

DEFINITION

Forest Stand Improvement (FSI) is the manipulation of species composition, stand structure and stocking by cutting or killing selected trees and understory vegetation.

FSI can refer to both pre-commercial (intermediate) treatments and commercial harvesting operations.

PURPOSES

- » Increase the quantity and quality of forest products by manipulating stand density and structure
- » Harvest forest products
- » Initiate forest stand regeneration
- » Development of renewable energy systems
- » Reduce wildfire hazard
- » Improve forest health by 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

CONDITIONS WHERE PRACTICE APPLIES

All forest land.

CRITERIA

General Criteria Applicable to All Purposes

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

Base forest stand improvement choices on the following selection criteria:

- » Tree and forest health
- » Tree size, position and spacing
- » Crown size, position, and condition

- » Bole quality
- » Species
- » Species diversity

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

- » Cutting
- » Girdling
- » Frilling
- » Stem injection of herbicides
- » Foliar or basal bark spraying of herbicides

If needed, supplement mechanical cutting, girdling, or frilling with an application of herbicide to increase mortality and decrease stump sprouting.



Use the safest available herbicide. Pesticides used improperly can be injurious to humans, animals, and plants. Follow all label precautions.

Conduct tree cutting in forest stands that contain oak species only during dormant seasons, October 1 through March 1, to reduce chance of infection to the residual stand by oak wilt disease (*Ophiostoma fagacearum*).

Limit damage to the site by:

- » Using directional felling compatible with skid trail layout
- » Aligning cut tree stems for efficient skidding
- » Cutting out forks and large branches
- » Limiting trails to less than 15% of the site
- » Logging when soils are dry or frozen



- » Using the lowest-impact equipment available
- » Using well-organized access trails

Refer to Wisconsin NRCS Conservation Practice Standard (WI NRCS CPS), *Forest Trails and Landings (655)* for more information about trail establishment and maintenance.

Comply with applicable laws and regulations, including Wisconsin's Best Management Practices (BMPs) for forestland.

Protect all forestland from livestock grazing.

Retain a minimum of 2 large (>12" DBH) active den trees per acre, if possible.

Retain or create a minimum of 2 large (>12" DBH) snags per acre, if possible.

Treat slash and debris such that they do not present an unacceptable fire, safety, environmental, or pest hazard and will not interfere with the intended purpose or other management activities.

If burning is used to reduce slash and other debris on-site, follow WI NRCS CPS, *Prescribed Burning (338)*.

Additional Criteria to Increase the Quantity and Quality of Forest Products

For uneven-aged stands (hardwoods, conifers, or mixed forest types), perform Forest Stand Improvement when basal area is greater than 110 sq. ft. per acre. Remove 20 to 33% of the basal area, ensuring that residual basal area is no lower than 75 sq. ft. per acre, to regenerate shade tolerant species, e.g., sugar maple, and no lower than 60 sq. ft. per acre to regenerate shade intolerant or intermediate species, e.g., red oak.

For even-aged hardwood stands, perform Forest Stand Improvement when basal area is greater than 110 sq. ft. per acre. Remove 20 to 33% of the basal area, ensuring that residual basal area is no lower than 75 sq. ft. per acre.

For even-aged hardwood stands, these criteria can be achieved by following the guidance in [Table 1](#).

For even-aged conifer stands, perform Forest Stand Improvement when average tree spacing is less than D+4 or crown is less than one third of the total tree height. Increase average tree spacing to D+6, if possible, but do not remove more than half the trees in one treatment. Refer to [Table 2](#), for guidance on thinning to these spacing requirements.

Additional Criteria to Harvest Forest Products and to Initiate Forest Stand Regeneration

Use a harvest-regeneration system appropriate for the growth characteristics and shade tolerance of the species and forest cover type to be regenerated:

Table 1: Thinning Guidelines for Even-aged Hardwoods

Existing Stand:			Thin the stand to:		
Avg. DBH (in.)	Trees per acre	Average spacing between trees (ft.)	Trees/Acre	Average spacing between trees (ft.)	Basal Area (sq. ft. per acre)
5	≥ 770	≤ 7	681	8	95
6	≥ 535	≤ 9	436	10	87
7	≥ 393	≤ 11	302	12	82
8	≥ 301	≤ 12	258	13	90
9	≥ 238	≤ 14	194	15	85
10	≥ 193	≤ 15	151	17	83
11	≥ 159	≤ 17	134	18	90
12	≥ 134	≤ 18	109	20	86
13	≥ 114	≤ 20	90	22	83
14	≥ 98	≤ 21	82	23	88
15	≥ 86	≤ 23	70	25	86
16	≥ 75	≤ 24	60	27	84
17	≥ 67	≤ 26	56	28	88
18	≥ 59	≤ 27	48	30	85
19	≥ 53	≤ 29	43	32	85
20	≥ 48	≤ 30	40	33	87
21	≥ 44	≤ 32	36	35	87
22	≥ 40	≤ 33	32	37	84
23	≥ 36	≤ 35	30	38	87
24	≥ 33	≤ 36	27	40	85

Table 2: Thinning Guidelines for Even-aged Conifers

Existing Stand:			Thin the stand to:		
Avg. DBH (in.)	Trees per acre	Average spacing between trees (ft.)	Trees/Acre	Average spacing between trees (ft.)	Basal Area (sq. ft. per acre)
5	≥ 538	≤ 9	360	11	50
6	≥ 436	≤ 10	302	12	60
7	≥ 360	≤ 11	258	13	70
8	≥ 302	≤ 12	222	14	78
9	≥ 258	≤ 13	194	15	85
10	≥ 222	≤ 14	170	16	94
11	≥ 194	≤ 15	151	17	101
12	≥ 170	≤ 16	134	18	106
13	≥ 151	≤ 17	121	19	111
14	≥ 134	≤ 18	109	20	117
15	≥ 121	≤ 19	99	21	122
16	≥ 109	≤ 20	90	22	126
17	≥ 99	≤ 21	82	23	130
18	≥ 90	≤ 22	76	24	134
19	≥ 82	≤ 23	70	25	138
20	≥ 76	≤ 24	64	26	140
21	≥ 70	≤ 25	60	27	145
22	≥ 64	≤ 26	56	28	148
23	≥ 60	≤ 27	52	29	150
24	≥ 56	≤ 27	48	30	151



- » For uneven-aged systems, follow guidance in previous section.
- » For management of, or conversion to, even aged system, including pine plantations and aspen stands, use even-aged harvest-regeneration strategies, e.g., shelterwood, seed tree harvests, and clearcutting.

If natural regeneration is not likely, or is not present two years after the harvest, initiate reforestation. Refer to WI NRCS CPS, *Tree/Shrub Establishment* (612).

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 risk of crown fires.

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

Reduce or eliminate species with high volatility.

For additional wildfire risk and damage reduction, refer to WI NRCS CPS, *Firebreak* (394).

Additional Criteria to Improve Wildlife Habitat

Manage for a variety of native tree species and stocking rates that meet desired wildlife and pollinator species food and cover requirements.

Create and/or maintain 2 to 5 snags per acre (12” DBH+), and 2 to 5 den trees per acre (12” DBH+), if possible, depending on the requirements of the desired wildlife species.

Create and/or maintain adequate down woody material to meet requirements of desired wildlife.

Minimize improvement actions that disturb seasonal wildlife activities.

Refer to WI NRCS CPS, *Early Successional Habitat Development/Management* (647), *Rare and Declining Habitat Management* (643), *Upland Wildlife Habitat Management* (645), and *Wetland Wildlife Habitat Management* (644) to further develop and manage wildlife-related activities.

Additional Criteria to Increase Carbon Storage in Selected Trees

Manage for tree species and stocking rates that have higher rates of growth and potential for carbon sequestration.

CONSIDERATIONS

Use of a professional forester (Conservation District forester, professional consulting forester, etc.) to mark and layout practice will generally yield better results. This should be considered especially for large or complex sites.

The U.S. Forest Service North Central Research Station’s “Manager’s Handbook” series of publications provide excellent type-specific guidance for a variety of cover types. Search for “Manager’s Handbook” here: <http://www.ncrs.fs.fed.us/pubs/search.asp>.

Silvicultural objectives and harvest-regeneration strategies may change over time and may be limited by prior management.

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

To encourage regeneration of oaks and other species with intermediate shade tolerance, consider group selection to permit more sunlight to reach the forest floor.

Cut material can be arranged into 3 to 4 brush piles per acre to provide additional wildlife cover.

Time the practice 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.

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.

Control invasive or noxious woody vegetation.

Advise clients of their wildfire control responsibilities and consider the development of a wildfire control plan including “defensible” space, access routes, fire-season water source, and location of wildfire control facilities.

Timing of treatment and retention of dead or dying trees will minimize impacts on nesting wildlife.

Thinning of pine stands during the growing season (especially during dry periods) without proper treatment of logging slash, may subject the stand to increased risk of attack by bark beetles (*Dendroctonus* spp. and *Ips* spp.). Refer to WI NRCS CPS, *Forest Stand Improvement* (666) for additional information and references.

OPERATION AND MAINTENANCE

Periodic inspections during and after treatment activities are necessary to ensure that purposes 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.

For treatments intended to initiate forest stand regeneration, inspect the site after 2 years to determine if natural regeneration is adequate. If not, initiate artificial regeneration using WI NRCS CPS, *Tree/Shrub Establishment (612)*.

Forest Stand Improvement may be needed at 5 to 15 year intervals, depending on site type and site quality.



General Information

Client Name*: _____

Stand No.: _____ Field No.*: _____ Planned Implementation Date*: _____

Total Stand Acres: _____ Total Acres of Practice Planned*: _____

Site Map* - Attach a map or aerial photo indicating the location of area to be treated with FSI.

Purposes (check all that apply)*

- _____ Increase the quantity and quality of forest products by manipulating stand density and structure
- _____ Harvest forest products
- _____ Initiate forest stand regeneration
- _____ Development of renewable energy systems
- _____ Reduce wildfire hazard
- _____ Improve forest health by reducing the potential of damage from pests and moisture stress
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- _____ Improve wildlife habitat
- _____ Alter water yield
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Stand Information

Forest Cover Type/Dominant Spp.*: _____

Dominant Soil Types: _____ Site Index: _____ (S.I. Spp.: _____)

Silvicultural (Harvest/Regeneration) System (complete applicable section below):			
Uneven-aged System*		Even-aged System*	
Basal Area:	sq. ft./ac.*	Avg. DBH*:	Trees per ac.*:
Type of Intermediate FSI Treatment*:	Single tree selection Group selection Other:	Type of Intermediate FSI Treatment*:	Single tree selection Row thinning Other:
Type of Harvest FSI Treatment*:	Single tree selection Group selection Other:	Type of Harvest FSI Treatment*:	Shelterwood Seed Tree Clearcut Other:

* Required for certification of practice completion



Required Documentation and Verification

Practice amount applied is field verified by*: _____ on: _____
(date)

Before payment is made, the following information is required to be in the case file:

Photographs of established practice must include*:

- Statement “Photo was taken in the field by (enter name)”*
- Date photo was taken in the field*
- Statement of what the photo represents if it needs clarification*

Field verification is documented and a certified planner verified “as installed” this practice meets NRCS standards and specifications.*

Practice Certification (NRCS USE ONLY)

I certify that the practice as installed is complete and meets the applicable Wisconsin NRCS Conservation Practice Standard and all applicable practice specifications. Any changes to the original practice design have been approved and are documented on the original practice design “as installed.”

Certified Planner (print)

(sign)

Date



