WOODY BIOMASS PRODUCTION METHODS

By Kai Hoffman-Krull

Woody biomass ready for treatment in San Juan County. Photo: Carson Sprenger

There are many methods that San Juan County forest owners can use to remove woody biomass from their forest to increase fire resiliency, sequester carbon, improve wildlife habitat, and generate modest income. This handout goes over how to manufacture biochar, build habitat piles, produce firewood, use small poles, and purchase a wood boiler.

BIOCHAR

PREPARATION

1. Wood

Make sure your fuel is as dry as possible. Segregate your fuel by size – mixing large pieces of wood with much smaller fuel will result in the large pieces not being completely charred and the small material turning to ash.

2. Burn site

Before setting up the kiln, clear the area under and around it of burnable material. A lot of heat will be generated and duff will dry quickly. Avoid proximity to roots near the surface that may ignite and smolder underground. Avoid low-hanging boughs that could catch fire.

3. Kiln

Different sizes of biochar kilns. Photo: Steve Bensel

Find a metal cylinder with approximately equal height and diameter, such as 4-feet tall by 4-feet wide. The proportions do not need to be exact – a 55-gallon barrel will work well. Taller cylinders with smaller diameter tops will result in cooler burns (below 850 degrees F) that do not convert woody biomass to charcoal as efficiently.

PRODUCTION

1. Starting the fire

Make an intense fire using kindling and small sticks. Allow air to enter the kiln from the bottom to facilitate starting the fire. When fire is burning well, seal the bottom of the kiln with dirt so that no air enters from the bottom perimeter.

Creating a passage for air flow under a biochar kiln. Photo: Steve Bensel

2. Adding material

Add larger pieces (no bigger than 12 inches in diameter), gradually filling the cylinder with burning/burned coals. When the previous charge is black and beginning to show gray ash, it is time to add more fuel. Continue adding fuel until the kiln is full of char or you run out of fuel or time.

Adding woody biomass to a biochar kiln. Photo: Steve Bensel

As the level of charred wood rises in the cylinder, make sure that the lower level of the outside of the cylinder is cooler than the area of active burning, indicating that no oxygen is entering the kiln from below.

3. Reading the Fire

The color of the smoke coming from the kiln will give some indication of the temperature:

- White = steam (fire is too cool, add fuel more slowly)
- Yellow = methane (a very damaging greenhouse gas, fire is too cool and overwhelmed with too much fuel, do not add any more fuel until smoke turns clear)
- Blue = some volatile gases are not being burned (blue smoke is hard to avoid completely, but indicates that the temperature is still on the low side)
- Clear, nothing but heat waves = GOOD (this is what we are after; a hot, clean burn)

The ideal burn temperature is between 850 and 1,050 degrees F (450 and 550 C). Note that the smaller the kiln and the wetter the fuel, the harder it is to maintain the higher temperatures.

The fire on the left is ideal, burning clear with no smoke. The yellow smoke on the right indicates that the fire is too cool and producing dangerous methane gas. Photo: Steve Bensel

PUTTING THE FIRE OUT

When the cylinder is filled with charred wood, douse coals with sufficient water to quench the flames (for a 4-foot by 4-foot cylinder, 5 to 10 gallons should be adequate). Be careful not to get burned by the steam – use a hose or other system for adding water from a distance. After this step you can choose a method:

- *Lid Method*: Slide a fitted lid into the inside of the cylinder, so that the lid sits on top of the char, and seal the gap between the lid and the edge of the cylinder with soil. If steam is leaking the seal needs to be tightened.

  Once the cylinder has cooled off entirely (this takes 2 days), tip it over to retrieve the

biochar. Be very careful with fresh char, as it can hold heat for a surprisingly long time. If live coals are exposed to air, they will continue to burn. Make sure there is no heat in the char before transporting.

- *Dousing Method:* If there is plenty of water (80-100 gallons) available close to the kiln, you can douse the fire with some diligence. First, quench the flames with water and cool the cylinder by spraying the exterior with water. The kiln must then be tipped over, either by hand if it is a small kiln or by mechanical means (tractor or come-a-long) if larger. Spray the char with water while raking it around. Continue stirring and wetting the char while looking for hot spots. Any steam issuing from the pile indicates a hot spot. After an hour or two, return to the pile and spray and rake it again. It is highly recommended that the char be inspected at least once more before assuming that the fire is out and the char is safe to handle and transport.

The lid method (left) or the dousing method (right) are both ways to extinguish biochar fire. Photos: Steve Bensel

POST PROCESSING

Pulverizing charcoal into small pieces and dust creates higher amounts of surface area, maximizing the charcoal's effectiveness in the soil. In order to pulverize, make sure the charcoal is wet, as the dust can be harmful to your lungs. Place the charred coal on a tarp and crush it – for example, drive a tractor or car over it.

It is possible to incorporate any desired fertilizer at this point to soak into the biochar, which is also called "charging" the charcoal. These fertilizers should include nitrogen, phosphorus, and, ideally, active biological activity, such as that found in composted manures. Dry fertilizers, such as pelleted chicken manure, can be added during your pulverizing process. You will want to wet the charcoal while charging, but do not put it in standing water, as access to oxygen is key to keeping biological activity alive.

Additional methods for charging biochar is to use it as bedding material for animals or to add it to compost piles. Raw charcoal, without added nutrients, can absorb fertility from your soil and cause ill effects in the first year.

WILDLIFE HABITAT FEATURES

When restoring forest ecosystems to reduce fire risk, it is important not to remove too much dead wood. Trees can have a long life even after they are dead. Snags – standing dead trees also called "wildlife trees" – provide critical habitat for birds, small mammals, insects and other wildlife. Snags that fall into streams and rivers add important micro swells and pools that provide temporary resting grounds for fish and the insects they eat. As forest thinning occurs, it is important to leave a significant portion of the dead snags standing, as long as they are in safe areas that are not within falling distance of a home or outbuilding.

A habitat pile in Olympia, WA.
Photo: Matt Freeman-Gleason

HABITAT PILES

Habitat piles made from small poles, limbs, and brush can mimic some of the benefits of large snags and down wood, providing shelter for small mammals and birds such as rabbits, quail, turkeys, skunks, raccoons, and sparrows. In addition, these piles offer temporary cover from predators as prey travel between food sources. Piles are usually 10 feet in diameter and 6 feet high. When constructing these piles, there are several site considerations:

- Avoid the bottoms of drainage ways and low spots where standing water or flooding might reduce the usefulness of brush pile for upland wildlife species.
- Avoid placing brush piles in grasslands since the addition of vertical structure in these settings can be detrimental to many native grassland birds.
- Keep brush piles away from houses and lawns to avoid increasing fire risk and problems with nuisance wildlife like rats and mice.

Do not use materials that contain toxic substances like treated wood, tires, plastics, etc., as these toxins can harm wildlife and persist in the ecosystem.

To construct a habitat pile, start by building a base with poles that are 6 to 10 inches in diameter and 6 to 8 feet long. Place 4 to 10 poles on the ground parallel to one another, 8 to 12 inches apart. Place more poles of the same size perpendicularly across the top of the first set of poles. Other materials can be used for the base such as large rocks, stumps, or combinations of both. These large materials will serve to keep "tunnels" under the pile open after the brush is stacked on top. After the base is constructed, pile limbs and brush on top until the brush pile is 6 feet high. Start with larger limbs first and gradually add smaller sized limbs. Make the pile denser in the middle and looser near the edge. It may be necessary to add more limbs in years to come as the pile decomposes and settles. Planting vines and shrubs near the edge will add years to the pile's lifespan. For more information on building a successful habitat pile, visit https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1081685.pdf.

FIREWOOD

Firewood, the oldest fuel for home heat, can be produced with a variety of manufacturing methods, ranging from axes to industrial log splitters. The following section outlines the key techniques for axe and small log splitters, as those are the two most common methods forest landowners use.

AXE AND CHAINSAW

Firewood manufacturing begins with cutting logs into pieces that are typically 14 - 18 inches in length with a chainsaw or hand saw. If you are not familiar with chainsaw safety, please seek out personal education or a safety class before beginning. It is best to let these rounds cure in a covered stack for 6 to 12 months before splitting them. Cracks in the face of the round will illustrate that the piece is dry enough to split. When splitting, use these cracks as guides for where to place the axe head, as they indicate the natural splitting angle in the wood fiber. If there are numerous cracks, find the crack farthest from knots in the wood (locations where branches have been cut off), as splitting on top of a knot will make the log difficult to crack.

An axe used to split firewood. Photo: Duncan Toms, Flickr CC

When cutting wood with an axe, or splitting maul, it is important to remember to always keep your blade sharp, as dull axe heads can glance off a hard knot and slice into your leg. If the log is difficult to cut with an axe, you can place a metal wedge in a crack and hit it into the wood with a sledgehammer or maul.

LOG SPLITTERS

Log splitters can nearly process a cord of wood 10 times faster than it takes to by axe. Log splitters also allow you to split firewood from green or freshly cut logs, although the product must still cure for at least one year before use. For quantity production, hydraulic log splitters provide more cost-savings for production. Log splitters can range from $600 to $4,000, and require maintenance and a covered storage space.

A log splitter in use. Photo: Jinx McCombs, Flickr CC

Large industrial size processors, such as the Cord King Firewood Processer, can cost between $65,000 and $70,000 and produce an average of 2 cords per hour and loads logs with a hydraulic belt feed. In the San Juan Islands, Harvey Logging, LLC provides large-scale firewood cutting services through the use of their Cord King Firewood Processer.

Trucks or ordinary trailers can be used to haul logs or rounds out of the forest for use. If you are processing firewood in large quantities, a low-boy trailer is an ideal transport tool as it sits closer to the ground and make it easier to get wood on and off the trailer.

SMALL POLES

Poles are peeled logs that can be used for barns, decks, fences, and other forms of construction where round timber is desired. The quality of poles increases with more uniform diameter, denser growth rings and fewer knots. It also depends on species (different wood types are desired for different applications).

For fencing, cedar posts are ideal, as their natural resins resist rot in the ground. To increase their duration in the soil. Charring the outside of the end that will be sunk into the soil increases rot resistance, thus increasing their durability.

For home or building construction, Douglas fir poles provide the best density and strength for structural support. Understory fir trees that come down in forest thinning operations can provide the highest quality strength, as they often can be the same age as the overstory canopy but be smaller and denser due to lack of light.

A gazebo constructed from small poles thinned from San Juan County forests. Photo: NNRG

To create a pole, you must first cut the tree down and limb it. To remove the bark, you can either use a draw knife, a timber log peeler, or a hand-held log peeler:

- A draw knife is a blade with two handles that gives you the maximum leverage to peel bark by hand.
- A timber log peeler attaches to your chainsaw and carves off the bark as you hold the end of your bar against the tree.
- A hand held log peeler operates like a sander with a large stainless disk with teeth that easily removes the bark.

WOOD BOILER SYSTEMS

Wood boiler systems are a cutting-edge combustion technology that maximizes the energy and heat obtained from wood. Wood boilers can be scaled for either home, commercial, or community heating systems. While there are different designs, wood boilers tend to burn wood in a two-part process, burning wood chips in the primary chamber and capturing gases and wood particulates in a secondary combustion chamber where they are also converted into heat. This increases the efficiency of the burn and minimizes release of particulate matter into the atmosphere. Wood chips are a locally produced and renewable resource that creates economic opportunities while supporting forest health thinning. Cost projections usually find that modern wood boiler systems can be as efficient as natural gas, and can pay for themselves in as little as 3 years.

Most systems utilize "hog fuel," a coarse wood chip material that is produced directly from forest management and restoration activities. Hog fuel can be produced in a single pass through a large chipper/grinder and does not need additional processing. Home systems require smaller, drier wood (ideally 5% moisture) whereas community systems can utilize fresher, greener wood at 55% or less moisture content.

For more information on pricing a boiler from a local supplier, please contact Wisewood Energy at wisewoodenergy.com.

A home boiler system in Eastsound, WA. Photo: NNRG

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Northwest Natural Resource Group

To strengthen the ecological and economic vitality of Northwest forests and communities by connecting landowners with the knowledge, skills, and markets they need to steward their forests.

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