

## SETTLEMENT AGREEMENT

This SETTLEMENT AGREEMENT is entered into between Concrete School District, Quillayute Valley School District No. 402, Naselle-Grays River School District, Clallam County Fire District Number 4, Wahkiakum County, Pacific County, Skamania County, Mason County, City of Forks, American Forest Resource Council (“AFRC”), Port of Port Angeles, Clallam County Fire District Number 5, Lewis County, and Darrington School District (collectively “Plaintiff Coalition”) and the State of Washington, the Washington Department of Natural Resources, and the Washington Board of Natural Resources (collectively “DNR”). Plaintiff Coalition and DNR are collectively “the Parties.”

### I. RECITALS

A. Plaintiff Coalition challenged the Sustainable Harvest Calculation (“2015 SHC”) for the 2015-2024 planning decade, and the adoption of Resolution 1560 by the Board of Natural Resources on December 3, 2019, and the amendment to the 1997 Habitat Conservation Plan and the adoption of Resolution 1559. That challenge is pending in *Concrete School District, et al. v. State of Washington, et al.*, Skagit County Superior Court Case No. 20-2-00010-29, consolidated with *Skagit County, et al v. State of Washington, et al.*, Case No. 19-2-01469-29, and in *Concrete School District, et al. v. State of Washington, et al.*, Thurston County Superior Court Case No. 20-2-01653-34.

B. The Parties, through their authorized representatives, and without any admission or final adjudication of the issues of fact or law with respect to Plaintiff Coalition’s claims, have reached a settlement that they consider to be a just, fair, adequate, and equitable resolution of the disputes set forth in Plaintiff Coalition’s Complaints. The Parties have agreed to settle the claims, and Plaintiff Coalition agrees to voluntarily dismiss their litigation.

C. This Settlement Agreement is intended to 1) improve the forest inventory data used by DNR for the development of the 2025-2034 Sustainable Harvest Calculation (“2025 SHC”); 2) transition DNR to a plot-based, stand-level inventory program covering all operable acres of forest trust land in Western Washington; 3) prescribe a process to improve the accuracy and precision for identifying the operable land base used in the development of the 2025 SHC; 4) facilitate DNR’s development of the 2025 SHC and a Tactical Plan that will implement the 2025 SHC using modeling that produces spatially explicit harvest schedules (see Paragraph 16); and 5) commit to annual reporting to provide accountability for the 2025 SHC.

D. Nothing in this Settlement Agreement changes or modifies any procedural or substantive obligations DNR has to consult with the Technical Advisory Committee (“TAC”) under 2SHB 1168 related to issues of forestland inventory or the 2025 SHC.

## II. AGREEMENT

### A. Development, Maintenance, and Use of Stand-Based Forest Inventory

1. DNR shall transition to a plot-based, stand-level inventory program on all operable DNR-managed forest lands over 20-years of age in Western Washington. DNR will call this program the Stand-based Forest Inventory System (“SFIS”). Details of that program, including but not limited to what data will be collected from individual plots, is provided in Exhibit A, which is incorporated into and made a part of this Settlement Agreement.

2. DNR shall begin its implementation of the SFIS program immediately upon the signing of this Settlement Agreement, and DNR will maintain this plot-based, stand-level inventory moving forward, subject to available funding as identified in paragraph 7, below.

3. Initial SFIS Data: DNR will obtain SFIS data for approximately 500,000 acres, through the solicitation and use of contractors by December 31, 2024. Of these data, 200,000 acres will be sampled by June 30, 2023. An additional 300,000 acres will be sampled by December 31, 2024. The Parties recognize that DNR may face limitations in obtaining this SFIS data, including DNR’s contracting requirements and contractor limitations. As such, the Parties agree that contingencies clause (paragraph 8) applies to this requirement. In any event, DNR shall endeavor in good faith to collect the SFIS data on the above timeline, and shall report its progress to the Plaintiff Coalition’s Designated Representatives (see paragraph 36) upon request.

4. DNR will periodically re-inventory stands so that the inventory data of operable stands over age 20 years are inventoried on a 10-year cycle. DNR will inventory stands age 0 to 19 in post-planting surveys at ages 2 to 5 and in preparation for and following precommercial thinning operations as needed.

5. DNR and Plaintiff Coalition’s Designated Representatives will meet and strategize how to increase funding for the inventory identified in paragraph 4 if DNR is unable to maintain the inventory within its existing budget.

6. DNR will routinely and regularly update its SFIS data by editing the data to reflect changes in the land base, including but not limited to harvests; land sales, acquisitions, and/or exchanges; boundary changes; and habitat changes for marbled murrelet, northern spotted owl or other listed species.

7. Funding: DNR will submit a request to the Legislature for sufficient funding to implement the terms of this Settlement Agreement each biennium. The Parties commit to working together to secure funding to complete and maintain the SFIS of operable trust lands. In the event Legislative appropriations are insufficient, these funding options include, but are not limited to, increasing the management rate withheld from trust gross revenue, requesting additional funding from the Legislature from alternative sources to supplement the Resource Management Cost Account and the Forest Development Account, soliciting federal funds, or pursuing mechanisms to diversify sources of revenue from the trust lands.

8. Contingencies: If it becomes impossible or impractical for DNR to collect the Initial SFIS Data on the schedule identified in paragraph 3, DNR shall meet with Plaintiff Coalition's Designated Representatives to discuss how to implement the plot-based, stand-level inventory committed to in this Settlement Agreement. If limitations are identified, the Parties shall work together to overcome those limitations so as to achieve the objectives of this Settlement Agreement. If necessary to achieve the objectives of the Settlement Agreement, one potential course of action is to request that the Board of Natural Resources adjust the schedule for approval of the 2025 SHC so that more Initial SFIS Data can be used in the calculation. The potential to adjust the schedule does not displace the Parties' ability to implement other actions that may become necessary to achieve the objectives of the Settlement Agreement. Similarly, if it becomes impossible or impractical for DNR to comply with paragraph 4, DNR shall meet with Plaintiff Coalition's Designated Representatives to discuss how to best maintain the SFIS inventory.

**B. Process to Improve the Accuracy and Precision of the Land Base Included in the 2025 SHC**

9. The Parties' objective is to accurately represent the area of forested trust lands that can be sustainably managed in DNR's forest estate model, consistent with the Policy for Sustainable Forests, State Trust Lands Habitat Conservation Plan, federal and state laws, and its fiduciary obligations to generate perpetual revenue for current and future generations of trust beneficiaries.

10. Within 6 months of signing this Settlement Agreement, DNR shall delineate Planning Analysis Units ("PAUs") within its GIS database. (See Exhibit A). The Parties agree that the contingencies clause (paragraph 8) applies to this requirement. In any event, DNR shall endeavor in good faith to collect the PAU data on the above timeline, and shall report its progress to the Plaintiff Coalition's Designated Representatives upon request.

11. DNR and Plaintiff Coalition's Designated Representatives will meet as needed to discuss the delineation of areas that restrict DNR forest operations.

12. DNR will routinely and regularly update its PAU GIS to ensure that the quality of the data stays consistent with that sought by Exhibit A.

13. Upon request, DNR will make the PAU GIS database available to Plaintiff Coalition, and will assist in helping Plaintiff Coalition understand the GIS database.

14. For the 2025 SHC, DNR shall use its RS-Hydro model, as that model may be modified over time based on receipt of additional data or improvements in modeling. Where DNR does not have field verification for the break point between stream types, stream buffers will be based on the stream type as determined by the RS-Hydro model. When DNR changes its RS-Hydro model, it will provide the data and assumptions that support the modification to Plaintiff Coalition's Designated Representatives.

15. For the 2025 SHC, forest roads will only be excluded from the forested land base if they are excluded from the PAU GIS database. (See Exhibit A).

### **C. 2025 SHC Development and Implementation**

16. DNR's objective is to produce a final sustainable harvest level for the Board of Natural Resources' consideration by July 2024. The final product of the 2025 SHC will be a decadal sustainable harvest level for each of the 20 Western Washington Sustainable Harvest Units ("SHU") identified in the Policy for Sustainable Forests, accompanied by a Tactical Plan that implements the 2025 SHC. The Tactical Plan will use modeling to produce harvest schedules to guide identification of timber harvest units and development of 2-year Timber Sale Plans. The Tactical Plan will be updated every 2 years, taking into account forest inventory changes, such as new forest inventory data, sold timber harvests, significant natural disturbances and land transactions in formulating the map.

17. The SFIS data collected by January 31, 2023, will be used in preparing the 2025 SHC.

18. For purposes of the 2025 SHC, DNR will work with a third-party consultant to develop its growth-and-yield methodology as required by 2SHB 1168, Section 3(4). DNR will use the SFIS data and other inventory data sources to project the growth-and-yield of PAUs. For PAUs where SFIS data is not available, DNR will seek review and recommendations from the TAC and the Plaintiff Coalition's Designated Representatives for its growth-and-yield projections.

19. Stratification: The PAU stratification effort will rely on existing datasets including RS-FRIS data. Where doing so will result in a stratum of at least 1,000 acres, PAU strata will be limited to the unit administrative level, and will be further stratified by available data sets, including but not limited to site index class, primary species, age and/or density. Other strata will be as localized as possible, generally grouping PAUs by, among others, forest type, site productivity, timber volume. Where necessary because of lack of adequate data within a stratum, data from other nearby or comparable strata may be used for modeling until adequate data within the stratum is available.

20. Comparative Analysis: Once DNR has sampled 200,000 acres of SFIS data, DNR will conduct an analysis of at least two different approaches to representing the forest inventory and its growth-and-yield in the strategic and tactical models used to calculate the sustainable harvest level. The two approaches that DNR will compare are:

a. DNR's Approach:

Using all the available forest inventory data, all PAUs, including those under 20 years of age, will be assigned a strata with their corresponding yields. The yields and other relevant data associated with each PAU will be used in both the strategic and tactical models, plus additional data will be included in the tactical model. The Tactical Plan will

be provided to the Plaintiff Coalition's Designated Representatives and will inform development of 2- and 5-year Timber Sales plan during the first decade. DNR will periodically re-run the tactical model during the planning decade to reflect changes and provide the basis for updated 2 and 5-year Timber Sales plan during the first decade.

b. Plaintiff Coalition's Approach:

Within each strata, PAUs for which data is collected in the first 200,000 acres of SFIS field inventory work will be modeled using the data specific to each PAU. All other PAUs over 20 years of age that were not sampled will have their tree lists and yields, assigned through imputation based on inventory data from sampled PAUs with similar forest metrics (these metrics will include the datasets used in the stratification process). It is recognized that this will create temporary datasets for the strategic modeling aspects of the Sustainable Harvest Calculation, which will be replaced over time as additional stand level inventory work allows replacement of the imputed values. For PAUs less than 20 years old their tree lists, and yields will reflect their forest metrics based on planting and silviculture records for those PAUs. The yields and other relevant data associated with each PAU will be used in both the strategic and tactical models. A spatially explicit schedule file (including all current and in-progress sales) for the tactical model outputs will be provided to the Plaintiff Coalition's Designated Representatives and will guide development of 2- and 5-year harvest plans for the first decade. DNR will periodically re-run the tactical model during the planning decade to reflect changes and provide the basis for updated 2 and 5-year harvest plans as the decade progresses.

c. Evaluation:

When the modeling is complete, the parties will meet to evaluate which approach results in the most robust management tool. The parties may agree on modifications of either approach in order to enhance the utility as a management tool or statistical validity. If the Parties cannot agree, they will consult with the TAC, and if needed present their competing views to the Board of Natural Resources for resolution.

21. Between execution of the Settlement Agreement and June 30, 2024, DNR's biometrics experts and consultants will meet with Plaintiff Coalition's Designated Representatives' biometrics experts on at least three occasions (remotely as needed) to discuss the assumptions, modeling approach, and programming of Forest Vegetation Simulator ("FVS") and Woodstock for purposes of the 2025 SHC and the Tactical Plan. DNR will promptly provide Plaintiff Coalition's Designated Representatives with the data and programming on request for them to fully understand DNR's proposed approach and to allow them to make meaningful suggestions for improvement.

22. If at the conclusion of the meetings in paragraph 21, the Parties are not in agreement on the preferred approach, Plaintiff Coalition's Designated Representatives' experts will be given an opportunity to present their conclusions in a written report and a presentation to the TAC. DNR will also present its opinions to the TAC. After the presentation to the TAC,

Plaintiff Coalition’s Designated Representatives’ experts can request to present their report and recommendations to the Board of Natural Resources as part of the Chair Report. DNR and members of the TAC will also present their recommendations to the Board of Natural Resources. DNR, TAC, and Plaintiff Coalition’s Designated Representatives’ experts will be given an opportunity to respond to questions from the Board of Natural Resources.

23. DNR’s objective is to produce a draft sustainable harvest calculation based on current policies, and solicit review by DNR field staff prior to publishing a Draft Environmental Impact Statement (“DEIS”) in 2023. After DNR field staff have reviewed and provided input, and any changes to reflect that input have been incorporated into the model, DNR will publish the DEIS.

24. This paragraph describes the process that DNR will take to evaluate the SFIS data that was not available in time to incorporate it into the Final 2025 SHC. When the first 200,000 acres of SFIS data collection is complete, and again when the Initial SFIS data collection is complete (see paragraph 3), DNR will recalculate the 2025 SHC as adopted by the Board of Natural Resources and re-run the Tactical Plan using the Initial SFIS data. For any sustainable harvest units where the recalculation results in a 10% change in the 2025 SHC volume, DNR shall submit to the Board of Natural Resources a recommendation that the 2025 SHC be amended. Regardless of Board of Natural Resources’ action, DNR will update the Tactical Plan with new inventory data (see paragraph 16).

25. The discount rate used for the 2025 SHC will be consistent with existing Board of Natural Resources’ policy, which states, “The department will utilize a comprehensive approach to review and update the financial assumptions used in forest management decisions.” This comprehensive approach to determining the discount rate for the 2025 SHC will at a minimum include a review of the rate for Washington Municipal Bonds and a review of discount rates used by timberland investors of a similar scale as DNR.

#### **D. Reporting**

26. Upon the Board of Natural Resources’ adoption of the 2025 SHC, DNR will prepare the following reports for each of the SHUs, and provide them to trust beneficiaries, the Plaintiff Coalition’s Designated Representatives, the Board of Natural Resources, and the public. The reports will be published on the timetables indicated below. The reports will not replace the existing quarterly meetings DNR holds with county beneficiaries. Either party may propose modifications to the report format to make it more useful by written notification to the other party’s representative(s) at least six months prior to report due date. The reports will contain the following information at a minimum:

By the July Board of Natural Resources meeting of each year:

1. A 2-year Timber Sale Plan by SHU and Region, listing the potential timber sales, their available draft unit maps, estimated or cruised timber volume (MMBF), and estimated sale revenue by SHU and region.

Within six months after the close of each fiscal year:

2. Sold Timber Sales, including the sale volume (MMBF), timber sale area (acres), timber sale maps, advertised minimum bid value, (sale price as advertised), and sold value for the previous fiscal year's timber sales summarized by SHU and Region.
3. Comparison of Sold Timber Sales<sup>1</sup> (report 2, ¶ D.26.(2)) versus the 2-Year Timber Sale Plan (report 1, ¶ D.26.(1)) for the reporting fiscal year: the comparison will include advertised volume (MMBF), sale area, and sold vs estimated planned sale value by SHU and Region.
4. A map<sup>2</sup> that shows, at a minimum, the following GIS data:
  - a. The forest strata
  - b. The PAUs that were selected for harvest from the Tactical Plan<sup>3</sup> (see report 6, ¶ D.26.(6)).
  - c. The 2-year Timber Sale Plan (report 1, ¶ D.26.(1)) for that fiscal year.
  - d. The Sold Timber Sales (report 2, ¶ D. 26(2)) from the inception of the 2025 to 2034 Planning Decade to the reporting fiscal year.
5. A table that provides a Cumulative Report comparing Sold Timber Sale total volume (MMBF), total area and sale price for the 2025-34 decade to the Sustainable Harvest Level by SHU and Region

Upon adoption of the SHC and again within six months after the close of each fiscal biennium:

6. A map will be generated that shows the PAUs identified for harvest during the entire Planning Decade in the SHC, as updated by changes that have occurred during the decade to date. This is the Tactical Plan that shall be updated every two years (see paragraph 16).

**E. Judicial Dismissal of Claims, and Enforcement of the Settlement Agreement**

27. This Settlement Agreement must be approved by each member of the Plaintiff Coalition and DNR. The Settlement Agreement will not be submitted to the Board of Natural Resources until it has been signed by all Plaintiff Coalition members. Prior to Board of Natural Resources' approval, it should be referred to publicly as the Proposed Settlement Agreement.

28. Within ten days of approval of the Settlement Agreement by the Board of Natural Resources, the Plaintiff Coalition will submit a notice of voluntary dismissal with prejudice of all claims in both Skagit County and Thurston County Superior Courts.

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<sup>1</sup> "Sold Timber Sales" are actual transactions.

<sup>2</sup> Map refers to an online viewer of GIS products.

<sup>3</sup> "Tactical Plan" is described in paragraph 16.

29. Any claim for breach of this Settlement Agreement may be brought in the Skagit County Superior Court.

**F. Miscellany**

30. This Settlement Agreement may be electronically signed, or signed in counterparts, with copies to be sent to counsel for the Parties.

31. This is a negotiated Settlement Agreement, with both Parties being represented by counsel. In case of ambiguity, no party will be treated as the “drafter” of the Settlement Agreement. It shall be construed to effectuate the purpose described in Recital C above.

32. The effective date will be the date that the Settlement Agreement is approved by the Board of Natural Resources.

33. This Settlement Agreement may be amended only with the written agreement of all Parties.

34. This Settlement Agreement may be amended to add Skagit County Plaintiffs as a third party prior to Board of Natural Resources’ approval.

35. Except for the obligations of paragraph 26 above, this Settlement Agreement will terminate (a) upon DNR’s completion of its inventory of all operable lands over 20-years of age in Western Washington, (b) on June 30, 2030, if at least eighty percent (80%) of DNR’s inventory of all operable lands over 20-years of age in Western Washington is complete, or (c) on June 30, 2035; whichever occurs first.

The obligations of paragraph 26 will terminate upon the adoption of a sustainable harvest calculation for the 2035-2044 planning decade.

36. During the term of this Settlement Agreement, Plaintiff Coalition will be represented by one or more Designated Representatives that will be periodically identified by the Plaintiffs Coalition. These representatives will have the ability to rely on various technical experts, when applicable, in discussions with DNR. DNR will be represented by Commissioner of Public Lands or the Commissioner’s delegate. Either party may modify its representative(s) by written notification to the other party’s representative(s).

37. By signing this Settlement Agreement, the Parties acknowledge that the terms of this Agreement were reached through dispute resolution negotiations and have been reviewed with and discussed with respective counsel for each of the Parties. The Parties warrant and represent that the signatory is fully authorized to enter into and legally bind their party to the terms and conditions of this Agreement.

[Remainder of page intentionally left blank; signature pages to follow]



Agreed:

Concrete School District



by Wayne Barrett

Its Superintendent

Date 6-29-22

Quillayute Valley School District No. 402

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by \_\_\_\_\_

Its \_\_\_\_\_

Date \_\_\_\_\_

Naselle-Grays River School District

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by \_\_\_\_\_

Its \_\_\_\_\_

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Clallam County Fire District No. 4

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by \_\_\_\_\_

Its \_\_\_\_\_

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Wahkiakum County

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Pacific County

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Concrete School District

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by \_\_\_\_\_

Its \_\_\_\_\_

Date \_\_\_\_\_

Quillayute Valley School District No. 402

Diana Reaume

by Diana Reaume

Its Superintendent

Date 6/28/2022

Naselle-Grays River School District

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by \_\_\_\_\_

Its \_\_\_\_\_

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Clallam County Fire District No. 4

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Quillayute Valley School District No. 402

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Its \_\_\_\_\_

Date \_\_\_\_\_

Naselle-Grays River School District

*Lisa Nelson*  
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by LISA NELSON

Its Superintendent

Date 6.22.22

Clallam County Fire District No. 4

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Its \_\_\_\_\_

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Naselle-Grays River School District

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Clallam County Fire District No. 4

Marcus B Pacheco

by Marcus B Pacheco

Its Commissioner/Chair

Date 20 June 2022

Wahkiakum County

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Its \_\_\_\_\_

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Wahkiakum County

Pacific County

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by Lee Tischer

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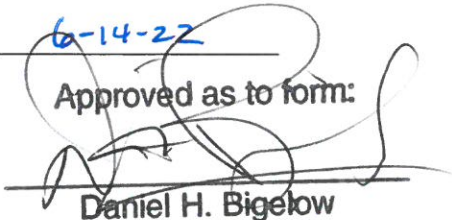
Its Vice Chair

Its \_\_\_\_\_

Date 6-14-22

Date \_\_\_\_\_

Approved as to form:



Daniel H. Bigelow  
Prosecuting Attorney

6/13/22

Settlement Agreement

Skagit County Superior Court Cause No. 19-2-01469-29

Thurston County Superior Court Cause No. 20-2-01653-34

Agreed:

Concrete School District

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Quillayute Valley School District No. 402

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Clallam County Fire District No. 4

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Wahkiakum County

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Its \_\_\_\_\_

Date \_\_\_\_\_

Pacific County



by Lisa R. Olsen

Its Chair

Date 6/14/2022

Skamania County



by Richard Mahas

Its Chair

Date 6/15/22

Mason County

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by \_\_\_\_\_

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City of Forks

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American Forest Resource Council

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Port of Port Angeles

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Clallam County Fire District Number 5

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Skamania County

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Its \_\_\_\_\_

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Mason County

Sharon Trask

by Sharon Trask

Its Vice-Chair

Date June 21, 2022

City of Forks

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by \_\_\_\_\_

Its \_\_\_\_\_

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American Forest Resource Council

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Mason County

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City of Forks



by Tim FLETCHER

Its Mayor

Date 13 JUNE 2022

American Forest Resource Council

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by \_\_\_\_\_

Its \_\_\_\_\_

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Port of Port Angeles

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Clallam County Fire District Number 5

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Skamania County

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City of Forks

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Its \_\_\_\_\_

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American Forest Resource Council



by Travis Joseph

Its President

Date June 27, 2022

Port of Port Angeles

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by \_\_\_\_\_

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Clallam County Fire District Number 5

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American Forest Resource Council

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Its \_\_\_\_\_

Date \_\_\_\_\_

Port of Port Angeles



by GEOFFREY JAMES

Its EXECUTIVE DIRECTOR

Date JUNE 29, 2022

Clallam County Fire District Number 5

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by \_\_\_\_\_

Its \_\_\_\_\_

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Port of Port Angeles

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Its \_\_\_\_\_

Date \_\_\_\_\_

Clallam County Fire District Number 5

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by *[Signature]*

Its *Fire Commissioner*

Date *6/22/2022*

Lewis County

Darrington School District

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by Lindsay R. Millard, ovm

by \_\_\_\_\_

Its Chair, Board of County Commissioners

Its \_\_\_\_\_

Date 6/29/2022

Date \_\_\_\_\_

State of Washington

Department of Natural Resources

Board of Natural Resources

\_\_\_\_\_

by Hilary Franz

Commissioner of Public Lands

Date \_\_\_\_\_

Lewis County

\_\_\_\_\_

by \_\_\_\_\_

Its \_\_\_\_\_

Date \_\_\_\_\_

Darrington School District

*Tracy Franke*

by Tracy Franke

Its Superintendent

Date 6/29/2022

State of Washington

Department of Natural Resources

Board of Natural Resources

\_\_\_\_\_

by Hilary Franz

Commissioner of Public Lands

Date \_\_\_\_\_

**ADDENDUM**

Pursuant to paragraph 34 of the Settlement Agreement, Skagit County, on its own behalf and as assignee of the claims of Sedro-Woolley School District No. 101, Burlington-Edison School District No. 100, Skagit County Hospital District No. 304, and Central Skagit Partial County Library District (“Skagit County”) agrees to join the Settlement Agreement between the Concrete School District, et al. Plaintiff Coalition and DNR. By joining the Settlement Agreement, Skagit County agrees to comply with its terms.

Consistent with paragraph 28 of the Settlement Agreement, Skagit County will submit a notice of voluntary dismissal with prejudice of all claims in Skagit County Superior Court Cause No. 19-2-01469-29.

Agreed: *June 27, 2022*

**BOARD OF COUNTY COMMISSIONERS  
SKAGIT COUNTY, WASHINGTON**



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Peter Browning, Chair

**RECUSED**

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Lisa Janicki, Commissioner



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Ron Wesen, Commissioner

**ATTEST:**



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Linda Hammens, Clerk of the Board

**APPROVED AS TO FORM:**



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Will Honea, Deputy Prosecuting Attorney

## Exhibit A: Enhancing Forest Inventory Information for DNR-Managed Trust Lands

May 18, 2022

### Background

This document describes the Stand-based Forest Inventory System (SFIS) which will provide tree lists and forest metrics at the scale of Planning Analysis Units (PAU). Within DNR's western Washington operable forested trust lands, PAUs are intended to approximate harvest units – contiguous areas that can be efficiently harvested in a relatively short period of time and would be included in a timber sale. PAUs will be used to construct a spatially explicit forest estate model for western Washington DNR-managed trust lands.

The goals of SFIS are to provide 1) unbiased and sufficiently precise estimates of current forest metrics (e.g., board-foot volume) at the PAU level and 2) accurate PAU-level tree lists to project future forest conditions using a growth-and-yield model such as the Forest Vegetation Simulator (FVS).

Field procedures are included as Appendix A.

### Delineating Planning Analysis Units on DNR-Managed Trust Lands

PAUs will cover the entirety of operable DNR-managed trust lands in western Washington (Figure 1). PAUs are planning units that are intended to guide future harvest activities and will provide a potential harvest plan that implements the sustainable harvest calculation that can be used to aid and develop two and five-year timber sale schedules. PAUs will generally combine both upland<sup>1</sup> and adjacent riparian and wetland management zones (Riparian land class) as these units can be efficiently harvested together. PAUs may combine harvest methods of cable and ground harvest operations.

### Delineation Standards

The combined area of the PAUs will be exactly equal to the area of the operable<sup>2</sup> land base. There will not be any overlaps among PAUs, any slivers, or any gaps. PAUs will not contain any inoperable<sup>3</sup> area. All forest conditions within a PAU will be delineated as single-part polygons. Each PAU will have a unique identifier associated with the polygons within a PAU.

### PAUs

PAUs will meet the following criteria:

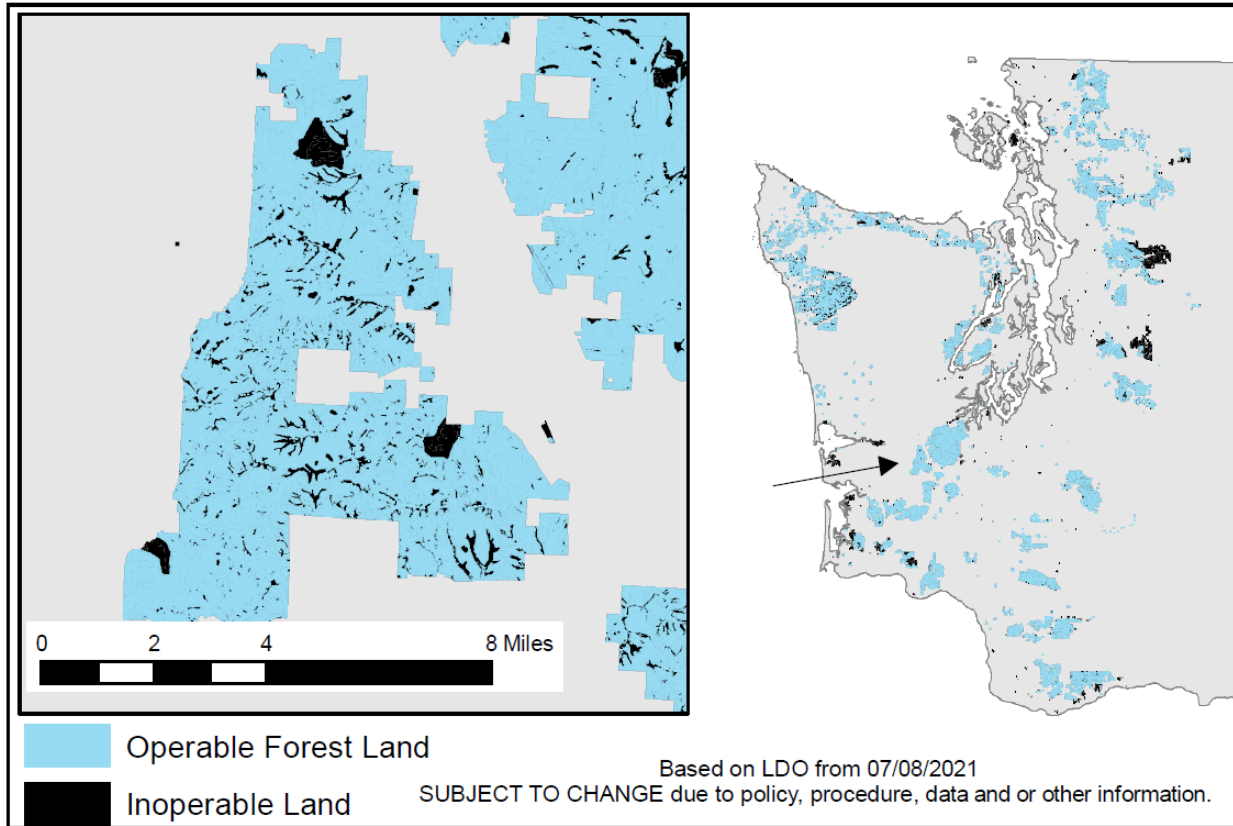
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<sup>1</sup> Uplands areas in this document references non-riparian and wetlands management zones. In DNR's land classification categories these uplands areas are defined as General Ecological Management (GEM) and uplands with specific management objectives (UPLANDS).

<sup>2</sup> Total operable land area in western Washington is approximately 1.2 million acres.

<sup>3</sup> The inoperable land base is defined as forest lands that are currently mapped as long-term deferrals from timber harvest due to ownership (e.g. Natural Areas), non-forested areas such as lakes and outcrops, Habitat Conservation Plan commitments (e.g. northern spotted owl patches; marbled murrelet occupied sites), Policy for Sustainable Forests (old growth, special ecological features), potential unstable slopes, desired forest conditions in riparian and DNR local staff knowledge (e.g. operational limits). This area is currently estimated at 340,000 acres.





**Figure 1. Operable land managed by DNR in western Washington. Operable land is forest land where even- and or uneven-aged timber harvest activity is permitted. No harvest activities are permitted on inoperable land.**

- Minimum area: 4 acres<sup>4</sup>
- Maximum area: 140 acres (inclusive of RMZ)
- Target area: 40 acres (inclusive of RMZ)

The target area is equal to the median area of recent (FY 2018 – 2022) overstory-removal forest management activities (FMA).

PAUs will not cross DNR administrative boundaries at the local level<sup>5</sup>. This follows the delineation standards in DNR’s Land and Resource Management (LRM) system.

PAUs will be delineated to approximate operational harvest units. Consideration will be given to harvest systems (e.g., the placement of towers, tail holds, and landings), stream crossing, haul routes, and other factors. Physical features, such as ridges, valleys, roads, and streams will often form PAU boundaries, but PAUs can contain these features. When these features are used to delineate PAUs, the boundary will follow the center of the stream or road as closely as possible.

<sup>4</sup> Where an operable PAU would be less than 4 acres in size, the PAU will be combined with the most appropriate adjacent operable PAU.

<sup>5</sup> DNR administrative levels from smallest to largest are Local or Unit, District, Region, Statewide.

The boundary between Uplands and Riparian Development Types will also be delineated within each PAU using RS-Hydro. See Figure 2.

PAUs will follow overstory-removal forest management activities (FMAs) to capture the imprint of previous management. Individual harvest FMAs will not be split into multiple PAUs as a general rule. PAUs will contain FMAs in their entirety but will also often contain areas outside of the harvest FMA such as adjacent riparian management zones or slivers. Figure 2 illustrates some of the guidelines for delineating PAUs.

The following GIS layers will be available for delineating PAUs. Other layers can be added if they are useful.

- **2019 Washington Orthophoto (1-ft Color)**
- **Aspect:** Lidar derived aspect
- **Bare Earth Elevation (Feet):** LiDAR derived
- **Bare Earth Hillshade:** LiDAR derived
- **Contour Lines:** LiDAR derived contour lines
- **Completed and Sold Harvests:** Harvest FMA polygons with harvest dates and other attributes. Pre-2018 polygons were delineated as forest management units (FMUs) and generally do not follow the management areas as closely as more recent FMAs
- **Planned Harvests:** Planned harvest FMAs
- **DNR Roads by Activity Status**
- **RS\_FRIS\_RASTERS:** A collection of 1/10<sup>th</sup> acre scale rasters of forest conditions (e.g., gross bf volume, canopy height, combined origin year) from the remote-sensing forest inventory
- **RS-Hydro Streams (Modeled State Lands Water Types):** linear stream features with water type predicted from LiDAR DEMs and statistical models
- **Slope Percent:** from LiDAR DEM

The following GIS layers will be used to separate inoperable areas from the land base. The process for combining these layers is built into the large data overlay process:

- **DNR-Managed Surface Trust Lands:** Community forests, NAP/NRCA are deferred
- **Local Knowledge:** compilation of non-harvestable polygons from State Lands Local Knowledge (LCL\_DF\_YR = 9999)
- **Mapped Old Growth:** all delineated old-growth areas are deferred
- **MM Analysis Area:** Only the intersection with NSO Habitat Types A and B is deferred
- **MM Occupied Sites:** All occupied site polygons & buffers
- **MM Special Habitat Areas:** all marbled murrelet habitat areas
- **NSO Habitat Types:** only Type A and B habitat intersected with MM Analysis Area is deferred
- **RS\_FRIS\_POLYS:** Non-forest inventory polygons, e.g., wetlands, developed sites (LAND\_COV\_CD not in (41,42,43,44))
- **State Lands – Northern Spotted Owl Nest Patches:** core areas + buffers

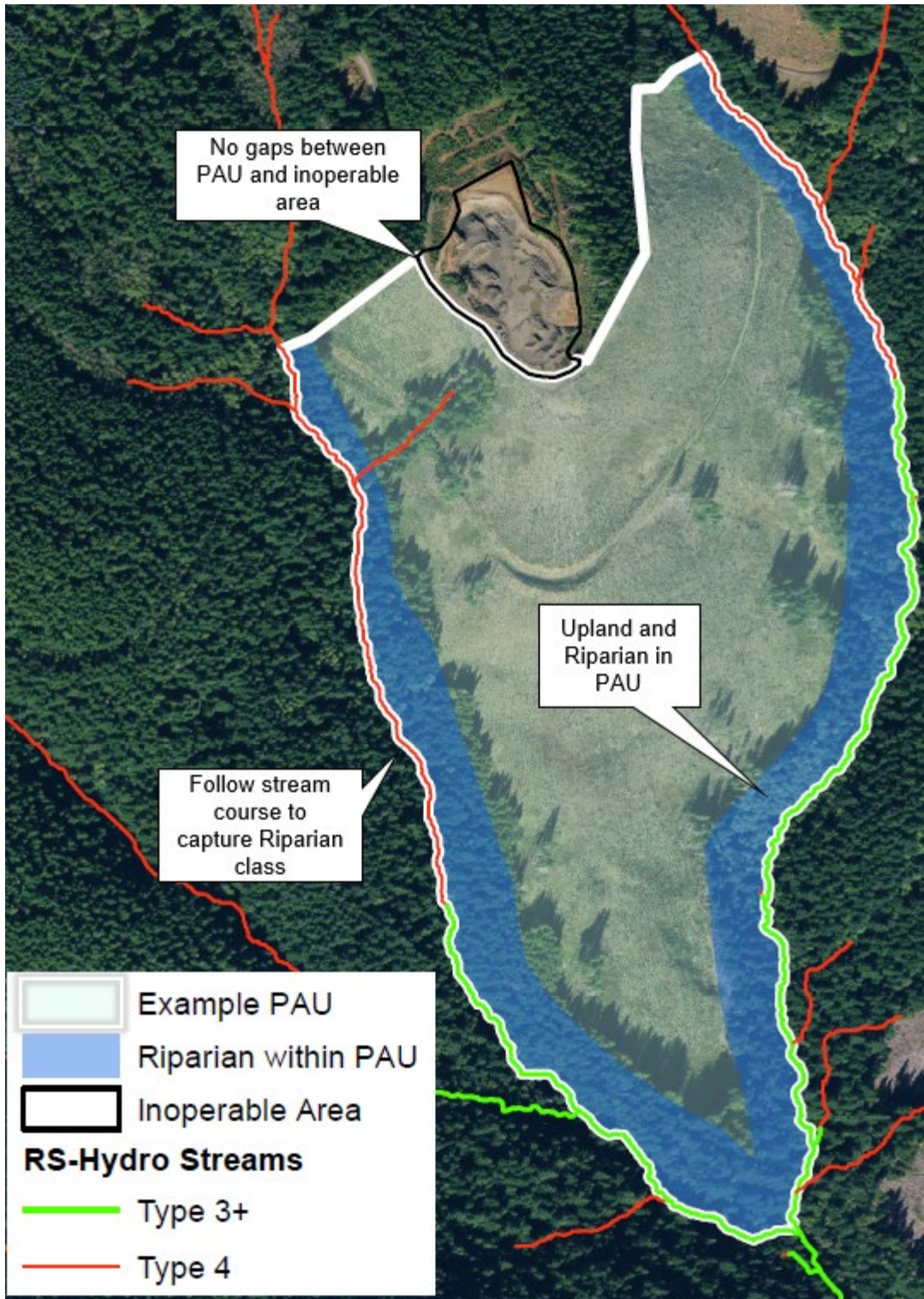


Figure 2. Example of PAU delineation. The PAU contains both the upland area (recently harvested in this case) and adjacent RMZ areas that would logically be harvested at the same time. An inoperable area (non-forest) to the north forms part of the PAU boundary.

## **Inventory Coverage**

The initial inventory sample will cover 500,000 operable acres of western Washington's DNR managed trust lands, of which up to 200,000 acres will be collected by June 30, 2023 and the remaining 300,000 acres by December 31 2024, subject to available budget. Operable lands are those where some type of harvest activity is permitted; inoperable lands are those lands where no harvest activities are permitted.

The SFIS will be a 'stand-based' or 'stand-level' inventory. This means that the population will be divided into smaller subpopulations and a statistical sample will be measured for each unit using a set of sample plots. The sample plots will also produce a tree list for each unit – a sample of trees with characteristics like species, diameters, heights, and crown ratios – that will be used to project future stand conditions.

The stands for the inventory will be planning analysis units (PAUs), areas of operable land that approximate harvest units.

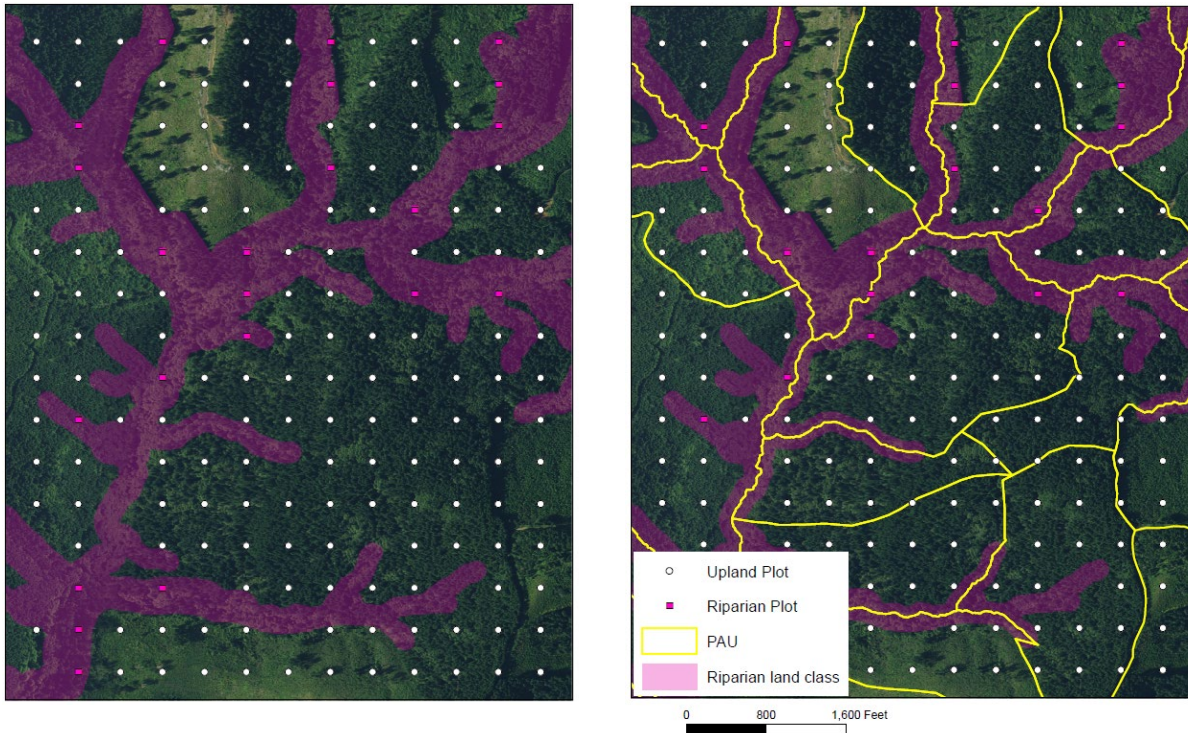
## **Sampling Strategy**

Plot location will be identified using an ownership-wide grid of sample points spaced at 1 plot per 4 acres outside of riparian areas and 1 plot per 8 acres within riparian areas (Figure 3). Intersection of the PAU layer with the grid will yield sample plot locations for a given PAU.

The inventory will only collect data on PAUs at least 20 years old. Those less than 20 years old will not be sampled. Data from verified forest surveys from DNR's LRM System will be used to estimate forest conditions within the PAUs < 20 years old.

Subsequent sampling strategy will be based on a 10-year inventory cycle. On average DNR will inventory 10 percent of its operable acres older than age 20 every year.

Live tree data required to be collected at each plot is described in the following sections.



**Figure 3. The land classification and sample grid will be produced before PAU delineation occurs (left). These layers will be provided to the vendor. After PAUs are delineated (right), the sample grid will be intersected with the PAU to assign sample points to individual PAUs. A sample of PAUs will be selected for inventory measurements. All sample points will be measured in PAUs that are selected for inventory measurements. The upland plot measurements will be used to estimate current forest inventory metrics and create development types (i.e., yields) for the upland portion of the sampled PAUs. The riparian sample points will be grouped with points from similar riparian areas to develop stratified inventory metrics and development types.**

### **Sampling Order and Selection**

PAUs will be randomly selected for inventory measurements to ensure that the inventory is an unbiased sample of all operable lands. To reduce the delay between the PAU delineation phase of the inventory and the field measurements, PAUs will be selected for field measurements as they are delineated. PAUs selected for measurement by June 30, 2023, will cover up to 200,000 acres in the first SFIS sample, where amount of acres sampled is dependent on the cost per plot, and will be used to build the stratified yields for use in the 2024-35 sustainable harvest calculation. An analysis of sampling results from the first SFIS sampled acres will be performed to ensure each stratified yield set has statistically sufficient data for yield projections. The remaining PAUs will be selected after the delineation and analysis of the first SFIS sampled acres is completed to ensure all strata are sufficiently sampled and the total area of field measurement is 500,000 acres.

The first SFIS sampled acres of PAUs will be selected using the cumulative relative frequency method<sup>6</sup>, which is an implementation of probability proportional to size sampling (PPS). The purpose of PPS is to select each acre with equal probability; using a typical random sample, acres in large PAUs would be sampled at a lower frequency than those in small ones. The method requires a tracking table similar to this:

PAU_ID	ACRES	CMT_ACRES
1	43.5	43.5
2	22.7	66.2
3	96.1	162.3
4	81.2	243.5
5	41.7	285.2
6	26.1	311.3
7	31.6	342.9

Where:

- PAU\_ID = arbitrary identifier
- ACRES = acres of the PAU
- CMT\_ACRES = cumulative acres, the cumulative sum of acres that is updated for each successive PAU

PAUs are added to the above table as they are created. They can be added either individually or in groups. The only information that is needed about each PAU is the PAU\_ID and acres.

DNR will supply the vendor with a list of random numbers between 0 and 1,212,955 (the current total number of acres of operable westside land), proportionate to the number of acres in the first SFIS contract. A PAU is selected if one of the random number is less than or equal to the CMT\_ACRES for the PAU and greater than the CMT\_ACRES for the previous PAU. For example, PAU 6 would be selected if 305.2 appears on the list of random numbers because  $285.2 < 305.2 \leq 311.3$ .

This sampling approach is an example of sampling with replacement. Some PAUs will likely be matched with multiple random numbers (e.g. for PAU 6 above, the unit would be selected for sampling twice if the random number list identified 286 and 310). In these cases the PAU will be sampled only once using inventory plots.

Figure 4 illustrates the entire process for selecting PAUs for sampling.

The second set of PAUs will be selected by the same method, or will be modified, pending analysis of inventory captured in the first SFIS acreage, until a total of 500,000 acres is reached. The second set will be done after all PAUs are delineated.

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<sup>6</sup> This approach is described on page 47 of Frees, F. 1962. Elementary Forest Sampling. USDA Forest Service Agricultural Handbook No 232. It is called the cumulative relative frequency method by Abdulla et al. 2014. On the selection of samples in probability proportional to size sampling: cumulative relative frequency method. Mathematical Theory and Modeling. 4.

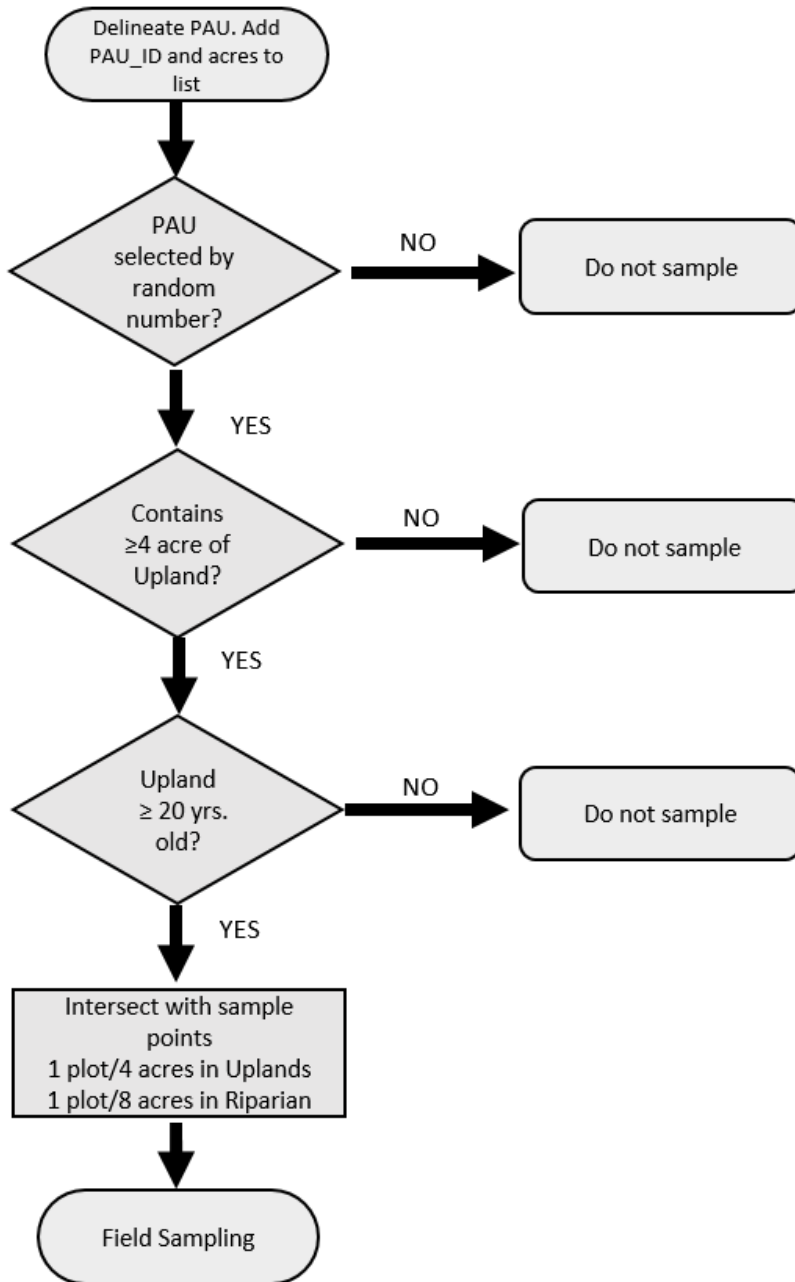


Figure 4. Strategy for assigning sample points to planning analysis units (PAUs).

## **Data Management and Application**

Data will be collected in the field using ruggedized Android tablets. The data-collection application has built-in error checks that improve data quality. The check-cruising approach and tolerances are described in Appendix A.

## **Appendix A: Inventory Field Procedures**

### **Introduction**

This document is the field protocol for DNR's Stand-based Forest Inventory System (SFIS). Tree measurements are recorded using, variable radius plots and down-wood measurements, where required, are recorded on transects. Sample points are located in planning analysis units (PAUs). PAUs can have multiple forest conditions, particularly when they contain a riparian management zone (RMZ). Sample points that fall on the edge of the RMZ should be treated as edge plots as described below.

### **Sample Point Location**

Data are collected on ruggedized tablets provided by DNR or on field computers owned and managed by vendors contracted to collect data. Sample points are located in the field by GPS. Crews will navigate using GPS until the unit indicates they are within 30 ft of the sample point. The last distance and bearing read on the unit when they reach within 30 ft should be followed, e.g., if the units says "29 ft at 131 degrees" then the cruiser will pace another 29 ft at 131 degrees and establish the sample point.

Check cruisers will follow the same protocol and sample points need to be found within 90 ft of the check locations.

Sample points will be measured where they fall, i.e., sample points that fall on roads will be measured without relocating the point. Sample points that fall in streams that cannot be safely entered will be measured at the edge of the stream.

Sample points will be monumented with a 20 penny or larger nail with flagging attached. Flagging will also be tied to nearby trees to allow check cruisers to relocate the sample point. A GPS location will be recorded at each sample point using the tablet.

Sample points can be recorded as inaccessible owing to standing water, excessive slope, scree fields, and other barriers. Up to 1% of points can be recorded as inaccessible without a pay deduction. DNR will not pay for inaccessible plots beyond the first 1% unless an exception is granted by DNR owing to unforeseen difficulties.

### **Basic Live Tree Measurements**

Live large trees ( $\geq 5.5$  in DBH) will be measured on a variable radius plot at each sample points. Basal area factors (BAFs) are predetermined by DNR and loaded onto the tablets in advance. BAFs are set based on stand conditions with the intent of measuring an overall average of 6 trees per plot. The BAF will be 54.4 for all RMZ plots. RMZ plots will be flagged in the data recorder. Borderline trees will be determined using the limiting-distance method.



Live small trees (< 5.5 in DBH and > 1ft tall) will be measured on fixed-area plots. The fixed-area plot radius will be preloaded on the data recorder and will be set as the limiting distance of a 5.5" tree for the given BAF of the PAU (e.g., 10.7 ft radius for 20 BAF). The radius is set so that all trees in the fixed-area plot are 'in' trees even if they exceed 5.5" DBH. Trees will be recorded by species and 1 inch diameter class for trees > 4.5 ft tall and 1-ft height class for smaller trees.

Trees will be recorded starting north and proceeding clockwise.

The following will be measured and recorded on all large trees:

- **Species, DBH** (recorded to 0.1 in)
- **Crown ratio:** estimated to nearest 10%
- **First-segment defect:** Length deduction within the first 32 ft (with 1 ft stump).
- **Top defect:** Length deduction between the first segment and 5 in DIB top.
- **Damage codes:** other damage and severity level

The following will be measured on sub-samples of large trees:

- **Total height and height to live crown:** measured on approximately 20% of trees selected by the data collection application. Measured to the highest live point on the stem and recorded to nearest 1ft.

If a tree cannot be measured for height then a note should be taken indicating the reason. Failure to measure a selected tree will result in a missed measurement unless an acceptable reason is given

The following will be measured on all small trees:

- **Species**
- **DBH** (1 in class) or **Height** (1 ft class)

### **Additional Live Tree Measurements**

The following will be measured on a subset of live trees. The number of trees selected for additional measurements will be predetermined before the sampling begins:

- **10-yr growth increments:** measured using increment cores. Measurements will be made to the nearest 0.05 inch using an engineer's scale ruler or calipers. Increments will be marked on the core and the core will be replaced in the hole for check cruising.
- **Site Index Trees:** age will be measured using increment cores. Cores should be long enough to reach the pith. Cores that miss the pith should pass the pith tangentially and be within an estimated 1 inch of the pith. Trees should be re-cored if the first core does not reach or pass the pith. Trees will be selected from the dominant and codominant crown classes and will be free from defects such as broken tops. Selected trees should represent the cohort that occupies most of the stand; legacy trees, leave trees, and understory trees will not be selected. The preference for tree selection will be 1) DF, 2) WH, 3) RC, and 4) RA. Trees can also be selected from off the plot only if no suitable trees are present. Total height will be measured on site index trees.

### **Dead Tree Measurements (Within the OESF, NRF and SPS-dispersal areas and all RMZs only)**

Dead trees > 5.5 in DBH and 10 ft tall will be selected using a 20 BAF prism.

The following will be measured on all dead trees:

- **Species**
- **DBH** (estimated to nearest 1 in)
- **Height** (estimate to the nearest foot)
- **Decay class** (see Appendix A.1)

### **Additional Down Wood Measurements**

A subset of sample plots may be selected for down-wood measurements. The plots will be selected before sampling begins. Down wood is measured using the line-intersect method on two 25-ft transects. The transect azimuths will be pre-populated by the tablet. The end of each transect will be marked with flagging.

The following will be measured for each transect:

- **Slope percent**

Pieces of down wood will be recorded when the central axis of the piece (i.e., a line running through the pith) is above ground and crosses the transect and the piece is  $\geq 4$  in diameter at the point of intersection. Curved or forked pieces and pieces that intersect both transects will be recorded at each point of intersection.

The following will be measured on all down-wood pieces:

- **Species:** RC or other (OT)
- **Decay class** (see Appendix A.2)
- **Diameter at Intersection:** measured to nearest 1 in using a tape
- **Small-end and large-end diameters:** estimated to nearest 1 in, ends do not have to be measured
- **Length:** estimated to nearest 1ft. Does not have to be measured

### **Edge Correction**

Edge-correction methods will be employed when sample points fall close to the edge of the PAU or between the RMZ and non-RMZ part of the PAU. If the boundary is a road, the mid-point of the road will be considered the boundary line. Plots will **not** be measured with edge-correction if there is no indication that the sample point is near an edge, i.e., forest conditions on both sides of the boundary appear to be the same.

The walk-through method will be used on large live and dead trees (Appendix A.3). Small trees can be adjusted by estimating the proportion of the plot within the unit and adjusting tree counts. A count field will be used in the data collection application to double-count trees. Adjustments should be noted in the notes fields.

Down-wood transects will be reversed (e.g., switched from 90 degrees to 270 degrees) if they extend beyond the unit boundary.

**Table A1. Potential check cruise tolerances.**

Criteria	Range
Plot missing, not recorded as inaccessible	None allowed
Plots found and located with 90 ft of intended point	-2% (2 out of 100 points)
Total number of large live trees tallied	+/- 5%
Total number of large dead trees tallied	+/- 10%
QMD of large live trees (by species)	+/- 1 in
Mean height of large live trees (by species)	+/- 5 ft
Missed ht measurement trees	-2%
Total number of small live trees tallied	+/- 10%

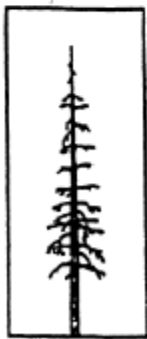
### Check Cruising

A check cruise of approximately 10% of the completed PAUs will be conducted. Scoring criteria will be based on the average differences between the cruise and check-cruise data. The check cruiser will start with a sub-sample of approximately 5 points within a unit. If the cruise passes then no additional points will be checked. If the check fails then an additional 25% of points will be checked. The process can be repeated until 100% of points are checked. A unit will fail when 100% of points are checked and not found to be within tolerances. Failed units will be remeasured. If three units from the same cruiser fail then all units measured by the cruiser or team will be remeasured and checked.

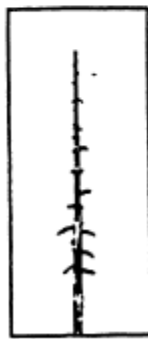
Appendix A.1 – Dead Tree Decay Classes (Within the OESF, NRF and SPS-dispersal areas and all RMZs only)

Characteristic	Decay Class Code			
	1	2	3	4
Bark	Intact	Intact	Trace	Absent
Twigs and branches < 1.2 in. dia.	Present	Absent	Absent	Absent
Texture	Intact	Intact to softening	Hard, large pieces	Small, soft blocky pieces
Shape	Round	Round	Round	Round to oval
Color of wood	Original color	Original color	Original to faded color	Light brown to reddish brown

Table 9-4. Dead Tree Decay Class.



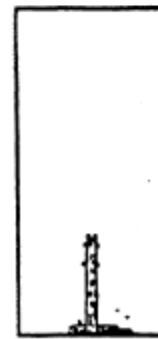
Recent Snag  
Decay Class 1



Hard Snag  
Decay Class 2



Soft Snag  
Decay Class 3



Very Soft Snag  
Decay Class 4

Appendix A.2 – Down Wood Decay Classes

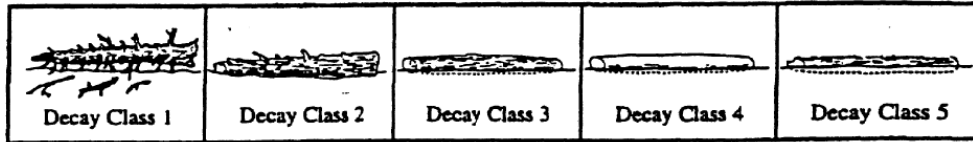


Figure 5-2 Decay Class Guidelines

Characteristic	Decay Class Code				
	1	2	3	4	5
<b>Bark</b>	Intact	Intact	Trace	Absent	Absent
<b>Twigs &lt; 1.2 in.</b>	Present	Absent	Absent	Absent	Absent
<b>Texture</b>	Intact	Intact to softening	Hard, large pieces	Small, soft blocky pieces	Soft and powdery
<b>Shape</b>	Round	Round	Round	Round to oval	Oval
<b>Color of wood</b>	Original color	Original color	Original to faded color	Light brown to reddish brown	Red brown to dark brown
<b>Portion on ground</b>	Log elevated on support points	Log elevated on support points, but sagging slightly	Log sagging near ground	All of log on ground	All of log on ground
<b>Invading roots</b>	None	None	In sapwood	In heartwood	In heartwood

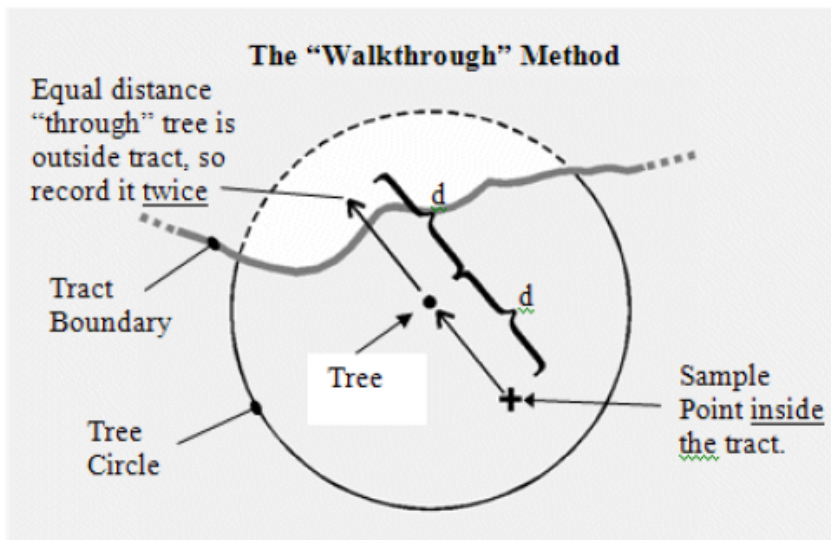
## Appendix A.3 The Walk Through Method For Edge Plots by Kim Iles

( Reprinted from [John Bell & Associates Inventory & Cruising Newsletter](#) )

There was a recent article, August, 2004 in the journal Forest Science, that was really useful – although perhaps not very readable, which is a common situation in Forest Science. I would like to bring it to your attention, if you have not already heard about it from the OSU short course or my book (which is the only discussion in a forest measurements book so far). The article was about the “Walkthrough Method”. This is one of those happy times when a practical problem produces a practical solution from the forest research community. The authors deserve real credit for one of the best ideas in a long time.

The method works with curved borders, small patches inside the stand, typed-out roads, and all those situations that make most other edge-effect methods impractical or make them incorrect. Try it. You’ll like it. It works with Variable or Fixed Plots. It is easy to teach, and easy to learn.

Every plot follows the same procedure. For any “in” tree, measure the distance (“d” in the illustration below) from the sample point to the tree, then duplicate that distance on the other side. If you fall outside the sample area at the end of this duplicated distance, record that tree twice. In most cases, you can simply estimate the distance, or the situation is obvious when you are not even near the

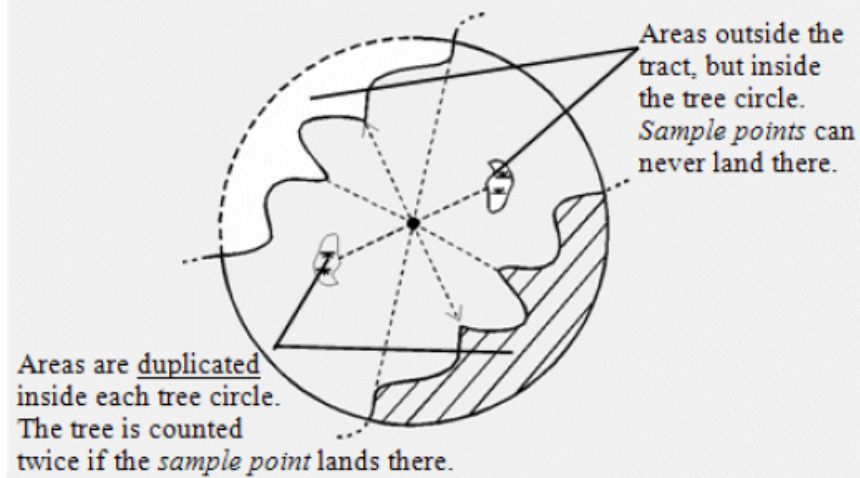


sample area border. This double counting makes it simple to do the computations, and computer programs do not require any modifications. For count trees, you would just count the tree twice. For measured trees, record it as two identical measured trees.

You will only have to check a few trees. Most of the situations will be obvious. One advantage is that you do not actually have to go beyond the sample area border (a good thing with

rivers, cliffs, and swamps), you just need to know that you would fall outside the sample area at that distance. The idea is shown in the illustration at the right.

### Example of how the geometry works



What is really happening here? The key to the system is that any part of the tree circle around each tree that falls outside the sample area is “duplicated” by rotating it 180 degrees. If the sample point falls into the duplicated part, you count the tree twice (that is what the process of “walking through” the tree is detecting). The number of times you count it twice makes up for the number of times a sample point would not fall into the part of the tree circles lying outside the area being sampled. The geometry may be a bit odd, but the field procedures are really simple.

It is hard to imagine a simpler process, or a more flexible one. If the sampled area is really narrow, or when you are in corners of the tract, the process is not exactly correct – but much of the bias that is caused by edge effect is accommodated even in these circumstances. Reports from the field have been very positive, and the procedure is fast becoming a standard for companies and government organizations.