The Application and Effectiveness of the Coastal Fisheries Forestry Guidelines in Selected Cut Blocks on Vancouver Island

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2569 Kenworth Road
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April, 1992

ABSTRACT

The Coastal Fisheries Forestry Guidelines, alone or in combination with site specific prescriptions, can effectively reduce the number and severity of the impacts experienced on streams in recently logged areas. Compliance with the guidelines and many prescriptions, however, was generally poor, regardless of location or the type of forest license involved. These were the findings of a recent survey of 21 logged cut blocks on Vancouver Island.

There was, on average, one major or moderate impact on one stream for every cut block inspected. Half of these impacts involved a Class I or II stream. The other half involved Class III or IV streams that were likely to have a negative effect in the near future on more valuable habitat downstream. Since most of the impacts were the result of debris torrents, large build-ups of sediment and debris were the main types of major impacts recorded in all stream classes. Overall stream impacts did not differ significantly between blocks cut under different forest licenses (TFL, FL or SBEP). They also did not differ significantly between blocks in west or east coast drainages.

Approximately 60 % of the major problems observed were attributed to excess debris loads in steep gully systems, and a failure to appreciate the transport capabilities of such streams during heavy rains. Other contributing factors were failures to fall and yard away from the streams, and failures to clean out the excess debris where cross stream yarding was permitted. Poor drainage controls on roads, and spur roads in particular, were responsible for approximately another 25 % of the most significant problems, while a combination of land slides and a poorly located gravel pit accounted for the rest of the problems. Some questionable harvest practices in Streamside Management Zones accounted for six minor or moderate problems, but the long term implication of the problems was beyond the scope of the present survey.

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Table 3. Number and severity of major types of stream impacts observed in cut blocks, March, 1992.

Impact Type	Severity of Impact: Major	Moderate	Minor	Total
Channel aggradation	12	2	1	15
Bank erosion	0	6	5	11
Channel scour	0	0	2	2
Increased debris loads	0	1	5	6
Total	12	9	13	34

It was common to see more than one type of impact along the length of a stream (Fig. 2). This was particularly true of torrented streams where all major types of impacts would be present, depending largely on stream gradient and the number of debris jams present. Of all the impacts, observed, channel aggradation and bank erosion were probably the most significant impacts inasmuch as these were the most common impacts recorded in Class I and II streams (Table 4). Increases in debris loads, however, were a much more widespread problem (Fig. 2). It occurred in 91.2 % of the streams examined, and was therefore considered to be one of the more important contributing agents to the problems observed.

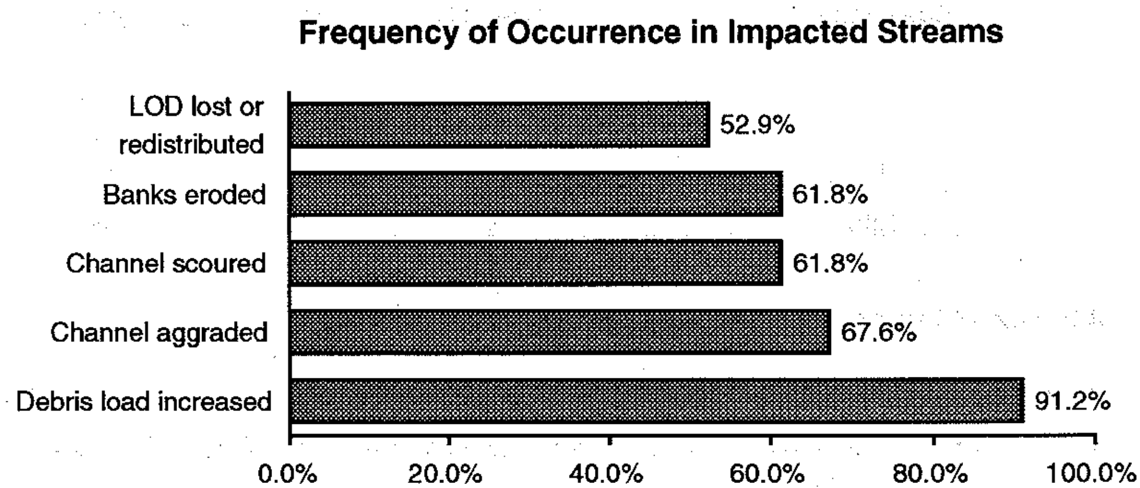

Figure 2. Frequency of occurrence of different impacts in streams in recent cut blocks on Vancouver Island, March, 1992.

the streams, or the volume of material involved is small relative to the amount of fish habitat present downstream.

When more than one impact was recorded on a stream, the impact with the greatest effect on fish was the impact used to determine the severity of the impact. Thus when a torrent occurred in a stream, the channel scour that occurred upstream in a class IV reach was of less significance that the resulting aggradation in a class I/II reach downstream.

Thirty-four (64.2 %) of the 53 stream reaches surveyed were affected to some degree (Table 2). Twelve (35.3%) had major impacts, nine (26.6%) had moderate impacts, and thirteen (38.2%) showed minor impacts (Table 2). Half of the streams that had major or moderate impacts were Class I and II streams, while most streams with minor impacts were Class III or IV streams. One out of two blocks had, on average, one Class I or II stream with a major or moderate impact that was related to logging. One out of two blocks also had a Class III or IV stream that was likely to impact on Class I or II waters in the near future because of the debris and sediments that had accumulated upstream.

Table 2. Number and severity of impacts observed in different stream classes, March, 1992.

Stream Class	Severity of Impact			Total
	Major	Moderate	Minor	
I	3	4	3	10
II	3	1	0	4
III	1	1	1	3
IV	5	3	9	17
Total	12	9	13	34

4.2 Type of Impacts

Channel aggradation was the most common impact encountered on streams, accounting for 44.4 % of the major, moderate and minor impacts combined, including 100 % of all major impacts.(Table 3). The latter were invariably associated with a debris torrent. Approximately two-thirds of the moderate impacts were mainly related to bank erosion, while 76.9 % of the minor impacts were primarily bank erosion and increased debris loads.

4 STREAM IMPACTS

4.1 Number and Severity of Impacts

The stream impacts observed during the block surveys were almost exclusively long term changes in channel morphology that were easily visible one to four years after logging. Short term changes such as increases in suspended sediment loads that may or may not have occurred during harvesting or periods of heavy rainfall and peak flow events could not be documented.

The severity of the impacts on Class I and II streams were rated as follows, with the major emphasis on habitat losses due to changes in coarse sediment and debris loads:

1) **Major Impact** - Complete habitat loss due to excessive channel aggradation or scour; in this study almost exclusively on first order Class I or II streams, but also on sidechannels of larger third order Class I and II streams;

2) **Moderate Impact** - Partial habitat loss due to some channel aggradation, scour or bank erosion; often because of a debris torrent deposit from a small first order stream into a larger third order stream. Deposits typically span less than a quarter of the channel;

3) **Minor Impact** - Minor habitat losses; some channel aggradation, scour or bank erosion evident, but no obvious changes in overall channel morphology.

Impacts on Class III and IV streams were similarly rated as major, moderate or minor, with the major emphasis on possible future impacts on downstream fish habitat, as follows:

1) **Major Impact** - Steep streams with moderate to high transport capability into Class I and II streams downstream. Channel is completely filled in with sediments, and the volume of temporarily stored sediments is large in relation to amount of usable fish habitat that may be impacted downstream. The risk of failures reaching Class I or II waters downstream is high;

2) **Moderate Impact** - Channel exhibits considerable aggradation and a large increase in stream debris loads, but is essentially still a free flowing, unobstructed channel. Sediment and debris transport capability is moderate to high. Chances of material eventually reaching Class I or II waters is good but the volume of material involved is unlikely to completely fill channel;

3) **Minor Impact** - Some channel aggradation, erosion, or scour is evident, along with an increase in the organic debris load. The potential for debris torrents is increased, but the likelihood of any significant impacts on Class I or II waters is small, either because the local topography indicates the torrent is unlikely to reach

Channel stability was rated lower if there appeared to be a significant build up of sediments and/or debris in the channel that could have an impact on downstream reaches, and unchanged or higher if the amount of sediments or debris present had declined significantly compared to upstream, with little chance of further impacts downstream. Thus streams that were considered stable if they were scoured out with essentially no debris or sediments left, or where the likelihood of sediments and debris moving again was very low because of topographic conditions. Streams that had large volumes of debris and sediments compared to upstream were considered more unstable, particularly if the material was liable to move rapidly downstream.

3 BLOCK CHARACTERISTICS

General characteristics of the blocks examined and the final distribution of sampling effort by tenure are presented in Table 1. Fewer SBFEP blocks were examined than anticipated in the initial project design as only four completed blocks met the location criteria at the time of the survey. TFL blocks were generally the largest and for that reason included the greatest number of streams, impacts and torrented streams. Landslides were observed only within FL blocks. Three of the four SBFEP impacts occurred within a single block.

Table 1. Summary of general block characteristics.

	Tenure				
	TFL	FL	SBFEP	Total	Average
No. examined	9	8	4	21	7
No. years cut before survey	1.8	1.8	1.3	No Data	1.7
Mean area (ha)	86.2	48.3	19.5	1240.2	59.0
Streams					
No. on Plan	46	17	11	74	3.5
No. surveyed	26	16	11	53	2.52
No. impacted	17	13	4	34	1.61
Mass wasting					
No. torrents	6	4	0	10	0.48
No. landslides	0	5	0	5	0.24

2.3 Stream Assessments

Streamside treatments for each fish bearing stream (Classes I, II or III), plus up to three non-fish bearing Class IV streams were examined in each block. Brief descriptions of each stream included the original stream class noted on the prescription, and its actual class in the field. Valley slopes (%), height and width (m) were recorded along with bankfull stream width (m), stream gradient (%), and length of stream examined (m). Probable fish use was based on visual sightings of fish, access to larger fish bearing streams, stream gradient, and a knowledge of typical fish life history strategies.

A stream's ability to transport debris was rated as large, small and fine according to the largest size class of debris moved by the stream. Debris transport capability was then rated as high if large and small debris could or had been transported, and low if only fine debris was transported. Debris size itself was as defined in the CFFG.

The condition of the streamside management zone (SMZ) or leave strip was examined for the following: width (m) and percentage of the stream length examined with an adequate SMZ; percentage wind throw in the SMZ and in stream; falling/yarding direction and work timing, and the extent or effectiveness of the debris removal.

All specific streamside prescriptions that could be located in the correspondence between MOE, DFO and the licensee, or which were recorded on the Pre-Harvest Silviculture Prescription from MOF, were checked for compliance and effectiveness. Where no specific prescriptions could be located, it was assumed that the Coastal Fisheries Forestry Guidelines were applied. Specific stream impacts recorded included:

1) sediment aggradation;
2) bank or sidewall erosion;
3) channel scour;
4) increased debris loads; and
5) debris lost or re-distributed.

Changes in the stability of each stream after logging were assessed primarily by comparing the conditions of stream sections in the block with unlogged or older logged areas upstream.

2) the blocks bounded on or encompassed a Class I/II stream reach; or

3) the blocks contained or bounded on a Class III/IV stream with the potential to impact Class I/II waters downstream.

A final random selection of the blocks was made in the absence of agency staff, or any foreknowledge of site conditions or harvest prescriptions that may have been recommended for the block. The main intent at this point was to maximize logistical efficiency, and at the same time achieve a sample set that was balanced with regard to tenure (TFL, FL, SBEP), location (east coast, west coast), and accessibility (easy, difficult). Once the blocks were selected, 1:5,000 scale maps and the stream side prescriptions, if any, for each block were obtained from a review of MOE files (where available) and from MOF Pre-Harvest Silviculture Prescriptions. Where no specific stream side prescriptions appear to have been recommended, it was assumed that the Coastal Fisheries Forestry Guidelines (1988) were applied.

2.2 Road Assessments

Roads were generally examined within the boundaries of each cut block. If insufficient length of road was available within the block, recently constructed road (post - 1988) outside the setting was also examined. Information recorded on the road surveys included road type (main line, spur line), length examined (m), present status (active, inactive, abandoned), recommended status, side slope traversed (%), and road slope (%). Other information included the material the road was constructed out of, the length of road within 30 m of a stream, and the amount of material sidecast too close to a stream.

The number of watercourses intersected by each road section was enumerated, along with the number of culverts and waterbars present, and their effectiveness. The length of effective or non-effective ditch present was also noted. Stream crossings (bridges) encountered were evaluated for encroachment on the high-water mark, whether specifications in the Coastal Fisheries Forestry Guidelines were followed, and whether the crossing had a negative impact on the stream.

boat or helicopter. An attempt was also made to balance the distribution of sites reviewed between companies operating under Tree Farm Licenses (TFLs), Forest Licenses (FLs) and the Small Business Forestry Enterprise Program (SBFEP or SBEP).

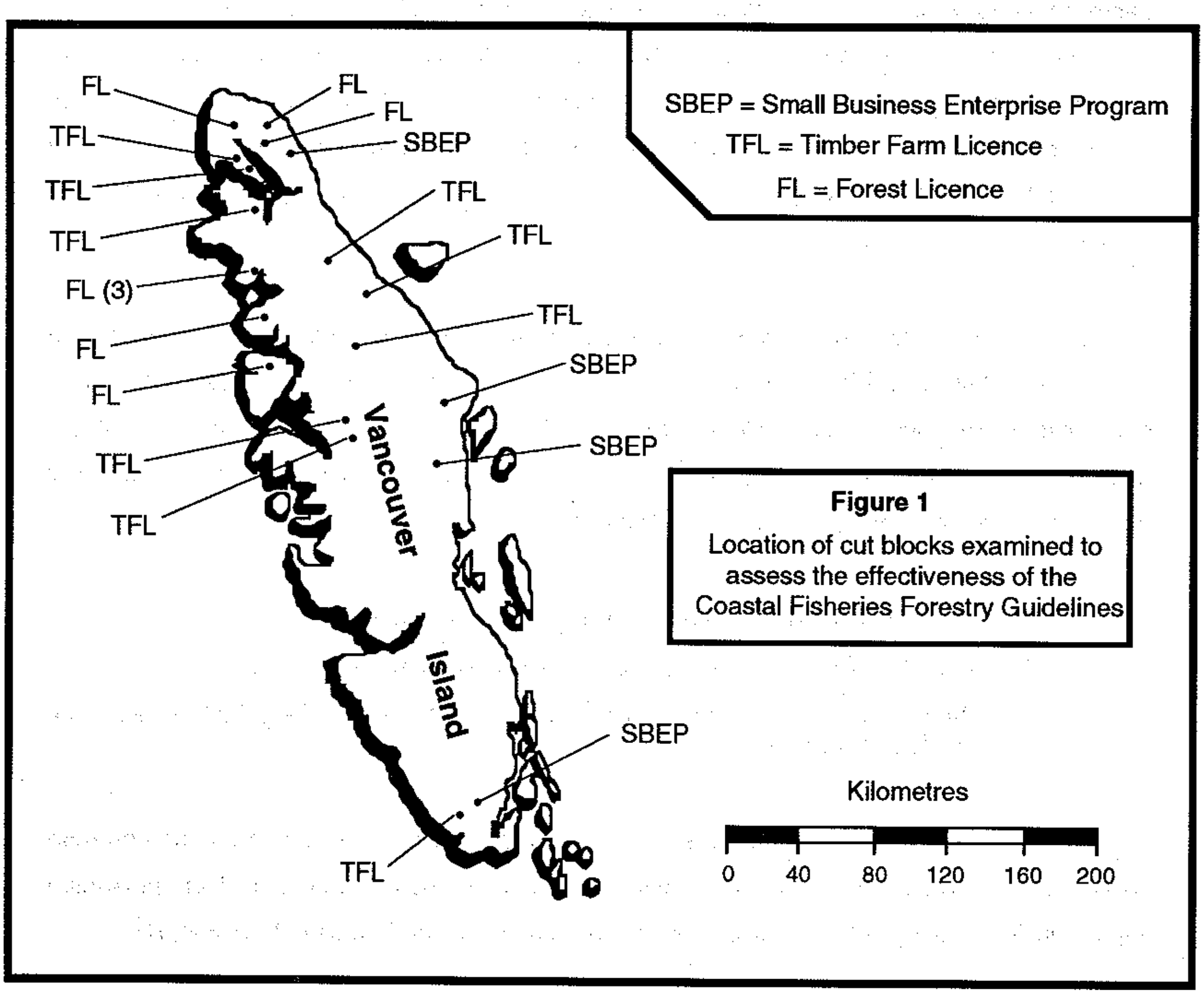

Figure 1. Location of cut blocks examined to assess the effectiveness of the Coastal Fisheries Forestry Guidelines.

To help avoid possible bias toward known problem blocks, twice the number of blocks required for the survey were initially selected from 1:20,000 scale five year plan maps. Specific cut blocks were included in the selection process if they basically met the following criteria:

1) blocks were harvested after publication of the Guidelines (1988);

1 INTRODUCTION

The British Columbia Coastal Fisheries Forestry Guidelines (CFFG, 1988) were formulated jointly by the forest industry and the environmental agencies (MOE, MOF, and DFO) responsible for integrating resource management in coastal watersheds. The Guidelines were developed as a common means for applying the management principles required to meet the objectives of each agency's mandate. Part of the development process for the guidelines included an evaluation of their effectiveness after a trial period of use throughout coastal B.C. The guidelines would then be refined or adjusted as necessary.

In March 1992, D Tripp Biological Consultants Ltd. was retained by the B.C. Ministry of Environment, Lands and Parks to evaluate forest harvesting operations in a random selection of cut blocks on Vancouver Island, within Region 1, to determine the degree of compliance with the Coastal Fisheries Forestry Guidelines (1988) by a range of forest industry operators. Specific objectives of the monitoring program were as follows:

1) Were the guidelines being appropriately applied in the field;
2) Were the objectives of the guidelines successfully achieved; and
3) What was the nature of the impact on fish habitat where the guidelines were not applied or successful.

This is a summary report on the results of the above survey. Specific information on road conditions and stream side treatments for each stream examined in each cut block are presented separately in a catalogue to the Ministry of Environment, Lands and Parks in Nanaimo, B.C.

2 STUDY DESIGN

2.1 Cut Block Selection

A total of 21 cut blocks were examined on Vancouver Island in March, 1992. Attempts were made during the selection process to balance the number of blocks between the east and west coast regions of northern Vancouver Island, and to include blocks that were only accessible by

FIGURES

Table 4. Types of stream impacts observed in different stream classes, March, 1992.

Impact Type	Stream Class I	II	III	IV	Total
Channel aggradation	3	4	2	6	15
Bank erosion	5	0	1	5	11
Channel scour	1	0	0	1	2
Increased debris loads	1	0	0	5	6
Total	10	4	3	17	34

Logging appears to have caused a substantial reduction in stream stability in the cut blocks examined, partly because of the increase in the debris loads present in the Class III and IV streams, and partly because of the increase in sediment volumes behind debris jams. The number of streams judged to be stable before logging, based on their condition upstream in older logged or unlogged reaches above the cut blocks, dropped from 84.9 % to 49.1 % (Fig. 3). The risk of further impacts to downstream reaches also appeared to have increased in 52.6 % of the streams examined.

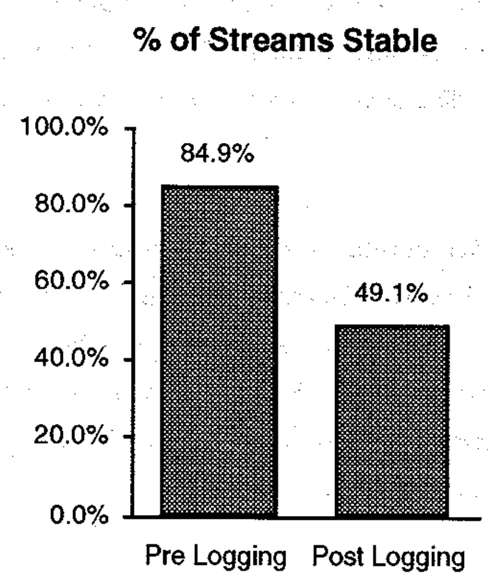

Figure 3. Average change in stream stability observed in recent cut blocks on Vancouver Island, March, 1992.

4.3 Effects of Tenure and Location

To assess the effects of tenure (i.e. license type) and location (east coast, west coast) on the forest companies' performance, each stream impact observed was first ranked as 0 (no impact), 1 (minor impact), 2 (moderate impact), or 3 (major impact). Major, moderate and minor impacts are as defined earlier in Section 4.1. Results are averaged and summarized in Table 5.

Table 5. Average stream impacts observed in recent cut blocks on Vancouver Island, by license type and location.

	No. Streams	Average Impact
License Type		
TFL	26	1.38
FL	16	1.69
SBEP	11	0.73
Location		
East coast	20	1.25
West coast	33	1.39

Kruskal - Wallis analysis of variance indicated that average stream impacts did not differ significantly between blocks harvested under a TFL, FL or the SBEP ($H = 4.3$, $P<0.05$, 2df). There was also no significant difference in overall impacts between blocks on east coast versus west coast drainages.

The overall average impact score for all streams, including those with no impacts, was 1.34. Blocks cut under the Small Business Enterprise Program had the lowest overall score (0.73), possibly because most of the streams in these blocks were block boundaries and had clearly identified setbacks. Hill slopes in the SBEP blocks also tended to have relatively more gentle slopes, and fewer gully systems compared to the TFL or FL blocks. Blocks cut under a Forest License had the highest score (1.69).

5 CAUSES OF PROBLEMS

Each of the impacts was reviewed to determine the principal cause of the impact (Table 6). Most of the problems were considered avoidable. Poor gully management was deemed responsible for 61.8 % (N = 21) of the impacts noted, while a combination of poor harvest practices in the SMZ, poor drainage controls on roads, and a poor choice of location for a gravel pit were responsible for 32.4 % (N = 11) of the problems. Only two problems were considered to be unavoidable. The latter included some blow down and, and a couple of open slope slides.

Table 6. Principal cause and severity of stream impacts observed, March, 1992.

	Severity of Impact			
Cause of Impact	Major	Moderate	Minor	Total
Avoidable				
Poor gully management	7	6	8	21
Harvesting in SMZ	0	3	3	6
Poor drainage control	3	1	0	4
Poor gravel pit location	1	0	0	1
Unavoidable				
Blowdown	0	0	1	1
Landslides	1	0	0	1
Total	12	10	12	34

5.1 Gully Management

Poor gully management was considered to be the cause of an impact where debris torrents had occurred or excessive debris was placed in a stream with moderate to high debris transport capability. Field observations indicate that while debris loading in gullies is not the only cause of torrents, it was clearly an important contributing factor.

Under the Coastal Fisheries Forestry Guidelines, cross stream falling and yarding is allowed in high gradient Class IV streams. However, Section 2.5.11 of the Guidelines also clearly requires that debris be cleaned out of Class III and IV streams if the streams have the ability to transport debris, at any time of the year. The Guidelines also recognize that flows sufficient to transport debris may not occur every year.

Not all streams surveyed required clean up, inasmuch as some streams had an SMZ in place, while others were felled and yarded away from to limit the amount of debris deposited in the stream. However, of 24 streams examined that were capable of transporting large or small organic debris, and which had large amounts of debris deposited in them during logging, only four (16.7 %) appeared to have had any clean-up at all (Table 7). In one case where clean up was moderate, the only debris removed was by a bridge. The rest of the stream still had debris in it.

Elsewhere, forest operators stated that stream clean up would be carried out during or immediately after yarding, but it appears that merchantable timber only was removed. All else remained behind.

Table 7. Extent of debris cleanup observed in streams with varying degrees of debris transport capability, March, 1992.

	Extent of Cleanup				
Stream Debris Transport	None	Moderate	Complete	Unknown	Total
High (large organic debris)	9	1	2	6	18
Medium (small organic debris)	8	0	1	2	11
Low (fine organic debris)	3	0	0	0	3
Total	20	1	3	8	32

Suitable guidelines for minimizing problems in gullies are provided for in the CFFG. The main problems are failure to recognize the debris transport capabilities of most Class IV streams, or failure to comply with specific prescriptions recommended to minimize the impacts when the risks to downstream resources are recognized. Cross stream falling and yarding with minimal clean up could continue, but results of this survey indicate that this practice greatly increases the chances of debris torrents in a stream. Some options include:

1) Stop logging in all gullies that have the potential for causing significant impact on Class I and II streams.

This was prescribed by MOE staff for a section of a block near Chamis Bay in the Kyoquot area. The area was extremely steep with a history of torrents in adjacent blocks. When the gullies were left intact, there were no torrents.

Aside from lost timber values, one of the principal problems with leave strips on gullies is reputed to be the increased potential for blowdown that could destabilize the gully walls and cause a torrent. However, evidence from this survey strongly suggests that gullies choked with debris as a result of logging pose a much greater risk to downstream fisheries values than blowdown. A second problem with leave strips on gullies is that they tend to increase the number of roads which, as described later, were the second most common cause of the problems observed.

2) Fall and yard away from all gullies containing a water course.

This would prevent a large percentage of debris from entering the gully and eliminate much of the need for clean up. It would, however, also involve more movement of yarding equipment and thus an increase in the number of roads and landings and their attendant problems.

3) Clean out all excess debris in Class IV streams with a moderate to high capability of moving debris downstream into Class I and II streams.

This is the recommended prescription for most potentially troublesome Class IV gullies, and the option most likely to succeed if the forest companies follow the prescriptions. If, however, the lack of compliance with the need to clean up is an indication of the difficulty of the task, better methods for removing the debris need to be developed.

The CFFG suggest "grizzlies" or "debris catchers" can be installed; however, they should only be installed as a last resort since their location is based mainly on where the roads cross the gullies. Field observations showed that many creeks are torrented below such debris catchers. If no access exists to the lower reaches of Class III or IV streams where an additional grizzly can be installed and maintained, debris and sediments from below the upper grizzly may adversely affect productive fish habitat downstream. Like culverts, grizzlies require considerable maintenance, however, once the access roads are deactivated or abandoned the amount of maintenance possible decreases significantly.

5.2 Drainage Control

Poor drainage controls on roads, and the spur lines in particular, were the second most common cause of problems after gully management. The road survey indicated that 25% of all major impacts were due to poor drainage control. The survey also determined that there was very little difference in road quality between tenures.

Mainline roads tended to be well constructed and maintained. On the mainline roads surveyed, approximately 86% of the road length had effective ditch (Table 8). Where the ditch was deemed to be non effective, over half of it was located in low laying areas where the lack of ditch was not likely to cause any problems. Where a section of mainline road was deactivated, all the culverts were removed and 61 % more waterbars were installed than required by the CFFG.

Table 8. Comparison of the gradient and drainage controls on main line versus spur roads (active and inactive combined) in recent cut blocks on Vancouver Island, March, 1992.

Road type	Length surveyed (km)	% steep road[1]	No. culverts / km	No. waterbars / km	% effective ditch
Main line	14.029	20.8	4.3	20.5	86
Spur line	16.793	65.4	2.4	6.4	75

[1]Steep road = a road with a gradient > 10%

Mainline roads are typically on gentler slopes than spur roads and are thus less likely to experience the rapid runoff that occurs on spur roads. They also receive more regular maintenance. Spur roads, by comparison, were not as well constructed or maintained. Spurs were generally located in steeper terrain yet had only half as many functioning culverts as mainline roads (Table 1). Active spur lines had effective ditch only 66 % of the time, or 75 % of the time when inactive and abandoned roads were combined. Where spur roads were deactivated there had 42 % fewer water bars than required by the CFFG. Where deactivated spur lines still had culverts in place, 37 % of the culverts had failed.

Spur line roads are not designed to the same standards as main line roads. This is reasonable since their life span is not as long as mainline roads nor is the amount of traffic as great. Due to the steep terrain that spurs are generally located in, however, the potential for impacts to streams from poor drainage control is felt to be greater on spur lines compared to main lines. Both main line and spur roads had fewer culverts than the number of water courses crossed. However, the shortage of culverts relative to the number of water courses crossed was considerably greater on spur lines (38.9 %, Fig. 4) than on main lines (14.8 %).

More culverts with effective ditch blocks and settling pits should be installed on all spur roads. Fewer culverts than the number of watercourses crossed can significantly alter drainage patterns and the capacity of ditches and other watercourses to handle the increased flows. By directing several ephemerals into one stream channel, the potential for bank erosion and channel scour is greatly increased as the stream widens and/or deepens to accommodate the larger flows during heavy rains. Ditch erosion is also enhanced, as is the downstream sedimentation of streams.

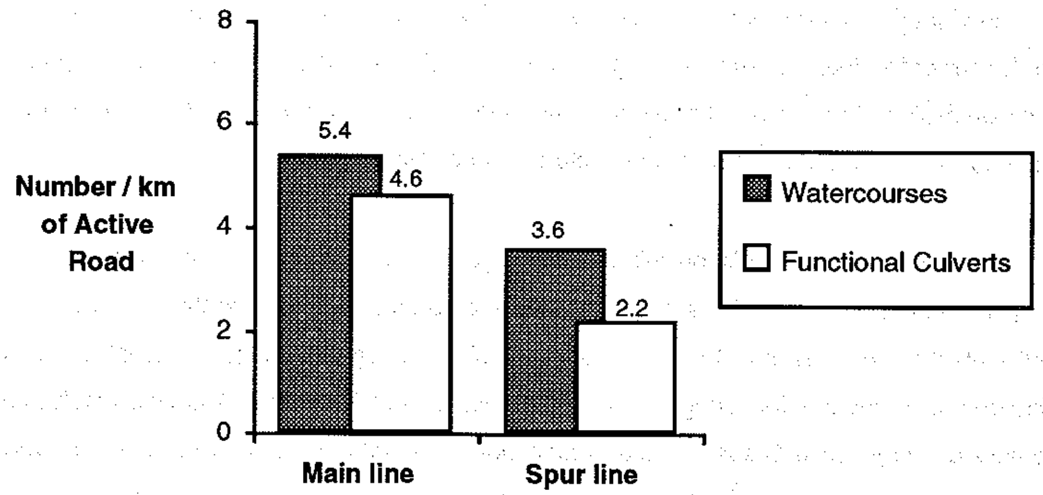

Figure 4. The number of water courses and functioning culverts present on mainline and spur roads in recent cut blocks on Vancouver Island, March, 1992.

Many culverts could have been constructed better. Culverts were rarely, if ever, skewed down and away from a line across the road; most were installed at right angles to the road axis. Few had settling pits or clean-out pits at the entrances or splash aprons at the exits. Ditch blocks that were not likely to wash out at high water were also uncommon. All of these factors greatly reduce the longevity or effectiveness of the culverts and increase the potential for the culvert to fail.

Maintenance of spur lines also appeared to be a problem. The ditches tend to fill in with logging debris which in turn blocks the culverts. To ensure proper drainage control during heavy rains, ditches and culverts must be cleaned out at regular intervals. Once a spur is deactivated and continued maintenance is impractical, all culverts should be removed and a sufficient number of water bars installed. All spur roads should be deactivated as soon as possible after harvesting, with due regard for silviculture and fire protection operations.

5.3 Other Problems

5.3.1 Stream Crossings

Stream crossings were not generally a problem, even though the guidelines were followed on only four of fourteen stream crossings examined (Table 9). The rest of the crossings (N = 10) all encroached on the stream channel in some manner. Either the abutments or the rip rap that was placed to protect the abutments constricted the channel.

Channel constriction is permitted by the guidelines on Class III and IV streams, provided there are no downstream impacts on Class I or II waters. Where impacts occurred they could be attributed to channel constriction in seven of eight stream crossings. Torrenting obscured the impacts of a constricting bridge on an additional Class IV stream. A thalweg shift immediately below a bridge on a Class I stream could not be absolutely attributed to bridge construction although it was suspected. In all seven crossings the impacts directly attributable to channel constrictions were bank erosion and scouring. Three of these crossings were on a Class I or II stream, but the impacts were minor at worst.

Table 9. Stream class, road type and number of impacts at stream crossings in recent cut blocks inspected on Vancouver Island, March, 1992.

	Tenure			
	TFL	FL	SBEP	Total
No. examined	5	7	2	14
No. impacting on stream	2	4	2	8
Road type				
Main line	4	4	1	9
Spur line	1	3	1	5
Stream class				
I, II	4	3	0	7
III, IV	1	4	2	7

5.3.2 Streamside Management Zones

Section 2.5.5 of the CFFG requires a streamside management zone or leave strip on all Class I and II streams. The purpose of the leave strips is to provide stability to the stream banks and riparian vegetation, and a future source of large organic debris (LOD). Leave strips that were left as a condition of the Coastal Fisheries Forestry Guidelines were observed on 37.7% (N = 20) of all steams surveyed (Table 10). Unintentional leave strips, i.e., those that were outside deflection or block boundaries were observed in three cases.

Table 10. Leave strip characteristics for cut blocks on Vancouver Island, March, 1992.

	Type of Leave Strip	
Leave strip condition	Intentional	Non-Intentional
No. of strips	20	3
% of stream length covered	86	100
Mean width (m)	12.8	21.6
No. strips with blowdown	19	0
% blowdown	18.9	0
% blowdown instream	16.2	0

The leave strip width reported above (12.8 m) is a liberal estimate of leave strip width in Stream Management Zones. It is only the width of the leave strips actually present i.e., it is not weighted to take into account sections of the SMZ that were harvested to the edge of the stream. Nine out of 20 strips only had leave strips present along 70 % of the stream. The width reported also includes the leave strips that had some or all of the merchantable timber removed. Where block boundaries were set back from the stream's edge, or where the deflection was inadequate to remove the timber, the leave strips tended to be much wider (21.6 m) and composed mainly of merchantable trees.

If too many are taken, the practice of harvesting merchantable trees within the SMZ may defeat the original purpose of the SMZ as outlined in the guidelines. Merchantable trees were much larger and thus more useful as LOD than the small conifers and alders typically left behind, though even small conifers down to 0.1 m in diameter were sometimes removed. When large trees were taken right off the banks, as was commonly observed, the stabilizing quality of their root wads was also lost, which increased the potential for bank erosion. Though not common, there were also instances where trees used as holdbacks on the stream bank were effectively girdled by cables. This kills the tree and causes a further loss of root strength on the banks, and thus an increased tendency for the channel to widen.

Blowdown was not as large a problem as first suspected. Some blocks had significant blowdown in the SMZ (up to 50 %), but overall, the average was fairly low (18.9 %, Table 10). Where blowdown did occur and salvage operations are approved, it is important to set limits on the amount of blowdown that may be salvaged, since one of the benefits of blowdown is the introduction of large stable debris to the stream. In one case a large area of SMZ was salvaged after it blew down, including all of the debris that entered the stream and its side channels. Islands in the river which had blowdown were also salvaged, although they were outside the original block boundaries and had to be cross stream yarded to remove the timber.

5.3.3 Stream Classification

Five of the 39 streams identified on the logging plans were misclassified. In two cases the change in classification was minor and would not have meant any change in streamside treatment under the guidelines. In the other three cases the lower reaches of Class IV streams were actually Class II waters. The five streams do not take into account six other Class III and IV streams, the mouths of which were too heavily aggraded to determine what fish use was originally.

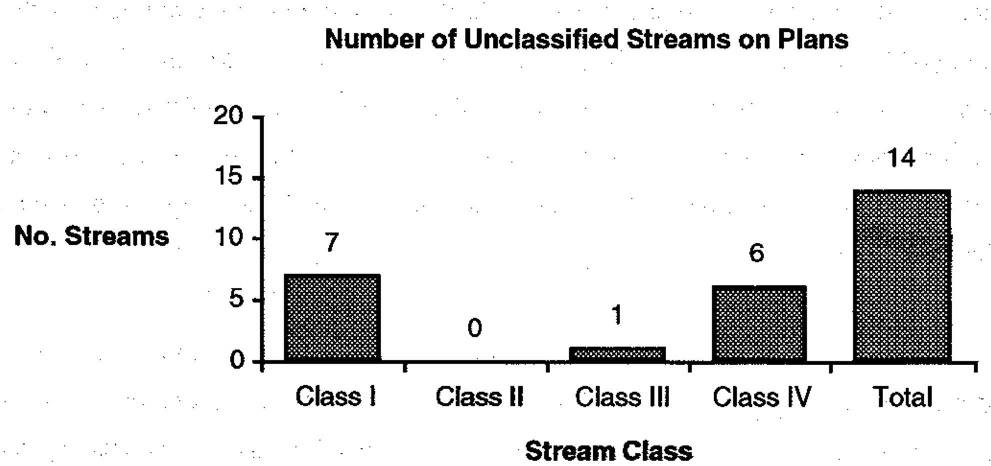

Figure 5. Number of streams not classified on the cutting plans.

Missing streams altogether was a greater problem than mistakes in classification, because of the greater potential for adverse impacts to fish bearing waters. Of the 53 streams surveyed, 14 streams (26.2% of the sample) were missed and thus left unclassified prior to harvesting (Fig. 5). All of these streams were first order streams that flowed into a third order stream within or close to the block. Seven of the streams were Class I waters, the rest were Class III and IV waters. All appear to have been treated as if they were Class IV waters.

The manner in which missed streams were harvested indicates a strong tendency for forest companies to classify streams in the field by stream order, as opposed to gradient, accessibility or actual fish observations. The value of low to moderate gradient, first order streams or stream reaches immediately adjacent to a large Class I mainstem stream should be readily apparent. Forest operators need to better recognize the importance of these small streams and adjust their streamside activities in the field accordingly.

6 PRESCRIPTIONS AND GUIDELINES

6.1 Types of Prescriptions

Site specific prescriptions or comments by government agencies were only made for streamside harvesting treatments. No specific prescriptions were found which dealt with major stream crossings, roads, culverts, or other road related drainage control problems as described earlier (Sections 5.2 and 5.3). In what follows, data on the compliance or effectiveness of site specific prescriptions or the Coastal Fisheries Forestry Guidelines deal only with streamside management.

Of the 53 streams inspected, 29 (55 %) had one or more site specific prescriptions for mitigating the impacts of logging on streams. The average was 1.8 prescriptions per stream. The most common prescription was to fall and yard away from the stream (N = 28), followed by recommendations to clean out excess debris (N = 10, Table 11). Prescriptions in most cases tended to focus on streams with a high transport capability. Hence the large number of recommendations to fall and yard away from a watercourse, and to clean up debris introduced into a stream or gully system. When impacts did occur more often than not it was where debris was not cleaned out of a Class IV stream or where the transport capability of a Class IV stream was underestimated. Other recommendations to establish a Streamside Management Zone or defer sensitive areas (N = 6), use special logging methods (N = 5), or do instream work (N = 3) were relatively less common.

Table 11. Compliance and effectiveness of the Coastal Fisheries Forestry Guidelines and other site specific prescriptions recommended for the cut blocks examined on Vancouver Island, March, 1992.

Prescriptions	No. times given	Compliance			Effectiveness		
		Yes	No	Unknown	Yes	No	Unknown
Fall and yard away	28	18	10	0	16	2	10
Clean out debris	10	2	7	1	2	0	8
Establish a SMZ	5	5	0	0	4	1	0
Work at approved times only	3	0	0	3	0	0	3
Use full suspension	2	1	1	0	1	0	1
Remove log jam	1	0	0	1	0	0	1
Install grizzly	1	1	0	0	1	0	0
Restore single channel	1	0	0	1	0	0	1
Defer sensitive areas	1	1	0	0	1	0	0
Sub Total	52	28	18	6	25	3	24
Follow CFFG	24	7	9	8	7	0	17
Total	76	35	27	14	32	3	41

A total of 24 streams (45 % of the total) had either no specific recommendations, or recommendations that were so impractical without onsite inspectors (e.g., "maintain water quality") that they were treated as if there were no recommendations. In these streams it was assumed that the CFFG were to be followed, as was specifically stated for other streams.

6.2 Compliance With Prescriptions

Contingency tests (Chi-square) indicate there were no significant differences in compliance with site specific prescriptions and/or the CFFG between different license types (Table 12). Differences in compliance on the east coast (70.0 %) versus the more inaccessible west coast drainage blocks (45.5 %) were also not significant, though they were suggestive (0.10>P>0.05).

Table 12. Compliance with prescriptions and/or the Coastal Fisheries Forestry Guidelines by license type (TFL, FL, SBEP) and area (east coast, west coast).

		Prescriptions and/or Guidelines		
	No. of Streams	Followed	Not followed	% Compliance
License Type				
TFL	26	14	12	53.8
FL	16	9	7	56.3
SBEP	11	6	5	54.5
Location				
East Coast	20	14	6	70.0
West Coast	33	15	18	45.5

Logging companies complied with 53.8 % of the site specific prescriptions recommended by MOE or DFO staff (Table 11). They did not comply with 34.6 % of the prescriptions. Compliance with 11.5 % of the prescriptions could not be determined mainly because of torrents or other changes in stream conditions after logging that obscured the original post-logging conditions.

The best compliance with specific prescriptions was achieved when sensitive areas were removed from the cut block, or the need for a Streamside Management Zone was emphasized (100 %). Recommendations to fall and yard away from a stream had the next best compliance (64.3 %), while instructions to clean out excess debris had the poorest compliance (20.0 %).

In the absence of specific prescriptions, compliance with the Coastal Fisheries Forestry Guidelines was generally poor (29.9 %). This includes, however, a relatively large number of streams (8 of 24) where post-logging impacts made it impossible to determine if the logging companies had complied with the guidelines. Eliminating streams where compliance with the CFFG was impossible to determine improved the overall record of compliance to 43.8 %.

6.3 Effectiveness of Guidelines and Prescriptions

Site specific prescriptions and the Coastal Fisheries Forestry Guidelines were deemed effective in reducing or eliminating problems in 32 out of the 35 cases (91.4 %) they were followed (Table 11).

The average impact recorded in streams where the CFFG or site specific prescriptions were followed were further compared with the impacts in streams where prescriptions or guidelines were not followed (Fig. 6). As before, impacts were scored as 0 (no impacts), 1 (minor impact), 2 (moderate impact), or 3 (major impact). Major, moderate and minor impacts are as defined earlier in Section 4.1.

Results indicate that, by themselves, the Coastal Fisheries Forestry Guidelines were effective in reducing the severity of logging impacts from an average score of 2.33 (major/moderate impacts, N = 12) to 0.58 (minor/no impacts, N = 12). The differences were significant at $P<0.005$ (Mann-Whitney U test). The overall reduction recorded in the severity recorded in all streams with or without site specific prescriptions was also significant ($P<0.005$), dropping from an average score of 1.96 (approximately a moderate impact) to 0.83 (less than a minor impact).

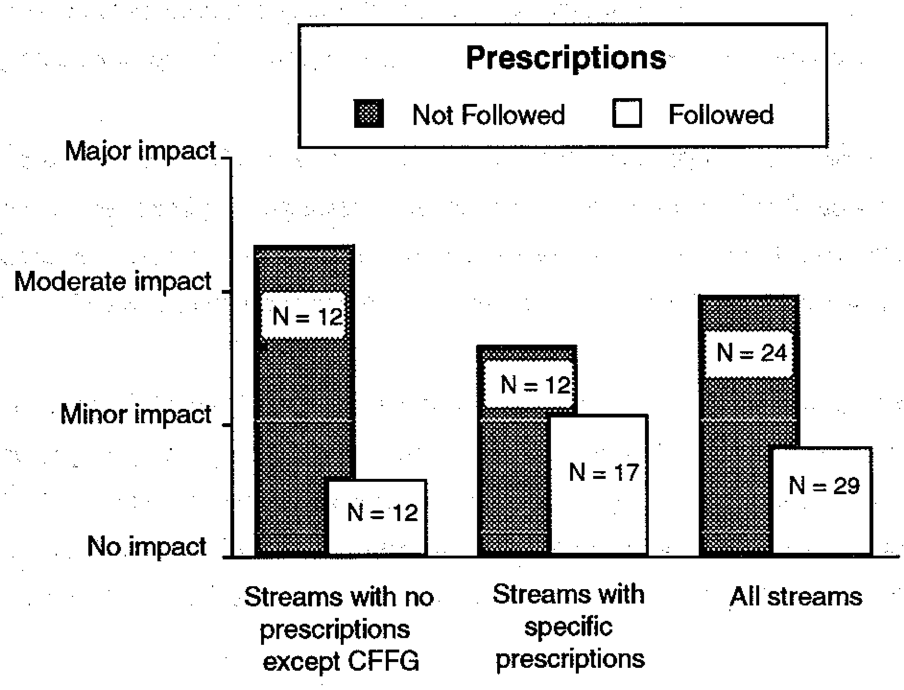

Figure 6. Effectiveness of the Coastal Fisheries Forestry Guidelines and other site specific prescriptions in reducing stream impacts in recent cut blocks on Vancouver Island.

Site specific prescriptions also appeared to reduce the overall severity of the impacts, from 1.58 (minor - moderate impacts) to 1.06 (minor impact). Unlike streams lacking specific prescriptions, however, the net differences in performance were not as great as when just the CFFG were applied, nor statistically significant. Possibly the absence of any significant declines in impacts simply reflects the fact the streams were more troublesome than other streams, and thus more likely to cause problems even when the prescriptions were followed. Because prescriptions "partly followed" were generally not distinguished from prescriptions "not followed", partial compliance with the prescriptions may have also masked the true effectiveness of the prescriptions.

7 RECOMMENDATIONS

The following recommendations are made to improve the performance of logging and the Coastal Fisheries Forestry Guidelines. Properly followed, the guidelines appeared to effective in reducing many of the impacts associated with clearcut logging on streams. In some cases, however, more onsite inspections during harvesting was clearly needed to ensure better compliance with the guidelines. In other cases, better compliance probably requires some clarification or modification of the guidelines.

Several sections of the guidelines need a greater emphasis. These include a need for a better appreciation in the field of the sediment and debris transport capabilities of gully systems, better recognition of the cumulative effects of gully washouts on mainstem streams, and better debris cleanup methods in general. The need to maintain natural drainage patterns should also receive greater emphasis, particularly on spur roads where it was common practise to gather several water courses into fewer channels.

7.1 Prescriptions and Guidelines

1) Prescriptions must be specific and enforceable. Without inspection or enforceable standards, prescriptions such as "maintain water quality" are impossible to achieve;

2) More regular inspections are required to ensure the guidelines are being followed. Onsite inspections are also required during harvesting or periods of heavy rain to assess the effectiveness of the Guidelines in reducing impacts that may only be visible at these times;

3) Where no prescription is given it should be stipulated that the CFFG will be adhered to.

7.2 Gully Management

1) Gully transport capabilities are too often underestimated. Stricter definitions or assessments of debris and sediment transport capabilities are needed;

2) Gullies with streams having debris transport capability should have logging debris removed to reduce the risk of torrents; or they should be felled and yarded away from; or there should be a leave strip left on all gullies of this type;

3) Develop better methods for cleaning excess debris out of gullies;

4) Install grizzlies only if no other options exist to prevent sediment and debris movements downstream. Grizzlies need continued maintenance after an area is harvested and access roads are deactivated.

7.3 Roads

1) Consider deactivating all spur roads immediately after each area serviced by the road is harvested. Otherwise increase the level of maintenance significantly to ensure all drainage controls are functioning properly;

2) Install a culvert at every watercourse on active roads to prevent gathering ephemerals into one channel;

3) Remove all culverts that are not absolutely required for access on deactivated roads;

4) Install more water bars on deactivated spur roads, as per the Coastal Fisheries Forestry Guidelines;

5) Where possible, reduce the length of ditches that run directly into stream channels. Also ensure ditches are large enough to handle peak flow events over the expected life of the roads.

7.4 Streamside Management Zones

1) All merchantable timber with the potential to provide useful LOD to the stream should be left in place in Streamside Management Zones;.

2) Any tree whose root wad is required for bank stability should be left intact;.

3) Trees on the stream bank should not have any cables attached to them in a manner that could cause the tree to be girdled or damaged;

4) Blowdown instream should be left in place unless it can be shown to have a negative impact on fish productivity.

7.5 Stream Classification

1) Adjust classifications where necessary to distinguish lower reaches of Class IV streams that may be of a higher classification;

2) Classify streams according to gradient, accessibility and probable fish use, not stream order;

3) Use 1:5,000 scale maps more often to reduce the likelihood of missed or misclassified streams.

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