

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD  
FOREST STAND IMPROVEMENT**

(Acre)

**CODE 666**

**DEFINITION**

The manipulation of species composition, stand structure and stocking by cutting or killing selected trees and understory vegetation.

**PURPOSE**

- Increase the quantity and quality of forest products by manipulating stand density and structure.
- Timely harvest forest products.
- Develop renewable energy systems.
- Initiate forest stand regeneration.
- Reduce wildfire hazard.
- Improve forest health reducing the potential of damage from pests and moisture stress.
- Restore natural plant communities.
- Achieve or maintain a desired native understory plant community for special forest products, grazing, and browsing.
- Improve aesthetic and recreation values.
- Improve wildlife habitat.
- Alter water yield.
- Increase carbon storage in selected trees.

**CONDITION WHERE PRACTICE APPLIES**

All forest land.

FOREST STAND IMPROVEMENT (Practice Code – 666) standard is not applicable for ALLEY CROPPING (Practice Code – 311), MULTI-STORY CROPPING (Practice Code - 379), WINDBREAK/SHELTERBELT ESTABLISHMENT operation and maintenance (Practice Code – 380),

and WINDBREAK/SHELTERBELT RENOVATION (Practice Code – 650).

**CRITERIA**

**General Criteria Applicable to All Purposes**

The harvest-regeneration strategy will be identified for all planned forest improvement harvesting using one of the following:

- Uneven-aged (all-aged) management systems (e.g., single-tree selection, group selection, coppice selection)
- Even-aged management (e.g., clear-cut, seed-tree, shelterwood, coppice)

The extent or size and orientation of treatment area(s) shall be identified as part of practice design. Utilize a professional forester or forestry certified Technical Service Provider (TSP) to separate forest land with different cover types, timber types or other distinctive characteristics into separate management units (stands) and plan them individually.

Identify and retain preferred tree and understory species to achieve all planned purposes.

Spacing, density, size class, number and amounts of trees and understory species to be retained will follow established guidelines for the intended purposes.

Prepare stocking guidelines in terms of crop trees, basal area, spacing and/or trees per acre by species and size class distribution.

Forest stand improvement activities shall be performed to minimize soil erosion, compaction, rutting, and damage to remaining vegetation and maintain hydrologic conditions.

Limit damage to the site by: Refer to FOREST TRAILS AND LANDINGS (Practice Code – 655)

- using directional felling
- aligning cut tree stems for efficient skidding

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service or download the standard from the [electronic Field Office Technical Guide](#) for Illinois.

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- cutting out forks and large branches prior to skidding
- limiting trails to less than 15% of the site
- logging when the soil is dry or frozen
- using the most appropriately sized equipment
- using well-organized access trails

The method, felling direction, and timing of tree cutting shall facilitate efficient and safe tree removal and protect site resources, e.g. residual trees, wetlands, cultural resources, riparian zones, threatened and endangered species, improvements and utilities.

Refer to the ACCESS ROADS (Practice Code - 560) standard for roads associated with forest stand improvement activities.

Slash, debris and vegetative material left on the site after treatment will not present an unacceptable fire, safety, environmental, or pest hazard. Remaining material will not interfere with the intended purpose or other management activities. Refer to WOODY RESIDUE TREATMENT (Practice Code – 384).

Burning of woody residue on-site will follow PRESCRIBED BURNING (Practice Code – 338).

Deaden unwanted trees, shrubs, and vines by any of the following means:

- cut stump treatment
- girdling/frilling
- stem injection
- basal bark spray

See Illinois Forestry Technical Note – *Controlling Undesirable Trees and Shrubs (TN2-IL666CUTS)*

*Herbicide application following mechanical cutting, girdling, and frilling will increase mortality and reduce stump sprouting.*

When choosing herbicides, review flashback potential, leaching, runoff potential, setback requirements, persistence, and toxicity ratings of chemical formulations. Use the safest available herbicide. Pesticides used improperly can be injurious to humans, animals, and plants. Follow all label directions and label precautions.

Base all management decisions on a thorough and current forest inventory for the intended purpose.

Base forest stand improvement choices on:

- relative tree position
- crown position
- crown condition
- tree health

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- stem quality
- species
- land user objectives

Protect riparian zones, unique areas, and structures. Leave a strip of existing native woody vegetation a minimum of 50 feet wide along streams to protect water quality and as landowner objectives dictate along other non-woodland boarders. Light forest stand improvement or edge-feathering along non-riparian boarders (see IL Job Sheet 645D - Woodland Edge Feathering) can be done in this strip. Where riparian protection is needed, follow RIPARIAN FOREST BUFFER (Practice Code – 391).

Release cuttings should be done as soon as the need becomes apparent. Cut or deaden:

- cull and "wolf" trees (may be retained for wildlife)
- undesirable species
- undesirable form and overstocked trees
- damaged or diseased trees
- surplus sprouts

Prescribed burning may be used when conducive with management objectives and recommended by IL DNR Forester or forestry certified Technical Service Provider (TSP):

- remove undesirable hardwoods
- reduce fuel build-up
- expose mineral soil for improved germination
- adjust community structure and composition

Refer to PRESCRIBED BURNING (Practice Code – 338) for additional guidance. A prescribed burn plan, consistent with (IL Job Sheet 338 – Prescribed Burn Plan), will be prepared.

All Forest Stand Improvement activities will comply with applicable federal, state and local laws and regulations during the installation, operation and maintenance of the practice. Appropriate cultural resources review will be conducted before beginning any practice that results in soil disturbance.

During planning and prior to tree cutting and/or prescribed burning activities, review: (1) *NRCS Bald Eagle Habitat Conservation Guidelines for Illinois*, and (2) *NRCS Forest Stand Improvement and Prescribed Burning Conservation Measures for Indiana and Gray Bats in Illinois*. Current versions of these documents are located in Section II of the Illinois Field Office Technical Guide.

For forest, woodland, and savanna communities protect the area from domestic livestock grazing with exclusion. See ACCESS CONTROL (472) for further guidance.

For silvopastoral systems, follow SILVOPASTURE ESTABLISHMENT (381) when domestic livestock grazing is involved.

### Additional Criteria to Increase the Quantity and Quality of Forest Products by Manipulating Stand Density and Structure

All management decisions shall be based on a woodland inventory and the intended purpose. Follow these general steps in developing management prescriptions.

Start thinning at an early age when the activity is expected to produce the desired effect on the targeted size class(es) and species. Additional thinning, based on site index and objectives, can occur at 10-15 year intervals.

Follow these general steps in developing a prescription for increasing quantity and quality of forest products:

- Determine existing conditions of the management area by a detailed forest inventory consistent with section (5.) of the Illinois Forest Management Plan (IFMP) outline.
- Determine owner objectives and resources for achieving desired forest products.
- Based on owner objectives, design a Silvicultural system and appropriate management techniques to achieve objectives.

For Illinois hardwoods, applicable systems of silviculture include:

- Single tree selection: Uneven-aged (all-aged) management and volume control of the forest (favors shade tolerant species).
- Group selection: Even-aged silviculture with uneven-aged management and volume control of the forest.
- Regeneration harvest: Even-aged silviculture with area control. Modifications include shelterwood and seed-tree methods.
- Mark trees for the desired treatment.
- Examine and evaluate the residual stand after treatment for desired future condition, growth, and development and/or regeneration success.

For even-aged stands with adequate trees of favorable species, potential quality and an average DBH of 6 inches or more, the following table can be used as a guide for residual stocking after thinning:

Avg. Stand Diameter (inches)	Target Spacing (feet)	Basal Area (sq. ft.)	Trees/Acre (number)
<b>Hardwoods</b>			
6	13	51	258
8	16	59	170
10	19	66	121
12	23	71	83
<b>Pine</b>			
6	12	59	304
8	14	78	222
10	16	93	170
12	18	106	135

USDA – Soil Conservation Service 1977 (D+X Thinning guide)

Keep improvement thinning in hardwoods light enough (maintain at least 60% stocking) to restrict the growth of any undesirable species, to maintain full site utilization, to reduce sunscald damage and to reduce epicormic branching (a shoot sprouting from a dormant bud on the stem of a tree) and basal sprouting.

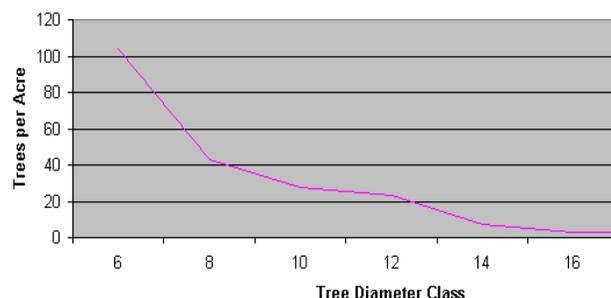
Strip or row thinning is possible in plantations with straight rows. A typical row thinning will remove one-third of the stand or every third row.

For uneven-aged (all-aged) stands, create or maintain age classes which occupy an equal amount of ground space per acre. Each improvement activity should:

- regenerate a new age/size class (if needed)
- harvest mature trees and excess numbers in each age/size class
- balance the age/diameter class distribution

(See following chart)

Diameter Distribution of an Uneven-Aged Stand



Remove/kill among the age/size classes according to the following priorities:

- defective and diseased trees
- high risk trees that might not survive another cutting cycle
- low value trees of any species
- least desirable species

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- excess numbers of desired species

With all thinning, provide at least 5 to 10 feet of crown growing space on a minimum of two sides of residual trees.

Thin stands below 6 inches DBH to a 10-foot spacing.

***For optimal production of even-aged and uneven-aged hardwood stands in Illinois, utilize "Recommended Silviculture and Management Practices for Illinois Hardwood Forest Types" in plan and specifications development for the appropriate forest site type.***

### *Crop Tree Management:*

Select and mark/flag 20 to 75 crop trees per acre based on the following criteria:

- dominant or codominant canopy tree
- healthy crown
- seedling origin or stump sprout at < 6"
- minimal epicormic branching
- good form
- free of defects and disease
- desired species
- adapted species

Landowner objectives and stand quality may result in as few as 5 to 20 crop trees released per acre, but never more than 100 trees per acre.

After selecting and marking crop trees, remove all trees in direct adjacent competition with the crop trees crown. It is not necessary to cut or kill trees that are overtopped unless it is a large shade tolerant tree (sugar maple, basswood, beech) that may grow up into the crown of the crop tree. Provide at least 10 to 15 feet of crown growing space on all sides of residual crop trees.

See Illinois Forestry Technical Note – Crop Tree Management (*TN1-IL666CTM*) for further guidance.

### **Additional Criteria to Develop Renewable Energy Systems**

Bioenergy intensity and frequency of energy biomass removals will be managed to prevent long-term negative impacts on the stand.

The harvesting of energy biomass shall be accomplished in a manner that will not compromise the other intended purpose(s) and functions. Additional information can be found in references.

### **Additional Criteria to Reduce Wildfire Hazard**

Reduce stocking rates of trees to minimize crown-to-crown spread of fire.

Remove "ladder" fuels to minimize the occurrence of crown fires.

Further treat or eliminate slash accumulations next to roads and trails.

Reduce or eliminate species with high volatility but not to a level that would compromise other intended purposes.

For additional wildfire risk and damage reduction, refer to FIREBREAK (Practice Code – 394).

### **Additional Criteria to Restore Natural Plant Communities**

For more information on restoration of natural communities, see practice standards RESTORATION AND MANAGEMENT OF DECLINING HABITATS (Practice Code – 643) and WETLAND RESTORATION (Practice Code – 657) and References.

### **Additional Criteria to achieve or maintain a desired native understory plant community for special forest products, grazing, and browsing.**

Refer to practice standards SILVOPASTURE ESTABLISHMENT (Practice Code – 381) or MULTI-STORY CROPPING (Practice Code – 379) and References.

### **Additional Criteria to Improve Wildlife Habitat**

Manage for tree species and stocking rates that meet desired wildlife species food and cover requirements and community restoration needs.

*Woodland or forest thinning will encourage fuller crown development, earlier seed production, and heavier herbaceous plant development.*

Create, recruit and maintain sufficient snags and down woody material to meet requirements of desired species in balance with conditions needed to achieve other intended purposes.

Minimize improvement actions that disturb seasonal wildlife activities.

Rotate forest stand improvements throughout the forest so that various stages of plant succession will be established.

*Wildlife as a Secondary Objective:*

Leave or establish 3 snags and 3 den trees per acre, ranging in size from 6 to 20 inches DBH.

Leave 2 to 3 vines per acre. Favor trees with vines that will be left as den trees and trees not considered crop trees for the purpose of forest products.

*Wildlife as a Primary Objective:*

Favor hard-mast producers (oak, hickory, pecan and walnut) and native conifers or evergreens.

Leave or establish 6 snags and 6 den trees per acre, ranging in size from 6 to 20 inches DBH. Leave one den tree per acre > 20 inches DBH, if available.

Leave 4 to 6 vines per acre. Favor trees with vines that will be left as den trees and trees not considered crop trees for the secondary purpose of forest products.

Low intensity prescribed fires may be used to improve/increase green browse for wildlife. Refer to PRESCRIBED BURNING (Practice code – 338) for additional guidance. A prescribed burn plan, consistent with (IL Job Sheet 338 – Prescribed Burn Plan), will be prepared.

Improve wildlife habitat in the stand by adding one or more of the following:

- Downed Tree Structure
- Edge Feathering
- Wildlife Brushpiles

Refer to UPLAND WILDLIFE HABITAT MANAGEMENT (Practice Code – 645), RESTORATION AND MANAGEMENT OF RARE OR DECLINING HABITATS (Practice Code – 643), EARLY SUCCESSIONAL HABITAT DEVELOPMENT/MANAGEMENT (Practice Code – 647) and WETLAND WILDLIFE HABITAT MANAGEMENT (Practice Code – 644) to further develop and manage wildlife-related activities.

**Additional Criteria to Improve Aesthetics and Recreation Values**

This activity is strongly influenced by subjective values and interests. Direct forest stand improvement toward:

- opening vistas

- installing trails
- increasing vegetation diversity (shape, texture, color, size)
- removing safety hazards near pedestrian use areas (snags, large dead limbs, etc.)
- creating visual screens
- releasing crop trees with unique or desirable characteristics (attractive flowers, colorful foliage, unique form or bark, etc.)

**Additional Criteria to Increase Carbon Storage**

Manage for tree species and stocking rates that have higher rates of growth and potential for carbon sequestration and are adapted to the site to assure strong health and vigor.

**CONSIDERATIONS**

Silvicultural objectives and harvest-regeneration strategies may change over time and may be limited by prior management and a host of other factors: time, funding, resource and either constraints, on-site technical assistance, etc.

Consult a professional forester for assistance in the planning and implementation of forestry practices, particularly the sale of timber.

Successful regeneration of desirable species is usually dependent upon timely application of forest stand improvement and other practices, e.g., PRESCRIBED BURNING (Practice Code – 338), FOREST SITE PREPARATION (Practice Code – 490), TREE/SHRUB ESTABLISHMENT (Practice Code – 612), PRESCRIBED GRAZING (Practice Code – 528A), and USE EXCLUSION (Practice Code – 472).

The extent, timing, size of treatment area, or the intensity of the practice should be adjusted to minimize cumulative effects (onsite and offsite), e.g., hydrologic and stream alteration, habitat fragmentation, nutrient cycling, biodiversity and visual resources.

The practice should be timed to minimize disturbance of seasonal pollinator and wildlife activities.

Landowners should secure a written contract with any service provider that specifically describes the extent of activity, duration of activity, liability and responsibilities of each party and amount and timing of payments for services provided.

Landowners planning to sell timber should: know the amount of timber to be sold through an inventory,

receive sealed bids, obtain a signed contract with an Illinois licensed timber buyer, receive full payment before cutting begins, and supervise harvest operations. For further information and sample contracts see [Here's How to...Write an Iron-Clad Timber Sale Contract](#) in References.

Slash, debris and other vegetation (biomass) removed during stand improvement may be used to produce energy. Management alternatives should consider the amount of energy required to produce and convert the biomass into energy with the amount produced by the biomass. Wildlife and sustainability requirements should also be considered.

Invasive or noxious woody vegetation should be controlled and eliminated when feasible.

Clients should be advised of responsibilities of wildfire control and consider the development of a wildfire control plan including "defensible" space, access routes, fire-season water source, and location of wildfire control facilities.

Forest stand improvement activity for lumber/veneer production is generally not justified on poor sites (below site index 55 if managing for oaks; or site index 45 if managing for pine).

## PLANS AND SPECIFICATIONS

Specifications for applying Forest Stand Improvement shall be prepared for each site and recorded using approved specification sheets, job sheets, technical notes and narrative statements in the conservation plan, or other acceptable documentation.

A current and fully prepared *Illinois Forest Management Plan (IFMP)* will provide complete specifications and serve as a plan of operations for Illinois State and Federal incentive programs.

## OPERATION AND MAINTENANCE

Periodic inspections during and after treatment activities are necessary to ensure that intended objectives are achieved and resource damage is minimized, e.g., assessment of insects, disease and other pests, storm damage, and damage by trespass. The results of inspections shall determine the need for additional treatment under this practice.

## REFERENCES

[Recommended Silviculture and Management Practices for Illinois Hardwood Forest Types](#), IL Technical Forestry Association 1972, 46 pp.  
INCLUDE ALL FUTURE ADDITIONS

[Crop Tree Management in Eastern Hardwoods](#), Perkey, A.W., B.L. Wilkins, and H.C. Smith, USDA-Forest Service, NE Area S&PF, Pub. NA-TP-19-93, 1994.

[Even-aged Silviculture for Upland Central Hardwoods](#), Ag. Handbook 355, Roach, B.A. and S.F. Gingrich, NE For. Exp. Sta., USDA-Forest Service, 1968, 39 pp.

[Forestry Best Management Practices for Illinois](#). Illinois Department of Natural Resources, Southern Illinois University – Carbondale, University of Illinois, Illinois Forestry Development Council, 2012.

[Here's How to...Write an Iron-Clad Timber Sale Contract](#). Society of American Foresters. 2001.

[Keeping the Forest Healthy and Productive](#). In: [A Landowner's Guide to Sustainable Forestry in Indiana](#). Purdue University Extension pub. FNR-182, 2002.

[The Tallgrass Restoration Handbook: For Prairies, Savannas, and Woodlands](#). Packard, S. and C.E. Mutel, Island Press, 1997.

[Forestry Handbook](#), Second Edition; Society of American Foresters; 1984.

[Managers Handbook for Oaks in the North Central States; General Technical Report NC-37](#); North Central Forest Experiment Station, Forest Service, USDA; 1977.

[The Practice of Silviculture](#); David M. Smith; John Wiley & Sons, Eighth Edition; 1986.

[Bioenergy Feedstock Best Management Practices: Summary and Research Needs](#). Biomass Research and Development Board  
[http://www.biomassboard.gov/pdfs/bioenergy\\_feedstocks\\_bmps.pdf](http://www.biomassboard.gov/pdfs/bioenergy_feedstocks_bmps.pdf)

Illinois Forest Management Plan (IFMP) outline and associated documents IL Field Office Technical Guide (Section III > Conservation Activity Plans Technical Criteria > Forest Management Plan)  
<http://efotg.sc.egov.usda.gov>  
2011 and all future editions.