Common Denominators of Escaped Prescribed Burns in the Lakes States

EASTERN REGION, USFS
2017

Audio will start at top of the hour
This webinar is listen only – to ask questions please use the chat box

DISCLAIMER

- This is a learning presentation, with a goal to develop High Reliability Organizations (HRO) and improve our learning culture.

- The escaped prescribed burns being discussed were all implemented by talented, highly motivated, well intended, professionals just like us!!

- People make mistakes!! This is 100% certain. We need layered defenses and good planning to defeat this fact.

Topics to be Covered

- High Reliability Organization Characteristics
- National Escaped Fire Statistics
- Common Denominators of Escaped RX Fires in the Lake States & Eastern Geographic Area
- Situational Learning tools to help reduce risk of escape or other undesired outcomes
- Mack Lake Staff Ride
- Foss Lake FLA
- Tips for Premortems during RX planning

... "There are no new accidents, just the same accident happening to a different individual, a different organization, or at a different time."

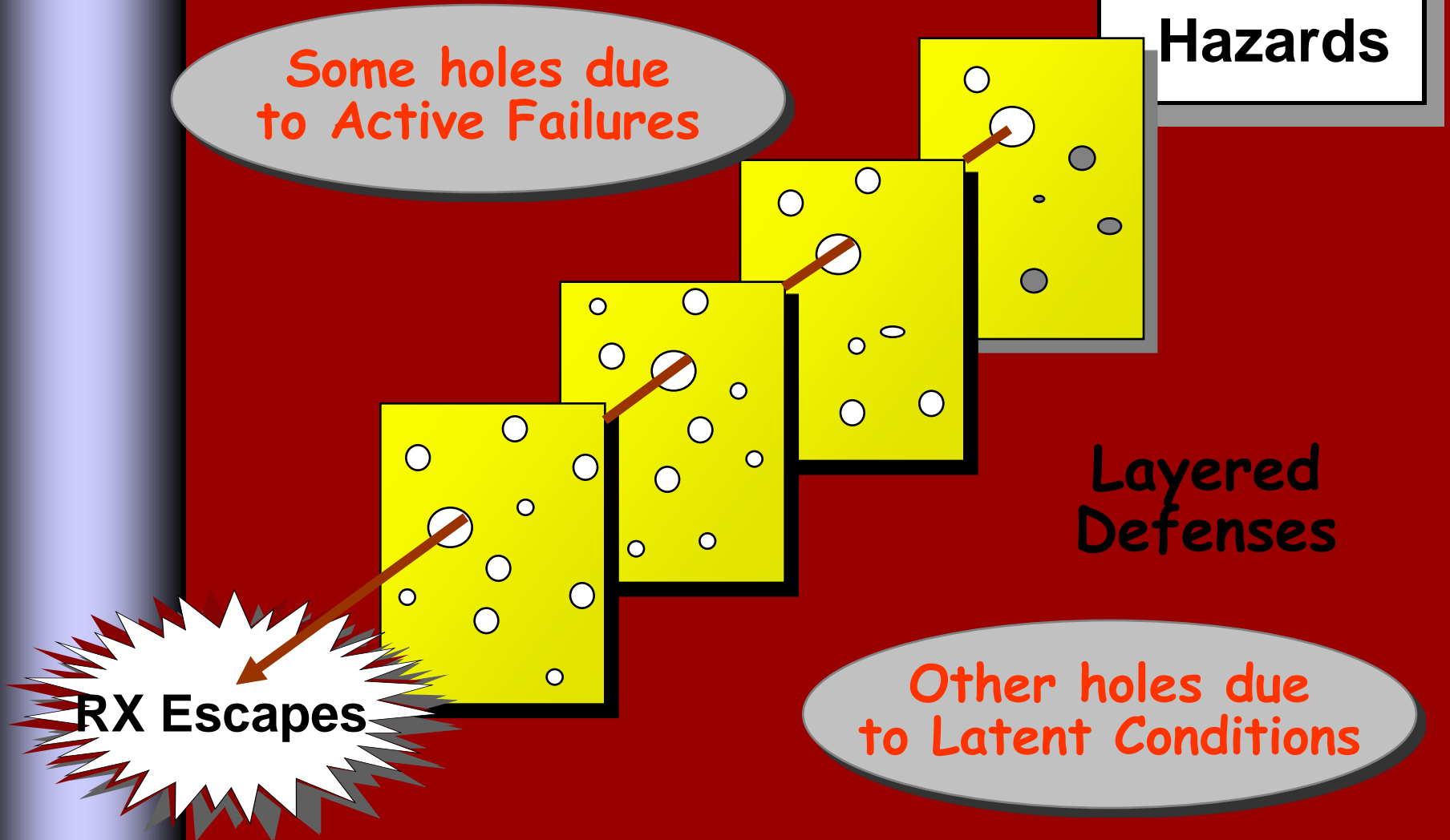# RX Escape Trajectory Passing through Defenses in Depth

DANGER

Hazards

Some holes due to Active Failures

Layered Defenses

RX Escapes

Other holes due to Latent Conditions

Building an HRO

The Five Key High Reliability Organization Activities

Through their research into the successful operations of organizations involved in high risk operations—including nuclear aircraft carriers, air traffic control, emergency rooms, and fire operations—Weick and Sutcliffe (2001) have identified five activities in which all successful high reliability organizations engage to manage unexpected events:

1. Preoccupation with Failure,
2. Reluctance to Simplify,
3. Sensitivity to Operations,
4. Commitment to Resiliency, and
5. Deference to Expertise.

These five activities can be grouped into two functional categories, "mindful anticipation," and "mindful containment."

Mindful anticipation includes actions that focus on:

- Identifying and responding quickly to conditions that can lead to failure (Preoccupation with Failure),
- Seeking and maintaining a diversity and complexity of perspectives (Reluctance to Simplify), and

- A constant vigilance to operations and updating our understanding of events based on our observations (Sensitivity to Operations).

Mindful containment includes:

- Decisive response and adaptation to unexpected developments (Commitment to Resiliency), and
- A deference to those with greatest expertise and firsthand knowledge of the developing events (Deference to Expertise).

HRO Planning is What Separates RX Fire from Wildfire

- We predict and select the weather conditions
- We select site location, and fuel conditions
- We select the timing of the RX fire
- We select the implementation resources
- We pick the control features or firelines
- We control everything except!!!!!
- All those imperfect people

60 Billion Flight Miles, 1 Fatal Accident in 8 Years

Table 6. Accidents, Fatalities, and Rates, 1995 through 2014,

for U.S. Air Carriers Operating Under 14 CFR 121, Scheduled Service (Airlines)

	Accidents		Fatalities					Accidents per 100,000 Flight Hours		Accidents per 1,000,000 Miles Flown		Accidents per 100,000 Departures	
Year	All	Fatal	Total	Aboard	Flight Hours	Miles Flown	Departures	All	Fatal	All	Fatal	All	Fatal
2007	26	0	0	0	19,014,677	8,024,313,000	10,734,170	0.137	-	0.0032	-	0.242	-
2008	20	0	0	0	18,580,166	7,813,371,000	10,282,575	0.108	-	0.0026	-	0.195	-
2009	26	1	50	49	17,182,970	7,248,702,000	9,564,891	0.151	0.006	0.0036	0.0001	0.272	0.010
2010	28	0	0	0	17,235,121	7,352,374,000	9,467,282	0.162	-	0.0038	-	0.296	-
2011	28	0	0	0	17,464,623	7,473,520,000	9,419,064	0.160	-	0.0037	-	0.297	-
2012	27	0	0	0	17,271,783	7,443,365,000	9,241,935	0.156	-	0.0036	-	0.292	-
2013	19	0	0	0	17,298,574	7,469,229,000	9,139,808	0.110	-	0.0025	-	0.208	-
2014	27	0	0	0	17,226,000	7,479,622,000	8,887,000	0.157	-	0.0036	-	0.304	-
Totals					141,273,914	60,304,496,000	76,736,725						

USFS RX Escapes

- 2003-2007
- USFS – 55 escapes
- 25% occurred during ignition
- 75% occurred well after ignition

2003 to 2007 Escape Issues

- Burning into worsening weather (outside of prescription)
- Inadequate staffing for known duration of the active burn (ignition and holding phases)
- Failure to Follow RX Plan
- Unexpected Weather

2008-2013

- 50 Escapes
  - 20 On Ignition Day (40%)
  - 30 After Ignition Day (60%)

Recurring Factors in Escapes 2008-2013

- New Fuel Types
- Effects of Prolonged Drought
- Unexpected changes in weather or changes occurring more rapidly than expected
- Piles holding heat longer than expected
- Landscape scale burns, multi-day operations

# Trends in USFS Prescribed Fire Program – 1996 to 2014

Year Range	1996 to 2001	2003 to 2007	2008 to 2014
Prescribed Fires	24,133	19,468	33,677
Annual Average	4,022	3,980	4,811
Acres Treated	6,406,217	7,079,427	9,812,690
Annual Average	1,067,703	1,415,885	1,401,813
Escapes	235	50	45
Annual Average	39	10	6
Reliability Rate	99.03%	99.75%	99.87%

Note: data for 2002 was omitted as unreliable

Prescribed Fire Escapes - US Forest Service 1996 to 2012

Escapes per 1,000 Prescribed Fire Projects Ignited
Note: USFS Averages ~4,500 Prescribed Fire Projects Treating ~1,400,000 acres/yr

Trend Line (3yr Running Avg.)
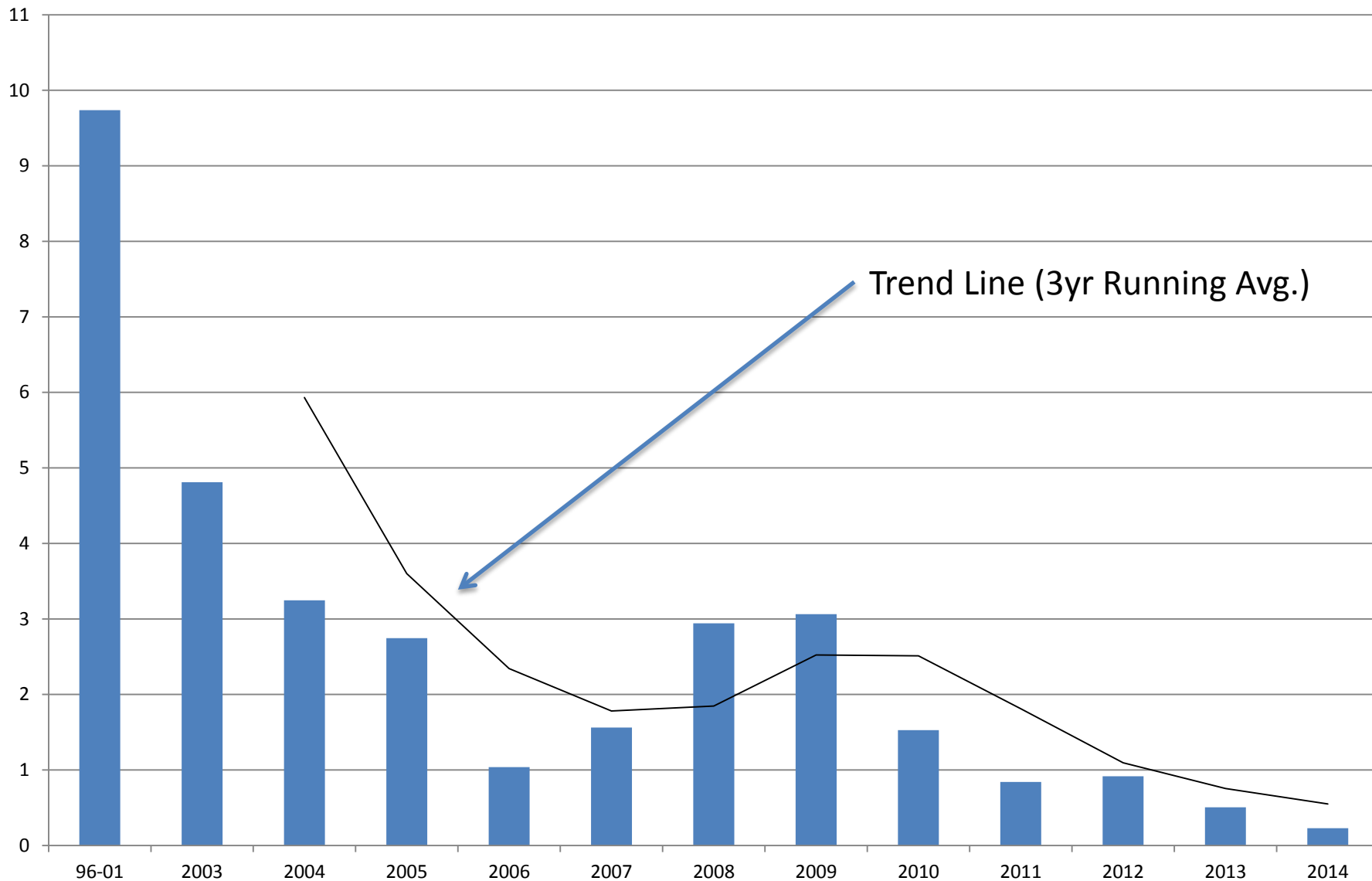
R9 Escaped/Injury RX Fires

Fire Name	Unit	RX Size	Wildfire Size	RX Fuel Type (s)	Wildfire Fuel Type	Date	Ignition	Time of Escape	RH	Equip. Failure or Accident	Frequent Spotting	Days Since Meas. Rain
Barraga Bump	OTF	16 acres	1,127	Grass & light slash	Jack pine	4/29/07	04/27/07	1430	23		Red Flag Wind	6D*
Mack Lake	HMF	28 acres	23,834	Grass & light slash	Jack pine	5/5/80	1026	1215	21	⚡	Spotting	6
Trail 3	IN DNR	26 acres	26	Grass	Grass, Jack Pine	4/26/06			34	⚡	Spotting	
Foss Lake	SUF	78 acres	936	Brush & Slash	Mixed-Con, FM9, Blowdown	5/19/16	1140	1407	28	⚡	Spotting	4D
Mississippi Meadows	CIP	223 acres	452	Brush & Grass	Jack Pine, grass, hardwoods	5/5/05	1200	1400	28	⚡	Spotting	*
Blueberry Blossom Fire	HIF	98 acres	700+	Grass & light slash	Jack pine	6/18/07	June 12-13	1600	34		Wind Event	D
Great Divide	CNF	3 acres	7	Grass		4/10/10	04/09/10	1100	23		Spotting	D
State Game Land 311	PA state	30 acres	N/A No Escape	Grass	Hardwood	3/23/16	1210	1335	27		Wind Gust	
Alley Springs Glade	NPS, MO	265 acres	130	Hardwood	Hardwood	4/04/05	1050	1600 (spots 1120)	27	⚡	Spotting	7D
Sunken Pond	WMF	2 acres	51	Shrubs, blueberry	Hardwood	5/03/00	1045	1200	27		Wind Gust	36 hours

Some Consequences

Fire Name	Unit	RX Size	Wildfire Size	Entrap-ment	Injury	Fatality	Structure Loss	Non Agency Lands	Damaged Reputation
Barraga Bump	OTF	16 acres	1,127					Yes	Yes
Mack Lake	HMF	28 acres	23,834	Yes	1	1	44	Yes	Yes
Trail 3	IN DNR	26 acres	26					Yes	Yes
Foss Lake	SUF	78 acres	936					No	Yes
Mississippi Meadows	CIP	223 acres	452	Yes	1			Evacuations	Yes
Blueberry Blossom Fire	HIF	98 acres	700+						Yes
Great Divide	CNF	3 acres	7						Yes
State Game Land 311	PA state	30 acres	N/A No Escape	Yes	1				Yes
Alley Springs Glade	NPS, MO	265 acres	130		3			Yes	Yes
Sunken Pond	WMF	2 acres	51						Yes

Lake States Compared to National

National Statistics

- 2003-2007

  25% escape during ignition

  75% escape well after ignition

- 2008-2013

  40% escape during ignition

  60% escape well after ignition

Great Lakes/ Eastern GACC

- 10 RX Examples

  70% escape during ignition

  30% escape 1 or more days later

RX Common Denominator Escape Trajectory

DANGER

Hazards

Some holes due to Active Failures

Grass Fuels
Poor Fireline Location
Pressure to get it done!
Drought

Ignite at Noon, RH 25%

Wind Gusts & Shifts, Spot Fires and Slopovers

RX Escapes

T6 Engine Breaks Down Slopover running @1400

Other holes due to Latent Conditions

Compromised Burn Unit Design

USFS
MI
1980

6. Use the principles of fire behavior as a basis for locating control lines and block boundaries.

The location of uncut aesthetic areas on the topography resulted in building some control line in indefensible locations. If the boundaries of uncut areas cannot be located properly from a fire control standpoint, the control lines should be located properly and some areas left untreated.

PA ST
2016

Secondary Control Lines and Contingency Plans

Near the slopover location, a secondary control line was available south of the burn unit, tying into the pond to the east. The line was a leaf covered skid trail accessible by Type 7, and perhaps Type 6, engine. A specified plan to use this secondary line could have precluded the direct/indirect attack undertaken at Points 10 and 11 where the injury occurred. Ultimately, crews did utilize this skid trail to stop fire spread outside the burn unit boundary.

Burn Unit – Size & Shape

- Foss Lake FLA 2016

    The Forest has experienced some internal functional implementation constraints regarding project-level decisions and analysis.

    Line Officers need to ensure that they are aware of their complete decision space, particularly when basing decisions on recommendations from resource areas that will constrain project implementation.

Common Denominators of RX Escapes

Fuels & Weather

- Grass, slash, jack pine
- RH below 30%
- Very low FDFM
- High probability of Ignition >60%
- Drought
- Conditions drier and higher than predicted winds
- Too many days since last measurable rain
- Mop up stage combined with very dry windy conditions

Human Factors

- Small RX size, average 77 acres in this sample
- Equipment failure and accidents
- Underestimate fire behavior at low RH
- Late April through May RX ignitions
- Poor fireline location and design
- Late morning, lunchtime ignition (day of escapes)
- Internal pressure to achieve
- Burning on "hot" side of prescription or outside of prescription (RAWS vs Sling)

How Do We Continue to Improve?

- **Post Mortems (have many discuss what happened)**
  - Staff Rides
  - Facilitated Learning Analyses
  - Rapid lesson Sharing, Including Near Misses
  - After Action Review

- **Pre Mortems (Have many find ways to make your project fail)**
  - Pre-decisional in planning stage (field, sand table, real time simulation)
  - Post decision operational pressure test (field, sand table, real time simulation)

A Staff Ride is About Leadership

Staff rides were developed by the Prussian Army in the early nineteenth century and have been used by the militaries in many countries since then. In the 1970's the U.S. Army and the U.S. Marine Corps turned to staff rides with great enthusiasm and now they are considered essential instructional techniques in advanced military schools and in field units.

- USFS and many other wildland fire agencies are now using this tool
- Need a trained cadre of facilitators to conduct the Staff Ride
- On site visit & study of historical event
- Intent to put you in the shoes of the decision maker of that event
- Not a tactical fault finding exercise
- Examine deeper questions of Leadership and decision making
- "What would I have done in this person's place?"
- "What explains repeated organizational success or failure?"
- "Can a senior leader make use of a competent but overzealous subordinate?"
- "How detailed should the guidance from a superior to a subordinate be?"

Mack Lake Staff Ride

- A leadership training program that walks you through the events of the Mack Lake Fire May 5, 1980.
- Currently under revision to also cover 2012 Little Mack lake fire & 2014 Maple Ridge RX fire. Both success stories!
- Takes about 6 hours in the field.
- Huron-Manistee NF will host the Staff Ride if requested in advance
- 12 national Staff Rides are on the following site, including the Cerro Grande RX escape
- http://www.fireleadership.gov/toolbox/staffride/library_staff_ride12.html
- http://www.wildfirelessons.net/home Lessons Learned Center will also house staff rides in the future

May 5, 1980

11 men, 1 tractor plow, 1 heavy engine, 1 light engine set out to accomplish prescribed fire in the morning before an approaching cold front

The Mack Lake Fire

Albert J. Simard, Donald A. Haines, Richard W. Blank, and John S. Frost
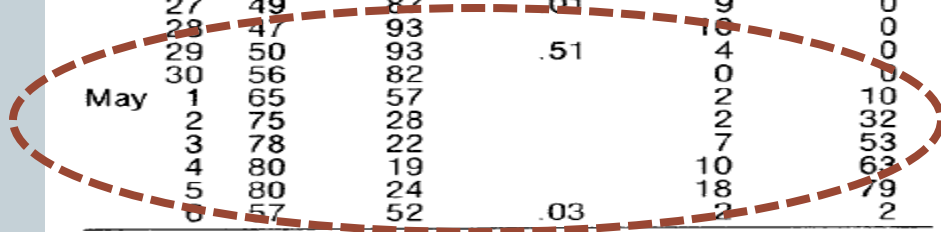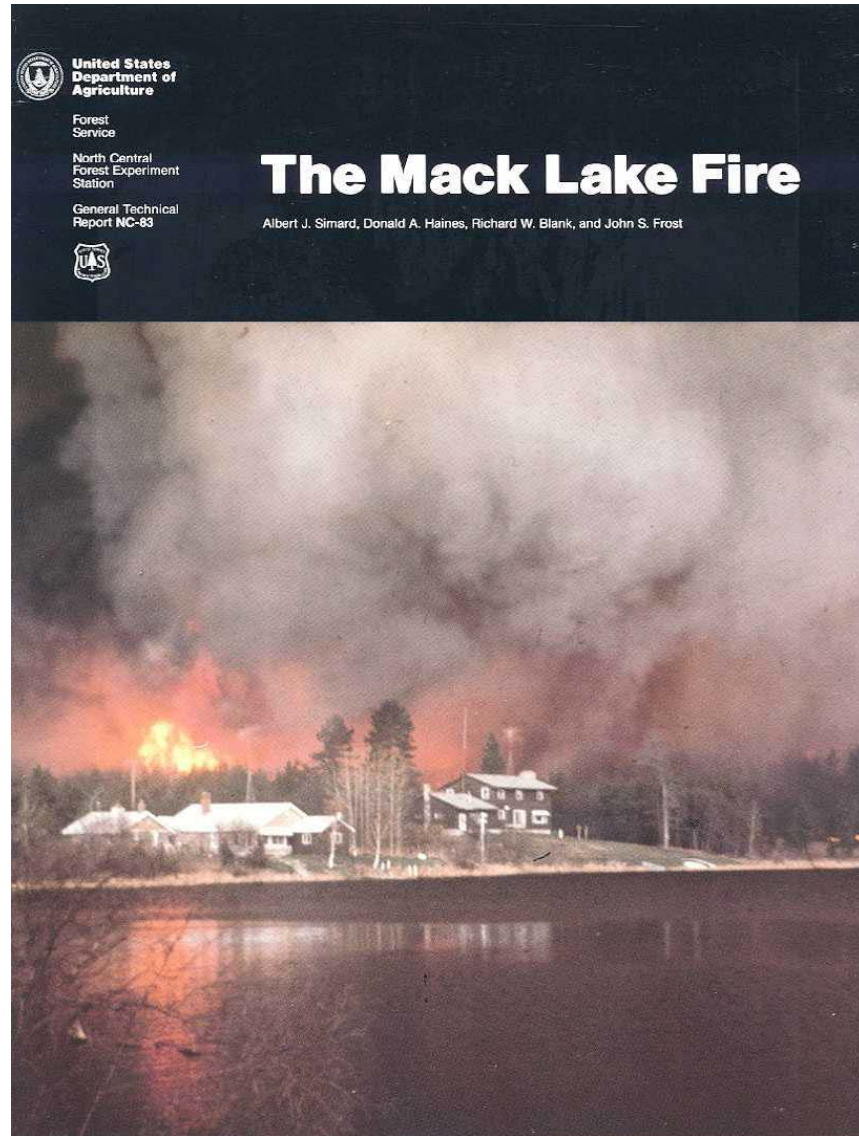
Crane Lake Prescription

- 28 acres of grass and light slash along HWY 33
- Temperature $\geq 45°$
- Wind Direction   West
- Wind speed   5-10
- Days since meas. rain   2-5
- Relative humidity   25-50%
- SI fuel sticks   9-15

Out Of Prescription??

Date		Temp.	Relative humidity	Precip.	Windspeed	NFDRS Burning Index
		°F	Percent	Inches	mi/h	Model Q
April	1	57	43		7	62
	2	58	21		10	70
	3	43	33		16	54
	4	52	82	0.43	13	0
	5	55	58		15	44
	6	51	71		10	47
	7	55	60	.01	4	37
	8	53	88	.33	4	0
	9	48	80	.52	6	0
	10	38	83	.31	7	0
	11	42	62	.02	4	10
	12	37	91	.31	4	0
	13	37	66		7	31
	14	34	81		9	0
	15	38	91	.53	6	0
	16	37	33	.03	10	52
	17	48	73		8	40
	18	63	30		8	58
	19	69	33		15	80
	20	65	21	.19	5	46
	21	69	19		4	49
	22	78	34		5	54
	23	49	32		15	90
	24	40	68	.03	17	73
	25	57	37		7	58
	26	48	86	.01	7	0
	27	49	87	.01	9	0
	28	47	93		16	0
	29	50	93	.51	4	0
	30	56	82		0	0
May	1	65	57		2	10
	2	75	28		7	32
	3	78	22		7	53
	4	80	19		10	63
	5	80	24		18	79
	6	57	52	.03	2	2

Crane Lake RX Becomes Mack Lake Fire

This is the Plan

- Cold front predicted to arrive in the afternoon
- Plan to RX burn 28 acres before that time
- Plan to ignite at 0900 and complete before prescription window closes

This is What Happened

- RX burn ignited @1026
- Fire spots repeatedly after ignition between control line and HWY 33
- Type 7 engine stalls and then gets stuck requiring assistance twice
- Fire spots across the highway and escapes by 1230

Swiss Cheese Hole – Control Line Design

Control line Design

- S, SW, W control lines are dirt roads
- East line is a tractor plow line
- Prescribe W wind is against this east line
- Timber leave strips for visual aesthetics
- Fire continually jumps plow line, eventually builds enough heat to spot across M33

Modified Investigation Drawing
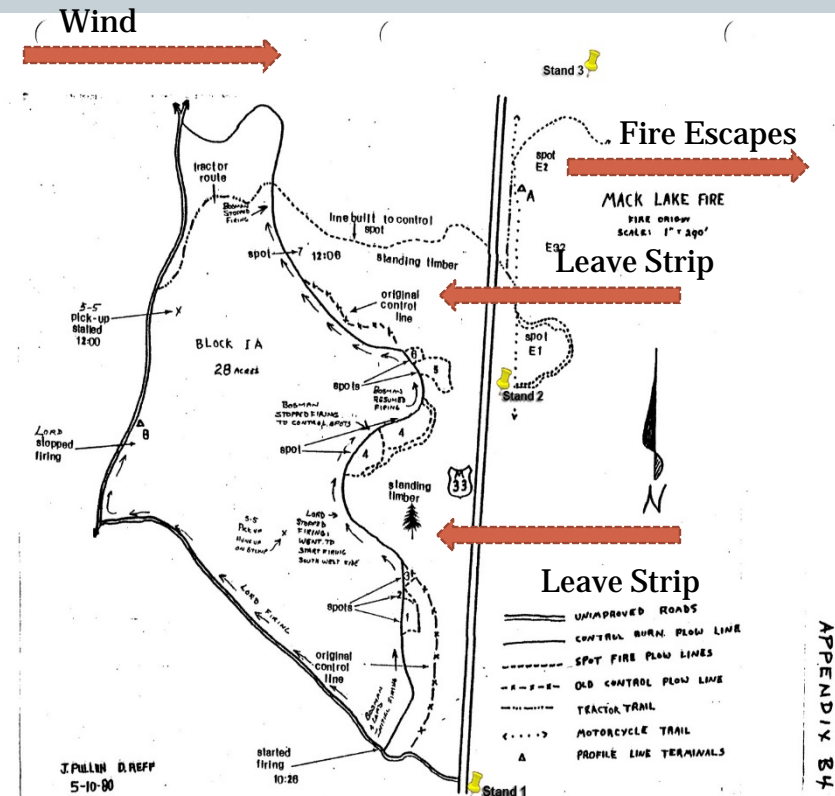
Mack Lake RX Escape

DANGER

Hazards

Any of these familiar
To your burns?

Out of prescription
Pressure to complete
Front is approaching
East fireline is weak
Prescribe wind is west

Late start, ignition 1026
Numerous spots right away

Defenses in Depth

Smoke affecting HWY 33
Type 7 engine gets stuck
Type 7 stalls & out of water

1215 Fire spots
across HWY 33

RX Escapes

RX escapes 1230, 1 fatality,
44 structures lost

How did you react?

Fire is Now a Killer Releasing the Energy of 9 Hiroshima Atomic Bombs

James L. Swiderski

Post Mortem Reverse Engineering the Mack lake Fire

1980 Mack Lake Fire

- Fire Ignited on 5/5 at 1026
- Weak, irregular control lines
- RX ignited away from subdivision (room to run)
- 6 days since rain
- RH 37% and dropping rapidly into 20's
- Front coming w/wind
- Afternoon warmer & drier
- PIG increasing to 60-90%

2014 Maple Ridge RX

- Blacklining fuelbreaks completed before main ignition day
- Fire ignited on 5/11 @ 1900
- Fuelbreaks and recent fire scar used as control lines
- Fire ignited adjacent to subdivision (can't run at the subdivision)
- 2 days since rain
- RH31% and climbing rapidly
- Weather will get cooler, wetter, calmer winds
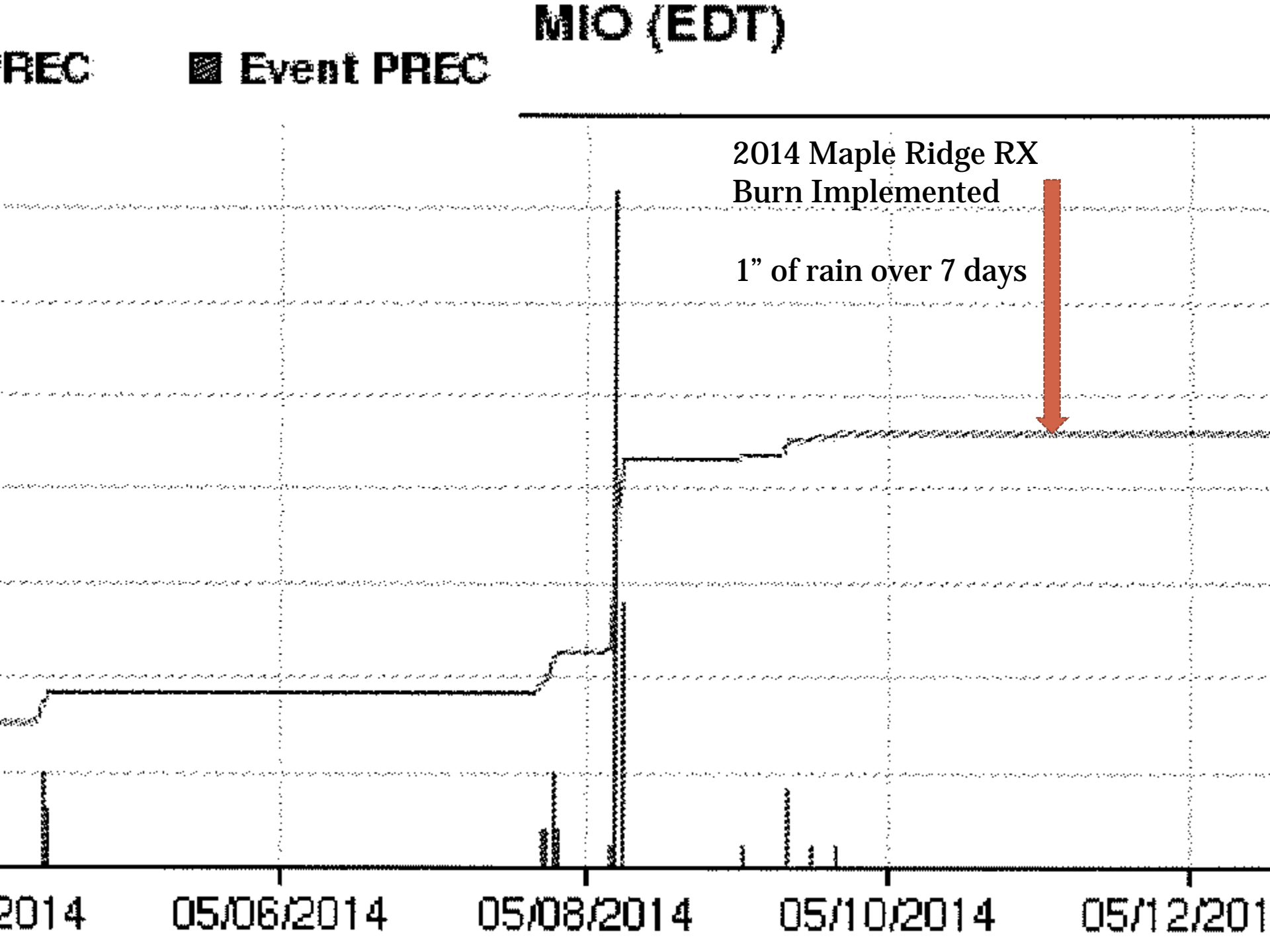- PIG 40% and dropping

300' Fuel break on the east border of the project is RX burned in Fall of 2013

North and West sides already burned in 2012 Little Mack Lake Fire (reduced fuels)

Wetland on the south border of the burn, thatch burned off April 2014

2012 Wildfire

RX Unit

Fuelbreaks and Swamp

Aerial View of Fire Control Features

MIO (EDT)

PREC ▧ Event PREC

2014 Maple Ridge RX
Burn Implemented

1" of rain over 7 days

2014   05/06/2014   05/08/2014   05/10/2014   05/12/201

Maple Ridge RX Burn

Humidity increased by 20 percentage points during the burn

Temperature decreased 9 degrees during the burn

Winds dropped from 8 MPH to 3 MPH

Wind direction changed from SW to NE

Time(EDT)	Temperature	Dew Point	Relative Humidity	Wind Speed	Wind Gust	Wind Direction	Quality check	Solar Radiation	Precipitation accumulated	Fuel Temperature	10 hr Fuel Moisture	Battery voltage
	° F	° F	%	mph	mph			W/m*m	in	° F	gm	volt
23:00	59.0	38.2	46	3	7	NE	OK	0.0	28.15	55.0	7	13.20
22:00	63.0	39.5	42	6	9	NE	OK	0.0	28.15	61.0	7	13.20
21:00	67.0	46.7	48	3	10	NE	OK	0.0	28.15	63.0	7	13.20
20:00	74.0	42.3	32	4	10	SSE	OK	50.0	28.15	73.0	7	13.30
19:00	76.0	40.5	28	8	11	SW	OK	191.0	28.15	79.0	7	13.40
18:00	77.0	39.5	26	9	16	W	OK	314.0	28.15	82.0	7	14.00
17:00	78.0	37.2	23	9	15	SSW	OK	701.0	28.15	90.0	8	14.40
16:00	78.0	37.2	23	7	14	WSW	OK	948.0	28.15	88.0	8	13.70
15:00	76.0	36.6	24	7	19	SW	OK	401.0	28.15	82.0	8	14.60
14:00	76.0	36.6	24	9	17	W	OK	410.0	28.15	85.0	8	13.90
13:00	76.0	30.8	19	4	12	W	OK	980.0	28.15	92.0	9	13.80
12:00	73.0	30.8	21	4	12	S	OK	870.0	28.15	90.0	10	13.80
11:00	67.0	32.8	28	5	11	SW	OK	328.0	28.15	77.0	11	14.00
10:00	61.0	35.9	39	4	7	W	OK	287.0	28.15	65.0	12	13.80
9:00	56.0	35.5	46	4	5	WSW	OK	223.0	28.15	61.0	14	13.40

Collapsing Burn Window

Ignition of perimeter began at 1900 hours

3 Dozers, 6 engines, 1 UTV on scene. Spotter plane and T3 helicopter on scene and available for recon

1900 on site weather temp 75, RH 31%, Winds south 1-3 MPH, PIG 40%

Two days since rain of .07" on 5/9

One week period prior to burn approx. 1" of rain in multiple events

Maple Ridge Burn Implemented on 5/11/14 @ 1900 hours. Backing fire off of north control line.

Black line along north control line complete

Spot ignition of interior, and ignition of east and west flanks underway

Equipment parked in east fuelbreak adjacent to the subdivision

Hand fired munitions

Perimeter ignition along previously burned fuelbreak

Southern portion of the unit ignited by strip head fire.

Flanking fire and centerfire, combine with north running strip head fire to consume the majority of the 50 acres within approximately 5 minutes.

2100 weather temp 68, RH 47%, winds light S-SW

Flame lengths 100-200' during peak of crown fire run


8:45 pm Crown Fire Run Initiated

"I consider learning from events to be a Forest Service core value, both equally fundamental to prevention and critical to your safety."

Tom Tidwell
Chief of the US Forest Service

"The way leadership responds to a bad outcome is enormously important. It will vector us either towards, or away from, a learning culture."

Harv Forsgren
Former Regional Forester, Intermountain Region

B. AN EXPANDABLE PROCESS: FROM BASIC TO COMPLEX FLA[5]

AAR	Rapid Lesson Sharing	Basic FLA	Complex FLA	SAI (DOI) Learning Review
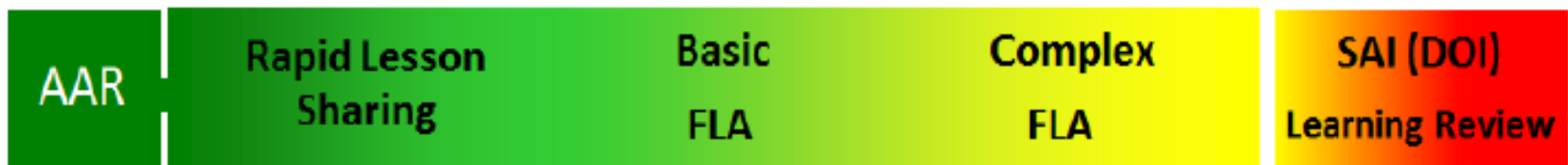
"Take your pick: You can blame human error, or you can try to learn from the failure."[4]

A 40 minute video "Overview of the FLA Process" is available at:

https://www.youtube.com/watch?v=_spEZD9aGc0

Facilitated Learning Analysis

Foss Lake Escaped RX

May 19, 2016 a 78 Acre RX unit escapes and results in a 936 acre wildfire

FLA developed to learn from this event
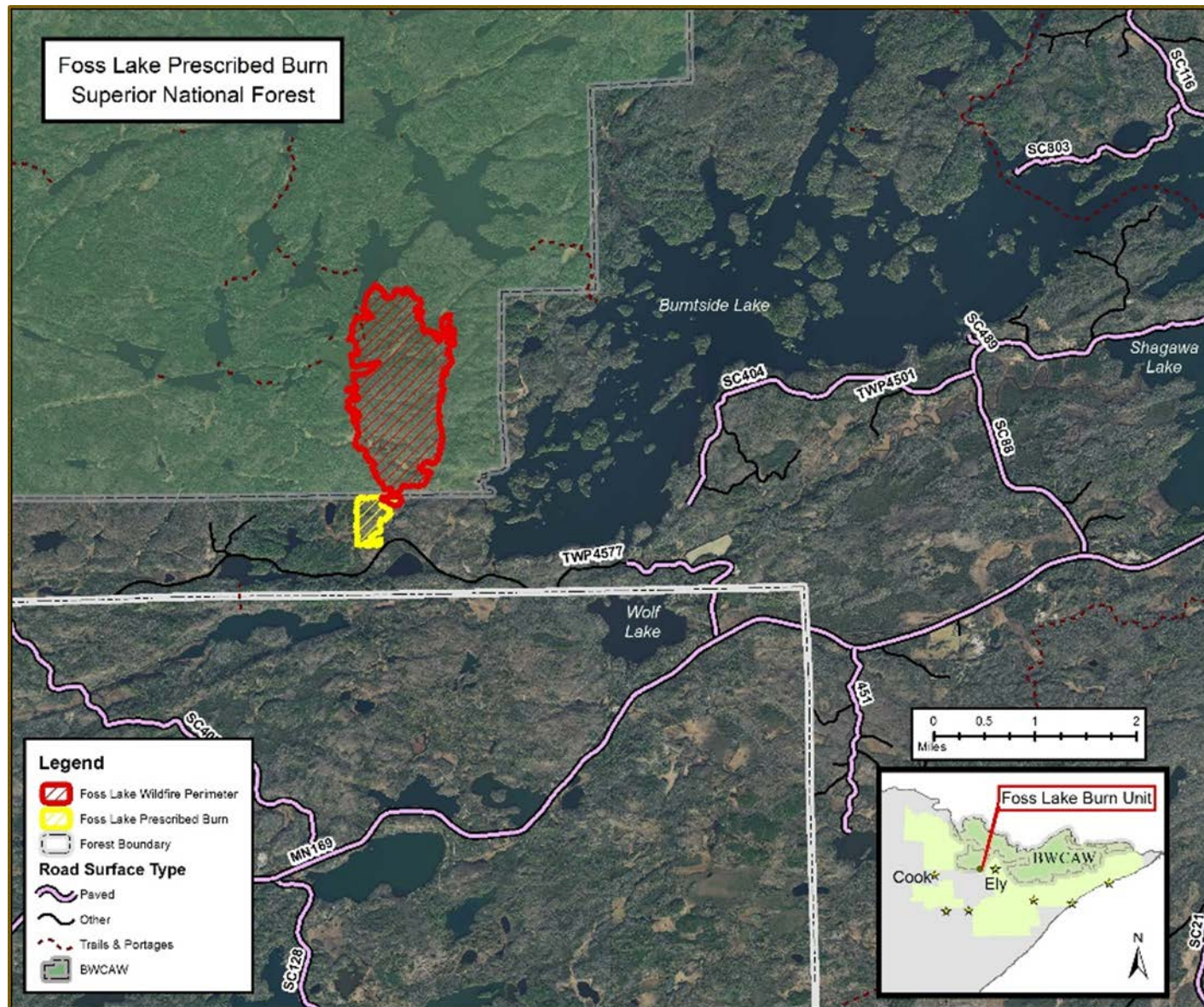
Now posted on the Lessons Learned Center website

FLA can be found on the LLC site

http://www.wildfirelessons.net/irdb

Superior National Forest, Region 9
June 2016

Foss Lake Prescribed Burn
Superior National Forest

Foss Lake RX Fire

DANGER

Hazards

Is your burn block strong?

Desire to implement
Small RX size
Mod-high intensity pres.
Bordering blowdown &
wilderness area

Drought conditions
Rain 4 days prior

Ignition @1150
Winds increase, spots 100 yds
RH onsite 30%, RAWS 22%

Defenses in Depth

Spot fire attacked in
wilderness, 2 portable
pumps fail, spot
continues to grow

**Who is watching all the
Weather & fuels data?**

RX Escapes

1407 spot still uncontrolled
Burn Boss declares wildfire

http://www.fs.fed.us/rm/human-factors/projects/escaped-fire

7 Very Short Videos to Avoid Your Next Escape!!

Don't Just Ask Yourselves How Your RX Could Fail, ask others!!

- Not just escape; Injury, vehicle accident, smoke, aviation issues
- Bring in people who don't have involvement in your project
- Use some people who have no fire experience (they don't normalize risk like you do, may see things you don't)
- Let your cooperators tear it apart and show you how it could fail.
- Find your strongest critic, maybe from the public, let them have at it.

Premortem Pressure Tests

- Greater than expected fire behavior due to winds, Fuel Moistures, Drought

- Incident Within Incident

- Equipment Fails

- Run a full scale field simulation with some of the common denominators

- Conduct Sand Table simulations to detect weaknesses

- Ensure you also test your contingency plan(s)

Questions?

2016-2017 Webinar Series
March 16, 2017

Survey and Analysis Design for Wood Turtle Abundance Monitoring Programs

Donald Brown

School of Natural Resources, West Virginia University, Morgantown, West Virginia /

Northern Research Station, US Forest Service

@LSFireScience

LakeStatesFireSci.net