Northwest Forest Plan -The First 15 Years (1994-2008)

Watershed Condition Status and Trend

Results for the Puget Sound

Steve Lanigan, Sean Gordon, Peter Eldred, Stephanie Miller

July, 2013

The Northwest Forest Plan Aquatic and Riparian Effectiveness Monitoring Program (AREMP) assesses watershed condition status and trend on federal lands (i.e., Forest Service (FS), Bureau of Land Management (BLM), and National Park Service (NPS)) at two different scales, inchannel and upslope/riparian. This report is summarized from is the Northwest Forest Plan (NWFP) 15-year report (Lanigan et al. 2012), AREMP's most recent effort to describe upslope/riparian condition status and trend.

Further documentation of the methods and NWFP results can be found in our full 15-year NWFP monitoring report (Lanigan et al. 2012), which is available at http://www.reo.gov/monitoring/reports/watershed-reports-publications.shtml

Inchannel Conditions

Inchannel condition is based on stream surveys in watersheds randomly selected from the Northwest Forest Plan (NWFP) area; it describes current condition for fish and other aquatic biota. AREMP inchannel evaluation criteria (aka benchmarks) are currently under revision, so we cannot supply an evaluation of inchannel conditions at this time. Unevaluated individual attribute data summarized at the site level are available upon request for select watersheds.

Upslope and Riparian Conditions

Upslope and riparian condition is evaluated based on GIS and remote sensing data, and it represents more of a risk assessment, i.e., what the likely impact of upslope and riparian conditions is on the future state of aquatic organisms. In this report we report on watershed condition status (latest evaluated condition) and trend (change in condition since 1994, when the NWFP was initiated). We compare status and trend in the Puget Sound area to the rest of the NWFP area, and we also report on trend in the Puget Sound broken down by a number of land management categories.

Methods

Study Area

For the NWFP monitoring effort, AREMP only evaluated watersheds with at least 25% federal ownership along the 1:100,000 USGS National Hydrography Dataset stream layer. For this analysis, the Puget Sound subset of these watersheds was defined by the boundaries used in the Puget Sound Watershed Characterization Project (http://www.ecy.wa.gov/services/gis/data/pugetsound/characterization.htm).

Land use allocations (LUAs) provide a key spatial component of the NWFP by assigning different management guidelines and priorities to zones within the NWFP area. AREMP has summarized the data in the context of two types of land classification: the general NWFP land use allocations (reserved, late-

successional reserve, matrix) and the NWFP aquatic conservation strategy (ACS) designations of key versus nonkey watersheds (Table 1). Boundaries for land use categories (including key watersheds) did not follow watershed boundaries; consequently each watershed was assigned to the class covering the largest amount of its area.

Table 1. NWFP Land use allocation descriptions.

Land use allocation	Description
Congressional reserves	National parks and monuments, wilderness areas, wildlife refuges, and other areas reserved by the administrative unit or act of Congress. These lands are generally not managed for timber production.
Late-successional reserves (LSR)	LSR's contain largely old-growth forest and were designated to provide habitat for old-growth-dependent species such as the northern spotted owl. Adaptive management areas managed under LSR guidelines were included in this class.
Matrix lands	The use allocation includes all lands not included in one of the other allocations. Scheduled timber harvest activities may take place on matrix lands. Adaptive management areas managed under matrix guidelines were included in this class.
Key watersheds	Identified to "serve as refugia for aquatic organisms, particularly in the short term for at-risk fish populations, to have the greatest potential for restoration, or to provide sources of high-quality water" (Haynes et al. 2006). Key watersheds were identified as part of the ACS and independent of the land use allocations in the NWFP, thus key and nonkey watershed designations overlay the other land use allocations.
Nonkey watersheds	All other watersheds

Assessment Model

Upslope/riparian condition was based on a variety of indicators calculated from mapped data. Indicators fell into three main categories: roads (e.g., road density based on FS and BLM geographic information system road layers), vegetation (e.g., tree canopy cover derived from satellite imagery), and landslide risk (a combination of roads and vegetation impacts by topography). The Puget Sound area includes watersheds from three of AREMP's provincial analysis areas (Olympic, North Cascades, West Cascades), and each province uses a somewhat different condition assessment model, as designed by the provincial expert teams (see Lanigan et al. 2012 appendix 4).

Watershed Scores

AREMP watershed condition scores are based on a composite of all federal lands within each qualifying watershed. The standardized model scores range from -1 to +1, with watersheds in good condition having higher scores than those in poor condition. Scores were calculated for 1994 and 2008, and the difference in these scores was used to represent trend. Because data on every watershed in the target population were analyzed, inferential statistics are not needed to test the reliability of generalizing results from a sample to a larger population. All differences are effectively statistically significant, so what remains for judgment is whether differences are meaningful in terms of biology or management.

Results

Land Use Allocations

As can be seen in Figure 1, the Puget Sound area contains a much larger proportion of congressionally reserved lands (the highest protection category) than the rest of the NWFP area.

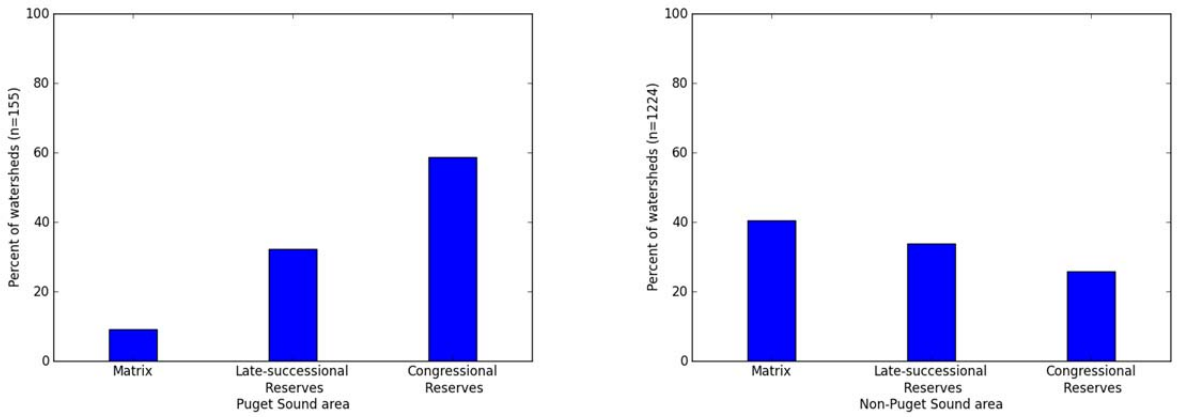

Figure 1. Comparison of land use allocations between the Puget Sound area (left) and the rest of the Northwest Forest Plan area (right).

Status

Overall watershed condition scores of the 155 watersheds within the Puget Sound area ranged from a low of -0.96 to a high of +1.0, with a mean score of +0.39 (standard deviation of 0.46). The mean score for the rest of the NWFP area was +0.18 (SD = 0.46). Figure 2 presents a view of the distribution of scores grouped into five status categories for watersheds in the Puget Sound sample (n=155) and watersheds in the rest of the NWFP area (n=1224). Puget Sound area watersheds were heavily skewed towards the higher condition categories, in contrast to the non-Puget Sound NWFP watersheds which were dominated by midrange scores. These differences are likely due the higher proportion of late-successional and congressional reserves in the Puget Sound area than the NWFP as a whole. These land-use areas are managed for less timber production than the remaining matrix lands. .

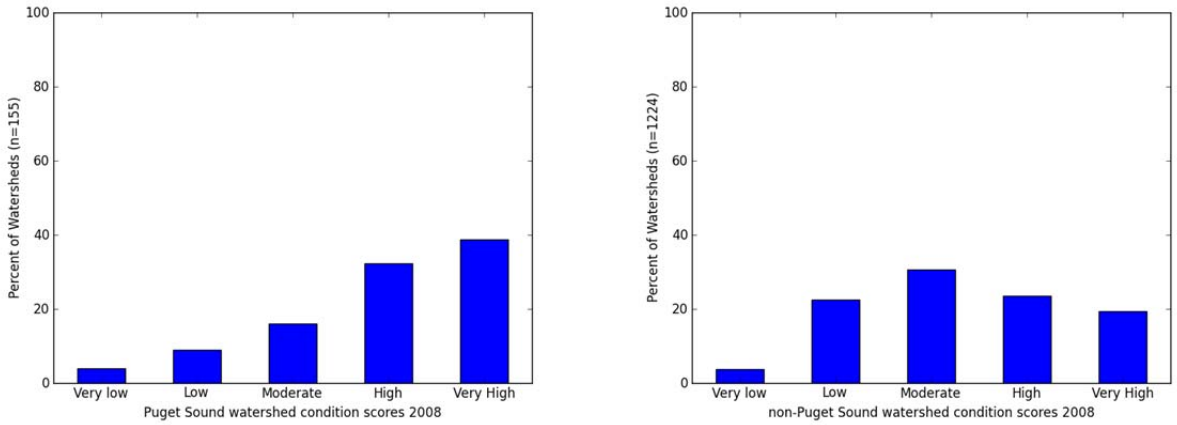

Figure 2— Latest (2008) watershed condition scores by status category for the Puget Sound area (left) as compared to the rest of the Northwest Forest Plan area (right).

The spatial distribution of watershed scores and major sub-scores are shown in Figure 3. Roads had the largest negative impact on scores, with 31% of watersheds receiving a very low (≤ -0.6) roads score as compared to 14% for landslide risk and only 6% scoring very low on vegetation attributes.

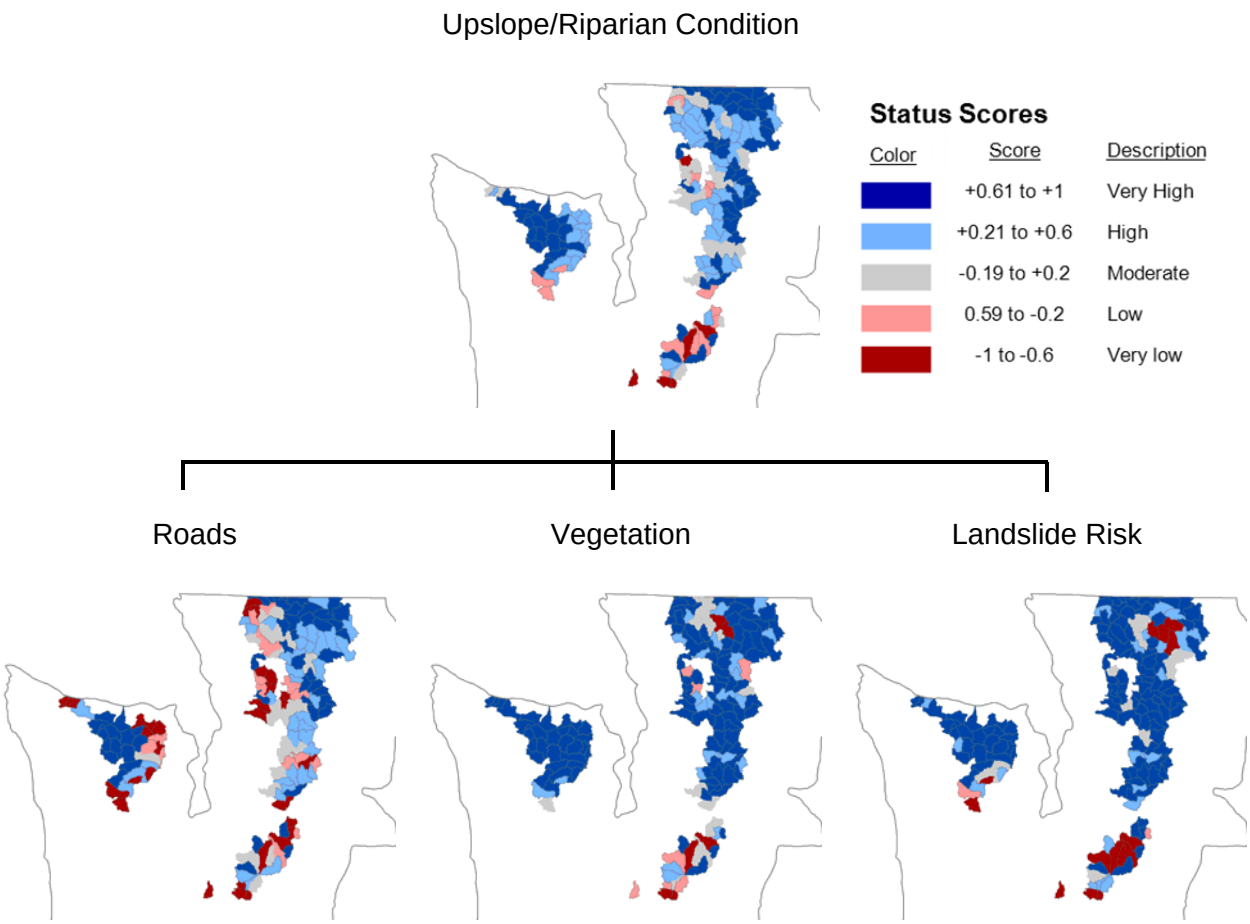

Figure 3. Watershed condition (upslope/riparian) status scores (2008) and major components for the Puget Sound.

Trend

In the Puget Sound area there was an overall positive change in watershed scores, from a mean score of +0.34 in 1994 to +0.39 in 2008. This change was slightly greater than the average change in the rest of the NWFP watersheds (+0.11 to +0.14). On average, road scores improved in both areas (+0.05 in Puget Sound vs. +0.03 elsewhere), but vegetation and landslide risk scores improved in the Puget Sound (+0.04 and +0.07, respectively) while the average scores for these attributes did not change in the rest of the NWFP area.

In the Puget Sound area, the distribution of watershed condition scores increased for 63% of watersheds versus 27% showing declines (Figure 4). The overall distribution in the Puget Sound area had fewer score increases and more declines (in relative percentage terms) than the rest of the NWFP area. However, most Puget Sound score changes (81%) were relatively small (± 0.1 in model score or ±5% of possible change from -1 to +1), and a portion of these small shifts is likely due to errors inherent in the satellite imagery vegetation classification process.

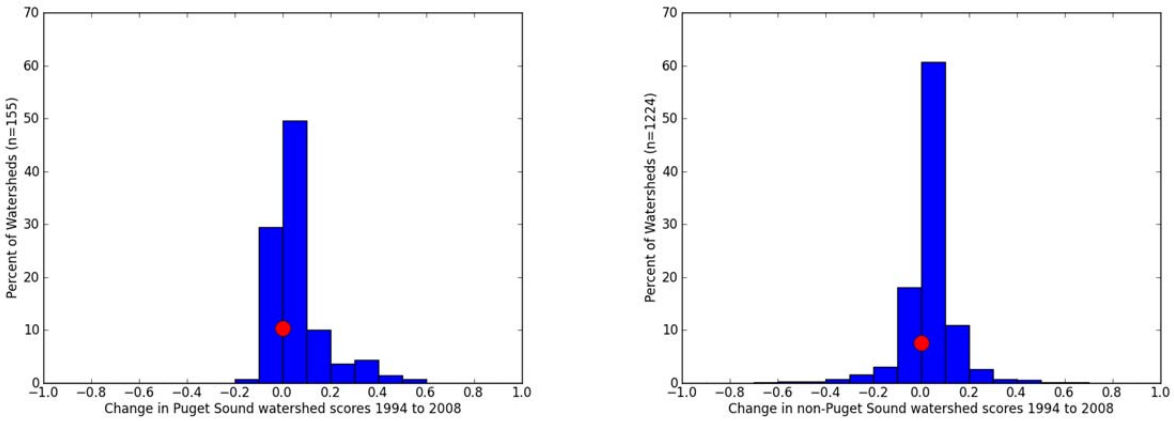

Figure 4. Distribution of changes in watershed condition scores between 1994 and 2008 for the Puget Sound area (left) as compared to the rest of the Northwest Forest Plan area (right). Red dot shows percentage of watersheds with no change in score.

Figure 5 displays the spatial configuration of score changes. The watershed condition trend map uses seven categories instead of five, and the central categories also have a smaller interval (0.2) than the extremes (0.5) for better discrimination because changes in scores tended to be more tightly grouped around zero than the status scores. Again it should be noted that small changes (± 0.1) in vegetation and associated landslide risk, such as those appearing along the Cascade Range, can be due to temporal biases in the satellite imagery classification.

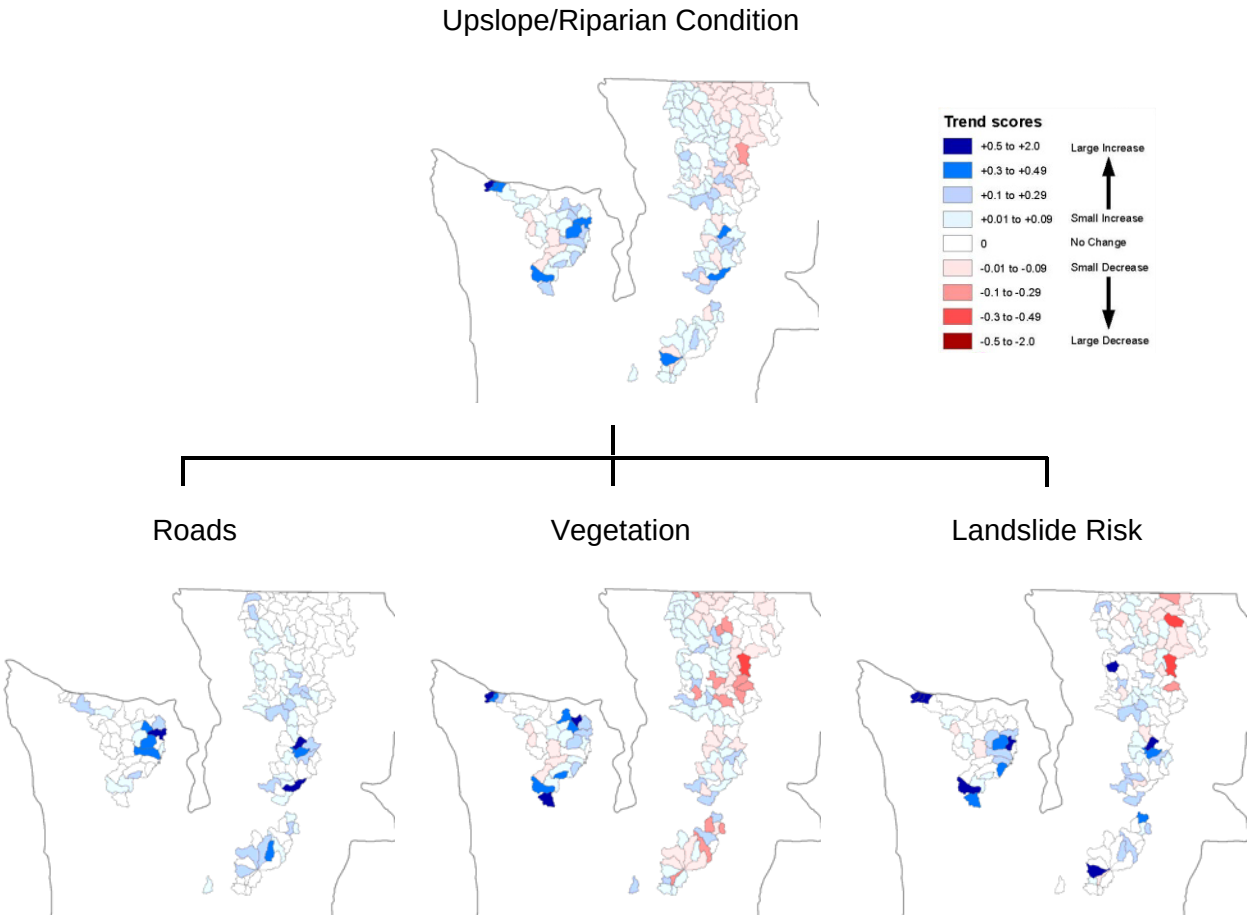

Figure 5. Change in watershed condition score and major components, 1994 to 2008, for the Puget Sound area.

Table 2 shows the percentage contribution of roads, vegetation, and landslide risk to the different levels of score changes in the Puget Sound area. Only one watershed declined by more than 5% (0.1): Cascade River Forks, which straddles the border between the Mt Baker-Snoqualmie National Forest and the North Cascades National Park on the western border of the Puget Sound area. This decline appears to be due to vegetation losses from the Mineral Park fire in 2003 (based on an overlay of the MTBS fire history GIS layer) and associated increase in landslide risks.

Scores declined by 0.1 or less in 26% of watersheds, and these declines were driven entirely by drops in vegetation scores (72%) and associated declines in landslide risk scores (28%). Ten percent of watersheds showed no change in score (red dot on Figure 4). Forty-five percent of the watersheds had score increases between 0 and +0.1. Increases in vegetation scores were again the dominant driver (51%) for this range, but with some contribution from both landslide risk (23%) and road (26%) improvements.

Positive trends in the +0.1 to +0.3 range were due to a combination of road decommissioning (44%), vegetation improvements (e.g. increases in average diameters and canopy cover, 26%), and reduced landslide risk (30%). Five percent of watersheds showed improvements in the +0.3 to 0.49 range, and

these were driven much more strongly by road decommissioning (40%), especially in landslide prone topographies (55%).

Only one watershed increased by more than +0.5: Deep Creek on the northwestern corner of the Olympic National Forest. Satellite imagery from the Landtrendr program (Kennedy et al. 2010) shows extensive harvesting occurred in the subwatershed in the late 1980s and early 1990s. The large contribution of landslide risk (83%) to the score improvement was driven by vegetation maturing from the higher risk (<4" diameter) to the lower risk class (>4"). The general vegetation assessment provided a lesser contribution (17%) to the overall score increase. Although a considerable area surpassed the upland hydrological maturity threshold (>5"), this was averaged with smaller improvements relative to the riparian vegetation standard (≥ 20" diameter).

Table 2—Attribute influences on the Puget Sound watershed condition score changes between 1994 and 2008

	All Watersheds (n = 155)		Attribute Influences (%)		
Score Change Categories	**Count**	**Percentage**	**Roads**	**Vegetation**	**Landslide Risk**
-0.5 to 2.0					
-0.3 to -0.49					
-0.1 to -0.29	1	1	0	62	38
-0.09 to <0	41	26	0	72	28
0	16	10	0	0	0
>0 to 0.09	69	45	26	51	23
+0.1 to 0.29	20	13	44	26	30
+0.3 to 0.49	8	5	40	5	55
+0.5 to 2.0	1	1	0	17	83

Watershed Trend by Land Use Category and Ownership

The magnitude of changes did differ somewhat by land use allocation (Figure 6). Although the majority of changes were small (< ±0.1) for all categories based on the percent of total land use allocation, the matrix (36%) and LSR (34%) classes experienced a greater proportion of larger positive changes (> +0.1) than the congressionally Reserved (8%) class. Somewhat counter intuitively, the congressionally Reserved class showed more small declines than the other two. Many of these small declines may be due to satellite classification errors compounded by the fact that watersheds at the top end of the scoring range (+1.0) could only go down. This same phenomenon appears also when looking at the trend by majority ownership (Figure 7), where the more highly protected Park Service lands show more small declines and fewer increases than the Forest Service lands.

Changes in key and nonkey watersheds were less pronounced, but key watersheds showed somewhat more of the larger positive changes (25%) than nonkey (17%). Figure 8 shows the trend map with key watersheds highlighted.

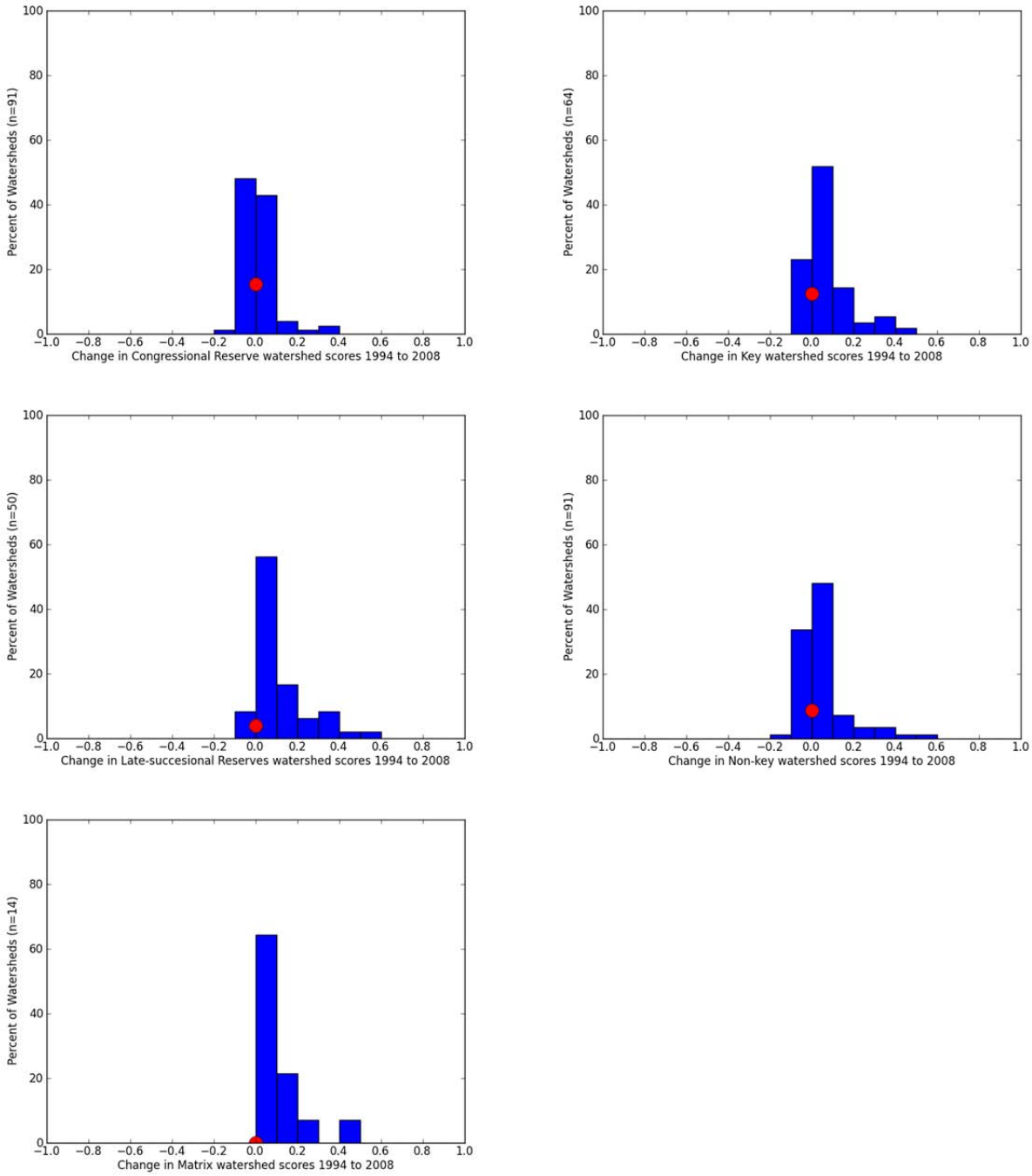

Figure 6. Puget Sound area watershed trend distributions by land use allocation (each sixth-field HUC was classified to the largest land use allocation, see Table 1). Red dot shows percentage of watersheds with no change in score.

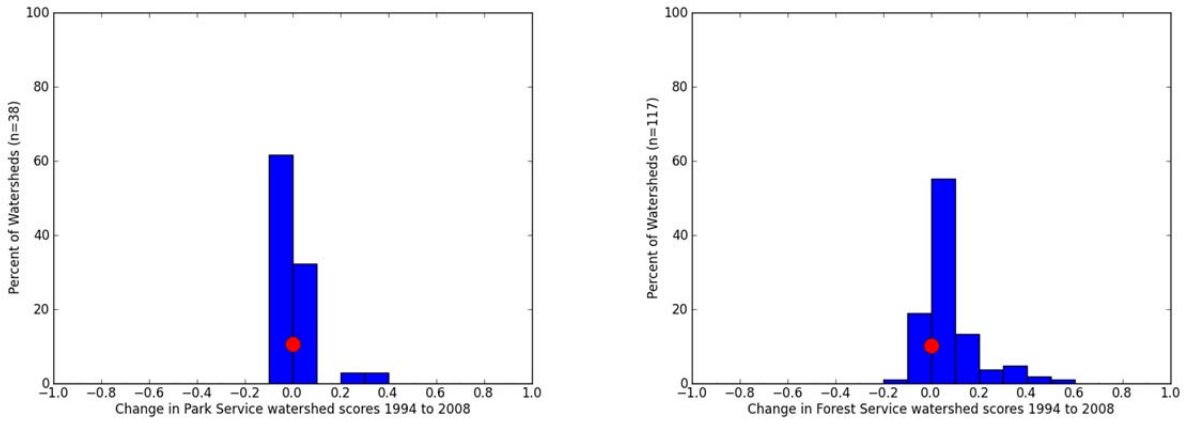

Figure 7. Puget Sound area watershed trend distributions by majority ownership (each sixth-field HUC was classified to the majority owner). Red dot shows percentage of watersheds with no change in score.

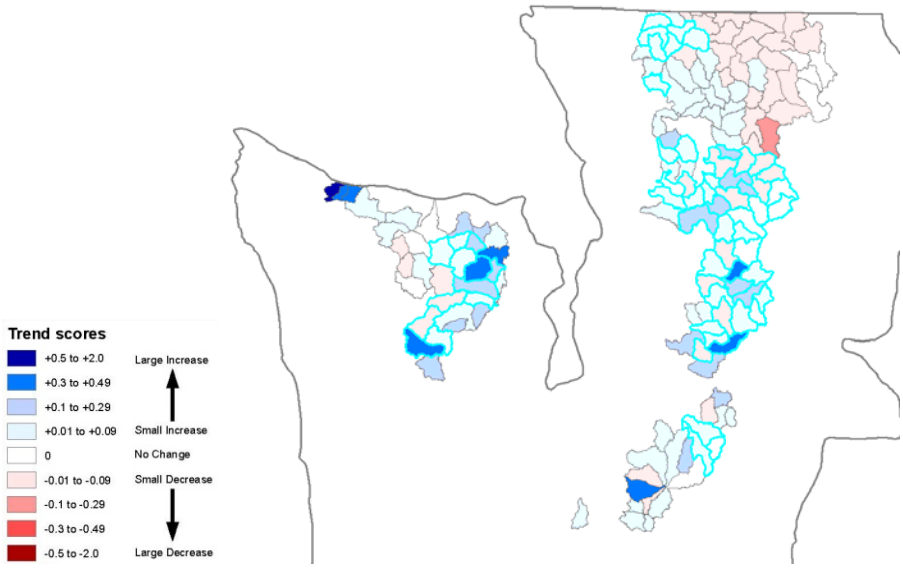

Figure 8. Watershed trend with key watersheds highlighted (light blue) within Puget Sound area.

Conclusions

The average watershed condition status score in the Puget Sound area is double the average score of the rest of the NWFP area. In a large part, this is likely because the Puget Sound contains a larger percentage of watersheds in the more protected categories in comparison to the rest of the NWFP area.

The average watershed condition trend was slightly higher in the Puget Sound area than in the rest of the NWFP. Improvements in vegetation indicators and associated landslide risk, particularly in the Olympic National Forest, were responsible for this difference. The Puget Sound area also included more watersheds with relatively large gains (+0.3-0.5 range), which were mainly due to road decommissioning, particularly in landslide prone topographies.

A 20-year assessment of upslope/riparian and inchannel condition status and trend will be done in 2014.

References

Kennedy, R.E.; Yang, Z.; Cohen, W.B. 2010. Detecting trends in forest disturbance and recovery using yearly Landsat time series: 1. LandTrendr -- Temporal segmentation algorithms. Remote Sensing of Environment. 114(12): 2897-2910. Internet: http://www.sciencedirect.com/science/article/B6V6V-51066K7-1/2/8e65b19b78110d834a481684d677773c

Lanigan, S.H.; Gordon, S.N.; Eldred, P.; Isley, M.; Wilcox, S.; Moyer, C.; Andersen, H. 2012. Northwest Forest Plan—the first 15 years (1994–2008): watershed condition status and trend. Gen. Tech. Rep. PNW-GTR-856. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 155 p. Internet: http://reo.gov/monitoring/reports/15yr-report/watershed/index.shtml