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FOREST VEGETATION MANAGEMENT AND PROTECTION OF STREAM QUALITY

Jerry L. Michael

USDA-Forest Service, 520 DeVa1l Drive, Auburn University, AL, 36849
Tel: 334-826-8700 Fax: 334-821-0037 Email: michajl@auburn.edu

Introduction

Globally, forest management activities significantly alter portions of the forest ecosystem on a temporal scale at the local level. Along with this alteration in the landscape comes changes in wildlife habitat and potentially the associated aquatic ecosystem. Most timber producing countries in the world have instituted forest regulations in an effort to respond to public concerns over the degradation of forest sites and to promote sustainability. In Argentina, the regulations are mandatory and designed to maintain plant species diversity, to protect native environment and to protect water quality .Australia allows for each state to provide its own regulation in much the same way as Canada and the United States of America (USA). Tasmania bases its Forest Practices Code on authorizations of the Forest Practices Act of 1985 and Victoria bases its Code of Forest Practices on a number of legislative polices including the Forests Act of 1958, Planning and Environment Act 1987, F1ora and Fauna Guarantee Act 1988, Catchment and Land Protection Act 1994 and others. The National Environment Policy 1981 provides guidance for the codes regulating Brazil's forest management. New Zealand's authorization is based on the Forests Act 1949, Forestry Accord of 1989 and the Resources Management Act of 1992. The Forest Act of 1991 provides the legal authority for South Africa's regulations. In the USA these regulations are based largely on the National Environmental Policy Act 1969 and as amended, the Endangered Species Act 1973, and the Clean Water Act of 1977 and its Amendments, but take the form of voluntary Best Management Practices (BMPs). Streamside management zone (SMZ) width recon1mended in BMPs may range in width from 0 in some instances for intermittent to more than 60 meters for perennial streams. By contrast, some countries require up to 300 m for perennial streams. SMZ requirements for representative countries around the world may be compared (Table 1). While in a few countries, SMZ requirements are based primarily on the objective of protecting water yield and secondarily on quality (South Africa and Australia for example), most countries focus primarily on the issue of water quality. The issues of wildlife habitat and rare and endangered plant species is also a concern in many countries including the USA and Argentina, but these issues are outside the scope of this paper which is concerned only with water quality.

Table 1. Range of streamside management zone widths recommended or required in different countries.

Country	Range in Meters	Source
Argentina	50-1.5 times stream width	Personal Communications
Australia-Tasmania	10-80	For. Comm. Of Tasmania
Australia-Victoria	10-40	Dept Nat. Resour. Environ
Brazil	30	Kellison, 1995
Canada-British Columbia	20-100	Ministry of Forests, BC
New Zealand	30-300	Kellison, 1995
South Africa	20/100	Kellison, 1995
USA	8/91	Blinn and Kilgore, 2001

Water quality carries a somewhat standard definition, worldwide, that includes the physical, chemical and biological attributes of water, but the terminology and measures that have been

devised and codified for its protection are as diverse as the countries, provinces, and states involved. Herein the terms streamside management zone, riparian management zone, special management zone, streamside reserve, will all be represented by the abbreviation SMZ. SMZ, streamside management zone, means a designated area that consists of the stream and an adjacent area of varying width where management practices that might impact water quality are modified or restricted. SMZ width is usually expressed as the width on each side of the stream measuring from the streambank, but for ephemeral or intermittent streams with nearly nondefined banks, it is usually expressed from the middle of the drainage. SMZs may include many components, depending on the location, country of origin, and purpose of the regulation. And these components are not necessarily uniform within a country or state. An SMZ may include such components as buffers, filter strips, primary zones, secondary zones, stringers, etc. They are universally applied to perennial streams and other bodies of water. SMZs are frequently applied to intermittent streams which have well-defined banks and natural channels, but typically have flowing water from a headwater source for only a portion of the year. Ephemeral streams, those that generally do not have well-defined channels, and flow only in response to localized precipitation are frequently left unprotected by SMZs. It is widely recognized that the maintenance of SMZs protect water quality to varying degrees, and it is common to recommend greater widths for more protection, but our research indicates width may not be the primary factor. This study compared different SMZ widths in protecting against herbicide movement into perennial streams.

Materials and Methods

Five similar watersheds, each > 40 ha and drained by a first order perennial stream, were selected in the Piedmont province of Alabama in cooperation with industrial forest landowners. One watershed was maintained as a reference forest and was not disturbed during the course of the study. The other watersheds were clearcut and each stream was left with an Sr-AZ ofa specific width. SMZ widths of 10 m (on two watersheds), 21 m, and 32 m were selected as multiples (1,2, and 3 times widths) of SMZ<; in typical use. In addition to varying tile SMZ width to multiples of those operationally applied, SMZ protection of ephemeral channels was also provided on three of the clearcut watersheds. The fourth clearcut watershed was a standard operational treatment with a 10 m SMZ, but with no protection of ephemeral streams. Timber harvest was followed after 6 months by aerial application of Imazapyr for site preparation. Streamflow was gauged with rectangular flumes and pressure transducers measured stage. Water samples were collected by automatic water samplers intensively during and between storms for quantification of stream contamination with imazapyr. Several studies conducted in this area following operational application of herbicides had already indicated large amounts of herbicide contamination of streams occur.

Results and Discussion

Results of imazapyr movement into streams in this study are given in Table 2. The maximum observed concentrations for streams protected by an SMZ throughout their length were well below those observed in other studies with similar SMZ width, but where ephemeral channels were not protected. Introduction of aerially applied imazapyr into ephemeral drain paths during application resulted in a peak concentration of 0.170 mg L-1 of imazapyr, but use of a 10 m buffer to protect this sensitive area reduced the peak imazapyr concentration to 0.041 mg L-1. This level of reduction (76%) was achieved with the additional inclusion of a very small amount of land, while the doubling or tripling of the SMZ width to 20 or 30 m over the entire length of the drainage channel resulted in the inclusion of a much larger amount of land. Even with the increased widths to 20 or 30 m it is doubtful whether imazapyr contamination of the stream would have been greatly reduced in the absence of protection of the ephemeral channel. Reduction of imazapyr transport in this

study to near nondetectable concentrations with the protection of ephemeral sections of stream channels and by doubling the SMZ width to 20 m is warranted in some cases depending on the sensitivity of the site and surrounding land ownership. However, due to the toxicological properties of imazapyr, there is no biological significance in the southern USA from the small amounts entering the streams in this study with a 10m SMZ that protected the ephemeral channel.

Table 2. *Peak imazapyr concentration.,; observed following aerial application of Arsenal Applicators Concentrate (BASF) to watersheds with SMZs of various widths protecting the entire stream channel or only the perennial and intermittent (NESMZ) portions of the channel draining the watersheds*

SMZ Width (meters)	Imazapyr Application Rate (kg ha^{-1})	Cumulative Precipitation (mm)	Maximum Observed Imazapyr Concentration (mg L^{-1})
Control–Not Harvested	0	91	0
10(NESMZ*)	0.50	-	0.170
10	0.54	114	0.041
20	0.42	114	0.000
30	0.62	119	0.011

*NESMZ-no ephemeral channel streamside management zone.

Most countries and all states in the USA recognize the need to protect perennial and to some extent intermittent streams. A few also protect lakes, fewer domestic water supplies, and still fewer protect wetlands and ponds through the use of SMZs. Ephemeral drains; drainage ditches, such as those found in lowland forestry where agriculture had previously been practiced and where drains of various types including tiles are installed; canals; and sink holes are almost never protected. Protection of such features with SMZs would greatly reduce the amount of pesticide reaching aquatic ecosystems.

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