Forest Planning and Practices in Coastal Areas with Streams

Technical Report

Contents

Key Concepts and Terms

These are definitions used in the investigation. Legislative amendments effective June 15, 1998, introduce revised definitions for streams and fish-streams.

Stream: a watercourse, having an alluvial sediment bed, formed when water flows on a perennial or intermittent basis between continuous definable banks.

Stream Reach: a section of a stream with relatively consistent characteristics, including the structure of the stream and fish habitat type. The average amount of stream reach examined in this investigation was approximately 130 metres in length.

Stream Classification: under the Code, streams must be classified based on the width of the stream and the presence or absence of fish. There are six classes of streams defined in the Code. The class of the stream determines the size of the riparian management area and the need for a riparian reserve zone.

Fish Stream: a portion of a stream that, a) is frequented by fish, or b) has a gradient less than 20% (and flows into fish bearing waters), unless a fish inventory (acceptable to the district manager) has shown the absence of fish.

Riparian Management Area: an area that is adjacent to a stream, consisting of a riparian management zone and, depending on the riparian class of the stream, a riparian reserve zone.

Riparian Reserve Zone: that portion, if any, of the riparian management area located adjacent to a stream, wetland or lake. Harvesting of trees is not permitted normally in the reserve zone unless approved by government in specific circumstances.

Riparian Management Zone: that portion of the riparian management area that is outside of any riparian reserve zone or if there is no riparian reserve zone, that area located adjacent to a stream. Harvesting of trees is permitted in the management zone.

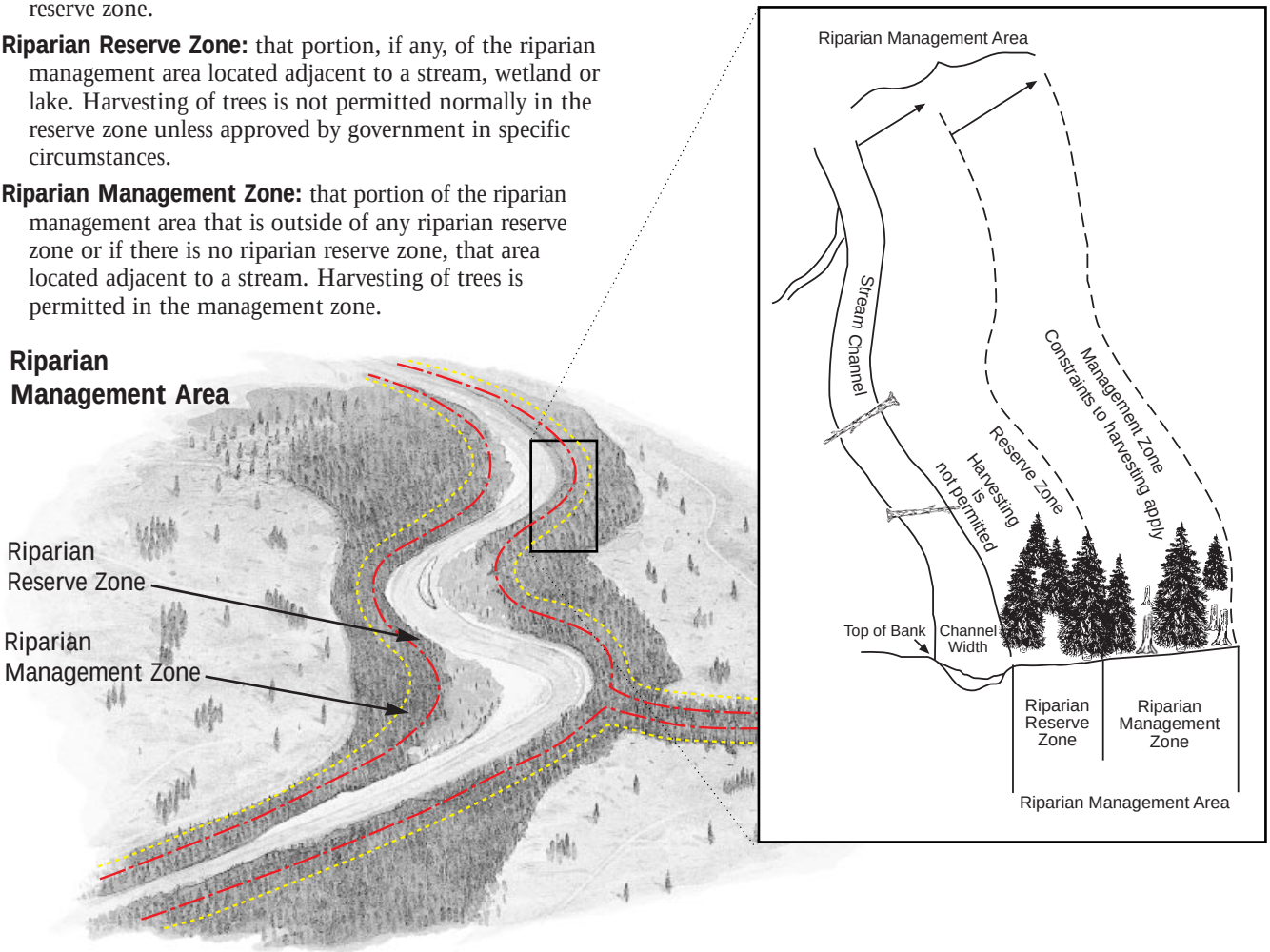
Specified minimum RMA slope distances for stream riparian classes

The Code defines riparian management areas, which consist of a management zone and, for fish streams of 1.5 metres in width or greater, a riparian reserve zone. Each of the zones has width requirements based on the stream classification. Constraints to forest practices are applied within these zones, with the most stringent requirements applied to the reserve zones.

Riparian class	Average channel width (m)	Reserve zone width (m)	Management zone width (m)	Total width (m)
S1 large rivers	≥ 100	0	100	100
S1 (except large rivers)	> 20	50	20	70
S2	> 5 ≤ 20	30	20	50
S3	1.5 ≤ 5	20	20	40
S4	< 1.5	0	30	30
S5	> 3	0	30	30
S6	≤ 3	0	20	20

Fish stream or community watershed

Not fish stream and not in community watershed



Summary

Introduction

In early 1997, the Forest Practices Board began a special investigation into forest planning and practices around streams in coastal British Columbia. Logging practices around streams were the subject of public controversy at the time. The Board decided to undertake this investigation in its role as public watchdog over effective forest management, and because streams and their adjacent riparian areas are of great interest to the public and to organizations involved in forestry.

The Forest Practices Code

The *Forest Practices Code of British Columbia Act* and its regulations and guidebooks, referred to collectively as the Code, direct the conduct of forestry operations on Crown forest lands in British Columbia. The Code was introduced in June 1995 amidst concerns about the need to improve forestry practices in British Columbia. Changes were made to the Code in June 1997, but many of the requirements related to riparian areas remain the same. This investigation was based on the requirements in place prior to the June 1997 changes.

One of the objectives of the Code is to ensure that planning and practices around streams and **riparian areas** provide protection to fish and fish habitat as well as the riparian area itself. The Code requires the identification of streams in and adjacent to cutblock areas proposed for logging and classification of the streams based on width and the presence or absence of fish.

Riparian areas occur next to the banks of streams, lakes and wetlands and include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Riparian areas contain many of the highest value timber and non-timber resources in the forest. Streamside vegetation protects water quality and provides a "green zone" of plants that stabilize streambanks, regulate stream temperatures, and provide a constant source of woody debris to the stream channel.

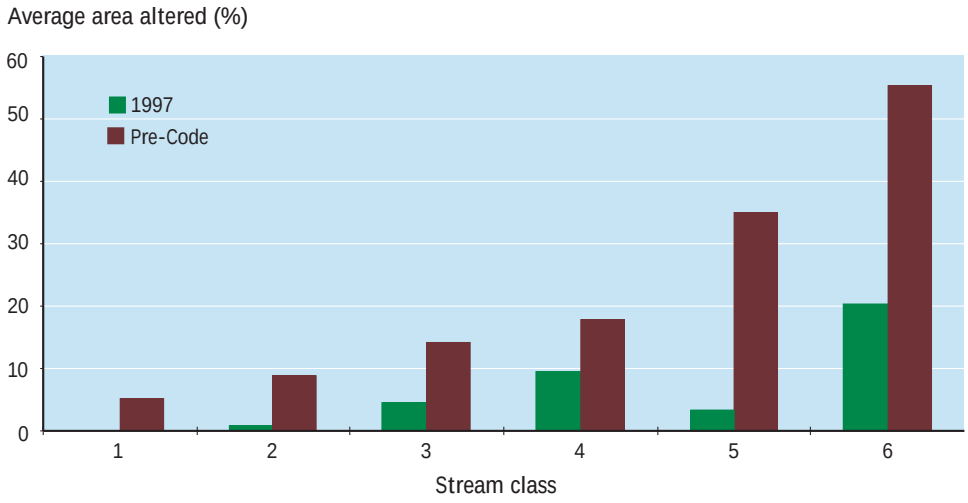
Under the Code, a riparian management area must be established next to all streams. This area consists of a riparian management zone and, for larger fish streams, a riparian reserve zone (see "Key Concepts and Terms" on previous page). Each of the zones has width requirements based on the stream classification. Restrictions on forest practices apply within these zones, the most stringent requirements affecting the reserve zone. Here, for example, the cutting of trees is restricted to help protect the stream ecosystem and the diversity of wildlife habitat and vegetation in the riparian area.

Investigation Findings

Comparison to Pre-Code Studies

The investigation found that alterations to streams caused by logging activities were significantly lower than in the pre-Code period examined in earlier studies (1988–92). This improvement is particularly evident for larger fish streams, and for non-fish streams that were previously subject to high levels of alteration (i.e., disturbance)(see graph on following page).

Between 1992 and 1995, the Ministry of Forests released several reports (principally authored by Derek Tripp, who also participated in this special investigation) on forest practices conducted around streams and in compliance with the *Coastal Fisheries Forestry Guidelines*, which were in place before the Code was enacted. The forest practices studied were carried out between 1988 and 1992.



Comparison of level of alterations to streams with pre-Code period

Objective and Scope of the Investigation

The objective of the investigation was to determine whether forest planning and practices in coastal areas comply with the Code and protect streams and associated riparian areas. Three questions were asked:

1. Do forest planning and practices comply with the Forest Practices Code?
2. Are the specific practices being used consistent with the best management practices outlined in the *Riparian Management Area Guidebook?*
3. Are the specific practices being used minimizing impacts on streams and riparian areas?

Selection of cutblocks and streams inspected

A sample of 96 coastal cutblocks was selected for field assessment from within six coastal Ministry of Forests districts. These were the Port McNeill and South Island forest districts on Vancouver Island, Chilliwack and Sunshine Coast forest districts on the southern coast, and the Kalum (Terrace) and Queen Charlotte Islands forest districts on the north coast (see map). The forest districts were chosen because they broadly represent the range of physical and geographic conditions that exist in the 10 districts along British Columbia's coast. On average, each coastal cutblock contained six streams. Of the 430 cutblocks logged on the coast between December 15, 1995, and March 31, 1997, only 7% did not contain streams. The investigation examined 355 stream reaches in the selected cutblocks.

The sample included cutblocks of forest companies and the Ministry of Forests Small Business Forest Enterprise Program. The sample was designed to adequately portray forest planning and practices around all six classes of streams under the Code.

The streams were examined using rigorous auditing methods to ensure the accuracy and the credibility of the results.

Several factors have contributed to the improvement, with the primary one being the introduction of the Code. Reasons for improvements under the Code include:

- Larger fish streams are now protected by mandatory riparian reserve zones, in which the cutting of trees is highly restricted.
- Compliance with plan requirements for reserves has increased. The Code sets out significant penalties and fines for non-compliance involving damage to streams.
- A greater emphasis is being placed on falling and yarding trees away from streams and cleaning logging debris from streams after the completion of harvesting.
- Detailed planning requirements, which apply to even the smallest non-fish streams, combined with training, have increased logging crews' awareness of streams and the need to minimize stream alterations.
- It has become common practice to exclude larger streams (both fish and non-fish) from harvest areas when designing cutblock layouts.

Compliance with Planning and Practices Requirements of the Code

Measuring compliance with the Code required examining the planning requirements that were followed and the practices implemented in the field. This included checking the identification, classification and mapping of streams, the establishment of riparian management areas, and the fulfilment of obligations set out in site-specific plans and other requirements.

Planning

The correct identification and classification of streams is important because stream class determines the extent and location of the riparian management area and the practices that will be applied around the stream. The investigation found this step to be the main aspect of planning that requires improvement. Although identification and classification of S1 and S6 streams was very good, nearly half of S3 and S4 streams were underclassified (see table below). This misclassification led to inappropriate practices in a number of cases, which resulted in the alterations to stream area observed in S4 streams, and harvesting in what should have been reserve zones along S3 streams. It is worth noting, however, that—despite the incorrect plans—the misclassification was sometimes corrected in the field by logging crews and the appropriate practices were carried out.

Accuracy of Stream Classification

Stream class	Number of stream reaches assessed	Number of stream reaches correctly classified	Number of stream reaches overclassified	Number of stream reaches underclassified	Total number of stream reaches incorrectly classified
S1	18	18	0	0	0
S2	29	23	0	6	6
S3	43	21	0	22	22
S4	42	20	4	18	22
S5	33	21	0	12	12
S6	190	163	8	19*	27
All	355	266	12**	77	89

* *Streams classed as S6 by the field teams, though operators had not previously classed them as streams.*

** *In addition to these were 25 watercourses classed as streams but subsequently determined by the field teams not to be streams.*

The main causes of misclassification were:

- measurement errors, for both stream width and stream gradient;
- failure to comply with the Code requirement to consider low gradient streams as fish streams when a fish inventory has not been completed;
- classification of low gradient streams as non-fish streams, based on a fish inventory that was not adequate to confirm fish absence; and
- failure to recognize watercourses as streams, because of a lack of clarity in the Code definition of what constitutes a stream. (Note: this definition has been revised as part of the recent changes to the Code.)

Many of the plans containing misclassified streams were approved by government without adequate information or work to determine the presence or absence of fish.

Once streams are identified and classified, plans must set out the riparian management areas that will be applied and the practices that will take place in the riparian area. The investigation found high levels of compliance with these planning requirements of the Code. However, for those streams that were underclassified, the plans were not appropriate for the actual stream conditions.

The investigation also found similar levels of compliance across districts, except for Kalum Forest District, which ranked lowest for planning.

Practices

Compliance with the requirements of the *Timber Harvesting Practices Regulation* was very high across all six stream classes. The regulation prescribes:

- leaving stable material in place in stream reaches;
- not depositing harmful amounts of slash and debris in stream reaches;
- removing temporary stream crossings, once operations are complete; and
- avoiding damage to the stream by ground-based machinery.

The practices set out in approved plans—maintenance of the riparian management zone, streambank retention, stream cleaning, and falling and yarding—were found to be generally followed on the ground. The compliance levels were higher in fish streams and lower in non-fish streams.

The main areas of non-compliance with plans were: failure to carry out stream cleaning, and falling and yarding across streams. In some cases, non-compliance resulted from poor plans that either proposed unsuitable practices for the site, or were too vague to indicate what was to take place on the site.

Nearly half of the alterations in fish streams were the result of misclassified streams and the subsequent approval in plans of inappropriate practices that were then followed on the ground. Where fish streams were correctly classified and the plans followed, practically no alteration was observed in the streams.

The practices of stream cleaning, falling and yarding trees away from streams, and maintaining streambank vegetation were highly effective in preventing stream alterations. So too was the establishment of riparian reserve zones. For their part, riparian management zones were effective in protecting the reserve zones and preventing blowdown in them (i.e., the uprooting of trees by the wind).

Summary of the Results of Forest Practices by Stream Class

Assessing the wildlife habitat values affected by logging activity was not possible in this investigation, since the Code does not specify objectives for the protection of wildlife habitat in riparian management areas. The focus of plans was stream protection. Specific measures to protect non-timber values in riparian areas were lacking, making it impossible to assess the wildlife habitat affected by logging activities. It is assumed, however, that maintaining riparian management areas, especially riparian reserve zones, contributes to the maintenance of wildlife habitat too.

Fish Streams

Alterations in large fish streams were found to be almost non-existent, as a result of operators' high level of compliance with the reserve zone requirements for these streams. For S1 and S2 streams, 41 out of 46 had reserve zones that were equal to or greater than Code requirements, with 16 maintaining significantly more trees than required.

For S3 streams, compliance with the reserve zone requirements was only 65%, due to the misclassification of 22 of the streams. Seven were corrected in the field by logging crews, but 15 did not receive the required reserve zone. This finding is a concern because establishment of adequate riparian reserves is one of the most important of the Code's riparian requirements.

Eighteen S4 streams were underclassified as S6 non-fish streams, which led to inappropriate practices in the riparian management zone with woody debris deposited in these small fish streams.

The level of alteration in smaller fish streams is notably lower than in pre-Code studies, but still remains a concern because their small size makes them more vulnerable to impacts from disturbance. Over half of the area altered in S3 and S4 fish streams resulted from inappropriate practices due to misclassification. Clearly, addressing the misclassification problem will reduce the incidence of alterations and ensure that requisite reserve zones and appropriate practices are applied around fish streams.

Non-fish Streams

Alterations were significantly lower for both classes of non-fish streams compared to what was shown in pre-Code studies. The larger S5 streams tended to be located along block boundaries rather than within the harvest area, and significantly more trees were maintained—an average of 2.5 times as many—than the maximum recommended in the Code's *Riparian Management Area Guidebook*, which helped reduce alterations.

The incidence of alteration in S6 streams has dropped significantly since pre-Code studies. Approximately 64% of the area altered in S6 streams resulted from practices (mainly leaving logging debris in streams) set out in approved plans. This reflects the less stringent requirements the Code applies to these small streams. Other alterations occurred primarily because operators failed to comply with plans, and left logging debris in the stream channels.

Of particular concern is that nearly half of the non-fish streams found with debris left in them had the potential to transport the debris downstream. Such situations can lead to stream blockages and diversions, and may ultimately affect fish streams.

Use of Guidebook Recommendations

Many of the specific forestry practices around streams and riparian areas are not prescribed by regulation, but are set out as recommended practices in the *Riparian Management Area Guidebook*. While guidebook recommendations are not legally binding, they represent practices that should be considered. Although some of the plans examined in this investigation were developed before the guidebook was released, many called for the recommended management practices in riparian management areas.

The *Riparian Management Area Guidebook* recommends stream cleaning and falling and yarding practices for S4, S5 and S6 streams.

In most cases, for example, stream cleaning, and falling and yarding recommendations were applied. So, too, were recommendations regarding the amount of streambank vegetation and trees that should be maintained in riparian management areas on larger fish streams. However, only 72% and 66% of S3 and S4 streams respectively, had the recommended amount of vegetation maintained in the riparian management zone.

Only 39% of S6 streams had the recommended amount of streambank vegetation and the recommended amount of vegetation in the riparian management zone maintained. These findings reflect the fact that, for small streams, operators have a general tendency to leave a larger number of trees on a few streams rather than a smaller number on all small streams.

The maximum recommended amounts of vegetation to maintain along streambanks and in riparian management zones are 50% for S1, S2 and S3 streams, 25% for S4 and S5 streams, and 5% for S6 streams.

The average amount of vegetation and trees maintained met or exceeded the maximum recommended for five of the six stream classes, although there was a wide range both above and below the recommendations in each stream class. As noted above, the anomaly with S3 streams was due to misclassification.

For S6 streams, the limited use of the guidebook recommendations was likely because clearcutting and cross-stream yarding—both considered by the Code to be acceptable practices on these small streams—are incompatible with maintaining streamside vegetation. Cross-stream yarding was permitted on 54% of non-fish streams and was likely a major contributor to the debris that was observed in the streams, and part of the reason that trees were not maintained in the riparian management zones.

Conclusions

In answering the three questions posed by this investigation, the Board reached the following conclusions:

1. The investigation found high levels of compliance with the planning and practices requirements of the Code, but two areas still requiring improvement are:
   - Proper classification of small fish streams is needed to ensure riparian reserve zones are maintained and debris is not deposited in these streams.
   - Appropriate stream cleaning and falling and yarding practices in and along non-fish streams need to be planned and carried out.
2. The practices recommended in the *Riparian Management Area Guidebook* are generally being used, except for the retention of vegetation along streambanks and the retention of vegetation in the riparian management zone for small streams.
3. When they are used, the practices recommended in the Code are effective in minimizing impacts on streams and riparian areas, and the level of impact is significantly lower than was found in pre-Code studies.

Key Recommendations

To remedy the problems identified during the investigation and encourage continued improvements in forest planning and practices in coastal British Columbia, the Board presents a detailed list of recommendations (see section 4, page 35). The Board's key recommendations are listed here:

- Government, working with the forest industry, should provide standards, guidance and training to improve stream inventories, identification and classification. A clear definition of a "stream" is also essential.
- Government should develop more specific requirements and recommendations for retention of trees and vegetation in riparian management zones, to meet objectives for biodiversity and habitat management.
- Government and the forest industry should work together to improve planning and practices around small streams, particularly to prevent the transport of debris in non-fish streams.

- Government and the forest industry should prepare plans that are clearly written and practical for the sites they address, so they can be implemented in the field.
- Government and industry should consider undertaking long-term assessments to monitor the effects of specified forest practices in controlling or preventing such occurrences as blowdown.

Acknowledgements

The Board wishes to thank everyone involved in this special investigation for their efforts and their cooperation in completing the project. The ministries of Forests and Environment, Lands and Parks, the Sierra Legal Defence Fund and the Coast Forest and Lumber Association all contributed to the development of the terms of reference for this investigation. The special investigation team dedicated countless hours of work to the collection and analysis of the data, both in the field and in the office. Staff of the forest companies and the Ministry of Forests district offices accompanied the investigation team in the field, reviewed summaries of the findings, participated in exit meetings, and provided their cooperation in ensuring the investigation team had all relevant information to complete the analysis. This special investigation would not have been possible without the contributions of all of these parties.

Special thanks to Darlene Dahl, Jon Davies, Bill Grant, Kevin Haberl, Shawn Hamilton, Sucha More, Chris Mosher, Chris Ridley-Thomas, Dag Rutherford, and Derek Tripp.

To Obtain More Information

To contact the Forest Practices Board call 1-800-994-5899 in BC,
or 250-387-7964 in Greater Victoria and from outside BC.
This report is also available on the Internet at http://www.fpb.gov.bc.ca.
You can also reach the Board by fax at 250-387-7009, or by mail at
P.O. Box 9905, Stn Prov Govt, Victoria, BC, Canada, V8W 9R1.

June 25, 1998

1. Introduction

1.1 Background

In early 1997, the Forest Practices Board began a special investigation into forest planning and practices around streams in coastal areas of British Columbia. Forest Practices around streams were the subject of public controversy at the time. This controversy was a result of a report by the Sierra Legal Defence Fund, which claimed that the province's new Forest Practices Code (the Code) failed to protect these sensitive and critical areas. In response, the government[1] requested that the Board conduct a thorough independent investigation into the issue.

The Board decided to undertake the investigation in its role as public watchdog over the Code and because streams and their adjacent riparian areas are of great interest to the public and to organizations involved in forestry in the province.

1.2 Forest Practices Code

The Code regulates the conduct of forestry operations on Crown forest lands in BC. It was introduced in June 1995 amidst concerns about the need to improve forestry practices in BC.

A key area of the Code is forest planning and practices around streams and their adjacent **riparian areas**. The Code requires the identification of streams within and adjacent to areas proposed for logging ("cut-blocks") and classification of the streams based on width and the presence or absence of fish and/or gradient.

Under the Code, a riparian management areas are established for all streams, consisting of a management zone and, for larger fish streams, a riparian reserve zone. The zones vary in width depending on the stream classification. Constraints to forest practices apply within these zones, with the reserve zone having the most stringent requirements. Restrictions on the cutting of timber from reserve zones helps maintain the diversity and sustainability of wildlife habitat and vegetation within riparian areas, as well as aquatic ecosystems.

1.3 Objectives of the investigation

The overall objective of the special investigation was to determine if forest planning and practices around coastal streams comply with the Code and protect streams and associated riparian habitat and features. To meet this objective, the following questions were asked.

Riparian areas are those next to the banks of streams, lakes and wetlands and include both the area dominated by continuous high moisture content and the adjacent upland vegetation that exerts an influence on it. Riparian areas contain many of the highest value timber and non-timber resources in the natural forest. Streamside vegetation protects water quality and provides a "green zone" of plants that stabilize streambanks, regulate stream temperatures, and provide a constant source of woody debris to the stream channel.

The majority of fish food organisms come from overhanging vegetation and bordering trees while leaves and twigs that fall into streams are the primary nutrient source that drives aquatic ecosystems. Riparian areas frequently contain the highest number of plant and animal species found in forests, and provide critical habitats, home ranges and travel corridors for wildlife. Biologically diverse, these areas maintain ecological linkages throughout the forest landscape, connecting hillsides to streams and upper headwaters to lower valley bottoms. There are no other landscape features within the natural forest that provide the natural linkages of riparian areas.

1 The Ministry of Forests and Ministry of Environment, Lands and Parks also undertook a joint review which examined the riparian management field practices in the 18 cutblocks field checked during the Sierra Legal Defence Fund study.

1.3.1 Do forest practices and planning comply with the Code?

Assessing compliance with the Code requires checking the identification, classification and mapping of streams, the establishment of riparian management areas and the fulfillment of obligations laid out in site-specific plans (silviculture prescriptions and logging plans) and other Code requirements.

The *Forest Practices Code of British Columbia Act* and the associated Regulations set out the regulatory requirements of the Code. The riparian elements of the Code are contained primarily in the *Operational Planning Regulation*, which details specific planning requirements, and the *Timber Harvesting Practices Regulation*, which details specific practices required on the ground.

1.3.2 Are the specific practices being used minimizing impacts on streams and riparian areas?

To assess whether forest planning and practices adequately protect streams and associated riparian habitat and features, the investigation looked beyond compliance with plans and examined the objectives for streams and riparian areas and their achievement in the field. This required assessing the extent of impacts and alterations to streams and riparian areas that resulted from logging.

1.3.3 Are specific practices being used consistent with the best management practices outlined in the *Riparian Management Area Guidebook*?

Many of the specific practices which take place around streams and within riparian management areas are not prescribed by regulation. The *Riparian Management Area Guidebook* provides guidance on appropriate management strategies.

Part of the investigation objective was to identify the range of practices around streams and riparian areas and to determine the extent to which recommended guidebook best management practices were incorporated into site-specific plans and carried out on the ground.

1.4 Limitations to investigation findings

The investigation report is intended to provide information on the immediate impacts of forest practices around streams. The cutblocks inspected were exposed only to a maximum of one full winter after logging. Assessing any potential longer-term alterations to streams, as a result of logging activities, was beyond the scope of this investigation.

The investigation focused only on harvesting practices around streams within or immediately adjacent to cutblocks. Right-of-way harvesting around streams crossed by off-block roads and other road construction, maintenance and deactivation practices around streams outside of cutblocks were not examined.

No generally acknowledged procedures have been developed for assessing habitat values within specific riparian management areas. In the absence of clear procedures for making such assessments, this investigation was limited to measurements of the length and width of the riparian management areas and the amount of timber retained in them. No attempt was made to assess how the changes in riparian management area or amount of standing timber left affected site-specific habitat values.

Subsequent to the completion of field work and prior to the release of this report, government introduced legislative amendments to the Code effective June 15, 1998. Although this report contains some

comments on the Code changes and how they relate to the investigation findings, a complete analysis of the Code changes and how they relate to the investigation findings was not undertaken. The Board has, where appropriate, referenced in its recommendations the legislative amendments that should be considered when implementing the recommendations.

1.5 Comparison with previous studies on coastal streams

Between 1992 and 1995, the government released several reports (principally authored by Derek Tripp, who also worked on this special investigation) on forest practices conducted around streams and in compliance with the *Coastal Fisheries Forestry Guidelines*. The focus of those reports was logging activities that were carried out between 1988 and 1992. As the Board's investigation used a similar methodology, it allowed general comparisons to be made between current and pre-Code practices in respect of the level of logging-related stream alterations (see section 3.1 of this report).

2. Methodology

The data used to compile this report were collected during June and July 1997 by two field teams, each consisting of a forester and a stream biologist. Altogether, 355 stream reaches were examined in detail, representing approximately 56% of the streams within and adjacent to the sampled cutblocks. The investigation focused on stream reaches because a stream can, under the Code, have a number of reaches with different classifications.

The data collected were summarized and sent to those licensees whose cutblocks were inspected. This allowed them to review the data and provide comments on any of the findings, including pertinent information not initially available to the field teams.

2.1 Selection of stream sample

Ministry of Forests records were used to determine the number of coastal cutblocks that were substantially logged by March 31, 1997, under the full compliance requirements of the Code. Only 29 (7%) of the 430 coastal cutblocks approved and harvested since December 15, 1997 (the end of the Code's transitional provisions for site-specific plans) did not have streams within and/or adjacent to the cutblocks. The remaining 401 cutblocks had an average of six streams per cutblock.

For logistical and cost reasons it was not practical to spread the sample across all 10 coastal Ministry of Forests' forest districts. A sample of 96 coastal cutblocks was randomly selected for field assessment from within six coastal forest districts. These were the Port McNeill and South Island forest districts on Vancouver Island, Chilliwack and Sunshine Coast forest districts on the southern coast, and Kalum (Terrace) and Queen Charlotte Islands forest districts on the north coast. These forest districts were chosen because they broadly represent the range of physiographic conditions present on BC's coast.

The sample was designed to adequately portray forest planning and practices around all six classes of stream under the Code. Only cutblocks logged since the requirement for full compliance with the Code

came into effect were included in the investigation. All site-specific silviculture prescriptions and logging plans approved on or after December 15, 1995 were required to fully comply with Code requirements. The sample includes cutblocks of major licensees, small licensees and the Small Business Forest Enterprise Program.

2.2 Measurement of compliance

2.2.1 Identification and classification of streams

On each cutblock the field teams visited, an assessment was made whether all streams within and adjacent to the cutblock were identified and correctly classified. Previously unidentified streams were classified by the field teams and any impacts or alterations to the stream were recorded.

Classification of streams is based on stream width and the presence or absence of fish (the Code also allows for streams to be treated as non-fish based on stream gradient requirements set out in the Code). In community watersheds all streams are classified as if they are fish streams, regardless of fish presence or absence.

Any fish sampling reports used by licensees in classifying streams were examined by the field teams. An assessment was made regarding the adequacy of the reports supporting the classification provided for each stream. The investigators supplemented these data with stream width and gradient measurements collected during the field examination to either confirm the stream classification in the plans or determine an alternative classification.

All streams classified by the investigators were on the basis of stream reach, as set out by the Code. This recognizes that a stream can have a number of reaches with different classifications, which could include reaches classified as fish or non-fish.

2.2.2 Measurement of compliance with site-specific prescriptions and the Code

The specific practices to be carried out around streams and their associated riparian areas vary from stream to stream and in many cases are not detailed in the Code, although limitations on the range of practices are imposed. Non-fish streams in particular have few legislated requirements. For these streams the Code does not specify stream cleaning practices, retention of streambank vegetation, the direction of falling and yarding, or riparian management area timber retention levels. Licensees are required to select and state the specific practices for these items in operational plans (the silviculture prescription and logging plan). Therefore, the quality of the plans and the achievement of the practices prescribed in the plans are critical elements of compliance with the Code.

The investigation teams checked that plans set out the required elements for streams and riparian management areas and that the practices on the ground were consistent with the plans (which is a legal requirement) and consistent with other specific practice requirements of the Code. Assessing field practices involved walking along each stream reach and taking detailed notes and measurements of the practices. On average, investigators examined 130 metres of each stream reach within the sample.

In order to provide an overall picture of the level of compliance across the coast, a scorecard was developed enabling the results for each stream reach to be scored for each key compliance question – with compliance receiving a score of “1” and non-compliance receiving a score of “0.” This allowed the overall percentages of compliance to be calculated for different elements of Code compliance and for each of the six stream classes.

2.3 Use of guidebook best management practices

Guidebooks are an integral part of the Code and provide information on how to apply the Code in the field. While guidebook recommendations are not legally binding, they represent practices that should be considered. Some of the practices are not necessarily appropriate for all stream reaches and their utilization at all times would likely be undesirable or inappropriate.

For coastal streams, the guidebooks detail specific best management practices, which vary by stream class. As part of the assessment procedures, the field teams determined the extent to which the best management practices detailed in the guidebooks were used in the field by licensees. This information was collected in the same manner as information on compliance with site-specific prescriptions.

2.4 Assessment of stream and riparian management area alterations

The investigation used alterations to streams and riparian areas to measure the effects of logging. As alterations can occur under approved plans (e.g., construction of a road through a riparian management area), the compliance or non-compliance related to an alteration was recorded. The magnitude of the alteration was also recorded.

The types of alterations considered are shown in Exhibit II-1.

EXHIBIT II-1
Types of alteration recorded by field teams

STREAM

Sediment aggradation – settlement of sand and silt within the stream

Bank or sidewall erosion – erosion and sloughing of the streambanks and gully sidewalls

Channel scour – changes in the streambed as a result of debris torrents, use of heavy machinery in the stream or yarding of logs through or along the stream

Introduced or removed woody debris – introduction of logs and branches to the stream as a result of logging and removal of embedded natural windthrow and downed timber from the streambanks

RIPARIAN MANAGEMENT AREA (RMA)

Approved harvest of timber – removal of trees in accordance with an approved operational plan

Total area of riparian reserve zones and riparian management zones harvested that were meant to be retained – removal of trees in contravention of an approved operational plan or as a result of not setting up an appropriate riparian reserve zone due to stream misclassification

Windthrow of trees – the extent of blowdown of retained trees within the riparian management area

Roads and trails established within the riparian management area – the area of roads within and major trails affecting the riparian management area (the road width within riparian management zones and the clearing width within riparian reserve zones)

Road failures and slides that enter the riparian management area – the area of roads the riparian management area affected by debris from slides and road failures

Harvest of specific wildlife trees that were meant to be retained – harvest of wildlife trees within the riparian management area that were identified for retention in approved operational plans

Total area of significantly disturbed soil within the riparian management area – the area of heavy rutting and scalping (forest floor removal) within the riparian management area

Alterations to streams were based on the degree of alteration to stream habitat in the affected area and the length of the stream affected by the alteration. For example, if the channel cross-section was half full of logging debris, a score of five out of 10 would be recorded for the degree of alteration. If 10% of the length of the channel was affected by the logging debris, a score of one out of 10 would be recorded for the extent of alteration.

An overall score was then calculated as the product of the degree and extent of the alteration expressed as a percentage. The overall percentage alteration for the above example would be 5%, or $^{1}/_{10} \times {}^{5}/_{10}$. It is likely that low levels of alterations will result in little or no adverse change to stream functions. For larger alterations, the likelihood of adverse change to stream functions is higher.

2.5 Assessment of prescription effectiveness

In order to assess the extent to which compliance with the Code minimizes the level of alterations to streams and riparian areas, an assessment was made of the effectiveness of correctly carried out prescriptions in minimizing alterations. These assessments were based on the general objectives of maintaining bank and channel stability, keeping logging debris out of the stream, and protecting riparian reserve zones.

The post-logging condition of the stream was assessed to determine the effectiveness of streamside prescriptions. The prescriptions were deemed to be effective if very little or no bank scour resulted and alteration to bank or channel stability or changes in levels of woody debris in the stream were minimal. In the case of small non-fish streams with little ability to transport debris to more critical reaches, the presence of logging debris in the stream was not deemed to render the practice ineffective.

Assessments of the effectiveness of riparian management area prescriptions was limited to two key tests:

1. an assessment of the effectiveness of the riparian reserve zone in ensuring there were no or very low levels of stream alterations in larger fish streams (S1, S2 and S3); and,
2. for riparian management zones associated with fish streams, an assessment of the effectiveness of the riparian management zone in minimizing windthrow in the riparian reserve zone (a specific Code objective for the riparian management zone).

2.6 Comparison with pre-Code practices

As the methodology used in the Board's investigation is similar to the one used in the pre-Code reports principally authored by Derek Tripp, broad comparisons can be made of the level of stream alterations.

To allow comparisons with the stream data gathered in the Board's investigation, it was necessary to convert the stream classification data from the pre-Code reports to classifications under the Code. For each of the pre-Code streams, a Code classification was assigned based on the stream width, presence or absence of fish, and/or gradient.

3. Main Findings

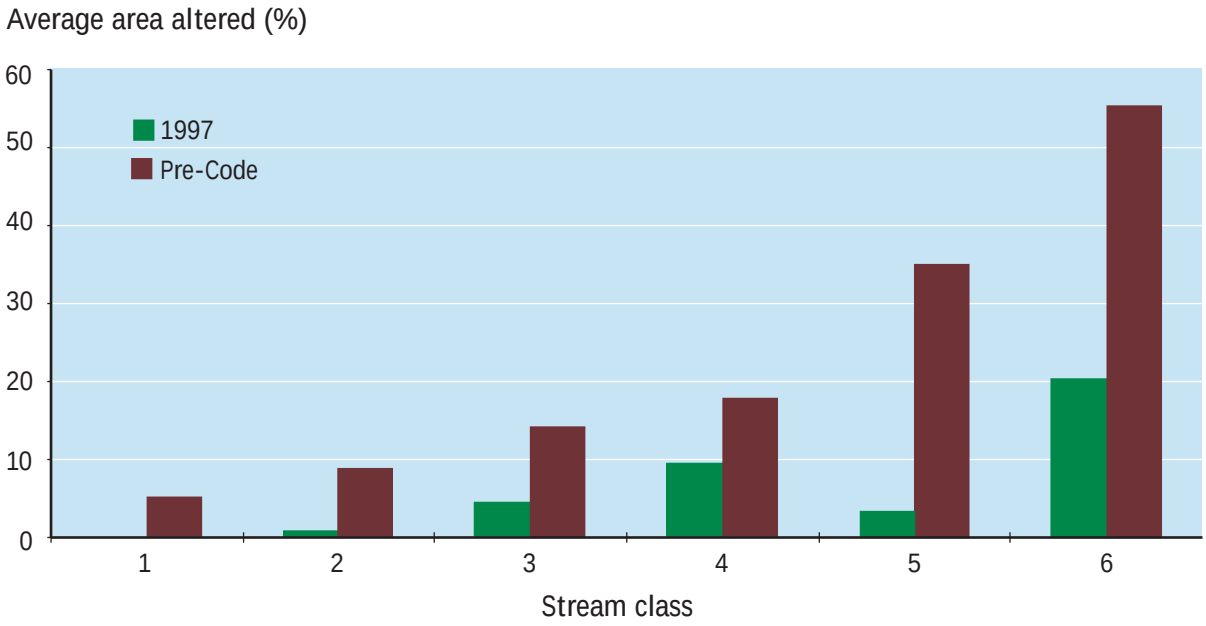
3.1 Improvement in practices under the Code

3.1.1 Stream area affected by logging activities

There has been a marked reduction in the level of logging-related alterations to streams since the period preceding Code implementation. The improvement in practices is especially evident for non-fish streams (S5 and S6), which were subject to high levels of alteration prior to the Code. The current level of alteration on large non-fish streams (S5) is lower than that experienced on any size of fish streams in the pre-Code period.

Exhibit III-1 provides details of the average percentage of total stream area altered as a result of logging operations in comparison to the pre-Code studies.

EXHIBIT III-1
Comparison of average percentage net stream area affected by logging activities under and prior to the Code



The pre-Code figures presented above are based on data collected for a series of reports published between 1993 and 1995 on the use and effectiveness of the coastal fisheries forestry guidelines (i.e., prior to the implementation of the Code). The methodology used in those reports was essentially similar to that used in the current investigation.

The cutblocks examined in the pre-Code studies were logged from 1988 to 1992. Although the cutblock data for these studies were collected up to four years post-logging, there was no indication that the longer time between logging and data collection significantly affected the recorded level of alterations (Tripp 1994). The comparison of these data with the current data should therefore be valid.

3.1.2 Reasons for improvements

The observed improvement in practices results from a number of reasons, which are described below.

- One of the most critical differences between the level of riparian protection provided under the Code and under previous legislation is the establishment of mandatory riparian reserve zones of specified widths around all fish streams of 1.5 metres and larger (S1, S2 and S3 streams). Restrictions on the cutting of timber in riparian reserve zones have practically eliminated harvesting-related alterations to these streams.
- The level of compliance with plans requiring reserves has increased. The Code sets out significant penalties and fines for non-compliance involving damage to streams.
- The Code places greater emphasis on falling and yarding away from streams where possible and on cleaning logging debris from streams after harvesting. As a result, stream alterations from falling and yarding practices (most commonly bank and bed scour and the introduction of logging debris) have declined substantially.
- Detailed planning and mapping requirements now apply to even the smallest of non-fish streams. Consequently, logging crews have become more aware of all streams, including objectives of minimizing alterations to the streams. The increased awareness also results from the emphasis placed on training by government and industry since the Code was implemented and the adoption by industry of compliance management systems to address legislation changes and minimize non-compliance events.
- It has become common practice to exclude larger streams (both fish and non-fish) from harvest areas when designing cutblock layout. This minimizes the risk of harvest-related stream alterations occurring. About 94% of fish streams and 75% of non-fish streams over five metres in width lay adjacent to, rather than within, the cutblocks sampled in the investigation.

3.2 Compliance with the Code

Measuring compliance with the Code required examining the planning requirements that were followed and the practices implemented in the field. This includes checking the identification, classification and mapping of streams, the establishment of riparian management areas, and the fulfilment of obligations set out in site-specific plans and other requirements.

3.2.1 Compliance with operational planning requirements

The operational planning process is a cornerstone of the Code as it provides the direction for all activities in the field. It also provides an appropriate forum for the public to review proposed logging activities.

For streams and riparian areas the process starts with the identification and mapping of streams in the field, which are then classified based on width, gradient and the presence or absence of fish. This information is then used in the selection of practices throughout the planning process, including the establishment of riparian management and reserve zones and the determination of appropriate logging practices around the stream. Any errors in stream classification can result in inappropriate practices being prescribed in plans.

Compliance with the content requirements of plans is both a measure of the quality of the plans and the quality of the government's approval process for plans. For a misclassified stream, a plan may be inappropriate and still meet all the content requirements, as the assumption upon which the plan is based (stream classification) is wrong.

Detailed findings on compliance with the operational planning requirements are presented and discussed below.

a) Stream and gully identification and stream classification

Overall, the level of compliance with the operational planning requirements of the Code to identify and classify streams averaged 78%. Exhibit III-2 shows that the range of compliance by stream class varied from 49% for the S3 streams to 100% for S1 streams.

The level of compliance for the identification and assessment of gullies was 89% for S5 streams and 80% for S6 streams.

EXHIBIT III-2
Compliance with the classification and assessment requirements for streams, by stream class

Planning requirement	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
Correct identification and classification of stream reaches (O.P.R. s.33 (3) (b) (i), s.39 (3))	100% 18/18	79% 23/29	49% 21/43	57% 24/42	64% 21/33	90% 171/190	78% 278/355
Correct identification and assessment of gullies (FPC Act s.17 (2) (a) (v); O.P.R. s.33 (2) (a) (iv) and, s.42 (1))	n/a	n/a	n/a	n/a	89% 8/9	80% 8/10	84% 16/19

The identification and classification of smaller fish streams (less than five metres wide) was considered the most significant problem area encountered during the investigation. The level of compliance averaged 49% for S3 stream reaches and 57% for S4 stream reaches.

The primary concern with underclassifying S3 streams is the risk of a riparian reserve zone not being established. Exhibits III-3 and III-5 show that 22 S3 streams were underclassified. However, in the field there were only 11 S3 streams that had little or no riparian reserve zone established (of which 10 had less than five percent retention of the riparian reserve zone and one with 23% retention), and four S3 streams in the 50 to 77% range for retention of the riparian reserve zone. Appropriate riparian reserve zones were established in the field for the other seven S3 streams that were underclassified, likely a result of logging crews making corrections in the field.

In reviewing the S4 streams that were underclassified as S6 streams, the primary concern was woody debris being added to the streams. The *Timber Harvesting Practices Regulation* has restrictions on the levels of woody debris that can be added to fish streams and streams capable of transporting debris into fish streams. As both S4 and S6 streams can be clearcut to

the banks, misclassification of S4 streams does not necessarily affect the level of timber retention within the management zone for these streams (see section 3.3 of this report for timber retention levels on S4 and other streams).

The identification and classification of S5 streams is less critical. Underclassification of these streams results in no differences in the amount of timber retention required for the stream reach.

In summary, streams were found to be underclassified[2] on 77 (22%) of the 355 stream reaches inspected and overclassified on 12 (3%). As stream overclassification[3] leads to a higher level of practices (i.e., more protection) than required for the correct stream class, this was not considered to create any potential environmental problem. Consequently, overclassification was not considered to constitute non-compliance. The Code tends to provide for overclassification by considering all low gradient streams to be fish streams in the absence of appropriate inventories.

The results of the examination of stream classifications are presented in Exhibit III-3.

EXHIBIT III-3
Assessment of stream classification by stream class

Stream class	Number of stream reaches assessed	Number of stream reaches correctly classified	Number of stream reaches overclassified	Number of stream reaches underclassified	Total number of stream reaches incorrectly classified
S1	18	18	0	0	0
S2	29	23	0	6	6
S3	43	21	0	22	22
S4	42	20	4	18	22
S5	33	21	0	12	12
S6	190	163	8	19*	27
All	355	266	12**	77	89

* *Streams classed as S6s by the field teams that operators had not classed as streams.*

** *There were also 25 watercourses classed as streams that the field teams determined not to be streams, according to the Code definition.*

Correct stream classification relies on three activities: stream identification (including stream location in the case of streams within community watersheds), stream measurement, and the determination of fish presence or absence, which are dealt with in turn below. The causes of stream misclassification are summarized in Exhibit III-4.

Stream identification

The field teams found a total of two unidentified fish streams and 20 unidentified non-fish streams on the 96 blocks inspected.

2 Underclassification occurs when a stream is shown as being of a lower class in the plan than its correct classification (e.g., an S3 stream might have been misclassified as an S4 or S6 stream).

3 Overclassification occurs when a stream is shown as being of a higher class in the plan than its correct classification (e.g., an S3 stream might have been misclassified as an S2 stream).

These unidentified streams were primarily small streams, averaging 1.45 metres in width and 19 centimetres in depth. Failure to identify these streams resulted in a noticeably higher level of alteration in these streams compared to similar size streams that were identified.

A further two fish streams and one non-fish stream were marked on plans but not classified or provided with a prescription.

Conversely, the field teams found that one fish stream and 24 non-fish streams identified as such in plans were not streams.

EXHIBIT III-4
Causes of stream misclassification

Cause of misclassification	Number of stream reaches		
	Fish streams	Non-fish streams	Total
Stream not identified	2	20	22
Stream identified but not classified	2	1	3
Stream measurements incorrect	15	18	33
Lack of fish inventories	18	–	18
Inadequate fish inventories	13	–	13
All	50	39	89

This variability in the identification of small streams is likely in part a result of the way streams are defined in the Code, which does not clarify the point at which a seepage becomes a stream. In the absence of more detailed guidance, inconsistent interpretations of the legislation were applied by professionals from a variety of backgrounds and with varying degrees of training.

In addition, many smaller streams do not flow year round, increasing the difficulty for identification and assessment.

Stream measurement

Incorrect measurements were responsible for 33 of the stream misclassifications. Likely causes for this are:

- An inadequate number of width measurements being taken (six measurements are recommended, spaced at the width of the stream, in order to reflect one pool/riffle sequence).
- Use of average gradients to justify non-fish status when the lower portion of the stream was a separate low gradient reach, which should be classified as a fish stream.
- Use of incorrect width measurement techniques. It appears that some measurements were based on the wetted width of the stream, which is used in determining the culvert size but can provide a substantially different figure than bankfull width used for determining classification.

Determination of fish presence or absence

No clear pattern was established between the likelihood of stream misclassification and the location of the cutblock in relation to known fish streams. Errors in the determination of fish presence or absence occurred on cutblocks with known fish streams and on cutblocks with no known fish streams.

Of the streams examined:

- 38% (of 136) streams were classified on a default (gradient) basis. Of these streams, 96% were appropriately classified with respect to fish presence/absence.
- 44% (of 155) streams were classified based on some form of inventory. Of these streams, 92% were appropriately classified with respect to fish presence/absence.
- 18% (of 64) streams either had no inventory or the method of determining fish presence/absence was unclear.

There were 33 streams incorrectly classified as non-fish streams. Of these, 18 had no inventory and 13 had inadequate inventories. The remaining two misclassified streams were based on incorrectly assessed gradients that were higher than actual when defaulting streams with a 20% or greater gradient to non-fish status.

The concern arising from these figures is the number of plans approved in the absence of fish inventories. Where fish inventories were gathered, they were generally acceptable. In cases where inventories were found unacceptable, it was generally due to inadequate temporal or spatial sample coverage, such as the use of insufficient fry traps to classify a reach (e.g., one fry trap).

It should be noted that at the time of this investigation there were no minimum standards for documenting fish inventory procedures and no accepted standard for fish inventory reports. Recommendations on report formats in the *Fish Stream Identification Guidebook* had not been widely implemented. Inventories were only required to meet the test of being acceptable to the district manager. Subsequent changes to the *Operational Planning Regulation* have inserted a requirement to carry out inventories in accordance with the *Fish Stream Identification Guidebook*. This amendment should lead to reduced potential for inadequate inventory work to go unnoticed and for plans to be approved with incorrect stream classifications.

Stream misclassification was the major factor leading to area alterations on fish streams (S1, S2, S3 and S4), accounting for 56% of the stream area altered on fish streams. Misclassification was not a major factor behind stream alterations on non-fish streams. Exhibit III-5 summarizes the impact of stream misclassification.

EXHIBIT III-5
Assessment of the impact of stream misclassification by stream class

Stream class	Number of stream reaches incorrectly classified	Number of stream reaches with instream alterations as a result of misclassification	Number of stream reaches with inadequate riparian reserve zones as a result of misclassification
S1	0	0	0
S2	6	0	2
S3	22	6	15
S4	22	7	N/A
S5	12	1	N/A
S6	27	9	N/A
All	89	23	17

b) Plan content requirements

Compliance with plan content requirements by stream class is shown in Exhibit III-6. The assessments were based on the content requirements in the Code for the stream classification provided in the plan, whether or not the classification was correct. If assessments were based on the correct classification, as determined in the field by the investigation field teams, the level of compliance with the planning requirements would be lower as some planning requirements would not be met. For example, an S3 stream misclassified as an S6 stream would not have the correct riparian management area widths or a riparian reserve zone as a result of the stream being misclassified.

EXHIBIT III-6
Plan compliance with the content requirements of the Code by stream class

Planning requirement	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
The plan contains the required riparian management zone and riparian reserve zone for the classification set out in the plan for the stream reach (O.P.R. s.33 (3) (b) (ii) and(iii) and, s.39 (3) (ii) and (iii)) (Note: This assessment assumes that once a stream classification is determined, correctly or incorrectly, the Code requirement for the classification is followed).	94% 17/18	100% 23/23	96% 27/28	100% 30/30	97% 32/33	95% 212/223	96% 341/355
Streambank and channel stability provided for on key tributaries; (O.P.R. s.45)	n/a*	n/a*	n/a*	100% 3/3	88% 14/16	100% 13/13	94% 30/32
Falling and yarding direction in the vicinity of the stream reach is stated in the plan (O.P.R. s.33 (3) (g) (i) (A))	n/a*	n/a*	n/a*	100% 15/15	87% 13/15	82% 142/174	83% 170/204
Practices proposed in the riparian reserve zone and riparian management zone are stated in the plan (O.P.R. s.39 (3) (ii) and (iii) and s.44 (a) and(b))	100% 18/18	96% 22/23	96% 27/28	100% 30/30	97% 32/33	100% 223/223	99% 352/355
Strategies for debris management are stated in the plan (O.P.R. s.33 (3) (g) (i) (A))	n/a*	n/a*	n/a*	100% 14/14	93% 14/15	88% 154/175	89% 182/204
Strategies for protecting the streambank and minimizing damage to understorey vegetation are detailed in the plan (O.P.R. s.33 (3) (g) (i) (B))	n/a*	n/a*	n/a*	89% 25/28	88% 28/32	81% 160/198	83% 213/258

* *Items are not applicable as a riparian reserve zone is established and these practices do not occur within a reserve zone.*

Determination of riparian management area width

The width of riparian management areas are set by regulation. There was a high level of compliance (96%) in setting up the required riparian management area widths in plans. Of the 96 coastal cutblocks examined, two cutblocks were approved with pre-Code classifications and no specified riparian management area widths.

Management practices proposed for riparian areas

Operational plans showed an average compliance of 91% with the specific planning requirements for describing logging practices around streams: provisions for streambank and channel stability on key tributaries; strategies for falling and yarding; practices within the riparian reserve and management zones; and strategies for debris management and streambank protection.

The required format of operational planning documents changed dramatically with the introduction of the Code. Historically plans were required to document harvesting constraints. Plans under the Code must document the harvesting activities being undertaken in considerably greater detail.

The level of compliance with the operational planning requirements, while high, indicates that there are still some plans that only document constraints. This was primarily in relation to non-fish streams.

3.2.2 Compliance with field requirements

Assessing compliance on the ground involved a determination of whether:

- an appropriate reserve zone was maintained in the field, based on the investigation field team's assessment of the stream class;
- practices in the field were carried out in accordance with the approved plan; and
- practices carried out in the field were in accordance with the *Timber Harvesting Practices Regulation*, which sets out general protection requirements around streams (e.g., retention of streamside trees; constraining slash and debris in and around aquatic environments).

a) Compliance with riparian reserve zone and riparian management zone requirements

Riparian reserve zone requirements

Maintenance of the riparian reserve zone is the single most important element of compliance with the Forest Practices Code for S1, S2 and S3 streams. An intact reserve zone will protect the stream from harvest-related alterations and provide habitat in the vicinity of these streams.

The overall level of compliance in the protection of riparian reserve zones was 77% (Exhibit III-7), averaging from 65% for S3 streams to 89% for S1 streams. Where non-compliance occurred, it was generally because of harvesting within the reserve zones of misclassified streams. Excepting stream misclassification as a factor, the investigation found the level of compliance with riparian reserve zone requirements at 91%.

The 89% level of compliance on S1 streams is a result of two S1 streams where harvesting had occurred within the riparian reserve zone. One had only 43% retention of the required reserve zone while the other had 98% retention of the reserve zone. Retention of the reserve zone on the other 16 S1 streams either met or exceeded Code requirements.

On the S2 streams there were four streams with lower retention of the reserve zone than required by the Code, with two at 33% and 49% retention and two with 87% and 97% retention.

On S3 streams, 16 of the 43 streams did not have the required riparian reserve zone. Of these, 10 had 5% or less retention. Misclassification was the main cause of the non-compliance in 15 of the 16 cases.

EXHIBIT III-7
Compliance with the riparian reserve zone requirements of the Code by stream class

Planning requirement	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
Riparian reserve zone maintained as required (FPC Act s.67 (1) (e) and (f))	89% 16/18	86% 25/29	65% 28/43	n/a	n/a	n/a	77% 69/90

Riparian management zone requirements

Riparian management zone activities were found to have 84% compliance overall (Exhibit III-8), with the level of compliance being higher on fish streams and lower on non-fish streams. The most common cause of non-compliance was the failure to leave non-merchantable timber when required by the prescription. In some cases this was due to the development and approval of prescriptions which followed specific guidebook recommendations that were not actually achievable on the ground (e.g., prescriptions to retain all non-merchantable timber within the riparian management area are extremely hard to achieve given the methods of falling and yarding in coastal terrain).

EXHIBIT III-8
Compliance with the requirements of approved plans, by stream class

Planning requirement	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
Riparian management zone maintained as prescribed (FPC Act s.67 (1) (e) and (f))	94% 17/18	93% 27/29	98% 40/41	89% 34/37	80% 24/30	79% 126/164	84% 268/319
Streambank retention achieved as prescribed (FPC Act s.67 (1) (e) and (f))	n/a*	100%* 3/3	94%** 15/16	89% 24/27	77% 20/26	71% 91/129	76% 153/201
Stream cleaning carried out as prescribed (FPC Act s.67 (1) (e) and (f))	n/a*	n/a*	83%** 10/12	100% 19/19	64% 9/14	77% 102/132	79% 140/177
Falling and yarding carried out as prescribed (FPC Act s.67 (1) (e) and (f); T.H.P.R. s.7 (1), s.8(1))	n/a*	n/a*	78%** 7/9	100% 20/20	100% 13/13	86% 117/136	88% 157/178

* *Items are not applicable as a reserve zone was established and these practices are not necessary within a reserve zone.*

** *In certain cases, a reserve zone was not established due to stream misclassification. In these cases, we assessed for compliance the streamside harvesting practices contained in the prescription.*

Overall comments on riparian management areas

Failure to follow the prescription was not a significant factor in the level of riparian management area alterations. Most riparian management area alterations occurred under approved plans – the most common being timber harvest and road construction. The main non-compliance-related alteration was the removal of timber required to be retained which affected, on average, approximately 3% of the riparian management area.

b) Compliance with streamside prescriptions

Streamside prescriptions apply to all S4, S5 and S6 streams (the larger S1, S2 and S3 streams are protected by riparian reserve zones, so normally there should be no streamside harvesting activities). The prescriptions are intended to provide a reasonable level of protection to these streams and to minimize the risk of downstream impacts on larger fish streams. Overall, the level of compliance with these elements of plans was approximately 81% (Exhibit III-8). In general, the level of compliance was lowest on small non-fish streams.

While falling, yarding and stream cleaning practices were responsible for much of the non-compliance, the poor quality of planning caused non-compliance in situations where the practices on the ground were acceptable. The most prevalent of these reasons are listed below:

- A number of plans set out prescriptions that could not be achieved in the field, such as retention of all streamside vegetation where cross-stream yarding was permitted. Although these prescriptions resulted in non-compliance, we found that, in many cases, appropriate practices occurred on the ground.
- Plans and prescriptions that were too general in nature to indicate the licensee's intention – such as "remove logging debris from streams" when the licensee's intention was to remove debris only from those streams that were likely to transport debris downstream.

Non-compliance with the prescription was only a minor factor in the level of stream alterations on fish streams (S1–S4). Of the very low levels of stream alterations observed, only 4% of these occurred as a direct result of failure to follow the prescription and only 1% occurred on correctly classified fish streams. Where stream alterations occurred, it was either due to post-harvest windthrow or related to inappropriate prescriptions or practices as a result of misclassification.

The higher levels of compliance with prescriptions around small fish streams (S4) is notable – at approximately 95%. However, it should be noted that the prescriptions for these streams were not always appropriate due to the levels of misclassification of small fish streams previously discussed (seven of the 42 S4 stream reaches had in-stream alterations as a result of misclassification).

For non-fish streams, non-compliance played a more significant role in the level of stream alterations. Non-compliance was involved in 44% of stream alterations on S5 streams and in 43% of stream alterations on S6 streams (section 3.3 provides details of the types and causes of alterations).

c) Compliance with the requirements of the *Timber Harvesting Practices Regulation*

There were uniformly higher levels of compliance with the requirements of the *Timber Harvesting Practices Regulation* as shown in Exhibit III-9. These requirements are based directly on stream alteration levels which have reduced substantially since the period prior to Code implementation (see section 3.1).

EXHIBIT III-9
Compliance with the requirements of the *Timber Harvesting Practices Regulation* by stream class

Planning requirement	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
Stable material left in place in stream reaches (unless removal allowed by the logging plan) (T.H.P.R. s.11)	100% 18/18	100% 29/29	100% 43/43	100% 42/42	100% 33/33	100% 190/190	100% 355/355
Harmful amounts of slash and debris not deposited in lakes, wetlands, fisheries-sensitive zones, marine-sensitive zones, fish streams, streams with known down-stream domestic water users, unstable gullies and streams capable of transporting debris into such areas (T.H.P.R. s.15)	100% 18/18	97% 28/29	98% 42/43	86% 36/42	88% 15/17	82% 9/11	93% 148/160
Removal of temporary stream crossings and avoid-ance of damage to stream by ground-based machinery (T.H.P.R. s.12, 16)	100% 18/18	100% 29/29	100% 43/43	98% 41/42	100% 33/33	99% 188/190	99% 352/355

d) Compliance with road construction, maintenance and deactivation requirements (in-block roads)

While a thorough investigation of compliance with road construction, maintenance and deactivation plans was not the focus of this investigation, stream and riparian manage-ment area alterations resulting from in-block road activities were recorded. The *Forest Road Regulation* requires that transport of sediment from the road prism (area containing road surface, cutslope and fillslope) and its effects on other forest resources be minimized.

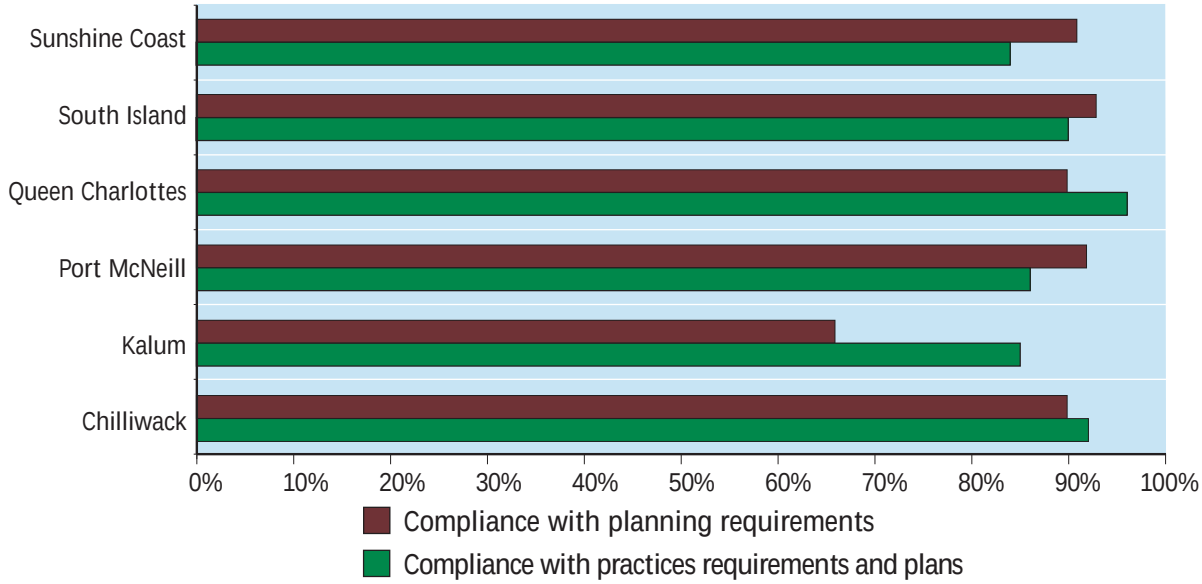
Overall it appeared that this objective was being achieved as there were very few road-related problems identified around the streams inspected. Road-related activities affected less than 1% of the stream area inspected for all stream classes except the small non-fish streams (S6), where they affected approximately 2% of the stream area. The most common form of alteration was localized sediment and scour immediately downstream of culverts. In only 12 cases was the alteration greater than 25 square metres. Of these 12 stream reaches, four were fish streams and eight were non-fish streams.

3.2.3 Compliance by district

The overall compliance data for the licensees and the Small Business Forest Enterprise Program in each forest district is presented in Exhibit III-10.

The results indicate some variability between districts in the level of compliance achieved. The level of compliance achieved in each district reflects both the performance of the licensees preparing and carrying out the plans and the regulatory agencies approving the plans. An analysis of the reasons for the variability in district results was not part of the scope of this investigation.

EXHIBIT III-10
Compliance with planning and practices requirements



3.3 Protection of streams and riparian areas

This section summarizes the investigation findings on the level of alterations to streams and riparian areas that occurred due to logging and the extent to which compliance with the Code minimizes those alterations.

3.3.1 Streamside practices

Assessments of prescription effectiveness for streamside practices were based on the general objectives of maintaining streambank and channel stability, and keeping logging debris out of the stream. In the case of small non-fish streams with little ability to transport debris to more critical reaches, the presence of logging debris in the stream was not considered to render the practice ineffective.

When followed, the prescriptions examined achieved a high level of effectiveness in protecting in-stream values, indicating that the Code successfully mitigates short-term harvesting-related alterations to streams. Exhibit III-11 below provides details on the effectiveness of the three key streamside practices where a specific prescription was developed and followed.

EXHIBIT III-11
Effectiveness of approved prescriptions in minimizing stream alterations

Planning requirement	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
Stream cleaning practices carried out	n/a*	n/a*	n/a*	100% 18/18	89% 8/9	96% 97/101	96% 123/128
Falling and yarding practices carried out according to plan	n/a*	n/a*	n/a*	94% 17/18	100% 14/14	86% 98/114	88% 129/146
Streambank vegetation retained	n/a*	n/a*	n/a*	100% 27/27	100% 22/22	97% 87/90	98% 136/139

The stream alterations observed were the result of a number of factors, being:

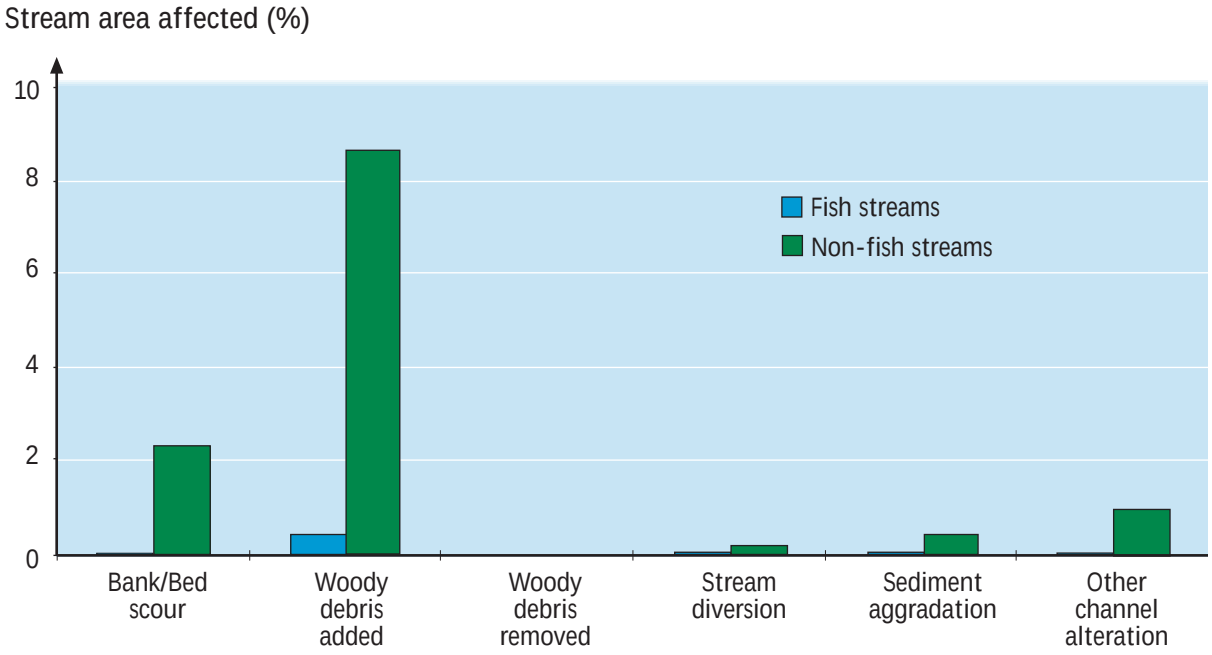
- Alterations acceptable to the licensee and regulatory agencies and approved in operational plans (such as leaving logging debris in a non-fish stream that has no ability to transport the debris downstream to fish reaches).
- Changes resulting from post-harvest events (such as windthrow-related streambank damage).
- Unacceptable changes as a result of non-compliance practices (such as streambank damage caused by yarding across a stream in contravention of the plan).

Although 278 alterations were observed on 182 streams, over half of the alterations were small – no greater than 25 square metres in size. An example of the most common type of alteration provides a sense of scale: two 15 metre logs of one metre diameter observed lying in a stream is a 30 square metre alteration. Another 89 alterations can be described as moderate, between 25 and 100 square metres.

Only 35 alterations exceeded 100 square metres – six were on fish streams and 29 were on non-fish streams, mainly S6 streams. Of these, 25 (71%) involved woody debris. These larger alterations accounted for 55% of the total stream alterations for both fish and non-fish streams.

The types of alteration are presented in Exhibit III-12. The addition of logging debris to streams was by far the most prevalent alteration, occurring primarily on non-fish streams.

EXHIBIT III-12
Stream alterations by alteration type for fish streams and non-fish streams



Causes of alteration

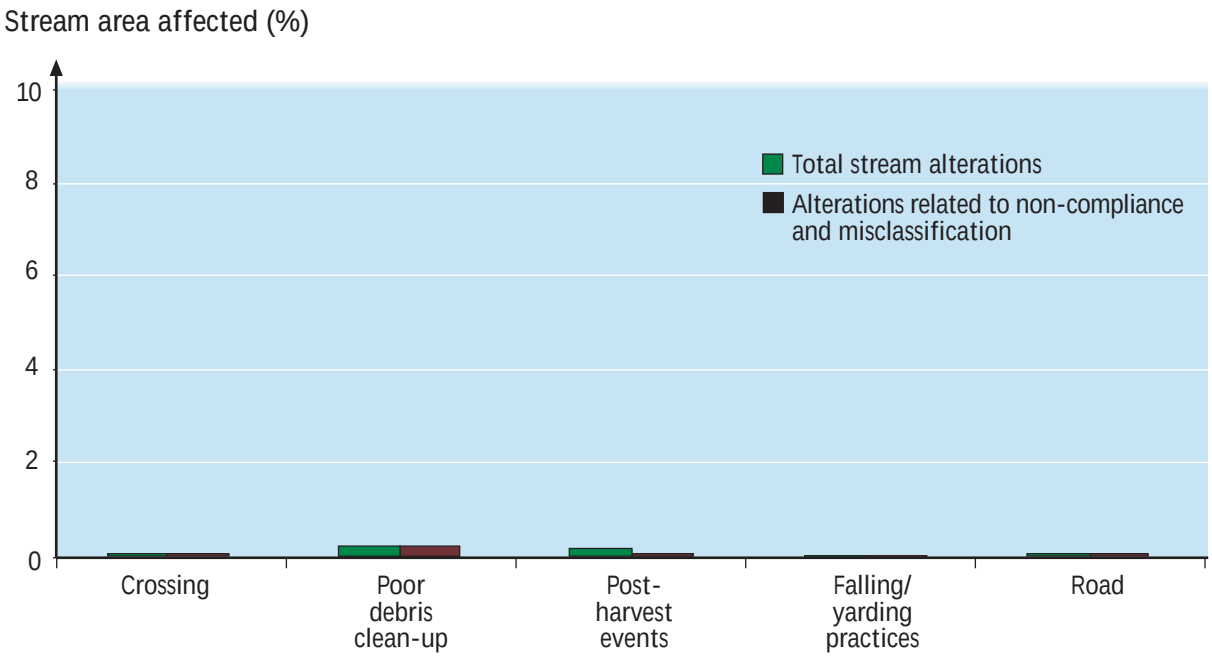
The critical factor leading to stream alterations varied according to the class of stream. The causes of alterations are presented in Exhibits III-13 and III-14 below.

The information presented in this report relates only to the areas inspected by the investigation field teams. As the field teams restricted their work to streams within and adjacent to cutblocks, the full length of the streams was not examined or estimated. Consequently, the level of alterations reported in this investigation cannot be used to estimate the level of alterations as a portion of the full lengths of the streams examined, which would be expected to be substantially lower.

Fish streams

Where stream alterations did occur on fish streams, most relate to misclassified streams which were treated as non-fish streams. The main cause of alteration was the failure to remove logging debris from the stream. The average alteration was about 0.5% of the stream area inspected, ranging from 0% for S1 streams to 10% for S4 streams.

EXHIBIT III-13
Stream area altered by cause of alteration for fish streams

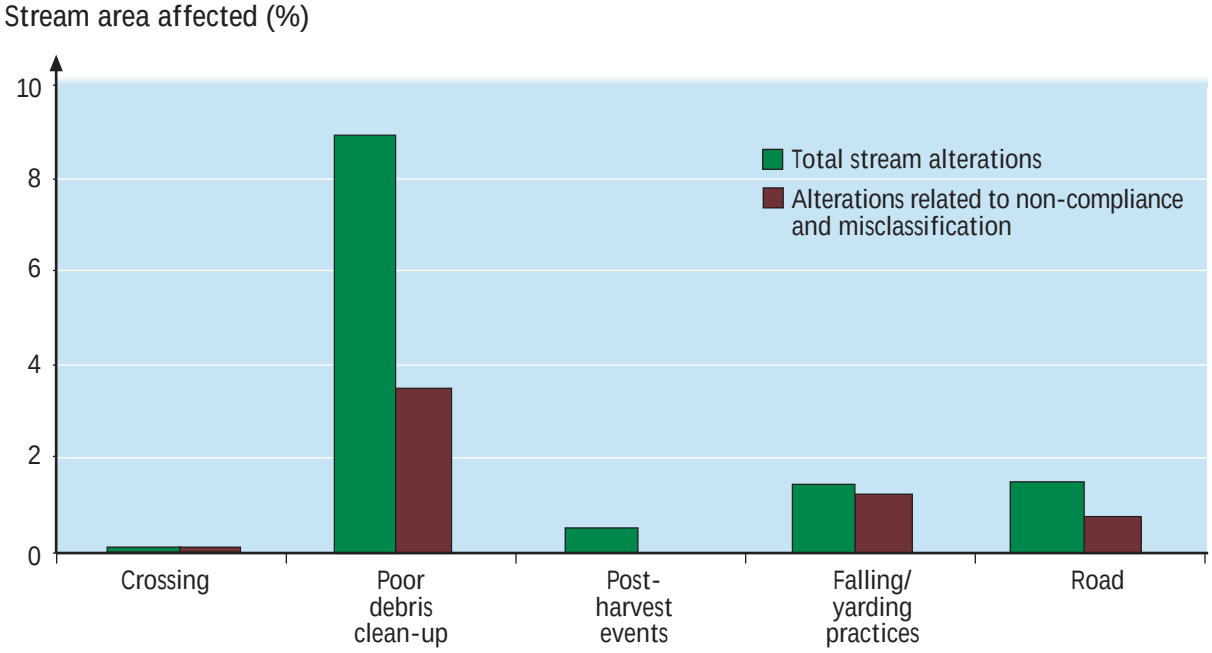


Non-fish streams

The level of alterations on large non-fish (S5) streams was low due to the high levels of timber retained around these streams. The altered areas were primarily related to non-compliance events (44%) and post-harvest windthrow (33%).

On the smaller non-fish streams (S6), the majority of altered areas occurred under compliance with approved plans (64%), reflecting the less stringent requirements for these streams.

EXHIBIT III-14
Stream alterations by cause of alteration for non-fish streams



Stream alterations on non-fish streams resulted primarily from logging debris left within the channel. The majority of this was allowed for within approved plans. About 40% of the logging debris was left in stream reaches with the ability to transport debris downstream.

Falling and yarding-related bank or channel scour was the next most frequent cause of alteration, although this affected less than 2% of the stream channel area inspected. This is considered to be a very low level of alteration, given that cross-stream yarding, which involves the log making contact with the streambanks during yarding, was allowed to some extent on 54% of non-fish streams.

Road-related alterations, consisting primarily of sediment deposition and sidecast, were the only other common cause of alteration, although these were generally minor alterations. For the purposes of this Exhibit, non-compliance events were taken to be those events that led to greater than 100 square metres of material being deposited in the stream reach. This was identified in only three cases.

3.3.2 Practices in riparian management areas

a) The purpose of the riparian management area

The concept of riparian management area under the Code is based on the recognition of two key functions:

- Riparian management areas can act as a protective zone between the stream and the cut-block, and are an integral part of the stream ecosystem.
- Riparian management areas contain valuable habitat for plants and animals in their own right.

The *Riparian Management Area Guidebook* provides a reference source for developing riparian management area practices appropriate for the protection of streams. However, there is no similar source of guidance for developing practices appropriate for the protection of riparian habitat itself. Objectives for the maintenance of key habitat within riparian management areas are generally unclear within the Code. The only guidance given are recommendations for various levels of timber retention in riparian management areas. These recommendations are not linked to any specific habitat values in the riparian management area, but to the width of the stream and its use by fish.

No generally acknowledged habitat assessment procedures have been developed for assessing the habitat value within specific riparian management areas. In the absence of clear guidance and procedures on habitat assessment it is unclear where licensees are expected to employ special practices to address riparian habitat values and what these practices should be.

There is a need for better guidance on the habitat objectives for riparian management areas, especially for the riparian management zones, where practices are largely discretionary.

Given the scope of the investigation, the development and use of adequate habitat assessment techniques was not practical. Alterations to riparian management areas were documented in detail to provide a picture of what is actually happening within riparian management areas on the coast.

A key element of the assessment was the comparison between actual levels of retention within riparian management areas and the maximum level of retention recommended within the *Riparian Management Area Guidebook*. While the maximum recommended levels of retention

do not actually address specific habitat goals, they do represent a government recommended limit on the maximum level of retention afforded to riparian management areas within BC, which incorporates both biological and socio-economic considerations.

b) Effectiveness of riparian management areas practices in protecting the stream and riparian reserve zone

For the purposes of this investigation, the riparian reserve zone was considered to be effective in protecting stream values if the level of stream alteration on the inspected stream reach was less than one percent. This was achieved on all S1 and S2 streams and on 88% of S3 streams where a reserve zone was established (see Exhibit III-15 below). Similarly, if there was less than 1% blowdown of timber[4] in the riparian reserve, the riparian reserve zone was considered to be adequately protected by the riparian management zone. This was found to occur in all cases for S1, S2 and S3 streams. However, it should be noted that the cutblocks inspected had only recently been logged. Therefore, a proper assessment of the adequacy of protection of riparian reserve zones from blowdown events can only be made after several years have passed.

EXHIBIT III-15
Effectiveness of approved prescriptions in minimizing stream and riparian reserve zone alterations

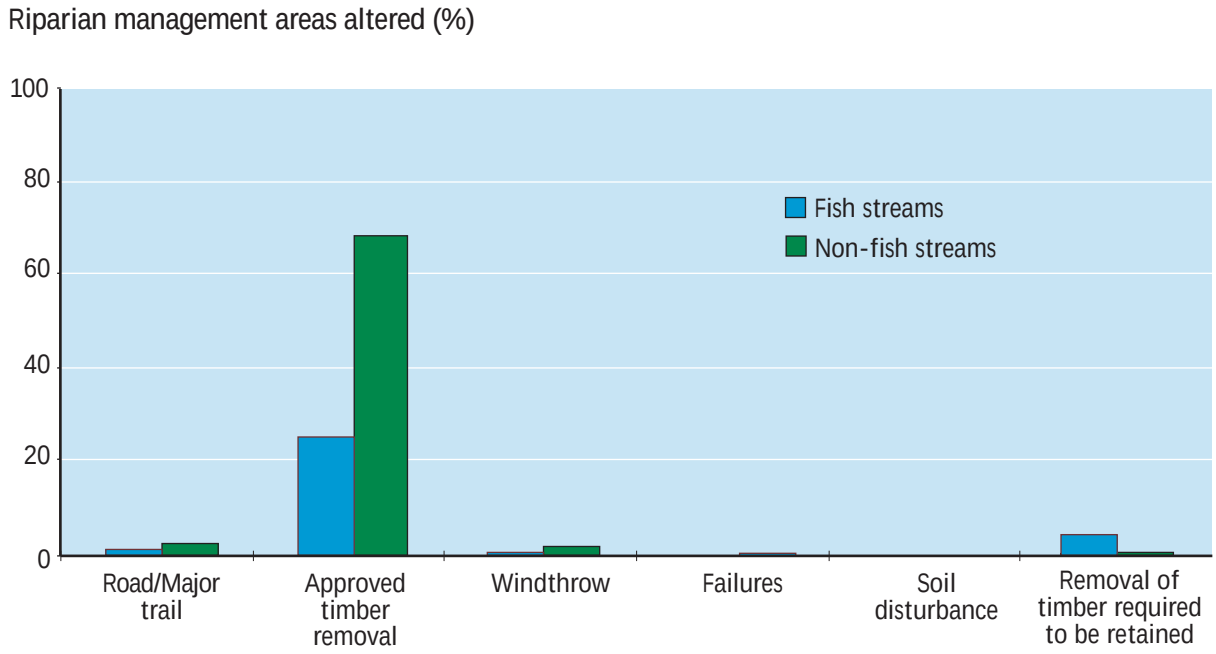
Planning requirement	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
Use of riparian reserve zone to protect stream was effective	100% 16/16	100% 21/21	88% 23/26	n/a*	n/a*	n/a*	95% 60/63
Use of riparian management zone to protect riparian reserve zone was effective	100% 16/16	100% 21/21	100% 26/26	n/a*	n/a*	n/a*	100% 63/63

c) Riparian management practices

Timber harvest was the most common change in riparian management areas. Other changes, such as windthrow and road construction, were all minor in comparison. Exhibit III-16 below shows the level of alteration by type of alteration for fish streams and non-fish streams.

4 It is recognized that 1% is well within the range of natural blowdown to be expected in an undisturbed coastal riparian ecosystem. Given the short time since logging, little post-harvest blowdown should have occurred.

EXHIBIT III-16
Alteration levels in riparian management areas of fish streams and non-fish streams

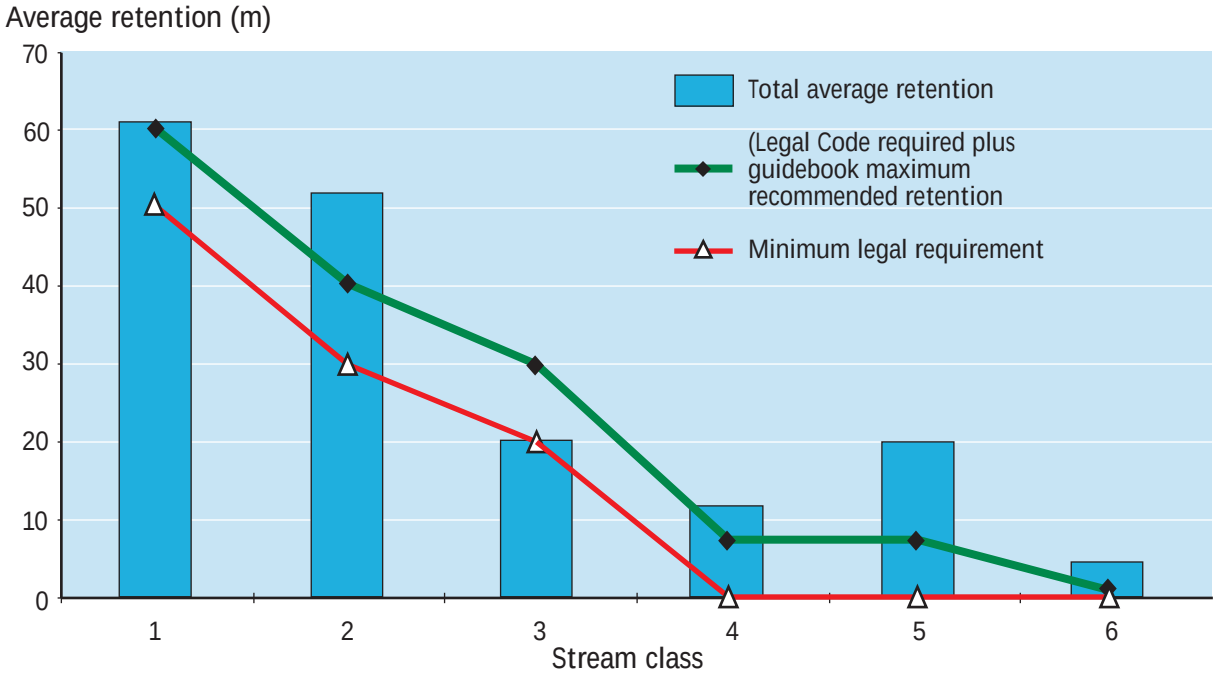


As the major types of alteration (e.g., timber harvest and road construction) within riparian management zones were approved, the level of alteration was not greatly influenced by non-compliance events, which led on average to a 3% alteration within riparian management areas. This is only a small proportion (6%) of the total alterations to riparian management areas. The non-compliance events related almost entirely to the harvest of timber prescribed for retention and the harvest of areas on misclassified streams that required riparian reserve zones based on the classification performed by the investigation field teams.

On average, the overall timber retention rates within riparian management areas exceed the sum of the legal Code requirement for riparian reserve zones plus the maximum recommended levels of retention in the *Riparian Management Area Guidebook* for management zones for five of the six stream classes (see Exhibit III-17 below). The anomaly in retention levels with respect to S3 streams, which on average met, but did not exceed the minimum legal requirement, is a result of misclassification of a number of these streams, which led to the harvest of part or all of the required riparian reserve zones, reducing the average level of retention in the riparian management area.

The limitation of reviewing Exhibit III-17 is that it provides information on averages. Section 3.2 provided information on the variability in the level of retention for the riparian reserve zones. The variability in the level of retention for the management zone ranges from it being clearcut to 100% retention. The average level of retention for each stream class can be calculated from Exhibit III-17, this being the difference between the total average retention less the legal Code required.

EXHIBIT III-17
Average retention levels within riparian management areas by stream class



The variability in the level of retention between individual streams within a stream class was considerable. In many cases, the riparian reserve zone established in the field was greater than the minimum required reserve zone. However, approximately 20% of fish streams, primarily S3 and S4 streams, and 56% of non-fish streams, mostly S6 streams, received less than 5% timber retention within the riparian management area.

Average timber retention on S5 streams far exceeded the recommended maximum retention, indicating a preference for staying away from these generally high transport streams. In the field, there was often significant retention along these streams, even where it was not required in the plan.

It should be noted that, by the time of this investigation, more blowdown occurred in the retained timber along S5 and S6 streams (4% and 8% respectively) than on any of the classes of fish stream which have mandatory riparian reserve zones. Although the level of blowdown is still small, the effectiveness of these generally narrow retained patches of timber should be monitored over time to determine whether they will stand up to the regular storm events seen on the coast.

3.4 Guidebook best management practices

The *Riparian Management Area Guidebook*, which was published jointly by the Ministry of Forests and the Ministry of Environment, Lands and Parks in December, 1995, contains recommended practices for activities around streams and retention levels in riparian management areas specific to individual stream classifications. As this investigation was based on plans approved after December 15, 1995, some of the plans were developed in the absence of the guidebook. However, while the lack of a guidebook during the development of the early plans is clearly a factor, it remains useful to examine the extent to which the guidebook recommended practices have been used in the field.

3.4.1 The purpose of guidebook best management practices

Guidebook best management practices were developed to help licensees design practices that minimize alterations to streams and riparian habitat within the constraints of a maximum impact on the available timber supply. While guidebook recommendations are not legally binding, they represent practices that should be considered. Some of the practices are not necessarily appropriate for all stream reaches and their utilization at all times would likely be undesirable or inappropriate.

3.4.2 Utilization of guidebook best management practices

The extent to which key guidebook best management practices were used is detailed in Exhibit III-18 below.

EXHIBIT III-18
Utilization of key guidebook best management practices by stream reach

Guidebook recommended practice	Stream class						
	S1	S2	S3	S4	S5	S6	All classes
Stream cleaning practices consistent with or exceed recommendations	n/a*	n/a*	n/a*	67% 16/24	71% 12/17	89% 151/170	85% 179/211
Falling and yarding practices consistent with or exceed recommendations	n/a*	n/a*	n/a*	80% 20/25	89% 16/18	82% 138/168	82% 174/211
Retention of streambank vegetation consistent with or exceed recommendations	n/a*	n/a*	n/a*	60% 24/40	82% 27/33	36% 61/170	46% 112/243
Retention within riparian management zone consistent with or exceed recommendations	100% 18/18	90% 26/29	72% 31/43	66% 27/41	82% 27/33	41% 78/190	58% 207/354

The high level of utilization of the stream cleaning and falling and yarding recommendations is reflected in the high level of effectiveness of these prescriptions, as already discussed, and the lower levels of stream alterations found in the field.

It is notable that recommendations for the retention of streambank vegetation have not been widely used on S6 streams. This is perhaps to be expected given that cross-stream yarding is an acceptable practice in the guidebook for many of these streams and due to its nature, cross-stream yarding makes retention of streambank vegetation very difficult.

Recommendations on retention of timber within the riparian management zone of S6 streams also appear to be not widely utilized. This is surprising, given the fact that average retention levels on S6 streams exceed the recommended maximum retention levels by approximately a factor of two. This shows that it is more common to leave larger amounts of timber on a small number of streams than to leave small amounts of timber on all small streams.

4. Recommendations

A. General

Government should develop objectives for identifying and managing key riparian habitat to ensure that protection measures are focused on the critical habitat.

In the development of plans, industry and government need to ensure stream transport potential is adequately considered in developing streamside prescriptions.

Government needs to develop clear guidelines around the way in which descriptions of practices that will be carried out in riparian management zones are set out in site-specific plans.

The Ministry of Forests should prepare guidance to licensees at the regional or district level on their interpretation of the *Timber Harvesting Practices Regulation* to ensure that the level of stream alterations which are considered acceptable is clear.

B. Stream identification and classification

Government should establish a standard format for stream classification reports to ensure that all appropriate information is presented in the reports.

Government should provide licensees with district- or region-specific information on appropriate fish sampling procedures and the required intensity of sampling, and make the guidance readily available to those conducting assessments.

Government should review the recent Code changes to the definition of a stream to ensure that adequate guidance is provided about when a seepage becomes a stream.

Government and industry should establish training requirements for individuals conducting stream classification work.

Government should be responsible for identifying temperature sensitive streams on the coast, so that site-specific plans can take into account the special requirements around these streams.

C. Selection of forest practices

1. Falling and yarding direction – generic prescriptions

Strict adherence to “fall and yard away” or “fall and yard across” requirements in planning documents leads to a lower standard of practice on the ground for small non-fish streams (through an increase in the “fall and yard across” prescription). Government should allow more flexibility in the use of “fall and yard away where possible” as this best reflects the reality of clearcut logging around small streams. Results should be judged in relation to the level of disturbance to the stream and streambanks not the specific direction of falling and yarding.

2. Stream cleaning

Where possible, stream cleaning should be conducted concurrently with yarding operations. Stream cleaning carried out after logging slash had been left in the stream for a winter is less effective due to the breakdown of larger debris and the formation of debris jams during high winter and spring run-off periods, increasing the likelihood of stream diversions and changes in channel morphology occurring before stream cleaning is complete.

D. Government approval of operational plans with streams

1. Review of stream classification reports

Government must ensure stream classification reports are prepared in all instances before approving operational plans. Where the operational plan covers an area with all streams having an average gradient greater than 20% and classifications are based on a default basis, this information must be set out clearly in the plan or an attached report.

E. Follow-up assessments

Government and industry should consider undertaking follow-up assessments, including that of blowdown, on some of the streams selected in the investigation to monitor the effects of specified forest practices over a longer time span.

Appendix A Methodology

A. Sample size and distribution

1. Sample size

In order to generate information on the population of coastal cutblocks logged under full compliance with the Code, each of the Ministry of Forests district offices along the BC coast (see Exhibit A-1 below) was contacted and asked to provide a listing of all cutblocks approved after December 15, 1995, which were harvested or substantially harvested by March 31, 1997. The date of December 15, 1995, was chosen as this was the date when cutblock-specific silviculture prescriptions were required to be in full compliance with the Forest Practices Code.

For each cutblock, information on the number of stream reaches within or immediately adjacent to the cutblock boundaries and their riparian classification were collected (a stream was considered to be immediately adjacent to a cutblock if the outer limit of the stream's riparian management area overlapped or lay along the cutblock boundary). The total number of cutblocks identified was 430, of which 401 had at least one classified stream reach. The population included cutblocks of major licensees, small licensees and the Small Business Forest Enterprise Program.

EXHIBIT A-1
Coastal Ministry of Forests district offices

Vancouver Forest Region	Prince Rupert Forest Region
Campbell River	North Coast (Prince Rupert)
Chilliwack	Kalum (Terrace)
Mid Coast (Bella Coola)	
South Island	
Port McNeill	
Queen Charlotte Islands	
Squamish	
Sunshine Coast	

To verify the number of cutblocks was reasonable, cross checks were carried out against Major License Silviculture Information System and Integrated Silviculture Information System records and by comparing the population against planned cutblocks in licensee forest development plans to ensure that all cutblocks falling within the population criteria were included within the cutblock listing.

Based on the information in silviculture prescriptions, six sub-populations of streams were identified, one for each stream classification (S1 to S6). The total number of streams in each sub-population and the number of cutblocks is shown in Exhibit A-2.

Based on the information on the number of stream reaches within each sub-population, a sample of 96 blocks was chosen for examination, providing a total of 355 streams. The 96 cutblocks represent approximately 22% of the blocks with streams and 14% of the stream reaches within the population.

EXHIBIT A-2
Sub-population sizes and sample size for each stream classification

Stream classification	Number of stream reaches in sub-population	Number of blocks	Sample size stream reaches (blocks)
S1	29	26	18 (17)
S2	61	51	29 (28)
S3	91	68	43 (31)
S4	111	62	42 (25)
S5	235	125	33 (23)
S6	1946	347	190 (82)
All	2457	401*	355 (96)

* *This figure is not additive as most cutblocks contain streams of more than one classification.*

2. Sample dispersion

For logistical and cost reasons it was not practical to spread the sample across all 10 of the coastal forest districts. The sample was therefore spread across six forest districts picked to provide as wide a range as possible of the different types of physiographic conditions along the BC coast. The six districts selected were Port McNeill and South Island districts on Vancouver Island, Chilliwack and Sunshine Coast districts on the southern coast, the Queen Charlotte Islands and Kalum district on the north coast.

The final sample allocation between districts is shown in Exhibit A-3.

EXHIBIT A-3
Sample dispersion by stream class for each district. Units are stream reaches (cutblocks).

	S1	S2	S3	S4	S5	S6	All classes
Port McNeill	2 (2)	6 (6)	3 (3)	10 (6)	7 (4)	46 (16)	74 (20)
South Island	5 (5)	7 (7)	12 (7)	9 (4)	13 (9)	47 (16)	93 (20)
Chilliwack	5 (4)	2 (2)	1 (1)	1 (1)	2 (1)	25 (8)	36 (10)
Sunshine Coast	0 (0)	5 (5)	4 (4)	3 (2)	3 (3)	28 (15)	43 (16)
Queen Charlotte Islands	2 (2)	7 (6)	16 (10)	13 (10)	3 (3)	30 (18)	71 (20)
Kalum district	4 (4)	2 (2)	7 (6)	6 (2)	5 (3)	14 (9)	38 (10)
All districts	18 (17)	29 (28)	43 (31)	42 (25)	33 (23)	190 (82)	355 (96)

B. Sample selection

The sample was spread across the six selected districts after considering the relative number of stream reaches present in each district and the need to adequately reflect the different coastal physiographic conditions in different districts.

1. District level sampling of cutblocks

Once the sample size was selected for each district, individual cutblocks were chosen randomly for each stream class. Following sampling, the respective silviculture prescriptions and opening files were reviewed to confirm that the selected cutblocks were actually logged. Where this was not the case, replacement sampling was carried out from the relevant sub-population until a cutblock with the required stream classification was found.

2. Sub-sampling within blocks

The number of stream reaches within each cutblock varied widely, with up to 30 stream reaches in some blocks. It was therefore not possible to examine every stream within each of the sampled blocks. Therefore, non-random sub-sampling of S4, S5 or S6 stream reaches was carried out on those cutblocks with large numbers of streams. In each case, the intent was to ensure all S1, S2 or S3 stream reaches and as many as possible of the S4, S5 or S6 streams. On each cutblock, all stream reaches were as a minimum viewed in the field to determine whether they existed. In addition, every cutblock was examined for evidence of stream reaches that were not classified or mapped.

Sub-sampling of S4 stream reaches was systematic in nature (i.e., every second or third stream). Sub-sampling of S5 and S6 stream reaches, which was also systematic in nature, was split between the low and high gradient streams within each cutblock to ensure a reasonable representation of each stream class.

C. Measurement of compliance

The specific practices to be carried out around streams and their associated riparian areas vary from stream to stream and in many cases are not detailed in the Code, although limitations on the range of practices are imposed. Non-fish streams in particular have few legislated requirements. For these streams the Code does not specify stream cleaning practices, retention of streambank vegetation, the direction of falling and yarding, or riparian management area timber retention levels. Licensees are required to select and state the specific practices for these items in operational plans (the silviculture prescription and logging plan). Therefore, the quality of the plans and the achievement of the practices prescribed in the plans are critical elements of compliance with the Code.

1. Measurement of compliance with the operational planning requirements of the Code

The logging plan and silviculture prescription for each stream reach examined in the field were assessed for compliance with the operational planning requirements of the Code. These consist, in general terms, of requirements for the identification and classification of all stream reaches and for the documentation of the proposed logging practices within the RMA of each stream reach.

a) Identification and classification of streams

On each cutblock visited by the field teams an assessment was made as to whether streams within and adjacent to the cutblock had been identified. Where streams had not been identified a field classification was performed and any impacts or alterations to the stream recorded.

i) Identification of streams

Given the lack of clarity in the definition of a stream in the Code, a conservative approach was taken to identifying streams in the field. All watercourses were considered to be streams unless it was clearly evident that there were no, or very limited, definable banks or alluvial sediment bed. To be considered a stream, definable banks also had to be continuous for a minimum of 30 metres. A watercourse with less than 30 metres of continuous, definable banks was not considered a stream.

ii) Classification of streams

To check stream classification, stream widths and gradients were measured and the differentiation between fish streams and non-fish streams was based on a review of fish classification reports. Where no fish classification report existed or the report was inadequate, streams were classified on a default basis using gradients.

In determining the adequacy of fish inventory reports the following were checked:

- barriers to fish passage had been correctly identified;
- the potential presence of resident fish had been checked;
- sampling intensity was not too limited spatially (e.g., by using only one fry trap to classify the stream);
- sampling methodology was suitable for the conditions (e.g., electrofishing was not conducted in very low temperature water); and
- where there were no barriers to fish migration from other streams and lakes, sampling had been conducted at two different times of the year to check for seasonal use.

One method sampling (e.g., electrofishing only or fry trapping only) was accepted as adequate provided it met the above criteria.

The default basis of stream classification was applied to all streams that did not have adequate fish inventory reports. Under this method, all streams with average gradients of less than 20% were considered to be fish-bearing unless they were:

- ephemeral in nature and had barriers to access;
- either perennial or ephemeral and flowing directly into a stream known to support no fish; or
- short (<100 m) in length and had barriers to access (i.e., there is inadequate habitat to maintain a resident population).

iii) Planned harvesting practices

The *Operational Planning Regulation* requires specific details of logging practices around streams and within riparian management areas to be documented in the logging plan and silviculture prescription. For each stream reach examined, the operational plans were checked to determine if they contained these regulatory content requirements.

EXHIBIT A-4
Riparian classes of streams under the Code

Riparian class	Average channel width (m)
S1 large rivers	≥ 100 m
S1 (except large rivers)	> 20 m
S2	> 5 m ≤ 20 m
S3	1.5 m ≤ 5 m
S4	< 1.5 m
S5	> 3 m
S6	≤ 3 m

Fish stream or community watershed

Not fish stream and not in community watershed

2. Measurement of compliance with the practices requirements of the Forest Practices Code

The assessment of on the ground practices involved walking along each stream reach and taking detailed notes and measurements of the practices followed. On average, the investigators examined 130 m of each stream reach within the sample.

3. Overall compliance with the Code

In order to provide an overall picture of the level of compliance across the coast, a scorecard was developed such that the results for each stream reach were scored (with compliance receiving a score of "1" and non-compliance receiving a score of "0") for each key compliance question. The scores were summed for each sampled stream reach and recorded as a percentage of the maximum score for both the operational planning requirements and the practices requirements of the Code.

D. Use of guidebook best management practices

Guidebooks are an integral part of the Code and provide information on how to apply the Code in the field. While guidebook recommendations are not legally binding, they represent practices that should be considered. Some of the practices are not necessarily appropriate for all stream reaches and 100% utilization would likely be undesirable or inappropriate. As part of their assessment procedures, the field teams determined whether the best management practices detailed in the guidebooks had been used by licensees in the field. This information was collected in the same manner as information on compliance with site-specific prescriptions.

E. Assessment of stream and riparian management area alterations

Alterations to streams and riparian areas were measured by the field investigators and "scored" based on both the degree of alteration in the affected area (e.g., if the channel cross-section was half full of logging debris a score of 5/10 would be recorded for the degree of alteration) and the extent of the stream affected by the alteration (e.g., if 10% of the length of the channel was affected by the logging debris a score of 1/10 would be recorded for the extent of alteration). An overall score would then be calculated based on both the degree and extent of the alteration (e.g., for the above example this would be 0.5/10, being $1/10 \times 5/10$)

The existence of an alteration does not necessarily mean that non-compliance was recorded for that stream or riparian area, as alterations may be allowed for under site-specific plans (e.g., a road within the riparian area would be considered an alteration of the riparian area but would be considered to be in compliance with the plan as long as the road had been identified in that position in the plan).

The types of impact and alteration considered are shown in Exhibit A-5.

EXHIBIT A-5
Types of alteration recorded by field teams

STREAM

Sediment aggradation – settlement of sand and silt within the stream

Bank or sidewall erosion – erosion and sloughing of the streambanks and gully sidewalls

Channel scour – changes in the streambed as a result of debris torrents, use of heavy machinery in the stream or yarding of logs through or along the stream

Introduced or removed woody debris – introduction of logs and branches to the stream as a result of logging and removal of embedded natural windthrow and downed timber from the streambanks

RIPARIAN MANAGEMENT AREA (RMA)

Approved harvest of timber – removal of trees in accordance with an approved operational plan

Total area of riparian reserve zones and riparian management zones harvested that were meant to be retained – removal of trees in contravention of an approved operational plan or as a result of not setting up an appropriate riparian reserve zone due to stream misclassification

Windthrow of trees – the extent of blowdown of retained trees within the riparian management area

Roads and trails established within the riparian management area – the area of roads and major trails affecting the riparian management area (the road width within riparian management zones and the clearing width within riparian reserve zones)

Road failures and slides that enter the riparian management area – the area of roads within the riparian management area affected by debris from slides and road failures

Harvest of specific wildlife trees that were meant to be retained – harvest of wildlife trees within the riparian management area that were identified for retention in approved operational plans

Total area of significantly disturbed soil within the riparian management area – the area of heavy rutting and scalping (forest floor removal) within the riparian management area

F. Assessment of prescription effectiveness

To assess the extent to which compliance with the Code minimizes the level of alterations to streams and riparian areas, an assessment was made of the effectiveness of prescriptions in minimizing alterations under compliance conditions. The assessments were based on the general objectives of maintaining bank and channel stability, keeping logging debris out of the stream and protecting riparian reserve zones.

Effectiveness of streamside prescriptions was determined based on field conditions, and required that there was either no or very little bank scour, alteration to bank or channel stability or changes in levels of woody debris in the stream. In the case of small non-fish streams with little ability to transport debris to more critical reaches, the presence of logging debris in the stream was not considered to render the practice ineffective.

The assessment of the effectiveness of riparian management area prescriptions was limited to two key tests:

- an assessment of the effectiveness of the riparian reserve zone in ensuring there were no or very low levels of stream alterations in larger (≥1.5 m wide) fish streams; and,
- for riparian management zones associated with fish streams, an assessment of the effectiveness of the riparian management zone in minimizing windthrow in the riparian reserve zone.

G. Completion of block summaries

Following each field assessment, a written summary of findings for each block was prepared and provided to the licensee for comments. This gave the licensee an opportunity to identify any inconsistencies or errors in the assessments and any unusual factors, such as major storm events that should be taken into account in the assessment. These comments were then gathered through written comments or exit meetings as appropriate.

H. Analysis of data

Once the final block summaries had been prepared, all data were entered into a spreadsheet to allow analysis of the results. The results of the analysis are detailed in the findings section of the main report.

No statistical analysis of the data was performed, other than where explicitly stated.

I. Comparison with pre-Code practices

Between 1992 and 1995 a number of reports commissioned by the government (principally authored by Derek Tripp, who also worked on the Board's special investigation) were released on forest practices around streams under the previous *Coastal Fisheries Forestry Guidelines*. The focus of these reports was logging activities that occurred from 1988 to 1992. As the Board's investigation used a similar methodology, it has allowed general comparisons to be made between current and pre-Code practices in respect of the level of logging-related stream alterations.

To allow comparisons with the stream data gathered in the Board's investigation, it was necessary to convert the stream classification data from the pre-Code reports to classifications under the Code. For each of the pre-Code streams, a Code classification was assigned based on the stream width, presence or absence of fish, and/or gradient.