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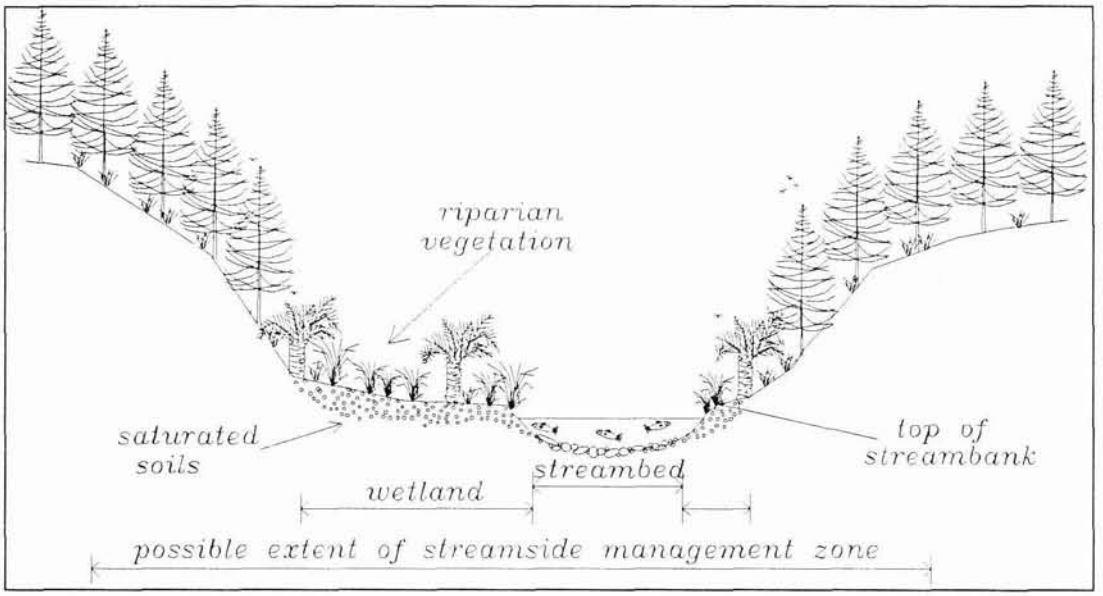
DEVELOPING STREAMSIDE MANAGEMENT GUIDELINES FOR NEW ZEALAND PRODUCTION FORESTRY

Rien Visser
Tony Fenton



ABSTRACT

What are appropriate streamside management practices for New Zealand's production forests? Considerable information and opinion exists regarding the importance of streams and streamside areas. The absence of guidelines to recommend practical and effective protection methods is allowing practices to occur that are both detrimental to the riparian and aquatic environments and costly to the forest industry. Existing information on common problem areas and currently acceptable levels of protection is supplemented in this report by a field survey of four different regions, and a questionnaire to regional councils and forestry company planners.

A framework for developing local or regional streamside management guidelines is outlined in four steps. Firstly important values are identified, followed by dividing the waterways into "classes", and finally determining the streamside management zone width and management requirements for each class. The framework is then used to develop an example set of guidelines focused on providing a reasonable level of protection for water quality, aquatic habitat, wetland areas, soil quantity and streamside vegetation values in New Zealand forestry conditions.

INTRODUCTION

Increasing environmental awareness has lead to more concern about the impacts of land use on values such as water quality and stream biota. The riparian zone is the interface between the land and the waterways, and, in addition to its own unique value, attention has been focused on the benefits of riparian zones to mitigate land-use impacts (Greynoth, 1979; Gilliam et al., 1992; Murphy, 1992).

There are inherent differences in physical streamside characteristics, stream ecology and water quality from varied land uses (for example, native forests, production forests, agricultural, horticulture and urban land-uses). The lack of understanding of land-use impacts on streams and streamside areas means it is currently difficult to establish exacting requirements to protect them. Accepting these limitations, the absence of any streamside guidelines for production forestry is leading to:

(a) a lack of general streamside protection in many locations

(b) adoption of practices or requirements that will not meet expectations, resulting in a loss of environmental quality and a cost to the forest industry

(c) an unnecessarily steep learning curve for field managers of regional councils and land owners/managers when establishing streamside protection requirements.

To solve a similar problem in the Pacific Northwest, Washington's Forest Practices (1993) contains a section with relatively practical streamside management requirements. They classify their waterways into four categories, and through extensive research and learning from past failures, set management requirements for each category. Similarly in Montana a colourful "Best Management Practices" guideline booklet has been produced for water quality protection (Logan and Clinch, 1991). It contains a section on streamside management in which suggestions do not differ greatly from those stated in Washington's forestry laws.

A New Zealand workshop on riparian zones was held in Rotorua in March 1992, highlighting issues, concerns, and the environmental benefits of managing this region (Fenton, 1992). Also recognised was the cost, inconvenience, and lack of conclusive information regarding performance of wide "no-go" buffer strips. Considerable confusion regarding terminology meant polarised views and little progress towards practical solutions.

In a paper planning study for forestry operations, Visser and McConchie (1993) showed the increasing roading requirements and decreasing setting size when increasing either the length or width of "no-go" riparian buffer strips. In summarising New Zealand sedimentation studies, Wallis and McMahon (1994) indicated that roads, tracks and landings can be a significant source of sediment. This highlights a need to evaluate proposed "protection measures" with regard to achieving objectives.

Hicks and Howard-Williams (1990) evaluated the function of buffer strips, and explained in more detail many of the values touched on in this report. The report concludes with the importance of protecting riparian zones, and its ability to mitigate adverse effects from on-site practices. It also recommends the use of guidelines, but stops short of establishing practical recommendations for forestry operations.

This report aims to improve the protection of stream and streamside values by providing a framework for the development of appropriate streamside management guidelines. It goes a step further by providing an example set of guidelines for production forests, based on the information compiled from the in-field and questionnaire surveys.

TERMINOLOGY

Fundamental to the agreement on streamside management practices is the consistent definition of terminology to be used. Most confusion arises over the term "riparian area", which has been instrumental to the lack of progress. The Oxford Dictionary defines the term riparian to mean "*of, pertaining to, or situated on, the banks of a river*". Effectively this has the same meaning as the self-explanatory term streamside. Scientifically used, the term "riparian area" refers to an area where the soil is often saturated, and subsequently has a unique plant community. "Riparian areas" are important for providing an unique habitat for both fauna and flora, particularly for our native aquatic species (G. Williamson, Department of Conservation, Rotorua. pers. com.).

Designating a fixed width zone alongside a waterway may be convenient for management purposes, but by referring to it as a "riparian area" insinuates it has unique values of importance. While all significant waterways and their sides are worth protecting for values such as water quality or instream ecology, it is important that we don't assign "riparian area" values to them.

Confusion can be avoided by adopting the 1991 Resource Management Act definition of wetland, which through its wording includes "riparian areas". Wetland *"includes permanently or intermittently wet areas, shallow water, and land water margins that support a natural ecosystem of plants and animals that are adapted to wet conditions"*.

Although technically incorrect, the term riparian buffer strip has long been associated with fixed width no-go strips alongside streams (Fenton, 1992). For forestry, it is therefore more appropriate to refer to streamside management zones. The term **zone** implies the need to establish a suitable width, and **management** indicates the need to apply appropriate practices to this particular zone. The streamside management zone can then encompass and give protection to wetland areas, as well as serving the more general function of overall stream and streamside protection.

A SYSTEMATIC APPROACH TO STREAMSIDE PROTECTION

There is a strong desire within the production forestry sector for consistency or a common approach to streamside regulation throughout the country (Evans, 1993). Concerns have been raised by some forest companies that similar issues are being dealt with by different regional authorities in markedly different ways. Similarly, regional authorities have raised concerns about the varied levels of protection given to streams and streamside areas.

Environmental protection should start in the planning phase with identification of important environmental values as outlined in the New Zealand Forest Code of Practice (FCoP), (LIRO, 1993). Streamside management restrictions should be developed with the objective of protecting these values. A systematic approach to establishing stream and streamside values, and determining required protection methods is outlined in Figure 1.

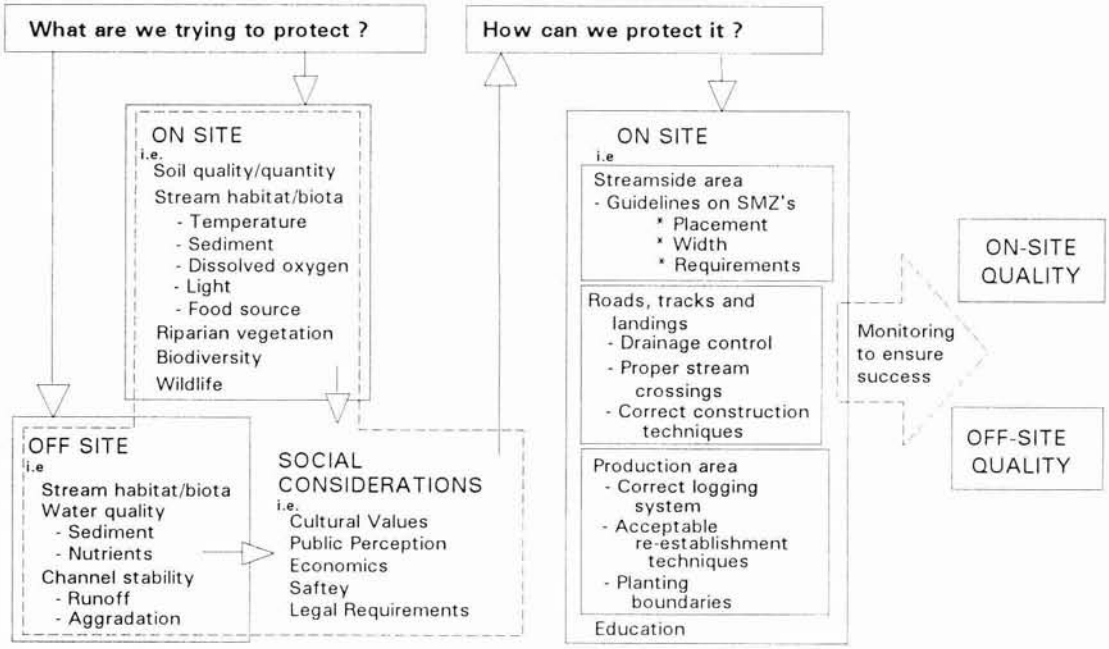


Figure 1 - A systematic approach to determining stream and streamside protection requirements

What are we trying to protect ?

Adequately defining local values is best achieved through meetings and consultation between forest companies, regional authorities, and key interest groups such as the Department of Conservation (DOC), Fish and Game Council, local Iwi and local public. This can be considered a pro-active process, as the values and concerns specific to a local area are defined early and it improves the planning and managing of forest operations.

The important values that need protecting in a specific area can be grouped into two categories: on-site and off-site. Stream habitat, stream biota and soil quality/quantity are examples of on-site values that can be important. Aspects of bio-diversity and wildlife within production forestry may be additional on-site values that need to be considered as part of the total management of the forestry land-use.

Identifying potential off-site values for protection is also important as the impacts of forest harvesting are sometimes perceived, often incorrectly, to have far reaching impacts on the aquatic environment. Water quality is a common off-site value that may require protection. Runoff-related off-site problems such as flooding and channel stability are also issues.

A number of social considerations can influence the determination of values. Local cultural values and public perception can affect the establishment and prioritising of values that need protecting. Economic, safety and legal requirements also need to be considered so that a balance between production and protection can be achieved.

How can we protect it ?

Having defined the important values, there is a need to establish how they can be protected. While this report focuses on using streamside management zones to protect stream or streamside values, land-use practices outside the immediate

streamside zone can also have adverse impacts on these values. Protection measures must integrate Best Management Practices (BMPs) in other sections of the forest, otherwise, even well planned and managed streamside management zones will be ineffectual at protecting the values (Figure 1).

BMPs, such as those set out in the FCoP, address planning and operational activities such as road/track/landing construction, and management of the production area. The primary goal of BMPs should be to maintain on-site and off-site quality, rather than just reduce off-site impacts. Regular monitoring will determine if the implemented BMPs are achieving the required degree of protection for the on-site and off-site values.

Education is another BMP that can play a major role in improving and maintaining environmental protection. There continues to be a need to improve peoples' understanding of environmental issues, processes and protection methods. This includes not only the general public's perception of forest practices, but also an understanding of environmental processes and protection methods by forestry and council personnel.

EVALUATION OF CURRENT STREAMSIDE MANAGEMENT PRACTICES

Evaluating current streamside management practices in New Zealand forests will provide an overview of common problem areas. Initially, literature and overseas guidelines were reviewed. To appreciate regional variation of site characteristics and currently acceptable practices, a field survey was undertaken of recently harvested sites in four regions with distinctly differing soil types: Central Volcanic Plateau (Pumice), Coromandel (Clay), Hawkes Bay (Mudstone), and Marlborough/Nelson (Gravels). Key personnel in these four regions from both the forestry companies and the regional councils were contacted to provide additional input to the project.

A questionnaire was distributed to evaluate the views of forest planners and regional council staff on current management practices and policies (or intended policies) for streamside areas. Individual answers are confidential; all 13 regional councils replied, while 13 out of 18 companies replied.

Out of interest, the questionnaire asked the forest planners how they felt about this type of study. Ten of the 13 thought it useful since it is pro-active and will help standardise the approach to avoid unrealistic and unpractical restrictions. One thought it would just expose the forest industry to additional restrictions on an issue that might otherwise not be of great concern. The remaining two felt parts of both statements were true.

What are the current problems ?

Most people contacted knew of the importance of streams and streamside areas, but nearly all stated there was a lack of readily available information on protection measures and their effectiveness. This was evident in the considerable variation in streamside protection seen. Some streams were protected well beyond council requirements, but others were badly affected by logging or planting practices.

The problems identified in the field, and from the discussions and questionnaires can be grouped into three main categories: erosion/sediment entering the streams, slash/debris build-up in the stream, and bad or inconsistent management practices.

Erosion/sedimentation

Poor drainage control of roads, tracks and landings was seen as a predominant contributor of sediment into waterways. In most of these situations, the company had policies or guidelines that should have prevented sediment reaching waterways. This indicated check-up and maintenance procedures in many cases were not effective.

Aspects missed by "driving around and having a look" were highlighted when visiting cable logging landings with minimal drainage control. At a glance all looked well, but below the debris pile, large amounts of sediment had eroded through the bird's nest and in places wide cracks in the soil could be seen, possibly indicating the instability of the bird's nest as a whole.

Actively eroding streambanks were common to areas either harvested using ground-based equipment or cable logged without much deflection. This created a number of actively eroding streambanks where vegetation could not readily re-establish itself. Less disturbed sites, however, appeared to revegetate within a one to two year period. If adequate protection is given to maintaining soils within the forested site, then the need for comprehensive restriction to protect other on-site and off-site values will be reduced.

Slash/debris build-up in the streams

Slash and debris in waterways after harvesting is common. Particularly large amounts of slash can be "swept" into the stream during cable logging operations. Larger woody debris in the stream tends to be a direct consequence of felling into or across the stream. Slash can deteriorate water quality, and an excess of larger organic debris can block fish passage (Figure 2). Some larger debris, however, is typically required to provide stability and diversity of habitat within a stream (Carlson et al, 1990: Mosley, 1981).

Figure 2 - Slash in waterway after harvesting

In general, council and company staff were uncomfortable with excessive slash or debris in a stream, but information quantifying actual impacts on parameters such as water quality or instream habitat are not readily available. Most councils either encourage or require slash to be removed upon the completion of the operation, to some degree dependent on the "significance" of the stream. At a number of sites more harm was inflicted on instream habitat by use of machinery in removing the slash, than simply leaving the slash in the stream.

Bad or inconsistent management practices

From councils' perspective, the problem appeared to be lack of time and resources to assess current or proposed streamside management for each site adequately. In the absence of specific consent requirements, company planning staff or supervisors are expected to set restrictions.

To a certain degree this meant stream protection was given only in convenient locations, such as highly visible sites. Also, in a number of instances the harvesting section of a company had ensured protection of native vegetation for aesthetic or stream protection purposes, only to have it cut down or desiccated by the planting crews.

Contractors spoken to stated the need for companies to provide adequate compensation if increasing environmental standards are to be met. Contractors were feeling the pressure to increase both their environmental and safety performance, in addition to meeting their financial obligations. In a competitive system where payment is based only on production, successful contracting will result in minimised environmental and safety standards.

It appears part of the streamside management problem arises when councils have attempted to write streamside management requirements. Council planners feel the need to be conservative, while company management see the need to retain land rights.

What should we protect ?

When company planners were asked, "Are there streams of considerable value in your forests?", nine out of the 13 stated that "some sections of some streams" in their forests were of "considerable value", as opposed to all or none. Four replied all were of considerable value, and this seemed to reflect the area they were in, being the Nelson and Coromandel regions. This indicates that forestry planners are well aware of the value of streams, and from the comments obtained, are pro-active with regard to wanting to protect them.

To ascertain the perceived relative importance of certain environmental considerations, the following question was asked (Table 1).

Table 1: "What do you consider to be some of the main environmental concerns in your area?"

Main Concerns	Company	R.C.
Sedimentation	20%	22%
Water quality	16%	22%
Bio-diversity	7%	6%
Stream habitat	14%	12%
Site productivity	12%	11%
Erosion	15%	21%
Visual impacts	16%	6%

Note: To obtain a relative measure on the replies to the questions, each person's vote (more than one category could be chosen) was split between their choices, and the result converted to form a percentage.

In addition, many identified other areas of "special significance" or problems in their forests that require protection. These areas included sacred or important Maori sites (that is, Waahi Tapu or traditional food sites), unique or endangered flora and fauna habitats, slope stability and water quality protection areas.

Some interesting trends can be seen from Table 1. Difficult to quantify concerns such as bio-diversity and site productivity rated relatively lowly, while the more traditional 'physical' parameters such as erosion, water quality and sedimentation rated highly. Although most of the above concerns are inter-related, making exact analyses difficult, no single parameter dominated. This highlights the problem of trying to formulate a comprehensive set of New Zealand rules or guidelines for streamside protection. Such a set of guidelines would need to address all the concerns, while in any given location only a few might be present.

The degree to which the values in streams and streamside areas should be protected will always be relatively subjective. Ideally, it should be analysed by relating

costs to benefits, but realistically this is also subjective, and particularly inadequate if completed in monetary terms (Lund, 1992). In most streamside locations, it would be reasonable to base protection requirements on currently acceptable operational methods (not to be confused with current operational methods).

How should we provide this protection?

Table 2 shows the replies to the question that was asked to determine who should be establishing the streamside requirements. Clearly, both the councils and the companies would like to interact, preferably on site, to set requirements.

Table 2: "What is your current policy on streamside protection when harvesting and planting?"

Current Policy	Harvesting		Planting	
	Company	R.C.	Company	R.C.
Leave it up to contractor	0%	0%	0%	0%
Leave it up to supervisor	9%	18%	9%	26%
Have or recommend guidelines	21%	5%	45%	14%
Interact with (R.C. or Industry)	39%	42%	23%	34%
Set out requirements on site	31%	35%	23%	26%

Councils however indicated that their field officers were often very busy, and therefore only visited particularly sensitive sites or sites of concern. This was reflected in our field visits to larger forests where council field officer visits were considered rare.

Where council field staff did get together with company planners, requirements were often developed quickly and satisfactorily to both parties. Personal contact and trust was considered very important, and in many cases this was being hindered by recent restructuring and high staff turnover in both councils and companies.

Most councils, however, also made it clear that they are no longer willing to provide extensive site-specific advice if not readily available ("we are not consultants") and therefore place the emphasis on companies to develop adequate plans to obtain consents and fulfil their RMA obligations. They also recognise, but have trouble dealing with, the apparent difference between the standard of operations carried out for the larger, in most cases more "responsible" forest companies, and the "fly-by-night" type contractors.

"When should riparian buffer strips be used?" was asked. The overwhelming response was that they should be used to minimise undesirable effects in "significant" streams, and complement other best management practices. Nearly all had additional comments stating that identifying or classifying "significant" streams was difficult. To establish what stream parameter people were most likely to identify with in determining the "significance" of a stream, the following question was asked (Table 3).

Table 3:
"How do you assess the value of a stream?"

Parameter	Company	R.C.
Water clarity	19%	26%
Number of trout	8%	11%
Stream width & depth	36%	29%
Surrounding vegetation	19%	22%
Visual (aesthetics)	18%	12%

Other values that were received as comments were: streamside vegetation, streambank stability, downstream values, and value of stream to Tangata Whenua. Stream width and depth are the parameters most easily related to stream importance by those most likely to determine requirements. The relatively high ranking of surrounding vegetation and water clarity indicates some desire for preservation of those waterways still fortunate enough to have those characteristics.

From this information, it would seem appropriate to develop stream categories (or "classes") for development of guidelines. This will allow more appropriate protection recommendations to reflect the importance of the stream, and avoid the undesirable "blanket" approach.

OTHER CONSIDERATIONS

The options and benefits of staging (limiting harvest areas over a certain time period) were also discussed during field visits. Historically, a lot of regions were planted en masse. While the economic benefit of harvesting en masse is clear, there are three main potential problems. Firstly, there is the higher risk of excessive erosion during an intense rainfall event. Secondly, there is the cumulative impact on the streams within a catchment. Finally there is a possible adverse public reaction to significant visual landscape changes. While there is no easy answer, due consideration to staging is appropriate for all harvest plans.

For companies that have separate harvesting and re-establishment groups, co-ordination between them needs to be enhanced to ensure environmental protection measures are not undone. It needs to be stressed that the planting phase of forestry can also have a great adverse impact through operations such as desiccation and planting in undesirable locations. Smaller regions completely managed by a single person or a small group avoided this lack of information transfer. It should be of interest that nearly all European forests require this type of management (Visser, 1993).

Oversowing after harvesting has proven to be of benefit in a number of ways (Smith and Fenton, 1993). It can provide stability to exposed soil, minimise erosion potential, suppress weed growth, add nitrogen, and also reduce the time frame of the visual impact. Oversowing is relatively cheap and in many areas can be very effective.

Because of the increasing interest in total management brought about by the increasing difficulty in taking more and more factors into consideration, a simple question on the use of Geographic Information Systems (GIS) was included. Apart from being a tool to help achieve total management for a company's resources, GIS can be interlinked between industry, councils and other departments to simplify consent procedures. Ten of the 13 councils and six of the 18 companies either had, or would have GIS in the near future.

Forestry companies must realise they are not alone in the difficult task of achieving stream and streamside protection. All interest groups are working hard to ensure their points of view are adequately considered, and are expressing their concerns in concise reports. Two examples are reports by the Department of Conservation (Richards and Williamson, 1993) and the Royal Forest and Bird Protection Society (1992) explaining their perspectives on the value and importance of stream and streamside management.

Most companies were starting to recognise the benefit of good public relations. The public tends to be the judge of any industry, with councils often reacting to public pressure. Introducing school children to forestry through field trips, opening forests to public recreation, and information panels for highly visible operations have all received favourable comments.

A FRAMEWORK FOR DEVELOPING GUIDELINES

An appropriate and effective way of preventing environmental damage to waterways and streamside areas can be achieved through developing and implementing streamside management guidelines. By localising the guidelines, the important site values can be protected and companies will avoid over-prescriptive recommendations from nationwide rules or guidelines. Providing information in clear and concise guidelines will make it readily available for those expected to implement it, improve overall protection of streams in New Zealand forestry and avoid the inconsistencies outlined in the introduction. Streamside management guidelines can be developed by following these four steps:

Step 1
Identify the important values in your stream and streamside areas

Important values (and why we should protect them) are best established by consulting with regional authorities and other interested groups such as local Iwi, Department of Conservation, Fish and Game Council and local public. Regional and district policy statements or plans are an important starting source of information that address regional and district concerns. Examples of other sources of information, both written and institutions, are listed in the FCoP appendix.

Step 2
Divide the waterways into 'classes' to reflect identified values

The term "waterway" is very broadly defined in the legal context of the 1991 Resource Management Act. Clearly a "blanket" approach for protection requirements is not desirable, and we must break our waterways into sections. By using either multiple criteria to define waterway 'classes', or plotting the waterway "classes" directly on to a working map, "blanket" requirements can be avoided. This will allow appropriate levels of protection to be provided in the correct locations.

Step 3
Determine a streamside management zone (SMZ) width for each class

For each "class" determine a reasonable width from the waterway where operations can have a direct impact on the identified values. While operations outside this area can still impact those values, they should be protected by on-site Best Management Practices in the production, or the roading/ tracking/landing area.

Step 4
Determine SMZ requirements for each class to protect the identified values

Information on establishing requirements that will protect the values can be found in literature or by evaluating current practices. Examples of sources of information include regional and district plans and guidelines, the interested groups, as well as the FCoP, including the following example streamside management guidelines. By evaluating current operational practices and learning from previous experiences, acceptable methods can be established that .protect the identified values.

EXAMPLE STREAMSIDE MANAGEMENT GUIDELINES

The following is an example of using the framework to develop some specific streamside management guidelines. These example guidelines focus on common values and common problems. The objective of these guidelines is to provide practical and relatively comprehensive information regarding stream and streamside protection.

Step 1 - Identify important values

The following five general 'important' values were identified for protection. It is important to note that more specific values, such as places of Maori importance or endangered species are not addressed in these guidelines and should be addressed separately.

i. water quality - to protect: off-site and on-site aquatic conditions; downstream water users; visual aspects of water quality

ii. aquatic habitat - to protect both indigenous and exotic aquatic species

iii. wetland areas - to protect: important spawning areas; unique flora and fauna; and bio-diversity

iv. soil quantity - to protect: site productivity; streambanks; water clarity; and timber near waters edge

v. streamside vegetation - to protect: both aquatic and terrestrial food source; provide some shading; prevent streambank erosion and collapse.

Step 2 - Divide waterways into "classes"

Wanting the example guidelines to remain simple but effective, just two classes were made, one to reflect the more "significant" waterways, the second to reflect all "other" waterways (for convenience referred to as Class 'A' and 'B' waterways, respectively).

The following criteria represent a lower bound for the Class 'A' waterways. The criteria conditions have been developed to reflect waterways where the identified values are likely to be of considerable importance. Text in italics are explanatory comments.

Criteria for the Class A waterways

- streams with a base-flow width of 1.5 metres or greater; or
  (since stream width is one of the easiest parameters with which people can identify)

- streams with a well defined streambed and banks 3 metres apart or wider; or
  (larger, well defined streambeds are a clear indication that although the base flows may be relatively small, it frequently carries larger quantities of water)

- streams that have important native fish populations; or

- streams that are used by trout or salmon for spawning; or
  (protection of 'significant' instream habitat)

- streams that directly provide domestic water supply or feed into closed water systems (for example, lakes); or
  (maintaining water quality in easily affected areas)

- wetland areas greater than 20 m^2
  (protection of all larger wetland areas regardless of location)

The following criteria represent a lower bound for the Class 'B' waterways. The guidelines suggest "waterways" beyond these criteria become part of the site and should be protected using on-site BMPs.

Criteria for the Class B waterways

- streams that flow continuously; or
  (easy to identify with, and most continually flowing streams are of some importance)

- intermittent streams with a gravel bed greater than 0.5 metres wide or with a bank to bank width of 1 to 3 metres; or
  (during rainfall events, these are likely to carry significant quantities of water)

- small gullies that feed directly into and are within 50 metres of a Class A waterway; or
  (any material near larger waterways may be transported during rainfall events)

- wetland areas greater than 5 m^2, adjacent to a one of the above.
  (recognising that all wetland areas, particularly those adjacent to streams, are important)

Step 3 - Establish SMZ width

The SMZ width should reflect the region that can 'significantly' impact the values in each class of waterway. For the Class 'A' waterways, a reasonable distance would appear to be 30 metres on either side (approx. length of tree). Forestry provides thorough protection for the common values around Class 'B' waterways. A zone of awareness is all that is required, where operations should be carried out with that extra level of care. A reasonable SMZ width would appear to be 10 metres on either side.

Step 4 - Determine SMZ requirements

Focusing on the protection of the five identified values, Table 4 shows some of the common problems currently seen in forestry, along with common precautions that will minimise or avoid that impact.

Value	Common Problem	General Precautions
Water quality	decrease in water clarity and sedimentation	keep streambanks intact, construct proper crossings, prevent up-slope erosion through proper drainage control and minimise site disturbance
	decrease in oxygen levels through high organic debris loading	avoid falling trees into waterways, remove slash
	chemical pollution	careful and correct application of chemicals particularly in the vicinity of any waterway
	nutrient change	requires site-specific analyses, but careful application (both quantity and placement) of fertiliser
	temperature regulation	retain streamside vegetation
Aquatic habitat	direct impact from machinery, or from sediment or chemicals in the water	avoid use of machinery in and around waterways, and avoid or minimise the falling or dragging trees through the waterways
	decreased diversity within stream	retain existing large organic debris in-stream, remove exotic slash, and avoid altering waterway (ie. proper design of culverts)
	impact on food source and breading area	retaining streamside vegetation
	sudden impact from change in conditions over a large area	proper consideration for aquatic habitat when harvest planning, and staging if required
Wetland areas	conversion to dry areas by drainage, destruction of habitat or damage to these areas	identify and protect remaining areas by excluding any activity there, avoid draining these areas
Soil quantity	streamside disturbance, streambank collapse	avoid use of machinery near streambank, and avoid planting on streambank or steep slopes
	continued erosion	revegetate disturbed areas with appropriate species
Streamside vegetation	streamside vegetation destruction	plan operations to minimise riparian vegetation disturbance
	removal of unique or endangered plants	identify and protect any riparian plants of particular value

Table 4 - *Summary of values, their common problems and general precautions.*

The following recommendations are developed from Table 4 to provide a reasonable level of protection in the two waterway classes. Since the Class "A" waterways are those where the values are most common, the requirements for the SMZ are quite prescriptive. Recognising that forestry is a land-use that provides a very stable environment for long periods of time, the Class "B" SMZ is more like a zone of awareness. Ensuring all operators are aware of the SMZ restrictions is an important first step for the implementation of guidelines.

Class A SMZ requirements

- no vehicle is to operate in the SMZ, unless crossing at a designated crossing, or operating on relatively flat land
  (avoid soil and vegetation disturbance, compaction and streambank collapse)

- construct proper crossings (see NZ Forest Code of Practice, pgs 35, 36)
  (badly constructed crossings have a direct and continued impact on watercourses)

- minimise understorey vegetation disturbance in the SMZ

- no tree is to be felled into the waterway, unless forced to by safety considerations
  (avoids direct impact on water quality and aquatic habitat)

- no tree harvesting on steep slopes leading down to a spawning stream during spawning season

- keep all stem butts well raised when cable logging through the SMZ
  (well raised stem butts minimise soil and vegetation disturbance and rutting)

- remove excessive slash in waterway by hand
  (using machinery to clean out streams often results in turning them into drains. The removal of slash by hand will not only have the least impact, it will also encourage less slash to end up in the waterways)

- revegetate all badly disturbed areas as soon as possible with appropriate species
  (badly disturbed areas will continue to erode for many years, reducing water quality and streambank stability)

- no chemicals, fuels or oils are to be stored in the SMZ
  (avoids risk of serious waterway pollution in case of heavy rainstorm, or accidental spillage)

- no tree planting within the first five metres of the SMZ
  (ensures trees are not planted on streambanks and promotes streamside vegetation)

- no tree planting on a slope leading down to a waterway that has proven to be too steep to maintain the trees in a stable and safe manner
  (planting on these slopes will result in fallen trees and difficulties at harvesting time)

- prune all edge trees, and keep the stand in the SMZ lowly stocked
  (allows more light in to sustain understorey vegetation)

Class B SMZ requirements

- avoid or minimise vehicle use in the SMZ, particularly the waterway itself
  (will reduce both soil and vegetation disturbance, as well as soil compaction)

- avoid accumulating any slash or disturbed soil in the SMZ
  (these materials will deteriorate water quality in rainfall events)

- avoid storing any chemicals, fuels or oils in the SMZ
  (avoids risk of serious waterway pollution in case of heavy rainstorm)

- keep all stem butts well raised when logging through the SMZ
  (stem butts should be well raised to minimise soil and vegetation disturbance and rutting)

CONCLUSIONS

Environmental protection for forestry must consider all the inter-related on-site and off-site processes that may have an adverse impact on important values. Streamside management restrictions should therefore not be developed without direct consideration of the other site management practices.

In this report, both literature and overseas guidelines are reviewed to determine appropriate methods of protecting our waterways. Current streamside management practices were evaluated by field visits to four regions and by questionnaires to forest company planners and regional council staff.

The report suggests that concise guidelines are very effective at providing the information for those carrying out operations near waterways. A framework for developing streamside management guidelines is provided using four steps. Firstly environmental values are established, followed by the development of waterway "classes" using either multiple criteria or mapping to reflect the values. Each waterway "class" is given a streamside management zone width, and requirements are set out for the zone to ensure appropriate levels of protection. These stream categories can be defined by using either multiple criteria or straight mapping of all the waterways in a given area.

By using the framework for developing streamside management guidelines, example guidelines are developed. The guideline is aimed at providing information for the general protection of stream and streamside areas in production forests for five common values: water quality, aquatic habitat, wetland areas, soil quantity and streamside vegetation. The degree of protection, or the streamside management zone requirements, are based on currently acceptable practices to balance their costs and benefits. The requirements are relatively prescriptive to avoid incomplete or inadequate information.

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