

Reforestation Compliance Monitoring Study Plan and Protocol

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AND
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1 Definitions

Note: The definitions that are derived from the Forest Practices Rules are current as of June 2023. Definitions may change with ongoing rule changes.

Clearcut: For purposes of this document, a “Harvest Type 1” and “Harvest Type 3” under the Forest Practice Administrative Rules (OAR 629-600-0100 (32), (34)). In FERNS, these types of activities are classified as “Clearcut/Overstory Removal”.

Dying or recently dead tree: "Dying or recently dead tree" means a tree with less than ten percent live crown or a standing tree which is dead but has a sound root system and has not lost its small limbs. Needles or leaves may still be attached to the tree. (OAR 629-600-0100 (18)).

E-Notification: The formal name used by the State of Oregon for the Forest Activity Electronic Notification System (FERNS).

FERNS: Forest Activity Electronic Notification System. The online tool used to notify the Oregon Department of Forestry when forest operations are planned. FERNS replaces earlier paper-based notification methods.

Harvest Type 1: An operation that requires reforestation but does not require wildlife leave trees. A harvest type 1 is an operation that leaves a combined stocking level of free to grow seedlings, saplings, poles, and larger trees that is less than the stocking level established by rule of the board that represents adequate utilization of the productivity of the site (OAR 629-600-0100 (32)). See OAR 629-610-0020 for applicable stocking levels.

Harvest Type 3: An operation that requires reforestation and requires wildlife leave trees. This represents a level of stocking below which the size of operations is limited under ORS 527.740 and 527.750 (OAR 629-600-0100 (34)).

Harvest Unit Boundary: A polygon drawn by ODF identifying the area to be sampled for reforestation. This polygon defines the area that was part of the harvest treatment and excludes riparian management areas. This polygon may be equal to or be a subset of the area included in the FERNS Unit.

Landowner: Any individual, combination of individuals, partnership, corporation, or association of whatever nature that holds an ownership interest in forestland, including the state and any political subdivision thereof (OAR 629-600-0100 (43)). For the purposes of this document, the term is also used to describe any manager, agent, or other person designated by the landowner to have authority to grant permission to access the Survey Area. The ODF monitoring unit uses the FERNS landowner identification fields to make initial determinations of ownership.

Landowner Type: Description of landowner business characteristics. In FERNS, Type is self-reported, and includes 1. Partnership/Corporation/Industrial Forest Landowner, 2. Individual/Private Non-Industrial Landowner, and 3. several government and nonprofit classes. For this study, these are summarized as 1. Private Industrial (PI), 2. Private Nonindustrial (PNI), and 3. Other (OTH) classes, respectively.

Live Tree: A tree that has 10 percent or greater live crown (Definitions 629-600-0100(40))

Notification: A Notification to the State Forester when performing forest operations, as described in ORS 527.670. Notifications are performed using FERNs. Synonyms include Notification of Operation, or NOAP.

Riparian Management Area: An area along each side of specified waters of the state within which vegetation retention and special management practices are required for the protection of water quality, hydrologic functions, and fish and wildlife habitat (OAR 629-600-0100 (63)). Riparian management area widths are given in the following table (OAR 629-635-0310).

	Type F	Type SSBT	Type D	Type N
Large	100 feet	N/A	70 feet	70 feet
Medium	70 feet	80 feet	50 feet	50 feet
Small	50 feet	60 feet	20 feet	

Saplings & Poles: Trees with diameter at breast height (DBH) greater than one inch, and less than 10 inches. (*Forest Practices Notes #2 – Reforestation. December 1994, pg.3*)

Snag: a tree which is dead but still standing, and that has lost its leaves or needles and its small limbs. (Definitions 629-600-0100(70)).

Sound Snag: a snag that retains some intact bark or limb stubs (Definitions 629-600-0100(71)).

Survey Plot: A circular sampling location centered on a Survey Point with a 16.7-foot radius where free to grow tree counts and species are recorded.

Survey Point: Potential plot locations. These are a grid of equidistant points within each Harvest Unit Boundary.

Trees: for the purpose of determining Seedling Equivalents of residual trees left after a harvesting operation, “Trees” are trees with a minimum 11-inch diameter. (*Forest Practices Notes #2 – Reforestation. December 1994, pg. 3*)

Type F Stream: A stream with fish use, or both fish use and domestic water use (OAR 629-600-0100 (85)).

Unit: An operation area submitted on a notification of operation that is identified on a map and that as single continuous boundary. Unit is used to determine compliance with ORS 527.676 (down log, snag, and green tree live retention), 527.740 and 527.750 (harvest type 3 limitation), and other forest practice rules (OAR 629-600-0100 (87)). For purposes of this study, this corresponds to the clearcut harvest unit as drawn by a notifier in the E-Notification or FERNs online forest operation notification system.

2 Background & Scope

Reforestation is required after commercial forest operations within the purview of the Oregon Forest Practices Act (FPA), and is considered “an essential factor in assuring continuous growing and harvesting of forest tree species, considering landowner objectives and consistent with the sound management of timber and other forest resources” (OAR 629-610-0000 (1)). The Reforestation Compliance Monitoring Study Plan was developed to monitor reforestation on privately-owned forests. The study also supports Oregon Department of Forestry’s (ODF) agency goals that include providing data to the Oregon legislature and Board of Forestry on FPA compliance, along with training, education, and outreach. The Reforestation Study was designed to assess compliance with the following subset of FPA rules from Division 610:

- 1) OAR 629-610-0040 (3): The landowner shall complete planting or seeding within 24 months unless a plan for an alternate practice for natural reforestation has been approved by the State Forester.
- 2) OAR 629-610-0050: Harvest units were restocked with tree species acceptable for reforestation.
- 3) OAR 629-610-0040 (4): By the end of the sixth full calendar year, the landowner shall have established a free to grow (FTG) stand of trees which meets or exceeds the minimum stocking level required by OAR 629-610-0020.

This study can estimate the percentage of harvest units in compliance with the above FPA rules for all clearcut operations that require planting for reforestation between 2 and 120 acres in size with private industrial (PI) and private nonindustrial (PNI) landowner types. Compliance with OAR 629-610-0040 (3) will be determined by evidence of planting, seeding will not be considered. This study will not evaluate rule compliance in riparian management areas (RMA).

3 Parameters of Interest

Compliance with the FPA rules of interest (OAR 629-610-0040 (3), OAR 629-610-0050, OAR 629-610-0040 (4)) is determined with two independent study designs and survey efforts: planting timeliness and FTG stocking surveys. Since the designs are independent, they can be conducted concurrently or separately, and results from one will not affect the other. First, planting timeliness (OAR 629-610-0040 (3)) and reforestation with acceptable species (OAR 629-610-0050) will be examined for a sample of harvest operations that were completed 24 to 36 months prior to study surveys. Second, FTG reforestation stocking (OAR 629-610-0040 (4)) will be assessed on a separate sample of harvests that were completed six to seven calendar years prior to FTG stocking surveys.

3.1 Planting Timeliness

Planting timeliness surveys will determine compliance with OAR 629-610-0040 (3) through visual inspection of the harvest unit. During visual inspection, surveyors will confirm replanting in suitable areas and record the species planted. Planting data will be collected using either a systematic random sample at Survey Points or a visual inspection of the entire unit. Harvest units will be considered in

compliance if planting was completed with acceptable species throughout the harvested area that is suitable for planting at the time of surveying.

3.2 Free To Grow Stocking

Free to grow stocking surveys will assess compliance with OAR 629-610-0040 (4). Harvest unit compliance will be determined based on FTG tree count data collected from a systematic random sample of fixed-area plots within each harvest unit. Tree counts from survey plots will be converted to trees per acre (TPA) and compared to required minimum stocking levels described in OAR 629-610-0020. Minimum stocking requirements will depend on the Cubic Foot Site Capability Class (CFSC) of each harvest unit. Compliance will be determined using one-sided tolerance intervals that estimate the minimum stocking for at least 80% of the harvest unit, per “well-distributed” criteria for minimum stocking (OAR 629-610-0000 Guidance). When the lower bound of the tolerance interval indicates that TPA meets or exceeds minimum stocking requirements, the unit will be considered in compliance.

4 Sampling Design

The planting timeliness and FTG stocking surveys will be completed for a random sample of harvest units selected from the Forest Activity Reporting and Notification System (FERNS) database, stratified by landowner type. Since the FERNS database does not include all necessary information to determine if a harvest unit is within the sample population and landowners must grant permission for access, a sample overdraw is required for each stratum to ensure sufficient sample sizes.

The sample draw process should proceed as follows:

1. Filter FERNS notifications using suitability criteria.
2. Randomize the filtered list of candidate notifications.
3. Conduct the sample overdraw by proceeding down the randomized list while screening each notification for harvest completion.
4. When screening indicates that harvest was completed within the desired timeframe, the notification will be added to the sample overdraw list.
5. Sample overdraw and screening is complete when the desired overdraw sample size is met.

4.1 Harvest Unit Selection

4.1.1 Sample Draw

The FERNS database will be used to generate lists of candidate harvest units that are likely to trigger reforestation requirements. Harvest notifications will be randomly drawn from FERNS after filtering notifications for the following suitability criteria:

Survey Type	Attribute	Suitability Criteria
Planting timeliness & free to grow stocking	Activity type	Clearcut
	Operation size	2 – 120 acres
	Private landowner type	PI or PNI
Planting timeliness	Harvest completion date	24 to 36 months prior to survey dates
Free to grow stocking	Harvest completion date	Six to seven calendar years prior to survey dates

After filtering for suitability criteria, FERNS notifications will be randomly ordered into a list. This list of candidate harvest notifications will likely include units that do not meet population criteria for the study. For example, harvests may not have occurred before the reported harvest completion date or there is an alternative plan for reforestation. The candidate list may also include harvest units that cannot be surveyed due to a lack of permission from the landowner. ODF does not currently have authority to enter private land without permission unless a warrant has been granted for specified inspection purposes (ORS 527.715). As a result of the inclusion of harvest units that do not meet the population criteria or cannot be accessed to survey, sample overdraw and additional screening will be conducted to ensure that the desired sample sizes are met.

ODF personnel will proceed down the randomized list of candidate FERNS notifications and screen each notification for indication of harvest completion until the desired sample overdraw is achieved for each survey and stratum. This will result in four sample overdraw lists, one for each landowner type in the planting timeliness and FTG stocking surveys.

Screening will utilize satellite imagery and supplemental information available in FERNS. GIS polygons from FERNS will be compared to Landsat imagery in ArcGIS Pro to determine whether harvest occurred. Landsat bands 6-5-2 (Shortwave IR, Near IR, Blue) will be displayed as red-green-blue to maximize contrast between forest vegetation and bare ground. Where an operation is determined to have occurred, the likely date of completion of the operation is recorded. If Landsat analysis leads to inconclusive results, a GIS overlay of FERNS notification polygons for harvest operations after the reported harvest completion date is also performed. If a FERNS clearcut notification covering the same area is also reported in the years subsequent to the initial notification, and spatially distinct harvests are not present in Landsat imagery, it is assumed that the original harvest notification was not completed and the notification is dropped from consideration.

FERNS will also be queried for site preparation notifications (e.g., herbicide) which is an indicator that harvest occurred. If Landsat imagery from 2022 or later does not indicate that harvest has occurred and there are no indications of site preparation, the notification is dropped from consideration.

Notifications will also be removed from consideration when:

- There is a plan for alternate practice (PFAP) that indicates the overall harvest would exceed 120 acres, or states an alternate plan for reforestation. PFAP documentation may not be clearly identified in the notification, so Stewardship Forester notes and additional documents will be examined when present.

- Operations include a land use conversion. This may be indicated in a FERNs conversion notification, Notification of Operation (NOAP) notes, or Landsat imagery that illustrates conversion activity.

4.1.2 Landowner Contact

Landowners from the sample overdraw lists must be contacted to confirm that harvests meet population criteria and to obtain permission for harvest unit access. To track this process, ODF will construct a contact database that contains all relevant contact information and details about correspondence efforts. Once again, ODF personnel will proceed down the list of candidate units. Landowners are first contacted via electronic mail. If a current email address is not available, a letter will be sent to the landowner's physical address. Based on the landowner response received, the harvest unit will be included or removed from the sample list. After an initial response, further discussion with landowners may be required to confirm that the harvest meets population criteria or to obtain access permission. If no response is received within 7 days (21 days for physical mail), a second email is sent followed by up to two phone calls. If no response is received within 7 days of the second email, any harvest unit notifications owned by the same landowner will be removed from sample list. The cause for removal will be noted in the contact database. This process will continue until the desired sample size is obtained. If harvest units are later removed from the sample for any reason (e.g., due to a change in ownership resulting in loss of access), additional landowners may be contacted using the randomized sample overdraw list.

4.1.3 Sample Size

In prior ODF FPA studies, including the Reforestation Pilot Study, compliance was near 100%. Given that compliance is a binary determination (compliance/noncompliance), it is not feasible to estimate sample sizes that will produce confidence intervals with reliable widths. Therefore, sample sizes (Table 1) were calculated to produce one-sided tolerance intervals that can state the expected minimum percent compliance for at least 80% or 90% of the population with 90% confidence with the equation (NIST 2023, chapter 7.2.6.4):

$$N \cong \frac{1}{4} \frac{(1+p)}{(1-p)} x_{\alpha,4}^2 + \frac{1}{2}$$

where N is the estimated sample size, p is the proportion of the population, and $x_{\alpha,4}^2$ is the critical value of the chi-square distribution with four degrees of freedom and confidence α . Samples are equally allocated across strata to produce consistent confidence in results.

For tolerance intervals with that can estimate minimum compliance for at least 90% of the population with 90% confidence, sample overdraw will total 223 harvest notifications (Table 1). This was calculated based on landowner response and harvest completion probability from the 2016 and 2017 Implementation Study. In that study, the likelihood that notifications were suitable varied by landowner type, and only 11% of PNI notifications resulted in a successful survey. This was most often due to notifications where harvest did not occur. In the Reforestation Study, this will be mitigated by screening notifications for harvest completion. The sample overdraw will be equal to the desired sample size

multiplied by 1.35 for PI notifications and 4.5 for PNI. This assumes the lowest inquiry response and access permission rates observed from the Implementation Study (PI: 83%; PNI: 25%) and 90% harvest unit suitability.

Table 1. Sample sizes and overdraw for one-sided tolerance intervals that can estimate compliance for at least 80% and 90% of the population with 90% confidence.

Percent of population included in interval	Sample Size			Overdraw		
	PI	PNI	Total	PI	PNI	Total
80%	18	18	36	25	81	106
90%	38	38	76	52	171	223

4.2 Within-unit Sample Selection

4.2.1 Planting Timeliness

Compliance with planting timeliness will be determined by visual inspection. The methods used to collect planting timeliness information is dependent on the desired amount of effort. Two methods are proposed that will be referred to as *systematic planting surveys* and *simplified planting surveys*. The chosen survey method must be applied for the entire sample of harvest units.

4.2.1.1 Systematic Planting Surveys

Systematic planting surveys use a Survey Point sampling design to provide estimates of compliance with planting timeliness. A systematic random sample will be obtained using a grid with at least 15 equidistant Survey Points within the Harvest Unit Boundary. The number of Survey Points was calculated to produce at least 10 samples to reliably estimate if planting occurred throughout harvested area suitable for planting. This was informed by the Reforestation Pilot Study that observed approximately 34% of Survey Points were unsuitable for planting. Each point will be visited to determine suitability for planting. If the point is suitable for planting, the surveyor will record whether planting has occurred in the immediate vicinity along with the species planted.

4.2.1.2 Simplified Planting Surveys

Simplified planting surveys use a visual inspection of the entire harvest unit to estimate compliance with planting timeliness. The surveyor will then walk the harvested area and look for evidence of planting. The surveyor will record whether planting occurred and the dominant planted species. The survey is complete when the entire unit has been visually inspected. Binoculars, spotting scopes, or similar may be used to assist with the survey.

4.2.2 Free To Grow Stocking

In each Harvest Unit Boundary, a systematic random sample will be obtained using a grid with at least 27 equidistant Survey Points that will be visited to determine suitability for a Survey Plot (Figure 1). The

number of Survey Points was calculated to produce reliable one-sided tolerance intervals to estimate the minimum stocking level for at least 80% of the harvest unit with 90% confidence (18 samples), and informed by plot suitability data from the Reforestation Pilot Study. Survey Points will function as the center of the Survey Plots, which will have a 16.7-foot radius (horizontal distance).

If the Survey Point is unsuitable for a Survey Plot due to a road or proximity to Harvest Unit Boundary or RMA, an offset procedure will be applied in the field to obtain a suitable location for a Survey Plot. If the Survey Point is unsuitable for any other reason (e.g., within an RMA), no survey will be conducted.

Results from the Reforestation Pilot Study indicate that 34% of points were unsuitable for surveying, and an offset procedure for roads and unit boundaries could reduce this to 19%. Therefore, we expect at least 20 successful Survey Plots within each harvest unit, greater than the 18 required for the specified tolerance interval.

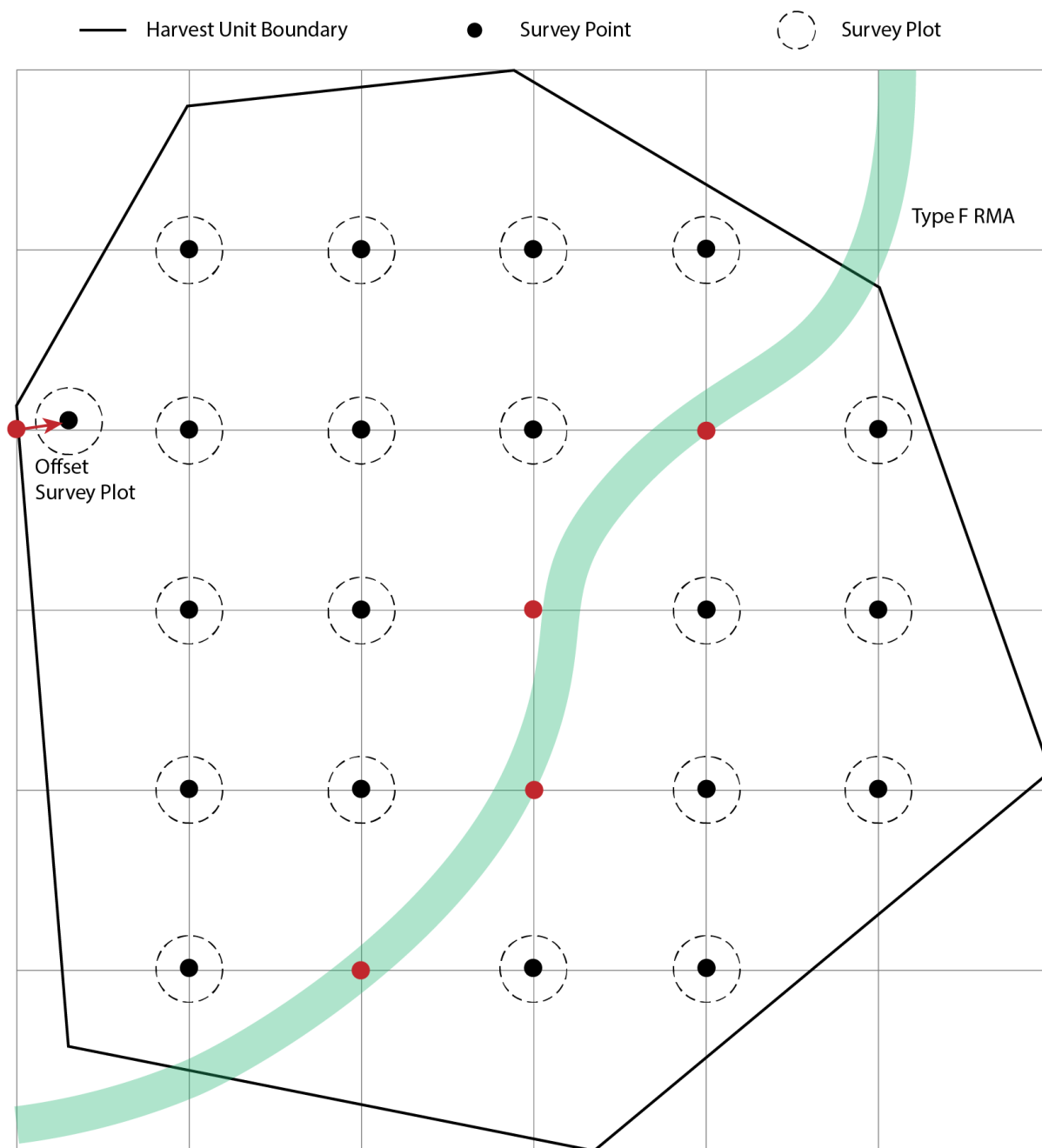


Figure 1. Conceptual diagram of survey area. Red dots indicate Survey Points that would be unsuitable for surveying.

4.3 Harvest Unit Access

The landowner (or agent of the landowner) will be contacted prior to accessing the harvest unit, unless the landowner has explicitly indicated that such contact is unnecessary. During this contact, permission will be reaffirmed to visit the unit on the intended date. Access routes and any additional considerations

(e.g., gates or dangerous animals) will be communicated at this time. All landowner requests will be documented and included with field data.

Landowner contact must occur within two weeks prior to the intended field visit unless the landowner indicates otherwise. The primary contact method will be a phone call. The surveyor will supplement this with written communication (email or letter) if verbal contact is not established within one day of the initial phone call. For timeliness, letters should request a response via phone or e-mail.

If the landowner does not respond within one week of the initial phone call, the surveyor will make two additional phone calls to the landowner. All attempts to contact the landowner will be documented and included with field data. A log will be kept to document phone calls and surface letters, with the accompanying result. For e-mail, copies of the communication will be the most appropriate documentation. If all contact attempts are unsuccessful, or if the landowner revokes permission to access land, the next uncontacted harvest notification from the randomized sample overdraw list will be selected, and the surveyor will request permission to access the alternate site's harvest unit following the above procedure. ODF will note this change in the contact database, along with reasons leading to the change.

5 Field Survey Protocol

Field survey methods for planting timeliness and FTG stocking are detailed below. The survey design and data collection methods are fixed; however, harvest unit access methods and other logistical considerations are subject to minor modification for safety and feasibility.

5.1 Planting Timeliness

To facilitate planting timeliness surveys, surveyors will be provided with:

- Digital field maps with associated metadata. Maps and metadata will contain Harvest Unit Boundaries and the location of designated Survey Points in latitude and longitude format (Figure 1 and Appendix 1 – Sample Data Sheets)
- Field Survey Protocol section of this document
- Planting timeliness survey data forms (see Appendix 1 – Sample Data Sheets)
 - **Note:** The free to grow stocking data forms can be used as a template for systematic planting surveys.
- Copies of signed permission forms
- Access route information
- Any special instructions and considerations from the landowner

In addition, the following equipment is required:

- GPS-enabled handheld device capable of accuracy within 16 feet
- Digital camera that collects and stores spatial metadata
- Systematic planting surveys: laser rangefinder with horizontal distance calculation and accuracy within 1 foot
- Simplified planting surveys: binoculars, spotting scope, or similar
- Simplified planting surveys: digital or physical map of harvest unit for markup

5.1.1 Systematic Planting Surveys

Order of Operations

A summary of the systemic planting survey protocol is as follows:

1. Navigate to the harvest unit and complete a harvest unit evaluation.
2. Navigate to a Survey Point.
3. Determine Survey Point suitability.
4. If suitable, record if planting occurred and the dominant species planted.
5. Navigate to the next Survey Point and repeat the process, starting at step 3, until all Survey Points have been visited.

Harvest Unit Evaluation

After navigating to the harvest unit, the surveyor will find a readily accessible vantage point and perform a 5-to-10-minute visual examination of the harvest unit. The results of this examination will be used as supplementary information outside of statistical analysis and compliance determination. During this examination, the surveyor will take at least one georeferenced photograph documenting site conditions. The surveyor will answer the following questions, based on visual impression:

1. Are there substantial differences between the Harvest Unit Boundary on the provided map and the observed harvest area?
2. Was stocking reduced to a level requiring reforestation?
3. Over how many acres was stocking reduced to levels requiring reforestation?

Determine Survey Point Suitability, Record Planting

Using a GPS-enabled device, surveyors will navigate to a Survey Point. Survey Points will first be evaluated for suitability by observing the area within the Survey Plot radius. Survey Points are considered unsuitable for a Survey Plot if they are: within 20 feet of a road, within 20 feet of a Harvest Unit Boundary, within 20 feet of a Type F RMA, or unsuitable for growing trees. Additionally, unharvested areas exceeding $\frac{1}{4}$ acres (including meadows with no evidence of harvest) will be considered unsuitable. Unharvested areas are characterized by groups of unharvested trees with undisturbed understory vegetation.

If a Survey Point is unsuitable, the surveyor will record the code indicating the reason (Table 2) and navigate to the next point. If the Survey Point is suitable, the surveyor will record whether evidence of planting can be observed within 23.5 feet of the point ($\frac{1}{25}$ th acre survey plot area), measured by laser rangefinder if necessary. The surveyor will then record the dominant tree species planted. This process will be repeated until surveys have been conducted at all suitable Survey Points within the Harvest Unit Boundary.

Table 2. Suitability codes for Survey Points during systematic planting surveys.

Code	Description	Procedure
S	Suitable	Conduct survey
XS	Trees cannot be grown because the location is on stone (>1/3 of survey plot area)	Move to next point
XW	Trees cannot be grown because location is on water or in a wetland (>1/3 of survey plot area)	Move to next point
XO	Trees cannot be grown for other reason	Describe in notes; move to next point
RM	Survey Plot is within 20' of an RMA	Move to next point
RD	Survey Plot is within 20' of a Road	Move to next point

UH	Location is unharvested (>1/3 of survey plot area)	Note how the unharvested condition was determined; move to next point
BO	Survey Point outside of Harvest Unit Boundary	Move to next point
OT	Another condition (e.g., unable to access safely) makes the plot location unsuitable, but trees are capable of being grown at the location	Describe in notes; move to next point

5.1.2 Simplified Planting Surveys

Order of Operations

A summary of the simplified planting survey protocol is as follows:

1. Navigate to the harvest unit and complete a harvest unit evaluation.
2. Conduct a visual inspection of the entire harvest unit, marking the inspected areas on a map of the harvest unit.
3. Record whether planting occurred throughout the unit, estimate the percent of total planting by tree species.

Harvest Unit Evaluation

After navigating to the harvest unit, the surveyor will find a readily accessible vantage point and perform a 5-to-10-minute visual examination of the harvest unit. The results of this examination will be used as supplementary information outside of statistical analysis and compliance determination. During this examination, the surveyor will take at least one georeferenced photograph documenting site conditions. The surveyor will answer the following questions, based on visual impression:

1. Are there substantial differences between the Harvest Unit Boundary on the provided map and the observed harvest area?
2. Was stocking reduced to a level requiring reforestation?
3. Over how many acres was stocking reduced to levels requiring reforestation?

Visual Inspection

The surveyor will proceed walk the area of the harvest unit suitable for planting, not including RMAs; the amount of area covered should be sufficient to obtain a reliable determination that planting or did or did not occur throughout the entire harvested area. During the survey, the surveyor will clearly mark the areas visually inspected on a physical or digital map of the harvest unit that includes the Harvest Area Boundary. The survey is complete when the entire harvested area has been inspected, verified by the harvest unit map. This map will be a data product delivered with survey results. Binoculars, spotting scopes, or similar may be used to assist with harvest unit coverage. The surveyor will record whether there is evidence of planting throughout the unit, along with planted tree species and approximate the percent of the unit planted by species.

5.2 Free To Grow Stocking

To facilitate field surveys, surveyors will be provided with:

- Digital field maps with associated metadata. Maps and metadata will contain Harvest Unit Boundaries and the location of designated Survey Points in latitude and longitude format (Figure 1 and Appendix 1 – Sample Data Sheets)
- Field Survey Protocol section of this document
- FTG stocking survey data forms (see Appendix 1 – Sample Data Sheets)
- Copies of signed permission forms
- Access route information
- Any special instructions and considerations from the landowner

In addition, the following equipment is required:

- GPS-enabled handheld device capable of accuracy within 16 feet
- Surveyor measuring tape (e.g., Spencer) with imperial marking
- Laser rangefinder with horizontal distance calculation and accuracy within 1 foot
- Reflective post for rangefinder
- Digital camera that collects and stores spatial metadata
- Red paint and/or biodegradable flagging

Order of Operations

A summary of the FTG survey protocol is as follows:

1. Navigate to the harvest unit and complete a harvest unit evaluation.
2. Navigate to a Survey Point.
3. Determine suitability for a Survey Plot, offset if applicable.
4. Delineate Survey Plot and mark location.
5. Tally FTG trees by size category.
6. Navigate to the next Survey Point and repeat the process, starting at step 3, until all Survey Points have been visited.

Harvest Unit Evaluation

After navigating to the harvest unit, the surveyor will find a readily accessible vantage point and perform a 5-to-10-minute visual examination of the harvest unit. The results of this examination will be used as supplementary information outside of statistical analysis and compliance determination. During this examination, the surveyor will take at least one georeferenced photograph documenting site conditions. The surveyor will answer the following questions, based on visual impression:

1. Are there substantial differences between the Harvest Unit Boundary on the provided map and the observed harvest area?
2. Was stocking reduced to a level requiring reforestation?
3. Over how many acres was stocking reduced to levels requiring reforestation?

4. Was planting attempted?

Determine Survey Plot Suitability

Using a GPS-enabled device, surveyors will navigate to a Survey Point. Survey Points will first be evaluated for suitability by observing the area within the Survey Plot radius. Survey Points are considered unsuitable for a Survey Plot if they are: within 20 feet of a road, within 20 feet of a Harvest Unit Boundary, within 20 feet of a Type F RMA, or unsuitable for growing trees. Additionally, unharvested areas exceeding $\frac{1}{4}$ acres (including meadows with no evidence of harvest) will be considered unsuitable. Unharvested areas are characterized by groups of unharvested trees with undisturbed understory vegetation.

If a Survey Point is unsuitable, the surveyor will record the code indicating the reason (Table 3). If the Survey Point is unsuitable due to proximity within 20 feet of a road or Harvest Unit Boundary, the Survey Point may be offset. The offset procedure is as follows:

- For Survey Points within 20 feet of roads, the surveyor will navigate perpendicular to the road in the direction nearest to the road edge and place the new Survey Point at the first suitable location between 20 and 50 feet from the road edge, measured in 10-foot increments. If no suitable point is found, the surveyor will note the reason and navigate in the opposite direction perpendicular to the road to the first suitable location between 20 and 50 feet from the road edge, measured in 10-foot increments. If both directions are unsuitable for any reason, the surveyor will move to the next Survey Point.
- For Survey Points within 20 feet of an RMA or the Harvest Area Boundary, the surveyor will navigate to the first suitable point between 20 and 50 feet from the boundary in the direction perpendicular to the boundary and toward the interior of the harvested area, measured in 10-foot increments. If suitable, a Survey Point will be placed and survey conducted. If unsuitable, the reason will be noted and the surveyor will move to the next Survey Point.

The location of all offset Survey Points will be recorded with a handheld GPS device in latitude and longitude format. If the Survey Point is unsuitable for any other reason, the surveyor will move to the next Survey Point.

Table 3. Suitability codes for Survey Points during free to grow stocking surveys.

Code	Description	Procedure
S	Suitable	Delineate Survey Plot
XS	Trees cannot be grown because the location is on stone (>1/3 of survey plot area)	Move to next point
XW	Trees cannot be grown because location is on water or in a wetland (>1/3 of survey plot area)	Move to next point
XO	Trees cannot be grown for other reason	Describe in notes; move to next point

RM	Survey Plot is within 20' of an RMA	Offset point
RD	Survey Plot is within 20' of a Road	Offset point
UH	Unharvested area >1/3 of plot.	Note how the unharvested condition was determined; move to next point
BO	Survey Point outside of Harvest Unit Boundary	Offset point if within 20' of boundary, otherwise move to next point
OT	Another condition (e.g., unable to access safely) makes the plot location unsuitable, but trees are capable of being grown at the location	Describe in notes; move to next point

Delineate Survey Plot

At suitable Survey Points, the surveyor will delineate the Survey Plot (Figure 2). Survey Points will be marked as the Survey Plot center with a 2.0 foot "X" using red paint and assigned a Survey Plot number. Plots may be marked with flagging when explicit permission is given by the landowner. From this center point, a 16.7-foot radius (horizontal distance) circular plot will be measured using a laser rangefinder. A measuring tape may be used to delineate the survey plot when necessary (e.g., no clear line of sight to Survey Point). Surveyors will record the whether laser rangefinder or tape was used to delineate the plot.

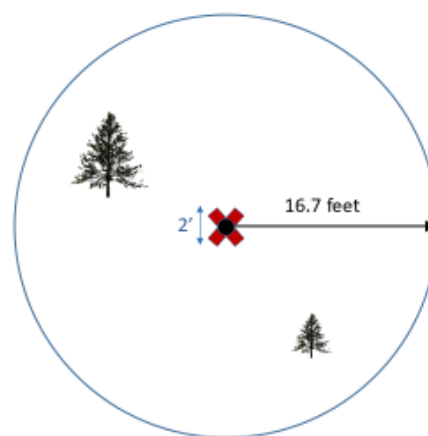


Figure 2. Diagram of Survey Plot.

Tally Free To Grow Trees

Trees that meet free to grow status are defined as “vigorous, healthy, and dominant over undesired competing vegetation”. Seedlings, saplings, pole-sized trees, and trees over 11 inches DBH meeting the following standards are considered free to grow (*definition is subject to change prior to field surveys*):

1. Potential for continued height growth consistent with the site’s productivity;
2. Freedom from damage by insects, disease, fire, wildlife, weather, or logging that would prevent growth to site potential¹:
 - a. Does not lean more than 30 degrees from vertical
 - b. Does not have a broken, dead, or missing main stem;

¹ Note that we are not collecting data on trees exhibiting these damages, but rather data for trees that are free of these damages. Data that will be collected are described in Appendix 1.

- c. For trees 8 inches DBH or larger, have not suffered scrapes from timber harvesting that penetrate the cambium on more than one half of the stem circumference at any point on the tree;
 - d. For trees less than 8 inches DBH, have not suffered scrapes from timber harvesting that penetrate the cambium on more than one third of the stem circumference at any point on the tree; and
 - e. Have not suffered visible severing, mutilation, or exposure from timber harvesting of more than one third of the root spread.
3. Generally, at least one-third of the tree height in full, live crown, though on some sites the dominant tree cohort may have less than a one-third live crown and retain adequate vigor. Surveyor should examine adjoining timber. At minimum, free to grow tree should have more than ten percent live crown.
 4. Taller than, and out-competing any grass, shrubs, or undesired trees growing within a ten (10) foot radius from the tree.

The surveyor will tally the number of FTG trees, by species and size class (seedling (< 1 in DBH), sapling or pole (1 to 10 in DBH), and sawtimber (11 in DBH and greater), within the Survey Plot. From a marked starting point, trees will be tallied in a clockwise direction. When a rangefinder is used to determine the plot radius, the distance from plot center to trees within one foot of the plot edge will be measured with a tape to ensure that the tree is within the survey plot. If the center of the tree stem is within the plot, then it will be tallied.

Once the first successful plot has been collected, the surveyor can move to the next Survey Point. This process will be repeated until surveys have been conducted at all suitable Survey Points within the Harvest Unit Boundary. All fields on the data collection forms should be filled out as follows:

Survey Point: Record the survey point number associated with the tally

Suitability Code: Indicate suitability code from

Offset Location: Record the coordinates of the offset survey point (Lat/ Lon)

Suitability Notes: Record any notes relevant to the suitability of the survey point

Tree Tally: Tally of the free to grow trees in each size category

5.3 Data Products

The surveyor must provide the following deliverables to ODF, according to the schedule listed in the Statement of Work. The surveyor may collect data either in electronic or hardcopy format. When possible, data will be backed up prior to the next field day. Hardcopy field data will be converted to electronic spreadsheets in the office. Data to be collected, with suggested formats, include the following:

- Documentation of surveyor efforts to contact landowners.

- Tabular data corresponding to the survey form. These data must include fields listing Site ID and plot number, so that the tabular data may be joined to the GIS data. Provide these in MS Access or ESRI-compatible format.
- Harvest Unit Boundaries prepared by the surveyor, where they are different from boundaries provided prior to field survey. Provide these in ESRI geodatabase or shapefile format.
- General notes, including directions for getting to unit, access considerations, and landowner requests.
- Field notes that provide information that assists with the understanding of surveyor procedures or site-specific conditions. Index these by site number and plot number. Provide these in tabular format (e.g., MS Access, csv).
- At least one photograph per unit displaying site conditions. If there are complications that limit the ability of the surveyor to perform the survey, or that add to understanding of the unit's reforestation, these should also be included. These photographs must be accompanied by a description of the condition that the photograph is supposed to display. GPS location information must accompany the pictures. Provide a table indexed to Site, Plot # (if applicable), and photograph number describing the purpose of each photograph.
- For simplified planting surveys: a harvest unit map that clearly marks that the entire unit was visually inspected.

5.4 Quality Control

Replicate planting and FTG stocking surveys will be conducted to ensure data accuracy. A random subset equal to 10% of sampled harvest units will be surveyed a second time by ODF personnel. Replicate surveys will follow the same field methods appropriate for the survey type and be completed for the entire harvest unit. Data collected during initial and quality control surveys will be analyzed and compared to confirm concordant compliance determinations. If compliance determinations are not consistent, then an additional quality control survey will be conducted at a different harvest unit surveyed by the initial survey party. If this subsequent quality control survey reveals continued inconsistency in compliance, then ODF will conduct remediation actions to mitigate the potential for systematic error, such as additional training or a supervised survey at a model site. Additionally, when

compliance determinations between initial and quality control surveys are not consistent, results from quality control surveys will be used for analysis and reporting.

6 Analysis

6.1 Planting Timeliness

Data collected during planting timeliness surveys will be analyzed and summarized based on the conducted survey protocol.

6.1.1 Systematic Planting Surveys

If systematic planting surveys were applied for the entire sample of harvest units, compliance with planting per OAR 629-610-0040 (3) will be estimated for clearcut harvest units that meet all population criteria. Harvest unit compliance will be determined based on data collected at Survey Points. If evidence of planting was observable near all survey points suitable for planting with acceptable species, the unit will be considered in compliance with OAR 629-610-0040 (3). Tree species data recorded during surveys will be designated as acceptable or unacceptable based on a region-specific species list developed by ODF based on OAR 629-610-0050 guidance (Appendix 2 – Acceptable Plant Species List).

Compliance by landowner type will be estimated by dividing the number of units in compliance by the sample size within the stratum. Percentage compliance will also be calculated across landowner type strata. Compliance across strata will be calculated by weighting compliance by the estimated population size within each stratum. The number of harvest units within strata will be estimated using the total number of FERNS notifications identified during the sample draw process multiplied by the likelihood that FERNS notifications met population criteria, based on results from the additional suitability screening after sample overdraw. Uncertainty surrounding compliance estimates will be quantified using one-sided tolerance intervals for binomial proportions (e.g., ‘tolerance’ package for program R) to estimate the expected percent compliance for at least 80% or 90% of the population with 90% certainty, depending on the sample size of harvest units.

6.1.2 Simplified Planting Surveys

For simplified planting surveys, units will be considered in compliance if planting with acceptable species was observed throughout the entire harvested area that is suitable for planting. Tree species data recorded during surveys will be designated as acceptable or unacceptable based on a region-specific species list developed by ODF based on OAR 629-610-0050 guidance (Appendix 2 – Acceptable Plant Species List).

Compliance by landowner type will be estimated by dividing the number of units in compliance by the sample size within the stratum. Percentage compliance will also be calculated across landowner type strata. Compliance across strata will be calculated by weighting compliance by the estimated population size within each stratum. The number of harvest units within strata will be estimated using the total number of FERNS notifications identified during the sample draw process multiplied by the likelihood that FERNS notifications met population criteria, based on results from the additional suitability

screening after sample overdraw. Uncertainty surrounding compliance estimates will be quantified using one-sided tolerance intervals for binomial proportions (e.g., 'tolerance' package for program R) to estimate the expected percent compliance for at least 80% or 90% of the population with 90% certainty, depending on the sample size of harvest units.

6.2 Free To Grow Stocking

Data collected during FTG stocking surveys will be analyzed to estimate compliance with minimum stocking (OAR 629-610-0040 (4)) for clearcut harvest units that meet all population criteria. FTG tree count data from Survey Plots will be used to estimate FTG stocking in trees per acre (TPA) for each harvest unit. TPA will be calculated by multiplying counts in each size class to a one-acre area and converting to seedling equivalent using methods described in OAR 629-610-0020(7).

The minimum required TPA will be determined for each harvest unit using the CFSC that applies to the unit that corresponds to values in OAR 629-610-0020. Maps from the Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) will be used to determine CFSC, where available. SSURGO provides CFSC data at 1:24,000 resolution. If SSURGO data is not available for the harvest unit, then the NRCS State Soil Geographic Database with 1:250,000 resolution will be used. If neither NRCS sources are available for a harvest unit, then Department of Revenue site capability information with 40-acre resolution will be used to determine CFSC. If multiple CFSC values are present within a harvest unit, then the CFSC value that applies for a majority of the unit will be applied.

Harvest unit compliance will be determined by comparing the lower bound of a one-sided tolerance interval to minimum stocking requirements. When the lower bound of the tolerance interval is equal to or greater than the minimum required TPA, the unit will be considered in compliance. The tolerance interval will be calculated using 90% confidence ($\alpha = 0.1$) and 80% population coverage. This is intended to be consistent with FPA Guidance that minimum stocking levels must be met for at least 80% of the harvest unit (OAR 629-610-0000 Guidance). Data from the Reforestation Pilot Study indicated that tree count and associated TPA data are not normally distributed and often heavily skewed to the right. Therefore, TPA data will be examined post-data collection to ensure that the proposed analytical method to estimate compliance is appropriate, and to obtain a suitable distribution for the tolerance interval calculation. The 'tolerance' package for the statistical program R has numerous options for parametric and nonparametric tolerance interval calculation.

The percent of harvest units in compliance will be estimated within and across landowner type. The number of harvest units within strata will be estimated using the total number of FERNs notifications identified during the sample draw process multiplied by the likelihood that FERNs notifications met population criteria, based on results from the additional suitability screening after sample overdraw. Values reported across strata will be calculated by weighting statistics based on estimated population size within each stratum. Uncertainty surrounding compliance estimates will be quantified using one-sided tolerance intervals for binomial proportions (e.g., 'tolerance' package for program R) to estimate the expected percent compliance for at least 80% or 90% of the population with 90% certainty, depending on the sample size of harvest units.

7 Reporting

ODF will document the findings of the Reforestation Study in a report. The report will address each study question, describe methods, and will discuss overall observations from the annual process as well as presenting the summary data and estimated percent compliance. Compliance will also be reported annually to the Oregon legislature.

8 References

NIST. 2023. NIST/SEMATECH e-Handbook of Statistical Methods.
<https://www.itl.nist.gov/div898/handbook/index.htm>.

9 Appendix 1 – Sample Data Sheets

PLANTING TIMELINESS, SIMPLIFIED SURVEY DATA FORM

Harvest Unit # _____

Harvest Unit Name _____

Date _____

Surveyor Name _____

Visual Evaluation

Does digital map Harvest Unit Boundary match the actual Harvest Unit Boundary? Y / N
(circle)

Stocking reduced? Y / N (circle)

Reforestation needed? Y / N (circle)

Acres of stocking reduction _____

SURVEY DATA

Was planting attempted throughout the harvested area that is suitable for planting?

Y / N (circle)

Tree Species	Percent of total planting (1-10%; 11-25%; 26-50%; 51-75%; 76-100%)	Notes

(Sample table and data. Format is negotiable but must be capable of collecting this information)

FREE TO GROW DATA FORM

Harvest Unit # _____

Harvest Unit Name _____

Date _____

Surveyor Name _____

Visual Evaluation

Does digital map Harvest Unit Boundary match the actual Harvest Unit Boundary? **Y / N** (circle)

Stocking reduced? **Y / N** (circle)

Reforestation needed? **Y / N** (circle)

Acres of stocking reduction _____

Planting Attempted? **Y / N** (circle)

Notable Observations

Appendices

Survey Plot Data

Plot Num.	Suitability Code	Tape/Range-finder (T/RF)	Tree Tally								Notes
			Seedling <1" DBH	Sap/Pole 1-10" DBH	11-15" DBH	16-20" DBH	21-25" DBH	26-30" DBH	31-35" DBH	36-40" DBH	
1	S	RF	3	1							
2	XS	RF									>50% stone

(Sample table and data. Format is negotiable but must be capable of collecting this information)

Appendices

10 Appendix 2 – Acceptable Plant Species List

Common Name	Scientific Name	NWOA	SOA	EOA
Alaska yellow-cedar	<i>Chamaecyparis nookatensis</i>	X	X	
bigleaf maple	<i>Acer macrophyllum</i>	X	X	
black cottonwood	<i>Populus trichocarpa</i>	X	X	X
California laurel (myrtle)	<i>Umbellularia californica</i>		X	
California red fir	<i>Abies magnifica</i>		X	
California redwood	<i>Sequoia sempervirens</i>		X	
Douglas-fir	<i>Pseudotsuga menziesii</i>	X	X	X
Engelmann spruce	<i>Picea engelmannii</i>			X
giant chinquapin	<i>Chrysolepis chrysophylla</i>	X	X	
grand fir	<i>Abies grandis</i>	X	X	X
incense-cedar	<i>Calocedrus decurrens</i>		X	X
Jeffrey pine	<i>Pinus jeffreyi</i>		X	X
lodgepole pine	<i>Pinus contorta</i>	X	X	X
mountain hemlock	<i>Tsuga mertensiana</i>			X
noble fir	<i>Abies procera</i>	X	X	
Oregon ash	<i>Fraxinus latifolia</i>	X	X	
Oregon white oak	<i>Quercus garryana</i>	X	X	X
Pacific madrone	<i>Arbutus menziesii</i>	X	X	
ponderosa pine	<i>Pinus ponderosa</i>	X	X	X
Port-Orford-cedar	<i>Chamaecyparis lawsoniana</i>		X	
red alder	<i>Alnus rubra</i>	X	X	
Sitka spruce	<i>Picea sitchensis</i>	X	X	
subalpine fir	<i>Abies lasiocarpa</i>			X
sugar pine	<i>Pinus lambertiana</i>	X	X	X
tanoak	<i>Notholithocarpus densiflorus</i>		X	
western hemlock	<i>Tsuga heterophylla</i>	X	X	
western larch	<i>Larix occidentalis</i>			X
western redcedar	<i>Thuja plicata</i>	X		
western white pine	<i>Pinus monticola</i>	X	X	X
white fir	<i>Abies concolor</i>		X	X

Sources:

Rose and Haase 2006. Guide to Reforestation in Oregon.
 ODF 2009. Forest Practices Rule Guidance, OAR 629-610-0030.
 Larry Swan, USFS, 2019. Personal Communication.
 PlantMaps.com, 2019. Plant Distribution Maps.