21. Soil and Water: Restoration

Goal: Maintain and restore the biological, physical and chemical integrity of the Tongass National Forest waters.

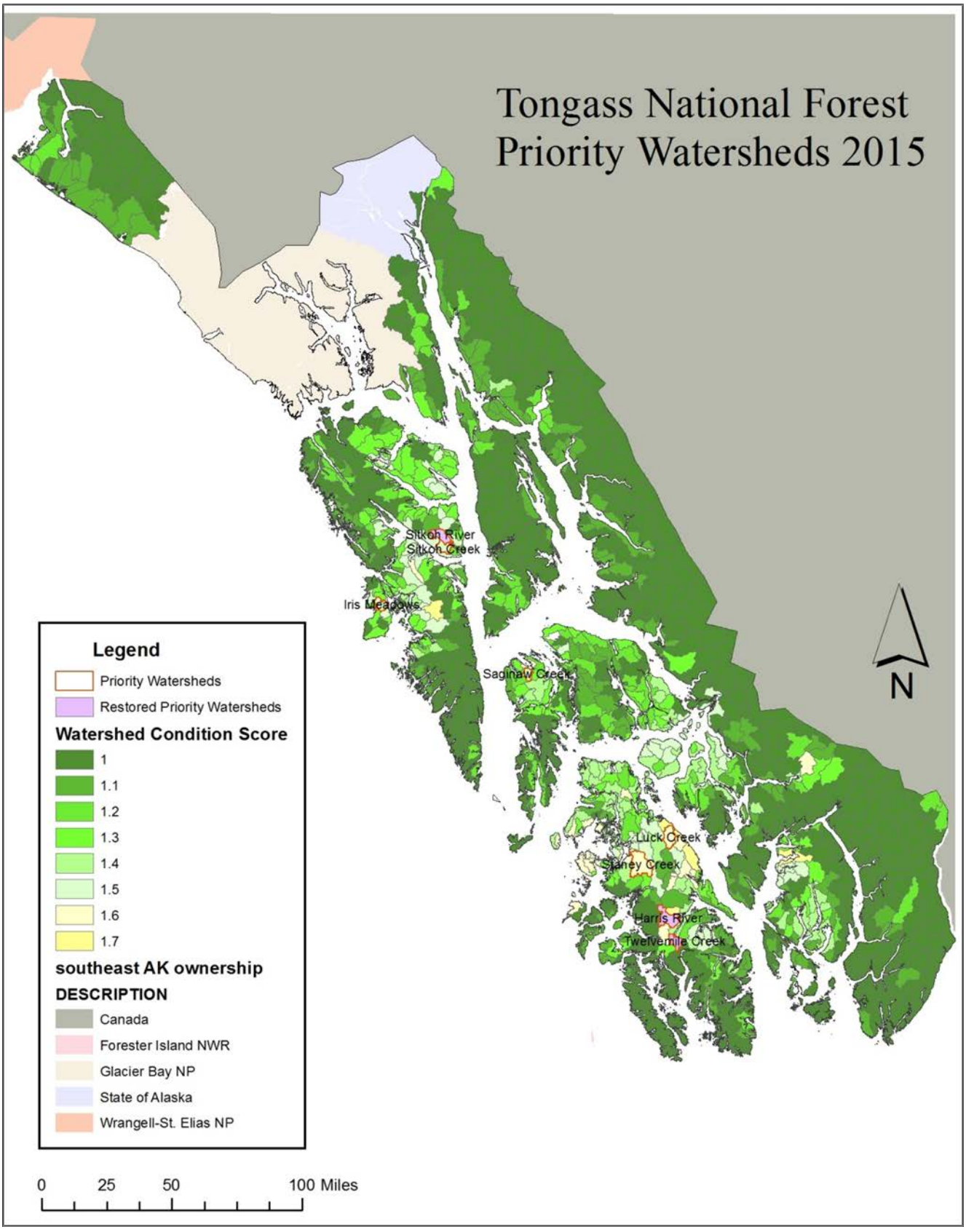
Objectives: Complete hydrologic condition assessments and restoration plans for priority watersheds. Complete watershed restoration plans in conjunction with Integrated Resource Program.

Soil and Water Question: *What is the ecological condition and trend of watersheds in terms of key characteristics (such as soil productivity, water quality and quantity, invasive species, etc.) of watershed health identified in the desired condition (aquatic ecosystem potential) of the plan area? How effective are management actions in improving watershed health (maintaining or moving watersheds toward condition class I)?*

As part of the Forest Service National Watershed Condition Framework, 12 core indicators were evaluated to classify watershed condition across the Tongass National Forest (USDA Forest Service 2011, p. 9 [Figure 2]). The National Watershed Condition Framework can be accessed online at: http://go.usa.gov/3Szj9.

Most of the 900 watersheds within the Tongass are in near natural condition (condition class I). Sixty-eight watersheds were rated "at risk" for maintaining ecological functions and aquatic resources due to past management practices. Watershed health issues on the Tongass primarily result from historical timber harvest and road building that occurred between 1950 and 1979, prior to full understanding of the importance of watershed resources and processes. Measures are now in place (and incorporated into the Forest Plan) to protect and maintain watershed health.

The watershed condition ratings, along with use and aquatic value criteria, led to designation of priority watersheds for restoration. Following a review by Tongass staff, district rangers and stakeholders, the forest supervisor formally established seven priority watersheds (Harris River, Twelvemile Creek, Staney Creek, Luck/Eagle Creek, Saginaw Creek, Sitkoh River and Sitkoh Creek) (Figure 1). Restoration plans and activities to improve watershed health have been focused in these watersheds. Essential projects were completed and watershed condition has been restored in four watersheds - Harris, Twelvemile, Sitkoh River and Sitkoh Creek. Restoration continues in the other priority watersheds. Iris Meadows/Shelikof Creek on Kruzof Island was added to the priority watershed list in 2014.



Soil and Water Figure 1. **Tongass Priority Watersheds**

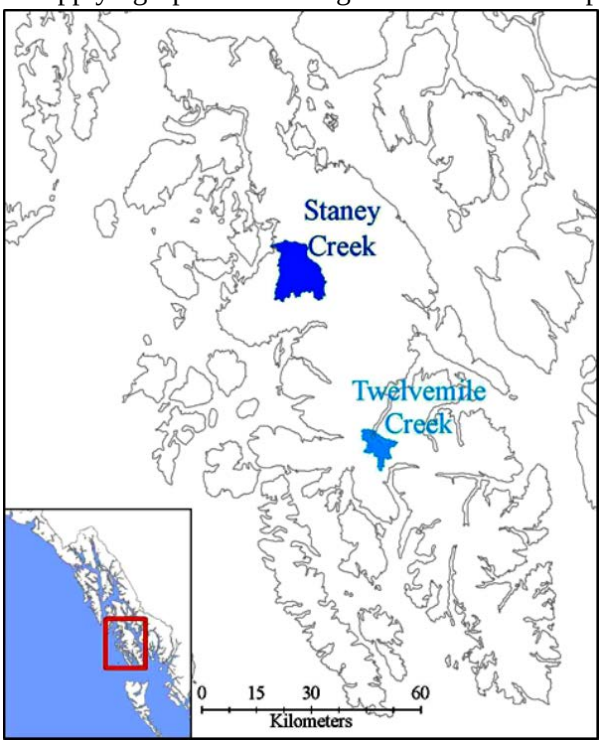
Evaluation Criteria

The Forest Plan states that the evaluation criteria for this question are "effects of management activities on Watershed Condition Class." Beginning in fall 2015, the Tongass will reassess watershed condition following the protocols of the national Watershed Condition Framework.

A protocol was developed to evaluate the effects of forest management on stream flow; this effort has been deferred until a forest canopy density model has been developed for the Tongass. Refer to the action plan for recommendations on this topic.

In 2009, the Tongass and the Pacific Northwest (PNW) Research Station began collaborating on a protocol for watershed restoration effectiveness monitoring (WREM). Original objectives included development and testing of an integrated suite of monitoring tools to evaluate the effectiveness of management actions at improving watershed health. A specific goal of the original effort was to identify meaningful surrogates for salmon responses to restoration by quantifying relationships between salmonid populations and other (lower-cost) metrics of ecosystem recovery. Demonstrating positive changes in characteristics of target salmon populations has proven difficult because of the complex life history and multiplicity of influences on salmon throughout their life cycle. The metrics used in the original WREM strategy are designed to augment information collected about fish populations (primarily population structure, diversity and condition) and physical stream habitat, to improve the interpretation of fish responses and ecosystem function. An experimental design was proposed to evaluate riparian forest and in-stream restoration treatments at a stream reach scale.

A search for restoration sites failed to identify streams that met all study design criteria; ultimately some compromises were made to select six small stream reaches (three pairs) in two priority "functioning at risk" watersheds on Prince of Wales Island (Staney Creek and Twelvemile Creek – see Figure 2). Young-growth riparian forest adjacent to these streams had previously been treated. As a result, metrics related to riparian young-growth treatments were dropped from the initial study and instead a decision support tool for applying riparian thinning treatments in other project areas was developed and tested. Data collection within the six study reaches focused on physical habitat measures and juvenile fish sampling to determine population size, densities and growth trends. In-stream treatments (wood placement) completed in 2011 were monitored through summer 2013.



Soil and Water Figure 2. Original watershed effectiveness monitoring locations

The terrestrial riparian vegetation component of the WREM project, designed to address the question of how thinning treatments impact stand development and the functions associated with mixed species stands of diverse age and structure, continued in 2014 with additional field evaluation and outreach and education. PNW Research Station completed a retrospective study which evaluated five conifer release treatments to better understand the mixed success reported for those treatments. The Tongass young-growth management strategy – riparian emphasis exhibit was updated in 2014 by PNW Research Station and Tongass specialists to incorporate the latest approaches to assessment, treatments and monitoring of riparian stands.

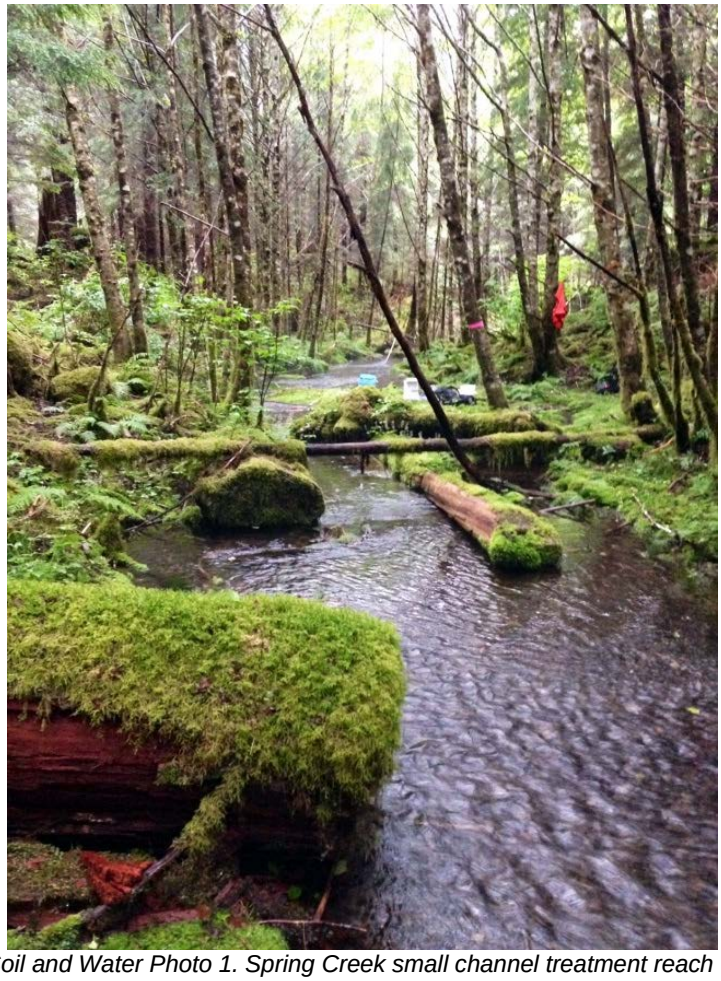
Program managers and monitoring principals met in November 2012 to review initial pre- and post-

treatment data summaries (2011-2012) and discussed what had been learned since inception of the WREM program. Findings suggested that the effort, though informative with respect to protocol refinement and overall progress, was not on track to achieve monitoring objectives.

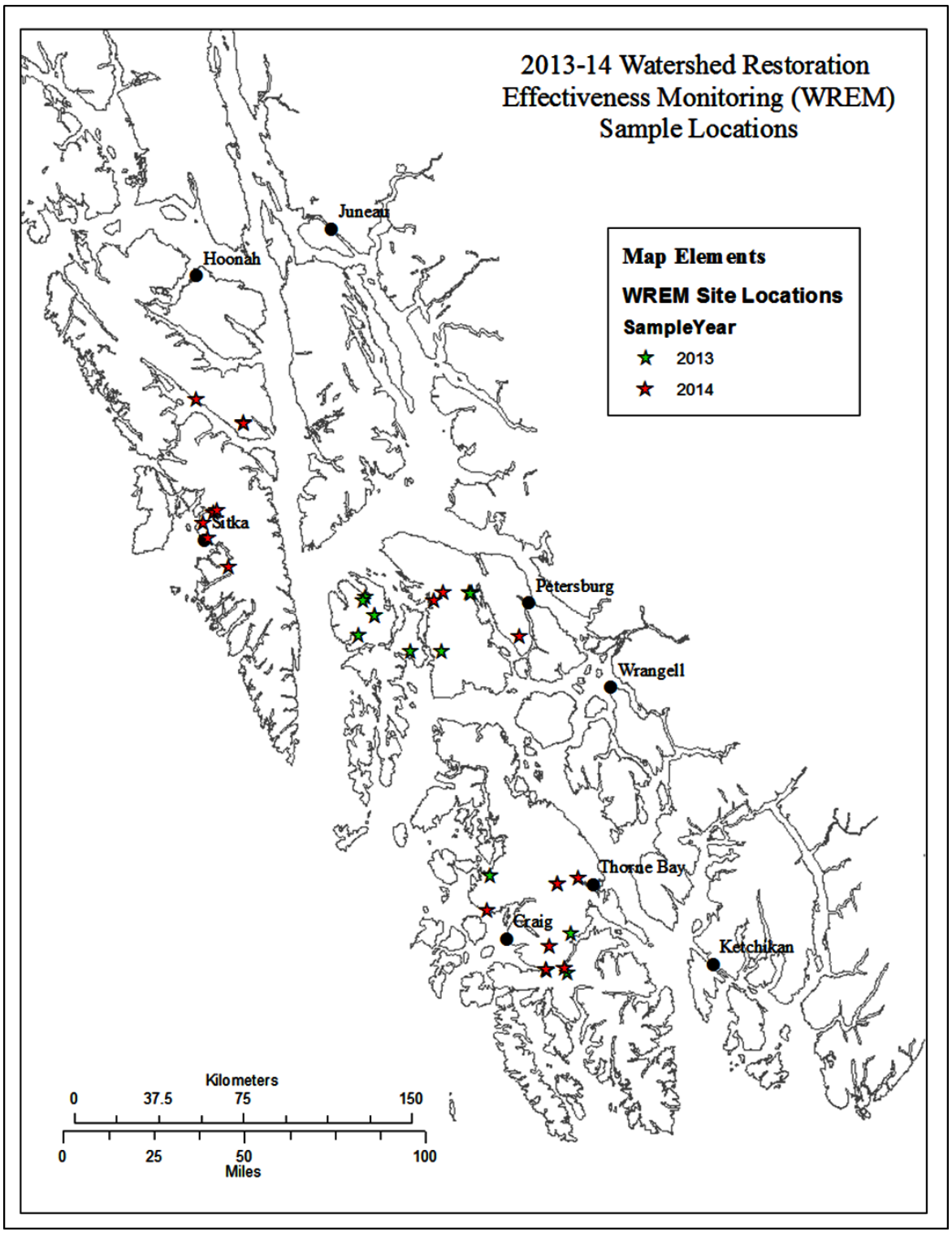
Three key findings were identified to drive an adaptive change to the strategy. First, the cost and time spent intensively sampling six small stream reaches prevented the programs forest-wide expansion to meet forest-level objectives. Second, the existing small sample size was not statistically rigorous, and the small streams sampled were not wholly relevant to broader scale and larger channel restoration treatments. Third, high variability in fish population data and tagging results between the six stream reaches and from one sampling event to the next in the same stream was bound to confound detection of responses to restoration treatments. The reformatted multi-faceted WREM strategy ensures a holistic package to look for trends across a broad scale and answer key restoration monitoring questions.

Beginning in FY2013, we expanded the original WREM study design from the two watersheds on Prince of Wales Island to include a broader range of channel sizes, and to better encompass forest-wide restoration projects, and to answer the following monitoring questions:

- Does large wood placement improve habitat in the restored reaches?
    - Does large wood placement increase frequency, areal extent, and quality of pools?
    - Does large wood placement increase channel complexity?
    - Does large wood placement improve stream bank stability?
- What are the fish characteristics (composition, relative abundance, diversity, and condition) in restored reaches?



Soil and Water Photo 1. Spring Creek small channel treatment reach



Soil and Water Figure 3. 2013-2014 Tongass-wide watershed restoration effectiveness monitoring locations

Under this expanded program and rotating panel sampling design, the intent is to sample a total of 72 stream reaches over a 4 year period and then return to these same reaches in the subsequent 4 year period. Reaches fall within one of three categories – reference, managed control (or un-restored) and treatment. Stream reaches are grouped into three categories based on channel width: small, medium and large channels. All are within alluvial stream process groups (floodplain and moderate-mixed gradient) and support salmon populations. The WREM sample design and objectives are detailed in the WREM monitoring plan.

We sampled a total of 35 reaches on islands throughout the north central, central and southern parts of the Forest in 2013 and 2014 (Figure 3). A total of 17 stream reaches were sampled in 2014. Photos 12-17 show representative sections of a subset of the 2014 sample reaches. We sampled physical habitat parameters and fish composition in each reach following the Alaska Region survey protocol (USDA Forest Service 2001) and other accepted methodologies as outlined in the WREM study plan summary. We supplemented this protocol with a longitudinal profile survey to evaluate bedform complexity. The suite of physical habitat and biotic metrics will be used to quantify trends and conditions in treatment reaches, which will be compared to conditions in similar reference and managed reaches. Table 1 provides a summary of the suite of metrics used to address the WREM monitoring questions.

Soil and Water Table 1. WREM monitoring questions and metrics utilized to address them

WREM Question	Metrics
Does large wood placement increase frequency, areal extent, and quality of pools?	Pool frequency expressed as pools per kilometer Ratio of wetted pool area to wetted riffle and glide area Average residual pool depth scaled by bedwidth
Does large wood placement increase channel complexity?	Mean square 'error' of thalweg profile (topographic variation about the mean slope)
Does large wood placement improve stream bank stability?	Length of undercut bank per meter Reach-average bankfull width to depth ratio
What are the fish characteristics (composition, relative abundance, diversity, and condition) in the restored reaches?	Species counts expressed as percent of total Fish per square meter broken out by species Number of species Fulton's K condition factor by species

Soil and Water Photo 2. Katlian River tributary small channel treatment reach

Soil and Water Photo 3. Newlundberry Creek small channel reference reach

Soil and Water Photo 4. Suntaheen Creek small channel managed control reach

Soil and Water Photo 5. Salmon Creek medium channel reference reach

Soil and Water Photo 6. Fubar Creek Phase 1 medium treatment reach

In addition to the WREM Tongass-wide reach-scale extensive post-treatment (EPT) monitoring strategy and the ongoing terrestrial riparian vegetation strategy component, the Twelvemile Creek smolt investigation located on Prince of Wales Island continued for a third consecutive year. This component is intended as a tool to estimate watershed-scale effects of habitat restoration on anadromous fish production and survival. A rotary screw trap is annually deployed in mainstem Twelvemile Creek near the estuary to estimate coho salmon smolt abundance and provide insights on the timing, size and age distribution of coho salmon, steelhead trout, and Dolly Varden char (Photos 7-10). As part of the project, a large portion of coho smolt are coded wire tagged to better estimate smolt abundance and enable the determination of marine survival and harvest rates for this recently restored priority watershed.

Sampling/Reporting Period

There is an annual sampling period with an 8-year rotating panel sample design for WREM extensive post-treatment (EPT) reach scale monitoring. Annual smolt sampling in Twelvemile Creek intended to run through 2015 with adult coho salmon re-capture work to continue into late 2016. The reporting and evaluation period is 5 years.

Monitoring Results

Data collected as part of the Tongass-wide WREM strategy in 2014 included stream physical habitat coupled with fish response (WREM 2014 progress report). The Twelvemile Creek watershed scale smolt investigation was conducted for a third consecutive year. Data from the terrestrial riparian vegetation component has been synthesized and is in draft form as a PNW Research Station general technical report.

Stream Physical Habitat and Fish Response

A total of 17 stream reaches were sampled during 2014. Interim results can be found in the WREM 2014 progress report. This is the second year of the eight year project using the rotating panel design; we do not have sufficient data for establishing trends at this time. Comparisons to the Tongass-wide fish habitat objectives (i.e., metrics) dataset show the relationship of individual sites and the natural range of variation. Group means will be compared for specific physical habitat and fish variables using standard statistical techniques, developed in consultation with a statistician.

Twelvemile Creek Smolt Investigation

A 5-foot rotary screw trap was operated in mainstem Twelvemile Creek from April 15 through May 25, 2014 during the peak of the coho salmon smolt out-migrant season. Along with the screw trap, juvenile emigrants were also captured at remote locations in the lower Twelvemile drainage. Emigration timing appeared very similar to 2013, assuming the number of smolt captured is somewhat indicative of run timing. A total of 14,199 coho salmon smolt, 205 steelhead smolt, and 733 Dolly Varden smolt were captured in the screw trap. The total number of smolt captured by the screw trap was higher in 2014 than in 2013 for all three species of smolt; 14,199 vs 8,467 for coho, 205 vs 100 for steelhead, and 733 vs 595 for Dolly Varden. It is unclear at this point if this is due to increased abundance in 2014 or capturing a larger proportion of the emigration, or a combination of the two. A total of 18,309 coho salmon smolt were coded wire tagged in 2014 with 18 post-tagging mortalities for a total of 18,291 tagged coho released.

Soil and Water Photo 7. Coded wire tagged coho salmon smolt

Soil and Water Photo 8. Coho salmon smolt

This is the third consecutive year of operation for the smolt trap and operations will continue through 2015 for smolt work and into fall 2016 to complete the two-event mark-recapture experiment necessary to estimate the 2015 coho smolt abundance. See the 2014 Twelvemile Creek Smolt Investigation Project Summary (Appendix C) for more information.

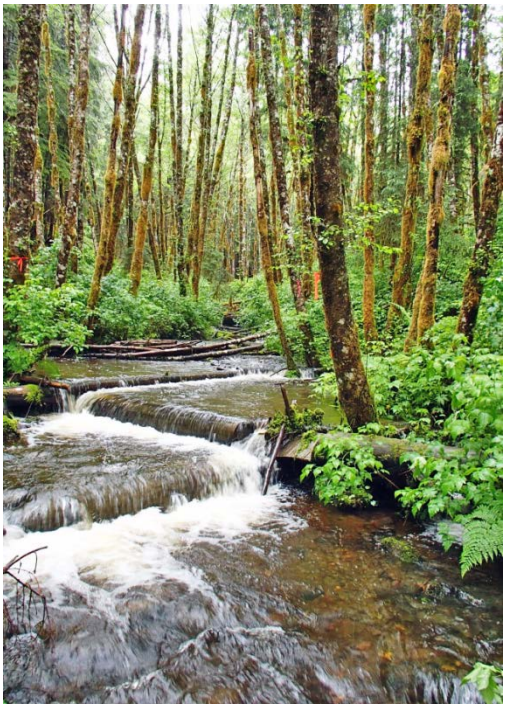
Soil and Water Photo 10. Cutthroat trout

Soil and Water Photo 9. Steelhead trout

Soil Geomorphology and Terrestrial Riparian Vegetation

The information obtained from the WREM terrestrial project provides initial guidance for assigning riparian treatments for the range of soil and geomorphic conditions through an adaptive management approach. Treatments considered for future treatment will utilize this guidance to array treatments in riparian forest stands by landform and stand structure to achieve desired future conditions in tree size and density. The intensive measurement protocol can be applied to evaluate the effectiveness of riparian stand treatments several years after treatment. The protocol can also be applied to sites that were treated in the past to expand the interpretive power and understanding of stand dynamics through a retrospective approach. A retrospective approach was utilized in 2014 within previously treated conifer release stands.

Because there has been some uncertainty about the effectiveness of the widely applied prescription of conifer release in riparian young-growth stands, yet no actual data to base a decision about the application of this treatment, a focused conifer release study was implemented in 2014. Individual release trees were measured, reach scale plots were established and trees within these plots were measured. A study plan was established and applied. Preliminary results of this study show that conifer release led to a growth response across the five observed stands for the period studied to date. A complete summary is in draft form as a PNW Research Station general technical report.



Soil and Water Photo 11. Alder-dominated riparian stand

Soil and Water Photo 12. Salmon carcass retention observed in a treatment stream

Evaluation of Results

The evaluation of data collected through 2012 was described above and led to an expanded sample design which began in 2013. Sampling continued in 2014, the second year of an 8-year rotating sampling panel. Data collected in 2013-2014 has been summarized in the WREM 2013 Progress Report.

In fall, 2014, a thorough review of the WREM expanded strategy and rotating panel design was conducted by John Buffington, US Forest Service, Rocky Mountain Research Station hydrologist (Buffington 2015). The review included the study objectives, indices and metrics utilized, statistical recommendations, and intended outcomes. Findings from the review are being integrated into the 2015 WREM sampling and analysis.

Tongass stream restoration project monitoring guidance for project level, stream restoration projects, in priority watersheds was updated in 2014. This document defines several qualitative and quantitative tools to be used for evaluating channel response to restoration. Physical channel metrics can be measured pre- and post-restoration to evaluate the channel response and determine whether project objectives were met. By monitoring and reporting these outcomes, we can learn from our experiences, adapt our practices through time, and better communicate the effects of restoration. This project level monitoring compliments the larger scale, watershed restoration effectiveness monitoring (WREM extensive post-treatment evaluation), which is ongoing at a forest level.

Project monitoring reports were completed for the Harris River mainstem and Twelvemile Creek mainstem restoration projects.

Presentations on the Watershed Condition Framework, Forest Service channel habitat metrics, and WREM program were made at a fall 2013 Southeast Alaska Fish Habitat Partnership meeting. An interagency and stakeholder workshop was held in fall 2013 to further discuss and seek feedback on the Tongass WREM program strategy. Watershed restoration presentations were made at December 2013 gillnet and seiner gear group task force and/or board meetings.

Action Plan

At this time, no changes to the Forest Plan are recommended. The following recommendations should be considered in the context of continued Watershed Restoration Effectiveness Monitoring (WREM) in the Tongass National Forest:

- Continue restoration plans and activities in priority watersheds in collaboration with partners and stakeholders. A reassessment of Tongass watershed conditions through the Watershed Condition Framework process is due to be completed by April 2016 and may incorporate an all-lands collaborative approach.
- Continue collaboration with Pacific Northwest Research Station to evaluate the effectiveness of restoration activities in improving watershed health.
- When a forest canopy density model is developed for the Tongass, consider its utility for evaluating the effects of forest management on streamflow. Incorporate recent findings on throughfall (Prussian 2010) and analysis of long-term streamflow records (personal communication with Ed Neal 2010).
- Continue to refine the Tongass Riparian Young-growth Strategy to reflect best science and ongoing retrospective monitoring results of riparian stand treatments. Ensure completion of a PNW Research Station general technical report which details field-based sampling and analysis in an experimental context across several riparian stands to better evaluate treatment options and predict future forest conditions in streamside forested communities.
- Compile a comprehensive database of historical riparian young-growth treatment areas to track evolution of riparian forest stands. This database should include information on site conditions and treatment prescriptions across the forest. The riparian soil geomorphic guide can be used to predict the condition in the stand and its estimated trajectory toward future desired conditions.
- Continue with the broader Tongass-wide scope, more focused metrics with less sampling

intensity WREM program for the duration of the 8-year rotating panel. Consider further testing of the hydrologic retention metric to determine its usefulness as a measure of channel complexity and nutrient retention in evaluating large wood placement projects.

- Continue smolt production monitoring in one restored Tongass watershed (Twelvemile Creek on Prince of Wales Island) to evaluate watershed scale effects of watershed restoration through 2015 with adult coded wire tagged coho salmon to be recaptured in fall 2016. Thereafter, adult coho salmon and steelhead escapement counts should continue as a tool for monitoring effectiveness of stream restoration actions.
- Continue with the forest requirement to collect a suite of routine physical metrics at all major watershed restoration projects as agreed upon in an updated 2014 version of the Alaska Region Core Aquatic Habitat Restoration Monitoring Guidance document.

Soil and Water Photo 13. Tongass Hydrology field crew at Gandlaay Haanaa (formerly called "Fubar Creek), part of the multi-agency Harris River Watershed Restoration effort near Hydaburg.

Citations

Buffington, J. 2015 [Internal report available upon request]. A review of the Watershed Restoration Effectiveness Monitoring Program (WREM), Tongass National Forest. USDA Forest Service, Tongass National Forest, Fisheries and Watershed Resources staff. Petersburg, AK.

Neal, E. 2010. USGS. Personal communication with Steve Paustian (US Forest Service), December. Updated comparative analyses of discharge data from Staney Creek (USGS station no. 15081497) and Old Tom Creek (USGS station no. 15085100) through the 2009 water year.

Prussian, K. 2010. Throughfall monitoring: Prince of Wales Island, Alaska.

USDA Forest Service. 2011. Watershed condition framework. A Framework for Assessing and Tracking Changes to Watershed Condition. FS-977. Watershed Condition Advisory Team. Washington D.C. http://www.fs.fed.us/sites/default/files/media/types/publication/field_pdf/Watershed_Condition_Framework.pdf.. Accessed May 2015.

USDA Forest Service. 2006. R-10 Amendment No. R-10 2509.22-2006-2 to FSM 2500 – Watershed and Air Management, Chapter 2550 – Soil Management. Juneau, AK. 117 pp. Online at: http://www.fs.fed.us/im/directives/field/r10/fsh/2509.22/2509.22_10.doc

USDA Forest Service. 2001. Aquatic Habitat Management Handbook. FSH, 2090.21_20 R10 Amendment 2090-2001-1. U.S.D.A. Forest Service, Region 10, Juneau Alaska. Online at: http://www.fs.fed.us/cgi-bin/Directives/get_dirs/fsh?2090.21