

Table 24 Summary of dead and downed wood retention targets from states with existing biomass harvesting guidelines

	Dead and Downed Wood	Citation
Maine	<ul style="list-style-type: none"> • Retain as many snags as possible • Retain as much pre-existing FWD and CWD as possible • Retain litter layer, stumps, roots intact as much as possible 	Benjamin 2010; Flatebo et al. 1999; Elliot 2008
Missouri	<ul style="list-style-type: none"> • Retain a minimum of 33% of the harvest residue • Retain as much FWD as possible • Retain woody debris from multiple tree species and size classes, with an emphasis on larger structures • Avoid removing all CWD • Retain 6-12 snags, depending upon vegetation type 	Enyart 2008
Minnesota	<ul style="list-style-type: none"> • Retain the forest floor, litter layer, root systems, stumps • Retain as much pre-existing CWD /FWD and logs as possible • Retain all snags when possible, if cut leave on site • Retain approximately 30% of harvest residue (leave 20% of harvest residue with 10-15% additional FWD coming from incidental breakage) 	MFRC 2007
Michigan	<ul style="list-style-type: none"> • Retain approximately 17-33% of the harvest residues (tops, limbs less than 4' diameter) • Retain more debris in stands with little woody debris prior to harvest • Retain as much pre-existing CWD as possible • Avoid removal of the forest floor, litter layer, stumps and roots. 	MI DNRE 2010
Pennsylvania	<ul style="list-style-type: none"> • Retain 15-30% of harvest residues • Retain slash during conventional timber harvests • Retain 2-5 non-merchantable logs per acre • Retain 1-5 snags per acre 	PA DCNR 2008
Wisconsin	<ul style="list-style-type: none"> • Retain and limit disturbance to pre-existing CWD /FWD • Retain 10% of harvest residues (tops and limbs <4" diameter), an additional 10-15% FWD is expected from incidental breakage • Do not remove the forest litter layer, stumps, and /or root systems • Retain snags based on guidelines found in WI DNR Silviculture Handbook, chapter 24 • The ultimate goal is to maintain 5 or more oven dry tons of FWD per harvested acre 	Herrick et al. 2009

Table 25 Summary of wildlife and biodiversity retention targets from states with existing biomass harvesting guidelines

	Wildlife and Biodiversity	Citation
Maine	<ul style="list-style-type: none"> • Refer to Biodiversity and the Forests of Maine: Guidelines of Land Management for general stand-level recommendations and specific guidelines for special habitat areas • Retain as much dead wood as possible (FWD/CWD/logs, snags) • Retain some green wildlife trees (trees with cavities and rot) • Retain some mast-producing trees (hardwood species) • Retain biological legacies in clumps and buffers 	Benjamin 2010; Flatebo et al. 1999; Elliot 2008
Missouri	<ul style="list-style-type: none"> • Avoid harvests in High Conservation Value Forests (HCVF) • Retain mast producing trees of various species and size classes • Retain 7-25 den trees and 6-12 snags per acre • Avoid “hard edges,” by creating a gradual transition into harvested areas • Consider creating travel corridors in large harvests (40 acres +) 	Enyart 2008
Minnesota	<ul style="list-style-type: none"> • Review existing leave tree and snag retention guidelines (in MI <i>General Guidelines and Timber Harvesting</i>) • Retain 20% of shrubs and small trees, cut and left on site • Retain all snags possible; avoid harvest activity in leave tree clumps • Avoid biomass harvests within sites where endangered or threatened plant or animal species are known to exist • Retain slash piles that show evidence of use by wildlife 	MFRC 2007
Michigan	<ul style="list-style-type: none"> • Avoid/limit biomass harvesting in areas of high conservation value/sensitive sites • Avoid biomass harvesting near state and federally listed threatened, endangered, or species of greatest conservation need • Retain CWD and snags from various size and decay classes, and tree species • Refer to Within-Stand Retention Guidance (IC 4110) for more information about wildlife habitat retention 	MI DNRE 2010
Pennsylvania	<ul style="list-style-type: none"> • Protect sensitive habitats (springs, vernal pool/ ponds, riparian zones, cliffs, caves) • Protect cavity trees, snags, and food-producing shrubs and vines • Develop specific management plans for unique areas • Avoid disturbing endangered, threatened or rare species, practices should protect and enhance habitat 	PA DCNR 2008
Wisconsin	<ul style="list-style-type: none"> • Refer to WI DNR Silviculture Handbook for specific recommendations and quantitative guidelines for the retention of reserve trees, wildlife trees, and snags • Retain a variety of mast producing trees and shrubs • Do not harvest from sites where federal or state endangered or threatened species are known to exist or are discovered • Protect High Conservation Value Forests (HCVF), sensitive ecosystems, and species of greatest conservation need 	Herrick et al. 2009

Table 26 Summary of water quality protection measures from states with existing biomass harvesting guidelines

	Water Quality and Riparian Management Zones	Citation
Maine	<ul style="list-style-type: none"> Refer to the existing <i>Water Quality BMP Manual</i> for specific recommendations about water quality protection Minimize disturbance to forest floor Woody biomass may be used to control water flow, prevent soil erosion, and/or stabilize exposed soil; these structures may be left in place after harvest 	Benjamin 2010; Flatebo et al. 1999; Elliot 2008
Missouri	<ul style="list-style-type: none"> Refer to the <i>Missouri Watershed Protection Practice</i> booklet Streamside management zones, of at least 50 feet in width, should be used on all perennial and intermittent streams Retain at least 33% of trees in the stream management zone (SMZ), 40 sq.ft. of basal area Avoid use of heavy equipment, cable yard if necessary Retain most of the vegetation within the SMZ 	Enyart 2008
Minnesota	<ul style="list-style-type: none"> Refer to <i>2005 MFRC General Guidelines and the Voluntary Site-Level Forest Management Guidelines</i> for specifics on maintaining water quality through the use of filter strips and water diversion, and protection of wetlands. Avoid removing biomass from riparian management zones or within 25ft of a dry wash (some roundwood harvesting is acceptable following existing guidelines) Install temporary erosion control devices 	MFRC 2007
Michigan	<ul style="list-style-type: none"> Refer to the 2009 Sustainable Soil and Water Quality Practices on Forest Land Manual (IC 4011) for specific recommendations about harvest activities and mitigation practices in riparian management zones, stream crossings, wetlands. Michigan's <i>Woody Biomass Harvesting Guidance</i> does not specifically address water quality protection measures related to woody biomass harvests 	MI DNRE 2010
Pennsylvania	<ul style="list-style-type: none"> Comply with all provisions of Chapter 102 and Chapter 105 of the Clean Streams law and Dam Safety and Encroachments Act PA DCNR's guidelines include a general discussion of stream crossings and road, skid trail, and landing design/placement. Riparian buffers should provide adequate protection; avoid contaminating water courses/bodies with soil, chemicals, and/or petroleum Operations should occur when soils are dry or frozen 	PA DCNR 2008
Wisconsin	<ul style="list-style-type: none"> Refer to WI DNR Best Management Practices (BMPs) for Water Quality. Wisconsin's <i>Forestland Woody Biomass Harvesting Guidelines</i> do not specifically address water quality protection measures related to woody biomass harvests 	Herrick et al. 2009

Table 27 Summary of soil productivity protection measures from states with existing biomass harvesting guidelines

	Soil Productivity	Citation
Maine	<ul style="list-style-type: none"> • Retain the litter layer, stumps and roots as intact as possible, except where necessary during site preparation • Retain as many tops and branches as possible on low fertility sites, shallow soils, coarse sandy soils, poorly drained soils, steep slopes, and other erosion-prone sites 	Benjamin 2010; Flatebo et al. 1999; Elliot 2008
Missouri	<ul style="list-style-type: none"> • Lengthening rotations and/or using uneven-aged management will encourage soil fertility • Retain a minimum of 33% of the harvest residue • Avoid skidding on shallow soils and steep slopes • Avoid grazing recently harvested areas 	Enyart 2008
Minnesota	<ul style="list-style-type: none"> • Refer to 2005 MFRC <i>General Guidelines and the Voluntary Site-Level Forest Management Guidelines</i> for specifics related to soil productivity • Avoid biomass harvesting on ombrotrophic, organic soils deeper than 24 inches; aspen/hardwood cover types on shallow soils (8 inches or less to bedrock) • Do not remove the forest floor, litter layer, and/or root system • Roads, skid trails, and landings should occupy no more than 1-3% of the site • Avoid additional biomass harvests from erosion-prone sites; install erosion control devices • For shallow soils and droughty sands, consider retaining 33% or more of the FWD post-harvest 	MFRC 2007
Michigan	<ul style="list-style-type: none"> • Refer to the 2009 Sustainable Soil and Water Quality Practices on Forest Land Manual (IC 4011) for specific guidelines related to maintenance of soil productivity • On shallow, nutrient poor soils, consider leaving additional residue (more than 33%) 	MI DNRE 2010
Pennsylvania	<ul style="list-style-type: none"> • Minimize soil compaction and rutting by matching operating techniques and season of operation to soil types and moisture levels • Minimize the soil disturbance through careful design and placement of landings, roads, and skid trails • Do not contaminate soils with equipment fuels or chemicals 	PA DCNR 2008
Wisconsin	<ul style="list-style-type: none"> • Do not harvest FWD on shallow soils (bedrock within 20 inches of surface) • Do not harvest FWD on dry, nutrient-poor, sandy soils • Do not harvest FWD on soils classified as dysic Histosols (wetland soils with 16inches organic material, nutrient-poor and low pH). • Retain the forest litter layer, forest floor, stumps, and/or root systems 	Herrick et al. 2009

Table 28 Summary of silvicultural recommendations from states with existing biomass harvesting guidelines

	Silviculture	Citation
Maine	<ul style="list-style-type: none"> • Maine's <i>Woody Biomass Retention Guidelines</i> do not include silvicultural recommendations related to woody biomass harvesting 	Benjamin 2010; Flatebo et al. 1999; Elliot 2008
Missouri	<ul style="list-style-type: none"> • Avoid damaging crop/leave trees • Avoid re-entering stands; biomass harvests should occur during sawlog harvests • Avoid high grading; specific recommendations about crop tree numbers and spacing are included • Avoid converting natural forests into plantations • Biomass harvests can be used as part of a salvage operation • Biomass harvests can be used to enhance aesthetics 	Enyart 2008
Minnesota	<ul style="list-style-type: none"> • Refer to <i>MFRC Timber Stand Improvement</i> for additional guidelines related to stand improvement activities • Refer to <i>MFRC General Guidelines</i> for recommendations about post operational activities • Avoid re-entering stands, especially if planting/regeneration treatments have occurred • Biomass harvests can be used to accomplish fuels reduction goals • Examples of how biomass harvests can help accomplish management objectives: avoided swamping, site preparation/regeneration, browse deterrent, bark beetle management, thinning 	MFRC 2007
Michigan	<ul style="list-style-type: none"> • Focus on the residual stand structure during intermediate harvests • Biomass harvests can be used to control/remove invasive or exotic plant species • Biomass harvests can be used to reduce hazard trees within recreational areas and fire risk • Biomass harvests can be used to achieve salvage and sanitation goals 	MI DNRE 2010
Pennsylvania	<ul style="list-style-type: none"> • Avoid high grading; focus on the residual stand structure • Avoid re-entering harvested stands • Biomass harvests can be used to accomplish salvage and sanitation goals • Avoid converting natural forests to short rotation woody crop plantations, appropriate SRWC practices are mentioned briefly • Guidelines address regeneration, residual stand conditions, aesthetics, as restoration treatments as they relate to woody biomass harvests 	PA DCNR 2008
Wisconsin	<ul style="list-style-type: none"> • Biomass harvests can be used to achieve site preparation, invasive/exotic plant removal, fuel reduction treatments, and restoration goals • Biomass harvests can be used during salvage and sanitation operations; 5% of the area should be left unsalvaged 	Herrick et al. 2009