A comparison of the US Forest Service national watershed condition classification system to the Northwest Forest Plan watershed monitoring results

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Background

The US Forest Service (FS) implemented a national watershed condition classification system (WCC) in 2010 to classify the condition of all National Forest System watersheds in a consistent manner (Potyondy and Geier 2011). Because other state, federal and non-governmental organizations (e.g., Northwest Forest Plan Aquatic Riparian Effectiveness Monitoring Program (AREMP), PacFish InFish Biological Opinion Monitoring Program, US Geological Services, Environmental Protection Agency (EPA), EcoTrust, Trout Unlimited) also have monitoring programs to assess stream and/or watershed condition, the potential exists to produce watershed condition status and trend products (e.g., maps) that show different results. Such conflicting results, especially from programs inside the same agency, have the potential to confuse the public and reduce our credibility. This white paper compares the results of the AREMP and the WCC, and offers "lessons learned" from AREMPs assessment of watershed condition status and trend over the past 15 years.

Aquatic Riparian Effectiveness Monitoring Program

The AREMP answers the question "what is the status and trend of watershed condition within the Northwest Forest Plan (NWFP) area?" A 15-year assessment of watershed condition in the NWFP area (fig. 1) using GIS and remote sensing data to assess upslope and riparian watershed condition using decision-support models in every 6th-field watershed with 25% federal land ownership along the stream length, a total of 1379 watersheds, was recently completed (Lanigan et al. 2012).

AREMP also assesses stream condition within 250 randomly selected watersheds in the Plan area by surveying an average of six stream sites per watershed (for a total of 1500 stream sites). The first round of stream surveys to establish status was completed in 2010; resampling streams began that same year to determine trend.

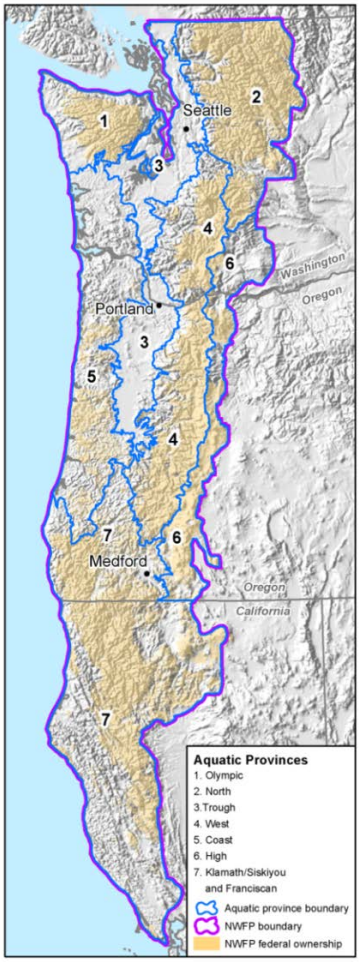

Figure 1. The Northwest Forest Plan area. The Plan area being evaluated by the Aquatic and Riparian Effectiveness Monitoring Program includes USDA Forest Service, USDI Bureau of Land Management, and USDI National Park Service lands. Aquatic provinces used to assess watershed condition in the Plan area are also shown.

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Watershed Condition Classification System

The national watershed condition classification system (WCC) is a national forest-based, reconnaissance level evaluation of watershed condition that can be aggregated for a national assessment of watershed condition (Potyondy and Geier 2011). The WCC is designed to—

- Classify the condition of all national Forest Service watersheds.
- Be quantitative to the extent feasible.
- Rely on Geographic Information System (GIS) technology.
- Be cost effective.
- Be implementable within existing budgets.
- Include resource areas and activities that have a significant influence on watershed condition.

How AREMP and WCC Differ

Both WCC and AREMP use the same general "multi-attribute" approach, in which a number of watershed indicators are evaluated individually and then their standardized scores are combined using a hierarchical model structure. However, the WCC differs considerably from the AREMP model in the watershed attributes used, how they are evaluated, and how they are combined.

In terms of attributes used, the national model is more subjective, in that it relies on experts to rate each watershed, taking into account whatever data they may have. The AREMP approach is more mechanistic; it applies expert-derived criteria to regionally-available datasets. The national assessment includes many indicators for which consistent data are not available, whereas each AREMP indicator must be represented by a regional dataset.

The structure of the models is also quite different. The WCC model score combines inchannel and upslope indicators, while AREMP reports these separately, due to the different samples available (all watersheds for upslope and riparian, and only a subset for inchannel). Also, using two models acknowledges that we are assessing two types of watershed condition attributes:

- inchannel attributes (measured in streams), which function as response variables that may take several years or decades to respond to management activities in upslope and riparian areas;
- upslope/riparian attributes that are surrogates for processes in a watershed and provide a risk assessment for what may impact stream channels.

The national model requires a fixed structure (fig. 2) and weighting of the attributes, while AREMP allowed each aquatic province workgroup to choose their own structure and weighting (fig. 3).

AREMP contributed its attribute ratings to Region 5 and Region 6 forests for the 2010 WCC assessment. However, there was sufficient overlap between the models for only 2 of the 12 national model attributes (riparian vegetation condition and open road density). AREMP stream data were not used because the WCC required rating all watersheds - AREMP has only surveyed streams in a small subset. Instead, forests used local stream survey data and professional opinion to evaluate aquatic physical habitat attributes. Region 5 Forest specialists did not to use any AREMP data when doing their assessments. Some Region 6 forests used the AREMP data and some did not (they felt they had better data available for the forest than was available regionally).

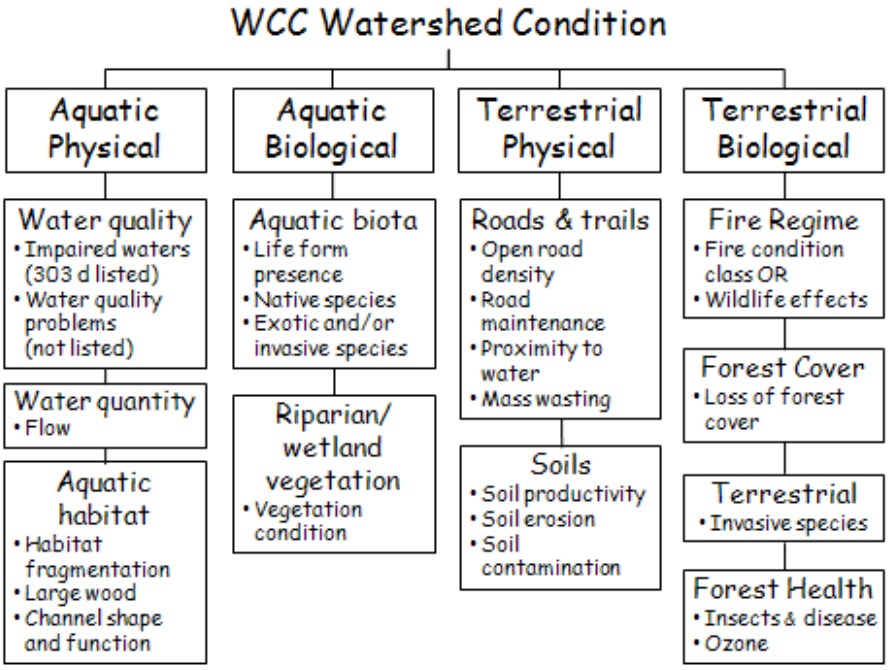


Figure 2. National watershed condition indicators used in the watershed condition classification system (Potyondy and Geier 2011)

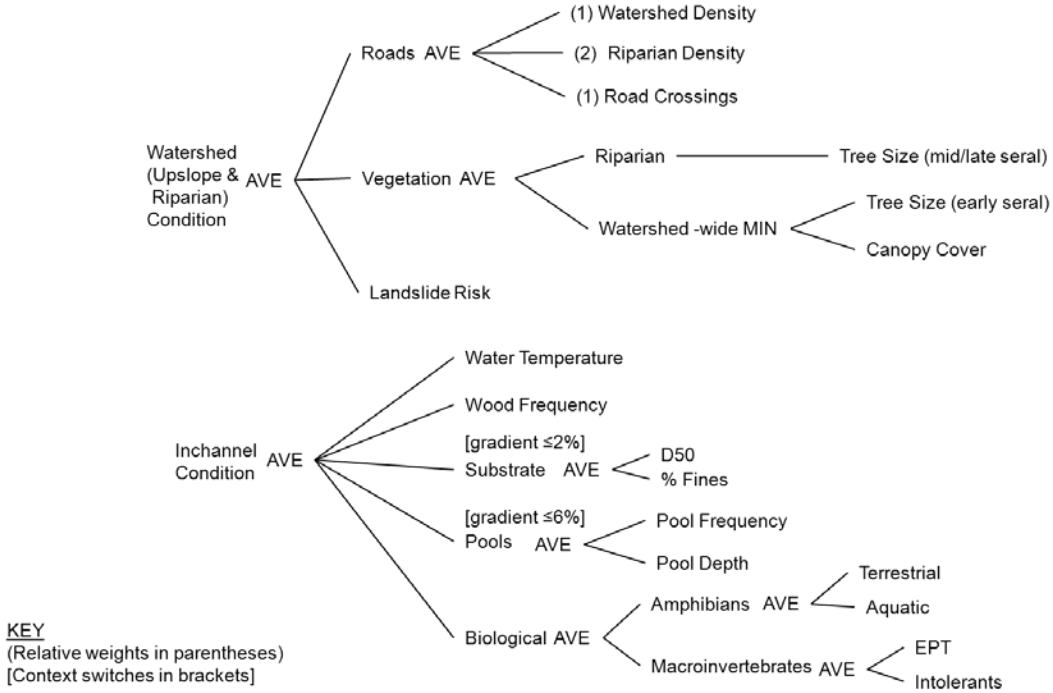


Figure 3. Illustrative model diagrams showing how Aquatic Riparian Effectiveness Monitoring Program indicators are combined into overall condition scores (actual structures for each province area are detailed in Lanigan et al. 2012 - app. 4).

Comparison of Results

In order to gauge the extent to which the different model structures produced different results, we compared the results of the two models by converting AREMP scores to the WCC rating scale of 1 (= good) to 3 (= poor). Because the WCC used newer watershed boundaries; did not analyze all federal lands; and considered all watersheds with more than 10% FS ownership, only a subset of watersheds were spatially comparable (371 in R5 and 841 in R6).

Figures 4 and 5, and Table 1 show that AREMP upslope/riparian "watershed" model scores were usually the same or less than WCC scores. AREMP's lower scores appear to be largely due to the different treatment of roads. In the WCC, roads scores get averaged with soil productivity scores using equal weights (fig. 6). The soil productivity attribute was given a 1.0 rating (very good) in most watersheds, which meant that the roads score would have to be >2.3 to tip the average from the good to fair category (given the good-to-fair breakpoint of 1.66). Road attribute scores ranged from 1.67 – 2.33 with few greater that the 2.3 threshold. In the AREMP models there is no such moderating influence and roads are often weighted more heavily (fig. 6).

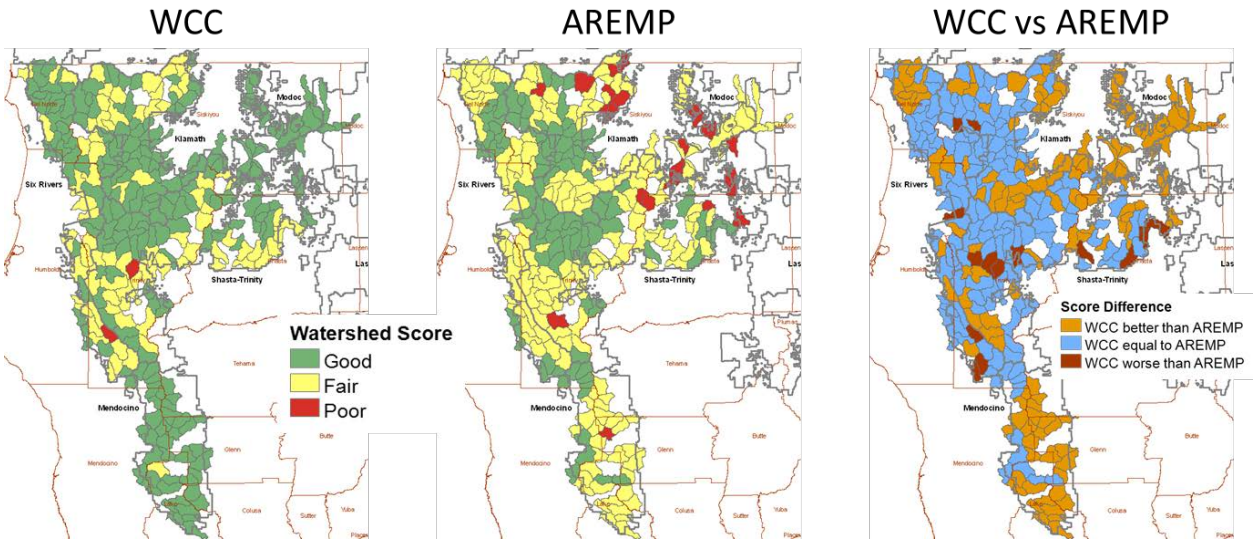


Figure 4. Northwest Forest Plan (NWFP) area in Region 5 (northern California) national watershed condition classification (WCC – on left) scores and Aquatic and Riparian Effectiveness Monitoring Program (AREMP – middle) upslope/riparian scores. A comparison of how the WCC and AREMP scores compare to each other is shown on the right. Blank areas inside national forest boundaries occur where a good comparison was not possible because the AREMP scores included significant BLM/National Park Service lands, the 6th-field watershed boundaries were different, or they fell outside the NWFP area.

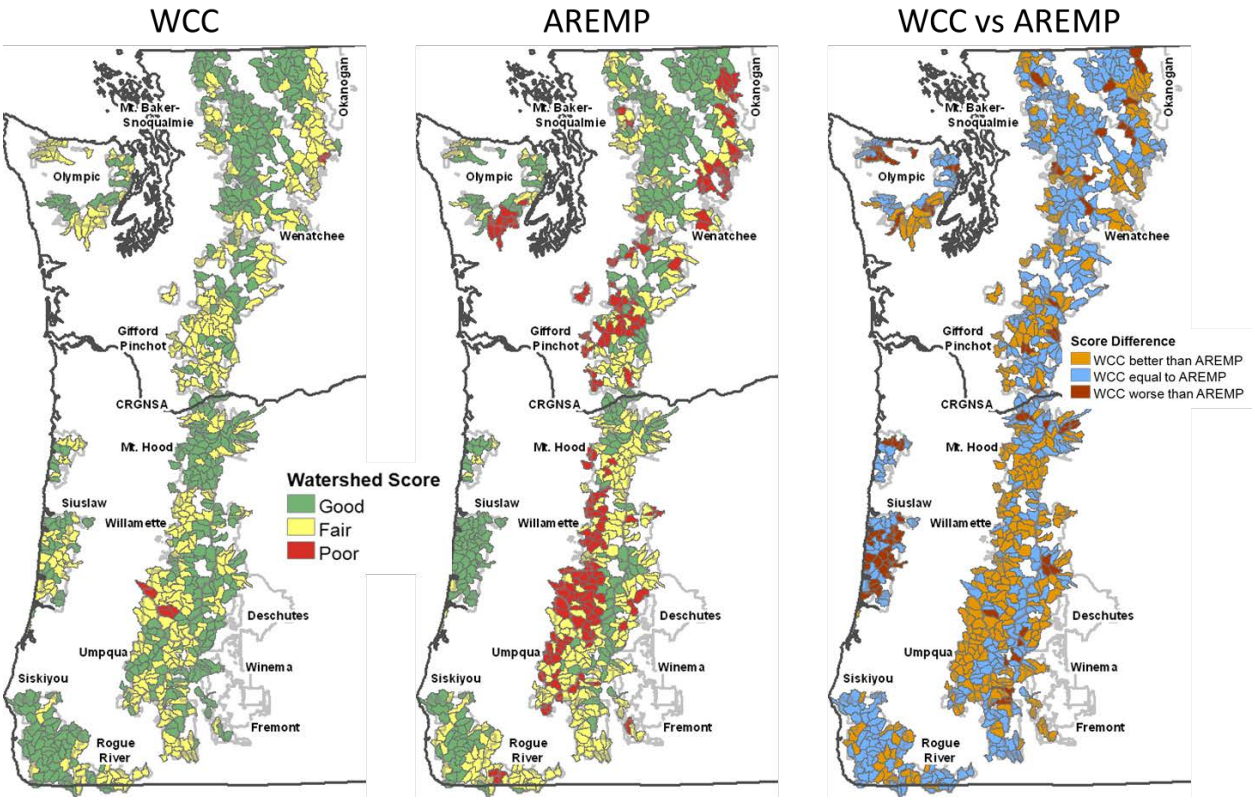
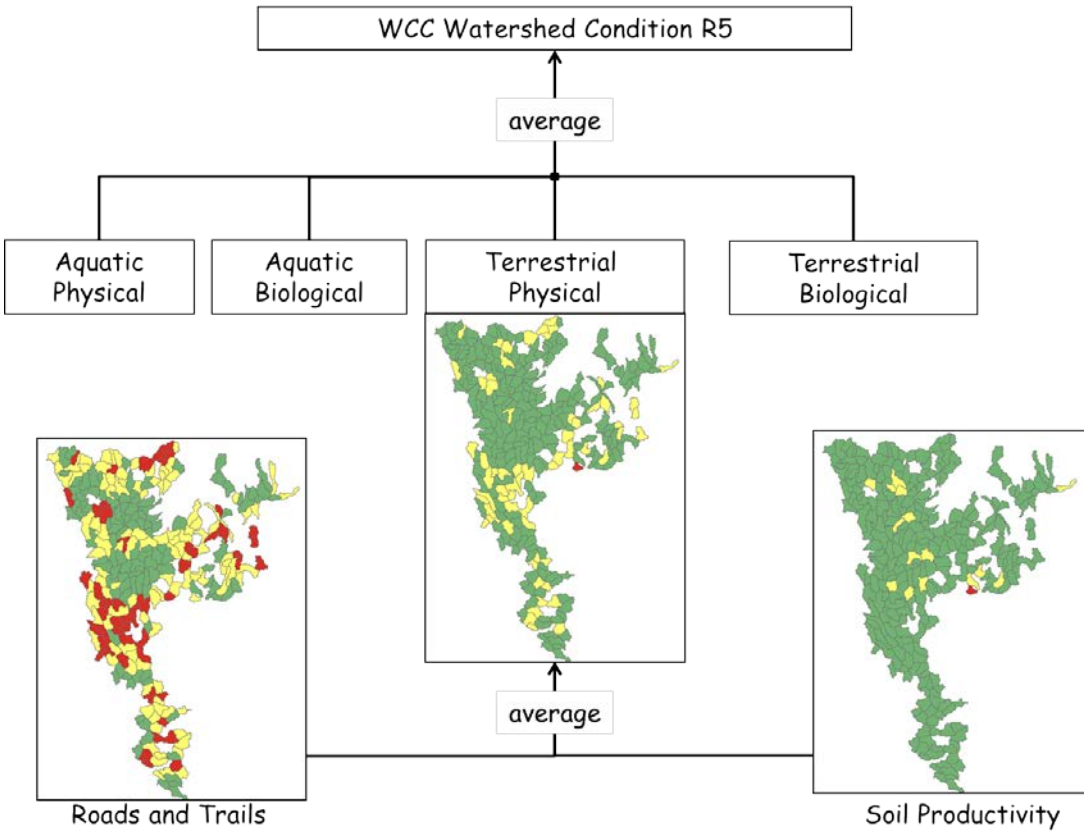


Figure 5. Northwest Forest Plan (NWFP) area in Region 6 (Oregon and Washington) watershed condition classification (WCC – on left) scores and Aquatic and Riparian Effectiveness Monitoring Program (AREMP – middle) upslope/riparian scores. A comparison of how the WCC and AREMP scores compare to each other is shown on the right. Blank areas inside national forest boundaries occur where a good comparison was not possible because the AREMP scores included significant BLM/National Park Service lands, the 6th-field watershed boundaries were different, or they fell outside the NWFP area.

Table 1. Number of (and percent) 6th-field watersheds compared within the Northwest Forest Plan area with watershed condition classification (WCC) scores less than, the same, and greater than Aquatic and Riparian Effectiveness Monitoring Program (AREMP) upslope/riparian condition scores.

	WCC worse than AREMP	WCC equal to AREMP	WCC better than AREMP
Region 5	16 (5%)	152 (48%)	149 (47%)
Region 6	71 (8%)	444 (53%)	326 (39%)



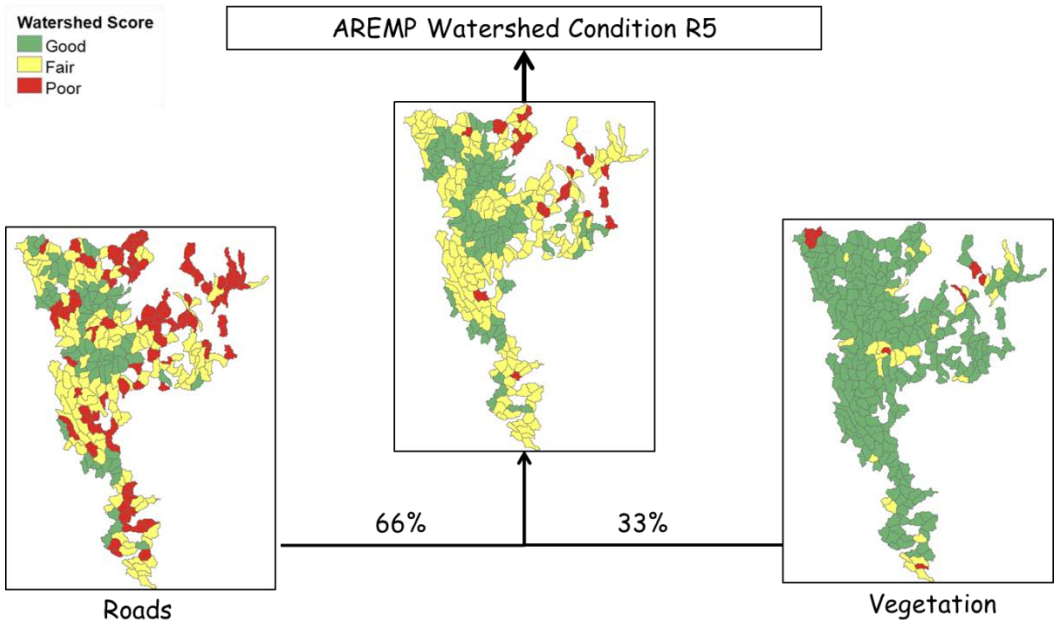


Figure 6. The "Roads and Trails" attribute in the Watershed Condition Classification (WCC) (upper) is averaged with soil productivity, and then averaged again with several other attributes. The roads attribute in the Aquatic and Riparian Effectiveness Monitoring Program (AREMP) model (lower) is weighted 2:1 with vegetation to produce an upslope/riparian watershed condition score.

Focus watersheds

US Forest Service Region 6 has identified a number of 5th-field "focus watersheds" as high priority areas for restoration (fig. 7). According to WCC, almost all the 6th-field watersheds within these larger focus watersheds are in fair or good condition; whereas AREMP rated a far larger share of these subwatersheds as in poor condition (Table 2).

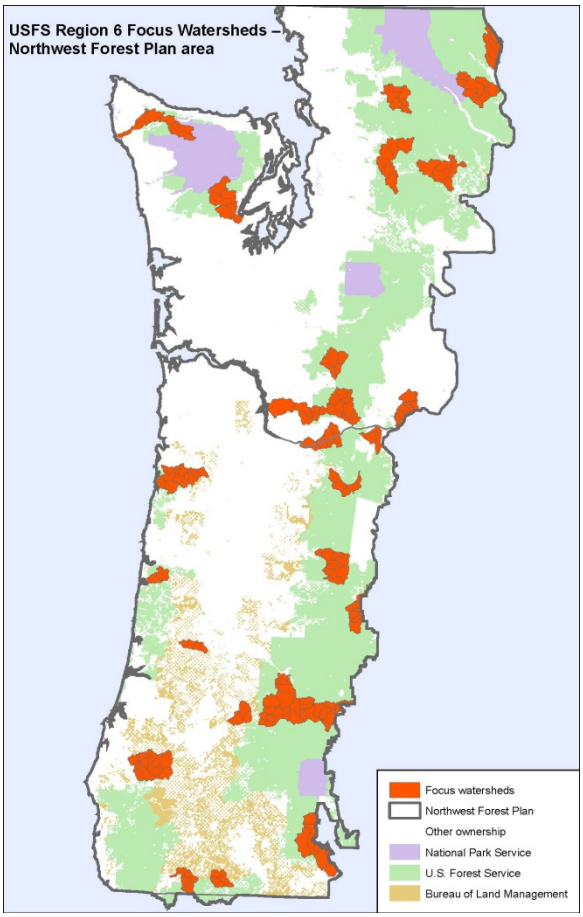


Figure 7. US Forest Service Region 6 5th-field "focus watersheds."

Table 2. Number (percent) of 6th-field watersheds within Region 6 5th-field "focus watersheds" (within the Northwest Forest Plan area) in good, fair, or poor condition as determined by the Watershed Condition Classification (WCC) scores and by the Aquatic and Riparian Effectiveness Monitoring Program (AREMP) upslope/riparian condition scores.

	WCC	AREMP
Good	50 (47%)	39 (37%)
Fair	54 (51%)	42 (40%)
Poor	2 (2%)	25 (23%)

Observations and Recommendations

Why not replace AREMP with WCC?

Perhaps the most fundamental difference between the two assessments is the need for AREMP to evaluate watershed condition trends since the inception of the NWFP (1994). It seems unlikely that the WCC's more expert opinion driven approach could provide a valid historical baseline assessment for 1994. While the AREMP approach relies on expert opinion for indicator thresholds, it applies these thresholds consistently to regional datasets representing different points in time. A challenge the WCC is likely to face is how to achieve such consistency over time and space when relying on a mix of local data and expert knowledge, especially considering that the participating experts will change over time.

A second basic challenge to the integration of the two approaches is that the NWFP monitoring framework covers all Bureau of Land Management (BLM) and National Park Service lands, as well as FS lands within the Plan area. It would be difficult to apply the WCC approach more extensively to non-FS lands because many of the WCC attributes rely on expert knowledge. Experts from other agencies would have to be recruited into the process, and the different types of data available within each agency would

make it challenging to make sure attributes were being assessed in a compatible manner.

Recommended changes to AREMP

Use one model structure for NWFP area

AREMP is planning to consolidate its six aquatic province models into a single "unified" model for the entire NWFP area. During this process, AREMP will investigate possibilities for adjusting our aquatic province models to better reflect the general model structure used by the WCC. However, based on feedback from government agency aquatic specialists[3] from throughout Region 5 and Region 6, we will still use contextual information to guide what evaluation criteria should be used for a given attribute. Some examples include:

- Rain-on-snow zones for canopy cover
- High versus low gradient streams for stream attributes
- Landtype associations

We will also evaluate stream condition and upslope/riparian condition separately and then aggregated together. This will allow AREMP to continue reporting stream condition separately from upslope/riparian condition, while also providing an overall evaluation similar to WCC.

Use the latest 6th-field watershed boundaries

The watershed boundaries used by AREMP in our 15-year assessment of watershed condition status and trend report (Lanigan et al. 2012) were the same ones used in our 10-year report (Gallo et al. 2005). We didn't foresee a need to change the watershed boundaries, even though we were aware watershed boundaries changes were occurring (fig. 8). However, in order to match up with the boundaries used by the WCC effort, AREMP will now use the same, latest boundary layer.

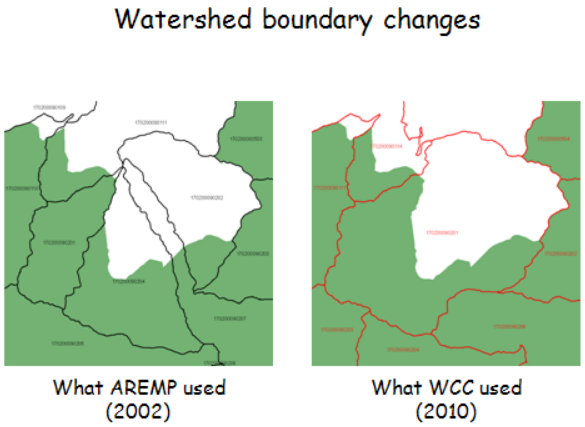


Figure 8. The left map shows an example of watershed boundaries used by AREMP for their 15-year watershed condition status and trend report, which was based on a 2002 GIS boundary layer. The 2010 watershed boundary layer used for WCC combined four different watesheds into one new watershed.

Provide quantitative data for WCC attributes

In the first iteration of the WCC, AREMP data were used only by Region 6, and only AREMP's riparian/wetland vegetation and roads and trails attributes data were used (fig. 9). We will work with specialists to develop additional regional data sets that can then be used for WCC.

Recommended changes to WCC

Compile local data into regional corporate data sets to reduce subjectivity of evaluating attributes

Figure 9 shows which attributes rely on professional judgment or local data sets. It may be that quantitative data are not available nationwide for many of the attributes, but using qualitative assessments has the following drawbacks:

- Results are not necessarily reproducible (if a different set of experts does the analysis)
- Trends may not be reliable (because of changes in expert groups or available data from year to year)

Regional corporate data sets are recommended to ensure consistency in how data are collected and evaluated. Data in a corporate data set are also less

[3] FS, Pacific Northwest Research Station, BLM, NOAA Fisheries, EPA, Washington Department of Ecology, Oregon Environmental Quality, Oregon Department of Fish and Wildlife, California Fish and Game, and National Park Service specialists participated in workshops to determine evaluation criteria for model attributes.

likely to be lost or tossed out compared to data stored on someone's computer or filed in boxes.

Evaluate trend based on measurable changes

National forests are required to revise the WCC on an annual basis when watersheds are known or suspected to have changed significantly from the previous year. A complete and more rigorous WCC will be conducted every five years (Potyondy and Geier 2011). Our assumption is that each iteration of the WCC will be used to assess watershed condition trend. Based on our experiences monitoring the NWFP area, a number of challenges can be expected.

The majority of changes in watershed condition, even at five year intervals, will be of a small magnitude. AREMP used eight categories of change so we could show changes occurring over 15 years. If WCC uses only the number of watersheds that change from one class to another to show trend, few changes between condition classes are expected to occur (fig. 10-11). Changes based only on class boundaries may also appear somewhat arbitrary. A small change (e.g. 0.1) at a class boundary will show, while a larger change (e.g. 1.0) within a class will not.

In the AREMP assessment, the largest positive score changes were due to road removal. The model structure of the WCC will make it very difficult to show changes occurring due to road removal because the contribution of roads to the watershed condition score is already relatively minor due to the averaging of roads and soil productivity (the latter is usually rated as good) in the model structure.

Changes to the model structure, particularly the weighting of roads, may make it more easy to show improving trends. Using several categories of change would also make it easier to show trend.

Despite the challenges of showing trends in the empirical value of watershed condition, our recommendation is to focus on doing this. An alternative method that has been discussed would consider watershed condition class to have improved when restoration activities are done in a given watershed. This is basically saying, "Trust us, things are getting better," without providing any empirical proof. Given the lack of trust with many groups scrutinizing Forest Service actions, this approach seems fraught with peril. In our opinion, if we can't measure that changes are occurring, then we shouldn't claim they are.

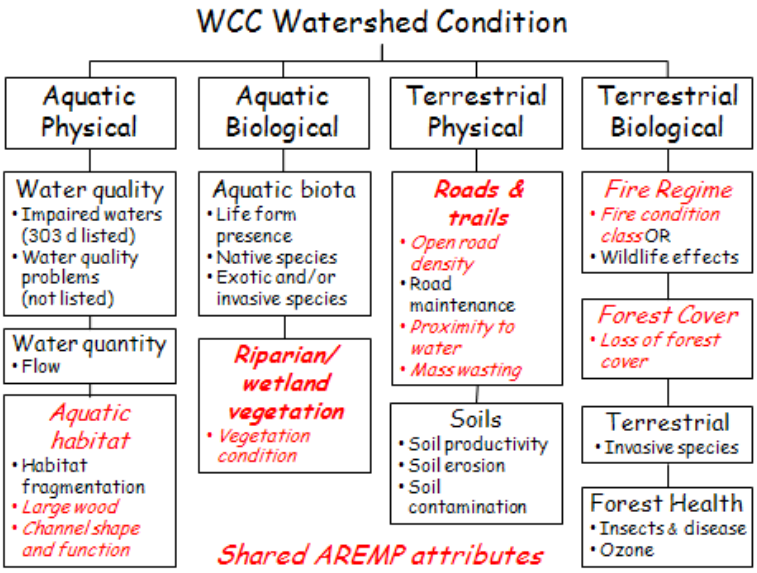
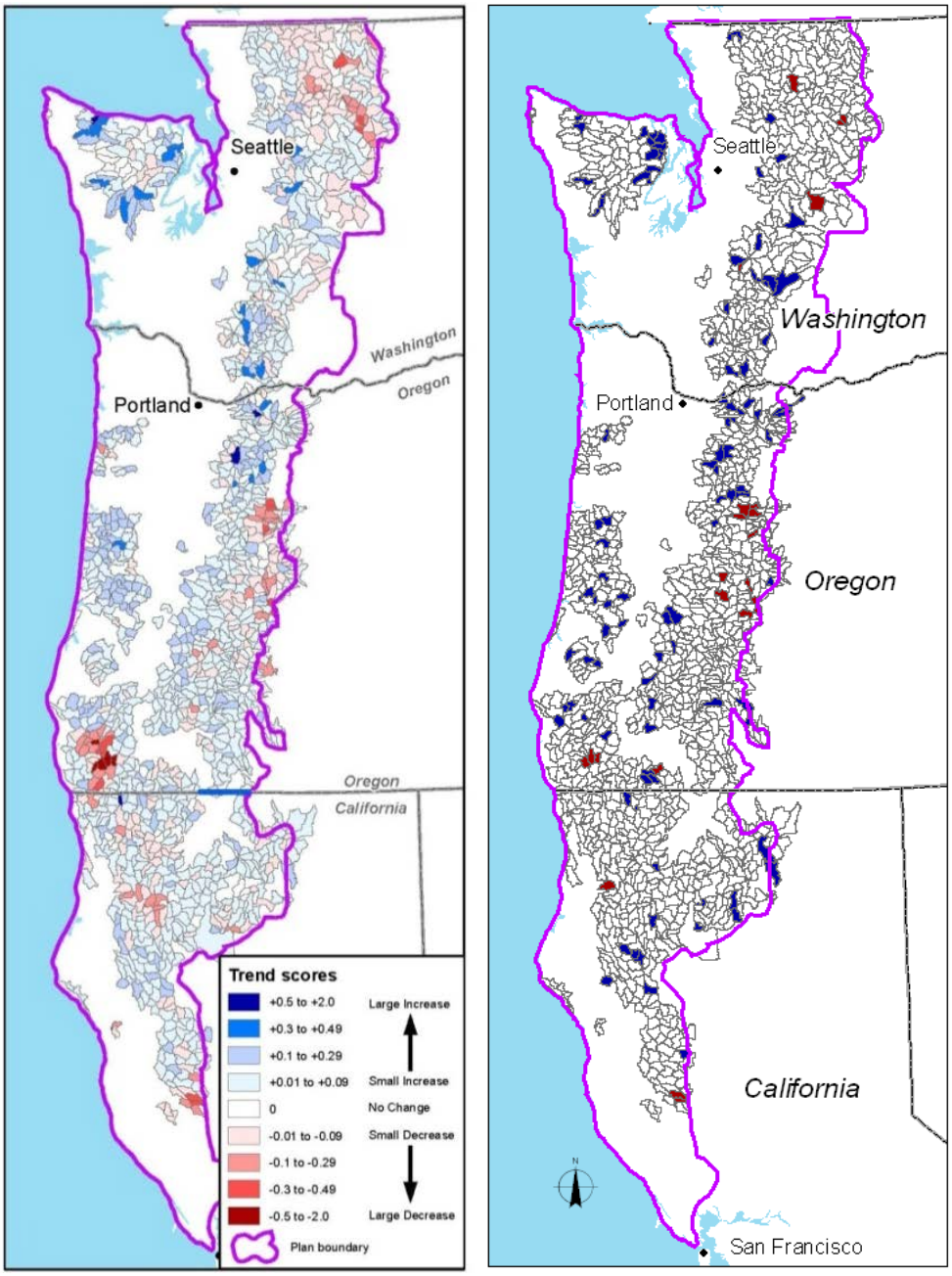


Figure 9. Attributes shared by the WCC and AREMP models and for which regional quantitative datasets are available (shown in red italics). The red bolded text show the attributes AREMP provided to Forests to use in their assessments. The remaining WCC attributes are based on professional judgment or local data sets/knowledge.



(A) (B)

Figure 10. Changes in AREMP watershed condition score (1994 to 2008) using A) AREMP's finer-scaled change classes, and B) WCC's condition class changes.

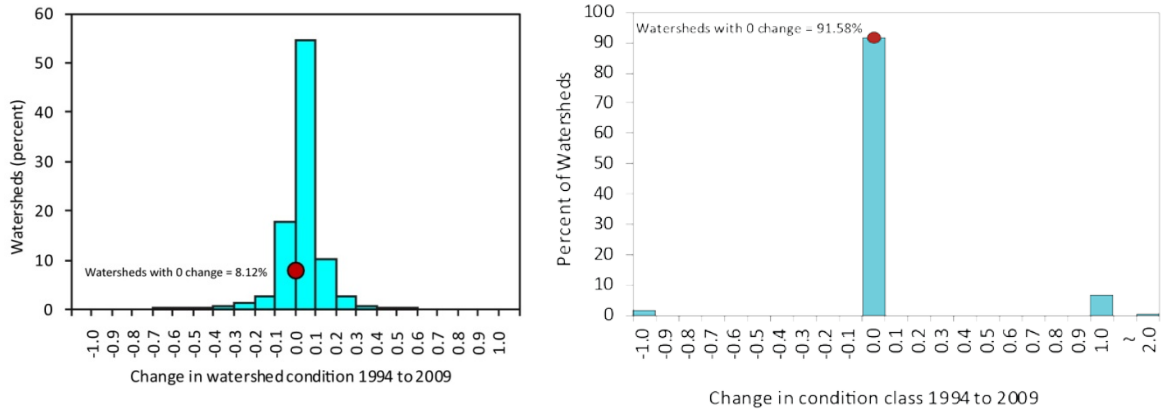


Figure 11. Distribution of changes in AREMP watershed condition scores (1994 and 2008) using finer-scaled change classes (left figure), and WCC's condition class changes (right figure).

Allow weighting of attributes based on local ecoregion knowledge

Watershed attributes have different impacts in different ecoregions. For example, AREMP expert groups rated road impacts differently on the wet westside forests (with considerable runoff) as compared to the dry eastside forests. We therefore recommend the WCC provide more flexibility in the weighting of attributes. Landtype associations, currently under development for all the NWFP area in Region 5 and Region 6, could guide which different model structure weights should be used.

Discretionary weighting does introduce an element of variability between regions; however, it is relatively easy to switch out weighting schemes in this type of model. If regional weights appeared to be producing undue inconsistency, the national weighting schemes could easily be reapplied.

Weighting attributes could also better reflect restoration priorities. This would make it easier to communicate with the public why certain restoration efforts are needed, whereas the current WCC model may obscure the value of key activities (e.g. road mitigation).

References

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