

BURNING QUESTIONS

November 20th, 2019

Julia Chandler

Evelyn Hamilton*

Sybille Haeussler

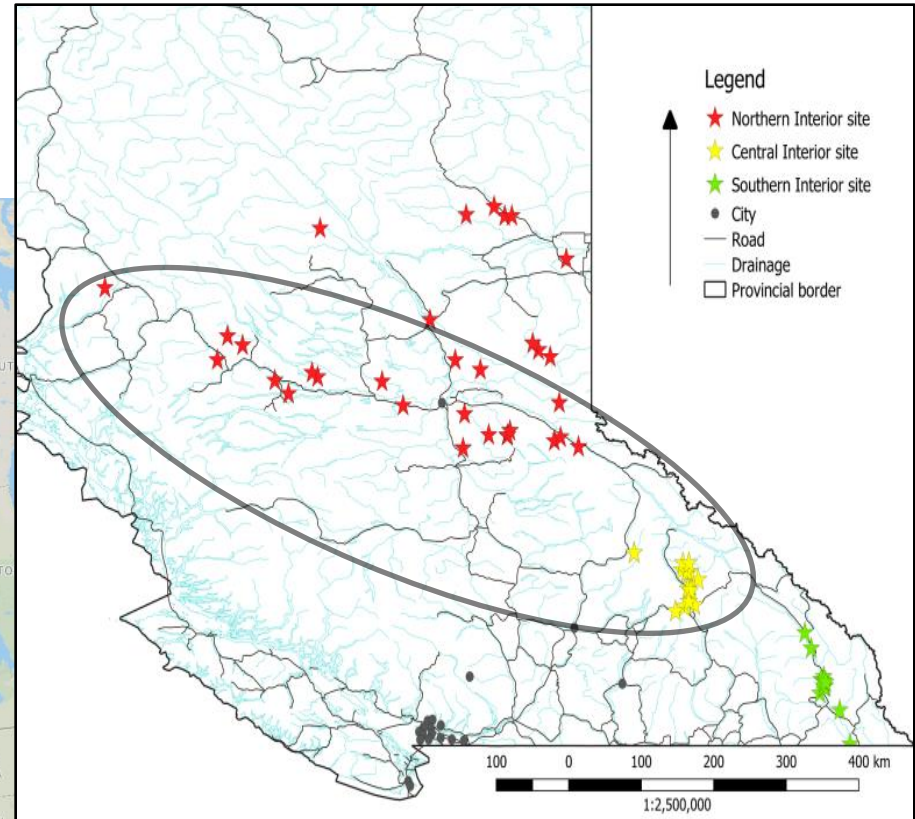
**Project Lead*



Project Rationale

- Databases at risk of being lost but new questions
- 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)

Study Area



73 datasets catalogued describing vegetation response to fire slashburns, restoration burns, wildfire

49 datasets were updated & analyzed in north and central regions

Burning Questions

- 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?



Photo: © JR Chandler

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 -

	A	B	F	G	H	I	J	K	L	M	N	Q	S	T
1	Latitude	Longitude	Elev	BEC Zone	Site Series	Site Group	db	Site Code	Site	Dropbox folder Site name	Dropbox subfolder name Site name	Relevant Documents	Type of files	Description of study Treatments
2	54.383039	-122.054599	980	SBS	SBSvk1	1	1	MG	McGregor	Mcgregor Model Forest (Driscoll MSC)			paper	comparison of st
7	54.214402	-123.8711836	790	SBS	SBSdw3/01-06	2	1	SR	Stuart River	Stuart River Prov Park	Stuart RPP 2016 Deliver data, photos, reports			grassland restora
10	54.040128	-125.600831	780	SBS	SBSdk/81	2	1	RH	Red Hills	Uncha Mountain Red	deGroot Haeussler Red data, site maps, reports			8 year post burn
11	54.2293495	-125.8542561	710	SBS	SBSdk/01-10	2	1	SF	Swiss Fire	Swiss fire (Morice ER)			data, report	monitoring veg d
14	54.664372	-120.981099	536	SBS	SBSdk/81	2	1	HH	Hubert Hill	Hubert Hill	Tudinay (Toodienia) HReport: Helkenberg & H data			grassland restora
15	54.566454	-120.7637331	865	SBS	SBSdk/81	2	1	DI	Dieleman	Dielemann-Grouse Mt			DeGroot and Haeussler data, 3 reports	burned (2002), I
19	56.40602009	-125.0168271	852	BWBS	BWBSdk2/02	3	1	ME	Mesilinka	Mesilinka fire S of Chase Pro Pk			Rapai et al (ChuCho)20: data, photos reports	3 parts - pilot, lic
20	55.96666667	-120.4666667	720	BWBS	BWBSmw/101	4	1	BO	Boreal LTSP	Peace River Bore Peace LTSP			https://www.for.gov.bc papers	logged vs unlogg
21	56.5842	-121.6038	890	BWBS	BWBSmw/101	4	1	IL	Inga Lake	Peace River Bore Peace Inga Lk				
22	56.6	-122.317	920	BWBS	BWBSmw/111	4	1	IR	Iron Creek	Peace River Bore Peace Iron Cree				
23						5	0	PR	prospect/comm	Peace River Boreal				
24						5	0		prospect/comm	Peace River Bore Peace W				
25	56.72	-121.8	900	BWBS	BWBSmw/111	5	1	WO	Wonowon	Peace River Bore Peace Wo				
27						5	0		prospect/comment3	Smith				
28						5	0		prospect/comment4					
29	56.58531544	-121.4723735	865	BWBS	BWBSmw/111	5	1	FA	Farrell	Peace River Bore Peace Wildfire			data	wildfire
30	56.58531544	-121.4723735	865	BWBS	BWBSmw/111	5	1	BL	Blair	Peace River Bore Peace Wildfire			data	wildfire
31	56.58531544	-121.4723735	865	BWBS	BWBSmw/111	5	1	ON	Osborn	Peace River Bore Peace Wildfire			data	wildfire
32	56.58531544	-121.4723735	865	BWBS	BWBSmw/111	5	1	SI	Siphon	Peace River Bore Peace Wildfire			data	wildfire
33						0	0	NI	Nithi	Nithi				
34						0	0	BP	Besa Prophet	Besa Prophet				
35						0	0	LC	Laidman Caribou	Laidman Caribou Trial				burned 2004, mc
36	50.5	-124.02	865	BWBS	BWBSmw/101	1	1	TW	Transcan West, B Dupuis	Transcan W Bell Pole	Dupuis MSC thesis (was another name)			wildfire
37	51.61316	-124.02	865	BWBS	BWBSmw/101	6	1	FC	French Creek	Dupuis ICH	French Creek	Dupuis MSC thesis (was another name)		wildfire
38	51.375094	-124.02	865	BWBS	BWBSmw/101	6	1	DO	Downie, Oak Stre	Dupuis ICH	Downie Oak Street	Dupuis MSC thesis (was another name)		wildfire

Unique key to relate to the database

Included in the database or not

Latitude, Longitude, Elevation, BECZone, Site Series, Site Group, db, Site Code, Site, Dropbox Folder, Treatment, Monitoring Dates, Relevant Documents, File Types, Description of Study, Sampled Dates, General Location, Data Collected, Expt Layout, #Plots, Agency or Funder Responsible, Team Contact, Latest Contact Info, Comments, To Do

DB2020

db_2019_07_22.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Acrobat

Calibri 11 A A Wrap Text General

B I U Merge & Center \$ % .00 .00 Conditional Formatting Format as Table Cell Styles Insert Delete Format AutoSum Fill Sort & Filter Find & Select

recordID	site	siteID	lat	long	easting	northing	UTMzone	elev	BECzone	BECseries	block	plot	survyr	cut	log	fire	burn	pburnyr	age	plant	ABIEAMA	ABIEGRA	ABIELAS	JUNISCO	PICEEN	PICEGLA	PICEMAR	PINUALB	PINUON	PINUMC
8086	WC08085	Walker Creek	WC	53.9083	-120.5958	657926.2	5975997.3	10	1050	ICH	SBS(ICH)w/01	4	07F1	2008	1	CC	1	FB	22	22	Sx	0	0	0	0	60	0	0	0	0
8087	WC08086	Walker Creek	WC	53.9083	-120.5958	657926.2	5975997.3	10	1050	ICH	SBS(ICH)w/01	4	07F2	2008	1	CC	1	FB	22	22	Sx	0	0	0	0	60	0	0	0	0
8088	WC08087	Walker Creek	WC	53.9083	-120.5958	657926.2	5975997.3	10	1050	ICH	SBS(ICH)w/01	4	07V1	2008	1	CC	1	FB	22	22	Sx	0	0	0	0	60	0	0	0	0
8089	WC08088	Walker Creek	WC	53.9083	-120.5958	657926.2	5975997.3	10	1050	ICH	SBS(ICH)w/01	4	08F1	2008	1	CC	1	FB	22	22	Sx	0	0	0	0	0	0	0	0	0

db_2019_07_22.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Acrobat

Calibri 11 A A Wrap Text General

B I U Merge & Center \$ % .00 .00 Conditional Formatting Format as Table Cell Styles Insert Delete Format AutoSum Fill Sort & Filter Find & Select

Site Code	Site	Latitude	Longitude	Easting	Northing	UTM Zone	Elevation	BEC Zone	Site Series	
1	BD	Bednesti	53.87	-123.483	468241.1	5969166.1	10	825	SBS	SBSdw3/05
3	BL	Blair	56.58531544	-121.4723735	593998	6272612	10	865	BWBS	BWBSmw/111
4	BM	Brinks Mill	53.4375	-121.5608	595603.2	5921905.1	10	910	SBS	SBSvk/01
5	BO	Boreal LTSP	55.96666667	-120.4666667	658115.2	6205267.2	10	720	BWBS	BWBSmw/101
6	CA	Carnes	51.2893	-118.1648	418775	5682646	11	806	ICH	ICHwk1/03 & ICHvk/05
7	CH	Chuchinka								
8	CL	Call Lake								
9	DH	Downie, Hemlock								
10	DI	Dieleman								
11	DO	Downie, Oak Street								
12	DS	Downie, Sorcerer								
13	DW	Downie								
14	FA	Farrell	56.5							
15	FC	French Creek	5							
16	FL	Francis Lake								
17	GL	Genevieve Lake								
18	GO	Goldstream, Blackfoot Trail	51							
19	GR	Goat River								
20	HC	Haggen Creek								
21	HH	Hubert Hill								
22	HI	Hwy 23 North								
23	HL	Helene								
24	HR	Herron								
25	IC	Indianpoint Creek								
26	IL	Inga Lake								
27	IR	Iron Creek								
28	JL	Joel Lake								
29	KI	Kinskuch								
30	LA	Laforme								
31	LM	Lucille Mountain								
32	MA	Mackenzie								
33	ME	Mesilinka	56.4							
34	MG	McGregor	5							
35	MK	McKendrick								
36	OC	Otter Creek								
37	OS	Osborn	56.5							
38	RH	Red Hills	5							
39	SF	Swiss Fire	54							

db_2019_07_22.xlsx - Microsoft Excel

File Home Insert Page Layout Formulas Data Review View Acrobat

Calibri 11 A A Wrap Text General

B I U Merge & Center \$ % .00 .00 Conditional Formatting Format as Table Cell Styles Insert

Code	Scientific Name	Life Form	J Chandler:	English Name	Native	Taxon Level
1	ABIEAMA	Abies amabilis	1 (Life Form (Growth Form of the Species))	amabilis fir	N	spe
2	ABIEABI	Abietinella abietina	9 (H)	wiry fern-moss	N	spe
3	ABIEGRA	Abies grandis	1 (1 = coniferous tree)	grand fir	N	spe
4	ABIELAS	Abies lasiocarpa	1 (2 = broad-leaved tree)	subalpine fir	N	spe
5	ABROLAT	Abronia latifolia	7 (3 = evergreen shrub)	yellow sand-verbena	N	spe
6	ACERGLA	Acer glabrum	7 (4 = deciduous shrub)	Douglas maple	N	spe
7	ACHMIL	Achillea millefolium	4 (5 = fern or fern-ally)	yarrow	N	spe
8	ACHNOCC	Achnatherum occidentale	6 (6 = graminoid)	stiff needlegrass	N	spe
9	ACHNRIC	Achnatherum richardsonii	7 (7 = forb)	spreading needlegrass	N	spe
10	ACONDEL	Aconitum delphinifolium	6 (8 = parasite or saprophyte)	mountain monkshood	N	spe
11	ACTARUB	Actaea rubra	7 (9 = moss)	baneberry	N	spe
12	ADENBIC	Adenocaulon bicolor	7 (10 = hepatic)	pathfinder	N	spe
13	ADIANTU	Adiantum sp.	5 (11 = dwarf woody plant)		N	spe
14	ADOXMOS	Adoxa moschatellina	7 (12 = macro alga)	moschatel	N	spe
15	AGOSAU	Agoseris aurantiaca	7 (Hook.) Greene	orange agoseris	N	spe
16	AGROEXA	Agrostis exarata	6 Trin.	spike bentgrass	N	spe
17	AGROSCA	Agrostis scabra	6 Willd.	hair bentgrass	N	spe
18	AGROSTI	Agrostis sp.	6	bentgrass	N	gen

RStudio

File Edit Code View Plots Session Build Debug Profile Tools Help

Go to file/function Addins

Project: (None)

ich_species - no KLR

```

17 > #####
18 # I. Prepare the data:
19 > #####
20
21 dat <- read.table("C:/users/50 LBS/Desktop/trove/R/db_2019_07_22_veg.csv", sep=";", header = TRUE)
22 ich.dat <- dat[dat$BECzone == "ICH" & !dat$burn == "PB" & !dat$site == "Kinskuch",] #select the records in the ich, r
23
24 # set up the environmental data
25 ich.env <- ich.dat[,c(2, 9, 11, 12, 14, 18, 20, 21)]#ich.env <- ich.dat[,c(1:21)] #all env vars
26 ich.env <- droplevels(ich.env) #remove levels not represented in the remaining data set
27 ich.env <- as.data.frame(lapply(ich.env,as.factor))
28
29 # set up the vegetation data (% cover)
30 ich.veg <- ich.dat[,47:380] #slice out the vegetation data (% cover): select only understory spp. (remove trees and br
31 ich.veg <- as.data.frame(lapply(ich.veg,as.numeric)) #require numeric (some entries imported as integer ie subplot mea
32 ich.veg <- ich.veg[, colsums(ich.veg) != 0] #select species with data in remaining ICH plots
33
34 # combine the data.frames to collapse the data lengthwise
35 table <- data.table(ich.env, ich.veg)
36
37 > # reduce the dataset to the block level
41 > #####
42
43 > # reduce the dataset to the site level####
44 df <- aggregate(. ~ site + burn + age + elev + BECseries + survyr + plant, table, mean) #reduce dataset to site level
45 df <- df[,-8] #remove the block factor that is now no longer a factor but a categorical "mean"
46
47 # create the vegetation data (% cover) and environmental factor matrices
48 veg <- df[,8:ncol(df)] #slice out the vegetation data (% cover)
49 env <- df[,1:7]
50
51 # examine the veg matrix
52 summary(veg)
53 plot(table$PAXIMYR ~ table$burn)
54
55 > # calculate sparsity ####
56 zeros <- rowSums(veg == 0)
57 x <- Reduce("+", zeros)
58 nonz <- rowSums(veg != 0) # or use nnzero(veg) # from Matrix package
59 y <- Reduce("+", nonz)
60 x+y
61 m <- nrow(veg)*ncol(veg)
62 m
63 x/m*100 # ~82 % of the data matrix are zeros (~92% when aggregated to block level)
64
65

```

18:1 (Untitled) R Script

Console Terminal Markers

```

C:/Users/50 LBS/Desktop/trove/R/
>
> # reduce the dataset to the site level####
> df <- aggregate(. ~ site + burn + age + elev + BECseries + survyr + plant, table, mean) #reduce dataset to site level (52
unique site/year records)
> df <- df[,-8] #remove the block factor that is now no longer a factor but a categorical "mean"
>
> # create the vegetation data (% cover) and environmental factor matrices
> veg <- df[,8:ncol(df)] #slice out the vegetation data (% cover)
> env <- df[,1:7]
>

```

Environment History Connections

Global Environment

Data

Object	Observations	Variables
dat	8378 obs.	of 482 variables
df	52 obs.	of 149 variables
env	52 obs.	of 7 variables
ich.dat	2987 obs.	of 482 variables
ich.env	2987 obs.	of 8 variables
ich.veg	2987 obs.	of 142 variables
table	2987 obs.	of 150 variables
veg	52 obs.	of 142 variables

Files Plots Packages Help Viewer

Zoom Export

PLOT PHOTOS

Genevieve Lake (SBSdk)



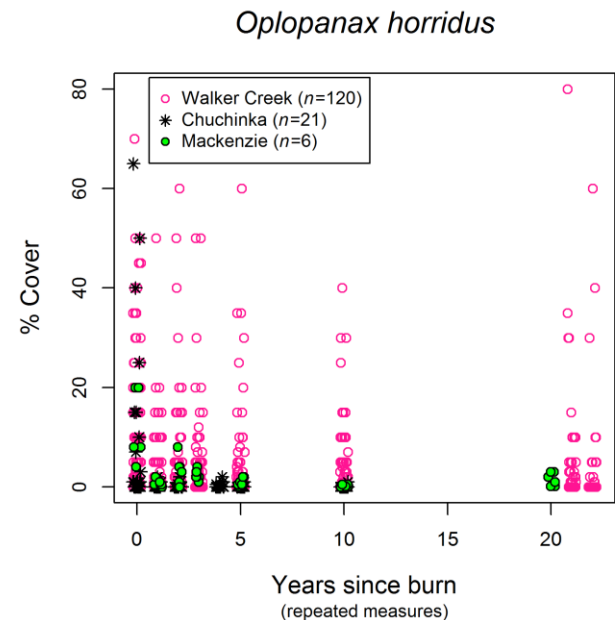
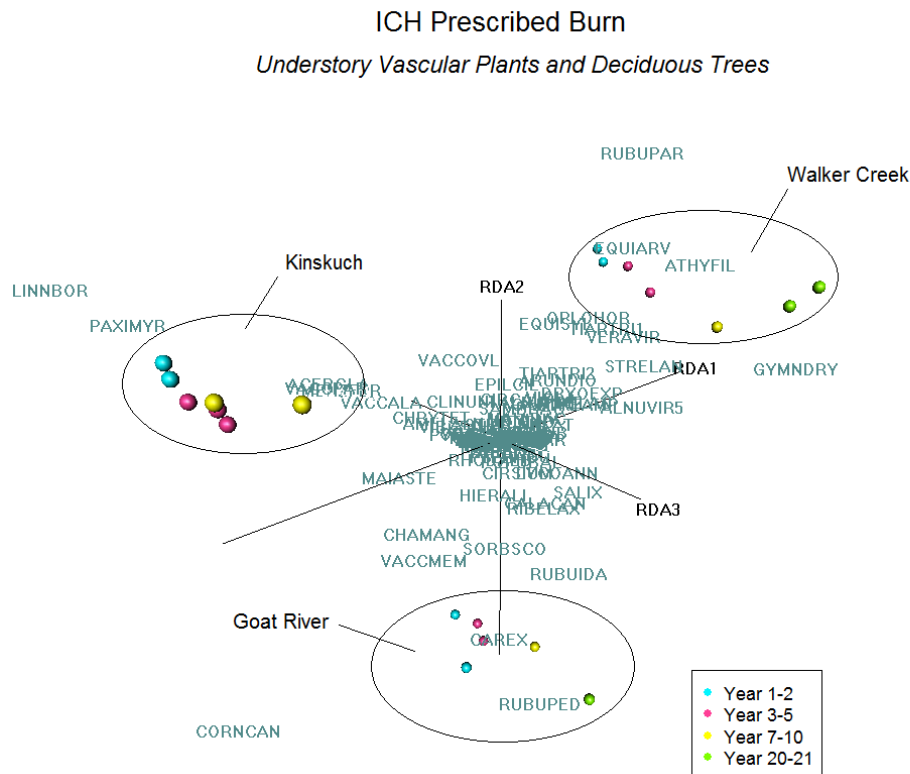
Year 10

Year 20

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 Between 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: © JR Chandler

Meta-analyses *within* Interior Cedar-Hemlock

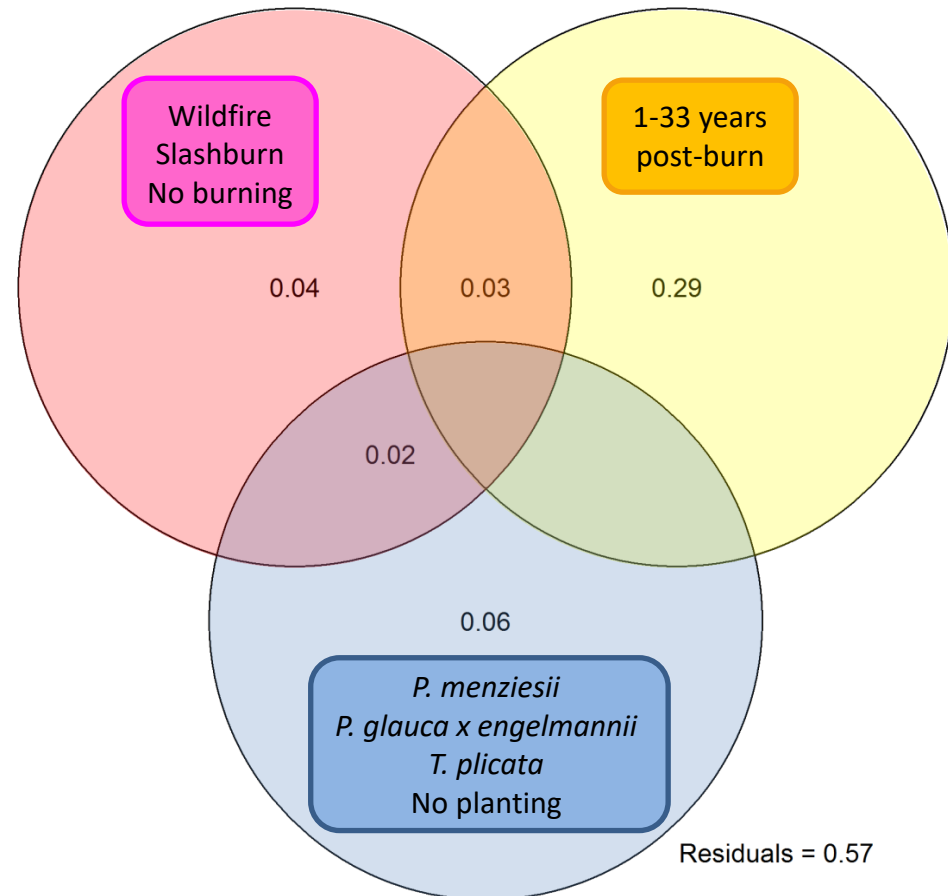
1. Distribution free multivariate analysis of variances (using distance matrices) to describe how variation is attributed to different experimental treatments or uncontrolled covariates ($n = 505$).

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

```
Plant R2 = 0.06747 p = < 0.001  
Burn R2 = 0.08535 p = < 0.001  
Age R2 = 0.29308 p = < 0.001
```

2. Variance Partitioning to partition the variation of the community matrix by the 3 explanatory factors

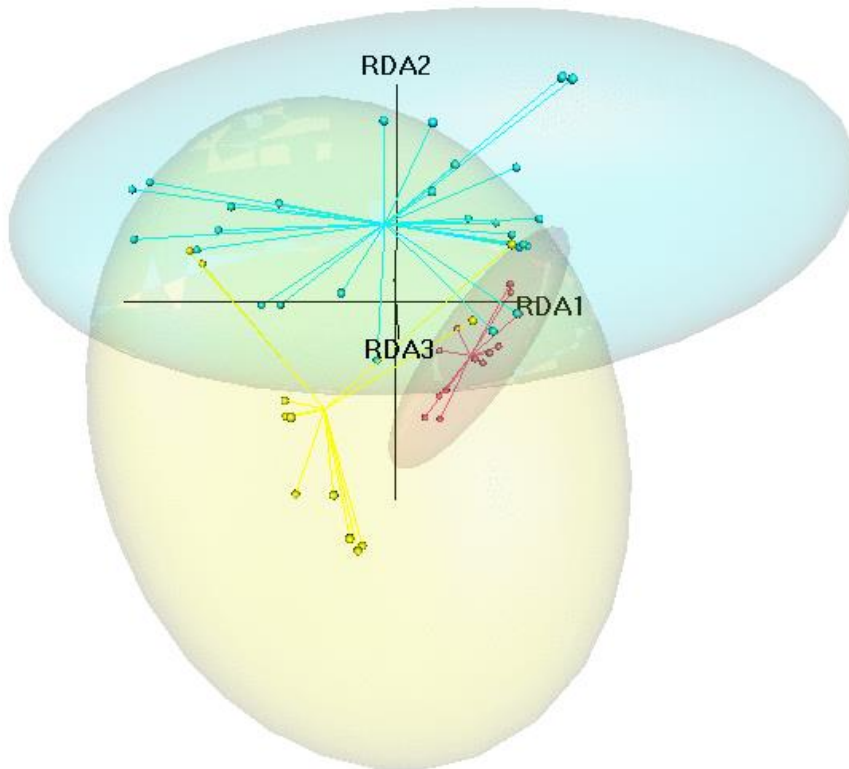
3. RDA to test significance of fractions of interest individually
 - all tests result in $p = < 0.001$



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

*41 sites

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.



Oplopanax horridus (Devil's club)

- Traditional Use
- Current trends in medicine
- Marketed as northern Ginseng
- Lack of regulation protecting



Photo: © Dee E. Warenycia

Pine Blister Rust Alternate Hosts

Genevieve Lake (SBSdk) 20 years after clearcut and slashburn



Photo: © JR Chandler

- 5 *Ribes* species in the database
- 2 rare species with 5 records total: *R. hudsonianum* (Mackenzie River - year 20 at 1%); and *R. oxycanthoides* (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.

	<i>R. lacustre</i>		<i>R. laxiflorum</i>		<i>R. glandulosum</i>	
	mean	sd	mean	sd	mean	sd
Brinks Mill (<i>n</i> =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 (<i>n</i> =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)

Management Implications

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

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



Photo: © E Hamilton

Project Conclusions and Looking Ahead

- 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 **THANK YOU for your interest!**

Abstract

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 America. Efforts to reduce GHG and 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.