A Paradigm Shift in Watershed Restoration

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Watershed and stream restoration on National Forest System (NFS) lands of the Pacific Northwest have changed dramatically in the past decade. A new paradigm for the restoration of riparian and aquatic ecosystems has quietly emerged. It reflects substantial improvements in the understanding of ecosystem- and watershed-scale dynamics and involves the development and implementation of new management strategies for riparian and aquatic resources.

The primary driver for many changes has been the implementation of a comprehensive Aquatic Conservation Strategy (ACS). The ACS, which is part of the Northwest Forest Plan (Plan) (USDA *et al.* 1994), emphasizes ecosystem management at the landscape scale. It is science-based and provides for comprehensive and consistent protection and restoration across more than 24 million acres (about 10 million hectares) of NFS land in Oregon, Washington, and northern California. The ACS replaces 20 individual forest plans that varied substantially in their content, approach, and quality of management direction for riparian and aquatic resources.

Aquatic Conservation Strategy (ACS)

The ACS has four components that are implemented in a co-ordinated manner to achieve aquatic and riparian ecosystem health described by nine ACS objectives. These objectives address a variety of physical and biological processes including: timing and duration of streamflow; physical and biological connectivity; and introduction/routing/storage of large wood and sediment, plant/animal species, and habitat diversity. The four ACS components are as follows:

1. Riparian Reserves

Land and water areas are managed to emphasize the sustained production of riparian-dependent resources (fish, water, certain species of plants and animals, etc.). Riparian reserves apply to lands adjacent to all streams (perennial and intermittent/ fish and non-fish bearing), lakes, reservoirs, springs, wetlands, and unstable slope areas likely to affect riparian and aquatic ecosystems.

2. Key Watersheds

A network of watersheds are managed as refugia for fish stocks at risk, and for the continued production of high quality water critical to downstream habitat. These watersheds represent the best remaining, or most readily restorable, aquatic habitat in the plan area.

3. Watershed Analysis

Ecosystem conditions are examined at the watershed scale (20,000–200,000 acres or 8,000–80,000 hectares). The mid-level analysis offers an interdisciplinary diagnosis of watershed health comparing current resource conditions to reference conditions and identifying key processes likely responsible for major gaps between the two. The analysis gives watershed-scale context for future management and an initial strategy for the restoration of watershed conditions to benefit aquatic- and riparian-dependent resources.

4. Watershed Restoration

A comprehensive, long-term program guides watershed-scale restoration of aquatic resources. Restoration activities focus on those watersheds most likely to positively respond to treatment. Identification and completion of high priority work are emphasized. Watershed analysis is completed before any restoration activity is begun.

The Restoration Strategy changed the approach to aquatic restoration. First, it focused activities on a few high priority watersheds and "secured" or "stormproofed" them by removing risk factors (e.g., unstable roads, areas of severe erosion). Second, before the implementation of any restoration activity, a watershed-scale analysis is required to identify key processes and watershed areas needing attention, and prioritize timing of future treatments. The requirements for Watershed Analysis broadened the scale of analysis and planning for restoration. Interdisciplinary teams were forced to identify key processes controlling conditions and to design treatments for root causes of altered conditions.

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Finally, the Strategy provided the framework to treat whole watersheds with an integrated set of watershed-scale restoration treatments (roads: drainage and/or

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stabilization, decommissioning, fish passage, upslope-surface erosion, and slope stabilization; riparian areas: fencing, planting, silvicultural treatments, large wood introduction and instream creation and complexing of habitats, bank stabilization, nutrient supplementation, etc.). Although these and other changes may seem trivial today, they reflected a cutting-edge approach when they were introduced. These changes fostered lively debate and dramatically shifted organization and delivery of the restoration program. Table 1 summarizes changes to aquatic restoration since the Plan was implemented in 1994.

In the 10 years of implementing the Restoration Strategy, much has been accomplished. Annual funding has averaged about $15 million per year. Roughly 60% of these funds have gone into road-related treatments, particularly decommissioning, stabilization, and fish passage improvement with a focus on "stormproofing." Riparian and instream works have accounted for

Major road fill before removal. Road restoration activities, especially decommissioning, stabilization, and fish passage, are a major element of the Restoration Program and account for nearly 60% of annual restoration funding.

about 30% of the funding. Much of this work is centred on increasing the complexity of aquatic habitats and floodplains by adding large wood. The remainder of the funding has been used for upslope treatments (slope stabilization, soil decompaction, reforestation, etc.). To date, high priority work for 21 watersheds, each having an area of 25,000–50,000 acres (10,000–20,000 hectares), has been "completed." This accomplishment, although appearing simple, represents a major shift in the

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Major road fill after removal as part of decommissioning project. Fill removal allows reconnection of streams and significantly reduces future risk of wash and maintenance costs tied to major storm events.

focus and delivery of the restoration program.

Partnerships

Key to the watershed restoration paradigm shift have been partnerships with a wide variety of groups including: federal, state, and local agencies; tribal governments; non-governmental organizations; foundations; local communities; and landowners. The diversity of partners often allows consideration and treatment of priority sites throughout a watershed regardless of land ownership. Partnerships also provide for significant leveraging of skills and resources. On average, two to three dollars of partner funding are available for every one dollar of USDA Forest Service funding. Partners also frequently assist with/conduct monitoring and maintenance of completed work.

There is also a growing focus on setting up the conditions for stream processes to create the desired conditions rather than directly engineering them.

In the last few years, instream restoration protocols have also changed, with a more strategic approach to the selection of treatment sites at the watershed scale. Currently, more attention goes

Table 1. New versus old paradigms for restoration of aquatic- and riparian-dependent resources

New	Old
1. The "best" watersheds are treated first. Highest priority treatments remove risk factors that may threaten the integrity of the watershed.	1. The "worst" watersheds are treated first. Highest priority is to create desired habitat conditions for stream segments/sites in the worst condition.
2. Efforts focus on a few priority watersheds.	2. Treatments tend to focus on stream segments or sites. They are scattered over several watersheds.
3. Watershed analysis precedes project work, identifies key processes, and prioritizes areas and associated treatment approaches that address "causes."	3. Analysis is generally limited to the project scale, and to addressing site-scale conditions. Treatments address "symptoms."
4. A wide range of treatments are generally integrated at a watershed scale and sequenced based on an overall work plan.	4. A narrow range of treatments usually focus on individual sites. They are not integrated at the watershed scale.
5. Highest priority work is completed in a watershed before work emphasis shifts to the next priority watershed.	5. Highest priority work is completed on individual areas or sites located in a number different watersheds.
6. Partnerships are an essential part of restoration. Skills and resources are strongly leveraged.	6. Partnerships are limited in number and scope. There is some leveraging of skills and resources.

into locating low-gradient, unconstrained areas with complex aquatic and riparian habitats, ensuring longitudinal connection to other areas of the stream channel, and lateral connection to the active floodplain and off-channel habitats. Treatments that once emphasized neat, engineered, well-ballasted, and/or anchored structures are now being replaced by the unanchored complexes of whole trees and large wood. As a result current instream work often appears "messy." These treatments are generally located strategically in the stream (geologic "nick" points, old jam locations, alluvial "hot spots" for fish production). There is also a growing focus on setting up the conditions for stream processes to create the desired conditions rather than directly engineering them. This often entails treating areas outside the low-flow (wetted perimeter) channel, including large areas of the active floodplain.

Table 2. New versus old paradigms for instream restoration treatments

New	Old
1. Treatments generally consider the full stream channel and include the active floodplain.	1. Treatments are generally limited to the low-flow or summer stream channel.
2. Treatments appear "messy" and are designed to mimic conditions created by natural processes.	2. Treatments are often "neat" and engineered. They are designed to create a specific hydraulic or habitat condition at a site.
3. Treatment materials, such as large wood and boulders, are not anchored or ballasted. Some downstream movement and re-complexing are expected.	3. Treatment materials are generally well ballasted and anchored. Movement from the site of placement is viewed as a "failure."
4. Reconnecting vertical (up and downstream) and lateral (stream channel/off channel/floodplain) access for adult and juvenile fish and other aquatic species is increasingly a priority.	4. Reconnecting access is generally limited to improving vertical (up and downstream) access for adult salmon only.

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Stream before treatment with large woody debris (LWD) to increase habitat complexity and improve stream connectivity with the floodplain.

Stream after treatment. Groupings of LWD pieces are placed at natural collection points. Often they are not anchored and will move short distances, creating complexes that provide excellent habitat.

Changes to instream restoration philosophies have demanded improved understanding of watershed and stream channel processes. Better analytical skills in various subjects such as hydrology, fluvial geomorphology, silviculture, and hydraulic engineering are prerequisites for most projects. Interdisciplinary planning teams are now critical. As confidence in analytical and operational capabilities has grown, projects have become larger and more demanding. Increasingly these involve reconstruction of severely altered channel/floodplain sections and removal/replacement of road fills and crossings. Table 2 summarizes the paradigm shifts for instream restoration treatments.

Conclusion

The current U.S. Watershed Restoration Program is a major improvement from previous efforts on public lands in the Pacific Northwest. The process is more strategic, better integrated, and more likely to contribute to long-term change in watershed and aquatic habitat conditions. The program is part of the ACS, which is based on the premise that active restoration only occurs when linked to a larger set of strategic actions that ensure the protection and passive restoration of watersheds at a broad scale.

Today we are just beginning to see priority restoration work completed for individual watersheds. Although project effectiveness, as well as the overall ACS, is still being monitored, it will likely be some time until the long-term success of the new paradigm shift can be determined.

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Reference

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