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Emission Inventory for Prescribed and Wildland Fire:

- What we mean by EI? $\text{Level of Activity} \times \text{EF}_{\text{pollutant}}$
- Who needs EI's, and why ?
- What has been done, and how well ?
- Current Activity ?
- What statistics comprise an EI ?
- How good should an EI be ?
- How can/should/will we compile EI ?

References Available ?

- **EI Summary (2002) (Tom Battye/Tom Pace, EPA)**
- **WRAPAir.org**
 - GCVTC, Fire Emissions Project, 1996, 2018 Inventory (Air Sciences), Emission Tracking Policy, Natural Emissions, Emission Goals, ESMP..
- **Others:**
 - **Smoke Management Guidebook (2002) (Hardy NWCG, EPA),**
 - **Fire Effects on Air (2003) (Sandberg JFSP)**
 - **Strategic Plan Fire and Air Information Systems (Express Team, NWCG)**
 - **FACA White Papers (Peterson, Sandberg, Leenhouts; EPA)**
 - **Historical perspective (Leenhouts 2001)**
 - **Emission Reduction (Peterson and Leenhouts)**

What's happening now ?

- **WRAP Air Emissions Inventory (Air Sciences)**
- **Other RPO's (Vista....)**
- **Real Time Fire Monitoring (Wei Min Hao, NFP)**
 - 2 x Daily Modis satellite
 - NFDR fuel model x consumption constant
- **Natural and Anthropogenic Sources (Mckenzie & Sandberg, NFP)**
 - 2064 projection (Climate, Land Use, Fuels Treatment, Ecosystem Health...)
 - Fuel Classification (FCC) and Emission Production (EPM v2)
- **BlueSky (Ferguson, NFP and JFSP)**
 - Real-time emission and impact prediction
- **Washington and Oregon EI systems and PNW-GA support (1988)**
 - Statistically valid defaults
 - Emission reduction parameters
 - Modeled consumption
 - Fastracs

What's **not** happening now ?

- Strategic Plan (Express)
 - **Recommendation 4: Air quality impact assessment** – Better wildland and prescribed fire information is needed to compile emissions inventories, for regional haze analysis and for determination of compliance.
 - **Recommendation 8: National fire and air quality information database** – A readily accessible source of information on past, current, and predicted future fire activity levels, emissions production, and air quality impacts from fires does not exist. Such a database is needed to analyze past experiences and replicate successes.
- How accurately and precisely should we commit to providing an inventory of emissions from prescribed and wildland fires?
- What is the appropriate mix of event reporting, ground-based data collection, modeling, remote sensing, and analysis to deliver an emissions inventory?
- What national policy support do ask for to make it happen?

Case Study in Data Quality: WRAP Emissions Inventory

- **Data Requirements (defined by Regional Haze Rule)**
 - 1996, Typical Year, 2018, 2064...
 - Annual and Five year increments
 - Daily emissions in order to focus on 20%
- **Data Requirement (defined by Smoke, CMAQ, Models3)**
 - Hourly geo-referenced (or gridded) emissions rate
 - Plume rise: distribution of pollutant among 8 vertical strata ?
 - Criteria pollutants and chemical precursors ?
- **Data Available**
 - Individual Wildfire Reports
 - Seasonal Prescribed Fire Estimates → State daily inventories
 - FEP projections

Case Study in Data Quality: WRAP Emissions Inventory

PM-2.5 Emissions

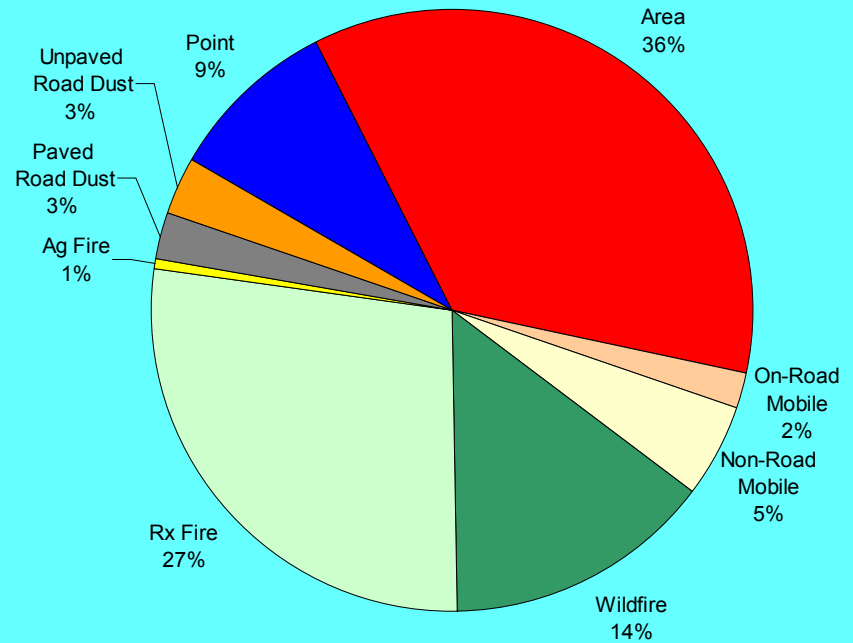
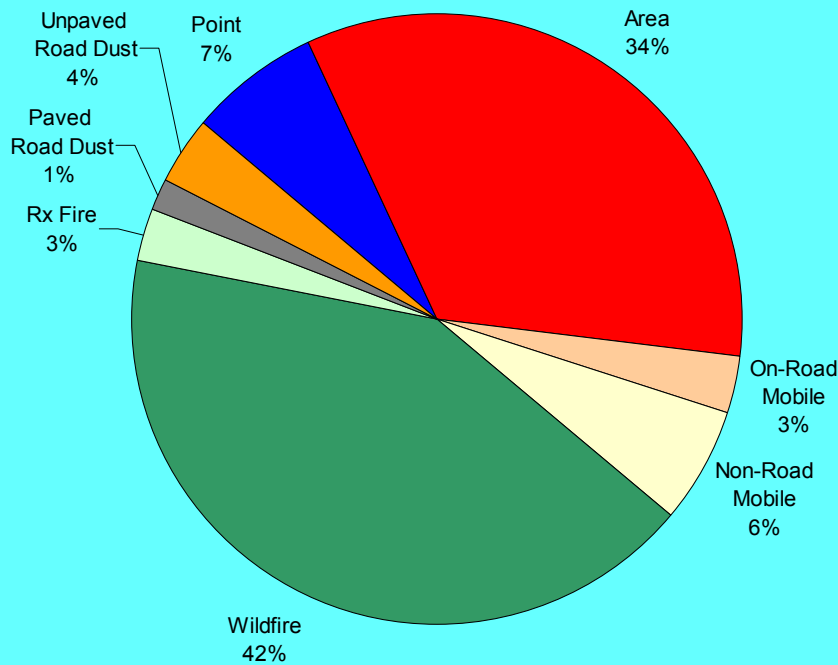
1996

1,547,661 T

2018

1,620,072 T

Increase = 72,412 Tons (+5 %) from 1996



Who needs an EI?

- **Why do **they** need an Emission Inventory?**
 - Source Apportionment “Pie” (State for SIP’s)
 - Regional Haze SIP’s and Tracking (EPA, States)
 - Regulatory Emissions “Goal” or “Cap” (per WA, OR, WRAP)
 - HAPs, Air Toxics, Hg, Risk assessments....

- **Why do **we** need an Emission Inventory?**
 - NEPA, FLM Responsibility
 - LMP, Fire Plans
 - Correlate Tracking with Monitoring, Source Apportionment
 - Accomplishment Monitoring “Give us Credit”
 - Demonstrate Emission reduction
 - Accomplish National Fire Plan goals
 - Wildland Fire Emission reduction
 - Carbon Accounting

What is an Emission Inventory Class?

Emission Factor in class

Lb ton⁻¹ consumed

X

Acres burned in class

X

Fuel Loading

X

Portion Consumed

= Tons consumed

Vegetation Type
Fuel Characteristics
Fire Type
Regulatory Status
Geographic Area
Time Period

Tons Consumed in class

How Many Statistical Classes ?

- Emission Factor x Level of Activity
 - Statistical Representation of Each

Emission Factor in class

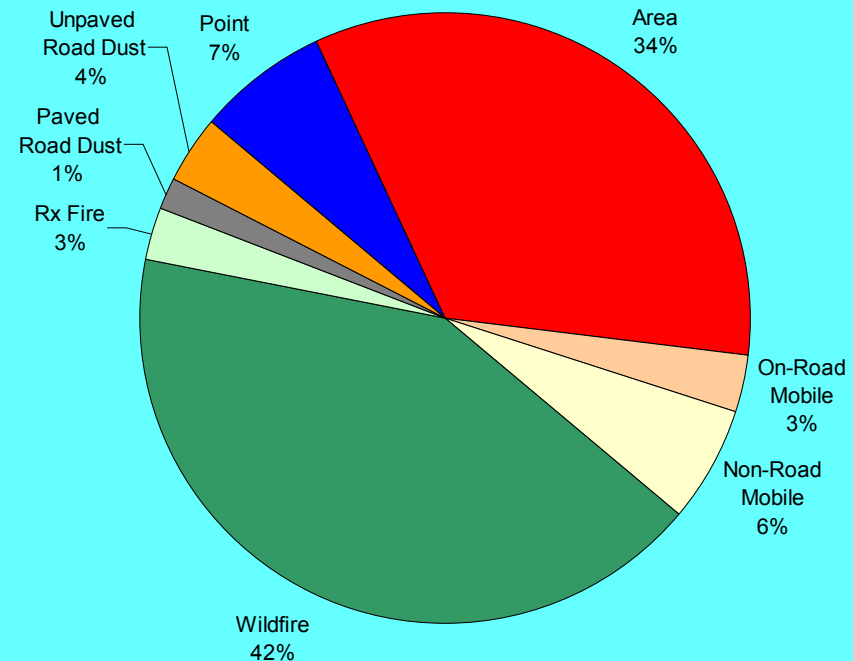
Lb ton⁻¹ consumed

X **Tons Consumed in class**

What constitutes a **class** ?

- state or other geographic region ?
- regulated class ?
- prescribed, anthropogenic...?
- statistically different EF or LOA ?
- individual fire event ?
- portion of individual fire event ?

WRAP 1996 PM 2.5

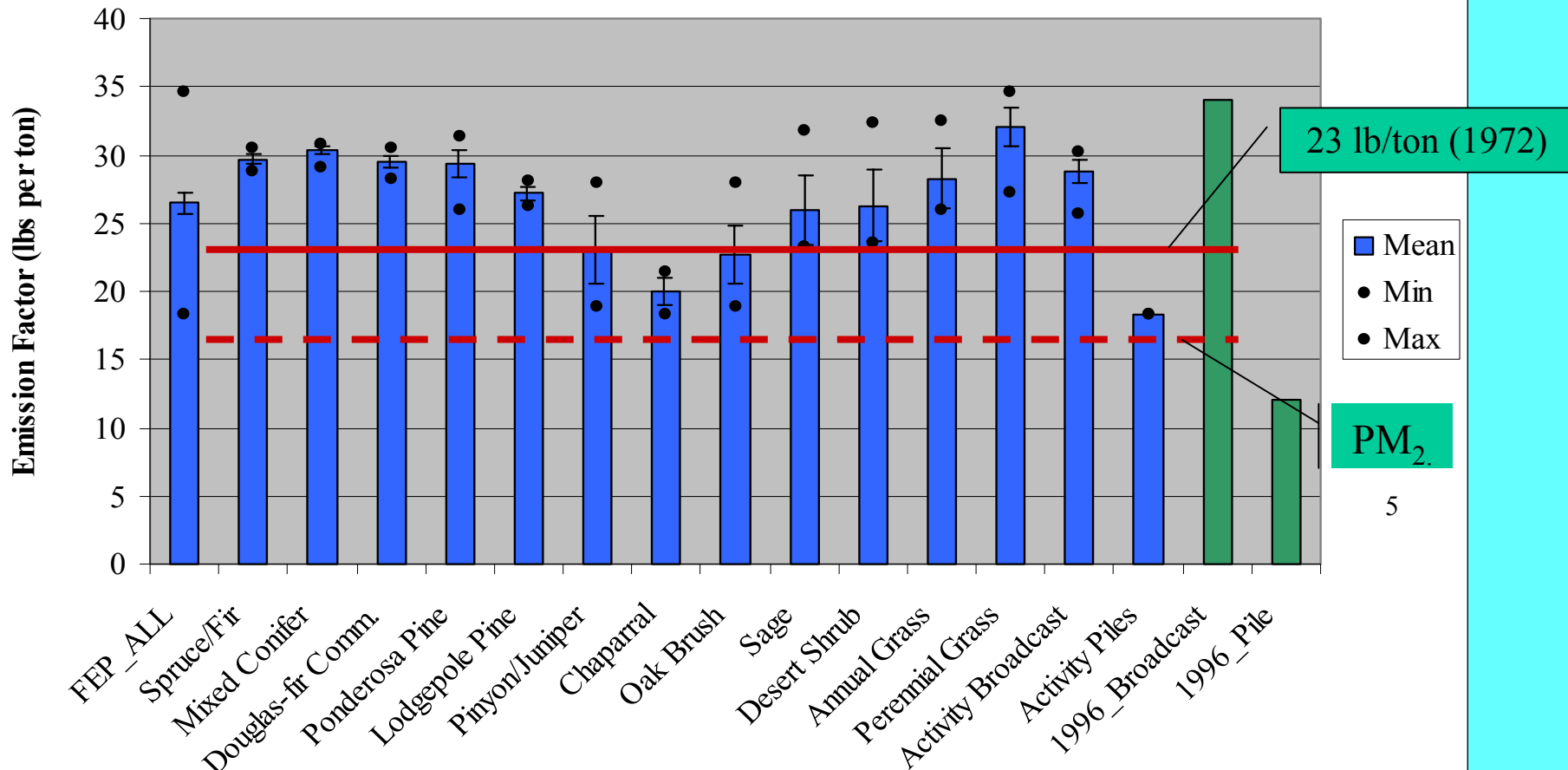


Emission Factor in class

Statistically Different EF's for:

- Vegetation Cover (for EF and Fuel Character)
- Type of Burn (Pile, Wildfire, Broadcast....)
- Combustion Stage (Flame, Smolder, Residual)

PM_{total} emission factor comparison: FEP and 1996-EI



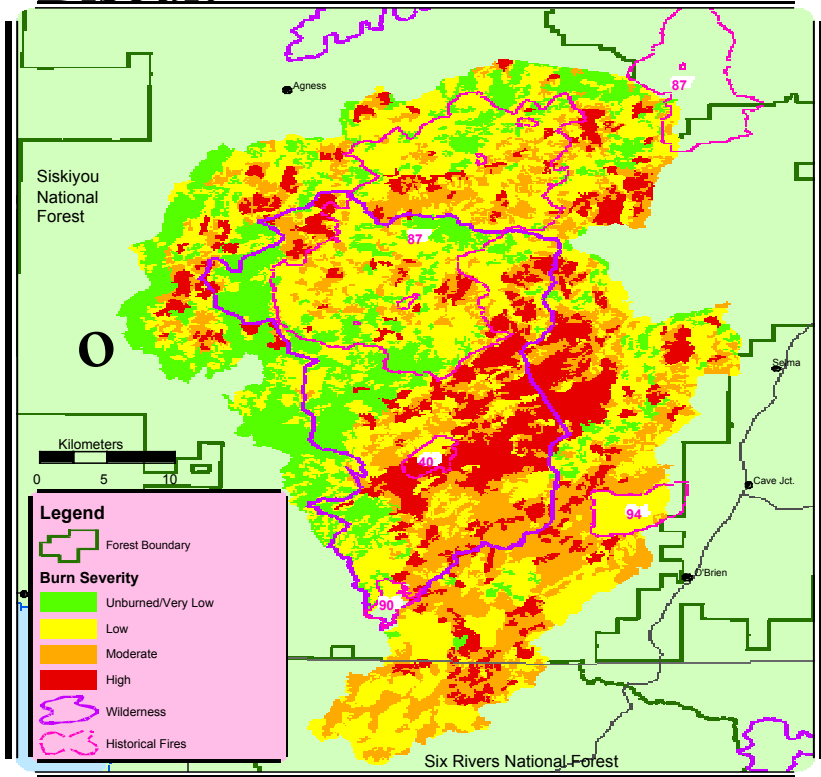
Acres burned in class

Acres Perimeter

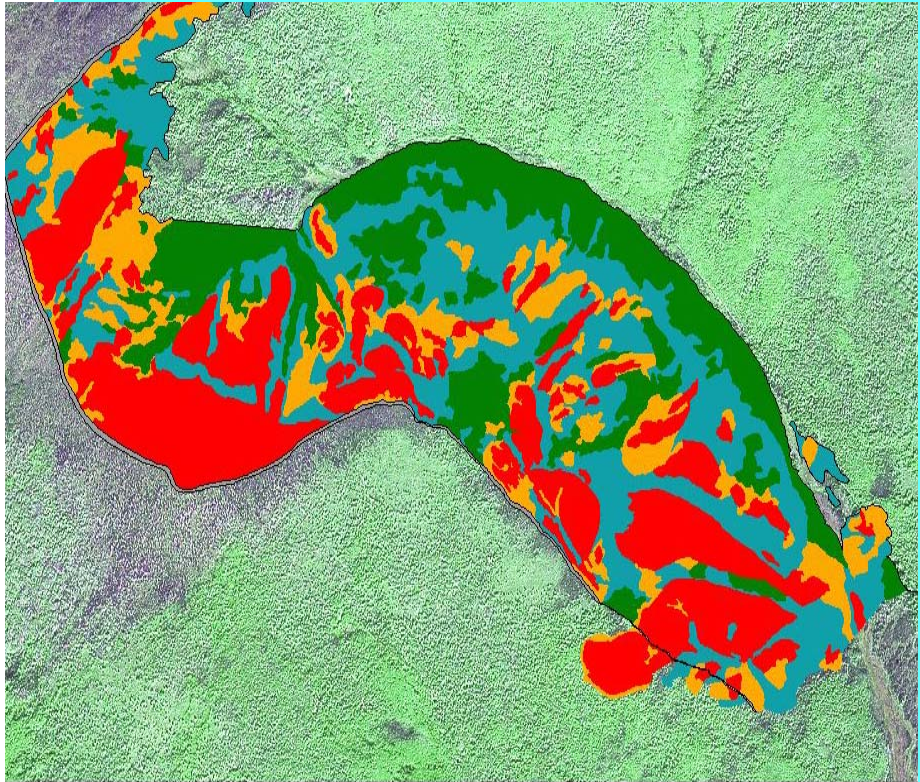
Accuracy, Unburned acres

Severity Distribution (green, yellow, brown, black,)

Biscuit



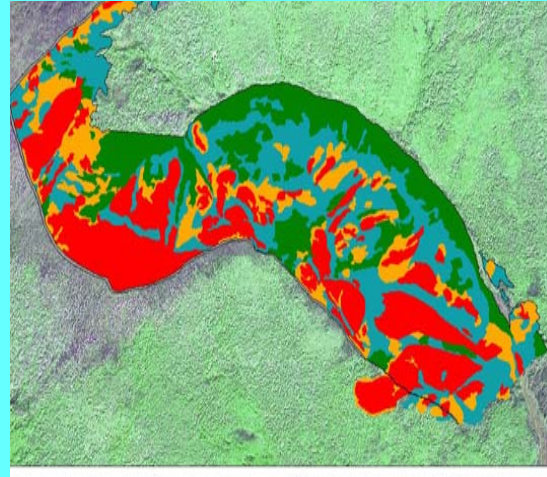
FrostFire



X

Portion Consumed

-- Severity distribution



-- Combustion stage weighting (EF and time period)



-- Unreliability of direct estimates

Acres burned in class

Table 5. Options for Estimating the Area Burned in Wildfires

	→ → Increasing level of detail and accuracy → →				
Option	DOI and FS summary reports (State level)	Federal and state incident databases	Federal and state incident databases with auditing and quality assurance	Satellite data with auditing and quality assurance	Ground-truthing with land surveys, aerial surveys, etc.
Advantages	Easy to use for general calculations	Good spatial and temporal detail	Improved accuracy	Superior spatial and temporal detail Good accuracy is expected	Best accuracy
Disadvantages	Lack of spatial and temporal detail	Incomplete coverage Double counting Reported area typically exceeds blackened area Errors in location data	Analyzing reports is resource intensive	Processing of satellite data is resource intensive Processed data sets are not yet available	Resource intensive

Table 6. Options for Estimating the Area Burned in Prescribed Fires

	→ → Increasing level of detail and accuracy → →					
Option	Previous inventory estimates	State incident databases	State incident databases with auditing and quality assurance	Survey land managers for different ownership categories	Satellite data with auditing and quality assurance	Ground-truthing with land surveys, aerial surveys, etc.
Advantages	Easy to use for general calculations	Good spatial and temporal detail	Improved accuracy	Good accuracy is expected	Superior spatial and temporal detail Good accuracy is expected	Best accuracy
Disadvantages	Lack of spatial and temporal detail	Not always available Errors in location data Reported area may overstate burned area	Analyzing reports is resource intensive	Considerable effort required	Resource intensive Processed data sets are not yet available	Resource intensive

Fuel Loading

NFDRS Fuel Models

NFDRS	FUEL LOADS						WOODY	HERBS		DUFF	CROWN
		1-HR	1-HR	100-HR	1000-HR						
A	ANNUAL GRASS	0.2					0.3				
L	PERRENIAL GRASS	0.25					0.5				
N	SAWGRASS	1.5	1.5				2				
C	OPEN TIMBER/GRASS	0.4	1			0.5	0.8		4		
D	SOUTHERN ROUGH	2	1			3	0.75		7.7	8	
T	SAGEBRUSH/GRASS	1	0.5			2.5	0.5				
B	MATURE CHAPARRAL	3.5	4	0.5		11.5					
F	INTERMEDIATE BRUSH	2.5	2	1.5		9					
E	HARDWOODS/WINTER	1.5	0.5	0.25		0.5	0.5		1.1		
P	SOUTHERN PLANTATION	1	1	0.5		0.5	0.5		13.3	10	
R	HARDWOODS/SUMMER	0.5	0.5	0.5		0.5	0.5		1.1		
U	WESTERN LONG-NEEDLE	1.5	1.5	1		0.5	0.5		10.6	14.2	
	NW	1.5	1.5	1		0.5	0.5		9.7	4.9	
	SW	1.5	1.5	1		0.5	0.5		9.9	4.9	
I	HEAVY SLASH	12	12	10	12				18.2		
J	MEDIUM SLASH	7	7	6	5.5				16.9		
K	LIGHT SLASH	2.5	2.5	2	2.5				9.7		
O	POCOSIN	2	3	3	2	7			58.2		
S	ALASKAN TUNDRA	0.5	0.5	0.5	0.5	0.5	0.5		32.6		
H	CLOSED SHORT-NEEDLE	1.5	1	2	2	0.5	0.5		16.9	18.7	
	SW	1.5	1	2	2	0.5	0.5		18.7	18.7	
G	SHORT-NEEDLE, HEAVY	2.5	2	5	12	0.5	0.5		18.2	19.2	
Q	ALASKAN BLACK SPRUCE	2	2.5	2	1	4	0.5		57.9	26.8	

X

Fuel Loading


The FCCS rapid prototype - Microsoft Internet Explorer provided by USDA Forest Service


File Edit View Favorites Tools Help


Back Forward Stop Home Search Favorites History Print View Source


Address http://duet.cfr.washington.edu/~jeffs/FCCS/code/fccs_select_prototype.php Go Links >>


Here is the script: This document last modified on: 01/24/2003 11:22:12 Here is the script: This document last modified on: 01/24/2003 11:22:12

 The United States Department of Agriculture



 **FERA**
Fire and Environmental Research Applications

 **ONLY YOU CAN PREVENT WILDFIRES.**



Fuelbed Characteristic Classification System

Select the prototype fuelbed that most closely resembles your fuelbed

Step 2: Select FuelBed prototype

This is a rapid prototype of the FCCS system! The session ID is

- Lots of Western Red Cedars
- Mixed Douglas Firs and Hemlocks
- Alders, maples and other deciduous trees
- Sitka Spruces

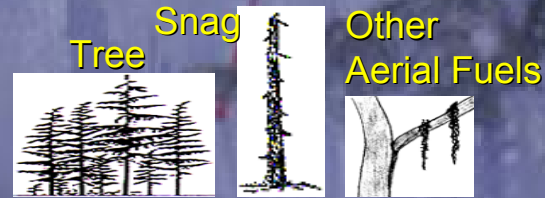
refresh screen back next custom search

W3C HTML 4.01

Done Internet

Fuel Loading

Canopy
Stratum



Shrub
Stratum



Low Vegetation
Stratum



Woody Fuel
Stratum



Moss, Lichen, Litter
Stratum



Ground Fuel
Stratum



Fuelbed Strata and Categories

Fire Potential Classification ≈ 120

X

Fuel Loading

A consistent means of classifying fuelbed output for comparison and communication.



Mature lodgepole

Crowning Potential

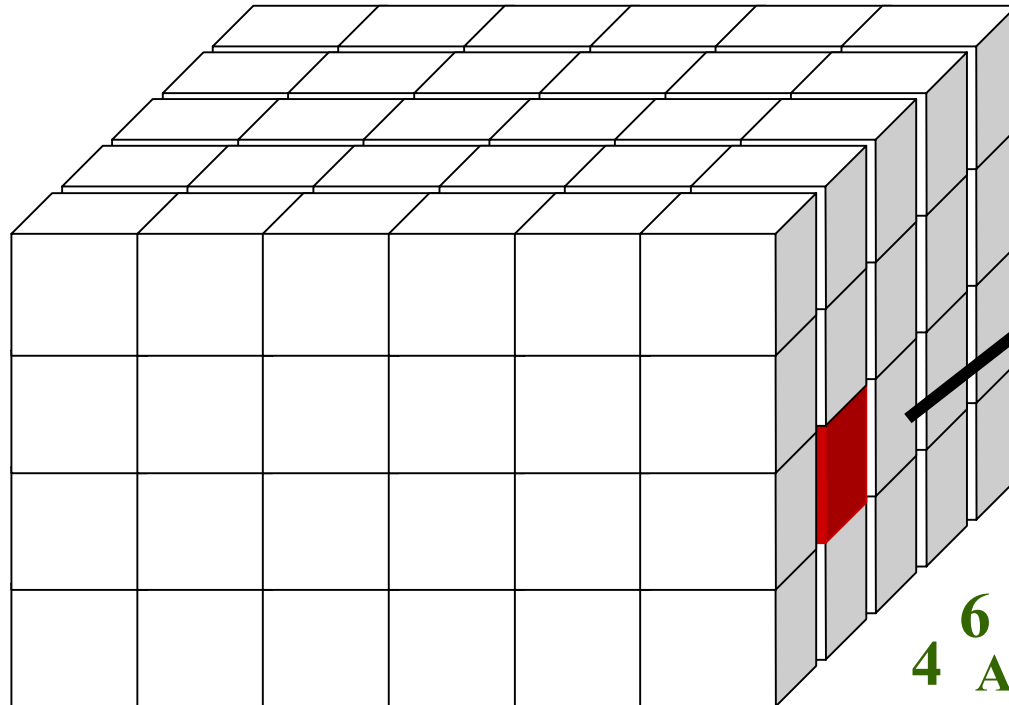
9

6

3

0

Pinyon/juniper



FCC# 923



Mature DF/hemlock

Available Fuel Potential

1

2

4

6

8

9

0

2

4

6

8

Fire Behavior Potential

Sparse grass



Dense grass



Sparse grass



Consumption Results

Buoyancy Results

Emission Results

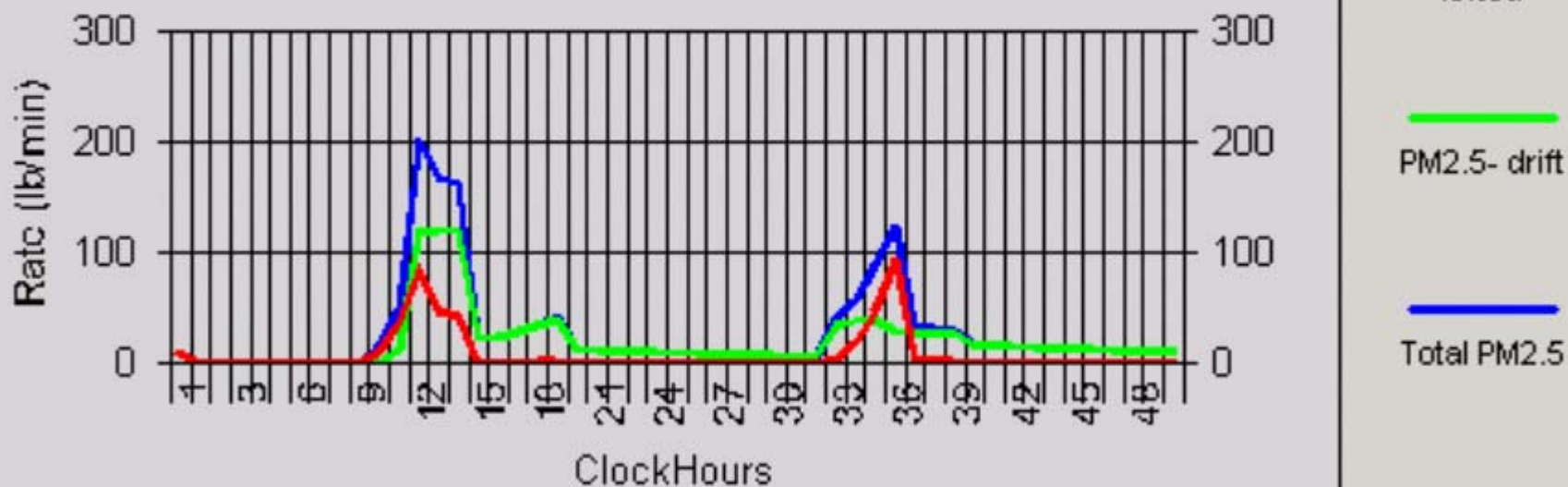
Graph - Consumption

Graph - Plume Rise

Graph - PM2.5

Graph - CO Emissions

PM2.5 Emission Rates



[View Unit Information](#)

Consumption Results

Buoyancy Results

Emission Results

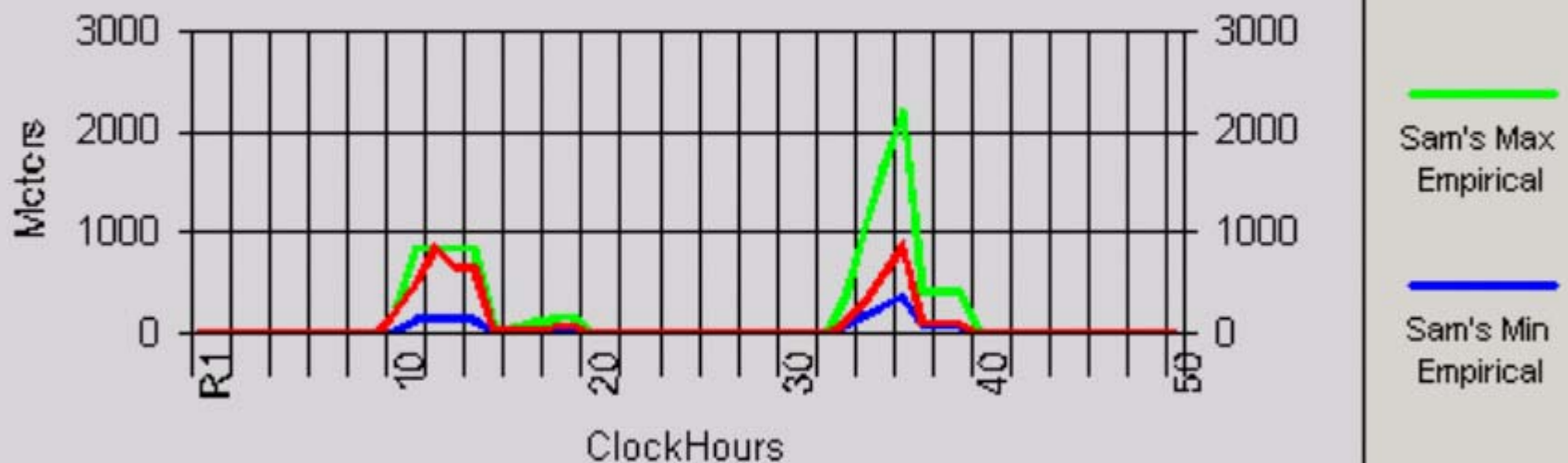
Graph - Consumption

Graph - Plume Rise

Graph - PM2.5

Graph - CO Emissions

Plume Rise



View Unit Information

How good does an EI need to be?

- **Qualitative Assessment (Event, Summary statistics)**
 - Variability ?
 - Scale of application ?
 - Absolute value or change ?
 - Plan, Predict, Real-Time, Long Term Projection
 - Goal of detection or accomplishment ?
 - Decision process (regulation, notification, action...) ?
 - Source Apportionment?
- **Quantitative assessment (not: “as good as possible”)**
 - Value of information
 - Quality of information sources
 - Unexplained Variability

Table 3. Options for Obtaining the Inputs Needed for Prescribed Fire Emissions Inventories

Parameter	Increasing level of detail and accuracy					
	→ →	→ →			→ →	→ →
Area burned	Previous inventory estimates	State incident databases	State incident databases with auditing and quality assurance	Survey land managers for different ownership categories	Satellite data with auditing and quality assurance	Ground-truthing with land surveys, aerial surveys, etc.
Vegetative cover	Regional defaults	Estimates from existing inventories		Satellite data	Survey land managers	Ground-truthing with land surveys, aerial surveys, etc.
Fuel loading and characteristics	General estimate	Land manager determination of NFDRS fuel classes	Land manager determination of fuel type, with emission model defaults	Fuel characteristics classification system	Photo-series correlation	Transect measurements
Fuel consumption	Regional defaults		Vegetation-specific defaults	Fuel consumption models with default inputs		Models with input from land managers
Emission factors	General defaults	Regional defaults	Separate factors for flaming and smoldering	Emission models or correlation with CO or CE	Emission models with input from land managers	Vegetation-specific emission data
Impact of mitigation measures	Default emission factors for activity fuels	Account for activity fuels in fuel consumption modeling		Account for impacts of fuel moisture		Situation-specific emission data
Temporal distribution of emissions	Default seasonal and/or hourly profiles	Allocation using actual seasonal fire frequencies		Fire-specific emission calculations		Fire-specific hourly modeling

Table 2. Options for Obtaining the Inputs Needed for Wildfire Emissions Inventories

Parameter	Increasing level of detail and accuracy					
	→ →	→ →	→ →	→ →	→ →	→ →
Area burned	DOI and FS summary reports		Federal and state incident databases	Federal and state incident databases with auditing and quality assurance	Satellite data with auditing and quality assurance	Ground-truthing with land surveys, aerial surveys, etc.
Vegetative cover	Regional defaults	Estimates from existing inventories		Satellite data	Survey land managers	Ground-truthing with land surveys, aerial surveys, etc.
Fuel loading and characteristics	General estimate	Land manager determination of NFDRS fuel classes	Land manager determination of fuel type, with emission model defaults	Fuel characteristics classification system		
Fuel consumption	Regional defaults		Fuel consumption models with dry fuel assumption	Fuel consumption models with crown adjustment		Models with input from land managers and crown adjustment
Emission factors	General defaults	Regional defaults	Separate factors for flaming and smoldering	Emission models or correlation with CO or CE	Emission models with input from land managers	Vegetation-specific emission data
Temporal distribution of emissions	Default seasonal and/or hourly profiles	Allocation using actual seasonal fire frequencies		Fire-specific emission calculations		Fire-specific hourly modeling

What **needs** to be done ?

- **Data Quality Assessment (Event, Summary statistics)**
 - **Daily event-specific record of accomplished acres by fuel type, burn type, and severity. 100 acres resolution per class, (95% compliance)**
 - **0.5% statistical audit of reported accomplishment. (30%)**
 - **0.5% statistical audit of remote-sensing and model outputs (30%)**
 - **2-5% statistical measure of change variables (5%)**
 - **1% sample of hourly profile of emission rate, plume rise (50%)**
- **National commitment (policy, action)**
 - **Proactive delivery of planned, accomplished, and envisioned EI by class:**
 - **Vegetation, Source Class, Location, Land Use Class**
 - **Design efficient combination remote sensing, modeling, recording, auditing.**
 - **Honestly Implement Model and Remote sensing applications**
 - **Analysis of “what might have been” – i.e. Accomplishment reporting**
 - **Open communication of fire and emissions database**
 - **Incorporate analysis into LMP, operational decisions**
 - **Ten-year implementation deadline**