ABoVE: Synthesis of Post-Fire Regeneration Across Boreal North America

Get Data

Documentation Revision Date: 2022-11-09

Dataset Version: 1.1

Summary

This dataset is a synthesis of species-specific pre- and post-fire tree stem density estimates, field plot characterization data, and acquired climate moisture deficit data for sites from Alaska, USA eastward to Quebec, Canada in fires that burned between 1989 and 2014. Data are from 1,538 sites across 58 fire perimeters encompassing 4.52 Mha of forest and all major boreal ecozones in North America. To be included in this synthesis, a site had to contain information on species-specific post-fire seedling densities. This included sites where seedlings had been counted 2-13 years post-fire, a timeframe over which there was little change in relative dominance of species based on densities. Plot characterization data includes stand age, site drainage, disturbance history, crown combustion severity, seedbed conditions, and stand structural attributes. Gridded values of Hargreaves Climate Moisture Deficit (CMD) were obtained for each plot where plot coordinates were available. These values included 30-year normals (1981-2010) and CMD in the two years immediately following the fire year. CMD anomalies were calculated as the difference between the 30-year normal and the single year values for each of the first two years after a fire. These synthesis data are provided in comma-separated values (CSV) format.

There is one data file in comma-separated values (.csv) with this dataset.

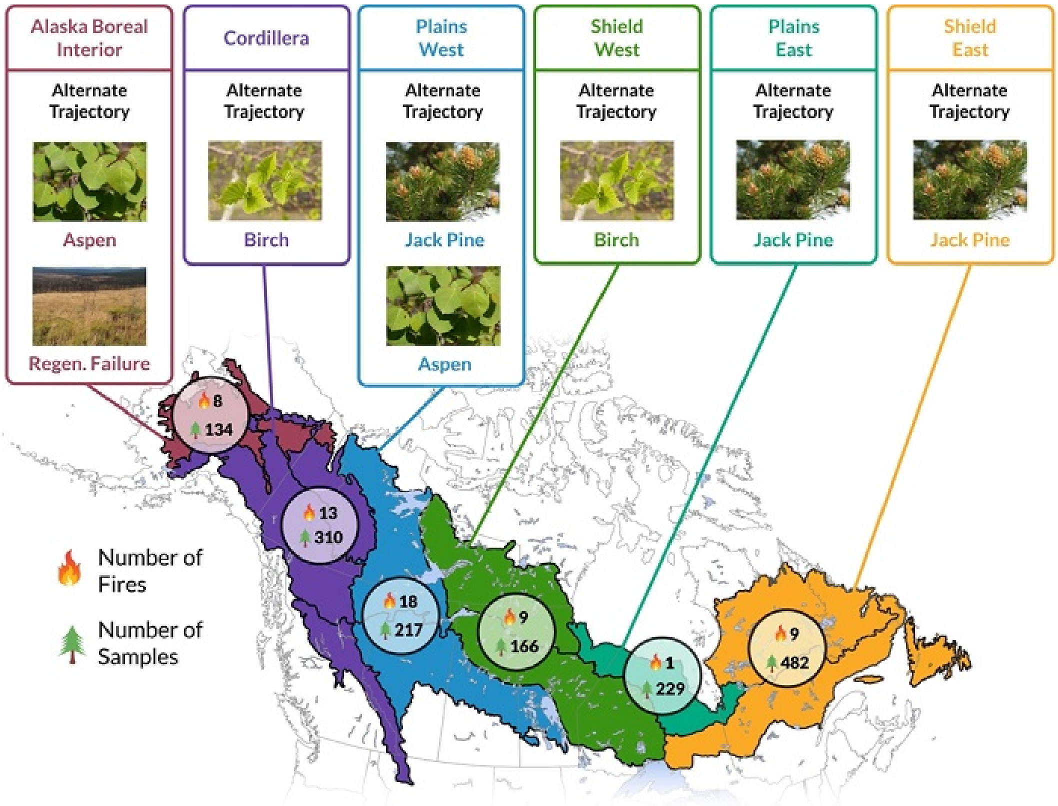

Figure 1. Number of fires and sites across combined ecozones as follows from west to east: Alaskan Boreal Interior, Cordillera (Boreal Cordillera and Taiga Cordillera), Plains West (Taiga Plains and Boreal Plains), Shield West (western portions of Taiga Shield and Softwood Shield), Plans East (Hudson Plains), Shield East (eastern portions of Taiga Shield and Softwood Shield). Alternate trajectories indicate the most common state changes away from black spruce dominance as quantified in the associated synthesis manuscript (Baltzer et al., 2021).

Citation

Baltzer, J.L., N.J. Day, X.J. Walker, D.F. Greene, M.C. Mack, D. Arseneault, J. Barnes, Y. Bergeron, Y. Boucher, L.L. Bourgeau-Chavez, C.D. Brown, S. Carrière, B.K. Howard, S. Gauthier, M.A. Parisien, K.A. Reid, B.M. Rogers, C. Roland, L. Sirois, S. Stehn, D.K. Thompson, M.R. Turetsky, E. Whitman, and J.F. Johnstone. 2022. ABoVE: Synthesis of Post-Fire Regeneration Across Boreal North America. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1955

Table of Contents

1. Dataset Overview

This dataset is a synthesis of species-specific pre- and post-fire tree stem density estimates, field plot characterization data, and acquired climate moisture deficit data for sites from Alaska, USA eastward to Quebec, Canada in fires that burned between 1989 and 2014. Data are from 1,538 sites across 58 fire perimeters encompassing 4.52 Mha of forest and all major boreal ecozones in North America. To be included in this synthesis, a site had to contain information on species-specific post-fire seedling densities. This included sites where seedlings had been counted 2-13 years post-fire, a timeframe over which there was little change in relative dominance of species based on densities. Plot characterization data includes stand age, site drainage, disturbance history, crown combustion severity, seedbed conditions, and stand structural attributes. Gridded values of Hargreaves Climate Moisture Deficit (CMD) were obtained for each plot where plot coordinates were available. These values included 30-year normals (1981-2010) and CMD in the two years immediately following the fire year. CMD anomalies were calculated as the difference between the 30-year normal and the single year values for each of the first two years after a fire.

Project: Arctic-Boreal Vulnerability Experiment

The Arctic-Boreal Vulnerability Experiment (ABoVE) is a NASA Terrestrial Ecology Program field campaign being conducted in Alaska and western Canada, for 8 to 10 years, starting in 2015. Research for ABoVE links field-based, process-level studies with geospatial data products derived from airborne and satellite sensors, providing a foundation for improving the analysis, and modeling capabilities needed to understand and predict ecosystem responses to, and societal implications of, climate change in the Arctic and Boreal regions.

Related Publication

Baltzer, J.L., N.J. Day, X.J. Walker, D. Greene, M.C. Mack, H.D. Alexander, D. Arseneault, J. Barnes, Y. Bergeron, Y. Boucher, L. Bourgeau-Chavez, C.D. Brown, S. Carrière, B.K. Howard, S. Gauthier, M.-A. Parisien, K.A. Reid, B.M. Rogers, C. Roland, L. Sirois, S. Stehn, D.K. Thompson, M.R. Turetsky, S. Veraverbeke, E. Whitman, J. Yang, and J.F. Johnstone. 2021. Increasing fire and the decline of fire adapted black spruce in the boreal forest. Proceedings of the National Academy of Sciences 118:e2024872118. https://doi.org/10.1073/pnas.2024872118

Related dataset

Walker, X.J., J.L. Baltzer, L.L. Bourgeau-Chavez, N.J. Day, W.J. De groot, C. Dieleman, E.E. Hoy, J.F. Johnstone, E.S. Kane, M.A. Parisien, S. Potter, B.M. Rogers, M.R. Turetsky, S. Veraverbeke, E. Whitman, and M.C. Mack. 2020. ABoVE: Synthesis of Burned and Unburned Forest Site Data, AK and Canada, 1983-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1744

Bourgeau-Chavez, L.L., S. Endres, L. Jenkins, M. Battaglia, E. Serocki, and M. Billmire. 2017. ABoVE: Burn Severity, Fire Progression, and Field Data, NWT, Canada, 2015-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1548

Acknowledgements

This study was funded by NASA ABoVE Grant NNX15AT71A with in kind support of the BNZ LTER program from NSF (DEB-1636476) and USDA Forest Service (RJVA-PNW-01-JV-11261952-231). Additional, project-specific funding sources not already acknowledged in the references in Table 3 are NASA ABoVE Grant NNX15AU56A to BMR and FQRNT Concerted-Action grant to LS. Dedicated research time for JLB was provided by the Canada Research Chairs program.

2. Data Characteristics

Spatial Coverage: Point locations from Alaska, USA to Quebec, Canada

ABoVE Reference Locations

Domain: Core ABoVE

State/Territory: Alaska, Canada

Spatial Resolution: Point

Temporal Coverage: Burns occurred during 1989-2014; measurements were made during 1998-2018, 2-13 years post-fire

Temporal Resolution: One-time estimates

Study Areas: Latitude and longitude are given in decimal degrees.

Study Areas	Flight Line	Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
Canadian Shield, Northwest Territories, Canada	bakerc, daring	-152.20	-71.013	66.962	49.116

Data File Information

There is one data file in comma-separated values (.csv) with this dataset: **BorealNA_Postfire_Regeneration_1989_2014.csv**

Table 1. Variables in the data file. Refer to *Data Acquisition, Materials and Methods* for additional details. Where ~ precedes a variable name, this indicates that species-specific and total values for that variable suffix are provided. Species included in the dataset are provided in Table 2.

Variable	Units	Description
project_id		Project name
burn_id		Name of fire perimeter
site_id		Unique site identifier
burn_year	YYYY	Year of burn, ranging from 1989 to 2014
count_year	YYYY	Year of measurement, ranging from 1998 to 2018
years_postfire	y	Time elapsed from year of burn to measurement year
latitude	degrees north	Latitude. GPS. Datum: WSG84
longitude	degrees east	Longitude. GPS. Datum WSG84
ecozone		US EPA Ecoregion Level 2 (https://www.epa.gov/eco-research/ecoregions)
ecozone_combined		Ecozones as collapsed for Figure 1 and Baltzer et al. (2021).
elevation	m	GPS. Meters above sea level
moisture		Site drainage was determined using topoedaphic characteristics (Johnstone et al., 2008; Beckingham et al., 1996); for data compilation, moisture indices were reduced to an ordinal variable with three levels (1 = dry, 2 = moist, 3 = wet).
residual_organic	cm	Mean depth (thickness) of post-fire organic soil to mineral soil, permafrost, or other impenetrable layer
TSLF	y	Time in years after last fire was determined based on dendroecological assessment of basal stem sections and/or cores taken from 2-12 trees at each site and representing the dominant size cohort within the stand
canopy_combustion		Ordinal variable indicating aboveground combustion (0 = no burn; 1 = some combustion of foliage and twigs; 2 = combustion of most fine fuels and some branches; 3 = combustion of all branches only main stem remains). Compilation of this variable is described in detail below.
CMD_sm_norm	mm	Hargreaves' CMD for summer (June, July, and August, or JJA) 30-year normal (1981-2010) retrieved from Climate North America (Wang et al. 2016)
CMD_sm_1YF	mm	Hargreaves' CMD for JJA (summer) 1 year after fire retrieved from Climate North America (Wang et al. 2016)
CMD_sm_2YF	mm	Hargreaves' CMD for JJA (summer) 2 years after fire retrieved from Climate North America (Wang et al., 2016)
CMD_diff_y1	mm	Indicates CMD anomaly 1 year after fire. Calculated as the difference between CMD.sm.norm and CMD.sm.1YF
CMD_diff_y2	mm	Indicates CMD anomaly 2 years after fire. Calculated as the difference between CMD.sm.norm and CMD.sm.2YF
~_BA	m^2 ha^{-1}	A total measured basal area (m2) is given on an area (ha) basis for pre-fire stems of each tree species as well as the total. ~ represents an individual species code, defined in Table 2. For example, abibal_BA, betneo_BA.
~_density	stems m^{-2}	A density was calculated for pre-fire stems of each tree species as well as the total. ~ represents an individual species code, defined in Table 2.
~_sdlg_dens	seedlings m^{-2}	A post-fire seedling density was calculated for each tree species as well as the total. ~ represents an individual species code, defined in table 2.
~_sucker_dens	suckers m^{-2}	Some studies reported post-fire sucker (resprouting recruitment) densities for each species. These are given as well as the total. ~ represents an individual species code, defined in Table 2.
~_sdlg_sucker_dens	recruits m^{-2}	Post-fire density for all measured recruits (tree seedlings and suckers) on an area basis. Most studies did not distinguish seedlings and suckers (both are reported as seedlings) so this combined variable should be used as a measure of recruitment densities. ~ represents an individual species code, defined in Table 2.

Table 2. Key to species codes used in file **BorealNA_Postfire_Regeneration_1989_2014.csv**.

Code	Species name and authority
abibal	*Abies balsamea* (L.) Mill.
betneo	*Betula neoalaskana* Sarg.
betpap	*Betula papyrifera* Marshall
larlar	*Larix laricina* (Du Roi) K. Koch

picgla	*Picea glauca* (Moench) Voss
picmar	*Picea mariana* (Mill.) Britton
pinban	*Pinus banksiana* Lamb.
popbal	*Populus balsamifera* L.
poptre	*Populus tremuloides* Michx.
conifer	All conifers combined including abibal, larlar, picgla, picmar, pinban
broad	All broadleaved species combined including betneo, betpap, popbal, poptre

3. Application and Derivation

This dataset synthesizes post-fire regeneration studies from across boreal North America. Data are from 1,538 sites across 58 fire perimeters encompassing 4.52 Mha of forest and all major boreal ecozones in North America. Although many of the data contributions to this synthesis have been used in publications, in many cases, seedling count data were not published so this dataset represents a novel data product. Furthermore, this is the first attempt to characterize forest regeneration processes at a biome scale.

4. Quality Assessment

There was not an evaluation of uncertainty.

5. Data Acquisition, Materials, and Methods

Study areas

Data were obtained from 1,538 sites across 58 fire perimeters encompassing 4.52 Mha of forest and all major boreal ecozones in North America including Interior Boreal Alaska, Boreal Cordillera, Taiga Cordillera, Taiga Plains, Boreal Plains, Taiga Shield, Softwood Shield, and Hudson Plains. Site selection and sampling methods differed between studies, but to be included in this dataset, studies had minimally to contain information on species-specific, post-fire seedling densities. This included sites where seedlings had been counted 2-13 years post-fire, a timeframe over which there was little change in relative dominance of species densities (Johnstone et al., 2020). For a subset of sites (n = 1,400) field collected data on pre-fire species-specific basal area and stem density were provided supporting the determination of post-fire state changes and for 1,046 of these sites, field collected data on stand age, canopy combustion, residual soil organic layer thickness (i.e., seed bed quality), and site moisture were also provided. Sources for the compiled datasets are provided in Table 3.

Table 3. Data sources for seedling regeneration sites by ecozone with an indication of the burn years and number of fires sampled as well as the total number of sites contributed through each study.

Ecozone	Reference	Burn year	Fires	Sites
Alaskan Interior	Barnes, J., and J. Hrobak. National Park Service, Alaska Western Area FFI Fire Effects Monitoring Data 2021. https://irma.nps.gov/DataStore/Reference/Profile/2284297	2000 2001	4	55
	Johnstone, J.F., T.N. Hollingsworth, F.S. Chapin, and M.C. Mack. 2010. Changes in fire regime break the legacy lock on successional trajectories in Alaskan boreal forest. *Global Change Biology* 16:1281-1295. https://doi.org/10.1111/j.1365-2486.2009.02051.x	2004	2	24
	Walker, X.J., M.C. Mack, and J.F. Johnstone. Predicting ecosystem resilience to fire from tree ring analysis in black spruce forests. *Ecosystems* 20:1137-1150. https://doi.org/10.1007/s10021-016-0097-5	2004	2	27
	Roland, C.A., H. Schmidt, and E.F. Nicklen. 2013. Landscape-scale patterns in tree occupancy and abundance in subarctic Alaska. *Ecological Monographs* 83:19-48. https://www.jstor.org/stable/23596740 Walker, X.J., B.K. Howard, M. Jean, J.F. Johnstone, C. Roland, B.M. Rogers, E.A. G. Schuur, K.K. Solvik, and M.C. Mack. 2021. Impacts of pre-fire conifer density and wildfire severity on ecosystem structure and function at the forest-tundra ecotone. PLOS ONE 16:e0258558. https://doi.org/10.1371/journal.pone.0258558	2013	1	28
Boreal Cordillera	Johnstone, J.F. 2006. Response of boreal plant communities to variations in previous fire-free interval. International Journal of Wildland Fire 15:497-508. https://doi.org/10.1071/WF06012 Johnstone, J.F., and E.S. Kasischke. 2005. Stand-level effects of soil burn severity on post-fire regeneration in a recently-burned black spruce forest. Canadian Journal of Forest Research 35:2151-2163. https://doi.org/10.1139/x05-087 Johnstone, J.F., E.J.B. McIntire, E. Pedersen, G. Kind, and M.F.J. Pisaric. 2010. A sensitive slope: Estimating landscape patterns of forest resilience in a changing climate. Ecosphere 1:1-21. https://doi.org/10.1890/ES10-00102.1 Johnstone, J.F., T.N. Hollingsworth, F.S. Chapin III, and M.C. Mack. 2010. Changes in fire regime break the legacy lock on successional trajectories in Alaskan boreal forest. Global Change Biology 16, 1281-1295. https://doi.org/10.1111/j.1365-2486.2009.02051.x	1994 1995 1998 2004	6	205
	Walker, X.J., B.K. Howard, M. Jean, J.F. Johnstone, C. Roland, B.M. Rogers, E.A. G. Schuur, K.K. Solvik, and M.C. Mack. 2021. Impacts of pre-fire conifer density and wildfire severity on ecosystem structure and function at the forest-tundra ecotone. PLOS ONE 16:e0258558. https://doi.org/10.1371/journal.pone.0258558	2013	1	20

	Walker, X.J., M.C. Mack, and J.F. Johnstone. Predicting ecosystem resilience to fire from tree ring analysis in black spruce forests. *Ecosystems* 20:1137-1150. https://doi.org/10.1007/s10021-016-0097-5	2004 2005	4	55
Taiga Cordillera	Brown, C.D., and J.F. Johnstone. 2011. How does increased fire frequency affect carbon loss from fire? A case study in the northern boreal forest. *Int. J. Wildland Fire* 20:829-837. https://doi.org/10.1071/WF10113	2005	2	16
	Walker, X.J., M.C. Mack, and J.F. Johnstone. Predicting ecosystem resilience to fire from tree ring analysis in black spruce forests. *Ecosystems* 20:1137-1150. https://doi.org/10.1007/s10021-016-0097-5	2004	1	12
Western Cordillera	Hesketh, M.D., F. Greene, E. Pounden. 2009. Early establishment of conifer recruits in the northern Rocky Mountains as a function of postfire duff depth. *Canadian Journal of Forest Research* 39:2059-2064. https://doi.org/10.1139/X09-120	1999	1	2
Taiga Plains	Bourgeau-Chavez, L.L., S. Endres, L. Jenkins, M. Battaglia, E. Serocki, and M. Billmire. 2017. ABoVE: Burn Severity, Fire Progression, and Field Data, NWT, Canada, 2015-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1548	2014	3	14
	Walker, X.J., J.L. Baltzer, S.G. Cumming, N.J. Day, J.F. Johnstone, B.M. Rogers, K. Solvik, M.R. Turetsky, and M.C. Mack. 2017. Soil organic layer combustion in boreal black spruce and jack pine stands of the Northwest Territories, Canada. *Int. J. Wildland Fire* 27:125-134. https://doi.org/10.1071/WF17095 Day, N.J., A.L. White, J.F. Johnstone, G.E. Degre-Timmons, S.G. Cumming, M. C. Mack, M.R. Turetsky, X.J. Walker, and J.L. Baltzer. 2020. Fire characteristics and environmental conditions shape plant communities via regeneration strategy. *Ecography* 43:1-11. https://doi.org/10.1111/ecog.05211 Day, N.J., J.F. Johnstone, K.A. Reid, S.G. Cumming, M.C. Mack, M.R. Turetsky, X.J. Walker, J.L. Baltzer. 2022. Material legacies and environmental constraints underlie fire resilience of a dominant boreal forest type. *Ecosystems*, https://doi.org/10.1007/s10021-022-00772-7	2014	4	135
	Whitman, E., M.-A. Parisien, D. Thompson, and M. Flannigan. 2018. Topoedaphic and forest controls on post-fire vegetation assemblies are modified by fire history and burn severity in the Northwestern Canadian boreal forest. *Forests* 9:151. https://doi.org/10.3390/f9030151 Whitman, E., M.-A. Parisien, D. K. Thompson, M.D. Flannigan. 2019. Short-interval wildfire and drought overwhelm boreal forest resilience. *Sci Rep* 9:18796. https://doi.org/10.1038/s41598-019-55036-7 Thompson, D.K., M.-A. Parisien, J. Morin, K. Millard, C.P.S. Larsen, and B.N. Simpson. 2017. Fuel accumulation in a high-frequency boreal wildfire regime: from wetland to upland. *Canadian Journal of Forest Research* 47:957-964. https://doi.org/10.1139/cjfr-2016-0475	2003	5	41
Boreal Plains	Greene, D.F., S.E. Macdonald, S. Haeussler, S, Domenicano, J. Noel, K. Jayen, I. Charron, S. Gauthier, S. hunt, E.T. Gielau, Y. Bergeron, and L. Swift. 2007. The reduction of organic-layer depth by wildfire in the North American boreal forest and its effect on tree recruitment by seed. *Can. J. For. Res.* 37:1012-1023 https://doi.org/10.1139/X06-245	1995 1996	2	11
	Walker, X.J., M.C. Mack, and J.F. Johnstone. Predicting ecosystem resilience to fire from tree ring analysis in black spruce forests. *Ecosystems* 20:1137-1150. https://doi.org/10.1007/s10021-016-0097-5	2002 2003 2009	5	16
Taiga Shield W	Bourgeau-Chavez, L.L., S. Endres, L. Jenkins, M. Battaglia, E. Serocki, and M. Billmire. 2017. ABoVE: Burn Severity, Fire Progression, and Field Data, NWT, Canada, 2015-2016. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1548	2014	1	6
	Day, N.J., S. Carrière, and J.L. Baltzer. 2017. Annual dynamics and resilience in post-fire boreal understory vascular plant communities. *Forest Ecology and Management* 401:264-272. http://doi.org/10.1016/j.foreco.2017.06.062	1996 1998	2	60
	Walker, X.J., J.L. Baltzer, S.G. Cumming, N.J. Day, J.J. Johnstone, B.M. Rogers, K. Solvik, M.R. Turetsky, and M.C. Mack. 2018. Soil organic layer combustion in boreal black spruce and jack pine stands of the Northwest Territories, Canada. *Int. J. Wildland Fire* 27:125-134. https://doi.org/10.1071/WF17095 Day, N.J., A.L. White, J.F. Johnstone, G.E. Degre-Timmons, S.G. Cumming, M. C. Mack, M.R. Turetsky, X.J. Walker, and J.L. Baltzer. 2020. Fire characteristics and environmental conditions shape plant communities via regeneration strategy. *Ecography* 43:1-11. https://doi.org/10.1111/ecog.05211 Day, N.J., J.F. Johnstone, K.A. Reid, S.G. Cumming, M.C. Mack, M.R. Turetsky, X.J. Walker, J.L. Baltzer. 2022. Material legacies and environmental constraints underlie fire resilience of a dominant boreal forest type. *Ecosystems*, https://doi.org/10.1007/s10021-022-00772-7	2014	3	89
Boreal Shield W	Dieleman, C., B.M. Rogers, S. Potter, S. Veraverbeke, J.J. Johnstone, J. LaFlamme, K. Solvik, X.J. Walker, M.C. Mack, and M.R. Turetsky. 2020. Wildfire combustion and carbon stocks in the southern Canadian boreal forest: Implications for a warming world. *Global Change Biology* 26:6062-6079. https://doi.org/10.1111/gcb.15158	2006	3	11
	D. Duros, D. 2006. Les déterminants de la régénération forestière après les feux de 1989 dans le Nord de la forêt boréale. These-Université du Québec à Rimouski.	1989	1	229

Hudson Plain	Perrault-Hébert, M., Y. Boucher, R. Fournier, F. Girard, I. Auger, N. Thiffault, and F. Grenon. 2017. Ecological drivers of post-fire regeneration in a recently managed boreal forest landscape of eastern Canada. *Forest Ecology and Management* 399:74-81. https://doi.org/10.1016/j.foreco.2017.05.026	2005 2007 2010	4	20
	Boucher, D., S. Gauthier, J. Noël, D.F. Greene, and Y. Bergeron. 2014. Salvage logging affects early post-fire tree composition in Canadian boreal forest. *Forest Ecology and Management* 325:118-127. https://doi.org/10.1016/j.foreco.2014.04.002 Greene, D.F., S. Gauthier, J. Noël, M. Rousseau, and Y. Bergeron. 2006. A field experiment to determine the effect of post-fire salvage on seedbeds and tree regeneration. *Frontiers in Ecology and the Environment* 4:69-74 https://doi.org/10.1890/1540-9295(2006)004[0069:AFETDT]2.0.CO;2	1997	1	13
	Greene, D.F., S. Gauthier, J. Noël, M. Rousseau, and Y. Bergeron. 2006. A field experiment to determine the effect of post-fire salvage on seedbeds and tree regeneration. *Frontiers in Ecology and the Environment* 4:69-74. https://doi.org/10.1890/1540-9295(2006)004[0069:AFETDT]2.0.CO;2	2002	1	3
Taiga Shield E	Duros, D. 2006. Les déterminants de la régénération forestière après les feux de 1989 dans le Nord de la forêt boréale. Theses-Université du Québec à Rimouski.	1989	2	446

Data Synthesis

Compiled Field Site Observations

Stand age (years after post-disturbance establishment and a metric of fire return interval) was determined based on dendroecological assessment of basal stem sections and/or cores taken from 2-12 trees at each site. Site drainage was determined using topoedaphic characteristics (e.g., Johnstone et al., 2008, Beckingham et al., 1996) but the resolution of these measurements varied by study from a maximum of six levels to a minimum of three levels; as such this variable was reduced to an ordinal variable with three levels (1 = dry, 2 = moist, 3 = wet) as described in Table 4. Residual soil organic layer thickness was measured as the depth to mineral soil, bedrock, or permafrost in small soil pits at multiple locations at each site. Soil combustion estimates were not available for many studies; therefore, residual organic soil layer thickness was used to represent integrated effects of pre-fire organic soil depth and fire severity on post-fire seedbed quality (Walker et al., 2018a). Within quadrats or transects, the diameter at breast height and identity of all woody stems was recorded allowing the calculation of species-specific pre-fire stem density (trees m^{-2}) and basal area (m^2 ha^{-1}). Estimates of canopy combustion were based on either combustion of structural classes resulting in an ordinal variable ranging from 0 (canopy survived fire, i.e., live canopy) to 3 (all fine fuels and branches combusted) (Walker et al., 2018b) or canopy Composite Burn Index (CBI), which is a similar metric that quantifies the level of consumption of canopy foliage and stems on a scale of 0 (canopy survived fire) to 3 (all needles and branches consumed) (Key and Benson, 2003). For sites where both measures of canopy combustion were available, type II regression indicated a significant positive relationship (r^2 = 0.57; $p < 0.0001$) that did not differ from unity ($p = 0.9577$), supporting the combination of these metrics. Modifications by dataset necessary for data compilation are provided in Table 4.

Table 4. Modifications made to canopy combustion and moisture variables provided in the original datasets based on discussions with data providers to allow the combination of these variables across studies. Species present in each dataset are also provided; species codes can be found in Table 2.

Project ID	Sites	Spp. present	Moisture conversion	Canopy combustion conversion
DDuros	675	picmar,pinban, larlar,poptre	subxeric=1, mesic=2, subhygric=3	< 10% = 0; 10-25% = 1; >25-60% = 2 (max value was 60% indicating stand-level combustion was never severe)
NPS.Denali	55	picmar,larlar, picgla,popbal	mesic=1, moist=2, wet=3	As measured
Quebec	20	picmar,pinban, betpap,abibal	subxeric=1, mesic=2, subhygric + mesic_subhygric=3	NA - canopy combustion estimates not made
Dempster	16	picmar	mesic=2	1 = 1; 4 = 3
CIMP	224	picmar,pinban, larlar,poptre, picgla,betneo	xeric+subxeric=1, mesic+mesic_subxeric=2, mesic_subhygric+hygric=3	As measured
TibbittLake	60	picmar, pinban, betneo	xeric=1, subhygric=3	NA - canopy combustion estimates not made
Greene	16	picmar, pinban	mesic=2	NA - canopy combustion estimates not made
Denali	48	picmar,picgla	subxeric=1, mesic+mesic_subxeric=2, subhygric+ mesic_subhygric=3	As measured
JFSP2004	90	picmar, poptre,betneo	1 & 2=1, 3 & 4=2, 5 & 6=3	As measured
Fox1998	81	picgla,poptre	SWfacing=1, Lowland=2, NEfacing=2	NA - canopy combustion estimates not made
Delta1994	22	picmar	subxeric=1, mesic +submesic=2, subhygric=3	NA - canopy combustion estimates not made
YT_Overlap	36	picmar,poptre, betneo,picgla	1 & 2=1, 3=2, 4 & 5=3	low = 1; med&high = 2; v.high = 3
NWT	20	picmar,pinban, larlar,poptre	dry + moist=2,soggy + standingwater=3	As measured
Saskatchewan	11	picmar,pinban, potre,betpap	1 + 2=1, 3 = 2	NA - canopy combustion estimates not made

Quebec	13	picmar,pinban, poptre,popbal, betpap	NA – no moisture values provided	Light = 1; moderate = 2; severe = 3
NWT/AB	41	picmar,pinban, poptre,picgla, popbal,betpap	xeric+subxeric=1, mesic+submesic=2, subhygric+hygric=3	As measured
AK/YT/SK	110	picmar,pinban, betpap	1 + 2=1, 3 + 4=2, 5 + 6=3	NA - canopy combustion estimates not made

Climate Moisture Deficit Data and Calculations

Growing season Hargreaves' CMD was generated with the ClimateNA v5.60 software package (Wang et al., 2016) for the two years following fire for each site and the 1981-2010 normal (CMD_{normal}). The difference between CMD following fire and CMD_{normal} was used to reflect climate anomalies in the two years following fire ($CMD_{postfire}$) with the expectation that anomalies relative to the climate normal would be more relevant than absolute $CMD_{postfire}$ values given the substantial climatic variation across North America. Most seedling recruitment occurs in the first two years following stand-replacing fire (Johnstone et al., 2020), which includes climate anomalies in years 1 and 2 post-fire.

6. Data Access

These data are available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

ABoVE: Synthesis of Post-Fire Regeneration Across Boreal North America

Contact for Data Center Access Information:

- E-mail: uso@daac.ornl.gov
- Telephone: +1 (865) 241-3952

7. References

Baltzer, J.L., N.J. Day, X.J. Walker, D. Greene, M.C. Mack, H.D. Alexander, D. Arseneault, J. Barnes, Y. Bergeron, Y. Boucher, L. Bourgeau-Chavez, C.D. Brown, S. Carrière, B.K. Howard, S. Gauthier, M.-A. Parisien, K.A. Reid, B.M. Rogers, C. Roland, L. Sirois, S. Stehn, D.K. Thompson, M.R. Turetsky, S. Veraverbeke, E. Whitman, J. Yang, and J.F. Johnstone. 2021. Increasing fire and the decline of fire adapted black spruce in the boreal forest. Proceedings of the National Academy of Sciences 118:e2024872118. https://doi.org/10.1073/pnas.2024872118

Beckingham, J, D. Nielsen, and V. Futoransky. 1996. *Field guide to ecosites of the mid-boreal ecoregions of Saskatchewan* (Canadian Forest Service, Northwest Region, Northern Forestry Centre).

Johnstone, J.F., G. Cellis, F.S. Chapin III, N. Hollingsworth, M. Jean, and M.C. Mack. 2020. Factors shaping alternate successional trajectories in burned black spruce forests of Alaska. *Ecosphere* 11:e03129 https://doi.org/10.1002/ecs2.3129

Johnstone, J.F., T.N. Hollingsworth, and F.S. Chapin. 2008. *A key for predicting postfire successional trajectories in black spruce stands of interior Alaska*. USDA Forest Service, Pacific Northwest Research Station, General Technical Report PNW-GTR-767 (Portland, OR, USA). https://doi.org/10.2737/PNW-GTR-767

Key, C.H., and N.C. Benson. 2003. *The composite burn index (CBI): field rating of burn severity* (U.S. Department of the Interior, Geological Survey, Northern Rocky Mountain Science Center).

Walker, X.J., J.L. Baltzer, S.G. Cumming, N.J. Day, J.J. Johnstone, B.M. Rogers, K. Solvik, M.R. Turetsky, and M.C. Mack. 2018a. Soil organic layer combustion in boreal black spruce and jack pine stands of the Northwest Territories, Canada. *Int. J. Wildland Fire* 27:125-134. https://doi.org/10.1071/WF17095

Walker, X.J., B.M. Rogers, J.L. Baltzer, S.G. Cumming, N.J. Day, S.J. Goetz, J.J. Johnstone, E.A.G. Schuur, M.R. Turetsky, and M.C. Mack. 2018b. Cross-scale controls on carbon emissions from boreal mega-fires of the Northwest Territories, Canada. Global Change Biology, 24:4251-4265 https://doi.org/10.1111/gcb.14287

Wang, T. A. Hamann, D. Spittlehouse, and C. Carroll. 2016. Locally downscaled and spatially customizable climate data for historical and future periods for North America. *PLOS ONE* 11:e0156720 https://doi.org/10.1371/journal.pone.0156720

Additional references to data sources are included in Table 3.

8. Dataset Revisions

V1.1 was published on November 9th, 2022 with an updated datafile with more precise stem density data. The earlier file had stem densities to one place of decimal whereas the updated file has stem densities to 2 places of decimal.