CHARACTERIZING SMOKE EMISSIONS AND BEHAVIOR OF LANDSCAPE-SCALE RX FIRES IN OHIO AND KENTUCKY WITH AIRBORNE AND IN-FIRE SENSORS AND FIELD SAMPLING

And

RADIO TRACKING NORTHERN BATS BEFORE, DURING, AND AFTER RX BURNS

Research funded by the Joint Fire Science Program

DRAFT - OPERATIONS PLAN

Tar Hollow, Unit#1 (Clark Hollow) – ODNR

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PROJECT OVERVIEW

This Operations Plan is intended to inform staff on the Daniel Boone National Forest (DBNF), the Wayne National Forest, and State Forests in Ohio about research activities planned for selected RX fires over the next 2-3 years and to establish a plan for coordination between RX fire operations and research activities.

As a minimum, we propose to monitor 9 RX burns over the next 2-3 years. Six of these burns will be a part of a fuel consumption and emissions project, and will be conducted during the dormant season. Three additional burns will be part of a study on behavior of northern bats (*Myotis septentrionalis)* before, during, and after RX fires, and will be conducted during the growing season on the DBNF alone.

The main research outcome of the dormant-season burns will be maps of fire characteristics (fuel consumption, flame lengths) over entire burn units. The maps from the experiments will be used as the basis for comparison with operational estimates of fuels, fuel consumption, and smoke emissions made during the course of associated workshops. In the dormant-season fires, fuel sampling will be conducted in the weeks before and days after the burns to estimate fuel consumption while aerial thermal-infrared (TIR) monitoring, ground-based plume monitoring, and in-fire monitoring (using unattended, fire-hardened equipment) will be conducted during the burns. In-fire monitoring will involve setting up equipment up to several days before the burn and on the day of the burn and taking down the equipment on the day of the burn or following day. Fuel moisture will be sampled just before ignition.

A primary objective of the growing season burns is to describe fire development over the burn units and related northern bat movements during the burn. Bat movements will also be monitored in the days and weeks before and after the burns. A secondary objective will be to collect data on fire behavior and emissions that can be compared with data from dormant-season fires. The growing-season burns we propose will differ from the dormant-season burns in that northern bat radio tracking will be conducted in the weeks before, during, and after the burns. All else will be the same (e.g., fuel sampling, aerial TIR monitoring, ground-based plume monitoring, in-fire monitoring, and fuel moisture sampling).

We propose to study burns on the Daniel Boone National Forest (2 dormant-season burns, 3 growing season burns), Wayne National Forest (2 dormant season burns, one each in relatively undisturbed and ice-damaged forest), and Ohio State Forests (2 dormant season burns, one each in relatively undisturbed and ice-damaged forest). Availability of suitable burn units over the course of the study and RX fire program priorities will in part determine where burns are monitored.

MEASUREMENTS AND OBSERVATIONS

General measurement categories include ground sampling, airborne remote sensing, and in-fire (remote) monitoring. Specific measurement activities associated with each category are listed in Table 1[1].

Table 1 – General measurement categories and specific measurement activities.

General Measurement Category	Specific Measurement Activity
Ground-based sampling	Site characterization and fuel loading estimates (pre- and post-burn) at plots within burns.
	Fuel moisture sampling, as close as possible to ignition time, across burn units, both within and outside of plots.
Airborne remote sensing	Thermal-Infrared (TIR) radiometric measurements of RX fire development from ignition to the end of the burning period; pre- and post-fire photographic imaging (?)
Ground-based monitoring outside of burn perimeter	As possible, two Sonic Detection and Ranging (SODAR) units will be set up in a clearing outside the burn perimeter for plume monitoring.
	Particulate sensors set up at key locations outside of perimeter.
In-fire monitoring (i.e., ground-based monitoring inside of burn perimeter)	Field-based, in-fire TIR radiometric measurements of fire properties at plot-level for airborne TIR calibration and fire behavior monitoring.
	Visual video-recording at plot levels.
	Gas (CO), particulate, and meteorology monitoring at two levels (~4 and 10 m, 12 and 30 ft) within plots.
	Gas monitoring in potential bat roosts near plots.
Northern bat behavior (growing-season burns, DBNF)	Growing-season mist-netting for locating Northern bat roosts and ensuring that endangered Indiana bats are not present on proposed unit.
	Pre-burn radio tagging and tracking to identify roost trees and describe movements. Continuation of tracking during the fire and after the fire. Tracking during the burning period will be from the perimeter unless permission is given from RX burn boss to enter blackened areas.

[1] For specific details of most measurement activities, refer to the full study proposal, *Fuel Consumption and Smoke Emissions From Landscape-Scale Burns in Eastern Hardwoods*, on file at the Forestry Sciences Laboratory, Delaware, Ohio, and at ftp://ftp2.fs.fed.us/incoming/dickinson/.

PRE-FIRE FIELD ACTIVITIES

Burn-unit and plot selection

Dickinson will coordinate with key RX burn staff to identify upcoming RX burns. It is important for the research effort that planned units be identified as far in advance as possible and that the expected burn perimeters are made available in GIS format. Planned firing pattern and site characteristics will be used to determine locations of 9 sample plots within each burn. Plot locations will be determined in consultation with RX burn staff. Triangular plots will be 25 m on a side (~75 ft) on uniform topography and fuels (as possible) (see Figure 1). These large plots are needed to ensure that the plane captures spreading flames in each plot on at least one pass over the fire (see below). The plots sampled for the Powder Mill burn are shown in Figure 1, below.

NEED IMAGE

Figure 1. Approximate fuel and fire monitoring plot positions on the Powder Mill burn unit.

Center of unit (not sure of datum):

Lat: 39 deg 21 min 39 s N

Lon: 82 deg 44 min 56 s W

Lat: 39 deg 21.659 min

Lon: 82 deg 44.927 W

www.stateparks.com/tar_hollow.html, link at middle of page: "view topo maps"

Ground-based sampling

In the weeks before a burn, a crew will conduct fuel sampling and site characterizations on the plots within each burn unit. On the day of the burn, as close to ignition time as possible, a crew will sample the moisture content of all fuel classes in each plot and across the burn units.

Ground-based monitoring outside of burn perimeter

In the days before a burn, one or two Sonic Detecting and Ranging (SODAR) units will be deployed in a clearing outside of the burn perimeter. The SODAR units describe airflow above the burn unit to a distance of either 200 or 600 m. The SODAR units require quiet clearings in which there will be limited activity before or during the burns.

Such areas may not be available on all burns. Particulate sensors will be placed around the burn perimeter (in addition to in-fire, see below) for the purpose of monitoring exposures to personnel and short-range smoke transport.

In-fire monitoring

In the days before and on the day of the burn, up to the time of ignition, crews will install instruments on plots in each burn unit.

Northern bat behavior

Growing season burns on DBNF. Mist netting will be conducted in the months before the burns to identify active and potential northern bat roosts and ensure that Indiana bats are not present. In the weeks and days before a burn and on the day of a burn, and before ignition, crews will monitor bat behavior with radio-tracking equipment.

ACTIVITIES DURING BURNS

Aerial TIR monitoring

Overflight of the burn with either a single or twin-engine aircraft will begin within the hour before planned ignition and end after flaming combustion has ceased or at the end of the burning period. Because of limitations on fuel and flight time, it is important that RX burn ignition stay as close as possible to the plan. Changes in ignition time will be communicated to the research team as soon as possible via their liaison (see below). Flight altitude will be near 10000 feet above-ground level. The aircraft will make a pass over the fire every ~4.5 minutes, with the camera in scan mode. The middle flight line will be used in Figure 2, below. Communications procedures with aircraft are described below.

NEED IMAGE

Figure 2. Flight lines for Tar Hollow RX burn, 10,000 feet above ground level. Only the middle flight line will be used. ????????????

Northern bat behavior

During growing-season burns on the DBNF, research staff will use areas outside of the fire perimeter to monitor radio transmissions from bats within the burns. After an area is blackened, researchers may request access through the Research Team liaison (see below).

ACTIVITIES AFTER BURNS

Ground sampling

Re-sampling of fuels for fuel consumption estimation will occur within days of the burn.

Ground-based monitoring outside of burn perimeter

In the days after a burn, SODAR units and particulate sensors will be taken down.

In-fire monitoring

On the day of the burn, or the following days, equipment will be taken out of the burn unit.

Northern bat behavior

Growing season burns on DBNF. Radio tracking will continue during the days and weeks following the burn until radio transmitters cease transmitting.

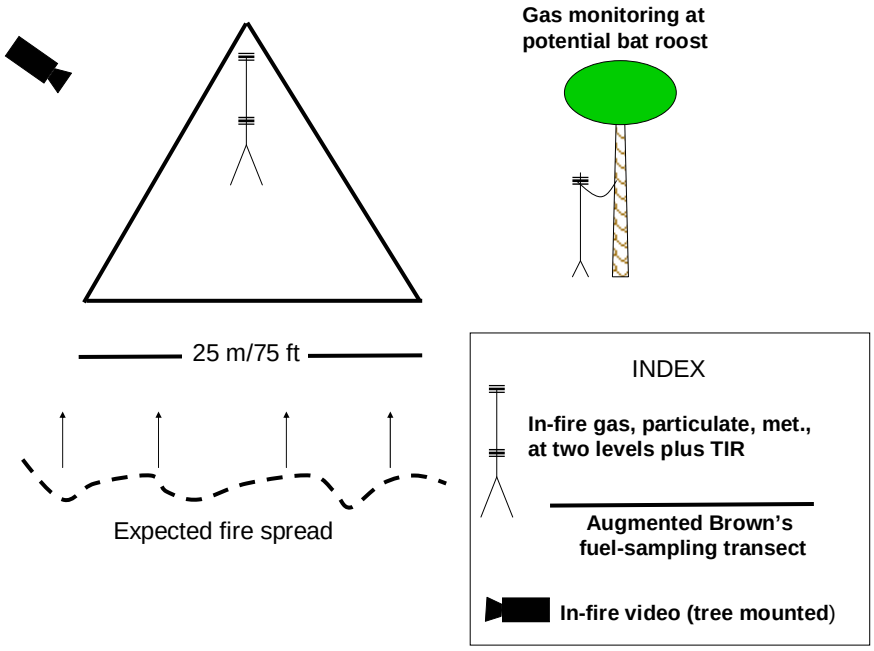

Figure 1. Typical plot layout and instrumentation.

COORDINATION BETWEEN RESEARCH AND RX FIRE TEAMS

COMMUNICATIONS

The Research Team will provide a team member as liaison to the RX Fire (Operations) Team. All non-emergency communication with the Research Team will go through the liaison. The liaison will attend the pre-fire briefing and will provide the RX Fire Team Lead with a roster of the Research Team members working in, above, and around the burn unit. It is requested that key members of the Research Team be supplied with radios by the RX Fire Team.

The aircraft (Piper Aztec, tail number N14521Y, "2-1-Yankee") is equipped with both AM and 10 kHz deviation FM ("wideband FM") radios and cellular phone and will be in communication with the Aircraft Group Lead on the ground. The AM radio

("aircraft/airband radio") frequency is 123.45 MHz. The frequency for the 10 kHz deviation FM is in the 2 m amateur radio band and will be decided when the plane gets to the burn area. FM radio on plane: 25 W radio, 5 W handheld on the ground, good for communications when plane is near overhead. Amateur radio for long-distance communication: 5 W radio in plane, needs a repeater on ground to complete communications, best not to use unless utterly necessary. Flight lines will be provided to the FMO prior to the burn. Flight following information will be provided by the FMO to the Aircraft Group Lead prior to the burn. Communications information for the aircraft will be supplied to the RX Fire Team Lead to enable rapid communications in the case of emergency (Table 2). Non-emergency communication between the RX Fire Team and the aircraft will go through the Research Team liaison (is this the best way?).

Table 2. Aircraft communications information (personnel listed in Table 3).

AM radio frequency	123.45 MHz
FM radio frequency	To be determined
Cell phone number Jason Faulring (observer)	585-820-4067

RESEARCH TEAM RESPONSIBILITIES, ORGANIZATION, AND QUALIFICATIONS

The RX Burn Boss will have full authority for dispatch, management, and stand-down orders for the Team. The Research Team liaison will work with the RX Team Lead to ensure compliance with all guidelines, policies, and orders.

The Research Team members for this study are comprised of individuals from Forest Service Research, Forest Service Regions 8 & 9, Rochester Institute of Technology, and University of Houston. The Research Team will be divided into four groups: the burn monitoring, aircraft, bat behavior, and SODAR groups. The aircraft, burn monitoring, and bat monitoring groups will each have at least one member with a minimum of Fire Fighter Type 2 (FFT2) training, including the annual Standards for Survival training and "arduous" Work Capacity Test. The SODAR group will either remain at the SODAR deployment site during the entire burn or will spend the burning period outside of the operational area. Because of personnel limitations, not all Research Team members have fire qualifications. The following will be adhered to by all Research Team members:

1) Research Team members assisting with RX Fire operations will be FFT2 qualified and outfitted with complete PPE, including fire shelter, as required (see #3, below).
2) Research Team members will enter the black on the day of the burn only after clearance from the appropriate RX Fire Team lead. Each group entering the black will include at least one FFT2 qualified individual.
3) Research Team personnel working in the black within a burn unit on the day of the burn will wear approved wildland fire personal protective equipment (PPE),

including aramid shirt and pants, helmet, leather gloves, eye protection, and lace type leather boots with non-slip (Vibram type) soles and minimum 8" top.

4) Research Team Group Leads will carry, at all times, a handheld radio provided by the RX Fire Team. Research Groups will remain physically together at all times (apart from the aircraft team which will include a person on the ground).

TEAM ORGANIZATION AND QUALIFICATIONS

Research Team members and their fire qualifications are listed in Table 3. Some listed individuals may not be present on all burns. A complete roster will be provided to the RX Fire Team Lead on the day of the burn.

Table 3 – Research Team members and current fire qualifications

Group and Member	TITLE—Affiliation [1]	2006 FIRE Qualifications
Burn Monitoring		
Matthew Dickinson (Lead and liaison)[2]	Ecologist--USFS-NERS	FFT2, arduous
Bob Kremens	Senior Scientist—RIT	FFT2, arduous
Ann Acheson	Air Resource Specialist--USFS R9	FFT2, no refresher
Cindy Huber	Air Resource Specialist--USFS R8	FFT2, no refresher
Tony Bova	Physical Scientist--USFS NERS	
Travis Stevens	Technician--USFS NERS	FFT2, Squad Boss, arduous
Robert Ford	Technician—USFS NERS	FFT2, moderate
Bill Borovicka	Technician--USFS NERS	FFT2, arduous
Levi Miller	Technician--USFS NERS	FFT2, arduous
David Hosack	VFEF Manager--USFS NERS	FFT2, moderate
Aircraft		
Bob Kremens (Lead, on the ground) [2]	Senior Scientist—RIT	FFT2, arduous
TBD (Pilot)		
TBD (In-flight technician)		
Bat Monitoring		
Dan Cox (Lead) [2]	PhD Student—UKY	FFT2, arduous
TBD		
SODAR		
Craig Clements (Lead)	Researcher—UH	
Xindi Bian	Meteorologist—USFS NERS	

[1] Affiliations are abbreviated per the following:
USFS NRS: USDA Forest Service, Northern Research Station
RIT: Rochester Institute of Technology, Center for Imaging Sciences
UH: University of Houston

[2] Individuals involved in deciding whether Research Team will deploy on a fire.

CONTACT INFORMATION

Table 4. The following telephone/communications list provides contact information for expected Research Team members.

NAME/ Affiliation	**Email**	**Phone**
Matthew Dickinson USFS NERS	mbdickinson@fs.fed.us	Office 740-368-0096 Cell 614-271-8154 Home 614-487-0065
Bob Kremens RIT	kremens@cis.rit.edu	Office 585-475-7286 Cell 585-200-4067 Home 585-248-5834
Jason Faulring/Airplane	Jason@faulring.com	Cell 585-820-4067
Steve Smetters/Pilot	s.smetters@hendersonaerial.com steve@smetters.com	Cell: 614-572-5945
Bob Boyles ODNR	Bob.Boyles@dnr.state.oh.us	Office 740-774-1596 Cell 740-591-6166 Home 740-596-2085
Mike Buchanan **Wayne NF**	mbuchanan@fs.fed.us	Cell 740-215-8432
Ann Acheson USFS R9	aacheson@fs.fed.us	Office 740-373-9055 Cell 740-350-9146 Home
Cindy Huber USFS R8		Office 540-265-5156 Cell Home
Tony Bova USFS NERS	abova@fs.fed.us	Office 740-368-0093 Cell 614-446-1941 Home 614-447-1942
Travis Stevens USFS NERS	tstevens@fs.fed.us	Office 740-596-4238 Cell 740-591-2058 Home 740-589-6979
Bill Borovicka USFS NERS	wborovicka@fs.fed.us	Office 740-596-4238 Cell 740-274-9911
Levi Miller USFS NERS	ldmiller@fs.fed.us	Office 740-596-4238 Cell 740-603-2057 Home 740-380-2621
David Hosack USFS NERS	dhosack@fs.fed.us	Office 740-596-4238 Cell 740-596-2058 Home 740-698-2833
Todd Hutchinson **USFS NERS**		Home 740-595-3085 Office 740-368-0090 Cell 614-395-7972
Joanne Rebbeck		Home 740-666-1809 Cell 740-816-2112
Dan Cox UKY		Office 859-257-8571 Cell 618-771-2368
Jake Royse	Jacob.royse@uky.edu	
Val Young	valy@bobcat.ent.ohiou.edu	Office 740-593-1496 Home 740-698-1000
Prafulla Rajput	pr275406@ohio.edu	Cell 740-818-9718
Craig Clements UH		
Xindi Bian USFS NERS		