Project Development Study of Forest Fertilization Impacts on Water Quality in the Little River Adaptive Management Area

Background

In the Oregon Cascades, fertilization is commonly used to accelerate growth and improve timber yields in commercial forests. The fertilizer is usually sprayed from helicopters over the plantations when the trees are about 15 years old. Urea fertilizer, with ammonium nitrogen as the active ingredient, is typically applied at the rate of 440 pounds per acre. Phosphorus is generally not applied, in part because of its natural abundance in the volcanic soils. Fertilizers are also sometimes applied to riparian reserves to accelerate plant growth, which will provide greater stream protection from erosion and sediment runoff, and increase stream shading to help control temperature.

In the Little River Adaptive Management Area (AMA), concern has arisen in recent years about the cumulative effects on water quality due to forest practices, including fertilization. The Little River AMA, located in the southern Oregon Cascades, contains 63,575 acres of land managed by the Umpqua National Forest and 19,802 acres managed by the Roseburg District of the Bureau of Land Management (BLM) (fig. 1). Adaptive Management Areas, of which the Little River is one of ten in the Pacific Northwest, are an outgrowth of the President's Northwest Forest Plan to integrate timber production and ecosystem management using watershed analyses. The Little River AMA watershed analysis plan (currently in draft) suggests conducting fertilization impact studies as a means of maintaining timber production while meeting Oregon Department of Environmental Quality(DEQ) water quality standards.

The cumulative water-quality effects of nitrogen fertilizing on tree plantations are complex and not fully understood. Although the nitrogen lost to adjacent streams is generally less than 0.5 percent of the total nitrogen applied, that small amount may be ecologically important in nitrogen limited aquatic ecosystems such as those in the Western Cascades. Maximum nitrogen concentrations have not exceeded DEQ standards; these standards are designed for humanhealth protection rather than ecological integrity. However, other water quality parameters have exceeded DEQ standards in some Little River streams (Powell, 1995). DiurnalpH has been shown to cycle from 9.1 in the late afternoon to 7.8 in the morning. HighpH can be associated with the growth of attached algae, which in turn could be associated with increased nutrient inputs. Nutrient transport pathways from the upland areas to the streams in the Little River basin, which are an important aspect of the cumulative affect of fertilization, are also not well understood. While some nutrients can be transported directly with storm runoff, evidence also suggests that nutrients can follow longer, slow moving ground-water pathways, thus entering streams by a variety of mechanisms and ultimately contributing to the growth of attached algae.

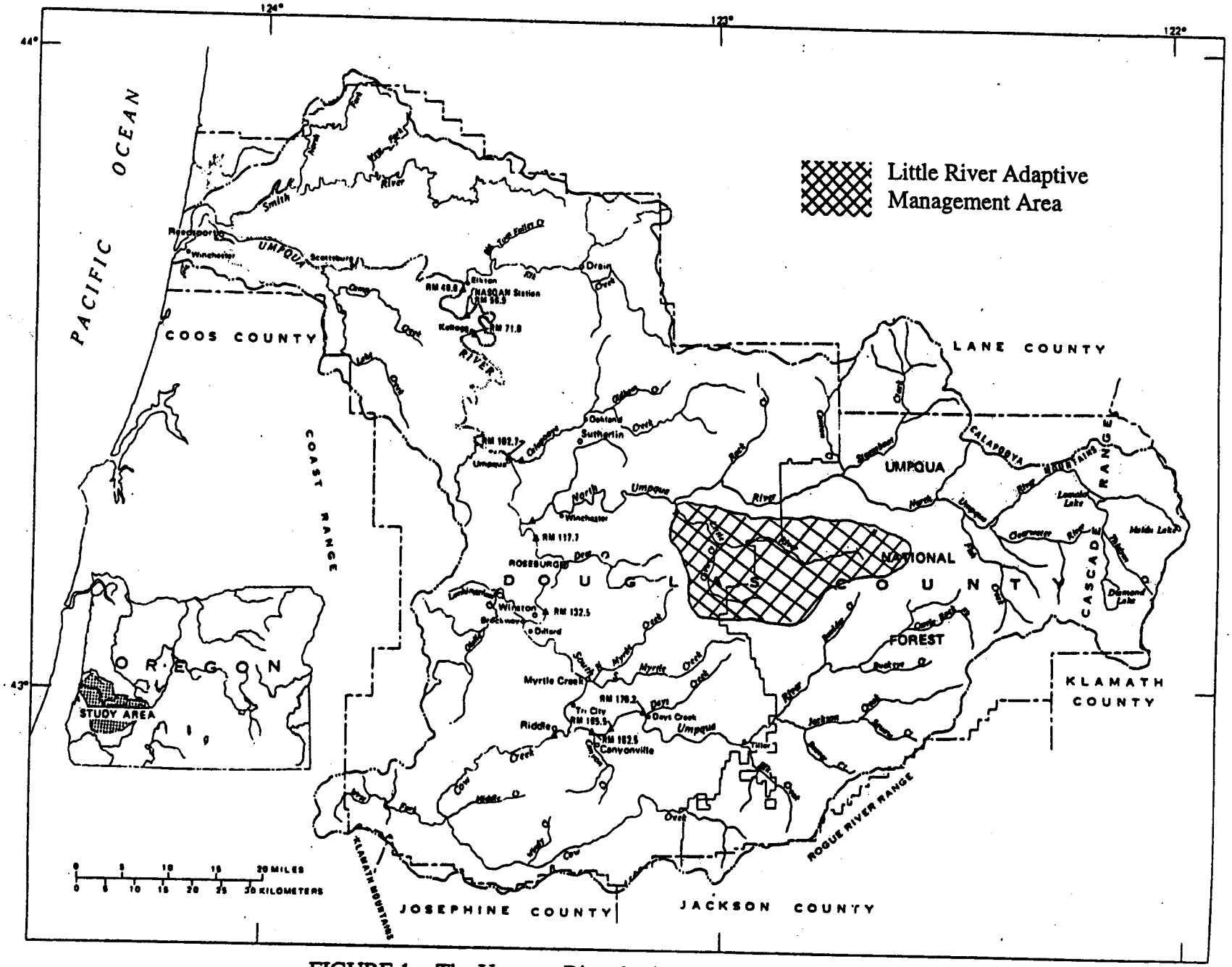

FIGURE 1. - The Umpqua River basin showing the proposed study area.

Water-Quality Fertilization Impacts Study

Many tree plantations within the Little River AMAwilI be ready for fertilization in the fall of 1999. As Department of Interior (DOI) agencies, the BLM and the Water Resources Division of the U.S. Geological Survey(USGS) arepotentially interested in studying the impact of fertilizer applications on water quality.

Overall objectives for a study in the Little River AMA would be to determine 1) effects of fertilizer nutrients inputs on the aquatic ecosystem, including algae and potentiaIly higher trophic levels, such as invertebrate and/or fish communities, 2) interactions in the Little River Basin between nutrient inputs, aquatic ecosystems, and water quality, particularly pH and dissolved oxygen, and 3) downstream cumulative impacts, both spatially and temporally, of forest fertilization on water quality and aquatic systems.

It is possible to integrate the fertilization program with water-quality monitoring design. As shown in table 1, the phases of the study could include Project - Development, Pre-Fertilization, Fertilization, and Post Fertilization components.' By integrating the fertilization program with the study, itwilI be possible to experiment with different size riparian reserves or varying application rates (instead of the standard 440 pounds of urea per acre) to determine a range of possible impacts on water quality.

The rest of this proposal pertains to the Project Development phase of awater-quality fertilization study in the Little River AMA (during fiscal years 1998 and1999), which will include an initial review of historical information and scientific literature, reconnaissance and background sampling, and the development of the overaII study workplan.

Objectives of the Project Development Phase

This proposal outlines activities that are needed before a full study begins. Findings from the Project Development phase will assist in the design and implementation of the subsequent study phases. The objectives of the Project Development phase are:

1) colkction of preliminary, baseline waterquality and aquatic biota data in the Little River AMA;

2) a comprehensive literature search of journal articles, agency publications, and other historical information pertaining to forest fertilization impacts on water quality; and

3) the development of a detailed proposal and workplan for a future study of quality impacts from fertibzation in the Little River AMA.

Table 1. Proposed study phases and schedule of tasks

Study Phase	Work Element	Quarter in Federal Fiscal Year																							
		FY98				FY99				FY00				FY01				FY02				FY03			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
I. Project Development	Reconnaissance Sampling				■	■	■																		
	Literature Review					■	■																		
	Tentative Letter of Agreement for Phase II				■	■																			
	Initial Fertilization Study Workplan					■	■																		
II. Pre Fertilization	Background Sampling							■	■																
	Refine Fertilization Study Workplan							■	■																
III. Fertilization	Data Collection									■	■	■	■												
	Initial Report, to include:												■	■	■										
	- Data Publication																								
	- Initial Data Interpretation																								
	- Assessment of additional study needs																								
	Possible proposal for additional study													■	■										
IV. Post Fertilization	Possible additional data collection														■	■	■	■	*	*	*	*	*		
	Final Report																		*	*	*	*	*	*	*

* - Timeframes and Scope to be determined and agreed upon by mutual consent of the USGS and BLM during FY01. The additional data may be needed to determine the importance of the long-term nutrient flow paths and long-term variability associated with a range of high- and low-flow years.

Approach for the Project Development Phase

Preliminary water-quality and aquatic biota data collection in the Little River AMA during the initial phase will enhance the understanding of water quality in the basin, and will be used to assist in the design of a workplan for the fertilization study. The reconnaissance data collection will identify appropriate subbasins for possible paired-basin studies and/or upstreamdownstream sampling locations for the fertilization study. It will provide baseline data, prior to fertilization, that can later be compared with post-fertilization data. It may also provide an understanding of ground-water flow paths and their role in nutrient transport. Sampling will potentially be at 15-20 sites and could include nutrient chemistry, field parameters (water temperature, specific conductance, pH, and dissolved oxygen), qualitative assessments of algal growth and riparian cover, and flow measurements. The sites will be located throughout the basin on streams of varying orders and will provide some understanding of the spatial variability of water-quality conditions within the basin. Some of the sites may also include ground-water seeps. In addition, 4 of these 15-20 sites will be measured at fixed intervals, possibly monthly from Fall 1998 to Spring 1999, as a means of estimating temporal variability,dependance of nutrient concentrations on streamflow levels, and loads. All water-quality samples will be sent to the USGS National Water-Quality Laboratory for analysis. Final details of the reconnaissance data collection will be determined jointly by the BLM and the USGS.

Examples of agency publications or other information sources that will be included in the literature search include journals; publications from university research, USFS research, U.S. Agricultural Research Service, U.S. Natural Resources Conservation Service, USGS, and US. Environmental Protection Agency; records from the Umpqua National Forest and the BLM Roseburg District; and, if possible, records from private timber companies. Some of the specific topics in the literature search may include, but are not limited to, (a) catchment hydrologic processes, (b) surface and ground-water nutrient transport mechanisms, (c) soil chemistry and its effects on stream biota, (d) timber productivity, (e) nutrient cycling in forested catchments and their streams(f) study design, methods, and findings from previous fertilization impact studies, (g) use of isotope tracers, (h) fertilization rates, and (i) hydrologic and chemical effects of riparian reserves, tree rotation, and logging roads. The search will be assisted by using search strategies, such as .DIALOG-an internet resource.

Findings from a comprehensive literature search and baseline sampling will be helpful in writing a detailed proposal and workplan for the fertilization impacts study. The proposal would provide guidance for integrating a Little River AMA aerial fertilization program (fall of 1999) with water-quality monitoring. The proposal will also specify the water-quality sampling parameters for the study. The cumulative water-quality impacts downstream of the Little River AMA into the North Umpqua River near Glide, and perhaps downstream, also will be investigated. The proposal will provide a description of products and reports from the study, and their timelines. USGS staff will work closely with BLM and other parties during the study design period. A letter of agreement will be written in the Fall of 1998 in order to formalize the partnership

between the BLM and the USGS, which would make this study a viable candidate for the USGS one-third cost-share program (where the USGS pays for one third and another DOI agency pays for two thirds).

Project Development **Phase Time Lines**

The work elements for the Project Development phase will be completed over an 8 month period (table 1). Field sampling will begin in summer 1998 because it is critical that some samples be collected prior to the fall 1998 wet season. Additional baseline data collection during summer and fall 1999 may be included as part of the Pre-Fertilization phase.

Project Development Phase Budget

The budget total for the Project Development phase literature review and workplan development during fiscal 1998 and 1999 is shown below (table 2). The budget below assumes the one-third cost share by the USGS for FY 1999.

Table 2: Cost by agency for the Project Development phase for Fiscal Years 1998 and 1999.

Agency	N-1998	N-1999	Total (through Q2)
USGS	-0-	$17,500[1]	$17,500[1]
BLM	$15,000	$35,000	$50,000
Total	$15,000	$52,500	$67,500

[1] Not confirmed.

References

Powell, M.A., 1995, Report on pH in the Jackson Creek and Little River drainage basins of the Umpqua National Forest: Roseburg, Oregon, U.S. Department of Agriculture, Forest Service, Umpqua National Forest, Draft report to the U.S. Forest Service, [variously paged].