Burning Questions

Meta-analysis of the effects of fire and post-fire reforestation on ecosystems and wildlife habitat: A step on the path to sustainable fire management of our future forests in British Columbia, Canada

Dr. Julia R. Chandler August 15th, 2019



Project Rationale

- Understanding response of forest ecosystems to fire and the risks for BC's forests and rangelands is a priority
- Effects of fire on fuels, soils, vegetation, tree growth studied since 1970s yet limited synthesis and meta-analysis relevant to current priorities
- Our project builds on considerable fire ecology knowledge and was funded by FESBC and MFLRNORD for 2017/18 (\$77K)
- Databases at risk of being lost but new questions



https://www.for.gov.bc.ca/hre/becweb/

in north and central regions

- Key Fire Related Information Needs -

Landscape-scale

 What are the expected rates of recovery of watersheds after wildfires? i.e., what are rates of vegetation development?

Wildlife

 What are implications of fire management for wildlife like grizzly bear, moose and caribou especially with respect to forage quantity and quality ?

Vegetation

 Can fire be used to restore/enhance First Nations food, medicine & cultural plants (e.g., berries, devil's club)?

Restoration and Reforestation

Does wildfire reduce lodgepole pine stem rusts or their alternate host species?

Types of Data & Products

- Vegetation (% cover), soils, treatment data
- Plot photos
- Maps and spatial analysis
- Able to perform tailored deep analysis that is targeted, produce answers to questions that span scales from species to ecosystems, and present future operational directions for land managers

- Metadata -

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17 -	***************************************	Global Environ	ament -	
18	# I. Prepare the data:	Data	and the second second	
20		() dat	8378 obs. of 482 variables	
21	<pre>dat <- read.table("c:/Users/50 LBS/Desktop/trove/R/db_2019_07_22_veg.csv", sep=",", header = TRUE)</pre>	odf	52 phc of 140 variables	
22	ich.dat <- dat[datSBECzone "ICH" & !datSburn "PB" & !datSsite "Kinskuch",] #select the records in the ich, re	O om	52 obs. of 2 contables	
23	# set up the environmental data	O dehv	32 ODS. OF 7 Variables	
25	<pre>ich.env <- ich.dat[,c(2, 9, 11, 12, 14, 18, 20, 21)]#ich.env <- ich.dat[,c(1:21)] #a]] env vars</pre>	o ich. dat	2987 ODS. OF 482 Variables	
26	ich.env <- droplevels(ich.env) @remove levels not represented in the remaining data set	O1ch, env	2987 obs. of a variables	
27	<pre>icn.env <= :as.data.trame(lappiy(lcn.env,as.tactor))</pre>	o ich. veg	2987 obs. of 142 variables	
29	# set up the vegetation data (% cover)	Otable	2987 obs. of 150 variables	
30	ich.veg <- ich.dat[,47:380] #slice out the vegetation data (% cover): select only understory spp. (remove trees and br	🖸 veg	52 obs. of 142 variables	
31	ich.veg <- as.data.trame(lapply(ich.veg.as.numeric)) #require numeric (some entries imported as integer le subplot me			
33	ten veg so ren vegt, colouis(ren veg) to of aserece species with once in remaining ten proces			
34	# combine the data.frames to collapse the data lengthwise			
35	table <- data.table(1ch.env, 1ch.veg)			
30	# reduce the dataset to the block level			
41 -	****			
42				
43-	# reduce the dataset to the site levels#### of < approach _ site hump + ape + alev + BECcaries + surport + plant table mean) eradure dataset to site level			
45	df <- df[8] wremove the block factor that is now no longer a factor but a categorical "mean"			
46				
4/	<pre># create the vegetation data (% cover) and environmental factor matrices veg <= dfl.8;ncg(dfl) estire out the vegetation data (% cover)</pre>			
49	env <- df[,1:7]	Files Plots F	ackages Help Viewer	-0
50				
51	# examine the yeg matrix			
53	plot(tableSPAXIMYR - tableSburn)			
54				
55 -	# calculate sparsity ####			
57	x <- Reduce("+', zeros)			
58	nonz <- rowsums(veg != 0) # or use nnzero(veg) # from Matrix package			
59	y <- Reduce("+", nonz)			
61	Arty m <- nrow(veg)*ncol(veg)			
62	TI CONTRACTOR OF CONT			
63	x/m=100 # -82 % of the data matrix are zeros (-92% when aggregated to block level)			
	* <u>III</u>			
18:1	Gundhed) 2 R Script 2			
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>				
> fre	Nuce the dataset to the site level##### _ angregate(_ site + hurn + ang + elev + RECseries + surver + nlamt, table, mean) #reduce dataset to site level (52			
uniqu	site/year records)			
> df <	- df[,-8] #remove the block factor that is now no longer a factor but a categorical "mean"			
2.00	ante the vecentation data (K cover) and emulanmental factor estimates			
> veo	<pre>c df.shcol(d)] #slice out the vegetation data (% cover)</pre>			
> env	<- df[,1:7]			
>				

PLOT PHOTOS Genevieve Lake (SBSdk)

Analytical Approaches

Multivariate and univariate analysis and data visualization were used to identify vegetation response. We addressed questions related to:

- Comparisons of plant community response between ecosystems
- Plant community response to treatments within a single ecosystem
- Single species response

Comparisons of Plant Community Response <u>Between</u> ICH, ESSF and SBS Ecosystems - 20 years after clearcut and slashburn -

1. Diagnostic Combinations of Species (DCS)

- In the wet South-Central Interior, cover of plants associated with mature forests increased forming >40% cover
- -> (abundance and composition matter!)
- 2. Plant Functional Types (PFT)
 - There was faster conifer growth and greater, more persistent deciduous tree & tall shrub cover in SBS compared to ESSF
 - Ericaceous shrubs were prominent in ESSF

3. Indicator Species

 Oplopanax horridus (Devil's club) was the only species with complete specificity and fidelity through all time periods

Photo: © Dee E. Warenycia

Meta-analyses *within* Interior Cedar-Hemlock

1. <u>Distribution free</u> multivariate analysis of variances (using distance matrices) to describe how variation is attributed to different experimental treatments or uncontrolled covariates (n = 505).

```
adonis(formula = veg ~ burn + age + plant.
data = env, permutations = 999, strata =
env$block, transfo = "hellinger")
Blocks: strata
Number of permutations: 999
```

```
Plant R^2 = 0.06747 p = < 0.001
Burn R^2 = 0.08535 p = < 0.001
Age R^2 = 0.29308 p = < 0.001
```

- 2. Variance Partitioning to partition the variation of the community matrix by the 3 explanatory factors
- 3. RDA to test significance of fractions of interest individually
 - > all tests result in p = < 0.001

Burn Class

- Wildfire
- Prescribed Burning
- No Burn

Interior Cedar-Hemlock (ICH)*

- 95% confidence ellipses were added to visualize the uniqueness and/or overlap of BURN TYPE
- High response variability to burn type even within the same ecosystem
- Plant communities in the ICH have distinct responses to fire type, stand age and reforestation species selection

Shepherdia canadensis (soapberry)

- Soapberry (an important food plant for First Nations and wildlife) on drier SBS and BWBS sites increased in cover over the 20 years after fire or clearing, and average cover is slightly higher on burned compared to unburned sites
- Our results are consistent with previous studies that found it moderately fire resistant and enhanced by burning
- Overall management implications: moderate to low severity broadcast burning is consistent with maintaining ecological values in these ecosystems.

Pine Blister Rust Alternate Hosts

Genevieve Lake (SBSdk) 20 years after clearcut and slashburn

- 5 *Ribes* species in the database
- 2 rare species with 5 records total: *R.* hudsonianum (Mackenzie River - year 20 at 1%); and *R. oxyacanthoides* (Genevieve Lake - year 20 at 2% and Helene - years 1, 2 at 0.5% and 3 at 1%)

Overall % cover for all years at each site by *Ribes* spp.

	<u>R. lac</u>	ustre	<u>R. laxij</u>	florum	<u>R. glandulosu</u>			
	mean	sd	mean	sd	mean	sd		
Brinks Mill (n=18)	1.3	(2.7)	0.3	(0.6)	0*	(0.0)		
Francis Lake (<i>n</i> =36) [∓]	1.3	(2.3)	0.3	(0.4)	0.2	(0.5)		
Genevieve Lake (<i>n</i> =24) [∓]	0.6	(0.7)	0.5	(1.1)	0*	(0.0)		
Goat River (<i>n</i> =42)^	0.1	(0.3)	2.6	(2.3)	0*	(0.0)		
Helene (<i>n</i> =135) [∓]	0.4	(0.6)	0.3	(0.6)	0.6	(1.0)		
Herron (<i>n</i> =70)^∓	1.4	(3.2)	0.6	(1.1)	0.6	(0.8)		
Mackenzie (<i>n</i> =42) [^]	2.0	(1.9)	1.0	(2.0)	0*	(0.0)		
Otter Creek (<i>n</i> =224)^∓	2.3	(2.8)	0.0	(0.1)	0*	(0.0)		
Walcott (<i>n</i> =130) [∓]	0.1	(0.4)	0.3	(1.0)	1.3	(1.6)		
Walker Creek (n=840) [^]	1.8	(4.4)	3.8	(6.4)	0.0	(0.0)		

^ These sites have preburn measures

⁺ Site was planted with *P. contorta* var. *latifolia*

* Species not recorded on site

Analysis included 10 sites (1561 plots) with repeated measures (years 1, 5, 10, and 20)

Photo: © JR Chandler

Management Implications

Future outcomes include providing fully accessible information to guide management decisions such as:

- 1. which wildfires to target in suppression actions
- when and where to prescribe burn to reduce flammability or increase habitat values
- 3. what areas should be left unsalvaged after wildfire
- where and how intensive reforestation should be avoided or otherwise implemented

Wildfire on a logging road ~20 km southwest of Fort St. James, B.C., on Aug. 15, 2018. (Darryl Dyck/Canadian Press)

Project Conclusions and Looking Ahead

Photo: © E Hamilton

- BC ecosystems are adapted to and fairly resilient to fire. Responses are variable and largely determined by ecosystem, site factors and adaptation to fire. Predictable to a degree.
- Importance of well designed research/monitoring that includes controls, exclosures, with pre- and post-treatment survey and multi-year sampling
- There is need for an entity to serve as a nexus for data and information
- Research/monitoring is stand level, decision making at landscape level need to bridge scale difference.

We would like to thank FESBC and FLNRO for funding and the many dedicated people conducting fieldwork and those who provided questions and answers in the form of data and insight.

For more information please see our website: DB2020.net

To provide feedback or for more information, contact Dr. Julia Chandler: juliarchandler@gmail.com (c) 412 999 3885 THANK YOU for your interest!

Abstract

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Forest ecosystems providing habitat for species whose populations are in decline (e.g. moose, grizzly bears, caribou, birds) are affected in various ways by fire, post-fire salvage and intensive reforestation. Changing climatic conditions are expected to lead to an increase in these activities; indeed, the last few years have witnessed significant increases in mega fires in North Efforts to reduce GHG and America. protect communities and resources will likely lead to increased use of prescribed fire and managed wildfire to reduce the likelihood of mega fires, and to intensive salvage and reforestation to fast track post-disturbance carbon sequestration. To date there has been limited synthesis to help resource managers avoid adverse implications for wildlife. With the Burning Questions project, we identified all in situ plant-fire datasets from central British Columbia and collated them into a single database (db2020). Next, we consulted land managers to identify their foremost questions about ecosystem response to fire. Meta-analysis of db2020 addressed many of those Burning Questions, and we relayed our results back to the land managers involved in the consultation process.