POST-FIRE CONDITIONS OF RIPARIAN VEGETATION

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INTRODUCTION

Our main objectives were: (1) to examine the summer 2000 post-fire conditions of riparian vegetation within several watersheds of the Frank Church Wilderness (Big Creek, Cabin Creek, Cliff Creek, Cougar Creek, Goat Creek, and Pioneer Creek) and other non-wilderness streams (Clear Creek and Waterfall Creek), (2) to determine historic fire "footprints," if possible, within Doe Creek and Waterfall Creek watersheds, and (3) to detect the presence of historic livestock grazing and its impacts on the vegetation, particularly through the presence of invasive species (Cabin Creek, Clear Creek, and Pioneer Creek).

Keywords: fire, grazing.

RESULTS

Clear Creek

The interest in Clear Creek was twofold: to examine riparian recovery following a large-scale fire and to locate possible areas of historic grazing by the occurrence of invasive species.

Reconnaissance fieldwork was conducted in July 2002, just after the imagery was flown. We recorded GPS points of large patches of homogenous vegetation and made observations of the general landscape and vegetation distribution after the fire in 2000 (Photos 1 and 2). A second field reconnaissance was conducted in October 2003 to verify vegetation maps. Additional GPS points were obtained at that time to record the distribution of vegetation and other interesting landmarks. We discovered a large blowout had occurred on the stream in late Summer 2003, expelling a large amount of sediment, ash, and large woody debris from the watershed (Photos 3 and 4). A local resident informed us the blowout occurred several kilometers upstream, at the confluence of Deadhorse Creek and Clear Creek. As a result of the blowout, Clear Creek changed its course and much of the vegetation along Clear Creek and its floodplain was buried under sediment (Photo 5).

Photo 1. Collecting GPS coordinates along Clear Creek, July 2002. Facing toward a debris dam on the far left of the photo.

Abundant riparian species of interest include birch (*Betula*), hawthorn (*Crataegus*), willow (*Salix*), wild rye (*Elymus*), poplar (*Populus*), and ponderosa pine (*Pinus ponderosa*). The invasive species most abundant in the Clear Creek watershed is cheat grass (*Bromus tectorum*).

Photo 2. Burned Douglas fir trunks with regrowth of fireweed and thimbleberry looking upstream along Clear Creek, July 2002. The trail is on the far right side of the photo.

Photo 3. Large woody debris that washed downstream during the Clear Creek blowout, Summer 2003. The stream changed direction 90° from its original course at this point. Photo was taken looking upstream in October 2003.

Photo 4. Large woody debris washed downstream during Summer 2003 blowout, as seen in October 2003. The orange vegetation on the far side of the floodplain is live hawthorn. Directly adjacent, on the right, are burned dead hawthorns.

Photo 5. Aerial view of mouth of Clear Creek watershed showing extent of mudflow (October 2003). Bright yellow areas on right side of photo above stream are large areas of cheatgrass.

Riparian Recovery

Due to the large blowout this past summer, much of the vegetation on the imagery is no longer there. This presented a problem during ground truthing in October. Therefore, we concentrated our efforts in a floodplain along Panther Creek, just downstream of the mouth of Clear Creek (Figure 1). The floodplain had almost all of the species of interest, and provided very useful data for verifying our vegetation maps. Figure 2 shows the distribution of classified vegetation along Clear Creek. The high accuracy of the species maps for the floodplain and surrounding areas unaffected by the mudflows leaves us confident that the vegetation maps along Clear Creek are quite accurate. Tree trunks of birch, poplar, and hawthorn that remain standing along lower Clear Creek provide further evidence of the accuracy of our vegetation maps. Table 1 lists the riparian species that were identified in the imagery and the area covered by each species within a 20m riparian buffer around Clear Creek. The most abundant species were burned poplar, ponderosa pine, and birch. We also were able to distinguish between burned and unburned vegetation for some species, including poplar and hawthorn (Figure 3).

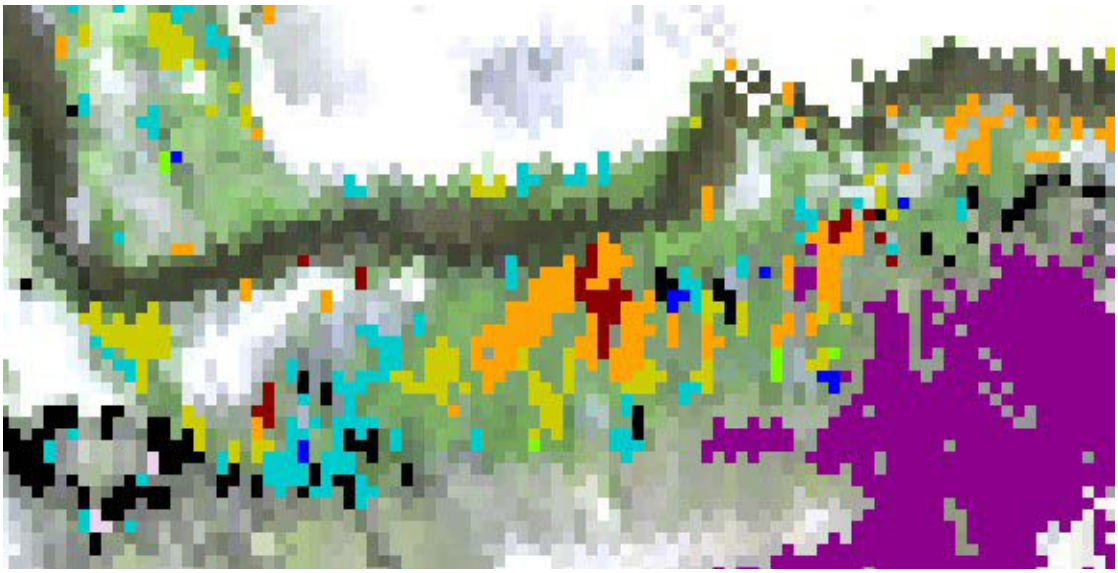


Figure 1. A true-color red-green-blue (RGB) composite of the floodplain surveyed in October 2003 along Panther Creek (shown as dark gray pixels), flowing from the upper right across the top of the image to the upper left, downstream of the mouth of Clear Crk.

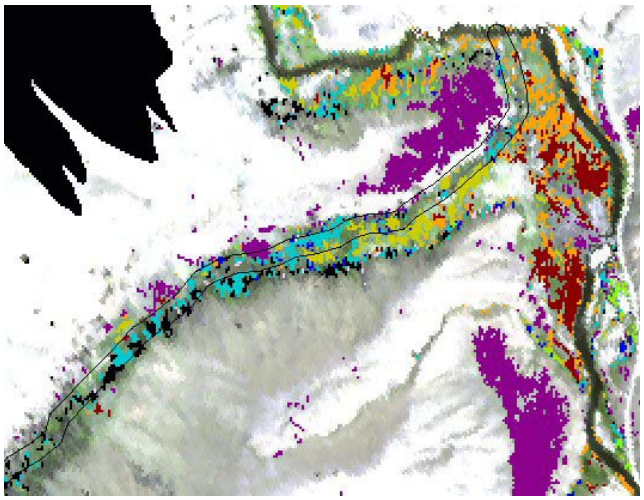


Figure 2. . True-color RGB composite of lower Clear Creek with the 20m buffer overlaid. As of Summer 203, the area along the buffer is under a layer of mud. Panther Creek flows from the lower right corner, along the right edge and exits in the upper center of the image. The floodplain surveyed in October 2003 is just to the left of where Clear Creek enters Panther Creek. After the mudflow, Clear Creek no longer turns to the left before emptying into Panther Creek; it now flows straight across the willow/rye grass flat. The black area in the upper left corner is the edge of the imagery. This imagery was flown July 2002.

Table 1. Composition of principal riparian vegetation within a 20m buffer zone along Clear Creek. The total area of the 20m buffer zone along Clear Creek is 106,436m^2. The total area of vegetation classified within the buffer is 27,094 m^2.

Species	% composition
Burned poplar	40.2
Ponderosa pine	24.3
Birch	14.9
Cheat grass	5.3
Willow	4.9
Burned hawthorn	4.0
Hawthorn	4.0
Ryegrass	2.1
Poplar	0.3

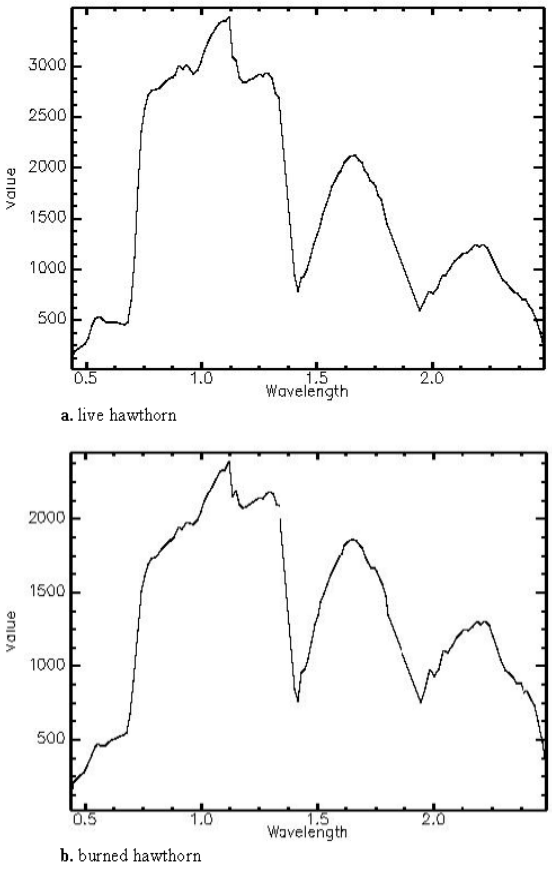


Figure 3. Unique spectral signatures of burned and live hawthorn along Clear Creek. The signatures look similar except at wavelength 0.7μm. The spectral signature for the live hawthorn shows an absorbance at 0.7 μm, whereas the spectral signature of the burned hawthorn shows not an absorbance, but a reflectance, at 0.7 μm.

Historic Grazing

We believe historic grazing occurred on a large elevated flat upstream of the mouth of Clear Creek because of the overwhelming abundance of cheat grass found there (Figure 4, Photo 6). There also are several hillsides upstream of Clear Creek, that mapped cheat grass in the imagery, and also suggest historic grazing. However, the large tract of cheat grass just upstream of Clear Creek (Figure 5) recently (2003) was sprayed by the Forest Service and is no longer as extensive as in 2002 when the imagery was flown.

Current Standing

This portion of the research is near completion. In the future we plan to examine the vegetation composition within two other riparian buffer zones 5m and 30 m, to gain a better understanding of the true size of riparian zones. We also will further examine the data using spectral unmixing to fine tune the percent composition of the vegetation within the buffer zones. Due to the heterogeneity of vegetation within the riparian zone, it is often difficult to identify large (5m) patches of homogenous vegetation as spectrally pure pixels. Spectral unmixing teases out the percentage of species within spectrally unpure pixels. Spectral unmixing will allow us to determine a larger percentage of the vegetation species composition along the riparian zone.

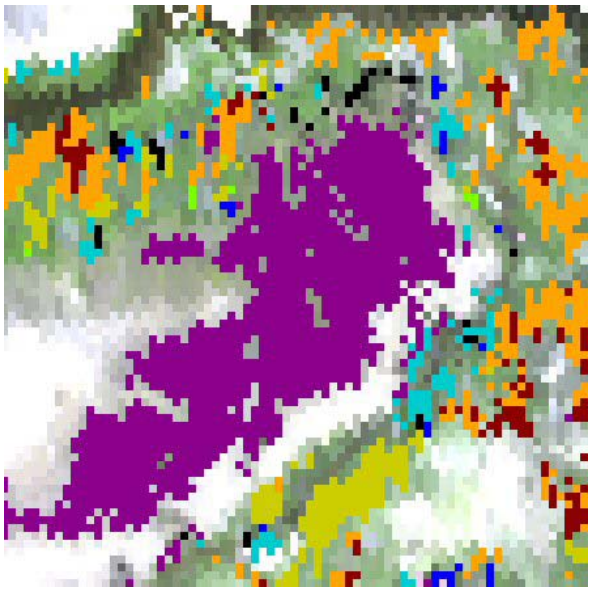


Figure 4. True-color RGB composite of a large tract of cheat grass (purple) located on elevated flat above Clear Creek, indicating historic grazing. Panther Creek runs across the top of the image. This imagery was flown July 2002.

Photo 6. Large field of cheatgrass on hill above Clear Creek, October 2003. The dot on the right side of the field near the horizon is a 6ft. tall man.

Big Creek and its Tributaries

The interest in Big Creek was to examine riparian recovery following a large-scale fire; to quantitatively map its areal extent and relative (percent) species composition; to locate the boundary of a 60-year burn using marker trees that did not burn in the 2000 fire; and to verify accounts of historic grazing in Cave Creek, Cabin Creek, and Pioneer Creek by the occurrence of invasive species. The entire study area along Big Creek extends approximately 20km from just above Doe Creek to the Big Creek Gorge, approximately 6km above the confluence of Big Creek with the Middle Fork Salmon River. For each stream in which we examined riparian recovery, we applied a 20m riparian buffer (20m on each side of the stream) to measure relative species abundance.

Reconnaissance work was performed in summer 2003 to verify vegetation maps created in the spring. We recorded GPS points in large clumps of homogenous vegetation to help revise vegetation maps after field verification. Since the field season this summer, we have been revising the vegetation maps for several species. Results for Cabin Creek, Cliff Creek, Cougar Creek, Doe Creek, Goat Creek, and the middle section of Big Creek are given in this paper. Much of the imagery of Cave Creek, which was completely burned in 2000, was darkened by shadows, so we did not concentrate our efforts on this stream. We have identified some recovering vegetation along Cave Creek (mainly maple), but the results are not included in this paper.

Abundant riparian species of interest include Douglas fir (burned and live) (*Pseudotsuga menziesii*), birch (*Betula* sp.), cottonwood (*Populus* sp.), dogwood (*Cornus sericea*), maple (*Acer glabrum*), hawthorn (*Crataegus* sp.), prickly rose (*Rosa acicularis*), and Lewis mock orange (syringa) (*Philadelphus lewsii*). Invasive species of interest is cheat grass (*Bromus tectorum*).

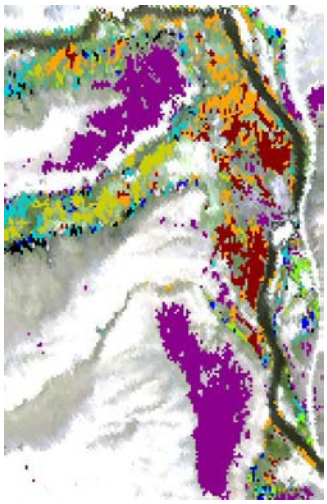
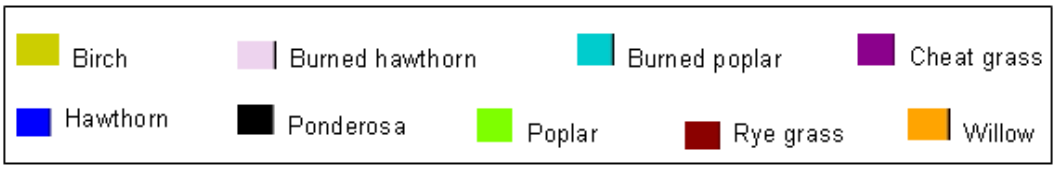


Figure 5. True-color RGB composite showing the location of cheat grass upstream of Clear Creek that was present when the imagery was flown (July 2002), but was recently (2003) sprayed with herbicides by the U.S. Forest Service. Also included, for reference, is the large field of cheat grass located on the elevated flat above Clear Creek (top left). Panther Creek flows from the lower right corner of the figure to the upper left corner.



Riparian Recovery

We classified riparian vegetation on a 7km section of Big Creek, extending from approximately 3km upstream of Taylor Ranch to the Big Creek Gorge. The area of the 20m buffer is 324,285 m^2. We could identify vegetation only for 6% of the area (Table 2). This was due to (1) the buffer included Big Creek itself, which is quite large (6th order stream), and (2) the riparian is highly intermixed with many vegetation species, so it is often difficult to find large (5m) areas of homogenous vegetation.

Table 2. Composition of principal riparian vegetation within a 20m buffer zone along Big Creek. The total area of the 20m buffer zone along Big Creek is 324,285m^2. The total area of vegetation classified within the buffer is 18,190.5 m^2.

Species	% composition
Birch	30.4
Hawthorn	26.1
Cheat grass	14.3
Dogwood	10.6
Douglas fir	6.8
Mock orange	5.9
Burned Douglas fir	5.5
Maple	5.1
Prickly rose	0.6

Lower Cliff Creek burned completely during the 2000 fire (Photo 7); however, regrowth of vegetation was rapid (Photos 8 and 9). Much of the recovering riparian vegetation present in 2003 is maple, but it is not detected in the imagery. In fact, very little vegetation can be identified as spectrally pure in Cliff Creek after the fire (Figure 6), suggesting a variety of low vegetation interspersed with rock, ash, and charcoal. The difficulty in detecting the regrowth of maple along Cliff Creek is most likely due to the imagery being flown two years after the fire and the maple not being large enough to be detected by the 5m-pixel coverage. The most abundant species identified within a 20m riparian buffer zone were birch, hawthorn, and burned Douglas fir (Table 3). Most of the spectrally pure pixels identified were in the upper part of the imagery. Other recovering species along Cliff Creek that are not detected by the imagery are mountain hollyhock (*Iliamna rivularis*) and thimbleberry (*Rubus parviflorus*).

Photo 7. Cliff Creek in September 2000, one month after the fires. Looking upstream.

Photo 8. Cliff Creek in July 2001, showing re-growth of vegetation along the floodplain.

The upper basin of Cougar Creek was burned in 1998. The imagery covers the lower part of Cougar Creek, but does not extend to the fire boundary. We were able to classify almost 40% of the vegetation as spectrally pure. Birch and Douglas fir comprise 70% of the vegetation within the 20m riparian buffer zone (Table 4). Figure 7 shows the distribution of vegetation species along Cougar Creek.

Photo 9. Cliff Creek in July 2002, the same month the imagery was flown. There is more re-growth of low shrubs and fireweed (seen on the right bank, looking upstream).

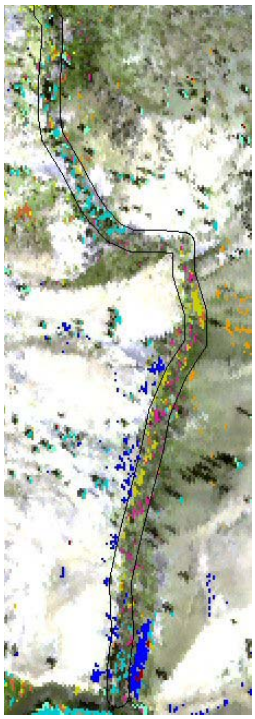


Figure 6. . True-color RGB composite of lower Cliff Creek, with the 20m buffer overlaid. Due to the severity of the burn in 2000, and the use of spectrally pure pixels, very little vegetation could be classified from the imagery, which was flown two years later, in July 2002. Big Creek flows from left to right at the bottom of the figure.

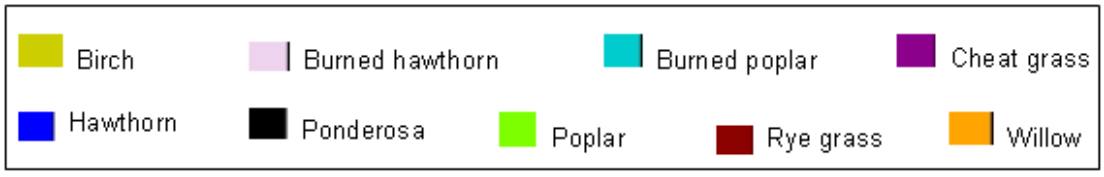


Table 3. Composition of principal riparian vegetation within a 20m buffer zone along Cliff Creek. The total area of the 20m buffer zone along Cliff Creek is 99,311 m^2. The total area of vegetation classified within the buffer is 12,124 m^2.

Species	% composition
Birch	31.4
Hawthorn	21.7
Burned Douglas fir	19.9
Maple	9.3
Douglas fir	6.5
Dogwood	5.5
Cheat grass	4.8
Cottonwood	0.4
Mock orange	0.4
Prickly rose	0.1

Table 4. Composition of principal riparian vegetation within a 20m buffer zone along Cougar Creek. The total area of the 20m buffer zone along Cougar Creek is 70,927 m^2. The total area of vegetation classified within the buffer is 26,944.5 m^2.

Species	% composition
Birch	40.7
Douglas fir	29.1
Maple	10.5
Dogwood	5.7
Hawthorn	3.9
Burned fir	3.7
Prickly rose	2.8
Cheat grass	2.3
Mock orange	1.3

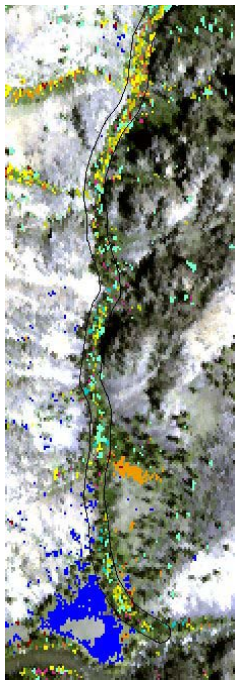
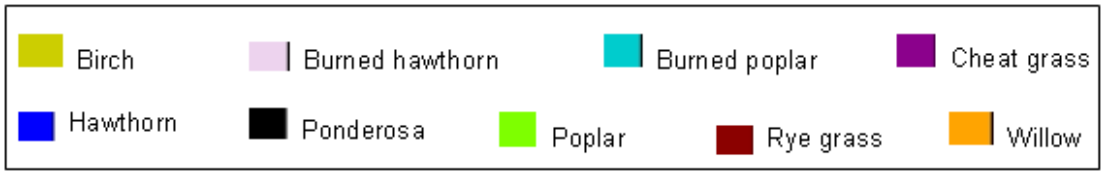


Figure 7. True-color RGB composite of lower Cougar Creek, with the 20m buffer overlaid. More vegetation was identified in the upper catchment than in the lower catchment. The large field to the left of Cougar Creek does have some cheat grass, but it is over-predicted in this composite. Big Creek flows from left to right across the bottom of the figure. The imagery was flown July 2002.



Goat Creek also was not burned in the 2000 fire. As in Cougar Creek, the imagery covers only the lower part of Goat Creek. Spectrally pure vegetation was classified for 56% of the vegetation within the 20m riparian buffer zone. Birch was the dominant vegetation, followed distantly by Douglas fir, prickly rose, and dogwood (Table 5). Figure 8 shows the distribution of vegetation species along Goat Creek.

Table 5. Composition of principal riparian vegetation within 20m buffer zone along Goat Creek. The total area of the 20m buffer zone along Goat Creek is 47,935 m^2. The total area of vegetation classified within the buffer is 27,053 m^2.

Species	% composition
Birch	38.0
Douglas fir	17.2
Prickly rose	14.2
Dogwood	13.7
Cheat grass	5.8
Maple	5.4
Hawthorn	3.1
Burned fir	0.7

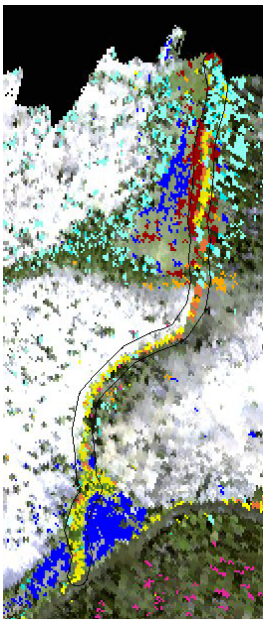
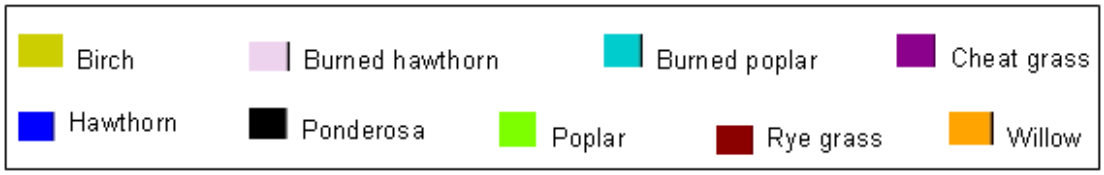


Figure 8. . True-color RGB composite of lower Goat Creek, with the 20m buffer overlaid. Birch is the dominant riparian species along Goat Creek. Imagery was flown July 2002. The black areas at the top of the figure are the edges of the imagery.



Historic Grazing

Large tracts of cheat grass were mapped along the hillsides around Cabin Creek, near the mouth of Pioneer Creek on a hill above Taylor Cabin, and in a field near the mouth of Goat Creek. There are accounts of grazing by homesteaders in the Cabin Creek drainage at the turn of the 20th Century. It is no surprise that most of the hillsides above Cabin Creek are covered with cheat grass (Figure 9). Most of the cheat grass is intermixed with other vegetation, namely tumble-mustard (*Sisymbrium altissimum*) and rabbitbrush (*Chrysothamnus*). A smaller tract of cheat grass was mapped along Pioneer Creek (Figure 10). The caretakers of Taylor Ranch previously grazed their horses along the hillside where the cheat grass was found. Although there are no historic accounts of grazing at the mouth of Goat Creek, a large field mapped out as predominantly cheat grass (Figure 11). The cheat grass at Goat Creek is intermixed with balsamroot (*Balsamorhiza*). The Goat Creek trail is used extensively by horseback riders and pack stock, so it is reasonable their animals would have grazed the field heavily over the years.

Historic Fire Footprints

Doe Creek catchment burned completely during the 2000 fire (Photo 10). However, there are isolated trees and small patches that did not burn during the fire. During field reconnaissance in Summer 2003 we found a large (5m) clump of live Douglas firs on a hillside above Doe Creek which did not burn in the 2000 fire (Photo 11). This stand is presumed to be around 60 years old, which is when a previous fire burned the entire

watershed. The spectral signature of this stand was used to locate other Douglas firs of the same age in the watershed, which are used to identify the historic fire "footprint."

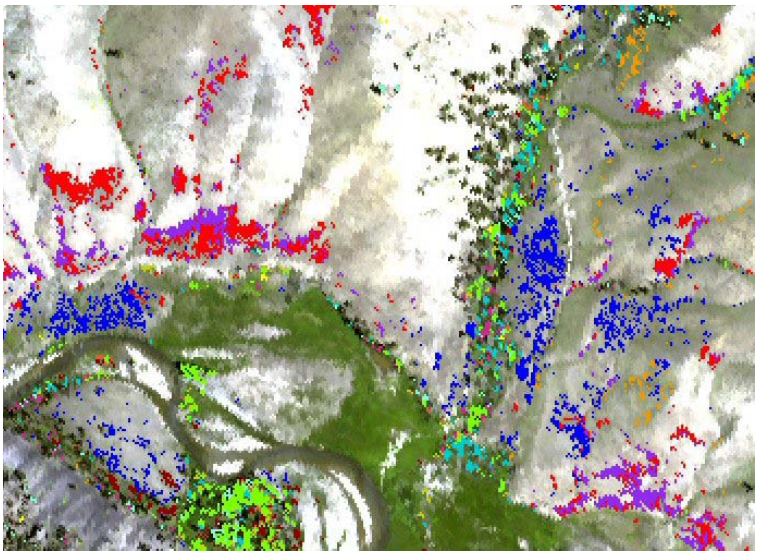
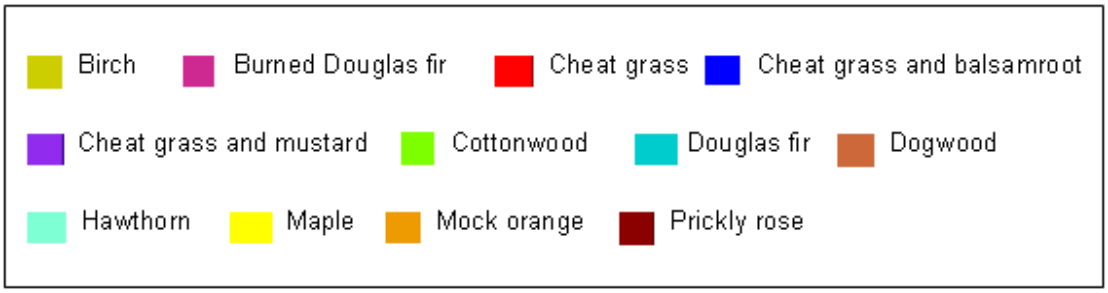


Figure 9. True-color RGB composite of lower Cabin Creek showing the distribution of cheat grass. These are located on well-drained sites and indicating historic grazing. There are three different cheat grass classifications, as indicated below in the color key. The imagery was flown July 2002



Preliminary results show the Douglas fir spectral signature is capable of finding some, but perhaps not all, 60-year old Douglas firs (Figure 12). It is not clear whether the spectral signature of the 60-year old Douglas firs is different from that of live Douglas firs of different ages, but this will be easy to determine for our existing coverages.

Current Standing

The historic grazing component of this research (Cabin Creek and Pioneer Creek) is near completion. We would like to further evaluate the percent composition of cheat grass versus other vegetation, such as tumble-mustard, rabbitbrush, and balsamroot. We will verify new vegetation maps in the field in Summer 2004, during our annual visit. Pertaining to the riparian recovery component, we plan to apply 5m and 30m buffer zones and quantify species abundance within these zones for all streams examined (Big Creek, Cliff Creek, Cougar Creek, and Goat Creek). We will determine the total vegetation cover, further refine the relative abundance numbers, and quantify the

abundance of rock, water, and other non-riparian vegetation. We will continue working on Doe Creek, revising the maps until all the 60-year old Douglas firs have been identified in the upper catchment.

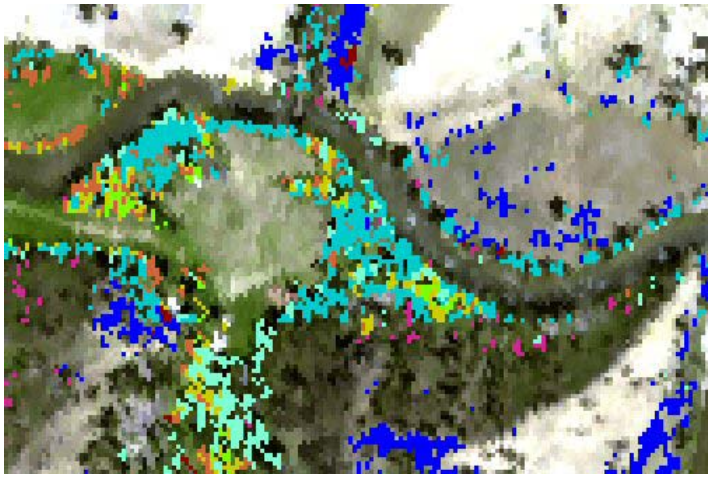
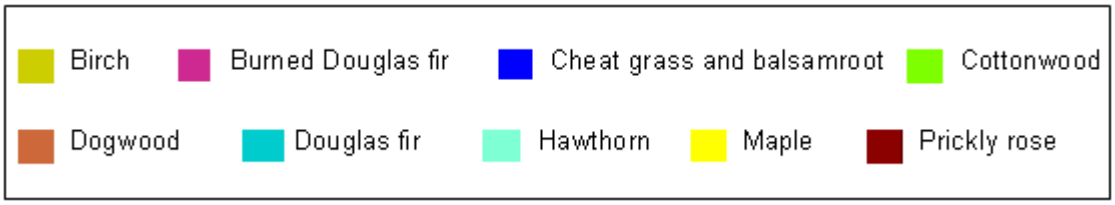


Figure 10. True-color RGB composite of Taylor Ranch, which lies between Pioneer Creek (left of center, bottom of figure) and Cliff Creek (top center). Big Creek flows from left to right along the middle of the figure. Cheat grass was identified on a hillside above Pioneer Creek (left side of figure). The large field downstream of Taylor Ranch (right side of figure) is largely cheat grass, but it is under-predicted in this field.



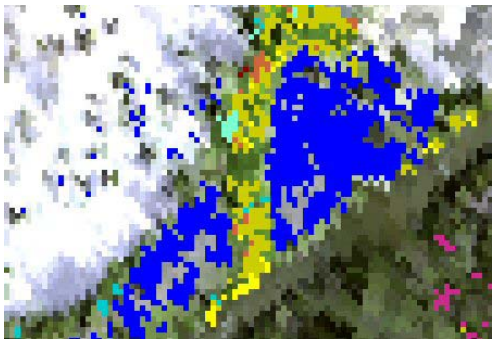


Figure 11. True-color RGB composite of the mouth of Goat Creek, showing the location of cheat grass. The imagery predicts well for cheat grass in these fields, which is intermixed with balsamroot. Imagery was flown July 2002.

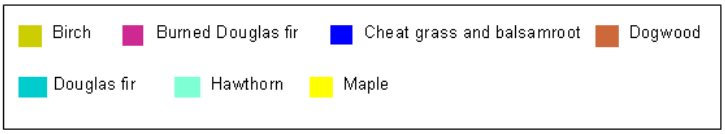


Photo 10. Doe Creek catchment as viewed from across Big Creek. This watershed was burned approximately 60 years ago and again in 2000. Most of the Douglas firs were burned in 2000; however, a few 60 year old trees can be seen on the far ridge line and near the mouth of the creek.

Photo 11. Looking upstream on Big Creek at Doe Creek coming in from the left. The large clump of Douglas firs on the hillside above the mouth of Doe Creek (right of center) is being used as a training point for 60-year old trees.

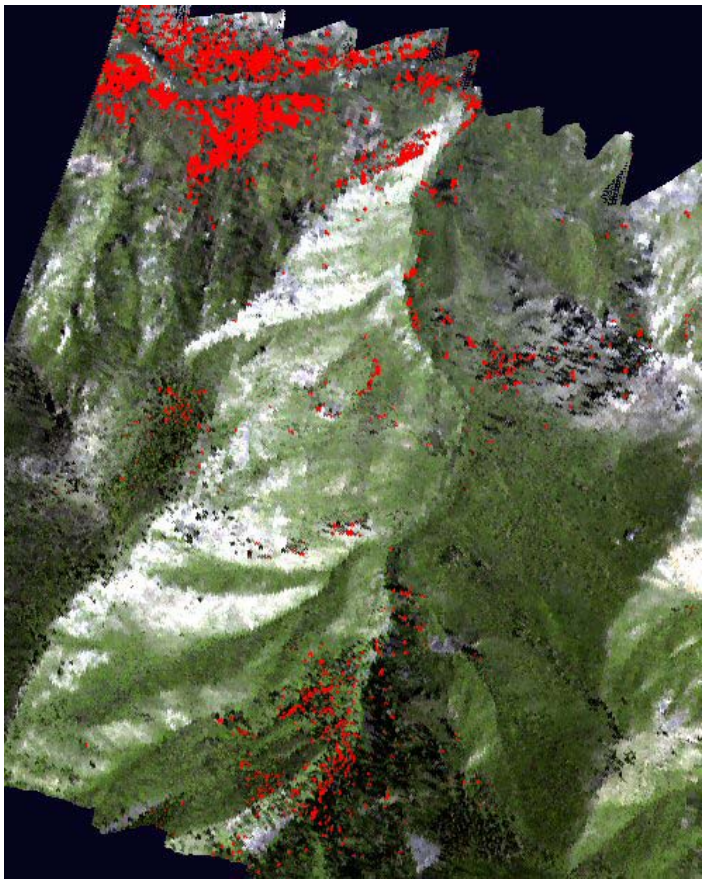


Figure 12. True-color RGB composite of Doe Creek catchment showing the location of living 60-year old Douglas firs (red). Doe Creek appears as a "ridge" extending from the bottom to the top in the center of the image. The mouth of Doe Creek lies just beyond the edge of the imagery in the upper right corner. Big Creek can be seen flowing between two large patches of Douglas firs in the upper left corner of the figure. The black areas in the upper left and upper right of the figure are the edges of the imagery. This imagery was flown July 2002.

ACKNOWLEDGEMENTS

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