Biotic and anthropogenic forces rival climatic/abiotic factors in determining global plant population growth and fitness

www.nrfirescience.org/resource/20734

Multiple, simultaneous environmental changes, in climatic/abiotic factors, interacting species, and direct human influences, are impacting natural populations and thus biodiversity, ecosystem services, and evolutionary trajectories. Determining whether the magnitudes of the population impacts of abiotic, biotic, and anthropogenic...

Author(s): William F. Morris, Johan Ehrlén, Johan P. Dahlgren, Alexander K. Loomis, Allison M. Louthan
Year Published: 2020
Type: Document
Book or Chapter or Journal Article

Global fire season severity analysis and forecasting

www.nrfirescience.org/resource/20694

Fire activity has a huge impact on human lives. Different models have been proposed to predict fire activity, which can be classified into global and regional ones. Global fire models focus on longer timescale simulations and can be very complex. Regional fire models concentrate on seasonal forecasting but usually require inputs...

Author(s): Leonardo N. Ferreira, Didier A. Vega-Oliveros, Liang Zhao, Manoel F. Cardoso, Elbert E.N. Macau
Year Published: 2020
Type: Document
Book or Chapter or Journal Article

Changing wildfire, changing forests: the effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA

www.nrfirescience.org/resource/20655

Background: Wildfires in the Pacific Northwest (Washington, Oregon, Idaho, and western Montana, USA) have been immense in recent years, capturing the attention of resource managers, fire scientists, and the general public. This paper synthesizes understanding of the potential effects of changing climate and fire regimes on Pacific...

Author(s): Jessica E. Halofsky, David L. Peterson, Brian J. Harvey
Year Published: 2020
Type: Document
Book or Chapter or Journal Article

Asking "What-if" Questions: New ST-Sim Tool Helps Managers Forecast Future Rangeland Conditions

www.nrfirescience.org/resource/20765

Unforeseen Events and Climate Variability: How do land management decisions shape landscapes decades into the future? With the influence of climate change and its associated stressors, it's an increasingly thorny question. According to Paulette Ford, a research ecologist with the Rocky Mountain Research Station in Albuquerque, New...

Author(s): Jessica M. Brewen
Year Published: 2020
Type: Document
Research Brief or Fact Sheet

Earlier fall precipitation and low severity fire impacts on cheatgrass and sagebrush establishment
In arid and semiarid ecosystems, invasion by exotic grasses may be driving state changes in vegetation defined by losses of native shrub communities. Changes in wildfire regimes and fall precipitation timing related to climate change may promote fluctuations in resource availability that reinforces invasion and state changes in...

Author(s): Tara B. B. Bishop, Baylie C. Nusink, Rebecca Lee Molinari, Justin B. Taylor, Samuel B. St. Clair

Year Published: 2020

Type: Document

Book or Chapter or Journal Article

Origins of abrupt change? Postfire subalpine conifer regeneration declines nonlinearly with warming and drying

Robust tree regeneration following high-severity wildfire is key to the resilience of subalpine and boreal forests, and 21st century climate could initiate abrupt change in forests if postfire temperature and soil moisture become less suitable for tree seedling establishment. Using two widespread conifer species, lodgepole pine (...

Author(s): Winslow D. Hansen, Monica G. Turner

Year Published: 2019

Type: Document

Book or Chapter or Journal Article

Wildfire and topography impacts on snow accumulation and retention in montane forests

Wildfires are increasing in frequency, severity, and size in many parts of the world. Forest fires can fundamentally affect snowpack and watershed hydrology by restructuring forest composition and structure. Topography is an important factor in snowpack accumulation and ablation as it influences exposure to solar radiation and...

Author(s): Jordan D. Maxwell, Anson Call, Samuel B. St. Clair

Year Published: 2019

Type: Document

Book or Chapter or Journal Article

Climate will increasingly determine post-fire tree regeneration success in low-elevation forests, Northern Rockies, USA.

Climate change is expected to cause widespread shifts in the distribution and abundance of plant species through direct impacts on mortality, regeneration, and survival. At landscape scales, climate impacts will be strongly mediated by disturbances, such as wildfire, which catalyze shifts in species distributions through widespread...

Author(s): Kerry Kemp, Philip E. Higuera, Penelope Morgan, John T. Abatzoglou

Year Published: 2019

Type: Document

Book or Chapter or Journal Article

Living on the edge: trailing edge forests at risk of fire?facilitated conversion to non?forest

Forests are an incredibly important resource across the globe, yet they are threatened by climate change through stressors such as drought, insect outbreaks, and wildfire. Trailing edge forests—those areas expected to experience range contractions under a changing climate—are of particular concern
because of the potential for...

Author(s): Sean A. Parks, Solomon Z. Dobrowski, John D. Shaw, Carol Miller
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Can wildland fire management alter 21st-century subalpine fire and forests in Grand Teton National Park, Wyoming, USA?
www.nrfirescience.org/resource/20515
In subalpine forests of the western United States that historically experienced infrequent, high-severity fire, whether fire management can shape 21st-century fire regimes and forest dynamics to meet natural resource objectives is not known. Managed wildfire use (i.e., allowing lightning-ignited fires to burn when risk is low...

Author(s): Winslow D. Hansen, Diane Abendroth, Werner Rammer, Rupert Seidl, Monica G. Turner
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Microclimatic buffering in forests of the future: the role of local water balance
www.nrfirescience.org/resource/19440
Forest canopies buffer climate extremes and promote microclimates that may function as refugia for understory species under changing climate. However, the biophysical conditions that promote and maintain microclimatic buffering and its stability through time are largely unresolved. We posited that forest microclimatic buffering is...

Author(s): Kimberley T. Davis, Solomon Z. Dobrowski, Zachary A. Holden, Philip E. Higuera, John T. Abatzoglou
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Spatiotemporal variability of human-fire interactions on the Navajo Nation
www.nrfirescience.org/resource/20437
Unraveling the effects of climate and land use on historical fire regimes provides important insights into broader human–fire–climate dynamics, which are necessary for ecologically based forest management. We developed a spatial human land-use model for Navajo Nation forests across which we sampled a network of tree-ring...

Author(s): Christopher H. Guiterman, Ellis Q. Margolis, Christopher H. Baisan, Donald A. Falk, Craig D. Allen, Thomas W. Swetnam
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Examining post-fire vegetation recovery with Landsat time series analysis in three western North American forest types
www.nrfirescience.org/resource/19436
Background: Few studies have examined post-fire vegetation recovery in temperate forest ecosystems with Landsat time series analysis. We analyzed time series of Normalized Burn Ratio (NBR) derived from LandTrendr spectral-temporal segmentation fitting to examine post-fire NBR recovery for several wildfires that occurred in three...

Author(s): Benjamin C. Bright, Andrew T. Hudak, Robert E. Kennedy, Justin D. Braaten, Azad Henareh Khalyani
Land-cover dependent relationships between fire and soil moisture
www.nrfirescience.org/resource/20414
For this study, we characterized the dependence of fire counts (FCs) on soil moisture (SM) at global and sub-global scales using 15 years of remote sensing data. We argue that this mathematical relationship serves as an effective way to predict fire because it is a proxy for the semi-quantitative fire-productivity relationship that...
Author(s): Alexander J. Schaefer, Brian I. Magi
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Climate will increasingly determine post-fire tree regeneration success in low-elevation forests, Northern Rockies, USA
www.nrfirescience.org/resource/18803
Climate change is expected to cause widespread shifts in the distribution and abundance of plant species through direct impacts on mortality, regeneration, and survival. At landscape scales, climate impacts will be strongly mediated by disturbances, such as wildfire, which catalyze shifts in species distributions through widespread...
Author(s): Kerry Kemp, Philip E. Higuera, Penelope Morgan, John T. Abatzoglou
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Climate seasonality as an essential predictor of global fire activity
www.nrfirescience.org/resource/19166
Aim: Fire is a globally important disturbance that affects nearly all vegetated biomes. Previous regional studies have suggested that the predictable seasonal pattern of a climatic time series, or seasonality, might aid in the prediction of average fire activity, but it is not known whether these findings are applicable globally....
Author(s): Michael V. Saha, Todd M. Scanlon, Paolo D'Odorico
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Modeling long-term effects of fuel treatments on fuel loads and fire regimes in the Great Basin - Final Report to the Joint Fire Science Program
www.nrfirescience.org/resource/20381
The principal motivation for this study is that sagebrush-steppe ecosystems are undergoing significant state changes, and land managers are challenged with optimizing their resources for both short- and long-term use. Yet, limited knowledge is available regarding how the sagebrush-steppe will respond to environmental changes related...
Author(s): Nancy F. Glenn, Alejandro N. Flores, Douglas J. Shinneman, David S. Pilliod
Year Published: 2019
Type: Document
Technical Report or White Paper
Predicting increasing high severity area burned for three forested regions in the western United States using extreme value theory

www.nrfirescience.org/resource/18791

More than 70 years of fire suppression by federal land management agencies has interrupted fire regimes in much of the western United States. The result of missed fire cycles is a buildup of both surface and canopy fuels in many forest ecosystems, increasing the risk of severe fire. The frequency and size of fires has increased in...

Author(s): Alisa Keyser, Anthony L. Westerling
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Use of landscape simulation modeling to quantify resilience for ecological applications

www.nrfirescience.org/resource/20184

Goals of fostering ecological resilience are increasingly used to guide U.S. public land management in the context of anthropogenic climate change and increasing landscape disturbances. There are, however, few operational means of assessing the resilience of a landscape or ecosystem. We present a method to evaluate resilience using...

Author(s): Robert E. Keane, Rachel A. Loehman, Lisa M. Holsinger, Donald A. Falk, Philip E. Higuera, Sharon M. Hood, Paul F. Hessburg
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Will landscape fire increase in the future? A systems approach to climate, fire, fuel, and human drivers

www.nrfirescience.org/resource/19068

The extent of the Earth’s surface burned annually by fires is affected by a number of drivers, including but not limited to climate. Other important drivers include the amount and type of vegetation (fuel) available and human impacts, including fire suppression, ignition, and conversion of burnable land to crops. Prior to the...

Author(s): Karen L. Riley, A. Park Williams, Shawn P. Urbanski, David E. Calkin, Karen C. Short, Christopher D. O’Connor
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Topography and post-fire climatic conditions shape spatio-temporal patterns of conifer establishment and growth

www.nrfirescience.org/resource/20108

Background: Concern is mounting that larger, stand-replacing forest fires may accelerate compositional shifts or conversions to non-forested states under a warming climate. Post-fire climatic conditions influence system trajectories by facilitating or hindering juvenile recruitment. But without an accurate, long-term understanding...

Author(s): Caitlin E. Littlefield
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Turning down the heat: vegetation feedbacks limit fire regime responses to global warming

www.nrfirescience.org/resource/20712
Climate change is projected to dramatically increase boreal wildfire activity, with broad ecological and socioeconomic consequences. As global temperatures rise, periods with elevated fire weather are expected to increase in frequency and duration, which would be expected to increase the number and size of fires. Statistical...

Author(s): Jean Marchal, Steve G. Cumming, Eliot J. B. McIntire
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Post-fire forest regeneration shows limited climate tracking and potential for drought-induced type conversion
www.nrfirescience.org/resource/19037
Disturbance such as wildfire may create opportunities for plant communities to reorganize in response to climate change. The interaction between climate change and disturbance may be particularly important in forests, where many of the foundational plant species (trees) are long-lived and where poor initial tree establishment can...

Author(s): Derek J. N. Young, Chhaya M. Werner, Kevin R. Welch, Truman P. Young, Hugh Safford, Andrew Latimer
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Tamm Review: Reforestation for resilience in dry western US forests
www.nrfirescience.org/resource/19956
The increasing frequency and severity of fire and drought events have negatively impacted the capacity and success of reforestation efforts in many dry, western U.S. forests. Challenges to reforestation include the cost and safety concerns of replanting large areas of standing dead trees, and high seedling and sapling mortality...

Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Wildfires and climate change push low-elevation forests across a critical climate threshold for tree regeneration
www.nrfirescience.org/resource/18982
Climate change is increasing fire activity in the western United States, which has the potential to accelerate climate-induced shifts in vegetation communities. Wildfire can catalyze vegetation change by killing adult trees that could otherwise persist in climate conditions no longer suitable for seedling establishment and survival...

Author(s): Kimberley T. Davis, Solomon Z. Dobrowski, Philip E. Higuera, Zachary A. Holden, Thomas T. Veblen, Monica T. Rother, Sean A. Parks, Anna Sala, Marco Maneta
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Impacts of growing-season climate on tree growth and post-fire regeneration in ponderosa pine
and Douglas-fir forests

We studied the impacts of climate variability on low-elevation forests in the U.S. northern Rocky Mountains by quantifying how post-fire tree regeneration and radial growth varied with growing-season climate. We reconstructed post-fire regeneration and radial growth rates of Pinus ponderosa and Pseudotsuga menziesii at 33...

Author(s): Lacey Hankin, Philip E. Higuera, Kimberley T. Davis, Solomon Z. Dobrowski
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Climate, environment, and disturbance history govern resilience of western North American forests

Before the advent of intensive forest management and fire suppression, western North American forests exhibited a naturally occurring resistance and resilience to wildfires and other disturbances. Resilience, which encompasses resistance, reflects the amount of disruption an ecosystem can withstand before its structure or...

Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Climate change likely to reshape vegetation in North America's largest protected areas

Climate change poses a serious threat to biodiversity and unprecedented challenges to the preservation and protection of natural landscapes. We evaluated how climate change might affect vegetation in 22 of the largest and most iconic protected area (PA) complexes across North America. We use a climate analog model to estimate how...

Author(s): Lisa M. Holsinger, Sean A. Parks, Marc-Andre Parisien, Carol Miller, Enric Batllori, Max A. Moritz
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

A Double Whammy: Climate Change and Stand-Replacing Wildfires

In the Intermountain region of the Western United States, most forested landscapes are fire prone and adapted to a semiarid climate. With the severity of wildfires increasing as a result of excessive fuels, land managers are concerned about forest converting to non-forest types such as shrubland or grassland. “And then when you...”

Author(s): Rocky Mountain Research Station
Year Published: 2019
Type: Document
Research Brief or Fact Sheet
Wildfire refugia in forests: severe fire weather and drought mute the influence of topography and fuel age
www.nrfirescience.org/resource/20433
Wildfire refugia (unburnt patches within large wildfires) are important for the persistence of fire-sensitive species across forested landscapes globally. A key challenge is to identify the factors that determine the distribution of fire refugia across space and time. In particular, determining the relative influence of climatic...
Author(s): Luke Collins, Andrew F. Bennett, Steven W.J. Leonard, Trent D. Penman
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Wildfire detection and communication-aerospace applications-trade study
www.nrfirescience.org/resource/19177
Wildfires have increased in frequency, duration, and intensity worldwide. Climate change, drought, and other factors have not only increased susceptibility to wildfires, but have also increased the duration of the season. There are a number of factors affecting wildfires: detection, speed of communication/response time, resources/...
Author(s): Setrige W. Crawford, Kamran Eftekhari Shahroudi
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Widespread severe wildfires under climate change lead to increased forest homogeneity in dry mixed?conifer forests
www.nrfirescience.org/resource/20407
Climate warming in the western United States is causing changes to the wildfire regime in mixed?conifer forests. Rising temperatures, longer fire seasons, increased drought, as well as fire suppression and changes in land use, have led to greater and more severe wildfire activity, all contributing to altered forest composition...
Author(s): Brooke A. Cassell, Robert M. Scheller, Melissa S. Lucash, Matthew D. Hurteau, E. Louise Loudermilk
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Aboveground forest carbon shows different responses to fire frequency in harvested and unharvested forests
www.nrfirescience.org/resource/18801
Sequestration of carbon in forest ecosystems has been identified as an effective strategy to help mitigate the effects of global climate change. Prescribed burning and timber harvesting are two common, co?occurring, forest management practices that may alter forest carbon pools. Prescribed burning for forest management, such as...
Author(s): Luke Collins, Ross A. Bradstock, Fabiano de Aquino Ximenes, Bronwyn Horsey, Robert Sawyer, Trent D. Penman
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Living on the edge: trailing edge forests at risk of fire-facilitated conversion to non-forest
www.nrfirescience.org/resource/19138
Forests are an incredibly important resource across the globe, yet they are threatened by climate change through stressors such as drought, insect outbreaks, and wildfire. Trailing edge forests—those areas expected to experience range contractions under a changing climate—are of particular concern because of the potential for abrupt...

Author(s): Sean A. Parks, Solomon Z. Dobrowski, John D. Shaw, Carol Miller
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Wildfires misunderstood
www.nrfirescience.org/resource/20250
Rain is a natural process that provides a range of services to humans but certainly not all rainfall events (eg those generating floods) are beneficial to human societies. Biodiversity can also deliver a variety of services, even though there are species capable of harming humans. Likewise, the vast majority of life depends (...)

Author(s): Juli G. Pausas, Jon E. Keeley
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Biophysical feedback of global forest fires on surface temperature
www.nrfirescience.org/resource/19109

Author(s): Zhihua Liu, Ashley Ballantyne, L. Annie Cooper
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

From Farms to Forests: Landscape Carbon Balance after 50 Years of Afforestation, Harvesting, and Prescribed Fire
www.nrfirescience.org/resource/20152
Establishing reliable carbon baselines for landowners desiring to sustain carbon sequestration and identify opportunities to mitigate land management impacts on carbon balance is important; however, national and regional assessments are not designed to support individual landowners. Such baselines become increasingly valuable when...

Author(s): Doug P. Aubrey, John I. Blake, Stanley J. Zarnoch
Year Published: 2019
Type: Document
Book or Chapter or Journal Article

Biological and geophysical feedbacks with fire in the Earth system
www.nrfirescience.org/resource/17407
Roughly 3% of the Earth's land surface burns annually, representing a critical exchange of energy and matter between the land and atmosphere via combustion. Fires range from slow smouldering peat fires, to low-intensity surface fires, to intense crown fires, depending on vegetation structure, fuel moisture, prevailing climate, and...

Large-scale restoration increases carbon stability under projected climate and wildfire regimes
www.nrfirescience.org/resource/17573
Changing climate and increasing area burned pose a challenge to forest carbon (C) storage, which is compounded by an elevated risk of high-severity wildfire due to long-term fire suppression in the western US. Restoration treatments that reduce tree density and reintroduce surface fire are effective at moderating fire effects...
Author(s): Shuang Liang, Matthew D. Hurteau, Anthony L. Westerling
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Evidence for declining forest resilience to wildfires under climate change
www.nrfirescience.org/resource/16189
Forest resilience to climate change is a global concern given the potential effects of increased disturbance activity, warming temperatures and increased moisture stress on plants. We used a multi-regional dataset of 1485 sites across 52 wildfires from the US Rocky Mountains to ask if and how changing climate over the last several...
Author(s): Camille Stevens-Rumann, Kerry Kemp, Philip E. Higuera, Brian J. Harvey, Monica T. Rother, Daniel C. Donato, Penelope Morgan, Thomas T. Veblen
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Wildfire-vegetation dynamics affect predictions of climate change impact on bird communities
www.nrfirescience.org/resource/17360
Community-level climate change indicators have been proposed to appraise the impact of global warming on community composition. However, non-climate factors may also critically influence species distribution and biological community assembly. The aim of this paper was to study how fire-vegetation dynamics can modify our ability to...
Author(s): Adrián Regos, Miguel Clavero, Manuela D'Amen, Antoine Guisan, Lluís Brotons
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Climate change vulnerability and adaptation in the Northern Rocky Mountains - Part 2
www.nrfirescience.org/resource/17540
The Northern Rockies Adaptation Partnership (NRAP) identified climate change issues relevant to resource management in the Northern Rockies (USA) region, and developed solutions intended to minimize negative effects of climate change and facilitate transition of diverse ecosystems to a warmer climate. The NRAP region covers 183...
Author(s): Jessica E. Halofsky, David L. Peterson, S. Karen Dante-Wood, Linh Hoang, Joanne J. Ho, Linda A. Joyce
Year Published: 2018
Type: Document
Technical Report or White Paper
Effects of climate change on ecological disturbance in the Northern Rockies (Chapter 7)
www.nrfirescience.org/resource/17279
Disturbances alter ecosystem, community, or population structures and change elements of the biological and/or physical environment. Climate changes can alter the timing, magnitude, frequency, and duration of disturbance events, as well as the interactions of disturbances on a landscape, and climate change may already be affecting...
Author(s): Rachel A. Loehman, Barbara J. Bentz, Gregg DeNitto, Robert E. Keane, Mary Manning, Jacob P. Duncan, Joel M. Egan, Marcus B. Jackson, Sandra Kegley, I. Blakley Lockman, Dean E. Pearson, James A. Powell, Steve Shelly, Brytten E. Steed, Paul J. Zambino
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Effects of climate change on ecosystem services in the Northern Rockies Region [Chapter 11]
www.nrfirescience.org/resource/17534
In this chapter, we focus on the ecosystem services provided to people who visit, live adjacent to, or otherwise benefit from natural resources on public lands. Communities in the Forest Service, U.S. Department of Agriculture (USFS) Northern Region and the Greater Yellowstone Area (GYA), hereafter called the Northern Rockies region...
Author(s): Travis Warziniack, Megan Lawson, S. Karen Dante-Wood
Year Published: 2018
Type: Document
Technical Report or White Paper

It takes a few to tango: changing climate and fire regimes can cause regeneration failure of two subalpine conifers
www.nrfirescience.org/resource/18334
Environmental change is accelerating in the 21st century, but how multiple drivers may interact to alter forest resilience remains uncertain. In forests affected by large high-severity disturbances, tree regeneration is a resilience linchpin that shapes successional trajectories for decades. We modeled stands of two widespread...
Author(s): Winslow D. Hansen, Kristin H. Braziunas, Werner Rammer, Rupert Seidl, Monica G. Turner
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Thinning combined with biomass energy production impacts fire-adapted forests in western United States and may increase greenhouse gas emissions
www.nrfirescience.org/resource/17270
Biomass energy produced as a byproduct of forest clearing is increasingly being advocated in the western United States as a “win-win” for reducing fire risks and replacing fossil fuels. Many assumptions that justify thinning and biomass approaches, however, need to be substantiated to determine whether they are in fact...
Author(s): Dominick A. DellaSala, M. Koopman
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Climate Change and Wildlife in the Northern Rockies Region [Chapter 9]
www.nrfirescience.org/resource/17532
Temperature and moisture affect organisms through their operational environment and the thin
boundary layer immediately above their tissues, and these effects are measured at short time scales. When a human (a mammal) wearing a dark insulative layer walks outdoors on a cold but sunny day, he or she feels warm because energy from the... 

**Tree water balance drives temperate forest responses to drought**

Intensifying drought is increasingly linked to global forest diebacks. Improved understanding of drought impacts on individual trees has provided limited insight into drought vulnerability in part because tree moisture access and depletion is difficult to quantify. In forests, moisture reservoir depletion occurs through water use by...

**Effects of climate change on wildlife in the Northern Rockies [Chapter 8]**

Few data exist on the direct effects of climatic variability and change on animal species. Therefore, projected climate change effects must be inferred from what is known about habitat characteristics and the autecology of each species. Habitat for mammals, including predators (Canada lynx, fisher, wolverine) and prey (snowshoe hare)... 

**Assessing the effects of fire disturbance and timber management on carbon storage in the Greater Yellowstone Ecosystem**

Accurate characterization of Carbon (C) consequences of forest disturbances and management is critical for informed climate mitigation and adaptation strategies. While research into generalized properties of the forest C cycle informs policy and provides abstract guidance to managers, most management occurs at local scales and...

**Effects of climate change on forest vegetation in the Northern Rockies Region [Chapter 6]**

The projected rapid changes in climate will affect the unique vegetation assemblages of the Northern Rockies region in myriad ways, both directly through shifts in vegetation growth, mortality, and regeneration, and indirectly through changes in disturbance regimes and interactions with changes in other ecosystem processes, such as...
The nature of the beast: examining climate adaptation options in forests with stand-replacing fire regimes

www.nrfirescience.org/resource/17869

Building resilience to natural disturbances is a key to managing forests for adaptation to climate change. To date, most climate adaptation guidance has focused on recommendations for frequent-fire forests, leaving few published guidelines for forests that naturally experience infrequent, stand-replacing wildfires. Because most...

Author(s): Joshua S. Halofsky, Daniel C. Donato, Jerry F. Franklin, Jessica E. Halofsky, David L. Peterson, Brian J. Harvey

Year Published: 2018
Type: Document

Effects of climate change on snowpack, glaciers, and water resources in the Northern Rockies Region [Chapter 4]

www.nrfirescience.org/resource/17521

Water is critical to life, and the effects of climate change on ecosystems are mediated through changes in hydrology. Changes in how snow accumulates and melts are one of the more consistently noted climate-induced changes to water in the western United States (Barnett et al. 2005; Service 2004), and these changes affect when water...

Author(s): Charles H. Luce

Year Published: 2018
Type: Document

Climate change vulnerability and adaptation in the Northern Rocky Mountains - Part 1

www.nrfirescience.org/resource/17514

The Northern Rockies Adaptation Partnership (NRAP) identified climate change issues relevant to resource management in the Northern Rockies (USA) region, and developed solutions intended to minimize negative effects of climate change and facilitate transition of diverse ecosystems to a warmer climate. The NRAP region covers 183...

Year Published: 2018
Type: Document

Piecing together the fragments: elucidating edge effects on forest carbon dynamics

www.nrfirescience.org/resource/17579

Forest fragmentation is pervasive throughout the world's forests, impacting growing conditions and carbon (C) dynamics through edge effects that produce gradients in microclimate, biogeochemistry, and stand structure. Despite the majority of global forests being <1 km from an edge, our understanding of forest C dynamics is...

Author(s): Ian A. Smith, Lucy R. Hutyra, Andrew B. Reinmann, Julia K. Marrs, Jonathan Thompson

Year Published: 2018
Type: Document

Book or Chapter or Journal Article
Fire intensity impacts on post-fire temperate coniferous forest net primary productivity
www.nrfirescience.org/resource/17364
Fire is a dynamic ecological process in forests and impacts the carbon (C) cycle through direct combustion emissions, tree mortality, and by impairing the ability of surviving trees to sequester carbon. While studies on young trees have demonstrated that fire intensity is a determinant of post-fire net primary productivity, wildland...
Author(s): Aaron M. Sparks, Crystal A. Kolden, Alistair M. S. Smith, Luigi Boschetti, Daniel M. Johnson, Mark A. Cochrane
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Effects of climate change and climate-altered fire regimes on whitebark pine populations - Final Report to the Joint Fire Science Program
www.nrfirescience.org/resource/17562
As climate change alters global fire regimes, fire and forest managers must prioritize management actions that simultaneously protect sensitive resources and allow fire to maintain its ecological role. Over the last twenty years, this task has become more difficult, as increased fire severity and season length have caused...
Author(s): Diana F. Tomback, Elizabeth R. Pansing
Year Published: 2018
Type: Document
Technical Report or White Paper

Human impacts on 20th century fire dynamics and implications for global carbon and water trajectories
www.nrfirescience.org/resource/17317
Fire is a fundamental Earth system process and the primary ecosystem disturbance on the global scale. It affects carbon and water cycles through changing terrestrial ecosystems, and at the same time, is regulated by weather and climate, vegetation characteristics, and, importantly, human ignitions and suppression (i.e., the direct...
Author(s): Fang Li, David M. Lawrence, Ben Bond-Lamberty
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Effects of Climate Change on Cultural Resources in the Northern Rockies Region [Chapter 12]
www.nrfirescience.org/resource/17536
People have inhabited the Northern Rocky Mountains of the United States since the close of the last Pleistocene glacial period, some 14,000 years B.P. (Fagan 1990; Meltzer 2009). Evidence of this ancient and more recent human occupation is found throughout the Forest Service, U.S. Department of Agriculture (USFS) Northern Region and...
Author(s): Carl M. Davis
Year Published: 2018
Type: Document
Technical Report or White Paper

Fine-scale spatial climate variation and drought mediate the likelihood of reburning
www.nrfirescience.org/resource/16808
In many forested ecosystems, it is increasingly recognized that the probability of burning is substantially reduced within the footprint of previously burned areas. This self-limiting effect of wildland fire is
considered a fundamental emergent property of ecosystems and is partly responsible for structuring landscape heterogeneity...

**New development and application needs for Earth system modeling of fire–climate–ecosystem interactions**

Wildfire, climate and ecosystem are interactive components of the Earth system (Bowman et al 2009, Andela et al 2017). Climate and fuel moisture, which is heavily impacted by atmospheric conditions, are primary drivers for fire occurrence and behavior, while vegetation provides necessary fuels for combustion (Pyne et al 1996). On...

**Climate Change and Rocky Mountain Ecosystems**

Climate Change and Rocky Mountain Ecosystems describes the results of a cutting-edge effort to assess climate change vulnerabilities and develop adaptation options for ecosystems in the Northern Rocky Mountains region of the United States, focusing on national forests, grasslands, and parks in Northern Idaho, Montana, North Dakota,...

**Effects of climate change on recreation in the Northern Rockies Region [Chapter 10]**

Outdoor recreation is an important benefit provided by Federally managed and other public lands throughout the Rocky Mountains. National forests in the Forest Service, U.S. Department of Agriculture (USFS) Northern Region and Greater Yellowstone Area (a region hereafter called the Northern Rockies region) have an estimated 13.3...

**Fire refugia: What are they, and why do they matter for global change?**

Fire refugia are landscape elements that remain unburned or minimally affected by fire, thereby supporting postfire ecosystem function, biodiversity, and resilience to disturbances. Although fire refugia have been studied across continents, scales, and affected taxa, they have not been characterized systematically over space and...
The nature of the beast: examining climate adaptation options in forests with stand-replacing fire regimes
www.nrfirescience.org/resource/17221
Building resilience to natural disturbances is a key to managing forests for adaptation to climate change. To date, most climate adaptation guidance has focused on recommendations for frequent-fire forests, leaving few published guidelines for forests that naturally experience infrequent, stand-replacing wildfires. Because most...
Author(s): Joshua S. Halofsky, Daniel C. Donato, Jerry F. Franklin, Jessica E. Halofsky, David L. Peterson, Brian J. Harvey
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Effects of climate change on ecological disturbance in the Northern Rockies Region [Chapter 8]
www.nrfirescience.org/resource/17531
This chapter describes the ecology of important disturbance regimes in the Forest Service, U.S. Department of Agriculture (USFS) Northern Region and the Greater Yellowstone Area, hereafter called the Northern Rockies region, and potential shifts in these regimes as a consequence of observed and projected climate change. The term...
Author(s): Rachel A. Loehman, Barbara J. Bentz, Gregg DeNitto, Robert E. Keane, Mary Manning, Jacob P. Duncan, Joel M. Egan, Marcus B. Jackson, Sandra Kegley, I. Blakley Lockman, Dean E. Pearson, James A. Powell, Steve Shelly, Brytten E. Steed, Paul J. Zambino
Year Published: 2018
Type: Document
Technical Report or White Paper

A Statement of Common Ground Regarding the Role of Wildfire in Forested Landscapes of the Western United States
www.nrfirescience.org/resource/18177
For millennia, wildfires have markedly influenced forests and non-forested landscapes of the western United States (US), and they are increasingly seen as having substantial impacts on society and nature. There is growing concern over what kinds and amounts of fire will achieve desirable outcomes and limit harmful effects on people...
Author(s): Max A. Moritz, Christopher Topik, Craig D. Allen, Paul F. Hessburg, Penelope Morgan, Dennis C. Odion, Thomas T. Veblen, Ian M. McCullough
Year Published: 2018
Type: Document
Technical Report or White Paper

Effects of climate change on rangeland vegetation in the Northern Rockies Region [Chapter 7]
www.nrfirescience.org/resource/17529
Rangelands are dominated by grass, forb, or shrub species, but are usually not modified by using agronomic improvements such as fertilization or irrigation (Lund 2007; Reeves and Mitchell 2011) as these lands would normally be considered pastures. Rangeland includes grassland, shrubland, and desert ecosystems, alpine areas, and some...
Author(s): Matthew C. Reeves, Mary Manning, Jeff P. DiBenedetto, Kyle Palmquist, William Lauenroth, John Bradford, Daniel Schlaepfer
Year Published: 2018
Type: Document
Technical Report or White Paper
Putting climate adaptation on the map: Developing spatial management strategies for whitebark pine in the Greater Yellowstone Ecosystem
www.nrfirescience.org/resource/18842
Natural resource managers face the need to develop strategies to adapt to projected future climates. Few existing climate adaptation frameworks prescribe where to place management actions to be most effective under anticipated future climate conditions. We developed an approach to spatially allocate climate adaptation actions and...
Author(s): Kathryn Ireland, Andrew J. Hansen, Robert E. Keane, Kristin Legg, Rob Gump
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Random subset feature selection for ecological niche models of wildfire activity in western North America
www.nrfirescience.org/resource/17909
Variable selection in ecological niche modelling can influence model projections to a degree comparable to variations in future climate scenarios. Consequently, it is important to select feature (variable) subsets for optimizing model performance and characterizing variability. We utilize a novel random subset feature selection...
Author(s): James L. Tracy, Antonio Trabucco, A. Michelle Lawing, J. Tomasz Giermakowski, Maria D. Tchakerian, Gail M. Drus, Robert N. Coulson
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Climate vulnerability of native cold-water salmonids in the Northern Rockies Region [Chapter 5]
www.nrfirescience.org/resource/17526
During the 21st century, climate change is expected to alter aquatic habitats throughout the Northern Rocky Mountains, intermountain basins, and western Great Plains. Particularly in montane watersheds, direct changes are likely to include warmer water temperatures, earlier snowmelt-driven runoff, earlier declines to summer baseflow...
Author(s): Michael K. Young, Daniel J. Isaak, Scott Spaulding, Cameron A. Thomas, Scott A. Barndt, Matthew C. Groce, Dona L. Horan, David E. Nagel
Year Published: 2018
Type: Document
Technical Report or White Paper

Effects of climate change on forest vegetation in the northern Rockies (Chapter 5)
www.nrfirescience.org/resource/16482
Increasing air temperature, through its influence on soil moisture, is expected to cause gradual changes in the abundance and distribution of tree, shrub, and grass species throughout the Northern Rockies, with drought tolerant species becoming more competitive. The earliest changes will be at ecotones between lifeforms (e.g., upper...
Author(s): Robert E. Keane, M. F. Mahalovich, Barry Bollenbacher, Mary Manning, Rachel A. Loehman, Theresa B. Jain, Lisa M. Holsinger, Andrew J. Larson
Year Published: 2018
Type: Document
Book or Chapter or Journal Article
New development and application needs for Earth system modeling of fire-climate-ecosystem interactions

Research has traditionally focused on the wildfire impacts of climate and vegetation, using the approaches developed mainly based on empirical and statistical weather–fire behavior relationships as well as empirical and process-based vegetation–fire relationships. Recent studies have turned more attention to the feedbacks of...

Author(s): Yongqiang Liu
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Historical and projected climate in the Northern Rockies Region [Chapter 3]

Climate influences the ecosystem services we obtain from forest and rangelands. Climate is described by the long-term characteristics of precipitation, temperature, wind, snowfall, and other measures of weather that occur over a long period in a particular place, and is typically expressed as long-term average conditions. Resource...

Author(s): Linda A. Joyce, Marian Talbert, Darrin Sharp, Jeffrey T. Morriseette, John Stevenson
Year Published: 2018
Type: Document
Technical Report or White Paper

Woody material structural degradation through decomposition

Dead woody material (DWM) plays numerous important roles in forest ecosystems; however, through the process of decomposition, it undergoes structural and chemical changes that progressively alter its function in these roles. Much remains unknown about how DWM mechanical strength and structural integrity change through decomposition...

Author(s): Shawn Fraver, Mehdi Tajvidi, Anthony W. D'Amato, Daniel I. Lindner, Jodi A. Forrester, Amy M. Milo
Year Published: 2018
Type: Document
Book or Chapter or Journal Article

Human presence diminishes the importance of climate in driving fire activity across the United States

Growing human and ecological costs due to increasing wildfire are an urgent concern in policy and management, particularly given projections of worsening fire conditions under climate change. Thus, understanding the relationship between climatic variation and fire activity is a critically important scientific question. Different...

Author(s): Alexandra D. Syphard, Jon E. Keeley, Anne H. Pfaff, Ken Ferschweiler
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Disturbances catalyze the adaptation of forest ecosystems to changing climate conditions

The rates of anthropogenic climate change substantially exceed those at which forest ecosystems – dominated by immobile, long-lived organisms – are able to adapt. The resulting maladaptation of forests
has potentially detrimental effects on ecosystem functioning. Furthermore, as many forest-dwelling species are highly dependent...

Author(s): Dominik Thom, Werner Rammer, Rupert Seidl
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Tamm Review: Shifting global fire regimes: Lessons from reburns and research needs
www.nrfirescience.org/resource/19958
Across the globe, rising temperatures and altered precipitation patterns have caused persistent regional droughts, lengthened fire seasons, and increased the number of weather-driven extreme fire events. Because wildfires currently impact an increasing proportion of the total area burned, land managers need to better understand...

Author(s): Susan J. Prichard, Camille Stevens-Rumann, Paul F. Hessburg
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
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

Selective breeding of lodgepole pine increases growth and maintains climatic adaptation
www.nrfirescience.org/resource/16649
Climate change is disrupting historical patterns of adaptation in temperate and boreal tree species, causing local populations to become maladapted. Tree improvement programs typically utilise local base populations and manage adaptation using geographically defined breeding zones. As climates shift, breeding zones are no longer...

Author(s): Ian R. MacLachlan, Tongli Wang, Andreas Hamann, Pia Smets, Sally N. Aitken
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Analog-based fire regime and vegetation shifts in mountainous regions of the western US
www.nrfirescience.org/resource/15521
Climate change is expected to result in substantial ecological impacts across the globe. These impacts are uncertain but there is strong consensus that they will almost certainly affect fire regimes and vegetation. In this study, we evaluated how climate change may influence fire frequency, fire severity, and broad classes of...

Author(s): Sean A. Parks, Lisa M. Holsinger, Carol Miller, Marc-Andre Parisien
Year Published: 2017
Type: Document
Book or Chapter or Journal Article
The Constitution of the State of Montana, ratified in 1972, affirms Montanans' inalienable “right to a clean and healthful environment” (State of Montana 1972). Since the signing of the constitution, that declaration has galvanized Montanans to protect the state’s air and water, and to work toward keeping the state free from...

Author(s): Cathy L. Whitlock, Wyatt Cross, Bruce D. Maxwell, Nick Silverman, Alisa A. Wade
Year Published: 2017
Type: Document
Management or Planning Document

Forest restoration often includes thinning to reduce tree density and improve ecosystem processes and function while also reducing the risk of wildfire or insect and disease outbreaks. However, one drawback of these restoration treatments is that slash is often burned in piles that may damage the soil and require further restoration...

Author(s): Deborah S. Page-Dumroese, Matt Busse, Jim Archuleta, Darren McAvoy, Eric Roussel
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Trembling aspen covers a large geographic range in North America, and previous studies reported that a better understanding of its singular influence on soil properties and processes is of high relevance for global change questions. Here we investigate the potential impact of a shift in aspen abundance on soil carbon sequestration...

Author(s): Jérôme Laganière, Antra Bőa, Helga Van Miegroet, David Paré
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

A longer growing season with climate change is expected to increase net primary productivity of many rangeland types, especially those dominated by grasses, although responses will depend on local climate and soil conditions. Elevated atmospheric carbon dioxide may increase water use efficiency and productivity of some species. In...

Author(s): Matthew C. Reeves, Mary Manning, Jeff P. DiBenedetto, Kyle Palmquist, William Lauenroth, John Bradford, Daniel Schlaepfer
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Adaptive silviculture for climate change: a national experiment in manager-scientist partnerships to apply an adaptation framework
Forest managers in the United States must respond to the need for climate-adaptive strategies in the face of observed and projected climatic changes. However, there is a lack of on-the-ground forest adaptation research to indicate what adaptation measures or tactics might be effective in preparing forest ecosystems to deal with...

Author(s): Linda Nagel, Brian J. Palik, Michael A. Battaglia, Anthony W. D'Amato, James M. Guldin, Christopher W. Swanston, Maria K. Janowiak, Matthew P. Powers, Linda A. Joyce, Constance I. Millar, David L. Peterson, Lisa Ganio, Chad Kirschbaum, Molly R. Roske
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Disturbance and productivity interactions mediate stability of forest composition and structure

Fire is returning to many conifer-dominated forests where species composition and structure have been altered by fire exclusion. Ecological effects of these fires are influenced strongly by the degree of forest change during the fire-free period. Response of fire-adapted species assemblages to extended fire-free intervals is highly...

Author(s): Christopher D. O'Connor, Donald A. Falk, Ann M. Lynch, Thomas W. Swetnam, Craig P. Wilcox
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Post-fire forest regeneration in a changing climate - Final Report to the Joint Fire Science Program

Severe disturbance such as wildfire may create important opportunities for plant communities to reorganize in response to environmental change, including climate change. Disturbance may be particularly important in forests where the foundational plant species (trees) are long-lived and usually establish soon after disturbance. The...

Author(s): Derek J. N. Young, Andrew Latimer
Year Published: 2017
Type: Document
Technical Report or White Paper

Adapting fuel treatments in a changing climate - Prescribed fire, mechanical treatments, wildfire, and restoration

The Available Science Assessment Project (ASAP) leads, EcoAdapt and Oregon State University’s Institute for Natural Resources, hosted a workshop during the International Association of Wildland Fire’s 5th Fire Behavior and Fuels Conference, in cooperation with the Northwest Fire Science Consortium and the Northern Rockies...

Author(s): Corey L. Gucker
Year Published: 2017
Type: Document
Research Brief or Fact Sheet

Decomposition rates of surface and buried forest-floor material

Mechanical site preparation is assumed to reduce soil C stocks by increasing the rate at which the displaced organic material decomposes, but the evidence is equivocal. We measured rates of C loss of
forest-floor material in mesh bags either placed on the surface or buried in the mineral soil at four sites in different regional...
Author(s): Cindy E. Prescott, Anya Reid, Shu Yao Wu, Marie-Charlotte Nilsson
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Wildfire–vegetation dynamics affect predictions of climate change impact on bird communities
www.nrfirescience.org/resource/17774
Community?level climate change indicators have been proposed to appraise the impact of global warming on community composition. However, non?climate factors may also critically influence species distribution and biological community assembly. The aim of this paper was to study how fire–vegetation dynamics can modify our...
Author(s): Adrián Regos, Miguel Clavero, Manuela D’Amen, Antoine Guisan, Lluis Brotons
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Trend analysis of fire season length and extreme fire weather in North America between 1979 and 2015
www.nrfirescience.org/resource/16407
We have constructed a fire weather climatology over North America from 1979 to 2015 using the North American Regional Reanalysis dataset and the Canadian Fire Weather Index (FWI) System. We tested for the presence of trends in potential fire season length, based on a meteorological definition, and extreme fire weather using the non-....
Author(s): Piyush Jain, Xianli Wang, Michael D. Flannigan
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Climate change and the eco-hydrology of fire: will area burned increase in a warming western USA?
www.nrfirescience.org/resource/14916
Wildfire area is predicted to increase with global warming. Empirical statistical models and process-based simulations agree almost universally. The key relationship for this unanimity, observed at multiple spatial and temporal scales, is between drought and fire. Predictive models often focus on ecosystems in which this...
Author(s): Donald McKenzie, Jeremy S. Littell
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Direct and indirect climate controls predict heterogeneous early-mid 21st century wildfire burned area across western and boreal North America
www.nrfirescience.org/resource/16312
Predicting wildfire under future conditions is complicated by complex interrelated drivers operating across large spatial scales. Annual area burned (AAB) is a useful index of global wildfire activity. Current and antecedent seasonal climatic conditions, and the timing of snowpack melt, have been suggested as important drivers of...
Author(s): Thomas Kitzberger, Donald A. Falk, Anthony L. Westerling, Thomas W. Swetnam
Year Published: 2017
Climate, wildfire, and erosion ensemble foretells more sediment in western USA watersheds
www.nrfirescience.org/resource/15526
The area burned annually by wildfires is expected to increase worldwide due to climate change. Burned areas increase soil erosion rates within watersheds, which can increase sedimentation in downstream rivers and reservoirs. However, which watersheds will be impacted by future wildfires is largely unknown. Using an ensemble of...
Author(s): Joel B. Sankey, Jason Kreitler, Todd J. Hawbaker, Jason L. McVay, Mary Ellen Miller, Erich R. Mueller, Nicole M. Vaillant, Scott E. Lowe, Temuulen T. Sankey
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Montana Climate Assessment VIGNETTE: forest Management and a Changing Climate with Diana Six
www.nrfirescience.org/resource/15727
Diana Six has been studying pine bark beetles for 25 years, and still can’t say she completely understands them. Lately, she’s been diving into a topic she has always found even more confounding - forest management. This article describes an interview with Six that describes forest resilience in face of climate change.
Year Published: 2017
Type: Document
Research Brief or Fact Sheet

The normal fire environment—Modeling environmental suitability for large forest wildfires using past, present, and future climate normals
www.nrfirescience.org/resource/16643
We modeled the normal fire environment for occurrence of large forest wildfires (>40 ha) for the Pacific Northwest Region of the United States. Large forest wildfire occurrence data from the recent climate normal period (1971–2000) was used as the response variable and fire season precipitation, maximum temperature, slope, and...
Author(s): Raymond J. Davis, Zhiqiang Yang, Andrew Yost, Cole Belongie, Warren B. Cohen
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Adapt to more wildfire in western North American forests as climate changes
www.nrfirescience.org/resource/15327
Wildfires across western North America have increased in number and size over the past three decades, and this trend will continue in response to further warming. As a consequence, the wildland–urban interface is projected to experience substantially higher risk of climate-driven fires in the coming decades. Although many plants,...
Author(s): Tania L. Schoennagel, Jennifer Balch, Hannah Brenchert-Smith, Philip E. Dennison, Brian J. Harvey, Meg A. Krawchuk, Nathan Mietkiewicz, Penelope Morgan, Max A. Moritz, Ray Rasker, Monica G. Turner, Cathy L. Whitlock
Year Published: 2017
Type: Document
Book or Chapter or Journal Article
Climate change and wildfire effects in aridland riparian ecosystems: An examination of current and future conditions

Aridland riparian ecosystems are limited, the climate is changing, and further hydrological change is likely in the American Southwest. To protect riparian ecosystems and organisms, we need to understand how they are affected by disturbance processes and stressors such as fire, drought, and non-native plant invasions. Riparian...

Author(s): D. Max Smith, Deborah M. Finch
Year Published: 2017
Type: Document
Technical Report or White Paper

Climate drives episodic conifer establishment after fire in dry ponderosa pine forests of the Colorado Front Range, USA

In recent years, warming climate and increased fire activity have raised concern about post-fire recovery of western U.S. forests. We assessed relationships between climate variability and tree establishment after fire in dry ponderosa pine forests of the Colorado Front Range. We harvested and aged over 400 post-fire juvenile...

Author(s): Monica T. Rother, Thomas T. Veblen
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Spatio-Temporal Linkages between Declining Arctic Sea-Ice Extent and Increasing Wildfire Activity in the Western United States

We examined relationships between monthly Arctic sea-ice extent (ASIE) and annual wildfire activity for seven regions in the western United States during 1980-2015 to determine if spatio-temporal linkages exist between ASIE, upper-level flow, and surface climatic conditions conducive to western U.S. wildfire activity. Winter ASIE...

Author(s): Paul A. Knapp, Peter T. Soulé
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Climate drives inter-annual variability in probability of high severity fire occurrence in the western United States
A long history of fire suppression in the western United States has significantly changed forest structure and ecological function, leading to increasingly uncharacteristic fires in terms of size and severity. Prior analyses of fire severity in California forests showed that time since last fire and fire weather conditions predicted...

**Effects of climate oscillations on wildland fire potential in the continental United States**

The effects of climate oscillations on spatial and temporal variations in wildland fire potential in the continental U.S. are examined from 1979 to 2015 using cyclostationary empirical orthogonal functions (CSEOFs). The CSEOF analysis isolates effects associated with the modulated annual cycle and the El Niño–Southern Oscillation...

**Potential Climate Feedbacks of Changing Fire regimes in the U.S.: A review - Final Report to the Joint Fire Science Program**

Wildland fire is a disturbance that can profoundly impact the environment and human health and welfare. While climate is generally a critical driving factor shaping the occurrence and impacts of fire, fire can also play a role in shaping climate. With an increasing trend in wildland fire occurrence and extent, it is important to...

**Estimating the Effects of Changing Climate on Fires and Consequences for U.S. Air Quality, Using a Set of Global and Regional Climate Models - Final Report to the Joint Fire Science Program**

Emissions of aerosols and gases from fires have been shown to adversely affect US air quality at local to regional scales as well as downwind regions far away from the source. In addition, smoke from fires negatively affects humans, ecosystems, and climate. Recent observations have shown an upward trend of area burned over western...

**Analog-based fire regime and vegetation shifts in mountainous regions of the western US**

Climate change is expected to result in substantial ecological impacts across the globe. These impacts are uncertain but there is strong consensus that they will almost certainly affect fire regimes and
vegetation. In this study, we evaluated how climate change may influence fire frequency, severity, and broad classes of...

Author(s): Sean A. Parks, Lisa M. Holsinger, Carol Miller, Marc-Andre Parisien
Year Published: 2017
Type: Document
Book or Chapter or Journal Article

Non-deforestation fire vs. fossil fuel combustion: the source of CO2 emissions affects the global carbon cycle and climate responses
www.nrfirescience.org/resource/14328

Non-deforestation fire – i.e., fire that is typically followed by the recovery of natural vegetation – is arguably the most influential disturbance in terrestrial ecosystems, thereby playing a major role in carbon exchanges and affecting many climatic processes. The radiative effect from a given atmospheric CO2 perturbation is...

Author(s): Jean-Sebastien Landry, H. Damon Matthews
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Area burned in alpine treeline ecotones reflects region-wide trends
www.nrfirescience.org/resource/14828

The direct effects of climate change on alpine treeline ecotones – the transition zones between subalpine forest and non-forested alpine vegetation – have been studied extensively, but climate-induced changes in disturbance regimes have received less attention. To determine if recent increases in area burned extend to these...

Author(s): C. Alina Cansler, Donald McKenzie, Charles B. Hansler
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

High and dry: post-fire tree seedling establishment in subalpine forests decreases with post-fire drought and large stand-replacing burn patches
www.nrfirescience.org/resource/18412

Aim Climate warming and increased wildfire activity are hypothesized to catalyse biogeographical shifts, reducing the resilience of fire-prone forests worldwide. Two key mechanisms underpinning hypotheses are: (1) reduced seed availability in large stand-replacing burn patches, and (2) reduced seedling establishment/survival...

Author(s): Brian J. Harvey, Daniel C. Donato, Monica G. Turner
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Management impacts on carbon dynamics in a Sierra Nevada mixed conifer forest
www.nrfirescience.org/resource/14230

Forest ecosystems can act as sinks of carbon and thus mitigate anthropogenic carbon emissions. When forests are actively managed, treatments can alter forests carbon dynamics, reducing their sink strength and switching them from sinks to sources of carbon. These effects are generally characterized by fast temporal dynamics. Hence...

Author(s): Sabina Dore, Danny L. Fry, Brandon M. Collins, Rodrigo Vargas, Robert A. York, Scott L. Stephens
Year Published: 2016
Changing disturbance regimes, ecological memory, and forest resilience

Ecological memory is central to how ecosystems respond to disturbance and is maintained by two types of legacies – information and material. Species life-history traits represent an adaptive response to disturbance and are an information legacy; in contrast, the abiotic and biotic structures (such as seeds or nutrients) produced...

Author(s): Jill F. Johnstone, Craig D. Allen, Jerry F. Franklin, Lee E. Freligh, Brian J. Harvey, Philip E. Higuera, Michelle Mack, Ross K. Meentemeyer, Margaret R. Metz, George L.W. Perry, Tania L. Schoennagel, Monica G. Turner
Year Published: 2016

How will climate change affect wildland fire severity in the western US?

Fire regime characteristics in North America are expected to change over the next several decades as a result of anthropogenic climate change. Although some fire regime characteristics (e.g., area burned and fire season length) are relatively well-studied in the context of a changing climate, fire severity has received less...

Author(s): Sean A. Parks, Carol Miller, John T. Abatzoglou, Lisa M. Holsinger, Marc-Andre Parisien, Solomon Z. Dobrowski
Year Published: 2016

Climate change velocity underestimates climate change exposure in mountainous regions

Climate change velocity is a vector depiction of the rate of climate displacement used for assessing climate change impacts. Interpreting velocity requires an assumption that climate trajectory length is proportional to climate change exposure; longer paths suggest greater exposure. However, distance is an imperfect measure of...

Author(s): Solomon Z. Dobrowski, Sean A. Parks
Year Published: 2016

The science of firescapes: achieving fire-resilient communities

Wildland fire management has reached a crossroads. Current perspectives are not capable of answering interdisciplinary adaptation and mitigation challenges posed by increases in wildfire risk to human populations and the need to reintegrate fire as a vital landscape process. Fire science has been, and continues to be, performed in...

Year Published: 2016
Increased forest fire activity across the western continental United States (US) in recent decades has likely been enabled by a number of factors, including the legacy of fire suppression and human settlement, natural climate variability, and human-caused climate change. We use modeled climate projections to estimate the...

Author(s): John T. Abatzoglou, A. Park Williams
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Climate change adaptation is a rapidly evolving field in conservation biology and includes a range of strategies from resisting to actively directing change on the landscape. The term 'climate change resilience,' frequently used to characterize adaptation strategies, deserves closer scrutiny because it is ambiguous, often...

Author(s): Nicholas A. Fisichelli, Gregor W. Schuurman, Cat Hawkins Hoffman
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Shifts in rainfall patterns due to climate change are expected to increase drought-induced stress and mortality in forests, with widespread, negative consequences for forest productivity. Additionally, the extent, frequency and severity of natural and anthropogenic fires are rapidly changing, highlighting the need to understand the...

Author(s): Jennifer Fraterrigo, Tyler Refsland
Year Published: 2016
Type: Document
Technical Report or White Paper

With ongoing public concern regarding climate change and recent drought that has affected many areas of the western United States, this study provides context and direct evidence for the negative impact of water stress on forest ecosystems. The response of trees to drought is a tangible example of the impacts of climate change on...

Author(s): David L. Peterson, Jeremy S. Littell
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Fire and drought
www.nrfirescience.org/resource/14525
Historical and presettlement relationships between drought and wildfire have been well documented in much of North America, with forest fire occurrence and area burned clearly increasing in response to drought. Drought interacts with other controls (forest productivity, topography, and fire weather) to affect fire intensity and...

Author(s): Jeremy S. Littell, David L. Peterson, Karen L. Riley, Yongqiang Liu, Charles H. Luce
Year Published: 2016
Type: Document
Technical Report or White Paper

Replacing time with space: using laboratory fires to explore the effects of repeated burning on black carbon degradation
www.nrfirescience.org/resource/19123
Soil organic matter plays a key role in the global carbon cycle, representing three to four times the total carbon stored in plant or atmospheric pools. Although fires convert a portion of the faster cycling organic matter to slower cycling black carbon (BC), abiotic and biotic degradation processes can significantly shorten BC...

Author(s): Wade T. Tinkham, Alistair M. S. Smith, Philip E. Higuera, Jeff A. Hatten, Nolan W. Brewer, Stefan H. Doerr
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
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

Using scientific conferences to engage the public on climate change
www.nrfirescience.org/resource/15600
Climate change is often perceived as controversial in the public's view. One meaningful way scientists can address this problem is to engage with the public to increase understanding of climate change. Attendees of scientific conferences address climate change within meetings yet rarely interact with the public as part of...

Author(s): Jeffrey A. Hicke, John T. Abatzoglou, Steven Daley-Laursen, Jamie Esler, Lauren E. Parker
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Engaging communities and climate change futures with Multi-Scale, Iterative Scenario Building (MISB) in the western United States
www.nrfirescience.org/resource/14428
Current projections of future climate change foretell potentially transformative ecological changes that threaten communities globally. Using two case studies from the United States Intermountain West, this article highlights the ways in which a better articulation between theory and methods in research design
can generate proactive...
Author(s): Daniel Murphy, Carina Wyborn, Laurie Yung, Daniel R. Williams, Cory Cleveland, Lisa A. Eby, Solomon Z. Dobrowski, Erin Towler
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Is ‘resilience’ maladaptive? Towards an accurate lexicon for climate change adaptation
www.nrfirescience.org/resource/16876
Climate change adaptation is a rapidly evolving field in conservation biology and includes a range of strategies from resisting to actively directing change on the landscape. The term ‘climate change resilience,’ frequently used to characterize adaptation strategies, deserves closer scrutiny because it is ambiguous, often...
Author(s): Nicholas A. Fisichelli, Gregor W. Schuurman, Cat Hawkins Hoffman
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Climate change and novel disturbance regimes in national park landscapes
www.nrfirescience.org/resource/18425
Climate and disturbance regimes are both changing rapidly, and it is increasingly important for ecologists and park managers to understand the past and anticipate what lies ahead. The frequency, severity, and extent of natural disturbances are changing substantially as climate warms; effects on many ecosystems may be profound (... 
Author(s): Monica G. Turner, Daniel C. Donato, Winslow D. Hansen, Brian J. Harvey, William H. Romme, Anthony L. Westerling
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

A new method comparing snowmelt timing with annual area burned
www.nrfirescience.org/resource/14250
The interactions between climate and wildland fire are complex. To better understand these interactions, we used ArcMap 10.2.2 to examine the relationships between early spring snowmelt and total annual area burned within a defined region of the Rocky Mountains of the western United States....
Author(s): Donal S. O'Leary, Trevor D. Bloom, Jacob C. Smith, Christopher R. Zemp, Michael J. Medler
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Human-caused climate change is now a key driver of forest fire activity in the western United States
www.nrfirescience.org/resource/14809
Effects of climate warming on natural and human systems are becoming increasingly visible across the globe. For example, the shattering of past yearly records for global high temperatures seems to be a near-annual event, with the five hottest years since 1880 all occurring since 2005 (1). Not coincidentally, the single hottest year...
Author(s): Brian J. Harvey
Year Published: 2016
Type: Document
Book or Chapter or Journal Article, Synthesis
As climate has warmed over recent years, a new pattern of more frequent and more intense weather events has unfolded across the globe. Climate models simulate such changes in extreme events, and some of the reasons for the changes are well understood. Warming increases the likelihood of extremely hot days and nights, favors...

Author(s): Committee on Extreme Weather Events and Climate Change Attribution
Year Published: 2016
Type: Document
Technical Report or White Paper

A growing body of literature examines the vulnerability, risk, resilience, and adaptation of indigenous peoples to climate change. This synthesis of literature brings together research pertaining to the impacts of climate change on sovereignty, culture, health, and economies that are currently being experienced by Alaska Native and...

Author(s): Kathryn Norton-Smith, Kathy Lynn, Karletta Chief, Karen Cozzetto, Jamie Donatuto, Margaret Hiza Redsteer, Linda E. Kruger, Julie Maldonado, Carson Viles, Kyle P. Whyte
Year Published: 2016
Type: Document
Synthesis, Technical Report or White Paper

Forests near the lower limit of montane tree cover are expected to be particularly vulnerable to warming climate, potentially converting to non-forest for prolonged periods if affected by canopy-removing disturbances. Such disturbance-catalyzed shifts are by nature stochastic, offering few opportunities to test these predictions. We...

Author(s): Daniel C. Donato, Brian J. Harvey, Monica G. Turner
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

We contend that traditional approaches to forest conservation and management will be inadequate given the predicted scale of social-economic and biophysical changes in the 21st century. New approaches, focused on anticipating and guiding ecological responses to change, are urgently needed to ensure the full value of forest ecosystem...

Author(s): Stephen W. Golladay, Katherine L. Martin, James M. Vose, David N. Wear, Alan P. Covitch, Richard J. Hobbs, Kier D. Klepzig, Gene E. Likens, Robert J. Naiman, Allan W. Shearer
Year Published: 2016
Type: Document
Book or Chapter or Journal Article, Synthesis

Particulate air pollution from wildfires in the western US under climate change
Wildfire can impose a direct impact on human health under climate change. While the potential impacts of climate change on wildfires and resulting air pollution have been studied, it is not known who will be most affected by the growing threat of wildfires. Identifying communities that will be most affected will inform development...

Author(s): Jia Coco Liu, Loretta J. Mickley, Melissa P. Sulprizio, Francesca Dominici, Xu Yue, Keita Ebisu, Georgiana Brooke Anderson, Rafi F.A. Khan, Mercedes Bravo, Michelle L. Bell
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

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

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

Recent advances and remaining uncertainties in resolving past and future climate effects on global fire activity

www.nrfirescience.org/resource/15603

Fire is an integral component of the Earth system that will critically affect how terrestrial carbon budgets and living systems respond to climate change. Paleo and observational records document robust positive relationships between fire activity and aridity in many parts of the world on interannual to millennial timescales....

Author(s): A. Park Williams, John T. Abatzoglou
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring

www.nrfirescience.org/resource/14468

Prior work shows western US forest wildfire activity increased abruptly in the mid-1980s. Large forest wildfires and areas burned in them have continued to increase over recent decades, with most of the increase in lightning-ignited fires. Northern US Rockies forests dominated early increases in wildfire activity, and still...

Author(s): Anthony L. Westerling
Year Published: 2016
Type: Document
Book or Chapter or Journal Article

Mid-21st-century climate changes increase predicted fire occurrence and fire season length, Northern Rocky Mountains, United States

www.nrfirescience.org/resource/14968

Climate changes are expected to increase fire frequency, fire season length, and cumulative area burned in the western United States. We focus on the potential impact of mid-21st-century climate changes on annual burn probability, fire season length, and large fire characteristics including number
and size for a study area in the...

Author(s): Karen L. Riley, Rachel A. Loehman
Year Published: 2016
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
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...

Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Future mega-fires and smoke impacts
www.nrfirescience.org/resource/15579
"Megafire" events, in which large high-intensity fires propagate over extended periods, can cause both immense damage to the local environment and catastrophic air quality impacts on cities and towns downwind. Increases in extreme events associated with climate change (e.g., droughts, heat waves) are projected to result in more...

Author(s): Narasimhan K. Larkin, John T. Abatzoglou, Donald McKenzie, Brian E. Potter, E. Ashley Steel, Brian J. Stocks
Year Published: 2015
Type: Document
Technical Report or White Paper

Biomass and fire dynamics in a temperate forest-grassland mosaic: Integrating multi-species herbivory, climate, and fire with the FireBGCv2/GrazeBGC system
www.nrfirescience.org/resource/13195
Landscape fire succession models (LFSMs) predict spatially-explicit interactions between vegetation succession and disturbance, but these models have yet to fully integrate ungulate herbivory as a driver of their processes. We modified a complex LFSM, FireBGCv2, to include a multi-species herbivory module, GrazeBGC. The system is...

Author(s): Robert A. Riggs, Robert E. Keane, Norm Cimon, Rachel Cook, Lisa M. Holsinger, John Cook, Timothy DelCurto, Scott L. Baggett, Donald Justice, David Powell, Martin Vavra, Bridgett J. Naylor
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Ecological implications of climate change in Yellowstone: moving into uncharted territory?
www.nrfirescience.org/resource/13548
Climate science and understanding how climate change may affect the Greater Yellowstone Ecosystem (GYE) have come a long way since our 1992 Yellowstone Science article (Romme and Turner 1992, based on Romme and Turner 1991). In 1992, the potential for global warming driven by
Impacts of changing fire regimes in the alpine treeline ecotone

www.nrfirescience.org/resource/15577

We studied the effects of a shift in the fire regime of an ecosystem that is very sensitive to climate change: the ecotone from closed forest to open alpine tundra, hereafter the alpine treeline ecotone (ATE). Results suggest that ATEs will become more complex spatially in a warming climate, rather than moving up or down en masse....

Author(s): Donald McKenzie, C. Alina Cansler
Year Published: 2015
Type: Document
Technical Report or White Paper

Climate-induced variations in global wildfire danger from 1979 to 2013

www.nrfirescience.org/resource/15777

Climate strongly influences global wildfire activity, and recent wildfire surges may signal fire weather-induced pyrogeographic shifts. Here we use three daily global climate data sets and three fire danger indices to develop a simple annual metric of fire weather season length, and map spatio-temporal trends from 1979 to 2013. We...

Author(s): William Matt Jolly, Mark A. Cochrane, Patrick H. Freeborn, Zachary A. Holden, Timothy J. Brown, Grant J. Williamson, David M. J. S. Bowman
Year Published: 2015
Type: Document
Book or Chapter or Journal Article
The Columbia River treaty and the dynamics of transboundary water negotiations in a changing environment: how might climate change alter the game?

www.nrfirescience.org/resource/15653

This is a book chapter describing how climate change may alter water negotiations.

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

The climate space of fire regimes in north-western North America

www.nrfirescience.org/resource/18921

Aim: Studies of fire activity along environmental gradients have been undertaken, but the results of such studies have yet to be integrated with fire-regime analysis. We characterize fire-regime components along climate gradients and a gradient of human influence. Location: We focus on a climatically diverse region of north-western...

Author(s): Ellen Whitman, E. Batllori, Marc-Andre Parisien, Carol Miller, Jonathan D. Coop, Meg A. Krawchuk, Geneva W. Chong, Sandra L. Haire

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

Projected major fire and vegetation changes in the Pacific Northwest of the conterminous United States under selected CMIP5 climate futures

www.nrfirescience.org/resource/13743

Climate change adaptation and mitigation require understanding of vegetation response to climate change. Using the MC2 dynamic global vegetation model (DGVM) we simulate vegetation for the Northwest United States using results from 20 different Climate Model Intercomparison Project Phase 5 (CMIP5) models downscaled using the MACA...

Author(s): Timothy J. Sheehan, Dominique Bachelet, Ken Ferschweiler

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

The changing strength and nature of fire-climate relationships in the northern Rocky Mountains, U.S.A., 1902-2008

www.nrfirescience.org/resource/15636

Time-varying fire-climate relationships may represent an important component of fire-regime variability, relevant for understanding the controls of fire and projecting fire activity under global-change scenarios. We used time-varying statistical models to evaluate if and how fire-climate relationships varied from 1902-2008, in one...

Author(s): Philip E. Higuera, John T. Abatzoglou, Jeremy S. Littell, Penelope Morgan

Year Published: 2015

Type: Document

Book or Chapter or Journal Article

Disturbance interactions: characterization, prediction, and the potential for cascading effects

www.nrfirescience.org/resource/13423

Disturbances are fundamental components of ecosystems and, in many cases, a dominant driver of
ecosystem structure and function at multiple spatial and temporal scales. While the effect of any one disturbance may be relatively well understood, multiple interacting disturbances can cause unexpected disturbance behavior...

Author(s): Brian Buma
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Forest disturbance across the conterminous United States from 1985-2012: the emerging dominance of forest decline

www.nrfirescience.org/resource/13688
Evidence of shifting dominance among major forest disturbance agent classes regionally to globally has been emerging in the literature. For example, climate-related stress and secondary stressors on forests (e.g., insect and disease, fire) have dramatically increased since the turn of the century globally, while harvest rates in the...

Author(s): Warren B. Cohen, Zhiqiang Yang, Stephen V. Stehman, Todd A. Schroeder, David M. Bell, Jeffrey G. Masek, Chengquan Huang, Garrett W. Meigs
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Climate Contributors to Forest Mosaics: Ecological Persistence

www.nrfirescience.org/resource/15625
It is hypothesized that climate impacts forest mosaics through dynamic ecological processes such as wildfires. However, climate-fire research has primarily focused on understanding drivers of fire frequency and area burned, largely due to scale mismatches and limited data availability. Recent datasets, however, allow for the...

Author(s): Crystal A. Kolden, John T. Abatzoglou, James A. Lutz, C. Alina Cansler, Jonathan T. Kane, Jan W. van Wagendonk, Carl H. Key
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Climate change presents increased potential for very large fires in the contiguous United States

www.nrfirescience.org/resource/13373
Very large fires (VLFs) have important implications for communities, ecosystems, air quality and fire suppression expenditures. VLFs over the contiguous US have been strongly linked with meteorological and climatological variability. Building on prior modelling of VLFs (>5000 ha), an ensemble of 17 global climate models were...

Author(s): Renaud Barbero, John T. Abatzoglou, Narasimhan K. Larkin, Crystal A. Kolden, Brian J. Stocks
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Representing climate, disturbance, and vegetation interactions in landscape models

www.nrfirescience.org/resource/13639
The prospect of rapidly changing climates over the next century calls for methods to predict their effects on myriad, interactive ecosystem processes. Spatially explicit models that simulate ecosystem dynamics at fine (plant, stand) to coarse (regional, global) scales are indispensable tools for meeting this challenge under a...
The potential impact of regional climate change on fire weather in the United States

Climate change is expected to alter the frequency and severity of atmospheric conditions conducive for wildfires. In this study, we assess potential changes in fire weather conditions for the contiguous United States using the Haines Index (HI), a fire weather index that has been employed operationally to detect atmospheric...

Author(s): Ying Tang, Shiyuan Zhong, Lifeng Luo, Xindi Bian, Warren Heilman, Julie Winkler
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Modeling study of the contribution of fire emissions on BC concentrations and deposition rates

Regional air quality simulations were performed to evaluate the contributions of wildland fires to inter-annual variability of black carbon (BC) concentrations and to assess the contributions of wildfires vs. prescribed fires to BC concentrations and deposition rates to glacier areas and snow-covered surfaces in the western US....

Year Published: 2015
Type: Document
Technical Report or White Paper

Climate, snowpack, and streamflow of Priest River Experimental Forest, revisited

The climate record of Priest River Experimental Forest has the potential to provide a century-long history of northern Rocky Mountain forest ecosystems. The record, which began in 1911 with the Benton Flat Nursery control weather station, included observations of temperature, precipitation, humidity, and wind. Later, other...

Author(s): Wade T. Tinkham, Robert Denner, Russell T. Graham
Year Published: 2015
Type: Document
Technical Report or White Paper

The cost of climate change: ecosystem services and wildland fires

Little research has focused on the economic impact associated with climate-change induced wildland fire on natural ecosystems and the goods and services they provide. We examine changes in wildland fire patterns based on the U.S. Forest Service's MC1 dynamic global vegetation model from 2013 to 2115 under two pre-defined scenarios....

Author(s): Christine Lee, Claire Schlemme, Jessica Murray, Robert Unsworth
Year Published: 2015
Type: Document
Book or Chapter or Journal Article
Indicators of climate impacts for forests: recommendations for the US National Climate Assessment indicators system
www.nrfirescience.org/resource/13969
The Third National Climate Assessment (NCA) process for the United States focused in part on developing a system of indicators to communicate key aspects of the physical climate, climate impacts, vulnerabilities, and preparedness to inform decisionmakers and the public. Initially, 13 active teams were formed to recommend indicators...
Year Published: 2015
Type: Document
Technical Report or White Paper

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

Climate Contributors to Forest Mosaics: Ecological Persistence Following Wildfire
www.nrfirescience.org/resource/18953
It is hypothesized that climate impacts forest mosaics through dynamic ecological processes such as wildfires. However, climate-fire research has primarily focused on understanding drivers of fire frequency and area burned, largely due to scale mismatches and limited data availability. Recent datasets, however, allow for the...
Author(s): Crystal A. Kolden, John T. Abatzoglou, James A. Lutz, C. Alina Cansler, Jonathan T. Kane, Jan W. van Wagendonk, Carl H. Key
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Managing for climate change on federal lands of the western United States: perceived usefulness of climate science, effectiveness of adaptation strategies, and barriers to implementation
www.nrfirescience.org/resource/12997
Recent mandates in the United States require federal agencies to incorporate climate change science into land management planning efforts. These mandates target possible adaptation and mitigation strategies. However, the degree to which climate change is actively being considered in agency planning and management decisions is...
Author(s): Kerry Kemp, Jarod Blades, P. Zion Klos, Troy E. Hall, Jo Ellen Force, Penelope Morgan, Wade T. Tinkham
Year Published: 2015
Type: Document
Indicators of climate change in Idaho: an assessment framework for coupling biophysical change and social perception
www.nrfirescience.org/resource/15637
Climate change is well documented at the global scale, but local and regional changes are not as well understood. Finer, local- to regional-scale information is needed for creating specific, place-based planning and adaption efforts. Here the development of an indicator-focused climate change assessment in Idaho is described. This...
Author(s): P. Zion Klos
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Improved Bias Correction Techniques for Hydrological Simulations of Climate Change
www.nrfirescience.org/resource/15630
Global climate model (GCM) output typically needs to be bias corrected before it can be used for climate change impact studies. Three existing bias correction methods, and a new one developed here, are applied to daily maximum temperature and precipitation from 21 GCMs to investigate how different methods alter the climate change...
Author(s): David W. Pierce, Daniel R. Cayan, Edwin P. Maurer, John T. Abatzoglou, Katherine C. Hegewisch
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Climate change beliefs and hazard mitigation behaviors: homeowners and wildfire risk
www.nrfirescience.org/resource/14535
Downscaled climate models provide projections of how climate change may exacerbate the local impacts of natural hazards. The extent to which people facing exacerbated hazard conditions understand or respond to climate-related changes to local hazards has been largely overlooked. In this article, we examine the relationships among...
Author(s): Hannah Brenkert-Smith, James R. Meldrum, Patricia A. Champ
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Regional likelihood of very large wildfires over the 21st century across the western United States: motivation to study individual events like the Rim Fire, a unique opportunity with unprecedented remote sensing data
www.nrfirescience.org/resource/13681
Studies project that a warming climate will likely increase wildfire activity in many areas (Westerling and others 2002; Flannigan and others 2005, 2009; Littell and others 2009). These analyses are often of aggregate statistics like annual area burned, which are insufficient for analyzing changes in seasonality of fire events, the...
Author(s): E. Natasha Stavros, John T. Abatzoglou, Zachary Tane, Van R. Kane, Sander Veraverbeke, Bob McGaughey, James A. Lutz, Narasimhan K. Larkin, Donald McKenzie, E. Ashley Steel, Carlos Ramirez, David S. Schimel
Year Published: 2015
Type: Document
Conference Proceedings
Global fire size distribution is driven by human impact and climate
www.nrfirescience.org/resource/13256
In order to understand fire's impacts on vegetation dynamics, it is crucial that the distribution of fire sizes be known. We approached this distribution using a power-law distribution, which derives from self-organized criticality theory (SOC). We compute the global spatial variation in the power-law exponent and determine the main...
Author(s): Stijn Hantson, Salvador Pueyo, Emilio Chuvieco
Year Published: 2015
Type: Document
Book or Chapter or Journal Article

Seasonal climate variability and change in the Pacific Northwest of the United States
www.nrfirescience.org/resource/15671
Observed changes in climate of the U.S. Pacific Northwest since the early twentieth century were examined using four different datasets. Annual mean temperature increased by approximately 0.6°–0.8°C from 1901 to 2012, with corroborating indicators including a lengthened freeze-free season, increased temperature of the coldest...
Author(s): John T. Abatzoglou, David E. Rupp, Philip W. Mote
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

Climate change impacts on fire regimes and key ecosystem services in Rocky Mountain forests
www.nrfirescience.org/resource/16832
Forests and woodlands in the central Rocky Mountains span broad gradients in climate, elevation, and other environmental conditions, and therefore encompass a great diversity of species, ecosystem productivities, and fire regimes. The objectives of this review are: (1) to characterize the likely short- and longer-term effects of...
Author(s): Monique E. Rocca, Peter M. Brown, Lee H. MacDonald, Christian M. Carrico
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

Observed changes in false springs over the contiguous United States
www.nrfirescience.org/resource/15668
Climate warming fosters an earlier spring green-up that may bring potential benefits to agricultural systems. However, advances in green-up timing may leave early stage vegetation growth vulnerable to cold damage when hard freezes follow green-up resulting in a false spring. Spatiotemporal patterns of green-up dates, last spring...
Author(s): Alexander G. Peterson, John T. Abatzoglou
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

Climate change impacts in the United States: The third National Climate Assessment
www.nrfirescience.org/resource/18981
Climate change is already affecting the American people in farreaching ways. Certain types of extreme weather events with links to climate change have become more frequent and/or intense, including prolonged periods of heat, heavy downpours, and, in some regions, floods and droughts. In addition,
warming is causing sea level to rise...
Year Published: 2014
Type: Document
Technical Report or White Paper

Climate and very large wildland fires in the contiguous western USA
www.nrfirescience.org/resource/13009
Very large wildfires can cause significant economic and environmental damage, including destruction of homes, adverse air quality, firefighting costs and even loss of life. We examine how climate is associated with very large wildland fires (VLWFs > or =50,000 acres, or ~20,234 ha) in the western contiguous USA. We used composite...
Author(s): E. Natasha Stavros, John T. Abatzoglou, Narasimhan K. Larkin, Donald McKenzie, E. Ashley Steel
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

A primer on global climate-change science
www.nrfirescience.org/resource/15665
Most of us are familiar with the terms climate change and global warming, but not too many of us understand the science behind them. We don’t really understand how climate change will affect us, and for that reason we might not consider it as pressing a concern as, say, housing prices or the quality of local education. This book...
Author(s): John T. Abatzoglou, J.F.C. DiMento, P. Doughman, S. Nespor
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

Relative effects of climate change and wildfires on stream temperatures: a simulation modeling approach in a Rocky Mountain watershed
www.nrfirescience.org/resource/12998
Freshwater ecosystems are warming globally from the direct effects of climate change on air temperature and hydrology and the indirect effects on near-stream vegetation. In fire-prone landscapes, vegetative change may be especially rapid and cause significant local stream temperature increases but the importance of these increases...
Author(s): Lisa M. Holsinger, Robert E. Keane, Daniel J. Isaak, Lisa A. Eby, Michael K. Young
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

US strategy for forest management adaption to climate change: building a framework for decision making
www.nrfirescience.org/resource/12443
Recent policy changes in the USA direct agencies managing federal forests to analyze the potential effects of climate change on forest productivity, water resource protection, wildlife habitat, biodiversity, and other values. This paper describes methods developed to (1) assess current risks, vulnerabilities, and gaps in knowledge...
Author(s): V. Alaric Sample, Jessica E. Halofsky, David L. Peterson
Year Published: 2014
Type: Document
Book or Chapter or Journal Article
The Yellowstone to Yukon Conservation Initiative (Y2Y) was established over 20 years ago as an experiment in large landscape conservation. Initially, Y2Y emerged as a response to large scale habitat fragmentation by advancing ecological connectivity. It also laid the foundation for large scale multi-stakeholder conservation...

Adapting to climate change
Federal agencies have led the development of adaptation principles and tools in forest ecosystems over the past decade. Successful adaptation efforts generally require organizations to: (1) develop science-management partnerships, (2) provide education on climate change science, (3) provide a toolkit of methods and processes for...

Playing with fire: how climate change and development patterns are contributing to the soaring costs of western wildfires
Strong scientific evidence shows that climate change is producing hotter, drier conditions that contribute to larger fires and longer fire seasons in the American West today. The annual number of large wildfires on federally managed lands in the 11 western states has increased by more than 75 percent: from approximately 140 during...

Resilience to stress and disturbance, and resistance to Bromus tectorum L. invasion in cold desert shrublands of western North America
Alien grass invasions in arid and semi-arid ecosystems are resulting in grass-fire cycles and ecosystem-level transformations that severely diminish ecosystem services. Our capacity to address the rapid and complex changes occurring in these ecosystems can be enhanced by developing an understanding of the environmental factors and...

Linking environmental research and practice: lessons from the integration of climate science
and water management in the western United States
www.nrfirescience.org/resource/12626
Efforts to better connect scientific research with people and organizations involved in environmental decision making are receiving increased interest and attention. Some of the challenges we currently face, however—including complex questions associated with climate change—are unlike most of the environmental issues encountered...
Author(s): Daniel B. Ferguson, Jennifer Rice, Connie Woodhouse
Year Published: 2014
Type: Document
Synthesis, Technical Report or White Paper

Impacts of mega-fires on large U.S. urban area air quality under changing climate and fuels
www.nrfirescience.org/resource/15569
Mega-fires can adversely impact air quality in the United States and the impacts are likely to become more serious in the future due to the possibility of more frequent and intense mega-fires in response to the projected climate change. This study investigated U.S. mega-fires and fuel conditions and their environmental impacts under...
Author(s): Yongqiang Liu, Scott L. Goodrick, John A. Stanturf, Hanqin Tian
Year Published: 2014
Type: Document
Technical Report or White Paper

Current climate and recent trends
www.nrfirescience.org/resource/15670
While the paleoclimatic record is based on indirect measurements—for example, biological and geological indicators—more recent climate history is defined largely by in situ observations over the last 100–150 years. This chapter centers on what these observations and theoretical understanding reveal about the climate of North...
Author(s): Kelly T. Redmond, John T. Abatzoglou
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

Climate change effects, adaptation, and mitigation
www.nrfirescience.org/resource/15666
Most of us are familiar with the terms climate change and global warming, but not too many of us understand the science behind them. We don’t really understand how climate change will affect us, and for that reason we might not consider it as pressing a concern as, say, housing prices or the quality of local education. This book...
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

Regional projections of the likelihood of very large wildland fires under a changing climate in the contiguous western United States
www.nrfirescience.org/resource/13006
Seasonal changes in the climatic potential for very large wildfires (VLWF \geq 50,000 ac \sim 20,234 ha) across the western contiguous United States are projected over the 21st century using generalized linear models and downscaled climate projections for two representative concentration pathways (RCPs). Significant (p \leq 0.05...
Questionable evidence of natural warming of the northwestern United States
www.nrfirescience.org/resource/15655
Johnstone and Mantua (1) claim that changes in atmospheric circulation were the primary cause of the observed warming of sea surface temperature around the northeastern Pacific margins and surface air temperature (SAT) in Northern California, Oregon, and Washington from 1901 to 2012. The results of Johnstone and Mantua’s report...

Briefing: climate and wildfire in western U.S. forests
www.nrfirescience.org/resource/12991
Wildfire in western U.S. federally managed forests has increased substantially in recent decades, with large (>1000 acre) fires in the decade through 2012 over five times as frequent (450 percent increase) and burned area over ten times as great (930 percent increase) as the 1970s and early 1980s. These changes are closely linked...

Future fire probability modeling with climate change data and physical chemistry
www.nrfirescience.org/resource/15143
Climate has a primary influence on the occurrence and rate of combustion in ecosystems with carbon-based fuels such as forests and grasslands. Society will be confronted with the effects of climate change on fire in future forests. There are, however, few quantitative appraisals of how climate will affect wildland fire in the United...

The climate-wildfire-air quality system: interactions and feedbacks across spatial and temporal scales
www.nrfirescience.org/resource/13698
Future climate change and its effects on social and ecological systems present challenges for preserving valued ecosystem services, including local and regional air quality. Wildfire is a major source of air-quality impact in some locations, and a substantial contributor to pollutants of concern, including nitrogen oxides and...
Exploring how deliberation on scientific information shapes stakeholder perceptions of forest management and climate change - Final Report to the Joint Fire Science Program

Climate change has resulted in rapid biophysical changes in forests of the western US and has prompted the need for an increased understanding of potential impacts and adaption measures. Land managers, policy makers, and community officials lack locally relevant climate change science and are urgently calling for research to inform...

Author(s): Troy E. Hall, Jarod Blades
Year Published: 2014
Type: Document
Technical Report or White Paper

Climate change and United States forests

This volume offers a scientific assessment of the effects of climatic variability and change on forest resources in the United States. Derived from a report that provides technical input to the 2013 U.S. Global Change Research Program National Climate Assessment, the book serves as a framework for managing U.S. forest resources in...

Author(s): David L. Peterson, James M. Vose, Toral Patel-Weynand
Year Published: 2014
Type: Document
Book or Chapter or Journal Article

The missing mountain water: slower westerlies decrease orographic enhancement in the Pacific Northwest USA

Trends in streamflow timing and volume in the Pacific Northwest United States have been attributed to increased temperatures, because trends in precipitation at lower-elevation stations were negligible. We demonstrate that observed streamflow declines are probably associated with declines in mountain precipitation, revealing...

Author(s): Charles H. Luce, John T. Abatzoglou, Zachary A. Holden
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Estimating critical climate-driven thresholds in landscape dynamics using spatial simulation modeling: climate change tipping points in fire management - Final Report to the Joint Fire Science Program

Climate projections for the next 20-50 years forecast higher temperatures and variable precipitation for many landscapes in the western United States. Climate changes may cause or contribute to threshold shifts, or tipping points, where relatively small shifts in climate result in large, abrupt, and persistent changes in landscape...

Author(s): Robert E. Keane, Rachel A. Loehman
Year Published: 2013
Type: Document
Technical Report or White Paper

Postfire changes in forest carbon storage over a 300-year chronosequence of Pinus contorta-dominated forests
A warming climate may increase the frequency and severity of stand-replacing wildfires, reducing carbon (C) storage in forest ecosystems. Understanding the variability of postfire C cycling on heterogeneous landscapes is critical for predicting changes in C storage with more frequent disturbance. We measured C pools and fluxes for...

Author(s): Daniel M. Kashian, William H. Romme, Daniel B. Tinker, Monica G. Turner, Michael G. Ryan
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Wildland fire emissions, carbon, and climate: modeling fuel consumption

Fuel consumption specifies the amount of vegetative biomass consumed during wildland fire. It is a two-stage process of pyrolysis and combustion that occurs simultaneously and at different rates depending on the characteristics and condition of the fuel, weather, topography, and in the case of prescribed fire, ignition rate and...

Author(s): Roger D. Ottmar
Year Published: 2013
Type: Document
Book or Chapter or Journal Article, Synthesis

Climate change and wildfires

Wildland fire regimes are primarily driven by climate/weather, fuels and people. All of these factors are dynamic and their variable interactions create a mosaic of fire regimes around the world. Climate change will have a substantial impact on future fire regimes in many global regions. Current research suggests a general increase...

Author(s): William J. de Groot, Michael D. Flannigan, Brian J. Stocks
Year Published: 2013
Type: Document
Conference Proceedings, Technical Report or White Paper

Appendix 3: Response of western mountain ecosystems to climatic variability and change: a synthesis from the Western Mountain Initiative

The Western Mountain Initiative (WMI), a consortium of research groups in the Western United States, focuses on understanding and predicting responses – especially sensitivities, thresholds, resistance, and resilience – of mountain ecosystems to climatic variability and change (Peterson et al. 2012). The WMI addresses how climatic...

Author(s): Crystal L. Raymond
Year Published: 2013
Type: Document
Synthesis, Technical Report or White Paper

The merits of prescribed fire outweigh potential carbon emission effects

While North American ecosystems vary widely in their ecology and natural historical fire regimes, they are unified in benefitting from prescribed fire when judiciously applied with the goal of maintaining and restoring native ecosystem composition, structure, and function. On a modern landscape in which historical fire regimes...

Author(s): Association for Fire Ecology, International Association of Wildland Fire, Tall Timbers
The state of knowledge about climatic effects on forests of the Northwest region was recently summarized in a peer reviewed assessment of these effects in Washington (Littell et al. 2009, 2010) and a white paper on climatic effects on Oregon vegetation (Schafer et al. 2010). Recent PNW and West-wide modeling studies provide...

Author(s): Jeremy S. Littell
Year Published: 2013
Type: Document
Synthesis, Technical Report or White Paper

Rapid climate change has the potential to affect economic, social, and biological systems. A concern for species conservation is whether or not the rate of on-going climate change will exceed the rate at which species can adapt or move to suitable environments. Here we assess the climate velocity (both climate displacement rate and...

Author(s): Solomon Z. Dobrowski, John T. Abatzoglou, Alan Swanson, Jonathan A. Greenberg, Alison R. Mynsberge, Zachary A. Holden, Michael K. Schwartz
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Because it is an important regulator of terrestrial carbon cycling in North America, extensive research on natural and human disturbances has been carried out as part of the North American Carbon Program and the CarboNA project. A synthesis of various components of this research was carried out, and the results are presented in the...

Author(s): Eric S. Kasischke, Brian D. Amiro, Nichole N. Barger, Nancy H. F. French, Scott J. Goetz, Guido Grosse, Mark E. Harmon, Jeffrey A. Hicke, Shuguang Liu, Jeffrey G. Masek
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Traditional knowledge is increasingly recognized as valuable for adaptation to climate change, bringing scientists and indigenous peoples together to collaborate and exchange knowledge. These partnerships can benefit both researchers and indigenous peoples through mutual learning and mutual knowledge generation. Despite these...

Author(s): Terry Williams, Preston Hardison
Year Published: 2013
Type: Document
Book or Chapter or Journal Article
Evaluation of CMIP5 20th century climate simulations for the Pacific Northwest USA

Monthly temperature and precipitation data from 41 global climate models (GCMs) of the Coupled Model Intercomparison Project Phase 5 (CMIP5) were compared to observations for the 20th century, with a focus on the United States Pacific Northwest (PNW) and surrounding region. A suite of statistics, or metrics, was calculated, that...

Author(s): David E. Rupp, John T. Abatzoglou, Katherine C. Hegewisch, Philip W. Mote
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

The impacts of climate change on ecosystem structure and function

Recent climate-change research largely confirms the impacts on US ecosystems identified in the 2009 National Climate Assessment and provides greater mechanistic understanding and geographic specificity for those impacts. Pervasive climate-change impacts on ecosystems are those that affect productivity of ecosystems or their ability...

Author(s): Nancy B. Grimm, F. Stuart Chapin, Britta Bierwagen, Patrick Gonzalez, Peter M. Groffman, Yiqi Luo, Forrest Melton, Knute Nadelhoffer, Amber Pairis, Peter A. Raymond, Josh Schimel, Craig E. Williamson
Year Published: 2013
Type: Document
Book or Chapter or Journal Article, Synthesis

Climate change in the Northwest

In understanding causes of changes in global or regional climate, scientists often distinguish between processes external to the climate system and processes internal to the climate system. External processes include solar and volcanic forcings and the longlived greenhouse gases. Internal processes include fluctuations in water...

Author(s): Philip W. Mote, John T. Abatzoglou, Kenneth E. Kunkel
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Relationships between climate and macroscale area burned in the western United States

Increased wildfire activity (e.g. number of starts, area burned, fire behaviour) across the western United States in recent decades has heightened interest in resolving climate-fire relationships. Macroscale climate-fire relationships were examined in forested and non-forested lands for eight Geographic Area Coordination Centers in...

Author(s): John T. Abatzoglou, Crystal A. Kolden
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

When relationships estimated in the past cannot be used to predict the future: using mechanistic models to predict landscape ecological dynamics in a changing world
Researchers and natural resource managers need predictions of how multiple global changes (e.g., climate change, rising levels of air pollutants, exotic invasions) will affect landscape composition and ecosystem function. Ecological predictive models used for this purpose are constructed using either a mechanistic (process-based) or...

Author(s): Eric J. Gustafson
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Cultural impacts to tribes from climate change influences on forests
www.nrfirescience.org/resource/16123
Climate change related impacts, such as increased frequency and intensity of wildfires, higher temperatures, extreme changes to ecosystem processes, forest conversion and habitat degradation are threatening tribal access to valued resources. Climate change is and will affect the quantity and quality of resources tribes depend upon...
Author(s): Garrett Voggesser, Kathy Lynn, John Daigle, Frank K. Lake, Darren Ranko
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Wildfire and fuel treatment effects on forest carbon dynamics in the western United States
www.nrfirescience.org/resource/11981
Sequestration of carbon (C) in forests has the potential to mitigate the effects of climate change by offsetting future emissions of greenhouse gases. However, in dry temperate forests, wildfire is a natural disturbance agent with the potential to release large fluxes of C into the atmosphere. Climate-driven increases in wildfire...
Author(s): Joseph C. Restaino, David L. Peterson
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Climatic stress increases forest fire severity across the western United States
www.nrfirescience.org/resource/12012
Pervasive warming can lead to chronic stress on forest trees, which may contribute to mortality resulting from fire-caused injuries. Longitudinal analyses of forest plots from across the western US show that high pre-fire climatic water deficit was related to increased post-fire tree mortality probabilities. This relationship...
Author(s): Phillip J. van Mantgem, Jonathan C. B. Nesmith, MaryBeth Keifer, Eric E. Knapp, Alan L. Flint, Lorraine E. Flint
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Assessing social vulnerability to climate change in human communities near public forests and grasslands: a framework for resource managers and planners
www.nrfirescience.org/resource/14673
Public land management agencies have incorporated the concept of vulnerability into protocols for assessing and planning for climate change impacts on public forests and grasslands. However, resource managers and planners have little guidance for how to address the social aspects of vulnerability in these assessments and plans....
Author(s): A. Paige Fischer, Travis B. Paveglio, Matthew S. Carroll, Daniel Murphy, Hannah Brenkert-
Do carbon offsets work? The role of forest management in greenhouse gas mitigation
www.nrfirescience.org/resource/12450
As forest carbon offset projects become more popular, professional foresters are providing their expertise to support them. But when several members of the Society of American Foresters questioned the science and assumptions used to design the projects, the organization decided to convene a task force to examine whether these...
Author(s): Marie Oliver
Year Published: 2013
Type: Document
Research Brief or Fact Sheet

Bridging natural resource communication boundaries: public perceptions of smoke from wildland fires and forest managers' perspectives of climate change science
www.nrfirescience.org/resource/13479
Land managers of the northern Rocky Mountains and south-central U.S. are challenged with numerous social and ecological changes, many of which are linked to climate change. The work presented here focuses on two important research gaps: 1) managers do not understand public opinions toward smoke from prescribed fires (a necessary...
Author(s): Jarod Blades
Year Published: 2013
Type: Document
Dissertation or Thesis

Consequences of spatial heterogeneity for ecosystem services in changing forest landscapes: priorities for future research
www.nrfirescience.org/resource/13431
Changes in key drivers (e.g., climate, disturbance regimes and land use) may affect the sustainability of forest landscapes and set the stage for increased tension among competing ecosystem services. We addressed two questions about a suite of supporting, regulating and provisioning ecosystem services in each of two well-studied...
Author(s): Monica G. Turner, Daniel C. Donato, William H. Romme
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Managing forests and fire in changing climates
www.nrfirescience.org/resource/12433
With projected climate change, we expect to face much more forest fire in the coming decades. Policymakers are challenged not to categorize all fires as destructive to ecosystems simply because they have long flame lengths and kill most of the trees within the fire boundary. Ecological context matters: In some ecosystems, high-...
The impacts of changing disturbance regimes on serotinous plant populations and communities

www.nrfirescience.org/resource/12406

Climatic change is anticipated to alter disturbance regimes for many ecosystems. Among the most important effects are changes in the frequency, size, and intensity of wildfires. Serotiny (long-term canopy storage and the heat-induced release of seeds) is a fire-resilience mechanism found in many globally important terrestrial...

Author(s): Brian Buma, Carissa D. Brown, Daniel C. Donato, Joseph B. Fontaine, Jill F. Johnstone
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Drought seasonality explains patterns in widespread aspen forest mortality across the western United States

www.nrfirescience.org/resource/15679

Globally documented widespread drought-induced forest mortality has important ramifications for plant community structure, ecosystem function, and the ecosystem services provided by forests. Yet the characteristics of drought seasonality, severity, and duration that trigger mortality events have received little attention despite...

Author(s): Leander Anderegg, William R.L. Anderegg, John T. Abatzoglou, Alexandra M. Hausladen, Joseph A. Berry
Year Published: 2013
Type: Document
Book or Chapter or Journal Article

Aquatic species invasions in the context of fire and climate change

www.nrfirescience.org/resource/11273

This paper focuses on the nexus among native and nonnative fishes with respect to fire and climate change in the western United States. Although many taxa are involved, I emphasize native and nonnative salmonids because these are obligate coldwater species that might be expected to respond strongly to fire and because most research...

Author(s): Michael K. Young
Year Published: 2012
Type: Document
Technical Report or White Paper

Climate change, forests, fire, water, and fish: building resilient landscapes, streams, and managers

www.nrfirescience.org/resource/11270

Fire will play an important role in shaping forest and stream ecosystems as the climate changes. Historic observations show increased dryness accompanying more widespread fire and forest die-off. These events punctuate gradual changes to ecosystems and sometimes generate stepwise changes in ecosystems. Climate vulnerability...

Author(s): Charles H. Luce, Penelope Morgan, Kathleen A. Dwire, Daniel J. Isaak, Zachary A. Holden, Bruce E. Rieman
Year Published: 2012
Type: Document
Technical Report or White Paper

What are Plants Doing and When? Using Plant Phenology to Promote Sustainable Natural
Climate change models for the northern Rocky Mountains predict changes in temperature and water availability that in turn will alter vegetation. Changes include timing of plant life-history events, or phenology, such as green-up, flowering and senescence, and shifts in species composition. Moreover, climate changes may favor...

Author(s): Geneva W. Chong, Leslie A. Allen
Year Published: 2012
Type: Document

Experimental forests and climate change: views of long-term employees on ecological change and the role of Experimental Forests and Ranges in understanding and adapting to climate change

In this project, we examined the views of 21 long-term employees on climate change in 14 Rocky Mountain Research Station Experimental Forests and Ranges (EFRs). EFRs were described by employees as uniquely positioned to advance knowledge of climate change impacts and adaptation strategies due to the research integrity they provide...

Author(s): Laurie Yung, Mason Bradbury, Daniel R. Williams
Year Published: 2012
Type: Document

Chapter 2: Effects of climatic variability and change

Climate profoundly shapes forests. Forest species composition, productivity, availability of goods and services, disturbance regimes, and location on the landscape are all regulated by climate. Much research attention has focused on the problem of projecting the response of forests to changing climate, elevated atmospheric carbon...

Author(s): Michael G. Ryan, James M. Vose
Year Published: 2012
Type: Document

Can climate change increase fire severity independent of fire intensity? - Final Report to the Joint Fire Science Program

We tested the idea that climate may affect forest fire severity independent of fire intensity. Pervasive warming can lead to chronic stress on forest trees (McDowell et al. 2008; Raffa et al. 2008), resulting in higher sensitivity to fire-induced damage (van Mantgem et al. 2003). Thus, there may be ongoing increases in fire severity...

Author(s): Phillip J. van Mantgem, MaryBeth Keifer, Robert C. Klinger, Eric E. Knapp
Year Published: 2012
Type: Document

Effects of climatic variability and change on forest ecosystems: a comprehensive science synthesis for the U.S. forest sector

This report is a scientific assessment of the current condition and likely future condition of forest...
resources in the United States relative to climatic variability and change. It serves as the U.S. Forest Service forest sector technical report for the National Climate Assessment and includes descriptions of key regional issues and...
Year Published: 2012
Type: Document
Synthesis, Technical Report or White Paper

**Climate change in grasslands, shrublands, and deserts of the interior American West: a review and needs assessment**
www.nrfirescience.org/resource/11267
Recent research and species distribution modeling predict large changes in the distributions of species and vegetation types in the western interior of the United States in response to climate change. This volume reviews existing climate models that predict species and vegetation changes in the western United States, and it...
Author(s): Deborah M. Finch
Year Published: 2012
Type: Document
Synthesis, Technical Report or White Paper

**Effect of crown class and habitat type on climate-growth relationships of ponderosa pine and Douglas-fir**
www.nrfirescience.org/resource/11938
There is increasing interest in actively managing forests to increase their resilience to climate-related changes. Although forest managers rely heavily on the use of silvicultural treatments that manipulate stand structure and stand dynamics to modify responses to climate change, few studies have directly assessed the effects of...
Author(s): Gunnar C. Carnwath, David W. Peterson, Cara R. Nelson
Year Published: 2012
Type: Document
Book or Chapter or Journal Article

**Adaptation: planning for climate change and its effects on federal lands**
www.nrfirescience.org/resource/12449
National forest managers are charged with tackling the effects of climate change on the natural resources under their care. The Forest Service National Roadmap for Responding to Climate Change and the Climate Change Performance Scorecard require managers to make significant progress in addressing climate change by 2015. To help land...
Author(s): Marie Oliver
Year Published: 2012
Type: Document
Research Brief or Fact Sheet

**Fuel treatment impacts on estimated wildfire carbon loss from forests in Montana, Oregon, California, and Arizona**
www.nrfirescience.org/resource/8324
Using forests to sequester carbon in response to anthropogenically induced climate change is being considered across the globe. A recent U.S. executive order mandated that all federal agencies account for sequestration and emissions of greenhouse gases, highlighting the importance of understanding how forest carbon stocks are...
Author(s): Scott L. Stephens, Ralph E. Boerner, Jason J. Moghaddas, Emily E. Y. Moghaddas, Brandon M. Collins, Christopher B. Dow, Carleton B. Edminster, Carl E. Fiedler, Danny L. Fry, Bruce R.
Climate extremes and their linkage to regional drought over Idaho, USA

To investigate consequences of climate extreme and variability on agriculture and regional water resource, twenty-seven climatic indices of temperature and precipitation over Idaho, USA, were computed. Precipitation, mean temperature and maximum temperature, self-calibrated Palmer Drought Index and Standardized Precipitation Index...

Author(s): Mohammad Sohrabi, Jae H. Ryu, John T. Abatzoglou, John Tracy
Year Published: 2012
Type: Document
Book or Chapter or Journal Article

Synthesis of knowledge: fire history and climate change

This report synthesizes available fire history and climate change scientific knowledge to aid managers with fire decisions in the face of ongoing 21st Century climate change. Fire history and climate change (FHCC) have been ongoing for over 400 million years of Earth history, but increasing human influences during the Holocene epoch...

Author(s): William T. Sommers, Stanley G. Coloff, Susan G. Conard
Year Published: 2011
Type: Document
Synthesis, Technical Report or White Paper

Continued warming could transform Greater Yellowstone fire regimes by mid-21st century

Climate change is likely to alter wildfire regimes, but the magnitude and timing of potential climate-driven changes in regional fire regimes are not well understood. We considered how the occurrence, size, and spatial location of large fires might respond to climate projections in the Greater Yellowstone ecosystem (GYE) (Wyoming),...

Author(s): Anthony L. Westerling, Monica G. Turner, Erica A. H. Smithwick, William H. Romme, Michael G. Ryan
Year Published: 2011
Type: Document
Book or Chapter or Journal Article

Fire and fish dynamics in a changing climate

Wildland fire is a natural disturbance that affects the distribution and abundance of native fishes in the Rocky Mountain West (Rieman and others 2003). Fire can remove riparian vegetation, increasing direct solar radiation to the stream surface and leading to warmer summer water temperatures. Fire can also consume vegetation and...

Author(s): Lisa M. Holsinger, Robert E. Keane
Year Published: 2011
Type: Document
Book or Chapter or Journal Article
A comparison of statistical downscaling methods suited for wildfire applications
www.nrfirescience.org/resource/11973
Place-based data is required in wildfire analyses, particularly in regions of diverse terrain that foster not only strong gradients in meteorological variables, but also complex fire behaviour. However, a majority of downscaling methods are inappropriate for wildfire application due to the lack of daily timescales and variables such...
Author(s): John T. Abatzoglou, Timothy J. Brown
Year Published: 2011
Type: Document
Book or Chapter or Journal Article

Modeling climate changes and wildfire interactions: effects on whitebark pine (Pinus albicaulis) and implications for restoration, Glacier National Park, Montana, USA
www.nrfirescience.org/resource/11897
Climate changes are 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. High...
Author(s): Rachel A. Loehman, Allissa Corrow, Robert E. Keane
Year Published: 2011
Type: Document
Conference Proceedings

Changes in climatic water balance drive downhill shifts in plant species optimum elevations
www.nrfirescience.org/resource/15690
Uphill shifts of species’ distributions in response to historical warming are well documented, which leads to widespread expectations of continued uphill shifts under future warming. Conversely, downhill shifts are often considered anomalous and unrelated to climate change. By comparing the altitudinal distributions of 64 plant...
Author(s): Shawn M. Crimmins, Solomon Z. Dobrowski, Jonathan A. Greenberg, John T. Abatzoglou, Alison R. Mynsberge
Year Published: 2011
Type: Document
Book or Chapter or Journal Article

Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions?
www.nrfirescience.org/resource/8300
It has been suggested that thinning trees and other fuel-reduction practices aimed at reducing the probability of high-severity forest fire are consistent with efforts to keep carbon (C) sequestered in terrestrial pools, and that such practices should therefore be rewarded rather than penalized in C-accounting schemes. By evaluating...
Author(s): John L. Campbell, Mark E. Harmon, Stephen R. Mitchell
Year Published: 2011
Type: Document
Book or Chapter or Journal Article, Synthesis

It's a small world - How oceans and the climate can affect wildland fires thousands of miles away
www.nrfirescience.org/resource/8331
Sometimes it is hard to study the past. This is especially true if the past you want to study was
hundreds or thousands of years ago. It is made more difficult if the past you want to study has no written records. Some scientists, such as archeologists and paleontologists, use items from the past as clues. Archeologists usually use...

A synthesis of current knowledge on forests and carbon storage in the United States
www.nrfirescience.org/resource/12598
Using forests to mitigate climate change has gained much interest in science and policy discussions. We examine the evidence for carbon benefits, environmental and monetary costs, risks and trade-offs for a variety of activities in three general strategies: (1) land use change to increase forest area (afforestation) and avoid...

Forest responses to climate change in the northwestern United States: ecophysiological foundations for adaptive management
www.nrfirescience.org/resource/8297
Climate change resulting from increased concentrations of atmospheric carbon dioxide ([CO2]) 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...

Wildfire extent and severity correlated with annual streamflow distribution and timing in the Pacific Northwest, USA (1984-2005)
www.nrfirescience.org/resource/8375
Climate change effects on wildfire occurrence have been attributed primarily to increases in temperatures causing earlier snowpack ablation and longer fire seasons. Variability in precipitation is also an important control on snowpack accumulation and, therefore, on timing of meltwater inputs. We evaluate the correlation of total...

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
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...

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

www.nrfirescience.org/resource/11896

This paper synthesizes existing information about the disturbance ecology of high-elevation five-needle pine ecosystems, describing disturbances 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

**Climate change in western US deserts: potential for increased wildfire and invasive annual grasses**

www.nrfirescience.org/resource/15691

Anthropogenic climate change is hypothesized to modify the spread of invasive annual grasses across the deserts of the western United States. The influence of climate change on future invasions depends on both climate suitability that defines a potential species range and the mechanisms that facilitate invasions and contractions. A...

Author(s): John T. Abatzoglou, Crystal A. Kolden

Year Published: 2011

Type: Document

Book or Chapter or Journal Article

**Responding to climate change in national forests: a guidebook for developing adaptation options**

www.nrfirescience.org/resource/13428

This guidebook contains science-based principles, processes, and tools necessary to assist with developing adaptation options for national forest lands. The adaptation process is based on partnerships between local resource managers and scientists who work collaboratively to understand potential climate change effects, identify...

Author(s): David L. Peterson, Constance I. Millar, Linda A. Joyce, Michael J. Furniss, Jessica E. Halofsky, Ronald P. Neilson, Toni Lyn Morelli

Year Published: 2011

Type: Document

Synthesis, Technical Report or White Paper

**Estimating the vulnerability of fifteen tree species under changing climate in Northwest North America**

www.nrfirescience.org/resource/16883

In the Pacific northwestern(PNW)region of North America, climatic conditions have significantly warmed since a predominantly cool phase of the Pacific North American circulation patterns between 1950 and 1975. What are the implications of this shift in climate for the vulnerability of native tree species? To address this question, we...
Sink or source? Fire and the forest carbon cycle
www.nrfirescience.org/resource/12620
As the size and severity of fires in the western U.S. continue to increase, it has become ever more important to understand carbon dynamics in response to fire. Many subalpine forests experience stand-replacing wildfires, and these fires and subsequent recovery can change the amount of carbon released to the atmosphere...
Author(s): Christine Frame
Year Published: 2010
Type: Document
Research Brief or Fact Sheet

Effects of climate change and wildfire on stream temperatures and salmonid thermal habitat in a mountain river network
www.nrfirescience.org/resource/11440
Mountain streams provide important habitats for many species, but their faunas are especially vulnerable to climate change because of ectothermic physiologies and movements that are constrained to linear networks that are easily fragmented. Effectively conserving biodiversity in these systems requires accurate downscaling of...
Author(s): Daniel J. Isaak, Charles H. Luce, Bruce E. Rieman, David E. Nagel, Erin E. Peterson, Dona L. Horan, Sharon Parkes, Gwynne L. Chandler
Year Published: 2010
Type: Document
Book or Chapter or Journal Article

A synthesis of the science on forests and carbon for U.S. forests
www.nrfirescience.org/resource/12589
Forests play an important role in the U.S. and global carbon cycle, and carbon sequestered by U.S. forest growth and harvested wood products currently offsets 12-19% of U.S. fossil fuel emissions. The cycle of forest growth, death, and regeneration and the use of wood removed from the forest complicate efforts to understand and...
Year Published: 2010
Type: Document
Book or Chapter or Journal Article

Fire and climate variation in western North America from fire-scar and tree-ring networks
www.nrfirescience.org/resource/8221
Fire regimes (i.e., the pattern, frequency and intensity of fire in a region) reflect a complex interplay of bottom-up and top-down controls (Lertzman et al., 1998; McKenzie et al., in press). Bottom-up controls include local variations in topographic, fuel and weather factors at the time of a burn (e.g., fuel moisture and...
Author(s): Donald A. Falk, Emily K. Heyerdahl, Peter M. Brown, Thomas W. Swetnam, Elaine Kennedy Sutherland, Ze'ev Gedalof, Larissa L. Yocom, Timothy J. Brown
Year Published: 2010
Fire-climate interactions in the American west since 1400 CE
www.nrfirescience.org/resource/11992
Despite a strong anthropogenic fingerprint on 20th Century wildland fire activity in the American West, climate remains a main driver. A better understanding of the spatiotemporal variability in fire-climate interactions is therefore crucial for fire management. Here, we present annually resolved, tree-ring based fire records for...
Author(s): Valerie Trouet, Alan H. Taylor, Eugene R. Wahl, Carl N. Skinner
Year Published: 2010
Type: Document
Book or Chapter or Journal Article

A century of climate and ecosystem change in Western Montana: what do temperature trends portend?
www.nrfirescience.org/resource/13097
The physical science linking human-induced increases in greenhouse gasses to the warming of the global climate system is well established, but the implications of this warming for ecosystem processes and services at regional scales is still poorly understood. Thus, the objectives of this work were to: (1) describe rates of change in...
Author(s): Gregory T. Pederson, Lisa Graumlich, Daniel B. Fagre, Todd Kipfer, Clint C. Muhlfeld
Year Published: 2010
Type: Document
Book or Chapter or Journal Article

Effects of fuel treatments on carbon-disturbance relationships in forests of the Northern Rocky Mountains
www.nrfirescience.org/resource/8188
Fuel treatments alter conditions in forested stands at the time of the treatment and subsequently. Fuel treatments reduce on-site carbon and also change the fire potential and expected outcome of future wildfires, including their carbon emissions. We simulated effects of fuel treatments on 140 stands representing seven major habitat...
Author(s): Elizabeth D. Reinhardt, Lisa M. Holsinger
Year Published: 2010
Type: Document
Book or Chapter or Journal Article

Prescribed fire as a means of reducing forest carbon emissions in the western United States
www.nrfirescience.org/resource/8328
Carbon sequestration by forested ecosystems offers a potential climate change mitigation benefit. However, wildfire has the potential to reverse this benefit. In the western United States, climate change and land management practices have led to increases in wildfire intensity and size. One potential means of reducing carbon...
Author(s): Christine Wiedinmyer, Matthew D. Hurteau
Year Published: 2010
Type: Document
Book or Chapter or Journal Article

Carbon concentrations and carbon pool distributions in dry, moist, and cold mid-aged forests of
Although 'carbon' management may not be a primary objective in forest management, influencing the distribution, composition, growth, and development of biomass to fulfill multiple objectives is; therefore, given a changing climate, managing carbon could influence future management decisions. Also, typically, the conversion from...

Author(s): Theresa B. Jain, Russell T. Graham, David Adams
Year Published: 2010
Type: Document
Conference Proceedings

Climatic changes are predicted to significantly affect the frequency and severity of disturbances that shape forest ecosystems. We provide a synthesis of climate change effects on native bark beetles, important mortality agents of conifers in western North America. Because of differences in temperature-dependent life-history...

Author(s): Barbara J. Bentz, Jacques Regniere, Christopher J. Fettig, E. Matthew Hansen, Jane L. Hayes, Jeffrey A. Hicke, Rick G. Kelsey, Jose F. Negron, Steven J. Seybold
Year Published: 2010
Type: Document
Book or Chapter or Journal Article, Synthesis

This study explores potential adaptation approaches in planning and management that the United States Forest Service might adopt to help achieve its goals and objectives in the face of climate change. Availability of information, vulnerability of ecological and socio-economic systems, and uncertainties associated with climate change...

Author(s): Linda A. Joyce, Geoffrey M. Blate, Steven G. McNulty, Constance I. Millar, Susanne Moser, Ronald P. Neilson, David L. Peterson
Year Published: 2009
Type: Document
Book or Chapter or Journal Article

A warmer climate in western North America will likely affect forests directly through soil moisture stress and indirectly through increased extent and severity of disturbances. We propose that stress complexes, combinations of biotic and abiotic stresses, compromise the vigor and ultimate sustainability of forest ecosystems. Across...

Author(s): Donald McKenzie, David L. Peterson, Jeremy J. Littell
Year Published: 2009
Type: Document
Book or Chapter or Journal Article, Synthesis

Climate changes in the Prairie Potholes and Grasslands bioregion include increased seasonal, annual,
minimum, and maximum temperature and changing precipitation patterns. Because the region is relatively dry with a strong seasonal climate, it is sensitive to climatic changes and vulnerable to changes in climatic regime. For example...

Author(s): Rachel A. Loehman
Year Published: 2009
Type: Document
Technical Report or White Paper

Modeling the effects of fire and climate change on carbon and nitrogen storage in lodgepole pine (Pinus contorta) stands
www.nrfirescience.org/resource/13547
The interaction between disturbance and climate change and resultant effects on ecosystem carbon (C) and nitrogen (N) fluxes are poorly understood. Here, we model (using CENTURY version 4.5) how climate change may affect C and N fluxes among mature and regenerating lodgepole pine (Pinus contorta var. latifolia Engelm. ex S. Wats.)...
Author(s): Erica A. H. Smithwick, Michael G. Ryan, Daniel M. Kashian, William H. Romme, Daniel B. Tinker, Monica G. Turner
Year Published: 2009
Type: Document
Book or Chapter or Journal Article

Climate and wildfire area burned in western U.S. ecoprovinces, 1916-2003
www.nrfirescience.org/resource/8228
The purpose of this paper is to quantify climatic controls on the area burned by fire in different vegetation types in the western United States. We demonstrate that wildfire area burned (WFAB) in the American West was controlled by climate during the 20th century (1916-2003). Persistent ecosystem-specific correlations between...
Author(s): Jeremy S. Littell, Donald McKenzie, David L. Peterson, Anthony L. Westerling
Year Published: 2009
Type: Document
Book or Chapter or Journal Article

Climate and wildfire area burned in western US ecoprovinces, 1916-2003
www.nrfirescience.org/resource/18977
The purpose of this paper is to quantify climatic controls on the area burned by fire in different vegetation types in the western United States. We demonstrate that wildfire area burned (WFAB) in the American West was controlled by climate during the 20th century (1916–2003). Persistent ecosystem-specific correlations between...
Author(s): Jeremy S. Littell, Donald McKenzie, David L. Peterson, Anthony L. Westerling
Year Published: 2009
Type: Document
Book or Chapter or Journal Article

Understanding the science of climate change: talking points - impacts to western mountains and forests
www.nrfirescience.org/resource/11213
Observed climate changes in the Western Mountains and Forests bioregion include increased seasonal, annual, minimum, and maximum temperatures, altered precipitation patterns, and a shift toward earlier timing of peak runoff. These climatic changes have resulted in widespread mortality in western forests, species range shifts and...
Author(s): Rachel A. Loehman, Greer Anderson
Climate and fire in the northern Rockies: past, present, and future
www.nrfirescience.org/resource/11080
The Northern Rocky Mountains have sustained wildfire for centuries. Fires are widespread throughout the region during certain years, most recently in 2000, 2003, 2006, and 2007. However, until very recently there was little understanding of whether such years of widespread fire occurred prior to the 20th century or of the role of...
Author(s): Rachel Clark
Year Published: 2009
Type: Document
Research Brief or Fact Sheet

Landscape heterogeneity following large fires: insights from Yellowstone National Park, USA
www.nrfirescience.org/resource/8198
We characterised the remarkable heterogeneity following the large, severe fires of 1988 in Yellowstone National Park (YNP), in the northern Rocky Mountains, Wyoming, USA, by focussing on spatial variation in post-fire structure, composition and ecosystem function at broad, meso, and fine scales. Ecological heterogeneity at multiple...
Author(s): Tania L. Schoennagel, Erica A. H. Smithwick, Monica G. Turner
Year Published: 2008
Type: Document
Book or Chapter or Journal Article

Multi-season climate synchronized historical fires in dry forests (1650-1900), Northern Rockies, USA
www.nrfirescience.org/resource/8388
Our objective was to infer the climate drivers of regionally synchronous fire years in dry forests of the U.S. northern Rockies in Idaho and western Montana. During our analysis period (1650-1900), we reconstructed fires from 9245 fire scars on 576 trees (mostly ponderosa pine, Pinus ponderosa P....
Author(s): Emily K. Heyerdahl, Penelope Morgan, James P. Riser
Year Published: 2008
Type: Document
Book or Chapter or Journal Article

Climate and forest wildfire in the western US
www.nrfirescience.org/resource/8183
This chapter has three goals. First, to define what climate, as opposed to weather, is, and to explain what this implies for climate versus weather forecasts. Second, to describe the scientific community’s current understanding of the relationships between climate variability and forest wildfire in the western United States. And...
Author(s): Anthony L. Westerling
Year Published: 2008
Type: Document
Book or Chapter or Journal Article, Synthesis

Climate change effects on historical range and variability of two large landscapes in western Montana, USA
Quantifying the historical range and variability of landscape composition and structure using simulation modeling is becoming an important means of assessing current landscape condition and prioritizing landscapes for ecosystem restoration. However, most simulated time series are generated using static climate conditions which fail...

Author(s): Robert E. Keane, Lisa M. Holsinger, Russell A. Parsons, Kathy L. Gray
Year Published: 2008
Type: Document
Book or Chapter or Journal Article

Charcoal and carbon storage in forest soils of the Rocky Mountain West
Charcoal represents a super-passive form of carbon (C) that is generated during fire events and is one of the few legacies of fire recorded in the soil profile; however, the importance of this material as a form of C storage has received only limited scientific attention. Here, we review the formation of charcoal in temperate and...

Author(s): Thomas H. DeLuca, Gregory H. Aplet
Year Published: 2008
Type: Document
Book or Chapter or Journal Article, Synthesis

Multi-season climate synchronized forest fires throughout the 20th century, Northern Rockies, USA
We inferred climate drivers of 20th-century years with regionally synchronous forest fires in the U.S. northern Rockies. We derived annual fire extent from an existing fire atlas that includes 5,038 fire polygons recorded from 12,070,086 ha, or 71% of the forested land in Idaho and Montana west of the Continental Divide. The 11...

Author(s): Penelope Morgan, Emily K. Heyerdahl, Carly E. Gibson
Year Published: 2008
Type: Document
Book or Chapter or Journal Article

Climate change impacts on northwestern and intermountain United States rangelands
Our focus is on the Pacific Northwest and Intermountain Region including the Great Basin, Columbia Plateau, Colorado Plateau, and surrounding areas. The climate of this large, arid to semi-arid region is defined by generally low and highly variable precipitation. Much of the yearly precipitation arrives as winter snow because most of...

Author(s): Jeanne C. Chambers, Michael L. Pellant
Year Published: 2008
Type: Document
Book or Chapter or Journal Article

The fire-climate connection
JFSP-funded research is exploring and quantifying relationships among the large-scale drivers of climate and the occurrence and extent of wildfire in the various regions of the western United States.

Author(s): Gail Wells
Year Published: 2007
Type: Document
The asymmetry of trends in spring and autumn temperature and circulation regimes over western North America
www.nrfirescience.org/resource/15710
Observational evidence shows that spring temperatures over western North America have undergone significant warming over the past half century, while autumn temperatures have shown relatively little change. Low-frequency modes of atmospheric variability for spring and autumn are demonstrated to account for a great deal of the...
Author(s): John T. Abatzoglou, Kelly T. Redmond
Year Published: 2007
Type: Document
Book or Chapter or Journal Article

Climate Change: what it means for us, our children, and our grandchildren
www.nrfirescience.org/resource/15711
Most of us are familiar with the terms climate change and global warming, but not too many of us understand the science behind them. We don’t really understand how climate change will affect us, and for that reason we might not consider it as pressing a concern as, say, housing prices or the quality of local education. This book...
Author(s): J.F.C. DiMento, P. Doughman
Year Published: 2007
Type: Document
Book or Chapter or Journal Article

Forest fire and climate change in western North America: insights from sediment charcoal records
www.nrfirescience.org/resource/7930
Millennial-scale records of forest fire provide important baseline information for ecosystem management, especially in regions with too few recent fires to describe the historical range of variability. Charcoal records from lake sediments and soil profiles are well suited for reconstructing the incidence of past fire and its...
Author(s): Daniel G. Gavin, Douglas J. Hallett, Feng S. Hu, Kenneth P. Lertzman, Susan J. Prichard, Kendrick J. Brown, Jason A. Lynch, Patrick J. Bartlein, David L. Peterson
Year Published: 2007
Type: Document
Book or Chapter or Journal Article, Synthesis

Carbon storage on landscapes with stand-replacing fires
www.nrfirescience.org/resource/18456
Many conifer forests experience stand-replacing wildfires, and these fires and subsequent recovery can change the amount of carbon released to the atmosphere because conifer forests contain large carbon stores. Stand-replacing fires switch ecosystems to being a net source of carbon as decomposition exceeds photosynthesis—short-...
Author(s): Daniel M. Kashian, William H. Romme, Daniel B. Tinker, Monica G. Turner, Michael G. Ryan
Year Published: 2006
Type: Document
Book or Chapter or Journal Article

Planetary wave breaking and nonlinear reflection: seasonal cycle and interannual variability
Forty-six years of daily averaged NCEP–NCAR reanalysis data are used to identify the occurrence of planetary wave breaking (PWB) in the subtropical upper troposphere. As large-amplitude waves propagate into the subtropics where the zonal flow is weak, they may break. PWB is diagnosed by observing the large-scale meridional...

Author(s): John T. Abatzoglou, Gudrun Magnusdottir
Year Published: 2006
Type: Document
Book or Chapter or Journal Article

Carbon storage in coniferous landscapes with stand-replacing fires: effects of fire frequency, post-fire recovery, and ecosystem processes

Many conifer forests experience stand-replacing wildfires, and these fires and subsequent recovery can change the amount of carbon released to the atmosphere because conifer forests contain large carbon stores. Stand-replacing fires switch ecosystems to being a net source of carbon as decomposition exceeds photosynthesis - a short...

Author(s): Donald M. Kashian, William H. Romme, Daniel B. Tinker, Monica G. Turner, Michael G. Ryan
Year Published: 2006
Type: Document
Book or Chapter or Journal Article

Empirical analyses of plant-climate relationships for the western United States

The Random Forests multiple-regression tree was used to model climate profiles of 25 biotic communities of the western United States and nine of their constituent species. Analyses of the communities were based on a gridded sample of ca. 140,000 points, while those for the species used presence-absence data from ca. 120,000...

Author(s): Gerald E. Rehfeldt, Nicholas L. Crookston, Marcus V. Warwell, Jeffrey S. Evans
Year Published: 2006
Type: Document
Book or Chapter or Journal Article

Combustion properties of Bromus tectorum L.: influence of ecotype and growth under four CO2 concentrations

We grew from seed the exotic invasive annual grass Bromus tectorum L., collected from three elevation ecotypes in northern Nevada, USA. Plants were exposed to four CO2 atmosphere concentrations: 270, 320, 370, and 420 umol mol⁻¹. After harvest on day 87, above-ground tissue was milled, conditioned to 30% relative humidity, and...

Author(s): Robert R. Blank, Robert H. White, Lewis H. Ziska
Year Published: 2006
Type: Document
Book or Chapter or Journal Article

Response of western mountain ecosystems to climatic variability and change: the Western Mountain Initiative

Mountain ecosystems within our national parks and other protected areas provide valuable goods and services such as clean water, biodiversity conservation, and recreational opportunities, but their
potential responses to expected climatic changes are inadequately understood. The Western Mountain Initiative (WMI) is a collaboration...

Author(s): Nathan L. Stephenson, David L. Peterson, Daniel B. Fagre, Craig D. Allen, Donald McKenzie, Jill Baron
Year Published: 2006
Type: Document
Book or Chapter or Journal Article

Regional relationships between climate and wildfire-burned area in the Interior West, USA

www.nrfirescience.org/resource/11507
Recent studies have linked the Atlantic Multidecadal Oscillation (AMO) and the Pacific Decadal Oscillation (PDO) with drought occurrence in the interior United States. This study evaluates the influence of AMO and PDO phases on interannual relationships between climate and wildfire-burned area during the 20th century. Palmer's...

Author(s): Brandon M. Collins, Philip N. Omi, Phillip L. Chapman
Year Published: 2006
Type: Document
Book or Chapter or Journal Article

Carbon cycling at the landscape scale: the effect of changes in climate and fire frequency on age distribution, stand structure, and net ecosystem production - Final Report to the Joint Fire Science Program

www.nrfirescience.org/resource/11151
We are working in Yellowstone National Park to determine how initial post-fire structural heterogeneity controls carbon dynamics over the full cycle of individual forest stands, and how climate-mediated changes in the fire regime could potentially alter the behavior of the entire Yellowstone ecosystem as a net sink or net source in...

Author(s): Michael G. Ryan, Daniel M. Kashian, Erica A. H. Smithwick, William H. Romme, Monica G. Turner, Daniel B. Tinker
Year Published: 2005
Type: Document
Technical Report or White Paper

Climate drivers of fire and fuel in the Northern Rockies: past, present & future - Final Report to the Joint Fire Science Program

www.nrfirescience.org/resource/11154
This 3-year research project is identifying the climate drivers of regional fire and fuel dynamics in the Northern Rockies in the past, present, and future. We are identifying regional fire years from two sources: multicentury tree-ring reconstructions and multidecadal fire atlases. To elucidate the climate forcing of past fires, we...

Author(s): Penelope Morgan, Emily K. Heyerdahl, Carol Miller, Matthew G. Rollins
Year Published: 2005
Type: Document
Technical Report or White Paper

Climatic controls of fire in the western United States: from the atmosphere to ecosystems - Final Report to the Joint Fire Science Program

www.nrfirescience.org/resource/11155
The objective of this project is to conduct a diagnostic analysis of the variations in climate that govern the characteristics of the fire season in the western United States on intra-annual through decadal and longer time scales. We propose a retrospective, model-based analysis to understand better the role of
climate as a control...

Author(s): Steven W. Hostetler, Patrick J. Bartlein, Allen M. Solomon, J. O. Holman, Richard T. Busing, Sarah L. Shafer
Year Published: 2005
Type: Document
Technical Report or White Paper

Effects of tree density and stand age on carbon allocation patterns in postfire lodgepole pine
www.nrfirescience.org/resource/8263
Validating the components of the carbon (C) budget in forest ecosystems is essential for developing allocation rules that allow accurate predictions of C pools and fluxes. In addition, a better understanding of the effects of natural disturbances on C cycling is critical, particularly in light of alterations to disturbance regimes...
Author(s): Creighton M. Litton, Michael G. Ryan, Dennis H. Knight
Year Published: 2004
Type: Document
Book or Chapter or Journal Article

The impact of twenty-first century climate change on wildland fire danger in the western United States: an applications perspective
www.nrfirescience.org/resource/8343
High-temporal resolution meteorological output from the Parallel Climate Model (PCM) is used to assess changes in wildland fire danger across the western United States due to climatic changes projected in the 21st century. A business-as-usual scenario incorporating changing greenhouse gas and aerosol concentrations until the year...
Author(s): Timothy J. Brown, Beth L. Hall, Anthony L. Westerling
Year Published: 2004
Type: Document
Book or Chapter or Journal Article

Climate change, carbon, and forestry in northwestern North America: proceedings of a workshop
www.nrfirescience.org/resource/11203
Interactions between forests, climatic change and the Earth's carbon cycle are complex and represent a challenge for forest managers-they are integral to the sustainable management of forests. In this volume, a number of papers are presented that describe some of the complex relationships between climate, the global carbon cycle and...
Author(s): David L. Peterson, John L. Innes, Kelly O'Brien
Year Published: 2004
Type: Document
Technical Report or White Paper

Climatic changes, wildfire, and conservation
www.nrfirescience.org/resource/8156
Climatic variability is a dominant factor affecting large wildfires in the western United States, an observation supported by palaeoecological data on charcoal in lake sediments and reconstructions from fire-scarred trees. Although current fire management focuses on fuel reductions to bring fuel loadings back to their historical...
Author(s): Donald McKenzie, Ze'ev Gedalof, David L. Peterson, Philip W. Mote
Year Published: 2004
Type: Document
Mountains, fire, fire suppression, and the carbon cycle in the western United States
www.nrfirescience.org/resource/11044
Most mountain regions in the western United States are covered by forests, which are for the most part recovering from historical harvesting and have been experiencing active fire suppression over approximately the past 100 years (Tilman and others 2000). Whereas many western landscapes are currently perceived as pristine natural...
Author(s): David S. Schimel
Year Published: 2004
Type: Document
Technical Report or White Paper

The interaction of fire, fuels, and climate across Rocky Mountain forests
www.nrfirescience.org/resource/13583
Understanding the relative influence of fuels and climate on wildfires across the Rocky Mountains is necessary to predict how fires may respond to a changing climate and to define effective fuel management approaches to controlling wildfire in this increasingly populated region. The idea that decades of fire suppression have...
Author(s): Tania L. Schoennagel, Thomas T. Veblen, William H. Romme
Year Published: 2004
Type: Document
Book or Chapter or Journal Article

Western forest, fire risk, and climate change
www.nrfirescience.org/resource/11114
Climate warming may first show up in forests as increased growth, which occurs as warmer temperatures, increased carbon dioxide, and more precipitation encourage higher rates of photosynthesis. The second way that climate change may show up in forests is through changes in disturbance regimes-the long-term patterns of fire, drought...
Author(s): Valerie A. Rapp
Year Published: 2004
Type: Document
Research Brief or Fact Sheet

An initial analysis of relationships between 2- and 10-minute averaged winds at 10, 6, and 1.8 meters: implications for fire behavior and danger applications
www.nrfirescience.org/resource/8424
Recently there has been discussion in the National Wildland Fire Coordination Group (NWCG) fire danger and fire weather working teams about the impact of observations from different anemometer heights and more importantly, averaging times, on inputs to fire management systems such as National Fire Danger Rating System (Deeming and...
Author(s): Larry S. Bradshaw, Eugene Petrescu, Isaac C. Grenfell
Year Published: 2003
Type: Document
Conference Proceedings

Climate and wildfire in the western United States
www.nrfirescience.org/resource/8184
A 21-yr gridded monthly fire-starts and acres-burned dataset from U.S. Forest Service, Bureau of Land
Management, National Park Service, and Bureau of Indian Affairs fire reports recreates the seasonality and interannual variability of wildfire in the western United States. Despite pervasive human influence in western fire regimes,…

Author(s): Anthony L. Westerling, Timothy J. Brown, Alexander Gershunov, Daniel R. Cayan, M. D. Dettinger

Year Published: 2003
Type: Document
Book or Chapter or Journal Article

The role of climate and vegetation change in shaping past and future fire regimes in the northwestern U.S. and the implications for ecosystem management

www.nrfirescience.org/resource/8382

Fire is an important part of the disturbance regimes of northwestern US forests and its role in maintaining and altering forest vegetation is evident in the paleoecological record of the region. Long-term reconstructions of Holocene fire regimes, provided by the analysis of charcoal, pollen, and other fire proxies in a network of...

Author(s): Cathy L. Whitlock, Sarah L. Shafer, Jennifer R. Marlon

Year Published: 2003
Type: Document
Book or Chapter or Journal Article

Interannual to decadal drought and wildfire in the western United States

www.nrfirescience.org/resource/8344

Twentieth-century wildfire suppression and land management policies have promoted biomass accumulations in some ecosystems in the western United States where wildfire is a natural and necessary element. These changes have fueled large, stand-replacing crown fires in southwestern ponderosa pine forests, where they were rare under...

Author(s): Anthony L. Westerling, Thomas W. Swetnam

Year Published: 2003
Type: Document
Book or Chapter or Journal Article, Synthesis

Training ecologists to think with uncertainty in mind

www.nrfirescience.org/resource/12642

Predictive capacity is needed to anticipate the consequences of global change. Along with the computational challenges inherent in accounting for uncertainty in models of ecological and physical processes related to global change, we face educational challenges related to developing the intellectual capital for thinking with...

Author(s): Carol A. Brewer, Louis J. Gross

Year Published: 2003
Type: Document
Book or Chapter or Journal Article, Synthesis

Climate change and forest disturbances

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
Are old forests underestimated as global carbon sinks?  
**www.nrfirescience.org/resource/7916**

Old forests are important carbon pools, but are thought to be insignificant as current atmospheric carbon sinks. This perception is based on the assumption that changes in productivity with age in complex, multiaged, multispecies natural forests can be modelled simply as scaled-up versions of individual trees or even-aged stands....

Author(s): Eileen V. Carey, Anna Sala, Robert E. Keane, Ragan M. Callaway  
Year Published: 2001  
Type: Document  
Book or Chapter or Journal Article

Interactions between fire, grazing, and climate change at Wind Cave National Park, SD  
**www.nrfirescience.org/resource/7909**

Projected changes in global climate have important ramifications for the future of national parks and other reserves set aside to conserve ecological uniqueness. We explored potential implications of climatic changes on lifeform distribution and growth at Wind Cave National Park (WCNP), South Dakota, which lies on a climatically....

Author(s): Dominique Bachelet, James M. Lenihan, Christopher Daly, Ronald P. Neilson  
Year Published: 2000  
Type: Document  
Book or Chapter or Journal Article

Fire-climate interactions in the Selway-Bitterroot Wilderness area  
**www.nrfirescience.org/resource/11887**

Tree-ring reconstructed summer drought was examined in relation to the occurrence of 15 fires in the Selway-Bitterroot Wilderness Area (SBW). The ten largest fire years between 1880 and 1995 were selected from historical fire atlas data; five additional fire years were selected from a fire history completed in a subalpine forest....

Author(s): Kurt F. Kipfmueller, Thomas W. Swetnam  
Year Published: 2000  
Type: Document  
Conference Proceedings

Assessing simulated ecosystem processes for climate variability research at Glacier National Park, USA  
**www.nrfirescience.org/resource/8378**

Glacier National Park served as a test site for ecosystem analyses that involved a suite of integrated models embedded within a geographic information system. The goal of the exercise was to provide managers with maps that could illustrate probable shifts in vegetation, net primary production (NPP), and hydrologic responses....

Author(s): Joseph D. White, Steven W. Running, Peter Thornton, Robert E. Keane, Kevin C. Ryan, Daniel B. Fagre, Carl H. Key  
Year Published: 1998  
Type: Document  
Book or Chapter or Journal Article
Intermountain West lightning-caused fires: climatic predictors of area burned
www.nrfirescience.org/resource/11460
An increase in continuous fine fuels promoted by the expansion of aggressive annual exotic grasses in the Intermountain West has altered the region's fire regimes, with both ecologic and economic ramifications. I examine the predictive nature of seasonal climatic variables, seasonal precipitation and temperature data up to 2 years...
Author(s): Paul A. Knapp
Year Published: 1995
Type: Document
Book or Chapter or Journal Article

Soil-water trends following wildfire on the Entiat Experimental Forest
www.nrfirescience.org/resource/18575
From the text ... "The quantitative effects of the reduction in soil-water loss by evapotranspiration vary under different physiographic conditions, intensities or vegetation removal or deadening, and the kind of vegetation removed. Intense wildfire can destroy all foliar vegetation and would be expected to have the greatest impact..."
Author(s): G. O. Klock, J. D. Helvey
Year Published: 1976
Type: Document
Conference Proceedings

Climate change, disturbances and landscape dynamics
www.nrfirescience.org/resource/18407
This chapter is within a book by Walker and Steffen that presents a collection of essays by leading authorities who address the current state of knowledge. The chapters bring together the early results of an international scientific research program designed to address what will happen to our ability to produce food and fiber...
Type: Document
Book or Chapter or Journal Article

Climate change 2014: Mitigation of climate change
www.nrfirescience.org/resource/18411
The Working Group III contribution to the IPCC’s Fifth Assessment Report (AR5) assesses literature on the scientific, technological, environmental, economic and social aspects of mitigation of climate change. It builds upon the Working Group III contribution to the IPCC’s Fourth Assessment Report (AR4), the Special Report on...
Type: Document
Book or Chapter or Journal Article

The Impacts of Wildfire Characteristics and Employment on the Adaptive Management Strategies in the Intermountain West
www.nrfirescience.org/resource/18758
Widespread development and shifts from rural to urban areas within the Wildland-Urban Interface (WUI) has increased fire risks to local populations, as well as introduced complex and long-term costs and benefits to communities. We use an interdisciplinary approach to investigate how trends in fire characteristics influence adaptive...
Author(s): Liana Prudencio, Ryan Choi, Emily Esplin, Muyang Ge, Natalie Gillard, Jeffrey Haight, Patrick Belmont, Courtney Flint
Type: Document