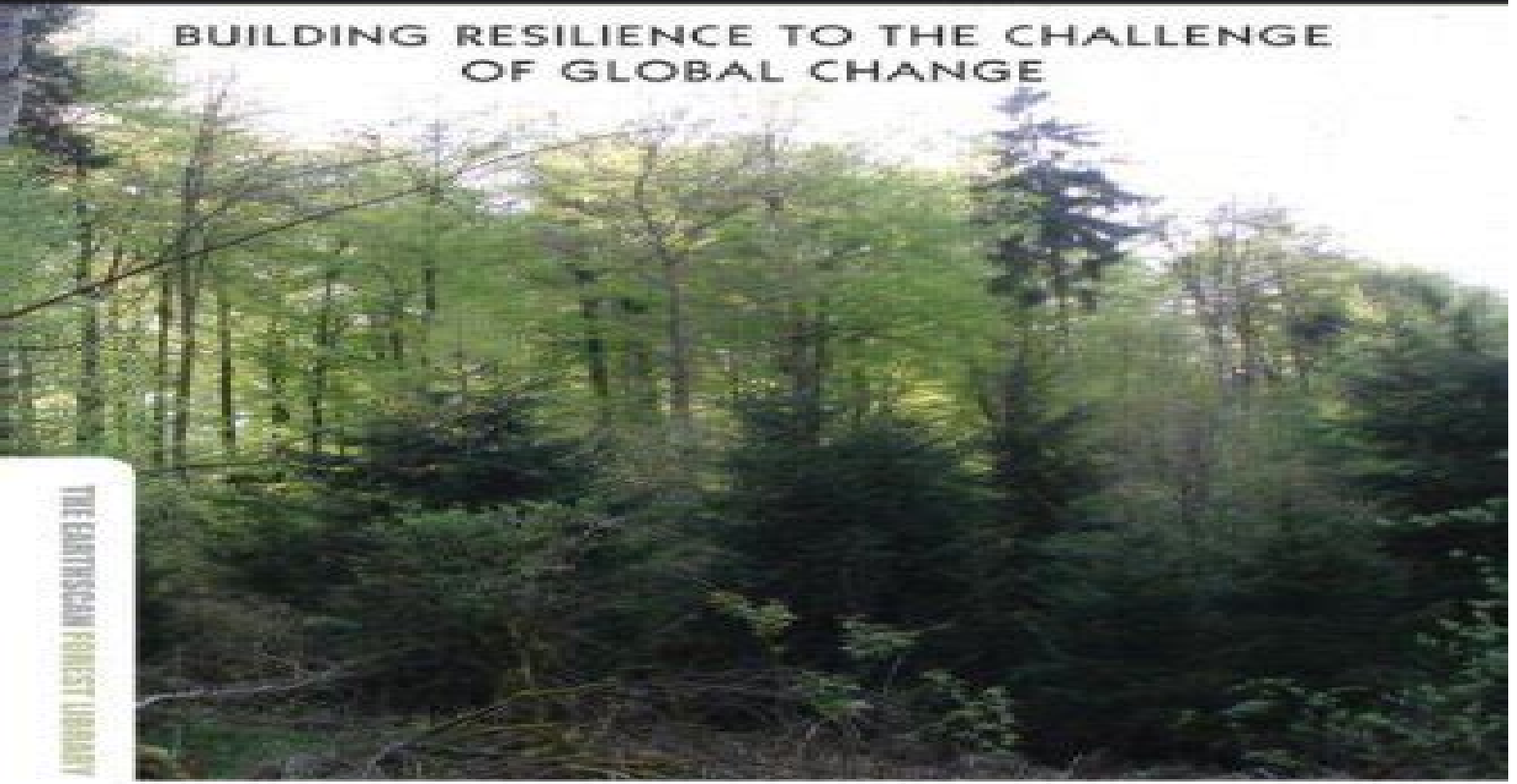
Managing Forests as Complex Adaptive Systems

BUILDING RESILIENCE TO THE CHALLENGE OF GLOBAL CHANGE



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Managing Forests As Complex Adaptive Systems Building Resilience To The Challenge Of Global Change The Earthscan Forest Library

Christian Messier,Klaus J. Puettmann,K. David Coates

Managing Forests As Complex Adaptive Systems Building Resilience To The Challenge Of Global Change The Earthscan Forest Library:

Managing Forests as Complex Adaptive Systems Christian Messier,Klaus J. Puettmann,K. David Coates,2013-02-11 This book links the emerging concepts of complexity complex adaptive system CAS and resilience to forest ecology and management It explores how these concepts can be applied in various forest biomes of the world with their different ecological economic and social settings and history Individual chapters stress different elements of these concepts based on the specific setting and expertise of the authors Regions and authors have been selected to cover a diversity of viewpoints and emphases from silviculture and natural forests to forest restoration and from boreal to tropical forests The chapters show that there is no single generally applicable approach to forest management that applies to all settings The first set of chapters provides a global overview of how complexity CAS and resilience theory can benefit researchers who study forest ecosystems A second set of chapters provides guidance for managers in understanding how these concepts can help them to facilitate forest ecosystem change and renewal adapt or self organize in the face of global change while still delivering the goods and services desired by humans The book takes a broad approach by covering a variety of forest biomes and the full range of management goals from timber production to forest restoration to promote the maintenance of biodiversity quality of water or carbon storage Ecological Forest Management Handbook Guy R. Larocque,2024-08-21 The second edition of Ecological Forest Management Handbook continues to provide forestry professionals and students with basic principles of ecological forest management and their applications at regional and site specific levels Thoroughly updated and revised the handbook addresses numerous topics and explains that ecological forest management is a complex process that requires broad ecological knowledge It discusses how to develop adaptive management scenarios to harvest resources in a sustainable way and provide ecosystem services and social functions It includes new studies on ecological indicators the carbon cycle and ecosystem simulation models for various forest types boreal temperate and tropical forests NEW IN THE SECOND EDITION Provides a comprehensive collection of sustainable forest management principles and their applications Covers new ecological indicators that can be applied to address forest environmental issues Includes all types of models empirical gap and process based models Explains several basic ecological and management concepts in a clear easy to understand manner This handbook is intended for researchers academics professionals and undergraduate and graduate students studying and or involved in the management of forest ecosystems Chapters 16 and 18 of this book are available for free in PDF format as Open Access from the individual product page at www taylorfrancis com They have been made available under a Creative Commons Attribution Non Commercial No Derivatives 4 0 license **Boreal Forests in the Face of Climate Change** Miguel Montoro Girona,Hubert Morin,Sylvie Gauthier,Yves Bergeron,2023-03-01 This open access book explores a new conceptual framework for the sustainable management of the boreal forest in the face of climate change

The boreal forest is the second largest terrestrial biome on Earth and covers a 14 million km2 belt representing about 25% of the Earth s forest area Two thirds of this forest biome is managed and supplies 37% of global wood production These forests also provide a range of natural resources and ecosystem services essential to humanity However climate change is altering species distributions natural disturbance regimes and forest ecosystem structure and functioning Although sustainable management is the main goal across the boreal biome a novel framework is required to adapt forest strategies and practices to climate change This collaborative effort draws upon 148 authors in summarizing the sustainable management of these forests and detailing the most recent experimental and observational results collected from across the boreal biome It presents the state of sustainable management in boreal forests and highlights the critical importance of this biome in a context of global change because of these forests key role in a range of natural processes including carbon sequestration nutrient cycling and the maintaining of biodiversity This book is an essential read for academics students and practitioners involved in boreal forest management It outlines the challenges facing sustainable boreal forest management within the context of climate change and serves as a basis for establishing new research avenues identifying future research trends and developing climate adapted forest management plans Climate-Smart Forestry in Mountain Regions Roberto Tognetti,Melanie Smith,Pietro Panzacchi,2021-11-24 This open access book offers a cross sectoral reference for both managers and scientists interested in climate smart forestry focusing on mountain regions It provides a comprehensive analysis on forest issues facilitating the implementation of climate objectives This book includes structured summaries of each chapter Funded by the EU s Horizon 2020 programme CLIMO has brought together scientists and experts in continental and regional focus assessments through a cross sectoral approach facilitating the implementation of climate objectives CLIMO has provided scientific analysis on issues including criteria and indicators growth dynamics management prescriptions long term perspectives monitoring technologies economic impacts and governance tools **Continuous Cover Forestry in Boreal Nordic Countries** Pasi Rautio,Johanna Routa,Saija Huuskonen,Emma Holmström,Jonas Cedergren,Christian Kuehne,2024-12-05 This open access book compiles the latest research on continuous cover forestry in boreal forests highlighting both the need for additional information and the exciting possibilities that this method presents Experts in the field explore topics such as forest regeneration genetic effects wood production and yield wood harvesting forest damage agents biodiversity water effects carbon cycles of forests economics forest planning methods multiple uses of forests and forest owners attitudes As the world faces increasing pressure to balance the multiple goals of forest management including raw material production carbon sequestration biodiversity and climate change adaptation it is becoming clear that different forest management methods are required Even aged forest management is well researched but continuous forest management is a newer and rapidly evolving approach that is gaining popularity in boreal forests While an overall synthesis of the subject is not yet possible this book provides an essential foundation for understanding the current

state of continuous cover forestry in boreal forests With the new research data being accumulated all the time this book is an invaluable resource for researchers policymakers and forest managers who want to stay up to date on this important topic

Pines and Their Mixed Forest Ecosystems in the Mediterranean Basin Gidi Ne'eman,Yagil Osem,2021-10-12 Almost 20 years after the first MEDPINE book Ecology biogeography and management of Pinus halepensis and P brutia forest ecosystems in the Mediterranean basin Ne eman and Trabaud 2000 was published this new book presents up to date and state of the art information covering a wide range of topics concerning Mediterranean pine trees growing in native and planted forests their ecosystems and management This will be an essential source of scientific information for learning exploring planning and managing mediterranean pine and mixed forests We focus on genetics adaptation distribution and evolution ecophysiology and drought resistance pine and mixed forest ecosystems forest dynamics biodiversity and biotic interactions fire ecology ecosystem services and policy afforestation and management all under the effect of global climate change While forests are studied mainly in temperate and tropical zones in the light of current climate change focusing on Mediterranean forests growing in semi humid to semi arid zones is more important than ever This book will include mostly review chapters and two outstanding case studies contributed by leading scientists foresters and managers and will serve as a scientific textbook for students of biology agriculture and forestry researchers of ecology forestry and related fields forest managers policy and decision makers **Large-scale Forest Restoration** David Lamb,2014-09-19 Landscapes are being degraded and simplified across the globe This book explores how forest restoration might be carried out to increase landscape heterogeneity improve ecological functioning and restore ecosystem services in such landscapes It focuses on large landscape scale reforestation because that is the scale at which restoration is needed if many of the problems that have now developed are to be addressed It also shows how large scale forest restoration might improve human livelihoods as well as improve conservation outcomes A number of governments have undertaken national reforestation programs in recent years some have been more successful than others The author reviews these to explore what type of reforestation should be used where this should be carried out and how much should be done For example are the traditional industrial forms of reforestation necessarily the best to use in all situations How can forest restoration be reconciled with the need for food security And are there spatial thresholds that must be exceeded to generate economic and environmental benefits The book also examines the policy and institutional settings needed to encourage large scale reforestation This includes a discussion of the place for incentives to encourage landholders to undertake particular types of reforestation and to reforest particular locations It also considers forms of governance that are likely to lead to an equitable sharing of the costs and benefits of forest restoration **The Landscape of the Sierra Nevada** Regino Zamora,Marc Oliva,2022-06-09 This book covers the landscape geography and environment of the Sierra Nevada in Spain The Sierra Nevada hosted the last glaciers in southern Europe Today it is one of the most important centers of plant diversity in the western Mediterranean and one of the most

outstanding in Europe This massif has ideal conditions to analyze past environments as well as the effects of global change on ecosystems This can be seen in the large number of projects that are being conducted within the umbrella of the Sierra Nevada Global Change Observatory This book summarizes all the scientific knowledge available about this massif from the geomorphological and ecological perspectives to the recent spatial adaptive management and Open Science initiatives Focusing on the very sensitive mountain environment of Sierra Nevada the book intends to be a reference for many people interested in mountain processes The audience would include scientists from all disciplines but it would also target on an audience beyond the academia territorial managers environmentalists mountaineers politicians technicians etc Canadian Journal of Forest Research ,2015 *Resilient Forest Management* Philip J. Burton,2025-05-06 Global forest management is now grappling with ways to address the many dimensions of global change including a warming climate and increasing forest disturbance from fires and pest outbreaks along with changes in public values However the dominant forest management paradigms still assume a constant and predictable world in which command and control i e treating long lived forests much like short lived agricultural crops and single value i e timber optimization still prevail This novel text argues for new approaches to forest management that focus on resilience and embracing adaptability to the changing socio ecological environment as it unfolds Resilience is the ability of a system to maintain its essential attributes in the form of composition structure and or function in response to stress disruption or disturbance Managing a system for resilience places an emphasis on persistence rather than growth efficiency or profitability which can be fulfilled by enhancing the capacity to resist change i e robustness or by enhancing the capacity to incorporate change in desirable directions i e flexibility or a combination of the two Resilient Forest Management develops many of the same resilience enhancing strategies for protected areas multi purpose forests and timber production lands but with different degrees of emphasis Featured prominently are practices that enhance diversity connectivity in space and time and adaptive management as informed by vulnerability analysis and broad stakeholder consultation In so doing Resilient Forest Management builds on foundational concepts of ecological forestry and our understanding of complex adaptive systems and takes sustainable forest management to the next level Resilient Forest Management will be suitable as a primary or supplementary text in forest policy and management It will appeal to graduate level students and researchers in the fields of forestry and conservation along with active policymakers in government the forest industry and environmental non governmental organizations While focused on forestry parks managers agriculturists and urban planners too will find much useful insight and many creative solutions to sustainable development in a changing world **Forests as Complex Social and Ecological Systems** Patrick J. Baker,David R. Larsen,Alark Saxena,2022-05-17 Professor Chadwick Dearing Oliver has made major intellectual contributions to forest science and natural resources management Over the course of his career he has actively sought to bring research and practice together through synthesis outreach and capacity building A common thread throughout his

career has been complexity and how we as a society understand and manage complex systems His work on forest stand dynamics landscape management and sustainability have all focused on the emergent properties of complex ecological and or social systems This volume celebrates a remarkable career through a diverse group of former students and colleagues who work on a wide range of subject areas related to the management of complex natural resource systems Over the past decade there has been considerable discussion about forests as complex adaptive systems Advances in remote sensing social methods and data collection and processing have enabled more detailed characterisations of complex natural systems across spatial and temporal scales than ever before Making sense of these data however requires conceptual frameworks that are robust to the complexity of the systems and their inherent dynamics particularly in the context of global change This volume presents a collection of cutting edge research on natural ecosystems and their dynamics through the lens of complex adaptive systems It includes contributions by a wide range of authors from academia NGOs forest industry and governmental organisations with diverse perspectives on forests and natural resources management Each chapter offers new insights into how these systems can be made more resilient to ensure that they provide a diversity of ecological and social values well into the future Together they provide a robust way of thinking about the many challenges that natural ecosystems face and how we as society may best address them **Forest Ecosystem Management and Timber Production** Russell Warman,2018-12-07 Timber sourcing is shifting from extraction from natural forests to forms of cultivation that are increasingly agricultural in nature This book takes a multidisciplinary approach to examine the socio political biophysical and discursive dimensions of this divergence of wood production from forests This analysis challenges the historical integration of wood production and forest ecosystem management exemplified by the institutions of forestry with their inherent wood forest connection This has significant implications for how wood and forest socio ecological systems confront change and challenge ideas about how to achieve sustainability Historically the institutions of stewardship forestry were founded on ideals of sustainable systems in long term equilibrium However these occur within rapidly evolving social and technological contexts that constantly challenge the maintenance of any equilibrium This creates considerable tension within wood and forest socio ecological systems and their institutions and governance Moving beyond adaptation to transformation however requires a willingness to consider post forestry conditions such as integration of emerging wood cultivation systems into agricultural and landscape approaches and increasing management of extensive forest ecosystems for non wood values in the absence of wood production This book includes four case studies a global modelling of shifts in wood production and three national case studies Australia Indonesia and New Zealand each analysing shifts in resilience in wood and forest socio ecological systems using a different disciplinary approach This book will be of interest to advanced students researchers and professionals in forestry land use conservation rural studies and geography *Forest Governance and Management Across Time* Erland Mårald,Camilla Sandstrom,Annika Nordin,and Others,2017-09-22 The influence of the past and of the future on current time

tradeoffs in the forest arena are particularly relevant given the long term successions in forest landscapes and the hundred years rotations in forestry Historically established path dependencies and conflicts determine our present situation and delimit what is possible to achieve Similarly future trends and desires have a large influence on decision making Nevertheless decisions about forest governance and management are always made in the present in the present time appraisal of the developed situation future alternatives and in negotiation between different perspectives interests and actors This book explores historic and future outlooks as well as current tradeoffs and methods in forest governance and management It emphasizes the generality and complexity with empirical data from Sweden and internationally It first investigates from a historical perspective how previous forest policies and discourses have influenced current forest governance and management Second it considers methods to explore alternative forest futures and how the results from such investigations may influence the present Third it examines current methods of balancing tradeoffs in decision making among ecosystem services Based on the findings the authors develop an integrated approach Reflexive Forestry to support exchange of knowledge and understandings to enable capacity building and the establishment of common ground Such societal agreements or what the authors elaborate as forest social contracts are sets of relational commitment between involved actors that may generate mutual action and a common directionality to meet contemporary challenges

Managing Forest Ecosystems: The Challenge of Climate Change Felipe Bravo,Valerie LeMay,Robert Jandl,2017-04-03 Climate change shaped the political agenda during the last decade with three issues as hot topics commonly making the headlines carbon budgets impact and mitigation of climate change Given the significant role that forests play in the climate system as sources sinks and through carbon trading this book update the current scientific evidences on the relationships between climate forest resources and forest management practices around the world By including the forest scientists expertise from around the world the book presents and updates a depth analysis of the current knowledge and a series of case studies focused on the biological and the economic impacts of climate change in forest ecosystems in Africa Asia Europe and North and South America The book will form a valuable resource for researchers and advanced students dealing with sustainable forestry climate change issues and the effects of climate change on natural resource management The Complex Forest Carol J. Pierce Colfer,2005 First Published in 2005 Routledge is an imprint of Taylor Francis an informa company Sustainable Forest Management in a Changing World: a European Perspective Peter Spathelf,2009-12-04 Yet another book on the topic of Sustainable Forest Management can only be justified by new information that is of direct relevance The contents of this volume concentrate on the very latest factors and developments thus hopefully contributing both to the book s attractiveness and to closing gaps in the discipline s database This book is written for researchers in the field of forest management international forestry and climate change related issues legal and policy advisors as well as for managers of private companies who deal with SFM The authors of the various sections are

scientists in the field of forestry and other environmental sciences They represent different institutions mainly universities and research agencies in Germany but also high level international institutions in development co operation such as the World Bank FAO and IIASA The scope of the book is to refresh the meanings and perceptions of SFM against the background of the rapid changes in our natural and social environment Climate change and the rapid increase of atmospheric CO concentration is a global process 2 with negative impacts of different kinds among others on natural ecosystems such as forests A crucial issue therefore is how forest management can contribute to forest conservation in light of changing climatic conditions Moreover policy changes such as the introduction of certification schemes and the new emphasis laid on Non Wood Forest Products justify the re evaluation of the role of SFM in delivering ecological goods and services from our forests

Forests in Landscapes Stewart Maginnis,Jeffrey A Sayer,2013-06-17 At last a really useful book telling us how all the rhetoric about ecosystem approaches and sustainable forest management is being translated into practical solutions on the ground CLAUDE MARTIN WWF INTERNATIONAL For too long foresters have seen forests as logs waiting to be turned into something useful This book demonstrates that forests in fact have multiple values and managing them as ecosystems will bring more benefits to a greater cross section of the public JEFFREY A MCNEELY CHIEF SCIENTIST IUCN This book demonstrates that ecosystem approaches and sustainable forest management are neither alternative methods of forest management nor are they simply complicated ways of saying the same thing They are both emerging concepts for more integrated and holistic ways of managing forests within larger landscapes in ways that optimize benefits to all stakeholders ACHIM STEINER AND IAN JOHNSON FROM THE FOREWORD Recent innovations in Sustainable Forest Management and Ecosystem Approaches are resulting in forests increasingly being managed as part of the broader social ecological systems in which they exist Forests in Landscapes reviews changes that have occurred in forest management in recent decades Case studies from Europe Canada the United States Russia Australia the Congo and Central America provide a wealth of international examples of innovative practices Cross cutting chapters examine the political ecology and economics of forest management and review the information needs and the use and misuse of criteria and indicators to achieve broad societal goals for forests A concluding chapter draws out the key lessons of changes in forest management in recent decades and sets out some thoughts for the future This book is a must read for practitioners researchers and policy makers concerned with forests and land use It contains lessons for all those concerned with forests as sources of people s livelihoods and as part of rural landscapes Published with IUCN and PROFOR *Forest Resilience Measured* Carrie Levine Levine,2017 Maintaining the resilience of ecological systems in an era of global change is a priority for management and conservation In California forests are currently threatened by a suite of disturbances that include altered fire regimes legacy effects from timber harvesting a warming and drying climate chronic air pollution and uncharacteristically severe attacks by insects and pathogens Managing to preserve the characteristic structure and function of California forests under novel disturbance

regimes requires a clear understanding of these forests historical conditions as well as an understanding of the drivers of change in these forests A major challenge of managing for resilience is the lack of quantifiable metrics to assess changes in a system s resilience over time This dissertation uses a multi timescale approach that quantifies changes in the structure and composition of California mixed conifer forests since European settlement and suggests a framework for measuring and monitoring forest resilience This work can be used to guide conservation and restoration activities with the goal of maintaining the characteristic structure and function of forests under changing disturbance regimes In Chapter 1 I explore the demographic responses that have led to a reordering of species dominance in Sierra Nevada mixed conifer forests California mixed conifer forests have been subjected to a century of fire suppression resulting in a shift in the structure and composition of these forests over time Historically a high frequency low severity fire regime maintained structurally heterogeneous forests where dominance was shared among several conifer species With the removal of fire from this system forest density increased as did the prevalence of shade tolerant fir species at the expense of pines Previous work suggests that species specific differences in demography have contributed to a shift away from a heterogeneous resilient forest to a monodominant forest that is more susceptible to catastrophic loss from fire drought or invasive pests or pathogens However these conclusions are typically derived from extrapolations from short term data I use a 57 year inventory record from an old growth mixedconifer stand in the Plumas National Forest CA where fires have been excluded since the early 20th century Using a Bayesian hierarchical modeling approach I measure species specific rates of mortality recruitment and growth over this 57 year period I also correlated climate trends with demographic data to determine whether climate may be a driver of shifts in species composition I found that basal area density and aboveground carbon have increased linearly over the 57 year period in spite of increasing temperatures which I expected might have negatively affected growth The recruitment and growth rates of Pseudotsuga menziesii Douglas fir and Abies concolor white fir were significantly higher than the community level means while the recruitment and growth rates of Pinus lambertiana sugar pine and Pinus ponderosa ponderosa pine were significantly lower than the community level means Mortality rates were similar among species These results indicate that differences in species specific growth and recruitment rates are the main drivers of a shift towards a low diversity forest system and may potentially lead to the loss of pines from mixed conifer forests These results also quantify the strong effect that fire has on the regulation of forest biomass and density in this system In Chapter 2 I address the need for accurate understandings of historical forest conditions to be used as guides when implementing management and restoration plans Because historical Sierra Nevada mixed conifer forests were considered to be resilient to disturbance due to their heterogeneous structure and function historical conditions are often considered to be the target state for restoration However multiple methods for estimating historical forest conditions are available and these methods sometimes give conflicting results regarding the density of forests prior to European settlement The General Land Office GLO surveys of the

late 19th and early 20th centuries provide data on forest structure across a broad geographic range of the western US Distance based plotless density estimators PDE have been used previously to estimate density from the GLO data but this approach is limited due to errors that arise when trees are not randomly distributed Recently an area based method was developed in order overcome this limitation of distance based PDEs The area based method relies on estimating the speciesspecific Voronoi area of individual trees based on regression equations derived in contemporary stands This method predicts historical densities that are 2 5 times higher than previous estimates and the method has not been independently vetted I applied three distance based PDEs Cottam Pollard and Morisita and two area based PDEs Delinc and mean harmonic Voronoi density MHVD in six mixed conifer and pine dominated stands in California US and Baja California Norte Mexico These stands ranged in density from 784 159 trees ha 1 I found that the least biased estimate of tree density in every stand was obtained with the Morisita estimator and the most biased was obtained with the MHVD estimator Estimates of tree density derived from the MHVD estimator were 1 4 times larger than the true densities While the concept of area based estimators is theoretically sound as demonstrated by the accuracy of the Delinc estimates the Delinc approach cannot be used with GLO data and the extension of the approach to the MHVD estimator is flawed The inaccuracy of the MHVD method was attributed to two causes 1 the use of a crown scaling factor that does not correct for the number of trees sampled and 2 the persistent underestimate of the true VA due to a weak relationship between tree size and VA The results of this study suggest that estimates of historical conditions derived from applying the MHVD method to GLO data are likely to overestimate density and that tree size is not an accurate predictor of tree area in these open canopy forests I suggest caution in using density estimates derived from the MHVD method to inform restoration and management in Sierra Nevada mixed conifer forests and recommend the Morisita estimator as the least biased of the distance based estimators In Chapter 3 I address the concept of resilience as it relates to forest ecology and management and outline a framework that can be used to determine quantifiable metrics of resilience Resilience is an aggregate property of ecological systems that maintains the structure function and composition of the system when faced with a disturbance The main challenge inherent in using resilience to inform management and conservation is the multitude of definitions and concepts that have been developed to describe the resilience of ecological systems The framework I develop for operationalizing resilience builds on the theoretical concept of resilience but provides explicit metrics for measurement In this framework resilience is composed of two properties resistance to disturbance and recovery from disturbance I outline four dimensions of resistance and recovery that can be used to measure and monitor resilience including heterogeneity complexity quality and reserves I dispense with the concept of strictly defined alternate stable states and instead focus resilience goals on target states which are determined by ecological economic recreational or aesthetic considerations I also conduct a literature review of papers which measure forest resilience to assess measurements and analyses that can be used to quantify the four dimensions of resilience in the

context of resistance and recovery The results of this review indicate that studies of resilience can effectively make use of simple methods for quantification and analysis and that the most compelling studies address both components of resilience resistance to and recovery from disturbance and multiple dimensions of resilience I then apply metrics to quantify the dimensions of resilience in three case study systems the Sierra Nevada mixed conifer forest of California the eastern hemlock forest of the northeastern US and the northern hardwood forest of the northeastern US I found that this resilience framework is limited by the fact that no single absolute measure of resilience can be derived However the framework is useful for defining baseline resilience measures and establishing protocols for measuring relative changes in forest resilience over time

Managing Forests and Water for People under a Changing Environment Ge Sun,Kevin Bishop,Silvio Ferraz,Julia Jones,2020-05-13 Forests cover 30% of the Earth s land area or nearly four billion hectares Enhancing the benefits and ecosystem services of forests has been increasingly recognized as an essential part of nature based solutions for solving many emerging global environmental problems today A core science supporting forest management is understanding the interactions of forests water and people These interactions have become increasingly complex under climate change and its associated impacts such as the increases in the intensity and frequency of drought and floods increasing population and deforestation and a rise in global demands for multiple ecosystem services including clean water supply and carbon sequestration Forest watershed managers have recognized that water management is an essential component of forest management Global environmental change is posing more challenges for managing forests and water toward sustainable development New science on forest and water is critically needed across the globe The International Forests and Water Conference 2018 Valdivia Chile http forestsandwater2018 cl a joint effort of the 5th IUFRO International Conference on Forests and Water in a Changing Environment and the Second Latin American Conference on Forests and Water provided a unique forum to examine forest and water issues in Latin America under a global context This book represents a collection of some of the peer reviewed papers presented at the conference that were published in a Special Issue of Forests

Managing Novel Forest Ecosystems Kevin Krasnow,2012 Unprecedented anthropogenic global changes challenge the ability of societies to sustain desirable features of the environment Some argue that we have entered a new global epoch where human activity is the major driver of environmental change This is resoundingly true for American western forests which have seen dramatic changes in disturbance regimes species composition and hydrologic and nutrient cycles due to fire suppression air pollution land use change and climate change These novel stressors have resulted in unprecedented conditions that may require new adaptive approaches to management focused on building resilience The following research examines novel approaches to revitalizing a disturbance dependent foundation tree species in the Sierra Nevada and reconstructs temporal and spatial components of historical fire regimes in the Sierra Nevada These research threads help us understand how Sierran ecosystems functioned before Euro American management how these ecosystems are behaving

today and give insight into how we can manage for ecological resilience in the century to come Aspen Populus tremuloides comprises only a small fraction 1% of the Sierra Nevada landscape yet contributes significant biological diversity to this range There is currently a high level of concern in the Western United States about declining vigor in mature aspen stands that often lack sufficient regeneration to ensure their long term persistence It is also highly uncertain if aspen will be able to accommodate the rapid climate changes predicted for the next century via migration through seedling establishment I the first two studies following I report on the efficacy of aspen revitalization management strategies post wildfire regeneration dynamics experimental human assisted migration and recent aspen seedling establishment in the Lake Tahoe Basin and eastern Sierra Nevada I find substantial evidence that greater disturbance severity yields increased aspen sprout density and growth rates I also find compelling evidence that post fire aspen ramets are robust transplant material having higher transplant survival rates than ramets from unburned stands as well as greenhouse grown seedlings Fire is a key ecological process in dry mixed conifer forests that historically burned frequently Many of these forests on the western slope of the Sierra Nevada have been highly altered by a century of fire suppression mining logging and land use change which have homogenized forest structure over large areas Historical spatial and temporal patterns of fire can be used to inform current and future disturbance based management seeking to restore ecosystem heterogeneity and resilience that had been supported by frequent low to moderate severity fires prior to the twentieth century Temporal patterns of historical fire are well known in these forests but there is a high degree of uncertainty regarding the spatial dynamics of the pre settlement fire regime In the final study presented here I reconstruct the spatial and temporal dynamics of wildfire from 1750 1900 in a 3000 ha mixed conifer forest in the southern Sierra Nevada using data from 118 fire scared tree samples Fire was once common in these forests that have not burned for 80 100 years with mean fire return intervals from both spatially explicit and non spatial temporal reconstructions ranging from 3 11 years A vast majority of fires in this area 97% occurred late in the growing season or during tree dormancy and no significant controls on fire frequency were identified by slope aspect Spatially explicit fire frequency reconstructions can aid in landscape scale disturbance based management aimed at increasing forest resilience and reducing fire risk

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