

## **Detection of Annual Spruce Budworm Defoliation and Severity Classification Using Landsat Imagery**

[www.nrfirescience.org/resource/17947](http://www.nrfirescience.org/resource/17947)

Spruce budworm (SBW) is the most destructive forest pest in eastern forests of North America. Mapping annual current-year SBW defoliation is challenging because of the large landscape scale of infestations, high temporal/spatial variability, and the short period of time when detection is possible. We used Landsat-5 and Landsat-MSS...

Author(s): Parinaz Rahimzadeh-Bajgiran, Aaron R. Weiskittel, Daniel Kneeshaw, David A. MacLean

Year Published: 2018

Type: Document

Book or Chapter or Journal Article

## **Ten Years of Monitoring Illustrates a Cascade of Effects of White Pine Blister Rust and Focuses Whitebark Pine Restoration in the Canadian Rocky and Columbia Mountains**

[www.nrfirescience.org/resource/17189](http://www.nrfirescience.org/resource/17189)

Whitebark pine forests are declining due to infection by white pine blister rust and mountain pine beetle, combined with the effects of climate change and fire suppression. The Canadian Rocky and Columbia Mountains represent a large portion of the whitebark range; a vast area, exemplifying the need for knowledge about whitebark pine...

Author(s): Brenda Shepherd, Brad Jones, Robert Sissons, Jed Cochrane, Jane Park, Cyndi M. Smith, Natalie Staf

Year Published: 2018

Type: Document

Book or Chapter or Journal Article

## **Environmental, Structural, and Disturbance Influences over Forest Floor Components in Interior Douglas-Fir Forests of the Intermountain West, USA**

[www.nrfirescience.org/resource/18077](http://www.nrfirescience.org/resource/18077)

Downed woody material (DWM) is a key component in forest ecosystems with age, structure, and disturbance described as primary factors that influence DWM dynamics. In particular, much emphasis is placed on large coarse woody debris (CWD). Fine woody debris (FWD) (less than 7.62 cm diameter), duff, and litter also contribute to carbon...

Author(s): Andrew D. Giunta, John D. Shaw

Year Published: 2018

Type: Document

Book or Chapter or Journal Article

## **Simulation of net ecosystem productivity of a lodgepole pine forest after mountain pine beetle attack using a modified version of 3-PG**

[www.nrfirescience.org/resource/17169](http://www.nrfirescience.org/resource/17169)

The most recent mountain pine beetle (MPB) (*Dendroctonus ponderosae*) outbreak in British Columbia (BC), which began in the late 1990s, killed ~54% of the mature merchantable lodgepole pine and was expected to impact gross primary productivity (GPP), ecosystem respiration (R) and thus net ecosystem productivity (NEP) of infested...

Author(s): Gesa Meyer, T. Andrew Black, Rachhpal S. Jassal, Zoran Nesic, Nicholas C. Coops, Andreas Christen, Arthur L. Fredeen, David L. Spittlehouse, Nicholas J. Grant, Vanessa N. Foord, Rebecca Bowler

Year Published: 2018

Type: Document

Book or Chapter or Journal Article

### **Characterizing interactions between fire and other disturbances and their impacts on tree mortality in western U.S. forests**

[www.nrfirescience.org/resource/16268](http://www.nrfirescience.org/resource/16268)

Increasing evidence that pervasive warming trends are altering disturbance regimes and their interactions with fire has generated substantial interest and debate over the implications of these changes. Previous work has primarily focused on conditions that promote non-additive interactions of linked and compounded disturbances, but...

Author(s): Jeffrey M. Kane, J. Morgan Varner, Margaret R. Metz, Phillip J. van Mantgem

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Landscape-scale quantification of fire-induced change in canopy cover following mountain pine beetle outbreak and timber harvest**

[www.nrfirescience.org/resource/15137](http://www.nrfirescience.org/resource/15137)

Across the western United States, the three primary drivers of tree mortality and carbon balance are bark beetles, timber harvest, and wildfire. While these agents of forest change frequently overlap, uncertainty remains regarding their interactions and influence on specific subsequent fire effects such as change in canopy cover....

Author(s): T. Ryan McCarley, Crystal A. Kolden, Nicole M. Vaillant, Andrew T. Hudak, Alistair M. S. Smith, Jason Kreitler

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Fires following Bark Beetles: Factors Controlling Severity and Disturbance Interactions in Ponderosa Pine**

[www.nrfirescience.org/resource/16727](http://www.nrfirescience.org/resource/16727)

Previous studies have suggested that bark beetles and fires can be interacting disturbances, whereby bark beetle–caused tree mortality can alter the risk and severity of subsequent wildland fires. However, there remains considerable uncertainty around the type and magnitude of the interaction between fires following bark beetle...

Author(s): Carolyn Hull Sieg, Rodman Linn, F. Pimont, Chad M. Hoffman, Joel D. McMillin, Judith Winterkamp, Scott L. Baggett

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Using landscape genetics simulations for planting blister rust resistant whitebark pine in the US northern Rocky Mountains**

[www.nrfirescience.org/resource/16568](http://www.nrfirescience.org/resource/16568)

Recent population declines to the high elevation western North America foundation species whitebark pine, have been driven by the synergistic effects of the invasive blister rust pathogen, mountain pine beetle (MPB), fire exclusion, and climate change. This has led to consideration for listing whitebark pine (WBP) as a threatened or...

Author(s): Erin L. Landguth, Zachary A. Holden, M. F. Mahalovich, Samuel A. Cushman

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **A multicentury dendrochronological reconstruction of western spruce budworm outbreaks in**

### **the Okanogan Highlands, northeastern Washington**

[www.nrfirescience.org/resource/16464](http://www.nrfirescience.org/resource/16464)

The western spruce budworm (*Choristoneura occidentalis occidentalis* Freeman) is recognized as the most ecologically and economically damaging defoliator in western North America. Synchronous western spruce budworm outbreaks can occur over much of a host species' range, causing widespread limb and tree mortality, regeneration...

Author(s): Todd M. Ellis, Aquila Flower

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Prescribed fire in grassland butterfly habitat: targeting weather and fuel conditions to reduce soil temperature and burn severity**

[www.nrfirescience.org/resource/16319](http://www.nrfirescience.org/resource/16319)

Prescribed burning is a primary tool for habitat restoration and management in fire-adapted grasslands. Concerns about detrimental effects of burning on butterfly populations, however, can inhibit implementation of treatments. Burning in cool and humid conditions is likely to result in lowered soil temperatures and to produce...

Author(s): Kathryn C. Hill, Jonathan D. Bakker, Peter W. Dunwiddie

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Interactions of landscape disturbances and climate change dictate ecological pattern and process: spatial modeling of wildfire, insect, and disease dynamics under future climates**

[www.nrfirescience.org/resource/15531](http://www.nrfirescience.org/resource/15531)

Context: Interactions among disturbances, climate, and vegetation influence landscape patterns and ecosystem processes. Climate changes, exotic invasions, beetle outbreaks, altered fire regimes, and human activities may interact to produce landscapes that appear and function beyond historical analogs. Objectives We used the...

Author(s): Rachel A. Loehman, Robert E. Keane, Lisa M. Holsinger, Zhiwei Wu

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **The Influence of Western Spruce Budworm on Fire in Spruce-Fir Forests**

[www.nrfirescience.org/resource/16730](http://www.nrfirescience.org/resource/16730)

Western spruce budworm (*Choristoneura freemani* Razowski; WSBW) is the most significant defoliator of coniferous trees in the western United States. Despite its important influence on Western forests, there are still gaps in our knowledge of WSBW's impact on fire, and little research has been done on this relationship in high-...

Author(s): Eric Vane, Kristen M. Waring, Adam Polinko

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Estimating aboveground tree biomass for beetle-killed lodgepole pine in the Rocky Mountains of northern Colorado**

[www.nrfirescience.org/resource/16593](http://www.nrfirescience.org/resource/16593)

The recent mountain pine beetle (*Dendroctonus ponderosae* Hopkins) epidemic has affected millions of hectares of conifer forests in the Rocky Mountains. Land managers are interested in using biomass

from beetle-killed trees for bioenergy and biobased products, but they lack adequate information to accurately estimate biomass in...

Author(s): Woodam Chung, Paul Evangelista, Nathaniel Anderson, Anthony Vorster, Hee Han, Krishna Poudel, Robert Sturtevant

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Evidence of compounded disturbance effects on vegetation recovery following high-severity wildfire and spruce beetle outbreak**

[www.nrfirescience.org/resource/16510](http://www.nrfirescience.org/resource/16510)

Spruce beetle (*Dendroctonus rufipennis*) outbreaks are rapidly spreading throughout subalpine forests of the Rocky Mountains, raising concerns that altered fuel structures may increase the ecological severity of wildfires. Although many recent studies have found no conclusive link between beetle outbreaks and increased fire size or...

Author(s): Amanda R. Carlson, Jason S. Sibold, Timothy J. Assal, Jose F. Negrón

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Climatic conditions for emergence and flight of mountain pine beetle: implications for long-distance dispersal**

[www.nrfirescience.org/resource/16454](http://www.nrfirescience.org/resource/16454)

A significant shift in the mountain pine beetle (*Dendroctonus ponderosae* Hopkins, 1902) range has been attributed to long-distance dispersal from the observed spatiotemporal patterns of beetle infestations in the recent outbreak in western Canada. However, long-distance dispersal is still the least understood aspect of mountain pine...

Author(s): Huapeng Chen, Peter L. Jackson

Year Published: 2017

Type: Document

Book or Chapter or Journal Article

### **Climate influences on whitebark pine mortality from mountain pine beetle in the Greater Yellowstone Ecosystem**

[www.nrfirescience.org/resource/14565](http://www.nrfirescience.org/resource/14565)

Extensive mortality of whitebark pine, beginning in the early to mid-2000s, occurred in the Greater Yellowstone Ecosystem (GYE) of the western US, primarily from mountain pine beetle but also from other threats such as white pine blister rust. The climatic drivers of this recent mortality and the potential for future whitebark pine...

Author(s): Polly C. Buotte, Jeffrey A. Hicke, Haiganoush K. Preisler, John T. Abatzoglou, Kenneth F. Raffa, Jesse A. Logan

Year Published: 2016

Type: Document

Book or Chapter or Journal Article

### **Forest disturbance interactions and successional pathways in the Southern Rocky Mountains**

[www.nrfirescience.org/resource/14423](http://www.nrfirescience.org/resource/14423)

The pine forests in the southern portion of the Rocky Mountains are a heterogeneous mosaic of disturbance and recovery. The most extensive and intensive stress and mortality are received from human activity, fire, and mountain pine beetles (MPB; *Dendroctonus ponderosae*). Understanding disturbance interactions and disturbance-...

Author(s): Lu Liang, Todd J. Hawbaker, Zhiliang Zhu, Xuecao Li, Peng Gong  
Year Published: 2016  
Type: Document  
Book or Chapter or Journal Article

### **Elevational shifts in thermal suitability for mountain pine beetle population growth in a changing climate**

[www.nrfirescience.org/resource/14987](http://www.nrfirescience.org/resource/14987)

Future forests are being shaped by changing climate and disturbances. Climate change is causing large-scale forest declines globally, in addition to distributional shifts of many tree species. Because environmental cues dictate insect seasonality and population success, climate change is also influencing tree-killing bark beetles....

Author(s): Barbara J. Bentz, Jacob P. Duncan, James A. Powell  
Year Published: 2016  
Type: Document  
Book or Chapter or Journal Article

### **Community structure, biodiversity, and ecosystem services in treeline whitebark pine communities: Potential impacts from a non-native pathogen**

[www.nrfirescience.org/resource/14358](http://www.nrfirescience.org/resource/14358)

Whitebark pine (*Pinus albicaulis*) has the largest and most northerly distribution of any white pine (Subgenus *Strobus*) in North America, encompassing 18° latitude and 21° longitude in western mountains. Within this broad range, however, whitebark pine occurs within a narrow elevational zone, including upper subalpine and treeline...

Author(s): Diana F. Tomback, Lynn M. Resler, Robert E. Keane, Elizabeth R. Pansing, Andrew J. Andrade, Aaron C. Wagner  
Year Published: 2016  
Type: Document  
Book or Chapter or Journal Article

### **Bark beetle-induced tree mortality alters stand energy budgets due to water budget changes**

[www.nrfirescience.org/resource/14974](http://www.nrfirescience.org/resource/14974)

Insect outbreaks are major disturbances that affect a land area similar to that of forest fires across North America. The recent mountain pine bark beetle (*Dendroctonus ponderosae*) outbreak and its associated blue stain fungi (*Grosmannia clavigera*) are impacting water partitioning processes of forests in the Rocky Mountain region as...

Author(s): David E. Reed, Brent E. Ewers, Elise G. Pendall, John M. Frank, Robert Kelly  
Year Published: 2016  
Type: Document  
Book or Chapter or Journal Article

### **Do insect outbreaks reduce the severity of subsequent forest fires?**

[www.nrfirescience.org/resource/14260](http://www.nrfirescience.org/resource/14260)

Understanding the causes and consequences of rapid environmental change is an essential scientific frontier, particularly given the threat of climate- and land use-induced changes in disturbance regimes. In western North America, recent widespread insect outbreaks and wildfires have sparked acute concerns about potential insect–...

Author(s): Garrett W. Meigs, Harold S. Zald, John L. Campbell, William S. Keeton, Robert E. Kennedy  
Year Published: 2016  
Type: Document  
Book or Chapter or Journal Article

### **Fortifying the forest: thinning and burning increase resistance to a bark beetle outbreak and promote forest resilience**

[www.nrfirescience.org/resource/14810](http://www.nrfirescience.org/resource/14810)

Fire frequency in low-elevation coniferous forests in western North America has greatly declined since the late 1800s. In many areas, this has increased tree density and the proportion of shade-tolerant species, reduced resource availability, and increased forest susceptibility to forest insect pests and high-severity wildfire. In...

Author(s): Sharon M. Hood, Stephen P. Baker, Anna Sala

Year Published: 2016

Type: Document

Book or Chapter or Journal Article

### **Conserving whitebark pine in ski areas - Demonstrations at Whitefish Mountain Resort**

[www.nrfirescience.org/resource/14705](http://www.nrfirescience.org/resource/14705)

As part of the Whitebark Pine Ecosystem Foundation's Annual Science and Management Workshop - Successes and Challenges in Managing the Jewel in the Crown of the Continent, participants saw first hand some of the challenges facing whitebark pine restoration, and they witnessed certification of the first Whitebark Pine Friendly Ski...

Author(s): Corey L. Gucker

Year Published: 2016

Type: Document

Research Brief or Fact Sheet

### **A 20-year reassessment of the health and status of whitebark pine forests in the Bob Marshall Wilderness Complex, Montana**

[www.nrfirescience.org/resource/14676](http://www.nrfirescience.org/resource/14676)

Whitebark pine plays a prominent role in high elevation ecosystems of the northern Rocky Mountains. It is an important food source for many birds and mammals as well as an essential component of watershed stabilization. Whitebark pine is vanishing from the landscape due to three main factors: white pine blister rust, mountain pine...

Author(s): Signe B. Leirfallom, Robert E. Keane, Molly L. Retzlaff

Year Published: 2016

Type: Document

Technical Report or White Paper

### **Prescribed fire does not promote outbreaks of a primary bark beetle at low-density populations**

[www.nrfirescience.org/resource/13941](http://www.nrfirescience.org/resource/13941)

The causes of bark beetle outbreaks - particularly the role of disturbances - are poorly understood. Stand-scale disturbances, like fires, can suddenly improve local host susceptibility and may attract beetles; however, whether such increases can lead to outbreaks in post-disturbance stands is unclear. Using low-density *Dendroctonus*...

Author(s): Crisia A. Tabacaru, Jane Park, Nadir Erbilgin

Year Published: 2016

Type: Document

Book or Chapter or Journal Article

### **Mountain pine beetles: A century of knowledge, control attempts, and impacts central to the Black Hills**

[www.nrfirescience.org/resource/14583](http://www.nrfirescience.org/resource/14583)

This publication chronicles the understanding, controlling, and impacts of mountain pine beetles (MPB) central to the Black Hills of South Dakota and Wyoming from the time they were described by Hopkins in 1902, through the presentation of data from work started by Schmid and Mata in 1985. The plots established by these two men from...

Author(s): Russell T. Graham, Michael A. Battaglia, Theresa B. Jain, Lance A. Asherin, Stephen A. Mata

Year Published: 2016

Type: Document

Synthesis, Technical Report or White Paper

### **Conservation and management of whitebark pine ecosystems**

[www.nrfirescience.org/resource/14563](http://www.nrfirescience.org/resource/14563)

This reference presents general guidelines for planning, implementing, and evaluating whitebark pine conservation and management activities on lands administered by the Bureau of Land Management.

Author(s): Dana L. Perkins, Robert E. Means, Alexia C. Cochrane

Year Published: 2016

Type: Document

Synthesis, Technical Report or White Paper

### **Cumulative disturbance on the landscape: lessons from the Pole Creek fire, Oregon**

[www.nrfirescience.org/resource/14519](http://www.nrfirescience.org/resource/14519)

Previous research has focused on quantifying fuel loadings and using operational fire behavior models to understand changes in fire severity following MPB outbreaks. In this study however, researchers used direct field measurements taken from the 2012 Pole Creek Fire that burned in lodgepole pine forests in central Oregon's...

Author(s): Northwest Fire Science Consortium

Year Published: 2016

Type: Document

Research Brief or Fact Sheet

### **Forest health in a changing world: effects of globalization and climate change on forest insect and pathogen impacts**

[www.nrfirescience.org/resource/14992](http://www.nrfirescience.org/resource/14992)

Forests and trees throughout the world are increasingly affected by factors related to global change. Expanding international trade has facilitated invasions of numerous insects and pathogens into new regions. Many of these invasions have caused substantial forest damage, economic impacts and losses of ecosystem goods and services...

Author(s): T. D. Ramsfield, Barbara J. Bentz, M. Faccoli, H. Jactel, E. G. Brockerhoff

Year Published: 2016

Type: Document

Book or Chapter or Journal Article, Synthesis

### **A dynamical model for bark beetle outbreaks**

[www.nrfirescience.org/resource/14984](http://www.nrfirescience.org/resource/14984)

Tree-killing bark beetles are major disturbance agents affecting coniferous forest ecosystems. The role of environmental conditions on driving beetle outbreaks is becoming increasingly important as global climatic change alters environmental factors, such as drought stress, that, in turn, govern tree resistance. Furthermore,...

Author(s): Vlastimil Krivan, Mark Lewis, Barbara J. Bentz, Sharon Bewick, Suzanne M. Lenhart, Andrew Liebhold

Year Published: 2016

Type: Document  
Book or Chapter or Journal Article

### **Recent tree mortality in the western United States from bark beetles and forest fires**

[www.nrfirescience.org/resource/14323](http://www.nrfirescience.org/resource/14323)

Forests are substantially influenced by disturbances, and therefore accurate information about the location, timing, and magnitude of disturbances is important for understanding effects. In the western United States, the two major disturbance agents that kill trees are wildfire and bark beetle outbreaks. Our objective was to...

Author(s): Jeffrey A. Hicke, Arjan J. H. Meddens, Crystal A. Kolden

Year Published: 2016

Type: Document  
Book or Chapter or Journal Article

### **Relative importance of climate and mountain pine beetle outbreaks on the occurrence of large wildfires in the western USA**

[www.nrfirescience.org/resource/14899](http://www.nrfirescience.org/resource/14899)

Extensive outbreaks of bark beetles have killed trees across millions of hectares of forests and woodlands in western North America. These outbreaks have led to spirited scientific, public, and policy debates about consequential increases in fire risk, especially in the wildland–urban interface (WUI), where homes and communities...

Author(s): Dominik Kulakowski, Nathan Mietkiewicz

Year Published: 2016

Type: Document  
Book or Chapter or Journal Article

### **Spatial variability in tree regeneration after wildfire delays and dampens future bark beetle outbreaks**

[www.nrfirescience.org/resource/14737](http://www.nrfirescience.org/resource/14737)

Wildfires have increased in western North America, creating extensive areas of regenerating forests. There is concern that recent large, stand-replacing fires will synchronize forest development and commit landscapes to a future of increased disturbance, such as bark beetle outbreaks that require extensive, well-connected forests of...

Author(s): Rupert Seidl, Daniel C. Donato, Kenneth F. Raffa, Monica G. Turner

Year Published: 2016

Type: Document  
Book or Chapter or Journal Article

### **Variables associated with the occurrence of Ips beetles, red turpentine beetle and wood borers in live and dead ponderosa pines with post-fire injury**

[www.nrfirescience.org/resource/14690](http://www.nrfirescience.org/resource/14690)

Recently, wildfires and prescribed burning have become more frequent in conifer forests of western North America. Most studies examining the impacts of insects on trees with post-fire injury have focused on contributions to tree mortality. Few studies have examined fire-caused injuries to estimate the probability of attack by...

Author(s): Jose F. Negrón, Joel D. McMillin, Carolyn Hull Sieg, James F. Fowler, Kurt K. Allen, Linda L. Wadleigh, John A. Anhold, Ken E. Gibson

Year Published: 2016

Type: Document  
Book or Chapter or Journal Article

### **Fire severity and cumulative disturbance effects in the post-mountain pine beetle lodgepole pine forests of the Pole Creek Fire**

[www.nrfirescience.org/resource/14007](http://www.nrfirescience.org/resource/14007)

Recent large scale mountain pine beetle (*Dendroctonus ponderosae* Hopkins, MPB) outbreaks have created concern regarding increased fuel loadings and exacerbated fire behavior and have prompted a desire to understand the effects of sequential disturbances on the landscape. However, previous research has focused on quantifying fuel...

Author(s): Michelle Agne, Travis J. Woolley, Stephen A. Fitzgerald

Year Published: 2016

Type: Document

Book or Chapter or Journal Article

### **Whitebark Pine Friendly Ski Area Certification Program launches this fall at Whitefish Mountain, Montana**

[www.nrfirescience.org/resource/14622](http://www.nrfirescience.org/resource/14622)

Where do most of the general public encounter whitebark pines? Ski areas! These recreational areas in high elevations allow many to encounter an otherwise remote and wilderness species. This accessibility of whitebark pines at ski areas serves as the motivation behind the Whitebark Pine Ecosystem Foundation's...

Author(s): Edie Dooley

Year Published: 2016

Type: Document

Research Brief or Fact Sheet

### **Fuel loads and simulated fire behavior in 'old-stage' beetle-infested ponderosa pine of the Colorado Plateau**

[www.nrfirescience.org/resource/14527](http://www.nrfirescience.org/resource/14527)

Recent bark beetle outbreaks in western North America have led to concerns regarding changes in fuel profiles and associated changes in fire behavior. Data are lacking for a range of infestation severities and time since outbreak, especially for relatively arid cover types. We surveyed fuel loads and simulated fire behavior for...

Author(s): E. Matthew Hansen, Morris C. Johnson, Barbara J. Bentz, A. Steven Munson

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Fire severity unaffected by spruce beetle outbreak in spruce-fir forests in southwestern Colorado**

[www.nrfirescience.org/resource/14156](http://www.nrfirescience.org/resource/14156)

Recent large and severe outbreaks of native bark beetles have raised concern among the general public and land managers about potential for amplified fire activity in western North America. To date, the majority of studies examining bark beetle outbreaks and subsequent fire severity in the U.S. Rocky Mountains have focused on...

Author(s): Robert A. Andrus, Thomas T. Veblen, Brian J. Harvey, Sarah Hart

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Does wildfire likelihood or severity increase following insect outbreaks in conifer forests?**

[www.nrfirescience.org/resource/14153](http://www.nrfirescience.org/resource/14153)

Although there is acute concern that insect-caused tree mortality increases the likelihood or severity of subsequent wildfire, previous studies have been mixed, with findings typically based on stand-scale simulations or individual events. This study investigates landscape- and regional-scale wildfire likelihood following outbreaks...

Author(s): Garrett W. Meigs, John L. Campbell, Harold S. Zald, John D. Bailey, David C. Shaw, Robert E. Kennedy

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Bark beetles and wildfires: how does forest recovery change with repeated disturbances in mixed-conifer forests?**

[www.nrfirescience.org/resource/13329](http://www.nrfirescience.org/resource/13329)

Increased wildfire activity and recent bark beetle outbreaks in the western United States have increased the potential for interactions between disturbance types to influence forest characteristics. However, the effects of interactions between bark beetle outbreaks and subsequent wildfires on forest succession remain poorly...

Author(s): Camille Stevens-Rumann, Penelope Morgan, Chad M. Hoffman

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Temperate forest health in an era of emerging megadisturbance**

[www.nrfirescience.org/resource/13722](http://www.nrfirescience.org/resource/13722)

Although disturbances such as fire and native insects can contribute to natural dynamics of forest health, exceptional droughts, directly and in combination with other disturbance factors, are pushing some temperate forests beyond thresholds of sustainability. Interactions from increasing temperatures, drought, native insects and...

Author(s): Constance I. Millar, Nathan L. Stephenson

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Tree physiology and bark beetles**

[www.nrfirescience.org/resource/13305](http://www.nrfirescience.org/resource/13305)

Irruptive bark beetles usually co-occur with their co-evolved tree hosts at very low (endemic) population densities. However, recent droughts and higher temperatures have promoted widespread tree mortality with consequences for forest carbon, fire and ecosystem services (Kurz et al., 2008; Raffa et al., 2008; Jenkins et al., 2012)....

Author(s): Michael G. Ryan, Gerard Sapes, Anna Sala, Sharon M. Hood

Year Published: 2015

Type: Document

Book or Chapter or Journal Article, Synthesis

### **Modeling spatial and temporal dynamics of wind flow and potential fire behavior following a mountain pine beetle outbreak in a lodgepole pine forest**

[www.nrfirescience.org/resource/13298](http://www.nrfirescience.org/resource/13298)

Patches of live, dead, and dying trees resulting from bark beetle-caused mortality alter spatial and temporal variability in the canopy and surface fuel complex through changes in the foliar moisture content of attacked trees and through the redistribution of canopy fuels. The resulting heterogeneous fuels complexes alter within...

Author(s): Chad M. Hoffman, Rodman Linn, Russell A. Parsons, Carolyn Hull Sieg, Judith Winterkamp  
Year Published: 2015  
Type: Document  
Book or Chapter or Journal Article

### **Tree mortality from drought, insects, and their interactions in a changing climate**

[www.nrfirescience.org/resource/13635](http://www.nrfirescience.org/resource/13635)

Climate change is expected to drive increased tree mortality through drought, heat stress, and insect attacks, with manifold impacts on forest ecosystems. Yet, climate-induced tree mortality and biotic disturbance agents are largely absent from process-based ecosystem models. Using data sets from the western USA and associated...

Author(s): William R.L. Anderegg, Jeffrey A. Hicke, Rosie A. Fisher, Craig D. Allen, Juliann Aukema, Barbara J. Bentz, Sharon M. Hood, Jeremy W. Lichstein, Alison K. Macalady, Nate McDowell, Yude Pan, Kenneth F. Raffa, Anna Sala, John D. Shaw, Nathan L. Stephenson, Christina Tague, Melanie Zeppel

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Low-severity fire increases tree defense against bark beetle attacks**

[www.nrfirescience.org/resource/14366](http://www.nrfirescience.org/resource/14366)

Induced defense is a common plant strategy in response to herbivory. Although abiotic damage, such as physical wounding, pruning, and heating, can induce plant defense, the effect of such damage by large-scale abiotic disturbances on induced defenses has not been explored and could have important consequences for plant survival...

Author(s): Sharon M. Hood, Anna Sala, Emily K. Heyerdahl, Marion Boutin

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Short-interval disturbance in lodgepole pine forests, British Columbia, Canada: understory and overstory response to mountain pine beetle and fire**

[www.nrfirescience.org/resource/14159](http://www.nrfirescience.org/resource/14159)

The recent mountain pine beetle (MPB) outbreak across western North America's interior lodgepole pine forests has altered the landscape such that the majority of wildfires in the region will now burn through MPB-affected stands. Study of plant community response to these combined disturbances is critical for our understanding and...

Author(s): Marc Edwards, Meg A. Krawchuk, Philip J. Burton

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Temperate forest health in an era of emerging megadisturbance**

[www.nrfirescience.org/resource/13501](http://www.nrfirescience.org/resource/13501)

Although disturbances such as fire and native insects can contribute to natural dynamics of forest health, exceptional droughts, directly and in combination with other disturbance factors, are pushing some temperate forests beyond thresholds of sustainability. Interactions from increasing temperatures, drought, native insects and...

Author(s): Constance I. Millar, Nathan L. Stephenson

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Area burned in the western United States is unaffected by recent mountain pine beetle outbreaks**

[www.nrfirescience.org/resource/14154](http://www.nrfirescience.org/resource/14154)

In the western United States, mountain pine beetles (MPBs) have killed pine trees across 71,000 km<sup>2</sup> of forest since the mid-1990s, leading to widespread concern that abundant dead fuels may increase area burned and exacerbate fire behavior. Although stand-level fire behavior models suggest that bark beetle-induced tree mortality...

Author(s): Sarah Hart, Tania L. Schoennagel, Thomas T. Veblen, Teresa B. Chapman

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Interactions among spruce beetle disturbance, climate change and forest dynamics captured by a forest landscape model**

[www.nrfirescience.org/resource/13909](http://www.nrfirescience.org/resource/13909)

The risk of bark beetle outbreaks is widely predicted to increase because of a warming climate that accelerates temperature-driven beetle population growth and drought stress that impairs host tree defenses. However, few if any studies have explicitly evaluated climatically enhanced beetle population dynamics in relation to climate-...

Author(s): Christian Temperli, Thomas T. Veblen, Sarah Hart, Dominik Kulakowski, Alan J. Tepley

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

### **Fire severity and tree regeneration following bark beetle outbreaks: the role of outbreak stage and burning conditions**

[www.nrfirescience.org/resource/13328](http://www.nrfirescience.org/resource/13328)

The degree to which recent bark beetle (*Dendroctonus ponderosae*) outbreaks may influence fire severity and postfire tree regeneration is of heightened interest to resource managers throughout western North America, but empirical data on actual fire effects are lacking. Outcomes may depend on burning conditions (i.e., weather during...

Author(s): Brian J. Harvey, Daniel C. Donato, William H. Romme, Monica G. Turner

Year Published: 2014

Type: Document

Book or Chapter or Journal Article

### **Moving forward: responding to and mitigating effects of the MPB epidemic**

[www.nrfirescience.org/resource/13711](http://www.nrfirescience.org/resource/13711)

The final webinar in the Future Forest Webinar Series provided an example of how managers utilized available science to address questions about post-epidemic forest conditions. Assessments of current conditions and projected trends, and how these compare with historical patterns, provide important information for land management...

Author(s): Claudia Regan, Barry Bollenbacher, Rob Gump, Michael Hillis

Year Published: 2014

Type: Document

Conference Proceedings

**Western spruce budworm outbreaks did not increase fire risk over the last three centuries: a**

### **dendrochronological analysis of inter-disturbance synergism**

[www.nrfirescience.org/resource/13637](http://www.nrfirescience.org/resource/13637)

Insect outbreaks are often assumed to increase the severity or probability of fire occurrence through increased fuel availability, while fires may in turn alter susceptibility of forests to subsequent insect outbreaks through changes in the spatial distribution of suitable host trees. However, little is actually known about the...

Author(s): Aquila Flower, Daniel G. Gavin, Emily K. Heyerdahl, Russell A. Parsons, Greg M. Cohn

Year Published: 2014

Type: Document

Book or Chapter or Journal Article

### **Landsat time series and lidar as predictors of live and dead basal area across five bark beetle-affected forests**

[www.nrfirescience.org/resource/13623](http://www.nrfirescience.org/resource/13623)

Bark beetle-caused tree mortality affects important forest ecosystem processes. Remote sensing methodologies that quantify live and dead basal area (BA) in bark beetle-affected forests can provide valuable information to forest managers and researchers. We compared the utility of light detection and ranging (lidar) and the Landsat-

Author(s): Benjamin C. Bright, Andrew T. Hudak, Robert E. Kennedy, Arjan J. H. Meddens

Year Published: 2014

Type: Document

Book or Chapter or Journal Article

### **Don't blame the beetles**

[www.nrfirescience.org/resource/13290](http://www.nrfirescience.org/resource/13290)

Tiny insects called bark beetles have devastated forests in western North America over the past decade. Life has drained from millions of hectares of forest so quickly that it seemed as if they had been abruptly unplugged, like a Christmas tree before bedtime. And many people have feared the infestation's fallout, worrying that the...

Author(s): Cally Carswell

Year Published: 2014

Type: Document

Book or Chapter or Journal Article

### **Recent mountain pine beetle outbreaks, wildfire severity, and postfire tree regeneration in the US northern Rockies**

[www.nrfirescience.org/resource/13007](http://www.nrfirescience.org/resource/13007)

Widespread tree mortality caused by outbreaks of native bark beetles (Circulionidae: Scolytinae) in recent decades has raised concern among scientists and forest managers about whether beetle outbreaks fuel more ecologically severe forest fires and impair postfire resilience. To investigate this question, we collected extensive...

Author(s): Brian J. Harvey, Daniel C. Donato, Monica G. Turner

Year Published: 2014

Type: Document

Book or Chapter or Journal Article

### **Post-epidemic fire risk and behavior**

[www.nrfirescience.org/resource/13708](http://www.nrfirescience.org/resource/13708)

Citizens, government officials, and natural resource managers are greatly concerned about potential impacts of the mountain pine beetle (MPB) epidemic on fire hazards and risk. Some mountain towns are surrounded by dead and dying trees. In the Rocky Mountain Region of the Forest Service, the MPB

epidemic threatens over 250,000 acres...

Author(s): Russell A. Parsons, William Matt Jolly, Paul G. Langowski, Megan Matonis, I. Sue Miller

Year Published: 2014

Type: Document

Conference Proceedings

### **Ecological Consequences Of Mountain Pine Beetle Outbreaks For Wildlife In Western North American Forests**

[www.nrfirescience.org/resource/17469](http://www.nrfirescience.org/resource/17469)

Mountain pine beetle (*Dendroctonus ponderosae*) (MPB) outbreaks are increasingly prevalent in western North America, causing considerable ecological change in pine (*Pinus* spp.) forests with important implications for wildlife. We reviewed studies examining wildlife responses to MPB outbreaks and postoutbreak salvage logging to inform...

Author(s): Victoria A. Saab, Quresh Latif, Mary M. Rowland, Tracey N. Johnson, Anna D. Chalfoun, Steven W. Buskirk, Joslin E. Heyward, Matthew A. Dresser

Year Published: 2014

Type: Document

Book or Chapter or Journal Article

### **Management for mountain pine beetle outbreak suppression: does relevant science support current policy?**

[www.nrfirescience.org/resource/13571](http://www.nrfirescience.org/resource/13571)

While the use of timber harvests is generally accepted as an effective approach to controlling bark beetles during outbreaks, in reality there has been a dearth of monitoring to assess outcomes, and failures are often not reported. Additionally, few studies have focused on how these treatments affect forest structure and function...

Author(s): Diana L. Six, Eric Biber, Elisabeth Long

Year Published: 2014

Type: Document

Book or Chapter or Journal Article, Synthesis

### **Future Forests Webinar Series, webinar proceedings and summary: ongoing research and management responses to the mountain pine beetle outbreak**

[www.nrfirescience.org/resource/12963](http://www.nrfirescience.org/resource/12963)

The Future Forest Webinar Series facilitated dialogue between scientists and managers about the challenges and opportunities created by the mountain pine beetle (MPB) epidemic. The series consisted of six webinars facilitated by the USFS Rocky Mountain Research Station, the Northern and Rocky Mountain Regions, and the Colorado Forest...

Year Published: 2014

Type: Document

Conference Proceedings

### **Bark beetle effects on fuel profiles across a range of stand structures in Douglas-fir forests of Greater Yellowstone**

[www.nrfirescience.org/resource/13301](http://www.nrfirescience.org/resource/13301)

Consequences of bark beetle outbreaks for forest wildfire potential are receiving heightened attention, but little research has considered ecosystems with mixed-severity fire regimes. Such forests are widespread, variable in stand structure, and often fuel limited, suggesting that beetle outbreaks could substantially alter fire...

Author(s): Daniel C. Donato, Brian J. Harvey, William H. Romme, Martin Simard, Monica G. Turner

Year Published: 2013

Type: Document  
Book or Chapter or Journal Article

### **Progress in understanding bark beetle effects on fire behavior using physics-based models**

[www.nrfirescience.org/resource/13297](http://www.nrfirescience.org/resource/13297)

Bark beetle outbreaks are a major disturbance of forests throughout western North America affecting ecological processes and social and economic values (Amman 1977, Bond and Keeley 2005). Since the 1990s, bark beetle outbreaks have affected between 1.1 and 13.5 million acres in the western United States and an additional 13.5...

Author(s): Chad M. Hoffman, Carolyn Hull Sieg, Penelope Morgan, William E. Mell, Rodman Linn, Camille Stevens-Rumann, Joel D. McMillin, Russell A. Parsons, Helen Maffei

Year Published: 2013

Type: Document  
Book or Chapter or Journal Article

### **Whitebark pine restoration challenges - Restoration site visits in the Bridger Mountains**

[www.nrfirescience.org/resource/12929](http://www.nrfirescience.org/resource/12929)

As part of the 13th Whitebark Pine Ecosystem Science and Management Workshop - Challenges of Whitebark Pine Restoration, participants visited a whitebark pine restoration area near Fairy Lake in the Bridger Mountains north of Bozeman, MT (Figure 1). The restoration site at about 8,000 feet supports both whitebark pine (*Pinus...*

Author(s): Corey L. Gucker

Year Published: 2013

Type: Document  
Research Brief or Fact Sheet

### **Health, reproduction, and fuels in whitebark pine in the Frank Church River of No Return Wilderness Area in central Idaho (Project INT-F-05-02)**

[www.nrfirescience.org/resource/12010](http://www.nrfirescience.org/resource/12010)

Whitebark pine (*Pinus albicaulis* Engelm.) is in serious decline across its range, largely due to the combined effects of *Cronartium ribicola* J. C. Fisch (an introduced fungal pathogen that causes white pine blister rust), replacement by late successional species, and widespread infestation of mountain pine beetle (*Dendroctonus...*

Author(s): Lauren Fins, Ben Hoppus

Year Published: 2013

Type: Document  
Technical Report or White Paper

### **Regional and forest-level estimates of carbon stored in harvested wood products from the United States Forest Service Northern Region, 1906-2010**

[www.nrfirescience.org/resource/13089](http://www.nrfirescience.org/resource/13089)

Global forests capture and store significant amounts of CO<sub>2</sub> through photosynthesis. When carbon is removed from forests through harvest, a portion of the harvested carbon is stored in wood products, often for many decades. The United States Forest Service (USFS) and other agencies are interested in accurately accounting for carbon...

Author(s): Nathaniel Anderson, Jesse Young, Keith Stockmann, Kenneth E. Skog, Sean P. Healey, Dan R. Loeffler, J. Greg Jones, James F. Morrison

Year Published: 2013

Type: Document  
Technical Report or White Paper

## **Cascading impacts of bark beetle-caused tree mortality on coupled biogeophysical and biogeochemical processes**

[www.nrfirescience.org/resource/8345](http://www.nrfirescience.org/resource/8345)

Recent large-scale outbreaks of bark beetle infestations have affected millions of hectares of forest in western North America, covering an area similar in size to that impacted by fire. Bark beetles kill host trees in affected areas, thereby altering water supply, carbon storage, and nutrient cycling in forests; for example, the...

Author(s): Steven L. Edburg, Jeffrey A. Hicke, Paul D. Brooks, Elise G. Pendall, Brent E. Ewers, Urszula Norton, David Gochis, Ethan D. Gutmann, Arjan J. H. Meddens

Year Published: 2012

Type: Document

Book or Chapter or Journal Article, Synthesis

## **Relationships between moisture, chemistry, and ignition of *Pinus contorta* needles during the early stages of mountain pine beetle attack**

[www.nrfirescience.org/resource/8317](http://www.nrfirescience.org/resource/8317)

Very little is known about how foliar moisture and chemistry change after a mountain pine beetle attack and even less is known about how these intrinsic foliar characteristics alter foliage ignitability. Here, we examine the fuel characteristics and ignition potential of *Pinus contorta* (lodgepole pine) foliage during the early...

Author(s): William Matt Jolly, Russell A. Parsons, Ann M. Hadlow, Greg M. Cohn, Sara S. McAllister, John B. Popp, Robert M. Hubbard, Jose F. Negron

Year Published: 2012

Type: Document

Book or Chapter or Journal Article

## **Do mountain pine beetle outbreaks change the probability of active crown fire in lodgepole pine forests? Comment 1 & 2, Reply 1**

[www.nrfirescience.org/resource/13342](http://www.nrfirescience.org/resource/13342)

Comment 1 - Simard et al. (2011) have produced a comprehensive data set and analysis concerning mountain pine beetle (MPB; *Dendroctonus ponderosae*)-caused mortality and associated crown fire feedbacks in lodgepole pine (*Pinus contorta*)-dominated forests. Misapplication of the NEXUS fire modeling system (Scott and...

Author(s): Christopher J. Moran, Mark A. Cochrane, William Matt Jolly, Russell A. Parsons, J. Morgan Varner, Bret W. Butler, Kevin C. Ryan, Corey L. Gucker, Martin Simard, William H. Romme, Monica G. Turner

Year Published: 2012

Type: Document

Book or Chapter or Journal Article

## **Interactions of whitepine blister rust and mountain pine beetle in whitebark pine ecosystems in the southern Greater Yellowstone Ecosystem**

[www.nrfirescience.org/resource/12915](http://www.nrfirescience.org/resource/12915)

Whitebark pine (*Pinus albicaulis*) is a fundamental component of alpine and subalpine habitats in the Greater Yellowstone Ecosystem. The magnitude of current white pine blister rust (WPBR) infection caused by the pathogen *Cronartium ribicola* and mountain pine beetle (MPB; *Dendroctonus ponderosae*) impacts, combined with the effect of...

Author(s): Nancy K. Bockino, Daniel B. Tinker

Year Published: 2012

Type: Document

Book or Chapter or Journal Article

### **Fire-injured ponderosa pine provide a pulsed resource for bark beetles**

[www.nrfirescience.org/resource/8353](http://www.nrfirescience.org/resource/8353)

Bark beetles can cause substantial mortality of trees that would otherwise survive fire injuries. Resin response of fire-injured northern Rocky Mountain ponderosa pine (*Pinus ponderosa* Douglas ex P. Lawson...

Author(s): Ryan S. Davis, Sharon M. Hood, Barbara J. Bentz

Year Published: 2012

Type: Document

Book or Chapter or Journal Article

### **A review of logistic regression models used to predict post-fire tree mortality of western North American conifers**

[www.nrfirescience.org/resource/8303](http://www.nrfirescience.org/resource/8303)

Logistic regression models used to predict tree mortality are critical to post-fire management, planning prescribed burns and understanding disturbance ecology. We review literature concerning post-fire mortality prediction using logistic regression models for coniferous tree species in the western USA. We include synthesis and...

Author(s): Travis J. Woolley, David C. Shaw, Lisa Ganio, Stephen A. Fitzgerald

Year Published: 2012

Type: Document

Book or Chapter or Journal Article, Synthesis

### **Effects of bark beetle-caused tree mortality on wildfire**

[www.nrfirescience.org/resource/13294](http://www.nrfirescience.org/resource/13294)

Millions of trees killed by bark beetles in western North America have raised concerns about subsequent wildfire, but studies have reported a range of conclusions, often seemingly contradictory, about effects on fuels and wildfire. In this study, we reviewed and synthesized the published literature on modifications to fuels and fire...

Author(s): Jeffrey A. Hicke, Morris C. Johnson, Jane L. Hayes, Haiganoush K. Preisler

Year Published: 2012

Type: Document

Book or Chapter or Journal Article, Synthesis

### **The future of high-elevation, five-needle white pines in western North America: Proceedings of the High Five Symposium. 28-30 June 2010; Missoula, MT**

[www.nrfirescience.org/resource/11894](http://www.nrfirescience.org/resource/11894)

High elevation five-needle pines are rapidly declining throughout North America. The six species, whitebark (*Pinus albicaulis* Engelm.), limber (*P. flexilis* James), southwestern white (*P. strobiformis* Engelm.), foxtail (*P. balfouriana* Grev....

Author(s): Robert E. Keane, Diana F. Tomback, Michael P. Murray, Cyndi M. Smith

Year Published: 2011

Type: Document

Conference Proceedings

### **Disturbance ecology of high-elevation five-needle pine ecosystems in western North America**

[www.nrfirescience.org/resource/11896](http://www.nrfirescience.org/resource/11896)

This paper synthesizes existing information about the disturbance ecology of high-elevation five-needle pine ecosystems, describing disturbance regimes, how they are changing or are expected to change, and the implications for ecosystem persistence. As it provides the context for ecosystem

conservation/restoration programs, we...

Author(s): Elizabeth M. Campbell, Robert E. Keane, Evan R. Larson, Michael P. Murray, Anna W. Schoettle, Carmen Wong

Year Published: 2011

Type: Document

Conference Proceedings, Synthesis

### **Modeling effects of climate change and fire management on western white pine (*Pinus monticola*) in the northern rocky mountains, USA**

[www.nrfirescience.org/resource/13512](http://www.nrfirescience.org/resource/13512)

Climate change is projected to profoundly influence vegetation patterns and community compositions, either directly through increased species mortality and shifts in species distributions or indirectly through disturbance dynamics such as increased wildfire activity and extent, shifting fire regimes, and pathogenesis. Mountainous...

Author(s): Rachel A. Loehman, Jason A. Clark, Robert E. Keane

Year Published: 2011

Type: Document

Book or Chapter or Journal Article

### **The magnificent high-elevation five-needle white pines: ecological roles and future outlook**

[www.nrfirescience.org/resource/11895](http://www.nrfirescience.org/resource/11895)

The High Five symposium is devoted to exchanging information about a small group of pines with little commercial value but great importance to the ecology of high-mountain ecosystems of the West. These High Five pines include the subalpine and treeline species-whitebark (*Pinus albicaulis*), Rocky Mountain bristlecone (*P. aristata*),...

Author(s): Diana F. Tomback, Peter Achuff, Anna W. Schoettle, John W. Schwandt, Ron J. Mastrogiuseppe

Year Published: 2011

Type: Document

Conference Proceedings, Synthesis

### **Forest responses to climate change in the northwestern United States: ecophysiological foundations for adaptive management**

[www.nrfirescience.org/resource/8297](http://www.nrfirescience.org/resource/8297)

Climate change resulting from increased concentrations of atmospheric carbon dioxide ([CO<sub>2</sub>]) is expected to result in warmer temperatures and changed precipitation regimes during this century. In the northwestern U.S., these changes will likely decrease snowpack, cause earlier snowmelt, increase summer evapotranspiration, and...

Author(s): Daniel J. Chmura, Paul D. Anderson, Glenn T. Howe, Constance A. Harrington, Jessica E. Halofsky, David L. Peterson, David C. Shaw, J. Brad St. Clair

Year Published: 2011

Type: Document

Book or Chapter or Journal Article

### **Do mountain pine beetle outbreaks change the probability of active crown fire in lodgepole pine forests?**

[www.nrfirescience.org/resource/13340](http://www.nrfirescience.org/resource/13340)

Disturbance interactions have received growing interest in ecological research in the last decade. Fire and bark beetle outbreaks have recently increased in severity and extent across western North America, raising concerns about their possible interactions. Although it is often presumed that bark beetle outbreaks increase...

Author(s): Martin Simard, William H. Romme, Jacob M. Griffin, Monica G. Turner  
Year Published: 2011  
Type: Document  
Book or Chapter or Journal Article

### **Silvicultural management of white pines in western North America**

[www.nrfirescience.org/resource/8235](http://www.nrfirescience.org/resource/8235)

Since the introduction prior to 1915 of white pine blister rust (*Cronartium ribicola*) into the forests of western North America, many populations of native white pine species have seriously declined. Because western white pine (*Pinus monticola*) and sugar pine (*P. lambertiana*) are highly valued timber species, their silviculture...

Author(s): Stefan Zeglen, John Pronos, H. Merler  
Year Published: 2010  
Type: Document  
Book or Chapter or Journal Article

### **Blister rust and western forest biodiversity: ecology, values and outlook for white pines**

[www.nrfirescience.org/resource/8234](http://www.nrfirescience.org/resource/8234)

Eight white pine species are widely distributed among the forests of western Canada and the United States. The different forest communities with these species contribute biodiversity to the western landscape. The trees themselves provide various ecosystem services, including wildlife habitat and watershed protection. White pine...

Author(s): Diana F. Tomback, Peter Achuff  
Year Published: 2010  
Type: Document  
Book or Chapter or Journal Article, Synthesis

### **Current health issues and management strategies for white pines in the western United States and Canada**

[www.nrfirescience.org/resource/8233](http://www.nrfirescience.org/resource/8233)

The introduced pathogen *Cronartium ribicola*, cause of white pine blister rust, has spread across much of western North America and established known infestations within all but one species of white pine endemic to western Canada and the United States. Blister rust damage to severely diseased trees reduces reproduction and survival....

Author(s): John W. Schwandt, I. Blakley Lockman, John T. Kliejunas, J. A. Muir  
Year Published: 2010  
Type: Document  
Book or Chapter or Journal Article, Synthesis

### **Management guide to ecosystem restoration treatments: whitebark pine forests of the Northern Rocky Mountains, U.S.A.**

[www.nrfirescience.org/resource/11143](http://www.nrfirescience.org/resource/11143)

Whitebark pine is declining across much of its range in North America because of the combined effects of mountain pine beetle epidemics, fire exclusion policies, and widespread exotic blister rust infections. This management guide summarizes the extensive data collected at whitebark pine treatment sites for three periods: (1) pre-...

Author(s): Robert E. Keane, Russell A. Parsons  
Year Published: 2010  
Type: Document  
Technical Report or White Paper

### **Review of literature on climate change and forest diseases of western North America**

[www.nrfirescience.org/resource/11232](http://www.nrfirescience.org/resource/11232)

A summary of the literature on relationships between climate and various types of tree diseases, and the potential effects of climate change on pathogens in western North American forests is provided. Climate change generally will lead to reductions in tree health and will improve conditions for some highly damaging pathogens....

Author(s): John T. Kliejunas, Brian W. Geils, Jessie M. Glaeser, Ellen M. Goheen, Paul E. Hennon, Mee-Sook Kim, Harry Kope, Jeffrey J. Stone, Rona Sturrock, Susan J. Frankel

Year Published: 2009

Type: Document

Synthesis, Technical Report or White Paper

### **Response of bark beetles and their natural enemies to fire and fire surrogate treatments in mixed-conifer forests in western Montana**

[www.nrfirescience.org/resource/13355](http://www.nrfirescience.org/resource/13355)

Four treatments (control, burn-only, thin-only, and thin-and-burn) were evaluated for their effects on bark beetle-caused mortality in both the short-term (one to four years) and the long-term (seven years) in mixed-conifer forests in western Montana, USA. In addition to assessing bark beetle responses to these treatments, we also...

Author(s): Diana L. Six, Kjerstin R. Skov

Year Published: 2009

Type: Document

Book or Chapter or Journal Article

### **Reciprocal interactions between bark beetles and wildfire in subalpine forests: landscape patterns and the risk of high-severity fire - Final Report to the Joint Fire Science Program**

[www.nrfirescience.org/resource/11136](http://www.nrfirescience.org/resource/11136)

The interactions of wildfire and bark beetle outbreaks and their reciprocal influences on fire behavior, bark beetle dynamics, and ecosystem structure are critical research issues in many coniferous forests of the Intermountain West. We combined field studies with new remote sensing methods to address three main questions regarding...

Author(s): Daniel B. Tinker

Year Published: 2009

Type: Document

Technical Report or White Paper

### **Cross-scale drivers of natural disturbances prone to anthropogenic amplification: the dynamics of bark beetle eruptions**

[www.nrfirescience.org/resource/16887](http://www.nrfirescience.org/resource/16887)

Biome-scale disturbances by eruptive herbivores provide valuable insights into species interactions, ecosystem function, and impacts of global change. We present a conceptual framework using one system as a model, emphasizing interactions across levels of biological hierarchy and spatiotemporal scales. Bark beetles are major natural...

Author(s): Kenneth F. Raffa, Brian H. Aukema, Barbara J. Bentz, Allan L. Carroll, Jeffrey A. Hicke, Monica G. Turner, William H. Romme

Year Published: 2008

Type: Document

Book or Chapter or Journal Article

### **Tough trees at timberline - whitebark pines in peril**

[www.nrfirescience.org/resource/8392](http://www.nrfirescience.org/resource/8392)

This article describes the whitebark pine tree and the tough environment it lives in, the hazards it faces, and how it fits the environment ecologically.

Author(s): Jane Kapler Smith

Year Published: 2007

Type: Document

Book or Chapter or Journal Article

### **The influence of white pine blister rust on seed dispersal in whitebark pine**

[www.nrfirescience.org/resource/8391](http://www.nrfirescience.org/resource/8391)

We tested the hypotheses that white pine blister rust (*Cronartium ribicola* J.C. Fisch.) damage in whitebark pine (*Pinus albicaulis* Engelm.) stands leads to reduced (1) seed cone density, (2) predispersal seed survival, and (3) likelihood of Clark's Nutcracker (*Nucifraga columbiana* (Wilson, 1811)) seed dispersal. We gathered data...

Author(s): Shawn T. McKinney, Diana F. Tomback

Year Published: 2007

Type: Document

Book or Chapter or Journal Article

### **Restoration classes based on blister rust infection and grizzly bear recovery zones - Map**

[www.nrfirescience.org/resource/11509](http://www.nrfirescience.org/resource/11509)

Mapped locations of restoration classes based on blister rust infection and grizzly bear recovery zones within the western United States.

Author(s): Fire Modeling Institute

Year Published: 2007

Type: Document

Research Brief or Fact Sheet

### **Ponderosa pine ecosystems**

[www.nrfirescience.org/resource/11142](http://www.nrfirescience.org/resource/11142)

Ponderosa pine is one of the most widely distributed tree species in western North America. It is highly-valued as a source of lumber, but also is key to the health and social value western forests, whether growing in pure stands or in mixture with other conifer and hardwood species. In recent years, management objectives for...

Author(s): Russell T. Graham, Theresa B. Jain

Year Published: 2006

Type: Document

Synthesis, Technical Report or White Paper

### **The influence of previous mountain pine beetle (*Dendroctonus ponderosae*) activity on the 1988 Yellowstone fires**

[www.nrfirescience.org/resource/13565](http://www.nrfirescience.org/resource/13565)

We examined the historical record of mountain pine beetle (*Dendroctonus ponderosae* Hopkins) activity within Yellowstone National Park, Wyoming, for the 25-years period leading up to the 1988 Yellowstone fires (1963-86) to determine how prior beetle activity and the resulting tree mortality affected the spatial pattern of the 1988...

Author(s): Heather J. Lynch, Roy A. Renkin, Robert Crabtree, Paul R. Moorcroft

Year Published: 2006

Type: Document

Book or Chapter or Journal Article

### **Interactions among fire, insects, and pathogens in coniferous forests of the interior western United States and Canada**

[www.nrfirescience.org/resource/8120](http://www.nrfirescience.org/resource/8120)

Natural and recurring disturbances caused by fire, native forest insects and pathogens have interacted for millennia to create and maintain forests dominated by seral or pioneering species of conifers in the interior regions of the western United States and Canada. Changes in fire suppression and other factors in the last century...

Author(s): Thomas J. Parker, Karen M. Clancy, Robert L. Mathiasen

Year Published: 2006

Type: Document

Book or Chapter or Journal Article, Synthesis

### **Distribution of bark beetle attacks after whitebark pine restoration treatments: a case study**

[www.nrfirescience.org/resource/8366](http://www.nrfirescience.org/resource/8366)

Whitebark pine (*Pinus albicaulis* Engelm.), an important component of high elevation ecosystems in the western United States and Canada, is declining due to fire exclusion, white pine blister rust (*Cronartium ribicola* J.C. Fisch.), and mountain pine beetle (*Dendroctonus ponderosae* Hopkins). This study was conducted to evaluate the...

Author(s): Kristen M. Waring, Diana L. Six

Year Published: 2005

Type: Document

Book or Chapter or Journal Article

### **Root diseases in coniferous forests of the Inland Northwest: potential implications of fuels treatments**

[www.nrfirescience.org/resource/11172](http://www.nrfirescience.org/resource/11172)

After nearly 100 years of fire exclusion, introduced pests, and selective harvesting, a change in forest composition has occurred in many Inland West forests of North America. This change in forest structure has frequently been accompanied by increases in root diseases and/or an unprecedented buildup of fuels. Consequently, many...

Author(s): Raini C. Rippey, Jane E. Stewart, Paul J. Zambino, Ned B. Klopfenstein, Joanne M. Tirocke, Mee-Sook Kim, Walter G. Thies

Year Published: 2005

Type: Document

Technical Report or White Paper

### **Forest entomology in Yellowstone National Park, 1923-1957: a time of discovery and learning to let live**

[www.nrfirescience.org/resource/13567](http://www.nrfirescience.org/resource/13567)

For several decades after the creation of Yellowstone National Park in 1872, protection of its biological and other resources was haphazard. For example, elk and bison were exploited to near extinction, prompting aggressive protection of them, which included extermination of the native gray wolf from the park. In those...

Author(s): Malcolm M. Furniss, Roy A. Renkin

Year Published: 2003

Type: Document

Book or Chapter or Journal Article

### **Using digital terrain modeling and satellite imagery to map interactions among fire and forest microbes**

[www.nrfirescience.org/resource/10989](http://www.nrfirescience.org/resource/10989)

Behavior and biology of many forest pests are tied to major forest disturbances and succession. Fire is the principal disturbance in the forests of the western United States. Fire regimes as well as distribution and behavior of forest pests and beneficial microbes are all strongly associated with plant communities. Thus, mapping of...

Author(s): GERAL I. McDONALD, JEFFREY S. EVANS, THOMAS M. RICE, EVA K. STRAND

Year Published: 2003

Type: Document

Conference Proceedings, Technical Report or White Paper

### **The role of wildland fire and subsequent insect attack on ponderosa pine mortality**

[www.nrfirescience.org/resource/10990](http://www.nrfirescience.org/resource/10990)

Survival of ponderosa pine following wildfire events depends on a number of factors, including the level of injury to the tree from the fire and the environmental conditions following the fire. The unprecedented fire year of 2000 provided an opportunity to quantify cumulative impacts of wildland fires and subsequent insect attack on...

Author(s): JOEL D. MCMILLIN, LINDA L. WADLEIGH, CAROLYN HULL SIEG, JOSE F. NEGRON, KEN E. GIBSON, KURT K. ALLEN, JOHN A. ANHOLD

Year Published: 2003

Type: Document

Conference Proceedings

### **Cascading effects of fire exclusion in Rocky Mountain ecosystems: a literature review**

[www.nrfirescience.org/resource/11187](http://www.nrfirescience.org/resource/11187)

The health of many Rocky Mountain ecosystems is in decline because of the policy of excluding fire in the management of these ecosystems. Fire exclusion has actually made it more difficult to fight fires, and this poses greater risks to the people who fight fires and for those who live in and around Rocky Mountain forests and...

Author(s): ROBERT E. KEANE, KEVIN C. RYAN, THOMAS T. VELEN, CRAIG D. ALLEN, JESSE A. LOGAN, BRAD C. HAWKES

Year Published: 2002

Type: Document

Synthesis, Technical Report or White Paper

### **Climate change and forest disturbances**

[www.nrfirescience.org/resource/13399](http://www.nrfirescience.org/resource/13399)

This article examines how eight disturbances influence forest structure, composition, and function, and how climate change may influence the severity, frequency, and magnitude of disturbances to forests. We focus on examples from the United States, although these influences occur worldwide. We also consider options for coping with...

Author(s): VIRGINIA H. DALE, LINDA A. JOYCE, RONALD P. NEILSON, STEVEN G. MCNULTY, MATTHEW P. AYRES, MICHAEL D. FLANNIGAN, PAUL J. HANSON, LLOYD C. IRLAND, ARIEL L. LUGO, CHRIS J. PETERSON, DANIEL SIMBERLOFF, FREDERICK J. SWANSON, BRIAN J. STOCKS, B. MIKE WOTTON

Year Published: 2001

Type: Document

Book or Chapter or Journal Article

### **Can the fire-dependent whitebark pine be saved?**

[www.nrfirescience.org/resource/7927](http://www.nrfirescience.org/resource/7927)

In recent decades, whitebark pine has been declining due to epidemics and fire exclusion (Keane and Arno 1993; Kendall and Arno 1990). In the northern Rocky Mountains, a project is underway to explore

the feasibility of using fire and silviculture to restore the tree's high-elevation habitat.

Author(s): Robert E. Keane

Year Published: 2001

Type: Document

Book or Chapter or Journal Article, Synthesis

### **Strategies for managing whitebark pine in the presence of white pine blister rust**

[www.nrfirescience.org/resource/7902](http://www.nrfirescience.org/resource/7902)

Description not entered

Author(s): Raymond J. Hoff, Dennis E. Ferguson, GERAL I. McDONALD, Robert E. Keane

Year Published: 2001

Type: Document

Book or Chapter or Journal Article, Synthesis

### **Fire, competition, and forest pests: landscape treatment to sustain ecosystem function**

[www.nrfirescience.org/resource/10988](http://www.nrfirescience.org/resource/10988)

Fire, competition for light and water, and native forest pests have interacted for millennia in western forests to produce a countryside dominated by seral species of conifers. These conifer-dominated ecosystems exist in six kinds of biotic communities. We divided one of these communities, the Rocky Mountain Montane Conifer Forest,...

Author(s): GERAL I. McDONALD, Alan E. Harvey, Jonalea R. Tonn

Year Published: 2000

Type: Document

Conference Proceedings

### **White pine in the American West: a vanishing species - can we save it?**

[www.nrfirescience.org/resource/13112](http://www.nrfirescience.org/resource/13112)

Forest scientists ask that everyone, from the home gardener to the forest manager, help revive western white pine by planting it everywhere, even in nonforest environments such as our neighborhood streets, parks, and backyards. White pine, long ago considered the "King Pine," once dominated the moist inland forests of the Northwest...

Author(s): Leon F. Neuenschwander, James W. Byler, Alan E. Harvey, GERAL I. McDONALD, Denise S. Ortiz, Harold L. Osborne, Gerry C. Snyder, Arthur Zack

Year Published: 1999

Type: Document

Technical Report or White Paper

### **Prefire heterogeneity, fire severity, and early postfire plant reestablishment in subalpine forests of Yellowstone National Park, Wyoming**

[www.nrfirescience.org/resource/8212](http://www.nrfirescience.org/resource/8212)

The 1988 fires in Yellowstone National Park provided an opportunity to study effects of a large infrequent disturbance on a natural community. This study addressed two questions: (1) How does prefire heterogeneity of the landscape affect postfire patterns of fire severity? and (2) How do postfire patterns of burn severity influence...

Author(s): Monica G. Turner, William H. Romme, Robert H. Gardner

Year Published: 1999

Type: Document

Book or Chapter or Journal Article

### **Fire and insects in northern and boreal forest ecosystems of North America**

[www.nrfirescience.org/resource/7945](http://www.nrfirescience.org/resource/7945)

Fire and insects are natural disturbance agents in many forest ecosystems, often interacting to affect succession, nutrient cycling, and forest species composition. We review literature pertaining to effects of fire-insect interactions on ecological succession, use of prescribed fire for insect pest control, and effects of fire on...

Author(s): Deborah G. McCullough, Richard A. Werner, David Neumann

Year Published: 1998

Type: Document

Book or Chapter or Journal Article, Synthesis

### **Stand hazard rating for central Idaho forests**

[www.nrfirescience.org/resource/11254](http://www.nrfirescience.org/resource/11254)

Growing concern over sustainability of central Idaho forests has created a need to assess the health of forest stands on a relative basis. A stand hazard rating was developed as a composite of 11 individual ratings to compare the health hazards of different stands. The composite rating includes Douglas-fir beetle, mountain pine...

Author(s): Robert W. Steele, Ralph E. Williams, Julie C. Weatherby, Elizabeth D. Reinhardt, James T. Hoffman, R. W. Thier

Year Published: 1996

Type: Document

Technical Report or White Paper

### **Restoring historic landscape patterns through management: restoring fire mosaics on the landscape**

[www.nrfirescience.org/resource/11250](http://www.nrfirescience.org/resource/11250)

Seral, fire dependent lodgepole pine (*Pinus contorta* Dougl.) communities are an important component of upper elevation forests throughout the Northern Rockies, where they cover 4 million acres, or about 17 percent of the land base. On the Bitterroot National Forest, lodgepole pine occurs mostly between 5,500 and 7,500 feet.

Author(s): Catherine A. Stewart

Year Published: 1996

Type: Document

Technical Report or White Paper

### **Rapid decline of whitebark pine in western Montana: evidence from 20-year re-measurements**

[www.nrfirescience.org/resource/12916](http://www.nrfirescience.org/resource/12916)

Whitebark pine (*Pinus albicaulis*), an important producer of food for wildlife, is decreasing in abundance in western Montana due to attacks by the white pine blister rust fungus (*Cronartium ribicola*), epidemics of mountain pine beetle (*Dendroctonus ponderosae*) and successional replacement mainly by subalpine fir (*Abies lasiocarpa*)....

Author(s): Robert E. Keane, Stephen F. Arno

Year Published: 1993

Type: Document

Book or Chapter or Journal Article

### **Forest fire frequency and western spruce budworm outbreaks in western Montana**

[www.nrfirescience.org/resource/7908](http://www.nrfirescience.org/resource/7908)

Duration and intensity of western spruce budworm (*Christoneura occidentalis* Freeman) outbreaks have increased with the decrease in forest fire frequency in Montana since 1910. Frequency of budworm outbreaks, however, was not affected. Feeding activity and fire occurrence were measured in 20 mixed Douglas-fir (*Pseudotsuga menziesii*)...

Author(s): Leslie Anderson, Clinton E. Carlson, Ronald H. Wakimoto  
Year Published: 1987  
Type: Document  
Book or Chapter or Journal Article

**Fire frequency reduced two orders of magnitude in the Bitterroot Canyons, Montana**

[www.nrfirescience.org/resource/8231](http://www.nrfirescience.org/resource/8231)

The fire cycle in low-elevation mesic coniferous forests of the Bitterroot Canyons, Montana, has changed from about 60 years before European settlement to about 7500 years between 1910 and 1980. The decreased fire frequency may be responsible for increased severity of western spruce bud worm outbreaks (*Choristoneuraoccidentalis*...

Author(s): Bruce McCune  
Year Published: 1983  
Type: Document  
Book or Chapter or Journal Article

**A review of some interactions between harvesting, residue management, fire, and forest insects and diseases**

[www.nrfirescience.org/resource/13140](http://www.nrfirescience.org/resource/13140)

Many species of insects and diseases create residues that predispose forests to fire. Conversely, natural factors such as fire, wind-throw, and other agents create forest residues that predispose forests to diseases and insects, including bark and cambium beetles, wood borers, and others. Man-made residues also predispose forests to...

Author(s): David G. Fellin  
Year Published: 1979  
Type: Document  
Technical Report or White Paper

**Wildland fires and dwarf mistletoes: a literature review of ecology and prescribed burning**

[www.nrfirescience.org/resource/12412](http://www.nrfirescience.org/resource/12412)

Wildfires play a multiple role in the distribution of dwarf mistletoes - they may either inhibit or encourage these parasites depending primarily on the size and intensity of the burn. Many reports suggest that fire exclusion policies of the past half century have resulted in increased dwarf mistletoe levels as, well as increased...

Author(s): Martin E. Alexander, Frank G. Hawksworth  
Year Published: 1975  
Type: Document  
Synthesis, Technical Report or White Paper