PennState College of Agricultural Sciences

Wildland Weed Management

Natural Resource Management Factsheet

Managing Young Forest Habitat 2

What is Young Forest?

Young Forest, also known as early successional habitat, is a patchy, varied community with significant cover from saplings and native shrubs, some residual trees, native forbs and grasses, and in proximity to blocks of mature forest (Figure 1). It is a dynamic forest community, changing as the woody components age.

A great number of wildlife and game species rely on Young Forest at some stage in their life cycle, including species of acute conservation concern such as Golden-winged Warbler (Figure 2); game species such as American Woodcock, white-tailed deer, wild turkey, ruffed grouse, and eastern cottontail; dozens of 'less charismatic' bird and mammal species; as well as reptiles and amphibians, and countless arthropods, including many pollinator species.

The footprint of this habitat type has been steadily decreasing the last century due to sprawl, changes in farming practices, and the influx of exotic plant species. A typical example of young forest that 'did not happen' is abandoned hay fields or pastures that still look like fields -grassy expanses with a few multiflora rose or autumn olive shrubs. They look 'wild', but have little to offer wildlife.

The first bulletin in this series, *The Benefits of Young Forest Habitat*, goes into greater depth explaining what Young Forest is and is not, its composition, the species that benefit, and why this plant community type is often a best fit for habitat management in Pennsylvania state parks.

Manage Young Forest Habitat

Young Forest has distinct habitat components we can manage. Some are positive, which we maintain or increase; and some are negative, which we try to

Figure 1. This Young Forest site at French Creek State Park features native saplings, shrubs, forbs and grasses, adjacent mature forest; as well as a minor population of exotic shrubs.

minimize. Our management goals are to optimize the ratio of positive to negative habitat elements in the plant community with the resources available.

The positives are native shrubs and saplings, residual trees, and native forbs and grasses. The most common negative components are exotic shrubs and exotic grasses.

The broad categories of management practices we use are cultural, mechanical, biological, and chemical.

Cultural – consider this "indirect" control. Practices that enhance desired species, such as planting, seeding, and prescribed fire are cultural, as are preventive practices such as equipment sanitation and use of weed-free aggregate and mulches.

Mechanical - operations that physically disrupt or remove target plants, such as pulling or cutting.

Biological - this traditionally refers to release of a federally permitted insect or disease organism that infests a specific weed species.

Chemical - the use of herbicides.

Habitat Components

The various plant community components can be divided into six main groups, three positive and three negative. The positives are native species of woody plants, forbs, and grasses; while the negatives are exotic species of woody plants, forbs, and grasses.

Native Shrubs and Saplings

Figure 2. Golden-winged Warbler populations are threatened by reduced availability of habitat, and are a prominent example of the many species that will benefit from increased and enhanced Young Forest.

Table 1. Native shrubs and small trees represent the most permanent component of Young Forest habitat. The list below is by no means exhaustive, but covers many of the commonly occurring species.

Common Name	**Scientific Name**
speckled alder	*Alnus incana*
smooth alder	*Alnus serrulata*
sweetfern	*Comptonia peregrina*
alternate-leaved dogwood	*Cornus alternifolia*
silky dogwood	*Cornus amomum*
gray dogwood	*Cornus racemosa*
red-stem dogwood	*Cornus sericea*
cockspur hawthorn	*Crataegus crus-galli*
fanleaf hawthorn	*Crataegus flabellata*
Washington hawthorn	*Crataegus phaenopyrum*
winterberry holly	*Ilex verticillata*
mountain laurel	*Kalmia latifolia*
spicebush	*Lindera benzoin*
common ninebark	*Physocarpus opulifolius*
rosebay rhododendron	*Rhododendron maximum*
smooth sumac	*Rhus glabra*
staghorn sumac	*Rhus typhina*
Allegheny blackberry	*Rubus allegheniensis*
black raspberry	*Rubus occidentalis*
pussy willow	*Salix discolor*
sandbar willow	*Salix exigua*
silky willow	*Salix sericea*
black elderberry	*Sambucus canadensis*
red elderberry	*Sambucus pubens*
highbush blueberry	*Vaccinium corymbosum*
mapleleaf viburnum	*Viburnum acerifolia*
arrowwood	*Viburnum dentatum*
nannyberry	*Viburnum lentago*
blackhaw	*Viburnum prunifolium*
cranberrybush	*Viburnum trilobum*

Native shrubs and saplings provide needed vertical structure, as well as hosting the insect species that are a vital food source for nesting birds and small mammals. Why native? Let's focus on migratory songbirds - they rely heavily on caterpillars to feed their young. Most leaf-eating caterpillars co-evolved with the species they eat. Exotic species are typically introduced to a new range without the species that feed on them. Most exotic species support very few insects, and therefore provide little habitat value.

Examples of common native shrubs include species of hawthorn, viburnum (Figure 3), dogwood, willow, alder, and elderberry. See Table 1 for a more expansive list.

Figure 3. This fall-color blackhaw viburnum (Viburnum prunifolium) is a prime example of a native shrub, providing insect habitat and high quality fruit.

Exotic Shrubs

Exotic shrubs do provide habitat structure, but very little food value. Their foliage supports few herbivorous insects and compared to many native shrubs species, their fruit is high in sugars rather than fat, reducing nutritional value for animals preparing to migrate or overwinter. Their aggressive growth and lack of food value makes suppression a high priority. In general, exotic shrubs are not browsed. They grow unchecked, and can reach a size and density that eliminates desirable species and requires intensive mechanical measures in a few years (Figure 4).

Common species of exotic shrubs include honeysuckles, autumn olive, multiflora rose, barberries, and privets (Table 2).

Native Forbs

Figure 4. Exotic shrubs, such as this thicket of autumn olive and shrub honeysuckle, are often the most challenging aspect of Young Forest habitat management.

Table 2. Exotic shrubs and trees represent the most persistent negative component of Young Forest habitat. Common species are listed below.

Common Name	Scientific Name
Amur maple	*Acer ginnala*
tree-of-heaven	*Ailanthus altissima*
European alder	*Alnus glutinosa*
Japanese angelica tree	*Aralia elata*
Japanese barberry	*Berberis thunbergii*
European barberry	*Berberis vulgaris*
Russian olive	*Elaeagnus angustifolia*
autumn olive	*Elaeagnus umbellata*
winged euonymus	*Euonymus alata*
border privet	*Ligustrum obtusifolium*
common privet	*Ligustrum vulgare*
Amur honeysuckle	*Lonicera maackii*
Morrow's honeysuckle	*Lonicera morrowii*
Tatarian honeysuckle	*Lonicera tatarica*
common buckthorn	*Rhamnus cathartica*
glossy buckthorn	*Rhamnus frangula*
black jetbead	*Rhodotypos scandens*
multiflora rose	*Rosa multiflora*
wineberry	*Rubus phoenicolasius*
basket willow	*Salix purpurea*
linden viburnum	*Viburnum dilatatum*
guelder rose	*Viburnum opulus*

Forbs, or 'wildflowers' provide ground-level structure, forage, floral resources, and seed. They host herbivorous insects, provide nectar and pollen for pollinators, and many produce edible seed. Forbs also provide aesthetic appeal, which helps engage the public in your habitat management efforts.

There are numerous native forbs, both generalists that verge on being weedy, and habitat specialists. Common forb examples include the "aster" family - aster species, goldenrods, and sunflowers; mints; legumes (pea family); and milkweeds. Table 3 provides a brief list of native forbs.

Despite their benefits, you can have too many forbs, or at least too many of one kind. It is increasingly common to see monocultures of goldenrod develop. Such areas are too dense to provide good ground-level habitat, and the lack of floral diversity reduces value to pollinators.

Native Grasses

Native grasses, particularly warm-season prairie grasses such as switchgrass (Figure 5), big bluestem, and Indiangrass (Table 4) are commonly associated with habitat plantings. The prairie grasses provide useful structure - their tall, tapered form provides space

Table 3. Native forbs are a valuable wildlife resource, providing ground-level shelter, forage, nectar and pollen, and seed. Common examples are listed below.

Common Name	Scientific Name
swamp milkweed	*Asclepias incarnata*
common milkweed	*Asclepias syriaca*
butterfly milkweed	*Asclepias tuberosa*
devil's beggartick	*Bidens frondosa*
partridge-pea	*Chamaecrista fasciculata*
common ticktrefoil	*Desmodium canadense*
grass-leaved goldenrod	*Euthamia graminifolia*
Joe-pye weed	*Eutrochium fistulosum*
oxeye sunflower	*Heliopsis helianthoides*
blazing star	*Liatris spicata*
Canada lily	*Lilium canadense*
wild bergamot	*Monarda fistulosa*
tall white beard-tongue	*Penstemon digitalis*
slender mountainmint	*Pycnanthemum tenuifolium*
black-eyed Susan	*Rudbeckia hirta*
green-headed coneflower	*Rudbeckia laciniata*
tall goldenrod	*Solidago altissima*
Canada goldenrod	*Solidago canadensis*
giant goldenrod	*Solidago gigantea*
New England aster	*Symphyotrichum novae-angliae*
white heath aster	*Symphyotrichum pilosum*
blue vervain	*Verbena hastata*
wingstem	*Verbesina alternifolia*
New York ironweed	*Vernonia noveboracensis*

Figure 5. Native, warm-season grasses such as switchgrass provide important ground-level structure as well as food value. This site is an example of a good stand density, as there is room for other species as well for wildlife at ground level. It is common for native grass seedings to be too dense.

Table 4.Native grasses, particularly the warm-season prairie grasses (Form = P W) provide valuable ground-level structure in Young Forest habitat. The "Form" column indicates if the species is annual (A) or perennial (P), and cool-season (C) or warm-season (W).

Common Name	Scientific Name	Form	
autumn bentgrass	*Agrostis perenne*	P	C
big bluestem	*Andropogon gerardii*	P	W
broomsedge	*Andropogon virginicus*	P	W
deertongue	*Dicanthelium clandestinum*	P	C
Canada wildrye	*Elymus canadensis*	P	C
bottlebrush grass	*Elymus hystrix*	P	C
riverbank wildrye	*Elymus riparius*	P	C
Virginia wildrye	*Elymus virginicus*	P	C
witchgrass	*Panicum capillare*	A	W
fall panicum	*Panicum dichotomiflorum*	A	W
switchgrass	*Panicum virgatum*	P	W
little bluestem	*Schizachyrium scoparium*	P	W
Indiangrass	*Sorghastrum nutans*	P	W
prairie cordgrass	*Spartina pectinata*	P	W
purpletop	*Tridens flavus*	P	W

at ground level for nesting and foraging, while the canopies provide cover from aerial predation. The prairie grasses have persistent stems that provide excellent winter cover, and the seed provides food for insects and birds. They also have deep, finely fibrous roots that stabilize soil and enhance drought tolerance.

A potential drawback of prairie grasses is that they can be planted too densely. The ground level space needed for foraging and nesting is lost, and dense stands also lack diversity, particularly native forbs and woody plants. Prescribed fire temporarily alleviates accumulation of debris at ground level, but does not provide any stand thinning to a more functional density.

Exotic Grasses

The exotic grasses we might describe as "pasture grasses" are examples of plants being a blessing or curse - based on your objectives. Tall fescue, orchardgrass, timothy, smooth brome, and reed canarygrass (Table 5) were introduced for livestock forage and soil conservation uses. They are persistent, durable, and have dense, fibrous root systems. Conversely, they provide comparatively little food value to insects, their growth habit provides little cover value, and they are very competitive, so they resist the establishment of native trees, shrubs, and forbs (Figure 6).

Many state parks created in the 1960's from former farmland still look like farms - the pasture and hayfields did not give way to diverse meadow, then forest. These exotic grasses have stalled the succession

Table 5. Exotic grasses can have a significant negative effect on Young Forest habitat. The "Form" column indicates if the species is annual (A) or perennial (P), and cool-season (C) or warm-season (W).

Common Name	Scientific Name	Form	
smooth brome	*Bromus inermis*	P	C
orchardgrass	*Dactylis glomerata*	P	C
quackgrass	*Elymus repens*	P	C
red fescue	*Festuca rubra ssp. rubra*	P	C
perennial ryegrass	*Lolium perenne*	P	C
Japanese stiltgrass	*Microstegium vimineum*	A	W
Chinese silvergrass	*Miscanthus sinensis*	P	W
reed canarygrass	*Phalaris arundinacea*	P	C
timothy	*Phleum pratense*	P	C
Kentucky bluegrass	*Poa pratense*	P	C
tall fescue	*Schedonurus arundinaceus*	P	C

process and greatly reduced the habitat value of considerable acreage.

Exotic Forbs

The remaining habitat component is exotic forbs. We will concern ourselves with exotic forbs if there is a significant population of weedy species such as Canada thistle, common mugwort, purple loosestrife, or biennials such as poison hemlock or common teasel. Otherwise, their management is a lower priority than the other plant types.

Put it into Practice

Young Forest management practice can be summarized by plant community components. We will describe use of practices to manage native trees and shrubs, exotic shrubs, native forbs and grasses, and exotic grasses.

The practices described below are further explained in the background section at the end of the document.

Manage Native Shrubs and Trees

Generally, we seek native woody cover of 15 to 70 percent in a young forest site. Managing this component may be a matter of increasing native shrubs and trees, likely while reducing exotic shrubs or grasses; or of reducing the size or density of the native woody species component.

Increasing Native Shrubs and Trees

Increasing the population of native shrubs and trees will typically involve reducing an exotic component of the plant community at the same time. Operations to reduce the cover from exotic shrubs and grasses are covered specifically in a following section. Increased plant numbers can come from release, planting, and seeding.

Release is a function of increasing growth and population of desired species by eliminating exotic shrubs and grasses. Spreading species such as gray dogwood, aspen, sassafras, and black locust will initiate suckers more abundantly in the absence of competition. Where white-tailed deer populations are high, release may be limited due to browsing.

Planting may be necessary where natural release doesn't provide the desired population increase or species diversity (Figures 7 and 8). Almost any tree or shrub planting will require protection from deer and rodents, and suppression of weeds. Protection can be individual shelters or exclosure fencing. Weed suppression is an integral part of planting, both before and after. Pre-plant weed suppression eases planting and creates a "free to grow" situation for quicker establishment. Post-plant weed suppression prevents the new plants from being overwhelmed and suppressed by weed competition, and also makes maintenance of shelters and exclosures easier.

Seeding woody plants is being researched to develop specific recommendations. Successfully implemented, it provides a means to get a lot of woody plants started that require less follow-up care because the mortality that occurs through competition and herbivory is accounted for in the initial planting density.

Reducing or Thinning Native Shrubs and Trees

Figure 6. Exotic, cool-season grasses such as reed canarygrass are very competitive, persistent, and have comparatively little habitat value.

Figure 7. The conventional method for establishing trees and shrubs is spring-planting bare-root or container stock, then protecting the plant with a rigid plastic tree shelter.

Young Forest is only young for so long, then it transitions to a stage where it is no longer providing the needed species composition and structure for species dependent on early successional habitat. In state parks, Young Forest acreage will usually be maintained through "reset". As trees and shrubs grow too large or dense, they are mechanically or chemically thinned to restore desired structure.

Another option is silviculture. The current practice of initially thinning the canopy with shelterwood cuts followed several years later by a final harvest that leaves residual trees produces excellent quality Young Forest habitat. Where forest tracts are large enough, this method provides cost recovery that pays for the active management, and regenerates the forest stand.

Operations to reset Young Forest can include targeted felling, mastication, prescribed fire, and herbicide application.

Targeted felling is useful to maintain a limited number of residual trees and reset individual stems. Based on the scale of the operation, this can be conducted with a chainsaw crew or mechanized using a tree shear. Most deciduous species will resprout when cut, providing several seasons of shrub-like regrowth until a dominant stem emerges.

Mastication can be implemented in a targeted manner to maintain a variety of densities and age classes. Rather than leveling large areas, maintain the desired patchiness by reducing the densest and tallest spots only.

Prescribed fire is best used for Young Forest management on sites where the woody population is desired to be at the smaller and less dense end of the spectrum (Figure 9). Fire will remove much of the top growth of well-established shrubs, but they will resprout. If you have exotic woody species under control prior to initiating a prescribed fire rotation, you can keep them in check as fire will set back or even kill any new volunteer plants, maintaining the dominance of the well-established native woody species.

Prescribed fire has a much wider application than Young Forest management, as there are a number of forest community types, particularly barrens, with mature canopy trees where fire is useful to manipulate the understory layers.

Herbicides can be useful when you do not need to eliminate the existing 'skeletons' of target plants. Targeted applications can be used to thin stands and eliminate larger stems of suckering species. For example, dormant season treatment of black locust stems will kill the stem but encourage new suckers.

Manage Exotic Shrubs

Any management of exotic shrubs will be directed at reducing or eliminating them, and replacing them with something better.

Exotic Shrub Suppression

Herbicides should be included in any program intended to *eliminate* exotic shrubs. Mechanical operations, prescribed fire, and even goats are effective for setting back the growth of exotic shrubs; but they do not prevent regrowth. All these methods can be useful first steps in a comprehensive program to replace exotic shrubs. If we view this as two-phases,

Figure 8. Live staking is an alternative to planting rooted stock, particularly in riparian areas.. Dormant stem pieces are inserted in the ground, leaving a few buds exposed. This method is well suited to volunteers of all ages.

initial and follow-up, we can mix and match approaches to suit available resources and timelines.

Preliminary Shrub Treatments

When we are viewing shrub suppression as a multiple step process, it is usually because shrubs have grown large or dense and it is difficult to treat them effectively in one operation. We can consider techniques from all categories of management practices for initial treatment.

Mechanical. Mastication is the most productive mechanical operation. You have a seven-month window between October and April to minimize disruption to species using the site.

Cultural. Prescribed fire can help reduce the amount of aboveground woody growth. Scattered shrubs can be left intact, while denser stands may need to be reduced with a mechanical operation prior to being burned. Established shrubs will rarely be killed by fire, but reducing the top growth makes a later-season treatment of the regrowth much easier.

Woody plant response to fire is complex, based on the species, surrounding fuels, time of year, and environmental conditions. Decisions to implement fire will be site and time specific.

Biological. Goats or other browsing livestock could be considered for smaller sites where there is environmental education or outreach value.

Chemical. Stands of large and/or dense shrubs can be treated with high-volume handgun herbicide treatments (Figure 10). The 'skeletons' remain after treatment, requiring another operation if you wish to reduce the aboveground woody biomass. It is difficult to be highly selective with high-volume applications. This is an example of a situation where cutting desirable species prior to application to a dense stand of target species makes the application much easier while preserving and releasing the desired species.

Figure 9. Prescribed fire is a multi-function cultural tool that can be used to maintain native, fire-adapted communities, thin native woody species, and set back exotic shrubs. (Photo by Wil Taylor).

Figure 10. When exotic shrub density is high, a high-volume herbicide treatment or mechanical operation are efficient operations to achieve initial reduction.

Follow-up Shrub Treatments

'Follow-up' treatments are appropriate when the target shrubs are smaller or less dense. This could be due to a preliminary treatment that reduced the stand, or because you are treating an infestation earlier in its development. The techniques available do not change, just the specifics of how they are implemented based on target size.

Mechanical. A common scenario for a mechanical treatment as the follow-up operation would be after an herbicide application, particularly to larger shrubs. Mechanically reducing the standing-dead woody biomass will facilitate subsequent work on the site, or reduce flame height and intensity during a prescribed burn.

Cultural. Prescribed fire can be used to reduce woody biomass, particularly after herbicide treatment or a mechanical operation that has left a lot of coarse debris.

Biological. Browsing animals such as goats would not be selective enough to be a useful follow-up method, and there are currently no species-specific biological agents for any common invasive shrubs.

Chemical. Herbicide follow-up, particularly after a mechanical clearance of dense growth, is a highly selective tool to prevent exotic shrubs

Figure 11. Foliar spot-treatment using a backpack sprayer is an efficient method to treat low-density shrub populations, or to follow-up on initial mechanical operations.

from reestablishing, while also releasing desirable vegetation. Follow-up herbicide treatments are readily accomplished using backpack sprayers to spot-treat the foliage of resprouts (Figure 11).

Exotic Shrub Replacement

Removing exotic shrubs is only a first step towards having desired vegetation fill that vacated space. Depending on the extent of the areas that have been opened, you can accomplish this with any combination of release, planting, or seeding. It is critical that the space be filled; otherwise it is vulnerable to being recolonized by exotic shrubs.

Manage Native Forbs and Grasses

Managing native forbs and grasses can include maintaining or increasing the current population, or reducing dense stands to encourage greater diversity and improve community structure.

Increasing the Native Herbaceous Layer

Forb and grass populations can be increased through release of existing plants or the seedbank, or by seeding (Figure 12). Either situation will require 'open space' created by suppressing existing vegetation. This can occur through tillage, mastication of woody vegetation, or herbicide application. You can elect to selectively manage the vegetation that colonizes these disturbances to release desirable species, or you can seed them.

You can use prescribed fire to manipulate the forb and grass composition of a stand. Spring fires can be used to increase the proportion of grasses, and fall fires to increase the proportion of forbs.

Although we place more emphasis on managing forbs, any seeding should include native grasses as well. A basic, native forb and grass seed mix is listed in Table 6.

Thinning the Native Herbaceous Layer

Sometimes stands of herbaceous vegetation are too dense. A critical element of habitat is space. Overly dense stands of grasses and forbs limit ground level movement and utilization. This typically occurs when warm-season grass plantings are seeded at too high a rate, or when rhizomatous goldenrod species become dominant in a stand.

Small patches of dense vegetation are acceptable, as they provide the floral resources pollinators seek and also provide refuge for small animals fleeing predators. Extensive patches should be broken up to provide diverse structure at ground level. Tillage, especially after a prescribed burn, or localized herbicide applications are methods to thin herbaceous stands to reduce density and encourage recruitment of other species.

Manage Exotic Grasses

Exotic grasses, particularly remnant cool-season 'pasture grasses' have little habitat value and they are highly persistent and competitive, inhibiting succession and plant community diversity.

Herbicides are the most effective means to eliminate exotic grasses. Fall is a good time to treat, as they are actively growing and will respond well to the

Figure 12. Seeding can be used to establish or supplement native forb and grass stands. Using seeding to establish woody plants is currently being evaluated. In this image, the site was prepared using herbicides before seeding.

herbicide treatment, and this also prepares the site for a spring seeding or planting.

Management Practice Details

The management plan you develop will match your habitat component objectives with the management practices you are able to implement. The practices are described as cultural, mechanical, biological, and chemical.

Cultural

Preventing the establishment of weedy species, and enhancing the growth of desired species are the most fundamental approaches to plant community management. Prevention is limiting the opportunity for invasive plant establishment as well as the dispersal of plant propagules. Enhancement techniques include planting, seeding, and prescribed fire.

Prevention

A key practice to limit the opportunity for invasive species to establish is to prevent unmanaged soil disturbance. Soil disturbance is unavoidable in a managed landscape, but take measures to ensure that desirable species are the first to revegetate bare soil. If a site already has a population of invasive species poised to spread further, suppress them prior to the disturbance and seeding or planting.

Limit invasive plant propagule movement by only importing, moving, or exporting clean materials, whether it is soil, mulch, or aggregate. Remove soil and plant debris from equipment before you leave an infested location. Shared equipment should always be cleaned before leaving a park, as well as when it arrives before going into the field.

Planting

'Planting' is distinct from 'seeding', and describes the placement of rooted plants or vegetative plant parts. This is the standard method to establish woody species, but can also be used with herbaceous plants in limited-scope projects.

Plant material types for woody species establishment include bare root, container, and live stakes. Bare root plants are young, typically one-year for deciduous plants, and two- to four-years old for conifers. They are dug from the nursery during dormant period, prior to spring bud break or after fall leaf drop, stored in a cooler, then planted as soon as possible after delivery. Spring-dug, bare root stock is the most common method to establish small woody plants,

Containerized stock offers the advantage of an intact root system, and therefore more planting timing flexibility - although early spring and late fall are still the best times to plant to avoid potential moisture stress from warm-weather planting. Container seedlings will cost more - approximately three to four times as much as bare root stock for plants of similar age.

"Live staking" is the dormant-season planting of hardwood branch cuttings of specific species (see *Technical Note #4 - Establishing Shrubs using Live Stakes)*. Common examples include shrub dogwoods and willows, and elderberry. Standard practice would be to use 12- to 24-inch cuttings, 3/8- to 3/4-inch diameter, and plant them deeply enough so that only two to four buds are aboveground, as you are trying to favor root production over leaf production initially.

For any type of planting stock, you may need to order a year in advance to guarantee availability.

Seeding

Seeding provides quick cover to stabilize soil, and establishes the perennial forbs and grasses that are a long-term component of your habitat.

Seed Mix Components

A seed mix will include some, or all, of the following components (Table 6):

Cover crop, also known as a 'nurse crop', is a quick-establishing species that provides immediate soil cover and competition against weeds. This is typically an annual species such as oats, grain rye, ryegrass, or buckwheat.

Cool-season grasses, are characterized by two growth peaks during the spring and early fall, with reduced growth occurring during the hot summer months. Examples of native, perennial cool-season grasses include deertongue, Virginia and Canada wildrye, and autumn bentgrass.

Warm-season grasses are characterized by peak growth during the summer months. In general, warm-season grasses are more heat and drought tolerant than cool-season grasses. Common examples include switchgrass, big bluestem, little bluestem, Indiangrass, purpletop, and broomsedge.

Forbs provide structure, forage, nectar, and seed for wildlife. Native species you might seed include asters, legumes such as partridge pea or ticktrefoils, mints such as bergamot and mountain mint, and milkweeds. Black-eyed Susan is a useful species because it is inexpensive, establishes quickly, and flowers the first season.

Seeding timing is dictated by the predominant perennial grasses in the seed mix. Cool-season grasses can be planted in spring, fall, and dormant periods;

Table 6. A general purpose seed mix for habitat plantings. The diversity of species will provide effective establishment in a range of shade, soil moisture and fertility conditions. The forb component can be regarded as optional. Seeding rates are specified as Pure Live Seed (PLS), except for the oats. This mix should be seeded in the spring or during the dormant season. The oats will dominate the first season, the wildryes will be prominent the second, and the warm-season grasses should begin to have a significant presence by the third season. The "Form" column indicates if the species is annual (A) or perennial (P), and cool-season (C) or warm-season (W).

Common Name	Scientific Name	Form		Seeding Rate	
				lb PLS/ac	lb/ac
Cover Crop					
spring oats	*Avena sativa*	A	C	- -	30
Grasses					
big bluestem	*Andropogon gerardii*	P	W	2	- -
deertongue	*Dicanthelium clandestinum*	P	C	2	- -
Canada wildrye	*Elymus canadensis*	P	C	5	- -
Virginia wildrye	*Elymus virginicus*	P	C	5	- -
switchgrass	*Panicum virgatum*	P	W	0.5	- -
little bluestem	*Schizachyrium scoparium*	P	W	2	- -
Indiangrass	*Sorghastrum nutans*	P	W	2	- -
purpletop	*Tridens flavus*	P	W	2	- -
Forbs					
blackeyed-Susan	*Rudbeckia hirta*	P	- -	2	- -
oxeye sunflower	*Heliopsis helianthoides*	P	- -	0.25	- -
wild bergamot	*Monarda fistulosa*	P	- -	0.25	- -
tall white beardtongue	*Penstemon digitalis*	P	- -	0.25	- -

while warm-season grasses should be seeded in spring or dormant periods.

Seeding Methods

The key to successful seeding is getting the seed in intimate contact with the soil when the soil temperatures and moisture are suitable. Well timed spring- or fall-seeding allows the seedlings to establish before the challenging conditions of summer or winter take hold.

The preferred method to seed is using a no-till drill on sites that have been previously treated with non-selective herbicide mixture to suppress the existing vegetation. However, there are many approaches available to achieve the objective of seed-to-soil contact while minimizing soil disturbance.

In the absence of a drill or seeder capable of metered sub-surface seed placement, any combination of operations that scarifies the surface to expose mineral soil and uniformly distributes the seed is acceptable. The simplest is *frost seeding*, which is simply distributing the seed on the surface during the late winter, when the soil goes through numerous freeze-thaw cycles. The expansion and contraction of the soil at the surface due to the freezing and thawing of ice crystals is enough to incorporate seed into the upper layer of the soil.

A more involved seeding technique is scarifying the soil surface prior to distributing the seed. Deep tillage is not the objective. A disc harrow or other implement that will shallowly scratch the surface is ideal. The seed can be applied by hand, through a drop- or rotary-spreader, or with a broadcast seeder. Dragging the surface or using an implement such as a cultipacker to help mix the seed into the soil helps ensure satisfactory germination.

Prescribed Fire

Human-set fire has been a part of the landscape for thousands of years. Prescribed fire can be used to 'reset' Young Forest communities and keep them in an early development stage. Fire converts plant residue to readily available nutrients in the form of ash, opens ground level space for small animals of all taxa, rejuvenates older shrubs, and releases suckers of clonal woody species such as aspen, black locust, and sassafras.

Once a site has been largely cleared of exotic shrubs, periodic fire can keep them in check as smaller, younger seedlings will have less underground mass to regenerate, compared to the desired mature shrubs you have released on the site.

Mechanical

Mechanical techniques range from hand-pulling small weeds to targeted felling of mature trees. The methods we will describe are pulling, digging, and various forms of stem removal - cutting, mastication, and felling.

Pulling

Herbaceous species such as mile-a-minute and garlic mustard, and small shrubs can be hand-pulled; moderate sized shrubs can be pulled with commercially available tools that feature a long handle for leverage and some form of jaws that clamp on the base of the plant. These activities are well suited for volunteer outings.

Digging

Digging is not recommended. It is *highly* labor intensive, and it is often difficult to remove all the underground propagules that may resprout.

Tillage

Tillage is typically used to prepare a seedbed in agricultural settings with implements described as plows, discs, or harrows, based on how deeply and aggressively they mix the soil. In a habitat setting, discing can be used to expose mineral soil prior to seeding, and also to thin dense stands of herbaceous vegetation and release other species, rather than prepare a seedbed. An additional use for tillage is creating breaks for prescribed fires.

Cutting

We distinguish cutting from mowing by limiting the term "cutting" to describe separating the shoots of a plant from its root system with a sharp tool, ranging from hand pruners, loppers, handsaws, to chainsaws. Cutting is useful to prevent species from going to seed, and to remove tall growth for subsequent herbicide treatment of stumps or regrowth. Cutting is a great first step in dealing with vines such as Oriental bittersweet, as the ground-level regrowth can be conveniently treated with a foliar herbicide treatment after the aerial portion has been killed by cutting it.

Conversely, cutting can be used to remove the top growth of a *desired* plant prior to foliar herbicide application. In this situation, the uncut, herbicide-treated plants die and the cut plants that had no foliage to intercept the spray are unaffected and resprout. This is useful when cutting a few plants would make an application much simpler than taking the time and effort to selectively treat target plants while preserving the desired plants.

Mastication

Literally, mastication is defined as "chew". This is the use of a specialized cutting implement, mounted on a skid-steer or tractor, with carbide-steel teeth on a horizontally-oriented drum that can quickly chew through woody stems several inches in diameter, as well as stumps and soil. There are a number of manufacturers of such implements, but the most familiar in the state park system is "FECON", which is often used as the generic term to describe this operation. The final product can be coarse, shredded debris, or a seedbed, depending on the number of passes over the site. Due to the nimble nature of skid-steer vehicles, a skilled operator can use this tool to selectively remove invasive shrubs while preserving desired native species. Where undesirable woody growth is too dense, this is a useful way to bring growth to ground level so that resprouts can be selectively managed to suppress exotics and release native species.

Targeted Felling

Felling of pole- to mature-size trees is often desirable to create more gradual transition from field to forest ("soft edges"), create canopy gaps to simulate wind throw openings, or to manage the number of residual trees on a site. The felled trees can be cleared, or left in place, based on the structure you are trying to create or future management operations. Fallen trees provide great habitat, but if you're planting, seeding, or burning the areas, you may need to limb, move (e.g. pile) or remove some of the woody debris.

Another aspect of large woody stem management is creating snags by girdling or herbicide treatments. Dead, standing trees provide useful habitat and raptor perches.

Mowing

Although almost every park has a rough-cut mower ("brush-hog"), there are very few sites that we wish to maintain as perpetual herbaceous openings. With the exception of prairie remnants or wildflower preserves, herbaceous openings should be managed to transition towards forest.

In Young Forest situations mowing is generally not useful or beneficial. Mowing obliterates habitat value. When used to keep exotic shrubs in check, mowing also removes native woody species, forbs, and grasses, and destroys all structure and cover. Additionally, mowing does not reduce exotic shrub populations - it simply resets them on a short cycle. In a three-year mowing cycle, you eliminate the habitat for 1/3 of the cycle, and you never actually improve the composition of the plant community.

Situations where mowing is useful include maintaining trails and fire breaks, removing existing biomass to encourage regrowth prior to a site-prep herbicide application prior to seeding or planting, and suppression of taller weeds in new seedings.

Biological Control

Biological control is the use of a biological agent such as an insect or pathogen to suppress a specific target organism. Current examples include the loosestrife beetle and the mile-a-minute weevil, which were imported from Europe and China, respectively.

Another example of biological control would the use of browsing or grazing animals. Goats are the most common example. Goats are not selective and should only be used when most of the plants on the target site are undesirable. Given time, goats will eat almost all plant material present, even resorting to stripping bark from trees.

Chemical

Chemical control describes the use of herbicides. For a detailed review, see the third bulletin in this series, "Herbicide Selection and Use". Herbicides can be applied to foliage, woody stems, or to the soil, depending on the target and objective.

Typical herbicide applications include foliar applications to spot-treat invasive shrubs or suppress existing vegetation prior to seeding or planting; stem-treatment of low- to moderate-density woody species; or early season pre-emergent application to prevent germination of invasive annuals such as stiltgrass or mile-a-minute.

Two key characteristics that define how an herbicide will be used are selectivity and soil activity, or "residual activity". We will explain these characteristics by describing three commonly used herbicides - glyphosate, triclopyr, and prodiamine.

Glyphosate is a non-selective, non-residual herbicide. It is applied to foliage or cut woody stems, and injures all treated plants. However, it is chemically bound to soil particles so that it does not move through the soil or get absorbed by roots. Selectivity is achieved by avoiding treatment of non-target vegetation.

Triclopyr is a selective herbicide with limited residual activity, that is applied to plant foliage or woody stems. Triclopyr injures dicot, or "broad-leaved" plants, but not grasses or most grass-like plants. At typical use rates, it does not affect even sensitive plants through root uptake from the soil, but it is possible at higher application rates.

Prodiamine is applied to the soil to prevent growth of weeds from seed. It has no activity when applied to plant foliage. It is selective in the sense that it does not injure plants that have an established root system, but it will impact seed germination of most species. At typical use rates it will provide at least two months of residual activity

Even with a limited selection of herbicides, you can accomplish a wide variety of objectives, particularly when you integrate herbicides with other practices.

Summary

By definition, Young Forest habitat is a mosaic of different plant communities of different species, sizes, and ages. This makes Young Forest a logical fit for State Park habitat management goals, as parks are typically patchy, often composed originally of multiple properties with different land uses.

The art and science of Young Forest management is not to homogenize the different parts, but to have them work together, providing resources for many species at different stages of their lives. Therefore, there is no rigid template to follow. Any well-directed work can enhance your Young Forest habitat. Even as the availability of personnel and equipment fluctuates during the year, there is always an opportunity to work, whether it's enhancing native species or suppressing exotic species. The work varies from the skilled use of specialized equipment, to the seemingly mundane act of planting seedlings and live stakes, and everything in between. This can engage the most experienced staff to the least experienced volunteer.

It is important to realize that the variability of Young Forest habitat creates not so much a right-or-wrong dynamic, but a sliding scale that will typically be “good-better-best”, based on resources available at the time.

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