Westside Forest Restoration Strategy:

A collaborative approach to defining restoration need, developing methodologies, and initiating a demonstration project in a pilot landscape on the Mount Baker Snoqualmie National Forest.

Background:

Initiated in February 2016, a set of partners began meeting with the following objectives:

- Foster collaborative discussion on approaches to assessing terrestrial and aquatic integrated landscape-scale restoration needs in westside forests.
- Develop a draft methodology for landscape assessment to inform forestwide strategy and apply in two watersheds (Upper White and Green River watersheds) on the Mount Baker Snoqualmie National Forest;
- Develop a group to reflect on various approaches including pilot effort on Mount Baker Snoqualmie National Forest to guide regional discussion on this issue.

Collaboration between partners continued following this meeting through 2017 with participation from US Forest Service staff (Kevin James, David Kendrick, Richard Vacirca), Department of Natural Resources (Josh Halofksy, Dan Donato), University of Washington (Derek Churchill, Jerry Franklin, Eden Pollock), Conservation Northwest (Jen Watkins, Dave Werntz), The Nature Conservancy of Washington (Ryan Haugo – former employee), Washington Conservation Science Institute (Bill Gaines, James Begley), and individual analysts (Bert Loosmore). Additional Forest Service staff members Karen Chang, Pierre Dawson, and Noel Ludwig participated in meetings specific to development of the aquatic strategies in this document.The final product is meant to foster discussion with a wider suite of partners and stakeholders, and inform ongoing collaboration.

Definition and Rationale for Landscape Scale Restoration on the Westside

The need for landscape scale restoration in forests west of the Cascade is an emerging issue across the Pacific Northwest. While fire has focused more attention toward eastside forests, the challenges presented by climate change and ongoing forest and watershed health issues on the westside are no less important. For Washington, we define "westside" as forests west of the Cascade Crest, including the Puget Trough and the Olympic Peninsula. There is significant need and potential to increase both aquatic and terrestrial restoration activities. In establishing a restoration strategy, it is imperative to first define and establish the underlying scientific basis and rationale.

The Mount Baker Snoqualmie National Forest (MBS NF) identified their intent in a 2016 memo (appendix A) to "manage resources in order to restore, maintain and develop resilient landscapes". Resilience is defined as the capacity of the natural environment to absorb and recover from disturbance (natural or human) so as to retain essentially the same function, structure, identity, and processes (Walker et al. 2004). Adaptive capacity, the ability of a system to adjust and adapt to shifting underling climate conditions while retaining similar structure and function, is often considered part of resilience as well. Therefore, the MBS has begun the process to "develop a landscape restoration strategy to restore, maintain and develop resilient landscapes across multiple spatial scales" and increase adaptive capacity.

Our collaboration began with a robust discussion of the scientific basis for westside restoration across the both Oregon and Washington. The key principles and drivers of restoration need that emerged from these discussions are described below. These principles underlie the framework for landscape restoration we developed in order to guide planning and implementation of on-the-ground pilot projects on the MBS.

- ***Increase pace of aquatic restoration***: Extensive forest road systems, past in-stream removal of logs, and past harvesting of riparian forests has had major effects on hydrology, large woody debris levels, sediment flows, and fish habitat across the westside. Effective landscape restoration requires full integration of aquatic and terrestrial restoration activities. Management adaptation strategies have been identified to increase the resilience of watersheds and riparian habitats to habitat fragmentation, habitat loss, and migration barriers (Beechie et al. 2013, Mantua and Raymond 2014). These include improving in-stream fish habitat, restoring flood plains, improving hydrologic function, and reducing downstream flooding are major needs across western Washington. Projected increases in the intensity of winter storms further elevates the need to reduce the impacts of the road system through both road upgrades and closing or decommissioning roads that have high aquatic impact (Halofsky et al. 2011, Strauch et al. 2014). Managing riparian forests to provide for large woody debris inputs is also necessary. Increasing the relative proportion of old forest and reducing density in plantations may also increase stream flows (Perry and Jones 2017).

- ***Role of fire & fire suppression in westside forests***: Unlike more fire-prone eastside interior forests, fire suppression has not had a dramatic impact on fire regimes or forest structure in westside forests. Fires in almost all westside forests are infrequent (200-400 year intervals), burn mostly at high severity over large areas (10,000s to 100,000s of acres), and are driven primary by weather rather than fuels (Agee 1993). Westside forests have historically been resilient to high severity fire in that they recover quickly back to closed canopy forests that reflect pre-disturbed species composition. Landscape fuels treatments beyond treatments close to homes and other areas of high human value thus do not restore westside forests, are inconsistent with other values such as old-growth, and are typically impractical due to rapid regrowth of surface and ladder fuels. Furthermore, continued fire suppression is a necessary management strategy in westside forest landscapes in order to sustain existing old-growth forest ecosystems for as long as possible. As late-seral forests are in short supply, stand replacing fires that burn 10s or 100s of thousands of acres of mature and old forest should not be facilitated by allowing small fires to smolder until conditions change and they blow up. Large, uncontrollable fires will occur despite best efforts at suppression, especially given climate change, and will create early seral habitat. Managed wildfire may be appropriate in higher elevation areas or where old or mature forests are not threatened.

- ***Late seral forest is fragmented and in short supply:*** Due to past harvesting and current management regimes on non-Federal land, late-seral forest has been greatly reduced and fragmented, while young to mid aged forests (10 ~ 120 years) are over abundant. Accelerating the development of old forest structure and habitat by thinning mid-aged forests will increase the abundance of late seral forests more rapidly than if left alone, and also result in larger patches of old forest as was present historically. Thinning forests will also make them more drought tolerant (Halofsky and Peterson 2016).

- ***Increase tree species diversity, especially broadleaf species and drought tolerant conifers:*** Currently, many westside forests are dominated by a single conifer species, leaving them vulnerable to the impacts of climate change. Managing for mixed species stands, as well as planting from a wider range of seed zones, are recommended climate adaptation strategies (Chmura et al. 2011). Increasing the proportion of broadleaf species within stands and managing for broadleaf dominated stand*s in portions of watersheds can also* fire spread, reduce risks of major insect outbreaks, accelerate recovery after a major fire, provide important wildlife habitats, and reduce water use (Kaufmann 1985). In low to mid elevation-stands heavily dominated by drought intolerant species such as western hemlock, increasing the proportion of drought tolerant species should be considered.

- ***Post-disturbance management:*** Conditions after a disturbance offer a primary opportunity to implement and experiment with different climate adaptation strategies such as shifting species composition, increasingly species diversity, and expanding genetic diversity through planting. Fires, as well as wind, insect, and pathogenic disturbances, create complex high functioning early seral habitat. Post-disturbance salvage harvests reduce the habitat functionality of early seral and do not reduce future fire risk in westside forests. Thus, there is no ecological rationale for salvage in westside forests, especially as complex early seral habitat is lacking across the westside. Planning post-disturbance management before major disturbances is critical to building the ability to respond to in a timely manner.

- ***Provide for high functioning, early seral habitat where lacking***: Complex early seral ecosystems are the most biologically rich of the ecosystems found in westside forest landscapes, exceeding forest-dominated stages in terms of both species richness and the number and complexity of food webs (Swanson et al. 2011, 2014). Based on our analysis below, this condition is currently the least common in the North and West Cascades. On intensively managed, non-Federal lands, current harvest, regeneration, herbicide, and other site preparation practices generally do not provide conditions for the development of early seral ecosystems nor habitat for the overwhelming majority of early-seral-dependent species. Habitat functionality can be increased through regeneration harvests that retain more live conifer and hardwood trees, snags, and down logs, as well as site preparation and planting practices that allow the non-tree vegetation community to develop and persist for longer time periods. Figure 1 illustrates the major differences between complex, high functioning early seral habitat and short lives, low functioning habitat. On Federal lands, suppression of fire and a focus on thinning treatments limit creation of this habitat. Variable retention harvests on Matrix and Adaptive Management Area lands would provide early seral conditions in watersheds where it is lacking. Restoration of huckleberry fields and meadows that have been encroached by conifers is an example that has been conducted recently on National Forests.

Figure 1: Left panel shows complex, high functioning early seral habitat created by a high severity fire in western Oregon. Note presence of snags, live legacy trees, broadleaf trees, and understory vegetation. Right panel show low functioning early seral created by a regeneration harvest followed by herbicide treatment.

Terrestrial Methodology for Identifying Restoration Need:

Defining reference conditions & estimating departure

Reference conditions provide a baseline for conditions that historically sustained native biodiversity and aquatic functions and were resilient to a range of disturbances and climatic fluctuations (Keane et al. 2009). Landscape scale reference conditions have been derived for other regions using simulation modeling and historical photographs. Because disturbances are infrequent and much of the landscape has been managed since historical photographs became available, we had to rely on simulation modeling. Specifically for this project, we utilized a State and Transition (STM) simulation model that was originally built for the Integrated Landscape Assessment Project (ILAP) (Halofsky et al. 2014).The model is based on vegetation structure and cover type classes, or states, and estimated transitions between states resulting from growth, natural disturbances, or management actions. Different iterations of the model were built for different potential vegetation series or forest types (e.g. Western Hemlock, Pacific

Silver Fir, Mountain Hemlock). Similar models are being used for current National Forest plan revision efforts across USFS Region 6. The model was run and refined by Josh Halofsky and Dan Donato from the WA DNR.

A key metric relevant to restoration is the abundance and distribution of seral stages across a given landscape, and the degree to which current conditions depart from those ranges. In the current effort, we used the STM to estimate the historical range of three major forest structure classes on the landscape: the percentage of early seral, mid-age, and late seral forest (Figure 2). These results are consistent with similar studies in western Oregon (Ripple 1994, Wimberly et al. 2000, Nonaka and Spies 2005). Finer classes do exist in the model, but these were combined into three broad classes for simplicity. In particular, the late seral class includes both mature forest (greater than 80-120 years old) and old growth (greater than 180-200 years old). We chose to utilize outputs from the model at the scale of all of the north and west Cascades (~6.5 million acres), as opposed to smaller watersheds, due to large size of historical fires in westside forests and the long time intervals between fires. We then calculated the current proportion of these three structure classes across the region using westside FIA plots that fell within the study extent. Finally, we assessed departure from HRV by comparing these current conditions against the historical range. Using this regional HRV information for watershed scale assessment is discussed subsequent sections.

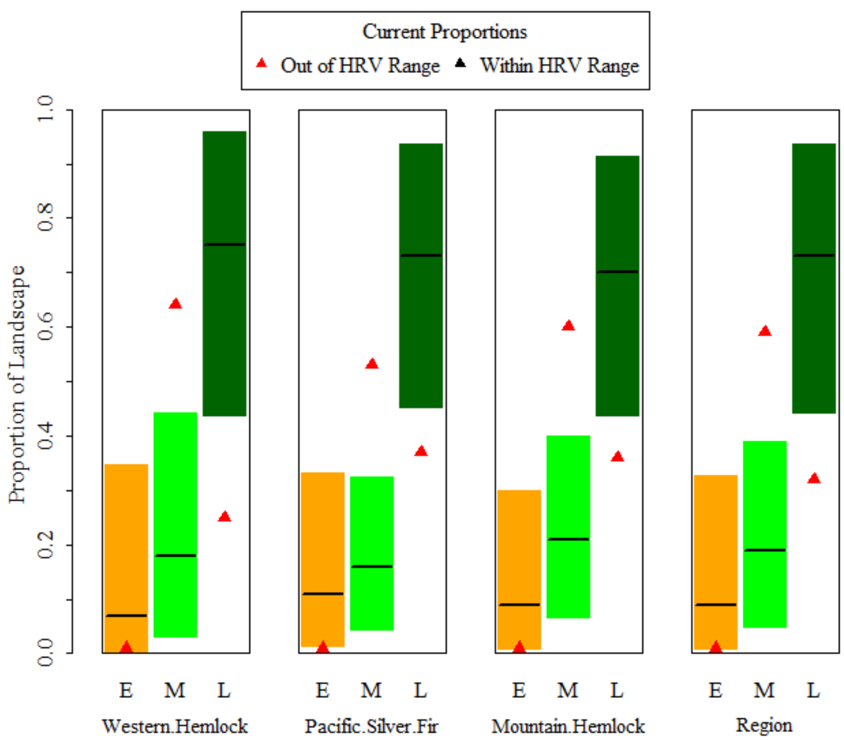

Figure 2: Historical range of variation of forest structure stages in western WA for 3 forest types (PVTs) and the whole region. Horizontal black lines show mean values. L: late seral, M: mid-age, E: complex, high functioning early seral. Late seral class consist of approximately ¼ mature forest (greater than 80-120 years old) and ¾ old growth (greater than 180-200 years old). Ranges are the 5^{th} - 95^{th} percentile of the actual distribution. Region is the north and west Cascades (~6.5 million acres).

Results show a low amount of late seral forests and high amount of mid-age forest relative to the HRV (Figure 2). While not surprising given past harvesting of old growth, these results quantify the high degree of departure in these landscapes. In most watersheds, shifting 15-25% of the landscape from mid-aged to late seral is needed to move conditions to within the HRV. Complex early seral habitat is lower than the HRV range for all PVTs. Nine percent of the region is currently in low-functioning early-seral, due to regeneration harvests on private lands that create low functioning habitat (Figure 1).

Assessing landscape pattern

Wildlife habitat, aquatic functions, and other ecosystem functions and processes are driven by both the amount of different structural stages on a landscape and the pattern in which they are arranged (Lindenmeyer and Franklin 2002, Lundquist et al. 2013). The STM we utilized to estimate HRV is not a spatially explicit model, however, and thus cannot estimate historical landscape pattern. Historical westside forests are thought to have been characterized by large patches of similar seral stage, arising from infrequent but large disturbance events (Ripple 1994). In contrast, in most westside watersheds, dispersed clear cutting and small unit sizes (e.g. 40 acres) have fragmented and reduced patch sizes and thus habitat value of remaining old forests (Franklin and Forman 1987, Nonaka and Spies 2005). As discussed above, a general principal for westside restoration is thus to build larger patches of late seral forest over time, which requires larger and more heterogeneous patches of mid and early seral stages to develop into late seral forest over time. However, explicit targets for patch sizes of different structural stages are not known.

To address this uncertainty and provide guidance for restoration, our group researched the availability of early 20th century aerial photography that could be used to determine pre-management landscape pattern, as well as corroborate the percentage of different structural stages estimated from the STMs. After conducting a thorough search, we came to the unfortunate conclusion that spatially extensive, high quality aerial photography does not exist for western Washington that was flown prior to major timber harvesting.

In order to obtain some information about historical landscape pattern, we derived patch size information from a recent low to mid elevation westside fire; the 8,500 acre Goodell Creek fire in the North Cascades National Park that burned in the summer of 2015. We used stereo, aerial imagery for this analysis and developed a protocol that could be used to document fire severity patch sizes on other recent westside fires in Washington and Oregon. Results indicate high and mixed severity patch sizes in the range of 25-1000 acres, with a mean patch size of 300 acres (Figure 3a). Also, all patches had individual and clumps of live trees scattered within them. However, the Goodell Creek fire is only one fire at the smaller end of the historical fire size distribution, and thus the conclusions we can draw from it are limited. Patch sizes created by larger westside fires were generally much larger, but still contained significant live legacies within them.

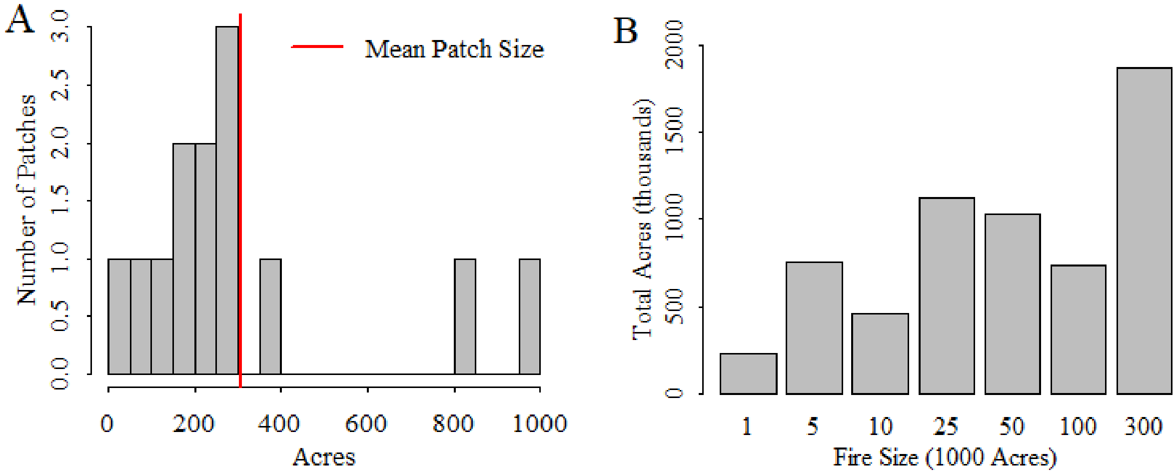

Figure 3: Panel A: patch size distribution of mixed and high severity patches from Goodell Creek fire. Panel B: area burned by fire size on the MBS from 1000 AD to 1930. Note than labels on x axis show up range of fire size bins.

We also summarized historical fire sizes on the MBS. We used a fire perimeter dataset assembled by Jan Henderson, the longtime Forest Service Area Ecologist for western Washington, that used forest age class data to approximate historical fire perimeters. Results confirm that large fires (> 25,000 acres) burned the majority of acres (Figure 3b). While patch size distributions cannot be inferred by fire size alone, larger fires tend to have larger patches within them (Wimberly 2002).

Results from the Goodell Creek fire, historical fire sizes on the MBS, and other studies all indicate that patch sizes created by fires were almost always larger than what past forest management created (e.g. 40 acre clearcuts). Thus, we feel there is a strong scientific basis for the general guideline to aggregate westside forest landscapes by creating larger patches as much as feasible. Patches should also have significant heterogeneity within them. In addition, small fires such as the Goodell Creek fire can provide a tractable reference for future management efforts aimed at creating early seral habitat, both in terms of patch sizes and retention of live trees within patches. Large fires will create the larger patches at some point in the future.

Focal wildlife species and habitat departure

A “coarse filter” evaluation of ecosystem diversity generally compares the amount and distribution of existing vegetation communities to a set of reference conditions (e.g., HRV) (Hunter et al. 1988, Baydeck et al. 1999, Landres et al. 1999, Samson 2002, Samson et al. 2003). A coarse-filter approach is one component of the Westside Forests Restoration Strategy (as previously described). A complementary approach to a coarse-filter analysis is necessary for species which ecological condition needed to maintain populations may not be completely provided by merely maintaining ecosystem diversity (Samson 2002, Suring et al. 2011). For example, species associated with fine-scale ecosystem components (e.g., snags) or habitat generalists whose populations are influenced by human activities such as road (Carroll et al. 2001) may not be adequately addressed by a broad-scale assessment of vegetation conditions (Cushman et al. 2007). The assessment of individual species is a “fine-filter” approach to conservation (Andelman et al. 2001, 2004; Holthausen et al. 1999, Holthausen 2002, Samson et al. 2003).

One approach used to conduct species-specific assessments is the “focal” species approach (Lambeck 1997). We relied on existing assessments to identify a small set of focal wildlife species to use in this initial evaluation of forest restoration needs and priorities (McComb et al. 2002, Kline et al. 2016, Gaines et al. 2017). We use the term “focal species” as described in Lambeck (1997) as a means of gaining insights to the integrity of the larger ecological system to which the species belongs (Lambeck 1997, Noss et al. 1997, Andelman et al. 2001, Noon 2003). This differs from how “focal species” are used in the 2012 planning rule where a set of “focal species” are selected for monitoring. The habitat associations for the focal species that were used in this assessment represent a diverse range of forest compositional and structural conditions (Table 1) intended to provide insights into how ecosystem conditions have changed from reference conditions. In future iterations of this strategy, additional focal species could be considered that represent riparian habitats (perhaps as a subset of the aquatic assessment) and species whose viability is influenced by human activities such as roads (Wisdom et al. 2000, Gaines et al. 2017).

The STM model used to generate HRV estimates for forest structural stages was also used to generate HRV ranges for the 5 focal species across all of western WA (Figure 4). This provides a broad scale picture of the amount of habitat relative to the amount that was historically available to these species. Comparison with current conditions show that habitats for wildlife species associated with complex early seral, and late-successional-old forest are departed and below their historical amounts. While there are not reference conditions for the spatial patterning of these habitats, past management actions high likely lead to extensive fragmentation of late-successional-old forest habitats. Clear-cutting and post-fire salvage harvest have contributed to the low amount of complex early seral habitats. Complex early seral habitats include many of the fine scale habitat features (snags, patches of green trees, downed wood, etc) that are important for wildlife species associated with these forest conditions.

Table 1: Focal species for habitat assessment

Species	**Habitat Associations**	**Reference**
Northern spotted owl (STOC)	Late-successional and old forest	McComb et al. 2002, Kline et al. 2016
Olive-sided Flycatcher (COCO)	Edge contrast	Kline et al. 2016
Pileated Woodpecker (DRPI)	Range of forest types – large snags	Gaines et al. 2017, Kline et al. 2016
Pacific Marten (MACA)	LSOF – subalpine fir forests, snags and downed logs	Gaines et al. 2017, Kline et al. 2016
Black-backed Woodpecker (PIAR)	Complex early seral forest	Gaines et al. 2017, Morzillo et al. 2014

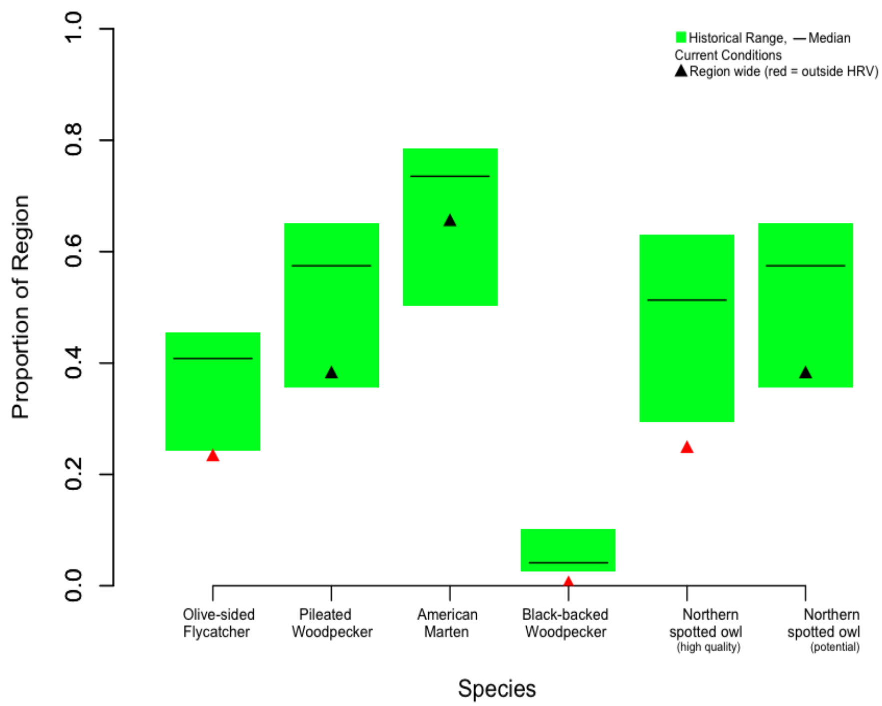

***Figure 4**:* HRV and current conditions of focal wildlife species derived from STM model for western Washington.

Whole Watershed Restoration Approach

The quality, quantity, storage, and movement of water on the MBS NF is a driving factor for all management decisions including a priority for restoration actions. At the headwaters to Puget Sound, the management actions on this national forest are directly correlated to the health of water downstream. According to the MBS NF Forest Plan, over 1,500 miles of fish-bearing streams and over 12,000 acres of fish-bearing lakes serve as both seasonal and year-round habitat for five species of salmon, three species of sea-run trout, and numerous other cold, freshwater species. These streams and lakes drain into seven major Puget Sound river basins.

The MBS NF continues to take progressive steps towards focusing on restoration of natural resources in an integrated framework, particularly in a landscape context. For watershed and aquatic resources there is long standing history of conducting resource assessment and prioritizing a range of essential treatments at watershed scales. Since the early 1990's watershed and fisheries programs have been implementing watershed-scale approaches, such as watershed analysis and more recently Watershed Condition Framework. These approaches have been a key part in the evolution of assessing watershed conditions and the factors impairing function. Therefore, for Watershed Practitioners conducting restoration in a "landscape context," is really a continuation of existing watershed-scale approaches evolving to a more contemporary whole watershed restoration context.

Through this collaboration, Forest Service aquatics staff at the Supervisor's Office led the development and integration of a "whole watershed restoration approach" into our discussions. In a whole watershed restoration approach Watershed Practitioners assess a larger suite of factors that are representative of physical, chemical and biological processes, while displaying sources of impairment on those processes. The restoration analysis then turns to understanding the options in which those impairments can be eliminated or decreased to an extent that achieves expected positive shifts in watershed functional conditions, such as water quality and fisheries habitat.

Borrowing from language in a 2015 document from the Okanogan-Wenatchee National Forest's Whole Watershed that was referenced in developing procedures for this forest:

Watershed restoration and forest health have been identified as core management objectives of the United States Department of Agriculture's National Forests and Grasslands (USDA Strategic Plan for FY 2010-2015). To achieve this objective the Forest Service has been directed to identify and restore degraded watersheds by strategically focusing on watershed improvement projects and conservation practices at the landscape and watershed scales (USDA 2011). As part of the identification of degraded watersheds, National Forests throughout the U.S. were mandated to implement the Watershed Condition Framework (WCF) process in 2010. The goal of WCF was to identify current conditions for each 6th hydraulic code sub-watershed and use that assessment to further identify priority subwatersheds where focused management could restore impaired watershed function.

The term "Restoration" has been defined in a variety of ways, with the major theme of restoration involving the return of a disturbed ecosystem to its condition prior to disturbance.

Restoration as defined by a National Research Council Report (1992) involves "… the return of an ecosystem to a close approximation of its condition prior to disturbance. In restoration, ecological damage to the resource is repaired. Both the structure and the functions of the ecosystem are recreated … The goal is to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs."

Ecologically based watershed restoration as defined by the EPA (1995) in terms of watershed management is "the restoration of chemical, physical and/or biological components of a degraded system to a pre-disturbance condition". The EPA further states that "restoration is also an important tool for preventing environmental degradation."

The Forest Service defines Ecological Restoration as "The process of assisting the recovery of resilience and adaptive capacity of ecosystems that have been degraded, damaged or destroyed. Restoration focuses on establishing the composition, structure, pattern, and ecological processes necessary to make terrestrial and aquatic ecosystems sustainable, resilient and healthy under current and future conditions" (FSM 2020.5).

On the MBS NF the Watershed Condition Framework identified watersheds that were "functioning at risk" and with "impaired function" to help prioritize restoration focus. For watersheds where various management regimes have occurred on the MBS, roads are a leading driver of watershed function impairment. The road networks were positioned on the landscape where they cut off floodplain processes, alter riparian structure, disrupt natural ranges of flow regimes and aquatic organism passage, increase sedimentation and artificially increase a watershed's drainage network. These factors have worked cumulatively to influence conditions where aquatic resources have become less resilient. At the same time, it's acknowledged that other legacy impacts are contributing to non-functioning watershed scale conditions and the restoration analysis needs to account for those factors. Finally, in addition to the legacy impacts effecting these watersheds, climate change impacts projected for this national forest will add additional stressors to aquatic systems from dramatic changes in hydrology to alterations of stream temperatures.

The integration of landscape analyses and context by linking watershed scale processes to factors that may be important to terrestrial ecological conditions is important to take in at the landscape scale in setting priorities for where to act and identifying areas of shared restoration need, while further integration is best done at the project scale within a watershed.

Methodologies for applying the "whole watershed restoration approach" are discussed at the project level scale in greater detail, as the approach for the Mount Baker Snoqualmie National Forest was piloted in our two watersheds of focus to inform future application forestwide.

Informing project level restoration planning at watershed scale

Ultimately restoration becomes reality at the project planning and implementation level. Therefore, laying forward a suite of tools and process for identifying restoration needs within a watershed to inform project level planning and implementation is critical. We chose to pilot approaches to identifying restoration need at the watershed scale in the Upper Green and Upper White HUC 5 watersheds in the Snoqualmie Ranger District of the Mount Baker Snoqualmie National Forest. Sub-watersheds (HUC 6) are the in process of being prioritized and selected for project planning.

Terrestrial Vegetation

We assessed departure of current forest structure and habitat conditions relative to historical reference conditions using the same approach we described in earlier sections (Figure 5). Results show that mid-aged forests are higher than HRV across the two watersheds, while late seral is lower than HRV in all watersheds except for the Upper White where late seral is at the low end. We assume that complex early seral is also departed based on the regional FIA data. Currently, the Upper Green has 9% in low functioning early seral and the Upper White has 5%. In addition, past regeneration cuts and checkboard ownership patterns have fragmented patches of old forest and created many, smaller patches of low functioning early and mid-seral forest.

The HRV departure assessment can provide broad targets for treatment need. We suggest deriving overall targets at the HUC 5 level, and then assessing where treatment opportunities exist within HUC 6 sub-watersheds to meet those targets. In the Upper White HUC 5, for example, shifting approximately 11,670 acres from mid-aged to late or early seral is needed to move within the upper HRV limit of mid-seral. To move to the mean HRV percentage for mid-aged would require shifting 35,000 acres, or 30% of the total area of the watershed. To move to the HRV percentage for late seral would require increasing late-seral by 31,500 acres. These results suggest thinning 12,000-35,000 acres of mid-aged forests to restore HRV conditions as fast as possible.

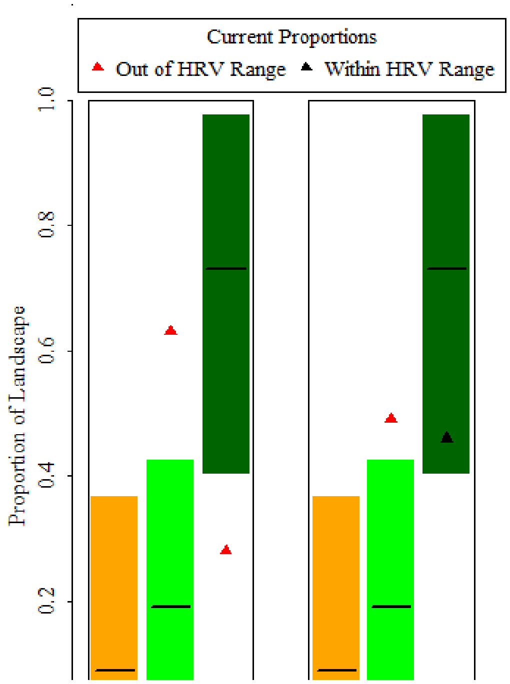

Figure 5: Current conditions in 2 pilot watersheds compared with the regional historical range of variation for 3 forest structural stages. E: high functioning early seral, M: mid-age, L: late seral. Note that the current complex, early seral proportions are estimates based on regional FIA data.

In terms of early seral, a more in depth analysis could assess the extent to which existing low functioning early seral has key habitat components such as snags, diverse and abundant shrub communities, live legacy trees, etc. Based on this analysis, the extent to which creating additional early seral is warranted could be determined. A priority would be to stitch together existing, small early seral patches (<100 acres) to create larger patches (200-1000 acres) by treating mid-aged forest in-between past regeneration harvests. This would not mean large areas with no trees as substantial live tree retention would mimic conditions left after most wildfires. These areas would not be immediately replanted, but instead left to slowly naturally regenerate over time. Broadleaf species could be planted if they do not regenerate naturally and snags created. As most of the Upper White is LSR, however, opportunities to create early seral are limited to gaps. More options exist in the Upper Green.

Sub-watersheds within the Upper White, such as the Lower-Greenwater and Silver Creek-White River, that have extensive opportunities to contribute towards these overall HUC 5 level goals can be selected for project areas. Factors that can be used to select the locations of treatments include:

- Road and aquatic restoration needs
- Opportunities to reconnect patches of late seral forest
- Dense, structurally simple forest where development of late seral characteristics will be slow.
- Opportunities to favor and release broadleaf species Stands dominated by a single species where diversification is possible.
- Revenue considerations
- Regulatory and operational constraints.

An additional consideration is to select larger unit sizes for thinning treatments that will maintain and build larger patch sizes of late seral forest over time and avoid further fragmentation. Small skips and no-cut buffers within thinning areas are ok as they contribute to within patch variability. An analysis of patch sizes within these watersheds would provide more concrete guidance for restoration of spatial pattern.

Focal Wildlife Species Habitats

We compared the current condition of habitats for wildlife focal species within the Upper Green and Upper White watersheds to regional estimates of HRV (as previously described) (Fig. 6). Results show that for focal species associated with complex, high functioning early-seral habitat, the current amount of habitat within both the Upper Green and Upper White watersheds are below regional estimates of HRV. In the Upper White River watershed, current availability for all focal species associated with late-successional-old forest habitats are consistently lower than regional estimates of HRV. In the Upper Green River watershed, the availability of late-successional-old forest focal species habitats are more similar to regional estimates of HRV, with the exception of high quality spotted owl habitat.

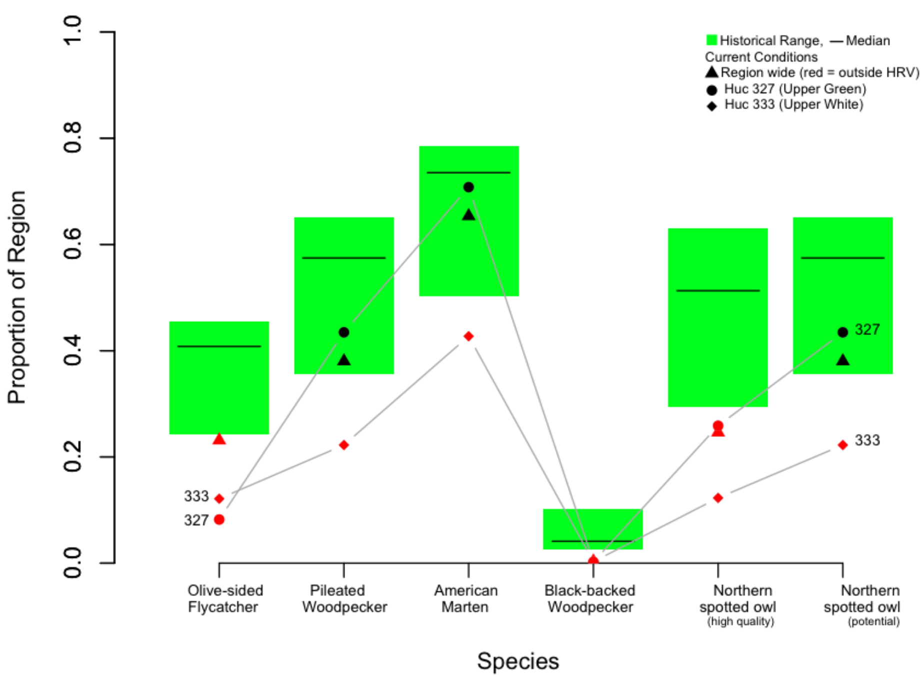

Figure 6: A comparison of habitats for focal wildlife species in the Upper Green River and Upper White River watersheds to regional estimates of the Historical Range of Variability.

Habitat conditions for focal wildlife species could be managed to be more representative of historical conditions through restorative treatments that accomplish the following objectives:

- Increase the availability of large trees and snags across the landscape in all forest seral stages
- Increase the availability and patch sizes of late-successional-old forest habitats;
- Following a disturbance, retain snags, downed logs, and remnant green trees to enhance the structural complexity of early-seral habitats
- Increase the availability and patch sizes of complex early seral habitats
- Reduce the effects of roads on riparian habitats.

Aquatic Resources

We recognized that existing resources including salmon recovery plans, watershed analyses, habitat assessments, and resource expert opinion all provide tremendous information on threats and opportunities for restoration of aquatic resources throughout the Upper Green and Upper White River watersheds. Future work requires a review and synthesis of these materials and outreach to partners in the watershed to complement and build upon the initial analyses for the Whole Watershed Restoration Approach that were initiated during this collaboration.

The unit in which the Whole Watershed Restoration Approach assessment and analysis occurs is normally at the subwatershed (HUC 12) scale, which ranges in size from 15,000 – 40,000 acres across the MBS. During this collaboration the assessment was run for the Upper White River watershed, which includes the following subwatersheds: Lower Greenwater River, Silver Creek-White River, Huckleberry Creek, Lower West Fork White River, Upper West Fork White River, and Headwaters White River.

An initial analysis was conducted in February 2017 by MBS NF hydrology and fisheries staff (Karen Chang, Richard Vacirca and Noel Ludwig) with assistance from the WO NRM AqS division (Pierre Dawson) using the whole watershed restoration procedural approach (including modeling tools) founded on the Okanogan-Wenatchee National Forest in 2015 referenced above. The goal was to utilize this approach to be effective and efficient in conducting technical assessments, inform project design, build communication tools during the internal Forest Service process needed to support recommendations and decisions, help support effects analysis and ESA consultation, support potential post-project monitoring at watershed scales and complete the technical work needed for any potential external funding mechanism during implementation phases.

<u>Initial Restoration Assessment</u>

The analysis was to follow a process aimed to help answer the following questions:

- Question 1: Which subwatersheds in the Upper White River are in need of active restoration and how would they be prioritized based on that need?
- Question 2: Which streams in the Upper White River are the most important to inventory in the 2017 field season in order to support critical information and project design needs?

Question 1

This question was identified to meet the District Ranger's desire to take a broader view of restoration need in the Upper White beyond Greenwater River subwatershed. Therefore, it was determined to move forward with displaying hydro-geomorphic condition factors which assess potential road causal mechanisms versus key indicators of impairment. The first part of the analysis partitions each subwatershed into smaller catchments (Figure 7). This is needed to draw down the scope of the analysis to see how the different intensity of road-caused impairment is predicted to be occurring across the landscape. Second, the metrics displaying causal mechanisms (road density, road density in riparian areas, increase in drainage network, road crossings per mile, riparian road length to stream length, and roads in floodplains) were assessed and scored per catchment (Figures 8 – 11, Figure 8 shown with the remainder including in appendix B). Note: the metric for roads in floodplains has not yet been developed due to refinement in mapping that supports this modeling tool.

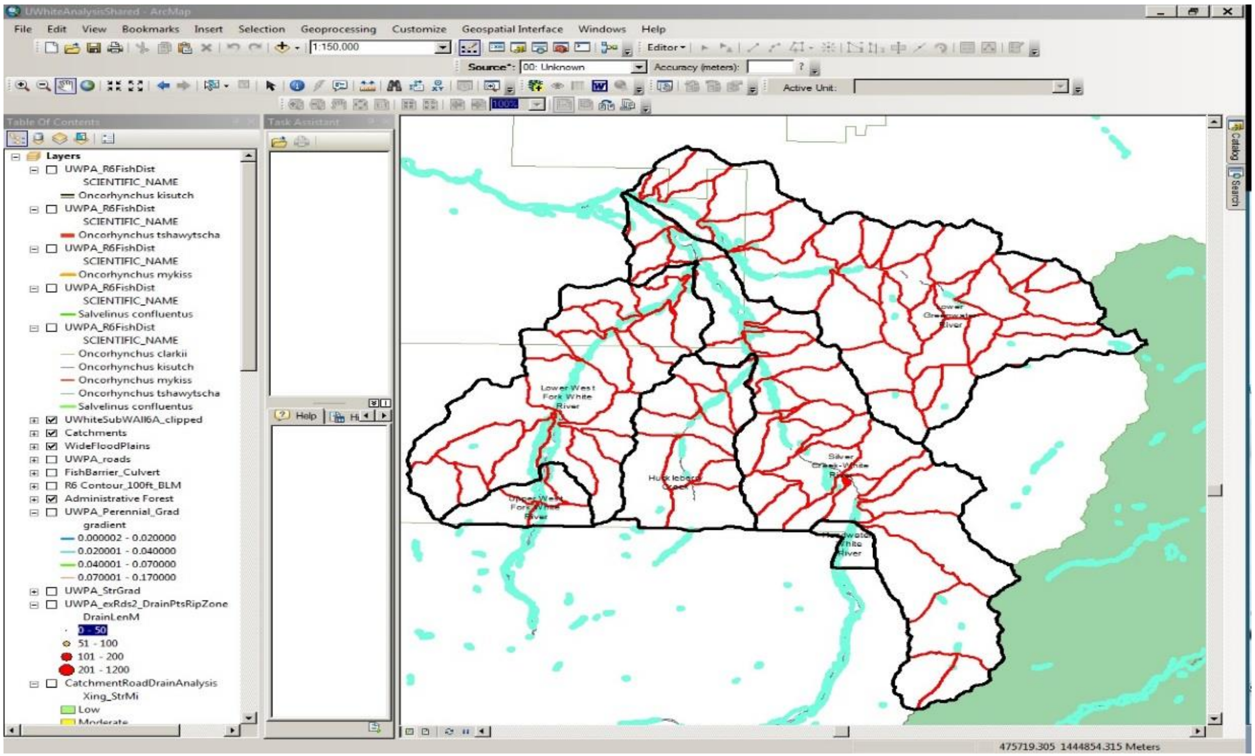

Figure 7. Each subwatershed is broken down into smaller catchments (red polygons).

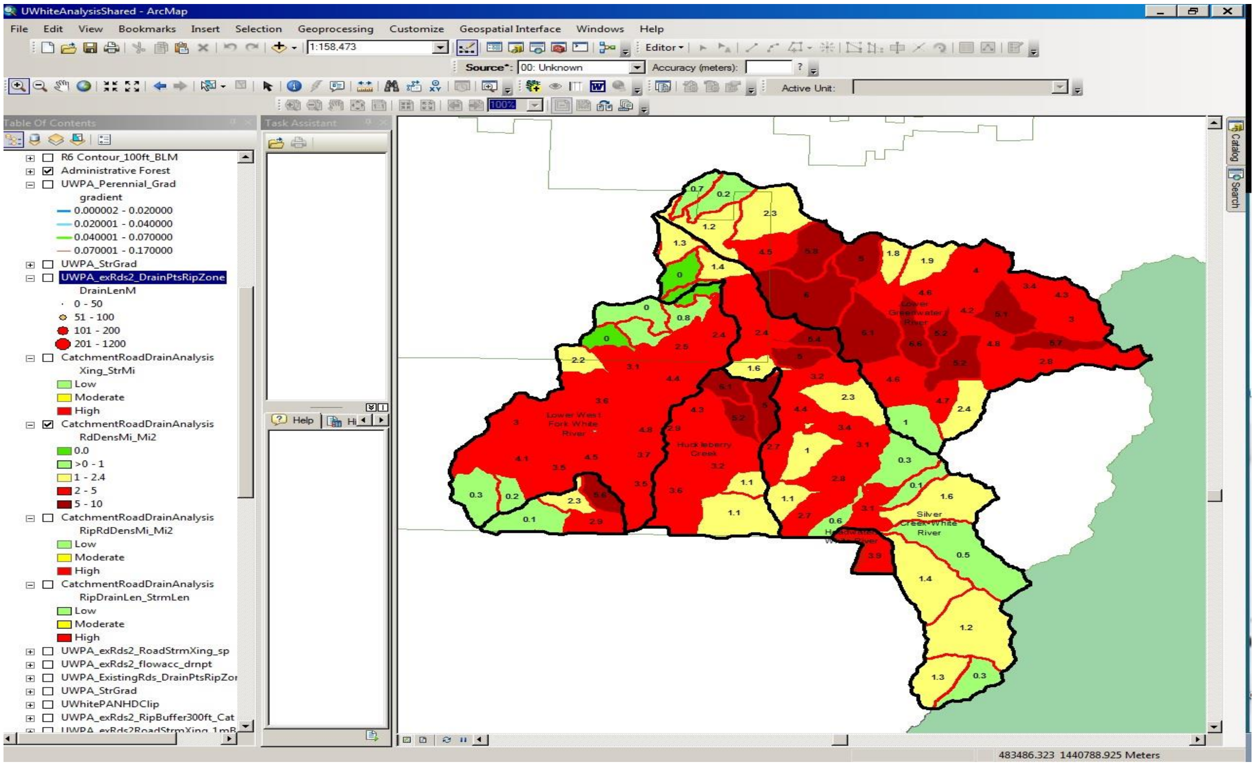

Figure 8. Distribution and intensity of road density per catchment (mi/mi²).

Third, the existing data sets representing both biological conditions (species distribution and potential habitat) were assessed. It's important to note that key indicators of impairment representing the hydro-geomorphic condition assessment (channel width-to-depth ratio, entrenchment ratio, bank instability and channel type) has not yet been done. Existing fish distribution and channel gradients representing a key factor of species intrinsic potential (or potential habitat) was displayed for the streams in the Upper White watershed (Figure 12 and 13, appendix B), this included Chinook salmon, steelhead trout, bull trout, coho salmon and coastal cutthroat trout. This part of the analysis is a proxy investigation into the importance of each subwatershed to fishes, especially Federally listed species.

This whole watershed restoration procedural approach effectiveness increases where field investigation has occurred validating road interactions and conditions. In addition, this information will be essential to use during in-office project planning of timber sale logging systems needing up-to-standard features (i.e. replacing existing non-functioning culverts at perennial stream crossings as part of road reconstruction activities).

For instance, the more current habitat that is occupied in a given subwatershed that faces the greatest amount of road derived threats, then the greater the need to implement active restoration. Which for the Upper White River the recommended priority to consider for restoration need includes:

1. Greenwater River (Upper and Lower) – It has the highest amount of occupied habitat and potential habitat that faces the greatest amount of road derived threats. Its potential to produce the greatest amount of tributary production of salmon, steelhead, bull trout and other salmonids is highest among Upper White River subwatersheds.
2. WF White River and Huckleberry Creek – These have the next highest amount of occupied habitat and potential habitat that faces the greatest amount of road-derived threats. Their potential to produce the greatest amount of tributary production of salmon, steelhead, bull trout and other salmonids is a degree more moderate versus Greenwater River.

3. Silver Creek-White River – Fish distribution and production is predicted to be more naturally constricted by high gradient tributaries and natural falls that are impassable. There is undoubtedly needed restoration work, however the gain is not as great as Greenwater, WF White or Huckleberry Creek.
4. Headwaters – This subwatershed falls almost entirely within Mount Rainier National Park, so the scale of need is very limited. However, the initial assessment demonstrates that there most likely is needed work that could be melded in if further consideration is made for Silver Creek.

Question 2

This question was identified by hydrology and fisheries staff in order to be prepared with a strategic field data collection plan for the upcoming 2017 field season. As with any analysis (especially for purposes of restoration planning and design) good field derived data covering a wide enough area is essential to inform well-crafted proposals. This whole watershed restoration procedural approach effectiveness increases where comprehensive stream habitat inventories have been done and are mostly current. And in this instance the data displays for existing stream habitat inventories (Figure 14, appendix B), fish distribution and potential habitat (using channel gradient) can be used to inform the following factors:

- Data gaps – Streams for which no aquatic habitat inventory data exists and those streams that map as currently being occupied by fish or potential habitat.
- Data currency – Streams that have been surveyed between 1994 – 1999 are now out of date as there is high probability that changes have occurred due to natural processes or anthropogenic impacts. Streams that have been surveyed between 1999 – 2008 are generally adequate, however if funding and time allow it would be good to re-survey these streams or rapidly verify certain condition factors. Streams that have been surveyed between 2008 – present are current and there is no need to invest in re-surveying them.
- Existing funding and capacity to conduct field inventories – Funding and capacity are limited, so it’s important to identify what’s important and focus those efforts as much as possible.

Based on the assessment of existing stream inventory data, data gaps and data currency for the following streams were identified as needs for inventory in 2017:

Prioritized Subwatershed	**Stream Name**	**Date Last Surveyed**
Greenwater River	Midnight Creek	No data - 1990 pre-Level II protocol and data not in NRIS AqS
Greenwater River	Whistler Creek	No data – modified Level II in 1996 but not available in NRIS AqS
Greenwater River	Pyramid Creek	No data – modified Level II in 1996 but not available in NRIS AqS
Greenwater River	Greenwater River	1998/1999
WF White River	Tribs to Jim Creek	No data
Huckleberry Creek	Eleanor Creek and Unnamed tribs	No data

This list can be further prioritized based on the Line Officer’s decision as to the geographic scope in which the project analysis area will occur. In addition, it will be crucial to interface field reconnaissance and data collection with the project Roads Planner. Most likely this will consist of a more rapid assessment approach where road-water/stream interaction features are cataloged, which then can be compared back to the key indicator analysis later in the project planning phases. Integration of assessments with the Roads Planner will be a crucial part of field verification.

Integration of terrestrial and aquatic restoration analyses to inform project level planning
The opportunity to fully reflect upon and integrate the results from both the terrestrial and aquatic analyses is vital in the early planning phases for a project at the watershed scale. The MBS NF has initiated pre-scoping discussions to explore restoration need and opportunities in the Green and Upper White River watersheds, where we have initiated the analyses described above. It is through this project planning process that we hope to continue to work towards this integration to influence the defined needs for restoration in this landscape, possible impacts for actions to benefit one resource for another, considerations for the sequencing of actions, and the opportunities for strategic actions to benefit multiple resources over time.

Conclusion

Westside forest restoration and integrated resource management are not only important on the MBS NF, but have regional significance across the northwest on multiple land ownerships. The collaborative discussion initiated through this process has resulted in this memo as one benchmark to capture the results of our work to date, but will also continue as both the MBS NF steps into project scale application and other landscapes address and define their approach and role to landscape scale restoration and processes in these forests.

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Appendix A

Restoration

The National Forest is the source of virtually all domestic water in the region and provides the headwaters for streams and rivers important to anadromous fish. Integrated management of aquatic and terrestrial systems requires a landscape approach to promote resiliency to climate change not just for the benefit of fish but also for wildlife, plants, the public forest users and our Trust responsibilities with the Tribes. One challenge on the Mt. Baker-Snoqualmie National Forest is to manage resources in order to restore, maintain and develop resilient landscapes. A resilient landscape or resilience is defined as the capacity of the natural environment to prevent, withstand, respond to, and recover from a disruption (man-made or natural). A landscape restoration strategy created with the purpose to ensure ecological processes and functions are not compromised will help managers meet this challenge. Additionally, our impending Forest Plan Revision and regional funding initiatives place an emphasis on restoration.

The MBS will further develop restoration in accordance with the U.S. Forest Service Strategic Plan: FY 2015-2020 Strategic Goals to:

- **Sustain Our nation's Forests and Grasslands**
    - Objective A. Foster resilient, adaptive ecosystems to mitigate climate change
- **Deliver Benefits to the Public**:
    - Objective D. Provide abundant clean water
    - Objective E. Strengthen communities

Goals:

- Develop a landscape restoration strategy to restore, maintain and develop resilient landscapes.
- Increase ecosystem resilience through a variety of multiple spatial scales, and diverse resources.

Strategic Objectives:

- The public, partners and Regional Office believe the case for ecosystem maintenance on the MBS is compelling.
- Integrated restoration/maintenance strategy is the basis of future project development.
- Ensure that ecosystems are healthy, resilient, and, thus, more adaptable to changing conditions or that they can be restored to a healthy state (USDA Strategic Plan).

Performance Gap:

- We believe ecosystem resilience and maintenance is a driver for restoration on the west-side. On our forest, the major consideration toward restoration involves water (soils and hydrology) and the flora and fauna it supports.
- Lack a common vision or definition, one shared with our partners, of what we collectively believe restoration means for MBS.
- A cohesive, all lands strategy for west-side restoration is lacking. Private and state lands adjacent to the National Forest are assumed to be in need of restoration activities as part of larger efforts aimed at connectivity of salt water to headwaters.
- Climate change links to restoration & maintenance activities are not being incorporated into the planning process. We anticipate climate change playing an important and increasing role in guiding future restoration and maintenance activities on the Mt. Baker Snoqualmie National Forest.

for the greatest good

March 4, 2016

USDA Forest Service is an equal opportunity provider and employer.

Appendix B. Screenshots of spatial results from Whole Watershed Restoration Approach assessments of the Upper White River Watershed (Figures 7-14).

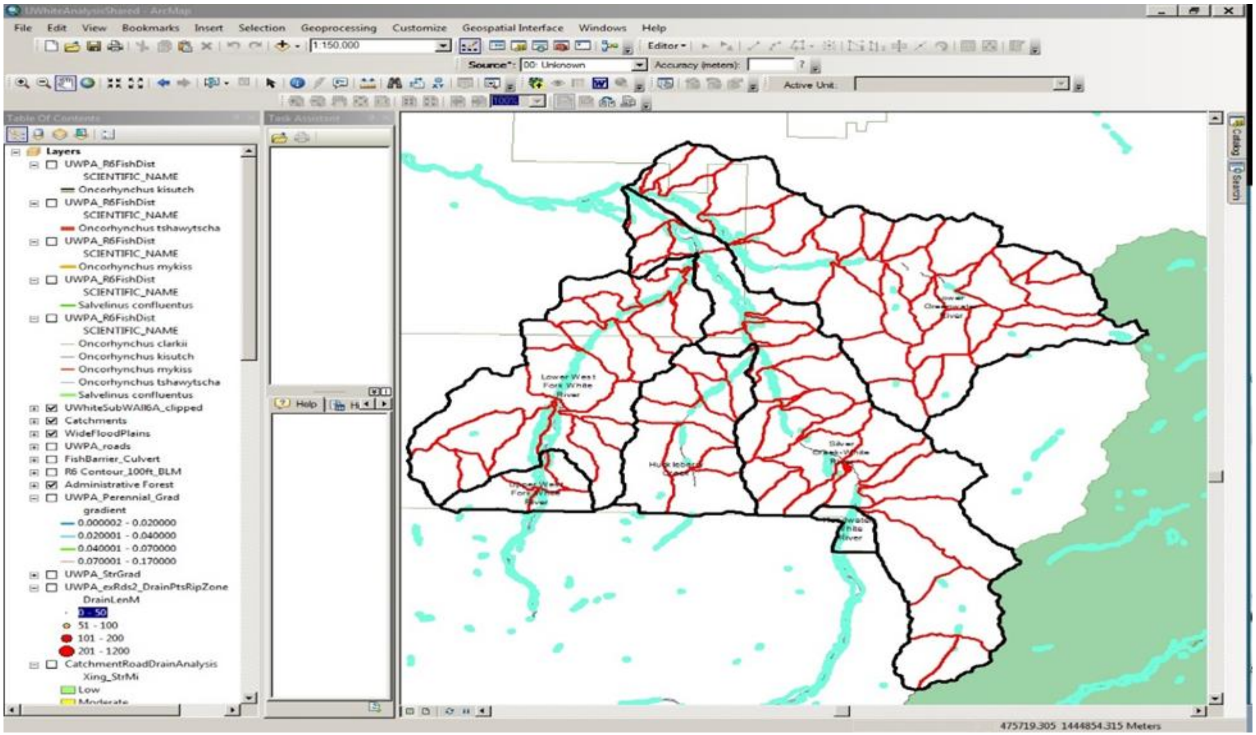

Figure 7. Each subwatershed is broken down into smaller catchments (red polygons).

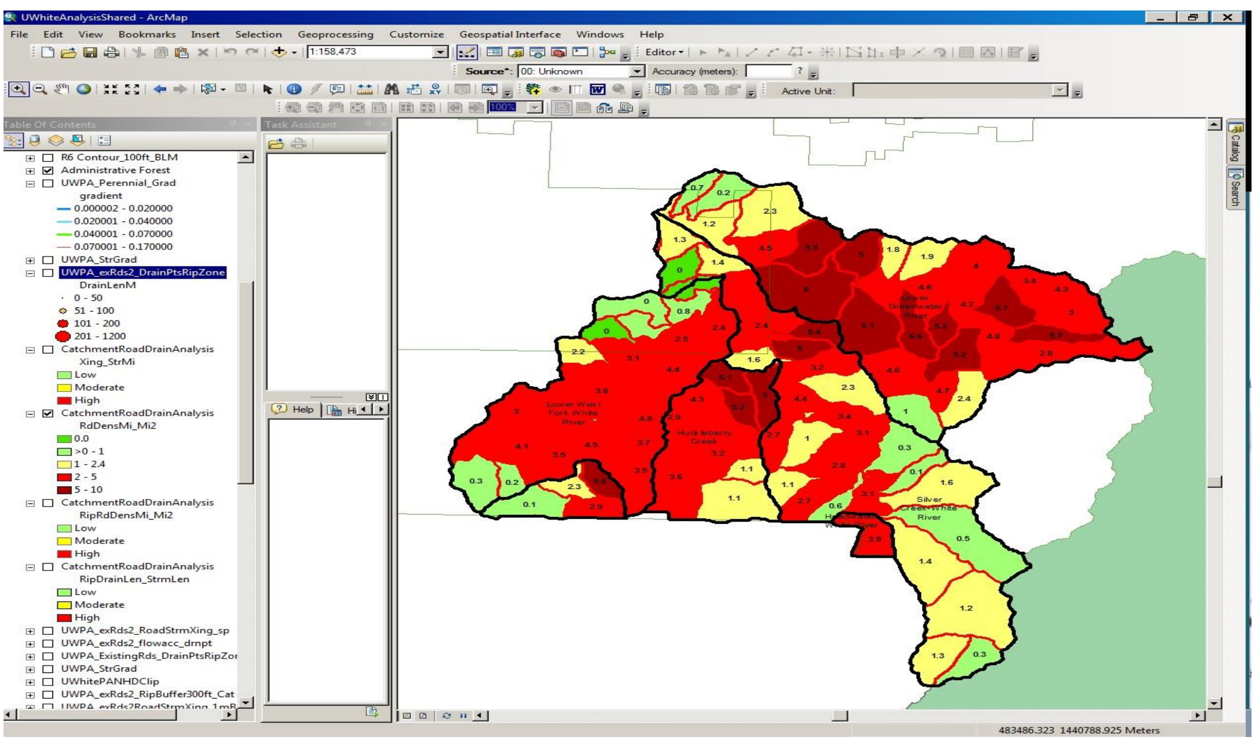

Figure 8. Distribution and intensity of road density per catchment (mi/mi²).

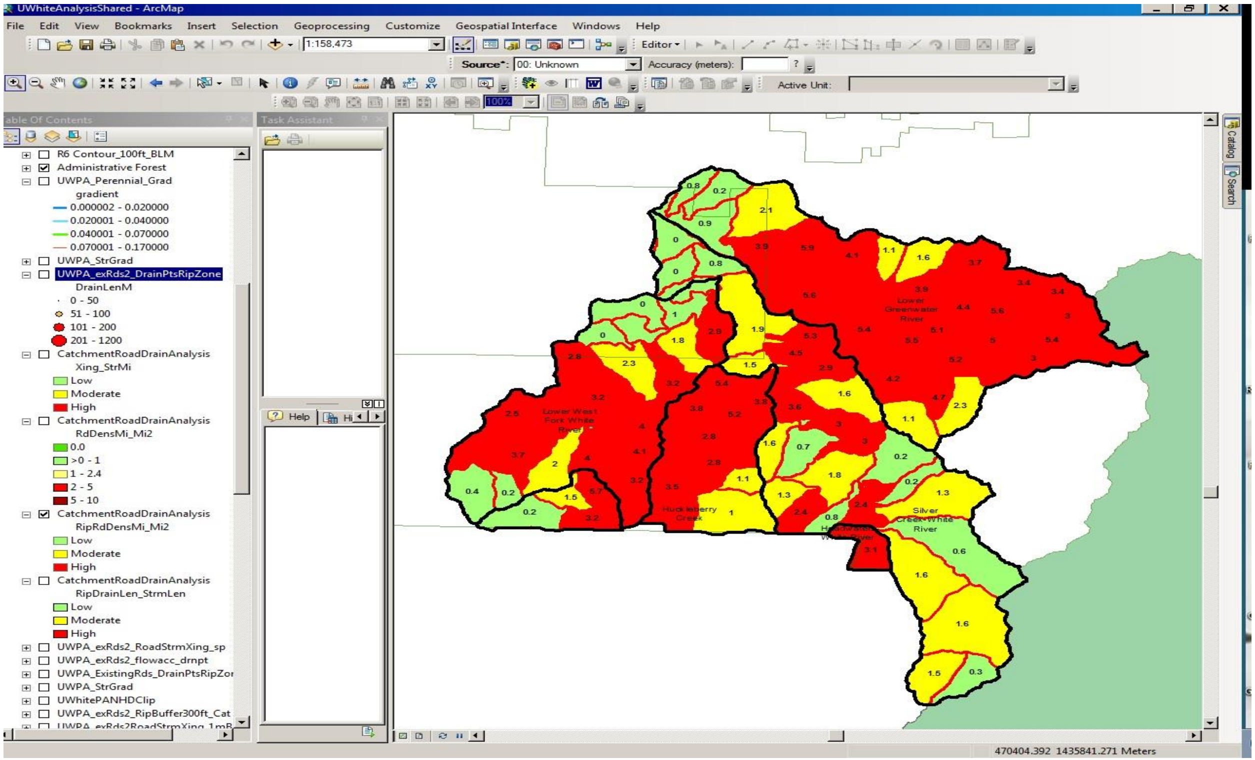

Figure 9. Distribution and intensity of riparian road density (mi/mi²).

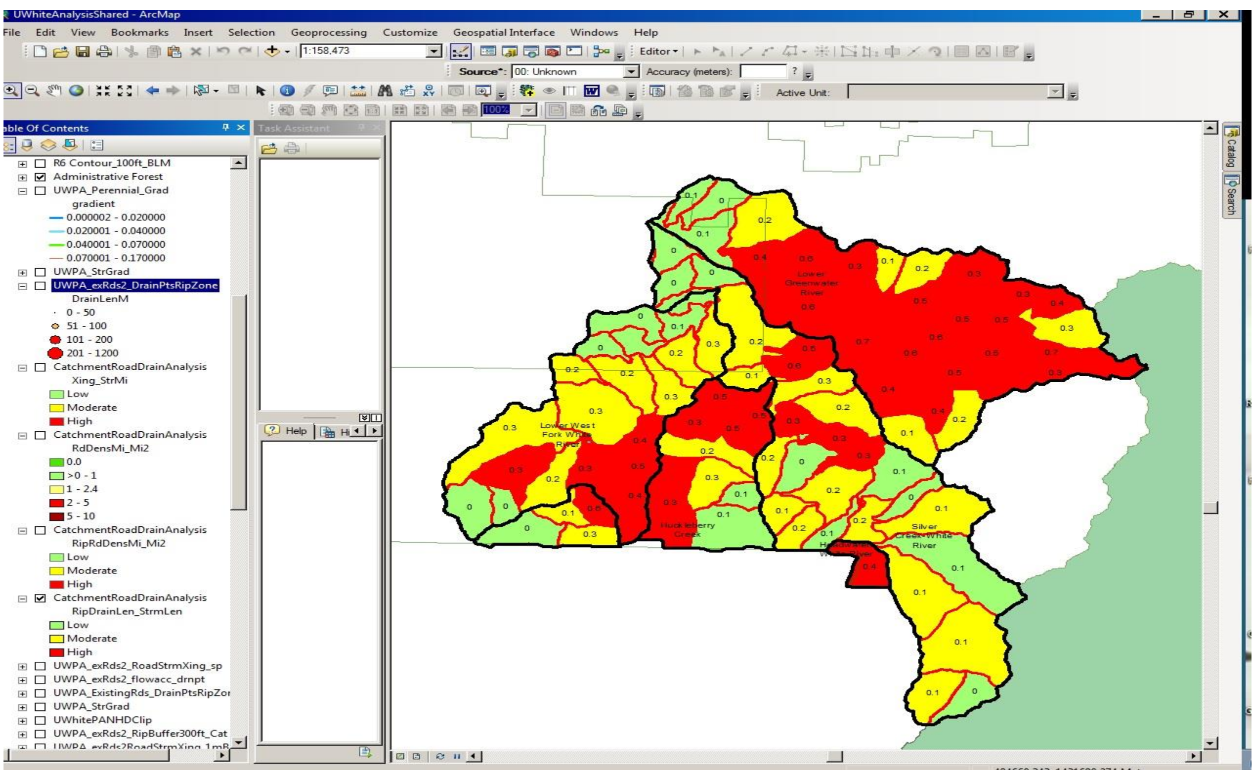

Figure 10. Distribution and intensity of riparian road length to stream length ratio.

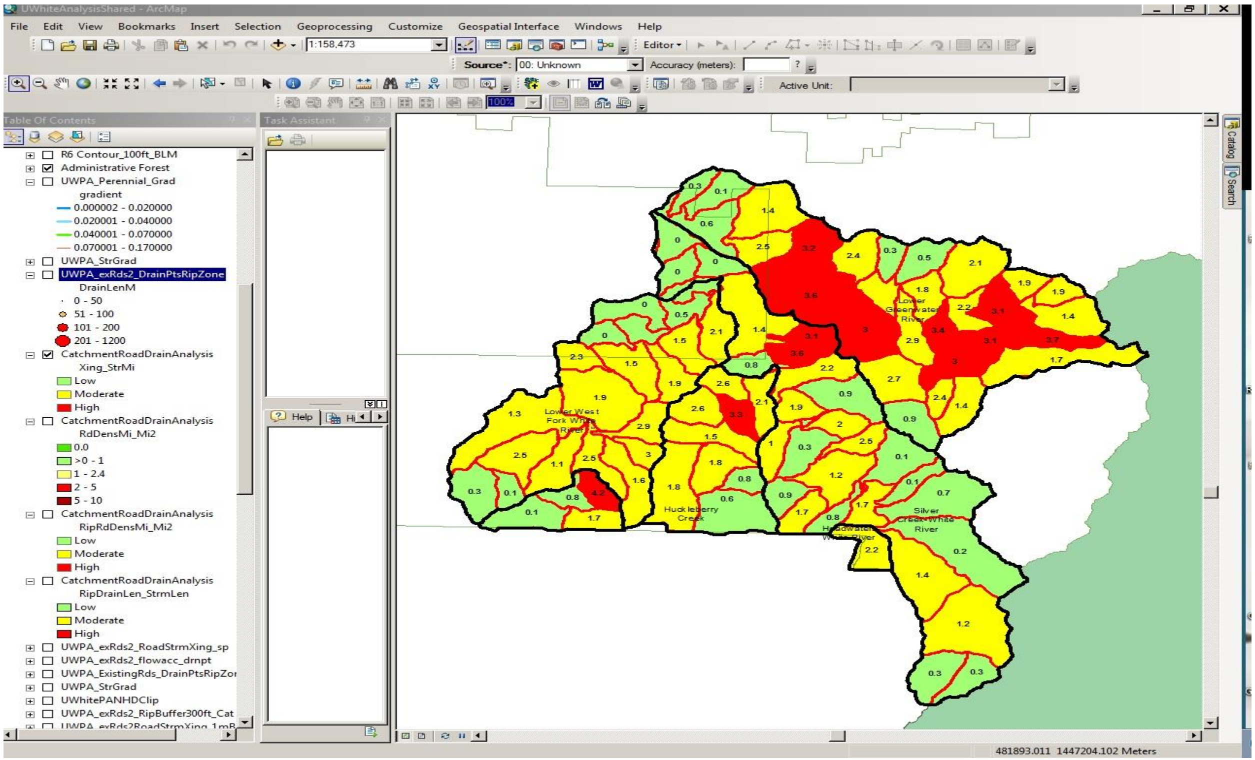

Figure 11. Distribution and intensity of road crossings per mile.

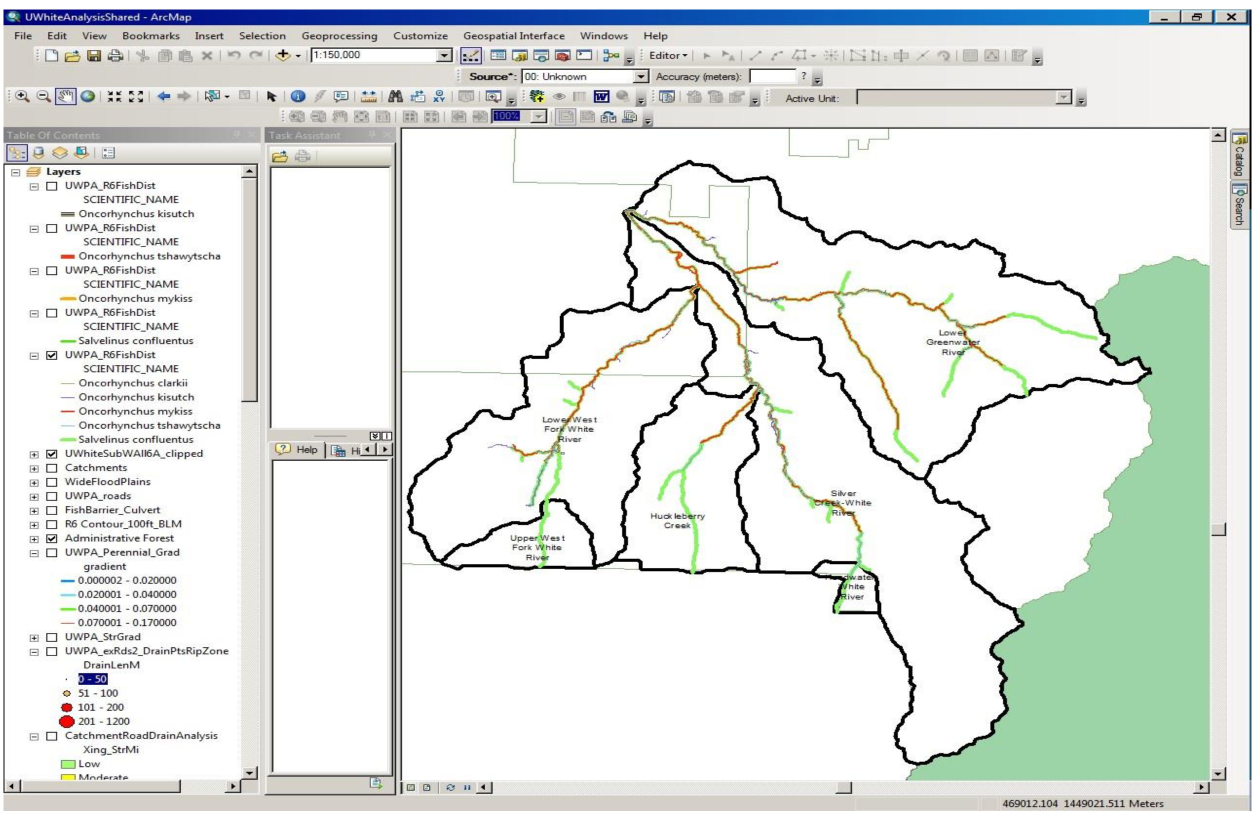

Figure 12. Plot of existing fish distribution data for Chinook salmon, steelhead trout, bull trout, coho salmon and coastal cutthroat trout.

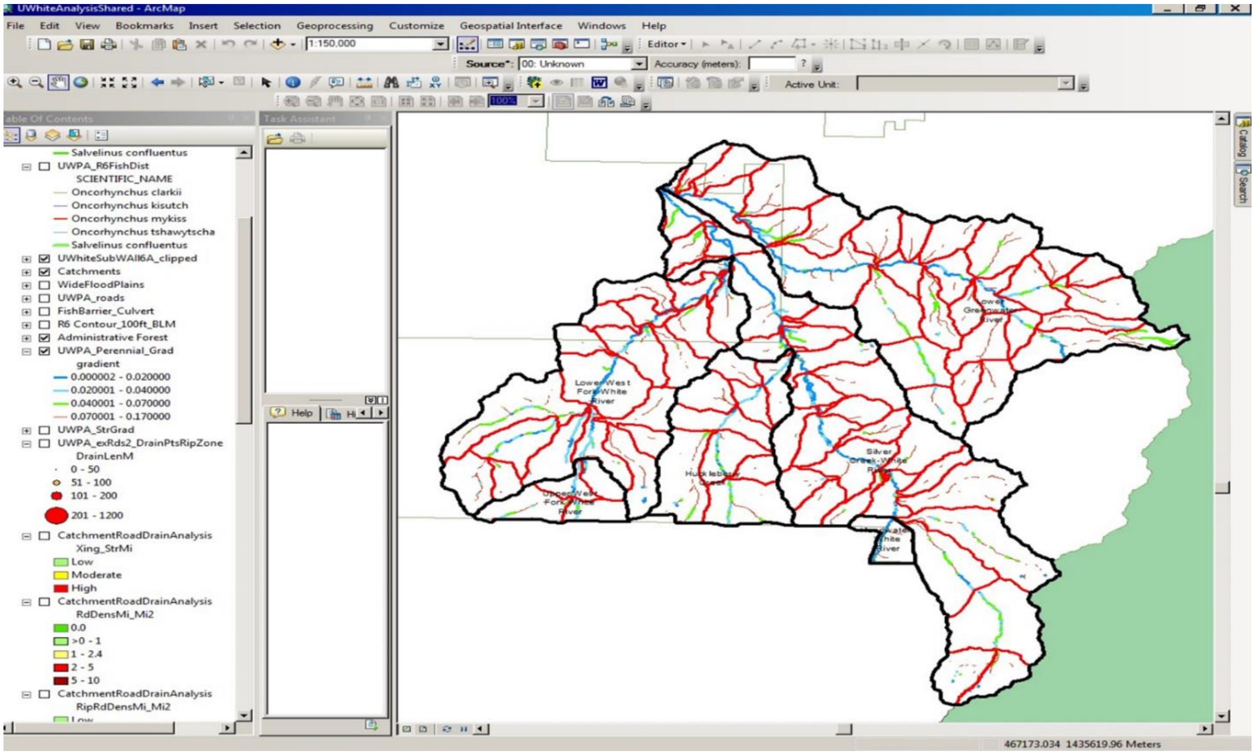

Figure 13. Plot of perennial streams and their modeled channel gradients. The higher the gradient the less likely a stream provides adequate or effective habitat for fish.

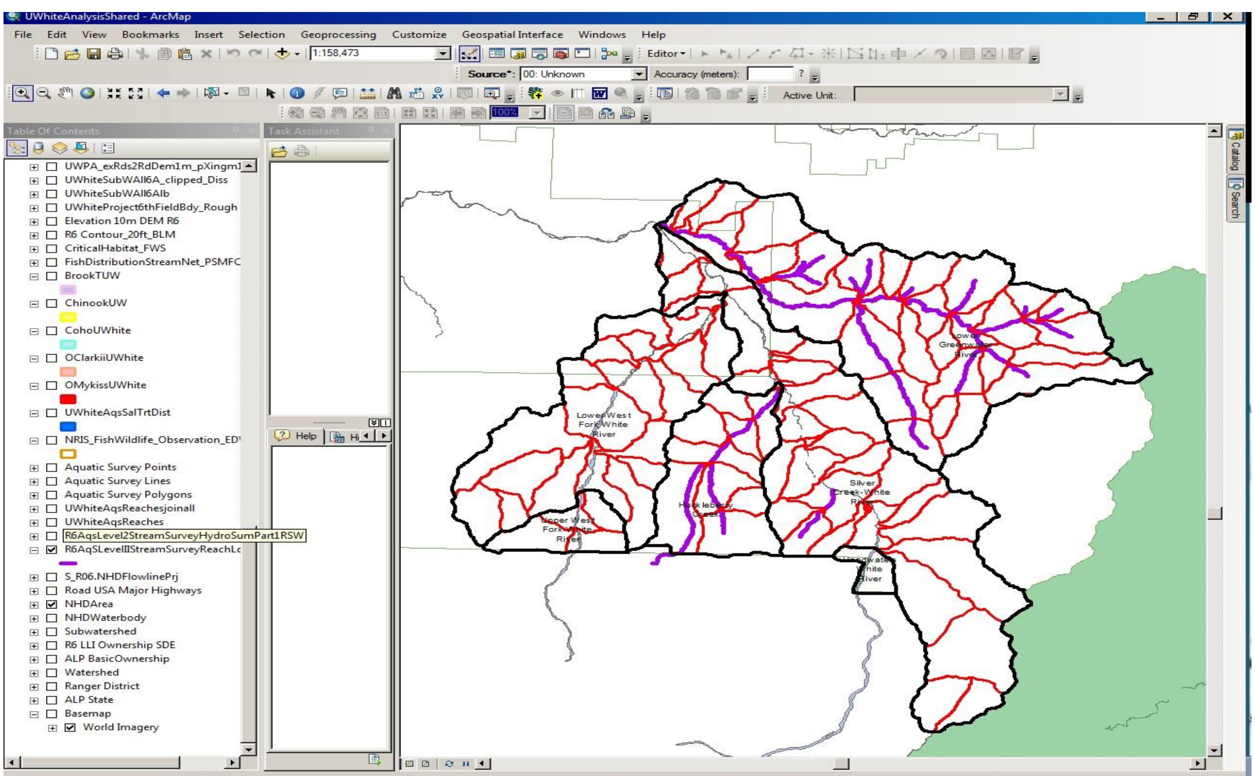

Figure 14. Existing stream habitat inventory data in the Upper White River watershed (purple highlighted streams).