TBC3 Terrestrial Biodiversity Climate Change Collaborative

Pepperwood
Inspiring conservation through science

TBC3 Forest and Fuels Management Working Group

2020 Fire Response and Research Needs Brainstorm - Meeting Notes 9/4/2020

Attending: Michelle Halbur, Tosha Comendant, David Ackerly, Ryan Ferrell, Matt Clark, Gillian Grant, Arthur Dawson, Melina Kozanitas, Rachael Olliff Yang, Morgan Gray, Devyn Friedfel, Brieanne Forbes, Aji John, Kyle Rosenblad, Paris Krause, Peggy Fiedler, Alan Flint, Lorraine Flint

IMMEDIATE RESEARCH PRIORITIES SUMMARY

PHASE 1 - immediately after fire before leaves drop:

- -assess differences between: scorch, torch, and fully consumed
- -assess first order fire effects: scorch heights, live canopy base, canopy cover, fuels (Browns transects), etc.
- -species differences between how quickly leaves fall (after two weeks post Tubbs - we saw leaves on the ground already)
- -fire can scorch abscission zone, some burned or scorched leaves persist for longer than they should; bay leaves stay on longer (scored and frozen pointing in direction of wind during fire event), evergreen seem to hold longer
- -if you are thinking about a one-time pass to assess, think of getting out there within 2-3 weeks
- -on ground, see impacts on surface vs. remote looking at canopy top
- -if you are putting in plots, how do you prioritize? Intersection of veg map with fire severity (if you don't have pre-fire plots, over topography
- -different sampling for grasslands (get out immediately, can green up fast depending on precip - perennial grasses will green up within 2 weeks of fire), chaparral (see stump sprouting, and seedlings typically starting 4-6 weeks after fire); forest (oak leaf scorch recovery evident 2-4 weeks after fire - e.g. coast live oaks totally leaf scorched sent out new leaves and flowers 2 weeks after Tubbs Fire)

PHASE II - before first rains hit

- WERT reports (Watershed Emergency Response Team) will be released for reference by CAL Geological Survey and team
- Soil infiltration studies (USGS at Pepperwood and other locations post-Tubbs/Nuns - monthly for one year mini-disk infiltrometers stratified across vegetation types)
    - Alan: hydrophobic soils are functioning at local levels (meters) - water will runoff and then infiltrate soils adjacent - no differences in runoff because of pockets of permeable soils
- Runoff,control soil (and toxic ash from development) stabilization, dozer line stabilization and restoration
- Canopy loss, ET, runoff, streamflow - with no pre-fire data… what would you look at?

    - Rely on historic stream gauge data - where is the closest stream gauge to your site? - Alan Flint can help with identifying the closest downstream gauge
    - Sediment collectors
    - Margaret Zimmer - UCSC - high-resolution watershed study - some of her project burned and is now regrouping for post-fire hydrology
- Soil toxicity - chromium? (known carcinogen that readily enters streams/groundwater)

MEETING NOTES AND DISCUSSION

What's important about these fires?

- Earlier in summer, so longer before rains, occurred during a period of severe drought with low live fuel moisture levels - foreshadowing for future years?
- Areas of repeated burn, relatively short intervals
- Many Bay Area protected areas impacted, including UC Natural Reserve System properties

Advice to reserve and park managers:

- If you have fire suppression damage from machinery, immediately get in touch with CAL FIRE (try to communicate directly with bulldozer operators, often contractors) who are required to come back and do 'repair' (e.g. smoothing berms, moving debris). At Pepperwood, we opted to NOT have them put in waterbars (in our experience they can cause more problems).
- After the Kincade Fire, Pepperwood opted to use hand crews to improve conditions on bulldozer lines (volunteers and contractors from Sonoma Ecology Center). Placed straw bales on steep slopes to then use as needed for erosion control (found it was effective to use hand tools to push straw into the ground, not just lay it on top)
- You can file claims with CAL FIRE for damage (e.g., fences, roads, gates, etc): set low expectations for the amount they will pay!
- Pepperwood opted to let the native seed come back and avoided adding seed.
- Important to move bulldozed material back in contact with soil to promote decomposition
- Monitor bulldozer lines for invasive species
- Create an inventory of all your equipment (PRE FIRE)
- Large amount of effort required for debris removal, hazard tree removal (trails, roads), culvert replacements, erosion control
- Develop preserve access protocols with clear safety guidelines (e.g. require hard hats in forested areas, footwear, etc)
- When replacing equipment - use fire resistant materials (e.g. like aluminum poles, not PVC!) and manage vegetation (e.g. mow) around weather stations, radio relays, and other sensors.
- Pepperwood conducted salvage logging operation on about 12 acres post fire to reduce direct hazards around structures and other infrastructure (removed large dead douglas fir)
- Utilize Watershed Emergency Response Team (WERT) reports - e.g. identify any risks of debris flows post fire
- Wires WILL burn! Need to protect them.
- Data will be suspect so be sure to investigate further

- Conduit - preferably below soil surface so it doesn't melt in a fire if in conduit above ground
- Recommend doing preliminary assessments of all properties affected - map bulldozer lines, hand lines, impacts to sensitive habitats, damaged infrastructure such as waterlines, culverts and fence lines. Do risk assessments of threats from the fire - such as locations that could be impaired from runoff or potential debris flows. Then use this information to help prioritize when and where to implement mitigation and restoration practices. Build that timeline working back from anticipated first rainfall.
- Need to start building lists of equipment and other items lost ASAP. It's easy to forget all the little things and insurance requires itemized lists with links to online prices if they are available.
- When building equipment lists itemize and prioritize their replacement - not everything will be replaced and some things will need to be upgraded to prevent loss or because the original version is no longer available.
- Recommend capturing impacts in photographs and video for posterity - simply drive along roads. Ideally establish some photopoint locations. A huge change will take place over the first year or two that is great to document.
- Revisit fire safety protocols and emergency response procedures while the experience is still fresh. Don't get lazy because unburned areas can still burn this year and next year it's all game to burn again.
- Hazardous trees need to be dealt with immediately along roads and trails. Hazardous trees continue to be problematic for years following a fire due to delayed mortality so this work needs to be built into your annual maintenance budget. Access permission may need to be altered. Consider access and liability issues with visitors versus staff. Consider providing hazardous tree training for all visitors since they may not be aware of all issues - such as below ground root burning, leaning trees, emergency protocols, first aid, etc. At Pepperwood we require all forest work be done in pairs with hard hats and not on days of rain or high winds. The forest is more dangerous now three years after the Tubbs Fire than the first year after the fire.

Rapid monitoring opportunities:

- Soil infiltration - contact Jon Stock, Jon Perkins (USGS) et al.
- Chromium toxicity survey - Alandra Lopez (Stanford) visiting scholar sampling at Pepperwood and Modini Preserves (ACR)
- Sediment runoff and stream monitoring
- Bulldozer lines, invasive species etc.
- First order fire effects (needs to happen before the rains hit)
- Fire followers (Land Trust of Napa Co, Nomad Ecology - Heath Bartosh, ACR- Brian Petersen)
- Fuels assessment post-fire
- Forest, grassland, chaparral, and wildlife monitoring
- Reforestation and planting post-fire - OR NOT!

Remote sensing products and analyses:

- Fire perimeters, here for Sonoma: https://sonoma.maps.arcgis.com/apps/View/index.html?appid=559218cced154065a6ec91898768ea07; here for state: https://gis.data.ca.gov/datasets/CALFIRE-Forestry::wildfire-perimeters
- Relativized Burn Ratio (RBR) -- rapid overview of fire severity as soon as smoke/cloud-free Landsat data are available
- Composite Burn Index (CBI) - field measurement, would need a rapid response
    - Need field data for calibration of RBR or other remote sensing burn severity measurements
    - CBI document: Key, C. H., & Benson, N. C. (2005). Landscape assessment: ground measure of severity, the Composite Burn Index; and remote sensing of severity, the Normalized Burn Ratio. FIREMON: Fire effects monitoring and inventory system, 2004.
    - GeoCBI: (Yinan He, UC Berkeley post-doc who made the recent burn severity maps recommends this field measurement, key point is that CBI doesn't include measures of cover which certainly influences spectral response observed by the satellite, whereas GeoCBI does have measures of LAI and cover included) https://www.sciencedirect.com/science/article/pii/S0034425708003246

Table 1
Field variables assessed to estimate burn severity

Variables assessed in the field	Reference
Percentage of tree basal area mortality	(Chappell & Agee, 1996)
Decrease in plant cover	(Jain & Graham, 2004b; Rogan & Yool, 2001)
Volatilization or transformation of soil components to soluble mineral forms	(Turner et al., 1994; Wang, 2002; Wells & Campbell, 1979)
Proportion of fine branches remaining on the canopy	(Moreno & Oechel, 1989)
Degree of canopy consumption and mortality	(Doerr et al., 2006; Kokaly et al., 2007; Kushla & Ripple, 1998; Patterson & Yool, 1998; Rogan & Franklin, 2001; Ryan & Noste, 1985)
Char and ash cover	(Smith et al., 2005b)
Composite Burn Index (CBI, Key & Benson, 2005) and its modifications	(Chuvieco et al., 2007; Cocke et al., 2005; De Santis & Chuvieco, 2007; Epting et al., 2005; Key & Benson, 2005; Miller & Yool, 2002; Miller & Thode, 2007; Sorbel & Allen, 2005; van Wagtendonk et al., 2004; Wimberly & Reilly, 2006)

STRATA	BURN SEVERITY SCALE							FACTOR SCORES
	No Effect	Low		Moderate		High		
	0	0.5	1.0	1.5	2.0	2.5	3.0	
A *SUBSTRATES*								
%DEAD LEAVES ON THE SOIL=						SOIL DEPTH (cm)=		
Litter/Light Fuel Consumed	Unchanged	--	50% litter	--	100% litter	>80% light fuel	98% light fuel	
Duff	Unchanged	--	light char	--	50% loss deep char	--	Consumed	
Medium /heavy Fuel	Unchanged	--	20% consumed	--	40% consumed	--	>80% loss, deep char	
Soil & Rock Cover/Color	Unchanged	--	10% change	--	40% change	--	>80% change	
			A. $\sum$ =		*N*=	$\bar{X}$ =		
B *HERBS, LOW SHRUBS AND TREES LESS THAN 1 METER*								
DOMINANT VEGETATION TYPE =					FCOV=			
%Foliage altered (blk- brn)	Unchanged	--	30%	--	80%	95%	100%+branch loss	
Frequency % Living	100%	--	90%	--	50%	<20%	0%	
New sprouts	Abundant	--	moderate-high	--	moderate	--	low-none	
			B. $\sum$ =		*N*=	$\bar{X}$ =		
C *TALL SHRUBS AND TREES 1 TO 5 METERS*								
DOMINANT VEGETATION TYPE =					FCOV=			
%Foliage altered (blk- brn)	0%	--	20%	--	60-90%	>95%	significant branch loss	
Frequency % Living	100%	--	90%	--	30%	<15%	<1%	
LAI change %	Unchanged	--	15%	--	70%	90%	100%	
			C. $\sum$ =		*N*=	$\bar{X}$ =		
D *INTERMEDIATE TREES 5 TO 20 METERS*								
DOMINANT VEGETATION TYPE =					FCOV=			
% Green (unalterad)	100%	--	80%	--	40%	<10%	none	
%Black/ Brown	0%	--	20%	--	60-90%	>95%	significant branch loss	
Frequency % Living	100%	--	90%	--	30%	<15%	<1%	
LAI change %	Unchanged	--	15%	--	70%	90%	100%	
Char Height	none	--	1,5 m	--	2,8 m	--	>5 m	
			D. $\sum$ =		*N*=	$\bar{X}$ =		
E *BIG TREES >20 METERS*								
DOMINANT VEGETATION TYPE =					FCOV=			
% Green (unalterad)	100%	--	95%	--	50%	<10%	none	
%Black/ Brown	0%	--	20%	--	60-90%	>95%	significant branch loss	
Frequency % Living	100%	--	90%	--	30%	<15%	<1%	
LAI change %	Unchanged	--	15%	--	70%	90%	100%	
Char Height	none	--	1,8 m	--	4 m	--	>7 m	
			E. $\sum$ =		*N*=	$\bar{X}$ =		

Fig. 2. The new version of the field form proposed for estimating burn severity as GeoCBI. New variables are in grey boxes.

- Ideally we would collect comprehensive CBI data to compare to RBR-as previous experience shows there can be high diversity of ground conditions within remote sensing defined severity categories
- Opportunity to conduct a Bay Area regional analysis of burn severity relative to past fires and fuel loads; fire refugia
- Repeat fire overlays, is fire severity lower in repeat fire zones?
- M. Clark - interested in getting another set of NASA AVIRIS hyperspectral flights over the Bay Area box, last flown in 2018. The box covers all recent fires in Sonoma, Napa, Santa Cruz, east Bay. Possibly more accurate fire severity metrics from these data, plus flow into species distribution modeling research we are doing.

- Create higher resolution fuel datasets (e.g. http://sonomaopenspace.maps.arcgis.com/home/item.html?id=2d194202dfee4ab5b157e978cd0e4901) and ladder fuel maps http://sonomaopenspace.maps.arcgis.com/home/item.html?id=7f397e21c31644b3a244cec4c7a4f6c4). Ladder fuels were a strong indicator of canopy damage for the 2017 Fires (Green, Tukman, et al) (https://sonomaopenspace.egnyte.com/dl/MVhJkIXYgE/)
- Fire severity maps may show where retardant lines were dropped, but may not be sufficient to show true extent - Rapid assessment - Drone flights and mapping effort?
- See statewide maps on canopy height, ladder fuels, etc. at California Forest Observatory:

Role of Microclimate and Topoclimates:

- Canopy loss and impact on microclimate change
- Temperatures near the soil surface (<50 cm) can have a strong influence on plant survival. Canopy loss from fire exposes surface to stronger solar insolation, leading to warmer temperatures. Ackerly lab has preliminary evidence that understory herbaceous communities in burned woodland sites have shifted towards plants adapted to hotter climates.
- Soil moisture in top layer - relationships to fuels and plants
- Impacts of canopy loss on reduced ET, streamflow
- Speed of post-fire recovery could incorporate into BCM modeling
    - Pepperwood understory observations in top-killed forest: year 1 = little understory growth but enhanced plant diversity, year 2 = fine fuel boom - high biomass and fine fuel heights
- Soil moisture and fire risk via live fuel moisture effects
- Streamflow - Pepperwood pressure transducer in creek - can see diurnal fluctuation from ET turning on/off
    - Kincade Fire came through then peaks/valleys of graph were reduced because vegetation upstream burned up so possibly due to less ET demand
    - Alan: logging can change ET demand and streamflow diurnal fluctuations

Vegetation monitoring and change:

- Pepperwood webinar on post-fire recovery: https://www.youtube.com/watch?v=kWa1RCS9XhE&t=8s
- Long-term vegetation cycles and trends
- Pepperwood post-Tubbs Fire chaparral survey by Nomad Ecology - final report (year 1 only) and 2 years post-fire data available at: https://portal.edirepository.org/nis/mapbrowse?packageid=edi.595.1
- Forest restoration and management applications key
- Wieslander base maps available (1920s-30s; https://www.lib.berkeley.edu/BIOS/vtm/)
- Conservation Lands Network produced a consistent veg map for the Bay Area
- Tree mortality, basal resprouting, topkill, etc.
- Protocols for post-fire surveys
    - Pepperwood's (Michelle Halbur) protocol

- FIA data
    - There's a plot in Pepperwood!
    - Are there any in NRS sites? Kyle may be able to help find out
- Grassland post-fire community and soils dynamics
- BORR, Hastings - what about water applications for fire suppression, fertilization effect of retardant
- Live fuel moisture - closely linked to chamise phenology - easy for students to monitor - Pepperwood collecting LFM in chaparral and forested areas - chaparral area is also a phenology transect with data going back to 2014 on chamise, bay, toyon, sticky monkeyflower
- Ackerly lab conducting long-term studies on mortality, topkill, resprouting, etc. in permanent forest plots at Pepperwood. See (links also on TBC3 Publications page):
    - Oldfather, M.F., M.N. Britton, P. Papper, M.J. Koontz, M.M. Halbur, C. Dodge, A.L. Flint, L.E. Flint, D.D. Ackerly. Effects of topoclimatic complexity on the composition of woody plant communities. AoB Plants 8: plw049, doi: 10.1093/aobpla/plw049
    - Ackerly, D.D., M. Kozanitas, P. Papper, M. Oldfather, M. Clark. 2019. Mortality and resprouting in California oak woodlands following mixed-severity fire. Proceedings of the International Oak Society, Davis CA.
- Post 2017 Fire Impact observations at Pepperwood-then following springs, get herbaceous survey; at Pepperwood - with lots of canopy release, saw increase in diversity, but not increase in biomass; but second year, lots of invasive weeds and tall fine fuel heights. Rapid succession in first few years.
- -next summer, look at canopy impacts - if leaf scorched, how does that relate to canopy damage
- -first year, second year, then five years, 10 years,
- -how likely is vegetation conversion? Key question, lots of interactions.
- -Arthur: by 30 or 40 years turns predominantly forest - fast dynamic situation - example of Bouverie - regular cycle;
- -Will the change in climate make if difficult for certain species

Situational Alert systems:

- Install fire cameras (alertwildfire.org)
- Research question to link soil moisture indicators and LFM

Wildlife ecology:

- Many camera grids in burn zone
- Cameras recorded exact time fire passed by each location, allowing reconstruction of fire progression
- Equipment losses and replacement need to be addressed to maintain record
- Camera images also capture fire behavior

Bird community response to fire - SSU Soundscapes to Landscapes-sound recorders (AudioMoth) in areas that have burned, revisit sites already visited in the Tubbs and Walbridge Fires. S2L will be deploying in the CNPS Sonoma County redwood plots in spring 2021

Research opportunities and interest; funding sources:

- CNPS grant application to SRL for Sonoma County redwood plot re-survey (Michelle co-PI with Julie Evens and Jennifer Buck-Diaz)
- Environmental Data Initiative - https://environmentaldatainitiative.org/ - repository for ecological data sets (NSF funded; have great summer fellowship program)
- California Department of Fish and Wildlife (Prop 1) - Pepperwood funded for post-fire restoration. Activities include thinning, prescribed fire, forest monitoring-monitoring plan attached to website
- CALFIRE research program (Chris Keithley)
- BLM-National Fire Science Program/CA Fire Science Exchange Network (Hugh Safford)
- NSF Rapid

Partners and collaborators:

- Save the Redwoods
- CNPS redwood plots
- Cal Poly SLO
- Bren School
- Midpen/POST/Santa Cruz Mountain Stewardship Network San Vincente - CZU complex - camera grid
- CDFW - LNU complex - camera grid (Knoxville)
- SALO California Forest Observatory
- Tukman Geospatial
- Land Trust of Napa County (largest private landowner in Napa Co, 6,000+ acres burned)- LNU complex - camera grid and multiple preserves burned including an area with rich endemic rare floral diversity that burned in the Nuns Fire and has post-fire plant lists
- Pepperwood interested in a budgeted project :)
    - Currently fielding calls to help property owners/managers get a sense of what follow up and monitoring can be done
    - Share list of key questions and personal experiences
- NRS - interested in collaborating - especially folks that are not trained as terrestrial ecologists so need guidance in setting up research plan - they have the people power but need some oversight and advice in what, where, design, etc. - bay area wide data set that is useful for NRS and is a collaborative effort
    - NRS - next step - set up a smaller meeting to determine who will do research design while another set work on getting funding - money from university?
    - HREC - burned in July 2018 - Valerie Eviner UCD grasslands, Justin Brashares UCB wildlife cameras

    - NRS RAMS - database with information about what research has been requested and possibly conducted on NRS properties
- Santa Cruz mountains - Puma project pre- and post-fire
- Ackerly lab - funded summer 2021 and can pivot to compare across the fires - NSF is flexible

Resources:

- MORTALITY ASSESSMENT OF REDWOOD AND MIXED CONIFER FOREST

TYPES IN SANTA CRUZ COUNTY FOLLOWING WILDFIRE - thesis, Steve Auten, 2012
Living with Fire symposium proceedings (https://www.pepperwoodpreserve.org/livingwithfire/