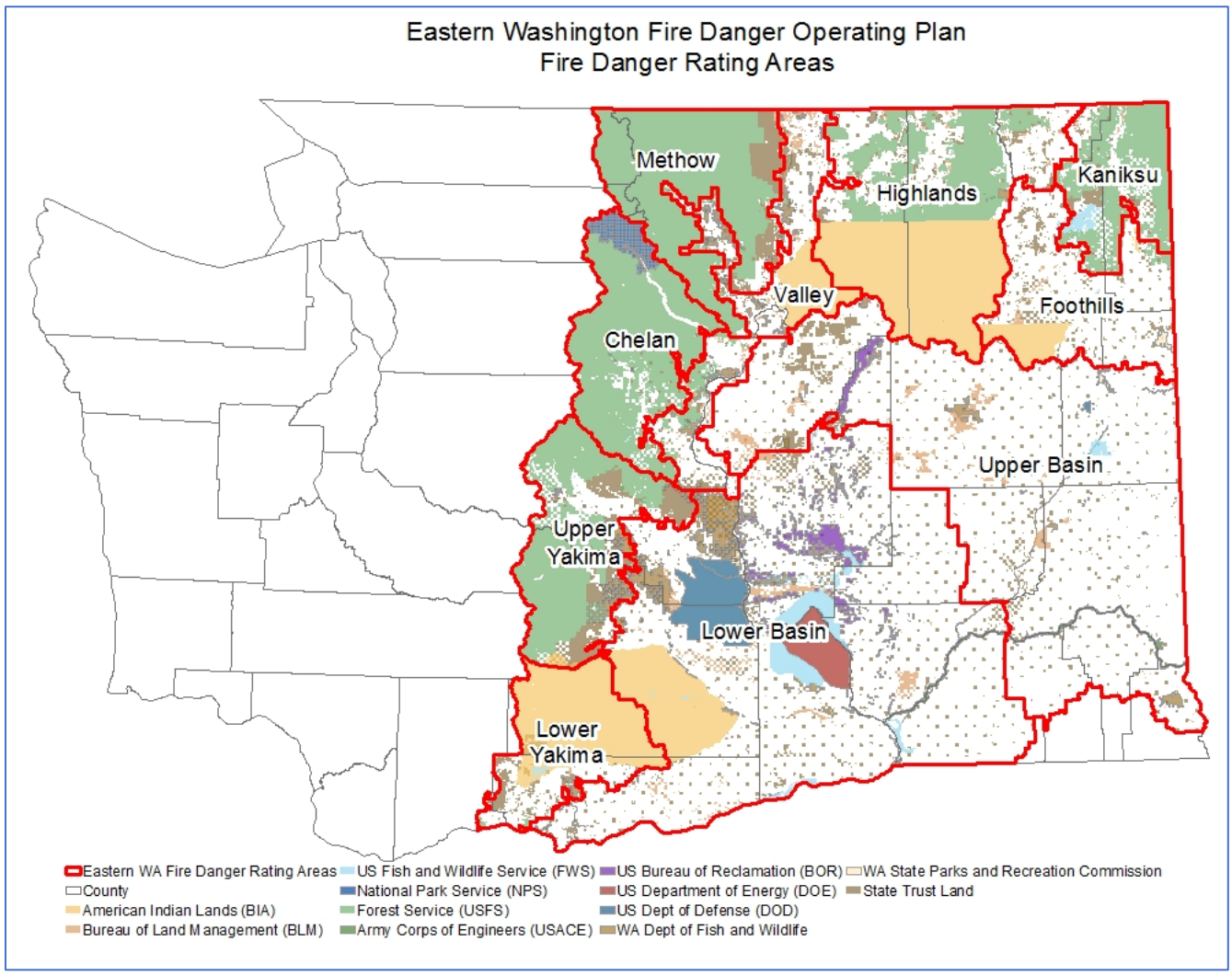
Central and Northeast Washington

Interagency Fire Danger Operating Plan



Version: 6/15/2022 (Revised 01/18/2024 to include breakpoint corrections for the Highlands FDRA as noted, no other changes were made from the previous 6/15/2022 version).

This plan is compatible with NFDR16, expires 5/1/2025.

Central and Northeast Washington

Interagency Fire Danger Operating Plan

Approved by:

Signatories to this plan include the following agencies.

- Bureau of Land Management, Spokane District
- Chelan County
- National Park Service, Lake Roosevelt National Recreation Area
- National Park Service, North Cascades National Park
- US Fish and Wildlife Service, Columbia National Wildlife Refuge Complex
- US Fish and Wildlife Service, Inland Northwest National Wildlife Refuge Complex
- US Forest Service, Colville National Forest
- US Forest Service, Okanogan Wenatchee National Forest
- Washington State Department of Natural Resources, Northeast Region
- Washington State Department of Natural Resources, Southeast Region

For simplicity's sake each agency will be responsible for maintaining a signed hardcopy on file.

Colville National Forest, Agency Administrator Printed Name: *Joshua White*

Signature:

JOSHUA P WHITE

Digitally signed by JOSHUA P WHITE
Date: 2024.03.07 13:26:17 -08'00'

_____

Okanogan Wenatchee National Forest, Agency Administrator Printed Name: *Cynthia Sandeno*

Signature:

CYNTHIA SANDENO

Digitally signed by CYNTHIA SANDENO
Date: 2024.03.25 14:26:53 -07'00'

_____

Contents

1.0 Introduction 1
1.1 Purpose 1
1.2 Policy and Guidance 3
1.3 Operating Plan Objectives 3
2.0 Fire Danger Planning Area Inventory and Analysis 4
2.1 Administrative Units 4
2.2 Weather 4
2.3 Fire Danger Rating Areas 4
3.0 Fire Danger Problem Analysis 7
3.1 Fire Occurrence 7
3.2 Identification/Definition of the Fire Problem(s) 7
4.0 Fire Danger Threshold/Decision Analysis 11
4.1 Climatological Breakpoints 11
4.2 Weather Station Analysis 12
4.3 Fire Business Analysis 13
4.4 Parameters Used to Calculate Fire Danger 16
4.5 Decision Points 18
4.6 Fire Business Decision Summary Table 19
5.0 Fire Danger Rating Level Decisions 20
5.1 Response (or Dispatch) Level 20
5.2 Staffing Level 21
5.3 Preparedness Level 21
5.4 Adjective Fire Danger Rating Level 22
5.5 Public Use Restrictions 22
5.6 Industrial Fire Precaution Level 23
6.0 Fire Danger Operating Procedures 23
6.1 Roles and Responsibilities 23
6.2 Daily Schedule 25

6.3 Critical Fire Danger 25
6.4 Season Ending Event 25
6.5 Fire Danger Pocket Cards/Seasonal Risk Analysis 25
6.6 Weather Station Maintenance 26
Appendices 27
Appendix A: Primary Distribution List 27
Appendix B: Fire Danger Rating Areas 28
Appendix C: Fire History 30
Appendix D: Weather Stations 41
Appendix E: Fire Business Analysis 51

1.0 Introduction

1.1 Purpose

The public, industry, and our own agency personnel expect the interagency wildland fire management agencies to implement appropriate and timely decisions which ultimately result in safe, efficient, and effective wildland fire management actions.

This fire danger operating plan (FDOP) is intended to document a decision-making process for agency administrators, fire management personnel, communication center personnel, and agency co-operators by establishing interagency planning and response levels based upon an assessment of vegetation, climate, and topography utilizing the national fire danger rating system (NFDRS).

This plan provides a science-based tool for incorporating a measure of risk associated with decisions which have the potential to significantly compromise safety and control of wildland fires. This is achieved using the best available scientific methods and an analysis of historical weather and fire data.

1.1.1 Fire Danger Operating Plan

Interagency policy and guidance require numerous unit plans and guides in order to meet preparedness objectives. Some of these plans and guides are inter-related or provide the basis for others, as depicted below.

This FDOP guides the application of information from NFDRS at the local level and describes how fire danger ratings will be applied to local unit fire management decisions. The actual implementation of the fire business thresholds is described in the following supplemental action plans.

1.1.1.1 Staffing Plan

The staffing plan describes daily resource availability/capability to respond to unplanned ignitions. Mitigating actions are designed to enhance the unit's fire management capability during short periods, one burning period, Fourth of July, or other pre-identified events, where normal staffing cannot meet initial attack, prevention, or detection needs. The decision points are identified and documented in this FDOP; the associated decisions and planned actions are located with the individual agency-unit.

1.1.1.2 Preparedness Plan

Preparedness plans provide management direction given identified levels of burning conditions, fire activity, and resource commitment. Preparedness levels (1 to 5) are determined by incremental measures of fire danger, fire activity, and resource commitment. The preparedness levels are identified and documented in this FDOP; the associated decisions and planned actions are located in with the individual agency-unit.

1.1.1.3 Prevention Plan

Prevention plans document the wildland fire problems identified by a prevention analysis. Components of the plan include mitigation (actions initiated to reduce impacts of wildland fire to communities), prevention (of unwanted human-caused fires), education (facilitating and promoting awareness and understanding of wildland fire), enforcement (actions necessary to establish and carry out regulations, restrictions, and closures), and administration of the prevention program. The analysis of fire problems and associated target groups in the Central and Northeast Washington are documented in this FDOP; the associated decisions and planned actions are located in with the individual agency-unit.

1.1.1.4 Restriction Plan

A restriction plan is an interagency document that outlines interagency coordination efforts regarding fire restrictions and closures. An interagency approach for initiating restrictions or closures helps provide consistency among the land management partners, while defining the restriction boundaries so they are easily distinguishable to the public. Based on the fire danger, managers may impose fire restrictions or emergency closures to public lands. Decision points when restrictions and/or closures should be considered are identified and documented in this FDOP; the associated decisions and planned actions are located with the individual agency-unit.

1.1.2 Wildfire Response

1.1.2.1 Initial Response Plan

Initial response plans, also referred to as run cards or pre-planned response plans, specify the fire management response to an unplanned ignition within a defined geographic area based on fire danger, fire management objectives, and resource availability. Response levels are identified and documented in this FDOP. The number and type of suppression resources

dispatched to a reported fire is documented in the associated initial response plan (contained within the Local Mobilization Plan for WACWC and WANEC).

1.1.2.2 Local Mobilization Plan

The mobilization plan identifies standard procedures, which guide the operations of multi-agency logistical support activity throughout the coordination system. The mobilization plan is intended to facilitate interagency dispatch coordination, ensuring the timeliest and most cost-effective incident support services available are provided. Communication between units, GACCs, state, regional offices and other cooperative agencies are addressed. The mobilization plan is updated annually and distributed to fire managers and posted on the WACWC and WANEC websites.

1.2 Policy and Guidance

Interagency policy and guidance regarding the development of Fire Danger Operating Plans can be found in the Interagency Standards for Fire & Aviation Operations (Red Book). Agency-specific direction can be found in:

- U.S. Department of Agriculture Forest Service - Manual 5120
- U.S. Department of the Interior, Bureau of Land Management - Manual 9211-1
- U.S. Department of the Interior, National Park Service - Manual 18, Chapter 5
- Fish and Wildlife Service - Fire Management Handbook, Chapter 10
- Bureau of Indian Affairs - Wildland Fire and Aviation Program Management Operations Guide

1.3 Operating Plan Objectives

1. Provide a tool for agency administrators, fire managers, dispatchers, agency co-operators, and firefighters to correlate fire danger ratings with fire business decisions.
2. Delineate fire danger rating areas (FDRAs) with similar climate, vegetation, and topography.
3. Establish an interagency fire weather-monitoring network consisting of remote automated weather stations (RAWS) which comply with NFDRS weather station standards (PMS 426-3).
4. Determine appropriate preparedness breakpoints and thresholds using an integrated database of historical fire weather and fire occurrence data.
5. Define roles and responsibilities to make fire preparedness decisions, manage weather information, and brief fire suppression personnel regarding current and potential fire danger.
6. Determine the most effective communication methods for fire managers to communicate potential fire danger to cooperating agencies, industry, and the public.
7. Provide guidance to interagency personnel outlining specific daily actions and considerations at each preparedness level.
8. Identify seasonal risk analysis criteria and establish general fire severity thresholds.
9. Identify the development and distribution of fire danger pocket cards to all personnel involved with fire suppression within the fire danger planning area.

10. Identify program needs and suggest improvements for implementation of the Fire Danger Operating Plan.

2.0 Fire Danger Planning Area Inventory and Analysis

2.1 Administrative Units

This document supports consistent application of fire danger decisions applied across multiple jurisdictional boundaries. Wildland fire management and suppression responsibilities are shared among Federal, State, and local cooperators. Administrative units participating in this plan can be found on the signature page.

2.2 Weather

All RAWS used in this plan to produce NFDR outputs comply with the National Wildfire Coordinating Group (NWCG) weather station standards and guidelines (PMS 426-3). Each RAWS receives, at a minimum, one annual on-site maintenance visit by either the local user or contracted personnel to ensure sensors are within calibration standards and to verify site and station conditions. Summary data table and hourly missing data analysis are contained in the Appendix D.

2.2.1 Weather Data

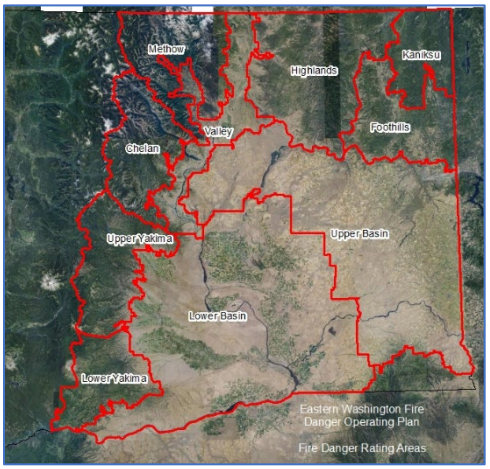
Remote Automated Weather Station (RAWS) hourly weather data for the period 2000 to 2019 was obtained from the Desert Research Institute Climate, Ecosystem and Fire Applications (CEFA). Data was gap-filled and made available late 2021 and early 2022, this would be considered the first version of gap-filled data for the Pacific Northwest. Stations known to be no longer operational were removed from the CEFA dataset. Snow flags were missing from several stations in the CEFA dataset, in this case snow flags were set using satellite snow cover for the period. Data after 2018 was dropped to align with available interagency fire data.

2.3 Fire Danger Rating Areas

A fire danger rating area (FDRA) is defined as a large geographic area relatively homogenous with respect to climate, vegetation and topography. Because of these similarities, it can be assumed that the fire danger within a FDRA is relatively uniform. FDRA were delineated based upon an analysis of these three factors: climate, vegetation, and topography. Delineations are depicted in Appendix B.

After these environmental factors were considered, the draft FDRAs were edge-matched to existing administrative boundaries. Primarily local fire district boundaries where available and a combination or major roads/river/ridges and administrative boundaries (mostly legal lines) elsewhere.

Communications center response area boundaries, although typically aggregated to form FDRAs, were not used as advised by WACWC and WANEC. It is important that response areas



utilized, in this case local fire district boundaries, are not split by FDRAs to avoid additional workload and confusion for operational personnel. The final FDRA delineation is depicted below and described below in section 2.3.1.

Changes made to FDRA since the last FDOP include those made at a gathering of the working group in Moses Lake in early 2021, as requested by Chelan County, and those made more recently at the request of the National Weather Service in relation to alignment of Fire Weather Zones in early 2022. The current FDRA shape is housed with the National Interagency Fire Center Arc GIS Online group.

2.3.1 FDRA Descriptions

The following broad regional descriptions were mostly lifted from the Western Region Climate Center state climate narratives.

2.3.1.1 East Slope Cascades (Chelan, Methow, Lower and Upper Yakima FDRAs)

General Location: This area extends from the summit of the Cascades eastward for distances varying from 25 to 75 miles and from the Canadian Border to the Columbia River. The area was further broken from north to south after the initial analysis along major hydrological divides and the Yakama response boundary to; reduce total FDRA size, account for changes in slope, fire business, and fire response. Currently the Yakama Nation are not participants in this plan.

Vegetation: Timber.

Climate: One of the outstanding features of the climate is the decrease in precipitation along the eastern slope of the mountains as the distance from the summit increases and the elevation decreases. For example, within a distance of 20 miles, the average annual precipitation decreases from 92 inches at Stampede pass (elevation 3,958 ft.) to 22 inches at Cle Elum (elevation 1,920 ft.).

Topography: In an easterly direction elevation decreases from the summit of the Cascade Mountain Range to approximately 2,000 feet above sea level.

2.3.1.2 Valley

General Location: This area includes fruit producing valleys along the Okanogan, Methow and Columbia Rivers, grazing land along the southern Okanogan highlands, the Waterville Plateau and part of the channeled scablands.

Vegetation: Grass and Brush.

Climate: The annual precipitation increases from 11 inches in the valley to 16 inches over some of the Plateau. Winter season snowfall varies from 30 to 70 inches. Both rainfall and snowfall increase in the higher elevations.

Topography: Elevation varies from approximately 1,000 feet in the lower river valleys to 3,000 feet over the Waterville Plateau and Okanogan highlands. North-south ranges of mountains extending into southern British Columbia reach elevations of 4,000 to 5,000 feet within a few miles of the Okanogan River.

2.3.1.3 Columbia Basin (Lower and Upper Basin FDRAs)

General Location: The [Columbia] Basin includes the Ellensburg valley, the central plains area in the Columbia basin south from the Waterville Plateau to the Oregon border and east to near the Palouse River. The southeastern most boundary was snapped to the existing Blue Mountains FDOP and is within the BMICC area of response.

Vegetation: Grass and Brush.

Climate: This is the lowest and driest section in eastern Washington. Annual precipitation ranges from seven inches in the drier localities along the southern slopes of the Saddle Mountains, Frenchman Hills and east of Rattlesnake Mountains, to 15 inches in the vicinity of the Blue Mountains. Summer precipitation is usually associated with thunderstorms. During July and August, it is not unusual for four to six weeks to pass without measurable rainfall.

Topography: Elevation increases from approximately 400 feet at the confluence of the Snake and Columbia Rivers to 1,300 feet near the Waterville Plateau and 1,800 feet along the eastern edge of the area.

2.3.1.4 Northeastern (Foothills, Highlands, Kaniksu FDRAs)

General Location: The northeastern and higher elevations of the Okanogan highlands, the Selkirk Mountains, and the lower elevations southward to the vicinity of the Spokane River are included in the northeastern area.

Vegetation: Timber.

Climate: The average annual precipitation increases in a northeasterly direction from 17 inches in the Spokane area to 28 inches in the northeastern corner of the State.

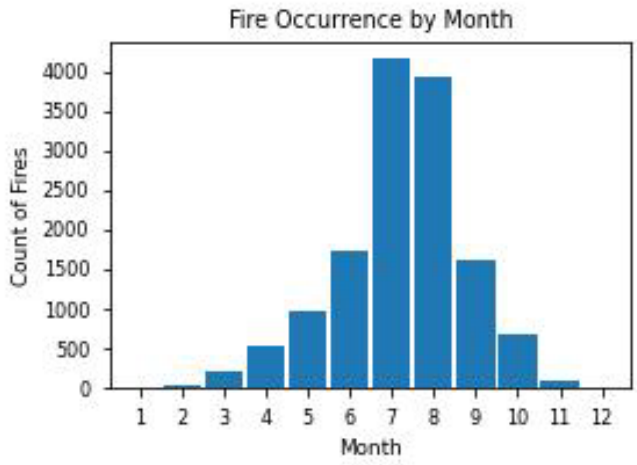
Topography: Ranges of mountains in this section of the State are separated by narrow north-south valleys. The elevation increases from 2,000 feet in the valleys to 6,000 feet along the higher ridges.

3.0 Fire Danger Problem Analysis

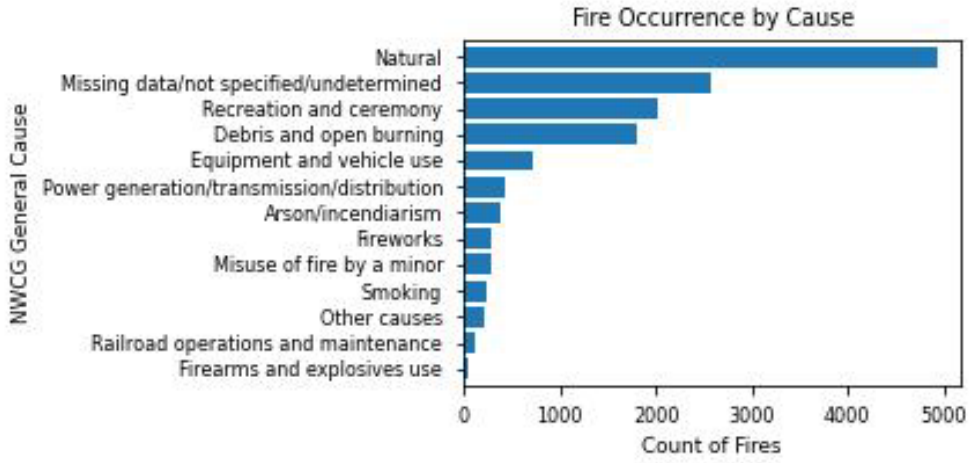
In order to apply a fire danger system which will assist managers with fire management decisions, ignition problems need to be identified, quantified, framed, and associated with a specific target group to determine the most appropriate fire danger-based decision tool to mitigate the given issue.

3.1 Fire Occurrence

Interagency fire occurrence data was obtained from the Fire Program Analysis Fire Occurrence Database version 5 (Short, Karen C. 2021). Fires prior to the year 2000 were dropped to align with available weather data.



Tribal fire history was removed for all agencies excepting the Spokane Tribe in the Foothills FDRA, as they are the only ones to express an interest in participation or utilization of the plan to date and inclusion of tribal data in other FDRA did affect analysis results.



3.2 Identification/Definition of the Fire Problem(s)

The ability to regulate, educate, or control a user group will be based upon the interface method and how quickly they can react to the action taken. Consequently, the most appropriate decision tool would depend upon the sensitivity of the target group to the

implementation of the action. In addition, each action will result in positive and/or negative impacts to a user group.

In selecting a component and/or index, several factors must be considered:

- Affected Target Group: The group of people commonly associated with the problem (e.g., agency, industry, or public).
    - Agency: Employees of the federal, state, and local governments involved in the cooperative effort to suppress wildland fires. This includes Federal, State, and County land management employees, along with volunteer fire departments who share a similar protection mission to manage wildland fires.
    - Industry: Employees affiliated with organizations which utilize natural resources and/or obtain permits or leases to conduct commercial activities on federal, state, or private lands. These entities or activities could include ranchers, wilderness camps, railroads, mines, timber harvesting, filming, building construction, oil and gas, electric generation, guiding services, etc.
    - Public: Individuals who use public lands for non-commercial purposes such as off-highway vehicle use, camping, hiking, hunting, fishing, skiing, firewood gathering, agriculture, mountain biking, general travel and recreation. This group also includes those living within the wildland urban interface.
- Problem Definition: This is the problem specific to the area of concern and includes ignition causes. The problem is framed to focus on the wildland fire management issue associated with a specific target group.
- Degree of Control: This is a general description of how much control the fire management agencies have over the target group (High to Low). This is a measure of how quickly the affected target group can respond to changing fire danger levels.
- Communication: Various methods of communication are utilized to influence an affected target group to change their behavior. Depending upon the specific target group, communication may include face-to-face verbal conversations, radio, telephone, email, newspaper, television, signing/posting, text messages, etc.
- Component/Index: Sensitivity of the NFDRS outputs should be commensurate with the ability to react (or communicate) to the target group.
- Management Action: The actions or applications are pre-defined and taken at breakpoints determined through an analysis of fire danger indices and fire occurrence. Collectively the decision points represent levels of fire danger applied as a communication mechanism to specific target groups. The intent is to minimize the risk of a fire ignition problem by controlling or influencing a specific target group (Agency, Public, and Industry).

The following table broadly identifies and defines the fire problem in Central and Northeast Washington.

TARGET GROUP		IGNITIONS CAUSE		RELATIVE DEGREE OF CONTROL	COMMUNICATION METHODS	PROBLEM
General	*Specific*	*General*	*Specific*			
Agency	Agency suppression resources and fire managers	1 - Lightning	Lightning	High	WACWC/WANEC communicates fire weather (LAL) and fire danger (SL and PL)	Fires which exceed the units capability to manage due growth on the discovery day
Agency	Agency suppression resources and fire managers	1 - Lightning	Abundant Lightning	High	WACWC/WANEC communicates fire weather (LAL) and fire danger (SL and PL)	Fires which exceed the units capability to manage because they cannot be staffed on discovery and escape initial attack on subsequent days
Public	Public using overnight developed recreation sites	4 - Campfire	Unattended (and escaped) campfires	High	PIO/Prevention Radio, media broadcast, news release and internet. Smokey Arm, adj. signs and prevention patrols	Campfires in developed recreation areas that escape and become large fires or tie up agency resources allowing other fires to grow and escape initial attack
Public	Public using agency lands for day use or undeveloped overnight use	4 - Campfire	Unattended (and escaped) campfires	Low	PIO/Prevention Radio, media broadcast, news release and internet. Smokey Arm, adj. signs and prevention patrols	Campfires in undeveloped or day use recreation sites that escape and become large fires or tie up agency resources allowing other fires to grow and escape initial attack

Industry	Woods workers and Industrial forest users operating on public lands	2 - Equipment	Any ignition associated with the target group from chainsaws to yarding	Moderate	WACWC/WANEC communicates IFPL for agency personnel, state posts on internet for public	Ignitions which become large fires resulting from industrial forest operations (equipment and smoking)
Public	Private Landowners	5 - Debris Burning	Escaped debris burns	Low	WACWC/WANEC PIO Posted on the dispatch website, Radio, media broadcast, news release and internet	Escaped debris burns which become large fires or tie up agency resources

4.0 Fire Danger Threshold/Decision Analysis

Decision points can be based upon either:

- Climatological Breakpoints, or
- Fire Business Thresholds.

The FDOP will be used to support fire management decisions made at specific decision points. A decision point is a point along the range of possible output values where a decision shifts from one choice to another. When conditions, or a combination of events and conditions, signal that it is time to do something different a decision point has been reached. Decision points are identified for selected indices and levels within each FDRA.

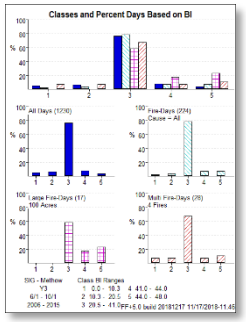
4.1 Climatological Breakpoints

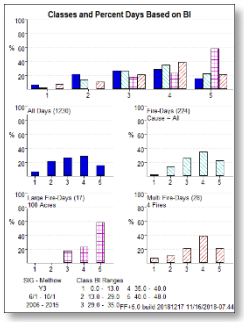
Climatological breakpoints are points on the cumulative distribution curve of a fire danger indices computed from climatology (weather). For example, the value at the 90th percentile ERC is the climatological breakpoint at which only 10 percent of the ERC values are greater in value. Climatological percentiles were originally developed for budgetary decisions by federal agencies, *without regard for associated fire occurrence*, and are predetermined by agency directive, as exemplified below:

- BLM: 80th and 95th percentiles
- FWS, NPS, USFS: 90th and 97th percentiles

When using climatology, it is important to identify the period of record used to determine the agency percentiles. The percentile values for the calendar year will be different from the percentile values for the fire season.

Thresholds identified in this FDOP are based upon the correlation of historical fire occurrence and weather data and, therefore, do not utilize climatological percentiles for decision points. Note the fire business charts below, climatological breakpoints on the left and fire business thresholds on the right. Increased preparedness actions taken at levels 4/5 have little potential to affect outcomes using traditional climatological breakpoints since most of the fire problems occur at level 3.





4.2 Weather Station Analysis

4.2.1 WACWC Fire Danger Rating Areas (East Slope Cascades, Valley, Columbia Basin)

Weather stations were chosen based on a combination of predictive power and ability to spread out decision points. Within each FDRA every possible combination of station, less than four, was tested against fire occurrence. Receiver Operating Characteristic (ROC) and Precision Recall (PR) Area Under the Curve were summed within each class, and then the ROC + PR for each class was summed within the Station Interest Group (SIG). Within the top five SIG within each rating area a selection was made based on the SIG with the best spread (minimum interval) between target class ROC optimum values. Minimum interval was added to the selection criteria after discovering previous utility in selecting a fuel model and was incorporated here to maximize range between decision point thresholds values. Sample results are presented in the Appendices for demonstrative purposes. ROC and PR methods are described in more detail in following sections.

Station correlation within FDRA was considered but was not a driving factor in selection.

Refer to the Appendix D for details regarding the weather station analysis.

4.2.2 WANEC Fire Danger Rating Areas (Highlands, Foothills, Kaniksu)

Within the WANEC FDRAs, each station and combination of stations with higher predictability were analyzed using FireFamilyPlus to determine the statistical correlation of each station and its indices to fire occurrence. Station location, data quality, Chi-squared, and Predictor Variable Range were all used to make final station/SIG selection.

4.2.3 NFDR Stations and Special Interest Groups (SIGS)

CENTER	FDRA	STATION ID	STATION NAME	OWNER
WACWC	Methow	452006	First Butte	FS-WAOWF
		452035	Douglas Ingram	FS-WAOWF
	Chelan	452134	Dry Creek	FS-WAOWF
		452132	Camp 4	FS-WAOWF
	Upper Yakima	452219	Swauk	FS-WAOWF
		452221	Sawmill	WADNR
		452306	Sedge Ridge	FS-WAOWF
	Lower Yakima	452304	Mill Creek	BIA-YAKAMA
		452307	Signal Peak	BIA-YAKAMA
		452317	Tepee Creek	BIA-YAKAMA
	Valley	452030	NCSB	FS-WAOWF
		452040	Kramer	BIA-COLVILLE
		452138	Entiat	FS-WAOWF
	Upper Basin	453002	Spring Canyon	NPS-LARO
		453601	Escure	BLM
	Lower Basin	453102	Columbia NWR	USFWS
		452701	Saddle	USFWS
WANEC	Highlands	452029	Lost Lake	FS-WACOF
		452513	Owl Mountain	FS-WACOF
	Foothills	452918	Wellpinit	BIA-SPOKANE
	Kaniksu	453413	Tacoma Creek	FS-WACOF

4.3 Fire Business Analysis

4.3.1 WACWC Fire Danger Rating Areas (East Slope Cascades, Valley, Columbia Basin)

4.3.1.1 Indices Selection

Indices selection was primarily driven by previous Fire Danger Operating Plan analysis using Fire Family Plus and traditional FIRES analysis statistics, as well as the intended indices use as it relates to stability. Cursory examination was given to ROC AUC across indices not used in this plan. Energy Release Component and Burning Index were selected as the two indices to primarily analyzed for use. Burning Index was dropped from several FDRA due to the inability of a single SIG to separate the target classes. Using separate SIG for each index would rectify this problem. An example of why BI was dropped from some FDRA is provided in the Appendices for demonstrative purposes.

4.3.1.2 Fuel Model Selection

Originally the intent was to utilize fuel model Y across the entire analysis area. Reasons for this include its predictive ability across all analysis areas, use in previous plan, stability, and a lack of effort to properly calibrate Growing Season Index (GSI) in the Columbia Basin and valleys. However, explorations using the ROC method to threshold indices showed that some fuel models work much better than others at separating the target classes from one another. An example of why a fuel model other than Y was chosen is provided in the Appendices for demonstrative purposes.

Unsurprisingly perhaps the FDRA assigned a fuel model with a live fuel component, and corresponding increase in pre green up fire danger, are also the FDRA that have recorded large fire occurrence during this shoulder season period.

Ideally ROC and PR AUC would have been used to evaluate all fuel models against fire occurrence, however the lack of an API for the NFDRS system makes this process labor intensive for this type of analysis. Additionally, while ROC AUC was high for individual target classes this metric does not account for separation of target classes from one another. A future effort should incorporate this logic into the machine learning process to reduce manual iterations.

Efforts to calibrate GSI are currently underway. Any changes made to GSI in Weather Information System (WIMS) station catalogues will require reanalysis.

4.3.1.3 Data Preparation

Fires were clipped to the analysis area and then joined to the Fire Family Plus Daily Listing based on station identification and fire discovery date so that each fire was associated with discovery date indices. Fires were classified into integers one through four based on percentile fire size for each analysis area. Days with no fires were classified as zero. Each station was limited to one fire occurrence of the highest class.

4.3.1.4 Threshold Analysis

A machine learning approach using the Python programming language was taken to develop four thresholds, or breakpoints, which were then used to form the five levels for each index. The problem was solved as a five-class multiclass problem, four fire classes plus the no fire day, or miss. Indices floating point values from the fire discovery date were used as the features (0.0 - indices maximum) and integer classifications (1 - 4) developed during data preparation were used as targets, and zero representing the no fire day.

Thresholds for all FDRA except Upper and Lower Basin were based on the FDRA 50th, 90th and 97th percentile fire size. Upper and Lower Basin FDRA used 75th, 90th, and 97th percentile fire sizes as there were too much noise at lower target acreage to differentiate target classes. Fire size percentile for each FDRA is provided in the Appendices.

Scikit Learn Stratified K-Fold was used to split the data into test and train sets. Stratified folding was used to maintain the relative number of samples in each class across the folds. This method was used instead of a single test-train-split due to the highly imbalanced nature of the data. Shuffle was set to true. Ten splits, or folds, were used.

The Scikit Learn Stochastic Gradient Descent (SGD) Classification model was used to solve the problem, the loss function was set to logistic regression. Shuffle was set to false since the data was shuffled during the stratified cross validation. For best results using the SGD classifier, according to Scikit direction, the training features were standardized by removing the mean and scaling to unit variance using the Scikit Learn Standard Scaler.

The results of the SGD model were used to plot Receiver Operating Characteristic (ROC) curves and identify optimal thresholds for each class and analysis area. Optimal thresholds are those with the highest true positive rate and lowest false positive, or lowest misclassification rate, along the ROC curve. The idea for this thresholding approach is credited to Matt Jolly with the Rocky Mountain Research Station.

Several data balancing techniques were assessed to address class imbalance, including Synthetic Minority Oversampling Technique and class weighting. However, improvements were minor, and none were carried forward for the sake of simplicity.

4.3.5 WANEC Fire Danger Rating Areas (Highlands, Foothills, Kaniksu)

A statistical correlation of fire occurrence with fire danger indices, weather stations, and fuel models was used in conjunction with the fire problem analysis table in Section 3.2 to determine the best combination for predicting the fire problem in each WANEC FDRA.

Fuel model X was selected due to both its live and dead fuel components. Originally the intent was to utilize fuel model Y across the FDRAs. Reasons for this include its use in previous plan, predictive ability, and stability. Fuel model Y, however, contains no live fuels and fuel model X corresponded well in pre green up fire danger and the large fire occurrence during this shoulder season period.

4.4 Parameters Used to Calculate Fire Danger

Slope Class was determined using GIS slope analysis. Herb type was determined through spatial analysis and working group deliberation. KBDI and annual precipitation, both required to run NFDR 2016, were left at the default values; 100 for KBDI and station catalogue for precipitation.

FDRA	SLOPE CLASS	HERB TYPE	FUEL MODEL
Methow	3	P	Y
Chelan	4	P	Y
Upper Yakima	2	P	Y
Lower Yakima	2	P	X
Valley	2	P	Y
Upper Basin	2	A	W
Lower Basin	1	A	V
Highlands	2	P	X
Kaniksu	2	P	X
Foothills	2	P	X

4.4.1 WACWC Fire Danger Rating Areas (East Slope Cascades, Valley, Columbia Basin)

The following Fire Danger Rating Area percentile fire sizes were used to in the Receiver Operating Characteristic analysis to determine fire business thresholds.

FDRA	PERCENTILE FIRE SIZE	FIRE SIZE (AC.)
Methow	50th	0.1
	90th	6.6
	97th	564.2
Chelan	50th	0.1
	90th	29
	97th	1567.1
Upper Yakima	50th	0.1
	90th	2
	97th	100
Lower Yakima	50th	0.1
	90th	2
	97th	8.9
Valley	50th	0.2
	90th	40
	97th	1193.6
Lower Basin	75th	2
	90th	19.8
	97th	1000
Upper Basin	75th	25
	90th	600
	97th	4992.5

4.4.2 WANEC Fire Danger Rating Areas (Highlands, Foothills, Kaniksu)

Large fires and multiple fire days for the following FDRAs were determined through analysis and participant input to determine fire business thresholds.

FDRA	LARGE FIRE AC	MULTI FIRE DAY N
Highlands	45	5
Kaniksu	28	5
Foothills	25	5

4.5 Decision Points

The decision points were revised on 01/18/2024 to include breakpoint corrections for the Highlands FDRA. The corrected values are listed along with the original values in parentheses. No other changes we made from the previous 6/15/2022 version.

FDRA	STAFFING (BI)		PREPAREDNESS (ERC)		FDRA	STAFFING (BI)		PREPAREDNESS (ERC)	
Methow	1	0	1	0	Upper Basin	1	0	1	0
	2	16.8	2	24.9		2	4.7	2	1.2
	3	23.5	3	32.9		3	6.6	3	2.1
	4	27.7	4	41		4	10.5	4	2.8
	5	38.4	5	56.5		5	14.2	5	4.9
Chelan	1	0	1	0	Lower Basin	1	0	1	0
	2	23.3	2	24.3		2	5.1	2	0.8
	3	30.7	3	31.8		3	13.7	3	1.6
	4	40.7	4	43.8		4	20.5	4	2.9
	5	44.5	5	44.5		5	25.9	5	3.9
Upper Yakima	1	0	1	0	Highlands	1	0	1	0
	2	18.5	2	21.4		2	7	2	10
	3	24.1	3	28		3	46 (42)	3	34 (30)
	4	28.4	4	33.9		4	87 (85)	4	61 (57)
	5	34.1	5	42.9		5	116	5	76
Lower Yakima	1	0	1	0	Foothills	1	0	1	0
	2	16.7	2	11.1		2	20	2	20
	3	24.1	3	16.7		3	75	3	48
	4	33.6	4	21.9		4	122	4	68
	5	48	5	31.1		5	161	5	84
Valley	1	0	1	0	Kaniksu	1	0	1	0
	2	14.9	2	21.7		2	15	2	14
	3	21.6	3	26.7		3	73	3	39
	4	29.3	4	36.4		4	110	4	78
	5	36	5	43.1		5	130	5	89

4.6 Fire Business Decision Summary Table

TARGET GROUP	DECISION POINTS	INDEX	PLAN INTENDED TO MODIFY TARGET GROUP BEHAVIOR
Agency	5	Burning Index	Staffing Plan
Agency	3	Burning Index	Response Plan
Agency	5	Energy Release Component	Preparedness Plan
Public	5	Energy Release Component	Prevention Plan (Adjective Rating)
Public	TBD by Unit	Energy Release Component	Prevention Plan or Public Use Restriction Plan
Industry	4	IFPL	WAC 332-24-301

5.0 Fire Danger Rating Level Decisions

The NFDRS utilizes the WIMS processor to manipulate weather and forecast data stored in the National Interagency Fire Management Integrated Database (NIFMID) to produce fire danger ratings for corresponding weather stations. The NFDRS outputs from the WIMS processor can be used to determine various levels of fire danger rating to address the fire problems identified previously in the Fire Problem Analysis Chart. The system is designed to model worst-case fire danger scenario. The NFDRS, along with other decision support tools, will be utilized to produce levels (thresholds) of fire business to address local fire problems by targeting public, industrial, or agency groups.

The NFDRS will be utilized to produce outputs to assist fire managers with six sets of decisions.

- **Response Levels** will be used as a decision tool for dispatchers to assign initial attack resources to a fire reported in a specific dispatch zone.
- **Staffing Levels** will be used for appropriate day-to-day suppression resource staffing.
- **Preparedness Levels** will assist fire managers with more long-term (or seasonal) decisions with respect to fire danger.
- **Adjective Rating Level** will be used to communicate fire danger to the public.
- **Industrial Fire Precaution Level** will be used to curtail preventable industrial ignitions.
- **Public Use Restriction Level** will be used to curtail public ignitions.

5.1 Response (or Dispatch) Level

Calculated and published twice daily by the communications centers, not broadcast.

Response (or dispatch) levels are pre-planned actions which identify the number and type of resources (engines, crews, aircraft, etc.) initially dispatched to a reported wildland fire based upon fire danger criteria. Dispatch levels are established to assist fire managers with decisions regarding the most appropriate response to an initial fire report until a qualified Incident Commander arrives at the incident. Response level in this plan is a direct function of staffing level.

BI DECISION POINTS (STAFFING)	RESPONSE LEVEL
1	1
2	
3	
4	2
5	3

5.2 Staffing Level

Calculated, published and broadcast daily by the communications centers.

The staffing level forms the basis for decisions regarding the degree of readiness of initial attack (IA) and support resources. Staffing Levels are expressed as numeric values where 1 represents the low end of the fire danger continuum and 5 the high end. Staffing level is intended to provide fire managers with day-to-day decision support regarding staffing of suppression resources such as employee overtime associated with working people beyond their normal schedules and extended staffing of shared resources such as air tankers, helicopters, hotshot crews and other large fire support resources.

The process for determining local staffing levels is not the same as staffing level calculated directly from WIMS. WIMS calculates staffing level on climatological breakpoints; WACWC and WANEC will calculate staffing level based on decision points defined in this plan and incorporate a measure of ignition risk using the worksheet below.

STAFFING INPUT VALUE	1 □	2 □		3 □		4 □		5 □	
RED FLAG WARNING, FIRE WEATHER WATCH, IA ACTIVITY?	↓	No □	Yes □	No □	Yes □	No □	Yes □	No □	Yes □
STAFFING OUTPUT VALUE	I	II		III		IV		V	

The primary input is the forecast or observed staffing level based on the burning index decision points defined in this plan. The secondary input is the occurrence of a red flag warning or fire weather watch within the respective dispatch area.

5.3 Preparedness Level

Input value calculated, published and broadcast twice daily by the communications centers. Actual value calculated by unit weekly or biweekly.

The preparedness level is a five-tier (1-5) fire danger rating decision tool that is based on NFDRS output(s) (energy release component) and other mid- to long-term indicators of fire business such as fine fuel loading or drought. Preparedness levels are established to assist fire managers with weekly or monthly planning decisions.

The preparedness level worksheet below is presented as an example. Units should document specific preparedness level procedures, including calculation frequency, in unit preparedness plans.

PREPAREDNESS INPUT VALUE	1 □	2 □		3 □		4 □		5 □	
US DROUGHT MONITOR LEVEL D3-D4?	↓	No □	Yes □	No □	Yes □	No □	Yes □	No □	Yes □
PREPAREDNESS OUTPUT VALUE	I	II		III		IV		V	

The preparedness input value should be an average, or weighted average, of the forecast preparedness level and trend pertinent to the unit. For example, Spokane BLM may choose to use the average of the Upper, Lower, and Valley fire danger rating area current/forecast trend value as the input since this covers the majority of their response area of concern. Drought status can be found via the US Drought Monitor in this example Spokane BLM may choose to use the Middle Columbia time series product found here.

5.4 Adjective Fire Danger Rating Level

Informed by preparedness input value calculated, published and broadcast twice daily by the communications centers. Actual value set weekly during fire season based on discussion with cooperators.

In 1974, the USFS, BLM and state forestry organizations established five standard adjective fire danger rating levels descriptions for public information and signing. For this purpose only, fire danger is expressed using the national adjective descriptions and colour codes.

Although NFDRS processors (e.g., WIMS) automatically calculate the adjective rating based on climatology, units participating in this plan will use FDRA preparedness level thresholds/breakpoints defined in this plan as the basis for discussions with cooperators for setting FDRA adjective rating level. Ignition component was removed as an input variable to reduce the output sensitivity (reduce frequency of rating changes). If daily, as opposed to weekly or bi-weekly, adjective ratings are desired in the future it should be reincorporated.

ERC DECISION POINTS (PREPAREDNESS)	ADJECTIVE RATING
1	LOW
2	MODERATE
3	HIGH
4	VERY HIGH
5	EXTREME

5.5 Public Use Restrictions

Set by the unit, ideally informed by adjective rating or unit calculated preparedness value.

Public use restrictions are implemented and set by the individual agencies participating in this plan. Currently there is not a coordinated interagency set of restrictions/levels (or actions) used by participants in this plan.

Ideally units will set public use restrictions based on, or informed by, adjective rating (less risk tolerant) or unit calculated preparedness level (more risk tolerant). Number of levels, actions, and basis for decision making will be defined in unit prevention plans or public use restrictions plans.

5.6 Industrial Fire Precaution Level

NFDR 2016 IFPL calculation TBD.

DNR, U.S. Forest Service, Bureau of Land management and Bureau of Indian Affairs all use the same four-level industrial regulation system. This system, which helps prevent wildfires by regulating work in the woods, is known as the Industrial Fire Precaution Level (IFPL) system. More information on IFPL in Washington can be found on the Washington Department of Natural Resources page here.

Current and prior IFPL are based on the precaution value, a function of indices calculated by the 1978 model. Discussions are ongoing regarding how IFPL will be calculated using NFDR 2016 as the analysis used for developing the IFPL calculation is no longer applicable (different fuel model, live and dead fuel moisture models, etc.).

6.0 Fire Danger Operating Procedures

6.1 Roles and Responsibilities

6.1.1 Agency Administrators

Agency Administrators will use this plan to coordinate with fire management officers on fire business related decisions.

6.1.2 Fire Program Managers

Fire program managers (FMOs) will use this FDOP and NFDRS outputs as a tool to coordinate and to make informed fire business decisions. The fire program manager is ultimately responsible for ensuring this plan is maintained, utilized, and communicated.

Fire program managers will ensure that their stations are maintained to NFDRS standards.

6.1.3 Fire Danger Technical Group

Each participating agency will be responsible for providing an NFDRS technical specialist to participate in the maintenance, review, and update of this plan. The following are specific individuals which have participated in plan development or review to date.

- Bureau of Land Management; Lonnie Newton (Spokane District BLM)
- National Park Service; Scott Ebel (North Cascades and Lake Roosevelt)
- US Fish and Wildlife Service; Tom Merritt (Inland Northwest National Wildlife Refuge Complex), Bruce Jackson (Mid-Columbia River National Wildlife Refuge Complex)
- US Forest Service; Ben Curtis, Shane Robson (Colville), Brian Maier (Okanogan Wenatchee)
- Washington State Department of Natural Resources; Tim Love (NE), Wyatt Leighton (SE)

- Spokane Tribe; Gary Hughes

Members of the Fire Danger Technical Group will monitor NFDRS to ensure validity, coordinate/communicate any problems identified, review plan implementation, coordinate plan revisions, present the plan, and be available for NFDRS technical consultation. The technical group will coordinate with fire managers from their unit for updates and additions to the plan. The technical group will coordinate annually to review plan implementation, decide if revisions are necessary, and accomplish revisions.

6.1.4 Fire Weather Station Owners/Managers

The station owners will ensure appropriate editing of the RAWS catalogues to match this plan and maintain *current* primary and secondary contacts for stations. Station owners will maintain stations in accordance with NWCG PMS 426-3 and ensure a timely response when notified of an unexpected need for repair.

6.1.5 Communication Center

The communication centers will ensure that the daily NFDRS indices are retrieved and that the daily staffing and preparedness levels are calculated, communicated, and made available during fire season, April 1st through October, or season end, and as requested by participants in this plan due to extenuating factors.

The communication center will monitor RAWS daily for unusual readings that may suggest an issue which needs attention and contact the station owners to arrange resolution and notify agency fire program managers (FMO).

The communication center will give WIMS the proper seasonal care and feeding required to run NFDR 2016, including setting snow flags and starting KBDI.

6.1.6 Duty Officers

Duty officer, from each agency, will be identified to the WACWC and WANEC throughout the fire season. It is the duty officer role to interpret and modify the daily staffing and preparedness levels (if warranted) by extenuating factors not addressed by this plan to make fire business decisions.

6.1.7 National Weather Service

Weather forecasts and products for the area are provided by the National Weather Service, Spokane office. The annual Northwest Fire Weather Operating Plan contains contact information and product listing (including NFDRS point and trend forecast products) and can be found on the Northwest Coordination Center Website.

6.2 Daily Schedule

Efforts will be made to continue to provide web NFDR products to WACWC and WANEC from which dispatchers and managers can quickly and easily obtain the needed information to calculate and communicate fire danger levels. This information has previously been hosted externally and communication centers should be prepared to obtain the outputs from WIMS and using the tables and worksheets in this plan.

Morning broadcasts will use the days forecast indices and will be effective until the afternoon broadcast. Afternoon broadcasts will use the days observed indices and be effective until the morning broadcast.

WACWC and WANEC morning and afternoon broadcast should include; observed BI and ERC, predicted BI and ERC when available, and predicted Staffing Level and ERC when available.

6.3 Critical Fire Danger

Critical fire danger events such as post thermal trough, marine push, and dry cold front winds will be typically captured by National Weather Service meteorologists in red flag warnings or fire weather watches. For more information see the publication Critical Weather Patterns of the United States which can be found on the NWCC website here.

Other critical fire danger elements contributing to explosive fire growth aside from wind, high daytime temperatures and low relative humidity, include abnormally low seasonal snowpack/streamflow, drought, and periods of poor overnight humidity recoveries.

Sustained maximum recoveries below approximately 40-45 percent combined with preparedness level input values of 5 (ERC generally above the 90th percentile) should be considered a watch out in the timber fuel types, especially when combined with any of the above frontal patterns. Effects of prolonged periods of poor humidity recovery on heavy fuels can last a day or two after frontal passage and humidity recovery.

Information on the current state of drought can be obtained from the US Drought Monitor here. Information on the current state of streamflow can be obtained from USGS here. Large fire growth days can be found in the Appendix F.

6.4 Season Ending Event

The NWCC conducted a season ending event analysis by predictive services area which can be found on their fire analysis page. Experience has shown locally that season ending analysis conducted in the traditional manner for individual fires or by FDRA come within a week or so either side of the NWCC analysis.

6.5 Fire Danger Pocket Cards/Seasonal Risk Analysis

The fire danger pocket card is a tool which can aid fire suppression personnel to interpret NFDRS outputs and understand local fire danger thresholds for a local area. Pocket cards can relate current NFDRS outputs with the historical average and worst-case values in a specific

geographic location. Visiting resources can use the pocket card to familiarize themselves with local fire danger conditions. The pocket cards meet NWCG guidelines and are posted on the NWCG website. Seasonal risk analysis (pocket cards with updated daily values) can be found on the communication center websites.

6.6 Weather Station Maintenance

Each agency is responsible for the annual maintenance and calibration of their RAWS used in this plan. Specifics regarding NWCG weather station standards and guidelines can be found in PMS 426-3 here.

Appendices

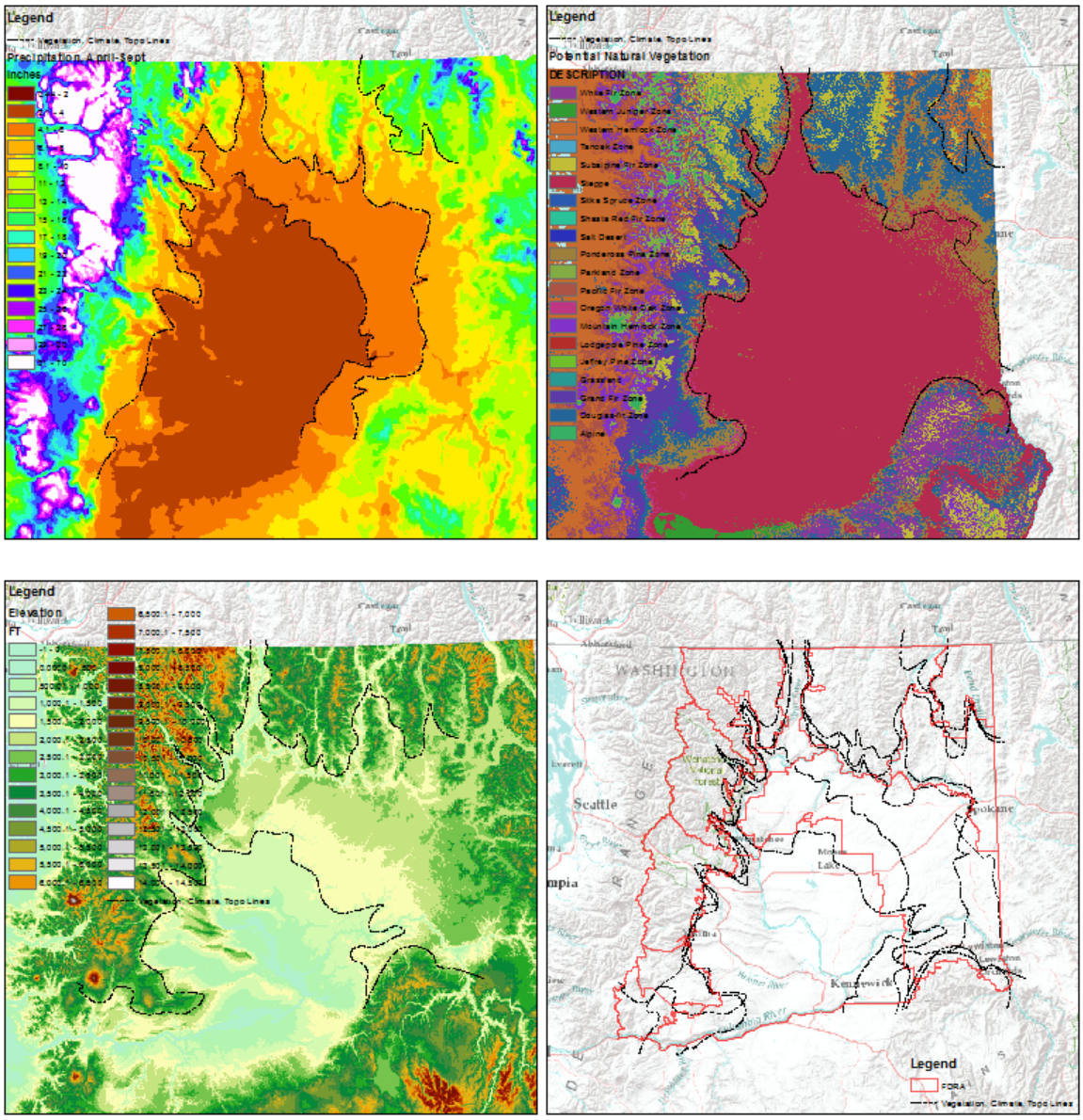
Appendix A: Primary Distribution List

This list indicates key personnel associated with this plan at this time.

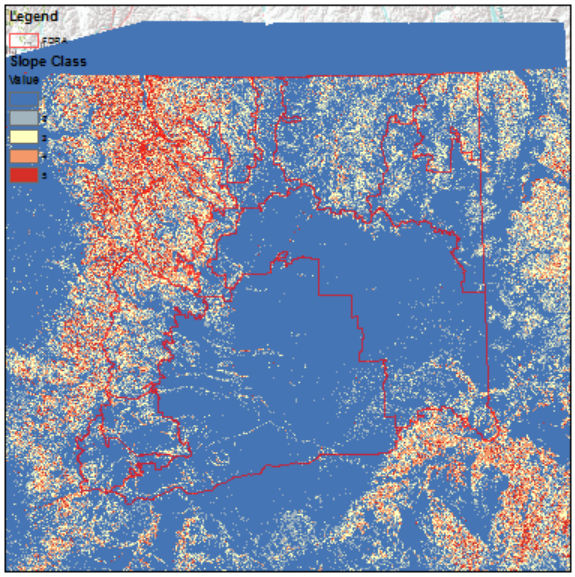
- Bureau of Land Management
    - Spokane Resource Area Fire Management Officer
- Communication Centers
    - Central Washington Interagency Communication Center Manager
    - Northeast Washington Interagency Communication Center Manger
- Forest Service
    - Colville National Forest Fire Management Officer
    - Okanogan Wenatchee National Forest Fire Management Officer
- National Park Service
    - North Cascades and Lake Roosevelt Fire Management Officer
- Spokane Tribe
    - Fire Management Officer
- US Fish and Wildlife Service
    - Inland Northwest National Wildlife Refuge Complex Fire Management Officer
    - Mid-Columbia River National Wildlife Refuge Complex Fire Management Officer
- Washington State Department of Natural Resources
    - Northeast Region Manager
    - Southeast Region Manager

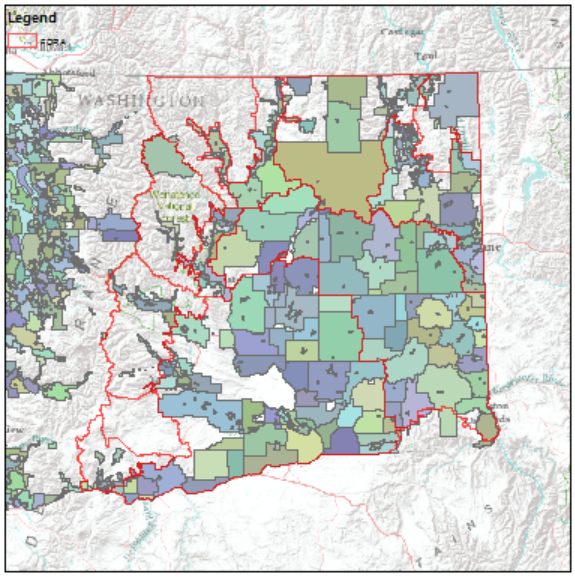
Appendix B: Fire Danger Rating Areas

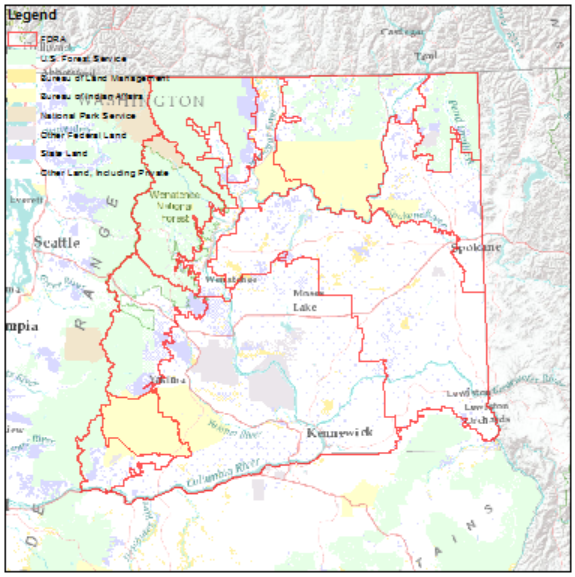
Delineation of fire danger rating areas select figures. Counter-clockwise from the top right; LANDFIRE Potential Natural Vegetation, PRISM April-September Precipitation 1981-2000, DEM Elevation, Delineations and Final FDRAs.



Counter-clockwise from top right, final FDRAs and; Fire Protection Districts, NFDR Slope Class, BLM LLI Ownership.







**Note that several small boundary adjustments and a merge have been made since these appendices' images were produced.*

Appendix C: Fire History

C.1 Percentile Fire Size

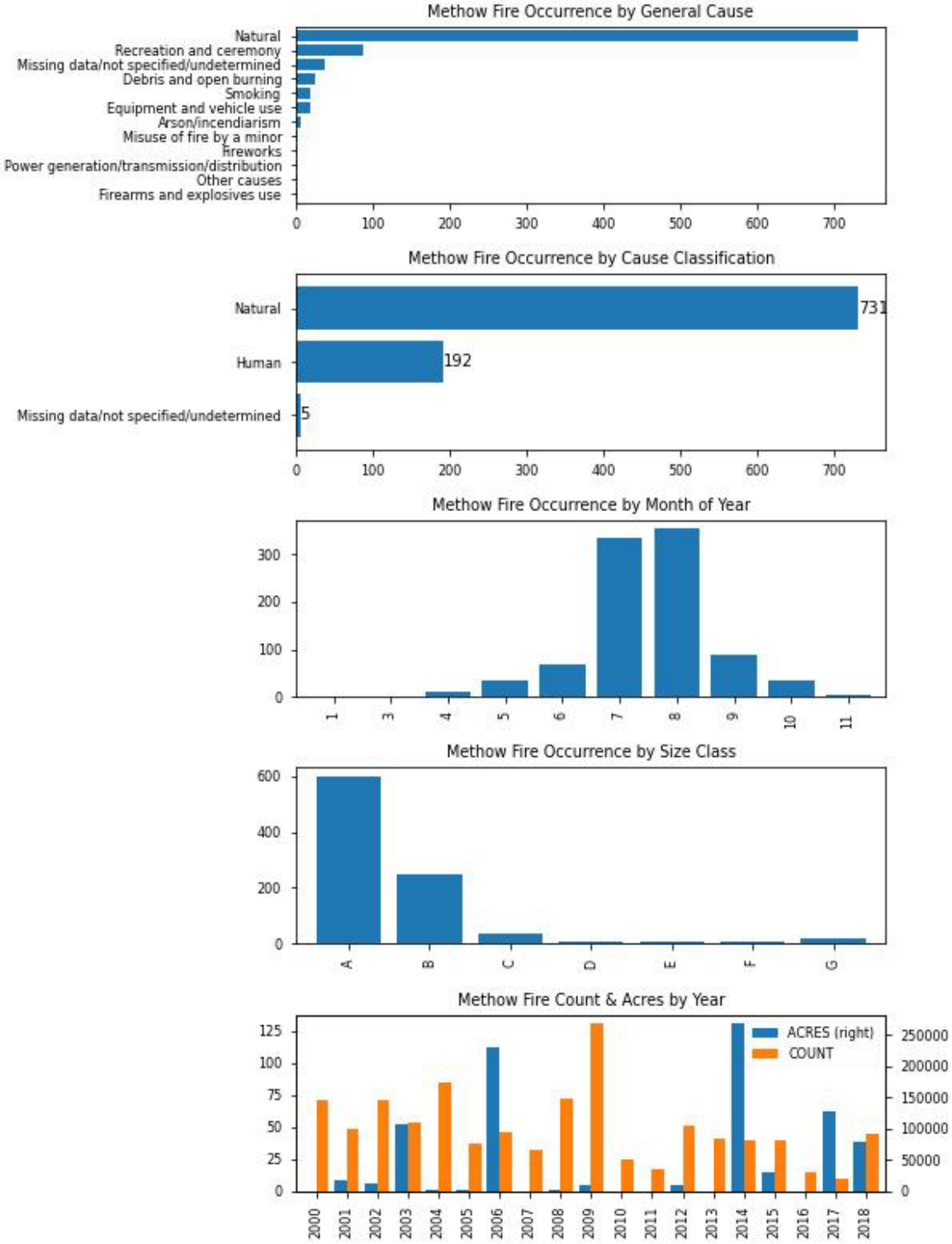
FDRA	25	50	75	85	90	95	97
Chelan	0.1	0.1	0.8	4	28.96	542	1567.12
Foothills	0.1	0.2	1	2	4	10	24.78
Highlands	0.1	0.15	1	3.2	7.5	32.48	102.616
Kaniksu	0.1	0.1	0.5	1	2	7	27.72
Lower Basin	0.1	1	8	41.7	140	830	2092.8
Lower Yakima	0.1	0.1	0.5	1.5	3	10	31.98
Methow	0.1	0.13	0.5	2	6.56	80.45	564.22
Upper Basin	0.1	0.25	2	7	19.88	211.38	1000
Upper Yakima	0.1	0.1	0.3	1	2	12	100
Valley	0.1	0.25	3	15	41.4	288.69	1281.92

C.2 Large Fire (97th percentile) Earliest & Latest Discovery Dates

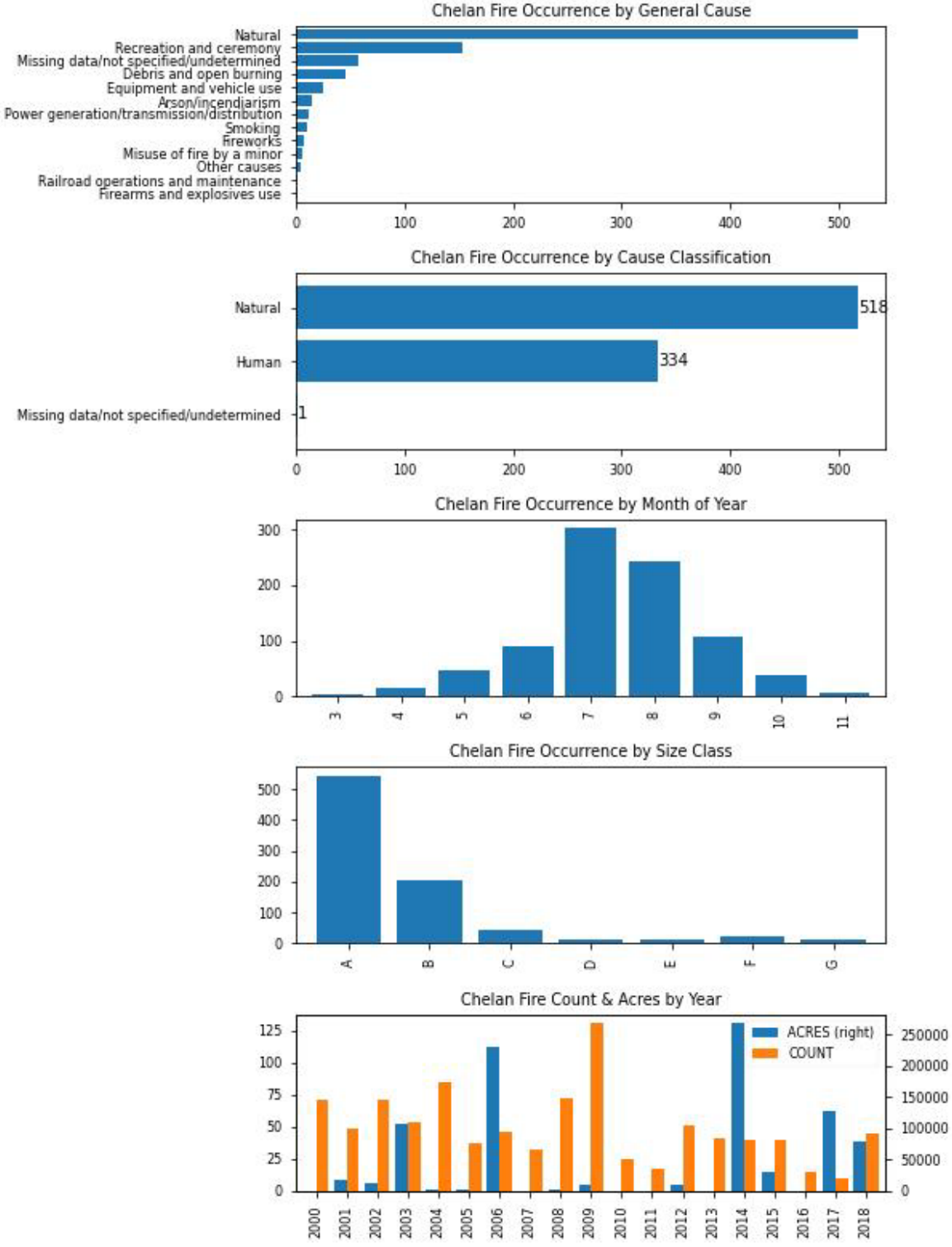
FDRA	Earliest Fire	Latest Fire	Large Fire Size
Chelan	26-Jun	9-Sep	1567
Foothills	1-Mar	25-Oct	25
Highlands	6-Mar	31-Oct	103
Kaniksu	2-May	10-Oct	28
Lower Basin	7-Jun	18-Oct	2093
Lower Yakima	27-Apr	28-Oct	32
Methow	24-Jun	15-Sep	564
Upper Basin	26-Jun	30-Sep	1000
Upper Yakima	27-Jun	12-Oct	100
Valley	21-May	9-Sep	1282

C.3 East Slope Cascades (Chelan, Methow, Lower and Upper Yakima FDRAs)

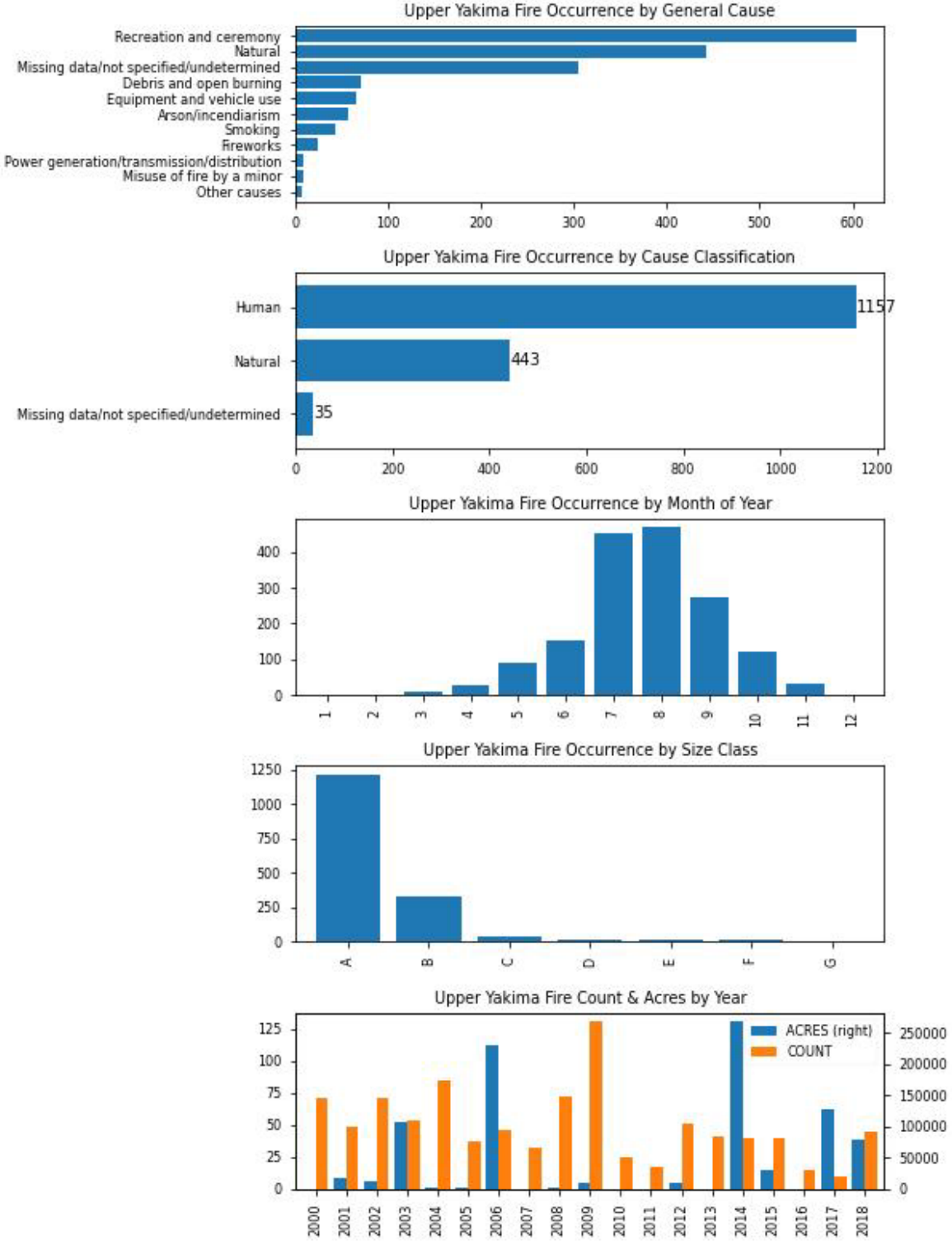
C.3.1 Methow



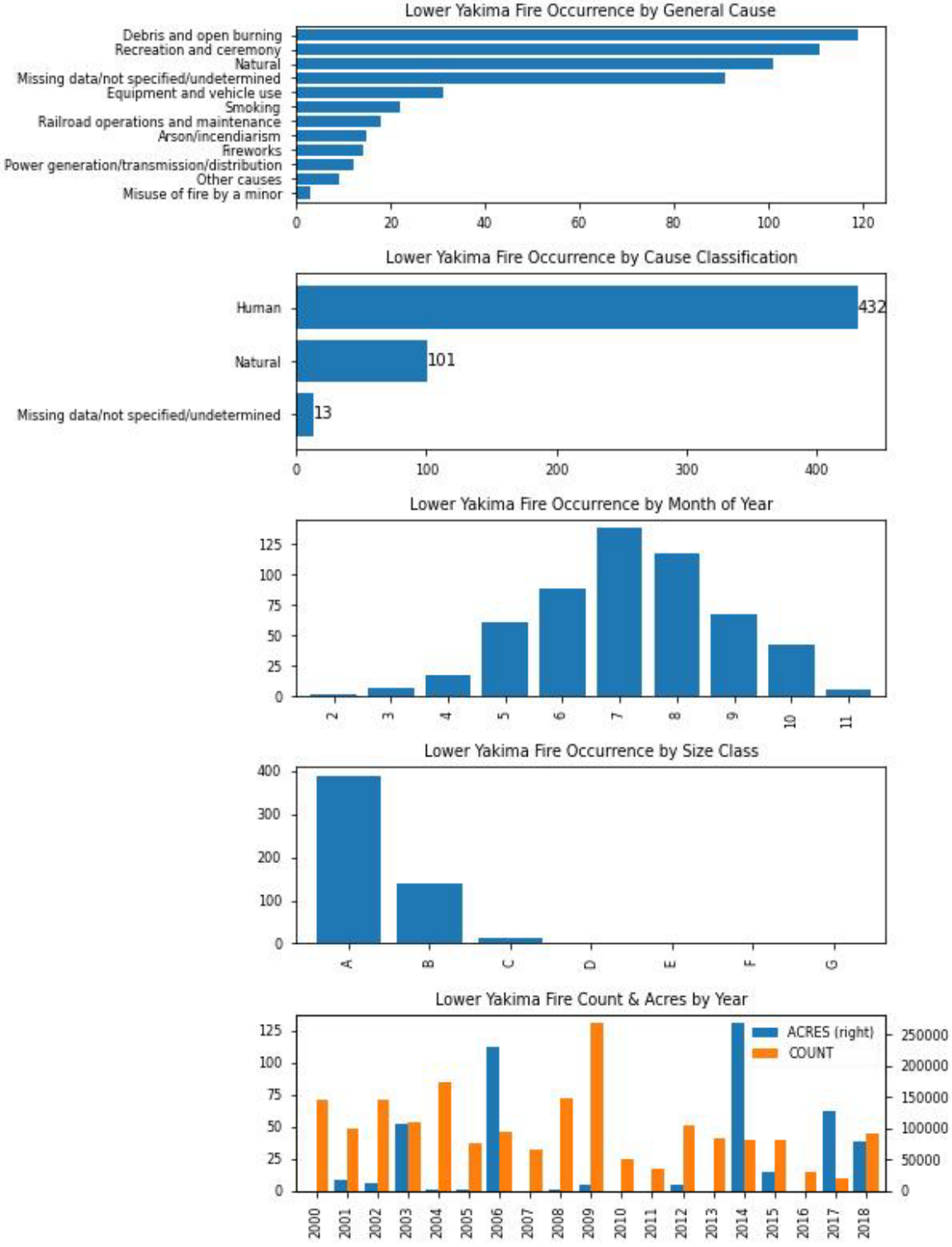
C.3.2 Chelan


Chelan Fire Occurrence by General Cause
Natural
Recreation and ceremony
Missing data/not specified/undetermined
Debris and open burning
Equipment and vehicle use
Arson/incendiarism
Power generation/transmission/distribution
Smoking
Fireworks
Misuse of fire by a minor
Other causes
Railroad operations and maintenance
Firearms and explosives use
0
100
200
300
400
500
Chelan Fire Occurrence by Cause Classification
Natural
Human
Missing data/not specified/undetermined
518
334
1
0
100
200
300
400
500
Chelan Fire Occurrence by Month of Year
300
200
100
0
3
4
5
6
7
8
9
10
11
Chelan Fire Occurrence by Size Class
500
400
300
200
100
0
A
B
C
D
E
F
G
Chelan Fire Count & Acres by Year
125
100
75
50
25
0
ACRES (right)
COUNT
250000
200000
150000
100000
50000
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

C.3.3 Upper Yakima

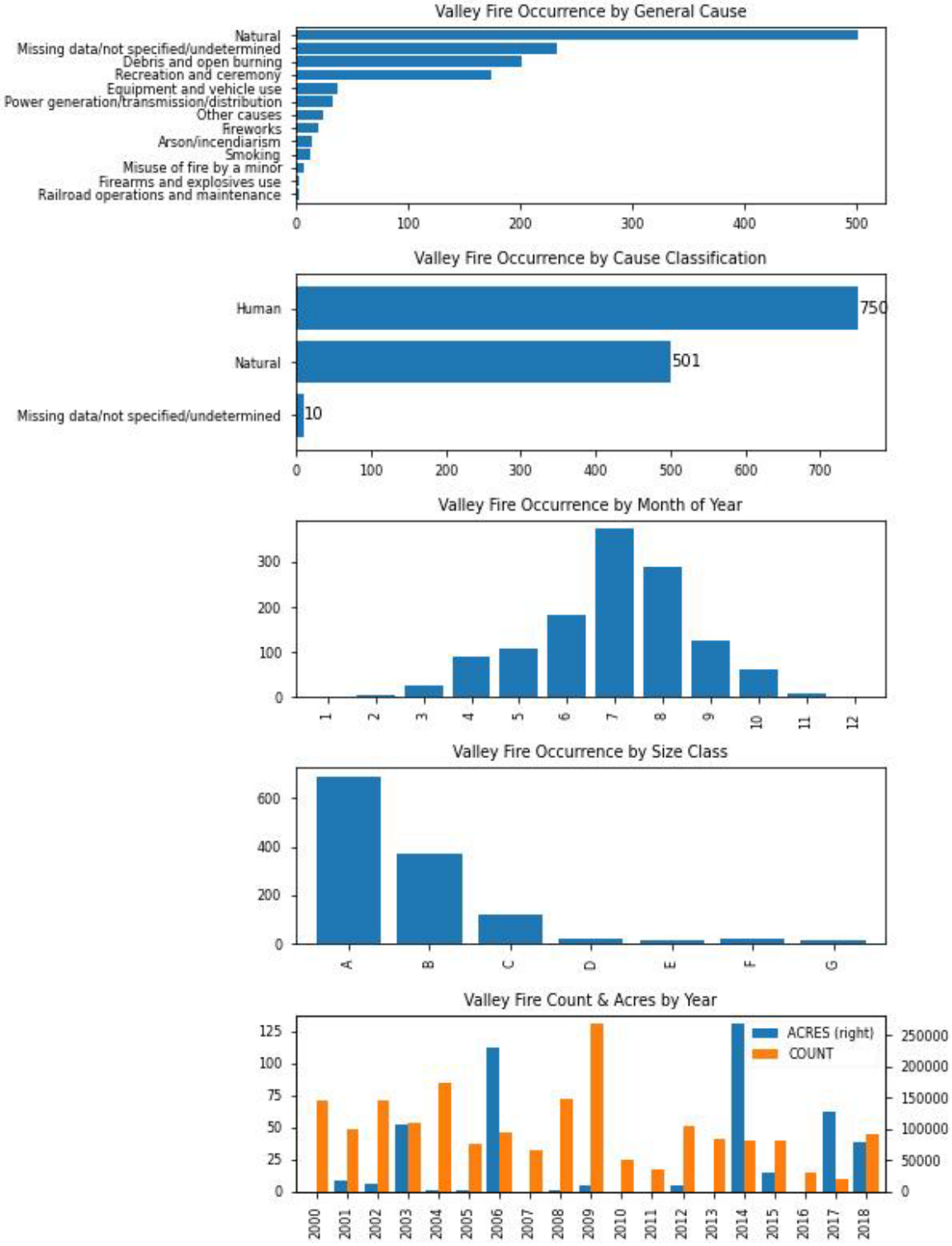


C.3.4 Lower Yakima



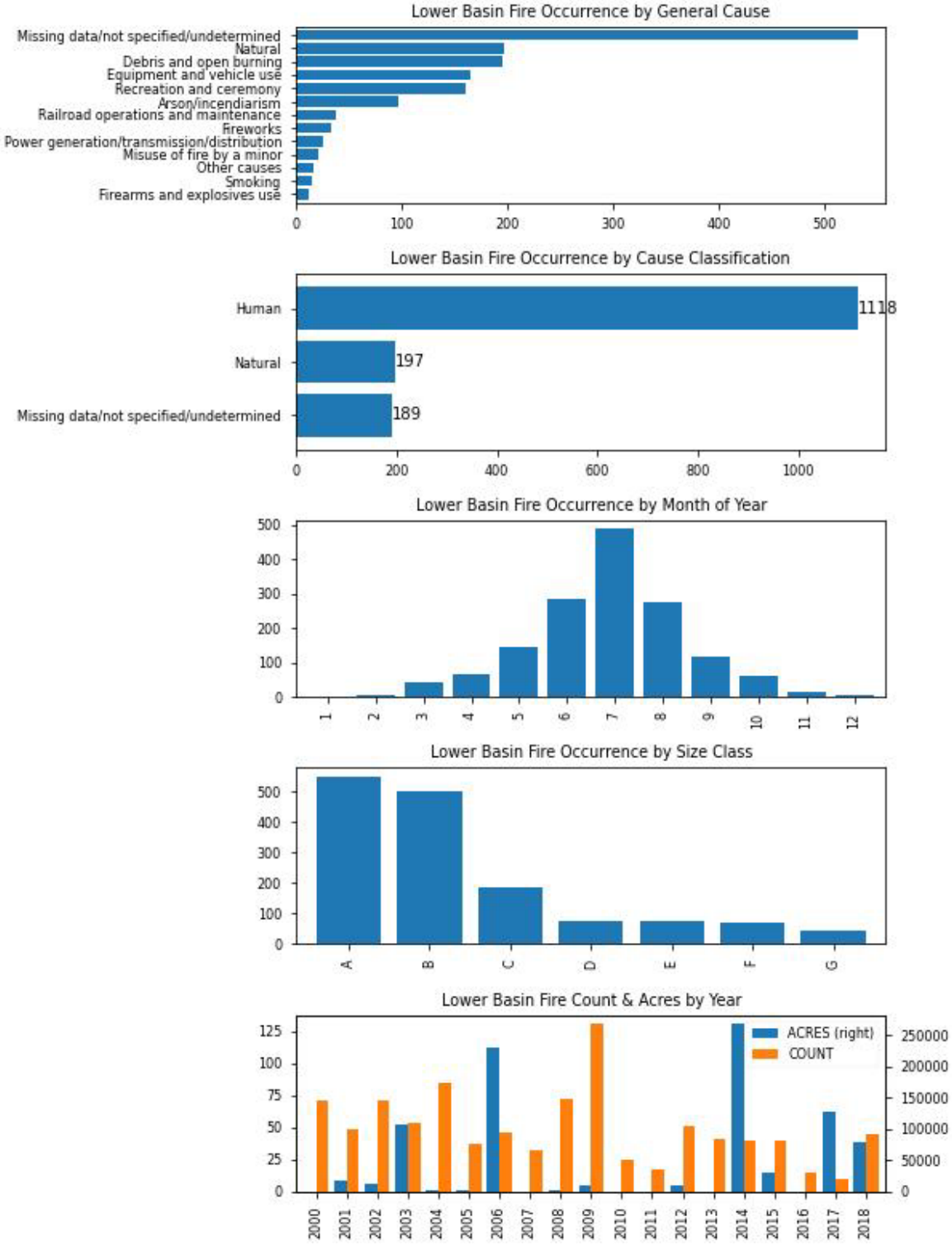
C.4 Columbia and Okanogan Valley

C.4.1 Valley

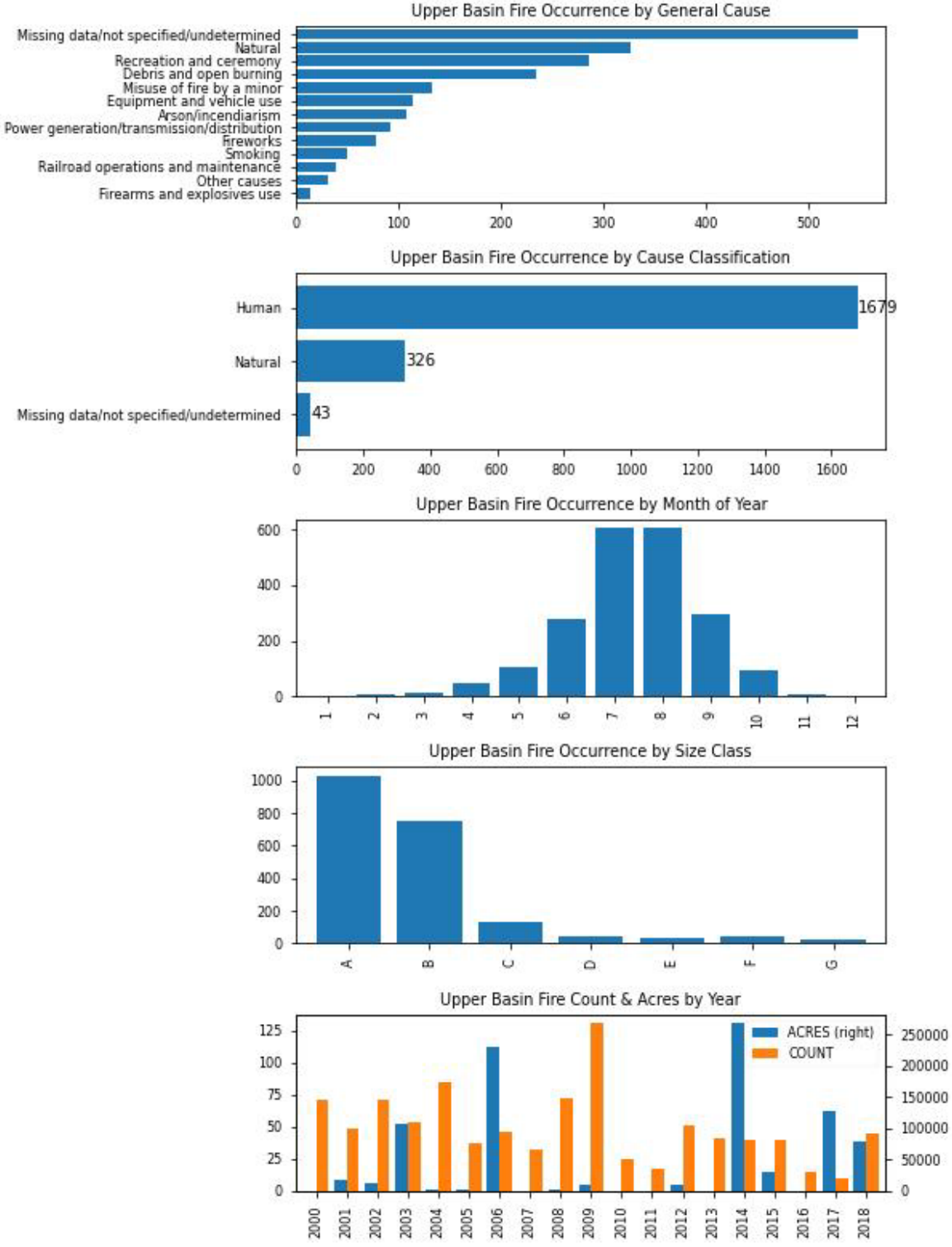


C.5 Columbia Basin (Lower and Upper Basin FDRAs)

C.5.1 Lower Basin

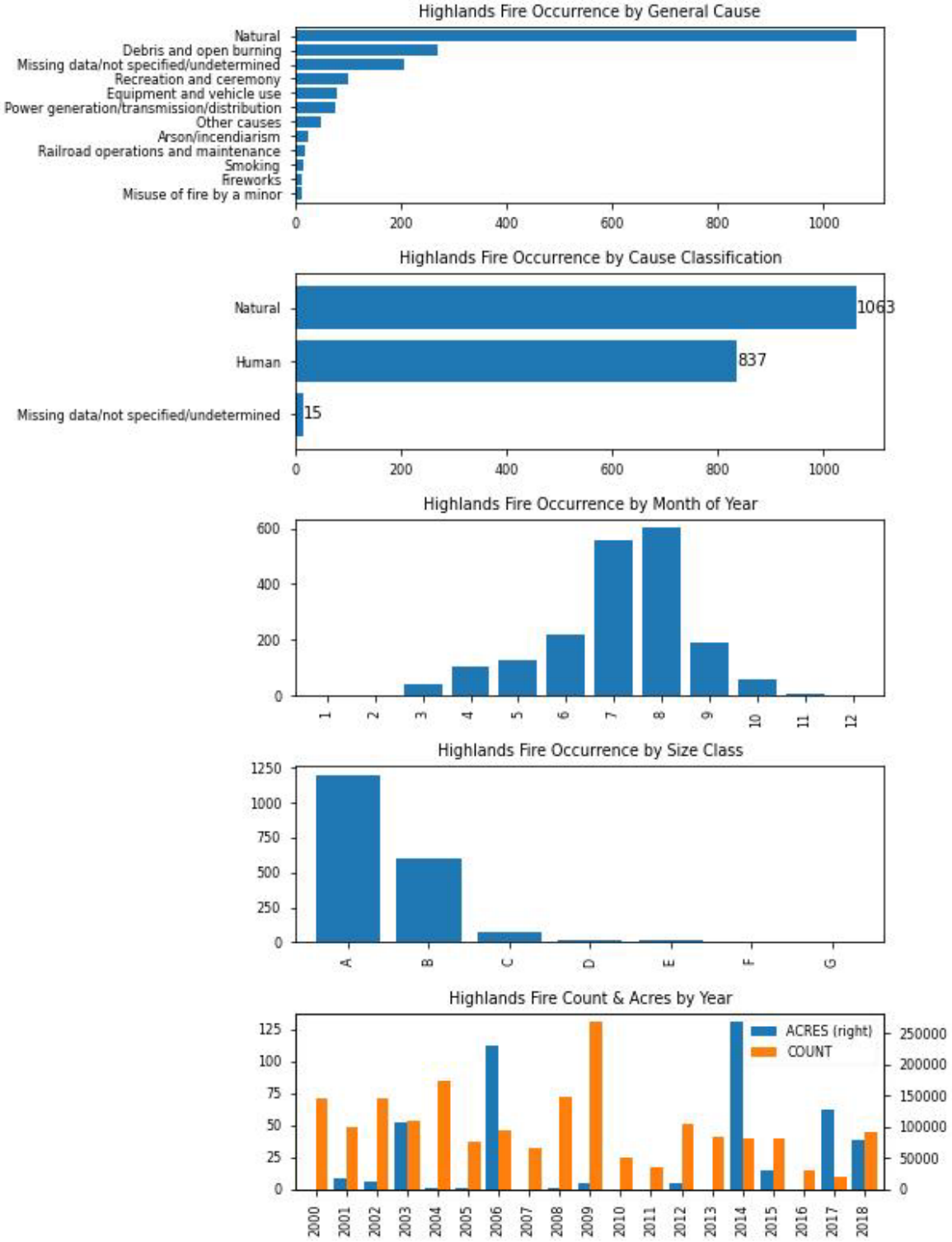


C.5.2 Upper Basin

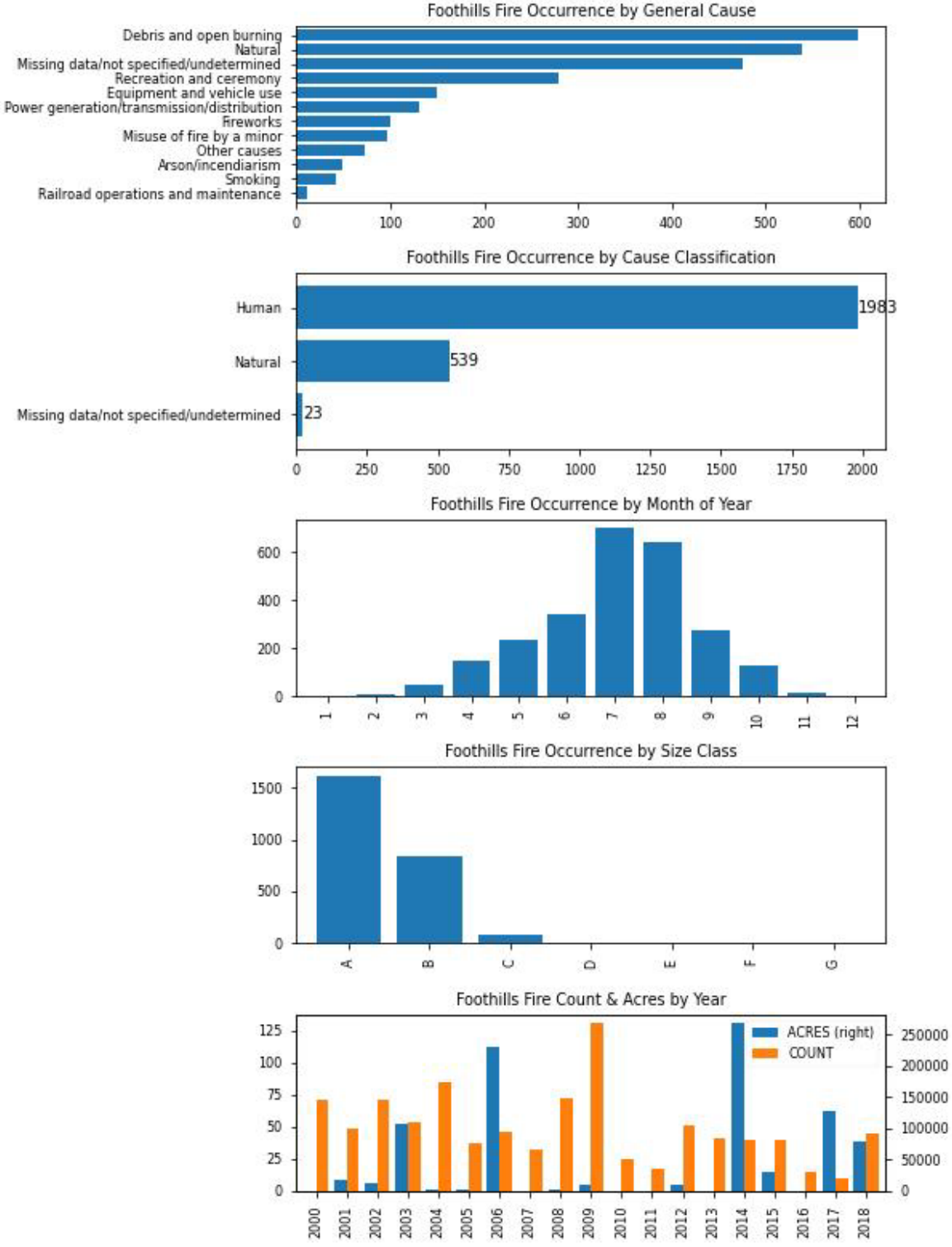


C.6 Northeastern (Foothills, Highlands, Kaniksu FDRAs)

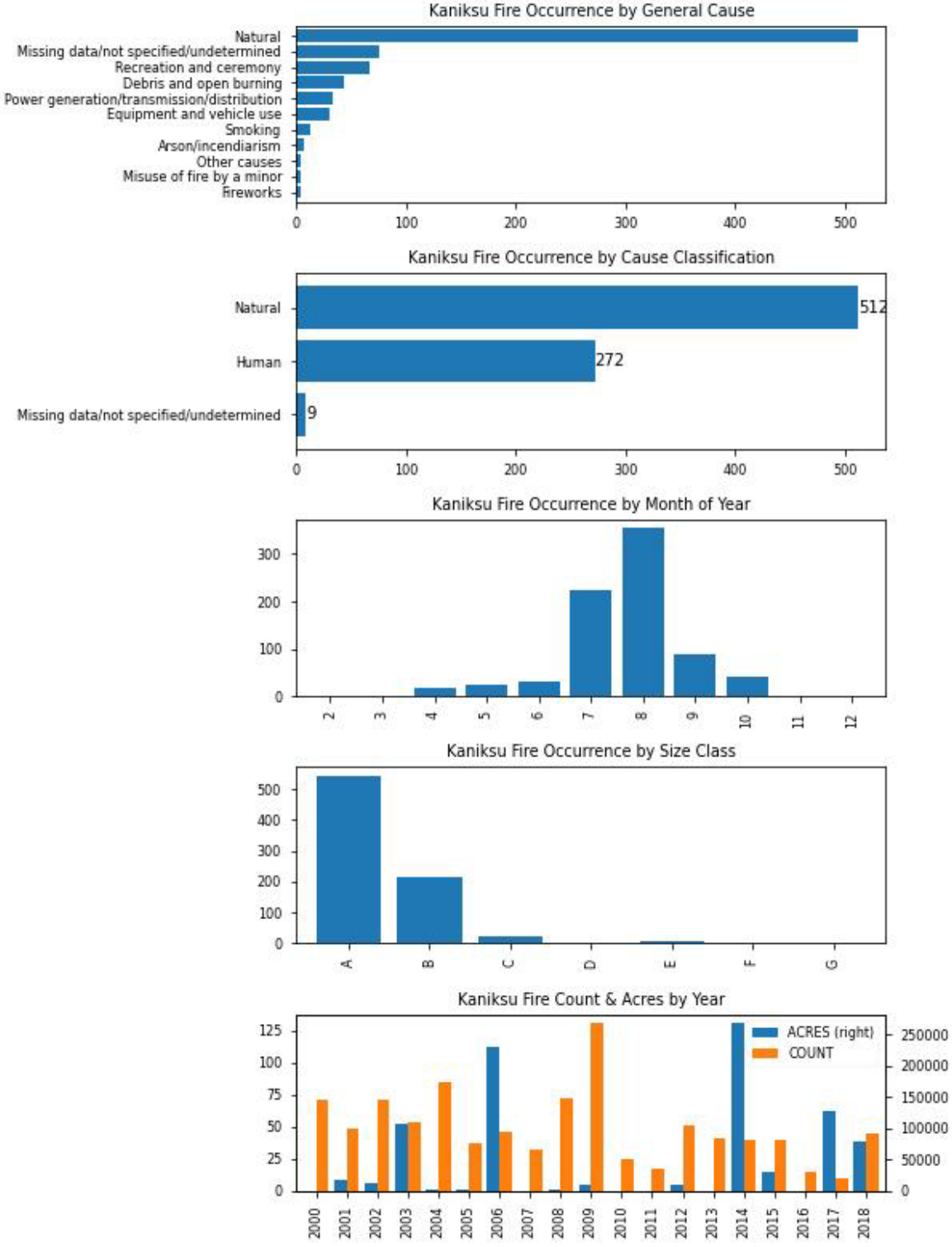
C.6.1 Highlands FDRA



C.6.2 Foothills



C.6.3 Kaniksu


Kaniksu Fire Occurrence by General Cause
Natural
Missing data/not specified/undetermined
Recreation and ceremony
Debris and open burning
Power generation/transmission/distribution
Equipment and vehicle use
Smoking
Arson/incendiarism
Other causes
Misuse of fire by a minor
Fireworks
0
100
200
300
400
500
Kaniksu Fire Occurrence by Cause Classification
Natural
Human
Missing data/not specified/undetermined
512
272
9
0
100
200
300
400
500
Kaniksu Fire Occurrence by Month of Year
0
100
200
300
2
3
4
5
6
7
8
9
10
11
12
Kaniksu Fire Occurrence by Size Class
0
100
200
300
400
500
A
B
C
D
E
F
G
Kaniksu Fire Count & Acres by Year
ACRES (right)
COUNT
0
25
50
75
100
125
0
50000
100000
150000
200000
250000
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018

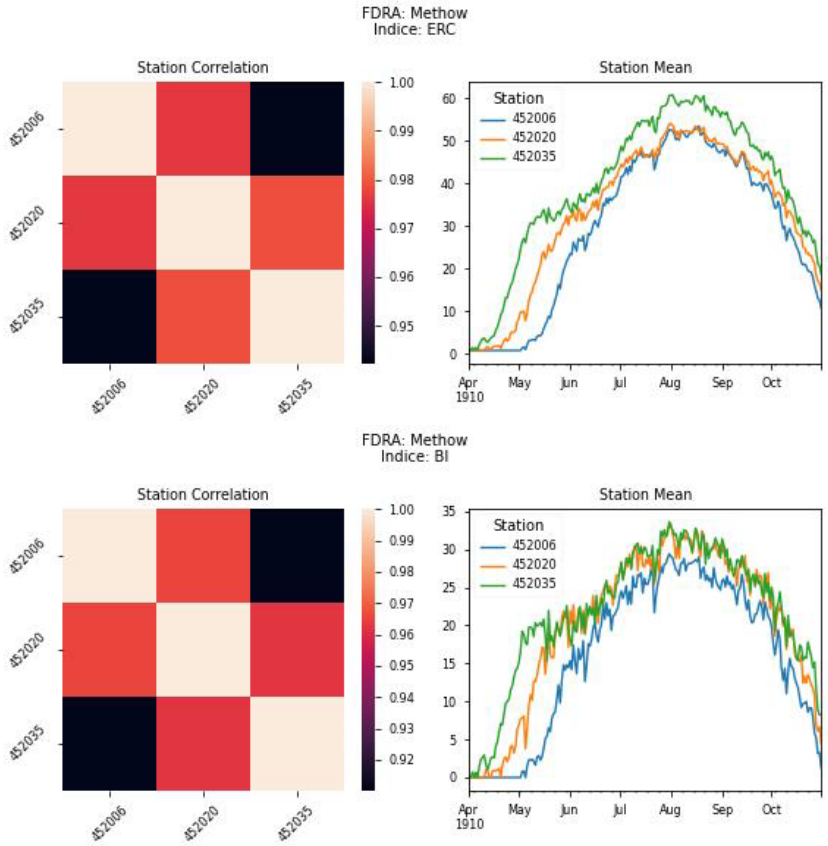
Appendix D: Weather Stations

D.1 Study Area Weather Station Selection

D.1.1 WACWC Fire Danger Rating Areas (East Slope Cascades, Valley, Columbia Basin)

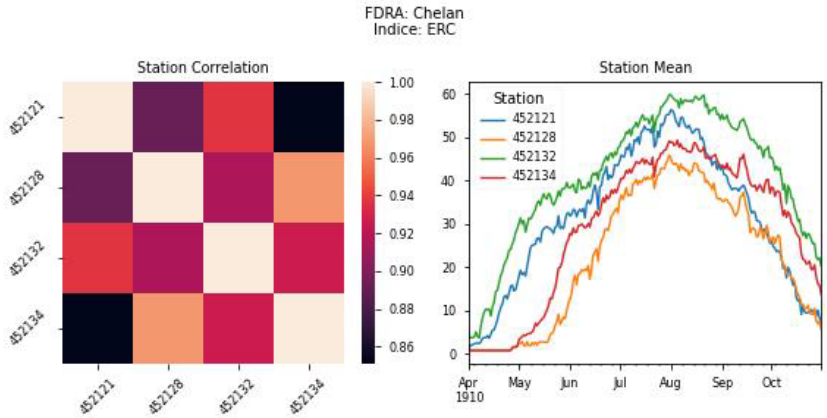
Methow

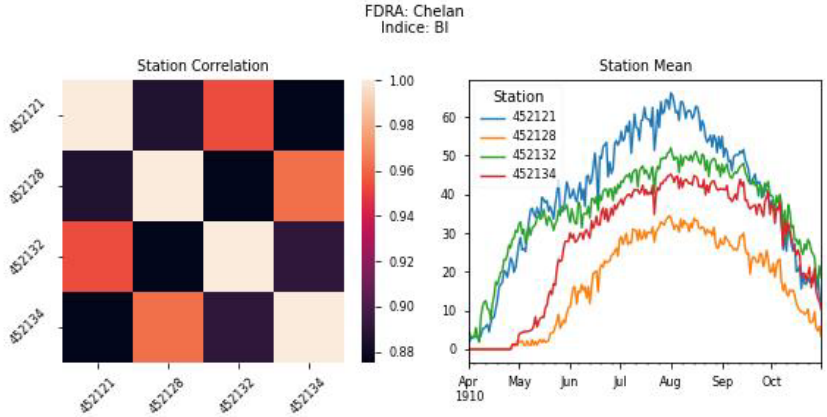
SIG (BI)	ROC+PR AUC (BI)	SIG (ERC)	ROC+PR AUC (ERC)
452035, 452020, 452006	3.883	**452035, 452006**	**3.912**
452035	3.876	452035	3.879
452035, 452006	**3.858**	452035, 452020, 452006	3.834
452035, 452020	3.809	452035, 452020	3.823
452020, 452006	3.723	452020, 452006	3.776



Chelan

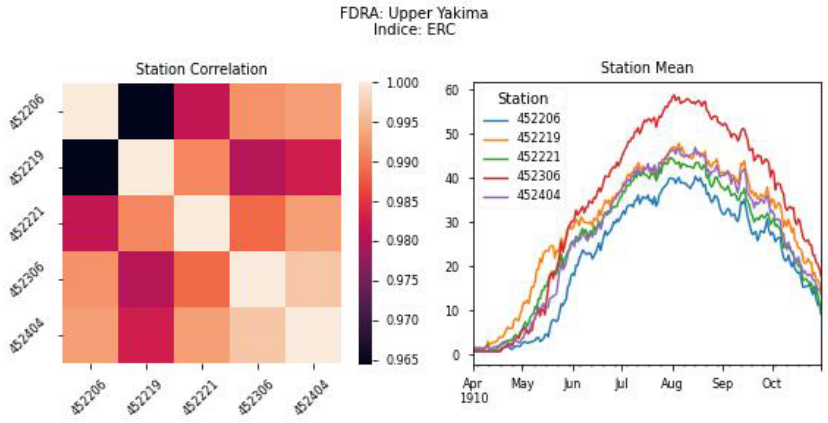
SIG (BI)	ROC+PR AUC (BI)	SIG (ERC)	ROC+PR AUC (ERC)
452134, 452132	**3.800**	**452134, 452132**	**3.873**
452134, 452128, 452132	3.784	452134, 452128, 452132	3.855
452128, 452132	3.763	452128, 452132	3.845
452134	3.751	452134	3.841
452134, 452132, 452121	3.749	452132	3.830

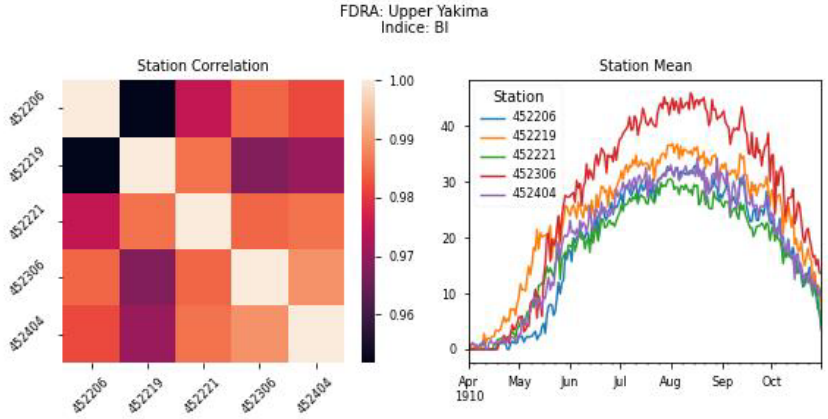




Upper Yakima

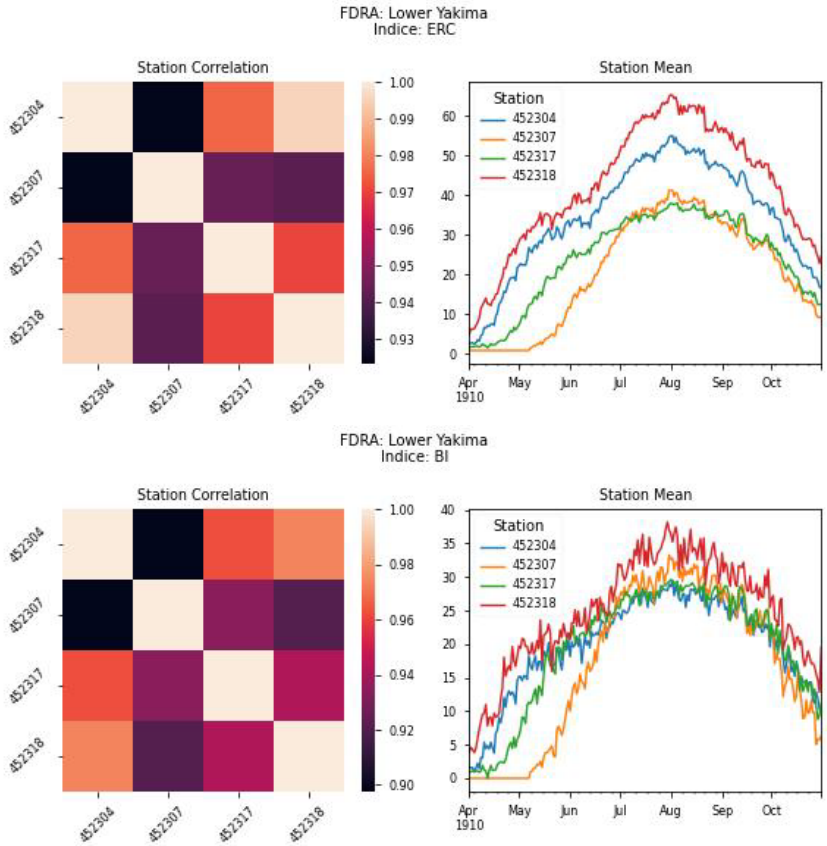
SIG (BI)	ROC+PR AUC (BI)	SIG (ERC)	ROC+PR AUC (ERC)
452306, 452221, 452206	4.233	452306, 452221, 452404	4.250
452221, 452206	4.231	452306	4.247
452306, 452206, 452219	4.231	452306, 452221, 452206	4.240
452221, 452206, 452219	4.207	452306, 452404	4.238
452306, 452221, 452219	**4.206**	**452306, 452221, 452219**	**4.237**





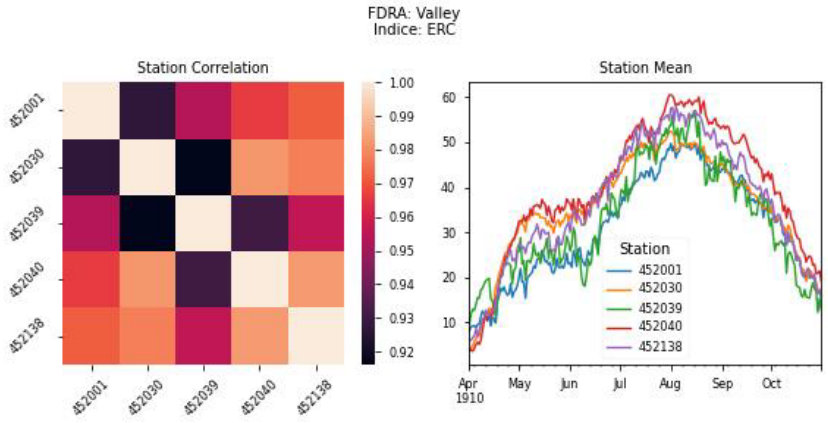
Lower Yakima

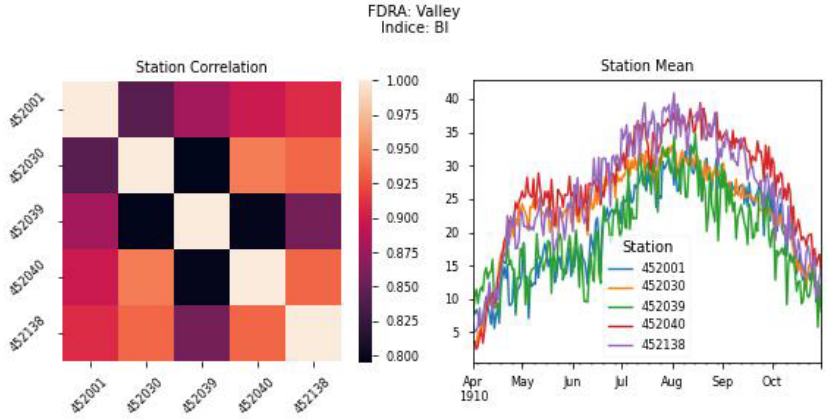
SIG (BI)	ROC+PR AUC (BI)	SIG (ERC)	ROC+PR AUC (ERC)
452318, 452317, 452307	3.329	452318, 452317, 452307	3.400
452317, 452307, 452304	**3.302**	**452317, 452307, 452304**	3.380
452317, 452307	3.257	452318, 452317	3.377
452317, 452304	3.220	452318, 452317, 452304	3.368
452307	3.162	452317, 452307	3.327



Valley

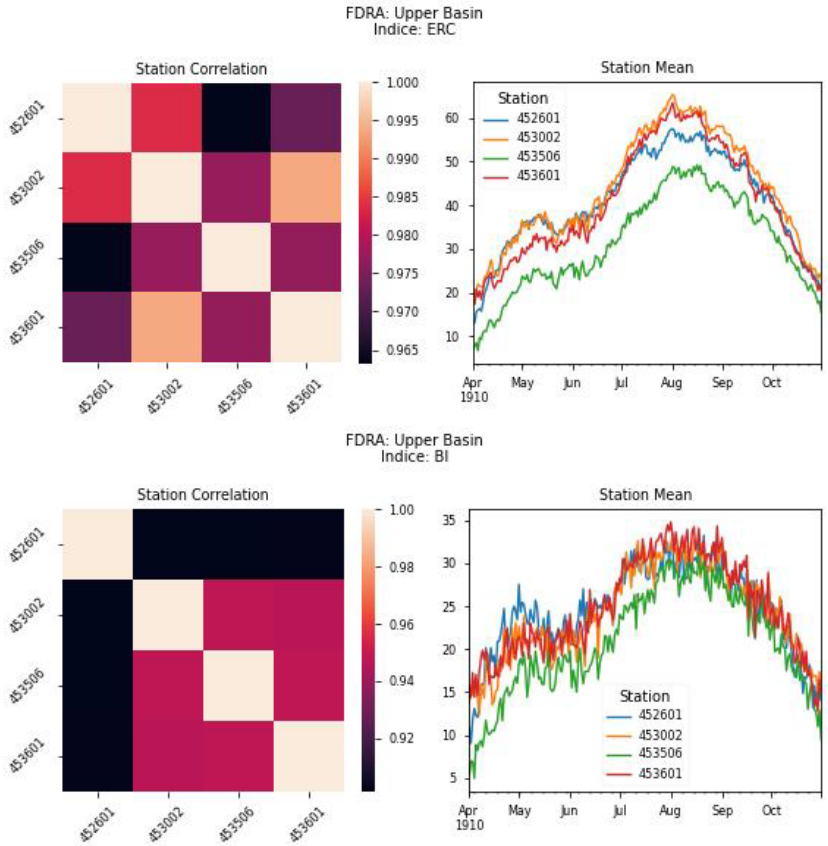
SIG (BI)	ROC+PR AUC (BI)	SIG (ERC)	ROC+PR AUC (ERC)
452040, 452138	3.646	452138, 452030, 452001	3.633
452040, 452138, 452030	**3.626**	452138, 452030	3.631
452138, 452030	3.594	**452040, 452138, 452030**	**3.620**
452138, 452030, 452001	3.592	452138	3.619
452040, 452138, 452001	3.587	452138, 452030, 452039	3.619





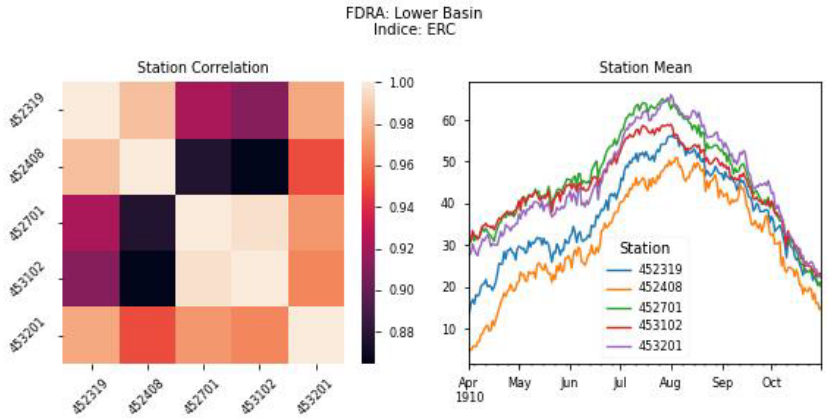
Upper Basin

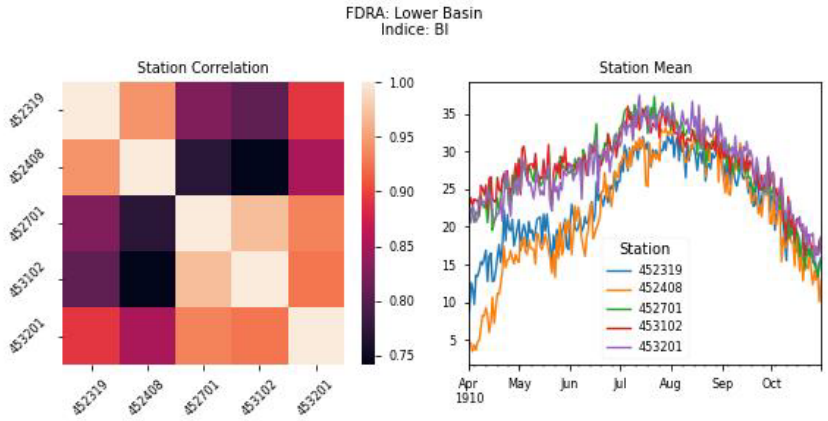
SIG (BI)	ROC+PR AUC (BI)	SIG (ERC)	ROC+PR AUC (ERC)
453002, 453601	**4.444**	**453002, 453601**	**4.547**
453601	4.402	453002, 453601, 453506	4.506
452601, 453002, 453601	4.380	452601, 453002, 453601	4.497
453002, 453601, 453506	4.371	453002, 453506	4.450
452601, 453601	4.318	453601	4.445



Lower Basin

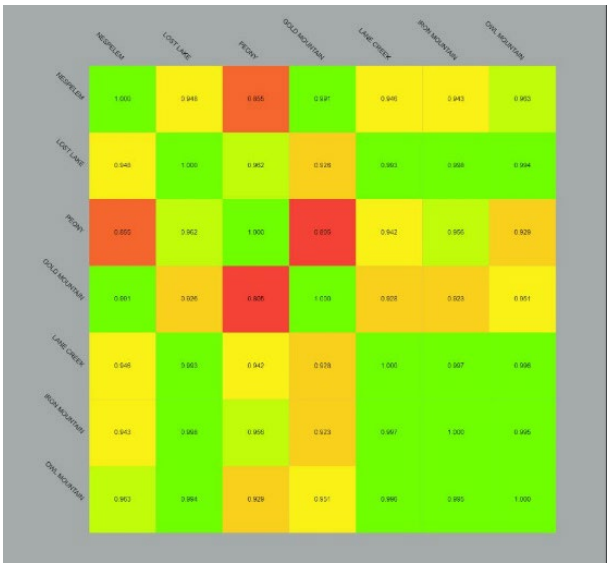
SIG (BI)	ROC+PR AUC (BI)	SIG (ERC)	ROC+PR AUC (ERC)
452701	3.616	452701	3.708
453201, 452701	3.574	**452701, 453102**	**3.617**
452701, 453102	**3.525**	453201, 452701	3.598
453201, 452701, 453102	3.482	453201, 452701, 453102	3.501
452408, 452701, 453102	3.444	453102	3.423

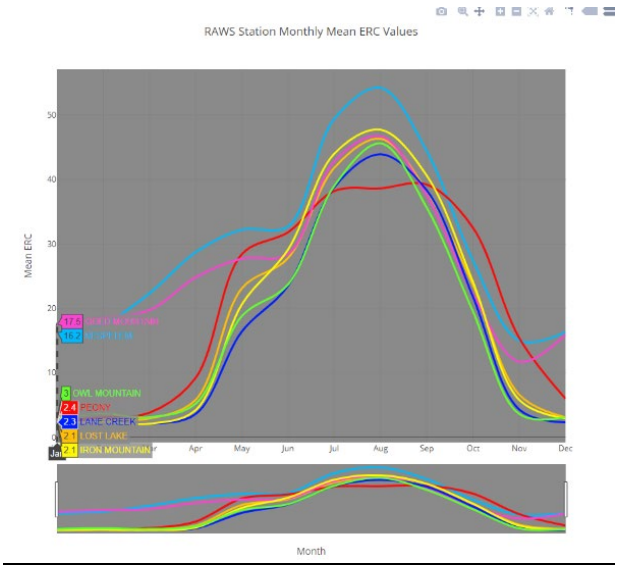




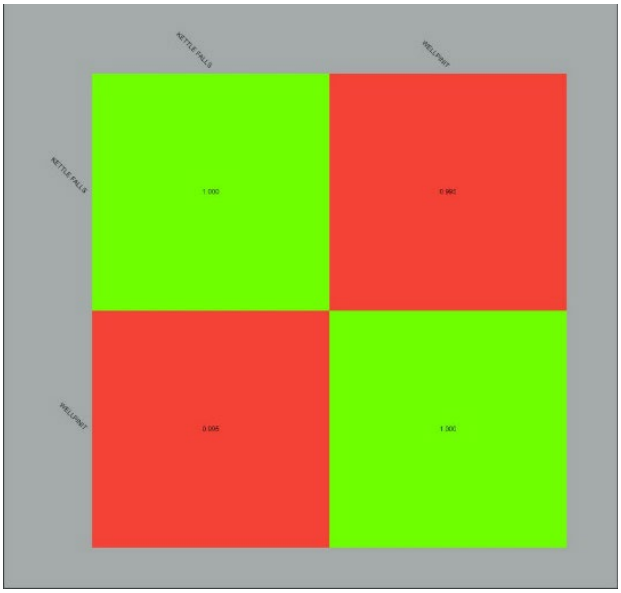
D.1.2 WANEC Fire Danger Rating Areas (Highlands, Foothills, Kaniksu)

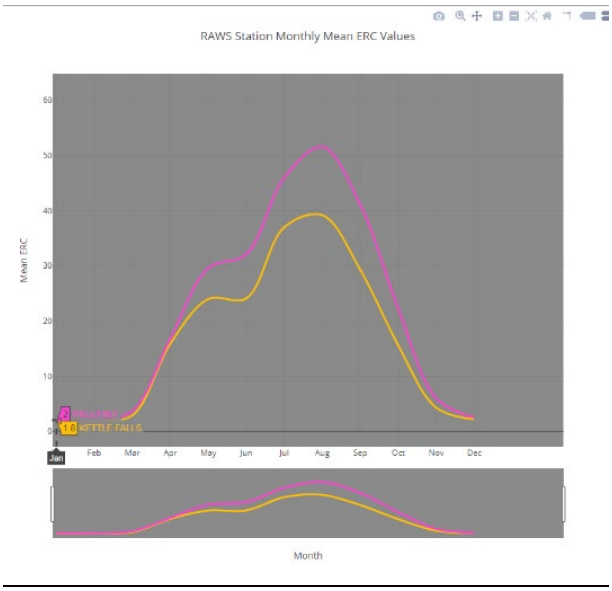
Highlands



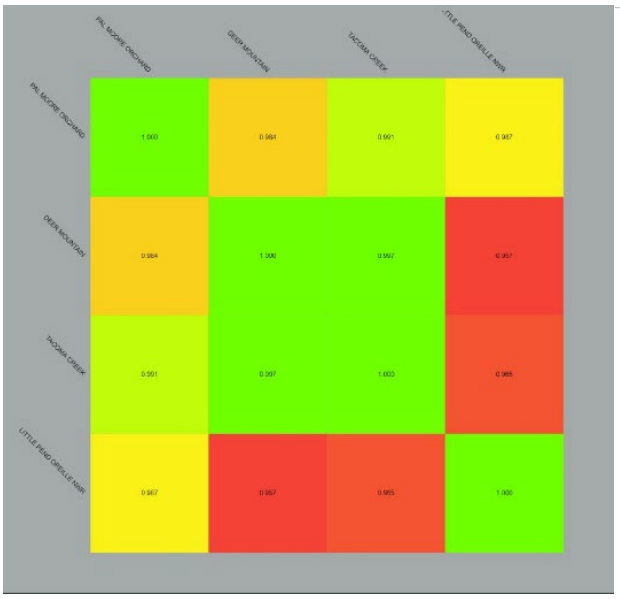


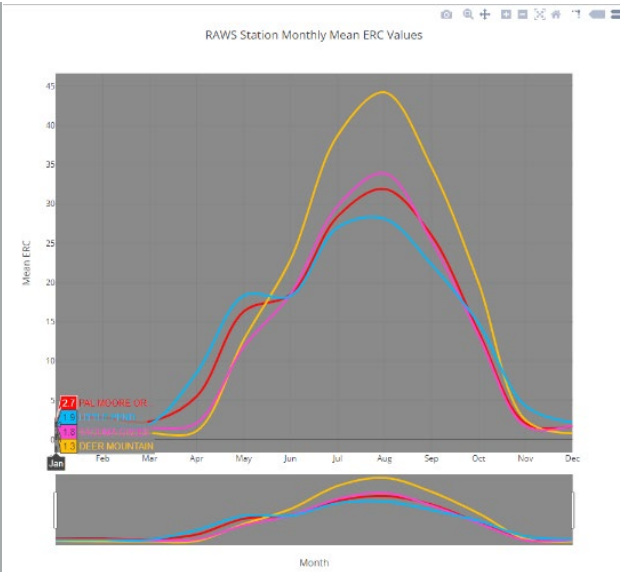
Foothills





Kaniksu


PAL MOORE ORCHARD
DEER MOUNTAIN
TACOMA CREEK
LITTLE PEND OREILLE NWR
1.000
0.984
0.991
0.987
0.984
1.000
0.997
0.987
0.991
0.997
1.000
0.985
0.987
0.987
0.985
1.000


RAWS Station Monthly Mean ERC Values
Mean ERC
45
40
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Z7 PAL MOORE OR
DEER MOUNTAIN
Month

D.2 Study Area Weather Station Summary

Note that this table is a relic of the previous plan. Assessing station data quality and completeness was not necessary for this iteration since gap-filled quality-controlled data was used.

RAWS NAME	NESDIS ID	NWS ID	OWNER	ELEV.	2006-2015 QUALITY	COMMENTS
BUCK CREEK	3261A52A	451917	FS-WAGPF	2690	POOR	BAD DATA
AENEAS	30074760	452001	WADNR-NE	5161	POOR	BAD DATA
FIRST BUTTE	3249A062	452006	FS-WAOWF	5509	GOOD	METHOW FDRA
LEECHER	326284C8	452020	FS-WAOWF	4991	GOOD	METHOW FDRA
NESPELEM	52119772	452028				NOT NFDR
LOST LAKE	3249D6F2	452029	FS-WAOWF	3876	GOOD	HIGHLANDS FDRA
NCSB	3249C584	452030	FS-WAOWF	1697	EXCELLENT	VALLEY FDRA
DOUGLAS INGRAM	3246936A	452035	FS-WAOWF	3566	GOOD	METHOW FDRA
PEONY	3260813C	452038	FS-WAOWF	3804	EXCELLENT	HIGHLANDS FDRA
OROVILLE	3243F14C	452039	BLM	1360	EXCELLENT	VALLEY FDRA
KRAMER	5210650C	452040	FS-WACOF	2720	EXCELLENT	VALLEY FDRA
STEHEKIN-AIRSTRIP	FA411054	452121	NPS-NOCA	1230	GOOD	CHELAN FDRA
VIEWPOINT	323807CC	452128	FS-WAOWF	3760	POOR	BAD DATA
CAMP 4	3245A1FE	452132	FS-WAOWF	3156	EXCELLENT	CHELAN FDRA
DRY CREEK	323814BA	452134	FS-WAOWF	3661	EXCELLENT	CHELAN FDRA
ENTIAT	3335C016	452138	FS-WAOWF	2825		ONLY 3 YEARS DATA
PEOH POINT	3000804A	452206	WADNR-SE	4020	GOOD	YAKIMA FDRA
SWAUK	3245B288	452219	FS-WAOWF	3480	GOOD	YAKIMA FDRA
SAWMILL FLATS	3245C418	452221	FS-WAOWF	3000	GOOD	YAKIMA FDRA
MILL CREEK	32640212	452304	BIA-YAKAMA	2928	EXCELLENT	YAKAMA FDRA
SEDGE RIDGE	300070CE	452306	WADNR-SE	4533	GOOD	YAKIMA FDRA
SIGNAL PEAK	3263F0A2	452307	BIA-YAKAMA	5052	GOOD	YAKAMA FDRA
TEPEE CREEK	52105096	452317	BIA-YAKAMA	2980	GOOD	YAKAMA FDRA
HIGHBRIDGE	52125562	452318	BIA-YAKAMA	2106	GOOD	YAKAMA FDRA
GRAYBACK	3000A6A6	452404	WADNR-SE	3766	GOOD	KITTITAS FDRA
GOLDENDALE EAST	300731F0	452408	WADNR-SE	2481		NO DATA AFTER 2009
GOLD MOUNTAIN	52118404	452510	FS-WACOF	4636	EXCELLENT	HIGHLANDS FDRA
LANE CREEK	32458712	452511	FS-WACOF	4430	GOOD	HIGHLANDS FDRA
IRON MOUNTAIN	333390A4	452512	FS-WACOF	4350	GOOD	HIGHLANDS FDRA
OWL MOUNTAIN	3262C7C2	452513	FS-WACOF	3560	POOR	BAD DATA
BROWN MTN. ORCH	326297BE	452514				NOT NFDR
DOUGLAS	32649770	452601	BLM	2530	POOR	BAD DATA
SADDLE MOUNTAIN	8374F59C	452701	USFWS	650	EXCELLENT	LOWER FDRA
PAL MOORE ORCHA	32459464	452915	FS-WACOF	3120	POOR	BAD DATA
KETTLE FALLS	FA501530	452916	NPS-LARO	1310	EXCELLENT	FOOTHILLS FDRA
CEDAR CREEK ORCH	32318784	452917				NOT NFDR
WELLPINIT	83756204	452918	BIA-SPOKANE	2240	EXCELLENT	FOOTHILLS FDRA
SPRING CANYON	FA500646	453002	NPS-LARO	1340	GOOD	UPPER FDRA
COLUMBIA NWR (O	83743082	453102	USFWS	890	EXCELLENT	LOWER FDRA
FLOWERY TRAIL	323194F2	453145				NOT NFDR
JUNIPER DUNES	3264A2EA	453201	BLM	950	EXCELLENT	LOWER FDRA
DEER MOUNTAIN	32457796	453412	FS-WACOF	3330	POOR	BAD DATA
TACOMA CREEK	3262A224	453413	FS-WACOF	3240	GOOD	KANIKSU FDRA
TEEPEE SEED ORCHA	3231D7F8	453414				NOT NFDR
LITTLE PEND OREILL	83745564	453416	USFWS	2020	EXCELLENT	KANIKSU FDRA
CHENEY	837460FE	453506				NOT NFDR
DOUGLAS (ESCURE)	3244756C	453601	BLM	1725	GOOD	UPPER FDRA
FAIRCHILD 36 RQF	AA1094C8	NO WIMS ID				NOT NFDR
BIG BLUE	32A18970	NO WIMS ID	WADNR-SE			INSTALLED 2018

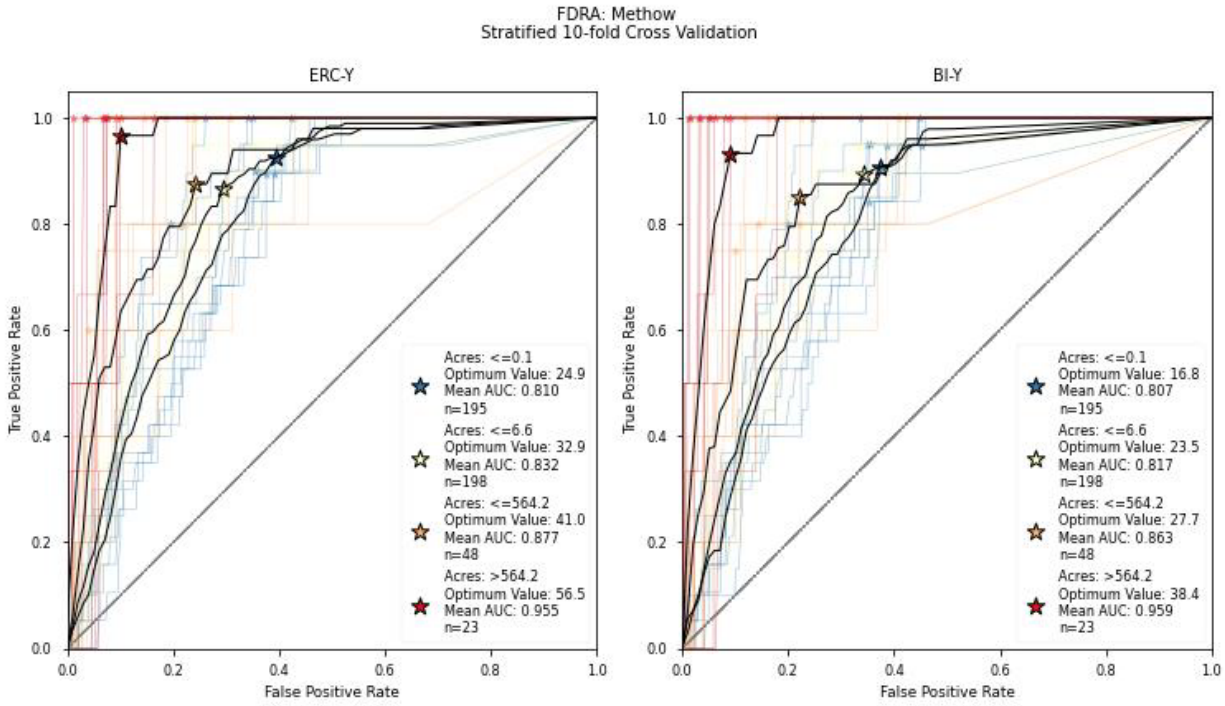
Appendix E: Fire Business Analysis

E.1 Decision Points

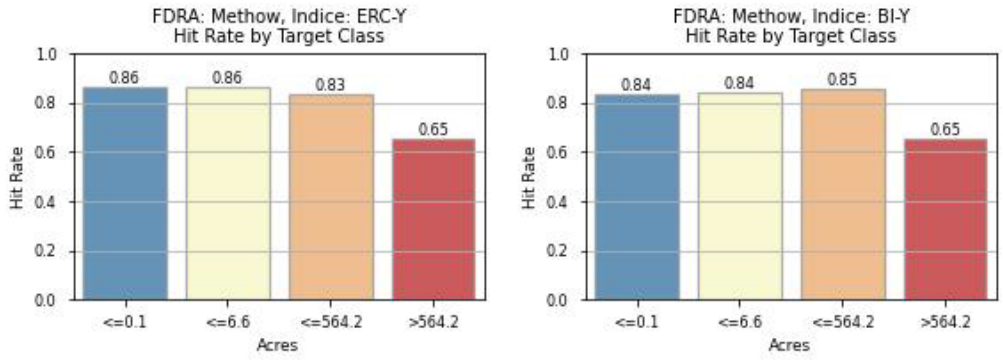
E.1.1 East Slope Cascades (Chelan, Methow, Lower and Upper Yakima FDRAs)

Methow FDRA

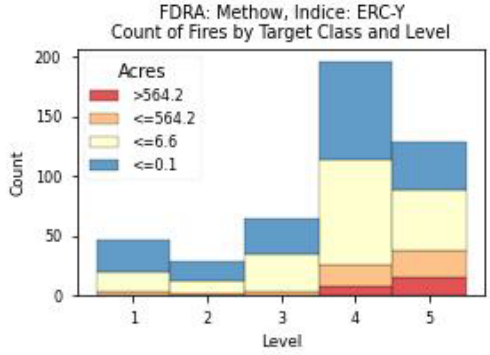
Receiver Operating Characteristic Curve & Optimal Thresholds

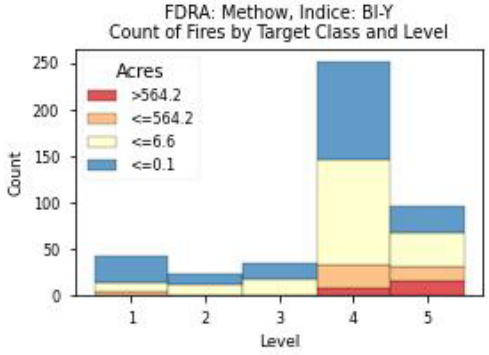


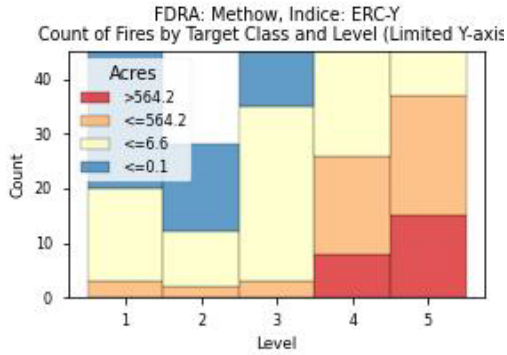
Optimal Threshold Model Performance

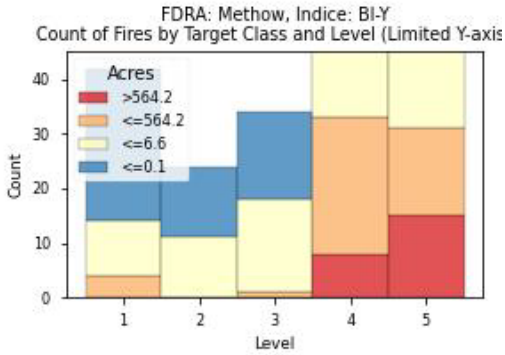


Optimal Threshold Classified Fire Business

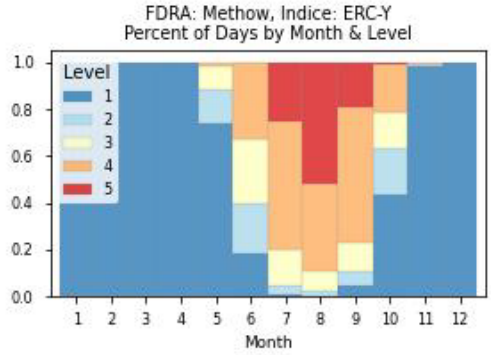


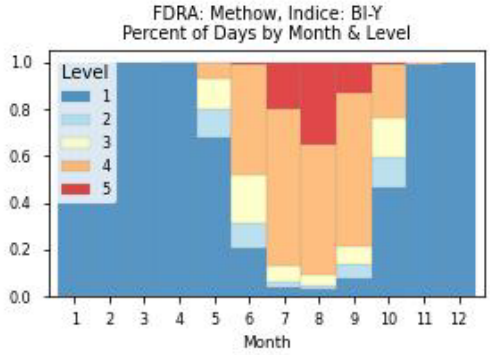




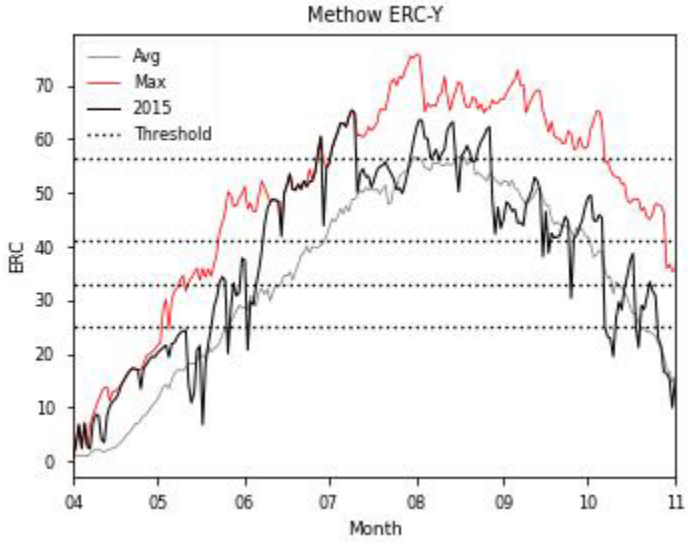


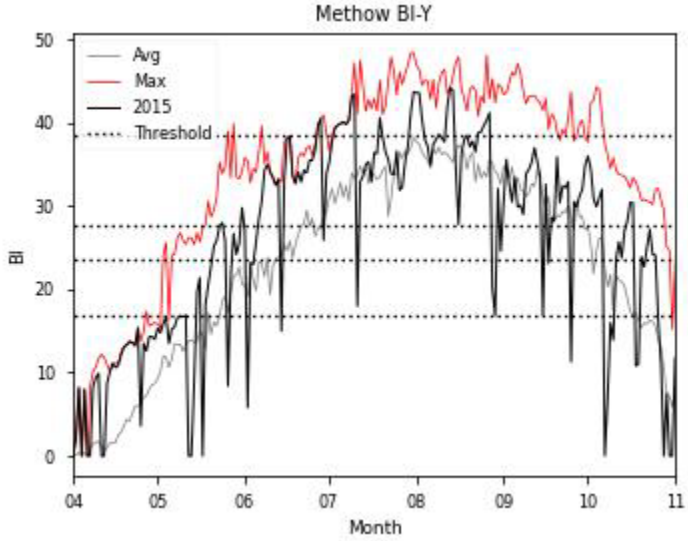
Optimal Threshold Classified Annual Days





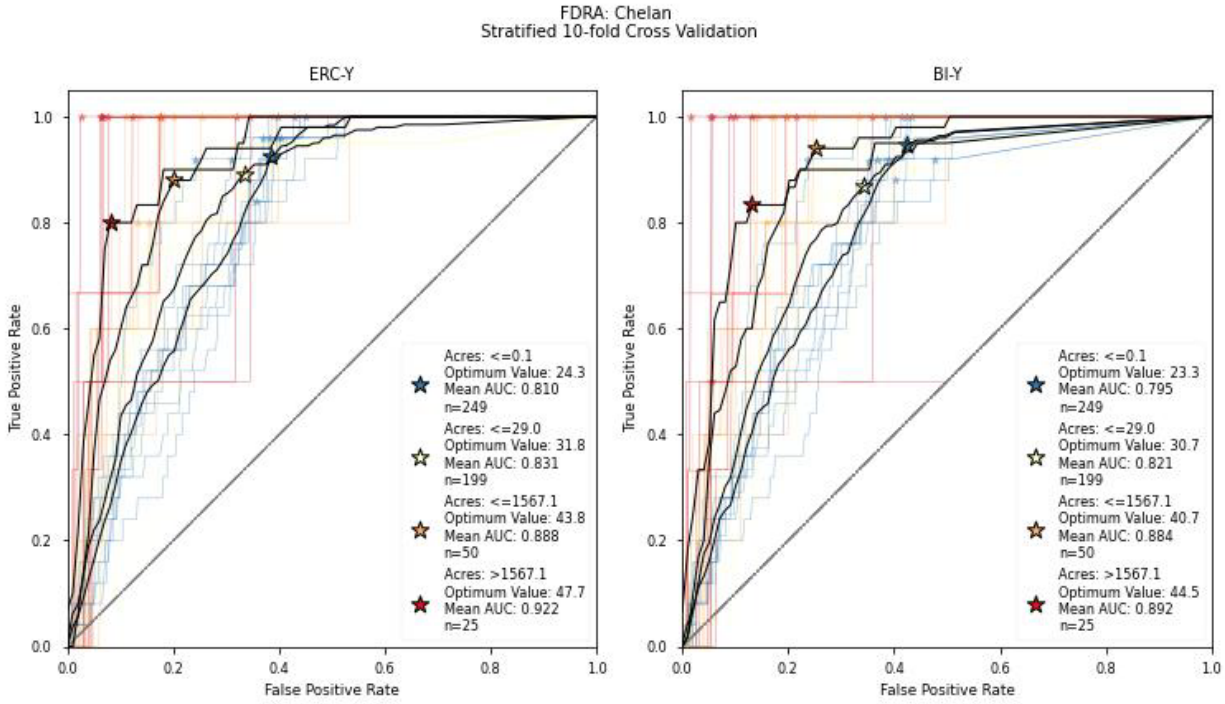
Optimal Threshold Fire Season



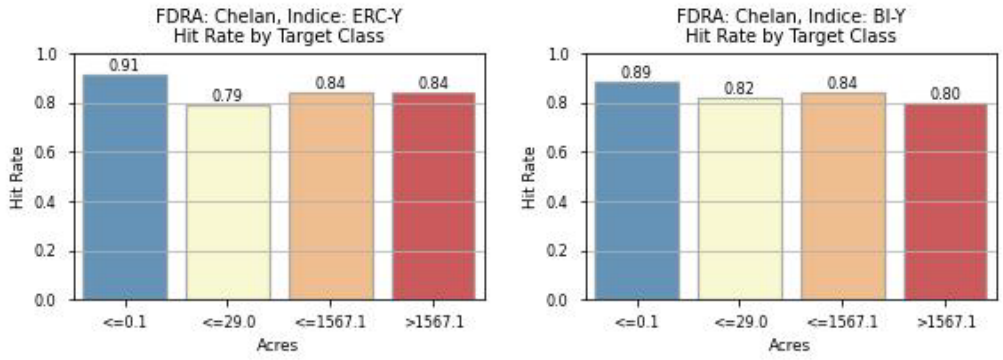


Chelan FDRA

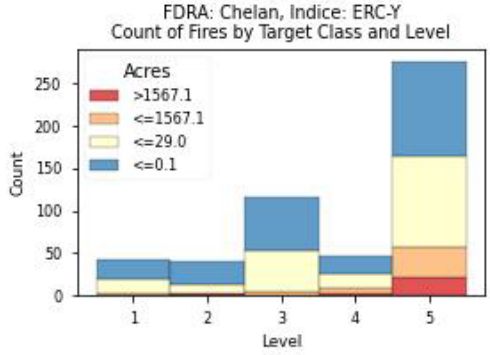
Receiver Operating Characteristic Curve & Optimal Thresholds

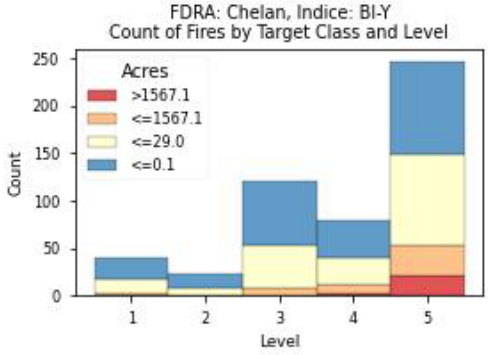


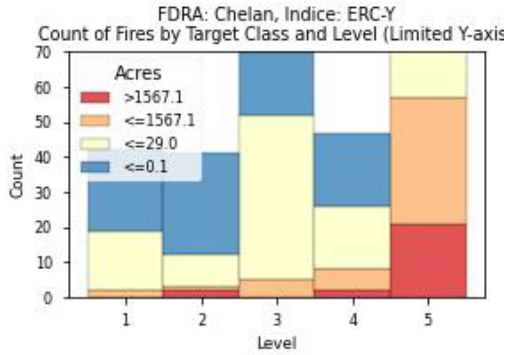
Optimal Threshold Model Performance

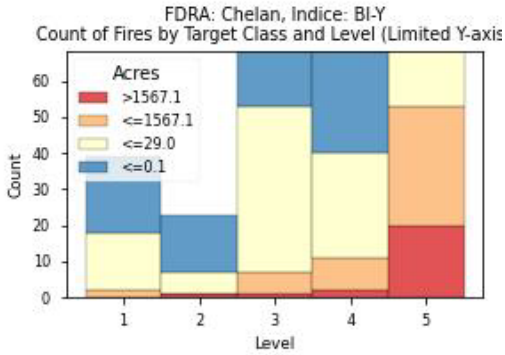


Optimal Threshold Classified Fire Business

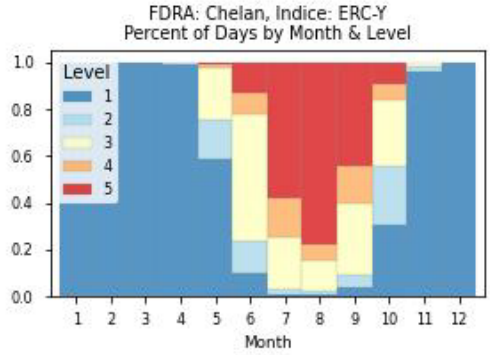


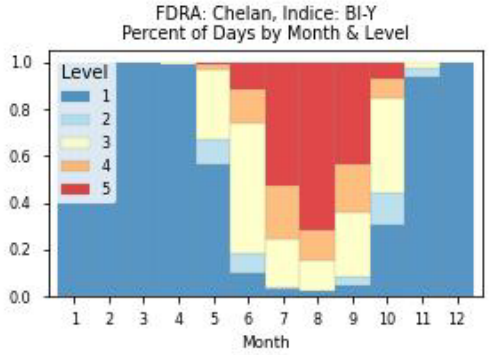




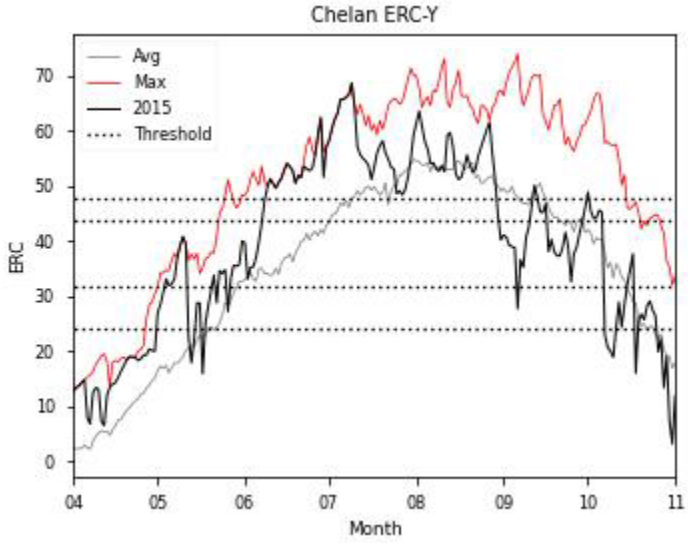


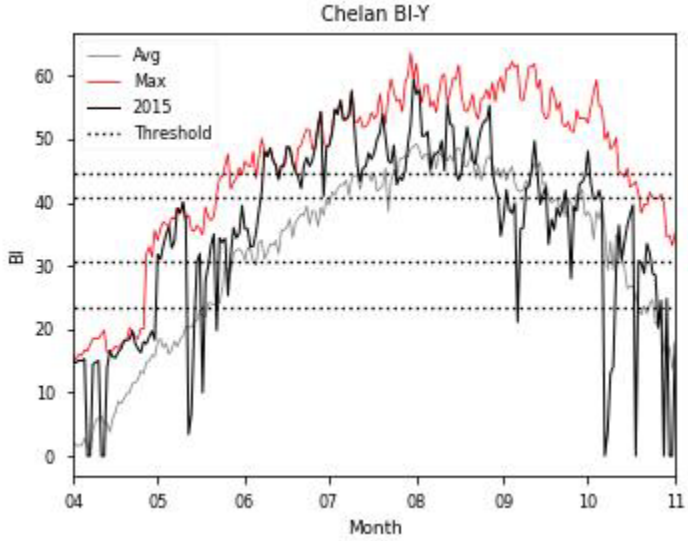
Optimal Threshold Classified Annual Days





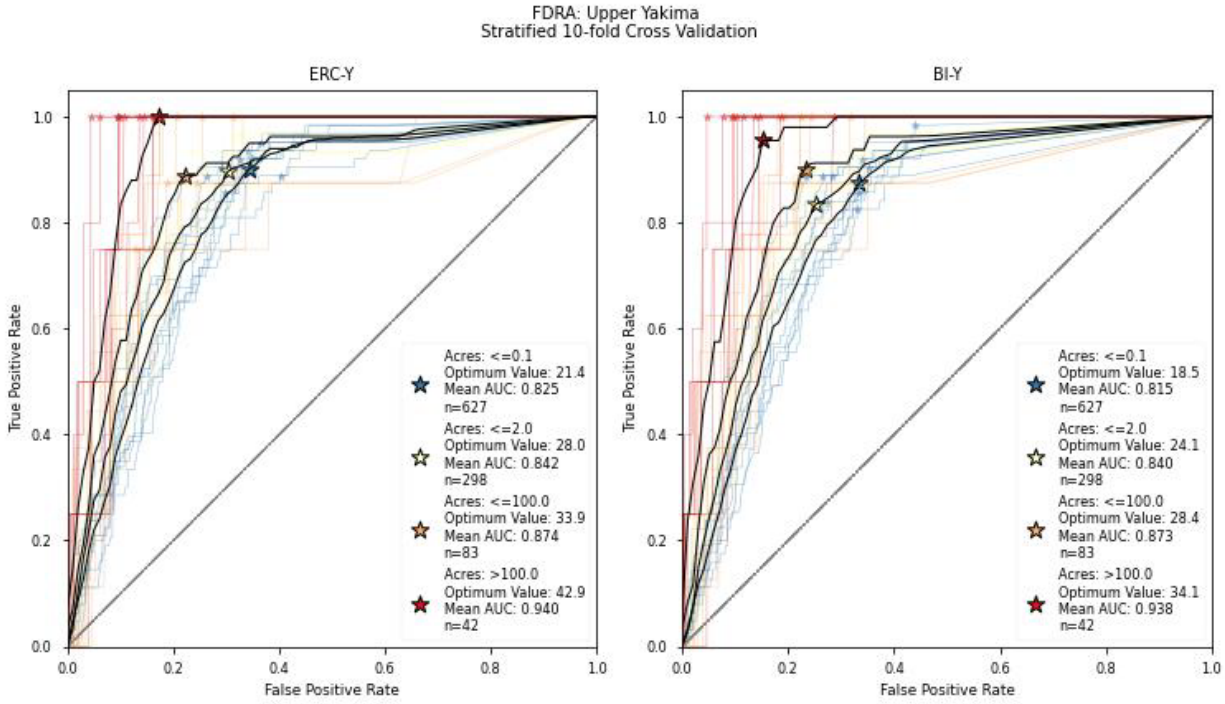
Optimal Threshold Fire Season



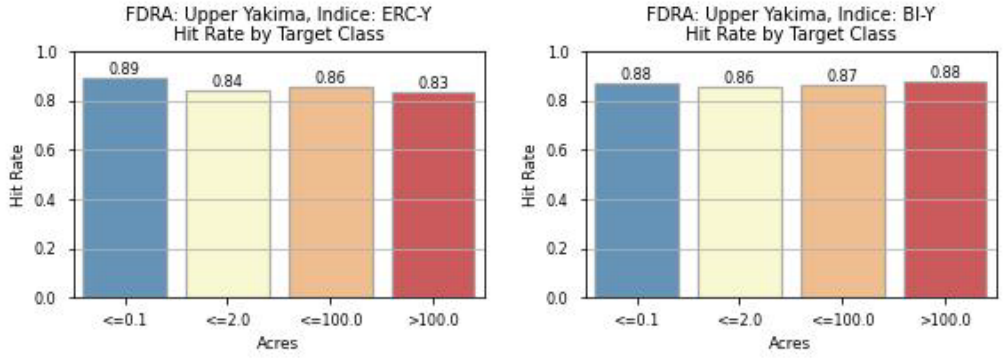


Upper Yakima FDRA

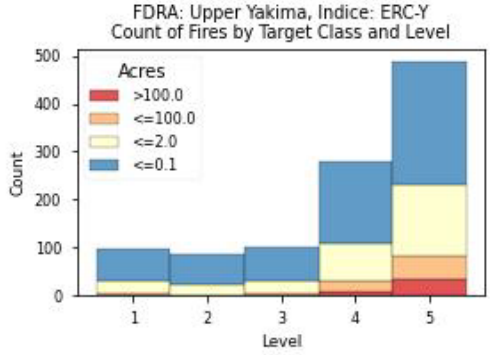
Receiver Operating Characteristic Curve & Optimal Thresholds

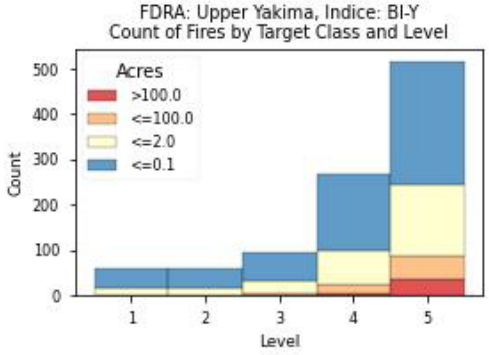


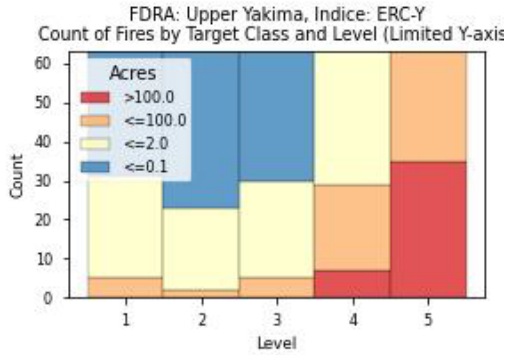
Optimal Threshold Model Performance

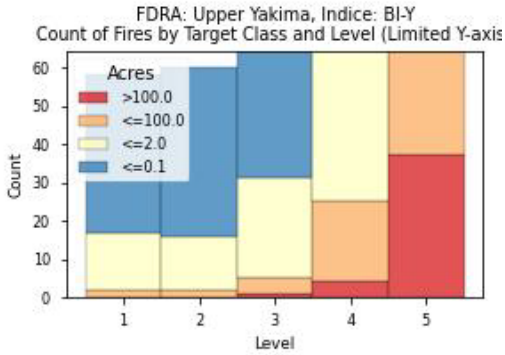


Optimal Threshold Classified Fire Business

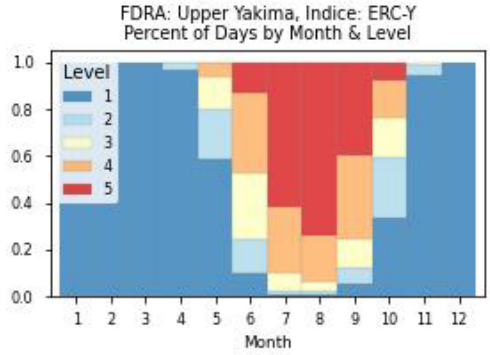


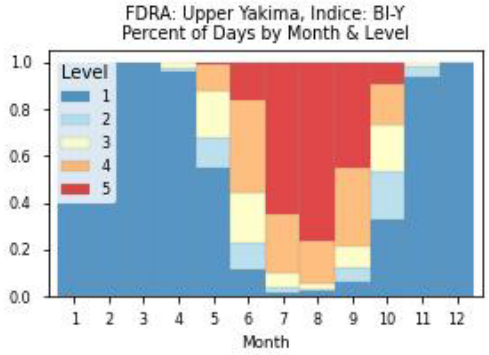




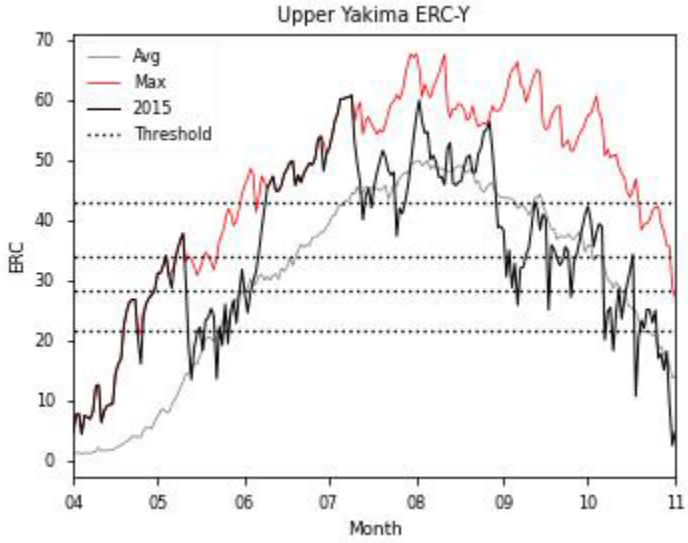


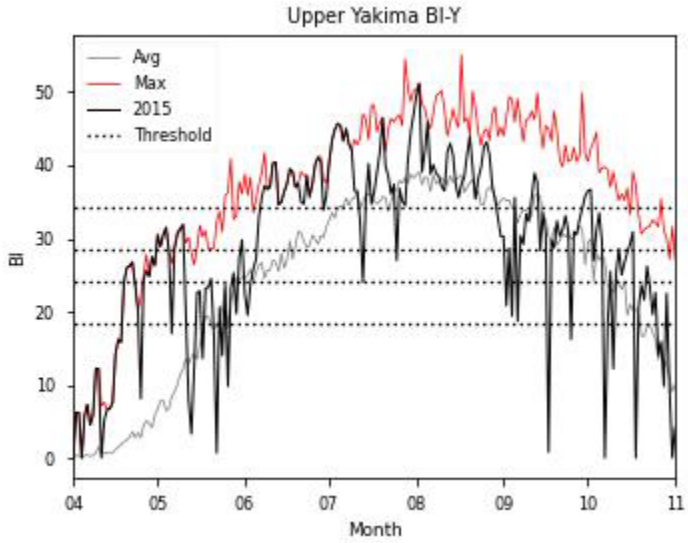
Optimal Threshold Classified Annual Days





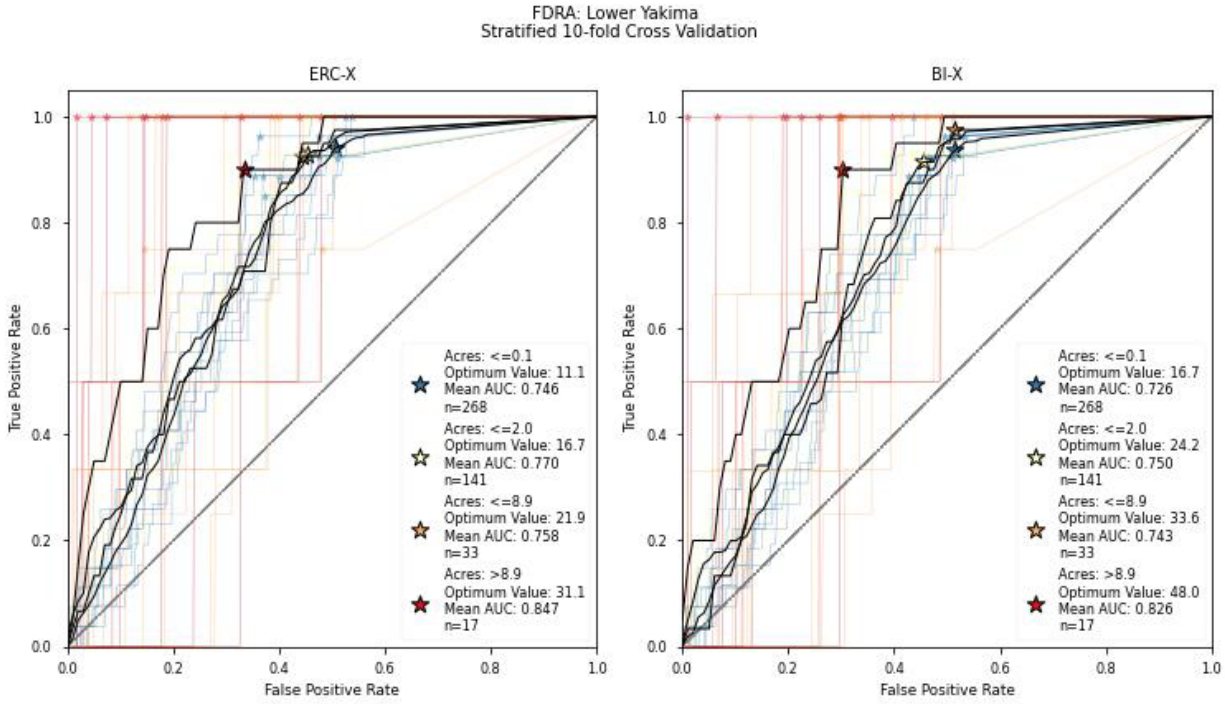
Optimal Threshold Fire Season



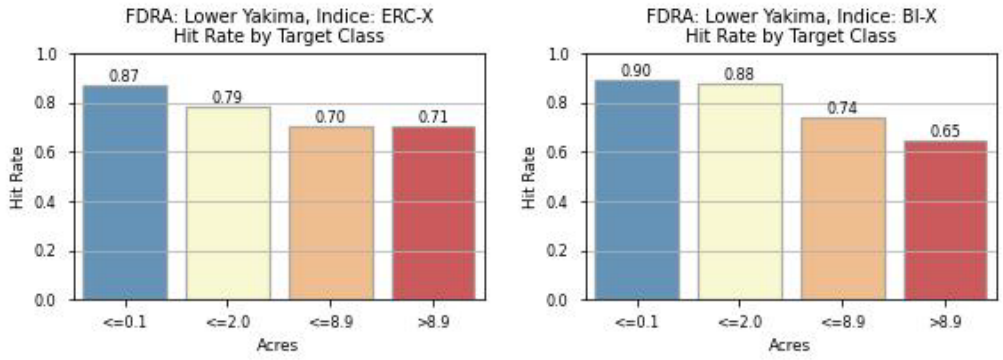


Lower Yakima FDRA

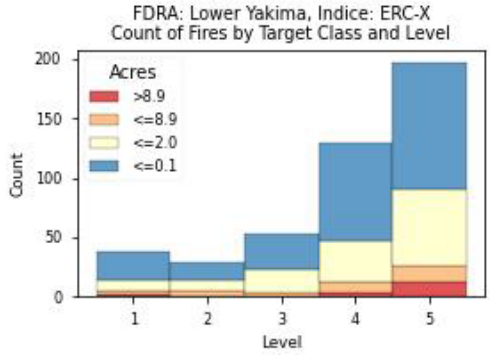
Receiver Operating Characteristic Curve & Optimal Thresholds

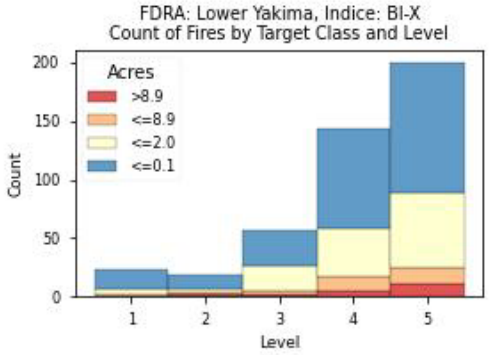


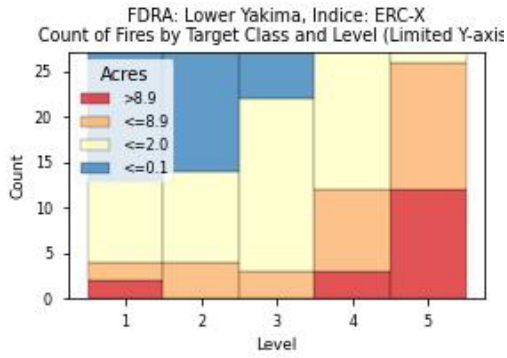
Optimal Threshold Model Performance

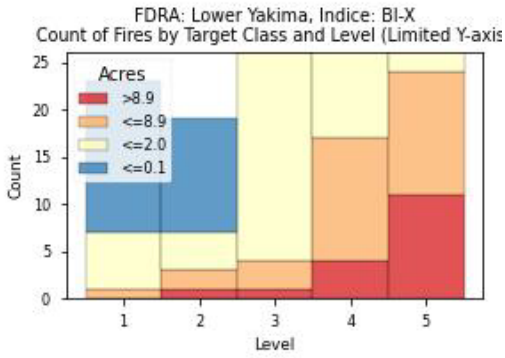


Optimal Threshold Classified Fire Business

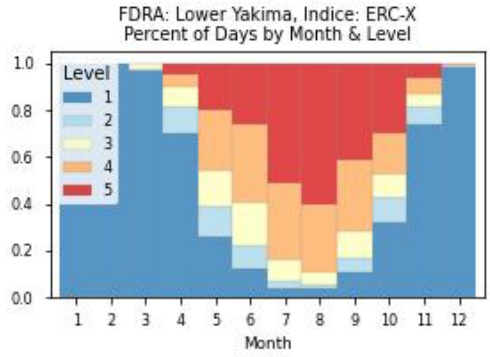


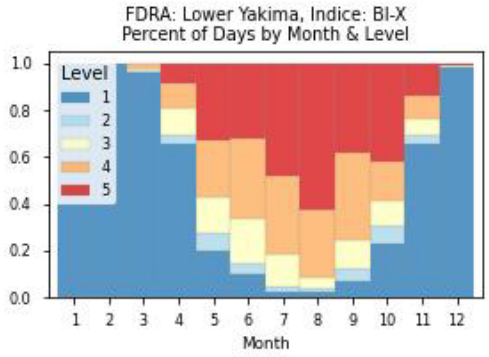




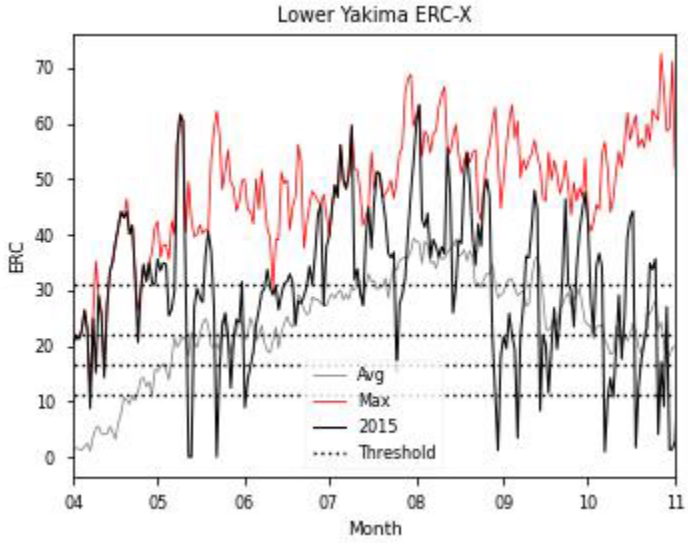


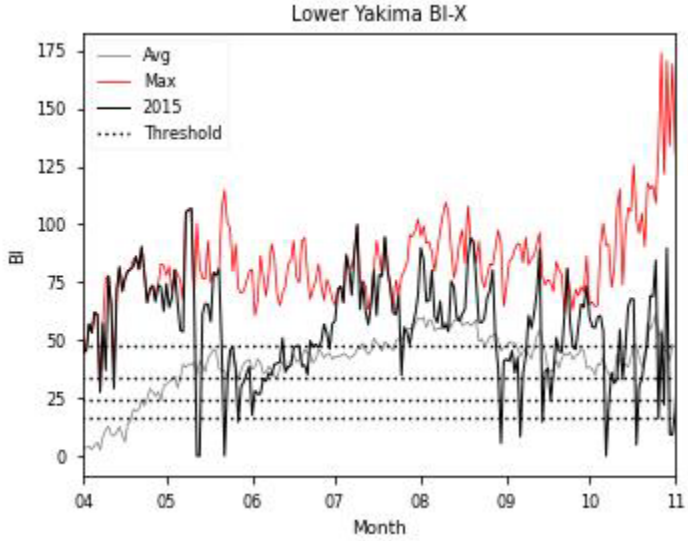
Optimal Threshold Classified Annual Days





Optimal Threshold Fire Season

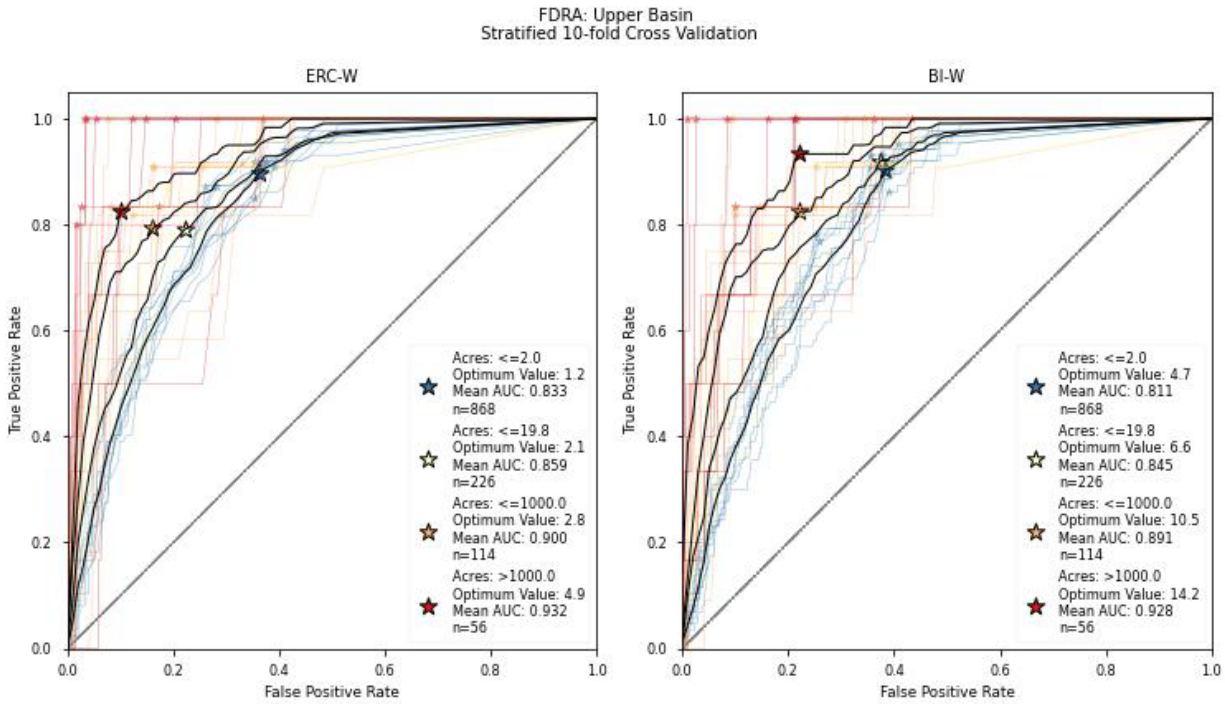




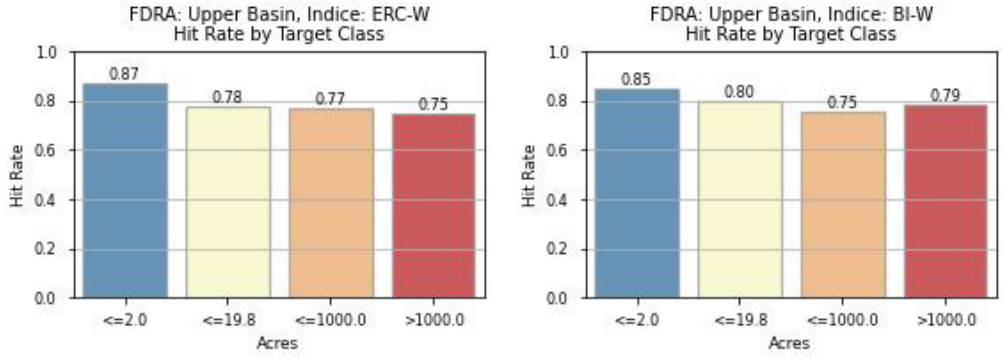
E.1.3 Columbia Basin (Lower and Upper Basin FDRAs)

Upper Basin FDRA

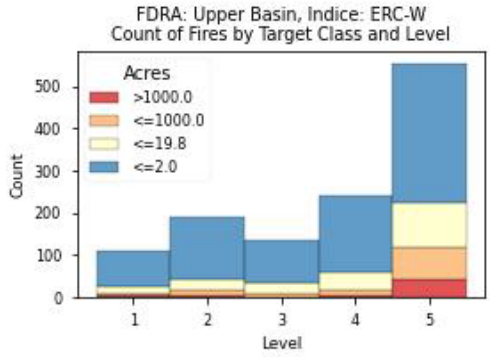
Receiver Operating Characteristic Curve & Optimal Thresholds

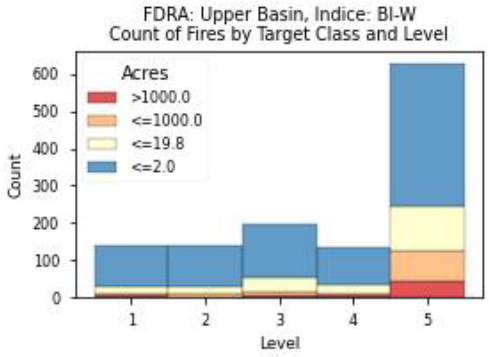


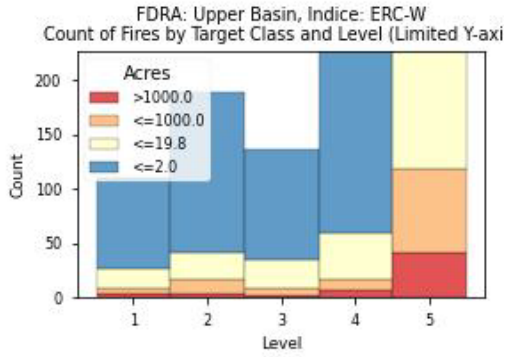
Optimal Threshold Model Performance

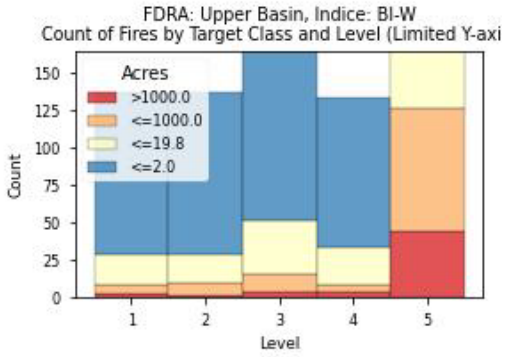


Optimal Threshold Classified Fire Business

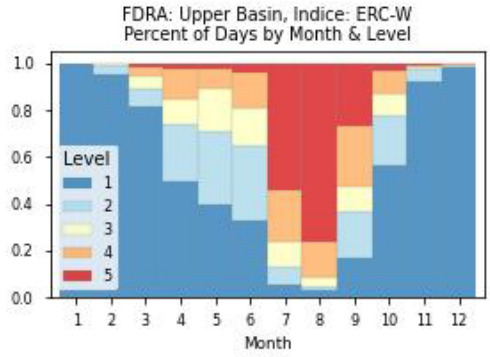


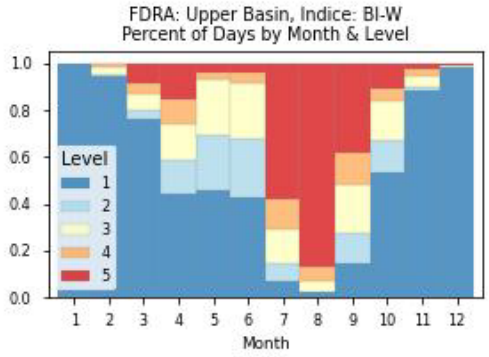




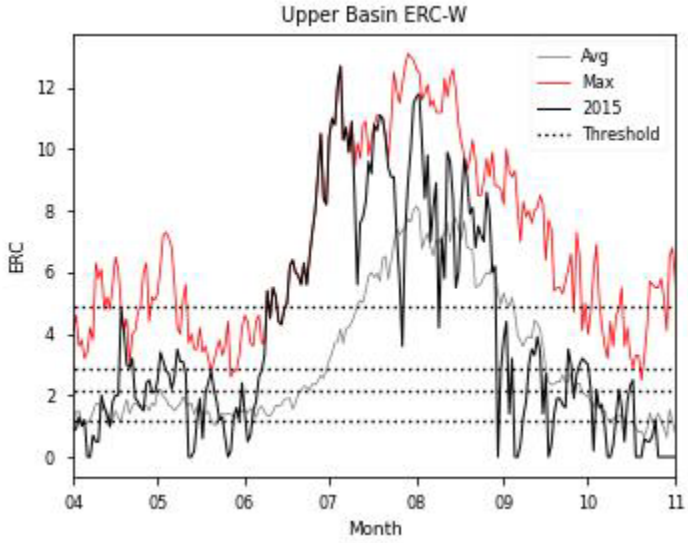


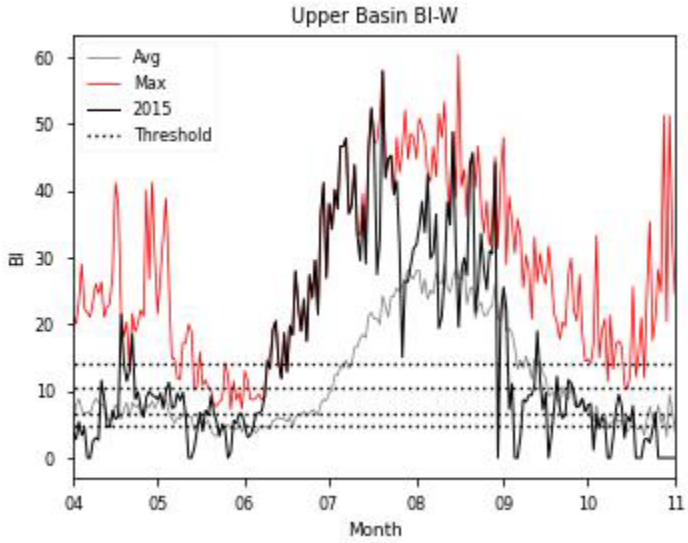
Optimal Threshold Classified Annual Days





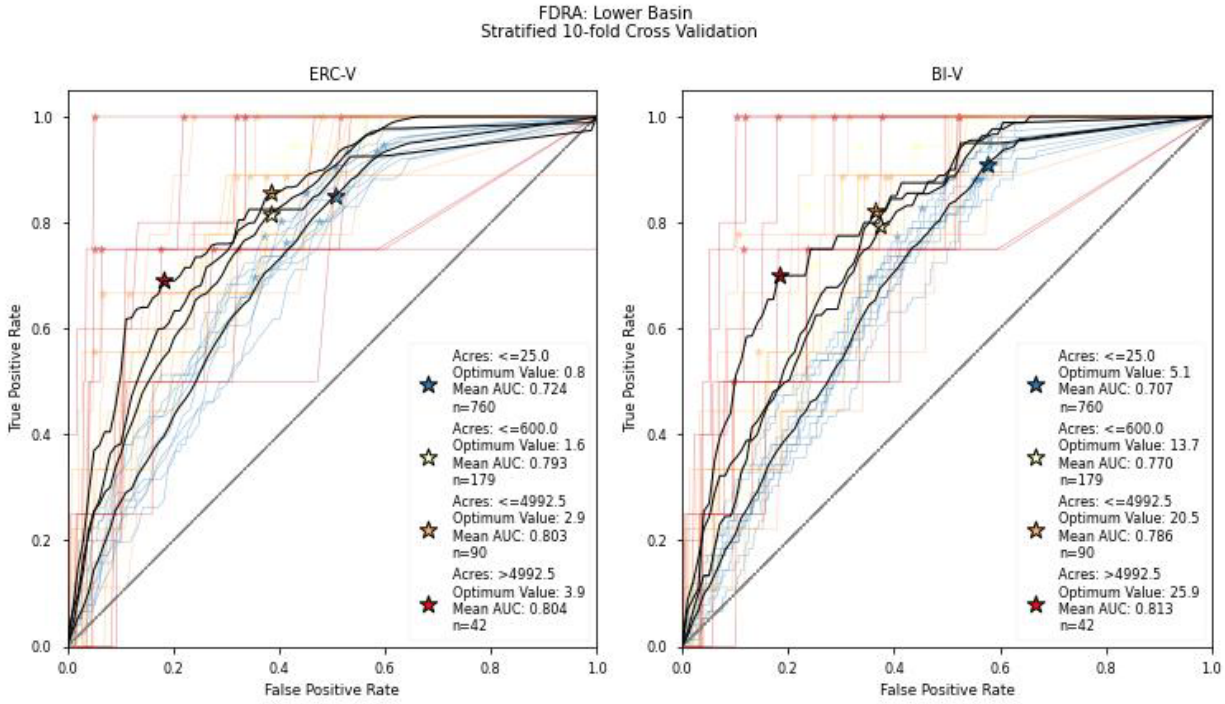
Optimal Threshold Fire Season



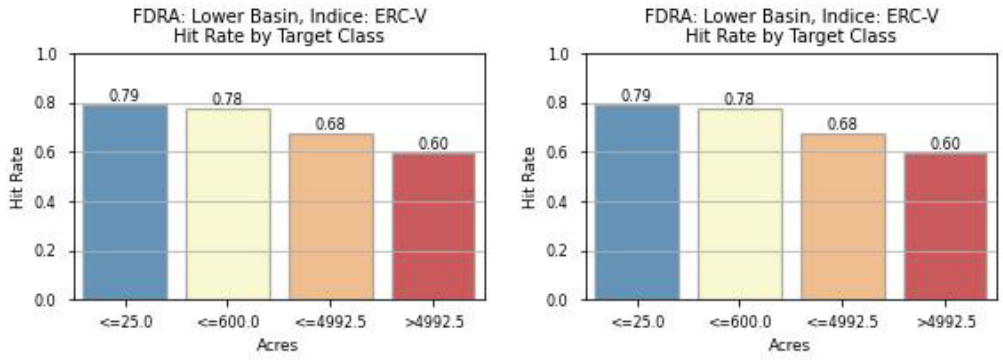


Lower Basin FDRA

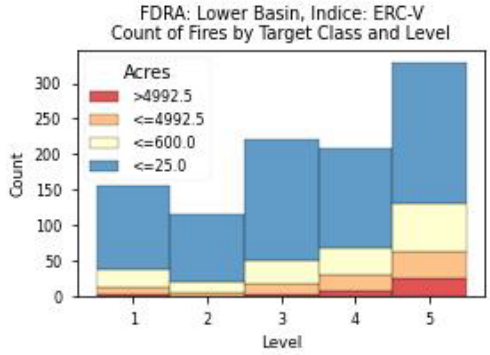
Receiver Operating Characteristic Curve & Optimal Thresholds

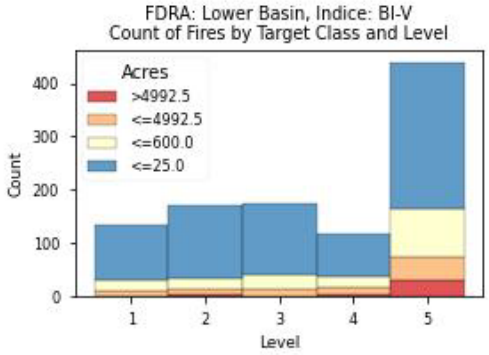


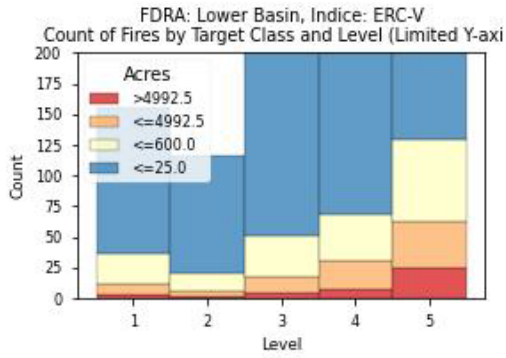
Optimal Threshold Model Performance

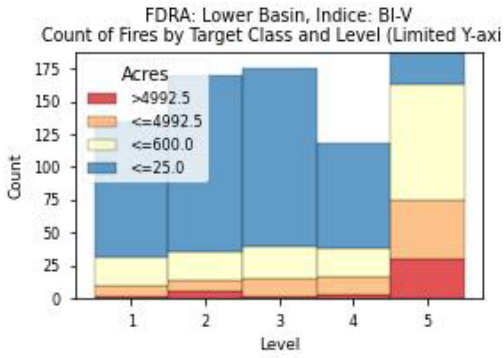


Optimal Threshold Classified Fire Business

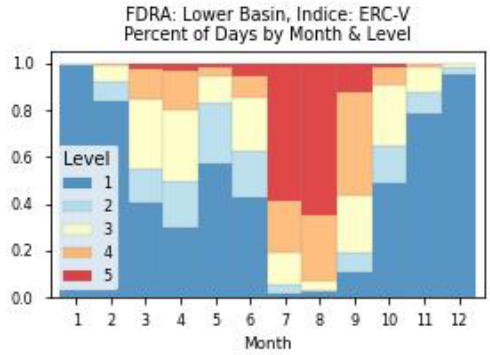


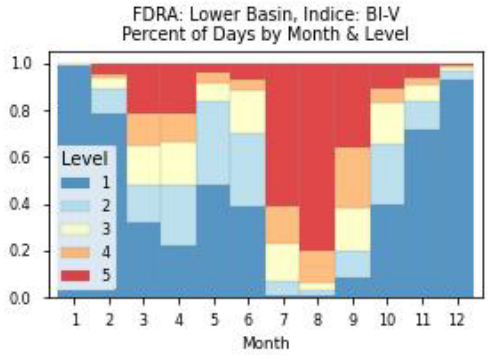




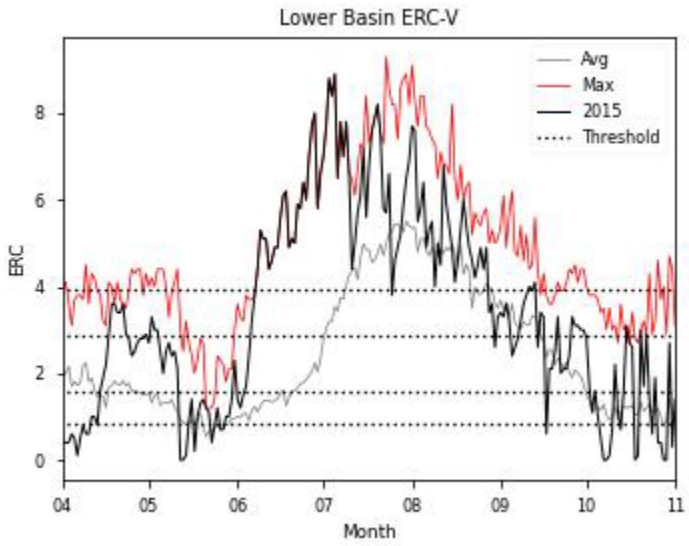


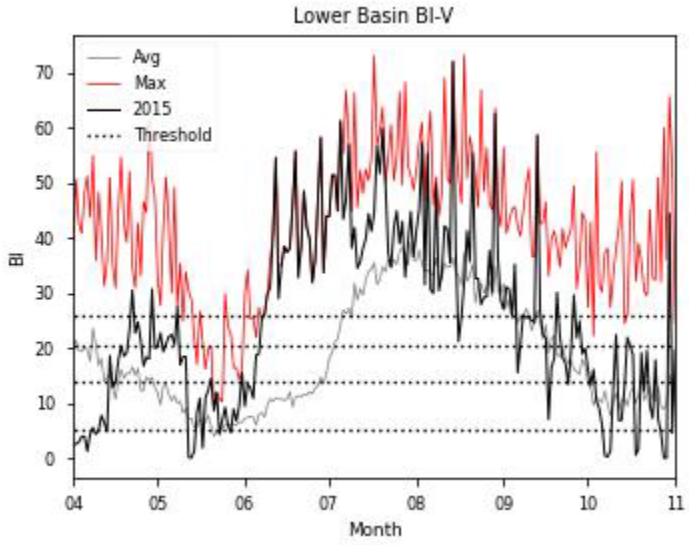
Optimal Threshold Classified Annual Days





Optimal Threshold Fire Season

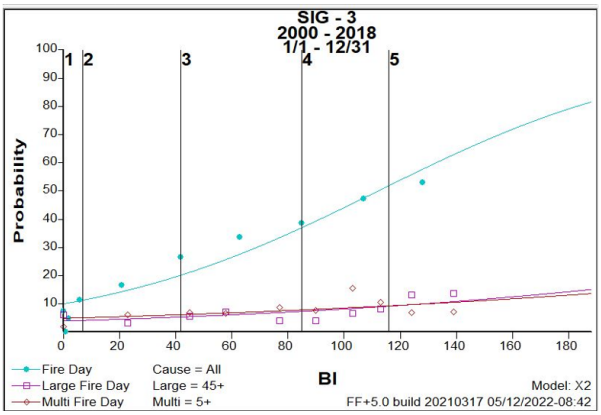


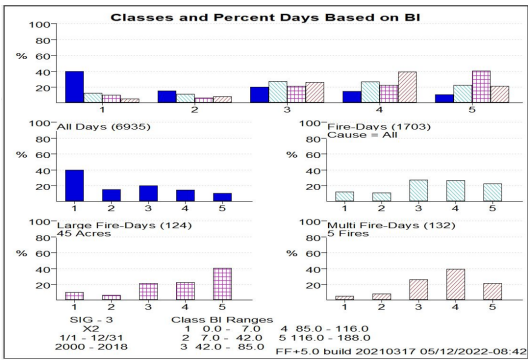


E.1.4 Northeastern (Foothills, Highlands, Kaniksu FDRAs)

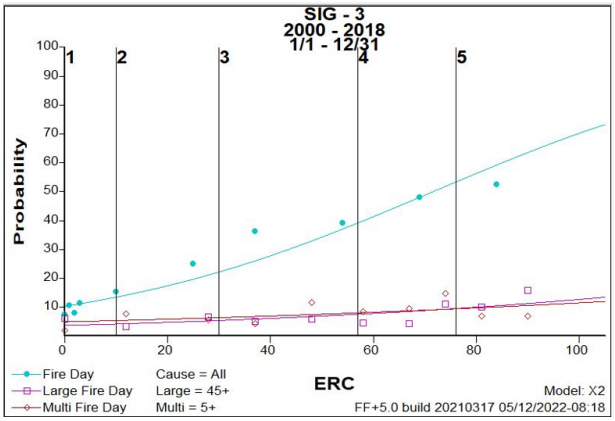
Highlands FDRA

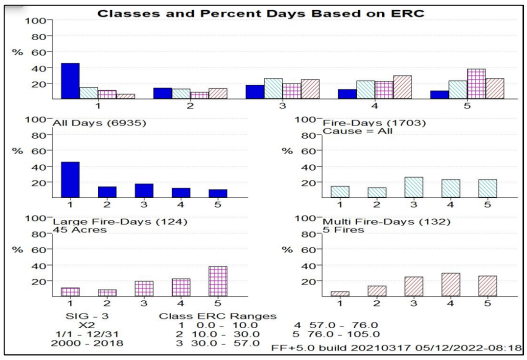
Burning Index





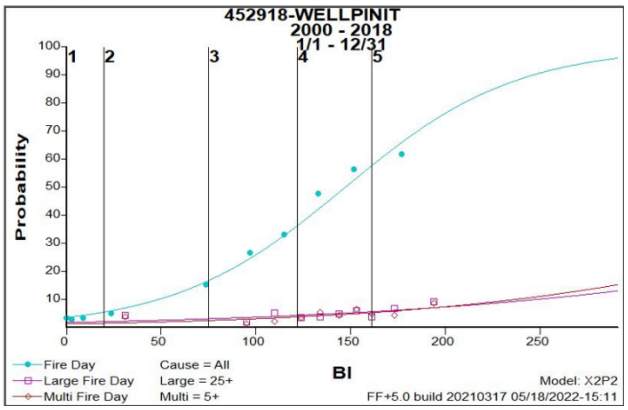
Energy Release Component

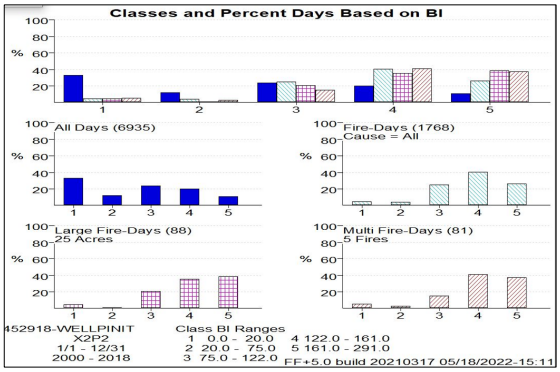




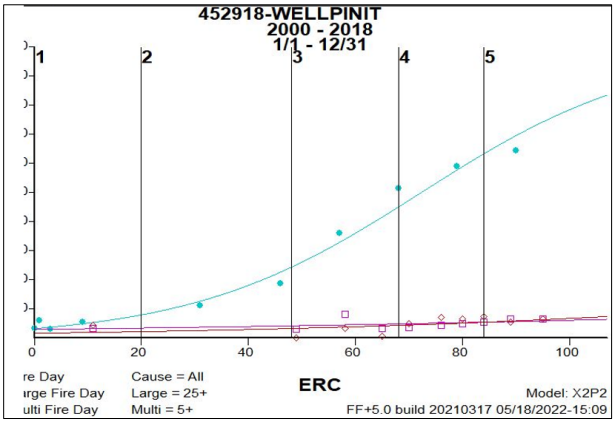
Foothills FDRA

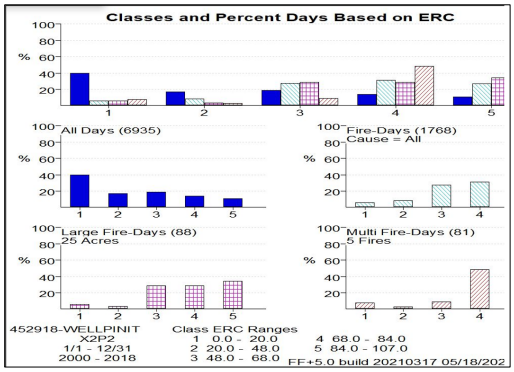
Burning Index





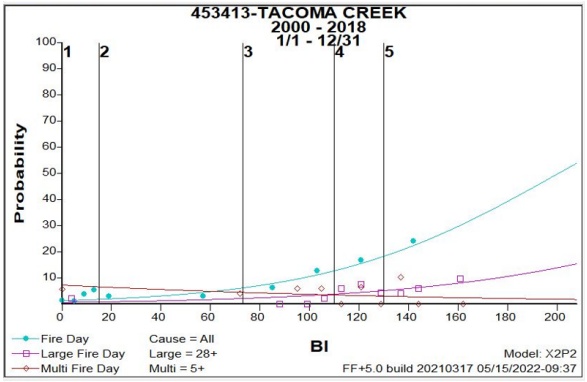
Energy Release Component

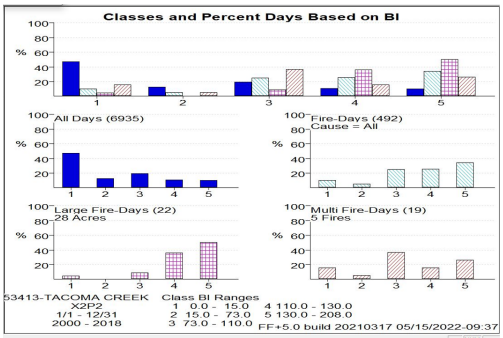




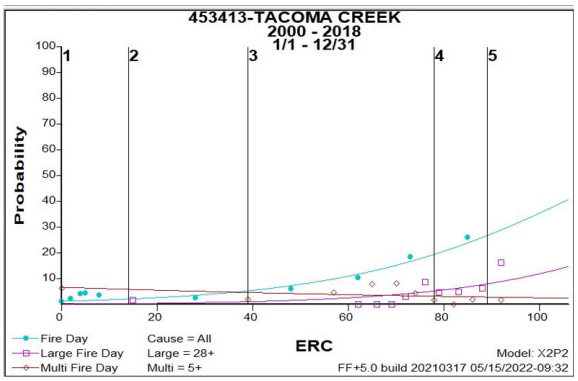
Kaniksu FDRA

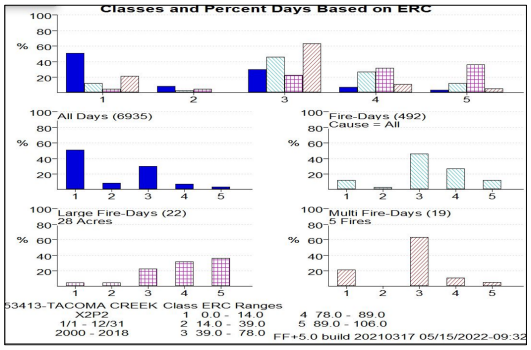
Burning Index





Energy Release Component





E.2 Statistical Results

**Lower Yakima rating area is currently based on climatological breakpoints (90/97).*

SIG/Station	Years	Annual_Filter	Variable	Model	FD_Type	FD_R^2	FD_Chi^2	FD_P-Val	FD_P-Range	LFD_Acres	LFD_R^2	LFD_Chi^2	LFD_P-Val	LFD_P-Range	MFD_Fires	MFD_R^2	MFD_Chi^2	MFD_P-Val	MFD_P-Range
SIG - Chelan	2006 - 2015	4/1 - 10/31	BI	Y4	All	0.92	10.57	0.2275	0.03 - 0.37	100 (C)	0.7	6.01	0.6466	0.00 - 0.42	4 (C)	0.29	11.87	0.1573	0.02 - 0.22
SIG - Chelan	2006 - 2015	4/1 - 10/31	ERC	Y4	All	0.94	8.8	0.3596	0.02 - 0.43	100 (C)	0.61	11.38	0.181	0.00 - 0.41	4 (C)	0.66	5.58	0.6944	0.01 - 0.32
SIG - Lower Basin	2006 - 2015	4/1 - 10/31	BI	Y1	All	0.91	21.93	0.0051	0.03 - 0.90	300 (C)	0.8	4.81	0.7779	0.01 - 0.40	4 (C)	0.34	14.87	0.0617	0.01 - 0.17
SIG - Lower Basin	2006 - 2015	4/1 - 10/31	ERC	Y1	All	0.97	11.2	0.1908	0.03 - 0.86	300 (C)	0.7	3.81	0.8737	0.03 - 0.21	5 (C)	0.6	8.77	0.3619	0.00 - 0.18
SIG - Methow	2006 - 2015	4/1 - 10/31	BI	Y3	All	0.93	8.96	0.3458	0.02 - 0.37	100 (C)	0.59	7.83	0.4502	0.00 - 0.29	4 (C)	0.1	7.9	0.443	0.05 - 0.15
SIG - Methow	2006 - 2015	4/1 - 10/31	ERC	Y3	All	0.91	15.98	0.0427	0.02 - 0.40	100 (C)	0.49	8.9	0.3505	0.00 - 0.26	4 (C)	0.62	4.28	0.8315	0.01 - 0.26
SIG - Upper Basin	2007 - 2015	4/1 - 10/31	BI	Y1	All	0.92	16.97	0.0304	0.01 - 0.90	300 (C)	0.82	5.18	0.7386	0.00 - 0.77	4 (C)	0.14	17.24	0.0277	0.01 - 0.19
SIG - Upper Basin	2007 - 2015	4/1 - 10/31	ERC	Y1	All	0.96	13.13	0.1074	0.01 - 0.73	300 (C)	0.82	3.95	0.8617	0.01 - 0.37	4 (C)	0.04	16.92	0.031	0.02 - 0.07
SIG - Upper Yakima	2006 - 2015	4/1 - 10/31	BI	Y3	All	0.93	17.03	0.0298	0.05 - 0.63	100 (C)	0.65	4.13	0.845	0.00 - 0.15	4 (C)	0.42	9.36	0.3128	0.00 - 0.16
SIG - Upper Yakima	2006 - 2015	4/1 - 10/31	ERC	Y3	All	0.95	12.79	0.1193	0.05 - 0.66	100 (C)	0.64	3.65	0.8871	0.00 - 0.15	4 (C)	0.49	7.87	0.4461	0.00 - 0.16
SIG - Valley	2006 - 2015	4/1 - 10/31	BI	Y2	All	0.74	14.04	0.0806	0.11 - 0.44	100 (C)	0.75	6.54	0.5872	0.01 - 0.44	4 (C)	0	5.06	0.7514	0.07 - 0.07
SIG - Valley	2006 - 2015	4/1 - 10/31	ERC	Y2	All	0.9	5.51	0.7017	0.11 - 0.38	100 (C)	0.68	8.3	0.4043	0.01 - 0.27	4 (C)	0.31	5.6	0.6924	0.03 - 0.12
SIG - Foothills	2000 - 2018	1/1 - 12/31	BI	X2P2	All	0.98	29.41	0.0003	0.04 - 0.96	25 (C)	0.43	7.86	0.4468	0.02 - 0.13	5 (C)	0.48	8.52	0.3847	0.01 - 0.15
SIG - Foothills	2000 - 2018	1/1 - 12/31	ERC	X2P2	All	0.98	32.63	0.0001	0.03 - 0.84	25 (C)	0.26	7.74	0.4596	0.03 - 0.06	5 (C)	0.21	21.52	0.0059	0.02 - 0.07
SIG - Highlands	2000-2018	1/1 - 12/31	BI	X2	All	0.81	232.07	0	0.13 - 0.89	45 (C)	0.66	10.09	0.2586	0.04 - 0.20	5 (C)	0.19	16.45	0.0363	0.06 - 0.13
SIG - Highlands	2000 - 2018	1/1 - 12/31	ERC	X2	All	0.81	216.48	0	0.14 - 0.91	45 (C)	0.78	6.48	0.4855	0.04 - 0.23	5 (C)	0.17	18.77	0.0089	0.06 - 0.13
SIG - Kaniksu	2000 - 2018	1/1 - 12/31	BI	X2P2	All	0.97	17.68	0.0237	0.01 - 0.54	28 (C)	0.42	5.29	0.7266	0.01 - 0.14	5 (C)	0.08	18.05	0.0209	0.02 - 0.07
SIG - Kaniksu	2000 - 2018	1/1 - 12/31	ERC	X2P2	All	0.97	21.47	0.006	0.01 - 0.41	28 (C)	0.51	8.69	0.3692	0.00 - 0.14	5 (C)	0.1	9.15	0.3301	0.03 - 0.07