NEVADA PINYON-JUNIPER PARTNERSHIP

Lessons Learned Report

September 2021

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Table of Contents

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Introduction and Background of Nevada Pinyon-Juniper Partnership

In 2009, a group of professionals met in Ely, Nevada to express concern and frustration with current events related to pinyon-juniper (PJ) woodland management and to find a solution to their shared concerns. Ecologically speaking, the state of Nevada was experiencing catastrophic wildfires at a scale and magnitude of destruction that were unprecedented. Fires occurring in sagebrush steppe as well as PJ woodlands were largely driven by an increased fuel load associated in part with climate-driven expansion, long-term fire suppression activities, and infill of woody fuels in the absence of large-scale treatment or historic fire regimes. With the wide, invasive establishment of cheatgrass throughout Nevada and due to the size and severity of wildfire associated with elevated fuel loads, burned areas were not repopulating with perennial grasses and forbs as expected but rather cheatgrass, an annual exotic species. In some cases, cheatgrass was establishing in burned areas as large monocultures (or near-monocultures), which greatly hampered those areas' ability to re-establish with native and desirable grasses, forbs, and shrubs. At the same time, Nevada's economy was entering the Great Recession with significant job losses in all sectors due in part to the collapse in the housing market in urban areas of the state. The question was advanced: could harvest of overstocked and expanding pinyon and juniper (PJ) woodlands (biomass utilization) benefit the ecological challenges that everyone was facing?

The nexus between ecological concern and economic opportunity drove the establishment of the Nevada Pinyon-Juniper Partnership (Partnership) in 2010. This became an informal group of federal land managers (US Forest Service and Bureau of Land Management), state agencies (Nevada Department of Wildlife and Nevada Division of Forestry), local government (Eureka, Lincoln, and White Pine Counties), conservation districts (Nevada-Tahoe Conservation District and Eureka Conservation District), economic development organizations (USDA Rural Development and Lincoln County Regional Development Authority) and private industry. The concept was to address an ecological need: namely proactive treatment of expanding and infilling PJ woodlands with an economic opportunity: providing jobs. From the outset, the Partnership realized that economics could not dictate the pace, scale, or types of treatments. Rather, sustainable ecosystems needed to be the top priority with economic opportunity,

helping to achieve this goal where possible. To achieve this balance, science and monitoring had to play a prominent role. Ultimately the Partnership adopted the tag line, "Promoting proactive restoration based on sound science for stronger communities."

Initial Partnership efforts culminated in a major Pinyon and Juniper Summit held in Las Vegas in December of 2010. This summit brought together major stakeholders and policymakers from both the state and federal levels to discuss shared concerns, challenges, and opportunities for managing PJ Woodlands. Proceedings of the summit are contained on the Partnership website. In summary, attendees shared the concern about the increased size and severity of catastrophic wildfire and increasing prevalence and dominance of cheatgrass. There was some divergence in the proposed solution and the role that economic opportunities around biomass utilization could play. Some believed that the natural ecosystems didn't need human intervention to reach equilibrium while others believed that free market harvest and utilization of biomass was the only viable solution to get restoration done at a landscape scale. At that time, the main bottleneck federal agencies faced as it related to landscape-scale restoration of sagebrush steppe and PJ woodlands was a lack of dedicated funding. Specifically, agencies lacked the capacity to plan restoration treatments at a landscape scale within the framework of the National Environmental Policy Act (NEPA) and when they were able to do so, they were often challenged in courts. The main impediment to biomass utilization wasn't so much the lack of products or markets, rather a lack of products and markets that would pay the high cost of harvesting and handling trees that look more like shrubs that are predominately located in areas that lacked significant infrastructure. The other challenge identified during the 2010 Summit was how best to synchronize the ecological need for restoration with the economic reality of doing so at break-even economics in a state that really had no biomass or forest harvesting industry. The delicate balance to "right size" both treatment (how many acres to treat and how many trees to remove) and utilization (how much biomass per acre could be sustainably removed in an ecologically sound manner) is a hurdle that has yet to be cleared.

A second Summit was held in 2014, largely to check back with the experts who had presented in 2010. The consensus of the second summit was that federal land management agencies were doing a better job of working through the planning and NEPA bottleneck, but now funding the implementation of such projects had become the major impediment. As it related to biomass utilization, no economically viable product or market had emerged. As such, there was no sizable economic driver that could help up-scale or help with the cost of implementing treatments. The most significant progress that had been made from 2010-2014 was the federal agencies' ability to plan restoration treatment at a larger scale, rather than small individual treatments. Planning funding was more readily available based on the recognition that there was a fuels problem and a real need for restoration planning at a larger scale existed. In combination, more scientific research, data and pre and post project monitoring had taken place. Restoration plans were becoming more refined and grounded in a combination of scientific background and real-world implementation.

Rather than get in the way of the progress being made in the areas of science and monitoring and proactive restoration, the Partnership actively sought a US Forest Service Wood Innovations Grant to determine if products or markets could be developed to help bring economic forces to bear in terms of implementing and expanding restoration projects that were increasingly becoming NEPA cleared. The Partnership chose to focus on soil amendments with a particular focus on the potential for an emerging product in *biochar.*

The below sections attempt to capture the lessons learned by the Partnership since its founding in 2010, categorized by its three main pillars: science and monitoring, proactive treatment, and biomass utilization.

Advancements in Science and Monitoring

When the Partnership started in 2009, much of the applied scientific knowledge around Pinyon and Juniper Management was well documented in the United States Geological Survey (USGS) Circular 1335: Pinon and Juniper Field Guide: Asking the Right Questions to Select Appropriate Management Actions (Tausch et al 2009 USGS Circular 1335, Final Report Link #1). That publication was developed in partnership with the US Department of the Interior, Joint Fire Science Program and the SageSTEP project.

Since 2009, a plethora of additional studies have been completed, management tools developed and monitoring data from restoration plots and large-scale projects completed. The most comprehensive current publication on the knowledge garnered around these woodlands can be found in *The Ecology, History, Ecohydrology, and Management of Pinyon and Juniper Woodlands in the Great Basin and Northern Colorado Plateau of the Western United States* (Miller et al 2019 GTR RMRS-GTR-402, Final Report Link #2). This is a General Technical Report (RMRS-GTR-403) published by the US Forest Service's Rocky Mountain Research Station. This synthesis describes a 20,000-year history of PJ woodlands and cites approximately 1,000 papers on the subjects it covers. The Rocky Mountain Research Station released an excellent summary of this document in its *Science You Can Use Bulletin for July/August 2021, Issue #49* (RMRS Science You Can Use Bulletin 2021, Final Report Link #3). This Partnership report cannot summarize the information contained in these two reports better than they do, nor will it attempt to. Rather, the Partnership would encourage readers to review these documents if ever there is a desire to learn more about the current state of knowledge on the PJ woodlands.

There are a handful of ongoing projects and efforts that should be noted specific to work in Nevada. The SageSTEP program continues to monitor, evaluate, and publish information on a series of pinyon and juniper sites throughout the Great Basin. Their work started prior to formation of the Partnership and continues today, providing invaluable information to managers and the public alike as it relates to "Science for Sagebrush Restoration." The Partnership encourages exploring their website for more information at: www.sagestep.org.

One of the more exciting projects that is cited and documented in the Miller et al. 2019 document cited above is the Porter Canyon Experimental Watershed. This field study site is located in the Desatoya Mountains of Central Nevada and has produced exceptional information relating to ecological and hydrological issues associated with PJ woodlands. Research has been conducted in partnership with the University of Nevada, Reno's College of Agriculture, Biotechnology and Natural Resources (UNR-CABNR), the USDA Agricultural Research Service, the Bureau of Land Management (BLM), and the Smith Creek Ranch. More information is available online at: Porter Canyon Experimental Watershed | Rangeland Ecology Lab | University of Nevada, Reno (unr.edu).

In addition to its work on the Porter Canyon Experimental Watershed, UNR-CABNR has also produced a series of products intended to inform land managers when making management decisions. These products have been developed in close partnership with the USDA Natural Resources Conservation Service (NRCS) and include State-and-Transition Models (STMs) and Disturbance Response Groups (DRGs) for various Ecological Site Descriptions (ESD). The STMs capture decades of research to describe (through graphics and text) the dynamic potential of various ecological sites and the states these sites can exhibit. The DRGs group ecological sites into similar associations allowing the application of STMs on a scaled-up basis. All of this information is organized by Major Land Resource Areas (MLRA) published online at: State and Transition modeling | Rangeland Ecology Lab | University of Nevada, Reno (unr.edu).

In addition to advanced knowledge of PJ woodland dynamics vegetation and ecohydrology, a growing body of information is now coming available as it relates to a variety of wildlife and specifically wildlife habitat and behavior responses to treatments. When the Partnership started in 2009, the best, readily available satellite imagery was based on Landsat information at a 30x30-meter resolution. The State of Nevada, through its Sagebrush Ecosystem Program and in coordination with the USGS has since mapped PJ woodlands across a large portion of the state at a one-meter resolution based on up-to-date imagery. The USGS has taken that one step further to develop predictive models to determine where treatments may most positively improve Sage-grouse habitat. More on this work can be found online at: Habitat Suitability Modeling and Work Products (nv.gov).

Another great source of information related to research and monitoring as it relates to sagebrush and PJ woodland restoration and wildlife is the NRCS's Sage Grouse Initiative. This program has documented a bevy of restoration projects as well as research and monitoring from projects that had an objective of improving wildlife habitat. While this information is largely associated with Sage-grouse, it includes information on other keys species such as songbirds. More information can be found online at: www.sagegrouseinitiative.com.

Lessons Learned in Science and Monitoring

The body of science and information that land managers have available to inform management decisions and design restoration treatments has increased exponentially since 2009. What's more exciting is just how readily available this information now is.

Curbing the enthusiasm of increased and more available information is the fact that managers are now making decisions in the face of unprecedented climate change. The existing body of information isn't always clear or in agreement as to the best management actions for a given scenario. This line from Miller et al. 2019, which leads Section 5 on "Restoration and Management" captures this situation well:

> *Some assume that managing rangelands for presettlement conditions can successfully maintain sustainability and biodiversity into the future. But this paradigm is challenged by several factors—a continually changing climate, new species introductions, and changing disturbance regimes.*

In the face of this challenge, three key lessons have emerged:

1. There likely is no perfect restoration treatment when it comes to PJ woodlands. Looking for one can create a "paralysis by analysis" scenario at a time when choosing the "no action alternative" favors catastrophic wildfire given the increasing fuel loads coupled with decreasing fuel moisture in the face or a warmer and drier climate. It has long been held that catastrophic wildfire in PJ woodlands is not a matter of "if" but a matter of "when", often with dire results. As such, treatments that seek to improve the overall resistance and resilience of a given treatment site based on site specific conditions, the best available science and real-world knowledge of previous treatment successes and failures remain the best course of action.
2. Knowing that there are no identified perfect restoration treatments, and in the face of ever-changing climatic and ecological dynamics, continued research and monitoring is of paramount importance. Federal land management agencies and research organizations have done a commendable job over the last decade, but a similar, ongoing level of research and data delivery must be maintained into the future to support management decisions.
3. Information sharing and critical analysis of restoration projects to inform future management decisions are more important than ever before. This is where partnerships amongst various entities and parties (government and non-government alike) become critical. Solutions to the challenge and dual threat of unprecedented fuel loads coupled with unprecedented climate change won't be found in the courtroom, rather through critical consideration of best available science, real-world information, experience, and continued monitoring.

Advancements in Restoration Treatments

When the Partnership originally formed in 2009, restoration of PJ woodlands and sagebrush steppe ecosystems was occurring. However, often these restoration treatments were small, perhaps a couple of hundred acres, and sometimes randomly distributed across the landscape. The Partnership was interested in "scaling up" treatments to better meet the magnitude of the problem. At the time, PJ woodlands were estimated to occupy over seven million acres across Nevada. In personal communications, Dr. Robin Tausch estimated that approximately 100,000 acres per year were crossing an ecological threshold from Phase 2 woodland to Phase 3 woodland where the lack of understory vegetation creates a woodland that is less resistant and resilient to fire. At the time, there really was not a good estimate for the number of acres of sagebrush that were experiencing encroachment where trees had not previously been part of the vegetative community. Several good models existed for getting treatments implemented.

One such model was being implemented by Eureka County. The County had actively partnered with private landowners, its local Conservation District, state agencies such as the Nevada Department of Wildlife, and non-profit organizations to pool funding to implement treatments on private lands. As of this report, nearly all private lands within the County with willing landowners have been treated where there were identified PJ woodlands outside of their proper or desired ecological state. It should be noted that the County had done a tremendous job of documenting the infill and expansion of PJ woodlands using historic and repeat photography (Eureka Co Map of Historic PJ Photos and GRSG Habitat, Final Report Link #4). This past summer, the County also completed a repeat photography project of treatment sites throughout the County (Eureka Co 2021 Repeat Photo Monitoring, Final Report Link #5). Additionally, the BLM's Battle Mountain District Office, recently approved the 3-Bars Landscape and Restoration Project as well as authorizing maintenance of historic treatments in the district that have been recolonized by trees. The County has also provided funding and approved contracts to maintain the treatments that they completed where young trees have begun to re-establish. There are other recent mechanisms in place through the BLM currently being used or available for use to treat PJ woodlands. These include Roadside Fuels Breaks and limited NEPA Categorical Exclusions for PJ treatments.

On the federal side, both the US Forest Service's Ely Ranger District and the BLM's Ely District have been models for planning, NEPA clearing, and implementing PJ treatments. Since the Partnership formed in 2009, the Ely Ranger District has NEPA-cleared nearly all areas where treatments in Phase 1 and early Phase 2 woodlands (primarily expansion woodlands) were identified to restore wildlife habitat. The district is now working with its local partners to design and implement treatments in more challenging sites. For instance, the district is beginning to assess the potential for prescribed fire in wilderness areas where limitations on mechanical removal exist. Another promising approach is the district's partnership with local tribes to develop treatments in late Phase 2 to Phase 3 woodlands that protect old growth

woodlands and promote pine nut production, a locally significant cultural aspect of the woodlands. The Ely BLM District was just beginning to implement its Resource Management Plan (RMP), which called for planning and development of restoration treatments at a watershed level. This model has proven to be most effective at assessing, planning and NEPA clearing large areas in a very strategic manner. It has resulted in the Ely District leading the state in terms of both NEPA-cleared acres as well as acres treated. This model has been used in other BLM Districts in Nevada, but typically on an area-by-area basis rather than a systematic approach by watershed. Some examples of these large-scale projects that have been planned, NEPA cleared and implemented (at least in part) include, but are not limited to:

- The Spruce Mountain Restoration Project, Elko BLM District, up to 10,000 acres of treatments within an 18,000-acre planning area;
- The Cave and Lake Valley Watershed Restoration Plan, Ely BLM District, up to 199,350 acres of treatments within a 583,832-acre planning area;
- The South Steptoe Valley Watershed Restoration Plan, Ely BLM District, up to 97,901 acres of treatments within a 201,522-acre planning area;
- The North Schell / Ward Mountain Restoration Project, Ely Ranger District, up to 55,000 acres of treatments within a 78,000-acre analysis area;
- The 3-Bars Ecosystem and Landscape Restoration Project, Battle Mountain BLM District, up to 127,000 acres of treatments within a 749,810-acre planning area;
- The Desatoya Mountains Habitat Resiliency, Health, and Restoration Project, Carson City BLM District, up to 32,705 acres of treatments within a 230,000-acre planning area; and
- The Pine Nut Land Health Project, Carson City BLM District, up to 24,564 acres of treatments within a 397,899-acre planning area.

The seven projects listed above represent over a half-million acres of treatment area that has been NEPA-cleared. While not all the restoration acres covered by these plans represent PJ treatments, a significant amount of this work is focused on such projects. It should also be noted that many of the listed projects represent work in Phase 1 and early Phase 2 woodlands and often don't represent the majority of the planning area. While these projects provide a great starting point for restoration efforts, there may be more work to do within the same planning areas in Phase 2 and Phase 3 woodland sites that require more intensive planning and implementation.

One of the primary drivers for focusing treatments in Phase 1 and early Phase 2 woodlands is the immediate habitat uplift they provide. Often Phase 1 and 2 sites are expansion woodlands that still contain significant understory that responds positively to tree removal with little additional effort. Funding, particularly around Greater Sage-grouse habitat restoration, has been readily available in the last decade for implementation of such projects in addition to

planning of such projects. However, as more and more of these areas are treated, there remains a need to address late Phase 2 and Phase 3 woodlands, and in particular, expansion woodlands.

Recent studies and information on PJ woodlands have begun to differentiate the difference between expansion woodlands (those that have generally established since European settlement) and persistent woodlands (those that were established prior to European settlement). The two woodland types have different evolutionary pathways and present different challenges for managers and resources for wildlife and people alike. One of the best short references on this matter is a position statement by the Intermountain Society of American Foresters entitled "Management of Pinyon-Juniper 'Woodland' Ecosystems" (Position of the ISAF, Final Report Link #6). In personal communications with Dr. Robin Tausch, retired Rangeland Scientist from the Rocky Mountain Research Station in Reno, Nevada, he suggests that Phases 2–3 persistent woodlands may be able to reach an equilibrium on their own where trees are spaced far enough apart to prevent a crown fire, while being spaced close enough together to suppress fire in the woodland understory. On the other hand, Phases 2-3 expansion woodlands have likely not reached such an equilibrium, resulting in a significant fuel load and fire danger that presents a serious threat to both the woodland itself and the very old growth trees that many regard so highly. At the same time, expansion woodlands in high elevation settings across Nevada have not only encroached upon old-growth PJ but also key tree species such a Quaking aspen and Mountain mahogany. Some treatments are beginning to focus on the restoration and conservation of old growth PJ, aspen and mahogany by removing PJ trees that have established in the last 150-200 years. However, these treatments unfortunately have not enjoyed the same dedicated funding stream as those with a more direct nexus to Greater Sage-grouse Habitat Restoration.

The needle on restoration of PJ woodlands at a landscape level has moved significantly in the past decade. However, much more work remains. The Partnership would view three main challenges to accomplishing the remaining work:

- Staffing levels and capacity funding available to federal land management agencies, namely the BLM and Forest Service, needs to be maintained or increased in order to continue data collection, planning and NEPA clearances.
- The same needs to happen in regard to maintaining and/or increasing capacity for contracting and implementation of restoration projects.
- Additional expertise and capacity are needed as project planning becomes more complex and/or if utilization of biomass is ever to become an effective tool at implementing restoration treatments.

Lessons Learned in Restoration Treatments

1. While treatments over the past decade haven't been perfect, they have been largely successful at achieving the planning objectives. As stated in the previous section, planning of future treatments will be best refined by best available science and monitoring of projects that have already been implemented.
2. Landscape level planning has proven to work, particularly when conducted in a systematic manner. The watershed planning approach implemented through the BLM Ely District Resource Management Plan has seemed to garner the best result, although the Ely Ranger District has also implemented a tremendous amount of work in the absence of a formal Forest Plan Amendment.
3. Dedicated funding for both planning, implementation and follow-up monitoring has greatly accelerated restoration where available. The significant increase in funding available for Sage-grouse related work has resulted in a similar significant increase in restoration where improvement of Sage-grouse habitat is one of the objectives. Similarly, increases in fuels management funding has allowed more treatments, but the focus is typically on reducing hazardous fuels and not necessarily on habitat or ecosystem restoration. One advantage that the Ely BLM and Forest Service Range District has is a dedicated fund for implementing restoration projects through the Southern Nevada Public Lands Management Act (SNPLMA). A similar dedicated fund and/or additional allocations from Congress would accelerate implementation, provided the agencies can increase capacity for contracting and project oversite.
4. Ecology continues to be more important than economics when planning restoration treatments. Where opportunities arise to encourage responsible biomass utilization, treatments should not be designed to maximize economic return. Rather, treatments should be designed to meet ecological goals and objectives and where biomass removal and utilization can help to meet those ecological outcomes, it should certainly be allowed and encouraged.
5. There is still a level of public opposition to restoration of PJ woodlands and sagebrush step by cutting and/or removing trees. While some public may benefit and have their opinions changed through education and outreach on the science, often there are strongly held core values that drive this position, and no amount of data or science will change this position. However, such positions need to be recognized and comments and feedback invited in the planning process. The fastest way to shut down proactive restoration is when projects result in poor ecological outcomes or negatively impact critical cultural or ecological resources.

Advancements in Biomass Utilization

In the early years of the Partnership, the most proven and promising large-scale biomass utilization option was development of combined heat and power biomass plants. However, several feasibility studies from Lincoln County (DRAFT A-Power Biomass Heat and Power Feasibility Study, Final Report Link #7) showed that the cost to harvest and haul biomass resulted in a sale price of power that was not competitive with other renewable energies, and solar in particular.

The Wood Innovations Grant (WIG) awarded to the Partnership was intended to develop products and/or markets to provide an economic outlet for biomass to encourage increased biomass utilization. At the time, several members of the Partnership had a real interest in studying biochar. The WIG focused particularly on soil amendments rather than biochar alone. Several small-scale demonstrations were completed in various parts of the state as described below.

Western Nevada

Initially the Partnership contracted with Genoa Tree, a smaller locally owned landscaping and composing company located in Minden, Nevada. The Forest Service's Bridgeport Field Office had a large-scale PJ treatment scheduled near the Sweetwater Summit and had committed to providing chips for composting at Genoa Tree. Shortly after the WIG was awarded, the planning process for that project was delayed indefinitely in large part due to local opposition by several indigenous tribes. This opposition was heightened when a previously approved treatment was mistakenly expanded into sensitive cultural areas adjacent to approved treatment areas (see Lesson 5 listed above). As such, the Partnership worked with the Nevada Division of Forestry's Biomass Utilization Program to seek out an alternate source of chips. Unfortunately, the only locally available source of chips was from a treatment in the Sierras where Jeffery pine and White fir were being removed as part of a wildland-urban interface project. This change in feedstock was authorized by the Forest Service and Genoa Tree was able to create both compost and biochar from the chips. Biochar was made in a stationary masonry block kiln that Genoa Tree constructed at their facility. While it worked well, it also cracked due to high heat during the initial batch. Shortly after Genoa Tree completed this composting project, they sold their operation. Both compost and biochar amended compost were provided to the Desert Farming Initiative operated by the UNR-CABNR Nevada Agricultural Experiment Station and the Prison Farm in Carson City operated by the Nevada Department of Corrections. While formal studies were not conducted, both entities reported that compost applications resulted in anticipated outcomes based on previous compost applications; however, the biochar amended compost did not seem to produce any significant advantages that would justify the additional cost of making the char. The Desert Farming Initiative study did note higher water retention in the biochar-amended product but also noted lower plant nutrient uptake. Some of the trials resulted in uneven results, likely due to the

coarse nature of the compost provided. A more robust demonstration was later completed in partnership with Full Circle Compost (see below section).

Another biomass project and potential utilization outlet located in Western Nevada is the 10-Megawatt Combined Heat and Power Plant located in Carson City. This mothballed facility is located immediately adjacent to the Northern Nevada Correctional Center and is on Department of Corrections land. This project was originally built utilizing Forest Service funding and was scheduled to provide both heat and power to the prison. However, a series of logistical problems and operational inefficiencies resulted in a shut down. While the Partnership never got directly involved in this project, some of the Partnership members do have a history with the project. A tour was set up some years ago where Department of Corrections indicated that they would be willing to facilitate operations by a private company but did not have an interest in purchasing heat or power from the plant. It seems that with a level of effort and cooperation, that this presently is an idle opportunity, not only for utilization of PJ biomass, but for biomass resulting from hazard fuel reductions in the Carson City and Lake Tahoe areas. Given its proximity to Full Circle Compost, it seems an ideal opportunity for a public (State of Nevada) – private (Full Circle Compost) partnership.

Eastern Nevada

Prior to the Partnership's formation, several utilization projects were developed or explored in Eastern Nevada:

- The introduction to this section mentioned Lincoln County's significant investigation into developing a combined heat and power facility there. The Lincoln County Regional Economic Development Authority has also explored the possibility of developing industrial wood pellets for export to overseas markets as well as development of advanced biofuel and polymer production. To date, only the combined heat and power project reached the point of a formal feasibility study.
- White Pine County developed what is believed to be the state's only successful and ongoing biomass utilization project based solely on PJ feedstocks. This is a fuel for schools' project that utilizes a small boiler to heat a local elementary school in Ely, Nevada. Given the small size of the project, it has been supplied with decades worth of PJ chips by the Ely BLM. Another project that was funded and in development prior to the Partnership's formation was a residential wood pellet facility in Ely. Anecdotally, this project was never fully implemented because the ash content of the PJ pellets was too high to meet a residential pellet standard. The Eastern Nevada Landscape Coalition (ENLC) partnered with the Nevada Division of Forestry Biomass Utilization Program to develop char from mobile metal kilns. While the demonstration project showed some early anecdotal success, the kilns and char process itself was not cost-effective. Also of note, several aquaponic and/or fish farming operations have explored the possibility of

locating in White Pine County. At least one had contemplated utilizing biomass fired boilers for power and heat; however, none of these projects have even come to fruition.

- Eureka County and the Eureka County Conservation District began looking for ways to utilize the biomass that had been created following implementation of their private land restoration treatments. They focused on pilot projects and demonstrations around biochar and various soil amendments in agricultural, reclamation, and mining applications. Documents summarizing the findings of this work from the University of Nevada Extension (The Potential Uses of Biochar - A Review, Final Report Attachment #9a; A Biochar Field Trial and Demo - Pyrolysis, Final Report Attachment #9b; A Biochar Field Trail and Demo – Effects of Biochar, Final Report Attachment #9c; and, The Economics of Biochar Production – A Review, Final Report Attachment #9d) were outputs of those efforts. Both studies showed promise in terms of the application of biochar in agricultural and reclamation applications; however, questions remained as to whether the benefit of biochar application could offset the cost of production.
- It should be noted that all of the above-listed communities also contain small-scale firewood companies that harvest and sell wood locally. Several efforts have been made to explore the possibility to scale-up firewood operations or even to develop a Cooperative in some of these communities. While there appears to be an existing local and semi-local market for firewood and an apparent increase in demand, none of the operators had ambitions of scaling up their operations.

Around the time the Partnership secured its WIG, Eastern Nevada Landscape Coalition partnered with Eureka County and some other Partnership entities to secure a NRCS Conservation Innovations Grant (CIG). The CIG was designed to study biochar applications in irrigated and non-irrigated settings in Diamond Valley. Diamond Valley contains hundreds of irrigation pivots that produce high-value alfalfa and grass hay. The problem is that the aquifer beneath Diamond Valley is severely overallocated. As such, there is a demand for products that can either increase crop production or decrease water usage. Given the current situation, some pivots may be forced to be decommissioned. As such, soil amendments that can help the transition from irrigated crops to non-irrigated crops without transitioning to non-desirable invasive weeds could be extremely important. Unfortunately, the lead investigators for the CIG project left their positions before the CIG research design could be implemented. This left Eureka County with a large pile of PJ chips that had been created in preparation for the CIG project.

Given that the Partnership was looking to develop biochar from a PJ source, and Eureka had a source of chips, a joint project emerged. Amaron Energy (Amaron) from Utah had been working with the Utah Biomass Resources Group to develop a mobile pyrolysis kiln that would produce both biochar and bio-oil end products. In fact, small demonstrations had been organized by both the Partnership and Eureka County. Amaron was in the process of

completing their first prototype production unit and needed a place to field test it. The Partnership was able to re-program a portion of the WIG grant to contract Amaron to produce up to 65 tons of biochar from the existing chips in Eureka County. The County was a gracious and ambitious host. Amaron mobilized their unit and began producing char. However, it wasn't long before logistical issues began to arise. The irregular shape of the chips, particularly the longer sticks that passed through the screening process, began causing problems with the feed systems. That in turn resulted in several blown motors and the need to order hard to find replacement parts. In addition, oil prices had begun to fall dramatically, and the bio-oil "co-product" became more of a liability when the refinery that had previously purchased the oil declined to take it anymore. After several months onsite, Amaron had to demobilize after producing about 11 tons of the desired 65 tons of biochar.

More recently, an opportunity to partner with Full Circle Compost arose. While Full Circle Compost is in Carson City, they were willing to haul an initial batch of PJ chips and Amaron-produced biochar from Eureka to its facility in Carson City. Both the chips and the biochar were incorporated into a series of products that was then returned to Eureka. Back-haul of additional chips and biochar was conducted to maximize the efficiency in hauling. The initial product was used as part of an Environmental Protection Agency (EPA) lead-contaminated soils remediation project to replace soils in yards in the town of Eureka. Additional products have been applied to alfalfa pivots and pivot corners to implement a basic study design like that originally contemplated in the CIG project. Results are still pending; however, Full Circle has been able to raise its exposure in the area. Initial feedback from Full Circle is that PJ chips may have more promise than PJ biochar for long-term incorporation into their existing product lines. However, developing a compost with PJ as the sole carbon source could be difficult given the nature of the wood itself. Full Circle is interested in continuing to explore the possibility of incorporating PJ chips into its overall compost mix that includes several dozen other feedstocks. They have noted that it would be difficult to do this in the absence of a tipping or handling fee, simply because of the handling and input costs associated with dealing with large volumes of material.

Lessons Learned in PJ Biomass Utilization

1. It remains extremely challenging to develop new products or markets from PJ biomass that are economically viable. This is particularly true given the low yield per acre of PJ treatments coupled with the long-haul distances associated with getting chips to a processing facility.
2. Appropriate feedstock volumes and security, along with appropriate long-term contracts remain a major hurdle. In Nevada, most PJ woodland is located on public lands. Given the long-term planning and NEPA timelines associated with large-scale restoration treatments, it is difficult to secure a long-term commitment that is needed to secure financing for capital-intensive biomass investments. Until recently, only 10-year

stewardship contracts were available through federal agencies. More economically favorable 20-year contracts are now available, but there are few on the private or agency side that have experience in setting up or administering such contracts.

3. For any biomass utilization project to work, the logistics must be sound from the start. Logistical challenges have been the undoing of at least two major utilization projects that the Partnership is aware of. In both cases, new technology and/or new operators resulted in initial inefficiencies that could not be overcome. As such, an existing technology or product developed from similar biomass (i.e., Red cedar found in the Midwest United States) may have a major advantage.
4. Mobile projects would appear to have a significant advantage over stationary projects. The major cost associated with biomass utilization in the PJ woodlands is harvesting and transportation. While harvesting costs can be mitigated to a point, the only way to significantly reduce transportation costs is to haul a finished product that weighs less and takes up less space than a green chip.
5. While traditional wood products (such as firewood or soil amendments) have an existing market, newer high-value products (such as advance polymers, biofuels, or even essential oils) may have an advantage. One way to overcome a high product cost is to develop a product that has a higher value. If there is a way of taking advantage of the constituents and components of PJ biomass (such as its unique chemical composition) to develop higher-value products, then a higher probability of a successful outcome is likely. Other emerging industries such as essential oils or composite wood products (i.e., cross-laminated timber, Trex, or particle board) may have a significant role to play if chemical extraction can be combined with utilization of the "pulp" or residual of the primary extraction process.
6. Co-products and co-processes may be critical. In the decade since the Partnership has been in existence, no one product or process has proven to be a "magic bullet" to overcome the challenge of producing a product that can be sold for more than it costs to make. It may be that a combination of products or processes could be more successful. For example, in California biomass plants produce biochar that is then sold as a secondary product.
7. Policy could significantly change the economic landscape for utilization. One specific example that the University of Nevada Extension pointed out as related to biochar is if a carbon market is ever established, it could significantly alter the value of biochar and possibly make it a viable stand-alone product. Similarly, subsidies for developing biomass-based energy or even removal of hazardous fuels from woodlands could be helpful.

Looking Ahead, Opportunities and Work to be Done

The most viable biomass opportunities in Nevada currently are expansion of existing markets and product lines, while taking advantage of existing infrastructure. Two such opportunities exist in Western Nevada.

The first is Full Circle Compost. Full Circle Compost has a strong product line and market; however, to this point they have not utilized very much PJ biomass. The primary reason is a lack of availability and transportation costs as compared to other feedstocks, such as residential yard waste and urban tree trimmings. The advantage of PJ biomass is that it is relatively uniform and free of urban waste and trash. Per the Partnership's demonstration trial, if markets expand in areas where PJ is being thinned, such as Eureka and finished product being shipped from Carson City can be coupled with a backhaul of chips, then the economics begin to work assuming harvest cost could be kept reasonable, and chips can be brought to a central load-out site. Another option could be development of a compost facility in Eureka, but that location may be limited by a lack of other resources necessary for compost ingredients.

The other existing opportunity is a mothballed 1-megawatt Combined Heat and Power (CHP) Plant located at the Northern Nevada Correctional Center in Carson City. This plant is located immediately adjacent to Full Circle Compost. Originally, the plant was installed to provide heat and power to the prison facility; however, operational, logistical and design constraints resulted in an inefficient plant that was ultimately shut down. Recent feasibility studies have shown that a significant investment would be required to get the plant operational and efficient. The Nevada Department of Corrections has indicated that it has no interest in running the plant or being a customer for heat or power, but they would be willing to arrange an outside party or company that had an interest in running the plant. That company may well be Full Circle Compost and its parent company, Terra Firma Organics (Terra Firma). Terra Firma has expanded its portfolio in recent years to include selling feedstock for composite building materials, those most recognizable being Trex. Terra Firma has indicated a need for onsite power and heat, which would allow it to become more of a biomass utilization hub. In such a scenario, diverse biomass coming to the site could be sorted and utilized in a variety of products. Clean, high-value feedstock could go into building materials, mid-grade feedstock could go into the CHP plant, and low-grade feedstock could go into compost. Such a multi-use system would maximize flexibility and provide economic stability, particularly given multiple product outputs across different markets. The other advantage that a Carson City location offers is the non-reliance on exclusive PJ feedstock. Residential yard and tree waste is readily available, as is forest residuals from the Sierra Nevada mountains, a multitude of nitrogen sources, and agricultural byproducts. PJ is available and accessible in the nearby Pine Nut and Virginia mountains, particularly for fuels projects that may require biomass removal such as wildland-urban interface areas in the Virginia Highlands or Smith Valley.

The other existing product and market that could be expanded nearly anywhere in PJ country is firewood. There is a strong demand for firewood in both rural and suburban Nevada, as well as surrounding states. While nearly every small town in Nevada has multiple family-run firewood operations, very few have attempted to establish a more substantial business model or co-ops. The biggest limitation to this product and market is the lack of labor and interest.

In terms of new opportunities, any new product or market will have a long road to work through the challenges of breaking into a new area with a lack of harvesting and handling skilled labor. However, there seems to be a few key characteristics that would make such a business more apt to succeed. These characteristics include:

- **Mobility and On-site Processing:** PJ is found largely in remote areas and harvest prescriptions and locations don't typically fit the model for a stationary facility. However, if there were a proven mobile process that didn't need significant inputs (i.e., power lines, gas service, water, etc.) that could establish a small footprint processing facility in the field, it would be a game changer. This would allow the processing to take place at or near the treatment area and limit transportation to a finished or partially processed product that would be more efficient to haul than would green chips that are both heavy and bulky.
- **Ability to Function on Multiple Feedstocks and Develop Multiple Products:** The certainty and flow of PJ biomass at scale may be difficult to obtain. This is where processes and products that can operate on multiple feedstocks have an advantage. If there is a disruption in the flow of PJ biomass, and the process can rely on another feedstock that is readily available, then there becomes more certainty. Biomass projects also tend to be highly capital intensive and therefore need longer time horizons to be economically feasible. Product costs, input costs and markets can swing dramatically in 10-year windows, let alone 20-year windows. However, if a biomass company is able to develop a portfolio of products and sell into a multitude of diverse markets, then it is more likely to survive a downturn in any one market.
- **High Value Products and Sound Logistics:** One possible reason that firewood hasn't been more popular as a PJ product may be that there isn't a lot of margins because firewood isn't a high value product. As such, any firewood company would need to have extremely sound logistics to maximize its profit margin. There may be more interest in PJ products if a higher end value existed. For instance, if PJ feedstock qualified for use in new composite building materials such as Trex. However, PJ feedstock has an inherent disadvantage given its physical and chemical nature. That being said, if those same characteristics were desirable for use in high value products, then the potential for success goes up tremendously. Two examples that have been encountered by the Partnership are:
    - The use of juniper (cedar) and pinyon to a lesser degree in essential oils.

- The use of green pinyon and juniper in development of high value bio-oils, polymers, and chemicals.

Obviously, the best chance for success is a company that can develop a high value end product, while at the same time implementing sound logistics in its harvesting and handling operations.

- **Like Scale for Ecology and Economics:** Perhaps the biggest hurdle the Partnership has faced in exploration of utilization of PJ biomass is right sizing the scale of ecological treatments with the economics of developing economically sound products. For instance, there probably isn't enough demand in firewood to keep up with the ecological need for treatment across Nevada. The inverse is true for products or industries that require treatment of tens of thousands of acres per year. Coupling the right flow of feedstock to match the ecological needs of the restoration treatments would result in the much sought-after win-win.

Policy Considerations, Challenges and Opportunities

Local Government

Many local governments (including conservation districts) in Nevada support proactive treatment, particularly where it results in hazardous fuel reduction or improvement of watershed function and wildlife habitat. While local governments can support treatments and biomass utilization through supportive policy, economic development programs, and funding, in some cases they often don't have authority to implement treatments at scale due to the majority of PJ woodlands being located on public lands managed by federal land management agencies. Local governments have been most successful in advancing treatments and biomass utilization in areas of the state where they have a good working relationship and open communications with their local BLM district or Forest Service Ranger district.

State Government

The State of Nevada has passed favorable policy resolutions through the State Legislature in 2013, Assembly Joint Resolution 3 (2013 NV Assembly Joint Resolution No. 3, Final Report Attachment #10a) and in 2021, Assembly Joint Resolution 2 (2021 NV Assembly Joint Resolution No. 2, Final Report Attachment #10b). SJR 3 spoke directly to the State's support for proactive management of PJ woodlands in coordination with local, state and tribal governments, as well as encouraging development of a biomass industry that could help support restoration treatments. AJR 4 spoke to the State's support for healthy watersheds and ecosystems.

Beyond favorable resolutions, the State hasn't passed policy specific to biomass energy generation or other forms of utilization. More generally, the State does have a favorable renewable energy portfolio standard, but biomass power generation has not proven cost competitive with other renewables, specifically geothermal and solar.

The State's Greater Sage-grouse Conservation Plan does set policy favorable to proactive treatment of PJ encroachment in Sage-grouse habitat, primarily by encouraging and incentivizing PJ removal in Phase 1 or 2 woodlands to mitigate the loss of habitat because of other anthropogenic development. Typically, these sorts of projects are not conducive to biomass utilization due to low tree densities.

Looking ahead, the State could incentivize biomass utilization through favorable policy or funding specific to the following:

- Incentivizing utilization of biomass from hazardous fuels reductions is something that has worked with mixed results in other states such as California where a more robust biomass industry is already established. Another California policy that has resulted in increased biomass utilization is a mandate to utilize compost or similar soil additives in projects completed by State agencies such as Cal Trans. Such policy and subsequent regulations/specifications would need to be carefully crafted so as not to flood markets with low value products. A more subtle approach may be incentivizing state agencies to utilize soil additives and products that are generated from local biomass waste or forest residuals.
- Project specific financial and technical support could be an arena where the state could encourage biomass utilization. The most ready-made specific project is re-starting the existing CHP Plant in Carson City. The most likely path to success with this project is a public (State) – private partnership that encourages a biomass "campus" with the existing industries already co-located at the site. The State may also be able to support such a venture by providing biomass feedstocks. The NDF biomass bin program was a successful model that was previously implemented in the Lake Tahoe Basin.
- Any state funding that could be made available to leverage federal funding that often requires a non-federal grant component would also be beneficial to both woodland restoration and biomass utilization.
- In recent years, the State of Nevada has focused on climate change policy. There could be a significant nexus between proactive woodland treatments that reduce fire risk and increase carbon sequestration as well as promotion of biomass products and markets that sequester carbon (i.e., biochar). The same case could be made for water conservation and use of soil amendments such as compost and/or aquifer recharge and spring restoration through selective, targeted woodland treatments.

Federal Government

Given the amount of federally managed public lands in Nevada (over 80%), any federal policy that influences woodland treatment or biomass utilization is significant. There are a host of federal policies and programs that have provided both a hurdle and an opportunity for biomass restoration. Some of the most critical experienced by the Partnership include:

- **NEPA**: NEPA compliance tends to be the most time intensive aspect of developing woodland restoration projects. From a utilization standpoint, long lead-time and uncertain outcomes influence financial decisions from businesses that may be interested in biomass utilization. The only way to reduce these factors is for NEPA analysis to encompass large acreages and to maintain a consistent pipeline of projects at various stages in the NEPA process which is directly related to the below section.
- **Land Management Plans**: BLM Resource Management Plans and Forest Service Forest Management Plans dictate management over large blocks of time (20 years in the case of BLM Resource Management Plans. However, many Resource Management Plans for Nevada BLM Districts haven't been updated for well over 20 years. The Forest Plan for the Humboldt-Toiyabe National Forest is very dated and pre-dates the merging of the Humboldt and Toiyabe Forests. The is an opportunity as these plans are updated to encourage NEPA planning at a land-scape level and to provide direction for biomass utilization where it meets an ecological need. Some of the newer BLM Resource Management Plans do just that. The best example may be the BLM's Ely District Management Plan, which encourages development of a biomass industry as well as enabling a systematic large-scale restoration planning effort on a watershed-by-watershed basis. This systematic approach has allowed the Ely District to plan restoration treatments of PJ woodlands and other key ecotypes at a scale that often exceeds 100,000 acres. This has resulted in a NEPA pipeline that includes projects that are complete and ready for implementation to those that are still in the assessment and pre-NEPA stage. This has resulted in much of the interest in biomass utilization focus in the Ely District, specifically in Lincoln and White Pine Counties.
- **Special Designations**: Special designations such as Conservation Areas, National Monuments, Wilderness Study Areas, Wilderness Areas, and Areas of Critical Environmental Concerns (ACEC) typically do not allow for PJ treatments that would include a biomass utilization component. In most instances, these areas tend to be located in steep terrain with limited access, so they aren't typically areas that would be viable from a utilization standpoint. However, many of these areas contain woodlands that are overstocked and have expanded into areas that were historically sagebrush dominated. There is still a need for ecological restoration, but with the limitation on the types of treatments that can be utilized.
- **Climate and Energy Policy**: Climate and energy policy at both the federal and state levels have greatly influenced the interest of biomass utilization in Nevada. During the Obama and Biden Administrations there tended to be a lot of interest around use of PJ biomass for biofuels as both Administrations sough home-grown alternatives to fossil fuels. This focal area waned during the Trump Administration as traditional fossil fuels flourished and oil prices lowered. However, the Trump Administration was able to extend Stewardship Contracting from a 10-year maximum to a 20-year maximum,

something that companies interested in the biomass industry had long advocated for. This sets up for a favorable biomass utilization climate in that increased NEPA-cleared acres are available, coupled with the ability to contract over a longer time frame, and driven by a desire for alternative fuels. As it relates to climate, the Biden Administration has thus far looked to significantly increase funding available for hazardous fuels treatments and baseline budgets for both the BLM and Forest Service. If more funding is made available, then increased implementation of restoration projects is a possibility if the BLM can staff-up to meet the contracting, monitoring and project management needs of such projects. The other specific policy items that could significantly increase the demand for a specific product, biochar, is the possible establishment of a state or federal carbon exchange. This one item could significantly increase demand for a single product, allowing it to move from uneconomical as a stand-alone product, to an economic stand-alone product.

- **Funding**: The short-term restoration funding prognosis appears favorable; however, since 2010, federal funding for BLM and Forest Service capacity (planning) and restoration projects has fluctuated. Where funding has been more consistent, for example, Eastern Nevada with access to the SNPLMA funding for restoration projects, more projects have been implemented on a more consistent basis. To expand NEPA throughput and implementation of restoration projects, more consistent funding will be required. Often this is difficult to do given federal budgeting challenges and cycles. The use of designated funding for restoration as highlighted by the SNPLMA example, is a potential long-term goal for increasing restoration projects. However, the BLM still needs in-house or contract capacity for project planning, contracting, and monitoring. This is one area where companies in the biomass utilization space may be able to contribute for a win-win private-public partnership.

Closing

Much has changed since the Partnership was formed in 2010 as it relates to management of PJ woodlands and utilization of biomass resulting from such treatments. What hasn't changed is the magnitude or the challenge, there are still millions of acres of overstocked and expansion woodlands in need of treatment, or the complexity of woodland restoration. While the collective pool of knowledge has greatly increased over the past decade, the new challenges and woodland/restoration project responses in the face of rapid climate continues to change woodland dynamics and our subsequent understanding of them.

More and larger scale restoration treatments are occurring now than in 2010, due in large part to a more concerted and in some cases systematic planning approach at a watershed scale. However, much of the treatments have focused in areas of Phase 1 and early Phase 2 woodlands where treatments are relatively easy and inexpensive. The buildup of fuels in late

Phase 2 and the transition into Phase 3, particularly for expansion woodlands, remains a growing challenge. This is complicated by a seemingly year-end fire cycle, where a wind driven event could result in a large catastrophic fire at any time during the year.

Utilization of PJ biomass has experienced an increased interest and investigation over the past decade, yet no one product or process has been able to overcome the collective challenges presented by the species' physical characteristics and geographic location. Even existing markets such as firewood have seemingly not been able to up-scale despite recent spikes in demand. That being said, it seems there has never been a better time for utilization given favorable regulations, forward-thinking NEPA clearances and additional interest in key products, particularly soil amendments and biofuels.

Ultimately for biomass utilization to work at scale will take the combination of forward-thinking resource managers and the ingenuity of private industry with a willingness to work at a scale and manner that puts the ecology of the woodlands as the top priority. Both the resource managers and industry leaders will have to be willing to take a risk as Nevada is essentially starting from ground zero in establishing a viable biomass utilization industry and/or market with PJ as a primary feedstock.

The biggest benefit the Partnership has offered over the past decade is its ability to assemble motivated and skilled professionals with a passion for improving the ecology and economics of their communities. These Partnerships and sharing of information will remain critical if the momentum built over the past decade is to continue into the decades to come.