Regional Forest and Fire Capacity Program

Demonstration Project Regional Priority Plan Section

NORTH COAST RESOURCE PARTNERSHIP

I. Title:

Title: Siskiyou County Fuel Reduction, Greenhouse Gas Reduction and Soil Health Amendment Demonstration Project

II. Abstract

The project demonstrated the creation of biochar by utilizing a Tigercat mobile 6050 carbonator to convert woody biomass generated from nineteen acres of a shaded fuel break and fuels reduction project. The biochar was distributed to five local ranches interested in using the biochar as soil amendment to increase water holding capacity, fertility and sequester carbon. The project introduced the concept of biochar and various applications and scales to the Scott Valley area.

III. Problem Statement/Question Addressed

Fuel management is needed greatly across the state and region. Pile burning or chipping are both commonly used to remove excess fuel from forests. Pile burning releases greenhouse gasses and creates a smoke hazard for local communities, is labor intensive and has some risk of escape. Chipping in these remote communities is often cost prohibitive because of the distances required to truck the chipped wood to a cogeneration plant. Cogeneration plants also release much of the carbon stored in the wood when the chips are burned. This project demonstrated and tested the economic feasibility of the creation of biochar on a commercial scale as a way to address healthy forest management, reduce carbon emissions and smoke, as well as sequester carbon. Biochar is a stable form of carbon that can be sequestered in the soil for decades, if not hundreds of years. In addition, biochar can improve soil health by increasing water holding capacity and fertility which could then reduce water use and fertilizer inputs. The mobile carbonator creates biochar locally for local use, connecting the need for fuel reduction in the uplands with the fertility of the agricultural lands in the valley bottoms.

IV. Project Goals and Objectives

- Goal 1: Reduce woody biomass from fuel reduction project into value-added biochar
  - Objectives: Consult and contract with Falk Forestry to operate the Tigercat 6050 carbonator for a two week demonstration to convert biomass to biochar
- Goal 2: Distribute biochar to agricultural producers for use as a soil amendment
  - Objectives: Survey agricultural producers about their interest in biochar. Provide landowners with information on best management practices for handling and use of biochar. Coordinate the distribution of biochar as it is produced in the two week period.
- Goal 3: Determine economic feasibility of carbonator technology with local markets and feedstocks
  - Objectives: Collect data and compile a cost-benefit analysis of the total cost of producing final product, water use and reclamation potential, conversion percentage of feedstock to biochar, and biochar quality.
- Goal 4: Host outreach workshop with Sonoma Ecology Center's Sonoma Biochar Initiative to introduce creation and use of biochar at multiple scales to the region.
  - Objectives: Develop public biochar workshop with the Sonoma Biochar Initiative to coincide with the operation of the carbonator.

V. Project location

Latitude: 41°30'55.51"N / 41.5154194

Longitude: 122°56'18.76"W / -122.9385444

VI. Overview of Work Completed

The Scott River Watershed Council initiated the project by developing agreements with its project partners, each of whom were responsible for different aspects of the project. Falk Forestry was contracted to operate the carbonator for a two-week period. Jefferson Resource Company (JRC) oversaw the permitting, thinning, and feedstock preparation. Quartz Valley Indian Reservation (QVIR) shared their previous experience with biochar production. Sonoma Ecology Center (SEC) provided background information on biochar and assisted with the demonstration day.

While the demonstration occurred on private land managed by the JRC, use of public funds triggered the need to demonstrate compliance with CEQA prior to the start of on the ground work. A Class 4 – Minor Alterations to Land exemption for operation of the carbonator and related work was noted by the County of Humboldt, acting as lead agency. A burn permit was obtained from CAL FIRE and shared with Siskiyou County Air Pollution Control District. The district determined an additional smoke management permit was not required. Both agencies were on site to observe the operation of the carbonator.

SRWC worked with SEC to amplify the benefits of their respective RFFC biochar demonstration projects. Together, they established complementary performance metrics and developed a Community Outreach Day in which three different biochar processes were shared with the public. SEC and Wilson Biochar Associates staff introduced the basic concepts of biochar including the structural components, benefits and uses, and how to make biochar from local feedstocks. Falk Forestry and Tigercat staff explained the carbonator mechanics and processes. The public was able to observe three different scales and methods for biochar creation: a conservation pile burn, Ring of Fire Kiln, and Tigercat 6050 carbonator. These methods were applicable to the participants which included farmers and ranchers, timber company representatives, heavy equipment operators, loggers, Registered Professional Foresters, small holding landowners, and other biochar producers. Representatives from local agencies also attended including CAL FIRE, Siskiyou Air Pollution Control District, and the USDA Natural Resources Conservation Service (NRCS). SRWC also participated in video production funded by NCRP during the demonstration to be shared with the region.

The demonstration site was prepared by JRC, who delivered the feedstocks and skidded the log piles to the landing where the carbonator was set up. Falk Forestry operated the carbonator for a total of 80 hours. The Project Manager collected data on the performance metrics developed in collaboration with SEC including biochar volume and run time. JRC provided metrics for the amount of feedstock consumed. Photos and video footage were taken before, during, and after including drone footage and a timelapse of the demonstration.

Throughout the demonstration, the Project Manager coordinated with the agricultural producers to receive the loads of biochar. A total of 216 cubic yards was delivered to five producers in the Scott Valley. SRWC worked with these agricultural producers to compost half of the biochar they received in order to conduct field trials through future funding that has since been secured. After the demonstration, SRWC worked with Wilson Biochar Associates to develop a biochar best practices guide that includes information on how to compost biochar prior to soil application. This guide was distributed to the SRWC mailing list, attendees of the Community Outreach Day and agricultural producers participating in the field trial.

VII. Budget

Grant funds awarded: $158,042 (158,040 expended)

Match funds committed: $74,307 (74,399 expended)

VIII. Methods

Preparation

The project fit into a larger fuel reduction and thinning project that was conducted on private land. The project took the existing thinned wood and turned it into biochar as an alternative to chipping that material and hauling it significant distances to a cogeneration plant.

In the spring and summer, wood was cut with a feller buncher and left to dry and cure over the summer months. The smaller piles were then placed in one large pile for easier access during biochar production. Additional piles were available as needed and were skidded into place. SRWC worked directly with Falk Forestry Inc. and JRC to assess the landing, fuel type, and work area needed to operate the carbonator. The road was rocked for access as wet clay soils would have made the project impossible during the operation season. The carbonator and the excavator were "walked in" and staged at the site. Prior to operation, weather forecasts were checked regularly to ensure significant rainfall had occurred and fire risk would be acceptably low. SRWC also acquired a burn permit from CAL FIRE and was in close communication with the Siskiyou County Air Pollution and Control District. A small settling pool was excavated and lined with rice straw bales. This captured any runoff from the machine as it was quenching and cooling the biochar.

Operation

To begin operation, a small fire is lit inside the carbonator. This fire continues to heat with the air curtains until it is able to sustain itself as additional feedstocks are added. The excavator was used to break up the feedstock and load it into the carbonator. Start up and cool down time was not included as run time each day. A water truck was staged nearby to provide additional water for quenching the biochar and, however unlikely, as insurance against an escaped ember causing an ignition outside the carbonator. A dump truck and a dump trailer were used to capture the biochar as it was being produced. Loads were delivered to agricultural producers throughout the run time. The four personnel required to operate the carbonator were sourced locally and from Falk Forestry, Inc. One individual ran the excavator preparing the feedstock and loading the carbonator. Two individuals managed the machine, quenched the biochar, and assisted with loading. A fourth individual operated the water tender, refilled the tank on the machine as needed, and delivered the biochar.

Data Collection

Data was collected during operation by Falk Forestry and verified by SRWC staff. Data collection methods were developed in collaboration with SEC prior to operation and included feedstock metrics, run time, and volume of biochar produced. Feed stock metrics included feedstock type, acres treated, method used, treatment cost per acre. Volume was tracked in yards as it was loaded into a measured dump truck and dump trailer. Several biochar samples were sent for analysis including biochar, discharge water, and fines. The five producers also began composting half of the biochar and samples of their compost were analyzed.

Demonstration and Outreach

The public demonstration took place on Day 3 of the operation. The Tigercat 6050 carbonator was in operation as well as a conservation burn and a Ring of Fire Kiln. Staff from Sonoma Ecology Center were on-site to provide background information about biochar. A representative from Tigercat was also on site as were Falk Forestry Inc operators. To adhere to Covid-19 protocols, the invite list was limited to 80 people with 37 attendees. Groups were staged throughout the day and social distancing was encouraged. Attendees included representatives from CAL FIRE, Siskiyou County Air Pollution Control District, Jefferson Resource Company, private timber companies, biochar businesses, the farming and ranching community, and Registered Professional Foresters. NCRP was able to send a videographer to help capture the demonstration and the different scales of biochar production. SRWC created a biochar use and application guide to provide information for end users. An economic feasibility report was also developed and will be distributed by NCRP and the SRWC mailing list, website and social media sites.

IX. Project Findings

The purpose of this project was to utilize innovative mobile carbonator technology to safely and efficiently produce value-added biochar for carbon sequestration and use as a soil health amendment. The project successfully enhanced fuel management efforts in the Scott Valley and introduced the concept of biochar to the community. The project enhanced the work that was being completed as part of a 1,297 acre fuel reduction and shaded fuel break funded by a California Climate Investments (CCI) grant located in the Patterson Creek drainage outside of Etna, California. The feedstock was predominantly Ponderosa Pine (*Pinus ponderosa*) at a low elevation site of 2,827 feet.

Pile burning was one management option for this site and is generally a cost-effective way to reduce biomass. However, piling and burning releases between 92% and 94% of the carbon in each slash pile to the atmosphere (Finkral et. al 2012). It also causes a smoke hazard for local communities especially on the valley floor. The project significantly reduced smoke and carbon released into the airshed. when compared to pile burning. Particulate matter was assessed visually by Air Quality Control Board staff on site. Particulate Matter emissions were not visible on-site during operation largely due to the air curtain, the high heat, and the efficiency of the carbonator. The pyrolysis process inside the carbonator produced very little smoke and contained the fire, thereby reducing risk of escape.

As part of the shaded fuelbreak project, a total of 19.6 bone dry tons per acre were harvested from 19 acres and staged for the biochar demonstration. The Tigercat 6050 carbonator was in operation for approximately 80 hours and in that time, reduced 373 bone dry tons of feedstock to 46.67 tons (93,340 lbs) of biochar. The biochar was approximately 13% of the bone dry tonnage.

The biochar produced during the project was sent for analysis to Control Labs in Watsonville, California. The initial analysis of the biochar showed a very low carbon content of 37.3%. Additional composite samples sent and were retested, and carbon content measured 50.8%. This further analysis shows that 50.8% carbon is a better representation of the carbon content as the first sample was likely not representative of the biochar as a whole but does indicate that there is some variability in the product being produced. Multiple composite samples taken throughout the biochar creation process might be of interest to better understand the overall carbon content and the heterogeneity of the biochar. These results showed that the biochar did meet the standards of International Biochar Initiative (IBI) Laboratory Tests for Certification Program for Class II biochar >30% carbon and <60% carbon(IBI Biochar Standards 2015). The lab analysis also showed there were not exceptionally high levels of concentrations of heavy metals. Given the lab-determined bulk density of 16 lbs/cubic foot (and assuming 50.8% organic carbon),

the project stored a total of 47,402.5 lbs of organic carbon as biochar. Generally, 1 lb of carbon is equal to 3.67 lbs of CO2. Our analysis shows that 173,967.17 lbs CO2 or 87 tons CO2 is stored as biochar generated through this project (US EIA). This does not account for recalcitrance in the soil. Typically, biochar has one to two orders of magnitude longer persistence than the biomass it is made from (UCANR). The Climate Action Reserve estimates recalcitrance at an assumed annual decay of 0.3% for biochar with H:Corg 0.44 = 70% for 100-year permanence period. It is expected that 70% of the carbon (121,777 lbs) will remain in the soil for 100 years. The Climate Action Reserve is also in the process of developing a Biochar Protocol that will provide guidance on how to quantify, monitor, report, and verify climate benefits from the production and use of biochar (Climate Action Reserve, 2021).

Biochar Analysis	
Moisture (time of analysis)	46.2 % wet wt.
Bulk Density	16.0 lb/cu ft
Organic Carbon	50.80%
Hydrogen/Carbon (H:C)	0.44
Total Ash	44.60%
Total Nitrogen	0.40%
pH value	8.45

SRWC and our partners learned about the logistics and operation of a Tigercat 6050 carbonator and the requirements to get the biochar to the end users. The use of the carbonator for this specific project had many built-in costs including the transportation and set up costs, as well as housing and amenities for employees. In our demonstration Falk Forestry Inc. brought their own excavator and operators but were able to source a local dump truck, water tender, and operators. For this 80-hour demonstration the production cost was $1635/hour. Costs could significantly be reduced if the carbonator was used for a longer period of time to amortize the transportation and set up costs and if local heavy equipment operators were trained to operate the carbonator. For example, if rental of the machines continued in our area for an additional 80-hour period with local labor the production rate would have been reduced to $666/hour. The rates include fuel costs for operation of the machinery and are more accurate when budgeting a longer-term carbonator operation. The total cost for preparing the feedstock and creating the biochar is estimated to be $847/hour.

This demonstration project provided many insights into the operation of the Tigercat Carbonator. The use of the Tigercat 6050 carbonator provided a solution to reduce excess forest fuel, sequester carbon, create a soil amendment, and reduce smoke emissions all on a forestry scale. However, there are a few economic barriers that need to be addressed to make it competitive with other methods of fuel reduction.

1.) The transportation costs for moving this equipment across the state is extremely expensive. This needs to be addressed to make this technology economically feasible. The carbonator needs to be run for many more hours in one area to amortize the transportation costs or more carbonators need to be available to operate in their region.

2.) The operation of the machine takes skilled operators and several of the employees working on this project had not operated the carbonator before. The conversion rate increased as the operators became more efficient. The project increased from 1.8 yards/hour to 5.15 yards per hour on the last day. If the project was able to run for longer, efficiency would have increased. Proper training of operators is

essential especially when operating on short time scales. Additionally, training and utilizing local operators would reduce labor and housing costs.

3.)The carbonator requires 1-2 hours of startup and cool down time. The carbonator requires many consecutive hours or run time to be efficient and operation days should be between 10 and 12 hours. This labor demand should be a consideration when hiring and planning operations.

4.)The carbonator can only be operated safely during the wet season in our region. Sparks and embers come out of the kiln as it is being loaded which is not a concern when there is significant ground moisture however it reduces the amount of operation hours in the year. This could make purchasing and paying for this expensive equipment not financially feasible.

The Tigercat 6050 carbonator is a viable tool for forest managers however external costs like transportation, skilled operators, run time, and seasonality all need to be considered when planning the purchase or operation. The benefits of potential carbon credits or selling the biochar could offset some of these costs. Also working over longer periods of time and potentially across the region could also make the operation more financially feasible. These issues are not insurmountable and should not be the limiting factor to using this technology.

X. Challenges Encountered

The operation of the carbonator went as planned. The project start date was delayed because of prolonged drought conditions but there was enough flexibility with the partners to operate the carbonator in early December. Planning considerations need to account for operation outside of fire season.

Covid-19 restrictions limited the amount of people that could be gathered in one place. To compensate for the smaller audience, NCRP provided a videographer to document the demonstration. SRWC also livestreamed the demonstration on their Facebook page.

The most expensive part of the operation was the mobilization of the machine. This cost was a significant portion of the budget as the machine had to be delivered from the coast. It would have been more effective to have the machine operating in the region for more time with more landowners. The move in and move out costs were a significant part of the budget. The size of feedstocks needed to be broken before going into the machine. This slowed the operation of the machine. Some time efficiencies could be saved by having the wood be precut to fit the fire box.

SRWC's forestry partners on the project were concerned with the efficiency of the machine when compared to chipping. If the biochar was being bought or subsidized through carbon credits, there may be more incentive to operate the machine. Carbon credits for biochar are currently being developed but they are not yet available.

XI. Recommendations for Application and Sharing with Others & Increasing the Pace and Scale of Forest Health

The Tigercat 6050 carbonator is a scaled-up tool for making biochar that can work on a forestry level scale of fuel reduction. However, it is important to consider that the operation of the carbonator can only occur outside of fire season. The carbonator is mobile and can go out to timber harvest or fuel reduction sites and operate in the field. This reduces the hauling costs of moving chips or logs and reduces the risks

associated with open pile burning. Distributing the biochar back into the forest can also provide carbon sequestration effects. Having a carbonator locally accessible to various landowners and projects would cut down on the expense of moving the equipment and make its use more cost-effective. For example, the carbonator could run behind a forest thinning project and could convert 2-5 acres of biomass to biochar per day. The carbonator is safe to operate in the winter months in our region and could be put to use on the coast or in a fixed protected location during the drier fire season. This coordination and collaboration would get the most run time on the equipment. Currently, there are only two Tigercat 6050 Carbonators in the state. One is privately owned and the other is for sale by Tigercat and is located in Redding.

There is a broad interest in biochar from around the region. Through our outreach, SRWC has also learned and promoted two new NRCS conservation practices that include the application and the creation of biochar. Both of these practices will help create more demand for the product and possibly the use of the small kilns or carbonator on larger projects. As the market and demand develops there may be more interest in using the carbonator for large scale biochar production. Access to biochar markets or carbon credits for the production and use of biochar could generate more interest and more widespread use.

XII. Project Benefits

Significance of Project Benefits

SRWC developed a Biochar Application and Use Guide to illustrate the benefits of using biochar in an agricultural setting. SRWC also provided an Economic Viability Report which includes the economic analysis of the project to help forestry professionals understand the costs and benefits of using this equipment over other types of fuel management tools.

The project demonstrated a conservation burn, Ring of Fire Kiln and Tigercat 6050 carbonator. These three methods illustrate three different scales of in the field biochar creation that can be used on fuel reduction projects. These three methods all reduce smoke and greenhouse gas production as well as reduce fuels which are potentially hazardous. The carbonator reduced 373 bone dry tons into 219 yards of biochar in 80 hours of run time. The biochar retained 50% organic carbon and will be applied to 7.5 acres of farmland for a future study.

The project also built partnerships with Kelpie Wilson at Wilson Biochar Associates, Sonoma Ecology Center, Falk Forestry, Jefferson Resource Company, Ecotrust Forest Management, NRCS local office staff, NRCS State Office, five local farmers and ranchers.

This project will also enhance public safety by creating safe on-site combustion that can efficiently manage large volumes of biomass without the escape risk that comes with open piling and burning. It also protects vulnerable populations that are sensitive to smoke inhalation by major reductions in noxious particulate matter, making fuel reduction safer for the community.

Unexpected Project Benefits

Additional funding was received through the NRCS Conservation Innovation Grant to field test biochar, composted biochar and compost in an agricultural setting.

Additional partnerships include the NRCS national Dynamic Soils Project. Two sites will be selected to be sampled as part of that project and results will inform the impacts of biochar over time on soil health and carbon sequestration.

XIII. Next Steps

SRWC's next steps are to test the biochar in the field at the five sites that received the biochar. In preparation, SRWC staff have been working with the producers to compost part of the biochar for field trials. These field trials have been funded through the NRCS Conservation Innovation Grant and will commence fall 2021 and run for three years and will test water holding capacity, plant productivity and carbon sequestration.

SRWC does not have plans to pursue carbonator operation at this time but is open to future partnerships and has shared experience and contacts with others throughout the region.

XIV. More Information

To learn more about this project, please contact Alexis Robertson (alexis@scottriver.org) and view the NCRP Demonstration Project Story Maps.

Climate Action Reserve: https://www.climateactionreserve.org/wp-content/uploads/2021/08/Biochar-Protocol-Kickoff-Webinar-081221.pdf

Finkral, Alex J.; Evans, Alexander M.; Sorensen, Christopher D.; Affleck, David L.R. 2012. Estimating consumption and remaining carbon in burned slash piles. Canadian Journal of Forest Research 42(9):1744-1749.: https://cdnsciencepub.com/doi/abs/10.1139/x2012-112#.UH2OFa5F-Wg

International Biochar Initiative (IBI) Standardized Product Definition and Product Testing Guidelines for Biochar That Is Used in Soil: https://www.biochar-international.org/wp-content/uploads/2018/04/IBI_Biochar_Standards_V2.1_Final.pdf

Scott River Watershed Council drone footage: https://www.scottriver.org/biochar

UCANR Biochar and Carbon Sequestration: https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=22224

US Energy Information Administration: https://www.eia.gov/tools/faqs/faq.php?id=82&t=11