

Wildland Fire, Human Perspectives and Fire Management in Jackson Hole, Wyoming

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Summary: This Wildland fire management course will examine the interface and interactions of forest ecology; fire behavior and physics; human values and economics; fire management and climate change. This course will focus on the forests of the Rocky Mountains using a case study of the Green Knoll fire and the Wildland Urban Interface in Jackson Hole, Wyoming. Students will experience fire and wildland urban interface field data collection, stakeholder interviews, management plan preparation, and synthesis of climate change adaptation. The overall educational approach is student inquiry followed by problem solving in a real world environment with presentation of solutions to stakeholders.

Topical areas: Wildland fire, fire ecology, resource management, socio-environmental synthesis, systems thinking

What course(s) is this case appropriate for? Graduate students in resource management, ecology, environmental science/studies. Undergraduate upper level science majors. Could be used with modifications and extensions in science majors in introductory courses and non-majors (liberal studies courses).

Education level: First year Master's students and upper division undergraduates

Type/method: This is a decision/dilemma case study that uses a problem based learning model, with minor jigsaw components.

Socio-Environmental Synthesis Learning Goals:

1. Understand and explore the historical role of fire and it's ecological importance
2. Understand history, assumptions, values, and evolution of American wildfire management
3. Experience and apply the S-E synthesis framework to modern wildfire management
4. Develop future directions / recommendations for wildfire policy / management / adaptation

Student Learning Objectives: Student Learning Objectives (SLO) are categorized by goals;

Goal 1: Understand and explore the historical role of fire and it's ecological importance

Student Learning Objectives:

SLO 1: Understanding of wildland fuel strata and fire behavior

SLO 2: Understanding of the major components of fire regimes (frequency, severity, size, seasonality, interactions)

SLO 3: Understand the relations between fire frequency and severity to both fuel and climate (understand and differentiate between fuel vs. climate limited systems)

SLO 4: Find/collect and analyze fire history data (dating fire scars from Sierra and JH)

SLO 5: Collect and/or analyze contemporary tree cores from Mosquito Creek/Green Knoll Fire

SLO 6: Link stand age data (and or fire scars) to past fire occurrence, post-fire regeneration, and fire adaptations of lodgepole pine (serotinous cones, fast maturity)

SLO 7: Understand future climate projections and ecological / physical impacts

Goal 2: Understand history, assumptions, values, and evolution of American wildfire management

Student Learning Objectives:

SLO 8: Understand the history of wildfire management in the US, and which forests have been altered as a result

SLO 9: Understand and track the development of human values in wildland urban interface in JH (and nationally)

SLO 10: Understand the recent history of JH fires. Appreciate the complexity of wildland fire management decision making

SLO 11: Identify major stakeholders and understand their values, perceptions, and priorities

Goal 3: Develop future directions / recommendations for wildfire policy / management / adaptation

Student Learning Objectives:

SLO 9: Understand and track the development of human values in wildland urban interface in JH (and nationally)

SLO 11: Identify major stakeholders and understand their values, perceptions, and priorities

SLO 12: Synthesize and articulate how modern fire management must balance historical ecology, human values, and likely future trajectories (of both fire occurrence and behavior as well as human development)

Goal 4: Develop and synthesize a climate adaptation plan for wildfire management in JH -- identify threats to agencies/interactions in Ostrom diagram, potential outcomes, and evaluate mitigation strategies

Student Learning Objective:

SLO 13: Experience and apply the S-E synthesis framework to modern wildfire management

Introduction/Background:

Communities adjacent to fire-adapted ecosystems face significant challenges associated with increasing frequency and spatial extent of wildland fire in the Intermountain West. The increased exposure to fire in this region is expected to continue as climate warms, fuels accumulate, and more people and property are located in the wildland urban interface. The cost of fire suppression has totaled over \$1 billion per year since 2010 and currently accounts for nearly half of the US Forest Service annual budget. Despite efforts in the last decade to reduce hazardous fuels over an area the size of Virginia, the USFS estimates that almost 400 million acres of the US are in areas of moderate to high risk of severe wildfires. Facing these challenges, the National Cohesive Wildland Fire Management Strategy aims to restore and maintain fire resilient landscapes, improve response to wildfire, and build fire-adapted communities.

Our proposed case study intends to examine the important role fire has historically played in the forests and shrublands of the southern Greater Yellowstone Ecosystem as well as the many challenges of maintaining this vital ecological process while at the same time protecting human values from

wildfire. Teton County, WY provides an ideal area in which to situate this case study due to its expansive public land base of fire-adapted ecosystems, extensive wildland urban interface areas, and diverse stakeholder viewpoints on conservation and natural resource management. Ninety-seven percent of the county is held in public ownership and managed by federal, state, and county agencies, including the United States Forest Service, National Park Service, US Fish and Wildlife Service, Wyoming Office of State Lands, and Teton County, exemplifying many of the challenges of human habitation of fire prone landscapes in the Intermountain West.

Classroom Management:

Phase 1 – Introduce Fire behavior, fire history and the influence of vegetation (fuel) and climate – Day 1

Phase 1A

Major Topic - Introduction to fire behavior triangle; experiential exercise examining the influence of fuel strata, topography, and weather on fire behavior; fire physics

Goals and Objectives

Goal 1: Understand and explore the historical role of fire and it's ecological importance

Student Learning Objectives:

SLO 1: Understanding of wildland fuel strata and fire behavior

Instructional Strategy – Lecture, experiential exercise

Introduction to Fire Triangle and Fire Behavior Triangle.



Fire Triangle

Fire Behavior Triangle

Introductory Lecture

Essential question: What three factors dictate wildfire behavior?

What is Fire?

Fire is a significant force in the forest environment. Depending upon the specific land management objective and a host of environmental variables, fire will sometimes be an enemy, sometimes a friend, and frequently its effects will be mixed between the two extremes.

Fire Triangle:

In order to have a **FIRE**, there must be three elements:

Fuel -- something which will burn (such as paper, wood, etc.)

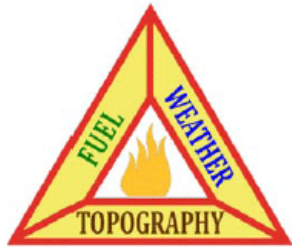
Heat -- enough to make the fuel burn

Oxygen -- air we breathe

Usually these three elements are expressed as a triangle, called the **FIRE TRIANGLE**. Remove one of these three elements and the fire will go out.

Fire Behavior Triangle:

Fire Behavior is one of the most important aspects of wildfires because almost all actions taken on a fire depend on how it "behaves." Success in pre-suppression planning and actual suppression of wildfires is directly related to how well Fire Managers understand and are able to predict fire behavior. The safety of all fire fighting personnel also depends on this knowledge.



What makes some wildfires burn so hot and others not? What makes fires spread fast one day and slow on another day? A wildfire behaves according to the environment in which it is burning. This environment consists of various elements of fuels, topography and weather. These elements and their reactions with one another - and the fire itself - determine the behavior of fire.

Fire Behavior is defined as: the manner in which fuel ignites, flame develops, and fire spreads as determined by the interaction of fuel, weather, and topography

There are many elements under each of the three major components of the fire's environment that affect how a fire behaves. A change in any one of these elements will cause a change in the behavior of the fire--and this change can be very abrupt and rapid.

Fire Behavior Triangle Elements:

Weather	Wind Temperature Relative Humidity Precipitation	Wind can push a fire along, fires also create their own wind currents. Low relative humidity can dry out fuels causing them to ignite more easily. Precipitation can put out a fire and conversely a lack of precipitation can make fire more likely by drying out the fuels.
Topography	Flat or Slopes Aspect	A fire moves more rapidly up hills. A fire is more likely on southern and western aspects which are dryer.
Fuels	Light or Heavy Arrangement Fuel Moisture	The dryer and lighter the fuels the more easily they will ignite. A continuous layer of fuels on the forest floor can aid in the spread of a fire.

Fuel:

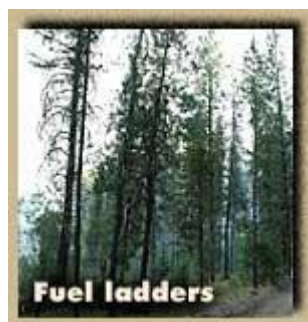
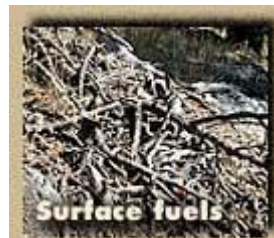
What is a fuel? It's anything that will burn – in the case of wildland fires, fuel is predominantly vegetation.

What fuels do you find in a forest?

Forests have plants at different levels - canopy, understory, and forest floor. So, the fuels in the forest will be at different levels, too. "**Aerial fuels**" do not in touch the ground. They are at least 1 meter (39 inches) above the ground. Aerial fuels could be branches, leaves, and bark still on the tree or tall bushes. "**Surface Fuels**" are on the ground. Here you'd find bushes, logs, stumps and fallen leaves, needles, branches, and cones. "**Ground fuel**" is anything that will burn below the surface fuels. That could be roots or rotting branches, leaves and needles.

Ground fires burn the ground fuels. These fires usually don't have much flame, they smolder. Surface fires burn the surface fuels. Crown fires burn the aerial fuels. Crown fires spread from tree to tree and are the most destructive.

Here's another way fires spread: **fuel ladders**. Fuel ladders form when fuels at different levels touch (called ladder fuels). Fuel ladders move fire up from the ground into the tree crown or canopy (creating a crown fire).



Learning Experience - The burning question: Introduction to wildland fire and wildfire behavior.

Essential question: What three factors dictate wildfire behavior?

Student activity – "Light my fire."

Student teams will have the opportunity to actually burn simulated landscapes while manipulating the three factors controlling fire behavior.

Materials needed:

- Match boards (see picture below, will need to be made prior to class, quantity depends on number of student groups)
- Wooden matches (quantity depends on number of student groups and spacing of holes in match boards)
- Drier lint, flammable leaf litter, or other flammable material that can easily be manipulated in the simulated environment (quantity depends on number of student groups)
- Hand held fans
- Fire extinguisher or ample water on hand (safety precaution just in case burning become dangerous)
- Hot mitts (may be required to more or handle hot or burning material in the case of an emergency)
- Open, safe space to conduct burning exercise. Would be ideal in an open ventilated space outside with non-flammable surface (i.e. parking lot), but could be done under an indoor ventilated hood safe for fire.
- Large rocks or stands to be used to support the match boards in order to change the slope angle
- Portable white board and markers or large printout of the fire triangle and fire behavior triangle

Preparation:

- Determine how many student groups you will have (2-3 people per group would be idea, but having four would be okay. Five would be too many)
- For each group, have two sets of match boards, enough matches to fill each board, and uniform quantity of drier lint or dry leaf litter for each board (each group should start with two full sets of boards and materials)
- Set up materials for each group in the safe area where you intend to do the exercise.

Instruction to students:

- 1) Split students into groups – make sure they are introduced to each other. Pick your favorite ice breaker or ask them to introduce themselves to their group and talk about any past experience they have with wildfire or their impression of the impact of wildfires.
- 2) Present the challenge – This exercise will result in a competition between groups to design two landscapes of wildland fuels and topography. Their task is to create two complete landscapes: the “slow” landscape is intended to burn for as long as possible (flaming combustion, not smoldering); the “fast” landscape should burn as quickly as possible, using only the materials provided. If any material is left unburned at the end, groups will be penalized accordingly (for “slow” landscape, each unburned match head will subtract 2 seconds from their time, and each cotton ball sized piece of lint will subtract 10 seconds. For the “fast” landscape, each unburned match head will add 2 seconds to their time, and each cotton ball sized piece of lint will add 10 seconds).
- 3) Introduce the tools and materials they have to use (matchboards, matches, drier lint, hand held fans, and rocks or stands). Try not to discuss the influence of any of these items on fire behavior – the goal is to have them discuss with their groups how fire behaves and to test their group’s hypothesis with the experimental fire. You will teach/discuss the impacts of fuel, topography, and weather on fire behavior after this exercise.
- 4) Give student groups time to discuss the objectives and their strategy, as well as to create their landscapes (20-30 min, more if necessary and available)

Burn, baby, burn: Now is the exciting time for the student groups to compete.

- 1) First give a safety briefing where you outline the potential hazards of this activity, point out the safety precautions of water/fire extinguisher, and outline a safe distance that students will need to stay from the burning landscapes (potentially even sketch a burn box on the ground with chalk that students are not able to enter). Note: if fire hazard is high in your area and it is a windy day, you might consider conducting this exercise inside or not doing it. Obviously, environmental conditions should be considered before engaging in burning.
- 2) First, conduct the slow burning contest: have each group arrange their burn boards with prepared fuel landscapes on within the approved burn area.
- 3) Next on the count of three, have each student group ignite their landscape in a single point at the same time and start a stop watch.
- 4) Next, watch the simulated landscapes burn, keeping an eye on risk management (no students too close to flames, no escaped burning material, and with the fire extinguisher at the ready).
- 5) Determine a burning time for each groups' landscape and determine a winner for the slowest burning landscape.
- 6) Next, do the same thing for the fast burning competition. Here risk management will be vitally important as fire behavior will likely be more extreme, and flames will be larger, and student groups might accidentally blow some burning material off of their board with a fan (if this seems dangerous, fans can always be eliminated – they are just a good way to show the influence of wind on fire behavior).
- 7) Time each group and determine a winner.
- 8) Once the competition is over, clean up the materials and go over each component of the fire behavior triangle with the students. Check for comprehension and have them apply the triangle to each of their burned landscapes. Discuss what components played a major role in both the slow burning and fast burning trials.



Left: An example of match-boards intended to demonstrate the influence of fuel density and slope angle on fire behavior (photo and boards: Kate M. Wilkin). We are suggesting the addition of drier lint to this setup – which would allow for further spacing between matches as well as the demonstration of various fuel strata (surface, ladder, canopy).

Instructor background information: Forest Fires: Behavior and Ecological Effects by E. A. Johnson & K. Miyanishi 2001.

Phase 1B

Major Topic – the historical role of fire in Rocky Mountain ecosystems

Goal 1: Understand and explore the historical role of fire and its ecological importance

Student Learning Objectives:

SLO 2: Understanding of the major components of fire regimes (frequency, severity, size, seasonality, interactions)

SLO 3: Understand the relations between fire frequency and severity to both fuel and climate (understand and differentiate between fuel vs. climate limited systems)

Instructional Strategy – Reading discussion; experiential exercise

Reading – Schoennagel, Tania, Thomas T. Veblen, and William H. Romme. 2004. The interaction of fire fuels, and climate across Rocky Mountain forests. *BioScience* 54.7: 661-676.

Learning Experience – Discuss Schoennagel et al. 2004

Location: Classroom

Students will:

1. Discuss Schoennagel et al. 2004 and list major outcomes of the study
2. Diagram front range of the Rocky Mountains: Vegetation, fuel, fire regime, climate or fuel limited (see teaching notes below)

Schoennagel, Tania, Thomas T. Veblen, and William H. Romme. 2004. The interaction of fire, fuels, and climate across Rocky Mountain forests. *BioScience* 54.7: 661-676.

Main points

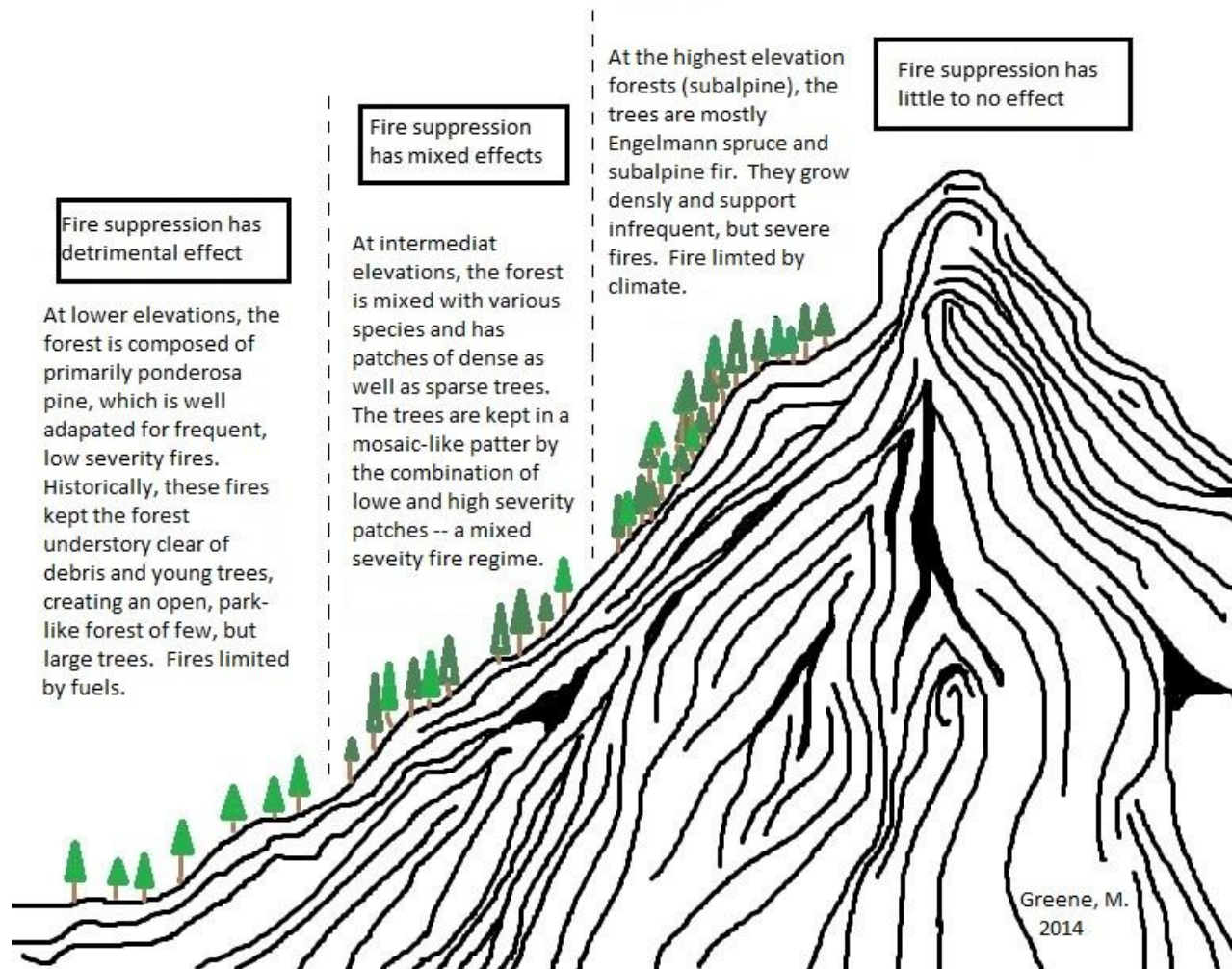
- Fuels reduction treatment have been uncritically applied to a variety of forest types under the guise of fire mitigation and restoration (under the assumption that fuels buildup is a reality on all forest types and locations)
- Fire mitigation (fuel reduction) and ecosystem restoration only converge in low ponderosa pine forests that historically experienced frequent, low-severity fires
- Identify three main differing historical fire regimes (high severity, mixed severity, and low severity)
- Link fire regimes to veg. types in the Rockies and comment on how fuels vs. climate interact in areas of each veg type
- Postulate the effect that fire exclusion has had, and the impacts of fuel reduction treatments for each veg. type
- Mixed severity regime is the trickiest to classify and put into a box – need to manage for heterogeneity of forest structure in these areas
- One “size fits all” management is not appropriate for all forest types or locations

Have students create and fill a chart similar to this one:

Fire regime	High	Mixed	Low
Veg type	Spruce-fir, lodgepole	Mixed Pipo, Mixed conifer	Ponderosa pine, great basin pine
Impacted by fire excl?	No – always lots of fuel	Variable (most pronounced in low woodlands)	Yes – more fuel and connectivity
Ave fuel load	High	Variable	Low – limited fire
Historic fire frequency	Low	Low → High	High
Historic fire severity	High	Low → High	Low
Treatments effective?	No	Under moderate weather	Yes
Fuel vs. Climate	Climate – thru moisture	Fuel and Climate (can override fuel)	Fuel – connectivity and abundance limiting
Example given	Yellowstone 1988	Hayman 2002	Rodeo-Chediski 2002

Assessment Tasks

1. Submit diagram of an elevational transect of the rocky mountains vegetation, fuel, fire regime, climate or fuel limited from Front Range of the Rockies. See example below:



Phase 1C Major Topic – Forest ecology; Fire ecology; Fire physics

Goal 1: Understand and explore the historical role of fire and its ecological importance

Student Learning Objectives:

SLO 4: Find/collect and analyze fire history data (dating fire scars from Sierra and JH)

Goal 2: Understand history, assumptions, values, and evolution of American wildfire management

Student Learning Objectives:

SLO 8: Understand the history of wildfire management in the US, and which forests have been altered as a result

Instructional Strategy –Experiential exercise

Reading – Refer to Schoennagel et al. 2004 (see above)

Learning Experience –Fire scar and fire history lesson

Location: Classroom – the authors use actual fire scar samples for this classroom activity (with data sheet provided in supplemental material). In the absence of these samples, this lesson is still possible, but students will not have the chance to date actual samples. In the powerpoint presentation, a master

fire chronology is given and this can simply be presented as the fire dates that they would have dated from the activity.

Fire_history_fire_scars_Krasnow.pptx – see powerpoint file in supplementary materials

Teacher notes for fire history lesson:

- 1) present agenda and learning goals on slide 1 of powerpoint
- 2) turn off the powerpoint and hand out a blank paper and pencil to each student
- 3) ask them to draw what the stump of a 10 year old tree would look like if it were cut down (10 rings -- most will get this). Diagram 1 of the fire scar formation guide (see supplemental materials)
- 4) now tell them a fire has injured the tree (and it's still alive) – erase some of the outer rings and make a scar
- 5) ask students to draw the next annual ring (this can be tricky for students to circulate around room and help students who are struggling).
- 6) ask them to draw the next 4 rings
- 7) tell them the outer ring was in 2008 (when the fire scar samples were taken) and ask them to date the fire: the sequence used in North America is
 - Put a dot in the center most ring (this is the zero ring). Count out to the the outer ring, putting one dot every 10 years, two every 50 years, and three every 100 years. In this case, you'll get to ring 15 on the outer ring (which was the calendar year of 2008)
 - Find the zero ring date by subtracting 15 from 2008 = 1993
 - Determine the ring number of the year of the fire (this will be ring 9 since the first ring is ring zero)
 - Add the ring number of the fire (9) to the date of the zero ring (1993) to get the date of the fire $1993+9=2002$
- 3) Continue the powerpoint presentation:
 - Show how trees grow around things and relate this to healing fire scars
 - Show some images of fire scars
- 4) if fire scar samples are being used, show the study sites (Sugar Pine and Last Chance in the Sierra Nevada)
- 5) Show the image of a fire scar and discuss the process of dating
- 6) “Now it's your turn to be a dendrochronologist “
 - Hand out data sheets and fire scar sample
 - Have student groups identify and date fire events in samples
 - Once students have the fire dates for their samples, have students pool data on a Composite Fire History Chart made on a large white board (it should look like slide #9)
- 7) Observe the pooled data with the class – ask for observations and insights
- 8) discuss the causes and consequences of the cessation of fire on the western slope of the Sierra Nevada in the early 20th century (slide 9)
- 9) show slides 10-17 to display the consequences of forest change in the 20th century

10) Wrap up with a quiz of the main learning goals for the lesson (slide 18) – (you can grade this quiz by removing the answers from the slide)

Assessment Tasks

1. Use the quiz on slide 18 as a learning assessment from this lesson.

Phase 2 – Introduce Fire history and vegetation patterns on the landscape – Day 2

Major Topic - Fire History and Fire Patterns on the landscape

Goals and Objectives

Goal 1: Understand and explore the historical role of fire and its ecological importance

Student Learning Objectives:

SLO 5: Collect and analyze contemporary tree cores from Mosquito Creek drainage and Green Knoll Fire

SLO 6: Link stand age data (and/or fire scars) to past fire occurrence, post-fire regeneration, and fire adaptations of lodgepole pine

Instructional Strategy - Field Data collection

Reading - Romme, W. H., & Despain, D. G. 1989. Historical perspective on the Yellowstone fires of 1988. *BioScience*, 695-699.

Learning Experience - Tree Age Exercise

Location: Completed on site in the Mosquito Creek drainage. Alternative non-field trip: Provide mounted cores from the unburned and burned stands. Provide photos of burned and unburned stands with clear photos of lodgepole pines from the unburned stands showing annual branch whorls.

Students will divide into teams of 3-4 and execute the following:

1. Extract cores from lodgepole pine within burned and unburned stands
2. Count rings to determine tree age
3. Count lodgepole annual branch whorls within the Green Knoll burn
4. Estimate the year of the Green Knoll fire
5. Estimate the year of the last stand replacing fire in the unburned stand

Learning Experience - Fire Mapping Exercise

Location: Completed on site in the Mosquito Creek drainage

On printed air photos of Mosquito Creek drainage from 1945 and 2013:

1. Outline burned areas in red and unburned areas in blue for each year
2. Compare and contrast the Green Knoll fire with stand boundaries in 1945
3. Draw conclusions about Green Knoll boundaries based on stand patterns in 1945

Phase 3 – Human presence and influence on fire management - Day 3

Phase 3A

Major Topic - WUI Patterns on the landscape

Goals and Objectives

Goal 2: Understand history, assumptions, values, and evolution of American wildfire management

Student Learning Objectives:

SLO 8: Understand the history of wildfire management in the US, and which forests have been altered as a result

SLO 9: Understand and track the development of human values in wildland urban interface in JH (and nationally)

SLO 10: Understand the recent history of JH fires. Appreciate the complexity of wildland fire management decision making

SLO 11: Identify major stakeholders and understand their values, perceptions, and priorities

Goal 3: Develop future directions / recommendations for wildfire policy / management / adaptation

Student Learning Objectives:

SLO 11: Identify major stakeholders and understand their values, perceptions, and priorities

SLO 12: Synthesize and articulate how modern fire management must balance historical ecology, human values, and likely future trajectories (of both fire occurrence and behavior as well as human development)

Instructional Strategy - Field mapping exercise and interviews of stakeholders

Reading - Theobald, D. M., & Romme, W. H. 2007. Expansion of the US wildland–urban interface. *Landscape and Urban Planning*, 83(4), 340-354.

Learning Experience - Wildland Urban Interface (WUI) Mapping Exercise

Location: Completed on site in the Mosquito Creek drainage

On printed air photos of Mosquito Creek drainage from 1945, 1999 and 2013:

1. Use the air photos from the Fire Mapping exercise with outlined burned/unburned areas
2. Map roads and housing development on each of 1945, 1999 and 2013 photos
3. Draw approximate WUI boundaries for each year on a single photo and compare changes in area and length of the WUI boundary through the years
4. Ocular assessment of standing fuel densities within Crescent H housing development versus National Forest

Learning Experience - Wildland Urban Interface human values assessment

Location: Completed on site in the Mosquito Creek drainage and Teton County offices

1. Site visit to Crescent H housing development
2. Tour of fuel reduction program and Green Knoll fire burned area in Crescent H
3. Interviews with Crescent H property manager and selected Crescent H homeowners
 - a. Students will assess aesthetic and economic value of living in the WUI
4. List key value assumptions from interviews related to living in the WUI
5. Interview with Alex Norton of Teton County Planning Department regarding Land Development regulations

Learning Experience - Wildland Urban Interface Fire Management

Location: Completed on site in the Mosquito Creek drainage

1. Interview fire managers from USFS (Andy Norman) and JH Fire Chief (Willy Watsabaugh) on fire suppression issues in the WUI.
2. Group Discussion to frame how modern fire management must balance historical ecology, human values, and likely future trajectories

Phase 3B

Major topic – Climate change impacts on fire ecology

Goal 1: Understand and explore the historical role of fire and its ecological importance

Student Learning Outcomes

SLO 7: Understand future climate projections and ecological / physical impacts

Instructional Strategy – Reading to understand climate projections and impacts

Reading– Westerling, A. L., Turner, M. G., Smithwick, E. A., Romme, W. H., & Ryan, M. G. 2011.

Continued warming could transform Greater Yellowstone fire regimes by mid-21st century. Proceedings of the National Academy of Sciences,108(32), 13165-13170.

Learning Experience –Have students read Westerling et al. 2011 and pass out color copies of the figures below for discussion. How will climate change influence fire dynamics in Greater Yellowstone?

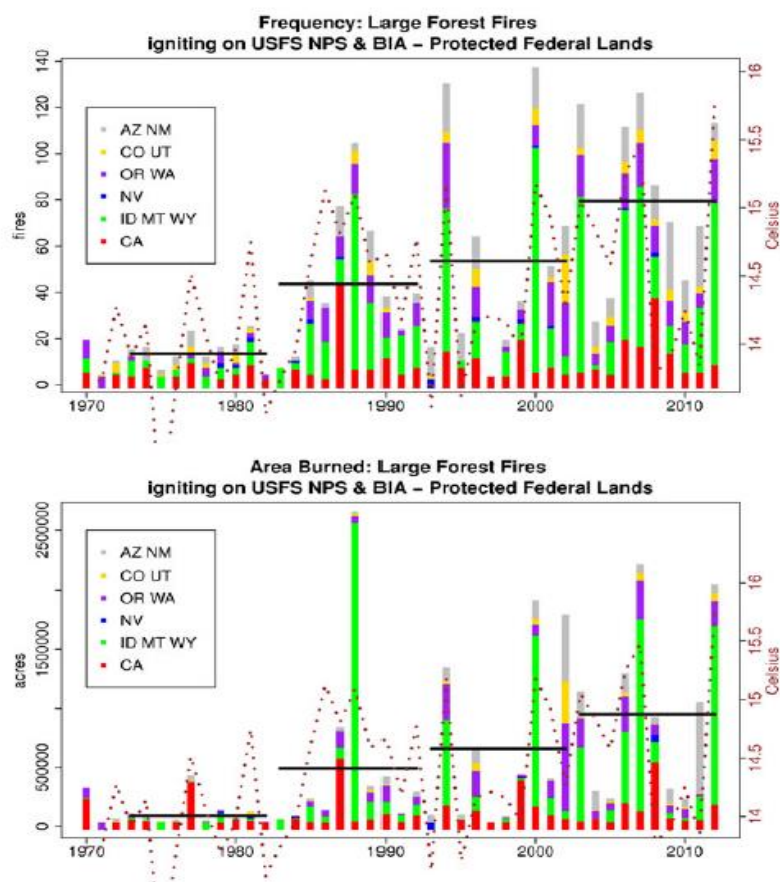
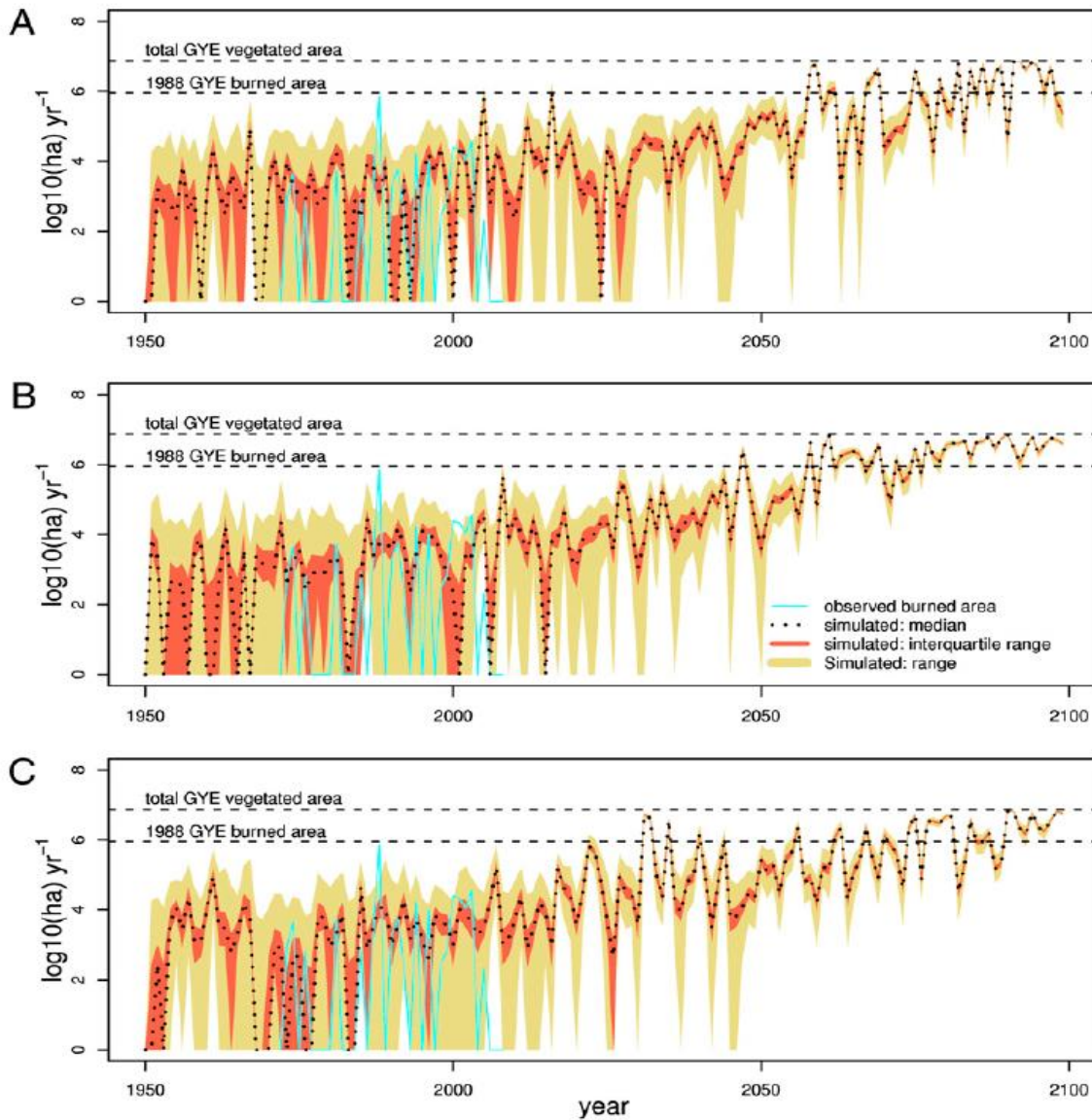


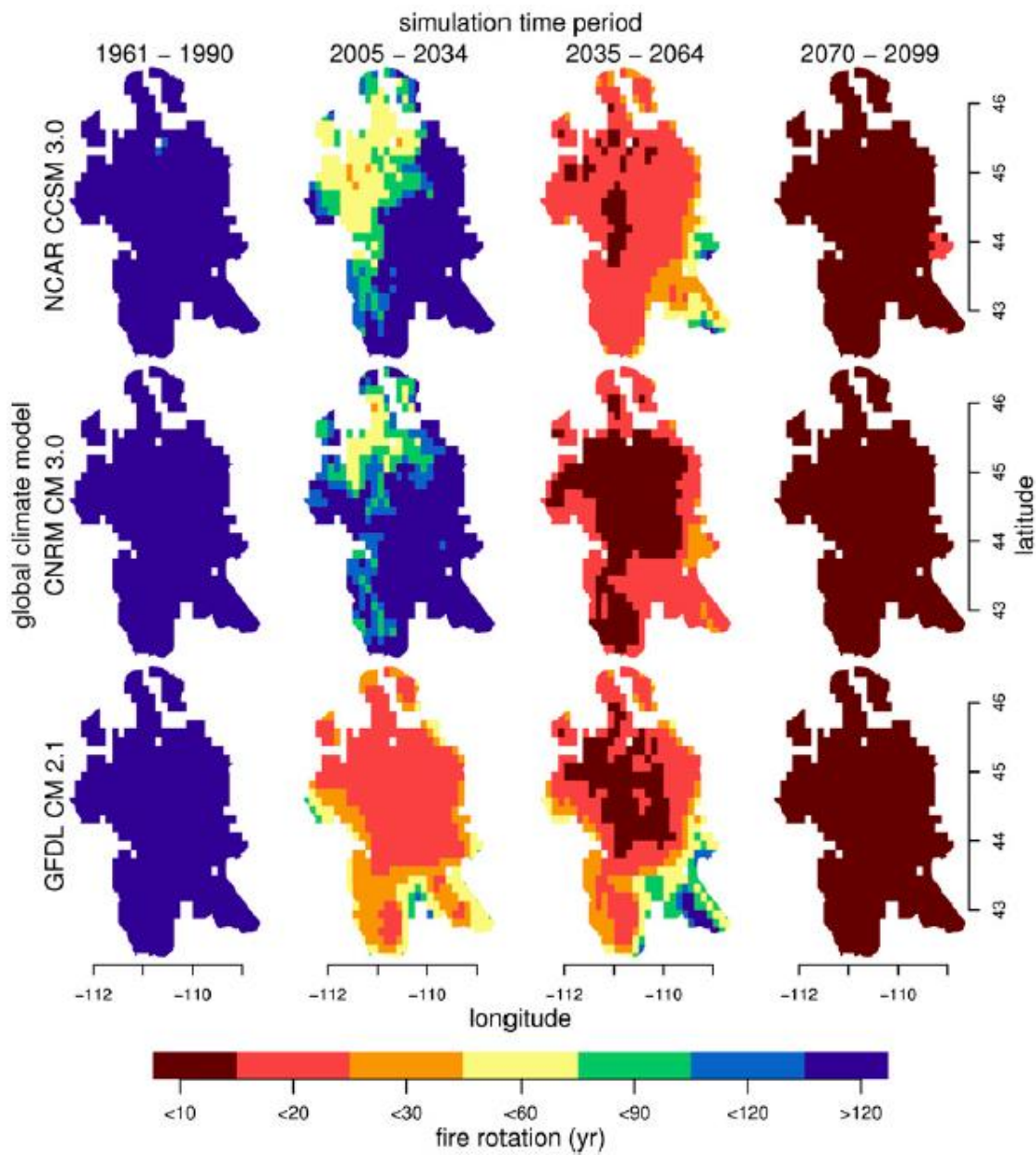
Figure 2. Frequency of (top panel) and area burned in (bottom panel) large (>1000 acre) forest fires. Fires are action fires for which suppression was attempted, reported by USFS, NPS and BIA as burning on federal lands in primarily forest vegetation. Fires are grouped by states (colored bar sections) with average regional spring and summer temperature overlaid (dashed line). Horizontal solid lines indicate averages for the last four decades. Large fires in the last decade are over 480% more frequent and burn 930% more area than fires in the first decade. Average annual area burned on these lands has increased by over 285,000 acres per decade for the last three decades, to just under 1 million acres per year at present.

The past and future area burned in the Greater Yellowstone Area:

Relationship of annual climate data and area burned for 3 climate scenarios – back-casted and compared to actual burned area and forecasted for projected climate warming



Above: The range (light shading), interquartile range (dark shading), and median (dotted line) of predicted area burned for 1,000 gridded monthly simulations, aggregated over the GYE by year, and the observed annual area burned (solid line) for three downscaled GCM SRES A2 climate scenarios: NCAR CCSM 3.0 (A), CNRMCM 3.0 (B), and GFDL CM 2.1 (C). From Westerling et al. 2011.



Above: Projected fire rotations for the Greater Yellowstone Area calculated for 1,000 monthly gridded simulations for four 30-y periods across three downscaled GCM SRES A2 climate scenarios. From Westerling et al. 2011.

Phase 2 & 3 Assessment Tasks

1. Submit maps from Fire Mapping exercise and report (2 page maximum) on WUI changes from 1945 to 2013
2. Submit management plan outline for Crescent H area that addresses the following:
 - a. Resident economic values
 - b. Resident aesthetic values
 - c. WUI fire suppression realities
 - d. Fuel treatment project proposals with map
 - e. Future development policy and land development regulations for consideration by Teton County Planning Department
3. Develop WUI fire management reality “game” with the goal of managing the WUI in the most ecologically, politically and practically feasible ways possible. Players will include 4 distinct stakeholder groups: Homeowners/developers; Fire managers; Policy makers; and Ecologists/environmentalists.
4. Output from the game is a map with fire management zones, development and suppression policies and fuel mitigation projects and a point score for each stakeholder group determining “winners and losers” from the negotiations.
5. Include the following activities in the game:
 - a. Formation of land development policy and regulations
 - b. Development of pre-suppression and mitigation projects and activities on private lands
 - c. Submission of fuel mitigation plans on public lands

Phase 4 – Human presence and influence on fire management - Day 4

Major topic – Synthesis of climate adaptation to fire management in JH

Goal 4: Develop and synthesize a climate adaptation plan for wildfire management in JH -- identify threats to agencies/interactions in Ostrom diagram, potential outcomes, and evaluate mitigation strategies

Student Learning Objective:

SLO 13: Experience and apply the S-E synthesis framework to modern wildfire management

Instructional Strategy – Reading to understand climate projections and impacts

Reading – Ostrom, E. 2009. A General Framework for Analyzing Sustainability of Social-Ecological Systems. Science 325, 419.

Learning Experience – Develop climate adaptation plan for fire management

Students will

1. Present their Crescent H management plans to class with stakeholders present
 - a. Receive authentic feedback from audience and stakeholders
2. Discuss Ostrom 2009
3. Conduct group planning sessions with students and stakeholders on how to use the Crescent H plan as a building block toward developing a climate adaptation plan for future more broad scale wildfire management plan for JH
4. Select 3 climate scenarios for analysis and inclusion into climate adaptation plan

5. Form 3 student groups; each group takes one climate scenario and develops a plan based on that scenario.
 - a. Coordination and collaboration between scenario teams required to produce coherent and comprehensive climate adaptation plan
6. Entire student team will present climate adapted fire management plan for JH to audience of stakeholders

Phase 4 Assessment Tasks

1. Submit written single climate adapted fire management plan
 - a. Each scenario team will be assessed on their section
 - b. Overall coordination assessment will be given to entire class
2. Presentation of climate adapted fire management plan
 - a. Each scenario team will be assessed on their section
 - b. Overall coordination assessment will be given to entire class

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