A Conceptual Framework to Guide

Research and Teaching at Rogers Research Site

NORTH LARAMIE MOUNTAINS, WYOMING

By Stephen E. Williams and Robert W. Waggener

University of Wyoming
Agricultural Experiment Station

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ROGERS RESEARCH SITE BULLETIN 3: A Conceptual Framework to Guide Research and Teaching at Rogers Research Site, north Laramie Mountains, Wyoming

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This is Bulletin 3 in an ongoing series focusing on research, teaching, extension, and other activities at the University of Wyoming's Rogers Research Site (RRS) in the Laramie Mountains, north Albany County, Wyoming. The approximate 320-acre site was bequeathed to UW in 2002 by Colonel William Catesby Rogers.

Colonel Rogers spent much of his retirement time at the mountainous, remote property, which he called the Triple R Ranch. UW renamed the property "Rogers Research Site" in memory of Colonel Rogers, who passed away in 2003 at age 96.

The February 16, 2002, amended living trust of Colonel Rogers states that:

> said ranch be used for the public benefit as a center for studies, a retreat for conducting meetings, conducting conferences, or conducting research in connection with the improvement of wildlife and forestry, or to hold as a natural wooded area in its original state with specific instructions that no part of it be subdivided or sold for residential or private business purposes but held as an entire tract. Said restriction is to continue in perpetuity. If violated, said property shall revert to the ownership of the U.S. Forest Service.

Overseeing management of RRS is the Wyoming Agricultural Experiment Station (WAES), UW College of Agriculture and Natural Resources. RRS is placed administratively under one of the WAES research and extension centers, the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle, Wyoming.

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ON THE COVER

University of Wyoming undergraduate student Kristina Kline, left, and UW Assistant Professor Linda van Diepen survey the survival rates of ponderosa pine seedlings that were planted three years after the 2012 Arapaho Fire, which killed the majority of pine trees across the Rogers Research Site (RRS) and neighboring lands in the Laramie Mountains. This photo was taken in July 2017. Preliminary results from the ponderosa pine restoration study will be presented in an upcoming RRS bulletin. (Photo by Stephanie Winters; cover design by Tanya Engel)

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STANDING ON THE COLONEL'S SHOULDERS

By Robert Waggener

> *"To laugh often and much; to win the respect of intelligent people and the affection of children…to leave the world a better place…to know even one life has breathed easier because you have lived. This is to have succeeded."*

Those words by Ralph Waldo Emerson, an American essayist and poet who led the transcendentalist movement and championed individualism, personify the spirit of Colonel William C. Rogers, who, too, believed in the inherent goodness of people and nature, individualism, and self-reliance. And he, too, believed in respecting others. That's why Colonel Rogers (Fig. 1), who had already gained the respect of many intelligent people across the country and world, was welcomed by area residents when he bought a remote piece of forested land in the Laramie Mountains, a 320-acre parcel that he could call home during what became a long, adventurous retirement.

Duane Walker, who has spent most of his life living in these rugged mountains, says that The Colonel, as he was known, befriended many of the locals because he made them feel welcome on his property, and, most importantly, because he treated them with respect. "Yea, that's kind of the way this country up here was put together," Duane says. "Neighbors working together make it, but when people fight each other there is nothing but trouble. Most everyone up here tries to stay away from that. They respect each other, and they help each other."

For Duane Walker and William Rogers, their respect for each other was undoubtedly strengthened by the fact that both proudly served their country in the military, Walker with the U.S. Navy and Rogers with the Army. "I came to realize that he was probably pretty good in the military. You could just sense that. I served in the Korean War. I was there when it started, and I was there when it finished. And I had heard that Colonel Rogers served in World War II."

To this day, Duane regrets not inquiring about Colonel Rogers' distinguished military career. "I'm kind of ashamed of that, but that's the way it turned out," he says. "But looking back, The Colonel wasn't one to let you know too much about his military and about his outside travels. I just always figured that if people wanted me to know something, they would tell me. I wasn't going to ask."

So how do people like Duane Walker know that Colonel Rogers was a good military man when his military career was never discussed? Duane says it comes down to a single word: respect. "He fit into our country up here just because of his personality. He moved in as a stranger, but made himself pretty well welcome. People liked him, as far as I know, and they respected him. The Colonel treated people with respect, and at least to me that's what he expected in return."

Could others tell that Colonel Rogers was a good military man as well? "Yes," responds Levida Hileman, matter-of-fact. Levida, along with daughter Colleen Hogan, spent many weeks each summer visiting The Colonel when she taught school in Casper, Wyoming; however, just like Duane Walker, she knew

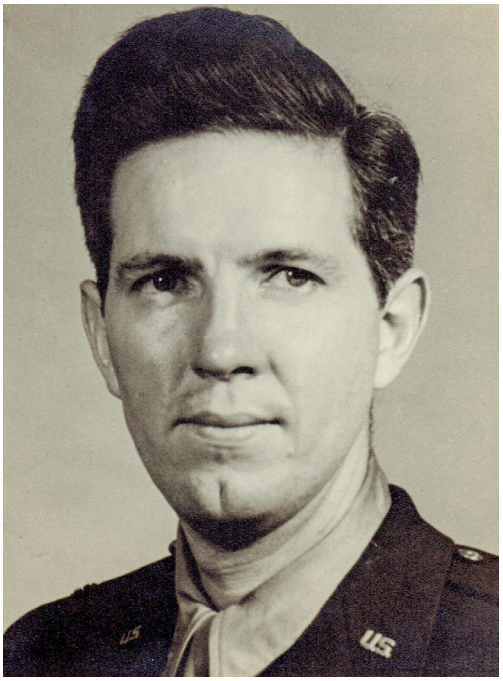

Figure 1. William Catesby Rogers (1906–2003) was called to active duty with the U.S. Army in 1942. He is a veteran of World War II, when this photo was taken (S. Stark Serra, personal communication, 2017). Rogers had achieved the rank of colonel by 1955, when he received the second highest decoration bestowed by the Republic of Korea for military merit. That award was based on his service as chief of the Korean Civil Assistance Command's transportation branch. (Photo courtesy Sarah Stark Serra)

little about his military service. “In many ways, The Colonel was a private person, and I was raised to respect people’s privacy. I felt whatever he wished to talk about, he would. If a few tentative questions were approached and he did not reply, I let the matter drop. I do believe that he was more open about his military career with the young men who came to visit.”

Levida says that she would like to learn more about The Colonel’s service if the opportunity ever presented itself, but her lack of knowledge does not downplay her feelings—the same feelings that Duane Walker holds—about the fact that Colonel Rogers was a man who treated people with dignity and respect while expecting others to do the same.

“He was a pretty strict man. He carried the military with him,” Levida says. “In my opinion he was a pretty moral man, and I am using that in the old-fashioned sense. He was very respectful toward females. He didn’t want anyone saying dirty jokes around women, not at all. One day I was trying to change a flat tire, and The Colonel came over to help. He got pretty frustrated when things weren’t going so well, and he wanted Colleen to wander off so she wouldn’t hear him say ‘damn’ or some other cuss word.”

With respect came trust, and those two things combined led to a friendship that grew stronger and stronger each summer as Levida

Figure 2. Spring water cascades down a rocky slope on the Rogers Research Site, which became the official name for the Triple R Ranch in memory of Colonel Rogers. Quaking aspen began actively regenerating following the 2012 Arapaho Fire. This photo was taken in June 2015. (Photo by Mollie Herget)

Figure 3. Storm clouds roll over the Laramie Mountains, partially covering the prominent Laramie Peak. This photo, taken in May 2017, shows the small reservoir that Colonel Rogers had constructed on his Triple R Ranch, which he bequeathed to the University of Wyoming in 2002. To the left of the reservoir and on the ridge are standing dead ponderosa pine trees, remnants of the 2012 Arapaho Fire. (Photo by Steve Paisley)

Figure 4. There were a number of old buildings at the Triple R Ranch, and Colleen Hogan and a friend, while in their teens, refinished the wood floors in one of the rustic cabins. Colonel Rogers called the structure on the left "The Sauna," while the cabin in the background was named "The Ever House." Colleen's mother, Levida Hileman, says that she believes The Sauna was the most unique building on the property. It was shaped similar to a pagoda, and The Colonel had it built for cleansing baths during colder weather. The small building consisted of a steaming room and a dressing room. The Ever House was occupied by the longtime caretaker of the property, Jim O'Brien. All of the buildings were destroyed during the 2012 Arapaho Fire, though an antique sheep wagon, which had previously been moved to a nearby property, survived the fire. (Photo by Colleen Hogan)

and Colleen spent cherished time with Colonel Rogers. Time amidst the butterscotch smells of ponderosa pine, rustling leaves of quaking aspen, storm clouds passing over the Laramie Mountains, and soothing sounds of spring water cascading down rocky slopes (Figs. 2–3). During that period, Levida was a single mother trying to raise five children by herself, and daughter Colleen grew especially fond of Colonel Rogers, who became both a fatherly and grandfatherly figure. "I trusted The Colonel enough that when Colleen became a teenager, I knew that I could leave her up there with Bill for two or three days, that he would make sure nothing happened to her," Levida says.

It's hard to imagine that four decades have passed since the mother-daughter pair met Bill. And when Colleen begins sharing stories about her friend, the quote by Ralph Waldo Emerson resonates through the words. The Colonel won the affection of Colleen, and she, in turn, won the respect of The Colonel. They laughed often and much. And her life became so much better for having known him. "He had a very positive influence on my life. He was a good role model who helped instill trust in me, which was important because my dad wasn't in our lives at that time. During my teen years, he hired me to do some work up there and my mother was totally comfortable leaving me alone with him. She knew that he was such a nice, kind, trusting man and that he would look out for me and that nothing would happen while I was up there."

Like Ralph Waldo Emerson, Colonel William Catesby Rogers believed in the inherent goodness of people. That's why they felt welcome on his land, and that's why they helped him in any way they could. For Duane Walker, that involved thinning 40 acres of ponderosa pine in the late 1960s. "The Colonel hired me to clean the place up and make something of it. He wanted a nice secluded spot for him and his friends, among them a lady friend who came up to write books with The Colonel. He wanted a little place tucked away in the woods so he wasn't bothered by anybody, and this was a pretty secluded place, a perfect place to write books with his friend."

Duane vividly remembers his first conversation with The Colonel. "It was his personality. He was exact and to the point in what he did talk about. He would explain something exactly, but he was a real nice gentleman about it. As far as I'm concerned, he was a real neat fella, a real nice gentleman, period."

The Colonel was a gentleman, a person who could make others laugh while still

maintaining a meticulous attention to detail, a man who believed in individualism and self-reliance, the type of guy who could breathe life into a conversation. "Colonel Rogers was eccentric, very eccentric. He was opinionated, extremely opinionated. He had a very powerful presence even though he was quite ill when I met him," says Rebecca Hilliker, a University of Wyoming professor emerita of dramatic literature and acting who became close friends with Bill late in his life. "You can see why he was attracted to the kind of women he was; they had to be really strong, powerful women to manage him, to exist with him. Otherwise, he would have just dominated the relationship. If they weren't strong and powerful, he wouldn't have been happy with them, and they wouldn't have been able to exist with Colonel Rogers."

Being strong and independent and powerful in her own way was how Levida Hileman gained both The Colonel's respect and friendship. "He made it quite clear when we came up there that we were on our own. But I was raised that way, and since I was a single mother I knew what it was like to be on my own. I was pretty independent, and I believe that helped gain The Colonel's respect."

And so did hard work, something that daughter Colleen learned when Colonel Rogers hired her and a friend to refinish an old wooden floor in one of the rustic cabins (Fig. 4). It was hard, back-breaking work, and he offered encouragement along the way. "Yes, I learned the value of hard work from The Colonel when we stripped the finish off that floor and then refinished it. He trusted us, as teenagers, which made me feel good. He didn't tell us what to do, but he did give us some pointers and then he said, 'Go get to work.' The floor looked really good when we were finished with the project, and he offered some very kind words."

The Colonel, too, offered kind words to Colleen and Levida after they spent many hours refurbishing his antique sheep wagon (Fig. 5), which became their home-away-from-home until Levida married Brock Hileman. The couple happily resorted to the comforts of a camper trailer while Colleen had a little place of her own, a place where she could read Ernest Hemingway under a dim light or go

Figure 5. Levida Hileman and her daughter, Colleen Hogan, who became close friends with Colonel Rogers, spent hours refurbishing this antique sheep wagon, which became their home-away-from-home during stays at the Triple R Ranch. Colonel Rogers bequeathed the wagon to the mother-daughter pair. Shortly after their friend passed away in 2003, Colleen, Levida, and Levida's husband, Brock Hileman, rented nearby property in the Laramie Mountains, where they moved the wagon and added this deck. All of the structures at the Rogers Research Site burned during the 2012 Arapaho Fire, and this antique would have been one of the casualties had it not been moved to an area that, fortuitously, escaped the massive wildfire. This photo was taken in 2016. (Photo by C. Hogan)

back to her childhood with Cowgirl Kate and Cocoa while listening to the bugles of Rocky Mountain elk and the distinct too-too-too calls of northern saw-whet owls. From people like Colonel Rogers, she began to believe in the inherent goodness of nature and the inherent goodness of people. To leave the world a better place…to know even one life has breathed easier because you have lived.

"The Colonel used to lead Colleen and me over his property picking raspberries and gooseberries so I could make him a pie—he had a real sweet tooth," Levida recalls with a smile. "We still see raspberry bushes up there, wild iris grows abundantly in wet areas (Fig. 6), and chokecherries are along the streams. Over many summers I made chokecherry jelly and syrup, and a little chokecherry wine. Years ago, with The Colonel, we would gather and cook wild mushrooms. And during those hikes we would see western tanagers and bald eagles. At dusk the bats would fly over. And you knew the beginning of warm weather and the end of warm weather by the arrival and departure of the nighthawks."

Levida says that The Colonel gave many people a fabulous gift, and that gift was filled with respect, friendship, and wonder, and that he left the world a better place because of how he lived. "I truly enjoyed our conversation," she quietly mentions. "For talking of The Colonel has brought back so many warm memories."

Figure 6. Rocky Mountain iris (*Iris missouriensis*) and many other wildflowers are abundant in the Laramie Mountains, including the Rogers Research Site. This photo was taken during a 2009 field day at RRS. (Photo by Kelly Greenwald)

A CONCEPTUAL FRAMEWORK TO GUIDE RESEARCH AND TEACHING AT ROGERS RESEARCH SITE, NORTH LARAMIE MOUNTAINS, WYOMING

By Stephen E. Williams[1–2] and Robert W. Waggener[3]

INTRODUCTION

During the early 2000s, there was an effort to organize a forestry-related component of the University of Wyoming's (UW) Wyoming Agricultural Experiment Station (WAES). This effort was made possible due to an endowed gift of approximately 320 acres (129.5 hectares) of forested land in southeast Wyoming by Colonel William C. Rogers (Rogers, 2002). The parcel, which has become known as the Rogers Research Site (RRS), is located in the Laramie Mountains, approximately five miles southeast of the prominent Laramie Peak and 25 miles northwest of Wheatland, Wyoming (Figs. 1–2).

Figure 1. Topography at Rogers Research Site, like surrounding lands in the vicinity of Laramie Peak, is quite varied, from relatively level grassland meadows to rocky slopes. This photo shows one of the ponderosa pine restoration study plots at RRS. It was taken on July 23, 2015, just over three years following the Arapaho Fire. (Photo by Michael Curran)

KEY WORDS
best management practices audit, Colonel William C. Rogers, Current Research Information System (CRIS), forestry research, James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC), Laramie Mountains, outreach, planning, ponderosa pine (*Pinus ponderosa*), Rogers Research Site, teaching, University of Wyoming, wildfire, wildlife research, Wyoming Agricultural Experiment Station

1 For specific questions about this report (along with general questions about the Rogers Research Site, including information about access, driving directions, etc.) please contact the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) at sarec@uwyo.edu; 307-837-2000; or 2753 State Highway 157, Lingle, WY 82223-8543.

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When the property passed to UW shortly after the death of Colonel Rogers in 2003, the site—as well as adjacent private and public lands—was dominated by ponderosa pine (*Pinus ponderosa* [Fig. 3]) forest and several stands of quaking aspen (*Populus tremuloides*).

The landscape changed dramatically in 2012 when a lightning-caused wildfire burned approximately 98,000 acres in the Laramie Peak area. This, the high-intensity Arapaho Fire (Fig. 4), swept through the entire RRS on July 2–3 The lead author of this bulletin (S. E. Williams) and many others—both

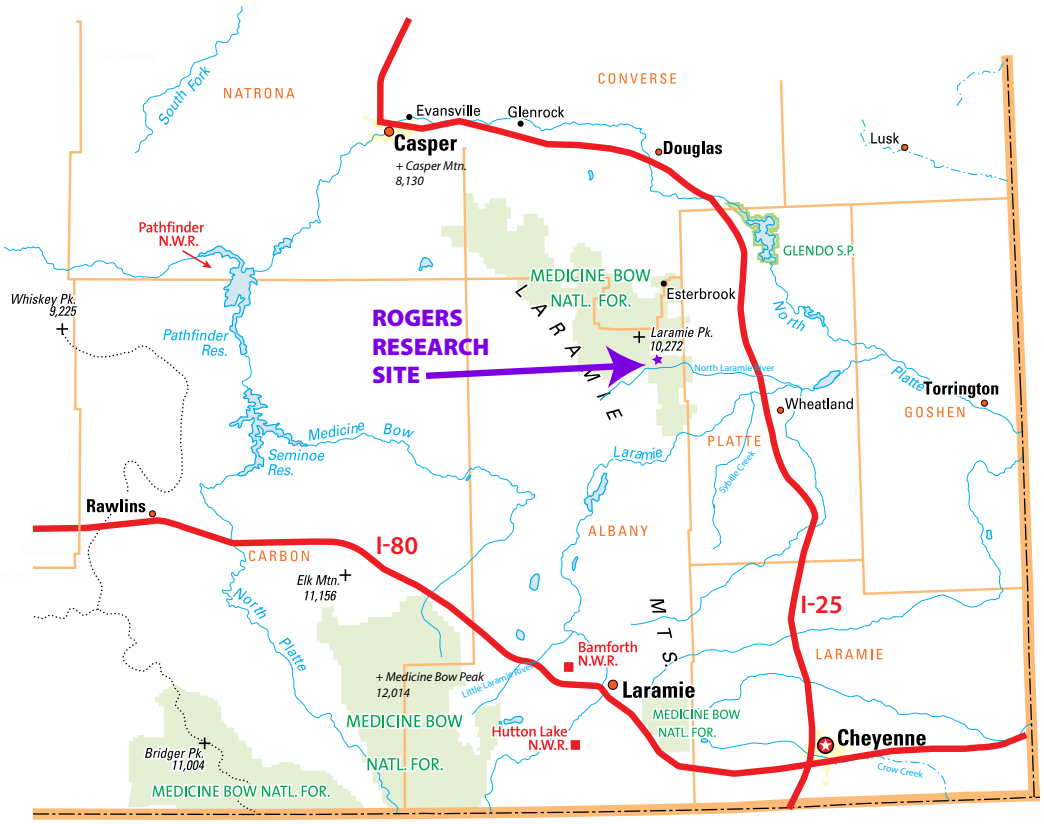

Figure 2. Rogers Research Site is located approximately five miles (8 kilometers) southeast of the prominent Laramie Peak and 25 mi (40 km) northwest of Wheatland, Wyoming. (Map by Tanya Engel)

Figure 3. When Colonel William C. Rogers donated his land in the Laramie Mountains to the University of Wyoming, it was covered with sparse and dense stands of ponderosa pine in various age classes. This photo was taken in June 2007, approximately five years before the Arapaho Fire. (Photo by Steve Williams)

Figure 4. Approximately nine years after the Rogers' land passed to UW, the lightning-caused Arapaho Fire burned nearly 100,000 acres of the Laramie Mountains near Laramie Peak, including the Rogers Research Site. The 2012 wildfire, which occurred during an extreme drought, consumed most of the vegetation in the area, including ponderosa pine and shrubs. It started on June 27, and swept through RRS and surrounding lands on July 2 and 3. It was declared "contained" on August 23 (National Interagency Fire Center, 2012). (Photo by Andrew Rose)

Figure 5. On RRS property and surrounding lands, ash from the Arapaho Fire was mostly light to white-colored at the surface, indicating a very hot fire, with temperatures reaching up to 900°F (500°C). The high-intensity fire even burned through aspen stands and riparian areas. This photo was taken on July 19, 2012, about three weeks after the fire burned through RRS. It shows the impact on aspen, a tree that generally re-sprouts rapidly after fire (see Fig. 28). (Photo by S. Williams)

within and outside of UW—have visited RRS numerous times since the fire. A complete inventory of fire intensity and impacts is still in the offing, but observations indicate that well over half of the ponderosa pine forest was impacted by crown fire, and aspen stands were burned as well (Fig. 5). The remainder of the pine forest burned in more of a ground fire, but the tops of almost all of the trees were subject to intense heat that killed the foliage. A few small stands and a few individual trees survived, but it is estimated that less than 5 percent of the original forest remains alive.

Shrub and forb understory was burned almost entirely by the fire in upland locations. Along drainages and water courses, the understory was also burned completely in most areas, but some unburned vegetation remains in the drainage above the small reservoir on RRS property. Small areas of grassland within RRS were also burned, although the Elk Park grassland just outside RRS mostly did not burn.

Several days after the fire, a storm dropped considerable precipitation on RRS. There was much water-induced overland flow of ash, which was deposited in drainages and low-lying areas. In fact, it is estimated that ash- and soil-derived sediments filled about one-third of the reservoir located in the western half of RRS (Fig. 6). Numerous dead fish were noted in the murky water as well as some live crayfish among many that were dead.

Although much of the ash from the fire had been mobilized and re-deposited by the storm, there were areas where tongues of ash remained on the surface. This ash was mostly light to white-colored at the surface (Fig. 5), but dark to very dark in the subsurface. This indicates a very hot fire at the surface—with temperatures reaching approximately 900°F (500°C). The color of subsurface soils indicates lower temperatures with increasing soil depth. There is some indication of deep soil heating in places where logs and other large, woody debris were in direct contact with soil. Many stumps and standing trees burned completely—even into the soil surrounding these—leaving burned-out stump cavities and channels into the soil originally occupied by roots.

The lead author visited RRS July 17–18, 2012, which was the earliest that fire control agencies allowed anyone to access the burned

Figure 6. The 2012 Arapaho Fire and subsequent rains led to erosion at RRS, and much ash and some silt deposited in the small reservoir on the property. Many fish and other aquatic life died. This photo was taken on July 11, about two weeks after the fire burned through RRS. The Wyoming Forestry Best Management Practices Audit report states that stream management zones (SMZs) at RRS, including the area around the reservoir and springs that feed the reservoir, should be clearly marked before any timbering activity, and a plan should be developed and followed to protect riparian habitat. Although wetland habitat has been burned, these areas should be protected during forest re-establishment. (Photo by Jim Freeburn)

Figure 7. Following the Arapaho Fire, there was a flush of noxious weed growth, including cheatgrass (aka downy brome) and Canada thistle, the latter of which is pictured in September 2012, nine weeks after the fire burned through RRS. It is recommended that UW collaborate with others to address the weed issue on RRS and neighboring lands. (Photo by J. Freeburn)

area. During this visit, it was noted that a considerable number of quaking aspen were already re-sprouting. There were areas where the noxious weed downy brome, aka cheatgrass (*Bromus tectorum*), was germinating, and there were patches of Canada thistle (*Cirsium arvense*) becoming established (Fig. 7). In areas that were grass-dominated prior to the fire, grasses were sprouting from root stock, and numerous species of forbs were also reestablishing. Large areas, however, did remain devoid of living vegetation.

RESEARCH, OUTREACH, AND TEACHING POTENTIAL AT RRS

Most of the effort prior to the fire was to prepare what is now known as the Rogers Research Site (RRS) for possible research, outreach, and teaching activities both within and outside of the UW community. During 2010 and early 2011, a planning document was developed for RRS. An ad hoc committee—which became known as the Rogers Research Site Management Committee—was formed and charged on May 14, 2010, by Bret Hess, WAES director and associate dean in the UW College of Agriculture and Natural Resources, to identify short- and long-term planning items for RRS (Appendix A).

Although the RRS Management Committee was not charged with synthesizing a research, outreach, or teaching agenda for RRS, the planning document does contain the following: "There is currently considerable concern regarding forest fires throughout the western United States. There are several reasons that form the basis for this concern. These include apparent climate change influences on temperatures, which are slowly rising; precipitation, including drought; soil moisture, which can drop for a variety of reasons, including higher temperatures, less precipitation, and earlier snowmelt; and fuel characteristics, including dead and dying trees from bark beetle epidemics. Adding to this concern is the number of private and public structures that can be, have been, and clearly will be threatened by fire because they are embedded in forests or are adjacent to public or private forest lands, as is the case with the Laramie Mountains." Land ownership in these mountains is highly heterogeneous with various types of public lands mixed with various private land ownership types. The area is home to many year-round homes, summer cabins, ranch houses, and ranch outbuildings. These structures within and near forested lands make forest management—including prescribed burns—that much more difficult.

Fire control on RRS lands will be a function of control on surrounding lands, which, in the immediate area, are largely U.S. Forest Service (USFS), State of Wyoming (trust lands), and private lands. Control efforts must be part of short-term as well as long-term planning. Fire and related control could and likely should be a theme in research, teaching, and outreach that might occur at RRS (Appendix A)."

In the wake of the Arapaho Fire and the damage that was done to buildings and the landscape at RRS in July 2012, the words of the RRS Management Committee carry a ring of prophecy, in that fire-related activities in the short- and long-term will be a major theme at RRS and possibly surrounding lands affected by the fire.

ECOSYSTEMS AND THEIR SUSCEPTIBILITY TO DISTURBANCE

In early 2012 (but before the Arapaho Fire), a project was approved and funded to (1) inventory soils; (2) complete an all-taxa biodiversity inventory; (3) research nitrogen

Figure 8. Soil samples were collected across the various ecosystems at RRS in spring 2012 (shown here is UW student Mike Curran employing a good old-fashioned sampling tool). That work was fortuitous because within weeks, the Arapaho Fire would burn across the site. Since then, additional soil samples were taken, which allowed the lead author of this bulletin and UW graduate student Claire Wilkin to make pre- and post-fire soil comparisons. Their work will be presented in an upcoming RRS bulletin. (Photo by S. Williams)

fixation by leguminous and non-leguminous plants (the fire completely changed the research direction from conifer vegetation soil ecology to post-fire ecology, which could be the subject of future research); and (4) establish a weather station. This research is certified as National Institute of Food and Agriculture CRIS (Current Research Information System) Project WYO-465-11 (Appendix B). The project was started in earnest in spring 2012 with a partial vegetation inventory as well as procurement of a full set of soil samples from pits excavated and selected to represent the various ecosystem components of RRS (Figs. 8–9). Vegetation and soils were discussed in Rogers Research Site Bulletin 1, and details of vegetation and soils mapping will be presented in upcoming papers in the RRS bulletin series.

In early July, the Arapaho Fire moved across RRS lands, destroying all of the facilities except a small storage shed (fortuitously, Colonel Rogers' antique sheep wagon had been moved to a nearby parcel of land, and it survived the fire and is still being used today [Williams and Waggener, 2017]). The high-intensity fire, which occurred during an extreme drought, also consumed most of the vegetation at RRS and surrounding lands, and it also altered soils. This dramatically changed proposed activities at RRS to post-fire research in combination with those projects that were still deemed viable in the 2011 report (see below and Appendix A), i.e., those that weren't affected by fire.

Figure 9. This photograph shows a fairly well developed forest soil profile at RRS just prior to the fire of 2012. The pins (with red plastic markers) indicate the approximate boundaries between soil horizons. The top horizon is constituted almost entirely of organic debris and partially decomposed organic materials. It extends from the surface to about 4 cm (~1.5 in) and is called the O horizon. The second interval—from ~4 to ~11 cm (~1.5–4.5 in)—is a horizon containing minerals, but also considerable organic carbon; it is designated as an A horizon. The third interval from the surface is the B horizon (in this case, a horizon of accumulated clay), and it extends from about 11 to 17 cm (~4.5–7 in). From 17 cm (7 in) and deeper (out of the photograph) is the C horizon, usually described as the parent material for the soil; here, the parent material is a sandy substrate. (Photo by S. Williams)

ECOSYSTEMS CHARACTERIZED BY DISTURBANCE

Many ecosystems are characterized by susceptibility to disturbance. In the face of extreme disturbance, like the 2012 Arapaho Fire, even the most resilient of these systems

can be disarticulated. Succession theory explains how resilient systems accommodate disturbance and return to equilibrium once the disturbance is muted. Many systems, however, are better explained by state and transition theory (Friedel, 1991), in which they do not return to pre-disturbance equilibrium. Management of these, therefore, may require special actions that include mitigation as well as either minimization or complete elimination of certain types of impacts, whether in the Laramie Mountains, including RRS, or other public and private lands in Wyoming and across the West.

YELLOWSTONE FIRES OF 1988

The most publicized and researched fire event in the history of Wyoming was the Yellowstone wildfires of 1988. Despite having happened nearly 30 years ago, those events still provide a road map for research elsewhere. The Greater Yellowstone Ecological Assessment Panel (GYEAP) made recommendations regarding post-fire management, mitigation, and needed research in its final report (Christensen et al., 1989a), which were summarized in a later report (Christensen et al., 1989b). Their research recommendations and management prescriptions are applicable, to a degree, for post-fire efforts at RRS.

The GYEAP recommended that post-fire seeding of short-lived species (grasses) to retard erosion should be done judiciously, mainly because of the possibility of introducing aggressive, exotic invaders with such seed. Further, the introduced species could compete with native species for resources (water and nutrients) available on the site. The team also recommended that reforestation be done judiciously because many tree species re-sprout from roots post-fire while others may require fire to open cones and/or release seed from inhibiting substances. The latter are chemicals within seeds that keep the seeds from germinating until the chemicals are modified by fire, e.g., this breaks the dormancy of the seeds. The biology of dominant and desirable species needs to reviewed and used to make reforestation prescriptions.

The research agenda that GYEAP suggested for the Greater Yellowstone Area (GYA) included: (1) fire behavior and management; (2) fire history; (3) geomorphic and hydrologic processes; (4) soils and belowground processes; (5) aquatic ecosystems; (6) succession patterns; (7) biodiversity; (8) human interactions; and (9) ecosystem interactions.

APPLYING THE YELLOWSTONE RESEARCH AGENDA TO RRS

Most of these nine agenda items could be applied to RRS, although it must be recognized that one of the major differences between GYA and RRS is one of scale: the Yellowstone fires being approximately eight times larger than the Arapaho Fire (Appendix C). Another difference is land-use type. Most of the land in the GYA is federally owned, whereas the area surrounding RRS is a mixture of federal, state, and private lands (details are presented in RRS Bulletin 1). Also, federal lands surrounding RRS are subject to the multiple-use philosophy of USFS; whereas, the dominant philosophy in the GYA is to preserve the natural and cultural resources and values for present and future generations.

RRS MANAGEMENT OBJECTIVES

The intent of research at RRS—both pre- and post-fire—was and is to provide a sound scientific basis to the sustainable management of forested ecosystems. Though the wildfire did change many short-term goals and some long-term goals, the aim is still to provide information and strategies for management to address (1) the chemical, physical, and biological attributes underpinning natural functioning of ecosystems; (2) human dimensions including tangible and intangible products that humans take from and provide to ecosystems; and (3) human-mediated disturbance that threatens ecosystem function and stability. Even at this limited scale, this is a substantial undertaking. It necessitates that investigations—at least initially—be focused on specific and achievable objectives. Thus, the research objectives will need to be stratified at both temporal and spatial scales to satisfy

short- and long-term water, soil, vegetation, wildlife, and other management outcomes.

Multiple land-use capability is proposed as the central and unifying theme for RRS. More specifically, this is management of public and private forested ecosystems to maintain and enhance multiple-use potentials. This is a close approximation to the philosophy of RRS's largest neighbor, the USFS Douglas Ranger District. It is also the reality of how public and private lands are managed in the immediate vicinity as well as the region. People use these lands for a diversity of purposes: recreation, including hunting, fishing, camping, and hiking; summer and year-round homes; livestock grazing; among others. The foci of activities at RRS should, therefore, include anthropogenic impacts of land use including those caused by human activities and nature, optimization of forest resources, weeds and weed management, and wildlife- and livestock-diseases and their interactions, to name just a few. These should be addressed in inclusive and consultative manners.

IMPROVING WILDLIFE AND FORESTRY RESOURCES

This lays the foundation and opportunity to engage with many stakeholders, including adjacent landowners, both private and public; faculty, staff, and students from UW and other schools; federal agencies including USFS and the U.S. Bureau of Land Management (BLM); state agencies including the Wyoming Game and Fish Department (WGFD) and Wyoming State Forestry Division/Wyoming Office of State Lands and Investments; among others. In following the wishes of Colonel Rogers, such activities should focus on the improvement of wildlife and forestry resources. Following are directives from The Colonel's will: "… that said ranch be used for the public benefit as a center for studies, a retreat for conducting meetings, conducting conferences, or conducting research in connection with the improvement of wildlife and forestry, or to hold as a natural wooded area in its original state…"

Rogers Research Site Bulletin 2 focused on a 2005 open house at RRS where participants were asked to share their thoughts about the management of RRS as well as possible activities and research that could take place at the site (see RRS Bulletin 2, Waggener, 2017). Fifty attendees filled out the questionnaire, and their input laid the foundation for future planning at RRS, which began in earnest in May 2010 when WAES Director Bret Hess created the Rogers Research Site Management Committee (Appendix A). This ad hoc committee, which met through early 2011, was put in charge of developing a plan that would address everything from short- and long-term management to encouraging on-site research. That committee developed numerous recommendations, which are outlined in this report. One of the major focuses at RRS involved research relating to forestry and wildlife resources, but the Arapaho Fire greatly impacted—and redirected—the type of research that would take place at the site and surrounding lands.

MAJOR RESEARCH FOCUSES IDENTIFIED

A second RRS ad hoc committee—known informally as the Rogers Research Site Ad Hoc Committee—was formulated shortly after the 2012 Arapaho Fire, and was done so rapidly to address issues developing in the wake of the fire (Appendix C). This committee identified four major research areas pertaining to post-fire management (Fig. 10). These tie directly to the will of Colonel Rogers, but they also reflect the Arapaho Fire's drastic changes to the site, which would make a portion of the will inapplicable—"… to hold as a natural wooded area in its original state…" The four research focuses identified by the committee—along with 2017 updates—follow:

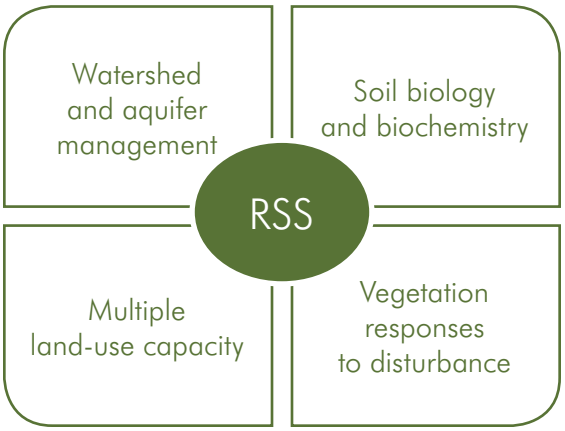

Figure 10. Research at Rogers Research Site following the 2012 Arapaho Fire has focused on four key areas. (Graphic by S. Williams)

Watershed and Aquifer Management and Maintenance of On-Site and Down-Stream Water Quality

The quality and quantity of both surface and ground water resources should be documented. This should be supported through mapping of geomorphic characteristics relating to geology (including soils), topography, and climatic inputs. This may necessitate the installation of (1) a weather station; (2) v-notch weirs to meter water flows in open channels; and (3) piezometers to measure stemflow (the flow of water down the trunk of a tree, which causes the ground area around the trunk to receive additional moisture). The majority of those filling out the survey during the 2005 open house identified a weather station as a primary need at RRS (Waggener, 2017).

Figure 11. A weather station with remote access was installed at Rogers Research Site in 2013. That winter, however, mice climbed through a small opening in the bottom of the data logger box and caused extensive damage. UW irrigation specialist Vivek Sharma repaired the station in October 2017 (J. Tanaka, personal communication, 2017). It is recommended that standing dead trees in the vicinity of the station be removed to avoid further damage and, most importantly, to make the area safer for workers. (Photo by Linda van Diepen)

Figure 12. Soil moisture detection blocks were installed at the Rogers Research Site weather station to monitor soil water as part of the weather data set acquired for RRS. The blocks are set at 5, 10, and 20 cm (2, 4, and 8 inches) below the surface. Data, however, won't be acquired until repairs are made to the above-ground data logger, which was destroyed by mice shortly after being installed in 2013. This work is expected to take place in summer 2017. (Photo by S. Williams)

Update: A weather station with remote accessibility was installed at RRS in 2013 by UW Department of Plant Sciences Assistant Professor Axel Garcia y Garcia[4] and a graduate student (Figs. 11–12). Shortly after the installation, however, mice climbed through a small opening in the bottom of the data logger box and caused extensive damage to panel wiring and other electronic equipment. Vivek Sharma, an irrigation specialist and assistant professor of agronomy in the UW Department of Plant Sciences, got the station up and running in October 2017 (J. Tanaka, personal communication, 2017). Weather data is available on the Wyoming Agricultural Climate Network website at http://www.wrds.uwyo.edu/WACNet/Stations.html. It is recommended that standing dead trees surrounding the weather station be removed to prevent additional damage. For more details about the weather station, see RRS Bulletins 1 and 2.

Soil Biology and Biochemistry

Quantification of microbial and nutrient budgets will underpin examination of principal themes, which are manifested now as fire-disturbance related. Approaches should include both conventional and molecular biological techniques to identify microbial and edaphic constraints limiting plant productivity. The current project that is ongoing at RRS is focused on providing this information (National Institute of Food and Agriculture's Current Research Information System [NIFA CRIS] Project WYO-465-11 [Appendix B]).

4 Axel Garcia y Garcia is now an assistant professor at the University of Minnesota's Southwest Research and Outreach Center in Lamberton, Minnesota.

Update: Pre- and post-fire soil analyses have been conducted by this bulletin's lead author, S. E. Williams, and UW graduate student Claire Wilkin[5] at eight permanent plots that are spread across RRS (Figs. 8–9). They performed chemical and physical characteristics of the soils at each plot, and found that marked soil chemical and biotic changes occurred following the 2012 Arapaho Fire. Further, nucleic acids were extracted from soils both pre- and post-fire. These extracts are being analyzed by Linda T.A. van Diepen, an assistant professor of soil microbial ecology in the UW Department of Ecosystem Science and Management. Additionally, Larry Munn,[6] professor of soil science in the UW Department of Ecosystem Science and Management, mapped soils at RRS in 2013 and 2014, determining that they are Alfisols, Entisols, Inceptisols, and Mollisols. Also involved in the soils work is Professor Michael Urynowicz in the UW Department of Civil and Architectural Engineering. A summary of their research is presented in RRS Bulletin 1, while further details will appear in upcoming reports (NOTE: Alfisols was not included in the list in Bulletin 1.)

Vegetative Responses to Disturbance

Fire (occurrence, impact, and management) is a disturbance commonly studied in ecosystems across the state and continental U.S. The 2012 Arapaho Fire presented such an opportunity at RRS and surrounding lands in the Laramie Mountains.

Update: Studies have been conducted at RRS to evaluate pre- and post-vegetation across the site (Figs. 13–16). Further, a

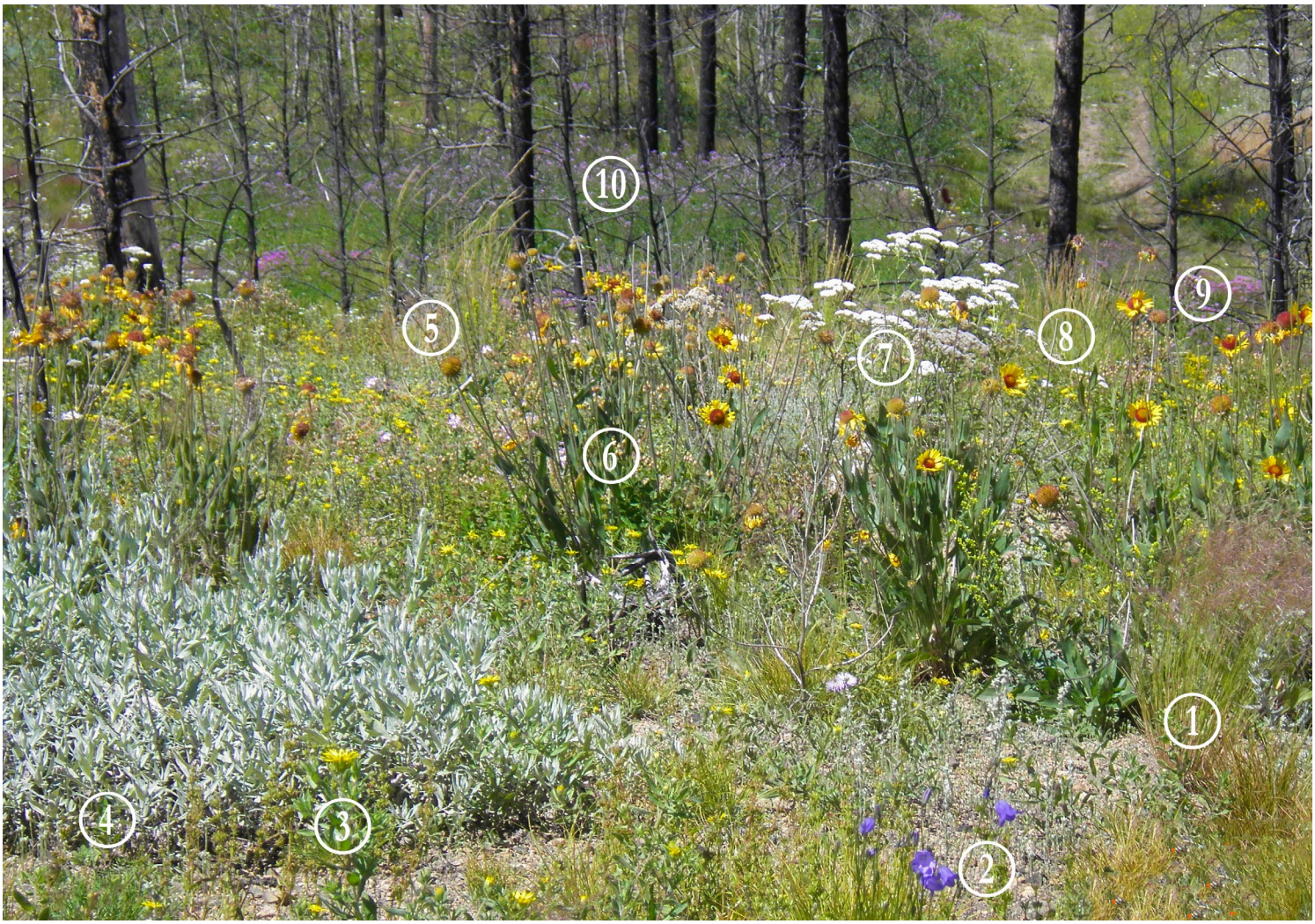

Figure 13. Numerous grasses (both native and invasive), forbs, and weeds reestablished after the 2012 Arapaho Fire. Among the species in this photo are (1) unidentified bunchgrass; (2) bluebell, aka bellflower (*Campanula rotundifolia*); (3) unidentified yellow flower; (4) sagewort (*Artemisia ludoviciana*); (5) unidentified bunchgrass; (6) blanketflower (*Gaillardia aristata* Pursh); (7) common yarrow (*Achillea millefolium* L.); (8) unidentified bunchgrass; (9) Canada thistle (*Cirsium arvense*); and (10) beebalm (*Monarda fistulosa*). This photo was taken on July 23, 2015, just over three years after the wildfire burned through the site. (Photo by M. Curran)

5 Claire Wilkin earned her master's degree at UW and is now an environmental consultant with WSP in San Jose, California.

6 Since conducting the soil surveys, Larry Munn retired from UW. Now a professor emeritus, Munn welcomed our invitation to compile his work into a chapter for an upcoming RRS bulletin.

Figure 14. A variety of forbs respond well to fire disturbance. Among the species observed at RRS following the 2012 Arapaho Fire were beardtongue (*Penstemon* spp.), the blue flowers; Pursh's wallflower (*Erysimum capitatum* var. *purshii*), the larger yellow flowers; and dwarf mountain ragwort (*Senecio fremontii*), the smaller yellow flowers. This photo was taken in midsummer 2013. We anticipate that pre- and post-fire vegetation surveys at RRS will be presented in an upcoming bulletin. (Photo by S. Williams)

Figure 15. Dogbane (*Apocynum androsaemifolium*) is another forb that responds positively to fire disturbance, as was the case at RRS following the 2012 Arapaho Fire. This photo was taken in late summer 2014 (Photo by S. Williams)

Figure 16. Another forb that reestablished after the Arapaho Fire was bigflower cinquefoil (*Potentilla fissa* Nutt.). This photo was taken on June 17, 2015, just shy of three years following the wildfire. (Photo by Mollie Herget)

landscape-level study is underway to determine methods of reestablishing ponderosa pine and grass following a high-intensity fire (Figs. 17–21). This project was launched by S. E. Williams and Mollie Herget[7] (Fig. 22), and it is being continued by van Diepen, John Derek Scasta, and their teams, including Stephanie Winters, UW master's degree student in soil science (Fig. 23). Scasta is an assistant professor of rangeland management in the UW Department of Ecosystem Science and Management and a rangeland specialist with UW Extension. An RRS bulletin summarizing early findings from this project is scheduled to be released later this year.

Grazing Impacts

Wildlife and livestock grazing are other disturbances that, when optimized, can enhance overall land productivity, but optima are moving targets easily missed.

Update: Since the Arapaho Fire a fence was rebuilt around RRS, which will help control domestic animal trespass. Prior to the fence being reconstructed, cattle were observed grazing on the site. But in recent times, damage has occurred to new fencing due to falling trees (from the Arapaho Fire) and large animals (most likely elk and possibly domestic livestock) (Fig. 24). Livestock grazing has been postponed indefinitely to allow vegetation to return and to avoid damaging research plots. It is recommended, too, that standing dead trees along fence lines be removed to avoid additional damage to new fencing, to make these areas safer for workers and others who visit the site, and to help prevent livestock from entering RRS lands.

SHORT- AND LONG-TERM OBJECTIVES AT RRS

The development of both short- and long-term goals for RRS—including management of the site in addition to research, teaching,

7 Mollie Herget earned her master's degree at UW and is now an agronomist at the Elsberry Plant Materials Center operated by the U.S. Department of Agriculture's Natural Resources Conservation Service in Elsberry, Missouri.

Figure 17. A timber contractor selectively removes burned ponderosa pine as part of a study to determine the best methods of reestablishing ponderosa pine following a high-intensity fire. This research, which also involves erosion control studies (planting grass seed vs. no planting), will be presented in an upcoming RRS bulletin. (Photo by S. Williams)

Figure 18. The post-fire ponderosa pine restoration study involved six different combinations of treatments, including no cutting, cutting with slash left behind, cutting and slash removal, no replanting, planting ponderosa pine seed, and planting ponderosa seedlings. This picture shows a plot where cut trees will be removed, but slash left behind. Results will be presented in an upcoming RRS bulletin. (Photo by S. Williams)

Figure 19. Summer intern James Harkin plants a ponderosa pine seedling in one of the restoration study plots at RRS on July 21, 2015, about three years after the Arapaho Fire. (Photo by M. Herget)

Figure 20. Among the treatments in the ponderosa pine regeneration study were no planting (to examine natural regeneration), planting tree seedlings (as pictured in June 2015), and planting seed. Preliminary results, including survival rates of the seedlings and success of the seed plantings, will be presented in an upcoming RRS bulletin. (Photo by S. Williams)

Figure 21. Summer interns James Harkin (yellow hardhat) and Noah Snider (white hardhat) plant ponderosa pine seedlings on July 21, 2015, in plot 2-7-OT+. This stands for block 2, plot 7, cutting treatment O (no cutting), planting treatment T (planting of ponderosa pine "tublings"), and erosion control treatment + (seeding the site with a native grass mix). Details of the cutting, tree planting, and erosion treatments, along with preliminary findings, will be presented in an upcoming RRS bulletin. (Photo by M. Herget)

Figure 22. Mollie Herget poses for a snapshot in one of her ponderosa pine restoration plots at RRS. The treatment at this site included the removal of slash, which was placed in slash piles just outside of the plot, and the planting of pine seedlings. The photo was taken on July 23, 2015, approximately three years after the Arapaho Fire. (Photo by M. Curran)

and outreach potential—has involved much input from numerous stakeholders. Early recommendations came from those attending a 2005 open house and subsequent field days at RRS (see RRS Bulletin 2). Their suggestions were followed up with formal planning, a forestry audit, and work to secure research funding, activities that collectively occurred over a three-year period starting in 2010. The four key components to these undertakings included the:

1. Rogers Research Site Management Committee, 2010–2011;
2. Wyoming Forestry Best Management Practices Audit, 2011;
3. USDA Current Research Information System (CRIS) Project, 2012;
4. Rogers Research Site Ad Hoc Committee, 2012.

In the following four sections we present a summary of the committee work including objectives and recommendations that were developed, the forest audit, and U.S. Department of Agriculture (USDA) CRIS Project WYO-465-11, in addition to 2017 updates on progress.

SECTION ONE: ROGERS RESEARCH SITE MANAGEMENT COMMITTEE RECOMMENDATIONS

The Rogers Research Site (RRS) Management Committee, which formed in May 2010 and represented a variety of interests (Appendix A), identified numerous objectives (both short- and long-term) for RRS. These were detailed in the committee's final report released in February 2011. Some of the objectives were in response to a survey completed by 50 people attending an open house at RRS in 2005 (see RRS Bulletin 2). Other objectives were informally discussed during and following a 2009 field day at RRS (Fig. 25) and other meetings (RRS Bulletin 2). The 2009 event attracted participants from a variety of UW departments, the Laramie Peak Fire Zone, Wyoming Game and Fish Department (WGFD), among others, and three attendees (Jim Freeburn,[8] Bob Shoemaker,[9] and Ryan Amundson[10]) would become active members of the RRS Management Committee the following year (Figs. 26–27; Appendix A). Joining them were this bulletin's lead author and Bryan Anderson.[11] The RRS Management Committee met periodically over a period of eight months, and during that time it developed many of the objectives and recommendations detailed in Appendix A. Following is a summary of the committee's recommendations with 2017 updates.

Form a New Committee to Oversee RRS Activities, Including Research, Outreach, and Teaching

In its 2011 report, the RRS Management Committee stated that members of a new committee shall be appointed by the WAES director and will have a term of four years with two new members (or new terms for existing members) added every year. The composition of the committee shall be as follows, with one member from each: UW Department of Botany, UW Department of Renewable Resources,[12] UW Real Estate Operations, Laramie Peak Fire Zone volunteer fire department, Wyoming Game and Fish Department (WGFD), Wyoming Office of State Lands and Investments/Wyoming State Forestry Division, Medicine Bow-

8 Jim Freeburn is now the regional training coordinator for the Professional Development Program of the U.S. Department of Agriculture's Western Sustainable Agricultural Research and Education.

9 Bob Shoemaker is warden of the Laramie Peak Fire Zone (LPFZ) volunteer fire department and was a member of the 2010–2011 RRS Management Committee.

10 Ryan Amundson is WGFD's statewide habitat biologist based in Wheatland, Wyoming.

11 Bryan Anderson is district forester for the Wyoming State Forestry Division in Casper.

12 In 2011, the UW Board of Trustees approved renaming the department the Department of Ecosystem Science and Management.

Figure 23. Examining one of the ponderosa pine restoration and erosion control plots at RRS are, from left, Mollie Herget, Derek Scasta, Bret Hess, and Steve Williams. This particular site (block 4, plot 9) includes cutting treatment X (cutting trees and removing slash), planting treatment T (planting ponderosa "tublings"), and erosion control treatment + (seeding the site with a native grass mix). This photo was taken on October 28, 2015, about three years, four months after the Arapaho Fire burned through RRS. Details about the restoration study will be presented in an upcoming bulletin. (Photo by L. van Diepen)

Figure 24. Fence maintenance has been an ongoing issue at RRS. Most of the fencing was either destroyed or heavily damaged during the 2012 Arapaho Fire. Fencing was replaced or repaired after the fire, but since then sections have been damaged by falling trees (remnants of the fire) and large animals (most likely elk and possibly domestic livestock). This photo, taken in May 2017, shows fence that was likely damaged between late fall 2016 and early spring 2017. (Photo by Steve Paisley)

Routt National Forests, and a resident and landowner within the Medicine Bow-Routt National Forests' Laramie Peak Unit. Since that report was completed, RRS was put under the management of the UW James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle, Wyoming. SAREC is one of four R&E Centers under WAES.

WAES Director Hess says that with the retirement of the lead author of this bulletin, S. E. Williams, who served as chair of the 2010–2011 RRS Management Committee and 2012 RRS Ad Hoc Committee, UW assistant professors Linda van Diepen and Derek Scasta have informally taken on this role until a committee is formed (B. Hess, personal communication, 2016). John Tanaka, WAES associate director and SAREC director, says that it is his goal to have a new committee in place in the coming months (J. Tanaka, personal communication, 2017). A possible name is the Rogers Research Site Management and Research Committee.

Develop a Management Plan (Short-Term and Long-Range) for the Property, Including a Protocol for Planning and Implementing Management Practices

The development of such a plan was in the beginning stages when the Arapaho Fire burned through RRS and surrounding lands in 2012. That dramatically changed both short-term and long-range management, research goals, and site activities. Once a new RRS management and oversight committee

is formed, development of a management plan should be one of the immediate charges. The plan should build on recommendations contained in this bulletin and RRS Bulletin 2, but it should also address issues that have not previously been raised—among them, steps should be taken to ensure that new research projects do not affect ongoing studies.

Establish a Stakeholders' Focus Group for RRS, and Interface with Other Stakeholders

The time is right for organization of this effort, and the following is a partial list of groups that could be involved.

1. UW colleges, interdisciplinary institutes, schools, and offices, including the College of Agriculture and Natural Resources, Wyoming Agricultural Experiment Station (WAES), UW Extension, College of Arts and Sciences, Haub School of Environment and Natural Resources, Wyoming Natural Diversity Database, Biodiversity Institute, Rocky Mountain Herbarium, Wyoming EPSCoR (Experimental Program to Stimulate Competitive Research), Outdoor Program, Wyoming Conservation Corps, Real Estate Operations, among others.
2. UW faculty, staff, and students from the following academic departments and programs: Agricultural and Applied Economics, Animal Science, Botany, Program in Ecology, Ecosystem Science and Management, Geography, Geology and Geophysics, Microbiology, Molecular Biology, Plant Sciences, Veterinary Sciences, Zoology and Physiology, among others.
3. Neighboring landowners including private, State of Wyoming, and USFS.
4. Laramie Peak Fire Zone volunteer fire department member(s).
5. Albany County Weed and Pest Control District and Laramie Rivers Conservation District representative(s) (the Platte County districts could also be involved).
6. State agencies including the Wyoming Office of State Lands and Investments/ Wyoming State Forestry Division, WGFD, Wyoming Department of Agriculture, Wyoming Department of Environmental Quality (WDEQ), and Wyoming Wildlife and Natural Resource Trust.
7. Federal agencies including the USFS Medicine Bow-Routt National Forests/ Douglas Ranger District, and BLM.
8. Initial contact has been made with several private landowners in the area, WGFD, Wyoming State Forestry Division, Medicine Bow-Routt National Forests, and faculty and staff within several UW departments and offices. It is recommended that a new RRS management committee be formed (see next paragraph) and that this committee be charged, in part, with developing a list of interested stakeholders and informing those stakeholders of current and potential research, extension, teaching, and other activities at RRS.

Provide Recommendations on How to Encourage Research, Teaching, and Extension Potential at RRS

This should be one of the immediate charges for the new RRS management committee. In the meantime, WAES Director Hess says that he has been encouraging UW faculty, staff, and students to perform on-site research (B. Hess, personal communication, 2016). A variety of funding sources for research projects and habitat improvement at RRS provide additional incentive to potential users. Two examples include the WAES Competitive Grants Program and the Colonel William C. Rogers University of Wyoming Excellence Fund, the latter of which supports proposals and projects that show promise of stimulating creative and innovative activities at UW, among them forestry and wildlife. Results from research at RRS can be published in peer-reviewed papers in the RRS bulletin series as well as other publications, including scientific journals, magazines such as *Reflections*, which is published yearly by WAES, and the annual WAES *Field Days Bulletin*. Among the early works to be published in the RRS bulletin series are a (1)

Figure 25. The Rogers Research Site Management Committee, which met from 2010 to 2011, developed its objectives and recommendations for RRS from a variety of sources, including input provided by field day and open house participants. Among those attending the 2009 field day at RRS were: front, Ginny Alm, office associate in the UW Department of Plant Sciences (now retired); middle, from left, Jim Freeburn, director of the James C. Hageman Sustainable Agriculture Research and Extension Center (now with Western Sustainable Agricultural Research and Education), Stephen Miller, director of the Wyoming Agricultural Experiment Station (now retired), and Josh Decker, assistant director of UW Real Estate Operations (now REO manager); and, back, from left, REO employees Eric Sneesby and Doug Haggerty (they have since accepted GIS-related jobs in Casper, Wyoming, and Fort Worth, Texas, respectively). (Photo by Kelly Greenwald)

vegetation mapping project using high spatial resolution photography, by UW undergraduate student Mathew Seymour,[13] Kenneth Driese, a senior lecturer in the UW Department of Botany, and the co-author of this bulletin, Robert Waggener; (2) the long-term study involving the restoration of ponderosa pine and grass (discussed above); (3) pre- and post-fire soils analysis (discussed above); and (4) an ongoing study examining what species of grasses, forbs, shrubs, and trees are returning following the Arapaho Fire.

Develop a Protocol for Handling Requests to Utilize the Property.

SAREC Director John Tanaka says that the protocol now in place for this is the online "Study Area Resource Request Application (SARRA)." UW faculty, including student researchers they are overseeing, along with staff and administrators, can submit requests through SARRA. Applications and other information can be found on the WAES website at www.uwyo.edu/uwexpstn. Click on the SARRA link. The new RRS management committee should build on this protocol, developing specific guidelines for RRS, including assurances that new research projects won't affect ongoing studies.

Have a UW Attorney Examine the 2011 Planning Document and Provide Advice Regarding Our Interpretation of the Will of Colonel Rogers and How it Pertains to Activities and Research at RRS

A UW attorney has not yet been asked to examine the will and provide advice, but those involved with RRS planning have carefully read the will and are carrying out research and other activities keeping in mind the wishes of Colonel Rogers coupled with the Arapaho Fire's effects on the property and surrounding lands.

Develop an Aspen Treatment Program to Enhance Wildlife Habitat, and Then Carry Out and Monitor that Program

The committee stated that improving aspen stands would improve wildlife habitat, but that more information was needed before a management decision could be made. Among the questions to consider: (1) how much aspen is present on RRS lands (Seymour et al., 2017, offers important baseline data); (2) what kind of affect did the Arapaho Fire have on the health of aspen stands (Figs. 5 and 28); (3) what are the costs per unit area of aspen treatments; and (4) is there a research or demonstration project that could be linked to such treatments? Committee members Ryan Amundson and Bryan Anderson agreed to perform audits of the aspen stands on RRS lands. As of June 2017, this proposal was on hold; however, it is recommended that discussions continue in the coming years concerning the enhancement of wildlife and forestry resources on the property and neighboring lands, per the wishes of Colonel Rogers. This could tie directly into on-site research, teaching, and extension, as well as collaborative work with the WGFD, Wyoming

13 Mathew Seymour earned a bachelor's degree at UW, master's degree at Hólar University College in Hólar, Iceland, and Ph.D. at ETH in Zurich, Switzerland. He is now a postdoctoral researcher at Bangor University in Bangor, Gwynedd, United Kingdom.

State Forestry Division, and other state agencies; as well as neighboring landowners, including both private and public, the latter of which includes the Wyoming Office of State Lands and Investments, USFS, and BLM (Fig. 29).

Conduct a Forest Pathogen Inventory

A variety of fungi have been recorded at RRS. An overview is in RRS Bulletin 1, and details will be presented in an upcoming paper in the RRS bulletin series.

Develop a Short- and Long-Term Fire Management Plan

The 2012 Arapaho Fire impacted most of the vegetation, including ponderosa pine, on RRS and surrounding lands, which greatly diminished the fire danger in the short-term. Since then, UW hired a private contractor to selectively remove dead trees on RRS lands as part of an ongoing research project involving ponderosa pine restoration (discussed above) as well as to clear burned trees along the perimeter of the property to accommodate new fencing.

Bob Shoemaker, warden of the Laramie Peak Fire Zone (LPFZ) volunteer fire department and a member of the 2010–2011 RRS Management Committee, recommends that slash piles left behind following the timbering activities be burned to reduce fire danger even further (B. Shoemaker, personal communication, 2016). If that suggestion is carried out, it would have to be done in close consultation with UW faculty, staff, and students who are conducting studies at RRS to ensure that their research is not affected by such burning. It should also be done following recommendations from the Wyoming Forestry Best Management Practices Audit of RRS in 2011 (discussed below). Long-term, UW should work collaboratively with LPFZ, Wyoming State Forestry Division, USFS, private landowners, and others on a fire-management plan. Mr. Shoemaker recommends that stakeholders, including a representative from UW, attend the annual meeting of LPFZ, which is typically held in May.

Figure 26. During the 2009 field day at RRS, Jim Freeburn, right, then director of SAREC, thanks Bob Shoemaker for his service as warden of the Laramie Peak Fire Zone (LPFZ) volunteer fire department and superintendent of the Platte County Weed and Pest Control District. Shoemaker, who retired as weed and pest superintendent, but continues as LPFZ warden, was an active member of the RRS Management Committee. In the background, upper left, are remnants of an old root cellar (L. Hileman, personal communication, 2017). (Photo by S. Williams)

Figure 27. Among those attending the damp, rather cool 2009 field day were, from left, in foreground, Martin Hicks, Wyoming Game and Fish Department (WGFD) wildlife biologist; Steve Paisley, UW Extension beef cattle specialist; Jim Waggoner, associate professor in the UW Department of Ecosystem Science and Management (now retired); and Ryan Amundson, WGFD habitat biologist who became an active member of the RRS Management Committee. In the background are representatives from UW Real Estate Operations, from left, Doug Haggerty, Eric Sneesby, Josh Decker, and Kendra Hamel. (Photo by K. Greenwald)

Construct a Joint UW/Local Fire District Building to House Fire-Fighting Vehicles and Equipment

There were preliminary discussions about UW possibly partnering with the project. Those involved with RRS planning thought that such a facility could accommodate both the LPFZ fire department as well as researchers conducting studies on RRS and neighboring lands. Though UW was not involved in subsequent talks and decision-making, LPFZ and others worked diligently to ensure that a station was built. In 2012, work started on a fire hall about eight miles from RRS. Though the Arapaho Fire delayed construction, the building was completed that fall. It houses equipment, and there is space for training and meetings. Also included are dining, shower, and bathroom facilities. Land for the hall was donated by a local rancher, and funding for the project came from the Wyoming State Loan and Investment Board and Albany County. The hall will better allow volunteer and professional firefighters to protect structures as well as private and public lands in the Laramie Peak area, including

Figure 28. Quaking aspen, a fire-adapted species, began regenerating at RRS in the months and immediate years following the 2012 Arapaho Fire. Though the high-intensity wildfire killed aboveground stems of aspen trees—even in wet areas—belowground living root stocks were regenerating prolifically on the surface by mid-September—just 2½ months after the fire burned through RRS. (Photo by J. Freeburn)

Figure 29. In his will, Colonel Rogers wanted his property to be used, in part, for forestry and wildlife research. This gives the University of Wyoming much opportunity to collaborate with other stakeholders, including state and federal agencies as well as private landowners. Among the species that inhabit the area is the bighorn sheep (*Ovis canadensis*). This herd of rams was photographed in Sybille Canyon in June 2008. The rugged canyon, one of many in the Laramie Mountains, is approximately 30 miles (~48 km) south of RRS. (Photo by Martin Hicks)

RRS property (Mitchell, 2012; B. Shoemaker, personal communication, 2016).

Locate, If Possible, Long-Term Weather Records for the Area to Aid Future Researchers

The most complete weather records in the vicinity were kept by the Double Four Ranch about four miles southwest of RRS. See RRS Bulletin 1 for more information.

Additionally, George Portwood, the long-time foreman of the Double Four Ranch, has continued to collect weather data at his personal property since retiring in 2006 (Portwood's property is about five miles [eight km] from RRS). Pertinent weather data will be presented in the upcoming RRS bulletin that details the post-fire ponderosa pine study.

Construct a Weather Station at RRS

A weather station with remote access was installed in 2013. This is discussed above and in RRS Bulletins 1 and 2.

Discuss the Possible Acquisition of Land Adjacent to RRS and How Such Acquisition Fits Into the Long-Term plan of RRS

There are 80 acres of Wyoming state trust lands and 40 acres of private lands immediately south of RRS. Those involved in initial planning thought the additional lands would allow for easier access since private land has to be crossed to access RRS, and they also felt that the additional land would expand research opportunities. There were preliminary discussions about acquiring the lands if an opportunity presented itself, but there have been no discussions since (J. Decker,[14] personal communication, 2016). The current owner of the private land has been very cooperative in terms of those having permission to legally access RRS lands, and the state has been open to the idea of UW conducting research on the state lands immediately south of RRS as well as 640 additional acres of state lands just to the southwest of RRS. It is recommended that UW collaborate with the Wyoming State Forestry Division, Wyoming State Board of Land Commissioners, WGFD, USFS, private landowners, and others concerning possible research projects on RRS and adjacent lands.

Obtain Permission from the Wyoming Office of State Lands and Investments to Conduct Research on State Trust Lands Adjacent to RRS

The lead author of this paper submitted a "Request for Authorization to Conduct Research or Educational Activities on Wyoming State Trust Lands" to the Office of State Lands and Investments in 2012, shortly after the Arapaho Fire swept across RRS and surrounding lands. By then research at RRS had turned to post-fire since the majority of vegetation burned, including ponderosa pine. The research proposed in 2012 required equivalent, unburned forested areas on the state lands immediately south of RRS. The state approved the request, but to date no research has occurred on those state lands. The original authorization expired September 4, 2017; thus, it would behoove researchers wanting to utilize this State of Wyoming land to contact the Office of State Lands and Investments and seek approval via a new request. Forms are available from SAREC, as is a copy of the original request submitted in 2012. (Contact information for SAREC is contained in the footnote on the lead page of this report.)

Document the Site Photographically and With Mapping

Numerous people have documented the site photographically, both pre- and post-fire, and others have been involved in mapping projects. Photographs and mapping work are presented in RRS Bulletins 1 and 2, as well as this report, and additional photos and maps will be featured in upcoming RRS bulletins, including Seymour et al., 2017, which details the pre-fire vegetation mapping project by Mat Seymour and Ken Driese.

14 Josh Decker was promoted manager of UW Real Estate Operations in 2010.

Develop a Website for RRS

This report along with other information about RRS, including upcoming bulletins detailing research at the site, will be posted on the UW Extension website at www.uwyo.edu/uwe (click on the "Publications" link, and type Rogers Research Site into the "Search Publications" box).

Release Information about RRS Research and Other Activities to Stakeholders Within and Outside of UW as Well as the General Public

Information is and will be released in a variety of ways, including RRS bulletins, the UW Extension website, the WAES *Field Days Bulletin* (www.uwyo.edu/uwexpstn/publications/index.html), UW College of Agriculture and Natural Resources publications, and UW Extension publications and news releases. It is suggested that open houses be held (at an interval yet to be determined) at RRS to showcase research projects and other activities. Ideally, these would occur annually or every other year. A field day was tentatively being planned for late summer or fall 2017 or in 2018 (J. Tanaka, personal communication, 2017).

SECTION TWO: WYOMING FORESTRY BEST MANAGEMENT PRACTICES AUDIT RECOMMENDATIONS

Introduction

In an effort to be proactive in protecting water quality in Wyoming, the state in 2000 began implementing Best Management Practices' (BMPs) audits at a small number of forested sites across Wyoming. Initially, the major goal for each site was to prevent non-point source (NPS) pollution in waterways during timber harvesting activities. Starting in 2011, site selection was broadened to also include such activities as fuels mitigation, aspen restoration, and hazardous tree reduction.

Teams with the Wyoming Forestry Best Management Practices Audit program conducted audits in 2000, 2001, 2004, 2007, 2011, 2013, and 2016 at selected sites across the state. Each site was evaluated on key components of the particular activity being audited. Among the audit items for timber cutting activities, like those that occurred at RRS, are planning, roads, harvesting, slash treatment, re-vegetation, chemical use, and fire management.

Five Sites, Including RRS, Audited in 2011

In 2011, RRS was one of five sites in Wyoming to be audited (Figs. 30–31), while a sixth site was re-audited. Sites were recommended and selected by the audit team from a pool of forest management projects on state, federal, and private forestland. In order to establish equal representation of forestland ownership and to focus on timber sales with the greatest potential to affect water quality, baseline criteria were used to select timber sales from the list of potential sites. These criteria included: (1) harvest must have been completed within the last two years; (2) timber sale or other cutting activities must have harvested a minimum of 1,000 board feet (MBF) of timber per acre; (3) timber sale area must include live water crossings, riparian areas, federally designated wetlands, perennially or ephemerally saturated soils, or other important hydrologic features or resources; and (4) one audit site must be a re-audit from the 2007 BMP field audits (Wyoming Forestry Best Management Practices Audit Team, 2012).[15]

The 2011 state audit team consisted of representatives from the BLM, USFS, Black Hills Forest Resource Association, WGFD, Wyoming State Forestry Division, WDEQ, Devils Tower Forest Products, Colorado State Forest Service, and UW. This bulletin's lead

15 A copy of the report by the Wyoming Forestry Best Management Practices Audit Team, which conducted the forestry BMPs audit of RRS in 2011, is available by contacting the James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) at sarec@uwyo.edu; 307-837-2000; or 2753 State Highway 157, Lingle, WY 82223-8543.

Figure 30. Members of the Wyoming Forestry Best Management Practices Audit, which conducted a forestry audit at RRS in 2011, along with several local residents who were invited to participate, are briefed about the audit procedure before breaking into smaller groups. Among those participating include, from left, Rich Edwards, Colorado State Forest Service, blue shirt; Jim O'Brien, local resident, on ATV; Bonnie Parker, local resident, blue shirt; Colin Tierney, WGFD, red shirt; George Portwood, local resident, blue/red shirt; Melissa Dempsey, USFS, brown shirt; Carson Engelskirger, Black Hills Forest Resource Association, now with Wyoming State Forestry Division, yellow shirt; Bob Means, BLM, gray vest; and Mark Stiller, Neiman Enterprises/Devils Tower Forest Products, gray sweatshirt. The audit team and our RRS research teams extend our thoughts to the family, friends, and colleagues of Bob Means, who passed away suddenly at his Cheyenne, Wyoming, home on May 26, 2015. Please see the tribute to Bob in the front of RRS Bulletin 1. (Photo by J. Freeburn)

Figure 31. Wyoming Forestry Best Management Practices Audit Team members and local residents work together to score RRS in terms of best-management criteria. Pictured are, from left, Melissa Dempsey, USFS; Colin Tierney, WGFD, red shirt; George Portwood, Laramie Peak resident, red/blue shirt, in background; Bonnie Parker, Laramie Peak resident, blue shirt, in background; Carson Engelskirger, Black Hills Forest Resource Association, now with Wyoming State Forestry Division, yellow shirt; Bob Means, BLM (Bob passed away suddenly in 2015), gray vest; Carol Purchase, USFS; and the lead author of this bulletin, Steve Williams, far right. (Photo by J. Freeburn)

Figure 32. The Wyoming Forestry Best Management Practices Audit states that RRS property is well maintained and following accepted best management practices, but there are a few minor departures that need to be addressed, among them road erosion. This photo was taken in September 2013, approximately 14 months after the Arapaho Fire swept through the property. The fire burned the majority of vegetation, which worsened the erosion problem. It is recommended that a road management plan be developed for RRS to avoid additional damage caused by erosion from the fire as well as on- and off-road vehicle traffic, and to protect ongoing research plots. (Photo by S. Williams)

author was the UW representative; he was the catalyst that spurred the state audit team to include RRS in the 2011 survey.

The audit team toured the six sites across Wyoming, including RRS, to evaluate the voluntary compliance to BMP standards detailed in the publication *Wyoming Forestry Best Management Practices: Forestry Stewardship Guidelines for Water Quality, 2011 Field Audit Report*. The sites ranged in size from 13.6 acres to 457 acres, and timber sales ranged from one to 10,000 board feet (10 MBF) per acre.

Overall Findings from All Six Sites

The report by the Wyoming Forestry Best Management Practices Audit Team (2012) states that many of the audit items were properly applied and effective across all six sites, including soil and water resource monitoring and evaluation, knowing and complying with regulations governing the storage and handling of hazardous substances, and establishing proper sites for servicing and refueling to prevent spills from entering the water. With consideration to topography, soil type, and season, each site, including RRS, established an appropriate logging system and location for skid trails. And all sites minimized soil compaction and displacement during skidding operations and provided sufficient drainage for landing (skidding is the practice of dragging cut trees to a landing).

Summary of RRS Audit

The audited timber activities at RRS were carried out in the years preceding the 2012 Arapaho Fire and were administered by the Wyoming State Forestry Division. The report states that one to five MBF of timber were removed per acre on approximately 10 percent of the 320-acre (129.5-hectare) site. Following is the audit summary for RRS lands:

"RRS is an example of the non-traditional timber sale[16] sites we visited throughout the week and will continue to see in the future. Overall, the BMPs were well maintained on this site with a few minor departures. Timber harvest activities on the site followed BMP standards with the exception of not properly marking the SMZs (stream management zones) prior to harvest. The only other departures at RRS were related to road maintenance and drainage. In particular, there was one two-track road that had moderate erosion the entire length of the slope with no maintenance or water bars present (Fig. 32). There was obvious sedimentation coming off the road, though not enough to reach live water. These departures can be easily remedied with minor road maintenance according to the report by the Wyoming Forestry Best Management Practices Audit Team (2012)."

(In the years immediately following the 2012 fire, a private contractor was hired to remove burned trees around the perimeter of the site to accommodate new fencing, and to selectively cut burned trees as part of the ponderosa pine restoration study, the latter of which is discussed in RRS Bulletin 1 and will

16 Though the 2012 Wyoming Forestry Best Management Practices Audit Team report refers to RRS as being an example of a "non-traditional timber sale," it is our understanding that no timber was sold from the site. Instead, cut trees and limbs were put into slash piles, and other trees and limbs were left on the ground as part of an ongoing ponderosa pine restoration study.

be presented in detail in an upcoming RRS bulletin.)

Following are specific recommendations pertaining to RRS from the 2011 audit, with 2017 updates:

Develop a Road Management Plan

A road management plan at RRS had not been developed as of late 2017. From verbiage of the audit team is the recommendation that such a plan be developed and implemented as soon as possible to avoid additional damage caused by erosion. It should specifically address both on- and off-road travel involving passenger vehicles (Fig. 33), all-terrain vehicles (ATVs) used by researchers (Fig. 34), and timber harvesting equipment (Fig. 35). It has been noted (by the lead author) that private, mostly recreational ATVs, often use RRS without permission. As many as five ATVs have been observed at one time on RRS property using the established roads as well as driving off-road. This issue should be addressed, and it is recommended that the RRS management team collaborate with neighboring landowners.

Mark SMZs Prior to Conducting Any Timber Harvesting

SMZs (stream management zones) are areas of riparian forest that are adjacent to live water on RRS lands. Before any timber removal activities occur on the site in the future: (1) SMZs should be clearly marked; and (2) a determination should be made in advance whether any timber harvest will occur within these zones. If cutting is to take place in an SMZ, a plan should be created and closely followed to protect riparian habitat, including areas surrounding the approximate five springs on the property.

Rehabilitate Existing Two-Track Roads to Correct Erosion Problems

Lack of road maintenance was an issue prior to the 2012 Arapaho Fire, and since the fire unimproved roads have seen considerable erosion (Fig. 32), and in places they have become nearly impassible, especially during wet weather (Fig. 33). The latter issue has been compounded by the fact that numerous

Figure 33. The RRS Management Committee in 2011 recommended the development of a road management plan to address on- and off-road travel involving passenger vehicles, all-terrain vehicles, and timber harvesting equipment. Unimproved roads continue to degrade because of erosion and vehicle traffic during wet weather. As an example, on June 5, 2015, a four-wheel-drive truck carrying a team of researchers became stuck on this road, and it took a tractor to free the vehicle from mud, which caused additional resource damage. (Photo by M. Herget)

Figure 34. This picture shows allowed ATV use at RRS. In this case, researcher Mollie Herget transports one-year-old ponderosa pine seedlings (in the boxes) to planting sites at RRS during summer 2015. Many people on ATVs, however, have been seen on the property without permission, and it is recommended that the RRS management team work with neighboring landowners and possibly others to address this issue. (Photo by S. Williams)

standing dead trees have fallen across improved and unimproved roadways (Fig. 36). These issues should be addressed as soon as possible to avoid further damage and to help make roads and parking areas safer for workers and visitors alike.

Conduct Re-Audit if Advised

Though re-audits have been advised for some sites, a re-audit was not proposed for RRS since BMPs were generally well maintained on the site. Further, says Josh Van Vlack, assistant state forester for the Wyoming State Forestry Division, another audit at this time is not necessary because there have been a limited number of activities on the site

Figure 35. The RRS Management Committee's 2011 report stated that a road management plan is needed to address timber harvest activities. Further, the 2011 Wyoming Forestry Best Management Practices Audit report stated that the stream management zones (SMZs) at RRS were not properly marked prior to harvest. These zones would take into account the springs and other riparian areas at RRS, and before harvesting occurs the SMZs and equipment limitation zones (ELZs) should be clearly marked. Additional steps should also be taken to avoid resource damage during the spring and other periods of wet weather. This photo was taken on June 17, 2015. (Photo by M. Herget)

Figure 36. Lack of road maintenance was an issue at RRS prior to the 2012 Arapaho Fire, and since then unimproved roads have seen additional damage from erosion. Issues surrounding road maintenance and travel have been compounded by dead trees falling across travel routes. This issue should be addressed to allow workers access to their research sites and, more importantly, to make travel routes and parking areas safer. This photo was taken in May 2017. (Photo by S. Paisley)

since the 2012 wildfire. If UW has specific concerns or questions concerning forestry-related management of the site, Wyoming State Forestry Division would be happy to work with those involved (J. Van Vlack, personal communication, 2016).

SECTION THREE: NATIONAL INSTITUTE OF FOOD AND AGRICULTURE CRIS PROJECT OBJECTIVES

In early 2012, a project was approved to inventory soils, plants, and animals at RRS, research nitrogen fixation by plants, and monitor weather at the site. This research was certified as USDA National Institute of Food and Agriculture CRIS (Current Research Information System) Project WYO-465-11 (Appendix B). Among the goals were to develop baseline data to better assist future researchers with their projects at RRS. The project was started in earnest in spring 2012 with a partial vegetation inventory as well as procurement of a full set of soil samples from pits excavated and

selected to represent the various ecosystem components of RRS.

In early July, the Arapaho Fire moved across RRS lands, destroying buildings, killing most of the vegetation, and altering soils. This dramatically changed proposed activities at RRS to post-fire research in combination with those projects identified by the RRS Management Committee (2010–2011) and the BMP audit (2011) that were still deemed viable. Following is a list of projects approved under CRIS—with 2017 updates.

Inventory Soils

As discussed earlier, Larry Munn, a professor of soil science in the UW Department of Ecosystem Science and Management, conducted a soil survey at RRS in 2013 and 2014. A summary of his work appears in RRS Bulletin 1, and details of his mapping will be presented in an upcoming RRS report. Additionally, soil survey information for the general area can be derived from the Albany County soil survey completed by the U.S. Department of Agriculture's Natural Resources Conservation Service (2017a, 2017b).

Complete an All-Taxa (Plants and Animals) Biodiversity Inventory

As discussed earlier, assistant professors Linda van Diepen, Derek Scasta, and others have and are conducting detailed plant and related soil surveys at RRS. Bonnie Heidel, lead botanist at the Wyoming Natural Diversity Database on the UW campus, says that documentation of RRS flora is consistent with baseline succession and management research. RRS researchers are encouraged to document the flora by depositing vouchers at the Rocky Mountain Herbarium in the UW Department of Botany (B. Heidel, personal communication, 2017). A similar project involving wildlife could be initiated, which would follow the wishes of Colonel Rogers. Concerning wildlife studies, it is recommended that collaboration between UW departments, WGFD, USFS, and others be established to address study objectives. For example, WGFD has been collecting information about a threatened species that inhabits the Laramie Mountains, the Preble's meadow jumping mouse (*Zapus hudsonius preblei*). One of the detections was at Friend Creek, just seven miles west of RRS (N. Bjornlie,[17] personal communication, 2017). WGFD and USFS are also tracking confirmed sightings of another threatened species found in the area, the northern long-eared bat (*Myotis septentrionalis*) (T. Byer,[18] personal communication, 2017). Studies like these and many others could involve UW faculty, staff, and students.

Research Nitrogen Fixation by Leguminous and Non-Leguminous Plants

Rik Smith,[19] an assistant professor in the UW Department of Plant Sciences, started a project to study the nitrogen (N)-fixing capability of antelope bitterbrush (*Purshia tridentata*), an important shrub species for wildlife on RRS and surrounding lands (Fig. 37). Shortly after this project began, the Arapaho Fire burned the majority of vegetation at RRS, including bitterbrush. Regeneration of bitterbrush is slowly occurring. There has been very little regrowth from original plants because of the intensity of the fire; instead, regeneration is from the native seedbank left after the fire. Since Smith is no longer at UW, another faculty member will have to take this project on if it still has merit. If the study resumes, it is strongly recommended that a graduate student(s) be included.

There are numerous other N-fixing systems at RRS that were active prior to the fire. The several buckbrush species (*Ceanothus* spp.) as well as a diversity of legumes were

17 Nichole Bjornlie is WGFD's statewide nongame mammal biologist.

18 Tim Byer is district wildlife biologist for the U.S. Forest Service's Douglas Ranger District.

19 Rik Smith is now an associate professor at Columbia Basin College in Pasco, Washington.

Figure 37. Antelope bitterbrush (*Purshia tridentata*) is an important shrub species for many wildlife species in the Laramie Mountains. In 2011, UW Assistant Professor Rik Smith initiated a project at RRS to study the nitrogen fixing capability of antelope bitterbrush; however, the 2012 Arapaho Fire burned the majority of vegetation at RRS, including bitterbrush. There has been very little regrowth from original plants because of the intensity of the fire; instead, regeneration is from the native seedbank. Since Smith is no longer at UW, another faculty member will have to take this project on if it is deemed to still have merit, and it is recommended that a graduate student be involved with such work. This photo, taken in July 2015, shows bitterbrush re-sprouting following a low-intensive prescribed fire elsewhere in the Laramie Mountains. (Photo by Ryan Amundson)

Figure 38. A number of nitrogen-fixing plants reestablished following the 2012 Arapaho Fire, including white locoweed (*Oxytropis sericea* Nutt.). Nitrogen (N) is generally in short supply in most agro-ecosystems, and reestablishment of N-fixing plants at RRS would be an appropriate project currently and in the future for a faculty-graduate student team, perhaps in collaboration with others. (Photo by S. Williams)

observed prior to the 2012 fire—and are returning post-fire (Fig. 38). These are all well-known N-fixing plant systems that host the key microbial components ultimately responsible for the fixation process. Nitrogen as a nutrient is generally in short supply in most agro-ecosystems, and the forests at RRS are likely of no exception. Reestablishment of N-fixing plants post-fire would be an appropriate project currently and in the future.

Establish a Weather Station

A weather station with remote access was installed in 2013, but was subsequently damaged by mice and threatened by standing dead trees (from the Arapaho Fire) that are beginning to fall. As discussed above, the weather station was repaired in October 2017.

SECTION FOUR: ROGERS RESEARCH SITE AD HOC COMMITTEE RECOMMENDATIONS

In summer 2012, the Arapaho Fire burned through the area, which dramatically changed many of the objectives developed by both the RRS Management Committee and the Wyoming Forestry Best Management Practices Audit Team. In response to the fire, the Rogers Research Site Ad Hoc Committee formed in late summer 2012 to address the impacts of the fire and to develop a list of possible post-fire research topics (Appendix C). The lead author of this bulletin, S. E. Williams, chaired this committee. Other members included Josh Decker, Axel Garcia y Garcia, Bret Hess, Kristina Hufford,[20] Brian Mealor,[21] Bob Means,[22] Gary Moss,[23] Calvin Strom,[24] John Tanaka, Ramesh Sivanpillai,[25] and Nick Williams.[26] They received input from graduate student Claire Wilkin, who has conducted research at RRS (discussed earlier and below).

Determine the Extent of the Arapaho Fire's Impact

Until being contained in late August, the high-intensity Arapaho Fire caused "extensive damage" to all 98,100 acres it burned in the Laramie Mountains (National Interagency Fire Center, 2012). Studies conducted by this paper's lead author (S. E. Williams) and Claire Wilkin determined that the fire was moderate- to high-intensity at RRS, with temperatures reaching approximately 900°F (500°C). The fire burned the majority of vegetation on the property. Pre- and post-fire soil studies were outlined in RRS Bulletin 1 and will be presented in detail in an upcoming paper.

Provide an Estimate of Damages from the Fire

Those involved in RRS planning were asked to report on property damages from the Arapaho Fire at the request of UW administration and Josh Decker, manager of UW Real Estate Operations. This could include loss of pre-fire research projects, livestock grazing, timber, fences, buildings, electrical service, etc. The fire destroyed several

20 Kristina Hufford is an associate professor in the UW Department of Ecosystem Science and Management.

21 Brian Mealor in 2015 was promoted to associate professor in the UW Department of Plant Sciences and was named director of the Sheridan Research and Extension (R&E) Center, one of four R&E centers in Wyoming operated by WAES.

22 Bob Means was the Wyoming state forester for the U.S. Bureau of Land Management. In addition to participating on the 2012 RRS Ad Hoc Committee, Bob was a valued member of the 2011 Wyoming Forestry Best Management Practices Audit Team that conducted a forestry audit at RRS and several other forested sites in the state. Bob passed away suddenly on May 26, 2015, at his Cheyenne, Wyoming, home. There is a tribute to Bob in the front section of RRS Bulletin 1.

23 Gary Moss was associate director of WAES. He is now a professor emeritus in the UW Department of Animal Science.

24 Calvin Strom is assistant director of the Wyoming Reclamation and Restoration Center, which is located in the UW College of Agriculture and Natural Resources.

25 Ramesh Sivanpillai is a senior research scientist with the Wyoming Geographic Information Science Center located in the UW College of Agriculture and Natural Resources.

26 Nick Williams was a fire resource forester with the Wyoming State Forestry Division. In 2014, he resigned and moved to North Carolina to be involved with his family's business.

old, rustic buildings on RRS lands, including a cabin that was being occupied by the longtime resident of the property, Jim O'Brien, as well as the rustic one-room cabin that was utilized by Colonel Rogers before ill health prevented him from spending summers on his property. The remnants of these buildings and other debris were removed; however, UW determined not to turn in a claim for the old buildings. Insurance, however, did help cover the removal and replacement of fences that were destroyed in the fire (J. Decker, personal communication, 2016).

Repair Electric Lines to RRS and Surrounding Lands

Electrical service to RRS and surrounding lands was disrupted by the Arapaho Fire on July 1, 2012. This service was restored to RRS and surrounding lands, but not at UW's cost (J. Decker, personal communication, 2016).

Clean-Up Burned Structures and Other Debris

There was significant debris and rubble from the buildings that burned. There was other debris on the site as well (wires, cables, general trash, etc.) that became more apparent after the fire. Some of this has since been removed, but an effort should be made to remove remaining debris that poses a threat to workers and visitors. Aesthetics should also be taken into account; however, as discussed in RRS Bulletin 2, some of the remnants represent a monument to the Arapaho Fire, to Colonel Rogers himself, and to others who either lived on the property or were visitors. Because of this, it is recommended that the next RRS management committee take deliberate action to determine what should be removed and what should remain in place to preserve history.

Repair and Replace Fences So Livestock from Neighboring Lands Don't Indiscriminately Graze On RRS Property

UW hired a private contractor to cut and remove burned timber around the RRS perimeter and to cut timber in a staging area. This work was performed to make the area safe for contactors who were hired to build new fence, a project that has been completed. Since then, however, sections of fence have been damaged by falling trees (remnants from the Arapaho Fire) and large animals (most likely elk). The damaged fence was discovered in May 2017 by a SAREC faculty member (S. Paisley, personal communication, 2017). Fence maintenance is an ongoing issue, and it is recommended that the damaged fence discovered in early 2017 be repaired so that ongoing research is not damaged by domestic livestock that now have access to the site.

Temporarily Suspend Livestock Grazing on RRS Lands Until Adequate Vegetation Returns

The new fence helps to prevent livestock from wandering onto the property. Additionally, grazing has been indefinitely suspended because of the amount of vegetation that burned and to protect research plots. However, fence maintenance continues to be an issue (see previous paragraph).

Control Invasive Weeds, and Develop a Long-Term Management Plan

Brian Mealor told the committee that there is considerable, legitimate concern that the area will be vulnerable to invasion by cheatgrass (aka downy brome, *Bromus tectorum*) and other invasive species, including Canada thistle (*Cirsium arvense*). Since the fire, cheatgrass has spread rapidly in several areas within RRS, and Canada thistle has established in dense patches in several locations (Fig. 7). It is recommended that a new RRS committee collaborate with the Albany and Platte County Extension offices, the Albany and Platte County weed and pest control districts, and neighboring landowners (USFS, Wyoming Office of State Lands and Investments, and private landowners) in developing and carrying out a weed management plan.

Develop a List of Possible Post-Fire Research Topics

Research projects that were discussed and are now underway include (1) restoration of ponderosa pine and the influence of

erosion grass seeding on pine reestablishment following high-intensity wildfire (Figs. 17–23, 39); (2) pre- and post-fire soil comparisons (Figs. 8–9); (3) soil amendment and microbial community recovery after high-severity wildfire; and (4) pre- and post-fire vegetation surveys. These projects were outlined in RRS Bulletin 1, and it is our goal that all are covered in-depth in upcoming RRS bulletins.

UW Assistant Professor Derek Scasta, who is currently overseeing research at RRS with Assistant Professor Linda van Diepen, stated in June 2017 that he believes the most viable and needed research in the short-term is on the restoration of ponderosa pine—one of the projects that is currently underway (Figs. 17–23, 39). Additionally, many questions persist about post-fire plant community changes; thus, vegetation monitoring on an annual basis is also needed (D. Scasta, personal communication, 2017).

There are many other viable research projects in the near- and long-term, as well. Among those identified by the authors of this bulletin are to:

1. research the reestablishment of plant-based symbiotic N-fixing plant systems. Biologically available nitrogen (N) in granitic soils, such as those of and around RRS, is characteristically low; however, there are numerous plants that existed pre-fire at RRS that are known to fix N. These include a host of legumes and some non-leguminous shrubs and small trees.
2. study the lichens that were present pre-fire that are capable of fixing N. The study of these and other lichens at RRS would be a valuable research endeavor so as to uncover the ecological role of these organisms, and also to determine the level of biologically available N these organisms provide.
3. investigate on-site biological soil crusts (these are communities of living organisms on the soil surface in arid and semiarid ecosystems, such as many of the ecosystems found in the Laramie Mountains, including at RRS). There is probably some asymbiotic N-fixation on the site since biological crusts have been noted in numerous locations. Investigation as to how much N these contribute to this N-limited ecosystem would help to complete the N input portfolio for the post-fire regeneration of plant communities at RRS and, particularly, regeneration of ponderosa pine.
4. monitor (including the comings and goings as well as population changes) wildlife that inhabit the area, which could include a long-term study of their habitat and potential projects that could improve this habitat. The area is home to a variety of wildlife species, including big-game animals such as bighorn sheep, elk, and mule deer; trophy game species including mountain lion and black bear; many native and migratory non-game animals; migratory birds of concern, such as the northern saw-whet owl; and at least two mammals that are under Endangered Species Act protection, the Preble's meadow jumping mouse and the northern long-eared bat, which are both listed

Figure 39. Summer intern Noah Snider on July 21, 2015, plants a ponderosa pine seedling in one of the post-fire restoration research plots at RRS. Early findings from this project will be presented in an upcoming RRS bulletin. (Photo by M. Herget)

Figure 40. There are many potential research projects at RRS and surrounding lands including a study of the fire history, which would provide information on the fire-return interval for the area. Of the ponderosa pine killed during the 2012 Arapaho Fire and then cut post-fire, many exhibit fire scars, some created more than 100 years ago. This tree, which measures 23 inches (58.5 cm) across, was approximately 150 years old when it died in the fire. The tree ring count indicates that trees can grow large in the area, but that they grow very slowly. (Photo by S. Williams)

Figure 41. University of Wyoming Assistant Professor Derek Scasta, left, and the lead author of this bulletin walk through one of the post-fire restoration research plots at RRS on July 23, 2015. (Photo by M. Curran)

as "threatened" species. Of particular interest is the interaction of some of these species with domestic livestock (including both cattle and bison) that graze much of the surrounding U.S. Forest Service (USFS), state, and private lands. Such studies could be in collaboration with USFS, Wyoming Game and Fish Department (WGFS), U.S. Fish and Wildlife Service (USFWS), private landowners, and others.

5. study the fire history at RRS and nearby lands, which would provide much needed information on the fire-return interval for the area. Of the trees killed during the 2012 Arapaho Fire and then cut post-fire, many exhibit fire scars, some created more than 100 years ago (Fig. 40). There are well-established methods for detailing fire history from such fire scars. This would be an informative and most interesting study at RRS and the surrounding area. It would be of value mainly so that land managers would have a notion of the fire-return interval for the area and, thus, some indication of very roughly when the forest would again be susceptible to an incident of the size and intensity of the 2012 Arapaho Fire. Clearly, such information does not provide precise predictions because of the many variables, but the return interval, fuel loads, weather conditions (including climate change), and both natural- and human-generated ignition sources will help future land managers determine when ponderosa pine forests of the area will once again be susceptible to a large and intense forest fire.
6. continue researching the pine bark beetle. Despite the apparent demise of the beetle epidemic, there is still much work that can be done on this insect. Monitoring of the beetle in trees that survived the fire and in the new forest as it develops is probably a very long-term program; however, it has the potential to provide important information for future forest managers.
7. conduct a thorough inventory of structures lost or saved during the 2012 Arapaho Fire. Prior to the high-intensity wildfire, which burned nearly 100,000 acres, many structures in the Laramie Mountains were protected against fire by removing dead and dying trees, pruning and thinning live trees, clearing brush, mowing grass, etc., around homes and outbuildings. What treatments worked, what treatments did not work, and why? Possible collaborators include the Laramie Peak Fire Zone, Wyoming State Forestry Division, UW Extension, USFS, and private landowners, among others.
8. communicate with the WAES director and associate director, future RRS management committees, faculty members within the UW College of Agriculture and Natural Resources, UW Extension, other departments on campus that are involved in natural resources and related fields, states agencies including the Wyoming State Forestry Division and WGFD, federal agencies including USFS and USFWS, neighboring private landowners, and additional collaborators to develop a list of other viable research projects and goals. A vitally important recommendation is to include graduate and undergraduate students in these discussions and, ultimately, the on-the-ground work. Clearly, there are many viable projects at RRS; such work, however, should keep the wishes of Colonel William C. Rogers in mind. In his will, he stated that research should be conducted in connection with the improvement of wildlife and forestry resources, which opens up a broad array of research, extension, and teaching potential at RRS and surrounding lands, both in the short- and long-term. This potential is limited only by the imagination of those who want to help carry on the legacy of Colonel Rogers and his gift to the University of Wyoming and our great state of Wyoming.

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Much appreciation goes to those members of the 2010–2011 RRS Management Committee who actively participated in committee work (Jim Freeburn, Bob Shoemaker, Ryan Amundson, Bryan Anderson, and the lead author of this report), and to the members of the 2012 RRS Ad Hoc Committee (members are listed in Section Four of this report). UW Assistant Professor Linda T.A. van Diepen provided information about current research that is taking place at RRS and that will be detailed in upcoming RRS bulletins. Josh Decker, manager of UW Real Estate Operations, has provided valuable assistance throughout work on this report and others in the RRS bulletin series.

We thank Klayton "Shay" Rogge, assistant fire management officer for the Medicine Bow-Routt National Forests and Thunder Basin Grassland, for sharing photographs of the Arapaho Fire. The fire photo that appears in this bulletin was taken by Andrew Rose and is courtesy of InciWeb. Providing the military photo of William C. Rogers was his niece, Sarah Stark Serra, of Williamsburg, Virginia. Thanks, too, go to Colleen Hogan, Kelly Greenwald, Jim Freeburn, Mollie Herget, Michael Curran, Linda van Diepen, Steve Paisley, Martin Hicks, and Ryan Amundson for sharing photographs. Tanya Engel designed the map, George Portwood provided weather data that he has collected for many years in the Laramie Peak area, and Bob Shoemaker provided details about the new fire hall that serves landowners in the Laramie Peak area. Vivek Sharma and John Tanaka gave an update on the weather station at RRS that Axel Garcia y Garcia and others established, Brenda Davis supplied information about the steps that researchers must take before conducting studies on state lands adjacent to RRS and elsewhere in Wyoming, and Steve Paisley gave on update on RRS fencing. Nichole Bjornlie and Tim Byer shared information about two threatened wildlife species that are found in the area of RRS, while Bonnie Heidel, Ernie Nelson, and Brian Mealor shared their expertise about plants and plant documentation. We thank Ann Tanaka, UW Extension website designer/developer for posting the bulletins on the Extension website (http://www.wyoextension.org/publications/) and the SAREC website (http://www.uwyo.edu/uwexpstn/centers/sarec/). Appreciation is also extended to Steve Miller, senior editor, and Chavawn Kelley, writer/editor with UW

A burned ponderosa pine stands out sharply on a very foggy spring day at Rogers Research Site. This photo was taken on May 18, 2015. On this particular day, a University of Wyoming student/faculty team broadcast-seeded native grass in 18 research plots as part of the ponderosa pine restoration study that will be detailed in an upcoming RRS bulletin. (Photo by S. Williams)

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APPENDIX A. ROGERS RESEARCH SITE MANAGEMENT COMMITTEE SHORT- AND LONG-TERM GOALS FOR RRS.

Editor's Note: Following is the final report submitted February 10, 2011, by the Rogers Research Site Management Committee. The committee was charged with developing short- and long-term goals for the approximate 320-acre (129.6-hectare) Rogers Research Site in the Laramie Mountains. The land was bequeathed to the University of Wyoming in 2002 by Colonel William C. Rogers. (Please note: The committee's final report has been amended herein to provide more background information than present in the original report. This was done to offer perspective and clarity.)

PREAMBLE

In a document dated May 14, 2010, Bret Hess, associate dean in the UW College of Agriculture and Natural Resources, and director of the Wyoming Agricultural Experiment Station (WAES), created and charged the Rogers Research Site (RRS) Management Committee. Since that date, committee members have met at RRS, have commented on a draft document addressing the charge to the committee, and have had further discussion especially those regarding immediate management issues. This document is intended to address the charges from WAES Director Hess and establish an outline for the management of RRS.

RRS MANAGEMENT COMMITTEE MEMBERS

Following is a list of RRS Management Committee members who attended meetings, participated in discussions, and provided comments that were used in this report:

1. Steve Williams,[1] UW Department of Renewable Resources,[2] committee chair, Laramie, Wyoming
2. Jim Freeburn,[3] director, UW James C. Hageman Sustainable Agriculture Research and Extension Center, Lingle, Wyoming
3. Bob Shoemaker, warden, Laramie Peak Fire Zone volunteer fire department
4. Ryan Amundson, habitat biologist, Wyoming Game and Fish Department, Wheatland, Wyoming
5. Bryan Anderson,[4] assistant district forester, Wyoming State Forestry Division, Office of State Lands and Investments, Casper, Wyoming

INTRODUCTION

The Rogers Research Site is located on the eastern flank of the Laramie Mountains at elevations between 6,700 and 7,300 feet (2,000–2,200 m). The geology is largely metamorphic. The topography is highly variable with some level areas, but also steep slopes and even some precipitous zones. The climate is semiarid with snowfall during at least half of the year and a growing season (temperatures above 32°F [0°C]) of 100 days or less. Vegetation is largely ponderosa pine (*Pinus ponderosa*) and quaking aspen (*Populus tremuloides*), with an understory of shrubs including antelope bitterbrush (*Purshia tridentata*) and at least two buckbrush species (*Ceanothus velutinus* and *C. fendleri*). Numerous

1 UW Professor Emeritus Steve Williams retired in 2013. He and his wife, UW Professor Emerita Karen Cachevki Williams, reside in Laramie, Wyoming.

2 In 2011, the UW Board of Trustees approved renaming the department the Department of Ecosystem Science and Management. This department is in the College of Agriculture and Natural Resources.

3 Jim Freeburn is now the regional training coordinator for Western Sustainable Agriculture Research and Education's Professional Development Program. He and his wife, Jolene, live in Fort Laramie, Wyoming.

4 Bryan Anderson was promoted to district forester for the Wyoming State Forestry Division in Casper in 2012.

graminoids, forbs, and some invasive weeds are also evident.

For all practical purposes, RRS is embedded in U.S. Forest Service (USFS) lands designated as the Laramie Peak Unit (Douglas Ranger District) of the Medicine Bow-Routt National Forests. This unit is atypical of many national forest lands in the West in that it constitutes nearly 180,000 ac (72,800 ha) of National Forest System land intermingled with an approximate similar acreage composed of private, State of Wyoming, and U.S. Bureau of Land Management lands.

RRS is embedded in a nearly contiguous parcel of USFS lands—immediately surrounding the property to the west, north, and east are 640 ac [259 ha]) of lands under federal management. To the south are 80 ac (932 ha) of State of Wyoming trust lands and 40 ac (16 ha) of private lands (see ownership map in RRS Bulletin 1).

Approximately five miles (eight kilometers) west and northwest of RRS is one of the largest contiguous parcels of USFS lands in the Laramie Peak Unit. It is about 60 sections in size (about 38,400 ac [15,540 ha]) and contains the high point in the unit—the prominent Laramie Peak at 10,272 feet (3,131 meters). The salient point here is that the small parcel (~320 ac [129.6-ha]) that constitutes RRS is embedded in lands that are mostly controlled by USFS. Within a five-mile radius of RRS, there are also roughly 43 sections of private land (about 27,520 ac [11,137 ha]) and six sections of State of Wyoming trust lands (about 3,840 ac [1,554 ha]). The balance, about 30 sections (approximately 19,000 ac [~7,700 ha]) are USFS lands.

CHARGES TO THE RRS MANAGEMENT COMMITTEE

From the RRS Management Committee charge, May 14, 2010, the following charge components have been extracted:

1. Provide input and recommendations on management practices planned to be implemented in the very near future, including (A) aspen treatments; and (B) land acquisition.
2. Develop a management plan (short-term and long-range) for the property, including a protocol for planning and implementing management practices, among them (A) fire management; and (B) interfacing with the Medicine Bow-Routt National Forests.
3. Determine if the following three components of UW's tripartite mission are appropriate for RRS: research, outreach, and teaching. And if they are, detail the potential for each.
4. Develop a protocol for how requests to utilize the property should be handled.
5. Provide recommendations for (A) the RRS Management Committee's role in the future; (B) the terms of future committee members; (C) selection of committee representatives; and (D) whatever else may be pertinent to the committee's purview.

RESOLUTION OF CHARGES TO THE MANAGEMENT COMMITTEE

The following five charges were given to the RRS Management Committee:

1. Provide Input and Recommendations on Management Practices Planned to be Implemented in the Very Near Future

Aspen Treatments

One of the immediate issues the management committee addressed was that of impending aspen treatments on RRS lands. The proposal was to cut and masticate much of the aspen as an enhancement for wildlife. The committee's position was that more information was needed before a decision could be made. Specifically, how much aspen is present on RRS lands? What is the health of the aspen stands? What are the costs per unit area of the aspen treatment? Is there a research or demonstration project that could be linked to the aspen treatment?

Committee members Ryan Amundson and Bryan Anderson have agreed to perform audits of the aspen stands on RRS lands. This would include an inventory of stand acreages, structure of each stand (distribution of trees by species and size), and health of the trees. These audits have yet to be completed. The RRS

Management Committee recommends that the proposed aspen treatments be suspended at least in the immediate future.

Land Acquisition

It is possible that 80 to 120 additional ac (32–49 ha) of grassland immediately south of RRS could be added to RRS (80 ac of state trust lands and/or 40 ac of private land). But how does this possible acquisition fit into the management of the site?

One important consideration is that access to RRS is currently across this small grassland.

In addition, there is a full section (640 ac [259 ha]) of State of Wyoming trust lands located southwest of the site that is forested. Forestry research requires often considerable areas of land for treatments and long-term observations. The RRS Management Committee recommends that the grassland parcel be purchased and added to RRS. The committee also recommends that representative(s) of the committee meet with the Wyoming State Board of Land Commissioners and explore the possibility of using the adjacent section of state land for appropriate activities related to work at RRS. The committee further recommends that representatives(s) of the committee meet with officials from the Medicine Bow-Routt National Forests about activities at RRS that might have impact on those National Forest System lands that share boundaries with RRS.

Decision-Making Process for RRS

The two incidences above have provided test situations that inform the RRS Management Committee regarding its role in the decision-making process. A proposed role of the committee is provided near the bottom of this report in the section titled "4. Develop a protocol for how requests to utilize the property should be handled."

2. Develop a Management Plan (Short-Term and Long-Range) for the Property, Including a Protocol for Planning and Implementing Management Practices

Amended Living Trust of William C. Rogers

There are several major themes that to the RRS Management Committee are principle to management of RRS as well as research, teaching, and outreach activities that might occur on the site. Among these are the improvement of wildlife and forestry resources. These themes are consistent with the 2002 Amended Living Trust of William C. Rogers, which conveyed to UW his 320-ac (129.5-ha) Triple R Ranch. The ranch later was officially renamed "Rogers Research Site" in memory of Colonel Rogers and the research that is taking and could take place on the site.

The critical language germane to UW and its use of the property is: "… I direct that my Successor Trustee convey any interest I retain at my death in Triple R Ranch in the amount of 320 acres located in Township 26 North, Range 71 West, of Albany County, Wyoming, to the University of Wyoming with the requirement that said ranch be used for the public benefit as a center for studies, a retreat for conducting meetings, conducting conferences, or conducting research in connection with the improvement of wildlife and forestry, or to hold as a natural wooded area in its original state with specific instructions that no part of it be subdivided or sold for residential or private business purposes but held as an entire tract. Said restriction is to continue in perpetuity. If violated, said property shall revert to the ownership of the U.S. Forest Service."

The salient points of the trust emphasize that the Triple R Ranch should be used for the public benefit as a center for studies, a retreat for conducting meetings, conducting conferences, or conducting research in connection with the improvement of wildlife and forestry, or to hold as a natural wooded area in its original state.

Colonel Rogers provided an open and relatively clear account of what he wanted done with the property. One could argue

that when he uses the conjunction "or," that there should be a choice between the various possible functions. However, that it is to be used as a "center for studies" covers almost anything UW would want to do at the facility, including using it as a "retreat for conducting meetings," an outdoor location for "conducting conferences," and a site in the Laramie Mountains for "conducting research in connection with the improvement of wildlife and forestry" resources. Even the use of "to hold as a natural wooded area" unambiguously comes under the heading of a "center for studies."

Based on the above extraction from the trust as well as our interpretation, the RRS Management Committee makes the following recommendations: (A) that a UW attorney examine our committee's document and provide advice regarding our committee's interpretation of that section of the Rogers' trust that covers the donation of land to UW; (B) that the RRS Management Committee as well as other officials in the decision-making process accept as the basis for current and future activities at RRS that Colonel Rogers was purposefully very broad-based in his wording in the trust such that a diversity of activities related to at least wildlife and forestry could be conducted; (C) that a principle component of the Rogers' trust was that the lands he bequeathed to UW should not subdivided or sold, but instead should remain as an entire tract; and (D) that the RRS Management Committee will base its work on the wording and above interpretation of the Colonel Rogers' trust.

Planning

Herein, *short-term* planning is defined as those immediate activities—ongoing or in the very near future—designed to maintain the ecological integrity of RRS so that potential futures uses of the site are not impaired.

Herein, *long-term* planning is defined as those activities planned for the future designed to fulfill the trust Colonel Rogers has placed in UW. These activities simultaneously will be aimed to benefit the citizens of Wyoming and beyond.

For RRS, there are two clear mandates that must occur with regard to planning. The first is management of the site such that it does not pose a risk to users nor does it represent a risk to landowners in the immediate area. Second is conducting research, teaching, and outreach activities at RRS that are consistent with the needs of the citizens of the state and nation. There is currently considerable concern regarding forest fires throughout the western United States. There are several reasons that form the basis for this concern. These include apparent climate change influences on temperatures, which are slowly rising; precipitation, including drought; soil moisture, which can drop for a variety of reasons, including higher temperatures, less precipitation, and earlier snowmelt; and fuel characteristics, including dead and dying trees from bark beetle epidemics. Adding to this concern is the number of private and public structures that can be, have been, and clearly will be threatened by fire because they are embedded in forests or are adjacent to public or private forest lands, as is the case with the Laramie Mountains. These structures within and near forested lands make forest management—including prescribed fires—that much more difficult.

Fire control on RRS lands will be a function of fire control on surrounding lands, which, in the immediate area, are largely USFS, State of Wyoming, and private lands. Fire control must be part of short-term as well as long-term planning. Fire and fire control could and likely should be a theme in research, teaching, and outreach that might occur at RRS.

Short-term activities have included removal of persons living on the property without permission, clean-up of trash, and removal of old and unsafe buildings. Fencing of the property has also occurred, and cattle guards have been installed. Fire breaks have been created, and dead trees and brush were removed from RRS. There are other short-term projects that need to be developed for RRS.

Longer-term activities and planning are yet to be manifest. There has been considerable conversation about locating a fire station at or near RRS. This would be a joint UW-

Laramie Peak Fire Zone building that would accommodate equipment storage as well as sleeping and eating quarters. It would also make use of and likely upgrade the power available at RRS and surrounding lands. Construction of the facility could also improve road access to RRS, and it could make use of the gravity-flow water well located on the site. There has also been some discussion that if such a facility were established, there might be a possibility of putting in a small laboratory and extending the sleeping facility to accommodate researchers.

How Does RRS Interface with the Principle Neighbors and Other Land Management Agencies

The RRS Management Committee or another designated individual or group should communicate with officials of the Medicine Bow-Routt National Forests to keep them apprised of our plans and to seek their input. Likewise, a meeting of private landowners in the area would be of considerable benefit to get their perspective on projects that might be needed in the area. Other agencies that have some primacy in the area that should be consulted include the Wyoming Office of State Lands and Investments, Wyoming Game and Fish Department, U.S. Bureau of Land Management, and perhaps the U.S. Geological Survey, Wyoming State Geological Survey, and the federal Natural Resources Conservation Service. Further, the Rocky Mountain Research Station, a branch of USFS, has a research mandate for USFS. Interaction with this Fort Collins, Colorado-based research station would be of benefit.

3. Determine if the Following Three Components of UW's Tripartite Mission are Appropriate for RRS: Research, Outreach, and Teaching. And if They Are, Detail the Potential for Each

Research, Outreach, and Teaching Potentials: Are All of These Appropriate for RRS?

To a degree, this is an open question. Perhaps more to the point is what kind and intensity of research, outreach, and teaching potentials could be addressed at RRS? The first requests to utilize the station for a project will test this question.

What is Needed to Enhance Research, Outreach, and Teaching Potential at RRS?

RRS is almost completely unknown to most of the faculty and staff at UW who might utilize the site. Probably some more general announcements as well as media efforts to publicize the station and its potential are in order. However, there are issues with the station that are slowly being resolved, among those outlined in this report. One issue that will not be resolved is that of geography—the station is a little far from campus to be used on a routine basis for teaching. In good weather, it is an approximate 4½-hour roundtrip drive from the main UW campus in Laramie, Wyoming, a 3-hour roundtrip drive from the UW James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC) near Lingle, Wyoming, and a 1½-hour roundtrip drive from Wheatland, Wyoming. During bad weather, unnecessary travel to this remote section of the Laramie Mountains is not advised. However, it seems that some outreach type of work could be focused from RRS, and there are research opportunities as well. Making the campus faculty and staff—along with graduate and undergraduate students in a variety of programs—aware of the site and its broad range of potential uses is a way to initiate use of the site. A variety of funding sources for research projects and habitat improvement at RRS provide additional incentive to potential users. Two examples include the WAES Competitive Grants Program and the Colonel William C. Rogers University of Wyoming Excellence Fund, the latter of which supports proposals and projects that show promise of stimulating creative and innovative activities at UW, among them forestry and wildlife. Arrangements with the Medicine Bow-Routt National Forests, State of Wyoming, and possibly private landowners for use of adjacent lands might further enhance the appeal of this site for research, outreach, and teaching. A more complete audit of plant communities and soils, identification of weather records in the

area, establishing a weather station on-site, and a precise evaluation of the geology of the site would provide potential researchers baseline information that could help attract them to the site, provide information important for proposals related to research, outreach, and teaching, and aid researchers with their studies at RRS.

4. Develop a Protocol for How Requests to Utilize the Property Should be Handled

To provide a protocol to handle requests, it is appropriate to establish an administrative structure for RRS. The directorship of the site is part of the responsibility of the director of operations at SAREC.[5] The RRS/SAREC serves under the WAES director. These two individuals are key to the administration of RRS. A newly formed committee—perhaps called the Rogers Research Site Management and Research Committee—would be the principle body that would make comprehensive recommendations regarding requests to use RRS. It would also be the principle body to make similar recommendations on management issues. The chair of the committee would work closely with the RRS/SAREC director and the WAES director to determine if a given suggested management item or other use of the property would require an opinion rendered by the new RRS committee. Requests for usage would likely go to the RRS/SAREC director, the WAES director, or the chair of this new committee.

5. Provide Recommendations for the RRS Management Committee's Role in the Future

Among the important questions to ask are: (A) what is the committee's role in the future; (B) how would committee members be selected; (C) what would their terms be; (D) and is there anything else pertinent to the committee's purview?

The RRS Management Committee is a temporary committee. Once this planning document is in place, the committee would cease to exist and would be replaced by a new committee (Rogers Research Site Management and Research Committee is a possible name). The role of this new committee in the future is partially described in the above section. This function would not be automatic for every request, but would be as needed by the RRS/SAREC director, the WAES director, and the chair of the new RRS committee. The committee would also make requests for upgrades to the station and for attenuation of management strategies.

Members of the new committee shall be appointed by the WAES director and will have a term of four years with two new members (or new terms for existing members) added every year. The composition of the committee could be as follows, with one member from each: UW Department of Botany, UW Department of Renewable Resources, UW Real Estate Operations, Laramie Peak Fire Zone, Wyoming Game and Fish Department, Wyoming Office of State Lands and Investments/Wyoming State Forestry Division, Medicine Bow-Routt National Forests, and a resident and landowner within the Medicine Bow National Forest Laramie Peak Unit.

The WAES director and the RRS/SAREC director shall be *ex officio* members.

5 John Tanaka, professor and former department head of the UW Department of Ecosystem Science and Management, was named associate director of WAES and director of SAREC in 2015.

APPENDIX B. 2011 CRIS PROPOSAL TO PROVIDE FUNDAMENTAL BASELINE INFORMATION FOR THE ROGERS RESEARCH SITE, LARAMIE MOUNTAINS, WYOMING.

Editor's Note: This appendix contains the 2011 proposal that was submitted to the U.S. Department of Agriculture, National Institute of Food and Agriculture (USDA-NIFA) for federal Current Research Information System (CRIS) funds to help pay for research and related activities at the Rogers Research Site. Another proposal for funding was submitted concurrently to the University of Wyoming committee that oversees the Colonel William C. Rogers University of Wyoming Excellence Fund, which was established by Colonel Rogers to stimulate creative and innovative activities at UW and across Wyoming, including those that benefit our state's wildlife and forests. The application for funding from the Colonel Rogers UW Excellence Fund was not approved; however, USDA-NIFA approved the following proposal through the CRIS program (see Addendum 1 at the end of this appendix). This approval allows various federal funds allocated to the Wyoming Agricultural Experiment Station (WAES) to be used to support this project (WAES ultimately oversees all management of RRS). Funds for initial research, vegetation mapping, extension, teaching, and forest management at RRS were also provided by other sources, among them WAES, University of Wyoming Extension, Department of Ecosystem Science and Management in the UW College of Agriculture and Natural Resources, Department of Civil and Architectural Engineering in the UW College of Engineering and Applied Science, WyomingView, AmericaView, and U.S. Geological Survey. (Please note: the below proposal does not appear exactly how it was submitted to USDA; it was edited to clarify points throughout and to make more readable for a general audience. Additionally, the detailed funding breakdown is not included.)

CRIS PROPOSAL

Funding proposal submitted to: U.S. Department of Agriculture, National Institute of Food and Agriculture, Current Research Information System (CRIS).

Title of project: Development of biological property rubrics, including symbiotic associations and nitrogen cycling, to supplement soil surveys.

Applicants: Stephen E. Williams,[1] professor, University of Wyoming Department of Renewable Resources;[2] Axel Garcia y Garcia,[3] assistant professor, UW Department of Plant Sciences; and James W. Freeburn,[4] director, James C. Hageman Sustainable Agriculture Research and Extension Center (SAREC).

Year of submission: 2011

Project number: WYO-465-11

JUSTIFICATION

This proposal has two fundamental agenda items. These items are both focused on providing fundamental baseline information about the Rogers Research Site (RRS). This site is a new addition to the Wyoming Agricultural Experiment Station's (WAES)

1 Stephen E. Williams was the project lead on many of the early studies and other activities at the Rogers Research Site (RRS). He retired in 2013, but has been heavily involved in ongoing post-fire research at RRS and in the co-writing of this and other RRS bulletins.

2 The year this proposal was submitted, the UW Board of Trustees approved renaming the department the Department of Ecosystem Science and Management.

3 Axel Garcia y Garcia is now an assistant professor at the University of Minnesota's Southwest Research and Outreach Center in Lamberton, Minnesota.

4 Jim Freeburn is now the regional training coordinator for the Professional Development Program of the U.S. Department of Agriculture's Western Sustainable Agricultural Research and Education.

research and extension center array that provides coverage of the state of Wyoming. Although it is arguable that the information generated by this work, should it be approved, will really be as much an investment in future activities of RRS rather as generating publishable research in the present. However, there is a piece of this work that is fundamental and represents a contribution to the open literature as well as contributing to the baseline information important to the functioning of this station. This piece has the potential to modify how we do soil surveys, in that it focuses on biological properties of soils as well as abiotic properties. Abiotic properties largely dominate soil survey and soil taxonomy currently.

But is this justification enough for this proposed effort? More succinctly, does Wyoming need another addition to its string of research stations?

WYOMING LAND OWNERSHIP

Wyoming's land base is split almost evenly between the public and private sectors. Those lands controlled by the federal government—U.S. Bureau of Land Management (BLM), U.S. Forest Service (USFS), National Park Service (NPS), and others—plus those lands controlled by the State of Wyoming, constitute 49 percent of the surface area of Wyoming. If we are to understand in detail our state resources and the management of those resources, we must establish research, instructional, and outreach liaisons that connect especially the federal land management agencies to economic and cultural interests of the state. The irony is that the State of Wyoming has a modest voice in the management of the federal lands in the state. Yet the well-being of Wyoming's human population is intrinsically connected to these lands. Much natural resource decision-making on federal lands goes through Washington, D.C., before it filters back to Wyoming. Although this is not necessarily an acrimonious situation and often there are bridges of communication between the state and federal government that are harmonious, such bridges vary from agency to agency and some do not exist at all. For example, in Wyoming, the state university (University of Wyoming [UW]) in partnership with the National Park Service (NPS) has established a premier physical presence at the UW-NPS Research Station on Jackson Lake in Grand Teton National Park. This is a very important link between the state and region to NPS and provides the outdoor as well as indoor laboratory, overnight and longer accommodations, public forums for dispersal of information, as well as a competitive, albeit modest, grants program.

OPPORTUNITIES TO COLLABORATE

The state university does not have an equivalent physical presence with regard to other federal agencies that control land in the state. The BLM controls far and away the largest surface area in the state (some 17,507,000 acres or 7,085,000 hectares) as well as controlling subsurface resources for NPS, USFS, and others. Nor does it have such an arrangement with USFS, despite the fact that USFS controls nearly three times as much surface area in the state as does NPS. The Glacier Lakes Ecosystem Experiments Site (GLEES) is maintained in the Snowy Range of southeast Wyoming by the USFS Rocky Mountain Research Station based in Fort Collins, Colorado. This is a high-elevation station focused on climate change and watershed research—and is very important in its own right. UW does have considerable collaborative research at GLEES and in surrounding USDA Forest Service lands.[5] However, now there is a developing opportunity to establish interface directly between UW and USFS as well as state agencies that have a forest focus

5 UW in 2012 received a $20 million, five-year grant from the National Science Foundation to study water in the state. This highly interdisciplinary award, the single largest grant in UW's history, brings together researchers and educators from four UW colleges and 11 departments, and is led cooperatively by two UW faculty members, Steve Holbrook and Scott Miller. For more about this award, go to www.uwyo.edu/uw/news/2012/07/uw-receives-biggest-ever-research-grant-to-study-water.html

amongst their directives (Wyoming State Forestry Division, Wyoming Department of Environmental Quality, Wyoming Game and Fish Department, etc.).

COLONEL ROGERS BEQUEATHS PROPERTY TO UW

Nearly a decade ago (and at the current date of this bulletin, well over a decade ago), one Colonel William C. Rogers bequeathed ~320 acres of land to UW at Fletcher Park near Laramie Peak south of Douglas, Wyoming, and northwest of Wheatland, Wyoming. According to his will, any interest he retained in the property was to be conveyed

> *". . . to the University of Wyoming with the requirement that said ranch be used for the public benefit as a center for studies, a retreat for conducting meetings, conducting conferences, or conducting research in connection with the improvement of wildlife and forestry, or to hold as a natural wooded area in its original state with specific instructions that no part of it be subdivided or sold for residential or private business purposes but held as an entire tract. Said restriction is to continue in perpetuity. If violated, said property shall revert to the ownership of the U.S. Forest Service."*

By accepting this gift, UW, for all practical purposes, enters into a venture to transform the tract into a viable component consistent with the will of Colonel Rogers. The choice could have been made to "hold as a natural wooded area in its original state." This has not been done. Indeed there has been considerable modification of the site already as fencing has been added, unsafe buildings removed, and firebreaks and other fire-control measures imposed at the site.

RESEARCH TIED TO FORESTRY AND WILDLIFE

The purposes of this proposal are twofold. One is to provide baseline information for the location willed by the late Colonel Rogers to the university as a center for especially teaching, research, and outreach as they pertain to forestry and wildlife resources. Addition of this site fills an ecological gap in the existing array of lands used for research, teaching, and outreach in Wyoming. Currently these lands include the Powell Research and Extension (R&E) Center, James C. Hageman Sustainable Agriculture R&E Center (SAREC) near Lingle, Laramie R&E Center, Sheridan R&E Center, UW-NPS Research Station at Jackson Lake, and GLEES in the Snowy Range, to name those with UW and/or federal sponsorship. The second is to audit the ecosystem factors of the site in a manner that has not been done in the past. From this audit we will propose inputs and outputs of the nitrogen cycle for the area, which should be applicable to the surrounding area as well. From early in this survey we will be able to derive hypotheses that will form part of the graduate theses that will come from this effort.

The baseline and audit will be accomplished by (1) establishing a climatic record at the location; (2) conducting an edaphic[6] audit (soil and biota survey; see below) of the area; and (3) initializing a nitrogen budget for the location. These items (weather, soils, other biota, and nitrogen) are directly connected to forestry and wildlife issues.

PREVIOUS WORK AND PRESENT OUTLOOK

It may seem obvious that a weather station is a device for recording fundamental environmental information important for making decisions. In research it provides

6 Edaphic refers to the capacity of soil to produce and support plant growth. Such a survey here goes beyond a usual soil survey, which relies mainly on abiotic characteristics of the landscape. This survey will include descriptions of plants, biotic crusts, fungi, microorganisms, and others. Emphasis will be placed on large-scale processes, such as nitrogen fixation and mycorrhizal associations, which often can be partitioned at the order level of soil taxonomy (see Bellgard and Williams, 2011).

information that dictates, for example, when research may start and end, treatments, and when access to a site can progress. Weather monitoring also helps to explain why treatment effects vary from year to year. Weather records provide data, too, for local, regional, and even wider climatic trends (e.g., see the Wyoming Climate Atlas) that have implications toward more accurate weather forecasting as well as addressing fundamentals of climate change.

CLIMATE RECORDS

There is little argument that climatic records are needed at RRS to provide baseline information that will be important to determining plant productivity including forest productivity. Further, weather data will be very important at short and long temporal scales regarding fire danger, history, and control. At this point in time it is outside of our budgetary target to provide a complete weather station, but we have settled on a reasonably priced set-up that should provide the information needed especially when supplemented by data from National Weather Service stations in the region.

SOIL AND EDAPHIC SURVEYS

Soil surveys in the United States go back to nearly the start of the 20th century. They follow principles set down by very early pedologists in Russia as well as here in the U.S. Much of what drove these soil surveys was imbedded in the *soil forming factors* at the centerpiece of Hans Jenny's work (1946), but certainly had input by many others as well. Jenny's *soil state equation* represents simply the factors that go into formation of any given soil, but also forms the backbone for soil taxonomies or at least articulates the theoretical structure for soil taxonomy. Simply, the concept is that soil is a function of parent material, climate, organisms, and topography as they interact across time. The equation is:

$S=F(PM, Cl, O, Topo)_t$.

The reality is that in soil surveys, the various factors have different weights. Of course in any given ecosystem, the factors may be manifest differentially. For example, in some systems climatic factors can be so dominant that parent material as a factor may be diminished. The desire is that this be reflected in the taxonomy. Such a reflection, however, is often subject to bias of the soil surveyor or biased by the current use of the area or the intended future use.

Recently there has been an attempt to move around bias by making soil surveys more inclusive. Rather than emphasize parent material in the description or organisms, the movement has been to include as much information as possible. The recent movement to *ecological site descriptions* (ESDs) is a reflection of this. In ESDs, the soil survey provides fundamental information, but on this is overlain a much more comprehensive description of especially the plant community. Recently (see Bellgard and Williams, 2011) there has been a suggestion that other biota (in the cited case, mycorrhizal fungi) may provide an aggregation of taxonomic units that had not been considered before either in classical soil taxonomy or in the much newer ESD classification.

There has been discussion about imbedding a belowground biological component into the taxonomy of soils or ESDs or both. This has been in the realm of soil microbiology, but in recent years has evolved more toward soil ecology. There are new tools for evaluating the belowground systems that were unavailable until just recently. Evaluation of phospholipid fatty acids has come online and is available at UW. Further, there are methodologies available now for tracking gene function in soils that should be evaluated in the context of soil taxonomy as well as ESDs. Pyro-sequencing (e.g., 454 Analysis) is being used more and more in ecology—especially belowground ecology descriptions—and is available through the macro-molecule laboratory[7] on the UW campus.

RRS provides an opportunity to examine these new technologies on the belowground portion of the soil taxonomic units present at the site. This proposal is to examine these on a

7 Since this proposal was submitted, the University of Wyoming macro-molecule laboratory was discontinued.

limited basis, but still to compare conventional belowground evaluations (such as spore counts of arbuscular mycorrhizal [AM] fungi) with phospholipid fatty acid (PLFA) analysis of the AM fungi marker with pyrosequencing amplicons of AM fungi. All of these will be partitioned according to the classical taxonomic units present at RRS.

NITROGEN BUDGET

Nitrogen drives, to a degree, ecosystem function. In this proposed work, as soil taxonomic units are identified, soil pits will be constructed to examine in detail the arrangement of horizons. The soils sampled will provide material for the soil survey/edaphic survey including PLFA and pyro-sequencing. Further, it will provide material for classical soil chemical and physical analysis (see Williams et al., 1985) including total nitrogen, extractable nitrate, and ammonium. Further, the RRS site is well documented as having numerous symbiotic nitrogen-fixing plants. These include a diversity of legumes, but also a substantial component of non-leguminous nitrogen fixers. These populations will be identified and mapped, and their contribution to the nitrogen cycle will be estimated.

OTHER BACKGROUND

The land of RRS is forested (largely ponderosa pine [*Pinus ponderosa*] and quaking aspen [*Populus tremuloides*]), and it lies at an elevation of ~7,000 feet. For some three to four years WAES and the UW College of Agriculture and Natural Resources have been moving toward development of this parcel of land into a site for research, teaching, and other activities. To date considerable effort has gone into fencing and removing unwanted items (old tires, rusted fence wire, unsafe buildings, etc.) as well as people who were living on the site without permission to do so. Over the last year, a management plan has been formulated by a committee composed of UW faculty from WAES, the College of Agriculture and Natural Resources, SAREC, and the College of Arts and Sciences. Stephen E. Williams chaired the committee. Membership on the committee also included representatives from the Wyoming Game and Fish Department (WGFD), Wyoming Office of State Lands and Investments/Wyoming State Forestry Division, and Laramie Peak Fire Zone volunteer fire department. This membership, in part, represents the ownership of resources in the surrounding area. WGFD officially manages the wildlife resources of the area. USFS is the principle landowner in the area surrounding the bequeathed property, and it shares boundaries on three sides. There is considerable state trust land managed by the Wyoming Office of State Lands and Investments; however, within a six-mile radius of the property is considerable private land as well.

OBJECTIVES

The committee has derived an ambitious list of needs at what we now call the Rogers Research Site (RRS), but several items are needed to set the stage for further development of the resource. The following three objectives are derived from the list of needs at RRS.

1. ESTABLISH A BASELINE OF CLIMATIC INFORMATION FOR RRS

Weather records are available from several relatively nearby stations (within 25 miles [40 kilometers]), but elevation and topography modify weather so much that at least a baseline of weather records are needed for RRS. This will require that we purchase and set up a weather station at the site. We want to make this station operated as self-sufficiently as possible, with records down-loadable electronically and remotely.

2. CONDUCT AN EDAPHIC SURVEY AT RRS

The edaphic survey will include mapping of soils and vegetation at RRS as well as identification of nitrogen-fixing species and a general identification of mycorrhizal fungi (ectomycorrhzal organisms and arbuscular

mycorrhizal organisms[8]) and their host plants at RRS.

The edaphic survey will also include excavation of key soil profiles across RRS, identification of pedogenic horizons, as well as chemical and physical properties (the properties are described below, in the section titled "Edaphic Survey"). Other site characteristics will be determined including slope and aspect, and geological substrates. All of these characteristics, plus data generated from the weather station (as well as data extrapolated from nearby National Weather Service stations) will provide fundamental baselines for determining soil taxonomy, completing the edaphic survey, and ascertaining the health of this experimental unit. This information will generate important baselines for further research and demonstrations in the future.

3. PROJECT A NITROGEN BUDGET FOR RRS

Another goal is to determine the putative rates of nitrogen fixation of target plants. These include non-leguminous nitrogen fixers, leguminous nitrogen fixers, and biotic crust fixation. This will be done to create a nitrogen inputs budget for RRS and will be determined, in part, using N^{15}/N^{14} natural abundance. This information plus data from soils will provide the skeleton of a nitrogen budget for the site. Further, this information will provide the basis for the graduate student we propose to work on this project. The student should be able to generate testable hypotheses from the natural abundance data and the edaphic survey. All of the above will provide a baseline for further forestry- and wildlife-related projects. Currently we have a proposed aspen thinning (mastication) project before us where we need soils and other information to make an informed decision on this treatment.

PROCEDURES

ESTABLISH BASELINE CLIMATIC RECORDS

The climatic records will be collected via a weather station that will be set up by Assistant Professor Axel Garcia y Garcia, who has considerable experience with such projects. There are numerous components to the weather station that will need to be brought together and a site located for the station and the transmitter.

EDAPHIC SURVEY

At least nine points across RRS will serve as centers for intensive survey of the above-ground ecosystem components as well as the belowground components (Table 1). At each sampling-point-center (Fig. 1), a soil pit—of surface dimension approximately one meter by one meter (3 by 3 feet)—will be excavated to at least 2 m (6 ft) or until lithic or paralithic contact. Horizons will be described, and three 1.5-kilogram (3.3-pound) soil samples will be taken from each, but at different locations around the pit. Approximately 1 kg (2.2 lb) of each sample will be used to determine the soil's (1) chemical properties (total nitrogen, extractable nitrate and ammonium, extractable phosphorus, extractable potassium, organic matter, organic carbon, saturation extract calcium, magnesium and sodium, saturation extract pH, and salt; and (2) physical properties (texture, mineralogy, and bulk density). The additional 0.5 kg (1.1 lb) of soil will be subdivided and half used for phospholipid fatty acid analysis. From the other half, a subsample will be taken for DNA extraction and amplification using PCR (polymerase chain reaction) technology. Organisms present in the DNA amplicon will then be identified using group-specific primers. Primers for arbuscular mycorrhizal fungi, ectomycorrhizal fungi, leguminoid nitrogen fixers (e.g., rhizobia), and non-leguminoid nitrogen fixers (e.g.,

8 Ectomycorrhzal and arbuscular mycorrhizal organisms are major symbiotic systems that integrate mostly plants and fungi into symbioses that allow survival of both in harsh climates or during harsh times. Evaluation of these systems can be used as an indicator of ecosystem health. This is a key issue for quaking aspen (*Populus tremuloides*) health across western North America, including the Laramie Mountains.

Frankia spp.) will constitute the minimum set of genetic analyses. These determinations will be done through the Nucleic Acid Exploration Laboratory on the UW campus. The remainder of the soil sample will be preserved at -20°C (-4°F) for future use.

Macro-Vegetative Features

Macro-vegetative features will be determined in each of four 50- by 50-m (164- by 164-ft) plots that intersect at the soil pit at each location (Fig. 1). These include mostly large conifers, predominately ponderosa pine (*Pinus ponderosa*). There are also stands of aspen (*Populus tremuloides*) and alder (*Alnus* spp.), which will also enter into this analysis. Stems per unit area, diameter at breast height, aka DBH (diameters at 1.22 m [4.00 ft] above the ground), and basal area per unit area will be determined for all species. Site index as well as merchantable volume will be determined. These factors are dependent on collecting tree ages (via coring) and estimates of tree heights.

Meso-Vegetative Features

Meso-vegetative features will be determined on three 10- by 10-m (33- by 33-ft) plots randomly distributed in each of the macro-vegetation plots. These plots are of a scale to capture cover of shrubs as well as forbs, grasses, and seedlings of conifers and deciduous trees. Shrubs include antelope bitterbrush (*Purshia tridentata*), buckbrush (*Ceanothus* spp.), mountain mahogany (*Cercocarpus montanus*),

Table 1. Sites for intensive sampling on RRS lands.

Site ID	Description	General Location*
1	Wetland above pond	On boundary between NW SW and NE SW
2	Aspen stand above pond	Northeast corner of SW SW
3	Rocky outcrop	Northwest corner of SE SW
4	Dense timber	West half of NE SW
5	Open timber	Center of NW SE
6	Open timber	Center of SW NE
7	Aspen stand	East in SW NE
8	Dense timber	Northwest corner of NW NE
9	Open timber	Northwest corner of NE NE

*Locations are approximately described as being in a 40-acre (16.2-hectare) parcel as shown on the parcel ownership map (this map is in RRS Bulletin 1). These parcels are described as 1/16th of a section (e.g., NW SW) here and can be keyed to the ownership map. General macro-vegetation and topography at these sites can be determined from inspection of the aerial photographs of RRS (these will be published in RRS Bulletin 4: *Vegetation mapping of Rogers Research Site, north Laramie Mountains, Wyoming, using high spatial resolution photography and heads-up digitizing*). Note: The researchers established the first eight plots prior to the 2012 Arapaho Fire, but the fire broke out before plot nine was established.

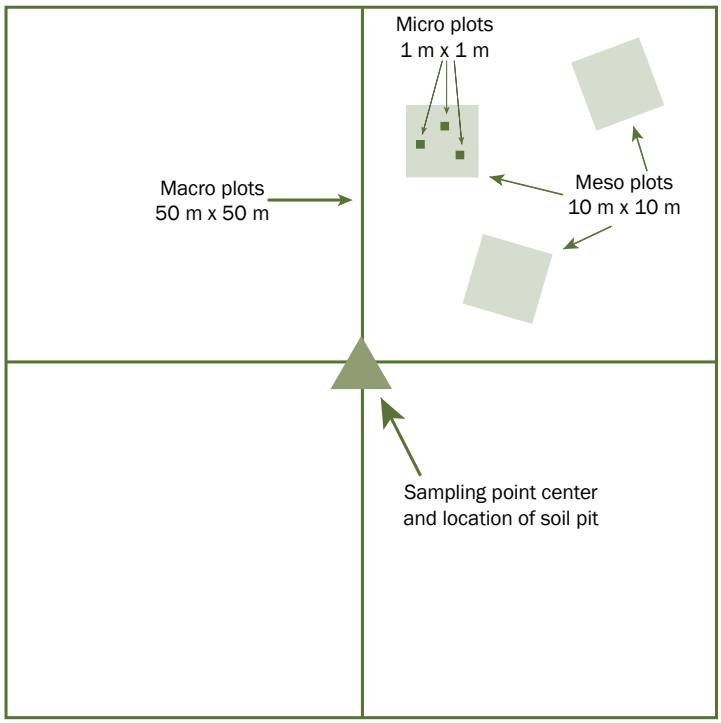

Figure 1. Surface view of a sampling point and surrounding plots for evaluation of macro-, meso-, and micro-surface bioltic parameters. At each sampling point are four macro-plots, each containing three meso-plots. Each meso-plot contains three micro-plots.

and buffaloberry (*Shepherdia canadensis*). All of these are non-leguminous nitrogen-fixing plants. Legumes are seasonally abundant on the site and include lupine (*Lupinus argenteus*), clovers (*Trifolium* spp.), milkvetch (*Astragalus* spp.), locoweed (*Oxytropis* spp.), and many others. There are other shrubs and forbs as well that will be documented. Percent cover will be determined as well as a list of species. These plots will also be used to identify macro-fungi (here identified as those fungi that produce a sporocarp[9]). However, macro-fungal surveys will not be confined to these plots. It is necessary to survey widely to capture at least the species present in this area.

Micro-Plots

Within each meso-plot, micro-plots (1 m by 1 m [3.2 x 3.2 ft]) will be established and used to survey and quantify surfaces occupied by cryptogamic materials such as lichen crusts, other biotic crusts, sphagnum mosses, Aeolian lichens (e.g., *Xanthoparmelia*), and others.

Determination of N^{15}/N^{14} natural abundance in leaves of nitrogen-fixing plants, lichens, and cryptogamic crusts will provide information that will allow estimation of rates of nitrogen fixation in this system. Anticipated also is establishing a precipitation collector at the weather station, which will collect (on a resin) nitrogen species that are dissolved in rainwater. This, along with nitrogen-fixation rates and nitrogen species in the soil, will allow construction of a nitrogen budget for the system.

PROBABLE DURATION

It is anticipated that this project will cover a period of 24 months of field and laboratory work and an additional six months to finalize results and publish.[10] It is anticipated that this study will commence on July 1 of the current year (2011). During the balance of the 2011 growing season, a forestry audit of RRS (best management practices audit overseen by the Wyoming State Forestry Division) will be conducted to identify problem areas (e.g., areas of high erosion potential) on the site as well as aspen health and location of experimental points (see above and Fig. 1). At least one pit will be constructed and methodology for surface evaluation tested. Lab analysis including soil analysis, nucleic acid analysis, and N^{15}/N^{14} natural abundance will continue until the start of the new growing season. During the winter months of 2011 and 2012, an outline of a thesis for the graduate study will be constructed and finalized.

Summer 2012 will see all soil pits and surface analysis initiated and completed during the growing season and likely into fall 2012. During winter 2012–2013, analysis will continue and writing up the project will initiate. May and June of 2013 will be used to finalize any lingering field work and analysis.

Funding is anticipated to end on June 30, 2013, but writing will continue into December (and likely beyond) to bring the thesis to fruition and the extraction of manuscripts.

FINANCIAL SUPPORT

Financial support shows the requested budget from the Colonel William C. Rogers University of Wyoming Excellence Fund (Rogers EF) plus a CRIS matching budget contingent on securing Rogers EF resources.

Editor's Note: As stated in the Editor's Note at the top of this appendix, the CRIS funding proposal was approved by USDA-NIFA (see Addendum 1 at the end of this appendix), but the proposal for funding from the Colonel William C. Rogers University of Wyoming Excellence Fund was not approved.

9 The sporocarp in fungi, also known as the fruiting body, is a multicellular structure on which spore-producing basidia, asci, and other structures are borne.

10 What the applicants projected in 2011 was thwarted by the 2012 Arapaho Fire, which burned nearly 100,000 acres in the Laramie Mountains, including RRS lands.

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UNITED STATES DEPARTMENT OF AGRICULTURE

National Institute of Food and Agriculture
Office of the Administrator
Washington, DC 20250
PROJECT REVIEW AND COMMENT SHEET

Accession No.	Project No.	Multistate No.	Project Type
227557	WYO-465-11		MCINTIRE-STENNIS

Project Status	Start Date *	Cooperating Institution
PENDING NEW.R	01 Aug 2011	UNIVERSITY OF WYOMING

Title: Development of biological property rubrics, including symbiotic associations and nitrogen cycling, to supplement soil surveys.

Environmental Impact Statement Required? [ ] Yes [✓] No

Action / Decision: [✓] Approved [ ] Deferred [ ] Not Approved

New Termination Date (Extension): _____

Comments:

[ ] 1. **Form AD-417** was modified to better represent proposed research.

[ ] 2. Title / Objective changed to conform with Multistate Project.

[ ] 3. Revise **Form CSREES-2008 for the following reason(s):**

[ ] 4. Other.

Signature

Date 2/6/12

* **Approval Date for use if Federal Funds**

(Form CSREES-166)
June 2003

Addendum 1.
U.S. Department of Agriculture, National Institute of Food and Agriculture funding approval for research at the Rogers Research Site.

APPENDIX C. ROGERS RESEARCH SITE AD HOC COMMITTEE RESEARCH AND MANAGEMENT GOALS FOLLOWING 2012 ARAPAHO FIRE.

Editor's Note: Following are the minutes from the October 1, 2012, meeting of the Rogers Research Site Ad Hoc Committee. The committee was formed in response to the 2012 Arapaho Fire, which burned nearly 100,000 acres in the Laramie Mountains, including lands within the ~320-acre (129.5-hectare) Rogers Research Site. The lightning-caused wildfire started on June 27 and was declared contained on August 23.[1] It burned across RRS lands in early July. The minutes were assembled by committee member Gary Moss. (NOTE: The original minutes have been edited to offer perspective and clarity.)

ATTENDEES

- Stephen E. Williams,[2] committee chair, University of Wyoming (UW) Department of Ecosystem Science and Management professor.
- Josh Decker, UW Real Estate Operations manager.
- Axel Garcia y Garcia,[3] UW Department of Plant Sciences assistant professor.
- Bret Hess, Wyoming Agricultural Experiment Station (WAES) director and UW College of Agriculture and Natural Resources associate dean.
- Kristina Hufford,[4] UW Department of Ecosystem Science and Management assistant professor.
- Brian Mealor,[5] UW Extension weed specialist and UW Department of Plant Sciences assistant professor.
- Bob Means,[6] U.S. Bureau of Land Management state forester for Wyoming.
- Gary Moss,[7] UW Department of Animal Science professor and WAES associate director.
- Calvin Strom, Wyoming Reclamation and Restoration Center (WRRC)[8] research scientist and assistant director.
- John Tanaka,[9] UW Department of Ecosystem Science and Management professor and department head.
- Ramesh Sivanpillai, Wyoming Geographic Information Science Center[10] senior research scientist.

1 Information about the Arapaho Fire came from InciWeb (Incident Information System) at https://inciweb.nwcg.gov/incident/2959/

2 Professor Emeritus Steve Williams retired in 2013, but was active in the development of several RRS bulletins.

3 Axel Garcia y Garcia is now an assistant professor at the University of Minnesota's Southwest Research and Outreach Center in Lamberton, Minnesota.

4 Kristina Hufford is now an associate professor in the UW Department of Ecosystem Science and Management.

5 Brian Mealor in 2015 was promoted to associate professor in the UW Department of Plant Sciences and was named director of the Sheridan Research and Extension Center.

6 Bob Means was also a member of the 2011 Wyoming Forestry Best Management Practices Audit Team, which audited several forested sites across Wyoming, including RRS, in an effort to help landowners better manage natural resources on those sites (the work of the audit team was discussed in earlier sections of this bulletin). Bob passed away suddenly on May 26, 2015, at his home in Cheyenne, Wyoming. There is a tribute to Bob in RRS Bulletin 1.

7 Professor Emeritus Gary Moss retired in 2005.

8 The Wyoming Reclamation and Restoration Center (WRRC) is housed in the UW College of Agriculture and Natural Resources and works closely with the UW School of Energy Resources.

9 John Tanaka in 2015 was named associate director of WAES and director of the James C. Hageman Sustainable Agriculture Research and Extension Center near Lingle, Wyoming.

10 The Wyoming Geographic Information Science Center (WyGISC) is an interdisciplinary research institute housed in the UW College of Agriculture and Natural Resources.

- Nick Williams,[11] Wyoming State Forestry Division fire resource forester.

MEETING CALLED TO ORDER

The meeting was called to order by committee chair Stephen E. Williams. Following introductions, Williams presented a PowerPoint presentation that illustrated the effects of the 2012 Arapaho Fire that burned the Rogers Research Site (RRS) in early July. The discussion focused first on steps taken since the fire and opportunities for data gathering and potential research projects for the site. Pertinent observations and activities include:

- Permission has been granted to use 720 acres of nearby state trust lands for fire remediation research. This came from the Wyoming Office of State Lands and Investments following a request by S. E. Williams.
- Soil samples at eight locations throughout the Rogers Research Site (RRS) were obtained prior to the fire.
- S. E. Williams reported that pH of soil from stump cavities has changed from approximately 5.5 pre-fire to greater than 8.0 after the fire. Surface pH in pine forests increased from ~5.5 to about 7.0. Extractable phosphate increased three- to five-fold.
- R. Sivanpillai[12] has conducted remote sensing of burned areas, which allows the areas to be categorized into high-, mid-, and low-intensity burns. These categories can be coupled with specific research goals and results to help determine impacts of treatments within burn-intensity areas.
- Fire severity categories are being related to soil characteristics.
- Invasive species (especially thistles and cheatgrass) are already making a comeback at the site, and in some areas they are establishing in dense patches.

POTENTIAL FOR ADDITIONAL DATA COLLECTION

Since the Arapaho Fire presents a unique opportunity to investigate many aspects of fire, additional suggestions for data collection include:

- Historical effects of fire, water, erosion, and wildlife on the site.
- Effects of the fire on erosion and water (especially the spring-fed pond). Since the pond is manmade, a question regarding its continued existence was raised. Because the pond is the only available water on the site at some times of the year,[13] it will be maintained.
- The evaluation of old tree dendrology[14] to form a detailed climatic history of the site including disturbance patterns.
- History of the site in regard to climate, fire history (i.e., wind direction, etc.). It was indicated that a fire progression map should exist for recent fires.
- An examination of past and possible future wildfire activity in the Laramie Mountains, which have had a series of fires since the 1990s. This presents the opportunity to observe the chronology of fires and re-burn potential. Based on disturbance reports and fire return

11 Nick Williams was promoted to statewide fuels program manager for the Wyoming State Forestry Division. In 2014, he resigned to work with his family's business near Ashville, North Carolina.

12 Ramesh Sivanpillai says that he completed preliminary work for conducting a remote sensing study of RRS in 2012, including the collection of several data points. However, Sivanpillai says that a funding proposal he submitted to WAES to complete the research was not approved (R. Sivanpillai, personal communication, 2017).

13 There are about five springs on RRS lands, and these springs help to feed the pond that Colonel William C. Rogers had constructed after acquiring the necessary permits, according to Brock Hileman, who frequently visited Colonel Rogers and his property with his wife, Levida Hileman, and stepdaughter, Colleen Hogan (B. Hileman, personal communication, 2016).

14 Dendrology is the scientific study of trees.

intervals, researchers should be able to determine if return intervals are longer or shorter for this region as compared to other sites and regions.
- The collection of weather information—this will soon be possible as a weather station[15] is being installed at RRS. In addition, the nearby Double Four Ranch has a weather station with data from approximately the past 25 years.
- Monitoring changes in vegetation.

OPPORTUNITIES FOR CONTROLLED RESEARCH STUDIES

Opportunities for controlled research studies at or near the site are numerous and are crucial to identifying best management practices for remediation of the effects of fire and to minimize detrimental effects of fire in the future. The Wyoming Reclamation and Restoration Center confirmed its support and willingness to contribute to projects as needed. UW Real Estate Operations will provide assistance with infrastructure needs. Potential research projects include:

- Wildlife-livestock interactions in regions damaged by fires and associated reclamation efforts.
- Influence of fire on soil (including hydrophobic soils[16]).
- Methods of reclamation. Foresters with the Wyoming State Forestry Division (WSFD) have already established treatment and non-treatment sites for fire control in the region. Albany and Converse counties have co-coordinators for thinning fire breaks. This appears to be a 'ready-made' research project. Similar sites exist on Casper Mountain. (Please see Addendum, below.)
- Invasive species research. The planned field trip to the site will help develop possibilities for controlled, hypothesis-driven projects.
- Revegetation studies. There is a need to gather information in regard to WSFD's plans related to aerial mulching, seeding bare ground, etc. Studies should be developed to complement and extend WSFD's plans and observations.

It was suggested that UW Extension's Sustainable Management of Rangeland Resources (SMRR) state initiative team be involved with remediation of the site. In addition, other experts suggested for inclusion in the effort include Dan Tinker[17] and Wayne Shepherd.[18] Studies also need to include an economic aspect to determine ultimate impacts.

ADDENDUM

S. E. Williams received the following message from N. Williams following the meeting:

Per our discussion last week, I would like to propose a topic for further discussion and propose a possible research project between the Wyoming State Forestry Division (WSFD) and University of Wyoming. One of WSFD's goals is assistance and technical advice to rural communities and private landowners. This is partially accomplished through our fuels management program focusing on community

15 A weather station with remote accessibility was installed at RRS in 2013, but during winter 2013–2014 mice gained access to the station through a small hole. The mice caused extensive damage, leaving the station inoperable. The station was repaired in 2017. Additionally, efforts need to be taken to clear dead standing trees from around the station to prevent additional damage. See RRS Bulletin 1, RRS Bulletin 2, and earlier sections of this bulletin for more discussion about the station.

16 Hydrophobic soils cause water to collect on the soil surface rather than infiltrate into the ground. Wildfires generally cause soils to be temporarily hydrophobic by increasing water repellency and surface runoff.

17 Daniel Tinker is an associate professor in the UW Department of Botany.

18 Wayne Shepherd is a research scientist emeritus with the U.S. Forest Service's Rocky Mountain Research Station in Fort Collins, Colorado.

planning, education, and physical hazardous fuels reduction for wildland fire.

One of our primary tools that my agency implements is hazardous fuels reduction treatments in high-priority areas identified as "communities-at-risk," which exist in the wildland–urban interface. These treatments include what we call defensible space, fuel breaks, and fuel treatments. For these treatments, the actual silvicultural prescriptions are dependent on a lot of variables such as initial fuel loading, types of vegetation present, topography, proximity to livable structures (homes), and prior knowledge (experience) of typical fire behavior for the area.

Most timber-woodland treatments involve thinning of the over-story canopy, reduction in understory canopy (reducing "ladder" fuels[19]), removal of dead and dying trees, and pruning limbs up to a specified height, and they could incorporate a reduction in the shrub and brush component.

Concerning the 2012 wildland fire season in Wyoming, our state experienced the most amount of burned area on record and the highest amount of money spent on suppression ever.[20] This year also saw the first significant and observable tests of our fuels management treatments on both state trust and private lands. WSFD had significantly impacted treatments implemented in areas of the Arapaho (Laramie Peak area), Oil Creek (Newcastle area), and Sheep Herder Hill (Casper Mountain) fires. We had anywhere from extreme to low fire behavior impact our treatment areas. We have some examples of where defensible space treatments were in place before the fire, where some homes survived and some did not. The major concern my agency has after the 2012 fire season is learning what specifically about our fuels treatments did and did not work given the fire behavior that was experienced this year.

WSFD and our cooperators would be able to provide details on pre-treatment, post-treatment, possibly fire behavior, Geographic Information Systems (GIS) data, photography, and other information required to develop this project into usable information. The discussion and conclusion of this project would go immediately and directly into planning of any future treatments in the state. This issue is again a major concern for my agency because of the investment we will continue to be committing to priority areas. I would really like for WSFD to lead such a project, but our agency is very small and we do not have the capacity to take on such a project alone.

I would really like to work with UW in this project. I think this sums up what the issues are, but please let me know if there is anything else you want more information on. I look forward to working with you on this in the future. Thank you for your time.

Nick Williams, fire resource forester, Wyoming State Forestry Division

19 When fire encounters areas of continuous grass, brush, and small trees, it can rise up these "ladder fuels" and quickly move from a ground fire into a crown fire.

20 Approximately 600,000 acres across Wyoming burned during the 2012 fire season, and the cost to fight these fires was estimated at $110 million, according to a summary letter by Wyoming State Forester Bill Crapser and USFS Rocky Mountain Regional Forester Dan Jirón (http://slf-web.state.wy.us/osli/spotlights/2013janWLR.pdf). The Yellowstone fires of 1988 burned more acreage (the estimate within the park's boundaries was 794,000 acres), and the cost to fight the fires was also higher (~$120 million), according to National Park Service reports (https://www.nps.gov/yell/learn/nature/1988fires.htm).

Among the recommendations for Rogers Research Site is the development of a road management plan to address both on- and off-road travel involving passenger vehicles, all-terrain vehicles, and timber harvesting equipment. The plan should focus on ways to cut down on erosion, protect riparian areas and stream crossings, such as this one, and avoid damage to ongoing and future research projects. This photo was taken in September 2013, approximately 15 months after the Arapaho Fire, which burned nearly 100,000 acres in the Laramie Mountains, including RRS lands. (Photo by Steve Williams)

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