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**Development of a Methodology for Building Fire History in Great Basin Shrub-grass Landscapes**

Principal Investigators:

Dr. Pat Barker<sup>1</sup>, State Archaeologist, Federal Cooperator  
Ms. Sandy Gregory<sup>1</sup>, Federal Co-Cooperator-GIS Specialist  
Dr. Stephanie Livingston<sup>2</sup>, Zooarchaeologist-Prehistorian  
Dr. Scott Mensing<sup>3</sup>, Char coal and Pollen  
Dr. Franco Biondi<sup>3</sup>, Dendrochronology/dendroclimatology

Affiliation: <sup>1</sup>Bureau of Land Management; <sup>2</sup>Independent Contractor;

<sup>3</sup>University of Nevada, Reno, Department of Geography

**Abstract:** Currently most fire histories for time before the historic period are constructed from fire-scarred trees. But there are few tree-ring studies for most of the interior Great Basin and tree-scar records cannot be obtained for shrub-grass vegetation dominated Great Basin valleys. Meanwhile fire-adapted cheatgrass (*Bromus tectorum*) is invading the Great Basin and appears to be rapidly creating conditions of frequent wildland fire in treeless shrub-grass valleys. The costs of these fires include not only the immediate financial outlay of people and equipment required to control them and associated risk to human life, but they occur in areas that impact the rural ranching economy and that provided critical habitat for native animals. Restoration of burned valley vegetation is hampered by the difficult problem of controlling the highly competitive invasive vegetation and by the absence of information regarding pre-contact vegetation composition and fire regimes. Further, the invasive plants have replaced native shrubs and grasses that supported indigenous animals that are no longer found in some valleys. And the native shrub-grass valley vegetation provided corridors through which animals could pass to maintain disjunct populations in high elevation habitat patches.

Some of the affected animals of the shrub-grass habitats, such as bison (*Bos bison*), pronghorn antelope (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*), rabbits (*Brachylagus idahoensis* and *Sylvilagus nuttalli*), and marmots (*Marmota flaviventris*), were important resources for prehistoric people, much as cattle are for people living in the central Great Basin today. In many parts of the arid west prehistoric people routinely burned sage and other brush to encourage the growth of native plants they ate, used as medicines, used as building materials, and/or that supported important animals they relied on for food. There is no documented use of fire as a landscape management tool in the central Great Basin, perhaps due to the theoretical paradigm under which ethnographic records of aboriginal lifeways were collected or because the people had also suffered population decline or decimation. But archaeological studies have shown that the ethnographic record is not a complete and secure analogy for prehistoric Great Basin lifestyles for the entire Holocene period; there were aspects of prehistoric subsistence and settlement systems that were significantly different from those described in ethnographies. The prehistoric people of the Great Basin may well have used fire to remove unwanted vegetation or to alter the structure or composition of the local vegetation. As the archaeological record for human use of landscapes in relation to prehistoric fire regimes becomes better known it provides not only a data source for reconstructing prehistoric plant

and animal histories, but it also provides an analogy from which the impact of changing fire regimes on human land use patterns may be evaluated.

This document is a description and demonstration of a methodology for reconstructing the long-term history of fire in shrub-grass landscapes in the Great Basin. Reconstruction of fire history in the shrub-grass landscapes will contribute to understanding the complex interaction between fire, landscape use by people, native and introduced plants, and changes in animal population size and distribution in an important landscape type. We have developed a methodology for data collection and analysis of historic and prehistoric materials from valley wetland sediments and archaeological sites that can be integrated with tree-ring data from adjacent uplands to construct fire histories that extend spatially beyond the treed areas of the Great Basin and temporally beyond the available written records, allowing a better assessment of the impact of changes in fire regimes and human activities on Great Basin valley landscapes.

## PROJECT JUSTIFICATION

Land management goals have traditionally focused on either maintaining public lands for sustained yield or preserving landscapes in their natural state (Nelson, 1995; Morgan, Barker, and Amme, 1996). The current frequency and intensity of wildland fires in shrub-grass landscapes in Great Basin valleys are counter to both management goals and their costs mount quickly each fire season. The cost of valley shrub and grass fires extend beyond the immediately obvious economic costs of controlling the fires, loss of rangeland, and cost of restoration. It is across the valleys, through these shrub and grass landscapes that are now vegetated by introduced species, that the native animals that inhabit the higher elevation islands of the Great Basin mountain ranges dispersed at the end of the Pleistocene (Brown 1978). And some boreal mammals continue to cross low elevation valleys dominated by sagebrush (Grayson and Livingston, 1993) which keeps their ranges from being truly isolated high elevation islands in the sagebrush ocean. There is now compelling evidence that some lower elevation landscapes supported more diverse mammalian faunas throughout the Holocene, losing species such as the bison (*Bos bison*), mountain sheep (*Ovis canadensis*), pronghorn antelope (*Antilocapra americana*), marmots (*Marmota flaviventris*), and rabbits (*Sylvilagus nuttallii* and *Brachylagus idahoensis*) in the latter part of the prehistoric period. All are grassland mammals that were important resources to indigenous peoples of the Great Basin. As fire adapted invasive grasses replace native grasses at lower elevations and spread into higher elevation habitats, they increase the fire potential of stands of tall sage that are the habitat of pygmy rabbits (*Brachylagus idahoensis*) and sage grouse (*Centrocercus urophasianus*). The dwindling distribution and abundance of these species reflect environmental change resulting from invasion of non-native grass species into areas previously vegetated by native bunch grasses and tall sage.

Considerable effort is being expended each year to preserve and restore Great Basin landscapes. The return of healthy populations of pronghorn to many areas is a testament to the success of such programs. Yet it remains unclear what the natural state of much of the Great Basin landscapes is, was, or should be in relation to fire regimes due in large part to the necessity of using the records from woodlands and forests to derive a record of fires that extends beyond the last century during which there are documents of at least those wildland fires that impacted human settlements or livestock enterprises. This is particularly true in shrub-grass dominated valleys where much of the economic base in the Great Basin lies: grazing range, farm lands, transportation routes, and population centers.

Despite concerted efforts to maintain Great Basin landscapes to current management standards, in the last two decades many wildland fires occurred in Great Basin sagebrush-grass dominated valleys, as well as the wooded and forested landscapes.

Much of the area burned in valley fires is now vegetated by introduced fire-adapted species, such as cheatgrass (*Bromus tectorum*) that rapidly accumulates as fuel and thrives on frequent burning (Billings, 1990). This is clearly a recent phenomenon. Cheatgrass is an annual grass that is native to Central Asia. It creates a fairly continuous understory under sagebrush, increasing the potential fuel load and displacing native bunch grasses. Prior to the invasion of cheatgrass in the late 1800s (Mack 1981), it is believed that the sagebrush understory was relatively free of herbaceous plants (Young and Sparks, 2002:252). Without fuel to carry a fire sagebrush fires may have been uncommon. Lightning clearly has a long history of igniting fires in desert environments where the vegetation turns to kindling by the time thunderstorms bring summer precipitation. But the fires started by lightning have little impact unless there is fuel to allow wildfire to spread. Studies of long-term woodland vegetation change have shown that woodlands tend to experience more fire as environments dry after wet intervals. The increased evidence of fire at such times is interpreted as natural removal of fuel that accumulated due to ideal conditions for understory growth. Similar understanding of shrub-grass dominated valleys is lacking. The methodology described here was developed to provide a means of extracting long-term fire history in shrub-grass landscapes where traditional methods based on fire-scarred trees cannot be used.

Another aspect of environmental fire that has received little consideration in the Great Basin, but may have had a tremendous impact on the nature of the valley landscapes for which fire histories are being developed, is the impact of prehistoric anthropogenic activities. Wildland fire is not only a natural part of the ecosystem, it is essential for maintaining environmental diversity by interrupting seral progression to climax vegetation stands, which generally means shrubs or trees that replace grasses that are more productive for human needs and those of many animals. Systematic fire suppression is a Euroamerican practice that began in the Great Basin in the early 20<sup>th</sup> century. Systematic fire suppression has clearly altered the nature of many landscapes where it has been practiced, allowing seral progression to establish woody species in grasslands and forest undergrowth to become overly dense for maximum productivity (Kay 1994; Cronon, 1995; Pyne, 1993). While there is a general recognition that fire

suppression and alteration of the composition of local flora and fauna by Euroamericans has significantly altered the fire regime of many parts of the Great Basin, the landscape prior to approximately 1850 is simply assumed to be pristine. Consequently, restoration to pristine conditions generally means restoration to pre-1850s conditions, or whatever conditions appear to have been present when the area was first described by explorers or settlers. Particularly lacking is information regarding changes in fire regimes in valley landscapes due to climate change, or use of fire for landscape management or prehistoric anthropogenic creation of either fire prone or fire retardant landscapes.

Fire is one mechanism by which native sagebrush and grass landscapes have been maintained in many parts of the American West. Unlike trees that can often withstand brief hot fires that remove undergrowth and open the stands, fires in grasslands being invaded by shrubs will generally remove the shrub growth allowing the grasses to maintain their hold. The fallacy of complete suppression of wildland fires that remove excess forest undergrowth that accumulates as fuel is now widely recognized by managers of forested areas. And the relationship between fuel build up, forest expansion and climate change is also becoming much better known allowing the construction of models for predicting the occurrence of forest fire during particular years and seasons. But the occurrence of wildland fire at lower elevation remains difficult to model due to the different response of introduced fire-adapted species and the lack of data from which to build a history of fire prior to the incursion of invasive grasses and other fire-adapted species. A more comprehensive fire history extending beyond the spatial and temporal limitations of the distribution and life-span of trees, and specifically addressing Great Basin shrub and grass landscapes is restricted to the last few decades during which written documents were kept. In building a fire history adequate for predictive modeling of fire in the Great Basin it is critical to address valley bottom shrub-grass fires as well as those that affect trees.

Fire histories that reveal patterns of wildland fire prior to Euroamerican settlement are being culled from historic documents and ethnographies for many native peoples of North America (Williams, 1994). In the Great Basin ethnographies there is little mention of the use of fire for landscape management, but the failure to record aboriginal landscape management practices may be due to the timing and the theoretical paradigm under which the first ethnographic data were collected. The Great Basin was colonized late in the history of Euroamerican expansion

into the frontier west, by which time many indigenous human populations had been decimated by disease or climate stress on food resources. Population decimation led to cultural disruption, causing abandonment of a number of aspects of native lifeways by the time anthropologists began documenting the cultures of the Great Basin. The most influential of the early anthropologists to work in the Great Basin was Julian Steward (1938), whose theoretical stance was that the environment determined the nature of human adaptations. The notion that people, particularly those of the Great Basin who had so little in the way of technology, could alter their environments to their own ends was inconceivable. Today there is ample evidence that Steward was wrong about a number of aspects of native cultures that had changed significantly shortly before he collected the Great Basin data on which his ethnographic accounts are based. Another influential anthropologist who studied the indigenous people of the American West a few decades later, Omer Stewart (1951), reported that use of fire was common in cultures throughout the west, but he also does not provide specific details for the Great Basin. Thus, the record for anthropogenic fire in the Great Basin is currently equivocal, but it is important to recognize the potential, and the probability, that fire was used to structure and maintain particular landscapes in the Great Basin as it was elsewhere. It is also possible, even probable, that some aboriginal activities contributed to making landscapes fire prone or fire resistant. Understanding of wildland fire regimes from a long-term perspective must, therefore, entail consideration of the relationship between fire and climate change in the absence of human intervention and the impact of deliberate setting or suppression of fire to modify landscapes for human interests.

## **THE PROJECT AREA**

Newark Valley (Fig.1) was chosen as the locus for the pilot study because there is an extensive spring complex in the valley at the foot of the Diamond Mountains which promised marsh sediments amenable to extracting a sediment core from which a stratified charcoal and pollen record could be obtained. Second, the Newark Valley is bounded on the west by the Diamond Range, which rises to over 10,000 feet of elevation and supports stands of trees that can be cored for tree-rings. On the east, the Maverick Spring Range also supports trees, and the Cherry Creek Range supports stands of limber pine that are over 400 years old. Third, there is a well documented archaeological record for the Newark Valley, including the excavated Newark Cave site from which there are faunal remains indicating that bison and marmots were present in the valley at various times during the last

5000 years and there are cultural similarities with groups to the east and south where fire was used to manage landscapes for encouraging grasslands that support some of the animal taxa found in the faunal assemblage.

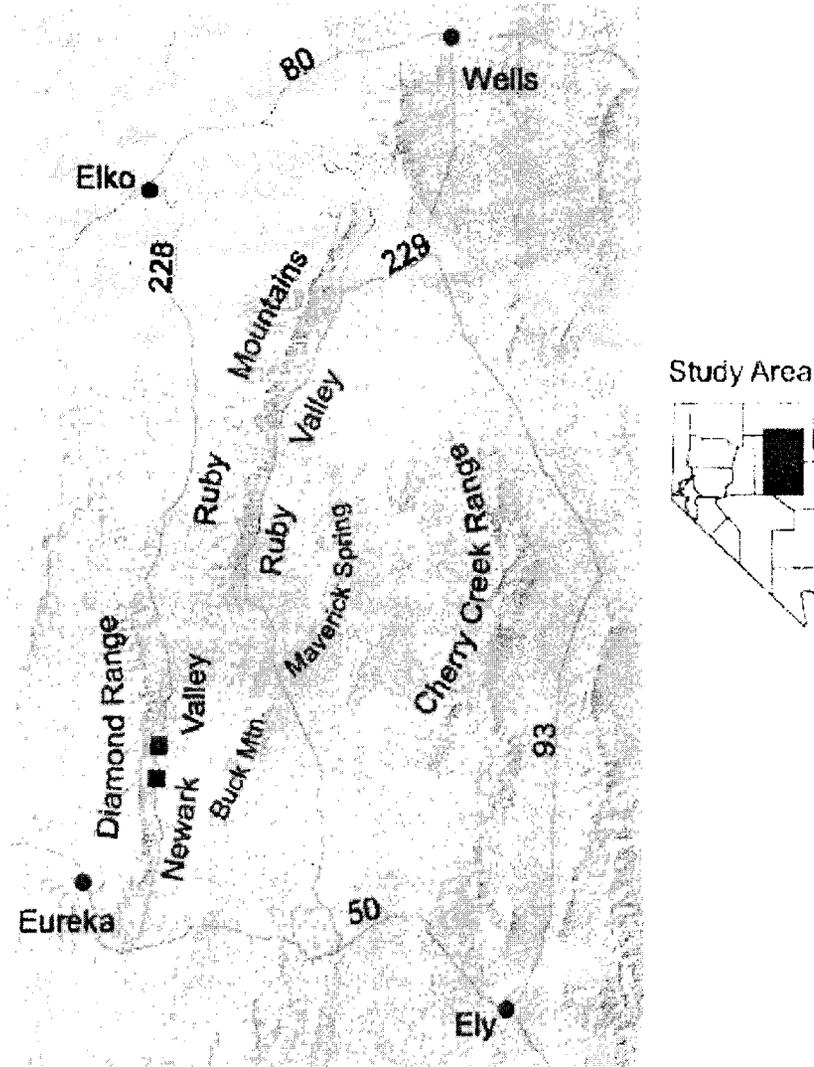


Figure 1. Study area site map. Solid squares represent recent fires of >1000 acres in Newark Valley.

Aside from offering a variety of different sources for prehistoric data, Newark Valley was chosen as a pilot site because at least two large fires have burned in the sagebrush in close proximity to the spring/meadow complex within the last twenty years. In 1986 more than 3500 acres burned and in 1999 more than 1000 acres burned. We predicted that charcoal from these fires would be evident in the near surface sediments collected in sediment cores from wetland sediments around the springs. If charcoal abundance in these layers is greater than in earlier layers that had no fires, we can be confident that fires of this

magnitude burning near the coring site will be recorded in the sedimentary record and we can reconstruct a fire history going back through time. If the upper layers of sediment contain no charcoal, then we would have had to conclude that coring for charcoal would not be an appropriate method for obtaining fire history data in sagebrush-grass environments.

**Environments of Newark Valley.** Newark Valley is between the Diamond Mountains (maximum elevation of 10,614 ft (3245 m) on the south end of the range) on the west, a southern spur of the Ruby Range formed by Bald Mountain (elev. 9036 ft, 2763 m) and Buck Mountain (elev. 9160 ft, 2800 m) on the east. The 800 square mile drainage basin is separated from the Huntington Valley to the north by a low bedrock and alluvium bench, and Antelope and Dry Mountains (elev. 7000 ft) to the south. Little Smokey Valley is a southern extension of Newark Valley.

The north end of Newark Valley (elev. 5840 ft, 1785 m) is a playa that marks the bed of Pleistocene Lake Newark. The highest of several beach lines and wave-cut terraces that mark the presence of the Pleistocene lake is approximately 6145 ft (1889 m). Newark Cave was cut by wave action of Newark Lake when it created this beachline (Eakin, 1960). Numerous large perennial springs that provide surface water along the edges of the playa are now providing irrigation water for pasture and alfalfa. The native vegetation of Newark Valley is dominated by sagebrush (*Artemisia* spp.), with some greasewood (*Sarcobatus* spp.), shadscale (*Atriplex* spp.), and rabbitbrush (*Chrysothamnus* spp.). Around the springs tules (*Typha*) and salt grass (*Distichlis*) are the dominant native species. Pinyon (*Pinus monophylla*) and juniper (*Juniperus* sp.) grow on the lower slopes of the surrounding mountains, and limber pine (*Pinus flexilis*) grows at higher elevations.

The historically reported native mammalian fauna of Newark Valley includes lagomorphs (*Lepus californicus*, *Sylvilagus nuttallii*, *Brachylagus idahoensis*), ground squirrels (*Spermophilus* spp.). Although Hall (1946:285) included the proximity of Newark Valley in his generalized estimate of their range, marmots (*Marmota flaviventris*) have been cited as missing from a number of mountain ranges, including the Diamond Range that borders the west side of Newark Valley, as part of the model of colonization and extinctions in high elevations that explains post-Pleistocene small mammal distributions in the Great Basin (Brown, 1971, 1978). Marmots have, however, been seen in healthy numbers in Sadler Creek Canyon on the east side of the Diamond Range (Grayson and Livingston 1993). A number of murid rodents are known from the area, including deer mice (*Peromyscus* sp.), harvest mice (*Reithrodontomys megalotis*) and woodrats (*Neotoma lepida*, and *N. cinerea* at higher elevations in the Diamond Range) (Hall, 1946). Muskrats (*Ondatra zibethicus*) are reported from as close as the west side of Ruby Valley in northern White Pine County (Hall, 1946:567), which suggests it is very likely they lived around the edges

of permanent springs to the south in the past. Beaver (*Castor canadensis*) is likewise reported from just north of Newark Valley (Hall, 1946:488). However, because beaver require deeper flowing water of streams and rivers, it is unlikely that these large furbearers were ever inhabitants of Newark Valley where the major water source is springs that are not tributary to any significant stream. Indigenous carnivores include coyote (*Canis latrans*), bobcat (*Lynx rufus*), and possibly red fox (*Vulpes fulva*) and some of the mustelids. However, none of the carnivores have been reported in sufficient numbers to represent populations that would attract trappers. Mule deer (*Odocoileus hemionus*) were the only native artiodactyl in the area when the first systematic mammal surveys were conducted (Hall, 1946). However, Hall did note that he believed pronghorn (*Antilocapra americana*) and mountain sheep (*Ovis canadensis*) may have once occupied a much larger range that included the Newark Valley and/or the adjacent ranges. Hall also included bison (*Bison bison*) as possibly having ranged in the northern and northwestern part of Nevada in his Hypothetical List: mammals possibly occurring in Nevada of which satisfactory record is lacking (Hall, 1946:643-44).

**The Historic Period in the Newark Valley.** There are at least four events in the historic period (1820's to the present) that may have significantly altered the intensity and return interval of fires in the northern half of the Great Basin: intense trapping between 1820 and 1840, the arrival of large herds of domestic stock in the 1860s, drought and extremely harsh winters between 1888-1890, and the beginning of a policy of total fire suppression in the 1910s. However, the impact of each event would have differed from place to place depending on the latitude, elevation, water sources, indigenous plants and animals existing there at the time.

The first trappers in the Great Basin were agents of the Hudson's Bay Company, whose agenda it was to deplete populations of fur-bearing animals to the point that there would be no competition between the Hudson's Bay Company and the American Fur Company for trapping rights in the area. They began trapping in the 1820s and ended before 1840 when the market for beaver crashed due to changing fashions in Europe. However, the impact of trapping for less than 2 decades along the Humboldt River was undoubtedly tremendous as the beaver populations were decimated, which would also have greatly altered the vegetation distribution and abundance along this major riparian corridor as abandoned dams failed with lack of repair. However, there is no evidence that the trapping expeditions reached as far south as the Newark Valley, the range of beaver probably extended no further south than

the southern end of the Ruby marshes. In fact, historic impact on Newark Valley probably was insignificant until the late 1850s.

Vale (1975) reviewed 29 historic journals and diaries kept by early explorers and immigrants to the Intermountain West. Seven of those accounts provided descriptions of the vegetation of Nevada landscapes between 1849 and 1871. He summarized the descriptions provided by immigrants that generally followed the Humboldt River as evidence that moist bottomlands provided forage for livestock, but the uplands were poor in grasses (1975:34), but that the Government expeditions in central Nevada found grass on high-elevation slopes, mountain canyons, and moist valley bottoms. Elsewhere, brush and scattered bunch grass characterized the vegetation... (1975:35). Although (Fowler, 1968a:1) suggested that Jedediah Smith's party *may* have passed through Newark Valley in the summer of 1827, on the basis of interpretations of his route by Cline (1963:157-158) and Morgan (1953:210), it is most likely that the Smith party passed to the south of Newark Valley, their closest approach to the project area possibly being the southern end of Little Smoky Valley. Regardless of their actual proximity, there is no evidence that they stopped to trap in any of the valleys along the central Great Basin part of their route. Simply passing through, they would have no ecological impact and may even have discouraged further exploration in the area for decades.

The Pony Express route crossed just north of Newark Valley in 1859, bringing regular traffic to the area and requiring the maintenance of riding stock and their caretakers along the route. The impact of these few, but regular, grazers on the range may have had a minimal impact. But at about the same time the second event that brought significant Euroamerican impact to the central Great Basin was the beginning of mining, with its associated sudden increase in human populations (particularly Euroamericans with a different relationship to the land), and the lumbering and livestock industries required to support the increased human populations and their industrial activities. During the 1860s and 1870s there were several mining districts in the region near Newark Valley. These mines were operated by a large population centered in the towns of Eureka and Hamilton (now a ghost town). The Newark (Strawberry) Mining District on the east slope of the Diamond Mountains began producing lead, silver and copper in the 1860s (Lincoln, 1923:252). The use of local timber for construction, mine shoring, stamp mill fuel, and firewood and the introduction of livestock into shrub-grasslands of Newark Valley undoubtedly had the same

deleterious impact on the local vegetation and fauna as has been described for the same period in the Reese River Valley to the north and east. In the Reese River Valley an early livestock industry was described in the local newspaper, the *Reveille*, as flourishing in a valley that resembled a vast field of barley or wheat and long, wavy grass which abounds in such profusion on the slope and main ridges and grass is more than knee-high ... consisting of blue joint, clover and red top (Thomas, 1971).

The third historic event that may have altered fire frequency and intensity in the Newark Valley was a series of short-term climate events: the drought of 1888-1889, followed by the extremely harsh winter of 1890. The impact of the drought and harsh winter is best remembered because these years of harsh and unexpected conditions took a significant toll on livestock, attested to by the reports of cattle deaths and projections of how cattle would fare during the next few seasons. Importantly, although harsh environmental conditions were regularly reported in the local newspaper, including the impact of weather events on livestock, wildfire was not. That drought years with lightning storms did not have the impact they do today is clear, as indicated by news articles such as the following report from the *Eureka Weekly Sentinel* of August 11, 1888,

**Struck by Lightning.** On Sunday last a very heavy thunder shower visited Spring Valley and vicinity, says the Pioche Record. Forked lightning played around promiscuously. On the hills around the valley several trees were struck and fired, and in a valley, a horse standing in a meadow on the Rice Bros. Ranch, was struck and instantly killed.

The greater concern expressed for the horse than the threat of wildfire in this account appears to reflect a general lack of concern for wildfire that appears to have characterized the historic citizens of Nevada. This is not to say there was no fear of fire. Fire damage to structures and property were common at the time, commonly reported as destroying buildings throughout the state and even as far away as the east coast. Most structural fires, however, started inside the building by heating, lighting, and cooking activities of the occupants. Mine shaft fires likewise are reported, again, started by activities of the people working in the mines. Even arson, was reported in the *Eureka Weekly Sentinel* of September 1, 1888, in an article picked up from the paper in Virginia City reporting the activities of 'Young Fire Bugs' who were eliciting ...much complaint in Gold Hill and on the divide... Apparently a group of boys were setting fire to fences and sheds and causing a significant loss of property, thus creating a reign of terror among residents who feared being burned out of their properties. Yet even in the face of the deliberately set

fires, there is no indication that the residents feared that the fire would escape and do damage to the landscape beyond burning their constructed property. This attitude appeared to continue throughout the drought that followed during 1888 and 1890, although the impact on the vegetation was clearly taking a toll on cattle throughout the state. The *Eureka Weekly Sentinel* reported, on August 10, 1889,

**The Stock Outlook.** The Virginia Enterprise says: The outlook on the cattle ranges of Nevada is not cheering. There will be a few places in which owners may be in a position to venture to undertake to keep and Winter their cattle, but in most sections they must be sold if fit for beef, and if not must be moved out of the country. Already many cattle are being sent away. Sheep are said to be doing very well. Everywhere they have fared better than cattle.

The absence of a threat of fire in Newark Valley may have been a result of the valley having been essentially denuded as the drought and harsh winter took its toll on the vegetation, and the hungry cattle ate what remained. Meanwhile, areas further north, where cattle had an impact earlier, were experiencing wildfire that was extensive enough to require outside help to get it under control. A news item in the *Eureka Weekly Sentinel* of August 10, 1889 reads,

**Aid for Burning Idaho.** A Washington dispatch says: Secretary Noble received a telegram from the Governor of Idaho Territory in which he says a terrible fire is now raging on Government lands, thirty miles from Boise City, in Boise county. The Secretary has directed the Government agent now in that vicinity to promptly render all necessary assistance. He is authorized to expend \$5,000 in employing men to subdue the fire.

Although the period from 1888 to 1890 is widely recognized as having been a significant climatic event by the residents of Nevada at the time, it should also be noted that similar events have been reported for 1870 and 1879. The *Eureka Weekly Sentinel* of July 14, 1888 reported:

Aaron Layton, an Eastern Nevada ranchman, says 1879 was a much drier year than the present. In 1879 no rain fell from February to October, and there was no hay to speak of along the Humboldt. There was another dry season nine years ago, and the Humboldt was not ankle deep in many places.

The earlier droughts may have been equally or even more severe in terms of the amount and seasonality of

precipitation, and may well reflect a decadal pattern of precipitation variability not uncharacteristic of general Great Basin weather patterns. But the period of 1888-1890 is remembered as having been severe throughout the Great Basin, because it happened when the livestock industry was becoming established. During the drought a decade earlier the conditions may have been as extreme, but the impact may not have been as severe because there weren't as many domestic animals on the range.

The fourth historic event that changed Great Basin fire regimes was introduction of the Euroamerican fire management practice of total fire suppression. We have found little information on the effects of fire suppression on shrub-grass landscapes.

**Prehistory of the Central Great Basin.** The central Great Basin is known for having a shorter and more ephemeral archaeological record than many of the surrounding areas, particularly the Bonneville and Lahontan Basins (cf. Thomas, 1982). Most central Great Basin archaeological sites are surface scatters of lithic debris that provide little material from which subsistence activities or their environmental impacts can be inferred. These sites do, however, provide evidence that people were present throughout most of the central Great Basin, including Newark Valley, by at least 5500 BP. The paucity of older sites could be due to loss of exposed artifacts to the elements. However, there are geological deposits older than 5500 years known from Gatecliff Shelter in the Monitor Range, Serendipity Cave in the Roberts Mountains, and Newark Cave in Newark Valley. In each of these sites the older deposits underlie artifact bearing strata, providing evidence that sediments were accumulating in cave and rockshelter sites but artifacts were not being deposited in them as in the overlying strata, making the inference more secure that people simply were not present in the central Great Basin during the early Holocene.

The ages of surface sites in the central Great Basin cannot be estimated by methods commonly used for buried sites, such as radiocarbon analysis, because they have no preserved organic materials associated with their artifact assemblages. For such sites, ages are estimated through comparison of projectile point types with the dated sequence first developed by Robert Heizer and his students at the University of California, Berkeley in the 1960s and revised by David H. Thomas in the 1980s. The dates for the phases described for the central Great Basin (Table 1) were derived from the clearly stratified and well-dated projectile point assemblage from Gatecliff Shelter in the

Monitor Range (Thomas, 1985). Those dates have been supplemented and supported by subsequent excavated materials from other archaeological sites.

**Table 1. Cultural chronology of the central Great Basin defined by Thomas (1985).**

Age	Phase	Series	Point Types
650 BP to present	Yankee Blade	Desert	Desert side-notched Cottonwood triangular
1450 to 650 BP	Underdown	Rosegate	Rosegate (Fremont)
3450 to 1450 BP	Reveille	Elko	Elko eared Elko corner-notched
4450 to 3450 BP	Devils Gate	Gatecliff	Gatecliff split stem Gatecliff contracting stem
5550 to 4550 BP	Clipper Gap	Triple T	Triple T concave base

The assemblages from which this chronology was derived generally support Thomas (1982) conclusion that prehistoric life in the central Great Basin differed little from the liveways documented in Julian Steward's (1938, 1941, 1955) ethnographies; the differences were primarily in the stylistic shapes of the projectile points not in resource or land use patterns. The prehistoric people of the Great Basin are frequently characterized as having a lifestyle closely adapted to the landscape. They were seasonally mobile desert foragers with low population numbers. Their lifestyle revolved around small family-based groups that moved seasonally to the areas where food resources occurred naturally, especially pinyon nuts after approximately 6000 BP. They gathered into larger village groups only in winter or to participate in communal antelope or rabbit hunts.

As they are described in ethnographies and interpreted from archaeological sites, the peoples of the Great Basin did not use fire to deliberately or actively manage their landscapes. But at least some groups did use fire as part of their subsistence activities, which most likely had an important effect on the local landscape. Rabbits, pronghorn, and deer were hunted communally, bringing together concentrations of people who were dispersed over much larger territories for the rest of the year. And at least in the southwestern Great Basin fire was used to drive the animals (Steward, 1933). It is, however, unclear how far this practice extended and in what kinds of vegetation

burning was practiced. In some areas hunting drives were accomplished simply by beating the brush and herding the animals into nets or corrals. Burning the shrub vegetation to drive animals would clear the area to allow greater productivity of forbes and grasses, but whether changing the nature of the dominant vegetation was the intended outcome or simply a side effect of other activities is also unclear.

Whether accomplished by burning or other methods of flushing and herding the animals, communal hunting of herbivorous animals in drives that depleted local populations may have had a less obvious affect on the fire regime of a particular valley. Although rabbit populations recover quickly, a communal antelope drive could deplete the pronghorn population to the point that it would require more than 12 years for their to recover adequately to allow another drive in the same valley (Steward, 1938:35). Dramatically reducing the population of a valley of its primary herbivore (especially in the case of pronghorn and deer) could have a significant impact on the local vegetation, particularly under drought conditions. Drives which deplete local populations also could have been done intentionally to take competitive pressure off plants the people used, increasing the production particularly of forbes and grasses.

The perseverance of cultural patterns that have been traced more than 5000 years into the past is a hallmark of Great Basin peoples that has attracted the attention of archaeologists for more than half a century (Jennings, 1957), and has been a source of controversy (cf. Heizer, 1956; Jennings, 1973). In contrast to the perceived continuity and stability of Great Basin cultural adaptations, there are a number of prehistoric adaptations to particular environments that differ significantly from the desert foragers described by Steward and the other 20<sup>th</sup> century ethnographers (cf. Aikens and Witherspoon, 1986).

It must be noted here, however, that ethnographic description of the Great Basin peoples were written in the early decades of the 20<sup>th</sup> century, after significant disruption of their cultural traditions as a result of conflict with Euroamericans, interaction with other Native American cultures, and environmental changes that occurred as a result of climate change, and the introduction of livestock grazing. The impact of the introduction of new human populations had repercussions that were not apparent to ethnographers collecting data on cultures that even they recognized as disappearing in the 20<sup>th</sup> century. The theoretical paradigm of cultural determinism, which embodies

the notion that the lifestyles of people were determined by the environment in which they lived (Steward, 1938), and under which much of the ethnographic data for the Great Basin were collected, inevitably led to the inference that the disrupted societies had always lived at the mercy of their environments.

Today there is ample evidence that ethnographic literature lacks descriptions for a number of aspects of the indigenous cultures of the Great Basin because of changes that occurred before ethnographic studies began. Only as knowledge of the archaeological record becomes more detailed, and theoretical paradigms from which to interpret archaeological data become more amenable to recognizing the changes that occurred, are the cultural changes of the last several thousand years of prehistory becoming known. Recent advances in theoretical approaches to archaeological data and the broadening of the archaeological database, particularly in the environmental and subsistence data, have revealed that the last 5000 years of Great Basin prehistory included a number of very important changes in the relationship between people and their environments.

Among those phenomena not known at the time the ethnographies were written is a cultural phenomenon in the eastern Great Basin commonly referred to as the Fremont. The Fremont, whose sites date from about 1600 to 650 BP, have been described as "...more or less sedentary horticulturists who lived in scattered farmsteads and small villages" (Marwitt, 1986:161). The Fremont are relevant to this study because they represent the replacement of the indigenous desert foragers by a people practicing more specialized subsistence activities that allowed people to congregate in population concentrations for longer periods of time. In a number of respects the Fremont were not unlike the Euroamericans who settled in the Great Basin in the mid to late 19<sup>th</sup> century. The first Euroamericans to settle in the central Great Basin can also be characterized as more or less sedentary horticulturists who lived in scattered mining camps, farmsteads, and small towns that grew up around the mines. The Fremont were a society with technological skills that were more complex than those of the desert foragers. Those skills included horticulture, even irrigation in some areas, the ability to hunt game as large as bison without the aid of guns and horses, the manufacture of pottery (durable utensils that were not readily transportable in contrast to the basketry used by desert foragers), and an ability to exploit marsh resources more intensively than the desert foragers. Such skills provided the Fremont with the ability to intensify their use of local resources to the extent that they could remain in the same place throughout the seasons, at least for a few years at a time as opposed to routinely moving their residences with seasonal changes.

The primary identifying Fremont trait is thin-walled gray pottery, but they also had a distinctive basketry style, a distinctive style of moccasins, and a distinctive art style (Madsen, 1989:3, 9-11). These four diagnostic traits do not necessarily occur together in all sites identified as Fremont, instead Fremont is characterized more by variability than by a uniform occurrence of a diagnostic set of culture traits. Consequently, there is much disagreement among archaeologists regarding who the Fremont were, where they came from, or why they disappeared about 650-700 BP. Some researchers see the Fremont as a cultural development that resulted from diffusion of traits from the cultural groups of the Southwest (pithouses, masonry architecture, pottery, cultivation of domestic plants) with some actual migration of Southwestern people who brought the traits with them; some have argued that the Fremont were bison hunters from the Great Plains who migrated into the Great Basin and adopted Southwestern traits, and some see the Fremont as a strictly *in situ* development with its roots entirely in the local indigenous desert foragers who adopted some traits from the Southwest at various times and places. Whatever the actual origin(s) of the Fremont culture, this enigmatic archaeological representation of a group of people is best characterized by its flexibility and adaptability to a broad range of environmental conditions. They

...lived in many different kinds of environmental settings and were flexible enough to adapt to all of them. As a result, there was apparently a wide degree of variation in behavior and there is no one set of material remains resulting from that behavior which we can identify as Fremont. The Fremont seem to have ranged from full-time settled farmers to full-time mobile hunter-gatherers with everything in between (Madsen, 1989:24-25).

Although Madsen (1989) argued that any single Fremont individual could, and probably did, participate in more than one of the adaptations that have been labeled variants of the Fremont culture, identifiable temporal and spatial variability among Fremont sites has routinely led to sites within geographic regions being classified into variants of Fremont based on differences in such aspects of their culture as pottery styles, house styles, and subsistence resources. Again, this variability is not unlike the first Euroamericans: some were miners, some were farmers, some were ranchers, and some merchants. Although many individuals could, and did, engage in more than one lifestyle, they often formed groups that reflected their primary activities: mining camps, farmsteads of nuclear or small extended families, and settlements for merchants and others involved in some sort of commerce. The population density and particular activities that occurred at any particular place depended on the resources of that area just as

mining camps occurred near ore deposits, farming and livestock raising activities occurred in valleys with amenable soils and water, and settlements grew up at crossroads where they were accessible to miners and farmers and where the local resources (water and gardens) would allow a denser population to remain sedentary.

Until recently the westernmost extent of Fremont culture was seen as generally following the Nevada state line: Ely and Elko are commonly cited markers (Madsen, 1986:3), the sites of Garrison and Danger Cave representing the major western manifestations of Fremont. The Garrison Site (Taylor, 1954) is the westernmost of the large sites of the Parowan variant of Fremont, and is the closest large Fremont site to Newark Valley. The Parowan variant of Fremont shows the most similarity to the Virgin Anasazi to the south. Parowan settlements consist of pit houses and coursed adobe storage structures. The larger sites occur in southern Utah while along the western edge of the Parowan Fremont area the settlements were smaller and may have been less permanent, with caves and rockshelters being used for hunting and gathering. Their economy was based largely on maize horticulture supplemented by hunting and gathering wild plant foods. The Great Salt Lake Fremont variant to the north extends into the Snake River Plain in south-central Idaho which may be the source of the Fremont people who left their traces in Newark Valley. In the Great Salt Lake Fremont

The usual Fremont pattern of mixed horticulture and foraging is replaced almost entirely by an economy based on the exploitation of wild flora and fauna, especially from marsh environments. Habitation sites...generally lack substantial dwellings...These sites were apparently occupied only seasonally when waterfowl were abundant. Sheltered sites...were also occupied by transient Fremont people as seasonal camps while harvesting seeds or hunting bison, antelope, and deer (Marwitt, 1986:167-168).

It now appears that Newark Valley was on the eastern periphery of the Fremont territory, and on the boundary between two variants - the Parowan variant to the south and the Great Salt Lake Fremont to the north. Although Fremont adaptations are routinely described as flexible and variable, each of the variants of Fremont is distinctive as being Fremont rather than desert forager by embodying a more specialized subsistence system than the desert foragers they replaced, whether it was horticultural, focused on marsh resources, or focused on large mammal hunting. It was those specializations in subsistence activities that allowed sedentary population concentrations. Being on the periphery of the Fremont cultural territory, we expect the Fremont of Newark Valley were sensitive to

changes in any aspect of the environment that would affect the resources that drew them to the area. Thus their responses to the effects of climate change, changes in fire regimes, and other environmental perturbations are expected to be more pronounced than those of desert foragers whose territories were larger broader, tenure on the landscape was longer, and use of resources was more generalized. In fact, as they did throughout their territory, the Fremont disappeared within approximately a millennium of their appearance, disappearing before Euroamericans arrived in the Great Basin. But descendants of the desert foragers remain today, maintaining what is possible of their a boriginal lifestyles and adopting Euroamerican traits as necessary.

Because the Fremont were gone before the historic period, there is no direct documentation that they used fire as a land management tool. It is clear that fire had a similar impact on structures of the Fremont that it did on Euroamerican structures, many burned to the ground. Given that, like their Euroamerican counterparts, Fremont structures had highly flammable roofs and interior firehearths, there is no way to determine whether the fires were accidental or deliberately set.

The goals of maintaining sustained yield and/or pristine landscape are not necessarily alternate or mutually exclusive objectives of managing Great Basin valley landscapes. Human use of natural resources, along with the effects of climate, have affected the structure of Great Basin landscapes for millennia. We are only beginning to be able to identify the role people have played in structuring landscapes, but it is becoming clear that they have been a significant part of Great Basin landscapes for much of the late Quaternary period. Recognizing the contributions of both climate and anthropogenic use of resources in structuring past landscapes at various times in the past will provide a baseline for preserving natural, if not necessarily pristine, landscapes that can be useful in designing fire management programs for the benefit livestock range use, maintaining wildlife diversity, and reducing the costs of fire control. The following studies in Newark Valley were conducted to develop methodologies for assessing the effects of climate and people on wildland fire regimes in valley landscapes.