USFWS

# Appendix E

## Habitat Management Plan Potential Management Prescriptions

- Upland Forests, Shrublands, and Grasslands
- Tidal and Freshwater Wetlands

# A. Upland Forests, Shrublands, and Grasslands

## ❖ Strategy 1. Manipulate Plant Species Composition

### *1.1 Silvicultural Prescriptions*

1.1a Clearcutting

Clearcutting is the removal of an entire stand of trees in one cutting with reproduction obtained naturally or artificially (i.e. planting, broadcast seeding, or direct seeding). Two common methods of clearcutting are patch or block clearcuts and strip clearcuts. This regeneration method is considered to be even-age management. Although, somewhat coarse multi-aged stands can be accomplished through progressive patch or progressive strip clearcut systems. Clearcut size does have an effect on regeneration. As clearcuts increase in size they tend to favor shade intolerant regeneration. As they become smaller they gravitate towards encouraging intermediately tolerant and tolerant species. The size and shape of the clearcut can have an effect on bird species richness as well as influence herbivore utilization.

*Patch Clearcut*

Patch or block clearcuts can be many different shapes and sizes depending on management objectives, forest type, terrain, or boundaries. Natural regeneration from the adjacent stands is not heavily relied upon, but can have varying degrees of influence depending on patch size. All stems 2" dbh and greater should be removed unless some advanced regeneration of desired species exists. Although somewhat difficult to apply, an alternate or progressive patch clearcut approach can be an option. These approaches are more often associated with the strip clearcut method. Application of these options should follow the respective strip clearcut strategy substituting the strips with patches.

*Strip Clearcut*

Strip clearcutting is used to promote natural regeneration and growth in the harvested strips through the adjacency of the unharvested area. In the harvest areas, all stems 2" dbh and greater should be removed unless some advanced regeneration of desired species exists. The unharvested strips act as a seed source and protection for the harvested areas. As regeneration is established in the harvested areas, the unharvested areas are progressively removed. Concerns related to wind damage are warranted when using this method of clearcutting because of the increase in amount of edge that is exposed. This can be avoided by minimizing the width of the strips being harvested (50-100 feet on stable soil and 30-50 feet on wet soil or questionable sites), ensuring at least one end of the strip is closed, and harvest as soon as cleared strips are regenerated. Strip clearcuts are more successful when applied to healthy forests found on deep, well-drained soils. These harvests can be designed in an alternate or progressive fashion.

*Alternate Strip Clearcut*

Alternate strip clearcuts are accomplished in two stages. The first harvest removes vegetation in long narrow clearcuts leaving unharvested leave-strips in between. The second harvest removes the leave strips once regeneration is established in the first-pass harvest areas. This technique does not allow for much regenerative influence on the second-pass areas, and may require artificial means to accomplish specific regenerative objectives. This requirement can be minimized if a seed source is in reasonable proximity, or advanced regeneration is present. To minimize windthrow, the strips should be oriented at right angles to the prevailing winds. Width of the strips should be influenced by seed dissemination ability for the preferred species and potential to wind damage.

*Progressive Strip Clearcut*

Progressive strip clearcuts accomplish results similar to the alternate strip clearcuts, but in three or more passes rather than in two. There are a number of advantages when using this method over the alternate strip clearcut method. One is the strips can be progressively harvested into the prevailing wind, reducing the exposed edge and windthrow. Another is more area has the ability to regenerate naturally resulting in less are requiring potential for costly artificial regenerative techniques. To some this may also have less negative aesthetic impact.

1.1b Single Tree Selection

Single tree selection is the removal of individual trees uniformly throughout a stand. This technique is often used to promote the quality and growth of the remaining trees. This method can also result in regeneration of mostly shade tolerant species due to the small canopy openings created during the harvest. Use of this technique, on a continual harvesting cycle, is considered un-even aged management. Actively managing a stand in un-even ages can result in reducing the stands natural ability to resist insect, disease, and other debilitating health issues. Careful extraction of the trees is necessary to help limit residual stand damage, which can create an opportunity for insects and disease to enter otherwise healthy trees. Root damage by soil compaction also needs to be considered. This technique can also be used during even-aged management and when done so is commonly referred to as an intermediate thinning. Single tree selection can be used to mirror a small scale disturbance. When only large trees are selected, the large opening produced in the canopy will typically be utilized quickly by the crowns of adjacent older trees.

1.1c Group Selection

Group selection is the removal of small groups of trees to maintain an un-even aged forest. Normally to be considered a group selection, as opposed to a patch clearcut, the size of the harvest group should be less than or equal to twice the height of the adjacent mature trees. This method will encourage regeneration of intermediately tolerant and tolerant species, but some intolerant species can appear towards the center of the harvest areas when the groups are at the maximum size. The likelihood of the harvest areas regenerating combined with the ability to schedule continual harvest entries, results in this technique being a method of choice to convert even-aged stands to un-even aged stands when desired. Actively managing a stand in un-even ages can result in reducing the stands natural ability to resist insect, disease, and other debilitating health issues. Careful extraction of the trees is necessary to help limit residual stand damage, which can create an opportunity for insects and disease to enter an otherwise healthy stand. Root damage by soil compaction also needs to be considered.

1.1d Shelterwood System

Shelterwood is a series of harvests carried out with the intent of regenerating a stand utilizing mature trees that are removed at the end of the scheduled rotation. This technique is typically used to regenerate intermediately tolerant (mid successional) and tolerant (late successional) species, but in certain instances can be used for intolerant (early successional) species. Use of this technique is considered even-aged management, although variations more often found in the irregular shelterwood system can result in a multi-aged stand. In order for a shelterwood system to be considered, a stand should be reasonably well stocked with a moderate to high component of the species desired for regeneration. A number of shelterwood system applications exist. The more commonly used is the open shelterwood system. Although less commonly used, the dense shelterwood, deferred shelterwood, irregular shelterwood, natural shelterwood, and nurse tree shelterwood systems are also useful in accomplishing specific regenerative needs as well as other resource management objectives.

*2-Stage Open Shelterwood System*

The 2-stage open shelterwood system consists of an initial harvest (stage 1) used to encourage regeneration, and an overstory removal harvest (stage 2) once regeneration is established. This technique usually results in regeneration with a higher component of intermediately tolerant species. In a well-stocked stand this translates into removing 30 to 50 percent of the stand in the first harvest. Residual crown closure should be between 30 to 70 percent. The harvest should focus on undesirable species, suppressed, co-dominant, and unhealthy dominant trees. The residual should be an evenly distributed stand of large crowned, healthy dominant and co-dominant trees. This will provide the greatest potential for seed production and resiliency to windthrow. Regeneration is considered established when it is found to be, at a minimum, > 1 foot tall for softwoods and > 3 feet tall for hardwoods and hemlock. A minimum of 5,000 well-distributed seedlings per acre should be established before the overstory removal (stage 2) is conducted. The overstory removal should be conducted during a winter season, with adequate snow depth, to help minimize damage to the regeneration.

*3-Stage Open Shelterwood System*
The 3-stage open shelterwood system consists of a preparatory harvest (stage 1) to encourage tolerant regeneration. A secondary harvest (stage 2) used to encourage intermediately tolerant and tolerant regeneration, and an overstory removal harvest (stage 3) once regeneration is established. This technique usually results in regeneration with a higher component of tolerant species. In a well-stocked stand this translates into removing a maximum of 15 percent of the stand in the initial harvest (stage 1). The harvest should focus on undesirable species and suppressed stems. An additional 15-30 percent of the residual stand should be removed in the secondary harvest (stage 2). Residual crown closure should be between 30-70 percent. The harvest should focus on undesirable species, suppressed, co-dominant, and unhealthy dominant trees. The residual should be an evenly distributed stand of large crowned, healthy dominant and co-dominant trees. This will provide the greatest potential for seed production and resiliency to windthrow. Regeneration is considered established when it is found to be, at a minimum, > 1 foot tall for softwoods and > 3 feet tall for hardwoods and hemlock. A minimum of 5,000 well-distributed seedlings per acre should be established before the overstory removal (stage 2) is conducted. The overstory removal should be conducted in the winter to help minimize damage to the regeneration.

*Dense Shelterwood System*
The dense shelterwood system consists of an initial harvest used to encourage tolerant regeneration, and an overstory removal harvest once regeneration is established. This technique usually results in regeneration with a higher component of tolerant species. In a well-stocked stand this translates into removing 15-30 percent of the stand in the first harvest. Residual crown closure should be around 80 percent. The harvest should focus on undesirable species, suppressed, co-dominant, and unhealthy dominant trees. The residual should be an evenly distributed stand of large crowned, healthy dominant and co-dominant trees. This will provide the greatest potential for seed production and resiliency to windthrow. Regeneration is considered established when it is found to be, at a minimum, > 1 foot tall for softwoods and > 3 feet tall for hardwoods and hemlock. A minimum of 5,000 well-distributed seedlings per acre should be established before the overstory removal (stage 2) is conducted. The overstory removal should be conducted during a winter season, with adequate snow depth, to help minimize damage to the regeneration.

*Deferred Shelterwood System*
The deferred shelterwood system consists of an initial harvest (stage 1) used to encourage regeneration, and a delayed overstory removal harvest (stage 2) once established regeneration is well advanced. This technique can be catered to encourage a high regenerative composition of either intermediate or tolerant species by adjusting the intensity of the initial harvest. In a well-stocked stand this translates into removing 15 to 50 percent of the stand in the first harvest. Residual crown closure should be between 30 to 80 percent. The harvest should focus on undesirable species, suppressed, co-dominant, and unhealthy dominant trees. The residual should be an evenly distributed stand of large crowned, healthy dominant and co-dominant trees. This will provide the greatest potential for seed production and resiliency to windthrow. Regeneration is considered well advanced when it is found to be, at a minimum, > 10 feet tall for softwoods and > 15 feet tall for hardwoods and hemlock. A minimum of 5,000 well-distributed seedlings/saplings per acre should be established before the overstory removal (stage 2) is conducted.

*Irregular Shelterwood System*
The irregular shelterwood system consists of an initial harvest used to encourage regeneration, optional intermediate harvests used to encourage supplemental regeneration, and an overstory removal harvest once regeneration is established. This technique usually results in regeneration with a higher component of intermediately tolerant or tolerant species. This technique differs from other shelterwood systems by introducing the concept of leaving a component of the original stand that can either be removed

during subsequent harvests or left throughout the series of harvests and beyond. The long-term residual component can be left singularly or in groups. Harvests can be applied in a variety of fashions including harvesting uniformly, in groups, or strips. The harvest should focus on undesirable species, suppressed, co-dominant, and unhealthy dominant trees. This will provide the greatest potential for seed production and resiliency to windthrow.

1.1e. Seed Tree System

Seed tree system is the removal of the majority of a stand while retaining a minority of seed producing trees, left standing to retain some component of the desired species in the regenerating stand. Seed trees can be left singularly and/or in groups, and should be distributed as uniformly as possible throughout the stand. This technique is usually prescribed when desired species are lacking as a seed source in the overstory (negating shelterwood as an option), or regeneration composition is not a primary objective. This technique could also be used, somewhat more unpredictably, to convert species composition to an earlier successional variety while retaining a small component of desired species (eg softwood to mixed wood). Desired species that are healthy, dominant, large crowned, and well rooted should be targeted to leave standing. The rest of the stand should be removed in its entirety (2" dbh and greater). The residual trees/groups can be removed after regeneration is established or may be left to accomplish other stand objectives. Residual trees are subject to harsh environmental conditions with very little protection. Sudden exposure to light can stimulate epicormic sprouting in hardwoods, which should be addressed and/or expected. A common approach to reduce epicormic sprouting is to leave adjacent trees that will provide immediate shade to the bole of the seed tree. The more shallow rooted softwoods have the least resilience to wind and other environmental factors, and are less likely to perpetuate until natural resilience is reestablished with the regenerating stand.

### *1.2 Stand Improvement*

Stand improvement consists of entering an even or uneven aged stand at any stage of development with the intent of tending to habitat needs through thinning, weeding, cleaning, liberation, sanitation, or other improvement methods. The primary function of this method is to control species composition and reduce an overabundance of stems per acre to a more desired stocking level. Another function of this method should be to consider other habitat needs during these stand entries, and introduce methods to help meet desired criteria. This translates into thinning young stands (pre-commercially) to control species composition, conducting intermediate thinnings in middle aged stands to maintain accelerated growth and remove unwanted vegetation, and control stocking levels of habitat features such as snag trees, cavity trees, den trees, downed wood and other features.

### *1.3 Herbivore Control*

Selective feeding or browsing by wild herbivores can negatively impact woody plant species composition and stand structure. Deer are the most common species that cause impacts of concern to wildlife and forest managers. Methods to reduce negative impacts include deterrents, exclusion, or population reduction. Deterrents (e.g., chemical application, scare devices) and exclusion (e.g., fencing, seedling tubes) are labor intensive and costly to employ, chemicals can create environmental hazards, and both methods usually are not practical or satisfactory except in small-scale situations such as nurseries or small plantations. Population reduction methods include reproductive controls (e.g., chemosterilants, contraceptives) that are costly and require continual reapplication, and public hunting. Hunting is the most widely practiced tool for reducing negative impacts of herbivory in these settings. Hunting must be regulated (e.g., hunting methods, timing of seasons, hunting pressure) and harvests monitored to prevent negative impact to long-term survival of target herbivore populations.

In some situations, beavers can conflict with certain refuge management objectives through excessive tree felling and girdling, and flooding of sensitive habitats. Beavers can also create wonderful wetland habitats. Installing anti-flooding/damming devices (e.g., "beaver bafflers") at culverts, water control structures, or bridges can sometimes be effective in mitigating undesired flooding.

### *1.4 Mechanical and Herbicidal Treatments for Native Vegetation*

Many treatments and numerous types of equipment are available for mechanically manipulating upland sites from one covertype to another. Selection of the type of mechanical treatment often depends on your habitat goals. Do you want to have all vegetative material left on the ground, have it removed from the site, piled in slash, broadcast spread, burned or chipped? If an area is cut from young forest and with the intention of creating a permanent shrubland, should stumps be removed?

Strategies and tools:

- Drum mowers for removal of small trees
- Hydro-Axe – this piece of equipment consists of an articulated tractor with a mower mounted on the front. It is generally able to cut trees up to approximately 6-8 ” dbh. Woody material is reduced to fine chips, often finer then those resulting from a roller mower.
- Roller Chopper Mower
- Mowing and brush hogging – mowing is an appropriate treatment for grass, forbes and small shrubs and saplings. Vegetation > 4 inches often needs a higher powered machine.
- Girdling – Girdling can be appropriate to kill single trees to create snags and open up the canopy for further development of understory. It can also cause stump sprouting.
- Chainsaws – Saw work can be appropriate to remove single trees or groups of trees and pen up the canopy for further development of understory. Stump sprouting may occur.
- Coarse Woody Debris Management – different prescriptions will leave differing amounts of woody debris. Objectives will drive the best management technique for dealing with the debris. Often times, it can be left to decay on the forest floor, however if conversion to another habitat type is desired (grassland or shrubland) the woody materials left must not complicate future management actions (i.e. leaving large logs in unit may make it hard to brush hog).
    - Chipping – materials can be chipped and broadcast on site. Depth of chips should not exceed 2-3 inches.
    - Piling – native vegetation may be piled on site and left for habitat or burned in a slash pile.
    - Removal from site – materials can be chipped and removed from site, removed as whole logs or shrubs
    - Spreading small slash will not make future treatments difficult and returns nutrients to the soil.
- Herbicides for Stable Shrublands – in some cases where the structure of a stable shrubland is desired selective herbicides are applied to tree species. This eventually results in the selection of a dense shrub overstory and the development of a minimal amount of trees. This can create habitat which will remain in the shrub stage for longer then most other management techniques.

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Maryland Partners in Flight Committee. 1997. *Habitat Management Guidelines for the benefit of landbirds in Maryland.* Maryland Partners in Flight.

### *1.5 Invasive Plant Control*

*Manual and Mechanical Control*

Mechanical removal of plants can be effective against some herbaceous plants, shrubs and saplings, and aquatic plants, especially if they are annuals or have a taproot. Care should be taken to minimize soil disturbance to prevent creating conditions ideal for weed seed germination. Repeated cutting over a growing period is needed for effective control of many invasive plant species. Care should be taken to properly remove and dispose of any plant parts that can re-sprout. Treatments should be timed to prevent seed set and re-sprouting. The following methods are available: hand-pulling, pulling with hand tools (weed wrench, etc.), mowing, brush-hogging, weed-eating, stabbing (cutting roots while leaving in place), girdling, mulching, tilling, burning using a hand held tool, smothering (black plastic or other), and flooding.

The advantages of mechanical treatment are low cost for equipment and supplies and minimal damage to neighboring plants and the environment. The disadvantages are higher costs for labor, increased soil disturbance and inability to control large areas. For many invasive species, mechanical treatments alone are not effective, especially for mature plants, those with extensive rhizomes, or well-established plants. Mechanical treatments are most effective when combined with herbicide treatments (e.g. girdle and herbicide treatment).

*Prescribed Fire*

Fire can either suppress or encourage any given plant species, so great care must be taken to understand the ecosystem and the life histories of the native and invasive plants before using this tool. This tool is most successful when it is used to mimic natural fire regimes. Proper timing of prescribed burns is essential for controlling target invasive species. The most effective fires for invasive plant control occur just prior to flower or seed set, or at the young sapling/seedling stage. Repeated burns or a combination of burning and herbicide treatments may be needed to effectively control the invasive plant and seedlings that may sprout after the burn.

This tool requires a good deal of pre-planning (including permitting) and requires a trained crew available on short notice during the burn window. Spot burning using a propane torch can be a good method to control small infestations of invasive plants. It can be advantageous where it is too wet or where there is little fuel to carry a prescribed fire.

*Biological control*

Biological control is the use of animals or disease organisms that feed upon or parasitize the invasive species target. Usually, the control agent is imported from the invasive species' home country, and/or artificially high numbers of the control agent are fostered and maintained. There are also "conservation" or "augmentation" biological control methods where populations of biological agents already in the environment (usually native) are maintained or enhanced to target an invasive species.

The disadvantage of biological control is the small chance that an introduced control agent can itself become an invasive species. Great care is taken in selecting appropriate biocontrol agents, they are regulated by the USDA. Appropriate control agents may not even exist for all invasive species. The advantages of this method are that it avoids the use of chemicals and can provide relatively inexpensive and permanent control over large areas. More effort is placed on using "conservation" approach to biological control; and this has great promise as an effective, long-term control method. If biological control methods are used, ensure all State and Federal permits are in place.

*Herbicides*

There are a wide variety of chemicals that are toxic to plant and animal species. They may work in different ways and be very target specific, or affect a wide range of species. Herbicides may be "pre-emergent," that is, applied prior to germination to prevent germination or kill the seedling, or "post-emergent" and may have various modes of action (auxin mimic, amino acid inhibitor, mitosis inhibitor, photosynthesis inhibitor, lipid biosynthesis inhibitor). Products may come in granular, pellet, dust or liquid forms. Liquid herbicides are commonly diluted to an appropriate formula and mixed with other chemicals that facilitate mixing, application or efficacy. Common application methods include foliar spray, basal bark, hack and squirt, injection, and cut stump.

The advantages are that the correct chemicals, applied correctly, can produce desired results over a large area for a reasonable cost. The disadvantages are that the chemicals may affect non-target species at the site (including the applicator) and/or contaminate surface or groundwater. Proper planning includes using the most target-specific, least hazardous (humans and the environment), and most effective chemical for the job. Additionally, attention to protective gear, licensing requirements and other regulations and is essential. Herbicides are most effective when used in combination with non-chemical methods described above.

### *1.6 Planting or Seeding*

Planting or seeding areas can change the species composition. Some examples are converting cool season grass fields to warm season through planting, restoring areas which have been damaged either by wildfire or erosion, introducing native ground cover to outcompete non-native plant species or jump starting areas to a new habitat type by planting shrubs or trees.

*Tools and Equipment*

The tools and equipment chosen will depend on the type of planting stock you are using. Warm season grass mixes may be broadcast seeded or a seed drill may be used. If seeds are broadcast spread the field should be lightly disked or packed to incorporate seed. Attachments on tractors can assist with shrub or tree planting. To minimize soil disturbance a large auger may be used to dig planting 18” holes. For bare root seedlings or whips, dibble sticks can be used to manually plant.

*Site Preparation*

Many native grass species are not good competitors with aggressive weedy species. The seed bed should be free of weeds and noxious plants before seeding. For native trees and shrubs, grass competition should be reduced by mowing and invasive shrubs and trees removed before planting. Minimizing soil disturbance during planting will help prevent the establishment of new nonnative plants. Follow up control of undesirable plants may be necessary.

*Planting Technique*

*Stock*

Season: Planting is best completed during times when there will be ample precipitation, either in early spring or fall. Avoid summer planting when possible as new transplants and tender seedlings are prone to drought damage.

*Monitoring*

Appropriate monitoring plans must be in place to measure plant survivorship and establishment of communities.

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Pfaff, S. and M.A. Gonter. *Florida Native Plant Collection, Production and Direct Seeding Techniques*. 1996. US Department of Agriculture. 61 pgs.

## ❖ Strategy 2. Maintain or Provide Structural Components of the Woody Uplands

### *2.1 Retain or Provide Coarse Woody Debris*

Snags or live trees that fall to the forest floor are known as coarse woody debris (CWD). CWD, ranging in size from branches to bole to entire trees, adds structural diversity, serving as hiding and thermal cover, den sites, foraging substrate, and winter access to subnivean (i.e. below the snow surface) habitats. As the wood decays essential nutrients such as sulphur, phosphorous, and nitrogen are released. The need for creating CWD depends on the forest type, stage of succession, and management history. Allowing snags to fall naturally, felling and leaving live trees, and/or leaving non-merchantable tops, limbs, and products other than logs during commercial logging can augment CWD levels.

### *2.2 Retain or Create Snags*

Snags play an important ecological role for at least 149 bird species, 73 mammalians, and 93 herptiles (Thomas et al. 1979). Based on the state of decomposition, snags can be hard (sound sapwood, rotting heartwood) or soft (rotting sapwood and heartwood). Snag abundance can be compromised in commercially managed forests because they are considered safety hazards. There are several ways to "create" snags, or initiate the decomposition process. Each is an effort to damage a healthy tree's integrity by creating a pathway for fungal infection. These include girdling, topping, branch removal, fungal inoculation, and herbicide injection. The density and size of suitable snags depends on the individual forest types and natural disturbance patterns. Snag retention must be done in appropriate places (i.e. not within felling distance to public walking paths).

Thomas, J. W. 1979. *Wildlife habitats in managed forests, the Blue Mountains of Oregon and Washington*. USDA, Forest Service, Agriculture Handbook No. 553.

### *2.3 Patch Retention*

Patch retention is leaving groups within a stand with the primary purpose of satisfying structural or other non-regenerative objectives. This can be applied in combination with other silvicultural systems. Patch size can vary and should be determined on how effectively it will meet the objective. Trees can be left singularly, but should be left in conjunction with groups to form a mosaic as opposed to uniform singular use that will resemble other silvicultural systems. Patches can be removed in a variety of scheduled intervals, but to set this method aside from variations that can be found in other silvicultural systems, longevity is vital.

### *2.4 Control Deer Populations*

Selective feeding or browsing by deer in particular can negatively impact woody plant species composition and stand structure in Northern Forest habitats. Methods to reduce negative impacts include deterrents, exclusion, or population reduction. Deterrents (e.g., chemical application, scare devices) and exclusion (e.g., fencing, seedling tubes) are labor intensive and costly to employ, chemicals can create environmental hazards, and both methods usually are not practical or satisfactory except in small-scale situations such as nurseries or small plantations. Population reduction methods include reproductive controls (e.g., chemosterilants, contraceptives) that are costly and require continual reapplication and are often ineffective except within island environments, and public hunting. Hunting is the most widely practiced tool for reducing negative impacts of herbivory in these settings. Hunting must be regulated (e.g., hunting methods, timing of seasons, hunting pressure) and harvests monitored to prevent negative impact to long-term survival of target herbivore populations. In general, shotgun seasons are more effective then bow seasons when the goal is to reduce deer populations. However, bow hunting is more acceptable within heavily developed areas. Doe only harvests are effective at reducing and controlling populations. Harvest of bucks will do little to control population growth.

## ❖ Strategy 3. Manipulate Site Conditions

### *3.1 Site Preparation*

See 1.6, these techniques can be applied at a smaller scale to increase structural objectives.

### *3.2 Prescribed Fire*

*Ecological Role of Fire*

Refuge managers will generally seek to reconstruct or maintain a forest mosaic that closely resembles the natural, historic conditions of the Northern forest. Although it is not possible to perfectly mimic natural disturbances, strategies that preserve their associated processes and diversity should be implemented where possible, in northern forest ecosystems (Bergeron et al. 1998).

(WE WILL ADAPT TO BCR 30 THIS IS FOR BCR 14) Spruce-fir forests (red spruce, balsam fir, white spruce, aspen) dominate northerly and higher elevation areas, while northern hardwoods (maples, American beech, birches) dominate the other areas of northern New England and the Adirondack Mountains (BCR website). Natural fire has never been a major ecological factor in development of these ecosystems (Lorimer 2001), in contrast to the pitch pine and oak-hickory forests of southern New England, whose modal fire regimes have been estimated at between 5-50 years (Jordan et al.). Bonnicksen (2000) estimates that light surface fires crept through the typical Northern Forest about once in 600 years, and severe fires only burned it once in 3,000 years. In the spruce-fir forests, the average area in northern New England burned only every 200-400 years; some areas escaped a major fire for as long as 800 years (Bonnicksen 2000). Cogbill (2000, 2001) estimates that the pre-settlement fire return interval for forests in northeastern Vermont, for example, was in the order of “several millennia” based on witness tree reports from colonial land surveys. Cogbill admits, however, that there is some uncertainty about the pre-settlement role of fire in shaping the lowland conifer forests. These “black spruce swamps” have environmental and floristic similarities to boreal systems in Canada, which burn regularly.

In summary, frequent or low-severity fires did not play a significant role as a natural disturbance in most Northern forest habitats, with the exceptions of the uncommon pitch pine and oak-hickory forests on sandy soils or rocky outcrops (e.g. the Ossipee and Concord Pine Barrens of NH and ME, the Montague Plains of central MA), jack pine stands, and black spruce bog habitats. Therefore, the use of fire in restoring historic ecological conditions, such as on a large-scale in wildlands or natural areas, is limited. Prescribed fire is more likely to be used in typical Northern forest habitats, in wildfire suppression, and for small-scale habitat manipulation.

*Hazardous fuel reduction*

Prescribed fire may be used to reduce scattered concentrations of dead-down woody materials, which pose a significant wildfire hazard to natural resources of concern (e.g. habitats for endangered species) or cultural resources of concern (e.g. historic buildings or archaeological sites), public resources (such as refuge administrative buildings or facilities), or adjacent private lands. Heavy fuel loads may be caused by natural events, such as ice storms, blow-downs, or insect outbreaks, yet may still pose significant threats to these important, and oftentimes, irreplaceable resources.

Fire is used to reduce hazardous fuel threats by focusing burns in significantly altered habitats, such along the wildland urban interface (the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels) along roads, or along existing or constructed fuel breaks. Controlled burns in such areas may reduce the Crowning Index (the wind speed at which active crown fire is possible) and fire intensity, and facilitate vehicular access for suppression actions, when unplanned ignitions occur.

Prescribed fire is generally used in conjunction with other forestry treatments to reduce hazardous fuels. For example, projects to reduce the threat of wildland crown fire in pitch pine forests to housing communities in Massachusetts involve first thinning mature mixed pine/hardwood stands, reducing original stocking densities from 100-170 $ft^2$ basal area/acres to 25-30 $ft^2$ basal area/acre (fuel objectives), increasing the crowning index from 30 to 60 mph. Heavy equipment is used to grind or pile slash after thinning; prescribed fire is then used to consume slash, and dramatically reduce wildfire behavior. Fire is generally reapplied on a short-term rotation (~ 5 years), to maintain low canopy density and well-spaced understory woody shrubs and saplings, and to maintain low downed fuel loads (Patterson and Crary 2004).

*Even-aged stand management*

Prescribed fire may augment even-aged silvicultural prescriptions (i.e. to create/maintain stands with trees representing one age class, or a narrow range of age classes). Most northern hardwood forests were dominated by old-growth forest in presettlement times, with young forest habitat (up to 15 years old) occupying <1% to 13% of the landscape (Lorimer 2001). Therefore, even-aged stand management, through a combination of cutting and fire, is likely to be applied in small patches, simulating the scale of natural disturbances that historically shaped the Northern Forest: deaths of single-trees (gaps) and blowdowns (larger gaps). The intended composition of these forests is thick, young woody growth, in full sunlight, dominated by shade-intolerant trees (e.g. jack pine, red pine, aspen) and shrubs (e.g. willow and cherry, *Prunus* spp). Management for temporary shrubby openings and young forests, on the order of 1- 2 ha, creates ephemeral habitats important for early successional forest species such as woodcock, eastern towhee, and yellow-breasted chat (Ehrlich et al. 1988, Dessecker and McAuley 2001, NatureServ 2005).

In this context, prescribed fire is mainly used in post-cutting treatments, once small patches of softwoods (red/white/black spruce, balsam fir, hemlock, northern white cedar, eastern tamarack, eastern white and red pines) or hardwoods (aspen species, paper birch, gray birch, red maple, silver maple, sugar maple, red/white oak, ash, and beech as principal species or associates) have been harvested through clearcut, shelterwood, or seed-tree methods (Dessecker and McAuley 2001, USFWS 2001). Timber harvest treatments remove sufficient canopy to promote dense sapling and shrub growth, while follow-up prescribed fire may be used to remove logging residue and slash. After a few years, most clearcuts become too thick for early successional forest birds. At this point, an understory prescribed may be used to thin out the vegetation but leave enough patchiness for species such as woodcock (Krementz and Jackson 1998). Fire should be applied at regular return intervals (approximately 10 years), to provide a disturbance to maintain low residual basal areas, on the order of <4.9 m2 (Dessecker and McAuley 2001).

*Forest Restoration*

Prescribed fire may be used to prepare degraded sites (e.g. heavily logged areas, former forest roads, mined sites), for natural and artificial tree regeneration. In general, burned-over surfaces and mineral soil are excellent sites for seed germination. In contrast, unburned organic layers on the forest floor, depending on their moisture content, provide less favorable sites for seed germination, and, depending on their composition, can impede the planting and development of artificial regeneration. Undisturbed organic materials often favor the establishment of heavy-seeded plants (with seeds that can penetrate the heavy organic layers) and advance regeneration. Conifers and deciduous tree species have differential responses to forest floor disturbance, as do shrub and forb species. Some species become established primarily from seed (e.g. jack pine, pitch pine), whereas others regenerate from sprouts (aspen). Prescribed fires that remove organic layers from the forest floor can be used to influence the composition and quantity of regenerating trees, favoring early-successional species such as pines (Graham et al. 1998).

*Early successional habitats*

Fire has historically been used on refuges in BCR 30 to maintain grassland openings for grassland birds and woodcock, such as abandoned pastures, old fields, and blueberry barrens. Prescribed fire may be used to: increase grass biomass (e.g. by eliminating woody shade plants, extending the growing season by removing litter, and buffering soil chemistry); selectively control tall forbs or fire-sensitive woody plants (by topkilling or causing mortality); mineralize litter; and increase community diversity (by altering the composition of early-flowering or late-flowering plants). Prescribed fire also may used to maintain an interspersion of shrub- and grass-dominated communities attractive to shrubland passerines, by topkilling shrubs in old fields, and allowing them to resprout into thickets. And finally, fire may be used to help eradicate exotic, invasive plants from open habitats, in some cases precluding the need to use chemical herbicides.

When using prescribed fire to alter woody plant cover in early successional habitats it is important to consider that many woody plants, especially shrubs, are adapted to disturbance, regenerating new shoots prolifically. Fire can increase or decrease shrub stem density in a habitat. Thus, fire can either help eliminate (through direct mortality) or maintain shrub-scrub habitat structure (by pruning tall woody plants back, killing less-fire adapted trees, encouraging shrub sprouts). The key to predicting fire effects on woody plants is fire regime (frequency, seasonal timing, severity, and geographic size of fire). The fire regime will affect: differential shrub and sapling mortality (which species dies, which doesn't); mortality vs. top-kill effects; and post-fire vegetative regeneration.

There are several principles that should be considered when employing prescribed fire to control woody plants in early successional habitats:

1. Plant mortality is strongly tied to death of "growth points" (i.e. meristems/buds), which are more sensitive to heat damage when actively growing, and when tissue moisture is high (Miller 2000). Therefore, applying

fire during spring, when target woody plants are mobilizing water/nutrients and breaking dormancy of leaf/flower buds, or during fall cold-acclimation periods, is more likely to kill growth points than Rx fire during dormant periods.

2. Total plant mortality is often the result of injury to **several different** parts of the plant, (i.e. crown damage coupled with stem tissue mortality). Many prescribed fires (often executed in the dormant season) "top-kill" shrubs, but fail to kill the entire plant, which re-sprouts from dormant buds. New shoots can originate from dormant buds located both above the ground surface (i.e. epicormic sprouts, root collar sprouts), and from various levels within the litter, duff, and mineral soil layers (i.e. rhizomes, root crowns). It is the severity of fires (depth of fire and ground char) that directly affects shrubs' re-sprouting ability from these buds. Moderate severity fires (moderate ground char, consumes litter layer, partially consumes duff layer) frequently cause the greatest increase in stem numbers from root sprouters such as rhizomatous shrubs, by pruning rhizomes below the surface, causing several new shoots develop per rhizome. High Severity fires (deep ground char, removes duff layer and large woody debris) are more likely to eliminate species with regenerative structures in duff layer or at duff/soil interface. In such fires, re-sprouting is eliminated from shallowly buried tissues, often delayed from deep rhizomes or roots (Miller 2000).

Therefore, if the goal is to increase density of shrub stems, a moderate severity, dormant season fire is probably preferred. If the goal is to decrease shrub stems, a high severity, growing season fire is probably best. If a management unit contains shrubs to be controlled, as well as shrubs to be maintained, no one burn prescription is going to accomplish this, and selective treatments will be necessary.

3. Concentrations of metabolic compounds, i.e. sugars, salts, lignins, vary seasonally, and have been shown to relate to seasonal effects on shrubs. Consequently, timing of treatments may be more important than the type (cutting versus burning) in controlling shrubs. To maximally reduce woody stems, fires should be applied during periods of low below ground carbohydrate storage (i.e. immediately after spring flushing and growth) and should be followed with a second growing season treatment (such as mowing, herbicide, or more prescribed fire) before total non-structural carbohydrate (TNC) levels are replenished. Repeated burning (several consecutive years) during the low point of a plant's TNC cycle can amplify the negative effects of the treatment (Richburg and Patterson 2003, 2004).

4. Fire reduces cover and thickness of organic soil layers; this can increase light (and, seasonally, temperatures) at the soil surface, causing an increase in sprouting from woody rhizomes (Miller 2000). Thus, to control shrubs, a follow-up treatment (herbicide, mowing) is almost always required, post-fire (Patterson 2003).

5. Invasive plants are well-adapted to disturbance, often surviving fire and rapidly spreading through a disturbed landscape. Studies in northeastern successional habitats have generally shown that fire alone *will not* remove invasive shrubs. Additional herbicide and/or cutting treatments are necessary (Patterson 2003).

6. In general, drought conditions (either normal lows in precipitation during summer/fall, or abnormal winter/spring droughts) dry large fuels and duff, increasing the potential for duff consumption and subsurface heating, and mortality for buried shrub regenerative structures (Miller 2000). Burning when litter layers, duff, and upper soil layers are saturated (i.e. winter and early spring) is not likely to suppress shrub stems.

7. Prolonged heating, such as that experienced during a slow, backing fire (versus a fast-moving head-fire) causes greater burn severity, and plant tissue death. Slow, backing fires, in general, cause more woody tissue damage than rapid head-fires (Miller 2000). However, the warmer the Wx conditions, the shorter the heating duration necessary to cause shrub tissue death, and the greater likelihood of suppressing shrub stems.

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### ❖ Strategy 4. Allow Natural Succession and Processes

Natural disturbances, such as wind throw, herbivory, beaver activities, native disease and insect outbreaks, major wind and ice storms, succession and flooding may provide desired structure for many upland habitats. Natural processes like succession and wind throw may result in the development of micro-habitats, while other natural processes such as outbreaks of native insects and hurricanes may result in stand replacing events. Often, these techniques can assist managers reach their desired habitat type. It is important to monitor these habitats though, to ensure that hands off approaches result in high value habitats for wildlife.

For many habitats freshwater marshes, shrublands and grasslands, natural processes may drive these habitats towards more mature stages. Site capacity, soil types, aspect ratio, climate, prior management will influence how stable these communities are. Some may require infrequent management (vegetation occurring on sandy or stressed soils like pine barrens and native shrublands), while other types, old field thickets, may progress rapidly. Monitoring and adaptive management of habitats where natural processes are the primary management tool is critical.

## B. Tidal and Freshwater Wetlands

### ❖ Strategy 1. Restore tidal hydrology to salt marshes

Restricted tidal flow can result in severe tidal marsh degradation as demonstrated by expansion/domination by invasive *Phragmites australis*, surface subsidence, conversion to open water, or conversion to brackish or freshwater plants (Roman et al. 1984). Such degradation can result in loss of habitat for salt marsh fish species, particularly *Fundulus heteroclitus*, and decreased use by shorebirds and wading birds. Restoration of tidal hydrology must proceed cautiously accounting for changes in marsh elevation (subsidence) that developed since the occurrence of restricted flow; immediate restoration of full tidal volumes could result in creation of mud flats or permanent open water. Full tidal restoration could also result in negative impacts such as flooding of human structures built on low lying elevations during the time of tidal restriction, and flooding of sharp-tailed sparrow and seaside sparrow nests (DiQuinzio et al. 2002). Installation of self-regulating tide gates has been used to address potential flooding of human structures (Roman et al. 1995). Benefits of tidal restoration include restoration of salt marsh habitat, control of invasive *Phragmites*, increased number and abundance of nekton species, increase use by shorebirds, wading birds, and sharp-tailed sparrows.

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DiQuinzio, D. A., P.W.C. Paton, and W.R. Eddleman. 2002. *Nesting ecology of saltmarsh sharp-tailed sparrows in a tidally restricted salt marsh*. Wetlands 22:179-185.

### ❖ Strategy 2. Control native aquatic vegetation community composition

- Altering Salinities - Freshwater species such as cattail can be controlled by allowing salt water into an area or an impoundment to increase salinity levels. This can set back vegetation either temporarily, in the case of impoundment management or permanently, in the case of tidal restoration. Changes in salinity can result in fish kills, and if done during the summer months can cause botulism. Changes in salinity will likely impact all freshwater biota and should be untaken with caution. Rachel Carson NWR does not manage impoundments, and is unlikely to alter salinities in freshwater environments.

- Setting back succession -

  - Use of prescribed burn, herbicides or mechanized equipment may be used to set succession back in areas where vegetation is too rank for wildlife use. This approach may be appropriate in cattail marshes which are so dense they are reverting to upland vegetation types. Mechanized equipment for use in wetlands is specially adapted with a low ground pressure so that habitats are not damaged.

## ❖ Strategy 3. Restoring natural hydrology within the salt marsh

Natural hydrology within salt marshes has been altered since colonial times through ditching and diking. Over 90% of all eastern marshes have been ditched by 1938, though that percentage is somewhat lower in Maine. Ditches have been constructed for salt haying, mosquito control and other purposes. Ditches drain surface water and groundwater from this tidally flooded habitat and have also been found to impound water on salt marshes through formation of peat spoil levees and clogging of ditches with debris and slumped peat blocks.

Natural, unditched salt marshes are characterized by large, highly sinuous creek and runnel systems. These drainage features remove surface water from a marsh without draining natural pools. While restoration of tidal flow *to* a marsh is often restricted to one small area (such as a culvert), restoring natural hydrology *within* a marsh is complicated by direct (surface water drainage) and indirect (impoundment, peat drainage) effects of ditching as well as their physical size and number.

While techniques historically employed to "restore" ditched marshes, such as filling and plugging, have increased surface water habitat, they have not restored pre-ditching hydrology. Ditch plugging has also led to saturation of peat up to 15 m perpendicularly away from a ditch resulting in the conversion of high marsh vegetation to low marsh vegetation. While this may be a desirable outcome in some circumstances, it does highlight the need to develop new techniques to restore ditched marshes. Public health officials in the late 1930s noted that ditching replaced one form of marsh hydrology (creeks) with another (ditches). In order to *restore* salt marshes we must consider the need to restore natural creek hydrology, i.e., remove ditches and return panne and pool habitat. Additionally, restoration efforts to date have highlighted the unique nature of each marsh site. Extensive site investigations and measurements must be part of the *planning* process in order increase the likelihood of project success and move the science of restoration forward.

Small impoundments, whether constructed incidentally as part of the ditching process or purposefully through diking for agriculture or other ends, also represents an alteration to natural within-marsh hydrology. Restoration of impounded or diked areas must proceed with the same cautions noted in strategy 1.

Pools are common features on unditched marshes but not ditched sites. They occur throughout New England and the mid-Atlantic coastal marshes. Ditching has led to their filling, drainage or loss. Restoration of pool habitat is a significant concern since they provide important habitat for fish, invertebrates, mammals and birds. Pool creation through excavation does increase surface water habitat on marshes. Careful consideration must be given, however, to correct pool dimension, particularly size, sidewall slope, and depth. Most natural pools contain less than 30 cm of water and have soft organic sediment bottoms. When creating pools, it is imperative not to excavate through the peat to underlying sediments (otherwise pools will not retain water). Furthermore, natural pools exist in a variety of depths -- though few over xx cm. The construction of sumps in man-made pools may be desirable but should be executed judiciously. Since peat excavation results in acute redox conditions deleterious to nekton, naturally formed pools should be left intact.

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Adamowicz and Roman 2005

Bourn & Cottam 195x

Rozsa et al. 198x

Miller & Egler 1950

Taylor, J. 1998. *Guidance for meeting U.S. Fish and Wildlife Service trust resources needs when conducting coastal marsh management for mosquito control on Region 5 National Wildlife Refuges*. U.S. Fish and Wildlife Services. 20 pp.

## ❖ Strategy 4. Restore freshwater or salt water wetland native vegetation

### *4.1 Planting or seeding*

Successful restoration of native marshes in New England depends on hydrology, salinity regime (for estuarine environments), and relative competitive strengths of native versus invasive plants. Planting or seeding a salt marsh restoration area is more expensive than allowing natural reseeding to occur but has several advantages. Planting or seeding provides a competitive advantage to native vegetation by occupying a space first. This is particularly important if a natural native seed source is at some distance. Purchased plant and seed stock should be carefully selected to ensure correct province, temperature tolerances, and other local genetic features. Plant material should be installed at the beginning of the growing season to allow plants sufficient time to establish before winter. One drawback of planted material is that it is often attractive to grazers such as snow and Canada geese.

### *4.2 Fill Removal*

Salt marshes have often been used as dumping grounds for dredge, sanitary landfill, and toxic materials. Removal of this material can range from simple and straightforward to highly regulated and complex. As with tidal flow restoration, it is imperative to establish correct elevations for tidal input and restored marsh surfaces. Because of the disturbed nature of many of these sites, hydrology and elevation are critical in controlling invasion of nearby *Phragmites*. The benefits of removing fill material can be significant – conversion of a disturbed fill area to high quality salt marsh habitat. Since fill areas often occur in urbanized locations, restored areas substantially increase available salt marsh habitat by a large percentage.

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Niedowski, N.L. 2000. *New York State salt marsh restoration and monitoring guidelines*. New York State Department of State, Division of Coastal Resources and New York State Department of Environmental Conservation, Division of Fish, Wildlife and Marine Resources. 172 pp.

Thunhorst, G., and D. R. Biggs. 1993. *Wetland planting guide for the Northeastern United States*. Environmental Concern, Inc. 179 pp.

### *4.3 Control invasive plants*

The majority of techniques for control of invasive plants in uplands are appropriate for wetlands with the caveat that required wetland permits are in place and that chemical control methods are labeled for wetland use.

## ❖ Strategy 5. Manage tidal marsh dieback

The occurrence of tidal marsh dieback appears to be a new phenomenon in the North East. Dieback can occur gradually, over the course of decades as in Jamaica Bay, NY, or rapidly, over the course of one growing season as in several locations in Connecticut, Massachusetts and Maine (Adamowicz and Wagner 2005). Successful strategies to manage dieback depend on identifying the causal agent(s) in each case. No specific causes have yet been identified in the Northeast. Footwear, gear and machinery decontamination has been recommended after visiting a dieback site as a minimum precaution until causal agents and remedies have been determined (Adamowicz and Wagner 2005). For additional information see www.brownmarsh.net and www.NEERS.org.

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Adamowicz, S. C. and L. Wagner. 2005. *Northeast sudden wetland dieback workshop proceedings*. U.S. Fish and Wildlife Service. 69 pp.

## ❖ Strategy 6. Manage contaminants

In addition to toxic materials (organic chemicals, heavy metals), salt marsh contaminants include nutrient and freshwater runoff (introducing reduced salinity regimes). Nutrient additions commonly occur through both atmospheric deposition and stormwater runoff. Successful strategies for controlling stormwater runoff include offsite treatment; correct location of discharge point; and maintenance of an adequately wide, naturally vegetated upland buffer (Bertness et al. 2004). Freshwater marshes can also have contaminant issues based on prior usages or location.

Bertness, M., B. R. Silliman, and R. Jefferies. 2004. *Salt marshes under siege*. American Scientist 92: 54-61.

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### ❖ Strategy 7. Allow Natural Succession and Processes

Many natural wetland types are relatively stable and are driven by natural processes, tides, soil type, surface water runoff, ground water and precipitation collecting in depressions or slopes. Seasonal changes in hydrology, or changes through the tidal cycle, create a fluctuating water table, resulting in wetland vegetation development. When these systems are functioning naturally, are devoid of invasive plants and are not heavily impacted by human development they often are not actively managed.

Tiner, R.W. 1994. *Maine Wetlands and Their Boundaries*. Institute for Wetland and Environmental, Education and Research. Sherborn, Massachusetts.

### ❖ Strategy 8. Mimicking Natural Freshwater Wetland Processes in Impoundments

Rachel Carson NWR has one small impoundment, a former fire pond, which is currently not managed as a moist soil unit. The impoundment is approximately one acre in size. Due to management constraints, the size of the impoundment and invasive plants, at this time the Refuge will not manage this unit for moist soil vegetation. If conditions management constraints are alleviated, the Refuge may consider managing the impoundment for fall migration by lowering water levels in the spring and slowly bringing them up after moist soil vegetation grows.