

FOREST PRACTICES
CODE

of
BRITISH COLUMBIA

Fish-stream Identification Guidebook

Second edition
Version 2.1

August 1998





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Preface

This guidebook has been prepared to help forest resource managers plan, prescribe and implement sound forest practices that comply with the Forest Practices Code.

Guidebooks are one of the four components of the Forest Practices Code. The others are the *Forest Practices Code of British Columbia Act*, the regulations, and the standards. The *Forest Practices Code of British Columbia Act* is the legislative umbrella authorizing the Code's other components. It enables the Code, establishes mandatory requirements for planning and forest practices, sets enforcement and penalty provisions, and specifies administrative arrangements. The **regulations** lay out the forest practices that apply province-wide. **The chief forester may establish standards**, where required, to expand on a regulation. Both regulations and standards are mandatory requirements under the Code.

Forest Practices Code guidebooks have been developed to support the regulations, however, only those portions of guidebooks cited in regulation are part of the legislation. The recommendations in the guidebooks are not mandatory requirements, but once a recommended practice is included in a plan, prescription or contract, it becomes legally enforceable. Except where referenced by regulation, guidebooks are not intended to provide a legal interpretation of the *Act* or regulations. In general, they describe procedures, practices and results that are consistent with the legislated requirements of the Code.

The Fish-stream Identification Guidebook is referenced in the *Operational Planning Regulation* (OPR) for (1) the definition of stream reach, (2) the methods acceptable for determining stream channel gradient, and (3) the methods acceptable for fish inventories for the purpose of fish-stream identification. Therefore, stream reaches must be identified, stream channel gradients determined, and fish inventories performed in accordance with the criteria and methods detailed in the following portions of this guidebook:

1. Part 1; page 4 provides the definition of reach for the purpose of the OPR. Supplementary information explaining the definition is in Part 1 pages 5 and 6.
2. Part 2, subsection "Determination of stream gradient in the field" on pages 46 to 48 provides the methods acceptable for the determination of channel gradient within a stream reach as referenced in paragraph (b) of the definition of fish stream. Boldface type at the head of this subsection indicates the reference to the OPR.
3. Part 2, subsection "Fish sampling procedures," page 51 identifies in bold-face type the alternatives that satisfy the requirements for an acceptable fish inventory as referenced in paragraph (b)(i) of the fish stream definition. The two options for

full field procedures for acceptable fish inventories are described in detail in “Acceptable survey methods” on pages 56 to 59. Boldface type at the head of this subsection indicates the reference to the OPR.

A bar along the page margin labeled with the specific regulation as well as a change in text typeface identifies portions of Part 2 of this guidebook that are referenced by regulation. Bold face type on page 33 of the Chapter “Methods for identifying fish streams” also direct the reader to the portions of Part 2 referenced by regulation.

The information provided in each guidebook is intended to help users exercise their professional judgement in developing site-specific management strategies and prescriptions designed to accommodate resource management objectives. Some guidebook recommendations provide a range of options or outcomes considered to be acceptable under varying circumstances.

Where ranges are not specified, flexibility in the application of guidebook recommendations may be required, to adequately achieve land use and resource management objectives specified in higher-level plans. A recommended practice may also be modified when an alternative could provide better results for forest resource stewardship. The examples provided in many guidebooks are not intended to be definitive and should not be interpreted as being the only acceptable options.

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*OPR = Operational Planning Regulation

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Introduction

The Forest Practices Code (Code) specifies planning and operational guidelines for each phase of timber harvesting operations around streams, lakes and wetlands. This document, in conjunction with others such as the *Riparian Management Area Guidebook*, provides managers, planners, and field personnel with suitable practices to meet the objectives of the riparian management regulations of the Code. One requirement is to correctly identify streams on the basis of fish presence in order to ensure the protection of fish populations and habitats during all phases of forest harvesting.

Riparian management areas (RMAs) around streams consist of a riparian management zone where some constraints to forest practices occur (e.g., basal area retention), and where required by the regulations, a reserve zone within which further constraints to forest practices are applied. The width of these zones is determined by the physical and biological attributes of stream reaches and adjacent terrestrial ecosystems. An important attribute of streams is the presence of fish species. The proponent is responsible for determining whether or not fish use a specific stream reach. The results of this determination form one component of the process for determining the appropriate RMA adjacent to that reach. To assist in fish-stream identification, the proponent can obtain existing fish inventory information and clarification of any of the requirements and procedures noted in this guidebook from the appropriate resource agencies.

Successful integrated management within watersheds for timber and aquatic resources depends upon careful planning, training and clear communications between all staff levels. Field information on fish populations in streams must be collected by properly trained and experienced staff by using appropriate methods and level of effort, and at the proper times of the year. This information should also be recorded and documented by using consistent, standard formats. Information standards should be consistent with those recommended by the federal-provincial Resources Inventory Committee (RIC) so that data may be collected, analyzed, stored and retrieved systematically. This systematic approach is essential to verify and support management decisions. These data should be clearly incorporated into operational plans. All staff including engineering, forestry, supervisory and field personnel must discuss these plans and ensure that all are aware of their roles in meeting the objectives of the plans. Maps showing fish-bearing streams, stream-riparian classes, and areas of environmental sensitivity should be provided to all supervisory staff and field crews.

The proponent is required to use the best available information for the identification, classification and mapping of streams for forest development plans. Known information will be made available to the proponent by government agencies (BC Ministry of Environment, Lands and Parks [MELP] and BC Ministry of Fisheries [BCF]). The identification, classification and mapping of *all* streams for site-level operational plans,

which include the silviculture prescription and road layout and design, is fully the responsibility of the proponent. The choice of appropriate procedures in each specific instance is also the responsibility of the proponent. This guidebook provides and refers to standard approaches and methodologies that should seriously be considered by the proponent, and will be used by resource agencies for assessment and audit of stream-riparian classifications, management and mapping. Use of known information on fish distribution contained within the provincial reconnaissance fish and fish habitat inventory will greatly assist the proponent in evaluating the likelihood of fish occurrence, and the need for field surveys for fish-stream identification for areas where this information has been collected. This will minimize the extent and cost of detailed surveys for fish-stream identification.

This document applies to the entire province. Cases where a guideline applies specifically to either the coastal or interior areas of BC are indicated.

Stream identification and classification objectives

An important step in determining the appropriate Code riparian prescriptions is to correctly identify fish bearing streams and those without fish. Consistent with the objectives for RMAs, correct classification of streams is critical for minimizing the effects of land use practices on stream channels and aquatic ecosystems including fish populations, their habitats, and water quality. Although minor effects on aquatic and riparian ecosystems are difficult to avoid completely, application of the present guidelines will minimize the harmful effects of forest harvesting upon them.

This guidebook consists of two parts. Part 1 contains the definition of reach for the purposes of the *Operational Planning Regulation* (OPR). Streams are defined on the basis of the reach. Part 2 contains the procedural requirements and recommendations for identifying fish streams, measuring stream channel width and gradient within stream reaches, and applying the appropriate stream class for each reach.

PART 1

DEFINITION OF REACH FOR PURPOSES OF THE OPERATIONAL PLANNING REGULATION

Definition of reach for purposes of the *Operational Planning Regulation*

Operational
Planning
Regulation
Section 1

- 1 The definition of reach in this Part does not apply to the rest of the guidebook except when used within the definition of stream.
- 2 For the purposes of the definition of “**reach**” in section 1 of the Operational Planning Regulation, B.C. Reg. 105/98,
“**reach**” means a watercourse that has a continuous channel bed that meets one of the following requirements:
 - (a) the channel bed is at least 100 m in length, measured from any of the following locations to the next of any of the following locations:
 - (i) the location where the watercourse begins or ceases to have a continuous channel bed;
 - (ii) the location where
 - (A) a significant change in morphology occurs, for example at the junction of a major tributary, and
 - (B) the mean width of the channel bed, as measured over a representative 100 m length of channel bed, upstream and downstream of the morphological change is sufficient to change the riparian class of the watercourse, if the watercourse were a stream;
 - (iii) the location where
 - (A) a significant change in morphology occurs, for example at the junction of a major tributary, and
 - (B) the mean gradient of the channel bed, as measured over a representative 100 m length of channel bed upstream and downstream the morphological change, changes from less than 20% to 20% or more, or vice versa;
 - (b) the channel bed is at least 100 m in length, made up of one or more segments, the boundaries of which are any of the locations referred to in paragraph (a);
 - (c) the channel bed is less than 100 m in length, if the continuous channel bed
 - (i) is known to contain fish,
 - (ii) flows directly into a fish stream or a lake that is known to contain fish, or
 - (iii) flows directly into a domestic water intake.

Operational
Planning
Regulation
Section 1
continued

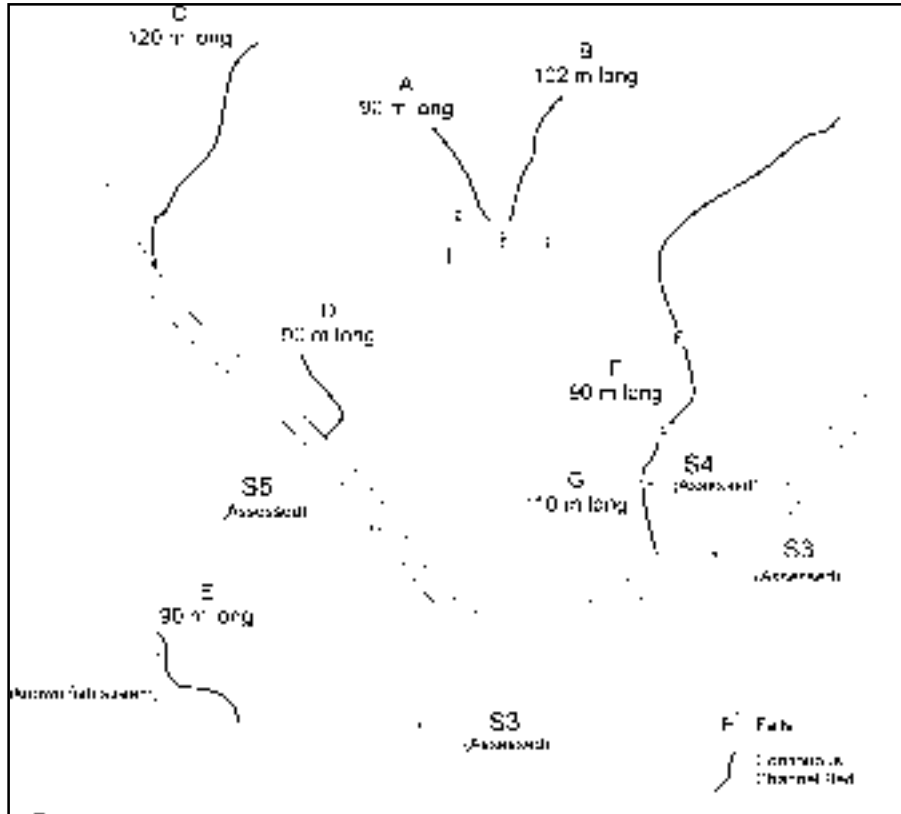


Figure 1. Examples for identifying watercourses as streams for the purposes of the OPR. For each example, assume that the continuous channel bed also satisfies the criterion of scour or alluvial deposition as required in the definition of stream in the OPR.

- A. Watercourse with a continuous channel bed < 100 m long, **not** known to contain fish, and flows into a swamp is **not** a stream [see 2(a)].
- B. Watercourse with a continuous channel bed > 100 m long and flows into a swamp **is** a stream [see 2(a)].
- C. Watercourse with a continuous channel bed > 100 m long and flows into a non-fish stream **is** a stream [see 2(a)].
- D. Watercourse with a continuous channel bed < 100 m long and flows directly into a non-fish stream is **not** a stream [see 2(a)].
- E. Watercourse with a continuous channel bed < 100 m long and **known** to contain fish **is** a stream [see 2(c)(i)].
- F. Watercourse with a continuous channel bed < 100 m long, and flows directly into an assessed and classified (S4) fish stream (G) **is** a stream [see 2(c)(ii)].

In this example, a tributary with two falls discharges into a non-fish stream. The two falls divide the tributary into three channel segments each 60 m long. Although each segment is < 100 m long, the segments are connected sequentially, and the channel bed is continuous for the entire 180 m total length. Therefore, the entire tributary length shown meets the definition of reach and therefore is a stream.

Gradient should be determined as a mean for the entire 180 m length of the three sequential segments. If the mean gradient is < 20%, the 180m reach is a default fish stream.

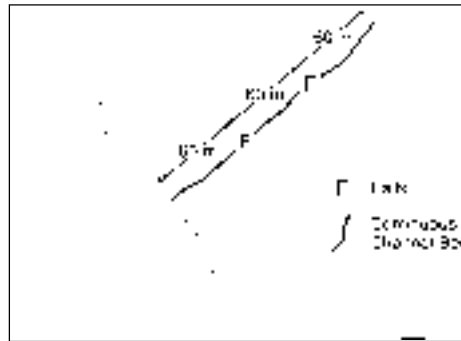


Figure 2. Illustration for section 2 paragraph (b) of the definition of reach for the purposes of the OPR.

PART 2

REQUIREMENTS AND RECOMMENDATIONS FOR FISH-STREAM IDENTIFICATION AND STREAM CLASSIFICATION

Stream-riparian classes

Streams

The Code defines a **stream** as a reach, flowing on a perennial or seasonal basis having a continuous channel bed, whether or not the bed or banks of the reach are locally obscured by overhanging or bridging vegetation or soil mats, if the channel bed:

1. is scoured by water, or
2. contains observable deposits of mineral alluvium.

The primary feature for determining whether a watercourse is a stream under the Code is the presence of a continuous channel bed. If a continuous channel bed exists, then either one of two other key features must be present demonstrating fluvial processes; that is, where flowing water has:

1. scoured the channel bed, or
2. deposited any amount of mineral alluvium within the channel.

Water flow in the channel may be perennial, ephemeral (seasonal), or intermittent (spatially discontinuous).

Channel bed

The channel constitutes the linear “vessel,” boundary or lining within which water, sediment and debris move downstream. The floor of the channel is commonly termed the bed, and the walls are the banks. Channels are incised into the terrain to various degrees due to the process of fluvial erosion. The channel must be continuous in order for water, sediment and debris to be transferred downstream. The boundary can be either alluvial (water-borne material) or non-alluvial (geological materials *not* deposited by streamflow and include bedrock, morainal tills and coarse colluvium). The channel bed (i.e., the stream) ceases to exist, that is, is discontinuous where flow seeps into the ground.

Banks

Most streams also have definable, visibly continuous banks. However, the banks of some smaller streams may be discontinuous. In these cases, the banks and channel bed of short segments of stream may not be visible due to the presence of bridging or overhanging vegetation, or the stream has scoured a channel underneath rooted mats of soil. In other cases, segments of the channel might be filled to the crest of the banks with colluvial deposits as a result of debris jams. However, in all cases, the channel should be detectable throughout the length of the stream being defined such that flow will also be continuous.

Some streams have multiple channels each with definable banks. In this case, the vegetated terrestrial area between the channels is not considered part of the stream when channel widths are measured as one part of the determination of stream-riparian class.

Scour

Scour should be sufficient to erode at least some portion of the channel bed down to the mineral substrate which might include soil and (or) bedrock. This erosion demonstrates that the watercourse has sufficient power to move materials downstream. Low gradient channels might have beds consisting primarily of finer materials such as sand or small gravel. In steep channels with more erosive power, high rates of scour sometimes result in channel beds consisting predominantly of bedrock, cobbles or boulders. In extreme cases, channels may be almost completely scoured of sediment such that only a few large cobbles or boulders remain in the streambed. The spectrum of channels ranging from low power watercourses with observable deposits of sand to channels demonstrating extreme degrees of scour are included within the definition of stream.

Evidence of scour should be more extensive than that shown at a small, isolated plunge pool, or by an isolated boulder or cobble. Scour might be observed to be either:

1. continuous along the entire reach,
2. intermittent along the reach and interrupted by areas of alluvial deposition, or
3. intermittently *visible* along a *continuous* channel bed that has been clearly formed by flowing water but has had some of its scoured (and depositional) portions locally overlain by a thin, seasonal cover of organic materials (these may be present, for example, from summer leaf fall and have accumulated because of low stream power in the autumn).

Deposition

Visible deposits of water-borne, mineral sediment might also be observed to be either:

1. continuous along the entire channel bed,
2. intermittent along the channel bed and interrupted by areas where the channel is scoured, or
3. intermittently *visible* along a *continuous* channel bed that has been clearly formed by flowing water but has had some of its sediment deposits (and scoured portions) locally overlain by a thin, seasonal cover of organic materials (these may be present, for example, from summer leaf fall and have accumulated because of low stream power in the autumn).

Alluvium

Alluvium includes all mineral (clastic) particles deposited by flowing water. These particles range in size from sands (i.e., 0.25–2 mm diameter) to gravels, cobbles and boulders. Silts (particles < 0.25 mm diameter) are included as alluvium only when lacustrine or marine deposits form the only available mineral substrate within a watershed.

Small watercourses with organic beds but no observable deposits of mineral alluvium, or no scour in their beds down to mineral soil, are not included under the definition of stream. Watercourses with organic beds may:

1. consist of accumulated detrital materials such as decomposed and (or) whole leaves, roots, twigs and moss
2. contain mixed silt/organic mud deposits which may be covered in living hydrophytic vegetation (e.g., brown moss, *Sphagnum*).

These watercourses, particularly common in the northern interior, are frequently found at the head of drainages in areas of low topographic relief, or in other sites where slope gradient is nearly zero. Flow in these channels is usually seasonal. The potential for scour is consequently low and is confirmed by the presence of an organic bed. These channels sometimes emerge immediately downslope from groundwater seeps. Seepage sites and other areas where unchanneled surface water occurs due to a seasonally elevated water table are also not streams.

Regions of minimal topographic relief such the Taiga Plains, the northeastern portion of the Queen Charlottes, and elsewhere in both coastal and interior drainages, contain slow-flowing watercourses that may be in the vicinity of wetlands and wetland complexes. Often, these channels are relatively large (> 1.5 m wide) but smaller watercourses may be included within this category. The channel beds of these watercourses are carved down into deep accumulations of peat, and mineral soil is present only at some greater depth. Alternatively, the only mineral material available are silts from lacustrine or marine deposits. Despite these features, watercourses with continuous channel beds are included within the definition of stream. They are accessible to fish in many cases, and therefore, are often fish streams.

Non-classified drainages

Watercourses which do not satisfy the definition of reach provided in Part 1 of this guidebook, and therefore, do not meet the criteria for the definition of stream in section 1 of the Operational Planning Regulation, are to be designated as **non-classified drainages (NCDs)**.

Artificial channels

The great majority of streams which will be encountered in forestry operations will have been formed naturally. Artificial channels, most often with ephemeral flow, which arise as a consequence of forestry activities such as road-building (ditches), recent yarding (tracks along hillslopes that channel rainwater runoff), are not streams.

Artificial channels constructed to enhance fisheries (e.g., salmon spawning and rearing channels) should also be managed as fish-bearing streams. There also are channels constructed historically as drainage ditches, often located within or near agricultural lands, that have become known fish habitats. These artificial drainages may contain important populations of fish and are managed for their fish resources. Consult with the BC Ministry of Forests (MOF), BC Ministry of Environment, Lands and Parks (MELP), BC Ministry of Fisheries (BCF), and Department of Fisheries and Oceans (DFO) to confirm the value of these artificial channels.

Stream reaches

The basic unit employed to determine whether a watercourse is a stream and to assign the correct stream-riparian class is the stream **reach**. Streams may consist of a single reach, but more commonly are composed of a sequence of different reaches extending from the headwaters to the stream mouth.

Part 1 provides the definition of reach for the purposes of the OPR but not for the purposes of fish-stream inventories in this Part.

For the purposes of this Part, reach is defined as follows:

A **reach** is a length of a watercourse having similar channel morphology, channel dimension and gradient.

Commonality and consistency exists between the definition of reach for the purposes of the OPR and the traditional definition and usual application of reach given in this Part. For example, even for purposes of fish-stream inventories, the reach concept must be applied first to identify a watercourse as a Code stream. For this purpose, the identifiable features characterizing channel morphology are the presence or absence of a continuous channel bed plus evidence of either scour or mineral alluvial deposits. The channel bed must be continuous for at least 100 m unless the exceptions to this rule listed in Part 1 apply, and these reaches are bounded as described in Part 1.

The 100 m minimum reach length prevents:

1. short, discontinuous watercourses from being defined as streams
2. the division of streams into unmanageably small portions that may be little more than individual habitat units such as riffles, pools or glides.

This Part provides more detail on reach characteristics, lists all morphologic reach types, and describes the full suite of reach boundaries.

Reach boundaries

Uniform channel morphology, channel dimension (and thus width and discharge), and gradient are primary attributes of reaches that encompass a number of component physical characteristics including channel pattern, confinement, and streambed and streambank materials. Together, these features are used to identify reach types in the field for the purpose of fish and fish habitat inventories. In a watershed inventory, **reach boundaries** are identified in order to divide stream channels into consecutive reaches. Once identified, the physical characteristics of each reach are described.

Reaches do not change gradually or along a continuum of features. Reaches are distinct and changes occur at clearly identifiable boundaries which occur at any of the following locations:

1. where the watercourse ceases to have a continuous channel bed;
2. where a major change in channel morphology occurs, for example, as from a single channel to braided, multiple channels, or from a confined canyon to a wide floodplain, or from one of the eight following channel morphology types to another:
 - a. riffle-bar-pool with gravel and wood – RPgw (Figure 3)
 - b. riffle-pool with cobbles and wood – RPcw (Figure 4)
 - c. debris-cobble-cascade-pool – CPcw (Figure 5)
 - d. boulder-cascade-pool – CPb (Figure 6)
 - e. debris-boulder-step-pool – SPbw (Figure 7)
 - f. boulder-step-pool – SPb (Figure 8)
 - g. block-step-pool – SPr (bedrock controlled channel; Figure 9)
 - h. “large-channel” morphology (Figure 10);
3. where the change in mean channel width is abrupt, for example, at the junctions with major tributaries, from a canyon to an unconfined channel, or where a major change in channel morphology type occurs
4. where the change in mean gradient is abrupt, for example, where a major change in channel morphology type occurs

5. where changes occur in the size and composition of streambed or streambank materials (in association with the changes in gradient, discharge, and morphology type)
6. where natural **barriers** to fish distribution occur and no fish occur upstream of the barrier (e.g., known from existing inventories or proven by fish-stream identification surveys).

Note: Culverts and other artificial features that have become barriers to fish passage are not reach breaks.

Additionally, for the purpose of fish-stream identification by gradient default, an important boundary occurs at the location where the mean gradient of the channel bed, as measured over a representative 100 m length of channel bed above and below a morphological change, changes from less than 20% to 20% or more, or vice versa.

Note: At the headwaters of a watercourse, the location of the upper boundary of the uppermost stream reach is the location where the first (or last, depending upon the direction of travel) significant evidence is found of scour through to the mineral substrate or alluvial deposition. Channel length measurements to satisfy the 100 m length minimum for a continuous channel bed begin or end at this boundary. See details for this determination in this guidebook in “Determination that a watercourse is a Forest Practices Code stream.”



Figure 3. Riffle-bar-pool with gravel and wood – RPgw.



Figure 4. Riffle-pool with cobbles and wood – RPCw.



Figure 5. Debris-cobble-cascade-pool – CPcw.



Figure 6. Boulder-cascade-pool – CPb.

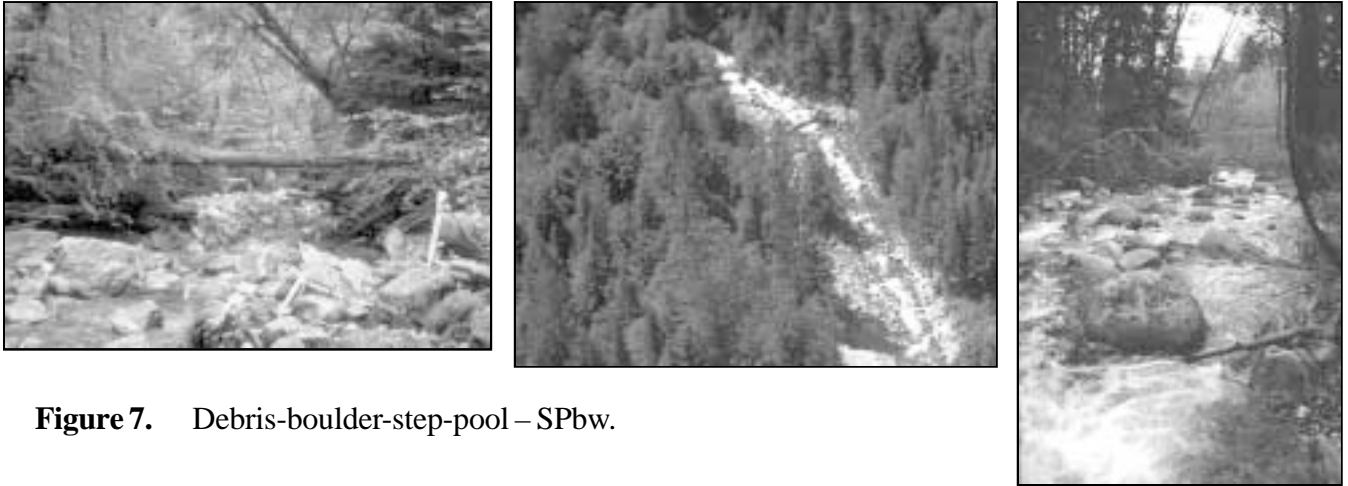


Figure 7. Debris-boulder-step-pool – SPbw.

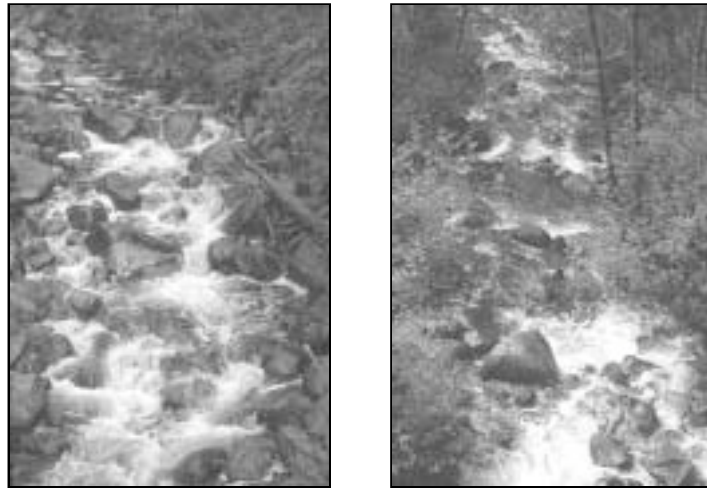


Figure 8. Boulder-step-pool – SPb.



Figure 9. Block-step-pool – SPr (bedrock controlled channel).



Figure 10. “Large-channel” morphology.

Both width and gradient are measured in the field over a representative (typical) 100 m length of a reach, or the entire length of shorter watercourses included in the three exceptions described above for channel bed, in or adjacent to a cutblock (see the sections “Determination of channel width” and “Determination of stream gradient in the field”).

Discharge, dimension, gradient and the materials that form the channel are clearly interrelated variables. Changes in one are usually reflected in changes in one or more of the others, with the result that a distinct change in channel morphology type (i.e., reach type) is evident. The *Channel Assessment Procedure Guidebook* details how these variables combine to result in *three* fundamental types of channel morphologies: riffle-pool (RP), cascade-pool (CP), and step-pool (SP) in order of increasing gradient and size of substrate materials.

These basic morphologies are further subdivided into *eight* types of stream reaches by specifying the dominant substrate type and the presence of large woody debris (LWD). These reach types, listed above in this section, are fully described in the *Channel Assessment Procedure Guidebook*.

The “large-channel” morphology or reach type occurs where gradient is very low and streamflow is slow and laminar. Large woody debris and large rocks have negligible influence on channel structure. The term “large-channel” is not an absolute term. It is used in a relative sense to describe channel form, and has no direct reference to channel width. Therefore, this channel morphology may also be shown by small (e.g., < 2 m wide), low-gradient streams. In many cases, these smaller streams flow through fine mineral deposits (e.g., sands or finer materials). This situation is common where topographic relief is low, as in some northern interior areas of BC such as in the Taiga Plains, where many low gradient, slow-flowing, meandering streams occur. Reaches with large-river morphology also occur at the mouths of streams where gradient is low.

Fish streams

The Code recognizes *two* broad categories of streams, **fish streams** and **non-fish streams**, based on the occurrence of certain fish species.

Fish streams are included within four separate stream classes, S1, S2, S3 and S4, based on mean channel width and designated for the purposes of riparian management¹ (see the *Riparian Management Area Guidebook*). Additionally, all streams within community watersheds are managed as fish streams regardless of fish presence or absence.

The regulations define fish streams (class S1 to S4) as follows:

Fish stream means a stream that

- a. is frequented by any of the following species:
 - i. anadromous salmonids;
 - ii. rainbow trout, cutthroat trout, brown trout, bull trout, Dolly Varden char, lake trout, brook trout, kokanee, largemouth bass, smallmouth bass, mountain whitefish, lake whitefish, arctic grayling, burbot, white sturgeon, black crappie, yellow perch, walleye or northern pike;
 - iii. identified threatened or endangered fish classified under section 71 (of the Operational Planning Regulation);
 - iv. regionally important fish classified under section 71, or
- b. has a slope gradient, determined in accordance with the Ministry of Forests' publication "*Fish-stream Identification Guidebook*," as amended from time to time, of less than 20%.
 - i. unless the stream has been identified in a fish inventory carried out in accordance with the Ministry of Forests' publication "*Fish-stream Identification Guidebook*," as amended from time to time, as not containing any of the species of fish specified in paragraph (a), or
 - ii. unless
 - A. the stream is located upstream of a known barrier to fish passage, identified on a fish and fish habitat inventory map,
 - B. all reaches upstream of the barrier are simultaneously dry at any time of the year, and
 - C. no perennial fish habitats exist upstream of the barrier.

¹ Fish streams are classified S1–S4. Class S1 streams are > 20 m wide; S2 streams are > 5 ≤ 20 m wide; S3 streams are 1.5 ≤ 5 m wide; and S4 streams are < 1.5 m wide. All community watershed streams are managed as fish streams.

Non-fish streams (classes S5 and S6) are those streams² or specific reaches of streams that:

1. are < 20% average gradient but are proven to contain no fish at any time of the year within the categories listed in the fish-stream definition
2. are ≥ 20% average gradient (with the exception of known fish presence detailed in the section “Gradients and stream fish distribution”).

Wherever stream classes S1, S2, S3 and S4 are used in this guidebook as examples of classified fish-bearing reaches, it is understood that all streams within community watersheds are included within this range of classification because all community watershed streams are managed as fish streams. The S5 and S6 non-fish designations for stream reaches do not apply within community watersheds.

In the absence of existing information for site-level plans such as the silviculture prescription, the proponent must conduct an acceptable fish inventory according to procedures detailed within this guidebook to establish that no fish are present *at any time of the year* in a stream of < 20% average gradient. After the absence of fish is confirmed, the stream may then be classified as either S5 or S6. Because habitat type and the presence of fish species and life stages vary seasonally, more than one survey per year may be required to confirm fish absence in some instances.

When fish-stream identifications are performed, documentation should specify whether fish-bearing status is assigned on the basis of either (a) an acceptable existing **fish inventory** or one recently completed by the proponent, or (b) **gradient criteria** alone.

Known barrier

For operational plans, a barrier is a **known** obstruction to fish passage. Known barriers will be shown on a 1:20 000 fish and fish habitat inventory map or otherwise made available by the district manager or designated environment official at least four months before the operational plan is submitted for approval. For the procedure to confirm fish absence upstream of known barriers (paragraph (b) (ii) of the fish stream definition), see the discussion in this guidebook under “Confirming fish absence upstream of known and potential barriers.”

² Streams without fish and that are not community watershed streams are classified S5 or S6. Class S5 streams are > 3 m wide, and S6 streams are < 3 m wide.

Fish species

Excluding any threatened and endangered species, roughly 25% of the fish fauna of BC is specifically identified in the Code for management purposes. Any stream is identified as fish bearing if it contains at any time of the year any of the following species or subspecies which fall into several different groups:

1. **anadromous salmonids:** coho salmon, chinook salmon, pink salmon, chum salmon, sockeye salmon, steelhead (rainbow) trout, cutthroat trout, Dolly Varden char and bull trout
2. **freshwater game fish species:**
 - (a) **non-anadromous salmonids:** kokanee (sockeye) salmon, rainbow trout (includes Kamloops trout), cutthroat trout, brown trout, lake trout, brook trout, bull trout, Dolly Varden char, mountain whitefish, lake whitefish and Arctic grayling
 - (b) **other species:** largemouth bass, smallmouth bass, walleye, yellow perch, black crappie, burbot, northern pike and white sturgeon
3. **identified threatened or endangered fish** by written order of the Deputy Minister of Environment, Lands and Parks, or a person authorized by the deputy minister, and the chief forester
4. **regionally important fish** classified by written order of the Deputy Minister of Environment, Lands and Parks, or a person authorized by the deputy minister, and the MOF district manager.

Salmonids are species belonging to a family of fishes known as the Salmonidae, and broadly include the Pacific salmon, trout, chars, whitefishes, and graylings.

Anadromous fish are those that begin life in freshwater, but leave to spend part of their life rearing in the ocean before returning to freshwater to spawn as sexually mature adults. Pacific salmon, which includes coho, chinook, sockeye, chum and pink salmon, are obvious examples of anadromous fish. Some salmonids such as cutthroat trout, rainbow trout, bull trout and Dolly Varden char can have either anadromous life histories or reside in freshwater throughout their lives (**non-anadromous** or “**resident**” fish).

Threatened or endangered fish means a fish species that in the opinion of the Deputy Minister of Environment, Lands and Parks or a person authorized by that deputy minister, is threatened or endangered. These species will be derived most likely from those “red-listed” by the BC Conservation Data Centre (see the section “References for fish-stream identification”).

Regionally important fish species could include populations of game or non-game fish that occur outside of their principal range, or are of specific scientific interest, or warrant protection to maintain biological diversity. These fish may include “blue-listed” species and populations that are considered vulnerable in BC because they are rare

and (or) have limited distributions. For the purposes of fish-stream identification, the written order to designate either **identified threatened and endangered** fish or **regionally important** fish is in effect when a notice that the order has been made and the locations where the details of the order may be obtained are published in the Gazette.

The mandate of provincial agencies responsible for fish is to protect and manage all fish species including those not listed in this guidebook. Despite inevitable exceptions, the designation of fish-bearing waters on the basis of the presence of the species listed in this document, and upon gradient criteria, will also protect the other components of the provincial fish fauna in the great majority of cases. For example, smelts, including eulachon, would receive protection at the fish-stream level because the lower reaches of the large river systems they use for spawning and egg incubation are also inhabited by salmon and other species listed explicitly in this guidebook.

In both coastal and interior watersheds, the species most likely to be encountered in the steepest stream gradients and highest altitudes inhabited by fish will be cutthroat trout or the chars (Dolly Varden or bull trout). The probability that other species such as chubs, dace or sticklebacks would occur in parts of a watershed that these salmonids could not also reach (stream headwaters or small, isolated lakes) is relatively low. Where this rare situation does occur, these populations are likely to be strong candidates for protection under the **regionally important** category. When these cases are encountered, the MELP regional office should be consulted. Fish such as chubs, dace and sticklebacks inhabiting small lakes will likely be afforded the protection of RMAs on the basis of other criteria included in the Code regulations and the *Riparian Management Area Guidebook*.

Direct tributary

Direct tributary means the reaches of a tributary stream that have the same stream order as the most downstream reach of the tributary.

Figure 11 shows a tributary stream entering a known temperature-sensitive stream. Extending upstream from the junction of the tributary with the temperature-sensitive stream are two adjacent reaches. The most downstream of these two is a second-order reach classified S4, and the one immediately upstream of it is classified S6. The S6 reach is also a second-order stream reach. Therefore, the length of the tributary to be identified as a **direct tributary** includes only the two second-order reaches. The two S6 first-order reaches occurring upstream of the second-order reaches are not included as part of the direct tributary.

The principle of the direct tributary is applied, for example, to determine the locations where the retention of streamside trees is necessary in a direct tributary S4, S5 or S6 reach to protect a known temperature sensitive stream [*Timber Harvesting Practices Regulation 22(1)*].

For a description and discussion of Strahler stream order, see pages 8 and 9 in Knighton (1984).

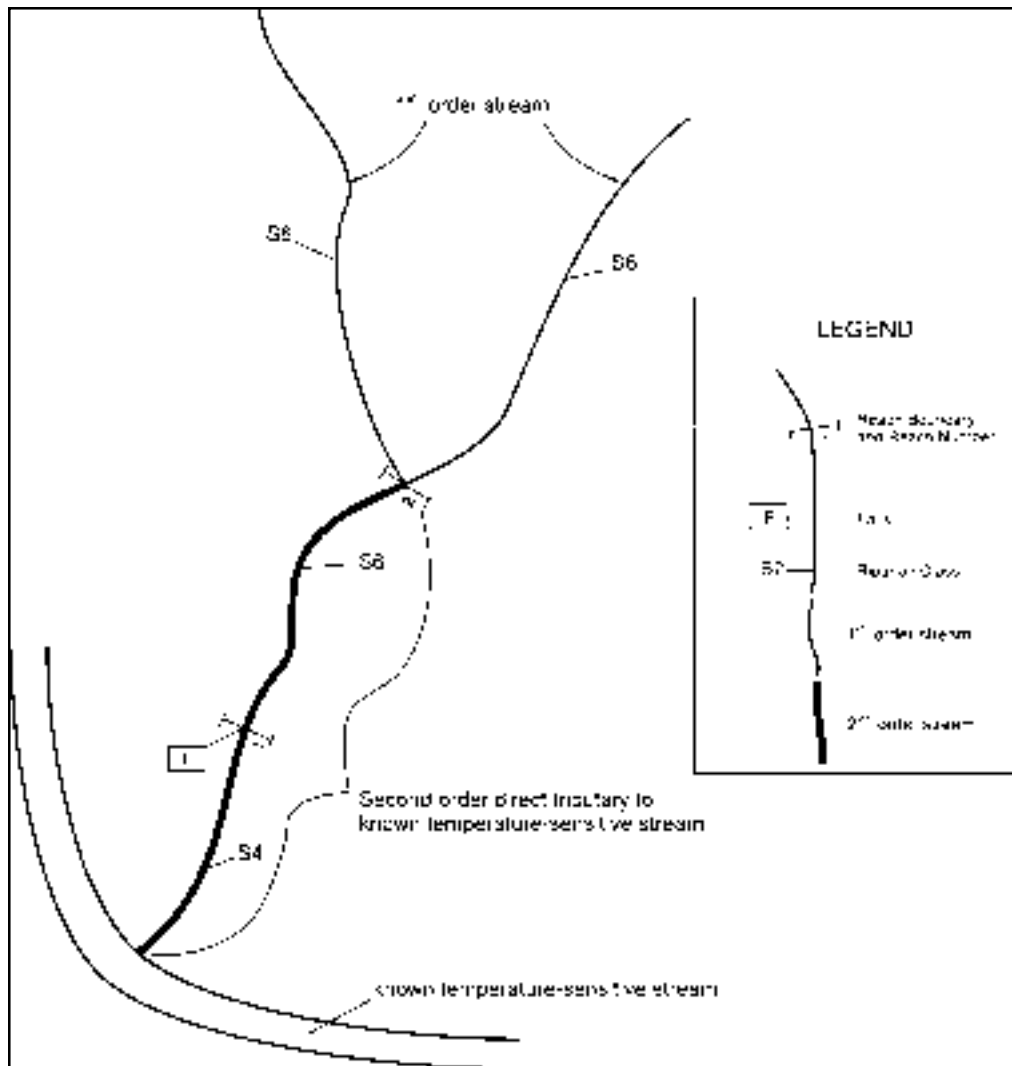


Figure 11. Example of a direct tributary to a known temperature-sensitive stream. The direct tributary consists of two reaches, each with a different stream-riparian class, but all within the same stream order. The requirement to retain streamside trees applies to the length of the second-order, direct tributary, but not to the two first-order tributaries upstream.

Factors influencing fish-stream identification

Determining the appropriate classifications for streams depends on:

1. carefully identifying **stream reaches** and their boundaries
2. determining reach widths and gradients
3. identifying reaches where fish use has already been documented
4. using approved sampling techniques to perform an inventory for fish where required in reaches of < 20% gradient at the appropriate time (or times) of the year
5. accurately identifying fish species present.

Stream reaches and fish inventories

Reaches are the units to be designated as either fish streams (S1 to S4) or non-fish streams (S5 or S6). This is the same physical unit used in standard fish and fish habitat inventories.

The physical characteristics that differentiate stream reaches also define the fish habitats they contain, and determine their ability to support fish populations. For example, reaches consisting of riffle-pool sequences (relatively low gradient) have generally the highest likelihood of supporting fish.

A length of channel that might be assigned a single stream-riparian class could contain two or more physically-distinct types of reaches. For example, a class S2 stream can increase in width from 6 to 20 m before it is wide enough to be classified S1, but may consist of component reaches with different morphological characteristics and consequently different probabilities of containing fish.

Despite differences in physical characteristics, adjacent stream reaches may have the same stream riparian class because of similar channel width and (or) the fish species present.

All reach boundaries as listed with the definition of reach in this Part, should be identified to partition a channel into physically-distinct reaches when planning a fish inventory for fish-stream identification. Knowledge of the reach types present simplifies the determination of which reaches to sample in order of priority to identify the limits of fish distribution.

Habitat use by fish

Habitat use by fish species (i.e., presence vs. absence) is the basis for fish-stream identification. Habitat use is confirmed by the occurrence of any life phase of each species at any time of the year, and includes:

1. spawning adults
2. incubating eggs and developing alevins within the streambed
3. rearing juveniles (spring and summer) and resident adults
4. use of overwinter shelter and overwinter rearing
5. migrating juveniles and adults
6. adults holding (salmonid spawners in freshwater at any time from several months prior to the spawning season to just before spawning).

In this guide, the term juveniles includes all ages of fish prior to sexual maturity. For the salmonids, these age classes include:

1. **alevins** which hatch from the eggs and develop within the streambed
2. **fry** which are individuals less than one year old
3. **parr** which are freshwater-resident fish more than one year old
4. **smolts** which are yearlings or older fish of anadromous populations, and have undergone the physical and physiological changes necessary for seaward migration and ocean rearing.

Gradients and stream fish distribution

Stream gradient is a useful guide for identifying and classifying stream reaches because it links hydrological processes, channel form and substrate materials. These processes and features result in a range of fish habitats with varying abilities to support fish. Gradient is generally useful to identify areas too steep for fish use: these usually are areas of $\geq 20\%$ grade. Most commonly, there is a sequential arrangement of reaches in streams ranging from low gradient reaches near the mouth, to the steeper headwater reaches and tributaries. However, short sections of steep gradient are also commonly found between two areas suitable for fish. A short section of steep gradient within a stream reach would not change the fish-bearing status of the reach if it was passable to fish.

In the absence of an acceptable fish inventory, all stream reaches having average gradients of $< 20\%$ will be designated as fish streams *by default*. The proponent must conduct an acceptable survey to establish that specific reaches within this gradient limit contain no fish. If a satisfactory survey or seasonal survey series determines that no fish inhabit the reach *at any time of the year*, the reach will be designated a non-fish stream.

The following guidelines should be considered during the planning stage when survey priorities are set for stream reach inventories associated with site-level plans such as the silviculture prescription.

1. Streams with gradients up to 8% have a *very high probability* of containing species such as salmon, trout and char. Therefore, these streams would very likely be confirmed as fish streams if surveyed. In coastal streams, this gradient range is sometimes called the “**anadromous fish zone**” because of the high probability that species such as coho salmon, rainbow (steelhead) trout, cutthroat trout and Dolly Varden char will occur there.
2. Stream reaches with gradients between 8 and 12% have a *moderate-to-high probability* of containing anadromous or resident salmonids in coastal watersheds, and resident salmonids (e.g., cutthroat and bull trout) in both interior and coastal drainages. The probability that these species will occur in the 8–12% gradient range *increases* when the longitudinal profile of the reach consists of a sequence of stepped pools accessible to fish. In this situation, pools are separated by small waterfalls up to 1.5 m high or higher. Trout and char can frequently occupy this type of habitat at gradients greater than those inhabited in situations of a less-stepped profile. Coho salmon sometimes spawn and rear in these stepped-pool reaches, especially in small coastal drainages.
3. Stream reaches with gradients between 12 and 16% have a *moderate probability* of containing fishes for which the fish-stream designation would apply. Chars and trout are the most likely species to be encountered. Their abundances in this gradient range are usually low. The probability that these species will occur in this gradient range increases if the reach consists of a series of stepped pools where the pools have sufficient volume, provide shelter from high stream velocities, and have pockets of gravel and cobble to support spawning and (or) rearing fish.
4. Stream reaches with gradients between 16 and 19% have a *low probability* of containing fishes for which the fish-stream designation would apply, especially in interior drainages. Chars and trout are again the most likely species to be encountered. Fish inhabiting these areas are usually low in number. Again, the probability that these species will occur in this gradient range increases if the reach consists of a series of stepped pools with appropriate habitat.
5. Stream reaches $\geq 20\%$ average gradient are not legally required to be surveyed to determine fish absence under the Code. However, fish such as cutthroat trout, bull trout, Dolly Varden char and sometimes rainbow trout have been observed to occur in very steep streams, well in excess of 20% gradient, where the reach has a stepped-pool profile and (or) where a lake occurs at the head of the drainage.

When the proponent identifies a situation where an accessible and (or) lake-headed stepped-pool reach of $\geq 20\%$ grade occurs in the upper parts of a fish-bearing stream, the proponent is encouraged in the interests of fish population conservation to contact and consult with the MELP regional office, and if necessary, the local DFO office in order to establish whether the reach might be surveyed for fish.

When fish listed in the definition of fish stream are found in a given reach, that reach is to be identified, classified and managed as a fish-bearing stream reach regardless of its gradient.

Stream size, ephemeral streams and side channels

Stream size can be a misleading indicator of fish presence. Fish are often assumed present in low-gradient streams with large pools, year-round flows, and relatively wide channels. However, a significant amount of fish rearing also occurs in very small channels, swamps, sloughs, ponds and seasonal streams. These sites may not be recognized as fish habitat; consequently, their importance to fish is sometimes overlooked. However, many of these areas are fish streams. Side channels and small tributaries are the most obvious and common of these features. Other sites which are not defined as streams are protected as fisheries-sensitive zones (see the section “Fisheries-sensitive zones”). Coho fry and yearlings use a wide range of these habitats ranging from mud-based swamps and sloughs, to small tributaries with sufficient flow to maintain a gravel substrate. Trout fry and parr are associated primarily with small tributaries.

Fish habitats that occur outside of the main channel of a stream system are also known as “off-channel” habitats. Frequently, adult fish neither reside nor spawn in these areas that can provide juvenile fish with rearing space. In coastal drainages, these areas can provide winter habitat for juvenile salmonids for a significant proportion of the total population when the main channel is subject to high, scouring flows. Juveniles originating from the main stream channel can inhabit most of the length of these smaller drainages.

Side channels are parts of the main stream and usually occur in close proximity to it, but are frequently isolated from the main flow. Because of this close association, these features are included within the RMAs of the main stream. Two ways in which side channels form are:

1. as a cut-off channel on the inside of a meander bend
2. as a remnant portion of the original channel left downstream of a logjam after the main channel has migrated around the blockage.

Side channels are diverse and may contain year-round, intermittent or ephemeral flows. Whenever they contain LWD, which provides cover and habitat complexity, these sites are especially important for juvenile salmonids overwintering in coastal drainages, and for spring and summer rearing in interior watersheds. Logjams at the upstream end of side channels may reduce the impact of extreme floods on fish survival. These channels can often provide salmonids with spawning habitat if good groundwater percolation is available.

Ephemeral streams have well-defined, continuous channels but flow for only part of the year, usually in winter and spring in coastal drainages, and in spring, early summer and the autumn in interior ones. Seasonal streams accessible to fish are important because they may provide overwinter shelter in coastal systems, and early spring spawning and rearing habitat in both interior and coastal drainages.

Intermittent streams do not dry up completely during seasonal periods of low rainfall, but retain water in separated pools along the channel. Intermittent tributaries that contain water all winter, but are reduced to isolated pools in summer, can support salmonids all year in both coastal and interior watersheds. These tributaries are commonly used by coho salmon juveniles, trout and char.

Although they might contain only marginal habitats when steep, ephemeral and intermittent streams must be considered as fish streams if their gradients are $< 20\%$, no barriers to fish access exist, and no acceptable fish inventory demonstrates otherwise.

Lakes and their tributaries

Many lake fishes, especially salmonids, commonly spawn and rear in the inlet tributaries of lakes or their outlet streams. Both anadromous sockeye salmon and kokanee may also spawn on gravel deltas and beaches in lakes from mid-summer to autumn. Burbot spawn near the mouths of tributaries, and in the shallow, littoral areas of lakes in late autumn and winter. Spawning may occur well after the lake surface has frozen. The reaches of lake tributaries that contain spawning and rearing habitats accessible to anadromous salmonids, game fishes, and regionally important fishes are fish streams. In some lake systems, fish may move up tributaries only for very short distances; nevertheless, this habitat could be critical for spawning and vital for population survival. Often, the only spawning habitat available to entire lake populations occurs in tributaries that contain water only during the spring period of increased discharge. All streams $< 20\%$ grade that are tributaries to lakes are highly likely to contain either stream-resident fishes or individuals that migrate into them from the lake.

Natural barriers to fish distribution

In most streams, the upstream migrations of anadromous fish and the distribution of resident fish are eventually limited by physical barriers such as **falls** or **steep cascades**. The ability of fish to move upstream past these obstacles can vary annually and seasonally. Salmon and trout species are capable of ascending some high falls or chutes during high-flow periods.

Waterfalls, impassable at one level of discharge, may be passable when flows have changed. Potential barriers such as falls must be examined at different flow conditions to assess whether they are passable to fish. For these reasons, all streams of $< 20\%$

average gradient are designated as fish streams, regardless of potential barriers, in the absence of an inventory that proves otherwise.

The best way to confirm whether falls limit the distribution of fish in a stream is to sample for fish upstream of the potential barrier.

Similarly, logjams or beaver dams consisting variously of large woody debris (LWD), small organic debris, and stream substrate materials may not define the upper limit of fish distribution in streams. Logjams and beaver dams are not permanent structures. Although they may serve as a temporary barrier to fish migrating upstream to spawn or rear, resident salmonid populations are frequently found upstream of these structures and in reaches between them if habitat and gradients are favorable. Logjams are often thought to be impassable to migrating spawners; however, most smaller logjams are passable unless a substantial buildup of bedload over the woody matrix of the logjam causes a major vertical change in the elevation of the streambed.

Adults and juveniles are often able to migrate past logjams because channels have been scoured underneath them. Scouring may not be possible in highly confined channels such as canyons (where the substrate may be largely bedrock), and the logjam may persist for a long time. Consult with local MELP and (or) DFO offices concerning situations where barrier permanence is questionable.

An artificial barrier (e.g., culvert) that limits the upstream movement of fish is not sufficient justification for the stream segment upstream of the structure to be designated as non-fish bearing if the gradient of that part of the stream is $< 20\%$.

Confirming fish absence upstream of known and potential barriers

If suitable habitat is available, resident fish may be present upstream of either a known or potential barrier to fish movement. The following steps are necessary to confirm fish absence upstream of either a known or potential barrier in those cases where it is suspected that:

1. all reaches upstream of the barrier are simultaneously dry at any time of the year
2. no perennial fish habitats exist upstream of the barrier.

One part of this confirmation requires an acceptable fish inventory performed as described in this guidebook under “Acceptable survey methods” in the reach immediately upstream of the barrier at a time of year when wetted habitat is available and sampling conditions (e.g., temperature) are suitable for the gear type selected (see “Sampling techniques and gear” and “Survey timing”). Modifications to these field assessment techniques can be made through local area agreement as described in this guidebook. If no fish are found by this inventory, all areas upstream of the barrier can be designated as non-fish bearing if visual confirmation is obtained that all reaches are

simultaneously dry and that no perennial fish habitats occur. Visual inspection from aircraft can be employed for this purpose where the canopy of the riparian forest is sufficiently open to allow observers an adequate view of the streambed of the drainage in question. Where the canopy obscures the view, visual inspections can be completed on foot.

If the visual inspections fail to confirm the lack of perennial fish habitats, or if water remains in any reach of the stream channel network < 20% gradient, these reaches are fish streams unless fish absence is demonstrated by an acceptable fish inventory, or unless a local area agreement is in place.

Fisheries-sensitive zones

The *Timber Harvesting Practices Regulation* defines fisheries-sensitive zone (FSZ) as follows:

Fisheries-sensitive zone means a flooded depression, pond or swamp, but does not include a stream, wetland or lake, that either permanently or seasonally contains water, and that is seasonally occupied by a species of fish listed in the definition of “fish stream” in the OPR.

Fisheries-sensitive zones are therefore the parts of a drainage basin that do not meet the Code definition of stream, are not classified as lakes or wetlands, but are occupied at least some time of the year by fish. These off-channel habitats provide aquatic environments important for the life history of several fish species. Flooded sites occurring in close association with streams and lakes include a wide variety of features. They may be small (< 0.1 ha) ephemeral sites that are especially difficult to detect when dry, or major floodplain features such as swamps (flooded woodland), sloughs (marsh or mixed woodland), valley wall-base ponds, and small watercourses that cannot be classified as streams.

Watercourses that are FSZs typically have very low gradients, organic beds, and no evidence of scour or mineral alluvium. They are most frequently ephemeral and represent the maximum extent of the watercourse network during seasons of high rainfall or snowmelt. These small channels may occur anywhere within a floodplain, frequently in the lower portions of watersheds, but also at the headwaters of drainages with low topographic relief. In headwater areas, they often arise downslope of seepage sites. These organic channels are especially common in the northern interior of the province.

In regions of moderate to high topographic relief, off-channel habitats are associated with lower-gradient reaches, generally in the lower sections of watersheds. The valley floors are wider and the floodplains more complex than in reaches upstream. The main stream channel is generally unconfined by canyons or other features. Many off-channel features are created over time by lateral movement of the main channel across its floodplain. These sites receive water during floods, from a raised water table in winter

in coastal drainages, or from a sidehill through an intermittent tributary, seepage or spring. Although these features were historically a part of the stream network, they no longer meet the definition of stream because the original channel bed has become obscured with accumulations of organic material, soil horizons are developing, and no evidence of scour exists. Any mineral sediment present tends to be fine lacustrine material rather than fluvial in origin. Perennial terrestrial vegetation often grows within these features.

In coastal watersheds, especially those in the southern and central coasts, off-channel areas are frequently important as overwinter habitat for coho salmon and cutthroat trout juveniles. Fry and parr generally enter these sites with the onset of autumn rains and freshets, remain there over the winter, and migrate back into the main channel (or directly into the ocean) in the spring. These sites of winter shelter can contribute substantially to the overall survival of juvenile salmonids in coastal watersheds.

In north-coast streams, coho fry and yearlings may enter off-channel habitats during early-spring floods, and reside there until they migrate back to the main channel as smolts one or two months later. In interior watersheds, off-channel sites may contain chinook salmon fry, bull trout juveniles, kokanee and anadromous sockeye fry, and other species for much of the spring and summer.

The importance of these small features to fish populations must not be underestimated. When anadromous salmonids, game fishes, regionally important fishes, or threatened and endangered fishes use these areas, they must be identified as fish-bearing waters.

Off-channel areas may be too small to receive protection as a classified wetland; however, FSZs are usually included within the RMA of a stream because they are most frequently a part of the active floodplain.

Fisheries-sensitive zones are generally characterized by low-energy water flows; therefore, the role of streamside vegetation is not as critical in protecting their perimeters and banks from erosion compared with stream channels. However, LWD entering these areas is still valuable as cover for fish and for providing habitat diversity. More flexibility is found in the Code regulations and *Riparian Management Area Guidebook* regarding habitat protection for FSZs. For example, there are no tree retention requirements for FSZs.

Protection for FSZs is provided by the following Code requirements:

1. Unless the district manager authorizes the following activities in writing with or without conditions, a person must not
 - a. fall timber onto a FSZ unless this is the only way timber can be felled to provide for worker safety, or
 - b. yard or skid timber through or over any FSZ.
2. Forest harvesting and silviculture treatments must not result in the deposit of a volume of slash or debris capable of damaging fish habitat or reducing water quality in
 - a. a FSZ or
 - b. in a stream that can
 - i. transport the slash or debris into a FSZ or
 - ii. may be destabilized by the slash or debris and result in increased sediment deposition into a FSZ.
3. The construction or modification of roads must not result in the deposition of slash and debris or erodible soil capable of damaging fish habitat or reducing water quality in the same water bodies in paragraph (2) above.
4. When constructing excavated or bladed trails, a person must not deposit soil material or slash in a FSZ or in a position where this material can be transported by water into an FSZ.

The presence of FSZs in floodplains is highly likely. Therefore, these resource features should be expected whenever cutblocks, roads or trails are sited within floodplains. During summer, when off-channel habitats may be dry and obscured by vegetation, they may be identified by the plants that frequently grow within them or around their margins. Depending on the region, these plants might include skunk cabbage, water sedges and species of *Equisetum* such as swamp horsetail.

There is no requirement to map FSZs (with one exception) or to flag them in the field. The exception is that known FSZs large enough to be mapped at the 1:20 000 scale are to be included in forest development plans as known resource features within the area of proposed category A cutblocks and for the adjacent areas that may be affected by these cutblocks and proposed roads [see OPR section 20(1)(a)(i)]. However, if these resource features are to be effectively protected, all FSZs should first be identified in the field. Flagging these sites, which are often small and easily overlooked, will allow them to be more easily seen by supervisors and operators on site when forestry activities are in progress.

Together with falling and yarding trees away from FSZs, and avoiding road construction through them, a best management practice is to maintain a machine

exclusion zone (5 m wide) around their perimeters. Operations should be timed and conducted to avoid:

1. introductions of sediment and debris
2. restrictions of natural water flow patterns and fish movements into FSZs and out from them.

Estuaries (coastal streams only) and marine-sensitive zones

Estuaries include the intertidal zone of coastal streams directly influenced by saline (brackish) water. They vary in size and complexity from single channels with a very limited intertidal area, to very large systems with extensive intertidal marshes, ponds and channel networks.

Estuaries are important and productive rearing areas for anadromous salmonids, as well as important spawning and rearing areas for marine species. Salmonid smolts migrate downstream to the estuary in spring and early summer. Depending on the species and location, smolts spend variable periods of time feeding and completing their adaptation to the saltwater environment before migrating offshore. Coho fry are also known to rear in the upper reaches of many estuaries.

Cutthroat trout and Dolly Varden char do not migrate offshore in contrast with salmon and steelhead trout, but may migrate from the stream to the estuary and back several times each year.

The estuarine portion of a stream is assigned the same fish-bearing status and stream-riparian class as the reach immediately upstream of tidal influence.

Because salmonids and other natural resources listed in the regulations occur in estuaries, the seaward portion of an estuary that does not meet the definition of stream is protected as a **marine-sensitive zone (MSZ)**.

In the regulations, marine-sensitive zones include herring spawning areas, shellfish beds, coastal marshes, aquaculture sites, juvenile salmonid rearing areas, and adult salmonid holding areas.

Forest harvest operations and coastal log handling can damage these marine sites directly by heavy equipment operations, by depositing fill, and by sediment and debris delivery especially from streams. These harmful effects should be avoided.

The main goal associated with forest harvesting in nearby sites is thus to avoid introductions of sediment and debris into estuaries and other MSZs from sources upstream. Marine-sensitive zones are a resource feature, and as such, the locations of *known* MSZs are to be included on forest development plan maps within Category A cutblocks and adjacent to them.

Protection for MSZs is provided by the following Code requirements:

1. Forest harvesting and silviculture treatments must not result in the deposit of a volume of slash or debris capable of damaging fish habitat or reducing water quality in:
 - a. a MSZ or
 - b. in a stream that can
 - i. transport the slash or debris into a MSZ or
 - ii. may be destabilized by the slash or debris and result in increased sediment deposition into a MSZ.
2. The construction or modification of roads must not result in the deposition of slash and debris or erodible soil capable of damaging fish habitat or reducing water quality in the same water bodies noted in paragraph (1) above.
3. When carrying out helicopter, balloon or another type of aerial harvesting, a person must not use the following sites as log drop areas:
 - a. the littoral zone of a marine or freshwater system,
 - b. water that is less than 10 m deep, or
 - c. an MSZ.

Methods for minimizing damage to MSZs are given in the *Riparian Management Area Guidebook*.

Methods for identifying fish streams

Specific subsections of this chapter contain compulsory methods referenced by the regulations (fish stream definition). These subsections are contained within “Field procedures.”

The subsection “Determination of stream gradient in the field” provides the acceptable methods for the determination of channel gradient within a stream reach.

Under “Fish sampling procedures,” the subsection “Acceptable survey methods” provides two acceptable field survey (fish inventory) options: **Option 1: Systematic-sample method, and Option 2: First-fish-captured method.** One of these field survey options must be employed to demonstrate fish absence in reaches of < 20% gradient where:

1. no local area agreement provides an alternative type of assessment, or
2. where there is insufficient existing information from 1:20 000 reconnaissance fish and fish habitat inventories for the proponent to generate an acceptable non-fish-bearing status report (based on an assessment of the available data).

Elsewhere within “Fish sampling procedures,” particularly within the subsections “Sampling techniques and gear” and “Survey timing,” critical information and guidelines are provided in support of the mandatory field procedures detailed in “Acceptable survey methods.” It is strongly recommended that these guidelines be seriously considered by the proponent that chooses to undertake field surveys to establish fish absence in streams.

This chapter provides the methodology for correctly identifying a fish-bearing stream reach and recording the pertinent information. Information and mapping requirements are detailed and methods are presented for identifying fish streams for application to the forest development plan and for assessments required for silviculture prescriptions and road layout and design. Within this guidebook, the terms “fish inventory” and “survey” are used synonymously. The term “assessment” when used to denote field activity for fish-stream identification, also has the same meaning as inventory or survey. However, an *assessment* of existing fish distribution information (i.e., 1:20 000 reconnaissance fish and fish habitat inventory data) as one part of the fish-stream identification process is an office exercise.

Forest development plans require that only *known* information be presented in most cases. Under the regulations, “known” refers to information that is:

1. contained within a higher level plan, or
2. otherwise made available by the district manager or designated environment official at least four months before the operational plan is submitted for approval.

Field assessments must be carried out to determine the riparian class of streams, wetlands and lakes before a forest development plan is made available for review for community watersheds and other areas where “joint approval” is necessary. Joint approval means the approval of both the district manager and the designated environment official.

Assessments for areas of joint approval are limited to those water bodies shown on 1:20 000 scale maps. The district manager can also require these field assessments to be performed for a forest development plan outside of joint approval areas if the information is deemed necessary to adequately manage and conserve forest resources (Code, section 41).

Field assessments are required for riparian classification at the silviculture prescription level and include **all** streams, lakes and wetlands in the area affected by category A (approved) cutblocks and roads. All streams within community watersheds are managed as fish streams; however, at the level of the silviculture prescription, fish-stream assessments are required in community watersheds where stream crossings are to be built in order to ensure safe fish passage in streams actually used by fish.

Planning assessment and identification at the level of the forest development plan

The first phase of fish-stream identification is largely an office exercise and should be performed as part of the development plan for a watershed.

The proponent must ensure that a forest development plan includes and maps, among other known information, the following *known* items for the entire area of the plan:

1. the location of streams, wetlands and lakes that are shown on 1:20 000 scale forest cover maps, or fish and fish habitat inventory maps (reconnaissance level), or terrain resource inventory maps (TRIM)
2. fish streams
3. the riparian class of streams, wetlands and lakes
4. lake class.

Additionally, *known* FSZs and MSZs large enough to be shown at 1:20 000 scale will be mapped as resource features within the area of proposed category A cutblocks and for the adjacent areas that may be affected by these cutblocks and proposed roads.

Document fish-stream status for all streams on the submitted plan map through the following planning sequences:

1. Obtain all available fish use information for the drainage basin in question.

Subject to any requirement to use known information, a person preparing an operational plan must use the most comprehensive and accurate information available (i.e., the best available information).

Fish and fish habitat inventories may have already been carried out by fisheries agencies in watersheds where harvesting is proposed. Fish-bearing stream reaches can often be determined for areas where this information is available.

Most available information on fish distribution and habitat has been compiled into the **Fisheries Information Summary System (FISS)**. FISS provides a standardized, systematic summary of information about fish, fish habitat and resource use (fishing). FISS is digital and fully georeferenced, using the BC Watershed Atlas and unique watershed/water-body identifiers. FISS may include information about all water bodies (lakes and streams) and all species of fish. Major components of FISS include a compilation of existing fish and fish habitat data, including known fish species distribution, references and 1:50 000 map-based habitat classification

FISS contains information previously available in the Stream Information Summary System (SISS) catalogues, and any other fisheries information available when the compilation was undertaken. Information from recent projects or significant sources that may have been missed in FISS, or may be more recent than the latest FISS update, should be sought. Contact regional fisheries staff regarding the status of FISS for the project area. Access to FISS data is discussed in Appendix 1.

The BCF and MELP also have a program of reconnaissance (1:20 000 scale) fish and fish habitat inventory. This is a sample-based survey covering whole watersheds (i.e., all lakes, stream reaches, and wetlands connected to these water bodies within the watershed) as defined from 1:20 000 scale maps and air photos. This inventory provides information on fish species characteristics, distributions and relative abundance as well as stream reach and lake biophysical data for interpretation of habitat sensitivity and capability for fish production. The reconnaissance inventory is directly applicable to fish-stream identification because it identifies *known and probable areas of fish presence and fish absence* at the 1:20 000 scale, and identifies areas of uncertainty where further sampling to determine fish stream status is required. This information is available in MELP regional offices.

Contact the MELP regional office to determine whether any **regionally important** or identified **threatened or endangered fish** might occur within the area in question. The proponent is still required to prove prior to the approval of site-level operational plans that these species do not occur in streams (a) for which no fish inventory information exists, and (b) that would be designated as fish streams based on gradient criteria.

2. Perform field assessments where required for forest development plans.

Field surveys must be performed to determine the riparian class of streams, wetlands and lakes for forest development plans within community watersheds and other areas of joint approval. These assessments are limited to those water bodies that:

1. are shown on a 1:20 000 scale reconnaissance fish and fish habitat inventory map, forest cover map, or terrain and inventory resource map
2. either:
 - are in or adjacent to a proposed cutblock (that is, could be affected by the cutblock), or
 - could directly affect a proposed road or be directly affected by a proposed road.

Inventories at the 1:20 000 scale are discussed in detail in the RIC manual *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory: Standards and Procedures* (see “References for fish-stream identification”). This manual is strongly recommended as reference material for survey planning and data standards. All procedures within the manual are consistent with site-specific field methods detailed in this guidebook (see “Field procedures”).

3. Present all known information on the forest development plan map.

Show all known fish-bearing stream reaches, riparian classes and resource features (mappable MSZs and FSZs) on the forest development plan map.

In addition to this basic requirement, the following information and method of presentation are recommended to clearly distinguish fish-bearing stream reaches from streams without fish, and to show key physical reach characteristics that determine the stream-riparian class. This documentation will assist in predicting the probable limits of fish distribution within the drainage, and therefore, aid in the determination of the need for fish surveys at the level of the silviculture prescription.

Information recommended for the FDP map includes a reach summary symbol (Appendix 2) that shows known fish presence, channel width, gradient, stream-riparian class, and known fish distribution limits and barriers to fish migration.

Label or show all fish streams in red on the plan map submitted. Classify these fish streams as either S1, S2, S3 or S4 on the basis of width (see the section “Determination of stream channel width” and the *Riparian Management Area Guidebook*).

Streams without fish will simply appear in blue on plan maps. Classify streams without fish as either S5 or S6 on the basis of width (see the section “Determination of stream channel width” and the *Riparian Management Area Guidebook*).

It is recommended that mapping be compatible with the RIC manual *Standards for Fish and Fish Habitat Maps* (RIC 1998). A map example is provided in Appendix 2.

Fish-stream identification and stream-riparian classification at the level of the silviculture prescription

For the silviculture prescription and road layout and design the correct riparian class must be determined for *all* streams, wetlands and lakes for the area of the plan. Field confirmation of different types of information included in forest development plans is required for detailed maps containing access roads and cut blocks at the recommended scale of 1:5000. The determination of the correct RMAs around streams requires accurate measurements of channel widths on site. Where existing information on fish distribution is not sufficient, field surveys will be required to establish fish absence in stream reaches of gradients < 20%.

The fish-bearing status of stream reaches may be assigned on the basis of gradient criteria alone or by field surveys. The decision on whether to accept the fish-stream default for reaches with < 20% gradient or perform field surveys to confirm fish absence will be based on an assessment of the likelihood that fish will occur in each reach. The process for determining survey priorities will be greatly assisted by obtaining and applying existing data about the specific stream or from the surrounding area in question. Data collected by the provincial program of reconnaissance (1:20 000) fish and fish habitat inventory (funded by Forest Renewal BC) are especially useful for this purpose and can substantially limit the numbers of field assessments that might otherwise be undertaken.

Determination of the need for field surveys for fish-stream identification

Application of information from the reconnaissance (1:20 000) fish and fish habitat inventory

The reconnaissance fish and fish habitat inventory is intended to form the area-based foundation for site-level inventories such as fish-stream identification where fish distribution and physical habitat data are collected. The reconnaissance procedure is designed to provide the 1:20 000 scale information suitable for forest development plans. This information is obtained systematically from whole watersheds from representative samples of stream reaches stratified by physical characteristics and location within the watershed (e.g., by gradient and stream size). These inventories not

only identify known areas of fish occurrence, they also collect detailed information on fish species distribution, relative abundance and stream biophysical data that together are necessary for the interpretation of the likelihood of fish presence and the capability of the habitat to support fish.

Therefore, the data generated from these watershed-level inventories are the best available for making decisions on which specific stream reaches to assess for fish-stream identification.

For areas where the reconnaissance inventory has been performed, the data should be obtained and reviewed by the proponent to identify priorities for reach surveys. On the basis of reconnaissance information, stream reaches can be described as having very high probability of fish presence, very low probability of fish presence, or a fish-bearing status that is less certain.

Many reconnaissance inventory projects generate a “non-fish-bearing status report” listing stream reaches that have sufficient evidence to support a designation of non-fish bearing. Other reaches will clearly have been confirmed as fish streams.

For cases where reconnaissance inventories have shown that fish presence is highly probable, further sampling of similar reaches from the same watershed **is not recommended**.

For cases where reconnaissance inventories have shown that fish absence is highly probable, and a justification (non-fish-bearing status report based on existing information) is prepared and kept on file by the licensee, further sampling of similar reaches within the same watershed **is not recommended**.

Priority can be assigned to assessing reaches of < 20% gradient where fish presence is uncertain.

Known information and local-area/regional agreements

Sufficient knowledge of fish distribution may already be available for specific areas from the reconnaissance fish and fish habitat inventory, FISS database, and other sources to warrant an agreement among the resource agencies (MELP regional representative and the MoF district manager) and licensees concerning sampling priorities, protocols and exemptions for fish-stream identification. For example, the requirement to confirm fish absence in the field may be waived for reaches of certain types, characteristics and (or) locations within a defined local area.

Local area agreements may therefore involve modifications to field sampling procedures for the purpose of fish-stream identification in specified situations (i.e., modifications of the acceptable protocols specified in this guidebook).

The areas under such an agreement may encompass a major watershed, a portion of a forest district, an entire forest district, or even a region. In all cases, the best basis of an agreement is sufficient information on the probabilities of fish presence or absence that the risk of error in assigning non-fish-bearing status to a reach is acceptably low. However, local area agreements are still possible where reconnaissance-level information is not yet available if all parties entering into the agreement are satisfied that the level of risk is acceptable.

Local agreements might apply, for example, to designate as non-fish bearing and thus exempt from field surveys all reaches occurring above a certain elevation, or to ephemeral or even perennial streams above some minimum gradient threshold. Additionally, existing information might demonstrate clearly what the minimum height for barriers to fish passage in small streams (e.g., < 1.5 m wide) might be. The local definition of barrier might then be adopted for a given situation by agreement. Again, whatever data or criteria are used as the basis of a local area agreement, the level risk must be mutually acceptable.

Inventory information in support of local area agreements may not yet be available for many areas. However, as surveys for fish-stream identification proceed, sufficient data may be available in the near future to further assist the parties that wish to consider developing these agreements with the objective of reducing the costs of fish surveys associated with stream classification requirements.

General considerations for assessments in areas with limited existing inventories

Together with considerations presented in the section “Factors influencing fish-stream identification” the following guidelines will assist in the evaluation of the need for field surveys, and for planning assessments.

1. If no fish distribution data are recorded, or if more information is required, determine whether the habitat in the subject area is capable of supporting fish in stream reaches where gradients are < 20%.
2. Review aerial photographs and topographical maps to assist in determining whether a stream reach is accessible to fish or has potential fish habitats. The location of the area in relation to topographic features and watershed drainage patterns will help in these assessments.
3. Identify potential barriers to fish access such as steep canyons or waterfalls occurring downstream. Note that resident species may occur upstream of these barriers.
4. Identify reaches containing floodplains because these sites likely contain side channels, small tributaries, and fisheries-sensitive zones. These features are frequently visible on aerial photographs. Off-channel habitats in both coastal and interior drainages accessible to anadromous salmonids will likely contain juveniles

of these species. Otherwise they may contain juveniles or adults of resident populations of game fish species.

5. In coastal drainages for which no fish information has been recorded, habitat use by anadromous fish is very likely unless an impassable barrier exists at the stream mouth. Habitat use by resident salmonids above those barriers is also difficult to discount in either coastal or interior streams if gradients are favorable. It is usually safe to assume that some level of habitat capability exists, especially in areas of < 12% average gradient. Therefore, the gradient criterion for fish stream designation (< 20% average grade) can either be accepted by the proponent, or plans for field assessments can be initiated.

Map scale and information review

Map scale is a critical factor for reviewing information to identify areas where fish-bearing streams may occur and whether further sampling may be required. The majority of watershed surveys have historically been carried out at a scale of 1:50 000. Reconnaissance inventory is limited to drainage networks visible on 1:20 000 TRIM and forest cover maps. Most forest planning (both five-year and 20 year plans) has historically been at a scale of 1:20 000. However, the scale frequently used for silviculture and stand management prescriptions, and logging plans has been 1:5000. Smaller features such as ephemeral side channels, some tributaries, and fisheries-sensitive zones can be shown at 1:5000 scale, but may be missed entirely on maps of 1:50 000 or 1:20 000 scale.

The accuracy of drainage networks depicted on the 1:20 000 base maps varies throughout the province. However, results of reconnaissance fish and fish habitat inventories and other surveys performed at the 1:20 000 scale can often be applied to an unsurveyed stream of similar characteristics within the immediate area even if it is not referenced on the reconnaissance map.

Standards, permits and qualifications for fish-stream identification

Data collection and recording standards

Fish-stream identification should be undertaken according to standards for field sampling, data collection and data recording established by the Resources Inventory Committee.

Detailed Resources Inventory Committee manuals prepared for fish and fish habitat inventories are available from Superior Repro at 200 – 1112 West Pender Street, Vancouver, BC V6E 2S1 (Internet: www.superiorprint.com; telephone (604) 683-2181). The *Reconnaissance (1:20 000) Fish and Fish Habitat Inventory Manual* is an essential reference on data recording protocols for fish-stream identification (see the section “References for fish-stream identification” in this guidebook). This manual contains standard data collection forms for stream reaches, reach sample sites, and fish collection records which are recommended for use. The standard for database

management is the Field Data Information System (FDIS) which is available to capture and store reach, sample-site and fish collection data.

Copies of the field forms can be obtained from Crown Publications at 521 Fort Street, Victoria, BC V8W 1E7 (Internet: www.com/crownpub/; telephone (250) 386-4636).

The RIC manuals contain much more information than that required to identify fish-bearing stream reaches because provincial reconnaissance inventories need to obtain more comprehensive and detailed information for resource management purposes.

However, there are many advantages for both licensees and resource agencies to collect, record and store information in a consistent and compatible manner.

Information supporting fish-stream identifications will be easier to access for review, and it will be easier to incorporate into provincial databases to expand these sources of readily available data on known fish distributions.

This information together with provincial inventories will provide the best foundation for future local-area agreements on fish-stream identification protocols, and will facilitate future cost-benefit decisions by licensees on whether to perform field surveys for fish-stream identification in specific situations.

The basic information needed for fish-stream identification is fish presence or absence; therefore, describing the distribution of fish in a drainage basin is far more important than gathering data on fish abundance or population age structure. Similarly, habitat quality is not a primary factor for fish-stream identification: fish-bearing status is not based upon the potential of the habitat to produce fish. However, habitat information can provide important clues to the type of fish-habitat use that can occur in an area, and it can identify operational considerations for locating stream crossings and harvesting in a site.

Inventory results are subject to review by the resource agencies in all cases. Audits may be carried out on the basis of the procedures outlined within this guidebook to ensure that fish-stream identification has been performed professionally, thoroughly and with minimum bias. The use of common standards can confirm the effort and diligence applied in developing stream-riparian classifications.

Recommendations for identifying and mapping water bodies

Identify by name and code all water bodies in question as accurately as possible.

Consistent with RIC standards, it is recommended that each stream (or lake) within the plan area be identified by its name (if one exists) and watershed code number.

All streams and lakes in BC that have received official names are included in the *Gazetteer of Canada* (see the section “References for fish-stream identification”). These names should be recorded on the plan map and eventually included in a stream inventory form. Local names should also be recorded if they differ from the official ones.

The MELP has developed a watershed coding system for the hierarchical numbering and cataloguing of watersheds, streams and lakes within the province. Most lakes and streams depicted on 1:50 000 scale maps have assigned watershed codes contained within a watershed code dictionary. These codes are explained in *A Guide to the Hierarchical Watershed Coding System for British Columbia* available from the BCF (see the section “References for fish-stream identification”).

For water bodies not identified with a watershed code number because of map scale, interim guidelines have been developed and are available from MELP. These guidelines, described in *Users Guide to the British Columbia Watershed/Waterbody Identifier System* require an **interim locational point** (ILP) to be assigned and mapped at the stream termination or lake outlet, and the information about the location recorded. The users guide includes a sample ILP record table. Correct watershed codes can be generated from the ILPs by the BCF for the watershed dictionary.

Identify and map all fish-bearing stream reaches in the area of the site-level plan.

Examine aerial photographs and topographical maps and identify streams, lakes and wetlands on the plan map. Identify all stream reaches, reach breaks and reach gradients.

Stream reach gradients can be first estimated from topographical maps, then confirmed in the field. Methods for estimating gradient from maps can be obtained from RIC fish habitat inventory manuals.

Reach numbers are recommended: preliminary numbers should be assigned at this stage. Reach numbers are assigned in an upstream ascending order starting from the mouth of the stream. These numbers and reach boundaries should be included on a field map if ground-based verification of gradients and fish presence is necessary at a later date. Beware of map scale: at larger scales, reaches may be further subdivided. Reach numbers are confirmed when the reach boundaries have been verified in the field. Ensure that assigned reach numbers are consistent with any existing ones assigned in stream surveys conducted previously. This information is a component of the fish and fish habitat inventories on file in MELP regional offices.

To capture reach type of information electronically, a data-entry screen for stream reach information is available in association with the RIC standard reconnaissance inventory database (FDIS).

Fish collection permits

Fish collection permits are necessary, and must be obtained before any fish sampling is undertaken. The appropriate MELP regional office must be contacted in regard to sampling for all freshwater fish species, and the appropriate DFO divisional office contacted to sample for anadromous salmon.

Sampling for fish during inappropriate times or by using inappropriate gear or methods can have significant harmful effects on individual fish or entire populations. A cautious approach, exercised through professional judgment and experience, is warranted. For example:

1. Avoid electrofishing near fish redds because electric shock can reduce egg and alevin survival. When sampling just after the salmonid spawning season, look for salmonid redds which may appear as mounds associated with variously-shaped depressions in the stream bed.
2. Avoid sampling where there are aggregations of spawning or overwintering fish. Employ caution in any situation where a species is known to be limited to single habitat type which itself has a very restricted occurrence within a water body.
3. Terminate sampling when survey objectives have been met. For example, stop sampling if fish are caught in abundance within the first few metres of stream during a fish-stream survey.

Always consult with regional fish/habitat inventory specialists and (or) regional fisheries management staff to identify any specific fish sampling concerns.

Fish species identification

Two references should be used to identify fish collected in the field (see the section “References for fish-stream identification”). The first, by McPhail and Carveth (RIC 1994), contains keys to fish species of British Columbia on a regional basis. The second, by Cannings (1993), will assist personnel to identify rare, threatened or endangered species.

Some fish species are very difficult to identify in the field. For example, the very young fry of some salmonids such as rainbow and cutthroat trout are difficult to separate. More challenges will be encountered with some threatened, endangered or regionally important fishes. In some cases (for example, some species of dace) species can be identified only by professional fish taxonomists because internal dissection of the specimens is required. Therefore, voucher specimens might be required to identify

some species or confirm some identifications made in the field. See *Fish Collection Methods and Standards* (RIC 1997).

Before initiating fish surveys, consult with MELP regional biologists to determine whether regionally important, threatened or endangered species might be encountered, and whether voucher specimens will be needed.

Qualifications and training

Field surveys for fish-stream identification must be well designed and will be carried out by qualified and experienced personnel who have the necessary expertise. Fish sampling will be conducted by persons who have appropriate expertise, or have received appropriate training in fish sampling techniques and fish species identification. Persons trained to the necessary level of expertise for fish surveys most commonly include biologists, biological technicians and environmental technicians.

Field procedures

Determination that a watercourse is a Forest Practices Code stream

To be designated as a stream under the Code, a watercourse must satisfy the definition of reach given in Part 1 of this guidebook. Therefore, unless the exceptions listed in the reach definition apply, a watercourse must have a channel bed continuous for at least 100 m, and the conditions of either scour or alluvial deposition must also be satisfied so that the watercourse can be designated an FPC stream (see these sections of this guidebook: “Channel bed,” “Scour,” “Deposition,” and “Alluvium”).

The length of a given watercourse should be measured (e.g., with a hip chain) along the centre of the channel, or if this is physically impractical, along one bank following the sinuosity of the channel. Although most watercourses of questionable stream status will be those with narrow channels (e.g., streams with channels usually ≤ 3 m wide), measurement error will always be a concern. Variations will occur among individuals making the measurements. When a channel is measured and the bed (that has sufficient evidence of scour or alluvial deposition) is continuous for nearly 100 m (e.g., 98 m long), consider a conservative approach and designate the watercourse as a valid reach and Code stream because of the potential for erosion, deposition and material transport downstream.

As discussed elsewhere in this guidebook, streams are characterized on the basis of the reach, and the boundaries of reaches (reach breaks) occur where there is a significant change in channel morphology. **At the head of a watercourse where the channel first emerges at the surface of the terrain, the location of the upper boundary of the uppermost stream reach is the location where the first significant evidence is found of scour through to the mineral substrate or**

alluvial deposition (if the crew was proceeding downslope). **Channel length measurements begin or end at this boundary.** Therefore, from that location, the watercourse must have a channel bed continuous for a minimum of 100 m in order for it to be designated a Code stream. If the crew was proceeding upstream, this upper boundary would be the last location where scour or deposition was evident.

If the channel bed in the uppermost part of the drainage failed to meet the 100 m minimum length, that length of watercourse would be designated an NCD (non-classified drainage). To determine the uppermost stream reach in the drainage, channel length measurements would begin again (or end, depending in the direction the crew was proceeding) at the next significant evidence of either scour or alluvial deposition.

Determination of stream channel width

Measurements of channel width are not required to identify stream reaches with fish and those without fish. Fish-stream identification only involves sampling fish and measuring gradient. However, methods for measuring width are summarized in this guidebook because:

1. field crews are required to measure width for stream-riparian classification (S1–S6)
2. good protocol and economics often dictate that reach widths and gradients are measured at the same times and locations.

Therefore, simultaneous measurements of width and gradient are strongly recommended.

Average channel width partially determines the stream-riparian class. Widths must be measured consistently, objectively and accurately. Because mean width varies between the headwaters of a stream and the mouth, width measurements should be made within each stream reach. Average widths can then be determined for each reach and used for reach classification.

Stream channel width is the horizontal distance between the streambanks on opposite sides of the stream measured at right angles to the general orientation of the banks. The point on each bank from which width is measured is usually indicated by a definite change in vegetation and sediment texture. This border is the “normal” high-water mark of the stream and is sometimes shown by the edges of rooted terrestrial vegetation. Above this border, the soils and terrestrial plants appear undisturbed by recent stream erosion. Below this border, the banks typically show signs of both scouring and sediment deposition.

Stream width measurements should not be made near (e.g., within 20 m) of stream crossings, at unusually wide or narrow points, or in areas of atypically low gradient such as marshy or swampy areas, beaver ponds or other impoundments.

Avoid measuring channel width in disturbed areas. “Normal” channel widths can be increased greatly by both natural and human-caused disturbances. These disturbances include debris torrents, logging operations (e.g., direct machine disturbance), and removal of LWD from the channel (see *Riparian Management Area Guidebook* for descriptions of disturbed channels).

To determine the mean reach width of a stream channel:

1. A fibre survey chain at least 50 m long can be used.
2. Include all unvegetated gravel bars in the measurement (these usually show signs of recent scouring or deposition).
3. Where multiple channels are separated by one or more vegetated islands, the width is the sum of all the separate channel widths. The islands are excluded from the measurement.
4. The width of the stream reach can be calculated by averaging at least six separate width measurements taken at equally spaced intervals
 - along a representative 100 m length of the reach (i.e., one measurement near either end of the 100 m sample and at least four measurements at locations in between), or alternatively
 - along the entire reach (i.e., one measurement near either end of the reach and at least four others at locations in between).
5. Always determine the undisturbed channel boundary. If there is evidence of disturbance, the proponent should consult with the local resource agencies on the appropriate stream width to be used. Generally, the following options will provide guidance:
 - move either upstream or downstream to points along the stream that do not show signs of disturbance (e.g., where banks are not eroded)
 - use the boundary of recently recolonized vegetation (e.g., alder, aspen, cottonwood).

Determination of stream gradient in the field

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see definition Fish
Stream paragraph b

This subsection provides the acceptable methods for the determination of channel gradient within a stream reach as referenced by regulation.

Gradient will be measured by obtaining one or more sightings that cover at least 100 lineal metres of stream channel. Measurements should be made along the longest sighting within a stream reach. The sighting distance should be at least 60 m long and preferably longer (e.g., 100 m). However, sighting distances along many small streams with thick riparian vegetation may be 30 m or less; therefore,

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Planning Regulation
Section 1 –
see definition Fish
Stream paragraph b
continued

where visibility is restricted, sightings in both upstream and downstream directions can be taken from a given point to maximize the length of stream covered from one location. More conveniently, the number of measurements can be increased by taking sequential readings in either the upstream or downstream direction.

The following acceptable procedures are based upon the use of a clinometer (e.g., a Suunto clinometer). Clinometers are commonly used to determine gradients. However, accuracy and precision is generally increased by using Abney levels and water levels (see RIC inventory manuals). The best precision is obtained by using rod and stadia.

1. The objective is to determine the average gradient for a reach and for sites within 100 m of a proposed stream crossing.
2. Gradient will be measured over a representative 100 m length of the reach, or for long reaches (e.g., 0.5–1.0 km long) or where sighting distances are short, obtain measurements at *three to six* sites along the reach.
3. Stream gradients should be measured with a clinometer to the nearest 0.5% at each site. The clinometer measures angles in a vertical plane upward or downward from the horizontal, expressed in degrees or per cent. The following steps detail the use of the clinometer:
 - One person stands at the water surface edge, for example, at the downstream end of the section to be measured. A second person stands at the upstream end at the water surface edge. The second person holds a rod or pole marked with fluorescent tape at the eye level of the person using the clinometer.
 - The person with the clinometer holds the instrument in front of one eye so that the scale can be read through the optics and round scale-window faces. The other eye is used to sight the eye-level mark on the pole held by the other person.
 - The instrument is aimed at the pole until the hair line viewed through the right eye is sighted at the eye-level mark on the pole.
 - The position of the hair line against the scale in the clinometer gives the slope reading in degrees (plus or minus) on the left scale and in per cent (plus or minus) on the right.
4. The gradient at each point in a stream reach can be measured in both upstream and downstream directions if possible, and readings averaged. Ideally, the sections in each direction should be at least 30 m long. Alternatively, average gradient can be determined from sequential and continuous sightings taken in either the upstream or downstream direction. Where heavy understorey vegetation limits visibility within a reach, shorter distances will have to be used, and measurement frequency increased.
5. If there are doubts about gradient uniformity within a long reach, obtain measurements at sites spaced at 100–200 m intervals to ensure that a

Operational
Planning Regulation
Section 1 –
see definition Fish
Stream paragraph b
continued

reliable mean gradient is determined. If the reach is known to be very uniform, gradient is determined sufficiently over a representative 100 m length. For surveys made over a large number of stream reaches, or for the entire watershed, a minimum number of measurements in specific reaches would be taken.

6. Be sure to note any points where the gradient changes abruptly. These points represent one type of reach break.
7. Where the channel has a strongly stepped profile or consists of a series of short segments bounded by morphological breaks such as falls, record (if possible) both the average slope over a long distance, and the average length and gradient of representative areas of the short segments (each < 100 m long) between the steps. This will aid in the determination of mean gradient for situations similar to that stated in paragraph “b” of the definition of reach (see Part 1).

Reach descriptions in support of fish-stream surveys

When fish-stream surveys are performed, the collection of basic information on stream reach characteristics and environmental conditions present (water temperature, streamflows) is recommended. This information is useful in evaluating conclusions on the fish-bearing status of a reach, and for assessing current and potential channel disturbance.

Stream reach characteristics, combined with an understanding of fish life cycles, will help to judge whether a reach has a high or low probability for bearing fish. If no fish are captured during a survey in a reach where gradient is < 20%, conclusions on fish absence can be justified from physical habitat characteristics observed in the field.

In addition, observations of channel features are important to identify whether any additional measures for stream channel protection are necessary. These observations can also reveal whether changes are required for width measurement procedures (for stream-riparian classification) because the channel has been widened due to disturbance. This information is easily recorded in the field by survey crews.

Field measurements can be recorded on the reconnaissance fish and fish habitat inventory site card. The site card is designed for data including fish migration barriers, reach types and channel disturbance indicators as described in the *Channel Assessment Procedure Guidebook*, and stream conditions at the time of sampling (e.g., water clarity, temperature and flow). An example of the site card is provided in Appendix 3. Components of the site card include:

1. **Key stream features** that relate to fish access and distribution. Obstructions to fish passage include falls, cascades or chutes, major logjams and culverts. Record the type of obstruction and note whether it is permanent (e.g., steep canyon) or temporary (e.g., logjam, culvert). The height and slope of the barrier should be measured, the presence of pools within the feature and upstream of it should be

noted, and photographs taken. Note the flow conditions in order to help assess whether fish can bypass the potential obstruction in higher flows. Be aware that resident game fishes may occur upstream of virtually any obstruction if gradients are favorable upstream.

- 2. Channel characteristics and reach type.** This information includes channel pattern and confinement, streambed material, bank characteristics, and channel width, depth and disturbance indicators. This information is used to determine reach type, disturbance and the relative value of the reach as fish habitat.
- Record whether the channel is dry, intermittent, obscured (e.g., due to sediment wedges), discontinuous or absent. This information can be used to determine whether the stream is perennial, ephemeral or (and) intermittent. More than one visit to a stream may be needed to determine whether it is seasonal. With the exceptions listed in Part 1, watercourses without a channel bed continuous for at least 100 m (and without evidence of either scour or alluvial deposition) are not Code streams. “Streams” noted on TRIM often have no visible channel, indicating incorrect mapping or subsurface flow.
 - Note the presence, amount and distribution of functional (structural) LWD in the channel. Large woody debris anchored in the channel or bank is the **stable** debris which is frequently associated with pools and fish habitat.
 - Note the streambed materials. This observation will reveal whether spawning gravels are present. Record the dominant and subdominant substrate classes among the following categories:
 - fines: clay, silt or sand (≤ 2.0 mm diameter)
 - gravel: > 2.0 to 64.0 mm
 - cobble: > 64 to 256 mm
 - boulder: > 256 mm
 - bedrock
 - Record the substrate D95 as an indicator of fish habitat quality. The D95 is the size of streambed material that is larger than 95% of the total substrate. Optionally, record the size of the largest movable particle to use in the channel morphology classification (*Channel Assessment Procedure Guidebook*).
 - Determine the reach type (one of seven types listed in the section “Stream reaches” in this guidebook; see the *Channel Assessment Procedure Guidebook* for methods).
 - Note the shape and texture of stream banks. This information provides evidence of erosion such as failing banks, complete loss of undercut banks, severe bank undercuts, or lateral channel movement.

3. **Channel disturbance indicators.** Note field indicators of channel disturbance related to banks, LWD, sedimentation and morphology. Disturbance indicators are field indicators of:
- streambed degradation (excessive scour) and aggradation (e.g., major bars)
 - changes in sediment characteristics related to both supply (e.g., gully and hillslope failures) and transport limitations (e.g., debris jams)
 - evidence of bank erosion (e.g., collapsing banks or exposure of recently removed materials)
 - features of morphology primarily related to abundance of pools and steps or riffles
 - evidence for debris movement, the presence of debris torrents, and any indication of mass transport of streambed materials such as the occurrence of large bars in the channel. Channels disturbed by debris torrents often have > 80% of both banks eroded, large bars, and little LWD within the channel or oriented across the stream. Any LWD present generally occurs at the channel margins and is oriented lengthwise with the channel. The size of logjams also indicates the potential magnitude of stream flows.
 - the widths of stream reaches. This parameter, together with wetted width, indicates the magnitude of potential flows, whether sediment and woody debris in the channel is likely to be transported, and may show that the channel has been widened by a disturbance. Stream flow is an important consideration in determining whether impacts are probable downstream from harvest sites.

Wetted widths are useful because, combined with channel widths, the two measurements provide the proponent with a means to judge the range in discharge occurring in the stream in question. Therefore, the potential for the stream to transport sediment and debris can be estimated. This information is also useful for assessing concerns and constraints for any planned stream crossings. In relatively unconstrained channels, flood signs are useful indicators of the occurrence of seasonally wetted off-channel areas and other FSZs that may provide seasonal habitat and refuge for stream fish.

Channels disturbed by debris torrents frequently have a wetted width less than about 20% of the channel cross section. This observation can be used to identify disturbed channels when measuring width to determine stream-riparian class.

Wetted width is the width of the water surface measured at right angles to the direction of flow at the time of the survey. Widths of multiple channels are summed to obtain total wetted width. Water beneath undercut banks, protruding rocks, logs, stumps and small bars (< 0.5 m across) surrounded by water are included in wetted width measurements.

4. **Cover for fish.** Note whether cover is available for fish, especially juveniles. Cover may be in the form of LWD, spaces between large substrate materials, or overhanging banks associated with pools.
5. **Water conditions.** Record water clarity, temperature and flow stage (low, moderate or high). These observations will indicate the suitability of conditions for fish sampling. Low temperatures, turbid water and high flows reduce fish-sampling efficiencies.

Fish sampling procedures

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The following alternatives will satisfy the requirements for an acceptable fish inventory as legally referenced in paragraph (b)(i) of the fish stream definition:

1. **A Non-fish-bearing Status Report based on an assessment of 1:20 000 reconnaissance fish and fish habitat inventories available for the local area in question;**
2. **A fish inventory performed under protocols specified within a local area agreement; or**
3. **One of the two alternative methods detailed below in the subsection “Acceptable survey methods.” Either the *systematic-sample method* (Option 1) or the *first-fish-captured method* (Option 2) must be employed to demonstrate fish absence in reaches of < 20% gradient.**

Option 2, the first-fish-captured method, is the same procedure required and detailed in the first version of the *Fish-stream Identification Guidebook* (July 1995). All field surveys performed to this standard remain fully valid as acceptable fish inventories.

In this section, “Fish sampling procedures,” and particularly the subsections “Sampling techniques and gear” and “Survey timing,” critical information and guidelines are provided in support of the mandatory field procedures detailed in “Acceptable survey methods.” It is strongly recommended that these guidelines be seriously considered by the proponent that chooses to undertake field surveys to establish fish absence in streams.

Fish collection permits and the requirements discussed previously under “Qualifications and training” are also mandatory. RIC standard data forms, recording and data management are recommended but not mandatory for the purpose of fish-stream identification.

The following protocols should be followed in order to conduct an acceptable survey to confirm the absence of fish from stream reaches if the decision has been made to undertake a fish sampling program. Fish presence can be determined by a number of acceptable techniques that cover a range of efficiency and sampling intensity. The simplest technique might be sufficient to determine

presence. Fish presence is confirmed once an individual specimen of the appropriate species is properly identified. Sampling information and results are then recorded and kept on file.

Determination of the absence of fish from a body of water is much more difficult. While no fish may be captured at successively greater levels of sampling intensity, the ultimate “proof” of absence must be associated with the most intensive and efficient procedure appropriate for the species, life stage and time of year. For example, when sampling for quantitative purposes, baited traps are ideally set over 24 hours for juvenile fish, or two-trial electrofishing is performed. It is recognized that these levels of effort are sometimes difficult to achieve.

In order to establish absence acceptably, a reasonable balance between sampling effort and risk of error must be achieved to produce satisfactory results consistent with the intent of this guidebook.

Sampling effort must include a significant portion of the stream reach and be applied in the seasons appropriate for the geographical area and habitat types present (main channel, off-channel, seasonal). The proper equipment must be used under appropriate environmental conditions. For example, electrofishing will be much less effective in cold water (i.e., < 5°C) or where electrical conductivity is low.

It is recommended that sampling be done in a systematic and repeatable way so that results can be accepted with confidence. This guidebook presents a series of sampling techniques and gear types that generally reflect intensity levels. The intent of this guidebook is *not* to identify electrofishing as the only acceptable and final “technique of choice,” although this gear type has become singularly advocated to determine fish presence or absence for fish-stream identification. Biologists and technicians conducting fish surveys must be aware that alternative techniques and gear are available, and in many cases may be more appropriate to the habitats, environmental conditions and species present.

Ultimately, an acceptable survey has been performed when there is, in total, sufficient evidence to support the conclusion that fish do not occur in a given stream reach. The evidence must include, ***in addition to fish capture results:***

1. any known information on fish presence upstream and downstream of the reach sampled
2. type and location of obstructions to fish migrations
3. sampling conditions including stream flow, temperature and conductivity
4. sampling methods and effort (include gear selection sample timing)
5. judgment of seasonal habitat availability
6. evaluation of seasonal fish use of stream and off-channel habitats.

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continued

Evidence that justifies the designation of a stream reach as non-fish bearing is reported in a **non-fish-bearing status report**. This brief summary may include results of any 1:20 000 reconnaissance fish and fish habitat inventory already conducted in the watershed. It is recommended that fish sampling results and methods used be recorded in the field on standard fish collection forms. Contractors that have the capability to enter the information into the FDIS database management system are encouraged to do so. These data standards will ensure data are captured and available for future uses including the review of the stream classifications.

Sampling techniques and gear

Several fish sampling techniques are available including: visual sightings of readily identifiable species, angling, pole seining, trapping and electrofishing.

Visual sightings are particularly useful for surveying adult salmonids during spawning periods. The seasonal timing of surveys is critical. For example, anadromous salmon spawn most frequently from mid-July (e.g., some interior sockeye stocks) to December (e.g., some coastal coho and chum stocks). Other salmonids such as steelhead trout have different populations that collectively spawn at times that include virtually the entire year. Consult with MELP regional offices and DFO divisional offices for normal salmonid migration times and spawning periods within the region of concern.

Visual surveys conducted while snorkeling can frequently be employed in both large and small streams to locate and identify adult and juvenile fishes. Use portable lights to inspect areas frequented by stream fish such as overhanging banks, tree-root masses and logjams.

Visual survey results are not appropriate to use as evidence of fish absence.

Apart from viewing fish, the simplest methods are angling and trapping. These methods employ light-weight equipment and have the advantages of being relatively cheap and safe.

Angling is straightforward and effective for older juvenile fish and larger specimens. It may not be effective for catching fry. A collapsible rod which can fit in a cruiser vest is convenient gear. An angling license is required for each person who uses this method. Again, angling surveys are not appropriate to use as evidence of fish absence.

Pole seines are most effective in relatively small, shallow and slow-moving streams with relatively few obstructions. This equipment is most frequently used for collecting juvenile fishes (e.g., salmonid fry, parr and smolts). Larger, fast-swimming fish are more difficult to catch. Seining is also ineffective and difficult where water is > 1.5 m deep, stream velocities exceed about 0.8 m/s, banks are

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continued

deeply undercut, and in areas with large amounts of small organic debris, tree root masses, and tree branches embedded in the stream substrate.

Pole seines about 3 m long and 1.5 m deep are frequently employed for sampling fish in streams. For most stream work, larger nets are difficult to transport and awkward to use. Because of their disadvantages, pole seines are usually used in combination with other techniques such as electrofishing.

Before seining, use a pair of barrier nets to enclose a habitat unit (e.g., a pool or riffle) to prevent fish from escaping the site. Employ two fishing trials per site. If no fish are captured in the first trial, a second trial might succeed. Fish are often easily caught in the second pass if the stream becomes cloudy and disorients the fish due to reduced visibility. Some fishes such as young coho salmon are attracted to suspended sediments because invertebrate prey is also stirred up from the stream bottom by the first seining effort.

Baited Gee-type traps (commonly known as minnow or fry traps) will not catch fish too large to enter the trap but will catch fry, parr, smolts and other juvenile fishes easily.

1. To use the trap, open it, put in some bait (e.g., salted fish roe or pierced cans of either shrimp or sardines), add a small rock for ballast, and close the trap.
2. Attach a long tether string and drop the trap into the stream. Make sure the trap is in water deep enough to be sufficiently submerged. Tie off the tether string so that the trap is secured to the stream bank, and mark the site with a piece of high-visibility flagging tape. Take care to select locations where trap recovery will be easy.
3. Gee traps work well in stream pools or in the quieter water downstream of boulders or debris, but tend to roll around too much if placed in a fast current, and therefore, will not fish effectively. If possible, orient the trap lengthwise into the flow (the apertures will then be in line with the flow).

Gee traps should be set during daylight hours on one day and ideally left to fish overnight at minimum, preferably for 24 h. This requirement may be logistically difficult when crews are attempting to cover many reaches in the quickest possible time. However, try to set traps so that fishing occurs during a period including either dawn or dusk. Fish are usually the most active at these times. In most cases, fish are caught within a few hours after the traps have been set.

If this method is employed, sufficient traps should be obtained to cover a significant part of a stream reach. Trap number and spacing will depend upon professional judgment. As a guide, try to achieve a trapping density of at least one trap per 10 lineal metres of stream, or place traps in the following key sites,

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continued

especially when the features occur within high-gradient reaches containing fast-flowing water and stepped pools. These features represent prime habitats for stream fishes:

- main channel pools, especially those on the downstream edge of large boulders or those downstream of stable, large woody debris
- off-channel pools near woody debris or overhanging banks
- logjam pools
- undercut banks
- riffle-pool junctions, especially under the cover of banks.

Observe the pools for awhile to see if there are larger fish present that are too big to enter the traps. Also check the stream margins for the presence of small fry because these sites are too shallow to be fished effectively with Gee traps.

Be sure to make every reasonable effort to recover all traps because they will continue to catch fish if they are not taken out of the stream. If any trap cannot be recovered, the trap location and reasons why recovery was not possible should be reported.

Electrofishing is a relatively complex procedure that requires training and technical certification to high standards by the Workers' Compensation Board. This procedure is not discussed in detail here. (See the RIC inventory manual *Fish Collection Methods and Standards*, Version 4.0 noted in "References for fish-stream identification" in this guidebook.) The same key habitats discussed under fish trapping should be covered when electrofishing is undertaken. Electrofishing is advantageous because entire stream reaches can usually be covered relatively quickly within one day. Unlike trapping, no overnight or sampling is required.

Use a small barrier net when electrofishing in streams, especially fast-flowing ones. Place the net just downstream of the riffle or pool being sampled so that any shocked fish collect against the net. In some steep stream reaches, shocked fish may be difficult to detect at the site where the probe is used because of turbulent water.

The effectiveness of electrofishing varies not only with environmental conditions and the species and size of fish, but also with the voltage, electric pulse frequency, and the experience of the electrofishing operator. If a single fishing trial fails to capture any fish, consider adjusting the frequency or voltage settings for a second trial.

Survey timing

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continued

Fisheries resource agencies usually sample for fish during mid-summer periods of low flows (July–August). This period is also recommended for surveys of fish presence or absence because (a) low flows may concentrate fish in stream pools at this time, and (b) juveniles of most species will be present in streams, lakes and wetlands. Exceptions in coastal streams include the fry of pink and chum salmon. These fry migrate downstream almost immediately after they emerge from the stream gravels in spring. However, both pink and chum occur most frequently in relatively low gradient reaches where the probability of anadromous and game fish presence is very high. In interior streams, Arctic grayling may spawn and inhabit ephemeral streams in spring and early summer. However, adults and juveniles may leave these sites during summer periods of low flows.

If seasonally flooded channels, wetlands, and other off-channel sites are to be confirmed for fish absence, an additional survey will be required (a) for the fall or spring in interior watersheds when water bodies are free of ice but contain seasonally elevated volumes, and (b) in the fall or winter in coastal drainages. Channels that are dry during summer, but flooded at these other times of the year, are potential fish habitats if the adjacent main channel contains fish. These sites must be checked at the times noted here for extent and duration of flooding, fish access and fish presence or absence.

Acceptable survey methods

The two alternative procedures detailed below will satisfy the requirements for an acceptable fish inventory as legally referenced in paragraph (b)(i) of the fish stream definition.

For sampling stream reaches and off-channel sites to determine fish presence or absence, it is recommended that sampling be done in a systematic and repeatable manner. Be sure to cover the best of the available habitat within a stream reach. Studies have shown that to establish the presence of certain species such as bull trout in some high-gradient, high-elevation reaches, as much as 1.2 km of stream coverage is necessary. Because of this pattern of distribution, the recommended sampling method for fish-stream identification had required the coverage of as much as 500 m to 1 km of stream to confirm the absence of species such as bull trout. This procedure, which involves fishing until the first “Code fish” caught is retained, is one of two alternate survey methods recommended for fish-stream identification.

To reduce the costs and simplify the logistics associated with the “**first-fish-captured**” method, an alternative “**systematic-sample method**” is recommended that involves sampling the entire length of a representative portion of a stream reach. This portion surveyed will be 100 m long or have a length equivalent to 10 bankfull channel widths (whichever is greater). The entire length

of the selected segment does not have to be sampled if fish are captured in abundance, even within the first few metres of coverage (see below).

The systematic-sample method offers important advantages. First, the total length of stream that needs to be covered within each survey will be substantially reduced in most cases. For example, the results of a single-trial systematic survey performed competently in the sample site will be acceptable if:

1. the sample site selected represents the available habitat in the reach
2. the site is sampled thoroughly at the right time of year by using gear suitable for the season, habitat, species and life stage
3. observations on habitat quality and accessibility to fish support the fish survey results.

Second, the results of the systematic survey generate useful data on the **probabilities** of fish presence or absence in streams of given size, gradient and location within a watershed. These data can be added to the base of knowledge from reconnaissance fish and fish habitat inventories. Systematic-survey results are even more important in areas where no reconnaissance inventories are available. Information accumulated from systematic surveys can be used to predict the likelihood of fish presence in similar streams in unsurveyed areas of a watershed. These data are thus the foundation of future local-area agreements.

Regardless of the method adopted, the first step is to determine the likelihood of fish presence from a review of the existing knowledge on fish distribution for the specific areas affected by forestry activities. If no information is available, then fish surveys must be conducted in reaches < 20% gradient to confirm fish absence.

When known information is reviewed, look for information on the potential occurrence of bull trout or other very rare (i.e., low density) fish for the sites that will be sampled. Fish are more difficult to detect if they are at very low population densities. If the data review suggests this is probable, a more rigorous sampling intensity is justified (see step 5 in the systematic method below).

One of the two sequences detailed below may be employed in the season most appropriate for fish presence considering the type of available habitat, species and life stage.

Option 1: Systematic-sample method

1. The first site recommended to be sampled is a representative length within the uppermost reach included in the affected area (cutblock or proposed road location). Fish distributions downstream of the reach, taking barriers and other features into account, can be assumed from the results of this survey.

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2. The length of the selected site will be equal to 10 bankfull channel widths, or 100 lineal metres (whichever is greater). The entire length of the site is sampled for fish. Sampling must systematically cover all available habitat types and employ techniques appropriate to the anticipated species and habitats present. Use the technique most appropriate for the season and physical conditions.

If no fish are caught in the first trial, but there are doubts about sampling efficiency, sample again with a second method. Sampling methods and results are recorded on the standard fish collection forms.

If electrofishing is employed and fish are caught in abundance, even within the first few metres of coverage, stop sampling. For example, if 10 to 20 specimens are captured within the first 5 to 10 metres, the reach clearly supports fish in abundance.

3. If no fish are captured in the initial sample site, the biologist or field technician must make a professional judgment as to whether and how much further fish sampling should be conducted.

If sampling at a different time of year is warranted due to water temperatures that are too low, or ephemeral habitats that are accessible to fish are present but dry, sampling should be terminated in favor of a follow-up survey at a more appropriate time.

4. Sampling is finished when the surveyor is confident that there is enough evidence to support the conclusion that no fish inhabit the reach. If the evidence to support fish absence is insufficient, then further sampling is required.
5. If no fish are found in the initial sample site, but habitat quality appears good and no barriers to fish access are evident, a second site of a length equal to the first site must be sampled within the same reach, again covering all habitat types. The most appropriate sampling method shall be employed. Sampling methods and results are recorded on the standard fish collection forms.
6. In cases where it has been previously determined that populations of fish occur in the area at very low densities, and if no fish have been captured in the initial sampling site, additional sampling is recommended. Consult with the local MELP representative prior to initiating surveys. It is expected that these situations will be relatively uncommon; however, sampling the remainder of the reach might be recommended for reaches < 500 m long. Sampling methods and results are recorded on the standard fish collection forms.
7. Evidence for justification of a non-fish bearing stream reach is reported as a "non-fish-bearing status report." An example of this report is provided in this guidebook. This may include results of any 1:20 000 reconnaissance fish and fish habitat inventory previously conducted in the watershed.

Option 2: First-fish-captured method

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(continued)

1. To sample for fish, begin at the downstream end of the reach and proceed sequentially upstream until a fish is caught and identified as one of the species of concern.
2. If no fish are caught, continue upstream and cover the entire length of reaches up to 500 m long. For reaches 1 km long or longer, surveys focused on the deepest pools and other key habitats noted above are recommended for an additional 500 m. Be sure to cover the available habitat. Studies have shown that to establish the presence of bull trout in some high-gradient, high-elevation reaches, as much as 1.2 km of stream coverage is necessary. In order to establish absence, sampling according to the procedures of this guidebook must be thorough enough to produce reliable results that minimize the likelihood of error.
3. Document sampling methods and results on the recommended fish collection form.
4. Evidence for justification of a non-fish bearing stream reach is reported as a “non-fish-bearing status report.”

Recommendations for maps and data records

Information to provide or retain for site-level plans such as the silviculture prescription include a plan map, any office or field data records, and a non-fish-bearing status report. To ensure that collected data are reported in a consistent fashion, standards sanctioned by RIC are recommended. A standard data format allows those responsible for reviewing information and approving fish-stream identifications to determine whether areas sampled, techniques employed, and environmental conditions during the surveys were adequate. The information must be retrievable and accessible to other users. RIC standards include data collection forms with an electronic data entry system (FDIS) and standard mapping symbols.

Maps

A plan map must be completed for site-level plans such as the silviculture prescription. **Present all pertinent information on the plan map.** This map must include verified existing information already shown on the forest development plan and new information on stream-riparian classes obtained from the stream channel and fish surveys.

Identify all stream reaches and riparian classes on the plan map on the basis of existing and new field fish distribution, habitat inventory and gradient information.

Information recommended for the plan map includes a reach summary symbol, presenting known fish presence, channel width, gradients and stream riparian class,

and known fish distribution limits and barriers to fish migration (see illustration in Appendix 2).

It is suggested that all fish streams are **labeled or shown in red** on the plan map submitted. Use a solid red line for streams where the fish-bearing designation is applied as the result of field survey information. Use a dashed red line for reaches identified as fish streams by using gradient criteria alone. Classify these fish streams as either S1, S2, S3 or S4 on the basis of width.

Streams without fish will simply appear in blue on plan maps. In the interests of provincial inventories, label those streams or stream reaches where fish absence was determined by field surveys. Classify streams without fish as either S5 or S6 on the basis of width.

It is recommended that mapping be compatible with the RIC manual *Standards for Fish and Fish Habitat Maps* (RIC 1998). A map example is provided in Appendix 2.

Data records

Supporting data records in the reconnaissance format should include any office or field information on stream reach boundaries and locations, reach (site) descriptions, and fish sampling locations, methods and results. Standard (RIC) data forms and electronic data files are recommended. The locations of all fish sampling sites and other observations should be linked to data records by map (and site) number.

Non-fish-bearing status report

All stream reaches for which non-fish-bearing status is proposed require a short, concise, written justification for this designation. This non-fish-bearing status report contains information that, in the professional opinion of the person responsible for the survey, provides sufficient evidence to support the conclusion that fish do not occur in the stream reach in question. Information that should be provided includes:

1. date and time of sampling events, including initial and any follow-up sampling efforts;
2. fish sampling methods and effort employed:
 - capture methods used (e.g., electrofisher; Gee traps; use of barrier nets at either downstream limit, upstream limit, or at both ends of the sampled site)
 - sampling area covered (number, length and area of sample site)
 - sampling effort (e.g., number of traps, electrofishing seconds)

3. stream conditions during sampling (e.g., specific conductance; flow stage of high, medium or low; temperature; turbidity)
4. supporting evidence:
 - known fish species presence both upstream and downstream
 - type and location of obstructions to fish migrations
 - seasonal habitat availability
 - seasonal fish use of stream and off-channel habitats
 - results of any 1:20 000 reconnaissance fish and fish habitat inventory conducted in the watershed
 - application of any local-area agreements.

Approach for review of non-fish bearing reaches

A summary flowchart and checklist for fish-stream identification is included in Appendix 4. Review of non-fish-bearing reports can be performed to determine whether acceptable fish-survey methods have been employed and that appropriate, justifiable conclusions have been made.

1. Focus review at points of transition between reaches identified as fish-bearing (S1 to S4) to those proposed for non-fish-bearing status (S5 or S6). These transitions might be shown as change in color coding from red lined to blue lined on plan maps.
2. A rationale must be supplied by the proponent to explain why the stream becomes non-fish bearing; e.g., known barriers, apparent natural barriers (falls, cascades) surveyed on either side for fish, gradients over 20%, or insufficient water. **An artificial barrier (e.g., culvert) is not sufficient justification for a stream reach to be designated as non-fish bearing.**
3. If a reach is classified as S5 or S6 and has a gradient lower than 20%, check to see if fish sampling was performed with appropriate methods and effort, and that sampling conditions were favorable for determining fish presence. Check the provided information to determine whether all of the following criteria have been satisfied for non-fish designations:

Sample-site length

1. If the systematic-sampling method was chosen, was a **minimum of 100 m** length of stream sampled in the apparent non-fish section? If the reach length is less than 100 m, the sampling distance should equal the reach length.
2. If the non-fish bearing rationale does not include other corroborative evidence (e.g., barrier to fish migration or significant habitat constraint), then further sampling should have been undertaken if adequate and accessible habitat was apparent.
3. If low-density species are known to inhabit the area and no fish were found in the initial 100 m systematic sample, was a further 100 m sampled, possibly followed

by a further 500 m of effort, depending on the weight of corroborative evidence supporting non-fish status? Was an equivalent amount of stream covered if the first-fish captured method was employed?

Sample methods and effort

1. Were fish sampling methods applied appropriate to determine absence (e.g., electrofishing, or Gee traps set in adequate numbers for sufficient durations of time)?
2. Should a second method of fish sampling been used and was a second method used as appropriate?

Sampling times and environmental conditions

1. Was sampling done at an appropriate time (or times) of the year? Was additional sampling at a more appropriate time of year done?
2. Were flow conditions appropriate (not a high flow stage and not dry)?
3. If electrofishing, was used:
 - was water conductivity above 30 μ s?
 - was water temperature above 4°C?

References for fish-stream identification

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- Resources Inventory Committee. 1994. Field key to the freshwater fishes of British Columbia. Compiled by J.D. McPhail and R. Carveth.
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- Resources Inventory Committee. 1998. Reconnaissance (1:20 000) fish and fish habitat inventory: Standards and procedures.
- Resources Inventory Committee. 1998. Standards for fish and fish habitat maps: Data forms and user notes. Version 2.0.
- Resources Inventory Committee. 1997. Fish collection methods and standards. Version 4.0.

Appendix 1. Acquiring existing data

Sources of FISS information

Fisheries information has been compiled into the Fisheries Information Summary System (FISS). This dataset contains information previously available in the Stream Information Summary System (SISS) catalogues, and any regional information available when the catalogue was compiled. Some information may have been missed in the initial compilation, and recent projects may not have been captured. Some of these may include:

- results of an interior or coastal watershed assessment procedure (IWAP, CWAP), and/or the results of any fish habitat assessment procedures (FHAPs)
- other government agencies (e.g., DFO), and specialist reports and studies
- fish-stream and riparian area classification maps done by forest companies.

FISS information is available from sources listed below.

Ministry of Fisheries

General or specific questions regarding the nature and/or content of FISS data, geographic status reports, or information about references may be directed to:

FISS Data Manager
Fisheries Inventory Section
Planning and Information Branch
BC Fisheries
780 Blanshard Street
Victoria, BC V8N 9M2
phone: (250) 356-9938; fax: (250) 356-1202
email: GOLIPHAN@FWHDEPT.ENV.GOV.BC.CA

If a request is large in scope, the agency prefers to receive details of the request by fax or email. Requests for photocopies of the original dataforms, lists of references, or copies of the actual reports should be made at this location. Copies of the *FISS: Data Compilation and Mapping Procedures Manual* may also be obtained here.

Information regarding watershed codes, RAB (Resource Analysis Branch – ‘Old Watershed Codes’), which are associated with FISS information, can be found on the BC Fisheries home page at: <<http://www.fisheries.gov.bc.ca>>.

Department of Fisheries and Oceans

FISS data are available through the DFO home page at:
<<http://habitat.pac.dfo.ca/heb/fhiip/>>.

Inquiries about the development of and access to the DFO home page should be directed to:

Brad Mason
Department of Fisheries and Oceans
Habitat Management Division
327 – 555 West Hastings Street
Vancouver, BC V6B 5G3
phone: (604) 666-7015; fax: (604) 666-7907
email: MASONB@MAILHOST.PAC.DFO.CA

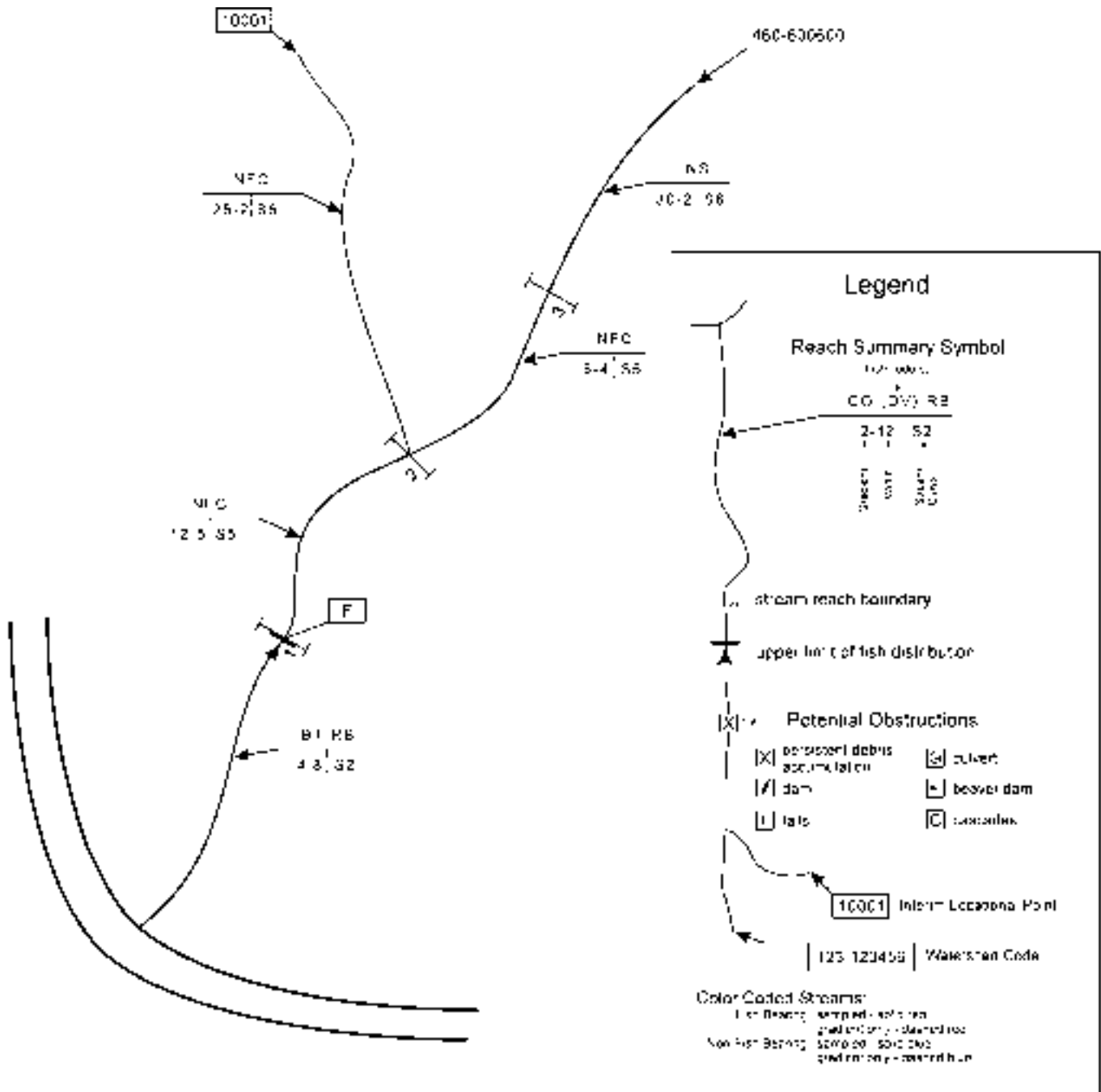
Hard copies of FISS maps

Hard copies of FISS maps are available at a cost from:

Archetype Print
459 – 409 Granville Street
Vancouver, BC V6C 1T2
phone: (604) 602-0282; fax: (604) 602-0283

Please note that Archetype Print is not responsible for map content. Queries about content should be directed to the BC Fisheries or DFO contacts listed above.

Appendix 2. Example map for presentation of data for forest development plans and silviculture prescriptions



Recommended symbology for streams showing the watershed code, interim locational point, stream reach boundaries, obstructions, fish distribution limits, fish bearing status and reach summary symbols including stream-riparian class designations. Additional information is available in *Standards for Fish and Fish Habitat Maps* (RIC, May 1998).

Fish collection form – front

FISH COLLECTION FORM																	
GAZETTED NAME										RIVER		LAKE		STREAM		WETLAND	
WATERBODY CODE																	
WATERBODY ID						UP WAD#				LP#		SITE LAKE/STREAM ATTACHED		Y N			
PROJECT ID						REASON#				FISHFORM TYPE							
DATE				TO		AGENCY				CREW		... DE SAMPLE					
SITE / METHOD	SITE #	MID NAME		MID #	SITE LTR				MID / NO	STREAM CONDITION		COMMENTS					
FISH SUMMARY	SITE #	MID #	U/P	SPECIES	SIZE	AGE	HTG #	MR L/MSL	MED HURSH	TOP AFI	COMMENTS						

Fish collection form – back

NET / TRAP SPECIFICATIONS														
TRAP SPECIFICATIONS	T	SITE #	MID #	FAU.	DATE IN	TIME IN	DATE OUT	TIME OUT	NETTYPE	LENGTH	DEPTH	MESH SIZE	SEE	FAB
ELECTRONIC SPECIFICATIONS	SITE #	MID #	PASS	TIME IN	TIME OUT	CYCLE	LENGTH	WIDTH	EYE	VOLTAGE	PWR	PULSE	MAKE	MODEL
COMMENTS														

CRC
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Appendix 4. Flowchart and checklist for fish-stream identification

