Puget Sound

Interagency Fire Danger Operating Plan

Mount Baker Snoqualmie National Forest, Mount Rainier National Park, North Cascades National Park, Olympic National Forest, Olympic National Park, Spokane Bureau of Land Management, Washington Maritime National Wildlife Refuge Complex, Washington State Department of Natural Resources

4/1/2015

(Partial Update 4/2018; FDRA Boundary Adjustment (2nd since original analysis), Dispatch, Preparedness, Restriction Guidance Calculation Adjustment)

*This plan is not compatible with NFDR 2016, full analysis and plan update due fire season 2019.

AGENCY ADMINISTRATOR APPROVAL

Name - Title	Date

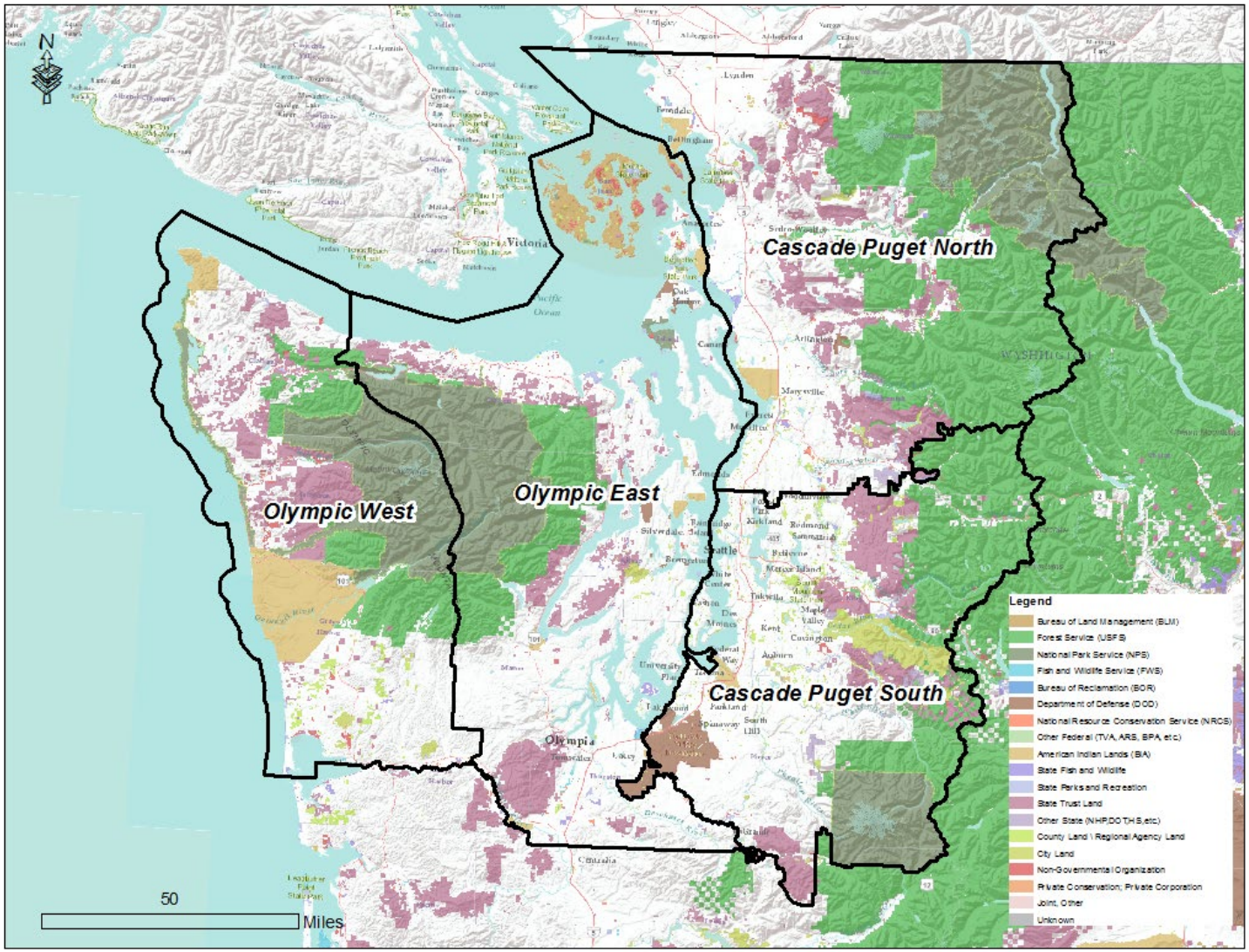

FIGURE 1: ***(**5/2018 UPDATE; BOUNDARY ADJUSTMENTS HAVE BEEN MADE ANNUALLY SINCE THE ANALYSIS WAS COMPLETED IN 2015, SHOWN ARE THOSE REACHED BY INTERAGENCY CONSENSUS MAY, 2018.)***

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Contents

INTRODUCTION

The public, industry, and our own agency personnel expect agency fire managers to implement appropriate and timely decisions which ultimately result in safe, efficient, and effective wildland fire management actions. An appropriate level of preparedness to meet wildland fire management objectives is based upon an assessment of wildfire potential utilizing the National Fire Danger Rating System (NFDRS).

This Fire Danger Operating Plan (FDOP) documents an operational planning and decision making process for agency administrators, fire managers, dispatchers and firefighters within the scope of the Puget Sound Interagency Coordination Center (PSICC) area of response. It guides the application of NFDRS at the local level by providing a common framework based on defined decision points applicable across agency boundaries and agency plans.

The process used to develop this FDOP is consistent with what is taught in the National Wildfire Coordinating Group (NWCG) courses and is based upon available scientific methods incorporating historical fire and weather analysis.

The development process generally involves:

1. Acquire and quality control historic weather and fire history data.
2. Delineate homogenous fire environments (fire danger rating areas) based on vegetation, climate and topography.
3. Define the fire problem.
4. Assign historic fire history and weather data to fire danger rating areas (FDRA).
5. Perform analysis for statistical correlation of historic fire occurrence with historic NFDRS outputs by FDRA and identify basis for future decisions.
6. Develop decision thresholds based on the NFDRS outputs and historic fire occurrence that best matches the intent of the decision.
7. Document the analysis, operation, communication, and maintenance re-evaluation process.

Guidance and policy for development of a FDOP can be found in the Interagency Standards for Fire & Aviation Operations (Red Book), Wildland Fire and Aviation Program and Management and Operation Guide (Blue Book), and Forest Service Manual 5120.

This Plan has been developed for use by the Olympic National Forest, Olympic National Park, Mount Baker Snoqualmie National Forest, Washington Maritime Refuge Complex, and Puget Sound Interagency Coordination Center. The analysis process was conducted across all agencies jurisdiction and using all agencies fire history and weather data with the intent of providing a plan for all agency inclusion in future iterations.

Objectives

1. Document the decision process used to create fire danger rating areas, station groups, and decision points.
2. Document daily operating procedures for development and conveyance of fire danger information to users.
3. Provide a common interagency picture of fire danger and a framework for development of local action plans.

FIRE DANGER PLANNING AREA INVENTORY

Administrative Units

This plan encompasses approximately 7.8 million acres in Western Washington covering all or portions of Clallam, Grays, Jefferson, King, Lewis, and Mason, Pierce, Skagit, Snohomish, and Whatcom counties. The plan boundary was based around the Puget Sound Interagency Communication Center response area (response unit shapefile dated 7/18/2015).

Initial Attack suppression resources within the plan area are dispatched out of Puget Sound Interagency Communications Center (PSICC). PSICC tracks and assigns resources to initial attack wildland fires based on response unit and closest forces.

Fire Danger Rating Areas

A Fire Danger Rating Area is defined as: "A geographic area relatively homogenous in climate, fuels and topography, tens of thousands of acres in size, within which the fire danger can be assumed to be uniform. Its size and shape is primarily based on influences of fire danger, not political boundaries. *It is the basic on-the-ground unit for which unique fire management decisions are made* based on fire danger ratings. Weather is represented by one or more National Fire Danger Rating System weather stations." (National Fire Danger Working Group, 2002)

Development – Vegetation, Climate, and Topography

An analysis of Washington west of the Cascade Crest was completed using seamless and consistent ESRI ArcGIS and spatial data. Data analyzed includes; 30-meter Digital Elevation Model (DEM), NFDRS Slope Class (DEM derived), Bio Physical Setting (LANDFIRE) as a surrogate for vegetation, and climate data produced by the PRISM Climate Group (Oregon State University); including 30 year normalized average annual precipitation and 30 year normalized average annual maximum temperature spanning 1981-2010.

Fire Danger Rating Areas were delineated based on the degree of affect separating the fire environment component (topography, vegetation, and climate) would have on NFDR indices and components.

For each layer representing climate (temperature and precipitation), vegetation (Bio Physical Setting), and topography (elevation and slope class), independent 'crayon style' delineations were made to separate relatively homogenous fire environment areas from one another. Analysis delineations were then overlaid and PSICC response units were 'snapped' to common delineation boundaries as closely as possible. The only internal boundary which does not follow a PSICC response area is the north-south divide across the Olympic Mountains in the Olympic National Park; this boundary follows a fire weather zone to connect response areas.

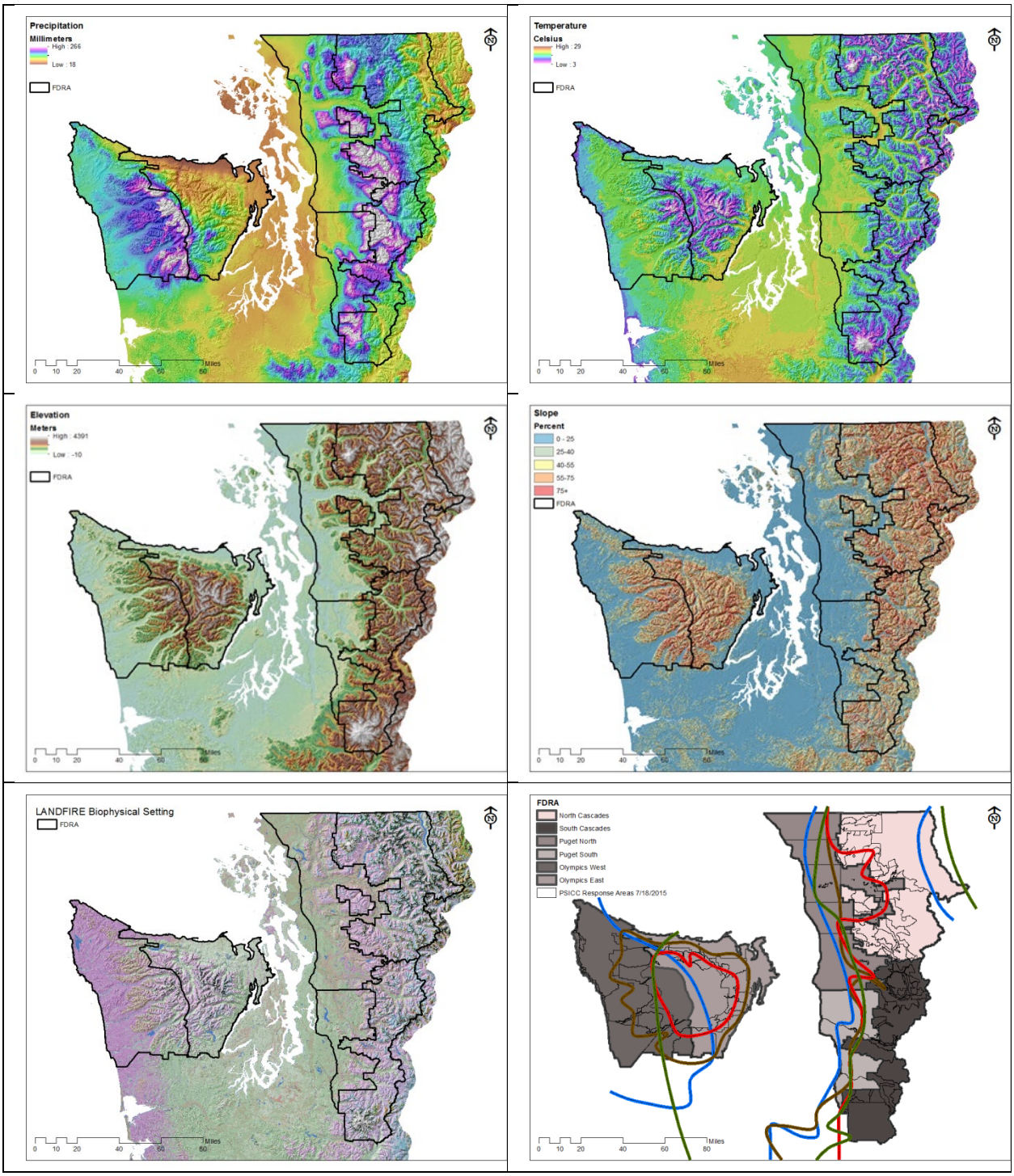


FIGURE 2: LEFT TO RIGHT FROM THE TOP; PRISM ANNUAL AVERAGE PRECIPITATION (1981-2010), PRISM AVERAGE ANNUAL TEMPERATURE, ELEVATION, SLOPE CLASS, LANDFIRE BIOPHYSICAL SETTING (VEGETATION SURROGATE), AND INITIAL FIRE DANGER RATING AREAS CARRIED FORWARD FOR FIRE BUSINESS ANALYSIS

Analysis delineations generally separated the Cascade and Olympic Mountains from the Puget Sound trough and coast. The exceptions were the precipitation and vegetation delineations on the Olympic Peninsula which contrasted strongly with the topography due to orographic effects. Olympic fire management personnel determined the precipitation and vegetation delineations were of primary

importance and for now further delineations to divide along elevation and slope gradients on the peninsula are not desirable.

The planning area analysis resulted in the following initial 4 rating areas; Western Olympic Peninsula, Eastern Olympic Peninsula, Puget Sound, and West Slope Cascades. The Puget Sound and West slope Cascade divisions were further split along an east-west division to reduce rating area size and account for regional variations in weather. The division was placed along a Mount Baker Snoqualmie Forest Service district boundary (Darrington/Skykomish) and Fire Management Zone divide (North Zone/South Zone) and Washington Department of Natural Resources (WADNR) region boundary/county (Snohomish/King) line to facilitate both future inclusion of WADNR and application of indices to specific planning and restriction actions.

A total of 6 Fire Danger Rating Areas were carried forward for analysis of fire weather and fire occurrence; North Cascades (1,744,030 acres), South Cascades (1,088,940 acres), Puget North (1,454,910 acres), Puget South (635,544 acres), Olympic East (1,247,740 acres), and Olympic West (1,640,190 acres).

	MEAN FDRA VALUE				
FDRA	ELEVATION (ft)	SLOPE %	PRECIPITATION (in)	TEMPERATURE (F)	MAJORITY BPS
North Cascades	3,930	58	106	68	North Pacific Mesic Western Hemlock-Silver Fir Forest
South Cascades	3,786	51	119	68	North Pacific Mesic Western Hemlock-Silver Fir Forest
Puget North	1,049	21	90	73	North Pacific Hypermaritime Western Red-cedar-Western Hemlock Forest
Puget South	1,358	22	101	73	North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest
Olympics East	2,290	42	64	70	North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest
Olympics West	1,263	33	113	70	North Pacific Hypermaritime Sitka Spruce Forest

FIGURE 3: ANALYSIS FDRA MEAN VALUES FOR VEGETATION, CLIMATE, AND TOPOGRAPHY, BARS REPRESENT THE RELATIVE VALUE OF THE DATA IN THE COLUMN

*An additional FDRA, from the Central Washington FDOP, will be utilized by PSICC to communicate fire danger for the portion of North Cascades National Park east of the Cascades Crest. Analysis for that FDRA (Chelan Mountains) is not covered in this plan.

Ownership

Ownership stats for the rating areas carried forward into the analysis process.

PROPERTY STATUS	NORTH CASCADES	SOUTH CASCADES	PUGET NORTH	PUGET SOUTH	OLYMPICS EAST	OLYMPICS WEST
BIA	0	0	2,902	0	457	232,061
BLM	22	138	598	160	85	123
DOD	0	0	0	0	0	55
FWS	0	0	0	0	396	134
NPS	616,842	234,610	0	0	462,506	435,533
USFS	1,094,910	651,294	5,427	1,796	314,403	316,142
WATER	408	125	9,177	5,654	8,901	15,599
LOCAL GOV	0	0	0	26	453	0
PRIVATE	25,495	197,755	1,065,077	533,805	337,506	364,554
STATE	7,085	5,526	372,724	94,491	121,658	272,543
UNKNOWN	0	74	0	0	0	0

FIGURE 4: ANALYSIS FDRA ACRES BY OWNERSHIP, BARS REPRESENT THE RELATIVE VALUE OF THE DATA IN THE COLUMN

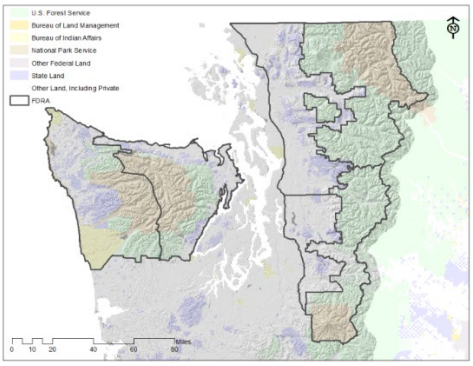


FIGURE 5: ANALYSIS FDRA OWNERSHIP

Fire History

Interagency fire occurrence records for this analysis were obtained from the Fire Program Analysis (FPA) Fire Occurrence Database (FOD). "The data product contains a spatial data base of wildfires that occurred in the United Stated from 1992-2013, generated for the national (FPA) system. The wildfire records were acquired from the reporting systems of federal, state and local fire organizations and local fire organizations. Basic error checking was performed and redundant records were identified and removed to the degree possible". (Short, 2014)

In order to facilitate use within Fire Family the cause codes from local and state government within the FPA FOD were translated to match federal cause codes. These inluded; fireworks, powerlines, and structure fires that had spread to the wildland, which were all changed to federal cause code 9, miscellaneous. At this time fires managed under a strategy other than full suppression from the initial attack stage have not been removed from the database.

For the period 1994-2013, and not inclusive of miscellaneous fires (32%); Campfires are the primary cause of ignitions requiring a suppression response (39%), followed by lightning (31%), and debris burning (16%). July, August, and September accounted for 80% of responses; May through October accounted for 95% of responses. August through October had the highest *average* fire size (10 acres) followed by June and July (5 acres).

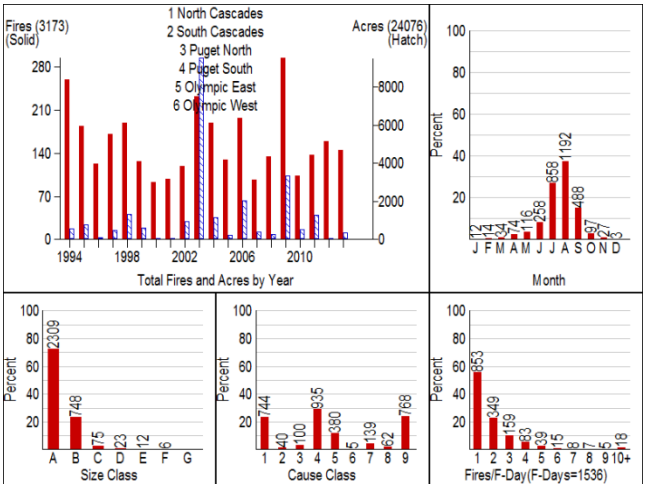


FIGURE 6: FIRE STATISTICS FOR FIRES WITHIN THE PSICC WILDCAD RESPONSE AREAS, ALL YEARS AVAILABLE IN THE DATASET, 1994-2013

North Cascades is the only FDRAs where the majority of responses are from naturally occurring fire. The majority of responses in all other FDRAs are a result of human ignitions. Campfires consitute a significant number of responses in all FDRAs. Lightning responses are a significant factor in the South Cascades and Olympics East FDRAs. Debris burning is significant in the Puget Sound and Olympic FDRAs.

FIGURE 7: ANALYSIS AREA FDRA FIRE STATISTICS BY FDRA, ALL YEARS AVAILABLE IN THE DATASET, 1994-2013

Fire Problem

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 mechanism to mitigate the given issue.

This plan will affect a wide range of entities. However, these entities can be grouped into three 'target groups:

- Agency - employees of the federal, state, and local governments involved in the cooperative effort to suppress wildland fires.
- Industry - organizations that either utilize natural resources or have permits to conduct activities on federal, state, or private lands *for commercial purposes*.
- Public - individuals who use the land for recreational purposes or general travel or live in the Wildland Urban Interface.

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 management action. In addition, each action has potential positive and/or negative impacts to the user groups. Consequently, the decision tool which would be most appropriate considers the sensitivity of the target group to the implementation of the action. In selecting a component and/or index, several factors must be considered:

- Problem - the problem specific to the area of concern inclusive of ignition source and framed to focus on the wildland fire management issue, such as the point when fire activity becomes a burden to the local suppression forces.
- Management Action - a way to link fire danger information with fire management decisions which affect specific target groups.
- Target Group: - the group of people commonly associated with the problem (agency, industry, or public).
- Degree of Control - this is a general description of how much control the agencies have over these entities and how quickly a target group can respond to management actions.

As previously identified the top causes of ignitions within the planning area which require a suppression response are; campfires, lightning, and debris burning which together comprise 86% of all interagency suppression responses in the planning area from 1994-2013. The following table documents the fire problems identified and addressed by this FDOP.

Problem Analysis							Management Action	
FRAMING THE PROBLEM	AFFECTED TARGET GROUP			RELATIVE CONTROL OF TARGET GROUP	ANTICIPATED COMMUNICATION WITH TARGET GROUP	PROBABLE IMPACTS	INDEX / COMPONENT	MANAGEMENT TOOL
	AGENCY	PUBLIC	INDUSTRIAL					
Problem: Multiple lightning ignitions that exceed resource capabilities to respond. *Suppression resources committed to multiple IA fires.*	**X**			High	*Dispatch* retrieves and broadcasts NFDRS values and **Lightning Activity Level** daily.	Positive: fewer fires exceed IA reducing expenditures & risk. Negative: Money spent on mobilization & staffing if no workload.	Staffing Level (ERC-G) LAL	*Fire Management & Agency Administrator* plan for and request additional/extended staffing based on the Staffing Level-**Staffing Plan/Drawdown Plan** actions**.**
Problem: Problem fire(s) that exceed the capabilities of overhead to manage incident(s) effectively or make local suppression resources unavailable for IA. *Overhead and/or Suppression resources overcommitted to problem fire(s).*	**X**			High	*Dispatch* retrieves the actual and forecast NFDRS values; processes, posts & broadcasts Staffing Level daily.	Positive: incidents managed safely & effectively as possible through increased operational & logistical support. Additional IA support results in fewer problem fires. Negative: Money spent on mobilization & staffing if no IA workload.	Staffing Level (ERC-G)	*Fire Management & Agency Administrator* plan for extended staffing based on **Staffing Plan** actions**.** Dispatch utilizes run cards to send resources when no other information is available **Response Plan**
Problem: *Initial fire response with little or no information available.*	**X**			High	*Dispatch* retrieves the observed or forecasted NFDRS values; processes & posts values for **Response Level** daily.	Positive: fewer fires become a problem. Negative: fires overstaffed, staffing cost exceeds suppression cost.	Response Level (derived from Staffing Level)	*Dispatch* sends IA resources based on Response Level/ Zone- **Response Plan (Run Card)**
Problem: Unattended or escaped campfires in developed & undeveloped recreation areas which threaten highly valued resources and commit IA resources.		**X**		Moderate (developed) Low (undeveloped)	*Agency Public Relations Officer* - Increased media communications, agency fire danger signage.	Positive: reduced resource commitment to abandoned campfires and resource loss from escaped campfires. Negative: public perception when conditions do not match restrictions, agency implementation takes time	ERC-G/Adjective Rating? PL?	**Adjective Rating-PUR** *Fire Mgmnt Recommends & Agency Administrator* implement Public Use Restrictions based on Adjective Level **Prevention Plan**
Problem: Miscellaneous fires which threaten highly valued resources and commit IA resources.		**X**		Low	*Agency Public Relations Officer* - Increased media communications, agency fire danger signage. Possible closure of lands.	Positive: reduced potential for problem fire resulting from misc. (human) ignitions. Negative: public perception when conditions do not match media	ERC-G/Adjective Rating	**Adjective Rating/Media (Lands Closure)** *Fire Mgmnt Recommends & Agency Administrator* implements temporary closure of lands to public use **Prevention Plan**
Problem: Fires resulting from industrial operations which threaten highly valued resources and commit IA resources	**X**	**X**	**X**	Moderate	*State* - IFPL posted to state web page and agency hotlines, IFPL posted on Smokey Signs.	Positive: reduced potential for problem fire resulting from industrial operations. Negative: industry perception when conditions do not match	IFPL (ERC-G & IC)	**IFPL** *Fire Managers* set industrial restrictions based on communications with partners

Problem Analysis							Management Action	
FRAMING THE PROBLEM	AFFECTED TARGET GROUP			RELATIVE CONTROL OF TARGET GROUP	ANTICIPATED COMMUNICATION WITH TARGET GROUP	PROBABLE IMPACTS	INDEX / COMPONENT	MANAGEMENT TOOL
	AGENCY	PUBLIC	INDUSTRIAL					
						restrictions, loss of industry revenue & trust.		and consideration of Industrial Fire Precaution Level. **Prevention Plan**
Problem: Fires resulting from escaped debris burns which threaten highly valued resources and commit IA resources		**X**		Low	*State* - Adjective Rating and burn ban restrictions and permitting posted to the state website	Positive: reduced resource/damage commitment to debris fires. Negative: public perception when conditions do not match restrictions.	ERC-G/Adjective Rating	**Public Use Restrictions/Burn Ban/Media** based on Adjective Level set by Fire Managers.

Weather Stations & Data

Twenty-two Remote Automated Weather Stations (RAWS) exist within the planning area. All but four stations have at least 20 years of data available for analysis. All stations have at least 10 years of data however not all stations (Buck Knoll) have 10 years of data that matches with the current available interagency fire history dataset used in this analysis (through 2013). Buck Knoll should be reconsidered in the next analysis in preparation for NFDR 2016.

Weather data from the Fire and Aviation Management Web Applications (FAMWEB) was used for the analysis. A more complete quality assurance review should be performed for this analysis for future endeavors. Data was examined for obvious errors using a rudimentary sort-by-field process and several values which were obvious errors were corrected.

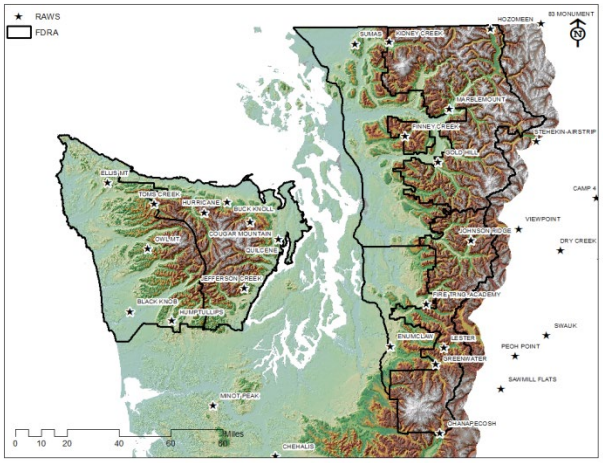


FIGURE 8: RAWS STATIONS

STATION NAME	NWS ID	OWNER	ELEV	DATA YRS	COMPLETENESS*	CAT GREEN UP	LFI/GSI GREEN UP
Black Knob	450321	BIA-Quinault	650	2004-2015	87%	18-May	Prior to data avail
Buck Knoll	450131	S&PF-WADNR	1630	2005-2015	88%	18-May	Prior to data avail
Cougar Mountain	450117	USFS-OLF	3000	1970-2015	93%	13-Jun	24-Apr
Ellis Mountain	450130	S&PF-WADNR	2671	2001-2015	88%	1-Jun	Prior to data avail
Enumclaw	451702	S&PF-WADNR	742	1970-2015	89%	20-May	21-Mar
Finney Creek	451509	USFS-MSF	1900	1970-2015	93%	25-May	3-Apr
Fire Training Acad	451721	USFS-MSF	1570	2001-2015	92%	26-May	2-Apr
Gold Mtn	451613	USFS-MSF	3400	1970-2015	87%	25-May	2-May
Greenwater	451718	S&PF-WADNR	2400	1979-2015	85%	20-May	30-Apr
Hozomeen	451412	NPS-NCNP	1700	1965-2015	61%	15-Jun	Prior to data avail
Humptulips	450312	USFS-OLF	2400	1969-2015	86%	17-Jun	26-Mar
Hurricane	450124	NPS-OLNP	5200	1979-2015	86%	17-Jul	29-May
Jefferson Creek	450911	USFS-OLF	2200	1969-2015	83%	13-Jun	26-Apr
Johnson Ridge	451611	USFS-MSF	2000	1969-2015	88%	25-May	24-Apr
Kidney Creek	451409	USFS-MSF	3000	1969-2015	83%	25-May	3-Apr
Lester	451705	USFS-MSF	1615	1961-2015	94%	20-May	19-Apr
Marblemount	451504	NPS-NCNP	357	1964-2015	87%	15-May	Prior to data avail
Ohanapecosh	451119	NPS-MRNP	1900	1979-2015	74%	18-Jul	23-Apr
Owl Mountain	450211	S&PF-WADNR	3398	1985-2015	75%	6-Jun	Prior to data avail
Quilcene	450207	USFS-OLF	62	1962-2015	92%	16-May	3-Apr
Sumas	451415	S&PF-WADNR	3201	1986-2015	80%	1-Jun	Prior to data avail
Toms Creek	450121	USFS-OLF	2400	1972-2015	85%	13-Jun	22-Apr
*for the period 1994-2013 (unless data began >1994, in which case first data year through 2013), June-September							

FIGURE 9: STATIONS WITHIN, OR NEAR, THE ANALYSIS AREA AND ASSOCIATED STATISTICS, BARS REPRESENT THE RELATIVE VALUE OF THE DATA IN THE COLUMN

CLIMATOLOGY & FIRE BUSINESS

This Fire Danger Operating Plan will be used to support preparedness, staffing and response decisions which are 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. Decision points can be based on *climatological breakpoints* or *fire business thresholds*.

Climatological Percentiles

Climatological breakpoints are points on the cumulative distribution curve of one fire weather/danger index computed from climatology (weather) without regard for associated fire occurrence/business. 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 and are predetermined by agency directive.

When identifying climatological percentiles it is important to identify the period or range of data analysis used to determine the agency percentiles. The percentile values for the calendar year (Jan – Dec) will be different from the percentile values for the fire season (Jun – Sept). Each agency will have specific (and perhaps different) direction for use of climatological percentiles.
Percentile values are provided in the Appendices explicitly for the purpose of requesting severity as defined in the Red Book.

Fire danger decisions based on climatological breakpoints (percentiles) will be used in this plan solely for the purpose of meeting agency directives for severity requests.

Fire Business Analysis

Fire business thresholds are values of one or more fire weather/fire danger indices that have been statistically related to occurrence of fires (fire business). Generally, the threshold defines a range of fire weather/fire danger values where fire activity has significantly increased or decreased. *Fire business thresholds more closely predict fire activity than climatological breakpoints and will be used in this plan for making preparedness decisions outside of severity requests.*

Process

A Fire Family Plus analysis of historic weather and fire occurrence was completed using the fire history and weather data described above to find the combination of station(s) that had the best statistical goodness of fit to the fire problem using a logistic regression model. Energy Release Component and fuel model-G were used for testing.

While it is generally desirable to test against different possible combinations of indices and fuel models against possible station combinations to break out of any potential decision traps ("fuel model-G and ERC work the best"); it was decided that it would be best not to 'rock the boat' twice in consideration of the forthcoming reanalysis associated with NFDR 2016 (new fuel models, live and dead fuel moisture models).

Fire Day and Large Fire Day goodness of fit were the primary considerations; Multi Fire Day was considered but was not a significant driver in final selection. Large fire day fit was given the most consideration with large fire size defined by fire managers as; the fire size at which local resources with typical preparedness staffing become stretched and without additional resources may not be able achieve containment in initial attack.

The following analysis process was used for each FDRA identified above:

1. Energy Release Component and fuel model-G were tested against different combinations of stations within and adjacent to individual Fire Danger Rating Areas. Stations having the best statistical correlation with fire business were identified and selected as Special Interest Groups for each rating area.
2. Adjacent rating areas were combined to examine statistical results.
3. Stations and rating areas resulting from the above process were then used develop thresholds for 5 classes of fire business.

Analysis Settings

The following settings were used for fire business analysis. The following Fire Family Plus catalog settings were set based on the FDRA analysis; NFDR slope class is based on GIS Digital Elevation Model percent slope and is equal to the mean slope class for the FDRA, Climate Class is based on PRISM average annual precipitation mean for the FDRA. Green up date was set based on the majority or approximate average (if no majority) for the group (SIG). Freeze date was left at station catalog settings, 12/31 for all stations.

FDRA	SLOPE CLASS	CLIMATE CLASS	HERB TYPE	LARGE FIRE SIZE	MULTI-FIRE DAY	GREEN UP
North Cascades	4	4	PERENNIAL	1	3	25-May
South Cascades	3	4	PERENNIAL	1	3	25-May
Puget North	1	4	PERENNIAL	1	3	25-May
Puget South	1	4	PERENNIAL	1	3	25-May
Olympics East	3	4	PERENNIAL	1	3	1-Jun
Olympics West	2	4	PERENNIAL	1	3	15-May

FIGURE 10: FIRE FAMILY PLUS ANALYSIS SETTINGS USED

A problem fire is defined, for the purpose of this plan, as a fire which significantly extends typical preparedness staffing, also as a fire which is likely to exceed initial attack efforts. Large fire size was set at 1 acres and multiple fire days at 3 acres.

Annual filter was set to June 1st through September 31st based when the majority of responses and preparedness staffing occur. Data years were set from 1998 through 2013 based on when the weather data became relatively consistent (beginning 1998) and when interagency fire history was available (through 2013).

Statistical Results

The following groups of stations had the best statistical fit to fire business. ***It should be noted at this point that the North Cascades and South Cascades were combined with the Puget North and Puget South respectively.***

FDRA	STN NAME	STN ID	WEIGHT
North Cascades & Puget North	Kidney	451409	1
	Marblemount	451504	1
	Finney	451509	1
	Gold	451613	1
South Cascades & Puget South	Johnson	451611	1
	Enumclaw	451702	1
Olympic East	Quilcene	450207	1
	Jefferson	450911	1
Olympic West	Tom Creek	450121	1
	Humptulips	450312	1

FIGURE 11: SPECIAL INTEREST GROUPS (SIGS) AND WEIGHTS FROM THE ANALYSIS

While excellent and good statistical correlations could be found for the Cascade FDRAs, the same could not be said for the Puget FDRAs (possible reasons for this could include the fact that the majority of responses are to human starts in the urban interface and may be requisite nuisance responses under conditions that may not support fire growth). Combining the Puget and Cascade FDRAs however did not negatively affect the correlation for the Cascades. Additionally the majority of the stations available for use in the study area are located on or near the border between Cascade and Puget FDRAs. Expanding the response areas (and analysis area) and including more fires in the Puget trough may make breaking the Puget and Cascades apart worthwhile in future plan iterations.

Goodness of Fit results from the statistical analysis. Conditional probabilities were used for statistical analysis. Chi squared values less than 13 are considered an excellent fit for this regression model (8 degrees of freedom); P values are associated with Chi squared, greater than .05 indicate a good Chi squared fit. R (L) squared values closer to 1 are better (1.0 is a perfect fit). Probability range was also considered in this analysis. It should be noted that the Olympics West FDRA did not have enough Large Fire or Multi Day fire days (20+) to utilize the statistics.

	FIRE DAY			LARGE FIRE DAY			MULTI FIRE DAY		
	Chi Square	*P Value*	*R(L) Square*	*Chi Square*	*P Value*	*R(L) Square*	*Chi Square*	*P Value*	*R(L) Square*
North Cascades	7.7	0.4596	0.95	8.5	0.3899	0.62	5.5	0.6996	0.65
North Cascades + Puget North	15	0.059	0.94	1.2	0.997	0.96	10.2	0.2496	0.6
South Cascades	7.5	0.4872	0.96	2.1	0.9764	0.7	9.2	0.3268	0.44
South Cascades + Puget South	9.2	0.3247	0.96	3.6	0.8949	0.65	7.9	0.4411	0.53
Olympic East	3.1	0.9302	0.98	4	0.8583	0.41	3.1	0.9261	0.46
Olympic West	5.2	0.7311	0.87	-	-	-	-	-	-

FIGURE 12: STATISTICAL RESULTS FROM THE ANALYSIS BASED ON THE SIGS IDENTIFIED IN FIGURE 10 ABOVE

Decision Points/Fire Business Thresholds

Thresholds were developed with the primary intent of placing approximately 60, 30, and 10 percent of Large Fire Days fit into Staffing Levels 5, 4, and 3 respectively while attempting to get the probability of a Large Fire Day to double at each decision point. Values were further adjusted from that point to optimize (reduce) the number of days in Staffing Level 4 and 5 (Staffing Level 5 to less than 20 percent of all days). Thresholds were based on data years 1998-2013, June through September.

			Model Probabilities (Risk)	
FDRA	**LEVEL**	**RANGE**	**LARGE FIRE DAY**	**MULTI FIRE DAY**
North Cascades & Puget North	1	0-3	1	0
	2	3-10	1-2	1
	3	10-20	2-4	1-2
	4	20-29	5-9	2-4
	5	29+	10-56	5-34
South Cascades & Puget South	1	0-5	0	0
	2	5-14	1	0-1
	3	14-23	1-2	1
	4	23-32	2-4	1-3
	5	32+	4-40	3-44
Olympics East	1	0-7	1	0
	2	7-15	1-2	0-1
	3	15-25	2-4	1-1
	4	25-32	4-5	1-2
	5	32+	6-19	2-11
Olympics West	1	0-2	-	-
	2	2-8	-	-
	3	8-19	-	-
	4	19-30	-	-
	5	30+	-	-

FIGURE 13: FDRA STAFFING LEVEL (ERC-G) VALUES AND ASSOCIATED LARGE FIRE DAY AND MULTI FIRE DAY MODEL PROBABILITIES

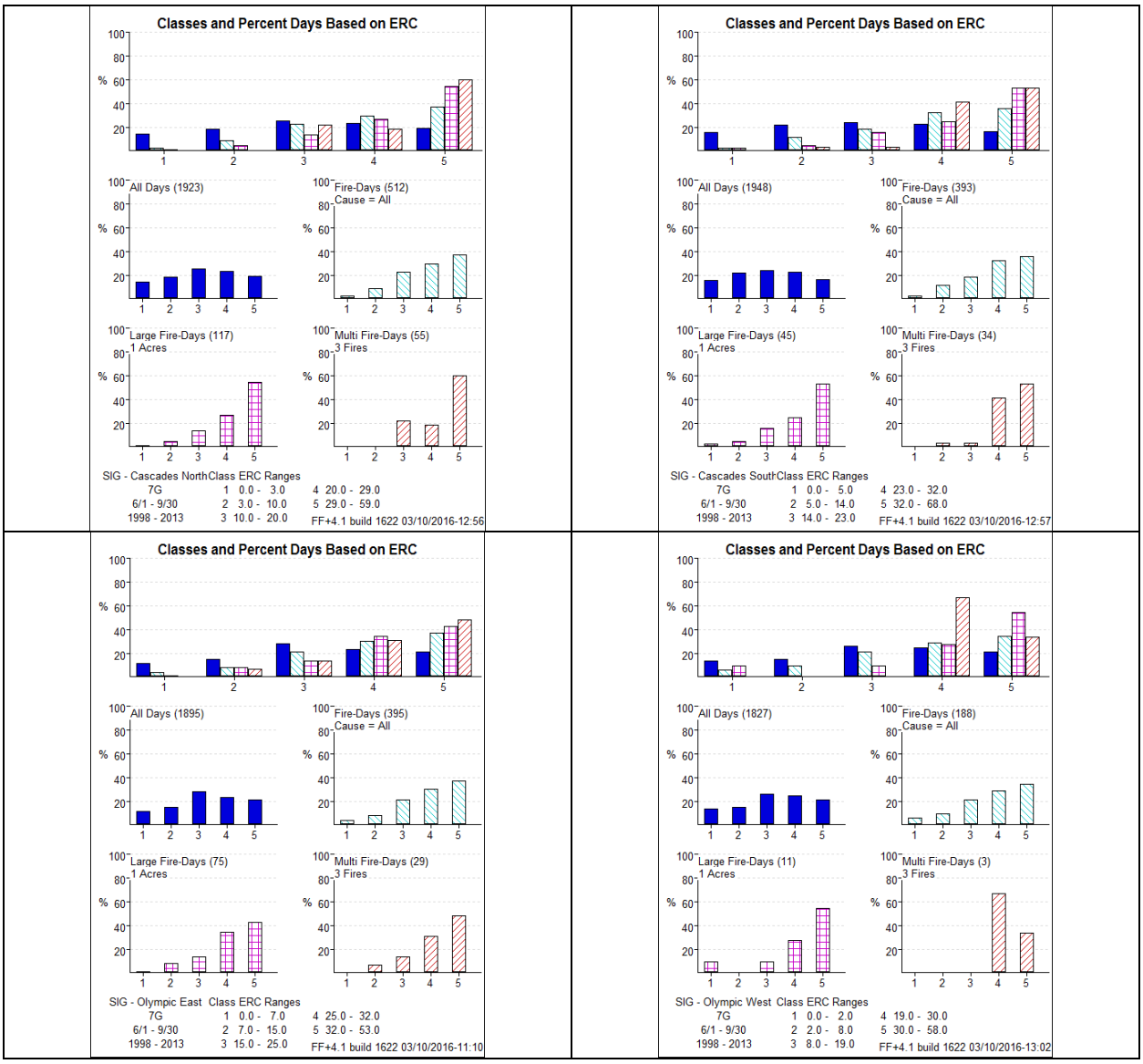


FIGURE 14: STAFFING LEVEL CLASSES AND PERCENT OF DAYS BY FDRA, FROM LEFT TO RIGHT STARTING AT THE TOP; NORTH CASCADE, SOUTH CASCADE, OLYMPIC EAST, AND OLYMPIC WEST

Climatology was considered, but not used, for setting Staffing Level in the Olympics West FDRA since there are not enough Large or Multi Fire days for statistical use.

FIRE DANGER BASED DECISIONS

Specific management actions to be taken at different decision thresholds are housed in separate supplemental plans including; Staffing, Preparedness, Prevention, Restriction, Initial Response (run card), and the PSICC Mobilization Guide. Supplemental plans should be reviewed commensurate with this FDOP (tri-annual) unless designated to be a shorter period based on specific agency direction.

National Fire Danger Rating System outputs will be utilized in the following ways for the purpose of this plan and supplemental plans.

Staffing Level (1-5)

Staffing Level (SL) represents a way of linking fire danger to fire management decisions. SL can be thought of as readiness level where the fire danger continuum is divided into classes to which management actions can be tied. SL classes also provide insight to where on the fire danger continuum you are today. Staffing Levels are expressed as numeric values where 1 represents the low end of the fire danger continuum and 5 represents the high end. SL is often confused with Preparedness Level which considers other elements in addition to fire danger.

SL will be used to make *daily* internal fire preparedness and operational decisions. At the protection unit level, the SL forms the basis for decisions regarding the day to day "degree of readiness" for initial attack resources and support resources. Observed and forecast Staffing Levels will be calculated and broadcast daily by PSICC within fire season, generally June through September.

Where applicable minimum SL and associated preparedness actions will be documented in individual unit Staffing Plans.

*Note although Staffing Level can be a direct output from the Weather Information Management System (WIMS); the WIMS output is based upon weather observations and climatological percentiles. Policy does not require the use of climatological percentiles for daily staffing decisions. The preferred method to delineate SL is based on statistical correlation of weather AND fire occurrence. *This FDOP will implement Staffing Level based upon fire business thresholds; not climatological percentiles.*

FDRA	LEVEL	ERC-G
North Cascades & Puget North	1	0-3
	2	3-10
	3	10-20
	4	20-29
	5	29+
South Cascades & Puget South	1	0-5
	2	5-14
	3	14-23
	4	23-32
	5	32+
Olympics East	1	0-7
	2	7-15
	3	15-25
	4	25-32
	5	32+
Olympics West	1	0-2
	2	2-8
	3	8-19
	4	19-30
	5	30+

FIGURE 15: STAFFING LEVEL ERC-G RANGES

***5/2018 Update; spring 2017 managers got together to review the FDOP. There was consensus that Staffing Level decision points were not appropriate (too conservative/too low). Climatological decision points were considered however group consensus was that the information obtained from using fire behavior breakpoints (better situational awareness) was still valuable. As an alternative the group tested keeping the SL breakpoints from the 2015 analysis but changing its value as the basis for informing further decision making (restriction, preparedness, dispatch) by subtracting 2 from the value (SL – 2).*

Response Level (1-3)

Response Level (RL) represents a way of linking fire danger information to a preplanned response, or prioritized response, to reported incidents. Response Level in this plan is a direct function of Staffing Level. (***5/2018 Update; Response Level guidance is now a function of SL - 2.)*

STAFFING LEVEL	RESPONSE LEVEL
1	1
2	
3	
4	2
5	3

FIGURE 16: STAFFING AND RESPONSE LEVEL RELATIONSHIP

For initial daily responses, when multiple ignitions are not expected and little information is available regarding the IA, the RL will be used to send IA resources based on the pre-planned response (run card) and WildCad Response Unit.

Preparedness Level (1-5)

The Preparedness Level (PL) is a five-tier fire danger rating decision tool that is based on NFDRS output(s) and other indicators of fire business (such as projected ignitions and current levels of resource commitment). Preparedness Levels will assist fire managers with long-term decisions with respect to fire danger.

The basis for PL will be an average of the applicable FDRA Staffing Level, further adjusted based on potential ignitions in the Northwest Coordination Center 7 day outlook and Puget Sound Interagency Communication Center resource commitment, and will be defined and calculated and set by PSICC on a weekly basis. (***5/2018 Update; Preparedness Level Feeder Value is now a function of SL - 2.)*

STAFFING LEVEL AVG.	1		2		3		4		5	
#1 →	○		○		○		○		○	
NWCC 7 DAY IGNITION TRIGGER	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
#2 →		○	○	○	○	○	○	○	○	
RESOURCES COMMITTED		No	Yes	No	Yes	No	Yes	No	Yes	
#3 →		○	○	○	○	○	○	○	○	
PREPAREDNESS LEVEL	I		II		III		IV		V	

1. Staffing Level average *(**5/2018 Update; SL Average – 2)*
2. Northwest Coordination Center High Risk Trigger for Ignitions, http://gacc.nifc.gov/nwcc/content/products/fwx/guidance/DL.pdf
3. Multiple local Initial Attack resources committed; less than fifty percent IA resources available

Industrial Fire Precaution Level (I-IV)

USFS Region 6 uses the Industrial Fire Precaution Level (IFPL) system to regulate activities to minimize risks associated with industrial operations. Industrial operation restrictions increase as IFPL Precaution Values increase. IFPL, calculated by the WIMS processor and based on an historic analysis of ERC and IC, fuel model G (Deeming, 1978); will be used to regulate industrial operations within the forest.

Processes for implementation of Industrial Fire Precaution Level will be documented at the unit level.

Adjective Rating Level

In 1974, the Forest Service, Bureau of Land Management and State Forestry organizations established five standard Adjective Fire Danger Rating Levels descriptions for public information and signing. Note* as with Staffing Level, the Adjective Fire Danger Rating Level can be obtained as a direct output in WIMS; like SL it is also based in part on climatological percentiles with no regard to historical fire occurrence. Policy does not require the use of Adjective Rating Level calculated by WIMS. The preferred method to determine Adjective Fire Danger Rating thresholds based on statistical correlation of weather observations AND fire occurrence*. This FDOP recommends implementing Adjective Fire Danger Rating based upon fire business thresholds; not climatological percentiles.*

Processes for setting Adjective Rating Level for each FDRA will be documented at the unit level in the units Prevention Plan. Preparedness Level should be utilized as a basis for decision making where:

PREPAREDNESS LEVEL	ADJECTIVE RATING
1	Low
2	Moderate
3	High
4	Very High
5	Extreme

FIGURE 17: PREPAREDNESS LEVEL AND ADJECTIVE RATING RELATIONSHIP

(***5/2018 Update; Adjective Rating guidance is now a function of Preparedness Level.)*

Public Use Restrictions

Processes for setting public use restrictions will be defined in individual unit Prevention Plans.

Staffing Level or Preparedness Level may be used to inform public use restrictions, depending on the number of restriction levels used by the unit something like the following may be utilized to guide decision making.

PREPAREDNESS LEVEL	PUR
1,2,3	1
4	2
5	3

FIGURE 18: PREPAREDNESS LEVEL AND PUBLIC USE RESTRICTIONS RELATIONSHIP

(***5/2018 Update; PUR Level guidance is now a function of Preparedness Level.)*

WIMS OPERATIONAL PROCEDURES

WIMS Station Catalog Settings

The table below represents ideal station catalog setting based on the results of the planning area inventory (slope class, climate class, herbaceous type) and fire business analysis (NFDR fuel model). Climate class is derived from the FDRA precipitation normal and climate class PRISM classifications (>50" annual is equal to climate class 4). Herbaceous type was set based on LANDFIRE Existing Vegetation Layer. Fuel model was selected based on a desire not to 'rock the boat' and make a chance prior to the mandatory fuel model change associated with the forthcoming NFDR 2016. Slope class is derived from the FDRA mean percent slope and averaged where FDRAs were combined (Puget and Cascades FDRAs).

	SLOPE CLASS	CLIMATE CLASS	HERB	FUEL MODEL
North Cascades + Puget North	3	4	PERENNIAL	G
South Cascades + Puget South	2	4	PERENNIAL	G
Olympic East	3	4	PERENNIAL	G
Olympic West	2	4	PERENNIAL	G

FIGURE 19:

Staffing Level breakpoints for WIMS catalog bins are not used in this plan.

WIMS Seasonal Schedule

PSICC lead Intelligence Dispatcher will coordinate with Fire Management Officers as green up approaches to set green up. Stations within fire danger rating areas should be greened individually if appropriate. PSICC Intelligence should monitor Normalized Difference Vegetation Index satellite imagery found on the Wildland Fire Assessment System (WFAS), http://maps.wfas.net/ and initiate annual contacts with Station Managers if needed as peak green up approaches.

The annual/seasonal cycle would be; begin entering observations ~1 month prior to green-up, pre-green stations ~2 weeks prior to green-up, green-up stations ~2 weeks prior to the peak of greenness, freeze stations after 3 consecutive days of minimum temperatures less than 28 degrees Fahrenheit (>9/01).

APPROX DATE	ACTION
15-Apr	Check that stations were Frozen
15-Apr	Begin entering Observations
1-May	Pre Green stations
15-May to 15-June	Green up stations
>1-Sept + Hard Freeze	Freeze Stations

Keetch-Byram Drought Index startup values were not considered since they are not used in the 78 NFDR. 1000-hr startup values were not considered either; as long as observations are entered ~1 month prior to green up (pre-green) 1000-hr carry over values will render the 1000-hr startup irrelevant.

WIMS Daily Schedule

The Dispatch Center will access WIMS daily and;

1. Quality Control Station Data; weather readings for the previous 24 hours will be checked by looking at hourly observations for abnormal or inappropriate readings. Notify Zone ZFMOs of suspect or missing readings.

2. Enter Daily Observations; all observations will be for the hourly record closest to 1300 hours. For stations that transmit later than 30 minutes after the hour a 1200 record should be used. State of the weather will be based on 1400 conditions for the majority of the FDRA, not necessarily the station. The Wet Flag will be set when appropriate based on the latest Tech Note or Help Desk guidance. Observations should be entered no later than 1500 daily so that they are available to the National Weather Service (NWS) for forecasting.
3. Fire Danger Product; from June 1st through season end the Fire Danger Product developed for PSICC in conjunction with this plan will be refreshed daily after the forecast from the NWS becomes available. The product will be posted in pdf format to the Center website preferably no later than 1730.

ROLES AND RESPONSIBILITIES

Program Manager (Unit Fire Management Officer)

The unit FMO will use this FDOP and fire danger outputs as a tool to help guide informed fire management decisions. The individual units are ultimately responsible for ensuring that this FDOP and plans and products tiered down from this FDOP are maintained, utilized, understood and communicated.

Program Managers will identify and designate Fire Weather Station Owners for each station utilized in this plan, preferably trained in RAWS maintenance and S-491.

Fire Weather Station Owners

Each unit participating in this plan will have their own Remote Weather Station Maintenance Plan, updated annually, which includes contact information for responsible parties, important maintenance dates, maintenance contacts, station annual maintenance (green up) contacts, responder training needs, and site maintenance needs. *This plan will be sent to PSICC on an annual basis prior to June 1st.*

Generally the unit Fire Management Officers are responsible for the following:

- Maintenance of RAWS including; annual maintenance, communications with the Boise RAWS Depot, WFMI documentation of site visits and upkeep to assure stations meet minimum Standards and Guidelines (http://raws.fam.nwcg.gov/nfdrs/pms426-3.pdf).
- Annual assurance that correct contact information for stations owners and event notifications are entered into WFMI.
- Monitoring data to ensure quality. Working with the Data Manager to provide corrected data when missing or erroneous data is identified.
- Monitoring and acting upon the Noncompliance and Station Event Reports generated from WFMI.
- Appropriate site selection and placement of fire weather stations (including portables), maintenance, and assurance that accurate observations are taken and transmitted. This includes assuring appropriate response to station malfunctions.
- Notifying the Data Manager when erroneous or suspect data is transmitted.
- Annually determine transition dates for live fuels (green-up) and notify the Data Manager to make changes within WIMS.
- Assuring that their resources are aware of and understand NFDRS outputs and that pocket cards are distributed to all local and incoming resources

Data Manager

PSICC is responsible for the operation and maintenance of the Weather Information System.

Responsibilities include:

- Ensuring that daily weather observations are edited as needed and published, preferably no later than 1600 hours.
- Monitoring data to ensure quality. This includes scanning the prior 24 hours of observations and reporting missing or suspicious data to the Station Owner.

- Periodically checking the observations database to make sure that all observations have been edited for calculations. Working with Station Owners to fill data gaps, fix known bad data, and submit corrections to the FAMWEB helpdesk for application to the WIMS database.
- Making station level adjustments as requested by Station Owners to live fuels and recalculating indices as needed.
- Disseminating fire danger information to include calculating, broadcasting, and posting daily indices and forecasts, updating and posting fire danger charts and tables, and posting restrictions and closures to the website.

Future Considerations

- Include, if possible, other wildland response agencies/units in future revisions of this plan to include all resources dispatched by PSICC (i.e. WA Department of Natural Resources).
- A more complete QA/QC on the weather data used in this plan should be completed prior to the next revision.
- Consider splitting the response unit which forms the Olympic Mountains proper (OLP3 as of this writing) into east and west response zones to facilitate dispatch logic in WildCad.
- Provide training opportunities (S-491, Advanced NFDR, RAWS maintenance) to individuals on the unit interested in Fire Danger and weather station maintenance.

Appendices

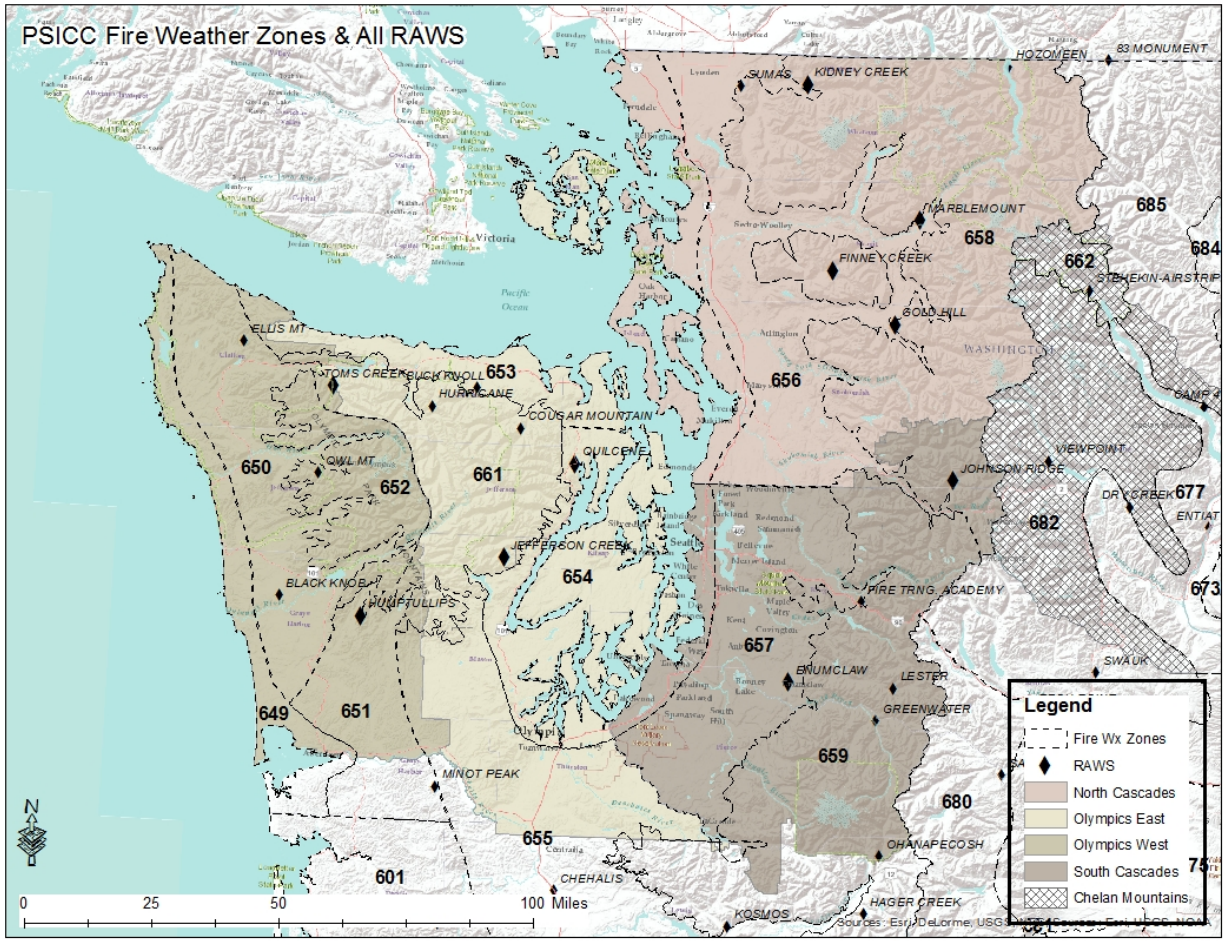
Annual Climatological Percentiles

Annual climatological percentiles (1998-2013, ERC-G) for severity requests where agency directive specifies use.

	90th	97th	80th	95th
North Cascades + Puget North	32	39	25	36
South Cascades + Puget South	33	40	26	38
Olympic East	34	41	29	38
Olympic West	34	41	27	38

Additional Reference Maps

Fire Weather Zones and Remote Automated Weather Stations



PSICC Fire History (Fires Used For Analysis), FPA-FOD 1998-2013