Final Report:
Imagining Fire Futures-- An interactive, online learning activity for high school and college students

IMAGINING FIRE FUTURES is a product of FireClim, Award ID 0903562 from the National Science Foundation's Dynamics of Coupled Natural and Human Systems Program

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Location and Availability:
IMAGINING FIRE FUTURES is online at http://feis-crs.org/firefutures/. The homepage contains a brief description of the activity, a student journal (Appendix A of this report), a user's guide for students (Appendix B), and a Teacher's Guide (Appendix C) that describes the activity, its objectives, connections to educational standards, and ways to assess student work. Copies of all files are available from jsmith09@fs.fed.us.

IMAGINING FIRE FUTURES is featured on the website of the Missoula Fire Sciences Laboratory, http://firelab.org/ .

Basis: This learning activity is based on model results from FIRECLIM— the National Science Foundation project entitled "Assessing and Adaptively Managing Wildfire Risk in the Wildland-Urban Interface for Future Climate and Land Use Changes."

Description: In IMAGINING FIRE FUTURES, students in a high school or college class use model results to develop a vision of the future for Flathead County, Montana. This is a rural area in the northern Rocky Mountains where more than half of the landscape is covered by wildland ecosystems that have evolved with and are shaped by wildland fire.

In FIRE FUTURES, each student adopts a "character"— human, other animal, or plant—whose interests he or she represents throughout the online activity and in the class's subsequent Community Planning Meeting. The student uses the website to learn about the character's habits and needs, examine predicted conditions as modeled by FireBGCv2 and FSIM, and then select the scenario most likely to produce abundant habitat (vegetation cover and structural stage) for the character. Students select scenarios based on their characters' preferences for:

1. Climate (predicted by A2 scenario vs. no change from 2010 onward)
2. WUI development (at 2% annual economic growth vs. no development after 2010)
3. Fuel treatment (treatment levels suggested by FIRECLIM participants vs. no treatment)
4. Inclusion of wildfire (95% of wildfires completely suppressed vs. 100% of fires suppressed)

In completing the online activity, students complete 12 "quizzes" that challenge them to demonstrate or improve their ability to interpret graphs, read maps, and use other skills. They use these skills to address

practical questions about the habitat and other living conditions that their characters may face during the next 50 years. Each student also completes a journal that contains:

- data about his or her character and its habitat
- interpretation of the data
- evaluation of future habitat for meeting the character's needs, and
- reflections on the adequacy of the model predictions.

After completing the online activity, students collaborate in a Community Planning Meeting to develop a vision of the future that could optimize habitat and wildland fire potential for all characters.

Structure:
FIRE FUTURES contains biographical information and photos describing 20 "characters" available for student adoption plus one "wild card," which students can use to create their own character. The activity contains 5 video segments, 204 photos, and 254 maps that show modeled habitat and fire potential for the years 2010 and 2060.

The instructional design structure for the FIRE FUTURES site centered on providing very fine-grained tasks and a purposefully linear task sequence through the material. This allows students to build on information previously presented. Because the activity may take more than one class period to complete, users can resume their progress through the activity on any computer by noting a "session code" when starting and entering it again at a later time. The session code is fully anonymous and cannot be connected to a real person or computer address.

The site is architected in fully standards-compliant HTML5, CSS, and JavaScript using the JQuery and JQuery UI frameworks. The flexible page layout works on all modern browsers and a wide range of screen sizes, including Mobile Safari on iPad. It uses the browser's HTML5 Local Storage facility to load content from the server once, making page transitions faster. All content is embodied in XML-based Excel spreadsheet files that can be edited in Excel, allowing the displayed text, images, and maps to be changed without editing HTML, CSS, or JavaScript files. Maps are displayed using the Google Maps APIs for JavaScript.

Documentation:
Data, model results, and other background for the information presented in IMAGINING FIRE FUTURES are identified within the learning activity. File copies and further documentation are on file at the Missoula Fire Sciences Laboratory, as are permissions for all photos and videos not in the public domain. Contact jsmith09@fs.fed.us.

Timeline:

September-November 2011	Scoping meeting with 11 high school/college teachers and environmental educators in Kalispell, MT (county seat for Flathead County). Discussed potential ways to develop the learning activity to meet teachers' needs and educational standards.
	Scoping meeting with 2 high school teachers in Whitefish, MT.
	Scoping meeting with Director, Glacier Institute, Kalispell, MT.

	Scoping meeting with 2 teachers at Salish Kootenai College, Pablo, MT.
November 2011-May 2013	Develop beta version of FIRE FUTURES.
21-25 May 2013	Test beta version of FIRE FUTURES at Flathead High School with 116 students in 4 classes, freshman through senior levels. Observe features of activity that facilitate learning and those that create obstacles. Obtain written comments from students.
June 2013-July 2014	Revise and complete FIRE FUTURES. Upload to Forest Service website: http://feis-crs.org/firefutures/
30 July 2014	Notify all contacts from scoping meetings and other sources of availability for classroom use. Request feedback.
31 August 2014	Final report completed.
	Site description uploaded to http://firelab.org/

Appendix A.

Fire Futures

Journal questions Name:

1. What is your character's NAME?

2. What kinds of WILDLAND PLACES do you like best?

3. What wildland plants or animals do you use for FOOD or COVER or to meet some other need?

4. Use this table to show your habitat choices. Put an "X" in the box for every kind of habitat listed on the left side of your screen. Don't put anything in the gray boxes.

Vegetation type		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine					
Main species: grand fir					
Main species: Douglas-fir					
Main species: lodgepole pine					
Main species: western larch					
Mixture of subalpine fir, spruce, and lodgepole pine					
Main species: whitebark pine					
Main species: cottonwood, aspen, or birch					
Mixture of grass, wildflowers, and shrubs					

Now record your answers to the "Assess vegetation" quiz:

- Which vegetation type is most common in your habitat?

- Which vegetation type is least common in your habitat?

- How much total habitat do you have, counting all vegetation types (in hectares)?

- How much habitat do you have in your most plentiful vegetation type (hectares)?

- Which structural stage is most common in your habitat?

5. Is any of your habitat SUPER-ABUNDANT, so you may have more than you need? Note any combination(s) of vegetation and structural stage that are this plentiful.

6. Is any of your habitat in DANGEROUSLY SHORT SUPPLY? Note this and explain why you're worried.

7. What vegetation types and structural stages in your habitat are MOST LIKELY TO BURN?

8. What vegetation types and structural stages in your habitat have the lowest CANOPY BASE HEIGHT, so fires are likely to get into the tree crowns?

9. If you have CROWN FIRES, will they be GOOD OR BAD for you? Explain.

10. If you have SURFACE FIRES, will they be GOOD OR BAD for you? Explain.

11. Would the predicted changes AFFECT YOUR HABITAT, lifestyle, or work? How?

12. How might CLIMATE CHANGE influence the likelihood of fire?

13. Why might fires occur more often EVEN IF CLIMATE DOESN'T CONTINUE TO CHANGE?

14. How is CANOPY BASE HEIGHT likely to change over the next 50 years?

15. Does CLIMATE CHANGE MAKE MUCH DIFFERENCE in predicted changes to canopy base height?

16. Based on canopy base height, will it be easier or harder for CROWN FIRES TO START in the future? Explain.

17. What do you like and dislike about your PREDICTED HABITAT?

18. What do you like and dislike about FIRE POTENTIAL and KINDS OF FIRE in your predicted habitat?

19. Would you PREFER CONTINUED CLIMATE CHANGE or not? Explain.

20. In what ways is WUI land GOOD or BAD FOR YOU? Think about how well you get along with people, pets, and buildings. Think about how much solitude you need.

21. About how much of your HABITAT will be in the WUI if there's little growth-- a tiny bit? half? nearly all?

22. What vegetation TYPES and structural STAGES of your habitat will be in the WUI if there's little growth?

23. What's the relationship between the suggested TREATMENT AREAS and the WUI you prefer?

24. How would the SUGGESTED FUEL TREATMENTS affect your habitat, if at all?

25. Does this model run predict much WILDFIRE for your HOME BASE if 5% of fires are unsuppressed? Explain, and note any areas predicted to burn more than once.

26. How is BURNABILITY likely to change if 5% of wildfires are unsuppressed from now until 2060?

27. How would the LIKELIHOOD OF FUTURE CROWN FIRES be affected if 5% of wildfires are unsuppressed from now until 2060?

28. How would CLIMATE CHANGE, FUEL TREATMENT, and WUI GROWTH probably influence the number of homes damaged by wildfire?
    - Climate change
    - Fuel treatment
    - WUI growth

29. Based on predictions of area burned if 5% of fires are unsuppressed from now until 2060, how would UNSUPPRESSED FIRES be likely to influence the number of homes damaged?

30. WHAT ACTIONS could be taken reduce the danger and potential for loss?

31. How are WILDFIRES likely to influence your future HABITAT?

32. All things considered, which future is best for you? Why?

33. How is your HABITAT LIKELY TO CHANGE over the next 50 years, given the choices you've made?

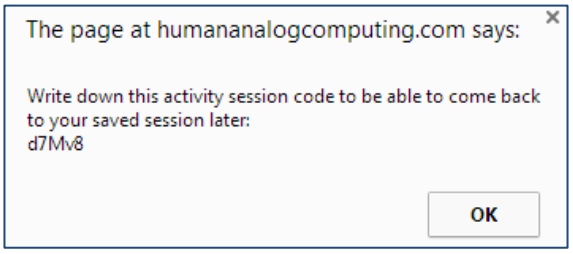
34. HOW DO YOU FEEL ABOUT THAT? Will you have enough habitat? Is it good quality? What are its shortcomings?

35. WHAT OTHER CHANGES, not included in this activity, might affect your character in the future?

Appendix B.

How to use the IMAGINING FIRE FUTURES website

Before you start the activity, begin a journal either on paper or in a computer file. From the "Welcome" page (the previous page), you can find a printable copy of the journal questions in this activity and also a copy that you can edit on the computer.



When you click the "Start" box, you'll receive a 5-character code. Write it in your journal. Use it later if you want to get back into the activity where you left off before, rather than start over from the beginning.

Tabs across the top of the screen and along the left side are steps you must complete to finish the activity. You can always back up to a step already completed if you want to change or repeat something.

If you are journaling in a computer document, you may sometimes want to copy a graph or map from the screen. It can be especially helpful to keep copies of habitat maps. Here's one way to do it—but note that various computer operating systems use different techniques:

- Have a Word or other word processing document open.
- Center the map or graph you want to copy on your screen. Use "+" or "-" to make it fit.
- Hit fn+prt sc on your keyboard. This will put the screen image on your clipboard.
- Go to the word processing document and paste the image into it.
- Type in a caption that tells you what the map or graph represents.

If you have suggestions for improving this learning activity, please send them to jsmith09@fs.fed.us.

Appendix C.

FOR TEACHERS: How to use IMAGINING FIRE FUTURES

FIRE FUTURES is intended for use in high school and introductory college classes. This interactive, computer-based learning activity lets students consider what the future is likely to bring to an area where people and fire can both shape the landscape. Each student adopts a single character—human, other animal, or plant—and examines the changes likely to occur in its environment over the next 50 years, given various choices regarding climate, population change, vegetation management, and fire management. Students use FIRE FUTURES to prepare for a "community planning meeting" in which they discuss current patterns of change and the potential for human choices to influence the future.

The particular landscape used in FIRE FUTURES is in Flathead County, Montana; it is described by data collected for the FIRECLIM project and analyzed with the computer model FIREBGCv2.

The objectives of FIRE FUTURES:

1. To increase understanding of ecology, climate, wildland fire, human communities, and their interactions
2. To increase understanding of the influence of societal choices on wildland ecosystems and the people who depend on them
3. To increase understanding of the potential and limitations of mathematical modeling as a tool for projecting future conditions and examining the possible consequences of societal choices

Links to educational standards:

Appendix A lists educational standards in reading, writing, mathematics, and science that can be addressed with FIRE FUTURES.

To use this activity, you will need:

- A computer or iPad with Internet connection for each student, or at least one for every two students. Each computer will need an Internet browser such as Google Chrome or Safari. The program does not run well in Internet Explorer or Mozilla Firefox.
- A printed list of journal questions for each student or capability for students to journal electronically

- At least 2 hours of classroom time for students to complete the Internet activity
- At least 2 classroom periods for students to report findings, discuss the implications, and discuss choices that might lead to an optimal future

About creating characters and choosing habitat in FIRE FUTURES:

FIRE FUTURES includes 20 "characters" for students to choose from. They can also create a "wild card" character, if they wish to take on a role not already covered, do independent research the character, and use the activity to find out how its habitat is likely to change over the next 50 years.

The current version of FIRE FUTURES does not evaluate a student's habitat choices, although this function may be added in the future. Currently, students can select inappropriate habitat, and the program will not correct them. However, YOU CAN COMPARE THEIR CHOICES to the "Recommended Basic Habitat" for each character, as listed in Appendix B. Complete, 100% agreement between student choices and the Recommended Basic Habitat may not be feasible or even desirable, but if a student does not include most of the recommended basic habitat in his or her choices (recorded in the student's journal, page 1, Question 4), it would be worthwhile to ask for an explanation.

Guiding questions for student reports and class discussions—

Students will have answers to some of the following questions in their journals. For others, they will need to consult their journal notes and possibly revisit parts of the activity**.**

1. **About modeling:**
    a. If you are familiar with actual conditions in Flathead County, does the description of present conditions in FIRE FUTURES seem accurate? If you don't know about conditions in Flathead County, how might you evaluate the data used in FIRE FUTURES? (Investigation of maps, descriptive and promotional literature on the County, consulting popular articles and scientific literature, contacting scientists, etc.)
    b. Here are some assumptions used in FIRE FUTURES. Do they make sense to you? Do you have information that contradicts them?
        i. Wildland fire can be completely excluded for the next 50 years.
        ii. The 20 characters in FIRE FUTURES are the ones that matter most for the future of Flathead County.
        iii. No new species are likely to arrive and make important changes—no new weeds, tree diseases, predators, fish, etc.
        iv. If the human population doesn't grow, very few new houses will be built in the WUI over the next 50 years.

v. Climate is likely to continue changing over the next 50 years in the same way it has changed over the past 50 years.
vi. Publicly owned land in Flathead County will continue to be publicly owned. It will not be sold to private individuals or companies.

c. When you compare present conditions with predicted futures, do the changes usually make sense—that is, do they go in the direction you expected?
d. Does the amount of predicted change seem reasonable to you, or was there more (or less) change than you expected?
e. What are the strengths and weaknesses of the FIRE FUTURES data and this modeling activity for helping people think about the future and plan for it?

2. About your character:

a. What change agents (climate, population growth, fuel treatment, and fire) seem most likely to control what happens to your character in the future? Are there others that are not included in FIRE FUTURES?
b. Which is the best scenario for you? Why? Which is second-best?
c. Which is worst? What is likely to happen to you in the worst-possible scenario? Will you go extinct?
d. Can you accept a less-than-best scenario if it benefits other characters? What would the consequences be for your character? Would you go extinct?
e. Would you need any additional information, besides what FIRE FUTURES provides, to make wise choices for your character? What additional information would help?

3. About the whole community—all characters and their environment:

a. Is there an "optimum" scenario—one that meets the needs of all characters, even if it's not "best" for all of them?
b. Can individuals—or society as a whole—make any choices that will increase the likelihood that the future will be "optimum"? If there are, what would be the costs of those choices?
c. If people cannot influence the coming changes, can anything be done to lessen the damage they are likely to cause?
d. What can we do as individuals to help create an optimum future? What should society do?
e. What additional characters or information about REAL LIFE in Flathead County would be needed to make wise choices for the future?

If you have suggestions for improving this learning activity, please send them to jsmith09@fs.fed.us.

Appendix A. Links to Common Core and Next Generation Science Standards

Common Core Reading Standards for Literacy in Science and Technical Subjects 9–12

Excerpted from http://www.corestandards.org/ELA-Literacy/RST/9-10/ and http://www.corestandards.org/ELA-Literacy/RST/11-12/

Key Ideas and Details

1. Cite specific textual evidence to support analysis of science and technical texts…

2. Determine the central ideas or conclusions of a text…

3. Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks…

Craft and Structure

4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context…

6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address… [for Grades 11-12] … identifying important issues that remain unresolved.

Integration of Knowledge and Ideas

7. [Grades 9-10] Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

7. [Grades 11-12] Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

8. [Grades 9-10] Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a scientific or technical problem

8. [Grades 11-12] Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

9. [Grades 9-10] Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

9. [Grades 11-12] Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.

Range of Reading and Level of Text Complexity

10. Read and comprehend science/technical texts … independently and proficiently.

Common Core Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects 9–12

Excerpted from http://www.corestandards.org/ELA-Literacy/WHST/9-10/ and http://www.corestandards.org/ELA-Literacy/WHST/11-12/

1. Write arguments focused on *discipline-specific content.*

a. [Grades 9-10] Introduce precise claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that establishes clear relationships among the claim(s), counterclaims, reasons, and evidence.

a. [Grades 11-12] Introduce precise, knowledgeable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences the claim(s), counterclaims, reasons, and evidence.

b. [Grades 9-10] Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

b. [Grades 11-12] Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form that anticipates the audience's knowledge level, concerns, values, and possible biases.

Common Core Standards for Mathematics – High School

Excerpted from http://www.corestandards.org/Math/

Modeling Standards: Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards.

Making Inferences and Justifying Conclusions S-IC:

Understand and evaluate random processes underlying statistical experiments

1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

2. Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation.

Make inferences and justify conclusions from sample surveys, experiments, and observational studies

3. Recognize the purposes of and differences among sample surveys, experiments, and observational studies; explain how randomization relates to each.

5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

6. Evaluate reports based on data.

Use probability to evaluate outcomes of decisions

7. Analyze decisions and strategies using probability concepts

Next Generation Science Standards

Excerpted from http://www.nextgenscience.org/search-standards

Interdependent Relationships in Ecosystems

HS-LS2-1. Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales.

HS-LS2-2. Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales.

HS-LS2-6. Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

HS-LS2-7. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-6. Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Weather and Climate

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Human Sustainability

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

Appendix B. Recommended Basic Habitat for FIRE FUTURES Characters

"1" indicates good to excellent habitat; "0" habitat may also be used but is not as important as "1."

Beargrass **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	0	0
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		1	0	0	0
Main species: lodgepole pine		1	0	0	0
Main species: western larch		0	0	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		1	1	1	1
Main species: whitebark pine		1	1	1	1
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	1				

Black cottonwood **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		1	1	0	0
Main species: grand fir		1	1	0	0
Main species: Douglas-fir		1	1	0	0
Main species: lodgepole pine		0	0	0	0
Main species: western larch		1	1	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		1	1	1	1
Mixture of grass, wildflowers, and shrubs	0				

Black-backed Woodpecker **Vegetation type**		Structural stage			
		seedling	pole	mature	large
Main species: ponderosa pine		1	1	0	0
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		1	0	0	0
Main species: lodgepole pine		1	1	0	0
Main species: western larch		1	0	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		1	0	0	0
Main species: whitebark pine		1	1	0	0
Main species: cottonwood, aspen, or birch		1	0	1	1
Mixture of grass, wildflowers, and shrubs	0				

Douglas-fir **Vegetation type**		Structural stage			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	0	0
Main species: grand fir		1	1	1	1
Main species: Douglas-fir		1	1	1	1
Main species: lodgepole pine		1	1	1	1
Main species: western larch		0	0	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	0				

Elk **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	0	0
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		1	0	1	1
Main species: lodgepole pine		1	0	1	1
Main species: western larch		1	0	1	1
Mixture of subalpine fir, spruce, and lodgepole pine		1	0	0	0
Main species: whitebark pine		1	0	0	0
Main species: cottonwood, aspen, or birch		1	1	0	0
Mixture of grass, wildflowers, and shrubs	1				

Fire Chief **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	1	1	0
Main species: grand fir		0	1	1	0
Main species: Douglas-fir		0	1	1	0
Main species: lodgepole pine		0	1	1	0
Main species: western larch		0	1	1	0
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	1				

Forester **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		1	1	1	0
Main species: grand fir		1	1	1	0
Main species: Douglas-fir		1	1	1	0
Main species: lodgepole pine		1	1	1	0
Main species: western larch		1	1	1	0
Mixture of subalpine fir, spruce, and lodgepole pine		1	1	1	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	0				

Grizzly bear **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	0	0
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		0	0	0	0
Main species: lodgepole pine		1	1	0	0
Main species: western larch		1	1	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		1	1	0	0
Main species: whitebark pine		0	0	1	1
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	1				

Home owner **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		1	1	1	0
Main species: grand fir		1	1	1	0
Main species: Douglas-fir		1	1	1	0
Main species: lodgepole pine		1	1	1	0
Main species: western larch		1	1	1	0
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		1	1	1	0
Mixture of grass, wildflowers, and shrubs	1				

Huckleberry **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	0	0
Main species: grand fir		1	1	0	0
Main species: Douglas-fir		1	1	0	0
Main species: lodgepole pine		1	1	0	0
Main species: western larch		1	1	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		1	1	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	0				

Hunter **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		1	0	1	1
Main species: grand fir		1	0	1	1
Main species: Douglas-fir		1	0	1	1
Main species: lodgepole pine		1	0	1	1
Main species: western larch		1	0	1	1
Mixture of subalpine fir, spruce, and lodgepole pine		1	0	1	1
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		1	1	1	1
Mixture of grass, wildflowers, and shrubs	1				

Lodgepole pine **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	0	0
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		0	0	0	0
Main species: lodgepole pine		1	1	1	1
Main species: western larch		1	1	1	0
Mixture of subalpine fir, spruce, and lodgepole pine		1	1	1	0
Main species: whitebark pine		1	1	1	0
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	0				

Mountain Bluebird **Vegetation type**		Structural stage			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	1	1
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		0	0	0	0
Main species: lodgepole pine		0	0	0	0
Main species: western larch		1	0	1	1
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		1	0	0	0
Main species: cottonwood, aspen, or birch		1	0	1	1
Mixture of grass, wildflowers, and shrubs	1				

Mountain pine beetle **Vegetation type**		Structural stage			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	1	1
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		0	0	1	1
Main species: lodgepole pine		0	0	1	1
Main species: western larch		0	0	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	1	1
Main species: whitebark pine		0	0	1	1
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	0				

Physician **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		1	0	0	1
Main species: grand fir		1	0	0	0
Main species: Douglas-fir		1	0	0	0
Main species: lodgepole pine		1	0	0	1
Main species: western larch		1	0	0	1
Mixture of subalpine fir, spruce, and lodgepole pine		1	0	0	0
Main species: whitebark pine		1	1	1	1
Main species: cottonwood, aspen, or birch		1	1	1	1
Mixture of grass, wildflowers, and shrubs	0				

Pileated Woodpecker **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	1	1
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		0	0	1	1
Main species: lodgepole pine		0	0	0	0
Main species: western larch		0	0	1	1
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		0	0	1	1
Mixture of grass, wildflowers, and shrubs	0				

Ponderosa pine **Vegetation type**		Structural stage			
		seedling	pole	mature	large
Main species: ponderosa pine		1	1	1	1
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		1	1	1	1
Main species: lodgepole pine		0	0	0	0
Main species: western larch		1	1	1	1
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	1				

Red squirrel **Vegetation type**		Structural stage			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	1	1
Main species: grand fir		0	0	1	1
Main species: Douglas-fir		0	0	1	1
Main species: lodgepole pine		0	0	1	1
Main species: western larch		0	0	1	1
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	1	1
Main species: whitebark pine		0	0	1	1
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	0				

larch **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		1	1	1	1
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		1	1	1	1
Main species: lodgepole pine		1	1	1	1
Main species: western larch		1	1	1	1
Mixture of subalpine fir, spruce, and lodgepole pine		0	0	0	0
Main species: whitebark pine		0	0	0	0
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	0				

Whitebark pine **Vegetation type**		**Structural stage**			
		seedling	pole	mature	large
Main species: ponderosa pine		0	0	0	0
Main species: grand fir		0	0	0	0
Main species: Douglas-fir		0	0	0	0
Main species: lodgepole pine		1	1	1	0
Main species: western larch		0	0	0	0
Mixture of subalpine fir, spruce, and lodgepole pine		1	1	1	1
Main species: whitebark pine		1	1	1	1
Main species: cottonwood, aspen, or birch		0	0	0	0
Mixture of grass, wildflowers, and shrubs	1				