TECHNICAL PRODUCTS FROM SMALL DIAMETER TIMBER FOR HABITAT ENHANCEMENT AND WATERSHED RESTORATION

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ABSTRACT

An under-appreciated outlet for small diameter roundwood is in watershed restoration, environmental, and habitat enhancement programs. Over $2 billion is spent in North America on habitat enhancement and watershed restoration each year. Of that amount, our estimate is that approximately $300 million is spent on materials that could be made from small diameter timber. Products manufactured from forest thinnings and subsequently placed back in the watershed completes the watershed cycle, and at the same time provides income for forest landowners, woods workers in rural communities, and environmental restoration contractors. This presentation details a number of technical products that can be manufactured from small diameter timber for use in erosion control, watershed restoration, and habitat enhancement.

Keywords: utilization, manufacturing, environmental, smallwood

CONVERGENCE OF POLICY, PUBLIC INTEREST AND PRACTICALITY

Millions of forested acres are scheduled for thinning to achieve silvicultural goals, improve forest health, or reduce the risk of catastrophic wildfire. Increases in thinning of suppressed understory on public forests results in the felling of 200–1000 small diameter trees per acre. Silvicultural thinning of private lands yields 100–300 small diameter trees per acre. Fuel reduction thinning programs in forested areas and at the wildland-urban interface result in a mix of stem sizes and highly variable quality. Ongoing and planned thinning programs promise to yield vast quantities of smallwood. Whether the wood is left on the land to decay or is extracted for value-added uses is a matter of products, markets, and costs. Value-added extraction may provide additional revenues to the landowner to improve business sustainability and/or support treatment of additional land area.

At the present time, the cost of extraction and trucking smallwood to urban areas often exceeds the wood value for conventional uses such as biomass energy, pulp chips, and small saw-logs. In most cases, the thinning material is chopped and scattered in the woods. Economic development programs sponsored by federal, state, and local agencies are working to 1) develop value-added products that utilize smallwood; 2) reduce the cost of extraction and transport for thinning materials; and 3) reduce the cost of processing smallwood into marketable products. This paper focuses on an ongoing program by Forest Concepts, LLC to develop roundwood products for habitat enhancement and watershed restoration.

Public policy encourages active protection of natural resources including water quality and fish and wildlife habitat. Policy is implemented through regulation, grants, cost-share programs, and other incentives. Over $2 billion is spent in North America on habitat enhancement and watershed restoration each year. Of that amount, our estimate is that approximately $300 million is spent on materials that could be made from small diameter timber.

While public policy encourages environmental protection and enhancement, it does little today to encourage completing the watershed cycle by giving preference to use of materials from a watershed for restoration and protection within the watershed. For example, the dominant riparian and boundary fencing materials used today are steel wire and steel fence posts. Wood posts are only used at corners and occasional other locations. The cost advantage of steel would be lessened if more wood fence was built, and materials were from local forests. Another example is the use of rice straw rolls in Pacific Northwest forests for erosion control after wildfires and on forest road construction sites. Alternative smallwood erosion control products exist that utilize forest thinning materials and are manufactured by workers in traditionally timber dependent communities. Public policy needs to further encourage the utilization of wood from the watersheds for local projects.

Many watershed restoration and habitat enhancement grant programs specifically target projects that include citizen-volunteers and conservation crews. Public interest in improving the environment is at an all-time high—providing pressure on the political systems as well as legions of willing volunteers. Environmental youth corps and displaced worker programs provide able bodied and skilled environmental workforces. Timber-dependent communities need to diversify the employment base and transition to products from small diameter timber, such as is available from thinning programs. They have a willing workforce that desires forestry and forest products related employment.

Among the challenges facing watershed and habitat project managers is that traditional methods of stream and wetland restoration rely on large wood weighing thousands of pounds and heavy construction machinery. Project coordinators find that traditional post-and-barbed wire riparian fencing is difficult and dangerous to install with citizen-volunteers. Wetland conversion and improvement projects do not include structural habitat because the soils will not support equipment required to place stumps and large logs into bog areas.

So, we have vast quantities of smallwood available in the forests, legions of willing workers who will volunteer or work for living wages, and high interest in environmental restoration and protection. Forest Concepts, LLC was formed to bring these forces together through the development of innovative smallwood products that make water-

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shed restoration, environmental protection, and habitat enhancement practical for hand-crews and volunteer programs.

Small Wood Opportunities

Fencing

Wood fences have been used for millennia to control the behavior of wild and domestic animals. Prior to the invention of barbed wire in the mid-nineteenth century, wood and rock fences were common. Barbed wire, and now high tension wire, maintain their dominance in rural and wildland applications today.

There are a number of forces of change that may result in dramatic increases in roundwood fence demand.

1. Public and user pressure on landowners and agencies to build fences that are aesthetically more pleasing and friendly to wildlife and recreational users.
2. Agreement between the EPA and the wood treating industry to phase out the use of arsenic-based wood preservatives. An important implication of the change is that traditional wood posts that are embedded in the soil will have a shorter life.

The service life of untreated lodgepole pine posts in western Oregon was 3–5 years in a long-term study conducted by Oregon State University (Miller 1986). Another study in South Dakota with ponderosa pine posts concluded that service life is 11–13 years for untreated posts versus 30-45 years for treated posts (Markstrom and Gjovik 1992). Most post failures occur due to microbial action at the ground line. This should result in a shift toward fence designs that are naturally less affected by rot.

Buck and rail (a.k.a. rail and stile) fences (Fig. 1) provide an alternative that meets the above forces of change. They are already used in wildland and ranchland situations throughout the intermountain region. Their popularity stems from the facts: 1) that they are easily constructed from posts and poles collected on the property; 2) they can be fabricated with simple tools; and 3) no post holes need to be dug. They tend not to be used in other areas due to the relatively high cost of materials per unit length, and the cost of transporting posts and poles from forested areas to rangeland areas.

Figure 1.—Buck and rail fence near Challis, ID, excludes cattle from riparian area and spring creek.

Recently, buck and rail fences have seen a resurgence of use, particularly for riparian protection and cattle exclusion. The buck and rail fences are an ideal application for smallwood. The fences use poles that are 5–8 inches diameter for the bucks and poles that are 3–4 inches diameter for the rails. Rails are typically 12 feet or 21 feet long.

Another common roundwood fence type is the Virginia rail fence, (a.k.a. stacked rail fence). This fence type dates to the 17th century in North America (Martin 1892). Examples of it are seen across the Pacific Northwest on parklands (Fig. 2) and private properties. The Virginia fences are very easy to construct and use about the same amount of wood as four-rail buck and rail fences.

Figure 2.—Virginia stacked rail fence near Salmon, ID, provides safety barrier along creek in a park setting.

Across the western United States, public landowners are building new fences at a rate of several thousand miles per year. Increased emphasis on riparian corridor and sensitive areas protection is resulting in additional fence construction. A cooperative effort across agencies, forest contractors, and roundwood products firms is likely to result in market-share gains for all wood fences.

Forest Concepts is currently working with the Bureau of Land Management-Medford District staff to design an improved buck and rail fence that is even more wildlife friendly than current designs. The project, which is funded by the National Fire Plan, hopefully will result in increased utilization of smallwood for fence construction.

Wetlands

For many years landowners, biologists, engineers, and others removed large woody materials such as logs, rootwads, and stumps from wetlands, riparian areas, and floodplains of the western United States and Canada. Wood removal was primarily driven by the desire to convert land use from natural areas to agriculture and forestry. By the early 1970s scientists and engineers began to recognize the critical roles that wood plays in the life cycle of fish, amphibian, small mammal, and bird species. Removal of wood greatly decreases the carrying capacity of wetlands and streams for many of the species currently protected under the Endangered Species Act. In recent years, creation, restoration, and enhancement of wetlands has become a national priority.

The design of wetland rehabilitation projects is often very good at including plant and landscape features, but overlooks the need for woody structure. Factors, including limited access, inability to use machinery, and threat of habitat destruction by heavy equipment can play a role in limiting wood placement in wetland areas. Downed logs and stumps provide critical habitat as well as organic nurse-log substrate for wetland plant communities.

Forest Concepts worked with ecologists and wetland restoration specialists to develop a coarse woody debris product that can be manufactured from small diameter poles (Maschhoff and Dooley 2001). ELWd® coarse woody debris stump and nurse-log structures have been installed in wooded wetlands and wetland pond areas of Washington and Idaho (Fig. 3).

Figure 3.—Smallwood manufactured wetland habitat and nurse-log structures in the Davis wetland near Cascade, ID.

The recommended density for coarse woody debris (CWD) in forested wetlands is 10–20 downed logs and 5–10 stumps per acre. CWD fabricated from small wood can be filled with wood chips to provide amphibian, reptile, and small mammal habitat. The hollow logs can be filled with compost and planted with berries and other plants commonly associated with nurse logs. Stumps provide perches for songbirds and raptors, as well as basking sites for small mammals.

Uplands

Remnant large diameter CWD is rare in managed forestlands (Hayes et al. 1997). Hayes suggests that because old remnant down wood is most attractive to wildlife, damage and removal of large CWD should be minimized. Unfortunately, episodic fires and long-term forest management has eliminated much of the down woody material in Pacific Northwest forests. Prescribed burns and mechanical thinning further reduces the coarse woody debris levels. Production-based forest management practices of the Twentieth Century emphasized smaller diameter trees and complete harvest which virtually eliminates replenishment of large diameter CWD as older logs decay. It will be many decades before "new forestry" and "late successional reserve" management delivers natural large diameter coarse woody debris.

Limited research has been done to determine what features of CWD are important to select small mammals. It has been suggested that for American Martens and their prey, downed wood of a minimum of 15 inches in diameter is important (Fig. 4) (Bull and Blumton 1999).

Figure 4.—Hollow log small mammal habitat structures manufactured from small diameter poles collected from fireline debris. More than 100 small mammal structures were deployed by the USFS after the Twenty-five Mile Creek fire in 1999.

Diameter of down wood is important because it provides elevation above vegetation in the warm months and runways above snowdrifts in the winter. Small mammals can also tunnel under the edges of large diameter logs to create travelways and resting areas during winter months. In addition to the importance of diameter, length of down wood is important. Before a log begins to decay, the space along its edges serve as shelter during inclement weather and refuge from predators.

Large diameter wildlife habitat logs are easily constructed from smallwood (Dooley, Burks et al. 1999). Habitat structures were constructed from fireline debris to jump-start the small mammal population after the Twenty-mile Creek fire in the Wenatchee National Forest. First-year assessment data suggests that more than half the habitat logs were used by small mammals for runways, den space, and/or cache space. Colonization by fungi and ants will provide additional value over time.

In urban and suburban areas, woody features contribute essential backyard wildlife habitat for birds, small mammals and other critters. In Bend, Oregon, smallwood habitat structures have been associated with a tripling of the chipmunk population in the yard of one suburban home. In Federal Way, Washington naturescape smallwood structures have been used by squirrels and birds as perches for more than three years.

Streams

Depletion and loss of functional large woody debris from streams and rivers of the Pacific Northwest has been implicated as a contributor to the decline in salmonid populations. Salmon, bull trout, steelhead, and other fish are dependent on functional large woody debris (LWD) for many of their in-stream habitat needs. LWD provides cover and shelter from predators, stimulates the formation of pools and calm waters, and aids in gravel sorting to provide spawning beds. Natural restoration of historic wood abundance of one functional LWD per channel width and one wood complex per 7-10 channel widths will take decades

or centuries in highly degraded systems, including those that are just now receiving riparian zone plantings. An ecological engineering approach that is being widely practiced is to import and place functional LWD in streams as a bridging solution to provide habitat, hydraulic and geomorphic benefits in the short term. It is expected that placed LWD will decay to provide fine organic matter and otherwise blend into the natural environment as riparian protection and silvicultural solutions begin to take hold. Unfortunately, functional LWD is difficult to procure in the quantities required, and is very expensive to transport and place due to its weight.

Smallwood has been used to create instream habitat and bioengineering structures. Bundles of small poles with branches left intact have been added to streams for nearly a century to improve fish habitat (Tarzwell 1937). An engineered large woody debris structure has been developed for use in habitat and watershed restoration projects (Dooley and Paulson 1998). The ELWd® structure was designed to accommodate readily available wood materials, low-tech manufacturing methods, and work-crew-based installation (Fig. 5). Technical features include a high organic surface area, structural integrity in an all-round-wood product, length proportional to channel width and diameter proportional to flow depth. The ELWd® structures have now been installed to provide a number of different functionalities including: scour pool formation, complex cover features, bank protection, flow routing, sediment storage and high flow refuge. ELWd® structures are now proven to be an effective alternative to solid LWD that enables volunteer and conservation crews to install large amounts of functional LWD with only labor and hand tools.

Figure 5.—Stream habitat and bioengineering logs constructed from smallwood are unloaded at a project site near Enumclaw, WA.

Lakes and Ponds

Near-shore coarse woody debris is important habitat for fish and other aquatic organisms. Wood in lakes provides basking habitat for turtles, birds, and amphibians. Wood provides rearing habitat, cover and refuge for fish. Over the past centuries most wood has been removed from lake margins to provide inexpensive saw timber, improve aesthetics of developed areas or to improve the safety of recreational users. The extent of wood loss is readily apparent in a study of undeveloped lakes versus developed lakes (Christiansen et al. 1996). Christiansen found an average of over 850 logs per mile of shoreline compared to less than 100 logs per mile of shoreline in developed lakes with cabins along the shore.

Today, there are many lake and pond restoration programs that include the addition of woody habitat structures. The objectives for projects are typically to improve recreational fishing success or to enhance the habitat of a threatened or endangered species (Fig. 6). Forest Concepts worked with the Washington Department of Fish and Wildlife and the Woodland Park Zoo to create special basking structures for use by the Western Pond Turtle habitat program. The western pond turtle is dependent on large diameter floating logs for basking habitat and predator avoidance (Bash 1999).

Figure 6.—Floating raft with elliptical surface was constructed from untreated pole stock to provide basking habitat for turtles, amphibians and birds in a pond.

Other specialized structures have been designed from smallwood for improving fish habitat. Fish habitat structures can be sunk to the bottom of a lake or anchored upright to provide perches as well as submerged habitat.

Fire Rehabilitation - Erosion Control

Contour-felled logs are among the most effective, and most ecologically sound methods to trap and store sediment on wildland hillslopes (Robichaud 2000). In a study conducted by the U.S. Forest Service, contour-felled logs stored more than two metric tons of sediment per hectare (Robichaud 2000). Additionally, collection of sediment behind logs, rocks and other debris provides a rich germination and early-growth medium for reestablishment of vegetative cover. Effective cross-slope erosion control products are from 4–10 inches in diameter. While standing dead trees are available in some locations, many thousands of burned acres include steep slopes devoid of standing small diameter timber. In such locations, all erosion control materials must be imported to the site.

Erosion control structures constructed from small diameter poles (particularly those from fuel reduction projects) completes the watershed cycle by using co-products of forest management back in the watershed for restoration and enhancement uses (Fig. 7). Hillslope erosion control materials constructed of smallwood last longer and are more ecologically compatible than straw products. Wood products are inherently free of invasive weed seeds, and are colonized by microorganisms that are indigenous to the area.

Fire rehabilitation products such as the FlowCheck™ structure from Forest Concepts can be easily manufactured year-around and stockpiled at depots for deployment to wildfire sites when needed. Stockpiling of materials enables rapid installation by environmental crews before summer thunderstorms and fall rains arrive.

Figure 7.—FlowCheck™ hillslope erosion control materials are constructed from smallwood as an alternative to cross-felled trees and straw waddles.

ENVIRONMENTAL PRODUCTS MARKET DEVELOPMENT

Opportunity and Limitations

The national market for technical products from small diameter timber for habitat enhancement and watershed restoration is potentially greater than $300 million per year. We have shown in this paper a number of applications where smallwood may replace large woody materials, and applications where smallwood products enable market growth.

Forest Concepts has demonstrated that environmental products can be designed for high functionality, yet low capital manufacturing methods. Local manufacture of watershed restoration, habitat and erosion control products supports rural economies, provides revenues to landowners, and adds jobs. It makes good public policy to utilize materials from local forests to make value-added products for use back in the watershed.

Forest Concepts has found that there are a number of factors that limit the rate of adoption for innovative smallwood environmental products. Most notably they include:

- Agency compartmentalization and procurement policy that precludes cooperation between forest management programs and environmental/ habitat enhancement programs.
- Product evaluation and certification processes that preclude innovation.
- Continuing large log, industrial forest products firm mindset in timber towns. Few agencies and communities have moved beyond the learned dependence on large corporate employers to fully support entrepreneurial and enclave approaches to forest products business. Few forest landowners and entrepreneurs have invested in equipment and manufacturing systems appropriate for smallwood.

The problems that limit adoption of new smallwood products are primarily procedural and cultural. Procedural limitations can be corrected through enabling legislation and policymaking. Cultural problems can only be resolved over time, if at all, through systematic support for innovation, demonstration and entrepreneurship. As community members and leaders observe first-hand the utility of innovative products, economic impact of new jobs and investment, and success of entrepreneurial smallwood ventures they may embrace a new culture of smallwood and enclave-based enterprise.

Requirements for Success

The primary requirement for successfully completing the watershed cycle is to systematically remove obstacles to innovation and adoption. We believe that each major agency needs to formally designate advocates for smallwood product adoption across the agency. Advocates must have both charge and budget to support more than information distribution. Advocates must be able to sponsor workshops, underwrite demonstrations and facilitate collaborative evaluations. Advocates must also be able to work with others to address procurement policies, technical standards, and other procedural obstacles.

The second requirement is to develop mechanisms for cooperative marketing of smallwood products across agencies. An example would be the Forest Service and BLM jointly promoting the use of roundwood fencing to state and local highway agencies around the country.

The National Fire Plan and the USDA Small Business Innovative Research Program (SBIR) are doing much to support development of smallwood products, manufacturing methods and efficient smallwood harvest techniques. The fruits of ongoing investment will enable additional products to be manufactured at reasonable costs. Economic success for the enterprises that result will be dependent on how fast markets develop for their products. Thus, we are back to the first two requirements stated above.

CONCLUSIONS

Environmental products, including fencing, habitat enhancement, and erosion control can be readily produced from smallwood. Examples of a wide range of products have been presented. The potential market for smallwood environmental products may exceed $300 million in North America. However, market penetration is dependent on agency support and preference for completing the watershed cycle.

About Forest Concepts, LLC

Forest Concepts, LLC is a developer, manufacturer, and marketer of innovative products from small-diameter poles. The company was formed in 1998 by experienced forest industry professionals and natural resources technical specialists who believed that innovative product and market opportunities exist where small-diameter poles from sustainable forests is available. Manufacture of small-wood

products provides new markets for forest landowners, supports silvicultural and forest health thinning programs, and provides jobs for rural and timber-dependent communities. The Company's product family includes specialized round-wood structures for habitat enhancement, bioengineering water quality projects and watershed restoration (including post-wildfire watershed rehabilitation). Other products under development include long-strand erosion control materials, wildlife-friendly fencing, and structural landscape products. More information on the company's business and products are on the Company web site www.elwdsystems.com.

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