products

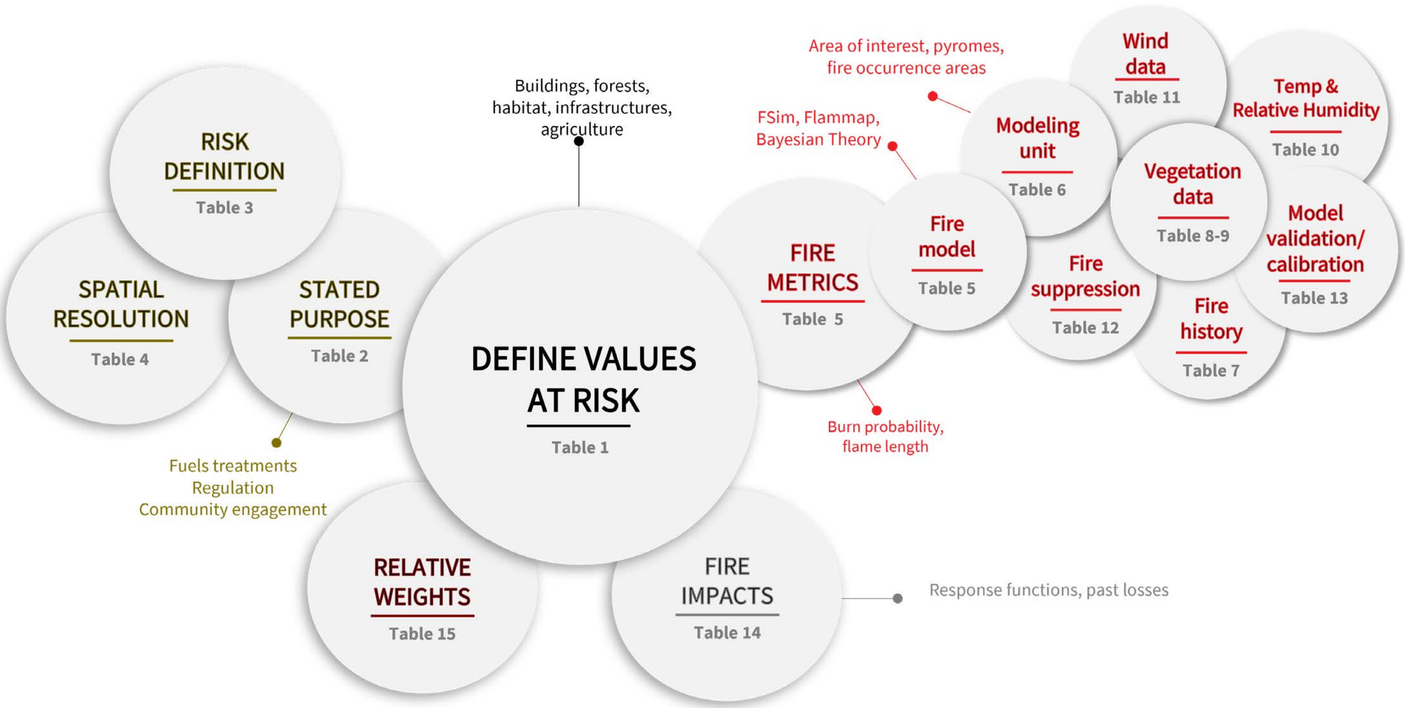
In a risk assessment, product developers and involved partners make several decisions that shape the results, such as which values and fire metrics to include, the geographic extent, and how to define risk, among others. The attributes included in this review are intended to enable users to understand the outcomes of these decisions across all products. There are many differences among wildfire risk products reviewed, but we also identified common components that helped us select which attributes to include in this work. Numerous product-specific decisions are not covered here. This review should be considered as a starting point, and users should refer to each product's documentation (Section 3) for more details.

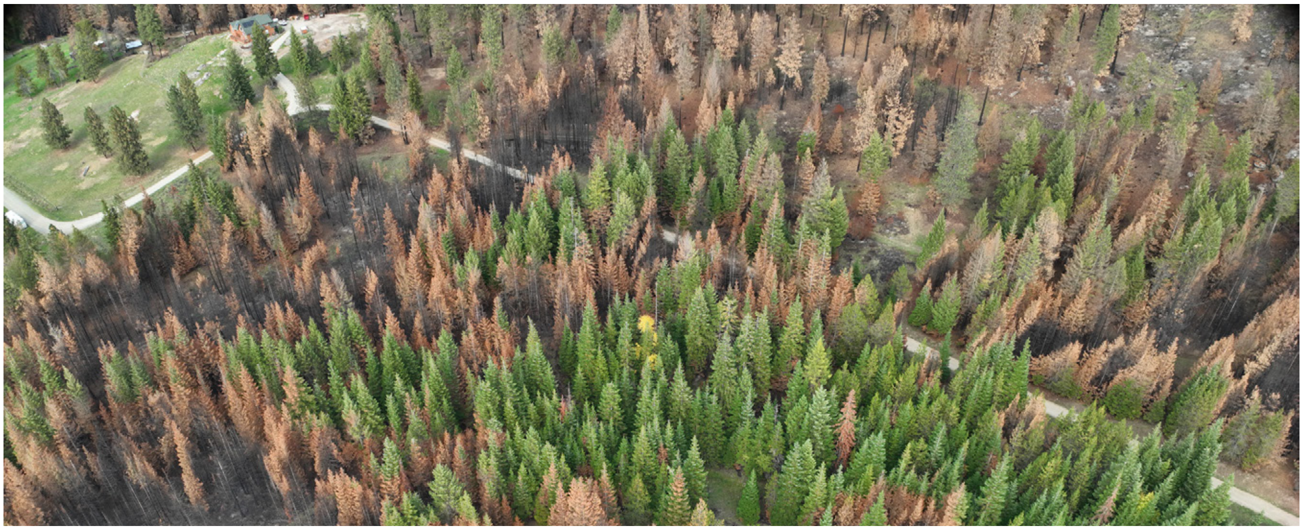
Figure 2 provides an overview of the central concepts of risk products described in this review. Bubbles relate to attributes included in Section 7 and include table numbers for easier cross-referencing between the text and the tables in Section 7.

Central to the concept of risk is identifying and mapping the values at risk (Table 1), which is closely associated with the assessment's purpose (Table 2), risk definition (Table 3), and spatial resolution (Table 4). All the products that we reviewed include one or more fire metrics derived through fire simulation (Table 5). Fire metrics are used to describe how often fire is expected to occur and expected fire intensity. In some products, fire metrics are combined to describe fire hazard. The red bubbles in Figure 2 correspond to components of the fire modeling compared across products. Fire modeling requires decisions about which modeling tools and metrics to use (Table 5) and the modeling unit—the landscape used as the basis for fire modeling, balancing computational efficiency and input data consistency (Table 6). Other relevant attributes include how fire history (Table 7), vegetation and topography (Tables 8-9), fire weather (10-11) and fire suppression (Table 12) are integrated into the fire modeling component of the risk assessment. When available, we included information about model outputs, validation and calibration (Table 13). Validation is a process to determine the degree to which a modeled output accurately represents real-world behavior or observations (within acceptable limits). Validation compares modeled products with a benchmark dataset that is considered an accurate representation of observed data. Calibration is a process that adjusts model inputs to improve agreement between model results and benchmark data.

A key component of wildfire risk is estimating the fire impact on values (Table 14). Some risk frameworks model the impacts of fire on each value as a function of fire intensity. In some cases, risk products consider only negative fire impacts, whereas other frameworks accommodate positive impacts, such as to ecological or cultural values. Different products use different methods to assess impacts, including response functions and historical records of past wildfire losses. Risk assessments that include multiple values (e.g., homes, forests, and power lines) can use relative weights to assign each value a different weight, indicating which is most important in determining overall risk (Table 15), but this approach is not universal.

Figure 2. Generalized diagram of common concepts associated with reviewed risk products that are highlighted as attributes in this review, with examples and references to specific comparison tables in-text. At the center of each product are the values assessed. Red bubbles represent components of the risk assessment associated with fire modeling.





5. Considerations for using risk products

Just as there are many risk products, there is a wide variety of potential purposes and users for which they are suitable. This can lead to confusion or resistance to using risk products or trying new ones (Rapp et al., 2020). Multiple risk maps coexist by design, as each map reflects different assumptions, data, and purposes. This diversity often leads to differences in how risk is portrayed across maps—even for the same landscape —which can generate confusion. It is important to understand the differences between available risk maps when considering the use of risk analytics for a specific purpose.

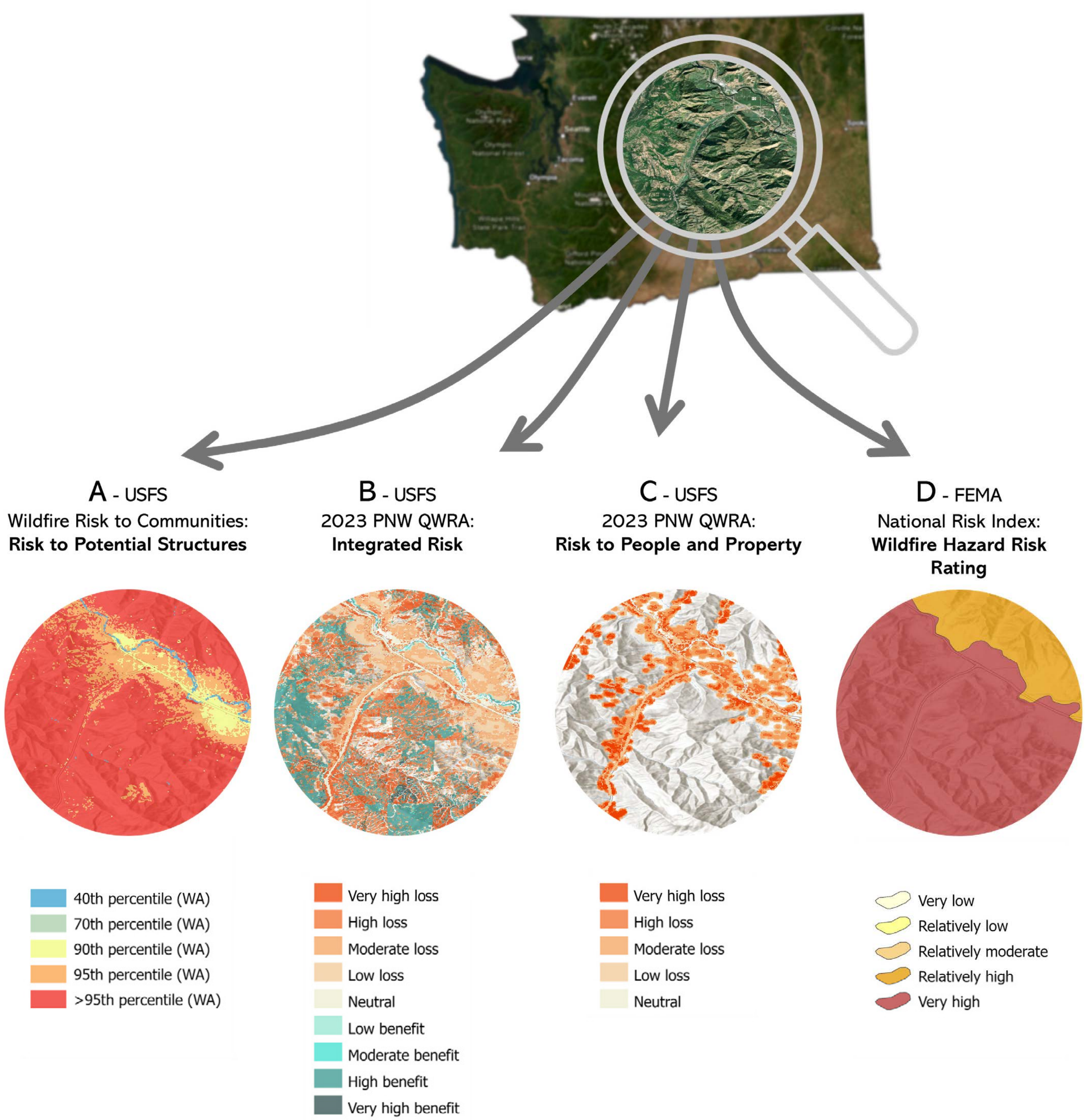
To illustrate this point, Figure 3 shows an example of three risk products (A-D) and their spatial data for the same area in Eastern Washington. Two examples show different suites of values for the same risk product (B-C):

A. Risk to Potential Structures from the Wildfire Risk to Communities product
B. Integrated Risk from the 2023 PNW QWRA product
C. Risk to People and Property from the 2023 PNW QWRA product
D. Wildfire Hazard Risk Rating from the National Risk Index product

The values included (or not included) in an assessment determine how risk to values of interest can be interpreted. For example, according to Wildfire Risk to Communities, most of the area in the example is above the 95th percentile for WA state's Risk to Potential Structures (A). The example area includes a community along a road that runs northwest to southeast along a river. In that area, risk to potential structures is between the 90th and 95th percentile for WA. The 2023 version of the PNW QWRA Integrated Wildfire Risk (B) shows areas of both fire benefits (greens) and losses (reds), and shows some areas as benefitting from fire where the Wildfire Risk to Communities (A) is showing high Risk to Potential Structures. Example C illustrates that the 2023 PNW QWRA Risk to People and Property ranges from very high to low losses, without showing fire benefits.

Risk assessments can focus on single values or integrate multiple values. Integrated assessments overlay multiple values at risk and depend on the spatial interplay of those individual layers. To understand which values are included in the analysis and mapped in that location, users need to know how to overlay individual risk layers and identify which overlap. For example, the difference between the Integrated Wildfire Risk (B) and the Risk to People and Property (C) is the types of values included in the assessment and how they interact. Integrated Risk (B) shows risk to multiple values, with individual risk layers combined using weights to reflect the relative importance of each value. The risk scoring in each location will be a combination of individual risks for all values present at that location. Integrated Risk (B) includes Risk to People and Property (C) and several other risk layers not shown in the figure: wildlife habitat, timber, infrastructure, ecological integrity, drinking water, and agriculture. Risk to People and Property (C) focuses on a single value – structures.

Figure 3. Example of outputs for three wildfire risk products representing different versions of wildfire risk for the same geographic area. Products B and C correspond to the same product (2023 PNW QWRA) and differ only in terms of the values at risk included.



The risk levels assigned by different products to the same value (e.g., structures) can vary due to modeling assumptions, data, and other methodological variables (e.g., exposure only in areas where structures currently exist vs. everywhere). For example, both the Wildfire Risk to Communities (A) and the Risk to People and Property (C) present measures of risk to structures, but differences in their methodologies explain apparent contradictions in the results. The Wildfire Risk to Communities (A) shows the majority of the area above the 95th percentile, while the Risk to People and Property (C) shows the same area not at risk. This difference is due to how these products map the spatial distribution of structures. Wildfire Risk to Communities (A) assumes a structure is present in every location that is burnable, whether a structure is present or not, hence the term 'potential structures'. The risk to that potential structure is based on the hazard and a response function that depends on the underlying vegetation. No other values are included in this assessment. In plain words, the Wildfire Risk to Communities product indicates that if homes existed in that landscape, they would be at a very high risk. The Risk to People and Property (C) maps existing values, not potential ones; it will only calculate risk to structures where structures are known to be present.

Dependence on historical loss values can also drive differences between risk assessments or specific regions within an assessment. For example, the Wildfire Hazard Risk Rating (D) integrates risk to people, buildings and agriculture into one rating. Whether all three values are reflected in the area shown depends on whether these values are mapped at the census block scale. The impacts of fire on these values are also calculated very differently and rely on a combination of fire intensity and historical loss values (in dollar amounts). This means the census block risk will be affected by historical losses from past fires.

For potential users of wildfire risk products, the strength of diverse approaches lies not in direct comparison but in recognizing the unique contributions each makes. Potential users should invest time in understanding what goes into each product and choose the best fit for their application or combine them to obtain different lines of evidence. A county planner interested in understanding the potential wildfire risk associated with expanding land use may find A and D useful, using information from both products to inform their assessments of risk. An application focusing on distributing funding for home hardening programs might prefer to use a risk product that relies on existing structures (C). Users who want to understand the overall landscape risk might consider using B, assuming the combination of values at risk and the weighting scheme is appropriate.

Consideration #1. Risk to what?

The first decision in risk assessment is determining the values at risk (Table 1). Although definitions of risk vary somewhat across products, they all share the central idea that wildfire risk involves future wildfire activity and its consequences for something people value. Most of the products reviewed considered only the negative consequences of fire, but not always (Table 14). While most products focused solely on negative impacts, some have included positive impacts as well, specifically, the 2018 and 2023 PNW QWRA and the Extension Fire Program Relative Risk Assessment.

The values included influence the components of the risk assessment such as:

- Its purpose, e.g., whether the risk product is to inform mitigation or regulation around a value (Table 2).
- The spatial resolution, e.g., parcel-level for risk to structures vs landscape-scale for risk to forests (Table 4).
- The response functions that determine how fire intensity impacts the value(s) (Table 14).
- Weighting to emphasize certain values (Table 15).

When a risk product combines multiple values into a single assessment, it's important to examine the risk associated with each value, especially when weighting is used to incorporate them into a single map (integrated risk). Because integrated risk maps can represent risk to many different values, users need to be able to answer the question "risk to what?" and understand how individual risk maps are combined to produce the integrated risk map. This is particularly important because not all the values shown may be relevant to every user, and some may disproportionately drive integrated risk, masking patterns that could be significant to specific groups.

Several of the risk products in this review rely on response functions to estimate how fire of varying intensities impacts resources at risk (Table 14). Response functions are an important part of a risk assessment, establishing the relationship between fire intensity and fire consequence to a wide range of values. Where appropriate, response functions also provide a mechanism for considering the beneficial role of fire. Response functions in the reviewed products are based on expert judgment and assumptions; users should review each response function to ensure it is appropriate for the intended application.

Box 2 includes a list of guiding questions to help users assess wildfire risk products. Not all the questions are yes-or-no, and they promote a better understanding of each product's capabilities, limitations and suitability for a specific application. Users should expect to make tradeoffs in order to select the risk product that represents the most suitable option for a given application.

Box 2. On the topic of values: Questions to guide product selection

- Do you need a map that shows risk to specific values, or does hazard meet your application needs?
- Are all the values in the integrated risk assessment relevant to your application?
- Are there values that are missing from the evaluation that are important to your purpose?
- Are values at risk mapped using the most up-to-date data available?
- How does the product assess the impact of fire, and does it assess both positive and negative effects?
- If response functions are used, are they relevant, based on well-supported methods?
- Can you rely on experts within your area of interest to fine-tune the response functions or assess their applicability within your local context?
- If the assessment includes multiple values, are risk assessments for individual values available, and how do they compare to the integrated risk map?
- If weights are used to combine multiple values into an integrated risk map, does the weighting of values reflect your local priorities or intended uses?

Consideration #2. How are risk products updated, and can versions be compared over time?

Risk products may be periodically updated to reflect new or higher-quality data, improved modeling techniques, and recalibrated assumptions or thresholds based on the latest scientific understanding and empirical data. **Box 3** summarizes key takeaways for users interested in tracking risk over time.

As technology and data evolve, improvements in risk products are necessary, but this also means that differences between versions cannot be interpreted solely as changes in real-world risk. For example, the 2018 and 2023 PNW QWRA use different versions of LANDFIRE data in their fuelscapes (Table 9), different fire occurrence data (Table 7), and different approaches to fire modeling (Table 5).

Changes in mapped risk may result from shifts in underlying conditions on the ground, enhanced mapping capabilities, model sensitivity, or, more likely, a combination of all the above. Version-to-version changes reflect both reality and design, making it difficult to isolate how much of a particular change is due to actual risk trends versus improvements in how it is measured and represented. This has implications when risk products are used to track and demonstrate the impact of mitigation efforts (Table 2). Suppose a location shows increased risk across map versions. Users may not be able to discern

Box 3. Takeaways for users interested in tracking risk over time

- How important is it to show changes in wildfire risk, relative to the initial risk map?
- Have the methods changed between versions of the risk map you'd like to use, and how do those changes impact the interpretation of risk changes over time?
- Consider the benefits and costs of combining on-the-ground monitoring and before-and-after case studies with risk product outputs across time to understand and communicate the impact of wildfire risk mitigation work.

whether the risk has worsened on the ground due to (or despite) mitigation strategies or whether the map reflects improved data and modeling capabilities.

The IFTDSS QWRA product enables users to compare risk between a treated and an untreated landscape, thereby quantifying the effects of fuel treatments on risk. This is possible using the same methods and inputs – the only difference between the assessments is the fuels in the treated areas.

Even when comparing risk across two congruent assessments, pairing it with on-the-ground data collection and before-and-after case studies can be a better way to understand and communicate the impact of mitigation work. For these reasons, care must be taken when using risk products to link mitigation investments to outcomes, quantify return on investment for forest treatments or landscape restoration, or tell success stories about how proactive work on the ground is making a difference.

Consideration #3. How trusted and accurate are risk products?

One cannot measure risk directly. Unlike physical measurements—like fuel abundance, distance to homes, or tree height—risk is about the future, and the future isn't observable. Consequently, modeling is used to understand uncertain futures and their probable consequences.

At the same time, the concept of risk is intuitive to everyone. Individuals have their own mental model of wildfire risk, based on personal experience with wildfire, knowledge, and attitudes towards risk, and use this assessment to make informed choices. When a risk map is released to the public, it's natural for people —whether community members, landowners, or local officials —to compare it with their own local knowledge, experience, and understanding of wildfire risk.

Public scrutiny of risk and hazard maps is magnified when these products are intended as the basis for regulatory frameworks. Risk maps are also perceived as having negative consequences for insurance and property values. Areas identified as high-risk for wildfire could experience a decline in land or property values (Dong, 2024). Risk assessments have also been used to inform insurance policy pricing, coverage limits, and terms, as well as underwriting (Berz, 1999; Keys and Mulder, 2024), although some insurers develop and use their proprietary tools rather than those described in this synthesis. In WA, insurers report annually to the state's Office of Insurance Commissioner on which wildfire risk products they use in underwriting and rates. As of the beginning of 2024, none of the products included in this review were directly referenced by insurers operating in WA.

Access to mortgage loans can also be influenced by wildfire risk assessment. Banks tend to tighten lending standards in disaster-hit counties, suggesting that lenders are more cautious in these locations since environmental disasters can increase the long-term risks to the local economy. Tighter bank lending standards can lower access to mortgage credit and have negative consequences for the housing sector (Dong, 2024; Duanmu et al., 2022). As a result, community members and others facing these risks may feel strongly about maps and other displays of risk levels and oppose their creation, question their accuracy, and challenge their use.

Validation of risk products is challenging because risk is a probabilistic concept based on uncertain data and assumptions. Therefore, it cannot be directly observed or measured in the real world. Instead, validation efforts have focused on the risk component – fire likelihood – which is often represented spatially as burn probability. Most wildfire risk products reviewed use fire modeling from FSim[4] (Table 5). Ager et al. (2021) showed that annual area burned was accurately replicated by the FSim model using LANDFIRE inputs, but that structure exposure (i.e., how often simulated fires overlapped with mapped structures) was substantially overestimated relative to observed exposure. Carlson et al. (2025) compared FSim burn probability with observed fires and found that across all pyromes, mean burn probability was moderately correlated with observed burned area. Moran et al. (2025) evaluated the performance of annual burn probability against subsequent wildfire activity in California and found strong predictive ability. Validation can also be done ad-hoc at a local scale by isolating specific elements such as burn probability and flame length, and reviewing them with fire managers and land managers who can help identify issues with maps and build credibility and consensus towards the final risk product.

Products that use burn probability from FSim (Table 5) include a validation and calibration process (Table 13) to ensure that the simulated fire-size distribution is within acceptable confidence intervals of observed fire distribution using the Fire Occurrence Database (FOD;

[4] *FSim is a fire growth and behavior simulation tool developed by the Missoula Fire Sciences Laboratory of the USDA-USFS Rocky Mountain Research Station – see Finney et al. (2011a, 2011b).*

Short, 2022), which is considered a benchmark for fire occurrence in the continental United States and used consistently amongst products (Table 7). This is typically done by comparing model results against available observed wildfire data to ensure they conform to the data.

We found no studies focused on validating simulated flame lengths, but some of the products reviewed included a process for calibrating flame length. The development of the PNW QWRA products included a process for generating flame length estimates under a worst-case fire weather scenario. These initial flame lengths were used to calibrate the fuelscape inputs (e.g., fuel model, canopy cover) using expert opinion from fire and fuels managers familiar with fuels and fire behavior for each fire occurrence area.

Sensitivity analysis can help understand how the different parts of the risk assessment affect the overall risk score for a given area. This involves varying the input variables to quantify how changes in various variables are likely to affect the output. Sensitivity can inform where data collection and model calibration may need improvement and increase a model's interpretability. Among the models in this review, only one (BLM Wildfire Risk Assessment) incorporated a sensitivity analysis of input parameters, providing insight into how input variability affects risk outcomes.

Even with best practices in place, uncertainty, evolving risks, and external factors can still influence outcomes. Universal acceptance of any risk product is unlikely, and it should not be the goal. Very much like risk, which cannot be eliminated but only reduced, opposition to risk maps can only be mitigated. Instead, the success of a risk product should be assessed through the lens of its purpose; in other words, how well it enables the wildfire adaptation it was designed to support. **Box 4** includes key takeaways around uncertainty and wildfire risk products.

Box 4. Takeaways on accuracy and validation

- Any risk map that is released to the public will be subjected to comparisons with their own local knowledge, experience, and understanding of wildfire risk.
- In WA, in 2024, insurance companies rely on proprietary risk assessments to establish policy availability, pricing and coverage and not the products reviewed in this synthesis.
- Validation of risk products is challenging because risk cannot be directly measured or observed in the real world. Validation efforts often focus on components of risk maps and remain limited.

Consideration #4. How can risk products be collaboratively developed and well-communicated?

It can be difficult to clearly explain what risk products can and cannot do in an accessible way, and partnerships can struggle to select the right tools for their needs and utilize the assessment to inform their actions (Colavito, 2021, Ecological Restoration Institute, 2018). It can be challenging to strike a balance between communicating the strengths and limitations of the product, and ensuring the information is both accessible and informative in partnership and community settings. This can be due to social factors such as existing conflicts about wildfire or other natural resource issues, perceptions of risk products as inaccurate or not ground-truthed, or distrust in government agencies and scientific partners. A collaborative process to determine which assessment tool(s) to use and how to interact with them can take hard work and careful planning and facilitation (**Box 5**).

Because risk cannot be measured directly, only estimated based on the best available knowledge and data, support for risk maps requires confidence and trust in the science and agency behind the map. This can be encouraged by clearly communicating the intent, limitations, and evolving nature of risk maps, as well as providing space for local knowledge and context, engaging early and often with stakeholders during map development and rollout and implementing feedback loops where appropriate corrections can be made (i.e., where gaps arise from inaccurate mapping). In some cases, working with multiple risk products can provide support to triangulate and reach decisions. These steps can create conditions where success is possible; where the risk map is accepted and used for the intended purpose.

Box 5. Recommendations for collaboration on risk products

- Plan an engagement process with workshops, one-on-one meetings, and other opportunities for in-depth discussion and collaboration among technical experts, agency managers, partners, and community members.
- Ensure there is adequate time, capacity and funding to manage effective participation in the development and use of risk products.
- Create and consistently use a common language that is accessible to a broad audience.
- Establish specific questions to be answered by risk products to ensure a common understanding of purpose.
- Clearly explain technical methods, risk definitions, data sources, and model limitations and uncertainties, including the conclusions that may and may not be drawn from the assessment's results.
- Acknowledge that risk perception is not objective and uniform, as individuals and groups often perceive and evaluate risks differently.
- Clarify when and how community and partner participation is used.
- Discuss how risk assessment results will inform future strategies and actions; and acknowledge the need for adaptation as products evolve.
- Validate and test of initial results with end users.

Consideration #5. Can a risk product be customized or integrated with other data and models?

Customization of available risk products is critical to enable users to create risk products that better reflect the specific context, priorities and data availability of a region or organization. **Box 6** includes guiding questions for assessing the customization feasibility of wildfire risk products.

Box 6. Guiding questions for assessing customization feasibility

- Do you have better information than what was used to develop the product?
- Does the product document opportunities for customization that will not affect the accuracy of the product?
- Do you have a clear understanding of interdependencies – how one component of the risk framework may affect others?
- Do you have the technical skills, software or computational resources needed to implement the customization?

Several of the reviewed products allow customization because they include all the intermediate data and modeling components that lead to the final risk map. Users with the appropriate knowledge and skills can adopt and customize elements to create a risk product tailored to their needs without extensive rework or technical overhead. Customization can also be an opportunity for additional partners, such as local agencies, community groups or researchers, to weigh in on the input layers and decision points, empowering users to create risk assessments that are both scientifically grounded and operationally useful.

Customization can take many forms, including mapping and adding values, refining response functions, altering value weights, or changing thresholds for final scoring, among others. One example is the risk assessment from WADNR, in which custom versions of risk maps were created using burn probability, flame length and adapted response functions from the 2018 and 2023 PNW QWRA.

The IFTDSS QWRA product is a suitable option for users seeking significant customization. This comes with tradeoffs such as the simplified weather inputs used in the fire behavior modeling portion, but allows users to customize values at risk, response functions and weighting schemes. The ability to customize which values to include in the assessment and to use local data on values can significantly improve the quality of a local risk assessment relative to regional or national risk products. Users can also review the fire modeling outputs that are used in the risk assessment (Table 5). This provides a good opportunity to ground-truth or supplement the analysis with local observations and incorporate finer-scale data if possible. If the area of interest has a "problem fire," i.e., where fire events of concern have a well-defined pattern of when and where they tend to occur, then products that allow for customization (IFTDSS QWRA) might also be a good option.

Another important customization concern is the definition of the qualitative thresholds that classify a continuous risk score into qualitative risk classes (e.g., low, moderate, high, and very high). Qualitative thresholds are often based on the geographic extent of the assessment and the distribution of values within it (for example, using quantiles to define low, medium, and high, and calculating them based on the risk value distribution for the continental United States). Because these thresholds – and the resulting map – depend on the scale and variability of the underlying data, users may benefit from customizing risk maps by using the raw risk data to apply thresholds appropriate to their area of interest.

In some cases, risk assessment is part of a larger objective, such as interdisciplinary land management planning, strategic planning for climate change mitigation, or fiscal budgeting. The goals, components and characteristics of a wildfire risk assessment in these cases could be integrated with other data and models. Combining risk products with other models and data enables the creation of customizable risk maps, identification of vulnerable areas, development of targeted mitigation, post-fire recovery or monitoring strategies, or representation of extreme fire conditions and climate change effects, among others. Once an appropriate risk product is chosen based on the specific context and available data, its outputs can be used to analyze risk patterns further or create effective visualizations for communication and informed decision-making.

Consideration #6. Can users of a risk product accept and communicate some uncertainty?

Wildfire is a naturally variable phenomenon. The timing, number and location of ignitions, and weather during fire ignition and spread, are all sources of uncertainty inherent to wildfire. Most of the risk products we reviewed include outputs from fire modeling (Table 5) to estimate fire likelihood and intensity. These fire models rely on the Rothermel mathematical model (Rothermel 1972) to calculate how surface fires spread through vegetated fuels. Like any model, the Rothermel model has limitations because of uncertain inputs and simplified assumptions about how fire behaves (Andrews 2018).

Fire models that employ probabilistic approaches to model fire occurrence and intensity do a better job of accounting for uncertainty than deterministic models, in which the outcome is determined by the inputs (e.g., a predetermined fixed ignition location, burning conditions, etc.). For example, instead of assuming that the impact of a high-severity fire in a closed canopy forest always results in complete stand mortality, a probabilistic approach could assign probabilities to different levels of mortality, reflecting more realistic effects. For that reason, fire models (and thus risk products they integrate) that produce probability distributions of likelihood and intensity provide a better representation of uncertainty. Overall, among the reviewed risk products, FSim stands out as one of the most used fire models (Table 5) and the only model to account for the role of suppression (Table 12) in perimeter containment (Finney et al., 2009). Furthermore, national data on likelihood and intensity using FSim are available for the conterminous United States, Alaska, and Hawaii (Dillon et al., 2023). The model is designed to replicate the growth of large fires under dry fuel conditions - users interested in using FSim outputs should consider this and assess its implications for the intended use.

Another type of uncertainty relates to imperfect knowledge. We don't fully understand how fire works as a natural process in every circumstance. Existing models are conceptualizations of how fire occurs, spreads and behaves to the best of our knowledge. This uncertainty can be reduced as models and input data improve and as additional research or experience leads to a better understanding of the processes the model replicates. For example, several of the fire models referenced in this review were developed to simulate fire growth and behavior in wildland areas (grasslands, shrublands, forests), not in places where people live, like towns, cities, or the wildland-urban interface (WUI). In these areas, the mix of homes, vegetation, roads, and other non-burnable surfaces creates a much more complex situation that these models weren't designed to handle (Moran et al., 2025) and a high degree of uncertainty remains around wildfire spread physics in the built environment, particularly firebrand generation (Thompson et al., 2025a and Thompson et al., 2025b).

Box 7 highlights key takeaways around uncertainty and wildfire risk products. Uncertainty or lack of definitive knowledge should not delay decision-making as expertise continues to evolve. Decision-makers must act based

Box 7. Takeaways on accepting and communicating uncertainty

- Fire models that produce probability distributions of fire likelihood and intensity account for some of the uncertainty in wildfire occurrence.
- The fire modeling tools in this review are not designed to model fire spread in the WUI, where wildlands mix with the built environment, nor in the built environment.
- Uncertainty should not delay decision-making. Wildfire adaptation should be based on the best available information, with transparency about the limitations of current products.
- Risk products with limited descriptions of methods can hinder informed use and the ability to transparently and clearly communicate to the public their strengths and weaknesses.
- The universe of available wildfire risk products extends far beyond products in this review, such as commercial and proprietary tools.

on the best available information, while transparently acknowledging limitations. To support this, developers should clearly communicate key points relevant to practitioners – appropriate use cases, limitations, practical implications of the product and clear guidance on the "dos and don'ts".

Consideration #7. What are the data limitations?

The products reviewed in this study rely on publicly available data and fire behavior models, which have limitations. Understanding the strengths and limitations of the data used in risk products can help users determine which may be best suited to their area of interest and most well-validated for their purposes. **Box 8** summarizes guiding questions for assessing data inputs.

Box 8. Assessing data inputs: Guiding questions on strengths and limitations

- How does the date of the input data relate to the dates of disturbances in your area of interest?
- Did the area of interest have large fires that happened after the fuels were mapped for the fire modeling component of the risk assessment?
- How many years have passed since fuels were originally mapped in non-disturbed areas – have fuels accumulated to an extent that results need to be taken with caution?
- Do the fuel models, canopy layers and spatial fire distributions match your understanding of on the ground conditions?
- How are ignitions distributed in your area of interest? Are there specific, clear patterns of fire-size occurrence that make a random model of ignitions a major limitation?
- If an ignition density grid was used and you have access to it, can its appropriateness to your area of interest be vetted?
- Can you rely on fire managers within your area to provide feedback on fire modeling outputs such as burn probability and flame length? Do the outputs align with what fire managers know about the area?
- Are risk products being used at an appropriate level of resolution relative to model inputs?

Vegetation (fuels) data

One commonality among the reviewed products is the use of LANDFIRE data to map fuels and topographic data used in the fire modeling (Tables 8-9). LANDFIRE data provides a nationwide dataset of the fuel layers necessary to simulate fire behavior. The data are free, readily available and continuously improved and updated, supporting a wide range of applications and increasing transparency. This consistency is crucial for regional and national planning, modeling, and policy-making decisions, as well as collaboration across jurisdictions. LANDFIRE data on fuel models, canopy cover, canopy base height, canopy height, and canopy bulk density are combined with elevation, slope, and aspect to create a fuelscape used in fire modeling applications. Variables used in the fuelscape are obtained through modeling, statistical analysis, and/or expert-based rulesets, rather than being directly measured (La Puma, 2023). This is necessary due to the scale of the data being mapped, as well as the lack of suitable instruments and inventory techniques to map certain attributes. Fuel models, for example, are assigned through a qualitative process based on the expert opinion of experienced fire and fuels managers for different geographic areas (Reeves et al., 2009). This type of data collection introduces subjectivity and complexity, limiting the ability to ground-truth the accuracy of any fuel model map (Reeves et al., 2009). Only a limited number of professionals, such as those that have experience with fires and fuels in each region, have the expertise to do so. In the products included in this review, only the PNW QWRA products describe a process to calibrate LANDFIRE products using fire and fuels specialists.

Another data limitation can be the downsampling of fuelscape inputs to a coarser resolution (e.g., 120 or 270 m) for modeling, from the source data, which is 30 m if LANDFIRE is used (Table 4). Coarser resolutions are often necessary due to the computational requirements of running fire models across large landscapes (Table 6). Figure 4 illustrates how information is lost in a canopy cover map as spatial resolution is reduced from 30 m to 270 m, a process often called resampling. In the higher-resolution map using the LANDFIRE resolution (B), the 30 m pixel has 0% canopy cover, as it includes both the structure and surrounding areas without trees, which is confirmed by the orthophoto (A). As the canopy cover map is resampled from 30 to 120 and 270 m, more of the 30 m pixels are averaged together, and information is lost. At 120 m (B), information about the non-forested area surrounding the building is lost, and the area changes from a non-forested class to a low-cover forest. However, some of the neighboring variability in canopy cover is still retained. At 270 m (C), there is increased loss in canopy cover variability, increased homogenization and less detail in canopy cover values.

The implication of data resolution for users is that interpreting or evaluating fire model products to resolutions greater than the one used in the calculations is misleading because the model does not operate at that scale. This is particularly important because several risk products are often resampled to 30m to match the resolution of original fuels data (Table 4) and better represent values on the landscape. This creates a spatial mismatch between the risk map and the hazard outputs (burn probability, flame length) generated by the fire model that can lead to a false sense of accuracy. Users may interpret (and expect) the hazard data to reflect the details and information on a 30 m map (B), whereas all the fire model "sees" (and uses in its calculations) are the data in the 120 or 270 m resolution map (C-D).

There are also limitations related to the age of data and modeling. Several products use past disturbances to update the landscape to current conditions (Table 9). This can be done for both natural and human disturbances, relying on a variety of remote sensing techniques, state and transition models or datasets of reported fuel treatments. LANDFIRE spatial data is updated annually to reflect fuel changes from human or natural disturbances captured with remote sensing, as well as vegetation and fuel changes submitted by land management agencies. Disturbances captured in LANDFIRE data include wildland fires, harvest/thinning activities, mechanical vegetation/fuel treatments, seeding/planting, chemical treatments, storm damage, insect and disease infestations, and exotic plant infestations. Users can examine the fuelscapes in the risk products and, if available, the disturbance geospatial data to confirm that relevant natural and human disturbances for their area of interest at the time of intended use are reflected in the fuelscape. For example, if the date of the fuelscape is December 2022, fires that occurred in 2023, 2024 and 2025 are not reflected in the fuelscape. This means that the fuelscape represents the pre-fire conditions, so modeled burn probability and fire intensity will too. As such, the risk map for those areas may not accurately describe their current condition.

In fuelscapes without disturbance, fuels reflect conditions in the year of the base LANDFIRE version (Table 9). Undisturbed areas are not updated to reflect vegetation growth and fuel accumulation over time. Instead, they are "stuck" in the year of the base map (either LANDFIRE 2014 or the 2016 LANDFIRE Remap). This limitation is most relevant in productive forest systems where fuels accumulate rapidly.

Fire occurrence data

Many of the risk products reviewed use historical fire data for fire occurrences from the FOD which is considered the most up-to-date and comprehensive source of point data on fire occurrence (Table 7). As such, the FOD is the benchmark for fire spatiotemporal fire occurrence and size. However, the FOD itself only extends back to 1992. In areas where fire regimes have return intervals of hundreds of years, FOD-derived distribution for these less frequent fires could be unreliable. Areas with higher fire frequencies, where the last 30 years of fire occurrence records accurately represent observed fire occurrence and size, will experience reduced uncertainty in likelihood and intensity outputs, as well as in subsequent risk estimates.

In addition, because the FOD records fires over the last 30 years, using it to calibrate fire modeling outputs assumes that the past fire size distribution will hold in the future. Depending on the intended application of the risk product, this might not be a reasonable assumption; for example, where climate change impacts are expected to be severe and accelerated or where population dynamics are expected to change patterns of fire occurrence.

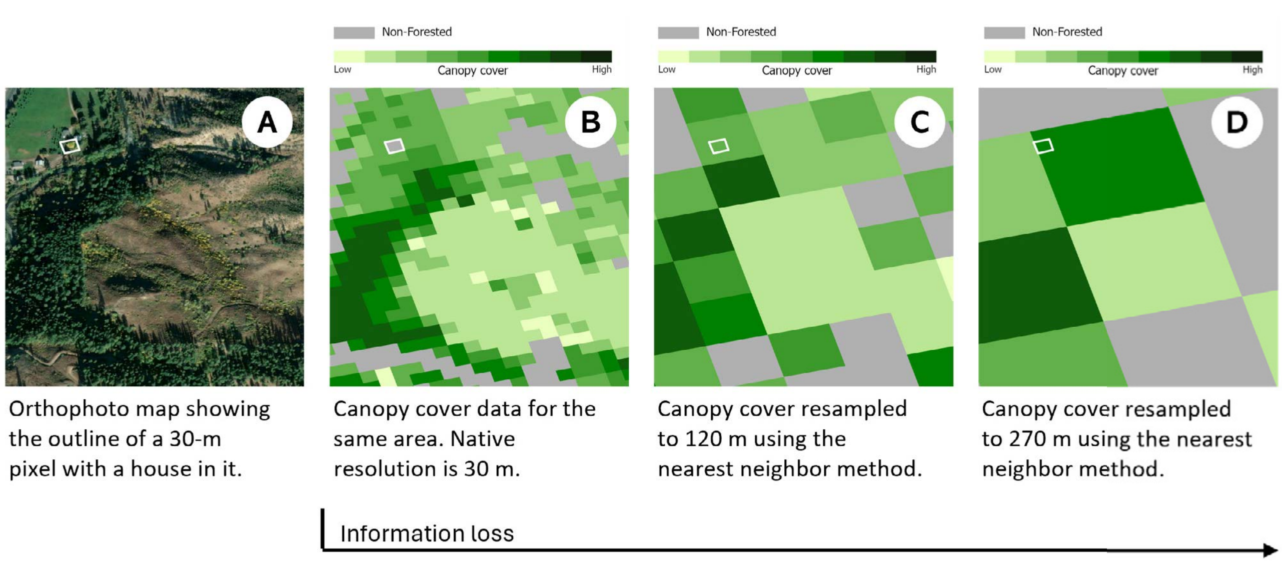
Several products did not incorporate observed fire occurrence or use random ignitions. These decisions come with tradeoffs. When evaluating these products, users should consider the observed fire patterns in their area of interest and assess their appropriateness accordingly. In regions with well-defined spatial patterns of fire occurrence, fire modeling with random ignitions may not yield representative results. On the other hand, if observed ignitions are distributed somewhat homogeneously across the landscape, frameworks with random ignitions might be a suitable simplification.

Weather data

Many of the risk products reviewed used historical weather data, such as average values recorded at select RAWS (Table 10-11). However, as with fire occurrence inputs, weather data may not be available to correlate with fire regimes with long return intervals or may not reflect future weather conditions. It's also worth mentioning that most products provide very limited information describing the fire weather inputs used in the model (e.g., descriptive statistics). This means that it is unclear how regional-scale weather data and assumptions accurately reflect the realities on the ground in a specific location. For example, users can consider the size of the fire modeling unit (Table 6) and the source of weather data (Table 10-11) and evaluate whether the selected data is representative of expected weather patterns for the entire modeling area. This is particularly important if a single RAWS was chosen to provide the fire weather data for large-scale modeling areas. Broader sources of weather data might adequately represent the overall area, but they can also smooth over important, unique local variations.

Understanding the nature of the weather input data can also set realistic expectations about the model's limitations in capturing extreme, rare, or even unprecedented events, such as the easterly winds that led to the Labor Day fires in 2020 (Mass et al., 2021). Wind events (and the accompanying changes in fuel moisture) that lack a contemporary analog or are infrequent in the historical record may be completely missed by models that rely on historical averages. In other words, if the model hasn't "seen" it in the input data, it can't simulate it. In addition to potentially missing outlier fire weather events, none of the reviewed products explicitly incorporates projections of future weather variables in the modeling of fire spread and behavior, except for the Future Risk Index.

Figure 4. Changes in spatial resolution related to data preparation for fire modeling. Most fuelscapes in this review rely on LANDFIRE data, which has a native resolution of 30 m (B). Most fire models use fuelscape at 120 or 270 m (C and D, respectively). This downscaling process reduces the spatial resolution, meaning that fine details (e.g., buildings, roads, or water bodies) can be lost to the model because inputs no longer accurately represent small features, which get averaged out or replaced by the dominant landcover.



6. Conclusion

Risk analysis is a complex field; it can be difficult for land managers, policymakers, and other users who rely on risk products to make decisions about how to best strategically address wildfire risk. Risk assessments are greatly influenced by their design and intended application. In risk mapping, this means risk products are likely to generate different outputs for the same area, which can have significant real-world impacts for community preparedness, fuel treatments, policy, and landscape resilience to wildfire. As the use of wildfire risk products grows, it's increasingly important to select these products based on their intended purpose carefully and with knowledge of their limitations.

The universe of wildfire risk products extends far beyond those reviewed here, including commercial and proprietary tools. Given the diversity of wildfire risk product offerings, users must invest time in understanding the tools they rely on to make informed decisions. The risk products reviewed here were developed by federal and state agencies, often in collaboration with private companies and universities, and generally offer open-access data and publicly documented methodologies – though the depth and clarity of documentation can vary. Products with limited documentation on their methods, underlying assumptions, inputs, and implications can hinder meaningful evaluation and informed use. Users need to carefully consider whether the benefits of these tools outweigh the lack of methodological transparency, potential for customization, and, more importantly, the challenges in clearly and confidently communicating their strengths and limitations to the public.

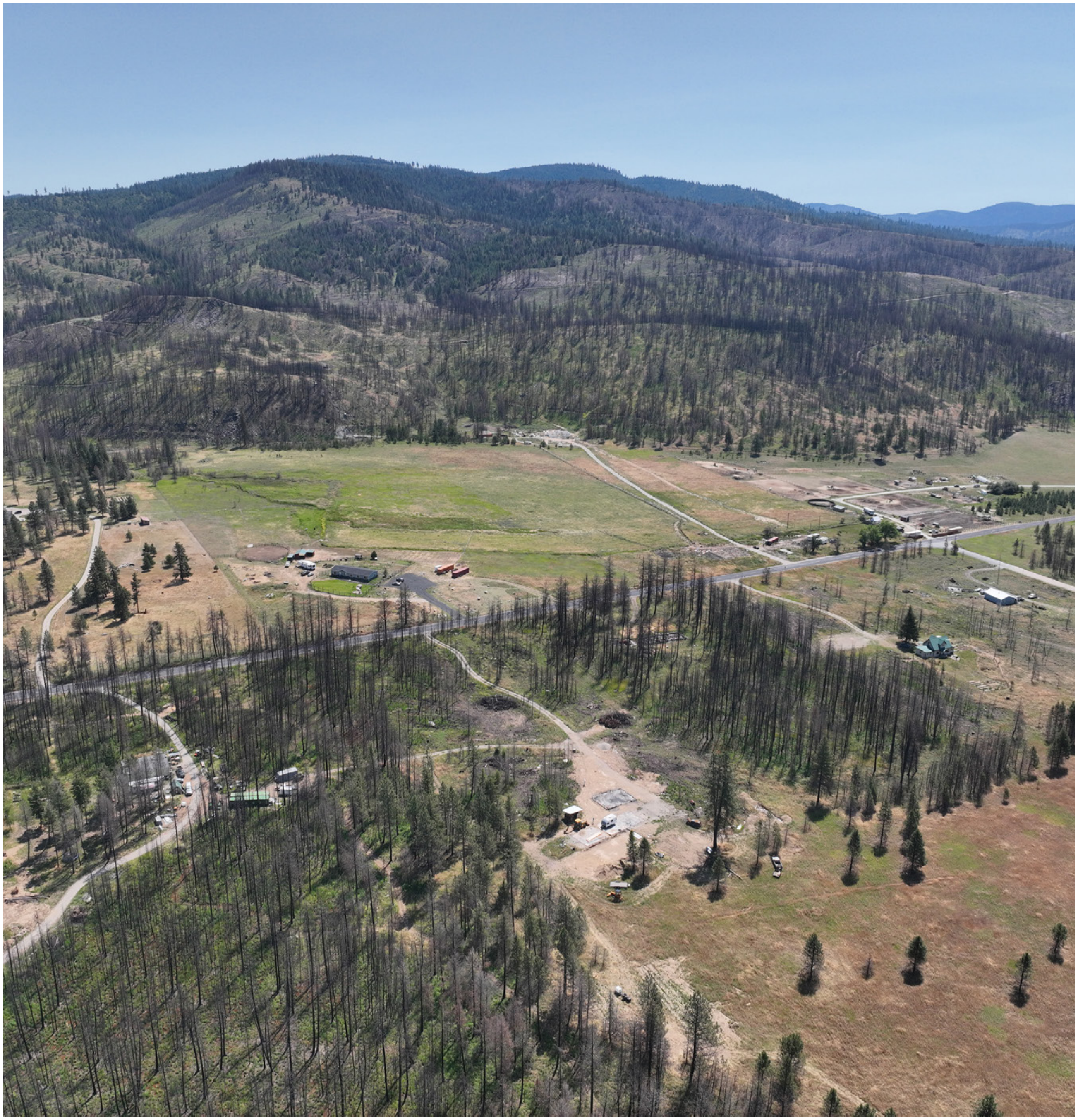
We offered an overview of wildfire risk concepts and a comprehensive review of wildfire risk products available for the PNW. A brief introduction to each product provides an overview of what it is, its geographic coverage, and key features, among others. Comparison tables provide additional details for each product, focusing on the values for which risk was assessed and the details of the risk calculation and fire modeling. Table 16 includes an overall comparison of selected attributes of wildfire risk products in the PNW. The table does not include all the attributes used in this comparative review, but those that most effectively highlight the differences among products. The information in this review is based on each product's technical documentation and feedback from the risk product developers. There are many other technical aspects of each risk framework that are not included in this review.

To better inform users of these tools, we also provided key considerations, takeaways and guiding questions for those considering using risk products to evaluate products beyond those included in this analysis. We do not offer recommendations on which products to use or provide a roadmap to select risk products. Instead, we focused on presenting clear, objective information that equips users to evaluate which product is most appropriate for their application. We believe this approach strikes a reasonable balance between providing the necessary information to assess products for a given application and avoiding the expectation that users of risk products must become risk assessment experts to use them effectively. At a minimum, this work consolidates information that is otherwise dispersed across various platforms and documents.

As losses from fire continue to increase and set historic records, interest in wildfire risk as a tool to anticipate, prepare for, respond to, and recover from wildfires will continue to grow. This, combined with the diversity of available products, the potential for customization, and ongoing development in fire science, makes a strong case for the benefits of use outweighing the limitations. There are no perfect risk products, but when users consider their strengths and limitations in the context of specific applications, engage early and often in collaboration, ask critical questions, and validate results locally, they become far more effective. They provide a structured approach to calculating and managing risk that goes beyond subjective judgment, helping turn complex data into actionable insights supporting more robust decision-making and better outcomes.

Table 16. Overall comparison of key attributes of wildfire risk products used in the Pacific Northwest

Product	Value weights vary	Frequently updated	Incorporation of observed fire occurrence	Integrates fire likelihood (burn probability)	Includes fire intensity (flame length)	Data publicly available for download	Cross-jurisdictional
Extension Fire Program Relative Risk Assessment	X			X	X		X
BLM – Wildfire Risk Assessment		X	X	X			
WADNR QWRA		X	X	X	X	X	X
West Wide Wildfire Risk Assessment	X						X
NPS – Wildfire Risk Assessment	X	X		X			
National Risk Index			X	X		X	X
2018 PNW QWRA	X	X	X	X	X		X
2023 PNW QWRA	X	X	X	X	X	X	X
Wildfire Risk to Communities 2.0		X	X	X	X	X	X
IFTDSS QWRA	X			X	X	X	X
Community-Level Wildfire Risk Rankings	X		X	X	X	X	
OR Statewide Wildfire Hazard Map			X	X	X	X	X



7. Comparative review of attributes: The tables

We summarize key attributes for each of the twelve products reviewed (Tables 2-16). We selected the most pertinent attributes that differentiate risk products, but do not include every possible feature. More details about the technical terms that may be unfamiliar to readers can be found in Appendix 1: Glossary. A description of the methods related to each risk product is available in Appendix 2: Summary of methods associated with each risk assessment.

Table 1. List of values at risk

In most cases, risk is calculated based on a specific value or set of values. Values can include both natural resources, like timber or habitat, and human-built assets, like homes and infrastructure. This table lists the values for which wildfire risk was calculated for each product, and it also describes the terminology adopted by each product to refer to these values at risk.

Product	List of values at risk
Extension Fire Program Relative Risk Assessment	Values are referred to as Highly Valued Resources and Assets (HVRAs). Resources are nature-made, and assets are human-made: 1. People 2. Buildings 3. Infrastructure 4. Agriculture 5. Timber 6. Habitat Species 7. Water
BLM – Wildfire Risk Assessment	Referred to as BLM values at risk of fire: 1. Fire-adapted Communities 2. Resilient Landscapes
WADNR QWRA	1. Wildland Urban Interface (WUI) 2. Forests 3. Infrastructure 4. Drinking Water 5. Commercially Managed Forested Lands
West Wide Wildfire Risk Assessment	1. Drinking Water Importance Areas 2. Forest Assets 3. Infrastructure Assets 4. Riparian Assets 5. Wildland Development Areas
NPS – Wildfire Risk Assessment	1. Facilities in NPS units
National Risk Index	Values are referred to as types of consequences to: 1. People 2. Buildings 3. Agriculture
2018 PNW QWRA	Values are referred to as HVRAs. Resources are nature-made, and assets are human-made: 1. Infrastructure 2. People and Property 3. Timber 4. Vegetation Condition 5. Watershed 6. Terrestrial and Aquatic Wildlife Habitat
2023 PNW QWRA	Values are referred to as HVRAs. Resources are nature-made, and assets are human-made: 1. People and Property 2. Ecological Integrity (including Forests and Rangelands) 3. Drinking Water 4. Infrastructure 5. Timber 6. Wildlife Habitat 7. Agriculture 8. Recreation Infrastructure
Wildfire Risk to Communities 2.0	1. Homes – assumes a structure exists on every burnable pixel
IFTDSS QWRA	Values are referred to as HVRAs. Resources are nature-made, and assets are human-made. Users can upload their own data, create custom categories, and create sub-HVRAs. Users can also pick HVRAs from a reference dataset built into IFTDSS which includes the HVRAs used in national risk assessments: 1. Air Quality 2. Communities 3. Ecosystem Function 4. Infrastructure 5. Surface Drinking Water 6. Priority Vegetation 7. Rangeland Values 8. Recreation 9. Wildlife
Community-Level Wildfire Risk Rankings	1. People and Property Represents wildfire risk to communities based on structure density and social vulnerability, or how likely people are to be harmed by wildfires due to social factors like income, age, health, housing, and access to resources. Uses the same structure density classes as the People and Property HVRA from the 2023 PNW QWRA and includes social vulnerability information from a social vulnerability index developed based on the 2016-2020 American Community Survey.
OR Statewide Wildfire Hazard Map	While this product does not directly define or map any specific values at risk, the focus on understanding hazards to structures and other human development is implicit.

Table 2. Stated purpose

The developer's stated purpose or objectives of the product as described in the metadata or technical documentation. Not all risk products are created for the same purpose, making it important that users understand which products are most aligned with their goals.

Product	Stated purpose
Extension Fire Program Relative Risk Assessment	Developed to help prioritize planning work around wildfire risk. Specifically, the assessment informs the strategic placement of six field-based extension regional fire specialists, provides initial regional assessments, facilitates the development or progress of collaborative networks, allows for adaptation to local values at a variety of spatial scales and facilitates repeated landscape-scale, cross-boundary assessments that will reveal changing patterns of risk as management treatments or natural disturbances occur.
BLM – Wildfire Risk Assessment	Developed to inform fuel management fund allocations for the five-year plan based on the National Cohesive Wildland Fire Management Strategy Goals. It provides a national baseline that state offices can use to create their risk-based assessments that include state or regional values and allocate funds based on local results. Additional objectives include creating a repeatable and scientifically defendable assessment, avoiding the multiplication of the number of geospatial datasets, developing an easy-to-understand methodology for combining data, creating a final map, documenting methods, and distributing all products.
WADNR QWRA	Developed for inclusion in landscape evaluations to support planning of forest and fuel treatments, to improve forest health, and to provide strategic operations for fire management across all lands.
West Wide Wildfire Risk Assessment	One of the earliest risk assessments in the western United States, was developed to quantify the wildfire problem in the West and level of risk to communities and resources. Additional goals include producing a report that summarizes data by state, documenting recent accomplishments since the implementation of the Healthy Forest Restoration Act, identifying future challenges and recommended actions, and enhancing the communication of wildfire risk to the public.
NPS – Wildfire Risk Assessment	Goals include 1) complete an inventory of facilities within NPS unit boundaries, 2) produce a wildfire hazard rating for facilities within NPS boundaries that characterize the facility's risk of ignition during a wildland fire, and 3) facilitate treatment planning and tracking - specifically concerning the treatment of defensible space around NPS facilities, communities, and developed areas.
National Risk Index	Developed to help users better understand the natural hazard risk to their communities and support emergency operation plans, enhance hazard mitigation plans, prioritize and allocate resources, identify the need for more refined risk assessments, encourage community-level risk communication and engagement, educate homeowners and renters, support enhanced codes and standards, and inform long-term community recovery. The Future Risk product is intended to empower communities to understand possible future natural hazard risk and to be used for planning purposes only.
2018 PNW QWRA	Developed to provide foundational information about wildfire hazards and risks to HVRAs. Outputs can drive the planning, prioritization and implementation of prevention and mitigation activities, such as prescribed fire and mechanical fuel treatments. Data can be used to support fire operations in response to wildfire incidents by identifying those assets and resources most susceptible to fire, aiding decision-making for prioritizing, and positioning firefighting resources.
2023 PNW QWRA	Developed to provide objective, science-based risk analytics that can be used to support strategic risk management across the PNW. Analytics produced as part of the PNW QWRA support community wildfire protection planning, fuels planning, active fire response, and a myriad of other land management needs at regional and sub-regional scales. The 2023 PNW QWRA does the following: 1) updates OR and WA's all-lands wildfire risk assessment to represent current conditions and scientific advances; 2) fulfills an important step in the risk management process, 3) provides information symmetry across agencies to support strategic planning and implementation across all-lands, 4) supports the efficient allocation of finite resources to areas and resources most at risk, 5) expands the number and distribution of values exposed to wildfire, 6) helps align land management agencies towards common goals of protecting societal values, and 7) informs and educates practitioners and the public about wildfire risk.
Wildfire Risk to Communities 2.0	Intended to help communities understand components of their relative wildfire risk profile, the nature and effects of wildfire risk, and actions they can take to mitigate it. It is designed to help community leaders, such as elected officials, community planners, and fire managers, understand how risk varies across a state, region, or county and prioritize actions to mitigate risk.
IFTDSS QWRA	Designed to address the stakeholder needs of users of the IFTDSS, to prioritize fuel treatment location, and assess proposed treatment effectiveness. The risk assessment task is one option in the IFTDSS planning cycle. The information produced characterizes the expected benefits and threats from a fire on values spatially distributed across landscapes. This information can be used to plan fuel treatments, pre-plan suppression responses, design fire effects monitoring programs, and other related management activities, while accounting for the predicted benefits and threats from fire and the relative importance of different landscape values. It is a scalable tool that is best applied at the unit or project level, which allows pre- and post-treatment comparisons.
Community-Level Wildfire Risk Rankings	Intended to integrate community risk stemming from biophysical hazard with community risk stemming from the socioeconomic characteristics of communities. This product addresses a known gap in risk assessments that only focus on biophysical components of risk. It is intended to provide decision-makers with a more complete representation of community wildfire risk in a single data product. It is designed to support strategic resource investment decisions for communities in the pre- and post-fire environment.
OR Statewide Wildfire Hazard Map	The purpose of the statewide wildfire hazard map is to 1) Educate OR Residents and property owners about the residents' and property owners' wildfire exposure by providing transparent and science-based information, 2) Assist in prioritizing fire adaptation and mitigation resources for the most vulnerable locations, and 3) Identify where defensible space standards and home hardening codes will apply. Note: The map was released in January of 2025 and repealed in June of 2025 by the OR Legislature as a tool to identify where defensible space standards and home hardening codes apply.

Table 3. Wildfire risk definition

This table describes how wildfire risk is defined and used in each product. When applicable, we include simplified equations for calculating risk. Definitions were kept consistent with the developers' terms.

Product	Wildfire risk definition
Extension Fire Program Relative Risk Assessment	Wildfire risk is the likelihood of a wildfire occurring and its potential effects on selected values. The hazard component describes the likelihood of fire, and the vulnerability component describes the potential effects. Risk = hazard x vulnerability
BLM – Wildfire Risk Assessment	Risk is defined as the probability of a threat and the consequence (either positive or negative) of that threat to selected values. Uses a Bayesian approach to calculate risk.
WADNR QWRA	Wildfire risk is the likelihood of a wildfire occurring and its potential effects on selected values. The hazard component describes the likelihood of fire, and the vulnerability component describes the potential effects. Risk = hazard x vulnerability
West Wide Wildfire Risk Assessment	Wildland fire risk is a combination of the possibility of fire and the harm and loss associated with that fire. The possibility of fire (Fire Risk Index, FRI) is represented by the Fire Threat Index (FTI) and the possible harm or loss is represented by the Fire Effects Index (FEI) as: FRI = FTI x FEI x 10000
NPS – Wildfire Risk Assessment	The assessment defines risk as the likelihood that a structure will ignite during a wildfire. This is based on factors such as the surrounding environment, building materials and design, accessibility, and the availability of protection resources. The raw score from the assessment form determines the risk rating in three classes – low, moderate, and high risk.
National Risk Index	Wildfire risk is the combination of the probability of a natural hazard event and the expected consequence. Expected annual loss measures the expected loss to values at risk and community risk factor is a scaling factor unique to each community based on the community's social vulnerability and community resilience values. Risk = Expected Annual Loss x Community risk factor
2018 PNW QWRA	Wildfire risk is the likelihood of a wildfire occurring and its potential effects on selected values. The hazard component describes the likelihood of fire, and the vulnerability component describes the potential effects. Risk = hazard x vulnerability
2023 PNW QWRA	Wildfire risk is the likelihood of a wildfire occurring and its potential effects on selected values. The hazard component describes the likelihood of fire, and the vulnerability component describes the potential effects. Risk = hazard x vulnerability
Wildfire Risk to Communities 2.0	Wildfire risk is the likelihood of a wildfire occurring and its potential effects on selected values. The hazard component describes the likelihood of fire, and the vulnerability component describes the potential effects. Risk = hazard x vulnerability
IFTDSS QWRA	Risk is the potential for the realization of adverse or beneficial consequences to HVRAs. In this risk assessment framework, the potential for effects is quantified as the expected value of the probability of an event occurring multiplied by the magnitude of the effect, given that an event has occurred.
Community-Level Wildfire Risk Rankings	Wildfire risk is the likelihood of a wildfire occurring and its potential effects on selected values. The hazard component describes the likelihood of fire, and the vulnerability component describes the potential effects. Risk = hazard x vulnerability
OR Statewide Wildfire Hazard Map	Does not apply. The Hazard definition used in this product is a numerical value that describes the likelihood and intensity of a wildfire, based on specific weather, climate, topography, and vegetation factors as modeled for a given pixel.

Table 4. Spatial resolution

Spatial resolution refers to the size of the smallest unit that can be distinguished in a map. The spatial resolution of the fuelscape describes the smallest unit of the native data on fuels and topography. In the fire model, spatial resolution refers to the spatial resolution of the fuelscape data used by the model to perform the calculations necessary for simulating fire growth. Note that the lower the cell size number, the higher the spatial resolution.

Product	Spatial resolution of fire model	Spatial resolution of the fuelscape	Spatial resolution of the risk product
Extension Fire Program Relative Risk Assessment	30 m	30 m	30 m
BLM – Wildfire Risk Assessment	270 m	30 m	90 m
WADNR QWRA	Varied between 120 m and 30 m, depending on whether the 2018 or 2023 PNW QWRA is used as the source hazard data.	30 m	30 m
West Wide Wildfire Risk Assessment	30 m	30 m	30 m
NPS – Wildfire Risk Assessment	270 m	The product uses the fuelscape associated with the modeling of burn probability from the Wildfire Risk to Communities dataset – version unknown.	Point estimate, i.e. risk estimate is per individual structure.
National Risk Index	270 m	30 m	Risk is shown aggregated by Census tract and county.
2018 PNW QWRA	120 m	30 m	30 m
2023 PNW QWRA	FSim simulations run at 120 m and are resampled to 30 m. WildEST[5] simulations run at 30 m.	30 m	30 m
Wildfire Risk to Communities 2.0	FSim simulations run at 270 m and are resampled to 30 m. WildEST simulations run at 30 m.	270 m for FSim and 30 m for WildEST.	30 m
IFTDSS QWRA	Limited by the size of the area of interest. Resampling is done automatically to adjust the resolution of the landscape to allow it to meet the computation needs of modeling applications and run successfully. The original landscape is resampled at 30 m (to either 60, 90, or 120 m) as needed to maintain a maximum landscape size of 1,500,000 pixels.	30 m with automatic resampling if the fuelscape is greater than 1.5 million pixels.	Same spatial resolution as the fire modeling
Community-Level Wildfire Risk Rankings	FSim simulations run at 120 m and are resampled to 30 m. WildEST simulations run at 30 m.	30 m	30 m
OR Statewide Wildfire Hazard Map	FSim simulations run at 120 m and are resampled to 30 m. WildEST simulations run at 30 m.	30 m	Hazard is shown by zones.

5 *WildEST is the Wildfire Exposure Simulation Tool, developed by Pyrologix to produce continuously variable landscape-scale spatial data representing fire weather and fire characteristics – see Scott et al. (2024) for more details.*

Table 5. What computer model is used to simulate fire behavior, and what outputs are used in the risk assessment?

For products that incorporate outputs from models simulating fire growth and behavior to provide estimates of fire likelihood and/or intensity, this table lists the fire model used and the specific outputs utilized in the risk product. Many of the fire models listed include several other outputs not listed in this table.

Product	What computer model is used to simulate fire behavior and what outputs are used in the risk assessment?
Extension Fire Program Relative Risk Assessment	FlamMap[6] implementation through IFTDSS. Outputs used in risk are the burn probability raster and the conditional flame length rasters in six classes.
BLM – Wildfire Risk Assessment	FSim. Risk calculation uses burn probability from the first edition[7] of the spatial datasets of probabilistic wildfire risk components for the conterminous United States
WADNR QWRA	This product uses the hazard layers from the 2018 or 2023 PNW QWRA, depending on the year of the assessment. When the 2018 version is used, all hazard products are based on FSim runs. When the 2023 version is used, burn probability is based on FSim and conditional flame length is based on WildEST runs.
West Wide Wildfire Risk Assessment	Custom tool using the same mathematical models as FlamMap. Outputs used in risk are the rate of spread and flame length at different weather percentiles, low, moderate, average and extreme.
NPS – Wildfire Risk Assessment	FSim. This product uses a burn probability raster combined with risk of ignition of an individual structure to calculate the structure's HIP. The risk of ignition associated with each structure is calculated using a field survey.
National Risk Index	FSim. Outputs used in risk are the burn probability raster and flame length probability classes five and six to determine exposure to wildfire, and flame length probability class 6 to determine historic loss rates. The product uses spatial datasets of probabilistic wildfire risk components (second edition).
2018 PNW QWRA	FSim. Outputs used in risk are burn probability raster and the conditional flame length rasters in six classes of flame length.
2023 PNW QWRA	FSim for burn probability and FlamMap using the WildEST methodology for conditional flame length rasters in six classes of flame length.
Wildfire Risk to Communities 2.0	FSim for burn probability and FlamMap using the WildEST methodology for conditional flame length rasters in six classes of flame length.
IFTDSS QWRA	Landscape Burn Probability (LBP). This model is identical to FlamMap, with fixed modeling inputs that the IFTDSS user cannot change – fixed weather conditions for a single burn period. Outputs used in risk are the burn probability raster, integrated hazard, conditional flame length rasters in six classes, and flame length proportion by class.
Community-Level Wildfire Risk Rankings	FSim for burn probability and FlamMap using the WildEST methodology for conditional flame length rasters in six classes of flame length.
OR Statewide Wildfire Hazard Map	FSim for burn probability and FlamMap using the WildEST methodology for conditional flame length rasters in six classes of flame length.

6 FlamMap *is a fire mapping and analysis system developed by the Missoula Fire Sciences Laboratory of the USDA-USFS Rocky Mountain Research Station – see Finney (2006) for more details.*

7 *Freely available national burn probability and conditional fire intensity level data generated for the conterminous United States using FSim, developed by the US Forest Service Missoula Fire Sciences Laboratory, to estimate probabilistic components of wildfire risk – see Short et al (2016).*

Table 6. What is the fire modeling unit?

For products that include a fire modeling component, this table describes the fire modeling unit. Modeling units are used to partition large project areas (e.g. continental US) into smaller chunks for processing efficiency and to customize input parameters, such as weather, fuel information, fire occurrence, and model calibration specific to each modeling unit.

Product	What is the fire modeling unit?
Extension Fire Program Relative Risk Assessment	Subdomains of the 50 Fire Service Areas.
BLM – Wildfire Risk Assessment	Pyromes. This product uses hazard layers from the first edition of the spatial datasets of probabilistic wildfire risk components for the conterminous United States.
WADNR QWRA	Fire Occurrence Areas (FOAs). This product uses fire hazard analytics from different versions (2018, 2023) of the PNW QWRA in its risk calculation. FOA boundaries are slightly different between the two versions of the PNW QWRA.
West Wide Wildfire Risk Assessment	Fire is modeled for a combination of Weather Influence Zones (WIZ) and FOAs. These are different from FOAs in the PNW QWRA products. In this product, FOAs are areas within which the probability of each acre igniting is the same, and the ignition probability is based on historical fire occurrence data.
NPS – Wildfire Risk Assessment	Pyromes. This product uses burn probability data from the Wildfire Risk to Communities dataset, which uses Pyromes.
National Risk Index	Pyromes
2018 PNW QWRA	FOAs. Individual FOA boundaries were generated using various inputs, including larger fire occurrence boundaries developed for national-level work (National FSim Pyrome boundaries), aggregated Level IV EPA Ecoregions, Fire Danger Rating Areas, and input from regional fire staff. FOAs include an external 17-km buffer to allow for fires to start outside a FOA and burn into it. Note: FOAs for the PNW QWRA differ both methodologically and spatially from those in the West Wide Wildfire Risk Assessment product.
2023 PNW QWRA	FOAs. Individual FOA boundaries were generated using a variety of inputs, including: larger fire occurrence boundaries developed for national-level work (National FSim Pyrome boundaries), aggregated level IV EPA Ecoregions, Fire Danger Rating Areas, and Regional fire staff input. FOAs include an external 17-km buffer to allow for fires to start outside a FOA and burn into it. Note: FOAs for the PNW QWRA differ both methodologically and spatially from those in the West Wide Wildfire Risk Assessment product.
Wildfire Risk to Communities 2.0	Burn Probability used Pyromes. A modeling unit for fire intensity is not described.
IFTDSS QWRA	Area Of Interest (AIO) as defined by the user (max: 12 million acres) or the user-defined landscape within which one or more AOIs can be.
Community-Level Wildfire Risk Rankings	FOAs. Individual FOA boundaries were generated using a variety of inputs including: larger fire occurrence boundaries developed for national-level work (National FSim Pyrome boundaries), aggregated level IV EPA Ecoregions, Fire Danger Rating Areas, and Regional fire staff input. FOAs include an external 17-km buffer to allow for fires to start outside a FOA and burn into it. Note: FOAs for the PNW QWRA differ both methodologically and spatially from those in the West Wide Wildfire Risk Assessment product.
OR Statewide Wildfire Hazard Map	FOAs. Individual FOA boundaries were generated using a variety of inputs, including: larger fire occurrence boundaries developed for national-level work (National FSim Pyrome boundaries), aggregated level IV EPA Ecoregions, Fire Danger Rating Areas, and Regional fire staff input. FOAs include an external 17-km buffer to allow for fires to start outside a FOA and burn into it. Note: FOAs for the OR Statewide Wildfire Hazard Map differ both methodologically and spatially from those in the West Wide Wildfire Risk Assessment product.

Table 7. How is empirical fire occurrence integrated into the modeling?

This section describes if and how ignitions are simulated focusing on whether the pattern is randomly generated (not actually observed), based on actual records of observed fires, or simply considered as a component of burn probability. This section also describes the datasets used to replicate fire occurrence, and the minimum fire size included in the analysis. See Section 4, Cautions and Considerations for more information about the implications of various approaches to the integration of fire occurrence.

Product	How is empirical fire occurrence integrated into the modeling?
Extension Fire Program Relative Risk Assessment	Randomly
BLM – Wildfire Risk Assessment	This product utilizes the 2016 edition of the spatial datasets for probabilistic wildfire risk components in the conterminous United States. Based on the metadata for this product, it's unclear whether ignitions used to model burn probability are random or based on historical fire occurrence patterns. Observed fire occurrences from 1992 to 2011, as recorded in the FOD, were used to establish the large fire-ERC relationships required by the model. The Bayesian approach to calculating risk initially included human-caused ignitions, but these were excluded due to a sensitivity analysis that showed they did not influence the fire risk probability at the national scale.
WADNR QWRA	This product uses hazard layers from the 2018 or 2023 PNW QWRA, depending on the year of the assessment. Analyses using the 2018 PNW QWRA use an ignition density grid (IDG), which replicates the spatial variability in historical wildfire occurrence across the landscape. The IDG was generated using the point location of all fires equal to or larger than 247.1 acres reported in the FOD between 1992-2015. In some FOAs with extremely low fire occurrence, smaller fires equal to or larger than 20 acres (8.09 ha) were also used. Analyses using the burn probability layer from the 2023 PNW QWRA use fires greater than 247.1 acres from 2007-2020, as recorded in the FOD and records from state and federal agencies for fires in 2021 were used to establish fire-size distributions that inform how many ignitions to model and grow. However, it is unclear whether an IDG or random ignitions were employed. Fire intensity modeled with WildEST does not account for fire occurrence.
West Wide Wildfire Risk Assessment	Ignitions were not directly modeled, but ignition probability areas based on historical fire occurrence data were used to develop each FOA. Only fires greater than 100 acres were considered. Data on fire occurrences were collected from states, the federal government, and the National Fire Incident Reporting System. Data spans different years based on data provenance, covering various periods from 1999-2009.
NPS – Wildfire Risk Assessment	The product uses burn probability from the Wildfire Risk to Communities dataset – version unknown.
National Risk Index	Ignitions are not directly modeled in his framework. The product uses the second edition[8] of the spatial datasets of probabilistic wildfire risk components. Based on the metadata for this product, it's unclear whether ignitions used to model burn probability are random or based on historical fire occurrence patterns. Observed fire occurrences from 1992 to 2013, as recorded in the FOD, were used to establish the large fire-ERC relationships required by the model.
2018 PNW QWRA	The model uses an IDG, which replicates the spatial variability in historical wildfire occurrence across the landscape. The IDG was generated using the point location of all fires equal to or larger than 247.1 acres reported in the FOD between 1992-2015. In some FOAs with extremely low fire occurrence, smaller fire equal to or larger than 20 acres (8.09 ha) were also used.
2023 PNW QWRA	The model uses an IDG based on the spatial location of empirical fires from the FOD to determine modeled fire occurrence. Fires greater than 247.1 acres from 2007-2020, as recorded in the FOD and records from state and federal agencies for fires in 2021, were used to establish fire-size distributions that inform how many ignitions to model and grow.
Wildfire Risk to Communities 2.0	Burn probability is modeled following historical spatial patterns through an IDG that was produced for each pyrome with a large-fire size threshold specific to each pyrome. The pyrome-specific IDGs use fire records from 1992-2020 in the FOD. Large fire size – ERC relationships are also based on empirical fires from 1992-2020 in the FOD. Fire intensity modeled with WildEST does not incorporate information on ignitions or empirical fire occurrence.
IFTDSS QWRA	Ignitions are explicitly modeled in a random pattern. Fire occurrence is not integrated into the modeling framework.
Community-Level Wildfire Risk Rankings	The model uses an IDG to influence where ignitions occur in each FOA. Ignition probabilities are based on FOD records. Fires greater than 247.1 acres from 2007-2020, as recorded in the FOD and records from state and federal agencies for fires in 2021 were used to establish fire-size distributions that inform how many ignitions to model and grow.
OR Statewide Wildfire Hazard Map	The model uses an IDG based on the spatial location of empirical fires from the FOD to determine modeled fire occurrence. Fires greater than 247.1 acres from 2007-2020, as recorded in FOD and records from state and federal agencies for fires in 2021, were used to establish fire-size distributions that inform how many ignitions to model and grow.

8 *Freely available national burn probability and conditional fire intensity level data generated for the conterminous United States using FSim, developed by the US Forest Service Missoula Fire Sciences Laboratory, to estimate probabilistic components of wildfire risk – see Short et al (2020).*

Table 8. How are vegetation and topography integrated into the fire modeling?

Wind, topography, and vegetation (also referred to as fuels) represent the three sides of the fire behavior triangle. This means these three variables will combine to determine fire spread and behavior. All the fire models in this review combine geospatial data of fuels and topography into a fuelscape. A fuelscape is a representation of understory fuels, canopy fuels, slope, aspect, and elevation for a given area, created using a combination of modeling, remote sensing data, and field data. Because fuels within a fuelscape change year to year due to annual growth and disturbances like logging or wildfire, the year a fuelscape represents can have significant impacts on risk assessments. This table describes the fuelscape year.

Product	How are vegetation and topography integrated into the fire modeling?
Extension Fire Program Relative Risk Assessment	Fuelscape representing end of 2021
BLM – Wildfire Risk Assessment	Fuelscape representing end of 2012
WADNR QWRA	Fuelscape. Depending on the year of analysis, either 2017 or 2021
West Wide Wildfire Risk Assessment	Fuelscape representing end of 2008
NPS – Wildfire Risk Assessment	Fuelscape associated with the modeling of burn probability from the Wildfire Risk to Communities dataset – version unknown.
National Risk Index	Fuelscape representing end of 2014
2018 PNW QWRA	Fuelscape representing end of 2017
2023 PNW QWRA	Fuelscape representing end of 2021
Wildfire Risk to Communities 2.0	Burn probability: fuelscape representing end of 2020 Fire intensity: fuelscape representing end of 2022
IFTDSS QWRA	Fuelscape with data pulling directly from the LANDFIRE Product Service (LFPS) as soon as updated data are released.
Community-Level Wildfire Risk Rankings	Fuelscape representing end of 2021
OR Statewide Wildfire Hazard Map	Fuelscape representing end of 2021

Table 9. What is the data source and year of fuel data and how were disturbed areas updated?

This table lists the LANDFIRE[9] version used to represent fuels and describes how fuels in disturbed areas were updated to capture changes since the date of data collection (the LANDFIRE reference year). Expert-based rules are established to modify the surface and canopy fuels to reflect changes resulting from disturbances such as wildfires or forest management activities. Undisturbed areas remain unchanged relative to the reference year; in other words, fuel growth and accumulation since the reference year are generally not reflected in the fuels map.

Product	What is the data source and year of fuel data and how were disturbed areas updated?
Extension Fire Program Relative Risk Assessment	LANDFIRE 2016 Remap (LF 2.0.0)
BLM – Wildfire Risk Assessment	LANDFIRE 2012 Refresh (LF 1.3.0)
WADNR QWRA	Depends on the year of analysis LANDFIRE 2014 (LF 1.4.0) or LANDFIRE 2016 Remap (LF 2.0.0)
West Wide Wildfire Risk Assessment	LANDFIRE 2008 (LF 1.1.0)
NPS – Wildfire Risk Assessment	The product uses the fuelscape associated with the modeling of burn probability from the Wildfire Risk to Communities dataset – version unknown.
National Risk Index	LANDFIRE 2014 (LF 1.4.0)
2018 PNW QWRA	LANDFIRE 2014 (LF 1.4.0). Fuels in areas burned in the 2015-2017 fires were updated using Rapid Assessment of Vegetation Condition After Wildfire (RAVG) and Monitoring Trends in Burn Severity (MTBS) and the Northwest Interagency Coordination Center (NWCC) fire perimeter data.
2023 PNW QWRA	LANDFIRE 2016 Remap (LF 2.0.0). Fuelscape incorporates spatial disturbance through the end of 2021 for wildfires and fuel treatments. Approximately 30 subject matter experts in fire modeling/fuels management provided inputs during a three-day workshop and the original fuelscape based on LF 2.0.0 was heavily edited.
Wildfire Risk to Communities 2.0	Burn probability uses LANDFIRE 2.2.0 and fire intensity uses the Risk Management Assistance 2023 fuelscape, which uses LANDFIRE 2.2.0, was updated to reflect fuel disturbances in 2021 and 2022.
IFTDSS QWRA	The tool enables users to extract information from various LANDFIRE versions to create a fuelscape suitable for fire modeling. The selected LANDFIRE version determines the conditions in the fuelscape. As of early 2025, the tool incorporates the latest dataset - LANDFIRE 2023 (LF 2.4.0).
Community-Level Wildfire Risk Rankings	LANDFIRE 2016 Remap (LF 2.0.0). Fuelscape incorporates spatial disturbance through the end of 2021 for wildfires and fuel treatments.
OR Statewide Wildfire Hazard Map	LANDFIRE 2016 Remap (LF 2.0.0). Fuelscape incorporates spatial disturbance through the end of 2021 for wildfires and fuel treatments. Approximately 30 subject matter experts in fire modeling/fuels management provided inputs during a three-day workshop and the original fuelscape based on LF 2.0.0 was heavily edited.

9 *See www.landfire.gov for more information about products and versions.*

Table 10. How are temperature and relative humidity integrated into the fire modeling?

In fire modeling, humidity and temperature are primarily used to predict fuel moisture, which refers to the amount of water contained in fuels. For this purpose, fuels are often classified into live fuels and dead fuels (cured or dead plants, snags, twigs, etc.). This is important because the water-retention capacity in response to weather conditions differs between live and dead fuels. Live plants have internal mechanisms that regulate water exchanges with the atmosphere, making them more difficult to ignite and burn than dead fuels.

Product	How are temperature and relative humidity integrated into the fire modeling?
Extension Fire Program Relative Risk Assessment	Fuel moisture for dead fuels and live fuels is predicted with FireFamilyPlus using the hottest and driest five-day period in the record for each RAWS.
BLM – Wildfire Risk Assessment	Burn probability is based on the 2016 edition of the spatial datasets of probabilistic wildfire risk components for the conterminous United States. Temperature and relative humidity are not used directly; instead, seasonal trends in the mean and standard deviation of Energy Release Component[10] (ERC) and live and dead fuel moisture content are considered by year-round percentile of ERC.
WADNR QWRA	This product uses the hazard layers from the 2018 or PNW QWRA, depending on the year of the assessment. Analyses using the 2018 PNW QWRA rely on hazard (burn probability and fire intensity) modeled with FSim. Temperature and relative humidity are not used directly. Instead, the model uses seasonal trends in the mean and standard deviation of ERC and live and dead fuel moisture content by year-round percentile of ERC. ERC is used in two ways within the model and with different data sources. The first use of ERC is to generate ignitions by combining ERC from the gridded dataset North American Regional Reanalysis (NARR) at 4 km with the FOD to develop a logistic regression of the probability of a large-fire day in relation to ERC. The second use of historic ERC is to create a simulated ERC time series statistically derived on the same 4-km grid as the historical ERC and covering 1,000 years of data (365,000 ERC values). These simulated ERC values are "coordinated" in that a given year and day for one FOA corresponds to the same year and day in all other FOAs—their values only differ due to their location on the landscape. This coordination permits analysis of fire-year information across all FOAs. Fuel moistures for dead and live woody and live herbaceous fuels are calculated for each fuel model and for the 80th, 90th and 97th, percentile conditions. Analyses using the 2023 PNW QWRA use burn probability modeled with FSim. Thus, temperature and relative humidity are not used directly. Instead, the model uses seasonal trends in the mean and standard deviation of ERC and live and dead fuel moisture content by year-round percentile of ERC. For each FOA, the logistic regression between large fire occurrence and ERC was calculated using daily weather records (2007 – 2021) sampled from a representative RAWS within each FOA. Fire intensity is modeled with FlamMap, conducted through the WildEST methodology. This incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction, and fuel moisture content. The 216 scenarios are weighed according to Weather Type Probabilities (WTPs), where more weight is assigned to scenarios associated with higher spread conditions. No additional information is available on the source or vintage of the wind data used to calculate the WTPs related to each scenario.
West Wide Wildfire Risk Assessment	Temperature and relative humidity are not used directly. Instead, the Spread Component (SC) from the National Fire Danger Rating System was calculated using data from each RAWS and used to create four weather scenarios based on different percentiles of SC. The dead fuel, live woody, and live herbaceous fuel moistures were identified for each percentile scenario and used in the modeling.
NPS – Wildfire Risk Assessment	The product uses burn probability from the Wildfire Risk to Communities dataset – version unknown.
National Risk Index	The product uses spatial datasets of probabilistic wildfire risk components (second edition). Temperature and relative humidity are not used directly. Instead, potential contemporary weather scenarios were generated for each simulation unit using ERC. A time-series analysis of ERC was employed to represent daily and seasonal trends and variability. This modeling uses a 4-km gridded dataset of wind speed and direction from 1979 to 2010. No additional details are provided.

[10] Energy Release Component is a number related to the available energy (BTU) per unit area (square foot) within the flaming front at the head of a fire. It's part of the National Fire Danger Rating System. Variations in ERC are due to changes in the moisture content of the various fuels present, both live and dead and as dry, the ERC values increase, providing a good reflection of drought conditions.

Product	How are temperature and relative humidity integrated into the fire modeling?
2018 PNW QWRA	Temperature and relative humidity are not used directly. Instead, the model uses seasonal trends in the mean and standard deviation of ERC and live and dead fuel moisture content by year-round percentile of ERC. ERC is used in two ways within the model and with different data sources. The first use of ERC is to generate ignitions by combining ERC from the gridded dataset North American Regional Reanalysis (NARR) at 4 km with the FOD to develop a logistic regression of the probability of a large-fire day in relation to ERC/ The second use of historic ERC is to create a simulated ERC time series statistically derived on the same 4-km grid as the historical ERC and covering 1,000 years of data (365,000 ERC values). These simulated ERC values are "coordinated" in that a given year and day for one FOA corresponds to the same year and day in all other FOAs–their values only differ due to their location on the landscape. This coordination permits analysis of fire-year information across all FOAs. Fuel moistures for dead and live woody and live herbaceous fuels are calculated for each fuel model and for the 80th, 90th and 97th, percentile conditions.
2023 PNW QWRA	Burn probability is modeled with FSim. Thus, temperature and relative humidity are not used directly. Instead, the model uses seasonal trends in the mean and standard deviation of ERC and live and dead fuel moisture content by year-round percentile of ERC. For each FOA, the logistic regression between large fire occurrence and ERC was calculated using daily weather records (2007 – 2021) sampled from a representative RAWS within each FOA. Fire intensity modeling with FlamMap, conducted through the WildEST methodology, incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction, and fuel moisture content. Scenarios use 4-Km gridded weather data. The 216 scenarios are weighed according to WTPs, where more weight is assigned to scenarios associated with higher spread conditions.
Wildfire Risk to Communities 2.0	Burn probability modeling with FSim uses daily values of ERC and dead fuel moisture content for the period 1992-2020. These values are calculated for a representative location within each pyrome from a gridded historical climatology derived from grid-MET data. Fire intensity modeling relies on fuel moisture, calculated from gridded data of temperature and relative humidity, which is binned into three classes and used to define 216 unique we that serve as weights for different fire weather combinations. WildEST allows for dead fuel conditioning - a function that allows dead fuel moisture to vary based on the exposure of fuels.
IFTDSS QWRA	Temperature and relative humidity are not used directly. Instead, users must select a foliar moisture content that is used in conjunction with canopy base height to determine the surface-to-crown fire transition threshold for each pixel. This live fuel moisture content is based on the stage of vegetative development. Users are also required to set the initial fuel moisture for dead fuels, live woody fuels, and live herbaceous fuels by fuel model. There is an option to condition fuels, i.e., conditioning can be used to adjust initial dead fuel moisture values to account for variations in local site conditions. Conditioning will utilize information from the fuelscape (slope, aspect, elevation, and canopy cover) and weather information (temperature, humidity, cloud cover, and hourly precipitation).
Community-Level Wildfire Risk Rankings	Burn probability is modeled with FSim. Thus, temperature and relative humidity are not used directly. Instead, the model uses seasonal trends in the mean and standard deviation of ERC-G and live and dead fuel moisture content by year-round percentile of ERC. For each FOA, the logistic regression between large fire occurrence and ERC was calculated using daily weather records (2007 – 2021) sampled from a representative RAWS within each FOA. Fire intensity modeling with FlamMap, conducted through the WildEST methodology, incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction and fuel moisture content. Scenarios use 4-Km gridded weather data. The 216 scenarios are weighed according to WTPs, where more weight is assigned to scenarios associated with higher spread conditions.
OR Statewide Wildfire Hazard Map	Burn probability is modeled with FSim. Thus, temperature and relative humidity are not used directly. Instead, the model uses seasonal trends in the mean and standard deviation of ERC-G and live and dead fuel moisture content by year-round percentile of ERC. For each FOA, the logistic regression between large fire occurrence and ERC was calculated using daily weather records (2007 – 2021) sampled from a representative RAWS within each FOA. Fire intensity modeling with FlamMap, conducted through the WildEST methodology, incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction and fuel moisture content. Scenarios use 4-Km gridded weather data. The 216 scenarios are weighed according to WTPs, where more weight is assigned to scenarios associated with higher spread conditions.

Table 11. How are wind direction and speed integrated into fire modeling?

Wind is a crucial driver of fire growth and intensity in both real fires and in fire modeling. It is also one of the most variable inputs fire models include. This table provides a general overview of how wind is captured in each product, focusing on information regarding the source (RAWS vs. gridded data) and time period.

Product	How are wind direction and speed integrated into fire modeling?
Extension Fire Program Relative Risk Assessment	Uses the mode of wind direction and maximum wind speed during the five-day period that was the hottest and driest period based on RAWS data for the entire time series available for each RAWS.
BLM – Wildfire Risk Assessment	Burn probability is based on the 2016 edition of the spatial datasets of probabilistic wildfire risk components for the conterminous United States. This modeling uses a 4-km gridded dataset of wind speed and direction from 1979 to 2010. No additional details are provided.
WADNR QWRA	This product uses the hazard layers from the 2018 or 2023 PNW QWRA, depending on the year of the assessment. Analyses using the burn probability and fire intensity from the 2018 PNW dataset used monthly distributions of hourly wind speed and direction (12000 to 2000 hours) 10-minute average values recorded at select RAWS. These are joint distributions of wind speed and wind direction for each month of the year and the calendar year as a whole. Each FOA is represented by one RAWS selected by fire and fuels specialists. When necessary, wind speeds are reduced or increased by fixed factors so that the simulated fire behavior matched fire behavior from managers' observations. Analyses using the 2023 PNW QWRA integrate wind data in different ways depending on the hazard layer. Fire intensity modeling with FlamMap, conducted through the WildEST methodology, incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction, and fuel moisture content. The 216 scenarios are weighed according to WTPs, where more weight is assigned to scenarios associated with higher spread conditions. The scenarios were developed using 4-km gridded data.
West Wide Wildfire Risk Assessment	A 20-foot wind speed blowing straight uphill is calculated for each Weather Influence Zone (WIZ). Uses RAWS data using the station that better fits the WIZ.
NPS – Wildfire Risk Assessment	The product uses burn probability from the Wildfire Risk to Communities dataset – version unknown.
National Risk Index	The product uses spatial datasets of probabilistic wildfire risk components (second edition). This modeling uses a 4-km gridded dataset of wind speed and direction from 1979 to 2010 to create distributions of wind speed and direction from surface weather records. No additional details are provided.
2018 PNW QWRA	The model used monthly distributions of hourly wind speed and direction (12000 to 2000 hours) 10-minute average values recorded at select RAWS. These are joint distributions of wind speed and wind direction for each month of the year and the calendar year as a whole. Each FOA is represented by one RAWS selected by fire and fuels specialists. When necessary, wind speeds are reduced or increased by fixed factors so that the simulated fire behavior matched fire behavior from managers' observations.
2023 PNW QWRA	Wind speed and direction are used differently in the different components of fire hazard. Burn probability uses the FSim model. Each FOA utilizes one set of daily and hourly wind speed and direction data from a RAWS representative of the FOA, selected by subject matter experts from the various land management agencies involved in the product's development. Fire intensity modeling with FlamMap, conducted through the WildEST methodology, incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction, and fuel moisture content. The 216 scenarios are weighed according to WTPs, where more weight is assigned to scenarios associated with higher spread conditions. The scenarios were developed using 4-km gridded data.
Wildfire Risk to Communities 2.0	Wind speed and direction are incorporated differently for the different components of fire hazard. Burn Probability uses wind data from a selected RAWS from each pyrome to determine monthly distributions of wind speed and direction for simulations. The data included each RAWS available record from 1992-2020, requiring a minimum of 10 years, observations from noon to 11pm, sustained wind speeds, a maximum sustained wind speed of 40 miles/hour, and uses the Weibull option for wind speed distributions. Fire intensity modeling uses wind speed and wind direction, which are binned into nine and eight classes, respectively. These classes and fuel moisture define 216 unique Weather Types that function as weights to the different fire weather combinations. The wind is downscaled from a 2-10 km source to a 120 m resolution using Wind Ninja to produce terrain-adapted wind speed and direction. No additional information is available on the source or vintage of the wind data used to calculate the WTPs associated with each scenario.

Product	How are wind direction and speed integrated into fire modeling?
IFTDSS QWRA	Burn probability and fire intensity are modeled with a fixed wind speed and direction. This approach is typically referred to as the "fire-problem" scenario, in which only one scenario of wind speed and direction is used, reflecting the predominant wind conditions under which severe fires occur in the area of interest. The user can choose to adjust wind speed and direction to topography or the same values for each cell.
Community-Level Wildfire Risk Rankings	Wind speed and direction are used differently in the different components of fire hazard. Burn probability uses the FSim model. Daily and hourly wind records from 2007 to 2021 were collected from RAWS. Records include speed and direction, which contribute to the daily weather stream sampled in FSim. Fire intensity modeling with FlamMap, conducted through the WildEST methodology, incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction, and fuel moisture content. The 216 scenarios are weighed according to WTPs, where more weight is assigned to scenarios associated with higher spread conditions. No additional information is available on the source or vintage of the wind data used to calculate the WTPs associated with each scenario.
OR Statewide Wildfire Hazard Map	Wind speed and direction are used differently in the different components of fire hazard. Burn probability uses the FSim model. Each FOA utilizes one set of daily and hourly wind speed and direction data from a RAWS representative of the FOA, selected by subject matter experts from the various land management agencies involved in the product's development. Fire intensity modeling with FlamMap, conducted through the WildEST methodology, incorporates wind through 216 deterministic scenarios, based on combinations of wind speed, wind direction, and fuel moisture content. The 216 scenarios are weighed according to WTPs, where more weight is assigned to scenarios associated with higher spread conditions.

Table 12. How is fire suppression integrated into the model?

Indicates the year of the latest release, previous releases, and frequency of updates for each product. This is important for considering which risk products may have the most up to date data and methods.

Product	How is fire suppression integrated into the model?
Extension Fire Program Relative Risk Assessment	Fire suppression is not integrated into the modeling framework.
BLM – Wildfire Risk Assessment	Suppression is integrated in the modeling of burn probability with FSim. Suppression is accounted for by a statistical model that indicates the probability of containment based on spread rates and fuel types throughout each fire simulation. A 'perimeter trimming' function, which reflects the influence of suppression activities on fire spread and improves modeled fire size distributions, is also included in the fire suppression module.
WADNR QWRA	This product uses hazard layers from the 2018 or 2023 PNW QWRA, depending on the year of the assessment. The technical description includes suppression as one of the components of the fire FSim model, but provides no additional information. Suppression is not accounted for in the modeling of flame length with WildEST.
West Wide Wildfire Risk Assessment	Fire suppression is not directly modeled. The final risk index includes a rating for suppression difficulty that is a function of fuel model and slope. These inputs are associated with suppression difficulty through published handline construction rates.
NPS – Wildfire Risk Assessment	The burn probability component is based on the Wildfire Risk to Communities burn probability. There is no indication of vintage, but the latest version of this dataset integrates suppression effects in the modeling of burn probability. Suppression is accounted for by a statistical model that indicates the probability of containment based on spread rates and fuel types throughout each fire simulation. A 'perimeter trimming' function, which reflects the influence of suppression activities on fire spread and improves modeled fire size distributions, is also included in the fire suppression module.
National Risk Index	Suppression is integrated in the modeling of burn probability with FSim. Suppression is accounted for by a statistical model that indicates the probability of containment based on spread rates and fuel types throughout each fire simulation. A 'perimeter trimming' function, which reflects the influence of suppression activities on fire spread and improves modeled fire size distributions, is also included in the fire suppression module.
2018 PNW QWRA	The technical description includes suppression as one of the components of the fire model but provides no additional information.
2023 PNW QWRA	The technical description includes suppression as one of the components of the fire FSim model, but provides no additional information. Suppression is not accounted for in the modeling of flame length with WildEST.
Wildfire Risk to Communities 2.0	Suppression is integrated in the modeling of burn probability with FSim. Suppression is accounted for by a statistical model that indicates the probability of containment based on spread rates and fuel types throughout each fire simulation. A 'perimeter trimming' function, which reflects the influence of suppression activities on fire spread and improves modeled fire size distributions, is also included in the fire suppression module. For fire intensity calculations, suppression is not accounted for.
IFTDSS QWRA	Fire suppression is not integrated into the modeling framework.
Community-Level Wildfire Risk Rankings	The technical description includes suppression as one of the components of the fire FSim model, but provides no additional information. Suppression is not accounted for in the modeling of flame length with WildEST.
OR Statewide Wildfire Hazard Map	The technical description includes suppression as one of the components of the FSim model, but provides no additional information. Suppression is not accounted for in the modeling of flame length with WildEST.

Table 13. How are fire modeling outputs validated/calibrated?

Describes the process used by developers to compare model outputs to benchmark data, the choice of benchmark (fire record source and years included) that is assumed to be accurate or true for validating the model, and the process to improve the agreement between the fire model outputs and benchmark data through adjusting parameters in the model (calibration).

Product	How are fire modeling outputs validated/calibrated?
Extension Fire Program Relative Risk Assessment	Outputs are not validated/calibrated.
BLM – Wildfire Risk Assessment	Burn probability is based on the first edition of the spatial datasets of probabilistic wildfire risk components for the conterminous United States using FSim. The number of fires and fire size distribution generated by the FSim model are evaluated by comparing them with historical fire patterns and statistics, including the mean annual burn probability and fire size distribution, for each pyrome. This evaluation is part of the FSim calibration process, whereby simulation inputs are adjusted until the slopes of the historical and modeled fire size distributions are similar and the modeled average burn probability falls within an acceptable range of the historical reference value (i.e., the 95% confidence interval for the mean).
WADNR QWRA	This product uses fire hazard analytics from different versions (2018, 2023) of PNW QWRA in its risk calculation. Analyses that employ the 2018 PNW QWRA are calibrated as follows: Large fire occurrence, including the mean historical large-fire size, mean annual burn probability, mean annual number of large fires per million acres, and mean annual area burned per million acres, are calibrated to match historical values. In final runs, these numbers are within the 70% confidence interval, with a minimum of 10,000 iterations. Analyses that use the 2023 PNW QWRA version, the calibration goals are to match the simulated distribution of fire size and annual number of large fires to the historical record. The Labor Day fires of 2020 are excluded from the calibration statistics to prevent overpredicting the size and likelihood of large wildfires that would lead to overpredictions of rare events.
West Wide Wildfire Risk Assessment	No information available
NPS – Wildfire Risk Assessment	The product uses burn probability from the Wildfire Risk to Communities dataset – version unknown.
National Risk Index	The product uses spatial datasets of probabilistic wildfire risk components (second edition). The modeled number of fires and fire size distribution are evaluated by comparing them with historical fire patterns and statistics, including the mean annual burn probability and fire size distribution, for each simulation unit. This evaluation is part of the FSim calibration process, whereby simulation inputs are adjusted until the slopes of the historical and modeled fire size distributions are similar and the modeled average burn probability falls within an acceptable range of the historical reference value (i.e., the 95% confidence interval for the mean).
2018 PNW QWRA	Modeled large fire occurrence, including mean large-fire size, mean annual burn probability, mean annual number of large fires per million acres, and mean annual area burned per million acres, are calibrated to match historical values so that in final runs these numbers are within the 70% confidence interval with a minimum of 10,000 iterations.
2023 PNW QWRA	Calibration of FSim burn probability matches the simulated distribution of fire size and annual number of large fires to the historical record for each FOA. Historical fires are represented in the FOD, which includes records from 1992 to 2020, as well as fires from 2021 that state and federal agencies reported. The Labor Day fires of 2020 are excluded from the calibration statistics to prevent overpredicting the size and likelihood of large wildfires that would lead to overpredictions of rare events.
Wildfire Risk to Communities 2.0	FSim model results are objectively evaluated through comparison with historical fire patterns using fire records in the FOD from 2006 to 2020 and statistics within each pyrome. This evaluation is part of the FSim calibration process, whereby simulation inputs are adjusted until the validation statistics fall within an acceptable range of the historical reference value (±10%). Statistics used as calibration targets are: a) the mean annual number of large fires per million burnable acres; and b) mean annual large-fire area burned per million burnable acres. In addition to the calibration targets, several variables are graphed in each pyrome as visual checks on the number and sizes of fires produced in the simulation. These variables include: historical vs. simulated 15-year cumulative fire size distribution (plotted as fire size against annual fire size exceedance probability), full FOD period (1992-2020) mean annual number of large fires and large-fire area burned, and first 15-years FOD (1992-2006) mean annual number of fires and large-fire area burned. There is no calibration process associated with fire intensity modeling with WildEST.
IFTDSS QWRA	Modeled outputs are not compared to empirical data.
Community-Level Wildfire Risk Rankings	Calibration of FSim burn probability matches the simulated distribution of fire size and annual number of large fires to the historical record for each FOA. Historical fires are represented by fire records in the FOD, which includes fires from 1992 to 2020 and records from state and federal agencies that occurred in 2021. The Labor Day fires of 2020 are excluded from the calibration statistics to prevent overpredicting the size and likelihood of large wildfires that would lead to overpredictions of rare events.
OR Statewide Wildfire Hazard Map	Calibration of FSim burn probability matches the simulated distribution of fire size and annual number of large fires to the historical record for each FOA. Historical fires are represented in the FOD, which includes records from 1992 to 2020, as well as fires from 2021 that state and federal agencies reported. The calibration process showed that the Labor Day fires of 2020 led to an overprediction of burn probability, and thus, these events were excluded.

Table 14. How are the impacts from fire (positive or negative) estimated?

This table describes how the different products estimate the impacts of fire on values at risk, emphasizing whether impacts vary by fire intensity and whether positive or negative fire effects are considered. Although there are different views on what may be considered positive or negative, from an ecological standpoint, positive fire effects could include, for example, when low-severity fire creates a few snags (dead but still standing trees) without causing significant tree mortality. Cavity nesting birds, such as woodpecker species, use snags for nesting habitat. In fire-adapted forests, low-intensity fires reduce shrubs and undergrowth growing underneath the canopies, which in turn reduces the intensity of subsequent fires is another example of positive fire impacts.

Product	How are the impacts from fire (positive or negative) estimated?
Extension Fire Program Relative Risk Assessment	Response functions for each value are based on different fire intensities. Fire response functions were adopted from the 2018 PNW QWRA, with refinements and additions made to reflect the specific conditions of the FSA and expected outcomes. Fire can have positive or negative impacts depending on intensity and value considered.
BLM – Wildfire Risk Assessment	The methodology identifies where areas are experiencing fire departure from historical fire trends, where other factors such as invasives are promoting uncharacteristic fire, and where communities may be at risk from fire, i.e., where fires are likely to have a negative impact. The methodology does not exclude positive fire effects but areas that receive a lower fire risk probability are likely not departed and don't have the factors that result in a higher fire risk probability. It does not directly include fire intensity in the calculation of risk.
WADNR QWRA	Response functions for each value are based on different fire intensities. For each value considered in the risk assessment, response functions assign a percentage value loss or gain for varying levels of fire intensity. Fire can have either positive or negative impacts, depending on its intensity and the value considered. Fire response functions were adopted from the 2018 and 2023 PNW QWRA and customized for the specific purpose of this risk assessment.
West Wide Wildfire Risk Assessment	Response functions for each value are based on different fire intensities. For each value considered in the risk assessment, response functions assign a percentage value loss or gain for varying levels of fire intensity. Response functions are never positive, i.e., no beneficial effects of fire are considered. Each state created fire response functions for each of the five values at risk and averaged them to make five west-wide response functions.
NPS – Wildfire Risk Assessment	This product does not relate fire intensity to impacts.
National Risk Index	Fire impacts are based on previous losses to fire, calculated in dollar amounts. Impacts from fire are always negative for the values considered.
2018 PNW QWRA	Response functions for each value are based on different fire intensities. For each value considered in the risk assessment, response functions assign a percentage value loss or gain for varying levels of fire intensity. Fire can have positive or negative impacts depending on fire intensity and the value considered. Response functions are based on expertise from Regional Resource Specialists, the Fuels Program Staff, along with Nature Conservancy, BLM, and WADNR representatives.
2023 PNW QWRA	Response functions for each value are based on different fire intensities. For each value considered in the risk assessment response functions assign a percentage value loss or gain for varying levels of fire intensity. Fire can have positive or negative impacts depending on fire intensity and the value considered. Relevant subject matter experts from around the PNW, including wildfire professionals, assigned response functions to each value. For values carried over from PNW QWRA 2018, the pre-existing response functions serve as a starting point, but in some cases were changed in the 2023 QWRA based on new science or knowledge. In the case of values new to the PNW QWRA 2023, working groups or subject matter experts developed draft response functions, which were then reviewed and adjusted when necessary.
Wildfire Risk to Communities 2.0	Response functions assign a percentage value of loss or gain for varying levels of fire intensity and, in some cases, subcategories of the value at risk. This product quantifies risk, assuming a structure in each burnable pixel, and response functions are based on fire intensity for the underlying life form mapped for that pixel. Response functions were developed separately for three life forms: grass/herbaceous, shrub, and tree, and assume that fire impacts are most significant where tree fuels are present, lower for shrubs, and lowest for grass fuels across all intensity levels.
IFTDSS QWRA	Response functions for each value are based on different fire intensities. For each value considered in the risk assessment, response functions assign a percentage value loss or gain for varying levels of fire intensity. Fire can have either positive or negative impacts, depending on its intensity and the value considered. Response functions are pre-populated if users choose to use values from the national risk dataset, but users can edit these default values. Response functions must be entered if users select values from the IFTDSS reference data or use custom values.
Community-Level Wildfire Risk Rankings	Response functions for each value are based on different fire intensities. For each value considered in the risk assessment response functions assign a percentage value loss or gain for varying levels of fire intensity. Fire can have positive or negative impacts depending on fire intensity and the value considered. It uses the same response functions as the People and Property HVRA in the 2023 PNW QWRA. For this HVRA, only loss is considered, i.e., there are no positive fire effects.
OR Statewide Wildfire Hazard Map	This product utilizes fire intensity modifiers to represent how intensity (represented by different flame lengths) across various fuel types (forest, shrubland, and grassland) impacts the level of potential damage and opportunities to mitigate hazards effectively. Forests, followed by shrublands and grasslands, have the most significant potential for damage and thus present higher modifiers. The impacts of fire on structures and other human developments are always negative, i.e., damage is always expected, starting at less than 2 ft flame length and increasing to greater than 12 ft flame lengths.

Table 15. How are different values weighted?

When the risk assessment involves multiple values (integrated risk assessment), it may include weights to capture the relative importance of each value. When weights are used, this requires a decision that some of the values included in the assessment matter more than others. This table describes whether and how weights were used in each risk product.

Product	How are different values weighted?
Extension Fire Program Relative Risk Assessment	Different weights are assigned to different values. Weights attributed to values are described as valuations and sometimes vulnerability. Valuations vary across fire service areas.
BLM – Wildfire Risk Assessment	This methodology does not use weights.
WADNR QWRA	This methodology does not use weights.
West Wide Wildfire Risk Assessment	Different weights are assigned to different values. There are also weights associated with the value (90%) and suppression difficulty (10%) scores of the Fire Effects index, which are used to calculate the final risk score (FRI). The weight assigned to each value compared to other values is called "valued impacted weight" and is calculated based on the relative extent of the value: • Infrastructure Assets, 46.2% • Wildland Development Areas, 44.7% • Drinking Water Importance Areas, 1% • Forest Assets, 3.6% • Riparian Assets, 4.5%
NPS – Wildfire Risk Assessment	The calculation of HIP uses different weights assigned to different facilities. Each facility has a pre-determined importance based on the Asset Priority Index (API) and Current Replacement Value (CRV). The API is based on the asset's contribution to an organization's individual strategy and value, as well as the degree to which a comparable substitute asset exists to fulfill the functional requirements or purpose of that asset. CRV is based on standardized per-unit values with a localized adjustment made for each park.
National Risk Index	The methodology does not use weights.
2018 PNW QWRA	Different weights are assigned to different values. The relative geographic extent of the HVRA in the analysis area moderates weights, and HVRAs with the highest relative importance weight (listed below in parentheses) might not ultimately have the highest overall relative importance per pixel. The weight assigned to each value compared to other values is called relative importance. Relative importance allocations for HVRAs are as follows: • People and Property (33%) • Infrastructure (18%) • Watersheds (18%) • Timber (12%) • Terrestrial and Aquatic Wildlife Habitat (10%) • Vegetation condition (9%)
2023 PNW QWRA	Different weights are assigned to different values. The weight assigned to each value compared to other values is referred to as its relative importance. The relative importance of HVRAs was determined during a workshop attended by the leadership of WADNR, ODF, USFS, and BLM. The relative geographic extent of the HVRA in the analysis area moderates weights, and HVRAs with the highest relative importance weight (listed below in parentheses) might not ultimately have the highest overall relative importance per pixel. Relative importance allocations for HVRAs are as follows: • People and Property (35%) • Drinking Water (18%) • Infrastructure (16%) • Timber (12%) • Ecological Integrity (11%) • Wildlife Habitat (7%) • Agriculture (1%) • Recreation (0.4%)
Wildfire Risk to Communities 2.0	The methodology does not use weights.

Product	How are different values weighted?
IFTDSS QWRA	User-defined. The weight assigned to each value compared to other values is referred to as relative importance. Users set relative importance for different values (both primary and sub-HVRA categories) included in the risk assessment. The relative importance of each value is moderated by the extent to which that value is present in the analysis area. Values with the highest relative importance may not have the highest overall relative importance.
Community-Level Wildfire Risk Rankings	Different weights to different categories of the People and Property HVRA. Categories are based on structure density thresholds and referred to as the People and Property sub-HVRAs. The weight assigned to each sub-HVRA is called relative importance and assigned as follows: • Very low density (less than 1%) • Low density (1%) • Moderately low density (35) • Moderate density (7%) • Moderate high density (14%) • High density (47%) • Very high density (28%) These weights are used in two frameworks: Framework #1 (conventional) assigns weights according to building density classes as described above. Framework #2 assigns weights based on building density classes and social vulnerability classes based on the Social Vulnerability Index (SVI) split into four classes (low vulnerability, moderate vulnerability, high vulnerability, and very high vulnerability). Each framework produces one ranking of communities at risk.
OR Statewide Wildfire Hazard Map	The methodology does not use weights.

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Appendix 1: Glossary

All lands
A land management approach incorporating multiple ownership types (e.g., federal, state, industrial, small private lands) in restoration and enhancement projects to improve resilience to wildfire at the landscape scale.

Behave/BehavePlus
Behave and BehavePlus are Windows-based computer programs that model fire behavior at the stand level.

Burn probability
The likelihood that a wildfire will burn in an area during a specified period. Burn probability is typically reported as a percentage. It describes the likelihood that an area will burn in a calendar year.

Calibration
The process that is used to check specific outputs of fire models for accuracy. This is typically done by comparing model results against available observed wildfire data.

Conditional flame length
Describes the mean flame length projected by a model for a given area under a range of weather conditions. Flame length is used as an indicator of wildfire intensity.

Confidence interval
A statistical term used to describe a range of values that contains the true population value for a variable of interest. This measure provides a measure of "confidence" that a scenario will occur based on statistical analysis. For instance, a risk tool may state that an area is likely to burn based on a 95% confidence interval. This means there is a 5% chance that the tool is incorrect, and the area will not burn in that scenario.

Crown fire
Crown fires are fires that burn fuels in the forest canopy, including tall shrubs and any fuels that lie well above the surface. Crown fires are typically started by surface fires that escape to the canopy through fuel ladders.

Deterministic scenarios
Deterministic modeling utilizes fixed inputs and assumptions, providing only one possible outcome.

Disturbance
Events or conditions that impact the structure and function of an ecosystem. In forests, common examples of disturbance include wildfire, logging, insects and disease, and severe weather.

Ember cast
The phenomenon in which burning embers are carried significant distances by wind during a wildfire, which can ignite new "spot fires" and cause wildfire complexes that are extremely difficult to contain.

Ensemble
A method of assessment that combines the outputs of multiple models and increase the accuracy of the assessment.

Fireshed
A term used by the U.S. Forest Service to delineate where fires ignite and are likely to, or not to, spread to communities and expose buildings. Fireshed maps are used to show the source of exposure to fire.

Fire Family Plus
An application that is a primary tool in the fire behavior/fire danger suite of programs which share data and models that are used in a variety of environments to address a range of business needs. FFP supports the spectrum of fire weather/fire danger/fire climate/fire occurrence analysis tools required by fire managers to successfully use the National Fire Danger Rating System (NFDRS).

Fire intensity
The amount of energy or heat given off by a forest fire at a specific time. Fire intensity is influenced by multiple factors, including weather conditions, fuel type, fuel moisture, and topography.

Fire occurrence
How often fires happen in a specific area over a certain period of time.

Fire Service Area
A geographic area supported by a fire service provider, also called a fire district. A fire service area is often comprised of multiple rural communities and unincorporated areas.

FlamMap
FlamMap is a fire analysis desktop application that can simulate potential fire behavior characteristics (spread rate, flame length, fireline intensity, etc.), fire growth and spread and conditional burn probabilities under constant environmental conditions (weather and fuel moisture).

FSim
A high-resolution wildfire simulation model, developed by the Rocky Mountain Research Station, that is used to simulate fire behavior and spread. FSim simulates a typical fire season thousands of times to generate a "library" of plausible fires that could occur on the landscape under varying weather conditions.

Fuel moisture
A measure of the amount of water in vegetation. It is typically referred to as a percentage, with 0% moisture being completely dry fuels. Fuel moisture directly contributes to wildfire intensity and spread.

Fuelscape
A geospatial representation of understory fuels, canopy fuels, slope, aspect, and elevation for a given area and is created using a combination of modeling, remote sensing data, and field data.

Gridded data
A type of spatial data structure used to represent geographic data. It consists of a grid of cells (also called pixels), where each cell contains a value representing information, such as temperature, canopy cover, elevation, land cover type, or fire intensity, at a specific location.

Monte Carlo simulation
A mathematical technique that uses repeated random sampling to estimate the possible outcomes of an uncertain event.

Pacific Northwest
Region encompassing Oregon and Washington state on the west coast of the United States of America.

Probabilistic simulation
Probabilistic simulation is the process of explicitly representing this uncertainty by specifying one or more inputs as a probability distribution and specifying any random events that could affect the system.

Pyrome
A geographic area that exhibits similar fire ecology, including fire frequency, intensity, size, and season lengths.

Raster
A data structure consisting of a matrix of equally sized cells, or pixels, arranged in rows and columns, and composed of single or multiple bands. In wildfire risk assessments, raster data is typically used to display a geographic area in which individual pixels are assigned a risk value.

Relative humidity
A meteorological term used to describe the amount of water vapor present in the air, which is expressed as a percentage of the amount needed to reach saturation at a particular temperature. Relative humidity can have significant impacts on fuel moisture and fire behavior.

Resampling
A statistical method in which additional samples or observations are taken within an already sampled population to better understand the variation within the population and develop more accurate estimates.

Response function
In the context of risk assessment, the response functions describe relationship between fire intensity and fire impacts to a specific value. Response functions translate how fire intensity (represented by flame length) changes the value of the resources and assets included in a risk assessment.

SHELDUS data
SHELDUS™ is a county-level hazard data set for the U.S. and covers natural hazards such thunderstorms, hurricanes, floods, wildfires, and tornados as well as perils such as flash floods, heavy rainfall, etc. The database contains information on the date of an event, affected location (county and state) and the direct losses caused by the event (property and crop losses, injuries, and fatalities) from 1960 to present.

Social vulnerability
Refers to how likely people are to be harmed by wildfires due to social factors like income, age, health, housing, and access to resources. This indicates what populations may face the most challenges in preparing for, experiencing, and/or recovering from wildfire.

Spatial resolution
Refers to the level of detail an image or geographic dataset can present. In the context of wildfire risk assessments, spatial resolution typically refers to the size of the area covered by a pixel in a raster dataset. Higher resolution datasets will have more pixels that cover a smaller area, while low resolution datasets will have fewer pixels covering a broader area.

Suppression difficulty
Describes the anticipated challenges in controlling a wildfire based on topography, fuel type, weather conditions, and other variables. Suppression difficulty is used to help plan and prioritize resources.

Surface fire
A fire that consumes surface fuels such as needles, moss, lichens, herbaceous vegetation, and small trees or shrubs. A surface fuel may scorch or occasionally escape into the canopy but primarily takes place on the forest floor.

Vulnerability
How much a value exposed to wildfire would experience potential impacts.

WildEST
The Wildfire Exposure Simulation Tool is a cloud-based software system that uses a command-line application of the FlamMap fire behavior modeling system to produce continuously variable landscape-scale spatial data representing fire weather, flame-front, and ember characteristics as well as integrated measures of risk to buildings, wildfire hazard, and suppression difficulty.

Wind Ninja
A computer program that computes spatially varying wind fields for wildland fire application.

Appendix 2: Summary of methods associated with each risk assessment

Product	
Oregon State University **Extension Fire Program Relative Risk Assessment**	***Note***: The state-wide risk assessment map was produced in response to a need for localized and customized wildfire risk assessments using a tool developed for local landscapes and partnerships. The tool, essential for fully realizing the potential of the risk assessment, enables localized users (preferably County-sized or smaller landscapes) to modify individual values at risk and fire behavior characteristics to produce overall-risk maps that can replace the broader-scale maps of risk initially produced. It is designed to use the foundation of the risk models and generated local inputs to customize overall values at risk based on local knowledge of fuels (vegetation), weather, topography, and adding and/or removing values at risk HVRAs of interest (or not) to local partners. The statewide Wildfire Risk Assessment for Oregon was intended to be integrated from the local to the state levels, replacing the original statewide (by region) assessment. Its primary purpose was to determine where to focus landscape-scale efforts for rapid resource assessments and prioritization of project implementation, mainly for private lands. The risk assessment starts with the creation of FSA which are meant to serve as fire modeling units and the boundaries of areas of service and responsibility for each Extension Fire Program Regional fire specialist. These were calculated through a similar clustering method using climate, topography, land cover and historic fire severity. The FSAs that resulted from this process were adjusted to existing geopolitical boundaries. Fire modeling is done on sub-domains within each FSA. Sub-domains are areas of influence of each RAWS. Subdomains are mapped using 163 RAWS as a starting point and using the same variables used to model FSAs. The process starts with a 2km circular area around each RAWS, for which each variable's average and standard deviation are calculated. This is repeated in an iterative process by which the radius is increased only if the inclusion of the additional area meets specific statistical criteria. This clustering process, combined with additional post-processing, results in 50 polygons of various shapes (hereafter subdomains). Weather inputs were based on RAWS data using the worst-case scenario: a five-day period in the RAWS record with the hottest and driest record, which became input to calculate fuel moisture using Fire Family Plus. This same period was used to calculate maximum wind speed and mode of wind direction. Fire modeling for the hazard component was conducted with the IFTDSS implementation of FlamMap for each subdomain. Areas mapped by LANDFIRE as unburnable but containing structures close to vegetation were considered fire-prone and assigned a non-zero burn probability and flame length probability in post-processing. This was done using a moving window filler that assigns values from neighboring cells. Methods accounted for three additional hazards that can increase final risk calculations. These were 1) long-term climate drought conditions; 2) insects or diseases affecting vegetation; and 3) the abundance of European gorse, an invasive and highly flammable species. The three hazards are added as risk factors that combine to create an Integrated Additional Risk Factor (IARF) that can increase final risk by up to 50%. This was done through multipliers where future drought contributed 1 to 1.25, presence of insects/disease and/or gorse contributed a maximum of 0.25. Relative Risk is the product between flame length probability, response function and valuation. This is done for each HVRA and then summed across all HVRAs occurring in one pixel. Once relative risk is multiplied by Burn Probability and IARF, the Overall Relative Risk is calculated. This is turned into 5 risk ratings based on quantiles for each FSA: Lowest, lower, medium, high and highest. Unburnable and not burned areas are also displayed.
Bureau of Land Management **Wildfire Risk Assessment**	This assessment uses fire resiliency, communities, and fire probability to determine fire risk probability and the need of management actions to increase fire resiliency. Starts with combining relevant datasets used to calculate fire probability – Residentially Developed Populated Areas (RDPA), altered fire regimes, invasives, juniper and pinon expansion, human-caused fires, BLM structures, and public infrastructure datasets. The second step uses a Bayesian belief algorithm to geospatially combine the probability of fire with BLM's values to determine where fuel management is likely needed to address fire risk. The Bayesian algorithm quantifies the conditional wildfire risk probability based on current knowledge of large fire probability and new information (consequences of wildfire to BLM values). Wildfire risk conditional probabilities are used to provide "certainty" about where fuel management opportunities may be best located or not a high priority nationally. Specifically, large fire burn probability serves as the input for current knowledge of wildfire risk and the average of the other input datasets (RDPA, altered fire regimes, invasives, juniper and pinon expansion, human-caused fires, BLM structures, and public infrastructure datasets) serve as new information where consequences may exist if exposed to wildfire. To create a categorization, the wildfire risk probabilities are rescaled by using a GIS-based logarithmic process to create a normal distribution of values that range from 1.0 to 10.0, where 10 represents the maximum wildfire risk probability value. Since the mean wildfire risk probability is relatively low across the United States for BLM lands, this log rescaling was the best method compared to other rescaling algorithms. The assessment includes sensitivity analyses to test the influence of each BLM value on the results. Based on this sensitivity analysis, some values are retained while others are dropped. Risk ratings are presented in 10 categories: • Category 0 = Represents non-burnable. • Category 2–4 = Lowest priority for fuels management given that there is higher certainty that conditional fire risk probabilities are low • Category 5 = Lower priority for fuels management given that mid probabilities offer less certainty about the conditional risk to fire but indicate where opportunities may exist to address fuels before uncharacteristic fire becomes an issue (e.g. such as invasives before the fire regime is disrupted) • Category 6 = Moderate priority for fuels management given that conditional fire risk probabilities indicate more certainty that risk to wildfire exist • Category 7–10 = High priority for fuels management due to higher certainty based on high conditional wildfire risk probabilities.

Product	
Washington Department of Natural Resources **20-Year Forest Health Strategic Plan for Eastern WA**	Uses the burn and flame length probability hazard products from the 2018 or 2023 PNW QWRA, depending on the year the landscape evaluation is being conducted. Mapping of HVRAs is the same as in the PNW QWRA for infrastructure but otherwise customized for all other HVRAs to use WADNRs data. Response functions are adapted from the PNW QWRA 2018/2023 with adjustments to reflect differences between HVRAs in the two methodologies. The WADNR framework assigns the same relative importance to all HVRAs and calculates eNVC and cNVC using the same methods as the PNW QWRA. Risk products are calculated for specific watersheds highlighted as priorities in the 20-Year Forest Health Strategic Plan for Eastern WA and integrated into that watershed's landscape evaluation. This includes a wildfire risk map which combines three of five HVRAs, without assigning relative importance: WUI, infrastructures and forest ecosystems. This risk map has six risk ratings: extreme, very high, high, moderate, low, and beneficial. Natural breaks on risk values calculated for landscape evaluations conducted in 2020 were used to determine the thresholds for the six risk categories, with some rounding. The landscape evaluation includes additional risk assessments: risk to drinking water and commercially managed lands which are used in the intermediate landscape evaluation analyses and not presented as standalone risk maps.
Oregon Department of Forestry **West Wide Wildfire Risk Assessment**	Wildfire risk is quantified through a Fire Risk Index (FRI), which is the product of the Fire Threat Index (FTI), Fire Effects Index (FEI), and a constant. FTI has three primary components: fire occurrence, fire behavior and suppression effectiveness. Fire occurrence identifies areas of uniform probability of an acre burning. These are called Fire Occurrence Areas (FOAS) but differ greatly from the FOAS in the PNW QWRA. In this product, FOAs are based on records of historical fire occurrences used to create a mean ignition rate geospatial layer. In this layer units are measured in the number of fires per 1000 acres per year. The fire behavior component of FTI uses the Rothermel fire behavior system to predict fire behavior for surface and canopy fire types. The weather used in the fire behavior calculation is variable and based on WIZ, representing areas of relatively homogeneous weather or climatology. For each WIZ, a RAWS was selected as the most representative of weather, and the SC of the National Fire Danger Rating System was calculated in FireFamily Plus. Weather conditions for four percentiles of SC were computed: low (0-15%), moderate (16-90%), high (91-97%) and extreme (98-100%). Values for dead fuels, live herbaceous, live woody and 20-foot wind speed were calculated as the average of days when the SC was equal to the median of each percentile scenario. Spread Component was also calculated for historical fires based on the fire's start date. Each historic fire was assigned to a percentile weather category that allowed for the estimation of the proportion of historic fires by percentile weather category. Fire behavior – the rate of spread, flame length and fire type – is calculated using a custom-built implementation of the Rothermel model for all percentile weather categories by FOA and combined into a weighted average using the proportion of historic fires per percentile weather category. The suppression effectiveness component of FTI is used to estimate fire size. This is done through relationships between fire spread rates and expected final fire size. For each WIZ fire occurrence, reports were used to gather information on the final fire size, and the average rate of spread for each fire size was estimated using a double ellipsis model. This resulted in a modeled relationship between the rate of spread and final fire size for each WIZ. Once all the components are estimated, FTI is calculated for each percentile weather category. It combines the inputs described above and the size of the FOA to calculate an FTI per scenario. FTI is the probability of an acre burning under a given scenario. The four FTIs (one per percentile weather category) are summed up to obtain the FTI for each 30-m cell. The final step is spatial smoothing that averages FTI using a moving window of eight 30-m cells. This is intended to include the flammability of adjacent cells in the FTI of any given cell. The smoothed FTI is assigned to each burnable cell in the project area. The FEI is the second component required to calculate FRI. The purpose of FEI is to identify areas that have significant values that can be affected by fire (VIR, Values Impacted Rating) and areas that are difficult or costly to suppress (SDR, Suppression Difficulty Rating). The first step to calculating VIR was defining response functions. Response function scores varied from 0 to -9, and only negative response functions were considered. Six flame length classes were considered to describe both fire intensity and the impacts of fire. Each western state produced response functions for each of the five HVRAs, and then the individual state response functions were averaged into a single dataset of response functions, creating a west-wide average. The effects analysis is done for each 30-me cell for each weather scenario and summed across scenarios. For each scenario, modeled flame length for each scenario is used to identify the corresponding response function score. The score is then multiplied by the FTI for the corresponding scenario, thus incorporating the likelihood of the fire effect occurring at a given percentile weather category. Along with response functions, each state also provided a measure of the relative importance of each value impacted in relation to other values impacted. The final weight scheme was calculated for the western US based on the valuations provided by the states and the extent of each value across the west of the US. With the weights available, the VIR is calculated as the weighted version of FTI. The last component needed for the calculation of FEI is the difficulty and potential cost for a wildfire to be suppressed – SDR. This rating results from fire line production rates as a function of surface fuels published in the NWCG Fireline Handbook combined with slope classes, resulting in a range from quickest fire line production (-1) to slowest fire line production (-9). The final FEI is a weighted calculation of VIR and SDR, with states providing input to weights: VIR was assigned a 90% weight and SDR a 10%. FRI is calculated from the FTI and FEI described above as a product of both multiplied by 10,000. Fire risk index has nine classes (FRI 1 - FRI 9).

Product	
National Park Service **Wildfire Risk Assessment**	The Wildfire Risk Assessment is a set of criteria describing the surrounding environment, access, structure materials and design and protection characteristics of each structure. The criteria included in the Wildfire Risk Assessment form are based on Firewise® Assessment Forms. Each criterion has a score, and the final hazard score for a given facility is calculated as the sum of all scores divided by 131. The overall assessment includes a companion metric, HIP, which developed to help prioritize NPS facilities for hazardous fuels treatments. The HIP score is calculated as the sum of scores from the NPS Wildfire Risk Assessment divided by 131. The importance of the score reflects the facility's monetary value, cost of recovery and importance to the NPS mission. Importance is defined for each facility and a function of its API and CRV. Every asset at a park has an API rating and a CRV. API is based on the asset's contribution to an organization's individual strategy and value and the degree to which a comparable substitute asset exists to fulfill the functional requirements or purpose of that asset. CRV is based on standardized per unit values with a localized adjustment made for each park. The burn probability captures the likelihood of fire impacting the facility. This is calculated using burn probability geospatial data from the Wildfire Risk to Communities product available online. Three ratings for HIP: low, moderate and high. Also mapped three additional categories: not surveyed, not found, and no wildfire risk.
Federal Emergency Management Agency **National Risk Index + Future Risk Index – Wildfire**	This assessment starts calculates Expected Annual Loss for each value, referred to in this framework as a "consequence". The framework includes three consequences: people, buildings and agriculture. Expected annual loss is the product of exposure to wildfire, annualized fire frequency and historic loss rate of value to fire. All components are calculated at the census block level and then aggregated to tract and county. Exposure is calculated by a spatial intersection between the developed/agricultural area in each census block and the places where burn probability>0 and probability of flame length greater than 8 feet is greater than zero. Raster maps of developed areas are used as the basis to identify the location of the people and building consequences. These are the areas with potential exposure to fire. Annualized frequency of fire is an area-weighted value of burn probability based on exposure. Historic loss ratio which is based on historical loss values (dollar amounts) from fire to property damage, injuries, fatalities and crop damage from the SHELDUS database. This database reports wildfire losses (in dollars) for fires occurring between 1996 and 2019. The SHELDUS data goes through several analytical pre-processing to result in a Loss Ratio Per Basis (LRB) for each county - the ratio of loss to exposure to wildfire for each consequence (building, population and agriculture). LRB is then used to calculate the Historic Loss Ratio for a given consequence and county. This is done using the county's LRB and the exposure to fire in that county. Exposure (area susceptible to fire) for the purpose of calculating Historic Loss Ratio is done differently than exposure calculations described above: only cells where probability of flame greater than 12 feet is greater than zero. Community Risk Factor is a scaling factor unique to each community and based on its social vulnerability and Community Resilience values. Expected Annual Loss at the census tract and county scales are multiplied by the Community Risk Factor to produce the Wildfire Risk Index Score. These scores are turned into ratings using k-means clustering. Risk ratings are provided in five qualitative categories describing the community's risk value to all other communities at the same level. Very low, relatively low, relatively moderate, relatively high and very high. Future Risk, which uses the values, scores, and ratings of the National Risk Index as the present-day baseline for natural hazard risk, applies a hazard multiplier within the context of the four potential future climate scenarios. The hazard multiplier is calculated for each county based on changes to the historical (1976-2005) Fire Weather Index relative to a future Fire Weather Index under each scenario, with parameters that reflect fuel distribution. Future risk calculations do not account for adaptation measures; they only consider climatological shifts and, more importantly, assume that wildfire risk due to climatological shifts can only increase from the observed historical baseline.

Product	
United States Forest Service **2018 Pacific Northwest Quantitative Wildfire Risk Assessment**	Hazard is quantified by two measures: the likelihood of any location burning (burn probability on that location), and fire intensity (flame length). FSim is used to model and map burn probability and flame length across the landscape. FSim models fire occurrence based on historical daily fire weather distributions and spatial patterns of historical fire occurrence; grows each ignition using locally relevant fuel, weather, and topography; and includes a fire suppression model. The model is calibrated for each FOA, and the results are spatial raster data of burn probability and flame length probabilities classified into six classes of flame length. Vulnerability is calculated for each HVRA and comprises exposure and susceptibility. Exposure measures the HVRA's occurrence in a hazardous environment i.e., where fire can happen. Exposure is calculated as the spatial overlap between the HVRA and burn probability. Susceptibility measures how a given HVRA will be impacted by fire of different intensities. Susceptibility is quantified through a tabular response function for each HVRA occurring in the analysis area. A response function is a tabulation of the relative change in the value of an HVRA if it were to burn in each of six flame-length classes. A positive value in a response function indicates a benefit or increase in value; a negative value indicates a loss or decrease in value. Response function values ranged from -100 (greatest possible loss of resource value) to +100 (greatest possible increase in value). Response functions are constructed based on input from resource specialists. The final component is the assignment of relative importance weights to each HVRA to account for differences in importance and are moderated by the extent of each HVRA in the final products. Wildfire risk value is calculated as the expected Net Value Change, also known as eNVC. This is calculated by first calculating cNVC for each pixel through the sum-product of flame length probability and response function value over all the six flame length classes, with a weighting factor adjustment for the relative importance per unit area of each HVRA. Finally, eNVC for each pixel is calculated as the product of cNVC and annual burn probability. The 2018 version of the QWRA did not present qualitative risk ratings. NVC (conditional and expected) was represented in nine classes ranging from negative to positive. No details were given on how thresholds for class bins were created.
United States Forest Service **2023 Pacific Northwest Quantitative Wildfire Risk Assessment**	Hazard is quantified by two measures: the likelihood of any location burning, which is quantified as burn probability on that location, and fire intensity, measured as flame length. This product uses FSim to model and map burn probability. FSim models fire occurrence based on historical daily fire weather distributions and spatial patterns of historical fire occurrence grows each ignition using locally relevant fuel, weather, and topography and includes a fire suppression model. The model is calibrated for each FOA, and the results are rasters of burn probability. Fire intensity is calculated with WildEST instead of the FSim intensity like in the previous version. WildEST to model intensity allows for modeling at 30 m as well as the use of additional models to adjust wind speed and direction to topography and conditioning of dead fuel moisture. Fire intensity through flame length is modeled with Flammap using 216 weather types, corresponding to combinations of wind direction, wind speed and fuel moisture. Each weather type has an associated weight based on its relative frequency, used to weight results from each Flammap run. While Flammap in the WildEST format only calculates intensity in the heading direction, spread in the non-heading direction is accounted for in the final flame length probabilities. Vulnerability is calculated for each HVRA and comprises exposure and susceptibility. Exposure measures the HVRA's occurrence in a hazardous environment, i.e., where fire can happen. Exposure is calculated as the spatial overlap between the HVRA and burn probability. Susceptibility measures how a given HVRA will be impacted by fire of different intensities. Susceptibility is quantified through a tabular response function for each HVRA occurring in the analysis area. A response function is a tabulation of the relative change in the value of an HVRA if it were to burn in each of six flame-length classes. A positive value in a response function indicates a benefit or increase in value; a negative value indicates a loss or decrease in value. Response function values ranged from -100 (greatest possible loss of resource value) to +100 (greatest possible increase in value). Response functions are constructed based on input from resource specialists. The final component in this risk assessment framework is the assignment of weights or importance to the various HVRAs considered. Relative importance weights are assigned to each HVRA to account for differences in importance and are moderated by the extent of each HVRA in the final products. Wildfire risk value is calculated as eNVC. This is calculated by first calculating cNVC for each pixel through the sum-product of flame-length probability and response function value over all the six flame-length classes, with a weighting factor adjustment for the relative importance per unit area of each HVRA. Finally, eNVC for each pixel is calculated as the product of cNVC and annual burn probability. Nine risk ratings based on percentiles of eNVC: Very high loss, high loss, moderate loss, low loss, neutral, low benefit, moderate benefit, high benefit, and very high benefit. Classification schemes were calculated using the 5th, 40th, 70th and 90th percentile values of negative risk to establish loss (negative risk) ratings and then the percentiles were mirrored to create class breakpoints for the benefit (positive) risk ratings.

Product	
United States Forest Service **Wildfire Risk to Homes from Wildfire Risk to Communities 2.0**	Hazard is quantified by two measures: the likelihood of any location burning, which is quantified as burn probability on that location, and fire intensity, measured as flame length. The likelihood of fire is obtained through modeling burn probability with FSim which simulates at least 20,000 fire seasons on a fuelscape representative of 2020 in each of the 136 pyromes. In each pyrome, the number of fires and fire size distributions are calibrated to match the observed fire record used for reference. Fire intensity is calculated with WildEST instead of the FSim intensity. Fire intensity calculations with WildEST use a different fuelscape than the one used for burn probability. Fire intensity uses the 2023 RMA fuelscape – which uses the same base data as the fuelscape used for burn probability calculations but updates canopy fuels and surface fuels to reflect disturbances that occurred in 2021 and 2022. Using WildEST to model intensity allows for modeling at 30 m as well as the use of additional models to adjust wind speed and direction to topography and conditioning of dead fuel moisture. Fire intensity through flame length is modeled with Flammap using 216 weather types, corresponding to combinations of wind direction, wind speed and fuel moisture. Each weather type has an associated weight based on its relative frequency, used to weight results from each Flammap run. While Flammap in the WildEST format only calculates intensity in the heading direction, spread in the non-heading direction is accounted for in the final flame length probabilities. Once the burn probability raster and the six flame length probability rasters are created, a series of post-processing steps ensue to account for how wildfire penetrates into developed (urban) environments. These environments are typically mapped as non-burnable and not accounted for in wildland fire spread models, but wildfires have been known to ignite urban conflagrations. This process is as follows: burn probability is resampled from the modeled 270 m to 30 m and "oozed" into developed areas adjacent to large contiguous areas of wildland fuels. The oozing process excludes small (500ha) areas of vegetated patches surrounded by developed to ensure that small urban parks and other small remnants of vegetation surrounded by unburnable do not contribute to the oozing. Oozing of burn probability values to adjacent developed areas is done through three successful 510-m moving window averages, which allows BP to spread into 1530 m (approximately a mile) into developed non-burnable fuels. Flame length probabilities are not oozed into developed areas. In this framework, response functions are based on life form: grass, shrub and tree, assuming that loss is greatest in tree fuels. Response functions vary between 0 (no loss) and -100 (complete loss), although the minimum amount of loss was -10 when fuels are grass and under flame lengths <2 feet. The flame length probabilities and response functions are used to calculate conditional Risk to Potential Structures (cRPS) to represent the potential consequence of fire to a home or structure at a given location if a fire were to occur and if a home were located there. cRPS is analogous to cNVC in other risk frameworks and referred to as Wildfire Consequence in the web application. The values of cRPS are also oozed into developed areas adjacent to wildland fuels, using the method above but without allowing for decay in the values of cRPS with distance. The oozed burn probability and the oozed cRPS are multiplied to calculate Risk to Potential Structures, which is analogous to eNVC in other risk assessments. Risk to Potential Structures is aggregated into four ratings based on percentiles calculated on the national dataset of risk: low (<40th percentile), medium (40th<=percentile<70th), high (70th<=percentile<90th) and very high (percentile>=90th)
United States Department of Interior & United States Forest Service **Interagency Fuel Treatment Decision Support System QWRA**	In IFTDSS users can access the modules required to conduct a quantitative risk assessment in the Strategic Planning phase of the planning cycle. IFTDSS guides users through all the steps with prompts for various parameters and users can select from available options. Risk can be calculated for any area of interest in the US up to a maximum size of 12 million acres if created with IFTDSS. Up to 600mb file size and less than 60,000,000 pixels if input landscape is created outside of IFTDSS and imported into the application. The different components needed are spread across different modules: Model Burn Probability module: users run the Landscape Burn Probability model to create the hazard layers (burn probability and flame length probabilities) for risk assessment. Map Values module: users select and map the HVRAs using their own custom mapping or relying on existing datasets on reference layers or from national HVRA data. Exposure Analysis module: users will assess the exposure of different HVRAs to fire – both in terms of likelihood and intensity. Exposure analysis might need all the information the analyst needs depending on the application. Risk Assessment module: where all of the abovementioned outputs are combined with response functions and relative importance to produce eNVC and cNVC outputs, maps and reports. Eleven ratings based on orders of magnitude for eNVC: Highest threat (<-1), higher threat (-1 to -0.1), middle threat (-0.1 to -0.01), lower threat (-0.01 to -0.001), lowest threat (-0.001 to <0), no benefit/threat and lowest benefit (>0 to 0.001), lower benefit (0.001 to 0.01), middle benefit (0.01 to 0.1), higher benefit (0.1 to 1) and highest benefit (>1)

Product	
Oregon State University **Community-Level Wildfire Risk Rankings for Oregon and Washington**	This product uses the 2023 PNW QWRA data to represent wildfire hazard (burn probability and flame length probabilities) and risk to People and Property. It combines it with Social Vulnerability calculated at the Census block groups in Oregon and Washington. The Social Vulnerability Index (SVI) uses American Community Survey Data 2016 – 2020 five-year estimates to evaluate 15 variables and calculate an overall vulnerability score. The block group-level scores are a relative evaluation of vulnerability, where each block group is ranked relative to all other block groups in Oregon and Washington. SVI is split into four classes (low vulnerability, moderate vulnerability, high vulnerability and very high vulnerability). All pixels within the study area with a structure density value greater than zero (i.e., buildings) were attributed to the pixel with the underlying social vulnerability class. The authors used data developed for the People and Property HVRA, which characterizes risk to people and property based on structure locations and density. The authors used the exact mapping of the HVRA, the same set of seven sub-HVRAs based on structure density and the same response functions based on structure density. SVI was integrated into the risk calculation through the relative importance of each sub-HVRA. In other words, the relative importance assigned to each sub-HVRA was moderated based on SVI. This was done by creating 28 sub-HVRAs reflecting the unique combinations of structure density (seven classes) and social vulnerability (four classes). The same density-based relative importance values were assigned to each density class. This was adjusted so that 60% of total relative importance was assigned to very high social vulnerability sub-HVRAs, 30% to high social vulnerability sub-HVRAs, and 5% each to moderate and low social vulnerability sub-HVRAs. This maintained the same relationship among density classes, accurately representing the relative importance per pixel, but also introduced additional weight to reflect social vulnerability. After calculating eNVC at the pixel level, eNVC was summed within community zones based on census-designated places. Communities (total of 1005 across both states) were ranked based on their total eNVC, the more negative the value, the greater the risk.
Oregon State University **Statewide Wildfire Hazard Map**	Wildfire hazard is a quantitative, spatial representation of the combination of wildfire likelihood and fire intensity. Wildfire likelihood represented by burn probability was modeled using the large fire simulator FSim. The model was used to simulate a minimum of 10,000 plausible fire seasons on a landscape representing 2022 conditions. Wildfire intensity was modeled using WildEST. The tool used the same fuelscape as FSim and 216 weather scenarios based on unique combinations of wind speed, wind direction and fuel moisture based on empirical weather records collected 2007-2021 and summarized within 4km grids, to simulate wildfire intensity under each scenario. This results in grids representing the probability that flame lengths will be within a specific Fire Intensity Level (FIL) given that a fire occurs. FIL classes range from 0 to >12 ft flame lengths in 2 ft increments. Flam lengths were then transformed into fire intensity modifiers as a way of expressing intensity on a scale of 0-100 and accounting for differences in fuel types. Modifiers and flame lengths were used of calculate the probability-weighted average fire intensity modifier value. In areas of irrigated crops (irrigated in at least 1 out of 5 years), woody crops (i.e., orchards) and wetlands, burn probability results out of FSim were replaced with 0.0001 (1 in 10,000 chance) and the intensity modifier was set to 10. These correspond to lowest values of burn probability and in dry landscapes of Oregon and lowest intensity in the analysis, respectively. Burn probability and fire intensity are then combined into an initial hazard value, multiplying burn probability by the spatially coincident flame length modifier at the 30 x 30-m pixel scale. Pixel-level hazard values were averaged across tax lots. The result is a feature class of property-level tax lots with associated hazard values. The hazard scores at the tax lot level were used to classify hazard into one out of three hazard zones according to the following ranges: • High Wildfire Hazard: hazard value > 0.137872. This range of values represents approximately the 90th percentile and above tax lot-level hazard values. • Moderate Wildfire Hazard: hazard value > 0.001911 - ≤0.137872. This range of values represents approximately the 40th – 90th percentile of tax lot-level hazard values. • Low Wildfire Hazard: hazard value ≤ 0.001911. This range of values represents hazard values at the 40th percentile and below of tax lot-level hazard values The initial draft property-level wildfire hazard data was released publicly for a 30-day public comment period. Significant public comment highlighted concerns about the neighbor-to-neighbor variation in developed areas and at the margin of hazard classes. To correct for speckling, property-level hazard scores were averaged at a 300-m pixel size. This produced a smoothed hazard map, which was then averaged across tax lots to obtain a final property-level hazard map.

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