APPENDIX B: C-SIP PRACTICE STANDARDS

Contents

C-SIP Practice Plan

(Forest Management or Forest Stewardship Amendment)

PURPOSE

The purpose of this practice is to prepare land stewards and their foresters to respond rapidly and effectively to forest disturbances, stabilize carbon stocks following canopy loss, and maintain long-term forest health and resilience.
Disturbance Preparedness Planning provides a structured approach to:

- Identify vulnerabilities to climate-driven disturbances
- Map conditions that influence operational response
- Prioritize mitigation and resilience treatments
- Ensure rapid recovery of carbon sequestration following disturbance events
- Engage land stewards in proactive stewardship

Rapid response to disturbance prevents secondary impacts, such as invasive plant establishment, deer browse pressure, soil exposure, and water-quality degradation, that can delay or hinder forest regeneration and carbon recovery. A timely, well-organized response allows wood to be directed into long-lived products and accelerates the recovery of carbon sequestration capacity.
As climate-driven disturbances intensify (e.g., storms, drought, pest outbreaks, heat stress), planning is essential. This practice equips land stewards with the information and tools needed to anticipate potential risks and apply appropriate mitigation and recovery actions.

GENERAL POLICIES

The C-SIP Practice Plan applies to all land stewards participating in the C-SIP Expansion Program and serves as the foundational planning requirement for all Practices*.
*Except C-SIP 5.4 Timber Mats

1. Required Participation

All C-SIP applicants must complete a C-SIP Practice Plan before initiating any funded practice (except timber mats). This plan ensures consistency, readiness, and baseline documentation for monitoring and future implementation.

The submission of a Practice Plan is not required at the time of application.

2. Relationship with Existing Plans

The Practice Plan may be incorporated into or appended to:

- A Forest Stewardship Plan (FSP)
- A Forest Stewardship Climate Plan (FSCP) and/or Foresters for the Birds Plan (FFTB)
- A Forest Management Plan (FMP)
- A plan amendment for implementing specific C-SIP practices

Each application shall include only one Practice Plan or amendment. For the same property, any subsequent C-SIP applications must document that previously approved practices have been implemented before receiving approval for additional financial assistance for new practice plans or amendments.

3. Eligibility

To be eligible, applicants must:

- Have a current Forest Management or Forest Stewardship Plan
- Intend to maintain the land in forest use for at least 10 years
- Intend to implement at least one C-SIP Practice
- Participate in C-SIP Monitoring (annual monitoring)

If the long-term forest use intent is unclear, the DCR Service Forestry Program reserves the right to request applicants for a written statement of intent.

4. Timing

The C-SIP Practice Plan must be completed **before** any C-SIP practice is implemented (except timber mats).

5. Practice Plan Submission

Applicants must provide prior to implementing C-SIP Practices:

- A completed Practice Plan form or a formal plan amendment
- Required spatial data (maps, layers, or annotated aerials)

COST-SHARING POLICIES

Authorized Cost-Share Activities

Cost-sharing is authorized for time spent by a Massachusetts Licensed Forester to:

- Develop the C-SIP Practice Plan
- Assess disturbance risks (pests, pathogens, storms, drought, wildfire)
- Map proposed activities and operational features
- Identify and recommend mitigation and resilience practices
- Document budgets and timelines for planned treatments
- Prepare associated spatial data (where applicable)

Not Authorized for Cost-Share

1. Activities required solely to meet permitting requirements
2. Activities related to land-use conversion or development
3. General property boundary surveys

C-SIP Practice Plan Cost-Share Rate

- **Flat Rate**: $500 per completed practice plan or amendment.
- **Limit**: One Practice Plan or amendment per application. Additional applications for the same property require proof that earlier approved practices have been implemented before new funding can be authorized for a subsequent Practice Plan or Plan Amendment.
- No acreage-based adjustments

TECHNICAL SPECIFICATIONS: Practice Plan (Plan Amendment)

Definition

Monitoring is an annual observational and documentation process that evaluates forest conditions, verifies practice implementation, and identifies signs of disturbance, pests, storm damage, or other stressors that may require responsive management actions.

Applicability

Monitoring applies to all C-SIP-enrolled forestland where practices are implemented and maintained.

Required Elements

A complete C-SIP Practice Plan must include the **C-SIP Practice Plan Form** or a standard amendment to an existing Forest Management (FMP) or Forest Stewardship Plan (FSP).
Standard amendments should address all elements required in the C-SIP Practice Plan form and integrate with C-SIP Monitoring requirements.

Integration with Monitoring Requirements

Plans must document how the land steward will meet C-SIP Monitoring requirements, including:

- Annual walkthrough locations
- Checklists and data to be collected
- Priorities for monitoring disturbance indicators

Monitoring results should inform plan updates, new practice planning, and plan amendments.

CONSIDERATIONS

1. Apply the best available climate science, ecological silviculture, and disturbance-response guidance.
2. Foresters should work with land stewards to align recommended practices with long-term stewardship and ownership goals.
3. Areas highly susceptible to disturbance may require treatment sequencing or prioritization.
4. Plans should consider landscape-scale factors, including adjacent management, wildlife corridors, hydrology, and watershed conditions.
5. Mapping should be sufficiently detailed to support operational response and integration with monitoring.
6. Climate impacts are increasingly unpredictable; plans should incorporate flexibility to enable a timely response.

SUMMARY

The C-SIP Practice Plan is a foundational component of the C-SIP Expansion Program. By identifying disturbance vulnerabilities, outlining mitigation and response strategies, mapping essential access and operational features, and preparing land stewards for rapid post-disturbance recovery, this practice ensures that forests remain resilient, productive, and capable of long-term carbon storage.

C-SIP Monitoring Practice

(Annual Forest Resilience & Disturbance Readiness Monitoring)

PURPOSE

Monitoring is a core requirement of the C-SIP Expansion Program. It ensures that enrolled properties are managed to enhance forest resilience, maintain carbon stability, and support rapid recovery following disturbance. Annual monitoring provides early detection of threats, verifies practice implementation, and promotes adaptive management by informing updates to Forest Management, Forest Stewardship, or C-SIP Practice Plans.

GENERAL POLICIES

1. Required Participation

All applicants enrolled in C-SIP Expansion must complete one (1) annual monitoring report for each year in which C-SIP practices are implemented or maintained.

Monitoring cost-share is based on the total acres of approved practices implemented within a 12-month period, not by individual practice. In other words, applicants would be eligible to receive one monitoring cost-share reimbursement payment per year, calculated on the total number of acres treated or implemented during that 12-month window.

2. Relationship to C-SIP Practice Plans and FSP/FSCP

Monitoring complements the C-SIP Practice Plan.

Resulting in:

- Documenting whether cost-shared or recommended practices were implemented and maintained
- Identifying any needed adjustments to management goals or prescriptions
- Updating Stewardship Plans, Management Plans, or C-SIP Practice Plans as conditions change

3. Eligibility

Monitoring is required for:

- Any property receiving financial assistance through C-SIP Expansion for Practices 1–9 (excluding timber mats)

4. Timing

- Monitoring must be completed and submitted within 12 months of practice completion.
- Additional monitoring is encouraged after severe weather, pest outbreaks, timber operations, or other significant disturbance events.

5. Submission Requirements

- Completed C-SIP Monitoring Checklist and form.
- Required documentation when applicable.
- Updates to mapped features when applicable.
- The land steward, a MA Licensed Forester, or another authorized agent, may conduct monitoring.

6. How monitoring cost-share is calculated

Monitoring cost-share is based on the total acres of approved practices implemented within a 12-month period, not by individual practice. In other words, applicants would receive one monitoring cost-share per year, calculated on the total number of acres treated or implemented during that 12-month window.

Example:
Year 1: 15 acres applied for, approved, implemented with a submitted Monitoring Checklist and form → $400
Year 2: 30 acres (15 acres C-SIP 4 + 15 acres C-SIP 1) applied for, approved, implemented with a submitted Monitoring Checklist and form → $600
Year 3: 15 acres applied for, approved, implemented with a submitted Monitoring Checklist and form → $400

Note: If the harvest layout (C-SIP 1) and invasive treatment (C-SIP 4) occurred on the same 15 acres, the monitoring acreage for that year would remain 15 acres, not 30, because acreage is counted once, even if multiple practices occurred on it.

COST-SHARING POLICIES

Authorized Cost-Share Activities

Cost-share is available for time spent on:

- Conduct the annual monitoring walkthrough
- Complete the Monitoring Checklist and form
- Document practice implementation and maintenance needs
- Record forest condition and disturbance indicators
- Update spatial data or field maps when applicable

Not Authorized for Cost-Share

- Work required solely for permitting
- Timber appraisal, marking, or boundary surveying
- Work related to land conversion or development activities
- Monitoring performed before practice implementation

C-SIP Practice Plan Cost-Share Rate

- **Flat Rate**: $500 per completed practice plan or amendment.
- **Limit**: One Practice Plan or amendment per application. Additional applications for the same property require proof that earlier approved practices have been implemented before new funding can be authorized for a subsequent Practice Plan or Plan Amendment.
- No acreage-based adjustments

TECHNICAL SPECIFICATIONS: Monitoring Practice

Definition

Monitoring is an annual observational and documentation process that evaluates forest conditions, verifies practice implementation, and identifies signs of disturbance, pests, storm damage, or other stressors that may

require responsive management actions.

Applicability

Monitoring applies to all C-SIP-enrolled forestland where practices are implemented and maintained.

Required Elements

1. Completed the Monitoring Checklist and form provided by DCR
    a. Field-verified observations of:
    b. Evidence of practice implementation
    c. Maintenance needs and performance of installed practices
    d. Forest health indicators (regeneration, vigor, mortality)
    e. Disturbance indicators (pests, pathogens, storm damage, flooding)
2. Updated spatial information, when applicable, including:
    a. Roads, trails, crossings, and BMP maintenance
    b. Shifts in sensitive areas (e.g., wetlands, erosion zones)
    c. Boundaries of practice areas
3. Documentation (when applicable), including:
    a. Photos of relevant findings
    b. Noted locations for follow-up work
    c. Recommendations for corrective actions

Integration with Existing Plans

Monitoring outcomes may be used to:

- Inform adaptive management decisions
- Update FMP/FSP prescriptions when forest conditions change
- Revise or add practices in the C-SIP Practice Plan
- Prioritize areas for rehabilitation, resilience, or disturbance-recovery interventions

Mapping Requirements

Monitoring must include review and verification of spatial data related to:

- Access and operational features
- Practice implementation areas
- BMP locations and condition
- Observed disturbance footprints

Maps may be produced in GIS or through annotated aerials/field maps.

CONSIDERATIONS

1. Monitoring should reflect current climate-driven risks and disturbance patterns.
2. Observations should be tied to land steward goals and long-term resilience priorities.
3. Frequent monitoring is encouraged in high-risk areas (e.g., hemlock stands, low-lying wet areas).
4. The monitoring process should reinforce consistent recordkeeping and readiness for rapid response.
5. Land stewards and foresters should incorporate relevant training from DCR and Mass Audubon.

SUMMARY

C-SIP Monitoring strengthens forest resilience by providing an annual assessment of forest condition, practice implementation, and disturbance impacts. The process ensures early detection of threats, supports adaptive management, maintains carbon stability, and guides timely plan updates across the life of the C-SIP Expansion Program.

C-SIP 1: Harvest Layout

PURPOSE

The purpose of this practice is to provide for the proper design and layout of skid roads in the field to help harvest equipment to avoid areas sensitive to wetter conditions, allow for an appropriate location for water control structures and soil protection measures, and reduce the overall number of skid trails and protect soil carbon through the reduction of soil compaction, mixing, and erosion.

A key aspect of effective harvest planning is the thoughtful design and layout of skid roads in the field, avoiding sensitive areas prone to wet conditions, incorporating water-diversion measures, and implementing soil protection measures in advance of harvest activity. Proper harvest layout may also reduce the number of skid trails, resulting in less soil disturbance, operational efficiency, and profitability.

The changing climate is leading to more unpredictable harvesting conditions, with increasing frequency and intensity of precipitation events and shorter periods of frozen ground. Historically predictable periods of dry summer ground conditions or deep winter freezes are not occurring with regularity, underscoring the need for and emphasis on harvest planning to reduce unintended impacts from logging equipment. In addition, carbon stored in forest soils accounts for up to 61% of forest carbon (87 tons/acre). Another land cover in Massachusetts that stores large amounts of soil organic carbon (SOC) is wetland soil, which, on average, store 321 tons of SOC per acre.

Wetlands, which have the highest soil carbon per land-cover unit area, are the most sensitive to soil compaction, mixing, and erosion, which can lead to the loss of soil organic carbon. Appropriate skid road locations can help avoid unintended impacts on these sensitive areas, protect soil organic carbon, and ensure timely approval of cutting plans.

GENERAL POLICIES

The C-SIP 1 Harvest Layout practice applies to all proposed or approved harvesting activities covered by a long-term designated Forest Cutting Plan.

Applicants will develop a C-SIP Practice Plan after approval, including spatial data of the harvest area.

To be eligible for C-SIP 1, the application must be submitted either before or at the time of the Forest Cutting Plan Submission or before harvesting activities. Applications for C-SIP 1 will not be accepted after harvesting activities begin.

Conserving our forests is a critical part of natural climate solutions. This practice is to be used only where harvesting activities are being considered for a long-term designated Forest Cutting Plan, and the applicant’s long-term (10+ year) intent is to maintain the land use as forest. In situations where an applicant's intent is called into question, due to but not limited to, a documented track record of property development, subdivision plans (including preliminary), proposed or signed lease agreements for solar, exploration for development such

as perk tests, then the applicant's C-SIP cost-share application may be denied or the applicant may be asked to make a written statement of intent to maintain the forest land beyond the duration of the Forest Cutting Plan. The land steward may appeal the decision to the Forest Stewardship Program Coordinator.

COST-SHARING POLICIES

C-SIP Cost-sharing is authorized for field work associated with a long-term designated Forest Cutting Plan and performed by a Massachusetts Licensed Forester to:

C-SIP 1: Clearly flag or mark (with paint) the following: truck roads, principal skid roads; extent of landing locations; water control structures (i.e., water bars or other water diversion structures); and soil protection measures if necessary (i.e., mats or road armoring).

Cost-sharing is not authorized for:

1. Any activity that is under M.G.L. Chapter 131, town bylaws, other state or federal laws, or activities as part of land use transition to non-forest use.

C-SIP 1 COST-SHARE RATES

Harvest Acreage	Cost-Share Rate
Up to 50 acres	Up to 4 hours (at $120/hour) Maximum $480
51-100 acres	Up to 8 hours (at $120/hour) Maximum $960
Greater than 100 acres	Up to 12 hours (at$120/hour) Maximum $1,440

TECHNICAL SPECIFICATIONS: C-SIP 1 Harvest Layout Design

Definition Purpose: Design and layout for skid trails and roads, the extent of landings, location of water control structures, and soil stabilization measures to protect forest soils before harvesting activities.

Condition Where Component Applies: Forest land with an approved long-term designated forest cutting plan or intend to submit a cutting plan proposing a long-term harvest. Applicants will prepare a C-SIP Practice Plan and provide spatial data of the harvest area after approval of the application.

Considerations:

1. Skid trails and roads must be clearly flagged or painted. The time between layout and harvest should guide the chosen method for skid road and trail layout.
2. Skid trails must be strategically laid out, considering topography, resource area(s), and the type of harvest machinery used to minimize skid road and trail impacts on forest soil.
3. Utilize NRCS soil maps or the USDA Web Soil Survey, along with knowledge of local soil conditions, to lay out skid trails and roads, avoiding and minimizing areas susceptible to wet conditions, steep slopes, water fluctuations, or otherwise unsuitable for heavy equipment.
4. Locations for water control structures, like water bars or reinforced water bars, must be clearly flagged

or marked.
5. Areas identified where stabilization through mats, slash, or similar means will significantly protect forest soils may be flagged or marked with paint.
6. If wetland resource areas are located within fifty (50) feet of a landing, the landing extent must be clearly flagged or marked with paint.

ADDITIONAL REFERENCES

DeArmond, D., Ferraz, J. B., & Higuchi, N. (2021). Natural recovery of skid trails: a review. *Canadian Journal of Forest Research*, *51*(7), 948-961.

Picchio, R., Mederski, P. S., & Tavankar, F. (2020). How and how much do harvesting activities affect forest soil, regeneration, and stands? *Current forestry reports*, *6*(2), 115-128.

Drezdahl-Zaltzberg, K., Gutwein, S., Lawlor, G., Horton-Krok, L., Lindsay, R., Newman, Johnson I., Toensmeier, E., Roszell, C., Dagoberto, M. (2023). The Massachusetts Healthy Soils Action Plan. https://www.mass.gov/doc/healthy-soils-action-plan-2023/download

C-SIP 2: Legacy Tree Retention

PURPOSE

Old, large trees are uncommon in the New England landscape. These trees provide ecological functions that cannot be replicated and are significant sources of long-term carbon storage. The purpose of this practice is to designate a variety of long-lived tree species (with an average lifespan greater than 200 years) as individuals or groups to be retained in perpetuity, thereby increasing stand complexity and carbon retention during management activities. Groups of legacy trees may be used to designate patch reserves for increased carbon storage and stand complexity.

The strategic retention of these legacy trees during management activities, particularly when situated near existing downed wood, snags, and other site features, provides additional ecological advantages. Such areas act as refugia, offering sanctuary to plant and animal species that colonize new environments more slowly. The time element of this practice is the most important. The legacy trees designated by this practice have the potential to be retained on the landscape over many human generations; therefore, marking and meticulously documenting these retention trees is paramount.

GENERAL POLICIES

This practice is open to all applicants who have a DCR-Approved Forest Management Plan, such as a Forest Stewardship Plan, Chapter 61 Plan, Bird Habitat Assessment, or Forest Stewardship Climate Plan. The forest management plan may have a 'Legacy Tree Retention' (C-SIP 2) practice in the management practices section, or this will be included in the C-SIP practice plan to be prepared after the application is approved. It is essential to protect legacy trees during management activities. The following guidelines will be followed:

- All new primary skid trails and roads must be located at least one hundred (100) feet from the identified Legacy Trees and fifty feet (50) from Legacy Tree Patches.
- Legacy Tree crowns and boles must be protected during harvesting.
- Legacy trees must be identified in the planning document for at least 2 plan cycles or 20 years, whichever is longer.

The strategic retention of these legacy trees, particularly when situated near existing downed wood, snags,

and other site features, provides additional ecological advantages.

This practice will be most effective if the land has a conservation restriction, a deed restriction, or another encumbrance that will ensure the land remains in a forested condition for the foreseeable future. Although the practice can be applied to any forest land with a state-approved Forest Management Plan, those forest areas with existing very large or ancient trees, which are less prone to disturbance, or regions with relatively high site quality and productivity capable of producing large trees, will provide a greater ecological and carbon storage benefit in the short term. **If you need help figuring out legacy tree patch/ individual, you can always have your Service Forester come out for an evaluation.**

COST-SHARING POLICIES

C-SIP 2 is authorized for a Massachusetts Licensed Forester's time to:

- Mark and locate legacy trees and patch reserves.

Cost-sharing is not authorized for:

- Marking of trees for removal for commercial or non-commercial purposes.
- Massachusetts Licensed Forester's time associated with fieldwork and/or preparation time of an applicant's Forest Cutting Plan.

C-SIP 2 COST-SHARE RATES

C-SIP 2 Practice	Cost-Share Rate
Individual Legacy Tree Retention (marking)	$30/tree Maximum Reimbursement $300/acre (10 trees/acre, average 66-foot spacing)
Patch Legacy Tree Retention (marking)	$640/acre Maximum Reimbursement $6,400

TECHNICAL SPECIFICATIONS: C-SIP 2 Legacy Tree Retention

Definition Purpose: To increase stand complexity and carbon retention, and to serve as a refugia for species with slow dispersal rates.

Condition Where Component Applies: All ownerships with an existing Forest Stewardship or Forest Management Plan.

Considerations:

Legacy trees should be:

- Located within an area identified as Prime Forest Land Classification for Forest Productivity in Massachusetts. MassGIS Data: Prime Forest Land | Mass.gov
- Capable of surviving another 50 years or more. Insect/ Disease vulnerability is low.
- Long-lived tree species capable of living 200 years or more.
- Wind firm.

- Dominant or co-dominant crown position.
- A variety of tree species.
- Generally larger than 15” DBH.
- Any living tree over 39” DBH.
- Evidence of surviving previous natural disturbances.
- Single legacy trees will be painted with an "L" on two sides, their positions mapped or locations captured (GPS, KML, GPX, shapefile, other) and documented in the C-SIP Practice Plan.
- The patch area cannot exceed 10% of the total acreage designated as Prime Forest Land Classification for Forest Productivity in Massachusetts on the property. The maximum reimbursement is $6,400.

Legacy trees serving as anchors for patch reserves will be painted with an “L” on two sides, and their positions will be mapped or locations captured spatially (GPS, KML, GPX, shapefile, other) and added to the C-SIP Practice Plan and Forest Cutting Plan.

- The perimeter of a Legacy Tree reserve patch will be painted and mapped, or locations spatially captured (GPS, KML, GPX, shapefile, other) and documented in the Forest Management Plan and C-SIP Practice Plan.
- No Primary Skid Trails/Roads or harvesting equipment located within fifty (50) feet of an identified Legacy Tree and one hundred (100) feet of a Legacy Patch.
- No skid trails/roads can be located, and no harvesting equipment can be operated within a Legacy Patch.

ADDITIONAL REFERENCES

D'Amato, Anthony & Catanzaro, Paul. (2009). A forest manager's guide to restoring late-successional forest structure. https://masswoods.org/sites/default/files/pdf-doc- ppt/forest_mgr_guide_ls_structure_web.pdf

Commonwealth of Massachusetts, Executive Office of Technology and Security Services, Bureau of Geographic Information (MassGIS). (2013, January). MassGIS data: Prime forest land. MassGIS Data: Prime Forest Land | Mass.gov

C-SIP 4: Invasive Plant Species Control

PURPOSE

Invasive plant species are projected to thrive and spread under changing climate conditions, impairing forest health, inhibiting natural plant communities, and negatively impacting wildlife habitat. Mitigating the impact of invasive plants is crucial to enhancing forest resilience and enabling forests to recover more effectively from both natural and human-induced disturbances.

This practice is designed to address invasive plant populations in forestlands by implementing treatments that reduce their prevalence on the applicant's property. The overarching goal is to bolster the health, vigor, reproductive capacity, and diversity of desirable native plant populations.

Methods of control to be implemented will depend on the species present, their density, and the degree of establishment. Most treatments will require chemical applications (foliar, basal bark, or cut stump), but mechanical methods may be used for new or minor infestations. By practicing this, the aim is not only to control invasive plants but also to foster a more resilient, ecologically robust forest ecosystem.

Invasive plants can be difficult to control effectively. This practice may be most effective for novel infestations, enabling rapid response and control. In cases of well-established invasive plant populations, multiple treatments will likely be necessary to obtain adequate control.

GENERAL POLICIES

This practice is open to all applicants who have a DCR-Approved Forest Management Plan, such as a Forest Stewardship Plan, Chapter 61 Plan, Bird Habitat Assessment, or Forest Stewardship Climate Plan. The forest management plan may include in the management practices section techniques specific to controlling Invasive Plant Species, or the C-SIP Practice Plan will describe these details when prepared.

COST-SHARING POLICIES

Cost-sharing is authorized for:

- Practice methods involving chemical treatments
- Massachusetts Licensed Pesticide applicator's time to treat invasive plants using a combination of mechanical and/or chemical methods to reduce invasive plant populations on the subject property.
- A land steward's time to treat invasive plants using mechanical and/or chemical methods to reduce invasive plant populations on the subject property.
- Practice methods involving Light Mechanical treatment for light or new infestations only
- Land steward, or contractor's time to mechanically reduce invasive plant populations on the subject property.
- One C-SIP application may cover multiple invasive treatment methods, including follow-up treatments that continue into the next growing season.

C-SIP 4 COST-SHARE RATES

C-SIP 4 Practice	Cost-Share Rate	Category
Invasive Plant Species Control HEAVY	$1,193/acre	HEAVY The target species occupy greater than 67% of the treatment area
Invasive Plant Species Control MODERATE	$543/acre	MODERATE Target species occupy 26% to 66% of the treatment area.
Invasive Plant Species Control LIGHT	$309/acre	LIGHT The target species occupy 10% to 25% of the treatment area.

Invasive Plant Species Control LIGHT MECHANICAL	$474/acre	LIGHT MECHANICAL Target species occupy 10%-25% of the treatment area, and conditions are appropriate for removal with a chainsaw, brush saw, and/or another mechanical method (e.g., a mower/chipper).

TECHNICAL SPECIFICATIONS: C-SIP 4 Invasive Plant Species Control

Definition Purpose: To decrease invasive plant populations on a property to promote native plant communities and tree regeneration. Restore or release desired vegetative cover to protect soils, control erosion, reduce sediment, improve water quality, enhance hydrology, and maintain or modify wildlife habitat.

Condition Where Component Applies: This practice is open to all applicants who have a DCR-Approved Forest Management Plan, such as a Forest Stewardship Plan, Chapter 61 Plan, Bird Habitat Assessment, or Forest Stewardship Climate Plan. If the Forest Management or Stewardship Plan does not include specifics on the locations and densities of the target invasive plants, the C-SIP Practice Plan and associated maps will consist of this information. Spatial data will be provided, along with the C-SIP Practice Plan, including locations and densities for treatments to be completed.

Considerations:

- Heavy control is applicable where access is limited due to distance or heavy slash, or where the number of invasive stems/acre is high or invasive cover exceeds 67% (ocular estimation).
- Moderate control is applicable where access is moderately poor, there is a mild to moderately high number of invasive stems/acres, or invasive cover is 26% to 66% (ocular estimate).
- Light control is applicable where access is good, and the coverage of invasive plants is patchy or dispersed at 10% to 25% (ocular method). This category would be used for light infestations or follow-up treatment after using Heavy OR Moderate control.

Light Mechanical control is applicable where access is fair to good, and the coverage of invasive plants is patchy or dispersed at 10% to 25% (ocular estimation). OR the treatment area is occupied by target species at 1% to 25% (ocular estimation). Still, conditions are appropriate for removal with a chainsaw, brush saw, weed wrench, and/or another mechanical method (e.g., mower/chipper).

C-SIP 5: Climate-Smart Best Management Practices for Forest Operations

PURPOSE

Forestry Best Management Practices (BMPs) dedicated to erosion control are proven techniques for mitigating the impacts of timber harvests on water quality, site productivity, and soil health. The efficacy of BMPs is most pronounced when planned before and implemented during harvesting activities. Long-term effectiveness

depends on monitoring, vigilant inspection, and adequate maintenance throughout the timber harvest and at harvest closeout.

The changes in our climate, characterized by rising temperatures and altered seasonal precipitation patterns, have introduced greater unpredictability to soil conditions in Massachusetts. A notable increase in heavy precipitation events, coupled with milder winters that lead to abbreviated frozen-ground conditions, has heightened the challenge of maintaining stable ground conditions during timber harvests. Extreme weather events associated with large equipment in forests can increase the risk of erosion, flooding, and sedimentation in nearby water resources.

In addition, carbon stored in forest soils accounts for up to 61% of forest carbon, with forested wetlands contributing a substantial share. Soil compaction, mixing, and erosion during logging operations can result in the loss of soil carbon. It is therefore essential to apply BMPs appropriately in areas of high resource concern or areas with disturbed soils.

GENERAL POLICIES

This practice is relevant to all Forest Cutting Plans designated as 'Long-Term'.

Climate-Smart forestry Best Management Practices (BMPs) must be applied and sustained both during and after harvest to be eligible for C-SIP cost-share reimbursement.

*Note: Maintenance of all Forestry BMPs as required by 302 CMR 16.00 Forest Cutting Practices is mandatory throughout the entire harvest process.

Erosion control and/or soil stabilization measures shall not be removed or disturbed until the site and soil conditions are stabilized or fully vegetated (if applicable) or otherwise authorized by the DCR Service Forester.

The use of Straw is required for erosion control because straw bales lack seed heads and therefore will not transport invasive plant seeds from one site to another.

Protecting soil health and water quality is a critical part of natural climate solutions. These Climate-Smart Forestry BMPs are only to be used where an approved Forest Cutting Plan with Long-Term designation has been issued.

Proper placement, spacing, and orientation will be assessed by Service Forestry staff using Table 3 from the Massachusetts BMP Manual for spacing and technical specifications and Illustration 4. The DCR Service Forester will make final decisions on the “Log Reinforced Water Bars,” including their layout, quantity, placement, spacing, and orientation.

COST-SHARING POLICIES

The applicant must submit a C-SIP application and be approved before incurring any costs associated with C-SIP 5. Costs incurred before being approved are not eligible for reimbursement.

The DCR Service Forester will review the application for eligibility and assign a cost-share reimbursement value based on the submitted application and, if necessary, a field review.

Applicants approved for the Climate-Smart BMP Materials and Timber Mats will receive reimbursement for eligible expenses after the submission and processing of the completed reimbursement form, required documentation, and receipts, in advance of the "Final Report" and at the discretion of the DCR Service Forester. All other C-SIP cost-share practice payments will be issued once the "long-term" designated Forest Cutting Plan receives a "Final Report" from the DCR Service Forester.

Cost-share reimbursement for C-SIP 5 is exclusively authorized for the execution of Climate-Smart Forestry Best Management Practices (BMPs) by Massachusetts-licensed timber harvesters operating within the framework of a long-term designated Forest Cutting Plan.

A C-SIP Practice Plan and required maps will be prepared. Stand maps shall include the structure and erosion control measures to be installed and their locations.

Examples of areas and/or locations for C-SIP 5:

- Areas of critical resource concern where Climate-Smart BMPs will be implemented (i.e., approaches to stream crossings and wetland crossings).
- Primary and Secondary Skid Trails/Roads where slopes exceed 10%
- Areas/locations where soils are expected to be highly compacted and heavily disturbed (i.e., landings).

C-SIP 5 COST-SHARE RATES

C-SIP 5 Practice	Cost-Share Rate	Category
C-SIP 5.1 Log-reinforced water bars (on slopes > than 10%)	$250/log-reinforced water bar	Properly constructed and maintained throughout the entirety of the harvest
C-SIP 5.1 Log-reinforced water bars (on slopes > than 10%)	$75/log-reinforced water bar	Properly constructed for harvest closeout
C-SIP 5.2 Seeding for soil stabilization and pollinator habitat	$600 - $1,200/acre Seeding Rates should increase if applied just before/during the dormant season. BMP Manual for Seeding	Seeding to stabilize soils on disturbed areas and slopes ≥10% on primary skid roads, landings, and approaches to stream crossings.
C-SIP 5.3 Climate-Smart BMP Materials	Climate-Smart BMP Materials may include one or more of the following components: Straw bale and stakes at $20/bale, Biodegradable Fiber Blanket $150/roll, Wattle and stakes at $150/wattle (Max.Reimbursement for C-SIP 5.3 is $600 per application)	Soil stabilization product(s) for use in the following: Pre-harvest During the operational period Post-harvest or Harvest Closeout

C-SIP 5.4 Timber Mats	$500/mat up to $10,000	Implementing BMPs that account for changing precipitation patterns and other climate factors helps reduce erosion and minimize stressors associated with forest harvesting and management activities.

TECHNICAL SPECIFICATIONS: Practice Component C-SIP 5.1: Log-reinforced water bars (on slopes ≥10%).

Definition Purpose: Log reinforced water bars constructed during, and/or after a harvest will outlast traditional earthen water bars and prevent water runoff from extreme weather events. Implementation of properly constructed and maintained water diversions for skid trails and roads to stabilize soil throughout the harvest.

Condition Where Component Applies: Access roads, primary skid roads, and secondary skid roads on forest land with an approved "long-term" designated Forest Cutting Plan.

Applicants will complete a C-SIP Practice Plan upon approval of the application. Spatial data of structures to be installed and erosion control measures will be included with the C-SIP Practice Plan.

Considerations:

- Logs used for reinforced water bars should have a minimum DBH of 8" and be at least 2'-4' longer than the skid road to allow outflow.
- Reinforced water bars during active harvest will prevent water runoff during extreme weather events, especially on steeper terrain. To assist with planning and mapping of water bars in the C-SIP Practice Plan, use Table 3 from the Massachusetts BMP Manual for spacing and technical specifications, and Illustration 4. Locations of water bars will be marked with flagging or paint in the field.
- Reinforced water bars created once the harvest is completed and before leaving the job can significantly help to prevent future, long-term erosion issues. To assist with planning and mapping of water bars in the C-SIP Practice Plan, use Table 3 from the Massachusetts BMP Manual for spacing and technical specifications, and Illustration 4. Locations of water bars will be marked with flagging or paint in the field.
- Log-reinforced water bars must be strategically constructed, taking into account topography, resource area(s), and the type of harvest machinery used.
- Utilize NRCS soil maps or the USDA Web Soil Survey, along with knowledge of local soil conditions, to install log-reinforced water bars on skid trails and roads.
- The DCR Service Forester will make final decisions on the "Log-Reinforced Water Bars," including layout, quantity, placement, spacing, and orientation.

TABLE 3: Water Bar Spacing Chart (from MA BMP Manual 2nd Edition, 2013)

4. Water Bar Technical Specifications

Illustration 4.
Water bar installation
Proper installation of water bar.

- Make angle to the center line of the road roughly 30 degrees (i.e., not perpendicular).
- Make height of berm depth of ditch.
- Allow outflow for water from the ditch to be open and extend beyond the edge of the skid trail; use shovel.
- Make water bars deep to ensure that they last a long time and serve as a possible deterrent or ORV traffic.
- Mulch or seed berm to reduce scouring or erosion and make it last longer.

ROAD GRADE (%)	SPACING (ft.)
0-2	250-500
3-5	165-250
6-10	140-165
11-15	125-140
16-20	100-125
21+	<100

Illustrations from: Massachusetts Forestry: Best Management Practices Manual

Example of a log-reinforced water bar on the active harvest. Photo credit: Colin Mettey.

TECHNICAL SPECIFICATIONS: Practice Component C-SIP 5.2: Seeding for soil stabilization and pollinator habitat

Definition Purpose: Seeding can stabilize soil and minimize soil erosion in disturbed areas and on slopes. Seeding establishes perennial vegetative cover, which helps control soil erosion in disturbed areas. It reduces erosion and sediment loss by protecting bare soil surfaces from displacement by raindrop impacts, reducing stormwater flow rates and volumes, and providing permanent stabilization. This practice is economical, adaptable to different site conditions, and allows selection of a variety of plant materials.

Seeding is well-suited to areas where permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing the soil. These include roughly graded areas that will not be disturbed for at least a year. Seeding's advantages over other methods of establishing plants include lower initial costs and reduced labor requirements.

Properly implemented permanent seeding can significantly reduce soil loss, often by up to 99 percent.

Condition Where Component Applies: Landings, stream crossing approaches, access roads, primary skid roads on forest land with an approved "long-term" designated Forest Cutting Plan. Approved applications will prepare a C-SIP Practice Plan and required maps for Climate-Smart BMPs, indicating where seeding is necessary and will be completed. Spatial data will be provided showing the locations of this practice.

Considerations:

Selecting suitable plant species depends on climate, soil, and topography. Consult regional, state, and local resources for recommendations on native, low- maintenance, shade-tolerant (if applicable), and low-water plant species. The Forestry BMP Manual provides a list of recommended native grasses and rushes (pg. 21)

Apply seeds uniformly using methods like manual scattering, seed spreaders, or hydroseeding. Recommended seeding periods are from April 15 to June 15 and August 1 to September 15. Protect seeds with mulch to retain moisture, regulate soil temperatures, and prevent erosion during seedling establishment. Seeding rates should align with the time of year, seed species mix, Pure Live Seed (PLS), and other factors.

Factors constraining the effectiveness of seeding include heightened erosion during the establishment phase, the need to reseed areas that do not successfully germinate, constrained planting seasons, and fluctuations in soil temperature and moisture content during germination and early growth. It is essential to recognize that seeding alone does not confer immediate soil stabilization. Hence, implementing supplementary temporary erosion and sediment control measures is advisable to prevent erosion from disturbed areas.

The DCR Service Forester will make final decisions on all C-SIP 5 practices.

ADDITIONAL REFERENCES:

Five Counties Salmonid Conservation Program (5C) (2012). 5C Roads Workshop Presentation, Understanding Erosion with the Revised Universal Soil Loss Equation. https://www.5counties.org/docs/roadedu/2012_5c_roads/rusle.pdf

Smolen, M. D., Miller, D. W., Wyatt, L. C., Lichthardt, J., & Lanier, A. L. (2013). Erosion and sediment control planning and design manual. North Carolina Sedimentation Control Commission; North Carolina Department of Environment and Natural Resources; North Carolina Agricultural Extension Service. https://www.deq.nc.gov/energy-mineral-and-land-resources/land-quality/erosion-and- sediment-control-planning-and-design-manual/design-manual-updates-may- 2013/design-manual-revision-packet-may-2013/download

Permanent Seeding (EPA.gov)—most of the above is info from this EPA document.

EROSION (mass.gov)
Recommended native grasses and rushes from the MA Forestry BMP Manual:

- Little bluestem (Schizachyrium scoparium)
- Switch grass (Panicum virgatum)
- Virginia wild rye (Elymus virginicus
- Big bluestem (Andropogon gerardii)
- Indian grass (Sorghastrum nutans)
- Deer tongue (Panicum clandestinum)
- Patridge pea (Chamaecrista fasciculata)
- Soft rush (Juncus effusus)
- Path rush (Juncus tenuis)
- Rough bentgrass/Ticklegrass (Agrostis scabra)

Suggestions for seed source:
USFS National Nursery and Seed Directory Reforestation, Nurseries and Genetics Resources (rngr.net)

TECHNICAL SPECIFICATIONS: Practice Component C-SIP 5.3 BMP Materials (Implementation of biodegradable soil stabilization products).

Definition Purpose: The proper use and placement of soil stabilization products, such as Straw Bales, Wattles, and Seeded Blankets, will be used as a temporary means to intercept extreme runoff/trap sediment in areas with disturbed soils and high resource concerns (i.e., along stream crossings, filter strips, areas of high-water flow, etc.) throughout the harvest.

Condition Where Component Applies: Landings, stream crossing approaches, filter strips, access roads, primary skid roads, secondary skid roads, etc., on forest land with an approved "long-term" designated Forest Cutting Plan. Once an application is approved, a C-SIP Practice Plan and required maps will be prepared. Spatial data will be provided, showing the locations of erosion control measures to be installed.

Considerations:

- Proper placement of straw bales is used DURING a harvest when the harvest is inactive (nights, weekends, weather delays) or in areas of high resource concern and soil disturbance.
- Proper placement of wattles is used DURING a harvest in areas of high-water flow and/or when the harvest is inactive (nights, weekends, weather delays) or in areas of high resource concern (steep banks along streams, steep skid roads).
- Proper placement of straw bales USED AT HARVEST CLOSEOUT in areas of high resource concern and soil disturbance.
- Proper placement of fiber blanket rolls USED AT HARVEST CLOSEOUT on slopes or approaches to stream crossings to reduce the overland flow of water and prevent sloughing of soil on steeper slopes.

- Proper installation and maintenance of soil stabilization product(s) during harvest: Straw bales; Wattles with biodegradable netting ≤1/4” or ≥2”; Wattles must be indicated on the C-SIP Practice Plan, shown on required maps, and flagged or marked with paint.
- Soil stabilization product(s) installed during the harvest must be strategically located, taking into account topography, resource area(s), and the area of soil disturbance.
- Utilize NRCS soil maps or the USDA Web Soil Survey, along with knowledge of local soil conditions, to install soil stabilization product(s).
- Proper installation and maintenance of soil stabilization product(s) at harvest closeout: Straw bales; Fiber Blankets made from natural biodegradable materials; Wattles filled with natural materials (wood fiber, Straw, coir) with biodegradable netting ≤1/4" or ≥2"; Wattles must be indicated on the Practice Plan and required maps and flagged or marked with paint.

Straw Bales: Straw bales should be used downslope of disturbed areas, such as landings, or upslope from a stream crossing, to keep water carrying sediment from entering the stream while the job is inactive (e.g., overnight, on weekends, or during known extreme weather events). Bales become ineffective when saturated with sediment. See the illustration below for proper installation of straw bales.

Installation:

- Excavate a trench 4 inches deep and the width of the bale.
- Position the bales in a single row or stagger them, ensuring there are no gaps where water could flow through.
- Place the bales in the trench and stake with at least two stakes per bale.
- Backfill with soil on the uphill side to keep water from flowing underneath the bale.
- Do not install bales in the streambed.

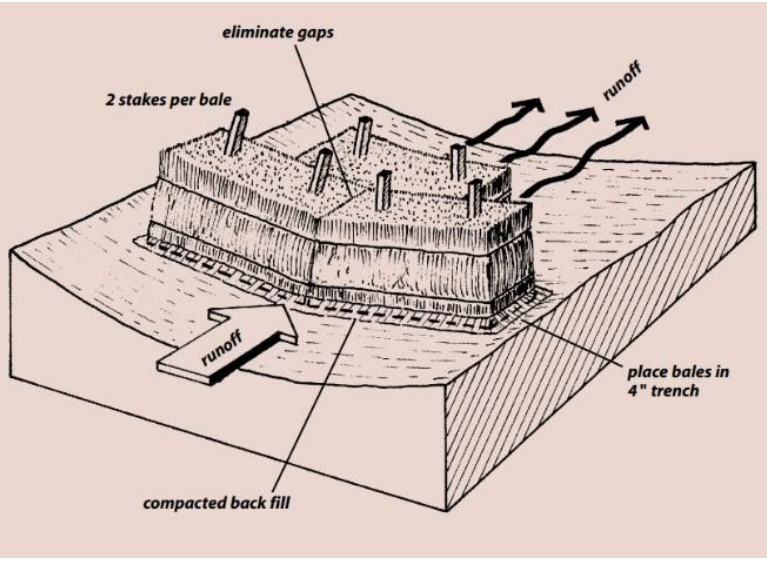

Illustration from Best Management Practices for Forestry: Protecting New Hampshire’s Water Quality

Blankets: Fiber blankets are made of biodegradable materials such as straw, coconut fiber, or shredded wood. These blankets can be placed on slopes or at approaches to stream crossings to reduce overland flow and prevent soil sloughing. Avoid netting or other mesh material with a nominal opening size between ¼" and 2" to avoid the entrapment of fish and wildlife. On slopes greater than 25%, blankets must be anchored with stakes. Blankets work best in ditch and swale sections (where there is concentrated runoff) when the slopes are gentle. Some products include a matrix of seeds to speed up re-stabilization and ensure that seeds are native to appropriate regions of the state.

Seed Blanket Installation:

- Begin at the top of the slope and unroll downgrade.
- Ensure uniform contact with the soil surface.
- Allow the mat to lie loosely on the soil; do not stretch.
- Bury the upslope end in an anchor slot no less than 6" deep.

Wattles: Erosion control wattles contain biodegradable materials such as straw or wood fiber, stuffed into netting or tube structures typically 8 to 20" in diameter. Such tubes can be used as alternatives to silt fencing or straw bales to slow the flow of sediment-laden water into the stream temporarily. Avoid netting and coarse material with nominal openings between ¼" and 2" that can trap and kill fish and wildlife. Wattle Installation:

- Install well-staked along slope contours, with ends wrapped uphill.
- Drive stakes through the rear half of the tubes at a 45-degree angle.
- Extend termination points uphill to minimize flow bypassing.
- Overlap adjoining tubes 6" and stake joints securely.
- On long slopes, establish multiple lines of protection.

Additional Considerations:

- The maximum reimbursement for the Climate Smart BMP Material is $600.
- C-SIP Cost-Share Application for the Climate-Smart BMP Materials contents MUST be approved before materials are purchased.
- Climate-Smart BMP Materials must be located on-site and covered from the elements until use.
- The DCR Service Forester will make final decisions on all C-SIP 5 practices.

ADDITIONAL REFERENCES:

Massachusetts Forestry: Best Management Practices Manual. 2nd Edition, 2013. Massachusetts Forestry: Best Management Practices Manual

Best Management Practices for Forestry: Protecting New Hampshire's Water Quality. University of New Hampshire, Cooperative Extension, 2005. Best Management Practices for Forestry: Protecting New Hampshire's Water Quality (unh.edu)

Practice Component C-SIP 5.4: Timber Mats.

Definition Purpose: Rising temperatures and altered seasonal precipitation patterns have introduced greater unpredictability to soil conditions across Massachusetts. Timber mats are an effective tool used in timber

harvesting that reduces impacts on hydrology, nutrient cycling, and soils that act as pools for forest carbon. Eligible applicants can receive financial assistance towards new mats through a cost-share reimbursement process.

Condition Where Component Applies: On forest land with an approved "long-term" designated Forest Cutting Plan.

Considerations:

1. Cost-share reimbursement of up to $500 per new, not previously used, timber mat. Example, if a mat costs $450, the program will reimburse $450. If a mat costs $550, the program will reimburse $500.
2. Up to 20 mats are eligible for reimbursement. The maximum reimbursement amount is $10,000.
3. Transportation costs are not eligible for cost-share.Mats must be new, not previously used, and constructed from durable hardwood timbers. Mats constructed from poplar, basswood, or softwood timbers are not eligible. Laminated mats are not eligible.
4. Mats must have minimum dimensions of 16’ long, 4’ wide, and 8” thick. Cost-share can be applied to hardwood mats that exceed the minimum dimensions.
5. Timbers must be secured by steel rods. Mats can have flush, beveled, staggered, or notched ends.
6. The applicant must purchase mats from a business that manufactures or resells mats. Mats can be purchased from out-of-state businesses.
7. Mats must be present on site of the approved “long-term” designated Forest Cutting Plan before reimbursement documents can be submitted.
8. The applicant must wait 12 months from their previous timber mat reimbursement approval date before applying again.
9. The applicant will retain ownership of the mats after reimbursement.

C-SIP 6: Temporary Barriers to Animal Browse

PURPOSE

In woody vegetation, climate change has some of the greatest direct impacts on seed establishment, seedlings, and saplings. These impacts, combined with other stressors that have decreased the richness of young tree establishment as well as structural diversity, likely reduce the ability of forest ecosystems to respond to climate change (Fisichelli et al. 2012). In certain circumstances, forest practitioners may need to directly support young tree establishment in the Northeast. Tree protection can be used in tandem with enrichment planting or as an assisted natural regeneration strategy by placing tree shelters or fencing around natural regeneration. C-SIP #6 supports the use of tree tubes or fencing for both strategies.

Assisted natural regeneration protects naturally occurring seedlings from animal browse with the use of temporary structures. This practice improves forest health and regeneration by reducing the impacts from deer and other wildlife. Tree protection of enrichment planting provides similar benefits, but with the supplementation of the currently present species via planting. Both activities, under this practice, aim to reduce over-browsing from herbivore damage and enhance the survival and health of desired tree regeneration.

This practice is designed to maintain and improve the adaptive capacity of a stand by reducing the impacts of herbivory. An emphasis should be placed on protecting tree species that are expected to persist or do better under future conditions (see Managing Forests for Climate Change in Massachusetts) and that improve species richness at the site. For additional details on the need for reforestation practices and the Seven Key Steps to Success: See *Reforestation Guide: Enrich, Restore, and Adapt Northern Forests.*

GENERAL POLICIES

This practice may be applied to all applicants with a DCR-approved forest management plan who have completed a C-SIP Practice Plan. The practice plan must provide sufficient documentation of the long-term adaptation benefit of the practice at the site.

This practice should be implemented using a climate adaptation framework that considers strategies that will best address climate change stressors at the site (e.g., resistance, resilience, or transition strategies). Partnering strategies (such as harvesting or planting) may be required depending on the circumstances. See Technical Specifications, sections 6a & 6b.

COST-SHARING POLICIES

Applicants may opt to receive tree protection (tubes and associated supplies) from Service Forestry Staff (subject to availability of materials*) in lieu of a portion of the cost share, or may secure their own supplies, provided tree protection meets the outlined requirements.
**Availability TBD (not available for January 2026)*

Shelters, stakes, and zip ties must be robust enough to support a minimum of a 50% survival rate after 4 years.

Tree tube requirements include

- Minimum of 5 ft tall
- Twin-wall structure or high-density plastic
- Ventilation holes in more than one location on the tube (a singular row of ventilation is insufficient)
- UV field rating of at least 5 years
- Bird netting is required.

Metal Shelter requirements include

- A minimum of 12 inches in diameter
- Galvanized materials required
- 19-gauge or stronger

Vole guards are strongly encouraged for riparian and afforestation projects.

Plastic mesh tree sleeves have not been found to promote long-term seedling success for most species and are not fundable via this program.

74” stakes are required for metal tree shelters; softwood and bamboo stakes <u>are not</u> permitted.

COST-SHARE RATES

$15 per tree, up to 100 trees per acre for CSIP 6a and up to 50 trees per acre for CSIP 6b. On a case-by-case basis, protection of up to 200 trees per acre may be allowed depending on the specifics of the site, the number of species being planted, and the goal/justification for higher densities of protection (maximum $3,000 per acre).

TECHNICAL SPECIFICATIONS: Practice Component C-SIP 6a Tree Shelters to reduce deer browse

Component Purpose

This practice is designed to maintain and improve the adaptive capacity of forests by reducing the impact that deer and other wildlife have on plantings via the use of tree shelters. Successful implementation of this practice will include tree shelters to protect planted seedlings from deer browse and will ensure each shelter is securely supported with a stake, adequate fasteners, and a bird cap. Prior to planting, prepare the site by clearing competing vegetation as needed and ensuring proper light and soil conditions to support healthy seedling establishment and growth.

Condition Where Component Applies: Projects are eligible for funding if trees are being planted to enrich a stand following or in preparation for a harvest, increase the stocking of an understocked stand, or for afforestation. Protecting seedlings must be below the browse line.

Considerations

Implementation sequence

1. Secure high-quality stock well in advance of project execution; two-year stock is often required.
2. Identify understocked areas with canopy gaps or reduce stand density through midstory and overstory reductions.
3. For plantings of slower-growing, moderate shade-intolerant species (E.g. Quercus, Carya) where more competitive vegetation is likely to outcompete the planting prior to midstory recruitment, control competing woody vegetation that is greater than 5 feet in height with the use of targeted herbicides or with mechanical intervention.
4. As needed, such as in areas with dense understory vegetation, mechanically control and suppress vegetation under 5 feet within the immediate vicinity of each planting (approximately 3ft x 3ft). Shallow-rooted and height-limited vegetation may have little to no competitive advantage over planted seedlings and may offer microclimatic benefits.
5. Plant stock and immediately install tree protection that includes a tree shelter, adequate stake, zip ties (if using tree tubes), and mesh bird caps (if using tree tubes).
6. Vole protection may be needed on some sites, particularly for afforestation projects and within edge or riparian habitats. Vole guards can be added within tree tubes/shelters. Vole guards that are 15” in size and have some ventilation are adequate. ShellT® provides a few versions of these guards
7. When competing understory vegetation is likely to crowd out plantings or hinder the functionality of tree shelters, spreading 4-5 inches of clean mulch (sourcing mulch on site or from areas with low invasion risk) can reduce maintenance needs and buffer against drought, particularly for afforestation projects. Biodegradable weed mats (consider thick paper weed mats or coconut coir) may reduce the amount of mulch needed to suppress competition, but are unlikely to be successful on their own.

Tree Tube Selection

There is a wide variety of tree shelters that can be used for enrichment planting. Tree tubes are often promoted because of the greenhouse effect that well-ventilated tree tubes, with a high light infiltration ratio, provide.

Many studies have found that seedlings protected in tubes put on height more rapidly in the first several years of growth compared to seedlings in wire/plastic mesh enclosures and unprotected seedlings (Ward & Stevens 1995; Sharew & Strang, 2005; Thyroff et al. 2022). Some studies have found an increase in diameter, though evidence for this is less conclusive (Abe 2021). For slow-growing and shade intolerant species, this competitive advantage may help increase the odds of overstory recruitment. These benefits, in addition to the reduced labor and mechanics (in comparison to metal mesh or fencing) are why tree tubes are commonly recommended.

When selecting a tree tube for your project, it is important to balance tradeoffs between cost, labor requirements, durability, ventilation, light infiltration, and the selection of more sustainable materials. Note that anecdotal evidence suggests that blue tree tubes may attract bears, risking impact on the seedlings. Consider the list below of tree tubes which meet the required size, ventilation, and service life that is needed for successful tree planting

Name	Ventilation	Material	Service Life	Link
Tubex Combitude Plus	Optional, yes	UV Stabilized Polypropylene	5-7 years	Forestry Suppliers
Miracle Tube Tree Grow Tube	Yes	Recycled HDPE	5-7 years	Tree Pro
Plantra 58" SunFlex Grow Tubes	Yes	HDPE (Resin ID #2)	7+ years	Plantra

Wire/Metal Tree Shelters

Wire Cages have been shown to be very effective. They can be constructed from various diameter and strength wire rolls. Chicken wire is unlikely to be durable enough on most sites, so hardware cloth or similar is recommended. These cages are preferred for coniferous species and shrubs but can also be used for hardwood species. Diameters of 12 inches and greater will reduce the risk of browse and lateral growth outside of the cage. A larger diameter may be needed for wide-form shrubs.

These shelters may have the advantage of lower maintenance or greater ventilation but typically have higher initial installation costs. A tree shelter must meet similar requirements to tree tubes, including being at least 5 feet tall, allowing adequate light infiltration, being able to withstand wind and other impacts, and having adequate service life. These shelters lack the added benefit of the greenhouse effect that well-ventilated solid tree tubes provide.

Tree Stake Selection

- Tree stake selection and installation should consider site conditions and require proper installation.
    - Stake should be installed approximately 1’ deep to ensure wind resistance.
    - Stake the tube at a distance from the tree equal to about one-half the diameter of the protector.
    - The stake should be on the side of the tree toward the prevailing wind (e.g., if the prevailing wind is from the west; the stake should be on the west side of the tree) or on the uphill side of the planting on steep sites.
- The top of the stake should be several inches higher than the top fastener.

- Wood, rebar, fiberglass, metal fence posts, and plastic-coated steel stakes are some of the most common stakes for tree shelters. The following table lists advantages and considerations for each. Pine and bamboo stakes are not fundable in this program:

Tree Shelter Stakes	Advantages	Considerations
Fiberglass Stakes	Balances durability and affordability. Works on a variety of sites. Reusable.	Prolonged UV exposure degrades strength
1"x 1" oak or rot-resistant wood	Easy installation, sturdy, and it works on a variety of sites. Lower carbon footprint.	Expensive and can break during installation. Can rot too soon on wet sites.
Metal fence t-posts or U-posts	Easy installation and removal, works on a variety of sites, best wild resilience and longevity	Expensive and posts may damage roots when removed
#3 or #4 rebar	Readily available, works for a variety of soils, reusable	A heavy tree may grow around the rebar if not removed, and can tip with animal rub or excessive wind
Plastic-coated steel stakes	Readily available, works for a variety of soils, reusable	Expensive, heavy, tree may grow around rebar if not removed

Table adapted from USDA NRCS Tree Shelter Installation and Maintenance Fact Sheet, 2011**Tips for successful implementation**

- For planting, tree shelters must be installed immediately after the planting is complete.
- Note that while ground contact is required, proper tube installation does not require the protector to be pressed down into the ground. Doing so increases the likelihood of mice, voles, and other animals building nests within the tubes.
- Bird netting prevents birds from nesting in tree tubes, which can kill both the tree and the eggs. It also reduces maintenance needs associated with debris accumulation.
- **Note:** Bird netting should be removed as soon as the trees are near the top of the tube. Follow-up treatments of competing vegetation may be required to promote recruitment.

Tree Tube Removal

- Trees should be allowed to grow above the height of the tree tube for at least 2 years to develop wind resilience. Tree tubes should be removed when the diameter of the tree reaches 3 inches or greater, and prior to the potential for tree tubes to restrict the diameter growth of the tree.
- Some tree tubes can be reused if they remain durable enough. Check the manufacturer's recommendations.

TECHNICAL SPECIFICATIONS: Practice Component C-SIP 6b Assisted Natural Regeneration (ANR)

Component Purpose

This practice is designed to maintain and improve the adaptive capacity of forests by reducing the impacts from deer and other wildlife with the use of tree shelters around natural regeneration. Successful implementation of this practice will include the selection of seedlings that can successfully reach co-dominant or dominant crown position or understory species with high herbivory rates (E.g. flowering dogwood). When selecting seedlings to protect, species that are well adapted to climate change and/or that are underrepresented at the site and at high risk of browse should be chosen. Similar considerations to those provided above for the appropriate installation and use of tree shelters should be followed (see CSIP 6a above). Site preparation is required in circumstances where understory or midstory vegetation is likely to prevent canopy recruitment.

Condition Where Component Applies: Practice must be implemented either for understory species at high risk of deer browse or in areas where midstory and overstory removal/mortality is high enough to allow for seedling recruitment into a co-dominant/dominant position in the canopy.

Considerations

Assisted Natural Regeneration requires careful selection of trees to protect. Depending on the goals of the project and recent or planned silviculture, species with varying shade tolerance can be selected. Consider the following guidance:

Open Canopy: If seedlings are exposed to direct sunlight for at least 6 hours per day, seedlings can be selected for protection regardless of shade tolerance. Tending of competing species may be needed. On higher productivity sites, moderate shade-intolerant species may require tending of competing species.

Partial Canopy: In areas where overstory trees allow in dappled light most of the day and a few hours of direct sunlight:

- **Moderate Shade Intolerant Species:** Genera such as Oak and Hickory (*Quercus &* Carya) may benefit from a partial canopy in their first few years of establishment. Midstory removal and several hours of direct sunlight are still required. Protect seedlings in the understory if these conditions are met, herbivory risk is high, and future release is planned. Tending of competing species is likely needed.
- **Moderate Shade Tolerant Species:** Species such as American basswood (*Tilia americana)* and black gum *(Nyssa Sylvatica) can be selected for protection* under partial light conditions with moderate midstory removal. Future release may still be needed, particularly for slow-growing species like black gum.
- **Shade Tolerant Species:** Protecting shade-tolerant species such as Ironwood (O*strya virginiana*), Flowering dogwood *(Cornus florida),* etc., can help to diversify forest structure in areas of high browse.

Fully Stocked - Closed Canopy: Assisted natural regeneration is likely only warranted if shade tolerant species like American hornbeam, Ironwood, Flowering dogwood are present but failing to establish, and the site could benefit from additional structural complexity.