



HEDGEROWS

for Rural & Working Lands in Western Washington

A How-To Handbook

Produced by WSU Thurston County Extension
Sponsored by Thurston County Stormwater Program

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• Hedgerow Plant Options Table	
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User's Guide to This Handbook

Why This Handbook?

This publication began as an effort to share the value and practicality of hedgerows with rural and agricultural landowners in Thurston County, with an emphasis on protecting local waterways and groundwater. As we started exploring the vast science of hedgerows and narrow buffers, our understanding of their diverse benefits deepened and the project expanded.

Fundamentally, we've created a series of tools to enable you to design and implement a hedgerow (or many!) to achieve goals that enhance our landscapes and protect local water resources, while achieving many other agricultural and landscape goals.

Organization & Elements

We provide this primary document, divided into four sections, plus several key tools:

- searchable, sortable plant tables;
- ready-made planting templates for different hedgerow goals; and
- appendices full of resources and details to help with implementation and technical questions.

All the parts are designed to interact, so users can follow all the steps necessary to construct and maintain their hedgerow projects with confidence and efficiency.

Hedgerow Science

The first section of this document enumerates the many benefits of hedgerows in varied diverse settings. You likely are already interested in at least one of these benefits, and you may want to skip ahead to the next section to learn more about how to just get started on creating a hedgerow. We encourage you to at least skim through to learn more about all the various ways hedgerows can improve agricultural production, protect water resources and habitat, and provide many benefits to support the people living nearby. Moreover, check out some of the many studies cited that support the effectiveness of this simple planting technique to accomplish so much in so little space on our landscapes!

How-Tos

As you engage more deeply with the "how-to" sections that follow Section 1, you'll learn how to use the other tools referenced above to help you design, build, and sustain your hedgerow over time. Many of these tools will be living documents, accessed from links on our WSU Extension website. Thus, we will be updating these as time goes on.

Please help us make these resources useful for all users well into the future by reporting any errors, new information, or additional resources that should be included. Please contact us at wsu.extension.thurston@wsu.edu or info@nativeplantsalvage.org to share updates.

As you learn more about the fruitful possibilities of hedgerows, we wish you great success making and sustaining your own!



What are Hedgerows & Why Have One?

I. What is a Hedgerow?

Broadly defined, a hedgerow is a row—or several rows—of plantings that are designed to complement each other and ultimately weave together in an informal, multi-species hedge. Hedgerows are formally defined as groups or rows of trees and shrubs, sometimes with the additions of mixtures of perennial and annual grasses and flowers. Typically, hedgerows are planted along fencelines or as substitutes for fences or privacy screens; you might find hedgerows along property boundaries, roadways, pasture or field divisions, or along waterways.¹

Hedgerows have been associated with agricultural lands on many continents for centuries.^{2,3} Hedgerows can creatively serve many functions in a wide variety of settings. The differences between a “hedgerow” and a common “hedge” are primarily these:

Hedgerows are equally valuable in urban, suburban, and rural settings—the goals may be different, but a hedgerow can be sized and planted to fit in just about any landscape.

Hedgerow	Hedge
<ul style="list-style-type: none"> Can serve as a natural fence, privacy screen, noise/wind reducer. 	<ul style="list-style-type: none"> A single species—typically evergreen, such as arborvitae or laurel.
<ul style="list-style-type: none"> A mix of evergreen and deciduous species planted in complementary combinations. 	<ul style="list-style-type: none"> Plants are spaced as directed, and will ultimately knit together upon maturity.
<ul style="list-style-type: none"> Plants are spaced much closer than usual—up to about 75% of their usual spacing requirements—creating overlapping layers and screening as plants mature. 	<ul style="list-style-type: none"> Plantings are formal and maintained through consistent, ongoing shearing to maintain uniformity. Depending on the species used, this can require considerable annual attention. Sheared vegetation will require removal/cleanup.
<ul style="list-style-type: none"> Plantings have an informal, relaxed, natural appearance. No need for shearing; plants will grow closely together, interweaving, and developing canopy and root connectivity. Leaves will drop and can be used under the hedgerow as natural mulch—no need for annual cleanup. 	<ul style="list-style-type: none"> A dense hedge occupies the entire vertical column and does not allow for herbaceous plants in the understory, limiting additional capacity for processing polluted runoff.
<ul style="list-style-type: none"> As the shrub/tree species mature over time, understory herbaceous plants and ferns can be planted, increasing capacity for intercepting stormwater and processing polluted runoff. 	<ul style="list-style-type: none"> Monoculture hedge limits diversity, reduces beneficial insects and crop productivity, and limits habitat.
<ul style="list-style-type: none"> Diversity of plants leads to reductions in pest insects, increases in beneficial insects, enhanced crop productivity and habitat support. 	<ul style="list-style-type: none"> For aesthetics, sections with damaged plants/limbs require replanting. There may be a gap in the hedge until the replacement grows to maturity.
<ul style="list-style-type: none"> For aesthetics, no need to replace a damaged limb or plant if damaged in a storm. Due to informal appearance, the plants will quickly grow over the damaged area. 	<ul style="list-style-type: none"> Design of the hedge involves choosing a single species best suited to site conditions. The flowers, fruit, and foliage interest will be limited.
<ul style="list-style-type: none"> Design of the hedgerow relies on creativity, aesthetic preferences, and the goals of landowners. Hedgerows can blend a wide variety of the landowner’s favorite species together. Depending on choices, landowners can enjoy flowers, fruit, and interesting foliage every month of the year. 	

Hedgerows are equally valuable in urban, suburban, and rural settings—the goals may be different, but a hedgerow can be sized and planted to fit in just about any landscape. A hedgerow may be short or tall; it may be as narrow as 10 feet or as wide as the space permits; it may be a few short feet long or planted for thousands of feet in length on a large property; it may be mostly trees and shrubs, or in some cases might even be largely based on perennial flowers and grasses. The height, width, length, and plants used will all vary depending on your site and your goals.

Note that throughout this document, we refer to the width and length of hedgerows. To clarify how we'll be using those terms, refer to **Figure 1**. Think of “length” in terms of the line along which you'll create a barrier: in the case of Figure 1, abutting a farm field on one side and a buffering a stream on its other side (but it could also be, for instance defining a pasture edge or property boundary, or blocking off visibility of a roadway along the property line). “Width” refers to the distance from front to back—and some think of it in terms of depth. In the case of Figure 1, width is from the hedgerow's edge on its field border to its edge buffering the stream.

Since hedgerows typically feature a diversity of species, they offer many layers or strata of woody—and even herbaceous—species. This feature creates more opportunities for different organisms that can benefit agriculture. The structure of some hedgerows may even permit trellising vines over shrubs and trees for even more diversity.

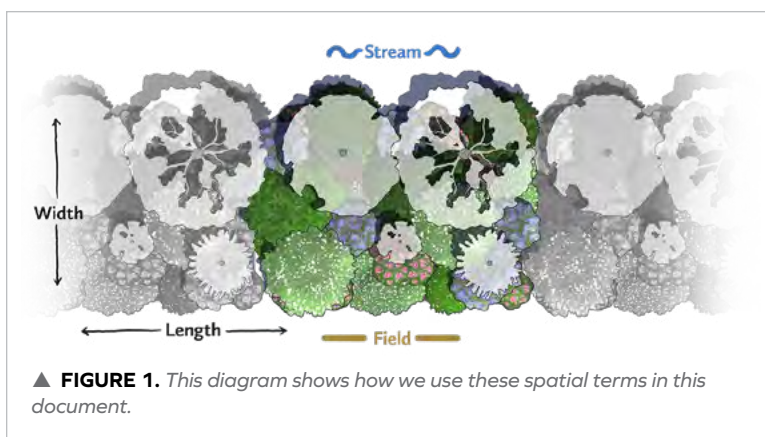
Size & Placement

Three examples help illustrate different goals for hedgerow design: (1) a small farm with habitat and production-related goals; (2) a ranch which located a hedgerow along a watercourse; and (3) a rural small-scale farm.

Example 1: A vegetable-farm hedgerow is planted with flowering evergreen and deciduous shrubs—some native species and some that are non-native drought-tolerant plants that bloom into late fall and winter. The farmers planted this hedgerow near their rows of vegetable crops and hoop houses, with three main goals:



▲ Hedgerows can provide multiple benefits to landowners and can be sized to fit in narrow spaces in rural to urban settings. (Photo: Erica Guttman)



▲ **FIGURE 1.** This diagram shows how we use these spatial terms in this document.



▲ A densely planted mix of evergreen and deciduous shrubs in this hedgerow features plants that bloom from January to November. Featured here in early spring are shrubs that support numerous beneficial insects: *Laurustinus* (*Viburnum tinus*), *Tall Oregon-grape* (*Mahonia aquifolium*), and *Red-flowering currant* (*Ribes sanguineum*). (Photo: Erica Guttman)

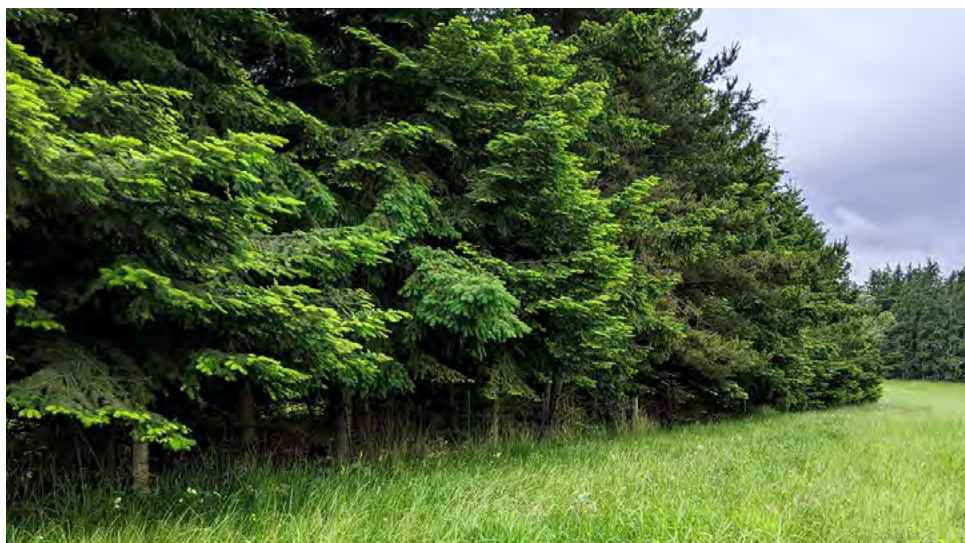
1. Create a windbreak across this open expanse of land, thereby reducing irrigation needs and expanding the growing season;
2. Create habitat for pollinators throughout the growing season; and
3. Host beneficial insects that prey on pest insects.

Example 2: A ranch hedgerow with a stream adjacent to the pasture features a narrow planting along the water’s edge. This hedgerow is mostly livestock-friendly fast-growing native conifer trees, with an understory of shade-tolerant dense and prickly deciduous shrubs, and herbaceous perennials and ferns added once shade was established. The goals of this hedgerow include:

Hedgerows can provide a wide variety of benefits, often with one hedgerow providing multiple positive results beyond its primary goal.

1. Protect the stream from nutrient runoff and keep the rancher's cattle from accessing the stream;
2. Provide shade and natural cooling to the stream, helping to sustain the historic salmon run; and
3. Support the stream banks to prevent erosion and loss of topsoil.

The rancher can still access the stream for intermittent irrigation needs and has installed a solar pump and troughs to provide cattle with access to drinking water while eliminating trampling along the streambank.



◀ *Closely spaced tall evergreen trees form the backbone of this streamside hedgerow, with shade-tolerant, prickly understory shrubs to repel livestock, and a dense network of roots and stems to filter field runoff. The stream is fully shaded with just 10–15 ft. (on both sides) at ground level removed from pasture or hay production. (Photo: Erica Guttman)*

Example 3: A hedgerow for a rural residence is planted near the home, separating the family from their neighbors’ property. This hedgerow is a closely-planted mix of large and small evergreen and deciduous shrubs, with a few hazelnut trees mixed in. There are three rows, and the front-most row includes many berry plants. The larger shrubs act as a windscreen from the prevailing winds, while also serving as a “living trellis” to support a small crop of hops. The goals of this hedgerow include:

1. Make a natural “fence” that delineates the property line and provides privacy, while saving the expense and hassle of building and maintaining a true fence;
2. Break strong winds that decrease crop productivity and increase plant stress in a nearby orchard and large vegetable garden;
3. Cut energy costs and make the home more comfortable by reducing winds that chill the house in the winter and providing shade to cool the house in the summer;
4. Grow flowers, berries, hops, and nuts for the family’s use, while adding an attractive landscape feature with beautiful flowers, fruits and foliage throughout the year; and
5. Attract pollinators and birds to benefit the crops; support other small wildlife, including birds of prey, that can reduce rodent populations.

II. Why Create a Hedgerow?

As is evident from the previous examples, hedgerows can provide a wide variety of benefits in rural and agricultural settings—often with one hedgerow providing multiple favorable outcomes beyond its primary goal. Hedgerow design is dependent on deciding what your most critical goal is. Often, the types of plants, the spacing between plants, and the placement of the plants within the hedgerow will vary depending on the primary goal. (We discuss the design criteria for primary goals in Section 3, IV. “Plant Selection Process.”)

Below we summarize the most common reasons rural landowners construct hedgerows and evidence to support their success in achieving goals.

“Although the idea of a windbreak may seem simple, their uses are only limited by the creativity of an observant landowner.”

Mark Shepard, Restoration Ecology—Real-world Permaculture for Farmers

Crop Productivity—Windbreaks & More

Several studies support using hedgerows as windbreaks, and it’s one of the most frequent reasons that landowners choose to create one. Strong winds near crops can diminish yields in various ways, including disrupting pollination activity and outright damaging fruits. When plants experience windstress, energy that could be spent developing crops must be instead directed into supporting root and stem growth.⁴ There are many benefits to a windbreak hedgerow—they regulate more than the wind!

- Studies from the United Kingdom and the Brittany region in France indicate that hedgerows managed as windbreaks can improve crop yields. Depending on the type of hedgerow, the crop, climate, and soil, a hedgerow can boost grain yields by just a few percent to as much as 25%, and in some cases vegetable and fruit yields increased by as high as 75%.^{5, 6}
- Windbreak hedgerows can support crop growth by minimizing windblown soil erosion.^{5, 7}
- If properly designed, hedgerows can reduce wind speed significantly over a distance of 12 times the height of a hedgerow on the downwind side, and four times on the upwind side.^{5, 8, 9}



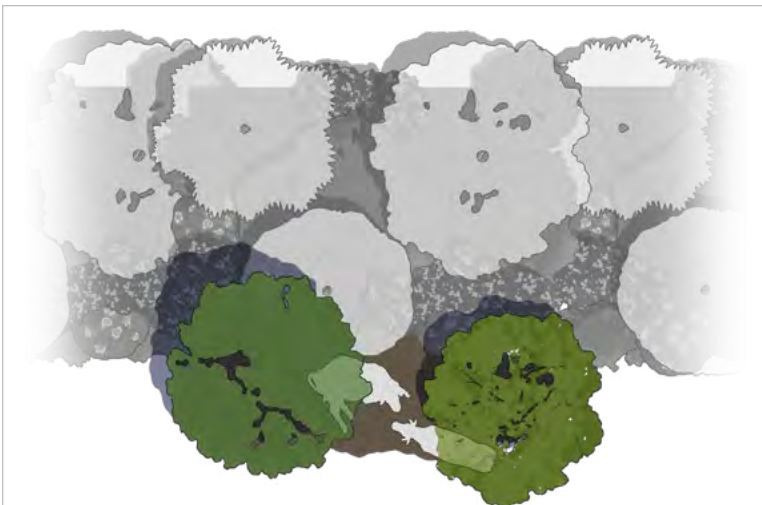
- Hedgerows regulate temperatures and maintain more consistent water in soils. Studies from the United Kingdom, where hedgerows are abundant, show that at a wider landscape scale, networks of hedgerows have a lot of influence on local climate, decreasing average wind speed by up to 50% and moderating both daytime and nighttime temperatures.^{10, 5}
- The addition of shade and reduction in wind reduces loss of moisture in the soils, conserving water.^{11, 12}
- A windbreak hedgerow can also provide more light to crops: the concentration of woody plants in a hedgerow can reflect light waves, which project outward from the foliage toward crops.¹¹



▲ *Black Hawthorn (Crataegus douglasii) is an ideal native tree in an exclusion hedgerow or living fence. Its dense thicket growth and giant thorns deter livestock, and its foliage is completely edible. Pollinators use the flowers, and birds enjoy the berries. (Photo: Erica Guttman)*



▲ *When mature, an exclusion hedgerow is useful for managing pastures, keeping livestock away from waterways, or creating a protective buffer to keep neighboring livestock separated, potentially reducing disease spread. Although a fence is required while the hedgerow is maturing, over time the need for as much fencing will decline as the hedgerow fills in and forms a dense barrier. (Photo: Envato Elements)*



▲ **FIGURE 3.** *From above, it's easy to see how a shelter pocket works with a hedgerow to provide shade for livestock. Plants used in a shelter pocket are non-toxic to livestock.*

- By blocking shifting winds, a windbreak hedgerow can save water and water crops more efficiently: it reduces evaporation of overhead irrigation and ensures that water is more evenly distributed.¹³

Livestock Exclusion & Shelter

Many landowners rely on hedgerows for the advantages of a “living fence” over the drawbacks of a traditional fence, or to minimize the materials used in an exclusion fence—with a dense thicket of plants providing some of the barrier. Over time, hedgerows can save money and hassle over building and maintaining extensive fence lines, especially in wet fields where posts are subject to water damage. However, livestock must be excluded along the hedgerow line until the plants are sufficiently mature to withstand some browsing and the branches are dense enough to provide a barrier.

Plants recommended for these hedgerow types are non-toxic to livestock, and some may even provide beneficial supplemental browse (see the Living Fence template in Appendix A).^{64, 14, 63}

Livestock exclusion hedgerows can be used just about anywhere a fence might be used, and should be combined with planned grazing systems to manage for potential overuse, trampling, and concentration of nutrients from manure. An exclusion hedgerow might be used:

- to keep livestock out of waterways;
- for pasture management;
- along property boundaries, to create a thicker barrier than a fence in order to prevent direct contact with neighboring livestock, thereby preventing the potential spread of pathogens.^{5, 8}

Shelter pockets: Depending on the location, a livestock exclusion hedgerow can be combined with pockets of additional plantings to create a source of shade and shelter. (This application isn’t appropriate near waterways, as it can concentrate runoff from manure.) Here are ways that these hedgerow shelter pockets support the health of livestock:

- In cold months, animals take refuge from wind and driving rain, and temperatures are warmer along the hedgerow line.

- During the summer, the hedgerow provides shade that can dramatically reduce heat stress, especially in young animals. Heat stress can negatively impact fertility and growth rates, and reduce milk output in dairy livestock.^{8, 15}
- Studies from the United Kingdom and New Zealand demonstrate that hedgerows can increase livestock growth rates, wool growth rate, milk yield, disease resistance, and fertility.
- Some of the woody plants in a livestock hedgerow can supplement animals' diets, supplying nutrients, minerals, and coarse plant material not found in pastures or feed.^{10, 64}
- Livestock hedgerows also reduce feed costs, as livestock protected from cold winter winds require less food.¹²

When creating shelter pockets for livestock, be mindful that additional measures may need to be employed to protect livestock from predators such as racoons or coyotes that could take refuge in the hedgerow or shelter pocket, potentially increasing their access to livestock.

Habitat for Wildlife, Pollinators, and Natural Pest Enemies

The inherent diversity of plant species in a hedgerow also supports biodiversity of animals, which benefit crops in numerous ways. Hedgerows offer critical food and shelter to native pollinators, predatory and other beneficial insects, parasitoids, insectivorous birds, and birds that prey on small mammals that may damage crops. The hedgerow creates a habitat that works in collaboration with cultivated areas for these critical bird and insect species to nest, rest, forage, take refuge from the elements and even overwinter.¹

The diversity of plant species in a hedgerow begets more beneficial interactions and more resiliency. The greater the structural and floristic diversity of your hedgerow, the greater the diversity of organisms it will support.¹⁶

Most agricultural crops that require pollinators only provide a food source to support them for a few weeks. A hedgerow with ongoing cycles of bloom

► There are many plants that flower in midsummer, but it's also important to include plants that bloom very early, such as this native Osoberry (*Oemleria cerasiformis*), and extend into late fall to provide pollen and other forage to pollinators. (Photo: Erica Guttman)



▲ A shelter pocket is most associated with an exclusion hedgerow, but could be added on to any hedgerow used near livestock. Shelter pockets provide extra canopy cover for sheltering animals from weather extremes and contain plants that—once matured—can withstand occasional browsing to provide beneficial dietary supplements. (Photo: Erica Guttman)



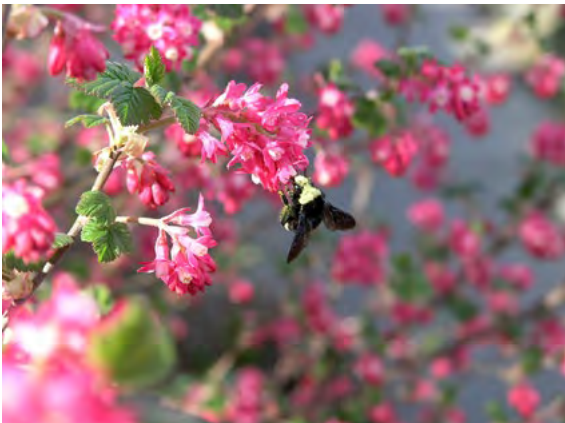
▲ A hedgerow planted to support crops will have a diversity of flowers, berries, and foliage, thus supporting a diversity of beneficial insects, pollinators, parasitoids, predators and insectivorous birds. (Photo: Michael Melton)



▲ The inclusion of plants that host the larvae of butterflies and moths is just as important as flower diversity. Willows (*Salix* spp.) are one of the most widely used larval hosts, while also supplying an early nectar source to bees. (Photo: Erica Guttman)



▲ A strip of herbaceous perennials and self-seeding annuals outside the footprint of the hedgerow's primary woody plants can provide an additional forage source for natural pest enemies and beneficial insects. (Photo: Alison Nichols)



▲ The diversity of species in a woody hedgerow has been documented to extend the availability of pollen sources before and after the growing season to support more a diversity of pollinators, providing forage during gaps in available nectar to sustain beneficial insects—all in a much smaller land area than woodland, pasture, and field margins. (Photo: Michael Melton)



▲ One way hedgerows attract and support beneficial insects, natural pest enemies, and pollinators is by providing refuge from storms and heavy winds, as well as overwintering habitat—enabling early movement of natural enemies and pollinators close to crops. (Photo: Michael Melton)

(and re-bloom where possible) can vastly enhance the variety of pollinator species and extend how long they remain in the area to benefit crops.¹

Plant species diversity for habitat: Planting a variety of plant species that feature different foliage and varying flower shapes and colors will support the most diverse pollinator populations. Hedgerows planted for attracting beneficial insects should feature plants that serve as the host species to the larvae of important pollinators, as well as supplying a nectar source. Consider extending species diversity beyond trees and shrubs with pollinator-attracting herbaceous perennials and grasses, as understory plants below the woody species, and as an additional planting beyond the woody footprint.^{11, 1, 17} (Plant selection is discussed more in Section 3.)

Structural design for habitat: Hedgerows for attracting wildlife, beneficial insects, and natural pest enemies typically feature a design that includes taller plants (especially trees); a wider footprint; dense vegetation in the midstory and close to the ground; and the inclusion of an herbaceous belt on the margins.^{18, 19}

Let's look at how hedgerows attract and support beneficial wildlife and helpful arthropods—insects, mites, spiders, and more.

Pollinators & Natural Pest Enemies

- Hedgerows attract pollinators into intensive farmland and export those pollinators into crops, increasing yields.²¹ The means by which hedgerows support pollinators include: more nesting and/or egg-laying sites, especially in trees and shrubs; a diversity of pollen and nectar sources to meet nutritional needs and extend food availability over more seasons; creating a warmer microclimate; and facilitating movement by providing connected corridors between the hedgerow and farm fields, especially beneficial for short-distance foragers.²²
- Diversely planted hedgerows can provide nectar throughout the growing season, from early to late, to support different pollinators needed as different crops flower, and when floral resources in a crop field are abundant for only short periods of time (e.g., apples, blueberries).²³ Further, hedgerows have been documented to provide more nectar per acre than other important sources (woodland, margins, pasture). Hedgerows can also provide more pollinator support during gaps in available nectar, while requiring less growing space (over other plant sources) to help bridge periods of insufficient pollinator forage.²⁴
- Hedgerows support our more unusual beneficial native bee populations. A California study found that native bees—which are preferred pollinators for dispersing pollen—were seven times more abundant within hedgerows than unmanaged vegetated edges, and that 40% of pollinators found on flowers were unique in the hedgerow edges vs. weedy edges.²¹

- Hedgerows provide breeding sites and food for beneficial insects and birds when crops are not in flower.^{1, 5, 18, 12}
- Hedgerows are particularly important for nesting bumblebees, who get much of their diet from woody plants.²⁵
- Properly placed, hedgerows are especially key for giving butterflies refuge from prevailing winds, and providing warmth from reflected light.¹⁷
- Planted properly, hedgerows can extend support and attract pollinators for both early and late crops—thereby extending the season on both ends.¹⁸
- Hedgerows support the predators and parasites of crop pests by providing a wide range of microhabitats across the different layers, from tree canopy down to leaf litter and soil; by providing everything predator organisms need to thrive, hedgerows can measurably reduce pest species in your crops.^{11, 18}
- Hedgerows also provide overwintering habitat so that natural enemies of pests move out into the crops in spring and summer to feed on aphids, slug eggs, and other pests.¹⁸
- Hedgerows sited along field edges displace weedy vegetation. This reduces the seedbank for invasive species while also supporting more beneficial insects. This can lead to a higher ratio of beneficial insects vs. pest insects, as pest populations tend to be higher in weedy plants, while natural pest enemies and pollinators (especially bees) favor the native plants that are the backbone of hedgerows; this finding is further supported by evidence that trimming the native plants in hedgerows reduced pollinator populations.^{1, 22}



▲ From the canopy to the leaf litter, the different layers of diversely planted hedgerows provide microhabitats that host important pest predators and parasites. (Photo: Michael Melton)



▲ Hedgerows provide the layers and complex structure needed by web-building spiders that are critical, yet often-overlooked, pest predators. (Photo: Erica Guttman)



▲ Hedgerows provide a corridor for other wildlife—including various birds, frogs and snakes—that can prey on rodents or other destructive mammals, slugs, snails, and other pests. (Photo: Michael Melton)

- Hedgerows can also help reduce some pest species by providing stability that sustains natural pest enemies, enabling them to control the pest. Several studies indicate that weeds and grasses in the crop field margin provide preferred egg-laying habitat for some species of click beetles, whose larvae are wireworms, a significant pest for several food crops. In margins dominated by hedgerows, wireworm crop damage is significantly reduced, likely by reducing both the intensity of wireworm outbreaks and providing stability for beneficial insects that manage wireworm populations.^{26, 27, 28}
- Web-building spiders—important natural predators of pests—particularly favor the structure of hedgerows, both in height and complexity. Web builders decline considerably when this structure is lost.¹⁸

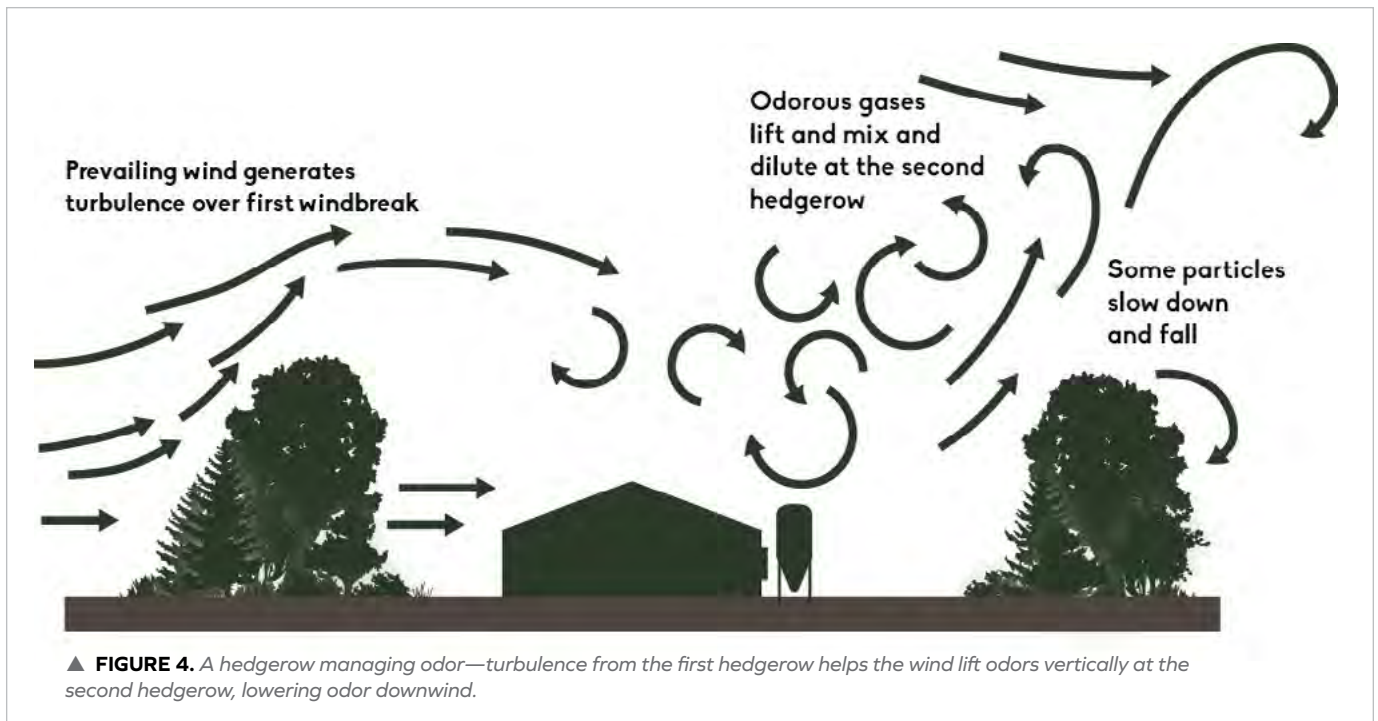
Other Wildlife

Hedgerows support a diversity of native wildlife, bridging the gap between field and forest. Supporting more biodiversity on the farm is not just altruistic. Native animals like raptors, frogs, snakes, and insectivorous songbirds provide further benefits to crops by preying on small, destructive mammals, pest insects, slugs, and snails.^{11, 1, 6, 29, 12, 17}

Management of Dust & Odors

Hedgerows can help manage transmission of dust and odors, due to their inherent structure that features multiple layers or strata of diverse plant species. Odor-capturing hedgerows can be custom-designed to complement the ventilation fans and other features surrounding the source of odors, and may even feature a variety of hedgerows on both the upwind and downwind sides.³⁰

It's critical to pay attention to the design recommendations of technical providers such as USDA Natural Resources Conservation Service (see Appendix C).



Mitigation of dust and odors occurs in various ways, including planting the hedgerow to maximize the capacity to manipulate the airflows near the source of the odors. Proper design can dilute odors with fresh airflow; reduce odor spread; and compel heavier dust particles to settle out of the airstream.

The hedgerow physically intercepts windblown dust particles and aerosols. Some will move through the hedgerow and be trapped by the plants (especially those with large, rough leaves); most will be diverted by the dense planting, which lifts the odor plume into more turbulent winds where it is diluted.^{31, 32} Arranging your plants into rows with space between increases the surface area for odor or dust to be trapped in the foliage, and using plants with a diversity of foliage can increase effectiveness.³² The vegetation itself can assist with odor as well. Here's how it works:

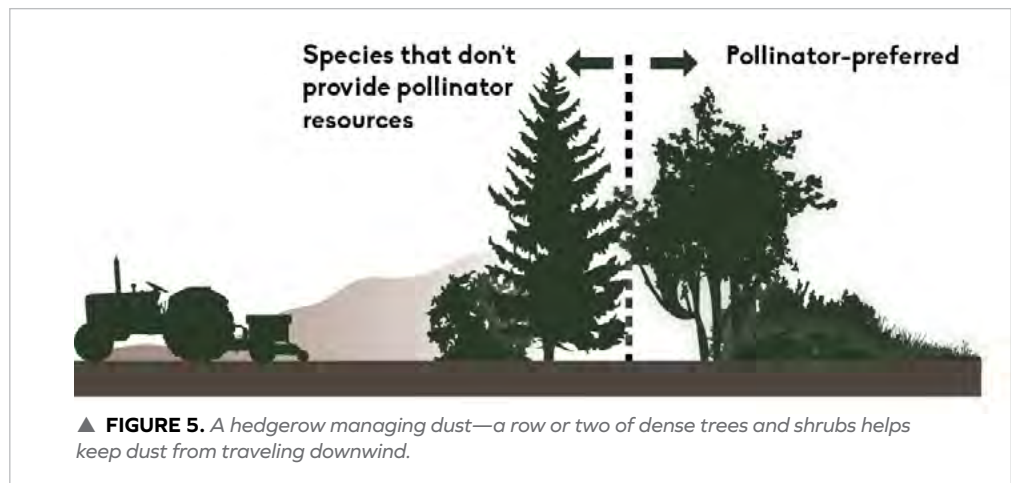
- Odor compounds on dust particles attach to leaf surfaces as the air flows through the vegetation.^{31, 32, 33, 30}
- Then, the bacteria that naturally live on the surfaces of leaves break down these smelly compounds.^{10, 21}
- This process is known as “phyllorremediation,” which is the natural process of mitigating air pollutants through leaves and leaf-associated microbes.³⁴



▲ The native Sitka spruce (*Picea sitchensis*) tree is an excellent choice for the evergreen component in many hedgerows, including windbreaks or odor-control: its qualities include fast growth and both height and branches that can extend as a ground-level barrier. (Photo: Erica Guttman)

Since smelly compounds leaving livestock areas are often attached to dust particles, trapping dust particles also reduces migration of odors off the property. Hedgerows can help mitigate odors at the source, perhaps reducing the amount of physical separation needed to prevent odors from impacting neighboring properties.^{31, 32, 33, 30}

Hedgerow buffers specifically associated with managing odors from animal enclosures may also help reduce the spread of infectious diseases by redirecting wind away from the enclosures. Be sure to use plants that won't produce tasty berries or seeds that might attract birds—they could spread the diseases you're trying to prevent.^{31, 66}

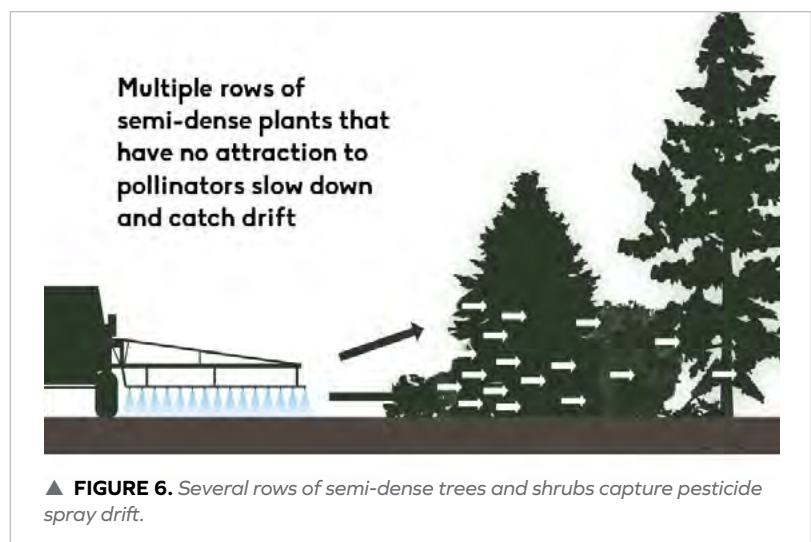


▲ **FIGURE 5.** A hedgerow managing dust—a row or two of dense trees and shrubs helps keep dust from traveling downwind.

Interception of Pesticide Drift

Similarly to interception of dust and odors, hedgerows can be used to intercept pesticide drift. For some growers, a pesticide-drift hedgerow may provide the best overall strategy to be in compliance with National Organic Program (NOP) requirements, while simultaneously reaping additional on-farm benefits, including blocking the movement of weed seeds.³⁵ These are the primary reasons why this goal may be important:

- Organic growers interrupt drift from conventional growers, roadways, residential areas, or other locations where prohibited substances may be applied that can contaminate the fields, in violation of regulations under the NOP.³⁵

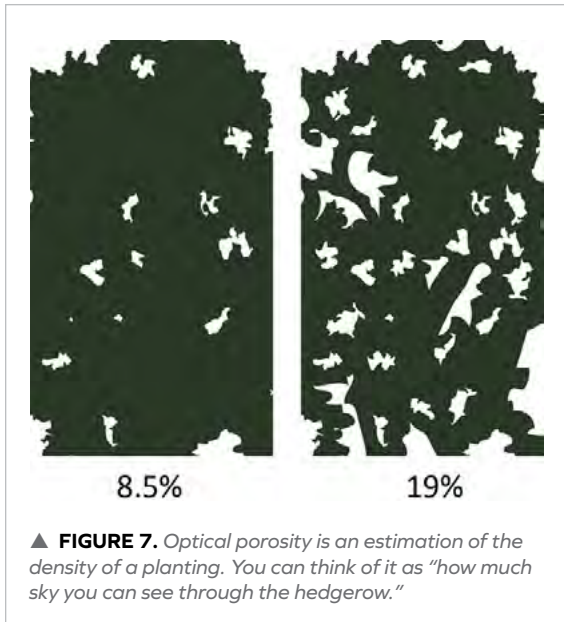


▲ **FIGURE 6.** Several rows of semi-dense trees and shrubs capture pesticide spray drift.

- Conventional growers prevent pesticides from migrating off their fields, thereby limiting liability.³⁵

Using multiple rows of trees and shrubs that are each medium density, but that all together provide around 40–50% tree canopy density (which could also be thought of as a hedgerow that is 50–60% porous, i.e., the amount you can completely see through—termed “optical porosity.” See Figure 7 for examples.), has been shown to prevent up to 90% of pesticide drift.

Even more than in dust/odor windbreaks, it’s important to use plants that are less attractive to birds or pollinators.³²



Wide forested buffers should be prioritized whenever space allows. But hedgerows can offer some of the same benefits of wider buffers, but in a narrower band, thereby permitting more working lands to stay in production.

Flood Management, Topsoil & Water Conservation

The role of hedgerows in controlling water flows has led to their use in natural flood management and reducing loss of topsoil from erosion during flooding events. Particularly in contrast to pasture, a few studies suggest that hedgerows can reduce flooding peak by up to 40%, primarily by vastly increasing the rate of stormwater infiltration.³⁶ Where hedgerows are planted, infiltration of water can be greater than 60 times that of neighboring fields without hedgerows.³⁷

Hedgerows conserve water in the soil. They intercept stormwater through their canopies, dense stems at ground level, and by mitigating soil compaction through their expansive root systems. Hedgerow plantings result in more water retention in the vegetation and directly through infiltration into the soil—which also recharges groundwater supplies and helps make water more available for irrigation needs later.³⁸ A study in Spain demonstrated that the presence of hedgerows significantly regulated soil temperatures and water content in soils, resulting in both higher water content and organic carbon in the soils of croplands adjacent to hedgerows.³⁹

The variety of root systems from the diversity of plants present in a densely planted hedgerow work together to stabilize the different levels of soil. The woody plants’ root systems are wider and deeper than annual crops, allowing for more water storage. Further, as water runs through the hedgerow’s dense stem network and spongy soils, it is slowed down, allowing it time to infiltrate. The reduction in overall surface water flows and the lessened energy of any runoff reduces the potential for scouring the soil, which helps retain topsoil on growing fields.^{6, 18}



▲ Through their layers of vegetation intercepting rainfall, and the dense network of stems in the lower layers slowing runoff as it flows over the landscape, hedgerows help retain topsoil, reduce soil compaction, and enhance water infiltration and retention in both vegetation and groundwater. (Photo: Erica Guttman)

Protecting Local Waterways & Enhancing Fish Habitat

One application that has been particularly important over the years is the use of hedgerows for water quality protection. In recent decades, many agricultural landowners have turned to hedgerows for both their benefits to improving productivity and as solutions to protecting nearby or adjacent local waterways.⁴⁰

Many rural landowners are familiar with wide forested riparian buffers. Linked to riparian habitat and salmon recovery, wide buffers have been used to replant farmland adjacent to waterways with native trees and shrubs. Riparian *hedgerows* can be a beneficial compromise when there is not the capacity to plant *wide forested* buffers. Hedgerows can achieve *some* of the same benefits of these wide forested buffers, but in a narrower band, thereby permitting more working lands to stay in production.

Hedgerows & Water Protection: Following are some ways that *all* types of vegetated riparian buffers help protect waterways and support aquatic life:

- Adjacent vegetation shades the waterway, helping keep temperatures in a cooler range needed for fish and other aquatic life. Recent studies show that even narrow or hedgerow buffers between 5–15 feet *can* provide shade and cooling equal to larger buffers.^{41, 42}
- Vegetation along streambanks binds soils together to prevent erosion—and further sedimentation.
- Dense vegetation and the accompanying rough leaf litter within a hedgerow intercepts the flow or runoff, traps sediment and can even remove nutrients such as phosphorus, which can bind to sediment particles.^{43, 18, 44}

- Intact soil and root systems allow soil biological processes to effectively degrade trapped pollutants and nutrients derived from agricultural activities. Once trapped, the biological activity of the plants' roots, soil structure and biogeochemistry, and associated mycorrhizal fungi help degrade pollutants into innocuous compounds.^{45, 46}
- Rainfall that is intercepted by vegetation slows long enough to trickle back into the soils—reducing the potential for flooding and recharging groundwater locally, thereby replenishing water supplies and feeding streams during dry times.
- Plant debris and insects from buffer vegetation drop into the waterways, supporting a critical building-block in the aquatic food web.



▲ The leaf litter generated by hedgerows can protect local waterways by providing a rough surface that slows down and traps runoff and sediment, retaining them on the landscape and preventing nutrients bound to sediment from entering waterways. (Photo: Erica Guttman)

Benefits of hedgerows as narrow buffers: Wider buffers should be prioritized whenever space allows. However, sometimes on working lands farmers, ranchers and other rural landowners need the flexibility offered by the narrower width of a hedgerow. Here are some of the specific conservation benefits hedgerows can provide while simultaneously supporting agricultural functions:

- Depending on how they are planted, hedgerows may be able to provide even greater shading and cooling benefits to waterways than traditional re-planted riparian buffers. Wider buffers tend to rely on wider spacing for a more natural forested buffer as the plants mature, whereas hedgerows rely on very close plant spacing that fills in faster. Depending on the species used, narrow hedgerows can have an overall structure that better retains cooler night-time temperatures. The air close to waterways that remains cooler longer into the day will naturally help keep water temperatures lower, thereby improving conditions for fish and other aquatic life.⁴²
- Densely planted hedgerows provide shade more rapidly than more widely spaced plants. In addition to providing conservation benefits, shading out potential weeds reduces maintenance effort more quickly after planting.⁴⁷
- Hedgerows are used to maintain drainage ditches that become blocked by reed canary grass, requiring frequent and costly dredging. Hedgerows can shade out the competing grasses without sacrificing much production land.⁴⁷



▲ This waterway through an agricultural area benefited from the landowners working with their conservation district to install a fast-growing, narrow hedgerow on both sides to shade the stream and slow and filter runoff. While wide forested buffers are best along riparian areas, densely planted hedgerows can quickly shade the waterway, maintaining the cooler temperatures required by many fish and other aquatic animals—while keeping more land in agricultural production. (Photos: Al Latham (before: left) & Michael Melton (after: right))

- In comparison to wide buffers, narrow hedgerow buffers require fewer plants, reduced labor to install, and generally fewer materials costs.⁴⁷ Any savings accrued can be potentially applied to creating buffers along longer stretches of affected waterways. In addition, hedgerow buffers require reduced inputs to irrigate, protect, and maintain the developing hedgerow as plants become established.
- Due to their narrower width, hedgerows can be placed on the landscape to provide a cost-effective and small-footprint strategy to intercept and capture pesticide aerial drift, thereby protecting water quality while also potentially meeting required standards.⁴⁸

Importance of wide riparian buffers: While narrow buffers and hedgerows can do a lot to protect water resources and habitat, it is critical to note that larger and wider expanses of vegetation between active agricultural activities and a waterway provide many benefits to a greater degree than narrow buffers. These wider plantings generally:

- Offer more overall wildlife habitat, both on land in the water;
- Help absorb changes to stream flows and meanders over time; and
- Naturally introduce wood into the streams—a critical part of aquatic habitat.⁵⁰

For overall ecosystem health and supporting the widest possible numbers of aquatic species, the value of wide, forested buffers that better mimic natural conditions cannot be overstated.

Multiple Benefits Close to Homes

In addition to all the agricultural benefits described, placing a hedgerow near the family home can provide such benefits as:

- Screening for privacy, noise reduction, and dust interception if nearby unpaved roads.¹⁸
- Intercepting air-pollution particulates if near roadways.⁵¹
- Designating property boundaries without a fence that requires maintenance.¹⁸
- Growing home-use woody food crops such as nuts, apples and berries close to the home.^{18, 12}
- Creating a trellis structure for small quantities of vining crops such as hops or grapes.
- Creating a vegetated buffer to receive and manage stormwater runoff from limited impervious surfaces, such as the rooftops and driveways associated with the home.¹⁸
- Creating summer shade for family and visitors, and provide natural cooling to homes or other nearby structures.¹⁸
- Blocking winter winds to cut down on home-heating costs.
- Beautiful flowers and other aesthetic enhancements near your home.¹⁸



▲ A hedgerow planted near a residence provides numerous benefits, especially creating a privacy and noise-reduction screen; reducing heating and cooling costs by providing summer shade and a winter windbreak; and maintaining property boundaries without the upkeep of a fence. (Photo: Erica Guttman)

Climate Change Mitigation

Our changing climate is the most pressing threat to agriculture, wildlife, water, and our homes. Hedgerows are a simple but effective way to sequester large stores of carbon, and many ecologists and rural-preservation experts advocate for planting new and preserving existing hedgerows as an important element in an overall climate-mitigation strategy.^{4, 52, 53} The greater diversity of woody species inherent to most hedgerow designs appears to be especially beneficial in storing more carbon than low-diversity plantings.⁵²

The benefits of hedgerows are as diverse as the needs and interests of the landowner. The remaining sections of this handbook will assist you in planning, implementing, and planting a hedgerow that meets your needs.



Photo: E. Guttman

Planning & Implementing Your Hedgerow

Once you've determined that a hedgerow is a good choice for your site, you'll want to explore the many resources available to assist you in designing and constructing it. But the first step is to clarify the purpose of your hedgerow (or hedgerows!), and understand the steps to implementation.

I. Define Goals

Step one in any planting project is to be clear about your goals. As noted in Section 1, there are many benefits to hedgerows, and you may find you have multiple goals that embrace these "co-benefits." But defining your **primary goals** for each hedgerow will help guide you in your next steps, including seeking assistance, determining your pathway to implementation, choosing plants, and creating a maintenance approach.



▲ With so many possible benefits derived from adding a hedgerow to your landscape, step one in implementation is defining your primary goals for each hedgerow you plan. Your goals set the stage for all design and implementation decisions. (Photo: Stephen Bramwell)

Your goals will impact the design and structure of the hedgerow, the plants you select, and possibly even the sources of funding available to assist you.

As a reminder, in Section 1, we grouped the primary goals of hedgerows as follows:

- Crop Productivity—Windbreaks & More
- Livestock Exclusion & Shelter
- Habitat for Wildlife, Pollinators, and Natural Pest Enemies
- Management of Dust & Odors
- Interception of Pesticide Drift
- Flood Management, Topsoil & Water Conservation
- Protecting Local Waterways & Enhancing Fish Habitat
- Multiple Benefits Close to Homes

II. DIY or Professional Help?

Your next step is considering how you will implement your project. Depending on your goals and the size of your project, you may want professional assistance with design, funding, and implementation (including equipment, supplies, plants, etc.).

Projects that are designed in support of conservation goals on agricultural lands or that will improve local waterways may be eligible for free technical assistance and even financial assistance through your local conservation district and USDA Natural Resources Conservation Service teams.



▲ The hands-on work of creating your hedgerow can be accomplished with professional help, your own labor (with friends!), or a little of each. Some funders will use DIY labor as a "match" against which you can secure funds for supplies, plants or renting equipment. (Photo: Erica Guttman)

There are also lots of resources for “Do-it-Yourselfers” who want to create small, “backyard” hedgerows, or for DIY folks who need a little support to bring their project to fruition. (See the technical assistance section in Appendix C.)

Many rural landowners use a hybrid approach, mixing professional and DIY labor, and—depending on the funding source—using their own labor as matching support to leverage funding for buying supplies. Others do most of the work themselves, but bring in professionals to assist with any elements of the project that challenge their knowledge, available time, or design capacity.

(Later in this section we discuss budgeting and ways to stretch your available resources.)

III. Implementation Plan

Whether seeking professional help or doing it all yourself, you’ll start with a plan. If you’re seeking professional help, your technical provider will assist you with some of these steps, but you’ll still need to consider all these factors and make your own decisions about how you will bring your plan to fruition.

Step 1: Size & Placement

Going back to your goals, you’ll make decisions on how wide, long, and tall you want your hedgerow to be to achieve your vision. Ultimately, your goals will drive these sizing decisions, and you’ll choose a combination of plant species that will achieve your vision (see Section 3).

- Minimal effective widths are generally at least 10–15 feet wide (though narrower is possible).
- Length will be typically determined based on what you’re trying to protect or exclude, while still maintaining key access points as needed.
- Height can vary over the length of a hedgerow, with occasional very tall plants interspersed with lower plants. Or, if shade is your goal, you’ll want to ensure that mature plants will ultimately be tall enough to cast sufficient shade during the summer months.

Placement: Next, you’ll determine the best location for your hedgerow to maximize its capacity to support your goals. As you consider this, remember a few basics:

- Site the planting so that irrigation can be provided for the first two to three growing seasons—this advanced planning will save you time and money later.
- Ensure that the hedgerow will not impede equipment access or that access can be provided as needed.
- Your hedgerow goal may determine how it should be placed. For instance, hedgerows for intercepting odors have very specific placement requirements in relationship to the source of the odor; hedgerows that support beneficial insects and natural enemies of pests should be placed in specific locations based on the prevailing wind direction in relationship with your crop.



▲ Technical providers from agencies such as USDA Natural Resources Conservation Service, your local conservation district, or your local Extension agricultural agent, can assist you with many steps in creating a successful design and implementation plan. (Photo: National Association of Conservation Districts)



▲ Hedgerow placement typically depends on the primary goals. This young hedgerow is sited where it can support pollinators and natural pest enemies, while also ensuring easy access to irrigation and not blocking equipment access to the fields. (Photo: The Farm at Franklin Pierce Schools)



▲ Several native shrubs spread aggressively via rhizomes, creating a thicket that is beneficial for many hedgerow goals. Rhizomatously spreading species can stretch your budget by helping fill in the lower levels of a hedgerow, but they're best used in hedgerows not adjacent to formal or tidy landscapes (e.g., not near homes). (Photo: Erica Guttman)



▲ Learning the details of your site's soils—from texture to drainage rates—is one of the most critical site-assessment steps to ensure you select the hedgerow plants best adapted to your site. (Photo: Erica Guttman)

- Place your hedgerow in the best alignment and the proper distance from crops to maximize its qualities for protection against wind and attractiveness to beneficial insects, while minimizing any conflicts, for instance:
 - > Tall or tree-based hedgerows can provide a good windblock for high tunnels, but they need to be far enough away to avoid casting shade.
 - > Ensure that your hedgerow placement won't impede the air circulation needed for your crops.
 - > Be sure that any shade or condensation generated from your hedgerow won't negatively affect your crops.
 - > Ensure that the hedgerow planting site will not be in conflict with crop space in the future—the hedgerow is a long-term investment.
- If your hedgerow is sited near your home and formal landscape, choose plants accordingly. Be cautious of using hedgerow plants that spread aggressively by rhizomes (underground stems), such as Nootka rose. The spreading feature is a benefit adjacent to a farm field or a natural area, but will encroach on tidy planting beds.
- Consider aesthetics, including views you **do** or **do not** want to obscure; for example, you may want to see your livestock, but maybe not their manure-management system.
- Hedgerows planted for wildlife, pollinators, and natural pest enemies often perform best when there is a greater level of connectivity with other hedgerows or natural vegetation, including forests and wetlands. When your goals are in alignment, consider how you can maximize connections or wildlife corridors.^{1, 18}
- Pay considerable attention to the design recommendations from USDA NRCS and experienced hedgerow designers.

Step 2: Site Assessment

(*See Appendix C, section 3 for more details about investigating some of these questions.)

There are many considerations in conducting a site assessment, but at minimum, you want to ensure a healthy and successful hedgerow planting. Here are the critical factors to consider, and we'll revisit some of these in Step 6: Site Preparation (p. 33).

Exposure: What is the sun exposure in summer? Light requirements and tolerances are an important first step in choosing the right plants for your site.

Soils and drainage: What is the soil texture, drainage capacity, and overall soil health?* Soil conditions, including how well your soils hold water and nutrients, will govern your plant list and possibly impact activities during site preparation.

Potential for seasonal flooding: Will the site be regularly inundated in the wet months? Plants tolerant of these conditions and summer drought can be used in your hedgerow.

Wind direction: Knowing how wind moves across your landscape in different seasons will ensure you site your hedgerow in the most beneficial location and orientation. As noted in the placement discussion, you need to know wind direction to ensure your hedgerow can best protect crops, high tunnels, and other infrastructure, as well as support and provide refuge for beneficial insects.

Suitable topography: Are there factors in the topography that will impede hedgerow growth and function? (For instance, is the soil so rocky that it will impede root expansion and slow the growth of the hedgerow's trees or shrub? Is the hedgerow location prone to such significant seasonal saturation that plant species will be severely limited?) It may be necessary to find a more viable location.

Potential for wildlife browse: Are there beavers, deer, cottontails, moles/voles/mice, or other herbivores likely to damage newly growing plants? You can plan for management of these species by protecting your plants when they're getting established (see Step 9, p. 40).

Potential for livestock browse: You may need to fence temporarily to ensure that your hedgerow can get established, and you'll choose plants that are beneficial for livestock and can withstand some browsing once they are mature.

Proximity to a waterway: Will the planting potentially affect a fish-bearing stream, requiring actions to avoid potential harm to the stream or requiring a permit with a wildlife agency? If your hedgerow planting is adjacent to a waterway, be mindful that soil-disturbing activities can impact water quality and may be restricted to particular times of year. You can implement sediment-catchment systems to prevent harm to the waterway.*

➤ Note that landowners are often unaware that a nearby waterway supports fish—they are often present without us noticing. Even if there are no fish in an immediately adjacent waterway, that waterway will drain to another water body that supports fish and other aquatic species that need clean, clear, cold water.

Endangered Species Act: In addition to impact to wild fish, there may be other critical animal species that could be impacted by your project, such as the Oregon Spotted Frog or the Mazama Pocket Gopher. Local NRCS professionals can guide you through this assessment and any necessary mitigation.



▲ If a hedgerow is placed in fields with wintertime saturation, care must be taken to ensure plants are selected to withstand the conditions. If a field experiences flooding throughout the year, it is likely not a good location for a hedgerow. (Photo: Envato Elements)



▲ As part of your site assessment, if you see signs of wildlife visiting the site that could cause damage or death to your new hedgerow plants through ongoing browsing, rodents girdling the bark, or deer/elk rubbing their antlers on establishing trees, you'll need to protect young plants by using various protection devices or temporary fencing. (Photo: Michael Melton)



▲ Fish and other animals in nearby streams must be protected from potential migration of silt during construction of hedgerows. If you have threatened or endangered fish or other species nearby, seek guidance from technical experts, such as USDA NRCS or your local conservation district. (Photo: Michael Melton)

Potential for historical or cultural resources: Will digging in the area potentially disturb cultural resources? Check in with the Washington State Department of Archaeology and Historic preservation to protect against accidentally disrupting archaeological or cultural resources during excavation, which landowners have a legal responsibility to protect. Note that if you're working with an agency such as USDA NRCS or your local conservation district, agency staff will assist you with this process. However, if you are doing your project without agency support, you can submit a confidential request to learn if there are known records on your site and ask questions about being in an area of concern. If you encounter historic resources or human remains, you should report them to DAHP.*

Utilities: Will there be any impact to power, water, gas, cable, or other utilities during site preparation or planting the hedgerow? A utility "locate" may need to be completed to identify any underground utilities,* and the presence of overhead power lines should also be considered with regard to tree height. If there are any utility easements, they will likely have defined, required setbacks. Before digging or bringing in large equipment, you must know where all utilities are so you can avoid them. See Appendix C, section 3 for public and private "locate" options.

Production areas, structures, access points: Be mindful of all human activities and ensure the hedgerow is placed and aligned to avoid conflicts.

Irrigation infrastructure—wells, mainline and other lines: Consider both access to irrigation for establishing your hedgerow as well as not impinging on access to these critical parts of sustaining your operations.



▲ Existing vegetation on the site can offer clues about site conditions and what hedgerow plants will be most successful. Keep an eye out for existing species that have particular needs that indicate challenging conditions. For example, plants like Skunk cabbage on a seemingly dry site would indicate subsurface water. (Photo: Erica Guttman)

Existing vegetation—presence of invasive or aggressive plants: Are there currently species, such as blackberries or reed canary grass, that must be managed before planting?*

Existing vegetation—clues to site conditions: What plants in the vicinity of your hedgerow site are growing well in similar soils? Make notes of these species, as they can provide clues about the site conditions and point the way to other species that are likely to thrive, or have been historically present. Even some invasive plant species will offer these clues if they have specific site-condition requirements for successful growth. If your hedgerow will be placed in a riparian area, you may need to look upstream or downstream to find intact habitat for clues of the plants that will grow well there.

Make notes regarding all these points and any other factors that need to be considered in planning your hedgerow implementation.

Step 3: Planting Plan

The next step is to determine the species of plants you will need. These multiple resources will make this process easier:

1. **Section 3** provides extensive details about plant selection, stock types, and general hedgerow design principles.
2. Our sortable **Hedgerow Plant Options Table** (discussed in Section 3, p. 56) allows you to create your own customized "wishlist" of plants for your hedgerow, or to expand on our Hedgerow Planting Templates.
3. The "ready-made" **Hedgerow Planting Templates in Appendix A** align with specific hedgerow goals. Each of these can be adapted to fit your site, and we offer substitutions for you to increase diversity or use alternative species.

During site preparation, it's possible to improve some unfavorable site conditions, but it's best just to make a site prep and planting plan that accommodates the realities of the site.

You will use the information gleaned during your site assessment to select plants that will thrive in the conditions your site offers. If your site offers very challenging growing conditions, it is possible to improve some conditions (mostly with regard to soils) as part of site preparation—especially if you are willing to improve soil tilth over a few years.

However, for most projects, it's best just to plan for the conditions that **currently exist**, and select the appropriate species (and mitigation efforts, if needed) to ensure a successful hedgerow. Challenging site conditions may narrow the list of plants to choose from, but there are plants that will grow successfully in just about any conditions.

General hedgerow structure: A typical hedgerow has a “backbone” species—usually a tree or large shrub. These are enhanced with large, medium and small woody plants for the various layers of the hedgerow. Depending on the goals, some people select a few specialty plants to integrate intermittently, such as fruit or nut plants. Hedgerows are usually a mixture of evergreen and deciduous woody plants, and some incorporate vines, using the woody plants as a trellis.

You'll see in Step 2 of Section 3, and in Appendix A, that different plant characteristics are needed for different goals. These tools will help you best select plants for your goals, including ensuring, for example, continuity of blooms and fruits if your goal is attracting pollinators and beneficial wildlife to enhance crop production. (These plant characteristics are discussed in more detail in the Plant Selection Process in Section 3, p. 53.)

Add-on strips: Some hedgerows also include an added “belt” outside the woody plants' footprint that features herbaceous perennials or non-invasive grasses/grass-like species. These are typically plants that will thrive in full sun when the trees and shrubs are too young to cast shade. Over time, at least part of these plantings may need to be replaced with a secondary list of species adopted for shade, after the hedgerow has matured and now has capacity for shade-tolerant low-growing shrubs, perennials, and ferns as an understory planting.

Since these sun-loving perennials may be providing additional forage for pollinators and other beneficial species during the growing season, consider making your perennial belt extra wide or leaving space for another, future planting in front of the shaded-out area. (In Appendix A, you'll find our suggestions for these shade-tolerant additions.)

Understory additions are not always part of hedgerow design, but can be useful depending on your goals. For instance, some



▲ In planning your hedgerow, first select the plants that comprise the “backbone” structure. Usually these are the largest trees or shrubs, and they're often evergreen. Shown here are Shore pines and California wax-myrtle, this hedgerow's backbone species and the first to be laid out and planted. (Photo: Stephen Bramwell)



▲ Planting herbaceous perennials, self-seeding annuals, and non-invasive grass-like plants as an add-on belt outside the perimeter of the hedgerow's footprint of trees and shrubs can support more beneficial insects and natural pest enemies, among other benefits. (Photo: Erica Guttman)



▲ As your hedgerow matures and provides shade, you may wish to add shade-tolerant low shrubs, ferns, and herbaceous plants. Additional species can enhance habitat, prevent weeds, and intercept/filter runoff. (Photo: Erica Guttman)



▲ Following typical spacing guidelines (or using the template blocks offered) should result in your hedgerow filling in with the appropriate level of density desired. You can choose to plant more or fewer plants to space them closer or further apart, depending on your goals. This aerial view shows a hedgerow in late winter, six years after planting, with only a few gaps still to be filled in as the larger plants mature. (Photo: Michael Melton)

of these species will enhance pollinator benefits or repel pest species. Cultivating an understory layer of densely twiggy or herbaceous species may increase the capacity of your hedgerow to treat polluted runoff and protect nearby waterways or groundwater, by intercepting and filtering runoff before it enters waterways or drinking-water aquifers.

Understory species can also cover bare ground to prevent unwanted species. Again, plant selection will be dependent on your goals. You can mix woody and herbaceous understory species for more season flux, but **if** the benefits of the herbaceous layer do not outweigh the expense and maintenance needs, you may choose to focus on the easier-to-manage woody plants alone.

Step 4: Number of Plants Needed & Row Design

Once you've chosen your species, the next step is to consider how many of each you will need; what kinds of plant stock you want or can afford; how to obtain the plants; and how to adjust any of these factors to fit your budget.

To determine numbers needed, you need to determine how far apart to space your plants from each other. The Hedgerow Planting Templates in Appendix A offer several spacing-density options, and the number and types of plants required for each. *These will allow you to bypass the need for making your own calculations, skipping directly to plant selection.* However, learning about spacing principles will help you remain agile in the future if your site,

goals, or budget changes—or if you prefer to customize our templates.

General spacing guidelines: Most hedgerow design guidelines recommend spacing shrubs 3–5 feet on center and placing trees 8–12 feet on center, depending on the species (more details in *Table 1: Hedgerow Plant Spacing* in Section 3, p. 52). However, you can make fairly accurate calculations if you consider the actual mature spacing recommendations for each species you've chosen, and then reduce that somewhat—forcing the plant to grow more closely to its neighbors, and better weaving together the density of your hedgerow.

These guidelines are good starting points, but bear in mind that different plant species have different growth habits, and spacing needs to adapt to accommodate those. For instance, some plants will create dense clumps and might spread into the interstitial spaces between other plants over time (e.g., snowberry and native roses); while others might have lateral branching patterns that will knit together with adjacent species.

Growth & fill-in rates: Speed of growth might also be a factor to consider. The fastest-growing species will occupy the space first and slower growers will need to accommodate that growth. Also, depending on how quickly you hope to establish your hedgerow, buying larger plants in the slower-growing species might be a way to hasten your hedgerow's maturity (if your budget permits the expenditure).

Key spacing principles: Some hedgerow designers suggest reducing the spacing as much as 75% the recommended

spacing you would use in a non-hedgerow planting. You can make your own decisions about how tightly you want to space your plants, balancing these factors to create a design that is just right for your goals:

- Take care not to space plants **too** closely—the plants need enough room to avoid competing unnecessarily for nutrients, water, and space. (An exception is that low-growing, rhizome-spreading plants, such as snowberry or thimbleberry, can be placed close to the larger plants to create thickets at the lower levels early in the hedgerow’s maturation.)
- The closer you space your plants, the more you will need—increasing the budget.
- The closer you space your plants, the faster you will create shade and outcompete weedy species, reducing maintenance time sooner. (See p. 46 “Understory species: yes or no?” for more on doing this inexpensively.)



▲ Plant species that spread by rhizomes can expedite closing gaps between plants to achieve a dense hedgerow. Here, we see Common snowberry (*Symphoricarpos albus*) and Nootka rose (*Rosa nutkana*) creating an impenetrable thicket for habitat and other benefits. These two species are also useful in their adaptations to sun or shade and many soil conditions. (Photo: Erica Guttman)



▲ Instead of removing all the pasture grasses prior to planting, on this site the grasses were stripped in rows just wide enough to plant. This hedgerow planting arrangement was designed for maintaining the pasture grasses through regular mowing until the hedgerow plants are established sufficiently to shade the grasses, with the spacing between rows the width of the landowner’s mower. (Photo: Kevin Jensen)

- If you expect high mortality due to planting conditions (e.g., rocky soils) or the kinds of stock you choose (e.g., tiny bare-root plants), you may need to overplant initially.

Row design: Most narrow hedgerows are at least two or three rows, such that plants can be placed in a triangulated pattern in relation to each other; this gives them each space to grow, while still resulting in the ultimate vegetation density desired. You'll determine both **how many** rows and **how wide** they should be based on your goals and the decisions you've made about how wide you want your hedgerow to be overall. (Our Hedgerow Planting Templates assume a 15-ft. width, and the "rows" for most templates are more loosely defined to maximize the density and diversity shown, but you can still arrange your plants in manageable rows, using our templates as guides for general layout and plant choices.)

Space for early maintenance: When your hedgerow is just developing, before plants start to weave together, you might find that occasionally mowing encroaching invasive grasses and other weeds is an easy way to reduce competition on the hedgerow plants you want to flourish. Thus, if it works with your planting plan, you can space your rows to accommodate the width of your existing mowing equipment.

This strategy is more difficult if you incorporate many live stakes of rhizomatous woody plants that will spread between rows, as you want to encourage those to mature and displace weeds, and mowing will delay their growth. However, if concerned about keeping up with encroaching weeds, another strategy is to delay—by a year or so—planting these "fill-in" low-growing and fast-spreading plants until the taller shrubs and trees are getting established and mowing is no longer needed.

An alternative to mowing between rows is the sheet-mulching method discussed in Step 6: Site Preparation, p. 33.

Step 5: Budget

Using the tools discussed in Section 3, you can calculate the approximate number of plants you'll need for each species you've selected. At that point, you'll be able to source your plants and start on your budget.

There are many factors that go into your budget. In Section 3, we delve into plant costs and options. For now, let's look at the **other potential costs** for installing your hedgerow:

Labor can include activities such as: site assessment; design and/or technical assistance; irrigation planning and installation; site preparation efforts (with or without equipment); planting; mulching; securing and removing predator-protection devices; maintenance—weeding, mowing, etc.; monitoring; replanting, as needed; fencing installation, if needed; building new alternative livestock drinking-water system (removed from the waterway), if needed.

Materials might include: rental or fuel for tilling equipment (if needed for site prep); purchase or delivery of sheet-mulching materials (burlap/cardboard and wood chips) if needed for site prep; plants; mulch/delivery; plant-protection devices (to prevent predation from mammals, such as deer and mice, if needed); livestock-exclusion fencing materials (if needed); irrigation supplies.

See the sample budgets included in Appendix B.

Budget-stretching options:

1. **Labor:** Many rural landowners find that installation of hedgerows even a few hundred feet in length can be accomplished through DIY labor, especially if gathering together friends and family to make it a fun and educational event.



▲ The hedgerow's plants will be one of the most important—and potentially costly—parts of the budget. Fortunately, there are ways to stretch your budget while still investing in quality plants from reputable regional native-plant and wholesale nurseries. (Photo: Ben Alexander)



▲ Gathering friends and family can make a much quicker job of prep work and planting the hedgerow, while saving money, building community, and teaching others about the benefits of hedgerows. (Photo: The Farm at Franklin Pierce Schools)



▲▼ Save money on plant purchases by maximizing the use of low-cost options such as live stakes for plants such as willows or snowberries (which grow easily from live stakes) (above); and by using inexpensive, small potted plants where possible, such as tubes or plugs for various grasses, rushes, sedges, and herbaceous perennials (below). Larger-sized stock can be worth the investment for plants that are critical to the design, but grow slowly. (Photos: Ben Alexander)

But larger projects will likely require hiring some help, and many with smaller projects do not have the time or physical capacity to provide DIY labor for these projects.

There are various government-funded programs, and some limited private foundations, that can help landowners achieve conservation goals through the installation of hedgerows.

2. **Materials:** The cost of these materials adds up quickly! Large hedgerow projects can easily strain one's budget, even when taking into consideration the potential benefits of the hedgerow that may result in future cost savings.



Investigating the options for grant-funded programs listed in Appendix C, section 1 can make a large project affordable.

Plant options for saving money: Additional savings can be realized based on the choices made when purchasing plants. The various options for different types of stock are discussed in Section 3, including ways to reduce costs. One variable is the age and stock type of the plants. Consider:

- Smaller potted plants are less expensive than larger ones.
- If you're not in a rush, live stakes of plants such as willows and snowberries are much cheaper than mature, potted plants, and you can plant them more densely for faster coverage. Bear in mind that there is a limited list



▲ **FIGURE 8.** If you place fresh mulch in advance of planting, be mindful to (1) move it out of the way when you plant so it doesn't go in your planting hole (spreading it out again after planting); and (2) to place the soil you dig out of each hole on a small tarp or burlap sack to prevent the soil and mulch from mixing (which can result in both future weeds and mulch inadvertently going back in the hole when you refill).



▲ If the timing between doing site work (such as removing invasive plants or improving soils) and planting leaves soils exposed, cover bare soils with heavy mulch until ready to plant. This prevents weedy species from taking root and keeps the topsoil from eroding—and after planting, the mulch will already be on the site. (Photo: Erica Guttman)

of species that will be successful as live stakes. (You can also learn to harvest them yourself from mature plants that may already be present on your property, saving even more.)

- Plants that spread aggressively by rhizomes can fill in bare areas and densify the hedgerow without you having to buy as many plants.
- If you can wait a few years for them to mature, bare-root plants, available in late winter for several hedgerow species, are also an inexpensive option.

3. **Phasing:** Another way to stretch your resources is to consider phasing in your project over time, by breaking it into manageable sections. This allows you to undertake a discrete section with the amount of resources available in a given time period. You'll need to be realistic about your timeframe and make a plan that encompasses as many months or years as you will need to bring each section to fruition.

If you're planning a very long hedgerow, for example, you could implement it in small sections. However, you should consider if this will ultimately save you money, as sometimes there are financial benefits from bulk-buying supplies or doing all your site preparation at one time, for example. Similarly, you may see a role for multiple hedgerows. Prioritize the most important and implement them in phases as you have adequate time and resources.

As you think about phasing your project, you should be sure that each activity is appropriate to the seasons. For instance, plan to remove invasive species in the spring or late summer if at all possible, and to plant in fall or early winter to get plants off to the best start. If you need to do site work that leaves soils exposed and you won't be planting immediately, you'll need to apply heavy mulch, such as arborists' wood chips, to prevent soil erosion and invasive species from getting started.

Step 6: Site Preparation

A new hedgerow's success is directly tied to the attention paid during the site-preparation stage. The amount of preparation is entirely dependent on the site conditions identified during the site assessment, with some sites requiring very minimal preparation and others possibly requiring many months of planning, or even action taken the *previous year or two* to begin suppression of invasive plants or improving the soil.

During your site *assessment*, you gathered a lot of information to plan for implementation. Here we discuss some of the critical elements in more detail.

The texture and health of the current soil conditions: Are the soils workable? Are the soils highly compacted, or so rocky that there is limited soil, or heavy clay, or fast-draining sand? Do they require the addition of organic matter? Organic matter can improve the structure of soils, water-holding capacity, and availability of nutrients.

Depending on the soils, organic matter can be easily added by evenly incorporating compost, or for a longer-term project, by piling a few inches of arborists' wood chips on the top of the soil and allowing the chips to slowly add organic matter and beneficial fungi to the soils over the course of a year or more. Patience can pay off here if you can keep adding wood chips for a few years and letting the decomposition process naturally improve your soils.

Sometimes site preparation requires tilling in organic matter, but that is not feasible in heavily rocky soils. Soils that have been heavily compacted over time—especially from heavy machinery—may require “ripping” with small excavators. Local technical experts from the USDA NRCS or conservation district can best advise you about probing for soil problems as well as how to address them. (These same experts can advise how to prevent sediment from soil-preparation activities from inadvertently harming nearby waterways.)

Some hedgerow experts advise a year of improving soil health through the use of successional cover crops such as crimson clover and buckwheat, and tilling those in prior to planting. Again, USDA NRCS and your local conservation district staff can offer advice for the best approach to your site.

► *What about fertilizing?* If you are concerned with soil's nutrients, your local conservation district can perform a soil test to assess any needs you may have. However, adding fertilizers is not necessary nor recommended for the native and water-wise plants used in hedgerows. Unnecessary fertilization of native plants can negatively affect both root growth and top growth, and may reduce plant biodiversity by causing certain species to grow at unnatural rates and outcompete other native plants. Unnecessary nutrients have even been found to disrupt the important relationship between plants and their associated below-ground mycorrhizal fungi.^{1, 54} Moreover, the high levels of nutrients can penetrate groundwater, run off and cause water-quality problems in local waterways, and damage important beneficial insects.^{12, 17, 55}

Rather than the investment in fertilizers, hedgerow experts advocate applications of



▲ Soils can be improved through top-dressing with compost, wood chips, or both, and allowing the organic material to work its way into the soils over time. On this site, prior to planting the farmer applied a layer of compost, topped by wood-chip mulch, to both improve soil structure and have mulch in place when fall planting commenced. (Photo: Stephen Bramwell)



▲ There are situations in which making a small change to the topography might enhance the hedgerow's capacity to meet goals or to grow successfully in challenging site conditions. Any changes to topography—small or large—may require a permit; check with local USDA NRCS advisors or county planning staff for assistance. (Photo: Greg Rabourn)



▲ Prior to planting, tackle the invasive plants that are present in your future hedgerow's planting footprint. For especially pernicious weeds, you may need to plan a year or more to fully eradicate them and ensure a successful project. (Photo: Erica Guttman)



▲ Site prep for this hedgerow utilized on-farm equipment to quickly remove pasture grasses from the planting area, with a maintenance plant to mow the grasses between the rows until the hedgerow matured enough to shade out or displace them. A sod pile from this type of prep can be sheet mulched, creating a compost-rich planting soil within a year or so after the smothered grasses have decomposed. (Photo: Kevin Jensen)

compost where needed and natural mulches, such as arborists' wood chips. Top dressing with organic matter supports the soil food web, including mycorrhizae, which all in turn support the plants in hedgerows.^{35, 56} Research by the mycologist Paul Stamets shows that simply applying coarse wood chip mulch to native forest plantings serves as a "source of delayed-release nutrients" and helps retain moisture. Moreover, wood chip application alone hosts enough range of mycorrhizae that increased tree growth above and below ground can be measured in less than a year over untreated plots on the same site.⁵⁶

Topography and potential for flooding:

Although plant species can be selected that are adapted to seasonal flooding, a hedgerow will be far more successful if it can incorporate a more diverse range of species. Many hedgerows adjacent to waterways have been successful through raising the elevations via berms or interspersed mounds in the planting zones.

If you're changing topography—either by raising the soil elevation or scraping soil away to make a flat or indented area—you should check in with a technical expert from your local USDA NRCS office and regulatory advisors from your local development-services agency. Especially near a waterway or another designated Critical Area, you may need to apply for a permit. Your county's planning department or permit assistance section will provide guidance on what is and is not permissible without a permit.

Current vegetation, including invasive or aggressive species: Before you can plant the desired species, invasive species must be removed or suppressed. Local weed-control agencies, WSU Extension offices, and conservation districts can provide guidance on appropriate removal techniques (see Appendix C).

Some hedgerow implementation guides encourage tilling in or plowing under weedy sections. However, if you till under rhizomatous invasive plants, you could inadvertently compound your future work! You also need to be careful to minimize soil disturbance, which can create erosion and safe harbor for weed seeds.

Depending on your planting plan, even weedy pasture grasses, heavily seeding annuals, and deeply tap-rooted perennials can be impediments to a successful start for hedgerow plants. However, it's also possible to manually remove these weeds just from the area around the root zones of the new plants, mulch or sheet mulch between the new plants, and then maintain the area to suppress these weeds for a few years sufficiently to permit the new plants to get established (and ultimately shade out some of these weeds).

Some landowners borrow, rent, or use existing on-site equipment—such as small tractors or backhoes—to scrape surface grasses and other weeds from the planting site. Recognize that this method may result in a loss of both topsoil and organic matter, and thus top dressing with compost may be needed to restore soil function.

Sheet mulching can both suppress weedy grasses and prevent new weeds from colonizing bare ground. Sheet mulching involves laying down thick layers of cardboard or other biodegradable material (such as burlap coffee-bean bags) and covering them with 3–6 inches of wood chip mulch. Alternatively, you can stake down thick layers of burlap without mulch, or (much less effectively), just lay down wood chip mulch in a heavy layer (six inches or more, depending on the weeds).

Another benefit to sheet mulching is that the resultant soils will have an added dose of organic matter from the decomposition of the weeds/sod and cardboard/burlap. Many choose this strategy for its multiple benefits, although it requires a larger initial investment in time and requires patience for the process to be completed. (See Appendix C for more directions.)

Solarization & occultation: Another strategy to kill invasive grasses, annual weeds, and some perennial forbs is “solarization” (with clear sheeting) and occultation (with opaque materials). This practice involves mowing the grasses and weeds to a very short length (or sometimes tilling), then securing sheeting or tarping over the weeds for the duration of the growing season.^{57,67} Note that clear sheeting is the fastest, and if black or opaque plastic or tarping is used, then a longer treatment time is required.⁵⁸

In addition to killing weeds and weed seeds, there are other documented benefits from solarization or occultation:

- By changing chemical and physical properties of the soil, organic matter in the soil is broken down more rapidly, thereby making nutrients more available to plants and improving growth.
- Some pests may be killed in the process, including soilborne pathogens and some nematodes.⁵⁸

There are also some limitations to solarization, chiefly that it is not entirely effective on some invasive plants, especially deeply tap-rooted perennial forbs and the persistent field bindweed



▲ Sheet mulching is a useful method that kills weeds while also improving soil. Weeds are smothered with castoff biodegradable materials like cardboard or burlap, which are then usually covered with wood-chip mulch to keep the layers of biodegradable barrier material in place. The material is left in place for several months to about a year, until the weeds below decompose, adding organic matter to the soil. (Photo: Andy Hopwood)



▲ Solarization (with clear sheeting) and occultation (with opaque materials) are other options for killing weeds prior to planting. After mowing weeds, sheeting is secured to the ground for the duration of the growing season. These methods can improve soils and may kill some pests or pathogens. (Photo: Ryan Maher, Cornell Small Farms Program)

(aka perennial morning-glory). Moreover, the extensive use of plastic sheeting can be expensive and wasteful, although this can be mitigated in a few ways:



▲ Solarization may create conditions that support beneficial fungi and bacteria that parasitize pathogens and support crop growth. Wood-chip mulch applied to the soils following a treatment of solarization or occultation may further boost beneficial fungi. (Photo: The Farm at Franklin Pierce Schools)

- Worn UV-stabilized sheeting from on-farm operations such as high-tunnels can be patched and repurposed for solarizing projects.
- Phase your project such that you solarize small sections at a time, allowing you to reuse the same UV-stabilized plastic sheeting over and over, thereby minimizing expense and waste.
- Temporarily repurposing existing heavy-duty tarps saves both the expense and waste.

Solarization raises obvious concerns about potential negative impacts to healthy organisms and mycelium webs that have mutualistic relationships with plants. However, researchers at University of California Division of Agriculture and Natural

Resources found that, “although many soil pests are killed by soil solarization, many beneficial soil organisms are able to either survive soil solarization or recolonize the soil very quickly afterwards. Important among these beneficials are the mycorrhizal fungi and other fungi and bacteria that parasitize plant pathogens and aid plant growth. The shift in the population in favor of these beneficials can make solarized soils more resistant to pathogens than nonsolarized or fumigated soil.”⁵⁸

In addition to mycorrhizae being more resistant to the destructive qualities of heat than most plant-pathogenic fungi, the addition of wood chip mulch on the soil surface following solarization will also reinvigorate beneficial fungi as the fungal hyphae colonize the woody substrate.⁵⁸ (For more about the science of solarization and various treatment options, see Appendix C.)

Seasonal timing for site preparation: You can do site prep at almost any time of year, but here are a few considerations to maximize effectiveness:

- Soil-moving work in winter when soils are saturated can damage your soil structure through compaction of pore spaces, and it could take years or application of organic matter for them to recover.
- Some invasive plants are best controlled through timing of both their bloom and the return of nutrients to their roots in fall before they go dormant. Tackling these plants when energy is directed to the flower (typically spring) or back to the roots (fall) will weaken them over time.
- Since the hot-weather months are not conducive to planting, productive activities for spring and summer months include removing invasive species, improving soil if necessary, and doing any other site preparation that doesn't leave the soil exposed to receiving new seeds.

Step 7: Planting & Mulching

Follow the planting plan you developed or the specific Hedgerow Planting Template you selected from Appendix A based on your goals. How and when you plant are important factors to consider.

Timing: In our region, fall is an ideal time to plant: soils are still warm enough that plants can establish some roots before winter, and Mother Nature helps “water in” the new plants, dramatically reducing the amount of irrigation required the following spring/summer. But we can also reliably plant through winter months, and sometimes that is necessary due to the availability of certain types of plant stock—discussed in Section 3, p. 48.

Potted plants can be planted at any time, but some species may sell out early, so reserve the ones you need. Live stakes can be harvested and planted when plants are dormant. The ideal window is mid-October to mid-March (depending on rainfall). Bare-root trees and shrubs are an excellent way to stretch the planting budget, as they are very inexpensive, but fall plantings may not align with their availability. Bare-root woody plants are typically available in winter months (January–March), though some nurseries **do** provide a limited species selection as early as October/November.

Consider your ideal planting window(s) as you plan for purchasing plants. Depending on the complexity of your plant choices, you may need to contact nurseries and reserve your preferred species as soon as you have your planting plan finalized (see more in Section 3, p. 57).

Planting techniques: A successful hedgerow installation requires good planting from the start; think “quality” over “quantity.” Depending on your soils, each plant may be quick or slow to plant—don’t rush this. There are specific planting techniques for installing live stakes, bare-root plants, and potted/containerized stock. Additionally, successfully planting on a slope requires learning a few tips to prevent erosion and ensure a good start for those plants. If you’re new to this kind of planting, take time to review the written and video tutorials noted in Appendix C, section 3.

Mulch tips: Mulching can be a new planting’s best friend: mulch suppresses competing/weedy plants; slows rainwater and irrigation so it penetrates plant roots instead of running off; helps retain moisture by keeping bare soil covered; prevents erosion; regulates soil temperatures so plants are warmer in winter and cooler in summer, reducing stress and evapotranspiration; supports healthy soil, by kickstarting soil biota and beneficial fungi; and adds new organic matter into the soil profile over time, as it breaks down. Mulch can even help treat polluted runoff!

Preferred mulch: Arborists’ wood chips are the preferred mulch. Studies by WSU and UW have consistently shown the value of this—typically free—material. Depending on where you live, you can often arrange for arborists to drop it off for you, either for free or a small delivery fee. Many



▲ Planting your hedgerow in fall allows time for new plants to establish some roots, while taking advantage of the fall rains. Fall plantings typically require less irrigation during their first summer than spring plantings. Planting in winter when plants are dormant is also possible, except during periods of extreme cold. This timing aligns well with the availability of bare-root stock and live stakes. (Photo: Erica Guttman)



▲ Different types of plant stock use different methods and tools for successful planting. Learn the techniques needed and ask local natural-resources agencies about borrowing tools, such as this planting bar shown above that makes pilot holes for live stakes, allowing quick planting in uncompacted soils. (Photo: Cameron Dunn)



▲ After planting, apply a coarse mulch between the hedgerow plants for numerous benefits, such as weed control, water regulation and conservation, erosion prevention, soil improvements, and more. (Photo: The Farm at Franklin Pierce Schools)



▲ Coarse, woody material—such as wood chips generated by arborists—make ideal mulch for hedgerow plantings. The coarse texture slows down rain, allowing it time to soak into the ground; it provides a good substrate to “kickstart” healthy soil organisms and encourage beneficial fungi; it provides a “blanket” to regulate temperatures; and over time it breaks down to add organic matter to the soil. (Photo: The Farm at Franklin Pierce Schools)

local landscape-supply businesses now sell and deliver it if you can’t get it free. See Appendix C for more on obtaining wood chips.

On the top, not in the hole: When applying mulch, you need to be mindful not to mix fresh or uncomposted mulch in the hole when planting. If you’ve sheet mulched in advance of your planting, carefully scrape the “green” mulch away from each hole so it does not fall in. After planting, apply the mulch up to a few inches thick over each plant’s rootzone, being careful not to pile it up such that it affects the plant’s stem. Between plants, apply the mulch even thicker if you have enough on hand. Adding cardboard between plants and then placing mulch on top can help if you’re still fighting invasive plants.

Step 8: Irrigation

Your hedgerow will require some form of irrigation for the first two to three growing seasons after planting. Planting in fall can reduce the amount of irrigation needed the first summer, and you will need considerably less the second summer. There are many irrigation options to explore, and a few of these are discussed more in Section 4, p. 60, “Irrigation Plan.”

Some grant programs, such as through USDA NRCS, pay for irrigation equipment—see the funding resources in Appendix C.



▲ Plan for regular irrigation during the first two to three growing seasons after planting, reducing the frequency of watering as the hedgerow matures. Some grant programs can support irrigation equipment, and irrigation strategies are discussed further in Section 4. (Photo: Stephen Bramwell)

Step 9: Animal Exclusion

Most new hedgerows need some protection from mammals of all sizes to allow them to thrive. Looking back at your site assessment results, you'll want to choose the right methods for the mammals you're contending with.

Wildlife browse: As part of your site assessment, you evaluated the potential for wildlife to browse or girdle your young hedgerow plants. If the likelihood is high for this damage, plan early to keep weedy grasses sheet mulched or mowed short between desirable plants to prevent some smaller mammals from hiding for easy predation.

Fencing & plant protectors: Depending on what kind of damage you are planning for, you may need to consider short- or long-term fencing or plant-protection devices. Some grant-funded programs, especially those through NRCS, will support the costs of plant protectors or fencing.

Tall plants may require fencing to prevent heavy deer browse, or livestock intrusion if that is a concern.

There are a variety of commercial plant-protection devices available to guard plants against browsing new buds, girdling from small mammals, or rubbing the bark of live stakes by deer or elk. Protection devices are highly visible, making it easier to keep track of your plants, and they prevent damage from close mowing or power weed trimmers—an especially useful feature on sites with heavy grasses that can overtake new plantings if left unchecked.

An additional feature of some types of protectors is that they act as a mini-greenhouse, increasing heat and humidity inside the tube, and frequently spurring faster growth. The plastic tubes might also provide a place for condensation to accumulate, thus providing a very small amount of direct moisture as the condensation flows off the plastic onto the ground. *One caution: the greenhouse effect is not always an advantage, and could actually cause plants to overheat on very exposed sites with excessively free-draining soils. In these conditions, opt for mesh protectors.*

Protection devices should be installed at the time of planting, and removed a few years later when plants are established. Follow instructions and ensure they are securely staked. Appendix C has information on different options.

Before buying new plant protectors, check with your local conservation district or NRCS office to see if other landowners have donated theirs back once they were no longer needed. Local land trusts and other conservation groups might also have



▲ If your site assessment revealed the presence of mammals likely to browse or girdle your plants, plan for short- or long-term fencing or plant-protection devices. Funding for devices may be provided through some grant programs, and natural-resources agencies can often loan used devices until your plants have matured adequately to no longer need them. (Photo: Ann Marie Pearce)



▲ Various styles of prefabricated plant-protection devices will protect plants from mammal damage. A closed plastic tube can also protect maturing plants from mowing or power weed trimmers, and can create a mini-greenhouse effect, providing more heat and moisture via condensation directly to each protected plant—which can be advantageous for some species but not others. (Photo: Frank Corey)



▲ Open mesh plant-protection devices allow more air flow and do not have the advantages or disadvantages of creating a mini-greenhouse effect. This style is very economical, especially if you need a taller tube for deer protection. An easy device to save for reuse, check with natural-resources agencies that might lend them or accept yours for donations to others when done. (Photo: Sound Native Plants)

protection devices to give away or for loan. (And consider donating yours to a conservation agency when done to minimize waste.)

Livestock exclusion: If you have free-roaming livestock, they must be excluded from the hedgerow until it has matured adequately to repel the stock animals—typically at least five years. Moreover, most grant-funded programs will require fencing livestock from accessing the hedgerow buffer and nearby waterways. When doing site preparation, ensure you make plans for livestock-exclusion fencing if warranted, and pay attention to placement of the fencing line: it will need to be positioned far enough from the planting to ensure that animals can't browse

on the tops of the maturing vegetation. Fencing can be customized to meet the needs of your livestock. (If you're planting your hedgerow to exclude livestock, investigate the plant options that are recommended for this, such as hawthorn trees, and avoid plants that could harm your livestock.)

Step 10: Monitoring, Maintenance, Adaptive Management

Once planted, your efforts turn to enjoying your hedgerow and keeping it surviving and thriving! A critical component of implementation is establishing a plan for how you will regularly monitor and maintain your hedgerow. Ongoing monitoring will help you address concerns and prevent them from becoming significant. These essential elements of ensuring your hedgerow is successful for the long haul are discussed in Section 4.



▲ Plan to exclude livestock from the hedgerow for at least five years, until plants have matured enough to withstand some browsing and livestock cannot easily penetrate the layers. Some grants may require fencing and will pay for it. (Photo: Envato Elements)



Photo: E. Guttman

Making a Planting Plan

Getting started: As you think about developing a plan for the plants in your own hedgerow, please note that this section is just an overview of some basic principles to keep in mind. Moreover, the focus is on the rural nature of this handbook and on plants best suited to Western Washington. There are many other resources to delve into for more ideas and depth of knowledge—please consult Appendix C.

I. The Plant List

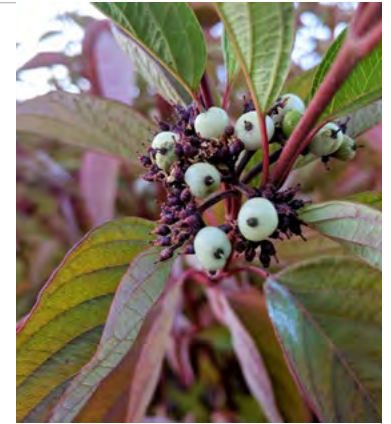
Tools: Now is the time to review your site assessment notes and goals. Using our sortable Hedgerow Plant Options Table (described in “Step 4: Plant Selection,” p. 56) and Hedgerow Planting Templates (Appendix A) to get you started, begin to determine which plant species can be on your list of possible options, based on the objectives of your hedgerow, your site-specific needs and the habitat and growing requirements of different species. Review the steps and principles below as starting points before beginning your research. Then, as you do your research, take notes about which species you think are good candidates for your site and goals.

It’s a good idea to double-check all your ideas, including going to your hedgerow site on a sunny day and “ground-truthing” your plans. Are the soils as wet or dry as you remembered? Will that Osoberry you like get too much sun there? When in doubt, make a more conservative choice with a plant that is adaptable to a variety of conditions. Be mindful that too much experimentation could result in high plant-mortality rates. You don’t want to lose money on failed plantings that could have been successful with the simple step of re-checking conditions before finalizing the plan and ordering plants.

Don’t risk losing money on failed plantings that could have been successful with the simple step of re-checking conditions before finalizing the plan and ordering plants.



▲ *Err on the side of caution when selecting plant species for your hedgerow. For instance, this Osoberry shrub (*Oemleria cerasiformis*) provides an early nectar source to native bees and is a larval host for butterflies, but it may not be successful in all settings, especially full summer sun. However, it could easily be added after a few years of growth if it can receive some protection from the maturing larger plants. (Photo: Erica Guttman)*



◀▲ *Shrubs such as Douglas spirea (*Spiraea douglasii*) (left) and Red-osier dogwood (*Cornus sericea* spp. *occidentalis*) (above) are thicket-forming adaptable species, tolerating seasonally wet soils but not requiring those conditions; and best in full sun, but adaptable to part shade over time. (Photos: Erica Guttman)*

Step 1: Goals Determine Plant Characteristics

One of your first steps will be to consider the features you need for each species selected in your plan. (Note: we created our sortable Hedgerow Plant Options Table to make this an easier process, as you can sort by several desired fields.) The primary goals of your hedgerow will govern the plant choices you make with regard to their characteristics—how tall, bloom times, root systems, foliage types, associations with beneficial insects, prickliness, and more.

For example, if your hedgerow is primarily for ...

Pollinator & wildlife habitat: Seek plants that can extend bloom times, such as those that bloom early or late in the growing season, or even plants that re-bloom. Seek diversity of flower shape and color, to attract different kinds of pollinators. Choose plants that serve as the host species to the larvae of important pollinators. Consider attracting birds that aid in on-farm pest control by offering plants with a variety of fruits and seed types.

Livestock exclusion/living fence: Seek plants that grow quickly and create a dense thicket. Consider plants with thorns, spurs, or prickles. Be sure that all the plants are safe—nothing that could inadvertently poison your livestock.

Windbreak or mitigation of odors and/or dust: Ensure a diversity of species at all levels: ground-hugging and mid-story shrubs, and tall, fast-growing trees. Choose plants with dense structure, and a good mix of both evergreen and heavily-twiggy deciduous species.

Interception of pesticide drift: Choose plants that are tall enough to intercept the drift of concern, and consider the need for plants with evergreen leaves. Frequently exposed hedgerows should be open enough that wind passes **through** one row to the next, intercepting via the consecutive planting; a hedgerow with less than 40% porosity may result in wind carrying drift up and **over** the rows, circumventing interruption.^{35, 59} Protect beneficial wildlife by avoiding or minimizing your use of pollinator-attracting plants.^{60, 57}

Water-quality protection & riparian buffer: Choose plants with dense root systems to bind soil layers and prevent erosion. Select plants adaptable to changing soil-moisture levels. To create shade in a riparian area, ensure plants are tall and dense enough to cast shade over the waterway. To intercept polluted runoff or sediment migrating from the edge of an agricultural field, plant native perennial grasses and forbs as an extra band outside the footprint of the hedgerow's trees and shrubs. Their dense vegetation and root network can trap and process the runoff. (See Appendix A.)

Multiple benefits: Of course, **most** of these strategies can be combined for multiple goals and benefits—as long as one goal is not in direct opposition to another (e.g., attracting pollinators and capturing pesticide drift). Additional features beneficial to the **people** enjoying the hedgerow should be considered and added where appropriate—for instance nut or fruit trees interspersed, using the hedgerow as a trellis structure for a small crop such as hops, and growing herbs that can be shared by the people and pollinators!

Make notes of your primary needs and secondary desires for plant characteristics at all strata of your hedgerow, from the lowest to the tallest plants. (Not all hedgerows have multiple canopy layers—depending on your goals, a mid-story shrub layer or tall canopy layer alone may be all you need.)



▲ Flowering quince (*Chaenomeles* spp.) is a non-native, water-wise deciduous shrub that forms a thorny, dense thicket while providing an early nectar source for bees, flies, and hummingbirds active in late winter and very early spring. (Photo: Erica Guttman)



▲ The dense thicket in this image features fast-growing shrubs that create a livestock-exclusion hedgerow quickly. The willow (*Salix* sp.) shown in the background also can provide beneficial browse to livestock, and the prickles on the native Nootka rose (*Rosa nutkana*) in the foreground deter mammals from penetrating the thicket. (Photo: Erica Guttman)



▲ In a riparian area, an add-on planting outside the hedgerow's woody footprint can help protect the waterway by interrupting sediment and other pollutants as they run off fields. Native rushes, sedges, and bulrushes that are tolerant of both winter saturation and summer drought are ideal in this setting, and they can be inexpensively added to your planting through the use of bare-root plants or plugs, as shown above. (Photo: Native Plant Salvage Foundation)

Step 2: Plant Placement

Infrastructure: Consider how you will arrange your various plants, especially larger woody plants, in terms of heights, proximity to crops/infrastructure, utilities/powerlines, fencelines, property lines, and more.



▲ When placing plants, especially the larger species, take into account their mature size and ensure they are placed so they won't interfere with infrastructure, crops, or cross property lines. When agreeing to share a hedgerow along the property line with a neighbor, consider a written agreement to protect the hedgerow if the property changes hands. (Photo: Erica Guttman)

Sun-loving species should be placed where they will continue to receive enough light, or be considered temporary plants to be replaced by shade-loving species once the hedgerow has matured sufficiently to shield them from the mid-summer sun.

Plan for growth and shade—layering: If you are creating a multi-canopy hedgerow, choose plants for the lower level that are adaptable to both sun and shade: sun (usually) for the initial planting, and shade once the taller plants have developed canopy cover. Plants such as snowberries, thimbleberries, and roses remain low and can adapt to changing sun exposure. Alternatively, wait a few years for your hedgerow to mature and add shade-adapted plants as understory (see options in Appendix A and the Hedgerow Plant Options Table).

Plan for growth and shade—interior to exterior: When placing the different species, be mindful that some plants will fail to thrive if they become shaded out, while others are very adaptable

to both sunny and shady conditions. For example, be sure to place sun-loving pollinator-magnets such as Red-flowering currant (*Ribes sanguineum*) and Tall Oregon-grape (*Mahonia aquifolium*) toward the outside of the hedgerow where they will still receive sun after taller plants mature (lower plants are fine in front of these). Meanwhile, flexible species such as Beaked hazel (*Corylus cornuta*), Western serviceberry (*Amelanchier alnifolia*), Oceanspray (*Holodiscus discolor*), Common snowberry (*Symphoricarpos albus*), and Nootka rose (*Rosa nutkana*) can adapt to virtually any placement within the hedgerow's borders.



▲ Some highly prized hedgerow species, such as Red-flowering currant (*Ribes sanguineum*) and Tall Oregon-grape (*Mahonia aquifolium*), are more specific about their site conditions and must be placed where they will receive sun even as the hedgerow matures—close to the perimeter with only shorter species in front of them. (Photos: Erica Guttman)

Thinking about plant placement will also set you up for later calculating how closely you need to plant each species, in relation to other plants and any other existing features (fences, crops, etc.). This will be part of determining the number of plants for each species.



▲ There are many hedgerow plants, such as Western serviceberry (*Amelanchier alnifolia*) (above), that can adapt to conditions that change over time: they can be placed in the typically sunny conditions when a hedgerow is first planted and continue to thrive even as they receive far less light as the planting matures. (Photos: Erica Guttman)

Step 3: "Right Plant, Right Place."

This adage is helpful to remember when choosing the species that will thrive on your site. Return to your site-assessment findings and ensure that every plant you select is adapted to your site's specific conditions: sun/shade in midsummer; soil texture and moisture

content; potential for browsing by wildlife, etc. The good news is that many plants are widely adapted to a variety of conditions, so there should always be at least a few good choices for every site.

With luck, your site assessment may have taken note of specific plants nearby that are already thriving, revealing more about what kinds of plants the existing conditions will support. Remember that you're planning for today's planting conditions, and that subsequent planting phases can incorporate additional species once conditions are right.

Here are a few additional considerations when choosing species for your list:

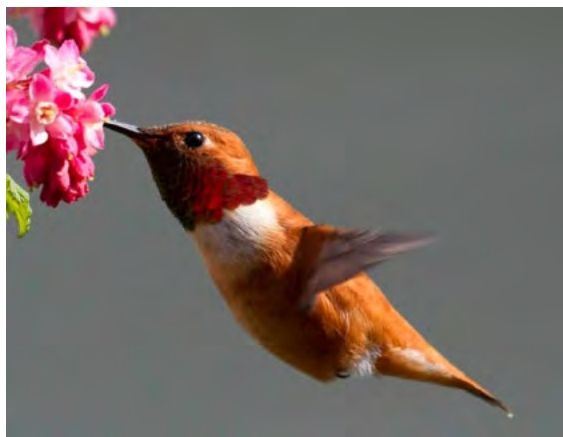
- **Native and "water-wise" options.** Native plants are those that grew in our region naturally prior to the arrival of Europeans. They have co-evolved with native animals and have long-term, often complex interactions, with specific benefits for attracting native wildlife. They are also adapted to our pests, native diseases, and historic climate, making them generally resilient.

"Water-wise" plants are typically non-native species from climates similar to ours, and—critically—have also proven to be **non-invasive**. Like native species, when planted in the right location they are drought-tolerant once established, and don't require chemical pesticides or fertilizers to be successful. While they do not have the long-term, complex relationships with native wildlife that native plants offer, they can provide season extensions—many bloom very early or late, and can thus provide more forage for beneficial insects. Additionally, many of these are terrific for adding sun-tolerant evergreen options that are shorter than our native giant conifer trees! Depending on your goals, you might assemble a plan with a healthy mix of both native and water-wise plants. However, sometimes an entirely native planting is required, especially in sensitive areas such as along waterways.

- **Understory species: yes or no?** The decision to increase plant diversity by adding non-woody perennials, native grasses, and ferns typically depends on your goals. This decision is typically a balance of benefits gained vs. added costs and potentially more challenging maintenance requirements (if more delicate plants must be protected from aggressive invasive species crowding them out). Perennial forbs are often selected to attract more pollinators, and dense native grasses and grass-like plants can filter more polluted runoff. If these are desired, be sure to place them appropriately: sun-loving perennials and grasses must be placed outside the bounds of the woody species or they will ultimately be shaded out; shade-loving perennials, ferns, and sub-shrubs must be added once the hedgerow has matured adequately to shield them from the mid-summer sun—usually several years after planting.

Some landowners choose to plant an herbaceous layer between woody plants, even recognizing it will be shaded out eventually, because a fast-colonizing, rhizomatous herbaceous layer (such as a native strawberry) may help prevent weeds in the short term. The same benefit may also be realized by planting rhizomatous woody plants such as snowberry or thimbleberry between larger plants—and these shrubs would be able to flourish as an understory species over time, as well, since they are adaptable to a variety of site conditions.

- **"Trellising" species.** Consider whether you want to add vines to your plan, which will trellis on the outside of the hedgerow's maturing structure. These might be enhancements to add after your hedgerow grows for a few years, but putting these on your wishlist in the planning stage will ensure you recall this desire later. Hops, fruits,



▲ Native plant species in the hedgerow will attract beneficial native animals, since the native plants and animals co-evolved and there are longstanding interrelationships between them. For instance, native Red-flowering currant blooms provide an early spring nectar source to Rufous Hummingbirds returning from winter migration. (Photo: Michael Melton)



▲ Although native plants have complex interactions with native animals such as pollinators and natural enemies, don't overlook the advantages of mixing non-native "water-wise" plants into your design. Water-wise plants offer benefits to water quality, are drought tolerant, and include many "backbone" evergreen hedgerow species that are fast-growing, sun-loving, and attractive to pollinators—such as the California lilac (*Ceanothus thyrsiflorus*). (Photo: Erica Guttman)



▲ Adding adaptable species that spread quickly by rhizomes, such as snowberry, thimbleberry, or native roses, can prevent weeds from establishing in bare areas between larger plants. They can be planted in full sun and continue to thrive in the subsequent shade from taller plants as they mature, as seen here with a thicket of Common snowberry (in early winter, with yellowish foliage and bare twigs) establishing below the shade of the larger evergreen *Laurustinus* (*Viburnum tinus*). (Photo: Erica Guttman)



▲ Vines can use the hedgerow structure as a trellis and add diversity of flowers, fruits and foliage, potentially attracting additional pollinators and natural pest enemies without increasing the hedgerow's footprint. (Photo: Erica Guttman)



▲ Food crops such as berries or nuts can be integrated into your hedgerow design. Grown at a large scale, these additions could potentially provide a small income stream, and many of these plants also provide forage for natural pest enemies—such as birds, attracted to the Chokecherry (*Prunus virginiana*) fruits shown above—and pollinators of all types. (Photo: Erica Guttman)

and flowering vines for pollinators are all great options for both people and wildlife. Vines also increase biodiversity, nesting and wildlife protection spots, and expand blooming and fruiting possibilities without increasing the size of your hedgerow.

- **Berries and fruit & nut trees.** Advocates of sustainable and restoration agriculture point out that hedgerows offer another opportunity to integrate food crops such as berry shrubs and apples, pears, cherries, hazelnuts, chestnuts, and even pine nuts.¹² Depending on the size of your hedgerow and the extent to which you integrate food crops, you might be able to harvest enough to add another source of income to your operation.⁴ In addition to providing an additional crop, many of these also support pollinators—including solitary bees—and birds that will variously eat pest insects and fruits.¹⁸
- **Varying site conditions.** If your site assessment revealed that part of the hedgerow location is dry and another part is wet, or one part is in the shade and another part is in the full sun, be sure your plan acknowledges different species will be needed for those different sections.
- **Size.** Plant size, structure, and density are important factors for achieving your goals. Be sure you research mature size thoroughly and only choose plants that will truly be the size you ultimately want without pruning to keep them in scale. As noted, hedgerows are planted more tightly on purpose, and the recommended species are tolerant of being squeezed together a bit. However, consider the ultimate mature size your plants will become, and take care to give them room to grow, ensuring they stay within bounds of property lines or the appropriate proximity to structures.
- **Diversity vs. simplicity.** Generally, having a healthy diversity of species will be beneficial for all your goals, including mixing evergreen and deciduous plants, extending the seasons of bloom and fruits, attracting various kinds of wildlife to benefit your crops, and creating a naturalistic aesthetic. Diversity will also ensure more success overall—a larger plant palette means that there will always be a “back-up” option to fill in if one plant fails to thrive. However, there are also advantages to keeping your species selection as simple as possible—as long as all your goals can be realized. A simpler plan is usually easier to maintain: limited species can mean a reduced list of care requirements to master, and can be easier to teach others (who might be helping you) which plants are intentional and which are not.
- **Plan for actual maintenance capacity.** Finally, when selecting your species, be realistic about what future maintenance plan will be manageable. If the reality is that you will only have time for power mowing between rows a few times per growing season, choose species that are tough, grow quickly, and are primarily woody.

When thinking about maintenance, evaluate whether plants that spread aggressively by rhizomes will be beneficial or not. Rhizomatously spreading plants such as snowberries and thimbleberries can be terrific for quickly colonizing bare soils, thereby crowding out would-be weeds. On the other hand, if there is potential for them to spread into nearby crops, lawns, or tidy areas, remember to limit their use in those areas.

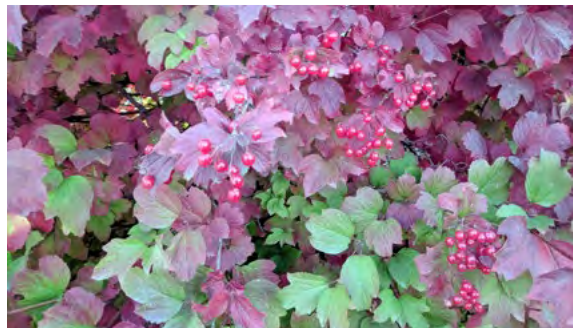
Putting it all together: After evaluating the factors you need to meet your goals and to thrive on your site, you'll make your "wishlists" of all possible options, sorted by goal or plant characteristics using our sortable Hedgerow Plant Options Table. It's always a good idea to have several options to consider for each layer in your hedgerow, as your first choices aren't always available in local nurseries or you may ultimately decide to choose one species over another based on cost or efficacy.

Even if you use our "ready-made" templates for each goal, you'll still want to research different plant possibilities using our sortable Hedgerow Plant Options Table and other resources. You'll see that each template suggests many alternative plants in each category. This enables you to:

- choose to use several of the alternatives to increase diversity, either within one block or by swapping out in each 20-foot length as you build your hedgerow;
- choose different options for different site conditions in your landscape, substituting as appropriate as the hedgerow extends into varying conditions;
- try out different plants when you're uncertain about which species will survive or perform best, so that if one option doesn't work, your hedgerow will still be viable.



▲ Species such as Thimbleberry (*Rubus parviflorus*) can reduce maintenance because they will colonize quickly—thereby crowding out weeds—and can grow in almost any conditions—thereby minimizing worry about plant mortality and subsequent gaps in your planting. (Photo: Erica Guttman)



▲ A hedgerow planting plan should have options for alternative species beyond your first choices. Alternatives provide more flexibility when sourcing plants (both for availability and cost), expand the hedgerow's diversity, and could provide opportunities to experiment with a few select species. (Photo: Erica Guttman)

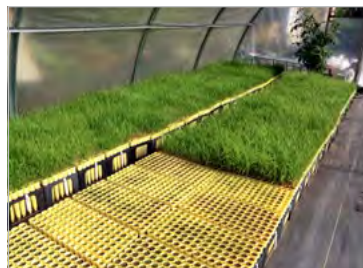
II. Nursery Stock Types & Sizes

The choices you make regarding plant stock type and sizes are intertwined with your available budget, which will determine the sizes and types of stock you can afford. After understanding the advantages and disadvantages for each stock type, you'll be better able to make a plan that balances these factors to suit your site situation and budget.

"Stock types" refers to the way the plant is grown and sold by the nursery. Although there are many nursery-stock choices, for the purposes of rural hedgerows, we will only concern ourselves with containerized plants (in pots, tubes, and plugs); bare-root plants; and live stakes.

- **Containerized plants.** These are widely available and come in a variety of sizes, from four-inch pots to multi-gallon-sized containers.

Pros: Potted plants are easy to work with and resistant to damage in the nursery and transport. Small containerized plants can be shipped easily if needed. Larger potted plants, especially when chosen for the large shrub or tree component of the hedgerow, will create presence and structure faster.



▲ An inexpensive option for plants such as native rushes, sedges, and some forbs are those grown in long tube-like containers (sometimes termed "cone-tainers"). These are usually available from native-plant specialty nurseries and can even be shipped to your site. (Photos: Sound Native Plants (left) & Erica Guttman (right))

Cons: Containerized plants can be expensive in comparison to bare-root plants and live stakes.

Some plants are grown in long tube-like containers (sometimes called “cone-tainers”). Species easy to find in tubes include emergents (such as rushes and sedges that you might plant in areas that receive regular inundation) and tap-rooted herbaceous perennials (such as lupines). Some restoration-focused nurseries also supply shrubs and trees in this form (though they will be very small).

- **Bare-root plants** are sold with their roots exposed rather than in soil. They have been grown in trenches in bulk quantities and are dug out and packaged when they’re dormant, usually in mid-winter, although some native forbs and grasses are often available in late summer to early winter.



▲ “Bare-root plants” are exactly what they’re called: both woody and herbaceous plants sold with exposed roots. Due to the bulk way these are grown and sold, they are considerably less expensive than containerized plants. Bare-root plants can be shipped directly to your address (above, left: nursery staff packaging shrubs for shipment). (Photos: Zahra Elkhafaifi, Fourth Corner Nurseries (left) & Native Plant Salvage Foundation (right))

Pros: The biggest advantage of bare-root stock is its relatively low price (50–75% or more savings over containerized plants). Bare-root plants can also be shipped inexpensively from a nursery far from your site. There is a wide variety of bare-root species available, from emergents (rushes, sedges) and herbaceous perennials to shrubs and trees.

Cautions: Available species are primarily those used in conservation projects, with a heavy focus on regional native species, and very few options for non-native “water-wise” plants. There are many fewer choices than containerized stock. With few exceptions, these plants will take longer to create hedgerow structure than larger potted plants.

Season of availability: Bare-root plants must be cared for to avoid damaging them prior to planting. Typically, the bare-root woody plants are only sold during the winter, so they must be planted when there may be concerns about frost heave or, conversely, excessively warm temperatures in early spring. Also, care must be taken to prevent the roots from drying out or getting moldy (which can happen if they’re stored in water or mucky soils during shipment or for an extended period). However, many herbaceous bare-root species are available earlier or later in the year than the woody plants are—depending on the species you could receive perennials or emergents to plant during the ideal fall-planting season.



▲ Availability of bare-root plants is a consideration when planning for purchasing and planting schedule. Bare-root trees and shrubs are typically available in winter (December-early spring), while bare-root herbaceous plants’ availability varies by species, but most are typically available in the ideal fall-planting window, such as this *Grindelia integrifolia*, a resilient native perennial that offers late-season forage for beneficial insects. (Photo: Cameron Dunn)

Sustaining until planting: If they cannot be

planted right away, there are a few strategies for keeping them healthy until you’re ready. (1) If you plan to plant them in fall, you will need to invest time, pots, and potting soil to place them in pots so they can mature over the summer. Then you’ll need to ensure they are regularly watered, and you’ll need space to store them. For a small hedgerow or some agricultural operations, this is not an excessive burden. (2) If you intend to plant within a few weeks, then you can “heel them in” for a short time. Two methods work for this: if you have big pots or plastic trash cans with drainage holes, you can place the roots of the plant in those containers and cover their roots with moist wood chips, sawdust, or soil; or, dig a shallow trench and cover the roots with those same materials. Either way, be sure that each plant has enough moist material around its roots and adequate drainage.

Soil type compatibility: Other concerns to consider: bare-root plants may be too small to thrive in excessively droughty soils such as stony loams or gravelly sandy loam; they may take longer to flourish, so special attention must be paid to early maintenance so they do not become overtaken by invasive species; you may have to overplant somewhat—depending on soils and maintenance capacity, add up to 25–50% more plants to compensate for expected losses due to the more fragile nature of bare-root over containerized stock.

- **Live stakes** are cuttings from deciduous trees or shrubs that are able to be planted directly into moist soil on a site and root after direct planting. The most commonly used species include willows (*Salix*, spp.), Red-osier dogwood (*Cornus sericea*), Black cottonwood (*Populus balsamifera*), and Common snowberry (*Symphoricarpos albus*). The stakes are inserted into the ground, and the buds below ground (in the soil) sprout roots while those above become branches. (More details on this method are in Resources, Appendix C.)

Pros: The advantages of using live stakes and cuttings include their low cost, ease of transport, and ability to be installed with very little soil disruption—a real plus in situations where you need to keep your soil intact and reduce the potential for erosion.

In addition to providing inexpensive new plants, live stakes and cuttings are the backbone of many large-scale revegetation projects, and several species will adapt well for some hedgerows. They provide long-term stabilization as their roots take hold in the soil. Hedgerows along riparian areas can take advantage of this cost-saving technique, since the species that are especially successful using live stakes are common in riparian plantings (especially willows). (You might even find some species you need already growing on your site, allowing you to harvest cuttings yourself.)

Live stakes should be mixed with containerized plants (the evergreen plants of your hedgerow won't work as live stakes). Common snowberry live stakes are an



▲ **FIGURE 9.** Heel plants in by digging a shallow trench for your plants, adding moist wood chips, sawdust, and/or soil to cover the roots until you're ready to plant.



▲ Incorporating live stakes into the hedgerow planting plan will dramatically stretch your budget, and many useful deciduous hedgerow plants are excellent options, including Common snowberry (*Symphoricarpos albus*), which offers a long season of pollinator forage (left), while making a dense thicket (right) in the understory, quickly spreading by rhizomes to fill gaps between larger plants. (Photos: Erica Guttman)



▲ Live stakes are especially favored directly adjacent to streams, allowing planting right to the edge and on the bank without the soil disruption of containerized plants—thereby preventing sediment going into the waterway. Willows (*Salix* spp.) are a key species in riparian areas and are especially successful from live stakes, as seen above in this mature hedgerow that completely shades the stream from spring through fall. (Photo: Frank Corey)

excellent addition to almost any hedgerow: this plant is great for pollinators, they will fill in the lower hedgerow strata, spread quickly by rhizomes, and adapt to almost any planting conditions.

Cautions: Using live stakes will limit your planting window to the late fall through winter months—the best months for planting anyway. Experts recommend installing live stakes from mid-October to mid-March, but as early as possible within this window. Care must be taken to gather cutting materials close to the planting date—they should be stored no more than two weeks before planting, and must be kept in cool, moist, shaded conditions.

Plant sizes: When considering what size plants to order, keep in mind the old adage that “good things come in small packages.” Smaller plants, in addition to being less expensive than larger ones, offer many other benefits:

- recover from transplanting more easily than larger plants
- require less watering during their establishment
- are easier to transport to the planting site and carry by hand while working
- require less soil disruption

While bigger may seem better, it’s more important to have a healthy, robust root system than a tall plant with minimal root structure. You can get a lot of bang for your buck using a combination of one-gallon containerized stock or large tubes, live stakes, and selected bare-root species. Smaller stock (such as four-inch pots or plugs) can be useful if you need to establish an herbaceous groundcover to prevent surface erosion, although these may also be available in bare-root form, such as Coastal strawberry (*Fragaria chiloensis*).

However, since some plants are slower growing than others, depending on your goals you may wish to invest in a targeted selection of larger plants—for instance, the key evergreen shrubs or trees—so that your hedgerow starts creating a barrier more quickly.



▲ Live stakes can be successfully planted from about October-March. Plan to purchase or cut your own live stakes close to your planting date, as they should not be stored for more than a few weeks after cutting (and must be kept cool and moist after collecting). (Photo: Ben Alexander)



▲ To stretch the hedgerow planting budget for containerized plants, purchase smaller plants as much as possible—where appropriate for the site—and use the savings for larger plants where they’ll be most effective: for critical evergreen backbone species, especially if some of those are known to be more slow-growing than the smaller plants planned. Very small plants can be quickly overrun by weeds, so ensure your site prep and maintenance plans will support the survival of your smallest purchases. (Photo: Native Plant Salvage Foundation)

III. Plant Spacing & Calculations

Once you’ve determined what plants you want and the best stock options for each species, it’s time to calculate the numbers you want for each species.

Table 1 shows typical recommendations for hedgerow spacing. Remember that you’ll likely be planting at least two to three rows, triangulating the plants in relation to each other, and focusing on trees or tall plants at the back or in the middle, moving to lower-strata plants in between or in the rows on the edge(s)—depending on your design goals.

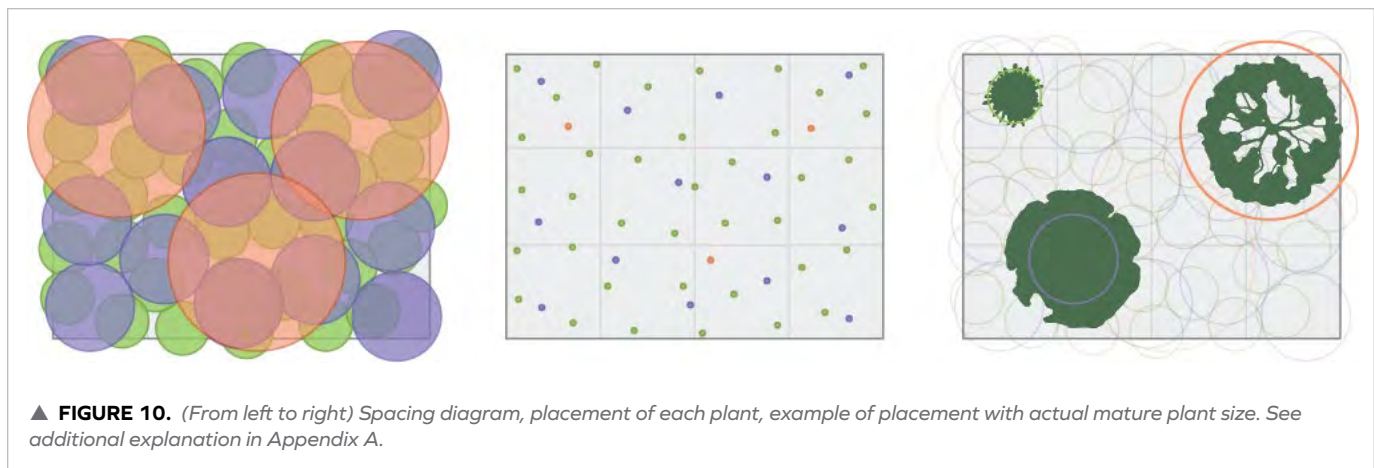
Table 1: Hedgerow Plant Spacing

Plant Type	Dense Spacing	Moderate Spacing
Tall trees/conifers	10 ft. on center	12 to 18 ft. on center
Large shrubs/narrow trees	4 to 6 ft. on center	7 to 10 ft. on center
Low shrubs	3 ft. on center	4 to 5 ft. on center
Grasses, forbs/herbaceous perennials (planted outside woody boundary, or understory with adequate shade)	1 to 3 ft. on center	1 to 4 ft. on center
Densely planting Live Stakes can replace certain potted plants. <ul style="list-style-type: none"> ■ Black cottonwood ■ Willow ■ Red-osier dogwood ■ Common snowberry 	<ul style="list-style-type: none"> ■ Black cottonwood: 5–10 ft. on center (may require thinning later) ■ Willow: 24–36” on center ■ Red-osier dogwood: 20–36” on center ■ Common snowberry: 8–12” on center 	

Calculating numbers: There are a few options for determining how many plants you will need. We have created several tools to make this easy, depending on how much or little you prefer a DIY approach.

- **DIY:** Using the spacing recommendations in Table 1 above, you could use an online plant calculator (see Appendix C) to determine the number of plants you need for each **plant type**.
- **Semi-DIY:** Table 2 (p. 55) shows four **pre-calculated** recommendations for spacing at different densities—to be selected based on your preferences and goals. You can apply these numbers to your specific needs.
- **Ready-made:** Select one of our Hedgerow Planting Templates based on which one best aligns with your goals, where the numbers are already set for the ideal density for that goal.

Figure 10 shows what a dense spacing layout might look like in a repeatable block. The circles represent the spacing (on center) recommendations for each type/size of plant (e.g., small shrubs vs. trees) rather than the size of the



plants themselves. This means the center of one tree (large, orange circles) should be 10 feet from the center of another tree, but large shrubs (medium, blue circles) can fill in and overlap the trees' spacing.

The actual plants you choose might be smaller than their spacing boundaries. When you replace the spacing circles with the actual widths of your chosen plants (shown on the right at about 10 years maturity), do so from largest category to smallest in order to get a sense of what will fit. Remember, trees spaced 10 feet apart could be bushy and wide near the ground, or have a narrow trunk and a 20-foot spread in the canopy, which will change the plants you choose to place around and under it. (As taller plants mature, the lower branches may lose their foliage or even die back as energy is focused on newer growth; as this happens, you'll have more opportunities for understory plantings within your hedgerow structure.) There are step-by-step instructions at the beginning of our Hedgerow Planting Templates (Appendix A).

Once you've figured out your number of plants and the spacing within your block, you can just repeat it over the entire length of your hedgerow. If you want more diversity, plants with similar characteristics can easily be substituted along the length, but consistent numbers per block make calculations easier.

IV. Plant Selection Process & Species Guide

Here is a simplified plant-selection process that we used to create our Hedgerow Planting Templates in Appendix A:

Step 1: Goals

The most common reasons for a hedgerow, and those we detail in Section 1 and 2, are:

1. Crop Productivity—Windbreaks & More
2. Livestock Exclusion & Shelter
3. Habitat for Wildlife, Pollinators, and Natural Pest Enemies
4. Management of Dust & Odors
5. Interception of Pesticide Drift
6. Flood Management, Topsoil & Water Conservation
7. Protecting Local Waterways & Enhancing Fish Habitat
8. Multiple Benefits Close to Homes

As noted in Part 1, Step 1 (pp. 43-44), each of these goals will have requirements for specific plant characteristics (e.g., evergreen leaves, or rhizomatous roots), and might also have specifications for things like plant spacing, siting, or a distinct arrangement or shape for the hedgerow (e.g., thicket-forming plants for a living livestock fence, or multiple rows with staggered spacing for intercepting pesticide drift).



▲ A diversely planted hedgerow with a high percentage of native plants will support a wide range of native animals, including pollinators and natural pest enemies. Birds such as Cedar Waxwings are attracted to native plants such as the Western serviceberry (*Amelanchier alnifolia*) (above), but also forage on insects. (Photo: Michael Melton)

To simplify this list for our Hedgerow Planting Templates, we've combined goals that have similar requirements for plant characteristics, and therefore would share similar plant choices. For example, you'll see below that the windbreak and mitigation of odors goals have similar needs, so a tall evergreen tree like a Douglas-fir (*Pseudotsuga menziesii*) would work in both situations.

Step 2: Plant Characteristics Required for Goal

Certain characteristics of a plant will aid in certain goals; for example, you'd want a dense, thicket-forming plant to help create a living fence to keep cattle in, or early- and late-blooming plants to attract and support pollinators in very early spring and well into autumn.

Here are some of the suggested characteristics in our sortable Hedgerow Plant Options Table, and the Hedgerow Planting Templates (Appendix A). These are only a fraction of the ways you could describe plants, but they paired well with the hedgerow-specific goals defined above:

Key Characteristics:

- ***Berries; fruit & nut trees:*** provide more diversity of habitat and forage for beneficial wildlife; enhance landowners' personal harvest
- ***Dense foliage:*** useful to intercept dust, odors, and pesticide drift; provides important habitat for birds, beneficial insects and other arthropods, and small mammals
- ***Dense root systems:*** useful for erosion protection, riparian habitat
- ***Foliage at lower & ground levels:*** to provide more layers of habitat; to intercept and filter nutrients/chemicals from agricultural fields and prevent sediment runoff; more density for barriers, privacy, wind blockage at lower levels
- ***High optical porosity:*** how much air could pass through unobstructed, or how much of the sky you can see through the canopy, for example; useful in any goals where wind needs to move through, rather than over, the hedgerow
- ***Larval hosts:*** important food and habitat for pollinators and natural pest enemies
- ***Livestock support & browse:*** palatable and medicinal plants for ruminants, providing extra nutrients
- ***Mid-height (6-15 ft.):*** to fill in the interstitial spaces between taller trees and shrubs for numerous interception goals, or as a barrier
- ***Pollinator-attracting:*** flowering plants that attract—and provide nourishment for—bees, hummingbirds, butterflies and moths, and other pollinators
- ***Shade-providing:*** to cool streams and other waterways; to provide shelter for livestock; to cool structures in summer and intercept winds in winter
- ***Shoulder-season blooming:*** plants that bloom early in the spring, or late in the summer into autumn to support beneficial arthropods and pollinators throughout the growing season
- ***Tall evergreens:*** for privacy, windbreaks, shade, and intercepting dust
- ***Thicket-forming/dense woody structure:*** to make a physical barrier and prevent erosion
- ***Has thorns, prickles/prickly foliage, spurs:*** additional obstacle for livestock; might provide habitat protection for birds

For each of the goals noted, we selected a few plant characteristics; every plant in the hedgerow does not need to meet each of these categories (e.g., a plant couldn't be considered both ground-hugging and a tall evergreen), but to meet the goal, some plants with each characteristic should be featured somewhere within the hedgerow:



▲ *Laurustinus (Viburnum tinus)* is a water-wise species useful for many goals: it is mid-height, grows in full sun to partial shade, creates a dense evergreen barrier and thicket, and supplies late winter/early spring nectar to pollinators. (Photo: Erica Guttman)



▲ *Black twinberry (Lonicera involucrata)* is a native deciduous shrub that is an excellent selection for hedgerows with seasonally damp spots, while also attracting pollinators from spring-midsummer. (Photo: Rod Gilbert)



▲ *Red-osier dogwood (Cornus sericea spp. occidentalis)* is a native deciduous shrub that can thrive in a variety of soils, from dry to seasonally damp—making it especially valuable along riparian corridors, where it also stabilizes soils with its fibrous root system. It can be grown from live stakes, forms open thickets via rhizomes, and offers spring nectar. (Photo: Erica Guttman)



▲ Black hawthorn creates a dense, edible thicket (unlike the invasive tree-form English hawthorn) which makes an ideal livestock barrier, reinforced by its immense thorns. (Photo: Erica Guttman)



▲ Strawberry tree (Arbutus unedo) and its compact, shrub form (A. unedo 'Compacta') are frequently used as backbone evergreen species due to their quick growth and habitat value with pollinator forage from October-January (above, in fall flower). Strawberry tree mixes well with other deciduous and evergreen species, such as Firethorn (Pyracantha sp.) (above, red fruits), which complements Strawberry tree's bloom time and offers thorny twigs. (Photo: Erica Guttman)

Grouped Goals and their recommended plant characteristics:

- **Windbreak / Management of Odors and/or Dust**
 - > Dense foliage
 - > Tall evergreen plants
 - > Mid-height (~6-15 ft.)
 - > Foliage at lower & ground levels
- **Waterway Habitat Protection / Erosion and Flood Management**
 - > Thicket-forming / dense woody structure
 - > Shade-providing
 - > Dense root systems
 - > Foliage at lower & ground levels
- **Interception of Pesticide Drift**
 - > Tall evergreen plants
 - > High optical porosity
- **Livestock Exclusion & Shelter / Living Fence & Privacy Screen**
 - > Tall evergreen plants
 - > Thicket-forming / dense woody structure
 - > Shade-providing / canopy-forming
 - > Has thorns, prickles/prickly foliage, spurs
 - > Mid-height (~6-15 ft.)
- **Habitat for Wildlife, Pollinators, and Natural Pest Enemies**
 - > Thicket-forming / dense woody structure
 - > Shoulder-season blooming
 - > Pollinator-attracting
 - > Larval hosts
 - > Berries, fruit & nut trees
 - > Foliage at lower & ground levels

Step 3: How Dense, How Tall, and How Many Plants

As you can see from the notes in Step 2, certain goals might have height or density requirements. Table 2 shows the calculations that we used in our Hedgerow Planting Templates (Appendix A) for different plant types, with different densities used for the different hedgerow goals (and assuming the 20-foot long and 15-foot wide hedgerow block that we use in our template blocks).

Type	# Large and/or Evergreen Trees	Spacing	# Large/Medium Shrubs and/or Slim Trees	Spacing	# Small Shrubs	Spacing
Mixed Height, High Density	3	10'	14-16	5'	30-33	3'
Mixed Height, Moderate Density	2	15'	5-6	8'	15-17	5'
Medium/Low Height, High Density	-	-	16-18	5'	38-41	3'
Trees Only	3-4	8-10'	-	-	-	-

Table 2: Recommended Plant Calculation Examples (for 20'x15' block)

These calculations might leave you with a few extra plants, but there are several places you might need them. And depending on your goals and preferred arrangement, you can accommodate any seemingly “extra” plants as you build your whole hedgerow. For instance, keep in mind that plants will hang over the 300 sq. ft. (of each template block), so it’s not as tightly bordered as a “block” plan suggests; more plants might be needed as you knit our arbitrary 20 ft.-length blocks together; and in some places you might plant extra densely or sparsely for pathways and a more natural look.

Customize it: By providing calculation examples and the templates in Appendix A, we are attempting to make the process simple for you. However, you should customize your hedgerow choices as much or little as needed for your own satisfaction. If you want to make your own calculations, use the spacing recommendation in Table 1 (page 52) and an online plant calculator (see Appendix C, section 4).

Step 4: Plant Selection

How to use the sortable Hedgerow Plant Options Table: This expansive list of plants ideal for hedgerows shows all of the characteristics listed in the previous step (under “key characteristics”) in addition to basic information such as height, color, and light requirements.

To facilitate your exploration of the depth of plant options to consider, we created this as an online table that allows you to sort by characteristics (and more), as well as search for plants you are interested in. Each characteristic is noted in separate columns for easy sorting and filtering. For example, you could simply sort plants by height, or filter the entire table to find only pollinator-preferred, thicket-forming evergreen shrubs for a sunny site, under 20 ft. tall at maturity.

You can access the table at <https://extension.wsu.edu/thurston/hedgerows/>. This online table will be maintained to expand and correct information as we collect additional recommendations and user feedback. (This sortable table is accessible through two websites: Washington State University Thurston County Extension and Native Plant Salvage Foundation.)

Choosing plants: As a starting point, use our sortable Hedgerow Plant Options Table to look for plants with the characteristics that match your goal.

For example, if you’re creating a hedgerow for riparian protection, you would want to look for individual plants that have one or more of the following characteristics: thicket-forming, shade-providing, or densely-rooted. One might choose Sitka spruce (*Picea sitchensis*) for its eventual height and evergreen shade; willows (*Salix* sp.) for their ability to grow quickly from inexpensive live stakes, bind soil layers on steep banks, and withstand seasonal flooding; and Western serviceberry (*Amelanchier alnifolia*) and Douglas spirea (*Spiraea douglasii*) because they are both thicket-forming and densely-rooted, while also being tolerant of various soil conditions.

► **Adapting for challenging sites:** This document and our Hedgerow Planting Templates assume “normal”/average physical conditions, like full sun to part shade, silt/loam/mixed soils, and good to average drainage. If you’re dealing with conditions like fast-draining soils, clay soils, or flooding/winter inundation, sort or filter the Table using the appropriate columns to find the plants especially well suited for those conditions. You’ll know best about your site and your limiting conditions, so be sure to think about those and replace the plants featured in the Templates with plants from these subsets.

As you review the recommended Hedgerow Planting Templates in Appendix A for each goal, notice that we provide an illustrated plan for



▲ This Whatcom Conservation District planting along a waterway features close spacing of several species of thicket-forming shrubs that are tolerant of seasonal saturation, including Red-osier dogood (*Cornus sericea* ssp. *occidentalis*), Clustered wild rose (*Rosa pisocarpa*), and Douglas spirea (*Spiraea douglasii*). (Photo: Frank Corey)



▲ *Planting in fall allows plants to start to establish, making them more resilient their first summer. Extending your planting into early winter—except when experiencing unusually frigid weather—opens up the availability of bare-root trees and shrubs, and takes advantage of precipitation over irrigation for the first few months of establishment.*
(Photo: Samantha Elie)



▲ *Anticipate your plant purchases, and begin contacting regional nurseries as soon as you have your list of preferred plants to inquire about available species and sizes, pricing, and delivery options. You can then adjust your final choices of species, sizes, and type of stock based on your projected schedule and budget. Anticipate that you'll likely buy plants from a few different regional specialty nurseries.*
(Photo: Cameron Dunn)

one suggested combination, but you can substitute within each template using the recommendations you find on the template—or by choosing another option from the sortable Hedgerow Plant Options Table, using the multiple columns for different plant characteristics to select appropriate plants for your needs (see introduction/instructions in Appendix A).

If you have a long hedgerow that requires several of our 20-foot blocks along its length, you could increase overall diversity within your hedgerow by making recommended substitutions in subsequent blocks, so that you end up with many different species. Diversity of species may help you expand your capacity to support your primary goal, and will also support more wildlife and pollinators—whether that is a primary or secondary goal.

V. Timing & Procurement

In our region, the best planting times are anytime in the fall after summer drought has broken (generally late September through November), followed by late winter/early spring. Fall plantings allow plants to establish new roots in moderate temperatures with plenty of rainfall. Generally, fall plantings have the greatest chances of survival through the stress of the following summer. Most root growth occurs during the fall and early spring (before bud break), and during mild winters, root growth can continue throughout the winter.

Usually in our region, we can count on good planting weather throughout the winter when plants are dormant and less prone to stress from transplanting, but cold-weather plantings do not have as many benefits as fall plantings. Moreover, a hard freezing spell in winter can delay your project if the ground is too frozen to dig, and deep freezes may heave plants out of the ground if they have not had time to establish a little root growth (especially problematic for small plants).

Plan for your purchasing window: There are many reputable regional native plant nurseries and wholesale nurseries that offer native and water-wise species. Once you have your plant wishlist in hand, begin contacting nurseries to determine what species they have, the sizes and stock types, and the prices. Your final planting list will likely be driven by the actual species available in ideal stock type at the prices you can afford.

Depending on when you're making inquiries, you might ask about future availability, especially for the month you intend to plant. Some wholesale native-plant nurseries grow specifically for the restoration market, anticipating fall plantings, and will be sold out of many species outside that window. Bare-root nurseries will be planning for fall and winter shipping. Most wholesale nurseries will reserve plants for you if you're purchasing in bulk quantities, make a deposit, or pay in advance. Put your orders in early for best availability at the time you plan to plant. Depending on the complexity of your plan, you could end up buying your plants in the different stock types from three or more regional suppliers.



Photo: Alison Nichols

Monitoring & Maintaining Your Hedgerow

I. Planning & Prevention

Plan for success: Developing a monitoring and maintenance plan is the often-overlooked—but essential—complement of any successful planting plan. Too many otherwise-well-designed planting projects fail due to lack of follow through. A new planting project requires at least some degree of oversight and nurturing to ensure its success.

Communication is another key to ensure a successful project. If your operation is large enough to support many employees, be sure that all staff are trained about the value and purposes of the hedgerow. Use signs if needed to delineate the hedgerow boundaries and any rules for protecting it from machinery or chemicals. Be sure important messaging is in all the primary languages spoken by your farm personnel.

Prevention first: The old adage “an ounce of prevention is worth a pound of cure” is apt for reducing extra work and increasing your likelihood of plant survival. Many problems can be prevented or minimized by following the strategies recommended in Section 2, Step 6: Site Preparation (p. 33) and discussed further in this section. Common problems and solutions include:

- ***Drought:*** maintain mulch application; create an irrigation plan.
- ***Weeds recurring:*** heavy mulch and sheet mulching; commercial mulch mats; plant protectors to allow mowing; plant fast-growing, aggressive native species to crowd out invasive weeds.
- ***Small mammals browsing and girdling:*** plant protectors; initial overplanting.
- ***Surface erosion of disturbed soil:*** mulch; plant fast-spreading groundcovers and rhizomatous woody plants; plant a low buffer to disrupt water flow and energy.
- ***Livestock & deer trampling and browsing:*** fencing and plant protectors; initial overplanting.
- ***Project is overwhelming/too big to manage:*** divide your project into phases (Section 2, page 33) to focus on just as much as you can manage at any given time. For instance, on a challenging site with poor soils or ongoing weed issues, focus on establishing woody plants first, then—if necessary—return after a few years to establish ground covers and herbaceous perennials that may be offered in very small containers or plugs.



▲ *Mulch is one of the best ways to ease maintenance chores. In addition to all its other many benefits, mulch helps prevent weeds and reduces watering needs. Mulch application immediately upon planting, combined with monitoring and maintaining mulch cover between plants over time, are simple but powerful keys to a successful hedgerow planting. (Photo: Erica Guttman)*

Key prevention tools:

Let's elaborate on two key strategies noted above: mulch (and sheet mulching) and an irrigation plan.

Mulch

The best action you can take to get your project off to a successful start is to apply a weed-free mulch to your new plantings. Mulch comes in many forms, and as noted in Section 2, arborists' wood chips—which are free or inexpensive—are a preferred mulch option. Wood chip mulch can inoculate a planting with beneficial fungi that supports plant growth. Wood

chips on bare soil are colonized by thread-like mycelium that makes the mulch like a sponge, retaining moisture and processing stormwater.

Here are specific ways mulch enhances your planting to prevent maintenance:

- reduces evaporation and lessens the impact of drought
- slows water and allows it time to soak back into the ground instead of running off
- saves on irrigation by preventing sunlight from drying bare soil
- makes a barrier to prevent new seeds from taking root
- suppresses existing weeds
- encourages healthier plants, thereby preventing them from being as susceptible to pest invasions or disease
- adds organic matter to the soil as mulches decompose over time
- regulates soil temperatures so that plants are warmer in winter and cooler in summer
- reduces or eliminates surface erosion of disturbed soils
- defines your planting area and offers a tidy, “finished” look that is aesthetically appealing to any planting

Sheet mulching: this was introduced in Section 2 (and further details are in Appendix C, section 3). In addition to using this method during site preparation to suppress weeds prior to planting, sheet mulching is an effective weed-control technique to reduce maintenance time during the establishment period.

Deep, infrequent irrigation encourages roots to develop and adapt to our summer drought conditions.

Irrigation Plan

As discussed in Section 2 (p. 39), you will need to irrigate for at least the first two to three summers after planting. Depending on your soils, the plants you have selected, and current climate conditions, you may need to extend your summer irrigation beyond the first few years—even if that means just one long soak in midsummer in outgoing years.

Since your hedgerow will rely on PNW native species, or non-native species that are drought tolerant, you must be careful not to *overwater*. The goal is to irrigate deeply and infrequently to encourage the roots to develop and adapt to our summer drought conditions.

Toward that end, if you set up an automatic irrigation system, your hedgerow irrigation system should be independent of crop irrigation, as you will not want to water as frequently as crops are watered. Overwatering your hedgerow plants will not encourage them to develop a drought-resistant root system.

Irrigation types: Choosing the type of irrigation you use might be one of the most important choices you make.⁶⁵ Any of the regular means of irrigating can be used for hedgerows, with the same efficiencies and considerations typical of each system. These include surface application (furrow or flood irrigation), hand or wheel lines, center pivot, traveling gun, or drip irrigation. With small projects, soaker hoses can be used. For hedgerows from ten to hundreds of feet long, the most common and suitable option will be drip irrigation.



▲ T-tape is one drip-irrigation option, with clear advantages and disadvantages (see Table 3). For hedgerows, T-tape with the greatest thickness and widest spacing is recommended to maximize durability, focus water on hedgerow plants, and avoid overwatering. (Photo: Stephen Bramwell)



▲ Drip-irrigation systems that use emitters are more expensive initially than T-tape systems and require more work to install, but advantages include increased durability and efficiency of water delivery directly to the desired plants, minimizing water wasted irrigating weeds. (Photo: Stephen Bramwell)

Drip systems: The two main types of drip-irrigation systems are those that use T-tape and those that use emitters. T-tape is less expensive than an emitter system, but more prone to damage. In terms of water use and weed management, T-tape irrigates not only the planting but also the entire distance between plantings, which can be considerable given plant spacing from a few to five feet or more. This watering of open ground will encourage weed growth and increase maintenance costs.

Cost: Prepare to pay several times more per foot for an emitter system (\$0.35/ft) compared to T-tape (\$0.05/ft) (recognizing that prices will vary by supplier). An emitter-based system is recommended to optimize water-use efficiency and durability while minimizing weed growth and associated maintenance.

Table 3: Drip-irrigation Systems: Selection Considerations

	T-tape	Emitters
Cost	<ul style="list-style-type: none"> ■ Least expensive (\$/ft) 	<ul style="list-style-type: none"> ■ More costly (\$/ft)
Installation	<ul style="list-style-type: none"> ■ Quick lay-out involves pulling tape from a spool 	<ul style="list-style-type: none"> ■ Requires laying out tubing & installing emitter(s) at each plant location
Durability	<ul style="list-style-type: none"> ■ Thin plastic tape is prone to damage ■ Easily & readily chewed by small mammals ■ Easily punctured during maintenance 	<ul style="list-style-type: none"> ■ Durable thick-walled tubing ■ Less easily chewed ■ Tolerant to rough handling & resistant to punctures
Water Use	<ul style="list-style-type: none"> ■ Less efficient than emitters ■ Irrigates entire distance between plants ■ Irrigates & encourages weed growth 	<ul style="list-style-type: none"> ■ Most efficient ■ Delivers water directly to each plant ■ Does not irrigate weeds

Above or below mulch? The question of whether or not to bury a drip irrigation system below the mulch layer hinges on balancing mild gains in water-use efficiency with increased difficulty of maintenance. Buried systems mostly eliminate evaporative losses and deliver water most directly to plant roots. On the other hand, buried systems are difficult to inspect, more easily damaged by burrowing rodents, and hard to find for repair and to replace parts.

Site conditions’ role: Some parts of your site may have different watering and overall maintenance needs than others, and may require more frequent checking and maintenance. **These might include:**

- Locations that are more exposed to more sun and wind will dry out more quickly.
- Sites with soils that are lacking in organic matter are more prone to drying out.
- Rocky, gravelly, or very sandy soils will dry out more rapidly than loam or silty soils.
- Unamended, heavy clay soils can be overly saturated in winter and excessively dry in summer.
- Areas with high or perched groundwater may have very wet soils well into early summer, and care must be taken to ensure you don’t overly saturate plantings in these conditions.

Here are some general irrigation guidelines:

- Maximize your water use by evaluating soil moisture (wetness or dryness) before irrigating, using guidelines from USDA NRCS (or other tools). Take a quick shovel-full of soil and look/feel if watering is really needed.
- Keep top of mind the texture of your soil (relative portions of sand, silt and clay particles) and adjust your watering accordingly. Sandier soils will need more frequent, lower-volume watering, while clay soils can hold more water for longer.
- During the growing season, keep an eye out for signs of too little or too much water. Note ponding water and excessive soil moisture or wilting plants (plants may show signs of **either** drought **or** overwatering with the same symptoms).
- During the first summer, provide consistent irrigation, which will vary by month, your site and planting conditions, and the weather patterns.
- By the second summer, water perhaps half as much (or even less) than you did the first summer, utilizing observation and feel methods to evaluate a spade-full of soil.
- The third summer may need as little as one long drink or none at all—it will all be dependent on your soils, site conditions, health and vigor of your plantings, and the weather. Remember to dig and look, and most of all to observe plants.
- Given that irrigation needs dramatically reduce within a short time, many landowners choose to install a temporary irrigation system only, counting on their plants to become drought resistant and not require ongoing water support after the third summer, generally.
- If you plant in the fall, your plants will require less water their first summer than a spring planting that same year.
- If supplying irrigation to your site is challenging, schedule your planting in fall to minimize required irrigation.
- Be prepared to irrigate as early as May, and adjust your watering plan in conjunction with the specific weather patterns.
- If you planted very large plants, provide them with extra water during the first growing season.
- If your plants look too stressed, with wilting leaves and drooping tops, increase the watering schedule (being careful not to misread the cues for overwatering, which can look similar).
- If your plants are healthy, you should not be alarmed if they move towards drought-dormancy a little early—in late August or early September.



▲ Site conditions, especially soil texture, influence irrigation requirements. In very fast-draining soils, use species tolerant of extremes to reduce excessively frequent irrigation, such as this Mock-orange (*Philadelphus lewisii*), which can grow in almost any soil type as long as it has sharp drainage. (Photo: Erica Guttman)



▲ Hedgerows that are placed far from easy irrigation infrastructure will likely require the use of watering trucks or other intermittent delivery method. In these settings, plan for insufficient irrigation by planting in the fall to get the best establishment, selecting the most drought-tolerant species possible, and overplanting from inexpensive stock such as live stakes and bare-root trees and shrubs. (Photo: Kevin Jensen)



▲ Reducing irrigation frequency over time will encourage plants to develop roots better able to withstand drought conditions. However, with our region's summers becoming increasingly hot and unpredictable, it's also important to respond to emergent events such as "heat domes," which result in damage to even decades-established trees and shrubs (above). If possible, support your hedgerow planting with supplemental water before or during these excessively stressful events. (Photo: Erica Guttman)

- Leaves turning yellow and even falling off may be fine. *Check to be sure that the buds at the base of the leaf stalks look lively.*
- If your site receives any substantial precipitation of about **one inch or more** within a few days, you can skip watering accordingly.
 - > **Always check under your mulch to be sure any rainfall has actually penetrated the soil.**
 - > A light rain shower might appear to provide adequate moisture, but often the soil is still parched.
- If you experience weather that is particularly stressful, such as many consecutive days over 95 degrees F. or a "heat dome" event, offer your plants a long drink during that time.
- In recent years, our region's summers have been increasingly hot and many planting projects have suffered by not responding to the changing climate.

If you're looking for an easy rule of thumb, consider this: Be tough and encourage your plants to adapt to the climate's stresses, but also protect your investment and provide extra irrigation during unusually hot, dry times.

For remote areas of the landscape where use of irrigation lines or even hoses is impractical, supplemental irrigation can be minimized by choosing extremely drought-tolerant species, having soils with high organic-matter content, overplanting (especially live stakes), mulching well, and planting in fall. However, even under these conditions, make a plan for first- and second-year irrigation with a water truck or some other low-tech method of bringing water to the site.

These strategies will lessen your maintenance concerns, but you still must plan for regular monitoring and maintenance.

II. Monitoring & Maintaining

Monitoring and maintenance go hand-in-hand. When you keep tabs on your landscape on a regular basis, you can regularly assess overall plant success and take action if necessary to mitigate problems before they escalate; and you can track how well the planting is meeting your initial goals and decide if you need to make changes.

Elements of a Monitoring & Maintenance Plan

Schedule: As with any planting, the first few years will require more frequent monitoring and maintenance until the plants are established. The number of times per year that you should monitor will be based on the specific plantings, the kind of irrigation system, and the goals. Here are a few things to consider:

- Plan to assess your new planting every few weeks (or possibly more frequently if it's very dry) during the **first** growing season, especially to assess that weeds aren't encroaching and to ensure adequate moisture in the soil.
- In the fall, be sure plantings and the overall site are prepared for winter, paying special attention to mulch and any need for preventative pruning.
- In winter, monitoring can be less frequent, though you should check your hedgerow's status after large weather events. Assess for limb damage or any loss of large sections of the hedgerow from falling trees or heavy branches. If using any plant protectors or plant stakes, check that they are not disrupted.
- Check your hedgerow during unusual weather events, including excessive heat waves or heat domes.
- Depending on the kinds of animal browse you anticipate, check on your plantings during the seasons appropriate for the most possible damage to be sure that your protection strategies are secure and working.
- After the first two growing seasons, reduce the number of assessments as needed, based on the past performance and specific challenges you know you must address.
- If using an established irrigation system (vs. setting up temporary irrigation), monitor water usage to alert you if any sections might be leaking.



▲ Track your hedgerow's successes, failures, your ongoing maintenance activities and schedules, and actions taken to address problems. This once-time-consuming task has been made quick and simple with smartphones and tablets, enabling easy recordkeeping that can be shared or reviewed as needed to make adjustments to maintenance activities or schedules. (Photo: Envato Elements)



▲ During regular monitoring and maintenance visits, you can note how the different hedgerow species are growing. If the timing is right (especially fall-winter), you can move plants from a spot with "volunteer" species to another spot that isn't flourishing, or you can take notes of areas that may need additional or replacement plants the following fall. (Photo: Stephen Bramwell)



▲ Despite your best efforts during site preparation to eradicate them, persistent weeds may return over time and hide in tall grasses or become closely entwined with your hedgerow plants. When too close to desired plants, you'll have to weed by hand, but with care you can weaken them and kill them over time using power weed trimmers. Be very cautious with power tools near the stems of your hedgerow species—it's often very hard to discern which is which, especially with eye protection obscuring your view. (Photo: Stephen Bramwell)



▲ Aggressive weedy grasses can outcompete short, young trees and shrubs. While your hedgerow plants are maturing, keep these weeds in check through maintaining sheet mulching or mowing. Within a few years, the woody hedgerow plants will be taller than the encroaching grasses and will ultimately shade out these competitors. (Photo: Erica Guttman)

Record-keeping: Document hedgerow progress and setbacks with simple notes and photos. In addition to helping you anticipate regular maintenance needs and time them according to your hedgerow's history, documentation also frees you to turn management over to someone else. Keeping track of what you encounter and how you addressed problems will remind you later of what worked and didn't work.

Monitoring growth rates, especially successful species, and species that struggle or fail will inform decisions about future plantings—either to expand your hedgerow, fill in bare spots, or replace plants that fail.

During your monitoring, you'll also see how your hedgerow is maturing and you can decide when and how to adapt to its revised needs. For instance, sun-loving understory plants will become shaded-out over time, and you'll need to decide if and when you may want to replace them with shade-loving plants.

Assessment: You should check each of these on each monitoring visit:

Invasive and inhibiting plant species: Preventing your plants from being overtaken by aggressive weeds is a balancing act of:

- > doing good site preparation before planting;
- > planting stock with appropriate top growth; and
- > maintaining your site adequately to minimize weed competition while plants are establishing.

From your initial site assessment and site preparation, you're already familiar with the invasive plants on site. Keep in mind that even aggressive grasses can inhibit the growth of young trees and shrubs and need to be either removed, sheet mulched, or mowed to reduce their impact. If you anticipate the need for regular mowing, you can establish your plants in rows sized to your mower to make mowing more efficient. Power weed trimmers will also work (although they are more work, especially in a long hedgerow). Using plant protectors early on helps prevent inadvertent damage from power equipment.

If you have a belt of perennial forbs and native grasses outside the hedgerow's footprint of woody plants, these may require more diligent weeding until they can establish and crowd out invasive forbs. Intermittent or an annual mowing of these perennial/grass belts **might** help keep the invasive species suppressed. However, you must evaluate the relative responses to this treatment and ensure that your desirable species will be able to outcompete the invasive plants.

On the other hand, establishing vigorous herbaceous perennials interspersed with trees and shrubs will fill the voids between your properly spaced woody species, thereby limiting weeds from getting established.

► **Timing:** Prevent future weeds by setting your weeding and mowing schedule to address weeds prior to them setting seed. Extra time and attention to managing weeds early and often during the hedgerow establishment period will save you time and work in future years. As you take on the chores of mowing and weeding your newly establishing hedgerow, take heart in the knowledge that as the hedgerow matures you'll first reduce, and eventually eliminate these tasks as the hedgerow crowds and shades out invasive plants.

Even more comforting might be the awareness that the hedgerow itself can reduce weeding chores in nearby crop beds by intercepting thousands of weed seeds from blowing into production fields.³⁷

*"As hedgerows mature, these plantings displace invasive weeds. If well maintained, this weed management lasts the lifetime of the hedgerow."*³⁷

— Oregon State University Extension

Mulch: As noted previously, mulch is critical to the success of your hedgerow planting. Check mulch coverage and depth, especially at the end of winter when it may have washed away, and again in late summer prior to fall rains beginning. Reapplying mulch in late summer prevents next spring's weed seeds from getting a foothold, and allows mulch particles more time to bind together with help from plant roots and mycorrhizae. Generously replenish mulch after weeding if needed.

Irrigation system: Independent of your irrigation plan previously discussed, you will need to monitor your system regularly. Look out for any potential for damaged tubing, T-tape, pipes or loosened joints, or any other potential spots for leaks. Check to be sure irrigation is going where it's intended to go: an obvious clue that you might have a leak is stressed-looking plants.

With no inspection and maintenance, a drip system will last only a few seasons until rodent damage makes them unreliable. With regular inspection, a system should be serviceable for 5 to 10 years, but this requires diligence and repairs. An emitter system is more durable than T-tape, but the tubing can be chewed through, and—rarely—emitters themselves.

► **Update timers:** If you are using an automatic timer, adjust the frequency of irrigation as the plants become established to reduce irrigation over time.

Pesticide damage: Generally, herbicides are discouraged from use as a maintenance strategy for hedgerows since they will harm the beneficial organisms the hedgerow is designed to attract and support. However, if conventional agriculture is immediately adjacent to the hedgerow, it is possible that overspray or drift can damage the hedgerow plants. If this occurs, make adjustments to the maintenance regime in the



▲ While the hedgerow's trees and shrubs are still maturing, fast-growing herbaceous perennials and self-seeding annuals can be planted in the gaps, providing more seasonal floral diversity and preventing weeds from colonizing the bare spaces. This is particularly effective when bare-root or other short-stature woody stock was planted, and the herbaceous species provide the dominant summer cover (as seen above), until the trees and shrubs develop stature. (Photo: The Farm at Franklin Pierce Schools)



▲ Mulch is especially important in a hedgerow's early years. During monitoring visits, ensure that bare ground is covered, especially before fall rains that can cause erosion and dispersion of weed seeds in spring. Existing farm equipment can be useful to move mulch close to where it's needed, saving labor time. (Photo: Kevin Jensen)



▲ Your monitoring visits should include inspection of irrigation systems, ensuring that no components are damaged so water is being wasted. Irrigation-system leaks that prevent or significantly reduce planned watering rates should be evident by noticing drought stress on the hedgerow's plants. (Photo: Stephen Bramwell)



▲ Since hedgerow plants are purposely crowded with close spacing, traditional pruning rules don't apply. Criss-crossing limbs and even small amounts of dead woody debris contribute to hedgerow's functional habitat. However, prevent damage through a pre-winter assessment of the potential for a well-established hedgerow to drop limbs during storms, and remove those as needed. (Photo: Erica Guttman)



▲ Shrubs like this Nootka rose (*Rosa nutkana*) that spread freely via rhizomes—while beneficial in creating habitat—may spread “out of bounds” if planted too closely to crops or formal landscape areas. Mowing or edging the border with croplands or landscape spaces can keep them in check if needed. (Photo: Erica Guttman)

adjoining bed and instruct all field personnel to be especially careful to avoid overspray near the hedgerow.

Fencing, plant protectors & stakes: Check any fencing to ensure that it is undamaged and posts are still strong and stable. Be sure that any plant protectors are still securely in place. Immediately repair or replace any damaged exclusion systems to prevent predators from damaging your hedgerow.

- **Remove devices:** As the hedgerow matures, evaluate the ongoing need for protection devices and *remove them* as you can.

Although tree staking is generally not needed, occasionally the site constraints make it beneficial. Large trees with underdeveloped root balls may need extra support for establishing roots in sites with extremely high winds, for example. Follow professional recommendations for correct staking techniques to address the precise problem you need to correct. Then, during monitoring, evaluate if the tree is sufficiently stable to permit removing the stake. *Ties should not remain attached to the tree for more than one year.*

Managing growth:

Pruning: By design, a hedgerow does not need traditional pruning. Unlike typical plantings where you want to ensure woody plants have good airflow and plenty of space to achieve a healthy form, hedgerow plants are intended to crowd together and form a dense network of criss-crossing limbs. Moreover, small amounts of dead wood within a hedgerow and fallen to the ground below can provide productive nesting and other habitat support to beneficial insects and birds.

However, *mature* hedgerows should be assessed in late fall for the potential for large, poorly attached or malformed branches to shear in severe winter storms, and thereby damage multiple trees and shrubs below in the process. If warranted, address such problems through occasional selective pruning before winter to prevent opening up large holes in the overall hedgerow structure. Such pruning should never take place during key nesting periods for wildlife—typically mid-March to mid-July (but consult your local natural resources professionals if you are conserving specific types of habitat).^{57, 61}

Rhizomes: To prevent them from encroaching on adjacent croplands, some woody hedgerow species may require intermittent pruning or even mowing of fresh shoots spreading via rhizomes.⁴³ (Prevent or minimize these future maintenance chores by planning appropriately in plant selection and proper spacing.)

Herbaceous maintenance principles: For some species, annual mowing or cutting back top growth can inspire more root growth and produce fresh top growth. Follow

maintenance recommendations for your specific species. However, be mindful of the year-round habitat provided by these perennial forbs and grasses and schedule your maintenance activities to avoid disrupting seasons of nesting or hibernating female bees, or the developing eggs and larvae of beneficial insects and other arthropods that provide services to croplands. Be cautious of excessive trampling or compacting the leaf litter below your hedgerow that supports insects and larvae.^{55, 62}

Usually spring is a good time to begin activities, with these guidelines:

- > Mow or cut back on the high side: up to 8–15 inches depending on species (the hollow-stemmed plants like asters are especially key species for nesting and hibernation).^{55, 62}
- > Stagger your activities annually, never cutting back more than about one-third of your perennial belt, so that the other two-thirds is always supporting the habitat of beneficial organisms that support crops.⁵⁷
- > Leave all cut organic matter in place as it may still be hosting beneficial organisms.^{55, 62}



▲► Herbaceous strips outside the woody hedgerow’s footprint provide year-round habitat and must be maintained to protect overwintering larvae, nesting, or hibernating insects and other beneficial arthropods in the stems (see inset illustration) or ground below these plants. Be sure to follow recommendations for when and how to cut back these plants, and always leave cut stems where they fall. (Photos: (left) Alison Nichols & (right) Andy Hopwood; original illustration/photo design: Cameron Dunn)

Plant health & survival:

Assessing the status of the hedgerow’s plants—especially in the early years of establishment—is one of the most critical reasons for your monitoring visits. At first, it will be easy to walk through each section of your hedgerow and take stock of each of the plants you planted. As it matures, you’ll be looking at the broader picture of how it’s weaving together and where the gaps or problems are. **Some key metrics to assess include:**

Overall survival: With good planning, monitoring, and maintenance, your hedgerow should have very low mortality rates. But if your site has “challenges,” such as poor soils, insufficient access to water, persistent infestation of hard-to-eradicate invasive plants, and deer you couldn’t fence out, survival rates may be disappointingly low. On the other hand, you might have overplanted in anticipation of these site constraints, thereby mitigating some of your losses in advance.

You could do a formal survival count, tracking the total number of plants—both living and dead—by species. But unless you have a need (such as grant reporting) to do this precise assessment, a simple count



▲ At the end of each of the first few growing seasons, take stock of how well plants are surviving. A hedgerow planted on a well-prepared site, with a diversity of species (as shown above), and a strong maintenance plan should have very minor plant mortality. Since you’ll know in advance if site conditions are not in the plants’ favor, hedge your bets by overplanting initially. Some grants may require a formal survival count, but most landowners can do an informal assessment and make a plan to address any problems. (Photo: Erica Guttman)

of any dead plants by species should tell you all you need to know. For example, your assessment might reveal that *one particular species* just did not fare well in a particular setting. Even with careful plant selection, this sometimes happens: there is something about the site that you couldn't anticipate would not be favorable to a particular species. Fortunately, if you've made a diverse planting, this kind of loss may not be devastating. Taking into account which species have died, if the losses are significant enough that you need to replace them, consider substituting species with similar characteristics but broader tolerances, if needed.

Timing: Check on plant survival after the first summer/fall, since the growing season is the most stressful for new plants. Late fall/early winter is a great time to conduct a survey. (Use your planting plan as a reminder of which species you placed where so you can be sure which ones have died, or take a class in wintertime deciduous plant identification to help you—these skills also work on dead plants.) Here are some advantages for an early winter count:

> After the growing season, herbaceous species are dormant, which may provide easier access to the site.



▲ Assessing plant survival in fall/winter has many advantages, including accessing the limited winter window to order economical bare-root plants to replace any significant plant losses. (Photo: Zahra Elkhafaifi, Fourth Corner Nurseries)

- > On-farm activities are typically less burdensome during this time, ensuring that you have room in your schedule to do this important assessment.
- > If you discover a significant failure of a particular species or section of the hedgerow, you can begin to plan for substitutions right away. You may be able to replant during the ideal plant-dormancy period with plenty of rain to water in the new plantings, reducing stress the following summer. You may also be positioned to order bare-root woody plants during their brief availability window in late winter.

Vigor and overall health of plants: Unlike the survival count, this is a *qualitative* assessment of your hedgerow's plants. Some examples of what you'll be scanning for include plants that:

- > have been browsed or girdled;
- > appear to have been trampled or otherwise broken;
- > indicate negative impacts from pesticide or fertilizer overspray or runoff into the soils;
- > show evidence of not enough or too much water;
- > exhibit signs of pest damage;
- > appear to have a disease, fungus or parasite; or
- > are otherwise generally struggling to survive with no clear culprit or reason (maybe planted in the wrong place?).



▲ Your ongoing monitoring will reveal how well your initial plans are working to maintain and protect your hedgerow plants. Problems should be quickly addressed by bolstering your existing systems or seeking solutions to unexpected problems; keep in mind local support for technical questions or identifying unknown pests/diseases can be found with your county's conservation district or WSU Extension office. (Photo: Michael Melton)

If your monitoring reveals problems such as those noted above, quickly adjust your management plan as needed to prevent further damage. You can seek additional support for technical concerns, unidentified pests or diseases, or questions about equipment from your local conservation district or WSU Extension office.

Growth & "fill-in" rate: This metric will help you evaluate if your plants will be fleshing out your hedgerow at the rates you expected, bringing its capacity to perform its functions

to fruition. You'll probably not start assessing this until after the plants have grown for at least a few years, unless from the start you hedged your bets by overplanting, or your budget pushed you to plant less than the recommended guidelines prescribed. A few prompts for the kinds of questions you'll explore are:

- > Are plants growing as expected?
- > Does the spacing appear too tight or too open?
- > Are some plants growing so much faster than adjacent species that you fear they'll outcompete or shade out their slower-growing neighbors and reduce diversity?

Depending on your assessment of growth rates (and taking into account your hedgerow's goals), you may need to move plants or add more.



▲▼ After a few seasons, you should be able to assess if your plants are filling the space as quickly as desired. The young hedgerow above (left) included plants appropriately selected for the seasonally wet soils, however the initial species weren't large enough to fill the space. The farmer subsequently added species with larger heights and widths, including the Pacific ninebark (*Physocarpus capitatus*) (above right) and Black twinberry (*Lonicera involucrata*) (below). (Photos: Stephen Bramwell)

Signs: As noted earlier, signage about the hedgerow's functions and boundaries can engender appreciation for the hedgerow's role in enhancing farm production while also preventing farm personnel from inadvertently harming any part of the structure with chemicals or power equipment. Some organizations have even created signs highlighting certain features, such as habitat for pollinators. During your monitoring visits, check that signs are:

- > still securely in place;
- > are clearly visible and not in jeopardy of becoming obstructed by overgrowth; and
- > not damaged nor beginning to fade.



Adaptive Management—Response to Monitoring Results

Adaptive management refers to the process of improving your management approach as you go, based on what you learn as your hedgerow matures. As you monitor, you'll learn what's working and what's not, and will tailor your remedies to the exact problems identified—within the context of your site conditions.

Adaptive management can involve:

- researching and trying substitute species when the original plants inexplicably fail;
- moving plants from an area where they're poorly suited to another spot with the right conditions;
- adding shade-loving understory species as the hedgerow matures and a canopy develops;
- moving “volunteer” plants or extra plants in one section to another section with less robust growth;
- adding more plants to sections that aren't maturing as quickly as desired;
- changing management strategies over time or in response to the original method not working; and
- keeping abreast of others' research and incorporating new ideas and technologies into your project as necessary.



▲ Practicing “adaptive management” simply means ensuring that the hedgerow project continues to perform successfully over time, by making ongoing adjustments to the management approach as the hedgerow naturally changes. Adaptive management also includes the landowner applying new lessons gleaned over time, both through new research and learned experience. (Photo: Michael Melton)

No planting stays static. You will adapt to and mitigate for the positive and negative changes, always with the goal of ensuring that your hedgerow continues providing the primary purposes and benefits you envisioned.

The adaptive management process will guide you to keep your eyes on the big picture: **Are you meeting the primary goals for which you designed and planted your hedgerow initially?**

Over time, your ongoing monitoring and deep familiarity with your hedgerow through regular observations will allow you to anticipate and mitigate potential concerns.

This flexible and goal-centered approach will ensure successful hedgerows and decades of performance to enhance your home and agricultural operations!



◀▲ Applying adaptive management might include experimenting with substitute species for failed plants, or adapting to changing conditions. For example, in the images above, the maturing Dwarf strawberry tree (*Arbutus unedo* 'Compacta') has been limbed up to provide room for shade-loving Low Oregon-grape (*Mahonia nervosa*) (left); and as the Beaked hazel (*Corylus cornuta*) grew (right), shade-tolerant Evergreen huckleberry (*Vaccinium ovatum*) has replaced the former understory plants that required full sun. (Photos: Erica Guttman)



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Additional Resources for Tables & Planting Plan Templates

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