A Survey of Channel Distances from the Uppermost Point of Perennial Flow to the Stream Channel Head: Coastal and Western Washington

Project Report

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Background and Purpose

The uppermost point of perennial flow (UMPPF) is the stream hydrologic feature used by the forest practice rules to delineate the break point between perennial (Type Np Waters) and seasonal stream segments (Type Ns Waters). Field surveys of headwater channels during the low-flow season are generally accepted as the most reliable method to establish the UMPPF (Hicks et al. 2012). However, it is not always possible to perform field surveys during the short dry season. Therefore the draft Board Manual (WFPB 2006) provided a wet-season method to estimate the UMPPF based on the physical relationship (i.e., distance) between the UMPPF location and the location of the stream channel head. Because the channel head (CH) can be located during any season the wet-season method is proposed as one option for delineating Np waters when dry season surveys are not feasible. Table 23-1 in the draft Board Manual (WFPB 2006) proposed default UMPPF to CH distances for the wet-season method; as 6 ft., 32 ft., and 32 ft. for the coastal, western and eastern precipitation zones, respectively. These default distances were derived from the CMER Type N stream demarcation studies (Palmquist 2005a and 2005b) which used field data on spatial flow categories (e.g., flowing, pocket water), associated features (e.g., seeps, springs), and channel type categories (e.g., defined channel, no channel) to delineate locations for the highest point of perennial water (referred to as Pd in Palmquist 2005a) and the CH.

The TFW Policy committee is considering a proposed revision to the default UMPPF to CH distances in Table 23-1. There is strong concern by forestland owners that use of the CMER data to estimate the UMPPF location, as proposed by some caucuses, would not be consistent with the field-observed UMPPFs that are routinely established and approved through the Forest Practices Application (FPA) process. Therefore, the Washington Forest Protection Association (WFPA) of large forest landowners implemented UMPPF to CH distance surveys at sites with approved FPAs (i.e., where the UMPPF was established during the dry season) to provide data that is representative of the field conditions and harvest unit planning procedures typical of the FPA process. This report describes the results of UMPPF to CH distance surveys that were performed by forest landowners during fall 2013 in the coast and western precipitation zones.

Survey Methods

The DNR Forest Practices GIS database (https://fortress.wa.gov/dnr/servicessa/dataweb/dmmatrix.html) was used to identify and extract all approved FPAs that indicated a harvest unit occurred within 50 ft. of Type Np waters. The query found 12,530 FPAs on record since 1995 and 8,863 FPAs were associated with WFPA owners[1]. The FPA population was further reduced to 1,111 FPAs that were initially listed as WFPA members for westside lands (coast and west precipitation zones) during years 2011 and 2012. The Forest Practice (FP) database did not include information about the FPA applicant, UMPPF location, or date of UMPPF surveys. Therefore, we downloaded a PDF copy of each FPA from the Forest Practice Application Review System (FPARS) search service (https://fortress.wa.gov/dnr/fparssearch/), extracted the needed UMPPF information, and combined these data with the GIS data to form an initial UMPPF database of 934 FPAs that were submitted by 15 members of the WFPA.

The initial UMPPF database was queried to create a source population (sample frame) of FPAs that potentially qualify for the survey. The objective is to only include FPAs that indicated an UMPPF was

[1] The number of FPAs associated with WFPA is approximate because the GIS query included all landowners that occurred within 500 ft of the WFPA landowner boundaries.

established during the summer. However, specific UMPPF information was inconsistently recorded. Therefore, the source population included all FPAs in the UMPPF database except those where it was clear that no UMPPF was established or it was established outside of the summer low-flow period. This resulted in a source population of 472 FPAs; 76 and 396 FPAs each in the coast and west zones, respectively.

We estimated, from an analysis of existing CMER data (see WFPA 2013), that a minimum of 45 randomly selected samples from each precipitation zone (coast and west) would provide an unbiased estimate of the UMPPF to CH distance. The sample population was allocated among 12 WFPA member-companies in proportion to their respective number of FPAs in the sample population for each precipitation zone (Table 1). Three companies were dropped from the survey because they only had a few FPAs in the sample population. The FPA sample population for each participating company was randomized and the respective samples were selected in order from the random-ordered list.

Each company was responsible to perform the UMPPF to CH distance surveys on their lands. Field protocol and data forms were provided to the companies for consistency (Appendix A). Only one UMPPF was surveyed from each FPA regardless of the number of UMPPFs listed. When more-than-one UMPPF was identified on the FPA, one site was randomly selected from the total sites listed or mapped in the FPA. Similarly, if more than one CH was located upstream of the UMPPF, one channel was randomly selected for the survey. Each survey included surveyor information, survey date, UMPPF to CH distance (i.e., slope distance), GIS coordinates, and associated field notes.

The lithology for each UMPPF location was post-stratified by Ted Turner (Weyerhaeuser geologist) using two geologic map sources, the USGS 1:500,000 scale map (http://mrdata.usgs.gov/geology/state/state.php?state=WA) and the WDNR 1:100,000-scale map (http://www.dnr.wa.gov/ResearchScience/Topics/GeosciencesData/Pages/gis_data.aspx). Although the DNR 1:100,000 map has better detail, previous experience found the USGS 1:500,000 to be more accurate at times (and vice versa), so we examined the results from both (Ted Turner, Weyerhaeuser, personal communication). Lithology types were reclassified with a more generic rock type to minimize the number of categories for statistical analysis. In most cases both data sources were consistently mapped. In cases where the maps differed the classification was based on the following criteria:

1. default to the DNR data because the map is at 1:100,000 scale versus 1:500,000 for the USGS map, or
2. default to USGS if the lithology is a surficial deposit (e.g., landslide, alluvium, glacial deposits, etc.).

Four lithology types were defined as follows:

- Tholeitte basalt (hard), andesite (hard), basalt (hard), breccias (soft and hard), volcaniclastics (soft): Volcanic
- Sandstone, siltstone, greywacke, marine sedimentary: Sedimentary
- Phyllite, greenstone, etc.: Metamorphic
- Glacial drift, alluvium, moraine, till, outwash, terraced deposits, landslides: Alluvium/Colluvium.

Data Analysis

The UMPPF to CH distance data were summarized using frequency distributions and descriptive statistics (mean, median). The differences in UMPPF to CH distances between precipitation zones and lithology types were examined using pairwise comparisons of distance distributions with nonparametric 2-Sample K-S Goodness-of-Fit tests.

Results

The twelve companies performed 112 qualified UMPPF to CH surveys (coast N = 49, west N =63) that were distributed across 15 counties of western Washington (Figure 1). To achieve the required sample, a total of 148 FPAs from the random-ordered list were examined and 36 were dropped either during the field survey or during the post-survey QA review (Table 2). The unqualified FPAs were rejected for the following reasons: 9-sites had no UMPPF in unit, 8-UMPPFs not established during summer, 7-sites were inaccessible due to snow or active logging, 7-sites the UMPPFs were not marked or not found, 3-sites changed landowners, and 2-sites had multiple CHs removed.

The UMPPF to CH distances ranged from 0 to 855 ft. and 0 to 1316 ft. for the coast and west precipitation zones, respectively (Figure 2). The data for both zones were right skewed with 32% to 38% of the UMPPFs co-occurring at the CH (Table 3). The cumulative distribution and box plots of these data show that the UMPPF to CH distances are similar with medians of 65 ft. and 70 ft. for the coast and west zones, respectively. Pairwise comparisons of the UMPPF to CH distance distributions found no significant differences between precipitation zones (P = 0.735).

The mean un-weighted UMPPF to CH distances are 170 ft. and 204 ft. for the coast and west zones, respectively, and 189 ft. for all data combined (Table 3). Because the number of surveys was not equal among companies we computed a weighted mean UMPPF to CH distance that is based on the proportional size of each company's sample in the total sample population. This resulted in mean weighted UMPPF to CH distances of 177 ft. and 238 ft. for the coast and west zones, respectively, and 227 ft. for all data combined (Table 3). The weighted mean is the preferred statistical estimate because it accounts for the disproportionate sample sizes among companies.

The post-stratification of UMPPFs by lithology indicated that all but two sites (i.e., those associated with metamorphic rock) were associated with three lithology types (Table 4). Therefore, we excluded sites with metamorphic rock from the analysis and performed pairwise comparisons of the distance distributions (Figure 3) for the three other rock types using an alpha of .05/3 = 0.017. The analyses showed that the UMPPF to CH distances for volcanic rock are statistically shorter in comparison to sedimentary rock (volcanic:sedimentary, P = 0.012), but no differences were found for other comparisons (i.e., volcanic:alluv/colluvium, P = 0.289; alluv/colluvium:sedimentary, P =0.408). The median and mean UMPPF to CH distances were shortest for volcanic rock and longest for sedimentary rock (Figure 3,Table 4).

References

Hicks et al. 2012. Forest and Fish Policy Type N Technical Subgroup Summary Report. Prepared for Forest and Fish Policy, Washington Department of Natural Resources, Olympia, WA

Palmquist, R. 2005a. Type N Stream Demarcation Study, Phase I: Pilot Results. Final Report. Unpublished Report. For the Washington State Cooperative Monitoring, Evaluation, and Research Committee. February 14, 2005.

WFPA 2013. A Survey to quantify distances from the stream channel head to the uppermost point of perennial flow in western Washington. A proposal by WFPA to Forest & Fish Policy Committee, 7/15/13.

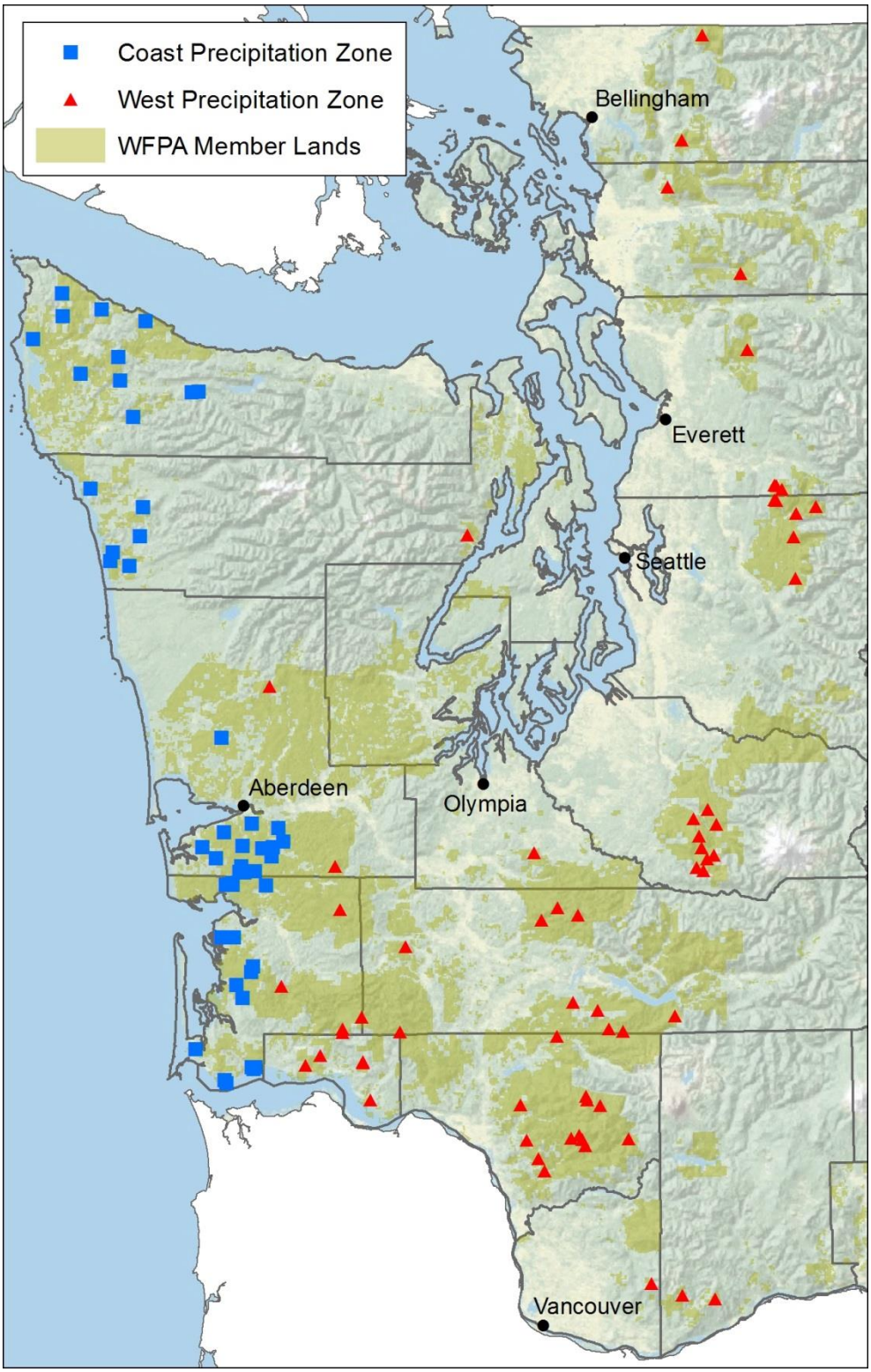
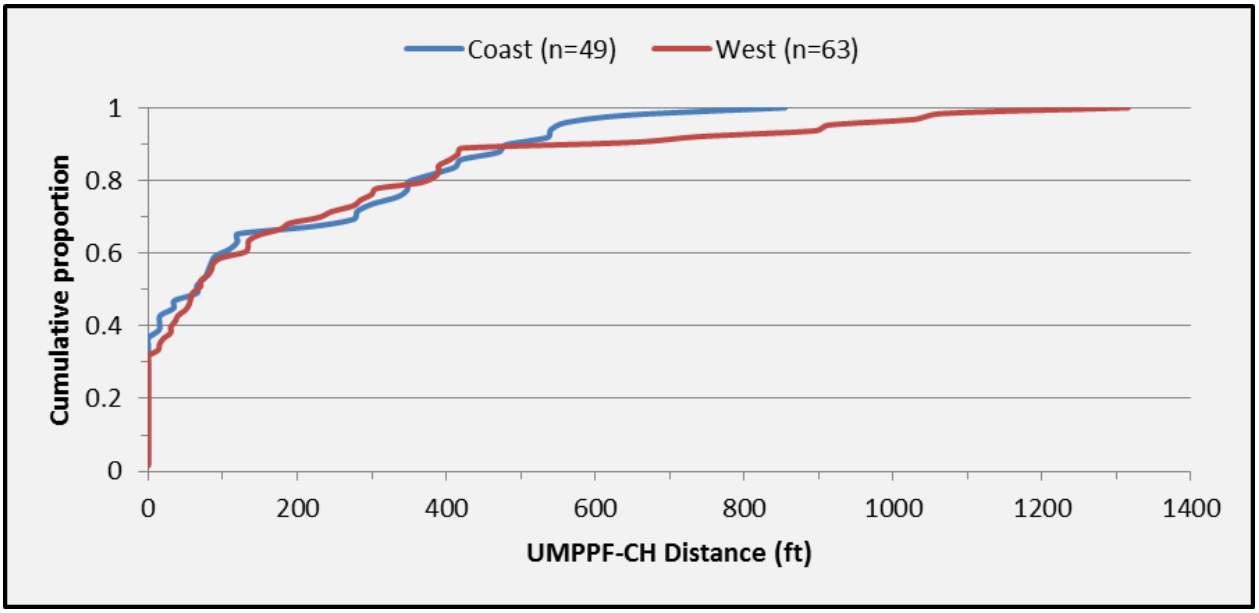


Figure 1. Location of UMPPF to CH survey sites by precipitation zone on WFPA member lands in coastal and western Washington.



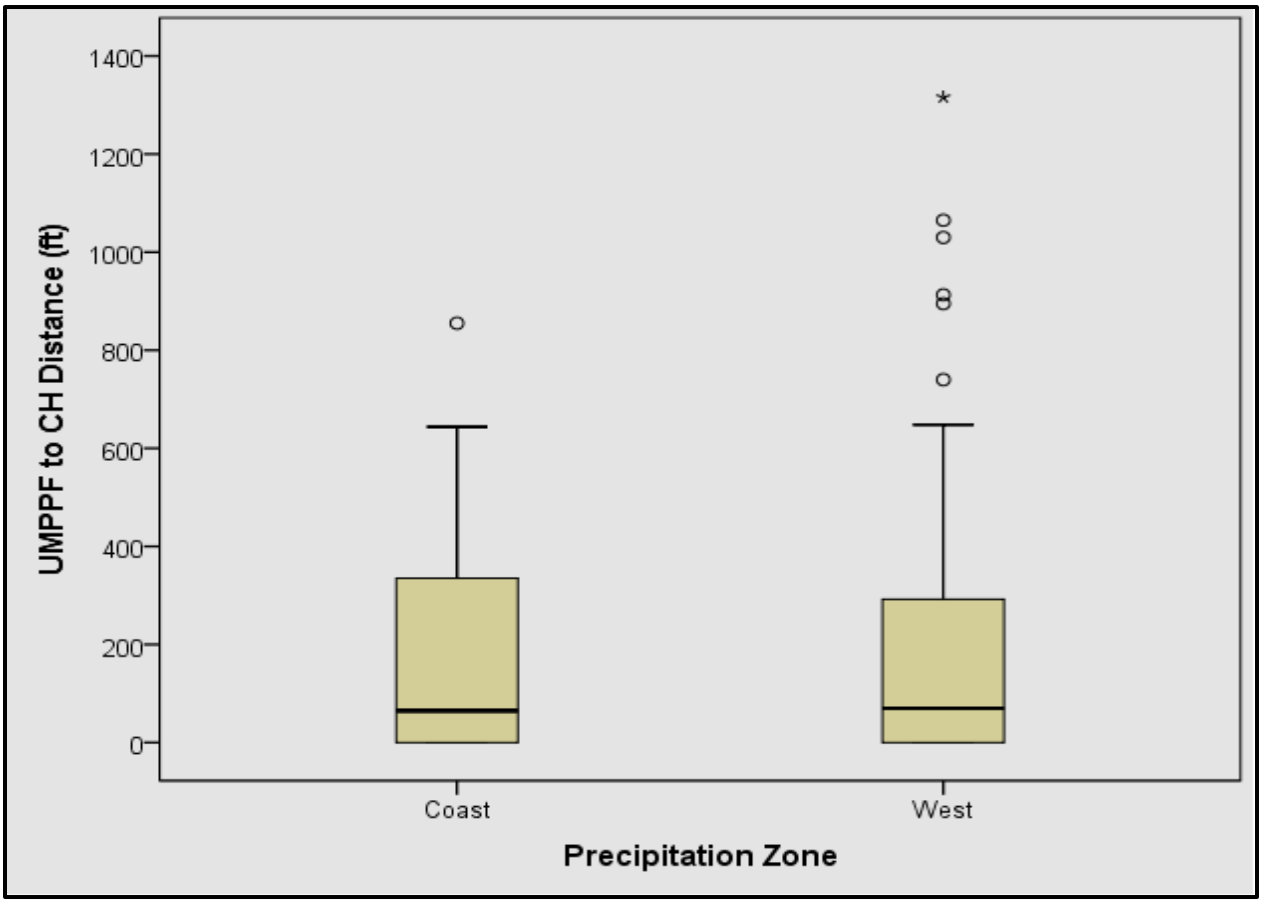
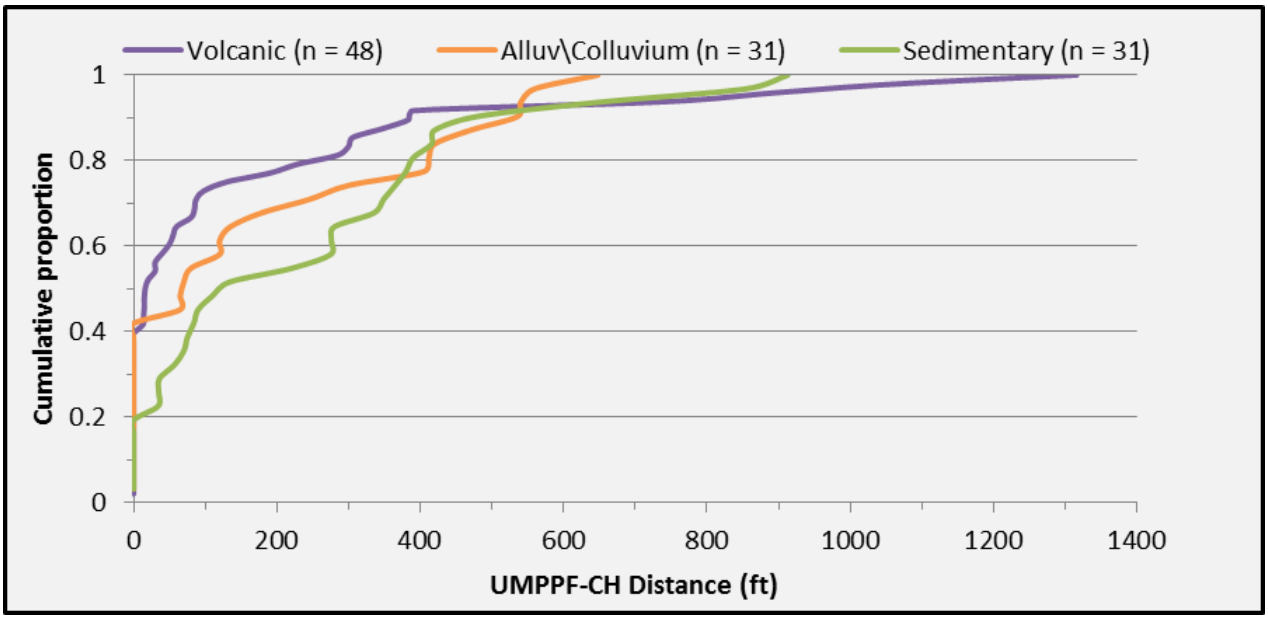


Figure 2. Cumulative frequency distribution (top) and boxplot of UMPPF to CH distance by precipitation zone (bottom). Each box shows the 25th, 50th (median), and 75th percentiles. The error bars represent the 10th (below) and 90th (above) percentiles; empty circles represent statistical outliers and stars are extreme values.



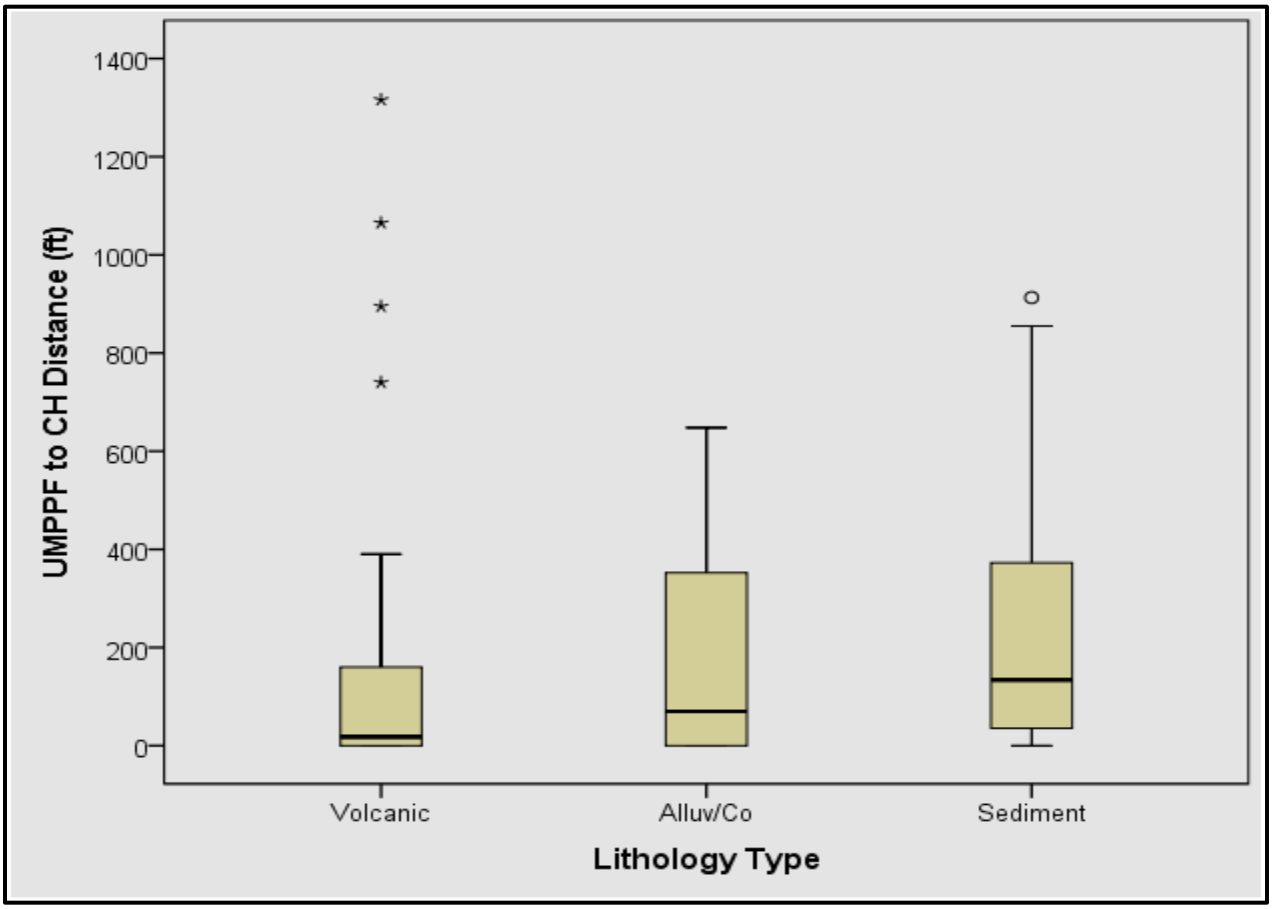


Figure 3. Cumulative frequency distribution (top) and boxplot of UMPPF to CH distance by lithology type. Each box shows the 25th, 50th (median), and 75th percentiles. The error bars represent the 10th (below) and 90th (above) percentiles; empty circles represent statistical outliers and stars are extreme values.

Table 1. Original FPA sample frame, sample frame proportion, and minimum number of samples requested for each company by precipitation zone. Sample size based on minimum requirement of 45 per zone.

	Coast Zone			West Zone			
Company	**Sample frame**	**Proportion**	**Sample size**	**Sample frame**	**Proportion**	**Sample size**	**Total**
Campbell Group	11	0.145	7	13	0.033	1	8
Fruit Growers	1	0.013	1	1	0.003	0	1
Grandy Lake*	--	0.000	0	4	0.010	0	0
Green Crow	5	0.066	3	1	0.003	0	3
Hancock Timber	17	0.224	10	35	0.089	4	14
Longview Timber	--	0.000	0	78	0.198	9	9
Merrill & Ring	3	0.039	2	--	0.000	0	2
Oly. Res. Manag	--	0.000	0	16	0.041	2	2
Pac. For. Manag.	1	0.013	1	--	0.000	0	1
Port Blakely	--	0.000	0	16	0.041	2	2
Rayonier	24	0.316	14	19	0.048	2	16
Seefeld Corp*	--	0.000	0	2	0.005	0	0
Sierra Pacific	--	0.000	0	27	0.069	3	3
Stevenson Land*	--	0.000	0	2	0.005	0	0
Weyerhaeuser	14	0.184	8	180	0.457	21	29
All	76	1.000	46	394	1.000	44	90

*No surveys were requested from these companies because of small representation.

Table 2. Number of FPAs examined and number of surveys qualified by precipitation zone.

	Coast Zone		West Zone		Total	
Company	**Examined**	**Qualified**	**Examined**	**Qualified**	**Examined**	**Qualified**
Campbell Group	10	7	1	0	11	7
Fruit Growers	1	1	--	--	1	1
Green Crow	4	3	--	--	4	3
Hancock Timber	17	13	36	25	53	38
Longview Timber	--	--	10	8	10	8
Merrill & Ring	3	3	--	--	3	3
Oly. Res. Manag	--	--	2	2	2	2
Pac. For. Manag.	1	1	--	--	1	1
Port Blakely	--	--	2	2	2	2
Rayonier	16	13	3	2	19	15
Sierra Pacific	--	--	6	3	6	3
Weyerhaeuser	10	8	26	21	36	29
All	62	49	86	63	148	112

Table 3. Summary metrics for UMPPF to CH distances by precipitation zone.

	Precipitation Zone		
Metric	**Coast**	**West**	**Combined**
Sample N	49	63	112
Proportion of samples with UMPPF to CH distances = 0	0.376	0.317	0.339
Median (ft.)	65	70	68
Mean, un-weighted (ft.)	170.0	203.7	188.9
Mean weighted by company sample proportions (ft.)	177.2	237.5	227.0

Table 4. Summary metrics for UMPPF to CH distances by lithology type.

	Lithology Type		
Metric	**Volcanic**	**Alluv\Colluvium**	**Sedimentary**
Sample N	48	31	31
Proportion of samples with UMPPF to CH dist. = 0	0.396	0.406	0.182
Median (ft.)	18	70	134
Mean, un-weighted (ft.)	151.8	173.2	236.3

Appendix A

WFPA Field protocol
UMPPF to Channel Head Distance Survey
10/16/13
Doug Martin

Overview

The UMPPF to channel head (CH) distance survey requires a minimum of 45 randomly selected samples from each precipitation zone (coast and west). Each company will collect a subsample of their respective FPAs that is proportionate to the total number of FPAs in the sample population for each precipitation zone (Table 1). For example, Weyerhaeuser will need to sample 8 of their 14 FPAs from the Coast and 21 of their 180 FPAs from the West. Green Crow will need to sample 3 of their 5 FPAs from the Coast and none in West, etc. The specific survey sites for each company will be determined from a random sample of the respective companies FPAs within each precipitation zone. Only one UMPPF will be surveyed from each FP regardless of the number of UMPPFs listed. When more-than-one UMPPF is identified on a FPA, one site will be randomly selected from the total sites listed or mapped in the FPA. Only UMPPFs that were originally established during the summer low flow period (July 1 to September 30) are eligible for this survey. The survey process includes a pre-field review and identification of FPAs by each landowner, a field survey to measure UMPPF-to-CH distances, and a post-field data entry and QC review. Each task is described below.

Pre-field Review and Sample Identification

The FPAs for each participating landowner are shown on company specific worksheets in an Excel file (OwnerFPAs_SurveyData). The sample size for each company is shown on the worksheet called "SampeSize" (note, the sample sizes may be slightly different than the ones you saw in an earlier email due to regrouping of some companies). Each company worksheet lists all FPAs in the sample population in random order (see Column A "Sequence") by precipitation zone. The FPAs that are needed to make-up each companies sample should be reviewed in the order shown on the list to determine if they qualify for the survey. Qualification requires the following:

- At least one UMPPF on each FPA must have been established during summer
- The summer-UMPPF noted on FPA can probably be found in the field

If an FPA does not meet the qualification, indicate the reason for dropping the site (e.g., no low-flow survey, no UMPPFs were established, no reasonable access) and continue reviewing until you have enough sites to achieve your companies sample requirement plus a few extras in case some are dropped during the field survey. Use the worksheet during the office review to verify, correct, and provide the following information:

A. FP identification number
B. Precipitation Zone (Coast, West)
C. landowner name
D. project name
E. county
F. date UMPPF was originally established

G. Indicate yes or no for qualified, or unqualified FPA
H. Give reason for dropping site based on office review

Next, for all qualified sites, determine the number of UMPPFs that are shown on map or are listed in FPA. If more than one UMPPF occurs, one site must be randomly selected. A simple way to randomize is to list the Ns segment (UMPPF) identification numbers on a separate spreadsheet and use the "RAND()" formula to create a random number in the adjacent column for each row with a segment ID, as shown in Figure 1. Then assign the new random order for the ID numbers using the RAND() sequence. In our example (Figure 1), segment 2a is first, segment 3c is second, etc. Use this random order for selecting the UMPPF when you do the field survey. In most cases you will only need the first UMPPF site for the survey. However, if the survey at the first site cannot be completed (e.g., can't find old flag), then go to the second site on your list, etc. Note, when using the "RAND()" formula it will change every time you try to do another task on the worksheet. So to prevent aggravation: first do the RAND() for each row, then immediately copy and paste the entire column of RAND() as a number, not as a formula, into an adjacent column.

Figure 1. Example of randomizing UMPPF identification numbers using the Excel RAND() formula.

Segment ID List	RAND()	Random order
1a	0.957479	6
1b	0.829888	4
2a	0.179006	1
3a	0.914798	5
3b	0.800342	3
3c	0.596695	2

During the office review, record the following information on the worksheet:

I. The number of UMPPFs on map or listed in FPA
J. List the UMPPF identification numbers in random order as determined by the randomization process. If you have many UMPPFs, you only need to list the first several IDs in random order, as it is unlikely that you would need to discard more than several sites during the field survey.

The random ordered list of qualified FPAs and associated random order of UMPPFs for each FPA will be used to guide the field survey sequence. To facilitate the field survey, I recommend that you copy and paste the FPA information, from your pre-field review, directly onto the field data form. Make one field data form for each FPA.

Field Survey

Each landowner or a designated representative (e.g., contract survey crew) is responsible for performing the field surveys on their respective lands. Surveys may be performed at any time assuming the mapped UMPPF can be reestablished and marked. Equipment needed for the survey includes:

- Random ordered list of qualified sites
- Distance measuring tool (e.g., hip chain, tape, rangefinder)
- GPS

- Field Data Forms (see example below) or other method for recording data
- Flagging and waterproof marker

The recommended sequence for the field survey is:

1. Select the first site from your list of UMPPF identification numbers
2. Find and reestablish the UMPPF location on the ground.
3. If you cannot find the UMPPF location, record the reason why not (e.g., can't find buried in slash, debris flow obscured channel, site not accessible, other) and then move-on to the next UMPPH in the random ordered list.
4. If the UMPPF is located, record the method for how you reestablished the UMPPF location (e.g., found original flag, used GPS coordinates, used UMPPF buffer to estimate location, other describe)
5. Record the GPS coordinates for the UMPPF and flag the location. On the flag, write UMPPF, date, and surveyor initials.
6. Hike upstream and measure the slope distance to the CH.
    - The CH is the highest observed point of the channel incision or scour that separates unmodified forest floor from the channel. The channel must have a definable bank and must be recognizable as a morphological feature independent of flow. The channel downstream from the CH must be discernible although portions of it may be covered by logging slash or it may flow through an underground soil pipe. If the CH is in question, be sure to hike upstream for about 100 ft then back downstream until you define the CH location. The CH may occur at an abrupt slope-break or it may occur as a gradual transition from a defined channel to a swale (i.e., a slope depression, but no defined channel). The rule-of-thumb is: look for what is most obvious and make your call.
7. After locating the CH, record the slope distance from the UMPPF to CH, estimate the percentage of UMPPF-to-CH distance that may be covered by logging slash, and estimate the percentage of UMPPF-to-CH distance that is under-ground channel. If the UMPPF and CH are at the same location, just record "0" for the distance.
8. Record the GPS coordinates for the CH and flag the location. On the flag, write CH, date, and surveyor initials.
9. Add field notes to explain problems or potential concerns about the survey data.

The following field data are required for each FP survey:

K. Surveyor name
L. Field survey date
M. UMPPF ID number
N. UMPPF found (yes or no)
O. Reason not found. Indicate reason why you can't reestablish UMPPF location
P. Location method. indicate how you reestablished the UMPPF location
Q. GPS coordinates for the UMPPF
R. Measured distance on ground from UMPPF to CH
S. Measurement metric (feet or meter)
T. Estimate percentage of UMPPF-to-CH distance that is an under-ground channel

U. Estimate percentage of UMPPF-to-CH distance that is covered by logging slash and debris
V. GPS coordinates for the CH
W. Field notes

Data Reporting

Transfer your field data to the "DataSheet" in the Excel file (OwnerFPAs_SurveyData). Check and correct any transcription errors. Email the file to Doug Martin at doug@martinenv.com

Field Data Form

Below is an example of the field data form. Use the form in file "UMPPF to CH Field Data Form" to print clean full size copies. Use one data form for each FP_ID and record the UMPPF survey data in Column 1. In most cases you won't need columns 2 and 3. However, if you can't locate the UMPPF for an FP that has multiple UMPPFs, use Column 2 to record data for the second UMPPF survey at the same FP_ID. If the second UMPPF can't be located, record the data for the next UMPPF, if available, in Column 3, etc.

UMPPF to CH Field Data FormField Data Form - UMPPF to Channel Head Distance Survey - 2013

FP_ID	Precip. Zone	Landowner	Project	County	UMPPF Estab. Date

No. of Segments	Random Order of UMPPF IDs	Surveyor name	Survey date

	Column 1	Column 2	Column 3
UMPPF ID No.			
UMPPF found (Y,N)			
Reason not found			
Location method			
GPS for UMPPF			
UMPPF-CH distance			
Measurement unit (ft, m)			
Under -ground %			
Slash cover %			
GPS for CH			

Notes: