NATURAL RESOURCES

Status and Trends Monitoring of Riparian and Aquatic Habitat in the Olympic Experimental State Forest

2012 Establishment Report: Field Reconnaissance and Delineation of Sample Sites

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WASHINGTON STATE DEPARTMENT O
Natural Resource
Peter Goldmark - Commissioner of Public Land

Acknowledgements

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Acronyms and Abbreviations

DBH – Diameter at Breast Height

DNR – Washington Department of Natural Resources

GIS – Geographic Information Systems

GPS – Global Positioning System

LED – Light-Emitting Diode

LWD – Large Woody Debris

OESF – Olympic Experimental State Forest

ONP – Olympic National Park

PNW RS – Forest Service Pacific Northwest Research Station

PVC – Polyvinyl Chloride

RP – Reference Point

Executive Summary

Three main goals were identified for the first year of Status and Trends Monitoring of the Riparian and Aquatic Habitat in the Olympic Experimental State Forest: 1) identification of sample basins (watersheds around smallest fish bearing streams); 2) delineation and permanent marking of sample sites; and 3) initial field characterization of the sample sites using protocols describing the condition of aquatic and riparian habitats.

Field reconnaissance was conducted in sixty eight basins during September and October of 2012 following the guidance of the project's study plan. Fifty basins in the Olympic Experimental State Forest and four basins in the Olympic National Park (ONP) were selected for long-term monitoring. All sample reaches within the basins were delineated and permanently marked and their GPS coordinates recorded.

One water and one air temperature data logger were installed in each of the 54 sample basins. The instruments will record data all year. A brief characterization of the sample reaches and adjacent areas was conducted to aid in developing field protocols. The sampled attributes included stream gradient, confinement, bankfull width, substrate, riparian vegetation, valley type, channel type, and fish presence.

Data management in 2012 consisted of organizing the field data and photo records in an Excel database, data verification, and processing of GPS points in ArcGIS. All information is stored at Washington Department of Natural Resources (DNR) Forest Resources Division.

The work was conducted by DNR in collaboration with the USDA Forest Service Pacific Northwest Research Station (PNW). The 2012 project team included eight researchers and 4 seasonal field technicians.

The first year of this project was funded by DNR, with in-kind contributions of equipment and staff time by PNW.

The project team held several presentations and meetings within DNR and with external parties to introduce the project, report on the work accomplished in 2012, and to solicit interest from potential research collaborators.

For 2013, the research team will develop, implement, and refine the field monitoring protocols at each sampling location, as well as continue to explore opportunities for additional partnerships with other organizations.

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Introduction

Riparian status and trends monitoring in the Olympic Experimental State Forest (OESF) is identified as a high priority project for Washington Department of Natural Resources (DNR) as it is expected to reduce key uncertainties around the integration of habitat conservation and commodity production. Specifically, it will provide empirical data on in-stream conditions, thus improving DNR planning and monitoring efforts; data to test presumed relationships between riparian, upland, and in-stream conditions; and data to evaluate the projections for improvement of riparian conditions as expected under the OESF Forest Land Plan (DNR, 2013). In addition, the results from this project will be used to make inferences about management effects on riparian and aquatic habitat across the OESF and to characterize baseline habitat conditions for future riparian validation monitoring.

The study plan for this project was developed in 2011 (Minkova et al. 2012) and was peer-reviewed later that year. DNR provided funding to launch the project in July 2012. It is expected that DNR will continue to fund the project in the long-term. The USDA Forest Service Pacific Northwest Research Station (PNW) joined as a research collaborator in the summer of 2012, contributing both scientific expertise and funding. In 2011 the OESF was added to the national network of experimental forests by the Forest Service and joins a number of other forests in the Pacific Northwest having a dedicated long-term research focus.

Three main goals were identified for the first year of the OESF riparian status and trends monitoring: 1) identification of sample basins; 2) delineation and permanent marking of sample sites; and 3) initial field characterization of the sample sites. This establishment report details the activities conducted in 2012.

Identification of Sample Basins

OFFICE RECONNAISSANCE

As described in the OESF Status and Trends Draft Study Plan (Minkova et al 2012), DNR used the following selection criteria to define a pool of 236 candidate Type 3 basins [1]for sampling:

- The basin was classified as a “true” basin, meaning it did not receive inflow from an upstream basin
- DNR managed at least 50 percent of the basin
- The basin was not a size outlier. Its log transformed basin size was within 2 standard deviationsof the mean.

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[1] A type 3 basin is the watershed for a type 3 stream. Type 3 stream is the smallest fish-bearing stream, as identified through biological criterion (fish presence) or through physical criteria (a stream ≥ 2 ft (0.7 m) wide and ≤16% gradient for basins up to 50 ac (20 ha) or with a gradient between 16% and 20% for basins larger than 50 ac). Type 3 streams can be considered loosely equivalent to Strahler’s 3rd order streams.

DNR then identified an initial set of 50 basins for sampling, using a random sample stratified by median gradient within the basin (Table 1).

Table 1. Initial list of Type 3 basins selected for sampling in the OESF (from Minkova et al. 2012).

#	Basin ID	Percent DNR ownership	DNR acres	Total acres	Median gradient	Gradient stratum
1	698	77%	201	261	0	0 – 9%
2	627	67%	480	718	4	0 – 9%
3	846	100%	1,791	1,791	4	0 – 9%
4	642	100%	263	263	5	0 – 9%
5	550	53%	246	464	6	0 – 9%
6	630	89%	1,228	1,379	8	0 – 9%
7	658	72%	550	764	9	0 – 9%
8	568	100%	463	463	11	10 – 19%
9	796	88%	1,552	1,764	11	10 – 19%
10	721	66%	807	1,215	15	10 – 19%
11	192	64%	473	738	16	10 – 19%
12	463	53%	61	115	17	10 – 19%
13	583	62%	934	1,509	18	10 – 19%
14	523	100%	2,037	2,037	18	10 – 19%
15	582	100%	181	181	19	10 – 19%
16	498	93%	1,473	1,585	19	10 – 19%
17	467	60%	43	71	20	20 – 29%
18	460	100%	128	128	21	20 – 29%
19	370	54%	276	511	21	20 – 29%
20	544	100%	126	126	21	20 – 29%
21	834	74%	36	49	23	20 – 29%
22	597	67%	565	837	24	20 – 29%
23	608	82%	339	415	24	20 – 29%
24	65	54%	285	524	26	20 – 29%
25	158	100%	519	519	26	20 – 29%
26	763	78%	342	439	31	30 – 39%
27	497	87%	433	499	33	30 – 39%
28	488	54%	171	318	33	30 – 39%
29	798	100%	327	327	34	30 – 39%
30	136	75%	257	341	36	30 – 39%
31	712	100%	475	475	38	30 – 39%
32	790	100%	849	849	39	30 – 39%
33	717	100%	150	150	42	40 – 49%
34	577	83%	821	992	44	40 – 49%
35	724	100%	177	177	46	40 – 49%
36	776	100%	176	176	48	40 – 49%
37	625	100%	537	537	49	40 – 49%
38	576	71%	646	908	50	50 – 59%
39	773	100%	414	414	53	50 – 59%
40	654	100%	1,503	1,503	53	50 – 59%
41	697	100%	1,434	1,434	55	50 – 59%
42	750	100%	298	298	56	50 – 59%
43	687	100%	736	736	57	50 – 59%
44	635	100%	318	318	60	60 – 69%
45	639	100%	327	327	61	60 – 69%
46	653	100%	149	149	64	60 – 69%
47	844	99%	700	709	4	0 – 9%
48	542	100%	382	382	17	10 – 19%
49	443	51%	183	359	20	20 – 29%
50	730	87%	775	895	39	30 –39%

During the office reconnaissance, the 50 basins in Table 1 were screened using ArcGIS to determine whether:

- the outlet point of the basin and/or part of the potential sample reach was on private land; if so, the basin was excluded.
- the sample basin was correctly delineated as Type 3 basin in DNR GIS layer; basins which consisted of two or more Type 3 watersheds were excluded.
- a building or another facility was located along the Type 3 stream; one basin was excluded because of a state hatchery.

The basins that did not meet the above three criteria were rejected. Each rejected basin was replaced with the next in the randomly generated list of basins for each gradient stratum. The GIS screening was repeated until the quota of basins per gradient strata was met (see the study plan for details on the allocation and selection of the sampling units). The resulting new list of 50 OESF basins was used for field reconnaissance.

The study plan included sampling four reference basins in order to characterize unmanaged habitat conditions and how they respond to natural disturbances over time. Four lower-elevation river valleys (Bogachiel, Hoh, South Fork Hoh, Queets) in the adjacent Olympic National Park, which were expected to have biophysical conditions similar to the OESF, were identified in the study plan as areas to look for reference basins. Since no Type 3 basins are delineated in the park, they were delineated during the office reconnaissance for the part of the valleys below 3500 ft (the max elevation in the OESF) and for the side of the river that is accessible by trail. Maps were printed and used for field reconnaissance.

The following DNR's GIS layers were used for the above procedures:

- Watershed boundary dataset (SHARED_LM.OESF_WATERSHED)
- DNR-Managed (Surface) Lands (ROPA.PARCEL_SV)
- Major Public & Tribal Lands (Washington State Non-DNR Major Public Lands)
- 2011 color orthophotos for Clallam and Jefferson Counties (NAIP CCM)
- 10-m Digital Elevation Model (dem10w)
- 24K Topographic maps with trails (USGS)

SURVEY EQUIPMENT AND SUPPLIES

Equipment and supplies used during the 2012 field season are listed in Appendix B. The temperature data loggers were tested, calibrated, and programmed in the office prior to installation.

Two handheld GPS units (Garmin GPSmap62s) were loaded with the stream and road layers, 40-ft topographic lines, and legal descriptions (townships, ranges, and sections) and the basin outlet points for all sample basins, identified by "Basin ID".

Booklets with topographic maps showing the basin's outline and outlet point were created for use in the field.

PERMIT TO MONITOR IN THE OLYMPIC NATIONAL PARK (ONP)

Washington DNR was granted a permit to establish stream reference sites within the ONP for the 2012 calendar year. Study #: OLYM-00361, Permit #: OLYM-2012-SCI-0075. The designated ONP liaison is Patrick Crain. A second permit was approved for the 2013 calendar year. Study #: OLYM-00361, Permit #: OLYM-20130SCI-0027. See Appendix F for copies of the ONP permits.

LOCATING AND ACCESSING THE SAMPLE REACH

DNR Quadrangle maps and project topographic maps were used to identify the travel routes to each basin. The Olympic Region staff at Forks, WA was consulted for pertinent information regarding access to the sample basins, road conditions (e.g. locked gates or closed roads), and management activities taking place in the basins. Driving directions, from Hwy 101, were recorded in the field form for each basin. Driving directions included road labels and relevant road conditions/accessibility (pavement/gravel, brushy-ness, stream crossings without bridge, gate key required, etc.). See Appendix D.

The sample reach parking place in each basin was described in the field form and flagged with pink flagging. The flagging was labeled with a permanent marker as: *Trail to basin [basin ID]*. A photo of the parking place was taken that included the vehicle and flagging. A GPS unit was used to mark the location of the vehicle and the point was labeled as: *PARK [basin ID]*.

A hiking route from the parking place to the basin's outlet point or start of the sample reach was flagged with pink flagging. The hiking route and directions were recorded in the field form including the steepness of the terrain, vegetation, barriers, and the field gear necessary to cross streams during low and high flow (e.g. hip waders). The water level and flow of other streams forded to gain access to sample reaches were noted; three categories were used to describe when it should be safe to cross the streams: 1 (year around), 2 (low flow – May through October), or 3 (lowest flow – August through October).

The procedure for locating and accessing the ONP reference sites was the same as the OESF sites except no flagging was used for the hiking route or parking location, following the marking recommendations in the ONP permit. Instead, detailed notes and photos were taken to describe the route.

EXCLUDING A BASIN IN THE FIELD

The field crews (refer to Table 3 for the list of participants in the 2012 field season) determined whether a basin met the requirements to remain in the sample. During field reconnaissance, basins were excluded based on the following criteria:

1. The sample reach was not safely accessible. For example: very steep slope, cliffs, crossing non-wadeable rivers (too deep or with very strong current) or loose logjams along the sample reach. A long and difficult hike to the outlet point did not constitute a reason to exclude a basin.

2. A stream channel did not exist in the area shown on the map and on the GPS unit or the stream channel was undefined or resembled a wetland (usually in a wide flat alluvial fan). All stream channels that showed signs of recent flow were considered, regardless of the presence or absence of flowing water. Signs of recent flow were: 1) active scour (i.e. fine particles were removed and pushed to the side and larger substrate was visible) and 2) well-defined bankfull indicators were present (refer to Appendix E).
3. The sample reach was smaller than a Type 3 stream based on the criteria described in Bigley and Deisenhofer (2006): the stream's bankfull width was less than 0.66 m (2 ft), measured as an average of 5 cross-sections over the first 20 m or the gradient was ≥20% over a considerable distance.
4. There was no surface flow for >200 m above confluence point with the main stream. Many sample streams disappeared subsurface in the lower portion of the channel but steady surface flow usually appeared not far from the confluence point.
5. There were no pools deeper than 0.5 m (≈ 2 ft) to cover the water temperature loggers during low flow.

See Appendix A for a list of the excluded basins and the reasons for exclusion.

Each rejected basin was replaced with the next in the randomly generated list of basins for each gradient stratum, GIS reconnaissance was conducted following the procedure described above, and field reconnaissance was completed. The process was repeated until the quota of basins per gradient stratum was met.

The field reconnaissance of the ONP reference basins included selection of one basin from the Type 3 basins delineated for each of the four valleys. In addition to the criteria listed above, the following criteria were considered:

- Gradient – selecting basins in the dominant OESF gradient strata.
- Geology – selecting basins with geology similar the OESF sampled basins.
- Size – selecting various size basins within the range of the OESF sample.

The basins with the shortest hiking distance, that met all other criteria, were chosen.

Delineation and Marking of Sample Sites

IDENTIFYING THE START OF THE SAMPLE REACH

Each survey began with the field crew visiting the basin's outlet point and measuring the 100-year floodplain of the main stem (Figure 1). The sample reach always started beyond the floodplain of the main stem to avoid water mixing and other disturbances caused by high flow in the main stem. The extent of the 100-year floodplain was determined using a stadia rod and clinometer- typically by projecting the doubled height of bank-full flow. Additional indicators were considered such as topographic breaks or changes in substrate.

Once beyond the 100-year flood plain of the main stream, the beginning of the sample reach started:

1. Where steady flow was first present (not just standing water).
2. Where the hillslopes came together and confined the stream into a defined channel.
3. Above logjams that could be potentially dangerous to field crews or monitoring equipment.

The start of the sample reach was recorded with the GPS unit and labeled as: *START [basin ID]*. The start of the sample reach was marked on a nearby tree with three identifiers: pink flagging, blue paint, and an aluminum tag (nailed to the tree and facing the stream). The flagging and tag were each labeled/inscribed: *start of reach [basin ID]*. The tree species, diameter at breast height (DBH) and location (left or right side of the stream) were recorded in the field form. Two photos were taken at the start of the sample reach, one upstream and one downstream.

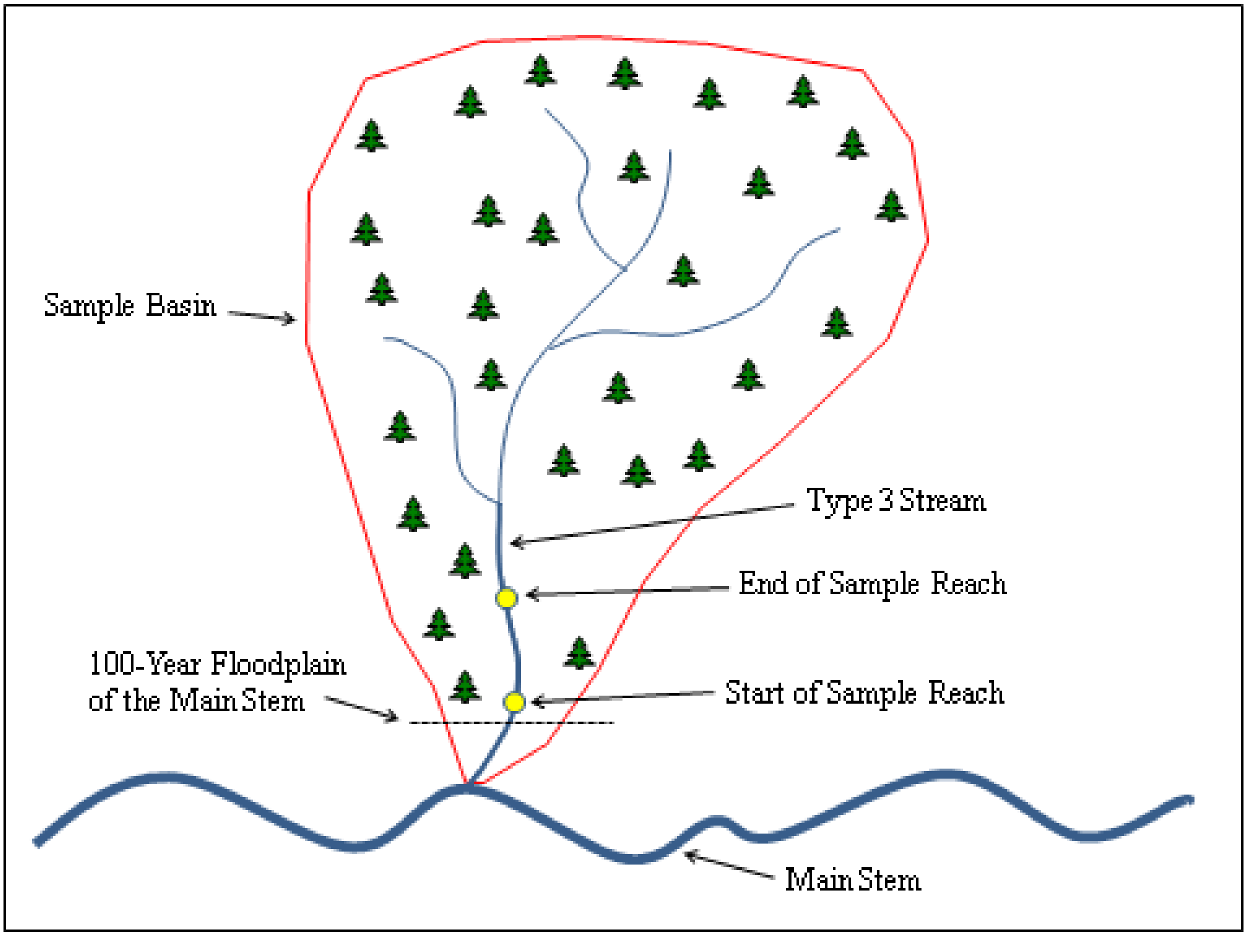

Figure 1. Illustration of a Sample Basin and Sample Site (not to scale).

The procedure for identifying the start of the sample reach in the ONP reference sites was the same as described above except no paint was used and red biodegradable flagging was used instead of pink plastic flagging. All marking in the reference sites was labeled following the permit requirements: *DNR, P. Crain, OLYM-361, OCT-13, start of reach [basin ID]*.

IDENTIFYING THE LENGTH OF THE SAMPLE REACH

As specified in the study plan, the length of each sample reach was determined as 20 times the bankfull width or at least 100 meters. This length is considered sufficient to define channel reach morphology by a minimum of three to four repeated associations of channel unit patterns (Pleus and Schuett-Hames 1998). At the start of the sample reach, the bankfull width was measured using the indicators and methods outlined in the Streamkeepers of Clallam County (2009) (See Appendix E). Both the bankfull width and the calculated sample reach length were recorded in the field form.

A meter tape was used to measure the total length of the sample reach along the thalweg of the stream channel. A Garmin GPSmap62s was used to map the entire sample reach. Using the Waypoint Manager function, points were entered manually with the “Mark” button approximately every 3-6 meters. The end of the sample reach was recorded with the GPS and labeled as: *END [basin ID]*. The end of the sample reach coordinates and the range of GPS points recorded during the stream segment tracking were each recorded in the field form. The end of the sample reach was marked with pink flagging and blue paint on a nearby tree. An aluminum tag inscribed: *End Reach [basin ID]* was nailed to the tree pointing towards the stream. The tagged tree species, DBH, and side of the stream (left or right) were recorded in the field form. A picture of the end of the sample reach was taken and the photo number was recorded in the field form.

The procedure for marking the end of the sample reach in the ONP reference sites was the same as described for the OESF sites except no paint was used and red biodegradable flagging was used instead of pink plastic flagging. All marking in the reference sites was labeled following the permit requirements: *DNR, P. Crain, OLYM-361, OCT-13, End Reach [basin ID]*.

ESTABLISHING A REFERENCE POINT

A reference point (RP) was established in each basin as a means to locate sampling locations along the sample reach (e.g. start of the sample reach and data loggers). The reference point will be used as a permanent benchmark; a vertical and horizontal control point used for all monitoring conducted at a sample site.

The RP was established on a stable substrate (a non-erodible slope) outside of the 100-year floodplain of the sample reach. It was typically placed between the start of the sample reach and the temperature data loggers, with a clear visual of both locations.

The reference point was established with a 60 cm (2-foot) rebar, usually pounded into the root of a live tree, solid piece of LWD, or sometimes directly into the ground. The rebar was installed so that only 20 cm (8 inches) remained above the surface. An orange plastic mushroom cap was placed on the top of the rebar. Pink flagging was labeled with a permanent marker: *Reference Point [basin ID]* and tied to the rebar. An aluminum tag, inscribed: *RP [basin ID]*, was attached to the rebar with metal wire. The rebar was also marked with blue spray paint. The reference point coordinates were documented in the field form and recorded with the GPS as: *RP [basin ID]*. A short description of the RP location was also included in the field form.

Two live, vigorous trees near the RP were identified as reference trees. They could be used to locate the RP in the future, if necessary. The species and DBH of each reference tree was recorded in the field form. The distances (to the nearest 0.1 m) and azimuth from each reference tree to the RP were measured and recorded. An aluminum tag was nailed to each reference tree, pointing towards the rebar and inscribed with the distance and azimuth to the rebar (for example: Ref. Tree #1 RP at 7.8 M @ 320°).

The two reference trees were flagged with pink flagging and marked with blue spray paint. A picture of the RP was taken from 2 m to the north of the RP; the tagged, flagged, and painted reference trees were included in the photo whenever possible. The picture number was recorded in the field form.

The procedure for establishing an RP and reference trees in the ONP reference sites was the same as described above except no paint was used and red biodegradable flagging was used instead of pink plastic flagging. All aluminum tags and flagging for the RP and reference trees had additional labeling: *DNR, P. Crain, OLYM-361, OCT-13*.

TEMPERATURE DATA LOGGERS: DESCRIPTION, PROGRAMMING, AND SPECIFICATIONS

Onset Tidbit© v2 temperature loggers will be used to monitor air and water temperatures at all sample reaches (Figure 2). All temperature sensors were calibrated according to the methods of Ward (2011) before deployment and are claimed by the manufacturer to have a resolution of $\pm 0.02^{o}$C. Their calibration will also be checked post-study. Each sensor was programmed to start recording on a specified date and to record the temperature every 80 minutes throughout the year following the protocol described in Dunham et al. (2005). This interval will provide less than 1% error recording the daily maximum temperature while providing up to 4 years of data storage if necessary.

Figure 2. An Onset Tidbit© v2 temperature logger.

INSTALLATION OF WATER TEMPERATURE LOGGERS

One water temperature data logger was deployed in each basin. The data logger was installed upstream from the start of the sample reach and close to the reference point. First, a solid anchor point was located to securely attach the data logger to withstand the winter high flows. Identifying a deep pool (>0.5 m) to place the data logger was also important since it needed to stay anchored and submerged year-round. The type of anchor used to secure the water temperature data loggers varied depending on the availability of solid natural features.

Figure 3. Examples of anchor points for the water temperature data loggers
A. live tree root; *B.* tree trunk; *C.* LWD with rebar; *D.* copper wire wrapped round the connection point of two boulders; *E.* drilling a lag screw into a boulder; *F.* completed lag screw anchor in a boulder.

The anchor point was chosen in the following order of preference: a) a solid live tree root at the stream bank, b) a tree trunk at the stream bank, c) a solid piece of LWD with a rebar pounded into it, d) a copper wire wrapped around the connection point of two boulders, or f) a lag screw drilled into a solid boulder. (Figure 3).

The ID number of the logger and the programmed start date were recorded in the field form and in the Forest Service's instrumentation form. Each data logger was checked in the field prior to installation to ensure that the LED was blinking indicating that the logger was recording or had been programed to record. The data logger was then placed in a green PVC housing and secured with nylon zip ties. A preassembled anchor consisting of copper wire wrapped around a brick was then zip tied to the PVC housing which kept the logger about 10 cm above the channel bottom. (Figure 4). The brick and PVC housing with the logger were then securely attached to the anchor point using abrasion and rot resistant nylon cord. The water temperature logger setup was placed in the deepest part of the channel and a medium-sized flat rock was placed on top to protect it and hold it in place.

Figure 4. Left: water temperature data logger setup zip tied into a protective PVC housing. Right: complete setup with data logger, anchor brick, zip ties, PVC housing, and nylon cord.

The location of the anchor point was marked with blue paint and blue flagging. A picture of the water temperature logger installation was taken and the photo number was recorded in the field form. The location of the logger can be identified from the permanent reference point for the site (see below).

The procedure for locating an anchor point and installation of the water temperature loggers in the ONP reference sites was the same as described above except no paint was used to mark the location of the anchor point according to permit requirements. Instead, blue biodegradable flagging was used and labeled: *DNR, P. Crain, OLYM-361, OCT-13, Water Logger [basin ID]*.

All 54 basins were equipped with water temperature data loggers during the 2012 field season.

INSTALLATION OF AIR TEMPERATURE LOGGERS

One air temperature data logger was also deployed at each sample reach to correlate air vs. water temperature and as a check in case the water logger became exposed to the air during its deployment.

The air logger was placed in a white plastic shade device to protect it in case exposed to direct sunlight and secured using nylon zip ties (Figure 5). Nylon cord was used to hang the assembly upside down from a live tree branch or tree trunk on the north side of the tree, located at or near the stream bank and in close proximity and microclimate as the water temperature logger. The air temperature logger was placed a minimum of 2 m above the stream to avoid being submerged during high flow.

Figure 5. ***Left*****: Air temperature data logger setup, view from inside the cup.** ***Right*****: Complete air temperature data logger setup, mounted on north side of a tree.**

The tree was marked with blue paint and blue flagging and referenced from the anchor point of the water temperature data logger. The distance (to the nearest 0.1 m) and compass bearing (azimuth) from the water temperature logger's anchor point were measured and recorded on the field form. A picture of the air temperature installation was taken from the stream and the picture number was recorded on the field form.

Figure 6. An example of a typical temperature data logger setup (basin 796).

The procedure for the installation of the air temperature loggers in the ONP reference sites was the same as described above except no paint was used to mark the location of the data logger. Blue biodegradable flagging was used and labeled: *DNR, P. Crain, OLYM-361, OCT-13, Air Logger [basin ID]*.

All 54 basins were equipped with air temperature data loggers during the 2012 field season.

LOCATING POINTS FROM THE REFERENCE POINT

The start of the sample reach and the water temperature data loggers anchor point were both referenced from the RP (Figure 7). A meter tape was used to measure the slope distance between the top of the RP rebar to the start of the sample reach at the thalweg, holding the tape at breast height. The azimuth from the RP was also recorded. The distance and azimuth were recorded on an aluminum tag: (e.g. Start of Reach 6.5 M @ 290°). The aluminum tag was then nailed to a "bearing tree", which was one of the RP reference trees. The same procedure was used to record the distance and azimuth from the RP to the anchor point of the water temperature data logger. All tags on the bearing tree were attached on the side of the tree facing the reference point.

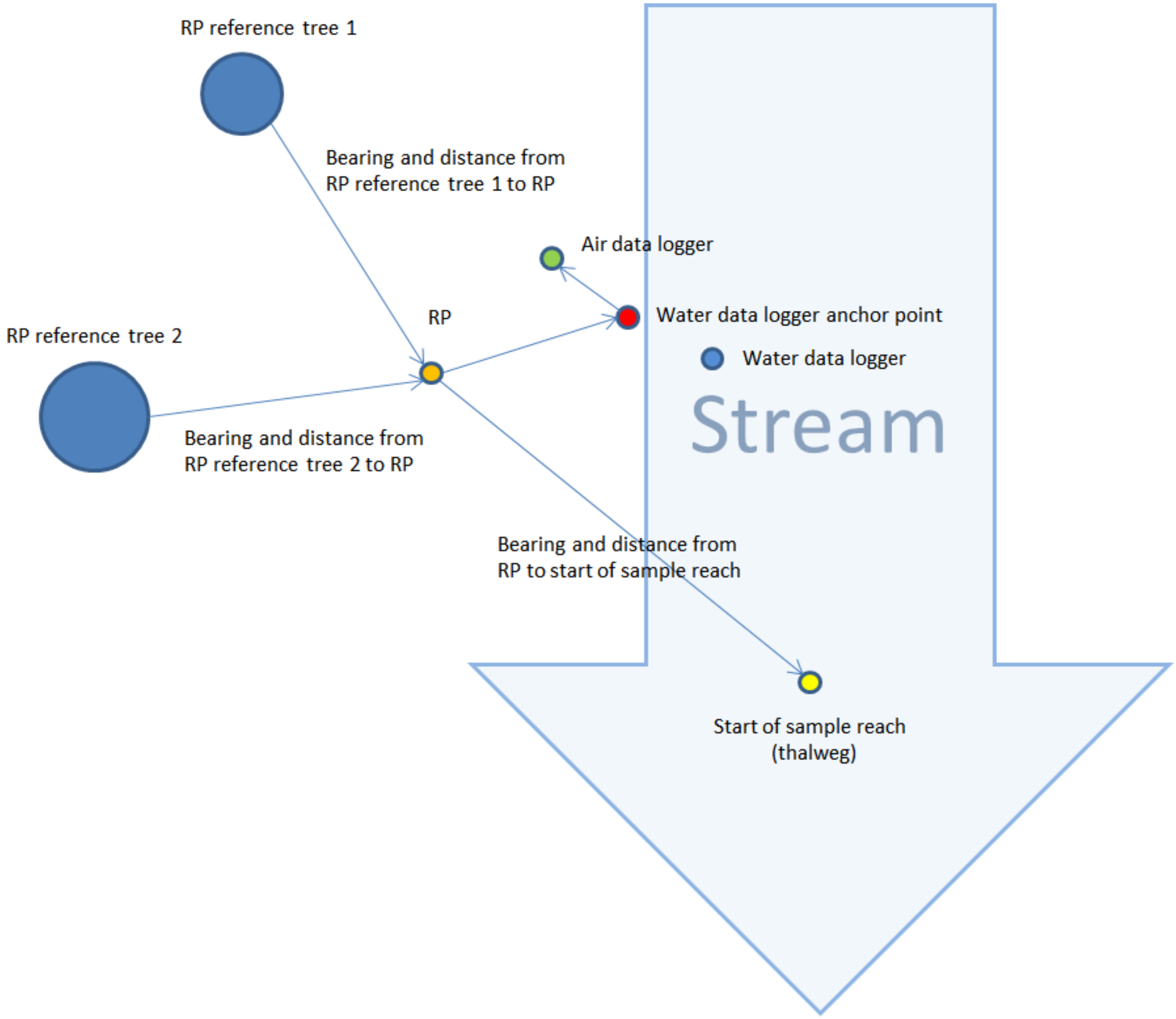

Figure 7. Illustration referencing the start of the sample reach, the anchor point of the water temperature data logger, and the air temperature data logger from the RP.

There was one basin where the topography prevented placing the RP close to the start of the sample reach and there was no visual between the RP and start of the sample reach. In this case, the start of the sample reach was referenced from the anchor point of the water temperature data logger by measuring the distance downstream along the thalweg. No azimuth was recorded for this situation.

The procedure for referencing points from the RP in the ONP reference sites was the same as described above except the aluminum tags also included the inscription: *DNR, P. Crain, OLYM-361, OCT-13*.

A field sketch was drawn in the field form that illustrated the locations of the start of the sample reach, the RP, reference tree #1, reference tree #2, the water temperature data logger, the air temperature data logger, and any other pertinent/notable features (e.g. large downed logs, snags, boulders, eroded banks) (see Appendix D).

CHARACTERIZATION OF THE SAMPLE SITES

A brief description of the sample reach was recorded during the field reconnaissance. The information was collected to aid in developing field protocols. Precise measurements of the stream gradient, confinement, sinuosity, width, depth, shade, substrate, habitat units, large woody debirs, riparian microclimate, and riparian vegetation will be conducted during the field sampling in 2013.

Several attributes of the sample reaches and adjacent areas near their RP’s were described:

1. **Stream channel type** was identified using the classification of Montgomery and Buffington (1993) in the following categories: cascade, step-pool; pool-riffle.
2. **Valley type** was visually identified using the classification from Moore et al. (2006) as referenced in the Oregon Department of Fish and Wildlife Aquatic Inventories Project. Valleys were classified as open V-shaped, moderate V-shaped, steep V-shaped, constraining terraces, or multiple terraces. See Appendix E for illustrations.
3. **Channel gradient** was measured with a clinometer in percent slope over average distance of 15 m (range 9.6- 39.0 m) along the stream channel.
4. **Channel confinement** was identified using one of the following 3 categories (Bisson et al. 2006):
    - unconfined (floodplain width >4 channel widths)
    - moderately confined (floodplain width = 2-4 channel widths)
    - confined (floodplain width <2 channel widths)
5. **Stream flow** was described using one of the following categories: 1) High energy 2) Steady 3) Intermittent 4) Absent.
6. **Substrate** was visually estimated as a percent coverage of different particles over a 2 m wide strip, perpendicular to the stream flow and stretching between bankfull channel edges. The following categories from the USDA Soil Survey Manual (1993) were used as guidelines:
    - Boulders (>600mm)
    - Stones (250-600mm)

    - Cobbles (75-250mm; baseball to bowling ball)
    - Gravel (2-75mm; pea to baseball)
    - Sand (0.05-2mm)
    - Silt (0.002-0.05mm)
    - Clay (<0.002mm)
7. **Riparian vegetation** was identified by species and noted as being either overstory (canopy trees) or understory (shrubs, ferns, ground cover, etc.).
8. **Fish presence** within the sample reach was noted via observation. It is possible that fishes were present at some of the sites but were not seen.

Other characteristics (e.g. log jams, unstable banks, culverts, tributaries, segments of subsurface flow) were also noted in the field form.

INSTALLATION OF VELCRO STRIPS TO ESTIMATE PEAK FLOW

Velcro strips were used to experiment with an inexpensive method for detecting annual peak flow following a suggestion from Dr. Susan Bolton, Professor of Hydrology at the University of Washington. Streams debris and sediment will stick to the Velcro and the highest flow will leave the highest marks on the Velcro. Both sides of the Velcro (loop and hook) were installed in each basin, as each will trap different material (moss vs. silt). Each strip was 10 cm wide by 1 m long. Eight out of the fifty-four basins in this study (#252, 488, 619, 621, 637, 653, 837, and Main Hoh) were used to test the method.

The location of the Velcro strips was between the RP and end of the sample reach. The Velcro strips were attached to a tree with DBH > 10 cm or a piece of LWD that was solid and non-peeling. The trees trunk or the LWD were selected to start near bankfull stage and to have a solid vertical attachment area of at least 20 cm by 1 m. The installation height of the Velcro strips varied by basin because of the differing levels of anticipated peak flow and availability of trees or LWD close enough to the stream.

The bankfull stage was marked at the installation location with blue paint. The two pieces of Velcro strips were placed parallel to each other in the vertical direction (Figure 8). To experiment with durability, the Velcro strips were oriented towards the stream flow in some basins and in others the strips were oriented with the stream flow. The Velcro strips were attached with staples or small nails.

The approximate installation location (in relation to the RP, start, end, data loggers, prominent features, etc.) was described and sketched in a special "Velcro" field form. The location was also recorded with the GPS and labeled as: *VELCRO [basin ID]*. The GPS coordinates were also recorded in the field form. The Velcro installation location was flagged with pink flagging that was labeled: *Velcro [basin ID]*. The tree's species name, DBH and location (left or right side of the stream) were recorded. A photo was taken of the Velcro installation and the photo number was recorded in the field form. For an example of a completed Velcro Field Data Form, see Appendix D.

The procedure for installing the Velcro strips in the ONP reference site was the same as described above except no paint was used and red biodegradable flagging was used instead of pink plastic flagging. The flagging had additional labeling: *DNR, P. Crain, OLYM-361, OCT-13*.

Figure 8. An example of a Velcro strips installation (basin 619).

Description of the Sample Basins from the 2102 Field Establishment

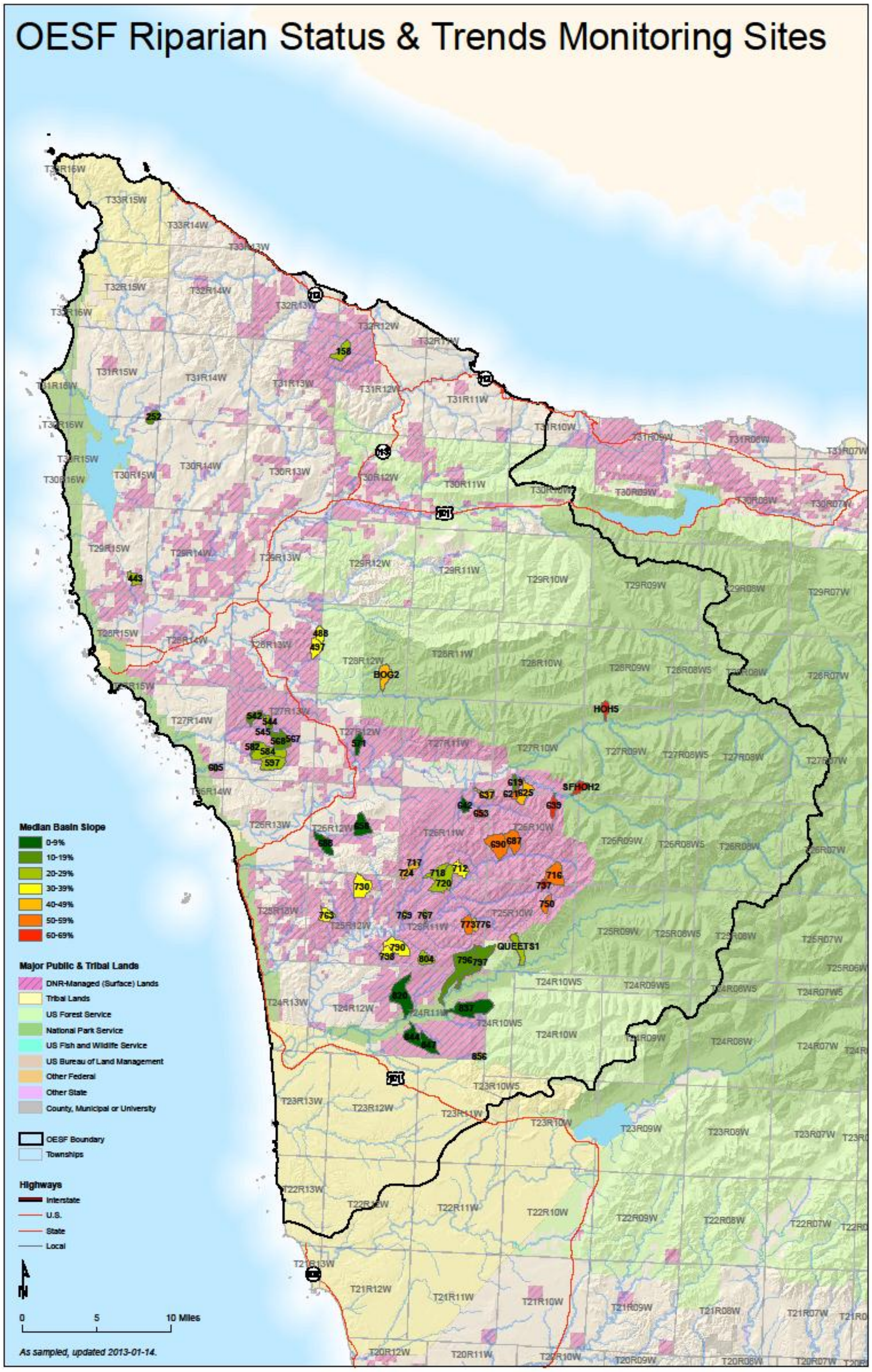

Figure 9. Fifty sample basins in OESF and four reference basins in ONP color coded by median basin slope.

Field reconnaissance was conducted in sixty eight basins during September and October of 2012. Fifty basins in the OESF and four basins in the ONP were selected for sampling (Figure 9 and Table 2).

Table 2. Selected sample basins

Basin ID*	Basin area (acres)	Basin median slope (%)	Legal description of the outlet point
158	519	26	T32-0N R12-0W S31
252	364	18	T31-0N R15-0W S36
443	359	20	T29-0N R15-0W S36
488	318	33	T28-0N R13-0W S12
497	499	33	T28-0N R13-0W S24
542	382	17	T27-0N R13-0W S17
544	126	21	T27-0N R13-0W S16
545	114	17	T27-0N R13-0W S16
568	463	11	T27-0N R13-0W S15
582	181	19	T27-0N R13-0W S29
584	995	20	T27-0N R13-0W S29
567	283	13	T27-0N R13-0W S15
571	388	4	T27-0N R12-0W S28
597	837	24	T27-0N R13-0W S28
605	88	14	T27-0N R14-0W S36
619	217	11	T27-0N R10-0W S29
621	221	53	T27-0N R10-0W S32
625	537	49	T27-0N R10-0W S33
637	294	46	T27-0N R11-0W S35
639	327	61	T26-0N R10-0W S02
642	263	5	T26-0N R11-0W S02
653	149	64	T26-0N R11-0W S12
658	764	9	T26-0N R12-0W S21
687	736	57	T26-0N R10-0W S29
688	603	3	T26-0N R12-0W S19
690	1085	50	T26-0N R10-0W S30
712	475	38	T26-0N R11-0W S35
716	901	57	T26-0N R10-0W S26
717	150	42	T26-0N R11-0W S32
718	493	21	T25-0N R11-0W S05
720	999	27	T25-0N R11-0W S03
724	177	46	T25-0N R11-0W S06
730	895	39	T25-0N R12-0W S10
737	159	62	T25-0N R10-0W S03
750	298	56	T25-0N R10-0W S02
763	439	31	T25-0N R12-0W S16
767	112	25	T25-0N R11-0W S21
769	76	30	T25-0N R11-0W S18

Table 2. Selected sample basins (continued)

Basin ID*	Basin area (acres)	Basin median slope (%)	Legal description of the outlet point
773	414	53	T25-0N R11-0W S13
776	176	48	T25-0N R11-0W S14
790	849	39	T25-0N R11-0W S15
798	327	34	T25-0N R11-0W S16
796	1764	11	T25-0N R11-0W S17
797	1135	16	T25-0N R11-0W S18
804	432	21	T25-0N R11-0W S19
820	1494	6	T25-0N R11-0W S20
837	1540	2	T25-0N R11-0W S21
844	710	4	T25-0N R11-0W S22
847	576	3	T25-0N R11-0W S23
856	110	27	T25-0N R11-0W S24
BOG2**	640	49	T25-0N R11-0W S25
SFHOH2**	329	67	T25-0N R11-0W S26
HOH5**	253	66	T25-0N R11-0W S27
QUEETS1**	552	29	T25-0N R11-0W S28

* Source of the basin ID#: DNR's GIS watershed boundary dataset (SHARED_LM.OESF_WATERSHED)
** Reference basin

The distributions of the sample basins by size, percent state lands, and median slope gradient are shown on Figures 10-12. They were compared with the sample frame of 236 basins to assess the representativeness of the sample. The only instance of non-representative sample was in the basin size category >1000 acres. Further analysis revealed that this is due to the incorrect delineation of Type 3 basins in the corporate DNR dataset, where several Type 3 basins were lumped together and identified as a single large Type 3 basin. Our study excluded those from the pool of potential sample basins during the GIS reconnaissance because of the incorrect delineation.

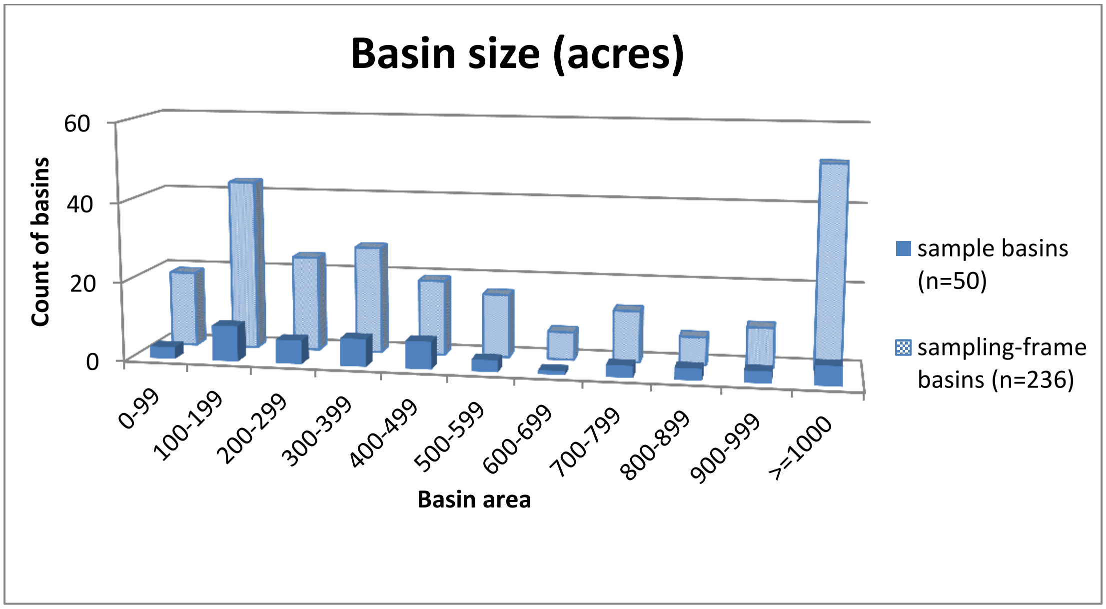

Figure 10. Distribution of sample basins and sample frame basins by basin size.

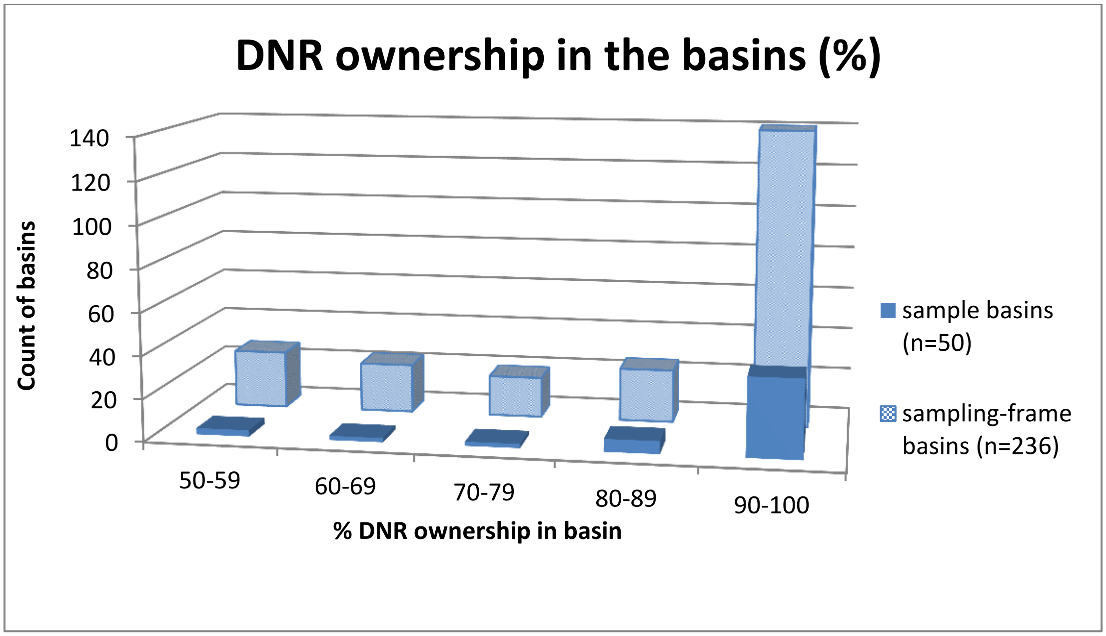

Figure 11. Distribution of sample basins and sample frame basins by percent DNR ownership.

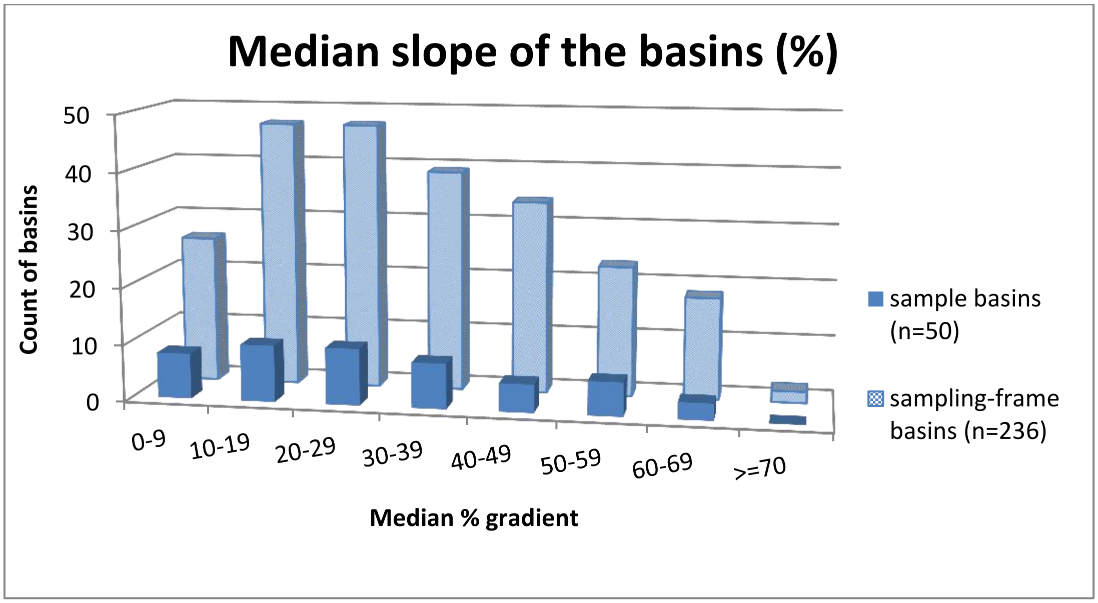

Figure 12. Distribution of sample basins and sample frame basins by median slope percent.

Description of Sample Reaches

A summary description of the sample reaches is presented in Figures 13-19. It is a result of a rapid field characterization during the 2012 field reconnaisance. More precise measurements and categorizations will be conducted when the sampling begins next field season. The sampling will follow standardized protocols which are currently under development.

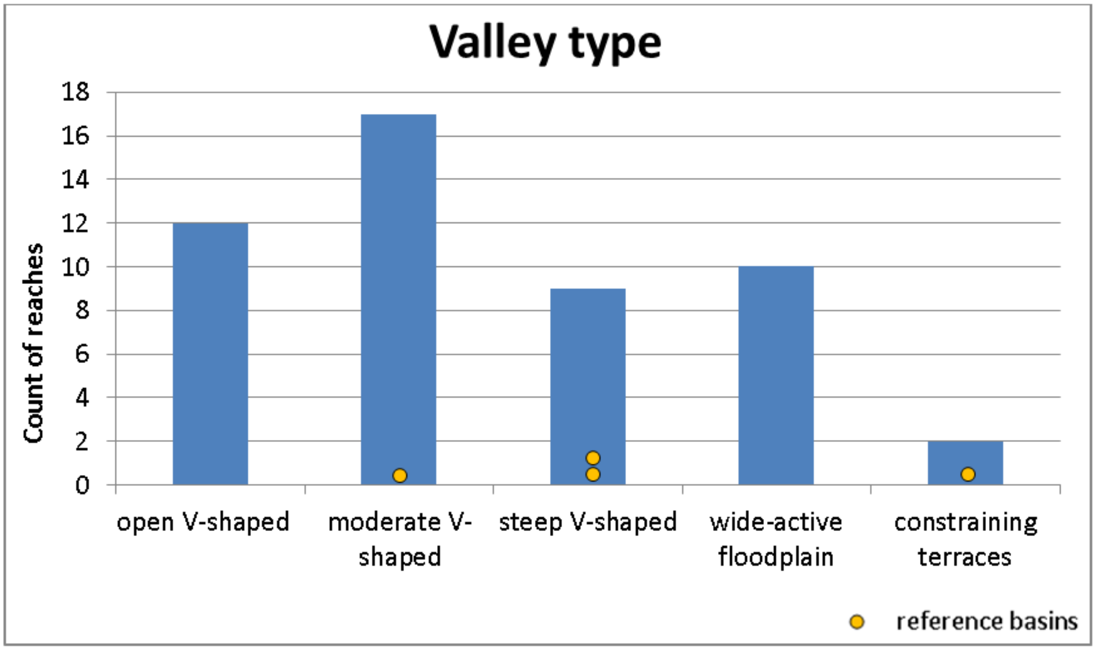

Figure 13. Distribution of sample reaches by valley type. Yellow circles are reference sites located within Olympic National Park.

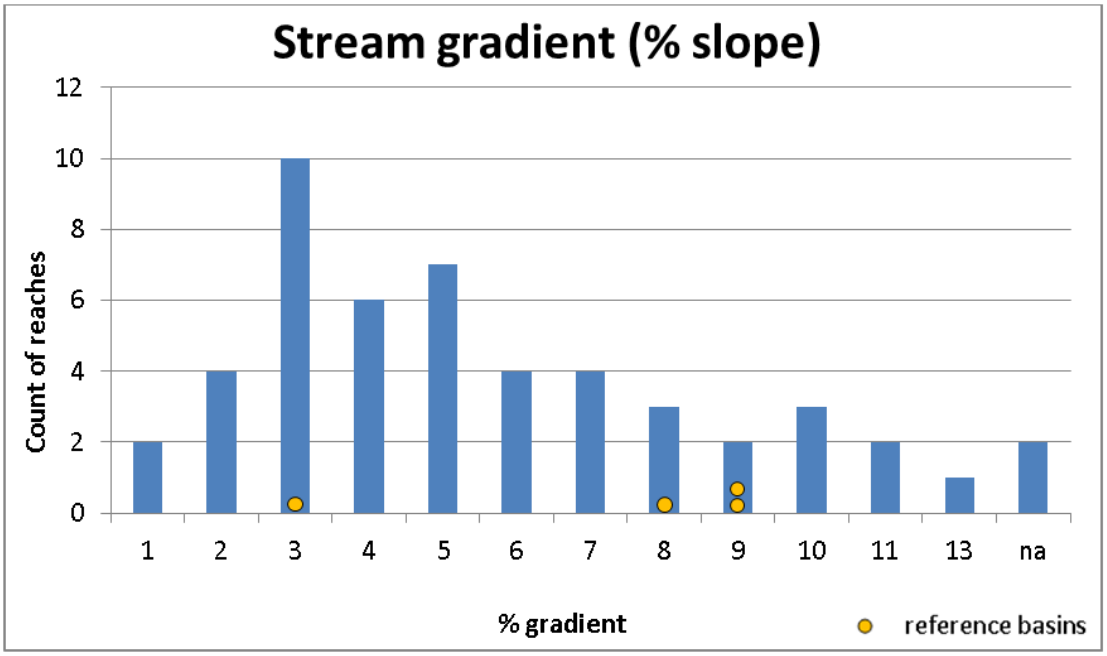

Figure 14. Distribution of sample reaches by stream gradient (% slope).

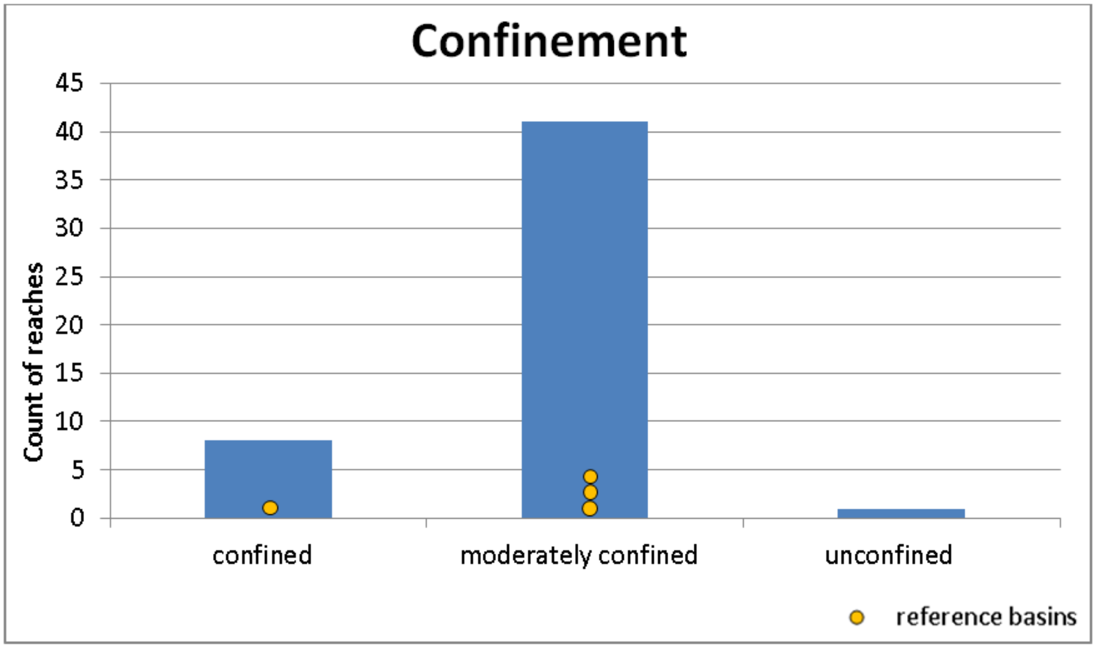

Figure 15. Distribution of sample reaches by confinement.

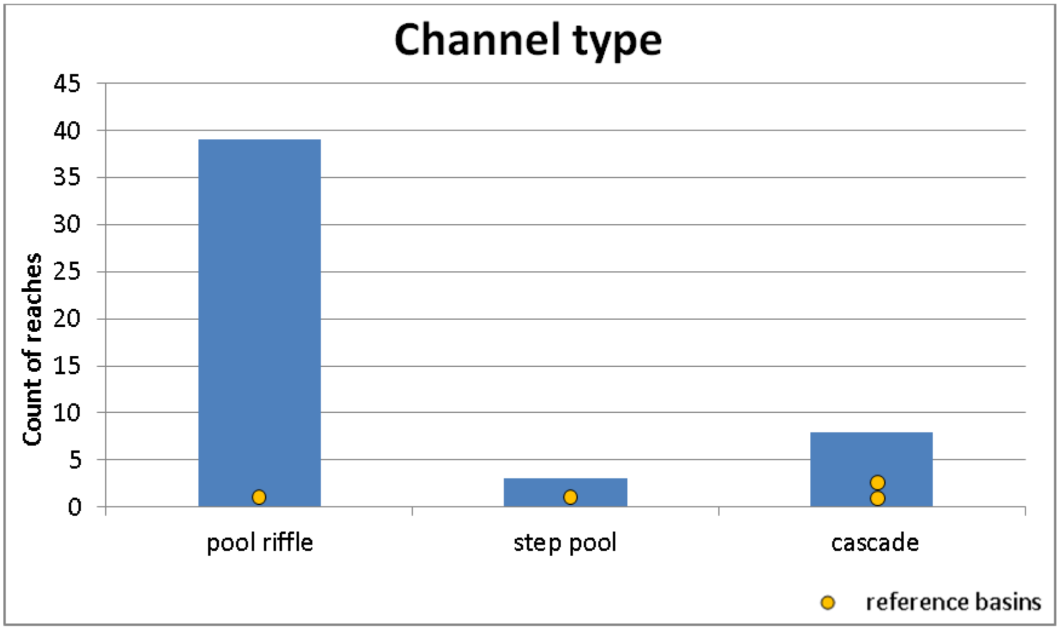

Figure 16. Distribution of sample reaches by channel type.

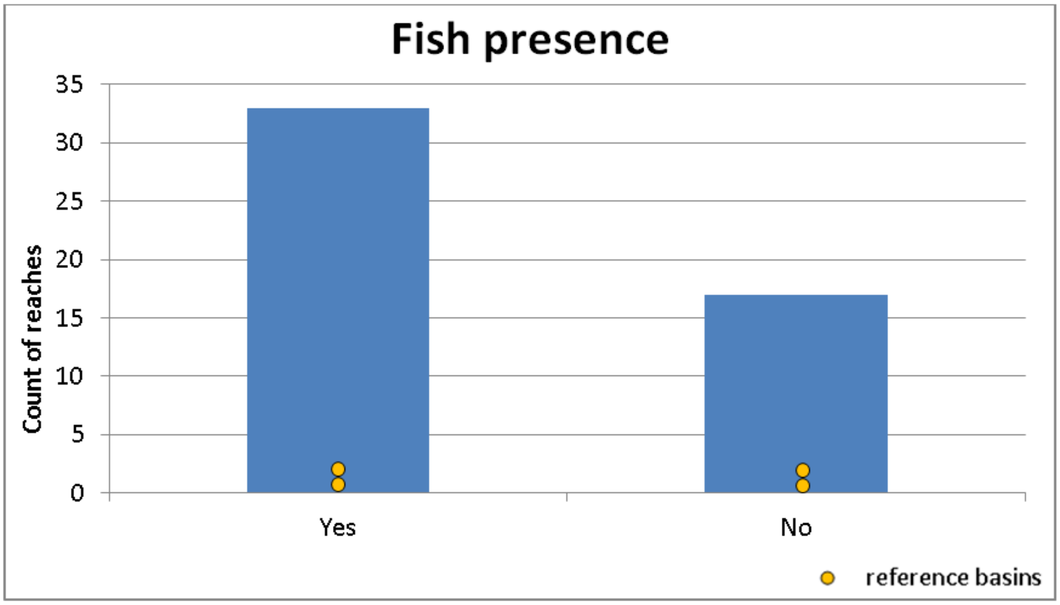

Figure 17. Distribution of sample reaches by fish presence (estimated though observation; this is a conservative estimate of fish presence).

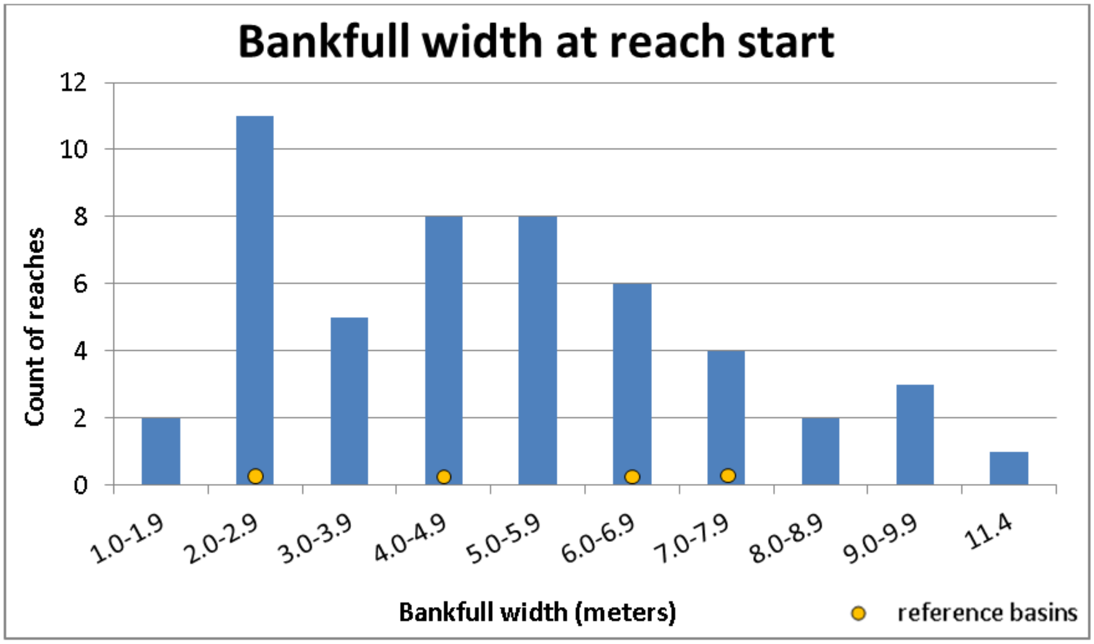

Figure 18. Distribution of sample reaches by bankfull width at reach start.

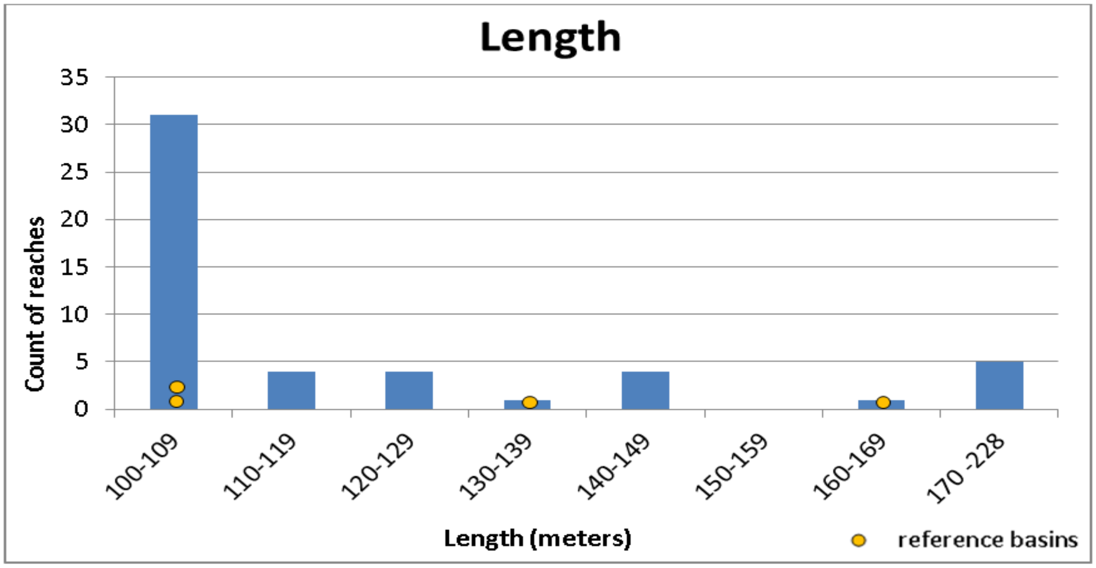

Figure 19. Distribution of sample reaches by length.

Data Management

The information from all field forms was entered into Excel spreadsheet with hyperlinks to photo documentation. Copies of the database are stored at DNR (contact person Teodora Minkova) and PNW (contact person Alex Foster). Hard copies of the field forms are catalogued and kept at DNR.

Data verification was conducted in the office upon entering the information from the field forms and a second time when the database was reviewed for omissions and outliers.

Databases will be developed for the individual indicators in the future. They will be described in the protocols (currently under development) and will include metadata and QA/QC procedures.

All GIS layers and digital maps developed for this project are stored at DNR (contact person Teodora Minkova).

Budget and Staff for the First Field Season

DNR provided $145,000 for this project for fiscal year 2013 (July 1, 2012 – July 1, 2013). Part of the funding was used for field technicians (including travel and lodging expenses), equipment, and personal field gear. The remaining funds from this installment will be used for the 2013 field season, expected to start in May 2013, and for external scientific consultation on the field protocols and the sampling design of the study.

DNR is expected to provide the same amount of funding for fiscal years 2014 and 2015.

PNW provided $18, 000 in 2012 which was used to buy, calibrate, and install 108 temperature data loggers, with several loggers held in reserve in case a field unit was lost or failed to function properly.PNW also contributed in-kind through field staff and scientific expertise.

The project staff for 2012 consisted of a research team and four field technicians.The staff members and their primary roles in the project for the reported year are listed in Table 3.

Table 3. Project team and primary roles for 2012.

Name	**Affiliation**	**Project position**	**Primary role in 2012**
Teodora Minkova	OESF Research and Monitoring Manager, DNR	Principal Investigator Project Manager	Overseeing GIS and field reconnaissance, project coordination, budget, hiring, supervising and training field techs, outreach and communication, data management, reporting
Peter Bisson	Emeritus Scientist, PNW	Principal Investigator	Scientific consultation on GIS and field reconnaissance
Alex Foster	Ecologist, PNW	Researcher	Scientific consultation on GIS and field reconnaissance, training field techs, preparation and installation of temperature data loggers
Shannon Claeson	Ecologist, PNW	Researcher	Scientific consultation on GIS and field reconnaissance
Richard Bigley	Silviculturist, DNR	Researcher	Scientific consultation on GIS and field reconnaissance, training field techs
Jeffrey Ricklefs	Environmental Analyst, DNR	Researcher	GIS reconnaissance, developing GIS layers and maps, scientific consultation on field reconnaissance
Scott Horton	Olympic Region Wildlife Biologist, DNR	Researcher	Scientific consultation on GIS and field reconnaissance, logistical support
Mitchell Vorwerk	Scientific Technician, DNR	Field technician	Field reconnaissance, preparation of 2012 establishment report
Ellis Cropper	Scientific Technician, DNR	Field technician	Field reconnaissance
Jessica Hanawalt	Scientific Technician, DNR	Field technician	Field reconnaissance, data entry and data management
Megan McCormick	Scientific Technician, DNR	Field technician	Field reconnaissance

Outreach and Communication

In 2012, the project team held several presentations and meetings within DNR and with external parties. There were two primary purposes for these efforts: 1) reporting and accountability and 2) soliciting interest from potential research collaborators.

COMMUNICATION WITHIN DNR

Presentation to DNR Forest Resources Division on 11/19/2012. The main purpose was to inform DNR managers and staff about this new project and to discuss overlap with and interest from other DNR programs and projects.

Presentation to DNR Olympic Region on 11/26/2012. The main purpose was to inform regional staff about this new project, to explain the relevance to management needs, and to solicit support for the next field season.

A brief report on the 2012 accomplishments was sent to DNR Executive Management via email in December 2012.

COMMUNICATION WITH EXTERNAL PARTIES

Several meetings with PNW were held to introduce the study and to solicit research collaboration. An agreement is currently being developed for scientific consultation on the field protocols and the inference design of the study.

The study was presented to National Oceanic and Atmospheric Agency's National Marine Fisheries Service in their role of a permiter for DNR's state lands HCP, on 12/04/2012. The main purpose was to introduce the study and to discuss relevance to HCP commitments such as riparian validation monitoring.

Meeting with the ONP research coordinator and the ONP liaison for this study took place in December 2012; the topics included data sharing, logistics, and research collaboration.

The study was introduced to the Olympic Forest Coalition on 11/27/2012 and to the American Forest Resource Council and City of Forks on 03/11/2012.

The project team plans to continue the communication with the above parties in 2013. In addition, the team intends contact the local Tribes (Hoh, Quinault, Quileute, and Makah) and local land managers, such as the Olympic National Forest and Rayonier, do discuss the potential for data sharing and other forms of collaboration.

The outreach to potential collaborators will include research institutions such as University of Washington and The Evergreen State College, and environmental organizations such as Wild Fish Conservancy and The Nature Conservancy.

CONSISTENCY WITH REGIONAL AND NATIONAL MONITORING PROJECTS

Numerous riparian and aquatic monitoring projects are currently conducted in the Pacific Northwest. It is well recognized that consistency between these projects will provide for

increased efficiency, lower costs, and opportunities for larger-scale assessments and greater statistical power (Roper et al. 2010).
The project team has done extensive research on the ongoing regional monitoring efforts and focused on two areas for increased consistency:

1. Participation in the national network for stream temperature monitoring maintained by FS Rocky Mountain Research Station (Figure 19). The OESF sample basins were included in the network in January 2013.

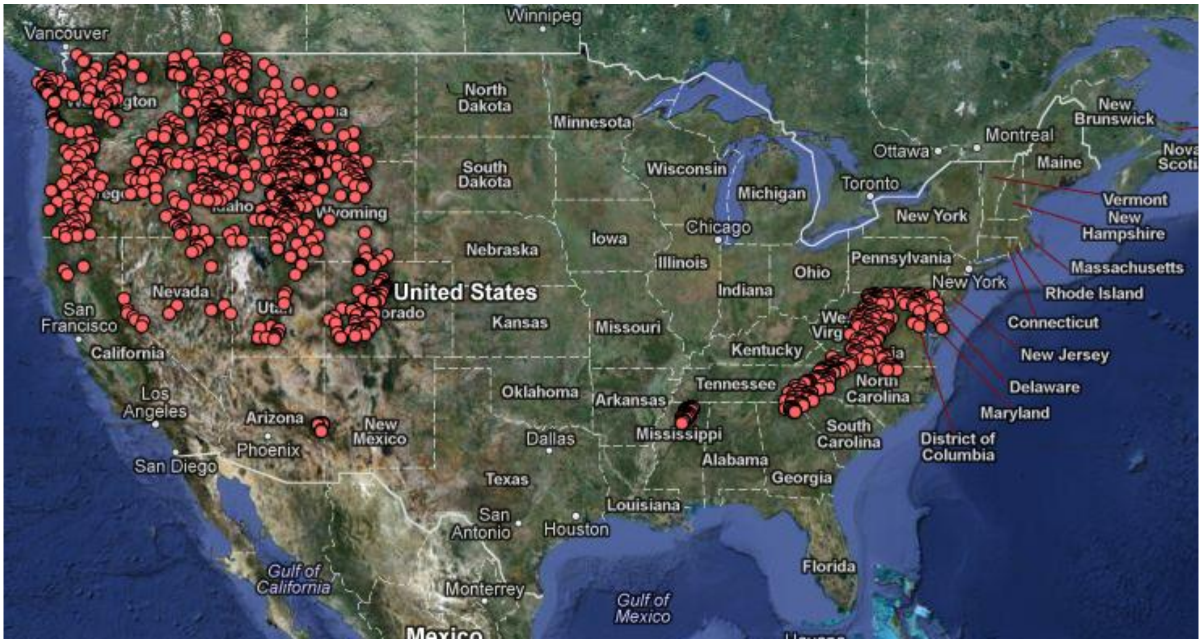

Figure 20. Map of nearly 3,200 sites on streams and rivers in the US and Canada where full year stream temperatures are currently being monitored by numerous agencies.
http://www.fs.fed.us/rm/boise/AWAE/projects/stream_temperature.shtml

2. Developing field protocols consistent with existing regional protocols. This effort is underway; the following protocols are being considered:
   - Timber Fish and Wildlife (TFW) Monitoring Program Method Manuals http://www.dnr.wa.gov/Publications/fp_tfw_am9_99_003.pdf
   - Environmental Monitoring and Assessment Program (EMAP) surface
   - Waters – Western Pilot Study Field Operations Manual http://www.epa.gov/emap2/html/pubs/docs/groupdocs/surfwatr/field/ewwsm_s7.pdf
   - Washington State Department of Ecology Monitoring Protocols https://fortress.wa.gov/ecy/publications/publications/1003109.pdf
   - Aquatic and Riparian Effectiveness Monitoring Program (AREMP) for the Northwest Forest Plan http://www.reo.gov/monitoring/reports/watershed-reports-publications.shtml
   - Columbia Habitat Monitoring Program (CHaMP) https://www.champmonitoring.org/Program/Details/1#protocol

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Appendix A. Excluded Basins

Basin ID*	Reason(s) For Exclusion:
133	No surface flow for >200 m above confluence point
161	No surface flow for >200 m above confluence point
328	No pools deeper than 0.5 m
460	No surface flow for >200 m above confluence point
470	No pools deeper than 0.5 m
489	No pools deeper than 0.5 m
548	No surface flow for >200 m above confluence point
550	Stream too small to be Type 3 (BFW<2 ft)
580	No surface flow for >200 m above confluence point
588	Loose dangerous logjams and low surface flow
604	Braided/undefined channel in a wide alluvial fan and no pools deeper than 0.5 m
635	Stream break (Type 3 to Type 4) within first 100 m
760	Braided/undefined channels in wide alluvial fan

* Source of the basin ID#: DNR’s GIS watershed boundary dataset (SHARED_LM.OESF_WATERSHED)

Appendix B. Equipment and Field Gear

Equipment List

- Brick halves
- Clinometers, Suunto brand
- Clipboards, aluminum
- Compass, Silva brand
- Cups, white plastic (for air data loggers)
- Flagging, blue and red, biodegradable
- Flagging, blue and pink, plastic
- Hammer, framing
- Hammer, mini sledge
- Maps, basin
- Nails, Steel and aluminum
- Pens/Pencils/Permanent Markers
- PVC pipe, green (for water data loggers)
- Rebar, 2ft lengths
- Rebar Caps, orange
- Rite in the Rain notebooks, soft cover
- Rope, green nylon
- Zip ties
- Spray Paint, blue
- Stadia Rods
- Tags, Aluminum
- Tape Measures, 50 m, fiberglass
- Tape Measures, D-tapes, metric
- Velcro strips
- Wire, large copper
- Wire, small aluminum

Personal Gear

- Boot Dryers
- Backpacks, external frame
- First Aid Kits
- Gloves
- Hard hats
- Hip waders and boots
- Safety Glasses
- Vests, orange
- Whistles

Electronics

- Batteries, AA
- CB Radios
- Cameras, Cannon
- GPS units, Garmin GPSmap62s
- Laptop, HP
- Temperature Data Loggers

Safety

Proper personal protective equipment was worn on a daily basis. Each field crew checked in/out of each basin, via handheld CB radio, with the Olympia Region radio dispatch. Important details communicated included: time of day, crew name, and basin coordinates (township, range, and section).

Appendix C. Glossary of Terms

Active channel – The channel within the bankfull.

Bankfull width – Horizontal distance between the bankfull stage on the left bank and the bankfull stage on the right bank of a stream.

Bankfull stage – Bankfull stage is delineated by the elevation point of incipient flooding, indicated by deposits of sand or silt at the active scour mark, break in stream bank slope, perennial vegetation limit, rock discoloration, and root hair exposure.

Bearing tree – A reference tree used to identify the bearings and distances from the RP to the start of the sampling reach and from the RP to the water data logger anchor point.

Canopy – The continuous cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

Channel confinement – The degree to which stream channel migration is limited in its lateral movement by terraces or hillslope. It is expressed as the ratio of the width of the floodplain to the channel's bankfull width.

Diameter at breast height (DBH) – The diameter of a tree, measured 4.5 feet above the ground on the uphill side of the tree.

Left bank – The side of the stream that is to the left of a person facing downstream.

Flagging – Colored ribbon used to identify hiking trails, sample reach segments, data loggers, reference points, or other features during the course of a survey.

100-year floodplain – the lateral extend of the water surface during flood occurring from a storm event that happens an average of every 100 years.

Hillslope – Natural boundaries confining the stream valley that have never been occupied by the stream.

Geographic information system (GIS) – A computer system that stores and manipulates spatial data, and can produce a variety of maps and analyses.

Indicator – Refers to the aggregation of metrics across the set of sites in a study, meant to characterize a domain's condition by inference from the set of site measurements.

Large woody debris (LWD) – Wood in the active channel that is larger than 10 cm in diameter and 1 meter in length.

Measurement – Refers to the value resulting from a field data collection event at a specific site and temporal period, i.e. what we actually measure/estimate in the field at a site (or within a site).

Outlet point – The confluence of the sample stream with the main stem (larger stream or river).

Reference tree – Marked tree that can be used to triangulate the position of a lost RP rebar.

Right bank – The side of the stream that is to the right of a person facing downstream.

Riparian zone – A narrow band of moist soils and distinctive vegetation along the banks of lakes, rivers, and streams.

Sample Basins – Type 3 basins identified for sampling through GIS and subsequent field reconnaissance

Sample Reach – A portion of a stream where field sampling takes place.

Thalweg – The line that connects the lowest points along the length of a river bed where there is active flow, and thus the line of fastest flow.

Terrace – The inactive floodplain, or active only during severe storm events on some rivers. These are raised areas on the valley flat that were historically part of the floodplain but were abandoned when the channel cut down (e.g., due to a new relation between discharge and sediment production).

Type 3 Basin – the watershed for a Type 3 stream.

Type 3 stream – smallest fish-bearing stream as identified through biological criterion (fish presence) or through physical criteria (a stream ≥ 2 ft (0.7 m) wide and ≤16% gradient for basins up to 50 ac (20 ha) or with a gradient between 16% and 20% for basins larger than 50 ac). Type 3 streams can be considered loosely equivalent to Strahler's 3rd order streams.

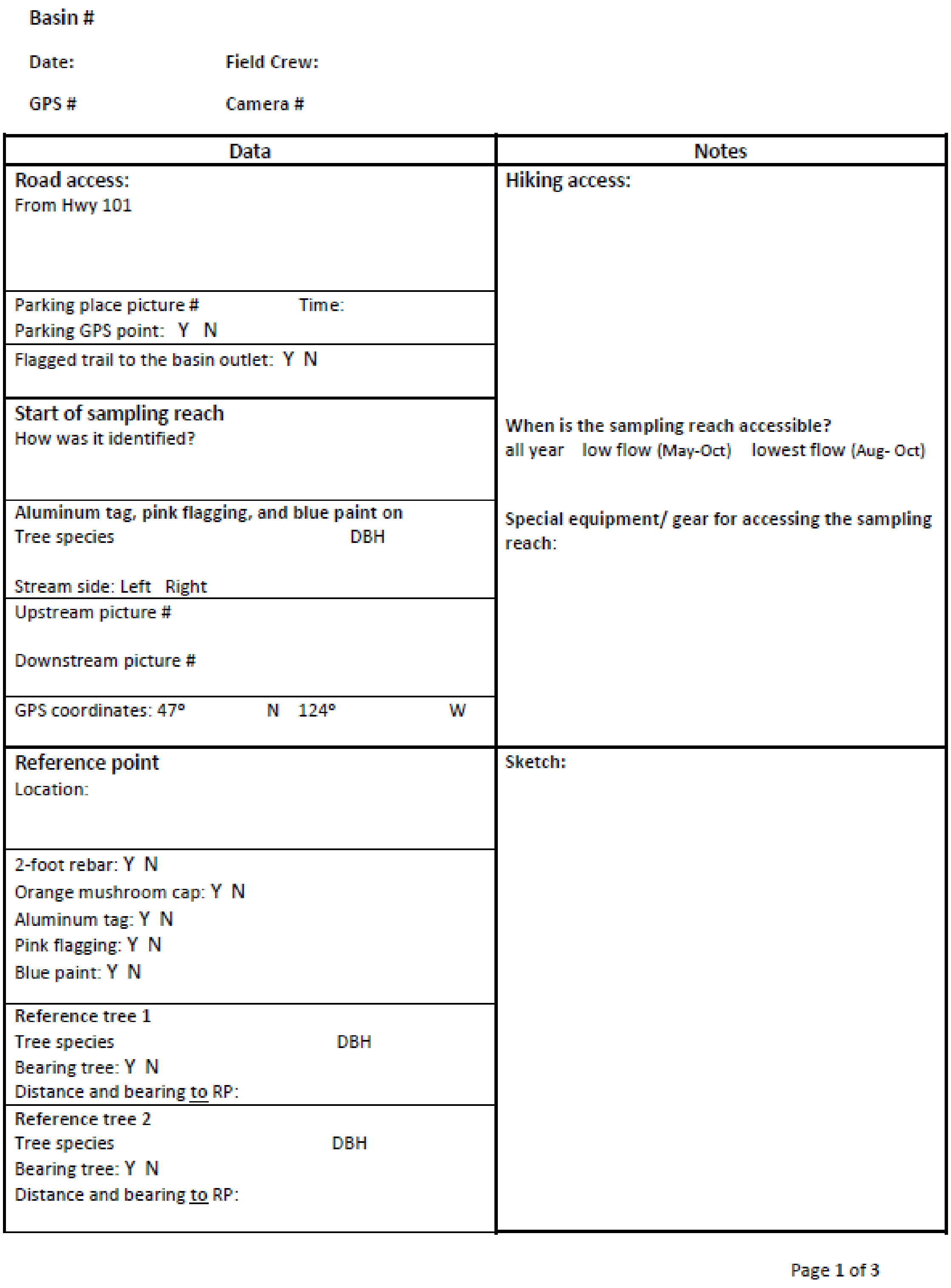
Valley width – The area that at some time in the past the channel has occupied each and every position across its width. Includes terraces and floodplain.

Wetted width – Farthest horizontal distance between water edge on the left and right sides of a channel.

Wetland – Areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions, such as swamps, bogs, fens, and similar areas.

Appendix D. Field Forms

Blank Field Form



Basin #

Date: Field Crew:

GPS # Camera #

Data	Notes
Road access: From Hwy 101	**Hiking access:**
Parking place picture # Time: Parking GPS point: Y N	
Flagged trail to the basin outlet: Y N	
Start of sampling reach How was it identified?	When is the sampling reach accessible? all year low flow (May-Oct) lowest flow (Aug- Oct)
Aluminum tag, pink flagging, and blue paint on Tree species DBH Stream side: Left Right	Special equipment/ gear for accessing the sampling reach:
Upstream picture # Downstream picture #	
GPS coordinates: 47° N 124° W	
Reference point Location:	Sketch:
2-foot rebar: Y N Orange mushroom cap: Y N Aluminum tag: Y N Pink flagging: Y N Blue paint: Y N	
Reference tree 1 Tree species DBH Bearing tree: Y N Distance and bearing <u>to</u> RP:	
Reference tree 2 Tree species DBH Bearing tree: Y N Distance and bearing <u>to</u> RP:	

Page 1 of 3

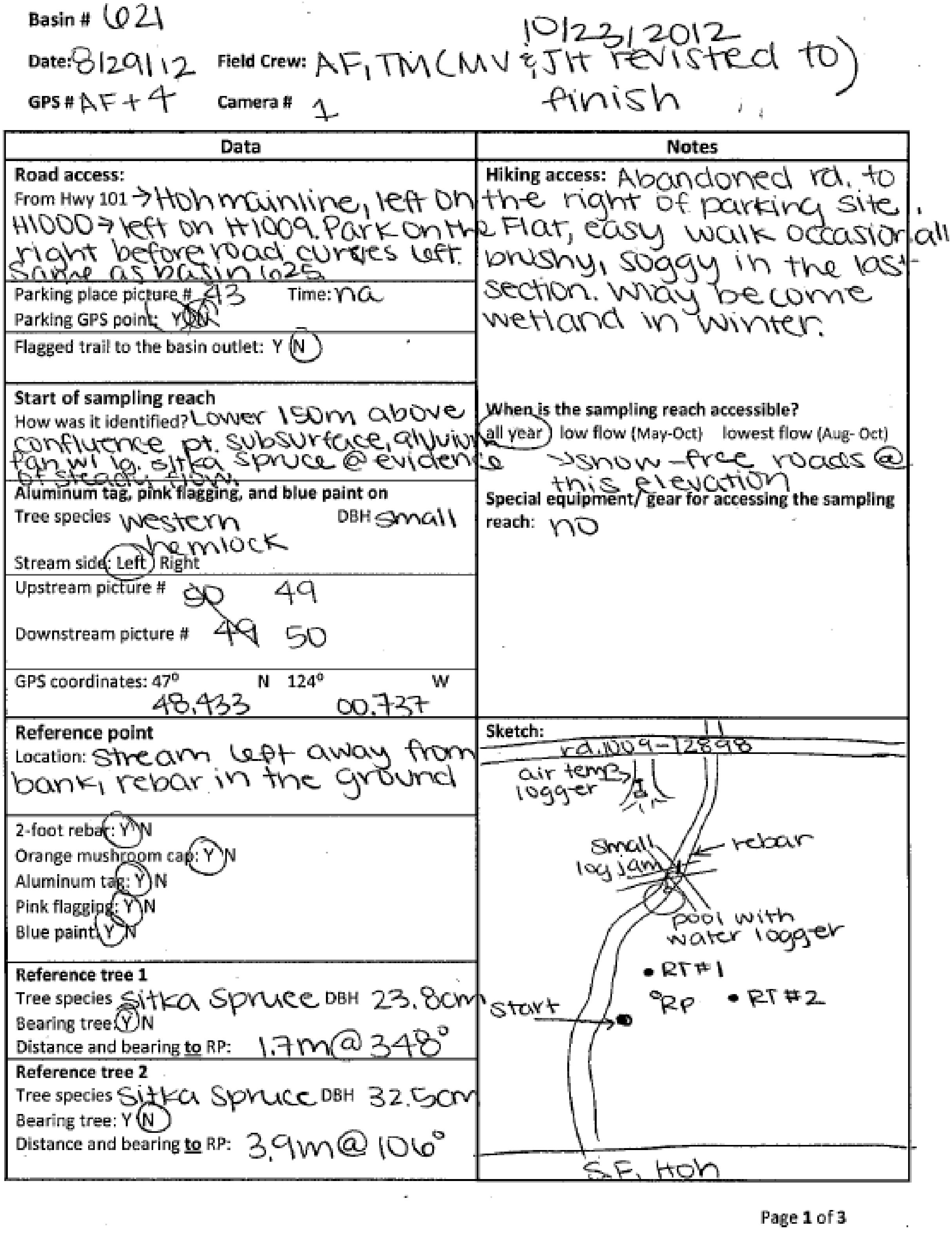
Picture of RP from 2 m at 0° (North):	
Distance and bearing of the reach start <u>from</u> RP:	
Distance and bearing of the water temp logger <u>from</u> RP:	
GPS coordinates: 47° N 124° W Recorded point in the GPS unit: Y N	
Stream description at reference point	
Valley type: Open V-shaped Moderate V-shaped Steep V-shaped Wide-active floodplain Constraining terraces Multiple terraces	
Gradient (% slope): % over m	
Confinement: Unconfined Moderately-confined Confined	
Channel type: Step pool Pool riffle Step pool cascade	
Substrate (% cover at bankfull width over 2 m length): Boulders (>600 mm) Stones (250-600 mm) Cobbles (75-250 mm; baseball to bowling ball) Gravel (2-75 mm; pea to baseball) Sand (0.5-2 mm) + Silt (<0.5 mm)	
Steam flow: High energy Steady Intermittent Absent	
Riparian vegetation (species and tree size): Overstory: Understory:	
Fish presence: Y N	
Other characteristics (tributaries, log jams, unstable banks, culverts):	

Page 2 of 3

Water Temperature Logger	
Logger #	
Programmed to start recording on , 2012	
Location:	
Attached to:	
Blue flagging: Y N Blue paint: Y N	
Picture #	
Air Temperature Logger	
Logger #	
Programmed to start recording on , 2012	
Location:	
Attached to:	
Blue flagging: Y N Blue paint: Y N	
Distance and bearing <u>from</u> water temp logger m at	
Picture #	
Bankfull width at reach start:	
Length of sampling reach:	
GPS tracking of sampling reach: Y N **Range of GPS points:**	
End of sampling reach Location:	
Aluminum tag and pink flagging on Tree species DBH Stream side: Left Right Picture #	
GPS coordinates: 47° N 124° W	
Check Access Description!	

Page 3 of 3

Completed Field Form



Basin # 1021

Date: 8/29/12 10/23/2012 **Field Crew:** AF, TM (MV & JH revisted to finish)

GPS # AF + 4 **Camera #** 1

Data	**Notes**
Road access: From Hwy 101 → Hoh mainline, left on H1000 → left on H1009. Park on the right before road curves left. Same as basin 1025	**Hiking access:** Abandoned rd. to the right of parking site. Flat, easy walk occasionally brushy, soggy in the last section. May become wetland in winter.
Parking place picture # 43 Time: na Parking GPS point: Y [✓ N]	
Flagged trail to the basin outlet: Y [✓ N]	
Start of sampling reach How was it identified? Lower 150m above confluence pt. subsurface, alluvium fan w/ lg. sitka spruce @ evidence of steady flow.	**When is the sampling reach accessible?** [✓ all year] low flow (May-Oct) lowest flow (Aug- Oct) → snow-free roads @ this elevation
Aluminum tag, pink flagging, and blue paint on Tree species western hemlock DBH small Stream side: [✓ Left] Right	**Special equipment/ gear for accessing the sampling reach:** no
Upstream picture # ~~50~~ 49 Downstream picture # ~~49~~ 50	
GPS coordinates: 47° 48.433 N 124° 00.737 W	
Reference point Location: Stream left away from bank, rebar in the ground	**Sketch:**
2-foot rebar: [✓ Y] N Orange mushroom cap: [✓ Y] N Aluminum tag: [✓ Y] N Pink flagging: [✓ Y] N Blue paint: [✓ Y] N	
Reference tree 1 Tree species Sitka Spruce DBH 23.8cm Bearing tree: [✓ Y] N Distance and bearing **to** RP: 1.7m@348°	
Reference tree 2 Tree species Sitka Spruce DBH 32.5cm Bearing tree: Y [✓ N] Distance and bearing **to** RP: 3.9m@106°	

Page 1 of 3

Picture of RP from 2 m at 0º (North): 51

Distance and bearing of the reach start **from** RP: 13.7m @ 32°

Distance and bearing of the water temp logger **from** RP: 26.5m @ 207°

GPS coordinates: 47º 48.430 N 124º 00.746 W

Recorded point in the GPS unit: [✓ Y] N

Stream description at reference point

Valley type:

Open V-shaped Moderate V-shaped Steep V-shaped

[✓ Wide-active floodplain] Constraining terraces Multiple terraces

Gradient (% slope): 2.5% over 15 m

Confinement:

Unconfined [✓ Moderately-confined] Confined

Channel type:

Step pool

[✓ Pool riffle]

Step pool cascade

Substrate (% cover at bankfull width over 2 m length):

Boulders (>600 mm) 0

Stones (250-600 mm) 5

Cobbles (75-250 mm; baseball to bowling ball) 30

Gravel (2-75 mm; pea to baseball) 50

Sand (0.5-2 mm) + Silt (<0.5 mm) 15

Steam flow:

High energy [✓ Steady] Intermittent Absent

Riparian vegetation (species and tree size):

Overstory: Sitka spruce, w. hemlock, red alder

Understory: salmonberry, huckleberry, oxalis, deer fern, sword fern

Fish presence: [✓ Y] N

Other characteristics (tributaries, log jams, unstable banks, culverts): waterfall over bedrock @ 30m

Page **2** of **3**

Water Temperature Logger

Logger # 10186913

Programmed to start recording on Sept 1, 2012

Location: Stream right

Attached to: rebar pounded into solid LWD

Blue flagging: [✓ Y] N

Blue paint: [✓ Y] N

Picture # 52

Air Temperature Logger

Logger # 10186939

Programmed to start recording on Sept 1, 2012

Location: right bank, close to water temp logger

Attached to: next to lg. sitka spruce

Blue flagging: [✓ Y] N

Blue paint: [✓ Y] N

Distance and bearing **<u>from</u>** water temp logger

4.45m at 142°

Picture # 53

Bankfull width at reach start: ~~2,7m~~ 3,1m

Length of sampling reach: 100m

GPS tracking of sampling reach: [✓ Y] N

Range of GPS points: 772-802

End of sampling reach

Location:

Aluminum tag and pink flagging on

Tree species Alder DBH 20.5cm

Stream side: Left [✓ Right]

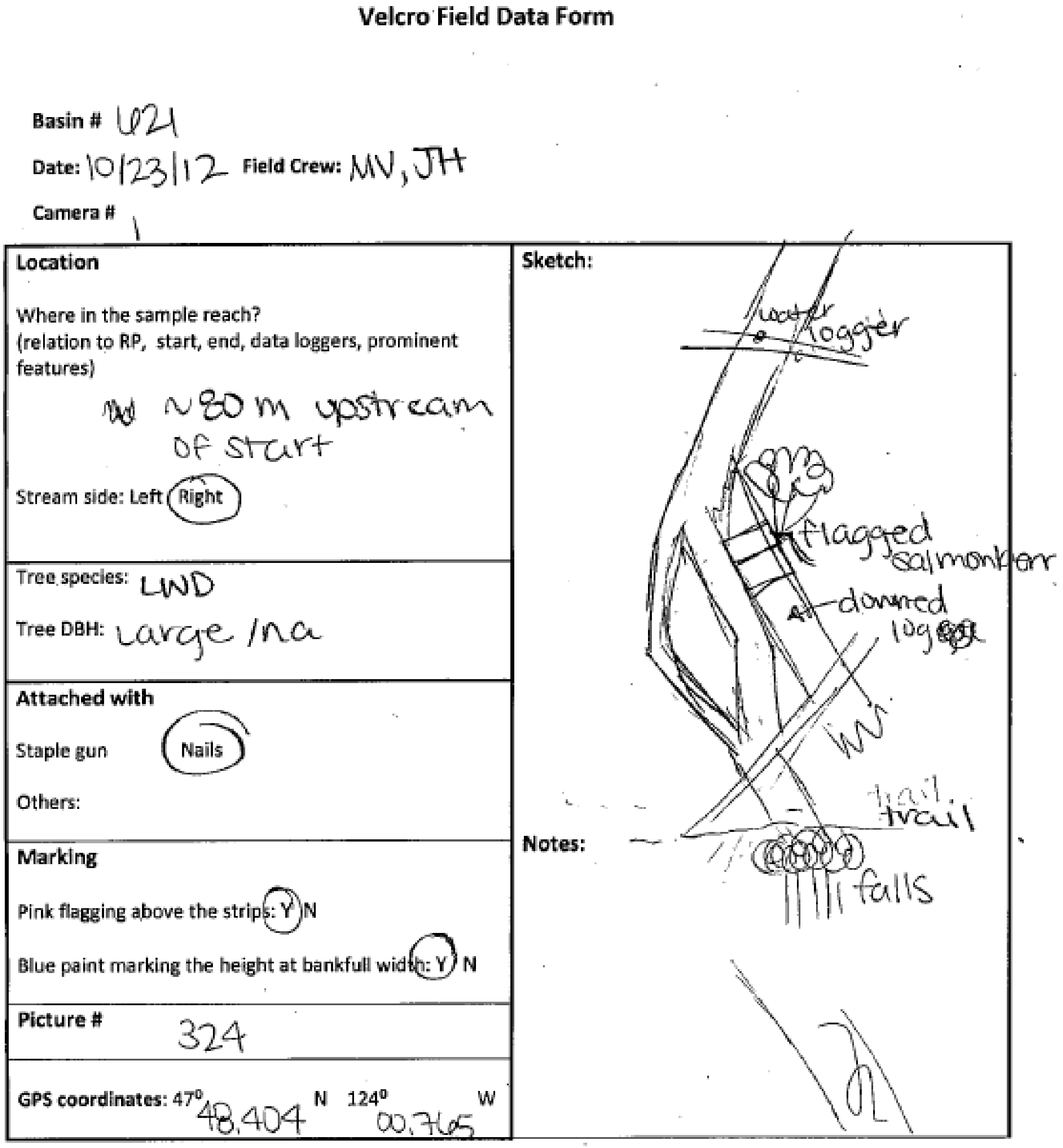
Picture # 323

GPS coordinates: 47° 48.396 N 124° 00.775 W

Check Access Description!

Page **3** of **3**

Velcro Field Form



Velcro Field Data Form

Basin # U21

Date: 10/23/12 **Field Crew:** MV, JH

Camera # 1

Location

Where in the sample reach?
(relation to RP, start, end, data loggers, prominent features)

~80 m upstream of start

Stream side: Left [✓ Right]

Tree species: LWD

Tree DBH: Large /na

Attached with

Staple gun [✓ Nails]

Others:

Marking

Pink flagging above the strips: [✓ Y] N

Blue paint marking the height at bankfull width: [✓ Y] N

Picture # 324

GPS coordinates: 47° 48.404 N 124° 00.765 W

Sketch:

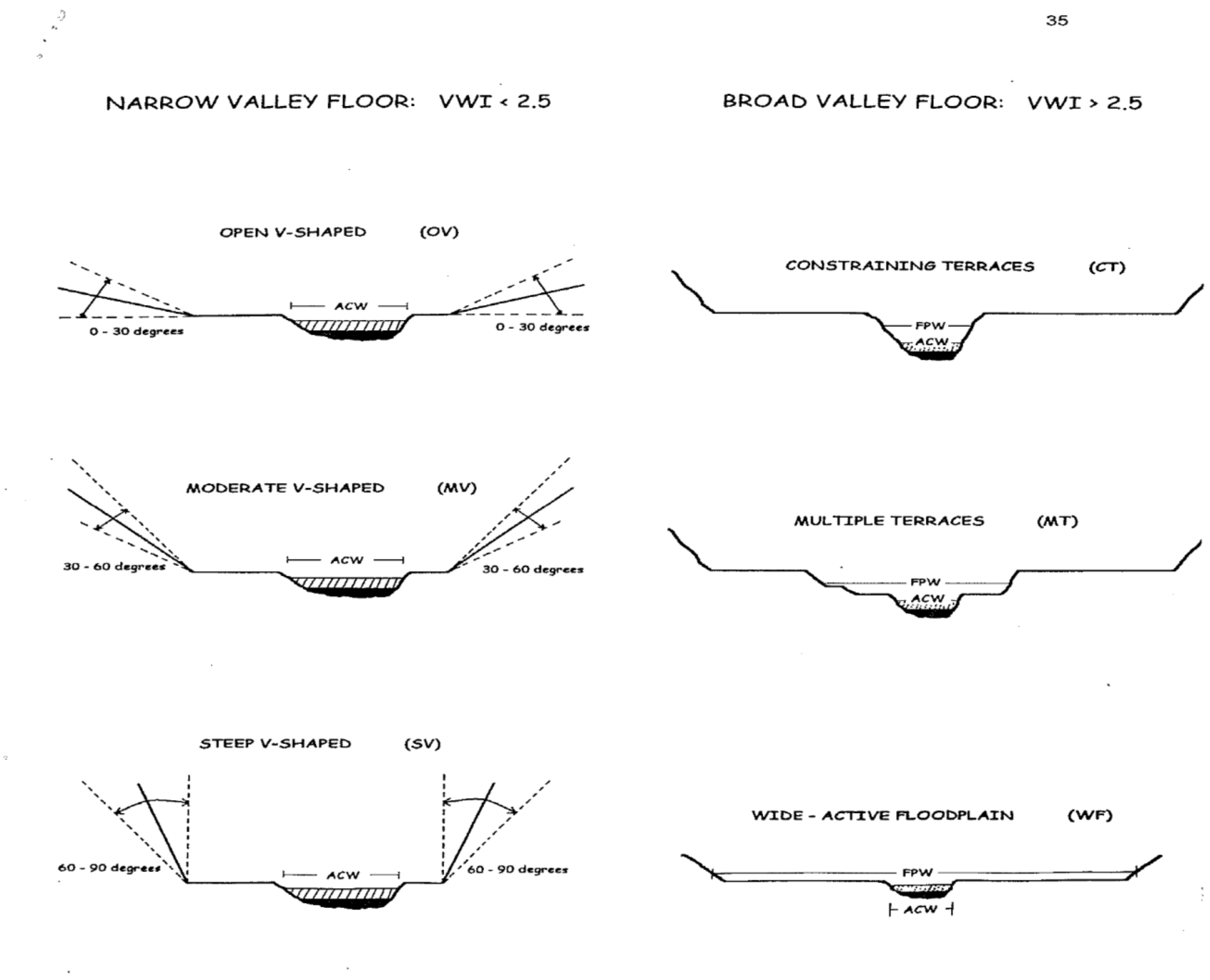
Notes:

Page 1 of 1

Appendix E. Reference Materials Used in the Field

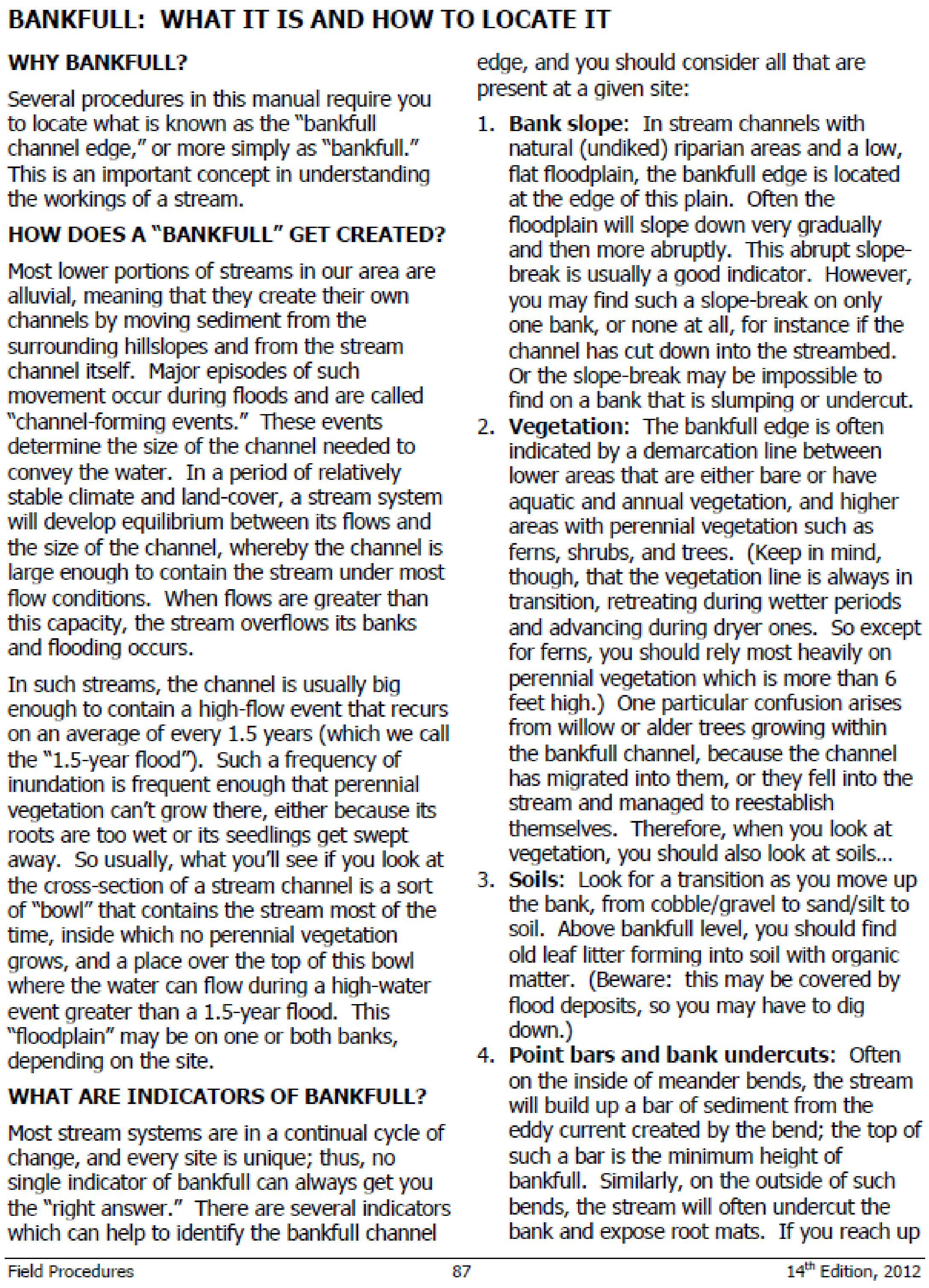
Reference Material Used to Identify Valley Shapes

Moore, K., K. Jones, J. Dambacher, et al. 2006. Methods for stream habitat surveys. Oregon Department of Fish and Wildlife, Aquatic Inventories Project, Conservation and Recovery Program, Corvallis, OR. https://nrimp.dfw.state.or.us/crl/Reports/AI/hmethd06-for%20website(noFishKey).pdf.



Reference Material Used to Identify Bankfull Stage

Streamkeepers of Clallam County. 2012. Field procedures. 14th Edition. http://www.clallam.net/SK/doc/FldProcdrft12.pdf.



BANKFULL: WHAT IT IS AND HOW TO LOCATE IT

WHY BANKFULL?

Several procedures in this manual require you to locate what is known as the "bankfull channel edge," or more simply as "bankfull." This is an important concept in understanding the workings of a stream.

HOW DOES A "BANKFULL" GET CREATED?

Most lower portions of streams in our area are alluvial, meaning that they create their own channels by moving sediment from the surrounding hillslopes and from the stream channel itself. Major episodes of such movement occur during floods and are called "channel-forming events." These events determine the size of the channel needed to convey the water. In a period of relatively stable climate and land-cover, a stream system will develop equilibrium between its flows and the size of the channel, whereby the channel is large enough to contain the stream under most flow conditions. When flows are greater than this capacity, the stream overflows its banks and flooding occurs.

In such streams, the channel is usually big enough to contain a high-flow event that recurs on an average of every 1.5 years (which we call the "1.5-year flood"). Such a frequency of inundation is frequent enough that perennial vegetation can't grow there, either because its roots are too wet or its seedlings get swept away. So usually, what you'll see if you look at the cross-section of a stream channel is a sort of "bowl" that contains the stream most of the time, inside which no perennial vegetation grows, and a place over the top of this bowl where the water can flow during a high-water event greater than a 1.5-year flood. This "floodplain" may be on one or both banks, depending on the site.

WHAT ARE INDICATORS OF BANKFULL?

Most stream systems are in a continual cycle of change, and every site is unique; thus, no single indicator of bankfull can always get you the "right answer." There are several indicators which can help to identify the bankfull channel edge, and you should consider all that are present at a given site:

1. **Bank slope**: In stream channels with natural (undiked) riparian areas and a low, flat floodplain, the bankfull edge is located at the edge of this plain. Often the floodplain will slope down very gradually and then more abruptly. This abrupt slope-break is usually a good indicator. However, you may find such a slope-break on only one bank, or none at all, for instance if the channel has cut down into the streambed. Or the slope-break may be impossible to find on a bank that is slumping or undercut.
2. **Vegetation**: The bankfull edge is often indicated by a demarcation line between lower areas that are either bare or have aquatic and annual vegetation, and higher areas with perennial vegetation such as ferns, shrubs, and trees. (Keep in mind, though, that the vegetation line is always in transition, retreating during wetter periods and advancing during dryer ones. So except for ferns, you should rely most heavily on perennial vegetation which is more than 6 feet high.) One particular confusion arises from willow or alder trees growing within the bankfull channel, because the channel has migrated into them, or they fell into the stream and managed to reestablish themselves. Therefore, when you look at vegetation, you should also look at soils…
3. **Soils**: Look for a transition as you move up the bank, from cobble/gravel to sand/silt to soil. Above bankfull level, you should find old leaf litter forming into soil with organic matter. (Beware: this may be covered by flood deposits, so you may have to dig down.)
4. **Point bars and bank undercuts**: Often on the inside of meander bends, the stream will build up a bar of sediment from the eddy current created by the bend; the top of such a bar is the minimum height of bankfull. Similarly, on the outside of such bends, the stream will often undercut the bank and expose root mats. If you reach up

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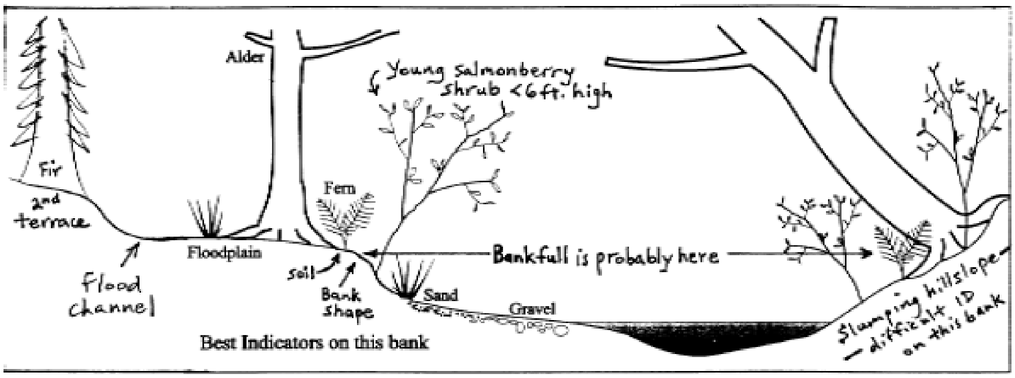
beneath this mat, you can estimate the upper extent of the undercut. This would also be the minimum height of bankfull.

5. **Lines on boulders/bedrock:** If you're in a steep channel with no clear floodplain, look for the highest mineral-stain line or the lowest line of lichen or moss on stable rock.
6. **Adjacent indicators:** If the indicators are unclear where you're looking, try looking up- or downstream to see if there is a clear bankfull line from which you can extrapolate.

HOW SHOULD I LOCATE BANKFULL?

The following method was found by the TFW program to maximize data precision and minimize bias toward over- or under-estimation of bankfull elevation:

1. Start on the bank with the best bankfull indicators.
    - a) Move up the bank from the channel, observing the indicators listed above. When you reach a point at which you're no longer 100% sure that you're below bankfull, mark that level with a flag or stick.
    - b) Then walk up to what is clearly dry land, and walk around, observing indicators and moving back toward the bankfull edge. When you're no longer 100% confident that you're above bankfull, mark that point.
    - c) Reassess the indicators and your confidence levels, and consult with your fellow samplers, and make adjustments as needed.
    - d) The bankfull channel edge is at the elevation point midway between these two points.
2. Now follow the same procedure on the other bank. If it is not possible to accurately identify the bankfull level on that bank (which often happens on the outside bank of a meander bend), locate it using a level line from the bankfull point on the first bank.

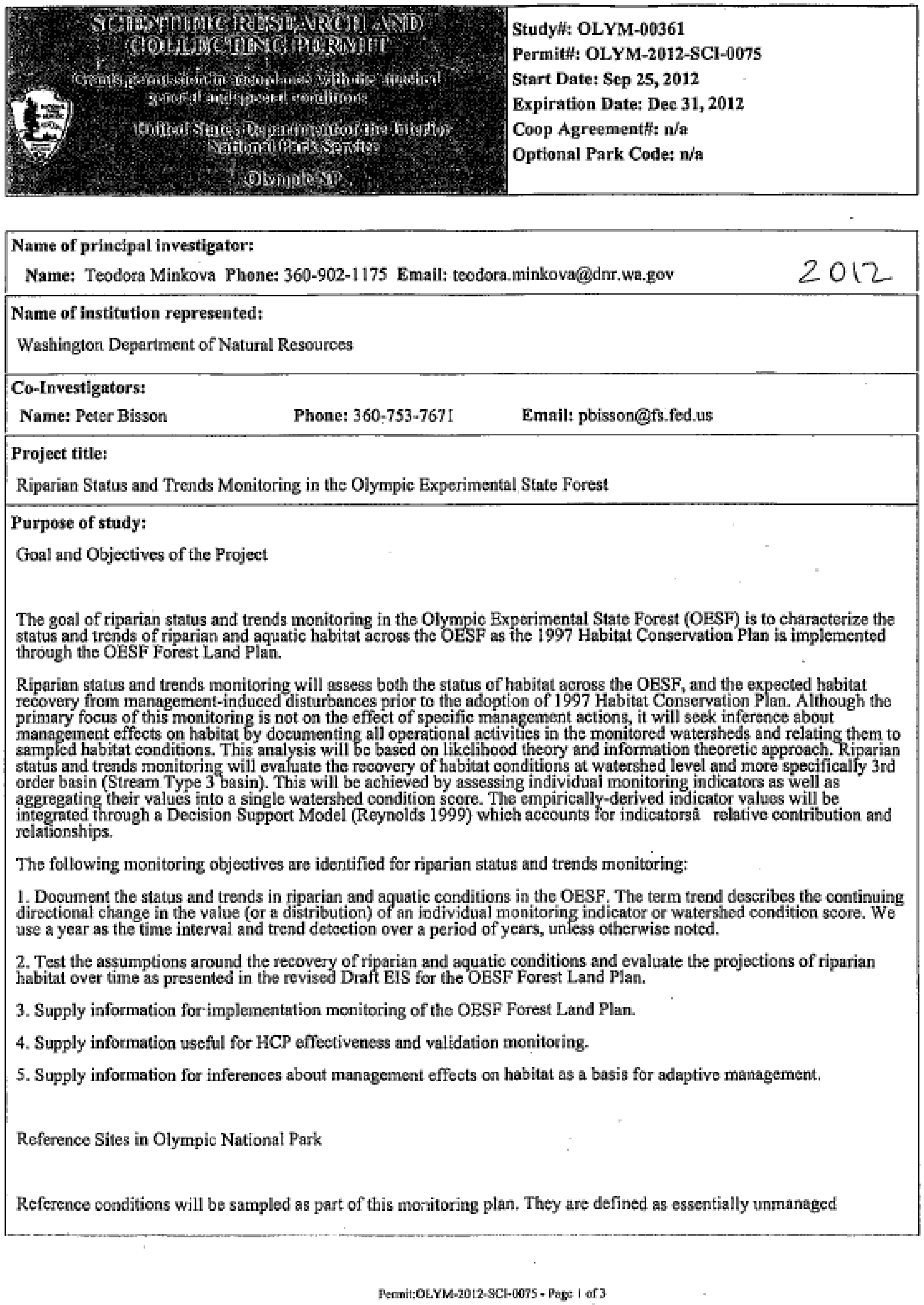


Typical bankfull ID situation, adapted from Pleus and Schuett-Hames, 1998.

(Also referenced for this section: Harrelson et al., 1994.)

Appendix F. Olympic National Park Permits

ONP Permit for the 2012 Calendar Year



SCIENTIFIC RESEARCH AND COLLECTING PERMIT

Grants permission in accordance with the attached general and special conditions

United States Department of the Interior
National Park Service

Olympic NP

Study#: OLYM-00361
Permit#: OLYM-2012-SCI-0075
Start Date: Sep 25, 2012
Expiration Date: Dec 31, 2012
Coop Agreement#: n/a
Optional Park Code: n/a

Name of principal investigator:

Name: Teodora Minkova **Phone:** 360-902-1175 **Email:** teodora.minkova@dnr.wa.gov

2012

Name of institution represented:

Washington Department of Natural Resources

Co-Investigators:

Name: Peter Bisson **Phone:** 360-753-7671 **Email:** pbisson@fs.fed.us

Project title:

Riparian Status and Trends Monitoring in the Olympic Experimental State Forest

Purpose of study:

Goal and Objectives of the Project

The goal of riparian status and trends monitoring in the Olympic Experimental State Forest (OESF) is to characterize the status and trends of riparian and aquatic habitat across the OESF as the 1997 Habitat Conservation Plan is implemented through the OESF Forest Land Plan.

Riparian status and trends monitoring will assess both the status of habitat across the OESF, and the expected habitat recovery from management-induced disturbances prior to the adoption of 1997 Habitat Conservation Plan. Although the primary focus of this monitoring is not on the effect of specific management actions, it will seek inference about management effects on habitat by documenting all operational activities in the monitored watersheds and relating them to sampled habitat conditions. This analysis will be based on likelihood theory and information theoretic approach. Riparian status and trends monitoring will evaluate the recovery of habitat conditions at watershed level and more specifically 3rd order basin (Stream Type 3 basin). This will be achieved by assessing individual monitoring indicators as well as aggregating their values into a single watershed condition score. The empirically-derived indicator values will be integrated through a Decision Support Model (Reynolds 1999) which accounts for indicatorsâ relative contribution and relationships.

The following monitoring objectives are identified for riparian status and trends monitoring:

1. Document the status and trends in riparian and aquatic conditions in the OESF. The term trend describes the continuing directional change in the value (or a distribution) of an individual monitoring indicator or watershed condition score. We use a year as the time interval and trend detection over a period of years, unless otherwise noted.

2. Test the assumptions around the recovery of riparian and aquatic conditions and evaluate the projections of riparian habitat over time as presented in the revised Draft EIS for the OESF Forest Land Plan.

3. Supply information for implementation monitoring of the OESF Forest Land Plan.

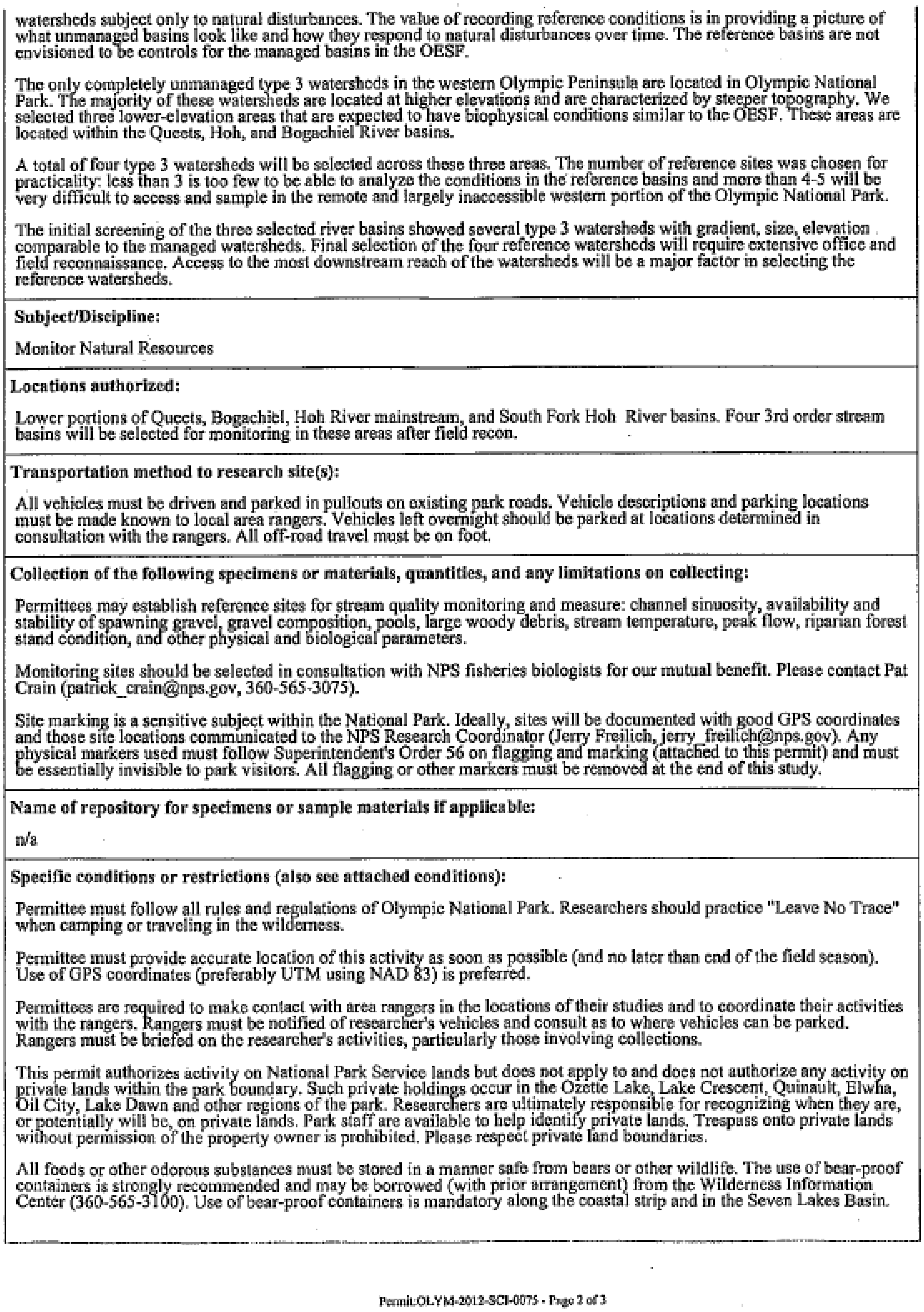
4. Supply information useful for HCP effectiveness and validation monitoring.

5. Supply information for inferences about management effects on habitat as a basis for adaptive management.

Reference Sites in Olympic National Park

Reference conditions will be sampled as part of this monitoring plan. They are defined as essentially unmanaged

Permit:OLYM-2012-SCI-0075 - Page 1 of 3



watersheds subject only to natural disturbances. The value of recording reference conditions is in providing a picture of what unmanaged basins look like and how they respond to natural disturbances over time. The reference basins are not envisioned to be controls for the managed basins in the OESF.

The only completely unmanaged type 3 watersheds in the western Olympic Peninsula are located in Olympic National Park. The majority of these watersheds are located at higher elevations and are characterized by steeper topography. We selected three lower-elevation areas that are expected to have biophysical conditions similar to the OESF. These areas are located within the Queets, Hoh, and Bogachiel River basins.

A total of four type 3 watersheds will be selected across these three areas. The number of reference sites was chosen for practicality: less than 3 is too few to be able to analyze the conditions in the reference basins and more than 4-5 will be very difficult to access and sample in the remote and largely inaccessible western portion of the Olympic National Park.

The initial screening of the three selected river basins showed several type 3 watersheds with gradient, size, elevation comparable to the managed watersheds. Final selection of the four reference watersheds will require extensive office and field reconnaissance. Access to the most downstream reach of the watersheds will be a major factor in selecting the reference watersheds.

Subject/Discipline:

Monitor Natural Resources

Locations authorized:

Lower portions of Queets, Bogachiel, Hoh River mainstream, and South Fork Hoh River basins. Four 3rd order stream basins will be selected for monitoring in these areas after field recon.

Transportation method to research site(s):

All vehicles must be driven and parked in pullouts on existing park roads. Vehicle descriptions and parking locations must be made known to local area rangers. Vehicles left overnight should be parked at locations determined in consultation with the rangers. All off-road travel must be on foot.

Collection of the following specimens or materials, quantities, and any limitations on collecting:

Permittees may establish reference sites for stream quality monitoring and measure: channel sinuosity, availability and stability of spawning gravel, gravel composition, pools, large woody debris, stream temperature, peak flow, riparian forest stand condition, and other physical and biological parameters.

Monitoring sites should be selected in consultation with NPS fisheries biologists for our mutual benefit. Please contact Pat Crain (patrick_crain@nps.gov, 360-565-3075).

Site marking is a sensitive subject within the National Park. Ideally, sites will be documented with good GPS coordinates and those site locations communicated to the NPS Research Coordinator (Jerry Freilich, jerry_freilich@nps.gov). Any physical markers used must follow Superintendent's Order 56 on flagging and marking (attached to this permit) and must be essentially invisible to park visitors. All flagging or other markers must be removed at the end of this study.

Name of repository for specimens or sample materials if applicable:

n/a

Specific conditions or restrictions (also see attached conditions):

Permittee must follow all rules and regulations of Olympic National Park. Researchers should practice "Leave No Trace" when camping or traveling in the wilderness.

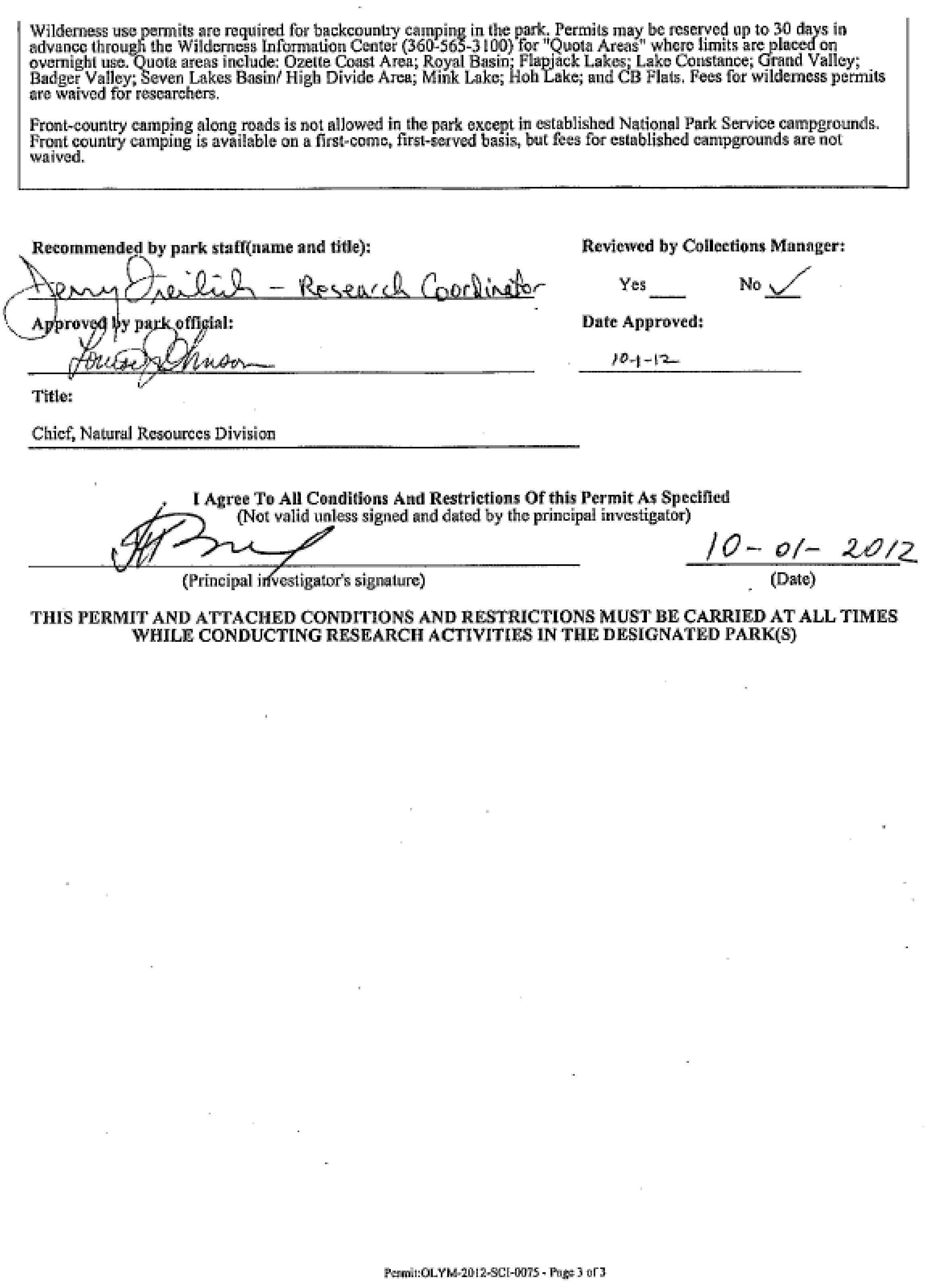
Permittee must provide accurate location of this activity as soon as possible (and no later than end of the field season). Use of GPS coordinates (preferably UTM using NAD 83) is preferred.

Permittees are required to make contact with area rangers in the locations of their studies and to coordinate their activities with the rangers. Rangers must be notified of researcher's vehicles and consult as to where vehicles can be parked. Rangers must be briefed on the researcher's activities, particularly those involving collections.

This permit authorizes activity on National Park Service lands but does not apply to and does not authorize any activity on private lands within the park boundary. Such private holdings occur in the Ozette Lake, Lake Crescent, Quinault, Elwha, Oil City, Lake Dawn and other regions of the park. Researchers are ultimately responsible for recognizing when they are, or potentially will be, on private lands. Park staff are available to help identify private lands. Trespass onto private lands without permission of the property owner is prohibited. Please respect private land boundaries.

All foods or other odorous substances must be stored in a manner safe from bears or other wildlife. The use of bear-proof containers is strongly recommended and may be borrowed (with prior arrangement) from the Wilderness Information Center (360-565-3100). Use of bear-proof containers is mandatory along the coastal strip and in the Seven Lakes Basin.

Permit:OLYM-2012-SCI-0075 - Page 2 of 3



Wilderness use permits are required for backcountry camping in the park. Permits may be reserved up to 30 days in advance through the Wilderness Information Center (360-565-3100) for "Quota Areas" where limits are placed on overnight use. Quota areas include: Ozette Coast Area; Royal Basin; Flapjack Lakes; Lake Constance; Grand Valley; Badger Valley; Seven Lakes Basin/ High Divide Area; Mink Lake; Hoh Lake; and CB Flats. Fees for wilderness permits are waived for researchers.

Front-country camping along roads is not allowed in the park except in established National Park Service campgrounds. Front country camping is available on a first-come, first-served basis, but fees for established campgrounds are not waived.

Recommended by park staff(name and title):

Jerry Freilich - Research Coordinator

Reviewed by Collections Manager:

Yes ___ No ✓

Approved by park official:

Louise Johnson

Date Approved:

10-1-12

Title:

Chief, Natural Resources Division

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

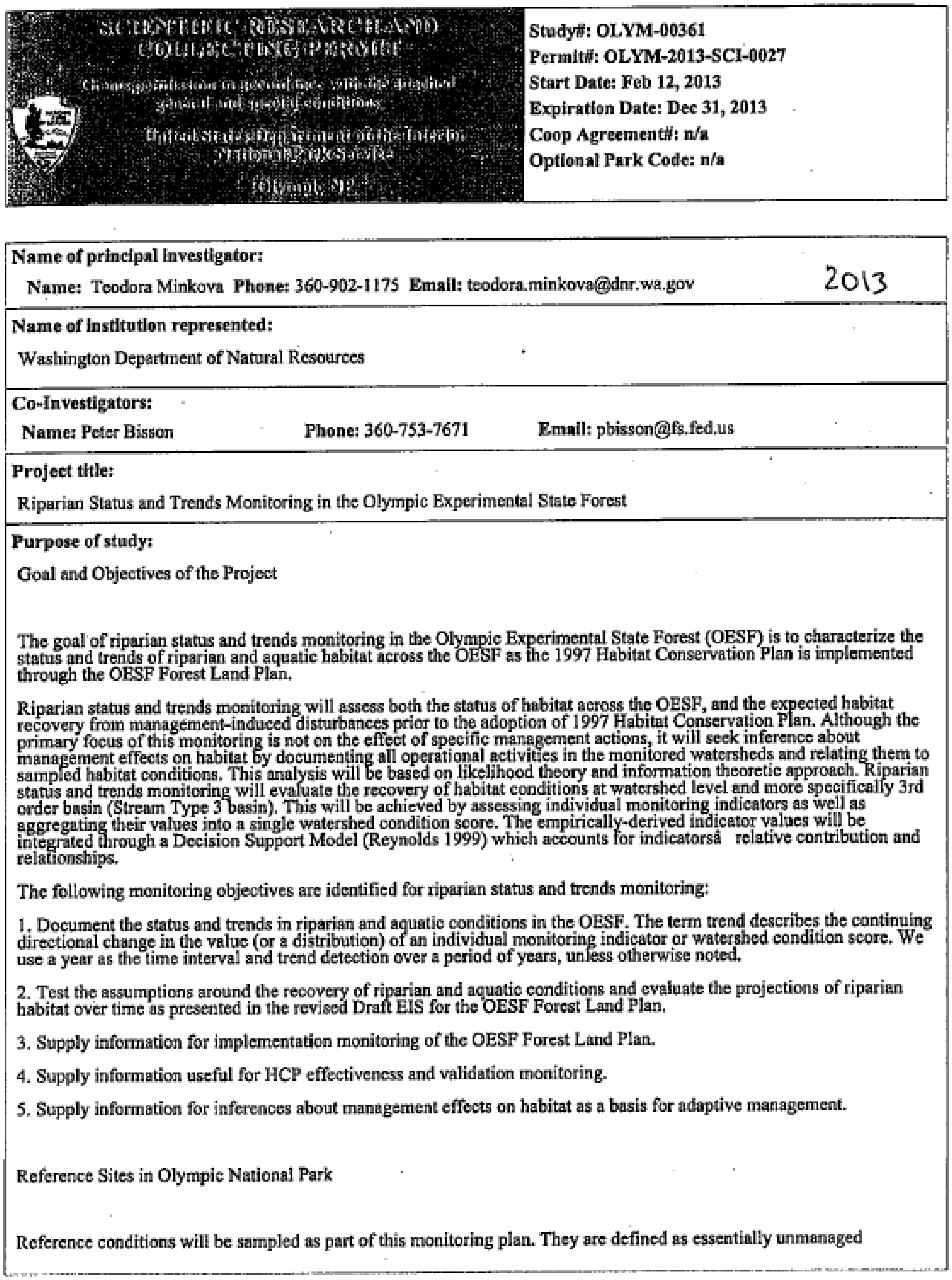
(Principal investigator's signature)

10-01-2012
(Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

Permit:OLYM-2012-SCI-0075 - Page 3 of 3

ONP Permit for the 2013 Calendar Year



SCIENTIFIC RESEARCH AND
COLLECTING PERMIT

Grants permission in accordance with the attached
general and special conditions

United States Department of the Interior
National Park Service

Olympic NP

Study#: OLYM-00361
Permit#: OLYM-2013-SCI-0027
Start Date: Feb 12, 2013
Expiration Date: Dec 31, 2013
Coop Agreement#: n/a
Optional Park Code: n/a

Name of principal investigator:

Name: Teodora Minkova **Phone:** 360-902-1175 **Email:** teodora.minkova@dnr.wa.gov

2013

Name of institution represented:

Washington Department of Natural Resources

Co-Investigators:

Name: Peter Bisson **Phone:** 360-753-7671 **Email:** pbisson@fs.fed.us

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Reference Sites in Olympic National Park

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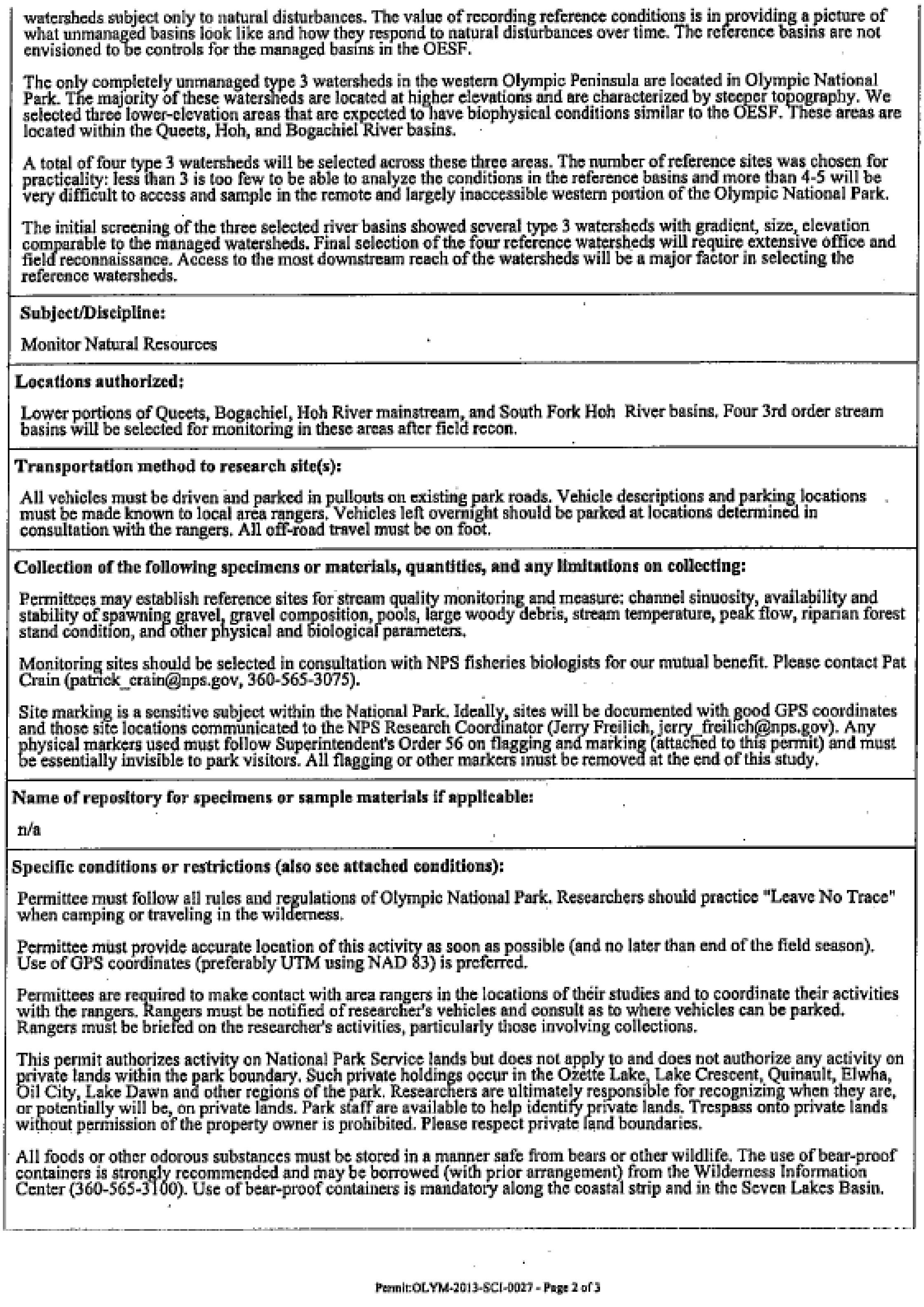
Permit:OLYM-2013-SCI-0027 - Page 1 of 3



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Lower portions of Queets, Bogachiel, Hoh River mainstream, and South Fork Hoh River basins. Four 3rd order stream basins will be selected for monitoring in these areas after field recon.

Transportation method to research site(s):

All vehicles must be driven and parked in pullouts on existing park roads. Vehicle descriptions and parking locations must be made known to local area rangers. Vehicles left overnight should be parked at locations determined in consultation with the rangers. All off-road travel must be on foot.

Collection of the following specimens or materials, quantities, and any limitations on collecting:

Permittees may establish reference sites for stream quality monitoring and measure: channel sinuosity, availability and stability of spawning gravel, gravel composition, pools, large woody debris, stream temperature, peak flow, riparian forest stand condition, and other physical and biological parameters.

Monitoring sites should be selected in consultation with NPS fisheries biologists for our mutual benefit. Please contact Pat Crain (patrick_crain@nps.gov, 360-565-3075).

Site marking is a sensitive subject within the National Park. Ideally, sites will be documented with good GPS coordinates and those site locations communicated to the NPS Research Coordinator (Jerry Freilich, jerry_freilich@nps.gov). Any physical markers used must follow Superintendent's Order 56 on flagging and marking (attached to this permit) and must be essentially invisible to park visitors. All flagging or other markers must be removed at the end of this study.

Name of repository for specimens or sample materials if applicable:

n/a

Specific conditions or restrictions (also see attached conditions):

Permittee must follow all rules and regulations of Olympic National Park. Researchers should practice "Leave No Trace" when camping or traveling in the wilderness.

Permittee must provide accurate location of this activity as soon as possible (and no later than end of the field season). Use of GPS coordinates (preferably UTM using NAD 83) is preferred.

Permittees are required to make contact with area rangers in the locations of their studies and to coordinate their activities with the rangers. Rangers must be notified of researcher's vehicles and consult as to where vehicles can be parked. Rangers must be briefed on the researcher's activities, particularly those involving collections.

This permit authorizes activity on National Park Service lands but does not apply to and does not authorize any activity on private lands within the park boundary. Such private holdings occur in the Ozette Lake, Lake Crescent, Quinault, Elwha, Oil City, Lake Dawn and other regions of the park. Researchers are ultimately responsible for recognizing when they are, or potentially will be, on private lands. Park staff are available to help identify private lands. Trespass onto private lands without permission of the property owner is prohibited. Please respect private land boundaries.

All foods or other odorous substances must be stored in a manner safe from bears or other wildlife. The use of bear-proof containers is strongly recommended and may be borrowed (with prior arrangement) from the Wilderness Information Center (360-565-3100). Use of bear-proof containers is mandatory along the coastal strip and in the Seven Lakes Basin.

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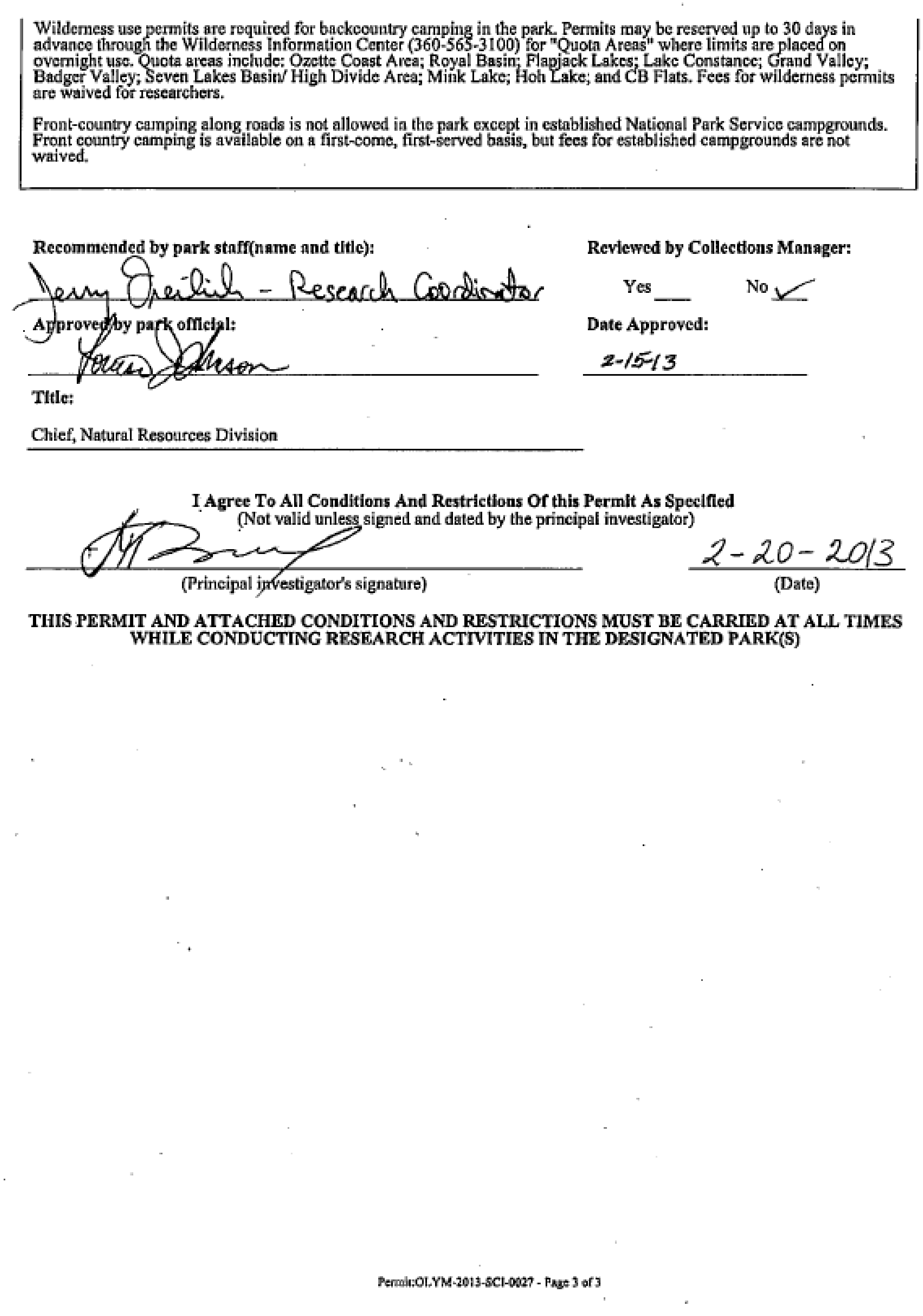

Wilderness use permits are required for backcountry camping in the park. Permits may be reserved up to 30 days in advance through the Wilderness Information Center (360-565-3100) for "Quota Areas" where limits are placed on overnight use. Quota areas include: Ozette Coast Area; Royal Basin; Flapjack Lakes; Lake Constance; Grand Valley; Badger Valley; Seven Lakes Basin/ High Divide Area; Mink Lake; Hoh Lake; and CB Flats. Fees for wilderness permits are waived for researchers.

Front-country camping along roads is not allowed in the park except in established National Park Service campgrounds. Front country camping is available on a first-come, first-served basis, but fees for established campgrounds are not waived.

Recommended by park staff(name and title):

Jerry Freilich - Research Coordinator

Reviewed by Collections Manager:

Yes ___ No ✓

Approved by park official:

Date Approved:

2-15-13

Title:

Chief, Natural Resources Division

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

(Principal investigator's signature)

2-20-2013
(Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

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