# A GLOBAL REVIEW OF GUIDELINES, CODES AND LEGISLATION PERTAINING TO FISH-FORESTRY INTERACTION.

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## INTRODUCTION

There are many impacts that forestry activities have on fish and fish habitat in freshwater and nearshore marine environments around the world. The causal factors include changes to sediment and nutrient regimes, stream flow, water temperature and chemistry, large organic debris, and riparian vegetation caused by logging, road construction, and forest management practices. In an attempt to reduce or eliminate the impacts on fish habitat, international organizations, national and regional governments, and various other organizations have adopted or proposed codes of forest practices that promote good forest practices and discourage bad ones. Several studies have summarized codes that guide forest practices in selected jurisdictions around the world (Applegate & Andrewartha 2002; Belt *et al*. 1992; Bull 1999a; Bull 1999b; Dykstra & Heinrich 1996; Young 2000; Westland 1995).

## TYPES OF CODES

Dykstra and Heinrich (1996) describe two basic approaches to establishing guidelines or codes of practice and summarize the benefits and limitations of each. First, codes can be in the form of guidelines that suggest or promote good practices to achieve an objective but do not actually require that those specific practices be carried out. Compliance with these codes is voluntary and the guidelines are often prepared to assist forest enterprises

achieve compliance with more general legislative provisions. Many of these types of codes are prepared by teams representing different interest groups and are developed with the understanding that those who endorse them are making a commitment to follow them. This approach has been used by international organizations, such as the Food and Agriculture Organization (FAO), International Tropical Timber Organization (ITTO), and Asia Pacific Forestry Commission (APFC) in numerous countries and by many states in the United States.

The second type of code is established in legislation that sets out very specific enforceable rules that must be followed. Failure to comply with the rules can result in fines or other administrative penalties. This approach has been used by governments in Tasmania, Chile, and Russia and especially in the five jurisdictions along the Pacific coast of North America where there are well-documented interactions between forestry activities and fish.

In this chapter we provide examples of these two different approaches in different jurisdictions and summarize some of the provisions that provide protection for fish and fish habitat in those jurisdictions. We have also identified three additional types of codes that are refinements on the two basic types and describe those briefly. In addition to providing a global overview we also provide a detailed analysis of one jurisdiction - British Columbia - that has experience over a long period of time with both of the two main approaches to regulating forest practices to reduce the impacts on fish habitat.

The third type of code blends detailed recommendations established in guidelines with broad requirements established in legally enforceable regulations. This approach is found in the Best Management Practices Guidelines in the U.S. states of Montana and Maine (Montana Department of State Lands 1991; Maine Forest Service 2002; State of Montana 1991) and in Cambodia's Code of Practice for forest harvesting (Cambodia Department of Forestry and Wildlife 1999).

A fourth type of code takes the shape of legislation that establishes general provisions and then mandates the preparation of forest management plans that contain a code or set of required practices for the specific management plan area. Once the code or the specific standards are adopted in a plan, they acquire the force of law and must be followed. This approach has been used in New Zealand and Malaysia (New Zealand Ministry of Agriculture and Forestry 2002; Awang 2002).

Finally, a fifth type of code is emerging in the standards for certifying forestry enterprises or forest management areas as "well managed". These codes promote voluntary compliance with an agreed standard that contains a set of principles, criteria, indicators and, in some cases, verifiers of performance. Certificates are awarded when a third party confirms compliance with the standard. Certification schemes such as the Forest Stewardship Council, Sustainable Forestry Initiative and Canadian Standards Association all contain such standards (American Forest and Paper Association 2000; Canadian Standards Association 1998; Forest Stewardship Council 2000).

Although fish and fish habitat are directly affected by logging, road construction and various post-logging forest management activities, few of the codes around the world specifically link restrictions on forestry activities to the protection of fish habitat. The dominant objectives in most codes relate more generally to protection of the environment, including the prevention of erosion and downstream sedimentation, or to the maintenance of a secure supply of clean water for domestic, irrigational, and industrial purposes. In most jurisdictions, codes of logging practices are considered part of environmental protection efforts. They are implemented as a part of sustainable forest management, not specifically as a means to protect fish and fish habitat within the forest. There are some notable exceptions in western North America and one in Tasmania, which are examined in some detail below.

Prior to 1994, most of the developed codes were in industrialized countries and regions, particularly in North America (Dykstra & Heinrich 1996). The National Code of Logging Practice in Fiji was a notable exception (Applegate & Andrewartha 2002). However, since 1994, codes have been developed in a number of tropical and developing countries, particularly in the Asia-Pacific region (APFC 2000). Codes, of one form or another now exist in Europe, Asia, Oceania, South and Central America, North America and Africa. These areas include most of the world's largest forested jurisdictions where there are important forestry-fisheries interactions in boreal, temperate and tropical forests – Canada, Russia, United States, China, Indonesia and Brazil.

## GUIDELINES THAT PROMOTE GOOD PRACTICES

### The FAO Model Code

Outside the industrialized world, the development of codes to guide forest practices was promoted by the Food and Agriculture Organization of the United Nations (FAO). In 1996, it produced a "Model Code of Forest Harvesting Practice" (Dykstra & Heinrich 1996) that was intended to stimulate the development of forest codes in FAO member countries around the world. This code is a good example of guidelines that promote good practices to achieve an objective but do not actually require that those specific practices be carried out. These types of codes are intended to achieve results through co-operation, rather than through an enforced regime, and encourage flexibility to achieve objectives (Dykstra & Heinrich 1996). Often they are developed co-operatively by groups of people representing different interests.

The FAO Code followed pioneering work in the development of voluntary guidelines to improve performance done by the International Tropical Timber Organization (ITTO 1992). The ITTO Guidelines provided some basic principles to stimulate the development of national policies regarding the protection of the environment in tropical forestry operations, including the establishment of buffer zones, avoiding soil displacement, limiting the season of operations and developing logging plans that minimize disturbance to streams.

The FAO model code provides a more thorough overview of guiding principles and objectives for regulating road construction, timber harvesting and log transport. It makes recommendations about the type of forestry activities that should be avoided to reduce or prevent impacts associated with these practices. These include establishing buffer zones and special management zones along streams where cutting is restricted or prohibited. It recommends that trees should not be felled across streams and when felled, should be directed away from the buffer zone. It describes the impacts of roads and landings and suggests that roads and landings should be locating away from streams and outside streamside buffers. It recommends that culverts should be installed to minimise disturbance to stream channels and stream flow and that skidding should use designated skid trails and be suspended during wet weather.

The FAO Model Code makes no mention of preventing impacts on fish or fish habitat. It is directed at a more general level of implementing sound forestry practices and protecting the environment. It does not suggest any specific width for buffer zones or any criteria for determining their width but it serves as a basic outline for the types of standards that should be in national or regional codes to prevent impacts on fish and fish habitat.

**The Asia-Pacific Code**

In 1999, the Asia Pacific Forestry Commission (APFC) followed the lead of the FAO model code and developed a code of forest practices for the Asia-Pacific Region (APFC 1999). Like the FAO code, the APFC code was developed to provide a model for the

development of national forest practices codes within the Asia-Pacific region. It incorporated provisions from several national codes that existed or were being developed in the region and included a review of codes from around the world. Like the FAO Code, it makes no specific reference to fish or fish habitat and provides no special measures specifically tailored to protect any of the attributes of fish habitat. It is also directed at a more general level of environmental protection as part of sustainable forest management.

After an elaborate two-year process, the APFC "Code of Practice for Forest Harvesting in Asia-Pacific" was endorsed by the 29 APFC member countries in 1998. It served as an interim set of guidelines for improved harvesting practices in those countries as they developed their national codes. It provided much more detailed guidelines than the FAO Code but is a voluntary, not an enforceable system.

The APFC code includes a very comprehensive and elaborate set of guidelines for planning forestry operations, constructing roads and watercourse crossings, cutting trees, transporting and storing logs, maintaining equipment and storing fuel. It also includes guidelines for camp hygiene and waste disposal, worker safety and fire protection.

The Code identifies the need to designate parts of the forest as "harvest exclusion areas". These are intended to protect areas of cultural significance, important biodiversity sites, rare and endangered species, and sites of ecological importance including swamps, wetlands, and mangroves. Within the remaining "production forest", it sets out elaborate guidelines for establishment of buffer zones around lakes, lagoons, shorelines and water

storage areas and along designated watercourses. These are designed to protect soil, water and riparian vegetation from the impacts of harvesting but there is no reference to protection of fish or fish habitat.

The APFC code defines watercourses to include all areas that receive and conduct concentrated overland flow for some period in most years. It classifies watercourses into streams, gullies and waterways and prescribes a width and composition of the buffer zone along them according to the classification. Five classes are defined based on the permanency of water flow, bed material, width, and bank slope. Three of the five classes are streams in which water flows for more than two months in most years and in which the streambed is composed of clean, water-washed stone, gravel or exposed bedrock. The three stream classes are based on stream width. Buffer zones are established on each side of the stream depending on its classification. Streams are:

- Class 1, more than 20 metres wide and have a buffer of at least 30 metres;
- Class 2, 10-20 metres wide and have a buffer of at least 20 metres;
- Class 3, less than 10 metres wide and have a buffer of at least 10 metres.

The Code recommends that no trees should be removed from the buffer zones of Class 1, 2 or 3 streams.

The other two classes are:

- Class 4, gully, a channel with at least one steep bank (having a slope more than 25%), where water flows less than 2 months of the year, and the bed is soil or covered with bark, branches or leaf litter, with a 10 metre buffer;

- Class 5, waterway, a channel having water less than 2 months of the year, side slopes less than 25%, and usually less than 2 hectares, with a 5 metre buffer zone.

The Code suggests that merchantable trees may be felled within the buffer areas of the Class 4 and Class 5 channels.

This classification system does suggest some protection for small, as well as large, streams and to areas that carry water for only short periods of the year. These streams are sensitive to damage and provide habitat for fish in critical periods and may influence downstream areas.

Buffers zones are also required around lakes, lagoons, shorelines and water storage areas. The code prescribes a minimum width for these buffers based on the slope of the adjacent land. Where the slope is less than 17%, the minimum buffer width is 50 metres; where the slope exceeds 17%, the buffer is 100 metres.

The APFC code also establishes a number of general restrictions for managing buffer zones along all the classes of watercourses and around lakes, lagoons, shorelines and water storage areas. Machine access is prohibited, except where watercourse crossings are permitted. No spoil from earthworks or debris from logging is to fall within a buffer zone and if any trees inadvertently fall into a watercourse, all debris is to be removed without disturbance to the bank.

Buffer zones are to be established whether or not the watercourses appear on maps and are to be marked in the field before harvesting commences. The buffer width is measured from the high water mark, or the edge of mangrove vegetation if this occurs above the high water mark.

At least fourteen countries in the Asia-Pacific region now have national or state codes or reduced impact logging guidelines that have very similar provisions because they have been developed under the APFC framework. These include Australia, Fiji, New Zealand, Papua New Guinea, Samoa, Solomon Islands, Vanuatu, Indonesia, Laos, Malaysia, Myanmar, Vietnam and Japan. In Cambodia, the APFC code has been enacted as the Cambodian Code of Practice for Forest Harvesting (Cambodia Department of Forestry and Wildlife 1999).

There is an ambitious strategy for implementing the APFC Code throughout the region (APFC 2000). Indonesia, for example, developed a set of Principles and Practices for Forest Harvesting in 2000 (Indonesia Ministry of Forestry and Estate Crops 2000). This was quickly followed by the development of a very comprehensive set of Reduced Impact Logging Guidelines (Elias *et al*. 2001) that encourage operators to use environmentally sound practices (Bull *et al*. 2001; Pulkki *et al*. 2001). These principles and guidelines use the same classification system developed in the APFC Code and suggest the same widths of buffer zones along watercourses.

**United States (selected eastern and central states)**

In the United States, several states with forest land have developed "Best Management Practices" which have served as guidelines to forest practices. Alabama, North Carolina and Florida provide good examples of these types of codes.

In Alabama, the Best Management Practices for Forestry set out non-regulatory guidelines (Alabama Forestry Commission 1993) for the maintenance and protection of water quality. They recommend a minimum streamside management zone of 35 feet (10 metres) on both sides of all streams, with the width extended to account for erodable soils, steep slopes or other values such as wildlife. Partial cutting is permitted within the streamside zone but on perennial streams, the guidelines recommend that 50% of the original crown cover should be retained. On intermittent streams, they recommend that permanent tree cover is not required as long as vegetation and organic debris is left to protect the forest floor along the stream bank. These Best Management Practices do not mention fish or fish habitat.

In North Carolina, the Best Management Practices are also voluntary guidelines and recommend measures to protect water quality. The width of the recommended stream management zone is based on a stream classification system that separates perennial and intermittent streams by stream width, and side slope. The recommended management zone ranges from 50 to 100 feet in width in which 80% of the vegetative cover is protected along perennial streams and 60% is protected along intermittent streams. In addition, 75% of the preharvest shade is recommended for protection on all stream

channels (North Carolina Department of Environment, Health and Natural Resources 1990; North Carolina Division of Forest Resources 1989).

In Florida, the Best Management Practices prescribe a Special Management Zone (SMZ) adjacent to streams, lakes, wetlands and other features such as sinkholes to protect water quality and wildlife habitat values. As with other Best Management Practices there is no reference to protecting fish and fish habitat.

The width of the SMZ and amount of cutting allowed within it is based on the size and type of waterbody involved, and on a Site Sensitivity Class that indicates the general potential for erosion and sedimentation. The more erodible the soil and the steeper the slope, the higher the site sensitivity class and the wider the SMZ that is prescribed.

On perennial streams, lakes, and wetlands, the SMZ varies in width from 35 to 300 feet (10 to 65 metres) per side, depending on the type and size of the waterbody and the site sensitivity class. Clearcutting is not permitted within 35 feet (10 metres) of the stream but selective harvesting may be conducted anywhere in the SMZ as long as 50% of a fully stocked stand is maintained. The widest SMZ's are applied on the most sensitive site classes.

For intermittent streams and lakes and sinkholes with intermittent water an SMZ at least 35 feet wide is also designated but unrestricted selective harvesting and clearcut harvesting are both permitted in the SMZ adjacent to these streams.

**Great Britain**

In Great Britain, the Forestry Commission developed a set of guidelines to assist foresters and landowners meet the requirements of the Water Act and other legislation. These Forestry and Water Guidelines (Forestry Commission, United Kingdom 1991) do recognize the habitat requirements of fish and establish a number of specific provisions to protect fish habitat.

The UK guidelines require riparian strips of vegetation with a minimum width of 5 metres on each bank of small headwater streams. Larger streams require a strip 2 or 3 times as wide as the stream. These strips are expected to act as seepage zones, to protect stream banks, to give intermittent shade and protective cover and, to provide nutrients to the stream system.

The UK guidelines also specify road construction and maintenance practices to ensure that culverts are not barriers to fish movement. They recommend that any in-stream work avoid periods when fish are spawning and when salmonid eggs and fry are in the gravel. Guidelines for road drainage suggest that drainage should be discharged through a stream side buffer strip sufficiently wide to prevent coarse sediment from reaching the stream. In areas of high risk of erosion, sumps, settling pools or silt traps are recommended.

The UK guidelines, in contrast to other guidelines which stress the importance of retaining trees along riparian areas, stress the importance of open ground beside the stream. They state that at least 50% of the stream should be open to sunlight with the remainder under intermittent shade from light foliaged trees and shrubs. Shade casting trees should be kept sufficiently far back to allow sunlight to reach the stream when the trees are fully grown. Heavy foliaged trees, whether conifer or broadleaf, must be pruned or cut periodically to maintain open areas and ground vegetation.

This is done because studies have shown that forest canopies scavenge pollutants (particularly gaseous sulphur and nitrogen) from the atmosphere, mist or cloud water. This may increase the acidity of the stream water to levels harmful to fish. In the wetter west of Britain, and particularly above 300 m., the scavenging of clouds and mist by forest stands is thought to be particularly important. The guidelines suggest that powdered limestone should be applied to streams if any significant planting of trees is planned near them.

## LEGISLATED CODES THAT REQUIRE COMPLIANCE

In several jurisdictions, very specific forest practices codes have been implemented as legislation.

### Tasmania

The Forest Practices Code of Tasmania (Forest Practices Board of Tasmania 2000) regulates forest practices in native forests and plantations and monitors compliance

through periodic audits. The Tasmanian Code establishes 4 classes of streams and determines the width of required streamside reserves and machine exclusion zones based on these classes. The four classes are based primarily on watershed size and are not related to the presence or absence of fish anywhere in the watershed. The classes are:

- Class 1, rivers, lakes, artificial storages and tidal waters that are named on 1:100,000 topographical maps, with a 40 metre reserve;
- Class 2, creeks and streams that have a catchment area greater than 100 ha., with a 30 metre reserve;
- Class 3, watercourses carry water most of the year in catchment areas between 50 and 100 ha., with a 20 metre reserve;
- Class 4, all other watercourses with running water for all or part of most years, with no reserve but a 10 metre machine exclusion zone.

Wider streamside reserves, including reserves on Class 4 stream can be required in plans where necessary to protect fish spawning or nursery areas. In most situations, all native vegetation including trees must be retained in the streamside reserves and trees are not permitted to be felled into reserves. However, there are provisions for the removal of trees on a selective basis as long as no more than 30% of the canopy is removed and trees are not felled in the 10 metres adjacent to the stream. Machines are not permitted to operate in the streamside reserves except on approved skid trails and crossings. The boundaries of streamside reserves must be marked in the field before harvesting begins.

**China**

The People's Republic of China has developed a draft National Code of Practice for Forest Harvesting (People's Republic of China Department of Forest Resources Management 2001). This code will apply to all forest harvesting and forest road construction on forest lands. It requires buffer zones on all streams (including intermittent streams), lakes, wetlands and reservoirs and no harvesting is allowed in these buffer zones. The buffer zone width is dependant on the width of the stream and ranges from 8m for a stream less than 10m wide to 30m for a stream greater than 50m wide. The Chinese code is simpler than other codes since there is distinction between steep streams and low gradient streams. Log landings need to be 40m from buffer zones.

**Russia**

In Russia, Decree #1404 requires the protection of riparian zones along all streams, rivers lakes and water reservoirs (Russian Federation 1996). The law applies to all manner of land use – including industrial plants, farms and feedlots, roads and community grounds – not just to forestry operations. The Russian law determines the width of reserve zones along waterbodies based on the distance of the portion of the watercourse affected by the land use from its source and does have special provisions for important fish habitats. For example, a stream within 10 km of its source, presumably a relatively small stream, requires a reserve zone of 50 m, but this is expanded to 100 metres if the stream has a high fishing value. A stream more than10 km but less than 50 km from its source requires a reserve of 100 m. A river more than 500 km from its source, presumably a very large river, requires a protective zone of 500 metres.

The width of reserve zones around lakes and wetlands is based on the size of the lake or wetland. For lakes of less than 200 hectares, the protection zone is 300 metres; for all lakes larger than 200 hectares, the zone is 500 metres.

**North America**

The most extensive use of legislated forestry codes to regulate forestry activities is in five jurisdictions on the west slope of North America – Alaska, British Columbia, Washington, Oregon and California. In all five jurisdictions, there are legally binding Codes which provide specific provisions to protect fish habitats. These codes include requirements to classify streams based on fish presence and physical features, and to refrain from many types of practices that have been shown to negatively impact habitat. The use of these legally binding codes probably reflects several factors, including the economic and social importance of salmonids and their dependence on freshwater habitat in forested watersheds. There has also been extensive research in these jurisdictions that has documented the impacts of logging and forest management practices on fish and their habitats. In at least one of these jurisdictions, British Columbia, earlier attempts to use voluntary guidelines to protect habitat failed.

These jurisdictions have developed codes of practice that are similar in some ways but quite different in others. Young (2000) provides an analysis of the different approaches to riparian zone protection in B. C., Washington, Oregon and California.

In Alaska, the Alaska Forest Resources and Practices Act of February 2000 requires riparian protection on all streams and waterbodies on private, state and other public lands that have anadromous or high value resident fish species that are used for commercial, recreational or subsistence purposes (Alaska Department of Natural Resources 2000). On state and other public lands, no harvest is permitted within 100 feet (30 metres) of these waterbodies unless it is determined that adequate protection remains. All streams with a gradient of 8% are assumed to be anadromous waters if there is no documentation of a blockage. Additional protection may be imposed through the adoption of land use plans.

On private land in Alaska, a more complex classification system is used to determine the width of the required riparian area on four classes of streams and the required buffer zones are not as wide.

The Washington Forest Practices Rules (Washington Department of Natural Resources 1995) divide streams into five classes, based on fish use, width and substrate. The first three classes are based on high, moderate or low fish use, or domestic water use and are subdivided into sub-classes based on width. Classes 4 and 5 are streams with no fish use. None of these classes of streams requires a no-harvest area along the stream but the three fish bearing classes are required to have riparian management zones (RMZ) ranging in width from 7.5 metres to 30 metres where practices are restricted. Within all the RMZ's operators must leave a number of representative trees on each side of the stream to provide shade. The required level of retention is expressed as a required number of trees

per 300 metres and is determined by the class and width of the stream and its elevation. It ranges from 25 to 100 trees per 300 metres of RMZ.

Oregon classifies streams into three classes – fish use, no fish use but domestic water use, and no fish or domestic water use – which are further subdivided into small, medium and large streams. The Oregon Forest Practice Administration rules require that a Riparian Management Area be established with a width that varies depending on the class and sub-class and also depending on their location within the state (Oregon Department of Forestry 1995). Within the RMA a minimum 6 metre no-harvest zone must be left along all streams except the smallest non-fish bearing streams. Outside the no-harvest zone within a wider Riparian Management Area, a number of large trees must also be retained along the fish bearing streams to meet a specified level of basal area retention. The required level of retention is determined by the size of the stream and the type of logging planned.

**British Columbia**

British Columbia provides an excellent example of a jurisdiction that has used both of the main approaches in an attempt to protect fish and fish habitat from the impacts of forestry activities. The province has extensive logging operations in thousands of watersheds that support important recreational and commercial fisheries. There has been a long history of conflict between the two resources, and B. C. has used a variety of approaches in attempting to manage the interactions and reduce the impacts of forestry operations on fish habitat. B. C.'s experience demonstrates a progression from rigid guidelines

developed by government in 1972 and implemented through mandatory clauses in permits, to voluntary guidelines co-operatively developed with the forest industry in 1986, to a complex legislated Forest Practices Code with mandatory compliance in 1995. Each of these approaches included measures that were specifically developed to protect fish habitat and each brought different results. In 2000, the government adopted a fundamentally different approach for the small area of privately owned forest land in the province and in 2001, made a commitment to fundamentally change the application of the 1995 Forest Practices Code on public lands. Work is now underway to develop yet another approach to managing fisheries forestry interactions.

The first set of guidelines to address the impact of forestry activities on other forest resources were distributed by the Chief Forester of the province in 1972. The "Planning Guidelines for Coast Logging Operations" (British Columbia Forest Service 1972) included provisions for the protection of water quality and the protection of fish and fish habitat by leaving strips or blocks of trees along stream banks and lakeshores. Using the words "shall" and "must", these guidelines established a limit on cut block size and a pattern of alternate cut and leave blocks in coastal watersheds. Blocks had to be logged in a checkerboard pattern with temporary leave blocks in between and could not face each other across a stream. Logging practices adjacent to the stream has to be conducted in a way that protected the stream bed and banks. These guidelines led, in 1974, to the development of a "P1 clause" (protection clause) that was inserted into all permits that allowed companies to log (British Columbia Forest Service 1974). The P1 clause required the retention of all immature, non-merchantable trees and trees leaning over the

stream in a 1 chain (20 metre) wide strip along the stream edge. The specified width was quickly removed but the concept of a fixed width streamside buffer remained in place. Another P clauses required that no trees be felled into or yarded over streams. Compliance with the clause was mandatory and enforceable.

The intent of these guidelines was noble and the mandatory "P clause" was a first attempt to restrict logging practices to afford some protection to streams and fish habitat. But this approach was soon widely criticized as arbitrary, impractical and expensive. The guidelines led to watersheds with large numbers of roads and, when the intervening leave blocks were cut, large clearcut areas were left on both sides of streams. The cut and leave pattern led to extensive blowdown and, in practice, very little vegetation was left along stream edges. A different approach was needed.

In response, the Ministry of Forests moved away from the approach of using mandatory clauses in permits and began to develop other approaches to managing the interaction between fisheries and forestry. They abandoned the cut and leave pattern and maximum cut block size of the 1972 Guidelines and reduced enforcement of the P1 clause requirements.

In the southern coastal area, they supported an alternative approach, based on the premise that the measures incorporated for stream protection should be determined on a site-specific basis and should reflect the characteristics and values in the streams (Moore 1980). The decision-making procedure recognized that different widths of buffer strips

and different falling and yarding practices should be used on streams with different physical characteristics and fish populations. The decision-making procedure introduced the first stream classification system for the province, with three classes of low gradient streams, based on fish presence, and one class of steep gradient streams. The width and composition of streamside leave strips and the falling and yarding practices allowed near the streams were based on an assessment of site-specific features and values. In contrast to the Planning Guidelines, this was a voluntary system and addressed the retention of trees in specific streamside areas, and the logging practices including falling and yarding of trees and removal of debris removal in those areas. It did not address rates or pattern of harvest within a watershed. The decision-making procedure was implemented by some companies and in some forest districts on the coast for a number of years.

On the Queen Charlotte Islands, a similar voluntary approach to protect fish habitat and water quality was developed in the "Streamside Management Methods for the Queen Charlotte Islands" (British Columbia Forest Service 1978). These recommended methods were developed to encourage flexibility and site-specific decision-making and were explicitly not guidelines that applied equally to all sites. They included a stream classification system that distinguished low gradient and steep gradient streams but also distinguished between single channel and multiple channel streams and streams in steep gullies. The streamside management methods recommended that logging should be confined to one side of a watershed as a way of reducing blowdown. Because of concern for blowdown, these methods stressed removal of large trees and suggested leaving deciduous trees and shrubs and coniferous understory trees along the edge of fish bearing

streams. No trees were to be felled into or yarded across fish bearing streams. The suggested pattern of harvest was combined with a "rate-of-cut" guideline that emerged from a study of the impact of the cumulative effects of extensive harvesting within watersheds on the islands (Toews & Wilford 1978). That study recommended that cutting in a watershed should be limited to one third of a watershed over a 25 year period in order to minimize changes to stream hydrology and fish habitat.

During the same time period, major research projects to study the impacts of forest practices on fish habitat were underway at Carnation Creek on Vancouver Island (Narver & Chamberlin 1976) and on the Queen Charlotte Islands (Poulin 1984). In 1977, Canada amended the Fisheries Act to provide much greater legal protection for fish habitat and to prevent the "harmful alteration, disruption or destruction of fish habitat". The Department of Fisheries and Oceans produced a handbook that described the many effects of forest activities on fish habitat and suggested measures to avoid them (Toews & Brownlee 1981).

By 1983, important information about the interactions between forest harvesting and fish habitat was emerging from Carnation Creek and the Queen Charlotte Island studies (Hartman 1982; Hartman & Scrivener 1983; Rood 1984; Tripp & Poulin 1986; Chamberlin 1987). Several high profile charges had been laid under the federal legislation, and there was increasing concern about the lack of adequate measures to protect fish habitat from the impacts of forest practices. The two governments jointly assembled a team to develop a comprehensive set of guidelines for the protection of fish

habitat from impacts of forestry activities in coastal B. C. After much negotiation, the Coastal Fisheries and Forestry Guidelines were completed in 1987 and endorsed for use by ministries of both government and representatives of the forest industry (British Columbia Ministry of Forests and Lands *et al*. 1987; British Columbia Ministry of Forests *et al*. 1988). These formal guidelines (referred to as the CFFG) replaced the other approaches in coastal B. C. and on the Queen Charlotte Islands.

Because the CFFG dealt with specific practices in specific cutting areas, the cumulative and hydrological effects of harvesting large areas of a watershed were still a concern. A watershed assessment procedure was developed to identify past hydrological impacts and assess the sensitivity of a watershed to more harvesting (Wilford 1987). This watershed assessment procedure was also incorporated into the CFFG and replaced the arbitrary rate of cut guideline developed on the Queen Charlotte Islands.

The CFFG were a classic example of the type of guidelines described in the FAO Model Code (Dykstra & Heinrich 1996). They recommended good practices to use and poor practices to avoid. They were developed by a team reflecting different interests. They promoted voluntary compliance and provided a considerable amount of flexibility for interpretation and application.

The CFFG depended on a classification system that distinguished four classes of streams based on fish presence and gradient. Streams were classified as follows:

- Class 1, a stream with anadromous fish or high numbers of resident fish and a gradient generally less than 8%;
- Class 2, a stream with low numbers of resident species that were large enough to be legally caught by sports fishermen and a gradient between 8% and 12%;
- Class 3, a stream with resident non-sport fish; and
- Class 4, a stream with no fish present and a gradient generally greater than 20%.

Guidelines for constructing roads and landing, falling and yarding trees and undertaking silvicultural treatment were established for each class. A streamside management zone was recommended on all classes of stream but the width and composition of the zone was not specified and was left to site-specific determination. Restrictions on falling and yarding across class 1 and 2 streams, and large class 3 and 4 streams were recommended. These guidelines were the product of intense negotiation between government and industry. Many were prefaced by the words "consider" or "generally" and the recommended practices were qualified by " where necessary", "where practical", "avoid…if possible", and "reasonable".

The guidelines were jointly developed by government and industry, and endorsed by the coastal forest industry. They were expected to be used in all forestry operations on the Coast. However they had no legal basis and, because of the qualified language, were essentially unenforceable. Concern grew that the guidelines provided too much latitude and were not being followed in many locations (Moore 1991). Even where they were followed, they were thought to be ineffective in protecting habitat. A series of audits was

commissioned to look at the use and effectiveness of the CFFG in protecting fish habitat in cutblocks logged since the guidelines came into effect (Tripp *et al*. 1992; Tripp 1994; Tripp 1995).

These audits provided compelling evidence that the guideline approach had failed. The guidelines were actually implemented in only a few operations and had apparently not changed forestry practices along streams (Tripp 1995). Half the streams inspected in the audits had been affected by logging activities. Roads had been assumed to be the main source of problems, but the audits clearly identified logging, and particularly logging practices along streams, as the main cause of most of the stream damage. The auditors concluded that "in the absence of site specific recommendations, or strictly defined limits, compliance with the guidelines is very poor. The more room left for interpretation, the more likely minimum standards will be selected." (Tripp 1998).

In response to the audits, the parties moved quickly to revise the guidelines and urged compliance with them (British Columbia Ministry of Forests *et al*. 1992; British Columbia Ministry of Forests *et al*. 1993). At the same time, many other guidelines to address wildlife and biodiversity concerns, road construction practices and many other aspects of forestry operations were being developed in the province. In the interior of the province, the Interior Fish, Forestry and Wildlife Guidelines (British Columbia Ministry of Forests & B. C. Ministry of Environment, Lands and Parks 1993) were being developed to protect fish habitat as well as wildlife and terrestrial biodiversity. These guidelines were the first to provide a specified width for a streamside management zone.

They recommended a minimum 30 metre wide streamside management zone (SMZ) on both sides of all continuous and intermittent watercourses. Streams were classified in a three class system based on fish presence. The extent of cutting within the SMZ was based on the classification, with no cutting being permitted in the SMZ for the Class A streams that have anadromous fish present. Wider SMZ's were recommended on steep slopes, areas with high windthrow potential or complex channels. These guidelines also included restrictions on the size of cutblocks, the extent of watersheds that could be cut, the timing of logging and road construction and on silvicultural activities, including herbicides and fertilizers.

It was clear by this time, however, that the guideline approach with voluntary compliance had not been widely implemented, was difficult to enforce and had not sufficiently improved practices. The Forest Resources Commission (Forest Resources Commission 1991) had already recommended a single all-encompassing code of forest practices that would set a clear and enforceable minimum standard of practices. They recommended that a code be created through the introduction of a Forest Practices Act.

Thus, in 1995, British Columbia abandoned the guideline approach and adopted a regulatory approach with the passage of the Forest Practices Code of British Columbia Act by the provincial legislature (British Columbia 1995). The legislation included an Act and 18 regulations that set very detailed mandatory minimum standards that had to be met in every forest operation on public lands in British Columbia. The Code covered all aspects of forest management, from strategic and operational level planning, to road

construction and logging operations, range management, post-harvesting road deactivation and silviculture treatments, fire, insect and disease management. Its scope included a broader range of forest values - recreation, drinking water and cultural values - than the fisheries resource addressed in previous guidelines but there were numerous measures specifically directed to the protection of fish habitat.

The Code provided a clear set of legally enforceable minimum standards for all operations across the province. It also recognized the wide variety of sites and conditions, and incorporated the site-specific decision making approach of earlier guidelines by giving government managers considerable discretion to approve deviations from the legal requirements if they were presented and approved in a plan. The legislation set penalties for failing to comply with the requirements and allowed officials to stop operations that appeared not to comply. To address cumulative impacts, the Code replaced the Watershed Workbook approach (Wilford 1987) with two Guidebooks outlining Watershed Assessment Procedures for coast and interior situations (B. C. Ministry of Forests 1999).

To protect fish habitat values, the Code established a 6 class riparian zone classification system along streams, (S 1 through S 6) as well as a classification system for lakes and wetlands (L 1 through 4 and W 1 through 5). Riparian classes S 1 through 4 were low gradient streams (less than 20%) that provided habitat for fish. As shown in Table 31.1, the classes were based on width. Classes 5 and 6 were steep gradient streams that did not

provide fish habitat. In many cases, these streams flowed down into fish habitat and could transport sediment and debris from upstream operations into fish-bearing water.

The Code also included many provisions that regulated machine use near streams, yarding of logs across steams, placement of culverts and bridges, locations of roads and silvicultural practices. The most important provisions, however, involved the protection of riparian areas.

The Code required that riparian management areas (RMA's) be established on all classes of streams (and on all classes of lakes and wetlands as well). By law, the RMA was composed of a riparian reserve zone (RRZ) beside the stream and a riparian management zone (RMZ) further from the stream. As shown in Table 31.1, the required minimum width of the RRZ and the RMZ for each stream class was set out in the legislation.

Collectively, the riparian reserve zone (RRZ) and the riparian management zone (RMZ) form the legally required riparian management area (RMA). No trees may be cut in the riparian reserve zones (RRZ) but trees may be cut within the riparian management zone (RMZ). Thus, as shown in Table 31.1, the total width of a riparian management area (RMA) on an S 3 stream is 40 metres. The 20 metres beside the stream must be an undisturbed reserve, and the outer 20 metres is a riparian management zone where no machines may operate but where trees may be cut and removed. On the very small, S 4, fish bearing streams and on the non-fish bearing streams (S 5 and S 6) no riparian

reserves are required so the RMA consists only of a 20 or 30 metre management zone (RMZ) where trees may be removed but where machine use is restricted.

The Code did not set a minimum standard on how many trees must be retained within the management zone (RMZ). Non-binding recommendations about the average basal area retention for each class of stream, described as best management practices, were provided in a Guidebook (B. C. Ministry of Forests & B. C. Environment 1995). For small fish bearing S-4 streams, the recommended average retention was 25% of the basal area and for S 6 streams, it was only 5%. Thus, although the legislation required that an RMZ be established, in practice, the management zone could be entirely clearcut. For small streams, including small fish bearing S-4 streams this meant that all trees along the stream edge could be legally cut down. On larger streams higher retention levels are recommended within the management zone and the reserve zone is 20 to 50 metres wide.

The limited amount of protection for the very small streams led to a report that was highly critical of the code riparian provisions for fish habitat protection and their implementation (Sierra Legal Defence Fund 1997). Based on a review of a sample of cublocks logged since the introduction of the Code in 1995, SLDF reported that most of the streams within cutting areas were small S 4, 5 and 6 and had no reserve zones. The Code provision that allowed logging within the RMZ of these small fish-bearing streams, and steep streams that flow into fish-bearing streams meant that the riparian areas of these streams were legally clearcut to the banks. The report also stated that many streams were either not classified or were misclassified and therefore reserve zones were either

smaller than required or were logged. A subsequent and much larger study by the Forest Practices Board reached similar conclusions about the extensive cutting of management zones of small steep gradient streams, misclassification and inappropriate reserve zones on small streams (Forest Practices Board 1998).

The Forest Practices Board study, however, found high levels of compliance with other provisions of the Code relating to reserves on S 1 and S 2 streams, falling and yarding practices on all stream classes, removal of any introduced debris and removal of culverts. On many S 5 streams, intact reserves were retained even though not required by the Code. The study found that the impact of logging on streams was significantly less than found in the audits undertaken before the Code (Tripp *et al*. 1992; Tripp 1994). The Board study concluded that, while there was room for improvement, the Code had been effective in significantly reducing the impacts of forest harvesting on coastal streams.

Audits conducted by the Forest Practices Board since the 1998 study confirm that some of the classification problems and the retention of trees in management zones along streams have been addressed. Compliance with Code requirements has improved each year, and damage to streams from logging has been rarely observed (Forest Practices Board 2001). In 2001, a separate study looked at practices along very small (less than 1.5 metre wide) fish bearing streams (S 4 streams) in the B. C. interior. This study concluded that the practices implemented to comply with the Code along small fish-bearing S 4 streams have been effective in protecting fish habitat (Chatwin *et al*. 2001).

The implementation of the regulatory regime in the Forest Practices Code greatly improved practices along streams in the province and led to a significant reduction in the impacts of forestry activities on fish habitat. Public concerns remain about the effectiveness of the measures to protect fish habitat in the Code, and the absence of measures to protect small headwater streams. There is also concern about the cumulative effects of harvesting on fish habitat in watersheds. However, the clear, legally required and enforceable standards in the Code were a much more successful way of protecting fish habitat from the impacts of forestry operations than the Coastal Fish Forestry Guidelines and other earlier versions of voluntary guidelines and decision-making procedures.

Despite the apparent effectiveness of the Code, B. C. is moving to implement yet another type of regime for managing fish forestry interactions. In 2002, a new provincial government announced a major initiative to replace the Forest Practices Code with a more "results-based" approach to regulating forest practices (British Columbia Ministry of Forests & B. C. Ministry of Water, Land and Air Protection 2002). This is to address concerns that the Code is too expensive, too restrictive, and too focussed on process and regulation. The new approach will streamline the existing legislation and replace many of its provisions. The "results-based Code" will establish objectives for specific forest and environmental values, including riparian areas, and will provide professional foresters and forest companies with greater latitude to implement forest practices and greater responsibility to achieve the required results. The government has stated that it

will maintain high environmental standards and that the new Code will incorporate the existing provisions for riparian reserve and management zones.

Initially, the new proposals have not been well received by environmental organizations, forest companies or the public (Hoberg 2002) and it is unclear how the provisions for fish habitat protection will be changed in the new legislation. However, it is clear that British Columbia is entering yet another phase in its search for an effective and efficient type of code to manage the interactions between forest harvesting and other forest resource values, including fish and fish habitat.

There is already one example of a "results-based" approach to fish habitat protection in B. C. It is used on the small area of privately owned forest land in the province. Private land is exempt from the riparian protection provisions of the Forest Practices Code and regulated instead by a separate private forest land regulation that was developed by government and the private land owners (British Columbia 1999). This regulation is intended to provide "results-oriented" environmental standards that allow private landowners latitude to use innovation and local knowledge to protect four key environmental values that include water quality and fish habitat. The regulation provides that a landowner must ensure that streambanks are protected, soil erosion is minimized, machine tracks along the stream edge do not lead to sedimentation and accumulations of debris in the stream do not cause harm to fish habitat. Understory vegetation and non-commercial trees within 5 meters of the stream edge must be retained. For fish bearing streams, there is a requirement that a landowner must retain at least 40 trees evenly

distributed along each 200 metres of any fish stream that is more than 3 metres wide. The trees must be retained in the same range of diameter classes and same proportion of coniferous to deciduous trees that were in the pre-harvest stand so that at least 40 trees are retained. For fish streams that are between 1.5 and 3 metres wide, the retention requirement is at least 20 trees along each 200 metres.

These requirements are supplemented by a handbook that describe best management practices guidance to achieve the fish habitat standards (Private Forest Landowners Association 1997).

## CONCLUSIONS

Codes of practice that regulate the interactions between forest harvesting activities and fish habitat are in place in many parts of the world, including Europe, Asia, Oceania, South and Central America, North America and Africa. This includes most of the world's largest forested jurisdictions where there are important forestry-fisheries interactions in boreal, temperate and tropical forests – Canada, Russia, United States, China, Indonesia and Brazil.

The codes of practice represent a broad spectrum of approaches ranging from very loose guidelines with no legal basis to very detailed prescriptive regulations established within law. We have described provisions in codes that conform to two basic types but have also identified an additional three types of codes that are used to regulate forest practices.

In most cases, the objective of the codes of forest practices is to protect water quality. Protection of water quality serves as a surrogate for protecting the fish and other organisms that live in the aquatic habitats but in most codes there is no explicit requirements or measures that protect fish or fish habitat directly. The most notable exceptions are in the five jurisdictions on the west coast of North America – Alaska, British Columbia, Washington, Oregon and California- where there is a long and well-documented history of interactions between forestry and fisheries. In these jurisdictions, there are very complex, legally enforceable codes that include provisions to protect fisheries values.

Similarly, most codes classify streams and rivers and identify appropriate practices based on physical features such as width, seasonality, soil susceptibility or slope rather than on the presence of fish. Again, the exceptions are on the west coast of North America where streams are classified and practices prescribed according to the presence of absence of particular species of fish.

The lack of any consistency in the approaches to developing codes and in the types of measures that they prescribe makes it impossible to translate experiences from one jurisdiction to another or to evaluate which approaches and measures are most effective. Independent monitoring of compliance with the codes of practice is generally lacking and many countries which do have codes of practice have poor governance structures leading to problems with compliance.

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**Table 31.1** Riparian Classes and Minimum Legal Widths of Riparian Reserve Zones (RRZ) and Riparian Management Zones (RMZ). Riparian Classes S1-S4 are known fish bearing streams, streams with a gradient of less than 20% or streams in a community watershed. Riparian Class 5 and 6 streams do not contain fish and are not in a community watershed.

| **Riparian Class** | **Average Channel Width** | **Reserve Zone Width (RRZ)** | **Management Zone Width (RMZ)** |
|---|---|---|---|
| S1 large rivers | More than100 m | 0 m. | 100 m. |
| S1 not large rivers | More than 20 m | 50 m. | 20 m. |
| S2 | 5 to 20 m | 30 m. | 20 m. |
| S3 | 1.5 to 5 m | 20 m. | 20 m. |
| S4 | Less than 1.5 m | 0 m. | 30 m. |
| S5 | More than 3 m | 0 m. | 30 m. |
| S6 | Less than 3 m | 0 m. | 20 m. |