watersheds program

treeline

partnering for climate adapted forests

June 2022

Missed the April Treeline Newsletter? Click *here* to learn about how our partners are looking at issues surrounding upland forest health.

Interested in submitting an article? Reach out to Kayla Seaforth *kseaforth@b-e-f.org*

Multi-age black cottonwood along a side channel in the Yakima Basin. Photo Credit: Katrina Strathmann

Treeline aims to: Engage PNW restoration practitioners, nursery partners and researchers who work for or represent tribes, indigenous groups, non-profits, agencies, businesses and more. We gather, disseminate, and discuss information and knowledge across a broad region.

The Seedling Propagation Issue

This issue of Treeline focuses on forests and how federal, state, local, tribal and NGO agencies are propagating all manner of plant and mycorrhizal material, new ideas, and ways of relating to one another and the world we all share.

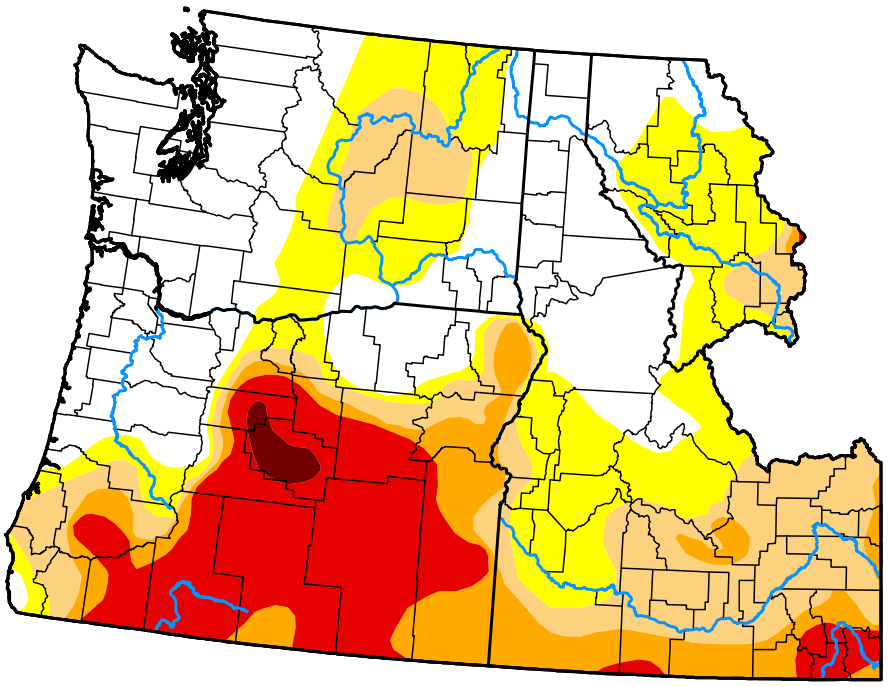
Drought Status Update for the Pacific Northwest

65%
of the region is in drought

16%
of the region is experiencing extreme to exceptional drought (D3-D4)

54
counties in the region have active emergency declarations related to drought, as of 6/16/22

Information provided by drought.gov and the National Interagency Coordination Center



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	35.35	64.65	42.86	25.40	15.28	0.69
Last Week *06-07-2022*	26.91	73.09	53.16	33.00	17.80	2.05
3 Months Ago *03-15-2022*	22.22	77.78	72.27	46.23	20.14	5.58
Start of Calendar Year *01-04-2022*	15.92	84.08	75.97	48.26	22.13	6.50
Start of Water Year *09-28-2021*	0.00	100.00	93.35	84.83	57.49	24.06
One Year Ago *06-15-2021*	5.33	94.67	76.61	49.36	19.89	1.95

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The U.S. Drought Monitor is jointly produced by the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. Map courtesy of NDMC.

Drought Status Unlikely to Change Across Much of the Region

- While there was some improvement this winter, precipitation over the winter and spring was not sufficient for recovery, especially in those areas hardest hit by drought in 2021. The increase in spring precipitation has also led to widespread flooding.
- In the Pacific Northwest and Northern Rockies, snowpack remains at many sites, and SWE (snow water equivalent) is above normal for this time of year due to persistent cool and wet conditions during April and May that caused a late SWE peak and slowed the snowmelt.
- Temperatures in the Pacific Northwest are predicted to be higher than normal July - September, while precipitation is predicted to be roughly equivalent to normal.
- The risk of outbreak of large, costly fires is expected to remain normal across the region in June, with the exception of central Oregon. In July, this elevated risk level will expand across most of southern Oregon and into Southwest Washington. In August, central Washington and more of southwest Oregon will also be at risk of the outbreak of large, costly fires.

Impacts

- Major Oregon reservoirs, especially those in the southern and eastern parts of the state, reflect low refill rates this year compared with historical conditions, with many at lower levels than on the same date (April 1) in 2021 (Figure 6) and well below median historical storage for this date. Four reservoirs in central Oregon, Wickiup, Prineville, Crescent Lake, and Ochoco, are at record low levels for this date.
- Impacts to agriculture, including rangelands, forage, crops, and livestock, will continue into spring and summer. Drought impacts submitted from Malheur County, Oregon, through the **Condition Monitoring Observer Reports** include dry soils resulting in blowing dust and loss of topsoil and plants that are not emerging from winter dormancy as they normally would in spring.

Stay up to date with the U.S. Drought Monitor

Seed Collection and Direct Seeding

Practices for a changing climate

By Kayla Seaforth

A 2021 survey of restoration practitioners indicated that 52% of respondents were interested in learning more about how varying times of seed harvest can promote climate resilient plant stock. 58% wanted to learn more about direct seeding. In this article, we dive into these concepts.

One way that seed collectors and growers promote genetic diversity in nursery grown native plant stock is by collecting seeds throughout a plant population's seed dispersal period. This practice increases the genetic diversity within a harvest and may help plants persist as phenology shifts in response to changing climate patterns. The use of genetically diverse and site appropriate plants becomes more imperative and challenging as we work with ecosystems that will look different in 20, 50 or 100 years due to anthropogenic climate change.

Temperature, light, and genetic variation influence flowering. A Doug fir common garden trial revealed that genotypes from warmer, drier locations flowering earlier than those from colder, wetter locations.

"Given what we don't know about how much phenological elasticity there is in a given species — collecting as much of the current availability in flowering/seed maturation timing as possible is what hopefully gives us a chance for plantings to continue to adapt to the increasing climatic shifts and maintain viable reproduction."

—Georgia Mitchell, Seed Collector

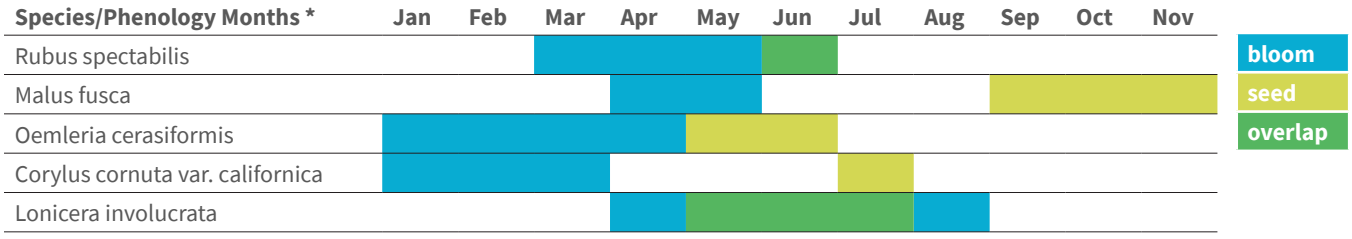
Bloom and seed maturation windows vary widely from plant to plant, and are also affected by climatic and geographic conditions. For example, salmonberry *(Rubus spectabilis)* seeds ripen over a relatively short period in early summer and are quickly desiccated or eaten by wildlife and people, so multiple collections may be impractical and may not capture as much variation in phenology as other species. In contrast, western crabapple *(Malus fusca)* ripens over a period of three months or more in the fall, so collection across a longer timespan of seed maturation for this species may be especially prudent.

Conditions can vary significantly at different elevations, even within a single watershed. While conservation-focused seed collection aims to capture the full range of genetic diversity within a target population, collection for climate resilience may mean intentional collection during time periods thought to more closely reflect future conditions. This may look like collecting seed from five sites within a 10 mile radius, all with different microsite characteristics (slope, aspect, shading, etc.), or may require traveling to higher elevation or more northerly sites within a plant's range as the season progresses. Above all, this practice requires a great deal of knowledge of the habits of individual species, and much observational skill and patience.

In seed production nurseries, practices may include varying harvest timing, or harvesting at early, mid and late

FIGURE 1: *Understanding flowering and seed set periods of native trees and shrub species is essential for collecting through their seed maturation windows. It is also important to have a sense of the historic trends in order to determine if and how climate shifts are affecting phenology.*

source: Burke Herbarium Image Collection (flowering timelines, based on Washington state averages https://biology.burke.washington.edu/herbarium/imagecollection.php), and Fourth Corner Nursery staff observation (seed ripening, focuses on patterns observed in NW Washington).



season peaks in seed maturity. This can be difficult in large scale operations where machinery is used to harvest seed crops, especially if the harvesting method damages plants in a way that prevents subsequent harvesting, but if provisions can be made to capture seeds that ripen at different times, the material sold to practitioners will represent a broader swath of the population's genetic diversity.

While widely accepted as a best practice, the reality of the nursery economy and pressure to grow more plants and species can make the practice of conducting multiple collections per season challenging. This can result in a narrower-than-ideal selection of seed used to grow large numbers of plants, reducing the overall diversity represented in the plants sold. Efforts to vary the timing and spatial range of seed collection has cost and capacity implications for seed collectors and nurseries that funders and purchasers may need to plan and budget for.

Direct Seeding

Another strategy that may bolster plant survival and drought resilience is direct seeding. This strategy requires different, sometimes more intensive site preparation than bare root planting and can limit weed control options later during the establishment period, so a careful weighing of site conditions, goals, benefits and costs is necessary.

Direct seeding differs from natural regeneration in that direct seeding approaches use seed that has been intentionally collected either on or offsite, rather than relying solely on natural seedling recruitment.

Direct seeding can be cost effective, reduce pest and pathogen transfer and can allow natural selection to exert pressure on plant populations at the restoration site.

Wendy and George Kral of Scholls Valley Native Nursery tested this strategy at a mitigation site in Washington County, Oregon where reed canary grass previously dominated. They prepped the site for two years to uncover bare ground and seeded a mix of spirea, swamp rose and chokecherry. Because they invested the time and upfront cost of controlling invasive reed canary grass before putting seed down, many were able to germinate and compete with the nonnative species on site.

What Could This Look Like in Practice?

A goal of many in the restoration economy is a future with numerous, well-trained seed collectors who collect at targeted, documented locations, with attention to sources that are thriving in microclimates or conditions that may mimic likely future conditions in a given location. Restoration practitioners will be able to choose among numerous stock types and approaches including direct seeding. These climate-smart approaches will be valued and supported by customers. communities and the public at large.

Just as diversity improves ecosystem resilience, an array of strategies will be essential in addressing likely future challenges in plant procurement and adapting to climate change. We need solutions at many scales, from small, innovative pilot projects to risk-informed larger scale measures.

FOR FURTHER READING, SEE TREELINE STORY FROM FEB 2021:

Article on the Seedlot Selection Tool by Dr. Dominique Bachelet

Earth Day Executive Action

In April, President Biden signed an **Executive Order** that authorized domestic support for mitigating climate change through enhanced forest stewardship and protection. The goals the White House outlined in the order are to:

1. Safeguard mature and old-growth forests on federal land
2. Strengthen reforestation partnerships across the country
3. Combat global deforestation
4. Enlist nature to address the climate crisis

While just one part of a complex puzzle, this order is a hopeful step toward federal support for some of the strategies needed most to respond to climate change. The order goes on to call out many strategies, including expanded nursery and seed collection capacity to meet the reforestation needs of the West following major forest fires.

Opportunities and Challenges to Planting a Sugar Pine Assisted Migration Seed Source Study in Southwest Oregon

By Scott Kolpak, SW Oregon Area Geneticist, Umpqua National Forest

Background

Given the recent increase in wildfire activity and current and projected changes in climate throughout the western US, there is a need to promote forest resiliency by planting trees adapted to current and future climates. Similar to forest managers utilizing species mixes to hedge against future climate uncertainty by adding more drought adapted tree species, such as pines, oaks, and incense-cedar to the historic species mix, within species assisted migration is one tool to help forests adapt to future climates. In this planting strategy, managers match the predicted future climate of a planting site with an off-site population (seed sources) currently growing and adapted to that climate.

In order to determine how this practice bears out on the landscape, field testing of these materials in seed source or assisted migration trials is needed to provide rigorous seed transfer guidelines. As we've seen in recent years, extreme events can have lasting impacts and it might take decades for deleterious climate mis-matches to show up. For instance, rare and irregular extreme weather events like extended subzero temperatures, late spring cold spells, and perhaps heat-domes are important drivers of adaptation.

Tiller Sugar Pine Assisted Migration Seed Source Study Design

Researchers used the Seedlot Selection Tool to identify four seed sources of sugar pine *(Pinus lambertiana)* that were climatically matched to current and future climates, and were blister-rust resistant. Each seed source was planted in five 1-acre blocks on April 27th, 2022 (Table 1, Figure 1). The 20-acre planting sits on a flat ridgetop at 4000' on Umpqua NFs, Tiller Ranger District (Figure 2). The north-facing site experienced a high-severity burn in the 2018 Columbus Fire.

TABLE 1: *Seed sources used in the Umpqua's Sugar Pine Assisted Migration Seed Source Study*

Seed Source	Elevation	Seed Origin	Climate period	Change in MCMT* (°C)
10044	2500'-4000'	Local seed source (control)	historic/local (MCMT=1.4 °C)	NA
10043	<2500'	Local seeds from lower elevation	early-century	+1.5
11054	2500'-4000'	Siskiyou National Forest—SE of experimental site	mid-century	+2.5
526	2500'-3000'	Eldorado National Forest—S of experimental site	late-century	+4.5

**Mean Coldest Month Temperature*

A planting crew member tucks sugar pine seedlings into the experimental planting site in the scar of the 2018 Columbus Fire. Photo Credit: Scott Kolpak

Challenges and Opportunities

Tree planting activities are always dynamic, with the need to make adjustments depending on changing weather and site conditions, and coordinating these with contract planters. The sugar pine AM trial had its share of challenges. After coordinating with North Umpqua District Silviculturists to complete site visits and a draft site layout, a warm weather rain event in January atop new snowfall produced multiple landslides that required us to move our site south to the Tiller Ranger District. Luckily, the large seed deployment zones of sugar pine (compared to Douglas-fir and Ponderosa Pine) permitted the climatically matching seed sources for the North Umpqua site to also be a good fit for the Tiller site. This was a relief because the seedlots had been growing in bareroot beds at the nursery for about 2 years. After picking among a couple possible sites on the Tiller RD, we rapidly completed a GIS layout of the planting blocks, and began the physical layout… walking amongst the burnt timber to install stakes at the block corners, and flagging the block boundaries to match the intended seed source color code.

Again, mother nature dropped 12-18 inches of snow on the experimental site during an unexpected early April storm. This proved to be an advantageous delay; it gave us time to locate surplus trees from the USFS R5 Nursery at Placerville, CA. The Eldorado NF seedlot gives us the opportunity to examine the effects of a blister rust resistant late-century seed source. A new District Planner was able to deliver five boxes of Eldorado trees to Tiller's tree cooler as he made his journey from his old position near Lake Tahoe.

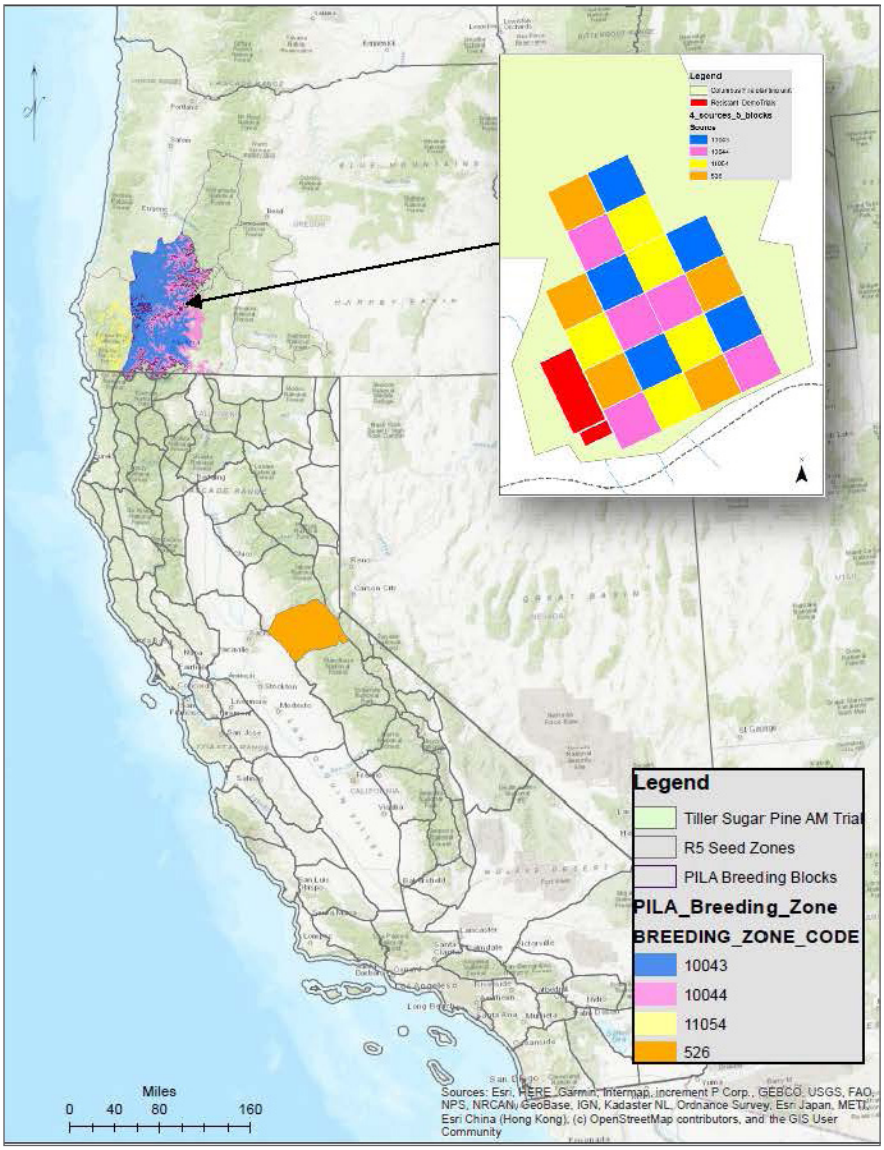


Figure 1: Context map and block design. Graphic created by Scott Kolpak

Future Plans

We will continue to monitor the site by establishing ¼ acre measuring plots so that we can track the relative growth and survival of the seed sources for a minimum of 15 years. In addition, the small neighboring visual demonstration plot will allow forest managers to compare the performance of seed sources planted in adjacent rows. The USFS's Dorena Genetic Resource Center is installing a blister rust resistance monitoring plot in upcoming years to help track the influence of disease on these seed sources. Data collection and analysis will be completed in coordination with USFS Geneticists, and PNW and PSW Station researchers and technicians through a new Washington Office Award, "The right seed in the right place: Assessing and achieving desired post-fire restoration outcomes in California, Oregon, and Washington." This program aims to work with local landowners to install a network of 20 – 30 assisted migration and advanced silviculture trials across the western US. We look forward to evaluating the results of this and other trials as we determine how, when and where to adapt forest management practices to climate change.

Cottonwood Regeneration

An Interview With Katrina Strathmann, Project Manager & Plant Ecologist, Mid-Columbia Fisheries Enhancement Group

This interview between BEF's Hannah Buehler and Katrina Strathmann originally ran in the April 2022 Floodplains by Design newsletter.

Can you explain the relationship between black cottonwood regeneration, hydrological flow patterns and salmon populations?

Cottonwood stand creation — ie. cottonwood forest regeneration — is linked directly to the hydrologic flow regime of a river. Several elements of the flow regime are critical: a flood flow with adequate power to create depositional areas; a spring freshet that is on its recessional limb during the time of cottonwood seed release, of adequate volume to wet up the depositional areas (seedling recruitment sites); and a flow recession rate that does not exceed the root growth rate of the cottonwood seedlings. Of course, seedlings that establish will be the ones that are not scoured out by future flood events in the first 1-2 years of life. Researchers **Jeff Braatne** and **John Stella** have elegant ways of explaining this complex flow-recruitment relationship. Without these factors coming together — the timing and shape of flow with the timing of seed release — new forest stands are not created and our current forests will age out.

One of the fascinating things about cottonwood regeneration and flow is that mature trees play a key role in creating the depositional areas that are the very sites where new seedlings are generated.

In terms of benefits for salmon, in our lowland, arid floodplains where cottonwood are the primary source of large wood, cottonwood forests play an irreplaceable role. Large wood in the river creates scouring, creating pools and channel complexity that allows for temperature stratification — which is important because salmonids require cool water. Large trees on the floodplain provide shade that keeps water temperatures low. Large wood in the river creates hiding places from predators, and also refugia from high velocities where fish swimming upstream can rest. Salmon also require clean, clear water, and the extensive roots of cottonwood and other woody riparian shrubs and trees slow natural bank erosion, and also create roughness in flood flows, slowing water and allowing sediments to drop out of the water column. Cottonwood leaves and debris also support the aquatic food web, providing a food supply for aquatic insects, which are a primary source of food for salmon.

Katrina Strathmann

Project Manager & Plant Ecologist, Mid-Columbia Fisheries Enhancement Group

Katrina Strathmann is a restoration ecologist with Mid-Columbia Fisheries Enhancement Group. Her current passion is riparian forest restoration and using new techniques that improve establishment or are effective over large floodplain areas. Katrina brings to her work over 23 years of experience managing ecological restoration projects in a wide variety of habitats, as well as landscape-scale inventories, vegetation monitoring, invasive plant and rare plant management, and native plant propagation. Katrina worked previously on ecological restoration for the Yakama Nation and the National Park Service. She received her M.S. in Biology from San Francisco State University, studying local and landscape influences on butterfly assemblages in mountain meadows of the Sierra Nevada mountains.

What are the key barriers to black cottonwood regeneration?

Cottonwood reproduces both sexually by seed and by vegetative reproduction or what I call clonal reproduction. As a sexual reproducer, the female catkins flower is fertilized, the fruit ripens, and then the fruits burst open releasing seeds that we know as cottonwood fluff. The seed is viable for 24 to 48 hours once it gets wet, so once it hits moist soil, it needs to be in the right spot.

In terms of clonal reproduction, cottonwood can resprout from stems or or roots; this is how existing stands are maintained, but clonal regeneration does not create new forest stands.

In the Kittitas reach of the Yakima River, the human-caused factors constraining cottonwood regeneration are channel confinement (from human development such as agriculture, residential use and infrastructure) and regulated flows on the river. If there is a levee preventing the river from being able to meander, there may be an opportunity if the agriculturist is not interested in farming anymore to look at opening up that floodplain and allowing the river to move and create those depositional areas.

The Yakima River is regulated, meaning that it has multiple dams and flows are released for agriculture, often at times and volumes that are quite different from an undammed flow regime. The change in flow regime also made it hard for seedlings to establish. On the Kittitas reach, many seedlings are underwater during the summer growing season, as the summer base flow increases to meet irrigation needs instead of dropping as snowmelt drops off. The Yakama Nation and Mid-Columbia Fisheries are identifying data gaps and modeling needed to be able to propose an environmental flow that could support more cottonwood regeneration, where the timing of flow releases are slightly tweaked. Because the Yakima Basin also supports a multi-billion dollar agricultural industry, any water management will need to work around the periphery of what works for agriculture — but we believe there are opportunities.

"Because the Yakima Basin also supports a multi-billion dollar agricultural industry, any water management will need to work around the periphery of what works for agriculture — but we believe there are opportunities."

How do cottonwood regeneration plantings look different from other riparian plantings?

Most of our forest restoration work currently focuses on creating shade, reducing erosion and creating roughness for surface flows. We have a lot of tools available to us — it is not all conventional planting with shovels. At the simplest level, if the problem with a cottonwood stand is herbivory and there's the potential for clonal regeneration, just reducing herbivory through fencing may allow a stand to rebound. In terms of planting, Mid-Columbia Fisheries has been using what we call a "deep-planting" technique, using an augur, a hydraulic ram or trenches to plant 5 ft tall saplings so that the root masses are placed up to 4 ft deep and in moist soil — so that irrigation isn't even necessary.

We are also starting to work on a new technique we learned about from Chris Hoag, called an "irrigated seed bed" where you use farming methods to create a recruitment site downwind of an existing stand of female cottonwoods. The seed bed needs to be within 2 m of groundwater — the maximum depth for cottonwood roots. Farming equipment is used to work up a seed bed that looks like it's ready for a corn crop, then wetting it up at seed release using irrigation. With Kittitas County Public Works, we are developing a pilot seedbed project to see how this technique works on a 17-acre parcel. We hope this is a way of creating new cottonwood forest stands at a far lower cost than hiring crews with shovels and water trucks.

You can also do this type of assisted stand creation through recontouring when earth-moving restoration activities create an open floodplain at the right elevation relative to groundwater. Mid-Columbia Fisheries and partners accidentally created these conditions on a recontoured floodplain at a restoration site on Reecer Creek, which flooded in its very first year at the time of cottonwood seed release. Now there is a 5 acre stand of Mackenzie willow and black cottonwood that was created without planting and irrigating. This type of reconouring could be done to intentionally create conditions for stand regeneration in restoration sites with the right configuration and elevations.

Much of Mid-Columbia Fisheries work on cottonwood forests has been supported by the Salmon Recovery Funding Board, which provided a grant that allowed us to complete an assessment of the condition and regeneration status of cottonwood forests along 30 miles of the Yakima River. The Department of Ecology's clean water grant program also funded outreach to landowners and identification of riparian forest restoration projects stemming from the SRFB assessment. This support has been critical for understanding the scope of the problem with forests and looking for solutions.

Have you observed the timing of seed dispersal in cottonwoods changing? What impact is that having on germination and establishment?

That's one thing we're really interested in learning more about. Mid-Columbia Fisheries is working with the Yakama Nation to start identifying the timing of seed release as related to air temperatures and degree-days. Then this data can be used to model seed release timing under different climate change scenarios. One fear is that peak seed release and the spring freshet flows may become decoupled.

How do large-scale restoration of river and floodplain processes help with the regeneration of cottonwood?

There is an incredible opportunity there. In fact, some of the restoration areas that we're proposing as potential opportunities for cottonwood regeneration are potential Floodplains by Design project sites. Largely, the process-based restoration projects support natural cottonwood regeneration. Levee setbacks are essentially removing or moving constraints so that the river has more room to move. So coupling that with modifying the managed flow, the regulated flow of the river, are the two things that we think could aid in the natural regeneration of cottonwood. That's where that's where this whole project is driving, is looking for where those opportunities exist in this 30-mile reach we're working to regenerate. As we work here, and down in the Wapato reach, we can look at the other major floodplains on the Yakima River.

"You can also do this type of assisted stand creation through recontouring when earth-moving restoration activities create an open floodplain at the right elevation relative to groundwater. Mid-Columbia Fisheries and partners accidentally created these conditions on a recontoured floodplain at a restoration site on Reecer Creek, which flooded in its very first year at the time of cottonwood seed release. Now there is a 5 acre stand of Mackenzie willow and black cottonwood that was created without planting and irrigating."

Cottonwoods Are Ecologically Valuable For Many Reasons:

- Preferred nesting tree for bald eagles
- Provide nesting for many birds, including woodpeckers, owls, herons and song birds
- Protect bees with antimicrobial resin
- Facilitate forest succession in floodplains
- Reduce sediment load and erosion in rivers
- Improve water quality
- Shade water and prevent water temperature from warming
- Enhance fish habitat
- Sequester carbon from the atmosphere
- Filter pollutants out of the air

Click here to learn more

Hydraulic ram mounted on an excavator installing 5-10 ft tall riparian plants on an 8 ft terrace bank along the upper Yakima River. Photo Credit: Katrina Strathmann

Root:Shoot Ratios in a Changing Climate

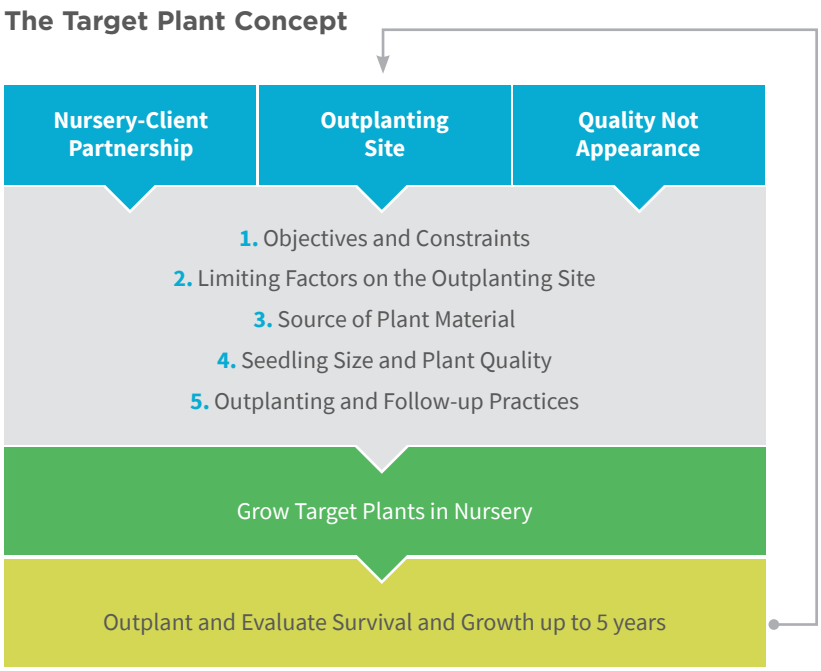
By Kayla Seaforth

A 2021 survey of restoration practitioners indicated that 56% of respondents were interested in learning more about root:shoot ratios and plant survival. Here, we look at this concept, and how it may factor into collaboration among growers and restoration practitioners.

The Root:Shoot ratio describes the amount of plant tissues that have supportive functions (root) relative to the amount of those that have growth functions (shoot), and is a proxy measurement for a seedling's above and below-ground performance, including photosynthesis, water and nutrient uptake. While standardized ratios can ensure quality plants, especially in large nursery contracts with multiple growers where millions of plants are sold and planted each season, some research has pointed to inconsistent utility of the specification when taken together with planting site characteristics, differences in species, and the nature of container vs. bare root stock types.

The implementation of root:shoot ratios has its basis in the Target Plant Concept (previously the Target Seedling Concept), which has gone through several iterations since it was developed in the first half of the 20th century. In addition to root:shoot ratio, other morphological characteristics including height and stem caliper and physiological characteristics like plant water potential, nutrient content and cold hardiness were prescribed to develop uniform seedlings for reforestation. These recommendations are rooted in a goal of promoting "fitness for purpose," that is, seedling metrics should be determined through collaboration between growers and outplanting site managers based on the goals of the site (reforestation, reclamation, afforestation, etc.). This concept served as a jumping off point for large scale nursery contract development in the Willamette Valley starting in the mid 2000s, and while they have undergone significant revisions, the blueprint developed nearly 75 years ago is still in use today.

FIGURE 1: *The target plant concept provides a framework to adapt growing and planting regimes to meet the needs of the outplanting site. It will be an important tool as sites change with the climate. Adapted from Landis, 2011.*



The Target Plant Concept is a framework for adaptive plant growth that relies upon regular communication between growers and practitioners, and regular monitoring of outplanting sites to inform future plant specifications. This framework tends to become both more important (in terms of potential losses if the feedback loop breaks down) and less detailed as scale increases due to the standardization that large scale operations prescribe. There is significant room for flexibility within the Target Plant Concept, as long as those engaged in the process have the time, willingness and resources to engage in the observation and dialogue necessary to inform beneficial change.

According to Forest Service Research Plant Physiologist and Tribal Nursery Specialist, Jeremy Pinto, "with larger contracts, that's where the communication piece comes into play. You're trying to leverage the strengths of the grower and the revegetation specialist. In building the [growing] targets, you could hone in on a lot

of different specifics in terms of optimizing plant material for a specific outplanting site, but as with anything you have to adjust with scale. If you think about the difference between local farming and mass produced farming it's the same thing."

He goes on to share how the Forest Service communicates with growers in the Coeur d'Alene, Idaho region, where collectively, nurseries produce 7.2 million seedlings per year for reforestation and research projects on federal lands. "The forest nursery in Coeur d'Alene has a client's meeting. Every year the Forest Service gets together with growers to talk about what's working and what isn't. This is really closing the Target Plant Concept loop in practice. It's human nature; we like to know how we're doing, how the puzzle pieces are fitting together."

As the restoration industry experiences and responds to climate change, some practitioners, researchers and growers are reexamining how they may adjust their expectations and standards. Naturally occurring root:shoot ratios vary from species to species, and as a response to site characteristics. A study of Douglas fir seedlings found that post-planting survival and root growth is largely dependent on Douglas-fir variety, stock type and site conditions. One finding of this study was a difference in root:shoot ratio after planting among coast and interior variety Douglas-fir, with coast varieties exhibiting reduced ratios and interior varieties showing higher root:shoot ratios. They also found that in bare root plants a high root:shoot ratio is negatively correlated with survivorship, and is positively correlated in container plants, which complicates the assumption that more roots are always better (Sheridan and Davis, 2021).

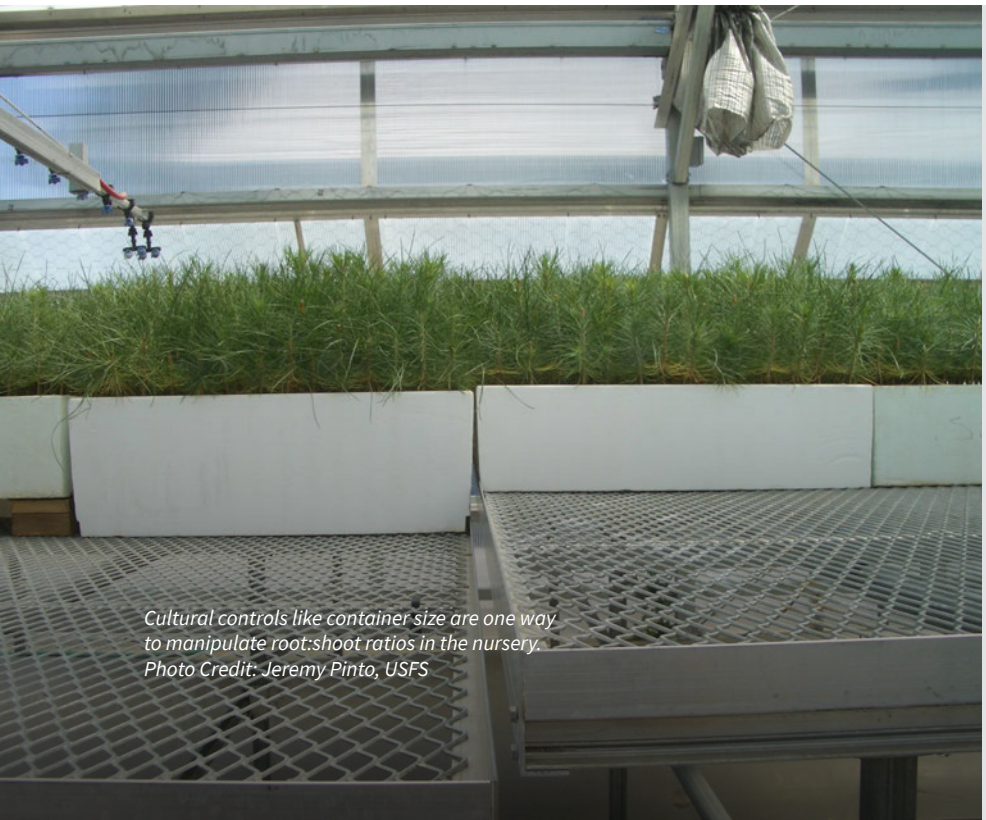
In addition to overall survival, conventional wisdom suggests that the larger a plant's root system is, the more drought tolerant it will be. However, the way that plants respond to environmental stressors varies greatly from species to species, and sometimes also varies between growing environments.

"When you're thinking about drought adaptation or dry planting scenarios, where you have high evapotranspiration demands, and the root system is what supplies the water, the thinking goes: the more roots we have, the more insurance that we have, but the way [plants] adapt and shift can be vastly different and understanding that is important. Some plants are capable of shifting and compensating much more rapidly than others.

There are certainly some population dynamics across species with climate and growing regimes. I had a student named Emily Rhoades, whose research will be published soon, looking at Wyoming big sagebrush from a broad regional distribution, all grown in a greenhouse under uniform propagation regimes, and the question was: "will these populations grow differently based on a uniform regime?" She had sagebrush from Idaho, Nevada, down into New Mexico. The root:shoot expressions in these greenhouse regimes ended up being completely opposite of what we would have expected; the [sagebrush] from New Mexico is a little more top heavy than the [sagebrush] from Idaho. The growing seasons are much different, with vastly different moisture regime cycles, which might affect the root expressions."

—Jeremy Pinto, USFS

The scale of the climate crisis, biodiversity loss and deforestation is enormous, and requires a mighty response. It is wise to remember though, in this herculean effort to protect and restore different forest systems, that one of the greatest tools that we can lean on is the simple act of talking to and learning from one another. It is tempting to prescribe uniform growing metrics so nurseries can standardize and scale their operations to meet this great need, but what might be better is an adaptive approach that emphasizes monitoring and communication. The truth is, we don't know what plant specs will perform best in future conditions, and nimbleness will be essential in responding to new information.



Cultural controls like container size are one way to manipulate root:shoot ratios in the nursery. Photo Credit: Jeremy Pinto, USFS

Works Cited

Dumroese RK, Landis TD, Pinto JR, Haase DL, Wilkinson KW, Davis AS (2016) Meeting forest restoration challenges: Using the target plant concept. Reforesta 1: 37-52.

Landis, Thomas D. 2011. The target plant concept—a history and brief overview. In: Riley, L. E.; Haase, D. L.; Pinto, J. R., tech. coords. National Proceedings: Forest and Conservation Nursery Associations - 2010. Proc. RMRS-P-65. Fort Collins, CO: USDA Forest Service, Rocky Mountain Research Station. p. 61-66.

Rose, R.; Haase, D.L. 1995. The Target Seedling Concept: Implementing a Program. In: Landis, T.D.; Cregg, B., tech. coords. National Proceedings, Forest and Conservation Nursery Associations. Gen. Tech. Rep. PNW-GTR-365. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: 124-130.

Sheridan, R.A.; Davis, A.S. Characterizing the Utility of the Root-to-Shoot Ratio in Douglas-Fir Seedling Production. Forests 2021, 12, 1745.

Houselessness and Natural Areas: Trauma-Informed Resources

By Hannah Buehler

As summer approaches, staff are increasingly in the field collecting seed, monitoring plants and working to reduce fire risk, while simultaneous seasonal pulses in the movement of unhoused people mean that land and water stewards may encounter people surviving outside in our region's parks and natural areas more frequently than in the colder months.

As the impacts of environmental, housing and public health crises continue to play out throughout the Pacific Northwest, many communities are struggling to meet the needs of the most vulnerable in their communities. In cities across the West coast, law enforcement often directs houseless people to seek shelter in parks, natural and riparian areas. Due to lack of public hygiene facilities and trash pick-up services that housed residents enjoy, fecal matter runs-off into bodies of water and general litter from camps often accumulates. Although this impact is likely no greater than **the environmental footprint of housed residents**, this pollution tends to be more visible, exacerbating neighborhood tensions, raising concern over the environmental impact of urban camping and further stigmatizing houseless community members.

Want to learn more about what water quality data can tell us about houselessness & the environment? Click here to learn more!

"I was a park ranger for a number of years with a high volume of engagement with unhoused folks. I was out there using tactical communication from state parks and law enforcement and often unconsciously triggering people. Certainly wearing my uniform didn't help. I made some good contacts too but the results weren't there. So on my own I started to do a wellness check with folks, asking things like "do you need water," asking "was it cold last night?" before trying to communicate information around park rules or requesting that people move. Making sure that contacts were healthy and building a level of care for individuals through a trauma informed lens. It works, and I saw it work immediately."

—Monty Woods, Metro Parks Operations Manager

These issues began to intersect with the work of Bonneville Environmental Foundation (BEF) in 2016 as land and water stewardship partners were reporting negative outcomes in engaging with people living in the natural areas they steward. Increasingly land and water stewards have found themselves, largely without preparation, on the frontlines of a social crisis. Environmental workers are in need of tools to foster positive relationships and interactions that help strengthen social networks with those living outside, **a foundational component in getting unhoused individuals connected to resources and services**.

BEF has partnered with **Trauma Informed Oregon**, **Right 2 Survive** and **Łush Kumtux Tumtum Consulting** to create online Trauma Informed Care modules to provide an understanding of the impact of trauma in engagement with unhoused individuals. Trauma-informed care provides a framework for land trust staff and natural area managers to help them navigate challenges in engagement with unhoused individuals and address potential impacts to protected lands with compassion and an eye towards long term solutions. You can learn more and take the online training **here**.

Trauma-informed approaches center meaningful relationship building with those living outside, as well as building connections with houseless advocates in order to better connect people to resources and services. Early outreach to community-based organizations that serve and represent houseless people can offer critical insight, support, and access to resources and increase capacity for outreach and engagement, and assist people in getting **access to the services** they need. Connections with houseless advocacy and service organizations can provide land stewards with people to call that can assist in providing services, understanding local systems and learning key background information to inform engagement. Building relationships with houseless community members and community-

Our friends at the **Resting Safe** project have created flyers on environmental hazards ranging from fire safety to mold and mildew prevention developed by and for houseless people, which you can find **here**.

based organizations that have strong relationships with the unhoused community takes time, intentionality and resources, but can be critical in yielding better long term outcomes and help with more effective and humane problem solving.

Steps to consider when seeking partnerships with advocacy organizations:

- Read about an organizations' work
- Reach out and see if there is a field staff member you can connect with
- Ask to tag along on an outreach visit
- If you connect with an advocate, ask if they can be a future resource
- Add key telephone numbers to field staff cell phones
- Lean on them with questions about effective communication, problem solving, and de-escalation, and be open to/invite them to set boundaries with their limited time
- Continue relationship building and note if you see any improvements

These efforts are merely small gestures, attempting to address critical challenge points of insufficient resources, neighborhood hostilities and environmental pollution and provide essential resources where there are enormous gaps. We encourage land and water managers to get creative, build partnerships with unhoused community members and engage them as co-conspirators in the stewardship of the natural areas we all love. If you'd like to sign up for updates and information on the online training modules, peer support discussion groups and more, please sign up for our mailing list **here**.

A man and his dog embrace at a Portland handwashing station. Photo Credit: Daniel Rushton

During the pandemic, BEF worked to establish hand washing stations at encampments in urban greenspaces. If hygiene or water quality impacts are of concern for your organization, think creatively about what facility access you may be able to provide. Want to read the full report on BEF's hygiene work? **Click here**.

Join us from **1:30-3:00pm PST on July 21st** for a peer support discussion with Trauma Informed Care facilitators around engaging with unhoused populations in parks and natural areas.

Please reach out to hbuehler@b-e-f.org for more information!

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

Partnering With Fungi to Steward Urban Natural Areas

By Toby Query, Portland Bureau of Environmental Services Ecologist

In the Treeline survey conducted last spring, the adaptation action respondents expressed the most interest in learning more about was pre-conditioning seedlings with mycorrhizae and beneficial bacteria; 68% of practitioners wanted to know more. This has been the subject of research for several decades and considering the mycorrhizal component of ecosystems has important implications for soil water holding capacity, infiltration capacity, hydraulic connectivity, erodibility and drought tolerance.

There is also interesting research that indicates plant-fungus communities are highly genetically controlled, reminding us that it is important to consider seed source and specific adaptations in ecological communities when deciding when and how to incorporate fungal inoculants.

Here, Portland Bureau of Environmental Services Ecologist Toby Query shares how he has been thinking about and incorporating local species of fungi into his restoration work:

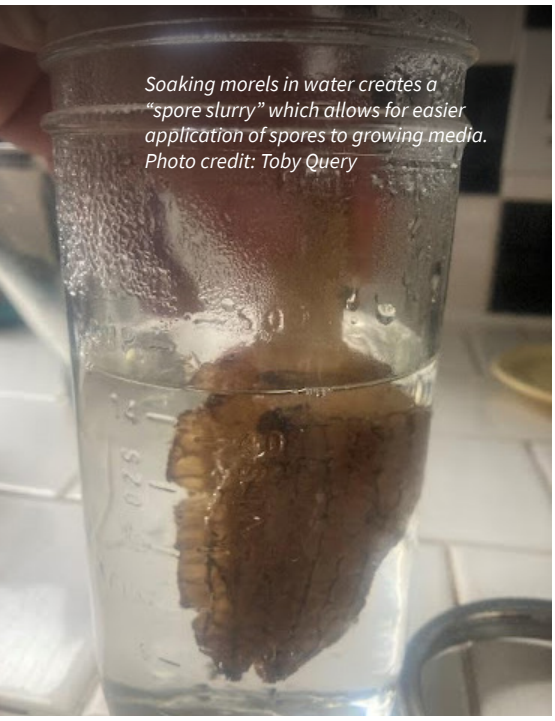
From the work of **Dr. Suzanne Simard** and others, we know the importance of the mycorrhizal network that connects, communicates, supports, and redistributes nutrients between mother trees and offspring, between alders and firs, and builds soil and resiliency over time. Besides connectors, fungi are transformers: they break down wood and create healthy soils and medicines. Many "white rot" fungi can degrade human-created persistent toxic chemicals such as PCB's, PAH's, and TNT into their nontoxic building blocks. Taxol, the powerful anti-cancer drug found in Pacific Yew tree, is produced by an endophytic fungus living in its bark that is thought to function as an immune system for the tree (Tiwari et al. 2022). Most every plant contains endophytic fungi, within and between their cells that may have many yet-undiscovered mutualistic interactions. What if forestry incorporated Simard's science and protected mother trees and mycelial connections? What if our job as land stewards was to protect beneficial fungi and improve soil ecology?

Learning ways to integrate fungi into land stewardship can have enormous benefits. I'm at an early stage of my own mycological education, but I've learned a few low-cost techniques that can introduce us to working with fungi.

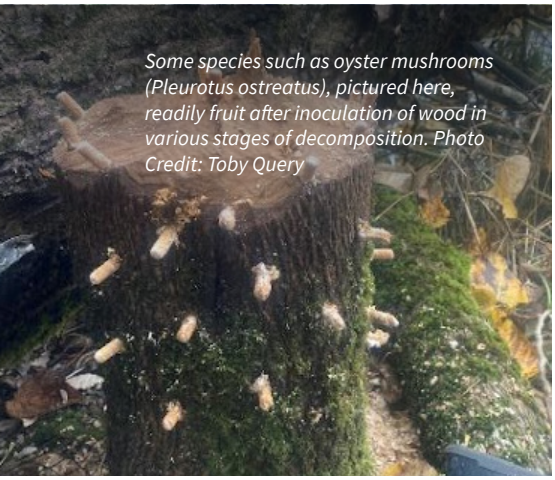
First, get to know the fungi around you. What species occur in different areas? Are they mycorrhizal or saprophytic? Do they produce medicine or food or dye? Do they break down toxic substances that occur in your area? What species don't occur in your area that live in "healthy" surrounding areas?

Lion's Mane Mushroom. Public Domain

Oyster Mushroom. Photo Credit: Gail Hampshire and licensed under CC by 2.0



Soaking morels in water creates a "spore slurry" which allows for easier application of spores to growing media. Photo credit: Toby Query



Some species such as oyster mushrooms (Pleurotus ostreatus), pictured here, readily fruit after inoculation of wood in various stages of decomposition. Photo Credit: Toby Query

Author Toby Query shows off the fruits of his labor: 3 mature queen stropharia mushrooms.

Next, experiment with incorporating fungi where it meets the goals of your stewardship. Below are a few techniques that I am experimenting with.

MYCORRHIZAL SPECIES: We know the importance of the mycorrhizal network, but how do we help and improve it? And how do different treatments such as chemical use, soil compaction, and removal of vegetation that are connected to the network impact the mycorrhizalsphere? To help support the network, I think it's important to assess and improve the soil first. Healthy soil means high organic matter (usually 3-4% or higher), fluffy soil, and soil that has a balance of nutrients, as well as the right mix of sand/silt/clay, for the site. I've been adding more organic matter including biochar and compost to amend soils, as well as decompacting imported soils after construction, using Dave Polster's **"Rough and Loose" technique**. With organic rich soil, we encourage the growth and spread of many types of fungi, which are an essential part of long lasting soil health. Beneficial fungi can be collected and propagated for use elsewhere. There are simple techniques to make spore slurries to help germinate spores and spread locally occurring species to nearby areas. This technique involves collecting a mushroom, soaking it in sterilized water, allowing it to germinate, and then spreading the spores to conducive areas.

Morels, which can be both saprophytic and mycorrhizal, can be amplified in this way with a few extra steps. I am experimenting using morel spore slurries and spawn to inoculate constructed beds of sawdust that will create food for the fungi and will eventually connect this food source to surrounding trees. This can improve the soil, increase water retention in the soil, increase climate resiliency for the forest, and produce tasty treats to land stewards!

DEAD WOOD: I've become skilled at planting and growing plants, but much less skilled in transitioning those plants back to soil when they die. We can partner with saprophytic fungi to inoculate recently killed trees (by drought, fire, beaver, wind throw, thinning, etc.) to hasten their transition to organic soil particles. By increasing nutrient cycling fungi can decrease fire risk, add more habitat for mycophagists (including flies and flying squirrels), and provide other mammals with food and medicine. You must match the fungi species with a compatible wood species, and timing and proper technique are important. Oyster mushrooms are a good starter species as they grow on many different types of wood, can be inoculated using wood dowels, and they are vigorous. I'm also experimenting with turkey tail, shiitake, lion's mane and other species using dowels and other methods.

WOOD CHIPS: Wood chips can be useful to suppress weeds during early project phases and promote increased water retention. I've found it easy to inoculate wood chips with the Queen Stropharia mushroom *(Stropharia rugosoannulata)* which can help increase nutrient cycling, which in turn promotes more rapid soil development. This species also is known to break down toxins (Kabiersh et al. 2001), **reduce levels of E. coli**, and shoot out spikes, called acanthocytes, that impale nematodes!

Next Steps

There is a need to continue learning and acknowledging the importance of fungi in our soil, in alive and dead plants, and in our water and air. After learning basic cultivation techniques using commercially available spawn, cultivation can expand to include culturing tissue of different species and strains as well as preserving and spreading spores of locally occurring species. In addition, fungi can be "trained" to eat different substrates (think of your locally occurring abundant **introduced plant**, pathogen, or **pesticide**). If this practice gains steam we may see the development of sterile labs, the fungal equivalent of seed collection and nursery operations, that can help propagate useful species that are local and useful to the area. The possibilities of incorporating fungi are almost limitless.

There is some caution to be thought through about introducing different strains or fungi species into project sites, as we have done and continue to do with plant species. I imagine a future where mycology, soil science, and botany and indigenous knowledge are equally valued to improve our ecosystems. Partnering with fungi in restoration is imperative for a future that cultivates connections.

BES hosted a workshop to explore methods that practitioners can use to boost the mycorrhizal diversity at restoration and remediation sites, including spreading wood chips that have been inoculated with mushroom spores. Photo Credit: Kas Guillozet

Questions For Future Consideration and Research:

- What effect does plant handling and storage have on mycorrhizae associated with roots after inoculation in the nursery?
- How to minimize the risk of introducing harmful pathogens and fungi into natural systems?
- What tools can practitioners use for low input analysis of fungi present at their restoration sites, so they choose the right inoculant for the site?
- What does this look like at scale?

Further Reading Recommendations

RADICAL MYCOLOGY by Peter McCoy

ORGANIC MUSHROOM FARMING AND MYCOREMEDIATION by Tradd Cotter

Works Cited

Kabiersch, G., et al. 2001. *Fate of bisphenol A during treatment with the litter-decomposing fungi Stropharia rugosoannulata and Stropharia coronilla,* Chemosphere, Volume 83, Issue 3.

Spinelli, Veronica & Ceci, Andrea & Bosco, Chiara & Gentili, Alessandra & Persiani, Anna. (2021). Glyphosate-Eating Fungi: Study on Fungal Saprotrophic Strains' Ability to Tolerate and Utilise Glyphosate as a Nutritional Source and on the Ability of Purpureocillium lilacinum to Degrade It. Microorganisms. 9. 2179. 10.3390/microorganisms9112179.

Taylor et al. 2014. Removal of Escherichia coli from synthetic stormwater using Mycofiltration. Ecological Engineering. Vol. 78.

Tiwari P, Bae H. Endophytic Fungi: Key Insights, Emerging Prospects, and Challenges in Natural Product Drug Discovery. *Microorganisms.* 2022;10(2):360. Published 2022 Feb 4. doi:10.3390/microorganisms10020360

Do you use fungal inoculants in plants that you grow or plant at restoration sites?

We'd love to hear from you. Reach out to kseaforth@b-e-f.org to connect.

Jonny Native Seed in Capable Hands

By Emily J. Wittkop

Jon passes the seed picking pole to Emily.

In the last issue of Treeline, Emily Wittkop contributed to an article on the barriers to land access for seed collection. Here she greets the restoration community as the new owner of Jonny Native Seed, which she took over from Jon Anderson earlier this year.

When I started working as a native seed collector six years ago, I had no idea how it would impact my life and the direction in which it would take me. I've always loved working with seed and spent several years volunteering for a local public domain seed breeding company **Peace Seedlings** before my employment with the Institute for Applied Ecology. In addition to leading the seed collection efforts at IAE, I managed the greenhouse production of various native plants including threatened and endangered species, and assisted with the management of the seed production farm. I am very passionate about plant materials and recognize that the limiting factor is availability. To have the opportunity to continue this work and expand upon my current experience as a business owner is a very exciting endeavor that I am very much looking forward to.

I met Jon Anderson years ago when I visited his seed cleaning barn with Rob Fiegener. At that time, my only exposure to professional seed cleaning was through the use of large industrial seed cleaning equipment. When Jon gave us the tour, I walked away inspired and impressed with his innovative tenacity to make improvements on home appliances and the use of the DybVig seed cleaner. I told others about his technique and knowledge base for years following. I later found out that Jon was wanting to retire and with the nudge of a few mentors, I decided to reach out.

I am so grateful for the time I have spent with Jon over last year and my only regret is wishing I had more time to learn from him. He continues to build incredible businesses that massively impact the native plant industry, and it is an honor to be continuing his legacy. In addition to providing high quality native seed, my hope is that I can continue to grow this business and foster seed stewardship in the next generation.

For those less familiar with Jon's story, he is thru-hiking the PCT with his wife Flip this summer. I highly suggest sending him a quick note of encouragement via email **jonnygms@gmail.com**. The adventure is inspiring and the photos are incredible.

I am so grateful for this opportunity and it is an honor to continue this work. My hope is to significantly impact the restoration industry by providing high quality native seed to a variety of vendors for years to come.

Thank you to Treeline for your continued support.

Emily J. Wittkop

Interested in Helping With Oregon Ash Research?

Researchers at the Forest Service and Penn State are conducting a landscape level genomics study of Oregon Ash (Fraxinus latifolia) by analyzing leaf tissue samples and they need samples from many locations across the species' range, especially in California and Washington. If you are interested in collecting leaf samples this spring contact Dr. Jill Hamilton at **jvh6349@psu.edu**. In order to be included in the study these samples need to be received by mid July, but the earlier the better. The Forest Service also needs Oregon Ash seeds to conduct further research on Emerald Ash Borer resistance. If you would like to help with this effort please contact Dr. Richard Sniezko at **richard.sniezko@usda.gov** to find out how to get involved.

Did You See the Results of the Treeline Survey?

This spring, we published the results of a survey of restoration practitioners, growers and land managers from government agencies, non-profits, Tribal governments and commercial businesses on attitudes and actions related to climate adaptation. If you missed it, check out the results **here**.

WEBINARS:

Monthly Webinars on Climate Adaptation for Forest-Dependent Wildlife

Federal land and wildlife management agencies are hosting a 12 part, monthly webinar series on forest ecosystems under climate change, as well as tools and management approaches that may facilitate adaptation. Webinars are hosted on the third Tuesday of each month through March 2023. Learn more and register **here**.

Pacific Northwest Drought and & Climate Outlook

Hosted by NOAA, the National Weather Service, USDA, and the Oregon Climate Change Research group, this webinar will go over the current and forecasted drought conditions in the Pacific Northwest, as well as implications for various stakeholders. Learn more **here**.

watersheds program

Do you have an idea for a future newsletter article or interview, or a suggestion for how we might improve? Please reach out to Kas Guillozet at **kguillozet@b-e-f.org**.